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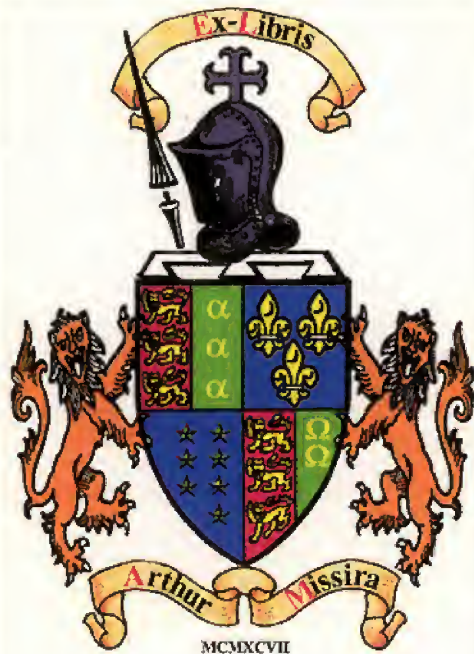
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POWER TRANSISTOR

POWER
TRANSISTOR
SEMICONDUCTOR DATA BOOK

SEMICONDUCTOR
DATA BOOK

TOSHIBA CORPORATION



MCMXCVII

**POWER
TRANSISTOR
SEMICONDUCTOR DATA BOOK**

IMPORTANT NOTICES

The circuit examples illustrated herein are presented only as a guide for the performances or the applications of our products.

Keep in mind that no responsibility is assumed by TOSHIBA for its use, nor for any infringements of patents or other rights of the third parties which may result from its use, and that no license is granted by implication or otherwise under any patent or patent rights of TOSHIBA.

INTRODUCTION

We would like to express our heartfelt thanks for your use of TOSHIBA semiconductor devices.

In recent years, the electronics industry has attained rapid technological advancements. Especially, semiconductor products now play a leading role in the electronic industry, expediting the electronization of all kinds of equipments for both industrial and consumer field. This has been a decisive factor in energy saving and rationalization in an age of low economic growth and has contributed greatly to the innovation of industry and to raising living standards.

In particular, transistors with flexible and extensive applications are expected to make greater strides in the future, being applied in a wider range of use as the pivot of active elements.

TOSHIBA intends to devote itself to enriching and developing products in this field and to producing excellent product groups with both high capacity and high reliability.

This volume comprises detailed technical data for power transistors among our numerous transistor and diode groups. Please use it in combination with the volume on small signal transistors.

We look forward to your continued patronage.

March 1983.

TOSHIBA CORPORATION
SEMICONDUCTOR GROUP
Tsuyoshi Kawanishi
Group Executive



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2SD685	690	2SD1052	782	2SD1409	880
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2SD687	696	2SD1069	788	2SD1411	884
2SD688	699	2SD1087	792	2SD1412	887
2SD689	700	2SD1088	795	2SD1425	890
2SD698	701	2SD1090	797	2SD1426	893
2SD700	704	2SD1092	800	2SD1427	896
2SD716	707	2SD1148	806	2SD1428	899
2SD717	709	2SD1160	808	2SD1429	902
2SD718	712	2SD1165A	811	2SD1430	903
2SD777	714	2SD1166	814	2SD1431	904
2SD797	720	2SD1187	817	2SD1432	905
2SD798	723	2SD1208	820	2SD1433	906
2SD799	726	2SD1220	825	2SD1438	907
2SD811	729	2SD1221	828	2SD1460	909
2SD818	732	2SD1222	830	2SJ115	913
2SD819	734	2SD1223	833	2SK324	919
2SD820	736	2SD1224	836	2SK325	922
2SD821	737	2SD1279	839	2SK355	925

**POWER
TRANSISTORS
SELECTION GUIDE**

Selection Guide

Transistors (Consumer Use)

General-Purpose High Frequency Transistors (Classification Table)

Uses Frequency (MHz)	Application	Small Signal		Large Signal
		Amplification	Oscillation	
0.55	TV AGC synchronization	2SC1815, 2SA1015, 2SC2458, 2SA1048	2SC1815 2SC2458 2SC380TM 2SC2669	
	BC Band Radio	2SC1815, 2SC2458, 2SC380TM, 2SC2669 2SC941TM, 2SC2670		
1.0	TV Video amplification	2SC1959, 2SC1815, 2SC2458		2SC2229, 2SC2068, 2SC1569, 2SC2482, 2SC2333, 2SC3334, 2SC3335, 2SA1320, 2SA1321, 2SA1322, S1298, S2057/A, S2058/A BF422, BF423, BF457 BF458, BF459, BF469 BF470, BF471, BF472
2.0				
3.0	TV SIF		2SC380TM 2SC2669 2SC2995	
	Short Wave Radio	2SC380TM, 2SC2669, 2SC2995		
10	FM IF	2SC380TM, 2SC2669, 2SC2995		
20	AM, SSB Transceiver	2SC2668, 2SC2669 2SC2995, 2SC1923, 2SC380TM, 3SK59, 3SK73, 3SK101 2SK161 2SK241, 2SK192A	2SC2995 2SC380TM 2SC2669	2SC1678, 2SC2098 2SC1036, 2SC2075

Frequency (MHz)	Uses	Application	Small Signal		Large Signal
			Amplification	Oscillation	
30		TV PIF (Europe) TV PIF (USA)	2SC3125		
		Transceiver	2SC2215, 2SC2216, 2SC2717		
50		TV PIF (Japan)	2SC382TM (1st), 2SC383TM (3rd), 2SC388ATM (3rd), 2SC1923, 2SC2668, 2SC2995	2SC1923 2SC2668 2SC2995	
		FM	2SK161, 2SK192A 3SK59, 3SK73, 3SK101, 2SK241, 3SK114		
100			3SK101, 3SK114		2SC994
200		VHF TV	2SC2805, 2SC2806, 2SC3122, 2SC2347, 2SC2348, 2SC3123, 2SC3136, 2SC3172 3SK63	2SC2806 2SC2349 2SC3124	2SC1199 2SC1164, 2SC2318, (CATV)
300					
500		UHF TV	2SC2498, 2SC2499, 2SC2644, 2SC3098, 2SC3099, 2SC2804, 2SC2805, 2SC3137, 2SC3119, 2SC3120, 2SC3121, 3SK115, 3SK102, 3SK121,	2SC3120 2SC3121 2SC3137 2SC2805 2SC2347	2SC1164, 2SC1199, 2SC2318, 2SC2319 (CATV)
1000					
			2SC2753, 2SC3011, 2SA1245 2SC2876, 2SC3268, 2SC3301, 2SC3302		
5000					

General Purpose Low Frequency Transistors (Classification Table)

Classification	Collector Dissipation P _c	Silicon Transistor					
		V _{CE0} (V _{CER})					
		~50V	50V~79V	80V~99V	100V~120V	121V~400V	1000V~
Low Power Low Noise	<500mW	2SC2878 2SK146 2SJ73 2SK147 2SK170 2SJ74 2SK147 2SJ72 2SK270 2SJ90 (TBC547~550) (TBC557~560)	2SK30ATM 2SK246 2SK117 2SK118 2SK184 (2SA1015 2SC1815 2SC732TM 2SC2458 2SA1048 (TBC546 TBC556	(2SC2868 2SA1158	(2SC2240 2SA970		
		2SC1959 2SA562TM 2SC2710 2SA1150 (TBC327/8 TBC337/8	(2SC1815 2SA1015 2SC2458 2SA1048		(2SC2240 2SA970 2SC2459 2SA1049		
Medium Power Output	0.51~1W	(2SC2120 2SA950 2SC2703 2SC2500 2SA1160 2SC2236 2SA966 2SC496 2SA496 BD135 BD136	(2SC2655 2SA1020 2SC495 2SA505 2SC2794 BD137 BD138	(2SC1627 2SA817 2SC1627A 2SA817A BD139 BD140	(2SC2235 2SA965	(2SC2229* 2SA949 2SC2230* 2SC2230A* 2SC2482* 2SC2383* 2SA1013* 2SC2705 2SA1145	
	1.1~10W (T _c =25°C)	(2SA2877 2SA1217 2SC2270 2SA1120 2SC1173 2SA473		(2SA1626 2SA816 S1375 S1376		(2SC2704 2SA1144 2SC2068* S1377*	

*: TV use (: Complementary pair * Ask separately.

Classifi- cation	Collector Dissipation PC	Silicon Transistor					
		V _{CE0} (V _{CER})					
		~50V	50V~79V	80V~99V	100V~120V	121V~400V	1000V~
	11~30W (T _c =25°C)	(BD233 BD234)	(2SC2562 2SA1012 2SC790 2SA490 2SD880 2SB834 (60V) 2SD1052 2SD1052A BD235 BD236)	(2SD526 2SB596 BD237 BD238)	(2SC2824 2SA1184 2SC1625 2SA815)	2SC1569* 2SC2231* 2SC2231A* 2SC1624 2SA814 2SC2073* 2SA940 2SC2233* 2SC2456* 2SC2242* 2SC2238 2SA968 2SC2238A 2SA968A 2SC2238B 2SA968B 2SC2481* 2SA1021* 2SC2483* 2SA1195*	
High Power Output	31~60W (T _c =25°C)		(2SB553 2SD553 2SD754 2SD844)	(2SB753 2SD843 S1236 S1237)	(2SD525 2SB595 2SD716 2SB686 *2SC3180 2SA1263)	2SD1069* 2SD1090* 2SC1617* BU407D* BU326A*	2SD818* 2SD819* 2SD820* 2SD821* 2SD822* 2SD811* 2SD868* 2SD869* 2SD870* 2SD871* 2SD1279* BU205* BU208* BU208A* BUY71* S2818* S2818A*
	61~200W (T _c =25°C)		2SD717 2SD1092* 2SD777* 2SD1294* 2SD1208*	2SD1187	*2SC3181 2SA1264 2SD718 2SB688 2SC2563 2SA1093 2SD1148 2SB863 *2SC3182 2SA1265	(2SD424 2SB554 2SD845 2SB755 2SC2564 2SA1094 2SC2565 2SA1095 2SC2706 2SA1146 2SC1195* 2SC3182 2SA1265 2SC3280 2SA1301 *2SC3281 2SA1302	2SD1425* 2SD1426* 2SD1427* 2SD1428* 2SD1429* 2SD1430* 2SD1431* 2SD1432* 2SD1433* 2SD1434*

*: TV use (: Complementary pair * Ask separately

Transistors For Audio Equipment

AM/FM Tuner

Package		TO-92	Mini	Super Mini	TO-72	H-SSTM	μ -X	DO-35
Uses								
FM	RF	2SC1923	2SC2668 2SK161 2SK192A 2SK241	2SC2714 2SK211 2SK210 2SK302	3SK59	3SK73	3SK101 3SK114	
	MIX	2SC1923	2SC2668	2SC2714	3SK59	3SK73	3SK101 3SK114	
	LO	2SC1923	2SC2668 2SC2995	2SC2714 2SC2996				
	IF	2SC380TM	2SC2669	2SC2715				
	AFC							IS2236*
AM	RF	2SC941TM	2SC2670	2SC2716				
	CONV & IF	2SC1815 2SC380TM 2SC941TM	2SC2458 2SC2669 2SC2670 2SC2995	2SC2712 2SC2715 2SC2716 2SC2996				
AM Tuning			ISV100* ISV102* ISV149*					
FM Tuning			ISV101* ISV103* ISV147*					
FM AGC		ISV99*		ISV128*				

*Diode

Low Frequency Small Signal Amplification

Application	Package					
	TO-92		Mini		Super Mini	
General purpose	2SC1815	2SA1015	2SC2458	2SA1048	2SC2712	2SA1162
	2SC2868	2SA1158	2SC2459	2SA1049	2SC2713	2SA1163
General purpose (Low Noise)	2SC1815⓪	2SA1015⓪	2SC2458⓪	2SA1048⓪	2SC3323	2SA1311
	2SC732 TM					
E.Q Amp Diff.	2SC2240	2SA970	2SC2459	2SA1049	2SC3324	2SA1312
Main Amp Diff.	2SC2240	2SA970			2SC3324	2SA1312
Low Frequency Amplifier	2SC2120	2SA950	2SC2710	2SA1150	2SC3265	2SA1298
	2SC1959	2SA562TM			2SC2859	2SA1182
Impeadance Converter	2SK246	2SJ103	2SK330	2SJ105	2SK208	2SJ106
	2SK30ATM		2SK118		2SK208	
Low Noise Audio Amplifier	2SK117		2SK184		2SK209	
Muting	2SC2878		2SC3327		2SC3326	

Application	Single Type		Dual Type	
	N-ch	P-ch	N-ch	P-ch
E.Q.Amp Diff	2SK170	2SJ74	2SK240	2SJ75
	2SK147 2SK369	2SJ72 2SJ111	2SK146	2SJ73
			2SK270 2SK389	2SJ90 2SJ109
Main Amp Diff			2SK270 2SK389	2SJ109

Power Amplifier

HF Series

Po	Stage	Diff. Amp	Pre. Driver		Driver		Out Put	
			NPN	PNP	NPN	PNP	NPN	PNP
3W		—	—	—	2SC1959	—	2SC2236	2SA966
5W		—	—	—	2SC1959	—	2SC2877	2SA1217
20W		2SA1015	2SC1627	—	2SC1627	2SA817	2SD880	2SD834
25W		2SA1015	2SC1627	—	2SC1627	2SA817	2SD526	2SB596
35W		2SA1015	2SC2705	2SA1145	2SC1627A	2SA817A	2SD716 2SC3180	2SB686 2SA1263
50W		2SA970	2SC2705	2SA1145	2SC2235	2SA965	2SD718 2SC3181	2SB688 2SA1264
70W		2SA970	2SC2705	2SA1145	2SC2824	2SA1184	2SD1148 2SC3182	2SB863 2SA1265
80W		2SA970	2SC2705	2SA1145	2SC2824	2SA1184	2SD845 2SC3280	2SB755 2SA1301
100W		2SA970	2SC2705	2SA1145	2SC2238	2SA968	2SC3281	2SA1302
150W		2SA970	2SC2704	2SA1144	2SC2238	2SA968	2SD845×2 2SC3281×2	2SB755×2 2SA1302×2

SHF Series

50W	2SA970	2SC2705	2SA1145	2SC2824	2SA1184	2SC2563	2SA1093
70W	2SA970	2SC2705	2SA1145	2SC2238	2SA968	2SC2706	2SA1146
80W	2SK270	2SC2705	2SA1145	2SC2238	2SA968	2SC2564	2SA1094
100W	2SK270	2SC2704	2SA1144	2SC2238	2SA968	2SC2565	2SA1095
150W	2SK270	2SC2704	2SA1144	2SC2238A	2SA968A	2SC2564×2	2SA1094×2
200W	2SK270	2SC2704	2SA1144	2SC2238B	2SA968B	2SC2565×3	2SA1095×3
70W	2SK270	—	—	2SC2704	2SA1144	2SK405**	2SJ115**
120W	2SK270	—	—	2SC2704	2SA1144	2SK405×2**	2SJ115×2**

** : Power MOS FET.

Transistor For TV

Tuner

Package		TO-92	μ -X	Equivalent to TO-236	1-5G1A	DO-35	1-2G1A	1-2J1A
Uses								
UHF	RF		3SK100(MOS) 3SK121(GaAs) 3SK115(MOS) 2SC2304	2SC3119				
	MIX		2SC2805 2SC3137	2SC3121 2SC3120				
	OSC	2SC2347	2SC2805 2SC3137	2SC3121 2SC3120				
	Tuning				1SV123*			1SV153*
	AFC				1SV123*	1S2094*		1SV153*
VHF	RF	2SC2348	3SK101(MOS) 3SK114(MOS)	2SC3122				
	MIX	2SC3136	2SC3172 3SK101(MOS) 3SK114(MOS)	2SC3123				
	OSC	2SC2349	2SC2806	2SC3124				
	Tuning				1SV123* 1SV138* 1SV75*			1SV153*
	AFC				1SV123*	1S2094*		1SV153*
	Band SW					1S2186*	1S155*	

* : Diode

Video, Chroma-System

Stage	Color TV			B/W TV			Type
	L	M	S	L	M	S	
Driver	■	■	■				2SA562TM
	■	■	■	■	■	■	2SA1015
				■	■	■	2SC1815
Output	■	■		■			2SC2068/S1298 TBF869/TBF870 TBF871/TBF872
		■	■		■	■	2SC2482
		■	■		■	■	2SC2456 2SA1322/2SC3335
			■			■	2SC2229 2SA1321/2SC3334
	■	■	■				2SC3333/2SA1320 BF422/BF423

Vertical Deflection System

Stage	Color TV			B/W TV			Type
	L	M	S	L	M	S	
Oscillator				■	■	■	2SC1815
				■	■	■	2SA1015
Driver	■	■	■				2SC2229
				■	■	■	2SC1959
Output	■	■					2SC2073 / 2SA940 S1236 / S1237
		■	■	■	■		2SC2481 / 2SA1021
				■	■		2SD880 / 2SB834
				■	■		2SC1173 / 2SA473
					■		2SC496 / 2SA496
					■	■	2SC2236 / 2SA966

L : Large Size Screen
M : Middle Size Screen
S : Small Size Screen

PIF, SIF, AGC, Synchronous Separation,

Synchronous Amplifier

PIF			SIF	AGC	Synchronous Separation	Synchronous Amplification
1st	2nd	3rd				
2SC382TM	2SC382TM	2SC383TM	2SC380TM	2SC1815	2SC1815	2SC1815
2SC2215	2SC2215	2SC388ATM	2SC380ATM	2SA1015	2SA1015	2SA1015
		2SC2216				
		2SC2717				
		2SC3125				

Horizontal Deflection System

Stage	Color TV			B/W TV			Type
	L	M	S	L	M	S	
	Oscillator	■	■	■	■	■	
Driver	■	■	■				2SC2068, S1377
	■	■	■				2SC2456
	■	■	■				2SC2482
				■	■	■	2SC2229
				■	■	■	2SC1959
Output	■	■		■			2SD822, 2SD1279, 2SD1433
	■	■		■			2SD821, BU208A, 2SD1432, S2000A
	■	■		■			2SD820, BU208, 2SD1431, S2000
		■	■		■	■	2SD819, 2SD1430
		■	■		■	■	2SD818, BU205, 2SD1429, S2056
	■	■		■			2SD871 *, S2818A *, 2SD1428 *, S2055A
	■	■		■			2SD870 *, S2818 *, 2SD1427 *, S2055 *
		■	■		■	■	2SD869 *, 2SD1426 *
		■	■		■	■	2SD868 *, 2SD1425 *
			■	■			2SC1617, BUY71
				■	■		2SD1069 *, BU407D
				■	■	2SC2233	

* Built in Damper Diode

Power Supply

Uses		Color TV			B/W TV			Type	Remarks	
		L	M	S	L	M	S			
Series Regulator	Error Amplifier	■	■	■				2SC2229, S1854	high + B	
					■	■	■	2SC1815	Low + B	
					■	■	■	2SA1015	Low + B	
	Driver		■	■	■				2SC2229	high + B
						■	■	■	2SC1815	Low + B
						■	■	■	2SA1015	Low + B
	Output		■	■	■				2SD1208, 2SD777	high h_{FE}
				■	■				2SD1092	high h_{FE}
			■	■					2SC1195	
				■	■				2SD1090, 2SD1294	high h_{FE}
						■	■	■	2SD880 or 2SB834	
					■		■	■	2SD1052, 2SD1052A	high h_{FE}
Switching Regulator	Driver	■	■		■	■		2SC2655		
		■	■		■	■		2SC2703		
				■			■	2SC2236		
				■			■	2SC2120		
	Output	■	■		■	■		2SD822, 2SD1279 2SD1434		
			■	■	■	■	■	2SD811, 2SD841, BU326A		
		■						2SC2790, 2SC2790A	High Speed	

Package	Type	Application	Maximum Rating			
			V _{CE0} (V)	I _C (mA)	P _C (mW)	
TO-92	2SC2498	VHF ~ UHF	20	50	300	
	2SC2499	Low noise amplifier	20	30	300	
	2SC2753		12	70	300	
	2SC2644	VHF ~ UHF Wide-band amplifier	12	120	500	
μ -X	2SC2876	VHF ~ C band Low noise amplifier	7.5	80	200	
Equivalent to TO-236	2SA1245	VHF ~ UHF	- 8	-30	150	
	2SC3098	Low noise amplifier	20	50	150	
	2SC3099		20	30	150	
	2SC3011	UHF ~ C band Low noise amplifier	7	30	150	
Power Mini	2SC3268	VHF ~ UHF Low noise amplifier	12	70	800	
	2SC3301	VHF ~ C band Low noise amplifier	7.5	80	800	
Package	Type	Application	Electrical Characteristic(TYP)			
			f _T (GHz)	S ₂₁ , ²	NF(dB)	f _c (GHz)
TO-92	2SC2498	UHF ~ UHF	3.5	14.5	2.5	0.5
	2SC2499	Low noise amplifier	4.0	15.0	1.7	
	2SC2753		5.0	10.5	1.7	1.0
	2SC2644		4.0	14.5	2.3	0.5
μ -X	2SC2876	UHF ~ C band Low noise amplifier	7.0	10.5	2.3	1.0
Equivalent to TO-236	2SA1245	VHF ~ UHF	4.0	9.5	3.0	0.5
	2SC3088	Low noise amplifier	3.5	14.5	2.5	
	2SC3099		4.0	15.0	1.7	
	2SC3011	UHF ~ C band Low noise amplifier	6.5	9.0	2.3	1.0
Power Mini	2SC3268	VHF ~ UHF Low noise amplifier	5.0	9.5	2.0	1.0
	2SC3301	UHF ~ C band Low noise amplifier	7.0	9.0	2.3	

Chip Device For Hybrid IC (1)

Super Mini Transistor (Equivalent to TO-236)

Type	Application	Electrical Characteristic				Marking	Complementary	Similar Type TO-92 (mini transistor)	Remarks
		V _{CEO} (V)	I _C (mA)	P _C (mW)	T _J (°C)				
2SA1162	Low frequency amplifier	-50	-150	150	125	S	2CC2712	2SA1015 (2SA1048)	-
2SC2712	Low frequency amplifier	50	150	150	125	L	2SA1162	2SC1815 (SC2458)	-
2SA1163	Low frequency high voltage amplifier	-120	-100	150	125	C	2SC2713	2SA970 (2SA1049)	-
2SC2713	Low frequency high voltage amplifier	120	100	150	125	D	2SA1163	2SC2240 (2SC2459)	-
2SC2714	FM RF amplifier	30	20	150	125	Q	-	2SC1923 (2SC2668)	-
2SC2715	AM convertor, FM IF amplifier	30	50	150	125	R	-	2SC380TM (2SC2669)	-
2SC2716	AM RF amplifier	30	100	150	125	F	-	2SA941TM (2SC2670)	-
2SA1182	Low frequency amplifier	-30	-500	150	125	Z	2SC2859	2A562TM	-
2SC2859	Low frequency amplifier	30	500	150	125	W	2SA1182	2SC1959	-
2SC2532	LED driver	40	300	150	125	A	-	2SC982TM	-
2SC2996	FM RF amplifier	30	50	150	125	G	-	(2SC2995)	-
2SA1255	High voltage amplifier	-200	-50	150	125	O	2SC3138	-	-
2SC3138	High voltage amplifier	200	50	150	125	N	2SA1255	-	-
*2SC3011	UHF ~ C band low noise amplifier	7	30	150	125	MA	-	-	f _T =6.5GHz
*2SC3098	VHF ~ UHF band low noise amplifier	20	50	150	125	MB	-	2SC2498	f _T =3.5GHz
*2SC3099	VHF ~ UHF band low noise amplifier	20	30	150	125	MC	-	2SC2499	f _T =4GHz
*2SA1245	High speed switching	-8	-30	150	125	MD	-	-	f _T =4GHz
2SC3119	UHF-TV RF amplifier	20	20	150	125	HA	-	-	f _T =900 MHz
2SC3120	UHF-TV convertor	15	50	150	125	HB	-	-	f _T =2.4GHz
2SC3121	UHF-TV oscillator	15	50	150	125	HC	-	-	f _T =1.5GHz
2SC3122	VHF-TV RF amplifier	30	20	150	125	HD	-	2SC2348	f _T =400MHz
2SC3123	VHF-TV convertor	20	50	150	125	HE	-	2SC3136	f _T =900MHz, MIN
2SC3124	VHF-TV oscillator	15	50	150	125	HF	-	2SC2349	f _T =600MHz, MIN
2SC3125	TV PIF amplifier	25	50	150	125	HH	-	2SC388ATM	f _T =350MHz

*Microwave transistor

TOSHIBA CORPORATION

FET

Type	Application	Electrical characteristic (Ta = 25°C)					Marking	Similar Type	Remarks
		V _{DSX} ** V _{GD0} V _{GRD} * (V)	I _{G,Id} * (mA)	P ₀ (mW)	I _{loss} (mA)	Y _{fsl} (mS)			
2SK208	Low frequency amplifier	-50	10	100	0.3 ~ 6.5	1.2 MIN.	J	2SK30ATM	
2SK209	Low noise low frequency amplifier	-50	10	150	0.6 ~ 14	15	X	2SK117	
2SK210	FM RF amplifier	-18*	10	100	3.0 ~ 24	7 TYP.	Y	2SK192A	
2SK211	FM RF amplifier	-18*	10	100	1.0 ~ 10	9 TYP.	K	2SK161	
2SK302	VHF band amplifier	20**	30*	150	1.5 ~ 14	10 TYP.	T	2SK241	MOS type FET

Diode

Type	Application	Electrical Characteristic (Ta = 25°C)					Marking	Similar Type	
		V _R (V)	I _F (mA)	C _T (PE)	NF(dB)	R _s (Ω)			
ISS154	UHF ~ S band mixer detector	6	30	0.8	9 MAX.	-	BA	-	
ISV128	VHF ~ UHF band attenuator	50	50	0.25	-	7	BB	ISV99	
ISS181	High Speed Switching	80	100	4.0	-	-	A3	-	Cathode Common
ISS184	High Speed Switching	80	100	4.0	-	-	B3	-	Anode Common
ISS226	High Speed Switching	80	100	4.0	-	-	C3	-	Series Type

Chip Device For Hybrid IC (2)

Power Mini Transistor (Equivalent to SOT-89)

Type	Application	Electrical Characteristic (Ta = 25°C)					Marking	Complement-ary pair	Similar Type T092MOD (TO-92)	Remarks
		V _{CEO} (V)	I _C (A)	P _C (W)	P _C * (W)	T _J (°C)				
2SA1200	High voltage switching, audio pre-driver	-150	-0.05	0.5	0.8	150	B	2SC2880	2SA949	
2SC2880	High voltage switching, audio pre-driver	150	0.05	0.5	0.8	150	A	2SA1200	2SC2229	
2SA1201	Power amplifier, audio driver	-120	-0.8	0.5	1.0	150	D	2SC2881	2SA965	
2SC2881	Power amplifier, audio driver	120	0.8	0.5	1.0	150	C	2SA1201	2SC2235	
2SA1202	Power amplifier, audio driver	-80	-0.4	0.5	1.0	150	F	2SC2882	2SA817A	
2SC2882	Power amplifier, audio driver	80	0.4	0.5	1.0	150	E	2SA1202	2SC1627A	
2SA12-3	Power amplifier	-30	-1.5	0.5	1.0	150	H	2SC2883	2SA966	
2SC2883	Power amplifier	30	1.5	0.5	1.0	150	G	2SA1203	2SC2236	
2SA1204	Power amplifier	-30	-0.8	0.5	1.0	150	R	2SC2884	(2SA950)	
2SC2884	Power amplifier	30	0.8	0.5	1.0	150	P	2SA1204	(2SC2120)	
2SA1213	Power amplifier, switching	-50	-2.0	0.5	1.0	150	N	2SC2873	2SA1020	Low V _{CE(sat)}
2SC2873	Power amplifier, switching	50	2.0	0.5	1.0	150	M	2SA1213	2SC2655	Low V _{CE(sat)}
2SC2982	Strobo flash	10	2.0	0.5	1.0	150	S	-	2SC2500	
2SC3268	RF Low noise amplifier	10	0.07	0.3	0.8	125	ME	-	(2SC2753)	VHF ~ UHF
2SC3301	RF Low noise amplifier	7.5	0.08	0.3	0.8	125	MA	-	-	VHF ~ C Band

PC *Mounted on 250mm² x 0.8mm Ceramic board

Chip Device For Hybrid IC (3)

Power Mold Transistor

Type	Application	Electrical Characteristic (Ta = 25°C)					Complimentary Pair	Similar Type TO-126,220	Remarks
		V _{CEO} (V)	I _c (A)	P _c (W)	P _c * (W)	T _J (°C)			
2SA1225	Driver Power amplifier	-160	-1.5	1.0	10	150	2SC2983	2SA9688	
2SC2983	Driver Power amplifier	160	1.5	1.0	10	150	2SA1225	2SC2238	
2SA1241	Power amplifier	-50	-2.0	1.0	10	150	2SC3076	**2SA1020	
2SC3076	Power amplifier Strobo flash	50	2.0	1.0	10	150	2SA1241	**2SC2655	
2SA1242	Medium power amplifier	-20	-5.0	1.0	10	150	2SC3072	2SA1120	
2SC3072	Strobo flash Medium power amplifier	20	5.0	1.0	10	150	2SA1242	2SC2270	
2SA1243	Power amplifier	-30	-3.0	1.0	10	150	2SC3073	2SA473	
2SC3073	Power amplifier	30	3.0	1.0	10	150	2SA1243	2SC1173	
2SA1244	Large current switching	-50	-5.0	1.0	20	150	2SC3074	2SA1012	
2SC3074	Large current switching	50	5.0	1.0	20	150	2SA1244	2SC2562	
2SB905	TV vertical deflection output TV Sound output (B class)	-150	-1.5	1.0	10	150	2SD1220	2SA1021	
2SD1220	TV vertical deflection output TV Sound output (B class)	150	1.5	1.0	10	150	2SB905	2SC2481	
2SB906	Low frequency power amplifier	-60	-3.0	1.0	20	150	2SD1221	2SB834	
2SD1221	Low frequency power amplifier	60	3.0	1.0	20	150	2SB906	2SD880	
2SB907	Switching Power amplifier	-40	-3.0	1.0	15	150	2SD1222	2SB677	Darlington
2SD1222	Switching Power amplifier	0	3.0	1.0	15	150	2SB907	2SD687	Darlington
2SB908	Switching Power amplifier	-80	-4.0	1.0	15	150	2SD1223	2SB676	Darlington
2SD1223	Switching Power amplifier	80	4.0	1.0	15	150	2SB908	2SD686	Darlington
2SD1224	Power amplifier	30	1.5	1.0	10	150	-	2SD549	Darlington
2SD1160	Motor control	50 (V _{CEs})	2.0	1.0	10	150	-	-	
2SC3075	High voltage power amplifier	400	0.8	1.0	10	150	-	-	

PC* TC = 25°C **TO-92MOD

Transistors (Industrial Use)

Classification Table

Classification		Silicon Transistor (NPN)									
	Ic (Max.)	Pc (Max.)	Basic Product		High Frequency	High Speed	High Voltage	Low Noise	For Governmental Offices		
			Typical Product Description	Classification					NHK Standards	Remarks	
Small Power Transistor	~150mA	~400mW	2SC372 [Ⓒ] TM 2SC2551	2SC372 [Ⓒ] TM 2SC373 [Ⓒ] TM 2SC980 [Ⓒ] TM 2SC980A [Ⓒ] TM 2SC2551	2SC387A [Ⓒ] TM	2SC752 [Ⓒ] TM	2SC780A [Ⓒ] TM 2SC2551	2SC1000 [Ⓒ] TM			
	~100mA	~250mW	2SC400 2SC1380	2SC400 2SC979 2SC979A 2SC1380				2SC1380A	2SC587 [Ⓔ]		
	~500mA	~400mW	2SC367 [Ⓒ] TM 2SC982 [Ⓒ] TM 2SC2550	2SC366 [Ⓒ] TM 2SC367 [Ⓒ] TM 2SC982 [Ⓒ] TM 2SC2550		2SC395A				2SC595 [Ⓔ]	
Medium Power Transistor	100 ~300mA	~750mW	2SC594	2SC507 2SC594			2SC505 2SC506 2SC507			2SC594 [Ⓔ]	
	600 ~800mA	~800mW	2SC108A 2SC503 2SC509 [Ⓒ] TM	2SC108A 2SC109A 2SC503 2SC504 2SC509 [Ⓒ] TM		2SC108A 2SC109A	2SC505 2SC506			2SC560 [Ⓔ]	
	~2A	~800mW	2SC510 2SC2655	2SC510 2SC512 2SC2655 2SC3007							
High Power Transistor	1.5~5A	~50W (Tc=25°C)	2SD686 2SD687 2SC522 2SD688 2SD689 2SC2534 2SC2552	2SC522 2SC524 2SD877 2SD686 2SD687 2SD688 2SD689 2SC2562		2SC2534 2SC2552	2SC2534 2SC2552 2SC3148			2SC833 [Ⓔ] 2SC598 [Ⓔ]	
	~7A	~50W (Tc=25°C)	2SC2200 2SC2535 2SC519A 2SD523 2SD633 2SD553	2SC2200 2SC519A 2SC520A 2SC521A 2SD523 2SD633 2SD634 2SD635 2SD553 2SD843		1SC2535 2SC2553	2SC2200 2SC2913 2SC2535 2SC2553 2SD798 2SD799 2SD1088			2SD51 [Ⓔ] 2SD51A [Ⓔ]	
	~15A	~100W (Tc=25°C)	2SC1576 2SD524 2SC2790	2SD369 2SC1576 2SD524 2SC2139 2SD867 2SC2555 2SD717 2SD1087 2SD1187			2SC2555 2SC2650 2SC2139 2SC2914 2SC1576 2SD640 1SC2790 2SC2790A 2SC2791 2SC2792 2SC2793			2SD52 [Ⓔ] 2SD52A [Ⓔ] 2SD53 [Ⓔ] 2SD53A [Ⓔ]	

Classification			Silicon Transistor (NPN)							
Ic (Max.)	Pc (Max.)	Basic Product		High Frequency	High Speed	High Voltage	Low Noise	For Governmental Offices		
		Typical Product Description	Classification					NHK Standards	Remarks	
15 ~ 40A	~ 300W (Tc=25°C)	2SD552 2SD797 2SD873 2SD878	2SD552 2SD797 2SD1313 2SD1314 2SD842			2SD641 2SD642 2SD1313 2SD1314		2SD555(N)		
Field Effect Transistor (FET)	Junction	2SK15 2SK112 2SK113 3SK28	2SK11 2SK12 2SK15 2SK48 2SK112 2SK113	3SK28	2SK113 3SK28	2SK112 2SK113	2SK15 2SK48 2SK112 3SK28	2SK12(N)		
	(Dual)	2SK18 2SK72	2SK18 2SK72 2SK18A				2SK18 2SK18A 2SK72	2SK72(N)		
	MOS	3SK38A	3SK38A							
	π -MOS (Power MOS)	2SK324 2SK355 2SK357 2SK386 2SK387 2SK417 2SK419 2SK421	2SK324 2SK325 2SK355 2SK357 2SK358 2SK386 2SK388 2SK419 2SK421		2SK324 2SK355 2SK357 2SK385 2SK387 2SK417 2SK418 2SK420 2SK325 2SK356 2SK358 2SK386 2SK388 2SK419 2SK421					

Classification Table

Classification			Silicon Transistor (PNP)				
	IC (Max.)	PC (Max.)	Basic Product		High Withstand Voltage	Low Noise	NHK Standard
			Typical Product Description	Classification			NHK Standards
Small Power Transistor	~ 150mA	~ 400mW	2SA495 [Ⓒ] TM 2SA1091	2SA495 [Ⓒ] TM 2SA1091	2SA429 [Ⓒ] T 2SA1091	2SA493 [Ⓒ] TM	
	~ 100mA	~ 250mW	2SA500	2SA499 2SA500			2SA522 [Ⓔ] 2SA522A [Ⓔ]
	~ 500mA	~ 300mW	2SA476 [Ⓒ] TM 2SA1090	2SA476 [Ⓒ] TM 2SA1090			
Medium Power Transistor	100 ~ 300mA	~ 750W	2SA594	2SA594			
	600 ~ 800mA	~ 800mW	2SA503 2SA509 [Ⓒ] TM	2SA503 2SA504 2SA509 [Ⓒ] TM			
	~ 1.5A	~ 800mW	2SA510 2SA1020	2SA510 2SA512 2SA1020			
High Power Transistor	1.5 ~ 5A	8 ~ 30W (T _c =25°C)	2SB676 2SB677 2SB502A 2SB434 2SB678 2SB679	2SB502A 2SB503A 2SB434 2SB435 2SB676 2BB677 2SB678 2SB679 2SA1012	2SA739		
	~ 7A	~ 50W (T _c =25°C)	2SA656A 2SB673	2SA656A 2SA657A 2SA658A 2SB673 2SB674 2SB675 2SB553 2SB753	2SA739		
	~ 15A	~ 100W (T _c =25°C)					
	15 ~ 40A	~ 300W (T _c =25°C)	2SB552 2SB833	2SB552 2SB833			

Notes: 1. 3SK38A is MOS FET and others are Junction FETs.
2. [Ⓒ]TM:Green transistor for industrial use (TO-92 epoxy package)
[Ⓔ]:NHK standards [Ⓔ] transistor
3. Complimentary transistor
2SC372 TM,2SC367 TM-2SA467 TM,2SC400-2SA500,2SC503F-2SA503F,
2SC510F-2SA510F,2SC595[Ⓔ]-2SA522[Ⓔ],2SC560[Ⓔ]-2SA560[Ⓔ],2SC516[Ⓔ]-2SA516[Ⓔ],
2SC516A[Ⓔ]-2SA516A[Ⓔ],2SB502F-2SD102F,2SC519AF-2SC519AF-2SA656AF,2SD552-2S3522
2SC255-2SA1090,2SC2551-2SA1091
F:Family

Selection Table

Application	Frequency Range	Power Range	Silicon Transistor				Remarks
			P N P		N P N		
			V _{CE0} <40V	V _{CE0} >40V	V _{CE0} <40V	V _{CE0} >40V	
Low Noise Amplifier	AF (audio frequency)	~100mW		2SA493ⒸTM	2SK12 2SK12Ⓔ 2SK15 2SK48 2SK72	2SC1000ⒸTM 2SC1380A 2SC18 2SK18A 2SK112	Notes: 1 Ⓒ : Green transistor for industrial use. Notes: 2 Ⓔ : NHK standards Ⓔ transistor Notes: 3. * : for UHF.
Low Frequency Amplifier Oscillation	AF (audio frequency)	~100mW	2SA500 2SA522	2SA495ⒸTM 2SA499 2SA522AⒺ	2SC400Ⓔ 2SC595	2SC372ⒸTM 2SC373ⒸTM 2SC979 2SC979A 2SC980ⒸTM 2SC980AⒸTM	
		100mW ~300mW	2SA467ⒸTM 2SA500 2SA522Ⓔ	2SA495ⒸTM 2SA499 2SA522AⒺ	2SC367ⒸTM 2SC400	2SC366ⒸTM 2SC505 2SC507 2SK112	
		300mW ~3W	2SA509ⒸTM	2SA504 2SA503 2SA510 2SA594 2SA1020	2SC509ⒸTM	2SC503 2SC510 2SC507 2SC594 2SC594 2SC504 2SC2655 2SC3007	
	LF (low frequency)	3W~10W				2SC522	
	10W~		2SA1012 2SA656A 2SB434Ⓒ 2SB435Ⓒ 2SB502A 2SB503A 2SB552 2SB553 2SB833 2SB753			2SC519A 2SD51Ⓔ 2SD52Ⓔ 2SD53Ⓔ 2SD55Ⓔ 2SD234Ⓒ 2SD235Ⓒ 2SD633 2SD640 2SD641 2SC1576 2SD523 2SD524 2SD552 2SD553 2SD843 2SD842 2SC2562	

Application	Frequency Range	Power Range	Silicon Transistor				Remarks														
			P N P		N P N																
			V _{CEO} <40V	V _{CEO} >40V	V _{CEO} <40V	V _{CEO} >40V															
UHF Amplifier Oscillation	VHF	3W~		2SA598	2SC2101																
HF (high frequency)	UHF				2SC2102			2SC2103A	2SC2178	2SC2180	2SC2104*	2SC2105*	2SC2106*	2SC2379*	2SC2380*	2SC2381*	2SC2391*	2SC2420	2SC2638	2SC2639	2SC2640

Selection Table

Application	Frequency Range	Power Range	Silicon Transistor				Remarks
			P N P		N P N		
			V _{CE0} <40V	V _{CE0} >40V	V _{CE0} <40V	V _{CE0} >40V	
DC Amplifier Low Level Amp. Chopper	DC	~100mW			2SK12 2SK12Ⓝ 2SK15 2SD38A 2SK48 2SK72	2SK18 2SK18A 2SC1000ⓄTM 2SC1380A 2SK112 2SK113	Notes: 1. 3SK38A is MOS FET and other are Junction FETs. Notes: 2.
Logical Circuit Control Circuit	~100kHz	~100mW	2SA500 2SA522Ⓝ	2SA495ⓄTM 2SA429ⓄTM 2SA499 2SA522AⓃ 2SA1090	2SC400 2SC752ⓄTM	2SC372ⓄTM 2SC780AⓄTM 2SC979 2S979A 2SC980ⓄTM 2SC980AⓄTM 2SC2550	Ⓞ: Green transistor for industrial use. (ⓄTM transistor is TO-92 package) Notes: 3. Ⓝ: NHK standards Ⓝ transistor.
		100mW ~300mW	2SA467ⓄTM 2SA500 2SA522Ⓝ	2SA495ⓄTM 2SA499 2SA522AⓃ 2SA1090 2SA1091	2SC367ⓄTM 2SC400 2SC587Ⓝ 2SC595Ⓝ	2SC366ⓄTM 2SC505 2SC2550 2SC2551	
	100kHz ~1MHz	~100mW	2SA500 2SA522Ⓝ	2SA495ⓄTM 2SA499 2SA522AⓃ 2SA1090	2SC372ⓄTM 2SC373ⓄTM 2SC400 2SC595Ⓝ	2SC979 2SC979A 2SC980ⓄTM 2SC980AⓄTM 2SC2550	
		100mW ~300mW	2SA467ⓄTM 2SA500 2SA522Ⓝ	2SA495ⓄTM 2SA499 2SA522AⓃ 2SA1090	2SC367ⓄTM 2SC400 2SC595Ⓝ	2SC366ⓄTM 2SC505 2SC2550	
		300mW ~3W	2SA504	2SA503 2SA510 2SA1020		2SC108A 2SC503 2SC504 2SC507 2SC510 2SC594 2SC594Ⓝ 2SC2655	
	1MHz ~5MHz	~100mW	2SA500 2SA522Ⓝ	2SA499 2SA522AⓃ	2SC752ⓄTM 2SC400 2SC587Ⓝ 2SC595Ⓝ 2SC372ⓄTMA 2SC373ⓄTMA 2SC395A	2SC979 2SC979A 2SC980ⓄTM 2SC980AⓄTM 2SK112 2SK113	
		100mW ~300mW	2SA467ⓄTM 2SA500 2SA522Ⓝ	2SA499 2SA522AⓃ	2SC395A 2SC400	2SC594 2SC594Ⓝ	
	5MHz ~15MHz	~100mW			2SC752ⓄTM		

Application	Frequency Range	Power Range	Silicon Transistor				Remarks
			P N P		N P N		
			V _{CEO} < 40V	V _{CEO} > 40V	V _{CEO} < 40V	V _{CEO} > 40V	
Power Supply Regulator DC-DC Converter DC-AC Converter	Control DC-DC Converter Oscillation			2SA1020 2SA1012 2SA510 2SA656A 2SB502A 2SB552 2SB553 2SB753		2SC510 2SC522 2SC519A 2SC833Ⓝ 2SC979 2SC2139 2SC2200 2SC2534 2SC2535 2SC2552 2SC2553 2SC3051 2SC3075 2SD51Ⓝ 2SD52Ⓝ 2SD53Ⓝ 2SD55Ⓝ 2SD523 2SD524 2SD552 2SD553 2SD640 2SD641 2SD797 2SD867 2SD873 2SD878 2SD843 2SC2655 2SC2562 2SC2913 2SC2914 2SD717 2SD1187	
				2SA1020 2SA504 2SA503 2SA510 2SA594		2SC503 2SC504 2SC510 2SC594 2SC594Ⓝ 2SC2655	
			2SA467ⓄTM 2SA500 2SA522Ⓝ	2SA495ⓄTM 2SA499 2SA522AⓃ	2SC367ⓄTM 2SC400	2SC372ⓄTM 2SC373ⓄTM 2SC366ⓄTM 2SC505 2SC594	
High Voltage High Power Switch		~100mW		2SA429ⓄTM 2SA1091		2SC780AⓄTM 2SC2551	
		100mW ~300mW		2SA499 2SA522A		2SC366ⓄTM 2SC505	
		300mW ~3W		2SA503 2SA510		2SC503 2SC507 2SC510	
		3W~10W				2SC522	

Application	Frequency Range	Power Range	Silicon Transistor				Remarks
			P N P		N P N		
			V _{CEO} <40V	V _{CEO} >40V	V _{CEO} <40V	V _{CEO} >40V	
High Voltage High Power Switch		~50W		2SA656A 2SA739 2SB434 ③ 2SB435 ③ 2SB553 2SB834		2SC519A 2SC2200 2SC3148 2SD51 ① 2SD234 ③ 2SD235 ③ 2SD523 2SD553 2SD633 2SD877 2SD798 2SD799 2SD1088	
		~150W		2SB552		2SC1576 2SC2139 2SD52 ① 2SD53 ① 2SD55 ① 2SD1313 2SD524 2SD552 2SD640 2SD641 2SD797 2SD867 2SD873 2SD878	

Regulator Transistor

System	Type	Maximum Rating *Tc=25°C					Package	
		V _{CB0} (V)	V _{CEO} (V)	I _c (A)	*P _c (W)	T _j (°C)		
Switching Regulator	2SC3051	500	400	0.8	10	150	Mold package	
	2SC3075			0.8	10			
	2SC2534			2	20			
	2SC2552			2	20			
	2SC2535			5	40			
	2SC2553			5	40			
	2SC2555			8	80			
	2SC2650			10	100			
	2SC2200			7	40			Can package
	2SC2913			7	40			
	2SC2137			7	80			
	2SC2139			10	100			
	2SC2914			10	120			
	2SC2444			30	250			

System	Type	Maximum Rating *Tc=25°C					Package
		V _{CB0} (V)	V _{CEO} (V)	I _c (A)	*P _c (W)	T _j (°C)	
Switching Regulator	2SC3148	900	800	3	40	150	Mold package
	2SC2790/A	850		2	80		Can package
	2SC2791	900		5	100		Mold package
	2SC2792	850		2	80		
	2SC2793	900		5	100		
Series Regulator	2SD880	60	60	3	30	150	Mold package
	2SD1052		50	3	30		
	2SD1052A		50	3	30		
	2SD877	110	80	3	25	175	Can package
	2SD867	130	110	10	100		
	2SD878	100	60	15	115		
	2SD873	160	140	16	150		
2SD797	100	80	30	200			

Regulator Transistor

Toshiba Supreme Power Transistors

Ic (A)	* V _{CEO} (sus) V _{CEO} (V)	Type		h _{FE}	V _{CE} (V)	Ic (A)	V _{CE(sat)} MAX(V)	Ic (A)	I _B (A)	f _T TYP (MHz)	Pc (W) T _c =25°C	Package
		NPN	PNP									
10	60	2N3713	2N3789	25~90	2	1	1.0	5/4	0.5/0.4	4MIN	150	TO-3
		2N3715	2N3791	50~150	2	1	0.8/1.0	5	0.5	4MIN	150	TO-3
	80	2N3714	2N3790	25~90	2	1	1.0	5/4	0.5/0.4	4MIN	150	TO-3
		2N3716	2N3792	50~150	2	1	0.8/1.0	5	0.5	4MIN	150	TO-3
		TSB3055		20~100	4	4	1.1	4	0.4	8	70	TO-3P
	* 200	2N6249		10~50	3	10	1.5	10	1	2.5MIN	175	TO-3
	* 275	2N6250		8~50	3	10	1.5	10	1.25	2.5MIN	175	TO-3
* 350	2N6251		6~50	3	10	1.5	10	1.67	2.5MIN	175	TO-3	
15	60	2N3055		20~70	4	4	1.1	44	0.4	2.5MIN	115	TO-3
	300	2N6546		12~60	2	5	1.5	10	2	15	175	TO-3
	400	2N6547		12~60	2	5	1.5	10	2	15	175	TO-3
16	140	2N3773		15~60	4	8	1.4	8	0.8	0.2MIN	150	TO-3
20	60	2N3772		15~60	4	10	1.4	10	1	0.2MIN	150	TO-3
	80	2N5303		15~60	2	10	1.0	10	1	2MIN	200	TO-3
	* 75	2N5039		20~100	5	10	2.5	20	5	60MIN	140	TO-3
	* 90	2N5038		20~100	5	12	2.5	20	5	60MIN	140	TO-3
30	40	2N3771		15~60	4	15	2.0	15	1.5	0.2MIN	150	TO-3
	* 40	2N5301	2N4398	15~60	2	15	0.75	10	1	2MIN	200	TO-3
	* 60	2N5302	2N4399	15~60	2	15	0.75	10	1	2MIN	200	TO-3

DC-DC Converter Transistor

LOW V_{CE} (sat) Series

Collector Current Ic (A)	Collector-Emitter Breakdown Voltage V _{CEO} (V)						Collector Power Dissipation * Pc (W)
	20 (V)		50 (V)		80 (V)		
	PNP	NPN	PNP	NPN	PNP	NPN	
12			2SA1328	2SC3345	2SA1329	2SC3346	40
10	2SA1327				2SD717	2SD1187	80
7			2SB754	2SD844			60
			2SB553	2SD553	2SB753	2SD843	40
5			2SA1012	2SC2562			25
	2SA1120	2SC2270					10
2	2SA1300 2SA1160 (V _{CEO} =10V)	2SC3279 2SC2500 (V _{CEO} =10V)	2SA1020	2SC2655	2SA1315	2SC3328	0.9 (Ta=25°C)

* T_c=25°C

TOSHIBA CORPORATION

Darlington Type Transistor

V_{CE0} I_c	30 V	40 V	60 V	80 V	100 V	150 V	200 V	250 V	300 V	350 V	400 V	450 V	600 V	900 V
0.3 A		2SC982TM*												
1.5 A	2SD549* 2SD1140*				2SB678* 2SB679* 2SD688* 2SD689*									
3 A														
4 A				2SB676* 2SD686*										
6 A								2SD1088*	2SD798*		2SD799*			
7 A			2SB675* 2SD635*	2SD664* 2SB674* 2SD634* 2SD523*	2SB673* 2SD633*									
10 A												2SD685*		
15 A				2SD524*	2SD1087*							2SD641* 2SD683*	2SD683A* 2SD1314*	
30 A				2SB833* 2SD842*		2SD703*	2SD643* 2SD699*			2SD694* 2SD695*	2SC2444*	2SD644* 2SD645*		
40 A									2SD702*			2SD642*		
50 A										2SD696A*		2SD646A* 2SD547*		
100 A												2SD697A*	2SD647A*	2SD1165A*
120 A												2SD548*		
200 A							2SD700* 2SD700D*							2SD1166*
300 A												2SD1034A*		
400 A									2SD648A*					
600 A							2SD698A*							

*: Can package
*: Plastic package

Giant transistor is shown in a rectangle.

FET for Communications Industry (Small Signals)

Type	Application	Structure
2SK11	chopper, switching	N-channel junction type
2SK12	chopper, switching	
2SK15	Low frequency low noise amplifier	
2SK18	Differential amplifier	N-channel junction type (dual)complete separation type
2SK18A	Differential amplifier	
2SK48	Medical equipment	N-channel junction type
2SK72	Differential amplifier	N-channel junction type (dual)complete separation type
2SK112	Low frequency low noise(high gm)	N-channel junction type
2SK113-R	Constant-current, switching	
2SK113-O	Switching, chopper	
2SK113-Y	Analog switch, chopper	
3SK28	Video pre-amplifier	
3SK38A	Chopper circuit	N-channel MOS type (enhancement type)

G-TR Module (Insulated Type)

I _c (A)	V _{CE(OUS)} (V)	Polarity	Structure	Type
±15	450	NPN	Darlington	MG15G1AL2
30	450	NPN	Darlington	MG30G1BL2
±30×2	450	NPN	Darlington	MG30G2CL2
50	450	NPN	Darlington	MG50G1BL2
±50×2	450	NPN	Darlington	MG50G2CL2
±75×2	500	NPN	Darlington	MG75H2DL1
±100	450	NPN	Darlington	MG100G1AL2
±100×2	550	NPN	Darlington	MG100H2DL1
±200	550	NPN	Darlington	MG200H1AL1




Power MOS FET (π -MOS)

Type	Maximum Rating				Package
	V _{DSX} (V)	V _{GSS} (V)	I _b (A)	P _F (W)	
2SK324	400	±20	10	120	TO-3
2SK325	450	±20	10	120	TO-3
2SK355	150	±20	12	120	TO-3
2SK356	250	±20	12	120	TO-3
2SK357	150	±20	5	40	TO-220AB
2SK358	250	±20	5	40	TO-220AB
2SK385	400	±20	10	120	TO-3P(L)
2SK386	450	±20	10	120	TO-3P(L)
2SK387	150	±20	12	150	TO-3P(L)
2SK388	250	±20	12	150	TO-3P(L)
2SK417	60	±20	10	60	TO-220BS
2SK418	400	±20	2	50	TO-220BS
2SK419	450	±20	2	50	TO-220BS
2SK420	400	±20	5	60	TO-220BS
2SK421	450	±20	5	60	TO-220BS
2SK422	60	±20	0.7	0.9	TO-92MOD
2SK423	100	±20	0.5	0.9	TO-92MOD
2SK405	160	±20	8	100	TO-3P
2SJ115	160	±20	8	100	TO-3P






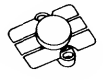
Uni-junction Transistor







Model	Use	Structure
2SH20	Thyristor gate turn on Timer	SIP emitter planer type
2SH21	Thyristor gate turn on Timer	SIP emitter planer type

RF Power Transistors

	Package			
	Po(W)	TO-220AB	φ9.5	φ12.7
HF/CB 30MHz	3~3.5	2SC1678 2SC2075		
	10~12	2SC2098	2SC2395	
	20	2SC2098	2SC2099	
	40			2SC1763 *
	60			2SC2290
	80			2SC1764 *
	100			2SC2879
	150			2SC2510 *
	200			2SC2652 **

* : E-Case
 * : V_{CC} = 28V
 ** : V_{CC} = 50V

	Package						
	Po(W)	TO-39	TO-39 Flange	φ9.5	φ9.5	□6.5	φ12.7
VHF 175MHz	1	2SC994 2SC998 *					
	2.5	2SC547	2SC1169 *				
	2.8	2SC1955 *	2SC2117 *				
	5		2SC2118 *				
	6			2SC2101		2SC2638	
	15			2SC2102	2SC2178	2SC2639	
	27			2SC2103A	2SC2508		
	32			2SC2420		2SC2640	
	40				2SC2181		
	50						2SC3147
80						2SC2782	

	Package						
	Po(W)	TO-39	TO-39 Flange	φ9.5	φ9.5	□6.5	φ12.7
UHF 470MHz	1	2SC1165 2SC1001					
	2.8		2SC1765				
	3			2SC2104	2SC2391		
	6			2SC2105	2SC2379	2SC2641	
	12			2SC2106	2SC2380	2SC2642	
	25			2SC2173	2SC2381	2SC2643	
	40						2SC2783

RF Power Module

Type	Application	Output Power P_o (W)	Frequency Range f (MHz)	Type	Application	Output Power P_o (W)	Frequency Range f (MHz)
S-AV5	10W FM Amateur radio	15	144~148	S-AU3	10W FM Amateur radio	15	430~450
S-AV6	25W FM Marine radio	28	154~162	S-AU4	10W FM/SSB Amateur radio	17	430~450
S-AV7	25W FM Amateur radio	28	144~148	S-AU5L	5W FM Land Mobile	7	400~440
S-AV8	10W FM/SSB Amateur radio	17	144~148	S-AU5M			440~480
S-AV9L	5W FM	8	135~155	S-AU5H			480~512
S-AV9H	Land Mobile		150~175	S-AU6L	400~440		
S-AV10L	10W FM	14	135~155	S-AU6M	10W FM Land Mobile	13	440~480
S-AV10H	Land Mobile		150~175	S-AU6H			480~512
				S-AU7	10W FM Land Mobile	15	806~825

Condition: V_{cc} , V_{con} :12.5V, P_i :0.2W

Diodes

Detector & Switching

V_R (V), I_{FM} (mA)	50~100	300	300~500	750
30	1SS176	1S1555	1S1588 1SS104	
50	1SS177	1S1554 1S2460	1S1586 1S1587	
60		1S1553		
70				1S2095A
80	1SS178		1S1585	
100	1S2091	1S2461	IN4148	
200	1S2092	1S2462		

Type	Use
1S1553 1S1554 1S1555	General Purpose
1N4148 1S1585 1S1586 1S1587 1S1588 1SS176~178	High Speed SW
1S2091 1S2092	High Voltage SW
1S2095A	Hjgh Current SW
1S2460 1S2461 1S2462 1S2463	High Voltage
1SS104	Low Leakage

Zener Diode

List of Zener Diode Products

Vz (V)	250mW Type	500mW Type	1 W Type		5W Type	10W Type
			Epoxy	Metal		
2.0~4.8	02BZ2.2 02BZ2.7 02BZ3.3 02BZ3.9 02BZ4.7	05Z2.0 05Z3.3 05Z2.2 05Z3.6 05Z2.4 05Z3.9 05Z2.7 05Z4.3 05Z3.0 05Z4.7		1S220		1S262
4.8~5.8		05Z5.1 05Z5.6		1S221		1S263
5.8~7.0	(Temperature compensation type) 1SZ57~1SZ59	05Z6.2 05Z6.8	1Z6.2 1Z6.8	1S222		1S264
7.0~8.4		05Z7.5 05Z8.2	1Z7.5 1Z8.2	1S223		1S265
8.4~10		05Z9.1 05Z10	1Z9.1	1S224 1S225		1S266 1S267
10~12		05Z11 05Z12	1Z10 1Z11	1S226 1S227		1S268 1S269
12~14		05Z13	1Z12 1Z13	1S228 1S229		1S270 1S271
14~17		05Z15 05Z16	1Z15 1Z16	1S230~232		1S272~274
17~20		05Z18 05Z20	1Z18 1Z20	1S233~235		1S275~277
20~24		05Z22 05Z24	1Z22 1Z24	1S236 1S237		1S278 1S279
24~29		05Z27	1Z27	1S238 1S239	5Z27	1S280 1S281
29~35		05Z30 05Z33	1Z30 1ZM30 * 1Z33	1S240 1S241		1S282 1S283
35~42		05Z36 05Z39	* 1Z36	1S242 1S243		1S284 1S285
42~50		05Z43 05Z47	* 1ZM50 * 1Z47	1S244~247		1S286~289
50~60		05Z51 05Z56	* 1Z51	1S248 1S249		1S290 1S291
60~72		05Z62 05Z68	* 1Z68	1S250 1S251		1S292 1S293
72~86		05Z75 05Z82	* 1Z75 * 1Z82	1S252 1S253		1S294 1S295
86~100		05Z91 05Z100	* 1Z100	1S254 1S255		1S296 1S297
100~120			* 1Z110	1S256~258		1S298~300
120~140				1S259 1S260		1S301 1S302
140~170			* 1Z150	1S261		1S303
170~200			* 1Z180			
200~400			* 1Z330 * 1Z390			

∴:New product

05Z Series (500mW)

Type	Zener Voltage						Measurement Current I _Z (mA)
	X		Y		Z		
	MIX.	MAX.	MIX.	MAX.	MIX.	MAX.	
05Z2.0	1.88	2.12			2.05	2.24	10
05Z2.2	2.08	2.33			2.20	2.45	10
05Z2.4	2.28	2.55			2.45	2.70	10
05Z2.7	2.50	2.75	2.65	2.95	2.85	3.10	10
05Z3.0	2.80	3.05	2.95	3.25	3.15	3.40	10
05Z3.3	3.10	3.35	3.25	3.55	3.45	3.70	10
05Z3.6	3.40	3.65	3.55	3.85	3.75	4.00	10
05Z3.9	3.70	3.95	3.85	4.20	4.10	4.40	10
05Z4.3	4.00	4.35	4.25	4.60	4.50	4.80	10
05Z4.7	4.40	4.75	4.65	5.00	4.90	5.20	10
05Z5.1	4.80	5.10	4.95	5.25	5.10	5.40	5
05Z5.6	5.30	5.60	5.50	5.80	5.70	6.00	5
05Z6.2	5.80	6.15	6.00	6.35	6.25	6.60	5
05Z6.8	6.40	6.75	6.65	7.00	6.85	7.20	5
05Z7.5	7.10	7.46	7.34	7.70	7.54	7.90	5
05Z8.2	7.70	8.10	7.96	8.40	8.26	8.70	5
05Z9.1	8.60	9.05	8.85	9.30	9.15	9.60	5
05Z10	9.40	9.90	9.75	10.25	10.10	10.60	5
05Z11	10.40	10.95	10.65	11.20	11.05	11.60	5
05Z12	11.40	11.95	11.70	12.25	12.05	12.60	5
05Z13	12.40	13.10	12.90	13.60	13.40	14.10	5
05Z15	13.90	14.65	14.40	15.15	14.85	15.60	5
05Z16	15.40	16.15	15.90	16.65	16.35	17.10	5
05Z18	16.90	17.80	17.55	18.45	18.20	19.10	5
05Z20	18.80	19.80	19.50	20.50	20.20	21.20	5
05Z22	20.80	21.80	21.50	22.50	22.30	23.30	5
05Z24	22.80	24.00	23.50	24.70	24.40	25.60	5
05Z27	25.1	26.5	26.3	27.7	27.5	28.9	5
05Z30	28.0	29.6	29.3	30.8	30.4	32.0	5
05Z33	31.0	32.7	32.2	33.9	33.3	35.0	5
05Z36	34.0	35.7	35.2	36.9	36.3	38.0	5
05Z39	37.0	38.8	38.1	39.9	39.2	41.0	5
05Z43	39.0	42.0	41.0	45.0	44.0	47.0	5
05Z47	43.0	46.0	45.0	49.0	48.0	51.0	5
05Z51	47.0	50.5	49.5	53.5	52.5	56.0	5
05Z56	51.0				62.0		5
05Z62	56.0				68.0		5
05Z68	62.0				75.0		5
05Z75	68.0				82.0		5
05Z82	75.0				91.0		5
05Z91	82.0				100		5
05Z100	91.0				110		5

Bidirectional Zener Diode

Vz Typical Value (V)	1W Type (Resin Mold Type)	Vz Typical Value	1W Type (Resin Mold Type)
17~24		72~140	⊡1ZM100
24~35	⊡1ZM27	140~200	⊡1ZM180
35~72	⊡1ZM47	200~400	⊡1ZM330 ⊡1ZM390

1ZM30 and 1ZM50 are also available.

⊡:New product

Variable Capacitance Diode

Tuning

Type	Package	V _R (V)	C _T (pF)		C _T (pF)		Application
			V _R (V)		V _R (V)		
1SV100	Mini	15	450~600	1	20~33	9	AM car radio, portable radio
1SV101		15	28~32	3	12~14	9	FM car radio, portable radio
1SV102		30	360~460	2	15~21	25	AM Hi-Fi tuner
1SV103		35	37~42	3	13.2~16.2	25	FM Hi-Fi tuner
1SV147		15	28.5~32.5	3	11.7~13.7	8	FM car radio, portable radio
1SV149		15	435~540	1	14.9~30.0	8	AM car radio, portable radio
1SV75	1-5G1A	28	26~32	3	4.5~6.0	25	VHF TV tuner
1SV123		30	12.04~13.63	3	2.172~2.454	25	VHF, UHF TV tuner
1SV153	1-2J1A	30	14.16~16.25	2	2.11~2.43	25	VHF, UHF TV tuner
1SV138	1-5G1A	30	26~34	2	2.4~3.2	25	CATV tuner

AFC

Type	Package	V _R (V)	C _T (pF)		Application
			V _R (V)		
1S2094	DO-35	18	7~11	4	VHF, UHF TV AFC
1S2236	DO-35	15	7~14	4	FM tuner AFC

PIN Diode

Type	Package	V _R (V)	I _F (mA)	r _s (Ω)			Application
					I _F (mA)	f(MHz)	
1S2186	DO-35	20	100	1.0Max	10	100	VHF, UHF TV Band SW
1SV99	Equivalent to To-92	50	50	10Max	10	100	Variable ATT, ANT SW, FM AGC
1SV128	Equivalent to TO-236	50	50	7 (TYP)	10	100	VHF, UHF Band SW Variable ATT
1SS155	1-2G1A	30	100	0.9Max	2	100	VHF, UHF TV Band SW

Mixer Diode

Type	Structure	Application
1SS154	Si Epi-pl, Schottky barrier	UHF-C band mixing, detection

Miscellaneous

Type	Application
1S144	Meter protection
1S2093	Trigger diode triode AC switch turn on

Magnetic Electric Transducer (Hall Effect Device)

Type	Structure	Application
THS102A	Ga-As ion impla planar	Magnetic-electric transducer
THS103A	Ga-As ion impla planar	Magnetic-electric transducer



EXPLANATION

Ratings of Transistors

1. Maximum ratings of transistors

The maximum allowable limits of currents, supplyable voltage, and power dissipation are defined as the maximum ratings for each kind of transistor.

The maximum ratings of transistors are one of the most important factors in determining the effective transistor drive and in expecting sufficiently high reliability of transistor circuits over intended periods of operation.

The most typical characteristic inherent to transistors, diodes, and other semiconductors is the temperature dependency of their electrical properties. Maximum ratings for semiconductors are mostly determined based on a thermal variation of electrical properties. For example, should the ambient temperature be increased while supplying constant voltage to a transistor, such an increase of ambient temperature in turn will increase conductivity of the transistor or current flow in the device. Thus, increased power dissipation of the transistor further raises the device temperature and increases the current. This endless circulation of temperature rise and current increase will finally result in thermal runaway and eventual damage to the device.

Transistor maximum ratings constitute those strict limits which must not be exceeded, in any phase, to assure long service life and high reliability of the transistors. Ratings, which are dependent on materials, structure, design, and fabricating conditions of transistors, differ according to the kinds. In principle, maximum ratings are regarded as absolute maximum ratings.

The term "absolute maximum rating" refers to a value that the operating conditions must not exceed at any phases—even momentarily. Should more than one item be determined as having an absolute maximum rating, neither of them should be applied to the transistor simultaneously.

Should an absolute maximum rating be exceeded, the properties of the transistor may not be recovered in certain instances. When designing a transistor circuit, care must be ex-

ercised not to exceed any of the absolute maximum ratings, while taking into account fluctuation of the supply voltage, deviation in properties of the electrical components, exceeding the maximum ratings while adjusting the circuits, variations in ambient temperature, and fluctuations of input signals.

Major items for which maximum ratings must be determined included the emitter, base, and collector currents, voltages between electrodes, power dissipation, junction temperature, and storage temperature of transistors. Because of the close correlation among these properties, none of these ratings can be considered independently of each other; the ratings are largely dependent on external connections.

2. Voltage ratings

Transistors are composed of input and output circuits by using one of the electrodes—namely, emitter, base, or collector—as the common terminal. Consequently, voltage ratings for transistors are rated as collector-to-base voltage (V_{CB}), collector-to-emitter voltage (V_{CE}), or emitter-to-base voltage (V_{EB}).

Breakdown voltages which determine voltage ratings are classified into those inherent to individual transistors ($V_{(BR)CBO}$, $V_{(BR)CEO}$, and so on) and those dependent on input circuit conditions ($V_{(BR)CER}$, $V_{(BR)CEX}$, and so on). Generally, the breakdown voltage is a function of the individual characteristics of the circuit and the transistor.

(1) Voltage ratings of collector

Since transistors are normally used in a common base or in a common emitter mode, ratings for collector voltages are most importance to these operation modes.

Fig. 1 reveals a breakdown of collector voltages in various operation modes; the breakdown voltages shown therein may be defined as follows:

$V_{(BR)CBO}$: maximum collector-to-base voltage with the emitter opened

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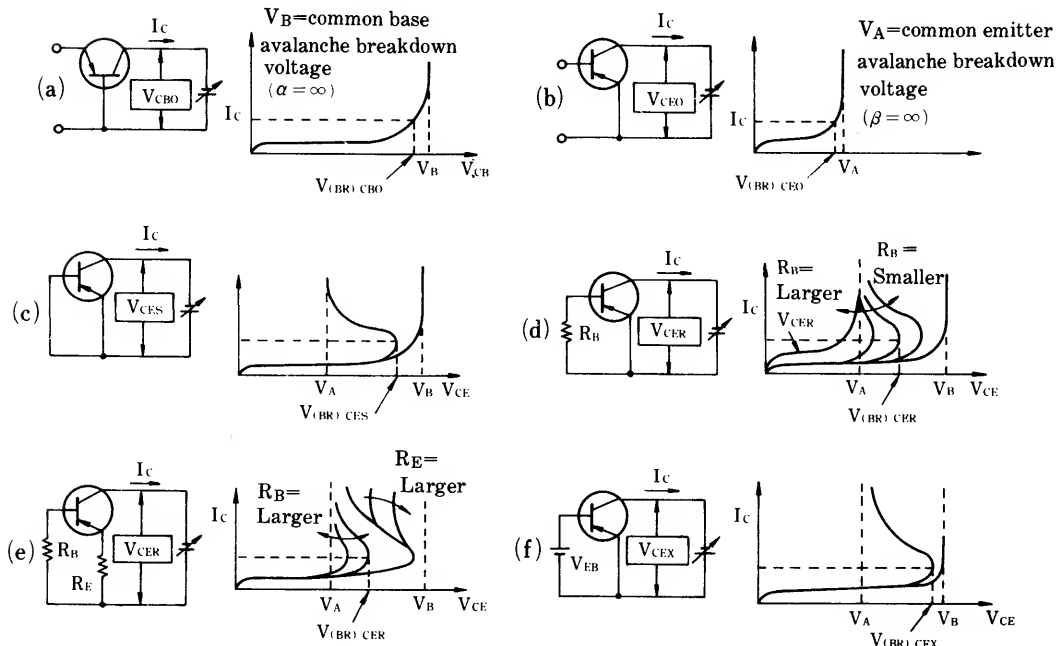


Fig. 1 Maximum collector voltage

$V_{(BR)CEO}$: maximum collector-to-emitter voltage with the base opened

$V_{(BR)CES}$: maximum collector-to-emitter voltage with the emitter and the base short-circuited

$V_{(BR)CER}$: maximum collector-to-emitter voltage with a resistance R between the emitter and the base

$V_{(BR)CEX}$: maximum collector-to-emitter voltage with reverse bias voltage applied between the emitter and the base

When comparing magnitudes of these breakdown voltages, they may be arranged in the following order, although no significant difference is seen between $V_{(BR)CBO}$ and $V_{(BR)CES}$:

$$V_{(BR)CBO} > V_{(BR)CES} > V_{(BR)CEX} > V_{(BR)CER} > V_{(BR)CEO}$$

(a) Maximum collector-to-base voltage with the emitter opened, $V_{(BR)CBO}$
 —Common base avalanche breakdown voltage—

Maximum collector-to-base voltage with the emitter opened, $V_{(BR)CBO}$ is equivalent to diode characteristics between the collector and the base. When reverse bias voltage is applied between the collector and the base, small leakage current I_{CBO} flows between them. By increasing such bias voltage, the depletion layer is expanded on both the collector and the base sides. After this process is repeated over and over, in which a small amount of carrier accumulates high energy from this accelerated electric field and collides with Ge or Si atoms to finally produce electrons and holes, a so-called avalanche multiplication phenomenon is produced in which a large amount of free carriers are produced, causing large current to flow rapidly.

This avalanche breakdown phenomenon restricts the maximum supplyable voltage applicable to a transistor.

When avalanche multiplication is present, the multiplication factor M of multiplication in junction-type transistors is experimentally represented by—

$$M = \frac{1}{1 - \left(\frac{V_{CB}}{V_B}\right)^n} \dots\dots\dots (1)$$

The total current amplification factor α is represented by—

$$\alpha = \alpha_0 \cdot M \dots\dots\dots (2)$$

Where,

V_B = true avalanche breakdown voltage

V_{CB} = voltage applied between collector and base

α_0 = common base current amplification factor in voltage where no avalanche multiplication occurs

n = Figure determined by the type of transistor; 3–4 for Ge PNP transistors, 4–7 for Ge NPN transistors, 2–4 for Si PNP transistors, and 2–3 for Si NPN transistors.

V_B is determined by a concentration of impurities on the high resistance side; the higher the concentration, the smaller becomes the V_B .

It is this V_B that definitely determines the maximum value of withstand voltage of a transistor. However, in manufacturers' catalogs, maximum ratings for transistors are usually described by using $V_{(BR)CBO}$ to represent a voltage at which the collector current reaches a predetermined value. In general, the stated value $V_{(BR)CBO}$ is smaller than V_B of the transistor.

The thermal coefficient of V_B is positive because it is related to mobility of a carrier. However, the $V_{(BR)CBO}$ may become smaller in the low-current region at high temperatures, because I_{CBO} rises in accordance with the temperature rise.

When constant input current is supplied to the emitter of a common base transistor, the collector current I_C is—

$$I_C = \alpha I_E + M I_{CBO} \dots\dots\dots (3)$$

- (b) Maximum collector voltage in open-base common emitter connection $V_{(BR)CEO}$ —avalanche breakdown voltage in common emitter connection V_A —

Avalanche breakdown of a common emitter transistor occurs at a collector voltage in which the common emitter current amplification factor β becomes infinite. The factor β can be represented as a function of α_0 and expressed as—

$$\beta = \frac{\alpha_0 M}{1 - \alpha_0 M} \dots\dots\dots (4)$$

The factor β becomes infinite when $\alpha_0 M = 1$ or $M = 1/\alpha_0$. In other words, as the collector voltage V_{CB} is low, collector current is mostly supplied by the base. But, at a certain collector voltage V_A , which is sufficiently high to create an avalanche phenomenon, the amount of carriers caused by electron multiplication becomes equal to that ($\gamma\beta_0 = \alpha_0$) injected from the emitter, due to emitter efficiency γ reaching the depletion layer with the conductivity rate β_0 . Base current to support the collector current then becomes unnecessary, or $\beta = \infty$, and avalanche multiplication occurs.

At this point, from $M = 1/\alpha_0$ and from equation (1) —

$$\alpha_0 = 1 - \left(\frac{V_{CB}}{V_B}\right)^n \dots\dots\dots (5)$$

In developing equation (5) for the collector voltage or the common emitter avalanche breakdown voltage V_A at which $\alpha_0 M = 1$ —

$$V_A = V_B^n \sqrt{1 - \alpha_0} \cong V_{(BR)CEO} \dots\dots\dots (6)$$

For collector voltages smaller than V_A , base current flows forward; the polarity of β is positive. On the other hand, for voltages larger than V_A , base current flows in reverse; the polarity turns to negative.

The relationship between β and the total current amplification factor α is shown in Fig. 2 as a function of the collector voltage.

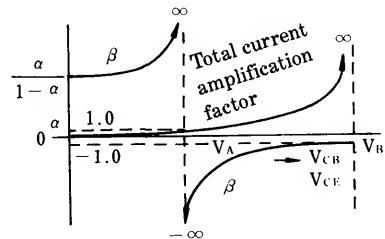


Fig. 2 Current amplification factor and collector voltage

When the input base current is retained constant, collector current I_C of a common emitter transistor is represented by the formula—

$$I_C = \beta I_B + (\beta + 1) M I_{CBO} \dots\dots\dots (7)$$

Temperature dependency of $V_{(BR)CEO}$ is determined by that of V_B , α_0 , and I_{CBO} (I_{CEO}); the polarity cannot be defined uniformly.

(c) Common emitter voltage rating as a function of circuit configuration —

$$V_{(BR)CER}, V_{(BR)CES}, V_{(BR)CEX}$$

When a transistor is operated with a resistor R_B inserted between the base and the emitter, the total collector leakage current MI_{CBO} flows through the internal base resistance r_b and external resistor R_B . When the emitter junction is forward-biased (or when its voltage becomes larger than the contact voltage V_d), emitter injection occurs; also, breakdown occurs between the collector and the emitter. The voltage $V_{(BR)CER}$ at this moment is represented by the equation —

$$V_{(BR)CER} = V_B^n \sqrt{1 - \frac{I_{CBO}(R_B + r_b)}{V_d}} \quad (8)$$

V_{CER} is in reverse proportion to R_B ; the breakdown voltage takes the largest value when $R_B=0$. When R_B is zero, voltage is expressed as base-to-emitter short-circuit breakdown voltage, or $V_{(BR)CES}$; (See Fig. 1-c)

When the base is opened (or $R=\infty$), operation of the transistor is controlled by β . All of the leakage current MI_{CBO} flows through the base and forms a collector current equal to $(\beta+1)MI_{CBO}$. Breakdown voltage occurs at a collector-to-emitter voltage where $\beta \rightarrow \infty$. This is the voltage previously defined as V_A (common emitter avalanche breakdown voltage).

Breakdown voltage corresponding to other values of R_B is larger than V_A but smaller than V_B . In other words, after emitter injection starts, total current amplification factor ($=\alpha_0 M$) becomes larger than 1, causing β to change to negative. Figure 2 shows that the negative values of β increase with a reduction of V_{CB} , in the region where V_{CE} is larger than V_A . At the breakdown point, emitter injection occurs and I_c increases suddenly. This increase in I_c reduces collector voltage V_c due to a voltage drop across terminal resistance. A decrease of V_c increases β and I_c .

This effect is accelerated accumulatively, and the transistor represents a negative resistance. V_c approximates V_A where $\beta \rightarrow \infty$.

Figure 3(a) reveals the characteristics of R_B and the breakdown voltage; Fig. 3(b) shows the relationship between $V_{(BR)CER}$ and R_B and that between I_{CER} and R_B . These figures represent the same characteristics.

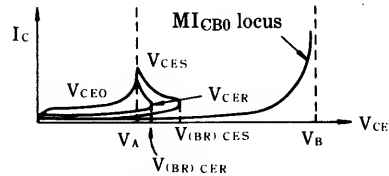


Fig. 3(a) Characteristics of R_B and breakdown voltage

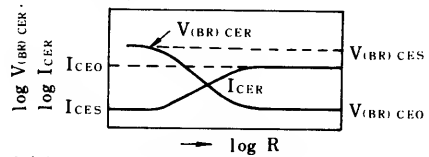


Fig. 3(b) Characteristics of $V_{(BR)CER}$, I_{CER} and R_B

If R_E is inserted in the emitter side as shown in Fig. 1(e), the negative feedback by R_E increases the avalanche voltage R_A as represented by the equation —

$$V_A' = V_B^n \sqrt{1 - \frac{\alpha_0 R_B}{R_B + R_E}} \quad \dots \dots \dots (9)$$

If the emitter/base is reverse-biased by using V_{EB} as shown in Fig. 1(f), the voltage takes the maximum value when emitter injection occurs, similarly to $V_{(BR)CER}$; it approximates V_A thereafter, displaying negative resistivity characteristics.

The maximum voltage thus obtained, namely V_{CEX} , is obtained by the following formula and is larger than $V_{(BR)CES}$:

$$V_{(BR)CEX} = V_B^n \sqrt{1 - \frac{I_{CBO} \cdot r_b}{V_d + V_{EB}}} \quad \dots \dots (10)$$

(2) Voltage ratings of emitter

Maximum emitter voltage with the collector opened, $V_{(BR)EBO}$, is similar to the above-mentioned $V_{(BR)CBO}$ in terms of essential. However, it is only a few volts in conventional types of transistors because the concentration of impurities is high in the emitter. Unlike the avalanche breakdown previously mentioned, zener breakdown caused by a tunnel effect is produced if breakdown voltage is around 6V or less. Care must be exercised if the base/emitter is reverse-biased at higher voltage; otherwise transistor characteristics will be deteriorated or damaged.

(3) Measuring the voltage ratings

The maximum voltage of a transistor is obtained by measuring the voltage which appears between the specified electrodes when supplying a specified current to specified elec-

trodes under specified conditions. Such measurement is usually effected by regulating the peak current of sinusoidal half-wave to a specified value.

Always refrain from conducting this test by using direct current; otherwise it will thermally breakdown the elements.

3. Current ratings

The current ratings for a transistor include the maximum value of current supplyable in the emitter $I_{E_{max}}$ forward direction and that which is supplyable in the collector $I_{C_{max}}$ reverse direction. Generally speaking, $I_{C_{max}} = I_{E_{max}}$ in most instances. Thus, current ratings are usually determined by duly considering the following items:

- (1) Current at which internal power dissipation does not exceed a rated value even though limited collector saturation voltage exists—namely, the current at which junction temperature does not exceed a rated value.
- (2) Current at which DC amplification factor h_{FE} is lowered to $1/2 \sim 1/3$ or less of a peak value—namely for switching purposes, $h_{FE} \cong 10$ for medium-power transistors or $h_{FE} \cong 3$ for large-power transistors.
- (3) Current at which internal leads are blown off—The maximum value of the base current $I_{B_{max}}$ generally takes the value— $I_{B_{max}} \cong 1/2 \sim 1/6 \times I_{C_{max}}$.

4. Temperature ratings

Maximum junction temperature $T_{j_{max}}$, specified in accordance with the quality of component materials and their reliability, should be determined by duly considering the characteristics related to reliability (such as deterioration and service life), and not by referring solely to operability.

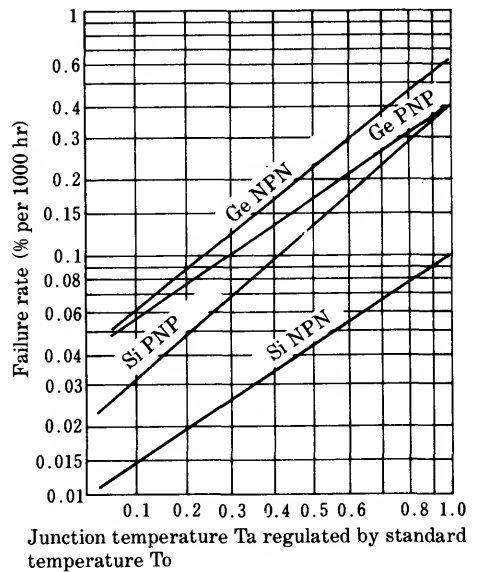
Generally speaking, transistor deterioration is more accelerated if the junction temperature is higher. The following relationship is found between the average service life L_m (hours) and the junction temperature T_j ($^{\circ}K$), with A and B as constants inherent to transistors.

$$\log L_m \doteq A + \frac{B}{T_j} \dots\dots\dots (11)$$

Therefore, the upper limit for allowable junction temperature based on defect ratios.

and reliability of components is specified for transistors whose long service life must be guaranteed ... $70 \sim 90^{\circ}C$ for Ge transistors, $100 \sim 150^{\circ}C$ for Si transistors, and $150 \sim 200^{\circ}C$ for Si planar transistors whose surface is stabilized.

Storage temperature T_{stg} indicates the temperature range in which a transistor can be stored without causing the transistor to operate. This is also specified according to the quality of component materials and reliability. Fig. 4 reveals the relationship between failure rate and junction temperature of transistors.



$$T_a = \frac{T_j - T_o}{T_{j_{max}} - T_o}$$

Fig. 4 Relationship between failure rate and junction temperature of transistors (based on MIL-HDBK-217A)

5. Power ratings

Power dissipated in a transistor is converted into thermal energy which in turn causes a temperature rise.

Internal power dissipation of a transistor operating at a certain operating point is represented by the sum of the collector loss $I_C \cdot V_{CB}$ and the emitter loss $I_E \cdot V_{BE}$. Normally, howev-

er, it is determined by the collector loss $P_C = I_C V_{CB} \cong I_C V_{CE}$, since the emitter junction is forward-biased—thereby $V_{CB} > V_{BE}$ and $I_C \cong I_E$.

Major parameters limiting maximum power dissipation $P_{C_{MAX}}$ include the maximum allowable junction temperature $T_{j_{max}}$ and the standard temperature T_o (ambient temperature T_a or case temperature T_c); it is well known that these parameters are related to each other in the following manner by thermal resistance θ (or R_{th})

$$P_{C_{max}} = \frac{T_{j_{max}} - T_o}{\theta} \dots\dots\dots (12)$$

Thermal resistance is a physical value representing the ratio of junction temperature rise per unit-power dissipation—or in other words, a difficulty in exhausting heat. Thus, it is necessary to select a transistor with a large $P_{C_{max}}$ to assure large power dissipation. It is very important to rationally design heat radiation in power transistors.

Maximum ratings $P_{C_{max}}$ stated in manufacturers' catalogs or other materials generally represent those at normal ambient temperature ($T_a = 25^\circ\text{C}$) or those at $T_c = 25^\circ\text{C}$ if use of a radiator is expected. It is possible to obtain thermal resistance between the transistor junction and the environmental temperature, or between junction and case by using former equation (12).

6. Derating

Transistor circuits may be designed by using the maximum ratings of voltage, current, and power (junction temperature) stated in a manufacturer's catalog and by establishing appropriate heat radiating conditions. However, it is a common practice to derate to a considerable extent the operating conditions of high-reliability circuits.

To balance both system reliability and economy, the following derating is recommended:

- Voltage: Voltages at worst operating conditions (including surge voltage) should be 80% or less of maximum rated voltage (especially V_{CEO}).
- Current: Currents at worst operating conditions (including surge current) should be 80% or less of rated value.
- Power: Power dissipation at worst condi-

tions (including surge) should be 50% or less of derated maximum allowable loss at the maximum ambient temperature of equipment.

- Temperature: The operating maximum junction temperature T_{jp} when considering surge and power concentration should be 70–80% or less of the rated maximum junction temperature $T_{j_{max}}$.

To calculate the power dissipation of transistors for switching use, the peak values of voltage, current, and power—as well as junction temperature, including surge conditions—must not exceed maximum ratings. However, average power dissipation will sufficiently support system reliability if derating is effected by taking reliability into account.

7. Safe Operating Area (SOA)

The safe operating area represents that area where a transistor retaining high reliability can be used without suffering destruction or deterioration.

Usually, the operating limit of a transistor is determined by its maximum ratings—such as maximum voltage, current, and collector loss. However, when using power transistors in a high-power amplifier or a circuit having an inductive load, deterioration of characteristics or destruction may sometimes result even when they are operated within the maximum ratings. This is caused by secondary breakdown (S/B) of the transistor.

Ever since this phenomenon was first discovered in 1958 by C.G. Tharnton and C.D. Simmons, additional consideration has been required for the concept of SOA, as well as for maximum ratings, when determining the operating limits of a transistor.

It would be very difficult to design high-reliability, economical transistor circuits without properly comprehending the SOA concept as mentioned above.

(1) Secondary breakdown (S/B) phenomenon

As shown in Fig. 5, the secondary breakdown phenomenon further increases current following the primary breakdown. When the current reaches a certain volt-ampere point ($V_{S/B}$, $I_{S/B}$), voltage between the collector and the emitter rapidly drops, descending to a low-impedance area within several microseconds or less, frequently causing destruction of a

transistor.

Such a phenomenon may be observed when the base-emitter bias is in a forward or reverse direction, as well as at V_{CE0} or V_{CBO} ; If the base bias condition differs, however, the S/B inrush point ($V_{S/B}$, $I_{S/B}$) will vary and align on the locus of the S/B curve shown in Fig. 5. This figure applies to DC. Since the inrush to the S/B possesses an energy dependency, the S/B curve varies in accordance with pulse width of the impressed pulse.

This curve determines an SOA for impressed pulses. Fig. 6 shows the relationship between the pulse width of impressed power and S/B. As the pulse width becomes smaller, the S/B power increases, while the S/B energy decreases. (S/B energy is termed "triggering energy", which implies energy absorbed by a transistor before the energy rushes into the S/B.)

Although various explanations have been given regarding the causes of this S/B, it is generally accepted as an established theory at present that a hot spot is created by a local concentration of current, and causes local thermal runaway. The possible causes for current concentration phenomena are assumed to be a fall of electric potential or instability of lateral temperature distribution in the base area.

Sometimes current will be concentrated when a lack of uniformity of the base width, faulty junction, or unbalanced mounting of the chip on the header material serves as a trigger.

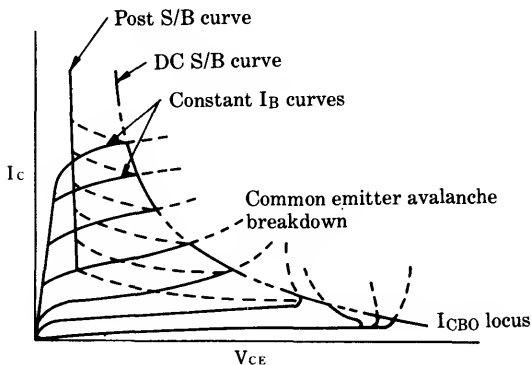


Fig. 5 Collector output characteristics and S/B curve

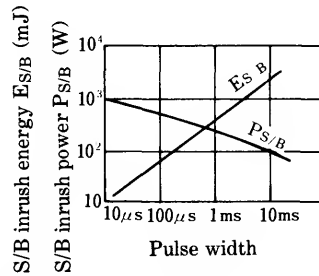


Fig. 6 Relationship between pulse width and $E_{S/B}$, $P_{S/B}$

(2) Forward biased S/B

When forward bias exists between the base and the emitter, a hot spot as a result of local current concentration is created on the emitter periphery.

This is because a fall of electric potential occurs in the base area as a result of the base current immediately flowing laterally below the emitter, and because the emitter periphery is more strongly biased than its center. Therefore, a minority carrier supply to the base is concentrated around the emitter periphery, and the current density rises higher there, as shown in Figs. 7(a) and 7(b).

When this carrier passes through the depletion layer of the collector, it causes a power loss, which leads to local heating, creating a repetition that results in a concentration of current, forming of a hot spot, and S/B.

(Relationship between S/B and transistor characteristics) Current at the inrush point $I_{S/B}$ during the forward bias is closely related to transistor characteristics. When the carrier supplied from the emitter to the base region arrives at the collector junction, it is usually fanned out in a cone-shaped pattern. Therefore, when the transit time of the carrier in the base region becomes longer, the current density becomes lower when it arrives at the collector depletion layer, due to this fan-out effect. And resulting in a hot spot hard to cause. This transit time of the carrier depends on the base width and drift field in the base region. Consequently, $I_{S/B}$ is strongly related to frequency characteristics of a transistor. A negative correlation exists between f_T and $I_{S/B}$ irrespective of the pulse width.

This relationship is shown in Fig. 8 below.

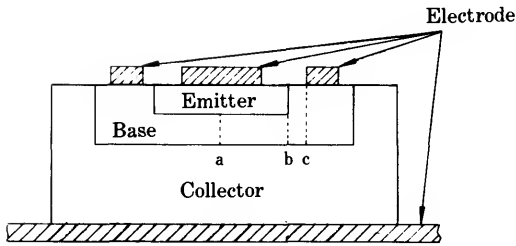


Fig. 7 (a) Planar type transistor

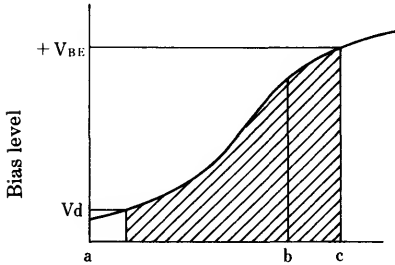


Fig. 7 (b) Emitter voltage (forward bias)

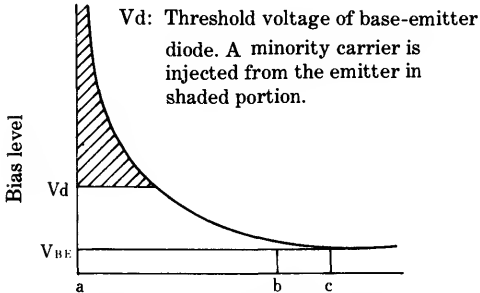


Fig. 7 (c) Emitter voltage (reverse bias)

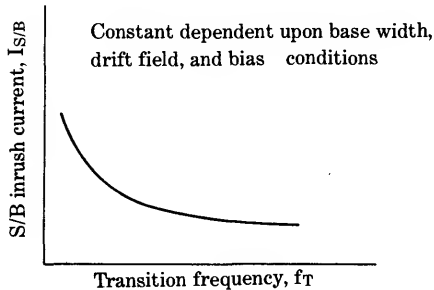


Fig. 8 Relationship between $I_{S/B}$ and f_T

(3) Reverse biased S/B

When reverse bias exists between the emitter and the base the direction of a fall of electric potential in the base region becomes contrary to that during forward bias.

Therefore, the carrier supplied from the emitter is concentrated on the center of the emitter. See Fig. 7(c). (The extent of this carrier concentration varies according to the type of transistor. For a ring-shaped emitter, pattern, the carrier concentrates on one point of the emitter center. For a comb-shaped emitter pattern, it concentrates on one line at the emitter center.)

When reverse bias is higher, the area of concentration at the emitter center becomes smaller. Consequently, triggering energy (energy absorbed by a transistor before it rushes into S/B) during reverse bias becomes far smaller than that during forward bias. The carrier supplied from the emitter, similarly to the case of the forward bias mentioned above, is also fanned out; thus, the base width and the existence of a drift field in the base region are closely correlated with S/B.

Reverse bias S/B occurs mostly in the case of an inductive load. The triggering energy $E_{S/B}$ depends on conditions lying between the base/emitter and the inductance L , as shown in Fig. 9.

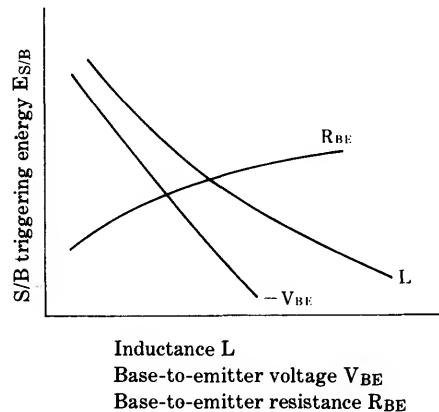


Fig. 9 Dependency of S/B triggering energy $E_{S/B}$ on load inductance and base-to-emitter condition

(4) S/B phenomenon and destruction or deterioration of transistors

Influences of the S/B phenomenon on the electrical characteristics of transistors vary depending on the types of transistors.

If the impressed power is small, or if the power supply is interrupted at the moment S/B occurs, unusual changes may or may not occur in the electrical characteristics, or a transistor may become deteriorated very slowly, even when S/B is caused to occur repeatedly.

Care must be exercised, however, because some transistors are destroyed when they are subjected to S/B just once. Electrical characteristics upon transistor deterioration or destruction due to S/B generally reveal the following aspects: maximum values of V_{EBO} , V_{CBO} , and V_{CEO} usually become lower, or one of them is often short-circuited. Especially, a short circuit between the emitter and the collector indicates a characteristic deterioration of S/B, where a melted spot is formed running from the emitter to the collector. Otherwise, durability against S/B is sometimes reduced even though the electrical characteristics remain unchanged. This is caused by a smaller S/B trigger energy $E_{S/B}$ mentioned above, thereby indicating that the transistor may be easily destroyed.

8. Measurement of SOA

Various methods have been proposed for measuring the SOA. Parameters in selecting an appropriate method include circuit configuration, transistor operating conditions, and other factors.

When attempting to directly measure the SOA, in some cases transistors may be deteriorated or destroyed. Thus, for confirming the SOA, it is recommended that the operating conditions of a transistor be measured immediately before the current rushes into the secondary breakdown.

There are three typical methods available for measuring the SOA —

- (1) S/B method
- (2) Latching method
- (3) Transient thermal resistance method

Actual examples of these measuring methods are described subsequently herein.

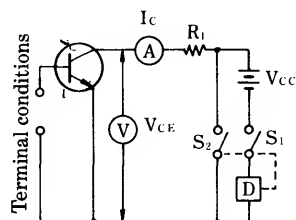
- (1) S/B method

This is a methods for actually measuring S/B inrush values by supplying voltage and current between the collector and the base or between the collector and the emitter of a transistor. (See Figs. 10 and 11.)

When applying this methods, a transistor may become deteriorated unless it is mounted in a high-performance protective circuit.

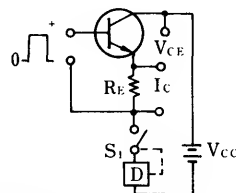
There is another way termed the $T_{S/B}$ method, which is an improved version of the S/B method.

Fig. 12 shows the $T_{S/B}$ method which is a measuring circuit for obtaining a forward-biased SOA when the time of supplied pulse is comparatively long or when using a current similar to DC. A transistor is operated by applying V_{CE} and I_C under a specified temperature (case temperature or ambient temperature) while forward-biasing between the emitter and the base. Measured by this method is the operating time required until I_C fluctuates more than $\pm 10\%$ or exceeds the specified final value. By repeating this measurement to obtain operating time in combinations of I_C and V_{CE} , and by drawing a graph with the operating time as a parameter on the curve of I_C and V_{CE} , the SOA can be obtained.



D: S/B detecting and protective circuit
S1, S2: Switches to be actuated by signals from D

Fig. 10 DC-supplied S/B method.



D: Detecting circuit
S1: Switch to be actuated by the signals from D

Fig. 11 Pulse-supplied S/B method (pulse to be supplied between emitter and base)

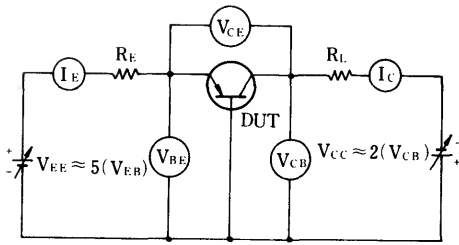


Fig. 12 Forward-biased SOA measuring circuit (TS/B methods)

(2) Latching method

This is a method for measuring the SOA of a transistor by setting it under specified conditions after keeping it in a saturated area under constant current or inductive load conditions.

It is possible to observe oscillation phenomena which occur when the S/B is started by using this method. (Fig. 13)

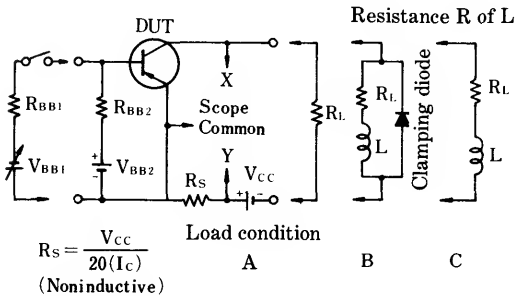
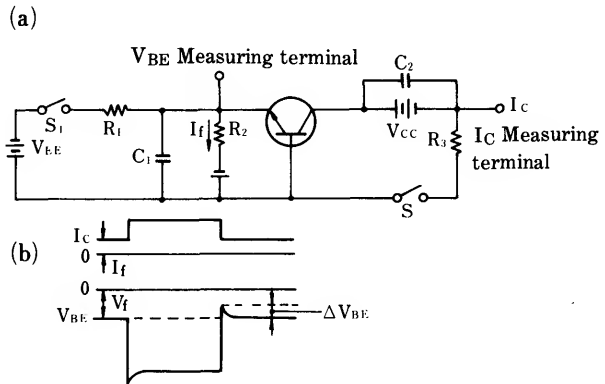


Fig. 13 Reverse-biased SOA measuring circuit (latching method)

(3) Transient thermal resistance method (ΔVBE, ΔVCE method)

Since S/B is regarded as a local temperature rise in the junction of a transistor, the S/B inrush condition can be determined by measuring the junction temperature. Fig. 14 illustrates a typical example. Measure the temperature coefficient of junction forward



ΔV_{BE} : Temperature drop as a result of power supply suspension
S1, S2: Switches to be actuated depending on conditions of the V_{BE} measuring terminal

Fig. 14 Transient thermal resistance method (ΔVBE method)

voltage in advance. The temperature rise in a junction can be obtained by measuring the difference between forward voltage before and after supplying power, transient thermal resistance thus being obtained.

This method displays an apparently narrower SOA compared with the two methods mentioned above, and cannot be used to measure reverse-biased SOA.

9. SOA of forward-biased transistors

Fig. 15 and 16 show examples of the SOA of forward-biased transistors.

The SOA implies that the safety operation of a transistor is assured when it is used within the indicated range.

The DC regions of these figures are applied to transistor operations in a DC circuit. A pulse-driven transistor may be used at larger power dissipations as shown in the pulse region of these figures, but safe operation of the transistor is assured only within the given pulse duration.

As shown in Figs. 15 and 16, the lower voltage region shows the thermal resistance limitation while the higher voltage region is limited by S/B. In the thermally limited region, the collector loss P_c is constant and $I = PV^{-1}$; thus, the thermal limitation gradient is -1 when plotted on a logarithmic graph. On the other hand, collector loss in the S/B limited region

deviates from the iso-power line of the $P_c = \text{constant}$. The gradient ranges from -1.5 to -4 according to the types of transistors. Note that the relationship of $I_{S/B} = PV^{-N}$ reduces the allowable collector dissipation.

Since the transistor SOA is reduced with a temperature rise, a derating curve shown in Fig. 17 must be used.

When temperature rises, the SOA is far more affected by thermal limitation than by the S/B limitation. Fig. 17 reveals an example of a derating curve for the S/B limitation and the thermal limitation ranges, as a parameter of case temperature. The SOA for transistor 2SA473 shown in Fig. 15 is, at $T_c = 100^\circ\text{C}$., rendered as narrow as shown by the dashed lines in Fig. 15. This is because the thermally limited and S/B limited regions are derated by 40% and 49% respectively according to the derating curve shown in Fig. 17 (b). For transistor 2SD526 shown in Fig. 16, where V_{CE} is lower and in the thermally limited region, the derating ratio based on thermal limitation must be considered.

Thermal derating ratio in the S/B limited region differs according to the structure of transistors, as shown in Fig. 17. If V_{CE} is high voltage and within the S/B limited region, derating is effected by using the derating curve of the S/B limitation shown in Fig. 17.

Taking as an example transistor 2SD526, illustrated in Fig. 17, the derating ratio d_T is shown as follows for the thermally limited region provided that the case temperature of the transistor $T_c = 60^\circ\text{C}$:

$$d_T = \frac{100}{T_{j\max} - 25} (T_{j\max} - T_c)\% \quad \dots (14)$$

By substituting $T_{j\max} = 150^\circ\text{C}$, $d_T = 72\%$.

Concerning the derating ratio in the S/B limited region ($d_{S/B}$), 2SD526 must be derated by 50% at 150°C because it is a triple diffused mesa transistor; thus, $d_{S/B} = 2/5 (150 - T_c) + 50\%$. And $d_{S/B}$ at $T_c = 60^\circ\text{C}$ is 86%.

In conclusion, it is derated by $d_T = 72\%$ and $d_{S/B} = 86\%$ at $T_c = 60^\circ\text{C}$. This is indicated in Fig. 16 by using dashed lines.

10. SOA of reverse-biased transistors

The SOA of reverse-biased transistors cannot be determined so simply as that of forward-biased transistors. However, the SOA in this direction is as important as that

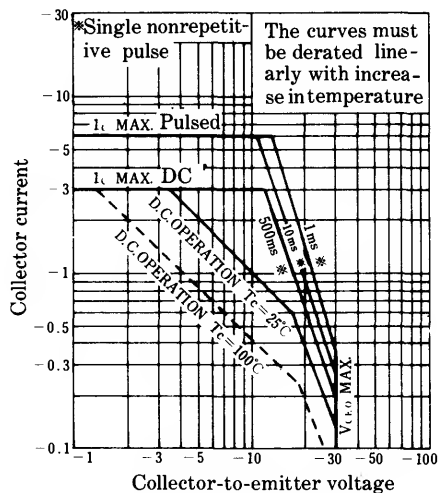


Fig. 15 SOA for 2SA473

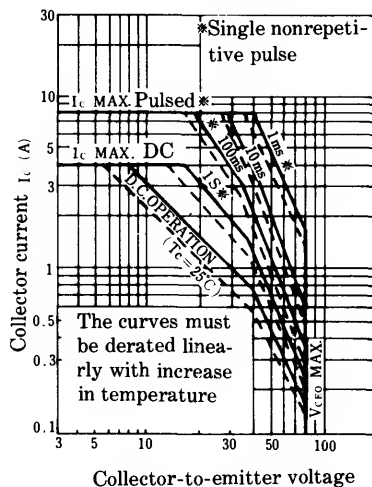


Fig. 16 SOA for 2SD526 and an example of derated SOA at $T_c = 60^\circ\text{C}$

in the forward-biased direction because high collector voltage is supplied frequently to a transistor in an inductance-loaded switching circuit, a horizontal deflection output circuit of TV receivers, or a DC-DC converter, while the base-to-emitter voltage is biased in the reverse direction.

In such operations, the worst load conditions are given by an inductive load. The SOA of reverse-biased transistors is ordinarily ob-

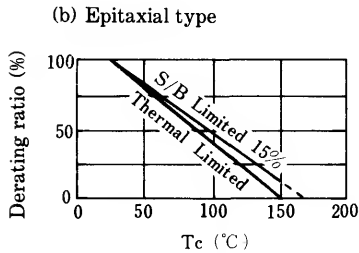
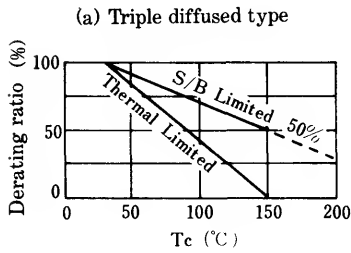


Fig. 17 Thermal derating of the SOA

Note: The above figures shown examples of thermal derating of the SOA for thermally and S/B-limited regions by types of transistor structures.

For a concept of the thermal derating of the SOA, refer to this section on "The SOA of forward-biased transistors."

tained by using the load condition C of the measuring circuit shown in Fig. 13. Fig. 18 (a) illustrates I_c - L curves of a transistor under specified reverse-bias conditions.

Figs. 18 (b) and 18 (c) show the derating of I_c when V_{BB2} and R_{BB2} are changed. It is possible to obtain the SOA for simple L -loaded circuits directly by using the curves shown in Fig. 18. For complicated circuits, however, the effective L must be obtained before utilizing the curves of Fig. 18.

However, plotting a typical SOA for a reverse-biased transistor as shown in Fig. 18 is quite difficult. It is also hard to obtain an effective L accurately from an actual load circuit for users. At Toshiba, the SOA is determined by selecting an adequate I_c , L , R_{BB2} , V_{BB2} , and other data for specific transistor applications and by regarding as defective those transistors whose load characteristics are outside the region shown in Fig. 19 and which display oscillation or partial flickering on the load line.

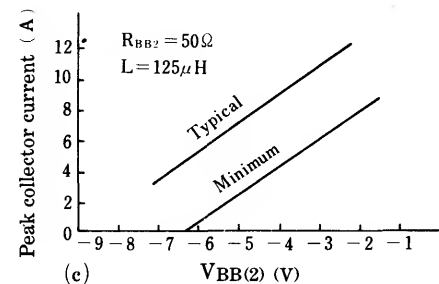
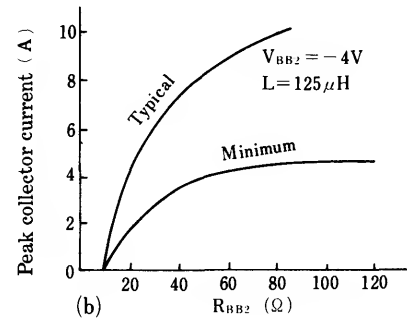
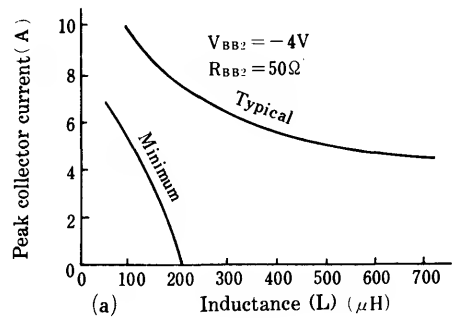
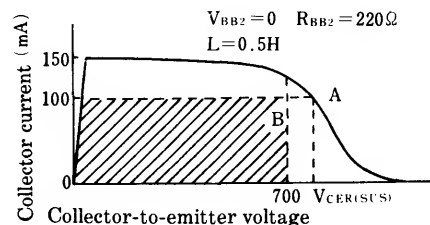


Fig. 18 Examples of SOA for reverse-biased transistors



Measurement is taken at the point (A) above where collector current drops to 100 mA when supplying 150 mA of collector peak current.

Fig. 19 Example of SOA for reverse-biased transistors

Identification System (Transistors, Accessories, and Radiator Holders)

1. Transistors

Example: 2SC 780 A G
 1st 2nd 3rd 4th groups

1st group: Represents the types of transistors as shown in the following Table:

1st group	Types of transistors
2SA	PNP transistor, fundamentally high-frequency use
2SB	PNP transistor, fundamentally low-frequency use
2SC	NPN transistor, fundamentally high-frequency use
2SD	NPN transistor, fundamentally low-frequency use
2SH	Uni-junction transistor
2SJ	P-channel field effect transistor
2SK	N-channel field effect transistor

2nd group: Figure starting from 11 (EIAJ number)

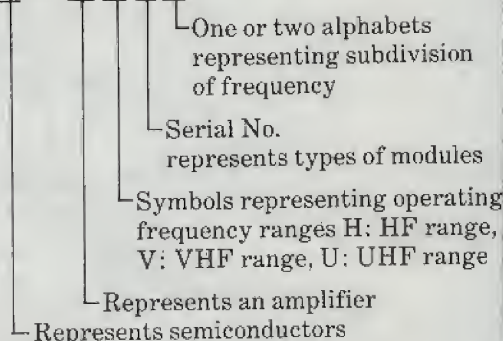
3rd group: Suffix denoting modifications in alphabetical order

4th group: Suffix denoting special applications

4th group	Types of special applications
G	: Green transistors for communications and industry applications
D	: Products specially approved by NTT (Nipon Telegraph and Telephone Public Corp.)
N	: Products specially approved by NHK (Japan Broadcasting Corp.)

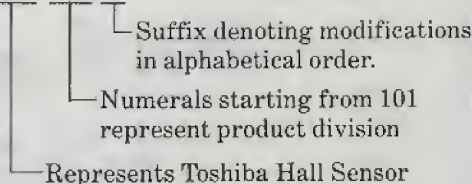
2. RF Power Amplifier Modules

Example: S - A U 5 L



3. GaAs hall sensor

Example: THS 102 A



4. Giant transistor modules

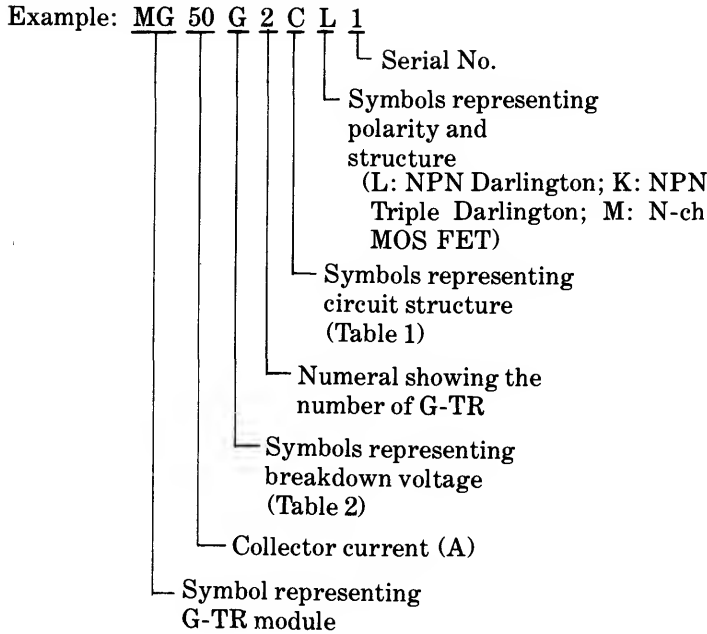




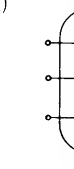
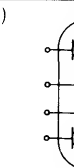
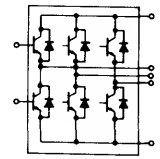
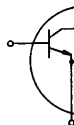
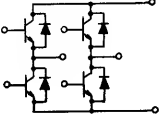


Table 2

Char-acters	Max. voltage range (V)	Char-acters	Max. voltage range (V)
Z	25 or more to less than 50	J	600 or more to less than 700
A	50 " ~ 100 "	K	700 " ~ 800 "
B	100 " ~ 150 "	L	800 " ~ 900 "
C	150 " ~ 200 "	M	900 " ~ 1000 "
D	200 " ~ 300 "	N	1000 " ~ 1100 "
F	300 " ~ 400 "	P	1100 " ~ 1200 "
G	400 " ~ 500 "	Q	1200 " ~ 1300 "
H	500 " ~ 600 "		

Table 1

	Circuit structure
A	(1)  (2) 
B	(1)  (2) 
C	(1) 
D	(1) 
E	
Z	Others
F	
G	

5. Accessories and radiator holder

Example : AC 23 A

1st, 2nd, 3rd groups

1st group: AC represents accessory

2nd group: Serial number

3rd group: Suffix denoting modifications

Example 2: RH - 16 A

1st, 2nd, 3rd groups

1st group: RH represents radiator holder

2nd group: Serial number

3rd group: Suffix denoting modifications

Thermal Stability and Radiation Design of Transistor Circuit

One of the characteristics of semiconductor products such as transistor and diode is that the electrical characteristic is very susceptible to temperature. Therefore, in circuit design, it is necessary to give consideration to operating temperature and a temperature rise caused by self-dissipation.

For instance, in case the ambient temperature rises in a condition that certain voltage is applied to a transistor, the conductivity of the element is raised and current increases, and thereby the transistor consumes more power and junction temperature rises, thus the current being further increased. This vicious circle leads to a phenomenon that will cause the transistor to be destructed in the end.

Therefore, a design considering changes of operating point caused by changes of temperature is required.

1. Temperature Characteristic of Transistor

(1) Thermal stability

Performance stability factor S is defined by the following expression.

$$S = \frac{\partial I_C}{\partial I_{CBO}} \dots \dots \dots (1)$$

That is, this shows a change of collector current I_C when a change was produced in collector cutoff current I_{CBO} by temperature. Among transistor parameters, those that depend most on temperature are leakage current I_{CBO} (I_{CEO}) and base-emitter voltage V_{BE} . These are expressed as function of temperature as follows.

$$I_{CBO}(T_x) = I_{CBO}(T_0) e^{K(T_x - T_0)} \dots \dots \dots (2)$$

$$I_E = I_{CBO} e^{qV_{BE}/KT} \dots \dots \dots (3)$$

where

T_0 : Reference temperature

T_x : Temperature to be found

K : Temperature coefficient:

generally $0.07 \sim 0.08/^\circ\text{C}$ when material is silicon

q : Electric charge

k : Boltzmann's constant

T : Absolute temperature

Suppose that the dissipation applied to the junction is P_c and that a variation of ΔP_c was produced in this dissipation by some cause. There appears a temperature change of $\Delta P_c \theta_{ja}$ in the junction. (θ_{ja} : thermal resistance from the junction to the open air, which will be described in the following chapter). Consequently, changes are produced in I_{CBO} and V_{BE} . These changes ΔI_{CBO} and ΔV_{BE} cause changes of $S \cdot I_{CBO}$ and $g_m \cdot \Delta V_{BE}$ to collector current.

(The g_m of the transistor is defined by $g_m = \partial I_C / \partial V_{BE}$)

If the variation of the dissipation caused by this change is larger than ΔP_c , the temperature will continuously rise. Therefore, this needs to be made small. That is,

$$\Delta P_c \geq V_C (S \Delta I_{CBO} + g_m \Delta V_{BE}) \dots \dots \dots (4)$$

where, V_C : Collector supplied voltage.

Under the above condition, it is considered that stability can be obtained.

Expression (4) is transformed as follows:

$$V_C \cdot S \cdot \frac{\Delta I_{CBO}}{\Delta P_c} + V_C \cdot g_m \cdot \frac{\Delta V_{BE}}{\Delta P_c} \leq 1 \dots (5)$$

As $\Delta T = \Delta P_c \cdot \theta_{ja}$ can be considered, expression (2) is differentiated by P_c .

$$\frac{\Delta I_{CBO}}{\Delta P_c} = \frac{\Delta I_{CBO}}{\Delta T} \cdot \frac{\Delta T}{\Delta P_c}$$

$$= K \cdot \theta_{ja} \cdot I_{CBO}(T_0) \cdot e^{K(T_x - T_0 + P_c \cdot \theta_{ja})} \dots \dots (6)$$

Then, obtain the temperature characteristic of V_{BE} by making emitter current I_E constant in expression (3).

$$\frac{\Delta V_{BE}}{\Delta T} \doteq \frac{KkT}{q} \doteq -2.0 \times 10^{-3} \text{V}/^\circ\text{C} \dots (7)$$

Note:

Generally, $-1.8 \text{ mV}/^\circ\text{C} \sim -2.2 \text{ mV}/^\circ\text{C}$ can be obtained according to the bias condition of the transistor, but the above $-2 \text{ mV}/^\circ\text{C}$ is usually used as a typical practical value. In Darlington transistor, temperature coefficient becomes twofold, and $-4.0 \sim -4.5 \text{ mV}/^\circ\text{C}$ is used as a typical value, depending on operating conditions.

Consequently,

$$\frac{\Delta V_{BE}}{\Delta P_C} = \frac{\Delta V_{BE}}{\Delta T} \cdot \frac{\Delta T}{\Delta P_C} \doteq -2.0 \times 10^{-3} \times \theta_{ja}$$

..... (8)

Expressions (6) and (8) are substituted for expression (5)

$$V_C \cdot S \cdot K \cdot \theta_{ja} \cdot I_{CBO(T_0)} \cdot e^{K(T_X - T_0 + P_C \cdot \theta_{ja})} - 2.0 \times 10^{-3} \cdot \theta_{ja} \cdot V_C \cdot g_m \leq 1 \quad \dots\dots(9)$$

where,

$$T_X - T_0 + P_C \cdot \theta_{ja} \leq T_{j \max} - T_0$$

That is, if expression (9) is satisfied, the circuit is considered to be stable. However, expression (9) is too complicated for practical use. If a change of I_c to the change of V_{BE} is included in the definition of S , the second term in expression (9) can be omitted for practical use. That is, expression (9) is simplified as follows:

$$V_C \cdot K \cdot \theta_{ja} \cdot S \cdot I_{CBO(T_0)} e^{K(T_X - T_0 + P_C \cdot \theta_{ja})} \leq 1$$

..... (10)

where, $T_X - T_0 + P_C \cdot \theta_{ja} \leq T_{j \max} - T_0$

Here, critical voltage V_{crit} is defined as follows.

$$V_{crit} = \frac{1}{K \cdot \theta_{ja} \cdot S \cdot I_{CBO(T_0)}} \quad \dots\dots\dots (11)$$

Expression (11) is substituted for expression (10);

$$\frac{V_C}{V_{crit}} e^{K(T_X - T_0 + P_C \cdot \theta_{ja})} \leq 1 \quad \dots\dots\dots (12)$$

By transforming the above and making $k=0.08$, reference temperature (ambient temperature) $T_0=25^\circ\text{C}$,

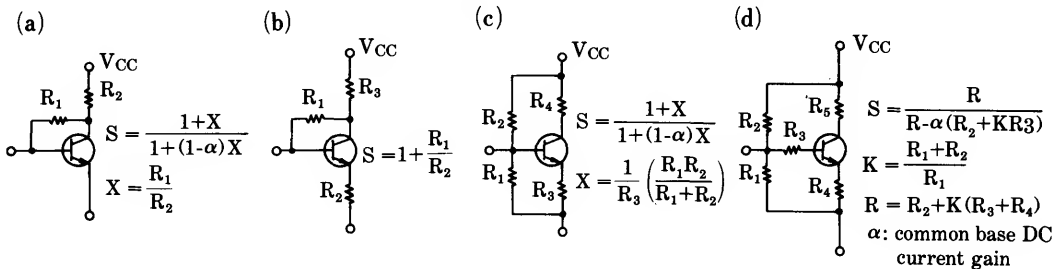
$$P_C \cdot \theta_{ja} + T - 25 \leq 29 \log \frac{V_C}{V_{crit}} \quad \dots\dots\dots (13)$$

Consequently, expressions (11) and (13) are expressions giving stability conditions of the circuit.

(2) Stability coefficient of bias circuit

As the stability coefficient of the circuit is described and calculated in various literatures on bias circuit design, only a few examples are mentioned below.

Fig. 1 shows what becomes of the stability coefficient of each bias circuit. (a), (b) and (c) show general bias circuits, and (d) shows a case where direct current resistance of an input transformer can not be ignored.



In general, the smaller the stability coefficient is, the better. However, with a small coefficient, the direct current dissipation of the circuit increases, thereby lowering the efficiency.

If the stability coefficient is made small in the bias circuit in output stage, this dissipation is made large, resulting in poor economy.

Therefore, the bias circuit in output stage generally adopts the method of improving thermal stability by a temperature compensating device.

If the temperature compensating device is

used, it is possible to optionally select the stability. As the temperature compensating device, thermistor and varister are commonly used.

For the use of them, refer to the catalog for each device. In case thermal stability is completely compensated by the temperature compensating device, it is enough for the transistor to take only the maximum rating of collector power dissipation into consideration.

2. Radiation Design

(1) Maximum allowable power dissipation and radiation equivalent circuit

The maximum allowable power dissipation (P_{Cmax}) of a transistor, if the thermal stability of the bias circuit described in the previous item is designed to be stable enough, can be given by expression (14), according to the ambient (open air) temperature (T_a) where the transistor is used, its maximum junction temperature (T_{jmax}) and the total thermal resistance (θ_{ja} or R_{th}) from junction to ambient (open air) depending on the radiating conditions to be described.

$$P_{Cmax} = \frac{T_{jmax} - T_a}{\theta_{ja}} \text{ (W)} \dots\dots\dots (14)$$

$$\left(P_{Cmax} = \frac{T_{jmax} - T_c}{\theta_i} \right)$$

For the path conducting the heat generated in the transistor junction to the outside, thermal movement is supposed to be equal to current, and an electric circuit is substituted for convenience's sake. Consequently, it is expressed by thermal resistance and thermal capacitance. In thermally stationary state, it can be shown by the radiation equivalent circuit in Fig. 2.

- θ_i : Internal thermal resistance (from junction to case)
- θ_b : External thermal resistance (from case to ambient)
- θ_s : Thermal resistance of insulating plate
- θ_c : Thermal resistance of contact (in contact with radiating plate)

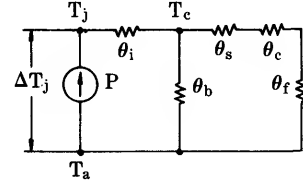


Fig. 2 Radiation Equivalent Circuit

θ_f : Thermal resistance of heat sink (to the open air)

The total thermal resistance θ_{ja} to the open air, viewed from the junction, is given by expression (15) from the radiation equivalent circuit illustrated in Fig. 2.

$$\theta_{ja} = \theta_i + \frac{\theta_b(\theta_s + \theta_c + \theta_f)}{\theta_b + \theta_s + \theta_c + \theta_f} \dots\dots\dots (15)$$

As transistors with middle or lower output generally use no heat sink, θ_{ja} will be:

$$\theta_{ja} = \theta_i + \theta_b \dots\dots\dots (16)$$

Though there appears maximum allowable power dissipation of $T_a=25^\circ\text{C}$ in catalogs for transistors with middle or lower output, the value given by the following expression with the θ_{ja} given by expression (16) and T_{jmax} is available.

$$P_{Cmax(T_a=25^\circ\text{C})} = \frac{T_{jmax} - 25}{\theta_{ja}} \dots\dots\dots (17)$$

The thermal resistance θ_b from the case to the open air depends on the material and con-

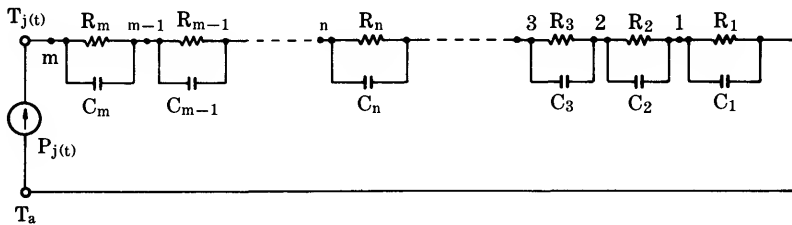


Fig. 3

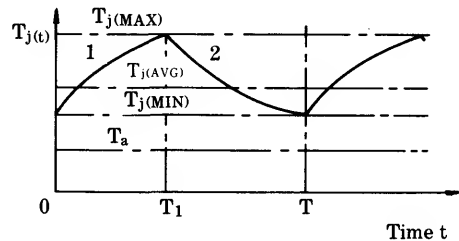
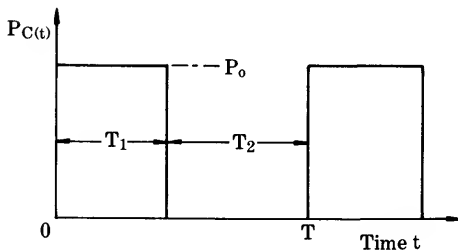


Fig. 4

figuration of the case, but it is a considerably large value as compared with θ_i , θ_c , θ_s and θ_f . Therefore, expression (15) is simplified and the following expression can be used in practice.

$$\theta_{ja} = \theta_i + \theta_c + \theta_s + \theta_f \dots\dots\dots (18)$$

In dealing with direct current dissipation, it is possible to realize a radiation design satisfying the maximum rating by finding expression (18).

In using transistors in a pulse circuit, etc., great care must be taken so that the peak value of T_j must not exceed T_{jmax} .

(2) Pulse response of junction temperature

In general, the thermal impedance of a transistor is given by such a distributed constant circuit as shown in Fig. 3.

When the pulse dissipation $P_j(t)$ shown in Fig. 4 is applied to the circuit shown in Fig. 3, a temperature change $T_j(t)$ that appears in the m th CR parallel circuit is given by the following expression.

(1) In the region of $P_j(t) = P_0$;

$$T_{j(t)} \sum_{n=1}^m \{ (P_0 R_n) - T_{n(min)} \} \times \{ 1 - \exp(-t/C_n R_n) \} + T_{n(min)} \dots\dots\dots (19)$$

(2) In the region of $P_j(t) = 0$;

$$T_{j(t)} \sum_{n=1}^m T_{n(max)} \exp(-t/C_n R_n) \dots\dots\dots (20)$$

By supposing $n=4$ for common transistors,

it is possible to approximate to the actual value. However, in case the values of C and R are not clear, it is hard to calculate the value of T_j .

Therefore, in general, T_{jpeak} is estimated by using the transient thermal resistance shown below.

Fig. 5 shows the characteristic of 2SC3236 as an typical example of transient thermal resistance characteristic.

When single nonrepetitive rectangular pulse (pulse width T_1 , peak value P_0) is applied, the transient thermal resistance $r_{th}(T_1)$ to pulse width T_1 is obtained and T_{jpeak} is given by the following.

$$T_{jpeak} = r_{th}(T_1) \cdot P_0 + T_a \dots\dots\dots (21)$$

When continuous pulses of cycle T are applied, the T_{jpeak} is given by the following expression in thermally stable state.

$$T_{jpeak} = P_0 \left[\frac{T_1}{T} \theta_{ja} + \left(1 - \frac{T_1}{T} \right) \cdot r_{th}(\tau + \tau_1) - r_{th}(\tau) + r_{th}(T_1) \right] + T_a \dots\dots (22)$$

The above expression (22) can be applied only in a region where current concentration is not caused by the so-called secondary breakdown.

In the radiation design of pulse circuit, great care must be taken so that the T_{jpeak} in expression (22) may not exceed the T_{jmax} of the transistor.

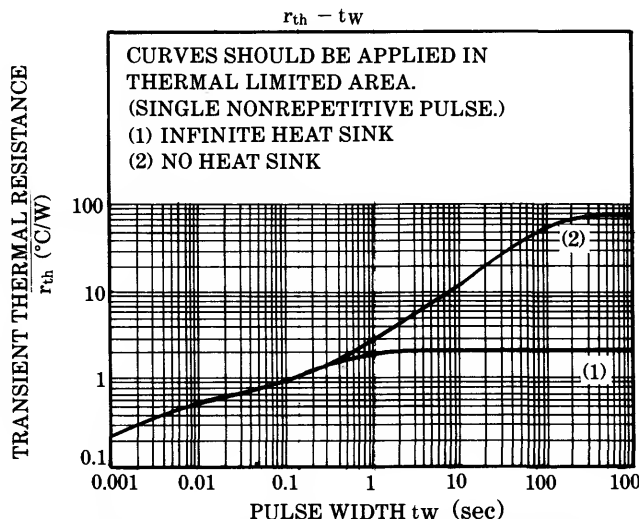


Fig. 5 Transient thermal resistance (2SC3236)

In the above analysis, the rectangular wave is discussed, but in adapting transistors to equipment in practice, $P_j(t)$ may not be a rectangular wave.

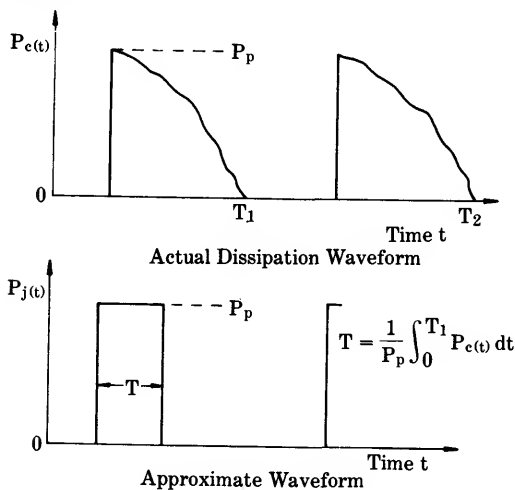


Fig. 6

In such case, by approximating a dissipation waveform to a rectangular waveform, T_{jpeak} can be calculated by expression (22).

3. Thermal Resistance

The thermal resistance in the radiation equivalent circuit shown in Fig. 2 is explained as follows.

(1) Junction-case thermal resistance (internal thermal resistance) θ_i

The internal thermal resistance θ_i from transistor junction to case is directly determined by transistor structure, material, mounting methods of the transistor chip to its case and case filler. Therefore, it is the thermal resistance peculiar to individual transistor.

For measuring this value in practice, it is necessary to keep the temperature of the transistor case constant to make a forcedly cooled state.

In case the transistor operates by cooling the case temperature to constant $T_c=25^\circ\text{C}$, the maximum dissipation allowable to the transistor is given by:

$$P_{C\max} = \frac{T_{j\max} - T_c}{\theta_i} \quad (\text{W})$$

$$= \frac{T_{j\max} - 25}{\theta_i} \quad (\text{W}) \quad \dots (23)$$

Though there appears $T_c=25^\circ\text{C}$ or maximum allowable collector power dissipation in using an infinite heat sink in catalogs for large-output transistors, it is determined by the internal resistance of the transistor, as clarified in expression (14).

(2) Contact thermal resistance θ_c

Contact thermal resistance θ_c is determined by the contact state between transistor case and heat sink, and is greatly influenced by plainness of contact surface, its coarseness, contact area and tightness. For example, with silicon grease applied to the surface, an influence by coarseness and plainness can be reduced.

In cases TO-3, TO-66, TO-220, etc., which are designed to be installed directly to heat sink, the contact thermal resistance comes to about 0.5°C/W if grease is applied.

However, in middle or lower output transistors that are not designed to be installed directly because of the miniaturization and economy of cases, the contact thermal resistance comes to a considerable large value

Table 1 Case-Heat sink Thermal Resistance Value ($\theta_c + \theta_s$)

Package	Insulating plate	$\theta_c + \theta_s$ [$^\circ\text{C/W}$]	
		Silicon grease	
		Present	Absent
TO-3	No insulating plate	0.10	0.3
	Teflon	0.70~0.80	1.25~1.45
	Mica (50~100 μ)	0.5~0.7	1.2~1.5
TO-66	No insulating plate	0.15~0.2	0.4~0.5
	Mica (50~100 μ)	0.6~0.8	1.5~2.0
	Mylar (50~100 μ)	0.6~0.8	1.2~1.4
TO-220AB	No insulating plate	0.3~0.5	1.5~2.0
	Mica (50~100 μ)	2.0~2.5	4.0~6.0
TO-220BS	No insulating plate	0.3~0.5	1.5~2.0
	Mica (50~100 μ)	2.0~2.5	4.0~6.0
TO-220IS	No insulating plate	0.4~0.6	1.0~1.5
(TO-3P) 2-16BIA 2-16CIA	No insulating plate	0.1~0.2	0.5~0.9
	Mica (50~100 μ)	0.5~0.8	2.0~3.0
(TO-3P II) 2-34A1A	No insulating plate	0.1~0.2	0.4~0.7
	Mica (50~100 μ)	0.5~0.7	1.2~1.5
(TO-3P(L)) 2-21F1A	In insulating plate	0.1~0.2	0.4~1.0
	Mica (50~100 μ)	0.5~0.7	1.2~1.5

depending on installation, when heat sink are used. For improving radiation for middle or lower output transistors, there are radiator holders that enable the transistors to be in-

stalled effectively to radiators according to their external diameters.

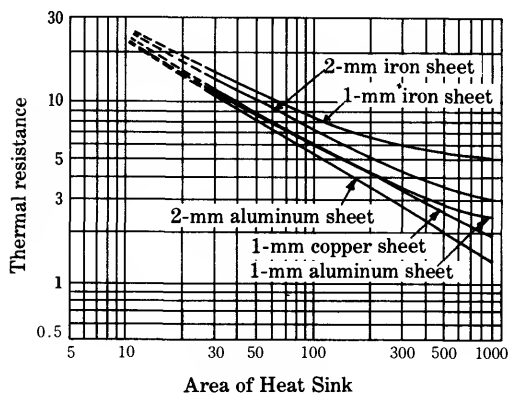


Fig. 7 Area of Heat Sink and Thermal Resistance (θ_f)

(3) Insulating plate thermal resistance θ_s

In case the transistor needs to be insulated from the radiator, an insulator should be used between the transistor and the radiator. The thermal resistance θ_s by this insulator is determined by its material, thickness and area, being a value that can not be neglected.

Regarding insulator conductivity, mica is the best and can be used at high temperature, but is hard to make a sheet of insulator with a uniform thickness and has a disadvantage of brittleness. Mylar is inferior to mica in respect of thermal conductivity but can provide uniform and thin insulators.

Generally, the Si transistor has a high junction temperature and adopts mica as insulator.

In these days, silicon rubber is used. This has good thermal conductivity but is hard to thin, so that careful study is required for its application.

When an insulating plate is used, it can not be considered independently of contact thermal resistance, because its thermal contact state is different from that of metal.

The thermal resistance ($\theta_c + \theta_s$) of each insulating plate including contact thermal resistance is as shown in Table 1.

In design, the sum of contact thermal resistance and the thermal resistance of an insulator plate is considered to be installation ther-

mal resistance ($\theta_c + \theta_s$). When mica is used and silicon grease is applied, it is appropriate to use 1.0°C/W for TO-3 and TO-66, 3.0°C/W for TO-220, and 1.2°C/W for TO-3P, with some allowance.

(4) Radiator thermal resistance θ_f

Radiator thermal resistance is considered to be distributed-constant thermal resistance of the path by which heat escapes from the radiator surface to the open air.

This is related with the state of the open air, the temperature difference between radiator and the open air and the useful area of the radiator and is hard to express by a numerical expression. At present, this is totally determined by actual measurement.

Fig. 7 shows the actual thermal resistance value measured with the radiator set in a vertical position when a transistor is installed in the center of the radiator.

In recent years, radiator manufacturers have been manufactured various radiators, it will be convenient to refer to their data for practical use.

For accessories necessary for installing the power transistor to the radiator and installation method, refer to the item "Accessories"

4. Calculation Example for Radiation Design

On the basis of the data described heretofore, an actual calculation example is shown. The constants to be given or obtained in calculation are classified into 4 as follows.

- (a) Transistor (θ_i, T_{jmax})
- (b) Power dissipation of transistor (P_{dc})
- (c) Ambient temperature (T_a)
- (d) Radiator thermal resistance (θ_f)

- (1) With transistor, ambient temperature and power dissipation given, a radiator is found.

Example 1 :

Giving power consumption $P_{dc}=15W$ to 2SD1187, find a radiator necessary to permit operation up to ambient temperature $T_a=60^\circ C$.

According to the catalog of 2SD1187, the given conditions are $P_{cmax}=80W$ ($T_c=25^\circ C$), $T_{jmax}=150^\circ C$, $P_{dc}=15W$ and $T_a=60^\circ C$.

If mica is used for insulation and silicon grease is applied, $\theta_c + \theta_s = 0.8^\circ C/W$.

From expression (14),

$$\theta_i = \frac{T_{j \max} - T_c}{P_{c \max}} = \frac{150 - 25}{80} \doteq 1.6^\circ\text{C/W}$$

$$\theta_{ja} = \frac{T_{j \max} - T_a}{P_{dc}} = \frac{150 - 60}{15} = 6^\circ\text{C/W}$$

Consequently, from expression (18),

$$\begin{aligned} \theta_t &= \theta_{ja} - (\theta_i + \theta_c + \theta_s) \\ &\doteq 6 - (1.6 + 0.8) \\ &= 3.6^\circ\text{C/W} \end{aligned}$$

A radiator whose thermal resistance is under 3.6°C/W is necessary. With a 2-mm-thick aluminum sheet, an area of 200 cm^2 is required from Fig. 7. Therefore, an aluminum heat sink with dimensions of $140 \times 140 \times 2 \text{ mm}$ is used.

- (2) With transistor, ambient temperature and radiator given, the maximum power dissipation allowed to the transistor is found.

Example 2:

When 2SC3258 is to be installed on an aluminum heat sink with dimensions of $100 \times 100 \times 2 \text{ mm}$, being insulated by mica, and to be operated up to ambient temperature $T_a = 60^\circ\text{C}$, find the maximum power dissipation allowed to the transistor.

According to the catalog, the given conditions are $P_c = 30\text{W}$ ($T_c = 25^\circ\text{C}$), $T_{j \max} = 150^\circ\text{C}$ and $T_a = 25^\circ\text{C}$, and from Fig. 7, $\theta_t = 5.4^\circ\text{C/W}$ or $\theta_c + \theta_s = 3^\circ\text{C/W}$.

First, from expression (23),

$$\theta_i = \frac{T_{j \max} - T_c}{P_{c \max}} = \frac{150 - 25}{30} \doteq 4.2^\circ\text{C/W}$$

Consequently, from expression (18),

$$\begin{aligned} \theta_{ja} &= \theta_i + \theta_c + \theta_s + \theta_t \\ &= 4.2 + 3 + 5.4 \\ &= 12.6^\circ\text{C/W} \\ P_{dc} &= \frac{T_{j \max} - T_a}{\theta_{ja}} \\ &= \frac{150 - 60}{12.6} \\ &\doteq 7.1\text{W} \end{aligned}$$

That is, the maximum power consumption of 7.1 W is allowable.

- (3) With transistor, radiator and power consumption given, the maximum ambient temperature permitting operation is

found.

Example 3:

When 2SD797 is to be installed on an aluminum heat sink with dimensions of $100 \times 100 \times 2 \text{ mm}$, being insulated by mica (silicon grease is applied), find the maximum ambient temperature permitting operation with the maximum power dissipation of 15 W.

According to the catalog, the given conditions are $P_{c \max} = 200\text{W}$ ($T_c = 25^\circ\text{C}$), $T_{j \max} = 175^\circ\text{C}$ and from Fig. 7, $\theta_t = 5.4^\circ\text{C/W}$ or $P_{dc} = 15\text{W}$, and $\theta_c + \theta_s = 1^\circ\text{C/W}$.

First, from expression (23),

$$\theta_i = \frac{T_{j \max} - T_c}{P_{c \max}} = \frac{175 - 25}{200} = 0.75^\circ\text{C/W}$$

From expression (18),

$$\begin{aligned} \theta_{ja} &= \theta_i + \theta_c + \theta_s + \theta_t \\ &= 0.75 + 1 + 5.4 \\ &\doteq 7.2^\circ\text{C/W} \end{aligned}$$

From expression (14),

$$\begin{aligned} T_a &= T_{j \max} - \theta_{ja} \cdot P_{dc} \\ &= 175 - 7.2 \times 15 \\ &= 67^\circ\text{C} \end{aligned}$$

That is, the maximum ambient temperature permitting operation is 67°C .

5. Radiation Design Considering Reliability

The fundamental conception and calculation for thermal stability and radiation in transistor circuit design have already described.

Now, it is necessary to consider the conception about reliability. Particularly, for communication equipment and equipment using numerous parts per unit, derating is required in consideration of reliability.

Generally, the degradation of a transistor has the relation of exponential function with junction temperature. An one-figure (tenfold) improvement of reliability is expected by derating of $40\text{--}50^\circ\text{C}$ with difference among individual kinds of transistor. In case high reliability is needed, it is necessary to keep junction temperature (temperature rise by applied voltage + ambient temperature) as low as possible.

A sudden change of junction temperature is caused by switching on and off of equipment, and its repetition gives rise to thermal fatigue of the electrode junction within the transistor. As a result, a long life may not be expected.

In order to avoid this, sufficient derating is required for junction temperature and its change.

A calculation example of the radiation design considering reliability is shown in Example 4.

Example 4:

When 2SC524 is operated at the maximum ambient temperature of 55°C with power dissipation of 3 W, let's find the necessary heat sink size.

According to the catalog of 2SC524, the given conditions are $P_{cmax}=10W$ ($T_c=25^\circ C$) and $T_{jmax}=175^\circ C$.

First, from expression (19),

$$\theta_i = \frac{T_{jmax} - T_c}{P_{cmax}} = \frac{175 - 25}{10} = 15^\circ C/W$$

For performing high reliable design, the maximum operating junction temperature is derated by 50°C, and the maximum operating junction temperature is:

$$T_{j(op)max} = 175 - 50 = 125^\circ C$$

From expression (17),

$$\begin{aligned} \theta_{ja} &= \frac{T_{j(op)max} - T_{amax}}{P_{dc}} \\ &= \frac{125 - 55}{3} \doteq 23.3^\circ C/W \end{aligned}$$

Consequently, with $\theta_c + \theta_f = 1^\circ C/W$ and from expression (18),

$$\begin{aligned} \theta_t &= \theta_{ja} - (\theta_i + \theta_c + \theta_s) \\ &= 23.3 - (15 + 1) \\ &= 7.3^\circ C/W \end{aligned}$$

A radiator whose thermal resistance is less than 7.3°C/W is required. From Fig. 7, an aluminum heat sink with dimensions of 80 × 80 × 2 mm is appropriate.

In this design, as compared with the design at maximum rating, an approx. two-figure (centuple) improvement of reliability is expected in the case of operation at an ambient temperature of 25°C, and an approx. 1-figure (tenfold) improvement of reliability can be expected even in the case of operation at the worst temperature of 55°C.

Precautions on Utilizing Transistors

It is necessary to carefully handle semiconductor products when operating them, especially when carrying or mounting them. The following refers to notes on handling transistors.

1. Mounting on a heat sink

Power transistors sometimes require heat sinks depending on the source voltage, current load conditions, and ambient temperature. In such a case, the following attentions must be paid so that the heat sink effect is maximized and the transistors are subjected to minimum stress.

(1) Coating with silicon grease

Coat the silicon grease between the transistor and the heat sink to optimize thermal resistance between them. Coat the silicon grease thinly and uniformly.

It is recommended for using a nonvolatile silicon compound. (Should a volatile compound be used, the grease may be cracked in the long run, thus degrading the heat sink effect.)

In some cases where silicon grease is applied to plastic package-type transistors, the base oil contained in the silicon grease may be separated and permeate in the transistor interior, extremely shortening transistor life time. Be careful when selecting the type of silicon grease.

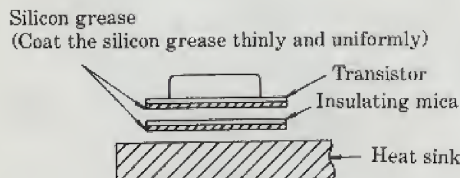


Fig. 1 Coating the silicon grease

Silicon Grease YG6260, produced by Toshiba Silicon Co., is recommended for this purpose. Its base oil is seldom separated, so that it does not affect the transistor life time.

This notice is not applicable to metal-sealed transistors.

(2) Mounting accessories for tightening screws and nuts

It is recommended following the mounting procedures shown in Fig. 2 (TO-3, Toshiba 2-21D1A), Fig. 3 (TO-66, Toshiba 2-13A1A) and Fig. 4 (TO-220 AB, Toshiba 2-10A1A), so that transistors are electrically insulated from the heat sink and thus increase the heat sink effect.

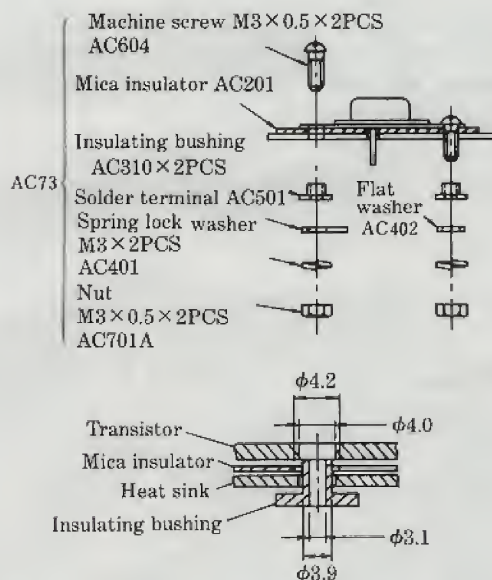
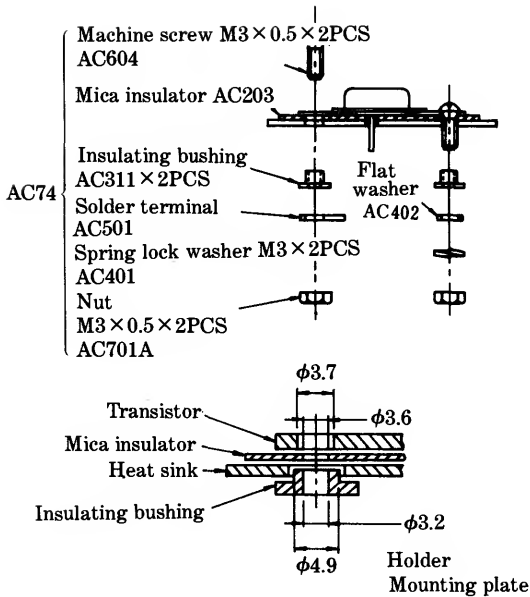
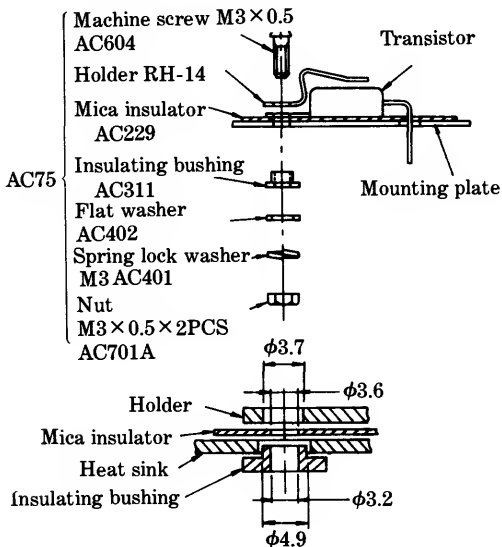


Fig. 2 Mounting transistor TO-3 (2-21D1A) on a heat sink



**Fig. 3 Mounting transistor
TO-66 (2-13A1A) on a heat sink**



**Fig. 4 Mounting transistor
TO-220AB (2-10A1A) on a heat sink**

(3) Screw tightening torque

Should a screw be tightened with excessive tightening torque, it may be wrenched off or

the transistor system may be strained or damaged.

Fig. 5 illustrates relations between screw tightening torque and thermal resistance. Should a certain value of torque be exceeded, thermal resistance becomes saturated.

It is recommended to force below following the tightening torque so that optimum thermal resistance is assured and the transistor is freed from stress, mentioned below (Table 1).

Table 1 Recommended screw tightening torque

Outline		Screw tightening torque (MAX.)
JEDEC	Toshiba product No.	
TO-3	2-21D1A	8kg·cm
TO-66	2-13A1A	6kg·cm
TO-220AB	2-10A1A	6kg·cm
TO-126	2-8F2A	4kg·cm
—	2-16B1A	8kg·cm
—	2-34A1A	8kg·cm

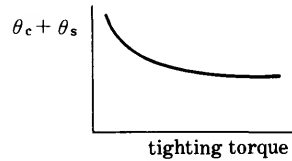


Fig. 5 Relations between screw tightening torque and thermal Resistance

When using a pneumatic screwdriver, it is necessary to control the tightening torque so that its maximum value falls within that listed in Table. 1

(4) Stress on transistor electrode leads

If excessive stress is applied to a transistor electrode lead, the internal connection of wires may be damaged. Especially as to plastic-packaged transistors, keep the stress below 1kg, as shown in Fig. 6.

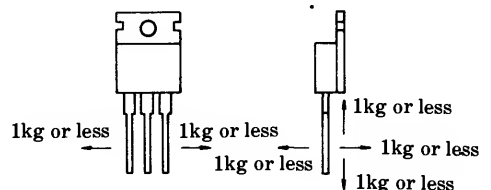


Fig. 6 Stress to electrode leads

(5) Lead Bending

Lead bendings are shown in Fig. 7 if they are require.

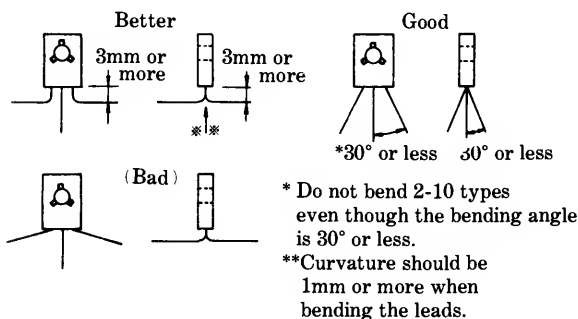


Fig. 7 Lead bending (common to 2-8F1A and 2-10A1A)

2. Electrostatic breakdown

Each transistor has its own maximum rating. The circuits are designed so that excessive voltage and current will not be applied. However, transistors are sometimes damaged before they are actually mounted on circuit boards. This is often resulted by overvoltage breakdown before mounting transistors. It is caused by static electricity produced by a charged human body or packing materials.

For instance, clothes made of chemical fiber which are worn daily are particularly charged with static electricity. Everyone experiences a static electricity "crackling" sound when they take off a coat on a fine and dry day. These values are known from experiments to be from around several kV to tens of kV as listed in Table 2.

Table 2 Voltage electrified by clothing friction (kV)

Static electricity in the human body immediately after removing a work uniform after strongly rubbing against one's underclothing.

(Ambient conditions: 25°C, 25% RH, Unit: kV)

Underclothing	Cotton	Wool	Acryl	Polyester	Nylon	Vinylon + cotton
Work uniform						
Cotton 100%	1.2	0.9	12	15	1.5	1.8
Vinylon/cotton (55%/45%)	0.6	4.5	12	12	4.8	0.3
Polyester/rayon (65%/35%)	4.2	8.4	19	17	4.8	1.2
Polyester/cotton (65%/35%)	14	15	12	7.5	15	14

It has been confirmed that such static electricity leads a transistor to overvoltage breakdown, when applying it to the transistor through its electrode. Although this voltage differs substantially depending on ambient conditions, such voltage will sometimes cause an unexpected breakdown in MOS FETs or high-frequency transistors which are rather easily affected by excessive voltage.

Therefore, take care of handling such transistors as follows.

(1) When storing transistors, it is recommended short-circuiting between electrodes with conductive materials, or to pack the entire transistor with aluminum foil or similar material.

Avoid storing or transporting transistors in nylon or plastic containers which are easily charged static electricity.

(2) When handling transistors, it is necessary to safely discharge static electricity in the ambient environment; for example, by grounding easily charged things on a desk or a human body. (Note)

Note: To ensure human safety, be sure to ground an employee's body through a resistance of 10MΩ or so, rather than directly grounding.

(3) As far as possible avoid using work uniforms of chemical fiber, nylon gloves, and similar fiber.

(4) When mounting transistors for a printed circuit board (PCB), the board often constitutes a high-impedance circuit if it is without being additionally processed.

Since it sometimes happens to apply overvoltage on transistors, it is recommended short-circuiting the electrodes of a PCB with each other in the same manner as when storing transistors.

(5) Although this is not caused by static electricity, when soldering transistors, be careful as to leakage from the soldering iron. It is necessary to protect the transistor from supplying voltage to the solder. It is advisable to ground the tip of the soldering iron through substantially low resistance.

3. Soldering

(1) Soldering temperature

When soldering a transistor onto a printed circuit board, 6/3 solder is usually used. When using this type of solder, it is expected that temperature of the soldering bath (such as flow solder) is about 240–260°C and that of the soldering iron is, 300°C or more.

Maximum rating for storing temperature of a transistor is usually from –55° to +125°C or from –65° to +175°C. It is preferable to solder transistors in as short a time and at as low temperature as possible.

Generally it is necessary to maintain a soldering temperature, 260°C and to shorten the soldering time to less than 10 seconds, except for specially designed transistors.

Even when considering use of a soldering iron, it is necessary to maintain 350°C and 3 seconds or less. It is also recommended that when using a soldering iron, pincettes or pinchers be employed to let heat escape from the transistor main body.

(2) Soldering procedures

As mentioned above, it is necessary that heat being transferred to a transistor be minimized when soldering it.

It is necessary to separate the transistor main body from a printed circuit board or to form its leads in such a manner as to lighten the stress from being applied to the main body, as shown in fig. 8 below.

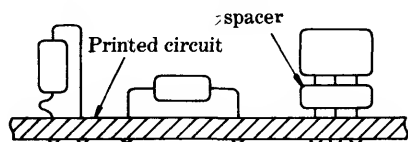


Fig. 8 Example of soldering method

(3) Cleaning method

To remove flux, cleaning is often conducted after soldering transistors to printed circuit boards. This cleaning often involves a cleaning agent for removing flux or an ultrasonic wave cleaning method. Since the outline and markings of semiconductor devices are very delicate, it is necessary to carefully select such solvents. It is recommended using freon-type solvents such as Freon TE and Dai-Freon Solvent S3-E.

When using an ultrasonic wave cleaning method, stress applied to a transistor differs substantially depending on the cleaning bath size, vibrator output, and resonance among devices. Therefore, it is recommended avoiding the use of an ultrasonic wave cleaning method for hollow transistors. However, if use of that method is unavoidable, it is necessary to position the main body of transistors in location not directly exposed to a vibrator and to reduce cleaning time to less than 30 seconds, so that no stress is applied to the main body of transistors.

Reliability of semiconductors

1. Quality assurance program

The quality and reliability of semiconductor elements are closely related and important to our daily lives as well as to industrial equipment.

In this section is explained the quality assurance program as shown in Fig. 1 and Table 1, including the ATS (Approval Test System) in which severe approval tests are defined for each stage of processes from planning through mass production when developing a new item, as well as the maintenance service after delivery of semiconductors.

(1) Development stage

The quality and reliability of semiconductor products are highly dependent upon the designing of element structures. In this stage, the designing, production technology, applied technology, and quality assurance departments and sections cooperate in deliberating on basic design, production processes, and quality and reliability, as well as market research.

Some examples of specific jobs in this stage include setting reliability goals, research on past data, checking design criteria, and establishing estimating methods and criteria considering application. After clearly solving these problems, the development and trial production are started.

In the development and trial production process, both electrical properties and reliability goals are checked and confirmed as to whether or not they have reached the levels initially established.

In this stage, production technology, especially processes peculiar to each product is estimated and confirmed. After quality and reliability are confirmed, a subsequent trial run for mass production is initiated.

In the trial run stage for mass production, are priority is given to the stability of production process estimates.

In this stage, it is important to check whether reliability confirmed in the development and trial run stage are constantly maintained

in a stabilized condition. The ability of production processes is confirmed and priority items are established to realize ideal process control, thus paving the way for subsequent mass production.

(2) Mass production stage

To maintain quality and reliability in the development stage for mass-produced items and to continue stable production with least variations, it is essential that the production process be stabilized, that quality control be thoroughly effected, and that the quality of parts and materials be stabilized.

Toshiba has established QCS (Quality Control Standards) with top priority on in-process quality control, based on the basic policy that "the production process plays the main role in assuring quality and reliability." The check points in process control assimilated in the development stage are strictly and closely followed.

For example, control items, sampling methods, equipment to be used, and supervisors, as well as persons to be contacted if any problems occur, are established for each process so that any abnormalities can be detected at an earlier stage, necessary actions can be taken promptly, and required data can be fed back correctly.

It is quite important to control the quality of component parts and materials. By standardizing individual specifications and quality control procedures, stringent quality control results.

Since semiconductor products and devices have made surprising progress over recent years, they have contributed to laborsaving, automation, and an improvement in quality and reliability. The facilities and instruments for quality control processes constitute important factors in quality control. Therefore, these factors are regularly controlled and calibrated in accordance with Toshiba's standards as well as national agencies.

In addition, the ZD (Zero defects) movement, small-group activities such as QC cir-

cles, and training and education programs as conducted to improve employees' work-

manship and morale.

Fig. 1 Quality Assurance Process

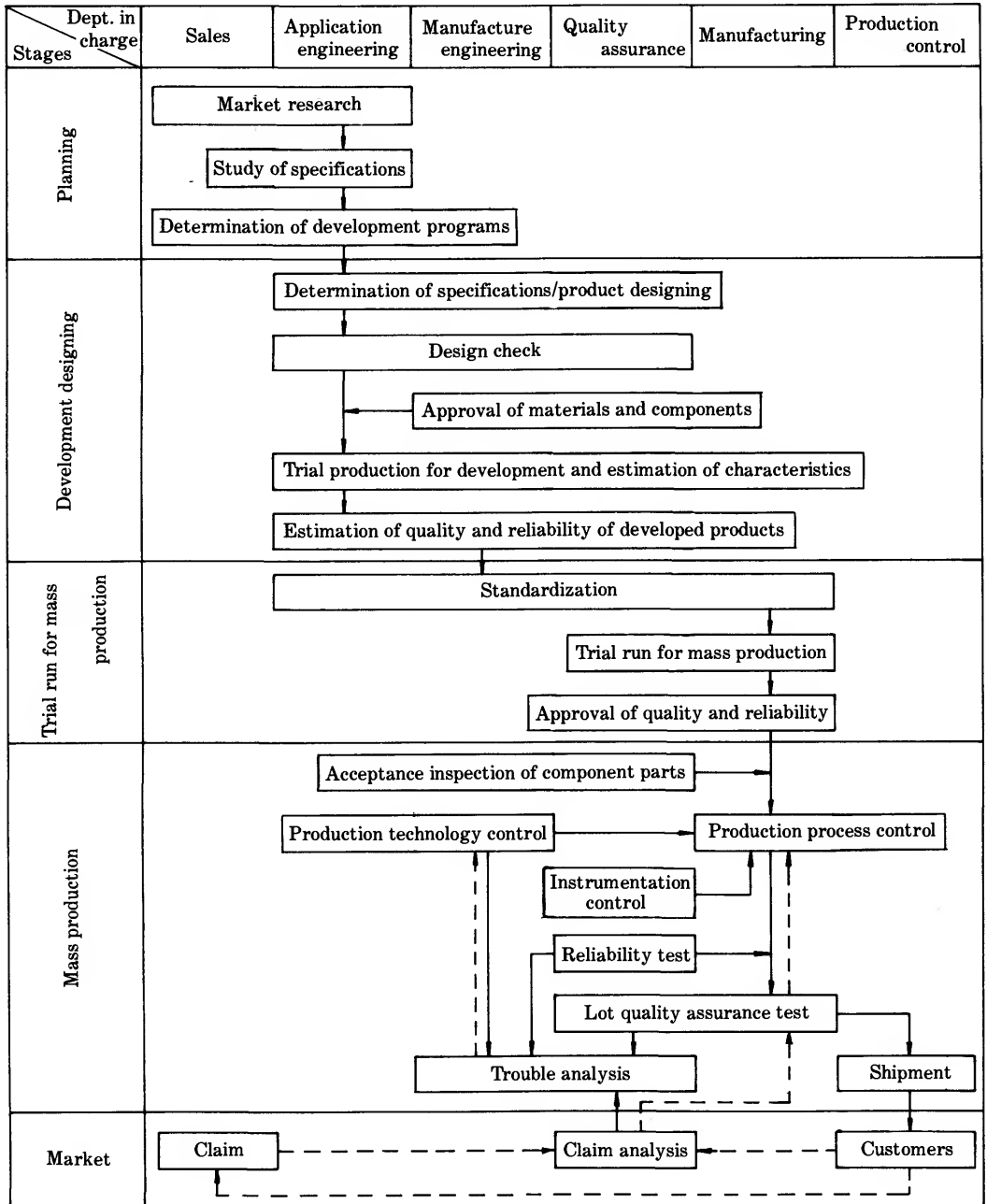

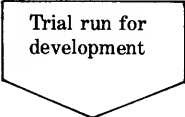
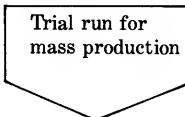
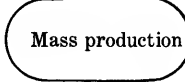


Table 1 Control system for product development

Development steps		Approval Test System (ATS)	Departments participating
 Research and designing	Research, study, and establishment of quality and reliability goals so that products to be developed fulfill the expected functions	Design check	Development designing, application engineering, and quality assurance depts.
 Trial run for development	Establishing production processes by duly considering economic merits and mass production capability, and by establishing quality and reliability	Estimation and approval of designs, DAT (Design Approval Test)	Application engineering, manufacturing engineering, fabrication group, and quality assurance depts.
 Trial run for mass production	Establishing quality and reliability levels and process stabilizing/quality controlling methods	Estimation and approval of quality and reliability levels QAT (Quality Approval Test)	Production technology, quality assurance, production, and production control depts.
 Mass production	Establishment of all controlling systems to manufacture standard products	DAT or QAT is conducted in accordance with the importance of any changes in components, materials, processes, and so on.	Production technology, quality assurance, production, and production control depts

(3) Quality assurance of delivered goods

The quality of products to be delivered is assured under the above-mentioned quality control, such as intermediate inspections and tests at each stage of processing and lot quality assurance tests (electrical properties, external appearance, structure, and service life).

Reliability check tests are regularly conducted to supervise quality and reliability levels. Results and data obtained from these inspections and tests are effectively utilized and filed for improving designing and production processes, as well as for estimating quality in the market.

The above-mentioned flow of products is shown in Fig. 2 quality assurance and confirmation flow chart.

The quality assurance criteria of Toshiba Corporation are based on the LTPD method

which is in accordance with MIL-S-1900.

Quality assurance levels of the criteria are as listed in Table 2.

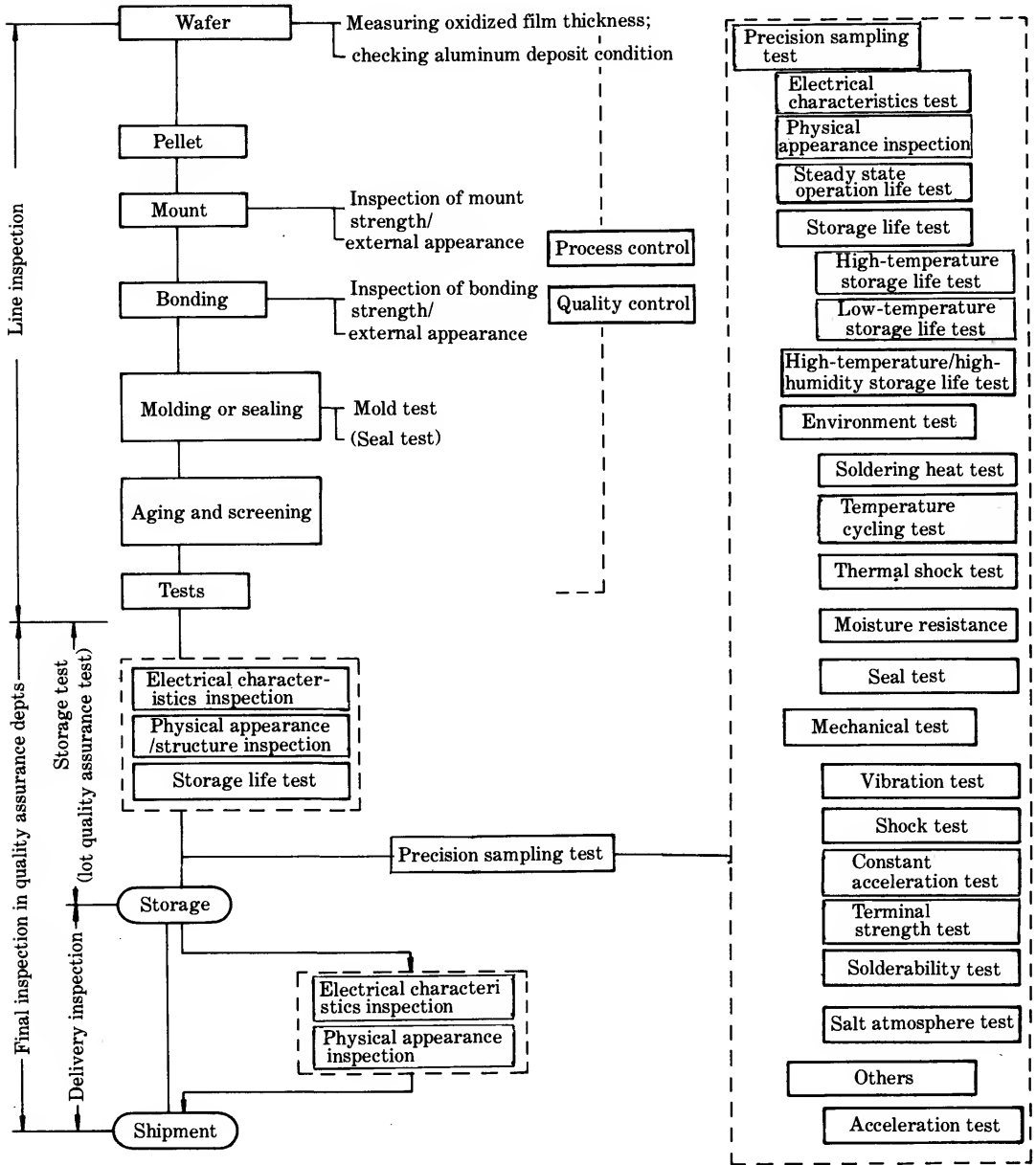
Table 2 Lot quality assurance level (LTPD method)

		Quality	
		Communications industry use	Household use
External appearance/structure/electrical properties	Catastrophic defects	1.5%	5%
	Major defects	5%	10%
	Minor defects	10%	25%

(4) Service activities after shipment

Market information related to quality and

Fig. 2 Quality assurance and confirmation flow chart



reliability of products already shipped is very important for quality control purposes as well as for sales activities. Especially, any information in which the history and conditions of trouble occurrence are clarified is effective as a direct guideline for improving the quality and reliability of such products.

A variety of information obtained through contacts with customers is processed and computed to serve for studying the causes of trouble and for determining preventive measures, thus contributing to quality improvement.

2. Concept and scale of reliability

The quality that makes an element highly reliable is, that when it is used as a part of equipment, it "offers objective functions under stable conditions without failure for a specified duration of time", such an element should be easily compatible in electrical properties when replaced if necessary.

To quantitatively represent reliability, the degree of reliability or the ratio of failure is used to express it as a function of distribution in which time is used as one of the parameters. Therefore, the exponential distribution or the Weible distribution is often used for semiconductor products.

Fig. 3 illustrates failures observed in ordinary electronic parts and semiconductors with time as a parameter; it has been recognized that this curve shows a certain trend.

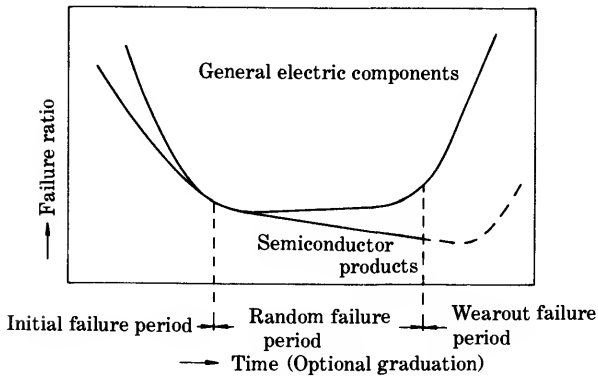


Fig. 3 Variation of failure rate regarding elapsed time

This trend is divided into three periods:

- Initial
- Random failure period
- Wearout failure period

Failure of semiconductor products is characteristic of a gradual reduction in the failure ratio during the random failure period; it is important to minimize the failure ratio in this period because failure occurs at random.

To represent the reliability of semiconductor products, an approximation is conducted by using various types of distribution functions. When assuming an exponential distribution, the most basic distribution pattern in life distribution of electronic components, the reliability function $R(t)$ can be expressed by

the equation —

$$R(t) = \exp(-\lambda t)$$

The instantaneous failure ratio $\lambda(t)$ and average life μ are expressed as —

$$\lambda(t) = \lambda \text{ (constant irrespective of time lapse)}$$

$$\mu = 1/\lambda$$

$$\mu = 1/\lambda = \text{MTTF.}$$

Generally, the failure ratio of semiconductor products is expressed by %/1,000 hours through assuming that time $(t) = 1,000$ hours. Since failure is rare and the failure ratio is small judging from the field data and estimated failure ratio, $1/10^4$ times this value — namely 10^{-4} (%/1,000 hours) = 10^{-9} (failures/hour) — is used under the unit of 1 Fit.

3. Reliability factors

The reliability of transistors should be handled not only for the transistors themselves, but by also taking operational stress and environmental stress into consideration. They are so closely related to each other that the following explanation will help users to utilize them with higher reliability.

(1) Operating conditions

Voltage and current supplied to transistors and the operating conditions surrounding equipment are important factors which affect transistor reliability. The operating points should be determined by selecting an appropriate element for an objective circuit and by designing an appropriate circuit.

It is known that the transistor failure ratio is substantially affected by temperature, and as the temperature rises, the ratio is increased. However, small-signal transistors handle such low voltage and current that no special consideration need be given to temperature, except for those circuits with special operation.

Instead of considering the influence of temperature, attention should be paid to the application of surge voltage and deviation in characteristics caused by external influences or induction. By lowering the limit values for allowable fluctuations in characteristics, to widen the difference between theoretical and actual operation limits when designing a circuit, it is possible to substantially increase the service life of a transistor, and hence, that of the equipment. On the other hand, power

transistors which handle comparatively large voltage and current have large dissipations as a result of a far larger volume of current compared with voltage.

This power dissipation causes a transistor to heat up, adversely affecting both its characteristics and its reliability. Such heat should be efficiently discharged. Refer to the explanation in the previous section for details of heat discharge.

It is recommended that derating be applied to the voltage, current, and temperature specified by maximum ratings, so that transistors may be employed with high reliability. Since derating is determined as a compromise between reliability and economic values, it is rather difficult to consistently specify the degree of derating. The degrees mentioned below are those generally recommended:

Voltage: 70—80% or less for maximum rating

Current: 50% or less for maximum rating

Power: 50% or less for maximum rating

Regarding the degrees of derating, certain government agencies in Japan have established their own standards for operation and designing, and have limited the application ranges. Such a movement constitutes one of the basic activities for improving transistor reliability.

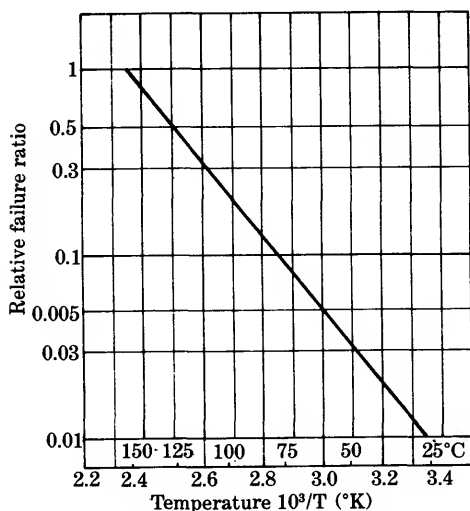


Fig. 4 Derating curve for silicon transistors

Fig. 4 shows an example of relations between the temperature and the failure ratio

by using a Toshiba silicon transistor. It is evident from that figure that the failure ratio is substantially affected by the operating temperature and that higher reliability can be expected by effecting derating.

(2) Variations in transistor quality

The automatization of production processes and the improvement and progress of production technology have been outstanding. The quality and reliability of transistors have continued to be improved year after year thanks to such development, and by positively adopting newly developed technology.

It has probably been stated that there are no variations in quality thanks to the use of modern controlling methods and the full automation of processes. However, transistors and other semiconductor products are extremely small in shape, structure, and size, and are based on microtechnology for conducting their high-precision control, reinforced by physical and chemical technology. Therefore, even the slightest deviation exercises a large influence upon a transistor's characteristics. It is rather difficult to maintain various types of characteristics uniform, even by making full use of today's latest technology.

(3) Resistance against environmental factors

The housings of semiconductor products are classified into the plastic resin-sealed type and the airtight-sealed type using metal. The plastic resin-sealed type, less expensive and possible to mass produce, recently has been employed in the majority of cases, covering application ranges from small signal to large power transistors.

This trend is backed by the facts that resins with high mechanical strength and excellent electrical insulation and resistance against environmental factors have been developed and employed, and that the reliability of this type has been greatly enhanced thanks to progress in molding techniques and surface treatment know-how.

The plastic resin-sealed type up to now has reached the level of the airtight-sealed type except concerning special environments, although transistors are subjected to many environments in the markets. Since the plastic resin-sealed type is not airtight, humidity infiltrates the transistor interior through the

resin. It is recommended employing the airtight-sealed type if the equipment or system is intended for use under a high-humidity environment or when high reliability is required.

Be careful not to directly expose semiconductor products to dust, harmful gases, salty (sea) air, radioactive rays, or similar environments; otherwise, they will suffer from unstable characteristics or rust in the lead wires.

4. Precautions of handling

(1) Mounting on printed circuit boards

When mounting a transistor on a printed circuit, it is assumed that lead wires will be processed or reformed due to space limitation or relations with other components. Even if no such special processing or reforming is conducted, exercise care on the following points:

- (a) Make the spaces of lead wire inserting holes on the printed circuit board the same as those of lead wires on a transistor.
- (b) Even if the spaces are not the same, do not pull the lead wires or push heavily against the transistor element.

For TO-220AB-type transistors, do not apply stress in the direction of the lead wire thicker side.

- (c) Use a spacer for form a lead maintain space between a transistor and a printed circuit board, rather than closely contacting them with each other.
- (d) When forming a lead prior to mounting onto a board:

- Bend the lead at a point 3 mm or more apart from the body. (Lead root)
- Bend one lead wire after securing the other lead wire (near the main body).
- Keep space between the transistor main body and a fixing jig.
- When bending the lead along the jig, be careful not to damage it with an edge of the jig.
- Follow other precautions described in respective standards.

- (e) When mounting a transistor onto a heat sink:

- Use the specified accessory.
- Drill threaded holes on the heat sink as per specifications and keep the surface free from burrs and undulations.
- Use Toshiba's recommended silicon

grease.

- Tighten the screws within the specified torque.
 - Never apply a pneumatic screwdriver to a transistor main body.
- (f) Do not bend or stretch the lead wires repeatedly.

When pulling in the axial direction, apply 500g or 1 kg power, depending on the shapes of lead wires.

(2) Soldering

When soldering a transistor to a printed circuit board, the soldering temperature is usually so high that it adversely affects the transistor. Normally, tests are conducted at a soldering temperature of 260°C for 10 seconds or 350°C for 3 seconds. Be sure to complete soldering procedures under these conditions of temperature and time.

Be careful to select a type of flux that will neither corrode the lead wires nor affect the electrical characteristics of a transistor.

The basic precautions for soldering procedures are as follows:

- (a) Complete soldering procedures in a time as short as possible.
- (b) Do not apply stress to a transistor after soldering by correcting or modifying its location or direction.
- (c) For a transistor employing a heat sink, mount it on the heat sink first; then solder this unit to a printed circuit board after confirming that it is fully secured.
- (d) Do not directly solder the heat-radiating portion of a transistor to a printed circuit board.
- (e) In flow solder jobs, transistors are apt to float on the solder due to solder surface tension. When adjusting the locations of transistors, be careful not to apply excessive stress to the roots of the transistor lead wires.
- (f) When using a soldering iron, select those which have less leakage, and be sure to ground the soldering iron.

(3) Cleaning a circuit board

After soldering, circuit boards must be cleaned to remove flux. Observe the following precautions while cleaning them.

- (a) The below-mentioned solvents are recommended for cleaning purposes:

- Freon TE, TF
- Di-Freon Solvent S3-E

- (b) Do not rub the indication marks with a brush or one's fingers when cleaning or while a cleaning agent is applied to the markings.
- (c) There are ultrasonic wave cleaning methods which offer a high cleaning effect within a short time. Since these methods involve a complicated combination of factors such as the cleaning bath size, ultrasonic wave vibrator output, and printed circuit board mounting method, there is fear that the service life of airtight seal-type transistors may be extremely shortened. Therefore, as far as possible avoid using the ultrasonic wave cleaning method. This concern is not applicable to plastic-type transistors, although below-mentioned basic requirements should be followed:

- Basic requirements of ultrasonic wave cleaning method

Frequency:	27—29 kHz
Output:	300W or less (about 0.3W/cm ² or less)
Recommended sol-vents:	Refer to details above
Cleaning time:	30 seconds or less

Conduct ultrasonic wave cleaning with both the printed circuit board and the transistors floating in the solvent, so that neither product comes in direct contact with the ultrasonic wave vibrator.

It is recommended adopting steam cleaning or jet stream cleaning methods which exert less influence on transistors than dose ultrasonic wave cleaning; it is assumed that various types of transistors are mounted on a printed circuit board.

(4) Static electricity

The maximum ratings designated for transistors denote those values which should not be exceeded even an instant, as described in the previous section; this is applicable commonly to semiconductor products.

It is probable, however, that static electricity or surge voltage that exceed such values may be applied to transistors directly or indirectly while handling or operating them.

Especially, static electricity sometimes

reaches several kV or tens of kV. Should this high voltage be discharged through the electrodes of transistors, high-frequency transistors and MOS-FET transistors which are less resistive to such high voltage in structure, they may be deteriorated or break down. Since protective devices to be mounted on the transistors themselves are restricted for the purpose of assuring electrical characteristics, pay special attention to handling procedures and to separate protective circuits.

Such wires as I/O signal wires and control wires connected to a printed circuit are often connected with other types of electronic components, and they are often very long. Should noise or surge voltage caused by induction be added to these I/O signal wires and control wires, transistors may sometime deteriorate or break down. Take advance protective measures such as inserting protective circuits.

5. Failure mode and failure mechanism

Types of failure are classified into open circuits, short circuits, and deterioration.

(1) Open failure

Factors causing open failure are

- (a) Structural flaws related to or caused by bonding
- (b) Those caused by electrochemical reaction such as electromigration and local cell formation
- (c) Application of stress exceeding that guaranteed by the standards

It is also possible that bonding wires and aluminum wires may be fused off as a result of a combination of the above three factors.

(2) Short failure

Principal factors causing short are

- (a) Excessive stress caused by overvoltage and overcurrent
- (b) Short failure caused by an extreme example of degradation
- (c) Electrochemical reaction

(3) Degradation

From the viewpoint of electrical characteristics, degradation denotes a reduction of withstand voltage lower than the specified value, an abnormal increase in current, and a drift of characteristic values.

Since transistors are produced based on

physical and chemical technology, it is assumed that thermodynamic changes on the surface or in the interior of a transistor caused by voltage, current, temperature, or humidity will result in changes in its physical and chemical properties. As such changes increase gradually, the specified values will be finally exceeded.

The principal factors for deterioration are supposedly—

- (a) Structural flaws
- (b) Designing problems
- (c) Operating problems

Table 3 Lists the relations between failure modes caused by these factors and failure mechanisms.

Table 3 Relationship between failure modes and failure mechanisms

Failure mode	Failure factors	Failure mechanisms				Structural items		Seal		Interior				Surge			
		Structural flaws	Contact and connecting portions	Correlation between components	Thermal fatigue	Defective housing	Sealing	Junction imperfection	Surface channel	Entrapped foreign gas ions	Ionic conduction	Corrosion	Overcurrent	Overvoltage	Static electricity		
Open circuit	Open lead (fused)																
	Open lead (mechanical)	○			○											○	
	Abnormal bonding	○	○	○	○										○		
Short circuit	Junction short circuit				○				○						○	○	○
	Arcing															○	○
	Pellet crack	○		○	○												
	Infiltrated foreign matter	○				○											
	Contact between leads	○	○	○		○											
Degradation	Atmosphere							○		○	○	○	○				
	Smears				○					○	○	○	○				
	Influence of surface oxidized film				○					○		○	○				
	Junction interior				○				○								○
	Arcing															○	○
	Pellet cracks	○		○	○												
Others	Defective external lead wires	○	○			○											
	Housing surface leak	○				○											
	Rust					○											

6. Reliability test

Reliability tests are conducted either for maintaining and confirming reliability assurance levels or for comprehending the design margins and limit levels for using such data when renewing a design.

The reliability test methods and conditions differ according to respective objectives. Normally, an accelerated life test and an environment test are conducted based on maximum ratings by simulating stresses to which transistors will be subjected in actual operation.

Since some tests possess destructive characteristics, it is important to establish reproducible, generally applicable test methods and conditions.

Standard test methods applicable to semiconductor products include JIS, EIAJ, MIL, and IEC standards. Some typical standards among them are described hereunder; the contents of reliability tests are listed in Table 3.

- Japanese Industrial Standards (JIS)
 - JIS C5003 General test procedure of failure ratio for electronic components
 - JIS C5700 General rules for reliability assured electronic components
 - JIS C7021 Environmental testing methods and endurance testing methods for discrete semiconductor devices
 - JIS C7030 Testing methods for transistors
 - JIS C7032 General rules for transistors
 - JIS C7210 General rules for reliability assured discrete semiconductor devices
- Electronic Industries Association of Japan (EIAJ) Standards
 - EIAJ SD-121 Environmental and mechanical test methods for discrete semiconductor devices
 - EIAJ SD-71 Transistor test methods
 - EIAJ SD-31 Field-effect transistor test methods
- U.S. Military Standards (MIL)
 - MIL-STD-202 Test methods for electronic and electrical components parts
 - MIL-STD-750 Test methods for semiconductor devices
 - MIL-S-19500 Semiconductor devices, general specifications for

Table 4 Types and Contents of Reliability Tests

Classification	Types	Description	Applicable standards
Initial performance test	Initial characteristics test	Items of electrical characteristics specified as ratings by respective standards are tested to confirm they fall within requirements of the standards.	
	Appearance, dimensions, and structure tests	Tests are conducted to confirm that materials, polarity, structure, external shapes, dimensions, marking, and external appearance of a transistor are in normal condition or within the allowable limits specified.	
Operation life test	Steady state operation life test:	Durability of a transistor is judged by applying electrical stress (voltage and current) and thermal stress (including temperature rise caused by load) to that transistor over a long period. This test is normally conducted by continuously applying voltage, current, or power at $25 \pm 5^\circ\text{C}$.	EIAJ SD-121 B-4 JIS C7021 B-4 MIL-STD-750B: 1026
	Intermittent operation life test:	Electrical and mechanical durability of a transistor is judged by intermittently feeding power to that transistor and by raising/lowering temperature in accordance with ON/OFF conditions. This test is normally conducted at $25 \pm 5^\circ\text{C}$ under separately specified electrical and time conditions (such as power feeding cycle and interrupting cycle.)	EIAJ SD-121 B-6 JIS C7021 B-6 MIL-STD-750B: 1036
Storage life test	High-temperature storage life test:	Durability of a transistor is judged by storing the transistor at high temperature. Normally, the test temperature is the maximum rated storage temperature (Tstg Max).	EIAJ SD-121 B-9 JIS C7021 B-10 MIL-STD-750B: 1031
	Low-temperature storage life test:	Durability of a transistor is judged by storing the transistor at low temperature. Normally, the test temperature is the minimum rated storage temperature (Tstg Min).	EIAJ SD-121 B-9 JIS C7021 B-12
	High-temperature/high-humidity storage life test:	Durability of a transistor is judged under operation and storage at high relative humidity over a long period. Normally, the test conditions are 60°C and 90%RH.	EIAJ SD-121 B-10 JIS C7021 B-11 MIL-STD-202E: 103B

Classification	Types	Description	Applicable standards
Mechanical test	Drop test:	Structural and mechanical durability is judged. Normally, a test piece is dropped three times from the height of 75cm onto a maple board.	EIAJ SD-121 A-8 JIS C7021 A-8
	Lead strength test:	Lead strength is determined as to whether or not leads are strong enough to endure force to be applied while mounting, wiring, or operating. Normally, lead wires are bent three times by 90° through applying a 250g weight.	EIAJ SD-121 A-8 JIS C7021 A-8 MIL-STD-750B: 2036
	Salt atmosphere test:	Corrosion resistance of a transistor is determined. Normally, the test is conducted at 35°C room temperature by spraying with 5% salt solution for 24 hours. The test is conducted for ten cycles, with one cycle continued for 24 hours.	EIAJ SD-121 A-2 JIS C7021 A-2 MIL-STD-750B: 1046
Acceleration test	Acceleration test:	Generally, life tests consume a long time; at present, especially, the time when the reliability of transistors has been enhanced substantially, life tests require an extremely long time and many samples. Therefore, a forced deterioration test is conducted by increasing stresses exceeding the rated values. The types of forced deterioration factors which should be used such as this test differ substantially depending on the mechanism to cause failures. It is important, therefore, to select forced deterioration factors suitable for the mechanism to be inspected. Additionally, it is necessary to fully comprehend the relations with normal life tests.	

7. Reliability data

Tables 5 and 7 display the results of reliability tests as a typical example of tests conducted in accordance with the above-mentioned test methods, by using a plastic resin sealed-type, small-signal transistor.

Typical criteria for judging failures in these tests are listed in Tables 6 and 8.

Variations by time of various characteristic parameters in operation tests are often analyzed in detail as one of the most basic procedures for estimating transistor reliability. Variations by time of such parameters in life tests conducted as to Tables 5 and 7 are shown in Figs. 5 and 6 as typical examples.

It is evident from these data that initial characteristics are maintained over long hours despite the fact that these tests were conducted based on test conditions using maximum ratings.

It is presumed, therefore, that high reliability can be expected under actual operating conditions of equipment or a device.

Table 5 Results of reliability tests using plastic resin sealed-type small-signal transistor 2SC1815

	Test item	Applicable standards (JIS C7021)	Test conditions	Sample size	Failures	Remarks*
Life test	Steady state operation	B-4	Vc=25V, Pc=300mW Ta=25°C, 1000Hrs	230	0	0.4
	High-temperature storage	B-10	Ta=125°C, 1000Hrs	210	0	
	High-temperature/ High-humidity storage	B-11	Ta=60°C, RH=90% 1000Hrs	230	0	
Environmental test	Soldering heat	A-1	260°C, 10 sec., 1 time (up to 1.5mm from lead root)	170	0	
	Temperature heat	A-4	-55°C~25°C~125°C~25°C 20 cycles	530	0	
	Thermal shock	A-3	100°C~0°C, 10 cycles	190	0	
	Moisture resistance	A-5	Ta=~65°C, RH=90~98% 10 cycles	190	0	
Mechanical tests	Vibration	A-10	100~2000Hz 20G 3 directions x four times each	60	0	
	Shock	A-7	1500G, 0.5ms 4 directions x 3 times each	60	0	
	Constant acceleration	A-9	20000G, 6 directions x 1 min.	60	0	
	Lead strength	A-11	250g, 90° bending x 3 times	90	0	
	Drop	A-8	75cm, maple board	90	0	
	Solderability	A-2	230°C, 5 seconds (using specified flux)	90	0	

*Failure ratio = %/1,000 hrs, 60% confidence level

2SC1815 PC=300mW OPERATION
(VC=6.0V IC=2mA)

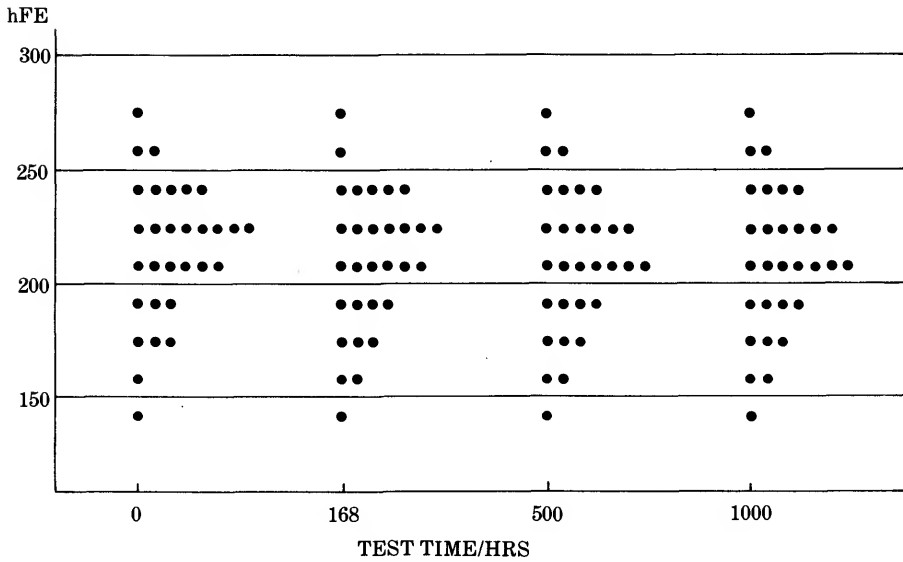


Fig. 5 Typical example of results of steady state operation life test of plastic resin sealed-type 2SC1815

2SK117V_{DG}=20V OPERATION
(V_{DS}=10V V_{GS}=0V)

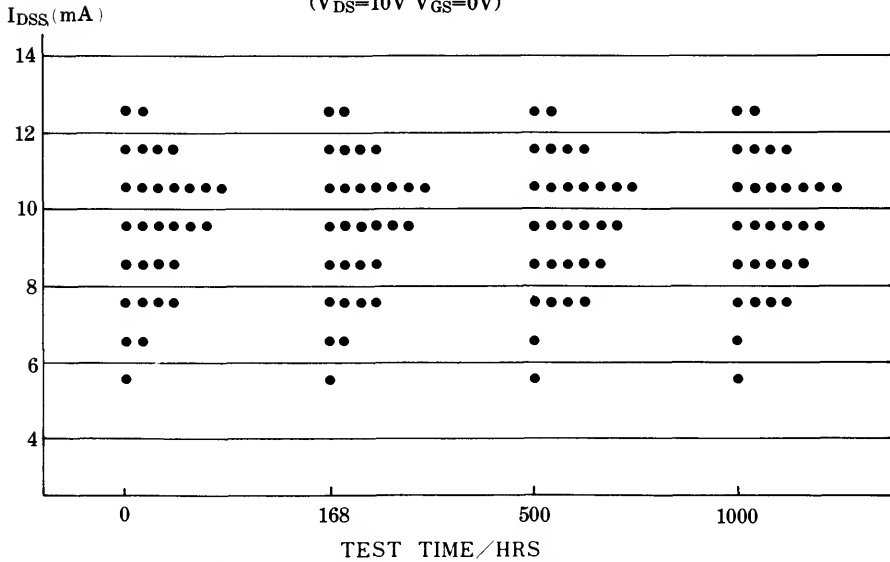


Fig. 6 Typical example of results of steady state operation life test of plastic resin sealed-type 2SK117

Table 6 Criteria on failures for 2SC1815

Items of characteristics	Symbols	Measuring conditions (Ta=25°C)	Criteria*	Remarks
Collector cutoff current	I_{CBO}	$V_{CB}=60V, I_E=0$	USLx2	0.2μA Max
Emitter cutoff current	I_{EBO}	$V_{EB}=5V, I_C=0$	USLx2	0.2μA Max
Static forward current transfer ratio	h_{FE}	$V_{CE}=6V, I_C=2mA$	USLx1.2 LSLx0.8	56~480

*USL: Upper specification limit, LSL: Lower specification limit

Table 7 Extracted results of reliability tests using plastic resin sealed-type FET transistor 2SK117

	Test item	Applicable standards (JIS C7021)	Test conditions	Sample size	failures	Remarks*
Life test	Steady state operation	B-5	$V_{DS}=20V$ $T_a=25^\circ C, 1000Hrs$	190	0	0.5
	High-temperature storage	B-10	$T_a=125^\circ C, 1000Hrs$	190	0	
	High-temperature/ High-humidity storage	B-11	$T_a=60^\circ C, RH=90\%$ 1000Hrs	190	0	

*Failure ratio = %/1,000 hrs, 60% confidence level

Table 8 Criteria on failures for 2SK117

Items of characteristics	Symbols	Measuring conditions (Ta=25°C)	Criteria*	Remarks
Gate leak current	I_{GSS}	$V_{GS}=-30V, V_{DS}=0$	USLx2	-2.0nA Max
Gate drain voltage with source short-circuited to drain	V_{GDS}	$V_{DS}=0, I_G \sim 100\mu A$	LSLx0.9	-45V Min
Drain current	I_{DSS}	$V_{DS}=10V, V_{GS}=0$	USLx1.2 LSLx0.8	0.48~16.8mA

*USL: Upper specification limit, LSL: Lower specification limit

Characteristics of Transistor

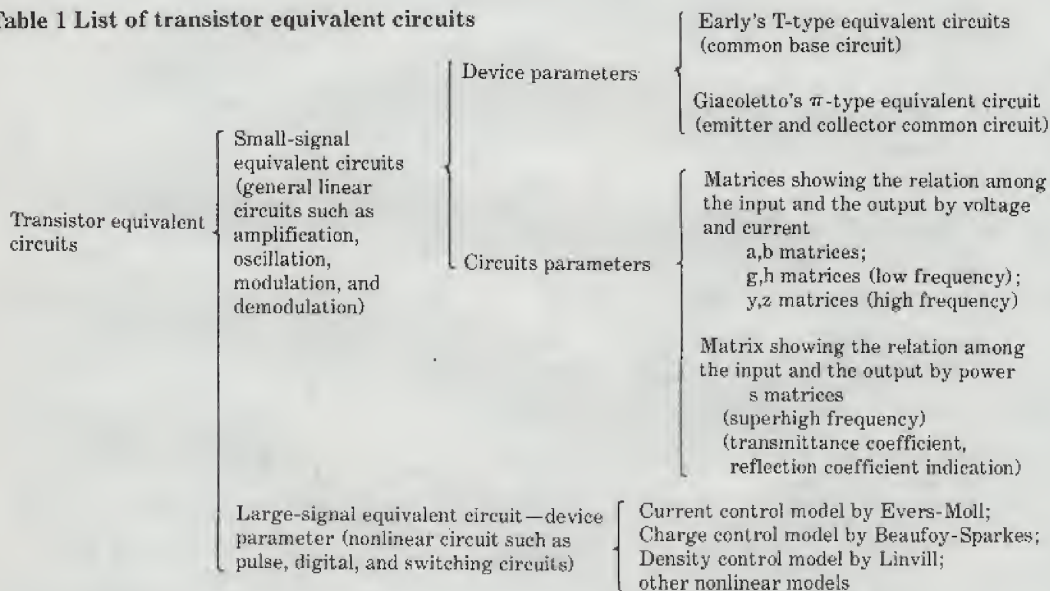
Equivalent parameters of a transistor include the device parameters which closely respond to the internal operating mechanism of a transistor and the circuit parameters which are indicated as a matrix obtained from regarding a transistor as a terminal circuit network.

These parameters are also divided into small-signal equivalent circuits (analog circuits) and large-signal equivalent circuits (digital circuits), in accordance with the

extent of signals (amplitude) to be handled.

Equivalent circuits have been developed very much. It is necessary for circuit designers to select an optimal one by paying attention to the application ranges and operating limits of respective equivalent circuits. Table 1 lists equivalent circuits presently employed. Among others, small-signal equivalent circuits are hereafter described, since they are generally used.

Table 1 List of transistor equivalent circuits



1. Device parameter

(1) Early's T-type equivalent circuit

(Bipolar transistor)

Figure 1 shows Early's T-type equivalent circuit.

r_e : Emitter resistance,

This is represented by the following equation, since it is forward-biased resistance with emitter-to-base junction:

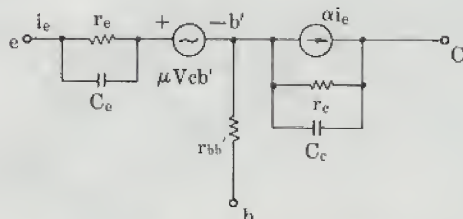


Fig. 1 Early's T-type equivalent circuit

$$r_e = \frac{kT}{qI_E} (\Omega) \dots\dots\dots (1)$$

where,

- k: Boltzman's constant
(1.38×10^{-26} J/°K)
- T: Absolute temperature (°K)
- q: Electric charge of electron
(1.60×10^{-19} C)

I_E : Emitter current (A)

Equation (1) is changed as follows at normal temperature (300°K) if the emitter current is represented by mA:

$$r_e = \frac{26}{I_E \text{ (mA)}} (\Omega) \dots\dots\dots (2)$$

C_e : Emitter capacitance ($C_{Te} + C_{De}$)

This is represented as a sum of the depletion layer capacitance and the diffusion capacitance. Normally since the depletion layer capacitance in an emitter-to-base junction is far smaller than the diffusion capacitance, it can be ignored.

The depletion layer capacitance C_{Te} and the diffusion capacitance C_{De} are represented as—

$$C_{Te} = A_e \sqrt{\frac{\frac{1}{2} \epsilon q n_N}{\phi_0 - V_{be}}} (F) \dots\dots\dots (3)$$

where,

- A_e : Emitter junction area (m^2)
- ϵ : permittivity
- n_N : Majority carrier density (m^{-3}) on high specific resistance side (NPN in this case)
- ϕ_0 : Contact potential difference (potential fault when balanced) (V)
- V_{be} : Potential applied to both ends of base to emitter junction (1)

$$C_{De} = \frac{qI_E W^2}{2kTD} (F) \dots\dots\dots (4)$$

where,

- W: Base width (m)
- D: Diffusion coefficient of minority carrier in base area (m^2/sec)
- μ : Voltage feedback ratio (Early constant)

This constant, known as the Early effect, is a base width modulation parameter,

$$\mu = \frac{kT d_c}{3qW(\phi_0 - V_{bc})} \dots\dots\dots (5)$$

where,

- d_c : Width of collector depletion layer (m)
- r_c : Collector resistance

This is a kind of base width modulation

parameter, represented as follows:

$$r_c = \frac{1}{I_E \left(\frac{\partial \alpha}{\partial V_{bc}} \right)} (\Omega) \dots\dots\dots (6)$$

The value of r_c is usually 1— 2 M Ω or so.

C_c : Collector capacitance

Similarly to emitter capacitance, this is shown as the sum of depletion layer capacitance and diffusion capacitance of the collector-to-base junction. However, since the diffusion capacitance of the collector-to-base junction is far smaller than the depletion layer capacitance, it can be ignored. The depletion layer capacitance is represented as

$$C_{Tc} = A_c^3 \sqrt[3]{\frac{\epsilon^2 q a}{12(\phi_0 - V_{bc})}} (F) \dots\dots\dots (7)$$

where,

- A_c : Collector junction area (m^2)
- a: Impurity concentration gradient (m^{-4})
- V_{bc} : Potential applied to both ends of base to collector junction (V)

Usually the value of C_c is 1—10pF.

α : DC forward current transfer ratio

This is the only parameter among Early's T-type parameters that depends on frequency, represented by the equation

$$\alpha = \frac{\alpha_0}{1 + j\omega C_e r_e} \quad f\alpha = \frac{1}{2\pi C_e r_e}$$

therefore,

$$\alpha = \frac{\alpha_0}{1 + j \frac{f}{f\alpha}} \dots\dots\dots (8)$$

where,

- α_0 : Value of α at low frequency
- $f\alpha$: α -interrupting frequency (frequency at which α is reduced by 3db less than α_0)

Fig. 2 shows the frequency locus of α . When actually measuring α , the difference between theoretical and measured values is increased as the frequency approaches $f\alpha$. This is because Early's equivalent circuit is based on the primary approximation of physical phenomena.

To correct it, Thomas-Moll introduced excess phase m and offered the equation

$$\alpha = \frac{\alpha_0}{1 + j\frac{f}{f_\alpha}} e^{-jm\frac{f}{f_\alpha}} \dots\dots\dots (9)$$

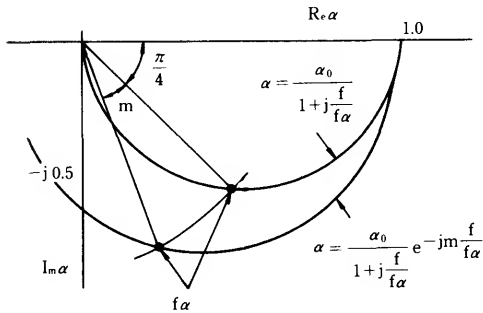


Fig. 2 Frequency locus of α

The above equation agrees well with measured values in frequencies less than f_α .

DC Current gain (β) at common emitter is represented as follows:

$$\beta = \frac{\alpha}{1 - \alpha} = \frac{\alpha_0}{(1 - \alpha_0) + j\frac{f}{f_\alpha}}$$

The β -interrupting frequency f_β is defined as the frequency at which the absolute value of β becomes $\beta_0/\sqrt{2}$, similarly to f_α , f_β is represented as—

$$f_\beta = \frac{\alpha_0}{\beta_0} f_\alpha$$

therefore,

$$\beta = \frac{\beta_0}{1 + j\frac{f}{f_\beta}} \dots\dots\dots (10)$$

$r_{bb'}$: Base diffusion resistance

This is resistance from the center of base area to the external base terminal which actually contributes to transistor action and is determined according to shape and dimensions of the transistor and base specific resistance.

$$r_{bb'} \doteq \frac{Q_B}{8\pi W} (\Omega) \dots\dots\dots (11)$$

where,

Q_B : Specific resistance of base area ($\Omega \cdot m$)

(2) Giacoletto's π -type equivalent circuit (bipolar transistor)

Fig. 3 shows the π -type equivalent circuit. This equivalent circuit is in itself the same as Early's T-type equivalent circuit mentioned above. The only difference from Early's T-type equivalent circuit is that each parameter has—in principle—no frequency response.

Since the physical meaning of each parameter is easy to understand, this circuit is popularly employed. When actually employed for circuit calculation, it will prove convenient if the basic style shown in Fig. 3 is slightly simplified by considering frequency range.

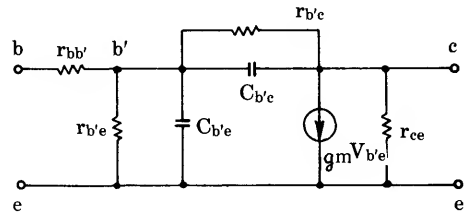


Fig. 3 π -type equivalent circuit

Parameters of the T-type equivalent circuit and those of the π -type have the correlation shown in Table 2.

Table 2 Relationship between parameters of T-type and π -type equivalent circuits

π -type equivalent circuit parameters	T-type equivalent circuit parameters
$C_{b'e}$	C_e
$r_{b'e}$	$\frac{r_e}{1 - \alpha_0}$
$C_{b'c}$	C_c
$\frac{1}{r_{b'c}}$	$\frac{1}{r_c} \frac{\mu(1 - \alpha_0)}{r_e}$
r_{ce}	$\frac{r_e}{\mu}$
g_m	$\frac{\alpha_0}{r_e}$
$r_{bb'}$	$r_{bb'}$

(3) FET equivalent circuit

Similarly to bipolar transistors, FET can be indicated by using an equivalent circuit. Fig. 4 is a schematic diagram of the equivalent circuit by relating to its structure.

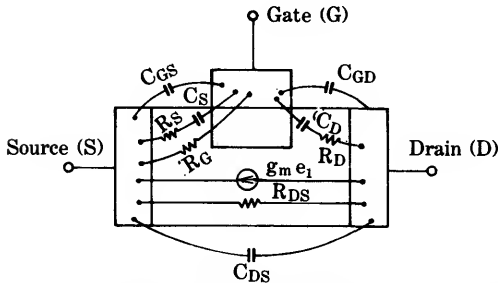


Fig. 4 equivalent circuit in relation to structure of an FET

This diagram is rewritten into an equivalent circuit in Fig. 5(a), and further rewritten into a practical, simplified equivalent circuit in Fig. 5(b).

C_{GD} , C_{GS} and C_{DS} shown here are parasitic capacitances. Since their values are relatively small, it is possible to ignore them unless this circuit is used in VHF regions.

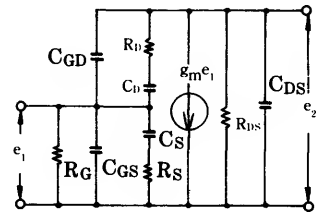
However, when using transistors whose capacitances between electrodes are large, such as a power FET and a high-gm FET in low-frequency regions, these capacitances must be considered fully.

For FET to be used in chopper circuits, it is necessary to keep the difference between C_{DG} and C_{GS} small to prevent spikes.

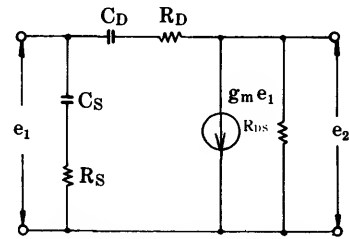
This equivalent circuit shows the characteristic of an FET very well, because it is related to the structure of an FET and it is shown by using basic parameters not depending on frequency.

As shown in the simplified equivalent circuit, for example, it is understood that DC input resistance (which is infinity) can be practically ignored and that C_D (internal feedback capacitance) is an unstable factor at high frequency.

At low frequency, it is possible to ignore capacitance; input resistance is infinity, while output resistance = R_{DS} . This is almost the equivalent circuit of a vacuum tube.



(a) Equivalent circuit



(b) Simplified equivalent circuit

Fig. 5 Equivalent circuit

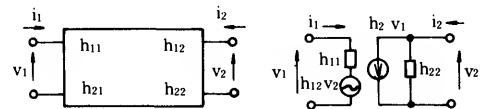
2. Circuit parameters

This is a method used to describe a transistor by regarding it as a four-terminal circuit network and by using the electrical characteristics of terminals irrespective of the physical characteristics of the transistor.

- (1) Matrices showing the relation among the input and the output by voltage and current.

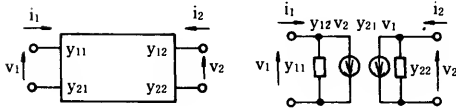
Those matrices have the six types shown in Table 1 (a, b, g, h, y, and z matrices). Among others, both "h" and "y" matrices are used comparatively often.

Fig. 6 and 7 show the definitions of "h" and "y" matrices. Classification between the common emitter and the common base is shown by using suffixes e or b after i, r, f, or o.



$$\begin{bmatrix} v_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \begin{bmatrix} i_1 \\ v_2 \end{bmatrix} = \begin{bmatrix} h_i & h_r \\ h_f & h_o \end{bmatrix} \begin{bmatrix} i_1 \\ v_2 \end{bmatrix}$$

Fig. 6 Circuit network by using "h" matrix



$$\begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = \begin{bmatrix} y_i & y_r \\ y_f & y_o \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

Fig. 7 Circuit network by using "y" matrix

The physical meanings of each parameter in Figs. 6 and 7 are as follows:

- h_i : input impedance
- h_r : voltage feedback ratio
- h_f : current gain
- h_o : output admittance
- y_i : input admittance
- y_r : reverse transfer admittance
- y_f : forward transfer admittance
- y_o : output admittance

The h matrix are often used for the low-frequency regions, and y matrix for the high-frequency regions.

(2) Matrix showing the relation among the input and the output by power

Such phenomena as the reflection and transfer of waves in microwave circuits (such as waveguides and cavity resonators) are usually indicated by a "s" matrix (scattering matrix).

As the frequency limits for semiconductor products expand, the "s" matrix is occasionally used as a circuit parameter.

The definition of the "s" matrix is shown in Fig. 8; the physical meanings of each parameter are as follows:

- s_{11} : input reflection coefficient
- s_{12} : reverse transfer coefficient

Table 3 Conversion of parameters

	[H]	[Y]	[S]
[H]	$\begin{matrix} h_i & h_r \\ h_f & h_o \end{matrix}$	$\begin{matrix} \frac{1}{y_i} & -\frac{y_r}{y_i} \\ \frac{y_f}{y_i} & \frac{y_i y_o - y_r y_f}{y_i} \end{matrix}$	$\begin{matrix} \frac{(1+s_o)(1+s_i) - s_r s_f}{(1-s_i)(1+s_o) + s_r s_f} \\ \frac{(1-s_i)(1+s_o) + s_r s_f - 2s_f}{(1-s_i)(1+s_o) + s_r s_f} \\ \frac{(1-s_i)(1+s_o) + s_r s_f}{(1-s_i)(1+s_o) + s_r s_f} \\ \frac{(1-s_i)(1-s_o) - s_r s_f}{(1-s_i)(1+s_o) + s_r s_f} \end{matrix}$
[Y]	$\begin{matrix} \frac{1}{h_i} & -\frac{h_r}{h_i} \\ \frac{h_f}{h_i} & \frac{h_i h_o - h_r h_f}{h_i} \end{matrix}$	$\begin{matrix} y_i & y_r \\ y_f & y_o \end{matrix}$	$\begin{matrix} \frac{(1+s_o)(1-s_i) + s_r s_f}{(1+s_i)(1+s_o) - s_r s_f} \\ \frac{(1+s_i)(1+s_o) - s_r s_f - 2s_f}{(1+s_i)(1+s_o) - s_r s_f} \\ \frac{(1+s_i)(1+s_o) - s_r s_f}{(1+s_i)(1+s_o) - s_r s_f} \\ \frac{(1+s_i)(1-s_o) + s_r s_f}{(1+s_i)(1+s_o) - s_r s_f} \end{matrix}$
[S]	$\begin{matrix} \frac{(h_i - 1)(h_o + 1) - h_r h_f}{(h_i + 1)(h_o + 1) - h_r h_f} \\ \frac{(h_i + 1)(h_o + 1) - h_r h_f}{-2h_f} \\ \frac{(h_i + 1)(h_o + 1) - h_r h_f}{(1+h_i)(1-h_o) + h_r h_f} \\ \frac{(h_i + 1)(h_o + 1) - h_r h_f}{(h_i + 1)(h_o + 1) - h_r h_f} \end{matrix}$	$\begin{matrix} \frac{(1-y_i)(1+y_o) + y_r y_f}{(1+y_i)(1+y_o) - y_r y_f} \\ -2y_r \\ \frac{(1+y_i)(1+y_o) - y_r y_f}{-2y_f} \\ \frac{(1+y_i)(1+y_o) - y_r y_f}{(1+y_i)(1+y_o) - y_r y_f} \\ \frac{(1+y_i)(1-y_o) + y_r y_f}{(1+y_i)(1+y_o) - y_r y_f} \end{matrix}$	$\begin{matrix} s_i & s_r \\ s_f & s_o \end{matrix}$

**Table 6 "h" parameters converted by Early's
T-type device parameters**

	Common base		Common emitter
h_{ib}	$\frac{r_e + r_{bb'} \left[(1 - \alpha_0) + j \frac{f}{f\alpha} \right]}{1 + j(f/f\alpha)}$	h_{ie}	$r_{bb'} + \frac{r_e}{(1 - \alpha_0) + j(f/f\alpha)}$
h_{rb}	$j2\pi f C_{c1} r_{bb'}$	h_{re}	$2\pi f \alpha C_{ce} \frac{j \frac{f}{f\alpha}}{(1 - \alpha_0) + j(f/f\alpha)}$
h_{fb}	$\frac{-\alpha_0}{1 + j(f/f\alpha)}$	h_{fe}	$\frac{\alpha_0}{(1 - \alpha_0) + j(f/f\alpha)}$
h_{ob}	$j2\pi f C_c$	h_{oe}	$2\pi f \alpha C_c \frac{j \frac{f}{f\alpha} (1 + j \frac{f}{f\alpha})}{(1 - \alpha_0) + j(f/f\alpha)}$

**Table 7 "y" parameters converted by Early's
T-type device parameters**

	Common base		Common emitter
y_{ib}	$\frac{1 + j \frac{f}{f\alpha}}{r_e + j r_{bb'} \frac{f}{f\alpha}}$	y_{ie}	$\frac{(1 - \alpha_0) + j \frac{f}{f\alpha}}{r_e + j r_{bb'} \frac{f}{f\alpha}}$
y_{rb}	$-2\pi f \alpha C_c \frac{j \frac{f}{f\alpha} \left(1 + j \frac{f}{f\alpha} \right)}{\frac{r_e}{r_{bb'}} + j \frac{f}{f\alpha}}$	y_{re}	$-2\pi f \alpha C_c \frac{\frac{r_e}{r_{bb'}} \frac{j \frac{f}{f\alpha}}{\frac{r_e}{r_{bb'}} + j \frac{f}{f\alpha}}}{\frac{r_e}{r_{bb'}} + j \frac{f}{f\alpha}}$
y_{fb}	$-\frac{\alpha_0}{r_e + j r_{bb'} \frac{f}{f\alpha}}$	y_{fe}	$\frac{\alpha_0}{r_e + j r_{bb'} \frac{f}{f\alpha}}$
y_{ob}	$2\pi f \alpha C_c \frac{j \frac{f}{f\alpha} \left(1 + \frac{r_e}{r_{bb'}} + j \frac{f}{f\alpha} \right)}{\frac{r_e}{r_{bb'}} + j \frac{f}{f\alpha}}$	y_{oe}	y_{ob}

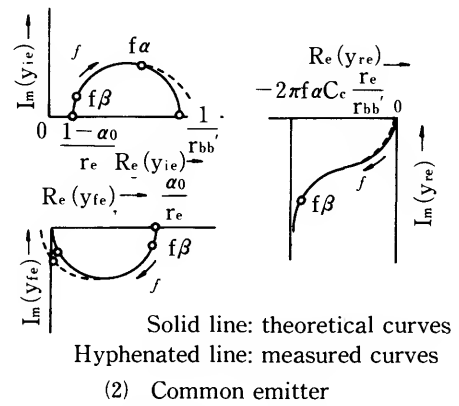
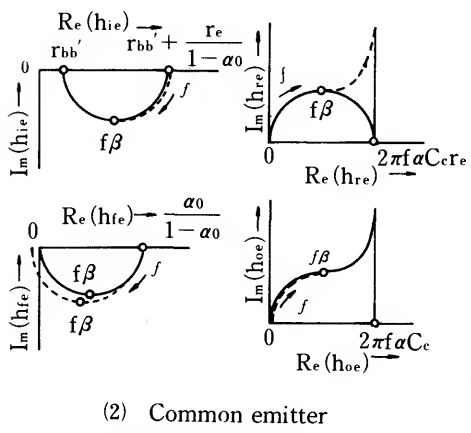
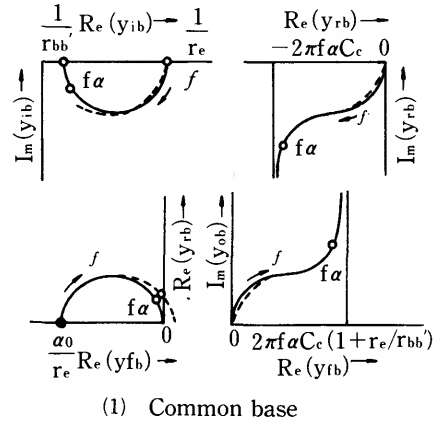
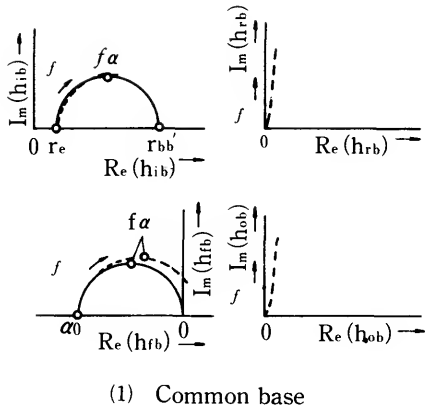


Fig. 9 Frequency locus of "h" parameters

Fig. 10 Frequency locus of "y" parameters

Please refer to Tables 3, 4, and 5 for the correlation and conversion of common base and common emitter among circuit parameters. Fig. 9 and 10 shows the frequency locuses of "h" and "y" parameters obtained from Tables 6 and 7.

The above-mentioned parameters vary according to the operating points and temperature; thus, circuit designers should effect designing by comprehending the rough trends of such variations.

3. Low-frequency, low-noise amplifier circuit

(1) Design for low-noise amplifiers

It is necessary to carefully select the types and operating methods of transistors to be

used when designing low-noise amplifiers. Voltage, current, and signal source impedance conditions to be operated should be fully checked and operate the transistors within the best noise characteristic range.

This section describes the concept of noise characteristics, the most suitable transistor conditions, and relations between the amplifier S/N ratio and the noise figure of transistors, so that circuits can be designed by fully utilizing the characteristics of low-noise transistors.

(2) Noise characteristics of transistors

The noise figures (NF) of transistors are represented by the equation

$$NF = 10 \log \left(\frac{E_{si}}{E_{ni}} / \frac{E_{so}}{E_{no}} \right)^2 \quad (\text{dB})$$

$$= 20 \log \left(\frac{E_{si}}{\sqrt{4kTR_g B}} \cdot \frac{E_{so}}{E_{no}} \right) \text{ (dB)} \quad (13)$$

- E_{si}:** input signal voltage
E_{ni}: input noise voltage
E_{so}: output signal voltage
E_{no}: output noise voltage
k: Boltzmann's constant
 $(1.38 \times 10^{-23} \text{ J/}^\circ\text{K})$
 $4kT = 1.63 \times 10^{-20} \text{ J}$
T: absolute temperature ($^\circ\text{K}$)
R_g: signal source resistance
B: noise bandwidth
 or $E_{ni} = 4kTR_g B$

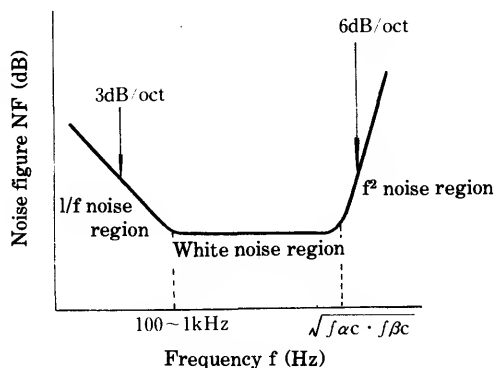


Fig. 11

Table 8

Items \ Types	1/f noise region	White noise region	f ² noise region
Description	Noise increasing in reverse proportion to frequency f	Constant noise irrespective of frequency	Noise increasing by 6 dB/oct in proportion to frequency f
Causes	Surface fluctuation	Thermal noise caused by base spreading resistance r _{bb'}	Fluctuation by current separation
Suitability for audio application	○	○	×
Equalizer amplifier	⊙	○	×

The relations between NF and the frequency is shown in the above figure. Noise characteristics are divided into ① 1/f noise region, ② white noise region, and ③ f² noise region, according to the frequency.

$$e_N = \sqrt{4kTR_N B}$$

$$i_N = \sqrt{2qI_B B}$$

Assuming that there is an ideal transistor possessing no noise sources, the above-mentioned noise figure (NF) can be represented as

$$NF = 10 \log \left(\frac{4kTR_g + e_N^2 + i_N^2 R_g^2 + 2\gamma e_N i_N}{4kTR_g} \right) \text{ (dB)} \quad (14)$$

where, B=1 Hz, and γ =correlated coefficient of e_N and i_N

This equation shows the relations between NF and e_N and i_N

It is evident from equation (14) that noise figure NF is dependent upon collector current I_c and signal source impedance R_g. Assuming that the total noise voltage = e_{NT} ,

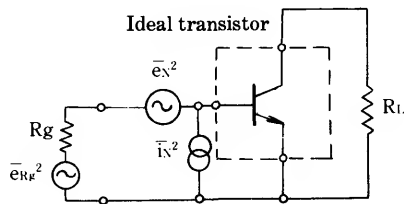


Fig. 12

Transistors can be identified by using the following voltage noise source e_N and current noise source i_N

$$e_{NT}^2 = 4kTR_g + e_N^2 + i_N^2 R_g^2 + 2\gamma e_N i_N \quad (15)$$

Therefore, there is the following relationship between e_{NT} and signal source impedance R_g.

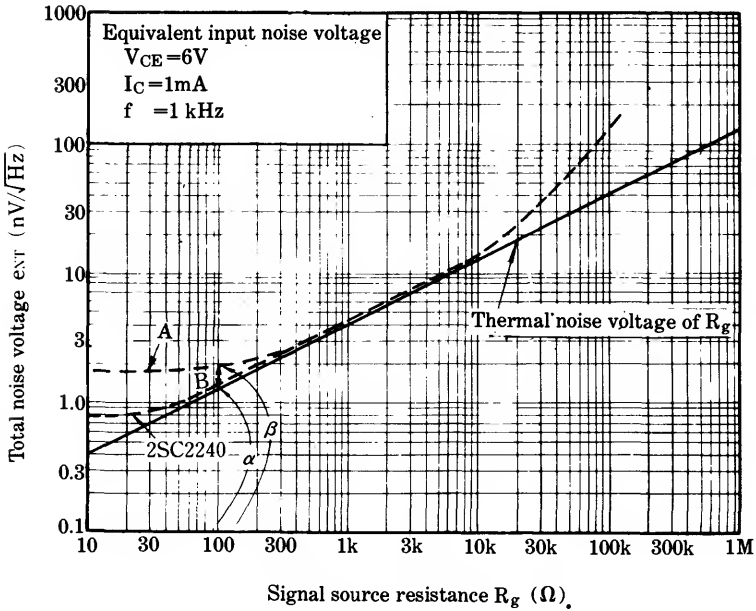
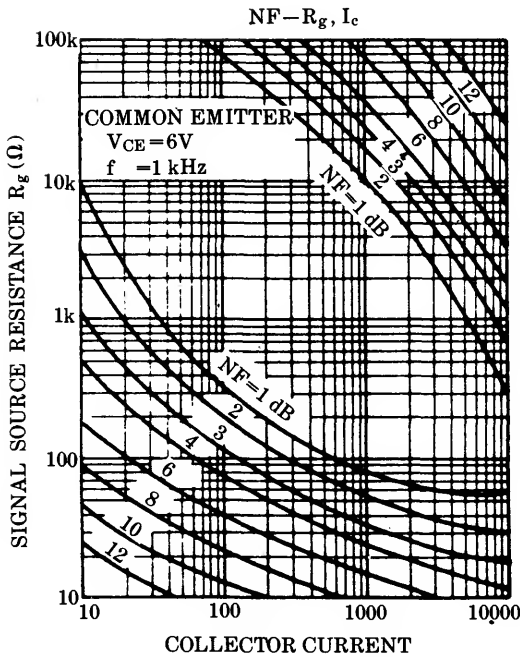


Fig. 13



(2SC2240)

Fig. 14

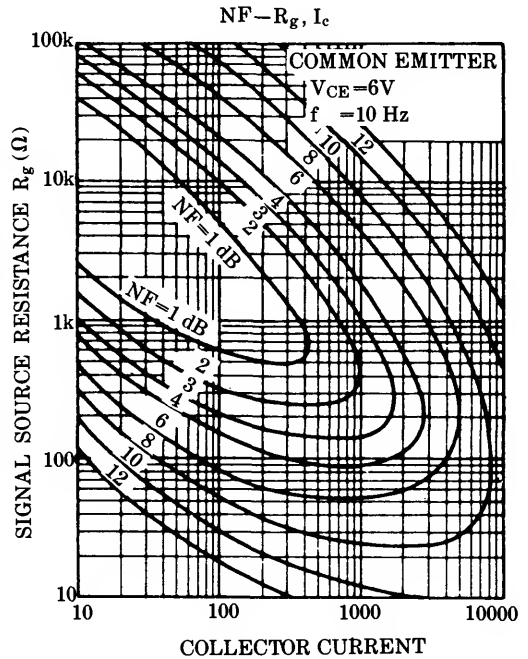


Fig. 15

When referring to the curve A in the figure of $e_{NT}-R_g$, NF can be represented by the difference B between the curve and the thermal noise voltage of R_g .

$NF=20(\log\beta-\log\alpha)$ corresponds to B in the above figure.

As is evident from equation (15), voltage noise plays the main role in those regions where signal source impedance R_g is small, while current noise plays the main role in those regions where R_g is large.

The figure termed an NF map, shown Fig. 14, Fig. 15, is obtained by adding the dependability of collector current to the graph of $e_{NT}-R_g$.

In this figure, contour lines of the NF are used to determine optimum operating conditions.

By referring to this NF map, the collector current I_c at which NFs at $f=1$ kHz and $f=10$ Hz are minimized is obtained by using the signal source impedance of a circuit to be used. When designing low-noise amplifiers, it is necessary to consider the conditions of circuits before and after them.

By referring to the foregoing description of NF, amplifier noise is explained in the next section.

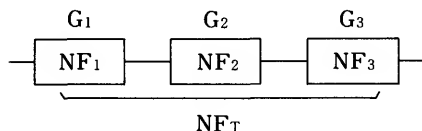


Fig. 16 NF of multistage amplifiers

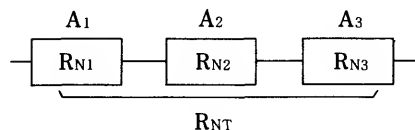


Fig. 17 Multistage amplifiers represented by using equivalent noise resistance

(3) Noise of amplifiers

The signal-to-noise ratio (S/N ratio) is an important factor in designing an amplifier.

$$S/N = 20 \log \frac{\text{rated output voltage}}{\text{output noise voltage}} \text{ (dB)}$$

From equation (13) for NF, equation (16) is connected with NF as follows:

$$\begin{aligned} S/N &= 20 \log \frac{E_{so}}{E_{no}} \\ &= 10 \log \frac{E_{so}^2}{E_{no}^2} \\ &= 10 \log \left(\frac{E_{si}^2}{E_{ni}^2} \cdot 10^{-\frac{NF}{10}} \right) \\ &= 10 \log \frac{E_{si}^2}{4kTR_gB} - NF \text{ (dB)} \end{aligned} \quad \dots (17)$$

$$\frac{\text{S/N ratio (dB) of amplifier}}{\text{of Input-side}} = \frac{\text{S/N ratio (dB)}}{\text{NF (dB) of Amplifier}}$$

(3-1) Noise figure of multistage amplifiers

The NF of the multistage amplifier shown in Fig. 16 is expressed as—

$$NF_T = NF_1 + \frac{NF_2 - 1}{G_1} + \frac{NF_3 - 1}{G_1 \cdot G_2} \dots (18)$$

- NF_T: total noise figure
- NF₁: first-stage noise figure
- NF₂: second-stage noise figure
- NF₃: third-stage noise figure
- G₁: first-stage power gain
- G₂: second-stage power gain
- G₃: third-stage power gain

When using equivalent noise resistance R_N , the R_{NT} is expressed as—

$$R_{NT} = R_{N1} + \frac{R_{N2}}{A_1} + \frac{R_{N3}}{(A_1 A_2)^2} \dots (19)$$

- R_{NT}: total equivalent input noise resistance
- R_{N1}: first-stage equivalent noise resistance
- R_{N2}: second-stage equivalent noise resistance
- R_{N3}: third-stage equivalent noise resistance
- A₁: first-stage voltage gain
- A₂: second-stage voltage gain

If the first-stage voltage gain G_1 is sufficiently large, the total noise figure NF_T is obtained as follows from equations (18):

$$NF_T \doteq NF_1 \dots \dots \dots (20)$$

Therefore, NF_T is determined by the NF of the transistor to be used at the first stage.

(3-2) Obtaining the noise figure of a circuit (NF_T) by using the NF of transistors

The NFs of transistors shown in catalogs are generally based on measurements at spot frequencies (such as 1 kHz, 100 Hz, and 10 Hz). They are not applicable without adjustment to such wide-bandwidth amplifiers as equalizer amplifiers in which low-frequency outputs are boosted.

Therefore, conversion is necessary by using the following method:

Since the f^2 noise region is related to high frequency, both the $1/f$ noise region and the white noise region are concerned with low-frequency amplification (see Fig. 11).

Assuming:

\bar{e}_g^2 : mean square voltage of thermal noise produced by signal source resistance R_g

\bar{e}_w^2 : mean square voltage of white noise

$\bar{e}_{1/f}^2$: mean square voltage of $1/f$ noise

and from the definition of a noise figure;

$$NF \text{ (for white noise region)} = \frac{\bar{e}_g^2 + \bar{e}_w^2}{\bar{e}_g^2} = NF_{(1kHz)} \dots \dots \dots (21)$$

$NF_{(1kHz)} = NF$ at 1 kHz spot frequency
When obtaining \bar{e}_w^2 from equation (21):

$$\bar{e}_w^2 = (NF_{(1kHz)} - 1) \bar{e}_g^2 \dots \dots \dots (22)$$

Assuming the noise figure at $f=10$ Hz to be $NF_{(10kHz)}$:

$$NF_{(10Hz)} = \frac{\bar{e}_g^2 + \bar{e}_w^2 + \bar{e}_{1/f(10Hz)}^2}{\bar{e}_g^2} \dots \dots \dots (23)$$

From equation (23),

$$\bar{e}_{1/f^2(10Hz)} = (NF_{(10Hz)} - NF_{(1kHz)}) \bar{e}_g^2 \dots (24)$$

Since $1/f$ noise varies at the rate of 3 dB/oct with frequency, \bar{e}_{1/f^2} at normal frequency is

$$\bar{e}_{1/f^2} = (NF_{(10Hz)} - NF_{(1kHz)}) \cdot \bar{e}_g^2 \cdot \frac{10}{f} \dots \dots \dots (25)$$

From equations (22) and (25), the total noise figure NF_T of an amplifier, whose frequency response and bandwidth are as shown in Fig. 18(a), (b), and (c), can be obtained from the equations

(a) Flat amplifier

$$NF_T = \frac{\int_{f_1}^{f_2} (\bar{e}_g^2 + \bar{e}_w^2 + \bar{e}_{1/f}^2) df}{\int_{f_1}^{f_2} \bar{e}_g^2 df} = NF_{(1kHz)} + \frac{10(NF_{(10Hz)} - NF_{(1kHz)}) \ln \frac{f_2}{f_1}}{f_2 - f_1} \dots \dots \dots (26)$$

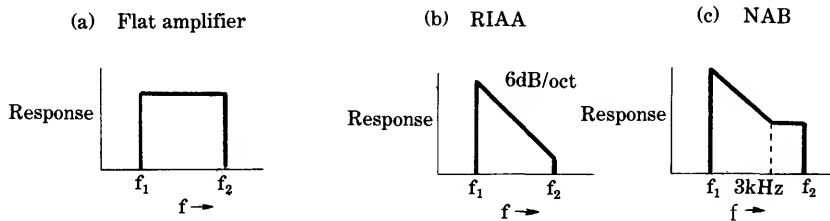


Fig. 18 Frequency response of wide-bandwidth amplifiers

(b) Equalizer amplifier (RIAA)

$$NF_T = \frac{\int_{f_1}^{f_2} (\bar{e}_g^2 + \bar{e}_w^2 + \bar{e}_1^2/f) (\frac{f_2}{f})^2 df}{\int_{f_1}^{f_2} \bar{e}_g^2 (\frac{f_2}{f})^2 df} \doteq NF_{(1kHz)} + \frac{5(NF_{(10Hz)} - NF_{(1kHz)})}{f_1} \dots\dots\dots (27)$$

(c) Equalizer amplifier (NAB)

$$NF_T = \frac{\left\{ \int_{f_1}^{3kHz} (\bar{e}_g^2 + \bar{e}_w^2 + \bar{e}_1^2/f) (\frac{3kHz}{f})^2 df + \int_{3kHz}^{f_2} (\bar{e}_g^2 + \bar{e}_w^2 + \bar{e}_1^2/f) df \right\}}{\left\{ \int_{f_1}^{3kHz} \bar{e}_g^2 (\frac{3kHz}{f})^2 df + \int_{3kHz}^{f_2} \bar{e}_g^2 df \right\}}$$

$$\doteq NF_{(1kHz)} + \frac{5(NF_{(10Hz)} - NF_{(1kHz)})}{f_1} + \frac{f_1}{(3kHz)^2} (f_2 - 3kHz) NF_{(1kHz)} \dots\dots\dots (28)$$

Fig. 19 shows an example of actual values calculated by using these equations. This figure shows how much the NF (1/f noise) at 10 Hz of a first-stage transistor influences a circuit in which the low-frequency region is boosted.

by substituting the wide-bandwidth noise figure NF_T thus obtained with that in equation (17), the S/N ratio can be calculated.

(4) Example of calculation of amplifier S/N ratio

By using the above-mentioned method, the S/N ratio of an amplifier using low-noise transistor 2SC2240 as the first-stage is calculated as

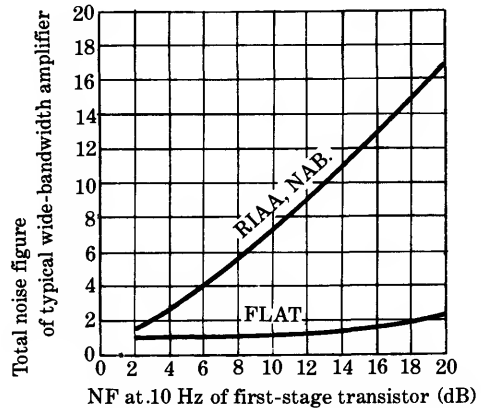


Fig. 19 Total noise figure of a typical wide-bandwidth amplifier

● Example of an amplifier

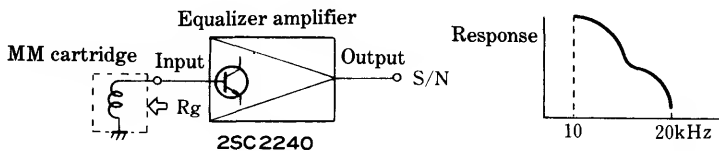


Fig. 20 Amplifier and typical frequency response

- Signal source resistance (R_g): 2.2 kΩ at 1 kHz
- Bandwidth(B): 10 ~ 20 kHz \doteq 20 kHz
- Minimum input signal level (E_{si}): 2 mV
- First-stage transistor: low-noise transistor
2SC2240
- Frequency response: RIAA

Assuming that $I_c = 100\mu A$ at $R_g = 2.2k\Omega$ from the NF map of 2SC2240 above,

$$NF (1kHz) = 1.0 \text{ dB}$$

$$NF (10Hz) = 1.0 \text{ dB}$$

and from Fig. 19 and equation (17), (27)

$$S/N \text{ (dB)} = 10 \log \left\{ \frac{(E_{si})^2}{4kTR_gB} \right\} - 1.0 \text{ (dB)}$$

$$= 10 \log \left\{ \frac{(2 \times 10^{-3})^2}{1.63 \times 10^{-20} \times 2.2 \times 10^3 \times 20 \times 10^3} \right\}$$

$$- 1.0$$

$$\approx 67.5 \text{ (dB)} - 1.0 \text{ (dB)}$$

$$= 66.5 \text{ (dB)}$$

Thus, the S/N ratio of an amplifier in which 2SC2240 is used as the first-stage transistor is 66.5 (dB). However, IHF-A curve is not considered in this instance.

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- 1) WILLIAM A. RHEINFELDER: DESIGN OF LOW NOISE TRANSISTOR INPUT CIRCUITS, LONDON ILIFFE BOOKS LTD. (1964)
- 2) J. WATSON: SEMICONDUCTOR CIRCUIT DESIGN, ADAM HILGER LTD. (1970)

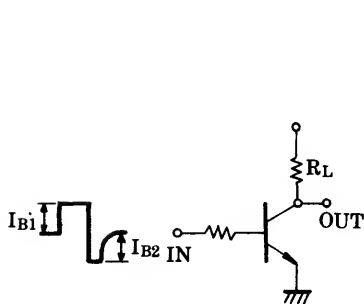


Fig. 21 Switching time measuring circuit

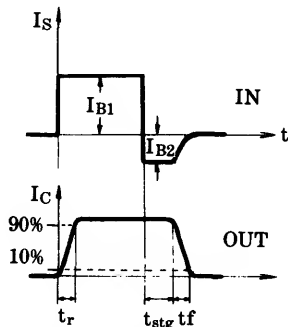


Fig. 22 Definition of switching waveform and switching time

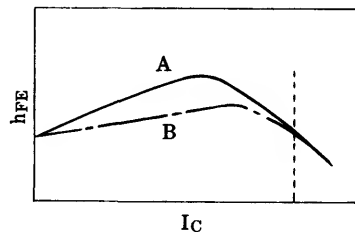


Fig. 23 I_c dependency of h_{FE}

4. Switching characteristics

This section refers to switching characteristics of a bipolar transistor. Should a pulse be supplied to the base in the circuit shown in Fig. 21, the waveforms of the base current and collector current are as shown in Fig. 22. Delay times of output waveforms to input waveforms, t_r , t_{stg} , and t_f , in Fig. 22 represent switching times of the transistor. The terms t_r , t_{stg} , and t_f represent rise time, storage time, and fall time respectively. Equations related to the switching characteristics of diffused base NPN transistors are generally expressed as

$$t_d \approx \frac{2}{I_{B1}} \left\{ C_{TE} V_{BE}^{1/2} (OFF) + C_{TC} [(V_{CC}^{1/2} + V_{BE(OFF)})^{1/2} - V_{CC}^{1/2}] \right\} \dots \dots \dots (29)$$

$$t_r = \tau_R h_{FE} \ln \left(\frac{h_{FE} I_{B1}}{h_{FE} I_{B1} - 0.9 I_c} \right) \dots \dots \dots (30)$$

$$t_{stg} = \tau_S \ln \left(\frac{h_{FE} (I_{B1} - I_{B2})}{I_c - h_{FE} I_{B2}} \right) \dots \dots \dots (31)$$

$$t_f = \tau_F h_{FE} \ln \left(\frac{I_c - h_{FE} I_{B2}}{0.1 I_c - h_{FE} I_{B2}} \right) \dots \dots \dots (32)$$

$$\tau_R \approx \tau_F \approx \frac{1}{2\pi f_T} + 1.7 R_L C_{TC} \dots \dots \dots (33)$$

$$\tau_S \approx \frac{0.6}{2\pi f_b} + \frac{\tau_{nc}}{2} \dots \dots \dots (34)$$

where,

- C_{TE} : emitter transition capacitance measured at $|V_{BE(OFF)} - \phi_0| = 1V$
- ϕ_0 : contact potential difference at base-to-emitter junction
- $V_{BE(OFF)}$: base-emitter voltage when transistor is off
- C_{TC} : collector transition capacitance measured at V_{cc} $V_{BE(OFF)} \ll V_{cc}$
- V_{cc} : collector supply voltage
- h_{FE} : DC current gain at end of saturation region
- f_T : transition frequency
- f_b : base cutoff frequency
- τ_{nc} : life time of minority carrier in collector layer

Consequently, it is possible to reduce t_d by reducing the emitter transition capacitance from equation (29) and t_r by using the high driving circuit at high h_{FE} and by increasing f_T from equation (30). t_f can be reduced by lowering the switching current ratio (I_c/I_{B2}), though it will be elongated if h_{FE} is increased, in accordance with equation (32). It is evident from equation (31) that t_{stg} is related to the recombination of minority carriers, and that life time of minority carriers in the base and collector regions are important factors. h_{FE} and t_{stg} are in proportion to each other; therefore, it is acknowledged that very difficult technology is required to collectively speed up t_r , t_f , and t_{stg} .

It is clear that equations from (30) to (32) are dependent upon h_{FE} . Though h_{FE} should be preferably kept small to lower the switching time, it must be large to reduce the drive energy when using a transistor. Thus, h_{FE} must be kept within a practical range.

When further research is conducted to improve this tradeoff as much as possible, the following method is found. Fig. 23 shows a collector current dependency of h_{FE} . Normally, there is a peak similar to A in Fig. 23. The peak of h_{FE} is often located on the low-current side from the operating point shown by a hyphenated line in that figure. h_{FE} at the operating point is fairly lower than that at the peak. When measuring the switching time at the operating point in the figure, it can be noticed that the switching time (especially t_{stg}) depends on h_{FE} at the peak more strongly than on that at the operating point.

By using this method, it is possible to lower the peak of h_{FE} without lowering h_{FE} at the operating point, by moving the peak of h_{FE} to a larger-current side (or the operating point side) as illustrated by line B. In other words, the problem is solved by making h_{FE} flat. To flatten h_{FE} coincides with the objective of the EPR structure in which the emitter is divided into minute portions (multi-emitter) to increase the effective area.

Then, research is conducted concerning equations (33) and (34) which are the logarithmic outer terms of equations (30) to (32). They include f_T and f_b , the parameters representing frequency response of a transistor. Conventionally, increasing the base width and depth was unavoidable to increase the breakdown voltage and safe operating area, frequency response thus being sacrificed.

Since transition frequency f_T ($f_T < f_b$) amounts to some MHz, the first term of equation (33) and (34) is assumed to be 10^{-6} or 10^{-7} s. This means that by adopting an EPR structure based on high-frequency technology of power transistors, the frequency response can be improved by one digit or so. The second term of equation (33), a time constant based on collector transition capacitance and load resistance, is normally as small as 10^{-7} to 10^{-8} s. On the other hand, the second term of the equation (34) is as large as 10^{-6} s, the first and the second term thus being almost similar conventionally. As previously mentioned, this can be improved in a manner such as the first term being ignored with reference to the second term.

τ_{nc} in the second term can be controlled by introducing heavy metals called "life time killers" to the collector layer. By allowing the first term to be ignored, this controllability is much enhanced.

As already mentioned, switching time can be reduced by improving the large current characteristics of h_{FE} (termed "improving h_{FE} linearity") and by increasing the high-frequency response. This is realized by using the EPR structure in which a multi-emitter is used. For this reason, the EPR structure has been widely employed in switching transistors.

GPL structure employed in switching transistor

This section describes new transistors using

a GPL structure, including an EPR structure.

Fig. 24 shows the FPR structure; Fig. 25 illustrates a section of the base-to-collector junction ends of this structure. The hyphenated lines in the figure illustrate base-to-collector junction is reverse-biased. It can be noticed that the depletion layer is narrower near the surface, and not bent in strict accor-

dance with the junction line. This is caused by action of the positive charge contained in the thermally oxidized film (SiO_2), a protective film for the surface. Therefore, the electric field applied to the junction is increased near the surface, breakdown thus being evident there (applicable only to NPN transistors).

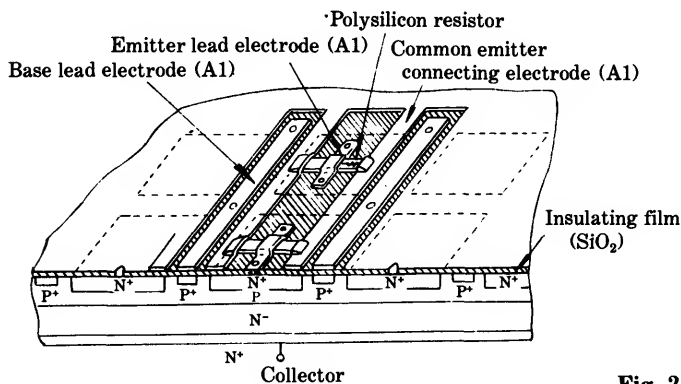


Fig. 24 EPR structure

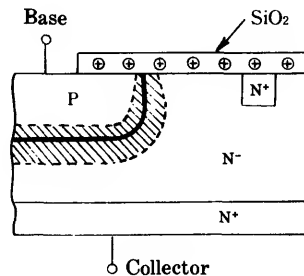


Fig. 25 Section of base-to-collector junction ends of EPR structure

In an ideal junction condition, breakdown voltage of the junction is determined by a concentration of impurities contained in the junction. It is known that even if the concentration of impurities is designed to assure high breakdown voltage, the objective is not achieved near the surface, as mentioned above.

To improve this condition, a new GPL structure is employed. Fig. 26 shows a schematic sectional view of the GPL structure. This structure is obtained by peeling off a thin layer of the Si surface near the junction, forming a glass film there almost flush with the surrounding surface, and introducing negative charges into the glass film. This expands the depletion layer near the surface to reduce the electric field, which in turn cause breakdown to occur in the inside junction, thus obtaining a higher breakdown voltage.

Fig. 27 shows a GPL structure actually employed in power transistors ($V_{\text{CEO}}=800\text{V}$) for switching regulators. The only difference between this and that in Fig. 26 is that a floating junction termed a "guard ring" is mounted outside the base junction. The reason is as fol-

lows: In Fig. 26, the curved portion of the inside junction (shown by the arrow) has a high electric field and determines the breakdown here. In Fig. 27, the same role is played by the curved portion of the guard ring whose voltage share is low, thus increasing the breakdown voltage. By further mounting a double or a triple guard ring, breakdown voltage approaches the theoretical value. Then it is possible to obtain a withstand voltage exceeding 2,000V without difficulty.

The reason for adopting glass for the protective film is that it is possible to easily introduce a stable, controllable charge into the glass film and it is also possible to produce a film thick enough to prevent the internal electric field from leaking outside. The glass film is formed by using an electrophoretic method that selectively causes glass powder to adhere onto the chip and by burning at a high temperature.

Conventionally, high breakdown voltage was obtained by using a mesa structure, but the existence of mesa grooves rendered photengraving of fine patterns rather difficult.

On the other hand, the GPL structure is feature of the realization of high breakdown voltage while using a planar structure to make a photoengraving of fine patterns as easy as those on IC's. As previously mentioned, the GPL structure is based on the technology of realizing higher breakdown voltage than that achieved by using an EPR structure in which fine patterns of a multi-emitter are used to produce high frequency and high output.

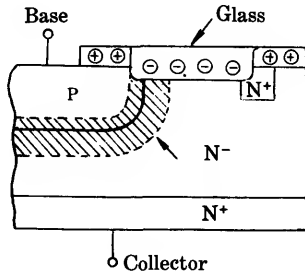


Fig. 26 Sectional view of base-to-collector junction end of basic GPL

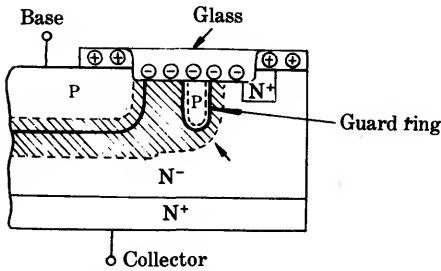


Fig. 27 Sectional view of base-to-collector junction end of GPL

Precautions for Handling Hybrid Application Devices

Hybrid application devices are small package and are assembled in a different method as compared with conventional TO-92, TO-92MOD, TO-126, and TO-220. This section describes general precautions for handling and other points on which users should take care.

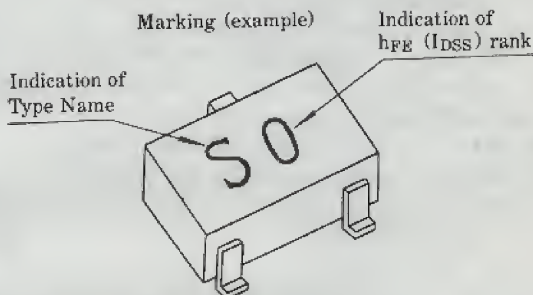
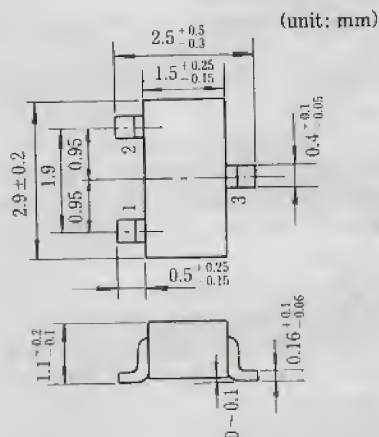
For further details, refer to the respective technical data.

1. Hybrid application devices

Hybrid application devices are divided into the following three groups:

- (1) Supermini-transistor (equivalent to TO-236)

Supermini-transistors are housed equivalents to TO-236 (SOT-23). Outline is shown in Fig. 1.



Electrode connection

Items	1	2	3
Transistor	Emitter	Base	Collector
2SK208/209	Drain	Source	Gate
2SK210/211	Gate	Drain	Source

Fig. 1 Outline of supermini-transistor

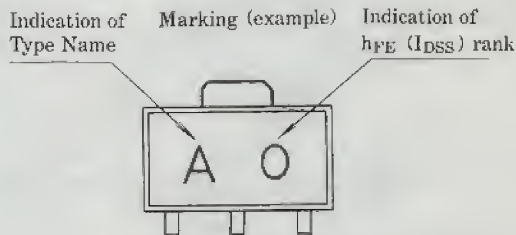
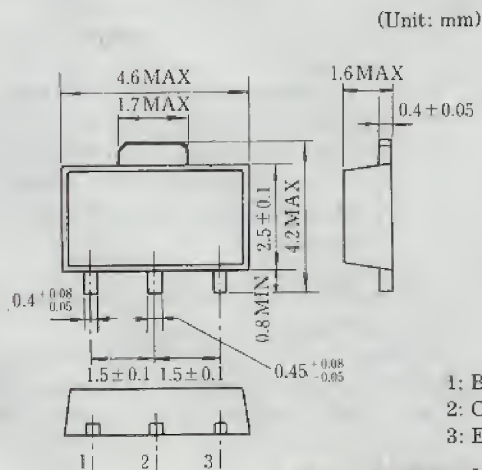


Fig. 2 Outline of power mini-transistor (equivalent to SOT-89)

(2) Power mini-transistor (equivalent to SOT-89)

Fig. 2 is outline of the power mini-transistor. The resin portion is small ($2.5H \times 4.5L \times 1.5T$, mm). Since the collector fin protrudes outside, it can be directly soldered to a ceramic substrate, making it possible to increase the collector Power Dissipation. This type of transistor is a flat package type in which the emitter, collector, and base leads are flush on the same surface to facilitate mounting on a ceramic substrate. Fig. 2 also shows a example of marking.

(3) Power mold transistor

Fig. 3 is outline of the power mold transistor. The resin portion is smaller ($5.5H \times 6.5L \times 2.3T$, mm) compared with TO-126 and TO-220, equivalent to this type of transistor. Since the collector fin protrudes outside, it is possible to increase the collector Power Dissipation by directly soldering the fin to a ceramic substrate.

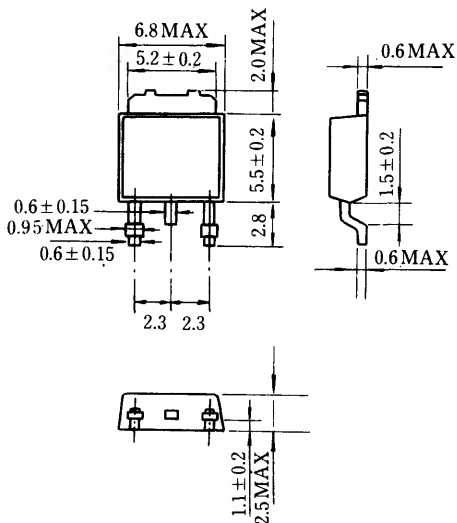


Fig. 3 Outline of power mold transistor

2. Precaution for handling

(1) General precaution

- (a) Since the external resin portion of hybrid application devices is smaller compared with the housing of conventional devices of equivalent types, the hybrid application devices may sometimes be inferior to conventional types in humidity experiment. Therefore, it is necessary to coat the sur-

face and surrounding units of such hybrid devices with resin or similar materials when using them under high-temperature, high-humidity conditions.

(b) Removing flux after soldering

After soldering a hybrid application device to a circuit board, flux which may have adhered while soldering or during the preflux treatment process must be removed. Should flux remain, rinsing is necessary because the flux component or compounds may cause a problem of lead wires corrosion. Do not attempt to remove inorganic flux by rinsing, because it can scarcely be rinsed off. Use of olefin cleaners such as Freon TE or Di-Freon Solvent S3-E is recommended.

(c) Handling of devices assembled with lead wires

Since the size of supermini-transistors is extremely small compared with other hybrid application devices, their lead wires may be deformed by slight force. Be careful concerning the following points.

- When mounting on a circuit board, do not handle the devices directly with the fingers; use a vacuum pincette or similar jig. By employing such a jig, the lead wire surface on which soldering is effected is kept free of oily contamination, thus facilitating soldering.
- Do not impart a force of 500g or more to the resin portion and lead wires while cleaning a circuit board; otherwise, lead wires may be deformed or disconnected and solderability will be reduced.
- Supersonic wave cleaning of circuit boards

As far as possible avoid using supersonic wave cleaning when cleaning a circuit board. Should this method be unavoidably employed, clean the board for a short period in a supersonic wave bath of low output.

(2) Precautions on mounting procedures

Preheating

Preheating is required for power mini-transistors and power mold transistors prior to mounting them on circuit boards. The following types of preheating methods are available:

- Method of using a heater

Heat an device at 100~150°C/2 minutes by using an infrared heater or a heating panel (with built-in heater). Be careful to raise the temperature as slowly as possible; the semiconductor pellets may be damaged if the temperature rise is abrupt.

- Lamp heat radiating method

This method utilizes a parabolic infrared lamp. Avoid an abrupt temperature rise, the same as in the method above, by regulating the lamp focus and the power distance applied.

- Other method

In addition to the foregoing are hot-air methods and others. If using these methods, preheat an element at 100~150°C for 2 minutes or similar conditions basically.

(3) Precautions on soldering process

(a) Allowable soldering time and temperature

The relation between allowable soldering time and temperature is as follows. Establish soldering conditions within these specifications.

- Supermini-transistors

Soldering temperature... 260°C... 20 sec. or less (only one application allowed)

- Power mini-transistors and power mold transistor

Soldering temperature... 250°C... 20 sec. or less (one each for preheating and soldering)

(b) Solder to be used

Be sure to use solder whose fusing point is as low as possible. The solder generally used is 6/3 or 6/4 solder with a fusing point of about 190°C. General soldering conditions include 220~240°C temperature and 3~5 seconds time.

When using creamy solder for printing by the metal mask method, use a newly mixed one as far as possible; be careful to avoid uneven printing or deformation. The recommended printing thickness of this solder printing is 200μm or more to improve lead wires solderability.

(c) Using a soldering iron

When using a soldering iron to mount an device on a circuit board, the device is often subjected to mislocation or package

damage. Thus, it is recommended using a soldering iron only for experiments or repair. When using it, be careful about the following points:

- Temperature of soldering iron tip (for bonding): 250°C, 3 sec. or less
- Diameter of soldering iron tip: φ1 mm or less
- Do not allow the tip to contact the resin portions.

(d) Relationship between time and temperature for soldering and preheating

Figs. 4 and 5 show the relation between temperature and time for preheating and soldering in device mounting procedures such as the solder dip method.

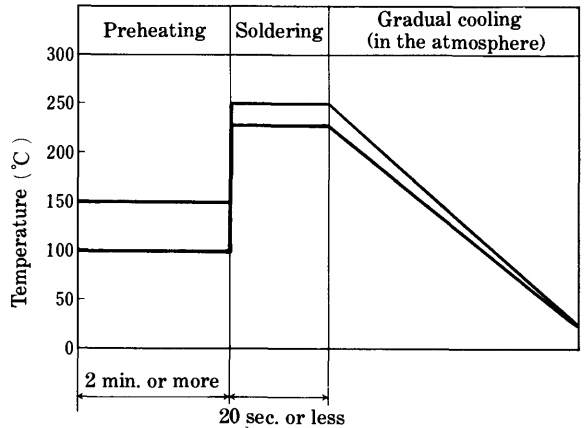


Fig. 4 Solder dip method

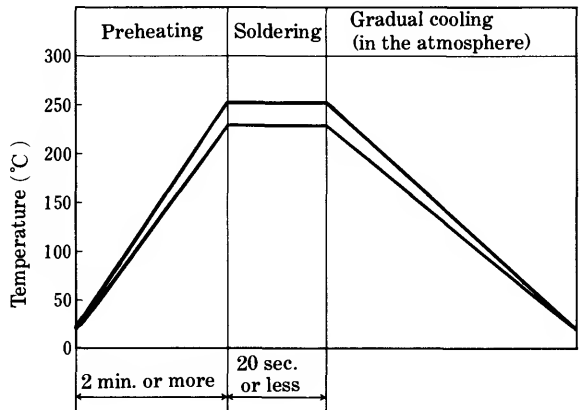


Fig. 5 Reflow soldering method (furnace soldering method)

(4) Precautions on allowable power dissipation (steady-state conditions)

The values of allowable power dissipation differ between an individual transistor and a transistor mounted on a circuit board. Changes in allowable power dissipation are described hereunder for typical models classified by their housing.

(a) Soupermini-transistor

Allowable power dissipation of super-mini-transistors is 100~200 mW when they are used separately.

When mounted on a ceramic board, dissipation will be increased as shown in Fig. 4, in accordance with board sizes. The transistors used for this figure were 2SA1162/2SC2712.

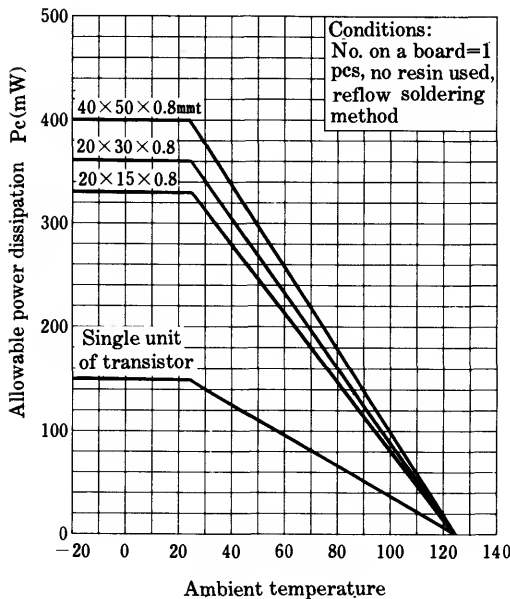


Fig. 6 P_c (max) – T_a characteristics of 2SA1162 and 2SC2712 mounted on an alumina ceramic substrate.

(b) Power mini-transistor

Being a small-sized housing, a power mini-transistor has an allowable power dissipation of 500 mW when used separately. When mounted on a board, however, it has an allowable power dissipation of a high 1.0W~2.0W because thermal diffusion from the collector fin to the board is

increased. Therefore, it is possible to effect circuit designing similar to TO-92MOD (800~900 mW) and TO-126 (1.0~1.2W).

Fig. 5 illustrates examples of allowable power dissipation for the 2SC2873 and 2SA1213 mounted on a board.

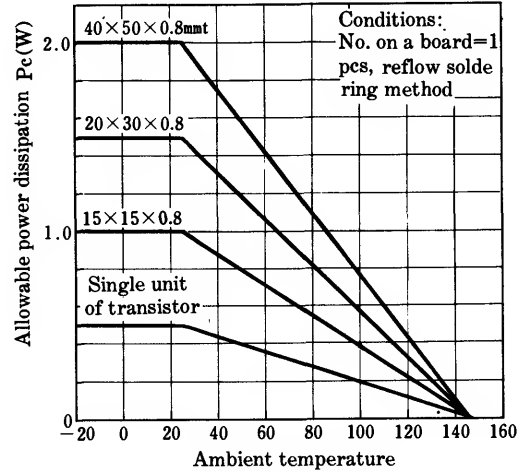


Fig. 7 P_c (max) – T_a characteristics of 2SC2873 and 2SA1213 mounted on an alumina ceramic substrate

(c) Power mold-transistor

Allowable power dissipation for the straight type is $P_c=1W$; however, that for the LB type is increased when mounted on a board through a collector fin. When soldering a power mold transistor to an alumina ceramic substrate, $P_c(1)$ (100mm²) and $P_c(2)$ (2500mm²) are increased to 2W and 3W respectively. Fig. 8 shows the relation between the allowable power dissipation P_c and the ambient temperature T_a by using transistors 2SC3074 and 2SC1244.

(5) Precautions on allowable power dissipation (transient conditions)

When using a device for stroboscopic flash and motor driving circuits, the circuit design requires allowable power dissipation applicable to a short time in addition to allowable power dissipation under saturated conditions. Several types can be applied to such applications among Toshiba

power mini-transistors and power mold-transistors. The relation between allowable power dissipation and pulse width under transient conditions for typical models for various packages is shown below:

(a) Power mini-transistor

Shown in Fig. 9.

(b) Power mold transistor

When using power mold transistors, it is also possible to take larger values of al-

lowable power dissipation in a transient condition than in a saturated one. By using 2SC3074 and 2SA1244, the allowable power dissipation shown in Fig. 10 can be taken.

Be careful on the following points in this respect:

- Collector Power Dissipation P_c is a value within an area with restricted thermal resistance.
- The curve shown in the Figure is based on a single nonrepetitive pulse.

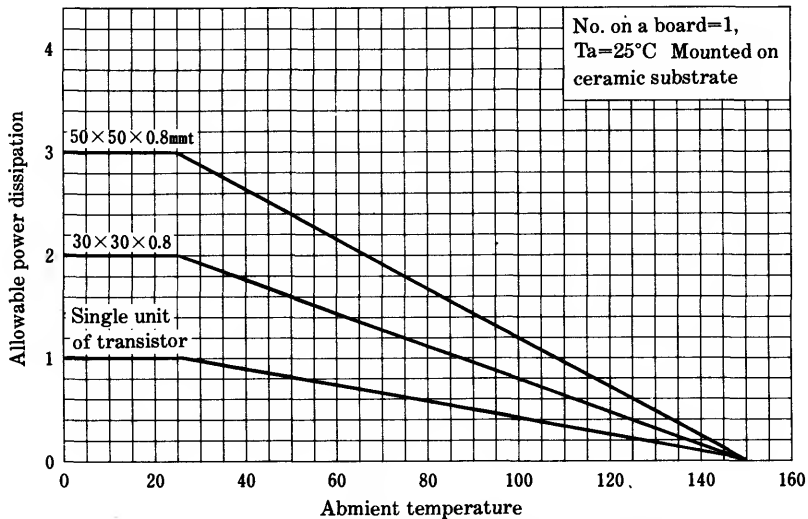


Fig. 8 P_c (max) - T_a characteristics of 2SC3074 and 2SA1244 mounted on an alumina ceramic substrate

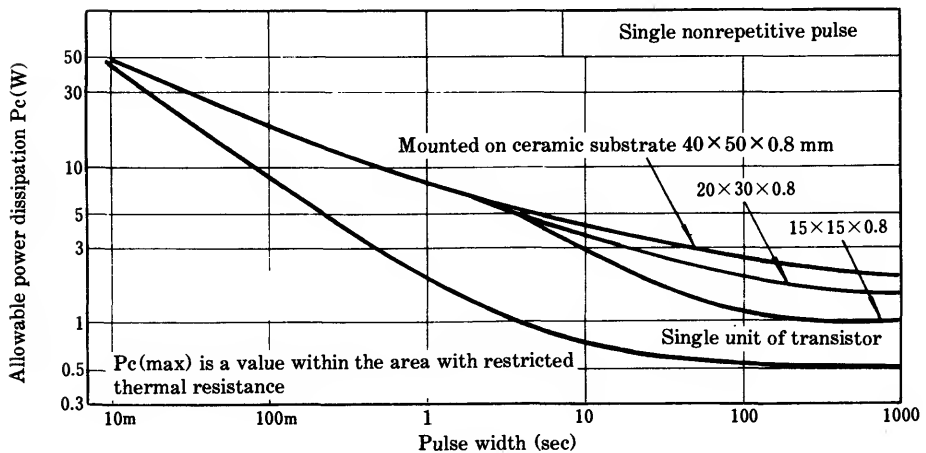


Fig. 9 Allowable power dissipation of 2SC2873 and 2SA1213 under transient conditions

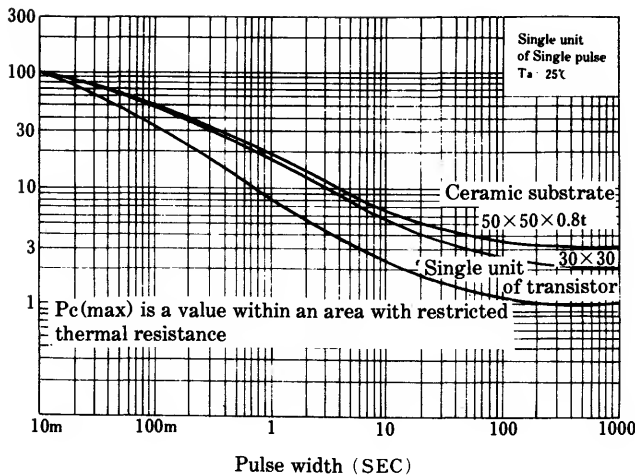


Fig. 10 Allowable power dissipation P_c —pulse width (2SC3074 and 2SA1244)

(6) Minimum pad size

(a) Supermini-transistor

Fig. 11 illustrates lead wire mounting locations and the minimum size of pads in supermini-transistors. Since the allowable power dissipation is substantially affected by the collector conducting pad area, it is advantageous to adopt a pad with as wide an area as possible, if the heat sink is taken into consideration.

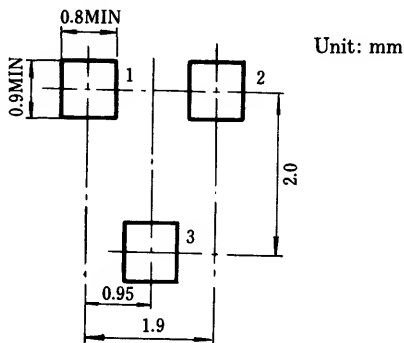


Fig. 11 Minimum size of mounting pad size for supermini-transistors

(b) Power mini-transistor

Fig. 12 shows the lead wire mounting locations and the minimum size of pads in power mini-transistors. Since the allowable power dissipation is substantially affected by the collector connecting pad

area, it is advantageous to adopt a pad with as wide an area as possible.

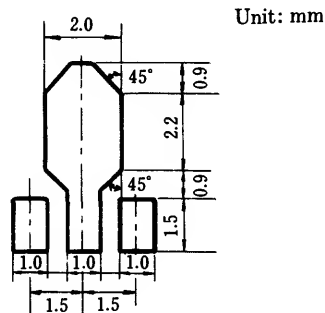


Fig. 12 Minimum pad size for power mini-transistors

(c) Power mold transistor

The thermal radiation of power mold transistors is effected mainly through a collector fin. If the area of conductor pattern connected to this portion is further increased, the allowable power dissipation is also increased. Thus, must be increase the conductor pattern size at the collector as much as possible. Shown in Fig. 13.

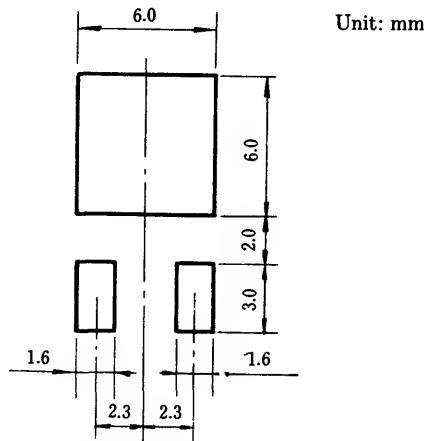


Fig. 13 Minimum pad size for Power-mold-transistor

Hybrid application devices, Group (1)

Supermini-Transistors (equivalent to TO-236)

*Transistor for microwave

Type Name	Application	Electrical characteristics (Ta=25°C)				Marking	Complementary Pair	Type Name similar to TO-92	Remarks (mini-transistor)
		V _{CEO} (V)	I _C (mA)	P _C (mW)	T ₁ (°C)				
2SA1162	General Purpose	-50	150	150	125	S	2SC2712	2SA1015	2SA1048
2SC2712	General Purpose	50	150	150	125	L	2SA1162	2SC1815	2SC2458
2SA1163	High Voltage Amp.	-120	-100	150	125	C	2SC2713	2SA 970	2SA1049
2SC2713	High Voltage Amp.	120	100	150	125	D	2SA1163	2SC2240	2SC2459
2SC2714	FM RF.	30	20	100	125	Q	—	2SC1923	2SC2668
2SC2715	AM CONV.	30	50	150	125	R	—	2SC380TM	2SC2669
2SC2716	AM RF.	30	100	150	125	F	—	2SC941TM	2SC2670
2SA1182	General Purpose	-30	-500	150	125	Z	2SC2859	2SA562TM	—
2SC2859	General Purpose	30	500	150	125	W	2SA1182	2SC1959	—
2SC2532	LED driver	40	300	150	125	AN	—	2SC 982	—
2SC2996	FM RF.	30	50	150	125	G	—	—	2SC2995
2SA1255	High-Voltage Amp.	-200	-50	150	125	O	2SC3138	—	—
2SC3138	High-Voltage Amp.	200	50	150	125	N	2SA1255	—	—
*2SC3011	UHF, C-Band RF.	7	30	150	125	MA	—	—	f _T =6.5GHz
*2SC3098	VHF, UHF RF.	20	50	150	125	MB	—	2SC2498	f _T =3.5GHz
*2SC3099	VHF, UHF RF.	20	30	150	125	MC	—	2SC2499	f _T =4GHz
*2SA1245	High-speed switching	-8	-30	150	125	MD	—	—	f _T =4GHz
2SC3119	UHF RF.	20	20	150	125	HA	—	—	f _T =900MHz
2SC3121	UHF OSC.	15	50	150	125	HC	—	—	f _T =1.3GHz
2SC3122	UHF RF.	30	20	150	125	HD	—	2SC2348	f _T =400MHz MIN.
2SC3123	VHF MIX.	20	50	150	125	HE	—	2SC3136	f _T =900MHz MIN.
2SC3124	VHF OSC.	15	50	150	125	HF	—	2SC2349	f _T =600MHz MIN.
2SC3125	PIF Stage	25	50	150	125	HH	—	2SC388ATM	f _T =350MHz

FETs

Type Name	Applications	V _{DSX} ** V _{GD0} V _{GD5} * (V)	Electrical characteristics (Ta=25°C)				Marking	Similar Type Name	Remarks
			I _C , I _D * (mA)	P _D (mW)	I _{DSS} (mA)	Y _{f5} (ms)			
2SK208	General Purpose	-50	10	100	0.3~6.5	1.2MIN	J	2SK30ATM	
2SK209	General Purpose	-50	10	150	0.4~14	15	X	2SK117	
2SK210	FM RF, MIX.	-18*	10	100	3.0~24	7Typ.	Y	2SK192A	
2SK211	FM RF, MIX.	-18*	10	100	1.0~10	9Typ.	K	2SK241	
2SK302	FM RF, MIX.	20**	30*	150	1.5~14	10Typ.	T	2SK241	MOS FET

Diodes

Type Name	Applications	Electrical characteristics (Ta=25°C)					Marking	Similar Type Name	Remarks
		V _R (V)	I _P (mA)	C _T (PF)	NF (dB)	R _s (Ω)			
ISS154	UHF, S Band MIX.	6	30	0.8	9 MAX.	—	BA	—	
ISV128	VHF, UHF Attenuator	50	50	0.25	—	7	BB	ISV99	

TOSHIBA CORPORATION

Hybrid application devices, Group (2)

Power mini-transistor (equivalent to SOT-89)

Pc; Mounted on ceramic substrate (250mm²×0.8t)

Type Name	Application	Electrical characteristics (Ta=25°C)					Marking	Complementary Pair	Similar Type Name (TO-92MOD)	Remarks
		V _{CEO} (V)	I _C (A)	P _C (W)	P _C * (W)	T _j (°C)				
2SA1200	High-voltage switching	-150	-0.05	0.5	0.8	150	B	2SC2880	2SA949	
2SC2880	High-voltage switching	150	0.05	0.5	0.8	150	A	2SA1200	2SC2229	
2SA1201	Audio Driver Amp.	-120	-0.8	0.5	1.0	150	D	2SC2881	2SA965	
2SC2881	Audio Driver Amp.	120	0.8	0.5	1.0	150	C	2SA1201	2SC2235	
2SA1202	Audio Driver Amp.	-80	-0.4	0.5	1.0	150	F	2SC2882	2SA817A	
2SC2882	Audio Driver Amp.	80	0.4	0.5	1.0	150	E	2SA1202	2SC1627A	
2SA1203	Power Switching	-30	-1.5	0.5	1.0	150	H	2SC2883	2SA966	
2SC2883	Power Switching	30	1.5	0.5	1.0	150	G	2SA1203	2SC2236	
2SA1204	Power Switching	-30	-0.8	0.5	1.0	150	R	2SC2884	2SA950	
2SC2884	Power Switching	30	0.8	0.5	1.0	150	P	2SA1204	2SC2120	
2SA1213	Power Amp., power switching	-50	-2.0	0.5	1.0	150	N	2SC2873	2SA1020	Low V _{CE(sat)}
2SC2873	Power Amp., power switching	50	2.0	0.5	1.0	150	M	2SA1213	2SC2655	Low V _{CE(sat)}
2SC2982	Stroboscopic flash	10	2.0	0.5	1.0	150	S	—	2SC2500	Low V _{CE(sat)}
2SA1314	Stroboscopic flash	-10	-2.0	0.5	1.0	150	T	—	2SA1160	Low V _{CE(sat)}
2SC3268	VHF~UHF RF.	12	0.07	0.5	0.8	150	UA	—	—	
2SC3301	VHF~UHF RF.	7.5	0.08	0.5	0.8	150	UB	—	—	

Hybrid application devices, Group (3)

Power mold-transistor

PC*: @T_C-25°C **T_O-92 MOD

Type Name	Application	Electrical characteristics (T _a -25°C)					Complementary Pair	Similar Type Name (TO-126, 220)	Remarks
		V _{CEO} (V)	I _C (A)	P _C (W)	P _C * (W)	T _j (°C)			
2SA1225	Audio Driver Amp.	-160	-1.5	1.0	10	150	2SC2983	2SA968	
2SC2983	Audio Driver Amp.	160	1.5	1.0	10	150	2SA1225	2SC2238	
2SA1241	Power Amp.	- 50	-2.0	1.0	10	150	2SC3076	2SA1020	
2SC3076	Power Amp.	50	2.0	1.0	10	150	2SA1241	2SC2655	
2SA1242	Stroboscopic flash	- 20	-5.0	1.0	10	150	2SC3072 Refer to hFE classification	2SA1120	
2SC3072	Stroboscopic flash	20	5.0	1.0	10	150	2SA1242 Refer to hFE classification	2SC2270	
2SA1243	Power Amp.	- 30	-3.0	1.0	10	150	2SC3073	2SA473	
2SC3073	Power Amp.	30	3.0	1.0	10	150	2SA1243	2SC1173	
2SA1244	High-current switching	- 50	-5.0	1.0	20	150	2SC3074	2SA1012	
2SC3074	High-current switching	50	5.0	1.0	20	150	2SA1244	2SC2562	
2SB 905	TV vertical output	-150	-1.5	1.0	10	150	2SD1220	2SA1021	
2SD1220	TV vertical output	150	1.5	1.0	10	150	2SB 905	2SC2481	
2SB 906	Power Amp.	- 60	-3.0	1.0	20	150	2SD1221	2SB834	
2SD1221	Power Amp.	60	3.0	1.0	20	150	2SB 906	2SD880	
2SB 907	Power Switching	- 40	-3.0	1.0	15	150	2SD1222	2SB677	Darlington Type
2SD1222	Power Switching	40	3.0	1.0	15	150	2SB 907	2SD687	Darlington Type
2SB 908	Power Switching	- 80	-4.0	1.0	15	150	2SD1223	2SB676	Darlington Type
2SD1223	Power Switching	80	4.0	4.0	15	150	2SB 908	2SD686	Darlington Type
2SD1224	Power Amp.	30	1.5	1.0	10	150	-	2SD549	Darlington Type
2SD1160	Motor control	50**	2.0	1.0	10	150	-	-	
2SC3075	High-voltage power Amp.	400	0.8	1.0	10	150	-	-	
2SC3303	High-current switching	80	5.0	1.0	20	150	-	2SC3258	
2SC3233	High-voltage switching	400	2.0	1.0	10	150	-	2SC2552	

** : V_{CE}S

POWER MOS FET

To meet the demand for ideal switching devices ensuring high frequency, high breakdown voltage and high power, the POWER MOS FET has been developed as a device that is the nearest to the ideal.

In principle, FET operates by only majority carrier, and is not influenced by minority carrier, as seen in a bipolar transistor (especially, storage effect t_{stg} in switching and secondary breakdown region S/B). Fundamentally, MOS FET has higher input impedance than J-FET.

In addition, it is easy to handle for enhancement mode.

For these advantages, the bipolar transistor approaching the utmost of capacity is about to give its leading status to the POWER MOS FET.

There are POWER MOS FETs of different basic structure made by different techniques of various companies.

Ours is of double diffusion type to meet the technical requirements of high reliability, high breakdown voltage, high speed and low cost, and has been named π -MOS FET for its basic structure (current flowing form).

1. Structure and Characteristics of π -MOS FET

(1) Basic structures of POWER MOS FET

The POWER MOS FET can roughly be classified into 3 kinds, as shown in Fig. 1.

(a) is an extension of the conventional small-signal MOS FET, and in this method, ion implantation technology is used in offset-gate structure and a high resistance layer is added, thus higher breakdown voltage being ensured.

This method has a disadvantage in respect of area efficiency (integration rate) because of its long channel length.

In (b), the gate is formed in V-groove (or U-groove) and the channel is formed by double diffusion and crystal anisotropic etching, thus higher breakdown voltage being ensured.

In this method, current concentration tends to occur at the groove end, and it is considered to be hard to attain higher breakdown voltage.

The theoretical limit in high breakdown voltage and large current with regard to mass production has not reached our target value.

In (c), the channel is formed by double diffusion, thus higher breakdown voltage being ensured. This is called D-MOS (Double Diffusion MOS).

As compared with the previous 2 methods, this is easy to ensure higher breakdown voltage and large current and also permits mass production at low cost.

Therefore, TOSHIBA used this D-MOS as basic structure and adopted a new guard ring structure for ensuring higher breakdown voltage and stability.

Obtaining high power and low ON resistance, such a fine processing technique as required for LSI is adopted to realize high efficiency.

(2) Structure of D-MOS

In the structure of the D-MOS, as shown in Fig. 1 (c), a base area to be served as channels by using the same diffusion window and a source area treated with high-concentration doping are diffused on a high resistance drain region, and a difference in diffusion depth between the two areas is used as channels.

The distribution of impurities in the base drain junction thus formed is less on the drain side. The depletion layer extends more on the drain side when drain voltage is supplied, and less on the channel side, high breakdown voltage thus being ensured even in a very short channel, resulting from the punch-through preventing breakdown voltage from being decreased.

In addition, by employing a structure that takes the drain electrode from the base plate rear side, higher integration becomes possible, resulting in contributing to the realization of higher power. This also offers the merit of reducing transfer capacitance of the MOS FET by existence of cascade connected junction FET.

On the other hand, when effecting actual designing, it is necessary to fully consider the fact that a parasitic transistor exists between

the source and the drain.

By adopting the basic structure of the D-MOS, it becomes possible to assure high breakdown voltage in the MOS EFT area; however, a new guard ring structure as shown in Fig. 2 is adopted to obtain higher breakdown voltage by determining breakdown voltage of the device at the chip peripheral areas.

Unlike conventional guard rings, this newly

developed guard ring structure makes it possible for the breakdown voltage to be stabilized. This is facilitated by lowering the potential of each field plate through connecting guard rings to these field plates, in a greater degree as it reaches the outermost position, and also by reducing the potential of the outermost field plate to less than a predetermined value.

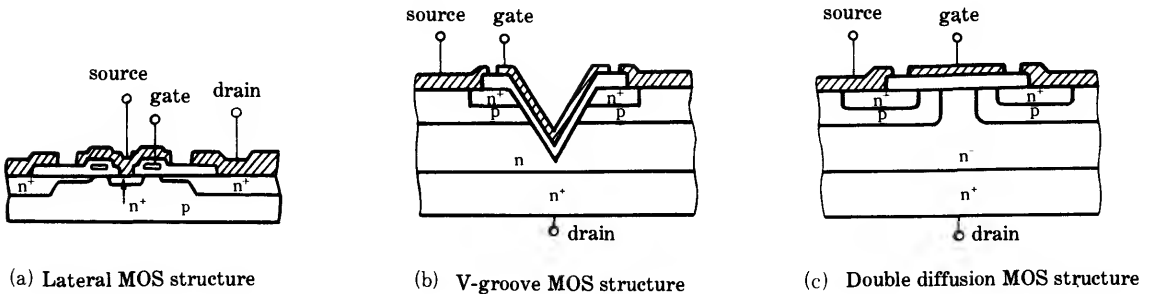


Fig. 1 Basic Structures of Power MOS FET

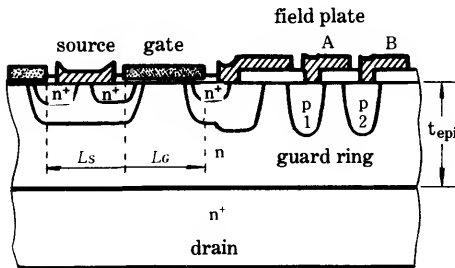


Fig. 2 New Guard Ring Structure

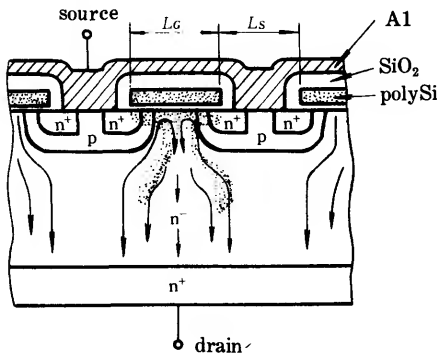


Fig. 3 Conceptual Diagram of Current Path within Exitaxial Layer

2. General Features of MOS FET

(1) The MOS FET is fundamentally a majority carrier device.

This differs much from the bipolar transistor that is a minority carrier device.

(2) Unlike the bipolar transistor that performs control by current, the MOS FET is a voltage-control device that performs control by voltage impressed between the gate and the source.

(3) As it is a majority carrier device, it can provide high frequency switching operation without carrier storage effect.

Except in the case of special ultra-high frequency operation, it does not need such a carrier dumping circuit as required in the bipolar transistor.

(4) In the bipolar transistor, full derating is performed in using the device because junction destruction is caused by the secondary breakdown phenomenon that is explained in electric field concentration produced in a high voltage region.

However, in the MOS FET, permission can be given to the nearly limit of the maximum rating.

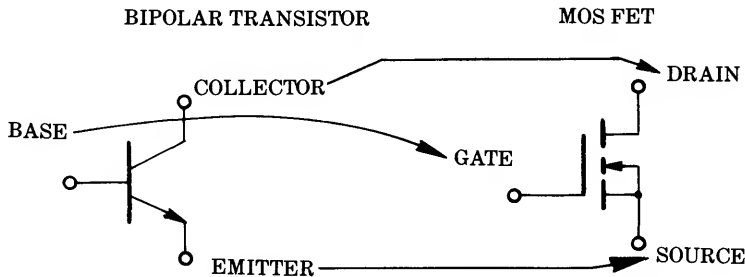
(5) When the MOS FET is used in switching

operation, the switching time namely rise time t_r and fall time t_f are 1-figure faster than those of the bipolar transistor, and its turn-on and turn-off loss values are almost negligible.

In the MOS FET, the losses based on ON-resistance in switching are domi-

nant, but the ON-resistance of the MOS FET has a positive temperature coefficient, so that the heat sink and heat radiation need to be designed in consideration of the ON-resistance at high temperature.

3. Definition of Terms



The names corresponding to those of the bipolar transistor are as shown by arrows in the above figure, but can not be compared as the same item, because the bipolar transistor is driven by current while the FET is driven by voltage. As main items for judging only the characteristics of the FET, the following can be mentioned.

- $|Y_{fs}|$: Forward transfer admittance

$$|Y_{fs}| = \Delta I_D / \Delta V_{GS} \text{ (S)}$$

This shows the sensitivity and amplifying capacity of the FET

- V_{th} : Gate threshold voltage

This is the threshold voltage of MOS device, and is expressed by the gate-to-source voltage at a certain low operating current value (1 mA for π -MOS)

Generally, at switching operation, it becomes:

$$V_{GS(OFF)} < V_{th} < V_{GS(ON)}$$

- $R_{DS(ON)}$: Drain-source ON resistance

This corresponds to $V_{CE(sat)}$ of the bipolar transistor, and serves as a criterion for finding self-dissipation in ON state.

(It varies slightly with I_D .)

- $V_{DS(ON)}$: Drain-source ON voltage

$R_{DS(ON)}$ applies to this item.

- C_{iss} , C_{rss} , C_{oss} : Capacitance

This is influential in switching speed (available frequency) and becomes the

capacitive load viewed from the driver stage.

As what corresponds to f_T in the bipolar transistor, the following figure of merit exists.

$$\text{Figure of merit} = |Y_{fs}| / C_{iss} \text{ (sec}^{-1}\text{)}$$

However, in general as theoretical cut-off frequency, the following is used:

$$f_{(MAX.)} = \frac{|Y_{fs}|}{2\pi(C_{iss} + A_V \cdot C_{rss})} \text{ (Hz)}$$

The other characteristics can be considered to be almost the same as those of the bipolar transistor. For details, refer to Chapter 10, list of terms for character symbols and graphic symbols.

4. Use of π -MOS FET

- (1) Precautions for handling

TOSHIBA π -MOS FETs have much larger endurance for electric charge in comparison with small-signal MOS FETs and memories.

But π -MOS FETs can potentially be damaged and destroyed by electric charge, and please take the following precautions for handling.

- (a) Transport and packing

- π -MOS FETs should be packed in conductive tray or pouch for MOS device, or

in aluminum foil.

- π -MOS FETs should be handled by the package, not by the leads; especially, don't touch the gate terminals.
- It is recommended to perform operation on the conductive table mats being grounded as far as possible.

(b) Test and inspection

In addition to the above item, make sure of the added surge of the measuring apparatus, etc.

- Voltage application should be started from 0 and reset to 0 after measurement. (Each terminal)

Especially, as for an automatic measuring apparatus, be particularly careful not to leave residual charge caused by the previous measurement.

- A 100-51 k ohm resistance should be connected in series with the gate to prevent oscillation.

This value varies with the sensitivity of the measuring apparatus and measurement method.

(c) Mounting

- Soldering irons that are used for π -MOS FETs should be grounded.
- Possible shortest wiring should be performed to eliminate unnecessary inductance and oscillating factors.

(2) Example of absorber insertion

In case there is a possibility that surge may occur between the drain and the source, such absorbers as shown in Fig. 4 should be inserted.

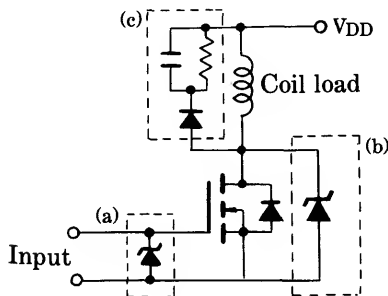


Fig. 4 Example of Absorber Insertion

(Recommended elements)

(a) For gate protection

$$(V_Z \leq V_{GSS} \times 0.8 \sim 0.9)$$

(b) For absorbing $V_{DS(surge)}$

Zener Diode: (attention to P_{surge})

$$(V_Z \leq V_{DSS} \times 0.8 \sim 0.9)$$

(c) For absorbing coil counter electromotive power.

The same as in the case of a bipolar transistor circuit.

But, high speed response is required.

5. Electrical Characteristics of MOS FET

(1) Characteristic comparison with the bipolar transistor

See Table 1, 2.

6. Maximum Rating of MOS FET

(1) V_{DS} (V_{DSS} , V_{DSX} , V_{DSR}) MOS FET Drain-source breakdown voltage

The method prescribing drain-source breakdown voltage is classified into 3 kinds according to gate-source bias conditions.

V_{DSS} : Gate-source zero bias (shorted state)

V_{DSX} : Gate-source reverse bias; for example, in the case of N-channel MOS, $V_{GS} = -3$ V.

V_{DSR} : When shunt is made by resistance between the gate and the source.

As the π -MOS for industrial use is of complete enhancement type with a double diffusion structure, $V_{DSS} = V_{DSX}$ is obtained.

Even if drain-source breakdown voltage is measured by inserting a certain resistance between the gate and the source (V_{DSR} mode), it differs little from the V_{DSX} mode in magnitude and the expression of $V_{DSS} = V_{DSX} = V_{DSR}$ can be formularized.

Consequently, there is no method prescribing larger drain-source breakdown voltage than the value V_{DSX} prescribed as the maximum rating for the π -MOS.

Therefore, note that in circuit design there is a little difference from the way of thinking of the maximum rating of bipolar transistors.

For reference, the prescribed modes of maximum rating for bipolar transistors and their relations in magnitude are outlined below:

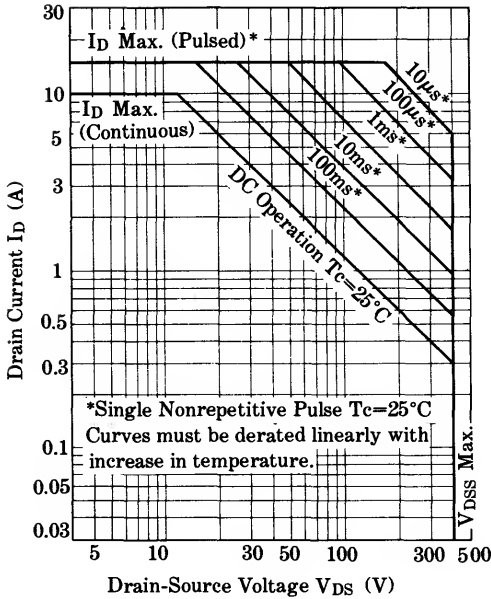
**Table 1 Comparison of Power MOS FET with Bipolar transistor
(Example: NPN Transistor, N Channel FET)**

Transistor		FET (field effect transistor)			
NPN		Type	Junction	MOS	
		Mode	Depletion	Depletion + Enhancement	Enhancement
		N channel			
Input vs. Output characteristic		Input vs. Output characteristic			
Assurance of higher breakdown voltage	◎		△ Difficult	× Difficult	○ (π -MOS)
Assurance of higher power	◎		△	×	◎ (π -MOS)
ASO	S/B region exists	ASO	◎ Without secondary breakdown region (same class)		
Input impedance	× Low	Input impedance	○ High	◎ High	◎ High
Switching speed	△	Switching speed	◎ High speed	○ High speed	○ High speed
ON Resistance	◎ Low	ON-Resistance	○	△ High	○ (π -MOS)

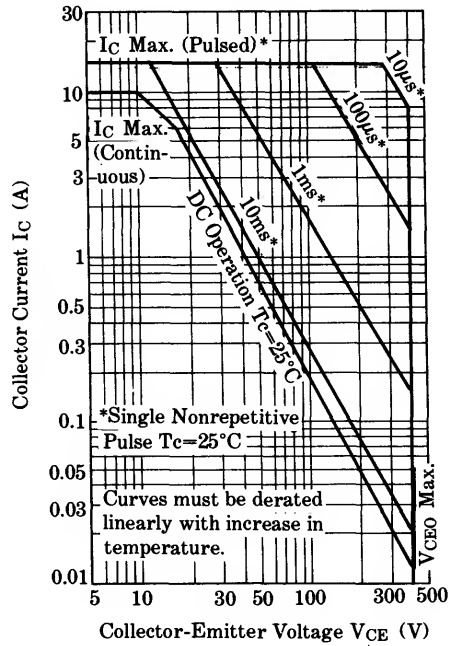
Table 2 Comparison of Main Characteristics between Power MOS FET and Bipolar Transistor

Specification of Power MOS FET				Specification of Bipolar Transistor			
Type No.	2SK324	2SK325	Type No.	2SC2914	Ultra-high speed transistor 2SC3384	2SD685 (Darlington transistor)	
Maximum Rating	V_{DSS}	400V	450V	V_{CBO}	500V	500V	600V
	V_{GSS}	$\pm 20V$	$\pm 20V$	V_{CEO}	400V	400V	400V
	I_D	10A	10A	V_{EBO}	7V	7V	5V
	PD	120W	120W	I_D	10A	15A	10A
Electrical Characteristics	$ Y_{fs} $	5S(typ.)	5S(typ.)	PC	120W	120W	100W
	RDS(ON)	0.6 Ω	0.7 Ω	hFE	12	15	400
	V_{th}	1.5~3.5V	1.5~3.5V	$V_{CE(sat)}$	1.0V	1.5V	2.0V
	t_r	50ns(typ.)	50ns(typ.)	$V_{BE(sat)}$	1.5V	1.5V	2.5V
	t_{on}	80ns(typ.)	80ns(typ.)	t_r	1 μ s	0.3 μ s	*1.0 μ s(typ.)
	t_{off}	350ns(typ.)	350ns(typ.)	* t_{on}			
				t_{stg}	2.5 μ s	1.5 μ s	12 μ s(typ.)
			tf	1 μ s	0.3 μ s	5 μ s(typ.)	

π -MOS FET 2SK324



Darlington Transistor 2SD685



High Speed Switching Transistor 2SC2914

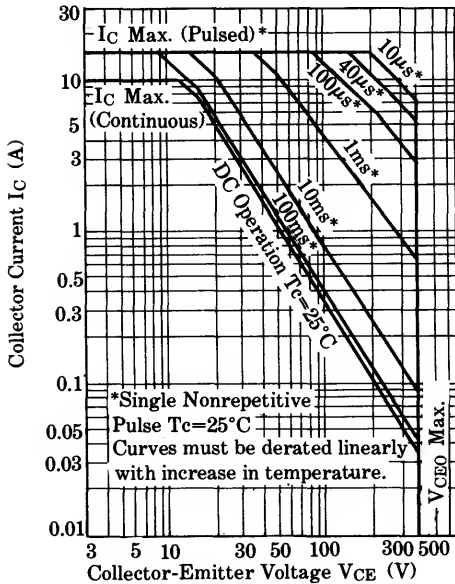


Fig. 5 Safe Operating Area

V_{CE0} : Collector-emitter breakdown voltage (when shunt is made by resistance between the base and the emitter)

Their relations in magnitude vary with the bias voltage value between the base and the emitter or resistance values to be shunted, but generally, the following relations can be set up.

$$V_{CB0} > V_{CEX} > V_{CER} > V_{CE0}$$

In general bipolar transistor circuit design, the V_{CE0} is usually taken as standard for collector-emitter breakdown voltage.

Even if collector-emitter voltage momentarily exceeds V_{CE0} at a transient time such as switching operation, etc., it is maintained by the V_{CEX} mode or V_{CER} mode that is higher than the V_{CE0} in voltage, thus there being cases in which transistors are not destructed.

On the other hand, in designing a circuit using MOS FETs, the V_{DSX} should not be exceeded even momentarily, being considered to be the real maximum rating, as there is no higher drain-source breakdown voltage mode than it.

- V_{CB0} : Collector-base breakdown voltage
- V_{CE0} : Collector-emitter breakdown voltage (with base terminal open)
- V_{CEX} : Collector-emitter breakdown voltage (base-emitter reverse bias; for example, in the case of NPN transistor, prescription of $V_{BE} = -1$ V, etc.)

The V_{DSO} (with the gate open) should not be used, because it can easily be put in ON state by electrostatic induction with the very high impedance of the FET itself and consequently may destruct the device.

(2) V_{GSS} : Gate-source voltage

This is caused by breakdown voltage of gate oxide film. In the π -MOS, the maximum rating is ± 20 V in consideration of service voltage and reliability. (Class for communication and industry application.)

The destruction point by surge is lowered as the chip is decreased in size, and great care should be taken in handling by referring to the previous item 4. (Use of π -MOS FET)

(3) I_D : Drain current

As for drain current I_D , the nominal value of $T_a=25^\circ\text{C}$ appears in the maximum rating items, but the following precautions should be taken in design and use.

● Temperature dependence:

$R_{DS(ON)}$ has a positive temperature coefficient as a general resistance element. (The absolute value and temperature coefficient vary with density.)

In addition, it fundamentally shows such an input vs. output characteristic as shown in Fig. 6, according to the temperature dependence of silicon mobility (the same as Junction FET).

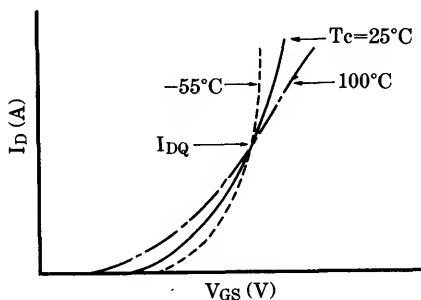


Fig. 6 I_D - V_{GS} Characteristic

Therefore, I_D shows positive and negative temperature coefficients with I_{DQ} as a boundary, and the operating point should be verified on the following points, especially, at fixed bias.

$I_D > I_{DQ}$ There is a possibility of destruction by overcurrent at low temperature.

$I_D < I_{DQ}$ There is a possibility of destruction by overcurrent and resultant thermal runaway.

Therefore, The maximum rating should be considered by derating according to temperature, including a temperature rise (change) by self-dissipation.

As countermeasures when abnormality occurs in a circuit, it is necessary to consider, for example, the saturation of inductive load (saturate with the transformer of switching power supply, and at lock of the motor, etc.)

With the saturation of inductive load, the load goes to low impedance and the device provides current to its capacity limit. This lead to destruction because of overcurrent or allowable power dissipation. If such a possibility exists, be sure to insert overcurrent limiting elements.

7. Switching Characteristic

The outstanding characteristic of the MOS FET as a majority carrier device is high speed and high frequency switching characteristic.

Because of this feature, it can be applied to high speed switching regulators ($f_0=100$ kHz \sim 300 kHz), broadcasting transmitters, motor controls, etc.

The cut-off frequency of the MOS FET reaches some GHz, but in practical circuits, it is limited by the parasitic resistance and input capacitance of the gate.

Fig. 7 shows the switching characteristic (drain current dependence of switching time when shunt is made by $R_{gs}=50\Omega$ between the gate and the source) in the case of 2SK324.

In the measuring circuit shown in Fig. 7, there are prescribed rise time t_r , turn-on time t_{on} , fall time t_f and turn-off time t_{off} by the waveform of drain-source voltage V_{DS} when the positive pulse of $V_{GS}=10$ V is applied between the gate and the source. Essentially, there is no carrier storage effect in the MOS FET, and the storage time t_{stg} expressed in the bipolar transistor does not exist. However, there is delay time by the wiring capacitance and wiring inductance of pellet pattern, and its value is quantified as t_{off} for expression.

The MOS FET is driven by the voltage V_{GS} supplied between the gate and the source.

This drive facility is quantitatively expressed by $Q_{on} = C_{iss} \cdot V_G$ according to the charge accumulated at the gate.

The i_g (pulse) that transiently flows in charging is given by the following expression.

$$i_g \text{ (pulse)} = Q_{on}/t_{on} = C_{iss} \cdot V_G/t_{on}$$

Therefore, when the MOS FET is operated at a very high speed, a capacitance permitting this i_g (pulse) to flow rapidly and momentarily to the drive circuit is required.

In actual measurement, Miller-effect appears and the equivalent capacitance between the gate and the source increases by the corresponding reverse transfer capacitance C_{rss} . Therefore, the C_{rss} should be taken into account.

The criterion of drive conditions in this case is given by the following expression.

$$Q_{on} = (C_{iss} + A_v \cdot C_{rss}) \cdot V_G$$

Moreover, the charging current i_g (pulse) that transiently flows is as follows.

$$i_g \text{ (pulse)} = (C_{iss} + A_v \cdot C_{rss}) \cdot V_G/t_{on} \\ = C_{gs} \cdot V_G/t_{on}$$

In case the reverse transfer capacitance is comparatively large, the drive conditions should be set up in consideration of the item of $A_v \cdot C_{rss}$. As shown in Fig. 8, the C_{rss} has large voltage dependence to drain-source voltage V_{DS} .

When the depletion region begins spreading in the drain region just under the gate electrode, the C_{rss} abruptly decreases; in the case of 2SK324, the capacitance decreases to about 1/10 around $V_{DS} = 2 \sim 5$ V.

In this way, the switching speed of the MOS FET is determined by gate-source equivalent capacitance. Therefore, in setting up drive conditions, the graph of electrostatic capacitance $-V_{DS}$ characteristic shown in Fig. 8 becomes very important.

In the MOS FET, the t_r and t_f of switching time are determined by the time constant $R_g \cdot C_{gs}$ set by gate-source capacitance and the time constant set by series connection of signal source resistance R_g .

Fig. 9 shows the switching time $-R_{gs}$ characteristic with the gate-source resistance R_{gs} varied.

If the R_{gs} is made larger, the time constant between the gate (terminal) and the source (terminal) is also made larger, so that the

speed becomes low.

Like the bipolar transistor, the MOS FET can decrease switching time t_f and t_{off} by applying reverse bias between the gate and the source.

Fig. 10 shows the t_{off} and t_f characteristics with $+V_{GS} = 5$ V fixed and $-V_{GS}$ varied from 0 V to 5 V.

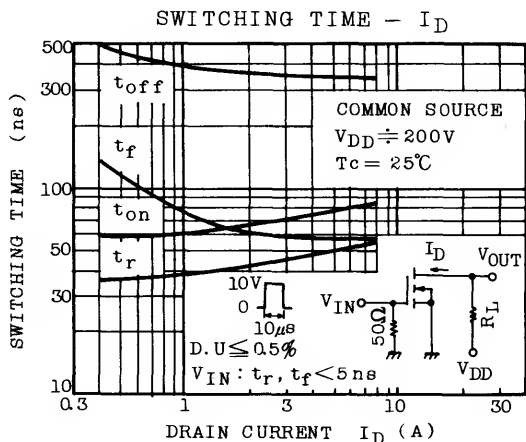


Fig. 7 Switching Time $-I_D$ (in the case of 2SK324)

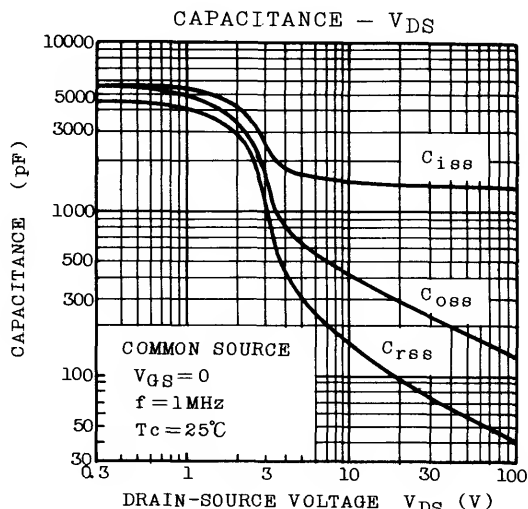


Fig. 8 Capacitance $-V_{DS}$ (in the case of 2SK324)

Consequently, the use of MOS FETs in circuit design holds an advantage.

8. Forward Bias Safe Operating Area SOA

The MOS FET in principle presents such a secondary breakdown phenomenon in the high voltage region as seen in the bipolar transistor, for lack of current concentration.

Therefore, the forward bias safe operating area of the MOS FET is expressed with the pulse width as parameter by the equipotential line (inclination: -1) limited by thermal resistance, as shown in Fig. 5 (2SK324).

On the other hand, in case the bipolar transistor is used as switching element, great care is needed for load locus in design because of presence of secondary breakdown phenomenon. In the case of the MOS FET, it is possible to operate it very extensively and safely within the drain-source breakdown voltage without narrowing SOA in the high voltage region.

As for the derating of SOA by temperature rise, the derating rate in thermal limited area or $d_T = (T_{chmax} - T_c) / (T_{chmax} - 25)$ is applied to all lines.

In thermal design, it is only required to consider that the channel temperature does not exceed the prescribed $T_{ch}(\max)$.

9. Reverse Bias Safe Operating Area SOA

In Case the switching device is applied for the use of power switching like switching regulator, etc., the load of the switching device becomes conductive.

In this case, both forward bias SOA and reverse bias SOA become significant. Therefore, in the case of the latest bipolar transistors, such a reverse bias SOA as shown in Fig. 11, with inductance L and base current I_{B1} and I_{B2} as parameters, is published.

Generally, in case the switching device is used for switching regulator, etc., the base-emitter junction is reversely biased forcedly and reverse current I_{B2} is caused to flow to decrease t_{stg} and t_f , in order to reduce a switching loss.

However, with I_{B2} increased, the reverse bias SOA narrows as shown in Fig. 11, and the operating area of the load locus at turn-off is limited.

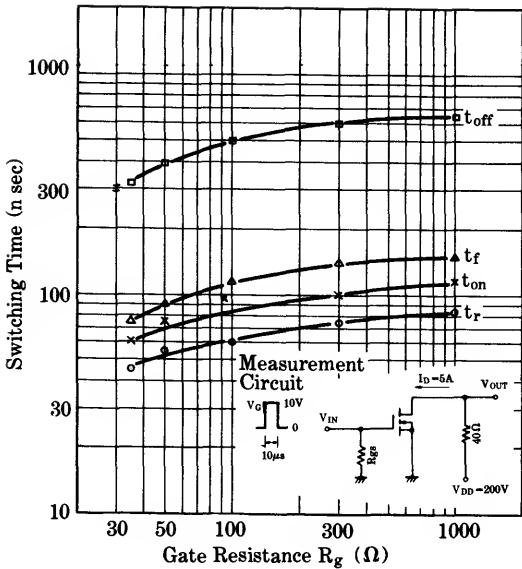


Fig. 9 Switching Time—Gate Resistance R_g (in case of 2SK324)

As the switching speed of the MOS FET structurally depends on the capacitive charge and discharge phenomenon between the gate and the source, it is little influenced by switching time temperature as compared with the bipolar transistor.

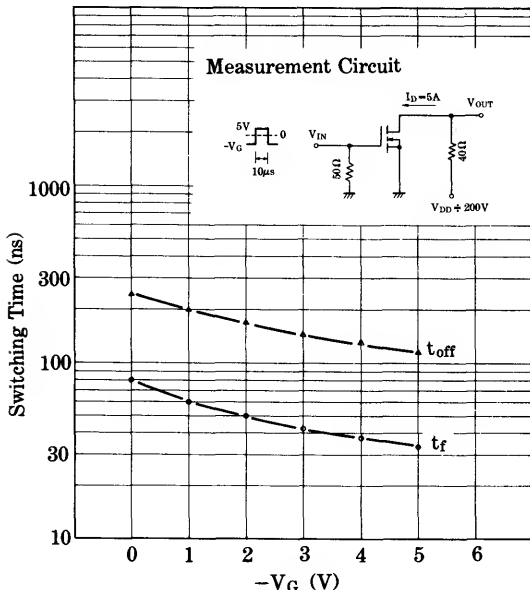


Fig. 10 Switching Time— I_D Characteristic (in the case of 2SK324)

On the other hand, t_r and t_{off} can be reduced by biasing reversely the gate-source, as described above.

At this time, in the MOS FET that is a majority carrier device, the reverse SOA does not become narrow by increasing $-V_{GS}$, because no carrier storage effect substantially exists.

It follows that in the use of MOS FETs, the safety degree in circuit design is increased.

10. Temperature Characteristic

The transfer characteristic ($I_D - V_{GS}$ characteristic) of the MOS FET is shown in Fig. 12.

In the large current area, the temperature coefficient of the transfer characteristic is negative, the output changes, the internal temperature rises and g_m [Yfs] goes down, so that a destructive phenomenon like thermal runaway is hard to occur without current concentration though a large drain current tries to flow.

On the other hand, in the small current area, the temperature coefficient is positive and the temperature coefficient of the transfer function changes from positive to negative with a crosspoint (I_{DQ}) as boundary.

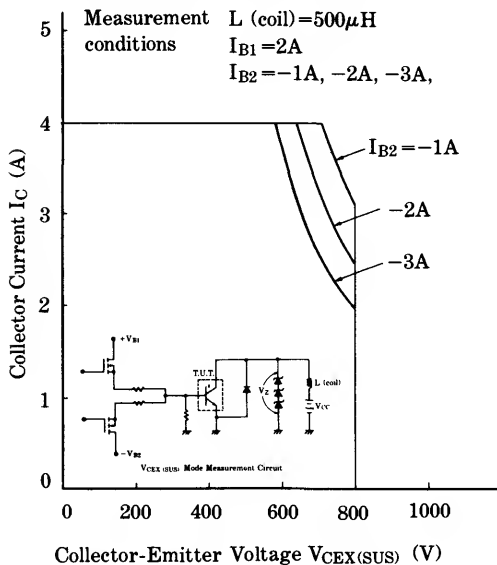


Fig. 11 Reverse Bias SOA Data of Bipolar Transistor (in case of 2SC2792)

Consequently, if the operating point is set to the crosspoint in an application circuit, any temperature compensating circuit is not needed.

In using the MOS FET, the item to consider with regard to temperature is the temperature dependence of drain to source ON resistance.

The ON resistance becomes about double with a temperature rise of 100 degrees.

(Refer to Fig. 13, $V_{DS(ON)} - T_c$ Characteristic.)

Therefore, in radiation design, the maximum temperature rise should be taken into consideration to select the heat sink, etc.

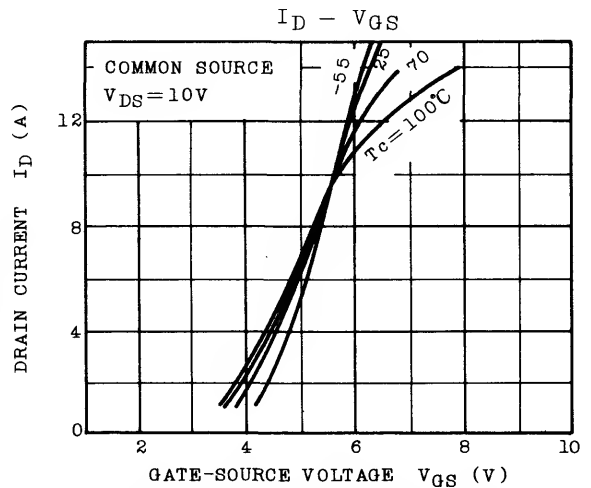


Fig. 12 $I_D - V_{GS}$ Characteristic (in the case of 2SK324)

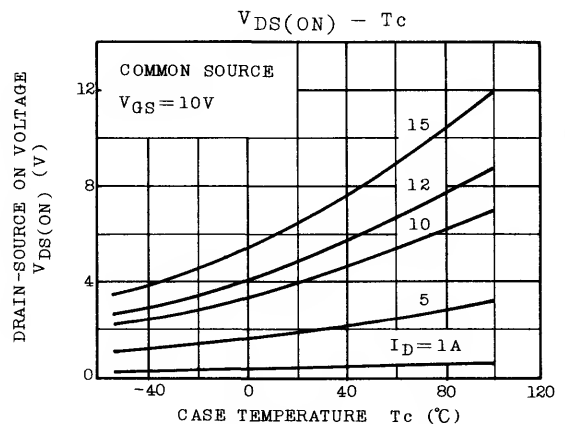


Fig. 13 $V_{DS(ON)} - T_c$ Characteristic (in the case of 2SK324)

11. Source-Drain Diode Characteristic

The MOS FET of D-MOS structure equivalently incorporates a diode between the source and the drain. The rating of forward current I_{DR} and the reverse breakdown voltage of this incorporated diode has the same capacity as the drain current I_D and drain-source voltage rating V_{DSX} of the MOS FET. But, as this incorporated diode is of 3-terminal including a gate terminal unlike common 2-terminal diodes (P-N junction), it shows some different forward characteristic according to the gate-source bias state.

Therefore, in application of the MOS FET, for example, in the bridge circuit of a switching regulator or motor control circuit (bridge type), it is fundamentally possible for this incorporated diode to be used as a commutation diode, but it is necessary to consider the fact that the forward characteristic varies with gate-source bias states.

If the gate-source is positively biased to form channels, the forward current of the diode flows in the same way as the drain current of the MOS FET, and in the small current region, linearity is established in the $I_{DR} - V_{DS}$ characteristic ($-V_{DS} \sim I_{DS} \times R_{ON}$) and $-V_{DS}$ becomes smaller than the forward voltage V_F of a general diode.

With a due application of the incorporated diode, it is possible to display the superiority of this 3-terminal diode.

12. Parallel Connection of MOS FET

It is often seen in circuits dealing with high power that versatile lower-cost devices are used in parallel connection.

In the case of bipolar transistors, as there is a secondary break-down phenomenon in the high voltage region, they are commonly used by the derating that the current per 1 transistor connected in parallel is 1/3 to 1/4 of the maximum collector rated current.

Considering a circuit dealing with high power with MOS FETs connected in parallel, the parallel connection of MOS FETs is very easy because there is no secondary breakdown phenomenon that is the greatest disadvantage of the bipolar transistor, and also it is possible to use them to the nearly limit of the maximum rating, so that the number of devices to be parallel-connected can be reduced. The advantages offered by the parallel connection of

MOS FETs are outlined as follows.

- 1 Since the MOS FET is driven by gate-source voltage V_{GS} , its parallel connection is easily made. It hardly needs such a resistance that is inserted for base current balance in the parallel connection of bipolar transistors.
- 2 As there is a negative region in the temperature coefficient of drain current, the T_{ch} of only a single MOS FET parallel-connected does not increase even if channel temperature T_{ch} rises.
In addition, temperature distribution is made uniform between parallel-connected devices, so that thermal runaway is hard occur in comparison with the bipolar transistor.
Naturally, current concentration is hard to occur.
- 3 As there is no secondary breakdown region in the safe operating area of the MOS FET, it can be used to the limit of the maximum rating of drain current I_D and drain-source voltage V_{DS} as load locus ($I_D - V_{DS}$ waveform).

The above can be enumerated as the main advantages of the parallel connection of MOS FETs.

The switching time dispersion caused by the dispersion of V_{th} can particularly mentioned as a precaution for the parallel connection.

That is, the V_{th} can be considered to be a criterion of the voltage value at the outset of operation; the smaller V_{th} an device has, the more rapidly its turn-on becomes and the more slowly its turn-off becomes.

Therefore, in case a plural number of devices are used in parallel connection, devices with the same V_{th} value are needed. We are preparing 6 kinds of V_{th} as quasi-standard in your need.

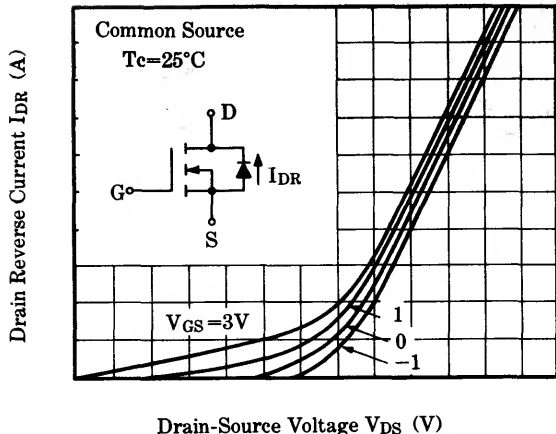


Fig. 14. $I_{DR} - V_{DS}$ Characteristic (in the case of 2SK324)

Packing;
2SK324 - ○ ← classification number

(3) Packing
Pairs of same V_{th} class devices are packed.

(4) Remark
It is impossible to designate V_{th} class on the orders.

TOSHIBA POWER MOS FET
 V_{th} CLASSIFICATION

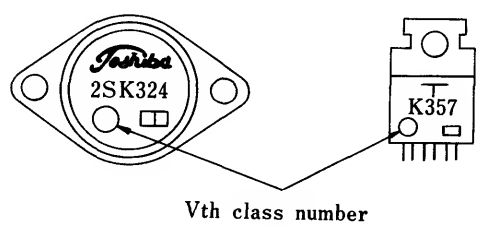
(For example, class for communication and industry device)

(1) Classification
(π -MOS FETs are classified into 6 classes according to gate threshold voltage V_{th} .)

(1) Classification

Class	V_{th} (V)	
	Min.	Max.
1	1.5	1.9
2	1.7	2.2
3	2.0	2.5
4	2.3	2.8
5	2.6	3.1
6	2.9	3.5

(2) Marking
Device:



Precautions for Handling RF Power Transistor and Module

1. Precautions for handling RF Power Transistor

(1) Mounting ceramic seal type transistor

For mounting such a transistor as shown in the figure, on a printed circuit board or heat sink, it is necessary to adopt either the method of making the lead level (Fig. 2, (a)) or the method of bending the lead downward (Fig. (b)); it is prohibited to mount it in such a way that upward stress is given to the foot of the lead.

The lead should be bended at a 1—2 mm distance from the ceramic part.

Note that the gain is reduced by an increase of inductance of the emitter lead in the

method shown in Fig. (b).

In mounting, press the transistor head lightly with a finger, hold it with a nut in the case of stud type or screw it in the case of flange type, and then solder the lead.

After soldering the lead, be careful not to give stress forcedly to the transistor.

In order to improve even a little the thermal contact state between the transistor and the heat sink, apply silicon grease with high thermal conductivity to the transistor bottom and stud screw in the case of stud type or to the flange bottom, screw mounting hole, etc. in the case of flange type.



Fig. 1

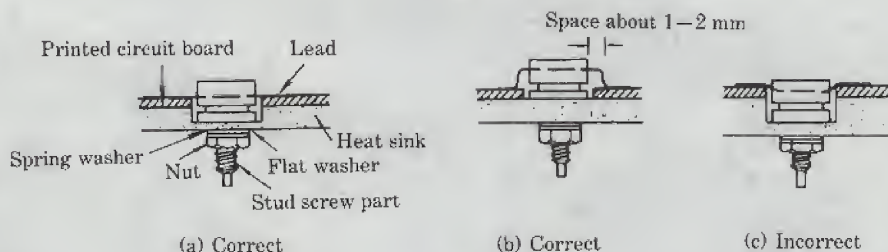


Fig. 2

(2) Screw stud torque

Excessive clamping of a transistor will not provide so much improvement of thermal resistance; on the contrary, it may cause damage to the screw part and lead and deformation to the surrounding unit and the inside of the pellet, deteriorating the characteristic.

On the other hand, if clamping is insufficient, thermal resistance naturally increases and the junction temperature of the transistor rises, resulting in destruction and a shorter life.

Table 1 shows the recommended clamping torque.

Table 1

Case Type	Stud parts	Stud torque
2-10G1A	M4 nut	5~6kg-cm
2-7A1A	M3 bis	"
2-10H1A	"	"
2-13C1A	"	"
2-13B1A	"	"

(3) External base-emitter resistance

In order to improve the stability against load and power variations of land-mobile transmitters, a resistance may be used in series with the choke coil on the input side in a part of the power amplifier circuit, as shown in Fig. 3.

If this series resistance is too large, the transistor is so deeply biased to class C that larger voltage than base-emitter breakdown voltage is momentarily applied, thereby a deterioration of h_{FE} and then a drop of output power being caused while it is used for a long time.

Therefore, it should be designed to use a resistance of a possible minimum value.

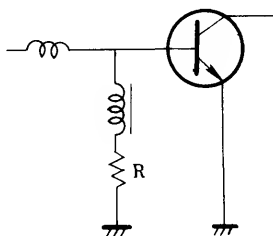
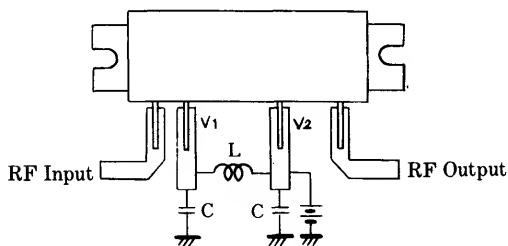


Fig. 3

(4) Treatment of wastse articles

Beryllium oxide porcelain is used in RF power transistors (except those with the collector shorted to the case).

Beryllium oxide (BeO), when transformed into powder or steam, does harm to a human body, incurring danger. Never produce neither powder nor steam by shaving, polishing, destroying, wiping with chemicals or buring the beryllium oxide.



C: Parallel connection of 15000pF, 10 μ F
L: ϕ 0.8 mm enamel wire, 8T, 5ID

Fig. 4

2. Precautions for Handling RF Power Amp Module

(1) Mounting Module

Use ϕ 4 mm screws and tighten them by a torque of 5 kg-cm—6 kg-cm. In order to improve the thermal contact state between the module and the heat sink as much as possible, be sure to apply silicon grease with good thermal conductivity on the rear side of the module radiation fin.

Don't give excessive mechanical and thermal stress to the lead terminal on the module.

The radiation fin of the moduel is connected to the ground.

In case the heat sink is grounded, good grounding effect can be obtained by clamp screws on both ends. In case only the printed circuit board is provided with ground, connect the radiation fin with the grounding electrode on the circuit board electrically by a metal plate that is as wide as possible.

(2) Prevention of oscillation by the RF feedback through DC line, etc.

For the prevention of oscillation by the RF feedback through DC line, connect L and C as shown in Fig. 4.

3. Thermal Design of RF Power Amp Module

(1) Thermal resistance and junction temperature of the used transistors

The RF Power Amp Mudule consists of 2-to-3-stage RF power transistor amplifiers.

Each stage is designed to permit operation under standard conditions of use so that the transistor junction temperature can leave a sufficient margin to the maximun rating (usually 175°C). The thermal design of the RF Power Amp Module S-AV5 for 144-148 MHz band 10 W amateur set is described below as an example.

(a) Operating state at nominal output

The nominal output of the S-AV5 is 15 W ($P_i=0.2$ W).

The total efficiency η_T is 50% MIN. Therefore, at the worst η_T , the total current I_T is:

$$I_T = \frac{P_o/\eta_T}{V_{CC}} = \frac{15/0.5}{12.5} = 2.4 \text{ (A)}$$

At this time, the I_C of the first-stage transistor and the last-stage transistor is

approximately as follows.

$$I_{C1}=0.39 \text{ (A)} \quad I_{C2}=2.01 \text{ (A)}$$

Moreover, at this time, the output of the first-stage transistor is approximately:

$$P_{o1}=2.0 \text{ (W)}$$

- (b) Thermal resistance of the used transistors
The standard junction-case thermal resistance value of each first-stage/last-stage transistor is as follows.

$$R_{thj-c(1)}=10 \text{ (}^\circ\text{C/W)} \quad R_{thj-c(2)}=3 \text{ (}^\circ\text{C/W)}$$

- (c) Junction temperature at nominal output
For the above (a) and (b), the transistor junction temperature at rated output is:

$$T_{j(1)}=(V_{CC} \times I_{C1}-P_{o1}+P_i) \times R_{thj-c(1)}+T_C=38.8+T_C \text{ (}^\circ\text{C)}$$

$$T_{j(2)}=(V_{CC} \times I_{C2}-P_o+P_{o1}) \times R_{thj-c(2)}+T_C=36.4+T_C \text{ (}^\circ\text{C)}$$

where, T_C : case temperature

Table 2 shows a list of thermal design values for TOSHIBA RF Power Amp Modules.

- (2) Heat sink and junction temperature

For designing a set with high reliability, it is necessary to mount it on a complete radia-

tion fin under good conditions.

As a criterion, the thermal resistance of the radiation fin ($R_{th \text{ fin}}$) is selected in order to that the case temperature T_c is below 90°C at the maximum ambient temperature ($T_{a \text{ max}}$).

As an example, the case of the aforementioned S-AV5 is described. Radiation fin required:

Supposing that $T_{a \text{ max}}$ is 60°C . When the rated output of the S-AV5 is 15 W, the worst efficiency is $\eta_{T \text{ MIN}} 50\%$. Consequently, to make T_c below 90°C ,

$$\begin{cases} T_C = \left(\frac{P_o}{\eta_T} - P_o + P_i \right) R_{th \text{ fin}} + T_{q \text{ max}} \leq 90^\circ\text{C} \\ R_{th \text{ fin}} \leq 1.97 \text{ (}^\circ\text{C/W)} \end{cases}$$

Furthermore, when $T_c=90^\circ\text{C}$, the junction temperature is:

$$\begin{cases} T_{j(1)}=30.8+T_C=120.8 \text{ (}^\circ\text{C)} \\ T_{j(2)}=36.4+T_C=126.4 \text{ (}^\circ\text{C)} \end{cases}$$

As for the other modules, the thermal resistance necessary to keep $T_c \leq 90^\circ\text{C}$ at $T_{a \text{ max}}=60^\circ\text{C}$ is shown in Table 2.

Table 2 Thermal Design values and Radiation Fins Required of TOSHIBA RF Power Amp Modules

Item Type	Module thermal design value (at rated output)															Radiation fin required $R_{th \text{ fin}}$ ($^\circ\text{C/W}$)				
	P_o MIN (W)	η_T MIN (%)	1st stage					2nd stage					3rd stage							
			I_c (A)	P_{o1} (W)	P_i (W)	R_{thj-c} ($^\circ\text{C/W}$)	$T_{j(1)}$ ($^\circ\text{C}$)	I_{c2} (A)	P_{o2} (W)	P_{o1} (W)	R_{thj-c} ($^\circ\text{C/W}$)	$T_{j(2)}$ ($^\circ\text{C}$)	I_{c3} (A)	P_{o3} (W)	P_{o2} (W)		R_{thj-c} ($^\circ\text{C/W}$)	$T_{j(3)}$ ($^\circ\text{C}$)		
S-AV5	15	50	0.39	2.0	0.2	10	$30.8+T_c$	2.01	15	2.0	3	$56.4+T_c$	/						1.97	
S-AV6	28	45	0.78	3.7	0.2	8	$50.0+T_c$	4.20	28	3.7	2	$56.4+T_c$								0.87
S-AV7	28	45	0.78	3.7	0.2	8	$50.0+T_c$	4.20	28	3.7	2	$56.4+T_c$								0.87
S-AV8 (*)	17	40	0.35	1.5	0.07	10	$29.5+T_c$	2.45	14	1.5	2	$36.3+T_c$								1.42
S-AV9L,H	8	40	0.37	1.4	0.2	10	$34.3+T_c$	1.23	8	1.4	3	$26.3+T_c$								2.46
S-AV10L,H	14	40	0.45	2.3	0.2	10	$35.3+T_c$	2.35	14	2.3	3	$53.0+T_c$								1.42
S-AU3	15	40	0.46	2.0	0.2	10	$39.5+T_c$	2.54	15	2.0	2.6	$48.8+T_c$								1.32
S-AU4 (*)	17	35	0.45	2.0	0.12	10	$37.5+T_c$	2.75	14	2.0	2.2	$49.2+T_c$								1.15
S-AV5L,M,H	7	40	0.32	1.4	0.2	10	$28.0+T_c$	1.08	14	1.4	2.6	$20.5+T_c$								2.80
S-AU6L,M,H	13	40	0.50	2.2	0.2	10	$42.5+T_c$	2.10	13	2.2	2.2	$34.0+T_c$								1.52
S-AU7	15	30	0.20	1.1	0.2	6	$9.6+T_c$	0.50	3.5	1.1	5.5	$21.2+T_c$		2.85	15	3.5	2	$48.3+T_c$		0.85

Note 1:

In (*)S-AV8 and S-AU4, P_o is converted into a practical use level of 14 W, for thermal design value and radiation fin required.

Note 2:

The radiation fin required is a thermal resistance of the fin necessary for $T_c \leq 90^\circ\text{C}$ at $T_a=60^\circ\text{C}$.

Letter Symbol and Graphical Symbol

1. Letter symbol

Table 1 General

Symbol	Description
NF	noise figure
P	allowable power dissipation
R_{th}	thermal resistance
$R_{th\ j-c}$	thermal resistance, (junction to case)
$R_{th\ j-s}$	thermal resistance, (junction to stud)
$R_{th\ j-a}$	thermal resistance, (junction to ambient)
$R_{th\ (t-a)}$	thermal resistance, (heat sink to ambient)
$R_{th\ (s-f)}$	thermal resistance, (stud to heat sink)
r_{th}	transient thermal resistance
T_a	ambient temperature
T_c	case temperature
T_j	junction temperature
T_{stg}	storage temperature
t_d	delay time
t_f	fall time
t_r	rise time
t_{rr}	reverse recovery time (diode)
t_{stg}	storage time
t_{on}	turn-on time
t_{off}	turn-off time

Table 2 Transistor

Symbol	Description
$V_{(BR)CBO}$	collector-base breakdown voltage, emitter open
$V_{(BR)CEO}$	collector-emitter breakdown voltage, base open
$V_{(BR)CER}$	collector-emitter breakdown voltage, with specified resistance between base and emitter
$V_{(BR)CES}$	collector-emitter breakdown voltage, with base short-circuited to emitter
$V_{(BR)CEX}$	collector-emitter breakdown voltage, with specified circuit between base and emitter
$V_{(BR)EBO}$	emitter-base breakdown voltage, collector open
b_{fb}	forward transfer susceptance, common base
b_{fe}	forward transfer susceptance, common emitter
b_{jb}	input susceptance, common base
b_{je}	input susceptance, common emitter
b_{ob}	output susceptance, common base
b_{oe}	output susceptance, common emitter
C_{ob}	output capacitance, common base
C_{oe}	output capacitance, common emitter
C_{ib}	input capacitance, common base
C_{ie}	input capacitance, common emitter
$C_e r_{bb'}$	$C_e \times r_{bb'}$ (collector-to-base time constant)
C_{re}	reverse transfer capacitance

f_{cb}	small-signal, short-circuit forward current transfer ratio cutoff frequency, common base
f_T	transition frequency (common emitter gain band-width product)
G_c	conversion power gain
G_{pe}	power gain, common emitter
G_{ve}	voltage gain, common emitter
g_{fb}	forward transfer conductance, common base
g_{fe}	forward transfer conductance, common emitter
g_{ib}	input conductance, common base
g_{ie}	input conductance, common emitter
g_{ob}	output conductance, common base
g_{oe}	output conductance, common emitter
g_{rb}	reverse transfer conductance, common base
g_{re}	reverse transfer conductance, common emitter
h_{fb}	small-signal, short-circuit, forward current transfer ratio, common base
h_{fe}	small-signal, current gain, common emitter
h_{FE}	DC current gain, common emitter
h_{ib}	small-signal, short-circuit input impedance, common base
h_{ie}	small-signal, short-circuit input impedance, common emitter
$Re(h_{ie})$	real part of small-signal, short-circuit input impedance, common emitter
$Im(h_{ie})$	imaginary part of small-signal, short-circuit input impedance, common emitter
h_{oe}	small-signal, open-circuit output admittance, common emitter
h_{ob}	small-signal, open-circuit output admittance, common base
h_{rb}	small-signal, open circuit reverse voltage transfer ratio, common base
h_{re}	small-signal, open circuit reverse voltage transfer ratio, common emitter
I_B	base current
I_C	collector current
I_E	emitter current
I_{CBO}	collector cutoff current, emitter open
I_{CBV}	collector cutoff current, with specified reverse voltage between base and emitter
I_{CEO}	collector cutoff current, base open
I_{CEX}	collector cutoff current, with specified circuit between base and emitter
I_{EBO}	emitter cutoff current, collector open
KF	overall harmonic distortion
P_o	output power
P_i	input power
P_c	collector power dissipation
Q_s	stored charge
$r_{bb'}$	base spreading resistance
R_E	external emitter resistance
R_G	signal source resistance
R_i	input resistance
R_L	load resistance

R_o	output resistance
UMAPG	maximum available power gain
V_{BE}	base-emitter voltage
$V_{BE(sat)}$	base-emitter saturation voltage
V_{CB}	collector-base voltage
V_{CBO}	collector-base voltage, emitter open
V_{CBV}	collector-base voltage, with specified voltage between base and emitter
V_{CE}	collector-emitter voltage
V_{CEO}	collector-emitter voltage, base open
V_{CER}	collector-emitter voltage, with specified resistance between base and emitter
V_{CES}	collector-emitter voltage, with base short-circuited to emitter
V_{CEV}	collector-emitter voltage, with base specified voltage between base and emitter
V_{CEX}	collector-emitter voltage, with specified circuit between base and emitter
$V_{CE(sat)}$	collector-emitter saturation voltage
$V_{CE(sus)}$	collector-emitter sustaining voltage
V_{EBO}	emitter-base voltage, collector open
V_i	input voltage
V_N	noise voltage
V_R	reverse voltage
V_{osc}	oscillating output voltage
y_{fb}	forward transfer admittance, common base
y_{fe}	forward transfer admittance, common emitter
y_{rb}	reverse transfer admittance, common base
y_{re}	reverse transfer admittance, common emitter
θ_{fb}	phase angle of forward transfer admittance, common base
θ_{fe}	phase angle of forward transfer admittance, common emitter
θ_{rb}	phase angle of reverse transfer admittance, common base
θ_{re}	phase angle of reverse transfer admittance, common emitter

Table 3 Unijunction transistor

Symbol	Description
I_B	base current
$I_{B2(Mod)}$	modulated interbase current
I_E	emitter current
I_{EB20}	emitter reverse current, base 1 open
I_{EM}	peak emitter current
I_P	peak point emitter current
I_V	valley point emitter current
V_{B2B1}	base 2-base 1 voltage
V_{B1E0}	base 1-emitter voltage, with base 2 open
V_{B2E0}	base 2-emitter voltage, with base 1 open
V_{EB1}	emitter-base 1 voltage
$V_{EB1(sat)}$	emitter-base 1 forward saturation voltage, with specified voltage between bases 1 and 2
V_V	valley point emitter voltage
V_P	peak point emitter voltage
R_{BBO}	base 1-base 2 resistance, with emitter open intrinsic standoff ratio

Table 4 Field Effect Transistor (FET)

Symbol	Description
SOA	safe operating area
CG1D	gate 1-drain capacitance
CG2D	gate 2-drain capacitance
C_{is}	input capacitance, common source
C_{os}	output capacitance, common source
C_{rs}	reverse transfer capacitance, common source
C_{iss}	small-signal, short-circuit input capacitance, common source
C_{oss}	small-signal, short-circuit output capacitance, common source
C_{rss}	small-signal, short-circuit reverse transfer capacitance, common source
f_{opr}	operated frequency
G_{ps}	power gain, common source
GR	gain reduction
g_{iss}	input conductance, common source
g_{oss}	output conductance, common source
I_D	drain current
I_{DR}	drain reverse current (refer to measuring conditions)
$I_{D(OFF)}$	drain cutoff current
I_{DSS}	drain current, with gate short-circuited to source
I_{DSX}	drain-source current with specified circuit between gate and source
I_G	gate current
I_{GSS}	gate-source cutoff current, with source short-circuited to drain
I_{GSX}	gate excess current
NF	noise figure
P_D	drain power dissipation
$R_{DS(ON)}$	drain-source ON resistance, DC
$R_{DS(OFF)}$	drain-source OFF resistance, DC
$r_{DS(ON)}$	drain-source ON resistance, AC
$r_{ds(ON)}$	drain-source ON resistance, internal equivalent
r_G	gate resistance, internal equivalent
T_{ch}	channel temperature
T_j	junction temperature
T_{stg}	storage temperature range
$t_{d(on)}$	turn-on delay time
t_r	rise time
t_{on}	turn-on time
$t_{d(off)}$	turn-off delay time
t_f	fall time
t_{off}	turn-off time
$V_{DS(ON)}$	drain-source ON voltage
V_{DSX}	drain-source voltage with specified circuit between gate and source
V_{DSF}	drain-source forward transfer voltage
V_{DSS}	drain-source voltage, with gate short-circuited to source
V_{emf}	drain-source thermal electromotive force
V_{GS}	gate-source voltage
$V_{GS(OFF)}$	gate-source cutoff voltage
V_{GSS}	gate-source voltage, with drain short-circuited to source
V_{GDS}	gate-drain voltage, with source short-circuited to drain

$V_{(BR)DSS}$	drain-source breakdown voltage
$V_{(BR)GDS}$	gate-drain breakdown voltage
V_N	noise voltage
$V_N(p-p)$	peak-peak noise voltage
$V_N(AV)$	average noise voltage
V_{th}	gate-source threshold voltage
$ Y_{fs} $	forward transfer admittance
y_{fs}	forward transfer admittance, common source
y_{is}	input admittance, common source
y_{rs}	reverse transfer admittance, common source
y_{os}	output admittance, common source

only for explanation purposes and do not comprise a part of relevant symbols.

The letters used here denote the following—

- E: emitter
 C: collector
 B: base
- D: drain
 G: gate
 S: source

- The following envelope symbols may be omitted if no confusion will arise or if none of the elements in a device is connected to an envelope.



Envelope Symbols

2. Graphical symbol

- Letters and numbers shown on the drawings of graphical symbols listed below are given

Description	Graphical symbol
PNP transistor	
NPN transistor	
NPN transistor (collector to case connected)	
P-channel junction type field effect transistor	
N-channel junction type field effect transistor	
N-channel junction type field effect transistor (gate taken out of a substrate)	
P-channel MOS enhancement type field effect transistor	

Description	Graphical symbol
N-channel MOS enhancement type field effect transistor	
N-channel MOS enhancement type field effect transistor (gate taken out of a substrate and connected to case)	
N-channel MOS depletion type field effect transistor	
N-channel MOS depletion type field effect transistor (gate taken out of a substrate)	
Dual-gate N-channel MOS depletion type field effect transistor (substrate internally connected to source)	
Twin transistor	
High-speed switching N-type base uni-junction transistor	



**TECHNICAL
DATA**



2SA

SERIES

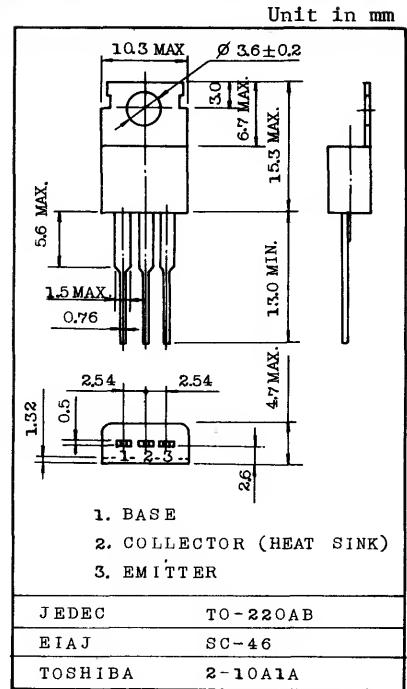
POWER AMPLIFIER APPLICATIONS.
 CAR RADIO AND CAR STEREO OUTPUT STAGE
 APPLICATIONS

FEATURES:

- . Good Linearity of h_{FE} .
- . Complementary to 2SC1173.

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-30	V
Collector-Emitter Voltage	V_{CE0}	-30	V
Emitter-Base Voltage	V_{EB0}	-5	V
Collector Current	I_C	-3	A
Emitter Current	I_E	3	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_c	10	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55~150	$^\circ\text{C}$

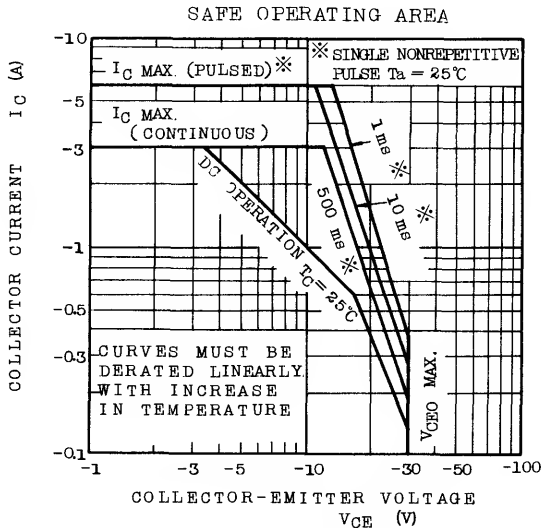
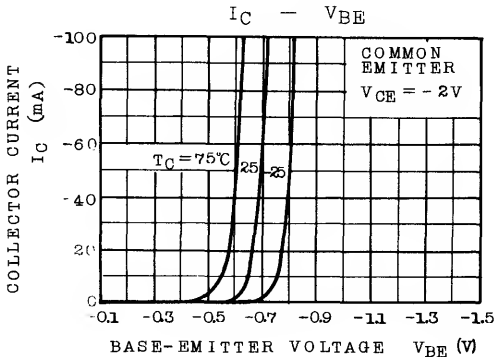
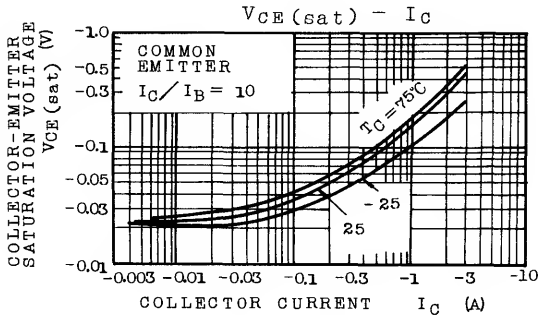
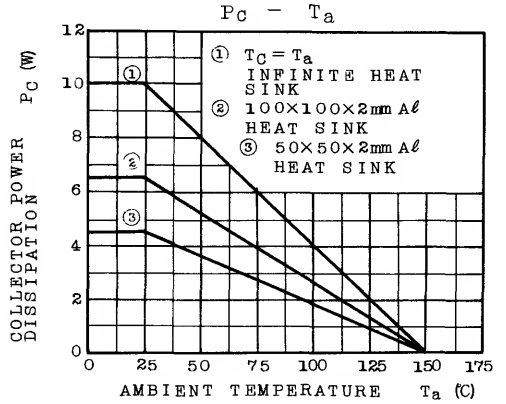
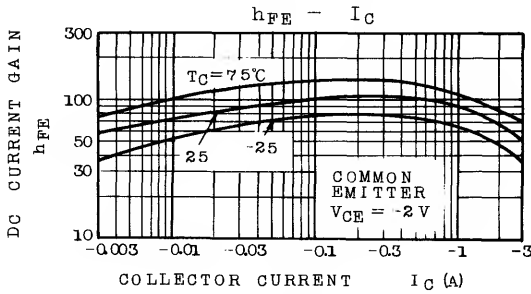
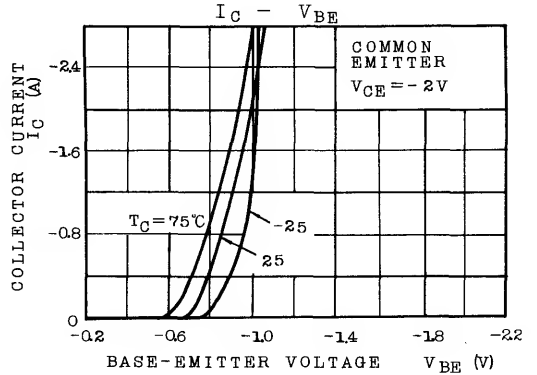
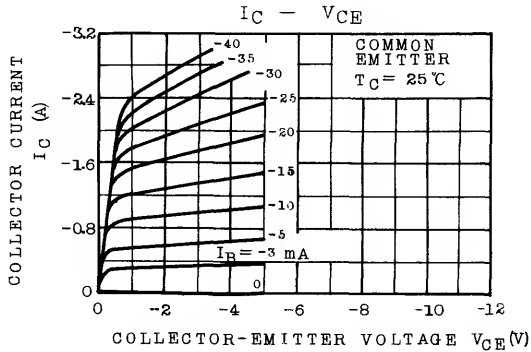


Mounting Kit No. AC75
 Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=-20\text{V}, I_E=0$	-	-	-1.0	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=-5\text{V}, I_C=0$	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=-10\text{mA}, I_B=0$	-30	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=-1\text{mA}, I_C=0$	-5	-	-	V
DC Current Gain	$h_{FE}(1)$ (Note)	$V_{CE}=-2\text{V}, I_C=-0.5\text{A}$	70	-	240	
	$h_{FE}(2)$	$V_{CE}=-2\text{V}, I_C=-2.5\text{A}$	25	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-2\text{A}, I_B=-0.2\text{A}$	-	-0.3	-0.8	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-2\text{V}, I_C=-0.5\text{A}$	-	-0.75	-1.0	V
Transition Frequency	f_T	$V_{CE}=-2\text{V}, I_C=-0.5\text{A}$	-	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10\text{V}, I_E=0, f=1\text{MHz}$	-	40	-	pF

Note: $h_{FE}(1)$ Classification 0 : 70~140, Y : 120~240



Unit in mm

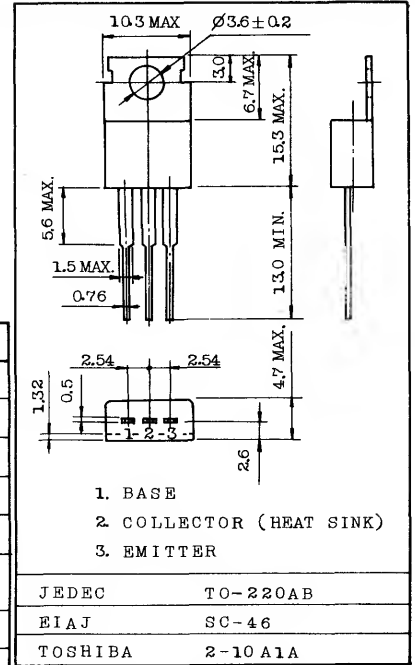
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SC790.
- 10 Watts Output Applications.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector - Base Voltage	V _{CB0}	-50	V
Collector-Emitter Voltage	V _{CE0}	-40	V
Emitter-Base Voltage	V _{EB0}	-5	V
Collector Current	I _C	-3	A
Emitter Current	I _E	3	A
Collector Power Dissipation (Tc=25°C)	P _C	25	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55~150	°C



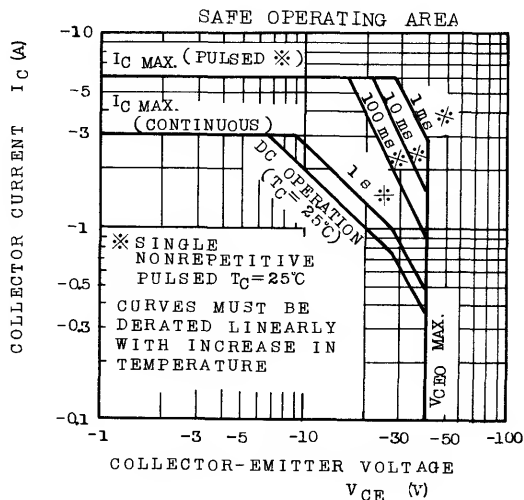
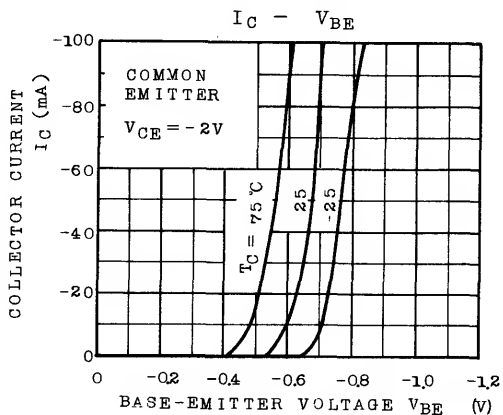
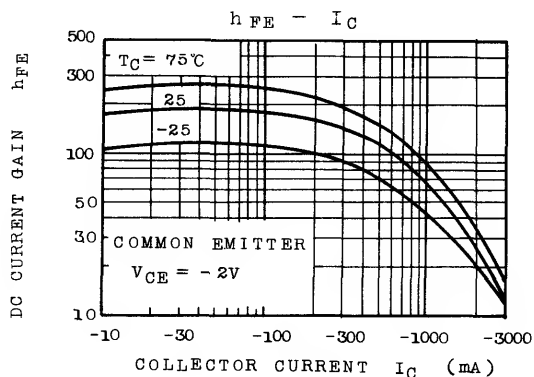
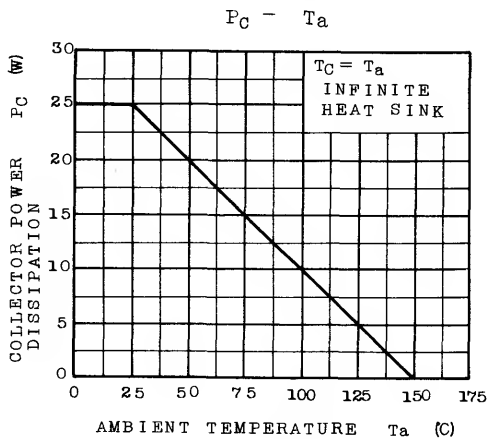
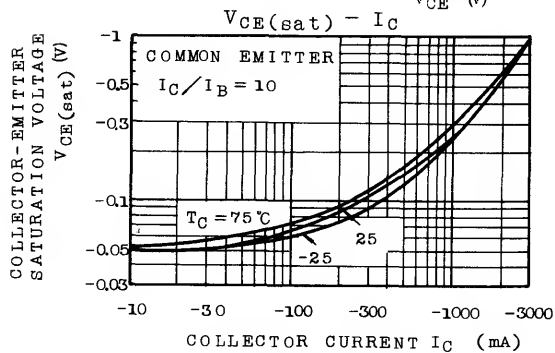
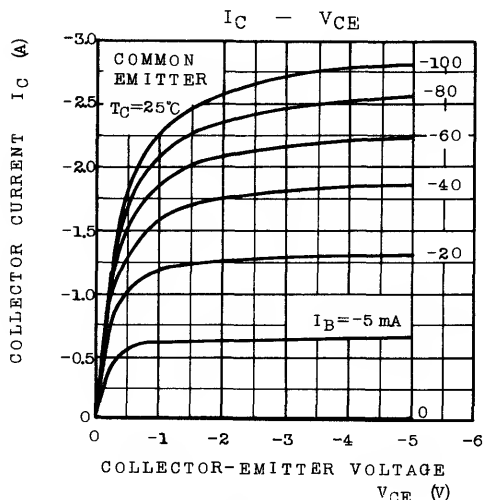
Mounting Kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =-30V, I _E =0	-	-	-10	μA
Emitter Cut-off Current	I _{EB0}	V _{EB} =-5V, I _C =0	-	-	-100	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CEO}	I _C =-50mA, I _B =0	-40	-	-	V
Emitter-Base Breakdown Voltage	V _{(BR)EBO}	I _E =-10mA, I _C =0	-5	-	-	V
DC Current Gain	h _{FE} (1) (Note)	V _{CE} =-2V, I _C =-0.5A	40	-	240	
	h _{FE} (2)	V _{CE} =-2V, I _C =-2A	13	50	-	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =-2A, I _B =-0.2A	-	-0.45	-1.2	V
Base-Emitter Voltage	V _{BE}	V _{CE} =-2V, I _C =-2A	-	-0.85	-1.8	V
Transition Frequency	f _T	V _{CE} =-2V, I _C =-0.5A	3	10	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =-10V, I _E =0, f=1MHz	-	150	-	pF

Note : h_{FE}(1) Classification R : 40~80 O : 70~140 Y : 120~240

2SA490



2SA496 2SA505

Unit in mm

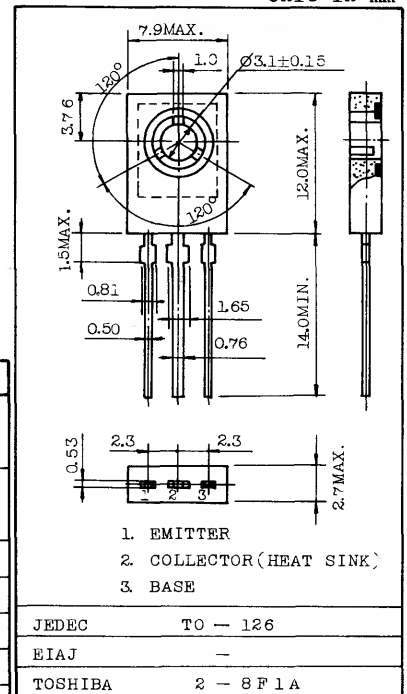
MEDIUM POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
: $V_{CE(sat)} = -0.32V$ (Typ.)
- Complementary to 2SC495 and 2SC496.

MAXIMUM RATINGS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	2SA505	-60	V
	2SA496	-40	
Collector-Emitter Voltage	2SA505	-50	V
	2SA496	-30	
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-1	A
Emitter Current	I_E	1	A
Collector Power Dissipation	P_C	1	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$



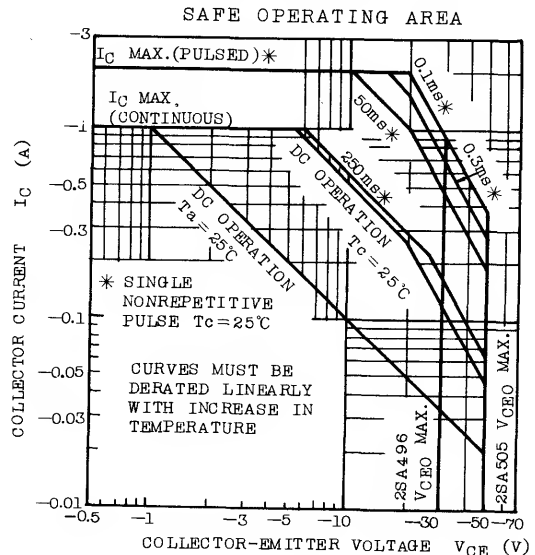
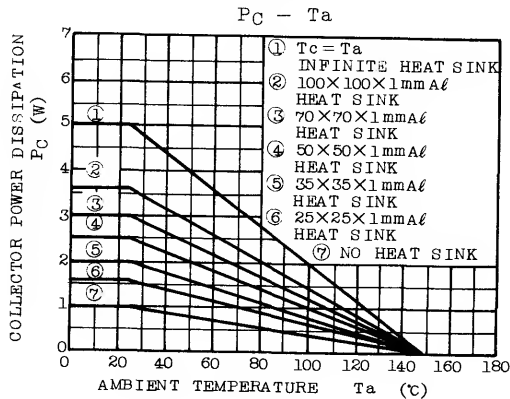
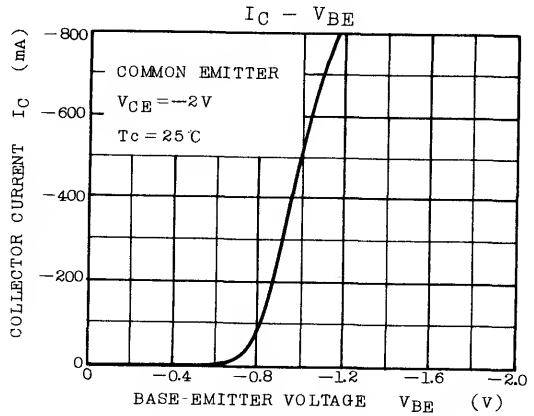
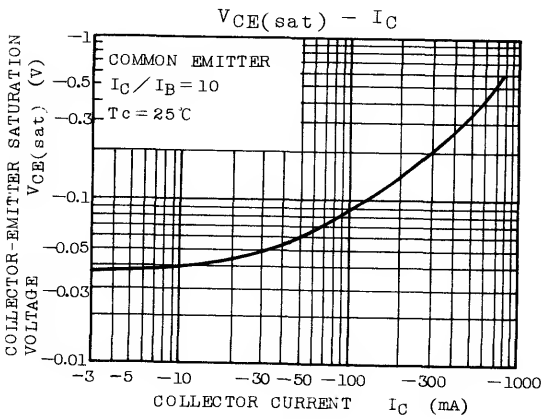
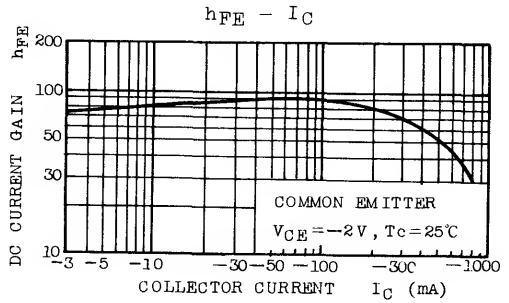
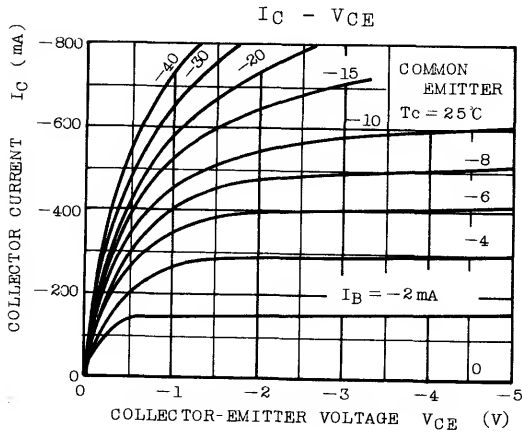
Mounting Kit No. AC46C
Weight : 0.72g

ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB} = -30V, I_E = 0$	-	-	-1	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB} = -5V, I_C = 0$	-	-	-1	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C = -10mA, I_B = 0$	-50	-	-	V
			-30	-	-	
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E = 1mA, I_C = 0$	-5	-	-	V
DC Current Gain	(Note) $h_{FE(1)}$	$V_{CE} = -2V, I_C = -50mA$	40	-	240	
	$h_{FE(2)}$	$V_{CE} = -2V, I_C = -800mA$	13	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = -500mA, I_B = -50mA$	-	-0.32	-0.8	V
Base-Emitter Voltage	V_{BE}	$V_{CE} = -2V, I_C = -500mA$	-	-	-1.3	V
Transition Frequency	f_T	$V_{CE} = -10V, I_C = -10mA$	50	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	20	-	pF

Note: $h_{FE(1)}$ Classification R : 40 ~ 80 O : 70 ~ 140 Y : 120 ~ 240

2SA496 · 2SA505



INDUSTRIAL APPLICATIONS
Unit in mm

HIGH FREQUENCY AMPLIFIER APPLICATIONS.

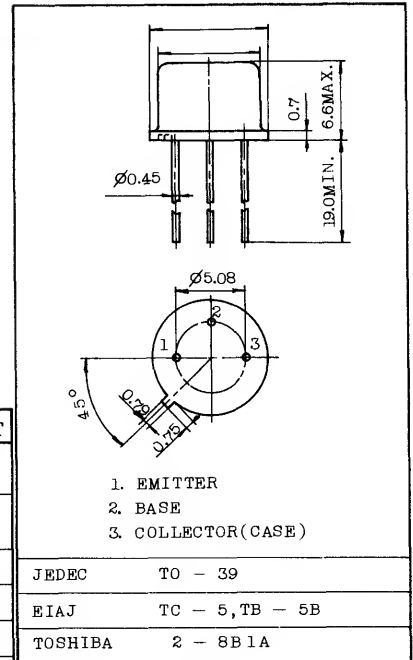
HIGH SPEED SWITCHING APPLICATIONS.

FEATURES:

- High Transition Frequency : $f_T=80\text{MHz}$ (Typ.)
- High Breakdown Voltage : $V_{CE0}=-80\text{V}$ (2SA503)
 : $V_{CE0}=-60\text{V}$ (2SA504)
- Low Saturation Voltage : $V_{CE(sat)}=-0.12\text{V}$ (Typ.)
 (at $I_C=-150\text{mA}$, $I_B=-15\text{mA}$)
- Complementary to 2SC503 and 2SC504.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SA503	V_{CBO}	-100	V
	2SA504		-80	
Collector-Emitter Voltage	2SA503	V_{CEO}	-80	V
	2SA504		-60	
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-600	mA
Base Current		I_B	-100	mA
Collector Power Dissipation	Ta=25°C	P_C	800	mW
	Tc=25°C		6	
Junction Temperature		T_j	175	°C
Storage Temperature Range		T_{stg}	-65~175	°C



Weight : 1.13g

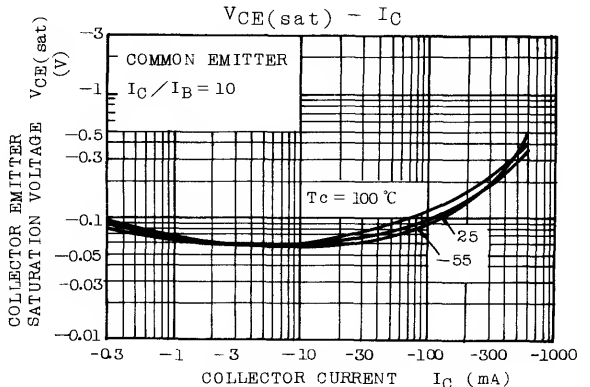
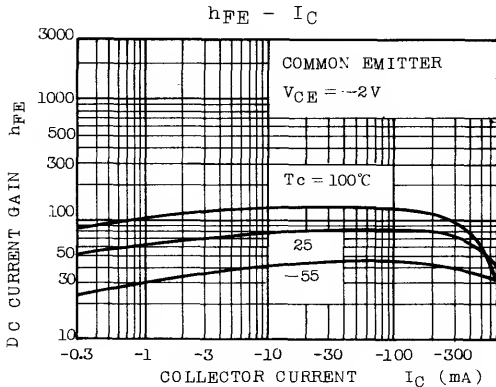
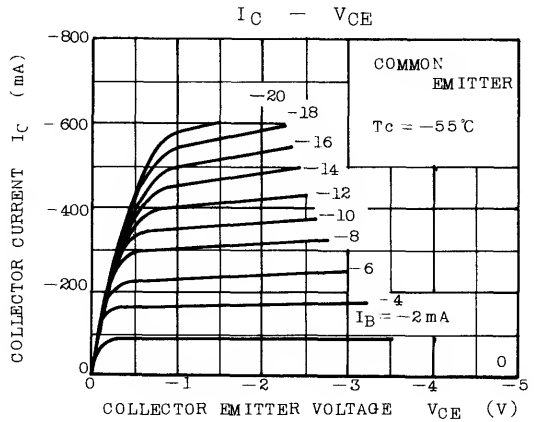
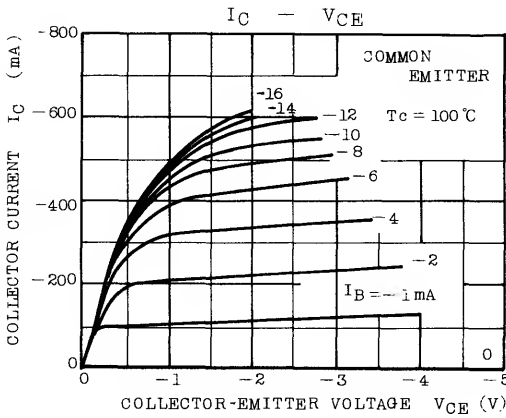
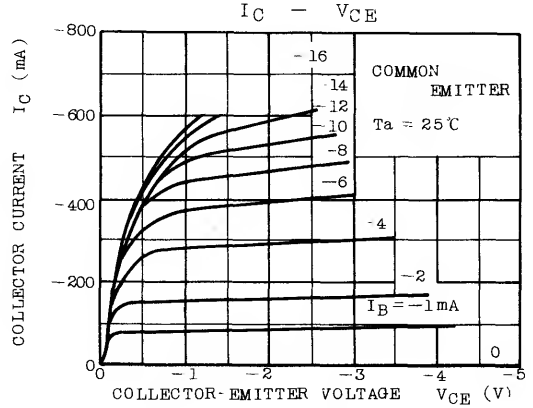
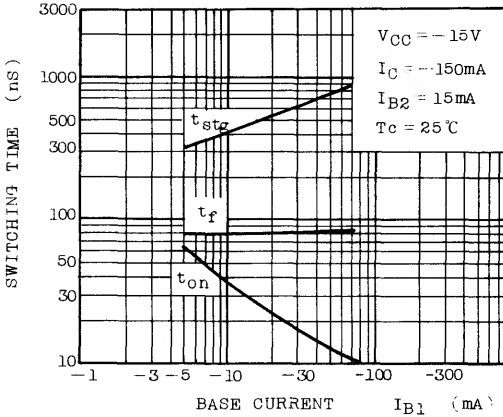
ELECTRICAL CHARACTERISTICS (Ta=25°C)

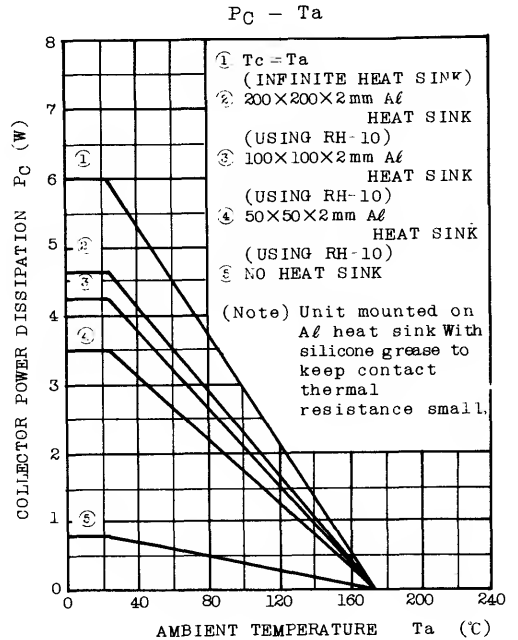
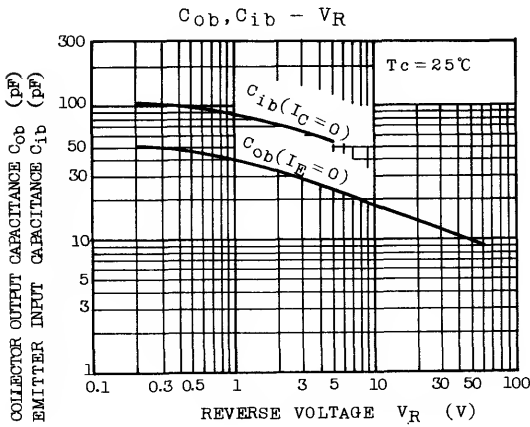
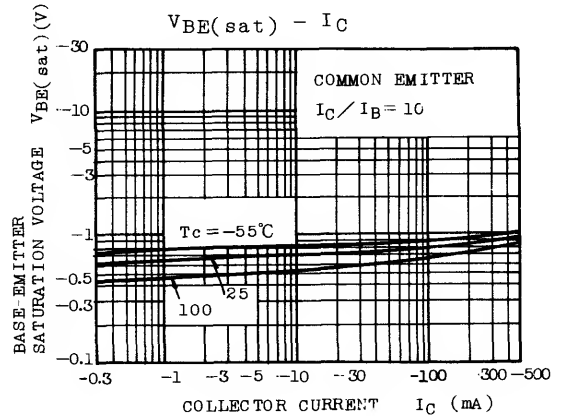
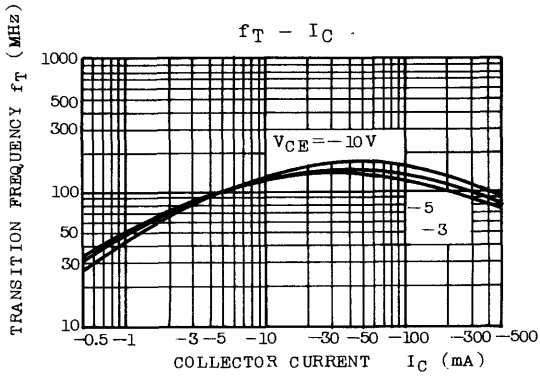
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	2SA503	I_{CBO}	$V_{CB}=-80\text{V}$, $I_E=0$	-	-	-0.5	μA
	2SA504		$V_{CB}=-60\text{V}$, $I_E=0$				
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-5\text{V}$, $I_C=0$	-	-	-1.0	μA
DC Current Gain		h_{FE} (No f_e)	$V_{CE}=-2\text{V}$, $I_C=-150\text{mA}$	30	-	300	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=-150\text{mA}$, $I_B=-15\text{mA}$	-	-0.12	-0.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=-150\text{mA}$, $I_B=-15\text{mA}$	-	-0.8	-1.5	V
Transition Frequency		f_T	$V_{CE}=-2\text{V}$, $I_C=-150\text{mA}$	50	80	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=-10\text{V}$, $I_E=0$, $f=1\text{MHz}$	-	22	30	pF
Base Intrinsic Resistance		$r_{bb'}$	$V_{CE}=-10\text{V}$, $I_E=1\text{mA}$, $f=30\text{MHz}$	-	12	30	Ω
Switching Time	Turn-on Time	t_{on}		-	60	-	ns
	Storage Time	t_{stg}		-	450	-	
	Fall Time	t_f		-	80	-	

Note : h_{FE} Classification O : 30~90, Y : 50~150, GR : 100~300

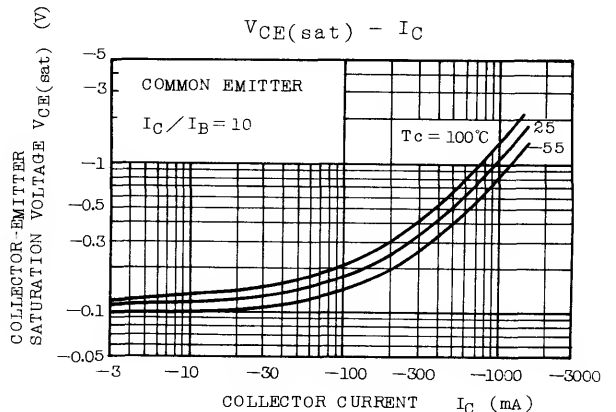
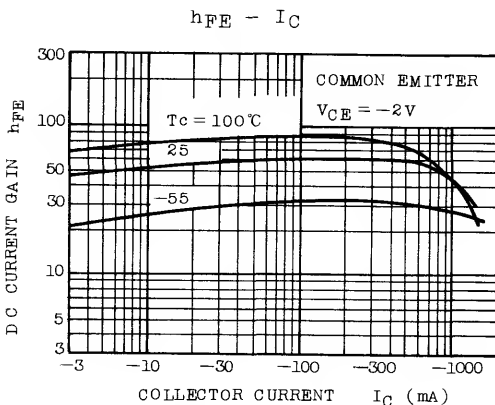
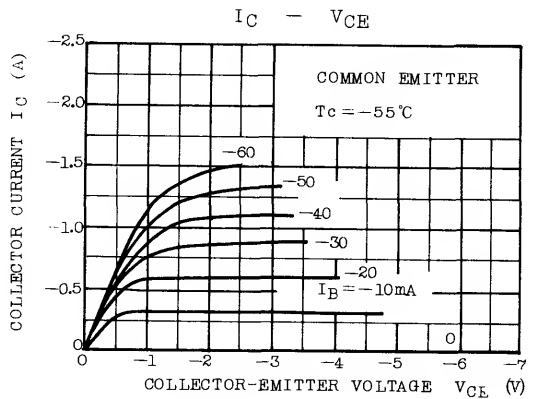
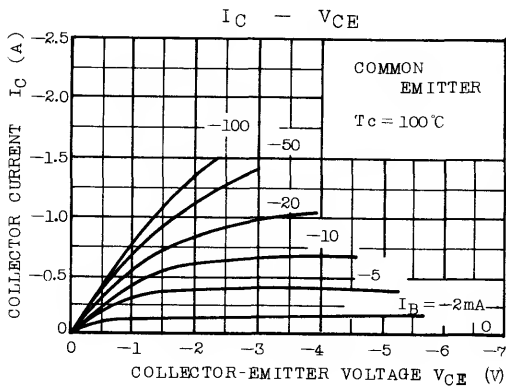
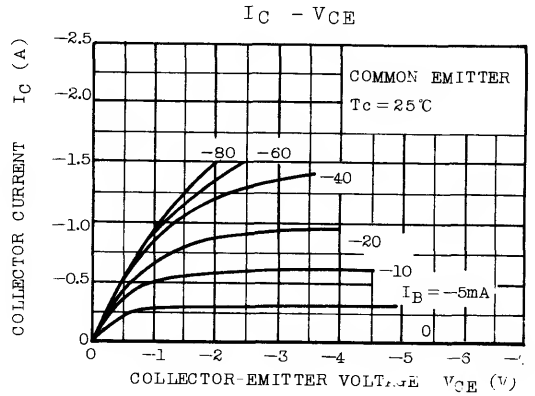
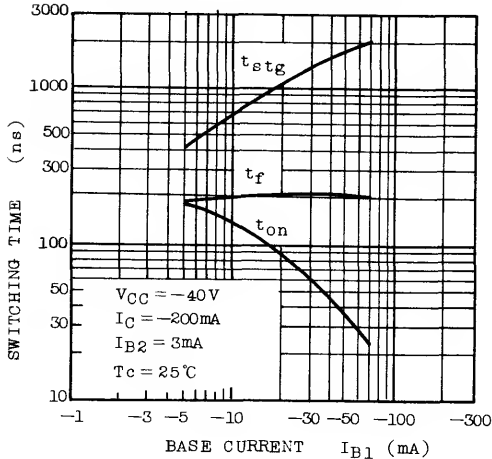
2SA503 · 2SA504

SWITCHING CHARACTERISTICS

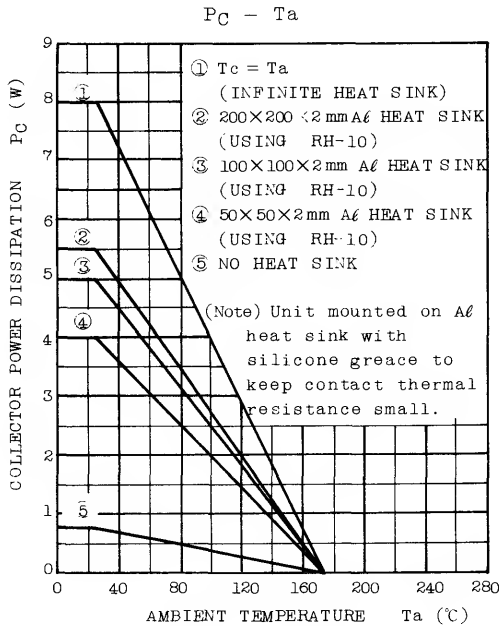
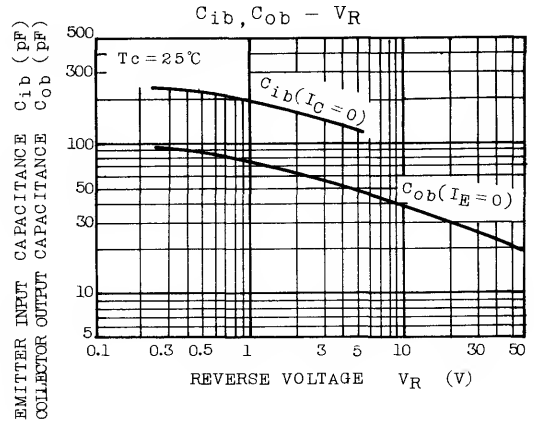
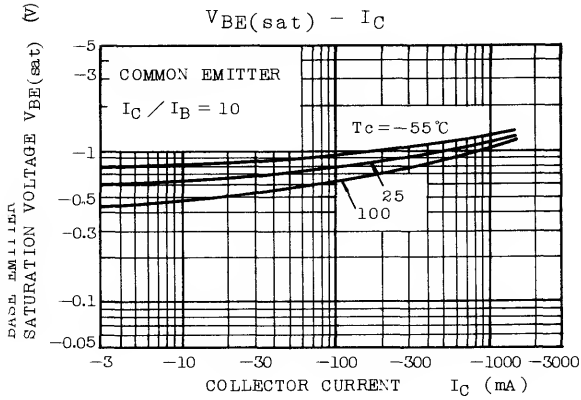




SWITCHING CHARACTERISTICS



2SA510·2SA512



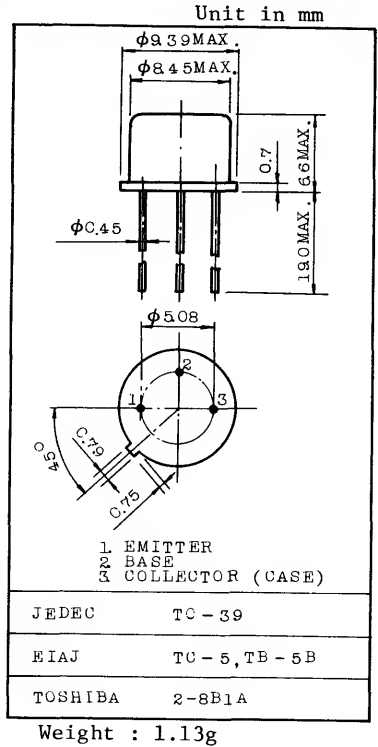
HIGH FREQUENCY AMPLIFIER APPLICATIONS
 VIDEO AMPLIFIER APPLICATIONS.
 HIGH SPEED SWITCHING APPLICATIONS.

FEATURES:

- . High Transition Frequency; $f_T = 200\text{MHz}$ (TYP.)
- . Low Output Capacitance; $C_{ob} = 3.5\text{pF}$ (Typ.)
- . Low Saturation Voltage; $V_{CE(sat)} = -0.3\text{V}$ (Max.)
 at $I_C = -100\text{mA}$, $I_B = -10\text{mA}$
- . Complementary to 2SC594

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-60	V
Collector-Emitter Voltage		V_{CEO}	-45	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-200	mA
Base Current		I_B	-50	mA
Collector Power Dissipation	$T_a=25^\circ\text{C}$	PC	750	mW
	$T_c=25^\circ\text{C}$		5	W
Junction Temperature		T_j	175	$^\circ\text{C}$
Storage Temperature Range		T_{stg}	-65 ~ 175	$^\circ\text{C}$

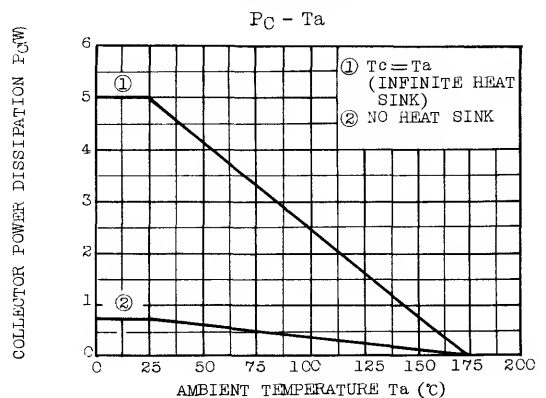
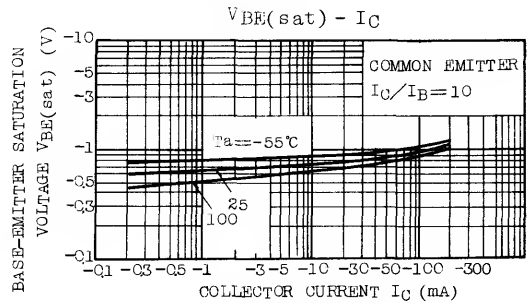
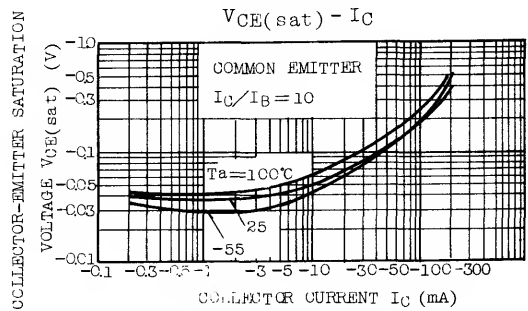
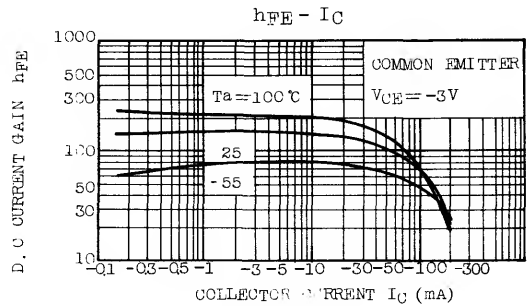
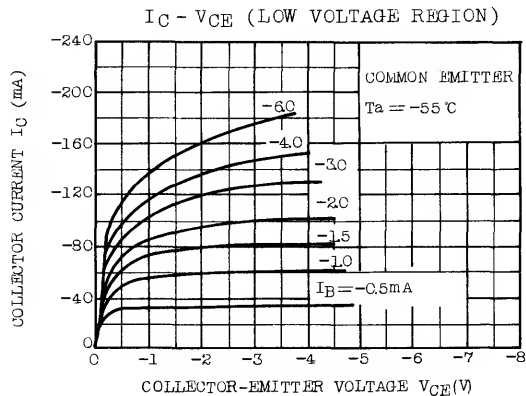
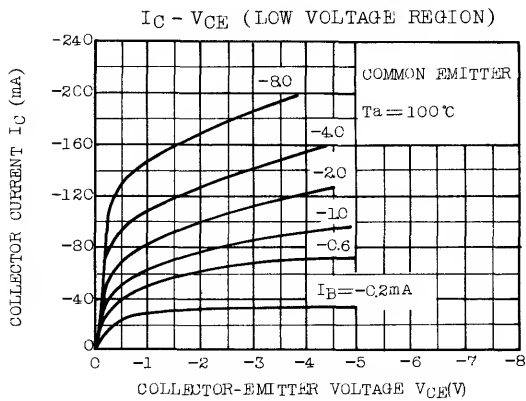
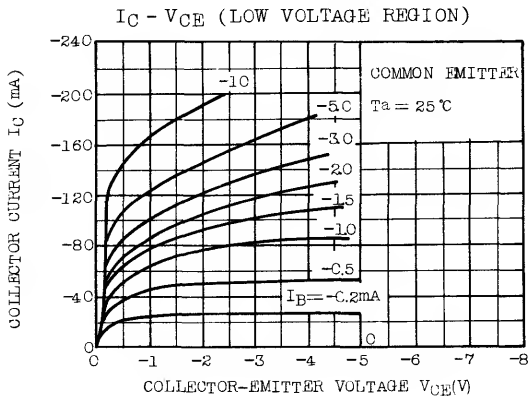


ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=-45\text{V}, I_E=0$	-	-	-0.1	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-5\text{V}, I_C=0$	-	-	-0.1	μA
DC Current Gain	$h_{FE}(1)$ (Note.)		$V_{CE}=-1\text{V}, I_C=-10\text{mA}$	40	-	240	
	$h_{FE}(2)$		$V_{CE}=-3\text{V}, I_C=-200\text{mA}$	20	-	-	
Collector-Emitter Saturation voltage		$V_{CE(sat)}$	$I_C=-100\text{mA}, I_B=-10\text{mA}$	-	-	-0.3	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=-100\text{mA}, I_B=-10\text{mA}$	-	-	-1.0	V
Transition Frequency		f_T	$V_{CE}=-10\text{V}, I_C=-10\text{mA}$	100	200	-	MHz
Input Resistance		h_{ie}	$V_{CE}=-10\text{V}, I_E=10\text{mA}, f=200\text{MHz}$	-	-	120	Ω
Collector Output Capacitance		C_{ob}	$V_{CB}=-10\text{V}, I_E=0, f=1\text{MHz}$	-	3.5	5	PF
Switching Time	Turn-On Time	t_{on}		-	40	-	ns
	Storage Time	t_{stg}		-	250	-	
	Fall Time	t_f		-	30	-	

Note ; $h_{FE}(1)$ Classification R : 40 ~ 80, O : 70 ~ 140, Y : 120 ~ 240

2SA594



2SA656A 2SA657A 2SA658A

INDUSTRIAL APPLICATIONS
Unit in mm

POWER AMPLIFIER APPLICATIONS.
POWER SWITCHING APPLICATIONS.
DC-DC CONVERTER APPLICATIONS.
REGULATOR APPLICATIONS.

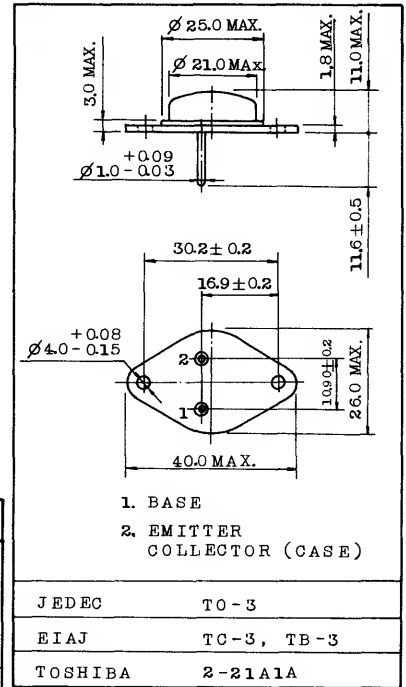
FEATURES:

- High Voltage : $V_{CB0} = -130V$, $V_{CE0} = -110V$ (2SA656A)
- Complementary to 2SC519A, 2SC520A and 2SC521A.

MAXIMUM RATINGS ($T_a = 25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SA656A	V_{CB0}	-130	V
	2SA657A		-100	
	2SA658A		-70	
Collector-Emitter Voltage	2SA656A	V_{CE0}	-110	V
	2SA657A		-80	
	2SA658A		-50	
Emitter-Base Voltage		V_{EB0}	-5	V
Collector Current		I_C	-7	A
Base Current		I_B	-2	A
Collector Power Dissipation	$T_c = 25^\circ C$	P_C	50	W
	(Note)		25	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-65 ~ 150	$^\circ C$

Note : Unit mounted a 300x300x2mm Al on a heat sink with silicone greased mica insulator.



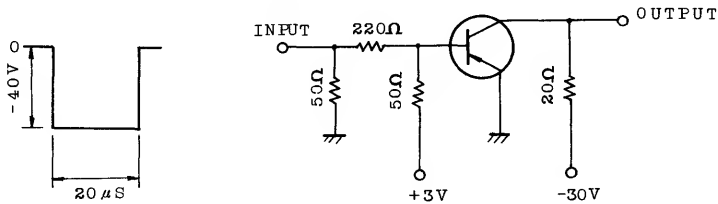
Mounting Kit No. AC73
Weight : 12g

2SA656A • 2SA657A • 2SA658A

ELECTRICAL CHARACTERISTICS (Ta=25°C)

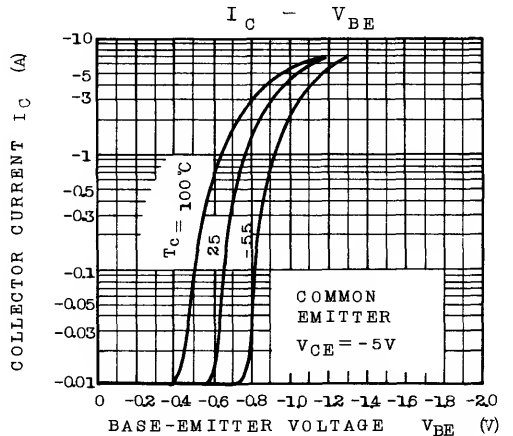
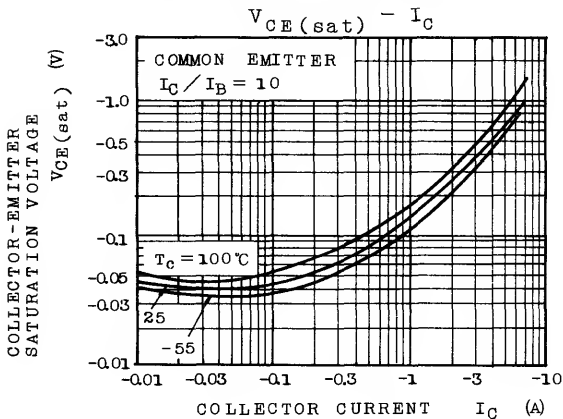
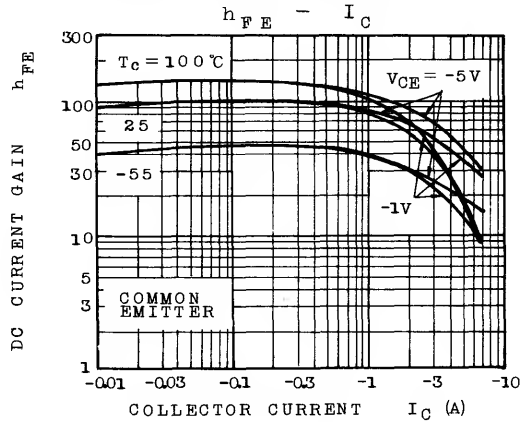
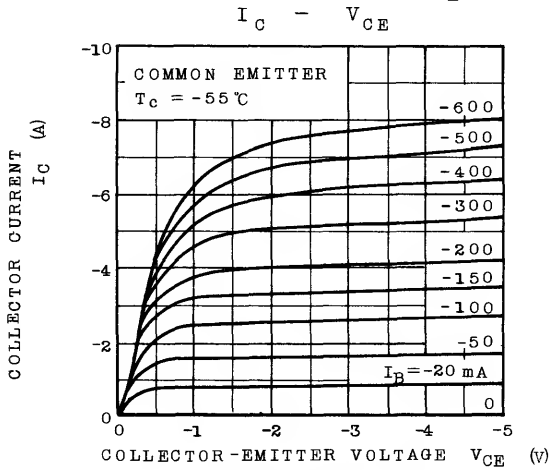
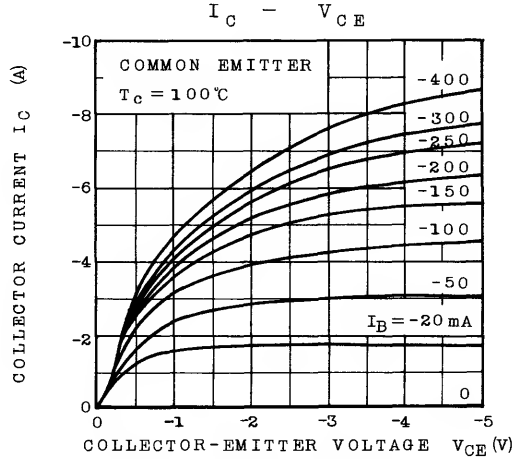
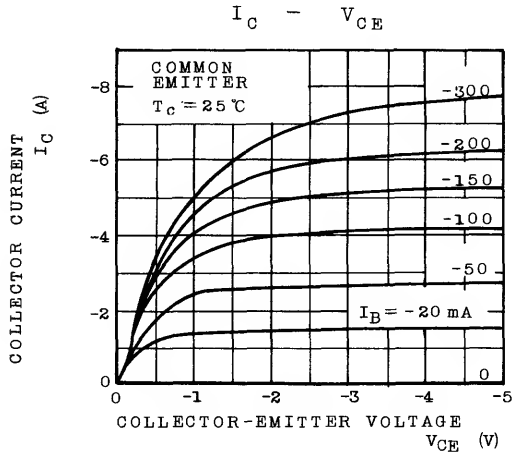
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	2SA656A	I_{CBO}	$V_{CB}=-130V, I_E=0$	-	-	-100	μA
	2SA657A		$V_{CB}=-100V, I_E=0$	-	-	-100	
	2SA658A		$V_{CB}=-70V, I_E=0$	-	-	-100	
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-5V, I_C=0$	-	-	-5	mA
Collector-Emittter Breakdown Voltage	2SA656A	$V_{(BR)CEO}$	$I_C=-50mA, I_B=0$	-110	-	-	V
	2SA657A			-80	-	-	
	2SA658A			-50	-	-	
DC Current Gain		$h_{FE(1)}$	$V_{CE}=-5V, I_C=-1A$	30	-	300	
		$h_{FE(2)}$	$V_{CE}=-5V, I_C=-5A$	15	-	-	
Saturation Voltage	Collector-Emittter	$V_{CE(sat)}$	$I_C=-5A, I_B=-1A$	-	-0.7	-2	V
	Base-Emittter	$V_{BE(sat)}$		-	-1.4	-2.5	
Transition Frequency		f_T	$V_{CE}=-10V, I_C=-1A$	-	5	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=-50V, I_E=0, f=1MHz$	-	150	-	pF
Switching Time	Turn-on Time	t_{on}	(Fig.)	-	0.5	-	μs
	Storage Time	t_{stg}		-	3.0	-	
	Fall Time	t_f		-	0.4	-	

Fig. SWITCHING TIME TEST CIRCUIT

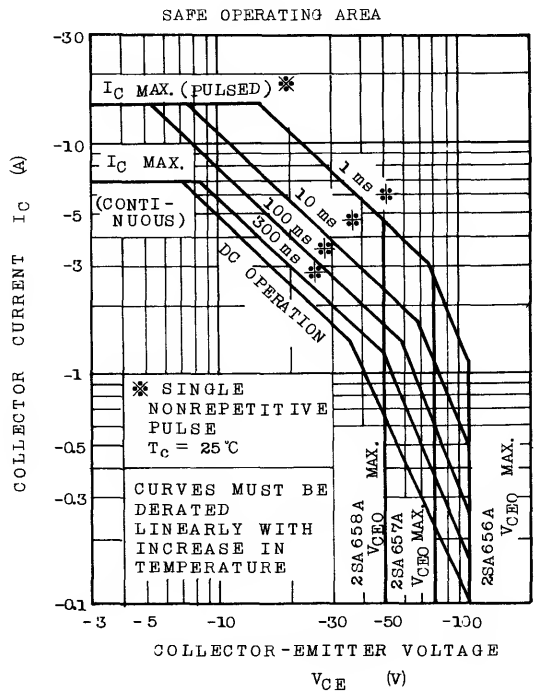
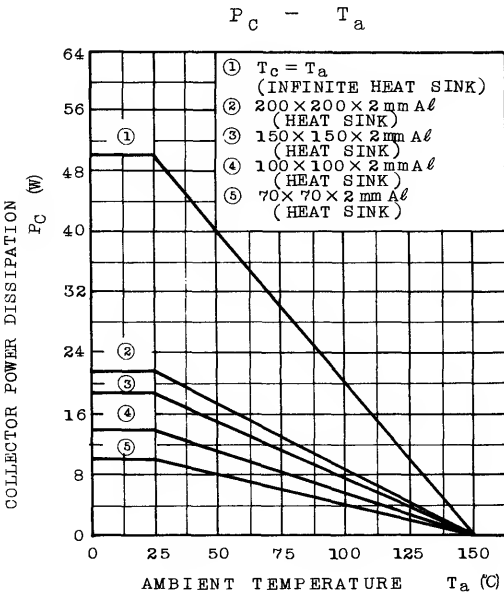
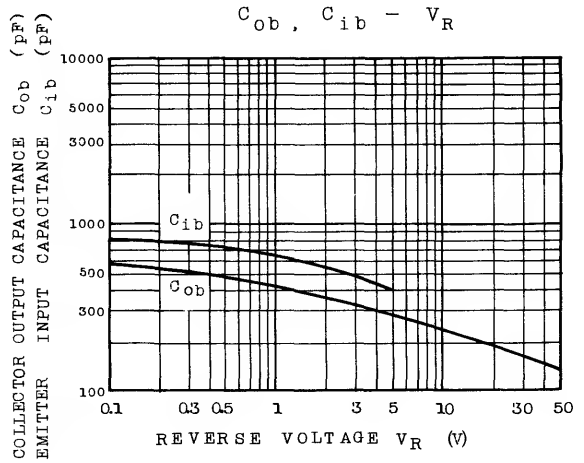
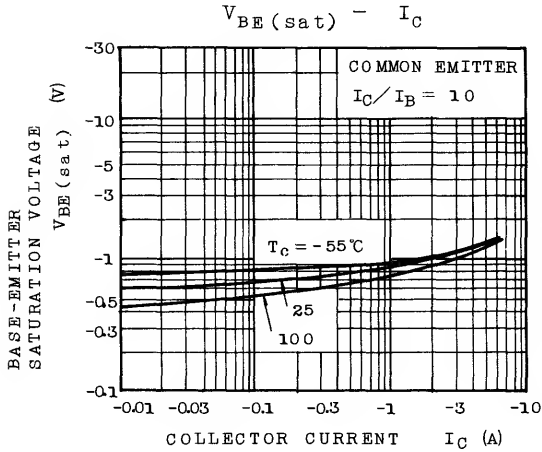


DUTY CYCLE $\leq 2\%$

2SA656A • 2SA657A • 2SA658A



2SA656A • 2SA657A • 2SA658A



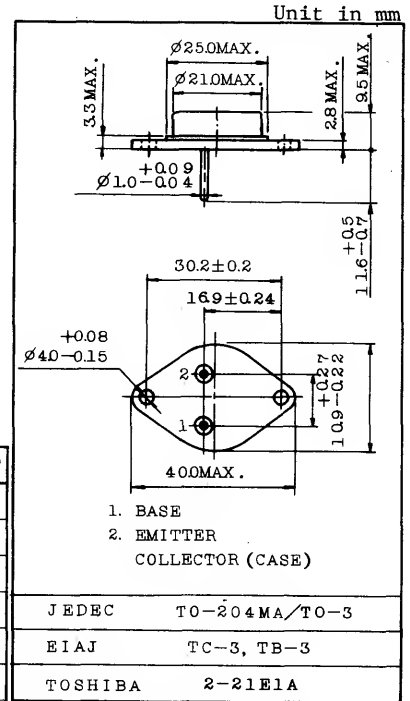
2SA739

INDUSTRIAL APPLICATIONS

HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

- High Voltage : $V_{CE0} = -400V$
- Low Saturation Voltage : $V_{CE(sat)} = -1.5V$ (Max.)
($I_C = -1A, I_B = -0.2A$)



Mounting Kit No. AC73
Weight : 15.8g

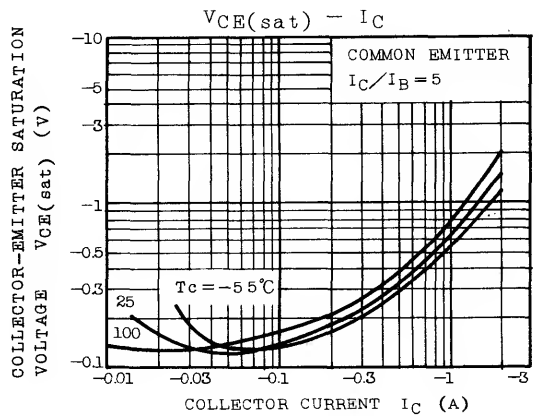
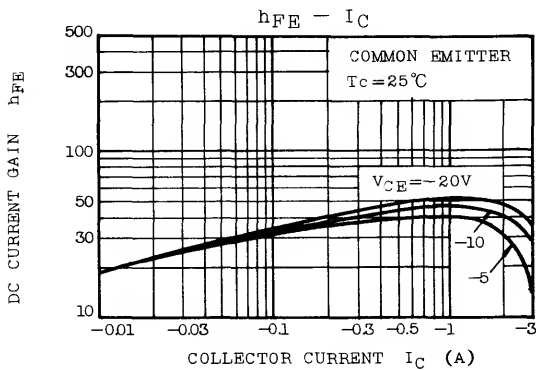
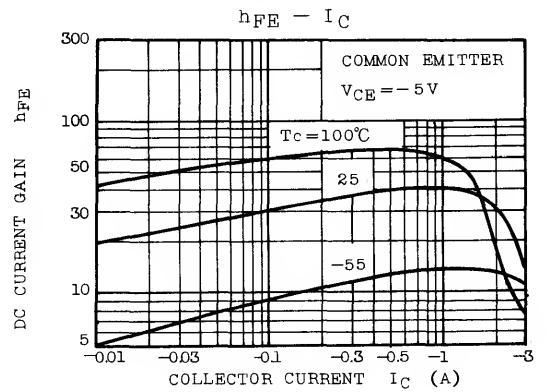
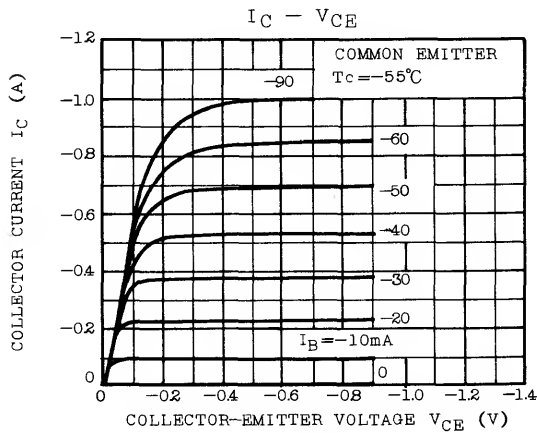
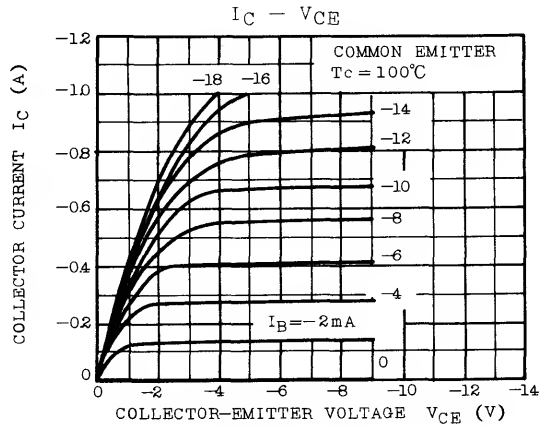
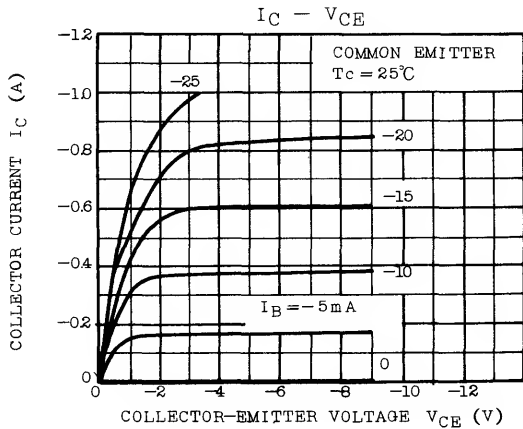
MAXIMUM RATINGS (Ta=25°C)

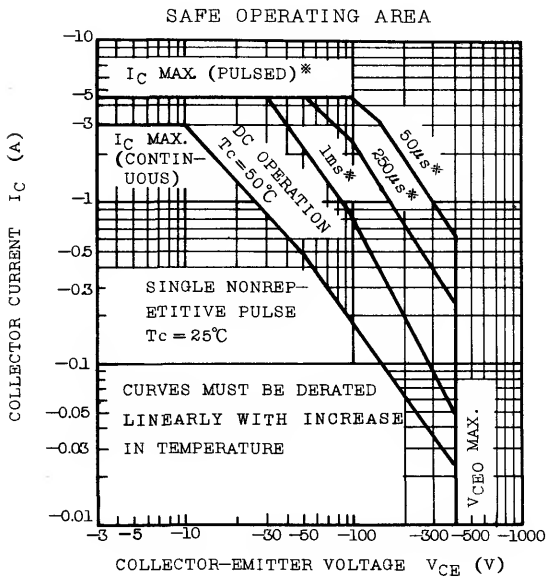
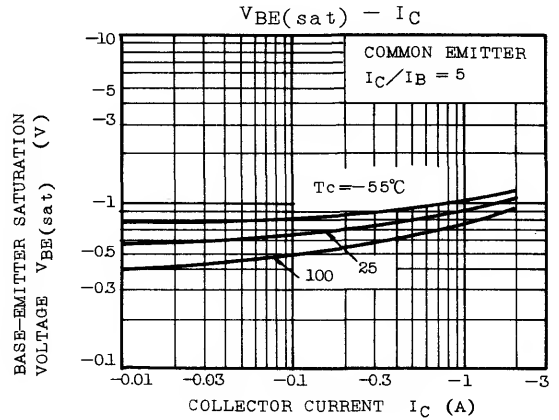
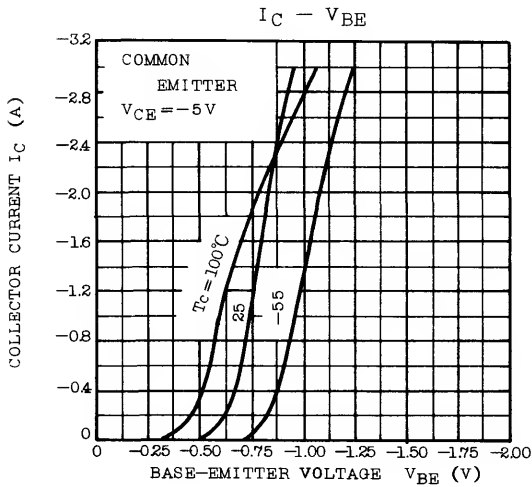
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-400	V
Collector-Emitter Voltage	V_{CEO}	-400	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-3	A
Base Current	I_B	-1	A
Collector Power Dissipation (Tc=25°C)	P_C	50	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65~150	°C

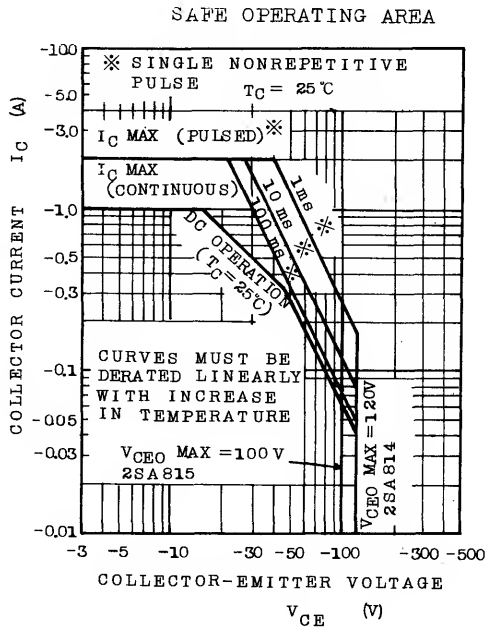
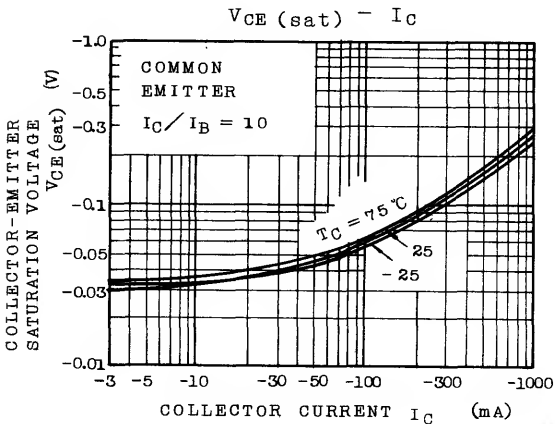
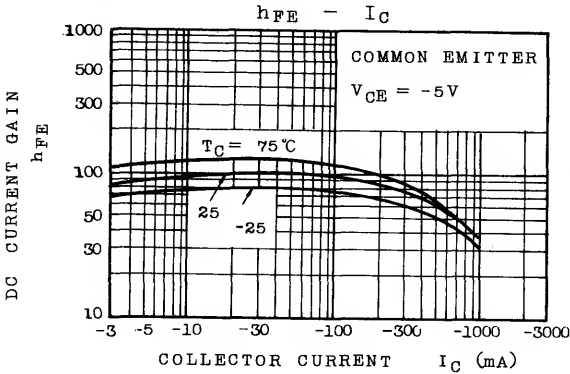
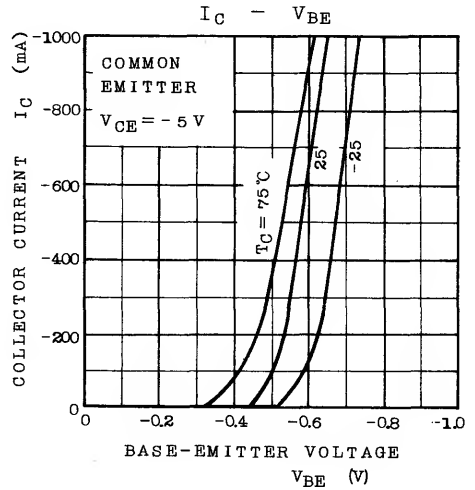
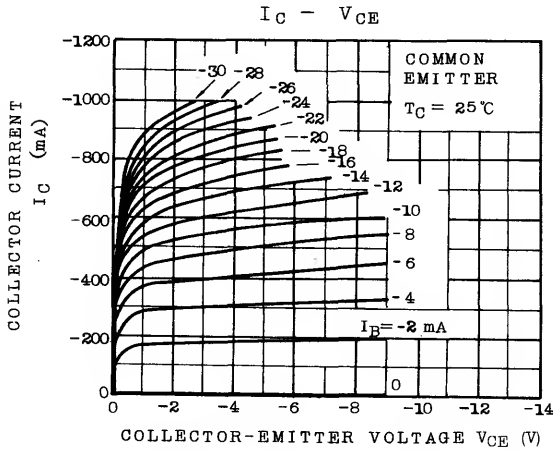
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB} = -300V, I_E = 0$	-	-	-100	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB} = -5V, I_C = 0$	-	-	-1	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C = -10mA, I_B = 0$	-400	-	-	V
DC Current Gain	h_{FE}	$V_{CE} = -5V, I_C = -0.5A$	20	-	300	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = -1A, I_B = -0.2A$	-	-	-1.5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C = -1A, I_B = -0.2A$	-	-	-2.0	V
Collector Output Capacitance	C_{ob}	$V_{CB} = -50V, I_E = 0, f = 1MHz$	-	100	-	pF
Switching Time	Turn-on Time	t_{on}	-	1.0	-	μs
	Storage Time	t_{stg}	-	2.0	-	
	Fall Time	t_f	-	1.0	-	

DUTY CYCLE $\leq 2\%$ $V_{BB} = 3V$ $V_{CC} = -25V$







2SA816

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

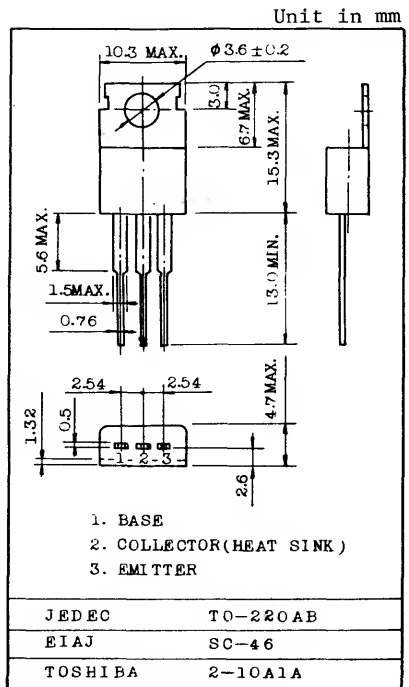
MEDIUM POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : $V_{CEO} = -80V$
- Complementary to 2SC1626.

MAXIMUM RATINGS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-80	V
Collector-Emitter Voltage	V_{CEO}	-80	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-750	mA
Emitter Current	I_E	750	mA
Collector Power Dissipation ($T_a = 25^\circ C$)	P_C	1.5	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$



Mounting Kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB} = -30V, I_E = 0$	-	-	-0.5	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB} = -5V, I_C = 0$	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C = -10mA, I_B = 0$	-80	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E = -0.1mA, I_C = 0$	-5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE} = -2V, I_C = -150mA$	70	-	240	
	$h_{FE(2)}$	$V_{CE} = -2V, I_C = -500mA$	40	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = -500mA, I_B = -50mA$	-	-	-0.5	V
Base-Emitter Voltage	V_{BE}	$V_{CE} = -2V, I_C = -500mA$	-	-	-1.0	V
Transition Frequency	f_T	$V_{CE} = -2V, I_C = -150mA$	50	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	20	-	pF

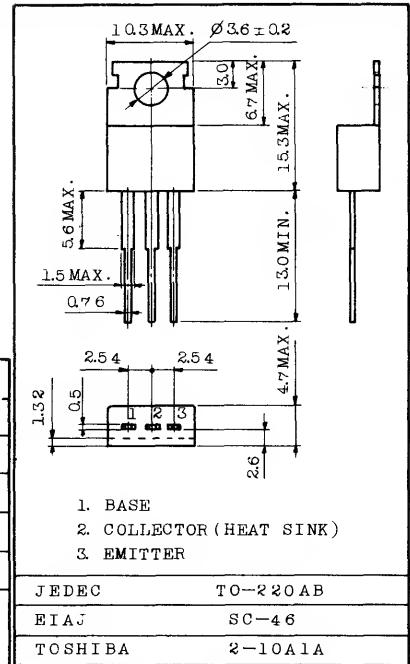
Note : $h_{FE(1)}$ Classification O : 70~140, Y : 120~240

Unit in mm

POWER AMPLIFIER APPLICATIONS.
VERTICAL OUTPUT APPLICATIONS.

FEATURES:

- Complementary to 2SC2073



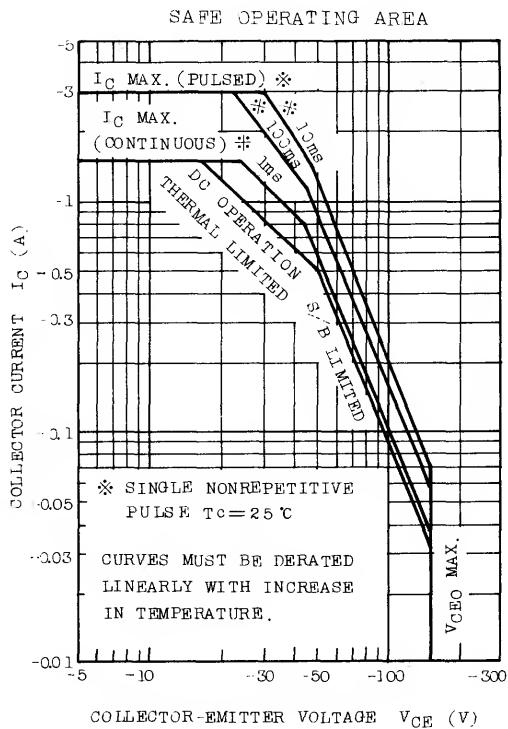
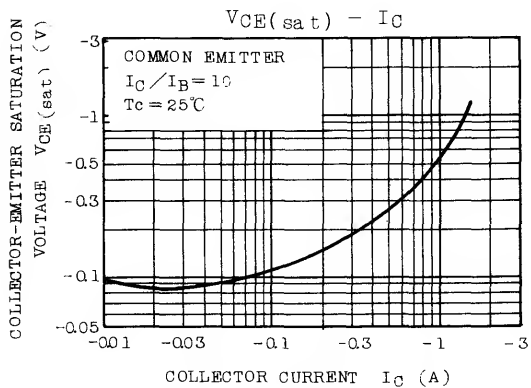
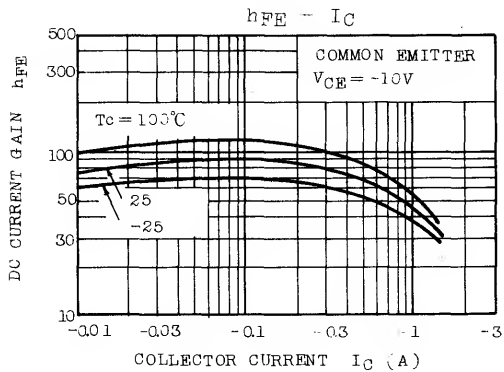
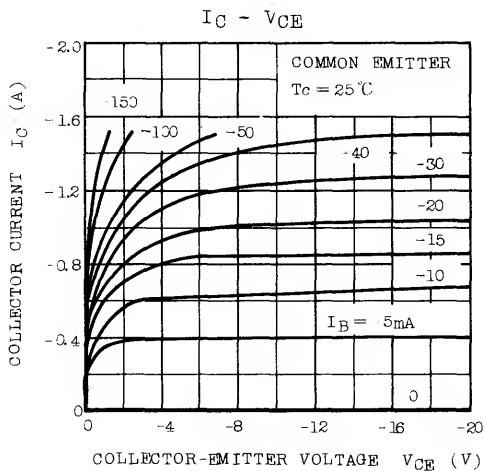
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V _{CB0}	-150	V
Collector-Emitter Voltage		V _{CE0}	-150	V
Emitter-Base Voltage		V _{EB0}	-5	V
Collector Current		I _C	-1.5	A
Base Current		I _B	-0.5	A
Collector Power Dissipation	Ta=25°C	P _C	1.5	W
	Tc=25°C		25	
Junction Temperature		T _j	150	°C
Storage Temperature Range		T _{stg}	-55~150	°C

Weight : 1.9g
Mounting kit No. AC75

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =-120V, I _E =0	-	-	-10	μA
Emitter Cut-off Current	I _{EB0}	V _{EB} =-5V, I _C =0	-	-	-10	μA
DC Current Gain	h _{FE}	V _{CE} =-10V, I _C =-500mA	40	75	140	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =-500mA, I _B =-50mA	-	-	-1.5	V
Base-Emitter Voltage	V _{BE}	V _{CE} =-10V, I _C =-500mA	-0.65	-0.75	-0.85	V
Transition Frequency	f _T	V _{CE} =-10V, I _C =-500mA	-	4	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =-10V, I _E =0, f=1MHz	-	55	-	pF



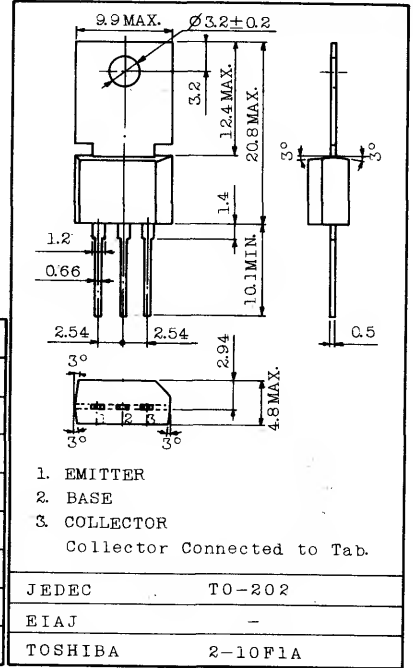
2SA962A

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Suitable for TV Sound Output, Vert. Deflection Output.
- Designed for Complementary Use with 2SC2194A.

Unit in mm



Weight : 1.37g

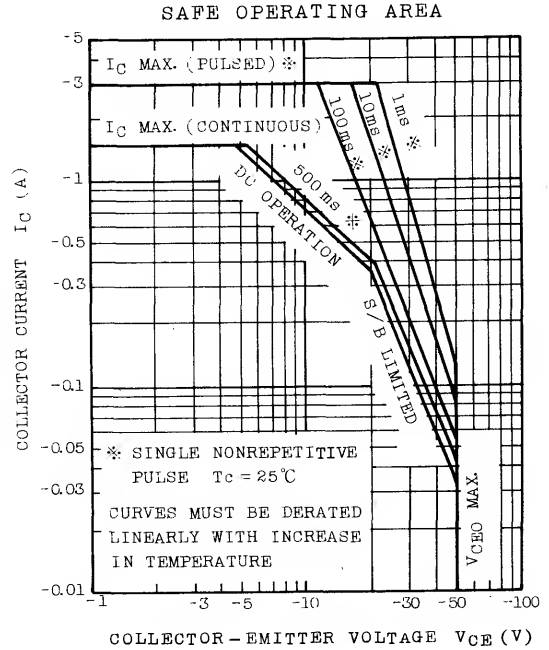
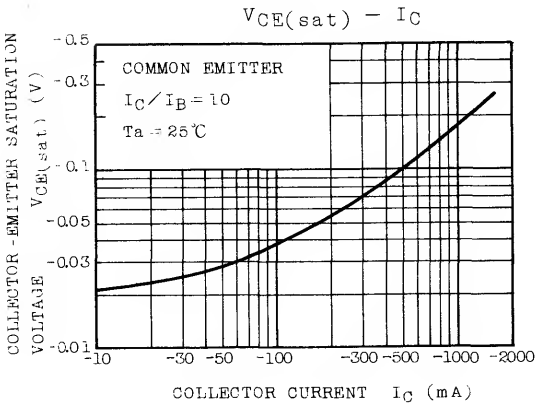
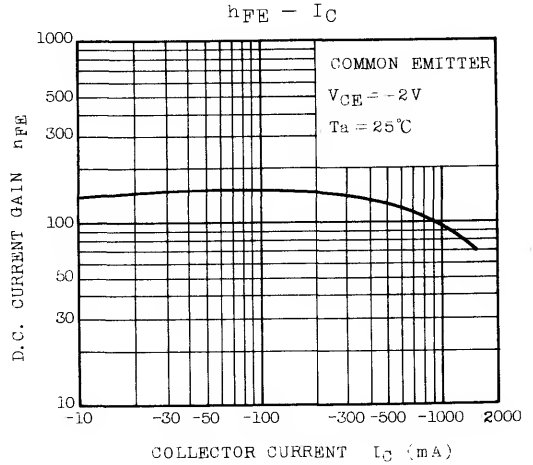
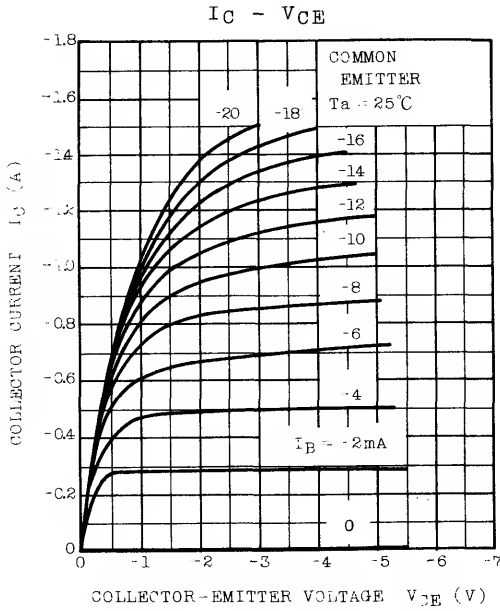
MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-60	V
Collector-Emitter Voltage	V_{CEO}	-50	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-1.5	A
Emitter Current	I_E	1.5	A
Collector Power Dissipation	P_C	1.5	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ\text{C}$

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CE}=-50\text{V}, I_E=0$	-	-	-1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=-5\text{V}, I_C=0$	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=-10\text{mA}, I_B=0$	-50	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=-2\text{V}, I_C=-150\text{mA}$	70	-	240	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-1\text{A}, I_B=-0.1\text{A}$	-	-	-1.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-10\text{V}, I_C=-10\text{mA}$	-0.50	-0.60	-0.70	V
Transition Frequency	f_T	$V_{CE}=-10\text{V}, I_C=-100\text{mA}$	50	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10\text{V}, I_E=0, f=1\text{MHz}$	-	30	-	pF

2SA962A



2SA968 2SA968A 2SA968B

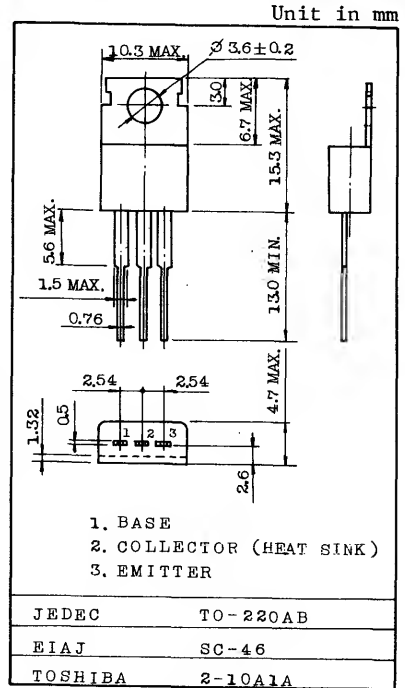
POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- High Transition Frequency: $f_T=100\text{MHz}$ (Typ.)
- Complementary to 2SC2238, 2SC2238A, and 2SC2238B

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	2SA968	-160	V
	2SA968A	-180	
	2SA968B	-200	
Collector-Emitter Voltage	2SA968	-160	V
	2SA968A	-180	
	2SA968B	-200	
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-1.5	A
Emitter Current	I_E	1.5	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	25	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55~150	$^\circ\text{C}$



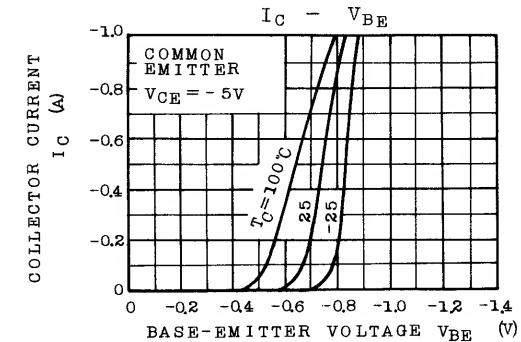
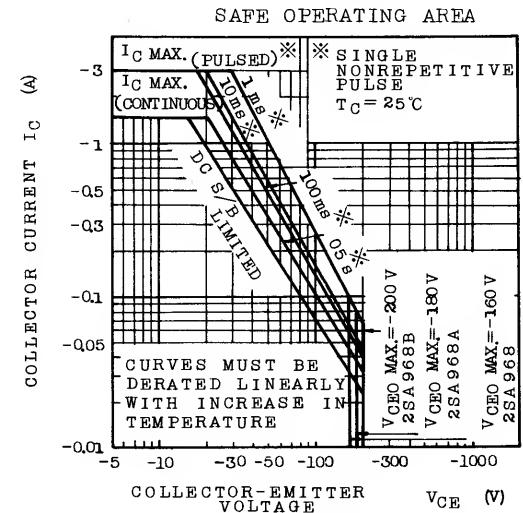
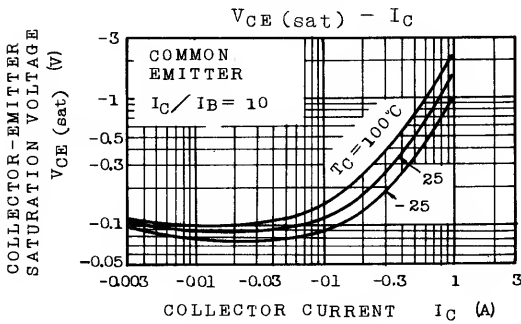
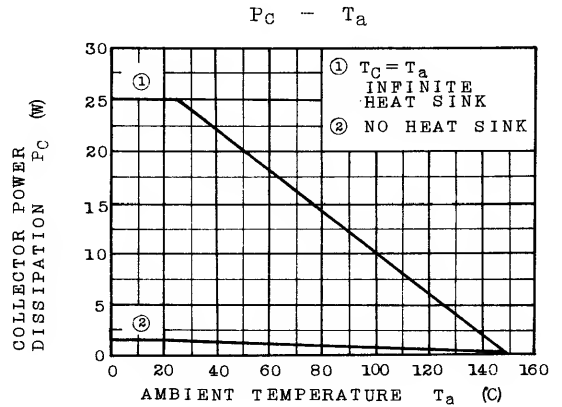
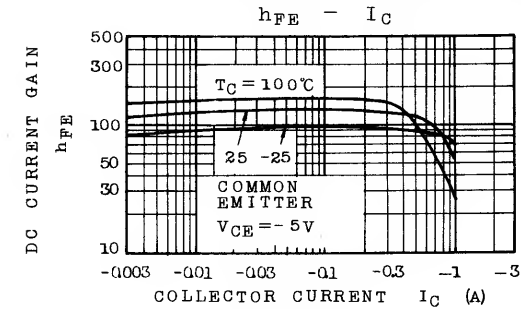
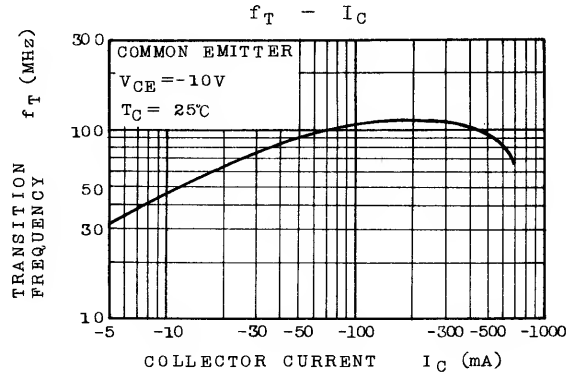
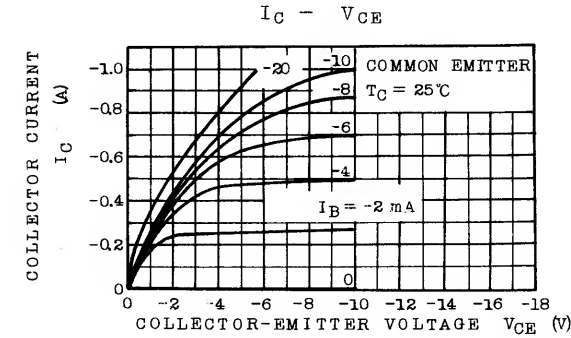
Mounting Kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=-160\text{V}, I_E=0$	-	-	-1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=-5\text{V}, I_C=0$	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	2SA968	$I_C=-10\text{mA}, I_B=0$	-160	-	-	V
	2SA968A		-180	-	-	
	2SA968B		-200	-	-	
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=-1\text{mA}, I_C=0$	-5	-	-	V
DC Current Gain	h_{FE} (Note)	$V_{CE}=-5\text{V}, I_C=-100\text{mA}$	70	-	240	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-500\text{mA}, I_B=-50\text{mA}$	-	-	-1.5	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-5\text{V}, I_C=-500\text{mA}$	-	-	-1.0	V
Transition Frequency	f_T	$V_{CE}=-10\text{V}, I_C=-100\text{mA}$	-	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10\text{V}, I_E=0, f=1\text{MHz}$	-	30	-	pF

Note: h_{FE} Classification O: 70~140, Y: 120~240

2SA968 · 2SA968A · 2SA968B



INDUSTRIAL APPLICATIONS

HIGH CURRENT SWITCHING APPLICATIONS.

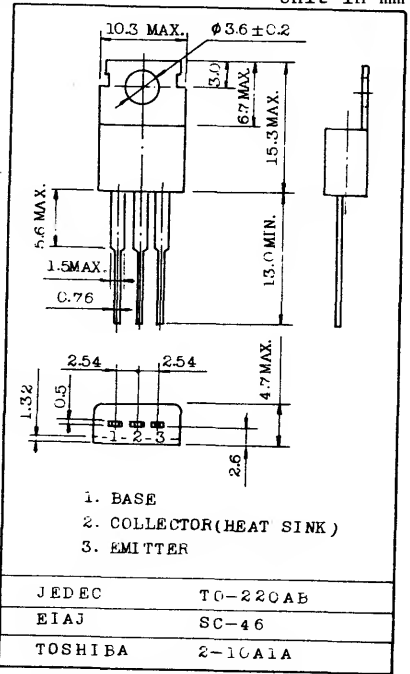
Unit in mm

FEATURES:

- Low Collector Saturation Voltage
 $V_{CE(sat)} = -0.4V(\text{Max.})$ at $I_C = -3A$
- High Speed Switching Time : $t_{stg} = 1.0\mu s(\text{Typ.})$
- Complementary to 2SC2562.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	-60	V
Collector-Emitter Voltage	V _{CEO}	-50	V
Emitter-Base Voltage	V _{EBO}	-5	V
Collector Current	I _C	-5	A
Collector Power Dissipation (Tc=25°C)	P _C	25	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55 ~ 150	°C



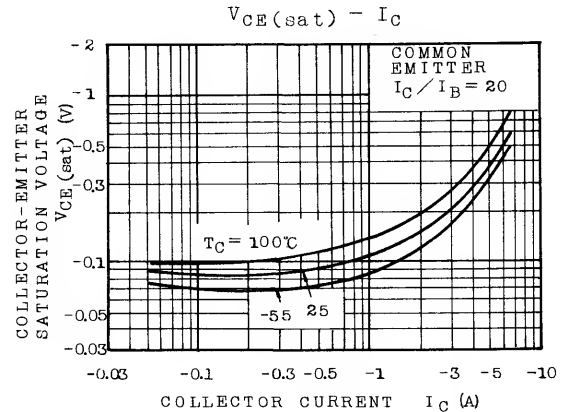
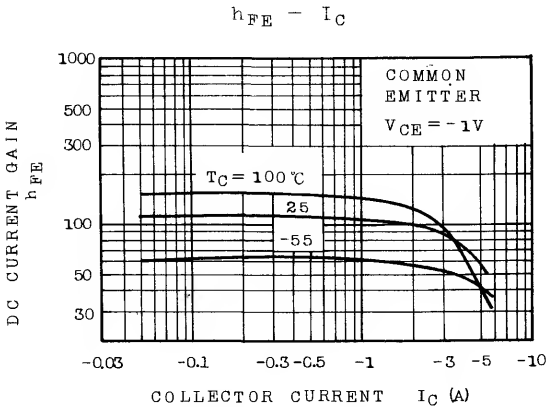
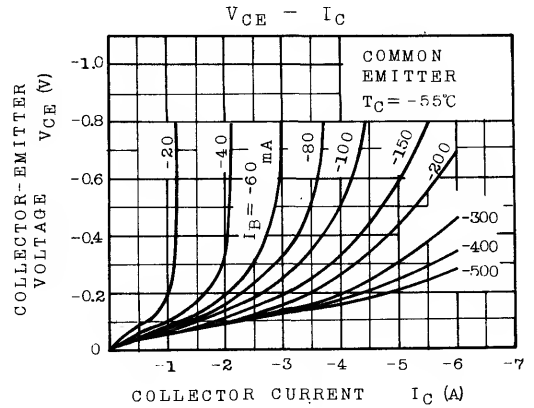
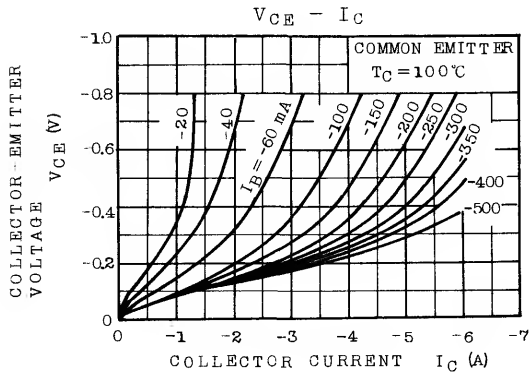
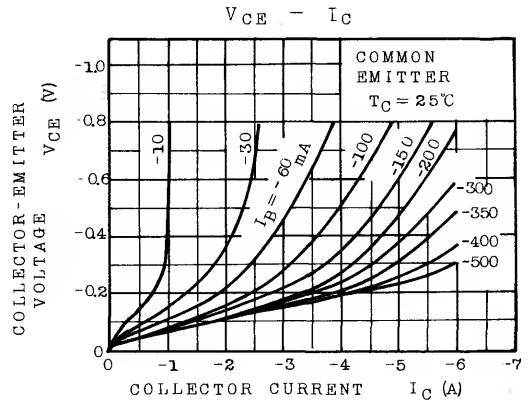
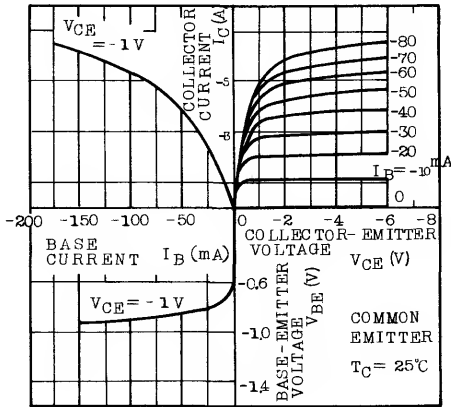
Mounting Kit No. AC75
 Weight : 1.9g

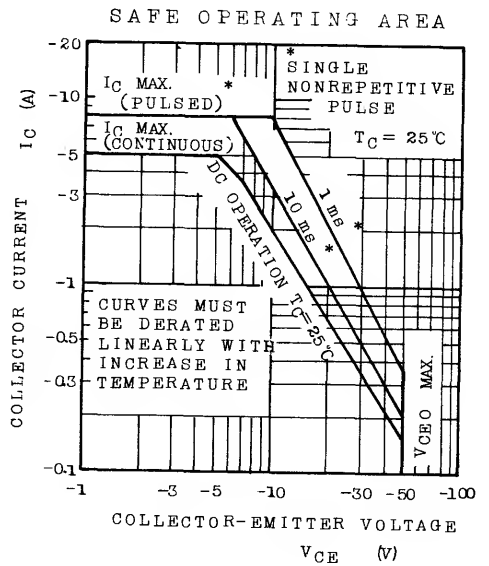
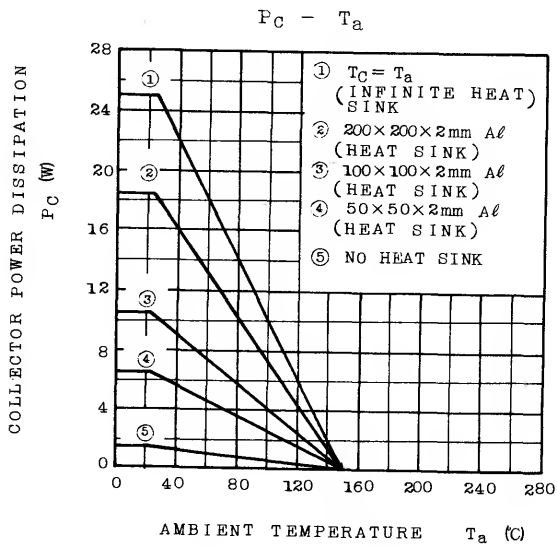
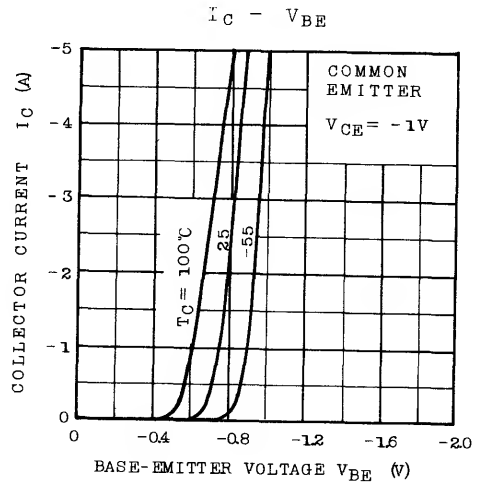
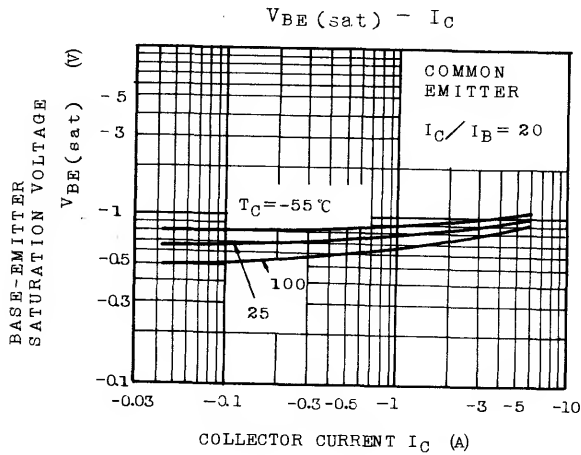
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I _{CB0}	V _{CB} = -50V, I _E = 0	-	-	-1	μA
Emitter Cut-off Current		I _{EBO}	V _{EB} = -5V, I _C = 0	-	-	-1	μA
Collector-Emitter Breakdown Voltage		V _{(BR)CEO}	I _C = -10mA, I _B = 0	-50	-	-	V
DC Current Gain		h _{FE} (1) (Note)	V _{CE} = -1V, I _C = -1A	70	-	240	
		h _{FE} (2)	V _{CE} = -1V, I _C = -3A	30	-	-	
Saturation Voltage	Collector-Emitter	V _{CE(sat)}	I _C = -3A, I _B = -0.15A	-	-0.2	-0.4	V
	Base-Emitter	V _{BE(sat)}	I _C = -3A, I _B = -0.15A	-	-0.9	-1.2	
Transition Frequency		f _T	V _{CE} = -4V, I _C = -1A	-	60	-	MHz
Collector Output Capacitance		C _{ob}	V _{CB} = -10V, I _E = 0, f = 1MHz	-	170	-	pF
Switching Time	Turn-on Time	t _{on}		-	0.1	-	μs
	Storage Time	t _{stg}		-	1.0	-	
	Fall Time	t _f		-	-	0.1	

Note : h_{FE}(1) Classification 0 : 70~140, Y : 120~240

STATIC CHARACTERISTICS





2SA1021

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

COLOR TV VERT. DEFLECTION OUTPUT APPLICATIONS.
 COLOR TV CLASS B SOUND OUTPUT APPLICATIONS.

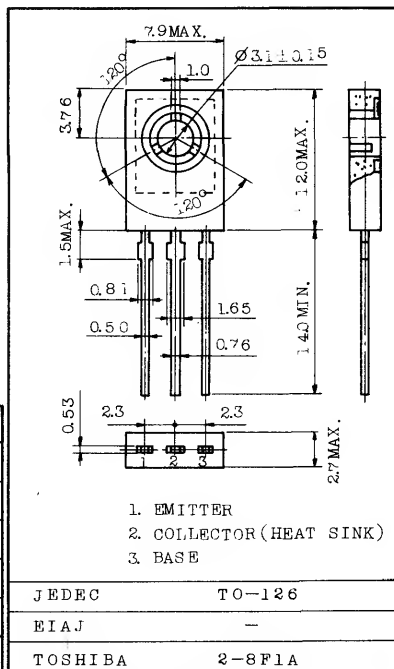
FEATURES:

- . Large Collector Current and Collector Power Dissipation Capability.
- . Recommended for Vert. Deflection Output & Sound Output Applications for Line Operated TV.
- . Complementary to 2SC2481.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V _{CB0}	-150	V
Collector-Emitter Voltage		V _{CEO}	-150	V
Emitter-Base Voltage		V _{EB0}	-6	V
Collector Current		I _C	-1.5	A
Base Current		I _B	-1.0	A
Collector Power Dissipation	Ta=25°C	P _C	1.2	W
	Tc=25°C		20	
Junction Temperature		T _j	150	°C
Storage Temperature Range		T _{stg}	-55~150	°C

Unit in mm

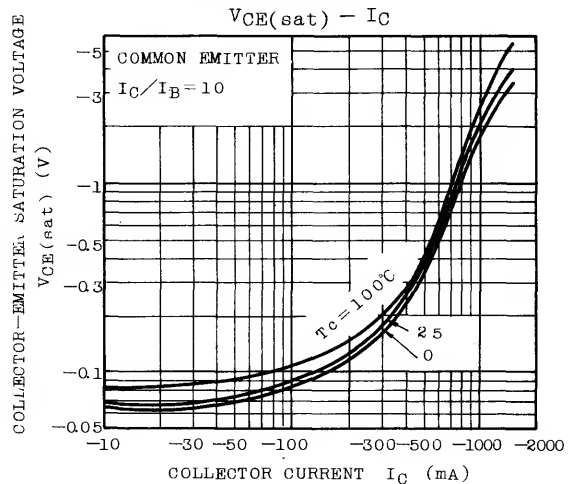
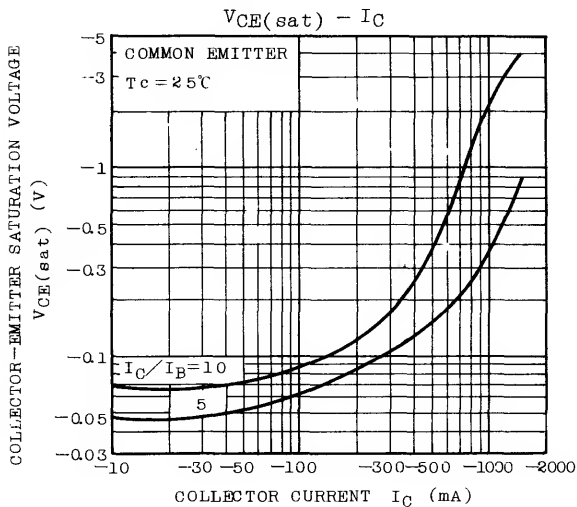
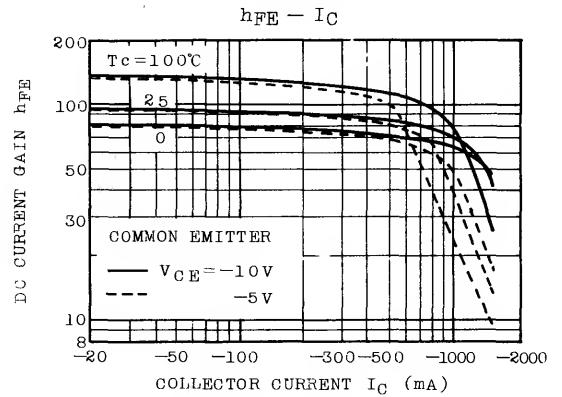
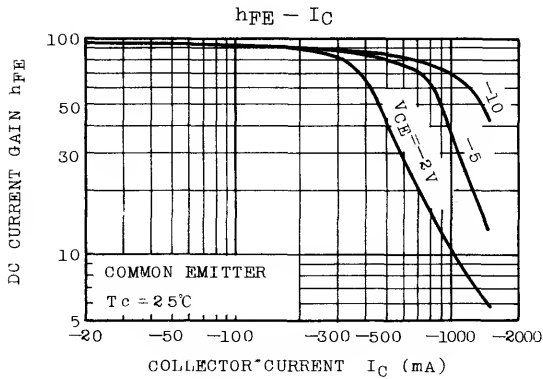
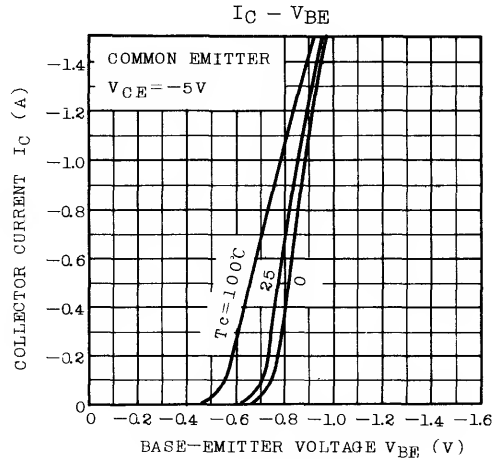
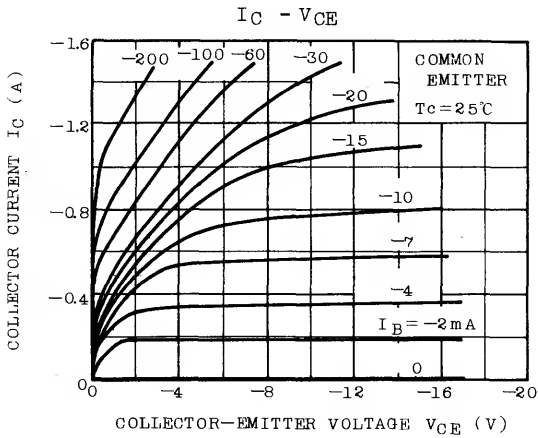


Mounting Kit No. AC46C
 Weight : 0.72g

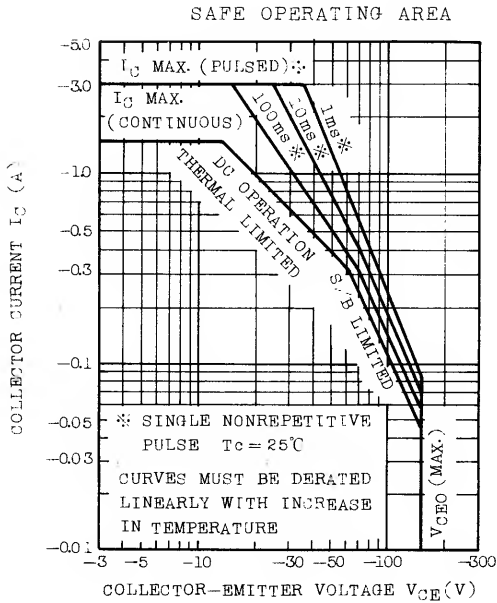
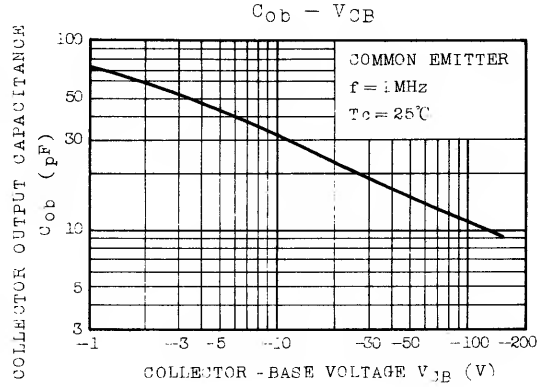
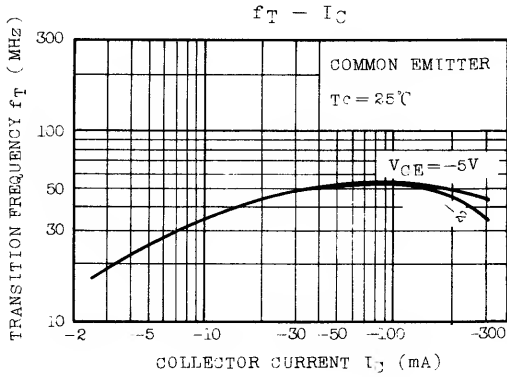
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =-150V, I _E =0	-	-	-1.0	μA
Emitter Cut-off Current	I _{EB0}	V _{EB} =-6V, I _C =0	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CEO}	I _C =-10mA, I _B =0	-150	-	-	V
DC Current Gain	h _{FE} (Note)	V _{CE} =-5V, I _C =-200mA	60	-	320	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =-500mA, I _B =-50mA	-	-	-1.5	V
Base-Emitter Voltage	V _{BE}	V _{CE} =-5V, I _C =-5mA	-0.5	-	-0.8	V
Transition Frequency	f _T	V _{CE} =-5V, I _C =-200mA	15	50	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =-10V, I _E =0, f=1MHz	-	-	35	pF

Note : h_{FE} Classification R:60~120 O:100~200 Y:160~320



2SA1021



Unit in mm

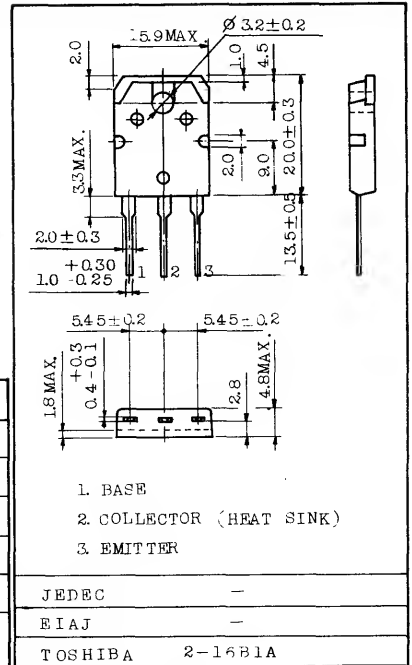
AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Complementary to 2SC2563.
- . Recommended for 50W audio amplifier output stage.
- . High transition frequency : $f_T=90\text{MHz(Typ.)}$

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-120	V
Collector-Emitter Voltage	V_{CE0}	-120	V
Emitter-Base Voltage	V_{EB0}	-5	V
Collector Current	I_C	-8	A
Base Current	I_B	-0.8	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	80	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55~150	$^\circ\text{C}$

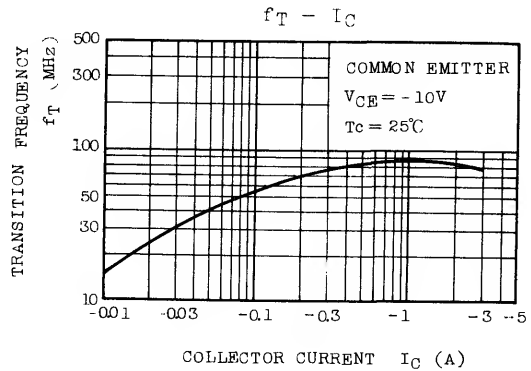
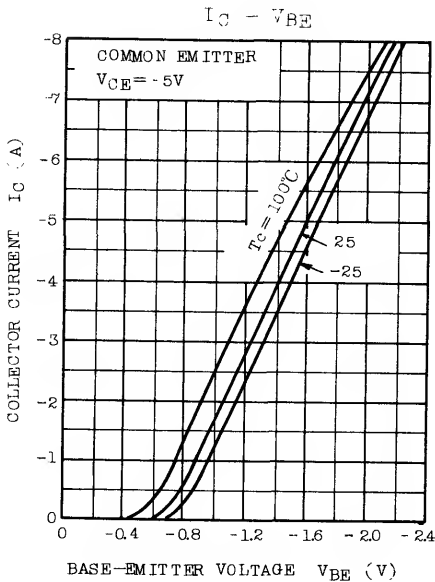
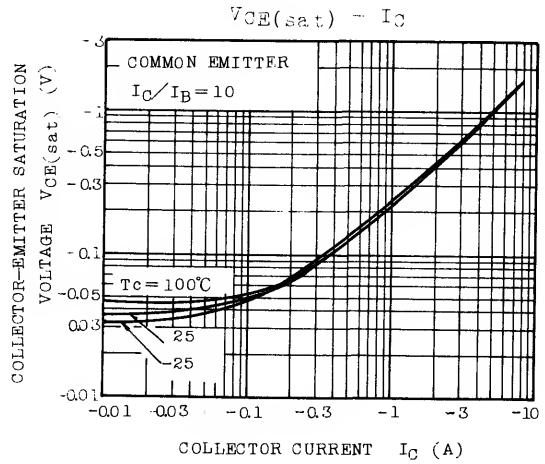
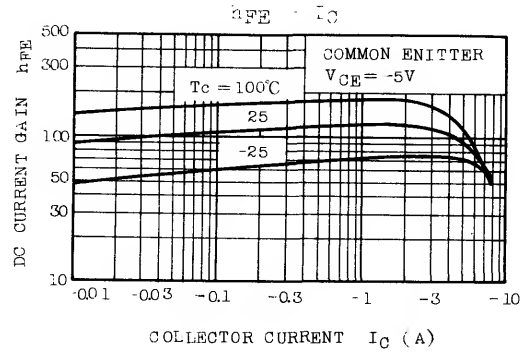
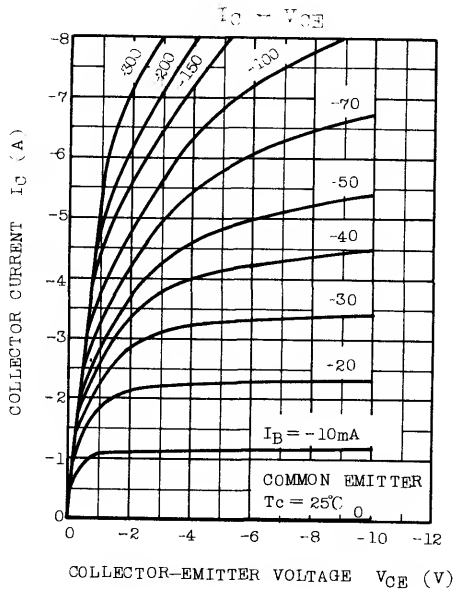


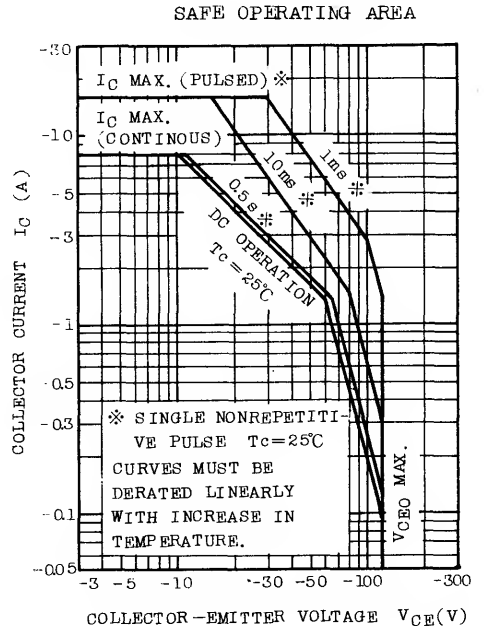
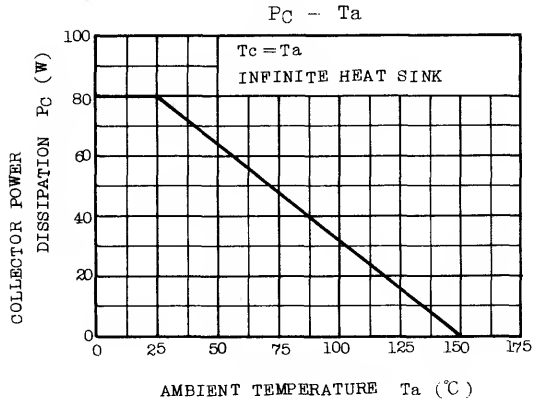
Weight : 4.6g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=-120\text{V}, I_E=0$	-	-	-50	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=-5\text{V}, I_C=0$	-	-	-50	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=-0.05\text{A}, I_B=0$	-120	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=-5\text{V}, I_C=-1\text{A}$	55	-	240	
	$h_{FE(2)}$	$V_{CE}=-5\text{V}, I_C=-4\text{A}$	30	-	-	
Collector Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-4\text{A}, I_B=-0.4\text{A}$	-	-1.0	-2.0	V
Base-Emitter Voltage	V_{BE}	$V_{CB}=-5\text{V}, I_C=-4\text{A}$	-	-1.5	-2.5	V
Transition Frequency	f_T	$V_{CE}=-10\text{V}, I_C=-1\text{A}$	-	90	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10\text{V}, I_E=0, f=1\text{MHz}$	-	150	-	pF

Note: $h_{FE(1)}$ Classification. R:55~110, O:80~160, Y:120~240





2SA1094

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

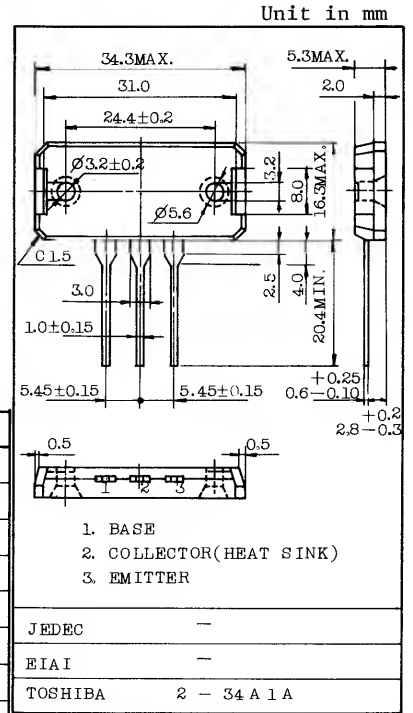
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : $V_{CE0} = -140V$
- High Transition Frequency : $f_T = 70MHz$ (Typ.)
- Complementary to 2SC2564.
- Recommended for 80W High-Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-140	V
Collector-Emitter Voltage	V_{CEO}	-140	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-12	A
Emitter Current	I_E	12	A
Collector Power Dissipation ($T_c = 25^\circ C$)	P_C	120	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55~150	$^\circ C$

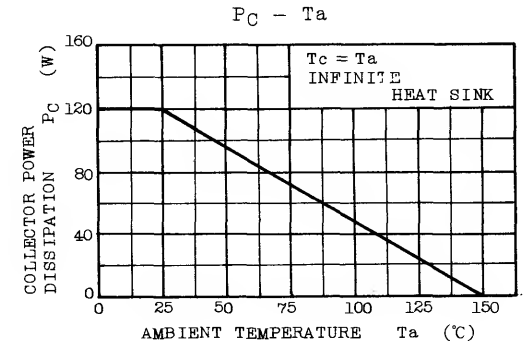
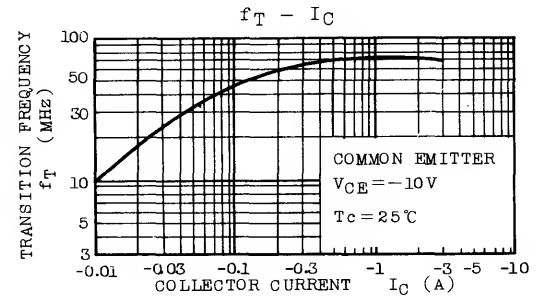
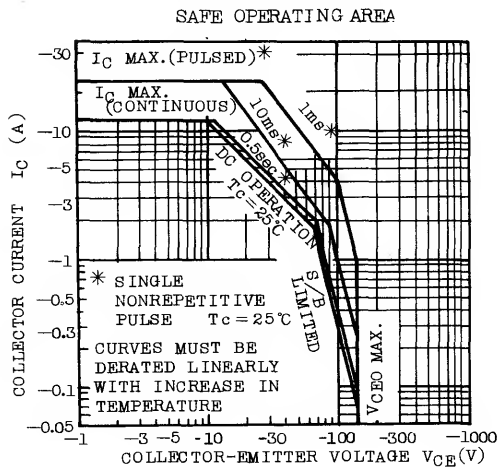
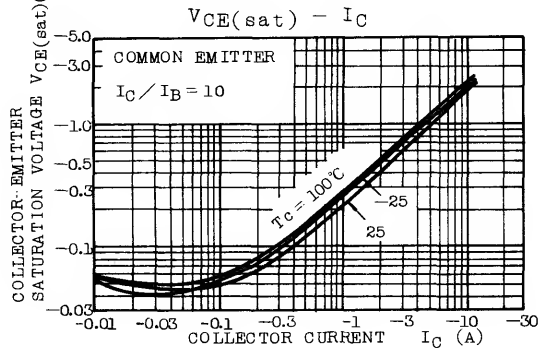
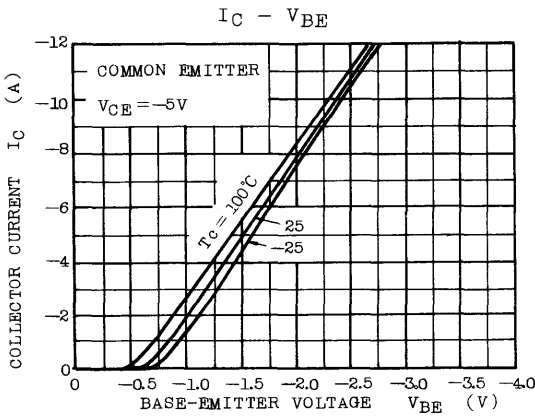
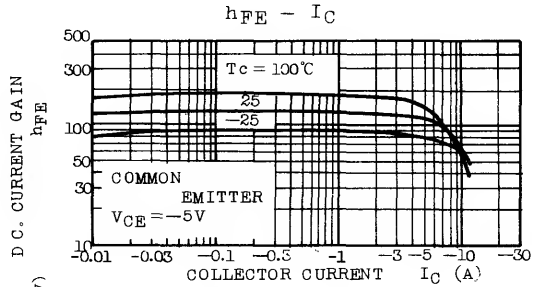
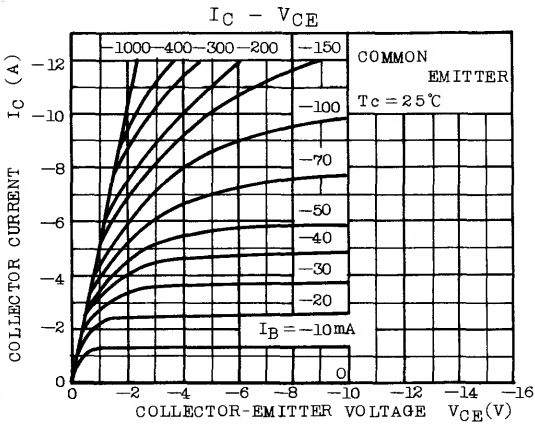


Weight : 10.8g

ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB} = -140V, I_E = 0$	-	-	-50	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB} = -5V, I_C = 0$	-	-	-50	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C = -0.1A, I_B = 0$	-140	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E = -0.01A, I_C = 0$	-5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE} = -5V, I_C = -1A$	55	-	240	
	$h_{FE(2)}$	$V_{CE} = -5V, I_C = -5A$	30	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = -5A, I_B = -0.5A$	-	-	-2.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE} = -5V, I_C = -5A$	-	-	-2.0	V
Transition Frequency	f_T	$V_{CE} = -10V, I_C = -1A$	-	70	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	220	-	pF

Note : $h_{FE(1)}$ Classification R : 55~110, 0 : 80~160, Y : 120~240



2SA1095

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

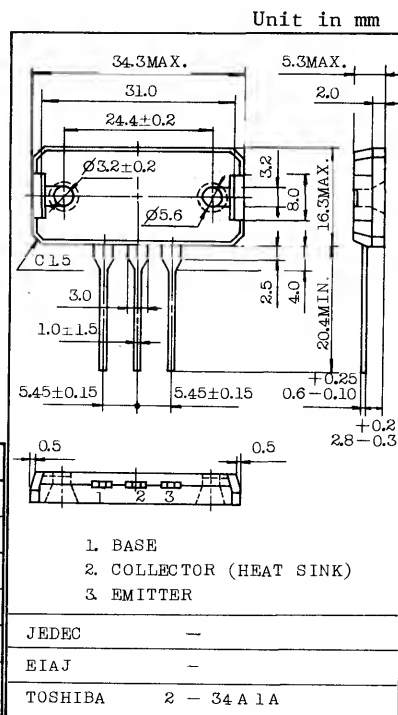
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : $V_{CE0} = -160V$
- High Transition Frequency : $f_T = 60MHz$ (Typ.)
- Complementary to 2SC2565.
- Recommended for 100W High-Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-160	V
Collector-Emitter Voltage	V_{CE0}	-160	V
Emitter-Base Voltage	V_{EB0}	-5	V
Collector Current	I_C	-15	A
Emitter Current	I_E	15	A
Collector Power Dissipation ($T_c = 25^\circ C$)	P_C	150	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55~150	$^\circ C$

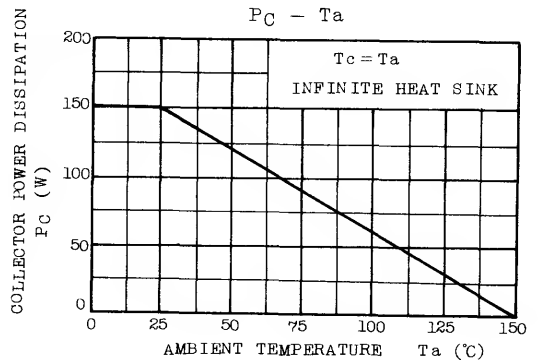
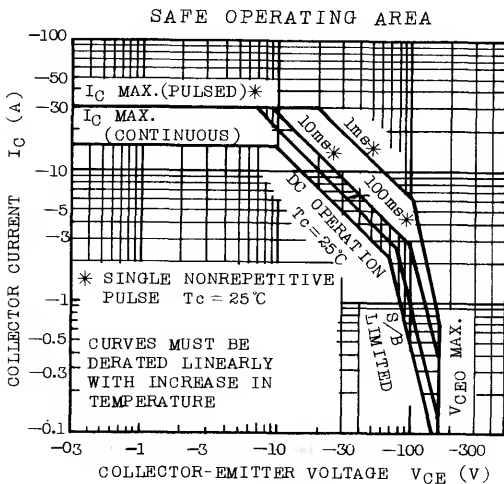
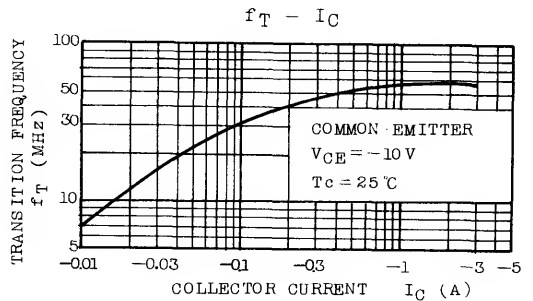
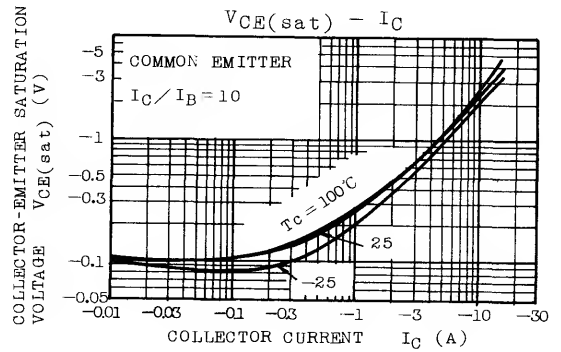
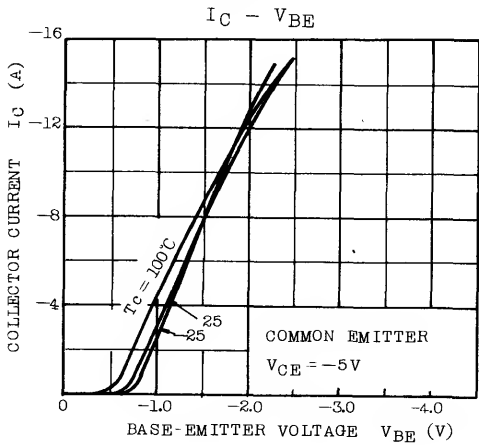
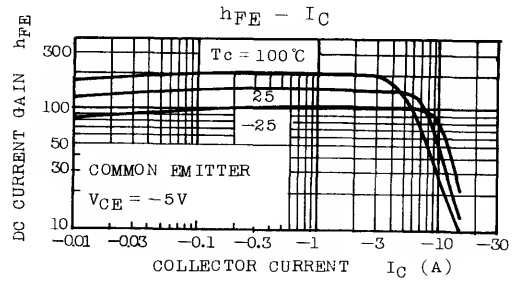
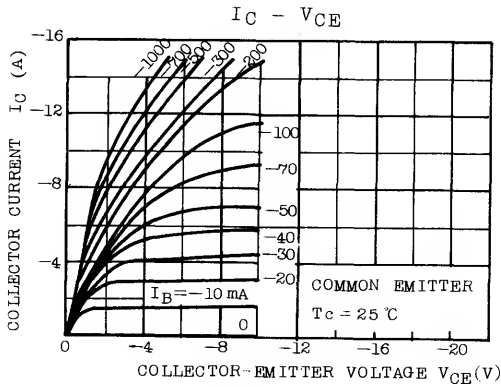


Weight : 10.8g

ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB} = -160V, I_E = 0$	-	-	-50	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB} = -5V, I_C = 0$	-	-	-50	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C = -0.1A, I_B = 0$	-160	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EB0}$	$I_E = -0.01A, I_C = 0$	-5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE} = -5V, I_C = -1A$	55	-	240	
	$h_{FE(2)}$	$V_{CE} = -5V, I_C = -5A$	40	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = -5A, I_B = -0.5A$	-	-	-2.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE} = -5V, I_C = -5A$	-	-	-2.0	V
Transition Frequency	f_T	$V_{CE} = -10V, I_C = -1A$	-	60	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	350	-	pF

Note : $h_{FE(1)}$ Classification R : 55~110, 0 : 80~160, Y : 120~240



2SA1120

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

STROBO FLASH APPLICATIONS.

AUDIO POWER AMPLIFIER APPLICATIONS.

FEATURES:

- MIN h_{FE} of 70 at -2V, -4A.
- -5A Rated Collector Current.
- MAX $V_{CE(sat)}$ of -1.0V at -4A I_C .
- 10W at 25°C Case Temperature.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-35	V
Collector-Emitter Voltage		V_{CEO}	-20	V
Emitter-Base Voltage		V_{EBO}	-8	V
Collector Current	DC	I_C	-5	A
	Pulsed(Note 1)	I_{CP}	-8	A
Emitter Current	DC	I_E	5	A
	Pulsed(Note 1)	I_{EP}	8	A
Collector Power Dissipation	Ta=25°C	P_C	1.0	W
	Tc=25°C		10	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

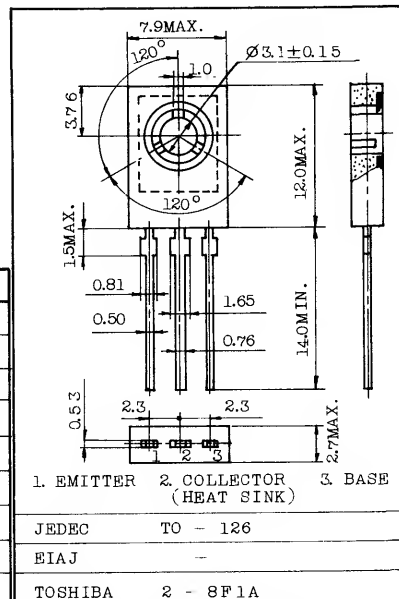
Note 1. Pulse Test : Pulse Width=10ms(Max.),
Duty Cycle=30%(Max.)

ELECTRICAL CHARACTERISTICS (Ta=25°C)

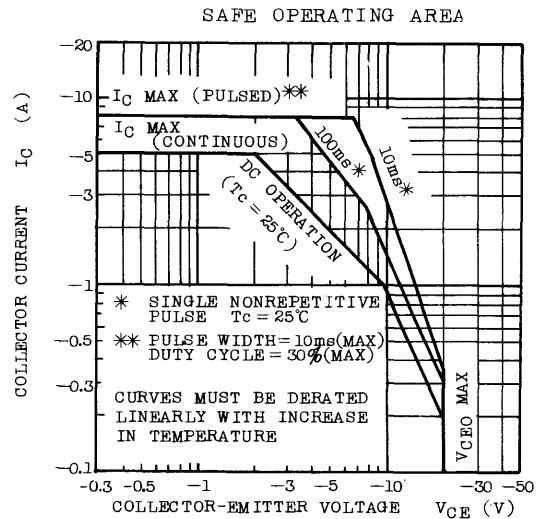
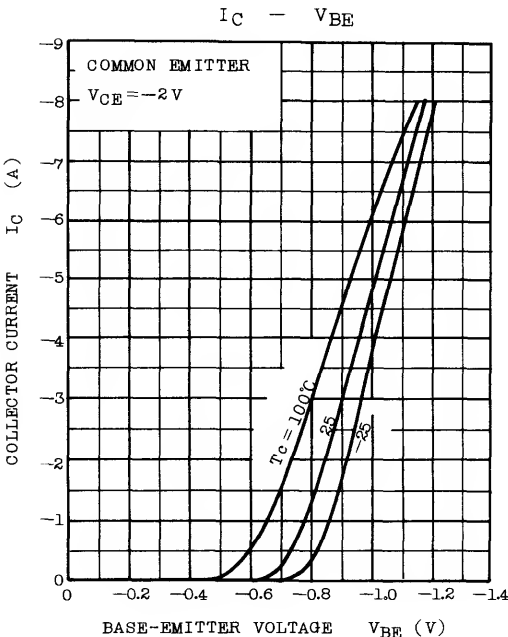
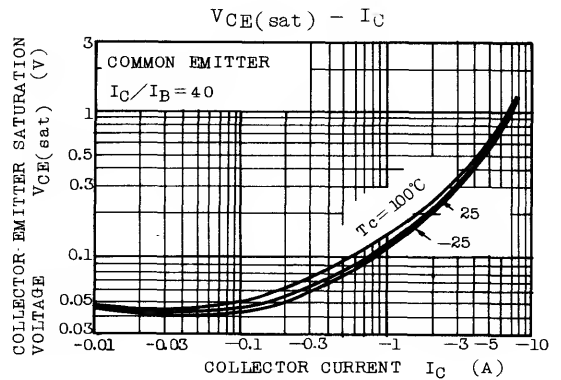
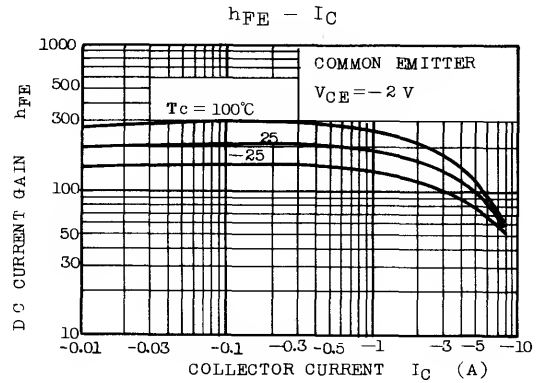
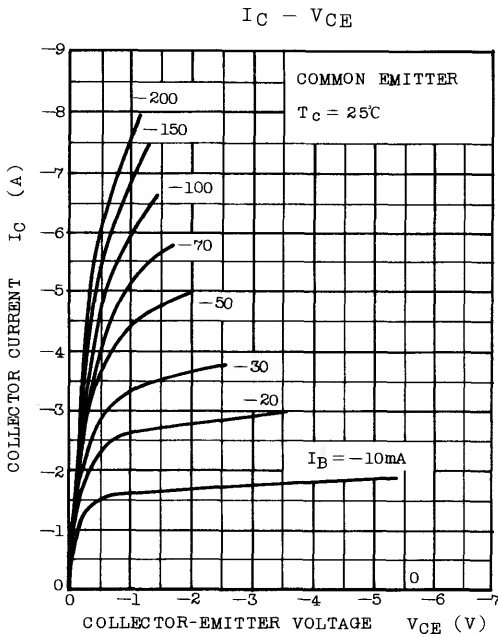
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=-35V, I_E=0$	-	-	-100	nA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=-8V, I_C=0$	-	-	-100	nA
Collector-Emitter Breakdown Voltage	V_{CEO}	$I_C=-10mA, I_B=0$	-20	-	-	V
Emitter-Base Breakdown Voltage	V_{EBO}	$I_E=-1mA, I_C=0$	-8	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note 2)	$V_{CE}=-2V, I_C=-0.5A$	100	-	320	
	$h_{FE(2)}$	$V_{CE}=-2V, I_C=-4A$	70	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-4A, I_B=-0.1A$	-	-	-1.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-2V, I_C=-4A$	-	-	-1.5	V
Transition Frequency	f_T	$V_{CE}=-2V, I_C=-0.5A$	-	170	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10V, I_E=0, f=1MHz$	-	62	-	pF

Note 2. $h_{FE(1)}$ Classification 0:100~200, Y:160~320

UNIT in mm



Mounting Kit No. AC46C
Weight : 0.72g



2SA1144

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

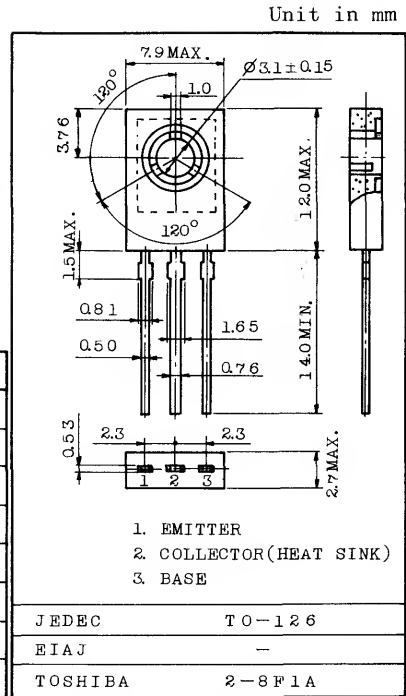
AUDIO FREQUENCY AMPLIFIER APPLICATIONS.

FEATURES:

- . Complementary to 2SC2704.
- . Small Collector Output Capacitance : $C_{ob}=2.5\text{pF(Typ.)}$
- . High Transition Frequency : $f_T=200\text{MHz(Typ.)}$

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-150	V
Collector-Emitter Voltage	V_{CE0}	-150	V
Emitter-Base Voltage	V_{EB0}	-5	V
Collector Current	I_C	-50	mA
Base Current	I_B	-5	mA
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	10	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55~150	$^\circ\text{C}$

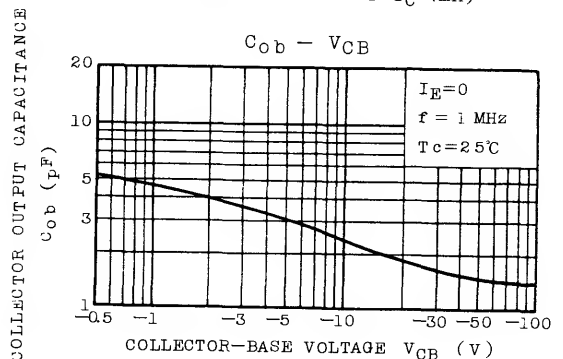
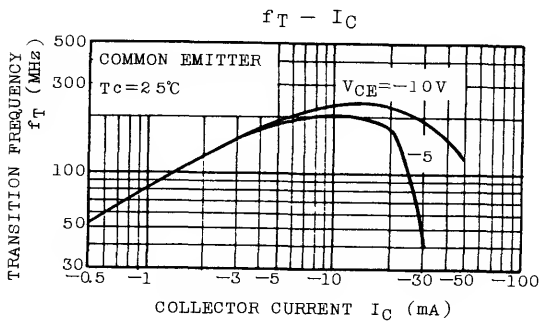
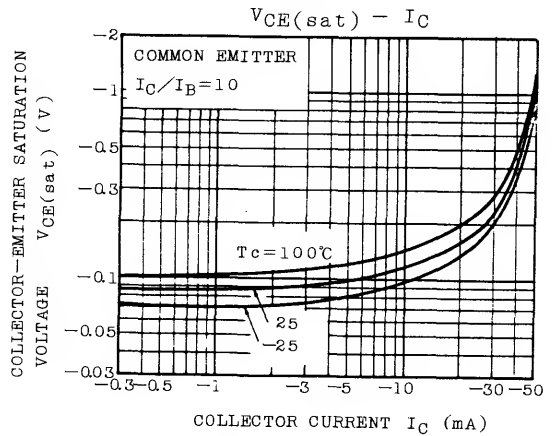
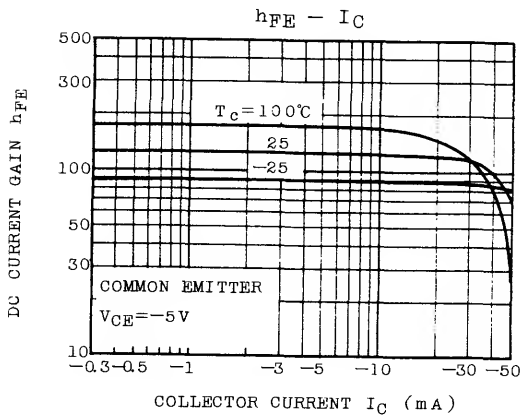
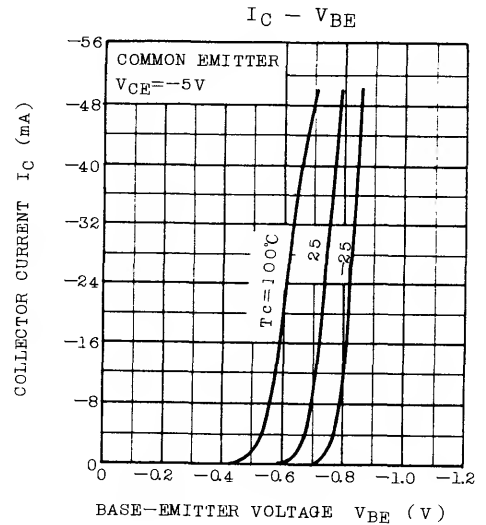
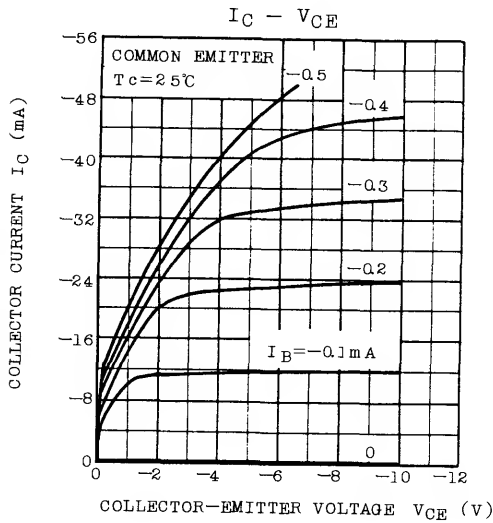


Mounting Kit No. AC46C
Weight : 0.72g

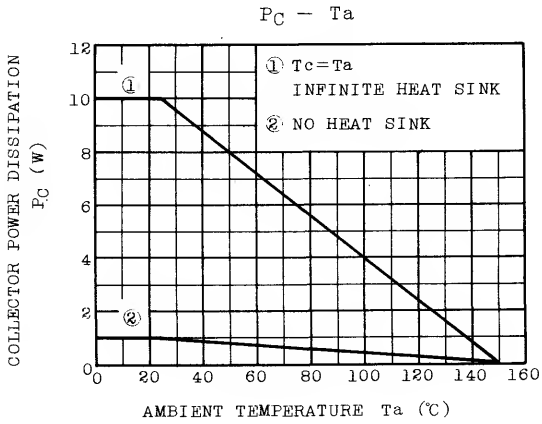
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=-150\text{V}, I_E=0$	-	-	-0.1	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=-5\text{V}, I_C=0$	-	-	-0.1	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=-1\text{mA}, I_B=0$	-150	-	-	V
DC Current Gain	h_{FE} (Note)	$V_{CE}=-5\text{V}, I_C=-10\text{mA}$	80	-	240	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-10\text{mA}, I_B=-1\text{mA}$	-	-	-1.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-5\text{V}, I_C=-10\text{mA}$	-	-	-0.8	V
Transition Frequency	f_T	$V_{CE}=-10\text{V}, I_C=-10\text{mA}$	-	200	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10\text{V}, I_E=0, f=1\text{MHz}$	-	2.5	-	pF

Note: h_{FE} Classification 0:80~160, Y:120~240



2SA1144



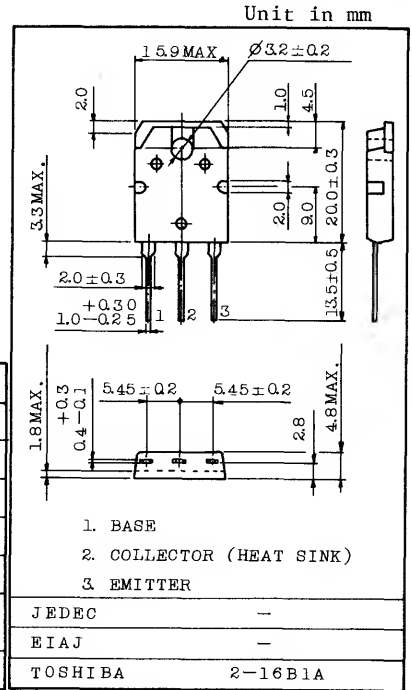
AUDIO FREQUENCY LOW POWER AMPLIFIER
APPLICATIONS.

FEATURES:

- Complementary to 2SC2706.
- Recommended for 70W audio frequency amplifier output stage.
- High transition frequency : $f_T=70\text{MHz(Typ.)}$

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-140	V
Collector-Emitter Voltage	V_{CE0}	-140	V
Emitter-Base Voltage	V_{EB0}	-5	V
Collector Current	I_C	-10	A
Base Current	I_B	-1	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	100	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ\text{C}$

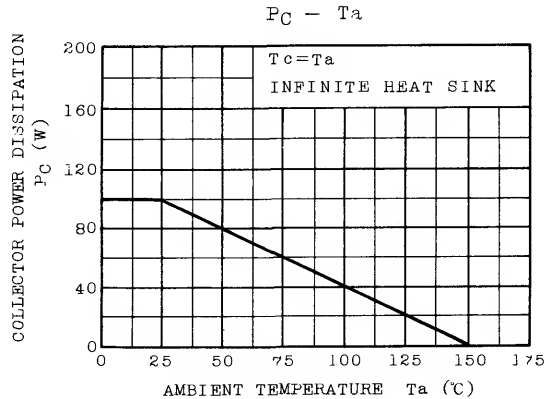
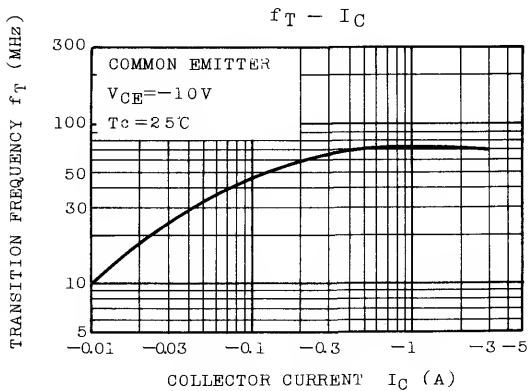
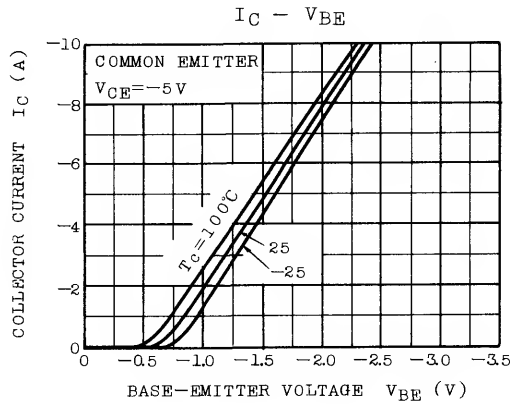
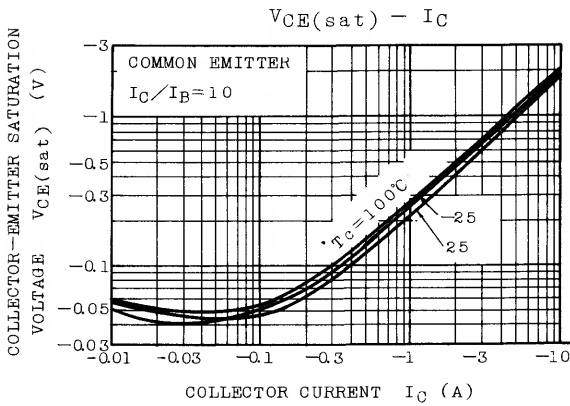
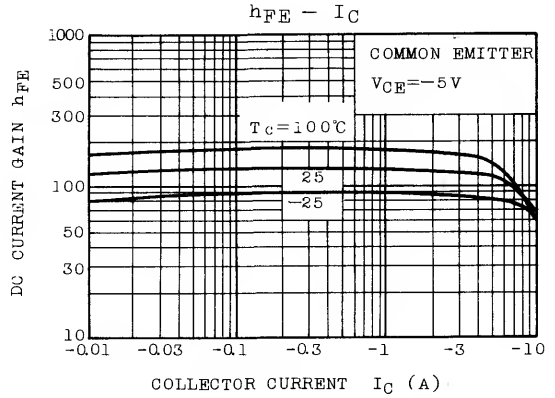
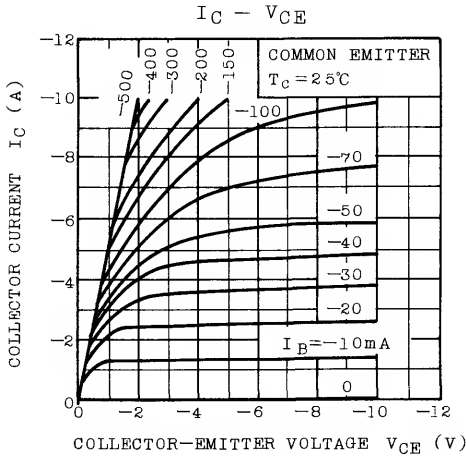


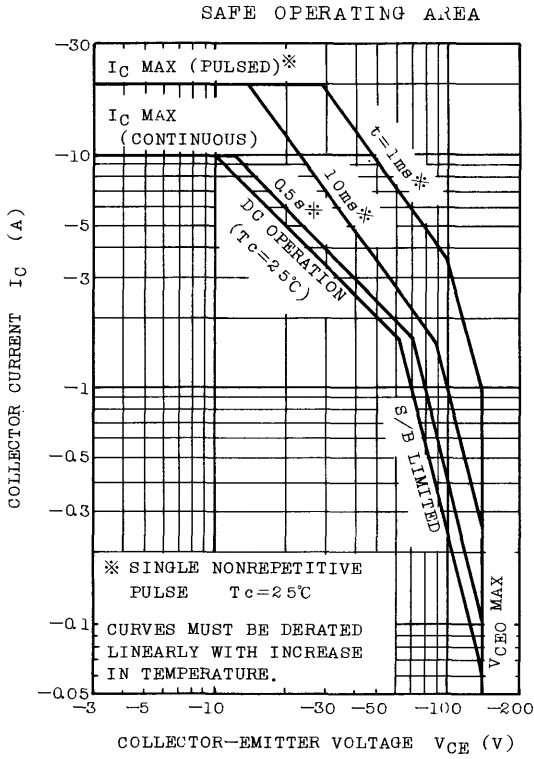
Weight : 4.6g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=-140\text{V}, I_E=0$	-	-	-50	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=-5\text{V}, I_C=0$	-	-	-50	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C=-50\text{mA}, I_B=0$	-140	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=-5\text{V}, I_C=-1\text{A}$	55	-	240	
	$h_{FE(2)}$	$V_{CE}=-5\text{V}, I_C=-5\text{A}$	30	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-5\text{A}, I_B=-0.5\text{A}$	-	-	-2.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-5\text{V}, I_C=-5\text{A}$	-	-	-2.5	V
Transition Frequency	f_T	$V_{CE}=-10\text{V}, I_C=-1\text{A}$	-	70	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10\text{V}, I_E=0, f=1\text{MHz}$	-	220	-	pF

Note: h_{FE} Classification R:55~110, O:80~160, Y:120~240





2SA1184

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

Unit in mm

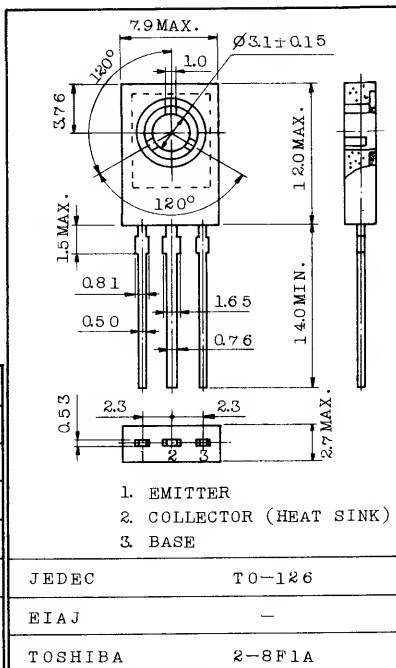
AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES :

- . Complementary to 2SC2824.
- . Suitable for driver of 60 to 80 watts.
- . High breakdown voltage.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	-120	V
Collector-Emitter Voltage	V _{CE0}	-120	V
Emitter-Base Voltage	V _{EB0}	-5	V
Collector Current	I _C	-1	A
Base Current	I _B	-100	mA
Collector Power Dissipation	P _C	Ta=25°C	1
		Tc=25°C	15
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55~150	°C



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC T0-186

EIAJ -

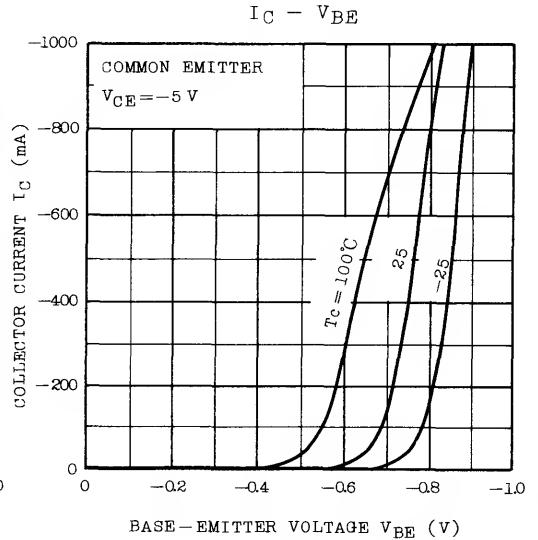
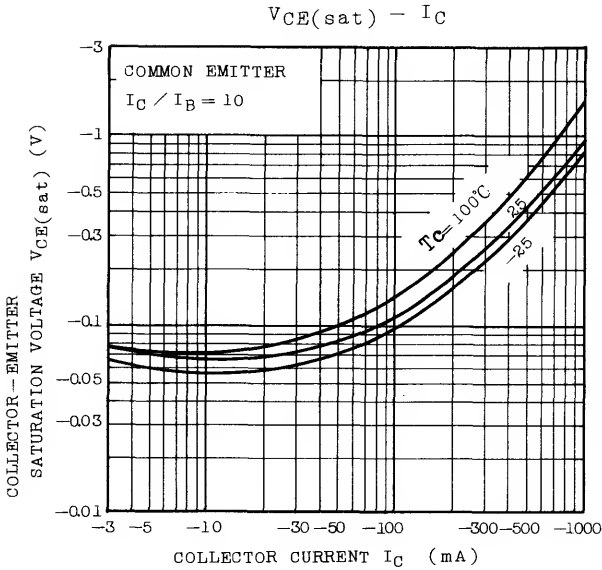
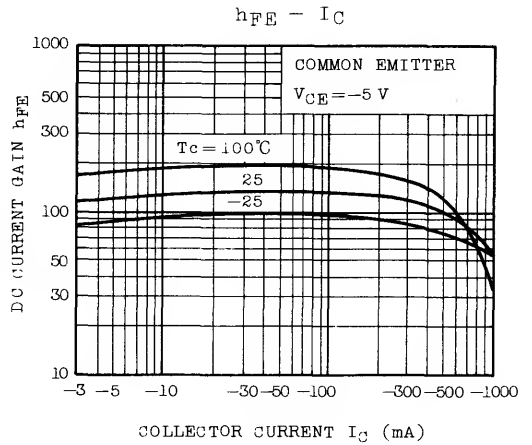
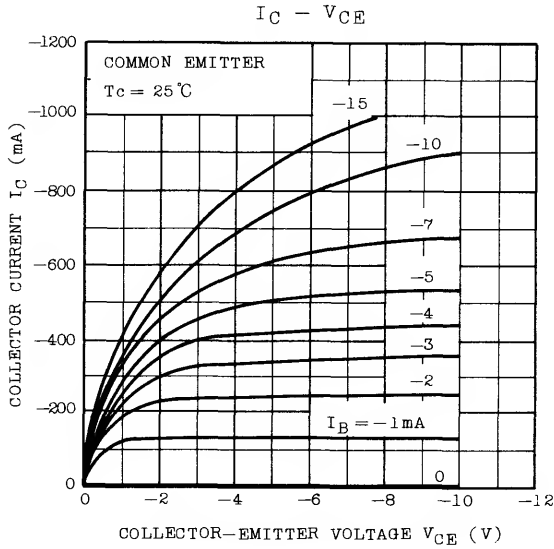
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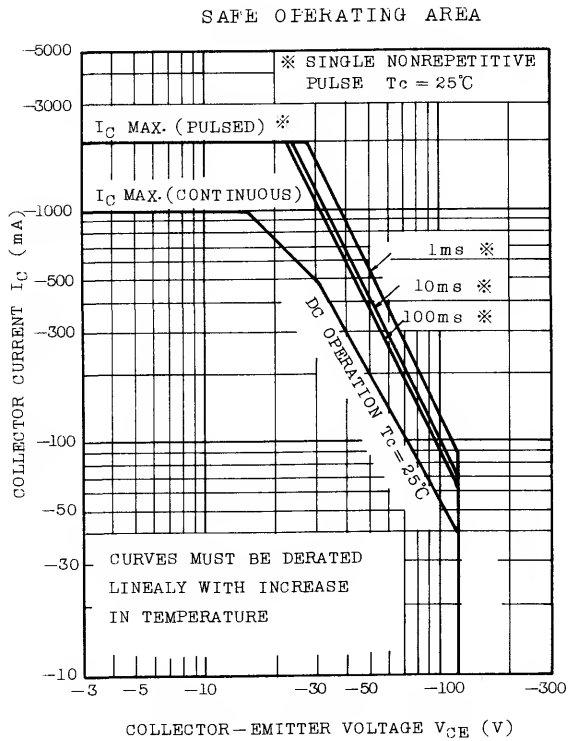
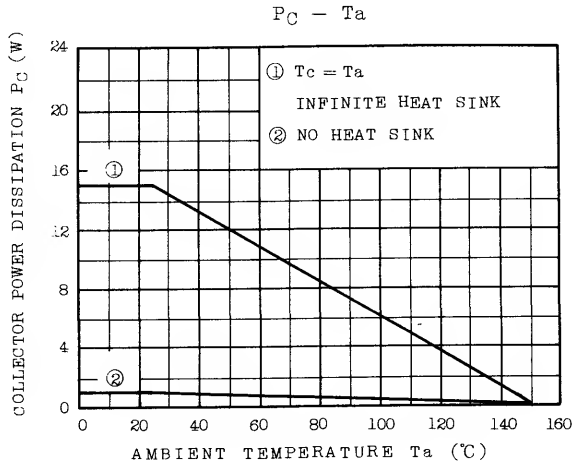
Mounting Kit No. AC46C
Weight : 0.72g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =-120V, I _E =0	-	-	-100	nA
Emitter Cut-off Current	I _{EB0}	V _{EB} =-5V, I _C =0	-	-	-100	nA
Collector-Emitter Breakdown Voltage	V _{(BR)CE0}	I _C =-10mA, I _B =0	-120	-	-	V
Emitter-Base Breakdown Voltage	V _{(BR)EB0}	I _E =-1mA, I _C =0	-5	-	-	V
DC Current Gain	h _{FE} (Note)	V _{CE} =-5V, I _C =-100mA	80	-	240	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =-500mA, I _B =-50mA	-	-0.40	-1.0	V
Base-Emitter Voltage	V _{BE}	V _{CE} =-5V, I _C =-500mA	-	-0.77	-1.0	V
Transition Frequency	f _T	V _{CE} =-5V, I _C =-100mA	-	120	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =-10V, I _E =0, f=1MHz	-	30	-	pF

Note : h_{FE} Classification 0:80~160 Y:120~240





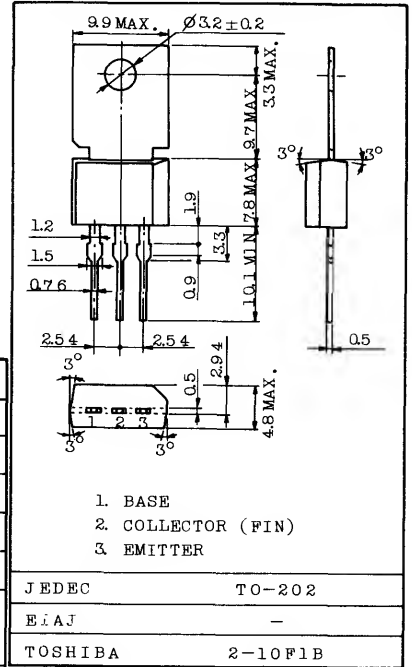
HIGH VOLTAGE GENERAL AMPLIFIER APPLICATIONS.
 COLOR TV CLASS B SOUND OUTPUT APPLICATIONS.

FEATURES:

- Large Collector Current and Collector Power Dissipation Capability. ($P_C=2.0W$ at $T_a=25^\circ C$)
- Designed for Complementary Use with 2SC2483.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-160	V
Collector-Emitter Voltage	V_{CE0}	-160	V
Emitter-Base Voltage	V_{EB0}	-6	V
Collector Current	I_C	-1.5	A
Base Current	I_B	-1.0	A
Collector Power Dissipation	$T_a=25^\circ C$	P_C	2.0
	$T_c=25^\circ C$	P_C	15
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$



Weight : 1.37g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=-150V, I_E=0$	-	-	-1.0	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=-6V, I_C=0$	-	-	-1.0	μA
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=-5V, I_C=-200mA$	60	-	200	
	$h_{FE(2)}$	$V_{CE}=-5V, I_C=-500mA$	40	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-500mA, I_B=-50mA$	-	-	-1.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-5V, I_C=-5mA$	-0.50	-0.57	-0.70	V
Transition Frequency	f_T	$V_{CE}=-5V, I_C=-200mA$	15	50	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10V, I_E=0, f=1MHz$	-	-	35	pF

Note : $h_{FE(1)}$ Classification R : 60 ~ 120, 0 : 100 ~ 200

2SA1217

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

AUDIO FREQUENCY POWER AMPLIFIER

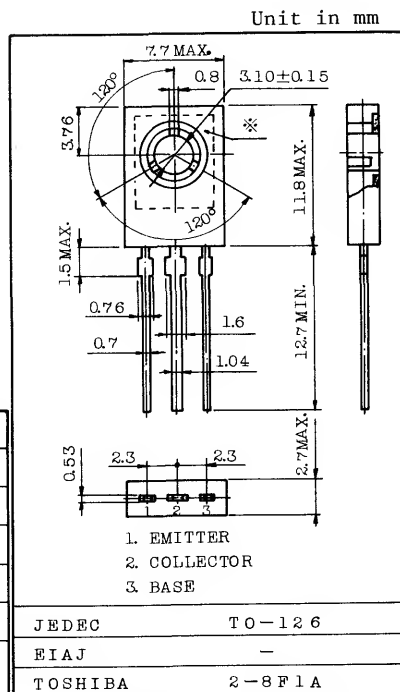
LOW SPEED SWITCHING

FEATURES:

- . Suitable for output stage of 5 watts car radio and car stereo.
- . Good linearity of h_{FE} .
- . Complementary to 2SC2877.

MAXIMUM RATINGS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-40	V
Collector-Emitter Voltage	V_{CE0}	-40	V
Emitter-Base Voltage	V_{EB0}	-5	V
Collector Current	I_C	-3	A
Base Current	I_B	-1	A
Collector Power Dissipation ($T_c=25^{\circ}\text{C}$)	P_C	10	W
Junction Temperature	T_j	150	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^{\circ}\text{C}$

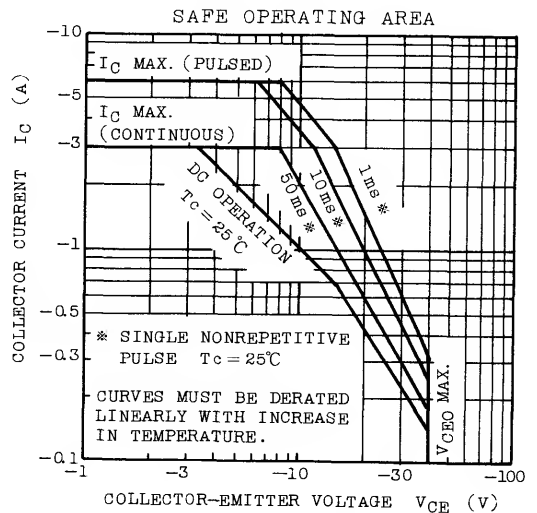
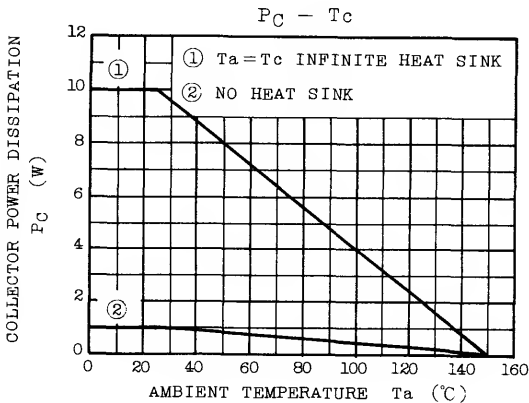
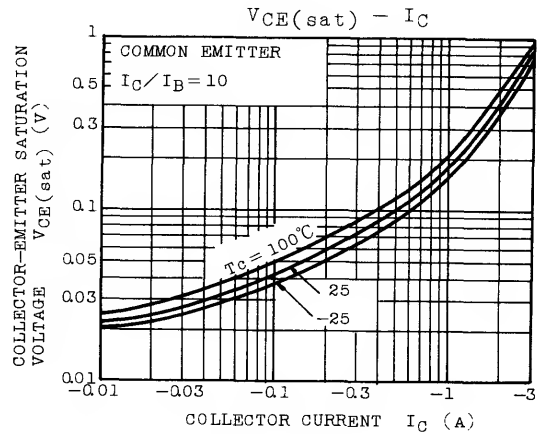
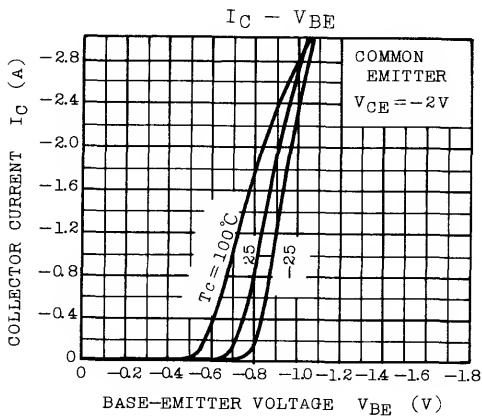
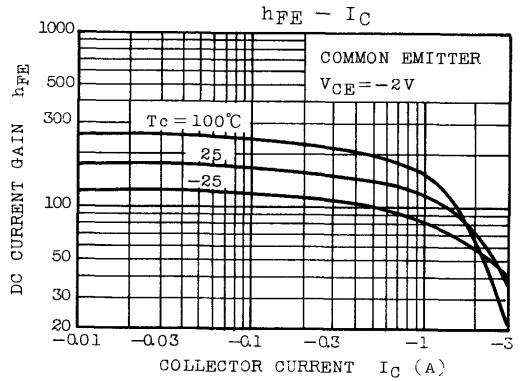
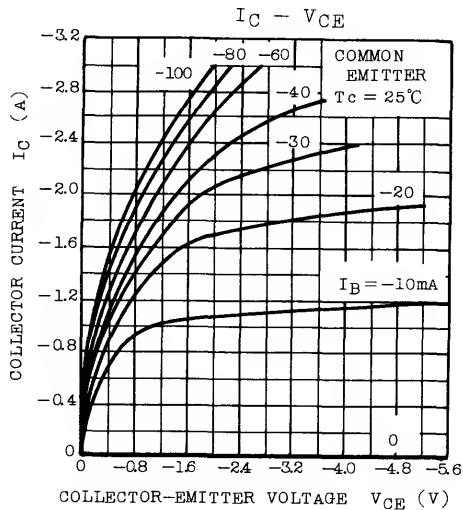


The inside metal of dotted line is connected to collector lead. Weight 0.72 g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cutoff Current	I_{CBO}	$V_{CB}=-40\text{V}, I_E=0$	-	-	-100	nA
Emitter Cutoff Current	I_{EBO}	$V_{EB}=-5\text{V}, I_C=0$	-	-	-100	nA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=-10\text{mA}, I_B=0$	-40	-	-	V
D.C Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=-2\text{V}, I_C=-0.5\text{A}$	80	-	240	
	$h_{FE(2)}$	$V_{CE}=-2\text{V}, I_C=-2.5\text{A}$	25	-	-	
Collector Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-2\text{A}, I_B=-0.2\text{A}$	-	-	-0.8	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-2\text{V}, I_C=-0.5\text{A}$	-	-	-1.0	V
Transition Frequency	f_T	$V_{CE}=-2\text{V}, I_C=-0.5\text{A}$	-	100	-	MHz
Output Capacitance	C_{ob}	$V_{CB}=-10\text{V}, I_E=0, f=1\text{MHz}$	-	35	-	pF

Note: h_{FE} Classification. 0 : 80 ~ 160 Y : 120 ~ 240



2SA1225

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

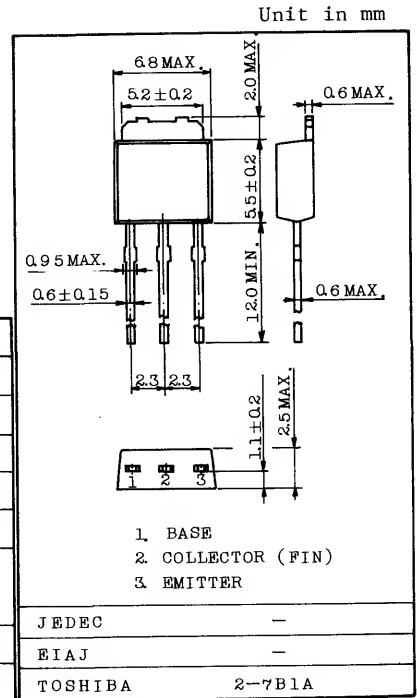
POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- . High Transition Frequency : $f_T=100\text{MHz}$ (Typ.)
- . Complementary to 2SC2983

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-160	V
Collector-Emitter Voltage	V_{CE0}	-160	V
Emitter-Base Voltage	V_{EB0}	-5	V
Collector Current	I_C	-1.5	A
Base Current	I_B	0.3	A
Collector Power Dissipation	P_C	$T_a=25^\circ\text{C}$	1.0
		$T_c=25^\circ\text{C}$	15
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ\text{C}$

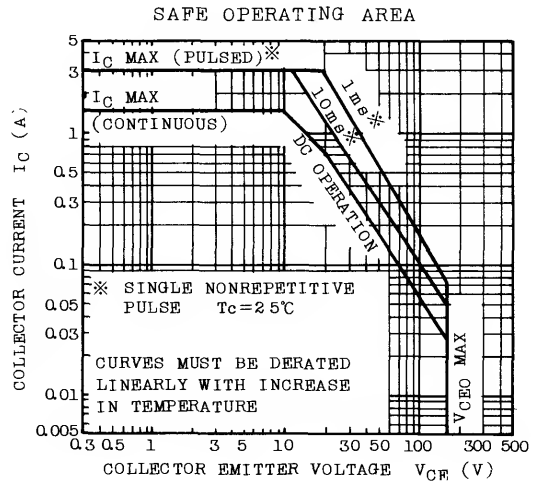
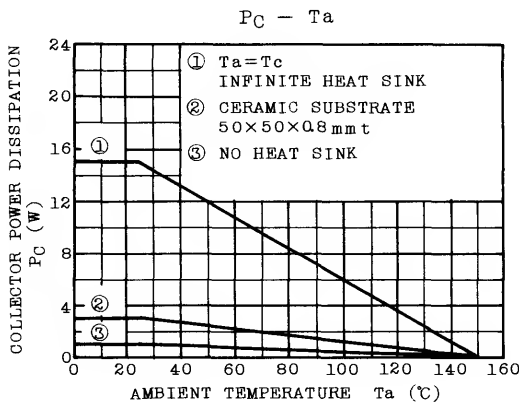
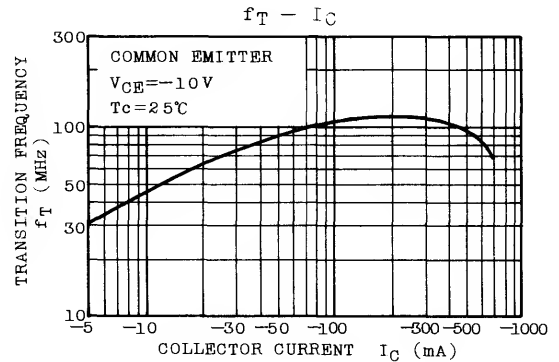
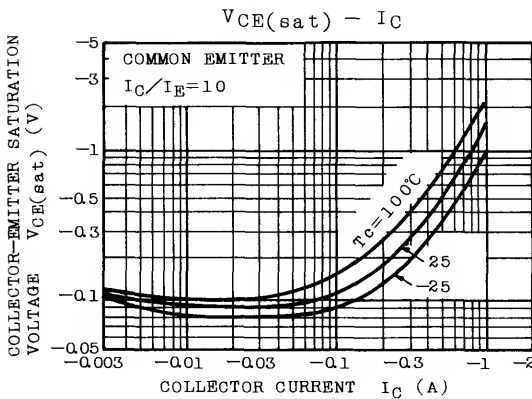
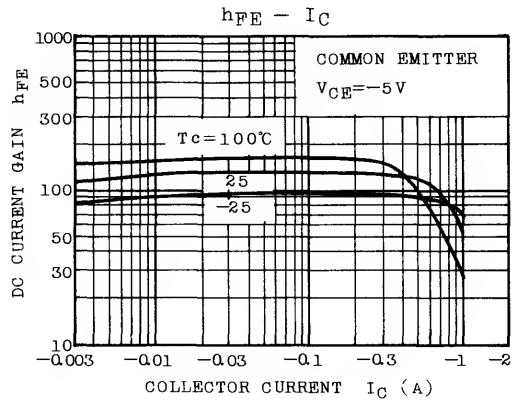
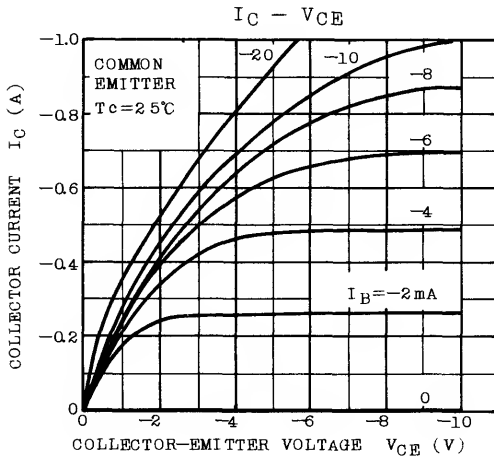


Weight : 0.36g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=-160\text{V}, I_E=0$	-	-	-1.0	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=-5\text{V}, I_C=0$	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C=-10\text{mA}, I_B=0$	-160	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EB0}$	$I_E=-1\text{mA}, I_C=0$	-5	-	-	V
DC Current Gain	h_{FE} (Note)	$V_{CE}=-5\text{V}, I_C=-100\text{mA}$	70	-	240	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-500\text{mA}, I_B=-50\text{mA}$	-	-	-1.5	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-5\text{V}, I_C=-500\text{mA}$	-	-	-1.0	V
Transition Frequency	f_T	$V_{CE}=-10\text{V}, I_C=-100\text{mA}$	-	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10\text{V}, I_E=0, f=1\text{MHz}$	-	30	-	pF

Note : h_{FE} Classification O : 70 ~ 140, Y : 120 ~ 240



2SA1241

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.

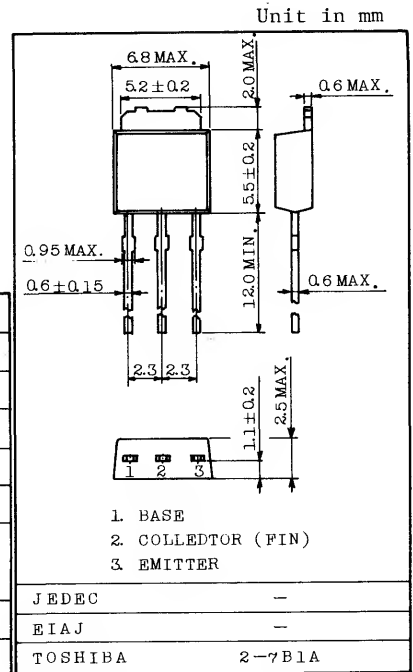
POWER SWITCHING APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
: $V_{CE(sat)} = -0.5V$ (Max.) ($I_C = -1A$)
- Excellent Switching Time : $t_{stg} = 1.0\mu s$ (Typ.)
- Complementary to 2SC3076

MAXIMUM RATINGS ($T_a = 25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-50	V
Collector-Emitter Voltage		V_{CEO}	-50	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-2	A
Base Current		I_B	-1	A
Collector Power Dissipation	$T_a = 25^\circ C$	P_C	1.0	W
	$T_c = 25^\circ C$		10	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature		T_{stg}	-55 ~ 150	$^\circ C$

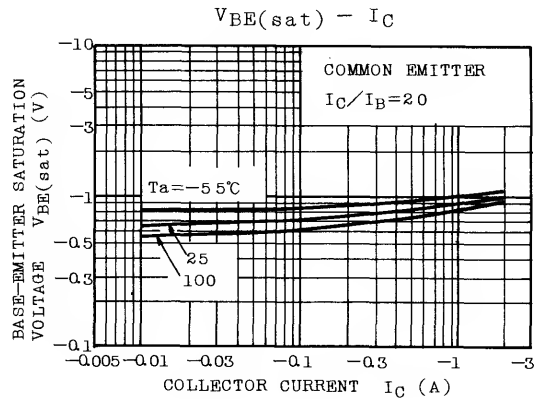
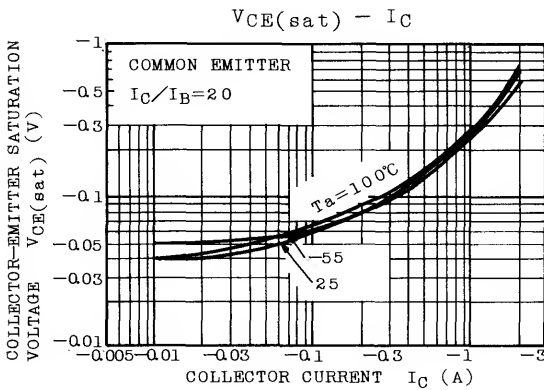
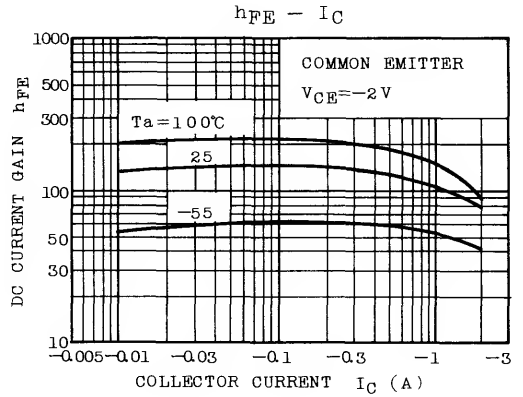
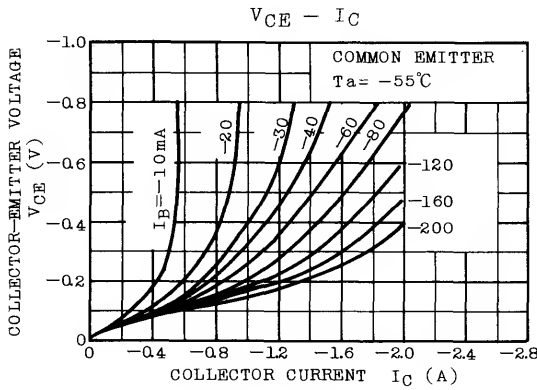
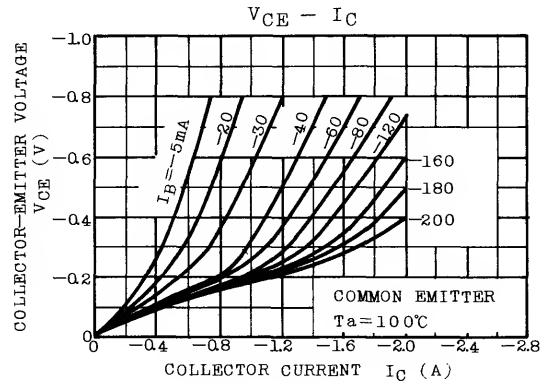
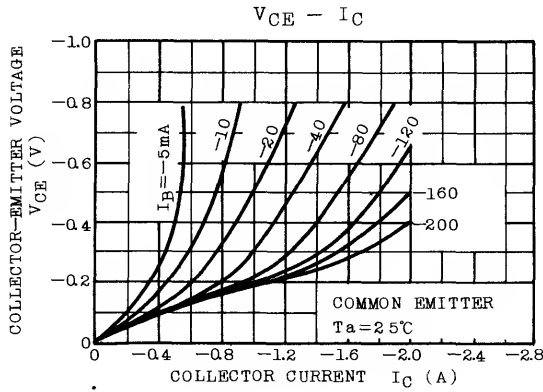


ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

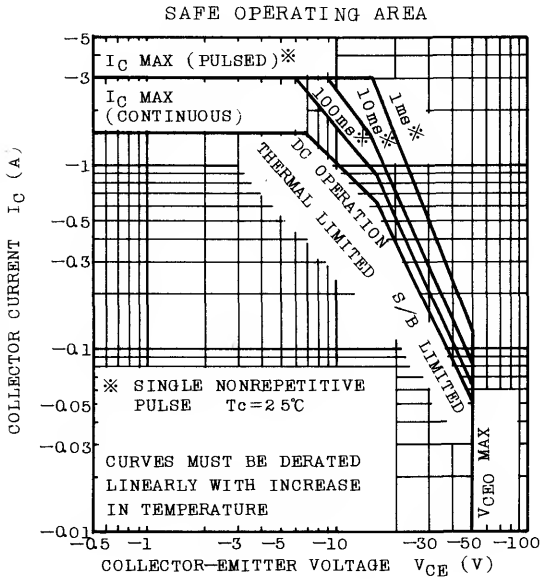
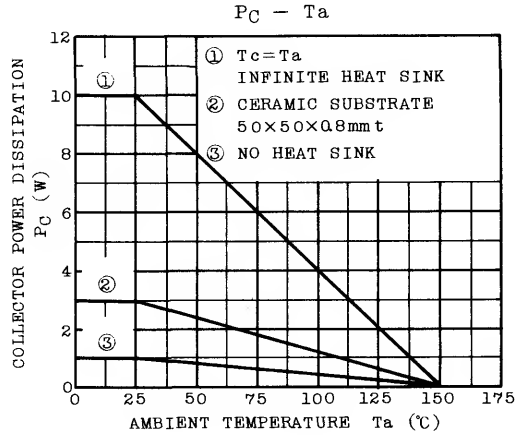
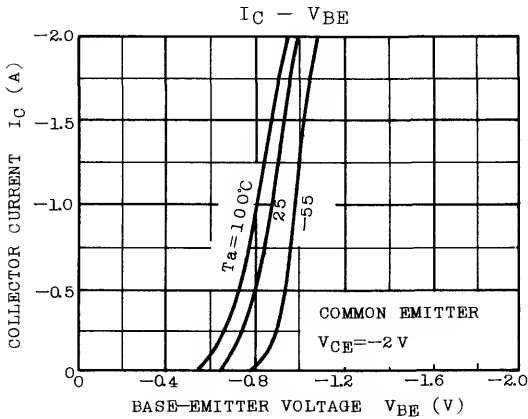
Weight : 0.36g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB} = -50V, I_E = 0$	-	-	-1.0	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB} = -5V, I_C = 0$	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C = -10mA, I_B = 0$	-50	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$h_{FE(2)}$	$V_{CE} = -2V, I_C = -0.5A$	70	-	240	
			$V_{CE} = -2V, I_B = -1.5A$	40	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C = -1A, I_B = -0.05A$	-	-	-0.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C = -1A, I_B = -0.05A$	-	-	-1.2	V
Transition Frequency		f_T	$V_{CE} = -2V, I_C = -0.5A$	-	100	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	40	-	pF
Switching Time	Turn-on Time	t_{on}	<p>INPUT I_{B2} OUTPUT 20μF I_{B1} I_{B2} 50Ω $-I_{B1} = I_{B2} = 0.05A$ $V_{CC} = -30V$ DUTY CYCLE $\leq 1\%$</p>	-	0.1	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

Note : $h_{FE(1)}$ Classification 0 : 70 ~ 140, Y : 120 ~ 140



2SA1241



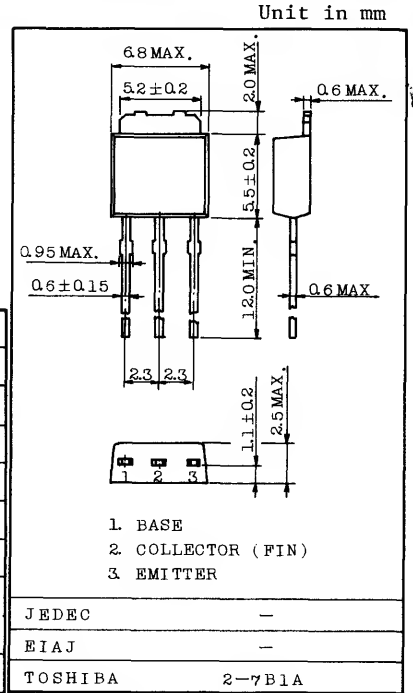
STROBO FLASH APPLICATIONS.
 MEDIUM POWER AMPLIFIER APPLICATIONS.

FEATURES:

- $h_{FE}=100 \sim 320$ ($V_{CE}=-2V$, $I_C=-0.5A$)
- $h_{FE}=70$ (Min.) ($V_{CE}=-2V$, $I_C=-4A$)
- Low Collector Saturation Voltage
 : $V_{CE(sat)}=-1.0V$ (Max.) ($I_C=-4A$, $I_B=-0.1A$)
- High Power Dissipation
 : $P_C=10W$ ($T_c=25^{\circ}C$), $P_C=1.0W$ ($T_a=25^{\circ}C$)

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB0}	-35	V
Collector-Emitter Voltage		V_{CEO}	-20	V
Emitter-Base Voltage		V_{EBO}	-8	V
Collector Current	DC	I_C	-5	A
	Pulsed (Note 1)	I_{CP}	-8	A
Base Current		I_B	-0.5	A
Collector Power Dissipation	$T_a=25^{\circ}C$	P_C	1.0	W
	$T_c=25^{\circ}C$		10	
Junction Temperature		T_j	150	$^{\circ}C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^{\circ}C$



Weight : 0.36g

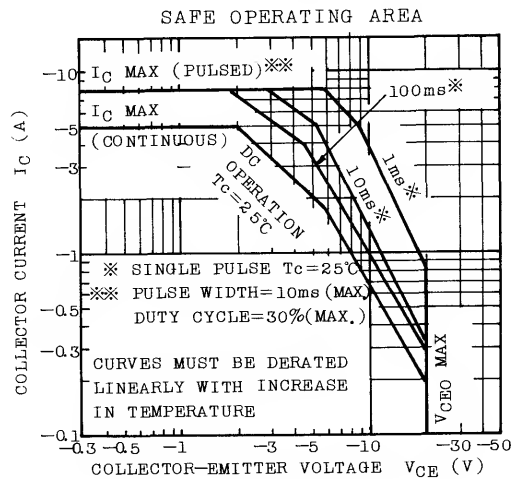
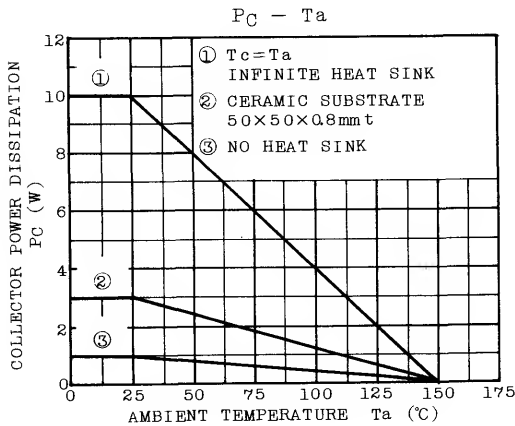
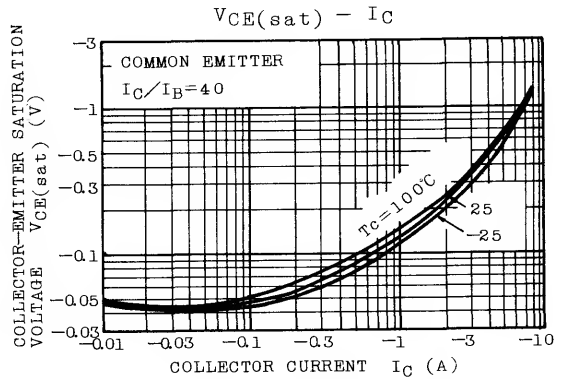
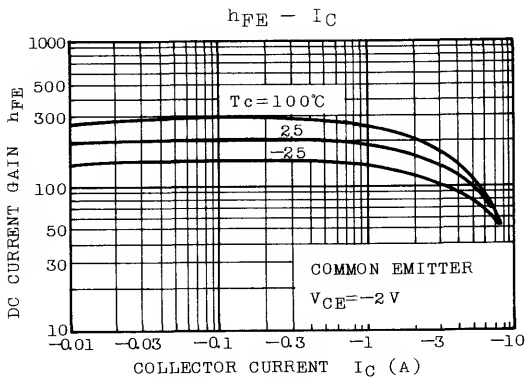
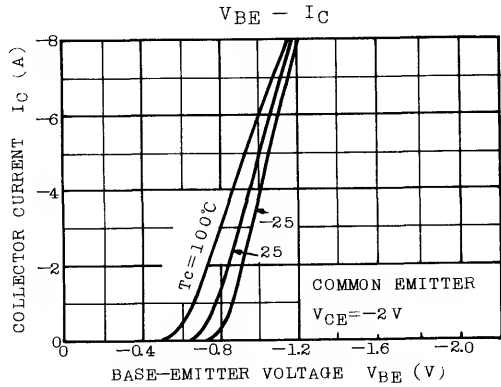
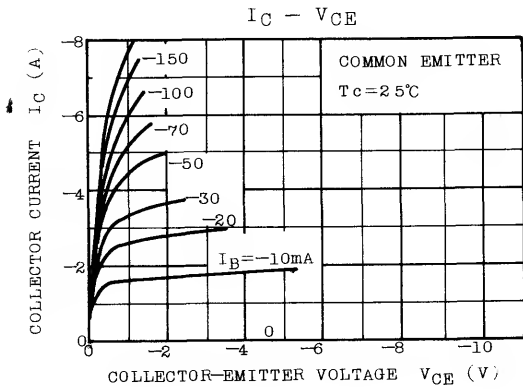
Note 1 : Pulse Test : Pulse width=10ms(Max.), Duty cycle=30%(Max.)

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=-35V$, $I_E=0$	-	-	-100	nA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=-8V$, $I_C=0$	-	-	-100	nA
Collector-Emitter Breakdown Voltage	V_{CEO}	$I_C=-10mA$, $I_B=0$	-20	-	-	V
Emitter-Base Breakdown Voltage	V_{EBO}	$I_E=-1mA$, $I_C=0$	-8	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note 2)	$V_{CE}=-2V$, $I_C=-0.5A$	100	-	320	
		$V_{CE}=-2V$, $I_C=-4A$	70	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-4A$, $I_B=-0.1A$	-	-	-1.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-2V$, $I_C=-4A$	-	-	-1.5	V
Transition Frequency	f_T	$V_{CE}=-2V$, $I_C=-0.5A$	-	170	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10V$, $I_E=0$, $f=1MHz$	-	62	-	pF

Note 2 : $h_{FE(1)}$ Classification 0 : 100 ~ 200, Y : 160 ~ 320

2SA1242



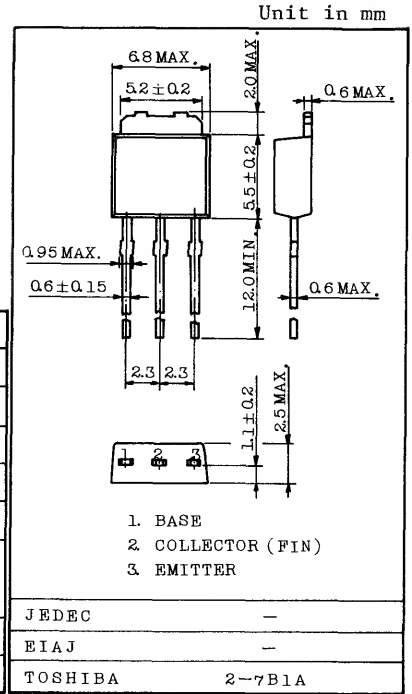
POWER AMPLIFIER APPLICATIONS.
 CAR RADIO AND CAR STEREO OUTPUT STAGE APPLICATIONS.

FEATURES:

- . Good Linearity of h_{FE}
- . Complementary to 2SC3073

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-30	V
Collector-Emitter Voltage		V_{CEO}	-30	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-3	A
Base Current		I_B	-0.6	A
Collector Power Dissipation	$T_a=25^{\circ}C$	P_C	1.0	W
	$T_c=25^{\circ}C$		10	
Junction Temperature		T_j	150	$^{\circ}C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^{\circ}C$



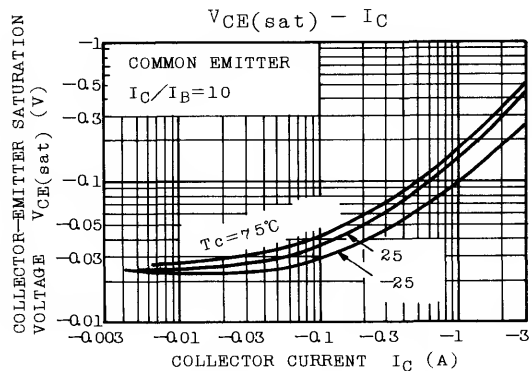
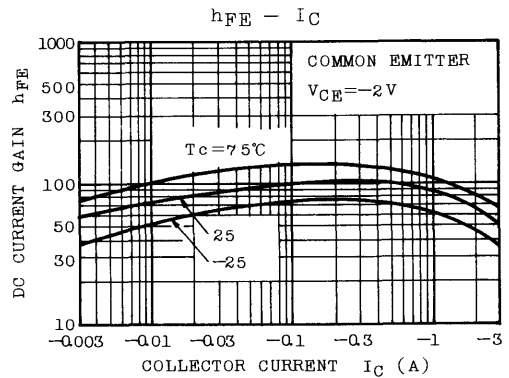
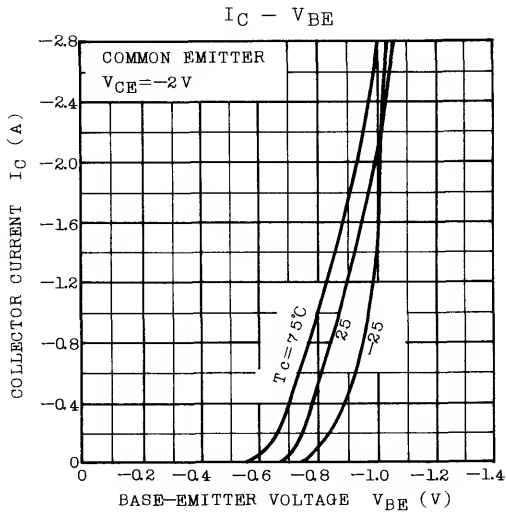
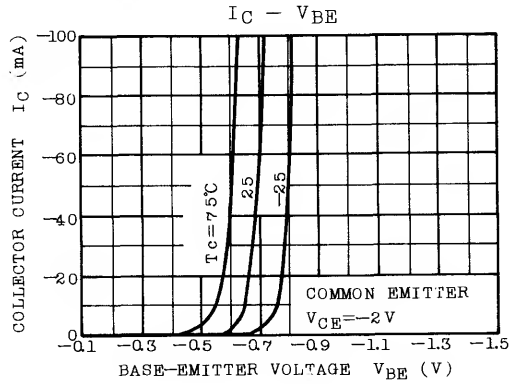
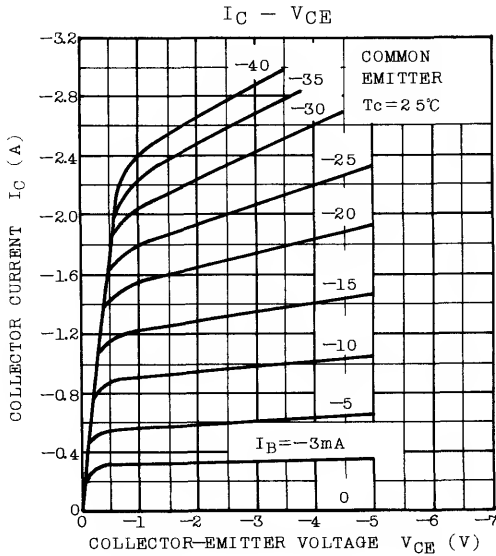
Weight : 0.36g

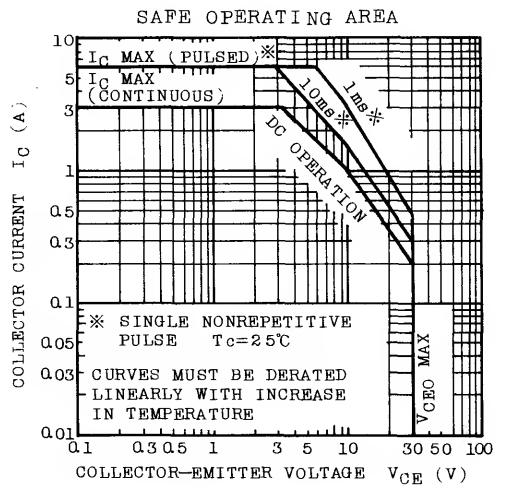
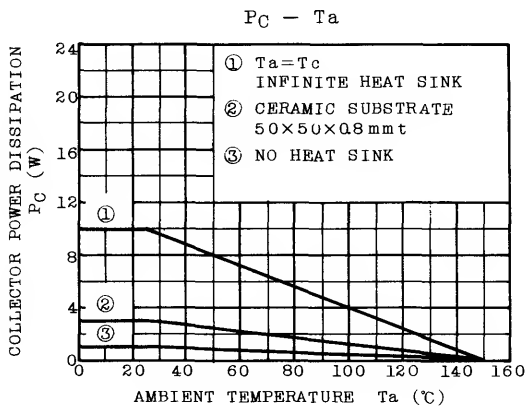
ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=-20V, I_E=0$	-	-	-1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=-5V, I_C=0$	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=-10mA, I_B=0$	-30	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=-1mA, I_C=0$	-5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=-2V, I_C=-0.5A$	70	-	240	
	$h_{FE(2)}$	$V_{CE}=-2V, I_C=-2.5A$	25	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-2A, I_B=-0.2A$	-	-0.3	-0.8	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-2V, I_C=-0.5A$	-	-0.75	-1.0	V
Transition Frequency	f_T	$V_{CE}=-2V, I_C=-0.5A$	-	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10V, I_E=0, f=1MHz$	-	40	-	pF

Note: $h_{FE(1)}$ Classification 0 : 70~140, Y : 120~240

2SA1243





2SA1244

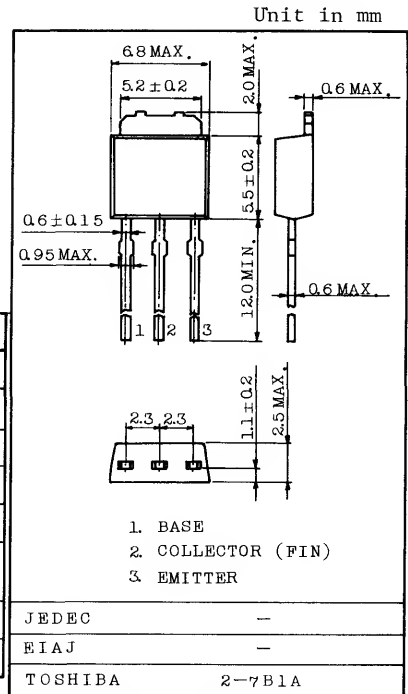
SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
: $V_{CE(sat)} = -0.4V(\text{Max.})$ at $I_C = -3A$
- High Speed Switching Time : $t_{stg} = 1.0\mu s(\text{Typ.})$
- Complementary to 2SC3074

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-60	V
Collector-Emitter Voltage		V_{CEO}	-50	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-5	A
Base Current		I_B	-1	A
Collector Power Dissipation	$T_a = 25^\circ C$	P_C	1.0	W
	$T_c = 25^\circ C$		20	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$



Weight : 0.36g

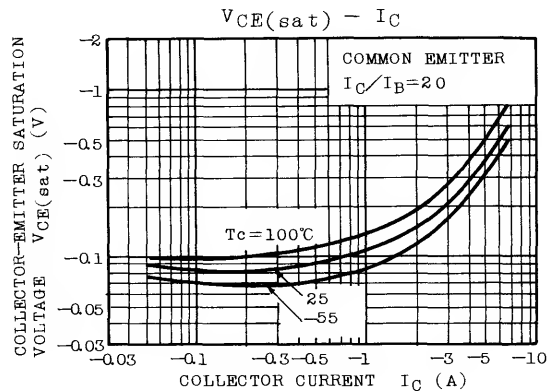
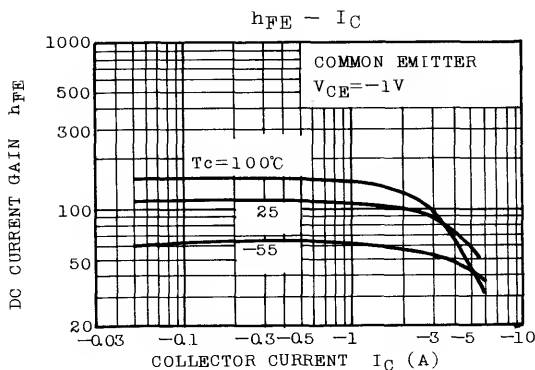
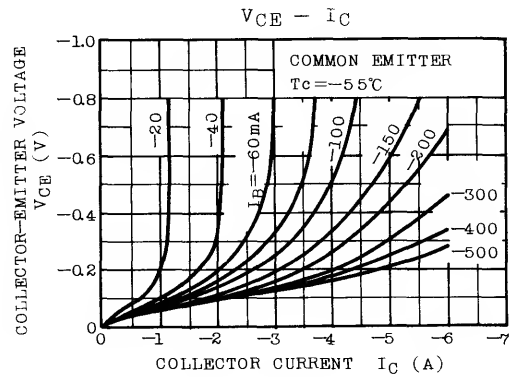
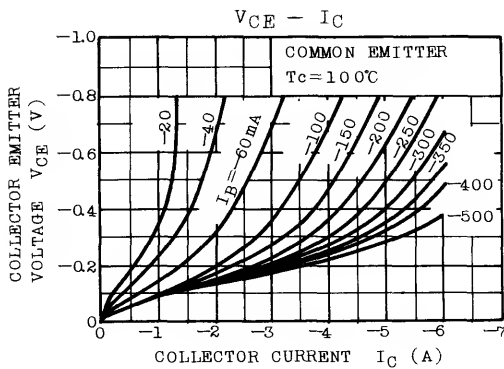
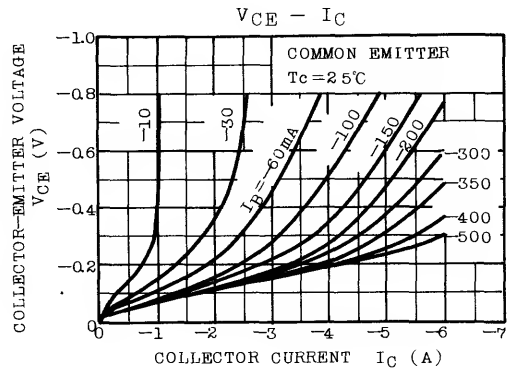
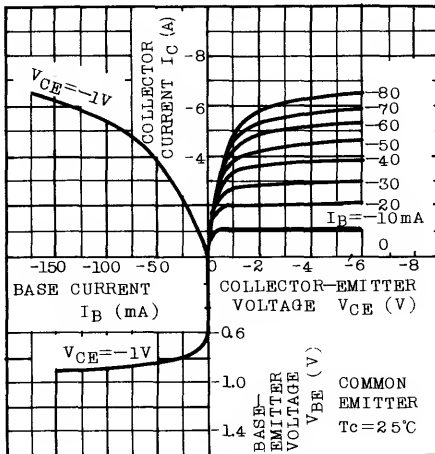
ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB} = -50V, I_E = 0$	-	-	-1	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB} = -5V, I_C = 0$	-	-	-1	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C = -10mA, I_B = 0$	-50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE} = -1V, I_C = -1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE} = -1V, I_C = -3A$	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C = -3A, I_B = -0.15A$	-	-0.2	-0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C = -3A, I_B = -0.15A$	-	-0.9	-1.2	
Transition Frequency		f_T	$V_{CE} = -4V, I_C = -1A$	-	60	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	170	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.1	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

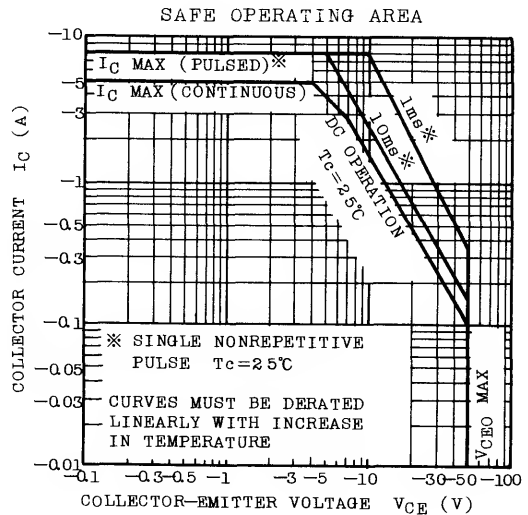
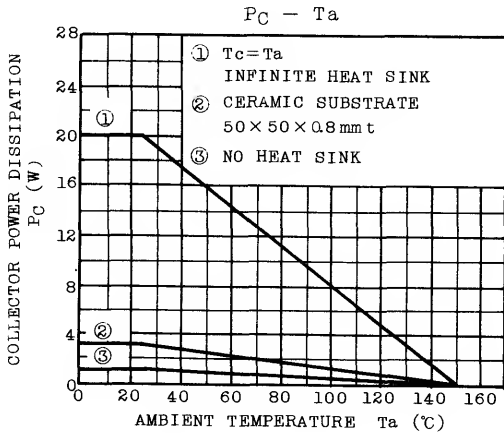
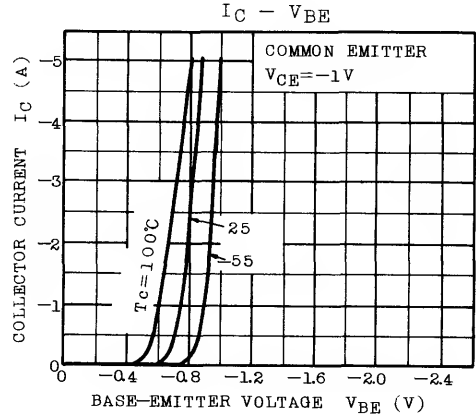
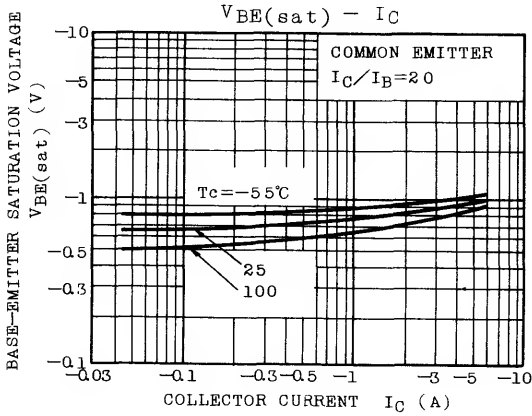
Note : $h_{FE(1)}$ Classification O : 70 ~ 140, Y : 120 ~ 240

TOSHIBA CORPORATION

STATIC CHARACTERISTICS



2SA1244

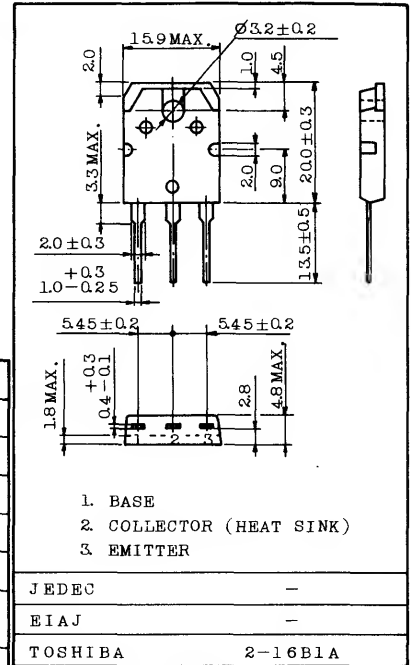


POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Complementary to 2SC3180
- . Recommend for 40W High Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



Weight : 4.6g

MAXIMUM RATINGS (Ta=25°C)

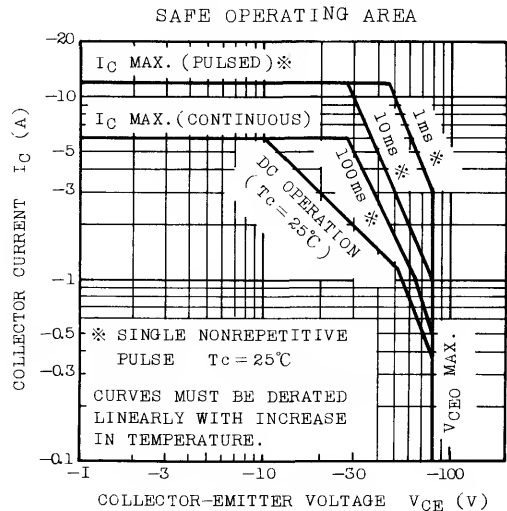
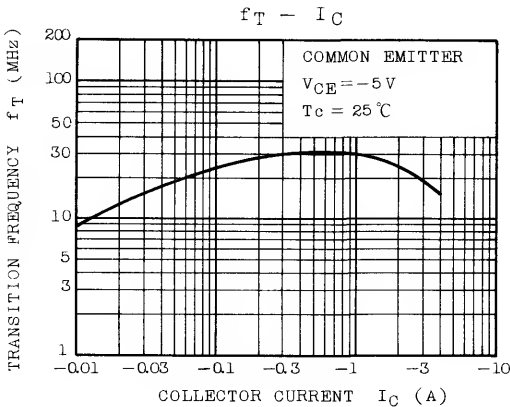
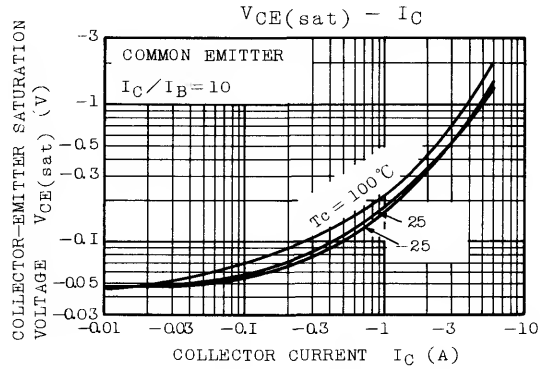
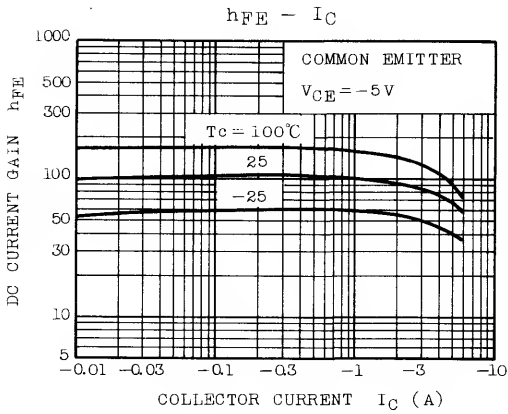
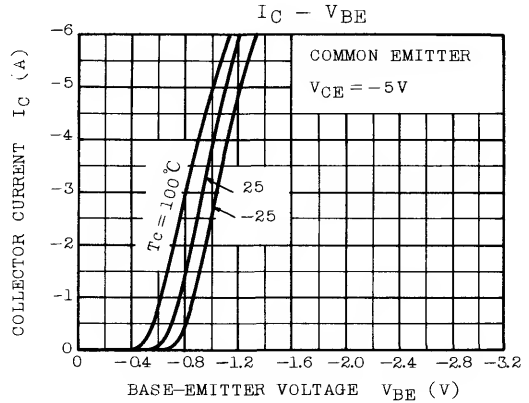
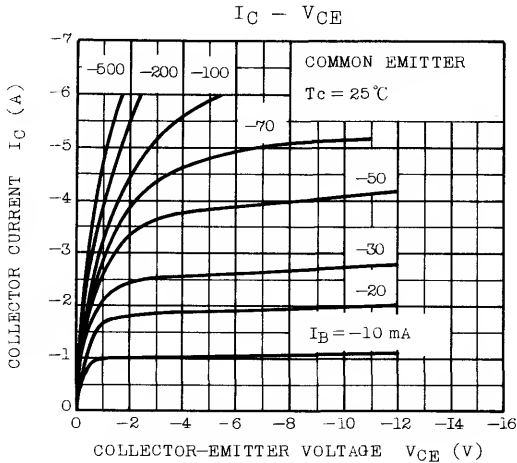
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	-80	V
Collector-Emitter Voltage	V _{CEO}	-80	V
Emitter-Base Voltage	V _{EBO}	-5	V
Collector Current	I _C	-6	A
Base Current	I _B	-0.6	A
Collector Power Dissipation (Tc=25°C)	P _C	60	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55 ~ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CBO}	V _{CB} =80V, I _E =0	-	-	-5.0	μA
Emitter Cut-off Current	I _{EBO}	V _{EB} =-5V, I _C =0	-	-	-5.0	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CEO}	I _C =-50mA, I _B =0	-80	-	-	V
DC Current Gain	h _{FE} (1) (Note)	V _{CE} =-5V, I _C =-1A	55	-	160	-
	h _{FE} (2)	V _{CE} =-5V, I _C =-3A	35	80	-	-
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =-5A, I _B =-0.5A	-	-1.0	-2.0	V
Base-Emitter Voltage	V _{BE}	V _{CE} =-5V, I _C =-3A	-	-0.95	-1.5	V
Transition Frequency	f _T	V _{CE} =-5V, I _C =-1A	-	30	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =-10V, I _E =0, f=1MHz	-	290	-	pF

Note : h_{FE}(1) Classification R : 55 ~ 110 O : 80 ~ 160

2SA1263

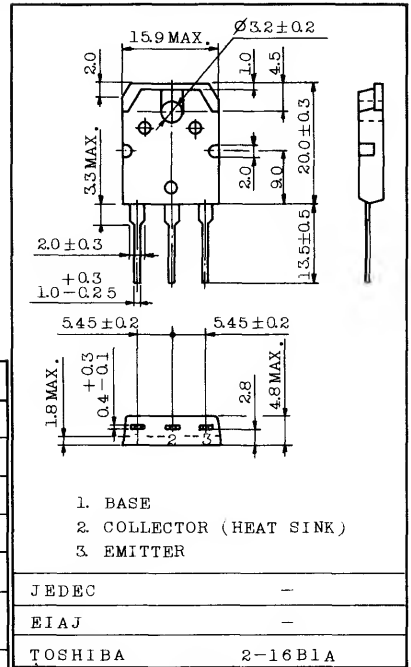


POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Complementary to 2SC3181
- . Recommend for 55W High Fidelity Audio Frequency Amplifier Output Stage.

Unit in mm



MAXIMUM RATINGS ($T_a=25^{\circ}\text{C}$)

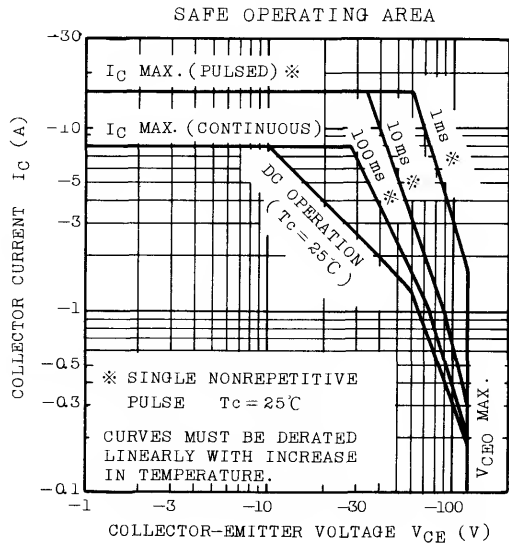
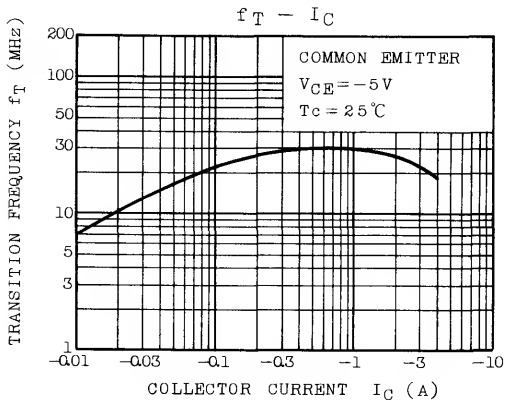
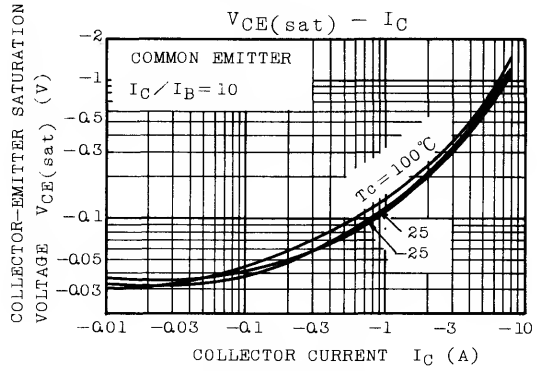
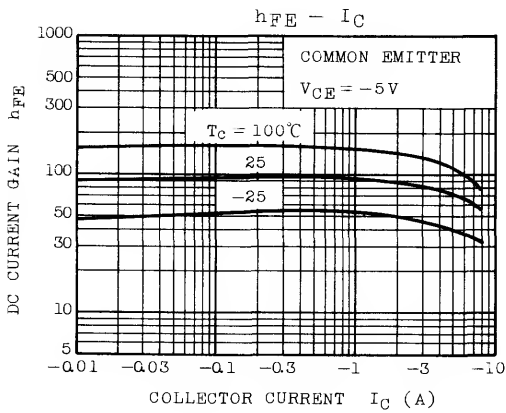
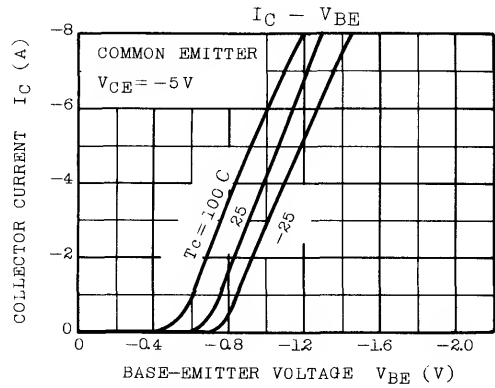
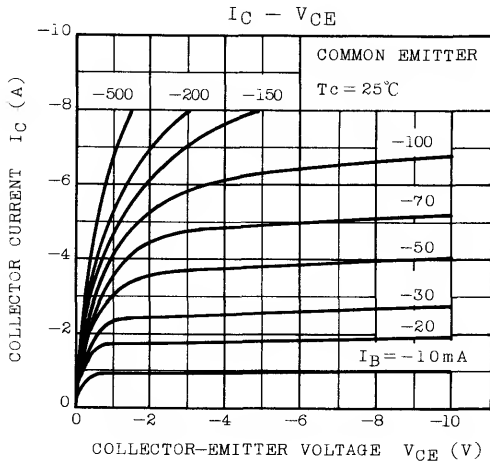
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-120	V
Collector-Emitter Voltage	V_{CEO}	-120	V
Emitter-Base Voltage	V_{EB0}	-5	V
Collector Current	I_C	-8	A
Base Current	I_B	-0.8	A
Collector Power Dissipation ($T_c=25^{\circ}\text{C}$)	P_C	80	W
Junction Temperature	T_j	150	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^{\circ}\text{C}$

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=-120\text{V}, I_E=0$	-	-	-5.0	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=-5\text{V}, I_C=0$	-	-	-5.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=-50\text{mA}, I_B=0$	-120	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=-5\text{V}, I_C=-1\text{A}$	55	-	160	
		$V_{CE}=-5\text{V}, I_C=-4\text{A}$	35	75	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-6\text{A}, I_B=-0.6\text{A}$	-	-0.80	-2.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-5\text{V}, I_C=-4\text{A}$	-	-0.97	-1.5	V
Transition Frequency	f_T	$V_{CE}=-5\text{V}, I_C=-1\text{A}$	-	30	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10\text{V}, I_E=0, f=1\text{MHz}$	-	420	-	pF

Note : $h_{FE(1)}$ Classification R : 55 ~ 110 O : 80 ~ 160

2SA1264

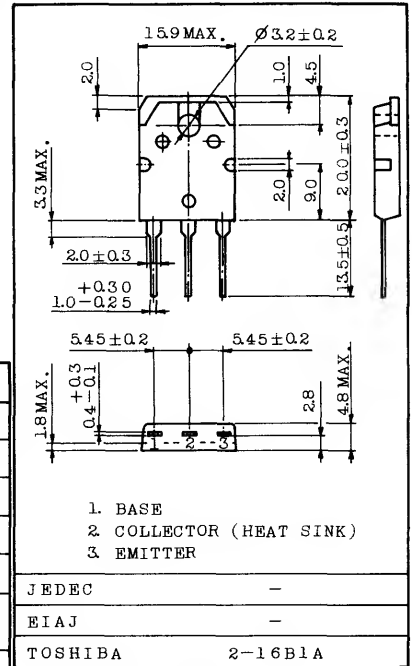


POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SC3182
- Recommend for 70W High Fidelity Audio Frequency Amplifier Output Stage

Unit in mm



Weight : 4.6g

MAXIMUM RATINGS (Ta=25°C)

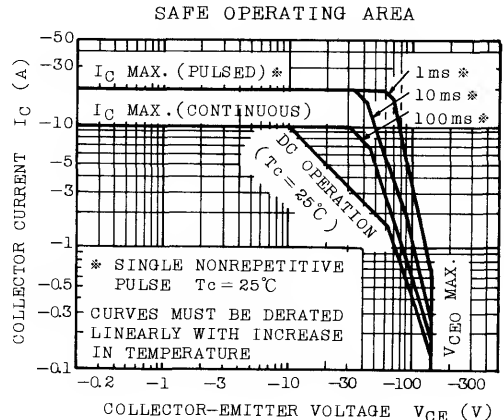
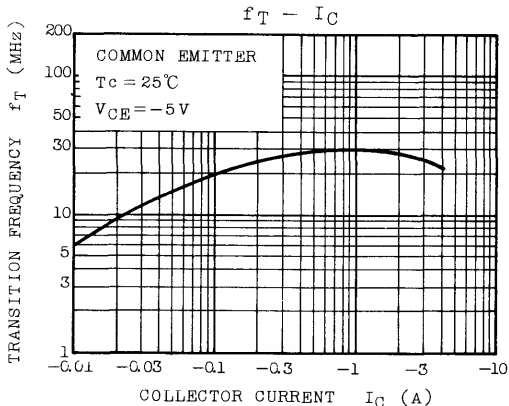
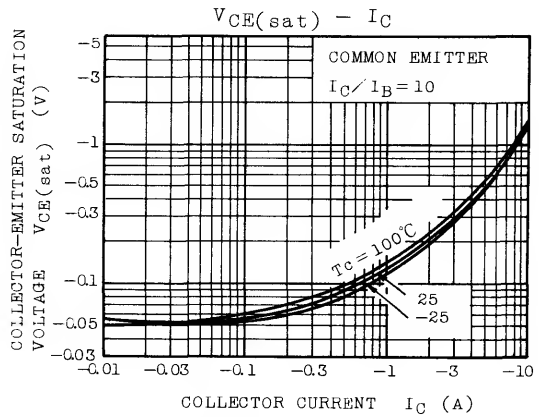
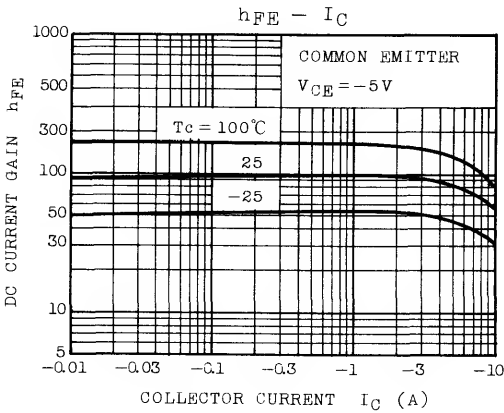
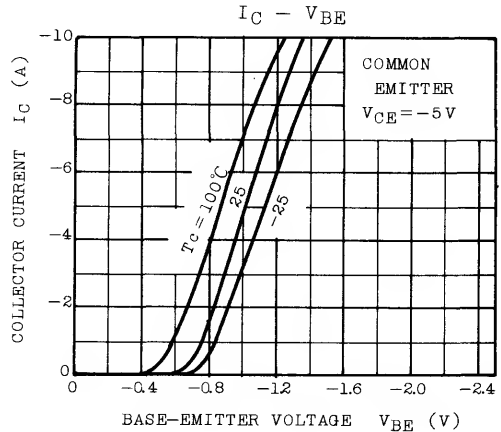
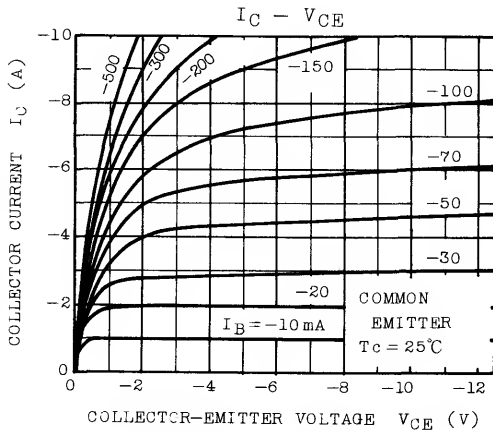
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	-140	V
Collector-Emitter Voltage	V _{CEO}	-140	V
Emitter-Base Voltage	V _{EB0}	-5	V
Collector Current	I _C	-10	A
Base Current	I _B	-1	A
Collector Power Dissipation (Tc=25°C)	P _C	100	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55 ~ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =-140V, I _E =0	-	-	-5.0	μA
Emitter Cut-off Current	I _{EB0}	V _{EB} =-5V, I _C =0	-	-	-5.0	μA
Collector-Emitter Breakdown Voltage	V(BR)CEO	I _C =-50mA, I _B =0	-140	-	-	V
DC Current Gain	h _{FE} (1) (Note)	V _{CE} =-5V, I _C =-1A	55	-	160	
	h _{FE} (2)	V _{CE} =-5V, I _C =-5A	35	83	-	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =-7A, I _B =-0.7A	-	-0.8	-2.0	V
Base-Emitter Voltage	V _{BE}	V _{CE} =-5V, I _C =-5A	-	-1.0	-1.5	V
Transition Frequency	f _T	V _{CE} =-5V, I _C =-1A	-	30	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =-10V, I _E =0, f=1MHz	-	480	-	pF

Note : h_{FE}(1) Classification R : 55 ~ 110, O : 80 ~ 160

2SA1265



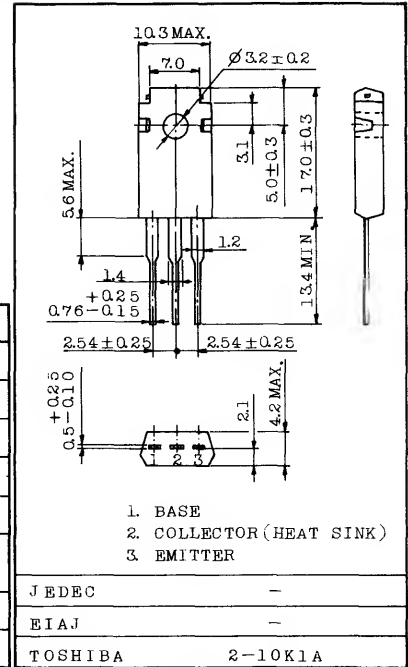
HIGH CURRENT SWITCHING APPLICATIONS.

INDUSTRIAL APPLICATIONS

Unit in mm

FEATURES:

- . Low Collector Saturation Voltage
: $V_{CE(sat)} = -0.4V(\text{Max.})$ (at $I_C = -3A$)
- . High Speed Switching Time : $t_{stg} = 1.0\mu s(\text{Typ.})$
- . Complementary to 2SC3239



MAXIMUM RATINGS ($T_a = 25^\circ C$)

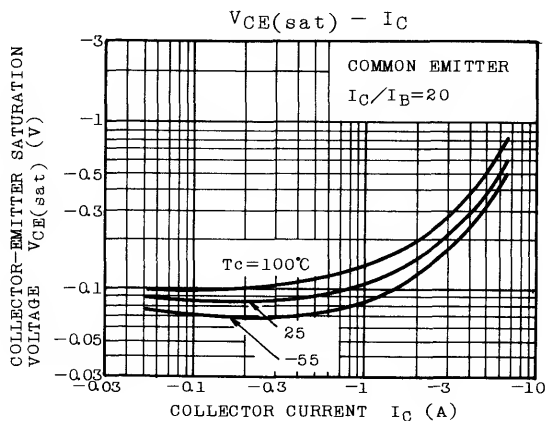
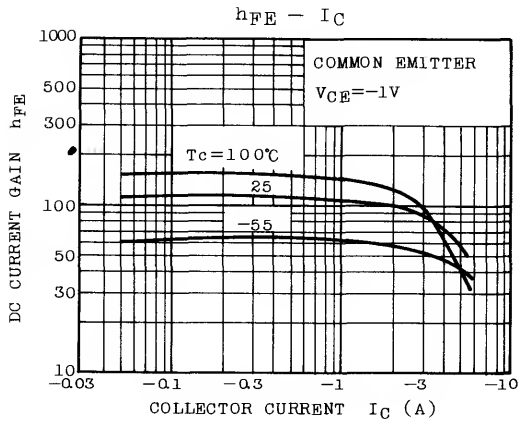
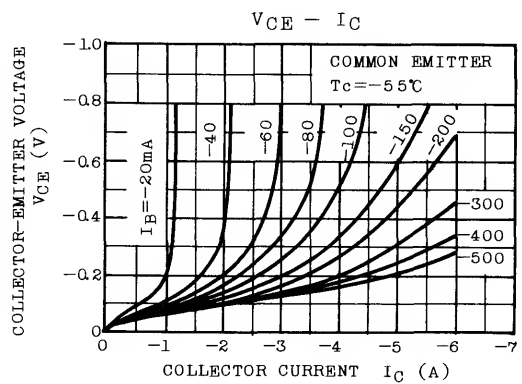
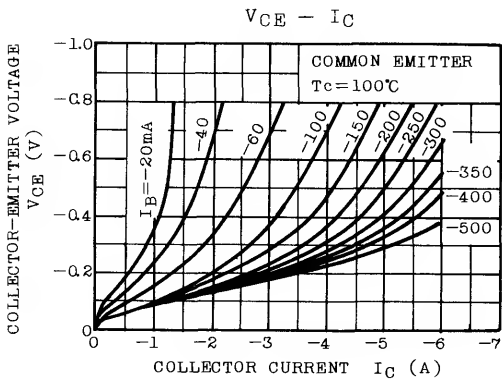
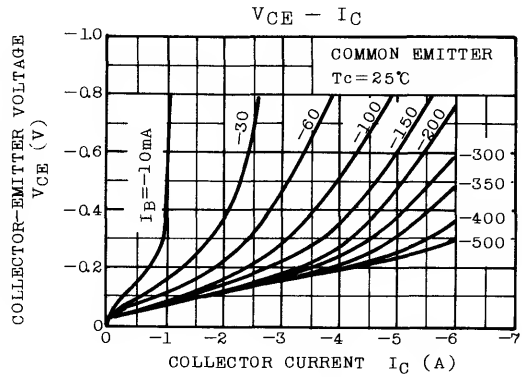
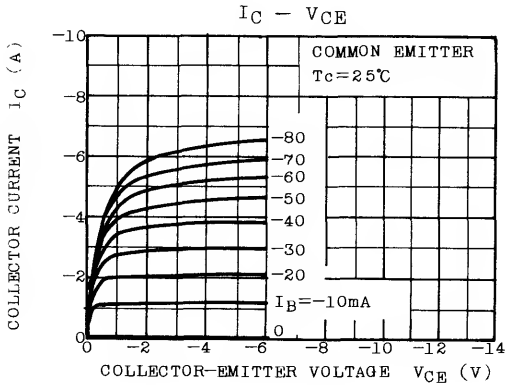
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-60	V
Collector-Emitter Voltage	V_{CE0}	-50	V
Emitter-Base Voltage	V_{EB0}	-5	V
Collector Current	I_C	-5	A
Base Current	I_B	-1	A
Collector Power Dissipation ($T_c = 25^\circ C$)	P_C	25	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$

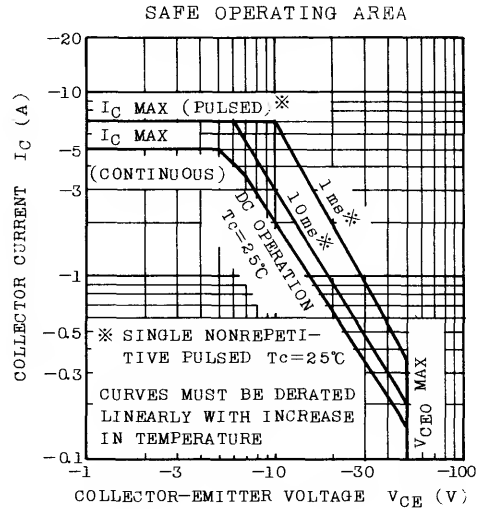
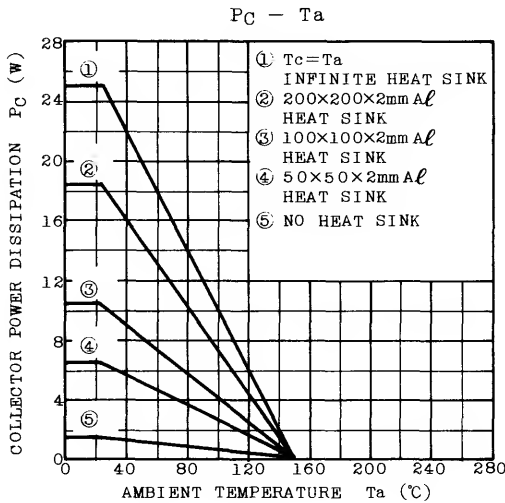
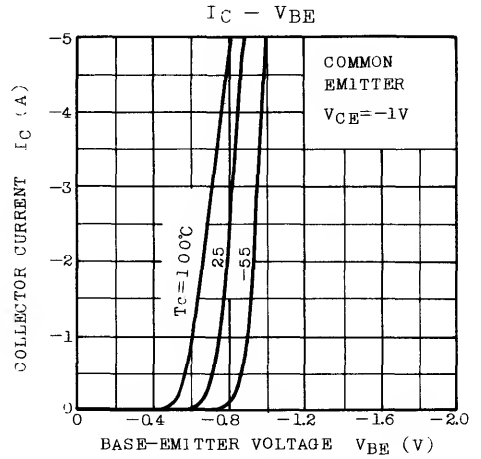
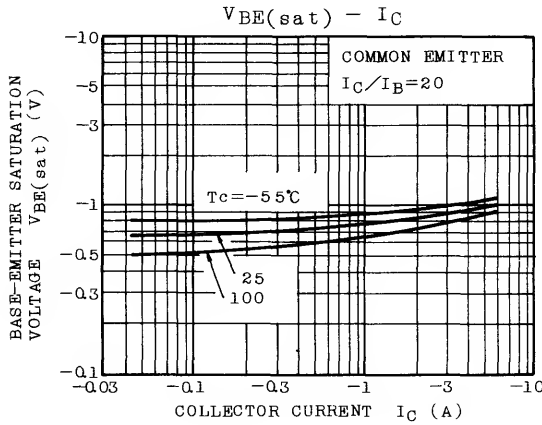
ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

Weight : 2.0g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CB0}	$V_{CB} = -50V, I_E = 0$	-	-	-1	μA
Emitter Cut-off Current		I_{EB0}	$V_{EB} = -5V, I_C = 0$	-	-	-1	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C = -10mA, I_B = 0$	-50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE} = -1V, I_C = -1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE} = -1V, I_C = -3A$	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C = -3A, I_B = -0.15A$	-	-0.2	-0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C = -3A, I_B = -0.15A$	-	-0.9	-1.2	
Transition Frequency		f_T	$V_{CE} = -4V, I_C = -1A$	-	60	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	170	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.1	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

Note : $h_{FE(1)}$ Classification 0 : 70~140, Y : 120~240





2SA1293

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

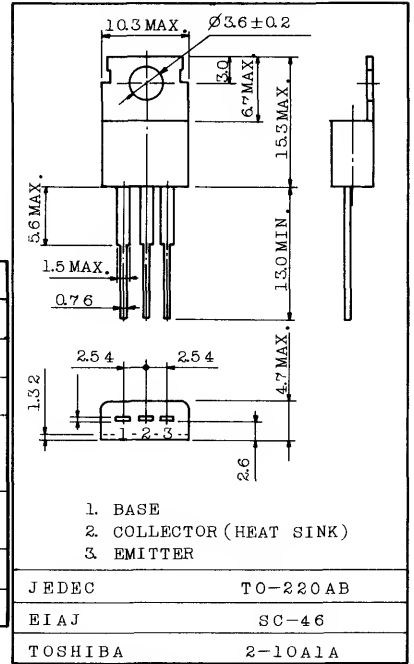
- Low Collector Saturation Voltage
: $V_{CE(sat)} = -0.4V(\text{Max.})$ at $I_C = -3A$
- High Speed Switching Time : $t_{stg} = 1.0\mu s(\text{Typ.})$
- Complementary to 2SC3258.

MAXIMUM RATINGS ($T_a = 25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB0}	-100	V
Collector-Emitter Voltage		V_{CE0}	-80	V
Emitter-Base Voltage		V_{EB0}	-7	V
Collector Current	DC	I_C	-5	A
	Pulse	I_{CP}	-8	
Collector Power Dissipation ($T_c = 25^\circ C$)		P_C	30	W
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$

INDUSTRIAL APPLICATIONS

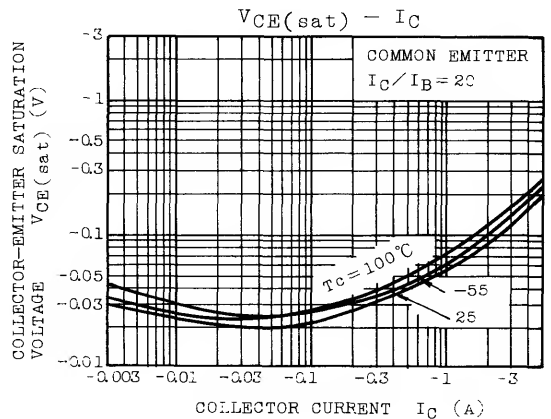
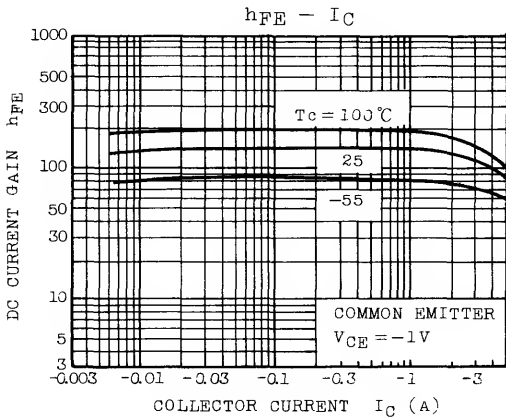
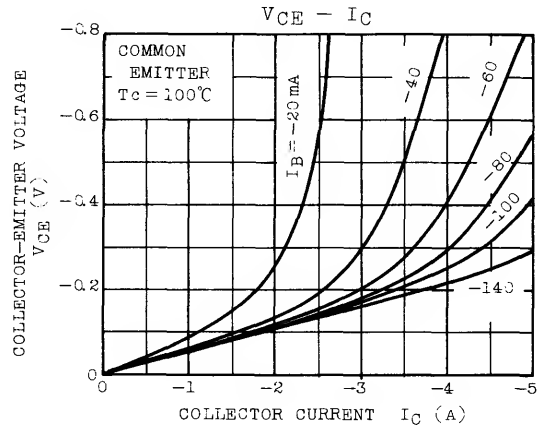
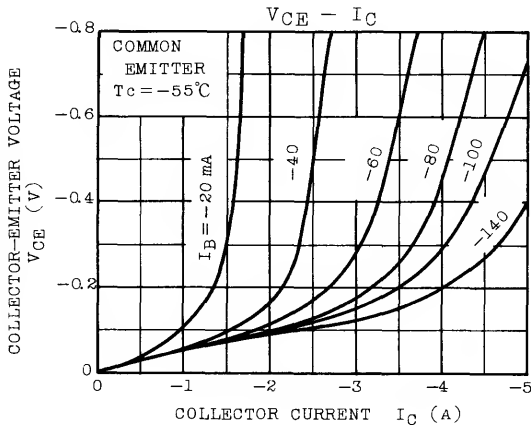
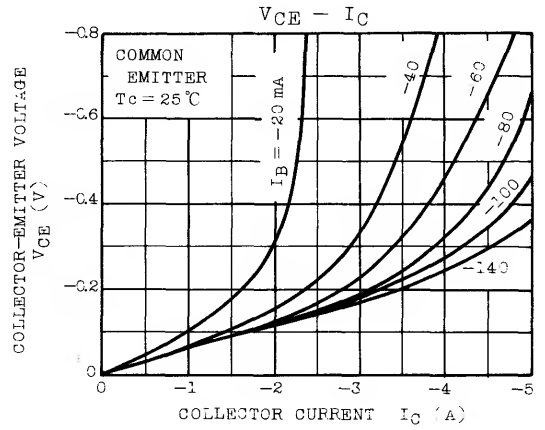
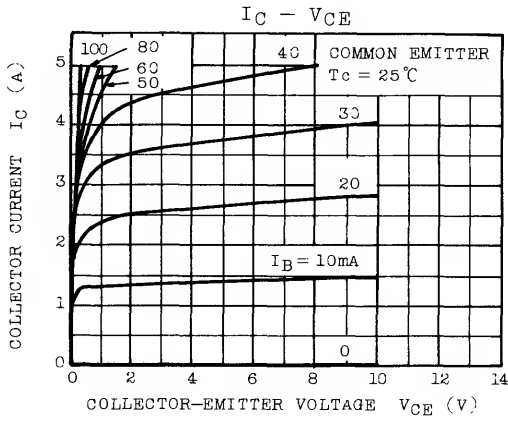
Unit in mm



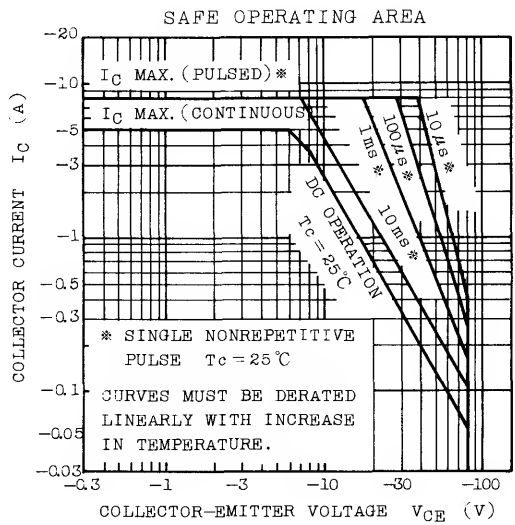
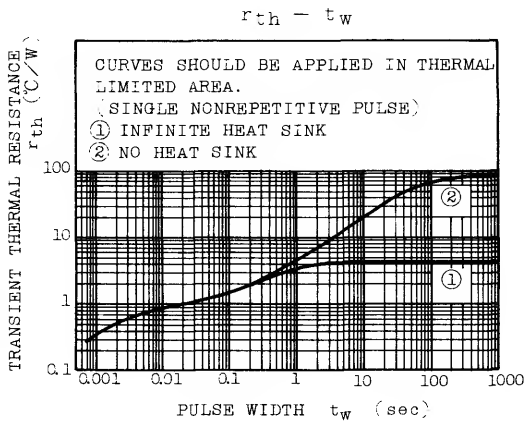
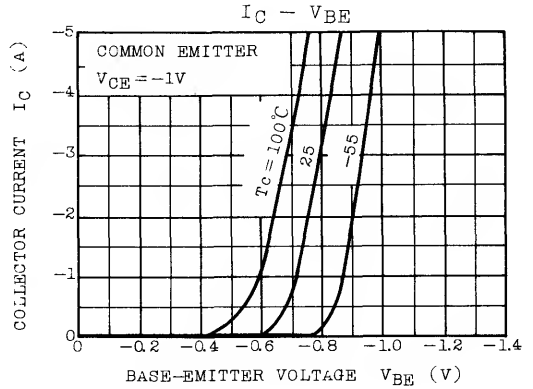
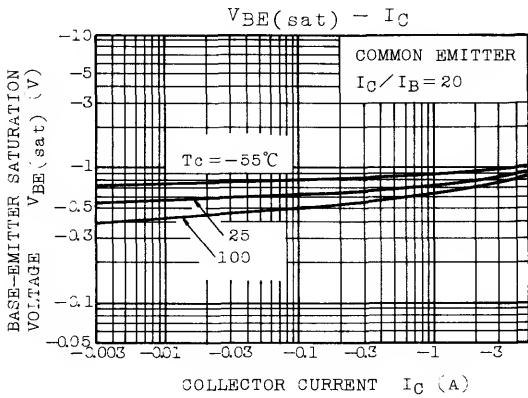
ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CB0}	$V_{CB} = -100V, I_E = 0$	-	-	-1	μA
Emitter Cut-off Current		I_{EB0}	$V_{EB} = -7V, I_C = 0$	-	-	-1	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CE0}$	$I_C = -10mA, I_B = 0$	-80	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE} = -1V, I_C = -1A$	70	-	240		
	$h_{FE(2)}$	$V_{CE} = -1V, I_C = -3A$	40	-	-		
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C = -3A, I_B = -0.15A$	-	-0.2	-0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C = -3A, I_B = -0.15A$	-	-0.9	-1.2	
Transition Frequency		f_T	$V_{CE} = -4V, I_C = -1A$	-	60	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	200	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.2	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

Note : $h_{FE(1)}$ Classification 0 : 70 ~ 140, Y : 120 ~ 240



2SA1293



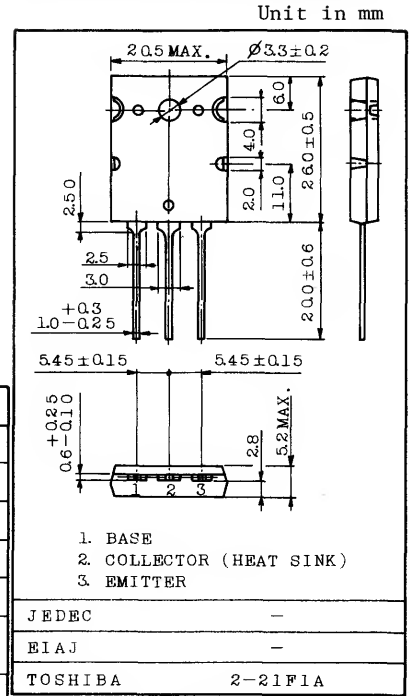
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Complementary to 2SC3280
- . Recommend for 80W High Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	-160	V
Collector-Emitter Voltage	V _{CEO}	-160	V
Emitter-Base Voltage	V _{EB0}	-5	V
Collector Current	I _C	-12	A
Base Current	I _B	-1.2	A
Collector Power Dissipation (Tc=25°C)	P _C	120	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55 ~ 150	°C



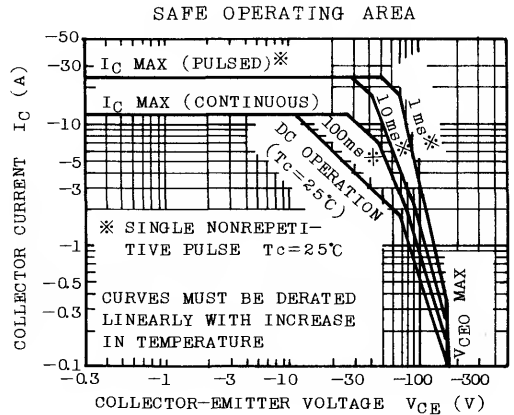
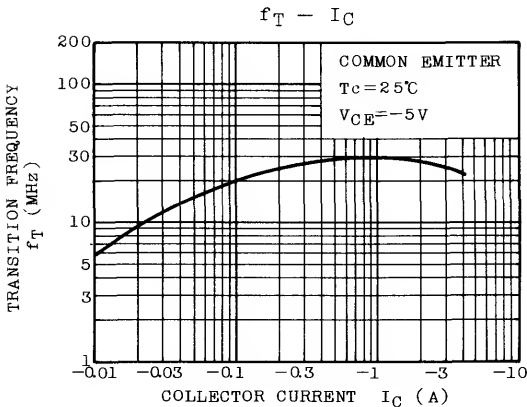
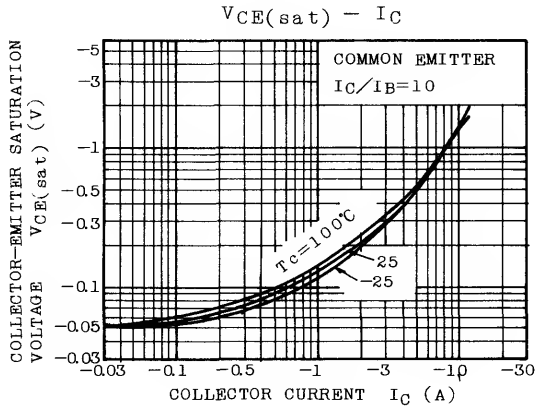
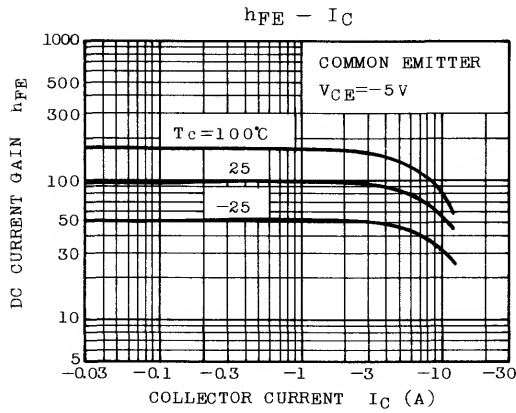
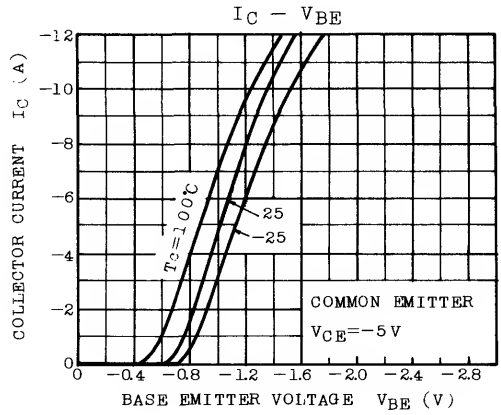
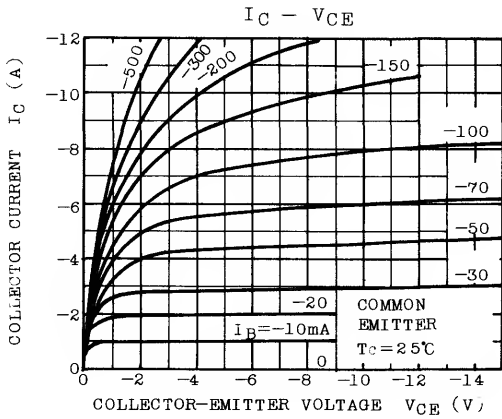
Weight : 9.75g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =-160V, I _E =0	-	-	-5.0	μA
Emitter Cut-off Current	I _{EB0}	V _{EB} =-5V, I _C =0	-	-	-5.0	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CEO}	I _C =-50mA, I _B =0	-160	-	-	V
DC Current Gain	h _{FE(1)} (Note)	V _{CE} =-5V, I _C =-1A	55	-	160	
	h _{FE(2)}	V _{CE} =-5V, I _C =-6A	35	80	-	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =-8A, I _B =-0.8A	-	-0.9	-2.5	V
Base-Emitter Voltage	V _{BE}	V _{CE} =-5V, I _C =-6A	-	-1.0	-1.5	V
Transition Frequency	f _T	V _{CE} =-5V, I _C =-1A	-	30	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =-10V, I _E =0, f=1MHz	-	480	-	pF

Note : h_{FE(1)} Classification R : 55 ~ 110 O : 80 ~ 160

2SA1301



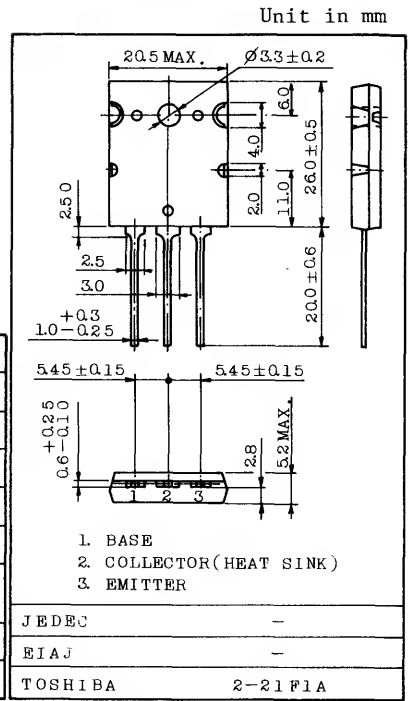
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SC3281
- Recommend for 100W High Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	-200	V
Collector-Emitter Voltage	V _{CE0}	-200	V
Emitter-Base Voltage	V _{EB0}	-5	V
Collector Current	I _C	-15	A
Base Current	I _B	-1.5	A
Collector Power Dissipation (Tc=25°C)	P _C	150	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55 ~ 150	°C



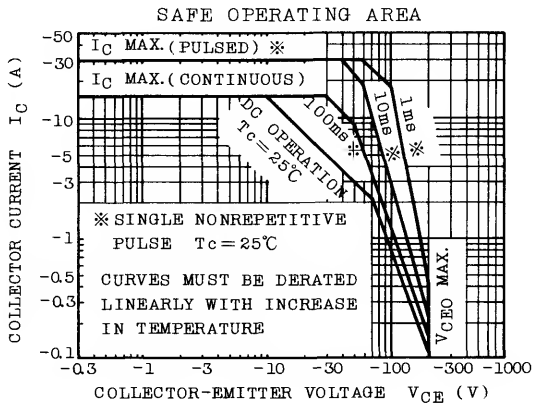
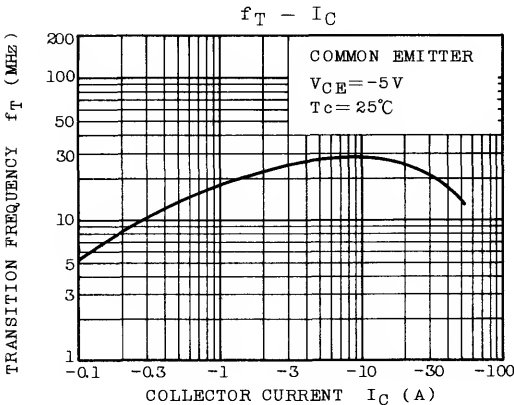
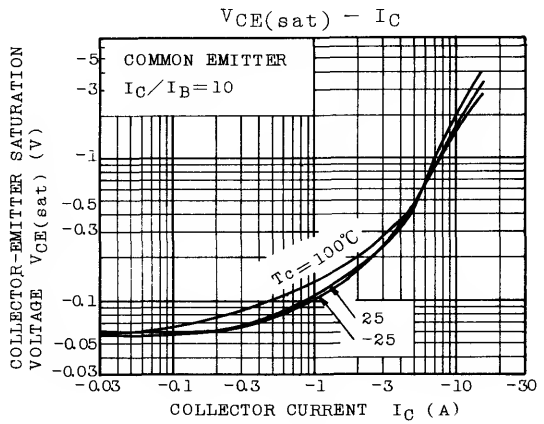
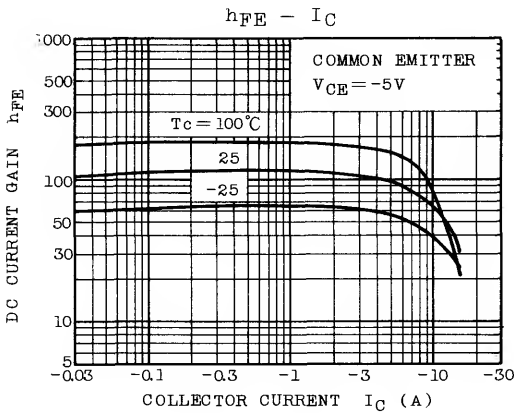
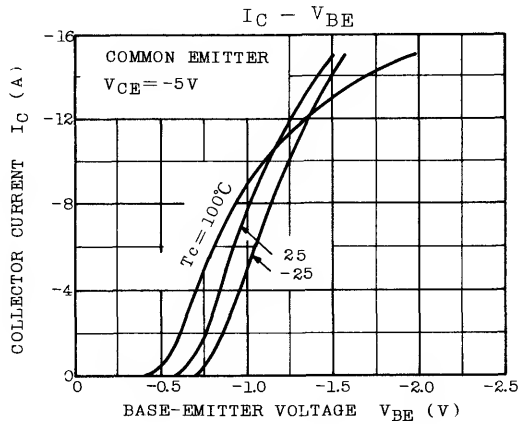
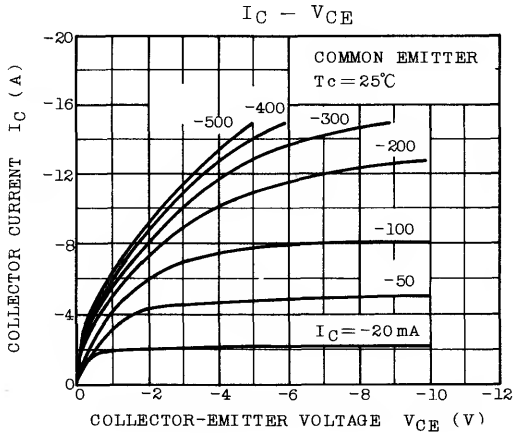
Weight : 9.75g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =-200V, I _E =0	-	-	-5.0	μA
Emitter Cut-off Current	I _{EB0}	V _{EB} =-5V, I _C =0	-	-	-5.0	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CEO}	I _C =-50mA, I _B =0	-200	-	-	V
DC Current Gain	h _{FE} (1) (Note)	V _{CE} =-5V, I _C =-1A	55	-	160	
	h _{FE} (2)	V _{CE} =-5V, I _C =-8A	35	60	-	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =-10A, I _B =-1A	-	-1.5	-3.0	V
Base-Emitter Voltage	V _{BE}	V _{CE} =-5V, I _C =-8A	-	-1.0	-1.5	V
Transition Frequency	f _T	V _{CE} =-5V, I _C =-1A	-	25	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =-10V, I _E =0, f=1MHz	-	470	-	pF

Note : h_{FE}(1) Classification R : 55 ~ 110, 0 : 80 ~ 160

2SA1302



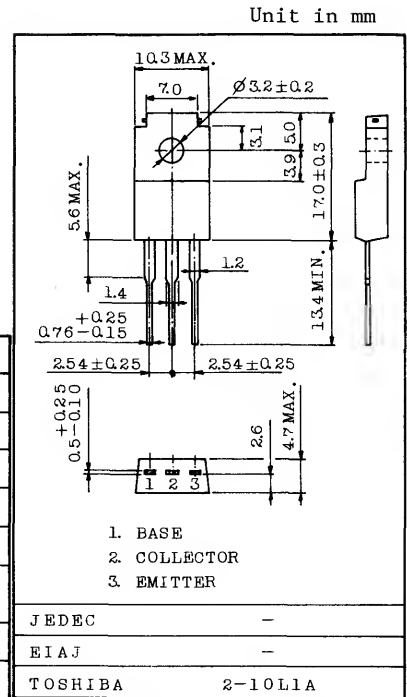
POWER AMPLIFIER APPLICATIONS.
CAR RADIO AND CAR STEREO OUTPUT STAGE APPLICATIONS.

FEATURES:

- Good Linearity of h_{FE}
- Complementary to 2SC3297

MAXIMUM RATINGS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-30	V
Collector-Emitter Voltage	V_{CEO}	-30	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-3	A
Base Current	I_B	-0.3	A
Collector Power Dissipation ($T_c=25^{\circ}\text{C}$)	P_C	15	W
Junction Temperature	T_j	150	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^{\circ}\text{C}$



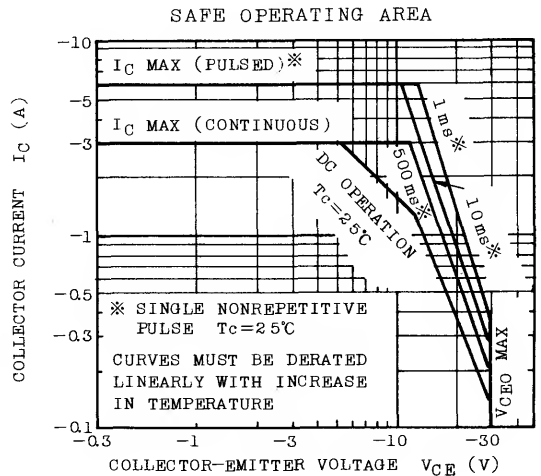
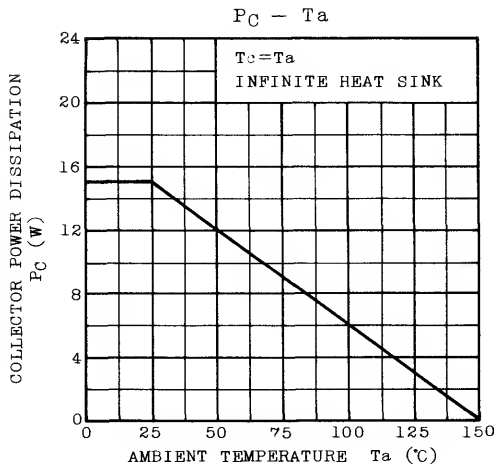
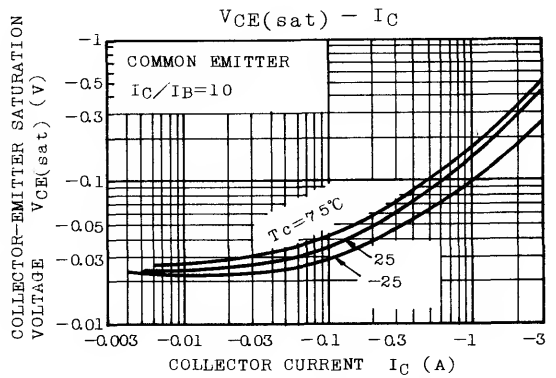
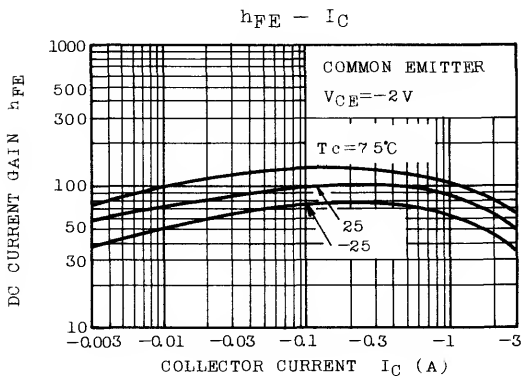
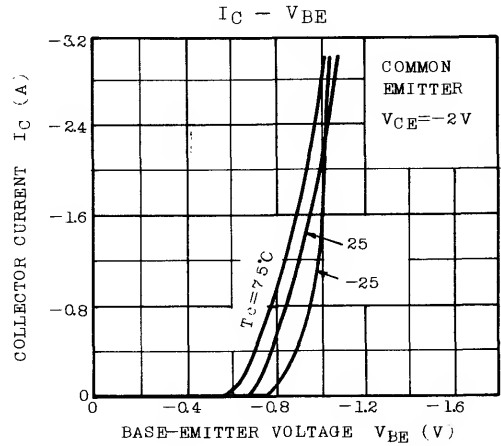
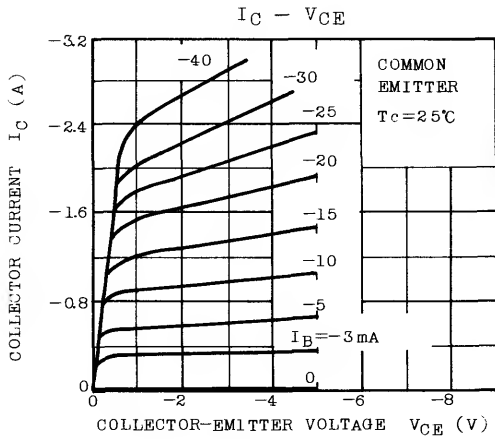
Weight : 2.1g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=-20\text{V}$, $I_E=0$	-	-	-1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=-5\text{V}$, $I_C=0$	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=-10\text{mA}$, $I_B=0$	-30	-	-	V
DC Current Gain	h_{FE} (Note)	$V_{CE}=-2\text{V}$, $I_C=-0.5\text{A}$	70	-	240	
	$h_{FE}(2)$	$V_{CE}=-2\text{V}$, $I_C=-2.5\text{A}$	25	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-2\text{A}$, $I_B=-0.2\text{A}$	-	-0.3	-0.8	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-2\text{V}$, $I_C=-0.5\text{A}$	-	-0.75	-1.0	V
Transition Frequency	f_T	$V_{CE}=-2\text{V}$, $I_C=-0.5\text{A}$	-	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10\text{V}$, $I_E=0$, $f=1\text{MHz}$	-	40	-	pF

Note : $h_{FE}(1)$ Classification O : 70 ~ 140, Y : 120 ~ 240

2SA1305



2SA1306 2SA1306A 2SA1306B

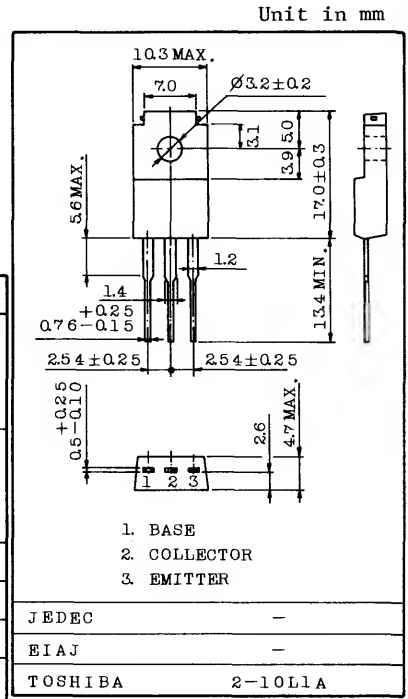
POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- High Transition Frequency : $f_T=100\text{MHz}$ (Typ.)
- Complementary to 2SC3298, 2SC3298A, 2SC3298B

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	2SA1306	-160	V
	2SA1306A	-180	
	2SA1306B	-200	
Collector-Emitter Voltage	2SA1306	-160	V
	2SA1306A	-180	
	2SA1306B	-200	
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-1.5	A
Base Current	I_B	-0.15	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	20	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ\text{C}$



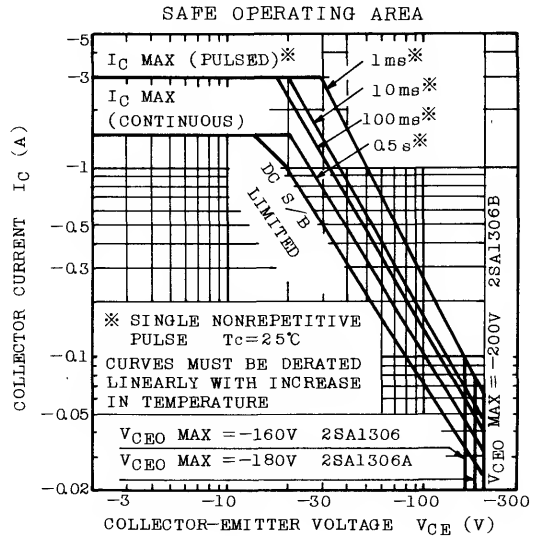
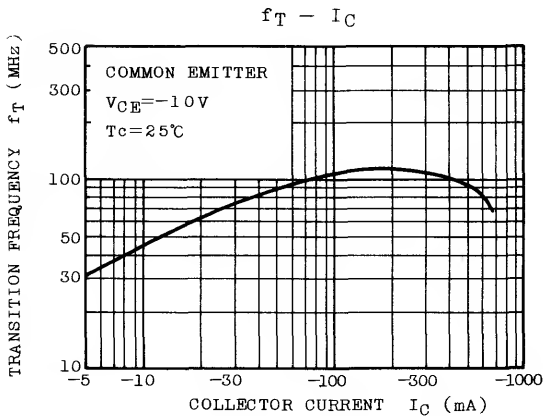
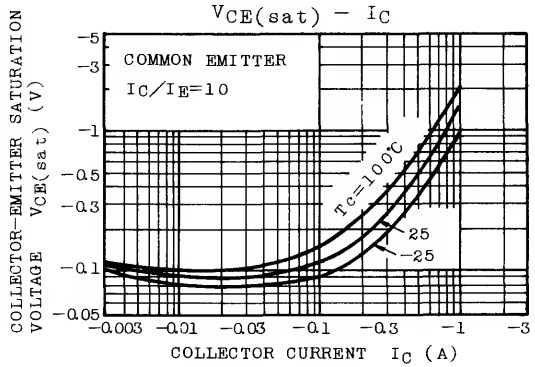
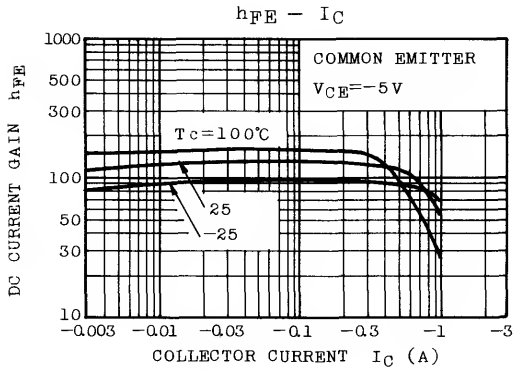
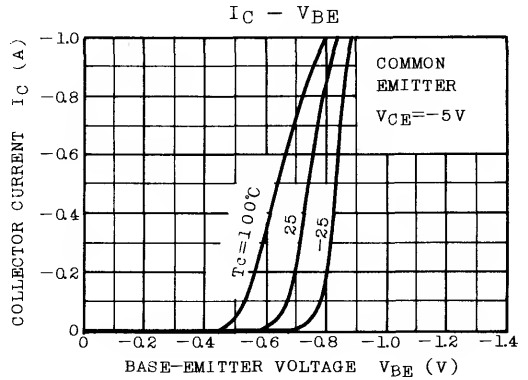
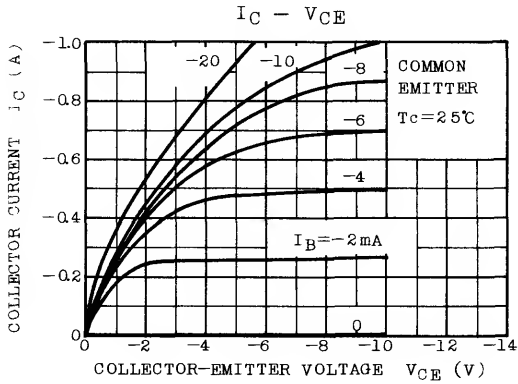
Weight : 2.1g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=-160\text{V}, I_E=0$	-	-	-1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=-5\text{V}, I_C=0$	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	2SA1306	$I_C=-10\text{mA}, I_B=0$	-160	-	-	V
	2SA1306A		-180	-	-	
	2SA1306B		-200	-	-	
DC Current Gain	h_{FE} (Note)	$V_{CE}=-5\text{V}, I_C=-100\text{mA}$	70	-	240	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-500\text{mA}, I_B=-50\text{mA}$	-	-	-1.5	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-5\text{V}, I_C=-500\text{mA}$	-	-	-1.0	V
Transition Frequency	f_T	$V_{CE}=-10\text{V}, I_C=-100\text{mA}$	-	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10\text{V}, I_C=0, f=1\text{MHz}$	-	30	-	pF

Note : h_{FE} Classification 0 : 70 ~ 140, Y : 120 ~ 240

2SA1306·2SA1306A·2SA1306B



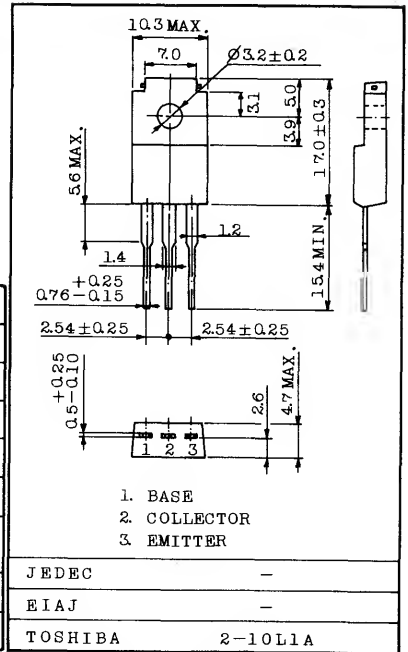
HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- Low Saturation Voltage
: $V_{CE(sat)} = -0.4V(\text{Max.})$ at $I_C = -3A$
- High Speed Switching Time : $t_{stg} = 1.0\mu s(\text{Typ.})$
- Complementary to 2SC3299

MAXIMUM RATINGS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-60	V
Collector-Emitter Voltage	V_{CE0}	-50	V
Emitter-Base Voltage	V_{EB0}	-5	V
Collector Current	I_C	-5	A
Base Current	I_B	-1	A
Collector Power	P_C	$T_a = 25^\circ C$	2.0
		$T_c = 25^\circ C$	20
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$



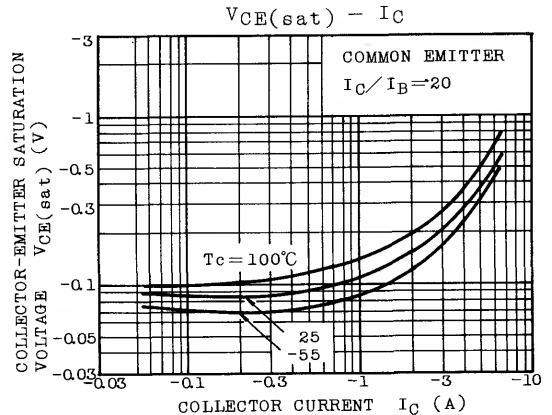
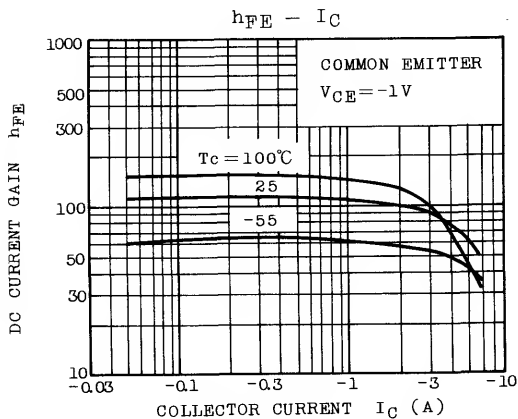
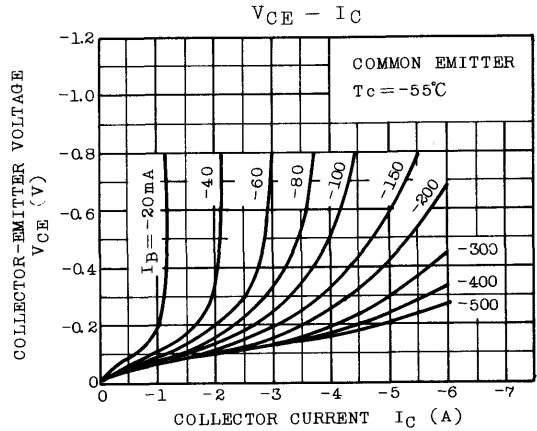
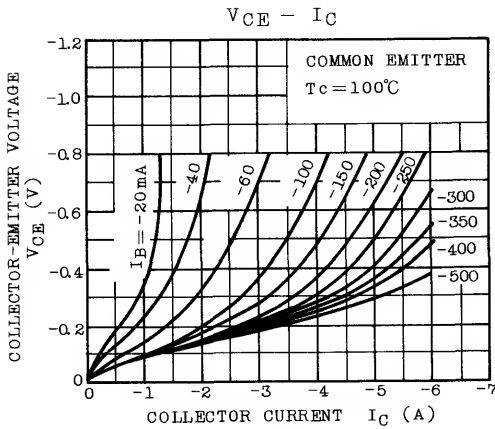
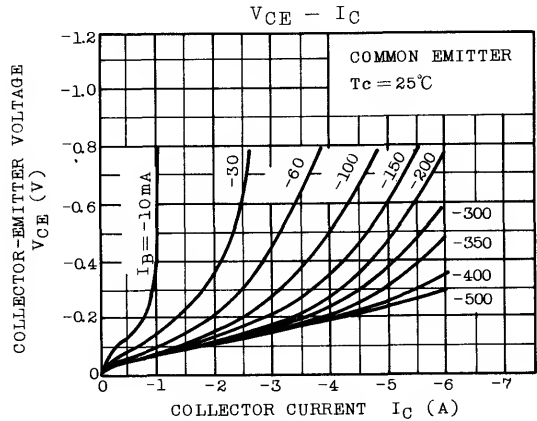
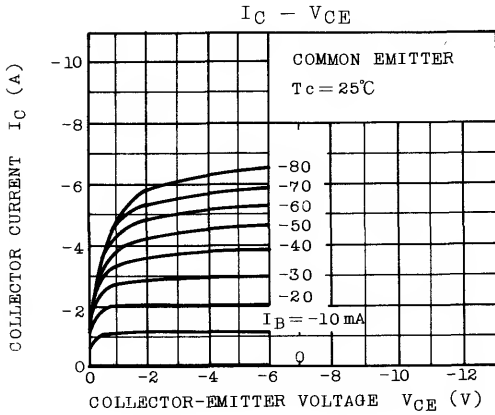
ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

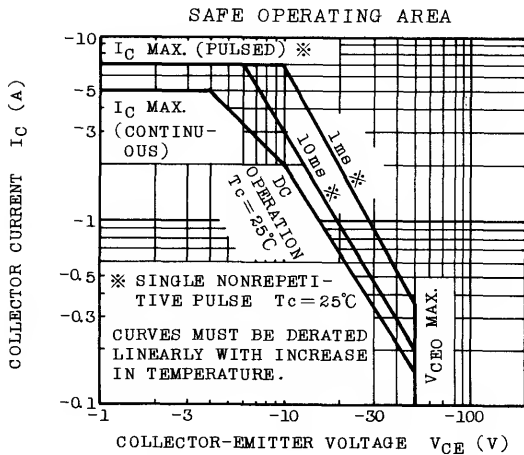
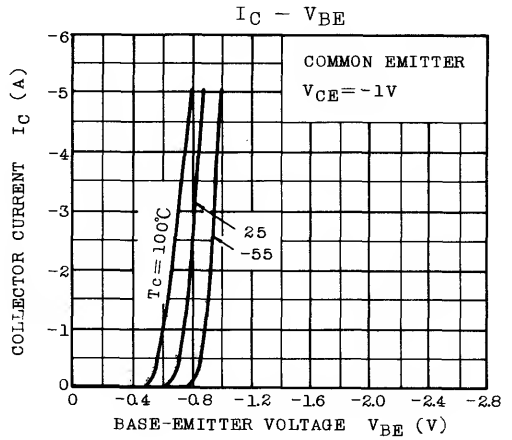
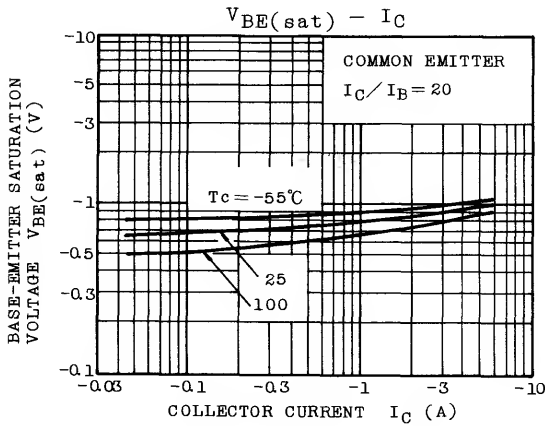
Weight : 2.1g

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Collector Cut-off Current	I_{CB0}	$V_{CB} = -50V, I_E = 0$	-	-	-1	μA	
Emitter Cut-off Current	I_{EB0}	$V_{EB} = -5V, I_C = 0$	-	-	-1	μA	
Collector-Emitter Breakdown Voltage	$V(BR)_{CE0}$	$I_C = -10mA, I_B = 0$	-50	-	-	V	
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE} = -1V, I_C = -1A$	70	-	240		
	$h_{FE(2)}$	$V_{CE} = -1V, I_C = -3A$	30	-	-		
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = -3A, I_B = -0.15A$	-	-0.2	-0.4	V	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C = -3A, I_B = -0.15A$	-	-0.9	-1.2	V	
Transition Frequency	f_T	$V_{CE} = -4V, I_C = -1A$	-	60	-	MHz	
Collector Output Capacitance	C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	170	-	pF	
Switching Time	Turn-on Time		-	0.1	-	μs	
	Storage Time		t_{stg}	-	1.0		-
	Fall Time		t_f	-	0.1		-

Note : $h_{FE(1)}$ Classification 0 : 70 ~ 140, Y : 120 ~ 240

2SA1307





2SA1308

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

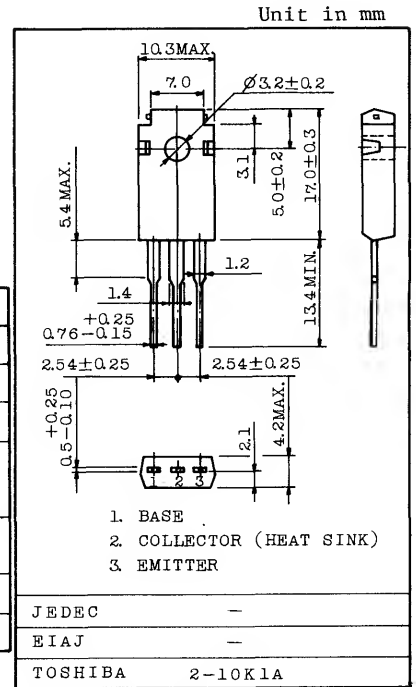
HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- . Low Collector Saturation Voltage
: $V_{CE(sat)} = -0.4V(\text{Max.})$ at $I_C = -3A$
- . High Speed Switching Time : $t_{stg} = 1.0\mu s(\text{Typ.})$
- . Complementary to 2SC3308.

MAXIMUM RATINGS (Ta=25°C)

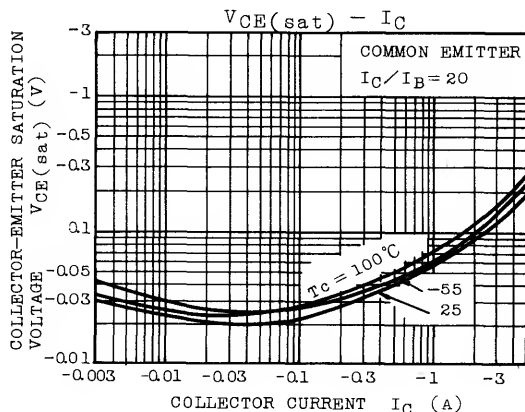
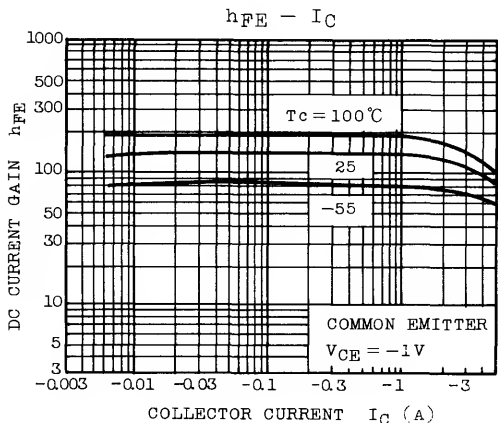
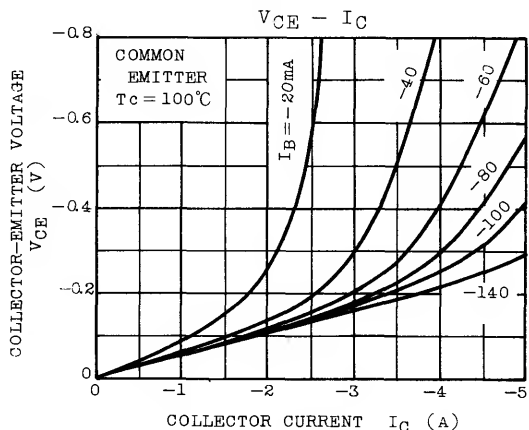
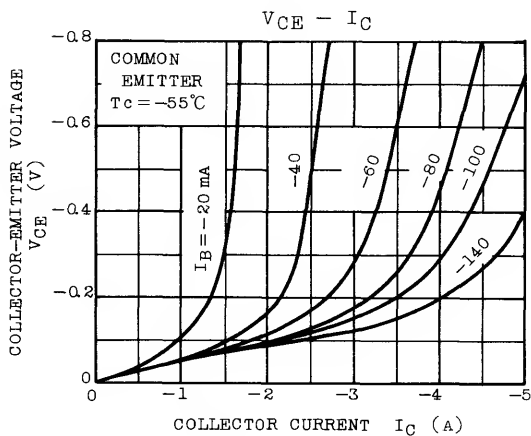
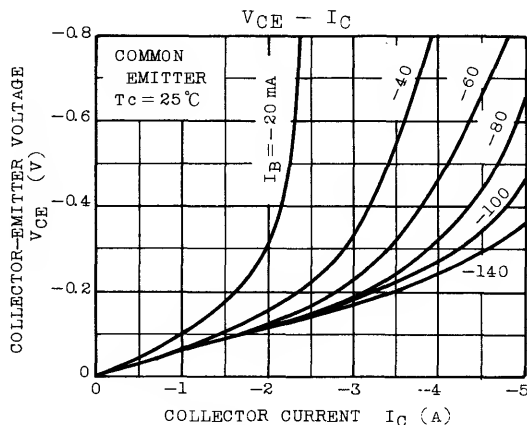
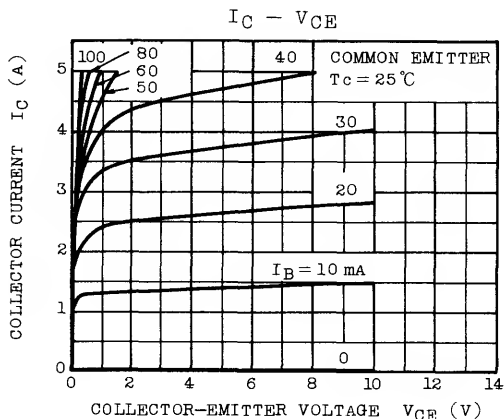
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-100	V
Collector-Emitter Voltage		V_{CEO}	-80	V
Emitter-Base Voltage		V_{EBO}	-7	V
Collector Current	DC	I_C	-5	A
	Pulse	I_{CP}	-8	
Collector Power Dissipation (Tc=25°C)		P_C	30	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

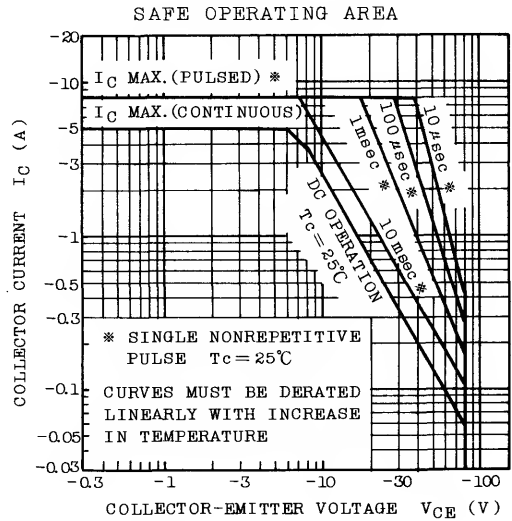
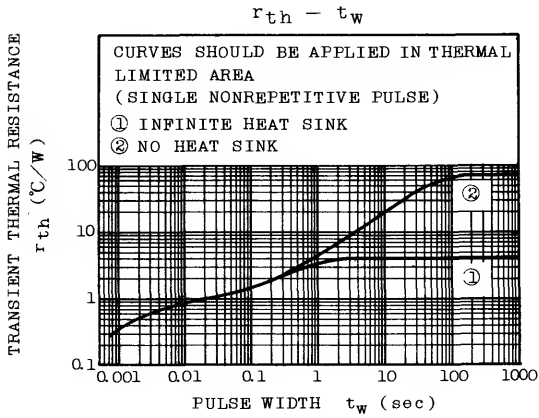
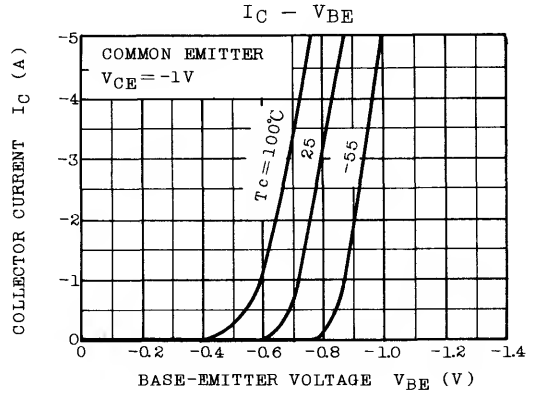
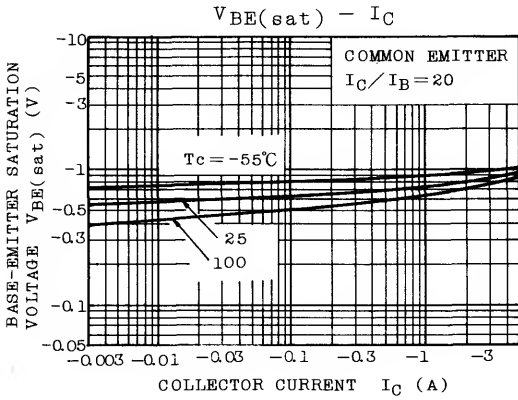


ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB} = -100V, I_E = 0$	-	-	-1	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB} = -7V, I_C = 0$	-	-	-1	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C = -10mA, I_B = 0$	-80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE} = -1V, I_C = -1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE} = -1V, I_C = -3A$	40	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C = -3A, I_B = -0.15A$	-	-0.2	-0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C = -3A, I_B = -0.15A$	-	-0.9	-1.2	
Transition Frequency		f_T	$V_{CE} = -4V, I_C = -1A$	-	60	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	200	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.2	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

Note : $h_{FE(1)}$ Classification 0 : 70 ~ 140, Y : 120 ~ 240





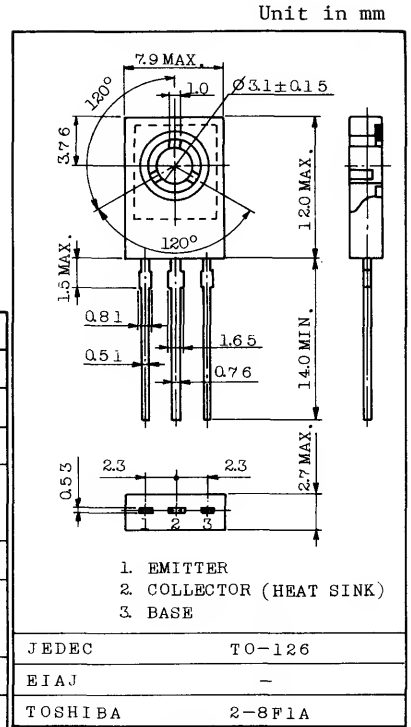
HIGH VOLTAGE SWITCHING APPLICATIONS.
 COLOR TV CHROMA OUTPUT APPLICATIONS.

FEATURES:

- . High Voltage : $V_{CE0} = -250V$
- . Low C_{re} : $2.2pF(Max.)$
- . Complementary to 2SC3335

MAXIMUM RATINGS ($T_a = 25^{\circ}C$)

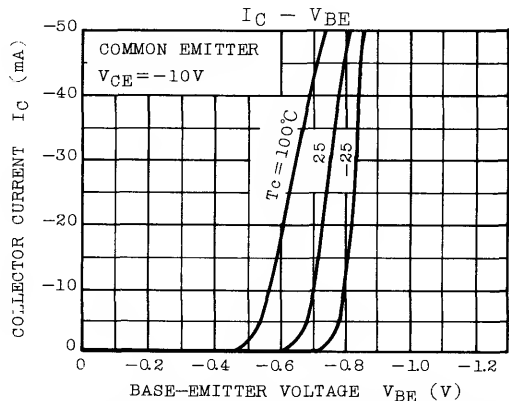
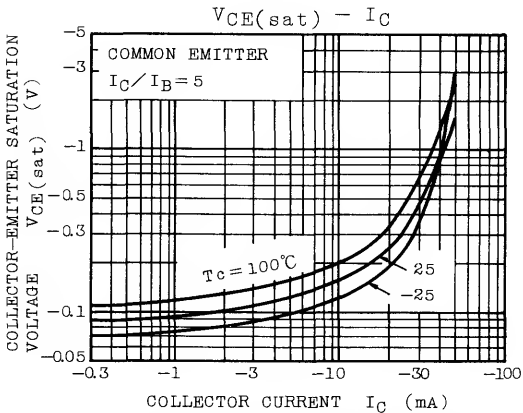
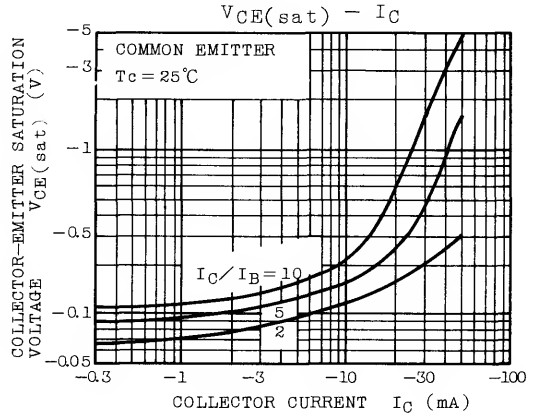
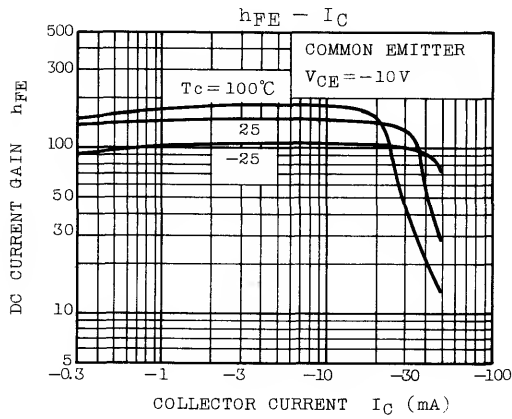
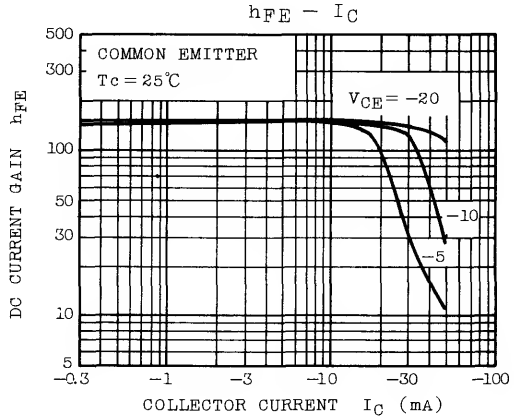
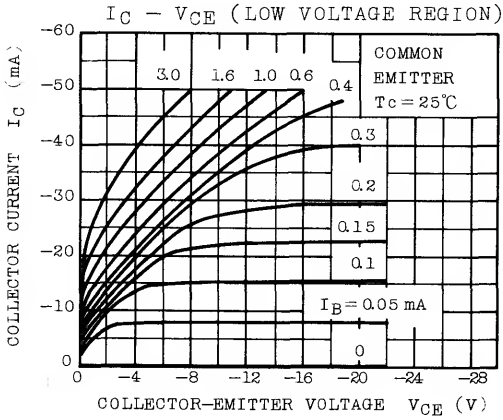
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB0}	-250	V
Collector-Emitter Voltage		V_{CE0}	-250	V
Emitter-Base Voltage		V_{EB0}	-5	V
Collector Current	DC	I_C	-50	mA
	Peak	I_{CP}	-100	
Base Current		I_B	-20	mA
Collector Power Dissipation	$T_a = 25^{\circ}C$	P_C	1.2	W
	$T_c = 25^{\circ}C$		5.0	
Junction Temperature		T_j	150	$^{\circ}C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^{\circ}C$

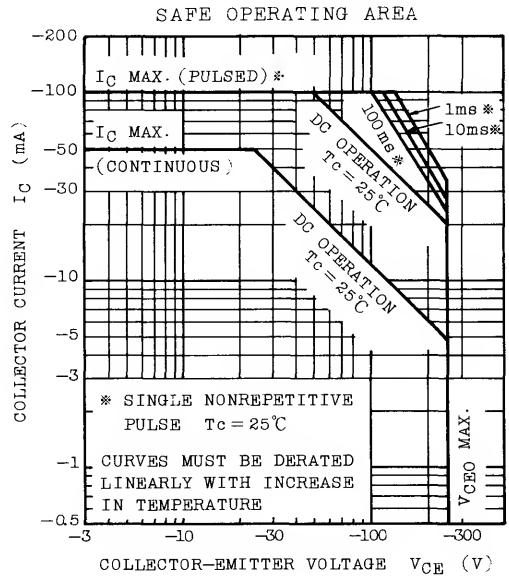
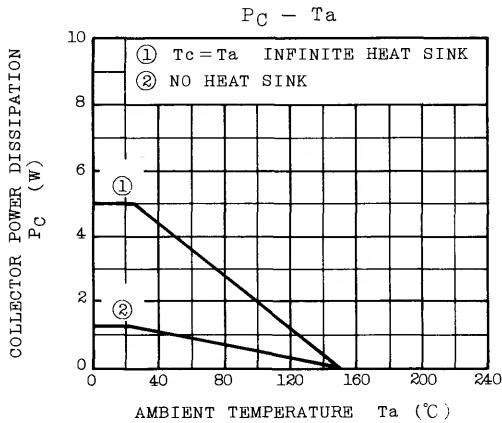
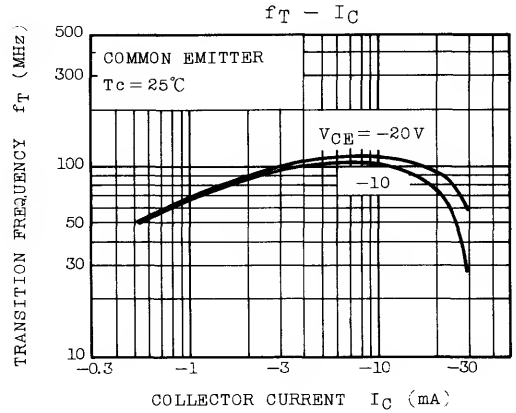
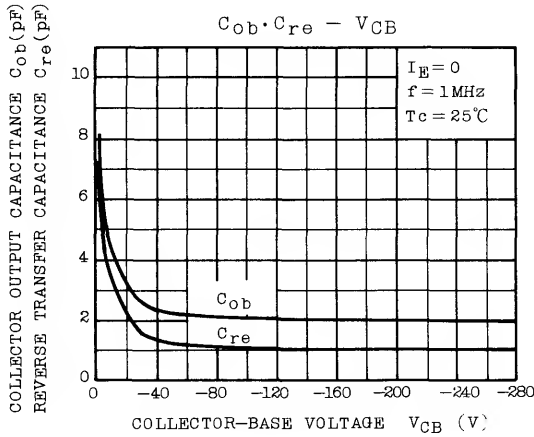


Weight : 0.72g
 Mounting Kit No. AC46C

ELECTRICAL CHARACTERISTICS ($T_a = 25^{\circ}C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB} = -200V, I_E = 0$	-	-	-1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB} = -5V, I_C = 0$	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C = -1mA, I_B = 0$	-250	-	-	V
DC Current Gain	h_{FE}	$V_{CE} = -20V, I_C = -25mA$	50	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = -10mA, I_B = -1mA$	-	-	-1.5	V
Base-Emitter Voltage	V_{BE}	$V_{CE} = -20V, I_C = -25mA$	-	-0.75	-	V
Transition Frequency	f_T	$V_{CE} = -10V, I_C = -10mA$	60	80	-	MHz
Reverse Transfer Capacitance	C_{re}	$V_{CB} = -30V, I_E = 0, f = 1MHz$	-	-	2.2	pF





2SA1327

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

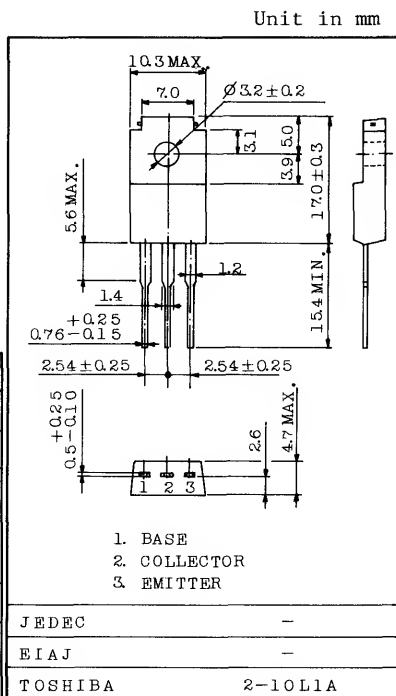
STROBO FLASH APPLICATIONS.
AUDIO POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . MIN. h_{FE} of 70 at -2V, -8A
- . -10A Rated Collector Current
- . MAX. $V_{CE(sat)}$ of -0.5V at -8A I_C
- . 20W at 25°C Case Temperature

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB0}	-50	V
Collector-Emitter Voltage		V_{CE0}	-20	V
Emitter-Base Voltage		V_{EB0}	-8	V
Collector Current	DC	I_C	-10	A
	Pulse	I_{CP}	-20	A
Base Current		I_B	-2	A
Collector Power Dissipation	Ta=25°C	P_C	2.0	W
	Tc=25°C		20	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

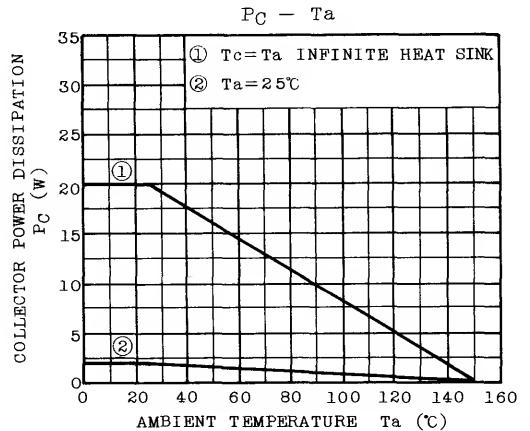
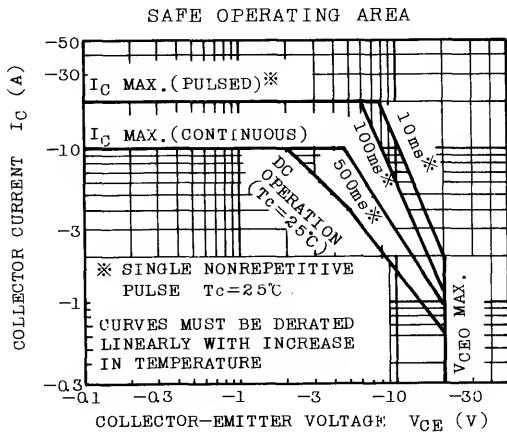
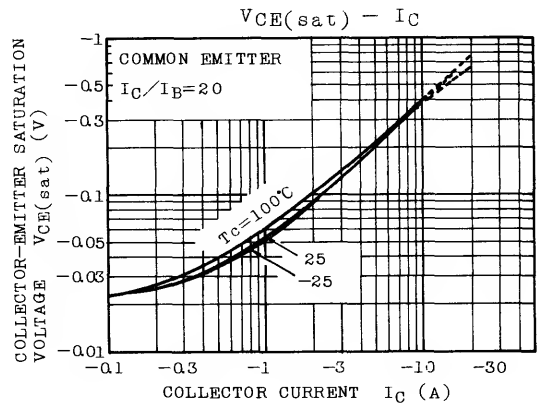
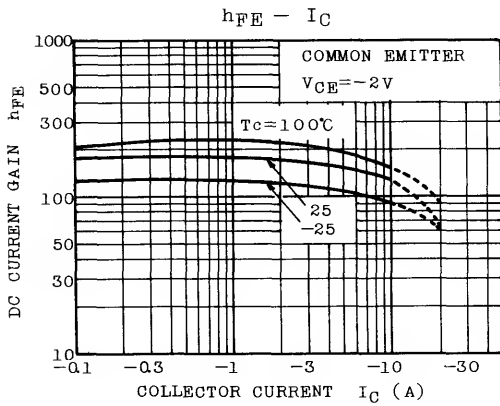
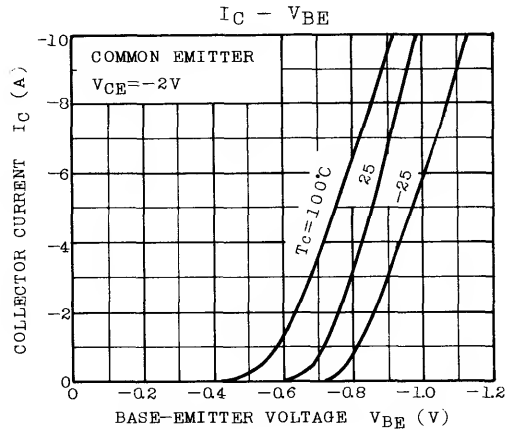
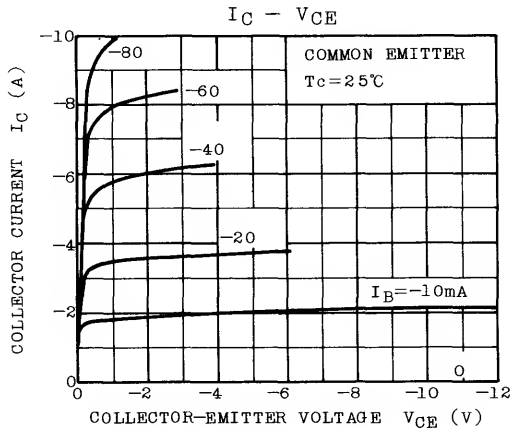


Weight : 2.1g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=-50V, I_E=0$	-	-	-1.0	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=-8V, I_C=0$	-	-	-1.0	μA
Collector-Emitter Brakdown Voltage	V_{CE0}	$I_C=-10mA, I_B=0$	-20	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=-2V, I_C=-1A$	100	-	320	
	$h_{FE(2)}$	$V_{CE}=-2V, I_C=-8A$	70	140	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-8A, I_B=-0.4A$	-	-0.3	-0.5	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-2V, I_C=-8A$	-	-0.95	-0.5	V
Transition Frequency	f_T	$V_{CE}=-2V, I_C=-1A$	-	45	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10V, I_E=0, f=1MHz$	-	400	-	pF

Note : $h_{FE(1)}$ Classification 0 : 100 ~ 200, Y : 160 ~ 320



2SA1328

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

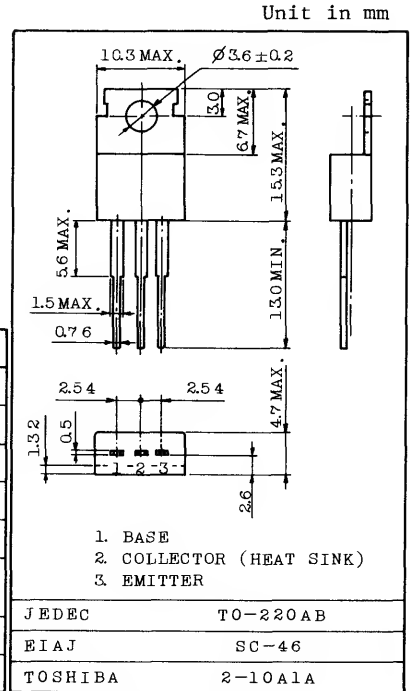
HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
: $V_{CE(sat)} = -0.4V(\text{Max.})$ at $I_C = -6A$
- High Speed Switching Time : $t_{stg} = 1.0\mu s(\text{Typ.})$
- Complementary to 2SC3345

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-60	V
Collector-Emitter Voltage	V_{CEO}	-50	V
Emitter-Base Voltage	V_{EBO}	-6	V
Collector Current	I_C	-12	A
Base Current	I_B	-2	A
Collector Power Dissipation (Tc=25°C)	P_C	40	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~ 150	°C

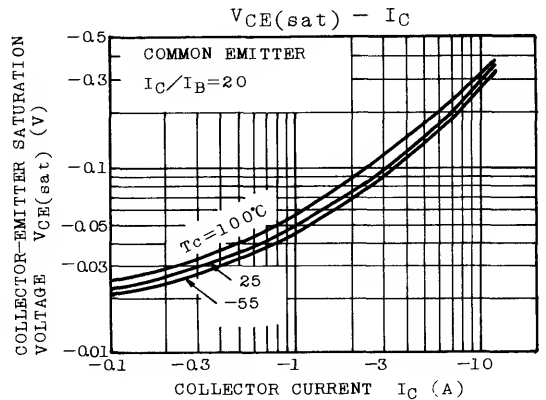
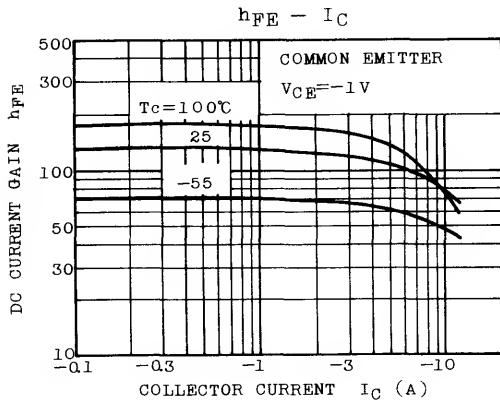
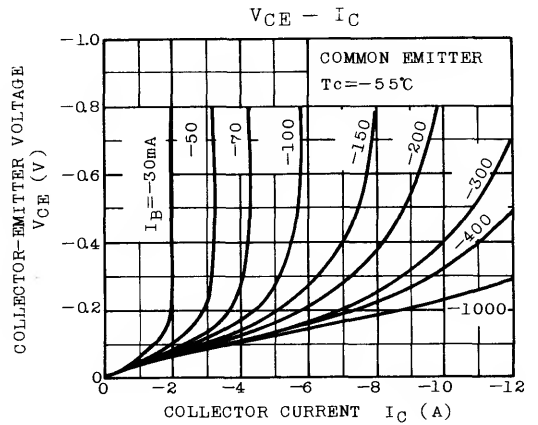
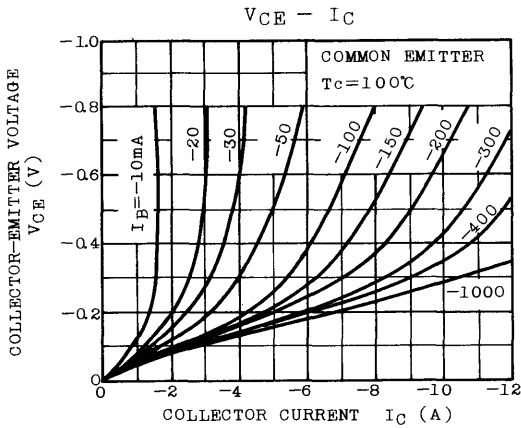
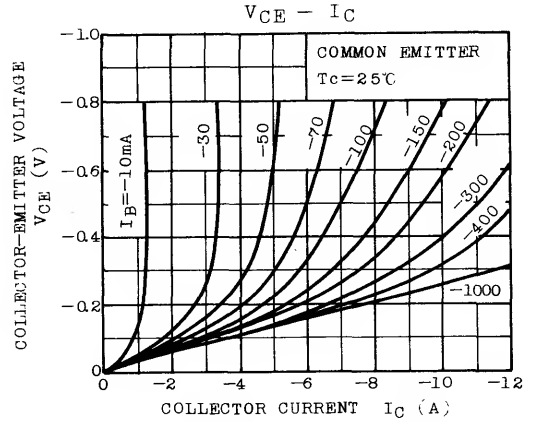
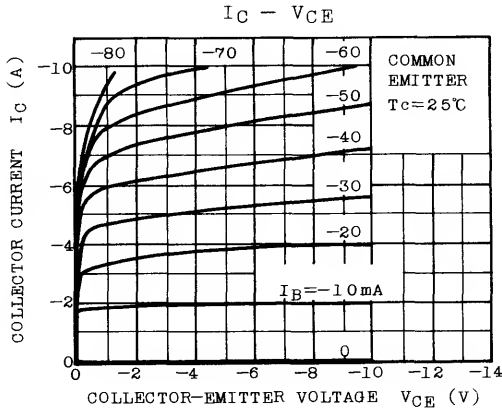


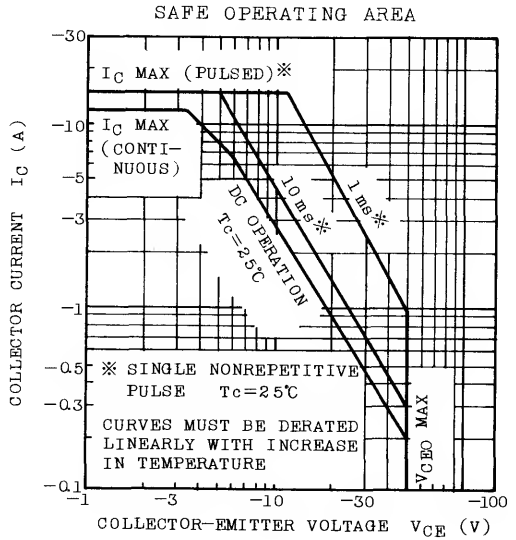
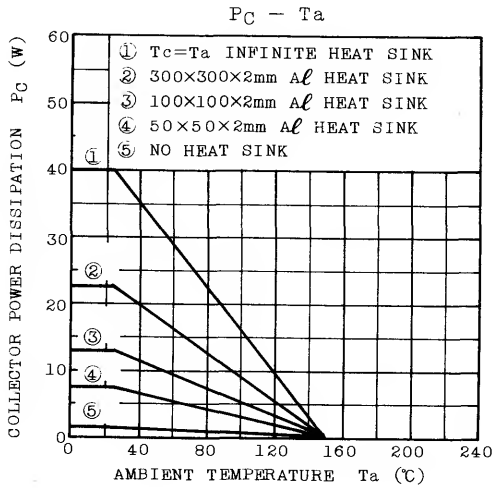
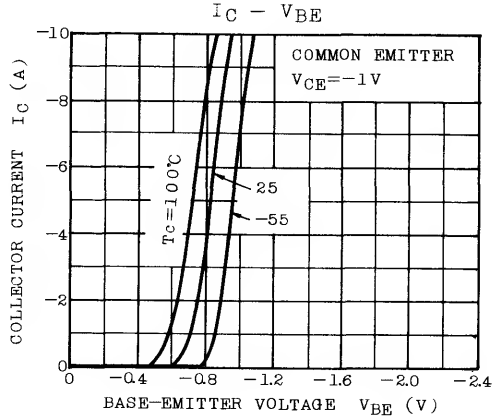
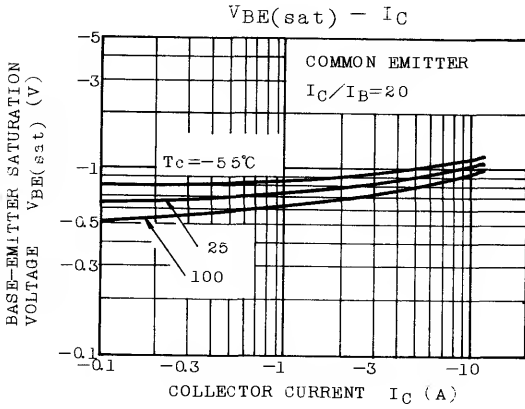
ELECTRICAL CHARACTERISTICS (Ta=25°C)

Mounting Kit No. AC75
Weight : 1.9g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB} = -60V, I_E = 0$	-	-	-10	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB} = -6V, I_C = 0$	-	-	-10	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C = -50mA, I_B = 0$	-50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE} = -1V, I_C = -1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE} = -1V, I_C = -6A$	40	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C = -6A, I_B = -0.3A$	-	-0.15	-0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C = -6A, I_B = -0.3A$	-	-0.9	-1.2	
Transition Frequency		f_T	$V_{CE} = -5V, I_C = -1A$	-	70	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	320	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.3	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.5	-	

Note : $h_{FE(1)}$ Classification O : 70~140, Y : 120~240





Unit in mm

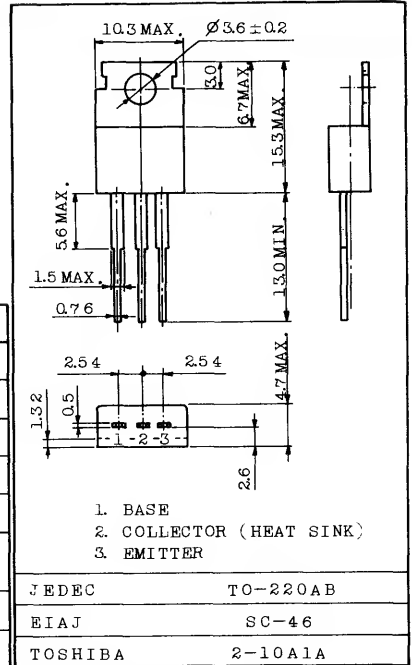
HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- . Low Collector Saturation Voltage
: $V_{CE(sat)} = -0.4V(\text{Max.})$ at $I_C = -6A$
- . High Speed Switching Time : $t_{stg} = 1.0\mu s(\text{Typ.})$
- . Complementary to 2SC3346

MAXIMUM RATINGS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-80	V
Collector-Emitter Voltage	V_{CE0}	-80	V
Emitter-Base Voltage	V_{EB0}	-6	V
Collector Current	I_C	-12	A
Base Current	I_B	-2	A
Collector Power Dissipation ($T_c = 25^\circ C$)	P_C	40	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$

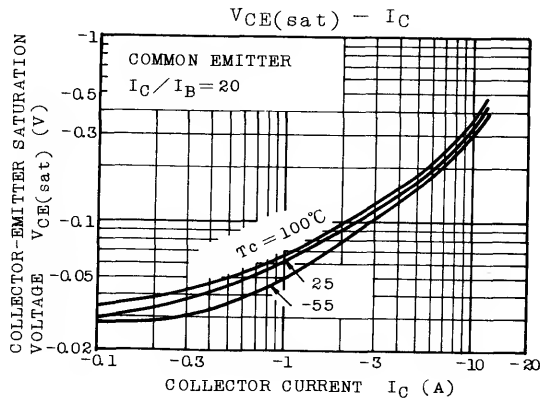
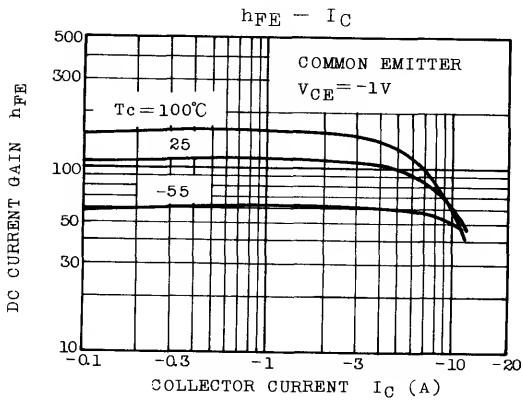
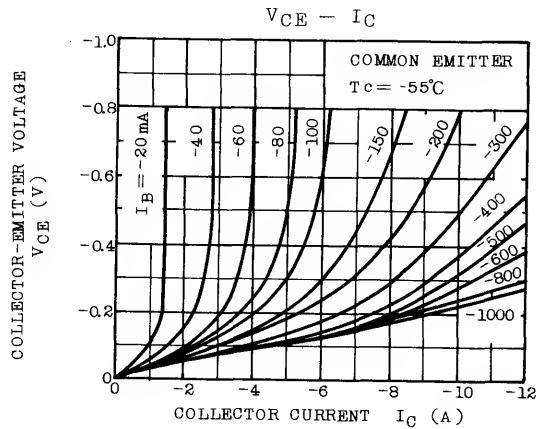
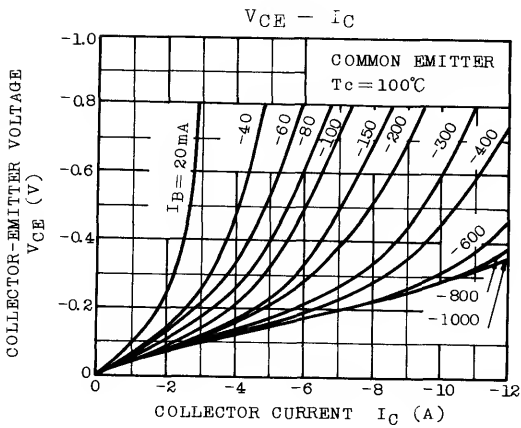
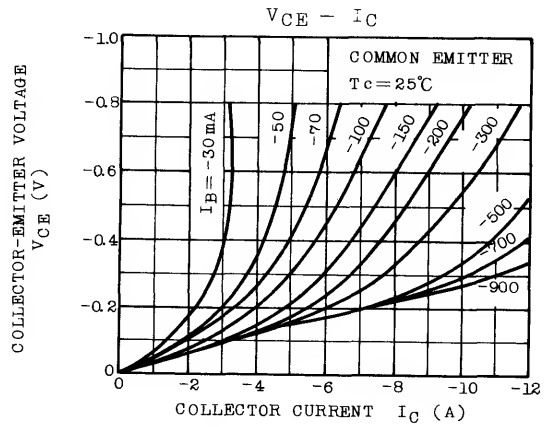
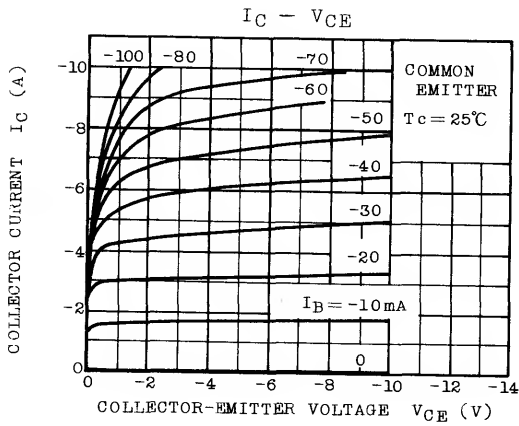


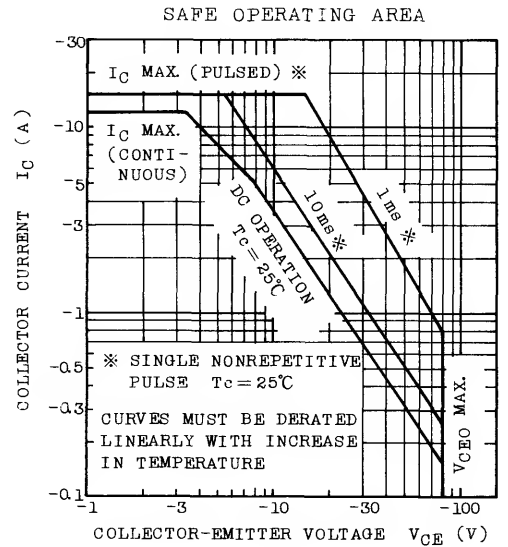
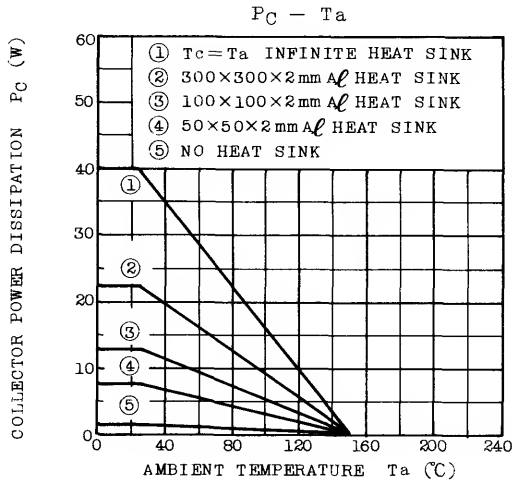
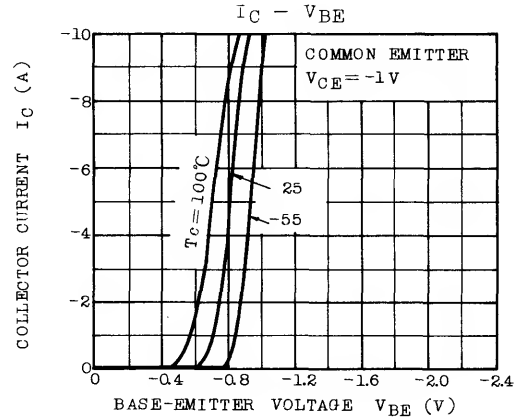
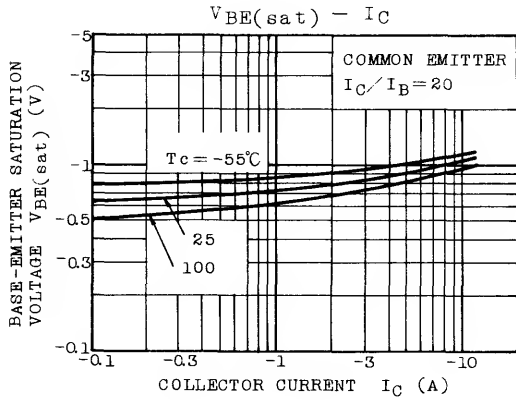
Mounting Kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CB0}	$V_{CB} = -80V, I_E = 0$	-	-	-10	μA
Emitter Cut-off Current		I_{EB0}	$V_{EB} = -6V, I_C = 0$	-	-	-10	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CE0}$	$I_C = -50mA, I_B = 0$	-80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE} = -1V, I_C = -1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE} = -1V, I_C = -6A$	40	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C = -6A, I_B = -0.3A$	-	-0.2	-0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C = -6A, I_B = -0.3A$	-	-0.9	-1.2	
Transition Frequency		f_T	$V_{CE} = -5V, I_C = -1A$	-	50	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	400	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.3	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	-	0.5	

Note : $h_{FE(1)}$ Classification 0 : 70 ~ 140, Y : 120 ~ 240







2SB
SERIES

2SB502A 2SB503A

AUDIO POWER AMPLIFIER APPLICATIONS.
REGULATOR APPLICATIONS.

FEATURES :

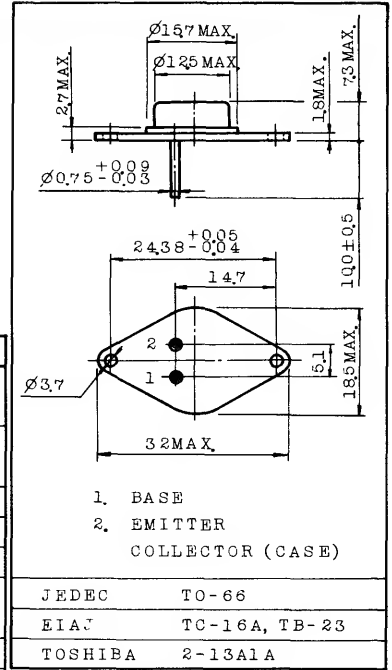
- Low Saturation Voltage : $V_{CE(sat)} = -1.5V(\text{Max.}) (I_C = -3A)$
- Complementary to 2SD877.

MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SB502A	V _{CBO}	-110	V
	2SB503A		-80	
Collector-Emitter Voltage	2SB502A	V _{CEO}	-80	V
	2SB503A		-50	
Emitter-Base Voltage		V _{EBO}	-10	V
Collector Current		I _C	-3	A
Emitter Current		I _E	3	A
Collector Power Dissipation	Ta=25°C	P _C	1.5	W
	Tc=25°C		25	
Junction Temperature		T _j	150	°C
Storage Temperature Range		T _{stg}	-65 ~ 150	°C

INDUSTRIAL APPLICATIONS

Unit in mm



Mounting kit No.AC74
Weight : 5.9g

ELECTRICAL CHARACTERISTICS (Ta = 25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	2SB502A	I _{CBO}	V _{CB} = -110V, I _E = 0	-	-	-100	μA
	2SB503A		V _{CB} = -80V, I _E = 0	-	-	-100	
Emitter Cut-off Current		I _{EBO}	V _{EB} = -10V, I _C = 0	-	-	-100	μA
Collector-Emitter Breakdown Voltage	2SB502A	V _{(BR)CEO}	I _C = -100mA, I _B = 0	-80	-	-	V
	2SB503A			-50	-	-	
DC Current Gain		h _{FE} (1) (Note 2)	V _{CE} = -5V, I _C = -0.5A (Note 1)	30	80	280	
		h _{FE} (2)	V _{CE} = -5V, I _C = -2.5A (Note 1)	15	25	-	
Saturation Voltage	Collector-Emitter	V _{CE(sat)}	I _C = -3A, I _B = -0.3A (Note 1)	-	-	-1.5	V
	Base-Emitter	V _{BE(sat)}	I _C = -3A, I _B = -0.3A (Note 1)	-	-	-1.8	
Transition Frequency		f ₁	V _{CB} = -10V, I _C = -0.5A	-	5	-	MHz
Collector Output Capacitance		C _{ob}	V _{CB} = -10V, I _E = 0, f = 1MHz	-	200	-	pF
Switching Time	Turn-on Time	t _{on}		-	1.0	-	μs
	Storage Time	t _{stg}		-	3.0	-	
	Fall Time	t _f		-	1.0	-	

Note 1 : Pulse Test : Pulse Width ≤ 300μs, Duty Cycle ≤ 2%
2 : h_{FE}(1) classification R : 30~70, O : 50~140, Y : 100~280

2SB552

SILICON PNP TRIPLE DIFFUSED TYPE

HIGH POWER AMPLIFIER APPLICATIONS.
HIGH POWER SWITCHING APPLICATIONS.
DC-DC CONVERTER APPLICATIONS.
REGULATOR APPLICATIONS.

FEATURES:

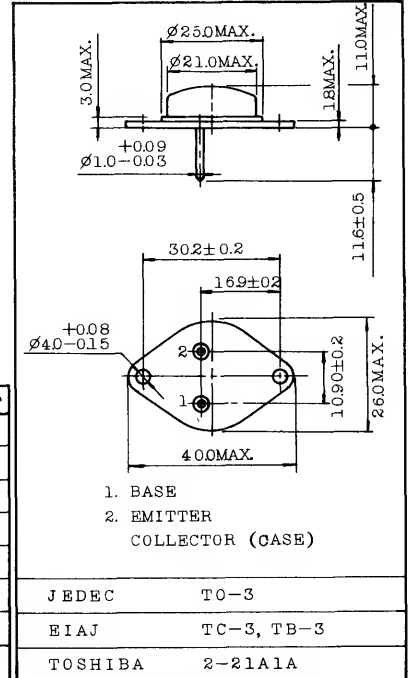
- High Collector Power Dissipation : $P_C=150W$ ($T_c=25^\circ C$)
- High Collector Current : $I_C=-15A$
- High Voltage : $V_{CE0}=-180V$
- Complementary to 2SD552.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-220	V
Collector-Emitter Voltage	V_{CE0}	-180	V
Emitter-Base Voltage	V_{EB0}	-5	V
Collector Current	I_C	-15	A
Base Current	I_B	-3	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	150	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-65~150	$^\circ C$

INDUSTRIAL APPLICATIONS

Unit in mm



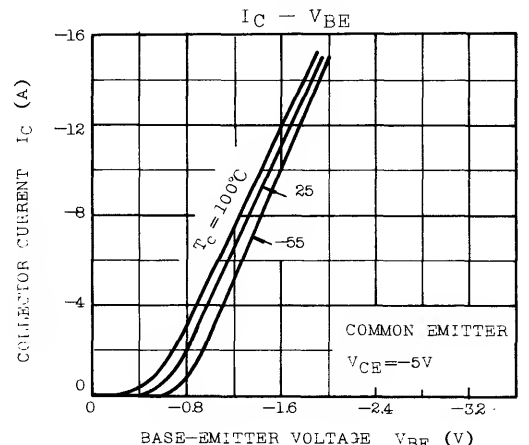
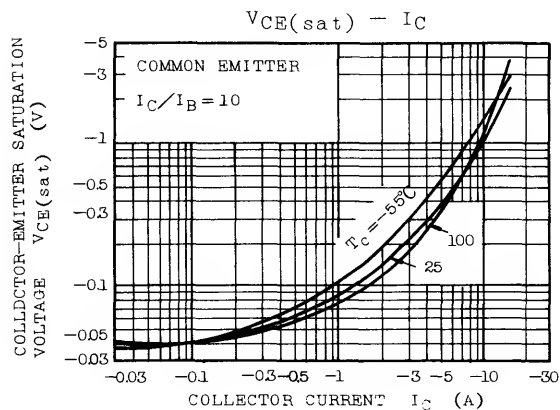
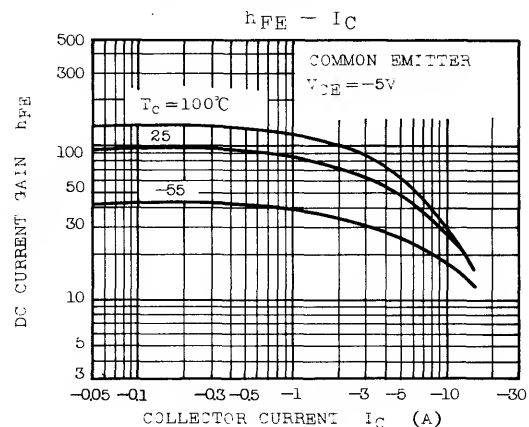
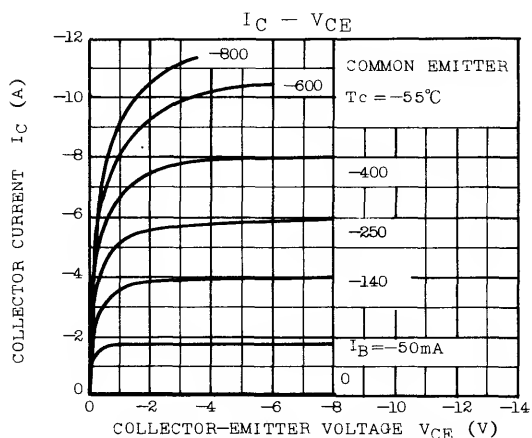
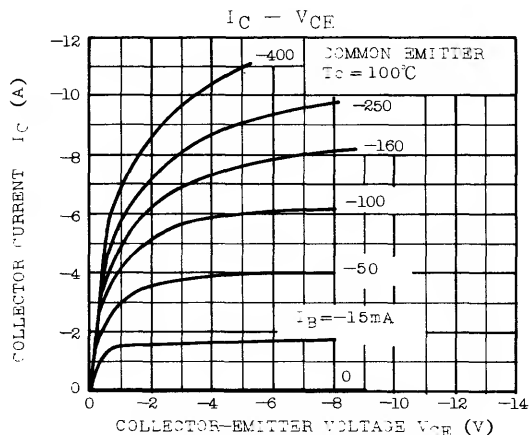
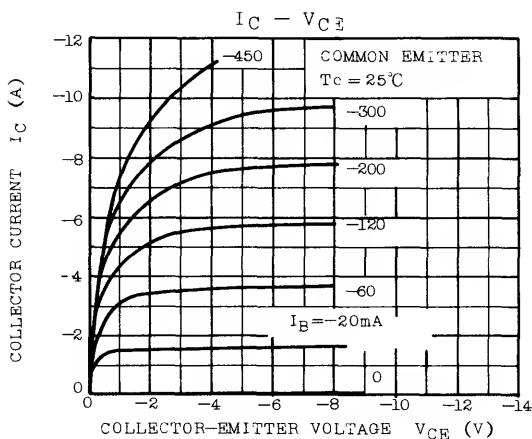
Mounting Kit No. AC73

Weight : 12.9g

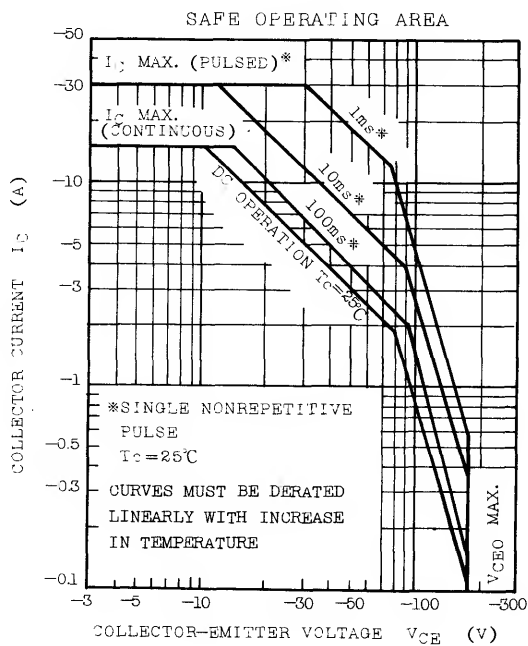
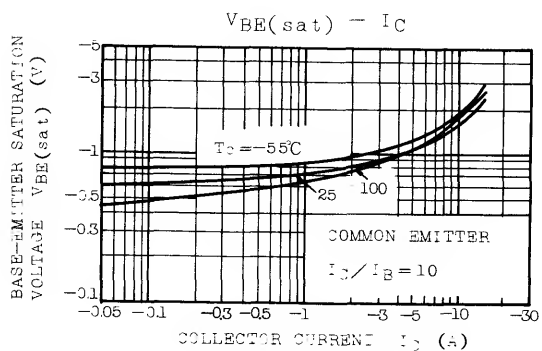
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=-150V, I_E=0$	-	-	-100	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=-5V, I_C=0$	-	-	-1	mA
Collector-Emitter Breakdown Voltage	$V(BR)_{CE0}$	$I_C=-50mA, I_B=0$	-180	-	-	V
DC Current Gain	$h_{FE}(1)$ (Note)	$V_{CE}=-5V, I_C=-5A$	25	-	80	
	$h_{FE}(2)$	$V_{CE}=-5V, I_C=-15A$	10	15	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-10A, I_B=-1A$	-	-	-2.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=-10A, I_B=-1A$	-	-1.6	-2.5	V
Transition Frequency	f_T	$V_{CE}=-10V, I_C=-1A$	-	3.5	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-50V, I_E=0, f=1MHz$	-	300	-	pF
Switching Time	Turn-on Time	t_{on}	-	1	-	μs
	Storage Time	t_{stg}	-	4	-	
	Fall Time	t_f	-	0.5	-	

Note : $h_{FE}(1)$ Classification BN : 25~50, R : 40~80



2SB552



INDUSTRIAL APPLICATIONS
Unit in mm

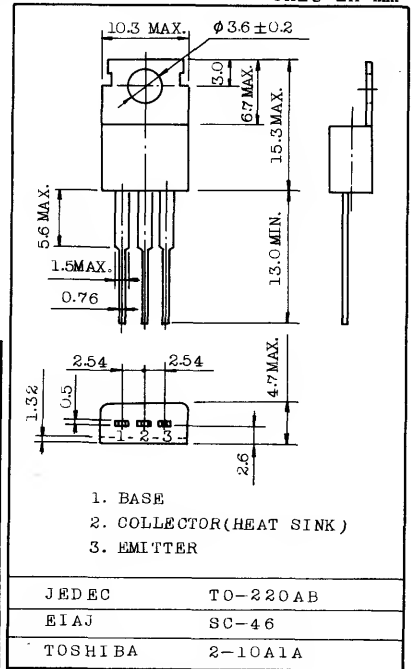
HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
: $V_{CE(sat)} = -0.4V$ (Max.) at $I_C = -4A$
- Complementary to 2SD553.

MAXIMUM RATINGS ($T_a = 25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-70	V
Collector-Emitter Voltage		V_{CEO}	-50	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-7	A
Collector Power Dissipation	$T_a = 25^\circ C$	P_C	1.5	W
	$T_c = 25^\circ C$		40	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55~150	$^\circ C$



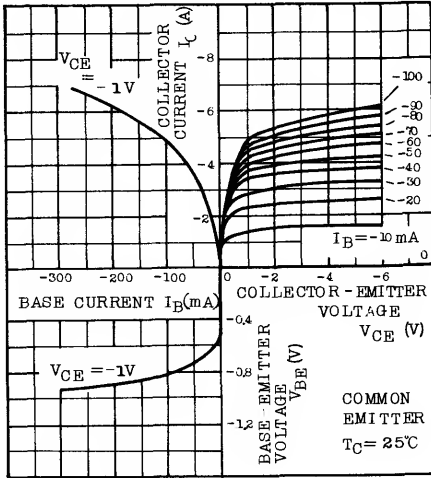
Mounting Kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

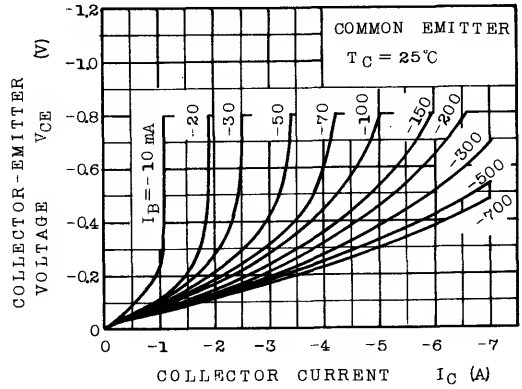
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB} = -70V, I_E = 0$	-	-	-30	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB} = -5V, I_C = 0$	-	-	-50	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C = -50mA, I_B = 0$	-50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE} = -1V, I_C = -1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE} = -1V, I_C = -4A$	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C = -4A, I_B = -0.4A$	-	-0.2	-0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C = -4A, I_B = -0.4A$	-	-0.9	-1.2	
Transition Frequency		f_T	$V_{CE} = -4V, I_C = -1A$	-	10	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1 MHz$	-	250	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.2	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		-	-	0.5	

Note : $h_{FE(1)}$ Classification 0 : 70~140, Y : 120~240

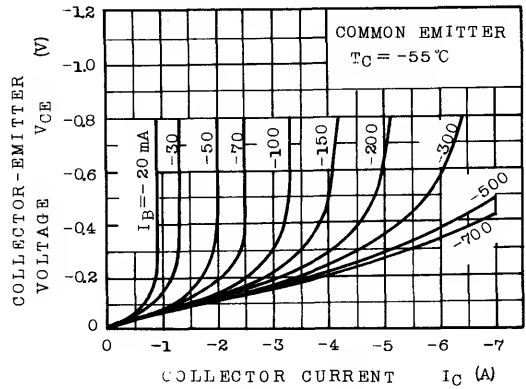
STATIC CHARACTERISTICS



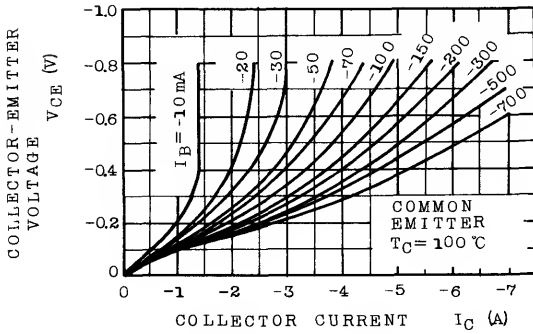
$V_{CE} - I_C$ (LOW VOLTAGE REGION)



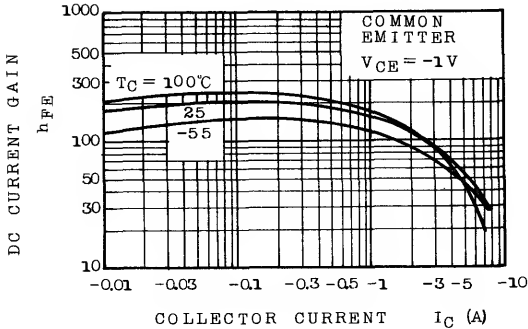
$V_{CE} - I_C$ (LOW VOLTAGE REGION)



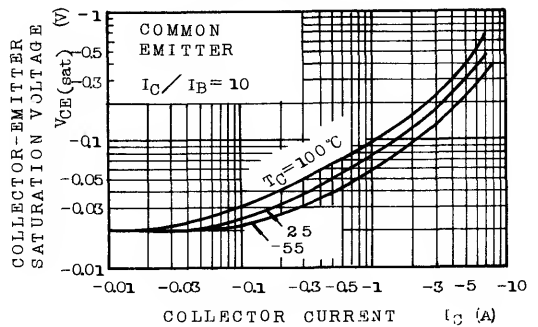
$V_{CE} - I_C$ (LOW VOLTAGE REGION)

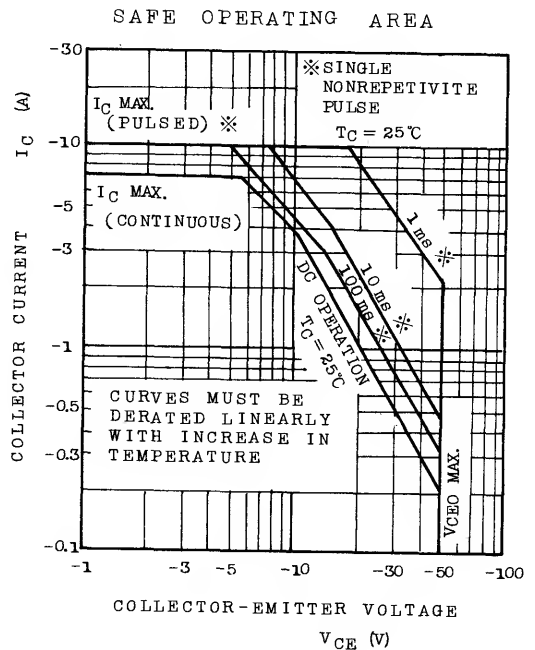
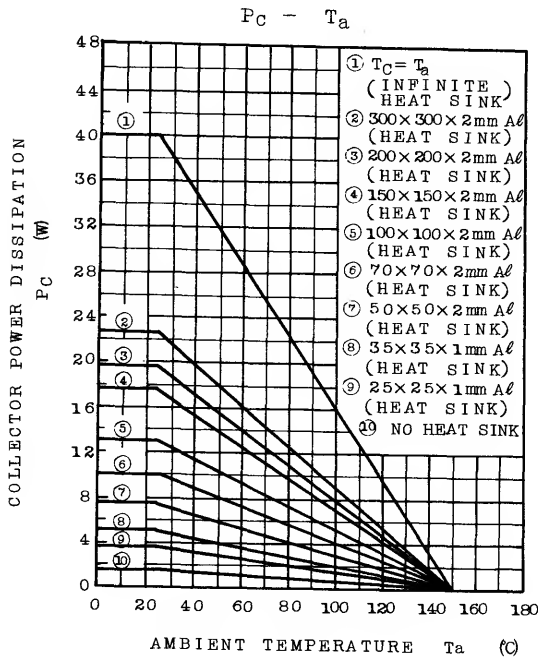
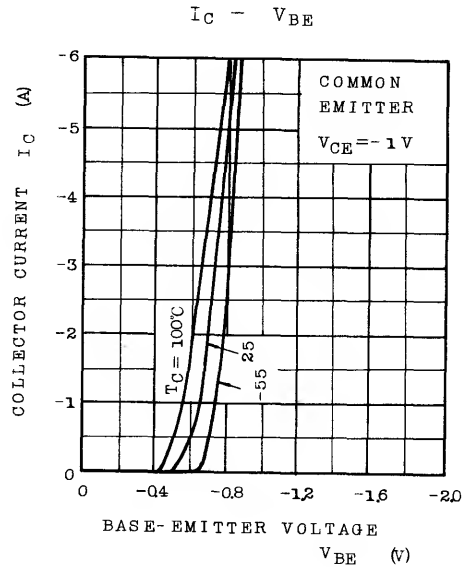
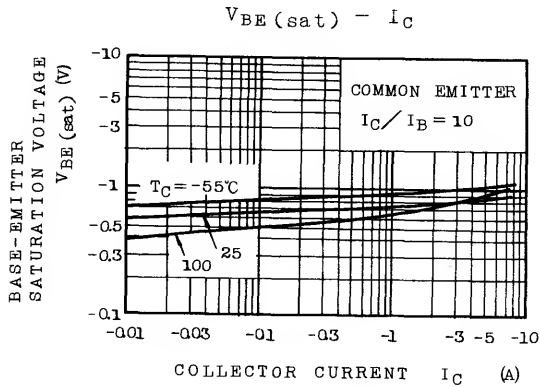


$h_{FE} - I_C$



$V_{CE(sat)} - I_C$





2SB554

SILICON PNP TRIPLE DIFFUSED TYPE

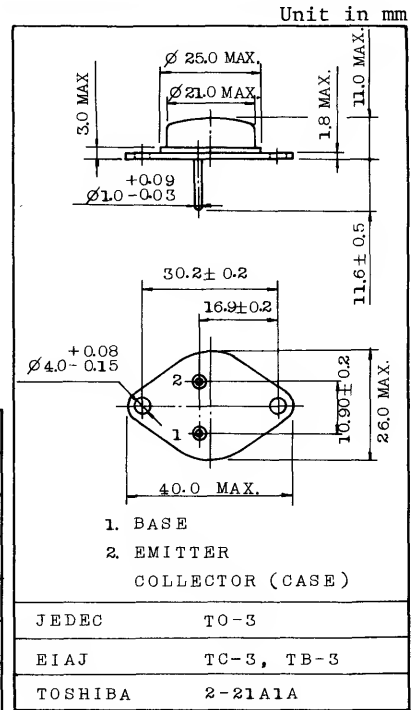
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Power Dissipation : $P_C = 150W$
- High Breakdown Voltage : $V_{CE0} = -180V$
- Complementary to 2SD424.
- Recommended for 100W High-Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-180	V
Collector-Emitter Voltage	V_{CE0}	-180	V
Emitter-Base Voltage	V_{EB0}	-5	V
Collector Current	I_C	-15	A
Emitter Current	I_E	15	A
Collector Power Dissipation ($T_c = 25^\circ C$)	P_C	150	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 150	$^\circ C$



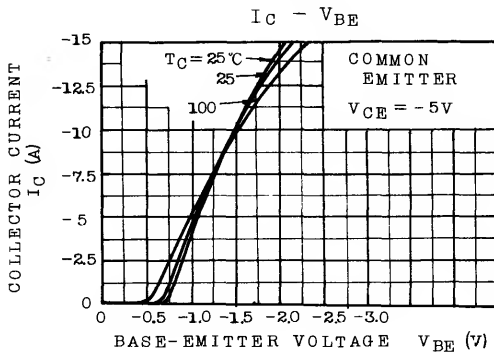
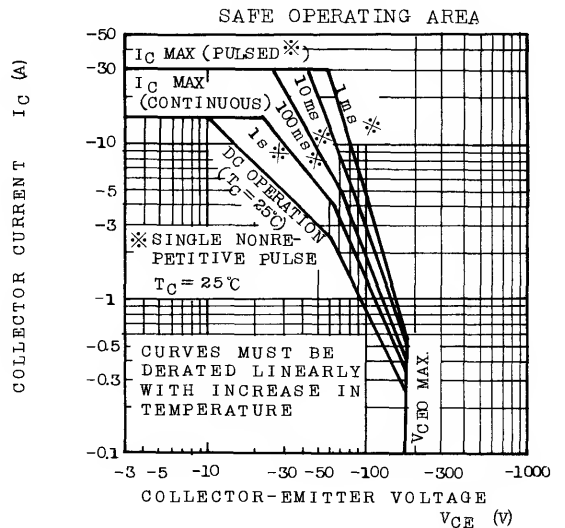
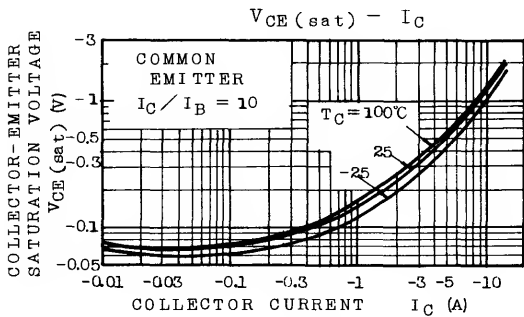
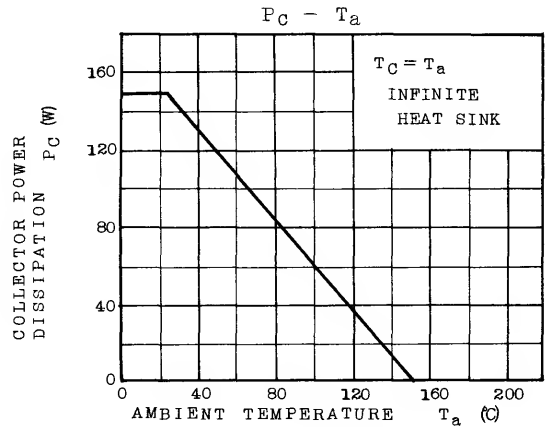
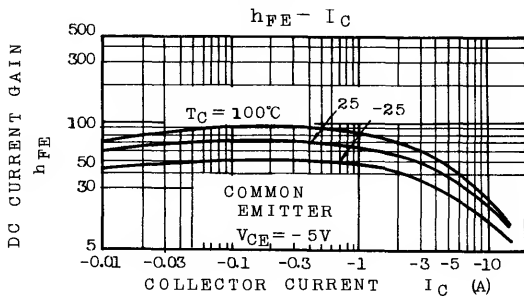
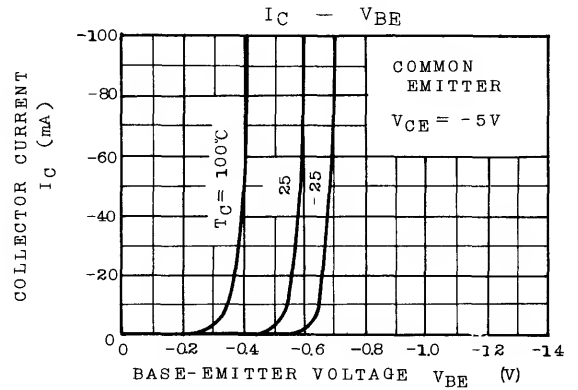
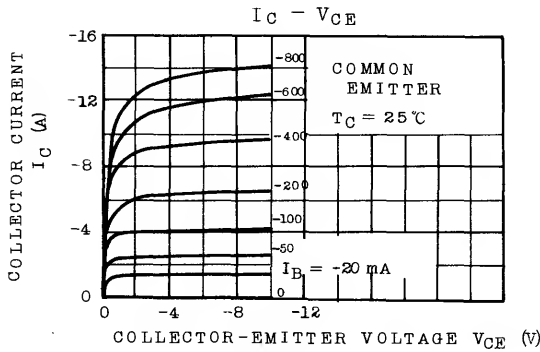
Mounting Kit No. AC73
Weight : 12.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CRO}	$V_{CB} = -90V, I_E = 0$	-	-	-100	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB} = -5V, I_C = 0$	-	-	-100	μA
Collector-Emitter Breakdown Voltage	$V(BR)_{CEO}$	$I_C = -0.1A, I_B = 0$	-180	-	-	V
Emitter-Base Breakdown Voltage	$V(BR)_{EBO}$	$I_E = -10mA, I_C = 0$	-5	-	-	V
DC Current Gain	h_{FE} (Note)	$V_{CE} = -5V, I_C = -2A$	40	-	140	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = -10A, I_B = -1A$	-	-	-3.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE} = -5V, I_C = -10A$	-	-	-2.5	V
Transition Frequency	f_T	$V_{CE} = -5V, I_C = -2A$	-	6	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	450	-	pF

Note: h_{FE} Classification R : 40 ~ 80, O : 70 ~ 140

TOSHIBA CORPORATION



2SB595

SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

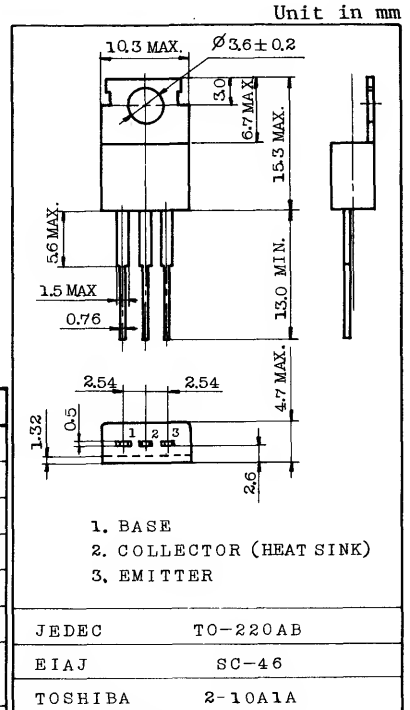
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : $V_{CEO} = -100V$
- Low Collector-Emitter Saturation Voltage : $V_{CE(sat)} = -2.0V (Max.)$
- Complementary to 2SD525.
- Recommended for 30W High-Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-100	V
Collector-Emitter Voltage	V_{CEO}	-100	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-5	A
Emitter Current	I_E	5	A
Base Current	I_B	-4	A
Collector Power Dissipation (Tc=25°C)	P_C	40	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~ 150	°C

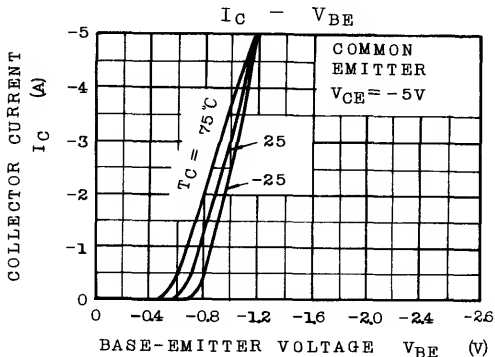
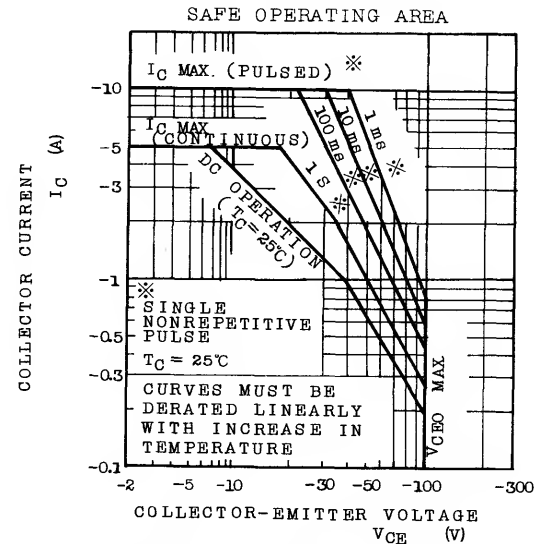
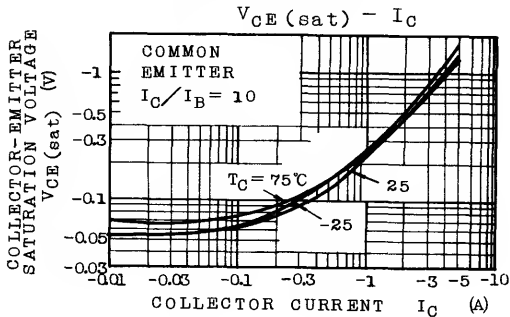
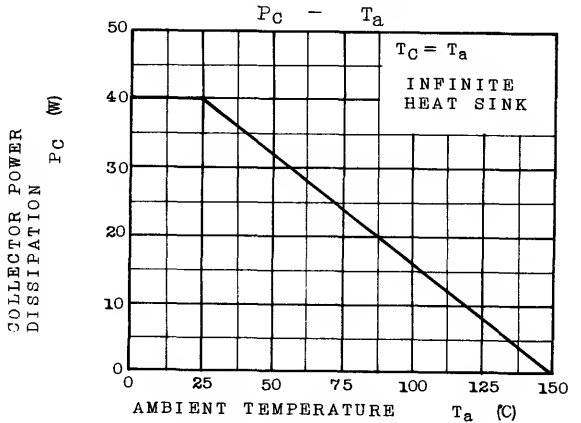
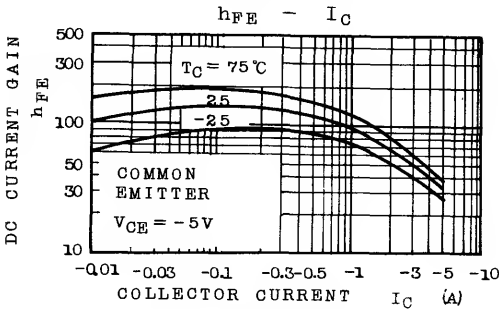
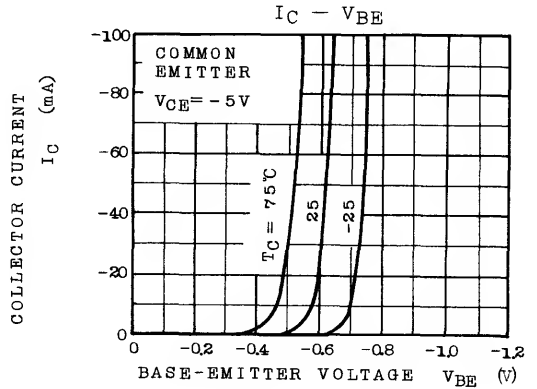
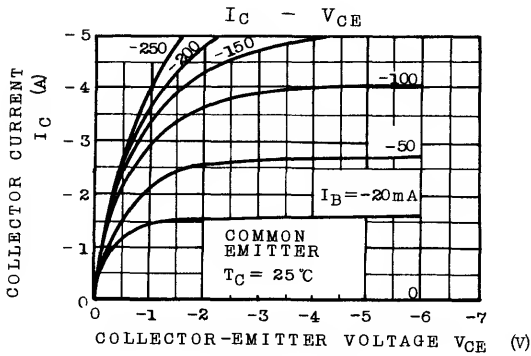


Mounting Kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB} = -100V, I_E = 0$	-	-	-100	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB} = -5V, I_C = 0$	-	-	-1	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C = -50mA, I_B = 0$	-100	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E = -10mA, I_C = 0$	-5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE} = -5V, I_C = -1A$	40	-	240	
	$h_{FE(2)}$	$V_{CE} = -5V, I_C = -4A$	20	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = -4A, I_B = -0.4A$	-	-	-2.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE} = -5V, I_C = -4A$	-	-	-1.5	V
Transition Frequency	f_T	$V_{CE} = -5V, I_C = -1A$	-	5	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	270	-	pF

Note : $h_{FE(1)}$ Classification R : 40 ~ 80, O : 70 ~ 140, Y : 120 ~ 240



2SB596

SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.

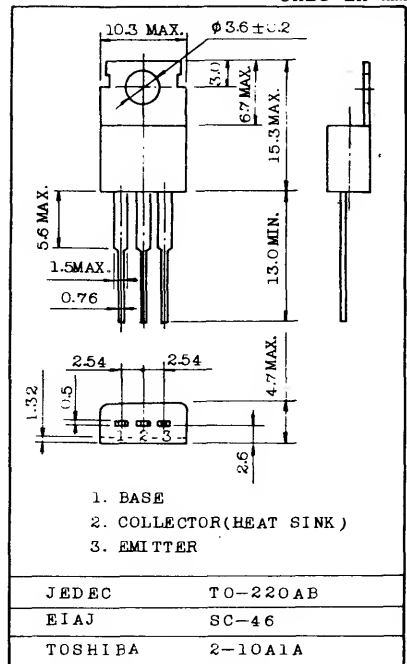
FEATURES:

- Good Linearity of h_{FE} .
- Complementary to 2SD526.
- Recommended for 20 ~ 25W High-Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	-80	V
Collector-Emitter Voltage	V _{CEO}	-80	V
Emitter-Base Voltage	V _{EBO}	-5	V
Collector Current	I _C	-4	A
Emitter Current	I _E	4	A
Base Current	I _B	-3	A
Collector Power Dissipation (Tc=25°C)	P _C	30	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55~150	°C

Unit in mm

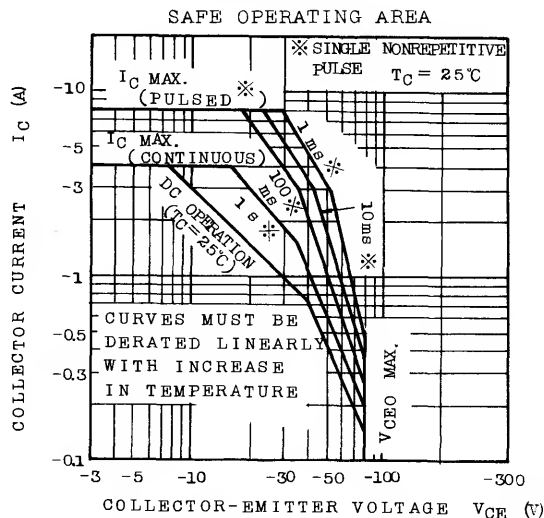
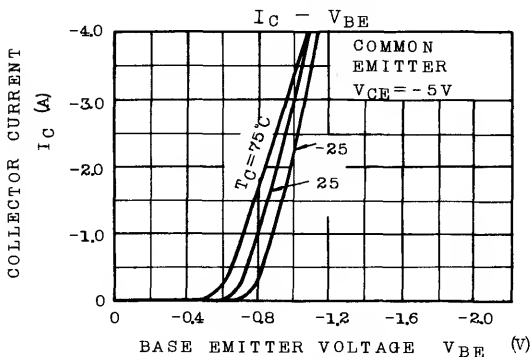
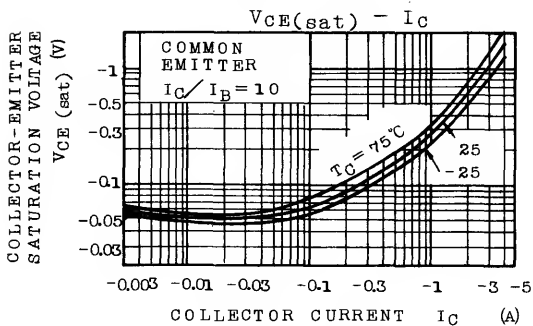
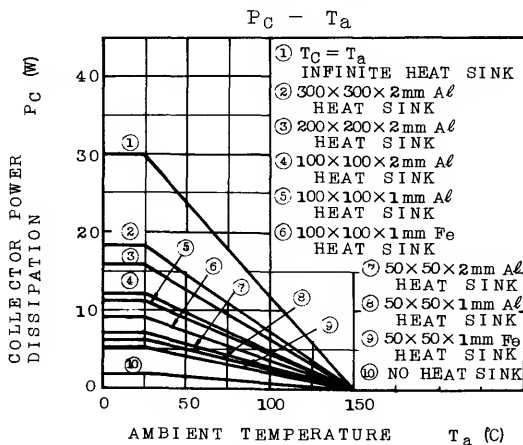
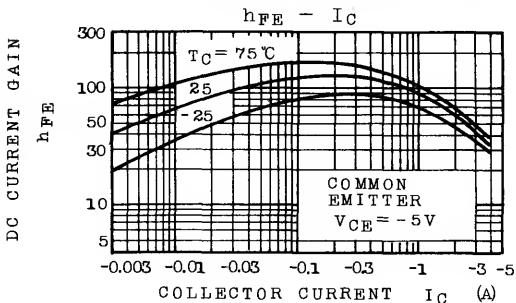
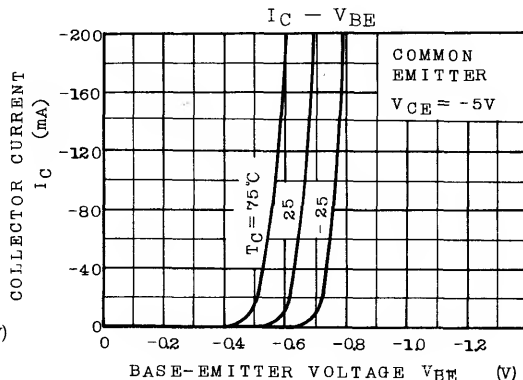
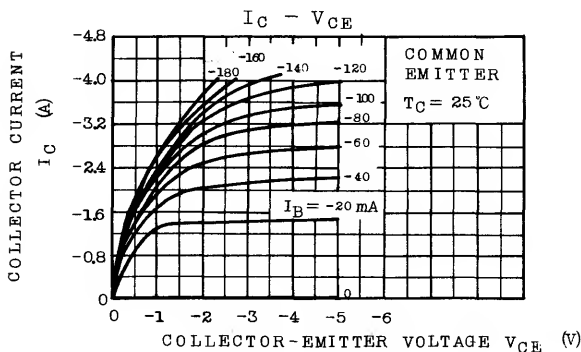


Mounting Kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =-80V, I _E =0	-	-	-30	μA
Emitter Cut-off Current	I _{EBO}	V _{EB} =-5V, I _C =0	-	-	-100	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CEO}	I _C =-50mA, I _B =0	-80	-	-	V
Emitter-Base Breakdown Voltage	V _{(BR)EBO}	I _E =-10mA, I _C =0	-5	-	-	V
DC Current Gain	h _{FE} (1) (Note)	V _{CE} =-5V, I _C =-0.5A	40	-	240	
	h _{FE} (2)	V _{CE} =-5V, I _C =-3A	15	-	-	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =-3A, I _B =-0.3A	-	-1.0	-1.7	V
Base-Emitter Voltage	V _{BE}	V _{CE} =-5V, I _C =-3A	-	-1.0	-1.5	V
Transition Frequency	f _T	V _{CE} =-5V, I _C =-0.5A	3	-	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =-10V, I _E =0, f=1 MHz	-	130	-	pF

Note : h_{FE}(1) Classification R : 40 ~ 80, O : 70 ~ 140, Y : 120 ~ 240



2SB673 2SB674 2SB675

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

HIGH POWER SWITCHING APPLICATIONS.
HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.

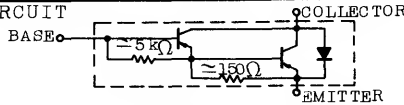
FEATURES:

- High DC Current Gain : $h_{FE}=2000(\text{Min.})(V_{CE}=-3V, I_C=-3A)$
- Low Saturation Voltage : $V_{CE}(\text{sat})=-1.5V(\text{Max.})(I_C=-3A)$
- Complementary to 2SD633, 2SD634 and 2SD635.

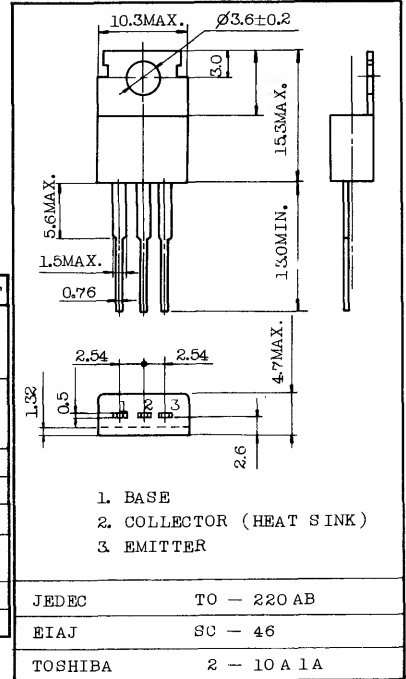
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SB673	V_{CBO}	-100	V
	2SB674		-80	
	2SB675		-60	
Collector-Emitter Voltage	2SB673	V_{CEO}	-100	V
	2SB674		-80	
	2SB675		-60	
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-7	A
Base Current		I_B	-0.2	A
Collector Power Dissipation (Tc=25°C)		P_C	40	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C

EQUIVALENT CIRCUIT



INDUSTRIAL APPLICATIONS
Unit in mm

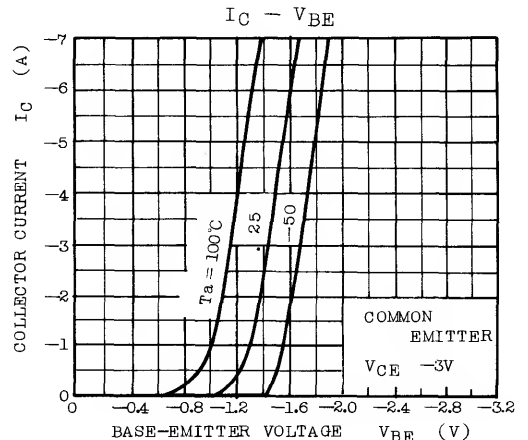
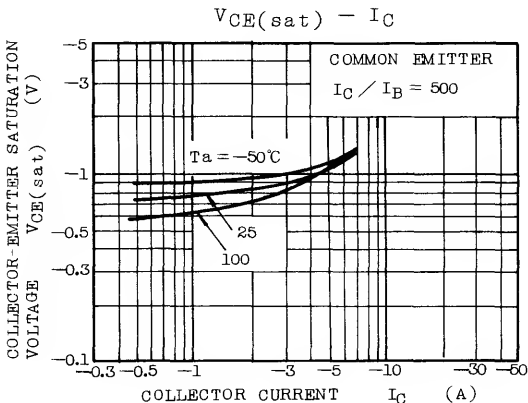
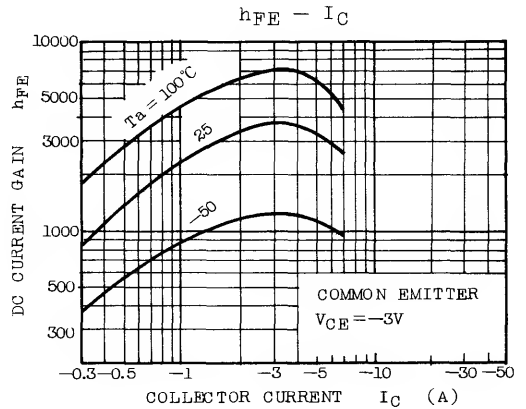
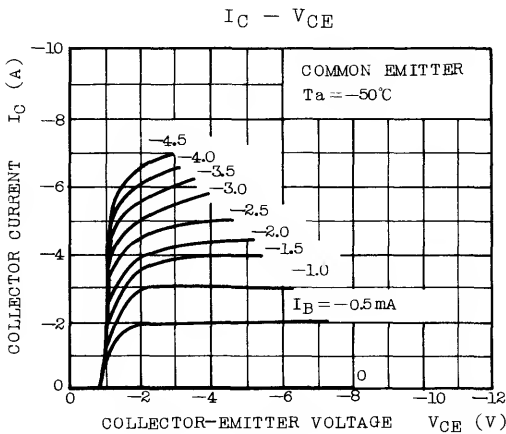
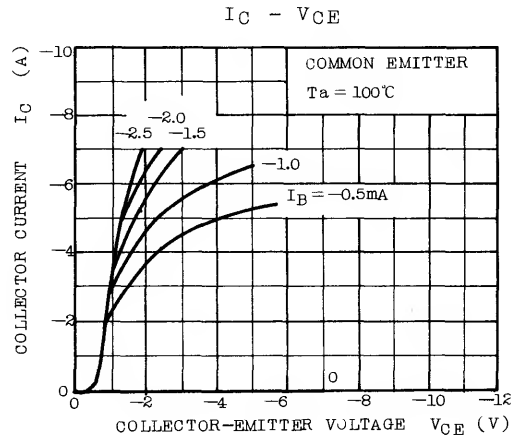
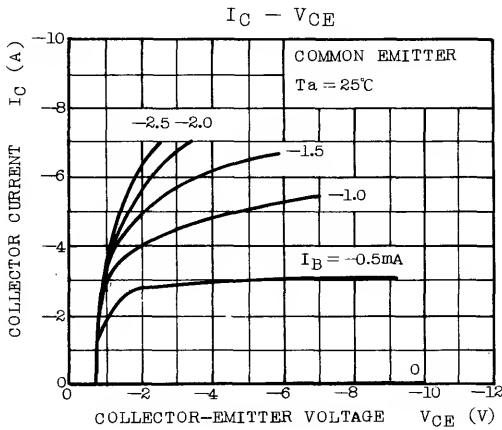


Mounting Kit No. AC75
Weight : 1.9g

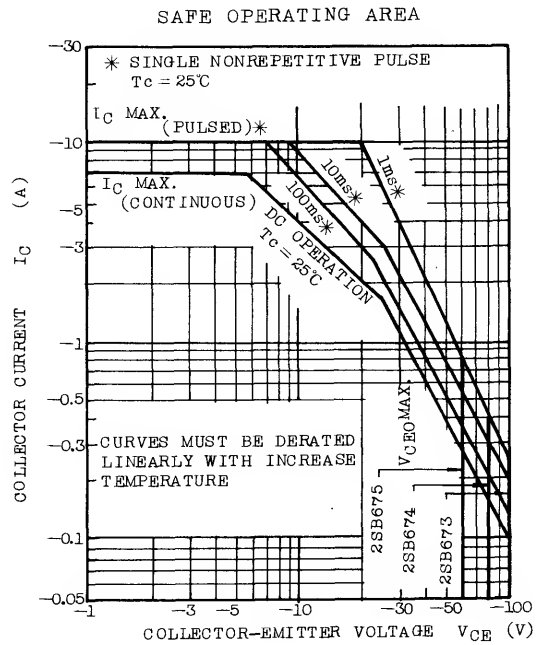
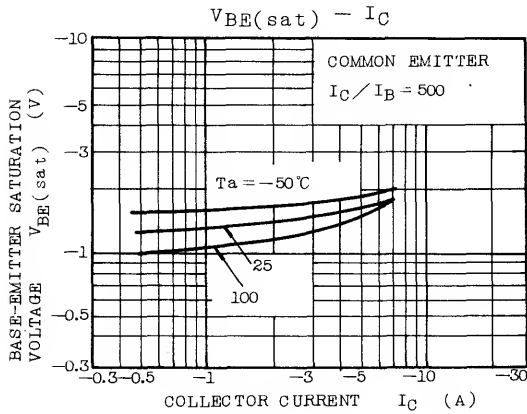
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Collector Cut-off Current	2SB673	I_{CBO}	$V_{CB}=-100V, I_E=0$	-	-	-100	μA	
	2SB674		$V_{CB}=-80V, I_E=0$	-	-	-100		
	2SB675		$V_{CB}=-60V, I_E=0$	-	-	-100		
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-5V, I_C=0$	-	-	-4.0	mA	
Collector-Emitter Breakdown Voltage	2SB673	$V_{(BR)CEO}$	$I_C=-50mA, I_B=0$	-100	-	-	V	
	2SB674			-80	-	-		
	2SB675			-60	-	-		
DC Current Gain			$h_{FE}(1)$	$V_{CE}=-3V, I_C=-3A$	2000	-	15000	
			$h_{FE}(2)$	$V_{CE}=-3V, I_C=-7A$	1000	-	-	
Collector-Emitter Saturation Voltage			$V_{CE}(\text{sat})(1)$	$I_C=-3A, I_B=-6mA$	-	-0.95	-1.5	V
			$V_{CE}(\text{sat})(2)$	$I_C=-7A, I_B=-14mA$	-	-1.3	-2.0	
Base-Emitter Saturation Voltage		$V_{BE}(\text{sat})$	$I_C=-3A, I_B=-6mA$	-	-1.55	-2.5	V	
Switching Time	Turn-on Time	t_{on}		-	0.8	-	μs	
	Storage Time	t_{stg}		-	2.0	-		
	Fall Time	t_f		-	2.5	-		

2SB673 · 2SB674 · 2SB675



2SB673·2SB674·2SB675



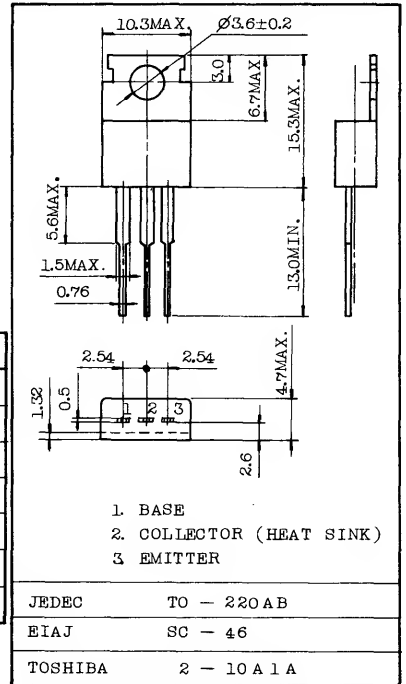
SWITCHING APPLICATIONS.
HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High DC Current Gain
- : $h_{FE}=2000$ (Min.) ($V_{CE}=-2V, I_C=-1A$)

INDUSTRIAL APPLICATIONS

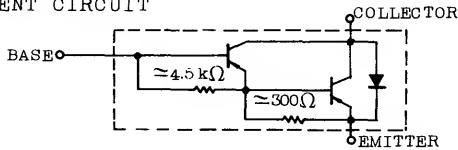
Unit in mm



MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-100	V
Collector-Emitter Voltage	V_{CEO}	-80	V
Emitter-Base Voltage	V_{EB0}	-5	V
Collector Current	I_C	-4	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	30	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55~150	$^\circ C$

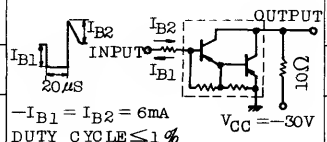
EQUIVALENT CIRCUIT



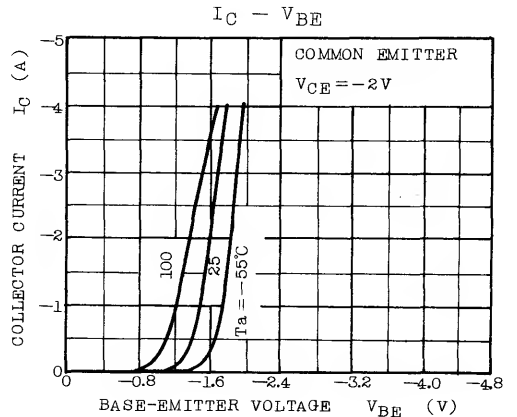
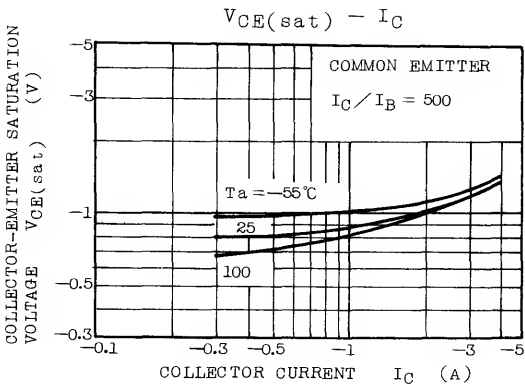
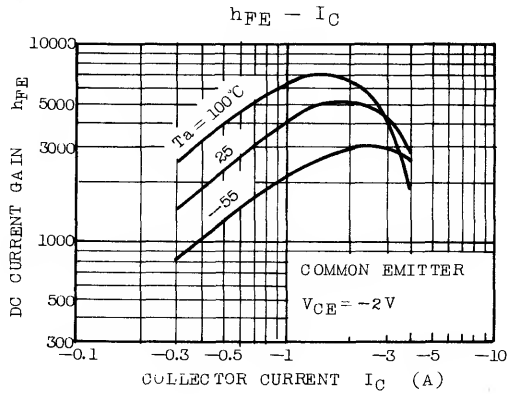
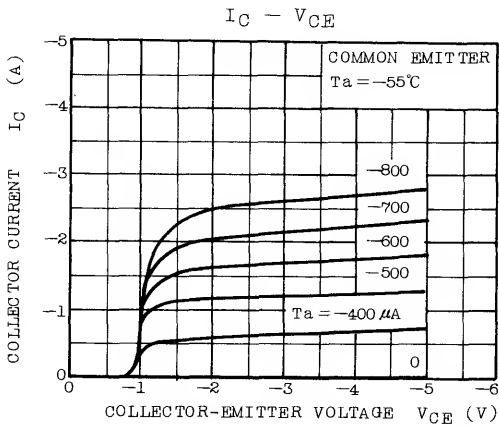
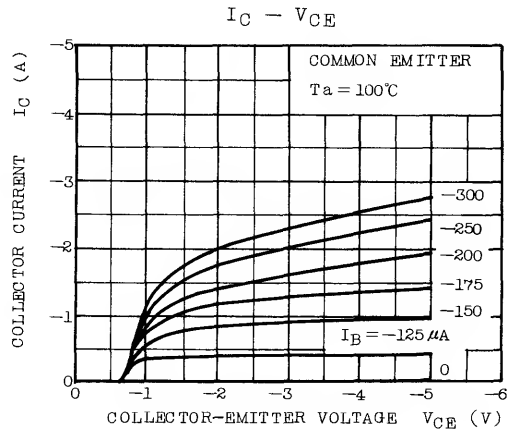
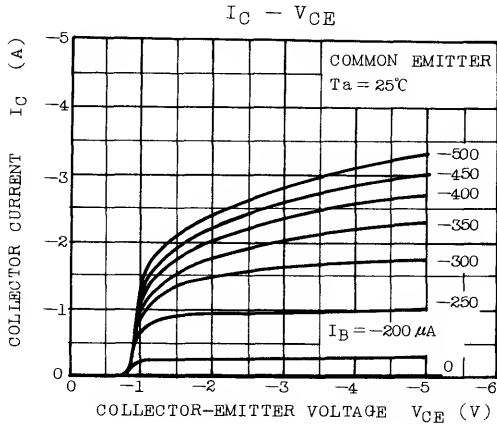
Mounting Kit No. AC75
Weight : 1.9g

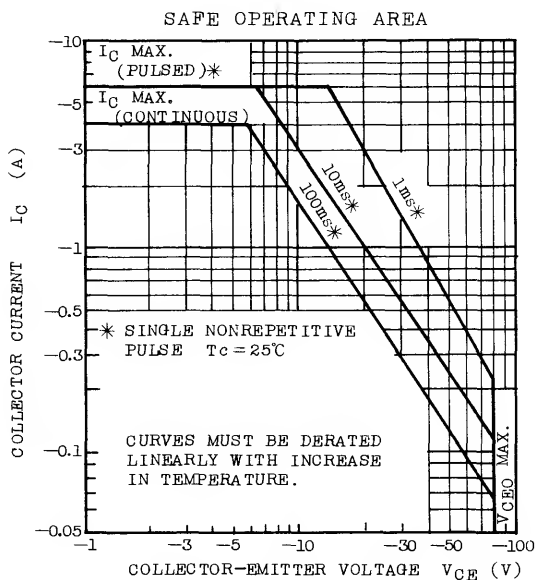
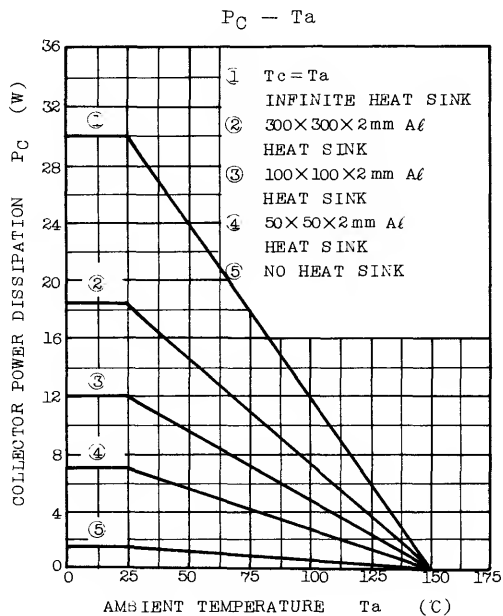
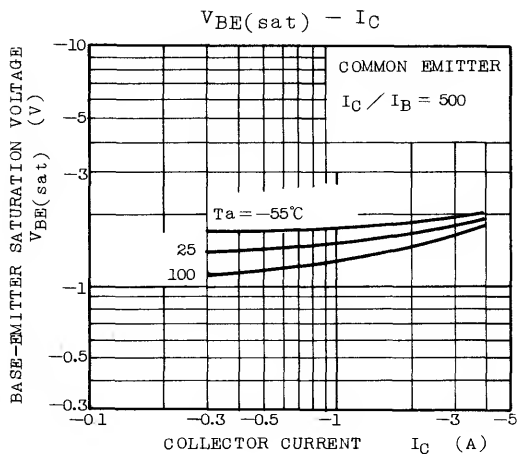
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=-100V, I_E=0$	-	-	-20	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=-5V, I_C=0$	-	-	-2.5	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=-10mA, I_B=0$	-80	-	-	V
DC Current Gain	$h_{FE(1)}$	$V_{CE}=-2V, I_C=-1A$	2000	-	-	
	$h_{FE(2)}$	$V_{CE}=-2V, I_C=-3A$	1000	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-3A, I_B=-6mA$	-	-	-1.5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=-3A, I_B=-6mA$	-	-	-2.0	V
Switching Time	Turn-on Time	t_{on}		0.15	-	μs
	Storage Time	t_{stg}		0.80	-	
	Fall Time	t_f		0.40	-	



2SB676





2SB677

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

SWITCHING APPLICATIONS.
HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

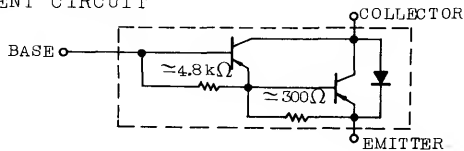
FEATURES:

- High DC Current Gain
: $h_{FE}=2000$ (Min.) ($V_{CE}=-2V$, $I_C=-1A$)
- Low Saturation Voltage
: $V_{CE(sat)}=-1.5V$ (Max.) ($I_C=-2A$)

MAXIMUM RATINGS ($T_a=25^\circ C$)

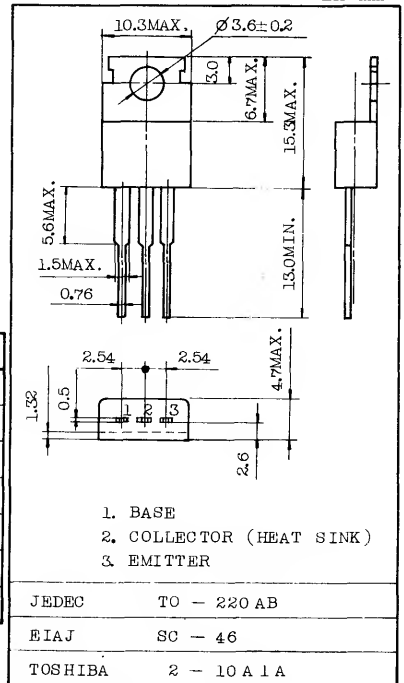
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-60	V
Collector-Emitter Voltage	V_{CEO}	-40	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-3	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	25	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55~150	$^\circ C$

EQUIVALENT CIRCUIT



INDUSTRIAL APPLICATIONS

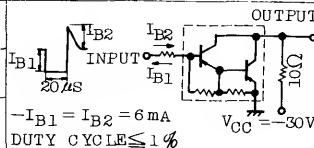
Unit in mm

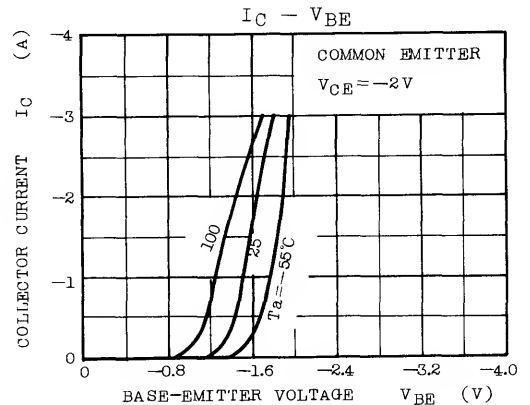
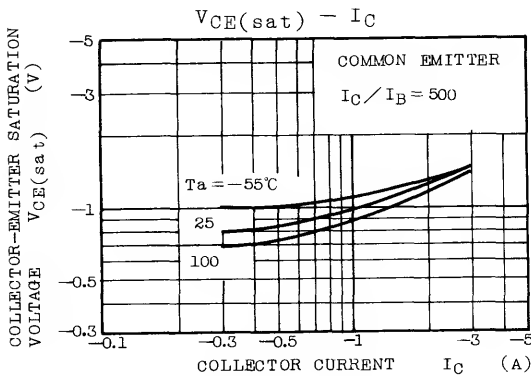
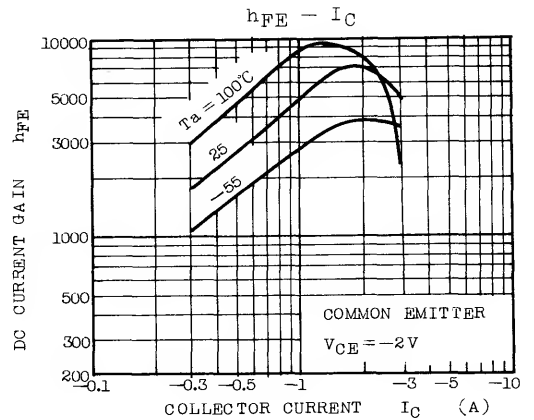
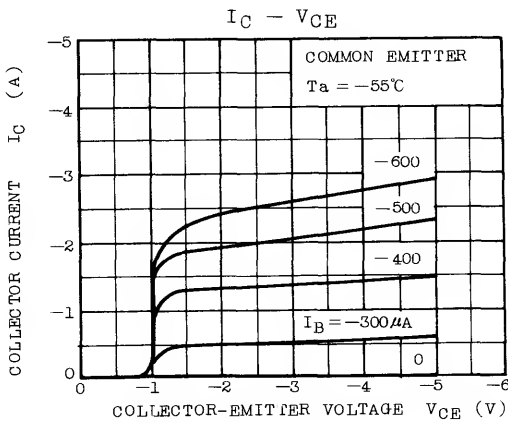
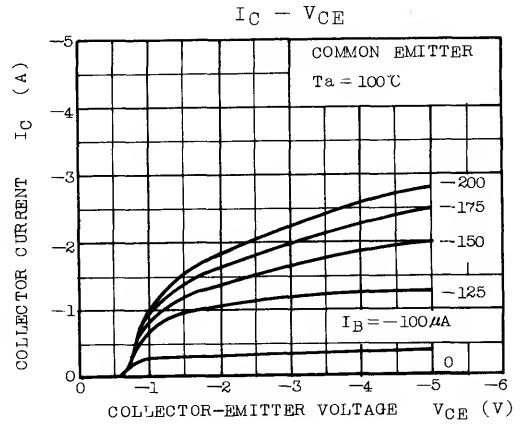
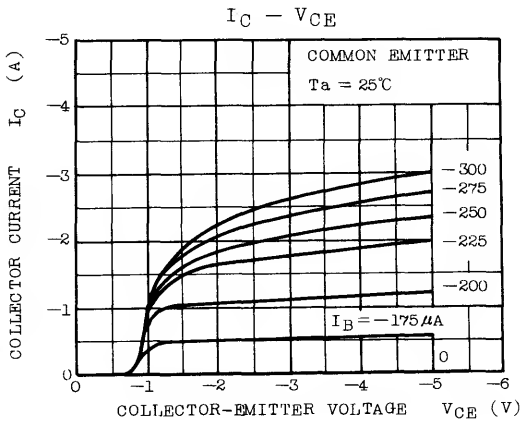


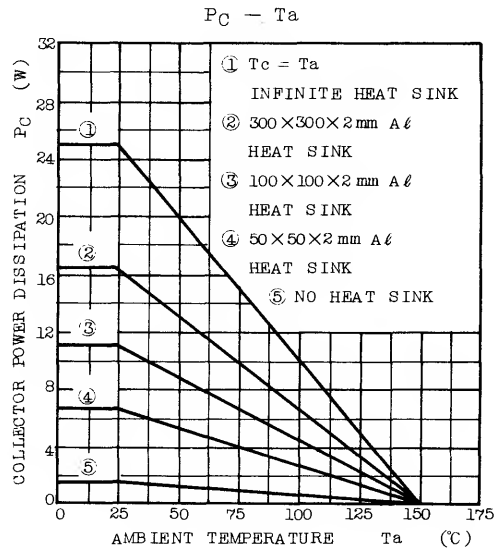
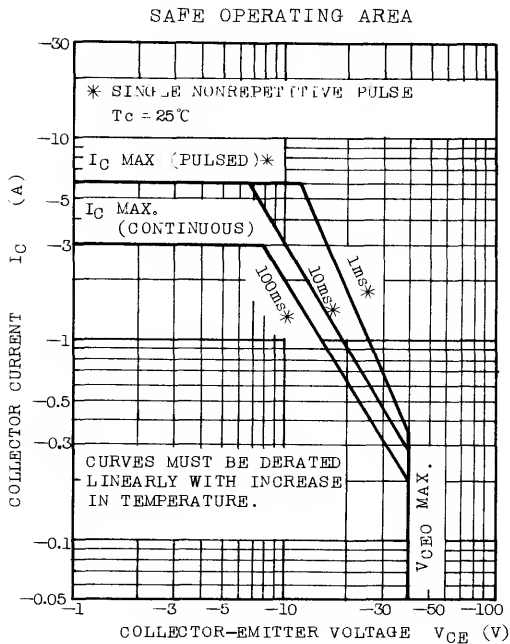
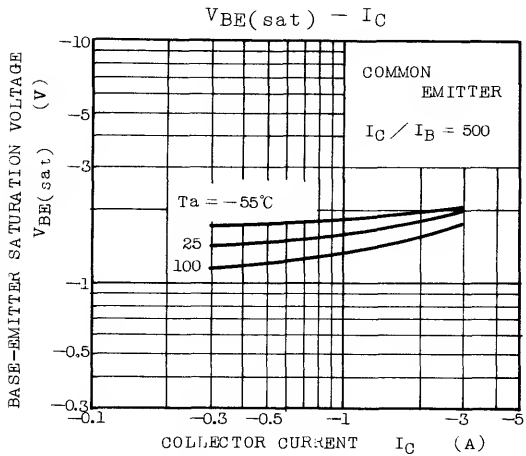
Mounting Kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=-60V$, $I_E=0$	-	-	-20	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=-5V$, $I_C=0$	-	-	-2.5	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=-25mA$, $I_B=0$	-40	-	-	V
DC Current Gain	$h_{FE(1)}$	$V_{CE}=-2V$, $I_C=-1A$	2000	-	-	
	$h_{FE(2)}$	$V_{CE}=-2V$, $I_C=-3A$	1000	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-2A$, $I_B=-4mA$	-	-	-1.5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=-2A$, $I_B=-4mA$	-	-	-2.0	V
Switching Time	Turn-on Time	t_{on}	-	0.30	-	μs
	Storage Time	t_{stg}	-	0.60	-	
	Fall Time	t_f	-	0.25	-	







INDUSTRIAL APPLICATIONS

LOW FREQUENCY MEDIUM POWER AMPLIFIER AND
MEDIUM SPEED SWITCHING APPLICATIONS.

PULSE MOTOR DRIVE, RELAY DRIVE AND HAMMER
DRIVE APPLICATIONS.

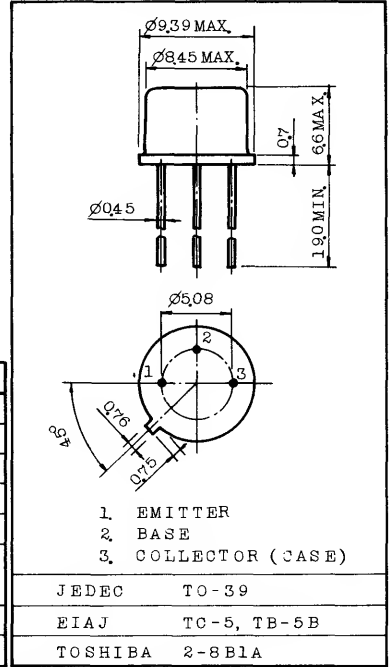
Unit in mm

FEATURES :

- High DC Current Gain : $h_{FE(2)}=1000(\text{Min.})$
($V_{CE}=-2V, I_C=-1A$)
- Low Saturation Voltage : $V_{CE}(\text{sat})=-1.5V(\text{Max.})$ ($I_C=-1A$)
- Complementary to 2SD688.

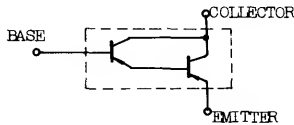
MAXIMUM RATINGS ($T_a = 25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-100	V
Collector-Emitter Voltage		V_{CEO}	-100	V
Emitter-Base Voltage		V_{EBO}	-10	V
Collector Current		I_C	-1.5	A
Emitter Current		I_E	1.5	A
Collector Power Dissipation	($T_a = 25^\circ\text{C}$)	P_C	0.8	W
	($T_c = 25^\circ\text{C}$)		8	
Junction Temperature		T_j	175	$^\circ\text{C}$
Storage Temperature Range		T_{stg}	-65~175	$^\circ\text{C}$



Weight : 1.13g

EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=-100V, I_E=0$	-	-	-10	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-10V, I_C=0$	-	-	-10	μA
Breakdown Voltage	Collector-Emitter	$V_{(BR)CEO}$	$I_C=-10\text{mA}, I_B=0$	-100	-	-	V
	Base-Emitter	$V_{(BR)EBO}$	$I_E=-5\text{mA}, I_C=0$	-10	-	-	
DC Current Gain		$h_{FE(1)}$	$V_{CE}=-2V, I_C=-0.1A$	2000	-	-	
		$h_{FE(2)}$	$V_{CE}=-2V, I_C=-1A$	1000	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE}(\text{sat})$	$I_C=-1A, I_B=-2\text{mA}$	-	-	-1.5	V
	Base-Emitter	$V_{BE}(\text{sat})$	$I_C=-1A, I_B=-2\text{mA}$	-	-	-2.5	
Switching Time	Turn-on Time	t_{on}		-	0.3	-	μs
	Storage Time	t_{stg}		-	2.0	-	
	Fall Time	t_f		-	0.7	-	

2SB679

SILICON PNP TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

INDUSTRIAL APPLICATIONS

Unit in mm

LOW FREQUENCY MEDIUM POWER AMPLIFIER AND
MEDIUM SPEED SWITCHING APPLICATIONS.

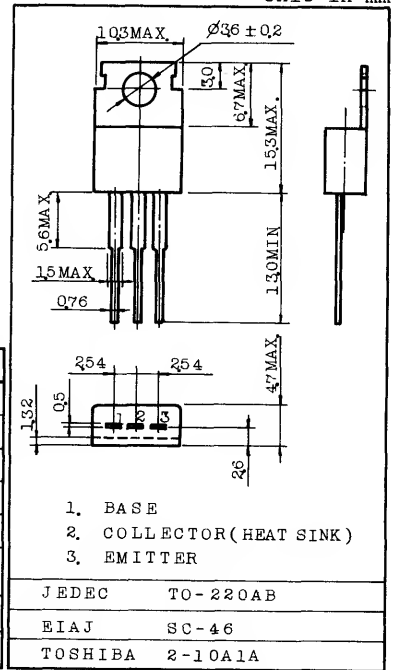
PULSE MOTOR DRIVE, RELAY DRIVE AND HAMMER
DRIVE APPLICATIONS.

FEATURES :

- High DC Current Gain : $h_{FE(2)}=1000(\text{Min.})$
($V_{CE}=-2V, I_C=-1A$)
- Low Saturation Voltage : $V_{CE(sat)}=-1.5V(\text{Max.})$ ($I_C=-1A$)
- Complementary to 2SD689.

MAXIMUM RATINGS ($T_a = 25^\circ C$)

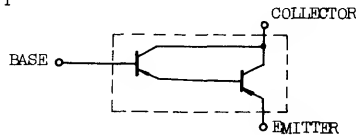
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-100	V
Collector-Emitter Voltage	V_{CEO}	-100	V
Emitter-Base Voltage	V_{EBO}	-10	V
Collector Current	I_C	-1.5	A
Emitter Current	I_E	1.5	A
Collector Power Dissipation ($T_c = 25^\circ C$)	P_C	10	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55~150	$^\circ C$



Mounting kit No.AC75

Weight : 1.9g

EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=-100V, I_E=0$	-	-	-10	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=-10V, I_C=0$	-	-	-10	μA
Breakdown Voltage	Collector-Emitter	$V_{(BR)CEO}$ $I_C=-10mA, I_B=0$	-100	-	-	V
	Emitter-Base	$V_{(BR)EBO}$ $I_E=-5mA, I_C=0$	-10	-	-	
DC Current Gain		$h_{FE(1)}$ $V_{CE}=-2V, I_C=-0.1A$	2000	-	-	
		$h_{FE(2)}$ $V_{CE}=-2V, I_C=-1A$	1000	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$ $I_C=-1A, I_B=-2mA$	-	-	-1.5	V
	Base-Emitter	$V_{BE(sat)}$ $I_C=-1A, I_B=-2mA$	-	-	-2.5	
Switching Time	Turn-on Time	t_{on}	-	0.3	-	μs
	Storage Time	t_{stg}	-	2.0	-	
	Fall Time	t_f	-	0.7	-	

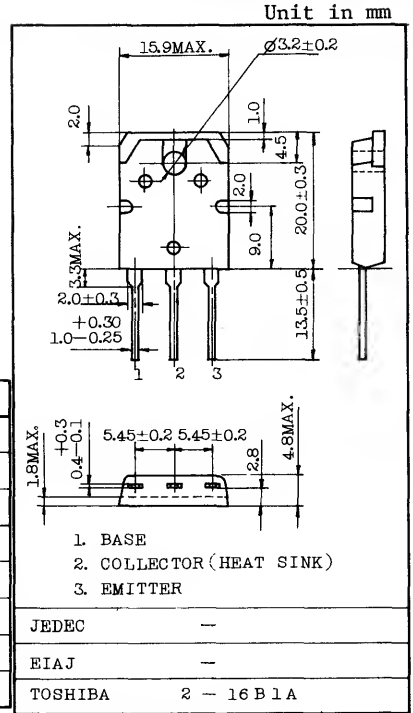
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SD716.
- Recommended for 30 ~ 35W High-Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	-100	V
Collector-Emitter Voltage	V _{CE0}	-100	V
Emitter-Base Voltage	V _{EBO}	-5	V
Collector Current	I _C	-6	A
Emitter Current	I _E	6	A
Collector Power Dissipation (T _c =25°C)	P _C	60	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55~150	°C

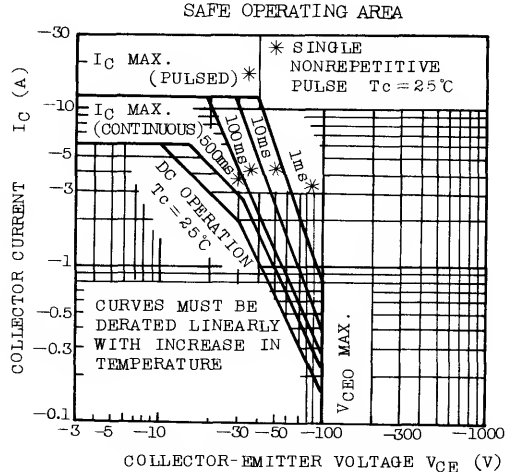
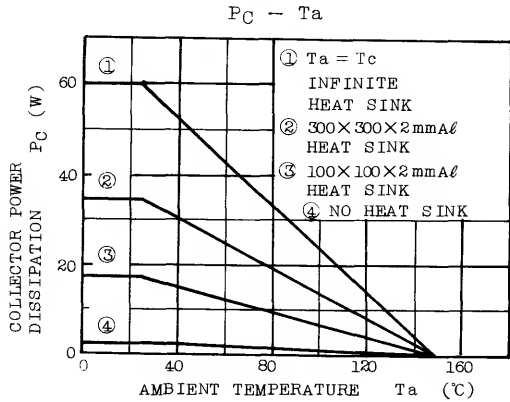
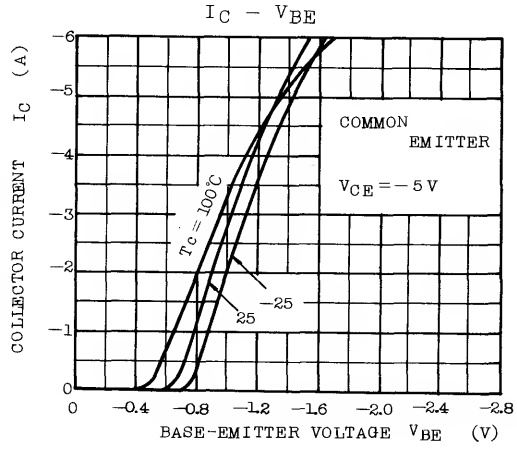
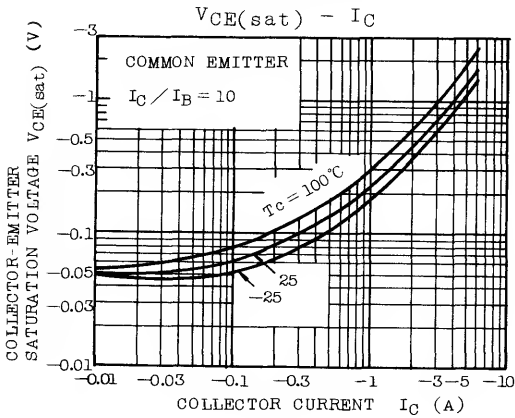
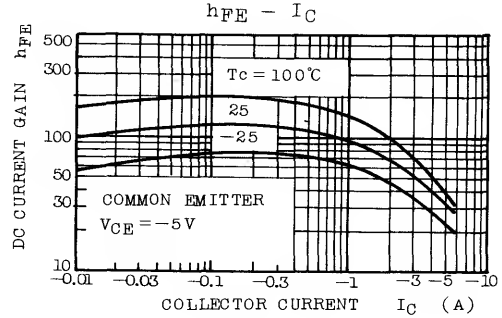
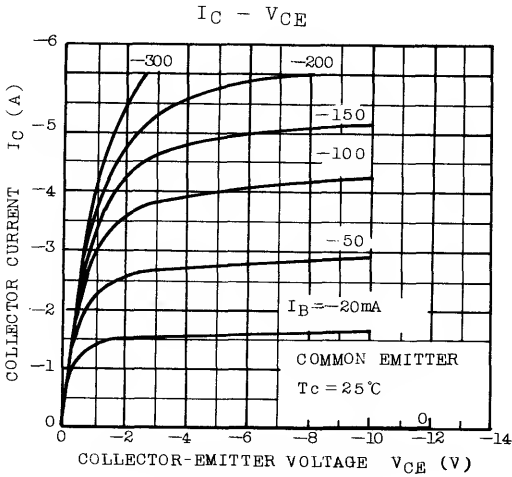


Weight : 4.6g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =-100V, I _E =0	-	-	-10	μA
Emitter Cut-off Current	I _{EBO}	V _{EB} =-5V, I _C =0	-	-	-10	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CE0}	I _C =-50mA, I _B =0	-100	-	-	V
Emitter-Base Breakdown Voltage	V _{(BR)EBO}	I _E =-10mA, I _C =0	-5	-	-	V
DC Current Gain	h _{FE} (Note)	V _{CE} =-5V, I _C =-1A	55	-	160	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =-4A, I _B =-0.4A	-	-	-2.0	V
Base-Emitter Voltage	V _{BE}	V _{CE} =-5V, I _C =-4A	-	-	-1.5	V
Transition Frequency	f _T	V _{CE} =-5V, I _C =-1A	-	10	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =-10V, I _E =0, f=1MHz	-	270	-	pF

Note : h_{FE} Classification R : 55~110, 0 : 80~160



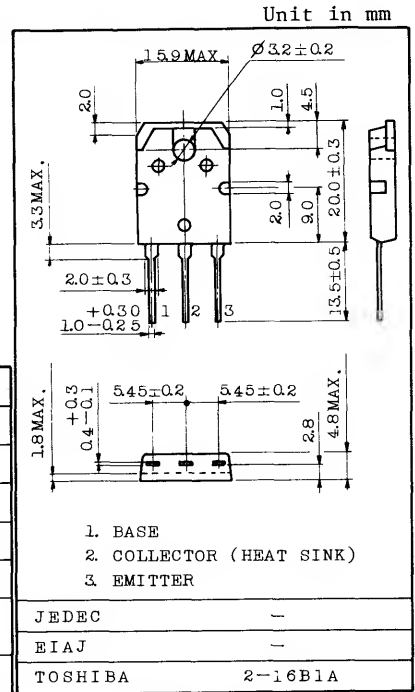
AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Complementary to 2SD718.
- . Recommended for 45 ~ 50W audio frequency amplifier output stage.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	-120	V
Collector-Emitter Voltage	V _{CE0}	-120	V
Emitter-Base Voltage	V _{EB0}	-5	V
Collector Current	I _C	-8	A
Base Current	I _B	-0.8	A
Collector Power Dissipation (T _c =25°C)	P _C	80	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55 ~ 150	°C



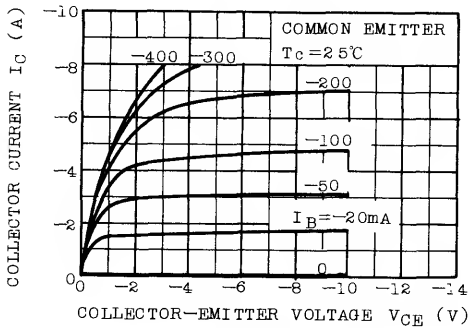
Weight : 4.6g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

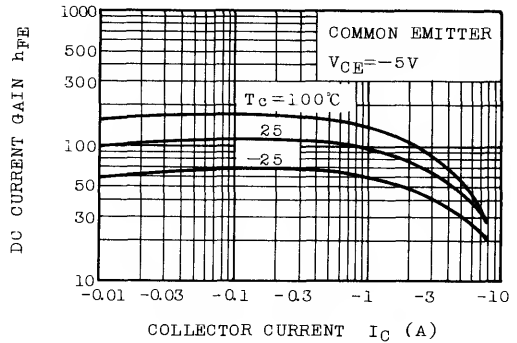
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =-120V, I _E =0	-	-	-10	μA
Emitter Cut-off Current	I _{EB0}	V _{EB} =-5V, I _C =0	-	-	-10	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CE0}	I _C =-50mA, I _B =0	-120	-	-	V
DC Current Gain	h _{FE} (Note)	V _{CE} =-5V, I _C =-1A	55	-	160	
Collector Emitter Saturation Voltage	V _{CE(sat)}	I _C =-5A, I _B =-0.5A	-	-	-2.5	V
Base-Emitter Voltage	V _{BE}	V _{CE} =-5V, I _C =-5A	-	-	-1.5	V
Transition Frequency	f _T	V _{CE} =-5V, I _C =-1A	-	10	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =-10V, I _E =0, f=1MHz	-	280	-	pF

Note: h_{FE} Classification R:55~110, O:80~160

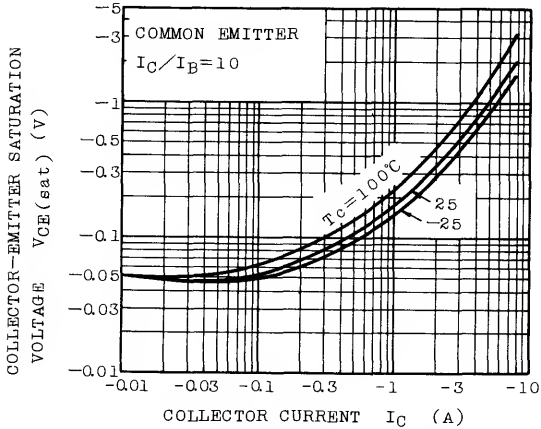
$I_C - V_{CE}$



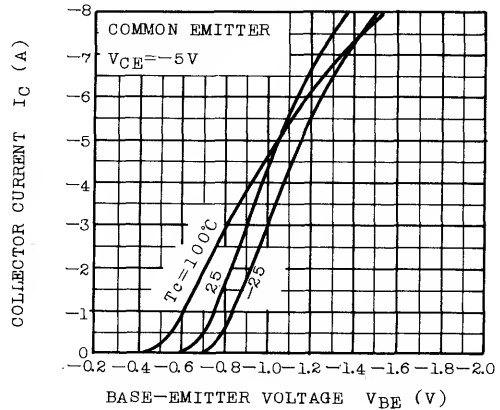
$h_{FE} - I_C$



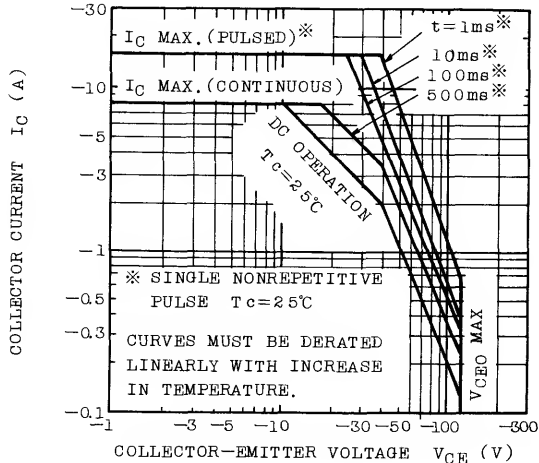
$V_{CE}(\text{sat}) - I_C$



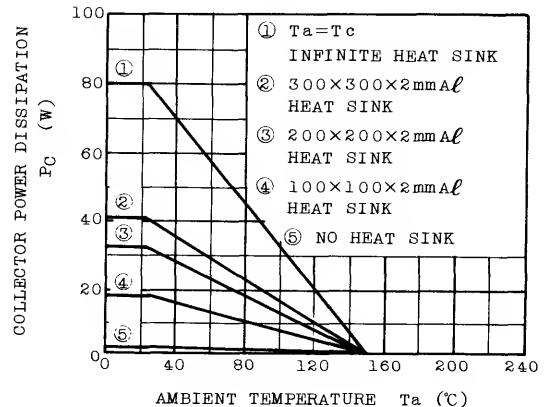
$I_C - V_{BE}$



SAFE OPERATING AREA



$P_C - T_a$



INDUSTRIAL APPLICATIONS
Unit in mm

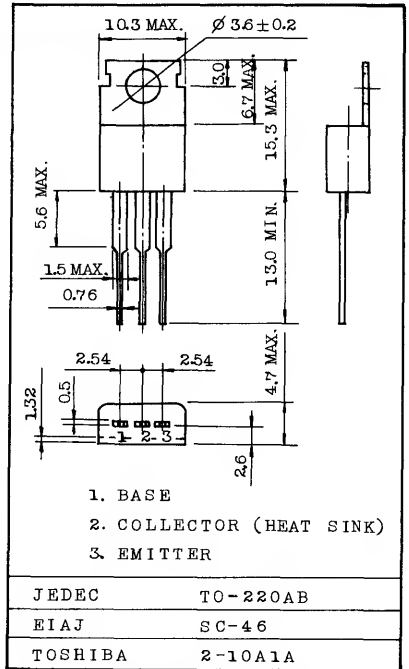
HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Collector Current : $I_C = -7A$
- Low Collector Saturation Voltage : $V_{CE(sat)} = -0.5V$ (Max.) at $I_C = -4A$
- High Collector Power Dissipation.
- Complementary to 2SD843.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-100	V
Collector-Emitter Voltage	V_{CEO}	-80	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-7	A
Collector Power Dissipation	Ta=25°C	P_C	1.5 W
	Tc=25°C	P_C	40 W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C



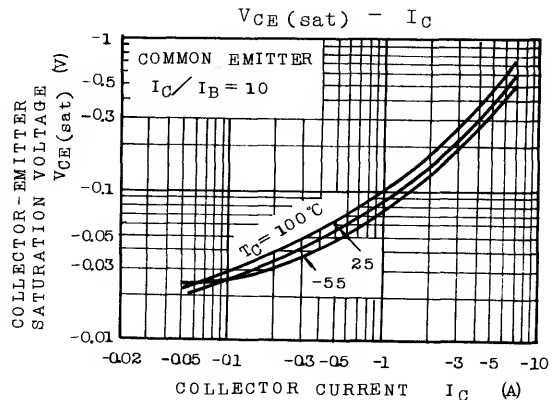
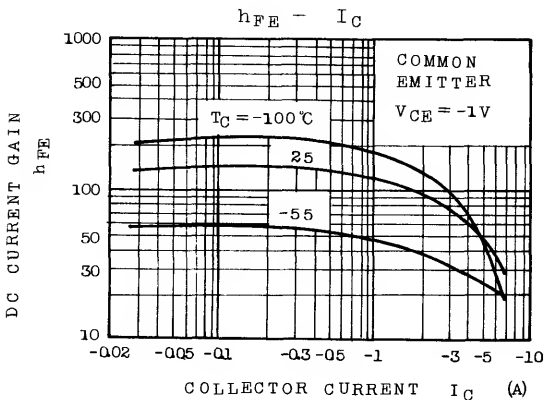
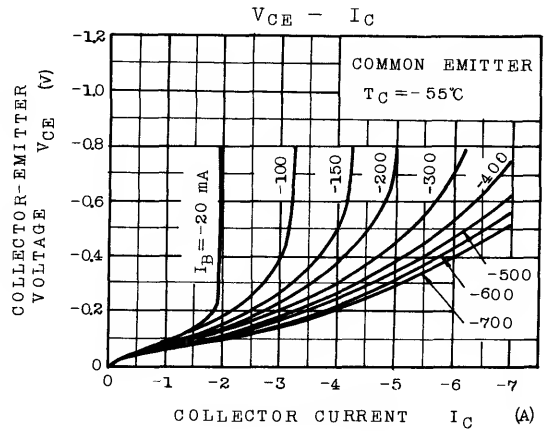
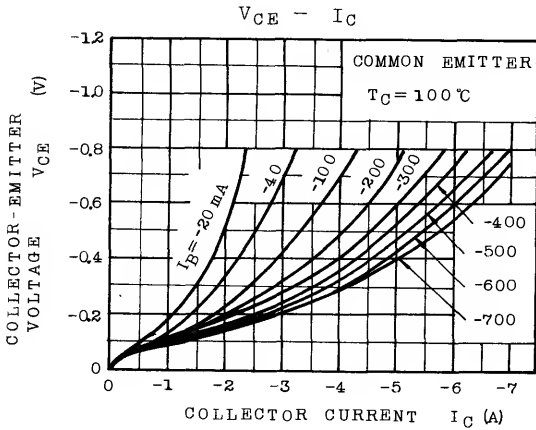
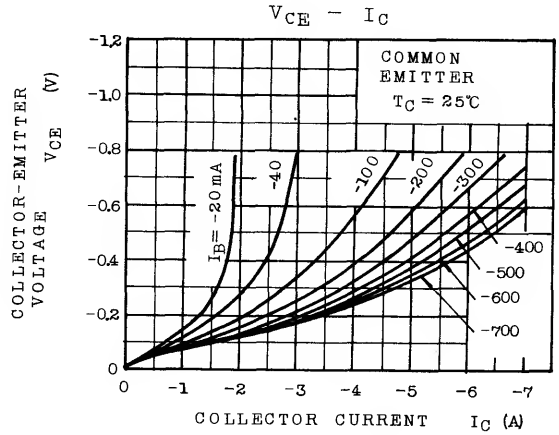
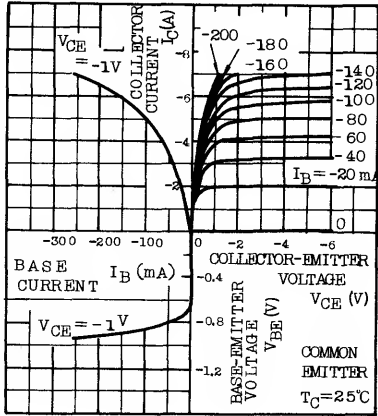
Mounting Kit No. AC75
Weight : 1.9g

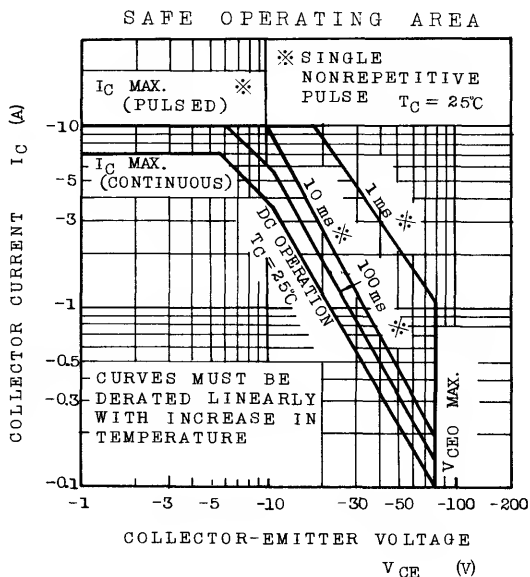
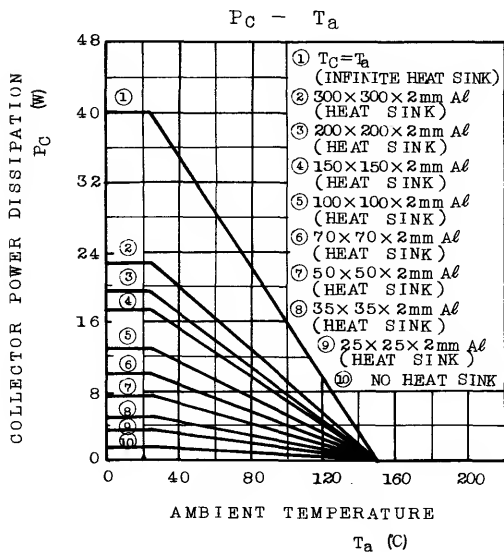
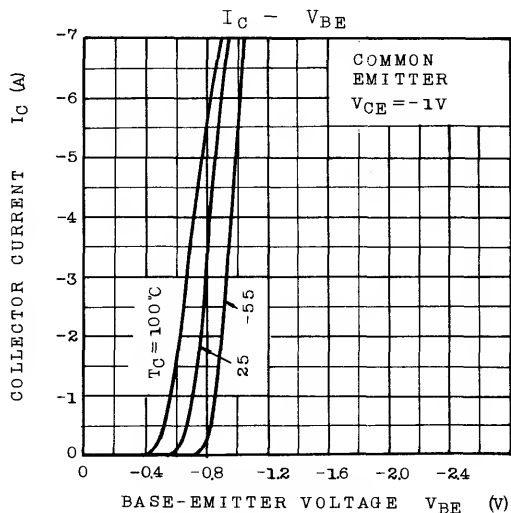
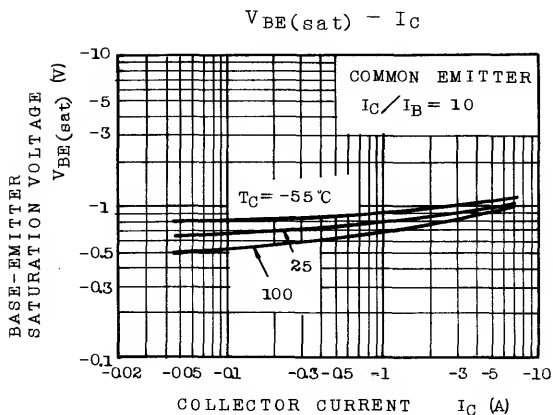
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB} = -100V, I_E = 0$	-	-	-5	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB} = -5V, I_C = 0$	-	-	-5	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C = -50mA, I_B = 0$	-80	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE} = -1V, I_C = -1A$	70	-	240	V
	$h_{FE(2)}$	$V_{CE} = -1V, I_C = -4A$	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	-	-0.3	-0.5	V
	Base-Emitter	$V_{BE(sat)}$	-	-0.9	-1.4	
Transition Frequency	f_T	$V_{CE} = -4V, I_C = -1A$	-	10	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1 MHz$	-	250	-	pF
Switching Time	Turn-on Time	t_{on}	-	0.4	-	μs
	Storage Time	t_{stg}	-	2.5	-	
	Fall Time	t_f	-	0.5	-	

Note : $h_{FE(1)}$ Classification O : 70 ~ 140, Y : 120 ~ 240

STATIC CHARACTERISTICS





2SB754

SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

Unit in mm

HIGH CURRENT SWITCHING APPLICATIONS.

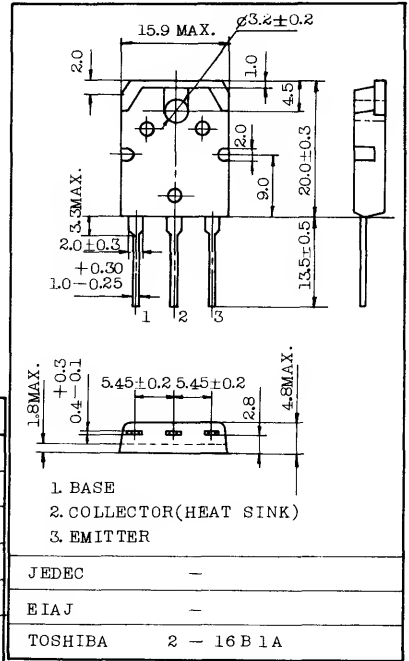
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Collector Current : $I_C = -7A$
- Low Collector Saturation Voltage
: $V_{CE(sat)} = -0.4V$ (Max.) at $I_C = -4A$
- High Power Dissipation : $P_C = 60W$ at $T_c = 25^\circ C$
- Complementary to 2SD844.

MAXIMUM RATINGS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-50	V
Collector-Emitter Voltage	V_{CEO}	-50	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-7	A
Emitter Current	I_E	7	A
Collector Power Dissipation	P_C	$T_a = 25^\circ C$	2.5
		$T_c = 25^\circ C$	60
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55~150	$^\circ C$



Weight : 4.6g

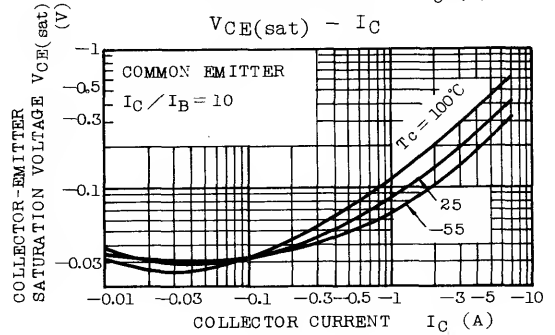
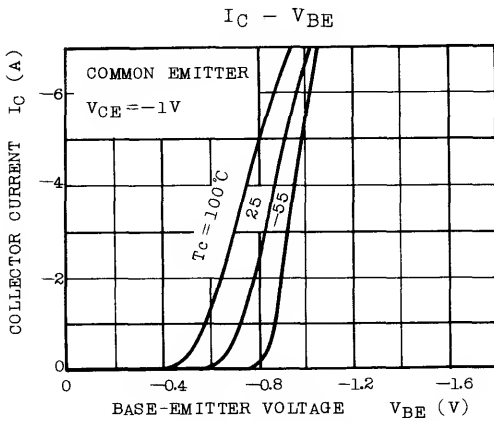
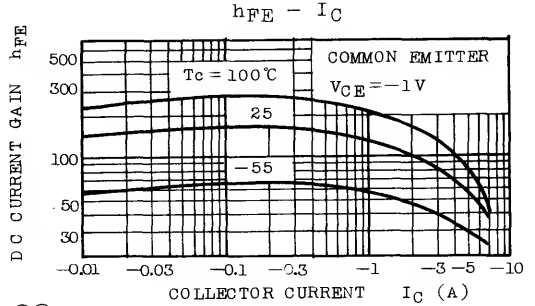
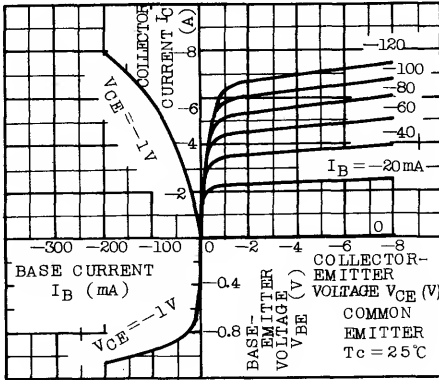
ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB} = -50V, I_E = 0$	-	-	-10	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB} = -5V, I_C = 0$	-	-	-10	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C = -50mA, I_B = 0$	-50	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E = -10mA, I_C = 0$	-5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE} = -1V, I_C = -1A$	70	-	240	
	$h_{FE(2)}$	$V_{CE} = -1V, I_C = -4A$	30	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = -4A, I_B = -0.4A$	-	-0.2	-0.4	V
Base-Emitter Voltage	V_{BE}	$V_{CE} = -1V, I_C = -4A$	-	-0.9	-1.2	V
Transition Frequency	f_T	$V_{CE} = -5V, I_C = -1A$	-	10	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	300	-	pF

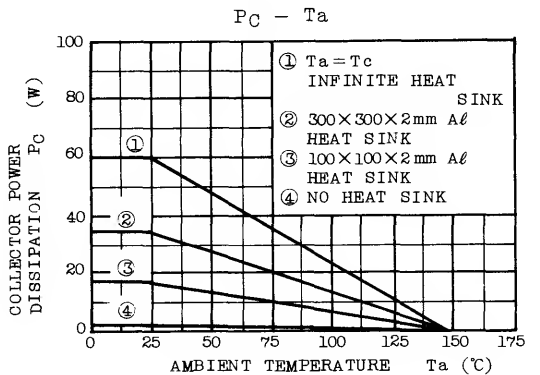
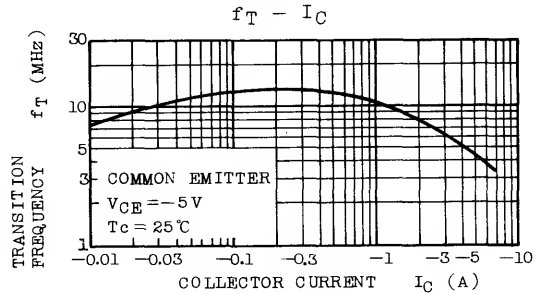
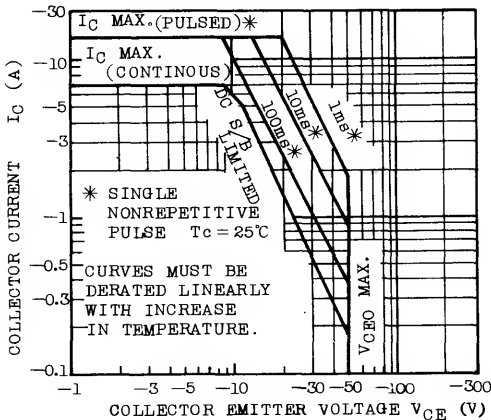
Note : $h_{FE(1)}$ Classification O : 70~140 Y : 120~240

TOSHIBA CORPORATION

STATIC CHARACTERISTICS



SAFE OPERATING AREA



2SB755

SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

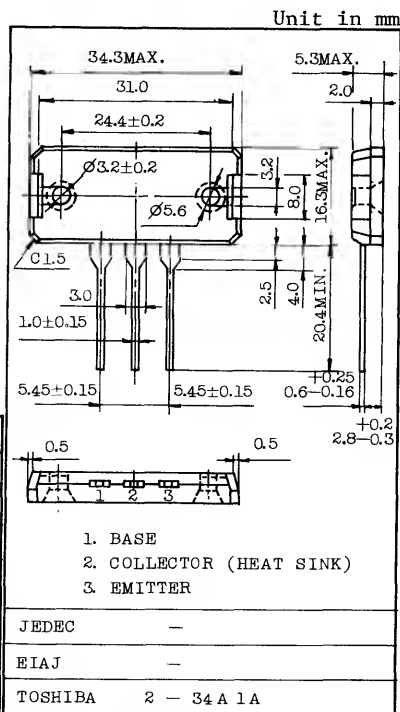
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : $V_{CEO} = -150V$ (Min.)
- High Transition Frequency : $f_T = 20MHz$ (Typ.)
- Complementary to 2SD845.
- Recommended for 80W High-Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-150	V
Collector-Emitter Voltage	V_{CEO}	-150	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-12	A
Emitter Current	I_E	12	A
Collector Power Dissipation ($T_c = 25^\circ C$)	P_C	120	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55~150	$^\circ C$

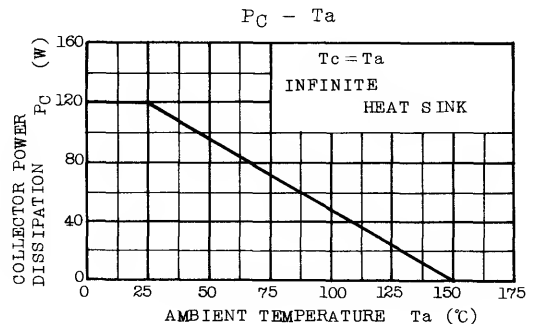
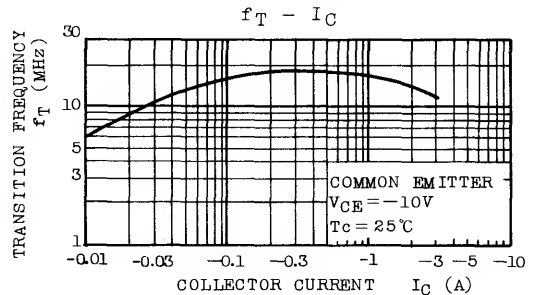
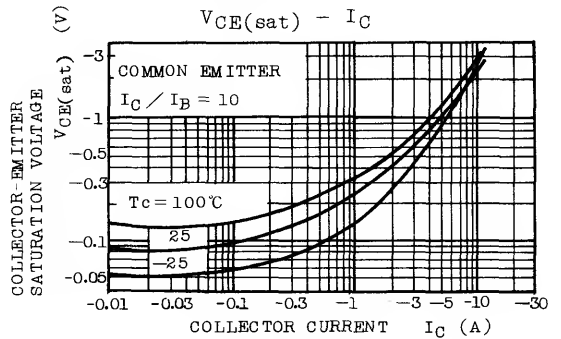
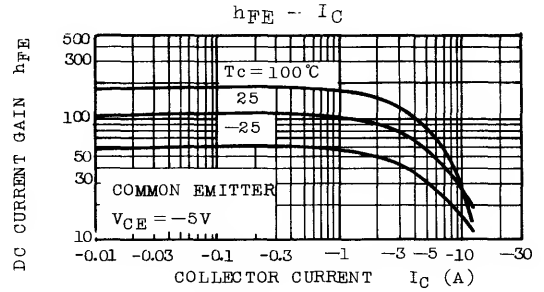
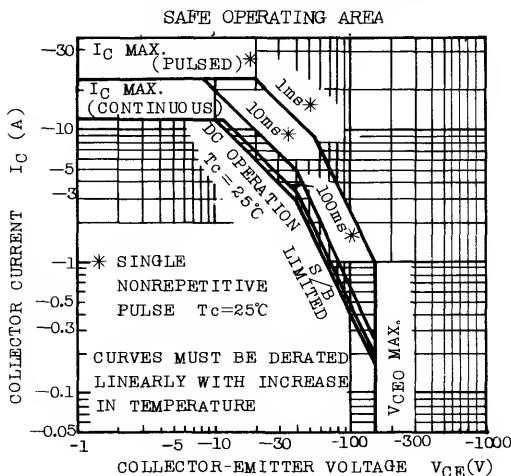
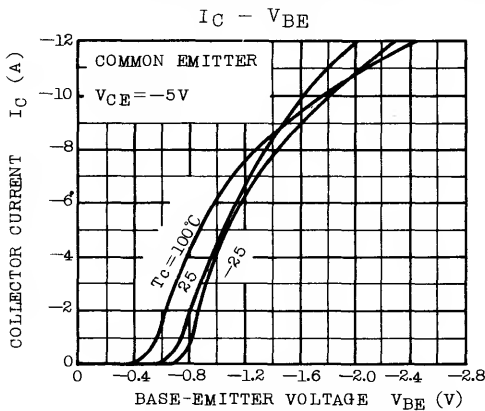
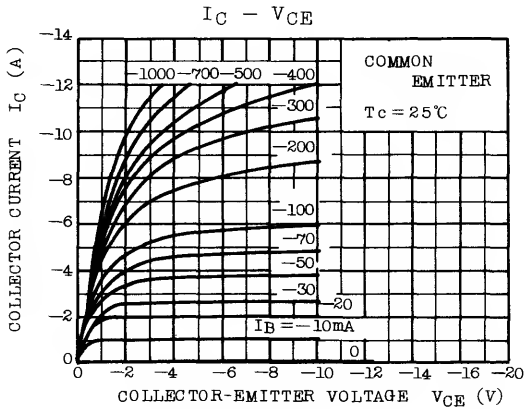


Weight : 10.8g

ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB} = -150V, I_E = 0$	-	-	-50	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB} = -5V, I_C = 0$	-	-	-50	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C = -0.1A, I_B = 0$	-150	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E = -10mA, I_C = 0$	-5	-	-	V
DC Current Gain	h_{FE} (Note)	$V_{CE} = -5V, I_C = -1A$	55	-	160	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = -5V, I_B = -0.5A$	-	-	-2.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE} = -5V, I_C = -5A$	-	-	-1.5	V
Transition Frequency	f_T	$V_{CE} = -10V, I_C = -1A$	-	20	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	450	-	pF

Note : h_{FE} Classification R : 55~110, 0 : 80~160



2SB833

SILICON PNP TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

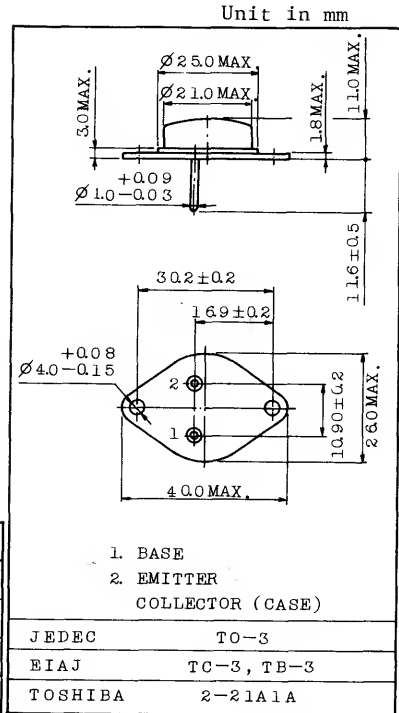
HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- High Collector Current : $I_C = -30A$
- High DC Current Gain
: $h_{FE(2)} = 1000(\text{Min.})$ ($V_{CE} = -5V, I_C = -20A$)
- Monolithic Construction with Built-In Base-Emitter Shunt Resistor.

MAXIMUM RATINGS ($T_a = 25^\circ C$)

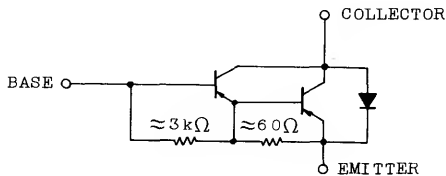
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-80	V
Collector-Emitter Voltage	V_{CE0}	-80	V
Emitter-Base Voltage	V_{EB0}	-5	V
Collector Current	I_C	-30	A
Base Current	I_B	-1	A
Collector Power Dissipation ($T_c = 25^\circ C$)	P_C	150	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 150	$^\circ C$



Mounting kit No. AC73

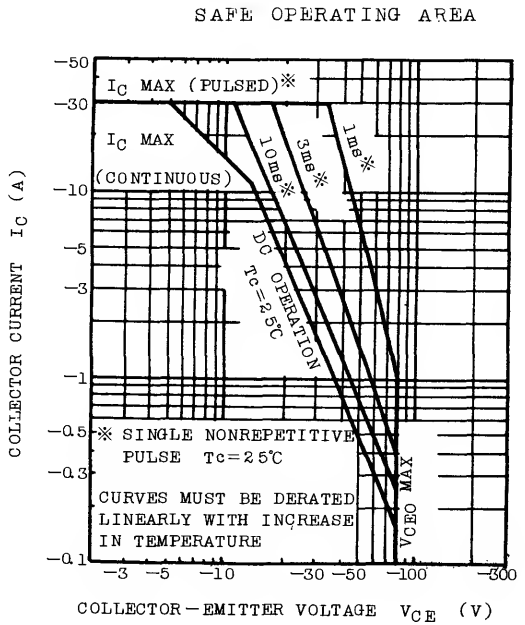
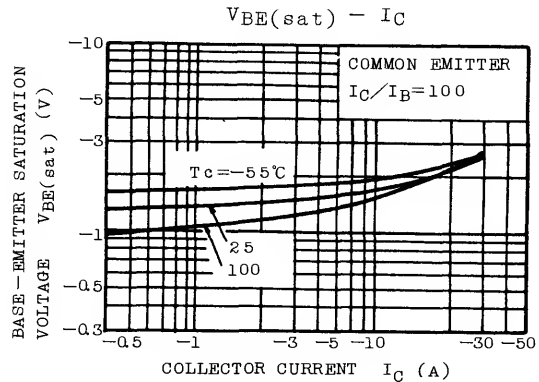
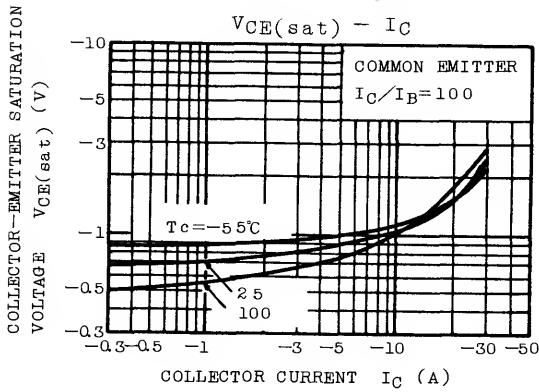
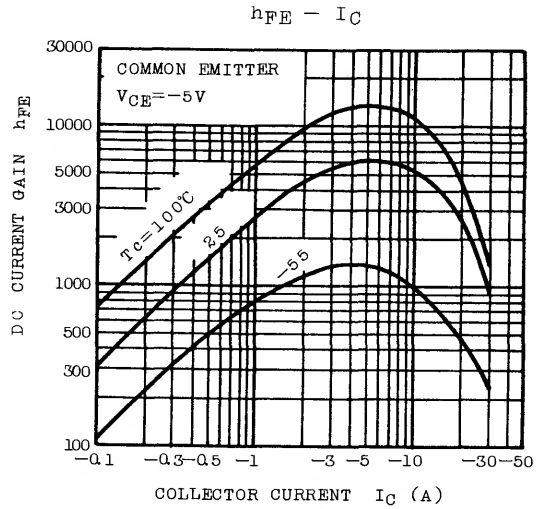
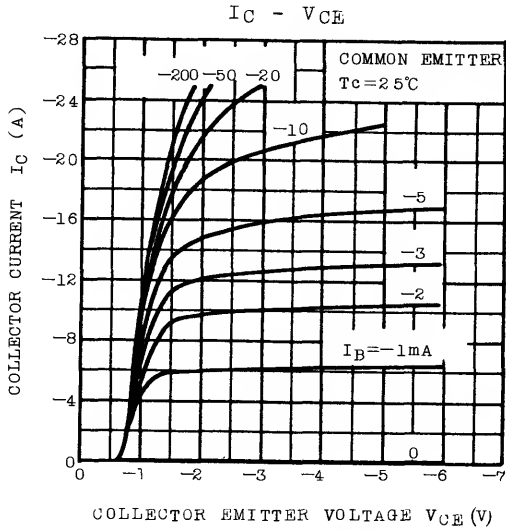
Weight : 12.9g

EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		ICBO	VCB=-80V, IE=0	-	-	-100	μA
Emitter Cut-off Current		IEBO	VEB=-5V, IC=0	-	-	-10	mA
Collector-Emitter Breakdown Voltage		V(BR)CEO	IC=-50mA, IB=0	-80	-	-	V
DC Current Gain		hFE(1)	VCE=-5V, IC=-20A	1000	-	-	
		hFE(2)	VCE=-5V, IC=-30A	200	-	-	
Collector-Emitter Saturation Voltage		VCE(sat)	IC=-20A, IB=-0.2A	-	-	-3	V
Base-Emitter Saturation Voltage		VBE(sat)		-	-	-3.5	V
Emitter-Collector Forward Voltage		VECF	IE=-10A, IB=0	-	-	-3	V
Transition Frequency		fT	VCE=-5V, IC=-1A	-	10	-	MHz
Collector Output Capacitance		Cob	VCB=-10V, IE=0, f=1MHz	-	400	-	pF
Switching Time	Turn-on Time	ton	<p style="text-align: center;"> $V_{CC} = -50V$ $R = 10\Omega$ INPUT $20\mu s$ OUTPUT $-I_{B1} = I_{B2} = 0.01A$ DUTY CYCLE $\leq 1\%$ </p>	-	1.5	-	μs
	Storage Time	tstg		-	4	-	
	Fall Time	tf		-	-	2	



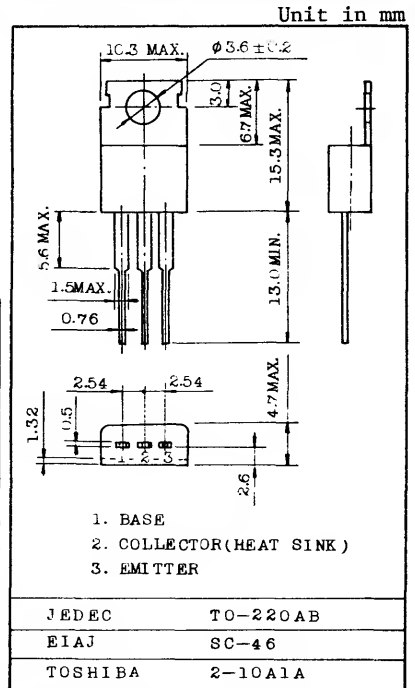
AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
: $V_{CE(sat)} = -1.0V$ (Max.) at $I_C = -3A$, $I_B = -0.3A$
- Collector Power Dissipation
: $P_C = 30W$ ($T_c = 25^\circ C$)
- Complementary to 2SD880.

MAXIMUM RATINGS ($T_a = 25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-60	V
Collector-Emitter Voltage		V_{CEO}	-60	V
Emitter-Base Voltage		V_{EBO}	-7	V
Collector Current		I_C	-3	A
Base Current		I_B	-0.5	A
Collector Power Dissipation	$T_a = 25^\circ C$	P_C	1.5	W
	$T_c = 25^\circ C$		30	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55~150	$^\circ C$

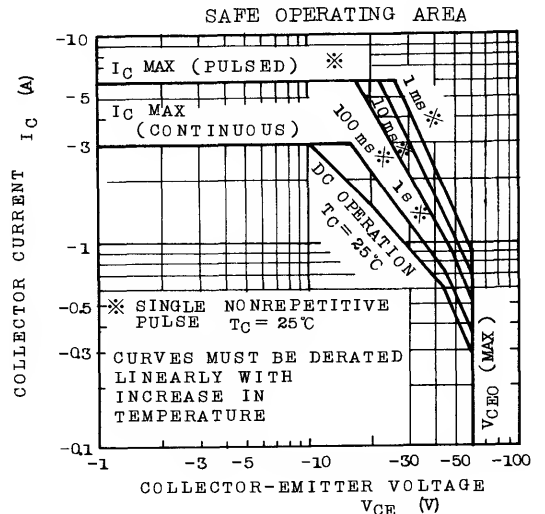
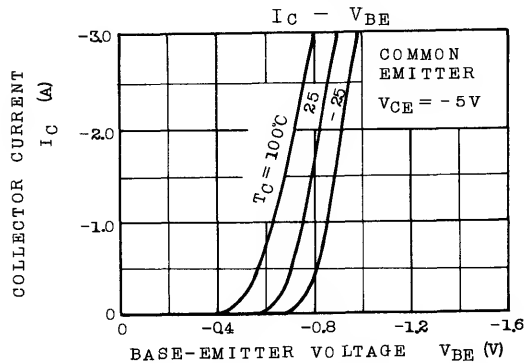
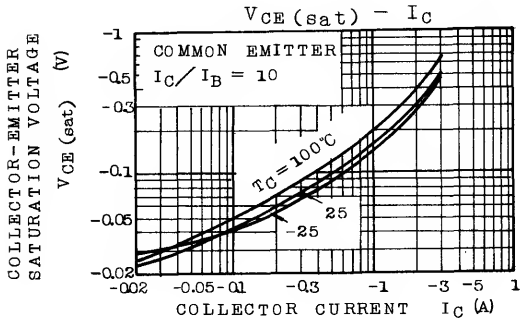
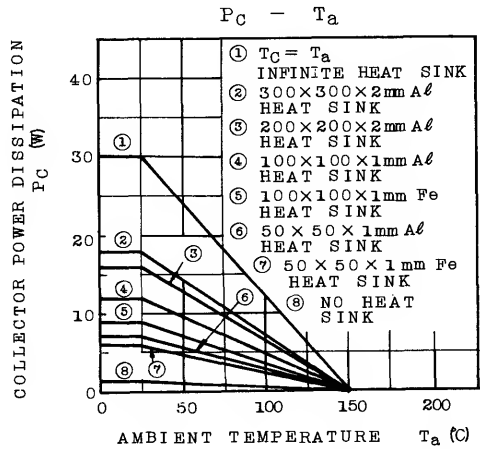
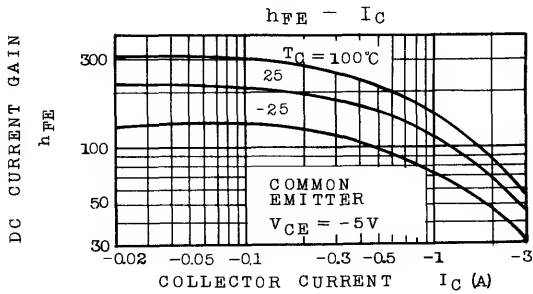
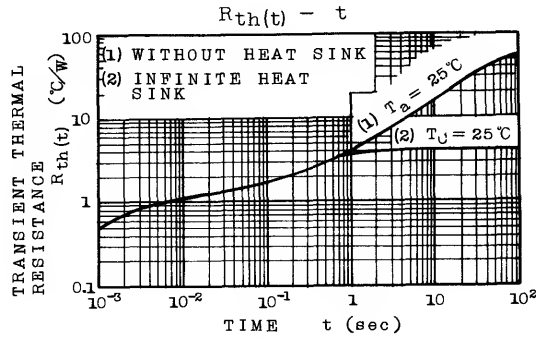
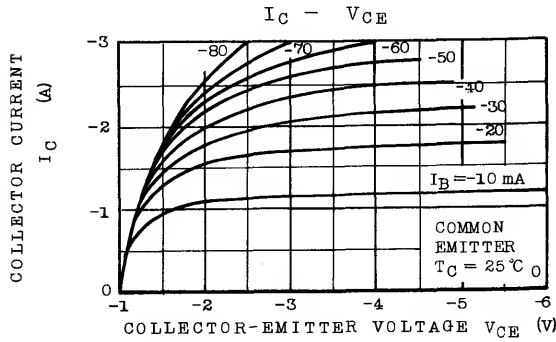


ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

Mounting Kit No. AC75
Weight : 1.9g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB} = -60V$, $I_E = 0$	-	-	-100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB} = -7V$, $I_C = 0$	-	-	-100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C = -50mA$, $I_B = 0$	-60	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$h_{FE(2)}$	$V_{CE} = -5V$, $I_C = -0.5A$	60	-	200	
			$V_{CE} = -5V$, $I_C = -3A$	20	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C = -3A$, $I_B = -0.3A$	-	-0.5	-1.0	V
Base-Emitter Voltage		V_{BE}	$V_{CE} = -5V$, $I_C = -0.5A$	-	-0.7	-1.0	V
Transition Frequency		f_T	$V_{CE} = -5V$, $I_C = -0.5A$	-	9	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB} = -10V$, $I_E = 0$, $f = 1MHz$	-	150	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.4	-	μs
	Storage Time	t_{stg}		-	1.7	-	
	Fall Time	t_f		$-I_{B1} = I_{B2} = 0.2A$ DUTY CYCLE $\leq 1\%$	-	0.5	

Note: $h_{FE(1)}$ Classification O: 60~120, Y: 100~200



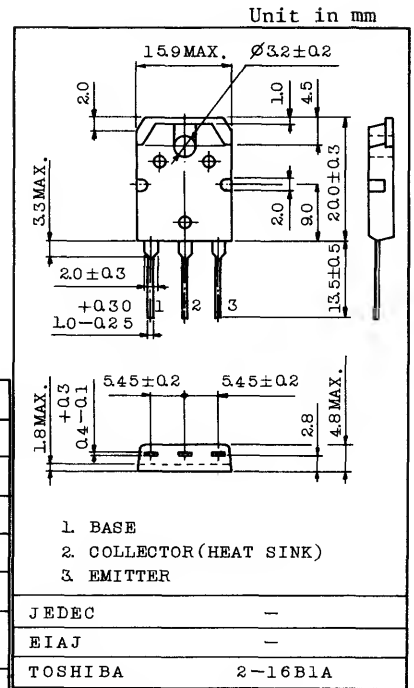
o POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SD1148
- Recommend for 70W High Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	-140	V
Collector-Emitter Voltage	V _{CE0}	-140	V
Emitter-Base Voltage	V _{EB0}	-5	V
Collector Current	I _C	-10	A
Base Current	I _B	-1	A
Collector Power Dissipation (Tc=25°C)	P _C	100	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55 ~ 150	°C

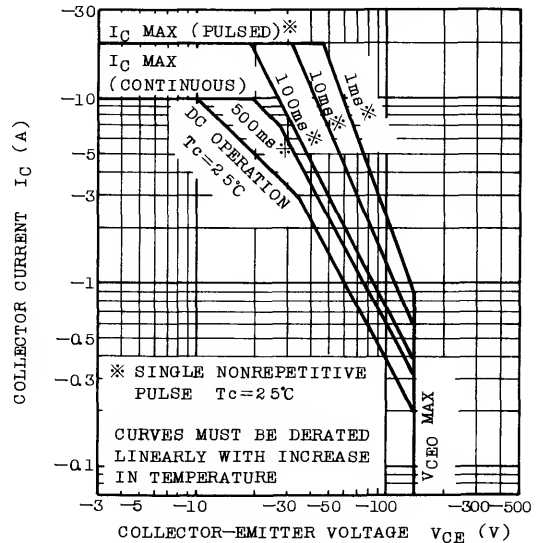
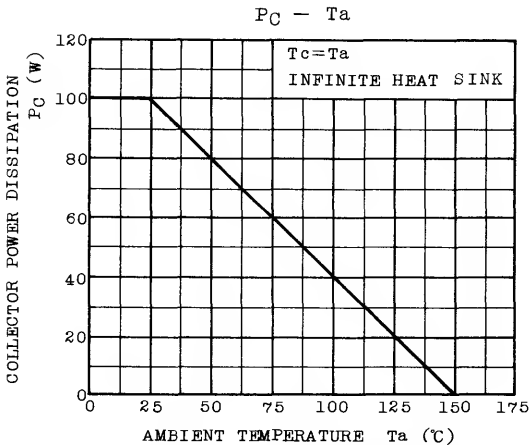
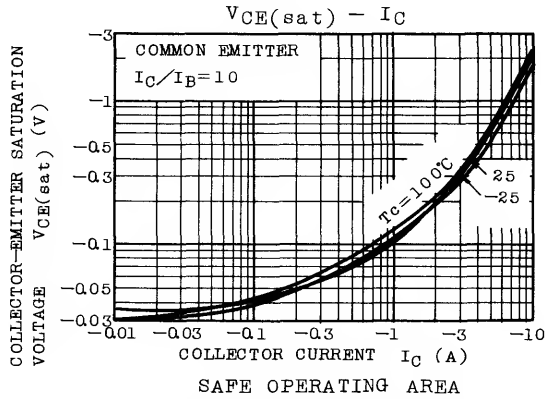
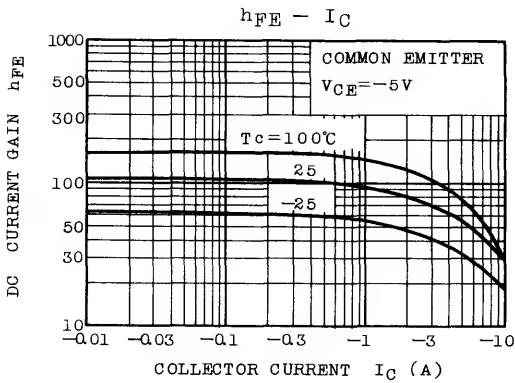
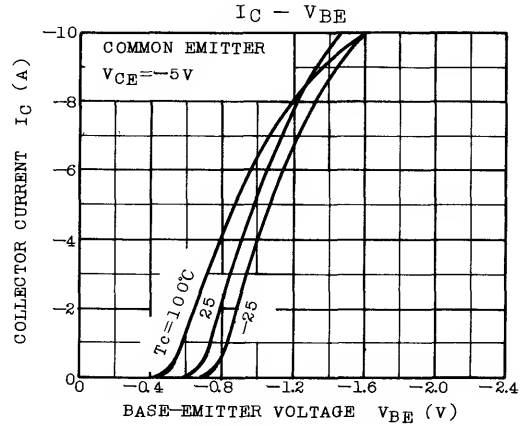
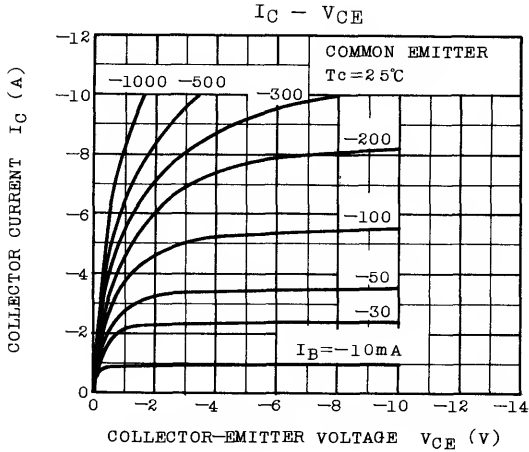


Weight : 4.6g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =-140V, I _E =0	-	-	-5.0	μA
Emitter Cut-off Current	I _{EB0}	V _{EB} =-5V, I _C =0	-	-	-5.0	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CEO}	I _C =-50mA, I _B =0	-140	-	-	V
DC Current Gain	h _{FE} (1) (Note)	V _{CE} =-5V, I _C =-1A	55	-	160	
	h _{FE} (2)	V _{CE} =-5V, I _C =-5A	25	-	-	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =-5A, I _B =-0.5A	-	-0.6	-2.0	V
Base-Emitter Voltage	V _{BE}	V _{CE} =-5V, I _C =-5A	-	-0.96	-1.5	V
Transition Frequency	f _T	V _{CE} =-10V, I _C =-1A	-	15	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =-10V, I _E =0, f=1MHz	-	400	-	pF

Note: h_{FE}(1) Classification R : 55~110 O : 80~160



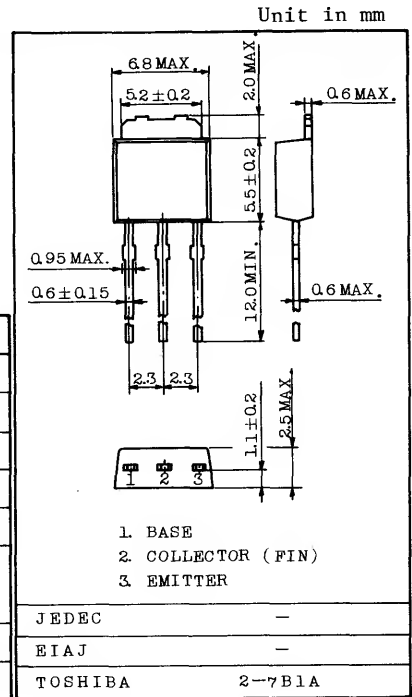
POWER AMPLIFIER APPLICATION.

FEATURES:

- Complementary to 2SD1220

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	-150	V
Collector-Emitter Voltage	V _{CEO}	-150	V
Emitter-Base Voltage	V _{EBO}	-6	V
Collector Current	I _C	-1.5	A
Base Current	I _B	-1.0	A
Collector Power Dissipation	P _C	Ta=25°C	1.0
		Tc=25°C	10
Junction Temperature	T _j	150	°C
Storage Temperature	T _{stg}	-55 ~ 150	°C



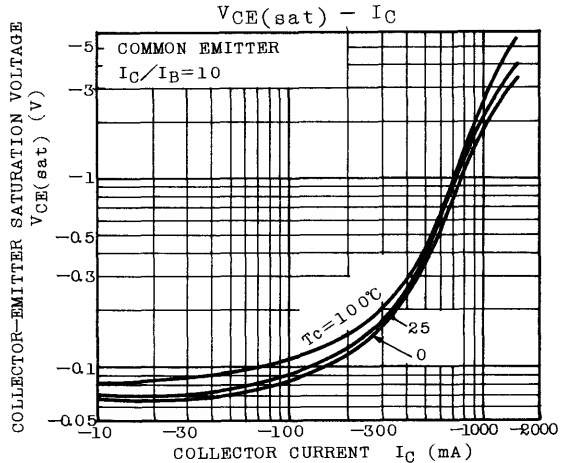
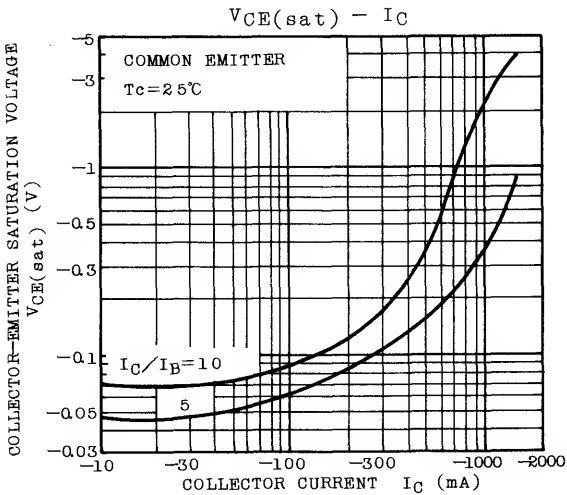
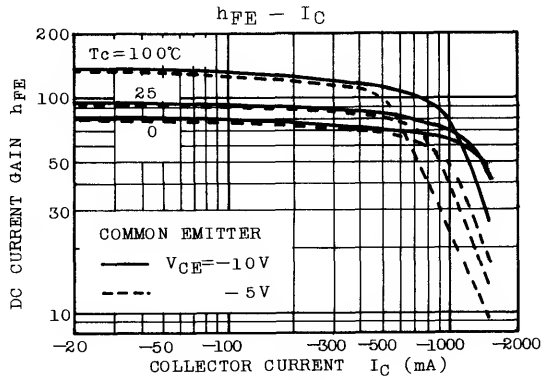
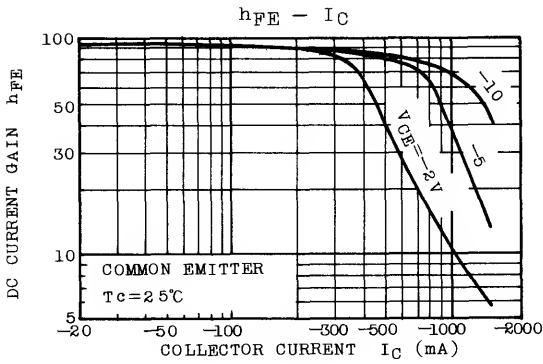
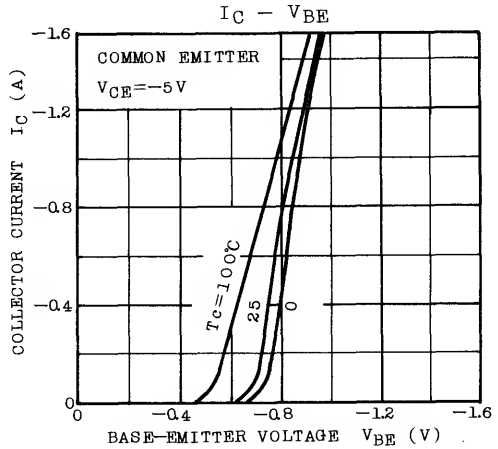
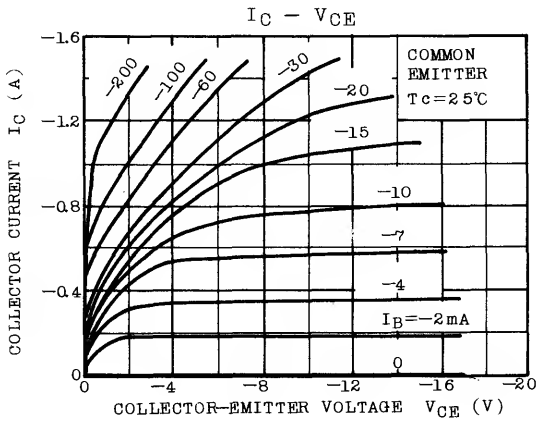
Weight : 0.36g

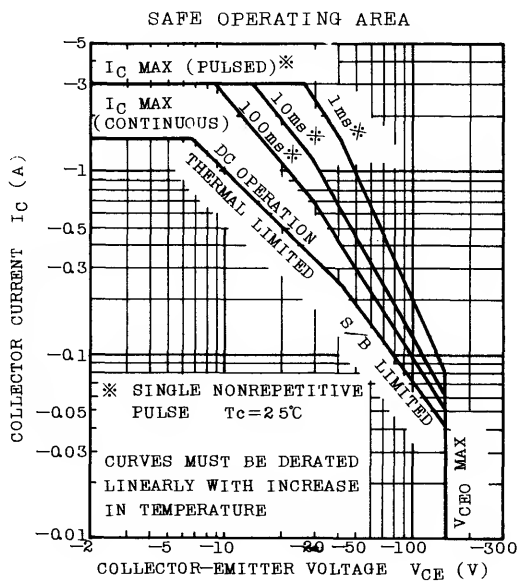
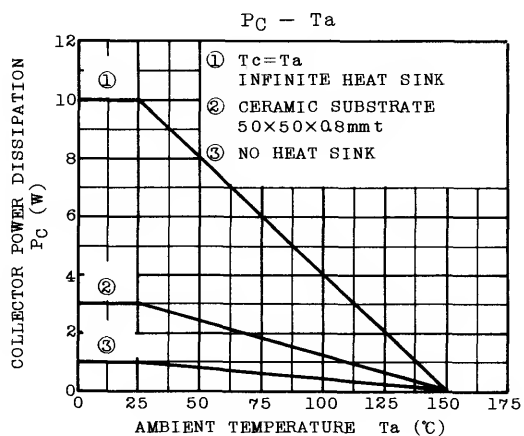
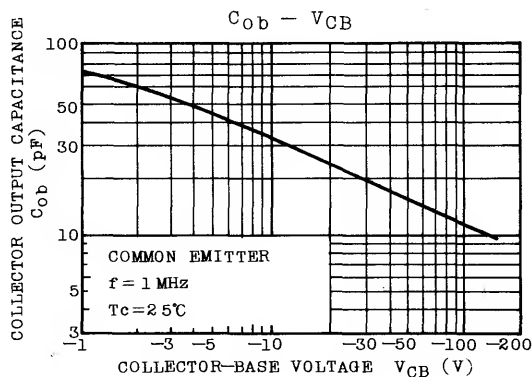
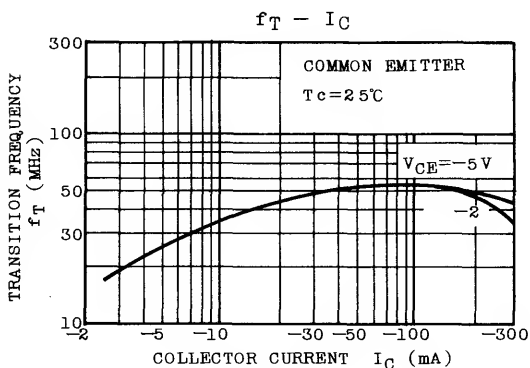
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CBc}	V _{CB} =-150V, I _E =0	-	-	-1.0	μA
Emitter Cut-off Current	I _{EBO}	V _{EB} =-6V, I _C =0	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CEO}	I _C =-10mA, I _B =0	-150	-	-	V
DC Current Gain	h _{FE} (Note)	V _{CE} =-5V, I _C =-200mA	60	-	320	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =-500mA, I _B =-50mA	-	-	-1.5	V
Base-Emitter Voltage	V _{BE}	V _{CE} =-5V, I _C =-5mA	-0.5	-	-0.8	V
Transition Frequency	f _T	V _{CE} =-5V, I _C =-200mA	15	50	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =-10V, I _E =0, f=1MHz	-	-	35	pF

Note: h_{FE} Classification R : 60 ~ 120, O : 100 ~ 200, Y : 160 ~ 320

2SB905





2SB906

SILICON PNP TIRPLE DIFFUSED TYPE (PCT PROCESS)

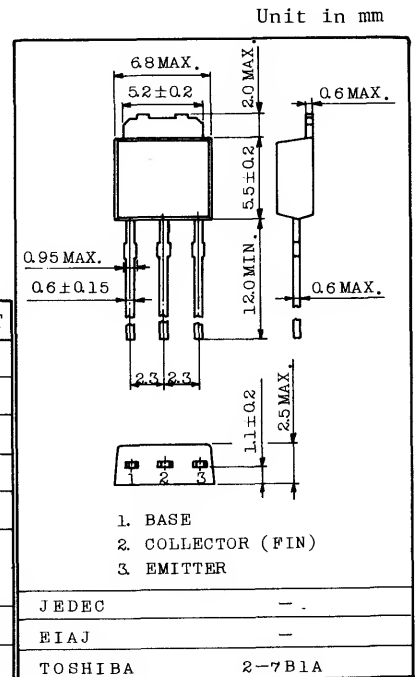
AUDIO FREQUENCY POWER AMPLIFIER APPLICATION.

FEATURES:

- Low Collector Saturation Voltage
: $V_{CE(sat)} = -1.0V$ (Typ.) ($I_C = -3A$, $I_B = -0.3A$)
- High Power Dissipation : $P_C = 20W$ ($T_c = 25^\circ C$)
- Complementary to 2SD1221

MAXIMUM RATINGS ($T_a = 25^\circ C$)

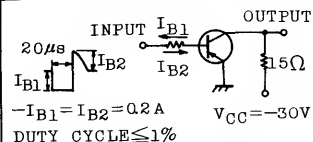
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-60	V
Collector-Emitter Voltage	V_{CE0}	-60	V
Emitter-Base Voltage	V_{EB0}	-7	V
Collector Current	I_C	-3	A
Base Current	I_B	-0.5	A
Collector Power Dissipation	P_C	$T_a = 25^\circ C$	1.0
		$T_c = 25^\circ C$	20
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature	T_{stg}	-55 ~ 155	$^\circ C$



Weight : 0.36g

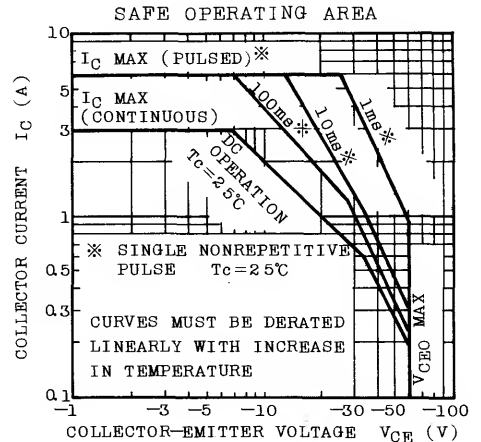
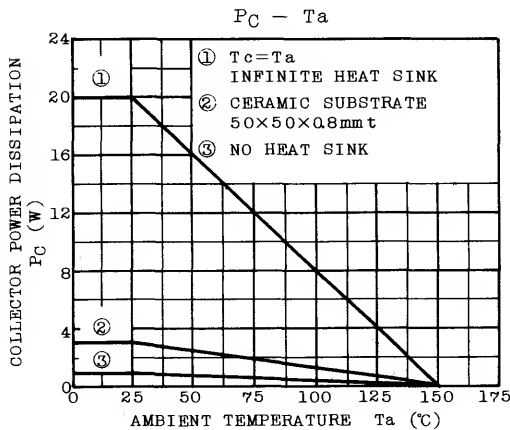
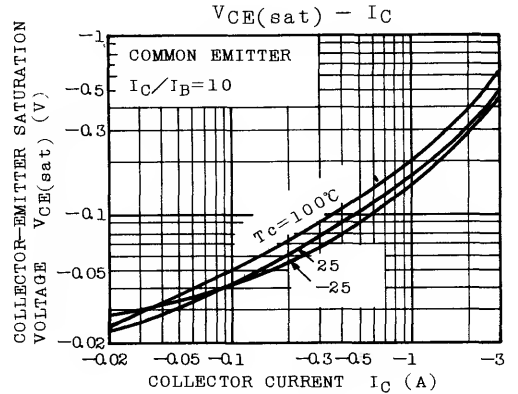
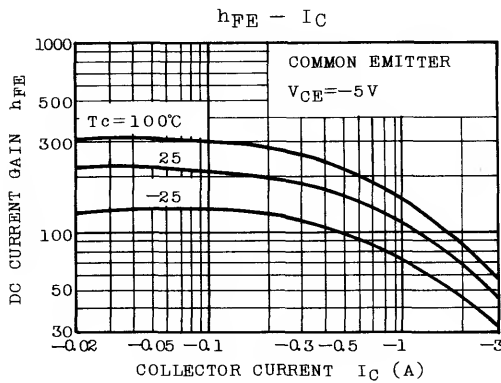
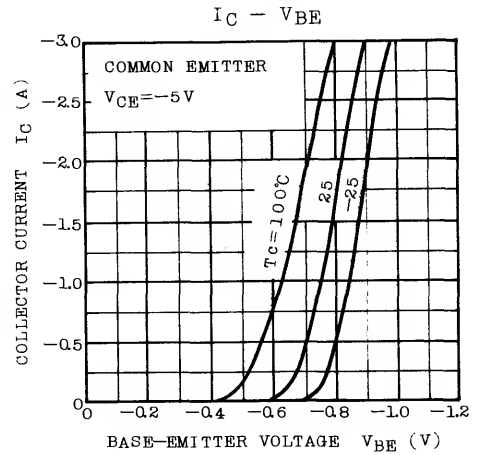
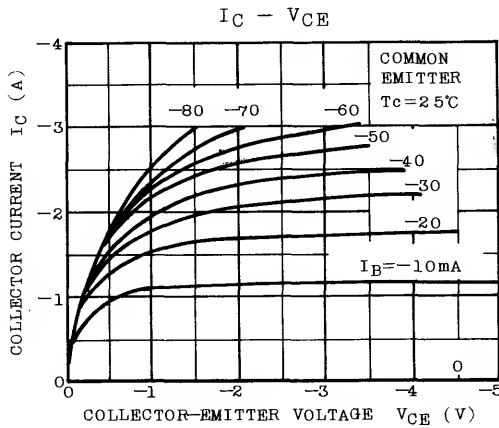
ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB} = -60V$, $I_E = 0$	-	-	-100	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB} = -7V$, $I_C = 0$	-	-	-100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C = -50mA$, $I_B = 0$	-60	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE} = -5V$, $I_C = -0.5A$	60	-	200	
	$h_{FE(2)}$	$V_{CE} = -5V$, $I_C = -3A$	20	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = -3A$, $I_B = -0.3A$	-	-1.0	-1.7	V
Base-Emitter Voltage	V_{BE}	$V_{CE} = -5V$, $I_C = -0.5A$	-	-1.0	-1.5	V
Transition Frequency	f_T	$V_{CE} = -5V$, $I_C = -0.5A$	-	9	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB} = -10V$, $I_E = 0$, $f = 1MHz$	-	150	-	pF
Switching Time	Turn-on Time	t_{on}	-	0.4	-	μs
	Storage Time	t_{stg}	-	1.7	-	
	Fall Time	t_f	-	0.5	-	



Note : h_{FE} Classification O : 60 ~ 120, Y : 100 ~ 200

TOSHIBA CORPORATION



2SB907

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

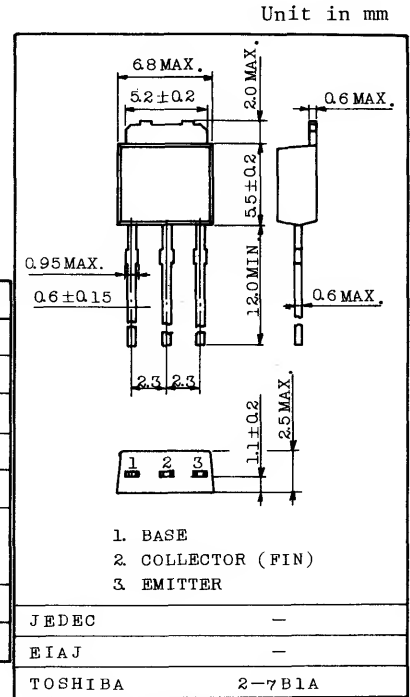
SWITCHING APPLICATIONS.
HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

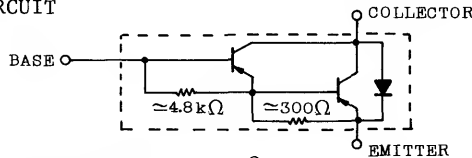
- High DC Current Gain
: $h_{FE(1)}=2000(\text{Min.})$ ($V_{CE}=-2V, I_C=-1A$)
- Low Saturation Voltage
: $V_{CE}(\text{sat})=-1.5V(\text{Max.})$ ($I_C=-2A$)
- Complementary to 2SD1222.

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-60	V
Collector-Emitter Voltage		V_{CEO}	-40	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-3	A
Base Current		I_B	-0.3	A
Collector Power Dissipation	$T_a=25^\circ\text{C}$	P_C	1.0	W
	$T_c=25^\circ\text{C}$		15	
Junction Temperature		T_j	150	$^\circ\text{C}$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ\text{C}$



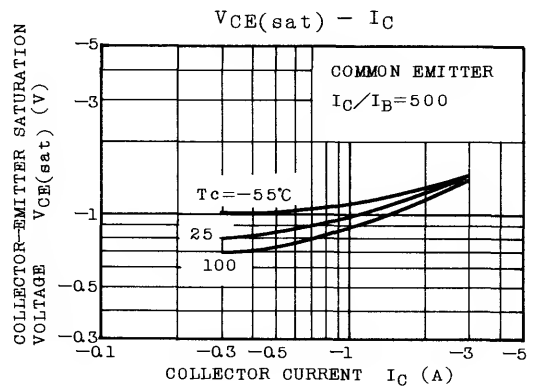
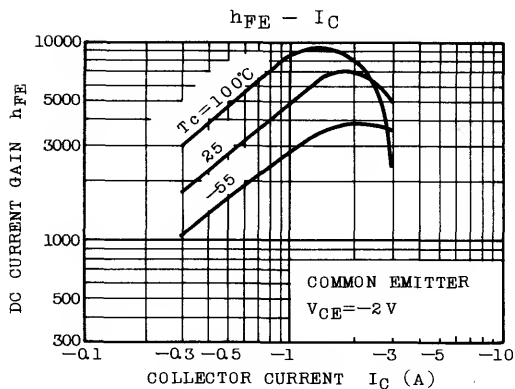
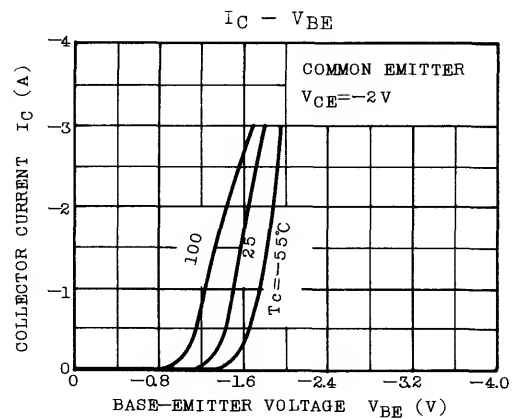
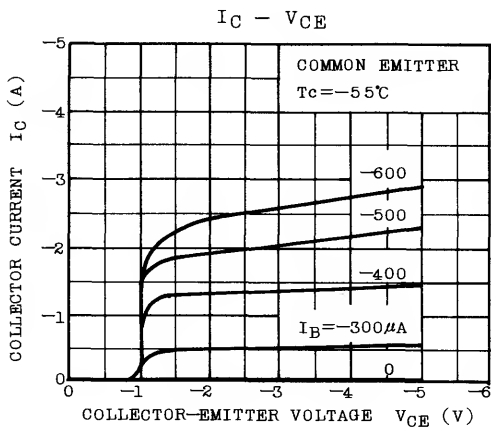
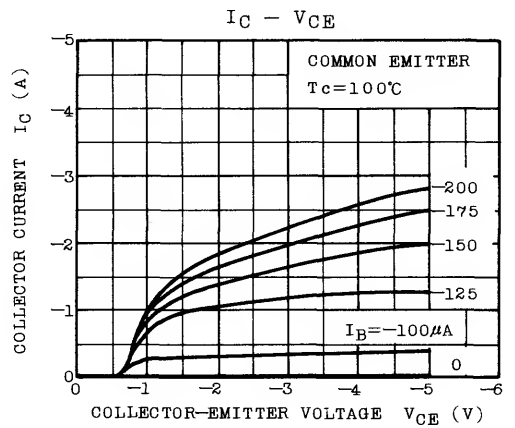
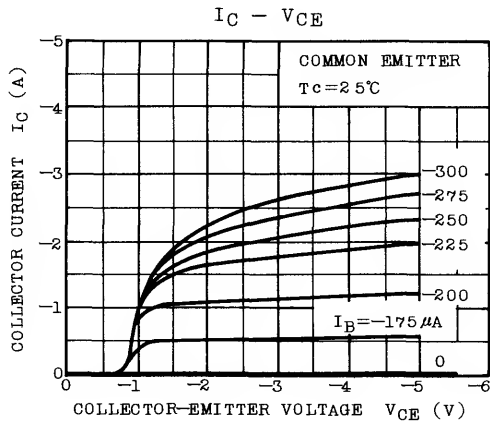
EQUIVALENT CIRCUIT



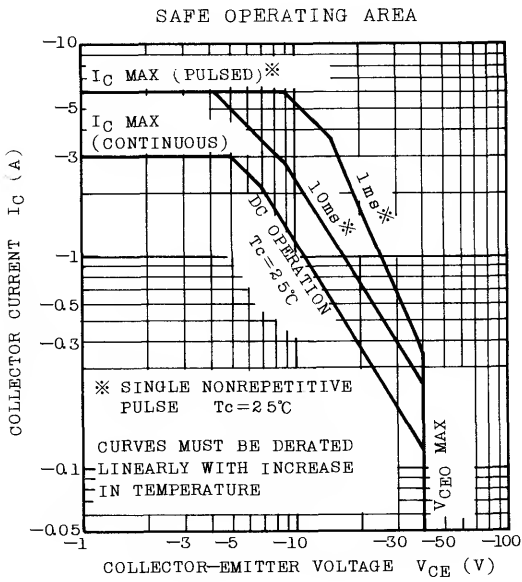
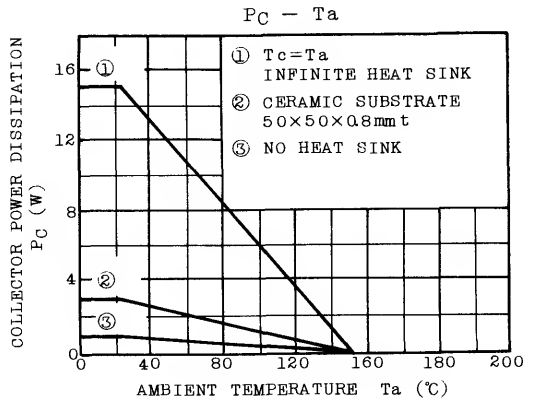
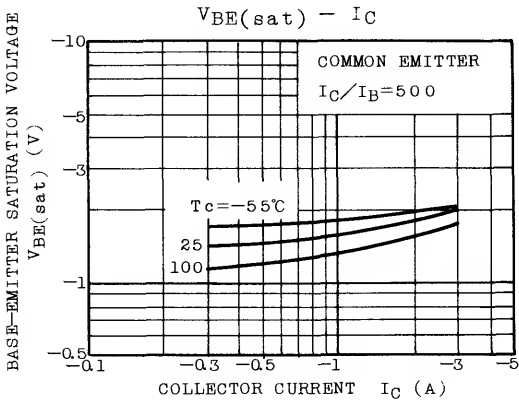
Weight : 0.36g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=-60V, I_E=0$	-	-	-20	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-5V, I_C=0$	-	-	-2.5	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=-25\text{mA}, I_B=0$	-40	-	-	V
DC Current Gain		$h_{FE(1)}$	$V_{CE}=-2V, I_C=-1A$	2000	-	-	
		$h_{FE(2)}$	$V_{CE}=-2V, I_C=-3A$	1000	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE}(\text{sat})$	$I_C=-2A, I_B=-4\text{mA}$	-	-	-1.5	V
	Base-Emitter	$V_{BE}(\text{sat})$	$I_C=-2A, I_B=-4\text{mA}$	-	-	-2.0	
Switching Time	Turn-on Time	t_{on}		-	0.30	-	μs
	Storage Time	t_{stg}		-	0.60	-	
	Fall Time	t_f		$-I_{B1}=I_{B2}=6\text{mA}$ $\text{DUTY CYCLE} \leq 1\%$ $V_{CC}=-30V$	-	0.25	



2SB907



SWITCHING APPLICATIONS.
HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

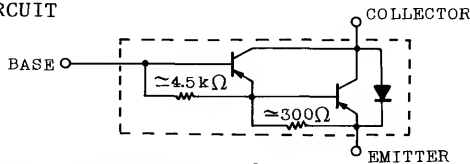
FEATURES:

- . High DC Current Gain
: $h_{FE(1)}=2000(\text{Min.})$ ($V_{CE}=-2V, I_C=-1A$)
- . Low Saturation Voltage
: $V_{CE(\text{sat})}=-1.5(\text{Max.})$ ($I_C=-3A$)
- . Complementary to 2SD1223.

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

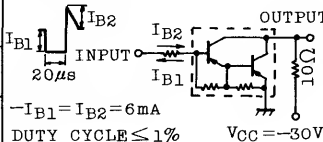
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-100	V
Collector-Emitter Voltage	V_{CE0}	-80	V
Emitter-Base Voltage	V_{EB0}	-5	V
Co-lector Current	I_C	-4	A
Base Current	I_B	-0.4	A
Collector Power Dissipation	P_C	$T_a=25^\circ\text{C}$	1.0
		$T_c=25^\circ\text{C}$	15
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ\text{C}$

EQUIVALENT CIRCUIT

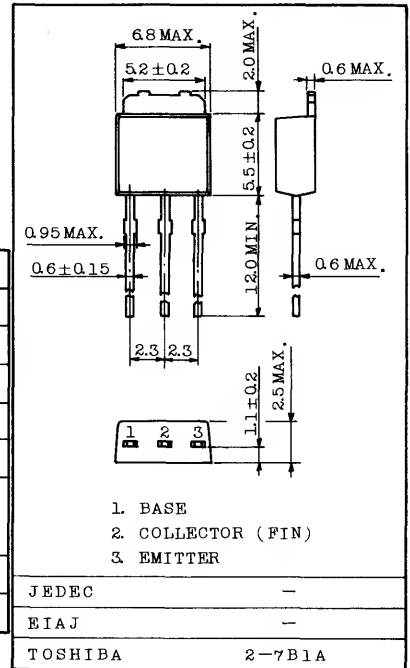


ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=-100V, I_E=0$	-	-	-20	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=-5V, I_C=0$	-	-	-2.5	mA
Collector-Emitter Breakdown Voltage	$V(\text{BR})_{CE0}$	$I_C=-10\text{mA}, I_B=0$	-80	-	-	V
DC Current Gain.	$h_{FE(1)}$	$V_{CE}=-2V, I_C=-1A$	2000	-	-	
	$h_{FE(2)}$	$V_{CE}=-2V, I_C=-3A$	1000	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(\text{sat})}$	$I_C=-3A, I_B=-6\text{mA}$	-	-	-1.5
	Base-Emitter	$V_{BE(\text{sat})}$	$I_C=-3A, I_B=-6\text{mA}$	-	-	-2.0
Switching Time	Turn-on Time	t_{on}		0.15	-	μs
	Storage Time	t_{stg}		0.80	-	
	Fall Time	t_f		0.40	-	



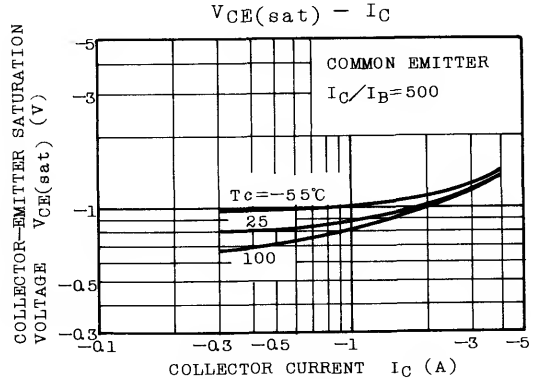
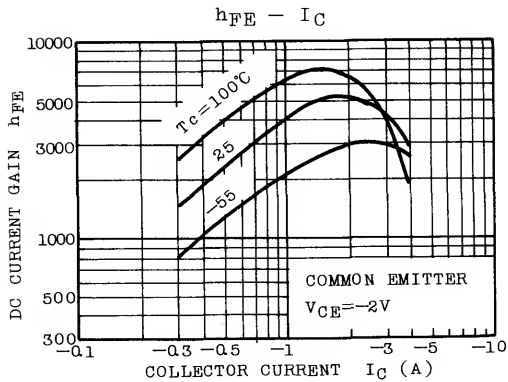
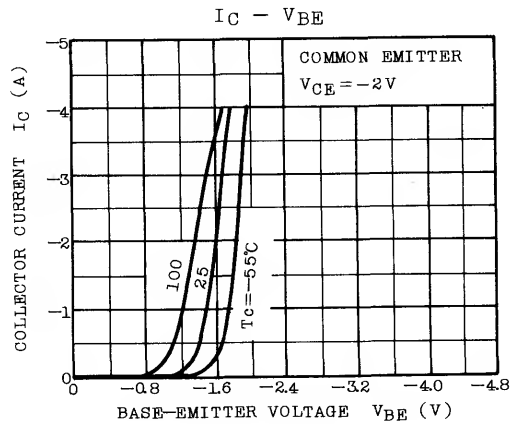
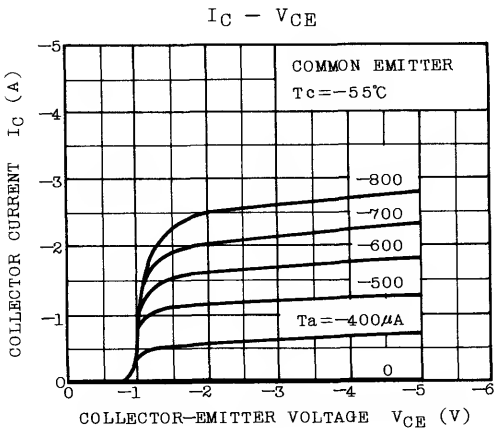
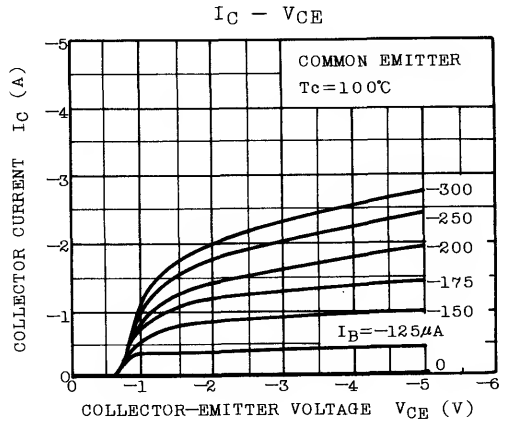
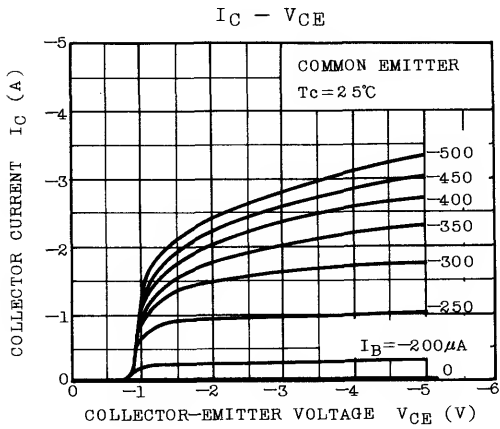
Unit in mm

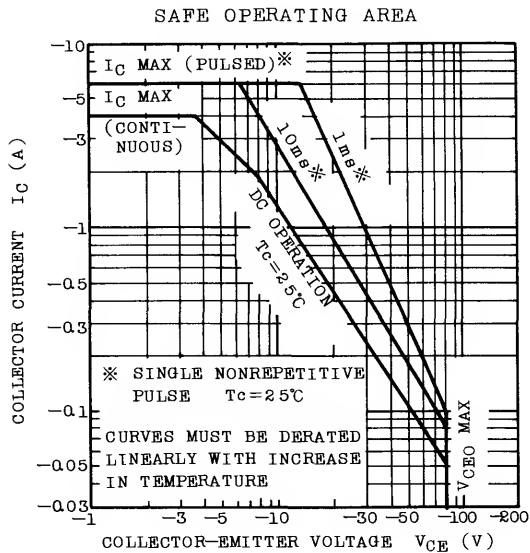
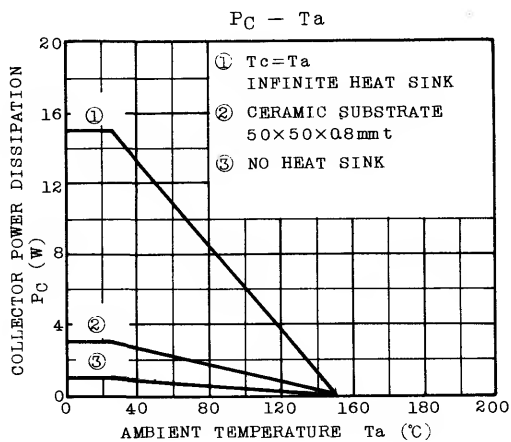
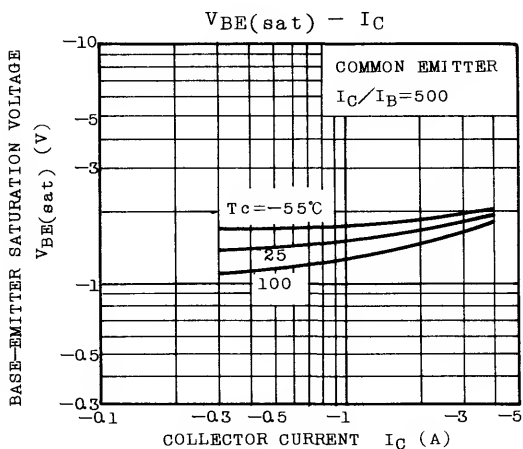


1. BASE
2. COLLECTOR (FIN)
3. EMITTER

JEDEC	-
EIAJ	-
TOSHIBA	2-7B1A

Weight : 0.36g





2SB992

SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

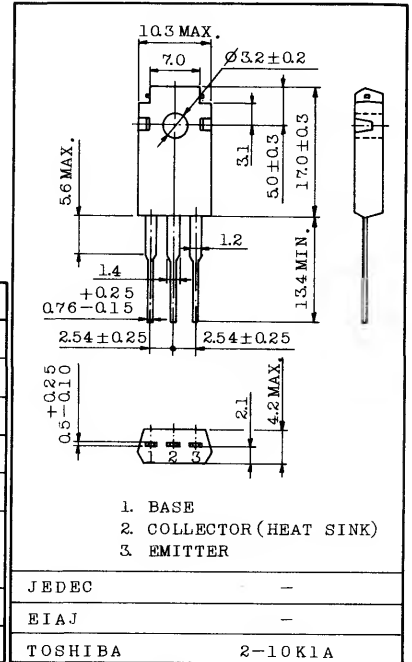
INDUSTRIAL APPLICATIONS
Unit in mm

FEATURES:

- High Collector Current : $I_C = -7A$
- Low Collector Saturation Voltage : $V_{CE(sat)} = -0.5V(\text{Max.})$ (at $I_C = -4A$)
- High Collector Power Dissipation : $P_C = 40W$ (at $T_c = 25^\circ C$)
- Complementary to 2SD1362

MAXIMUM RATINGS ($T_a = 25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB0}	-100	V
Collector-Emitter Voltage		V_{CE0}	-80	V
Emitter-Base Voltage		V_{EB0}	-5	V
Collector Current		I_C	-7	A
Base Current		I_B	-1	A
Collector Power Dissipation	$T_a = 25^\circ C$	PC	1.5	W
	$T_c = 25^\circ C$		40	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$

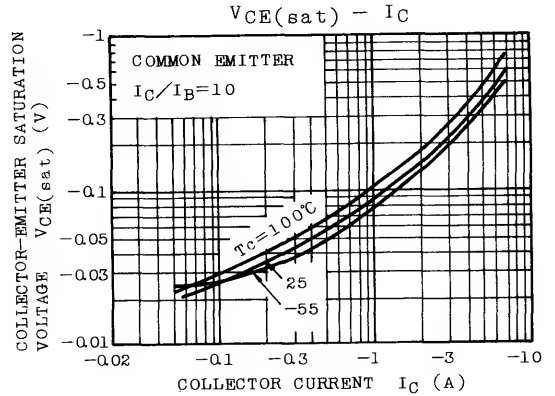
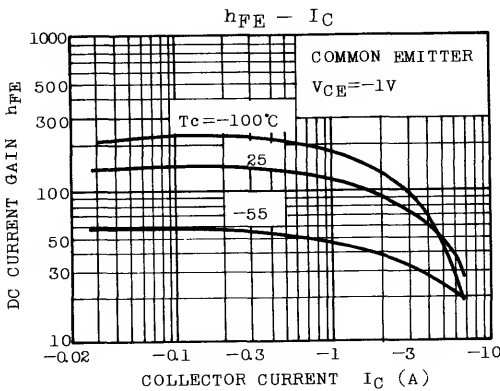
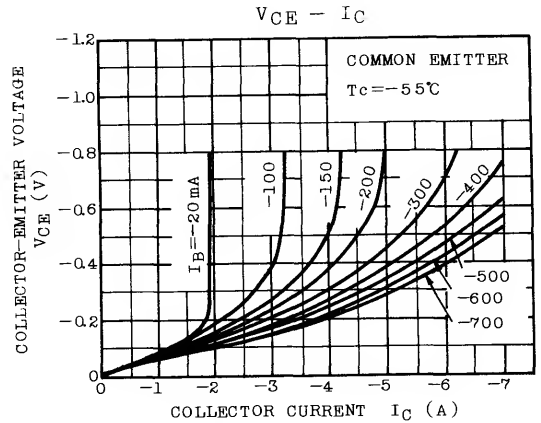
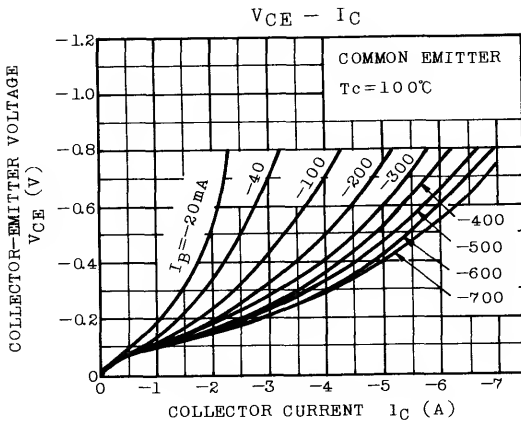
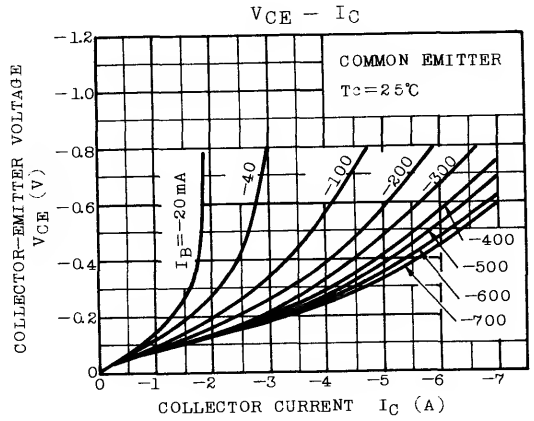
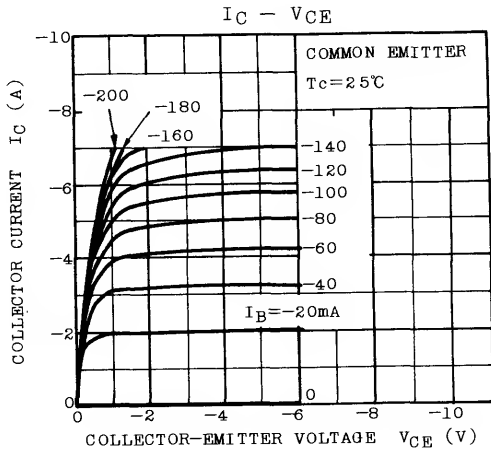


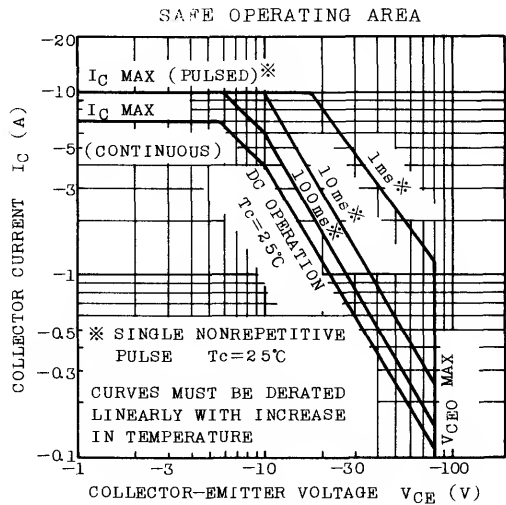
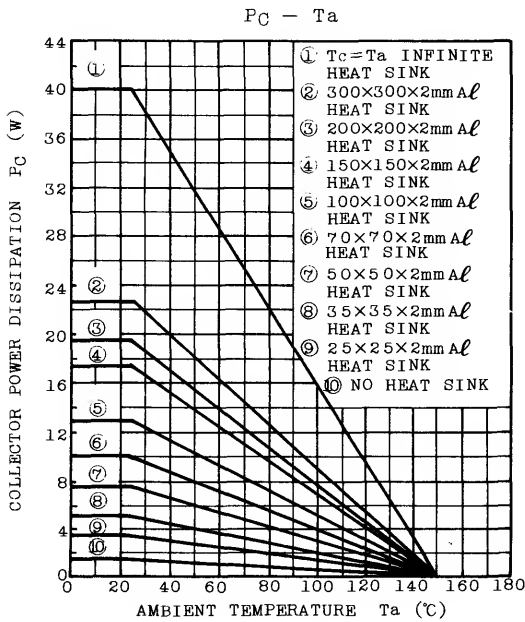
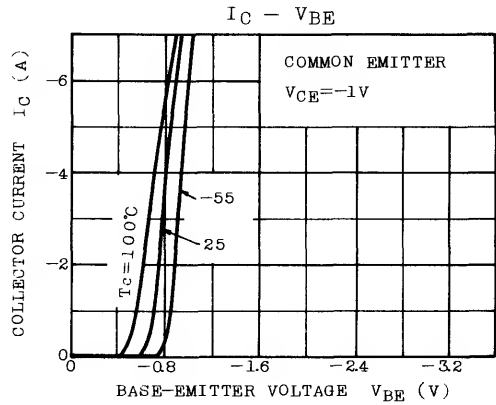
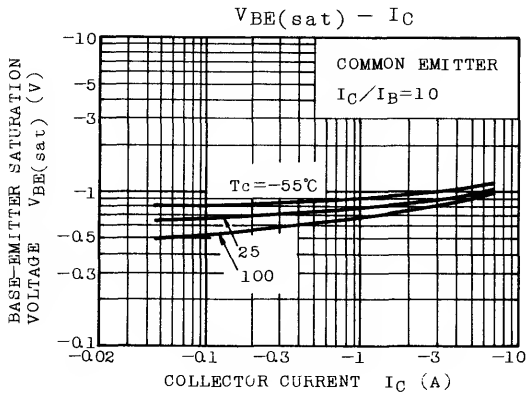
ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

Weight : 2.0g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB} = -100V, I_E = 0$	-	-	-5	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB} = -5V, I_C = 0$	-	-	-5	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C = -50mA, I_B = 0$	-80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE} = -1V, I_C = -1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE} = -1V, I_C = -4A$	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C = -4A, I_B = -0.4A$	-	-0.3	-0.5	V
	Base-Emitter	$V_{BE(sat)}$	$I_C = -4A, I_B = -0.4A$	-	-0.9	-1.4	
Transition Frequency		f_T	$V_{CE} = -4V, I_C = -1A$	-	10	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	250	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.4	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		-	0.5	-	

Note : $h_{FE(1)}$ Classification 0 : 70 ~ 140, Y : 120 ~ 240





HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

INDUSTRIAL APPLICATIONS

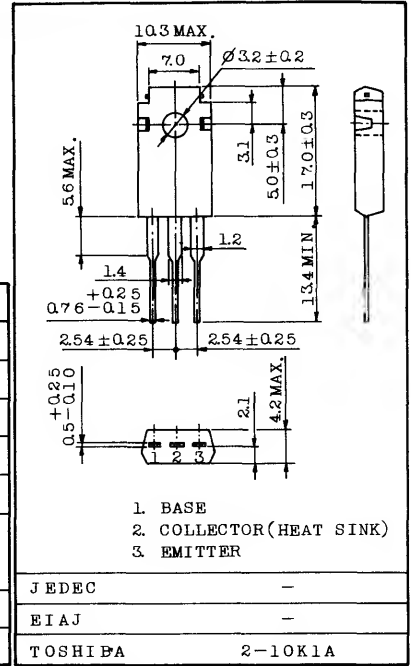
Unit in mm

FEATURES:

- High Collector Current : $I_C = -7A$
- Low Collector Saturation Voltage : $V_{CE(sat)} = -0.4V(\text{Max.})$ (at $I_C = -4A$)
- High Collector Power Dissipation : $P_C = 40W$ (at $T_c = 25^\circ C$)
- Complementary to 2SD1363

MAXIMUM RATINGS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-70	V
Collector-Emitter Voltage	V_{CEO}	-50	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-7	A
Base Current	I_B	-1	A
Collector Power Dissipation	P_C	$T_a = 25^\circ C$	1.5
		$T_c = 25^\circ C$	40
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$

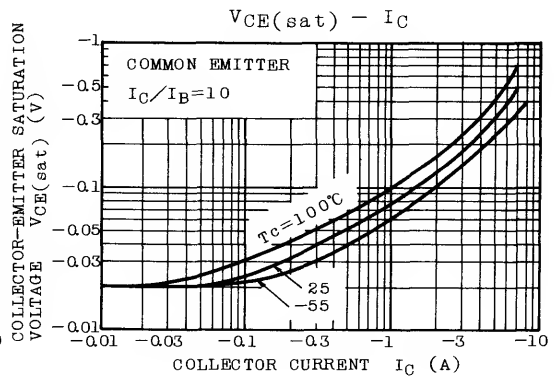
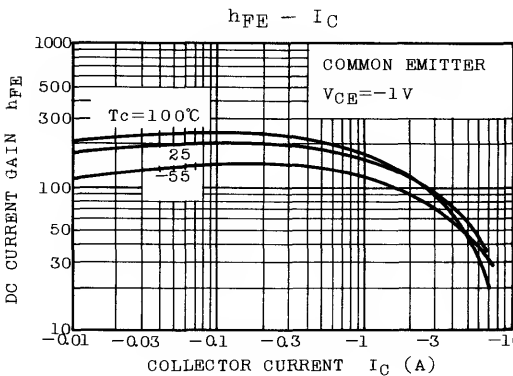
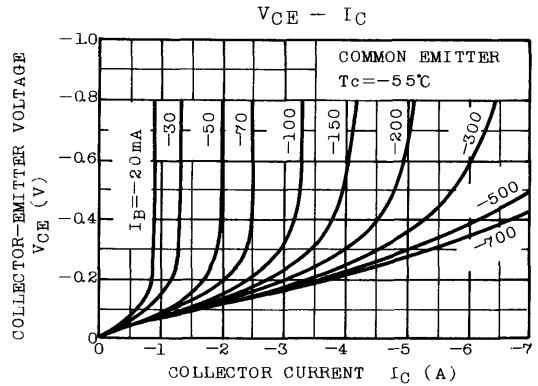
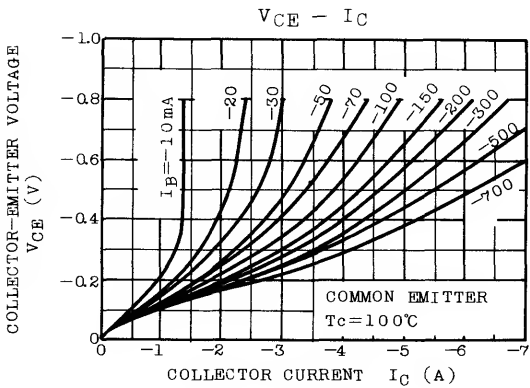
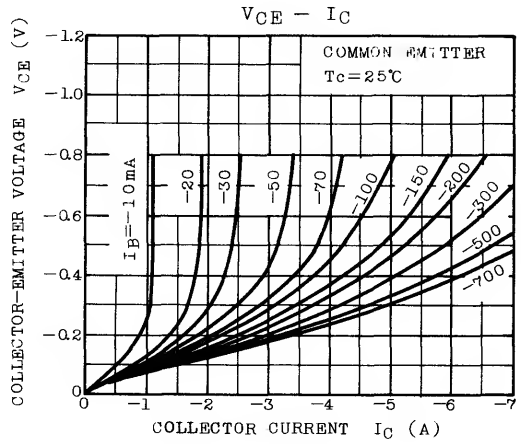
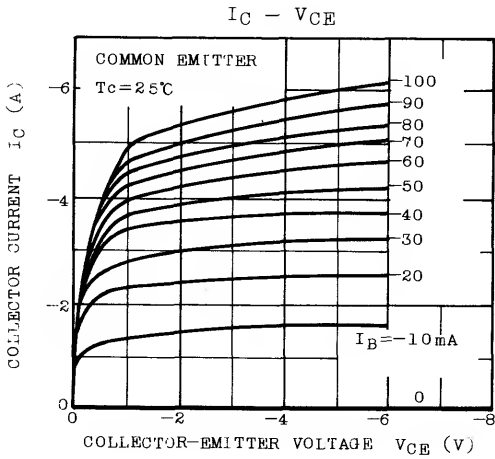


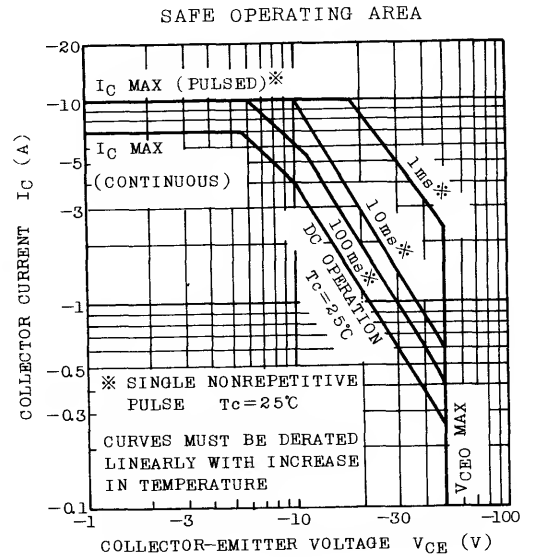
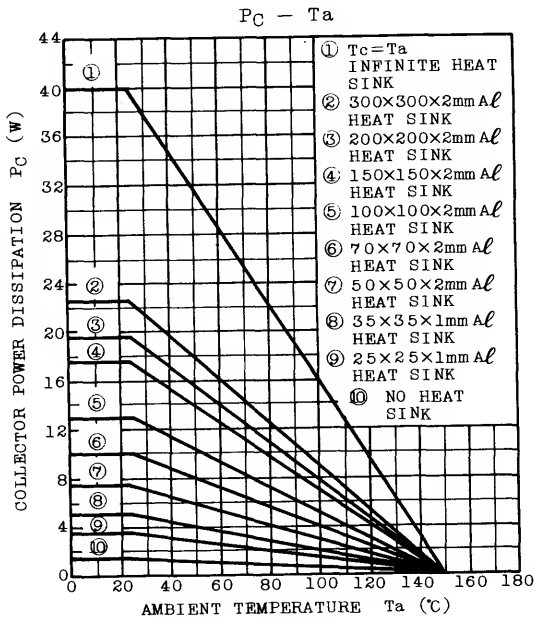
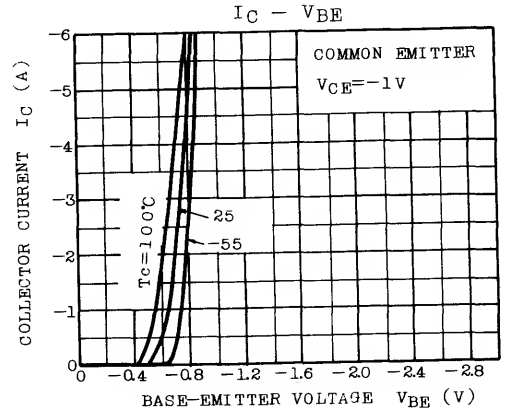
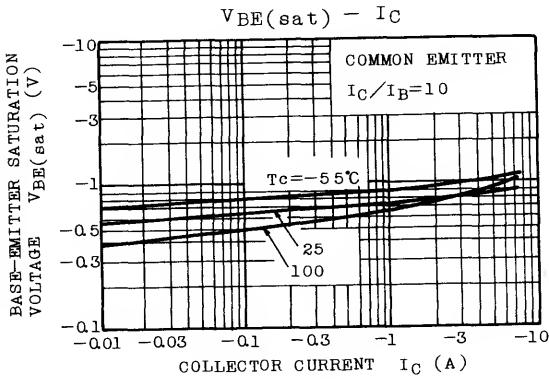
ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

Weight : 2.0g

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Collector Cut-off Current	I_{CBO}	$V_{CB} = -70V, I_E = 0$	-	-	-30	μA	
Emitter Cut-off Current	I_{EBO}	$V_{EB} = -5V, I_C = 0$	-	-	-50	μA	
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C = -50mA, I_B = 0$	-50	-	-	V	
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE} = -1V, I_C = -1A$	70	-	240		
	$h_{FE(2)}$	$V_{CE} = -1V, I_C = -4A$	30	-	-		
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C = -4A, I_B = -0.4A$	-	-0.2	-0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C = -4A, I_B = -0.4A$	-	-0.9	-1.2	
Transition Frequency	f_T	$V_{CE} = -4V, I_C = -1A$	-	10	-	MHz	
Collector Output Capacitance	C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	250	-	pF	
Switching Time	Turn-on Time	t_{on}		0.2	-	μs	
	Storage Time	t_{stg}		-	2.5		
	Fall Time	t_f		-	0.5		-

Note : $h_{FR(1)}$ Classification 0 : 70 ~ 140, Y : 120 ~ 240





2SB994

SILICON PNP TRIPLE DIFFUSED TYPE

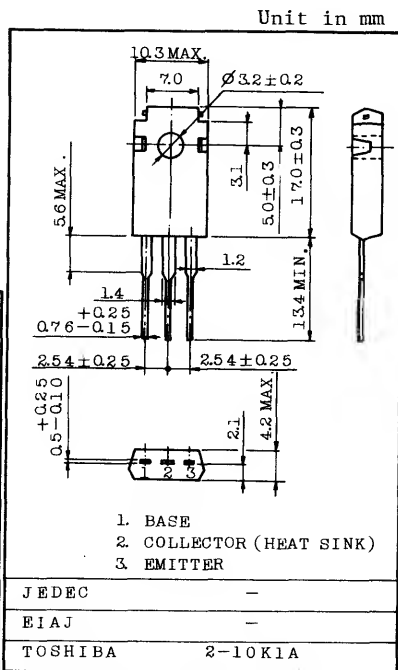
AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
: $V_{CE(sat)} = -1.0V(\text{Max.})$ at $I_C = -3A$, $I_B = -0.3A$
- Collector Power Dissipation : $P_C = 30W$ ($T_c = 25^\circ C$)
- Complementary to 2SD1354

MAXIMUM RATINGS ($T_a = 25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-60	V
Collector-Emitter Voltage		V_{CEO}	-60	V
Emitter-Base Voltage		V_{EBO}	-7	V
Collector Current		I_C	-3	A
Base Current		I_B	-0.5	A
Collector Power Dissipation	$T_a = 25^\circ C$	P_C	1.5	W
	$T_c = 25^\circ C$		30	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$

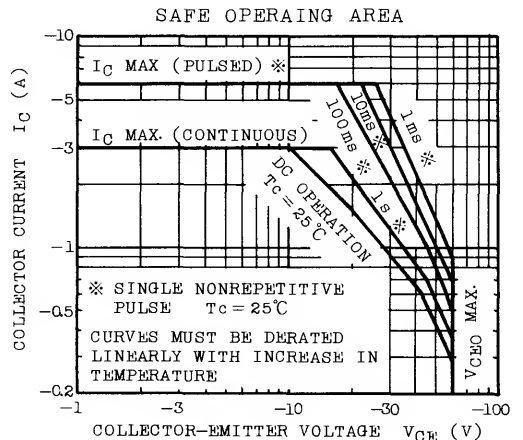
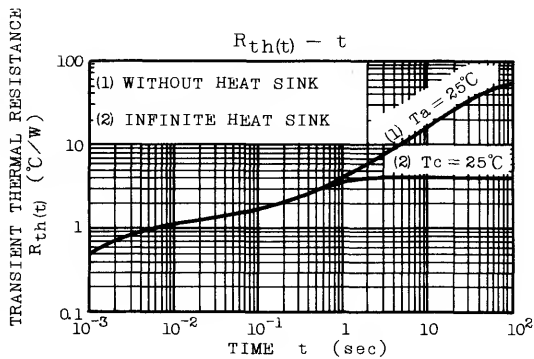
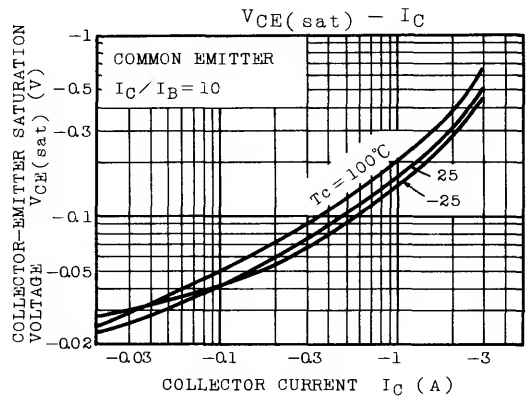
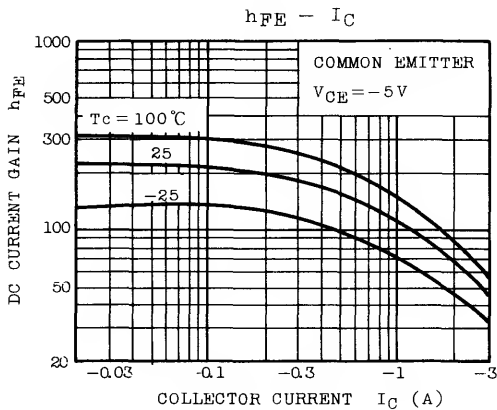
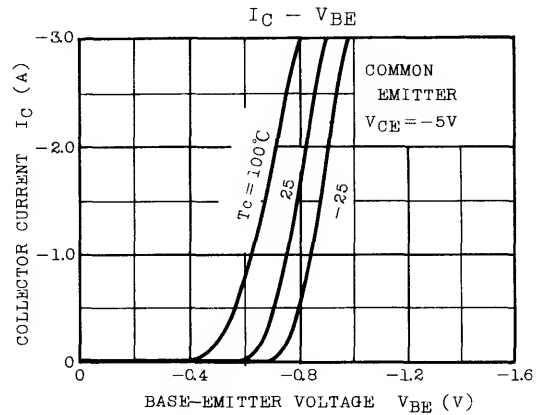
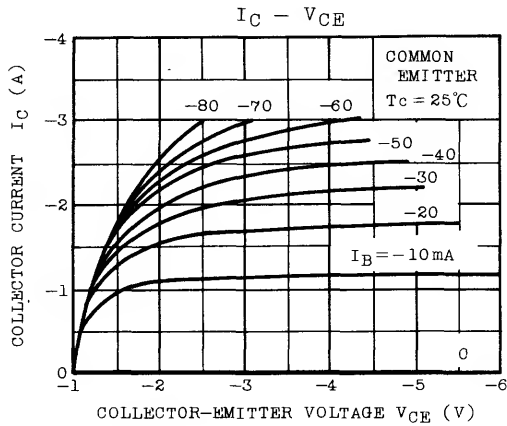


ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

Weight : 2.0g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB} = -60V, I_E = 0$	-	-	-100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB} = -7V, I_C = 0$	-	-	-100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C = -50mA, I_B = 0$	-60	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE} = -5V, I_C = -0.5A$		60	-	200	-
	$h_{FE(2)}$						
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C = -3A, I_B = -0.3A$	-	-0.5	-1.0	V
Base-Emitter Voltage		V_{BE}	$V_{CE} = -5V, I_C = -0.5A$	-	-0.7	-1.0	V
Transition Frequency		f_T	$V_{CE} = -5V, I_C = -0.5A$	-	9	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	150	-	pF
Switching Time	Turn-on Time	t_{on}	<p>INPUT I_{B1} OUTPUT I_{B1} I_{B2} 20μsec $-I_{B1} = I_{B2} = 0.2A$ DUTY CYCLE $\leq 1\%$ $V_{CC} = -30V$</p>	-	0.4	-	μs
	Storage Time	t_{stg}		-	1.7	-	
	Fall Time	t_f		-	0.5	-	

Note : $h_{FE(1)}$ Classification 0 : 60~120, Y : 100~200



2SB995

SILICON PNP TRIPLE DIFFUSED TYPE

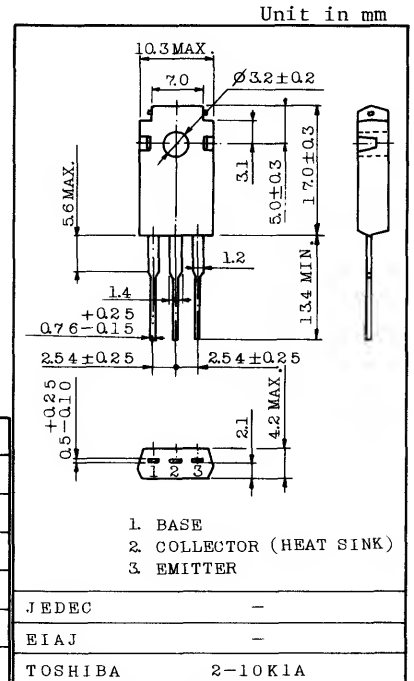
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : $V_{CEO}=-100V$
- Low Collector-Emitter Saturation Voltage : $V_{CE(sat)}=-2.0V(\text{Max.})$
- Complementary to 2SD1355
- Recommended for 30W High-Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-100	V
Collector-Emitter Voltage	V_{CEO}	-100	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-5	A
Base Current	I_B	-0.5	A
Collector Power Dissipation ($T_c=25^{\circ}C$)	P_C	40	W
Junction Temperature	T_j	150	$^{\circ}C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^{\circ}C$

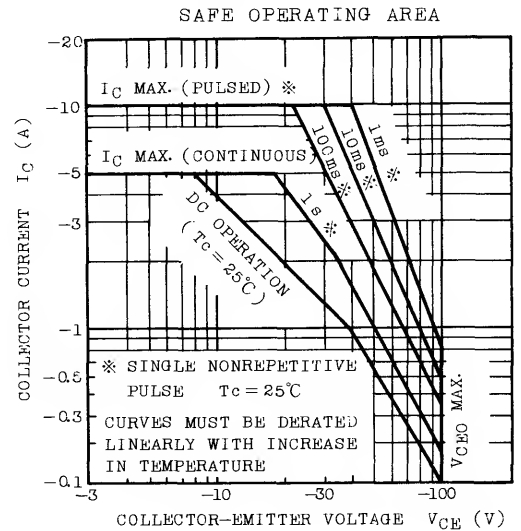
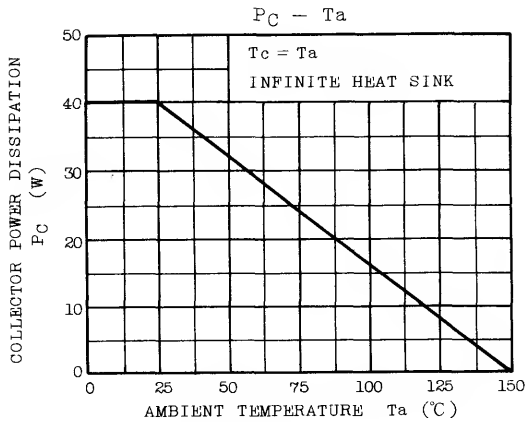
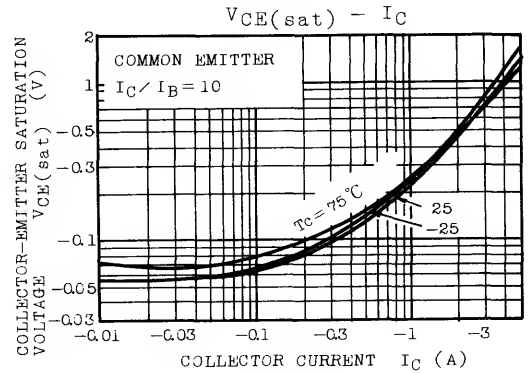
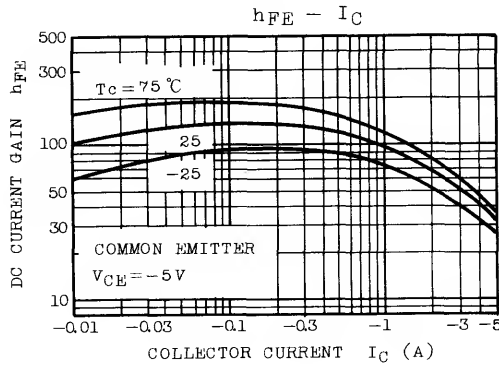
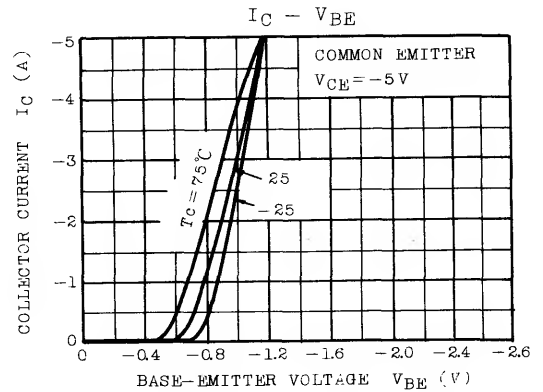
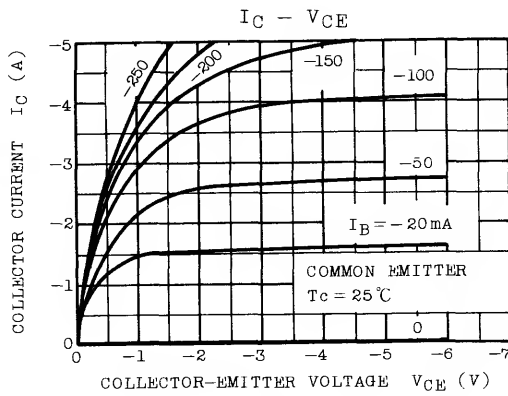


Weight : 2.0g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=-100V, I_E=0$	-	-	-100	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=-5V, I_C=0$	-	-	-1	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=-50mA, I_B=0$	-100	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=-5V, I_C=-1A$	40	-	240	
	$h_{FE(2)}$	$V_{CE}=-5V, I_C=-4A$	20	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-4A, I_B=-0.4A$	-	-	-2.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-5V, I_C=-4A$	-	-	-1.5	V
Transition Frequency	f_T	$V_{CE}=-5V, I_C=-1A$	-	5	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10V, I_E=0, f=1MHz$	-	270	-	pF

Note : $h_{FE(1)}$ Classification R : 40 ~ 80, O : 70 ~ 140, Y : 120 ~ 240



2SB996

SILICON PNP TRIPLE DIFFUSED TYPE

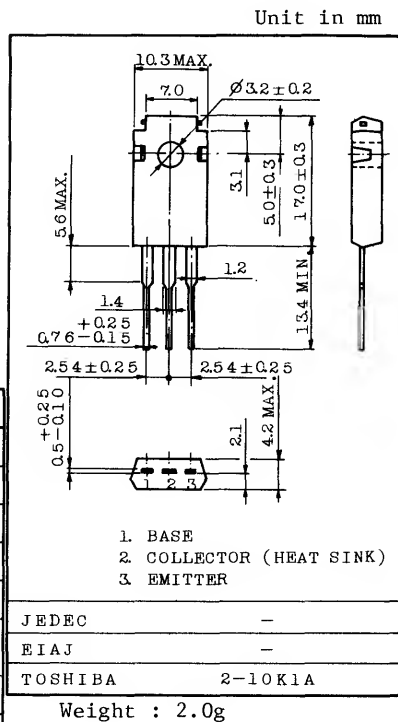
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Good Linearity of h_{FE}
- Complementary to 2SD1356
- Recommended for 20~25W High-Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

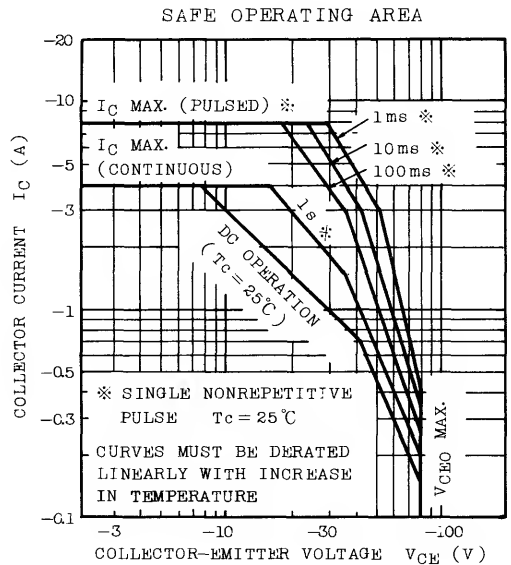
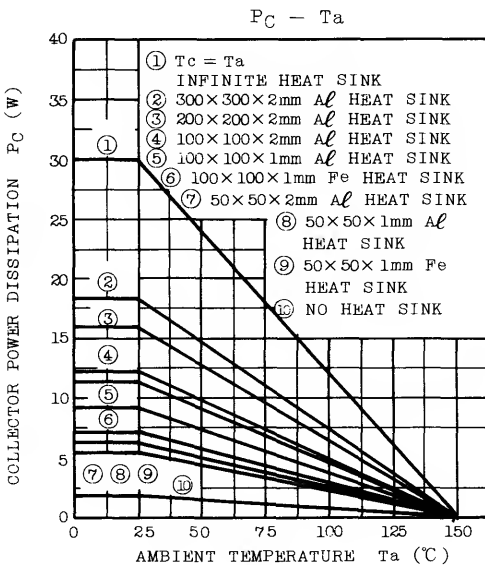
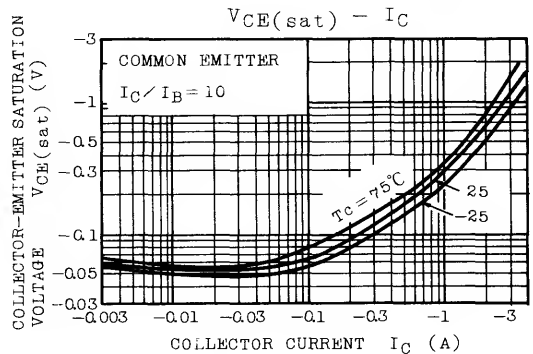
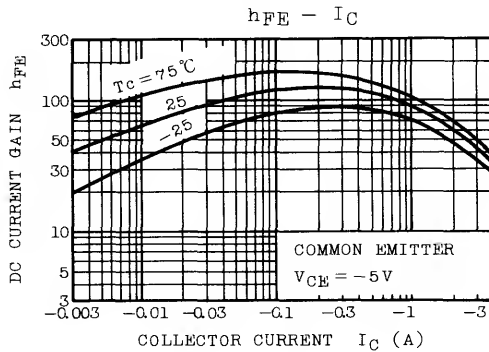
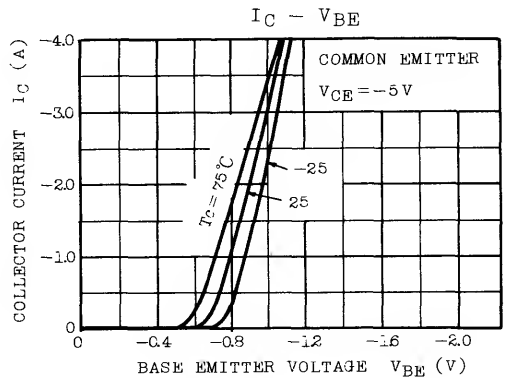
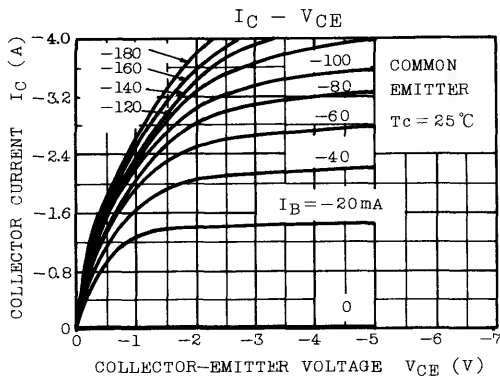
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-80	V
Collector-Emitter Voltage	V_{CE0}	-80	V
Emitter-Base Voltage	V_{EB0}	-5	V
Collector Current	I_C	-4	A
Base Current	I_B	-0.4	A
Collector Power Dissipation ($T_c=25^{\circ}C$)	P_C	30	W
Junction Temperature	T_j	150	$^{\circ}C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^{\circ}C$

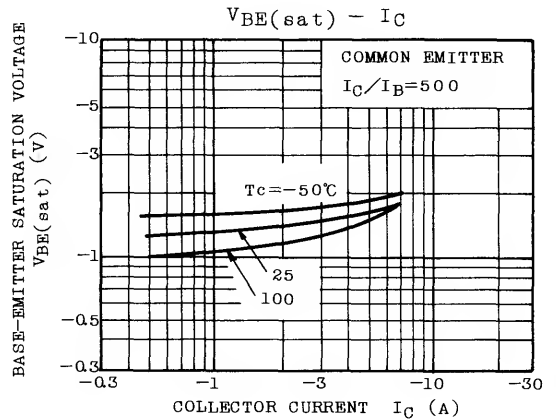
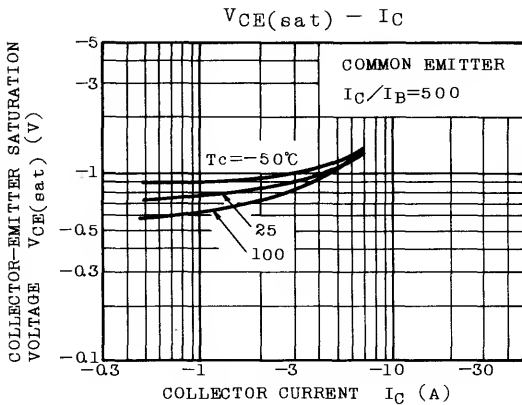
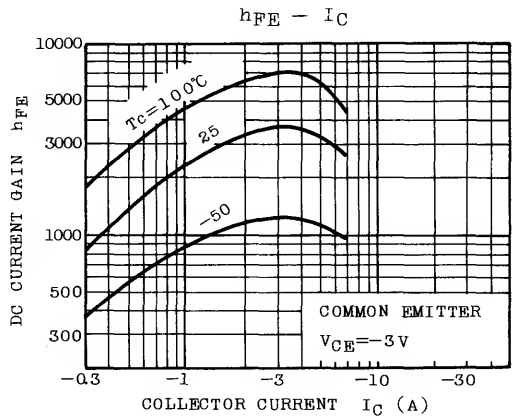
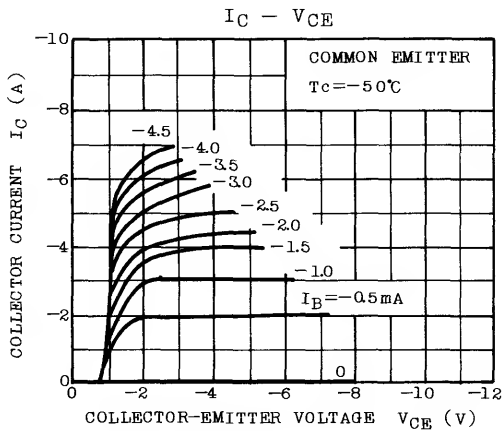
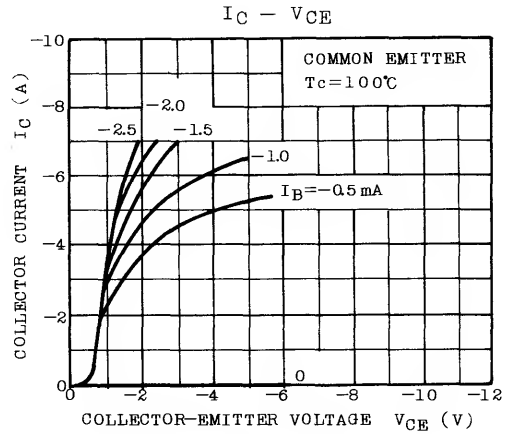
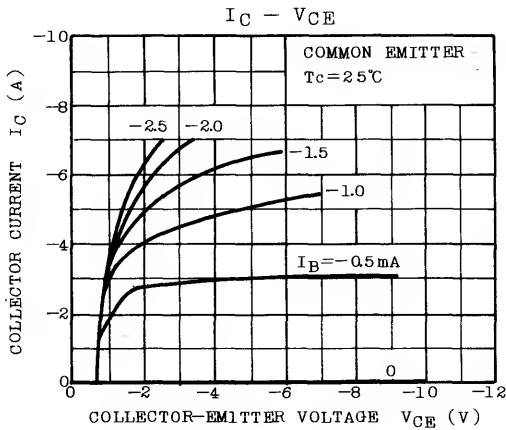


ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

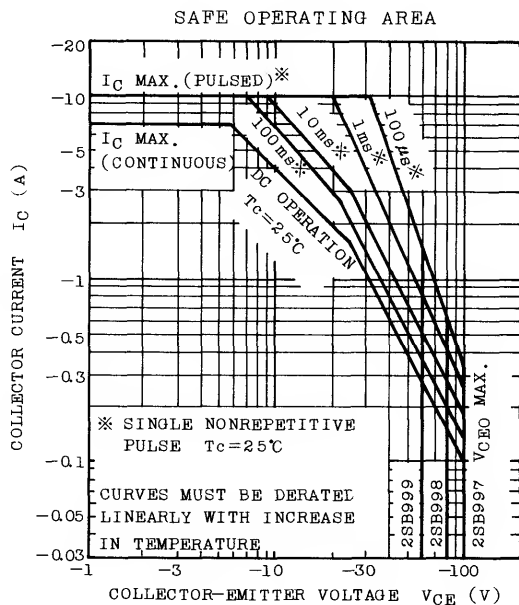
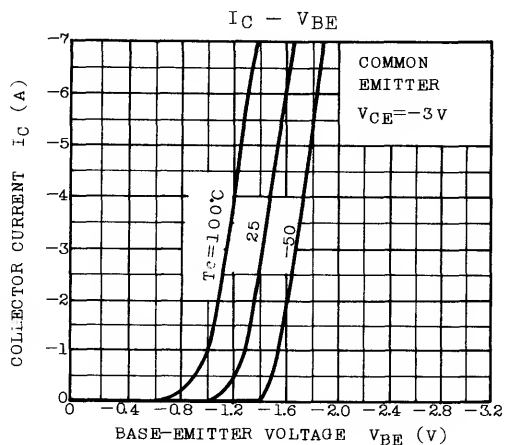
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=-80V, I_E=0$	-	-	-30	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=-5V, I_C=0$	-	-	-100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C=-50mA, I_B=0$	-80	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=-5V, I_C=-0.5A$	40	-	240	
	$h_{FE(2)}$	$V_{CE}=-5V, I_C=-3A$	15	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-3A, I_B=-0.3A$	-	-1.0	-1.7	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-5V, I_C=-3A$	-	-1.0	-1.5	V
Transition Frequency	f_T	$V_{CE}=-5V, I_C=-0.5A$	-	9	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10V, I_E=0, f=1MHz$	-	130	-	pF

Note : $h_{FE(1)}$ Classification R : 40~80, O : 70~140, Y : 120~240





2SB997 • 2SB998 • 2SB999



Unit in mm

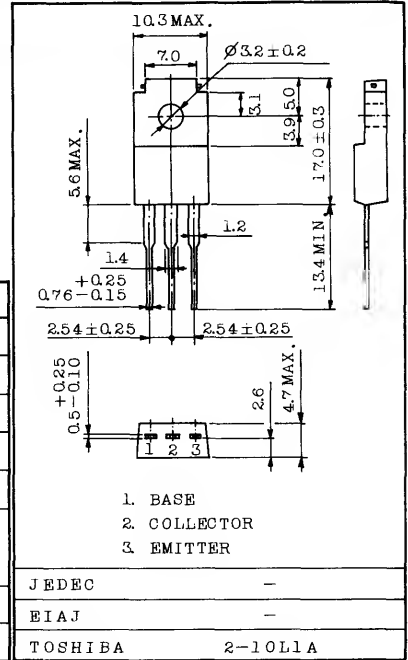
AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Low Collector Saturation Voltage
: $V_{CE(sat)} = -1.0V(\text{Max.})$ at $I_C = -3A, I_B = -0.3A$
- . Collector Power Dissipation : $P_C = 25W$ ($T_c = 25^\circ C$)
- . Complementary to 2SD1406

MAXIMUM RATINGS ($T_a = 25^\circ C$)

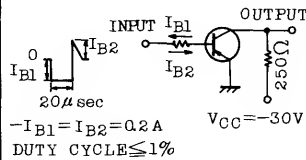
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-60	V
Collector-Emitter Voltage	V_{CE0}	-60	V
Emitter-Base Voltage	V_{EB0}	-7	V
Collector Current	I_C	-3	A
Base Current	I_B	-0.5	A
Collector Power Dissipation	P_C	$T_a = 25^\circ C$	2.0
		$T_c = 25^\circ C$	25
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$



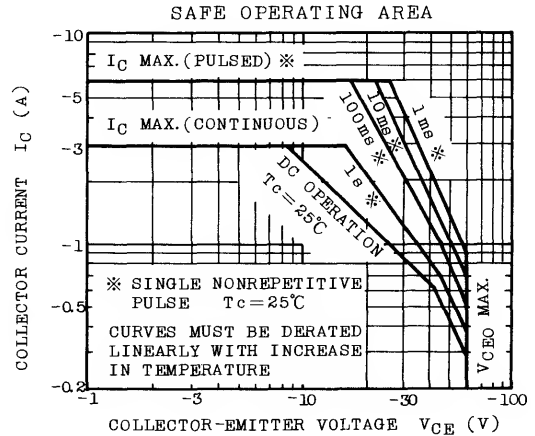
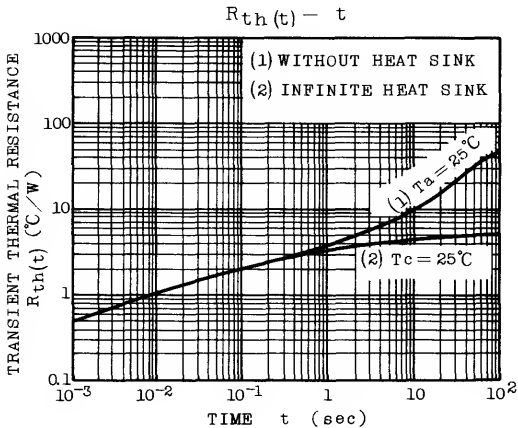
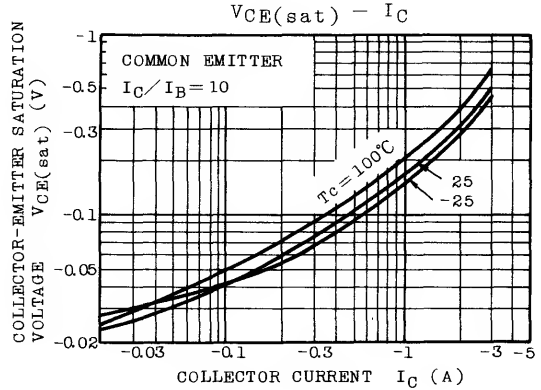
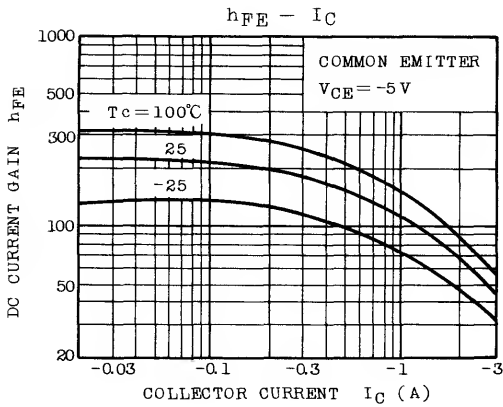
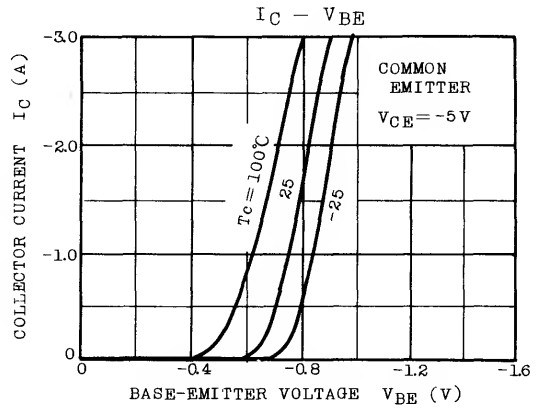
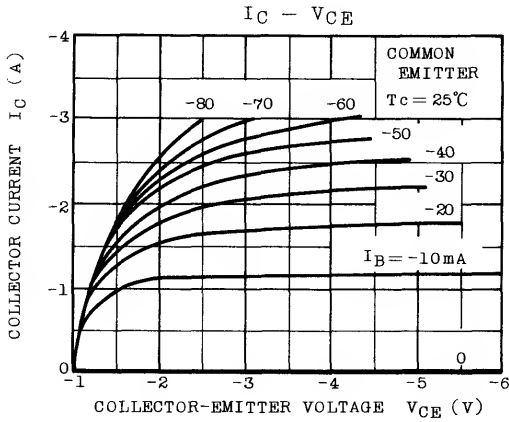
ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

Weight : 2.1g

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB} = -60V, I_E = 0$	-	-	-100	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB} = -7V, I_C = 0$	-	-	-100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C = -50mA, I_B = 0$	-60	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE} = -5V, I_C = -0.5A$	60	-	200	
	$h_{FE(2)}$	$V_{CE} = -5V, I_C = -3A$	20	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = -3A, I_B = -0.3A$	-	-0.5	-1.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE} = -5A, I_C = -0.5A$	-	-0.7	-1.0	V
Transition Frequency	f_T	$V_{CE} = -5V, I_C = -0.5A$	-	9	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	150	-	pF
Switching Time	Turn-on Time	t_{on}	-	0.4	-	μs
	Storage Time	t_{stg}	-	1.7	-	
	Fall Time	t_f	-	0.5	-	



Note : $h_{FE(1)}$ Classification 0 : 60 ~ 120, Y : 100 ~ 200



POWER AMPLIFIER APPLICATIONS.

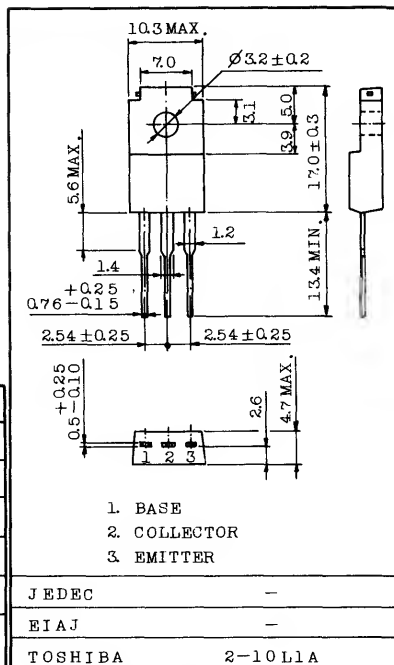
FEATURES:

- High Breakdown Voltage : $V_{CE0} = -100V$
- Low Collector-Emitter Saturation Voltage : $V_{CE(sat)} = -2.0V(\text{Max.})$
- Complementary to 2SD1407
- Recommended for 30W High-Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-100	V
Collector-Emitter Voltage	V_{CE0}	-100	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-5	A
Base Current	I_B	-0.5	A
Collector Power Dissipation ($T_c = 25^\circ C$)	P_C	30	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$

Unit in mm



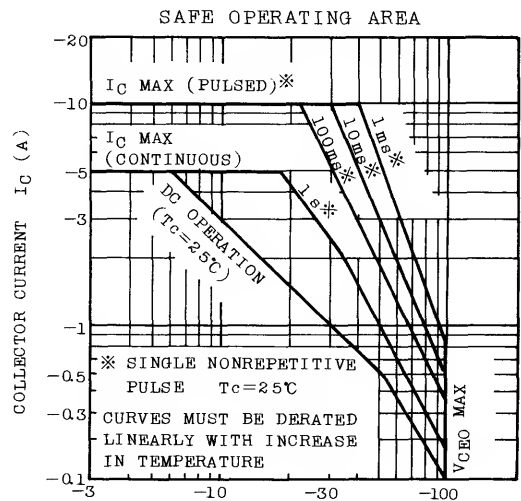
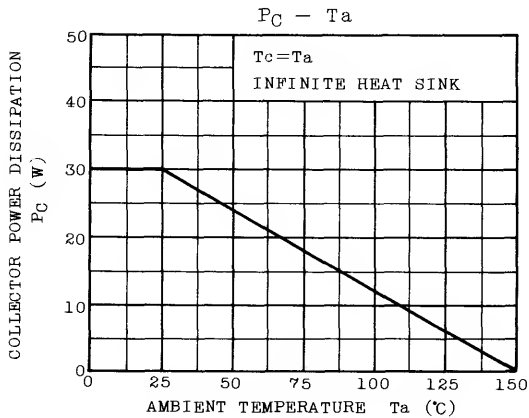
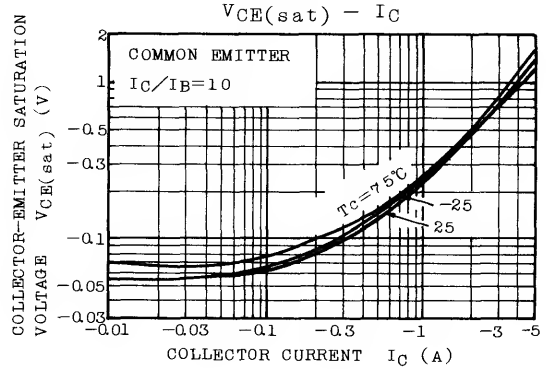
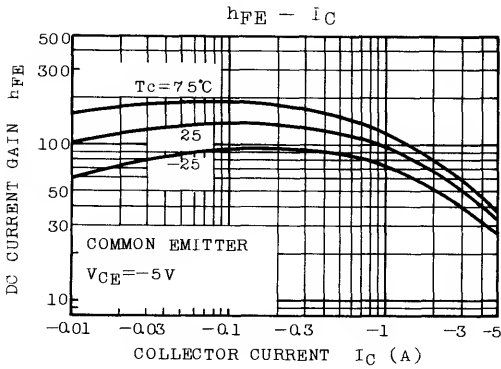
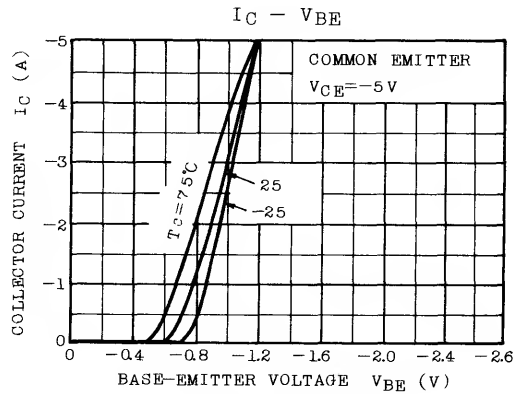
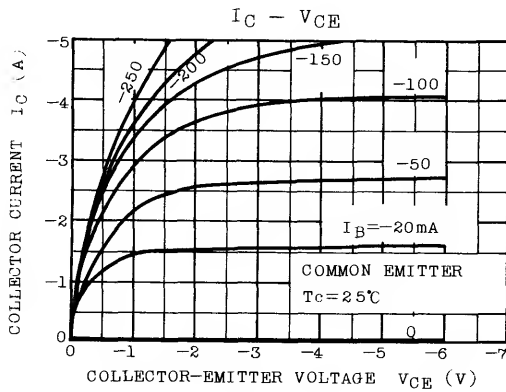
Weight : 2.1g

ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB} = -100V, I_E = 0$	-	-	-100	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB} = -5V, I_C = 0$	-	-	-1	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C = -50mA, I_B = 0$	-100	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE} = -5V, I_C = -1A$	40	-	240	
	$h_{FE(2)}$	$V_{CE} = -5V, I_C = -4A$	20	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = -4A, I_B = 0.4A$	-	-	-2.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE} = -5V, I_C = -4A$	-	-	-1.5	V
Transition Frequency	f_T	$V_{CE} = -5V, I_C = -1A$	-	5	-	MHz
Collector Output Capacitance	C_{OB}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	270	-	pF

Note : $h_{FE(1)}$ Classification R : 40 ~ 80, O : 70 ~ 140, Y : 120 ~ 240

2SB1016



POWER AMPLIFIER APPLICATIONS.

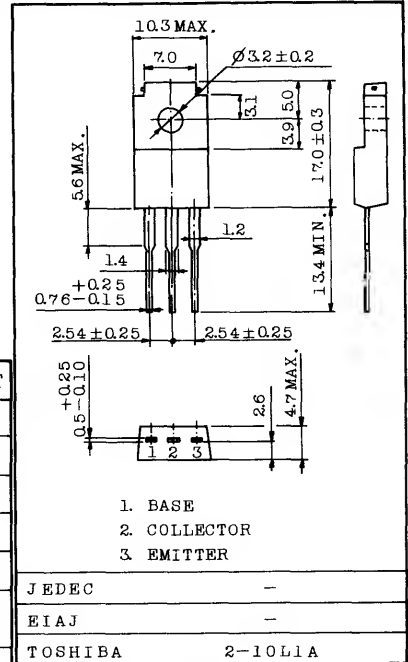
FEATURES:

- Good Linearity of h_{FE}
- Complementary to 2SD1408
- Recommended for 20~25W High-Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-80	V
Collector-Emitter Voltage	V_{CE0}	-80	V
Emitter-Base Voltage	V_{EB0}	-5	V
Collector Current	I_C	-4	A
Base Current	I_B	-0.4	A
Collector Power Dissipation ($T_c=25^{\circ}\text{C}$)	P_C	25	W
Junction Temperature	T_j	150	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^{\circ}\text{C}$

Unit in mm

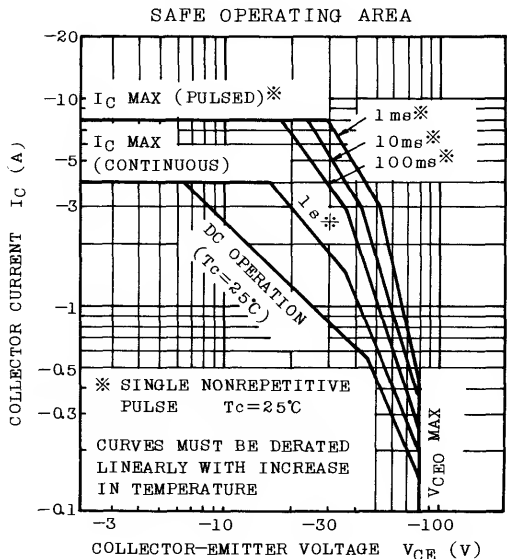
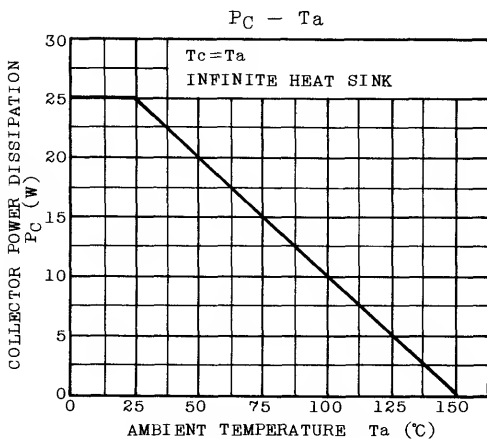
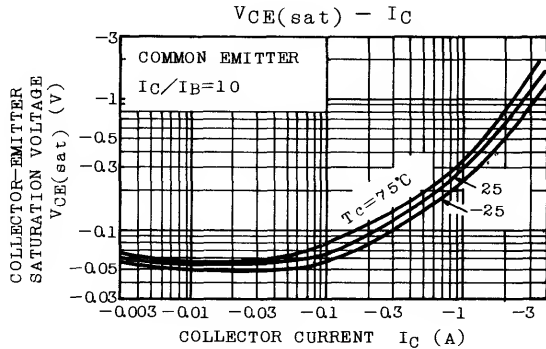
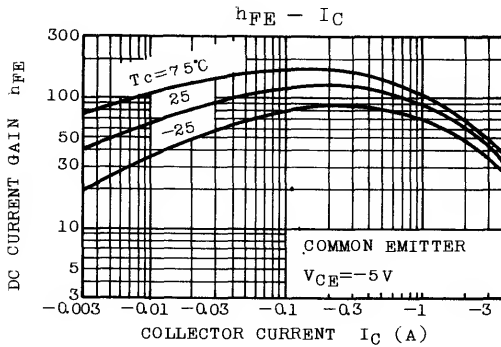
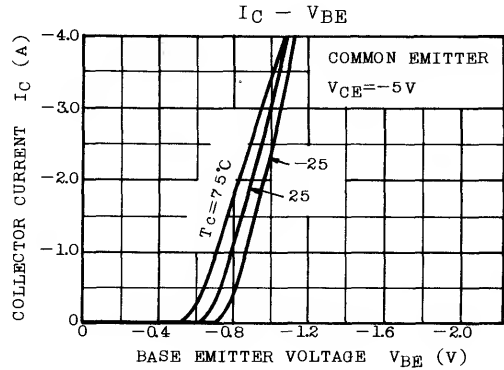
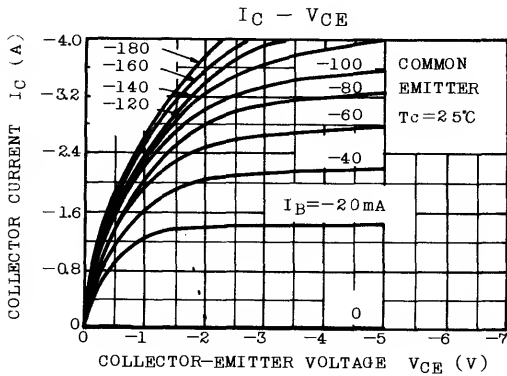


Weight : 2.1g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=-80\text{V}, I_E=0$	-	-	-30	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=-5\text{V}, I_C=0$	-	-	-100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C=-50\text{mA}, I_B=0$	-80	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=-5\text{V}, I_C=-0.5\text{A}$	40	-	240	
	$h_{FE(2)}$	$V_{CE}=-5\text{V}, I_C=-3\text{A}$	15	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-3\text{A}, I_B=-0.3\text{A}$	-	-1.0	-1.7	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-5\text{V}, I_C=-3\text{A}$	-	-1.0	-1.5	V
Transition Frequency	f_T	$V_{CE}=-5\text{V}, I_C=-0.5\text{A}$	-	9	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10\text{V}, I_E=0, f=1\text{MHz}$	-	130	-	pF

Note : $h_{FE(1)}$ Classification R : 40~80, O : 70~140, Y : 120~240



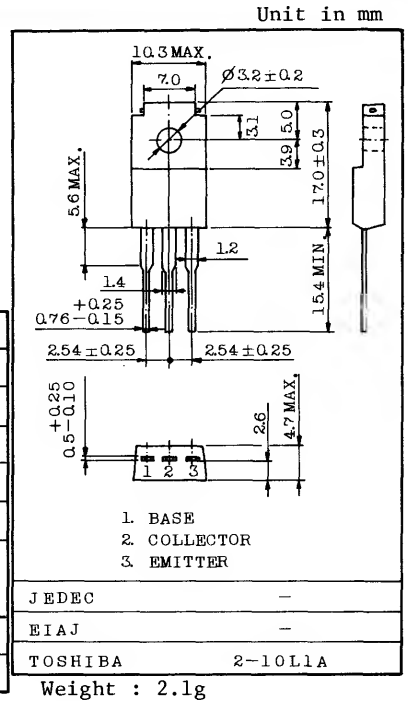
HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Collector Current : $I_C = -7A$
- Low Collector Saturation Voltage : $V_{CE(sat)} = -0.5V(\text{Max.})$ at $I_C = -4A$
- Complementary to 2SD1411

MAXIMUM RATINGS ($T_a = 25^\circ C$)

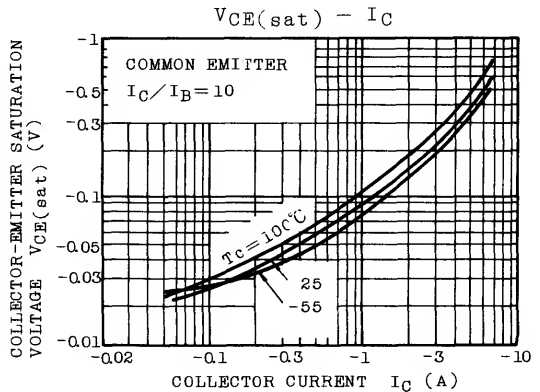
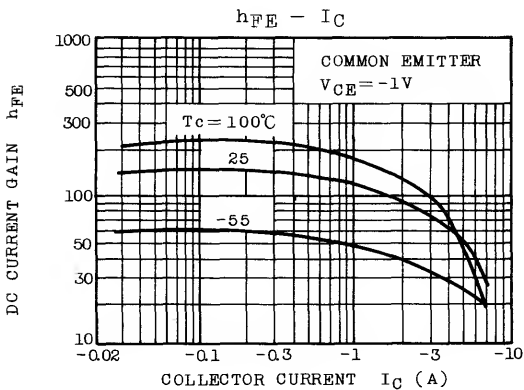
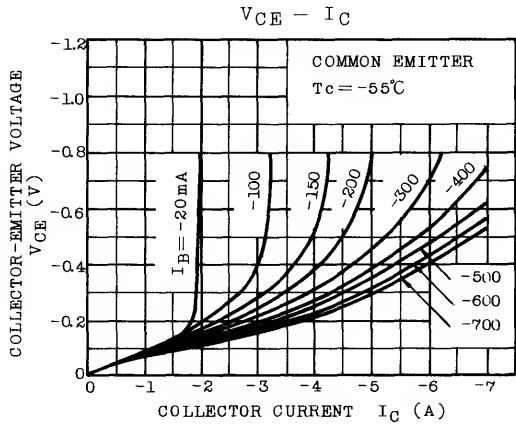
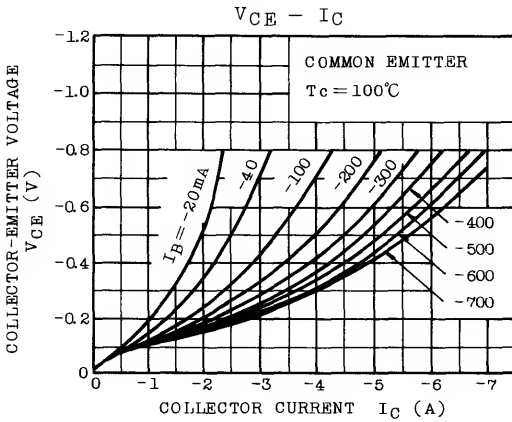
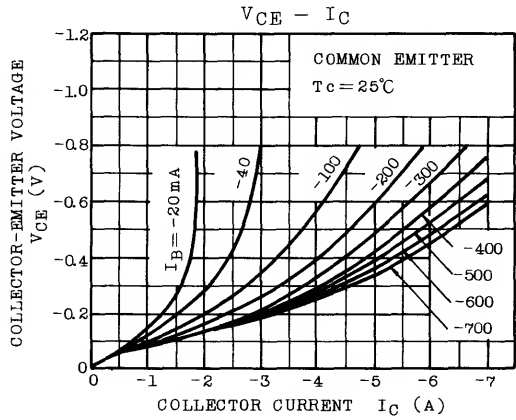
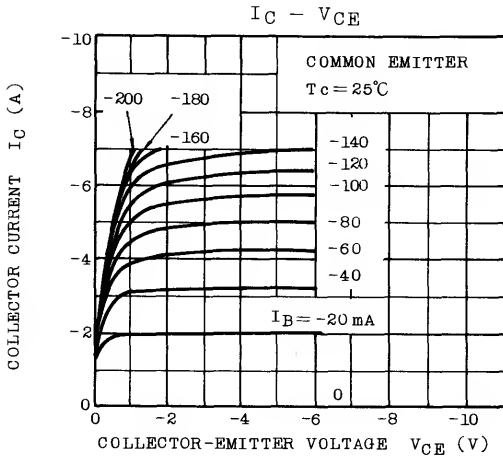
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-100	V
Collector-Emitter Voltage		V_{CEO}	-80	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-7	A
Base Current		I_B	-1	A
Collector Power Dissipation	$T_a = 25^\circ C$	P_C	2.0	W
	$T_c = 25^\circ C$		30	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$

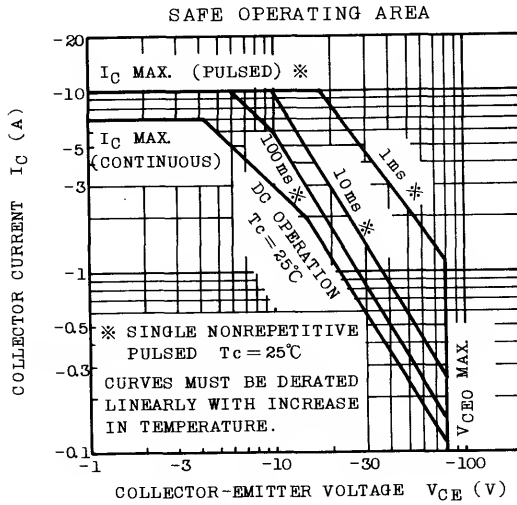
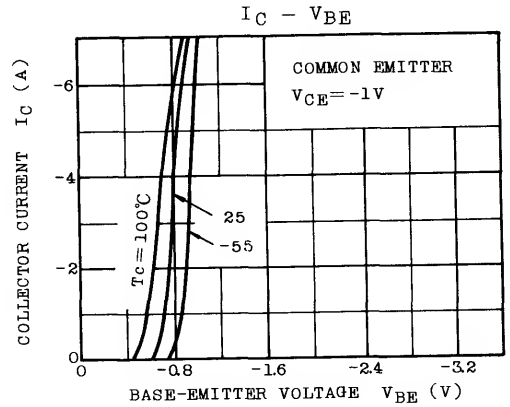
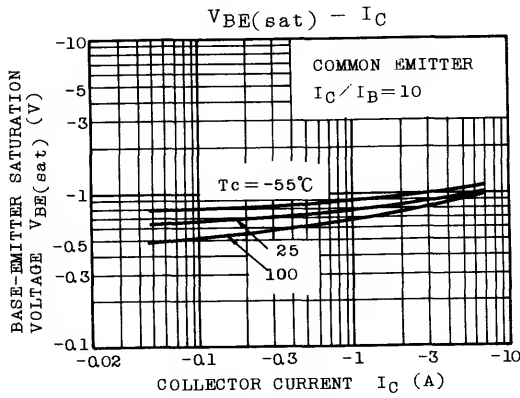


ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

CHARACTERISTICS		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB} = -100V, I_E = 0$	-	-	-5	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB} = -5V, I_C = 0$	-	-	-5	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C = -50mA, I_B = 0$	-80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE} = -1V, I_C = -1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE} = -1V, I_C = 4A$	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C = -4A, I_B = -0.4A$	-	-0.3	-0.5	V
	Base-Emitter	$V_{BE(sat)}$	$I_C = -4A, I_B = -0.4A$	-	-0.9	-1.4	
Transition Frequency		f_T	$V_{CE} = -4V, I_C = -1A$	-	10	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	250	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.4	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		-	-	0.5	

Note : $h_{FE(1)}$ Classification O : 70 ~ 140. Y : 170 ~ 240





2SB1019

SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

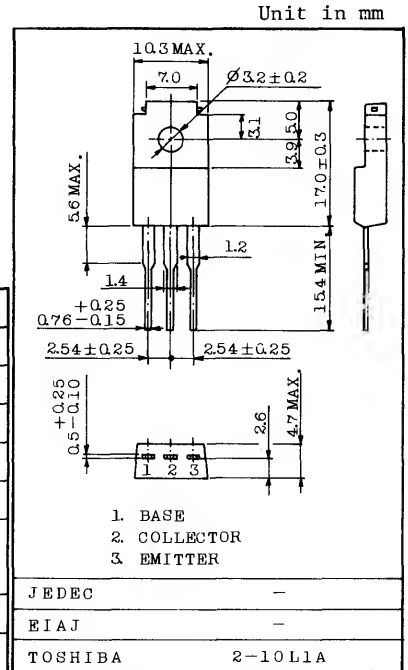
HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
: $V_{CE(sat)} = -0.4V(\text{Max.})$ at $I_C = -4A$
- Complementary to 2SD1412

MAXIMUM RATINGS ($T_a = 25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	-70	V
Collector-Emitter Voltage		V_{CEO}	-50	V
Emitter-Base Voltage		V_{EBO}	-5	V
Collector Current		I_C	-7	A
Base Current		I_B	-1	A
Collector Power Dissipation	$T_a = 25^\circ C$	P_C	2.0	W
	$T_c = 25^\circ C$		30	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$

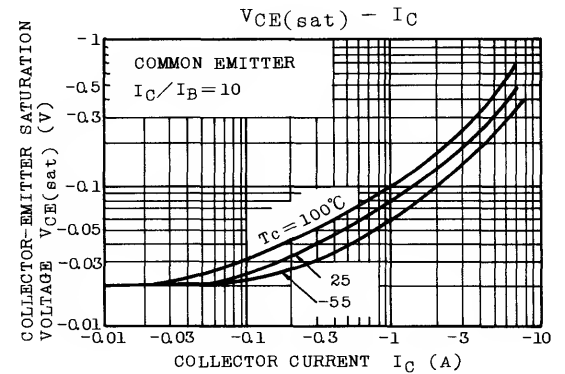
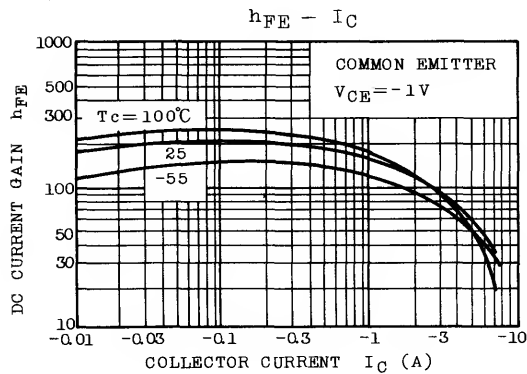
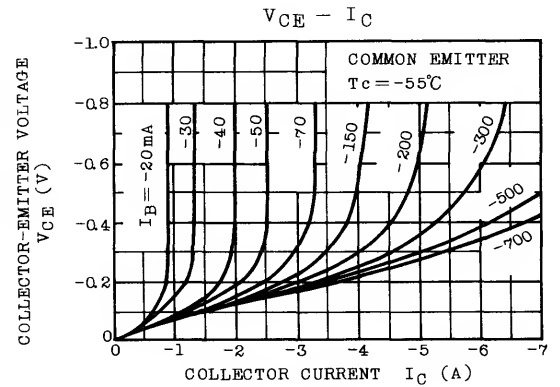
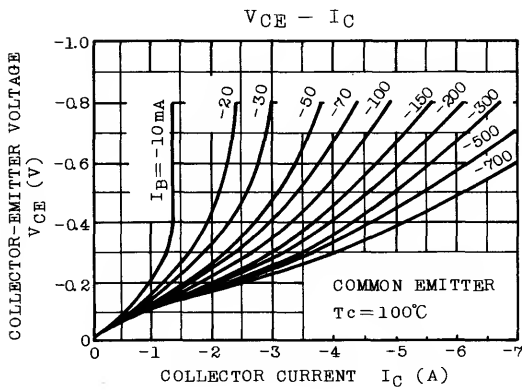
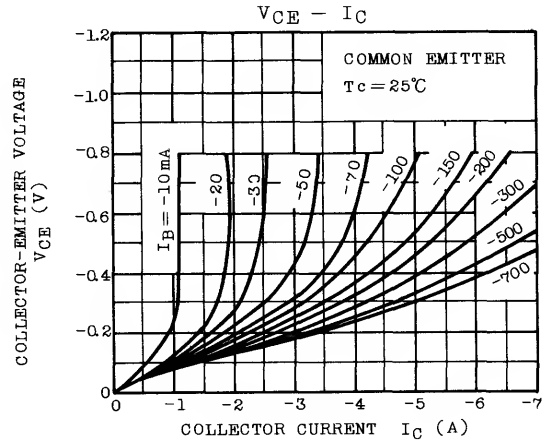
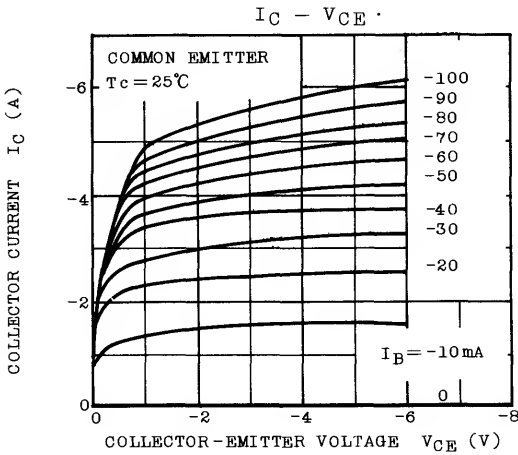


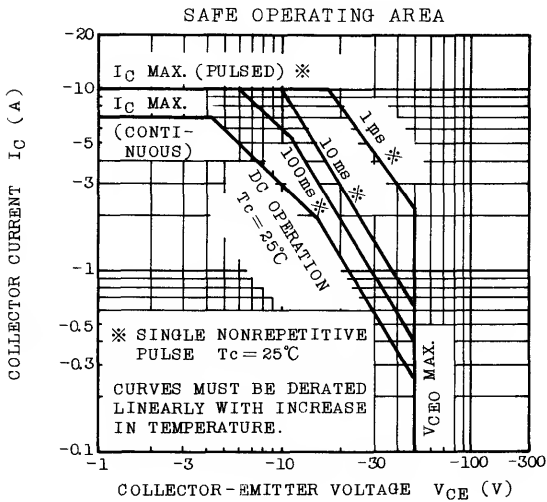
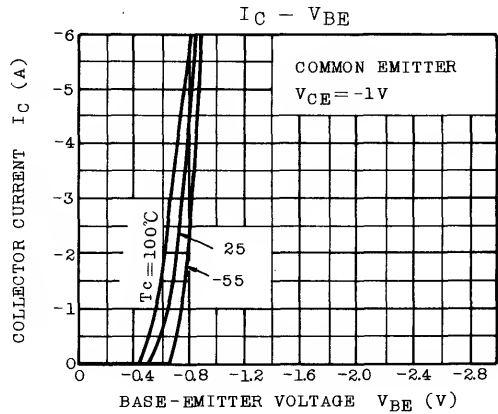
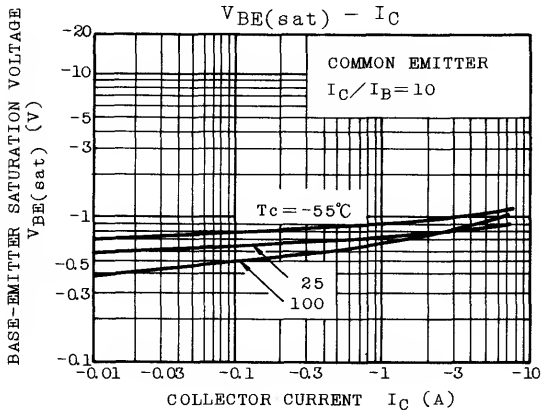
Weight : 2.1g

ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB} = -70V, I_E = 0$	-	-	-30	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB} = -5V, I_C = 0$	-	-	-50	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C = -50mA, I_B = 0$	-50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE} = -1V, I_C = -1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE} = -1V, I_C = -4A$	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C = -4A, I_B = -0.4A$	-	-0.2	-0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C = -4A, I_B = -0.4A$	-	-0.9	-1.2	
Transition Frequency		f_T	$V_{CE} = -4V, I_C = -1A$	-	10	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB} = -10V, I_E = 0, f = 1MHz$	-	250	-	pF
Switching Time	Turn-on Time	t_{on}	<p>INPUT I_{B2} I_{B1} OUTPUT I_{OUT} 20μs 100Ω $V_{CC} = -30V$</p>	-	0.2	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		-	-	0.5	

Note : $h_{FE(1)}$ Classification O : 70 ~ 140, Y : 120 ~ 240





MICRO MOTOR DRIVE, HAMMER DRIVE APPLICATIONS.
 SWITCHING APPLICATIONS.
 POWER AMPLIFIER APPLICATIONS.

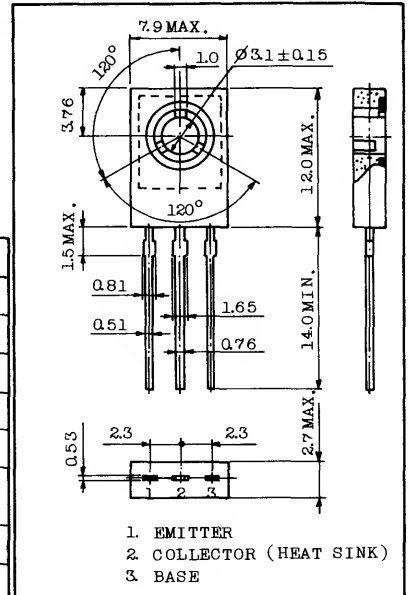
INDUSTRIAL APPLICATIONS
 Unit in mm

FEATURES:

- High DC Current Gain
 : $h_{FE}=2000(\text{Min.})$ ($V_{CE}=-2V, I_C=-1A$)
- Low Saturation Voltage
 : $V_{CE}(\text{sat})=-1.5V(\text{Max.})$ ($I_C=-1A, I_B=-1mA$)

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

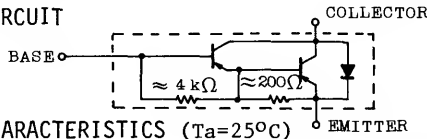
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	-80	V
Collector-Emitter Voltage	V_{CEO}	-80	V
Emitter-Base Voltage	V_{EBO}	-8	V
Collector Current	I_C	-2	A
Base Current	I_B	-0.5	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	15	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ\text{C}$



JEDEC	T0-126
EIAJ	-
TOSHIBA	2-8F1A

Mounting Kit No. AC46C
 Weight : 0.72g

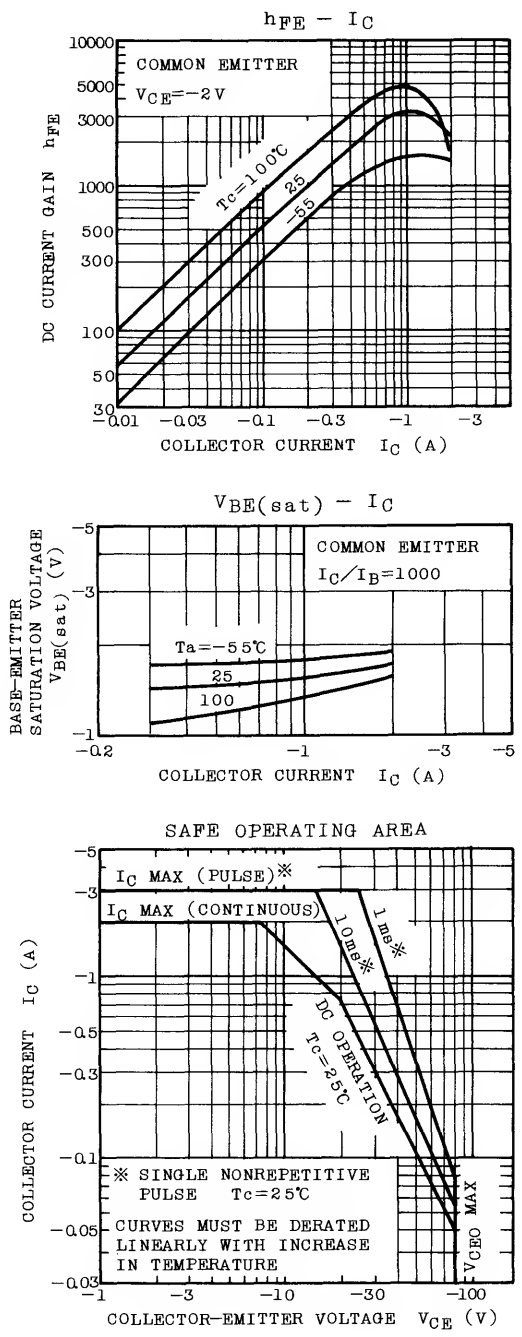
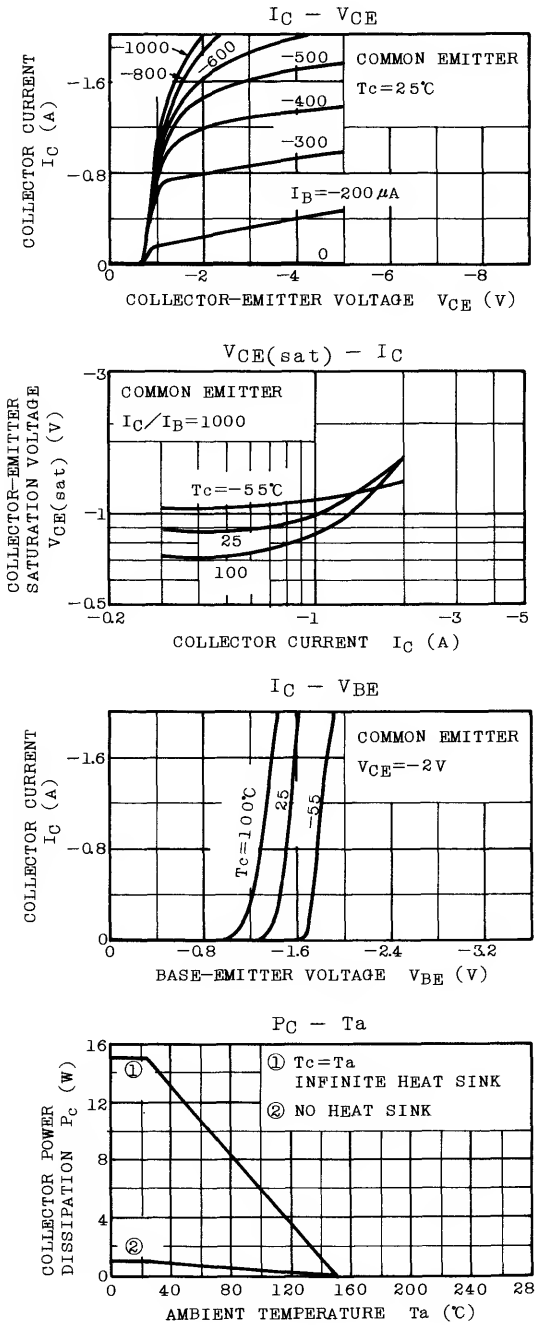
EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Collector Cut-off Current	I_{CBO}	$V_{CB}=-80V, I_E=0$	-	-	-10	μA	
Emitter Cut-off Current	I_{EBO}	$V_{EB}=-8V, I_C=0$	-	-	-4	mA	
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=-10mA, I_B=0$	-80	-	-	V	
DC Current Gain	h_{FE}	$V_{CE}=-2V, I_C=-1A$	2000	-	-		
Collector-Emitter Saturation Voltage	$V_{CE}(\text{sat})$	$I_C=-1A, I_B=-1mA$	-	-	-1.5	V	
Base-Emitter Saturation Voltage	$V_{BE}(\text{sat})$	$I_C=-1A, I_B=-1mA$	-	-	-2.0	V	
Transition Frequency	f_T	$V_{CE}=-2V, I_C=-0.5A$	-	50	-	MHz	
Collector Output Capacitance	C_{ob}	$V_{CB}=-10V, I_E=0, f=1\text{MHz}$	-	30	-	pF	
Switching Time	Turn-on Time	t_{on}			-	0.4	-
	Storage Time	t_{stg}	-	2.0	-	μs	
	Fall Time	t_f	-	0.4	-		

2SB1034





2SC
SERIES

2SC108A 2SC109A

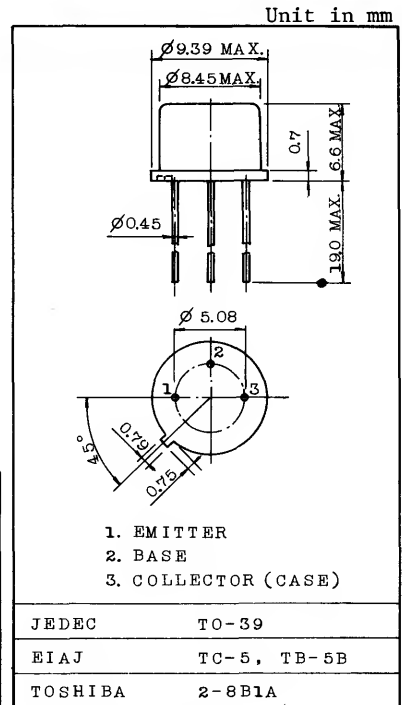
HIGH FREQUENCY AMPLIFIER APPLICATIONS.
HIGH SPEED SWITCHING APPLICATIONS.

FEATURES:

- High Switching Speed: $t_{stg}=60\text{nS}$ (Typ.)
- High Transition Frequency: $f_T = 150\text{MHz}$ (Typ.)
- High Breakdown Voltage
: $V_{CBO}=90\text{V}$ (2SC108A)
- Low Collector Saturation Voltage
: $V_{CE(sat)}=0.4\text{V(Max.)}$ at $I_C=200\text{mA}$, $I_B=20\text{mA}$

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC108A	V_{CBO}	90	v
	2SC109A		70	
Collector-Emitter Voltage	2SC108A	V_{CEO}	70	v
	2SC109A		50	
Emitter-Base Voltage		V_{EBO}	5	v
Collector Current		I_C	800	mA
Base Current		I_B	100	mA
Collector Power Dissipation		PC	800	mW
Junction Temperature		T_j	175	°C
Storage Temperature Range		T_{stg}	-65~175	°C



Weight : 1.14g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	2SC108A	I_{CBO}	$V_{CB}=80\text{V}$, $I_E=0$	-	-	0.5	μA
	2SC109A		$V_{CB}=60\text{V}$, $I_E=0$				
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5\text{V}$, $I_C=0$	-	-	1.0	μA
DC Current Gain		h_{FE} (Note)	$V_{CE}=2\text{V}$, $I_C=200\text{mA}$	40	-	240	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=200\text{mA}$, $I_B=20\text{mA}$	-	0.2	0.4	v
	Base-Emitter	$V_{BE(sat)}$	$I_C=200\text{mA}$, $I_B=20\text{mA}$	-	0.8	1.0	
Transition Frequency		f_T	$V_{CE}=10\text{V}$, $I_C=10\text{mA}$	100	150	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10\text{V}$, $I_E=0$, $f=1\text{MHz}$	-	9	15	pF
Switching Time	Turn-on Time	t_{on}		-	30	70	ns
	Storage Time	t_{stg}		-	60	80	
	Fall Time	t_f		-	20	40	

Note : h_{FE} Classification R : 40 ~ 80, O : 70 ~ 140, Y : 120 ~ 240

2SC495 2SC496

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

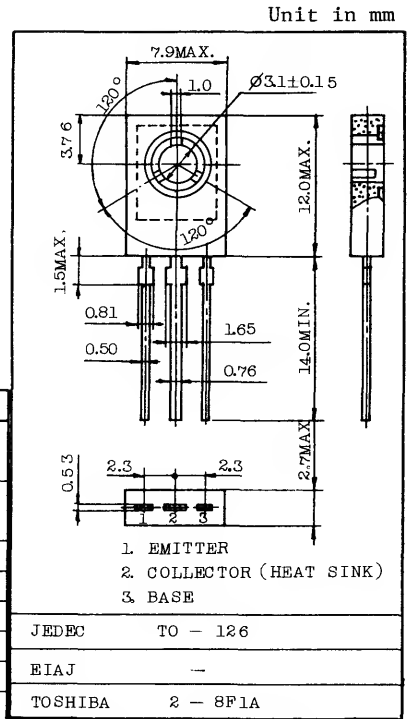
MEDIUM POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
: $V_{CE(sat)}=0.25V$ (Typ.)
- 0.5~2 Watts Output Application.
- Complementary to 2SA505 and 2SA496.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC495	70	V
	2SC496	40	V
Collector-Emitter Voltage	2SC495	50	V
	2SC496	30	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	1	A
Emitter Current	I_E	-1	A
Collector Power Dissipation	P_C	1	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~ 150	°C

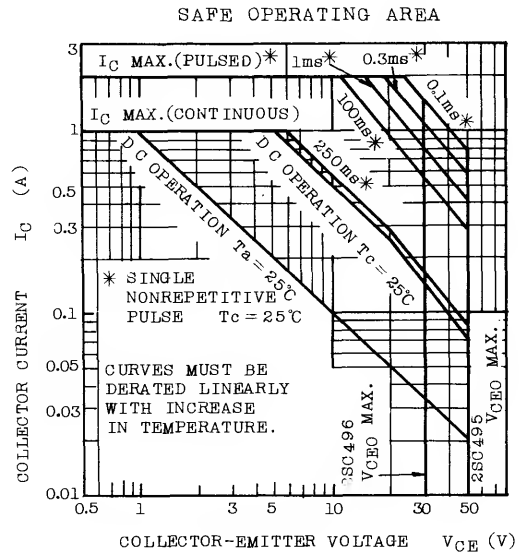
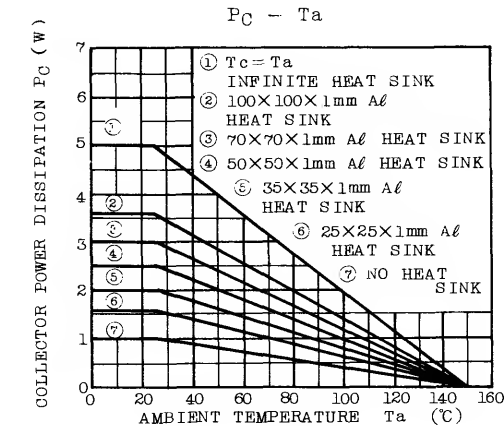
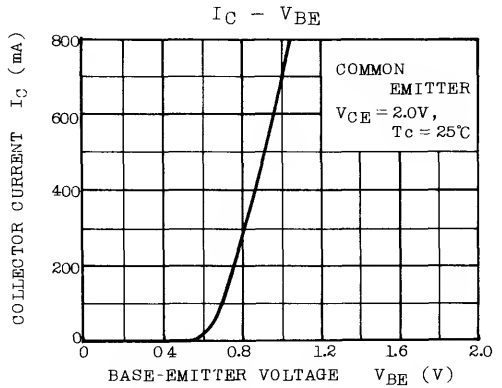
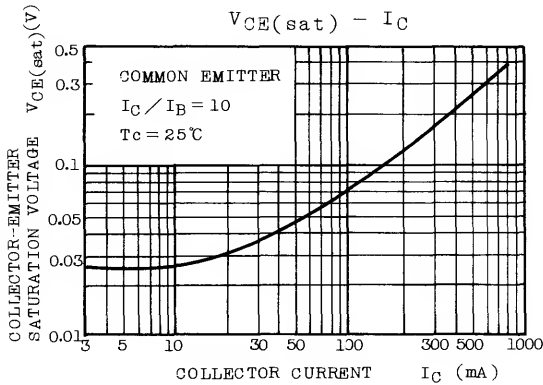
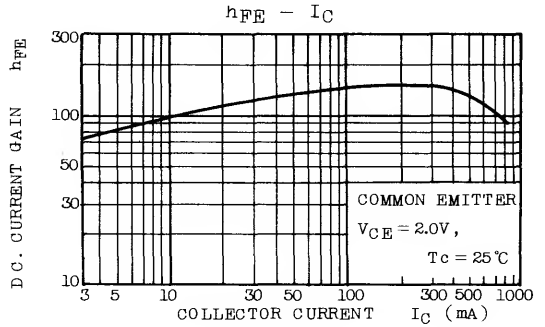
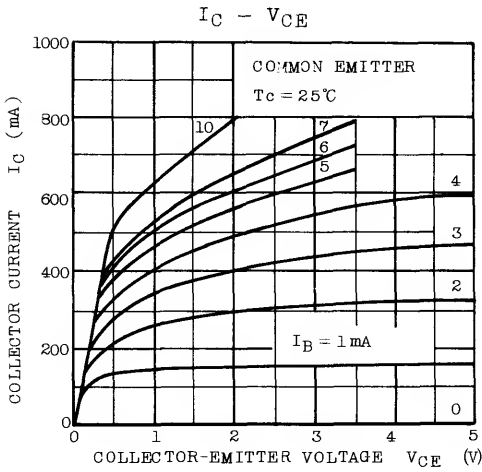


Mounting Kit No. AC46C
Weight : 0.72g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=30V, I_E=0$	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	50	-	-	V
			30	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA, I_C=0$	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=2V, I_C=50mA$	40	-	240	
			$h_{FE(2)}$	$V_{CE}=2V, I_C=800mA$	13	-
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=500mA, I_B=50mA$	-	0.25	0.8	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=2V, I_C=500mA$	-	0.9	1.1	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=10mA$	50	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	10	-	pF

Note : $h_{FE(1)}$ Classification R : 40~80, O : 70~140, Y : 120~240



2SC503 2SC504

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

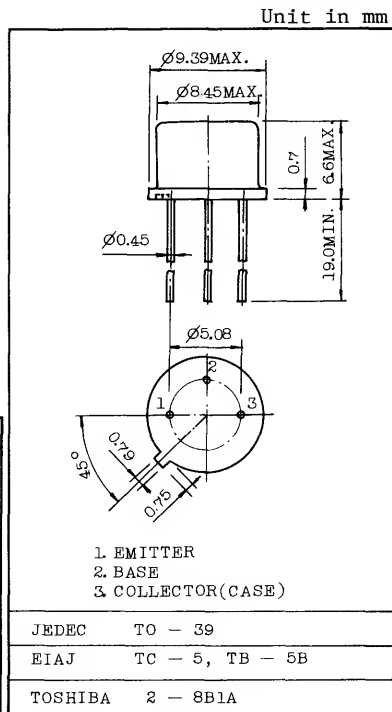
HIGH FREQUENCY AMPLIFIER APPLICATIONS.
HIGH SPEED SWITCHING APPLICATIONS.

FEATURES:

- High Transition Frequency : $f_T=80\text{MHz}$ (Typ.)
- High Breakdown Voltage
 - : $V_{CE0}=80\text{V}$ (2SC503)
 - : $V_{CE0}=60\text{V}$ (2SC504)
- Complementary to 2SA503 and 2SA504.

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC503	V_{CB0}	100	V
	2SC504		80	
Collector-Emitter Voltage	2SC503	V_{CE0}	80	V
	2SC504		60	
Emitter-Base Voltage		V_{EB0}	5	V
Collector Current		I_C	600	mA
Base Current		I_B	100	mA
Collector Power Dissipation	$T_a=25^\circ\text{C}$	P_C	800	mW
	$T_c=25^\circ\text{C}$		6	W
Junction Temperature		T_j	175	$^\circ\text{C}$
Storage Temperature Range		T_{stg}	-65~175	$^\circ\text{C}$

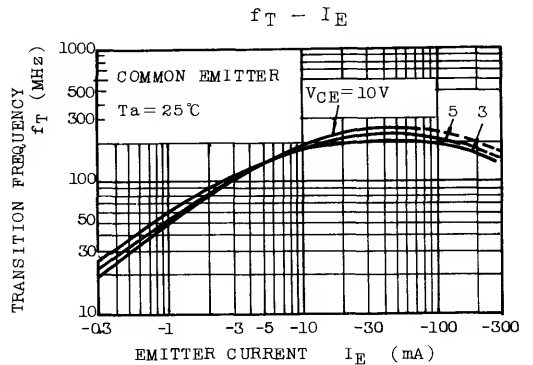
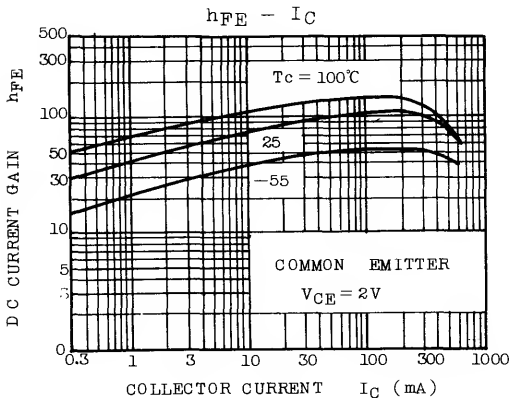
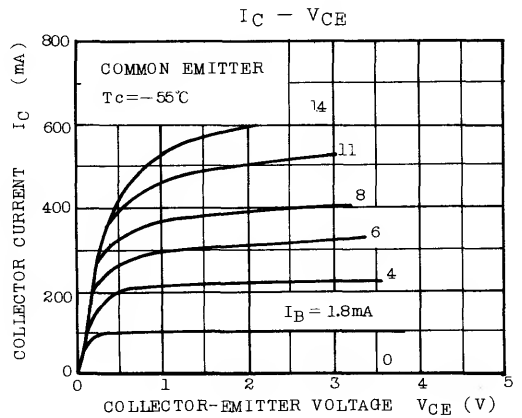
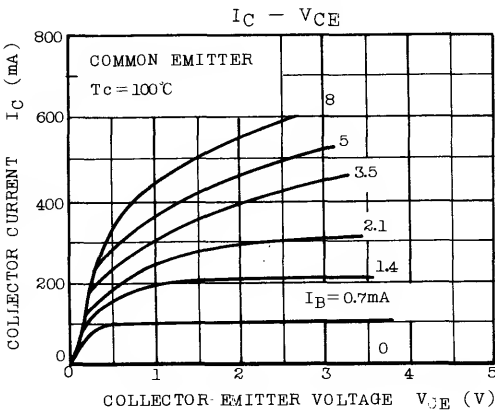
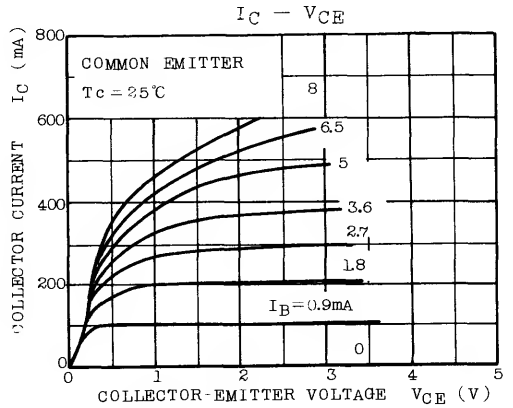
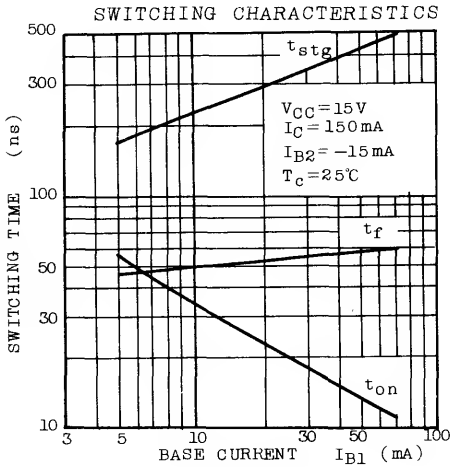


Weight : 1.13g

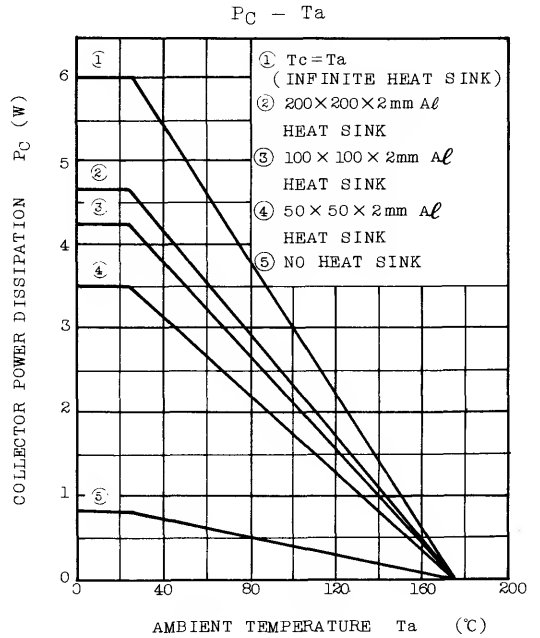
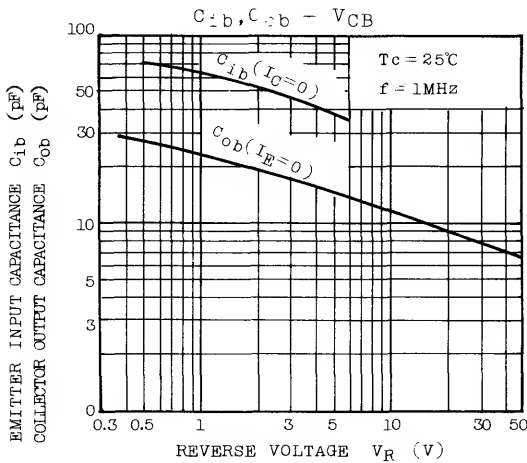
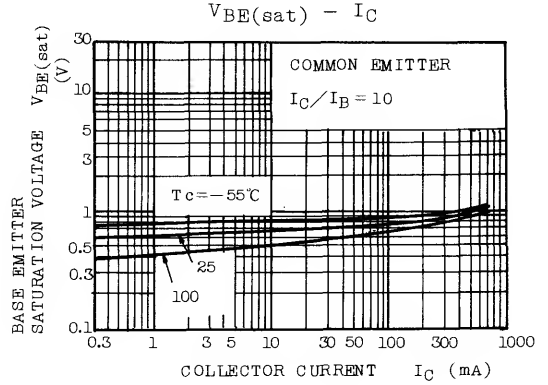
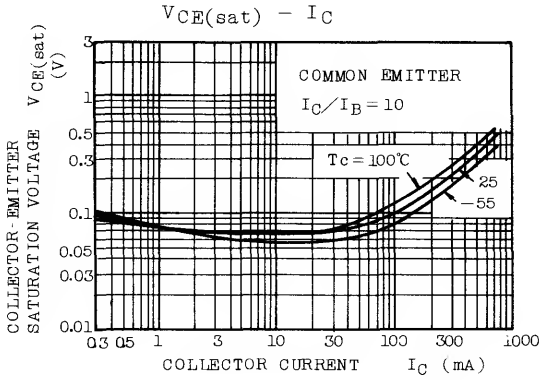
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	2SC503	I_{CBO}	$V_{CB}=80\text{V}, I_E=0$	-	-	0.5	μA
	2SC504		$V_{CB}=60\text{V}, I_E=0$				
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5\text{V}, I_C=0$	-	-	1.0	μA
DC Current Gain		h_{FE} (Note)	$V_{CE}=2\text{V}, I_C=150\text{mA}$	30	-	300	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=150\text{mA}, I_B=15\text{mA}$	-	0.06	0.5	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=150\text{mA}, I_B=15\text{mA}$	-	0.8	1.5	
Transition Frequency		f_T	$V_{CE}=2\text{V}, I_C=150\text{mA}$	50	80	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10\text{V}, I_E=0, f=1\text{MHz}$	-	13	30	pF
Base Intrinsic Resistance		$r_{bb'}$	$V_{CE}=10\text{V}, I_E=-1\text{mA}, f=30\text{MHz}$	-	16	25	Ω
Switching Time	Turn-on Time	t_{on}		-	40	-	ns
	Storage Time	t_{stg}		-	450	-	
	Fall Time	t_f		-	100	-	

Note: h_{FE} Classification 0 : 30~90, Y : 50~150, GR : 100~300



2SC503·2SC504



2SC505 2SC506

Unit in mm

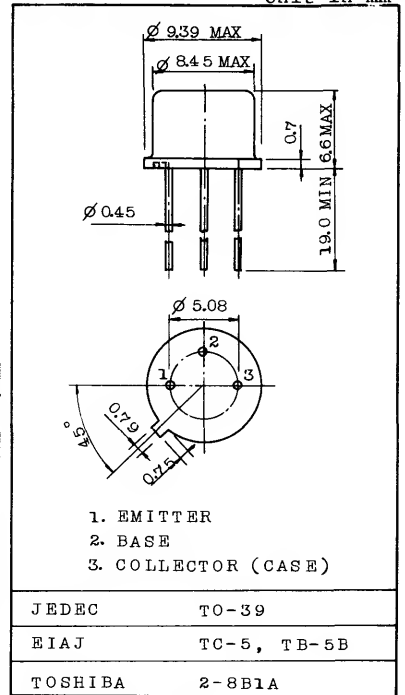
HIGH VOLTAGE AMPLIFIER APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

- High Breakdown Voltage : $V_{CEO}=300V$ (2SC505)
: $V_{CEO}=200V$ (2SC506)

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC505	300	V
	2SC506	200	
Collector-Emitter Voltage	2SC505	300	V
	2SC506	200	
Emitter-Base Voltage	V_{EBO}	3	V
Collector Current	I_C	200	mA
Base Current	I_B	50	mA
Collector Power Dissipation	P_C	600	mW
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65~175	$^\circ C$



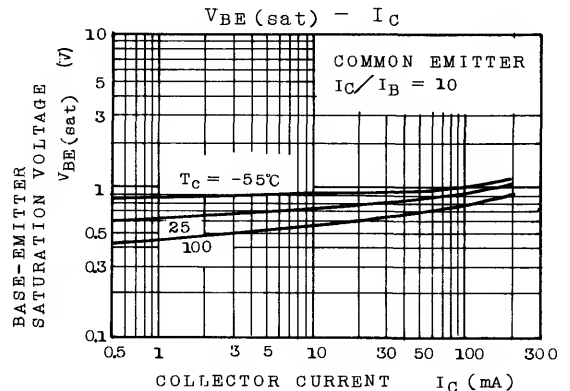
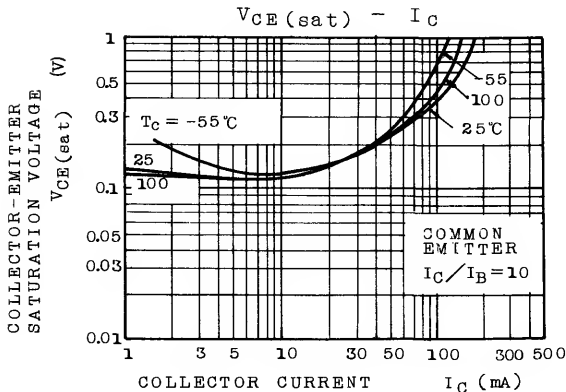
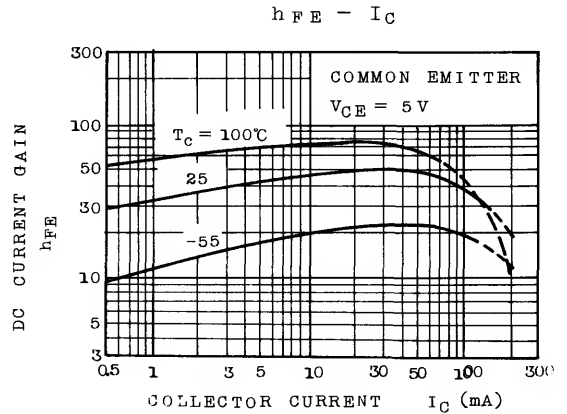
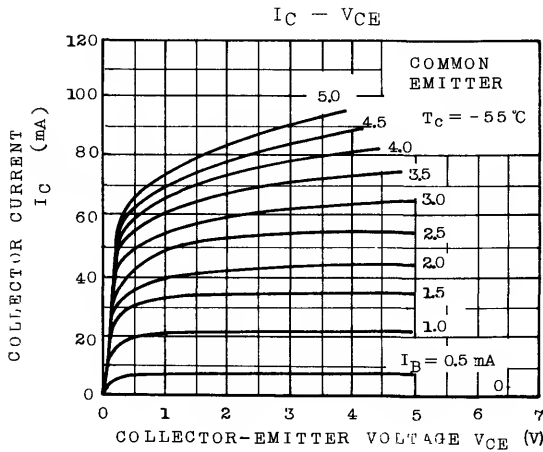
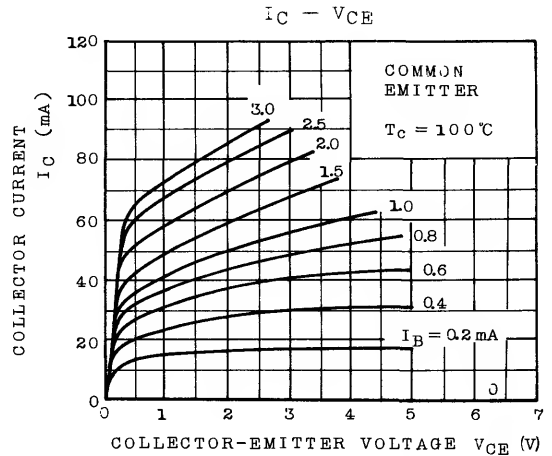
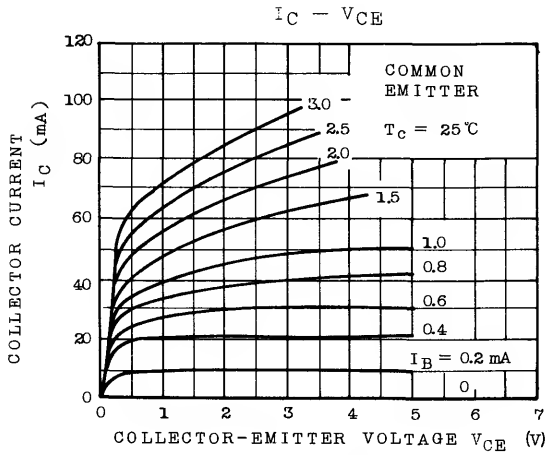
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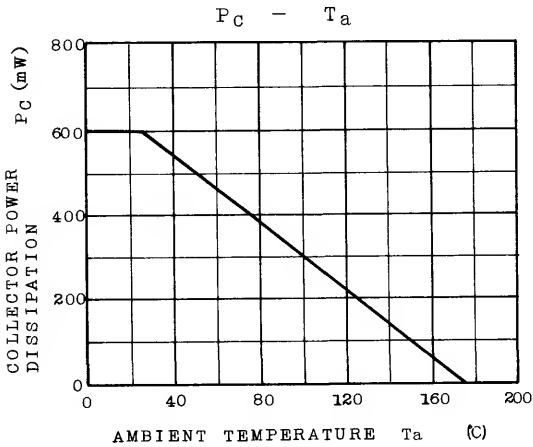
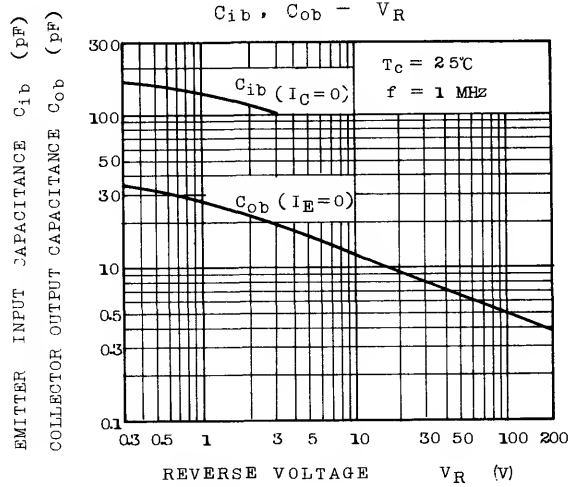
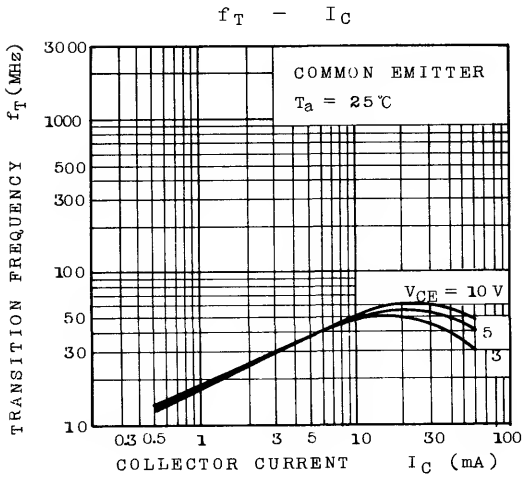
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=100V, I_E=0$	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=3V, I_C=0$	-	-	1.0	μA
Collector-Base Breakdown Voltage	2SC505	$V_{(BR)CBO}$ $I_C=0.1mA, I_E=0$	300	-	-	V
	2SC506		200	-	-	
Collector-Emitter Breakdown Voltage	2SC505	$V_{(BR)CEO}$ $I_C=2mA, I_B=0$	300	-	-	V
	2SC506		200	-	-	
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=0.1mA, I_C=0$	3	-	-	V
DC Current Gain	h_{FE} (Note)	$V_{CE}=5V, I_C=50mA$	40	-	140	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$ $I_C=50mA, I_B=5mA$	-	-	1.0	V
	Base-Emitter	$V_{BE(sat)}$ $I_C=50mA, I_B=5mA$	-	-	1.5	
Transition Frequency	f_T	$V_{CE}=10V, I_C=10mA$	30	60	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	-	20	pF
Base Intrinsic Resistance	$r_{bb'}$	$V_{CE}=10V, I_E=-3mA, f=30MHz$	-	-	20	Ω
Switching Time	Turn-on Time	$V_{CC}=50V, I_C=10mA$ $I_{B1}=-I_{B2}=1mA$	-	0.3	-	μs
	Storage Time		-	4	-	
	Fall Time		-	0.5	-	

Note: h_{FE} Classification R: 40~80, O: 70~140

2SC505 · 2SC506





2SC507

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

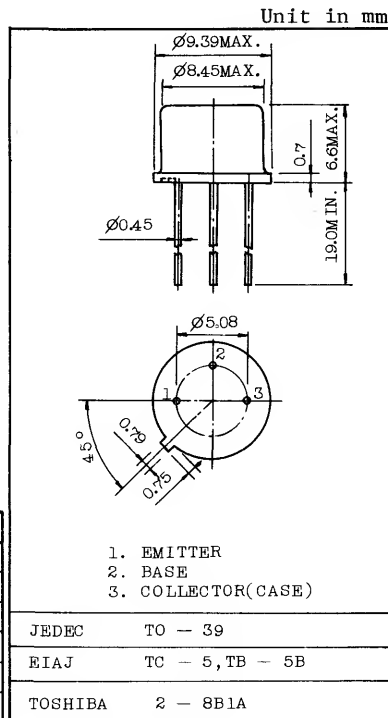
VIDEO AMPLIFIER APPLICATIONS.
HIGH FREQUENCY AMPLIFIER APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

- High Breakdown Voltage
: $V_{CB0}=170V$, $V_{CE0}=120V$
- High Gain and Excellent h_{FE} Linearity
: $I_C=100mA$ (Max.)
- High Transition Frequency : $f_T=250MHz$ (Typ.)
- Low Output Capacitance : $C_{ob}=2.8pF$ (Typ.)

MAXIMUM RATING (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB0}	170	V
Collector-Emitter Voltage		V_{CE0}	120	V
Emitter-Base Voltage		V_{EB0}	5	V
Collector Current		I_C	100	mA
Base Current		I_B	20	mA
Collector Power	Ta=25°C	P_C	750	mW
	Tc=25°C		23	W
Junction Temperature		T_j	175	°C
Storage Temperature Range		T_{stg}	-65~175	°C

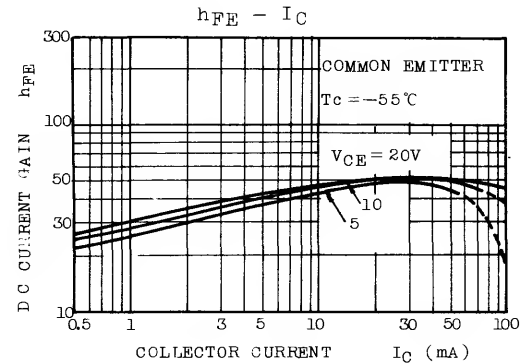
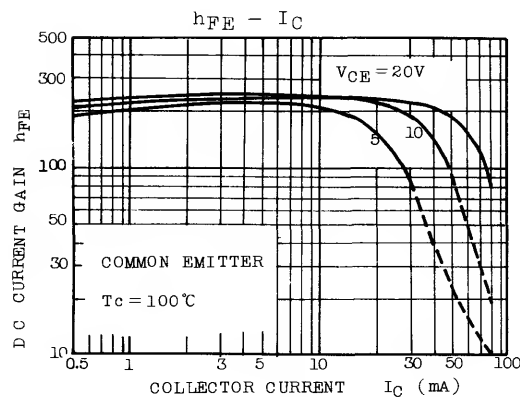
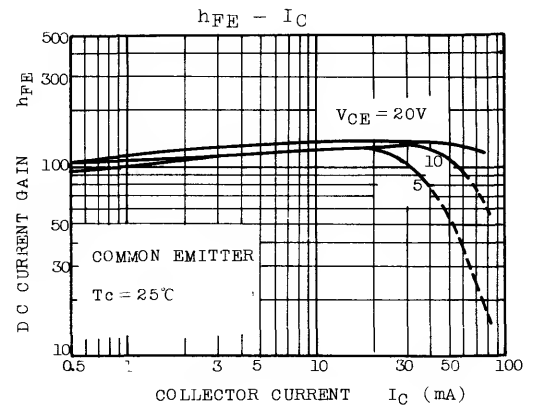
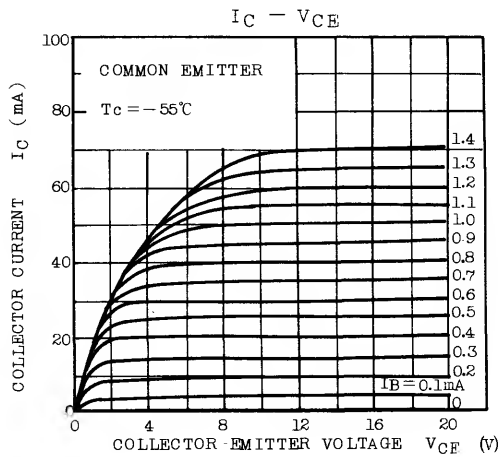
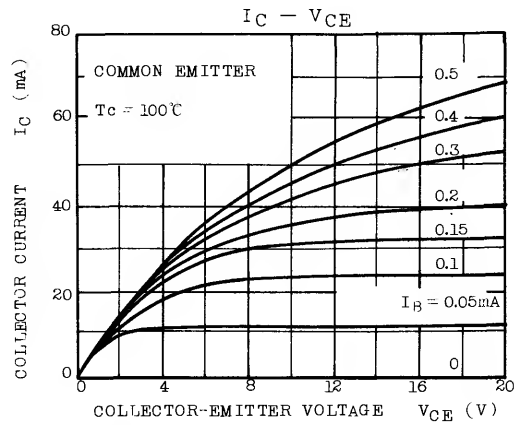
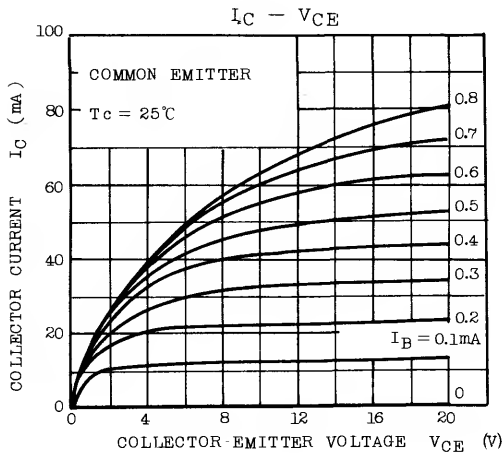


Weight : 1.13g

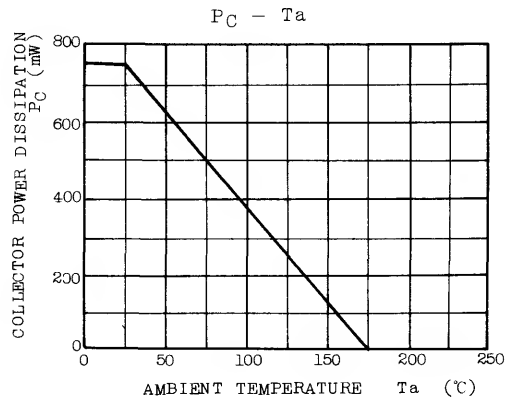
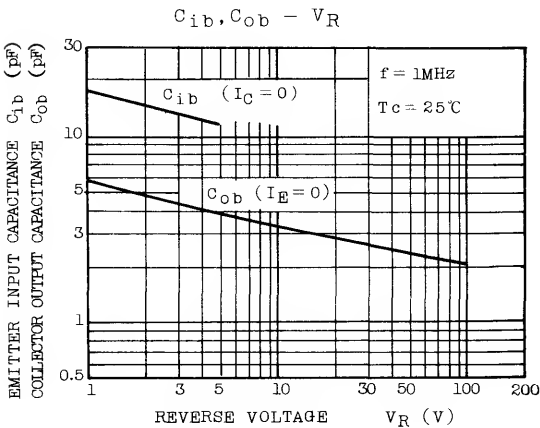
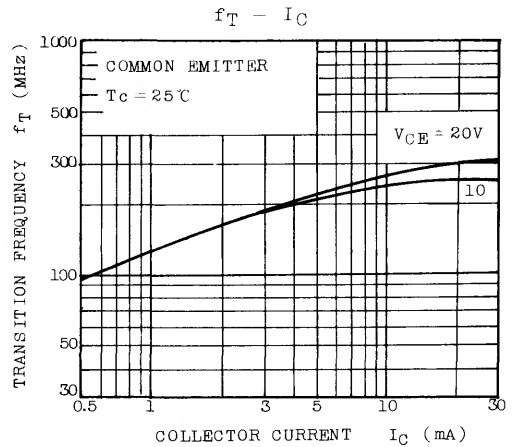
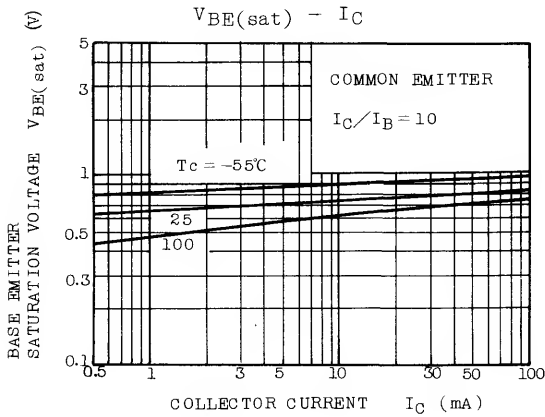
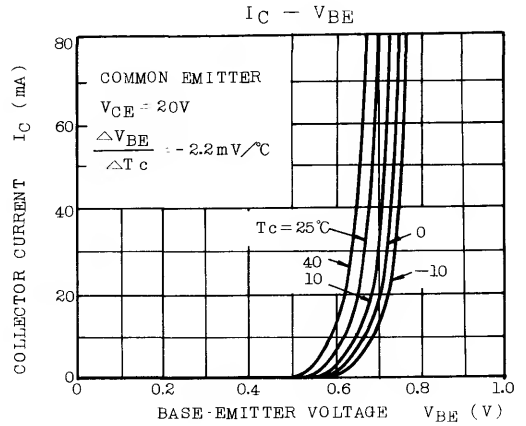
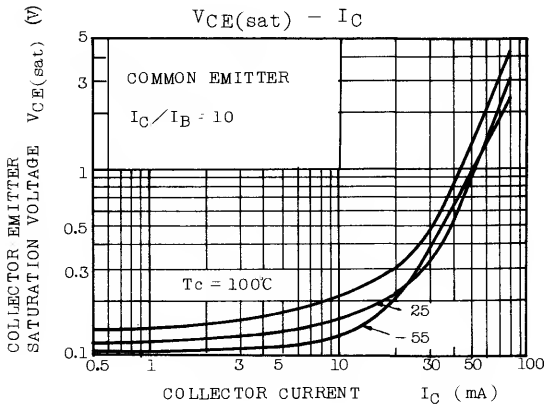
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=100V, I_E=0$	-	-	0.5	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1.0	μA
Breakdown Voltage	Collector-Base	$V_{(BR)CB0}$	$I_C=0.1mA, I_E=0$	170	-	-	V
	Collector-Emitter	$V_{(BR)CE0}$	$I_C=1mA, I_B=0$	120	-	-	
	Emitter-Base	$V_{(BR)EB0}$	$I_E=0.1mA, I_C=0$	5	-	-	
DC Current Gain		h_{FE} (Note)	$V_{CE}=5V, I_C=10mA$	40	70	240	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=10mA, I_B=1mA$	-	0.4	0.8	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=10mA, I_B=1mA$	-	0.85	1.2	
Transition Frequency		f_T	$V_{CE}=20V, I_C=10mA$	100	250	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=20V, I_E=0, f=1MHz$	-	2.8	4.0	pF

Note : h_{FE} Classification R : 40 ~ 80, O : 70 ~ 140, Y : 120 ~ 240



2SC507



2SC510 2SC512

Unit in mm

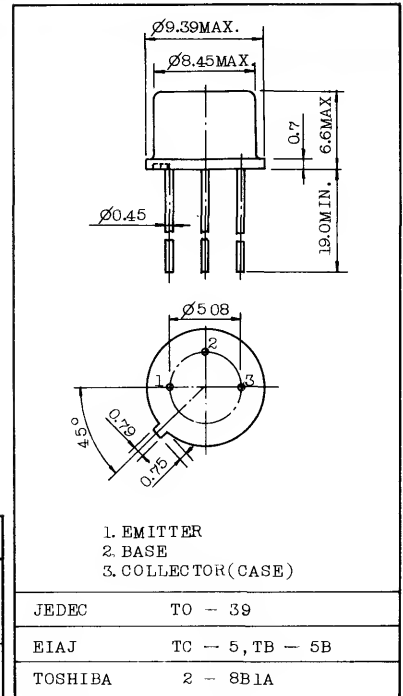
HIGH FREQUENCY POWER AMPLIFIER APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.
REGULATOR APPLICATIONS.

FEATURES :

- High Braekdown Voltage
: $V_{CE0}=100V$ (2SC510)
: $V_{CE0}= 60V$ (2SC512)
- Various Uses for Medium Power
: $I_C(\text{Max.}) =1.5A$
: $P_C(\text{Max.}) =800mW(T_a=25^\circ C)$, $8W(T_c=25^\circ C)$
- Complementary to 2SA510 and 2SA512.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC510	V_{CBO}	140	V
	2SC512		100	
Collector-Emitter Voltage	2SC510	V_{CEO}	100	V
	2SC512		60	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	1.5	A
Base Current		I_B	300	mA
Collector Power	$T_a=25^\circ C$	P_C	800	mW
Dissipation	$T_c=25^\circ C$		8	W
Junction Temperatuer		T_j	175	$^\circ C$
Storage Temperature Range		T_{stg}	-65~175	$^\circ C$



Weight : 1.13g

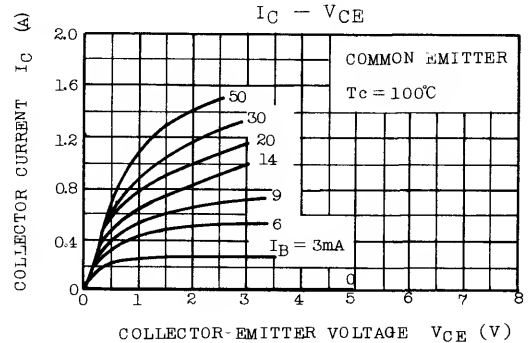
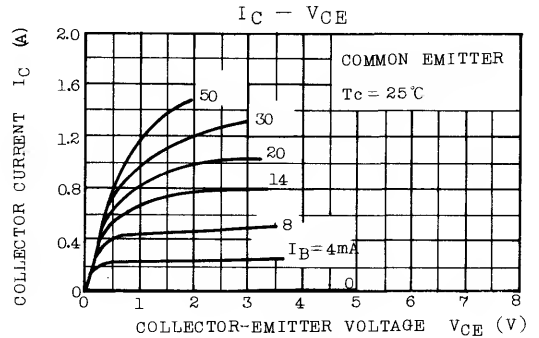
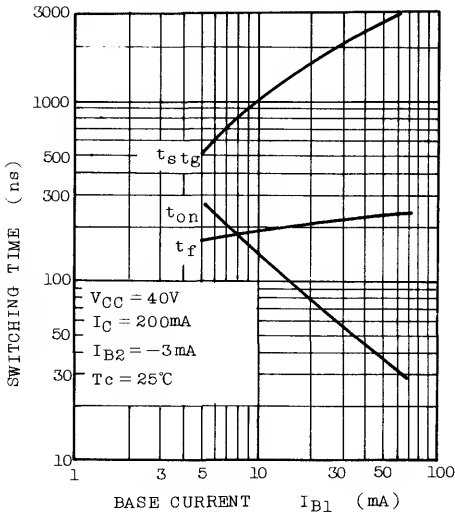
2SC510·2SC512

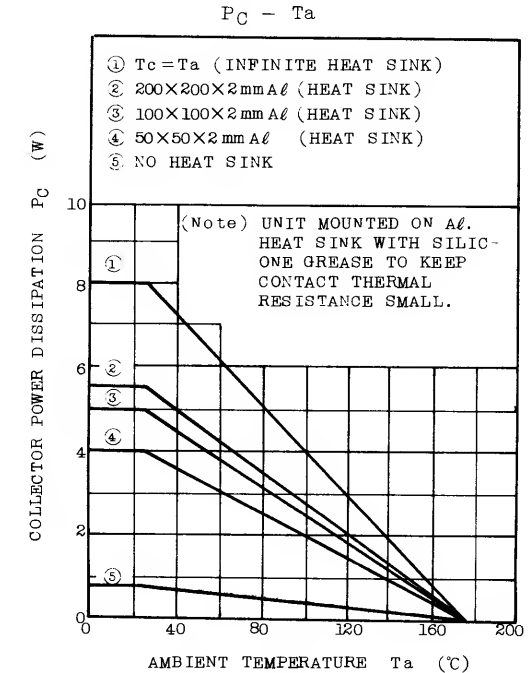
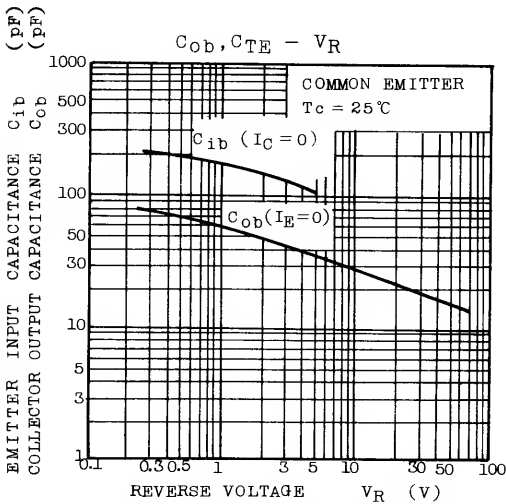
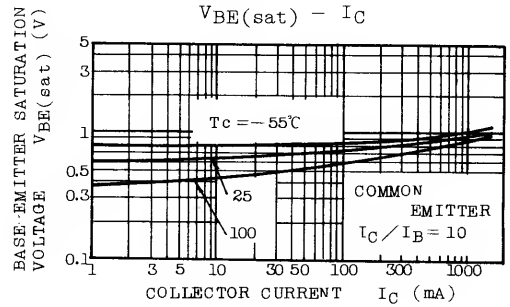
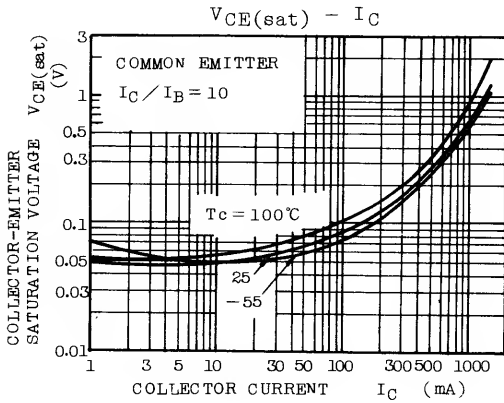
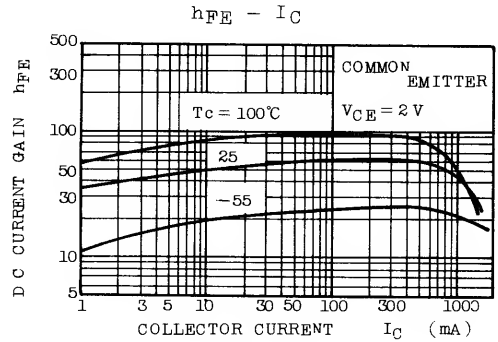
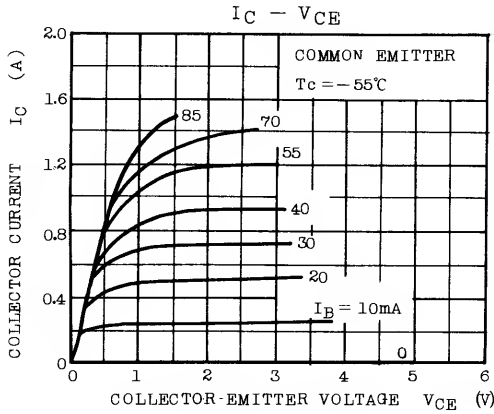
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=30V, I_E=0$	-	-	1	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	5	μA
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=2V, I_C=200mA$	30	-	150	
		$h_{FE(2)}$	$V_{CE}=5V, I_C=1A$	15	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=200mA, I_B=20mA$	-	0.2	0.6	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=200mA, I_B=20mA$	-	0.8	1.0	
Transition Frequency		f_T	$V_{CE}=10V, I_C=30mA$	20	60	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	25	40	pF
Switching Time	Turn-on Time	t_{on}		-	0.13	-	μs
	Storage Time	t_{stg}		-	3.0	-	
	Fall Time	t_f		-	-	0.2	

Note : $h_{FE(1)}$ Classification R : 30~90, O : 50~150

SWITCHING CHARACTERISTICS





2SC519A 2SC520A 2SC521A

SILICON NPN TRIPLE DIFFUSED TYPE

POWER AMPLIFIER, POWER SWITCHING APPLICATIONS.
DC-DC CONVERTER, REGULATOR APPLICATIONS.

INDUSTRIAL APPLICATIONS

unit in mm

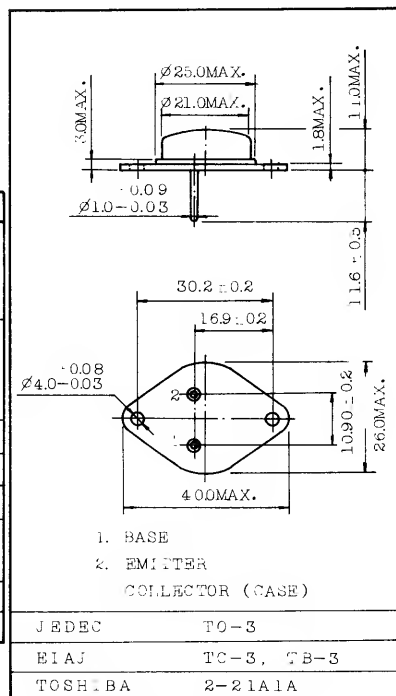
FEATURES:

- High Voltage : $V_{CBO}=130V(2SC519A), V_{CEO}=110V(2SC519A)$
- High Collector Power Dissipation : $P_C=50W (T_c=25^\circ C)$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC519A	V_{CBO}	130	V
	2SC520A		100	
	2SC521A		70	
Collector-Emitter Voltage	2SC519A	V_{CEO}	110	V
	2SC520A		80	
	2SC521A		50	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	7	A
Base Current		I_B	2	A
Collector Power Dissipation	$T_c=25^\circ C$	P_C	50	W
	(Note)		25	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-65~150	$^\circ C$

Note : Unit Mounted on a $300 \times 300 \times 2mm \Delta$ Heat Sink With Silicone Greased Mica Insulator

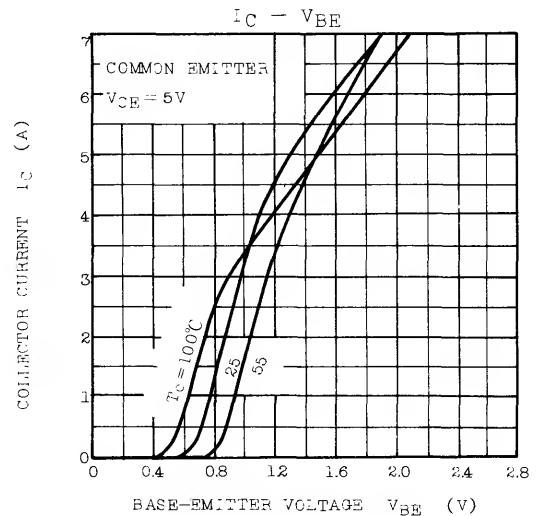
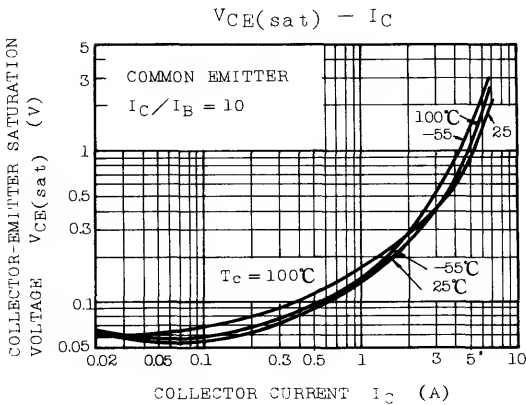
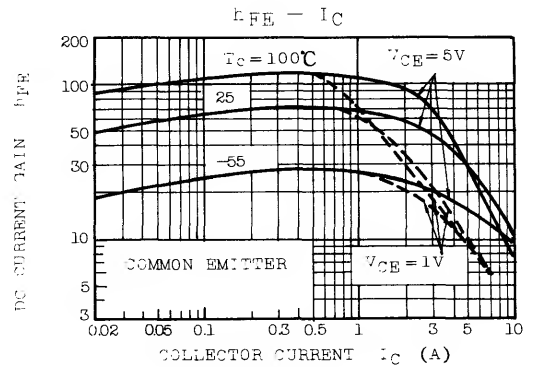
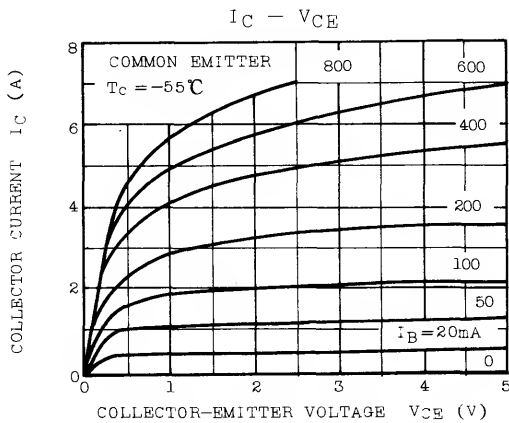
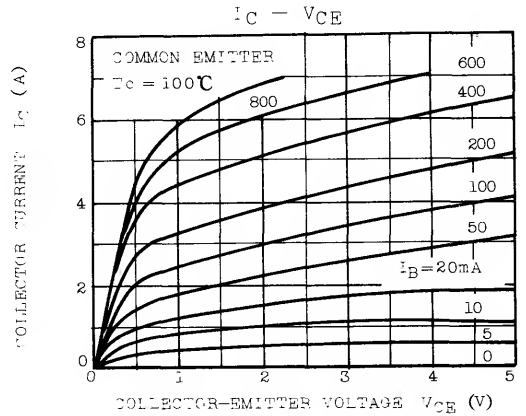
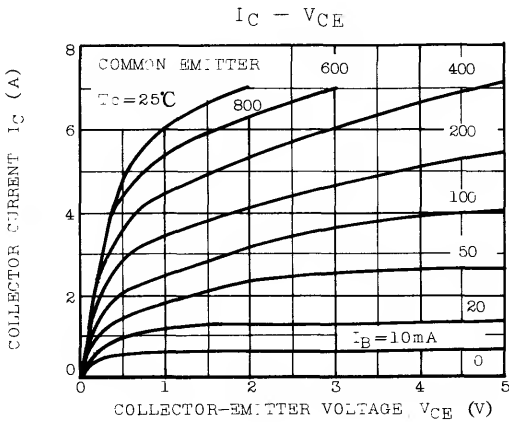


Mounting Kit No. AC73
Weight : 12g

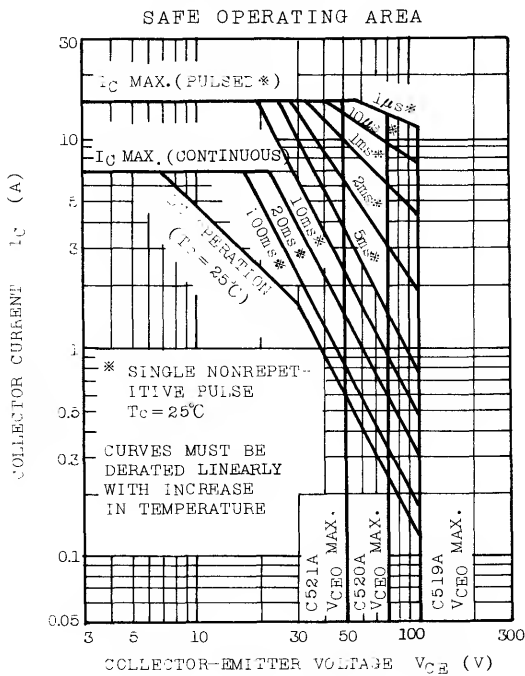
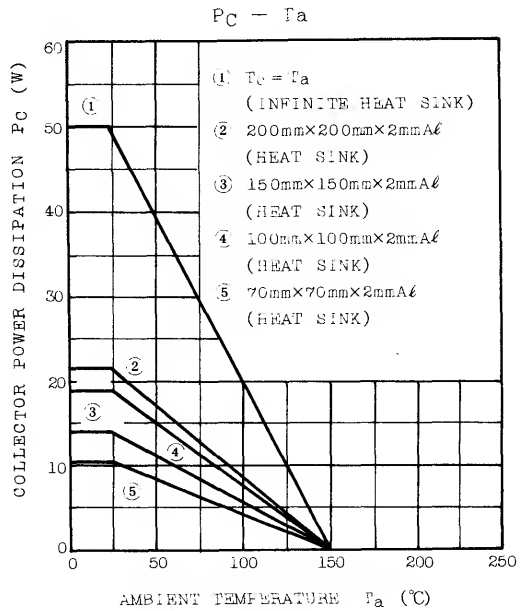
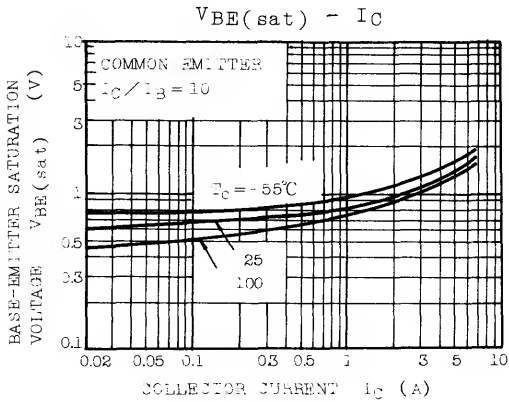
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	2SC519A	I_{CBO}	$V_{CB}=130V, I_E=0$	-	-	100	μA
	2SC520A		$V_{CB}=100V, I_E=0$	-	-	100	
	2SC521A		$V_{CB}=70V, I_E=0$	-	-	100	
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	5	mA
Collector-Emitter Breakdown Voltage	2SC519A	$V(BR)_{CEO}$	$I_C=50mA, I_B=0$	110	-	-	V
	2SC520A		$I_C=50mA, I_B=0$	80	-	-	
	2SC521A		$I_C=50mA, I_B=0$	50	-	-	
DC Current Gain		$h_{FE}(1)$	$V_{CE}=5V, I_C=1A$	30	-	300	
		$h_{FE}(2)$	$V_{CE}=5V, I_C=5A$	15	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=5A, I_B=1A$	-	0.6	2.0	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=5A, I_B=1A$	-	1.3	2.5	
Transition Frequency		f_T	$V_{CE}=10V, I_C=1A$	-	10	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=50V, I_E=0, f=1MHz$	-	90	250	pF
Switching Time	Turn-on Time	t_{on}		-	0.4	-	μs
	Storage Time	t_{stg}		-	4.5	-	
	Fall Time	t_f		-	0.4	-	

2SC519A • 2SC520A • 2SC521A



2SC519A · 2SC520A · 2SC521A



Unit in mm

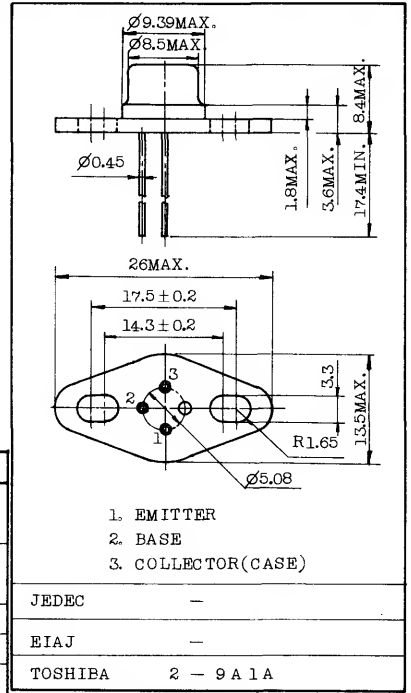
HIGH FREQUENCY AMPLIFIER APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.
REGULATOR APPLICATIONS.

FEATURES:

- High Breakdown Voltage : $V_{CE0}=100V$ (2SC522)
: $V_{CE0}= 60V$ (2SC524)
- Useful attachment for Heat sink.
- Various Uses for Medium Power
: $I_C=1.5A$ (Max.), $P_C=10W$ (Max.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	140	V
		100	
Collector-Emitter Voltage	V _{CE0}	100	V
		60	
Emitter-Base Voltage	V _{EB0}	5	V
Collector Current	I _C	1.5	A
Base Current	I _B	300	mA
Collector Power Dissipation (T _c =25°C)	P _C	10	W
Junction Temperature	T _j	175	°C
Storage Temperature Range	T _{stg}	-65~175	°C



Mounting kit No. AC26C
Weight : 3.7g

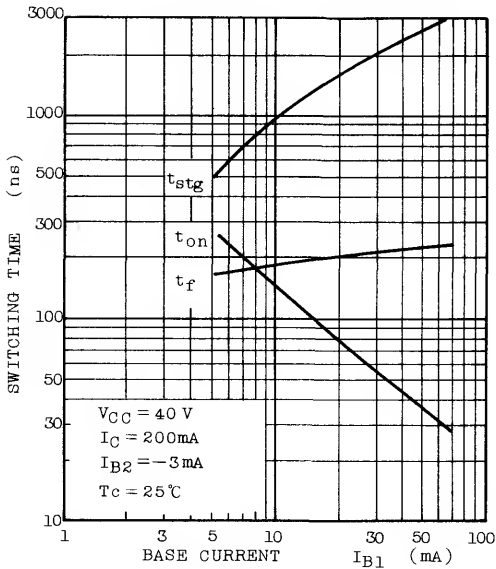
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Collector Cut-off Current	I _{CB0}	V _{CB} =30V, I _E =0	-	-	1	µA	
Emitter Cut-off Current	I _{EB0}	V _{EB} =5V, I _C =0	-	-	10	µA	
DC Current Gain	h _{FE} (1) (Note)	V _{CE} =2V, I _C =200mA	30	-	150		
		V _{CE} =5V, I _C =1A	15	-	-		
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =200mA, I _B =20mA	-	0.2	0.6	V	
Base-Emitter Saturation Voltage	V _{BE(sat)}	I _C =200mA, I _B =20mA	-	0.8	1.0	V	
Transition Frequency	f _T	V _{CE} =10V, I _C =30mA	20	60	-	MHz	
Collector Output Capacitance	C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	25	40	pF	
Switching Time	Turn-on Time	t _{on}					µs
	Storage Time	t _{stg}					
	Fall Time	t _f					

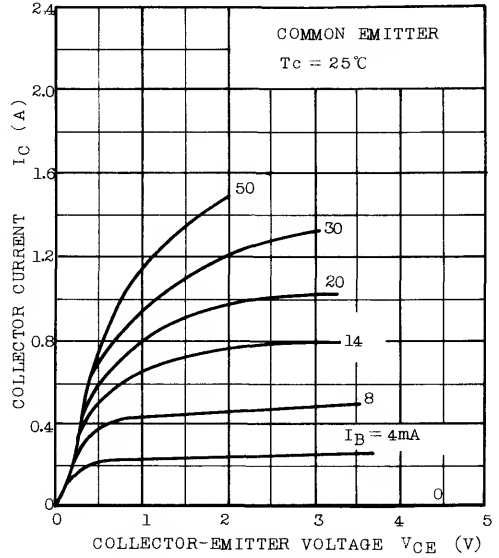
Note : h_{FE}(1) Classification R : 30~90, 0 : 50~150

2SC522·2SC524

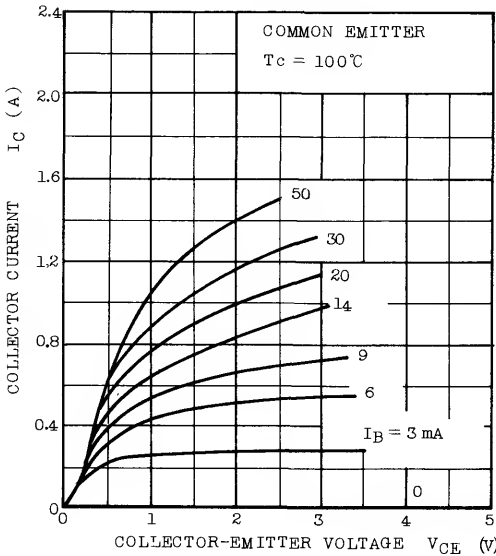
SWITCHING CHARACTERISTICS



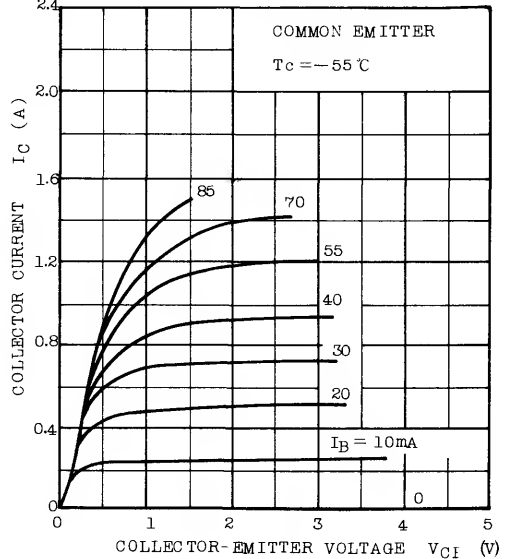
$I_C - V_{CE}$

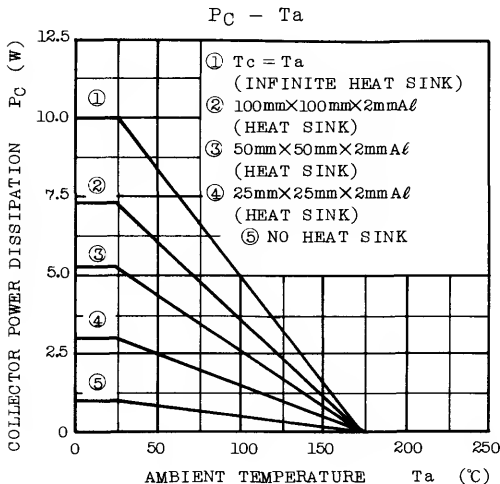
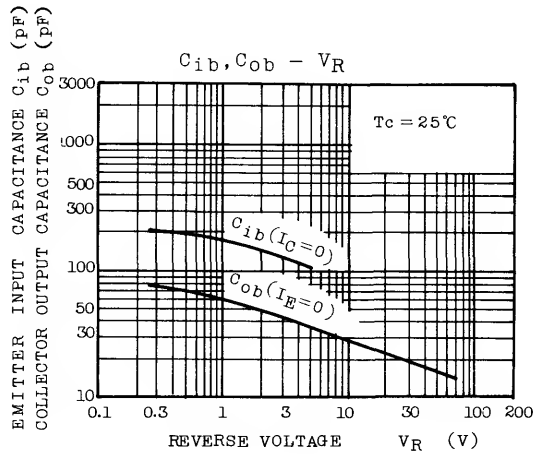
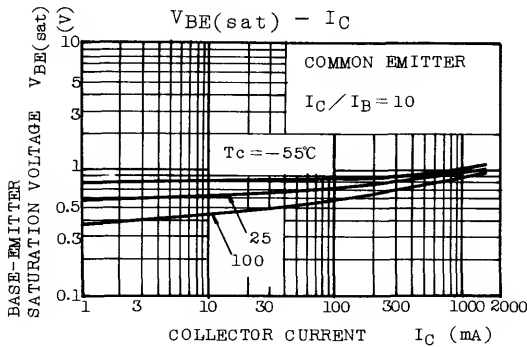
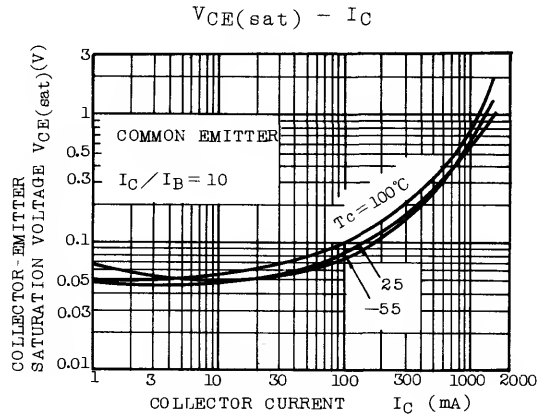
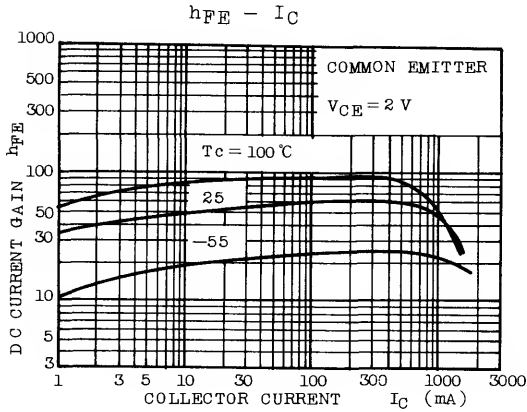


$I_C - V_{CE}$



$I_C - V_{CE}$





2SC594

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

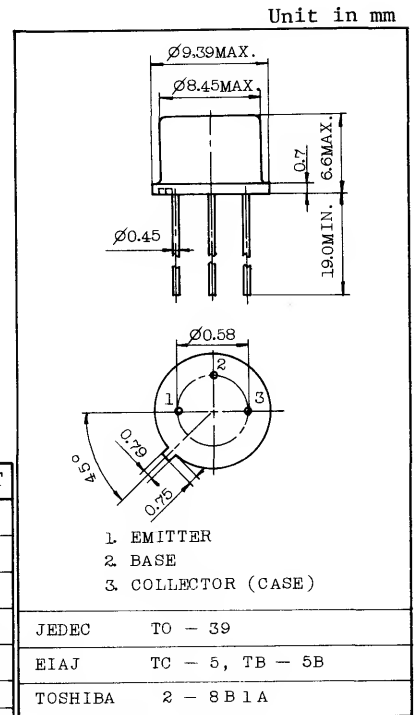
HIGH FREQUENCY AMPLIFIER APPLICATIONS.
VIDEO AMPLIFIER APPLICATIONS.
HIGH SPEED SWITCHING APPLICATIONS.

FEATURES:

- High Transition Frequency : $f_T=200\text{MHz}$ (Typ.)
- Low Output Capacitance : $C_{ob}=3.5\text{pF}$ (Typ.)
- Low Saturation Voltage
: $V_{CE(sat)}=0.3\text{V}$ (Max.) at $I_C=100\text{mA}$, $I_B=10\text{mA}$
- Complementary to 2SA594.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	60	V
Collector-Emitter Voltage		V_{CEO}	45	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	200	mA
Base Current		I_B	50	mA
Collector Power Dissipation	Ta=25°C	PC	750	mW
	Tc=25°C		5	W
Junction Temperature		Tj	175	°C
Storage Temperature Range		Tstg	-65~175	°C

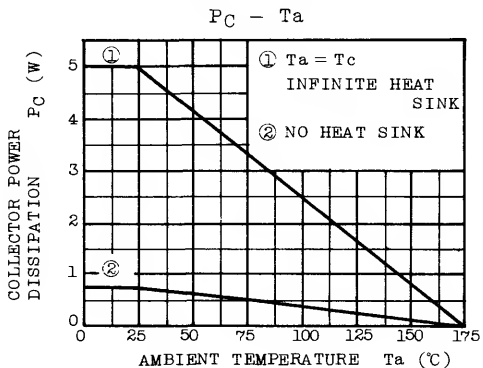
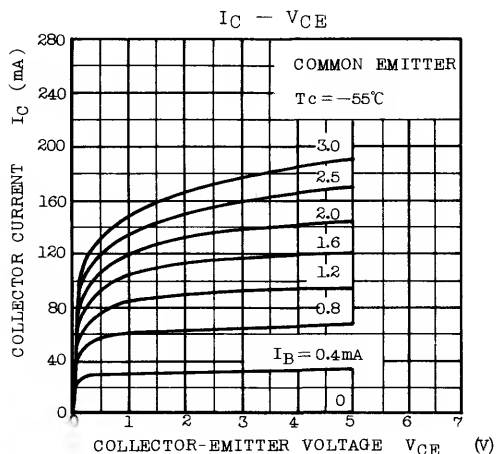
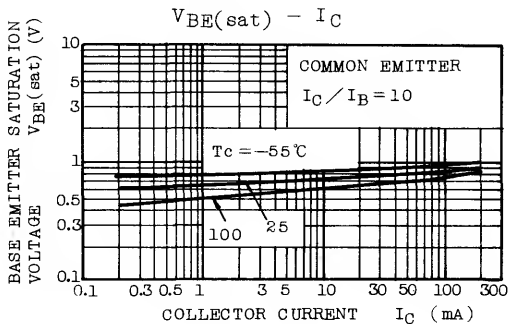
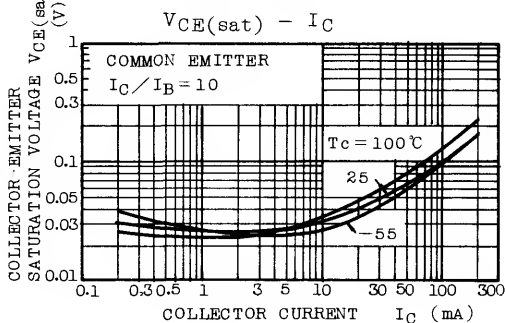
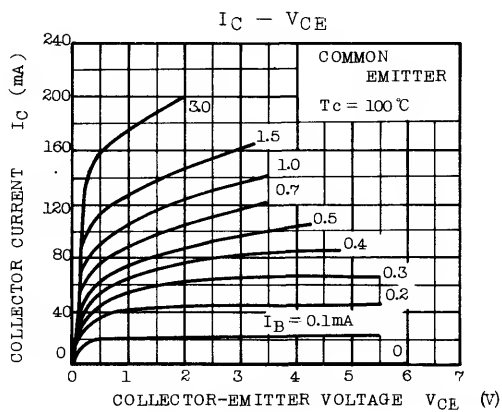
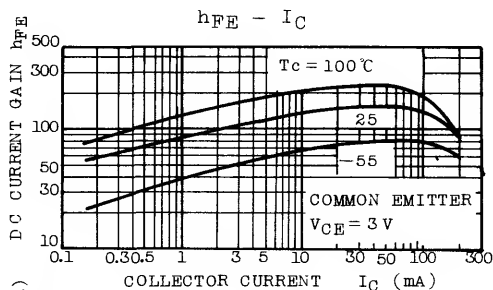
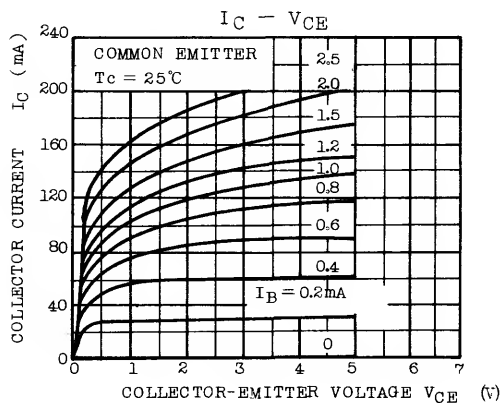


Weight : 1.13g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=45\text{V}$, $I_E=0$	-	-	0.1	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5\text{V}$, $I_C=0$	-	-	0.1	μA
DC Current Gain	(Note)	$h_{FE(1)}$	$V_{CE}=1\text{V}$, $I_C=10\text{mA}$	40	-	240	
		$h_{FE(2)}$	$V_{CE}=3\text{V}$, $I_C=200\text{mA}$	20	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=100\text{mA}$, $I_B=10\text{mA}$	-	-	0.3	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=100\text{mA}$, $I_B=10\text{mA}$	-	-	1.0	V
Transition Frequency		f_T	$V_{CE}=10\text{V}$, $I_C=10\text{mA}$	100	200	-	MHz
Input Impedance (Real Part)		r_{ie}	$V_{CE}=10\text{V}$, $I_E=-10\text{mA}$, $f=200\text{MHz}$	-	-	120	Ω
Collector Output Capacitance		C_{ob}	$V_{CB}=10\text{V}$, $I_E=0$, $f=1\text{MHz}$	-	3.5	5.0	pF
Switching Time	Turn-on Time	t_{on}		-	30	-	ns
	Storage Time	t_{stg}		-	250	-	
	Fall Time	t_f		-	30	-	

Note : $h_{FE(1)}$ Classification R : 40~80, O : 70~140, Y : 120~240,



2SC790

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

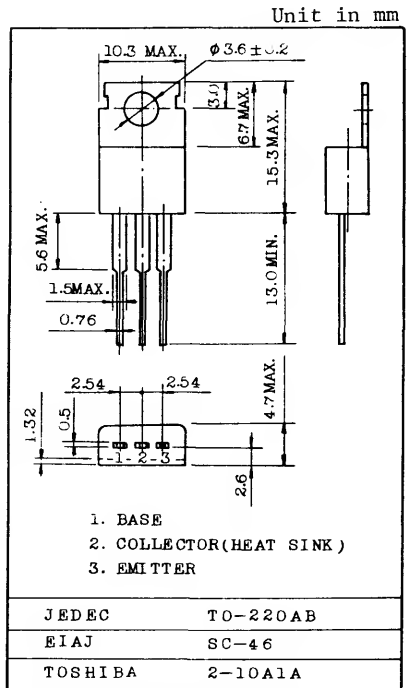
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SA490.
- Recommended for 10W High-Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	50	V
Collector-Emitter Voltage	V _{CEO}	40	V
Emitter-Base Voltage	V _{EBO}	5	V
Collector Current	I _C	3	A
Emitter Current	I _E	-3	A
Collector Power Dissipation (Tc=25°C)	P _C	25	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55 ~ 150	°C



Mounting Kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =30V, I _E =0	-	-	10	μA
Emitter Cut-off Current	I _{EBO}	V _{EB} =5V, I _C =0	-	-	100	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CEO}	I _C =50mA, I _B =0	40	-	-	V
Emitter-Base Breakdown Voltage	V _{(BR)EBO}	I _E =10mA, I _C =0	5	-	-	V
DC Current Gain	h _{FE} (1) (Note)	V _{CE} =2V, I _C =0.5A	40	-	240	
	h _{FE} (2)	V _{CE} =2V, I _C =2A	13	-	-	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =2A, I _B =0.2A	-	0.25	1.4	V
Base-Emitter Voltage	V _{BE}	V _{CE} =2V, I _C =2A	-	0.85	1.8	V
Transition Frequency	f _T	V _{CE} =2V, I _C =0.5A	3	10	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	85	-	pF

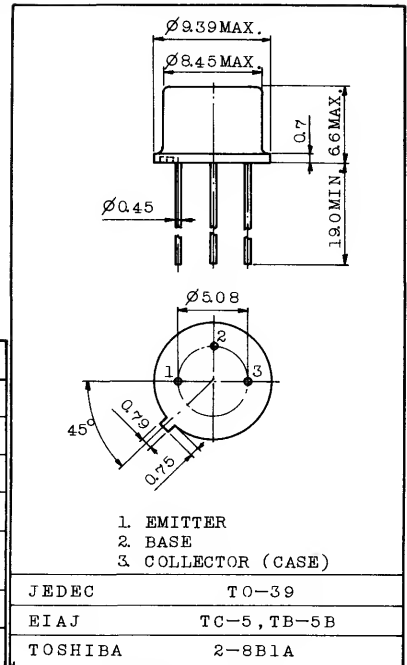
Note: h_{FE}(1) Classification R : 40 ~ 80, O : 70 ~ 140, Y : 120 ~ 240

Unit in mm

VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : $P_o=0.95W$ (Min.)
($f=175MHz$, $V_{CC}=13.5V$, $P_i=40mW$)



MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	36	V
Collector-Emitter Voltage	V_{CEO}	15	V
Emitter-Base Voltage	V_{EBO}	3	V
Collector Current	I_C	0.1	A
Collector Power Dissipation ($T_a=25^\circ C$)	P_C	0.6	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$

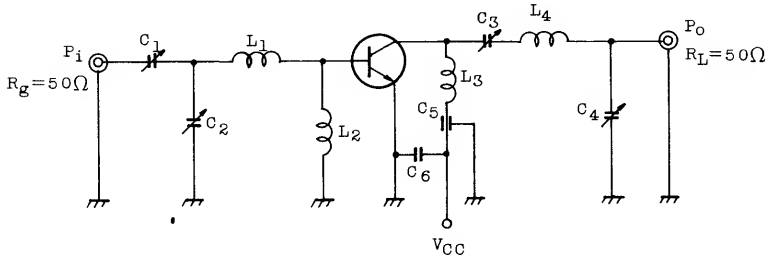
Weight : 1.1g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

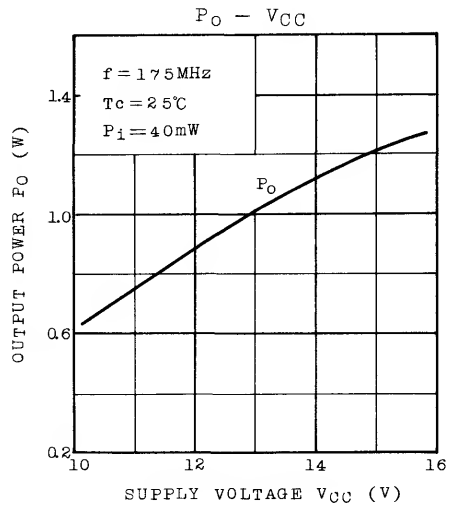
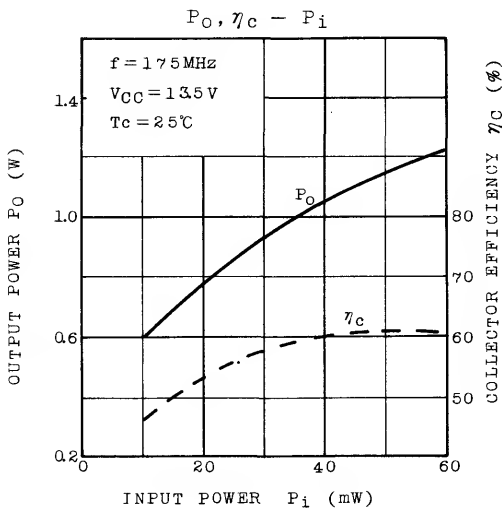
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1.0	μA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=0.1mA$, $I_E=0$	36	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=5mA$, $I_B=0$	15	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=3V$, $I_C=100mA$	20	-	400	-
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	3.8	5	pF
Output Power	P_o	(Fig.) $V_{CC}=13.5V$, $f=175MHz$,	0.95	1.05	-	W
Power Gain	G_{pe}	$P_i=40mW$	13.7	14.2	-	dB

2SC994

Fig. P_O TEST CIRCUIT



- C₁, C₂, C₃, C₄ : 3.5 ~ 30pF
- C₅ : 0.001μF FEED THROUGH
- C₆ : 0.05μF CERAMIC CONDENSER
- L₁, L₃ : φ1.2 SILVER PLATED COPPER WIRE, 8ID, 1T
- L₂ : 1μH CHOLK COIL
- L₄ : φ1.2 SILVER PLATED COPPER WIRE, 8ID, 5T

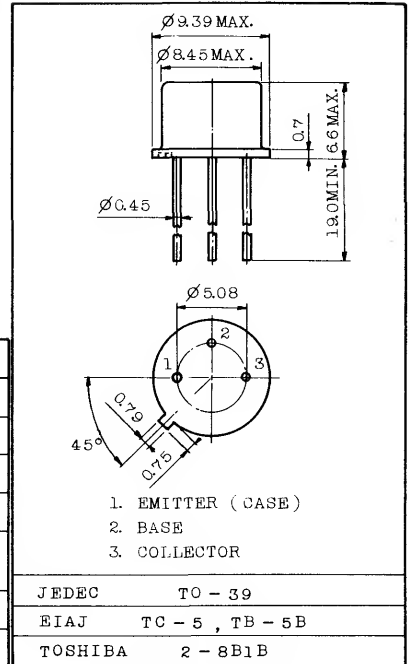


Unit in mm

UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Output Power : $P_o=1.2W(\text{Min.})$
($f=470\text{MHz}$, $V_{CC}=12.6V$, $P_i=0.3W$)



MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	40	V
Collector-Emitter Voltage	V_{CEO}	20	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	0.5	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	5	W
Junction Temperature	T_j	175	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ\text{C}$

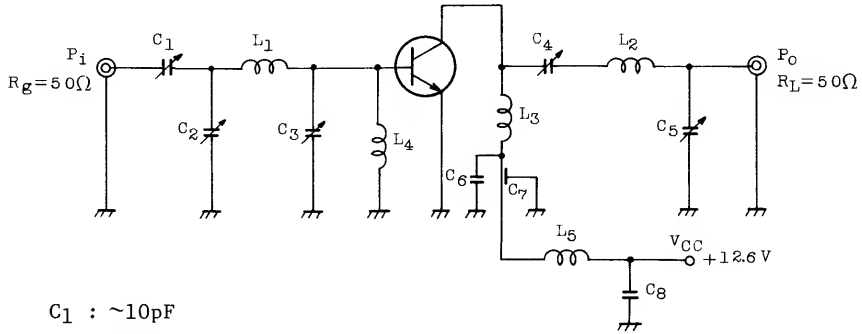
Weight : 1.2g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

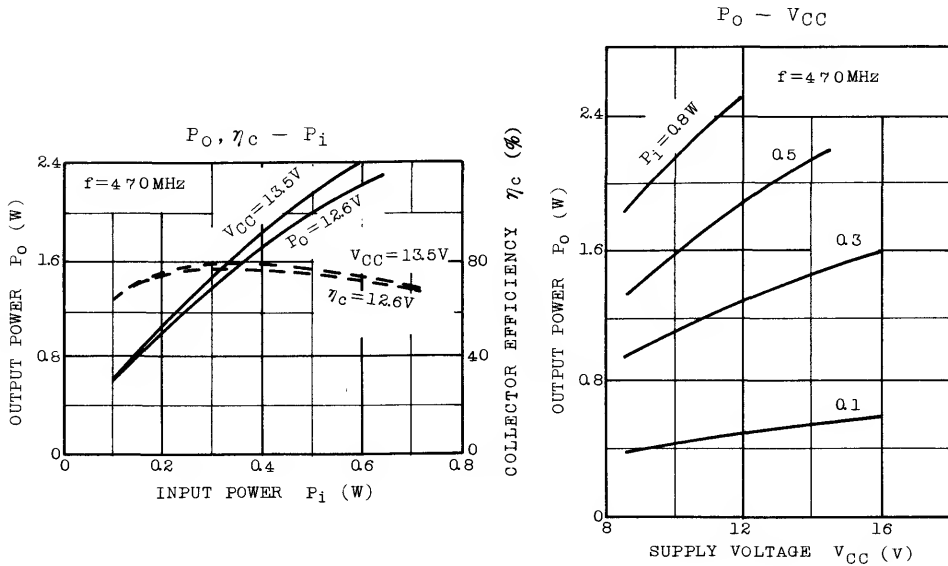
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1	μA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1\text{mA}$, $I_E=0$	40	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10\text{mA}$, $I_B=0$	20	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1\text{mA}$, $I_C=0$	4	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=0.1A$	20	-	-	-
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1\text{MHz}$	-	6.5	10	pF
Output Power	P_o	(Fig.)	1.2	1.5	-	W
Power Gain	G_{pe}	$V_{CC}=12.6V$, $f=470\text{MHz}$,	6	7	-	dB
Collector Efficiency	η_c	$P_i=0.3W$	60	-	-	%
Series Equivalent Input Impedance	Z_{IN}	$V_{CC}=12.6V$, $f=470\text{MHz}$,	-	$5+j6.5$	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=1.2W$	-	$22-j25$	-	Ω

2SC1001

Fig. P_o TEST CIRCUIT



- C_1 : $\sim 10\text{pF}$
- C_2, C_5 : $\sim 30\text{pF}$
- C_3, C_4 : $\sim 25\text{pF}$
- C_6, C_8 : $0.01\mu\text{F}$
- C_7 : 1000pF
- L_1 : $\phi 0.8$ SILVER PLATED COPPER WIRE, 6ID, 2T
- L_2 : $\phi 1$ SILVER PLATED COPPER WIRE, 25 LENGTH, STRAIGHT
- L_3 : $\phi 1$ SILVER PLATED COPPER WIRE, 20 LENGTH, STRAIGHT
- L_4, L_5 : RFC



Unit in mm

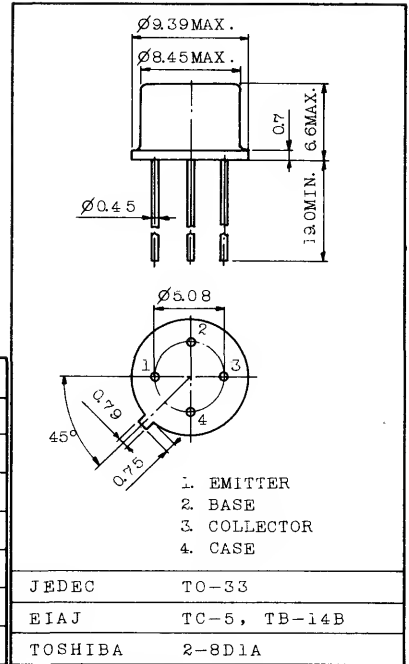
HIGH POWER AMPLIFIER FOR CATV APPLICATIONS.

FEATURES:

- . Wide Band and High Gain for Class A Amplifier.
- . Excellent Cross Modulation Characteristics.
- . All Electrodes Insulated from Case.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	50	V
Collector-Emitter Voltage	V _{CEO}	35	V
Emitter-Base Voltage	V _{EB0}	3	V
Collector Current	I _C	300	mA
Collector Power Dissipation	P _C	600	mW
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55 ~ 150	°C



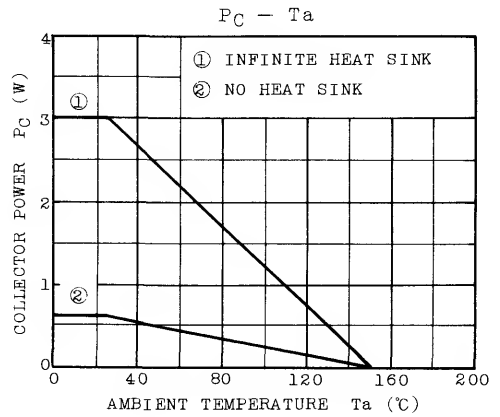
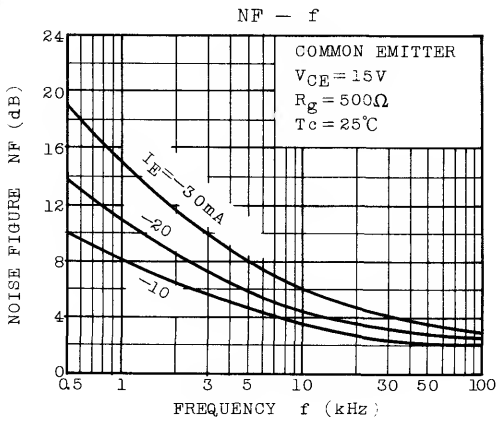
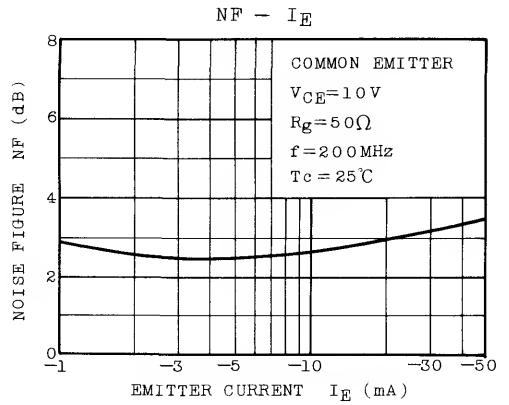
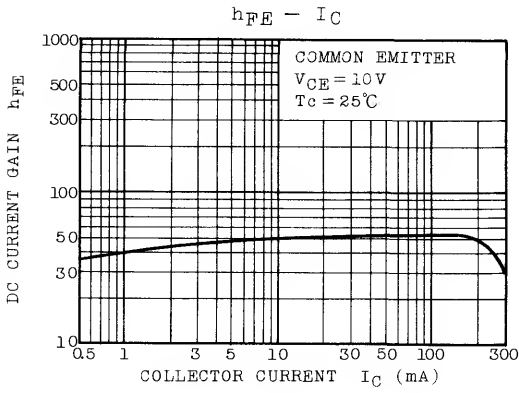
Weight : 1.2g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =20V, I _E =0	-	-	0.3	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CEO}	I _C =5mA, I _B =0	35	-	-	V
DC Current Gain	h _{FE} (Note)	V _{CE} =10V, I _C =50mA	25	-	90	
Transition Frequency	f _T	V _{CE} =20V, I _E =-50mA	1100	1400	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =15V, I _E =0, f=1MHz	-	2.2	3.0	pF
Noise Figure	NF	V _{CE} =20V, I _C =10mA R _g =50Ω, f=200MHz	-	4.0	5.0	dB
Power Gain	G _{pe}	V _{CC} =20V, I _E =-50mA f=200MHz	10	14	-	dB

Note: h_{FE} Classification R:25 ~ 50 0:45 ~ 90

2SC1164



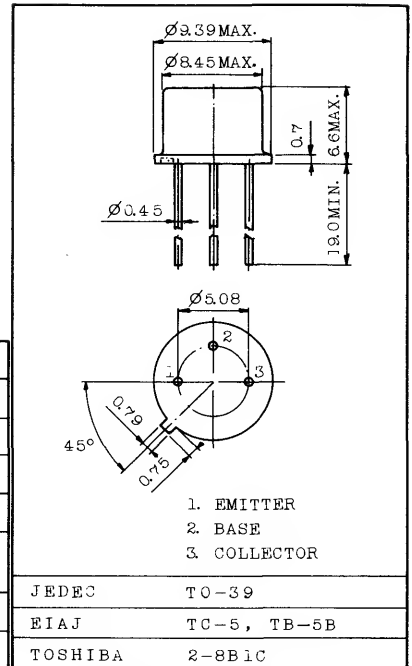
2SC1165

Unit in mm

UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Output Power : $P_o=0.9W(\text{Min.})$
($f=470\text{MHz}$, $V_{CC}=12.6V$, $P_i=0.3W$)
- . All Electrodes Insulated from Case.



MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CEO}	20	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	0.5	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	5	W
Junction Temperature	T_j	175	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ\text{C}$

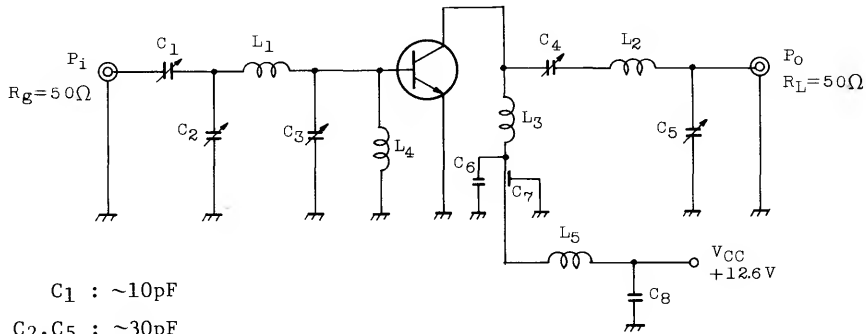
Weight : 1.2g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

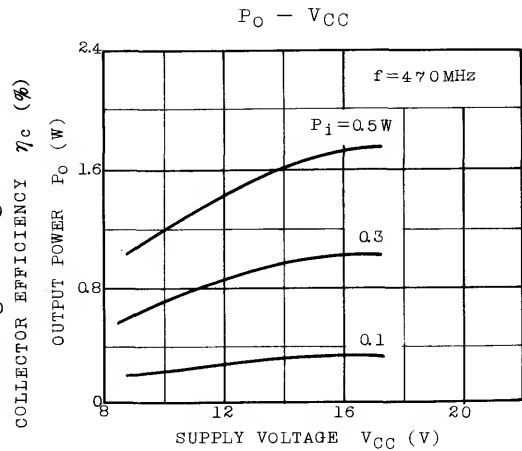
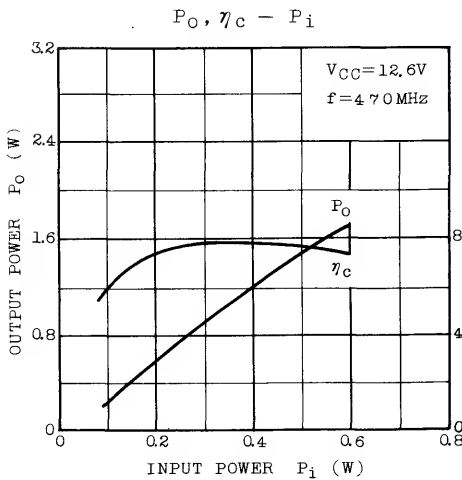
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1	μA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1\text{mA}$, $I_E=0$	40	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10\text{mA}$, $I_B=0$	20	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1\text{mA}$, $I_C=0$	4	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=0.1A$	20	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1\text{MHz}$	-	6.5	10	pF
Output Power	P_o	(Fig.)	0.9	1.0	-	W
Power Gain	G_{pe}	$V_{CC}=12.6V$, $f=470\text{MHz}$,	4.7	5.2	-	dB
Collector Efficiency	η_c	$P_i=0.3W$	60	-	-	%

2SC1165

Fig. $f=470\text{MHz}$ P_o TEST CIRCUIT



- C_1 : $\sim 10\text{pF}$
- C_2, C_5 : $\sim 30\text{pF}$
- C_3, C_4 : $\sim 25\text{pF}$
- C_5, C_8 : $0.01\mu\text{F}$
- C_7 : 1000pF
- L_1 : $\phi 0.8$ SILVER PLATED COPPER WIRE, 6ID, 2T
- L_2 : $\phi 1$ SILVER PLATED COPPER WIRE, 25 LENGTH, STRAIGHT
- L_3 : $\phi 1$ SILVER PLATED COPPER WIRE, 20 LENGTH, STRAIGHT
- L_4, L_5 : RFC

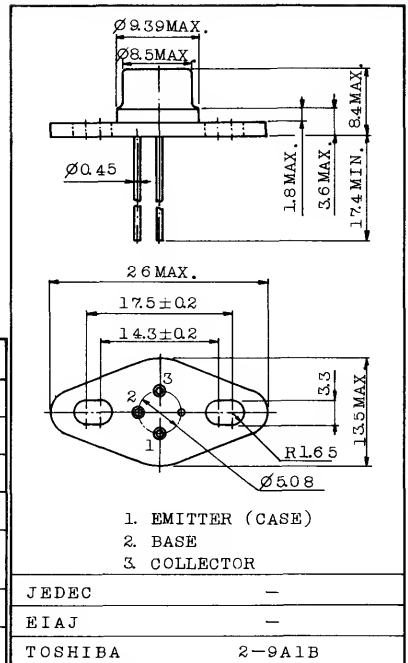


Unit in mm

VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : $P_o=2.5W$ (Min.)
($f=175MHz$, $V_{CC}=13.5V$, $P_i=0.25W$)



Weight : 3.7g

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

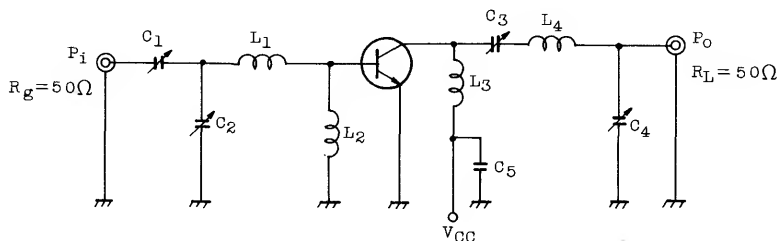
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CEO}	20	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	1	A
Collector Power Dissipation ($T_c=25^{\circ}C$)	P_C	10	W
Junction Temperature	T_j	175	$^{\circ}C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^{\circ}C$

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V, I_E=0$	-	-	1	μA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	40	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	20	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA, I_C=0$	4	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=0.2A$	20	-	-	-
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	6.5	10	pF
Output Power	P_o	(Fig.)	2.5	2.7	-	W
Power Gain	G_{pe}	$V_{CC}=13.5V, f=175MHz, P_i=0.25W$	10	10.3	-	dB
Collector Efficiency	η_c		60	73	-	%
Series Equivalent Input Impedance	Z_{in}	$V_{CC}=13.5V, f=175MHz,$	-	5.0 +j2.5	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=2.5W$	-	30 -j20	-	Ω

2SC1169

Fig. P_o TEST CIRCUIT



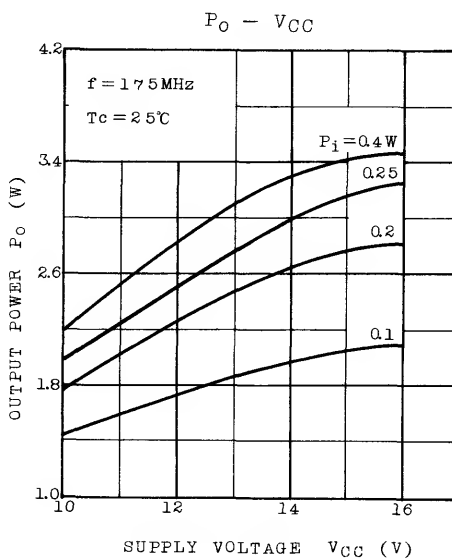
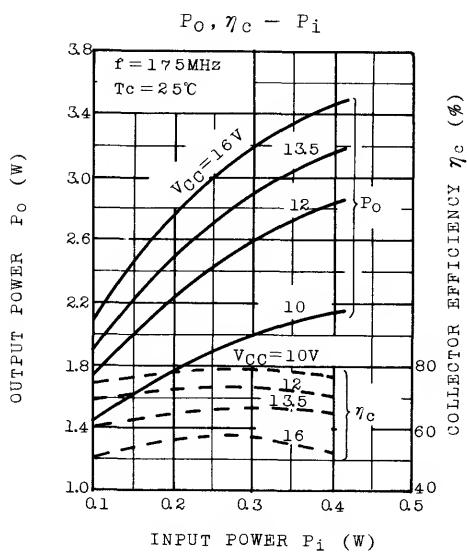
C_1, C_2, C_3, C_4 : 3.5 ~ 30pF

C_5 : 0.001 μ F FEED THROUGH AND 0.05 μ F CERAMIC CONDENSER

L_1, L_3 : ϕ 1.2 SILVER PLATED COPPER WIRE, 8ID, 1T

L_2 : 1 μ H CHOLK COIL

L_4 : ϕ 1.2 SILVER PLATED COPPER WIRE, 8ID, 7/4T



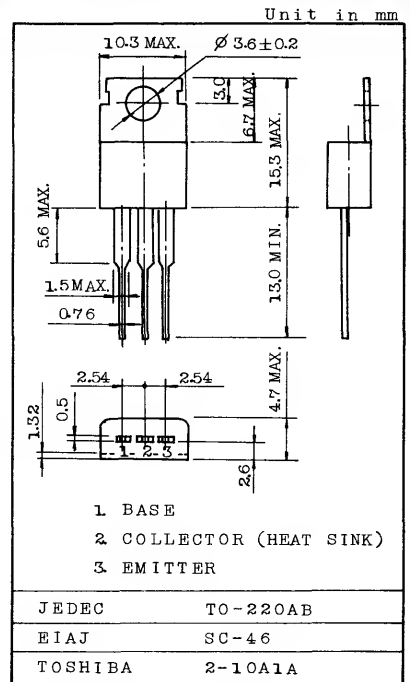
POWER AMPLIFIER APPLICATIONS.
CAR RADIO, CAR STEREO OUTPUT STAGE AMPLIFIER
APPLICATIONS.

FEATURES:

- Good Linearity of h_{FE} .
- Complementary to 2SA473 and 5 Watts Output Applications.

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	30	V
Collector-Emitter Voltage	V_{CEO}	30	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	3	A
Emitter Current	I_E	-3	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	10	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ\text{C}$

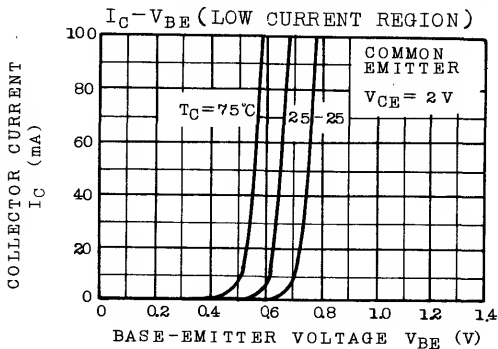
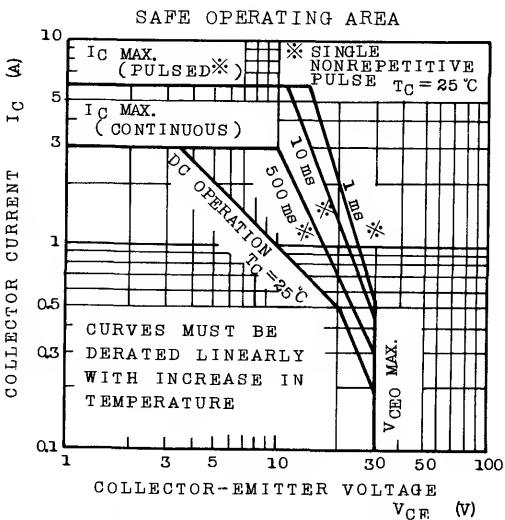
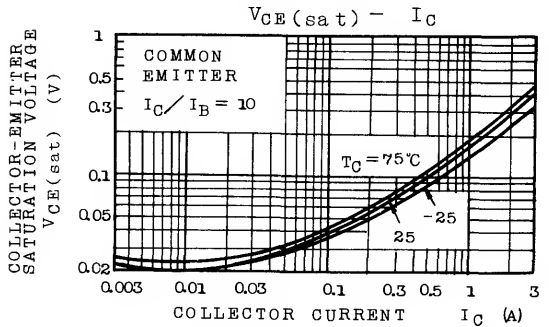
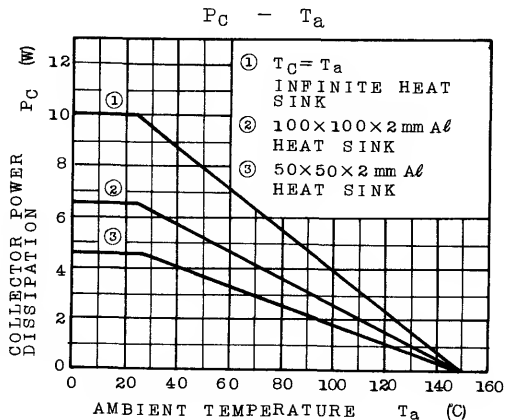
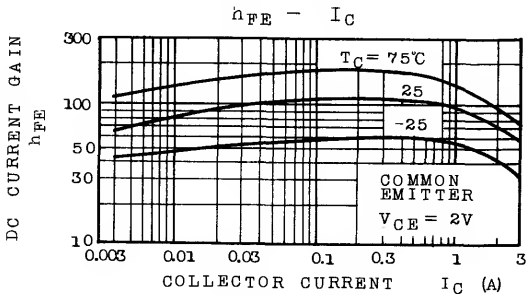
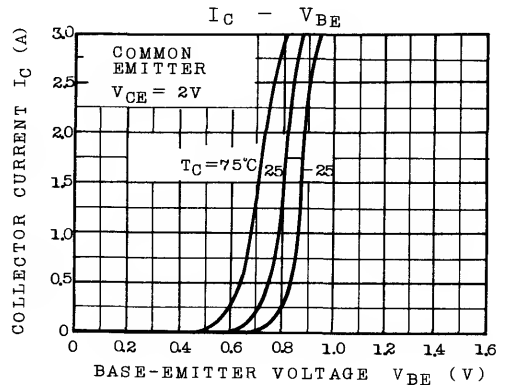
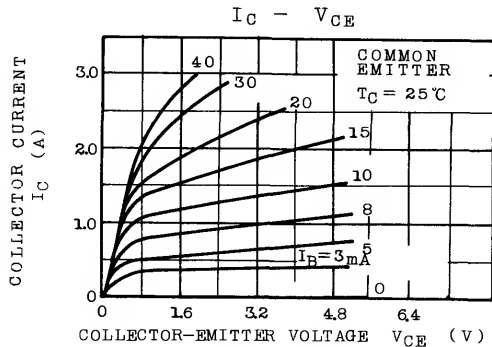


Mounting kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=20\text{V}, I_E=0$	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5\text{V}, I_C=0$	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10\text{mA}, I_B=0$	30	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1\text{mA}, I_C=0$	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=2\text{V}, I_C=0.5\text{A}$	70	-	240	
	$h_{FE(2)}$	$V_{CE}=2\text{V}, I_C=2.5\text{A}$	25	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=2\text{A}, I_B=0.2\text{A}$	-	0.3	0.8	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=2\text{V}, I_C=0.5\text{A}$	-	0.75	1.0	V
Transition Frequency	f_T	$V_{CE}=2\text{V}, I_C=0.5\text{A}$	-	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10\text{V}, I_E=0, f=1\text{MHz}$	-	35	-	pF

Note: $h_{FE(1)}$ Classification O : 70 ~ 140, Y : 120 ~ 240



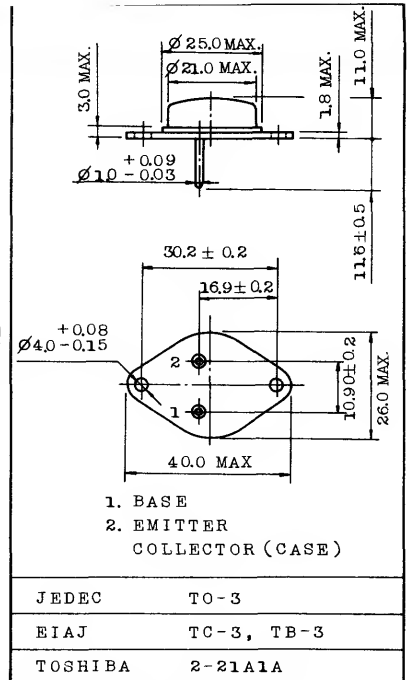
REGULATOR APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

- High Voltage : $V_{CE0}=200V$
- Large Collector Current : $I_C=2.5A$
- Wide Safe Operating Area.

MAXIMUM RATINGS ($T_a=25^\circ C$)

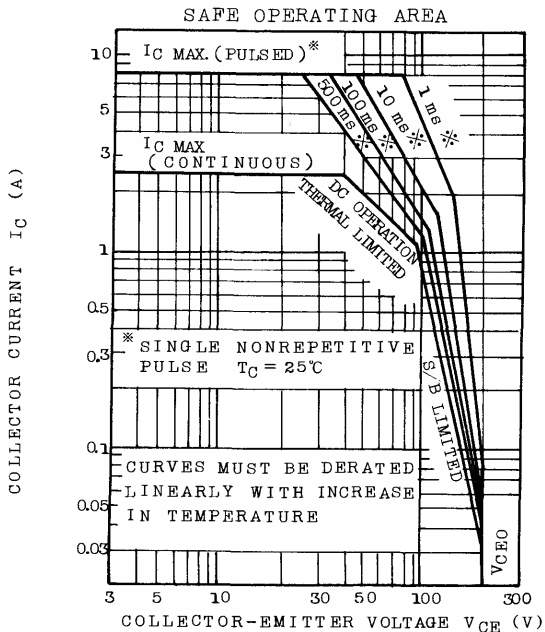
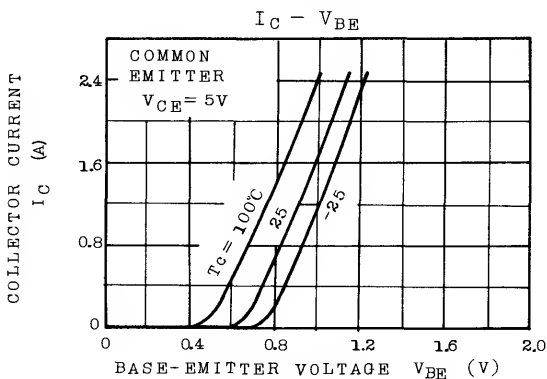
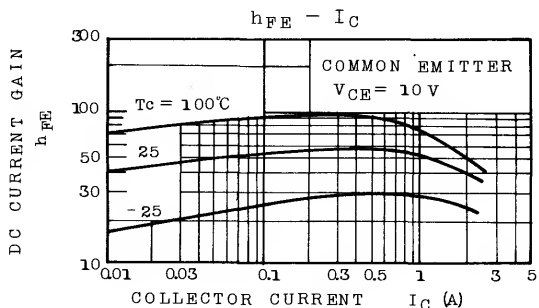
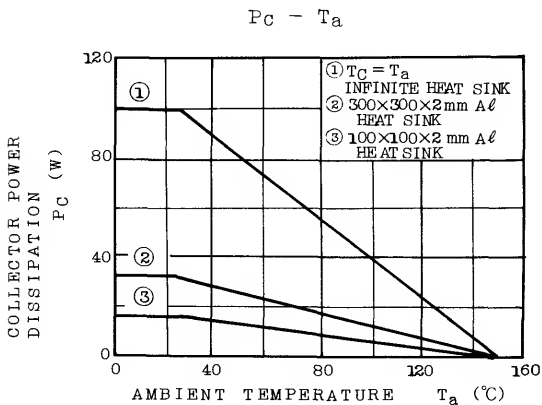
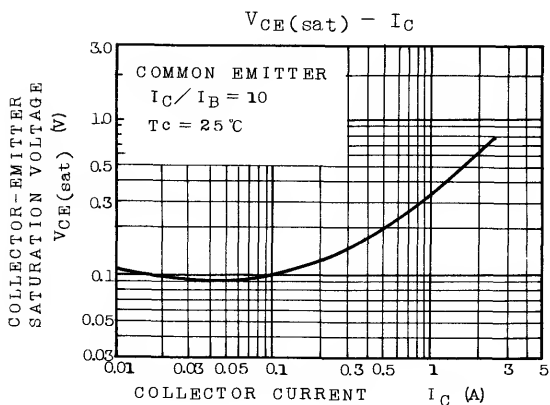
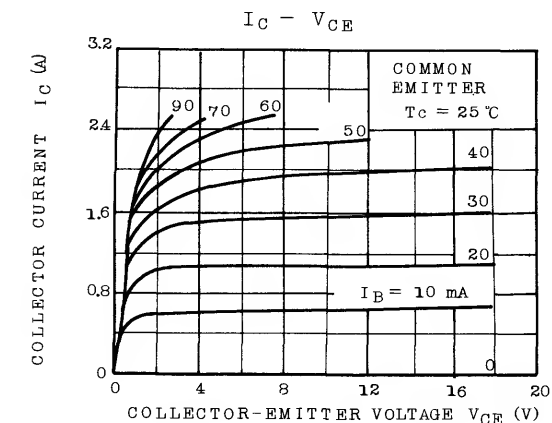
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	200	V
Collector-Emitter Voltage	V_{CEO}	200	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	2.5	A
Emitter Current	I_E	-2.5	A
Collector Power Dissipation ($T_C=25^\circ C$)	P_C	100	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 150	$^\circ C$



Mounting kit No. AC73
Weight : 12.0g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=200V, I_E=0$	-	-	10	μA
	I_{CEO}	$V_{CE}=200V, I_B=0$	-	-	0.1	mA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1.0	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	200	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=1A$	30	50	150	-
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=1A, I_B=0.1A$	-	-	1.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=1A, I_B=0.1A$	-	-	1.5	V



HIGH FREQUENCY WIDE BAND AMPLIFIER APPLICATIONS.
HIGH FREQUENCY LOW NOISE AMPLIFIER APPLICATIONS.

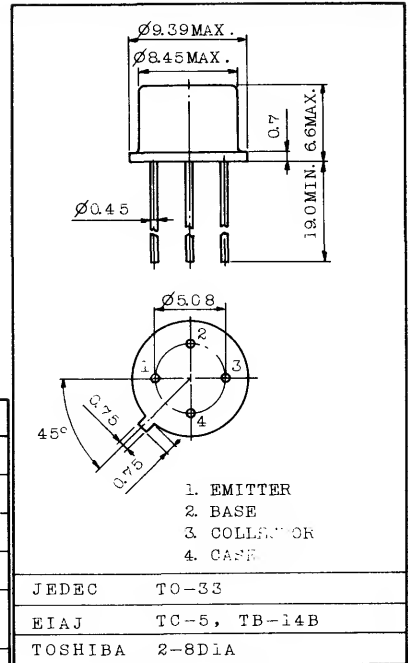
FEATURES:

- . Low Noise for High and Low Frequency
 - : NF=4.0dB(Max.) f=200MHz
 - : NF=11dB (Max.) f=10kHz

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	50	V
Collector-Emitter Voltage	V _{CEO}	35	V
Emitter-Base Voltage	V _{EBO}	3	V
Collector Current	I _C	300	mA
Collector Power Dissipation	P _C	600	mW
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C

Unit in mm

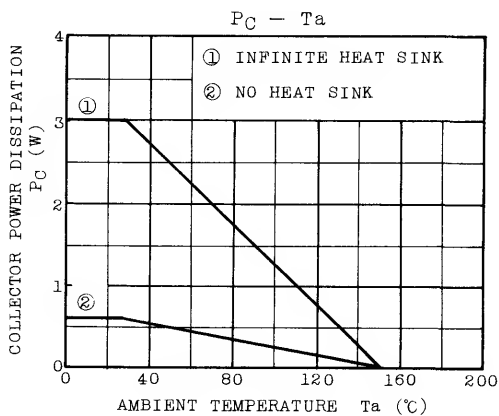
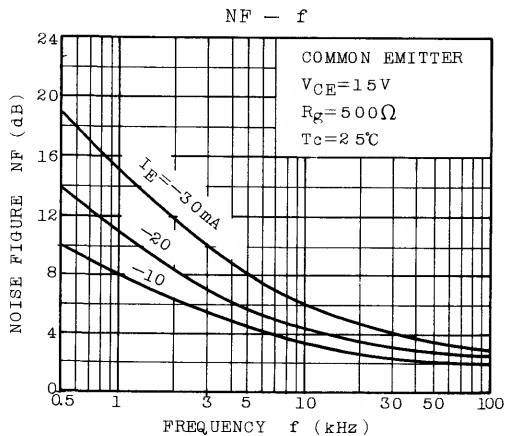
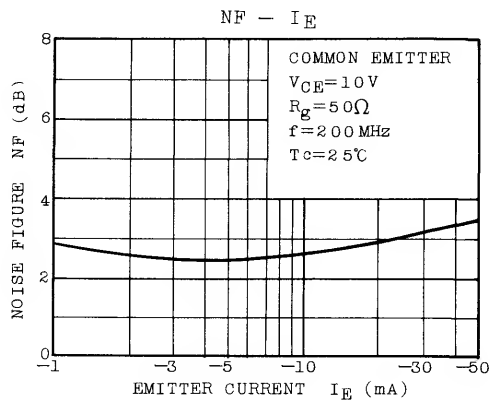
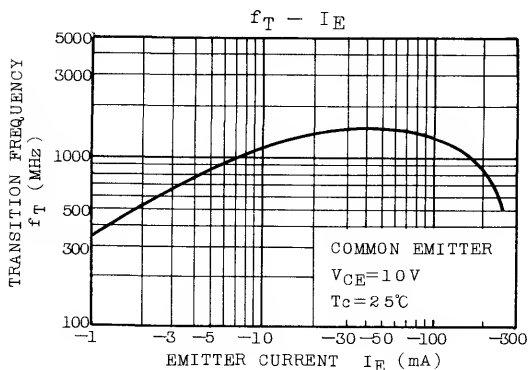


Weight : 1.2g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CBO}	V _{CB} =20V, I _E =0	-	-	0.1	μA
Collector-Base Breakdown Voltage	V(BR)CBO	I _C =0.1mA, I _E =0	50	-	-	V
Collector-Emitter Breakdown Voltage	V(BR)CEO	I _C =1mA, I _B =0	35	-	-	V
Emitter-Base Breakdown Voltage	V(BR)EBO	I _E =0.1mA, I _C =0	3	-	-	V
DC Current Gain	h _{FE}	V _{CE} =10V, I _C =20mA	40	80	200	
Transition Frequency	f _T	V _{CE} =10V, I _E =-20mA	1000	1400	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =15V, I _E =0, f=1MHz	-	2.2	3.0	pF
Noise Figure	NF(1)	V _{CE} =10V, I _E =-10mA, R _g =50Ω, f=200MHz	-	2.5	4.0	dB
	NF(2)	V _{CE} =15V, I _E =-30mA, R _g =500Ω, f=10kHz	-	6	11	dB

2SC1199



Unit in mm

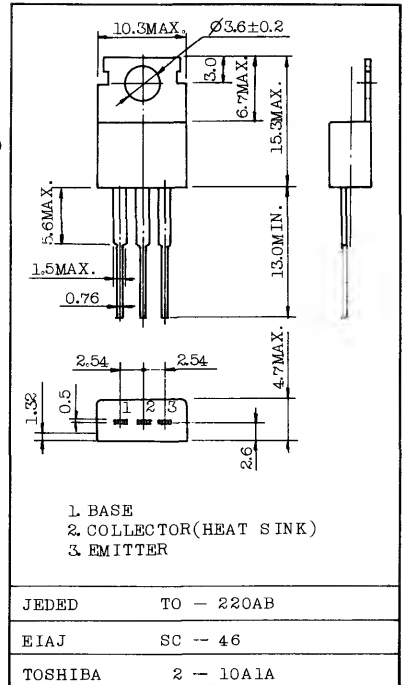
COLOR TV CHROMA OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : $V_{CEO}=300V$
- Small Collector Output Capacitance : $C_{ob}=5.0pF(Typ.)$
- High Transition Frequency : $f_T=100MHz (Typ.)$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	300	V
Collector-Emitter Voltage		V_{CEO}	300	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	150	mA
Emitter Current		I_E	-150	mA
Collector Power Dissipation	$T_a=25^\circ C$	P_C	1.5	W
	$T_c=25^\circ C$		12.5	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55~150	$^\circ C$

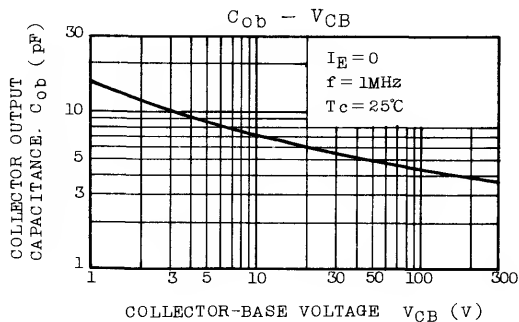
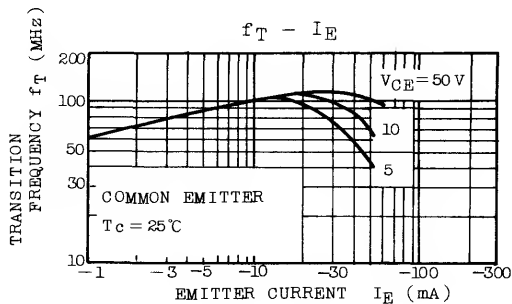
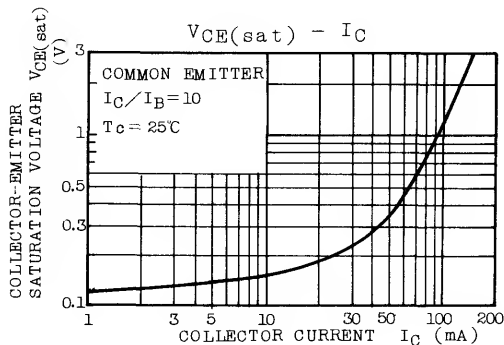
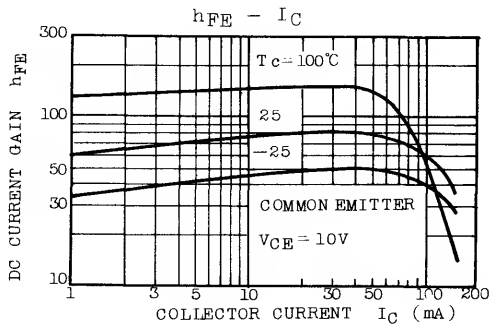
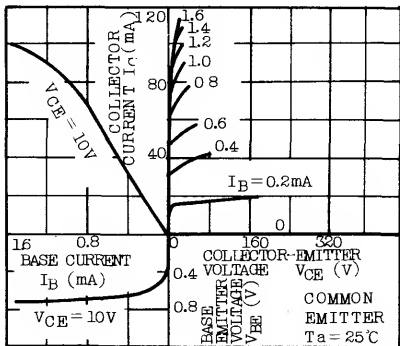


Mounting kit No. AC75
Weight : 1.9g

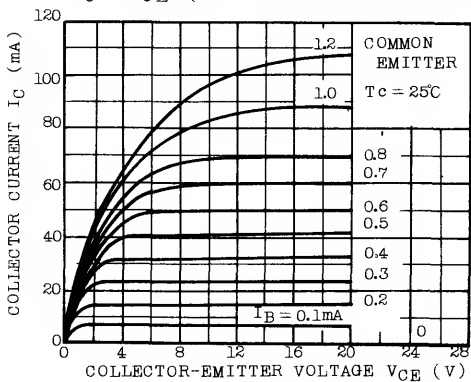
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=100V, I_E=0$	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=5mA, I_B=0$	300	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=10V, I_C=50mA$	40	-	170	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=100mA, I_B=20mA$	-	-	1.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=100mA, I_B=20mA$	-	-	1.2	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=30mA$	40	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=50V, I_E=0, f=1MHz$	-	5.0	6.5	pF

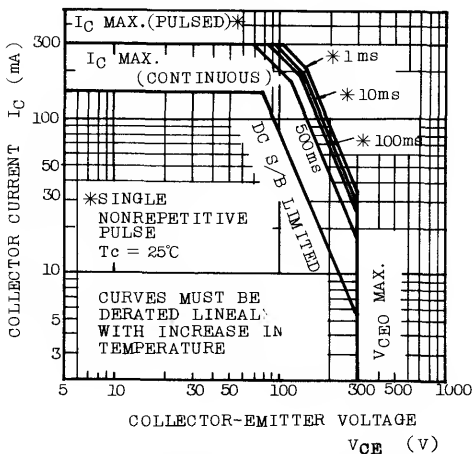
STATIC CHARACTERISTICS



$I_C - V_{CE}$ (LOW VOLTAGE REGION)



SAFE OPERATING AREA



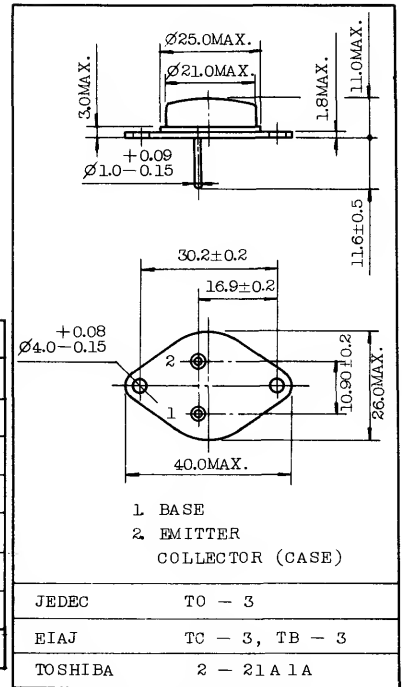
INDUSTRIAL APPLICATIONS

Unit in mm

REGULATOR APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

- High Voltage : $V_{CBO}=450V$
- Low Saturation Voltage :
: $V_{CE(sat)}=1.5V$ (Max.) ($I_C=5A, I_B=0.8A$)
- High Speed Switching Time : $t_{stg}=3.0\mu s$ (Typ.)



MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	450	V
Collector-Emitter Voltage	V_{CEO}	330	V
Emitter-Base Voltage	V_{EBO}	6	V
Collector Current	I_C	8	A
Base Current	I_B	2	A
Collector Power Dissipation ($T_c=25^\circ C$)	PC	100	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-65~150	$^\circ C$

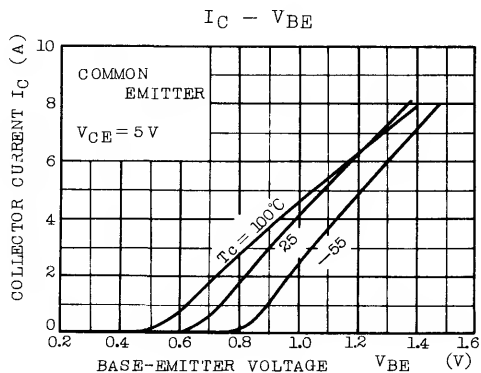
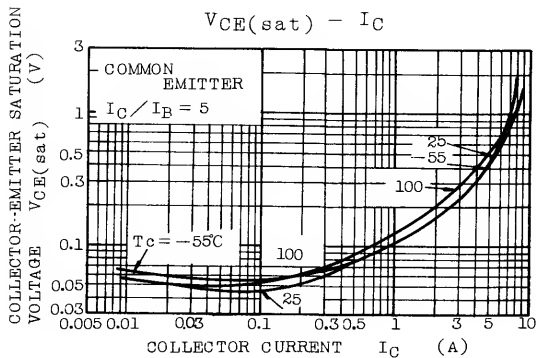
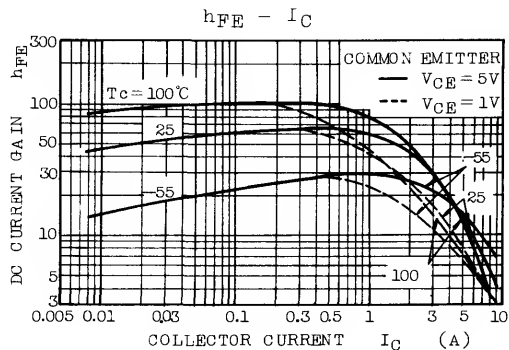
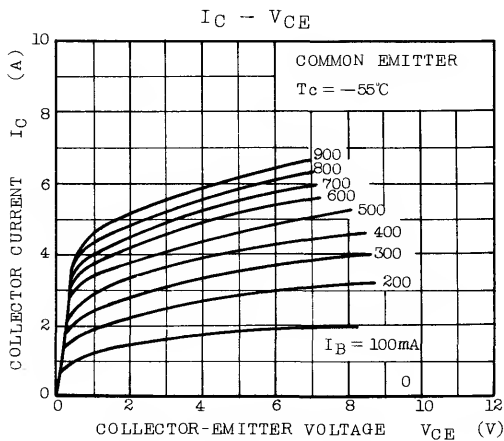
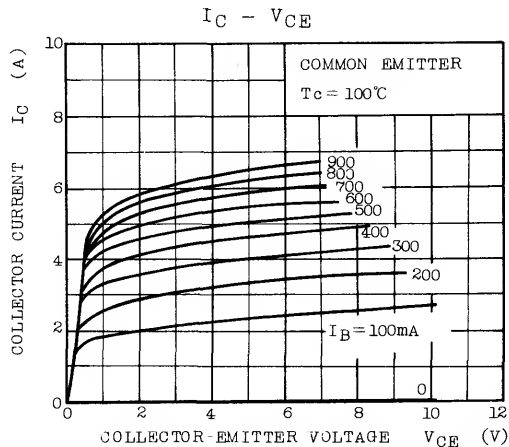
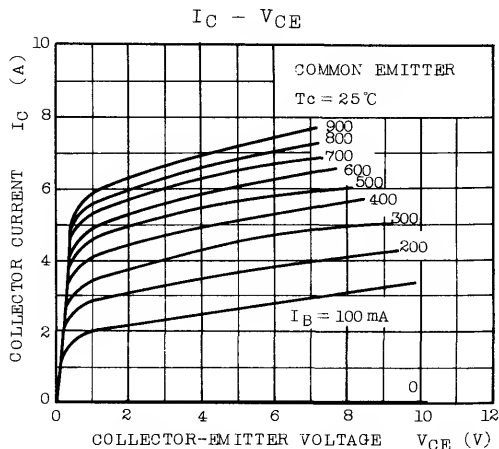
Mounting Kit No. AC73

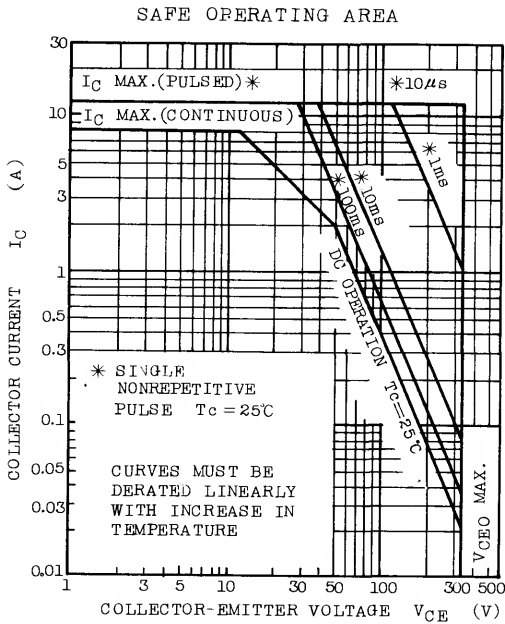
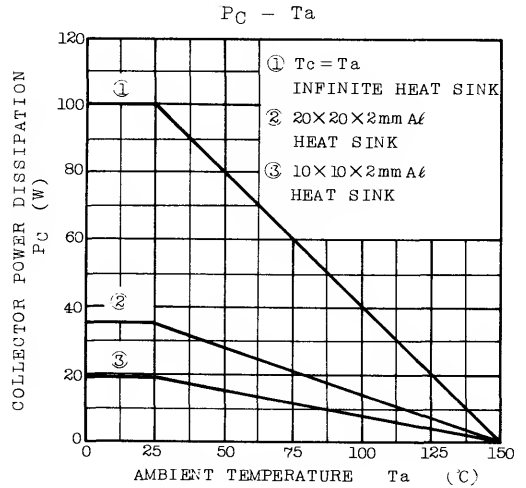
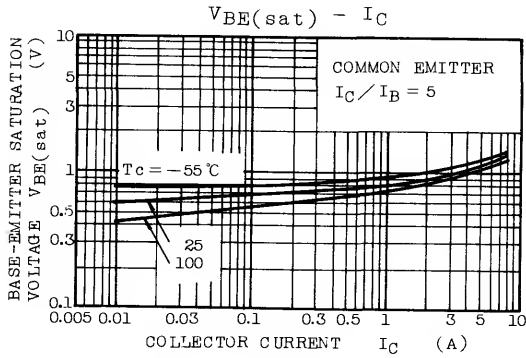
Weight : 12.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=450V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=6V, I_C=0$	-	-	1	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=5mA, I_B=0$	330	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=1A$	30	-	150	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=5A, I_B=0.8A$	-	-	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=5A, I_B=0.8A$	-	-	1.8	V
Switching Time	Turn-on Time	t_{on}	<p>$I_{B1} = -I_{B2} = 0.3A$ DUTY CYCLE $\leq 2\%$</p>	-	1.0	-	μs
	Storage Time	t_{stg}		-	3.0	-	
	Fall Time	t_f		-	0.8	-	

2SC1576





2SC1617

SILICON NPN TRIPLE DIFFUSED TYPE

BLACK AND WHITE TV HORIZONTAL OUTPUT APPLICATIONS.

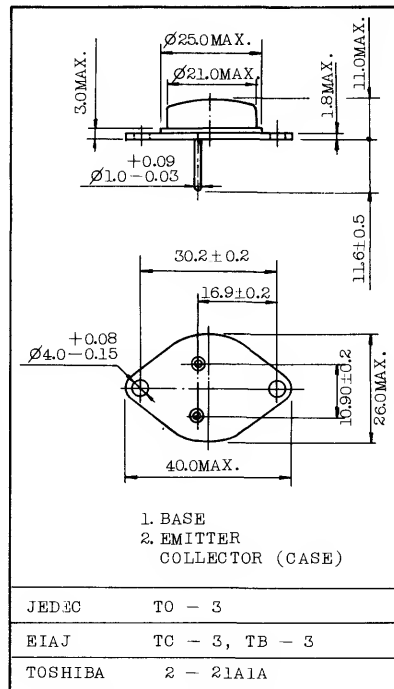
FEATURES;

- High Voltage : $V_{CBO}=300V$
- Wide Safe Operating Area.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	300	V
Collector-Emitter Voltage	V_{CEO}	100	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	7	A
Emitter Current	I_E	-7	A
Collector Power Dissipation	P_C	50	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

Unit in mm

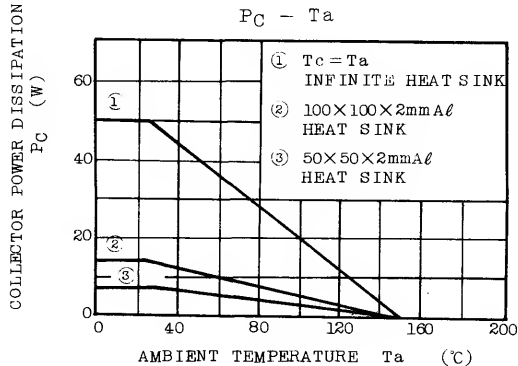
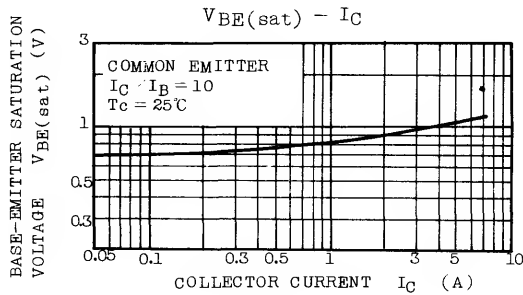
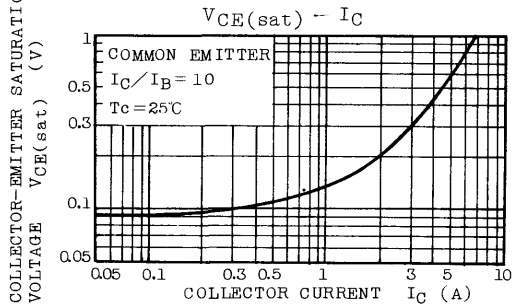
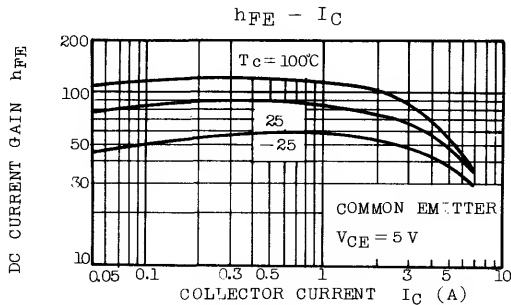
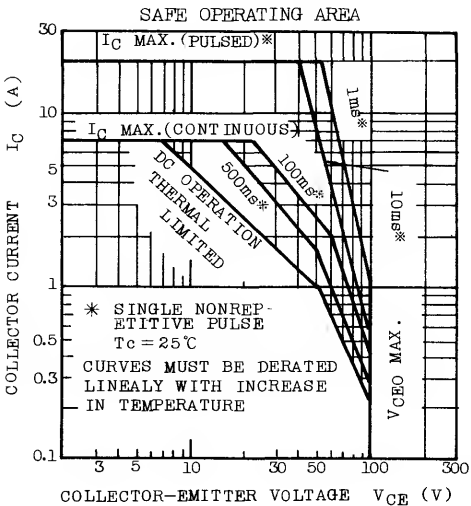
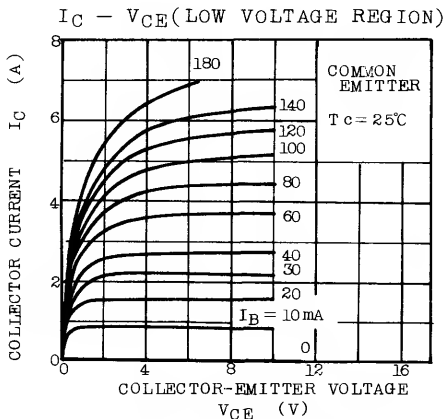
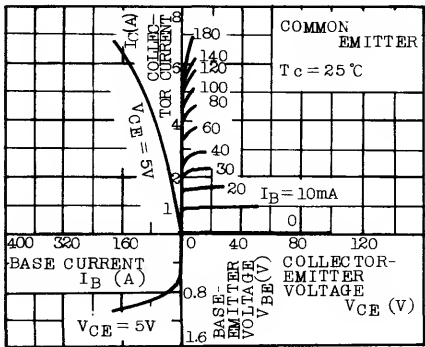


Mounting kit No. AC73
Weight : 12.0g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=250V, I_E=0$	-	-	1.0	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1.0	mA
DC Current Gain		$h_{FE(1)}$	$V_{CE}=5V, I_C=1A$	30	-	150	
		$h_{FE(2)}$	$V_{CE}=5V, I_C=7A$	15	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=5A, I_B=0.5A$	-	-	1.2	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=5A, I_B=0.5A$	-	-	1.5	
Transition Frequency		f_T	$V_{CE}=5V, I_C=0.5A$	-	10	-	MHz

STATIC CHARACTERISTICS



2SC1624 2SC1625

SILICON NPN PLANAR TYPE

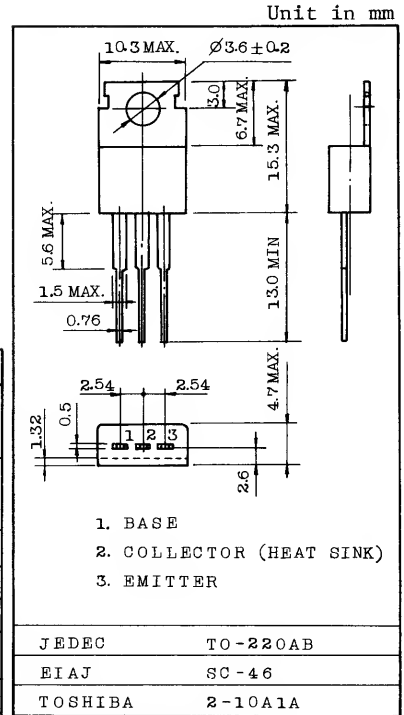
MEDIUM POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : $V_{CEO}=120V$ (2SC1624)
- Complementary to 2SA814 and 2SA815.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC1624	V_{CBO}	120	V
	2SC1625		100	
Collector-Emitter Voltage	2SC1624	V_{CEO}	120	V
	2SC1625		100	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	1	A
Emitter Current		I_E	-1	A
Collector Power Dissipation ($T_c=25^\circ C$)		P_C	15	W
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55~150	$^\circ C$



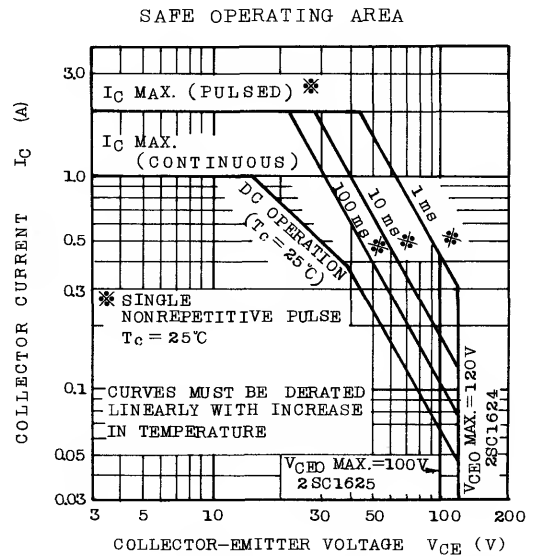
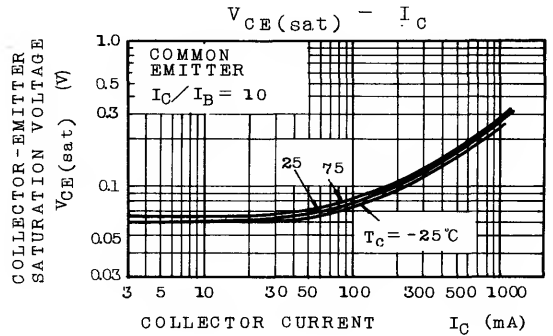
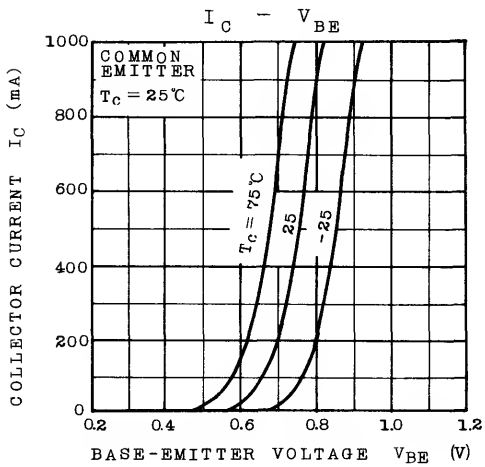
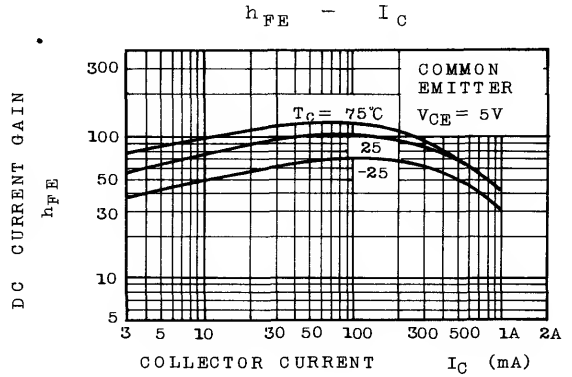
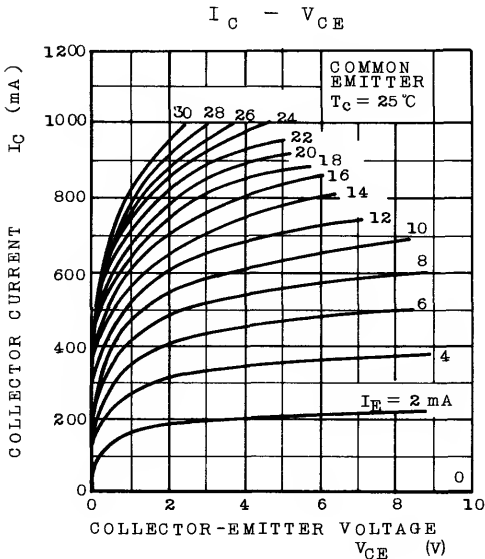
Mounting Kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=50V, I_E=0$	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	120	-	-	V
			100	-	-	
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA, I_C=0$	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=5V, I_C=150mA$	70	-	240	
	$h_{FE(2)}$	$V_{CE}=5V, I_C=500mA$	40	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=500mA, I_B=50mA$	-	-	0.5	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5V, I_C=500mA$	-	-	1.0	V
Transition Frequency	f_T	$V_{CE}=5V, I_C=150mA$	10	30	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1 MHz$	-	20	-	pF

Note : $h_{FE(1)}$ Classification 0 : 70~140, Y : 120~240

2SC1624·2SC1625



2SC1626

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

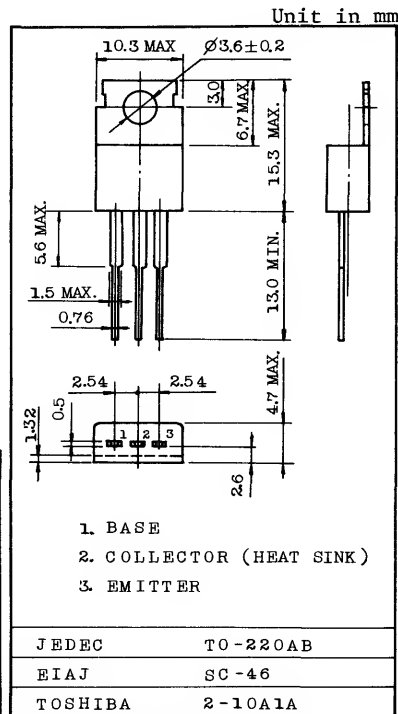
MEDIUM POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : $V_{CEO}=80V$
- Complementary to 2SA816.

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	RAINGS	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	750	mA
Emitter Current	I_E	-750	mA
Collector Power Dissipation	P_C	1.5	W
Junction Temperature	T_j	150	$^{\circ}C$
Storage Temperature Range	T_{stg}	-55~150	$^{\circ}C$



Mounting Kit NO. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=30V, I_E=0$	-	-	0.5	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1.0	μA
Breakdown Voltage	Collector-Emitter	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	80	-	-	V
	Emitter-Base	$V_{(BR)EBO}$	$I_E=0.1mA, I_C=0$	5	-	-	
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=2V, I_C=150mA$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=2V, I_C=500mA$	40	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=500mA, I_B=50mA$	-	-	0.5	V
Base-Emitter Voltage		V_{BE}	$V_{CE}=2V, I_C=500mA$	-	-	1.0	V
Transition Frequency		f_T	$V_{CE}=2V, I_C=150mA$	50	100	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	15	-	pF

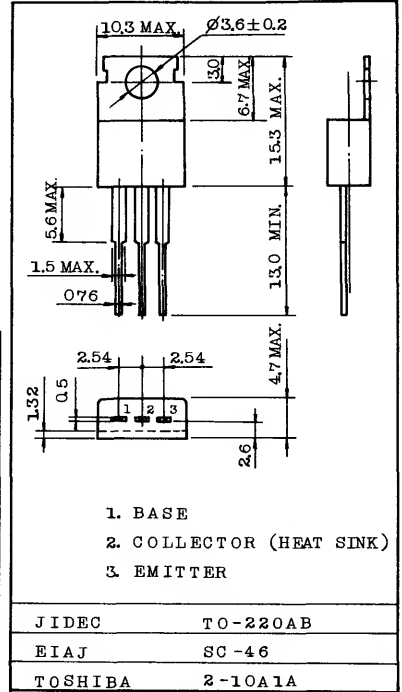
Note : $h_{FE(1)}$ Classification 0 : 70~140, Y : 120~240

27 MHz POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Recommended for Output Stage Application of AM 4W Transmitter.
- High Power Gain.

Unit in mm



MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CBO}	65	V
Collector-Emitter Voltage R _{BE} =10Ω	V _{CER}	65	V
Emitter-Base Voltage	V _{EBO}	4.0	V
Collector Current	I _C	3	A
Base Current	I _B	0.4	A
Emitter Current	I _E	-3	A
Collector Power Dissipation (T _c =25°C)	P _C	10	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55 ~ 150	°C

Mounting Kit No. AC75
Weight : 1.9g

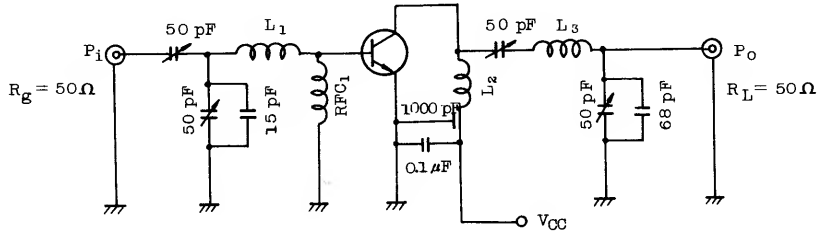
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I _{CBO}	V _{CB} =30V, I _C =0	-	-	10	μA
Collector Cut-off Current		I _{CEO}	V _{CE} =20V, I _B =0	-	-	100	μA
Breakdown Voltage	Collector-Base	V _{(BR)CBO}	I _C =1.0mA, I _E =0	65	-	-	V
	Collector-Emitter	V _{(BR)CER}	I _C =10mA, R _{BE} =10Ω	65	-	-	
	Emitter-Base	V _{(BR)EBO}	I _E =1.0mA, I _C =0	4.0	-	-	
DC Current Gain		h _{FE} (1)	V _{CE} =5V, I _C =0.5A (Note)	15	-	-	V
		h _{FE} (2)	V _{CE} =5V, I _C =1.5A (Note)	10	-	-	
Collector Emitter Saturation Voltage		V _{CE(sat)}	I _C =0.5A, I _B =0.05A	-	0.5	1.0	V
Transition Frequency		f _T	V _{CE} =5V, I _C =100mA	100	-	-	MHz
Collector Output Capacitance		C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	30	45	pF
Output Power	Fig.	P _o	V _{CC} =12V, P _i =0.4W I _{DC} =415mA(Typ.), f=27MHz	3.0	-	-	W

Note : Pulse Test : Pulse Width ≤ 300μs, Duty Cycle ≤ 2.0%

2SC1678

Fig. P₀ TEST CIRCUIT



- L₁ : \varnothing 0.5 mm ENAMEL COATED COPPER WIRE , 7 T, 8 mm I.D
- L₂ : \varnothing 0.5 mm ENAMEL COATED COPPER WIRE , 5 T, 8 mm I.D
- L₃ : \varnothing 0.3 mm ENAMEL COATED COPPER WIRE , 18 T, 6 mm I.D
- RFC₁ : \varnothing 0.2 mm ENAMEL COATED COPPER WIRE , 76 T, 5 mm I.D

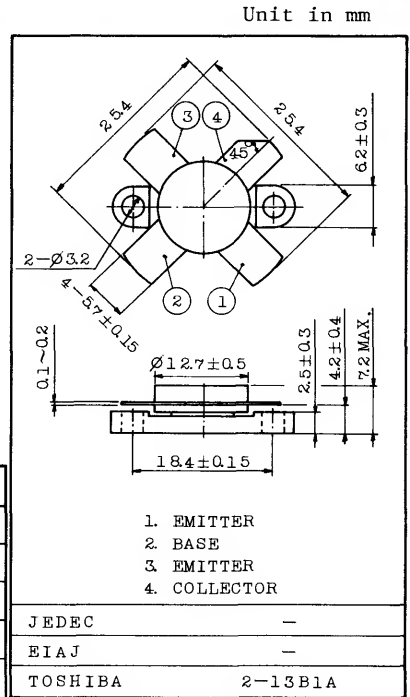
2 ~ 30MHz SSB LINEAR POWER AMPLIFIER APPLICATIONS.
(28V SUPPLY VOLTAGE USE)

FEATURES:

- Specified 28V, 28MHz Characteristics
 - : Output Power : $P_O=40W_{PEP}$
 - : Minimum Gain : $C_{pe}=16dB$
 - : Efficiency : $\eta_c=40\%$ (Min.)
 - : Intermodulation Distortion : $IMD=-30dB$ (Max.)

MAXIMUM RATINGS (Ta=25 °C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	65	V
Collector-Emitter Voltage	V_{CEO}	35	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	7	A
Collector Power Dissipation (Tc=25 °C)	P_C	80	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65 ~ 175	°C



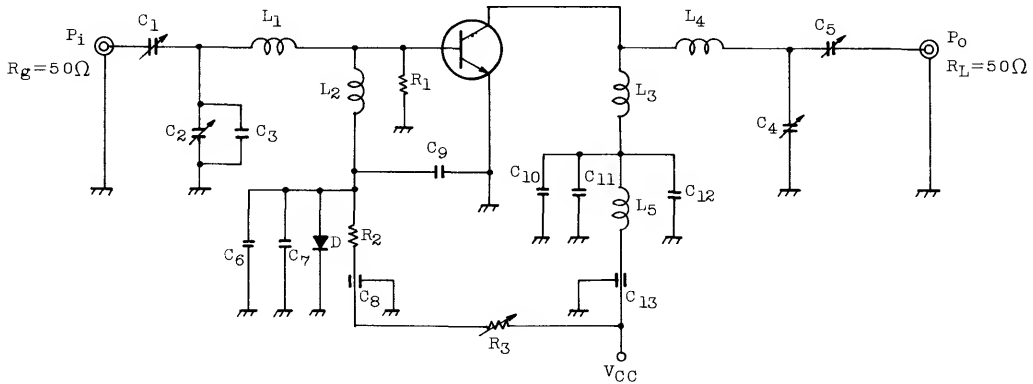
Weight : 5.2g

ELECTRICAL CHARACTERISTICS (Ta=25 °C)

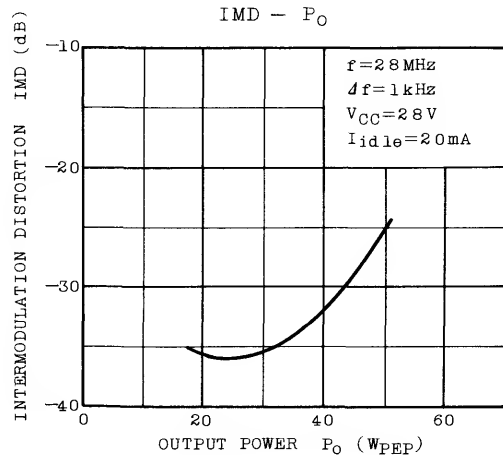
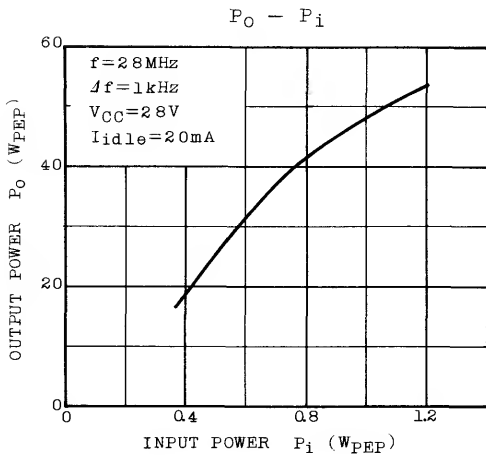
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CER}$	$I_C=1mA, R_{BE}=10\Omega$	65	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=10mA, I_C=0$	4	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=10V, I_C=5A$	10	-	-	
Transition Frequency	f_T	$V_{CE}=15V, I_C=0.1A$	50	-	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=28V, I_E=0, f=1MHz$	-	110	150	pF
Power Gain	G_{pe}	$V_{CC}=28V, f=28MHz$	16	-	-	dB
Input Power	P_i	2-Tone, $\Delta f=1kHz$	-	-	1	WPEP
Collector Efficiency	η_c	$I_{idle}=20mA, P_O=40W_{PEP}$	40	-	-	%
Intermodulation Distortion	IMD	(Fig.)	-	-	-30	dB

2SC1763

Fig. P_i TEST CIRCUIT



- | | |
|---|---|
| C ₁ , C ₄ , C ₅ : ~100pF | L ₁ : ϕ 1.0 SILVER PLATED COPPER WIRE,
12ID, 4T, 20 LENGTH |
| C ₂ : ~ 50pF | L ₂ : 10 μ H |
| C ₃ : 100pF | L ₃ : ϕ 1.6 SILVER PLATED COPPER WIRE,
12ID, 2T, 8 LENGTH |
| C ₆ , C ₁₀ : 0.1 μ F | L ₄ : ϕ 1.6 SILVER PLATED COPPER WIRE,
20ID, 3.5T, 22 LENGTH |
| C ₇ , C ₁₂ : 22 μ F | L ₅ : 10 μ H |
| C ₈ , C ₁₃ : 6000pF FEED THROUGH | D : 1S1555 |
| C ₉ : 0.1 μ F | |
| C ₁₁ : 0.01 μ F | |
| R ₁ : 10 Ω , 1W | |
| R ₂ : 500 Ω , 2W | |
| R ₃ : ~200 Ω | |



2 ~ 30MHz SSB LINEAR POWER AMPLIFIER APPLICATIONS.
(28V SUPPLY VOLTAGE USE)

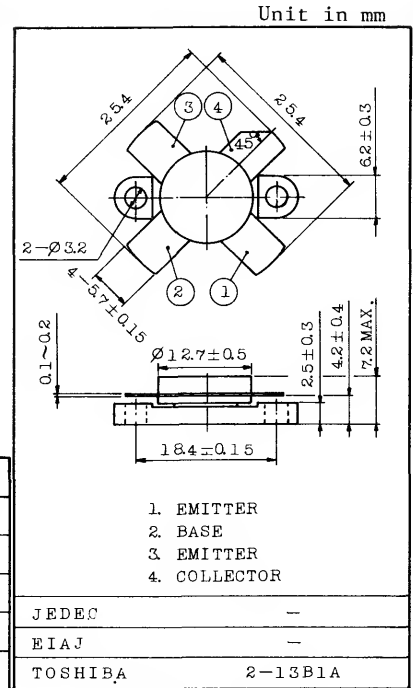
FEATURES:

Specified 28V, 28MHz Characteristics

- : Output Power : $P_o=80W_{PEP}$
- : Minimum Gain : $G_{pe}=14.5dB$
- : Efficiency : $\gamma_c=40\%$ (Min.)
- : Intermodulation Distortion : $IMD=-30dB$ (Max.)

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	65	V
Collector-Emitter Voltage	V_{CEO}	35	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	12	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	140	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$



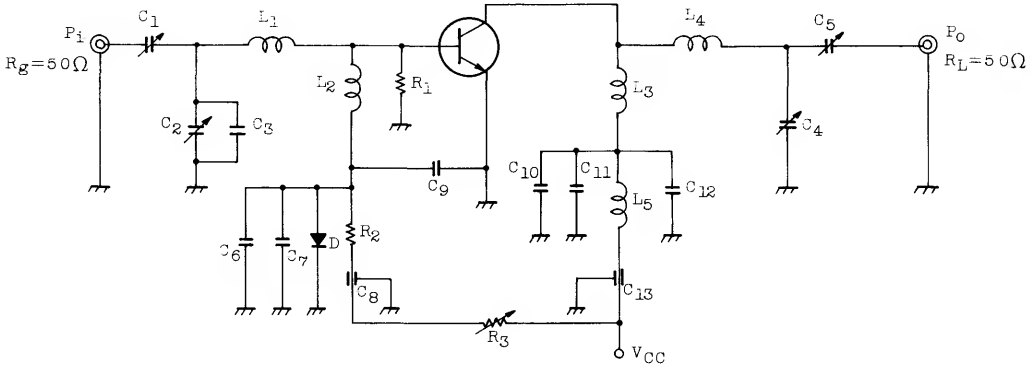
Weight : 5.2g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=100mA, I_B=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CER}$	$I_C=20mA, R_{EB}=10\Omega$	65	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA, I_C=0$	4	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=10V, I_C=10A$	10	-	-	
Transition Frequency	f_T	$V_{CE}=15V, I_C=0.2A$	50	-	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=28V, I_E=0, f=1MHz$	-	220	300	pF
Power Gain	G_{pe}	$V_{CC}=28V, f=28MHz$	14.5	-	-	dB
Input Power	P_i	2-Tone, $\Delta f=1kHz$	-	-	2.8	WPEP
Collector Efficiency	γ_c	$I_{idle}=40mA, P_o=80W_{PEP}$	40	-	-	%
Intermodulation Distortion	IMD	(Fig.)	-	-	-30	dB

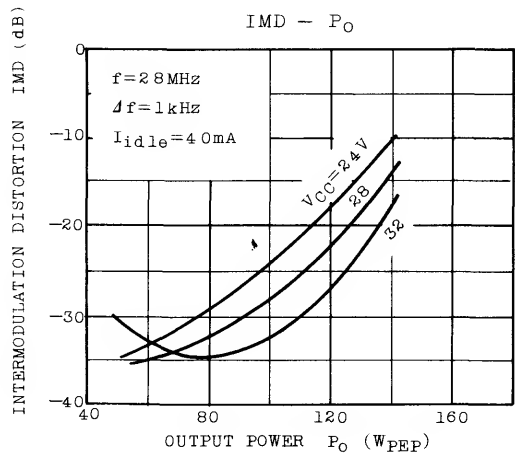
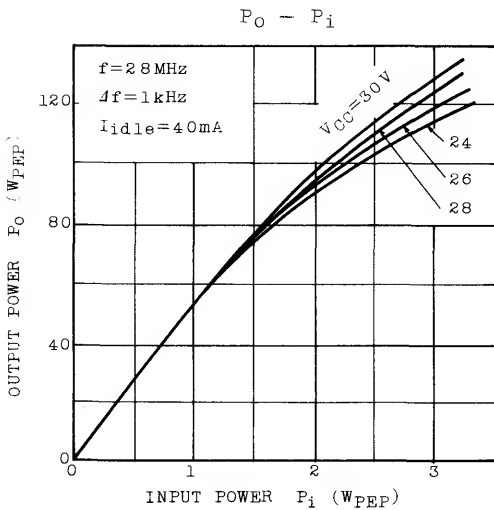
2SC1764

Fig. P_i TEST CIRCUIT



- C1, C4, C5 : ~100pF
- C2 : ~ 50pF
- C3 : 100pF
- C6, C10 : 0.1μF
- C7, C12 : 22μF
- C8, C13 : 6000pF FEED THROUGH
- C9 : 0.1μF
- C11 : 0.01μF
- R1 : 10Ω, 1W
- R2 : 500Ω, 2W
- R3 : ~200Ω

- L1 : φ1.0 SILVER PLATED COPPER WIRE, 12ID, 4T, 20 LENGTH
- L2 : 10μH
- L3 : φ1.6 SILVER PLATED COPPER WIRE, 12ID, 2T, 8 LENGTH
- L4 : φ1.6 SILVER PLATED COPPER WIRE, 20ID, 3.5T, 22 LENGTH
- L5 : 10μH
- D : 1S1555



Unit in mm

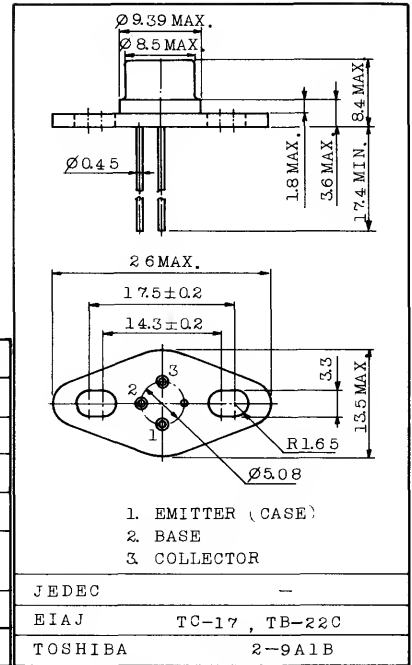
UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Output Power : $P_o=2.8W(\text{Min.})$
($f=470\text{MHz}$, $V_{CC}=12.6V$, $P_i=0.6W$)
- . 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=12.6V$, $P_i=0.6W$, $f=470\text{MHz}$

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	35	V
Collector-Emitter Voltage	V_{CE0}	17	V
Emitter-Base Voltage	V_{EB0}	3.5	V
Collector Current	I_C	0.8	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	7.5	W
Junction Temperature	T_j	175	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ\text{C}$



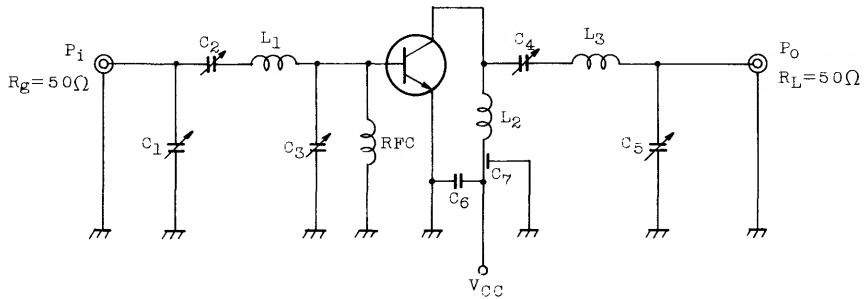
Weight : 3.7g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1\text{mA}$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=5\text{mA}$, $I_B=0$	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=0.1\text{mA}$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=0.5A$	10	-	-	-
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1\text{MHz}$	-	-	15	pF
Output Power	P_o	(Fig.)	2.8	3.2	-	W
Power Gain	G_{pe}	$V_{CC}=12.6V$, $f=470\text{MHz}$,	6.7	7.3	-	dB
Collector Efficiency	η_c	$P_i=0.6W$	60	-	-	%

2SC1765

Fig. f=470MHz P_o TEST CIRCUIT



C₁, C₂, C₃ : ~10pF

C₄, C₅ : ~30pF

C₆ : 0.02μF

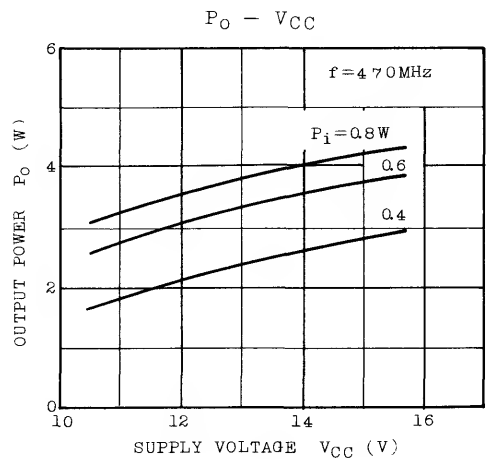
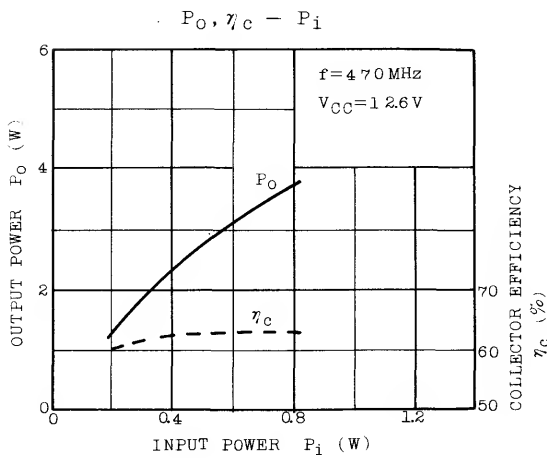
C₇ : 1000pF FEED THROUGH

L₁ : φ1.6 SILVER PLATED COPPER WIRE, 7ID, 1/2T

L₂ : φ1.2 SILVER PLATED COPPER WIRE, 10ID, 1/2T

L₃ : φ1.6 SILVER PLATED COPPER WIRE, 10ID, 1/2T

RFC : φ0.7 ENAMEL COATED COPPER WIRE, 3ID, 5T



2SC1955

Unit in mm

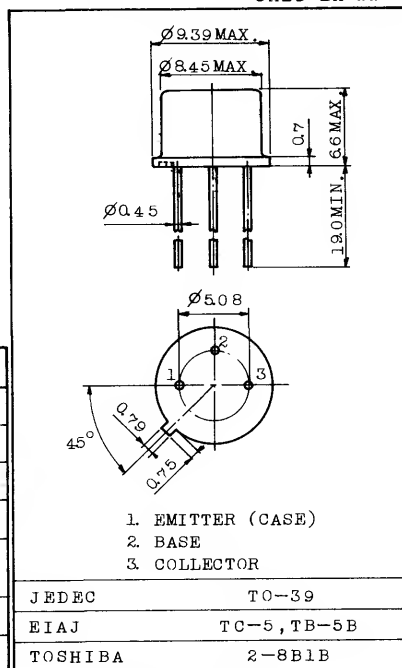
VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES ·

- Output Power : $P_o=2.8W$ (Min.)
($f=175MHz$, $V_{CC}=13.5V$, $P_i=0.15W$)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=13.5V$, $P_o=4W$, $f=175MHz$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	0.8	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	7.5	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$



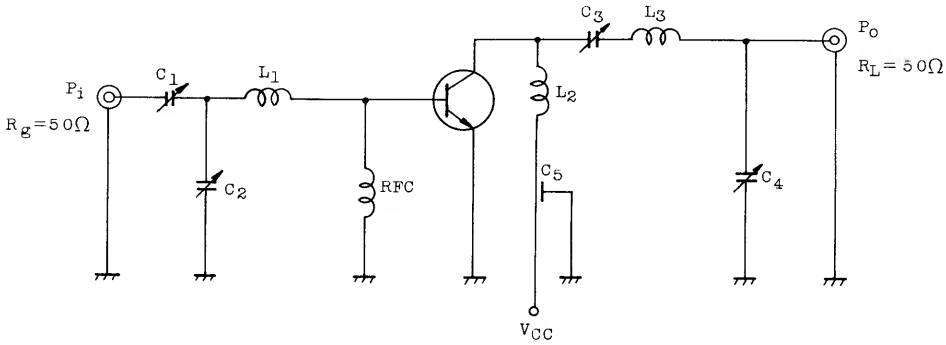
Weight : 1.2g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Voltage	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1mA$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=5mA$, $I_B=0$	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=0.5A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	-	15	pF
Output Power	P_o	(Fig.)	2.8	3.2	-	W
Power Gain	G_{pe}	$V_{CC}=13.5V$, $f=175MHz$,	12.7	13.3	-	dB
Collector Efficiency	η_c	$P_i=0.15W$	60	72	-	%

2SC1955

Fig. P_o TEST CIRCUIT



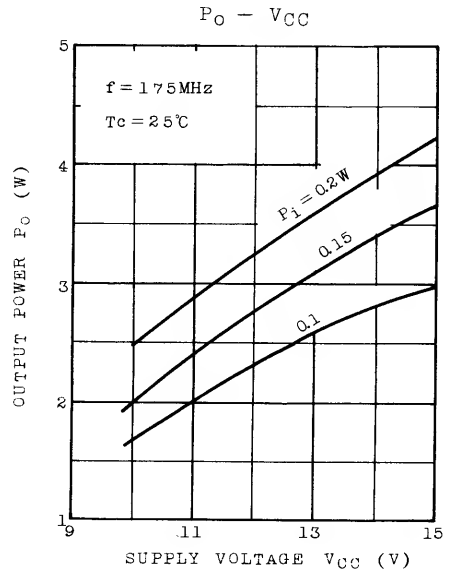
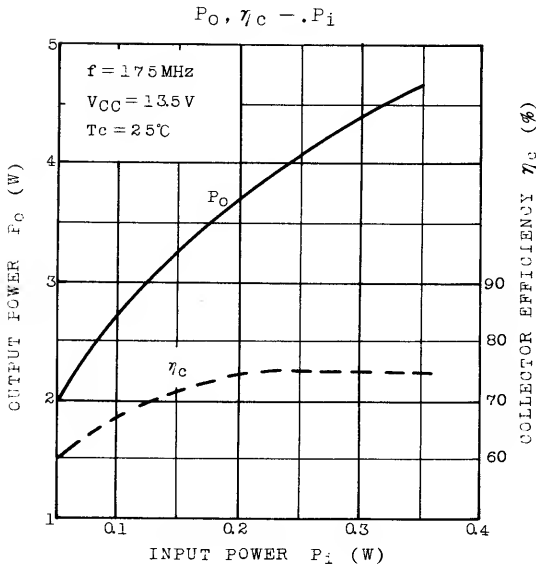
C_1, C_2, C_3, C_4 : $\sim 30\text{pF}$

C_5 : 1000pF FEED THROUGH

L_1, L_2 : $\phi 1.2$ SILVER PLATED COPPER WIRE, 8ID, IT

L_3 : $\phi 1.2$ SILVER PLATED COPPER WIRE, 8ID, $1\frac{3}{4}\text{T}$

RFC : 1 μH CHOKE COIL



2SC2068

Unit in mm

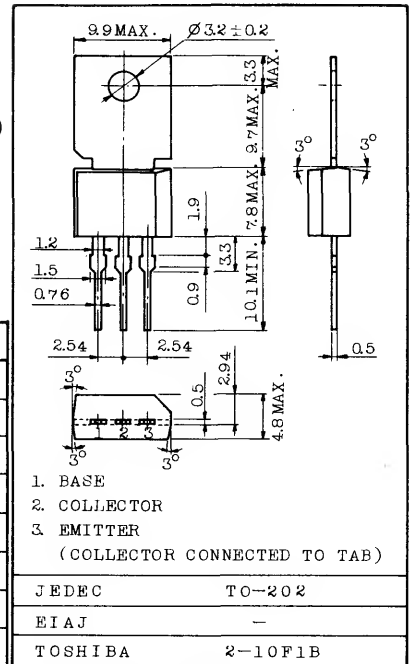
COLOR TV CHROMA OUTPUT APPLICATIONS.

FEATURES:

- . High Voltage : $V_{CE0}=300V$
- . Small Collector Output Capacitance : $C_{ob}=4.0pF$ (Max.)

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	300	V
Collector-Emitter Voltage	V_{CEO}	300	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	50	mA
Base Current	I_B	20	mA
Collector Power Dissipation	P_C	1.5	W
Junction Temperature	T_j	150	$^{\circ}C$
Storage Temperature Range	T_{stg}	-55~150	$^{\circ}C$

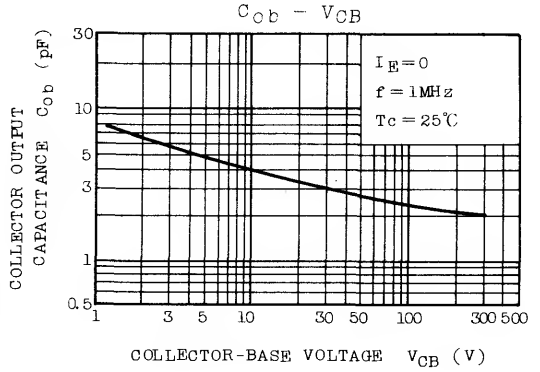
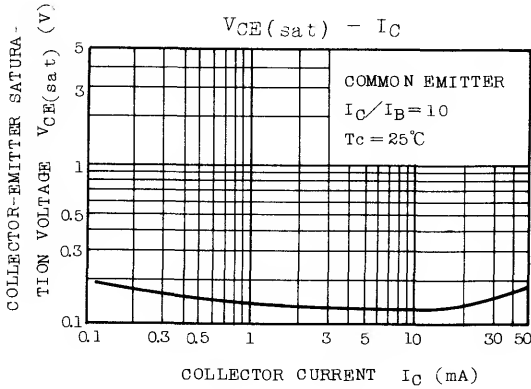
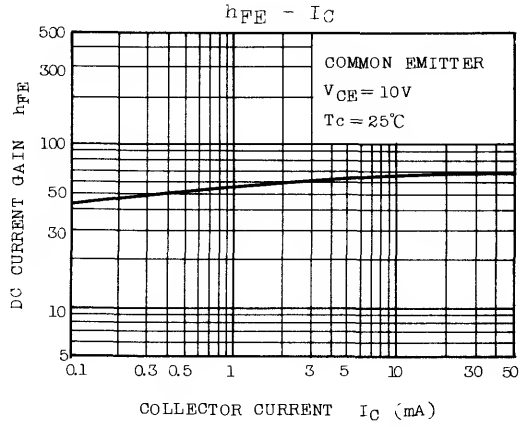
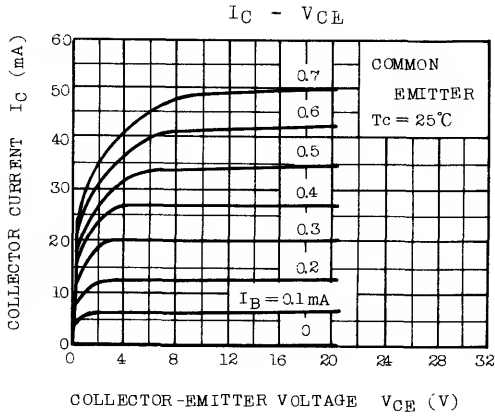


Weight : 1.4g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=240V, I_E=0$	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1.0	μA
DC Current Gain	$h_{FE}(1)$	$V_{CE}=10V, I_C=0.5mA$	20	-	-	
	$h_{FE}(2)$	$V_{CE}=10V, I_C=20mA$	30	-	200	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=10mA, I_B=1mA$	-	-	1.0	V
Transition Frequency	f_T	$V_{CE}=20V, I_C=20mA$	75	95	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=20V, I_E=0, f=1MHz$	-	-	4.0	pF

2SC2068



Unit in mm

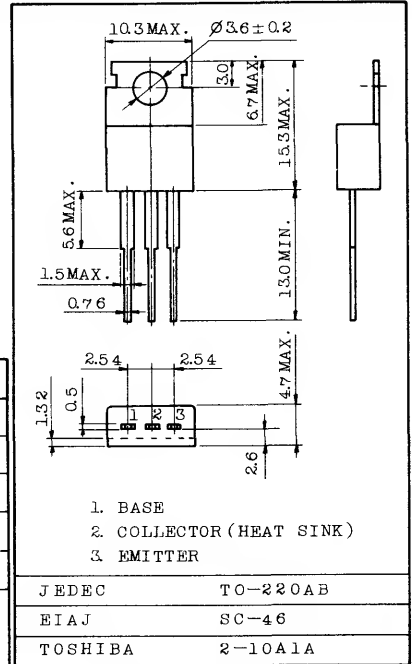
POWER AMPLIFIER APPLICATIONS.
VERTICAL OUTPUT APPLICATIONS.

FEATURES:

- . Wide Safe Operating Area.
- . Complementary to 2SA940

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V _{CB0}	150	V
Collector-Emitter Voltage		V _{CE0}	150	V
Emitter-Base Voltage		V _{EB0}	5	V
Collector Current		I _C	1.5	A
Base Current		I _B	0.5	A
Collector Power Dissipation	T _a =25°C	P _C	1.5	W
	T _c =25°C		25	
Junction Temperature		T _j	150	°C
Storage Temperature Range		T _{stg}	-55~150	°C



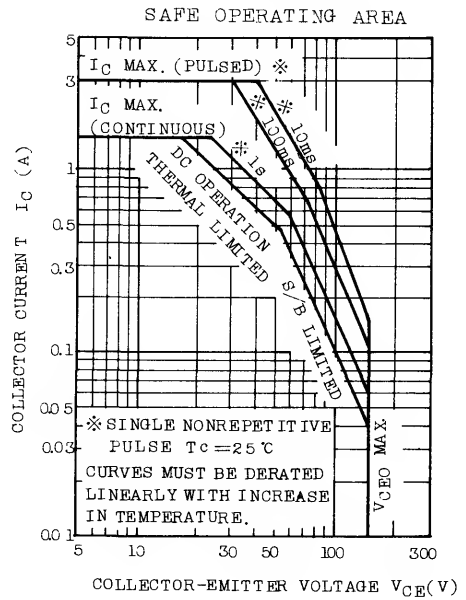
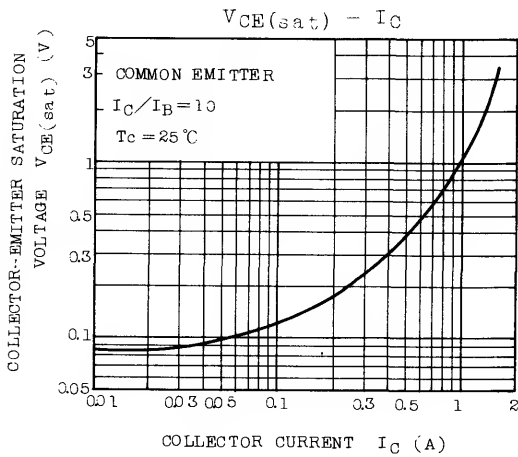
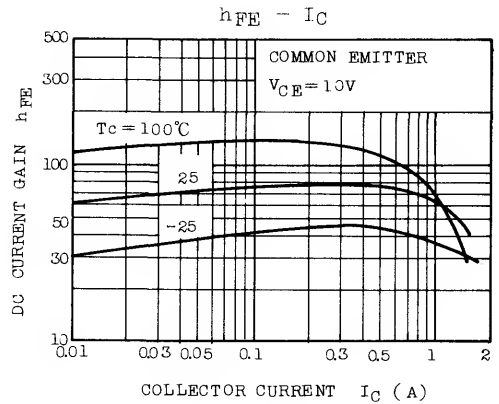
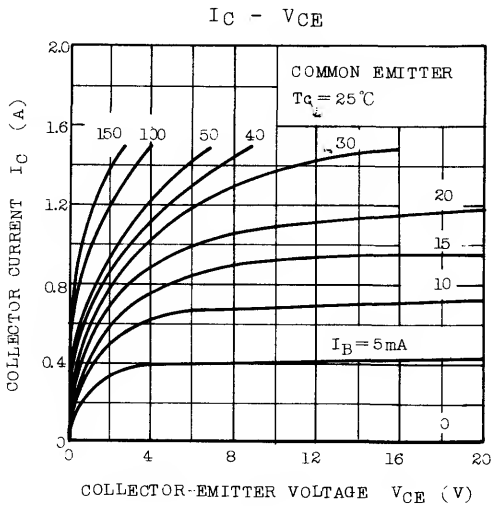
Weight : 1.9g

Mounting kit No. AC75

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =120V, I _E =0	-	-	10	μA
Emitter Cut-off Current	I _{EB0}	V _{EB} =5V, I _C =0	-	-	10	μA
DC Current Gain	h _{FE}	V _{CE} =10V, I _C =500mA	40	75	140	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =500mA, I _B =50mA	-	-	1.5	V
Base-Emitter Voltage	V _{BE}	V _{CE} =10V, I _C =500mA	0.65	0.75	0.85	V
Transition Frequency	f _T	V _{CE} =10V, I _C =500mA	-	4	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	35	-	pF

2SC2073



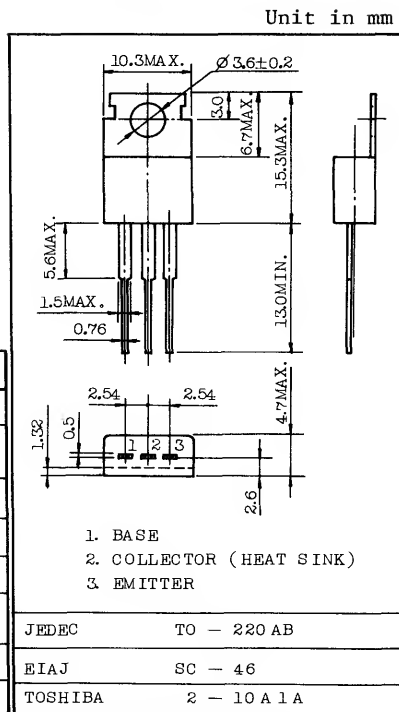
27MHz POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Recommended for Output Stage Application of AM 4W Transmitter.
- High Power Gain.
- Wide Area of Safe Operation.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	80	V
Collector-Emitter Voltage R _{BE} =50Ω	V _{CER}	80	V
Emitter-Base Voltage	V _{EBO}	4.0	V
Collector Current	I _C	4	A
Emitter Current	I _E	-4	A
Collector Power Dissipation (Tc=25°C)	P _C	10	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55~150	°C

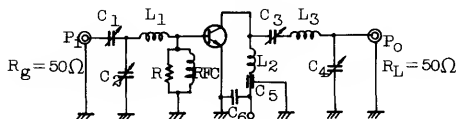


Mounting Kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I _{CBO}	V _{CB} =30V, I _E =0	-	-	10	μA
Breakdown Voltage	Collector-Emitter	V _{(BR)CER}	I _C =10mA, R _{BE} =50Ω	80	-	-	V
	Emitter-Base	V _{(BR)EBO}	I _E =1.0mA, I _C =0	4.0	-	-	V
DC Current Gain		h _{FE(1)}	V _{CE} =5V, I _C =0.5A	25	-	-	
		h _{FE(2)}	V _{CE} =2V, I _C =3A	15	-	-	
Collector-Emitter Saturation Voltage		V _{CE(sat)}	I _C =3A, I _B =0.3A	-	-	1.5	V
Transition Frequency		f _T	V _{CE} =5V, I _C =500mA	-	100	-	MHz
Collector Output Capacitance		C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	40	-	pF
Output Power (Fig. 1)		P _o	V _{CC} =12V, P _i =0.3W, f=27MHz	3.5	-	-	W

Fig.1 P_o TEST CIRCUIT



- C₁ : ~ 100pF, C₂, C₃ : ~ 150pF, C₄ : ~ 300pF, C₅ : 1000pF
- C₆ : 0.01μF R : 250Ω
- L₁ : 0.8mm∅ UEW, 7T, 8mm I.D. L₂ : 0.8mm∅ UEW, 5T, 8mm I.D
- L₃ : 0.8mm∅ UEW, 10T, 8mm I.D RFC : 0.35mm∅ UEW, 17T, 5mm I.D

2SC2075

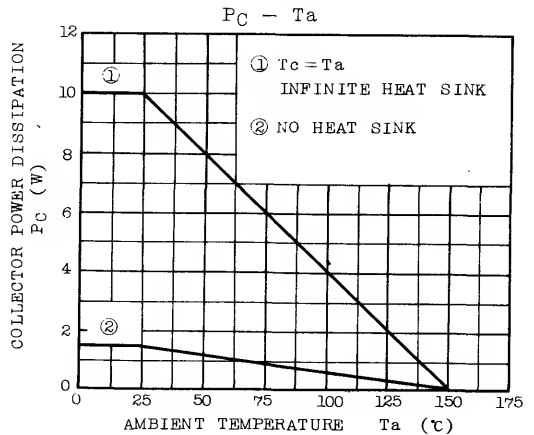
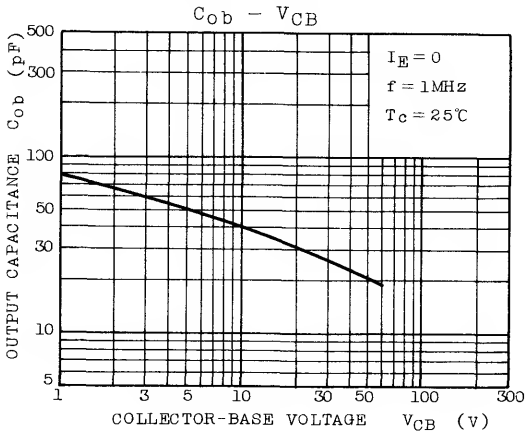
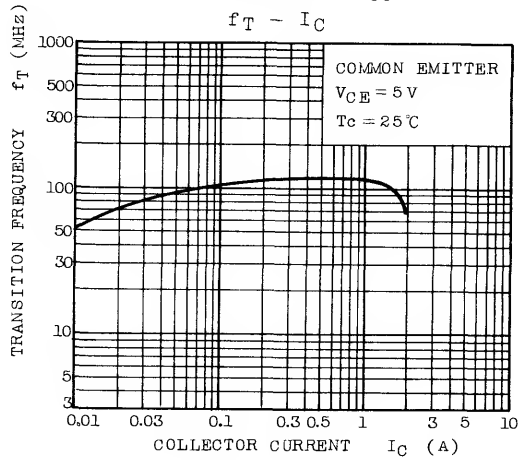
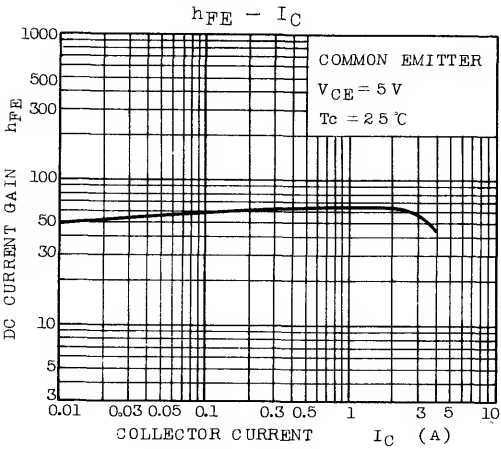
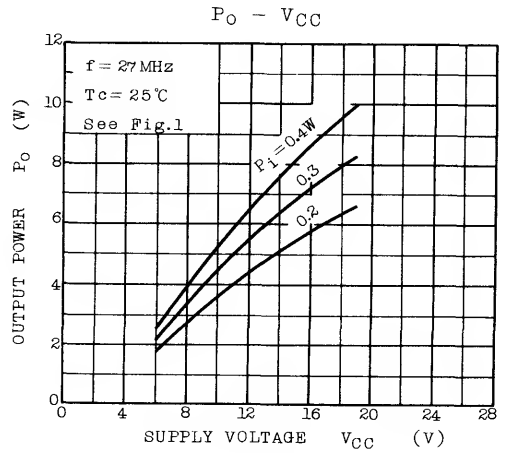
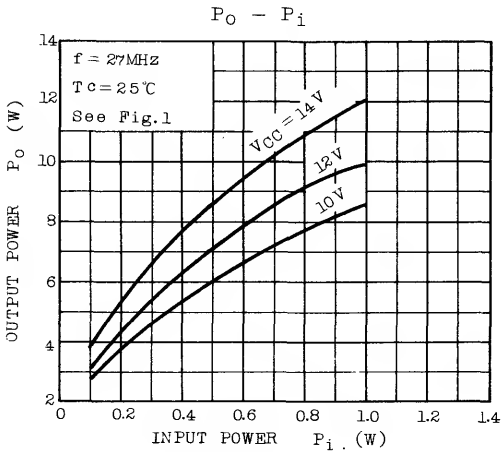
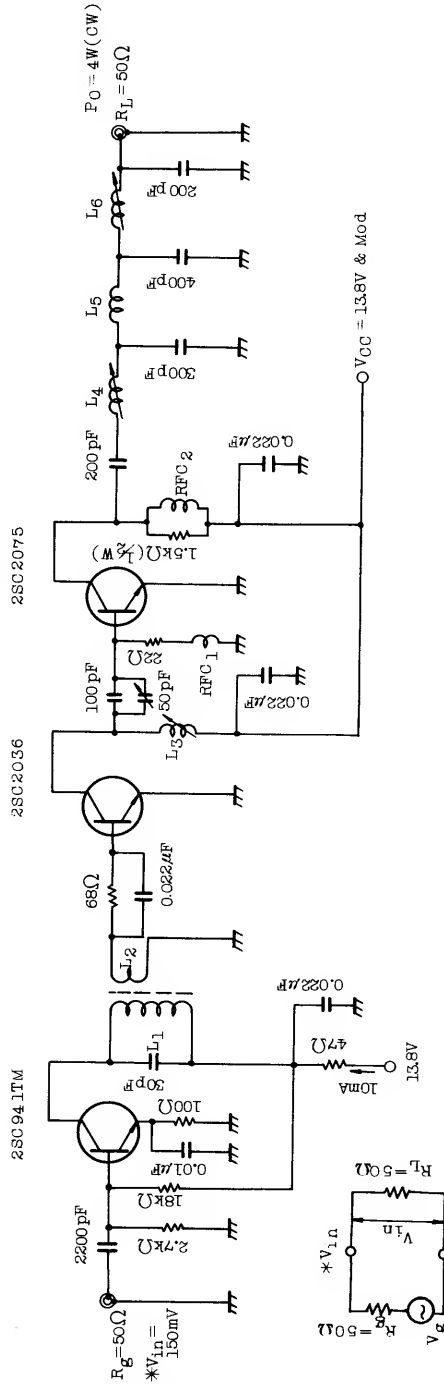


FIG. 2 27MHz 4W OUTPUT AM TRANSCEIVER CIRCUIT



L₁ : 4mm ϕ BOBBIN WITH FERRITE CORE , 0.08mm ϕ UEW, 8 TURNS

L₂ : 4mm ϕ BOBBIN WITH FERRITE CORE , 0.08mm ϕ UEW, 2 TURNS

L₃, L₆ : 6.5mm ϕ BOBBIN WITH FERRITE CORE , 0.6mm ϕ Sn PLATED COPPER WIRE 6 $\frac{1}{2}$ TURNS

L₄ : 6.5mm ϕ BOBBIN WITH FERRITE CORE , 0.6mm ϕ Sn PLATED COPPER WIRE 8 $\frac{1}{2}$ TURNS

L₅ : 0.6mm ϕ Sn PLATED COPPER WIRE , 6.5mm I.D., 8 $\frac{1}{2}$ TURNS

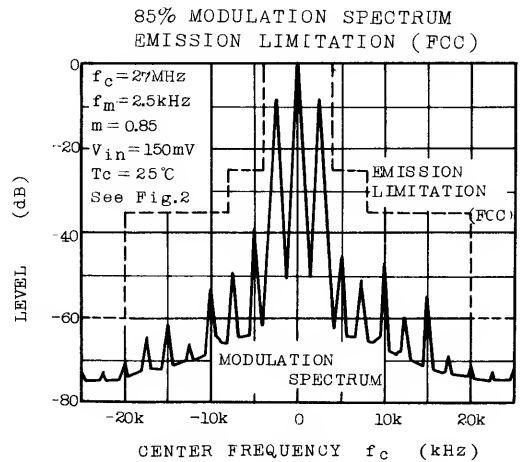
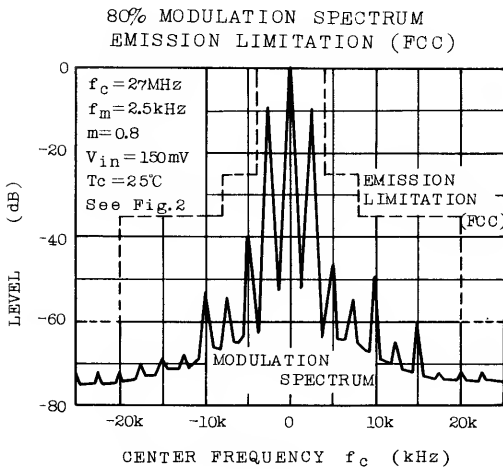
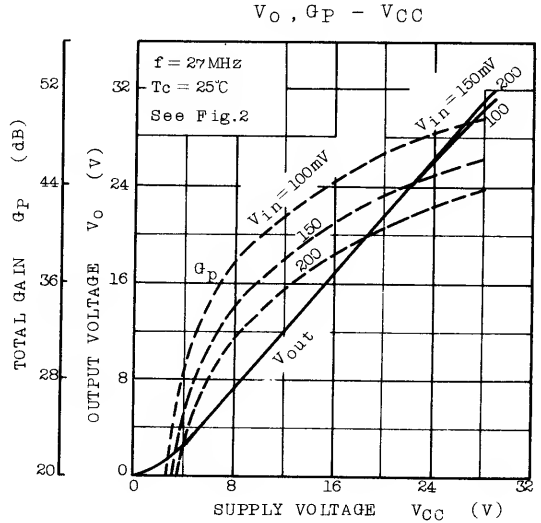
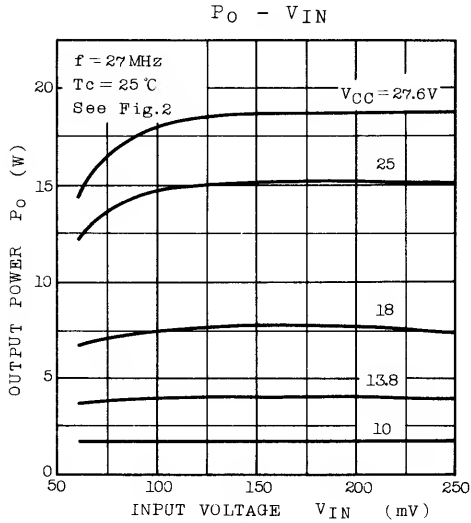
RFC₁ : 47 μ H, 7BA - 480k (TOKO)

RFC₂ : 0.2mm ϕ UEW, 50 TURNS

RESISTOR : $\frac{1}{4}$ W CARBON

CAPACITOR : CERAMIC

APPLICATION CIRCUIT CHARACTERISTIC



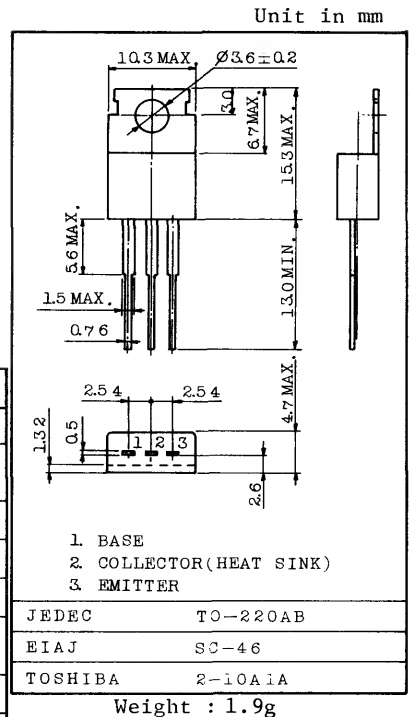
CITIZEN BAND AND HAM BAND UP TO 50MHz RF
POWER AMPLIFIER APPLICATIONS.
(LOW SUPPLY VOLTAGE USE)

FEATURES:

- Recommended for 12W(PEP) SSB Citizen Band Transceiver Applications.
- High Power Gain : $G_{pe}=11.8\text{dB(Typ.)}$ @ $f=28\text{MHz}$
- Designed to Withstand Load Mismatch at All Phase Angles with Infinite VSWR at 17 Volts.

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	70	V
Collector-Emitter Voltage ($R_{EB}=10\Omega$)	V_{CER}	70	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	6	A
Emitter Current	I_E	-6	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	20	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ\text{C}$

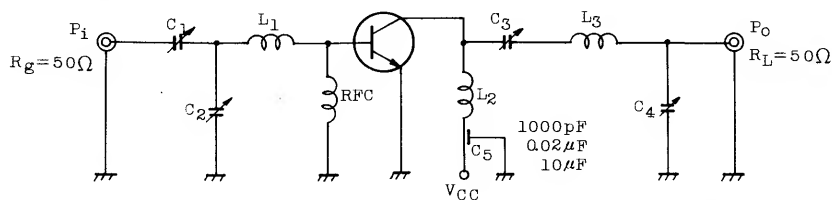


ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

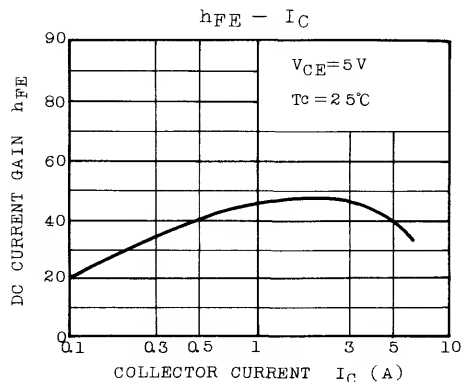
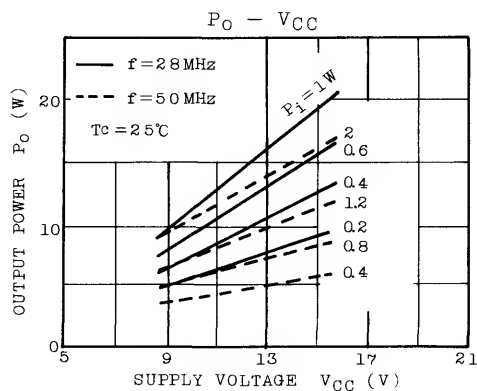
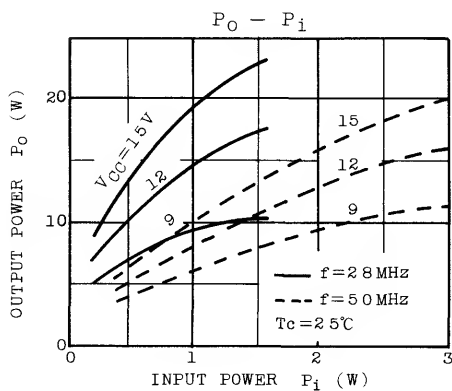
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=40\text{V}, I_E=0$	-	-	0.1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1\text{mA}, I_E=0$	70	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CER}$	$I_C=10\text{mA}, R_{EB}=10\Omega$	70	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1\text{mA}, I_C=0$	4	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5\text{V}, I_C=4\text{A}$	20	-	100	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4\text{A}, I_B=0.4\text{A}$	-	-	1.5	V
Transition Frequency	f_T	$V_{CE}=5\text{V}, I_C=0.5\text{A}$	100	-	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10\text{V}, I_E=0, f=1\text{MHz}$	-	80	120	pF
Output Power	$P_o(1)$	$V_{CC}=12\text{V}, f=28\text{MHz}$ $P_i=1\text{W}, \eta_c \geq 60\%$ (Fig.)	13	15	-	W
	$P_o(2)$	$V_{CC}=12\text{V}, f=50\text{MHz}$ $P_i=3\text{W}, \eta_c \geq 60\%$ (Fig.)	-	16	-	W

2SC2098

Fig. P_o TEST CIRCUIT



	28MHz	50MHz
C ₁ :	~100pF	~50pF
C ₂ , C ₃ :	~150pF	~100pF
C ₄ :	~300pF	~200pF
L ₁ :	∅0.8 SILVER PLATED COPPER WIRE, 10ID, 8T	10ID, 5T
L ₂ :	∅0.8 SILVER PLATED COPPER WIRE, 10ID, 5T	8ID, 5T
L ₃ :	∅0.8 SILVER PLATED COPPER WIRE, 10ID, 8T	10ID, 7T



2 ~ 30MHz SSB LINEAR POWER AMPLIFIER APPLICATIONS.
(LOW SUPPLY VOLTAGE USE)

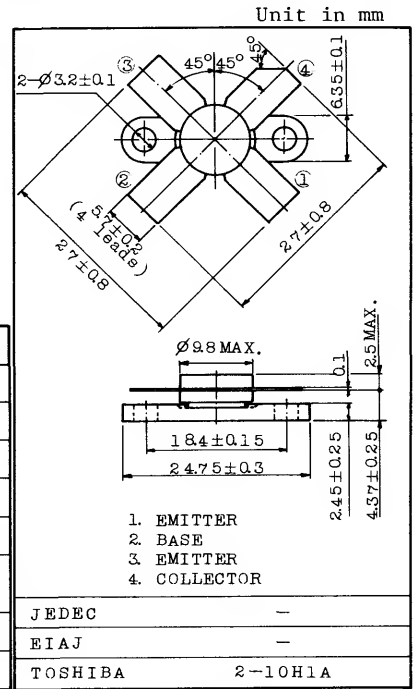
FEATURES :

• Specified 12.5V, 28MHz Characteristics

- : Output Power : $P_O=20W_{PEP}$
- : Minimum Gain : $G_{pe}=12dB$
- : Efficiency : $\eta_c=35\%$ (Min.)
- : Intermodulation Distortion : $IMD=-30dB$ (Max.)

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CES}	40	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	6	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	60	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$



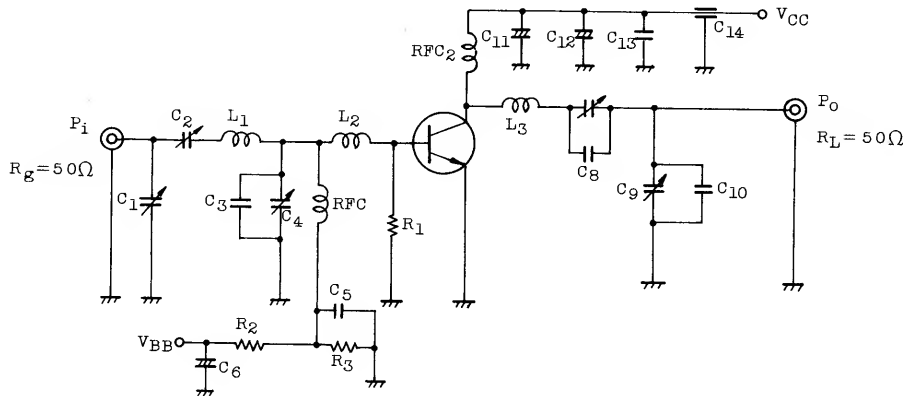
Weight : 40g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

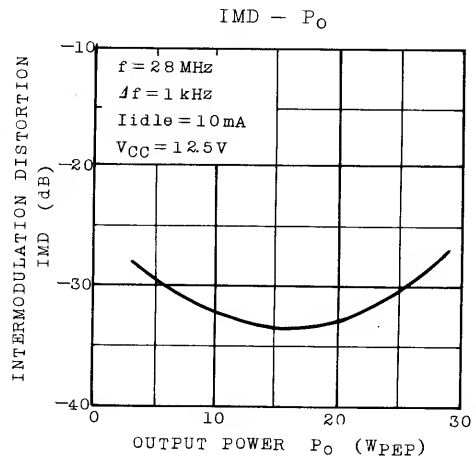
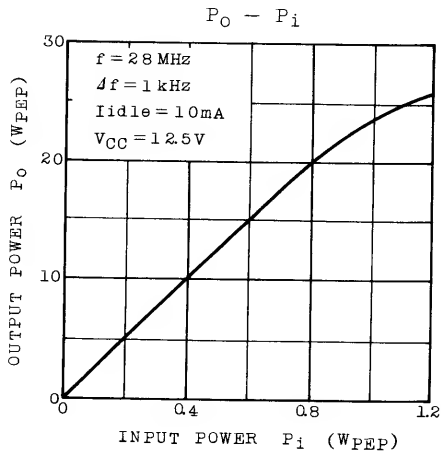
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	18	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CES}$	$I_C=50mA, V_{EB}=0$	40	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA, I_C=0$	4	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=1A$	20	-	-	
Transition Frequency	f_T	$V_{CE}=5V, I_C=0.5A$	-	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=12.5V, I_E=0, f=1MHz$	-	-	250	pF
Power Gain	G_{pe}	$V_{CC}=12.5V, f=28MHz$	12.0	-	-	dB
Input Power	P_i	2-Tone, $\Delta f=1kHz$	-	-	1.2	W_{PEP}
Collector Efficiency	η_c	$I_{idle}=10mA, P_O=20W_{PEP}$	35	45	-	%
Intermodulation Distortion	IMD	(Fig.)	-	-	-30	dB
Series Equivalent Input Impedance	Z_{in}	$V_{CC}=12.5V, f=28MHz, \Delta f=1kHz, P_O=20W_{PEP}$	-	1.1 -j0.25	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	3.0 -j0.75	-	Ω

2SC2099

Fig. P_i TEST CIRCUIT



- | | |
|---|--|
| C ₁ , C ₂ , C ₄ , C ₇ : 7 ~ 150pF | L ₁ ; ϕ 0.8 ENAMEL COATED COPPER WIRE, 9ID, 6T |
| C ₉ : 10 ~ 200pF | L ₂ : ϕ 1 SILVER PLATED COPPER WIRE, 9ID, 2T |
| C ₃ : 250pF | L ₃ : ϕ 1.5 ENAMEL COATED COPPER WIRE, 9ID, 5T |
| C ₅ , C ₁₃ : 0.4 μ F | RFC ₁ : ϕ 0.8 ENAMEL COATED COPPER WIRE, 9ID, 20T |
| C ₆ : 100 μ F 10WV | RFC ₂ : ϕ 1.5 ENAMEL COATED COPPER WIRE, 12ID, 15T |
| C ₈ : 150pF | R ₁ : 5.6 Ω (1/2W) |
| C ₁₀ : 600pF | R ₂ : 5 Ω (5W) |
| C ₁₁ , C ₁₂ : 22 μ F 35WV | R ₃ : 1.5 Ω (10W) |
| C ₁₄ : 1000pF | |
- (FEED THROUGH)

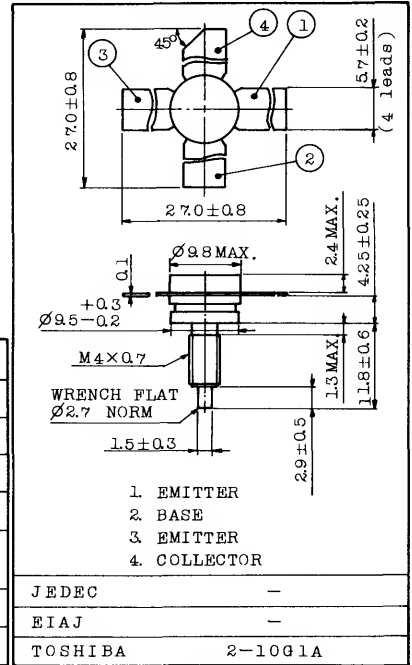


Unit in mm

VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : $P_o=6W$ (Min.)
($f=175MHz$, $V_{CC}=12.5V$, $P_i=0.5W$)



MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	35	V
Collector-Emitter Voltage	V_{CE0}	18	V
Emitter-Base Voltage	V_{EB0}	3.5	V
Collector Current	I_C	2	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	15	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$

Mounting Kit No. AC57

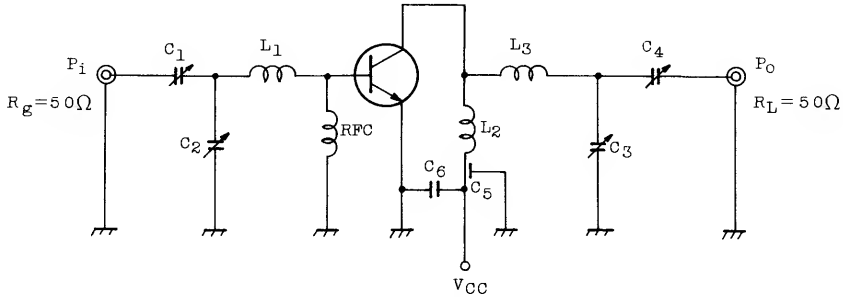
Weight : 3.3g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	0.1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1mA$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA$, $I_B=0$	18	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=1A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	-	25	pF
Output Power	P_o	(Fig.)	6	7	-	W
Power Gain	G_{pe}	$V_{CC}=12.5V$, $f=175MHz$	10.7	11.5	-	dB
Collector Efficiency	η_c	$P_i=0.5W$	60	68	-	%
Series Equivalent Input Impedance	Z_{in}	$V_{CC}=12.5V$, $f=175MHz$	-	1.1 -j0.5	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=6W$	-	5.4 -j10	-	Ω

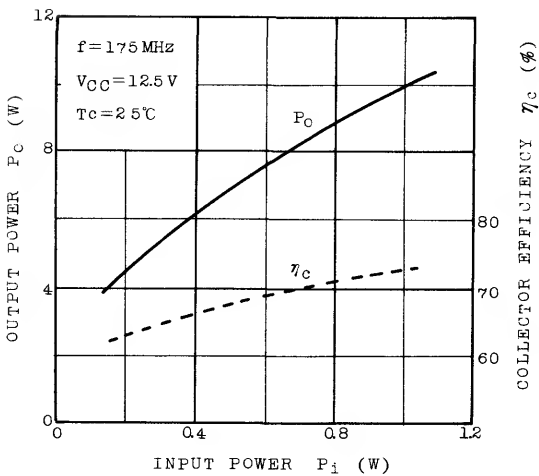
2SC2101

Fig. P_o TEST CIRCUIT

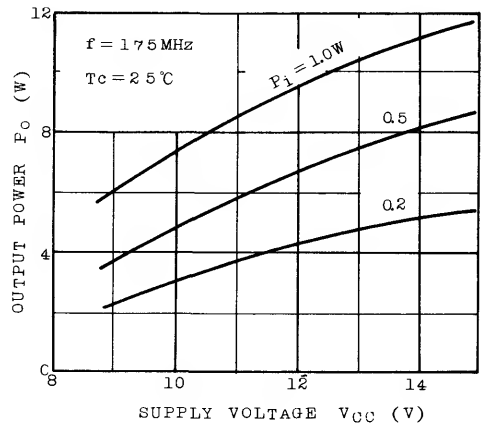


- C_1 : 3 ~ 12pF
- C_2 : 5 ~ 20pF
- C_3, C_4 : 3.5 ~ 30pF
- C_5 : 1000pF FEED THROUGH
- C_6 : 0.01 μ F CERAMIC CONDENSER
- L_1, L_2 : $\phi 1$ SILVER PLATED COPPER WIRE, 6ID, 2T
- L_3 : $\phi 1$ SILVER PLATED COPPER WIRE, 6ID, 1T
- RFC : $\phi 1$ ENAMEL COATED COPPER WIRE, 6ID, 8T

$P_o, \eta_c - P_i$



$P_o - V_{CC}$



Unit in mm

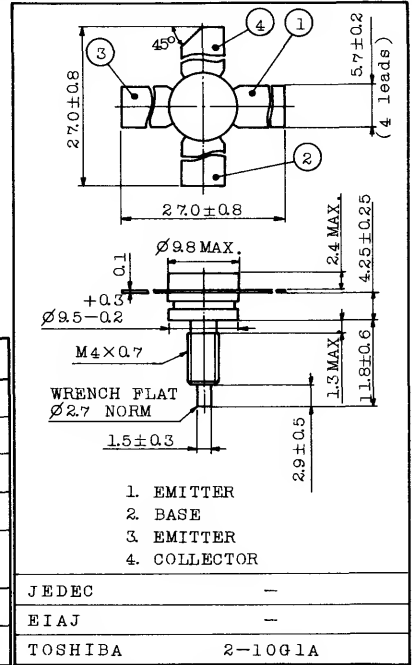
VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- . Output Power : $P_o=15W$ (Min.)
($f=175MHz$, $V_{CC}=12.5V$, $P_i=1.3W$)
- . 100% Tested for Load Mismatch Stress at All Phase Angles with 30;1 VSWR @ $V_{CC}=15V$, $P_i=1.3W$, $f=175MHz$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	3.5	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	35	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$



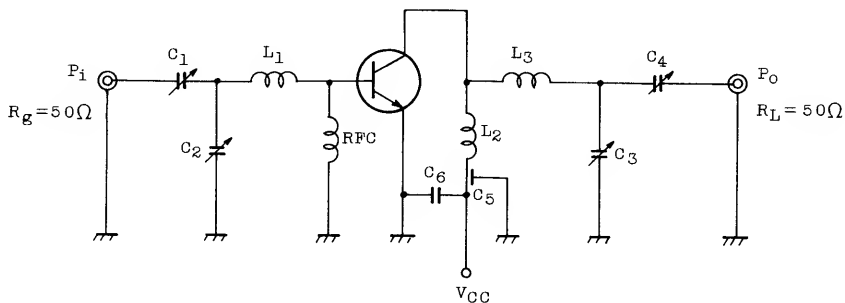
Mounting Kit No. AC57
Weight : 3.3g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

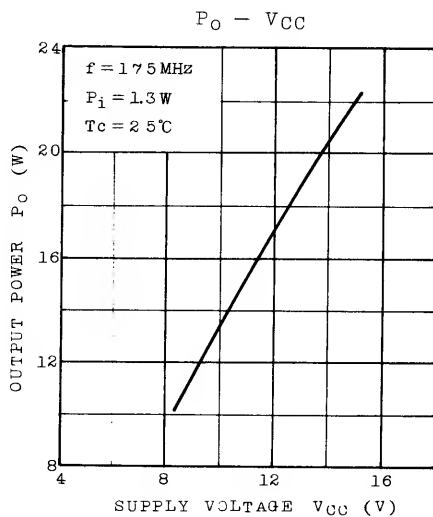
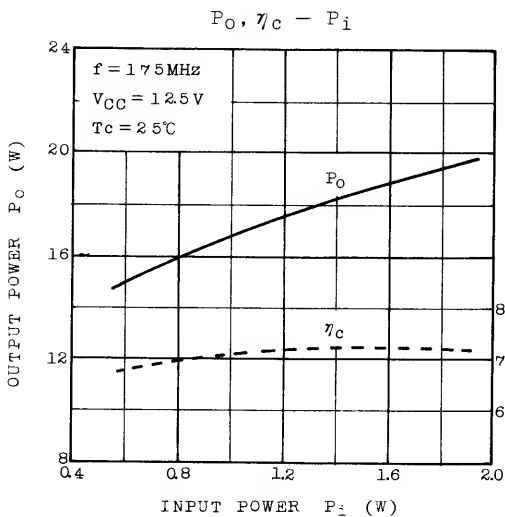
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1.0	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=10mA$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=25mA$, $I_B=0$	18	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=1A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	-	80	pF
Output Power	P_o	(Fig.)	15	18	-	W
Power Gain	G_{pe}	$V_{CC}=12.5V$, $f=175MHz$	10.6	11.4	-	dB
Collector Efficiency	η_c	$P_i=1.3W$	60	72	-	%
Series Equivalent Input Impedance	Z_{in}	$V_{CC}=12.5V$, $f=175MHz$,	-	0.8 +j0.1	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=15W$	-	3.6 -j1.9	-	Ω

2SC2102

Fig. P_o TEST CIRCUIT



- C₁ : 5 ~ 20pF
- C₂, C₃, C₄ : 3.5 ~ 30pF
- C₅ : 1000pF FEED THROUGH
- C₆ : 0.01μF CERAMIC CONDENSER
- L₁, L₃ : φ1 SILVER PLATED COPPER WIRE, 6ID, 1T
- L₂ : φ1 SILVER PLATED COPPER WIRE, 6ID, 2T
- RFC : φ1 ENAMEL COATED COPPER WIRE, 6ID, 3T



2SC2103A

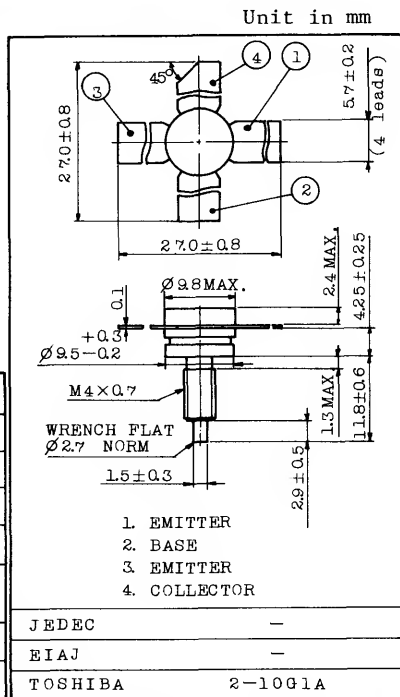
VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- . Output Power : $P_o=27W$ (Min.)
($f=175MHz$, $V_{CC}=12.5V$, $P_i=4.2W$)
- . 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=14.5V$, $P_i=4W$, $f=175MHz$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	4.0	V
Collector Current	I_C	6.0	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	50	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$



Mounting Kit No. AC57

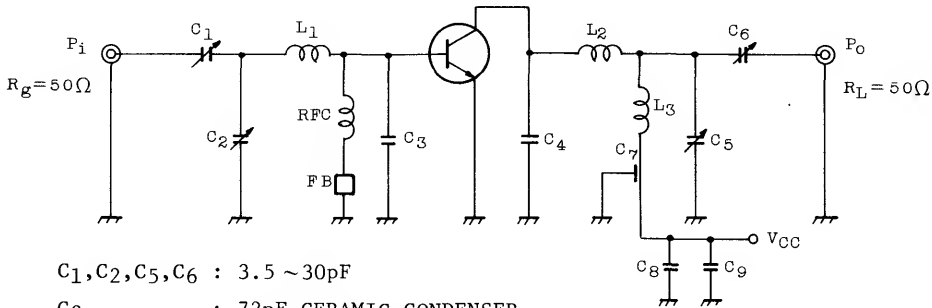
Weight : 3.3g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

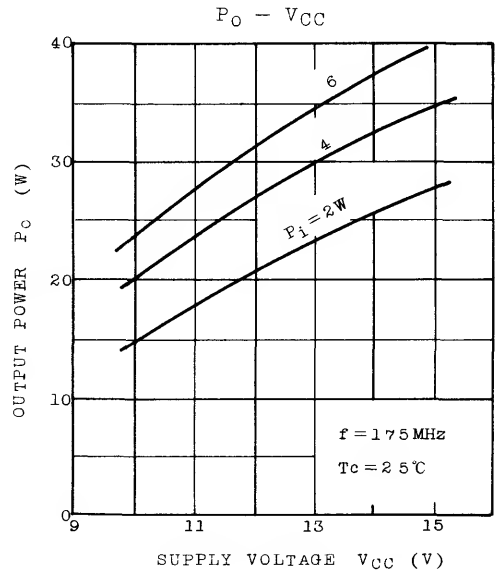
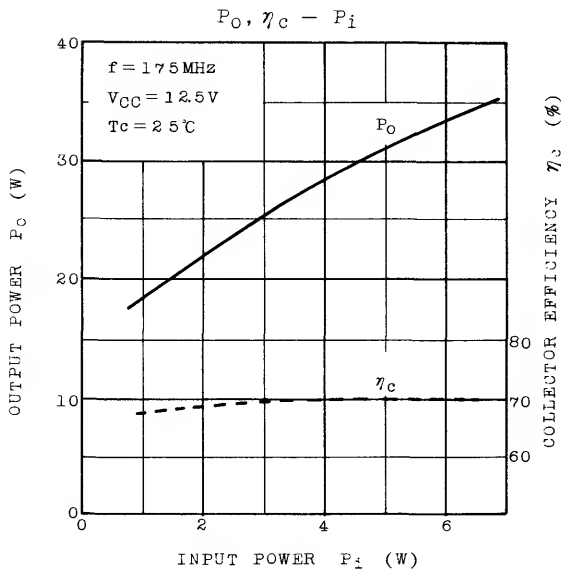
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1.0	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=10mA$, $I_E=0$	40	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=25mA$, $I_B=0$	18	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA$, $I_C=0$	4.0	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=3A$	10	-	150	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	-	80	pF
Output Power	P_o	(Fig.)	27	29	-	W
Power Gain	G_{pe}	$V_{CC}=12.5V$, $f=175MHz$,	8.0	8.4	-	dB
Collector Efficiency	η_c	$P_i=4.2W$	60	70	-	%
Series Equivalent Input Impedance	Z_{in}	$V_{CC}=12.5V$, $f=175MHz$,	-	0.75 +j2.0	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=27W$	-	3.4 +j3.4	-	Ω

2SC2103A

Fig. P₀ TEST CIRCUIT



- C₁, C₂, C₅, C₆ : 3.5 ~ 30pF
- C₃ : 72pF CERAMIC CONDENSER
- C₄ : 47pF CERAMIC CONDENSER
- C₇ : 1000pF FEED THROUGH
- C₈ : 0.01μF CERAMIC CONDENSER
- C₉ : 10μF CERAMIC CONDENSER
- L₁, L₂ : φ1 SILVER PLATED COPPER WIRE, 10ID, 1T
- L₃ : φ1 SILVER PLATED COPPER WIRE, 10ID, 2T
- RFC : φ1 ENAMEL COATED COPPER WIRE, 6ID, 10T
- FB : FERRITE BEADS



Unit in mm

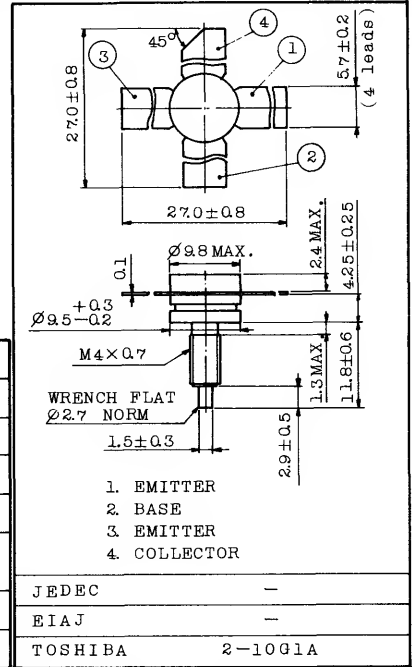
UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Output Power : $P_o=3W(\text{Min.})$
($f=470\text{MHz}$, $V_{CC}=12.6V$, $P_i=0.4W$)
- . 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=15V$, $P_i=0.4W$, $f=470\text{MHz}$

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	0.8	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	7.5	W
Junction Temperature	T_j	175	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ\text{C}$



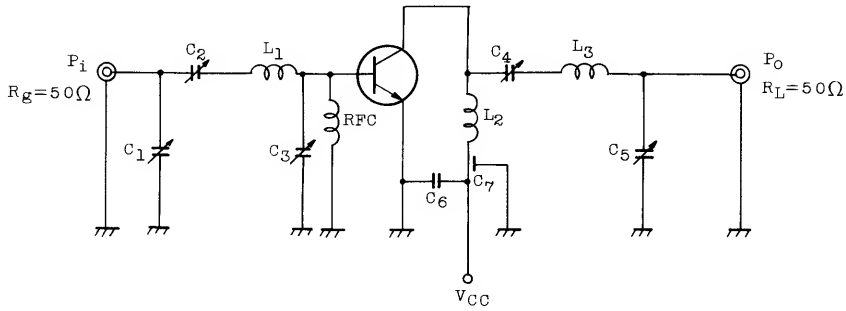
Weight : 3.3g
Mounting Kit No. AC57

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1\text{mA}$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=5\text{mA}$, $I_B=0$	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=0.1\text{mA}$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=0.5A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1\text{MHz}$	-	-	20	pF
Output Power	P_o	(Fig.)	3	-	-	W
Power Gain	G_{pe}	$V_{CC}=12.6V$, $f=470\text{MHz}$,	8.7	-	-	dB
Collector Efficiency	η_c	$P_i=0.4W$	50	-	-	%
Series Equivalent Input Impedance	Z_{IN}	$V_{CC}=12.6V$, $f=470\text{MHz}$,	-	$1.5+j3$	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=3W$	-	$17.5-j8.5$	-	Ω

2SC2104

Fig. f=470MHz P_o TEST CIRCUIT



C₁, C₂, C₃ : ~10pF

C₄, C₅ : ~30pF

C₆ : 0.02μF

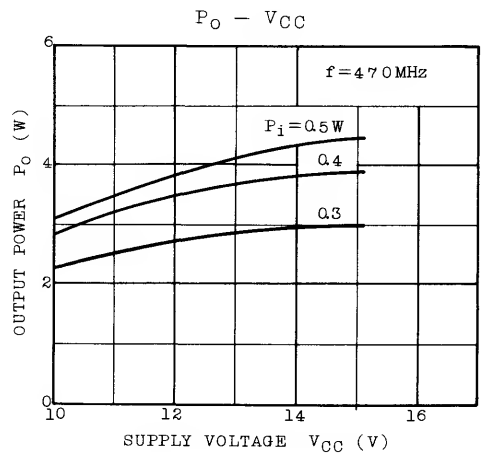
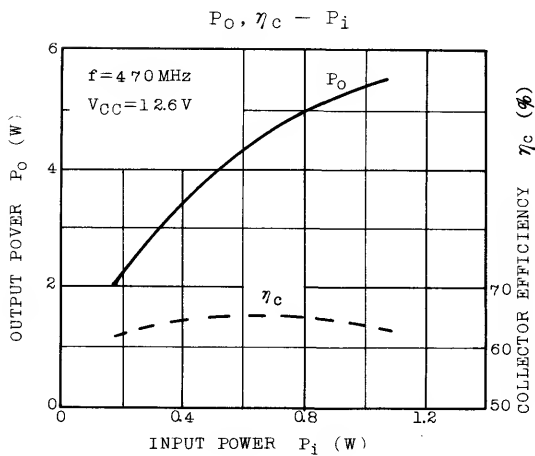
C₇ : 1000pF FEED THROUGH

L₁ : φ1.6 SILVER PLATED COPPER WIRE, 7ID, ½T

L₂ : φ1.2 SILVER PLATED COPPER WIRE, 10ID, 1½T

L₃ : φ1.6 SILVER PLATED COPPER WIRE, 10ID, ½T

RFC : φ0.7 ENAMEL COATED COPPER WIRE, 3ID, 5T



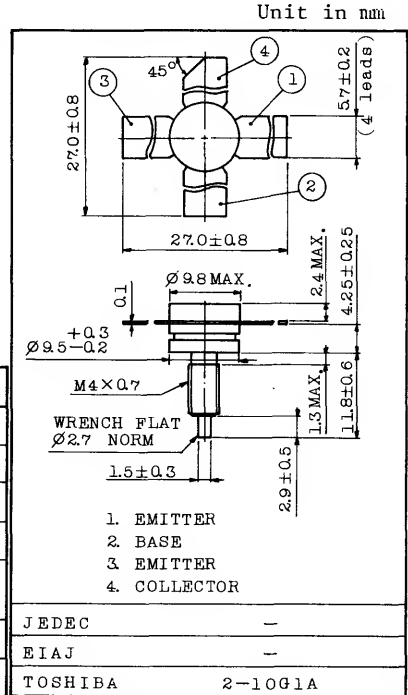
UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Output Power : $P_o=6W(\text{Min.})$
 (f=470MHz, $V_{CC}=12.6V$, $P_i=1W$)
- . 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=12.6V$, $P_o=6.5W$, f=470MHz

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	1.4	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	15	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$



Weight : 3.3g

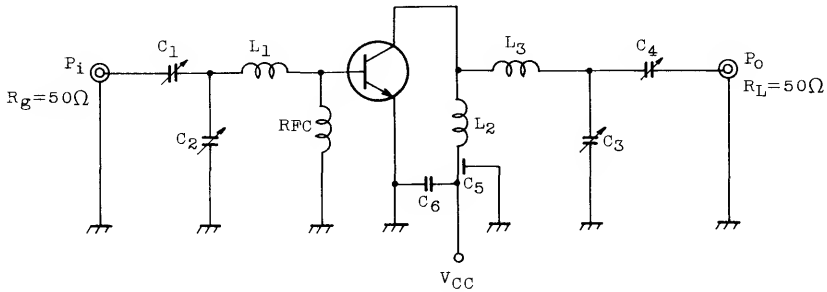
Mounting Kit No.AC57

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V, I_E=0$	-	-	1	nA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=2mA, I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=0.2mA, I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=1A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	-	25	pF
Output Power	P_o	(Fig.)	6	-	-	W
Power Gain	G_{pe}	$V_{CC}=12.6V, f=470MHz,$	7.7	-	-	dB
Collector Efficiency	η_c	$P_i=1W$	60	-	-	%
Series Equivalent Input Impedance	Z_{IN}	$V_{CC}=12.6V, f=470MHz,$	-	1.4+ j3.8	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=6W$	-	11.3- j2.5	-	Ω

2SC2105

Fig. f=470MHz P_o TEST CIRCUIT



C₁, C₃ : 1.5 ~ 5pF

C₂, C₄ : 2 ~ 15pF

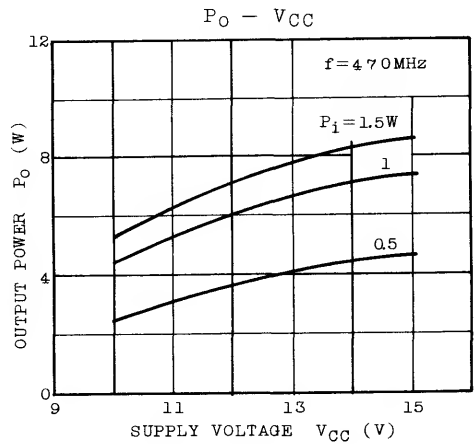
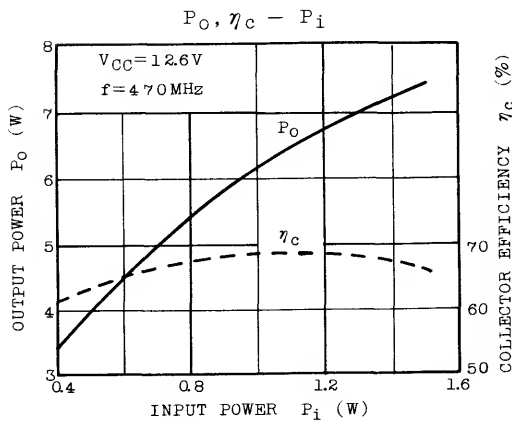
C₅ : 1000pF FEED THROUGH

C₆ : 0.01μF

L₁, L₃ : 5mm × 15mm COPPER PLATE

L₂ : φ1 SILVER PLATED COPPER WIRE, 10ID, ½T

RFC : φ1 ENAMEL COATED COPPER WIRE, 3ID, 5T



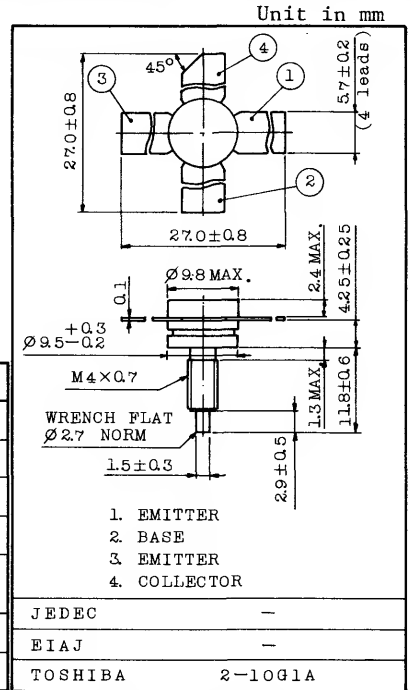
UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Output Power : $P_o=12W$ (Min.)
($f=470MHz$, $V_{CC}=12.6V$, $P_i=3W$)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=15V$, $P_i=3W$, $f=470MHz$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	2.8	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	30	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	165 ~ 175	$^\circ C$



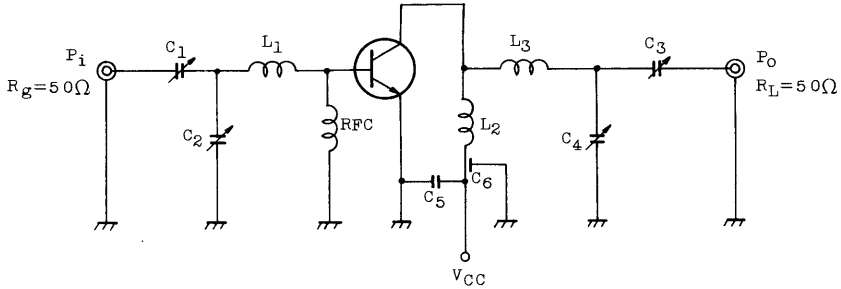
Weight : 3.3g
 Mounting Kit No. AC57

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1.5	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=2mA$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA$, $I_B=0$	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=0.2mA$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=1.5A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	-	45	pF
Output Power	P_o	(Fig.)	12	-	-	W
Power Gain	G_{pe}	$V_{CC}=12.6V$, $f=470MHz$,	6	-	-	dB
Collector Efficiency	η_c	$P_i=3W$	60	-	-	%
Series Equivalent Input Impedance	Z_{IN}	$V_{CC}=12.6V$, $f=470MHz$,	-	$0.9 + j3.5$	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=12W$	-	$5.3 - j1$	-	Ω

2SC2106

Fig. f=470MHz P_O TEST CIRCUIT



C₁, C₄ : 1.5 ~ 5pF

C₂, C₃ : 2 ~ 15pF

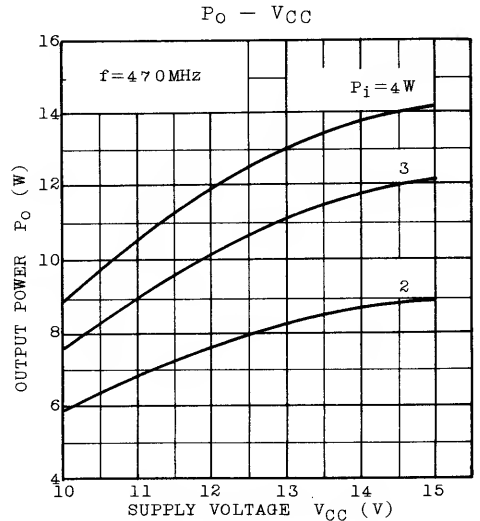
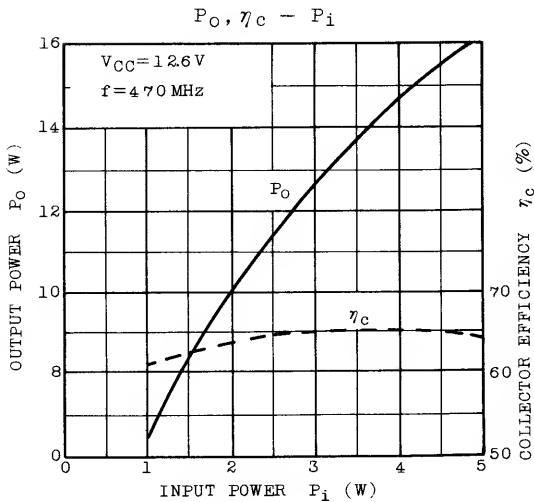
C₅ : 0.01μF

C₆ : 1000pF FEED THROUGH

L₁, L₃ : 5mm×15mm COPPER PLATE

L₂ : φ1 SILVER PLATED COPPER WIRE, 10ID, 1/2T

RFC : φ1 ENAMEL COATED COPPER WIRE, 3ID, 5T

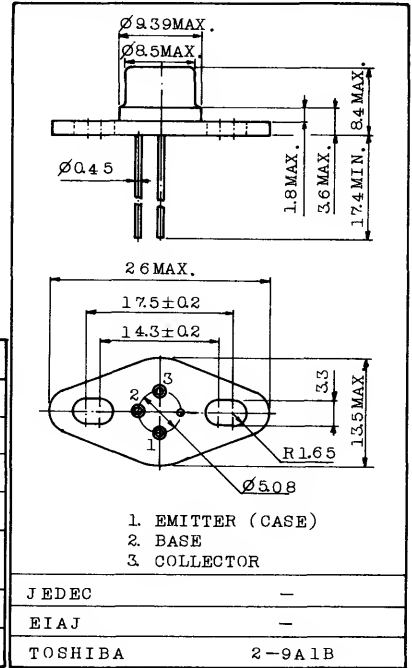


VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- . Output Power : $P_o=2.8W$ (Min.)
($f=175MHz$, $V_{CC}=13.5V$, $P_i=0.15W$)
- . 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=13.5V$, $P_o=4W$, $f=175MHz$

Unit in mm



Weight : 3.7g

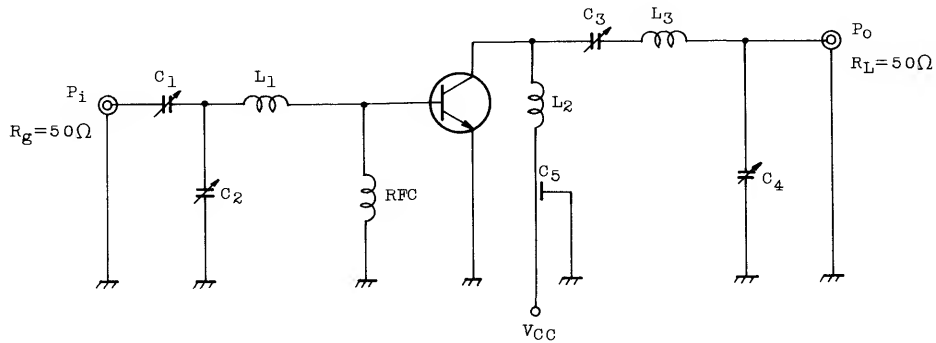
MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	0.8	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	7.5	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1mA$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=5mA$, $I_B=0$	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=0.5A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	-	15	pF
Output Power	P_o	(Fig.)	2.8	3.2	-	W
Power Gain	G_{pe}	$V_{CC}=13.5V$, $f=175MHz$	12.7	13.3	-	dB
Collector Efficiency	η_c	$P_i=0.15W$	60	72	-	%

Fig. P_o TEST CIRCUIT



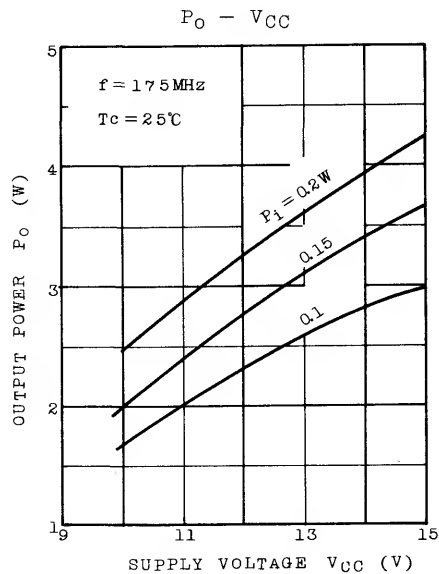
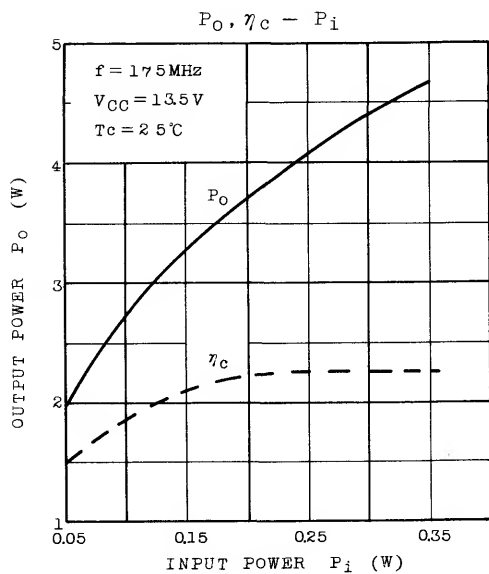
C₁, C₂, C₃, C₄ : ~30pF

C₅ : 1000pF FEED THROUGH

L₁, L₂ : φ1.2 SILVER PLATED COPPER WIRE, 8ID, 1T

L₃ : φ1.2 SILVER PLATED COPPER WIRE, 8ID, 1 $\frac{3}{4}$ T

RFC : 1μH CHOKE COIL



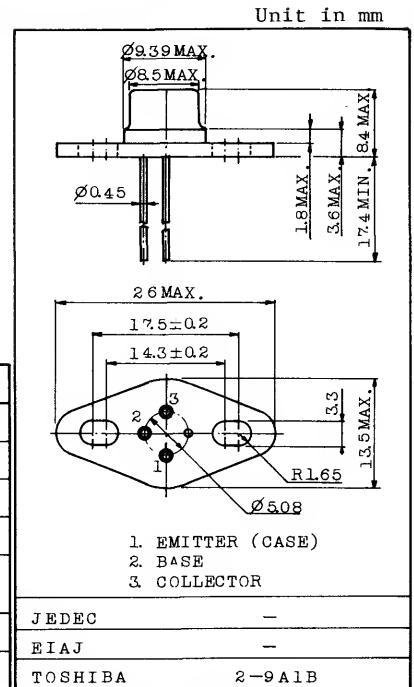
VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- . Output Power : $P_o=5W$ (Min.)
($f=175MHz$, $V_{CC}=13.5V$, $P_i=0.6W$)
- . 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=15V$, $P_i=0.6W$, $f=175MHz$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	1.4	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	10	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$



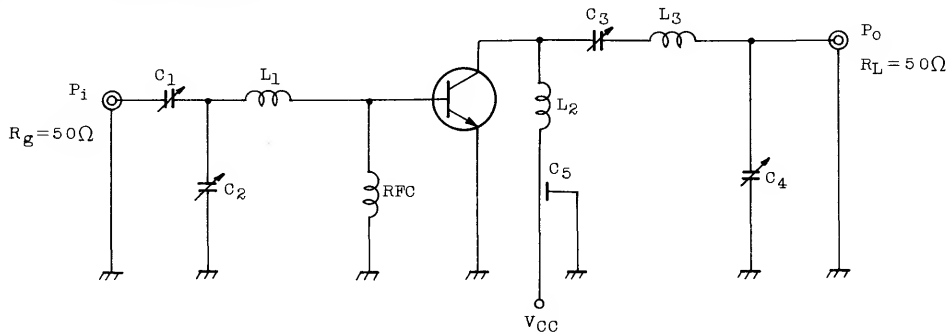
Weight : 3.7g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=2mA$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA$, $I_B=0$	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=0.2mA$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=1A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	13	25	pF
Output Power	P_o	(Fig.)	5.0	6.0	-	W
Power Gain	G_{pe}	$V_{CC}=13.5V$, $f=175MHz$,	9.2	10	-	dB
Collector Efficiency	η_c	$P_i=0.6W$	60	76	-	%

2SC2118

Fig. P_o TEST CIRCUIT



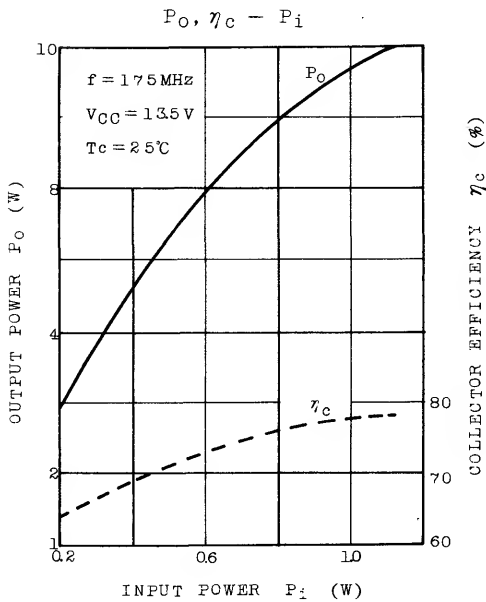
C_1, C_2, C_3, C_4 : $\sim 30\text{pF}$

C_5 : 1000pF FEED THROUGH

L_1, L_2 : $\phi 1.2$ SILVER PLATED COPPER WIRE, 8ID, 1T

L_3 : $\phi 1.2$ SILVER PLATED COPPER WIRE, 8ID, 7/4T

RFC : $1\mu\text{H}$ CHOKE COIL



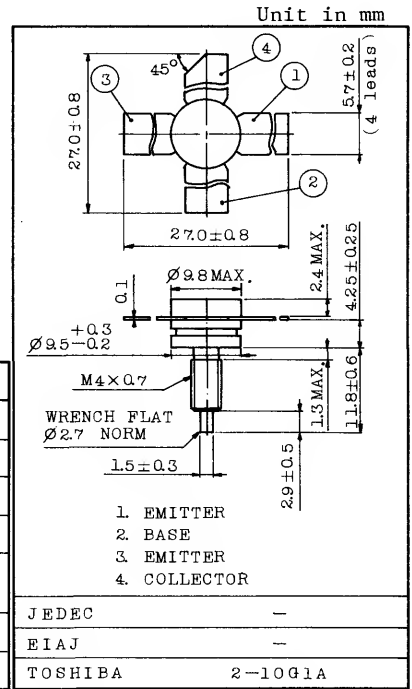
UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Output Power : $P_o=25W(\text{Min.})$
($f=470\text{MHz}$, $V_{CC}=12.6V$, $P_i=10W$)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=12.6V$, $P_i=10W$, $f=470\text{MHz}$

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	6	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	50	W
Junction Temperature	T_j	175	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ\text{C}$



Mounting Kit No. AC57

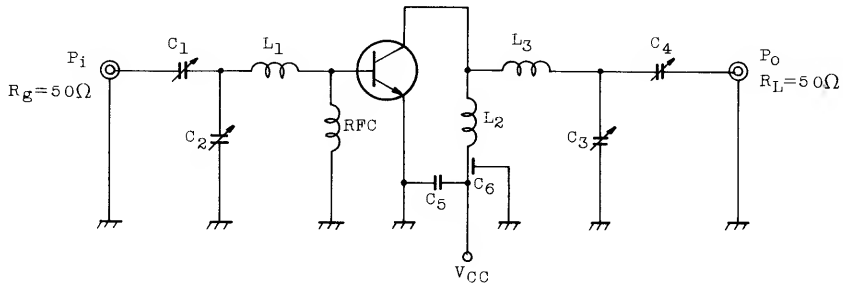
Weight : 3.3g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=10\text{mA}$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=25\text{mA}$, $I_B=0$	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1\text{mA}$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=3A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1\text{MHz}$	-	-	80	pF
Output Power	P_o	(Fig.)	25	28	-	W
Power Gain	G_{pe}	$V_{CC}=12.6V$, $f=470\text{MHz}$,	3.9	4.5	-	dB
Collector Efficiency	η_c	$P_i=10W$	60	-	-	%
Series Equivalent Input Impedance	Z_{IN}	$V_{CC}=12.6V$, $f=470\text{MHz}$,	-	1.1+ j2.6	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=25W$	-	3.7+ j0.8	-	Ω

2SC2173

Fig. f=470MHz P_O TEST CIRCUIT



C₁, C₃ : 1.5 ~ 5pF

C₂, C₄ : 2.2~15pF

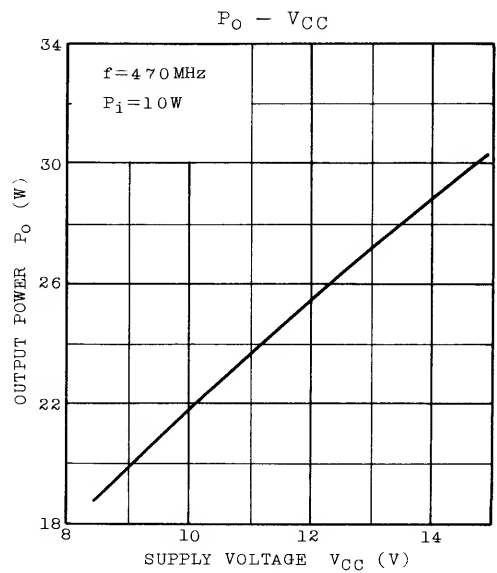
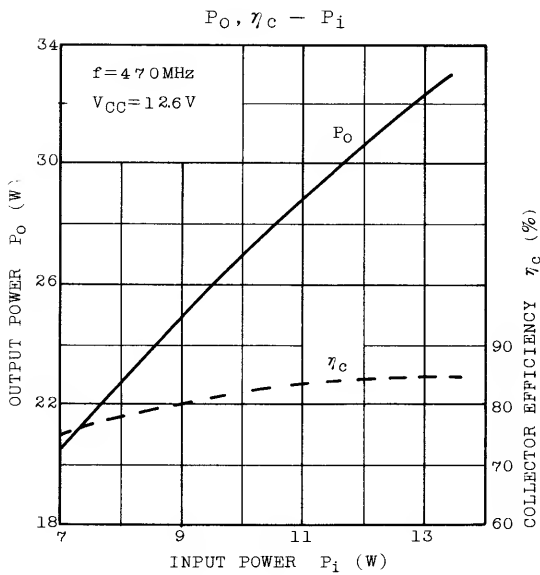
C₅ : 0.01μF

C₆ : 1000pF FEED THROUGH

L₁, L₃ : 5mm×15mm COPPER PLATE

L₂ : φ1 SILVER PLATED COPPER WIRE, 10ID, ½T

RFC : φ1 ENAMEL COATED COPPER WIRE, 3ID, 5T



Unit in mm

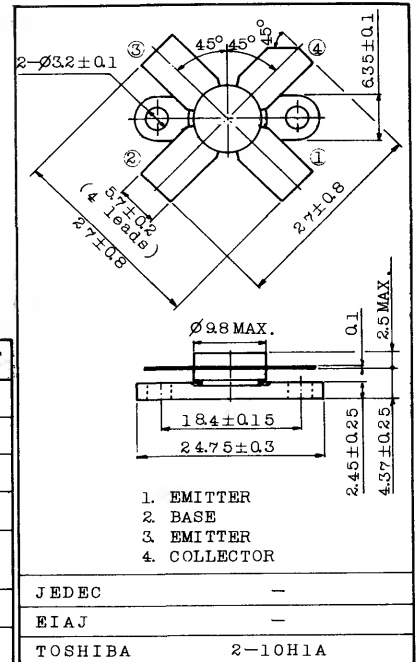
VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- . Output Power : $P_o=15W$ (Min.)
($f=175MHz$, $V_{CC}=12.5V$, $P_i=1.3W$)
- . 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=15V$, $P_i=1.3W$, $f=175MHz$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	3.5	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	35	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$



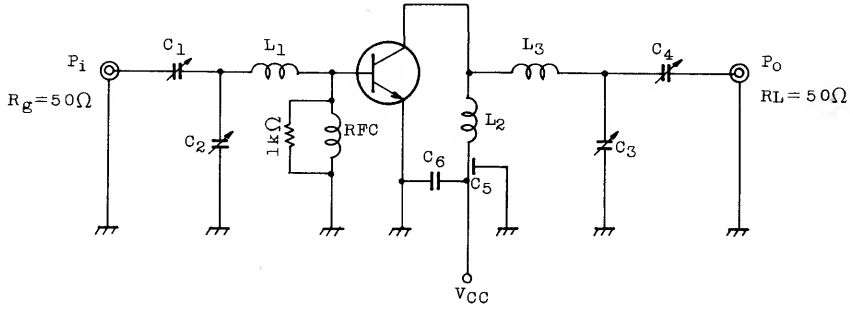
Weight : 4.0g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

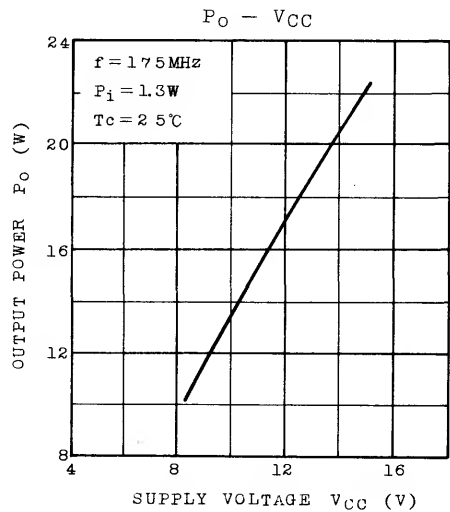
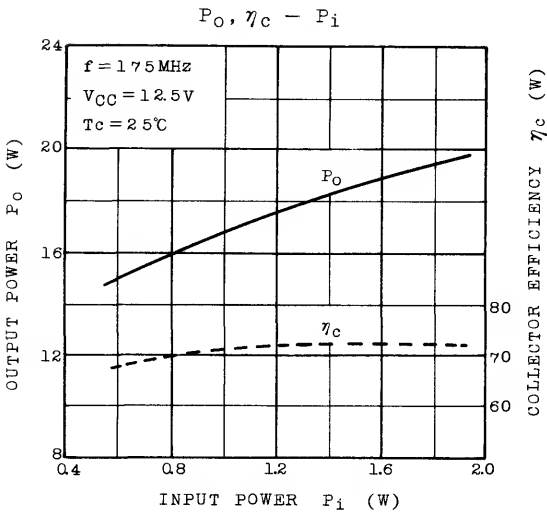
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1.0	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=10mA$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=25mA$, $I_B=0$	18	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=1A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	-	80	pF
Output Power	P_o	(Fig.)	15	18	-	W
Power Gain	G_{pe}	$V_{CC}=12.5V$, $f=175MHz$, $P_i=1.3W$	10.6	11.4	-	dB
Collector Efficiency	η_c		60	72	-	%
Series Equivalent Input Impedance	Z_{in}	$V_{CC}=12.5V$, $f=175MHz$, $P_o=15W$	-	1.25 +j0.6	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	4.9 -j3.0	-	Ω

2SC2178

Fig. P_O TEST CIRCUIT



- C₁ : ~20pF
- C₂, C₃, C₄ : ~30pF
- C₅ : 1000pF FEED THROUGH
- C₆ : 0.01μF CERAMIC CONDENSER
- L₁, L₃ : φ1 SILVER PLATED COPPER WIRE, 6ID, 1T
- L₂ : φ1 SILVER PLATED COPPER WIRE, 6ID, 2T
- RFC : φ1 ENAMEL COATED COPPER WIRE, 6ID, 3T



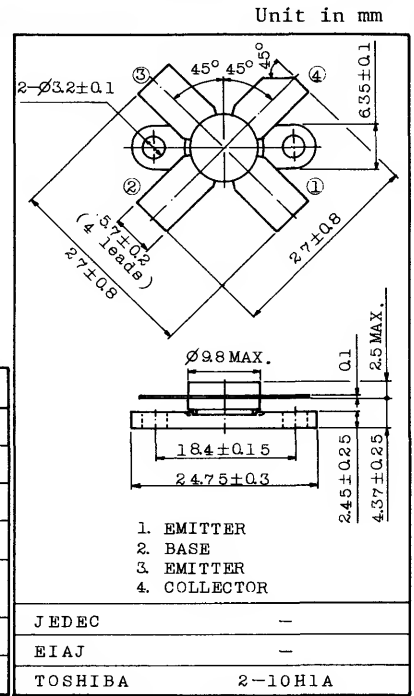
VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- . Output Power : $P_o=40W$ (Min.)
($f=175MHz$, $V_{CC}=13.5V$, $P_i=10W$)
- . 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=13.5V$, $P_i=10W$, $f=175MHz$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	10	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	70	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$



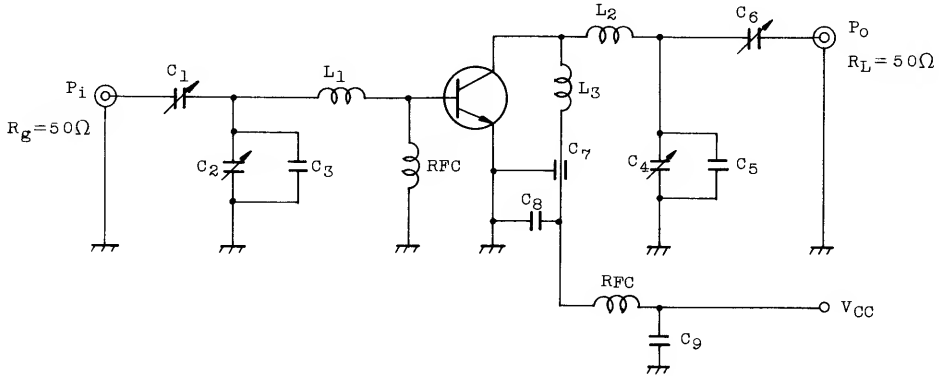
Weight : 4.0g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	2	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=20mA$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=50mA$, $I_B=0$	18	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=5A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	-	160	pF
Output Power	P_o	(Fig.)	40	44	-	W
Power Gain	G_{pe}	$V_{CC}=13.5V$, $f=175MHz$,	6.0	6.4	-	dB
Collector Efficiency	ζ_c	$P_i=10W$	60	73	-	%
Series Equivalent Input Impedance	Z_{in}	$V_{CC}=13.5V$, $f=175MHz$,	-	0.95 -j0.1	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=40W$	-	2.6 -j0.15	-	Ω

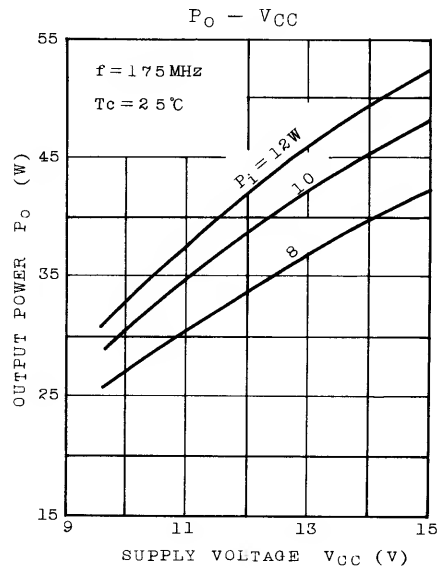
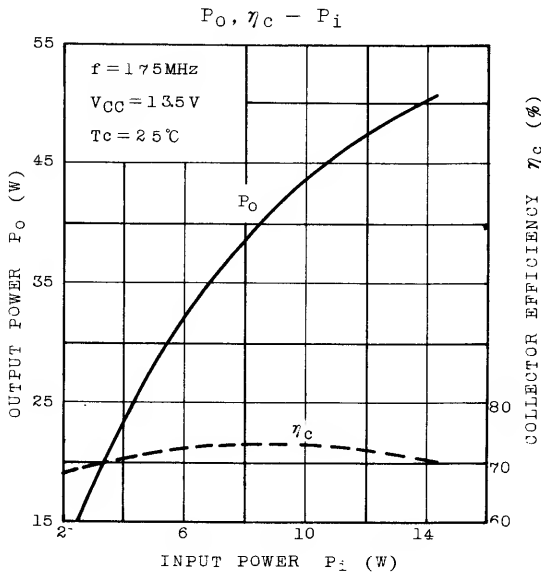
2SC2181

Fig. P_o TEST CIRCUIT



- C_1, C_2, C_4, C_6 : 3.5 ~ 30pF
 C_3, C_5 : 30pF CERAMIC CONDENSER
 C_7 : 1000pF FEED THROUGH
 C_8, C_9 : 0.01 μ F CERAMIC CONDENSER

- L_1 : ϕ 1.2 SILVER PLATED COPPER WIRE, 10ID, 1/2T
 L_2 : ϕ 1.2 SILVER PLATED COPPER WIRE, 10ID, 1T
 L_3 : ϕ 1.2 SILVER PLATED COPPER WIRE, 10ID, 2T
 RFC : ϕ 1.0 ENAMEL COATED COPPER WIRE, 8ID, 10T



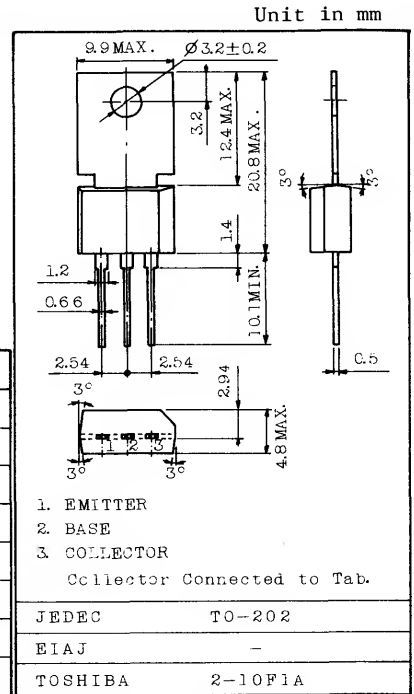
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Suitable for TV Sound Output, Vert. Deflection Output.
- . Designed for Complementary Use with 2SA962A.

MAXIMUM RATINGS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	60	V
Collector-Emitter Voltage	V_{CE0}	50	V
Emitter-Base Voltage	V_{EB0}	5	V
Collector Current	I_C	1.5	A
Emitter Current	I_E	-1.5	A
Collector Power Dissipation	P_C	1.5	W
Junction Temperature	T_j	150	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^{\circ}\text{C}$

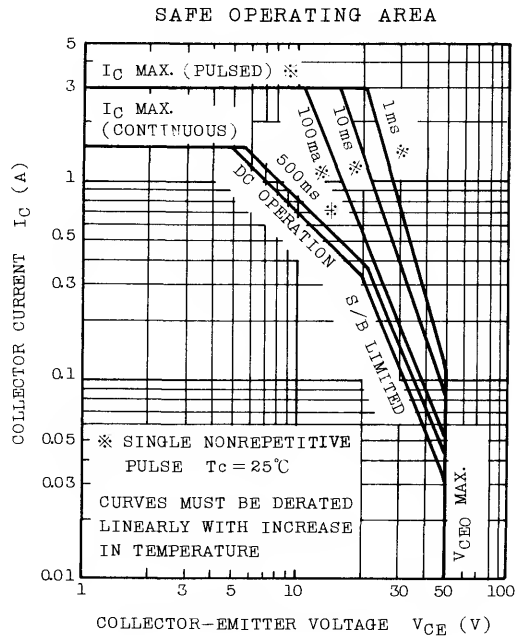
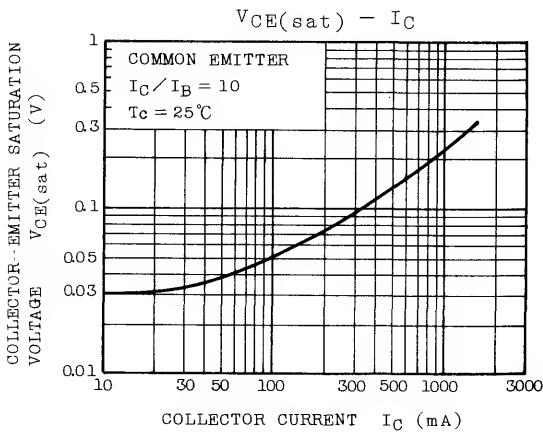
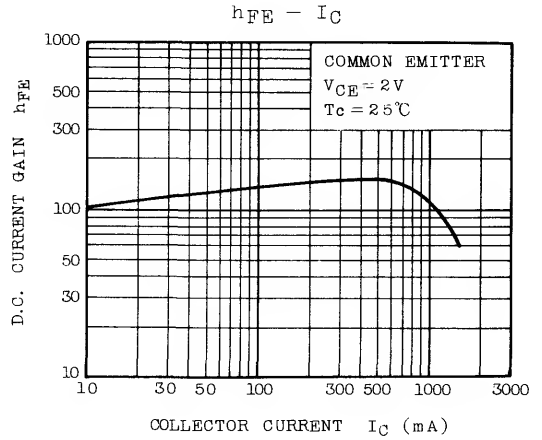
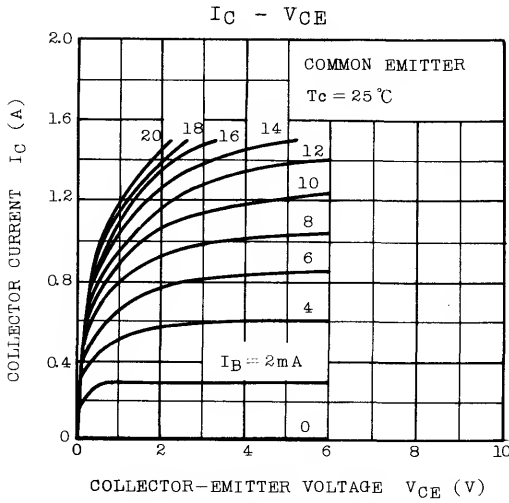


Weight : 1.37g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=50\text{V}, I_E=0$	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5\text{V}, I_C=0$	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10\text{mA}, I_B=0$	50	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=2\text{V}, I_C=150\text{mA}$	70	-	240	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=1\text{A}, I_B=0.1\text{A}$	-	-	1.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=10\text{V}, I_C=10\text{mA}$	0.50	0.60	0.70	V
Transition Frequency	f_T	$V_{CE}=10\text{V}, I_C=100\text{mA}$	50	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10\text{V}, I_E=0, f=1\text{MHz}$	-	20	-	pF

2SC2194A



INDUSTRIAL APPLICATIONS

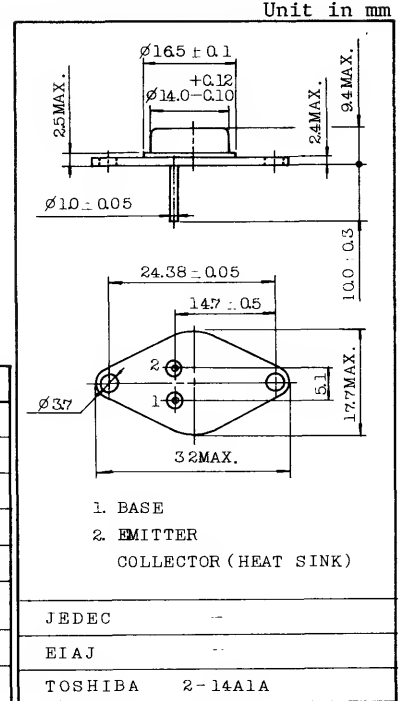
SWITCHING REGULATOR AND HIGH VOLTAGE
SWITCHING APPLICATIONS.
HIGH SPEED DC-DC CONVERTER APPLICATIONS.

FEATURES:

- Excellent Switching Time ($I_C=3A$)
: $t_r=1.0\mu s$ Max. $t_f=1.0\mu s$ Max.
- High Collector Breakdown Voltage : $V_{CEO}=400V$

MAXIMUM RATINGS (Ta=25°C)

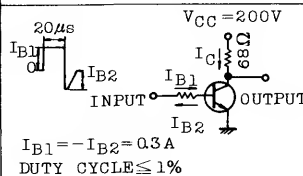
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	500	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	7	A
Base Current	I_B	3	A
Collector Power Dissipation (Tc=25°C)	P_C	40	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65~150	°C



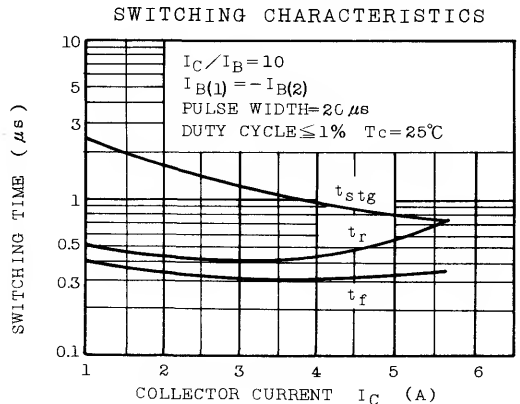
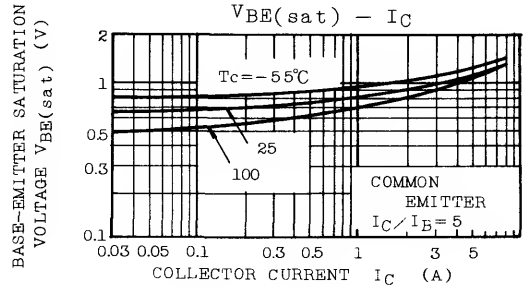
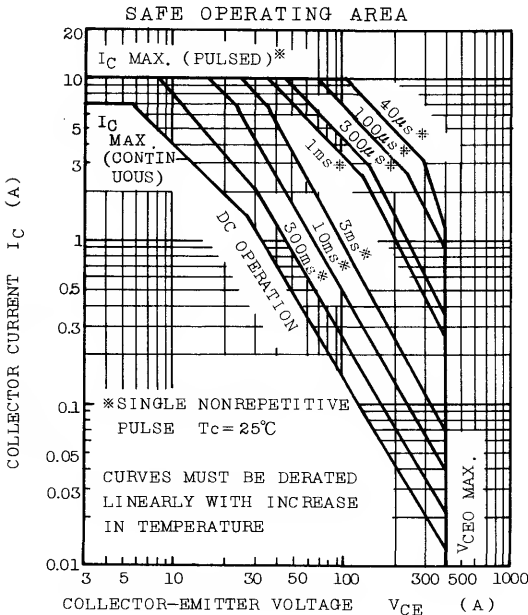
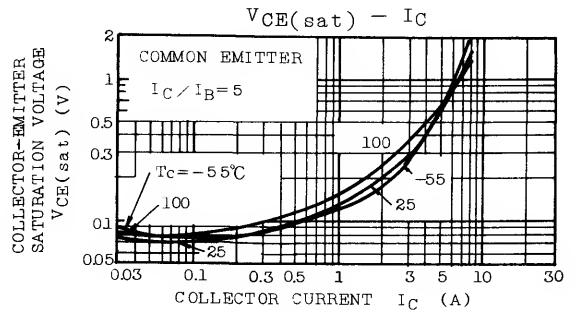
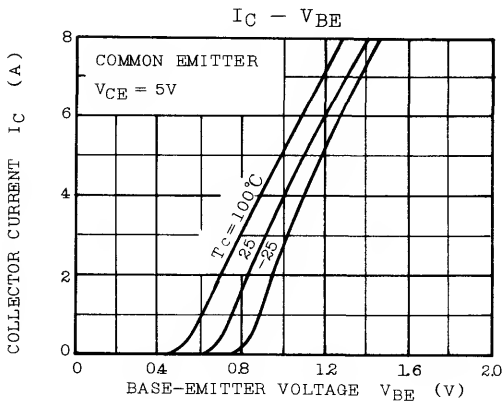
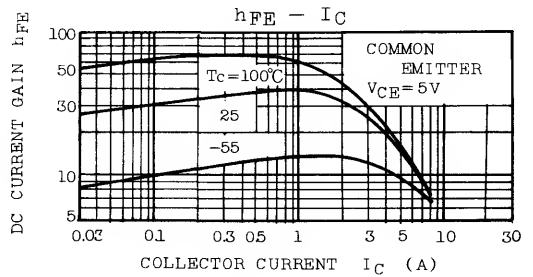
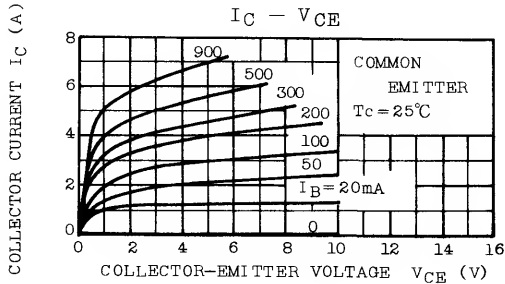
Mounting Kit No. AC74
Weight : 7.6g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=400V, I_E=0$	-	-	100	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	500	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	400	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA, I_C=0$	7	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=3A$	10	-	-	-
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=3A, I_B=0.3A$	-	-	1.5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=3A, I_B=0.3A$	-	-	2.0	V
Switching Time	Rise Time	t_r	-	-	1.0	μs
	Storage Time	t_{stg}	-	-	2.0	
	Fall Time	t_f	-	-	1.0	



2SC2200



2SC2204 2SC2220

HIGH POWER SWITCHING APPLICATIONS.
HIGH FREQUENCY INVERTOR APPLICATIONS.

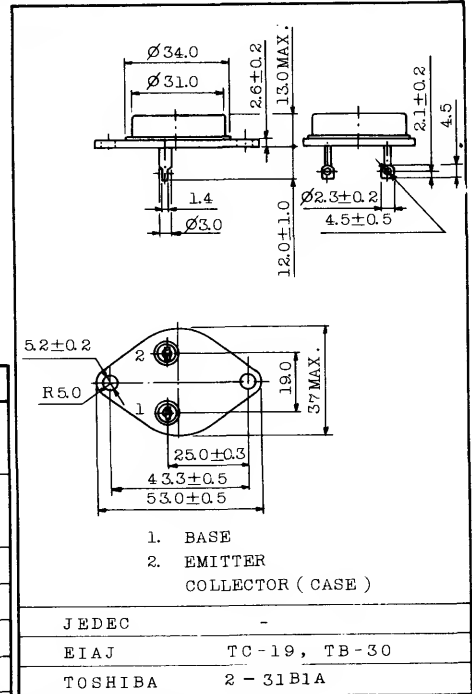
FEATURES :

- High Voltage : $V_{CE0}=400V(\text{Min.})(2SC2204)$
 $V_{CE0}=300V(\text{Min.})(2SC2220)$
 $V_{CBO}=800V(\text{Min.})(2SC2204)$
 $V_{CBO}=500V(\text{Min.})(2SC2220)$
- High Speed Switching : $t_f=0.7\mu s(\text{Typ.})$

MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC2204	V_{CBO}	800	V
	2SC2220		500	
Collector-Emitter Voltage	2SC2204	V_{CEO}	400	V
	2SC2220		300	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	30	A
Emitter Current		I_E	-30	A
Base Current		I_B	15	A
Collector Power Dissipation		P_C	250	W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-65~150	°C

Unit in mm



Mounting kit No.AC63
Weight : 46g

ELECTRICAL CHARACTERISTICS (Ta = 25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	2SC2204	I_{CBO}	$V_{CB}=800V, I_E=0$	-	-	1.0	mA
	2SC2220		$V_{CB}=500V, I_E=0$	-	-	5	
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	5	mA
Collector-Emitter Breakdown Voltage	2SC2204	$V_{(BR)CEO}$	$I_C=20mA, I_B=0$	400	-	-	V
	2SC2220			300	-	-	
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=30A$	10	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=30A, I_B=6A$	-	-	1.5	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=30A, I_B=6A$	-	-	2.0	
Collector Output Capacitance		C_{ob}	$V_{CB}=50V, I_E=0, f=1MHz$	-	400	-	pF
Switching Time	Turn-on Time	t_{on}		-	1.2	1.5	µs
	Storage Time	t_{stg}		-	3.0	4.0	
	Fall Time	t_f		-	0.7	1.0	

2SC2231 2SC2231A

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

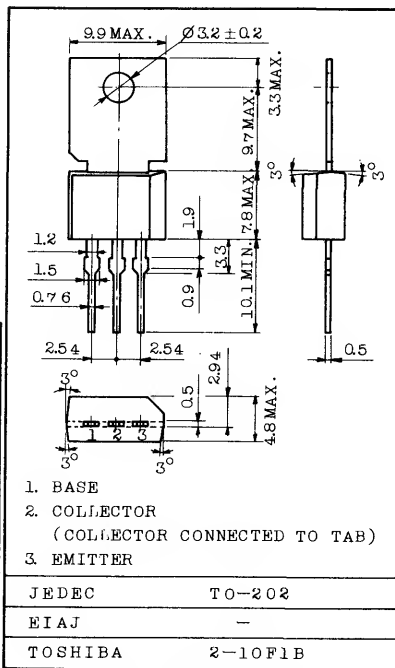
HIGH VOLTAGE GENERAL AMPLIFIER APPLICATIONS.

COLOR TV CLASS B SOUND OUTPUT APPLICATIONS.

FEATURES:

. High Voltage : $V_{CE0}=180V$ (2SC2231A)

Unit in mm



MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	200	V
Collector-Emitter Voltage	2SC2231	V_{CEO}	160	V
	2SC2231A		180	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	200	mA
Base Current		I_B	100	mA
Collector Power Dissipation	$T_a=25^{\circ}C$	P_C	1.5	W
	$T_c=25^{\circ}C$		12	
Junction Temperature		T_j	150	$^{\circ}C$
Storage Temperature Range		T_{stg}	-55~150	$^{\circ}C$

1. BASE
2. COLLECTOR
(COLLECTOR CONNECTED TO TAB)
3. EMITTER

JEDEC TO-202

EIAJ -

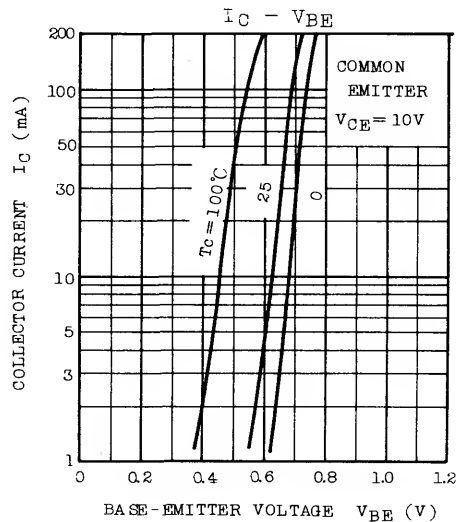
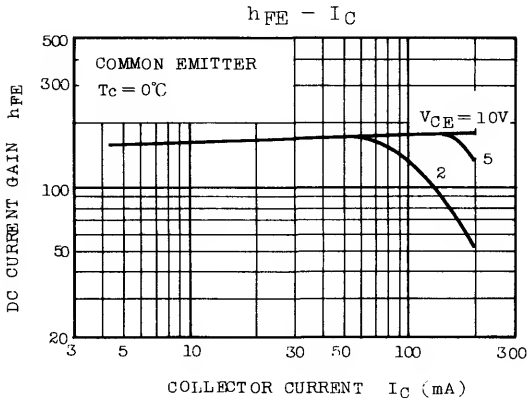
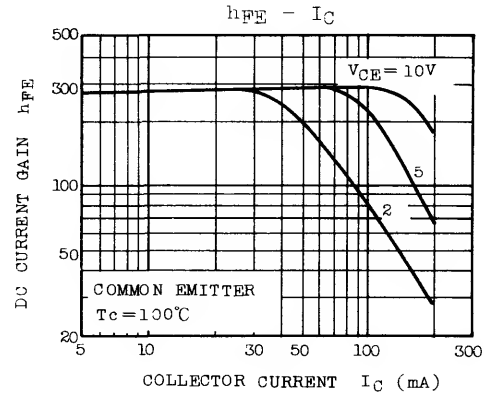
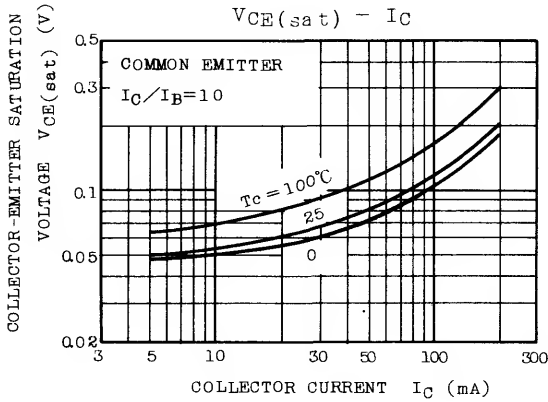
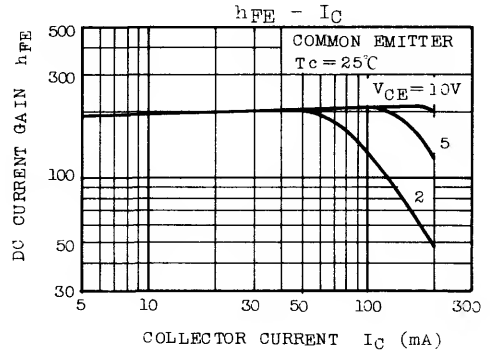
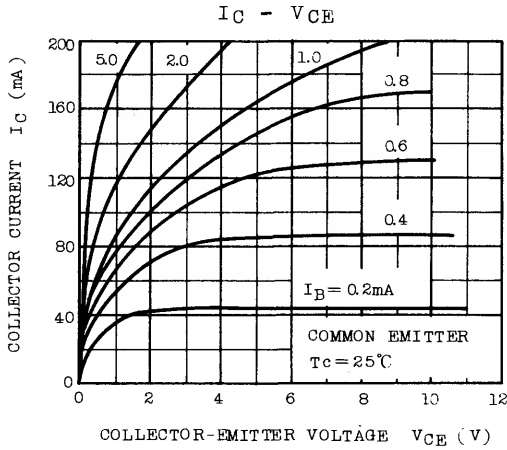
TOSHIBA 2-10F1B

Weight : 1.4g

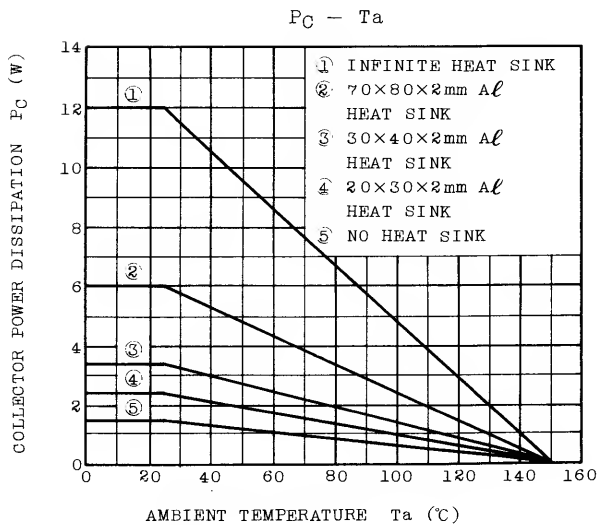
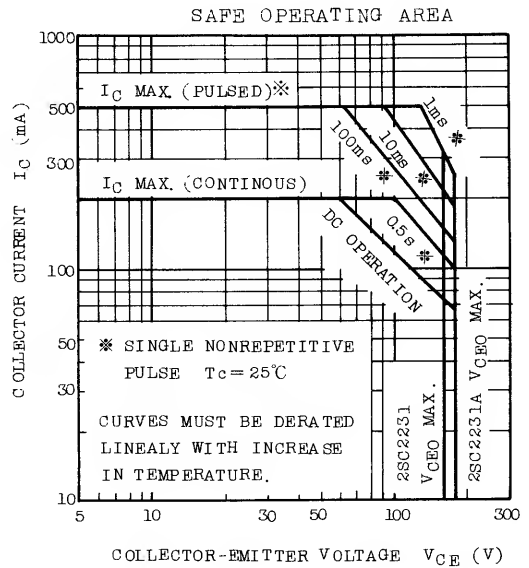
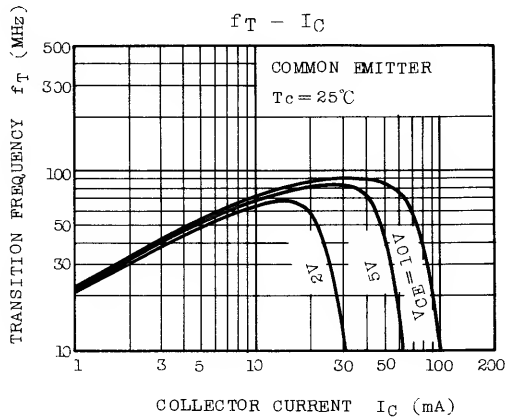
ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=200V, I_E=0$	-	-	0.1	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	0.1	μA
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=10V, I_C=50mA$	100	-	320	-
	$h_{FE(2)}$	$V_{CE}=10V, I_C=150mA$	80	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=200mA, I_B=20mA$	-	-	1.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=10V, I_C=5mA$	0.55	0.65	0.75	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=50mA$	50	-	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	-	10	pF

Note : $h_{FE(1)}$ Classification 0:100~200, Y:160~320



2SC2231 • 2SC2231A



Unit in mm

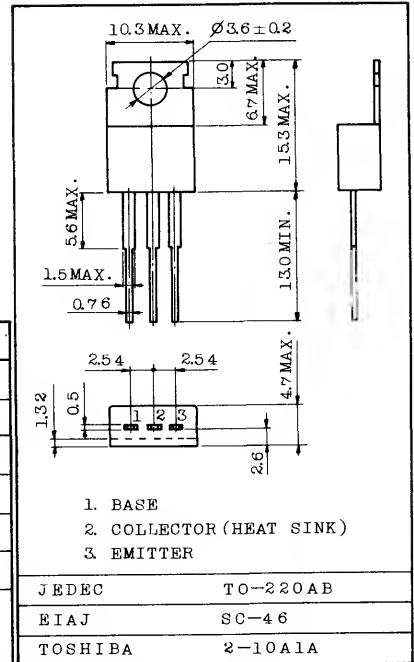
TV HORIZONTAL DEFLECTION OUTPUT APPLICATIONS.

FEATURES:

- . Large Collector Current Capability.
- . Large Collector Power Dissipation Capability.

MAXIMUM RATINGS (Ta=25°C)

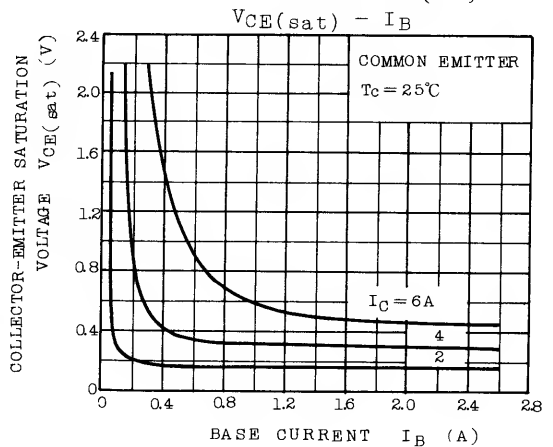
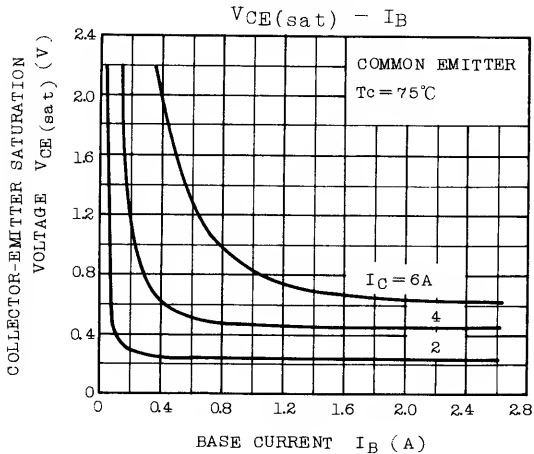
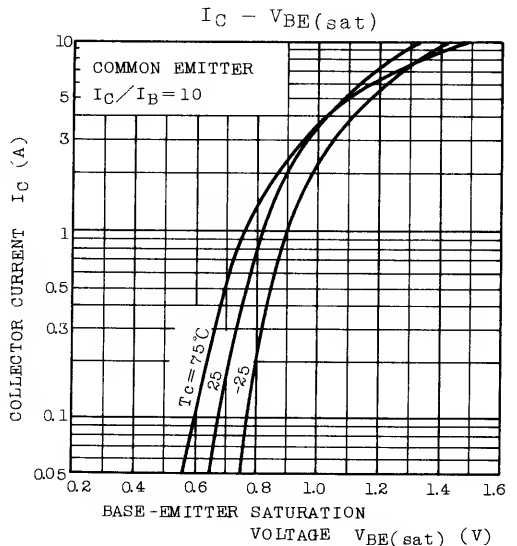
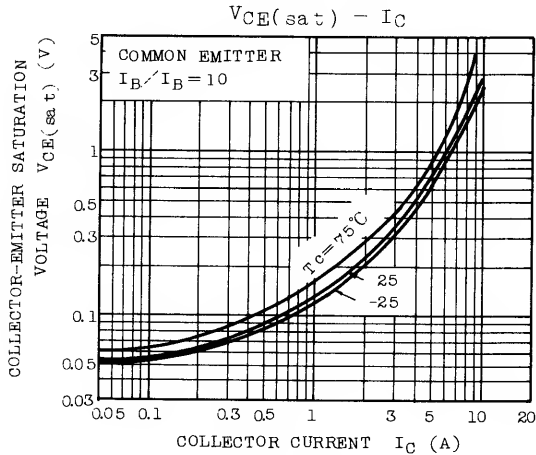
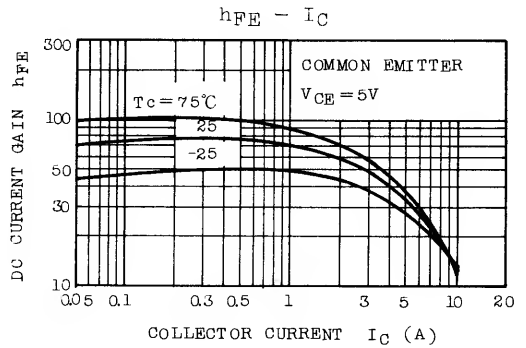
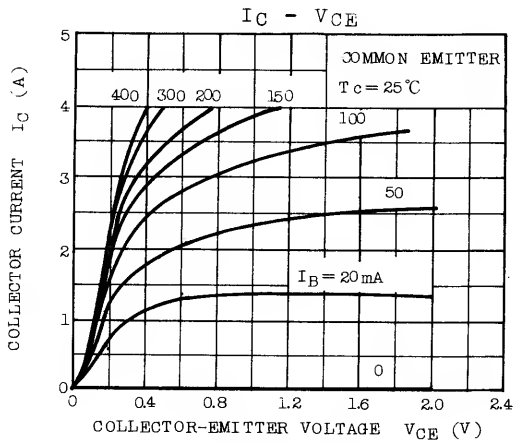
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V _{CB0}	200	V
Collector-Emitter Voltage		V _{CE0}	60	V
Emitter-Base Voltage		V _{EB0}	5	V
Collector Current		I _C	4	A
		I _{CP}	10	A
Base Current		I _B	1	A
Collector Power Dissipation	Ta=25°C	P _C	1.5	W
	Tc=25°C		40	
Junction Temperature		T _j	150	°C
Storage Temperature Range		T _{stg}	-55~150	°C

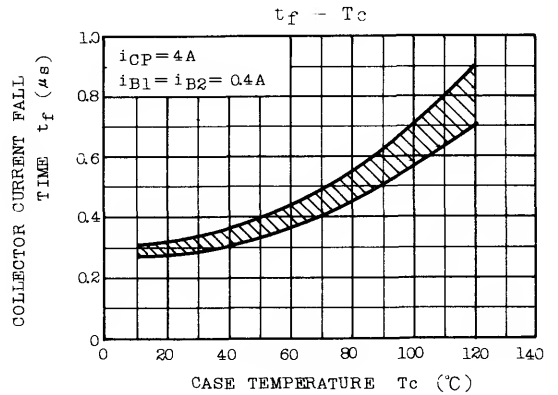
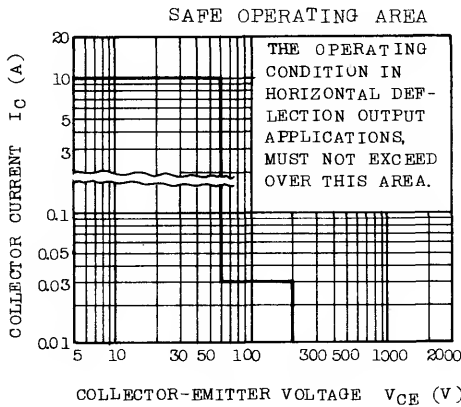
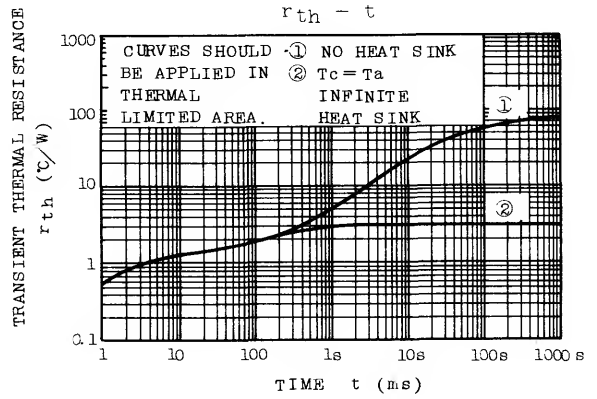
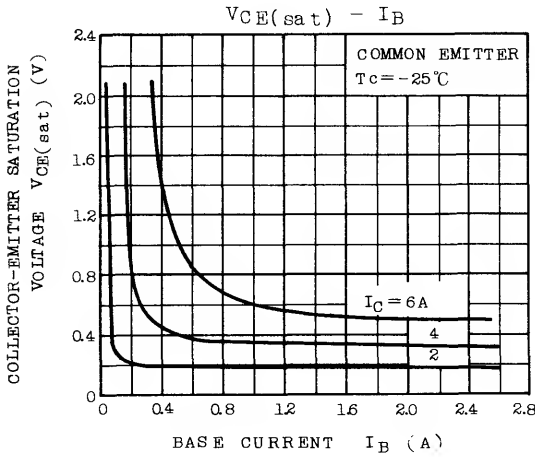


Weight: 1.9g
Mounting kit No. AC75

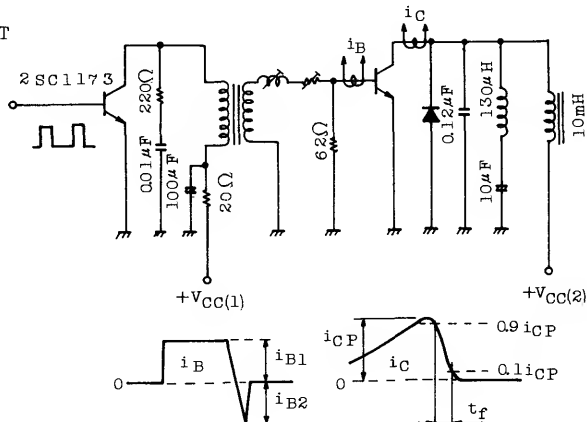
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =170V, I _E =0	-	-	10	μA
Emitter Cut-off Current	I _{EB0}	V _{EB} =5V, I _C =0	-	-	10	μA
DC Current Gain	h _{FE} (1)	V _{CE} =5V, I _C =1A	30	-	150	
	h _{FE} (2)	V _{CE} =5V, I _C =4A	20	40	-	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =4A, I _B =0.4A	-	-	1.0	V
Base-Emitter Saturation Voltage	V _{BE(sat)}	I _C =4A, I _B =0.4A	-	-	1.5	V
Transition Frequency	f _T	V _{CE} =5V, I _C =0.5A	-	8	-	MHz





TEST CIRCUIT



2SC2238 2SC2238A 2SC2238B

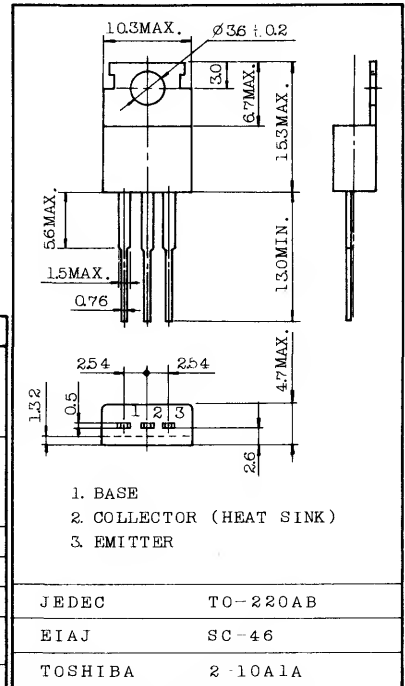
SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- High Transition Frequency : $f_T=100\text{MHz}$ (Typ.)
- Complementary to 2SA968, 2SA968A, and 2SA968B.

Unit in mm



MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT	
Collector-Base Voltage	V _{CB0}	2SC2238	160	V
		2SC2238A	180	
		2SC2238B	200	
Collector-Emitter Voltage	V _{CE0}	2SC2238	160	V
		2SC2238A	180	
		2SC2238B	200	
Emitter-Base Voltage	V _{EB0}	5	V	
Collector Current	I _C	1.5	A	
Emitter Current	I _E	-1.5	A	
Collector Power Dissipation (Tc=25°C)	P _C	25	W	
Junction Temperature	T _j	150	°C	
Storage Temperature Range	T _{stg}	-55~150	°C	

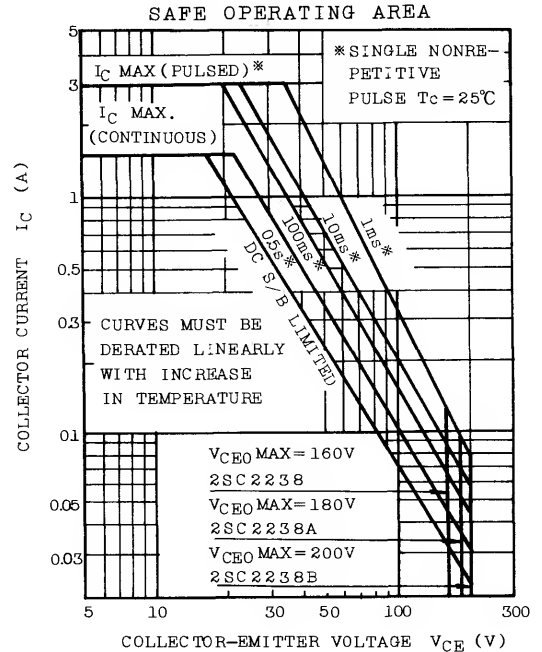
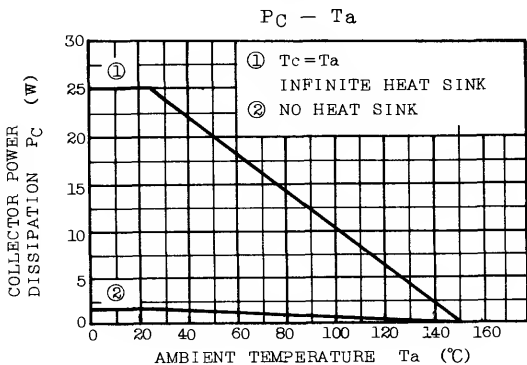
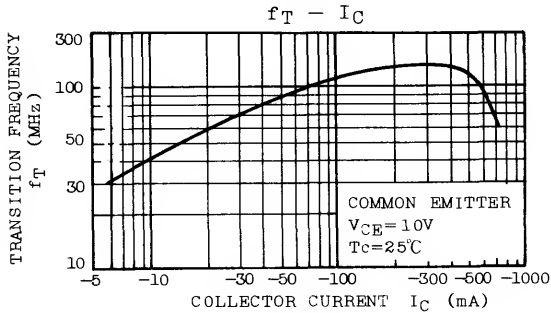
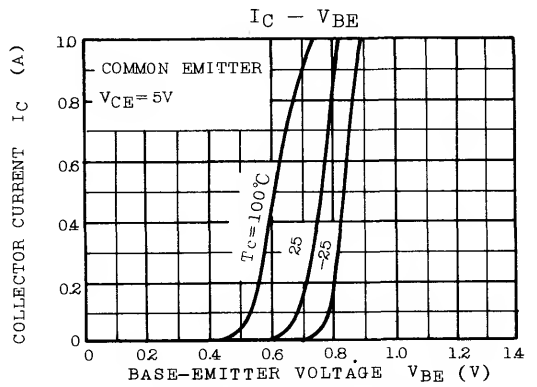
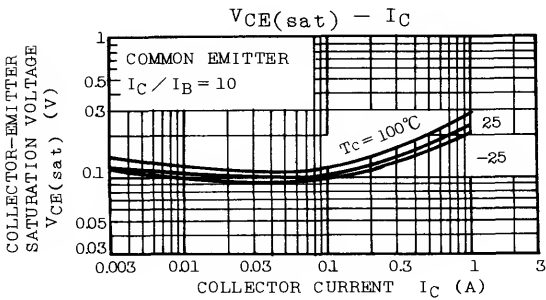
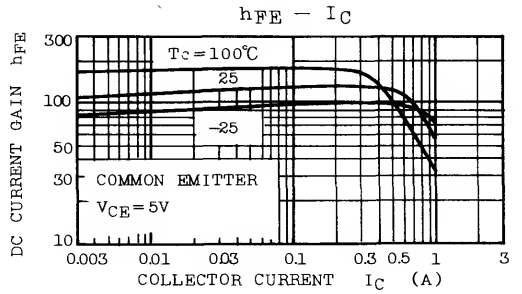
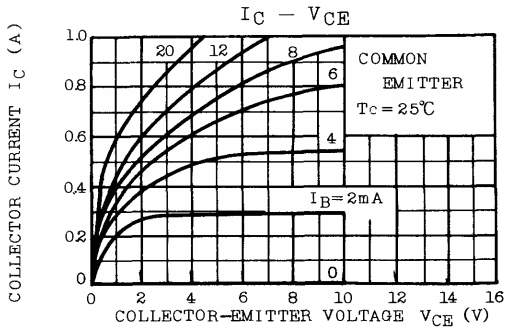
Mounting Kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Collector Cut-off Current	I _{CB0}	V _{CB} =160V, I _E =0	-	-	1.0	μA	
Emitter Cut-off Current	I _{EB0}	V _{EB} =5V, I _C =0	-	-	1.0	μA	
Collector-Emitter Breakdown Voltage	V _{(BR)CE0}	I _C =10mA, I _B =0	2SC2238	160	-	-	V
			2SC2238A	180	-	-	
			2SC2238B	200	-	-	
Emitter-Base Breakdown Voltage	V _{(BR)EBO}	I _E =1mA, I _C =0	5	-	-	V	
DC Current Gain	h _{FE} (Note)	V _{CE} =5V, I _C =100mA	70	-	240		
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =500mA, I _B =50mA	-	-	1.5	V	
Base-Emitter Voltage	V _{BE}	V _{CE} =5V, I _C =500mA	-	-	1.0	V	
Transition Frequency	f _T	V _{CE} =10V, I _C =100mA	-	100	-	MHz	
Collector Output Capacitance	C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	25	-	pF	

Note : h_{FE} Classification 0 : 70~140, Y : 120~240

2SC2238 · 2SC2238A · 2SC2238B



2SC2242

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.
 COLOR TV SOUND OUTPUT APPLICATIONS.

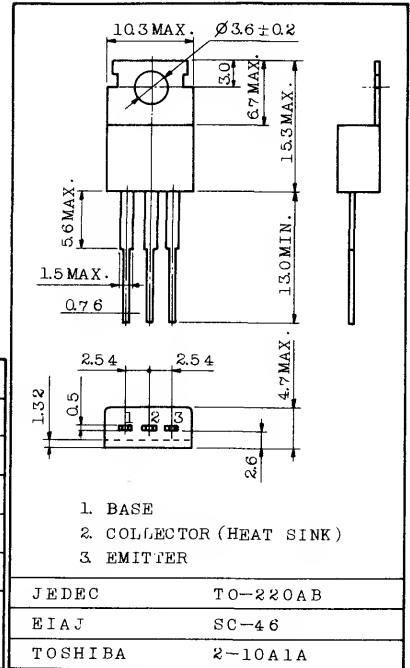
FEATURES:

- . Recommended for Sound Output Stage in Line Operated TV.
- . High Voltage : $V_{CE0}=300V$

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB0}	300	V
Collector-Emitter Voltage		V_{CE0}	300	V
Emitter-Base Voltage		V_{EB0}	5	V
Collector Current		I_C	150	mA
Base Current		I_B	50	mA
Collector Power Dissipation	$T_a=25^{\circ}C$	P_C	1.5	W
	$T_c=25^{\circ}C$	P_C	25	
Junction Temperature		T_j	150	$^{\circ}C$
Storage Temperature		T_{stg}	-55~150	$^{\circ}C$

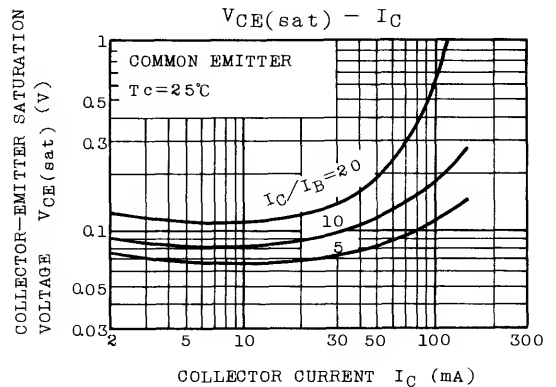
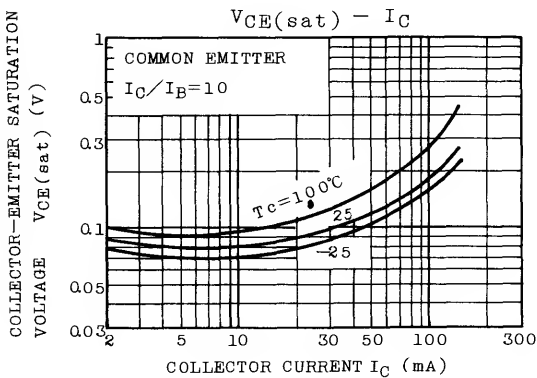
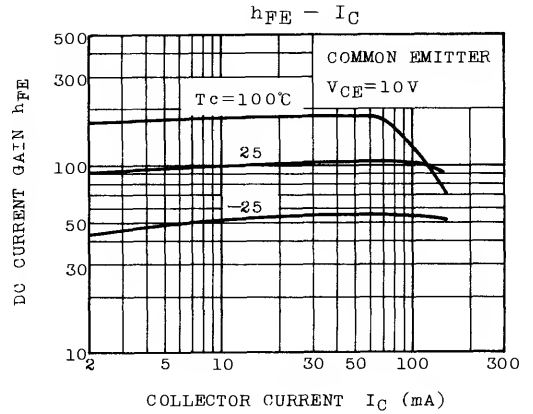
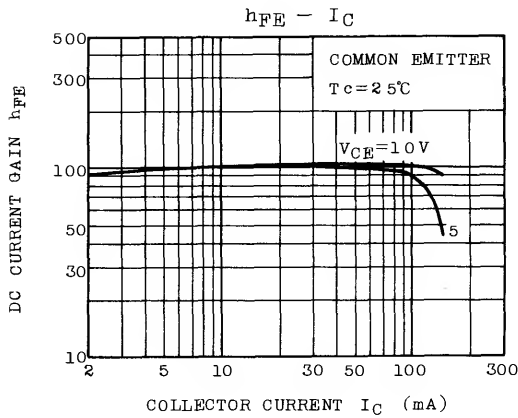
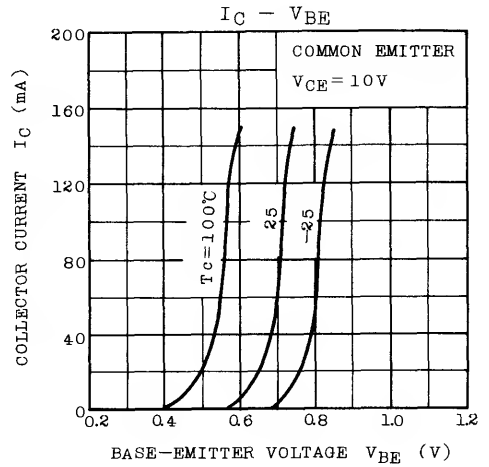
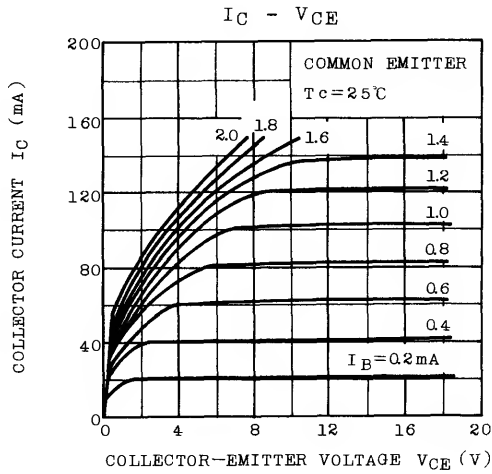
Unit in mm



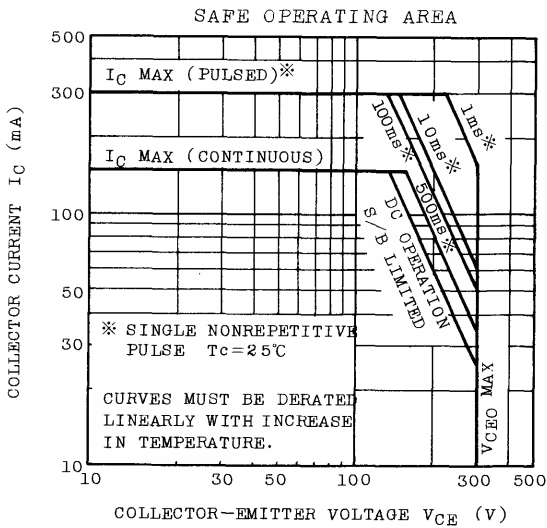
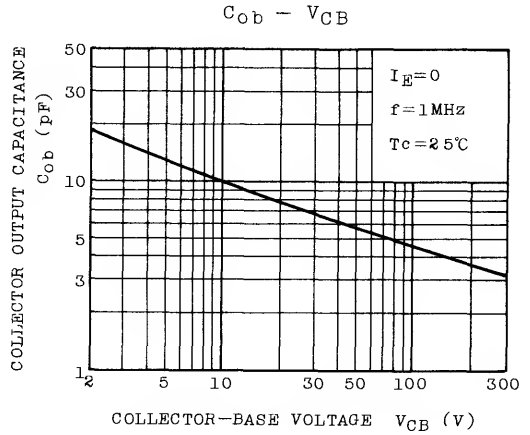
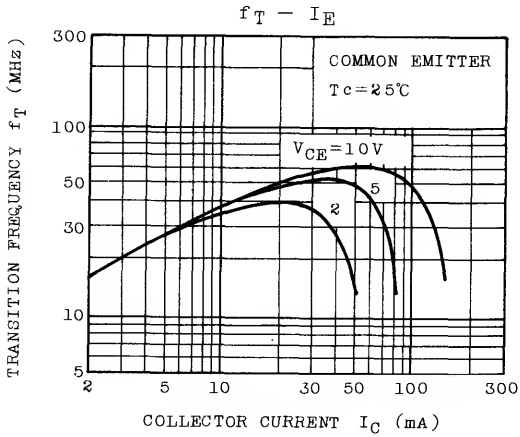
Weight : 1.9g
 Mounting kit No. AC75

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=240V, I_E=0$	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C=5mA, I_B=0$	300	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=10V, I_C=50mA$	40	-	170	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=100mA, I_B=10mA$	-	-	3.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=10V, I_C=50mA$	0.6	-	0.9	V
Transition Frequency	f_T	$V_{CE}=50V, I_C=20mA$	20	50	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=50V, I_E=0, f=1MHz$	-	5.5	12	pF



2SC2242



STROBO FLASH APPLICATIONS.
 MEDIMUM POWER AMPLIFIER APPLICATIONS.

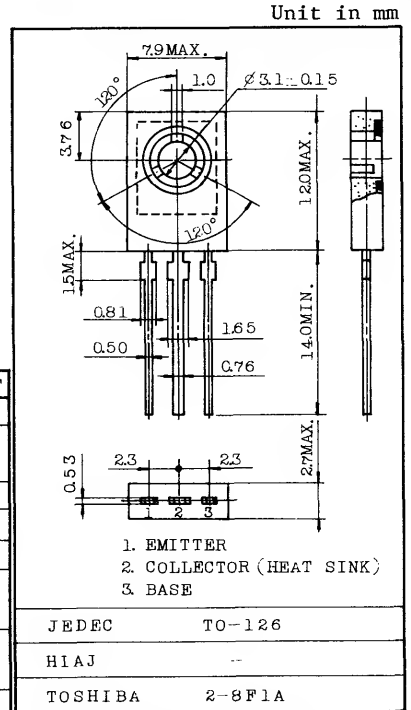
FEATURES:

- High DC Current Gain
 : $h_{FE}=140\sim 450$ ($V_{CE}=2V, I_C=0.5A$)
 $h_{FE}=70$ (Min.) ($V_{CE}=2V, I_C=4A$)
- Low Saturation Voltage
 : $V_{CE(sat)}=1.0V$ (Max.) ($I_C=4A, I_B=0.1A$)
- High Collector Power Dissipation
 : $P_C=10W$ ($T_c=25^\circ C$), $P_C=1.0W$ ($T_a=25^\circ C$)

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB0}	50	V
Collector-Emitter Voltage		V_{CES}	40	V
		V_{CE0}	20	V
Emitter-Base Voltage		V_{EB0}	8	V
Collector Current	DC	I_C	5	A
	Pulsed (Note 1)	I_{CP}	8	A
Emitter Current	DC	I_E	-5	A
	Pulsed (Note 1)	I_{EP}	-8	A
Collector Power Dissipation	$T_a=25^\circ C$	P_C	1.0	W
	$T_c=25^\circ C$		10	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55~150	$^\circ C$

Note 1 : Pulse Test :
 Pulse Width = 10ms (Max.)
 Duty Cycle = 30 % (Max.)

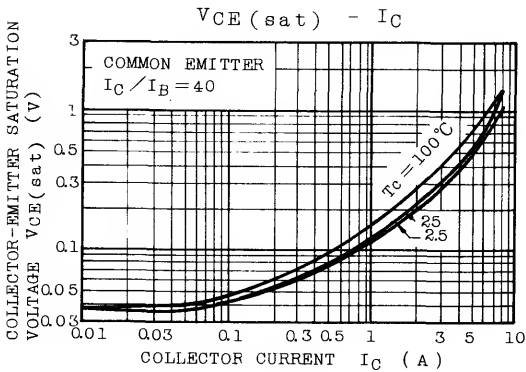
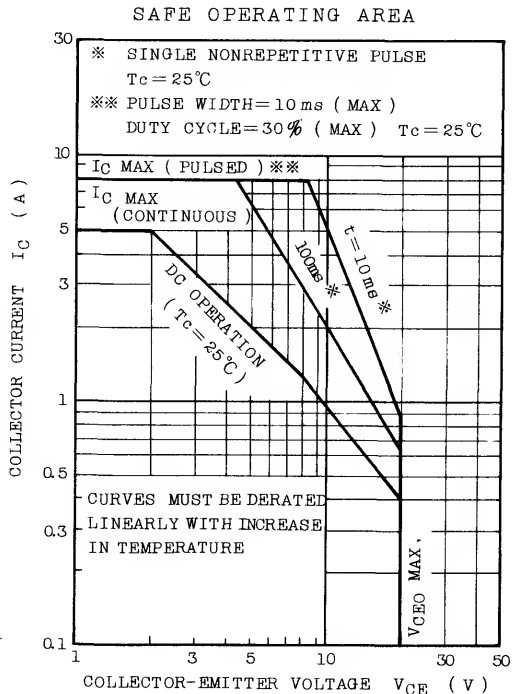
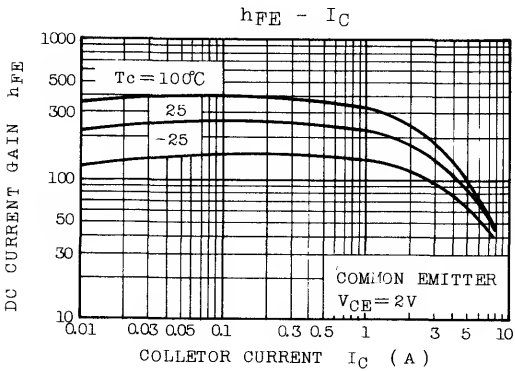
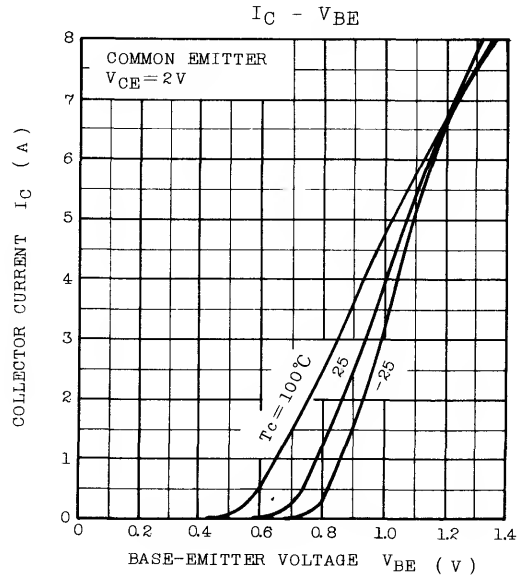
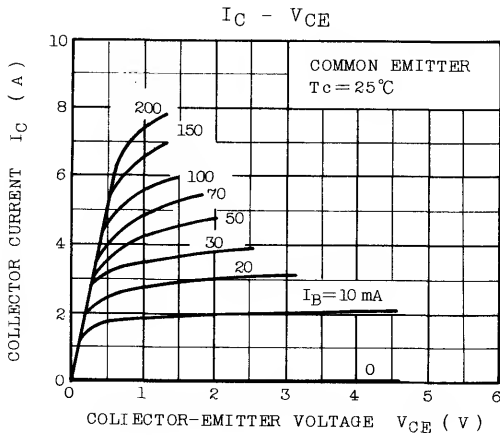


Mounting Kit No. AC46C
 Weight : 0.72g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=40V, I_E=0$	-	-	100	nA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=8V, I_C=0$	-	-	100	nA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	20	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA, I_C=0$	8	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note 2)	$V_{CE}=2V, I_C=0.5A$	140	-	450	
	$h_{FE(2)}$	$V_{CE}=2V, I_C=4A$	70	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A, I_B=0.1A$	-	-	1.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=2V, I_C=4A$	-	-	1.5	V
Transition Frequency	f_T	$V_{CE}=2V, I_C=0.5A$	-	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	40	-	pF

Note 2 : $h_{FE(1)}$ Classification A : 140~240, B : 200~330, C : 300~450



2 ~ 30MHz SSB LINEAR POWER AMPLIFIER APPLICATIONS.
(LOW SUPPLY VOLTAGE USE)

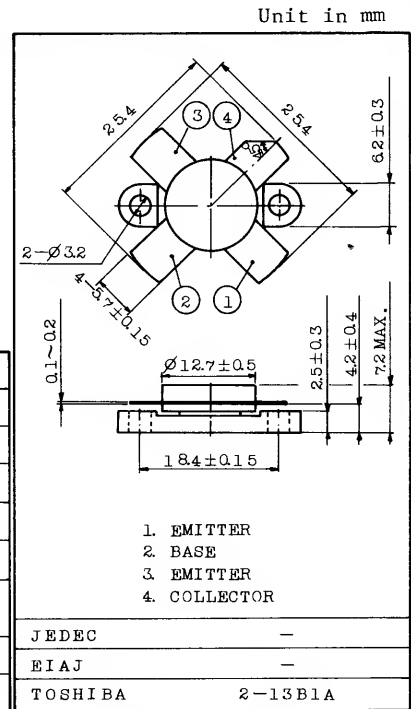
FEATURES :

• Specified 12.5V, 28MHz Characteristics

- : Output Power : $P_o=60W_{PEP}$
- : Minimum Gain : $G_{pe}=11.8dB$
- : Efficiency : $\eta_c=35\%$ (Min.)
- : Intermodulation Distortion : $IMD=-30dB$ (Max.)

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	45	V
Collector-Emitter Voltage	V_{CES}	45	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	20	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	175	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$



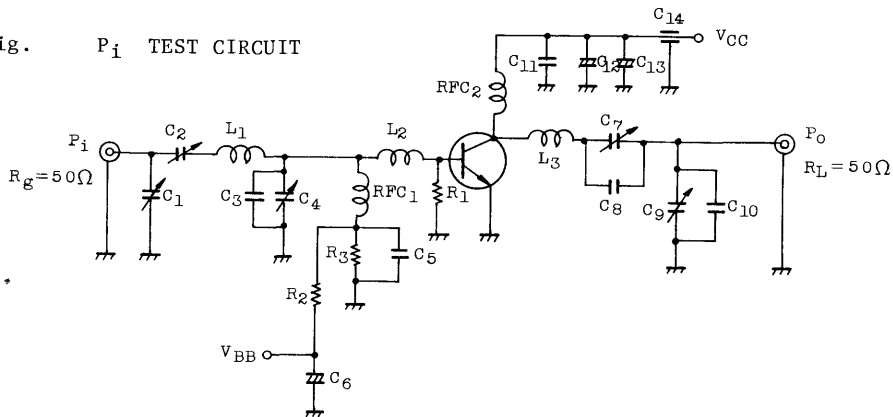
Weight : 5.2g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

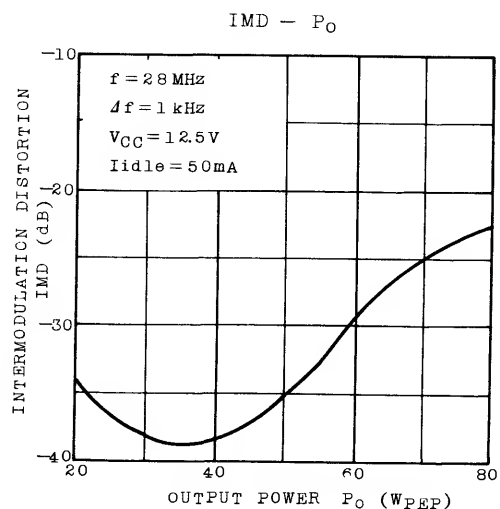
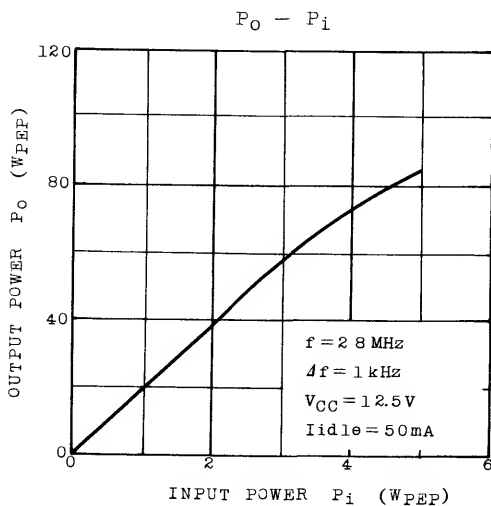
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=100mA, I_B=0$	18	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CES}$	$I_C=100mA, V_{EB}=0$	45	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA, I_C=0$	4	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=10A$	10	-	150	
Collector Output Capacitance	C_{ob}	$V_{CB}=12.5V, I_E=0, f=1MHz$	-	-	500	pF
Power Gain	G_{pe}	$V_{CC}=12.5V, f=28MHz$	11.8	13.8	-	dB
Input Power	P_i	2-Tone, $f=1kHz$	-	2.5	4	W_{PEP}
Collector Efficiency	η_c	$I_{idle}=50mA, P_o=60W_{PEP}$	35	-	-	%
Intermodulation Distortion	IMD	(Fig.)	-	-	-30	dB
Series Equivalent Input Impedance	Z_{in}	$V_{CC}=12.5V, f=28MHz$	-	1.02 -j0.17	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$f=1kHz, P_o=60W_{PEP}$	-	0.86 -j0.21	-	Ω

2SC2290

Fig. P_i TEST CIRCUIT



- | | |
|------------------------------------|---|
| C_1, C_2, C_4, C_7 : 7 ~ 150pF | L_1 : $\phi 0.8$ ENAMEL COATED COPPER WIRE, 9ID, 6T |
| C_9 : 10 ~ 200pF | L_2 : $\phi 1$ SILVER PLATED COPPER WIRE, 9ID, 2T |
| C_3 : 250pF | L_3 : $\phi 1.5$ ENAMEL COATED COPPER WIRE, 9ID, 5T |
| C_5 : 0.4 μ F | RFC_1 : $\phi 0.8$ ENAMEL COATED COPPER WIRE, 9ID, 20T |
| C_6 : 100 μ F 10W | RFC_2 : $\phi 1.5$ ENAMEL COATED COPPER WIRE, 12ID, 15T |
| C_8 : 150pF | R_1 : 5.6 Ω (1/2W) |
| C_{10} : 600pF | R_2 : 5 Ω (5W) |
| C_{11}, C_{12} : 22 μ F 35WV | R_3 : 1.5 Ω (10W) |
| C_{13} : 0.4 μ F | |
| C_{14} : 1000pF | |
- (FEED THROUGH)



Unit in mm

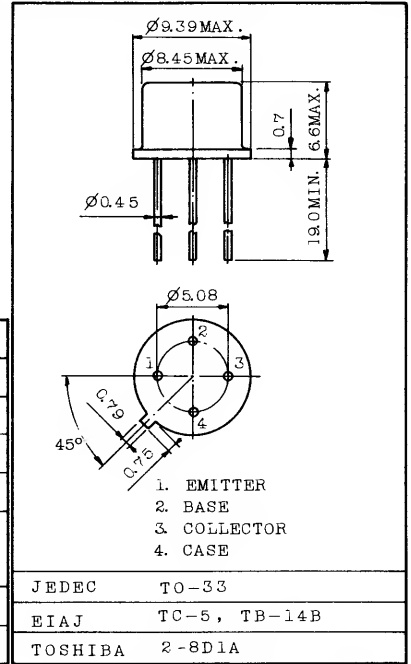
HIGH POWER AMPLIFIER FOR CATV APPLICATIONS.

FEATURES:

- . Wide Band and High Gain for Class A Amplifier.
- . Excellent Cross Modulation Characteristics.
- . All Electrodes Insulated from Case.

MAXIMUM RATINGS (Ta=25 °C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CBO}	40	V
Collector-Emitter Voltage	V _{CEO}	15	V
Emitter-Base Voltage	V _{EBO}	3.5	V
Collector Current	I _C	350	mA
Collector Power Dissipation (Tc=25 °C)	P _C	3.5	W
Junction Temperature	T _j	175	°C
Storage Temperature Range	T _{stg}	-65 ~ 175	°C



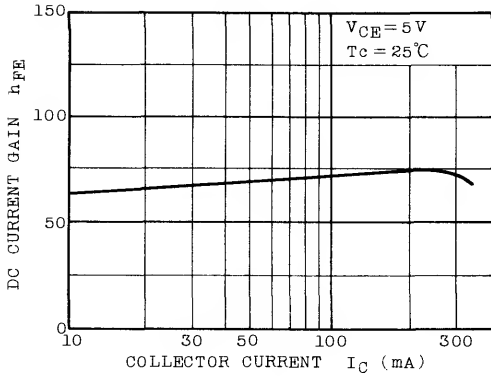
Weight : 1.13g

ELECTRICAL CHARACTERISTICS (Ta=25 °C)

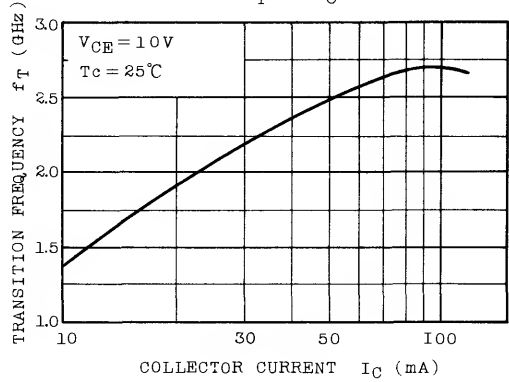
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CBO}	V _{CB} =30V, I _E =0	-	-	1.0	μA
Collector-Base Breakdown Voltage	V(BR)CBO	I _C =1mA, I _E =0	40	-	-	V
Collector-Emitter Breakdown Voltage	V(BR)CEO	I _C =10mA, I _B =0	15	-	-	V
DC Current Gain	h _{FE}	V _{CE} =5V, I _C =100mA	30	-	180	-
Collector Output Capacitance	C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	2.9	3.5	pF
Transition Frequency	f _T	V _{CE} =10V, I _C =90mA	2.0	2.7	-	GHz
Power Gain	G _{pe} (1)	V _{CE} =10V, I _C =90mA f=250MHz	14	16	-	dB
	G _{pe} (2)	V _{CE} =10V, I _C =90mA f=800MHz	-	6	-	dB

2SC2318

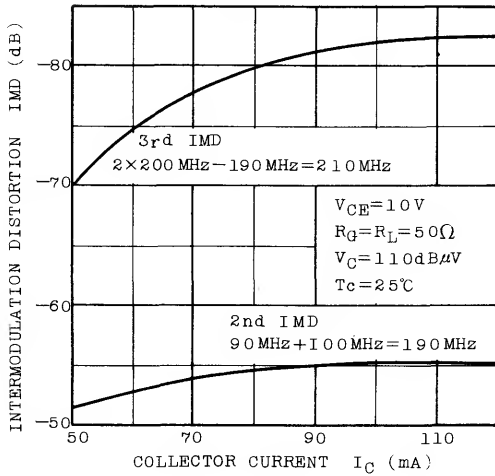
$h_{FE} - I_C$



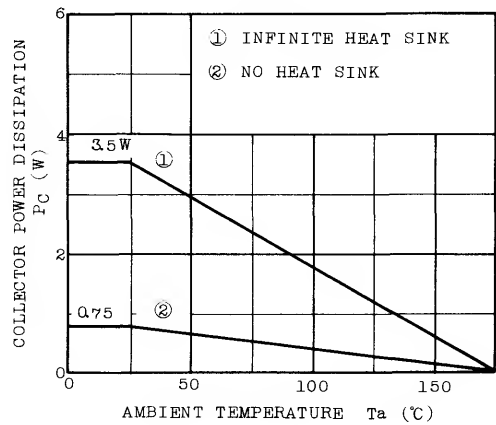
$f_T - I_C$



IMD - I_C



$P_C - T_a$



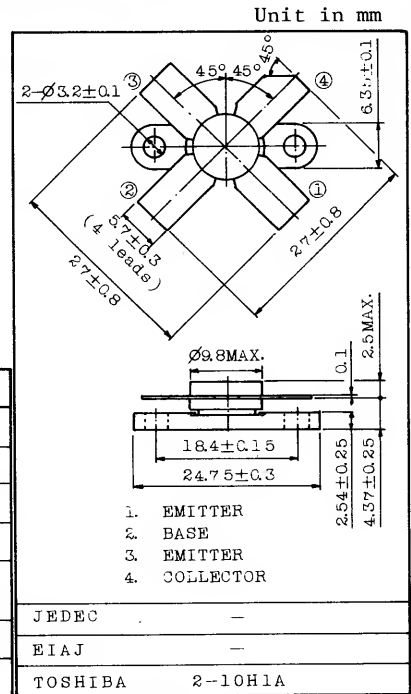
UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Output Power : $P_o=6W(\text{Min.})$
($f=470\text{MHz}$, $V_{CC}=12.6V$, $P_i=1W$)
- . 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=12.5V$, $P_o=6.5W$, $f=470\text{MHz}$

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	1.4	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	15	W
Junction Temperature	T_j	175	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	165 ~ 175	$^\circ\text{C}$



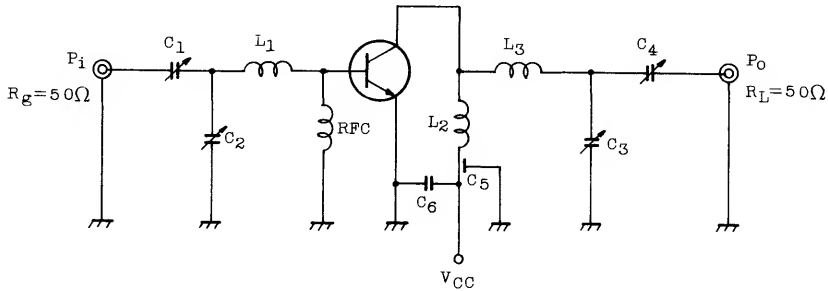
Weight : 4g

ELECTRICAL CHARACTERISTICS ($T_c=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=2\text{mA}$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10\text{mA}$, $I_B=0$	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=0.2\text{mA}$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=1A$	10	-	-	-
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1\text{MHz}$	-	-	25	pF
Output Power	P_o	(Fig.)	6	-	-	W
Power Gain	G_{pe}	$V_{CC}=12.6V$, $f=470\text{MHz}$,	7.7	-	-	dB
Collector Efficiency	η_c	$P_i=1W$	60	-	-	%
Series Equivalent Input Impedance	Z_{IN}	$V_{CC}=12.6V$, $f=470\text{MHz}$,	-	$1.4 + j0.9$	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=6W$	-	$5.5 - j7.2$	-	Ω

2SC2379

Fig. $f=470\text{MHz}$ P_o TEST CIRCUIT



C_1, C_3 : 1.5 ~ 5pF

C_2, C_4 : 2 ~ 15pF

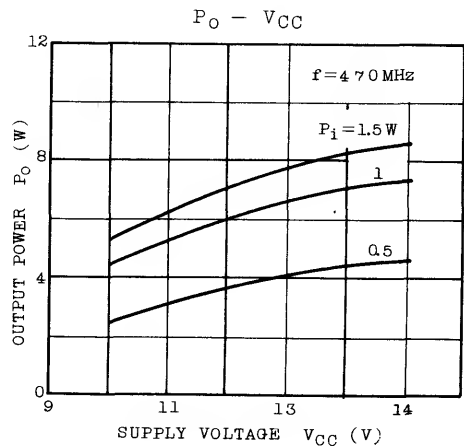
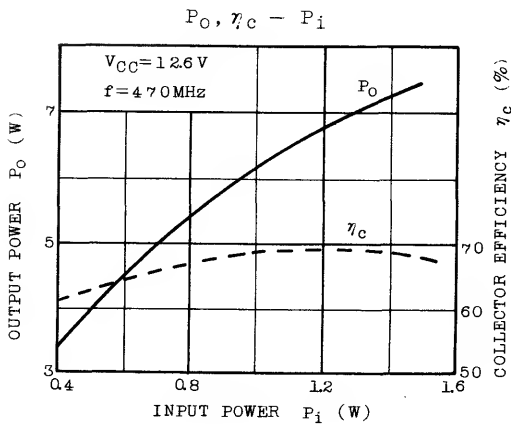
C_5 : 1000pF FEED THROUGH

C_6 : 0.01μF

L_1, L_3 : 5mm × 15mm COPPER PLATE

L_2 : φ1 SILVER PLATED COPPER WIRE, 10ID, ½T

RFC : φ1 ENAMEL COATED COPPER WIRE, 3ID, 5T



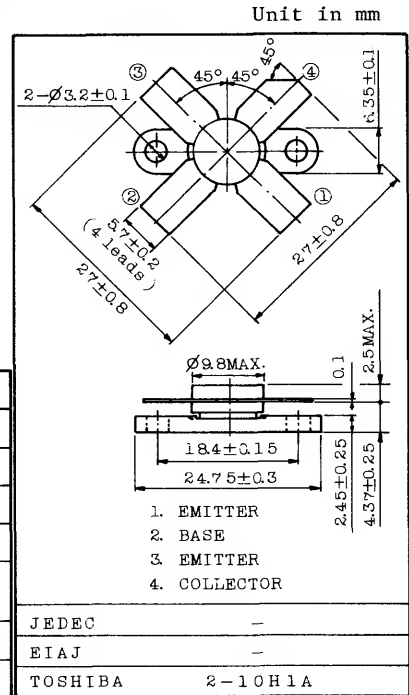
UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Output Power : $P_o=12W(\text{Min.})$
($f=470\text{MHz}$, $V_{CC}=12.6V$, $P_i=3W$)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=12.6V$, $P_i=3W$, $f=470\text{MHz}$

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	2.8	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	30	W
Junction Temperature	T_j	175	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	165 ~ 175	$^\circ\text{C}$



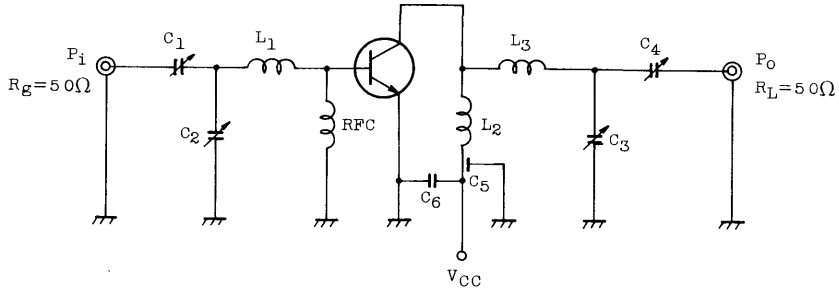
Weight : 4g

ELECTRICAL CHARACTERISTICS ($T_c=25^\circ\text{C}$)

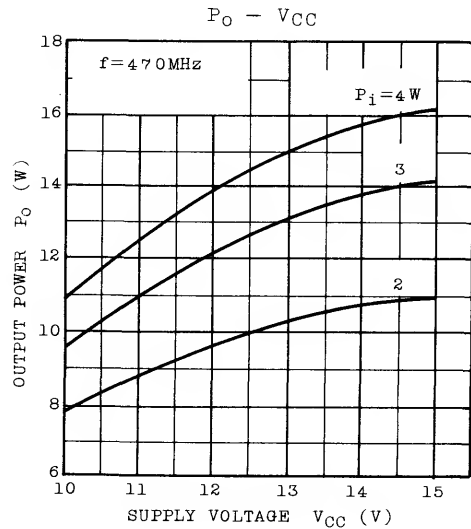
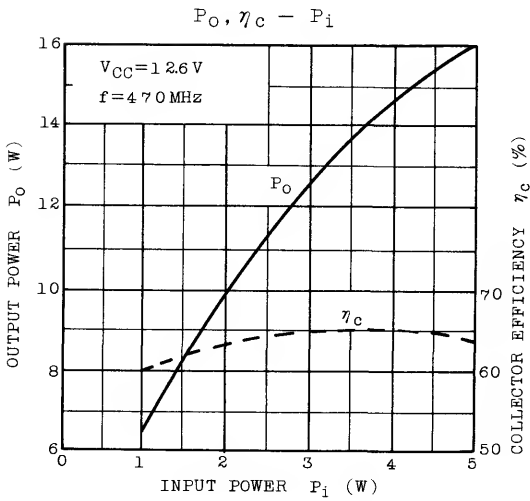
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1.5	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=2\text{mA}$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10\text{mA}$, $I_B=0$	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=0.2\text{mA}$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=1.5A$	10	-	-	-
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1\text{MHz}$	-	-	45	pF
Output Power	P_o	(Fig.)	12	-	-	W
Power Gain	G_{pe}	$V_{CC}=12.6V$, $f=470\text{MHz}$,	7.7	-	-	dB
Collector Efficiency	η_c	$P_i=3W$	60	-	-	%
Series Equivalent Input Impedance	Z_{IN}	$V_{CC}=12.6V$, $f=470\text{MHz}$,	-	1.5+ j1.3	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=12W$	-	3.6- j1.8	-	Ω

2SC2380

Fig. $f=470\text{MHz}$ P_O TEST CIRCUIT



- C_1, C_3 : 1.5 ~ 5pF
- C_2, C_4 : 2 ~ 15pF
- C_5 : 1000pF FEED THROUGH
- C_6 : 0.01 μ F
- L_1, L_3 : 5mm \times 15mm COPPER PLATE
- L_2 : ϕ 1 SILVER PLATED COPPER WIRE, 10ID, $\frac{1}{2}$ T
- RFC : ϕ 1 ENAMEL COATED COPPER WIRE, 3ID, 5T



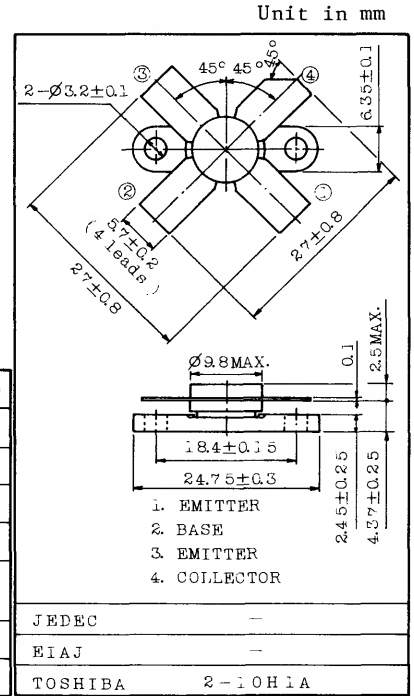
UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Output Power : $P_o=25W(\text{Min.})$
($f=470\text{MHz}$, $V_{CC}=12.6V$, $P_i=10W$)
- . 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=12.6V$, $P_i=10W$, $f=470\text{MHz}$

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	6	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	50	W
Junction Temperature	T_j	175	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ\text{C}$



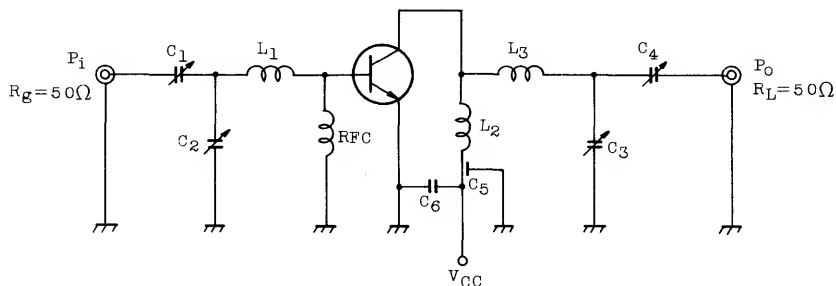
Weight : 4g

ELECTRICAL CHARACTERISTICS ($T_c=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=15V$, $I_E=0$	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CB0}$	$I_C=10\text{mA}$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=25\text{mA}$, $I_B=0$	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1\text{mA}$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=3A$	10	-	-	-
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1\text{MHz}$	-	-	80	pF
Output Power	P_o	(Fig.)	25	28	-	W
Power Gain	G_{pe}	$V_{CC}=12.6V$, $f=470\text{MHz}$,	3.9	4.5	-	dB
Collector Efficiency	η_c	$P_i=10W$	60	-	-	%

2SC2381

Fig. $f=470\text{MHz}$ P_o TEST CIRCUIT



C_1, C_3 : 1.5 ~ 2pF

C_2, C_3 : 2.2 ~ 15pF

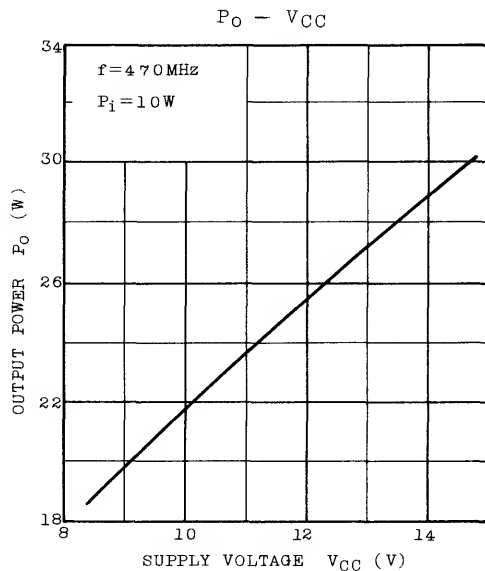
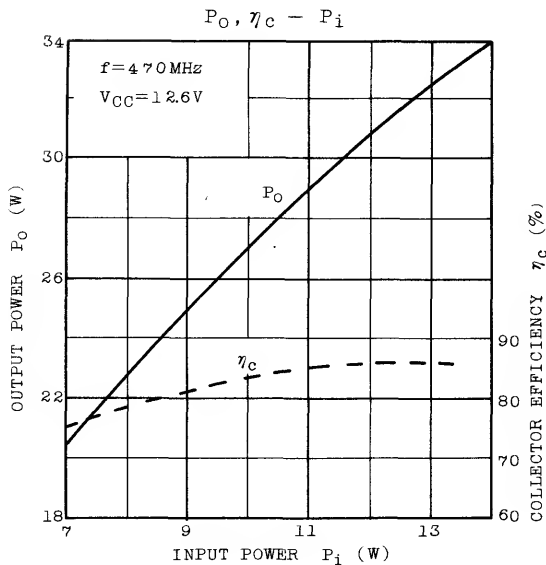
C_5 : 1000pF FEED THROUGH

C_6 : 0.01 μ F

L_1, L_3 : 5mm \times 15mm COPPER PLATE

L_2 : ϕ 1 SILVER PLATED COPPER WIRE, 10ID, $\frac{1}{2}$ T

RFC : ϕ 1 ENAMEL COATED COPPER WIRE, 3ID, 5T



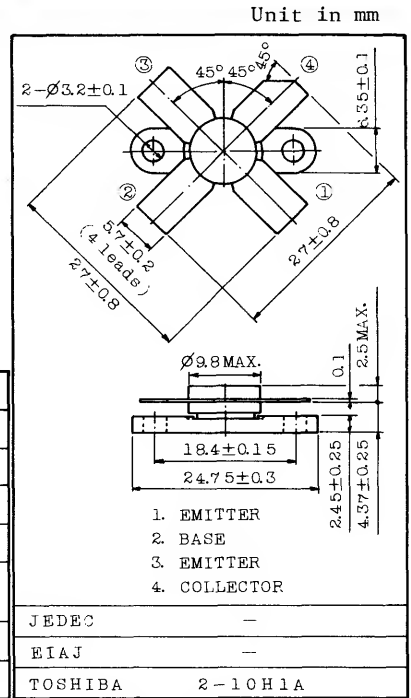
UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Output Power : $P_o=3W(\text{Min.})$
($f=470\text{MHz}$, $V_{CC}=12.6\text{V}$, $P_i=0.4\text{W}$)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=15\text{V}$, $P_i=0.4\text{W}$, $f=470\text{MHz}$

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	0.8	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	7.5	W
Junction Temperature	T_j	175	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ\text{C}$



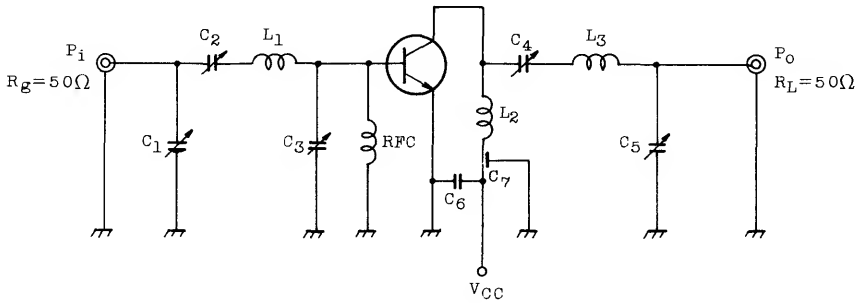
Weight : 4g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15\text{V}$, $I_E=0$	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1\text{mA}$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=5\text{mA}$, $I_B=0$	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=0.1\text{mA}$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5\text{V}$, $I_C=0.5\text{A}$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=10\text{V}$, $I_E=0$, $f=1\text{MHz}$	-	-	20	pF
Output Power	P_o	(Fig.)	3	-	-	W
Power Gain	G_{pe}	$V_{CC}=12.6\text{V}$, $f=470\text{MHz}$,	4.7	-	-	dB
Collector Efficiency	η_c	$P_i=0.4\text{W}$	50	-	-	%
Series Equivalent Input Impedance	Z_{IN}	$V_{CC}=12.6\text{V}$, $f=470\text{MHz}$,	-	1.7+	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=3\text{W}$	-	5.6-	-	Ω

2SC2391

Fig. $f=470\text{MHz}$ P_o TEST CIRCUIT



C_1, C_2, C_3 : $\sim 10\text{pF}$

C_4, C_5 : $\sim 30\text{pF}$

C_6 : $0.02\mu\text{F}$

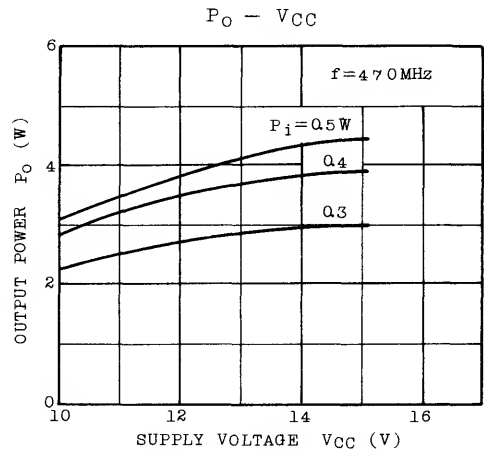
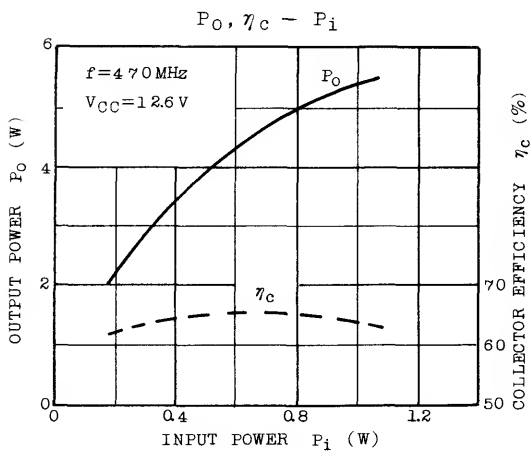
C_7 : 1000pF FEED THROUGH

L_1 : $\phi 1.6$ SILVER PLATED COPPER WIRE, 7ID, $\frac{1}{2}T$

L_2 : $\phi 1.2$ SILVER PLATED COPPER WIRE, 10ID, $\frac{1}{2}T$

L_3 : $\phi 1.6$ SILVER PLATED COPPER WIRE, 10ID, $\frac{1}{2}T$

RFC : $\phi 0.7$ ENAMEL COATED COPPER WIRE, 3ID, 5T



2~30MHz SSB LINEAR POWER AMPLIFIER APPLICATIONS.
(LOW SUPPLY VOLTAGE USE)

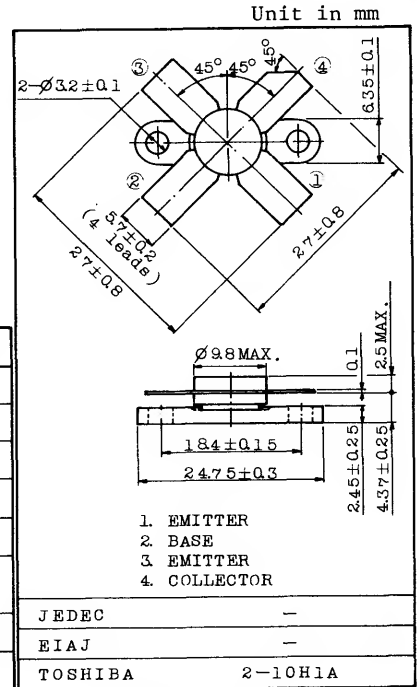
FEATURES :

• Specified 12.5V, 28MHz Characteristics

- : Output Power : $P_o=10W_{PEP}$
- : Minimum Gain : $G_{pe}=17dB$
- : Efficiency : $\eta_c=35\%$ (Min.)
- : Intermodulation Distortion : $IMD=-30dB$ (Max.)

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	40	V
Collector-Emitter Voltage	V_{CES}	40	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	5	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	40	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65~175	$^\circ C$

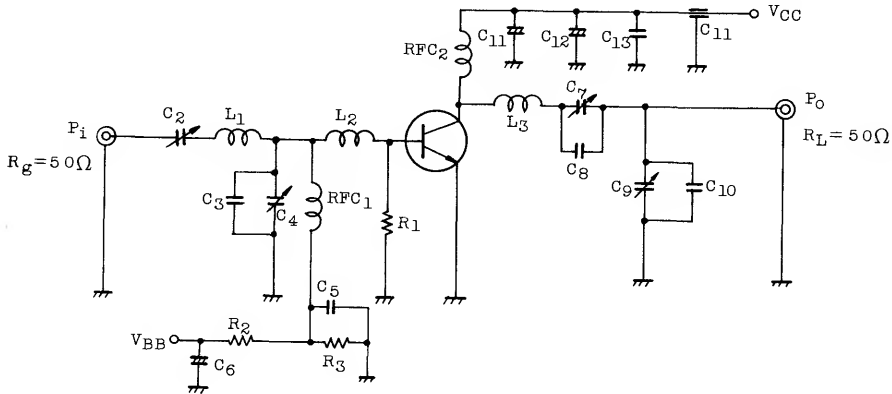


Weight : 4.0g

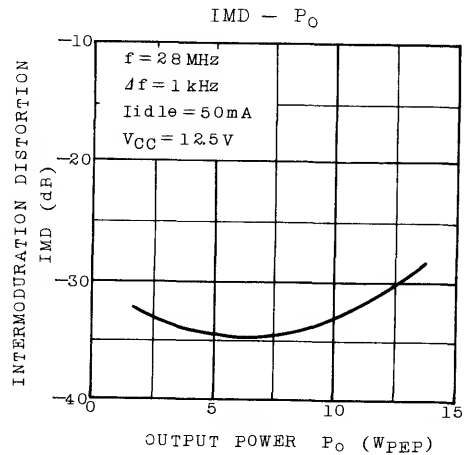
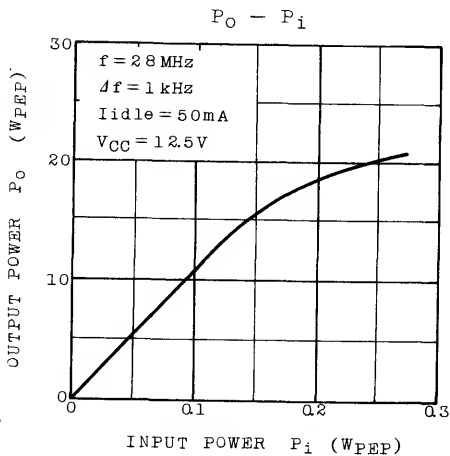
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	18	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CES}$	$I_C=50mA, V_{EB}=0$	40	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA, I_C=0$	4	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=1A$	20	-	-	
Transition Frequency	f_T	$V_{CE}=5V, I_C=1A$	-	200	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=12.5V, I_E=0, f=1MHz$	-	-	150	pF
Power Gain	G_{PE}	$V_{CC}=12.5V, f=28MHz$	17.0	-	-	dB
Input Power	P_i	2-Tone, $\Delta f=1kHz$	-	-	0.2	W _{PEP}
Collector Efficiency	η_c	$I_{idle}=50mA, P_o=10W_{PEP}$	35	45	-	%
Intermodulation Distortion	IMD	(Fig.)	-	-	-30	dB
Series Equivalent Input Impedance	Z_{in}	$V_{CC}=12.5V, f=28MHz$	-	1.5 -j1.0	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$\Delta f=1kHz, P_o=10W_{PEP}$	-	6.5 -j2.0	-	Ω

Fig. P_i TEST CIRCUIT



- | | |
|------------------------------------|--|
| C_2, C_4, C_7 : 7 ~ 150pF | L_1 : $\phi 0.8$ ENAMEL COATED COPPER WIRE, 9ID, 6T |
| C_9 : 10 ~ 200pF | L_2 : $\phi 1$ SILVER PLATED COPPER WIRE, 9ID, 2T |
| C_3 : 200pF | L_3 : $\phi 1.5$ ENAMEL COATED COPPER WIRE, 9ID, 5T |
| C_5, C_{13} : 0.4 μ F | RFC1 : $\phi 0.8$ ENAMEL COATED COPPER WIRE, 9ID, 20T |
| C_6 : 100 μ F 10WV | RFC2 : $\phi 1.5$ ENAMEL COATED COPPER WIRE, 12ID, 15T |
| C_8 : 350pF | R_1 : 5.6 Ω (1/2W) |
| C_{10} : 200pF | R_2 : 5 Ω (5W) |
| C_{11}, C_{12} : 22 μ F 35WV | R_3 : 1.5 Ω (10W) |
| C_{14} : 1000pF | |
- (FEED THROUGH)



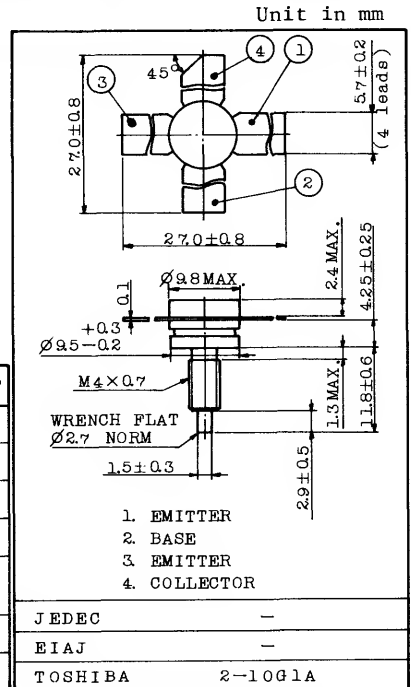
VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : $P_o=32W$ (Min.)
($f=175MHz$, $V_{CC}=13.5V$, $P_i=4W$)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=14.5V$, $P_i=4W$, $f=175MHz$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	6	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	70	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$



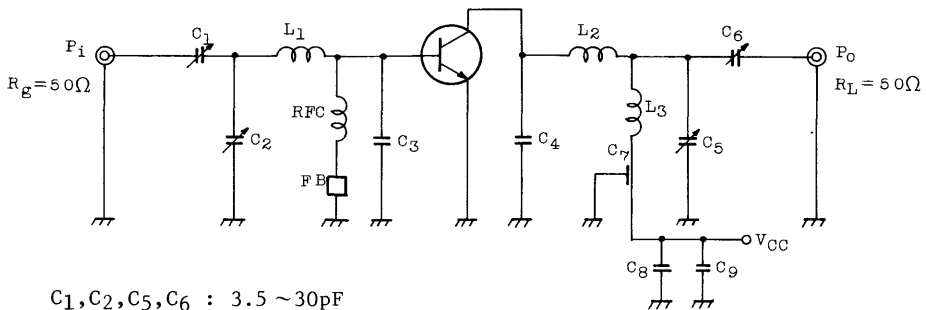
Mounting Kit No. AC57
Weight : 3.3g

ELECTRICAL CHARACTERISTICS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	2	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=10mA$, $I_E=0$	40	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=25mA$, $I_B=0$	18	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA$, $I_C=0$	4	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=5A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=13.5V$, $I_E=0$, $f=1MHz$	-	110	160	pF
Output Power	P_o	(Fig.)	32	34	-	W
Power Gain	G_{pe}	$V_{CC}=13.5V$, $f=175MHz$,	9.0	9.3	-	dB
Collector Efficiency	η_c	$P_i=4W$	60	70	-	%
Series Equivalent Input Impedance	Z_{in}	$V_{CC}=13.5V$, $f=175MHz$,	-	0.9 +j1.1	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=32W$	-	2.0 -j0.4	-	Ω

2SC2420

Fig. P_O TEST CIRCUIT



C_1, C_2, C_5, C_6 : 3.5 ~ 30pF

C_3 : 72pF CERAMIC CONDENSER

C_4 : 47pF CERAMIC CONDENSER

C_7 : 1000pF FEED THROUGH

C_8 : 0.01 μ F CERAMIC CONDENSER

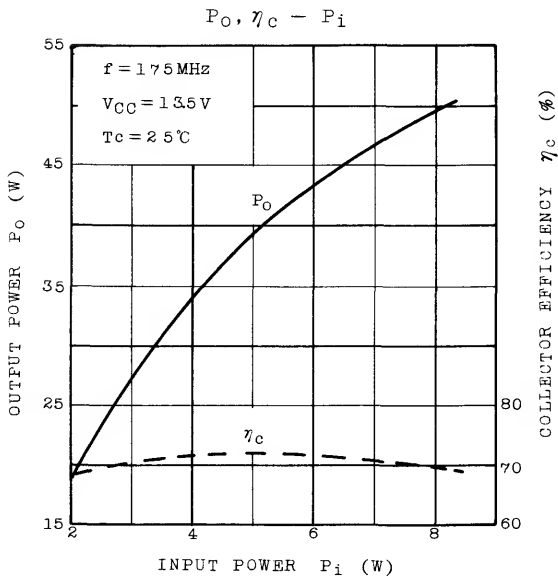
C_9 : 10 μ F

L_1, L_2 : ϕ 1 SILVER PLATED COPPER WIRE, 10ID, 1T

L_3 : ϕ 1 SILVER PLATED COPPER WIRE, 10ID, 2T

RFC : ϕ 1 ENAMEL COATED COPPER WIRE, 6ID, 10T

FB : FERRITE BEADS



INDUSTRIAL APPLICATIONS

Unit in mm

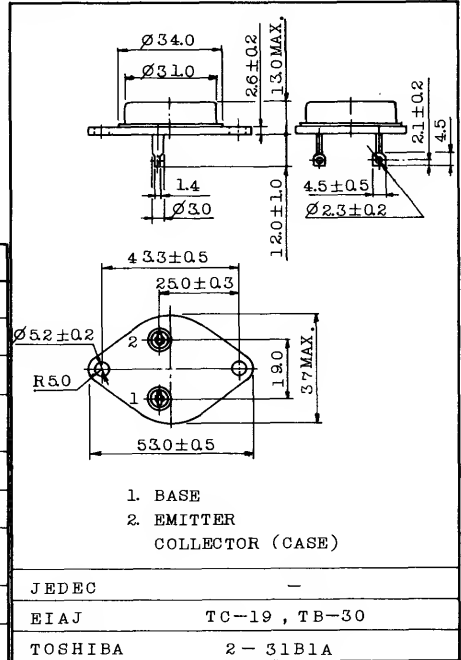
HIGH POWER SWITCHING APPLICATIONS.
HIGH FREQUENCY INVERTER APPLICATIONS.
SWITCHING REGULATOR APPLICATIONS.

FEATURES:

- High Collector Emitter Voltage

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	500	V
Collector-Emitter Voltage	V _{CE0}	400	V
Emitter-Base Voltage	V _{EB0}	5	V
Collector Current	I _C	30	A
Peak Collector Current	I _{C peak}	60 (1 ms)	A
Base Current	I _B	10	A
Collector Power Dissipation	P _C	250	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C



Mounting kit No. AC227 & AC88B
Weight : 50g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Collector Cut-off Current	I _{CB0}	V _{CB} =500V, I _E =0	-	-	0.2	mA	
Emitter Cut-off Current	I _{EB0}	V _{EB} =5V, I _C =0	-	-	0.2	mA	
Collector-Emitter Breakdown Voltage	V _{(BR)CE0}	I _C =10mA, I _B =0	400	-	-	V	
DC Current Gain	h _{FE}	V _{CE} =5V, I _C =20A V _{CE} =5V, I _C =30A	10 5	-	-		
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =20A, I _B =3A	-	-	1.5	V	
Base-Emitter Saturation Voltage	V _{BE(sat)}		-	-	2.0	V	
Collector Output Capacitance	C _{ob}	V _C =50V, I _E =0, f=1MHz	-	400	-	pF	
Switching Time	Turn-on Time	t _{on}			-	1.5	µs
	Storage Time	t _{stg}			-	3.0	
	Fall Time	t _f			-	1.0	

$2 I_{B1} = -I_{B2} = 6A$
 DUTY CYCLE=1%
 $V_{CC}=300V$

2SC2456

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

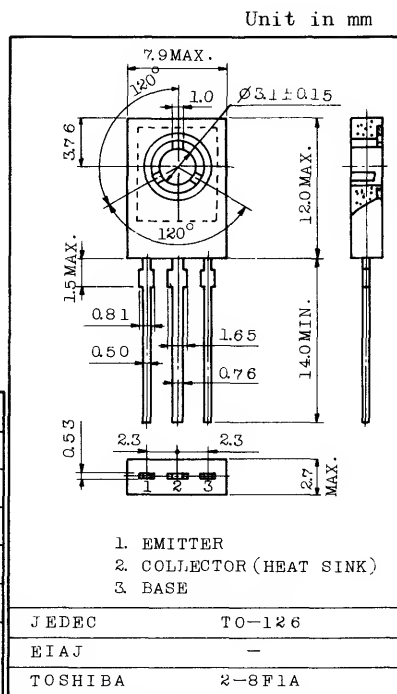
COLOR TV HORIZONTAL DRIVER APPLICATIONS.
 COLOR TV CHROMA OUTPUT APPLICATIONS.

FEATURES:

- . High Voltage : $V_{CE0}=300V$
- . Recommended for Chroma Output and Horizontal Driver Application for Line Operated TV.

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

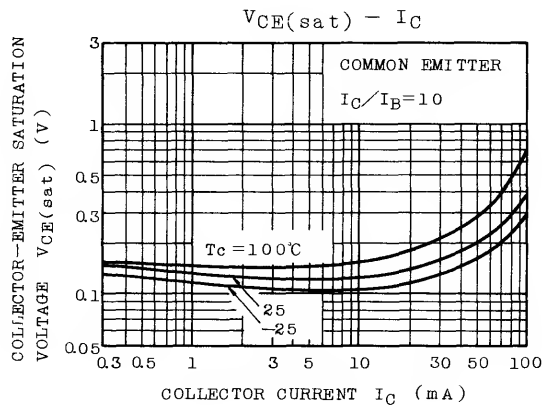
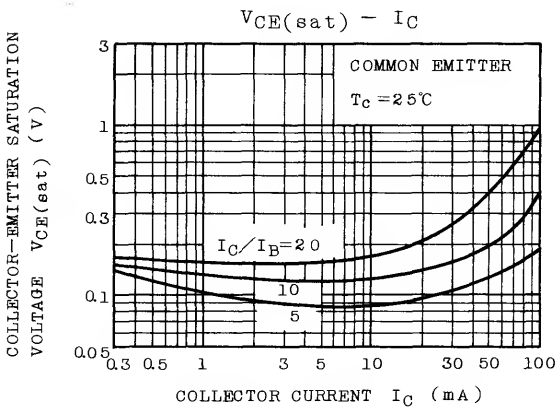
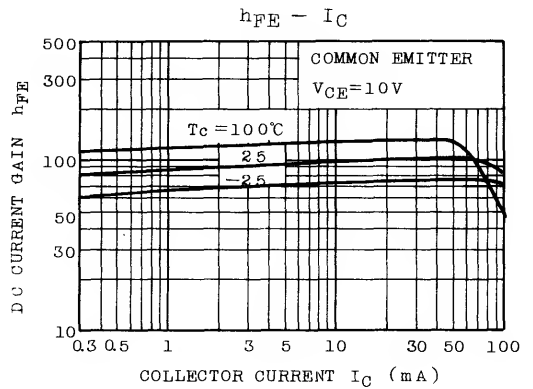
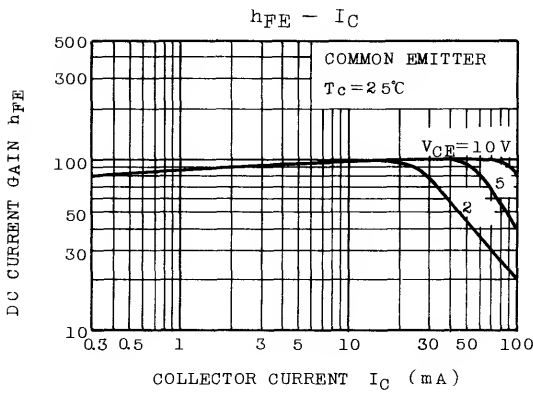
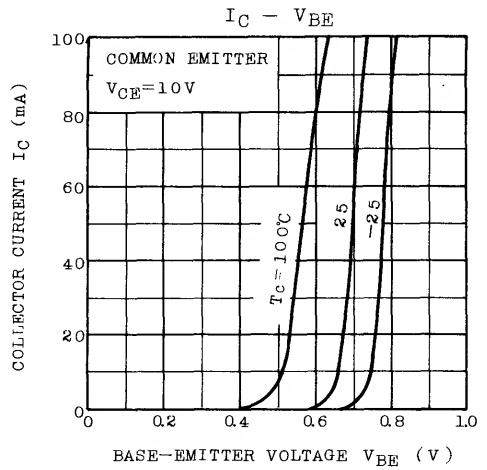
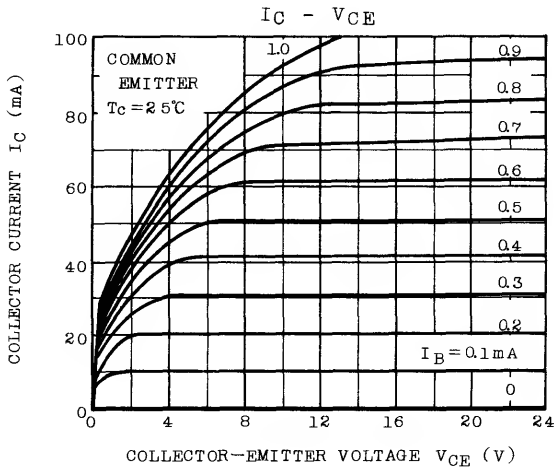
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB0}	300	V
Collector-Emitter Voltage		V_{CE0}	300	V
Emitter-Base Voltage		V_{EB0}	7	V
Collector Current		I_C	100	mA
Base Current		I_B	50	mA
Collector Power Dissipation	$T_a=25^{\circ}C$	P_C	1.2	W
	$T_c=25^{\circ}C$		10	
Junction Temperature		T_j	150	$^{\circ}C$
Storage Temperature Range		T_{stg}	-55~150	$^{\circ}C$



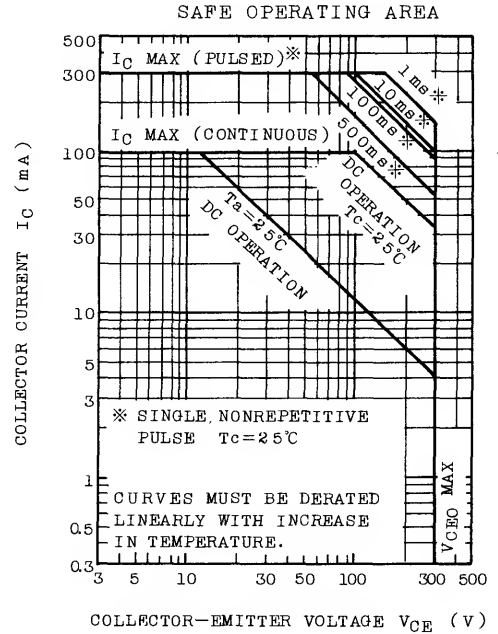
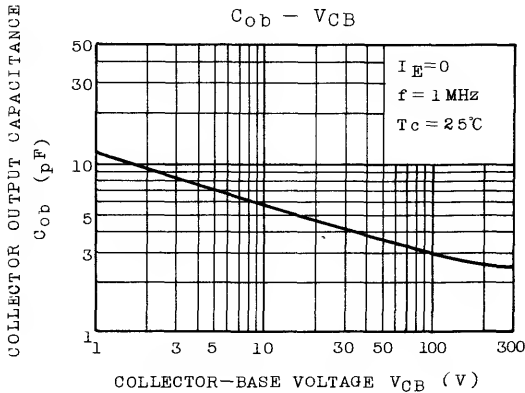
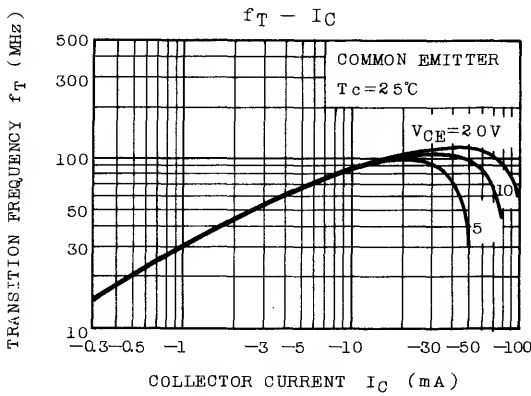
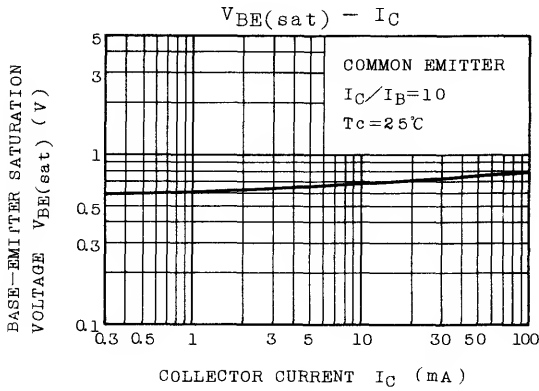
Mounting Kit No. AC46C
 Weight : 0.72g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=240V, I_E=0$	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1.0	μA
DC Current Gain	$h_{FE}(1)$	$V_{CE}=10V, I_C=50mA$	40	-	170	
	$h_{FE}(2)$	$V_{CE}=10V, I_C=100mA$	20	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=100mA, I_B=20mA$	-	-	1.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=100mA, I_B=20mA$	-	-	1.2	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=30mA$	50	-	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=50V, I_E=0, f=1MHz$	-	-	5.0	pF



2SC2456



COLOR TV VERT. DEFLECTION OUTPUT APPLICATIONS.
 COLOR TV CLASS B SOUND OUTPUT APPLICATIONS.

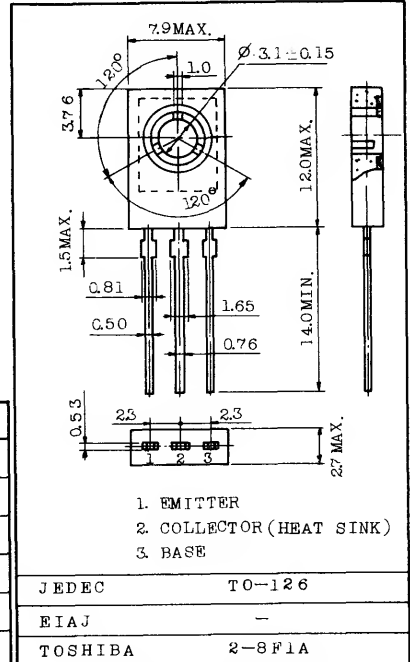
FEATURES:

- . Large Collector Current and Collector Power Dissipation Capability.
- . Recommended for Vert. Deflection Output & Sound Output Applications for Line Operated TV.
- . Complementary to 2SA1021

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V _{CB0}	150	V
Collector-Emitter Voltage		V _{CE0}	150	V
Emitter-Base Voltage		V _{EB0}	6	V
Collector Current		I _C	1.5	A
Base Current		I _B	1.0	A
Collector Power Dissipation	Ta=25°C	P _C	1.2	W
	Tc=25°C		20	
Junction Temperature		T _j	150	°C
Storage Temperature Range		T _{stg}	-55~150	°C

Unit in mm



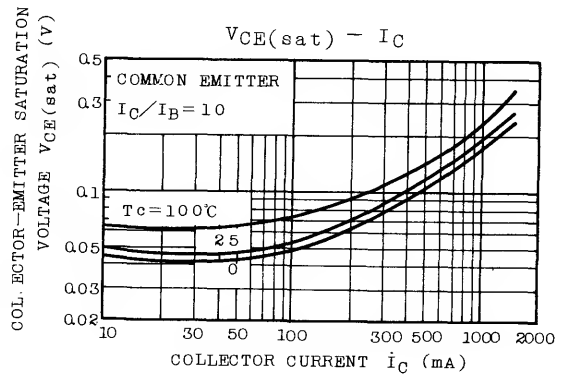
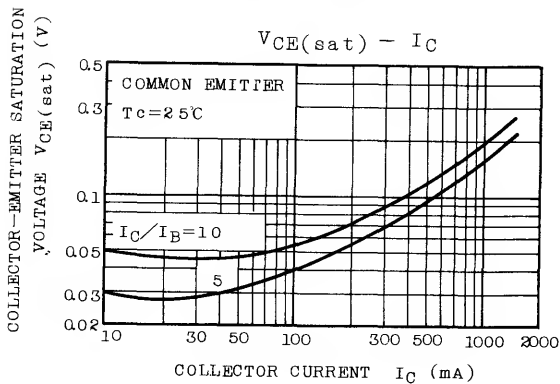
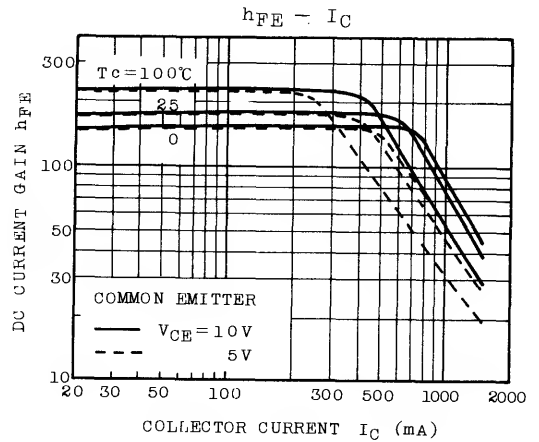
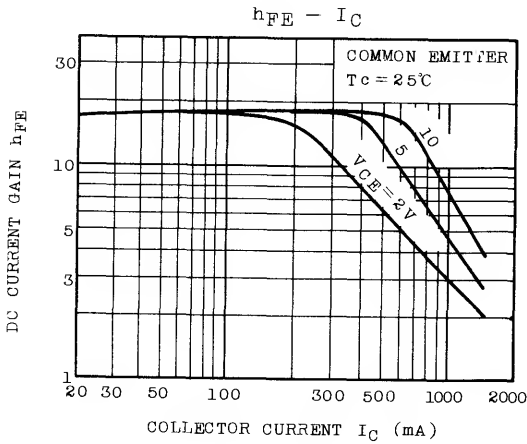
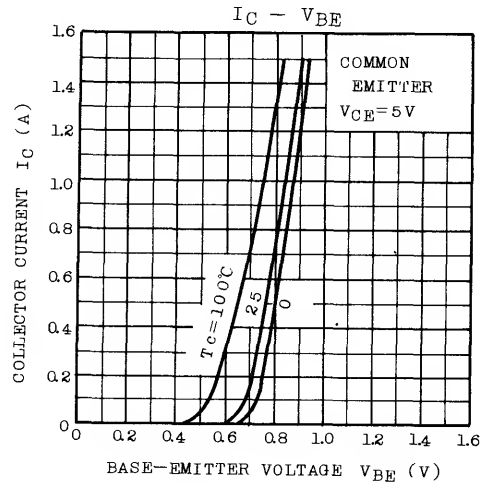
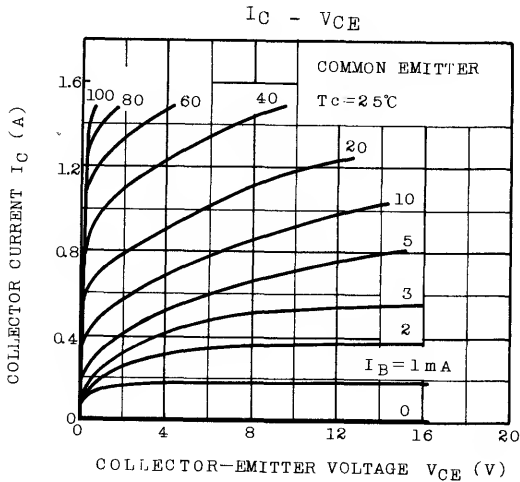
Mounting Kit No. AC46C
 Weight : 0.72g

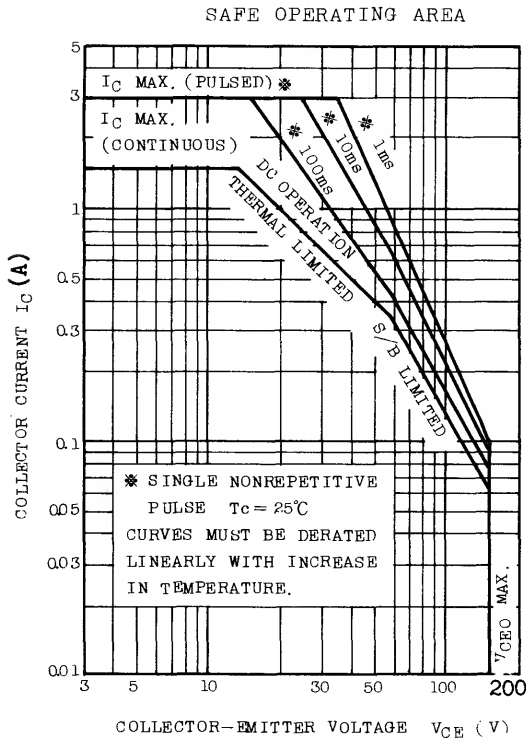
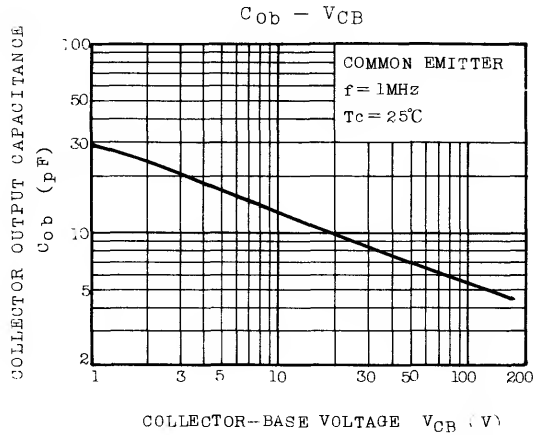
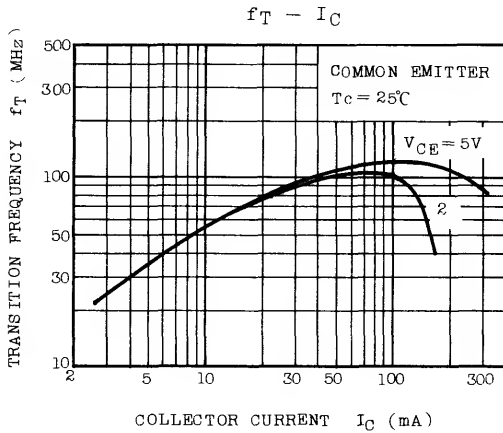
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =150V, I _E =0	-	-	1.0	μA
Emitter Cut-off Current	I _{EB0}	V _{EB} =6V, I _C =0	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CEO}	I _C =10mA, I _B =0	150	-	-	V
DC Current Gain	h _{FE} (Note)	V _{CE} =5V, I _C =200mA	60	-	320	-
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =500mA, I _B =50mA	-	-	1.5	V
Base-Emitter Voltage	V _{BE}	V _{CE} =5V, I _C =5mA	0.5	-	0.8	V
Transition Frequency	f _T	V _{CE} =5V, I _C =200mA	20	100	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	13	20	pF

Note : h_{FE} Classification R:60~120 O:100~200 Y:160~320

2SC2481





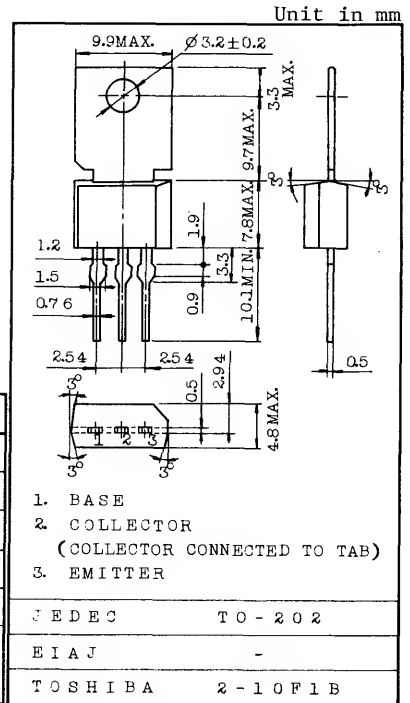
2SC2483

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

HIGH VOLTAGE GENERAL AMPLIFIER APPLICATIONS.
 COLOR TV CLASS B SOUND OUTPUT APPLICATIONS.

FEATURES:

- Large Collector Current and Collector Power Dissipation Capability. ($P_C=2.0W$ at $T_a=25^\circ C$)
- Complementary to 2SA1195



Weight : 1.4g

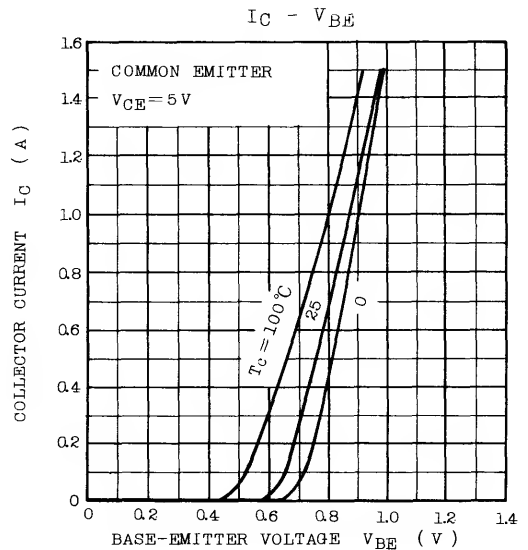
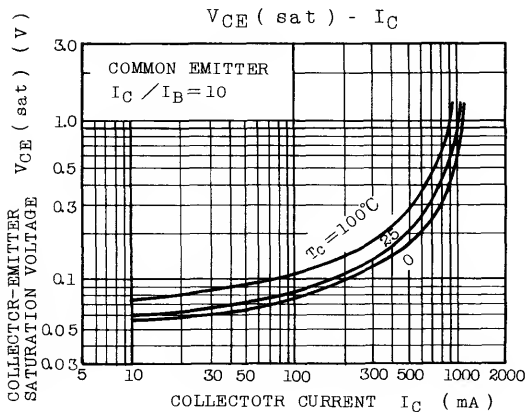
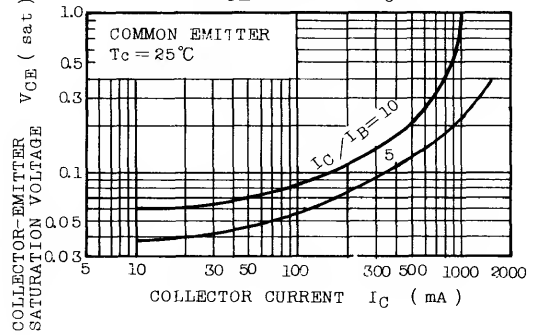
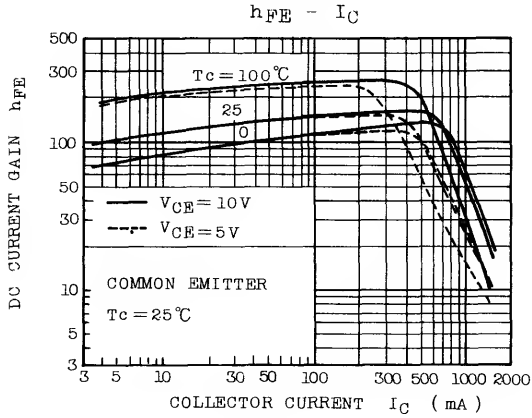
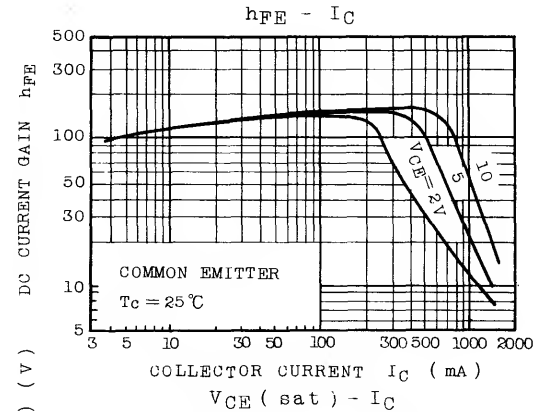
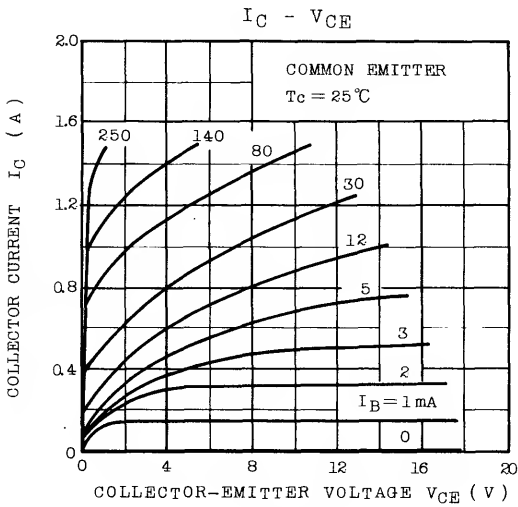
MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	160	V
Collector-Emitter Voltage		V_{CEO}	160	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current		I_C	1.5	A
Base Current		I_B	0.5	A
Collector Power Dissipation	$T_a=25^\circ C$	P_C	2.0	W
	$T_c=25^\circ C$	P_C	15	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55~150	$^\circ C$

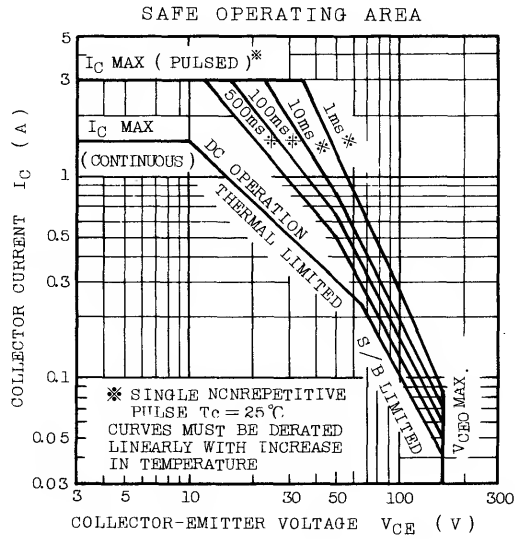
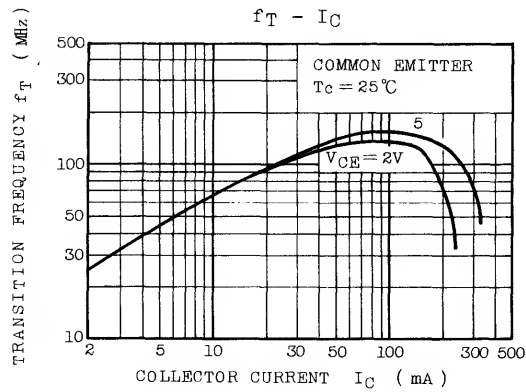
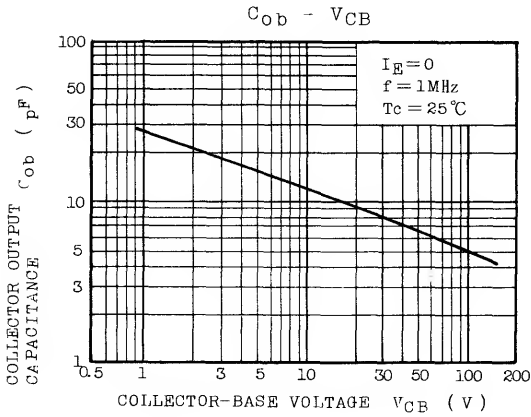
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=150V, I_E=0$	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=6V, I_C=0$	-	-	1.0	μA
DC Current Gain	$h_{FE}(1)$ (Note)	$V_{CE}=5V, I_C=200mA$	100	-	320	
	$h_{FE}(2)$	$V_{CE}=5V, I_C=500mA$	40	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=500mA, I_B=50mA$	-	-	1.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5V, I_C=5mA$	0.50	0.57	0.70	V
Transition Frequency	f_T	$V_{CE}=5V, I_C=200mA$	40	120	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	-	20	pF

Note : $h_{FE}(1)$ Classification 0 : 100~200, Y : 160~320



2SC2483



2SC2508

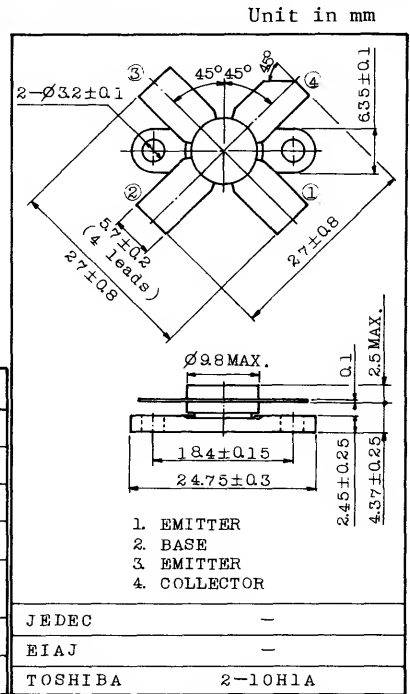
VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : $P_o=27W$ (Min.)
($f=175MHz$, $V_{CC}=12.5V$, $P_i=4.2W$)

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	6	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	50	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$



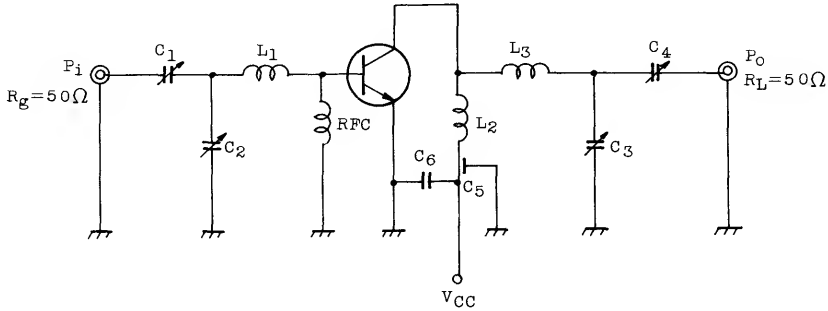
Weight : 4.0g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

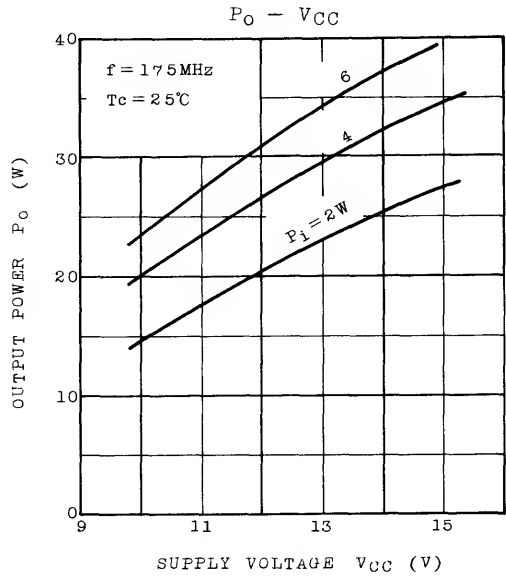
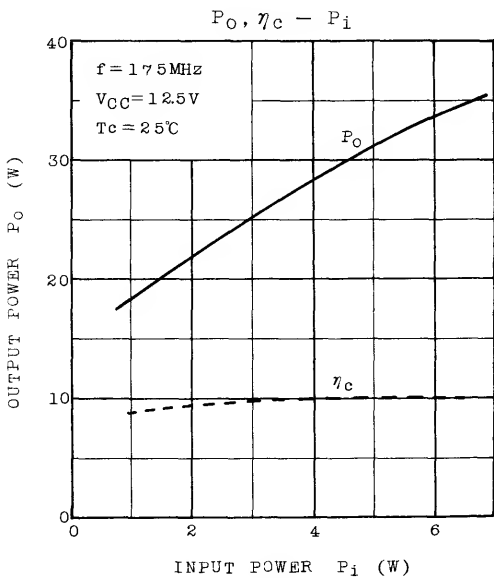
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=10mA$, $I_E=0$	40	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=25mA$, $I_B=0$	18	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA$, $I_C=0$	4	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=3A$	10	-	150	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	-	80	pF
Output Power	P_o	(Fig.) $V_{CC}=12.5V$, $f=175MHz$, $P_i=4.2W$	27	29	-	W
Power Gain	G_{pe}		8.0	8.4	-	dB
Collector Efficiency	η_c		60	70	-	%

2SC2508

Fig. P₀ TEST CIRCUIT



- C_1 : ~20pF C_2, C_3, C_4 : ~30pF C_5 : 1000pF FEED THROUGH
 C_6 : 0.01 μ F
 L_1, L_3 : ϕ 1 SILVER PLATED COPPER WIRE, 6ID, 1T
 L_2 : ϕ 1 SILVER PLATED COPPER WIRE, 6ID, 2T
 RFC : ϕ 1 ENAMEL COATED COPPER WIRE, 6ID, 8T



2SC2509

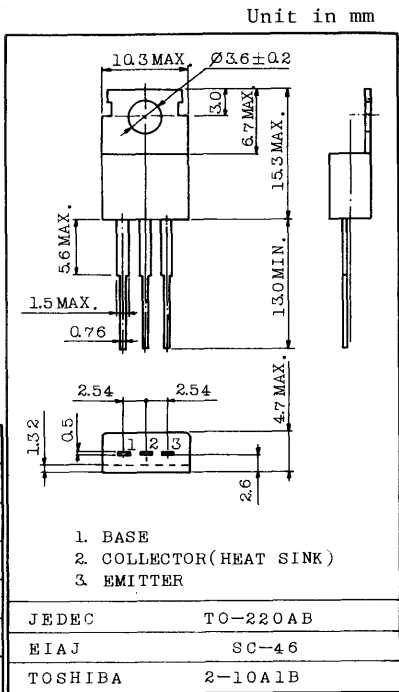
2~30MHz SSB LINEAR POWER AMPLIFIER APPLICATIONS.
(LOW SUPPLY VOLTAGE USE)

FEATURES:

- . Specified 12.5V, 28MHz Characteristics
- : Output Power : $P_o=10W_{PEP}$
- : Minimum Gain : $G_{pe}=14dB$
- : Efficiency : $\eta_c=35\%$ (Min.)
- : Intermodulation Distortion : $IMD=-30dB$ (Max.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CES}	40	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	5	A
Collector Power Dissipation (Tc=25°C)	P_C	20	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~ 150	°C



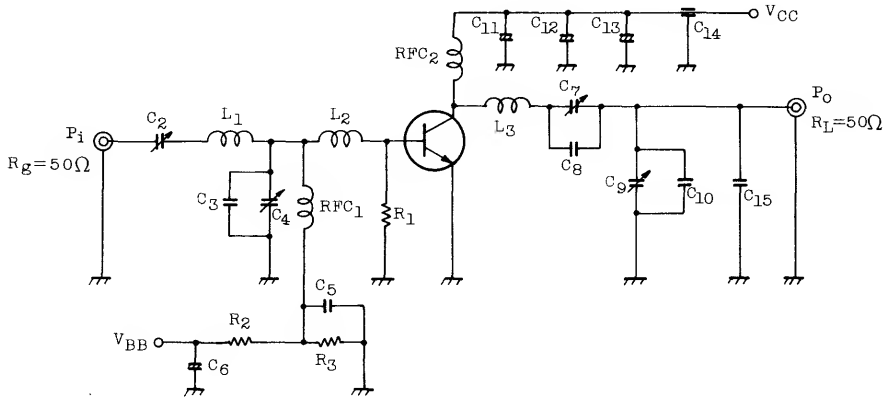
Weight : 1.9g
Mounting Kit No. AC75

ELECTRICAL CHARACTERISTICS (Tc=25°C)

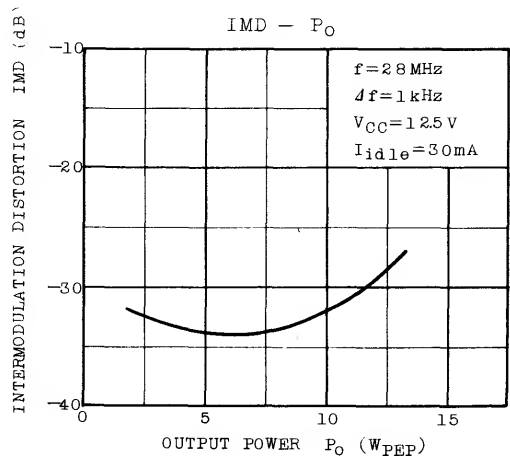
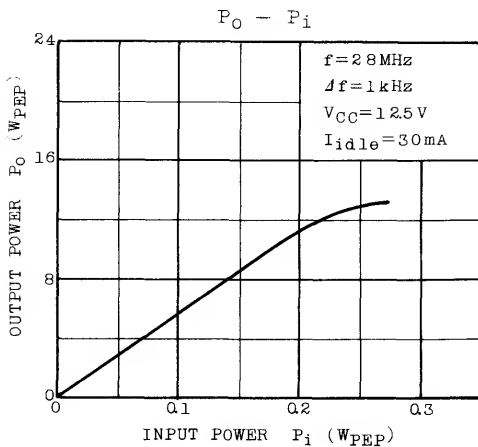
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	18	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CES}$	$I_C=50mA, V_{BE}=0$	40	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA, I_C=0$	4	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=1A$	20	-	-	
Transition Frequency	f_T	$V_{CE}=5V, I_C=1A$	-	200	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=12.5V, I_E=0, f=1MHz$	-	-	150	pF
Power Gain	G_{pe}	$V_{CC}=12.5V, f=28MHz$	14.0	-	-	dB
Input Power	P_i	2-Tone, $4f=1kHz$	-	-	0.4	WPEP
Collector Efficiency	η_c	$I_{idle}=30mA, P_o=10W_{PEP}$	35	-	-	%
Intermodulation Distortion	IMD	(Fig.)	-	-	-30	dB

2SC2509

Fig. P_i TEST CIRCUIT



- | | |
|--|---|
| C ₂ , C ₄ , C ₇ : 7 ~ 150pF | L ₁ : ϕ 0.8 ENAMEL COATED COPPER WIRE, 9ID, 6T |
| C ₉ : 10 ~ 200pF | L ₂ : ϕ 1 SILVER PLATED COPPER WIRE, 9ID, 2T |
| C ₃ : 400pF | L ₃ : ϕ 1.5 ENAMEL COATED COPPER WIRE, 9ID, 5T |
| C ₅ , C ₁₃ : 0.4 μ F | RFC ₁ : ϕ 0.8 ENAMEL COATED COPPER WIRE, 9ID, 20T |
| C ₆ : 10.0 μ F 10W | RFC ₂ : ϕ 1.5 ENAMEL COATED COPPER WIRE, 121ID, 15T |
| C ₈ : 400pF | R ₁ : 5.6 Ω (1/2W) |
| C ₁₀ : 200pF | R ₂ : 5 Ω (5W) |
| C ₁₁ , C ₁₂ : 22 μ F 35WV | R ₃ : 1.5 Ω (10W) |
| C ₁₄ : 1000pF | C ₁₅ : 100pF |
- FEED THROUGH



2SC2531

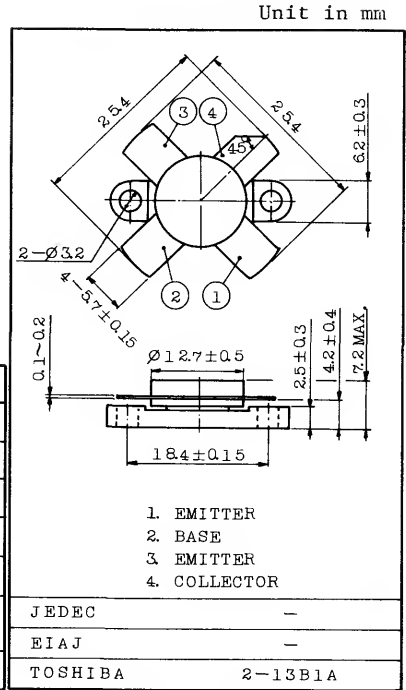
2 ~ 30MHz SSB LINEAR POWER AMPLIFIER APPLICATIONS.
(28V SUPPLY VOLTAGE USE)

FEATURES:

- . Specified 28V, 28MHz Characteristics
 - : Output Power : $P_o=150W_{PEP}$
 - : Minimum Gain : $G_{pe}=12.2dB$
 - : Efficiency : $\eta_c=35\%$ (Min.)
 - : Intermodulation Distortion : $IMD=-30dB$ (Max.)

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CES}	60	V
Collector-Emitter Voltage	V_{CEO}	35	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	20	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	250	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$



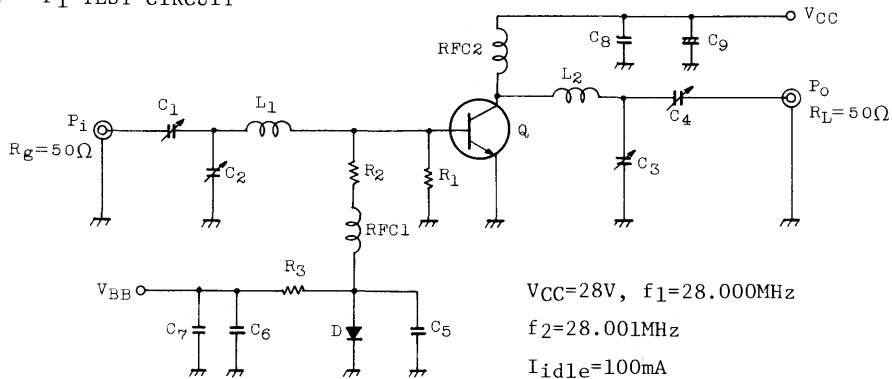
Weight : 5.2g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

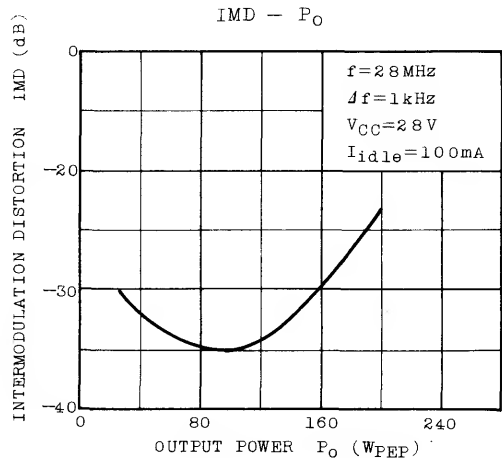
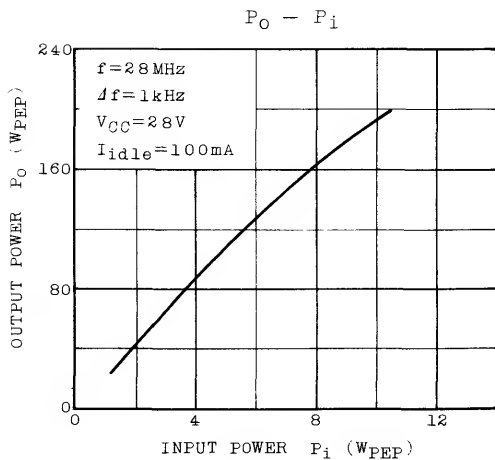
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=100mA, I_B=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CES}$	$I_C=100mA, V_{BE}=0$	60	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA, I_C=0$	4	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=10A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=28V, I_E=0, f=1MHz$	-	450	600	pF
Power Gain	G_{pe}	$V_{CC}=28V, f=28MHz$	12.2	13.3	-	dB
Input Power	P_i	2-Tone, $\Delta f=1kHz$	-	7	9	WPEP
Collector Efficiency	η_c	$I_{idle}=100mA, P_o=150W_{PEP}$	35	-	-	%
Intermodulation Distortion	IMD	(Fig.)	-	-	-30	dB
Series Equivalent Input Impedance	Z_{IN}	$V_{CC}=28V, f=28MHz$	-	1.4 -j0.9	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$\Delta f=1kHz, P_o=150W_{PEP}$	-	2.3 -j0.9	-	Ω

2SC2531

Fig. P_i TEST CIRCUIT



- | | |
|-----------------------------|--|
| C_1, C_2 : 7 ~ 150pF | L_1 : $\phi 0.8$ ENAMEL COATED COPPER WIRE, 14ID, 4T, 4P |
| C_3, C_4 : 7 ~ 150pF 2KWV | L_2 : $\phi 1.2$ ENAMEL COATED COPPER WIRE, 14ID, $3\frac{1}{2}$ T, 3P |
| C_5, C_6 : 0.022 μ F | RFC1 : $\phi 0.8$ ENAMEL COATED COPPER WIRE, 10ID, 9T
(Ferrite Core TDK K2) |
| C_7 : 47 μ F 10WV | RFC2 : $\phi 0.8$ ENAMEL COATED COPPER WIRE, 14ID, 20T |
| C_8 : 0.04 μ F | R_1 : 10 Ω (1W) |
| C_9 : 100 μ F 50WV | R_2 : 2 Ω (1/2W) |
| Q : 2SC2510 | R_3 : 10 Ω (5W) |
| | D : 1S1555 |



2SC2552

SWITCHING REGULATOR AND HIGH VOLTAGE
SWITCHING APPLICATIONS.
HIGH SPEED DC-DC CONVERTER APPLICATION

FEATURES:

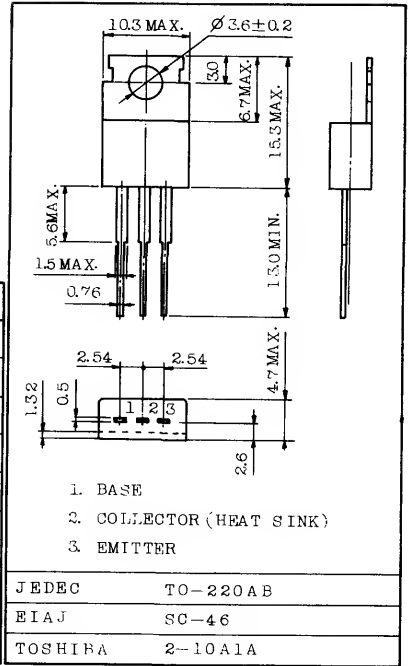
- . Excellent Switching Times
: $t_r=1.0\mu s$ (Max.) $t_f=1.0\mu s$ (Max.) at $I_C=0.8A$
- . High Collector Breakdown Voltage : $V_{CEO}=400V$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	500	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	2	A
Base Current	I_B	0.5	A
Collector Power Dissipation	P_C	$T_a=25^\circ C$	1.5
		$T_c=25^\circ C$	20
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$

INDUSTRIAL APPLICATIONS

Unit in mm

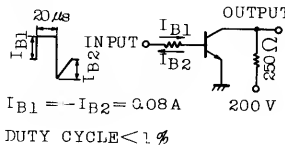


Mounting kit No. AC75

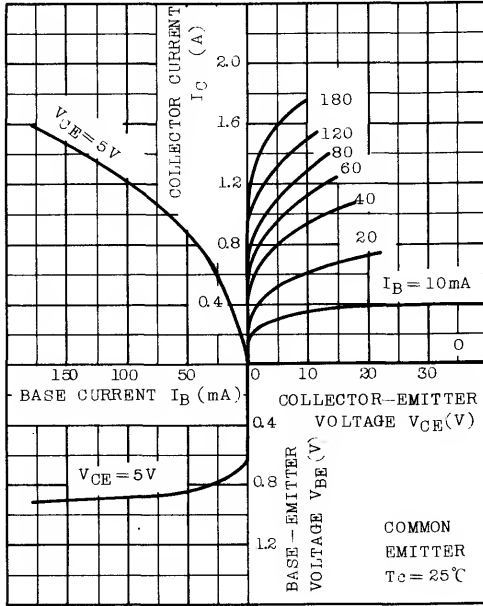
Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

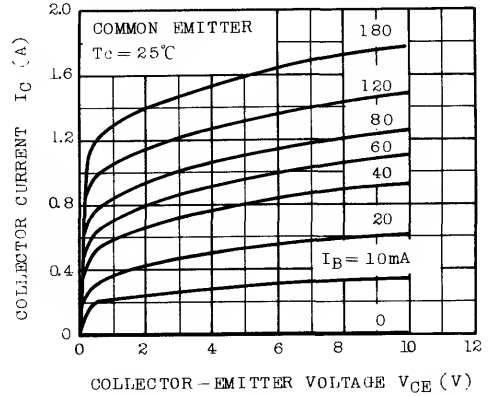
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=400V, I_E=0$	-	-	100	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	500	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	400	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=0.1A$	20	-	-	
		$V_{CE}=5V, I_C=1A$	8	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=1A, I_B=0.2A$	-	-	1.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=1A, I_B=0.2A$	-	-	1.5	V
Switching Time	Rise Time	t_r	-	-	1.0	μs
	Storage Time	t_{stg}	-	-	2.5	
	Fall Time	t_f	-	-	1.0	



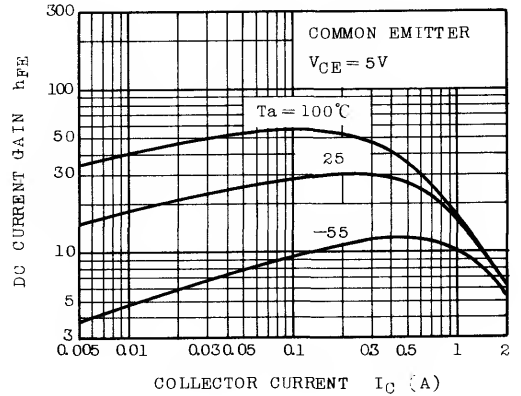
STATIC CHARACTERISTICS



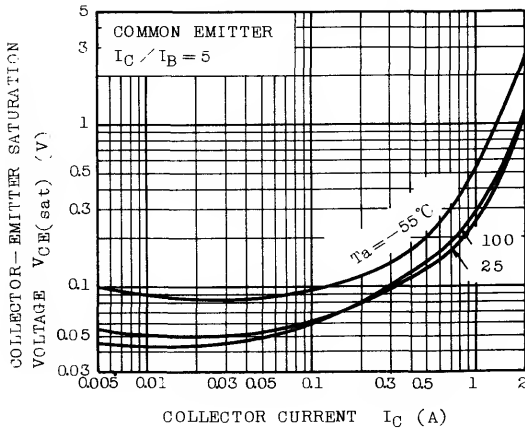
$I_C - V_{CE}$ (LOW VOLTAGE REGION)



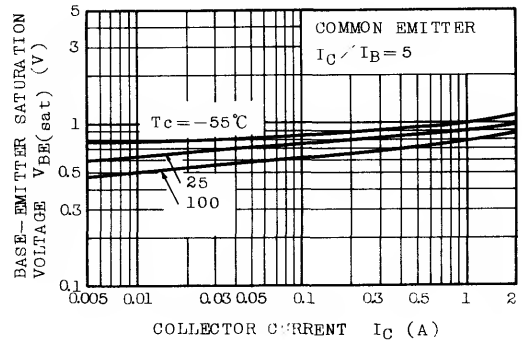
$h_{FE} - I_C$

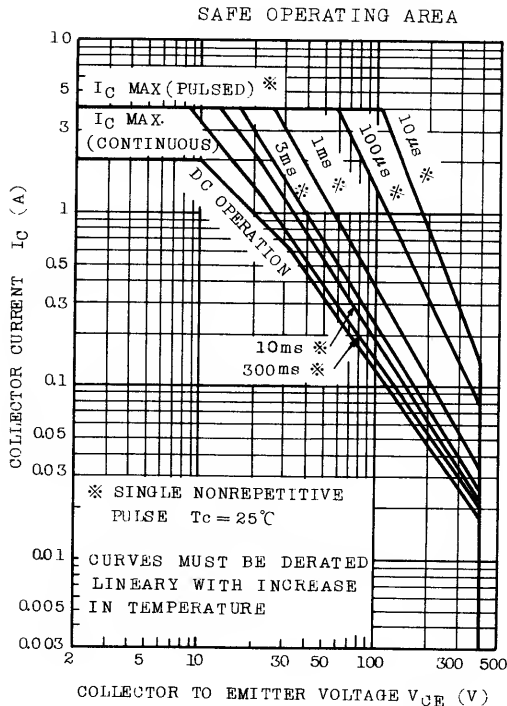
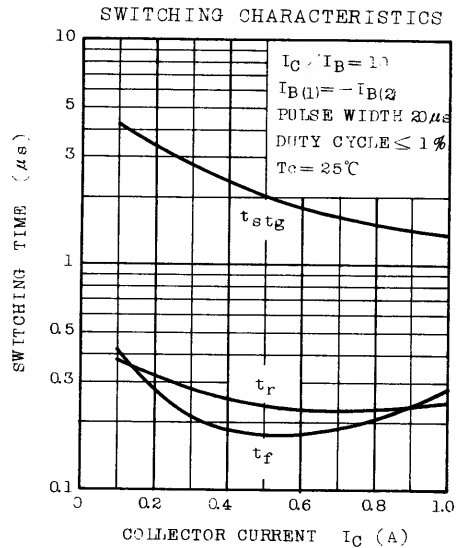
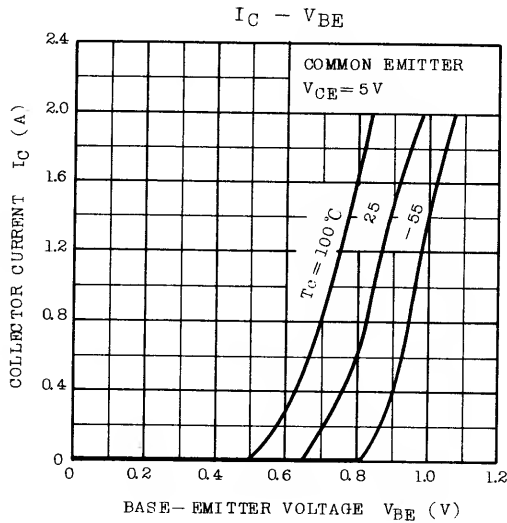


$V_{CE(sat)} - I_C$



$V_{BE(sat)} - I_C$





2SC2553

SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE
SWITCHING APPLICATIONS.
HIGH SPEED DC-DC CONVERTER APPLICATION.

INDUSTRIAL APPLICATIONS

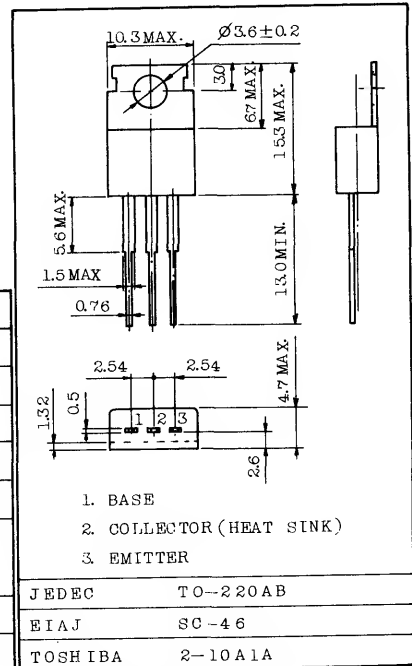
Unit in mm

FEATURES:

- Excellent Switching Times
: $t_r=1.0\mu s$ (Max.), $t_f=1.0\mu s$ (Max.) at $I_C=4A$
- High Collector Breakdown Voltage : $V_{CEO}=400V$

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	500	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	5	A
Base Current	I_B	1	A
Collector Power Dissipation	P_C	Ta=25°C	1.5
		Tc=25°C	40
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~ 150	°C



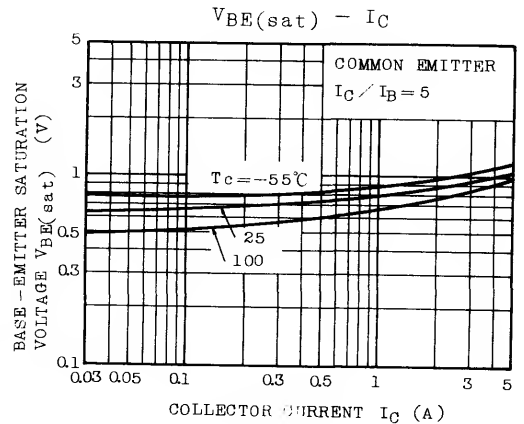
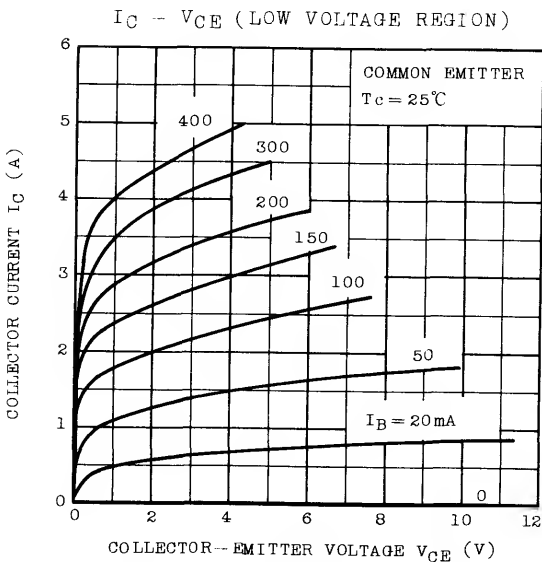
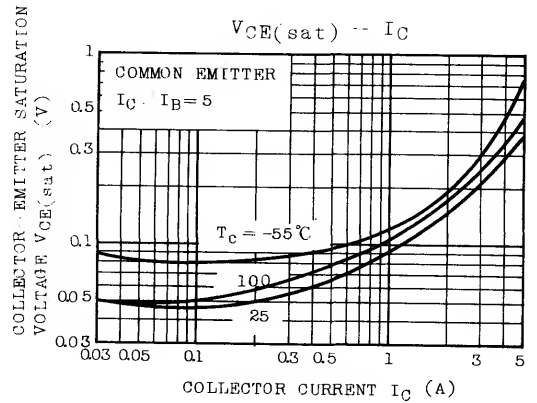
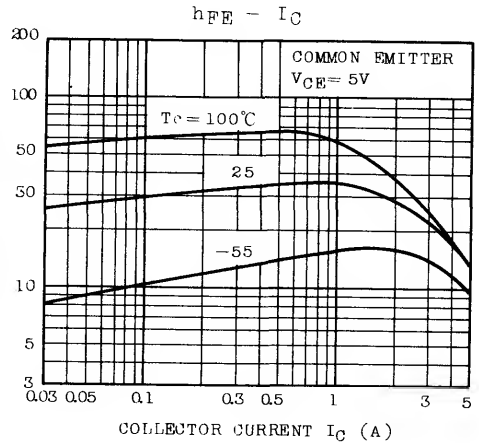
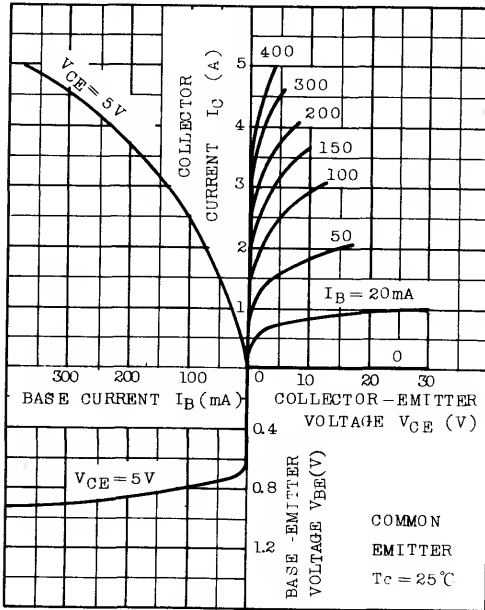
Mounting kit No. AC75

Weight : 1.9g

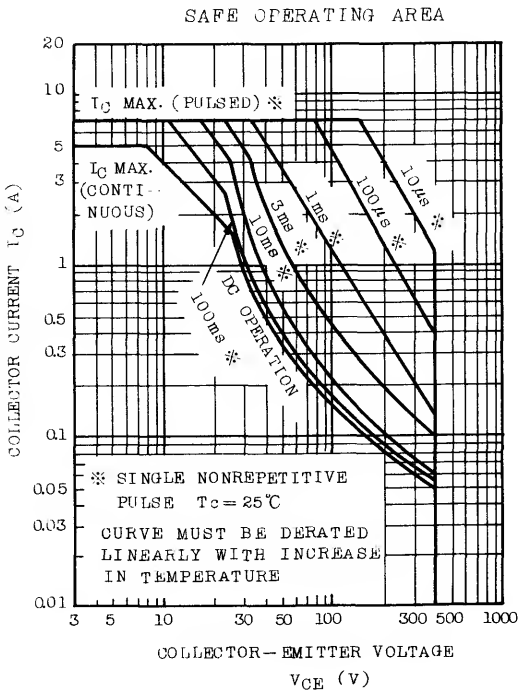
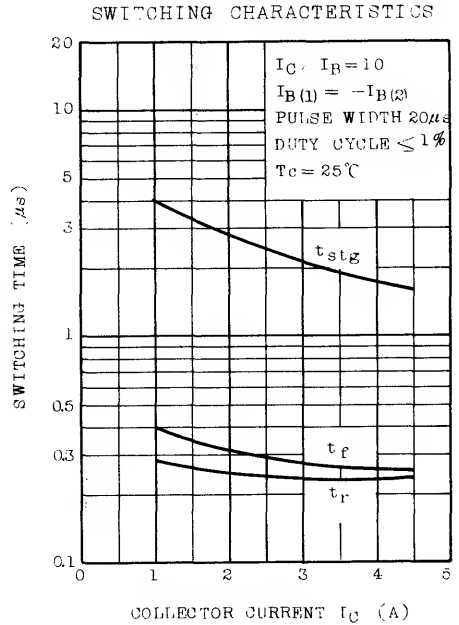
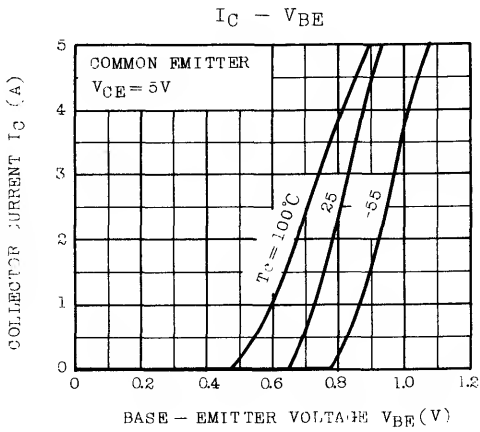
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT		
Collector Cut-off Current	I_{CBO}	$V_{CB}=400V, I_E=0$	-	-	100	A		
Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA		
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	500	-	-	V		
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	400	-	-	V		
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=3A$	12	-	-			
		$V_{CE}=5V, I_C=5A$	8	-	-			
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=5A, I_B=1A$	-	-	1.0	V		
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=5A, I_B=1A$	-	-	1.5	V		
Switching Time	Rise Time	t_r			-	-	1.0	μs
	Storage Time	t_{stg}			-	-	2.5	
	Fall Time	t_f			-	-	1.0	

STATIC CHARACTERISTICS



2SC2553



SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

- Excellent Switching Times
 : $t_r=1.0 \mu s$ (Max.) , $t_f=1.0 \mu s$ (Max.) at $I_C=4A$
- High Collector Breakdown Voltage : $V_{CE0}=400V$

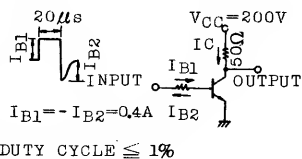
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	500	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	8	A
Base Current	I_B	4	A
Collector Power Dissipation	P_C	Ta=25°C	2.5
		Tc=25°C	80
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

Weight : 4.6g

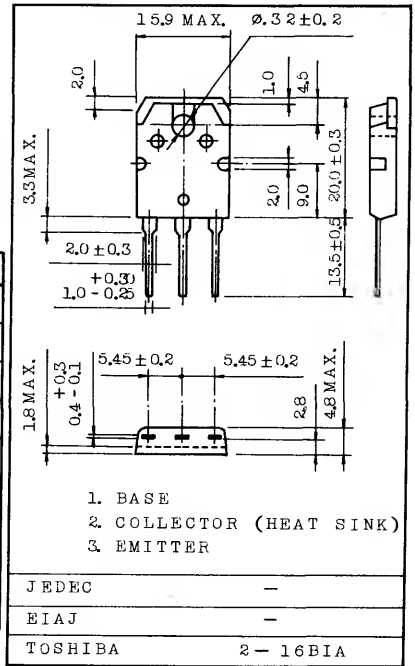
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=400V, I_E=0$	—	—	100	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V, I_C=0$	—	—	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	500	—	—	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	400	—	—	V
DC Current Gain	$h_{FE(1)}$	$V_{CE}=5V, I_C=1A$	15	—	—	
	$h_{FE(2)}$	$V_{CE}=5V, I_C=4A$	10	—	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A, I_B=0.8A$	—	—	1.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4A, I_B=0.8A$	—	—	1.5	V
Switching Time	Rise Time	t_r	—	—	1.0	μs
	Stotage Time	t_{stg}	—	—	2.5	
	Fall Time	t_f	—	—	1.0	



INDUSTRIAL APPLICATIONS

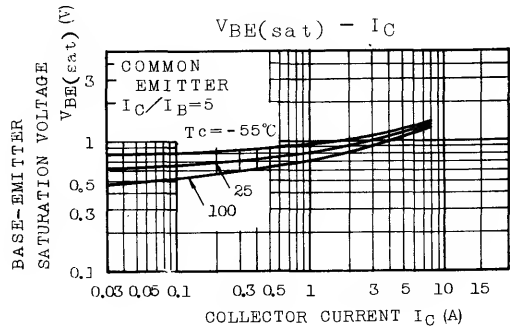
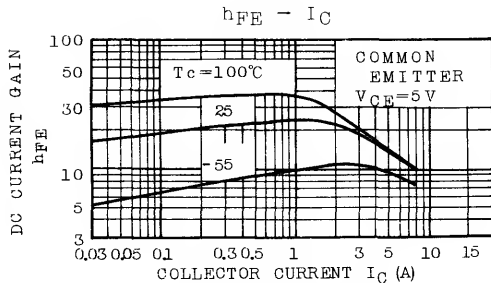
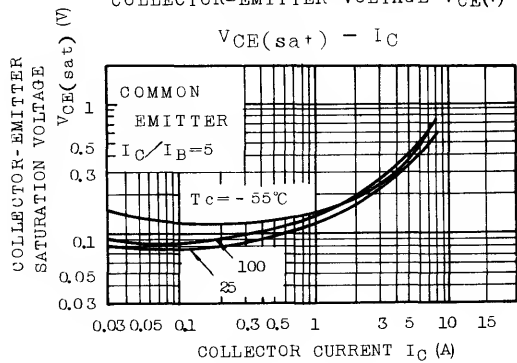
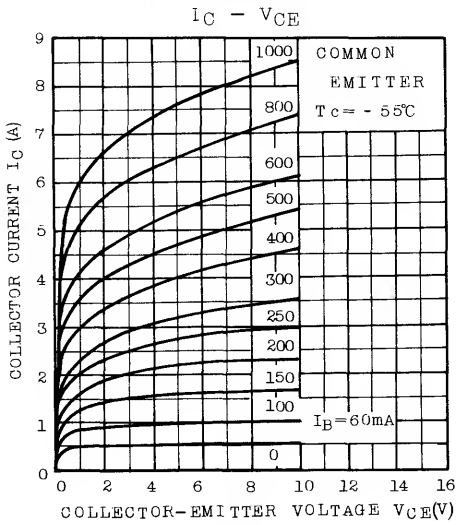
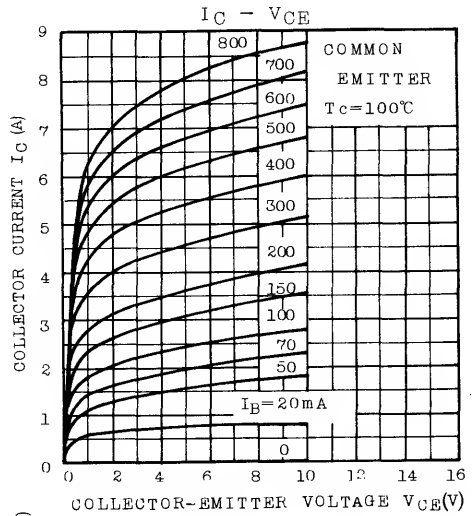
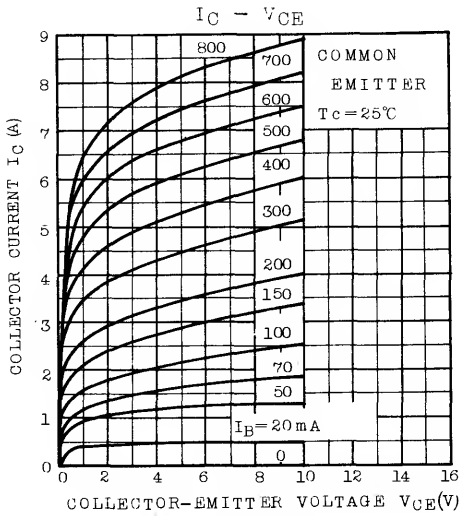
Unit in mm

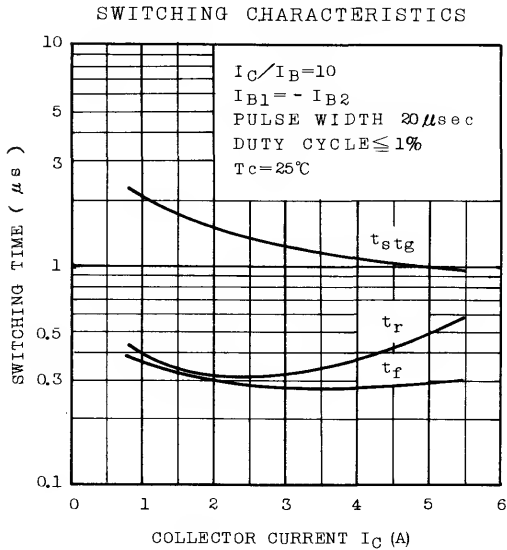
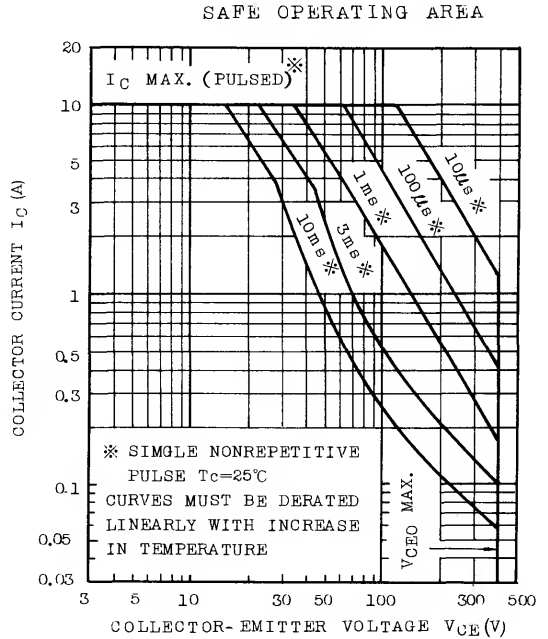
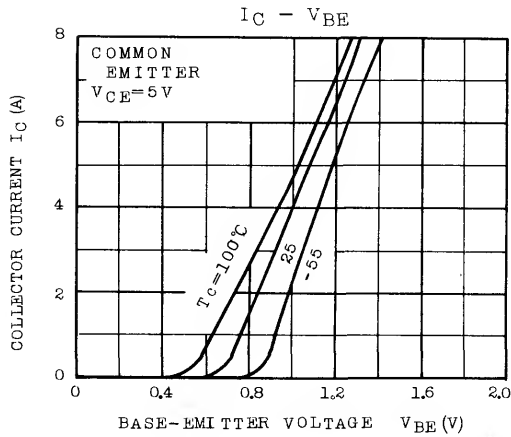


1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

JEDEC -
 EIAJ -
 TOSHIBA 2-16BIA

2SC2555





2SC2562

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

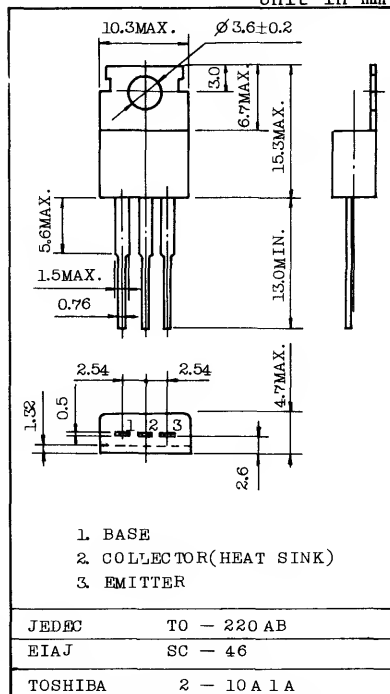
- Low Collector Saturation Voltage :
 $V_{CE(sat)} = 0.4V$ (Max.) (at $I_C = 3A$)
- High Speed Switching Time : $t_{stg} = 1.0\mu s$ (Typ.)
- Complementary to 2SA1012.

MAXIMUM RATINGS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CEO}	50	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	5	A
Collector Power Dissipation ($T_c = 25^\circ C$)	P_C	25	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55~150	$^\circ C$

INDUSTRIAL APPLICATIONS

Unit in mm



ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

Mounting Kit No. AC75

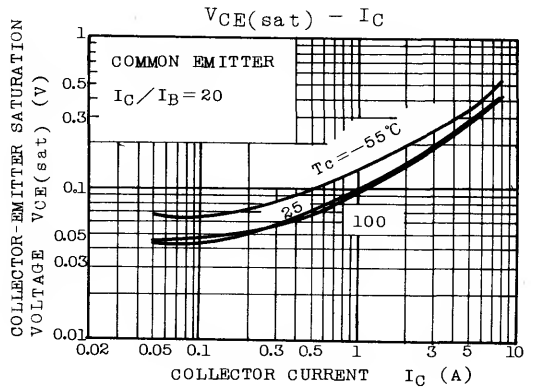
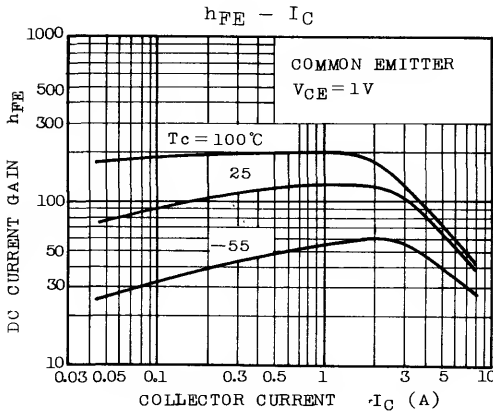
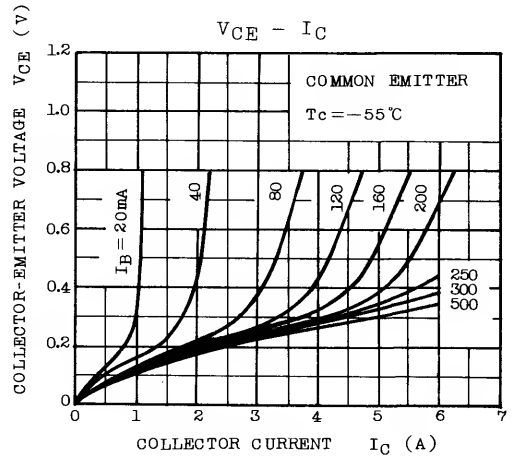
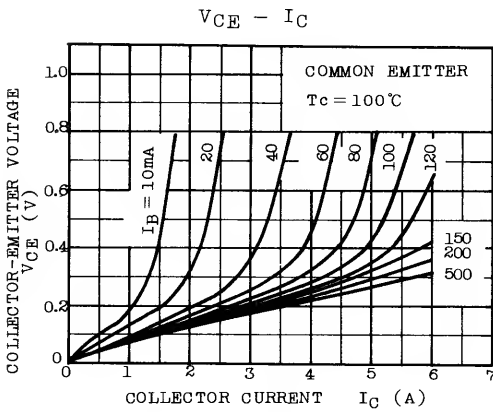
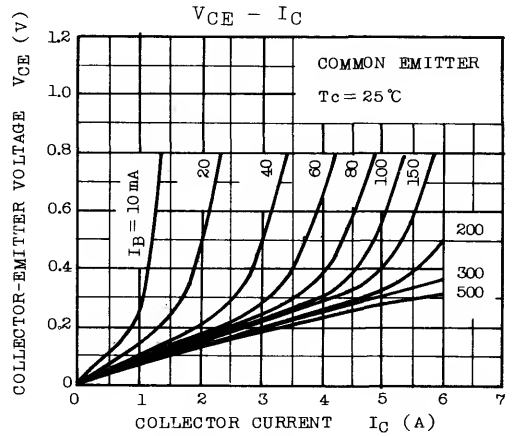
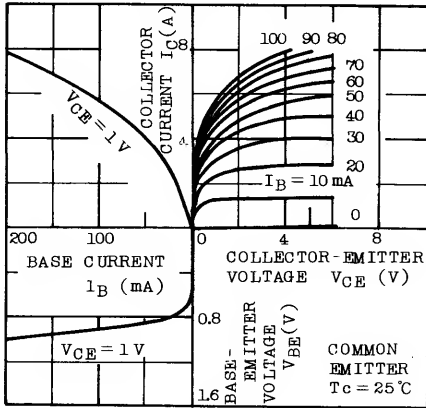
Weight : 1.9g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB} = 50V, I_E = 0$	-	-	1	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB} = 5V, I_C = 0$	-	-	1	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C = 10mA, I_B = 0$	50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE} = 1V, I_C = 1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE} = 1V, I_C = 3A$	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C = 3A, I_B = 0.15A$	-	0.2	0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C = 3A, I_B = 0.15A$	-	0.9	1.2	
Transition Frequency		f_T	$V_{CE} = 4V, I_C = 1A$	-	120	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB} = 10V, I_E = 0, f = 1MHz$	-	80	-	pF
Switching Time	Turn-on Time	t_{on}	 $I_{B1} = -I_{B2} = 0.15A$ DUTY CYCLE $\leq 1\%$ $V_{CC} = 30V$	-	0.1	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

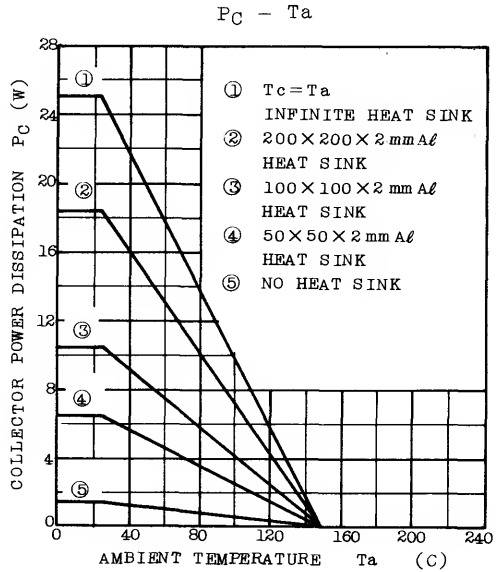
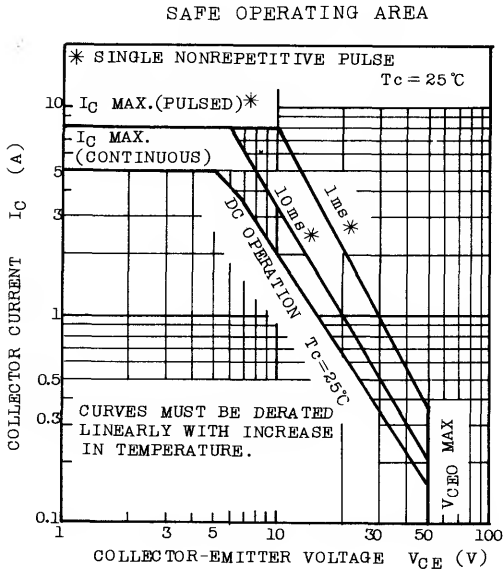
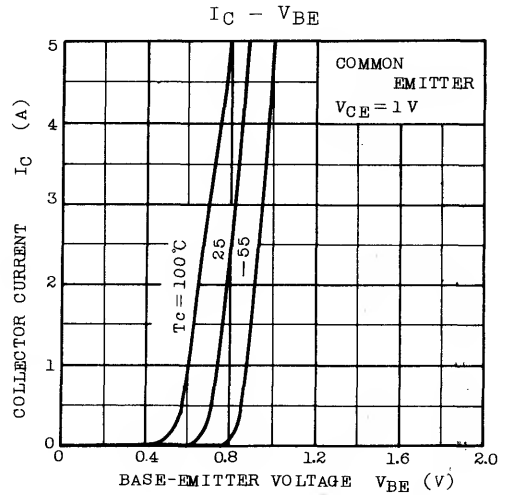
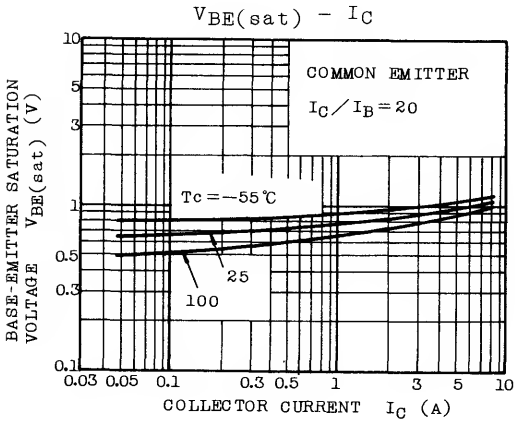
Note : $h_{FE(1)}$ Classification 0 : 70~140, Y : 120~240

TOSHIBA CORPORATION

STATIC CHARACTERISTICS



2SC2562



Unit in mm

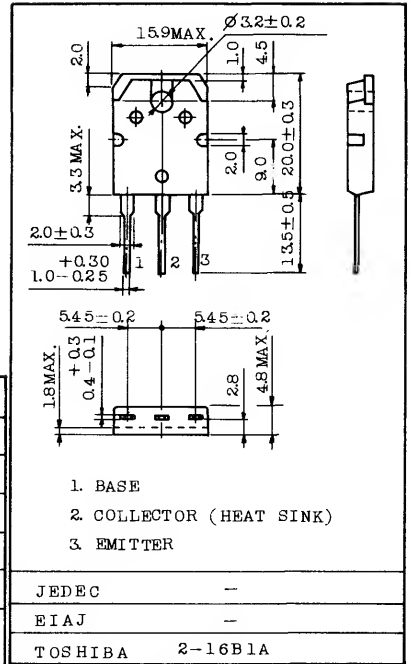
AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Complementary to 2SA1093.
- . Recommended for 50W audio amplifier output stage.
- . High transition frequency : $f_T=90\text{MHz}$ (Typ.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	120	V
Collector-Emitter Voltage	V _{CE0}	120	V
Emitter-Base Voltage	V _{EB0}	5	V
Collector Current	I _C	8	A
Base Current	I _B	0.8	A
Collector Power Dissipation (T _c =25°C)	P _C	80	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55~150	°C

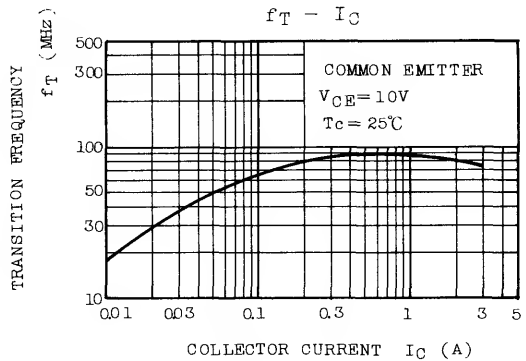
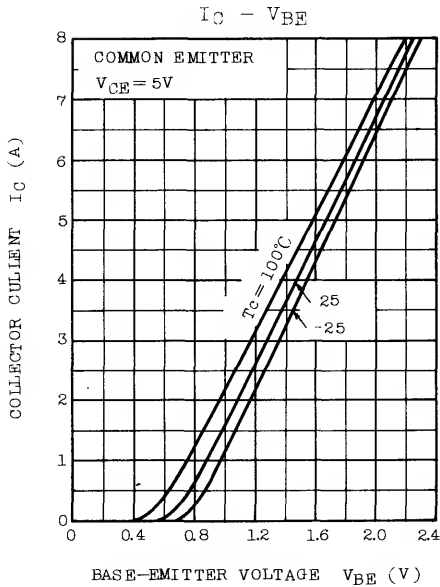
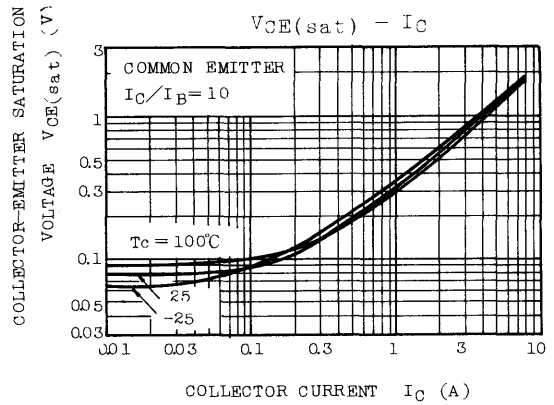
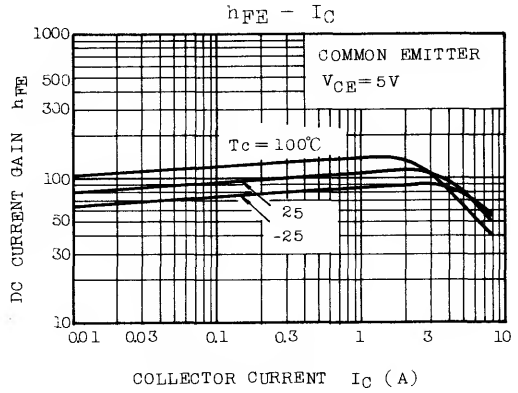
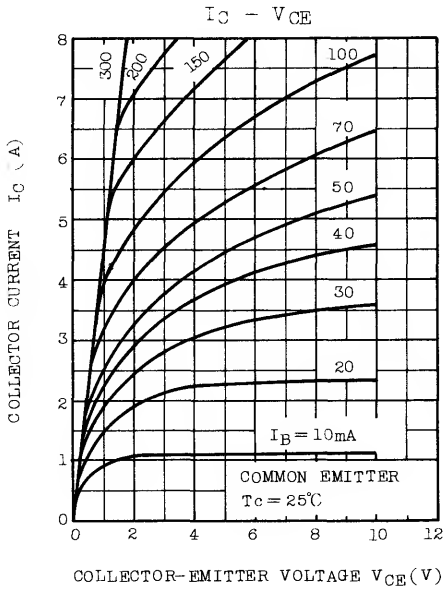


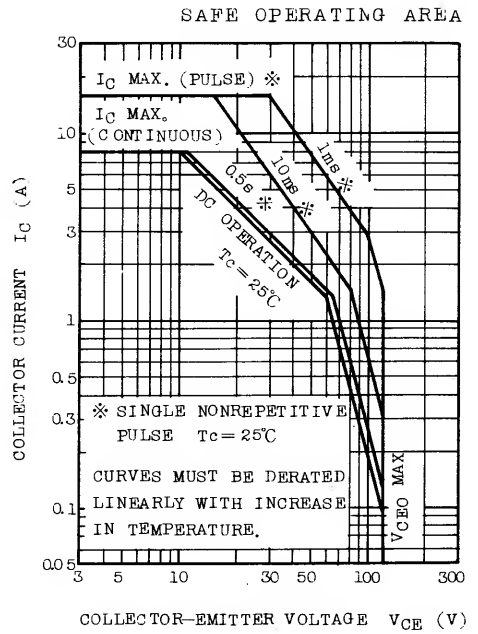
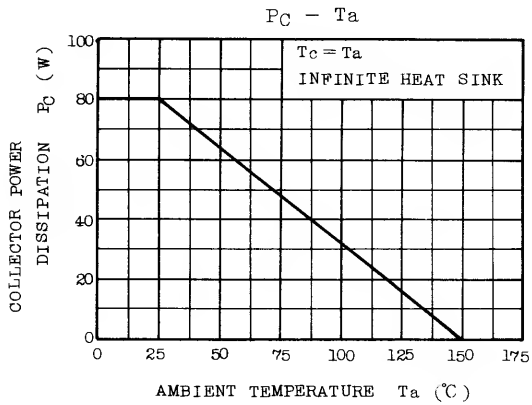
Weight : 4.6g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =120V, I _E =0	-	-	50	μA
Emitter Cut-off Current	I _{EB0}	V _{EB} =5V, I _C =0	-	-	50	μA
Collector-Emitter Breakdown Voltage	V(BR) _{CEO}	I _C =0.05A, I _B =0	120	-	-	V
DC Current Gain	h _{FE} (1) (Note)	V _{CE} =5V, I _C =1A	55	-	240	
	h _{FE} (2)	V _{CE} =5V, I _C =4A	30	-	-	
Collector Emitter Saturation Voltage	V _{CE(sat)}	I _C =4A, I _B =0.4A	-	1.0	2.0	V
Base-Emitter Voltage	V _{BE}	V _{CE} =5V, I _C =4A	-	1.5	2.5	V
Transition Frequency	f _T	V _{CE} =10V, I _C =1A	-	90	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	90	-	pF

Note: h_{FE} Classification. R:55~110, O:80~160, Y:120~240





2SC2564

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

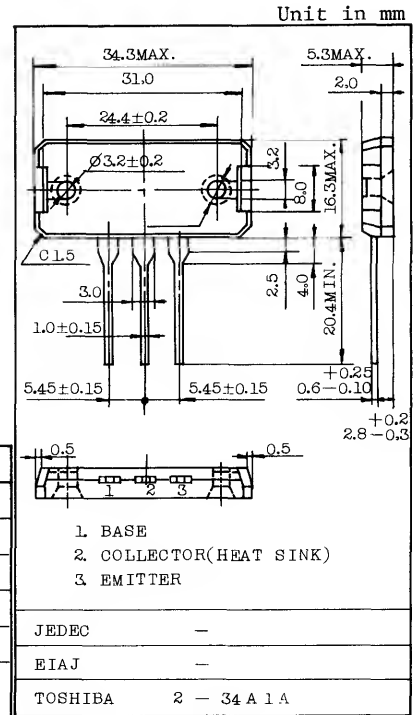
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : $V_{CEO}=140V$
- High Transition Frequency : $f_T=90MHz$ (Typ.)
- Complementary to 2SA1094.
- Recommended for 80W High-Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	140	V
Collector-Emitter Voltage	V_{CEO}	140	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	12	A
Emitter Current	I_E	-12	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	120	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55~150	$^\circ C$



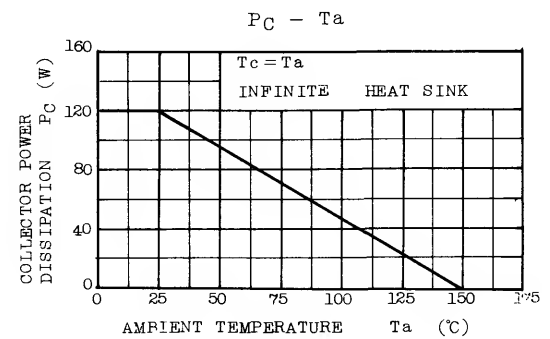
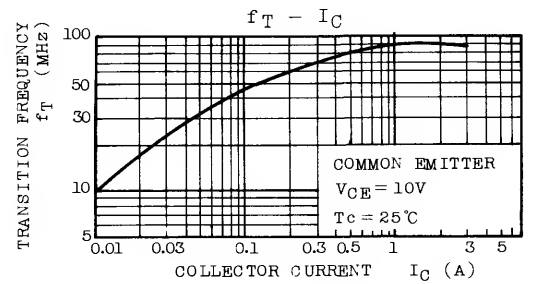
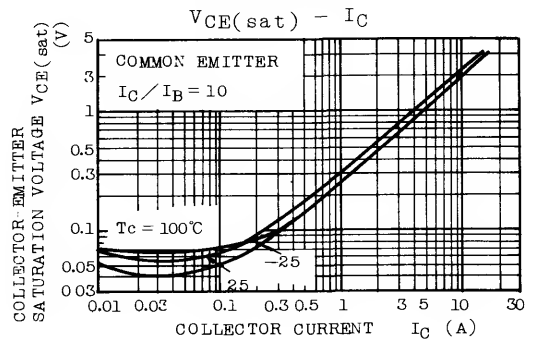
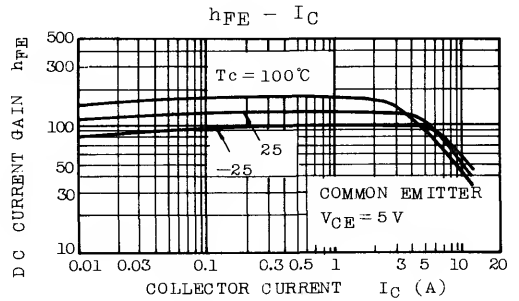
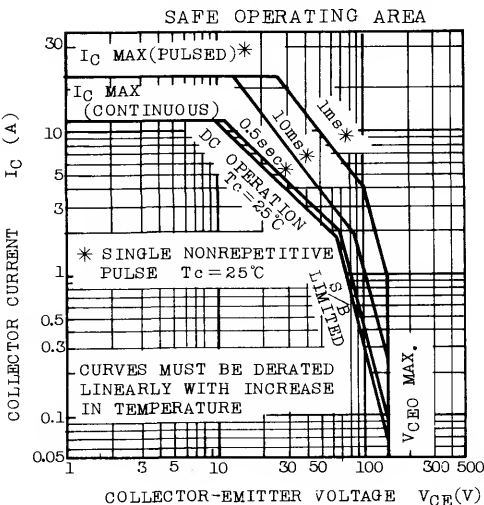
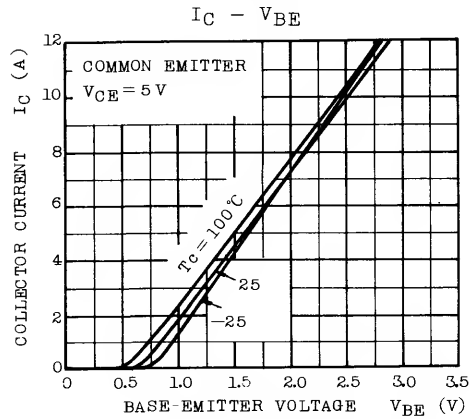
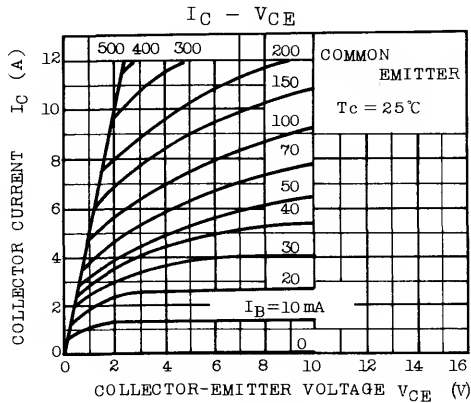
Weight : 10.8g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=140V, I_E=0$	-	-	50	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	50	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=0.1A, I_B=0$	140	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=0.01A, I_C=0$	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=5V, I_C=1A$	55	-	240	
	$h_{FE(2)}$	$V_{CE}=5V, I_C=5A$	30	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=5A, I_B=0.5A$	-	-	2.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5V, I_C=5A$	-	-	2.0	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=1A$	-	90	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	130	-	pF

Note : $h_{FE(1)}$ Classification R : 55~110, O : 80~160, Y : 120~240

TOSHIBA CORPORATION



2SC2565

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

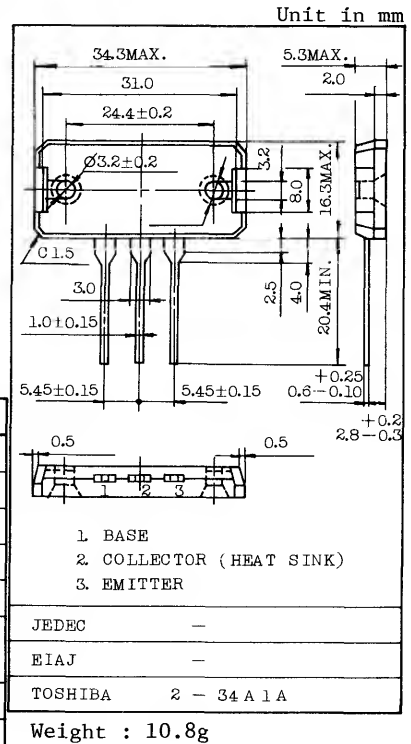
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : $V_{CE0}=160V$
- High Transition Frequency : $f_T=80MHz$ (Typ.)
- Complementary to 2SA1095.
- Recommended for 100W High-Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS ($T_a=25^\circ C$)

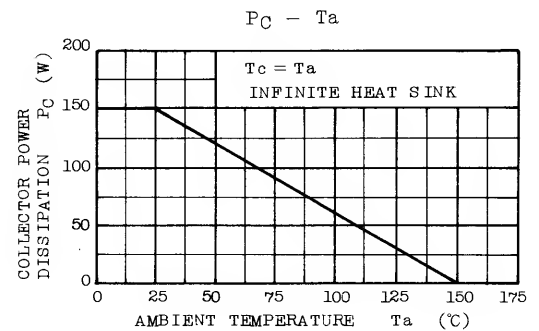
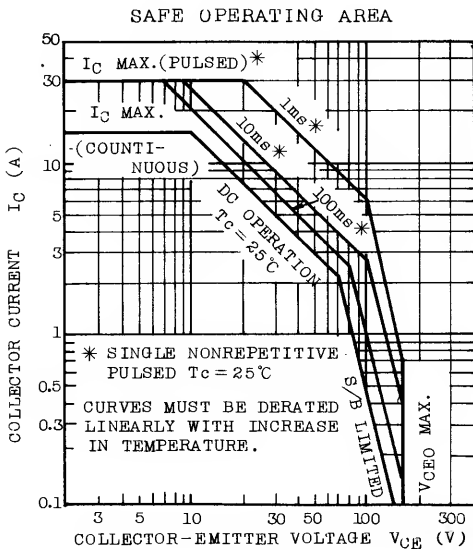
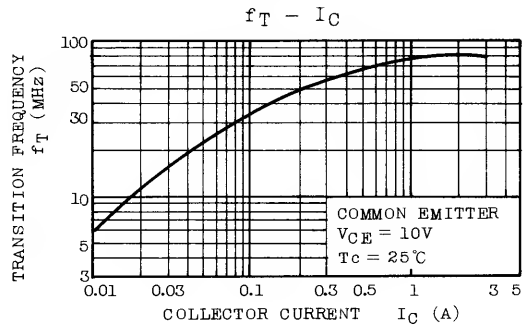
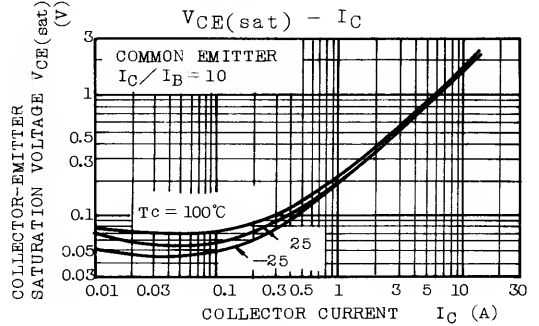
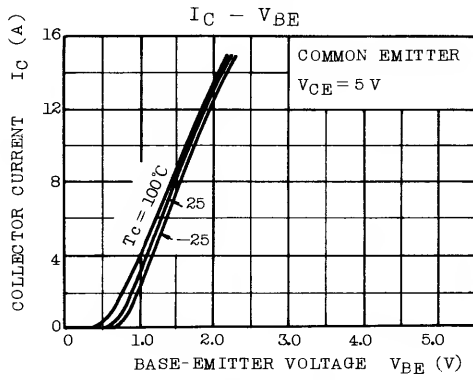
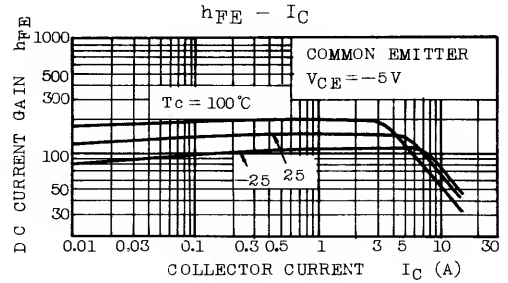
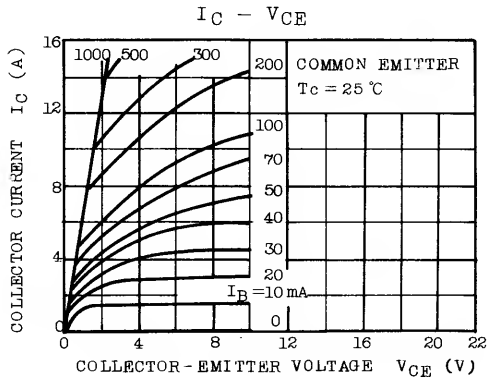
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	160	V
Collector-Emitter Voltage	V_{CEO}	160	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	15	A
Emitter Current	I_E	-15	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	150	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55~150	$^\circ C$



ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=160V, I_E=0$	-	-	50	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	50	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=0.1A, I_B=0$	160	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=0.01A, I_C=0$	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=5V, I_C=1A$	55	-	240	
	$h_{FE(2)}$	$V_{CE}=5V, I_C=5A$	40	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=5A, I_B=0.5A$	-	-	2.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5V, I_C=5A$	-	-	2.0	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=1A$	-	80	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	200	-	pF

Note : $h_{FE(1)}$ Classification R : 55~110, O : 80~160, Y : 120~240



2SC2638

SILICON NPN EPITAXIAL PLANAR TYPE

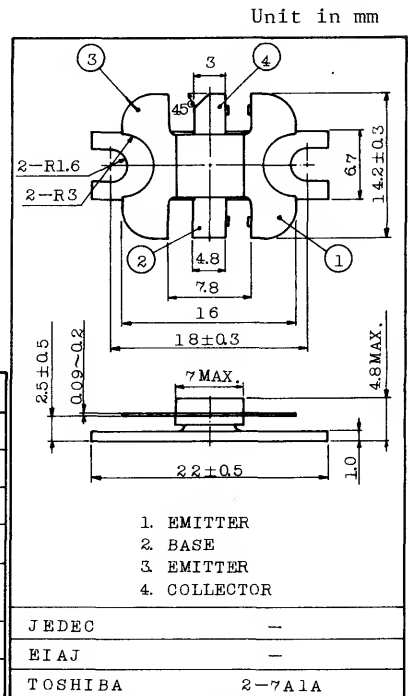
VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : $P_o=6W$ (Min.)
($f=175MHz$, $V_{CC}=12.5V$, $P_i=0.5W$)

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	2	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	15	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$

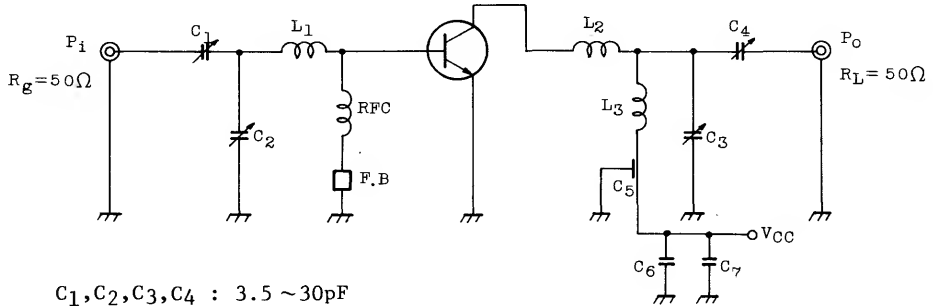


Weight : 1.6g

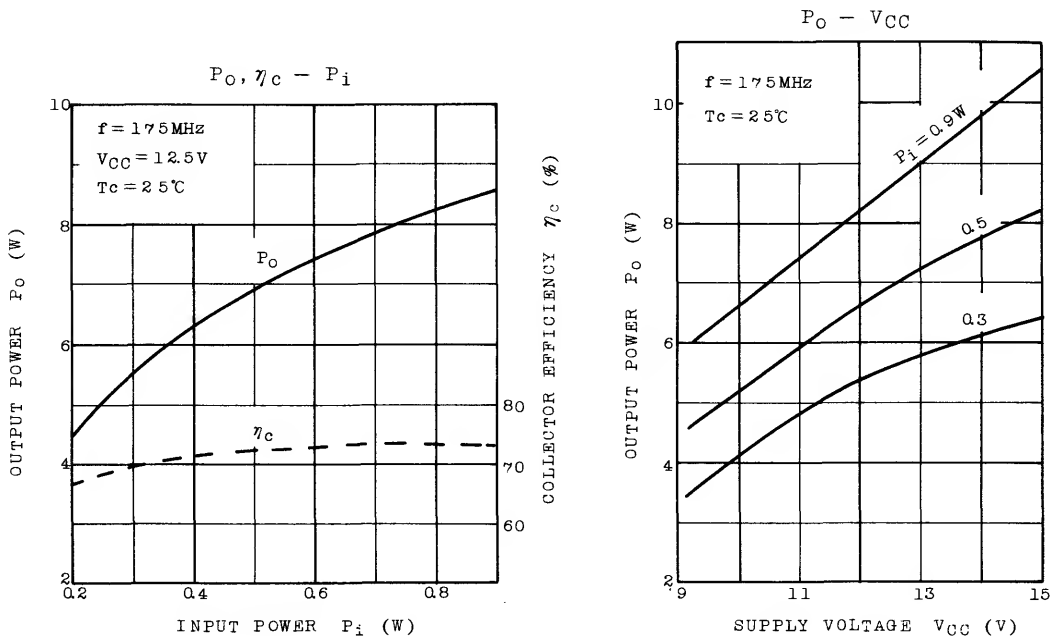
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	0.1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1mA$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA$, $I_B=0$	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=1A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	-	25	pF
Output Power	P_o	(Fig.)	6	7	-	W
Power Gain	G_{pe}	$V_{CC}=12.5V$, $f=175MHz$,	10.7	11.5	-	dB
Collector Efficiency	η_c	$P_i=0.5W$	60	72	-	%
Series Equivalent Input Impedance	Z_{in}	$V_{CC}=12.5V$, $f=175MHz$,	-	3.5 +j4.0	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=6W$	-	10 -j1.5	-	Ω

Fig. P_o TEST CIRCUIT



- C₁, C₂, C₃, C₄ : 3.5 ~ 30pF
- C₅ : 0.01μF FEED THROUGH
- C₆ : 0.033μF CERAMIC CONDENSER
- C₇ : 10μF
- L₁, L₂ : φ1 SILVER PLATED COPPER WIRE, 12ID, 1T
- L₃ : φ1 SILVER PLATED COPPER WIRE, 12ID, 2T
- RFC : φ0.5 ENAMEL COATED COPPER WIRE, 6ID, 10T
- FB : FERRITE BEADS



2SC2639

SILICON NPN EPITAXIAL PLANAR TYPE

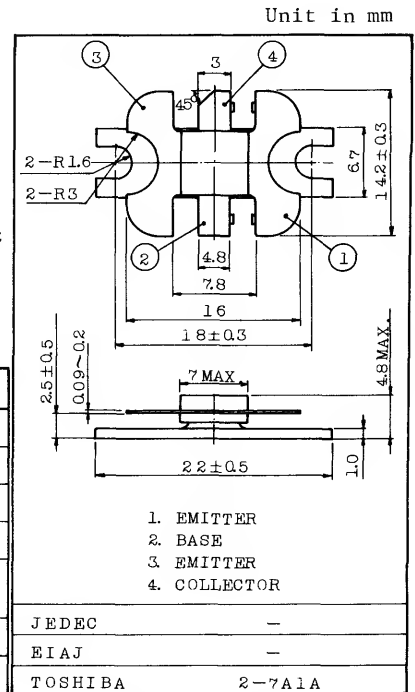
VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : $P_o=15W$ (Min.)
($f=175MHz$, $V_{CC}=12.5V$, $P_i=1.3W$)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=12.5V$, $P_i=1.3W$, $f=175MHz$

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	3.5	A
Collector Power Dissipation (Tc=25°C)	P_C	35	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65 ~ 175	°C

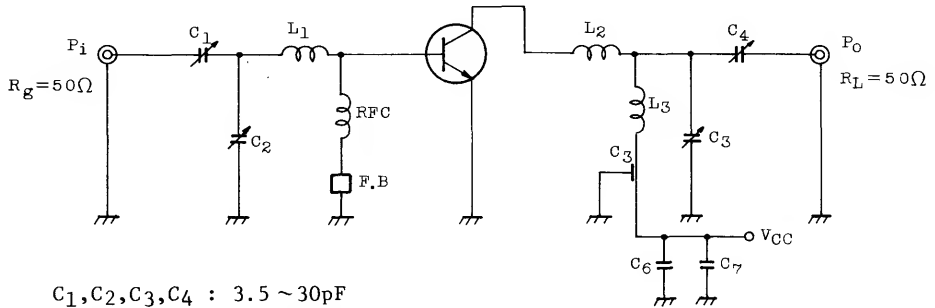


Weight : 1.6g

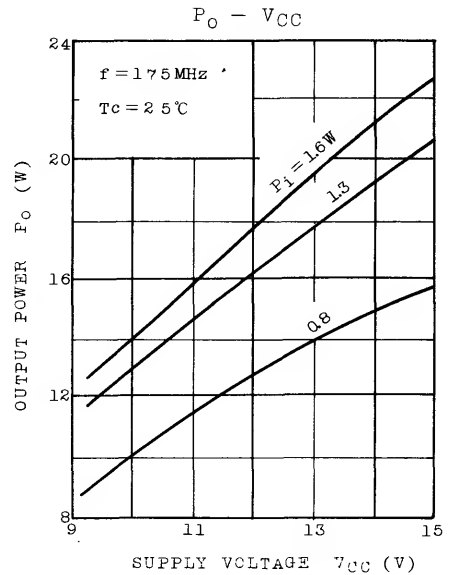
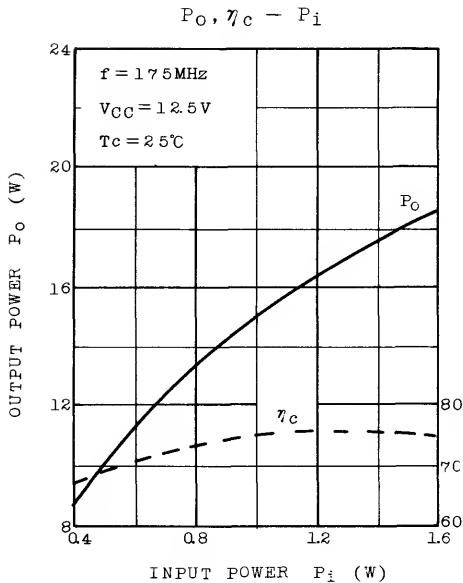
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1.0	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=10mA$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=25mA$, $I_B=0$	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=1A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	-	80	pF
Output Power	P_o	(Fig.)	15	17	-	W
Power Gain	G_{pe}	$V_{CC}=12.5V$, $f=175MHz$, $P_i=1.3W$	10.6	11.2	-	dB
Collector Efficiency	η_c		60	75	-	%
Series Equivalent Input Impedance	Z_{in}	$V_{CC}=12.5V$, $f=175MHz$, $P_o=15W$	-	1.5 -j2.0	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	5.0 -j1.0	-	Ω

Fig. P_o TEST CIRCUIT



- C₁, C₂, C₃, C₄ : 3.5 ~ 30pF
- C₅ : 0.01µF FEED THROUGH
- C₆ : 0.033µF CERAMIC CONDENSER
- C₇ : 10µF
- L₁, L₂ : ϕ 1 SILVER PLATED COPPER WIRE, 12ID, 1T
- L₃ : ϕ 1 SILVER PLATED COPPER WIRE, 12ID, 2T
- RFC : ϕ 0.5 ENAMEL COATED COPPER WIRE, 6ID, 10T
- FB : FERRITE BEADS



2SC2640

SILICON NPN EPITAXIAL PLANAR TYPE

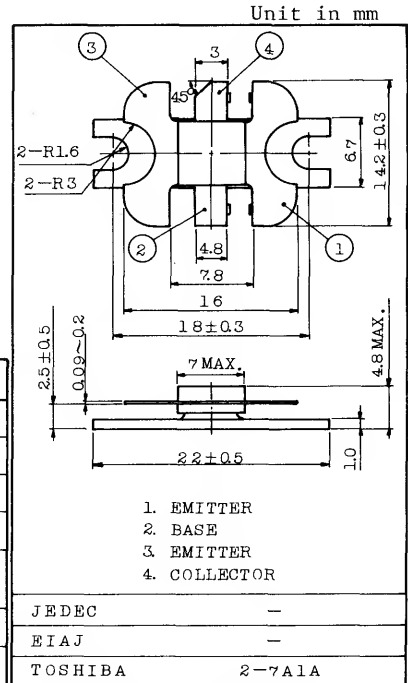
VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- . Output Power : $P_o=28W$ (Min.)
($f=175MHz$, $V_{CC}=12.5V$, $P_i=4W$)
- . 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=14.5V$, $P_i=4W$, $f=175MHz$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	4.0	V
Collector Current	I_C	6	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	70	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$

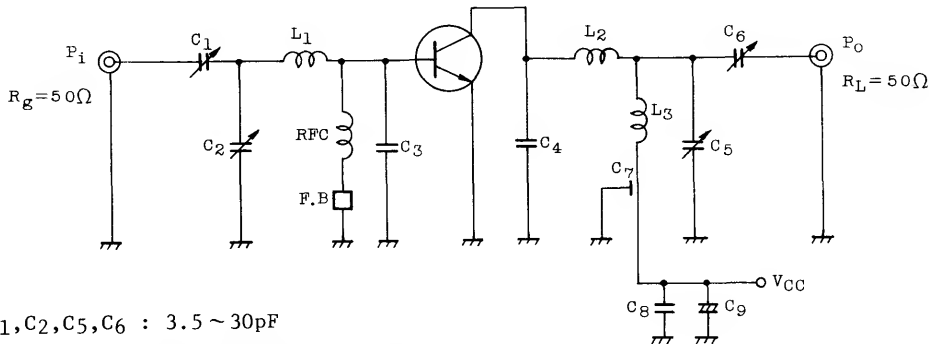


Weight : 1.6g

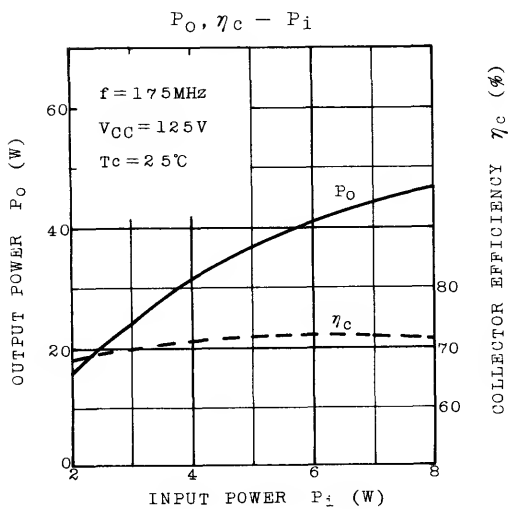
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	2	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=10mA$, $I_E=0$	40	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=25mA$, $I_B=0$	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA$, $I_C=0$	4	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=5A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	110	160	pF
Output Power	P_o	(Fig.)	28	31	-	W
Power Gain	G_{pe}	$V_{CC}=12.5V$, $f=175MHz$, $P_i=4W$	8.4	8.9	-	dB
Collector Efficiency	η_c		60	71	-	%
Series Equivalent Input Impedance	Z_{in}	$V_{CC}=12.5V$, $f=175MHz$, $P_o=28W$	-	0.95 +j3.0	-	Ω
Series Equivalent Output Impedance	Z_{OUT}		-	2.0 +j1.5	-	Ω

Fig. P_O TEST CIRCUIT



- C₁, C₂, C₅, C₆ : 3.5 ~ 30pF
- C₃ : 68pF CERAMIC CONDENSER
- C₄ : 82pF CERAMIC CONDENSER
- C₇ : 1000pF FEED THROUGH
- C₈ : 0.02μF CERAMIC CONDENSER
- C₉ : 10μF
- L₁, L₂ : φ1 SILVER PLATED COPPER WIRE, 12ID, 1T
- L₃ : φ1 SILVER PLATED COPPER WIRE, 12ID, 2T
- RFC : φ0.5 ENAMEL COATED COPPER WIRE, 6ID, 10T
- FB : FERRITE BEADS



2SC2641

SILICON NPN EPITAXIAL PLANAR TYPE

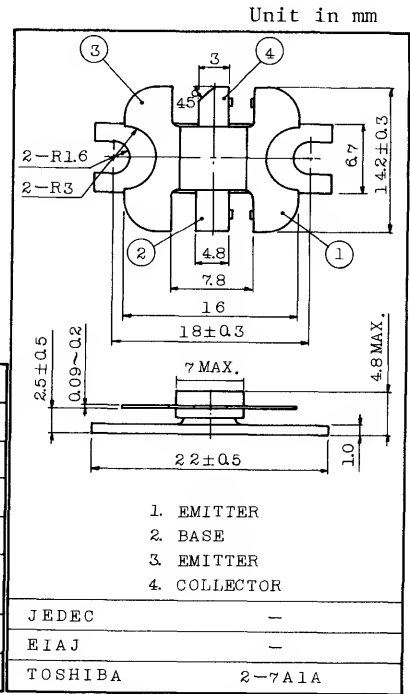
UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Output Power : $P_o=6W(\text{Min.})$
($f=470\text{MHz}$, $V_{CC}=12.6V$, $P_i=1W$)
- . 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=12.6V$, $P_o=6.5W$, $f=470\text{MHz}$

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	35	V
Collector-Emitter Voltage	V_{CE0}	17	V
Emitter-Base Voltage	V_{EB0}	3.5	V
Collector Current	I_C	1.4	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	15	W
Junction Temperature	T_j	175	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ\text{C}$

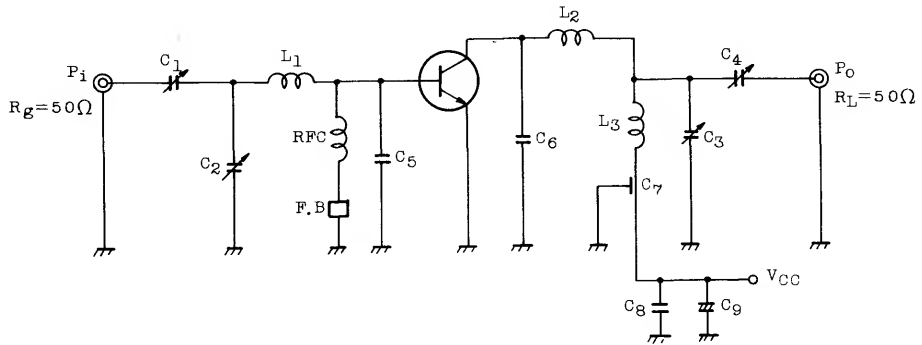


Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=15V$, $I_E=0$	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=2mA$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA$, $I_B=0$	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=0.2mA$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=1A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1\text{MHz}$	-	-	25	pF
Output Power	P_o	(Fig.)	6	-	-	W
Power Gain	G_{pe}	$V_{CC}=12.6V$, $f=470\text{MHz}$,	7.7	-	-	dB
Collector Efficiency	η_c	$P_i=1W$	60	-	-	%
Series Equivalent Input Impedance	Z_{IN}	$V_{CC}=12.6V$, $f=470\text{MHz}$,	-	$1.6+j4.5$	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=6W$	-	$6.5-j5$	-	Ω

Fig. f=470MHz P_O TEST CIRCUIT



C₁, C₂, C₃, C₄ : ~20pF

C₅, C₆ : 10pF

C₇ : 0.01μF

C₈ : 0.02μF

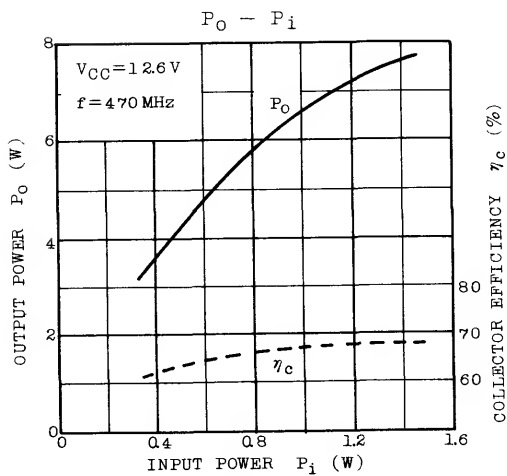
C₉ : 10μF

L₁, L₂ : 5mm × 10mm COPPER PLATE

L₃ : φ1 SILVER PLATED COPPER WIRE, 10ID, 2T

RFC : φ0.5 ENAMEL COATED COPPER WIRE, 7ID, 10T

F.B : FERRITE BEADS



2SC2642

SILICON NPN EPITAXIAL PLANAR TYPE

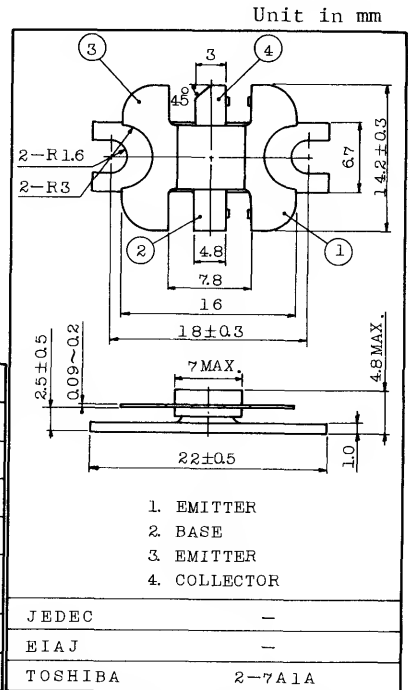
UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Output Power : $P_o=12W(\text{Min.})$
($f=470\text{MHz}$, $V_{CC}=12.6V$, $P_i=3W$)
- . 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=12.6V$, $P_i=3W$, $f=470\text{MHz}$

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	2.8	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	30	W
Junction Temperature	T_j	175	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ\text{C}$

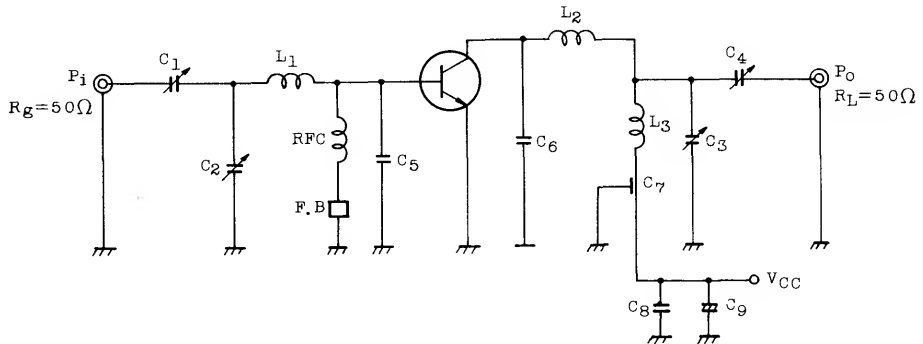


Weight : 1.6g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1.5	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=2\text{mA}$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10\text{mA}$, $I_B=0$	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=0.2\text{mA}$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=1.5A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1\text{MHz}$	-	-	45	pF
Output Power	P_o	(Fig.)	12	-	-	W
Power Gain	G_{pe}	$V_{CC}=12.6V$, $f=470\text{MHz}$,	6	-	-	dB
Collector Efficiency	η_c	$P_i=3W$	60	-	-	%
Series Equivalent Input Impedance	Z_{IN}	$V_{CC}=12.6V$, $f=470\text{MHz}$,	-	$1.2+j4$	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=12W$	-	$4+j0.5$	-	Ω

Fig. f=470MHz P_O TEST CIRCUIT



C₁, C₂, C₃, C₄ : ~20pF

C₅, C₆ : 10pF

C₇ : 0.01μF

C₈ : 0.02μF

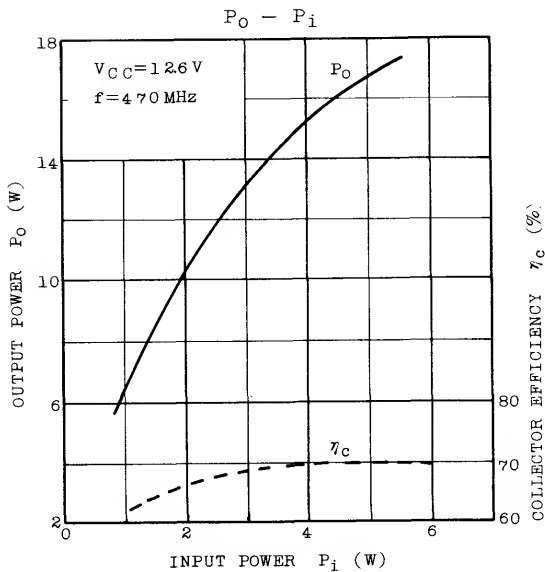
C₉ : 10μF

L₁, L₂ : 5mm × 10mm COPPER PLATE

L₃ : φ1 SILVER PLATED COPPER WIRE, 10ID, 2T

RFC : φ0.5 ENAMEL COATED COPPER WIRE, 7ID, 10T

F.B : FERRITE BEADS



2SC2643

SILICON NPN EPITAXIAL PLANAR TYPE

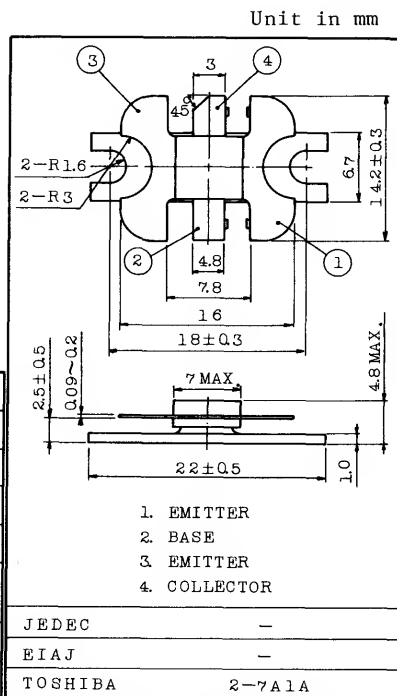
UHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Output Power : $P_o=25W$ (Min.)
($f=470MHz$, $V_{CC}=12.6V$, $P_i=8W$)
- . 100% Tested for Load Mismatch Stress at all Phase Angles with 30:1 VSWR @ $V_{CC}=12.6V$, $P_i=8W$, $f=470MHz$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	6	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	50	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$

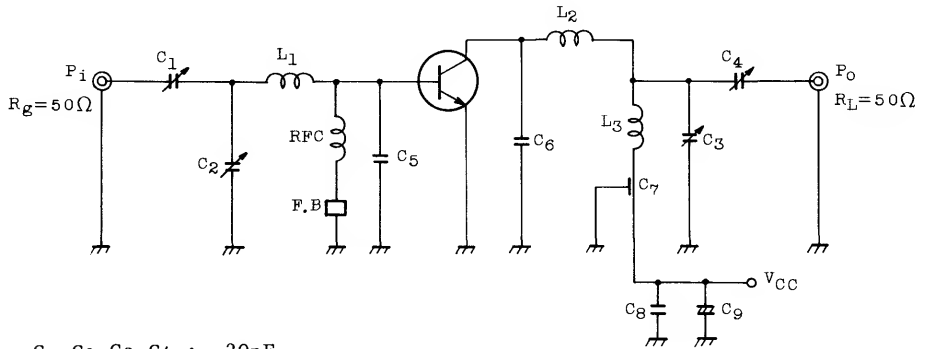


Weight : 1.6g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=10mA$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=25mA$, $I_B=0$	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=3A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	-	80	pF
Output Power	P_o	(Fig.)	25	27	-	W
Power Gain	G_{pe}	$V_{CC}=12.6V$, $f=470MHz$,	4.9	5.3	-	dB
Collector Efficiency	η_c	$P_i=8W$	60	-	-	%
Series Equivalent Input Impedance	Z_{IN}	$V_{CC}=12.6V$, $f=470MHz$,	-	$4+j3$	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=25W$	-	$3+j1$	-	Ω

Fig. $f=470\text{MHz}$ P_o TEST CIRCUIT



C_1, C_2, C_3, C_4 : $\sim 20\text{pF}$

C_5, C_6 : 10pF

C_7 : $0.01\mu\text{F}$

C_8 : $0.02\mu\text{F}$

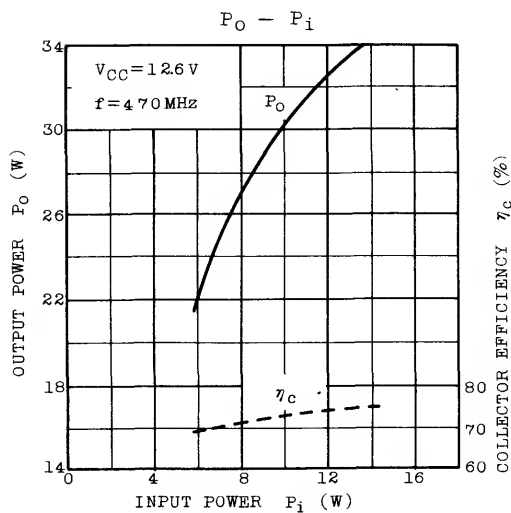
C_9 : $10\mu\text{F}$

L_1, L_2 : $5\text{mm} \times 10\text{mm}$ COPPER PLATE

L_3 : $\phi 1$ SILVER PLATED COPPER WIRE, 10ID, 2T

RFC : $\phi 0.5$ ENAMEL COATED COPPER WIRE, 7ID, 10T

F.B. : FERITE BEADS



2SC2650

SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

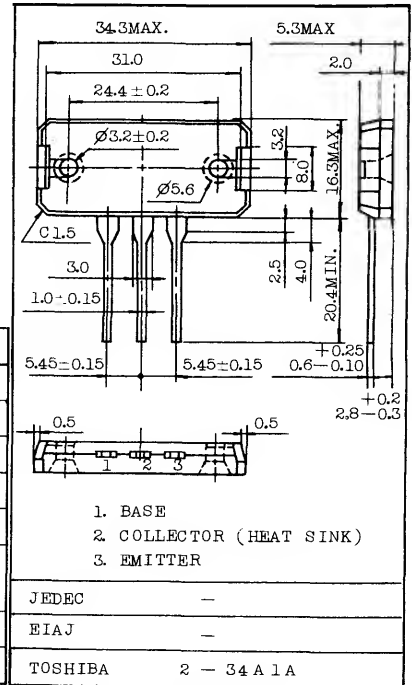
HIGH SPEED DC-DC CONVERTER APPLICATIONS.

FEATURES:

- Excellent Switching Times
: $t_r=1.0\mu s$ Max., $t_f=1.0\mu s$ Max. ($I_C=5A$)
- High Collector Breakdown Voltage : $V_{CEO}=400V$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	500	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	10	A
Base Current	I_B	5	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	100	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	$-55\sim 150$	$^\circ C$

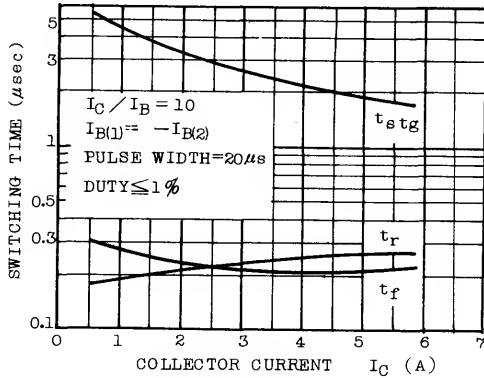


Weight : 10.8g

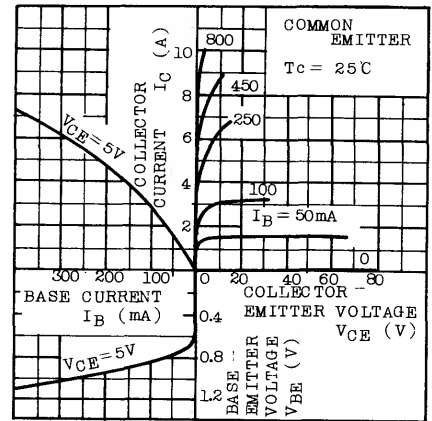
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=400V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	400	-	-	V
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	$I_E=1mA, I_C=0$	7	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=5A$	10	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=5A, I_B=0.5A$	-	-	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=5A, I_B=0.5A$	-	-	2.0	V
Switching Time	Rise Time	t_r		-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.0	

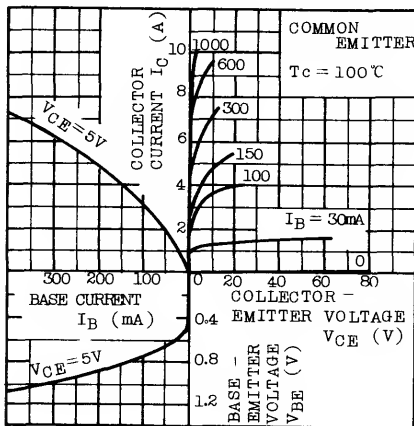
SWITCHING CHARACTERISTICS



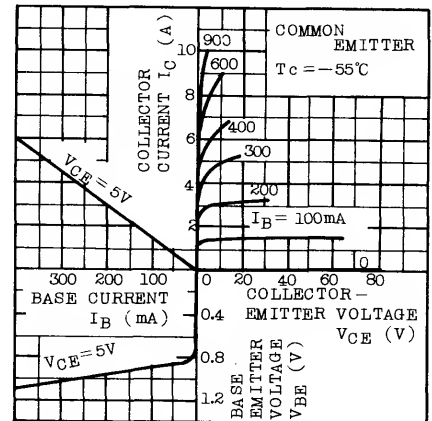
STATIC CHARACTERISTICS



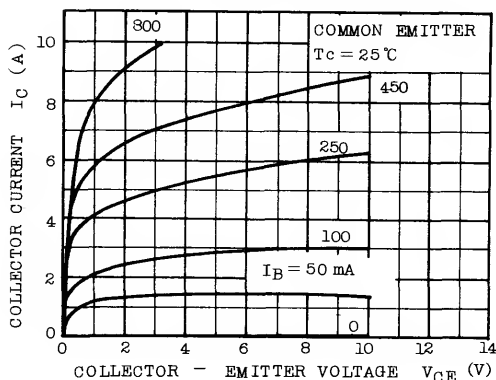
STATIC CHARACTERISTICS



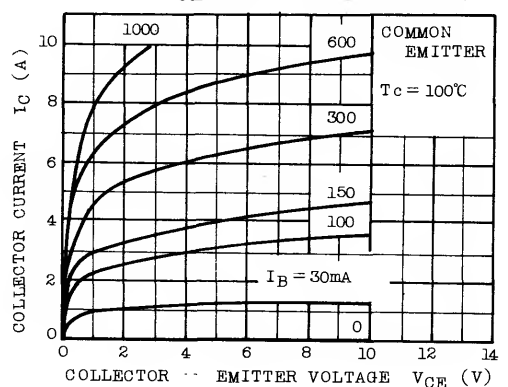
STATIC CHARACTERISTICS



$I_C - V_{CE}$ (LOW VOLTAGE REGION)

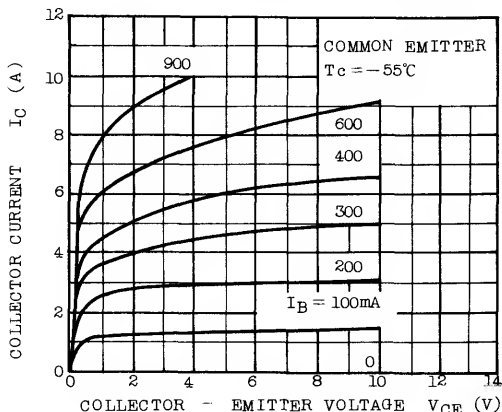


$I_C - V_{CE}$ (LOW VOLTAGE REGION)

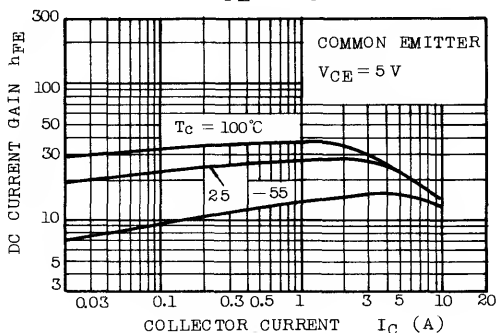


2SC2650

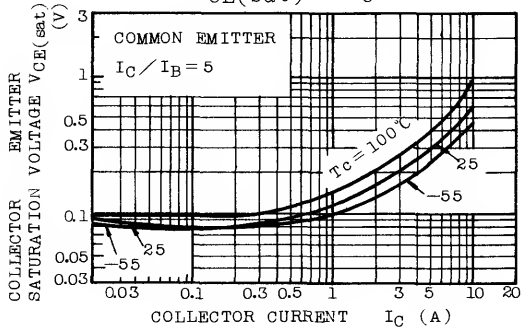
$I_C - V_{CE}$ (LOW VOLTAGE REGION)



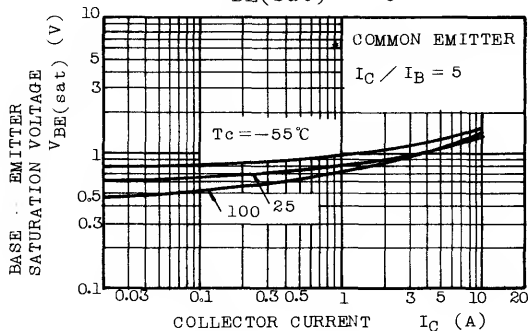
$h_{FE} - I_C$



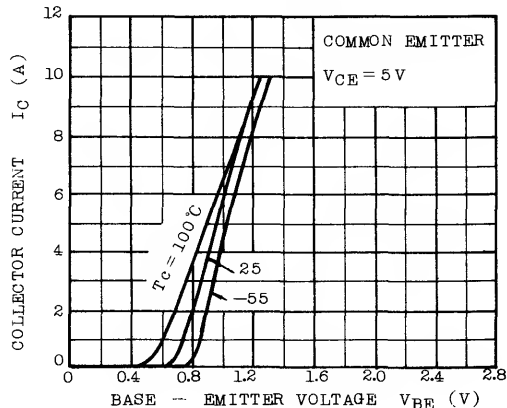
$V_{CE(sat)} - I_C$



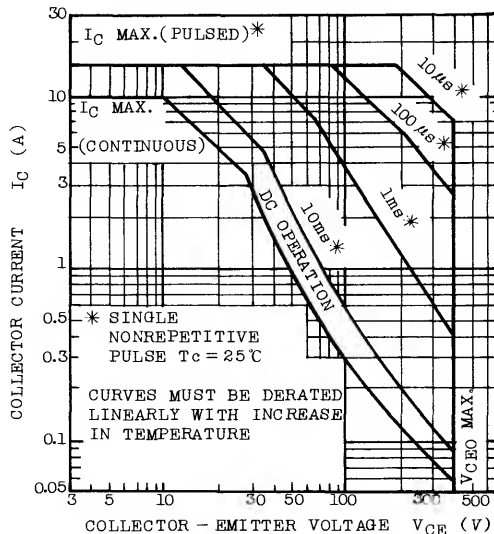
$V_{BE(sat)} - I_C$



$I_C - V_{BE}$



SAFE OPERATING AREA



2SC2652

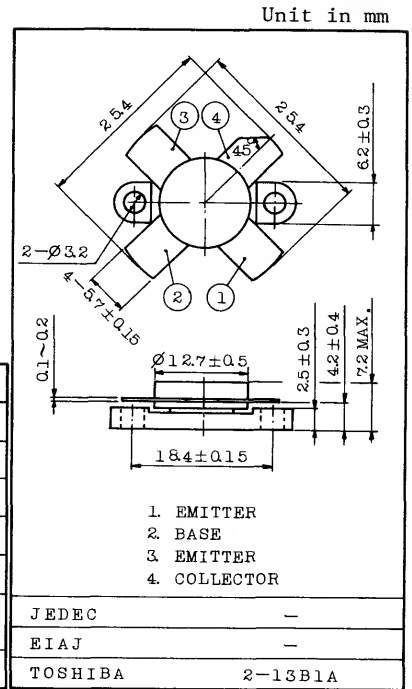
2~30MHz SSB LINEAR POWER AMPLIFIER APPLICATIONS.
(50V SUPPLY VOLTAGE USE)

FEATURES

- Specified 50V, 28MHz Characteristics
 - : Output Power : $P_o=200W_{PEP}$
 - : Minimum Gain : $G_{pe}=13dB$
 - : Efficiency : $\eta_c=35%$ (Min.)
 - : Intermodulation Distortion : $IMD=-30dB$ (Max.)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR
 - @ $V_{CC}=50V$, $P_o=150W_{PEP}$, $f=28MHz$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	85	V
Collector-Emitter Voltage	V_{CES}	85	V
Collector-Emitter Voltage	V_{CEO}	55	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	20	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	300	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$



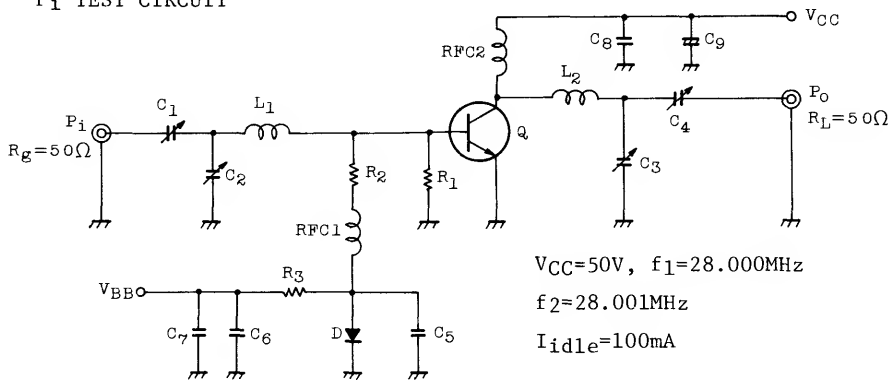
Weight : 5.2g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

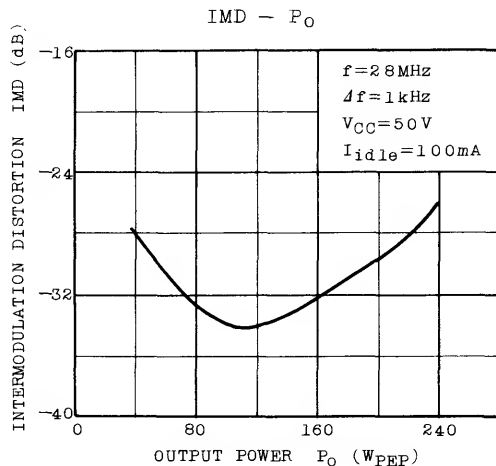
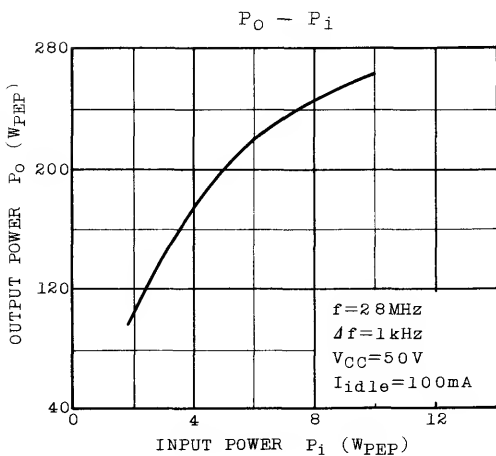
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=100mA$, $I_B=0$	55	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CES}$	$I_C=100mA$, $V_{BE}=0$	85	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA$, $I_C=0$	4	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=10A$	10	-	150	
Collector Output Capacitance	C_{ob}	$V_{CB}=50V$, $I_E=0$, $f=1MHz$	-	300	-	pF
Power Gain	G_{pe}	$V_{CC}=50V$, $f=28MHz$	13.0	15.2	-	dB
Input Power	P_i	2-Tone, $\Delta f=1kHz$	-	6	10	W_{PEP}
Collector Efficiency	η_c	$I_{idle}=100mA$, $P_o=200W_{PEP}$	35	-	-	%
Intermodulation Distortion	IMD	(Fig.)	-	-	-30	dB
Series Equivalent Input Impedance	Z_{IN}	$V_{CC}=50V$, $f=28MHz$	-	1.15 -j1.15	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$\Delta f=1kHz$, $P_o=200W_{PEP}$	-	5.4 -j2.0	-	Ω

2SC2652

Fig. P_i TEST CIRCUIT



- | | |
|-----------------------------|--|
| C_1, C_2 : 7 ~ 150pF | L_1 : $\phi 0.8$ ENAMEL COATED COPPER WIRE, 14ID, 4T, 4P |
| C_3, C_4 : 7 ~ 150pF 2KWV | L_2 : $\phi 1.2$ ENAMEL COATED COPPER WIRE, 14ID, $3\frac{1}{2}$ T, 3P |
| C_5, C_6 : 0.022 μ F | RFC1 : $\phi 0.8$ ENAMEL COATED COPPER WIRE, 10ID, 9T
(ferrite Core TDK K2) |
| C_7 : 47 μ F 10WV | RFC2 : $\phi 0.8$ ENAMEL COATED COPPER WIRE, 14ID, 20T |
| C_8 : 0.044 μ F | R_1 : 10 Ω (1W) |
| C_9 : 100 μ F 50WV | R_2 : 2 Ω (1/2W) |
| Q : 2SC2652 | R_3 : 10 Ω (5W) |
| | D : 1S1555 |



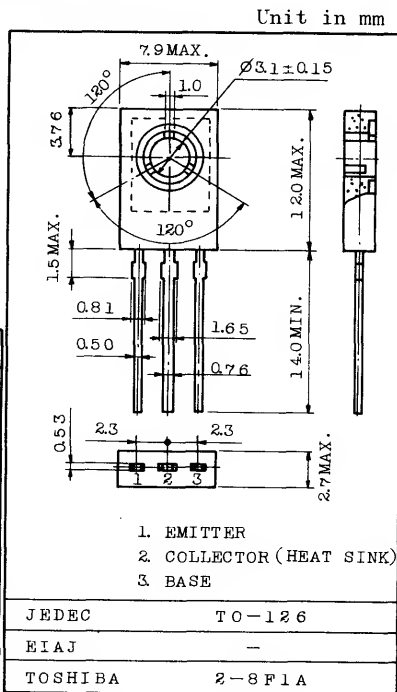
AUDIO FREQUENCY AMPLIFIER APPLICATIONS.

FEATURES:

- . Complementary to 2SA1144.
- . Small Collector Output Capacitance : $C_{ob}=1.8\text{pF(Typ.)}$
- . High Transition Frequency : $f_T=200\text{MHz(Typ.)}$

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	150	V
Collector-Emitter Voltage	V_{CE0}	150	V
Emitter-Base Voltage	V_{EB0}	5	V
Collector Current	I_C	50	mA
Base Current	I_B	5	mA
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	10	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55~150	$^\circ\text{C}$



Mounting Kit No. AC46C

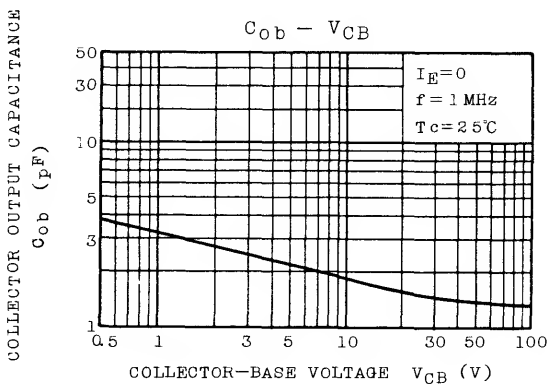
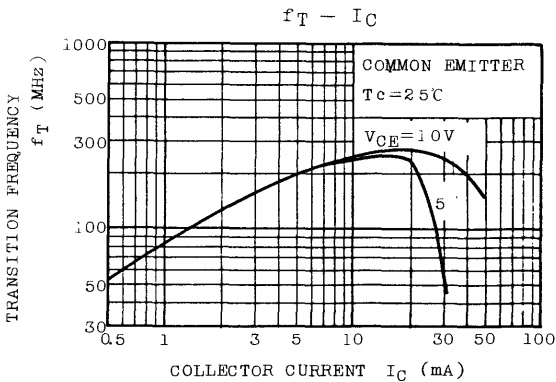
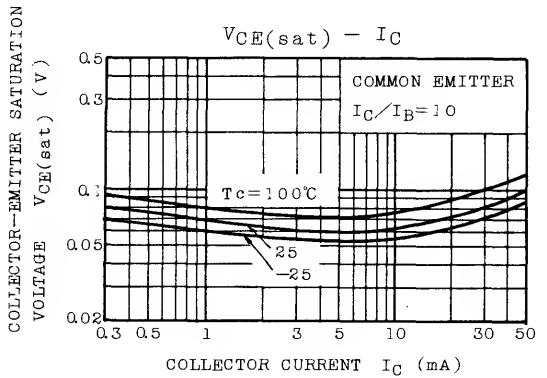
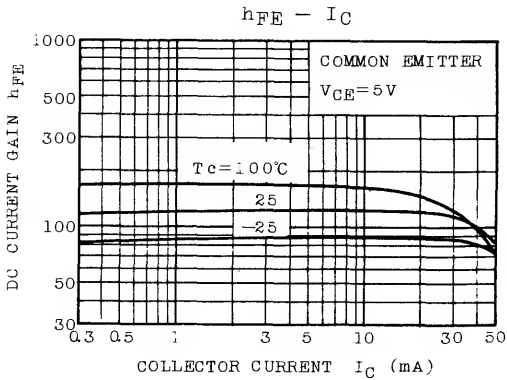
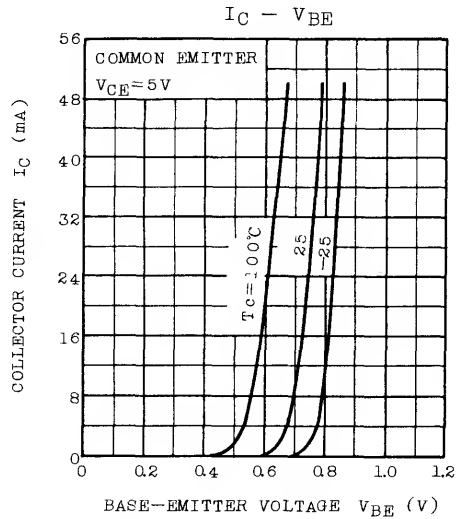
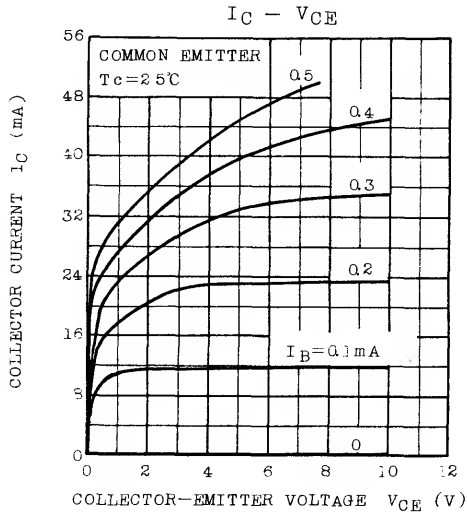
Weight : 0.72g

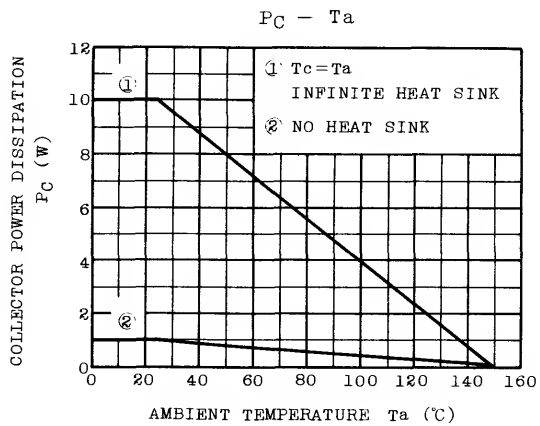
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=150\text{V}, I_E=0$	-	-	0.1	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=5\text{V}, I_C=0$	-	-	0.1	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C=1\text{mA}, I_B=0$	150	-	-	V
DC Current Gain	h_{FE} (Note)	$V_{CE}=5\text{V}, I_C=10\text{mA}$	80	-	240	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=10\text{mA}, I_B=1\text{mA}$	-	-	1.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5\text{V}, I_C=10\text{mA}$	-	-	0.8	V
Transition Frequency	f_T	$V_{CE}=10\text{V}, I_C=10\text{mA}$	-	200	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10\text{V}, I_E=0, f=1\text{MHz}$	-	1.8	-	pF

Note: h_{FE} Classification. O:80~160, Y:120~240

2SC2704





2SC2706

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

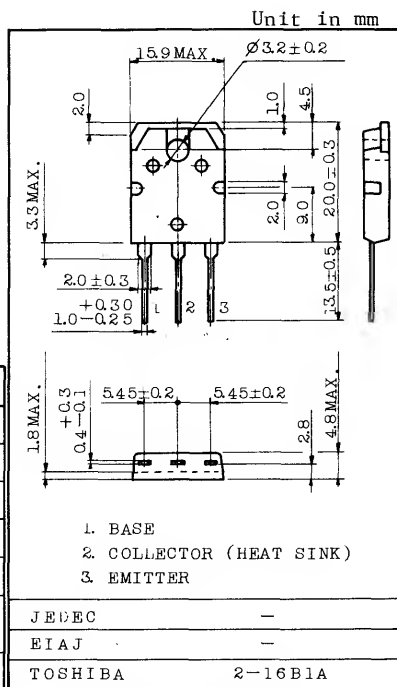
AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SA1146.
- Recommended for 70W audio frequency amplifier output stage.
- High transition frequency : $f_T=90\text{MHz(Typ.)}$

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CBO}	140	V
Collector-Emitter Voltage	V _{CEO}	140	V
Emitter-Base Voltage	V _{EBO}	5	V
Collector Current	I _C	10	A
Base Current	I _B	1	A
Collector Power Dissipation (T _c =25°C)	P _C	100	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55 ~ 150	°C

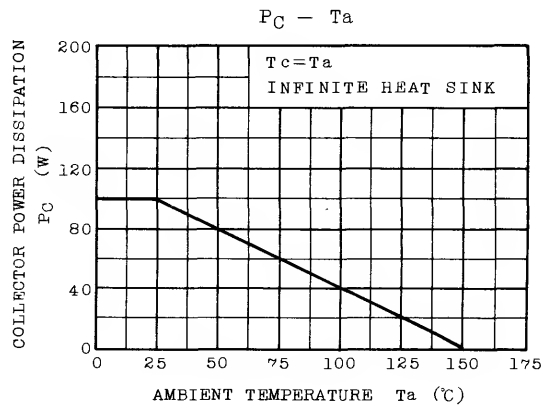
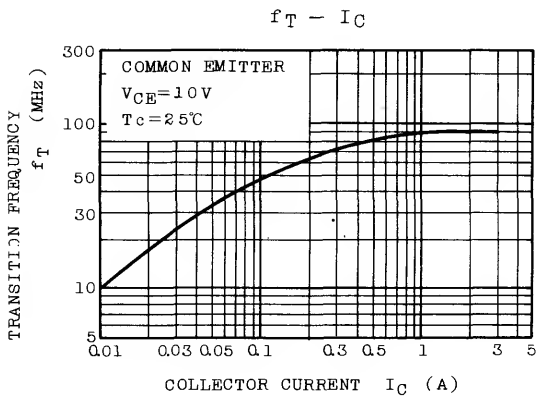
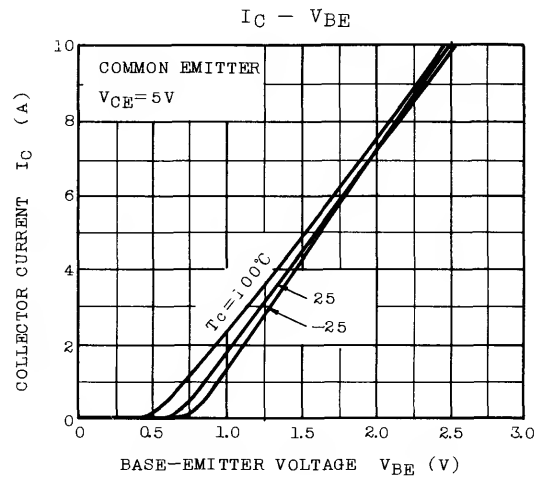
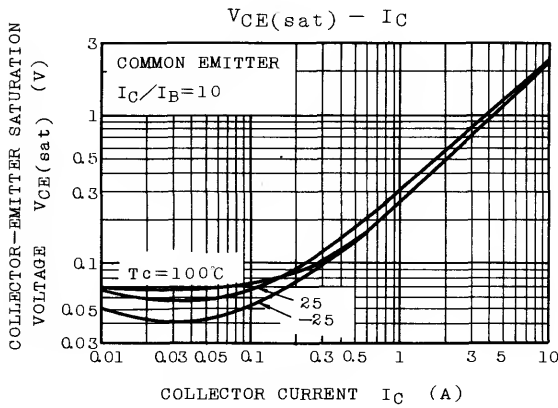
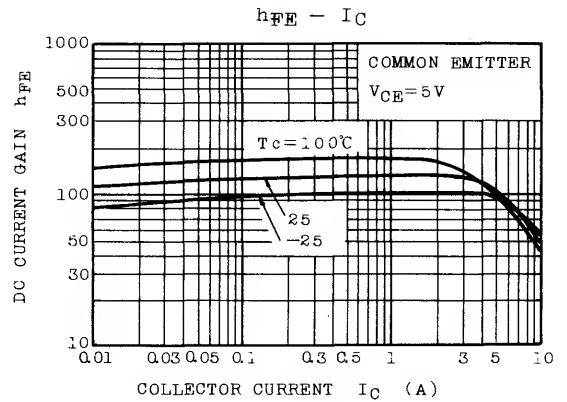
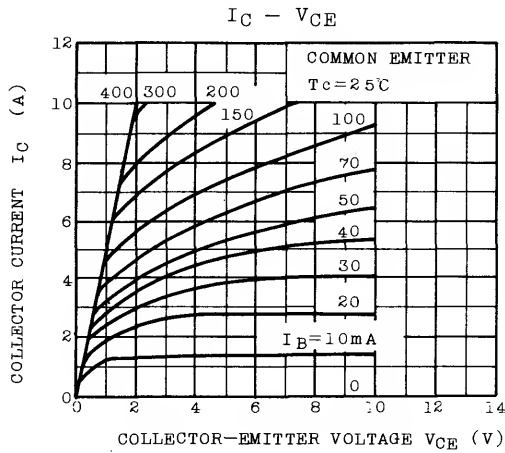


Weight : 4.6g

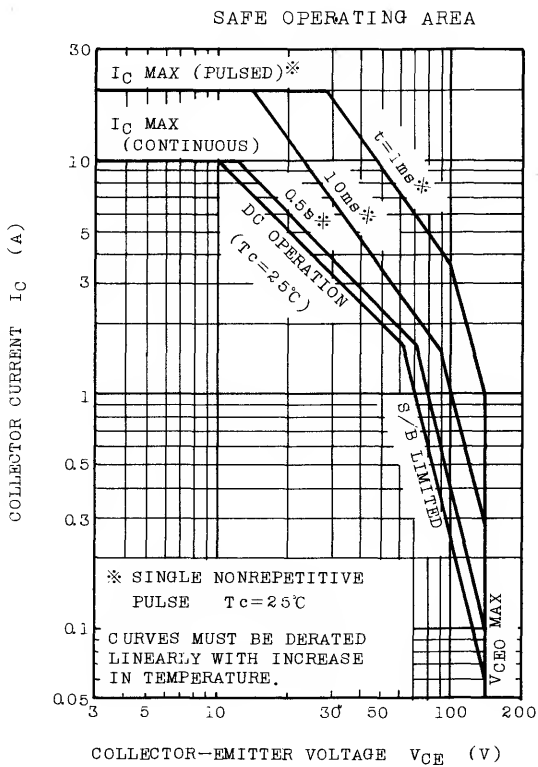
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CBO}	V _{CB} =140V, I _E =0	-	-	50	μA
Emitter Cut-off Current	I _{EBO}	V _{EB} =5V, I _C =0	-	-	50	μA
Collector-Emitter Breakdown Voltage	V(BR)CEO	I _C =50mA, I _B =0	140	-	-	V
DC Current Gain	h _{FE} (1) (Note)	V _{CE} =5V, I _C =1A	55	-	240	
	h _{FE} (2)	V _{CE} =5V, I _C =5A	30	-	-	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =5A, I _B =0.5A	-	-	2.0	V
Base-Emitter Voltage	V _{BE}	V _{CE} =5V, I _C =5A	-	-	2.5	V
Transition Frequency	f _T	V _{CE} =10V, I _C =1A	-	90	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	130	-	pF

Note: h_{FE} Classification. R:55~110, O:80~160, Y:120~240



2SC2706



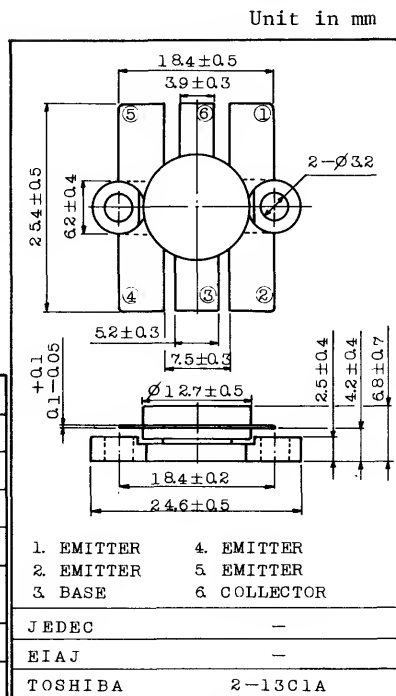
VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES :

- Output Power : $P_o=80W$ (Min.)
($f=175MHz$, $V_{CC}=12.5V$, $P_i=18W$)
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=12.5V$, $P_o=80W$, $f=175MHz$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	36	V
Collector-Emitter Voltage	V_{CEO}	16	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	20	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	220	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$

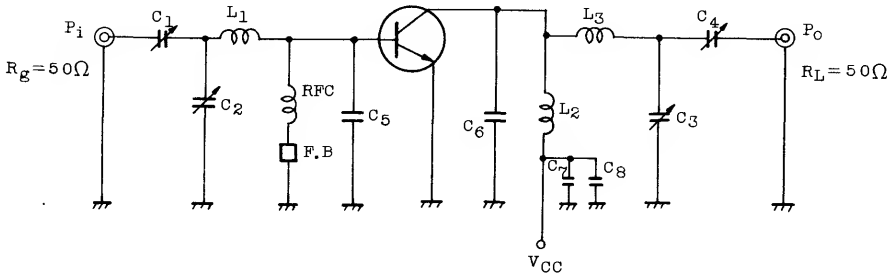


Weight : 5.5g

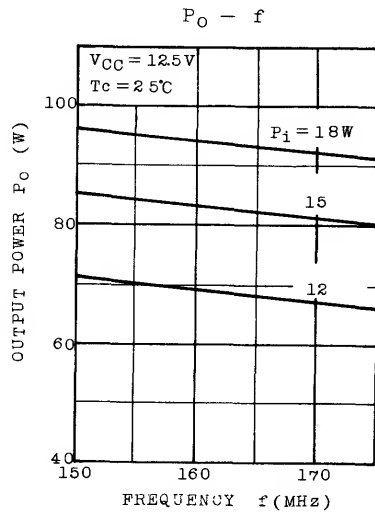
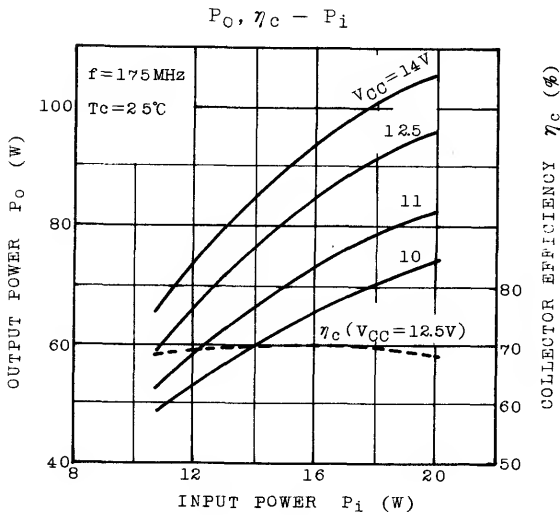
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=20mA$, $I_E=0$	36	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=50mA$, $I_B=0$	16	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA$, $I_C=0$	4	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=10A$	10	-	-	
Collector Output Capacitance	C_{ob}	$V_{CB}=12.5V$, $I_E=0$, $f=1MHz$	-	-	320	pF
Output Power	P_o	(Fig.)	80	90	-	W
Power Gain	G_{pe}	$V_{CC}=12.5V$, $f=175MHz$	6.4	6.8	-	dB
Collector Efficiency	η_c	$P_i=18W$	60	70	-	%
Series Equivalent Input Impedance	Z_{in}	$V_{CC}=12.5V$, $f=175MHz$	-	1.0 +j1.5	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=80W$	-	1.2 +j18	-	Ω

Fig. P_o TEST CIRCUIT



- C₁ ~ C₄ : ~20pF
- C₅ : 156pF (39pF × 4) CERAMIC CONDENSER
- C₆ : 132pF (33pF × 4) CERAMIC CONDENSER
- C₇ : 0.01μF CERAMIC CONDENSER
- C₈ : 10μF
- L₁, L₃ : φ1.5mm SILVER PLATED COPPER WIRE, 10 ID, 1T
- L₂ : φ1.5mm SILVER PLATED COPPER WIRE, 10 ID, 2T
- RFC : φ1mm ENAMEL COATED COPPER WIRE, 6 ID, 10T
- FB : FERRITE BEAD



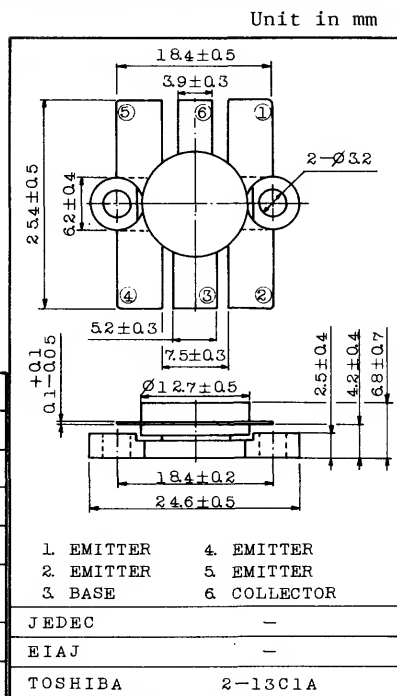
VHF BAND POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Output Power : $P_o=40W(\text{Min.})$
($f=470\text{MHz}$, $V_{CC}=12.5V$, $P_i=13W$)
- . 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ $V_{CC}=12.5V$, $P_i=13W$, $f=470\text{MHz}$

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	36	V
Collector-Emitter Voltage	V_{CEO}	16	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	8	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	150	W
Junction Temperature	T_j	175	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ\text{C}$

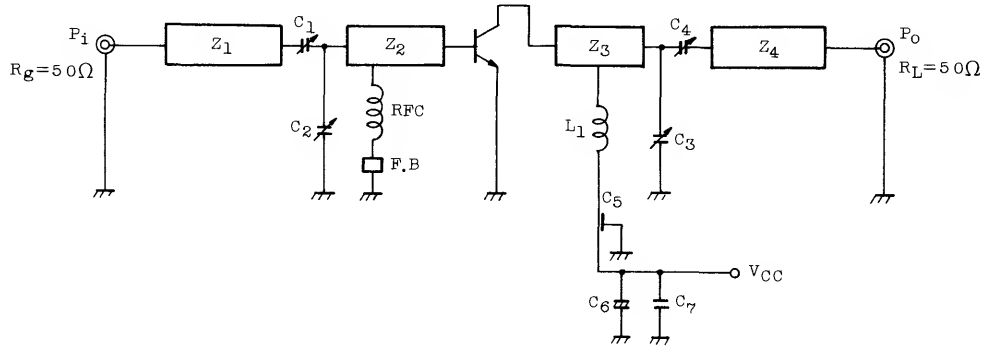


Weight : 5.5g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	6	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=10\text{mA}$, $I_E=0$	36	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=50\text{mA}$, $I_B=0$	16	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1\text{mA}$, $I_C=0$	4	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=5A$	10	-	150	
Collector Output Capacitance	C_{ob}	$V_{CB}=12.5V$, $I_E=0$, $f=1\text{MHz}$	-	110	150	pF
Output Power	P_o	(Fig.)	40	45	-	W
Power Gain	G_{pe}	$V_{CC}=12.5V$, $f=470\text{MHz}$, $P_i=13W$	4.88	5.4	-	dB
Collector Efficiency	η_c		60	65	-	%
Series Equivalent Input Impedance	Z_{IN}	$V_{CC}=12.5V$, $f=470\text{MHz}$,	-	$3+j3.2$	-	Ω
Series Equivalent Output Impedance	Z_{OUT}	$P_o=40W$	-	$1.7+j4.7$	-	Ω

Fig. $f=470\text{MHz}$ P_o TEST CIRCUIT



$C_1 \sim C_4 : \sim 20\text{pF}$

$C_5 : 1000\text{pF}$

$C_6 : 10\mu\text{F}$

$C_7 : 0.1\mu\text{F}$

F.B : FERRITE BEADS

$L_1 : \phi 1$ SILVER PLATED COPPER WIRE, 6ID, 3T

RFC : $\phi 1$ ENAMEL COATED COPPER WIRE, 6ID, 10T

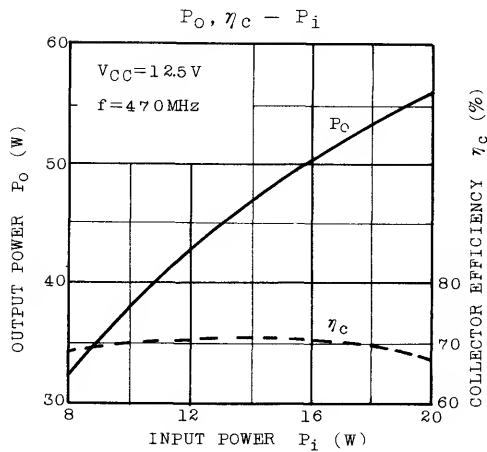
$Z_1 : 4\text{mm} \times 40\text{mm}$ MICROSTRIP

$Z_2 : 6\text{mm} \times 23\text{mm}$ MICROSTRIP

$Z_3 : 6\text{mm} \times 23\text{mm}$ MICROSTRIP

$Z_4 : 4\text{mm} \times 30\text{mm}$ MICROSTRIP

BOARD : 1.6mm TEFLONGLASS $\epsilon_R=2.5$



INDUSTRIAL APPLICATIONS

Unit in mm

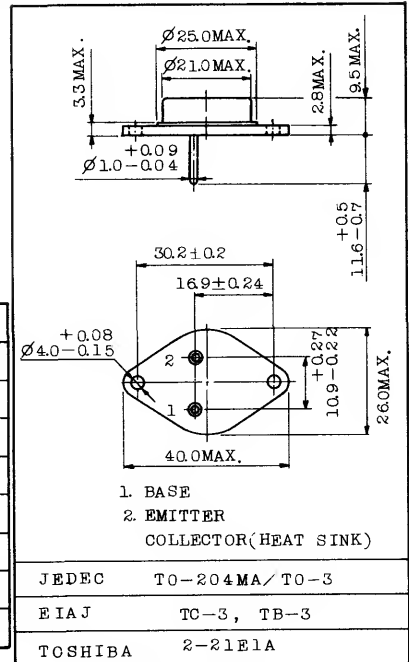
SWITCHING REGULATOR AND HIGH VOLTAGE
SWITCHING APPLICATIONS.
HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

- Excellent Switching Times
: $t_r=1.0\mu s$ Max. , $t_f=1.0\mu s$ Max. at $I_C=0.5A$
- High Collector Breakdown Voltage : $V_{CE0}=800V$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector - Base Voltage	V_{CBO}	850	V
Collector - Emitter Voltage	V_{CEO}	800	V
Emitter - Base Voltage	V_{EBO}	7	V
Collector Current	I_C	2	A
Base Current	I_B	1	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	80	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55~150	$^\circ C$



ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

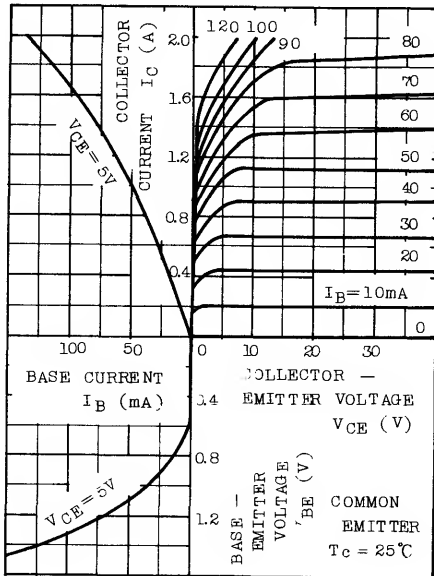
Weight : 16g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=800V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	850	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	800	-	-	V
DC Current Gain		$h_{FE}(\text{Note})$	$V_{CE}=5V, I_C=0.5A$	17	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$ (Note)	$I_C=0.5A, I_B=0.05A$	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$ (Note)	$I_C=0.5A, I_B=0.05A$	-	-	1.5	V
Switching Time	Rise Time	t_r		-	-	1.0	μs
	Storage Time	t_{stg}		-	-	4.0	
	Fall Time	t_f		-	-	1.0	

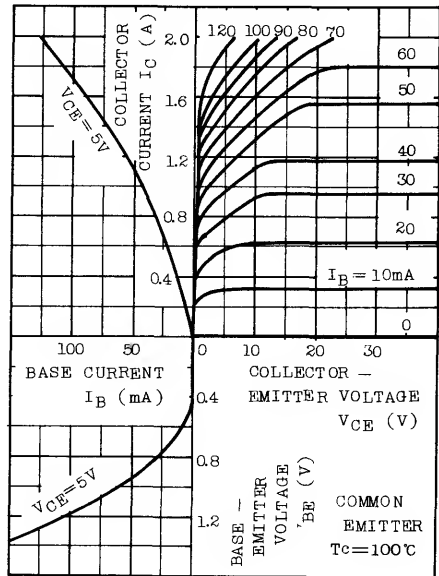
Note : Pulse Test : Pulse Width $\leq 300\mu s$, Duty Cycle $\leq 2\%$

2SC2790

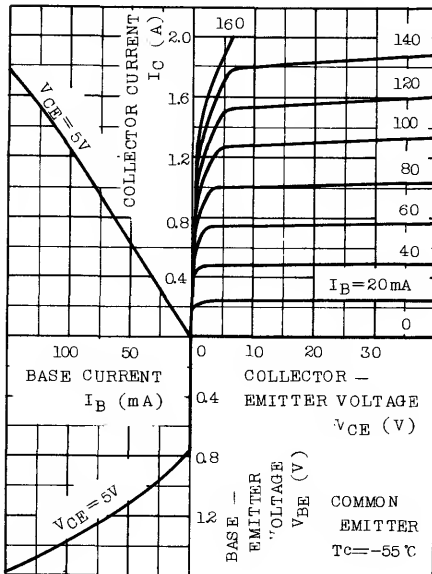
STATIC CHARACTERISTICS

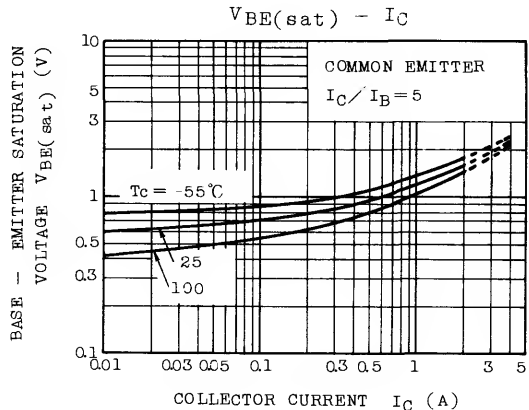
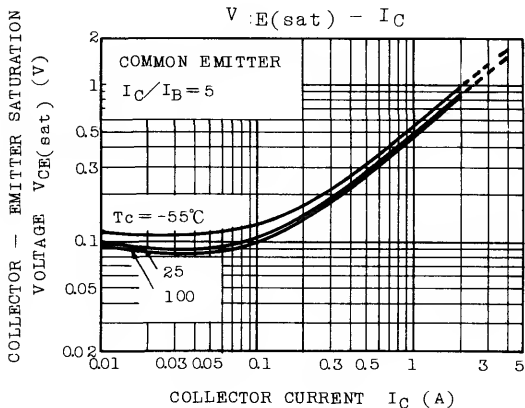
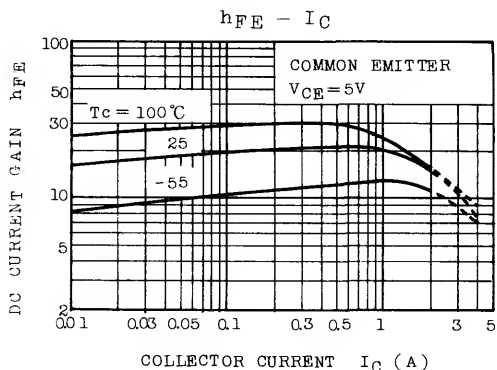
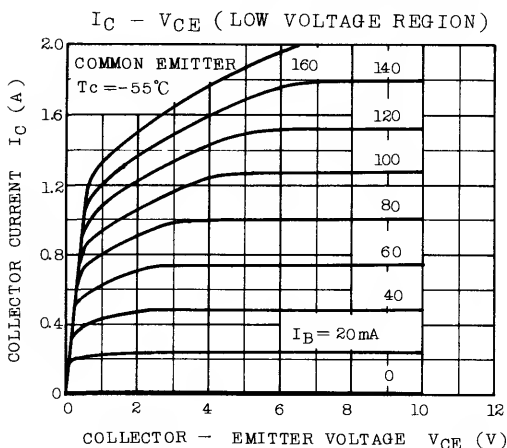
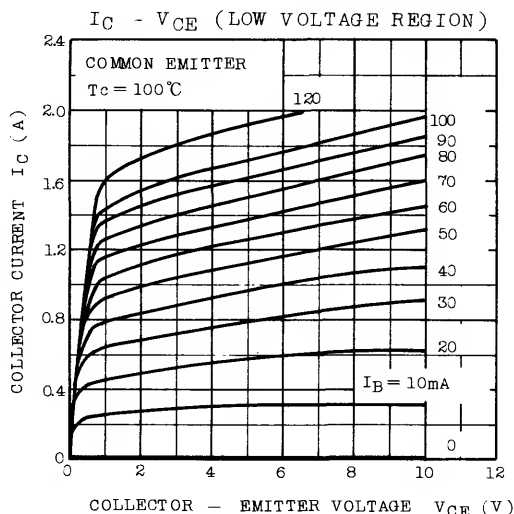
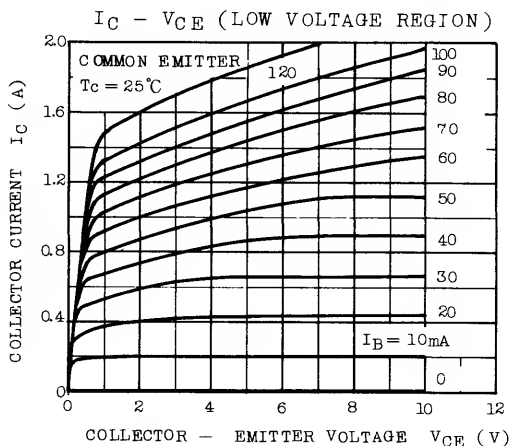


STATIC CHARACTERISTICS

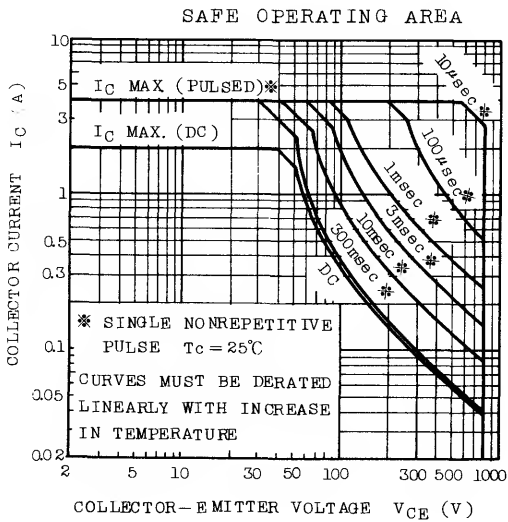
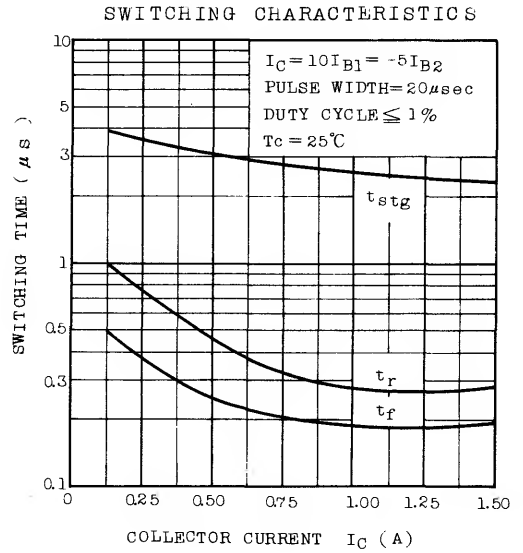
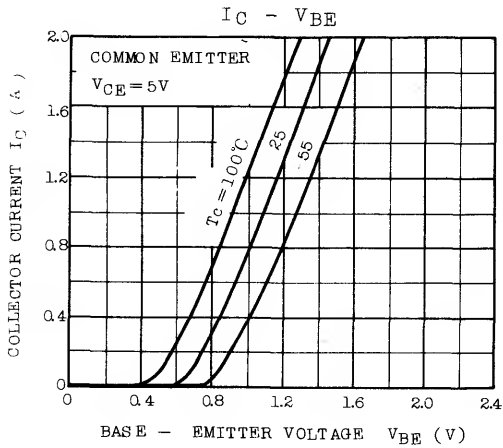


STATIC CHARACTERISTICS





2SC2790



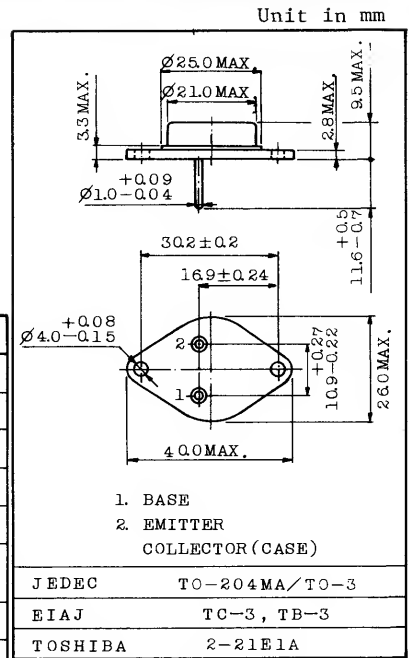
HIGH SPEED AND HIGH VOLTAGE SWITCHING APPLICATIONS.
 SWITCHING REGULATOR APPLICATIONS.
 HIGH SPEED DC-DC CONVERTER APPLICATIONS.

FEATURES:

- . Excellent Switching Times
 : $t_r=1.0\mu s$ (Max.), $t_f=1.0\mu s$ (Max.) ($I_C=3A$)
- . High Collector Breakdown Voltage : $V_{CEO}=800V$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	900	V
Collector-Emitter Voltage	V_{CEO}	800	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	5	A
Base Current	I_B	3	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	100	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$



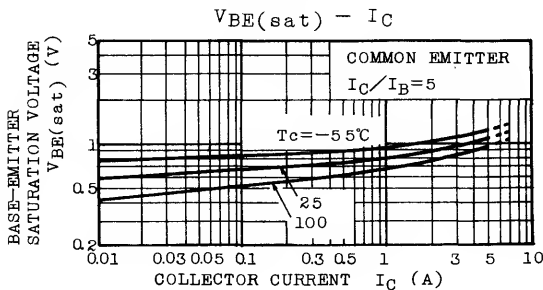
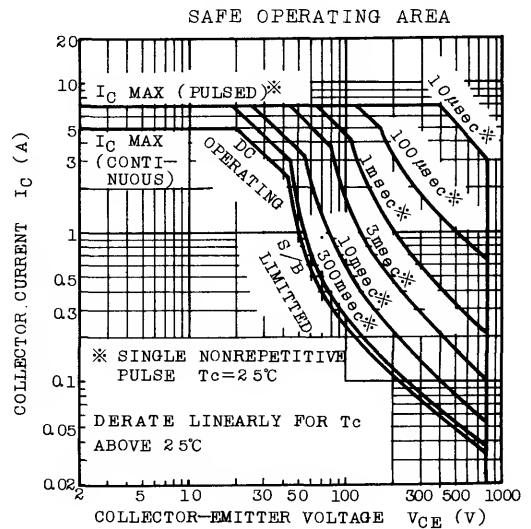
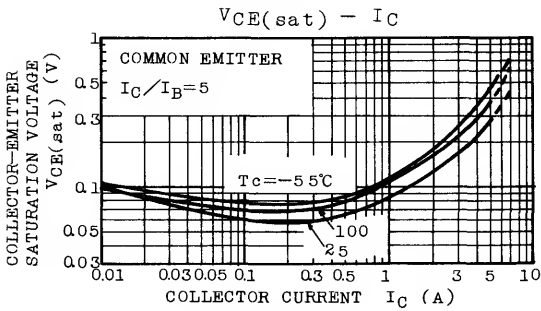
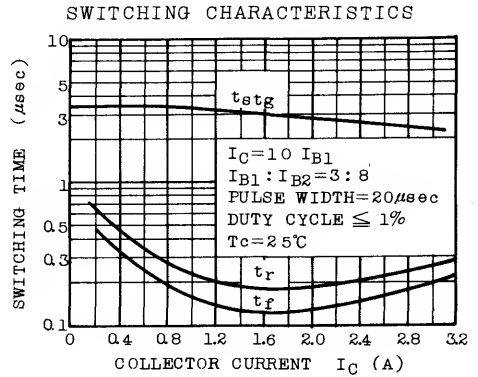
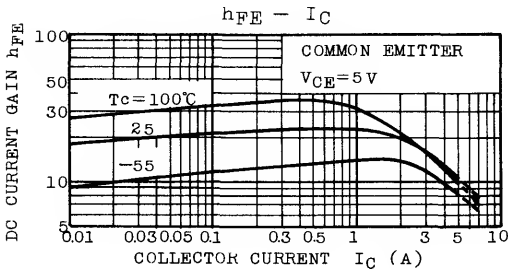
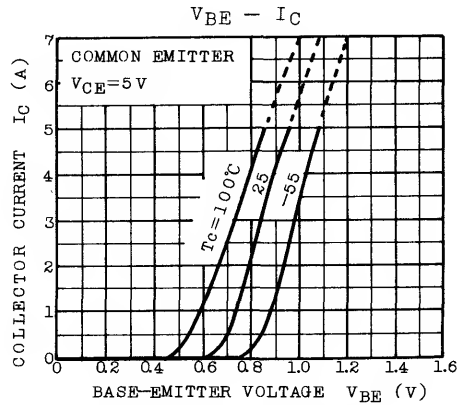
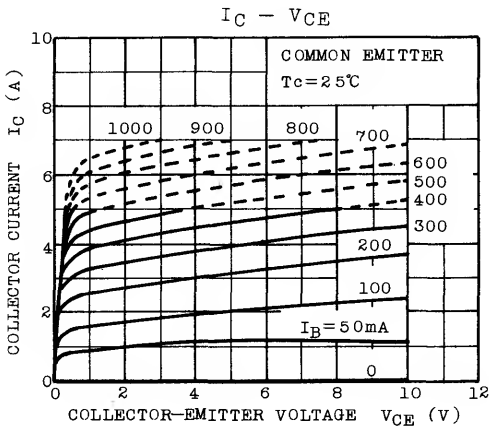
MOUNTING KIT No. AC100
 Weight : 16g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=800V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	900	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	800	-	-	V
DC Current Gain		$h_{FE(1)}$	$V_{CE}=5V, I_C=10mA$ (Note)	10	-	-	
		$h_{FE(2)}$	$V_{CE}=5V, I_C=3A$ (Note)	10	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=3A, I_B=0.6A$ (Note)	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=3A, I_B=0.6A$ (Note)	-	-	1.5	V
Switching Time	Rise Time	t_r		-	-	1.0	μs
	Storage Time	t_{stg}		-	-	3.5	
	Fall Time	t_f		-	-	1.0	

Note : Pulse Test : Pulse Width $\leq 300\mu s$, Duty Cycle $\leq 2\%$

2SC2791



SWITCHING REGULATOR AND HIGH VOLTAGE.
 SWITCHING APPLICATIONS.
 HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

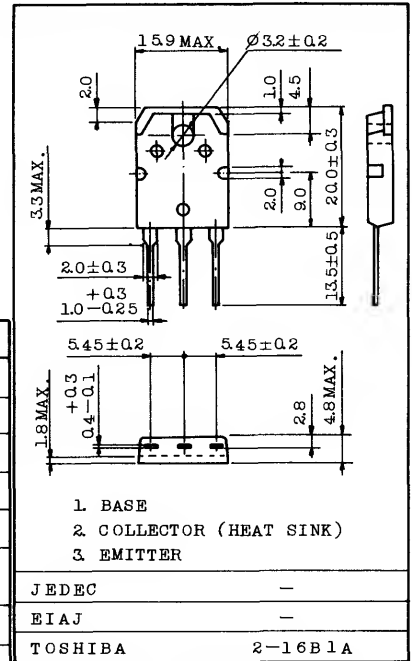
- Excellent Switching Times ($I_C=0.5A$)
 $t_r=1.0\mu s$ Max. $t_f=10.\mu s$ Max.
- High Collector Breakdown Voltage : $V_{CEO}=800V$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	850	V
Collector-Emitter Voltage	V_{CEO}	800	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	2	A
Base Current	I_B	1	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	80	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature	T_{stg}	-55 ~ 150	$^\circ C$

INDUSTRIAL APPLICATIONS

Unit in mm



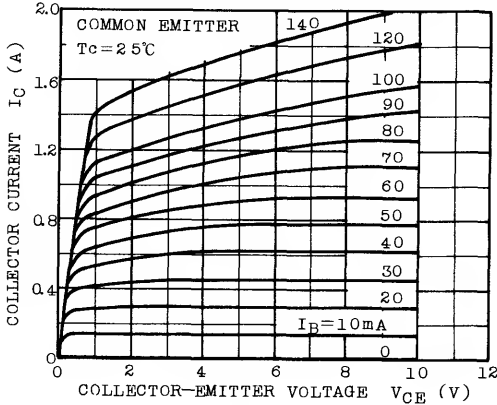
Weight : 4.6g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

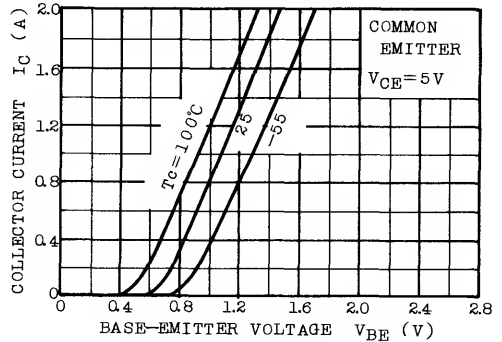
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cutoff Current		I_{CBO}	$V_{CB}=800V, I_E=0$	-	-	100	μA
Emitter Cutoff Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	850	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	800	-	-	V
D C Current Gain (Note)		h_{FE}	$V_{CE}=5V, I_C=0.5A$	10	-	-	
Collector-Emitter Saturation Voltage (Note)		$V_{CE(sat)}$	$I_C=0.5A, I_B=0.05A$	-	-	1.0	V
Base-Emitter Saturation Voltage (Note)		$V_{BE(sat)}$	$I_C=0.5A, I_B=0.05A$	-	-	1.5	V
Switching Time	Rise Time	t_r		-	-	1.0	μs
	Storage Time	t_{stg}		-	-	4.0	
	Fall Time	t_f		-	-	1.0	

Note ; Pulse Test : Pulse Width $\leq 300\mu s$, Duty Cycle $\leq 2\%$

$I_C - V_{CE}$ (LOW VOLTAGE REGION)

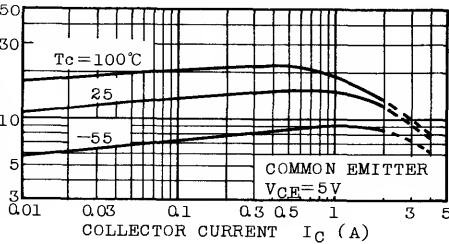


$V_{BE} - I_C$

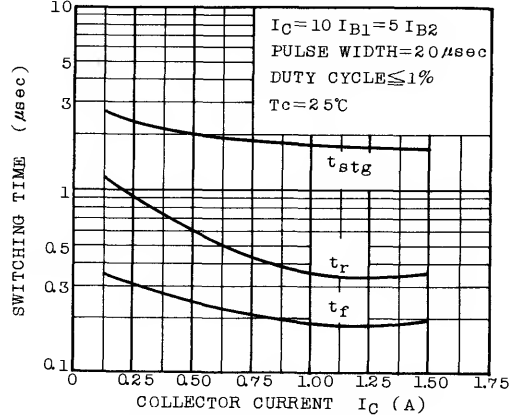


STATIC FORWARD CURRENT TRANSFER RATIO h_{FE}

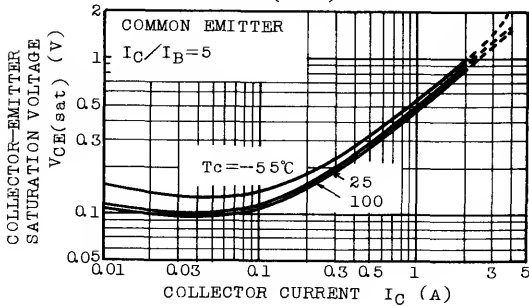
$h_{FE} - I_C$



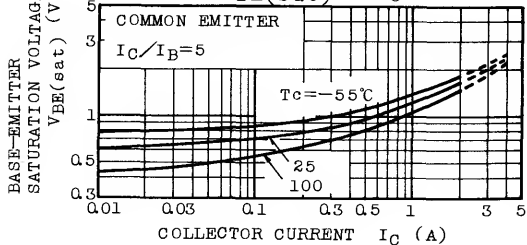
SWITCHING TIME - I_C



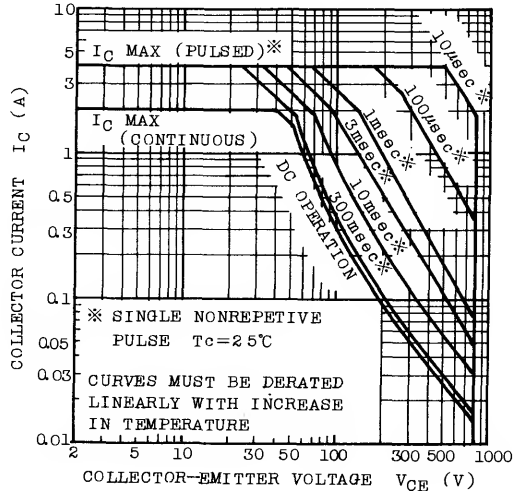
$V_{CE(sat)} - I_C$



$V_{BE(sat)} - I_C$



SAFE OPERATING AREA



2SC2793

HIGH SPEED AND HIGH VOLTAGE SWITCHING APPLICATIONS.
 SWITCHING REGULATOR APPLICATIONS.
 HIGH SPEED DC-DC CONVERTER APPLICATIONS.

FEATURES:

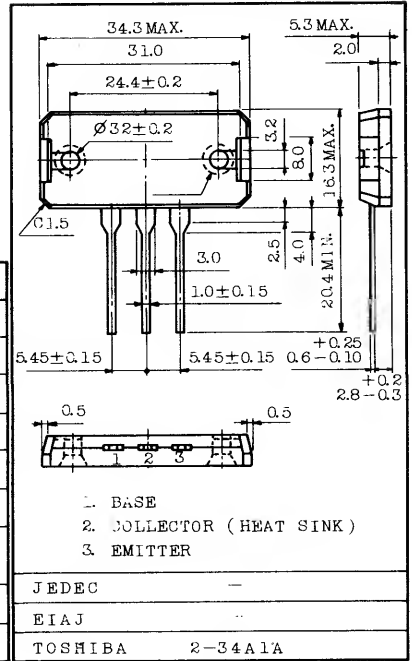
- Excellent Switching Times
 : $t_r=1.0\mu s$ (Max.), $t_f=1.0\mu s$ (Max.) ($I_C=3A$)
- High Collector Breakdown Voltage : $V_{CEO}=800V$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	900	V
Collector-Emitter Voltage		V_{CEO}	800	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	5	A
	Peak	I_{CM}	7	A
Base Current		I_B	3	A
Collector Power Dissipation ($T_c=25^\circ C$)		P_C	100	W
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$

INDUSTRIAL APPLICATION

Unit in mm



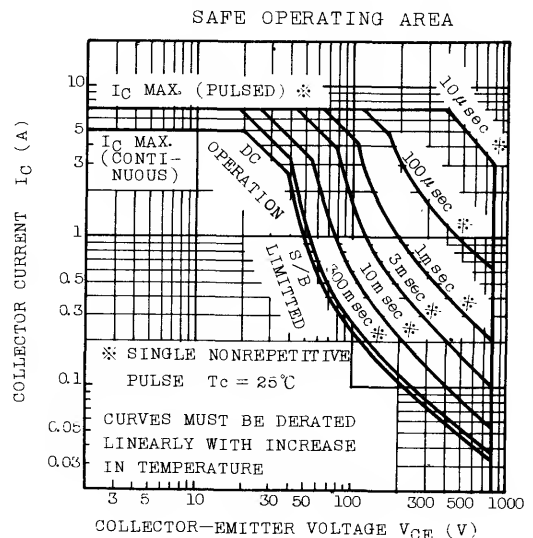
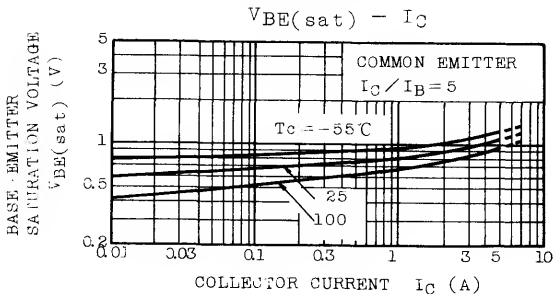
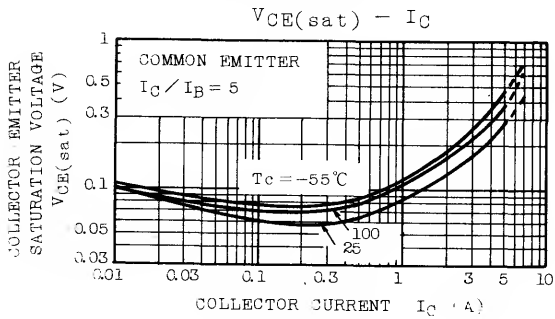
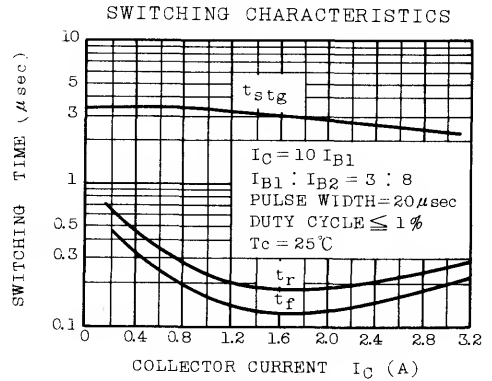
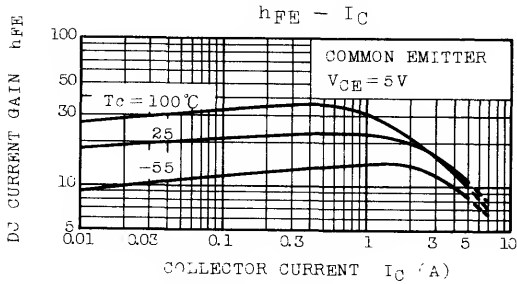
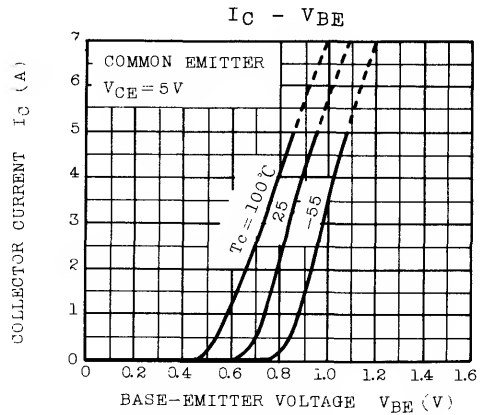
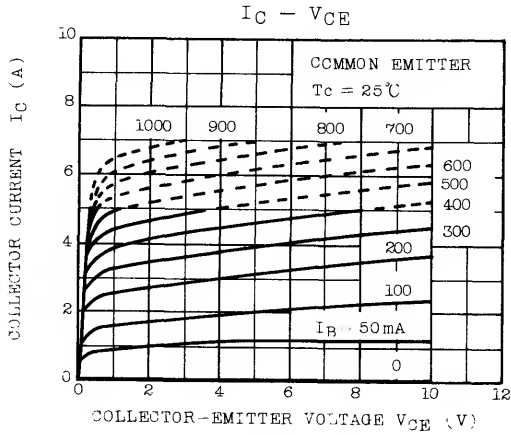
Weight : 10.8g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=800V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	900	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	800	-	-	V
DC Current Gain		$h_{FE(1)}$	$V_{CE}=5V, I_C=10mA$ (Note)	10	-	-	-
		$h_{FE(2)}$	$V_{CE}=5V, I_C=3A$ (Note)	10	-	-	-
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=3A, I_B=0.6A$ (Note)	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=3A, I_B=0.6A$ (Note)	-	-	1.5	V
Switching Time	Rise Time	t_r	<p>$V_{CC}=400V$ I_{C1} I_{B1} INPUT I_{B2} I_{C2} OUTPUT $I_C=3A$ $I_{B1}=0.3A, I_{B2}=-0.8A$ DUTY CYCLE $\leq 1\%$</p>	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	3.5	
	Fall Time	t_f		-	-	1.0	

Note: Pulse Test : Pulse Width $\leq 300\mu s$, Duty Cycle $\leq 2\%$

2SC2793



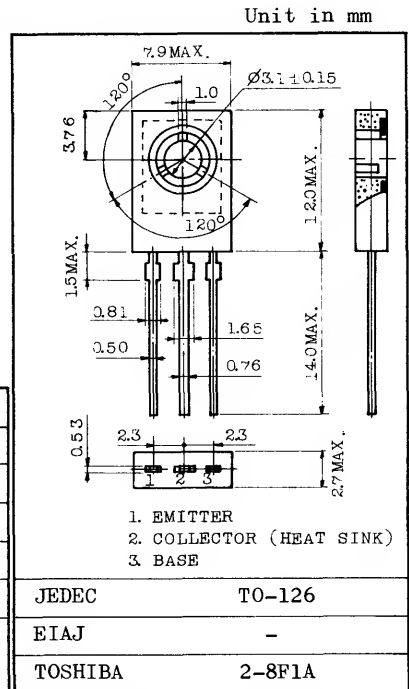
AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SA1184.
- Suitable for driver of 60 to 80 watts audio amplifier.
- High breakdown voltage.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	120	V
Collector-Emitter Voltage	V _{CE0}	120	V
Emitter-Base Voltage	V _{EB0}	5	V
Collector Current	I _C	1	A
Base Current	I _B	100	mA
Collector Power Dissipation	P _C	Ta=25°C	1
		Tc=25°C	15
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55~150	°C



Mounting Kit No. AC46C
Weight : 0.72g

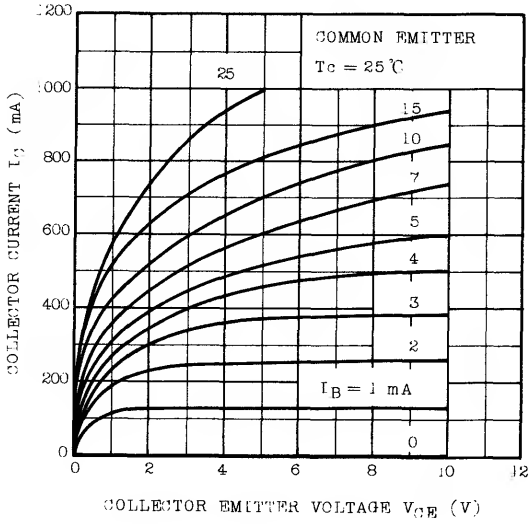
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =120V, I _E =0	-	-	100	nA
Emitter Cut-off Current	I _{EB0}	V _{EB} =5V, I _C =0	-	-	100	nA
Collector-Emitter Breakdown Voltage	V(BR)CE0	I _C =10mA, I _B =0	120	-	-	V
Emitter-Base Breakdown Voltage	V(BR)EBO	I _E =1mA, I _C =0	5	-	-	V
DC Current Gain	h _{FE} (Note)	V _{CE} =5V, I _C =100mA	80	-	240	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =500mA, I _B =50mA	-	0.30	1.0	V
Base-Emitter Voltage	V _{BE}	V _{CE} =5V, I _C =500mA	-	0.78	1.0	V
Transition Frequency	f _T	V _{CE} =5V, I _C =100mA	-	120	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	15	-	pF

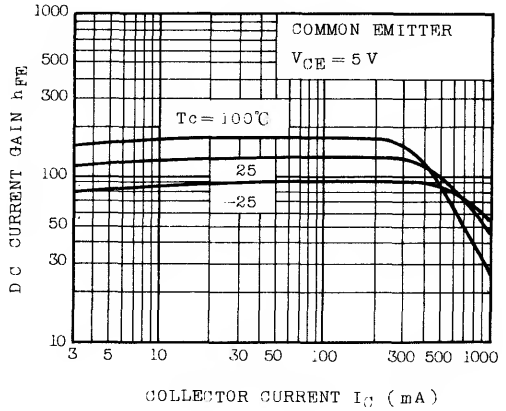
Note: h_{FE} Classification 0:80~160 Y:120~240

2SC2824

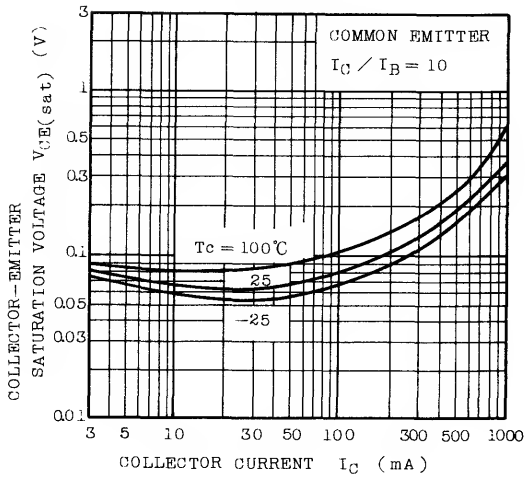
$I_C - V_{CE}$



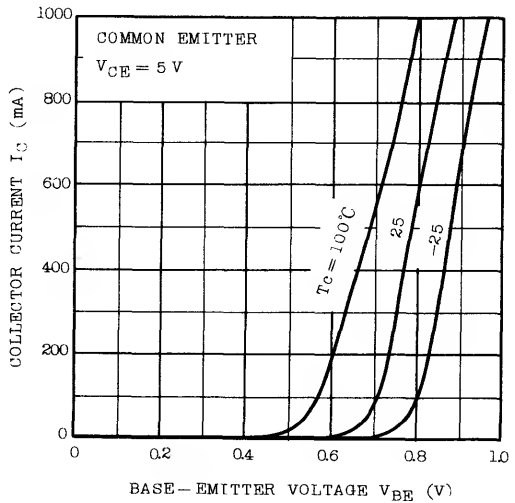
$h_{FE} - I_C$

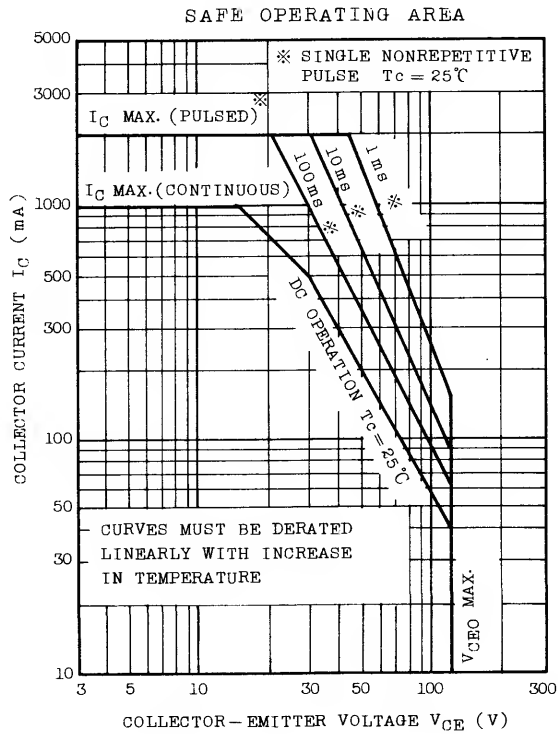
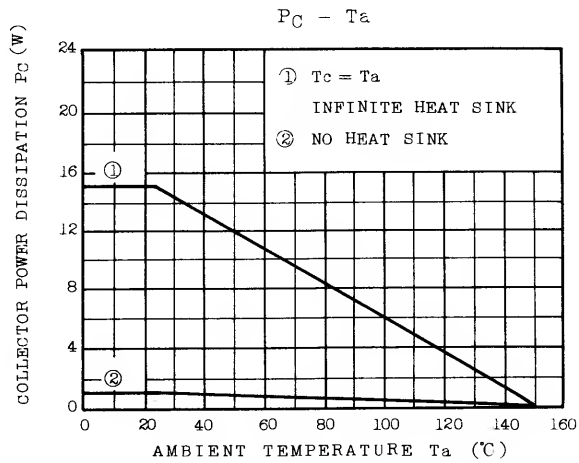


$V_{CE(sat)} - I_C$



$I_C - V_{BE}$





2SC2877

SILICON NPN EPITAXIAL PLANAR TYPE (PCT PROCESS)

AUDIO FREQUENCY POWER AMPLIFIER

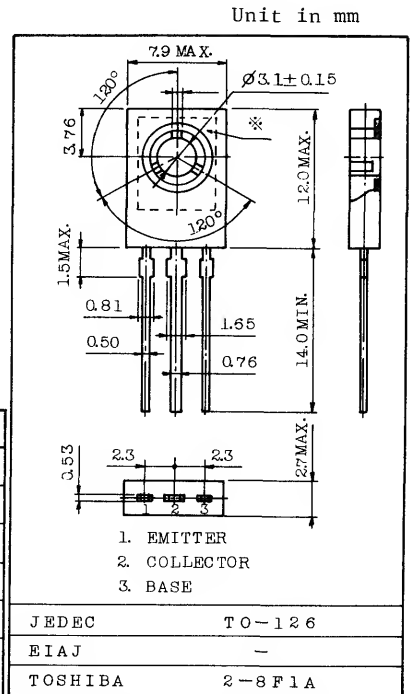
LOW SPEED SWITCHING

FEATURES:

- Suitable for output stage of 5 watts car radio and car stereo.
- Good linearity of h_{FE} .
- Complementary to 2SA1217.

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	V
Collector-Emitter Voltage	V_{CEO}	40	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	3	A
Base Current	I_B	1	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	10	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ\text{C}$

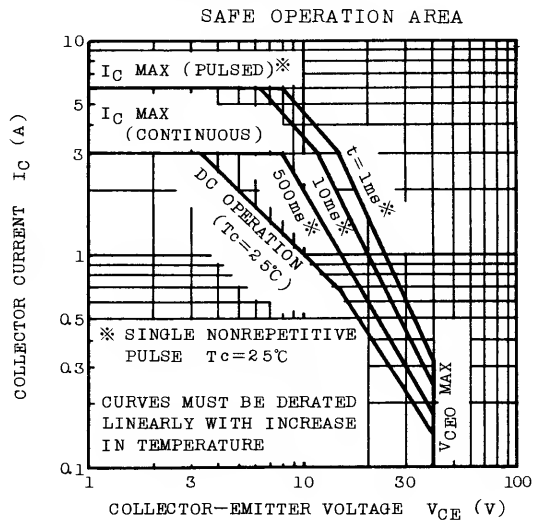
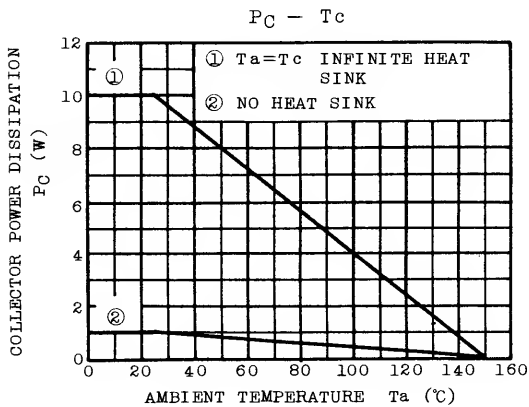
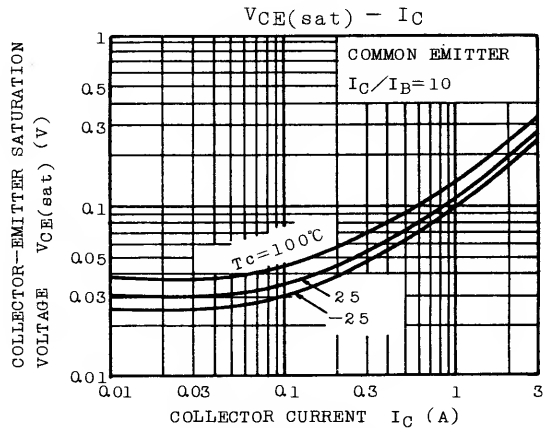
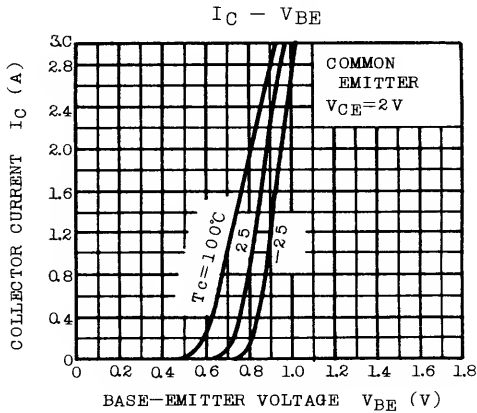
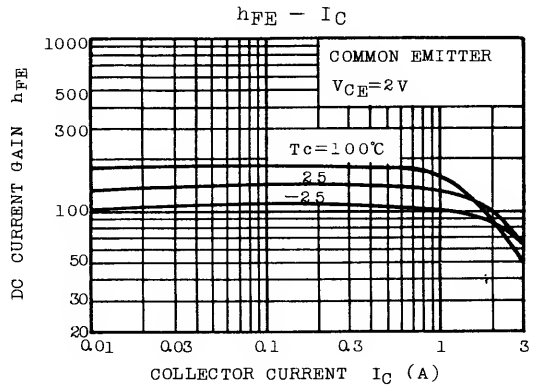
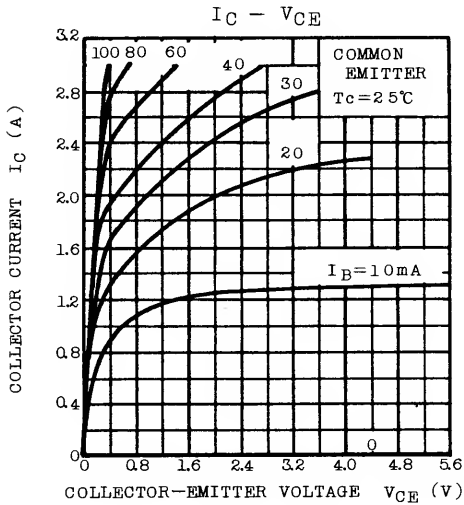


The inside metal of dotted line is connected to collector lead. Weight 0.72g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cutoff Current	I_{CBO}	$V_{CB}=40\text{V}, I_E=0$	-	-	100	nA
Emitter Cutoff Current	I_{EBO}	$V_{EB}=5\text{V}, I_C=0$	-	-	100	nA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10\text{mA}, I_B=0$	40	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=2\text{V}, I_C=0.5\text{A}$	80	-	240	
	$h_{FE(2)}$	$V_{CE}=2\text{V}, I_C=2.5\text{A}$	25	-	-	
Collector Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=2\text{A}, I_B=0.2\text{A}$	-	-	0.8	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=2\text{V}, I_C=0.5\text{A}$	-	-	1.0	V
Transition Frequency	f_T	$V_{CE}=2\text{V}, I_C=0.5\text{A}$	-	100	-	MHz
Output Capacitance	C_{ob}	$V_{CB}=10\text{V}, I_E=0, f=1\text{MHz}$	-	35	-	pF

Note: h_{FE} Classification 0 : 80~160 Y : 120~240



2SC2879

SILICON NPN EPITAXIAL PLANAR TYPE

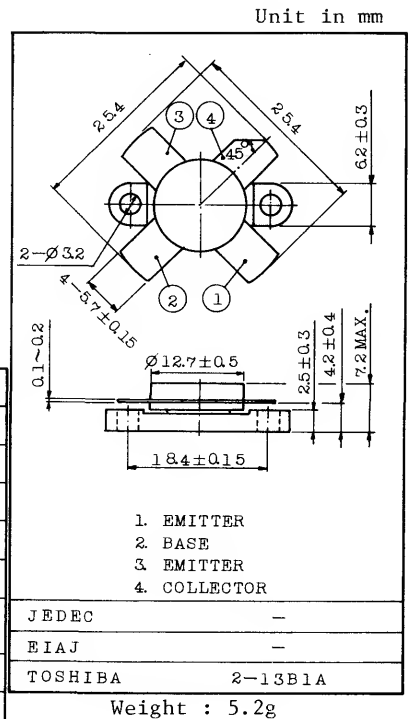
2 ~ 30MHz SSB LINEAR POWER AMPLIFIER APPLICATIONS.
(LOW SUPPLY VOLTAGE USE)

FEATURES:

- . Specified 12.5V, 28MHz Characteristics
 - : Output Power : $P_o=100W_{PEP}$
 - : Minimum Gain : $G_{pe}=10dB$
 - : Efficiency : $\eta_c=35\%$ (Min.)
- . Intermodulation Distortion : $IMD=-24dB$ (Max.)
(MIL Standard)

MAXIMUM RATINGS ($T_a=25^\circ C$)

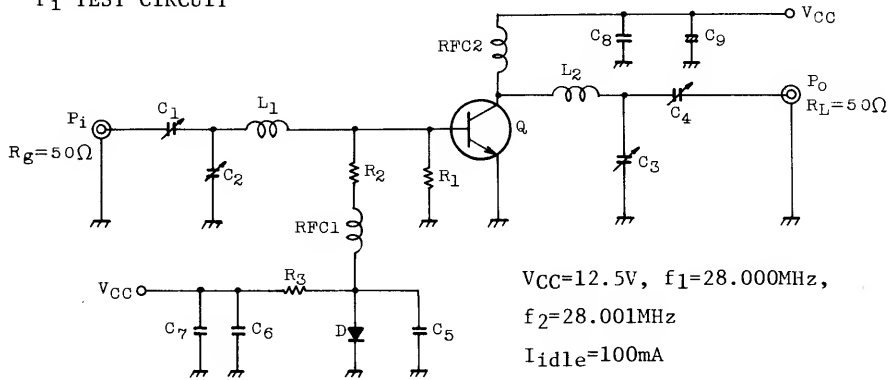
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	45	V
Collector-Emitter Voltage	V_{CES}	45	V
Collector-Emitter Voltage	V_{CEO}	18	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	25	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	250	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$



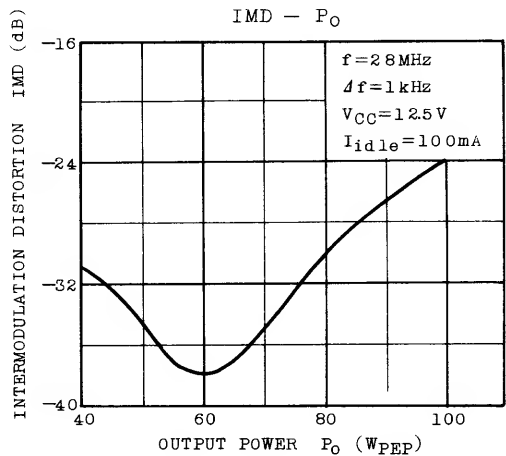
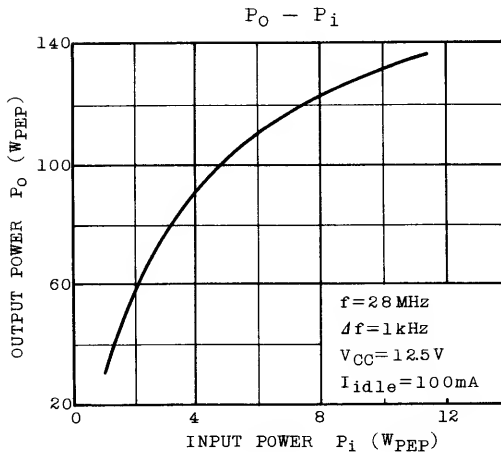
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=100mA, I_B=0$	18	—	—	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CES}$	$I_C=100mA, V_{BE}=0$	45	—	—	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA, I_C=0$	4	—	—	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=10A$	10	—	150	
Collector Output Capacitance	C_{ob}	$V_{CB}=12.5V, I_E=0, f=1MHz$	—	700	—	pF
Power Gain	G_{pe}	$V_{CC}=12.5V, f=28MHz$	13.0	15.2	—	dB
Input Power	P_i	2-Tone, $\Delta f=1kHz$	—	6	10	W_{PEP}
Collector Efficiency	η_c	$I_{idle}=100mA, P_o=100W_{PEP}$	35	—	—	%
Intermodulation Distortion	IMD	(Fig.)	—	—	-24	dB
Series Equivalent Input Impedance	Z_{IN}	$V_{CC}=12.5V, f=28MHz$	—	1.45 -j0.95	—	Ω
Series Equivalent Output Impedance	Z_{OUT}	$\Delta f=1kHz, P_o=100W_{PEP}$	—	1.45 -j1.0	—	Ω

Fig. P_i TEST CIRCUIT



- | | |
|-----------------------------|--|
| C_1, C_2 : 7 ~ 150pF | L_1 : $\phi 0.8$ ENAMEL COATED COPPER WIRE, 14ID, 4T, 4P |
| C_3, C_4 : 7 ~ 150pF 2KWV | L_2 : $\phi 1.2$ ENAMEL COATED COPPER WIRE, 14ID, 3½T, 3P |
| C_5, C_6 : 0.022 μ F | RFC1 : $\phi 0.8$ ENAMEL COATED COPPER WIRE, 10ID, 9T
(Ferrite Core TDK K2) |
| C_7 : 47 μ F 10WV | RFC2 : $\phi 1.8$ ENAMEL COATED COPPER WIRE, 14ID, 20T |
| C_8 : 0.044 μ F | R_1 : 10 Ω (1W) |
| C_9 : 100 μ F 50WV | R_2 : 2 Ω (1/2W) |
| Q : 2SC2879 | R_3 : 10 Ω (5W) |
| | D : 1S1555 |



2SC2913

SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE
SWITCHING APPLICATIONS.
HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

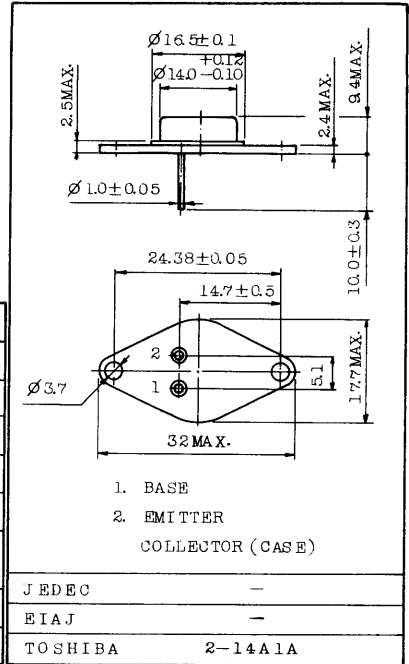
- Excellent Switching Times
: $t_r=1.0\mu s(\text{Max.})$, $t_f=1.0\mu s(\text{Max.})$ at $I_C=4A$
- High Collector Breakdown Voltage : $V_{CEO}=400V$

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	500	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	7	A
Base Current	I_B	2	A
Collector Power Dissipation (Tc=25°C)	P_C	40	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65 ~ 150	°C

INDUSTRIAL APPLICATIONS

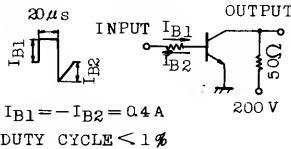
Unit in mm



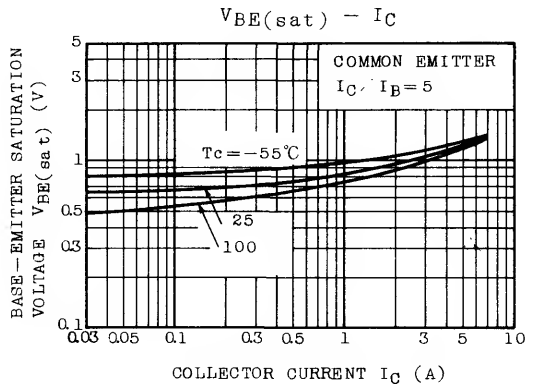
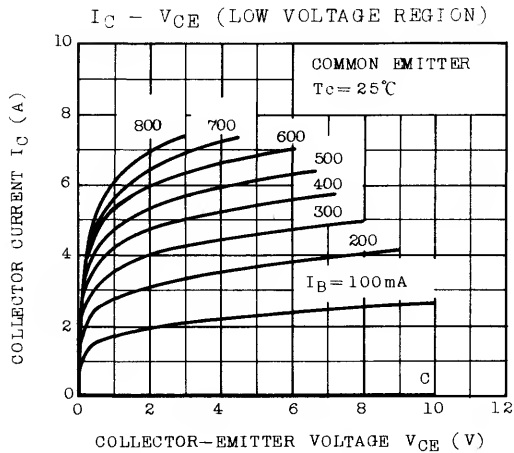
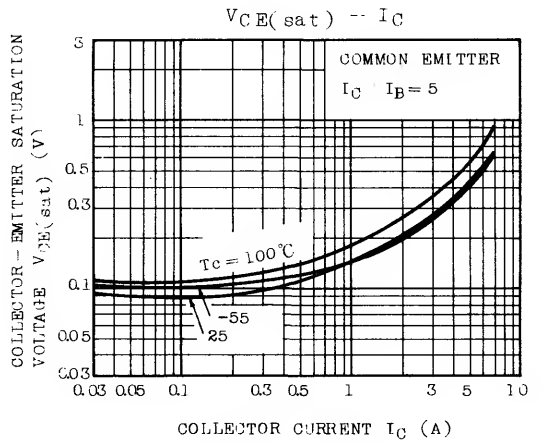
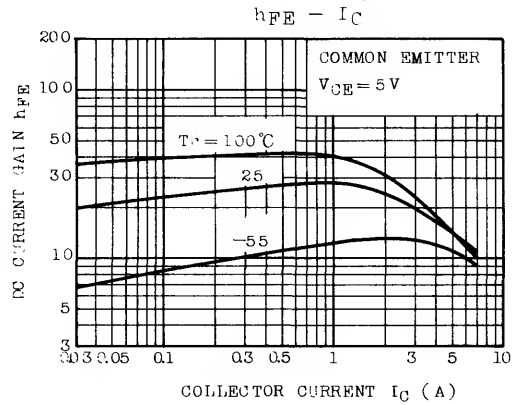
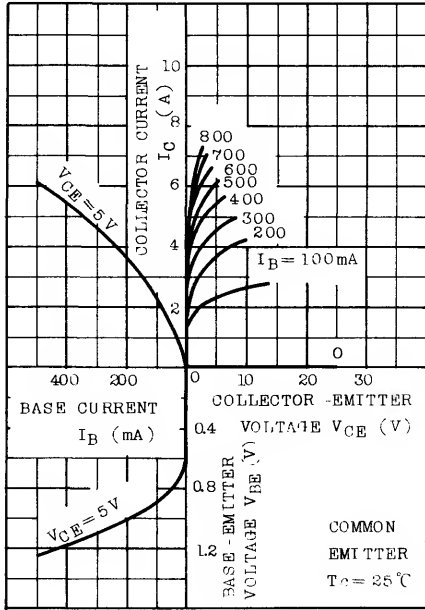
ELECTRICAL CHARACTERISTICS (Ta=25°C)

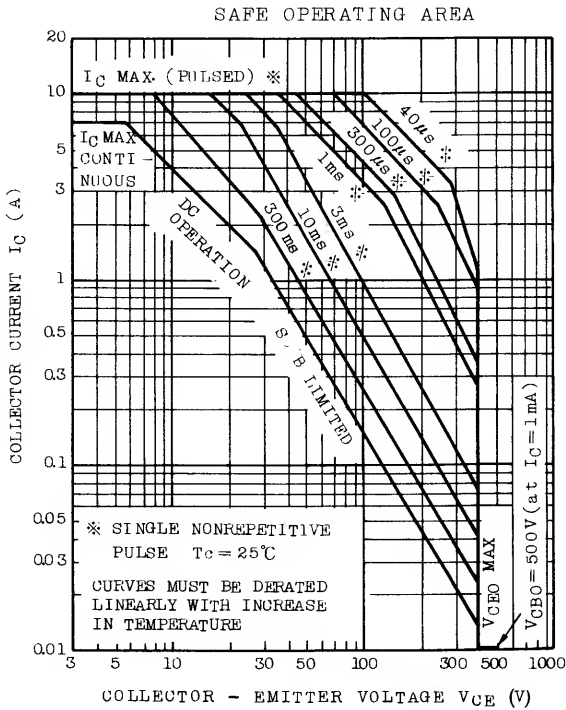
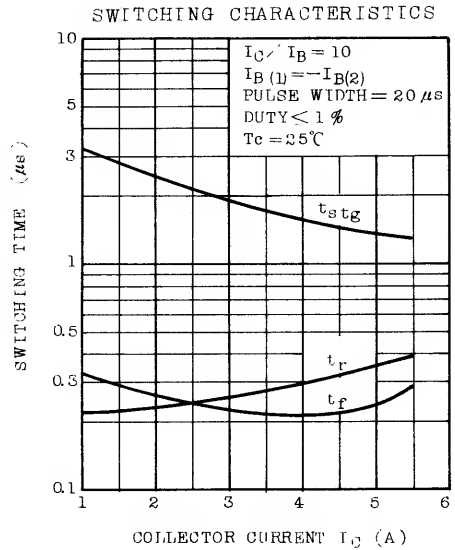
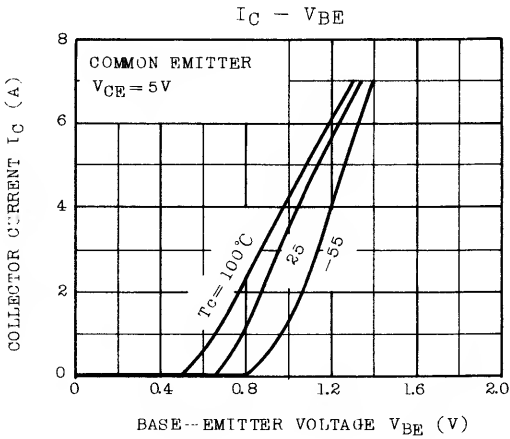
Mounting kit No. AC74
Weight : 7.6g

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=400V, I_E=0$	-	-	100	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	500	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	400	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=3A$	12	-	-	
		$V_{CE}=5V, I_C=7A$	8	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=7A, I_B=1.4A$	-	-	1.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=7A, I_B=1.4A$	-	-	2.0	V
Switching Time	Rise Time	t_r	-	-	1.0	μs
	Storage Time	t_{stg}	-	-	2.5	
	Fall Time	t_f	-	-	1.0	



STATIC CHARACTERISTICS





SWITCHING REGULATOR AND HIGH VOLTAGE
SWITCHING APPLICATIONS.
HIGH SPEED DC-DC CONVERTER APPLICATIONS.

FEATURES:

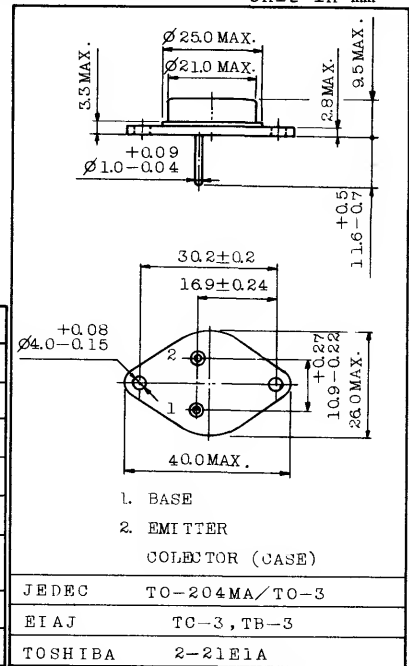
- . Excellent Switching Times
: $t_r=1.0\mu s$ (Max.), $t_f=1.0\mu s$ (Max.) at $I_C=7A$
- . High Collector Breakdown Voltage : $V_{CEO}=400V$

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	500	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	10	A
Base Current	I_B	3	A </td
Collector Power Dissipation (Tc=25°C)	P_C	120	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65 ~ 150	°C

INDUSTRIAL APPLICATIONS

Unit in mm



Mounting kit No. AC73

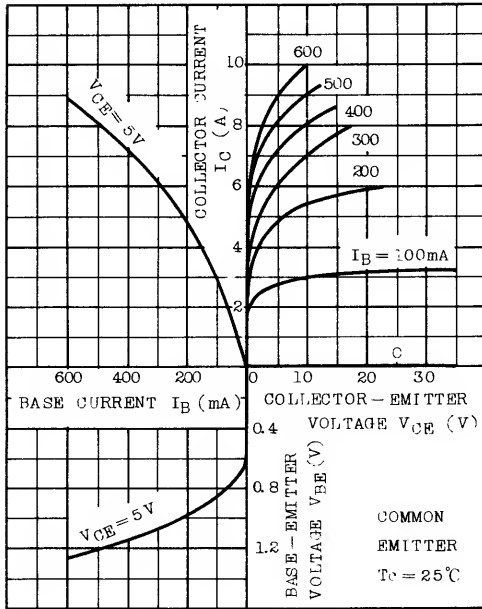
Weight : 15.3g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

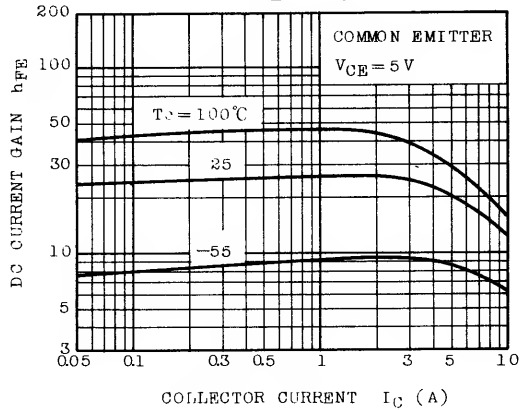
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=400V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
Collector-Base Breakdown Voltage		$V(BR)_{CBO}$	$I_C=1mA, I_E=0$	500	-	-	V
Collector-Emitter Breakdown Voltage		$V(BR)_{CEO}$	$I_C=10mA, I_B=0$	400	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=5A$	12	-	-	
			$V_{CE}=5V, I_C=10A$	8	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=10A, I_B=2A$	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=10A, I_B=2A$	-	-	2.0	V
Switching Time	Rise Time	t_r		-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.0	

2SC2914

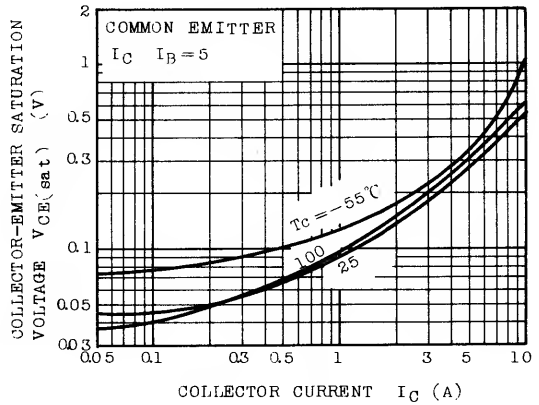
STATIC CHARACTERISTICS



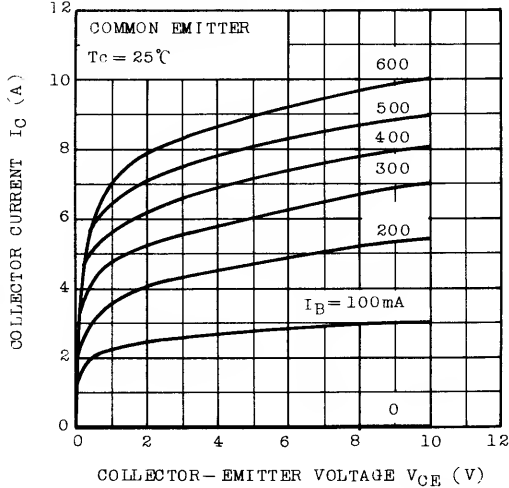
$h_{FE} - I_C$



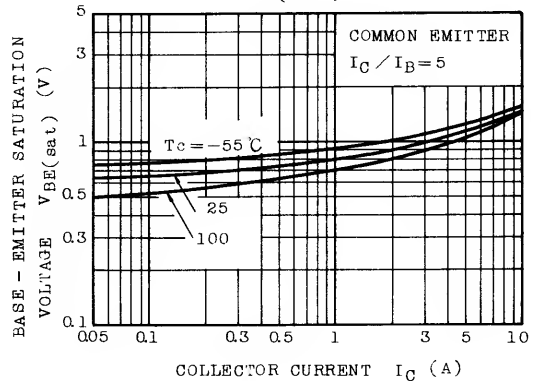
$V_{CE(sat)} - I_C$

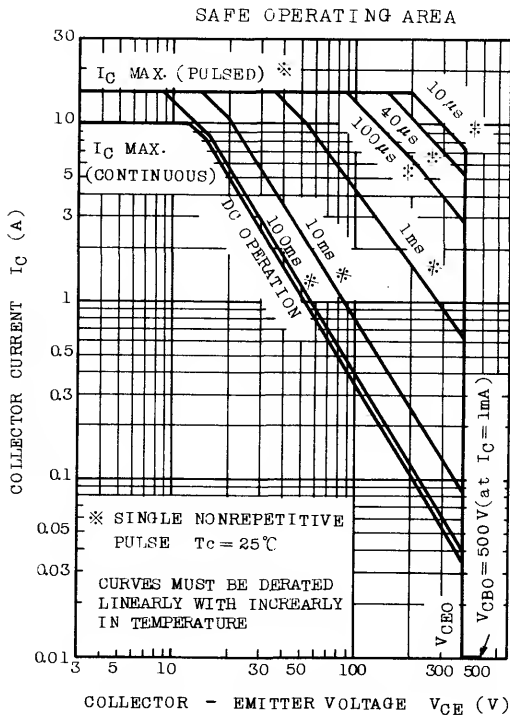
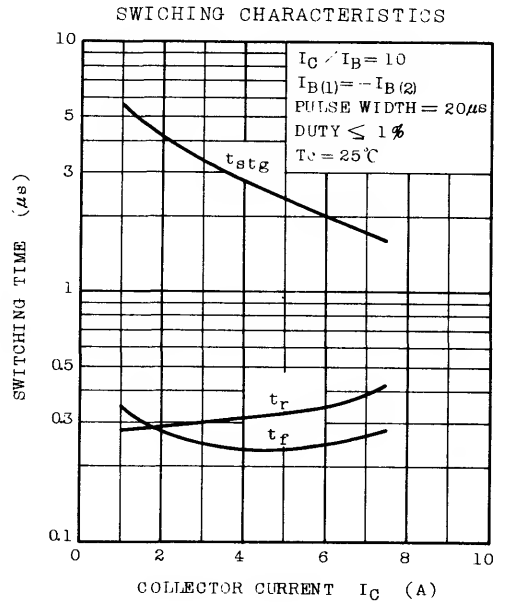
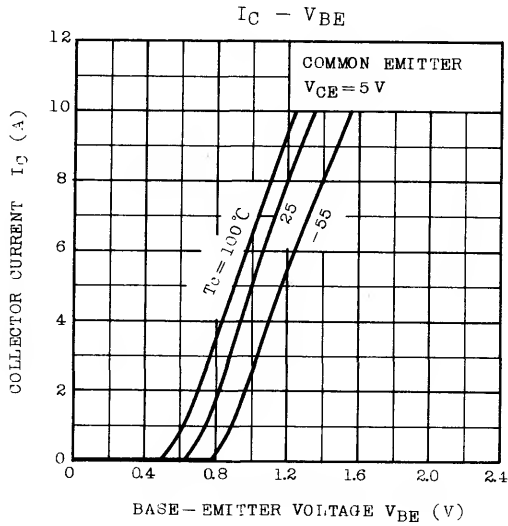


$I_C - V_{CE}$ (LOW VOLTAGE REGION)



$V_{BE(sat)} - I_C$





2SC2983

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

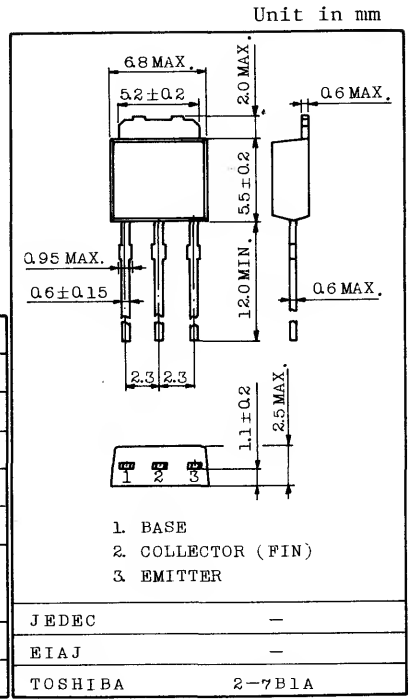
POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- . High Transition Frequency : $f_T=100\text{MHz}$ (Typ.)
- . Complementary to 2SA1225

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB0}	160	V
Collector-Emitter Voltage		V_{CE0}	160	V
Emitter-Base Voltage		V_{EB0}	5	V
Collector Current		I_C	1.5	A
Base Current		I_B	0.3	A
Collector Power Dissipation	$T_a=25^\circ\text{C}$	P_C	1.0	W
	$T_c=25^\circ\text{C}$		15	
Junction Temperature		T_j	150	$^\circ\text{C}$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ\text{C}$

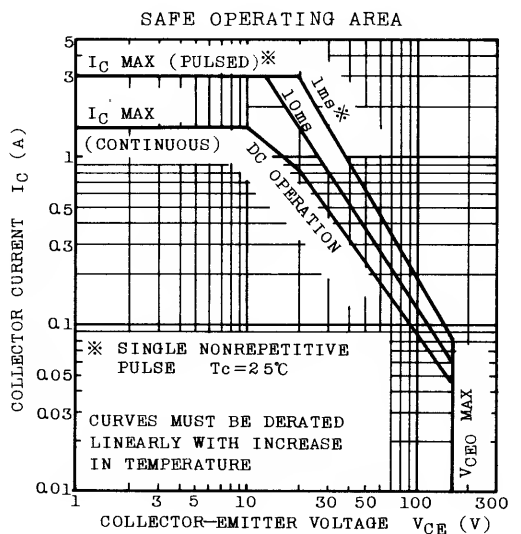
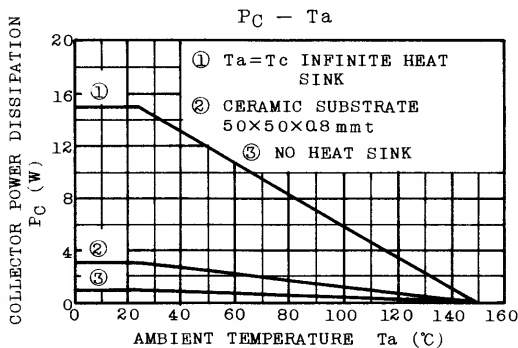
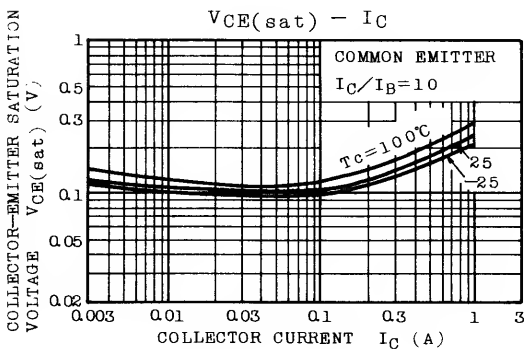
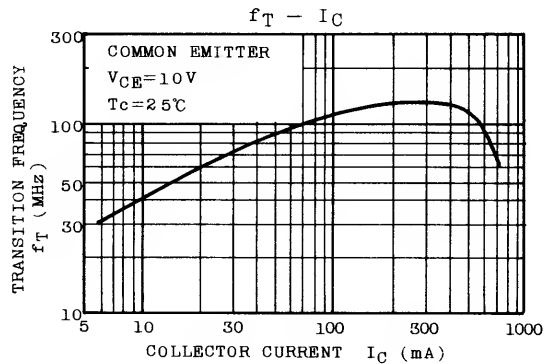
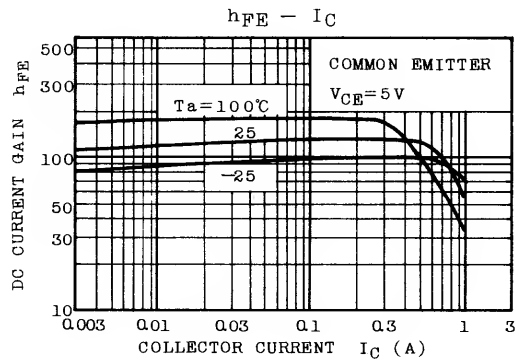
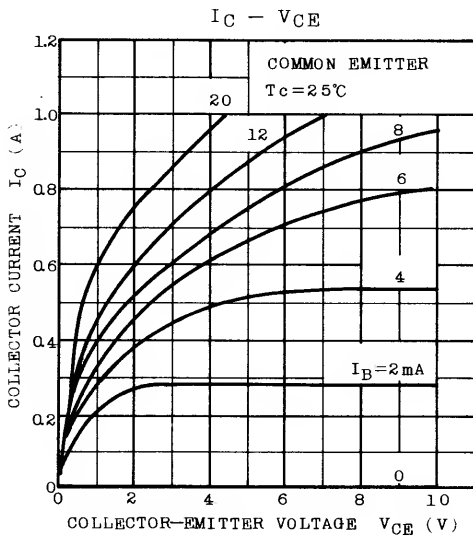


Weight : 0.36g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CB0}	$V_{CB}=160\text{V}, I_E=0$	-	-	1.0	μA
Emitter Cut-off Current		I_{EB0}	$V_{EB}=5\text{V}, I_C=0$	-	-	1.0	μA
Breakdown Voltage	Collector-Emitter	$V_{(BR)CE0}$	$I_C=10\text{mA}, I_B=0$	160	-	-	V
	Emitter-Base	$V_{(BR)EBO}$	$I_E=1\text{mA}, I_C=0$	5	-	-	
DC Current Gain		h_{FE} (Note)	$V_{CE}=5\text{V}, I_C=100\text{mA}$	70	-	240	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=500\text{mA}, I_B=50\text{mA}$	-	-	1.5	V
Base-Emitter Voltage		V_{BE}	$V_{CE}=5\text{V}, I_C=500\text{mA}$	-	-	1.0	V
Transition Frequency		f_T	$V_{CE}=10\text{V}, I_C=100\text{mA}$	-	100	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10\text{V}, I_E=0, f=1\text{MHz}$	-	25	-	pF

Note: h_{FE} Classification O : 70 ~ 140, Y : 120 ~ 240



2SC3006

SILICON NPN EPITAXIAL PLANAR TYPE

UHF BAND POWER AMPLIFIER APPLICATIONS.

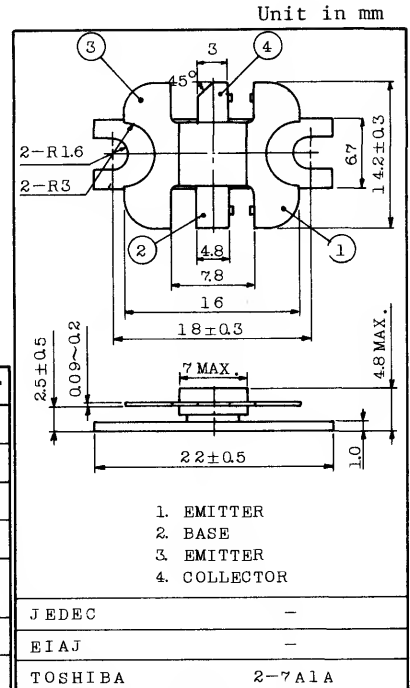
FEATURES:

. Output Power

: $P_o=3W$ (Min.) ($f=470MHz$, $V_{CC}=12.6V$, $P_i=0.4W$)

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	V
Collector-Emitter Voltage	V_{CEO}	17	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current	I_C	1	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	10	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 175	$^\circ C$

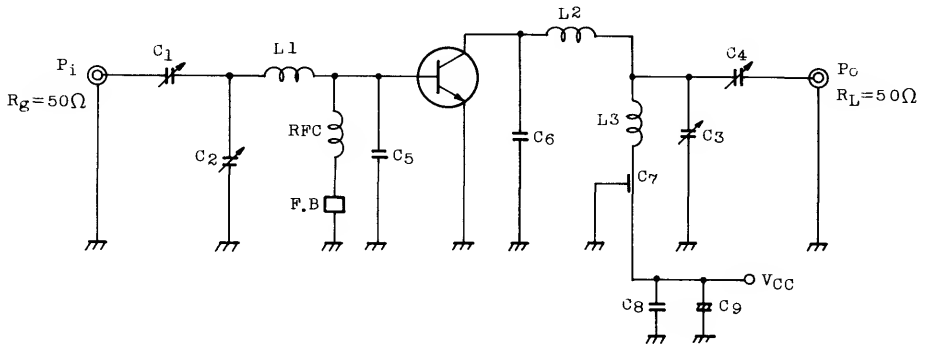


Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=15V$, $I_E=0$	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=2mA$, $I_E=0$	35	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=5mA$, $I_B=0$	17	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=0.1mA$, $I_C=0$	3.5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=0.5A$	10	-	-	-
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	10	-	pF
Output Power	P_o	$V_{CC}=12.6V$, $f=470MHz$, $P_i=0.4W$	3	-	-	W
Power Gain	G_{pe}	(Fig.)	8.7	-	-	dB
Collector Efficiency	η_c	(Fig.)	50	-	-	%

Fig. $f=470\text{MHz}$ P_O TEST CIRCUIT



C_1, C_2, C_3, C_4 : $\sim 20\text{pF}$

C_5, C_6 : 10pF

C_7 : $0.01\mu\text{F}$

C_8 : $0.02\mu\text{F}$

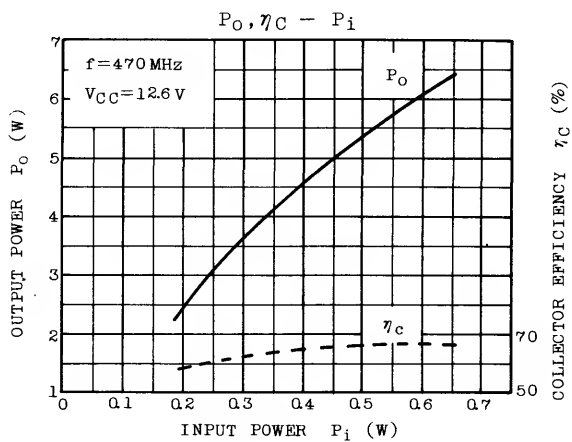
C_9 : $10\mu\text{F}$

L_1, L_2 : $5\text{mm} \times 20\text{mm}$ COPPER PLATE

L_3 : $\phi 1$ SILVER PLATED COPPER WIRE, 10ID, 2T

RFC : $\phi 0.5$ ENAMEL COATED COPPER WIRE, 7ID, 10T

F.B. : FERRITE BEADS



2SC3007

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

HIGH CURRENT SWITCHING APPLICATIONS.
HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

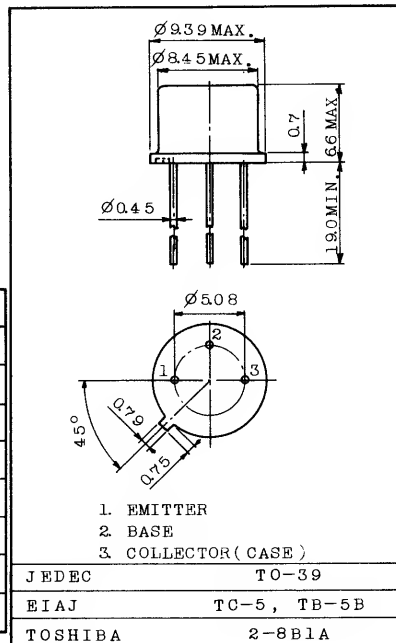
- Low Collector Saturation Voltage
: $V_{CE(sat)}=0.5V(\text{Max.})$ at $I_C=1A$
- High Speed Switching Time : $t_{stg}=1.0\mu s(\text{Typ.})$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	50	V
Collector-Emitter Voltage	V_{CEO}	50	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	2	A
Base Current	I_B	0.2	A
Collector Power Dissipation	P_C	800	mW
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$

INDUSTRIAL APPLICATIONS

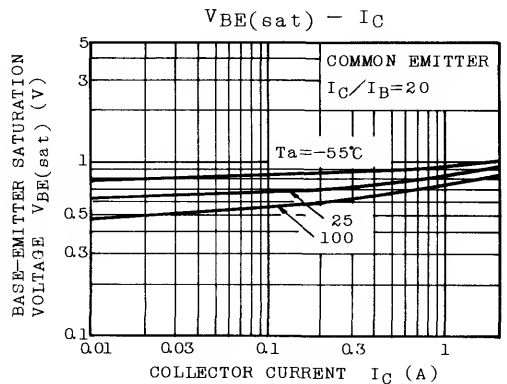
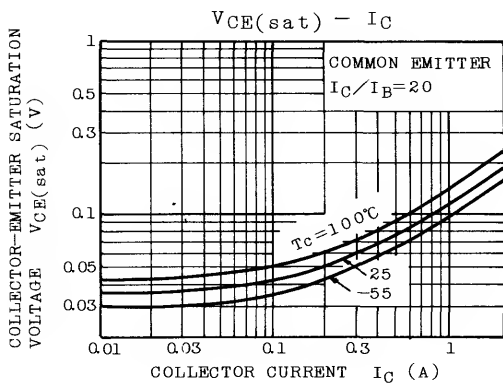
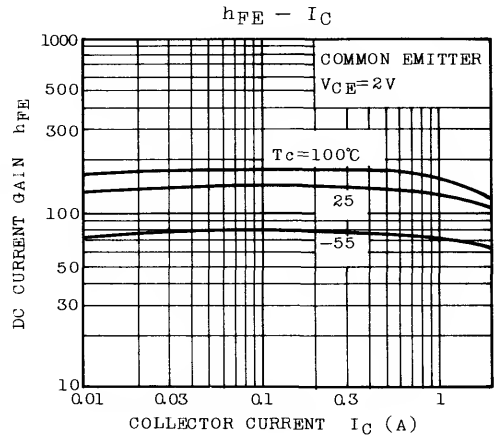
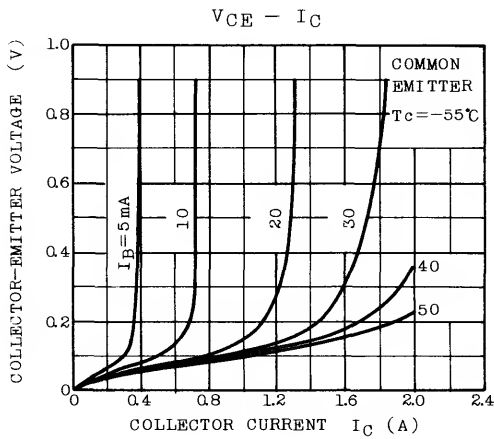
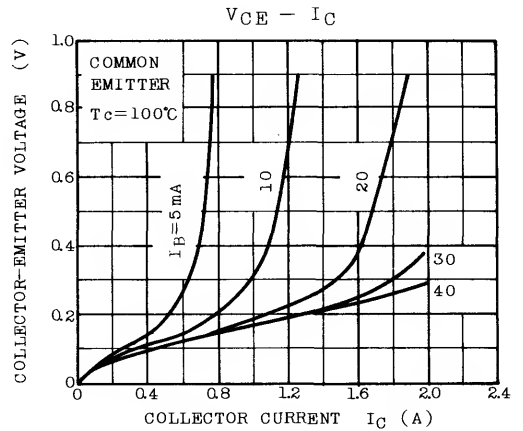
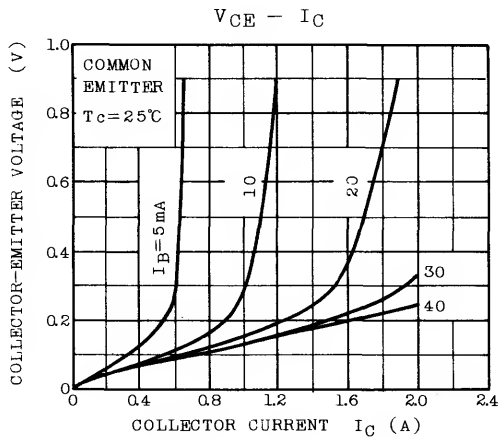
Unit in mm



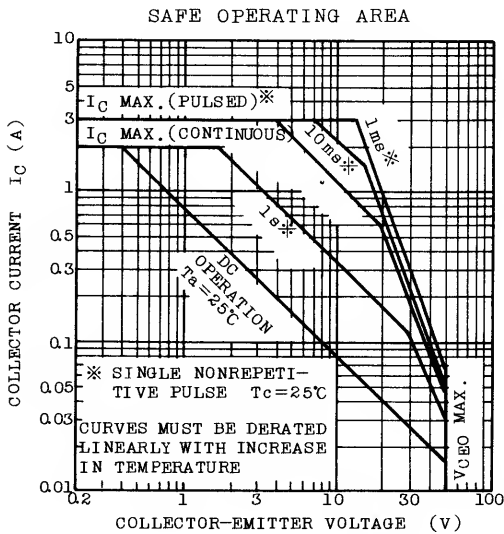
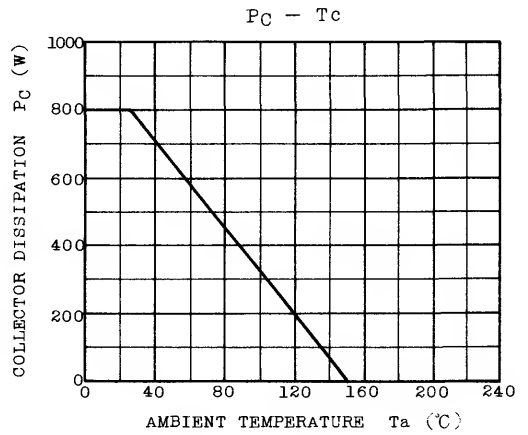
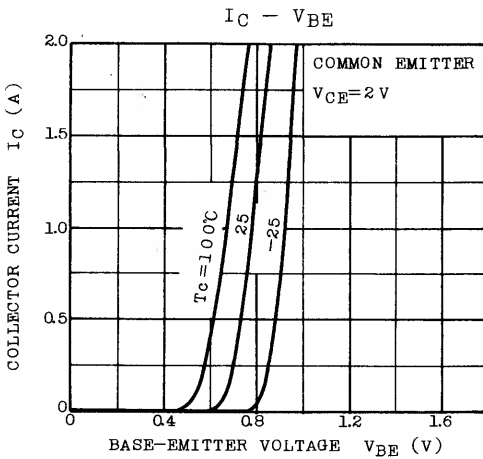
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

Weight : 1.13g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=50V, I_E=0$	-	-	1.0	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1.0	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	50	-	-	V
DC Current Gain		$h_{FE(1)}$	$V_{CE}=2V, I_C=0.5A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=2V, I_C=1.5A$	40	-	-	
Saturation Voltage	Base-Emitter	$V_{CE(sat)}$	$I_C=1A, I_B=0.05A$	-	-	0.5	V
	Collector-Emitter	$V_{BE(sat)}$	$I_C=1A, I_B=0.05A$	-	-	1.2	
Transition Frequency		f_T	$V_{CE}=2V, I_C=0.5A$	-	100	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	30	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.1	-	μs
	Fall Time	t_{stg}		-	1.0	-	
	Storage Time	t_f		$I_{B1}=-I_{B2}=0.05A$ DUTY CYCLE $\leq 1\%$	-	0.1	



2SC3007



Unit in mm

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

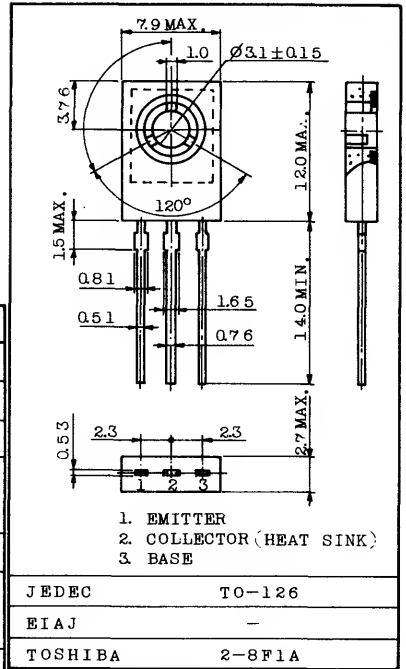
HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

- Excellent Switching Times
: $t_r=1.0\mu s(\text{Max.})$, $t_f=1.5\mu s(\text{Max.})$ at $I_C=0.5A$
- High Collector Breakdown Voltage : $V_{CE0}=400V$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	500	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	0.8	A
	Pulse	I_{CP}	1.5	
Base Current		I_B	0.5	A
Collector Power Dissipation	$T_a=25^\circ C$	P_C	1.0	W
	$T_c=25^\circ C$		10	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$

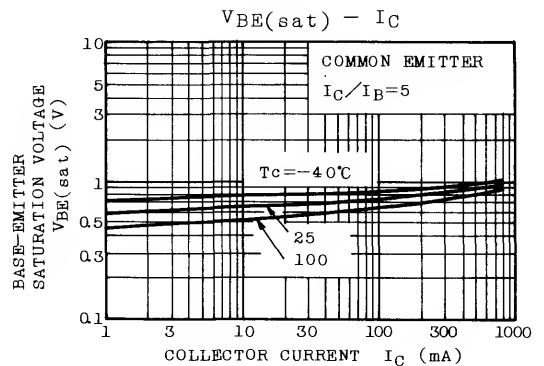
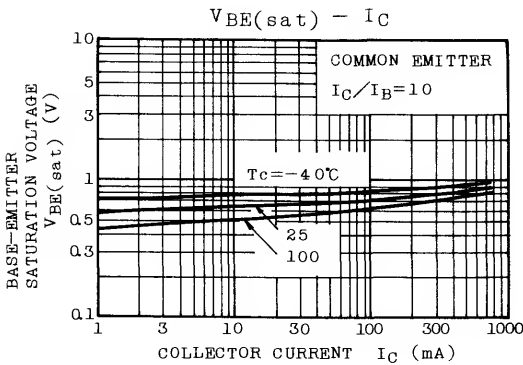
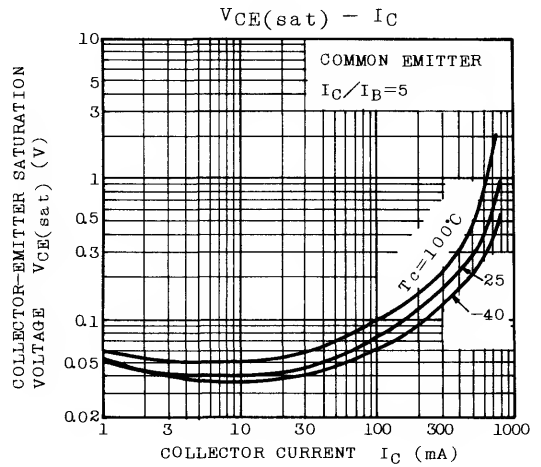
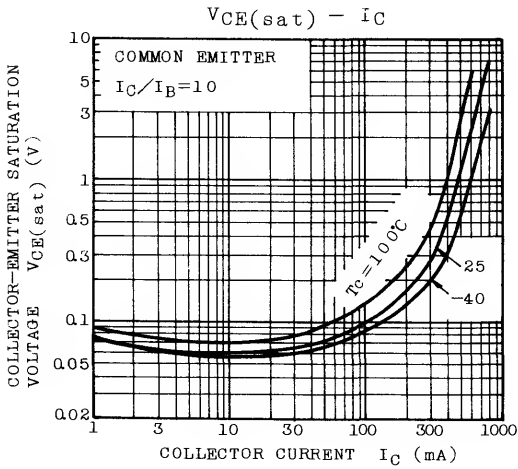
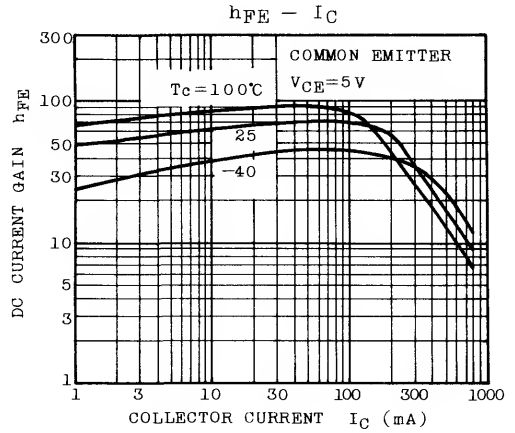
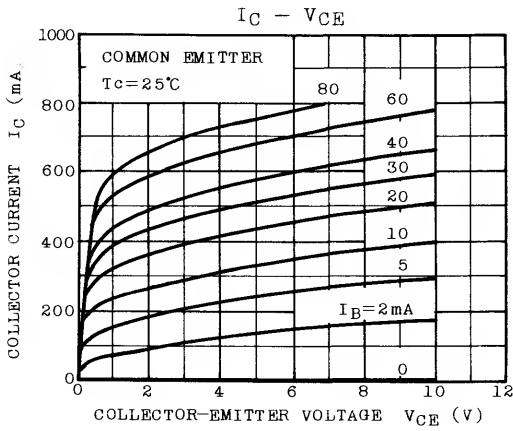


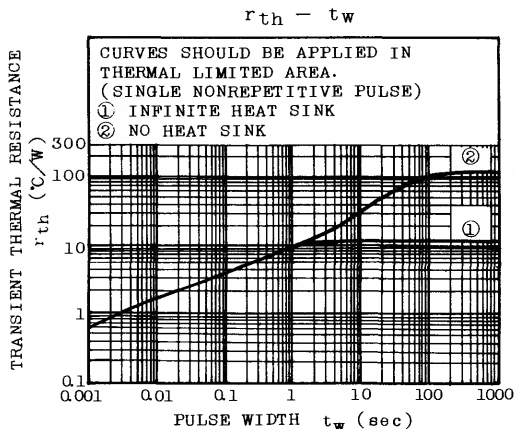
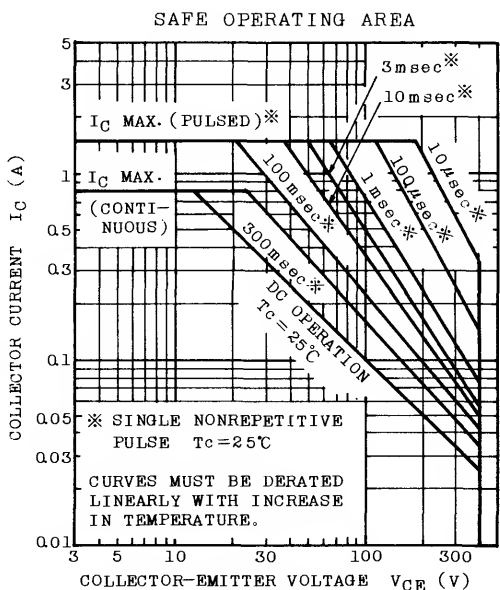
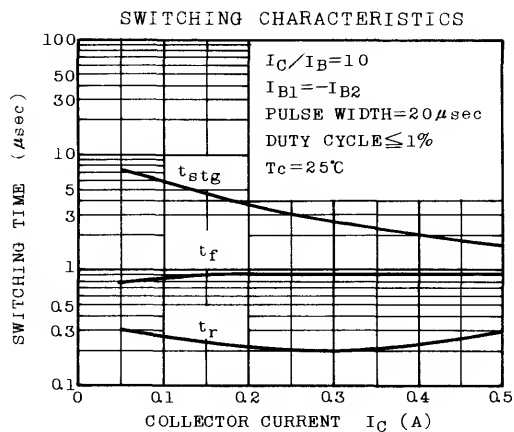
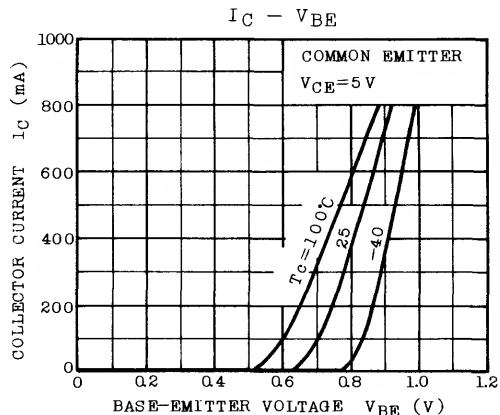
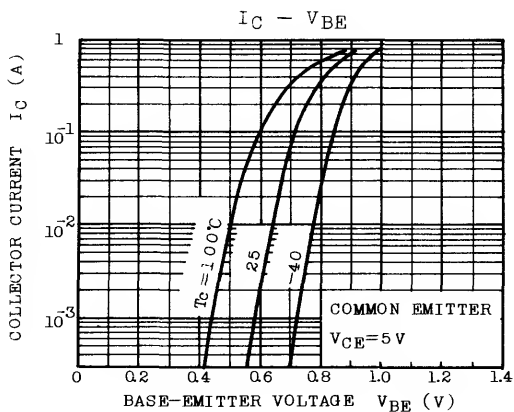
JEDEC TO-126
EIAJ -
TOSHIBA 2-8F1A
Mounting Kit No. AC46C
Weight : 0.72g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=400V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	100	μA
Collector-Base Breakdown Voltage		$V(BR)_{CBO}$	$I_C=1mA, I_E=0$	500	-	-	V
Collector-Emitter Breakdown Voltage		$V(BR)_{CEO}$	$I_C=10mA, I_B=0$	400	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=0.1A$	20	-	100	
			$V_{CE}=5V, I_C=0.5A$	10	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=0.1A, I_B=0.01A$	-	-	0.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=0.1A, I_B=0.01A$	-	-	1.0	V
Switching Time	Rise Time	t_r		-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.5	

2SC3051





2SC3072

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

STROBO FLASH APPLICATIONS.

MEDIUM POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . High DC Current Gain: $h_{FE}=140\sim 450$ ($V_{CE}=2V, I_C=0.5A$)
 $h_{FE}=70$ (Min.) ($V_{CE}=2V, I_C=4A$)
- . Low Collector Saturation Voltage
 $V_{CE(sat)}=1.0V$ (Max.) ($I_C=4A, I_B=0.1A$)
- . High Power Dissipation
 $P_C=10W$ ($T_c=25^\circ C$), $P_C=1.0W$ ($T_a=25^\circ C$)

MAXIMUM RATINGS ($T_a=25^\circ C$)

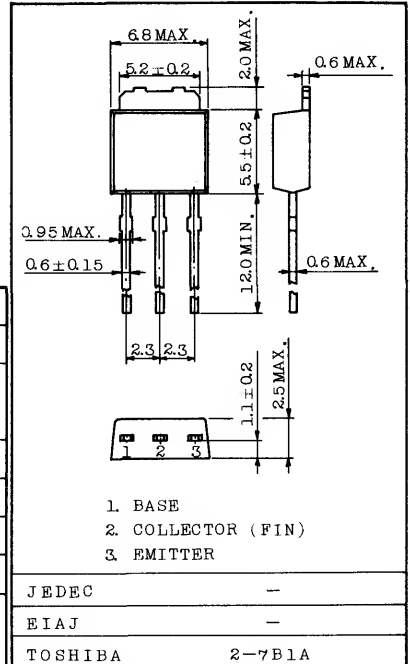
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	50	V
Collector-Emitter Voltage		V_{CES}	40	V
		V_{CEO}	20	
Emitter-Base Voltage		V_{EBO}	8	V
Collector Current	DC	I_C	5	A
	Pulsed (Note 1)	I_{CP}	8	A
Base Current		I_B	0.5	A
Collector Power Dissipation	$T_a=25^\circ C$	P_C	1.0	W
	$T_c=25^\circ C$		10	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=40V, I_E=0$	-	-	100	nA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=8V, I_C=0$	-	-	100	nA
Collector-Emitter Breakdown Voltage	V_{CEO}	$I_C=10mA, I_B=0$	20	-	-	V
Emitter-Base Breakdown Voltage	V_{EBO}	$I_E=1mA, I_C=0$	8	-	-	V
DC Current Gain	$h_{FE}(1)$ (Note 2)	$V_{CE}=2V, I_C=0.5A$	140	-	450	
	$h_{FE}(2)$	$V_{CE}=2V, I_C=4A$	70	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A, I_B=0.1A$	-	-	1.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=2V, I_C=4A$	-	-	1.5	V
Transition Frequency	f_T	$V_{CE}=2V, I_C=0.5A$	-	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	40	-	pF

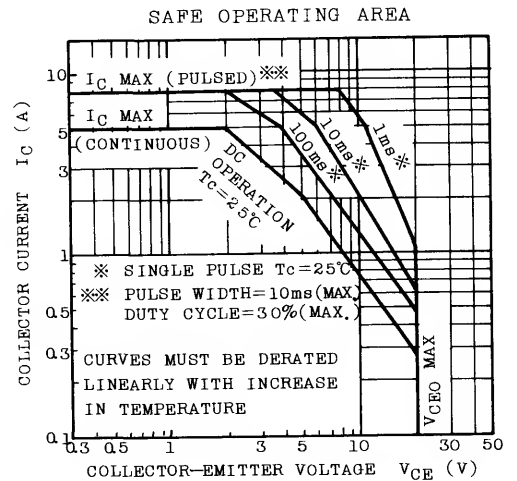
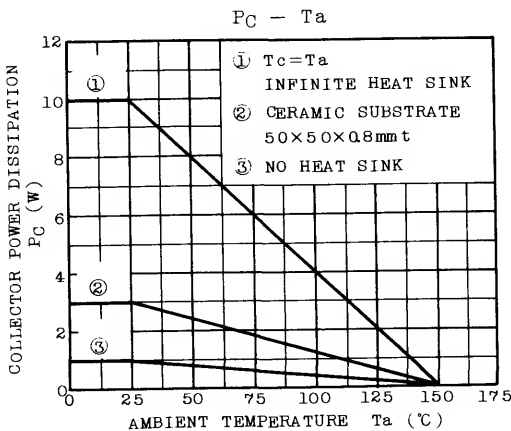
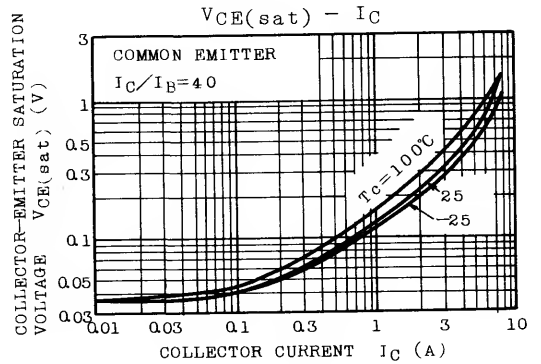
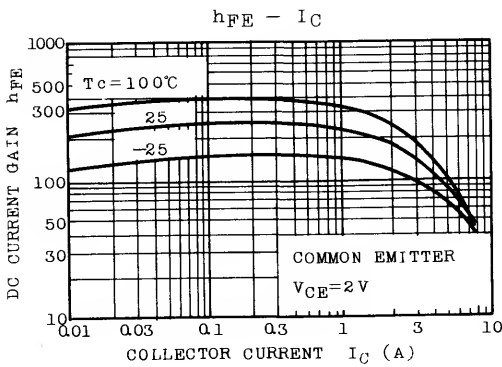
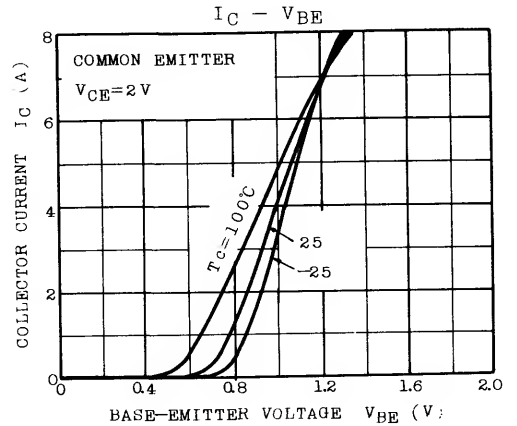
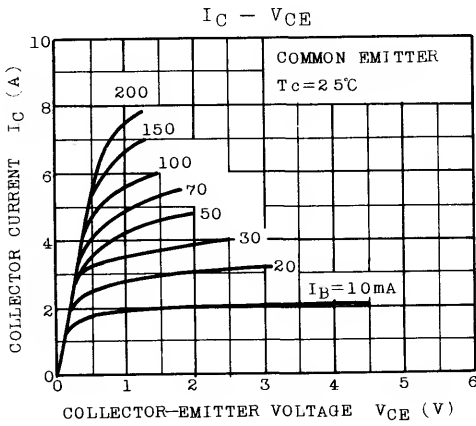
Note 2 : $h_{FE}(1)$ Classification A : 140 ~ 240, B : 200 ~ 330, C : 300 ~ 450

Unit in mm



Weight : 0.36g

Note 1 : Pulse Test: Pulse width = 10ms (Max.)
 Duty cycle = 30% (Max.)



2SC3073

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

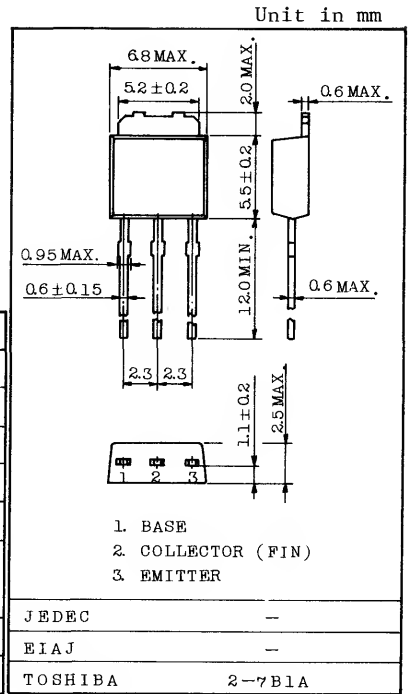
POWER AMPLIFIER APPLICATIONS.
 CAR RADIO, CAR STEREO OUTPUT STAGE AMPLIFIER
 APPLICATIONS.

FEATURES:

- . Good Linearity of h_{FE}
- . Complementary to 2SA1243

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB0}	30	V
Collector-Emitter Voltage		V_{CE0}	30	V
Emitter-Base Voltage		V_{EB0}	5	V
Collector Current		I_C	3	A
Base Current		I_B	0.6	A
Collector Power Dissipation	$T_a=25^\circ\text{C}$	P_C	1.0	W
	$T_c=25^\circ\text{C}$		10	
Junction Temperature		T_j	150	$^\circ\text{C}$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ\text{C}$

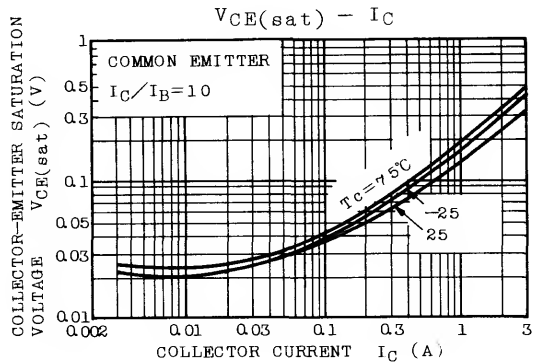
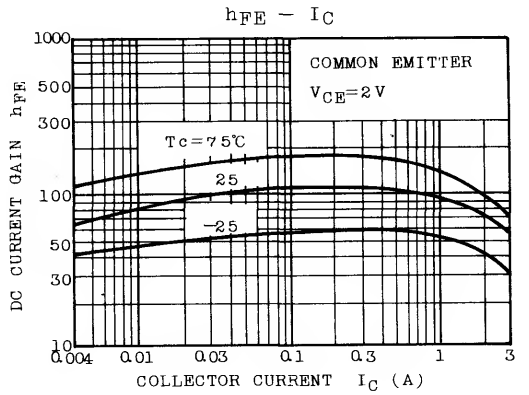
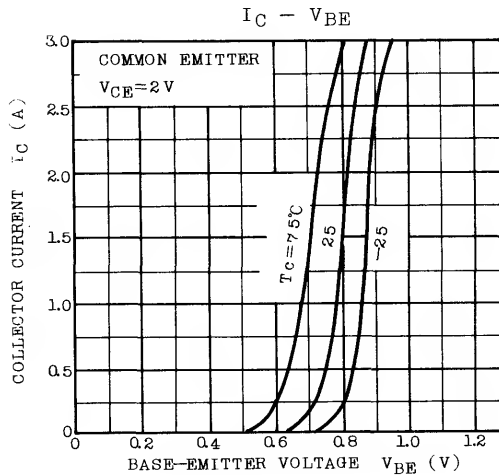
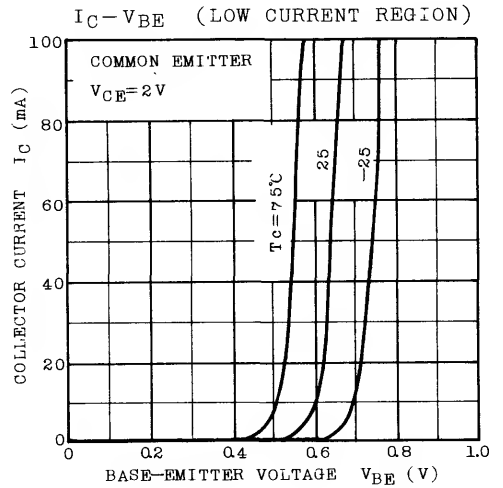
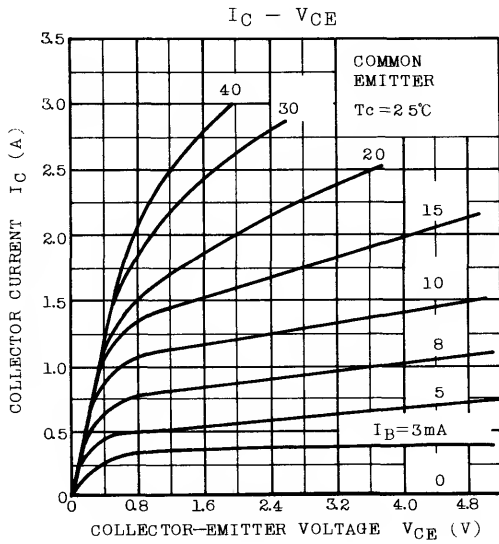


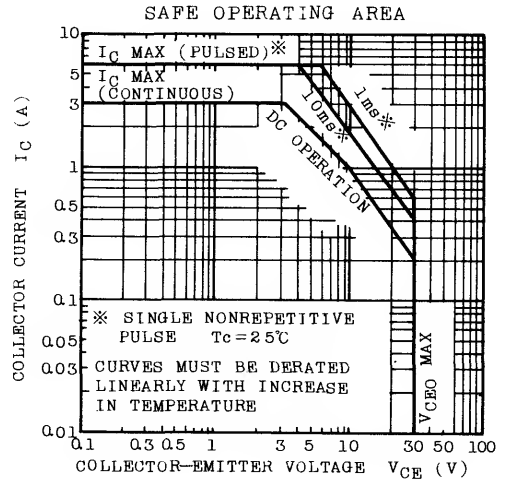
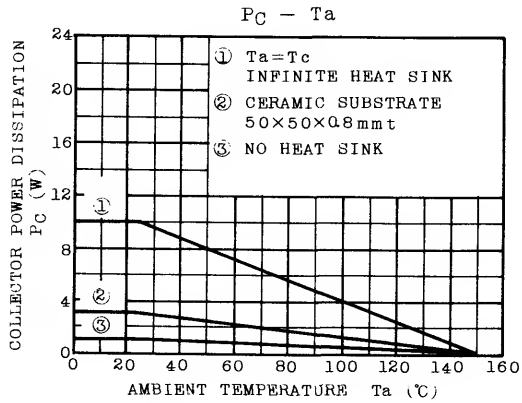
Weight : 0.36g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=20\text{V}, I_E=0$	-	-	1.0	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=5\text{V}, I_C=0$	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10\text{mA}, I_B=0$	30	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1\text{mA}, I_C=0$	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=2\text{V}, I_C=0.5\text{A}$	70	-	240	
	$h_{FE(2)}$	$V_{CE}=2\text{V}, I_C=2.5\text{A}$	25	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=2\text{A}, I_B=0.2\text{A}$	-	0.3	0.8	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=2\text{V}, I_C=0.5\text{A}$	-	0.75	1.0	V
Transition Frequency	f_T	$V_{CE}=2\text{V}, I_C=0.5\text{A}$	-	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10\text{V}, I_E=0, f=1\text{MHz}$	-	35	-	pF

Note: $h_{FE(1)}$ Classification 0 : 70 ~ 140, Y : 120 ~ 240



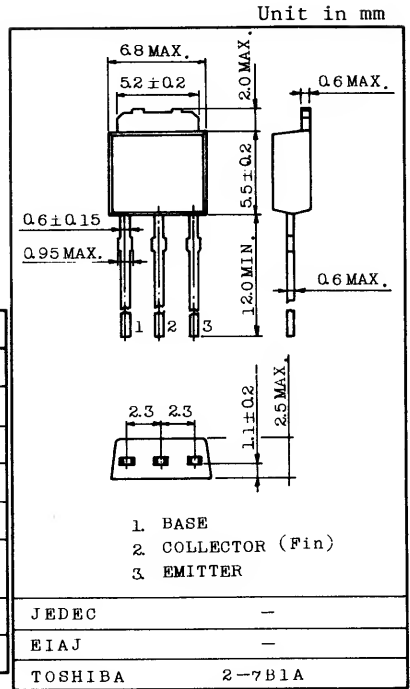


HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- . Low Collector Saturation Voltage
: $V_{CE(sat)}=0.4V(\text{Max.})$ (at $I_C=3A$)
- . High Speed Switching Time : $t_{stg}=1.0\mu s(\text{Typ.})$
- . Complementary to 2SA1244

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	60	V
Collector-Emitter Voltage		V_{CEO}	50	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	5	A
Base Current		I_B	1	A
Collector Power Dissipation	$T_a=25^\circ C$	P_C	1.0	W
	$T_c=25^\circ C$		20	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$



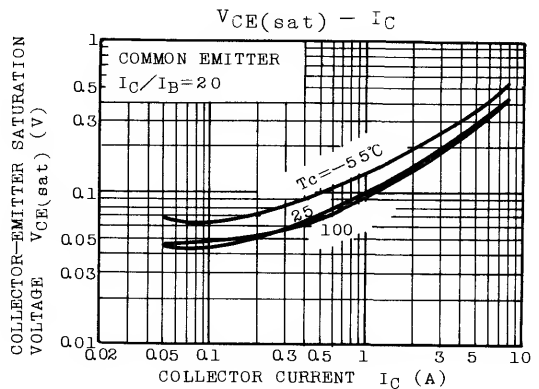
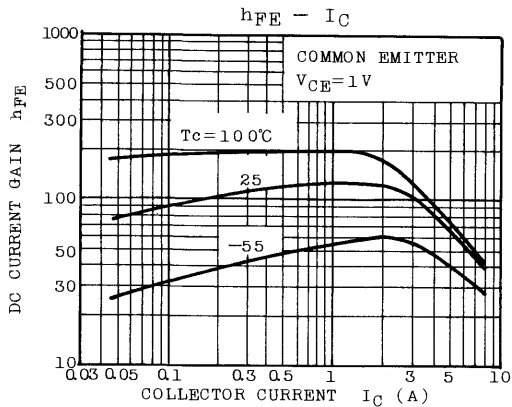
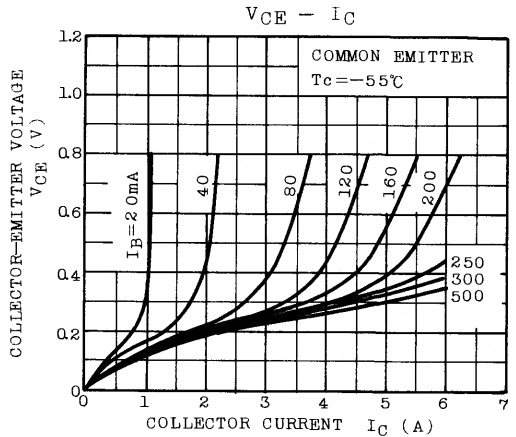
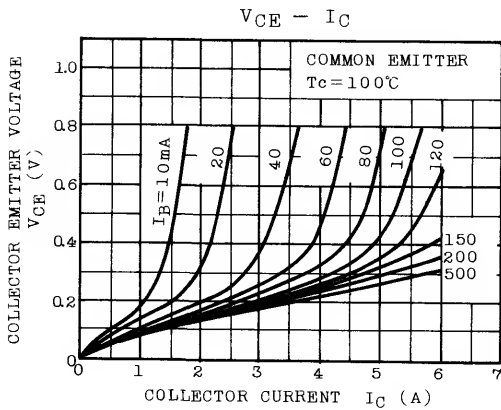
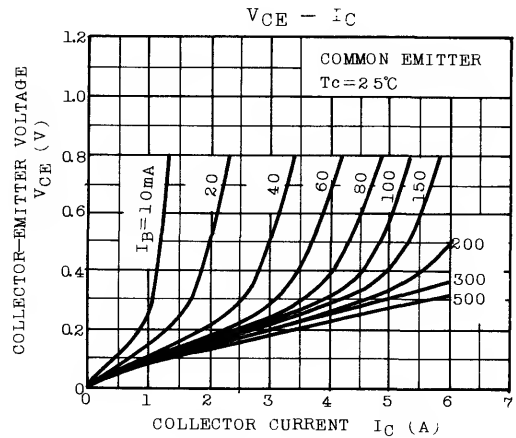
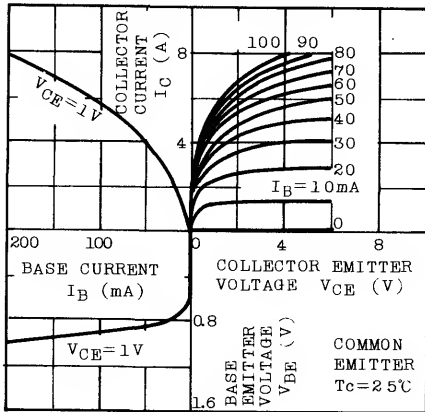
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

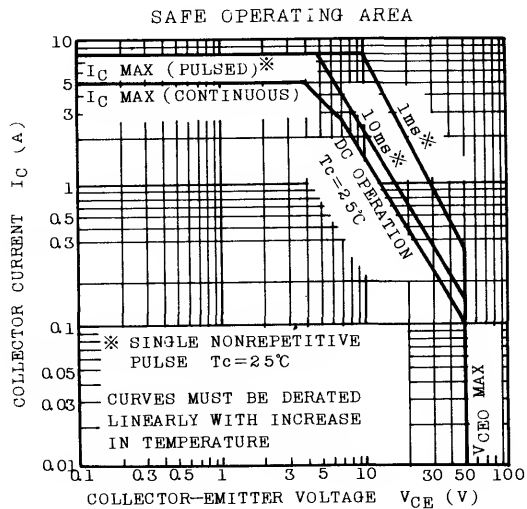
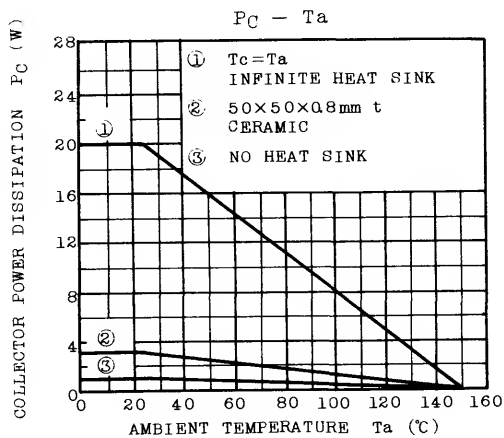
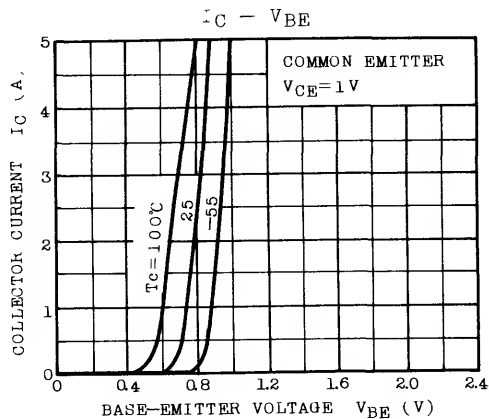
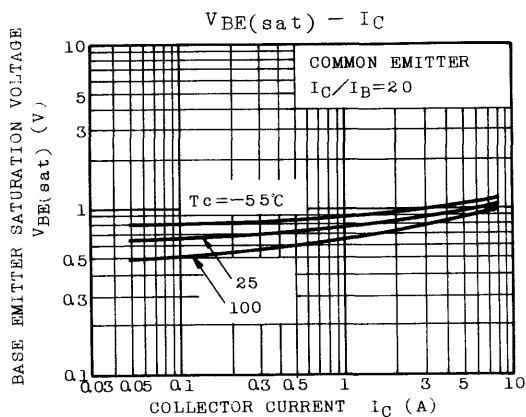
Weight : 0.36g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=50V, I_E=0$	-	-	1	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=1V, I_C=1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=1V, I_C=3A$	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=3A, I_B=0.15A$	-	0.2	0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=3A, I_B=0.15A$	-	0.9	1.2	
Transition Frequency		f_T	$V_{CE}=4V, I_C=1A$	-	120	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CE}=10V, I_E=0, f=1MHz$	-	80	-	pF
Switching Time	Turn-on Time	t_{on}	<p>$I_{B1} = -I_{B2} = 0.15A$ DUTY CYCLE $\leq 1\%$</p>	-	0.1	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

Note : $h_{FE(1)}$ Classification O : 70 ~ 140, Y : 120 ~ 240

STATIC CHARACTERISTICS





2SC3075

SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

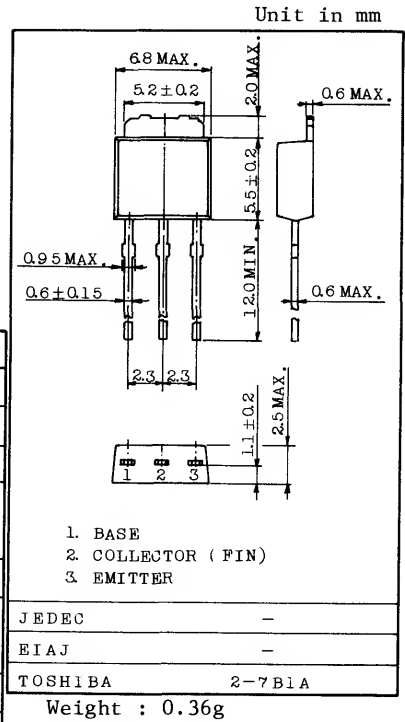
HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

- Excellent Switching Times
: $t_r=1.0\mu s(\text{Max.})$, $t_f=1.5\mu s(\text{Max.})$ at $I_C=0.5A$
- High Collector Breakdown Voltage : $V_{CE0}=400V$

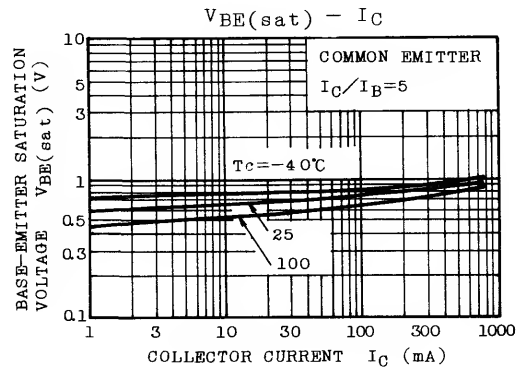
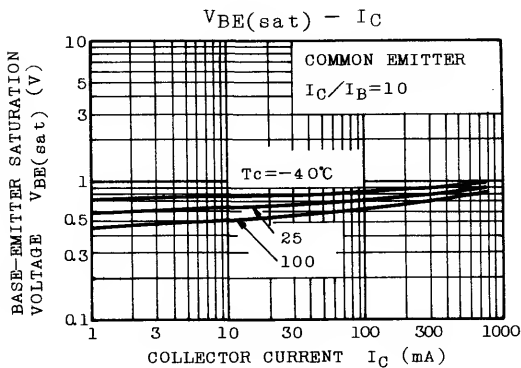
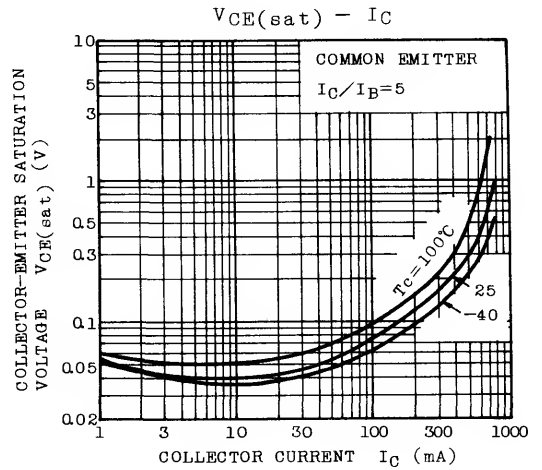
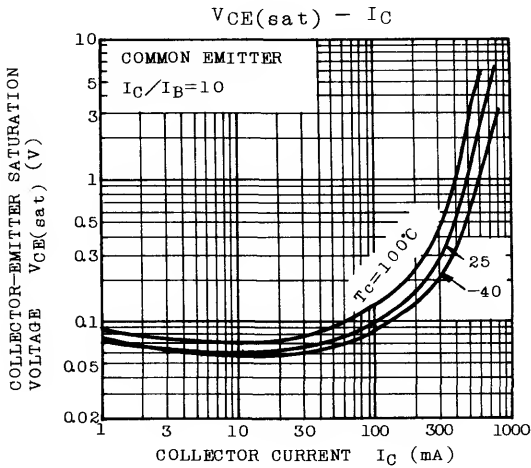
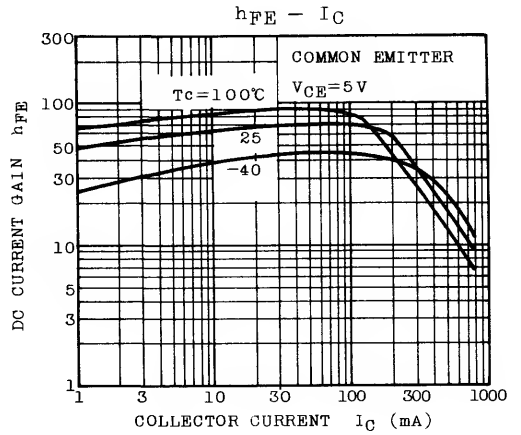
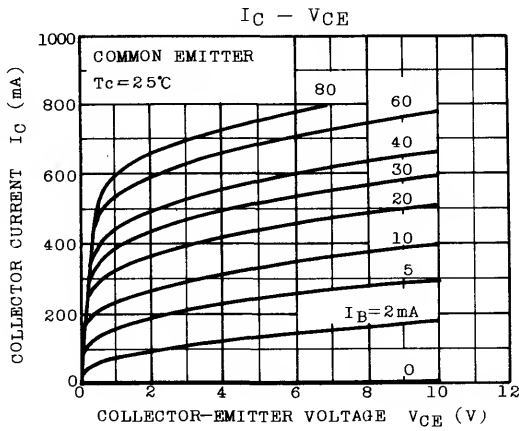
MAXIMUM RATINGS ($T_a=25^\circ C$)

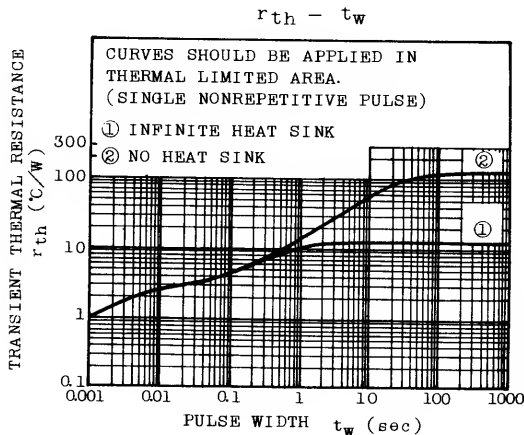
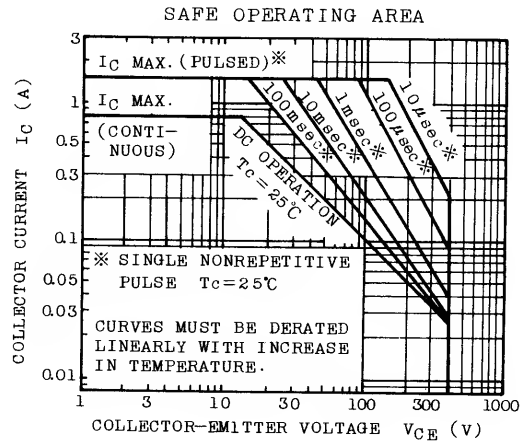
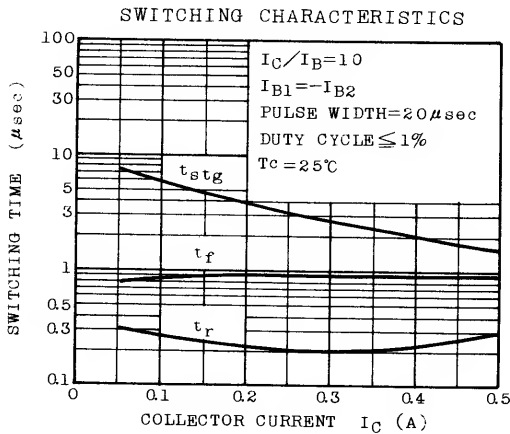
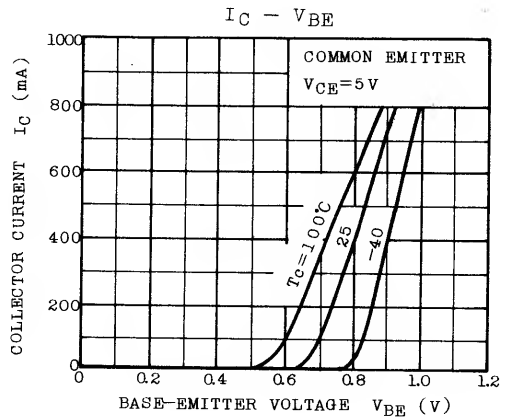
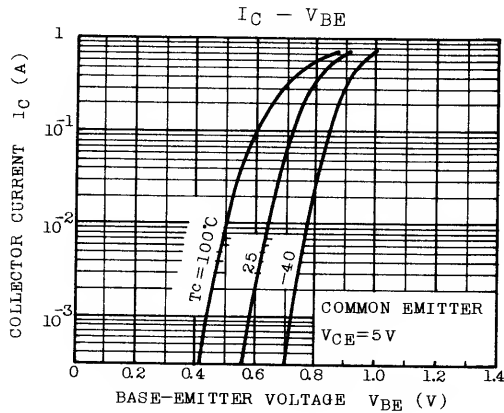
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB0}	500	V
Collector-Emitter Voltage		V_{CE0}	400	V
Emitter-Base Voltage		V_{EB0}	7	V
Collector Current	DC	I_C	0.8	A
	Pulse	I_{CP}	1.5	
Base Current		I_B	0.5	A
Collector Power Dissipation	$T_a=25^\circ C$	P_C	1.0	W
	$T_c=25^\circ C$		10	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$



ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=400V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	100	μA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	400	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=0.1A$	20	-	100	
			$V_{CE}=5V, I_C=0.5A$	10	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=0.1A, I_B=0.01A$	-	-	0.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=0.1A, I_B=0.01A$	-	-	1.0	V
Switching Time	Rise Time	t_r		-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.5	





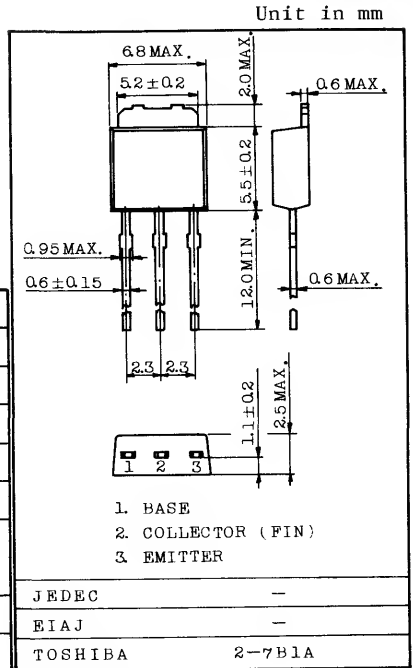
POWER AMPLIFIER APPLICATIONS.
POWER SWITCHING APPLICATIONS.

FEATURES:

- . Low Collector Saturation Voltage
: $V_{CE(sat)}=0.5V$ (Max.) ($I_C=1A$)
- . Excellent Switching Time : $t_{stg}=1.0\mu s$ (Typ.)
- . Complementary to 2SA1241

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	50	V
Collector-Emitter Voltage		V_{CEO}	50	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	2	A
Base Current		I_B	1	A
Collector Power Dissipation	$T_a=25^\circ C$	P_C	1.0	W
	$T_c=25^\circ C$		10	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature		T_{stg}	-55 ~ 150	$^\circ C$

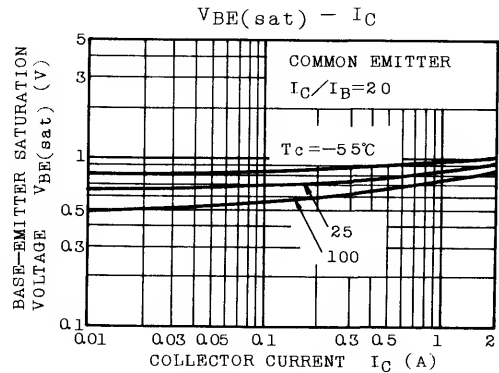
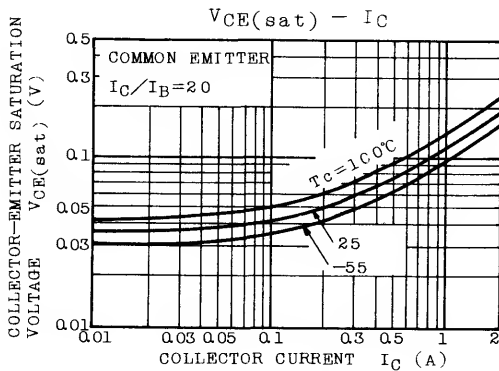
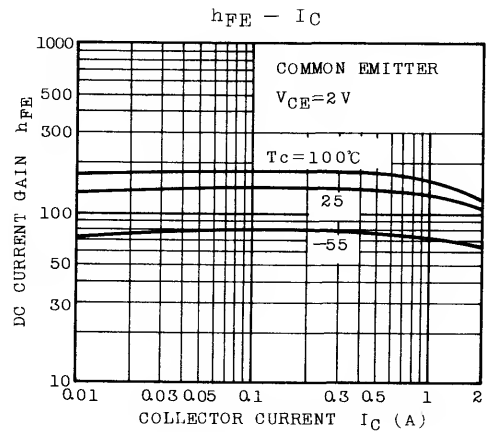
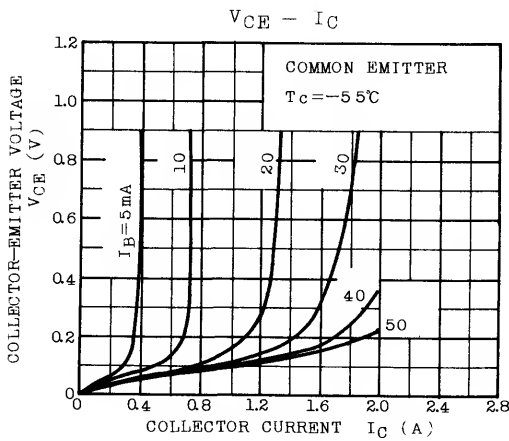
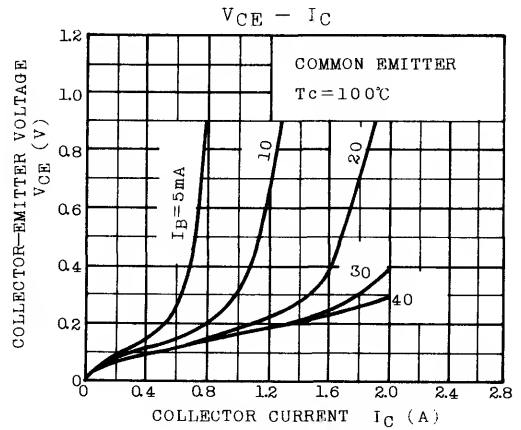
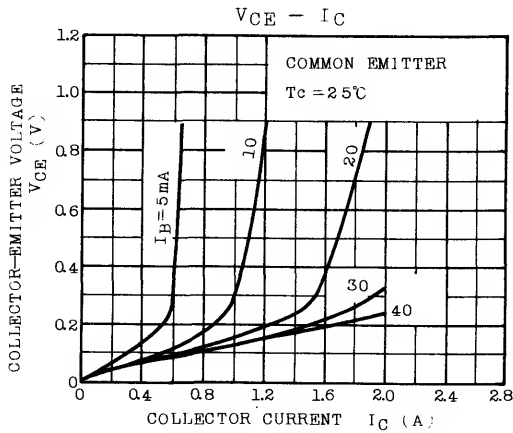


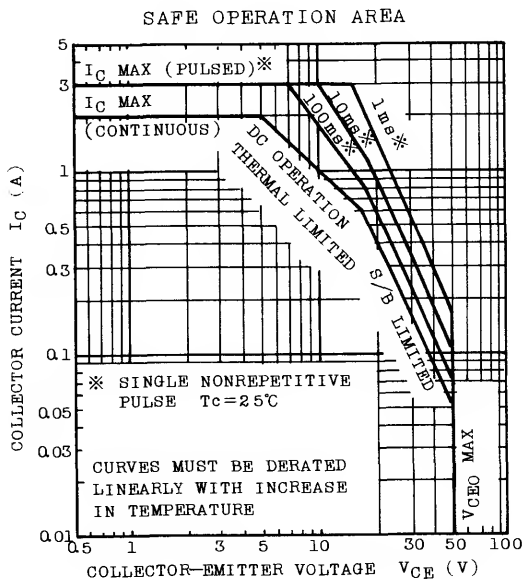
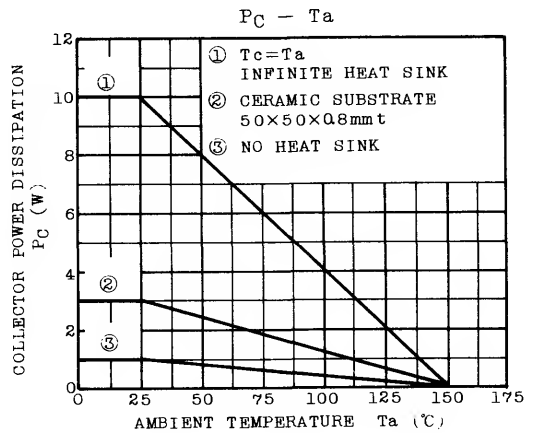
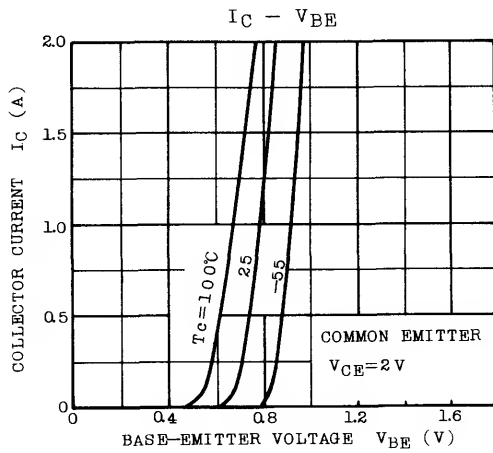
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

Weight : 0.36g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=50V, I_E=0$	-	-	1.0	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1.0	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=2V, I_C=0.5A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=2V, I_C=1.5A$	40	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=1A, I_B=0.05A$	-	-	0.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=1A, I_B=0.05A$	-	-	1.2	V
Transition Frequency		f_T	$V_{CE}=2V, I_C=0.5A$	-	100	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	30	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.1	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

Note : $h_{FE(1)}$ Classification 0 : 70 ~ 140, Y : 120 ~ 140





2SC3148

SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE.
SWITCHING APPLICATIONS.
HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

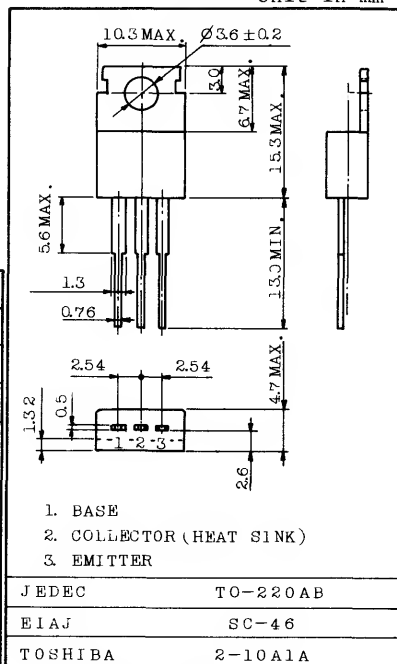
- Excellent Switching Times ($I_C=0.8A$)
 $t_r=1.0\mu s$ Max., $t_f=1.0\mu s$ Max.
- High Collector-Emitter Breakdown Voltage : $V_{CEO}=800V$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	900	V
Collector-Emitter Voltage		V_{CEO}	800	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	3	A
	Peak	I_{CP}	5	
Base Current		I_B	1	A
Collector Power Dissipation ($T_c=25^\circ C$)		P_C	40	W
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$

INDUSTRIAL APPLICATIONS

Unit in mm

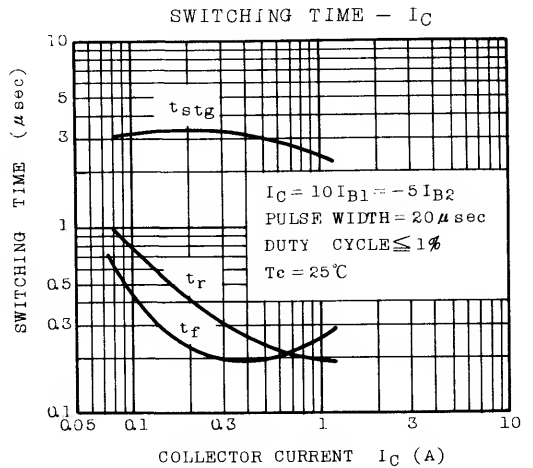
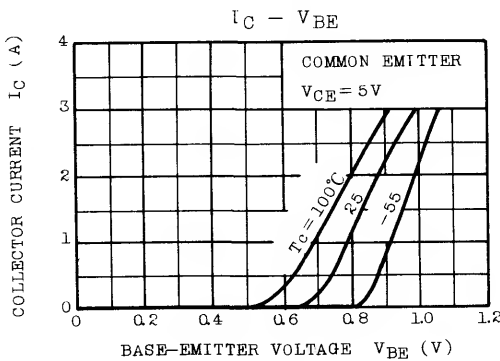
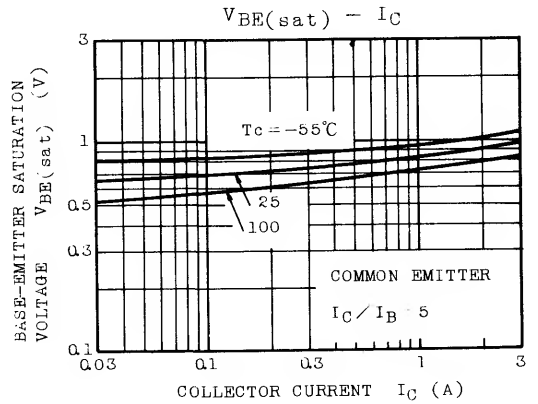
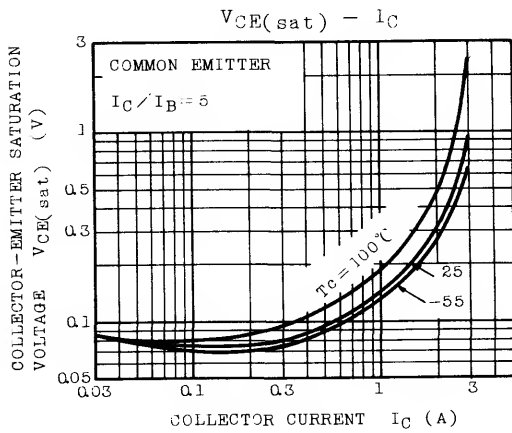
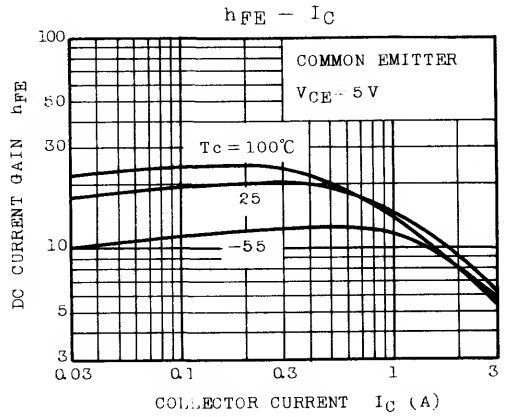
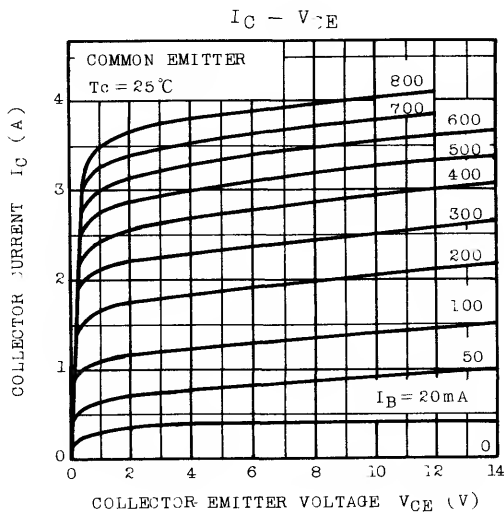


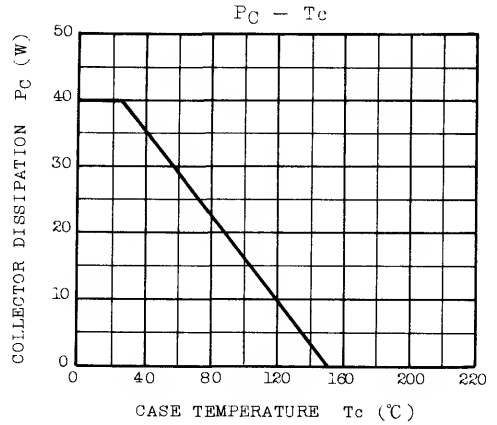
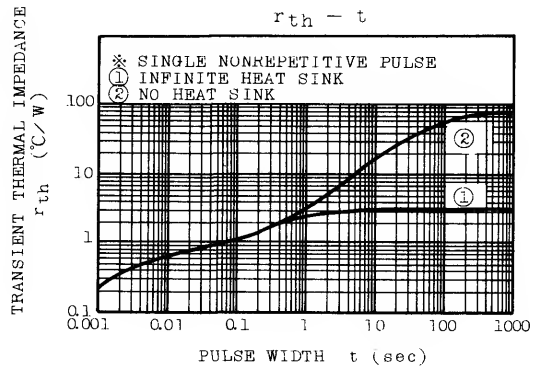
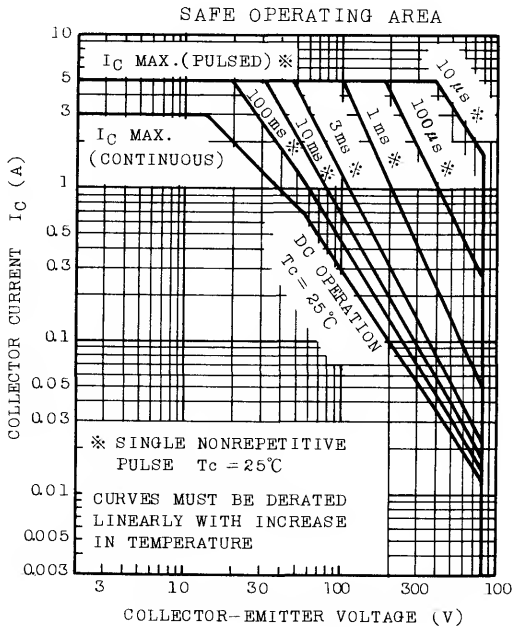
Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=800V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	900	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	800	-	-	V
DC Current Gain (Note)		h_{FE}	$V_{CE}=5V, I_C=0.8A$	10	-	-	-
Collector-Emitter Saturation Voltage (Note)		$V_{CE(sat)}$	$I_C=0.8A, I_B=0.16A$	-	-	0.6	V
Base-Emitter Saturation Voltage (Note)		$V_{BE(sat)}$	$I_C=0.8A, I_B=0.16A$	-	-	1.2	V
Switching Time	Rise Time	t_r		-	-	1.0	μs
	Storage Time	t_{stg}		-	-	4.0	
	Fall Time	t_f		-	-	1.0	

Note : Pulse Test: Pulse Width $\leq 300\mu s$, Duty Cycle $\leq 2\%$





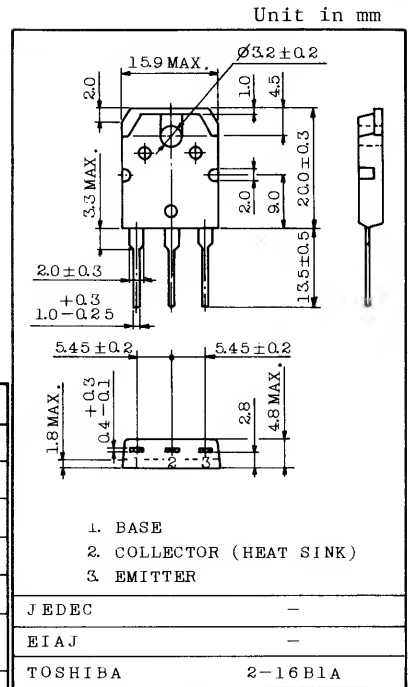
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SA1263
- Recommend for 40W High Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	80	V
Collector-Emitter Voltage	V _{CE0}	80	V
Emitter-Base Voltage	V _{EB0}	5	V
Collector Current	I _C	6	A
Base Current	I _B	0.6	A
Collector Power Dissipation (Tc=25°C)	P _C	60	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55~150	°C



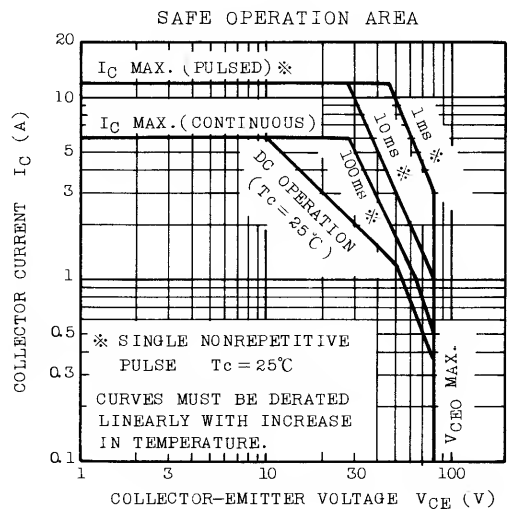
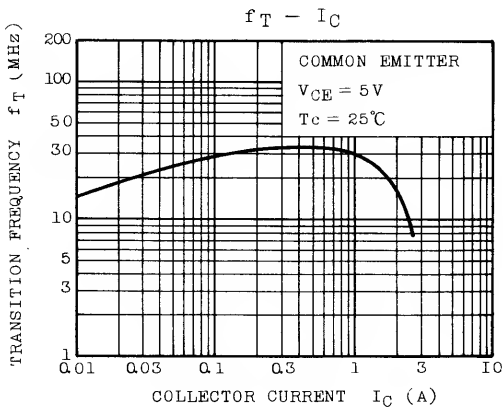
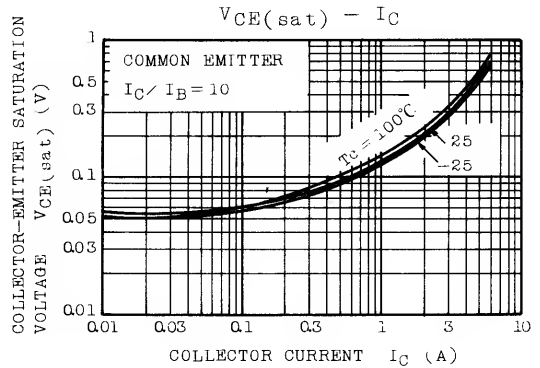
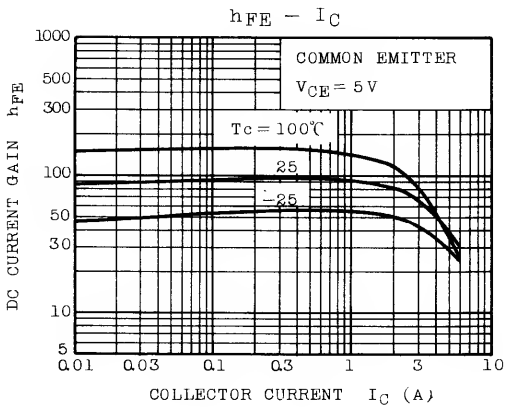
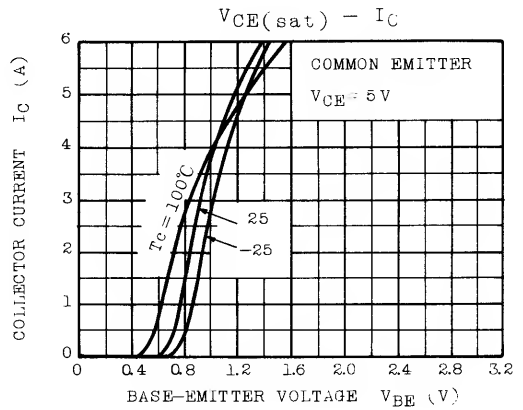
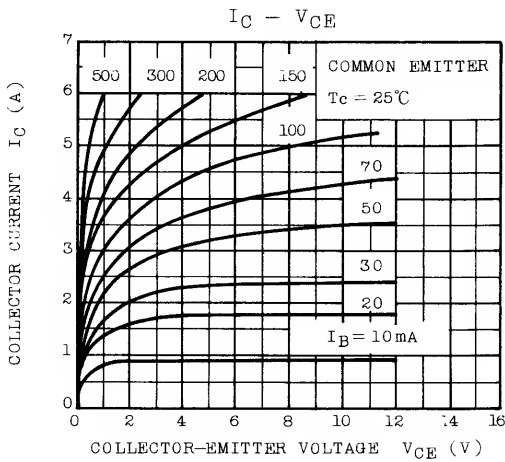
Weight : 4.6g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =80V, I _E =0	-	-	5.0	μA
Emitter Cut-off Current	I _{EB0}	V _{EB} =5V, I _C =0	-	-	5.0	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CEO}	I _C =50mA, I _B =0	80	-	-	V
DC Current Gain	h _{FE} (1) (Note)	V _{CE} =5V, I _C =1A	55	-	160	
	h _{FE} (2)	V _{CE} =5V, I _C =3A	35	75	-	
Collector Emitter Saturation Voltage	V _{CE(sat)}	I _C =5A, I _B =0.5A	-	0.45	2.0	V
Base-Emitter Voltage	V _{BE}	V _{CE} =5V, I _C =3A	-	0.92	1.5	V
Transition Frequency	f _T	V _{CE} =5V, I _C =1A	-	30	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	105	-	pF

Note : h_{FE}(1) Classification, R : 55~110 0 : 80~160

2SC3180



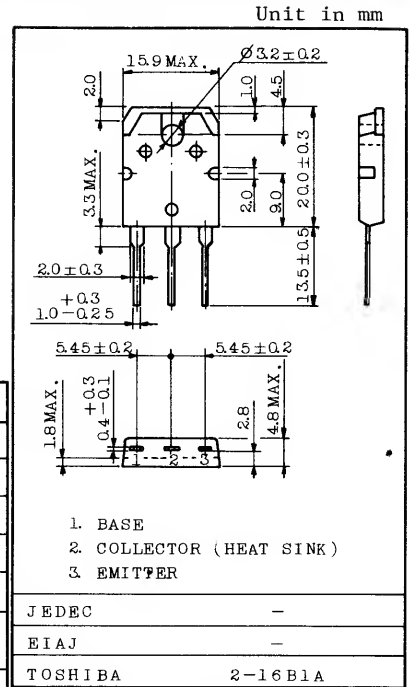
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SA1264
- Recommend for 55W High Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS ($T_a=25^{\circ}\text{C}$)

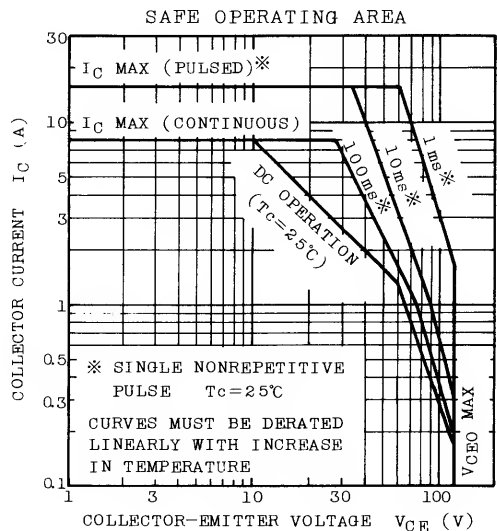
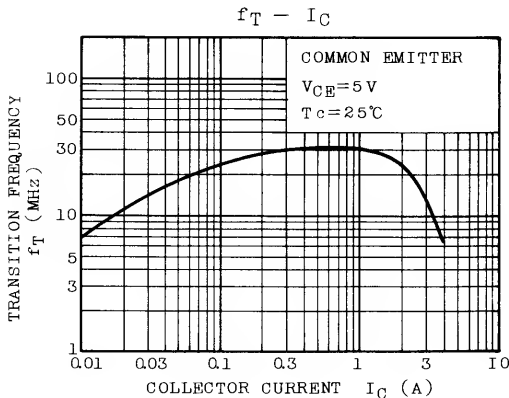
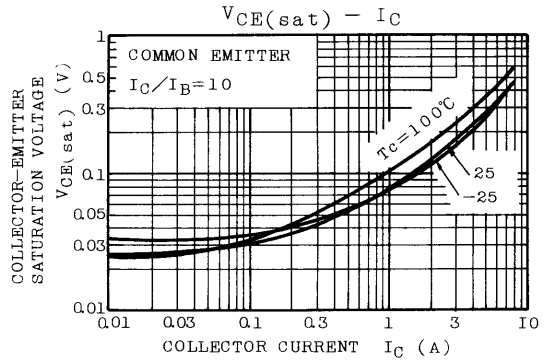
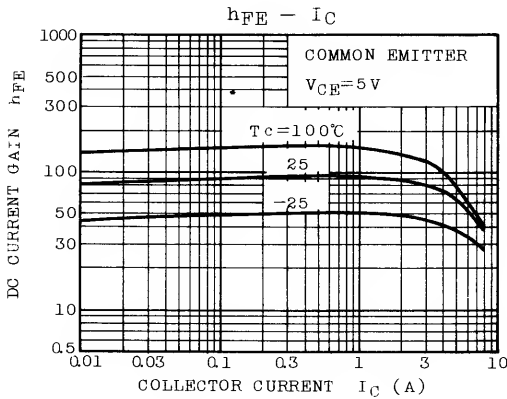
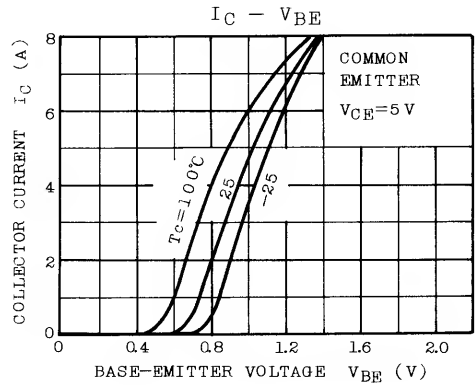
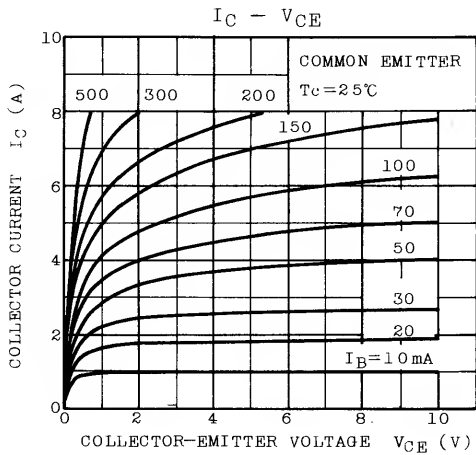
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	120	V
Collector-Emitter Voltage	V_{CE0}	120	V
Emitter-Base Voltage	V_{EB0}	5	V
Collector Current	I_C	8	A
Base Current	I_B	0.8	A
Collector Power Dissipation ($T_c=25^{\circ}\text{C}$)	P_C	80	W
Junction Temperature	T_j	150	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^{\circ}\text{C}$

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=120\text{V}, I_E=0$	-	-	5.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5\text{V}, I_C=0$	-	-	5.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=50\text{mA}, I_B=0$	120	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=5\text{V}, I_C=1\text{A}$	55	-	160	
	$h_{FE(2)}$	$V_{CE}=5\text{V}, I_C=4\text{A}$	35	75	-	
Collector Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=6\text{A}, I_B=0.6\text{A}$	-	0.35	2.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5\text{V}, I_C=4\text{A}$	-	0.95	1.5	V
Transition Frequency	f_T	$V_{CE}=5\text{V}, I_C=1\text{A}$	-	30	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10\text{V}, I_E=0, f=1\text{MHz}$	-	190	-	pF

Note : $h_{FE(1)}$ Classification, R : 55 ~ 110 O : 80 ~ 160

2SC3181



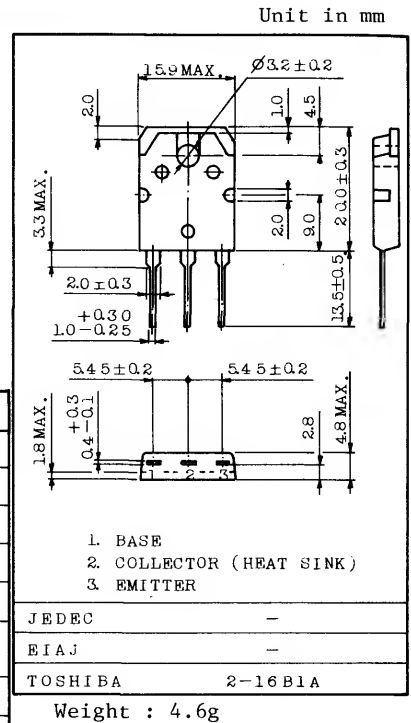
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SA1265
- Recommend for 70W High Fidelity Audio Frequency Amplifier Output Stage

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	140	V
Collector-Emitter Voltage	V _{CE0}	140	V
Emitter-Base Voltage	V _{EB0}	5	V
Collector Current	I _C	10	A
Base Current	I _B	1	A
Collector Power Dissipation (Tc=25°C)	P _C	100	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55 ~ 150	°C

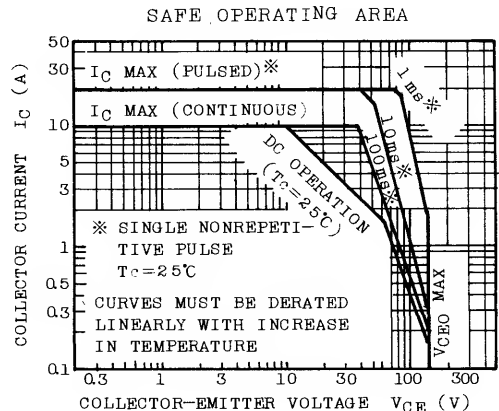
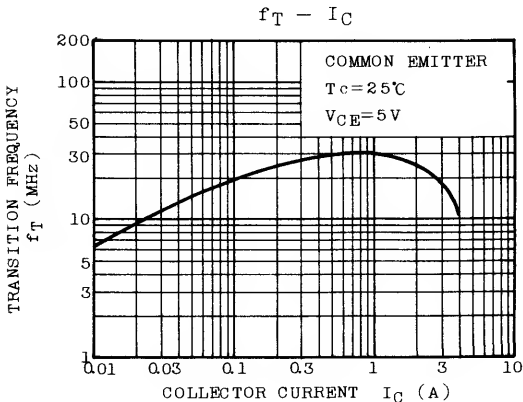
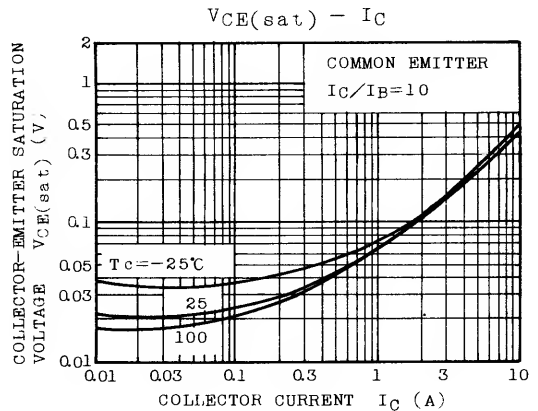
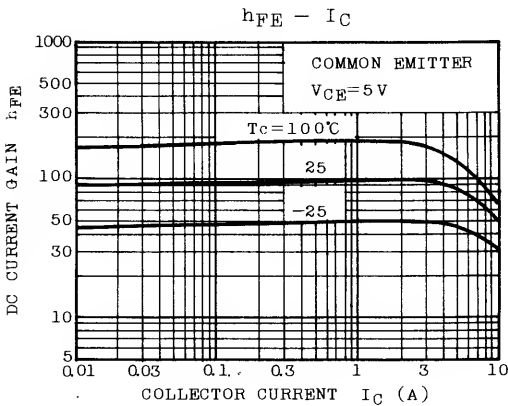
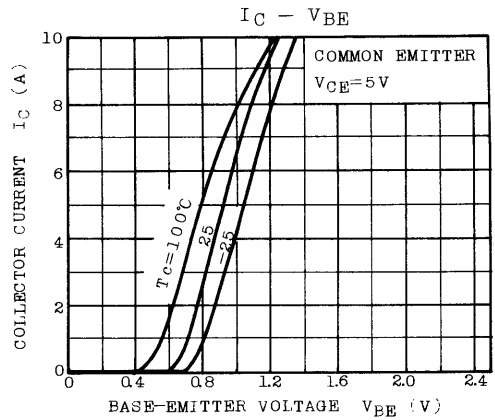
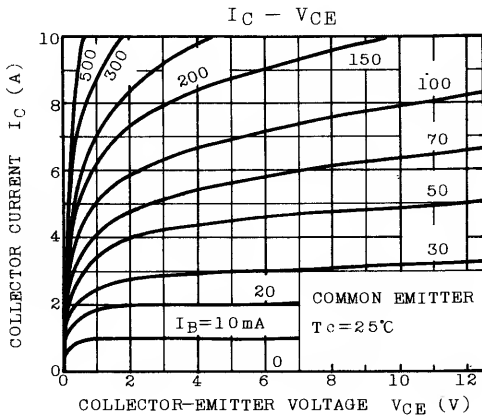


ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CBO}	V _{CB} =140V, I _E =0	-	-	5.0	μA
Emitter Cut-off Current	I _{EBO}	V _{EB} =5V, I _C =0	-	-	5.0	μA
Collector-Emitter Breakdown Voltage	V(BR)CE0	I _C =50mA, I _B =0	140	-	-	V
DC Current Gain	h _{FE} (1) (Note)	V _{CE} =5V, I _C =1A	55	-	160	
	h _{FE} (2)	V _{CE} =5V, I _C =5A	35	83	-	
Collector Emitter Saturation Voltage	V _{CE(sat)}	I _C =7A, I _B =0.7A	-	0.3	2.0	V
Base-Emitter Voltage	V _{BE}	V _{CE} =5V, I _C =5A	-	0.9	1.5	V
Transition Frequency	f _T	V _{CE} =5V, I _C =1A	-	30	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	220	-	pF

Note : h_{FE}(1) Classification R : 55 ~ 110, O : 80 ~ 160

2SC3182



SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

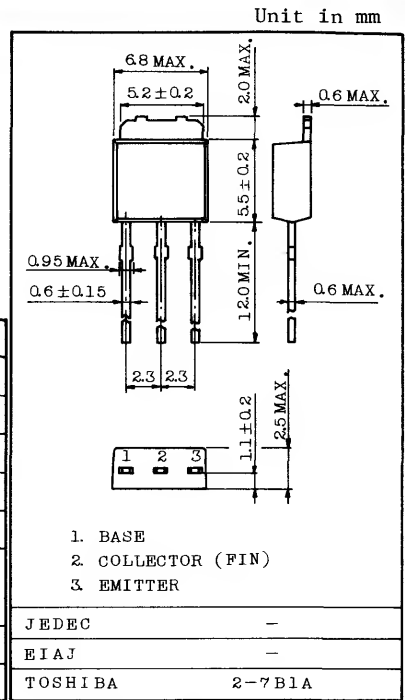
HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES;

- Excellent Switching Times
: $t_r=1.0\mu s(\text{Max.})$, $t_f=1.0\mu s(\text{Max.})$ at $I_C=0.8A$
- High Collector Breakdown Voltage : $V_{CE0}=400V$

MAXIMUM RATINGS ($T_a=25^\circ C$)

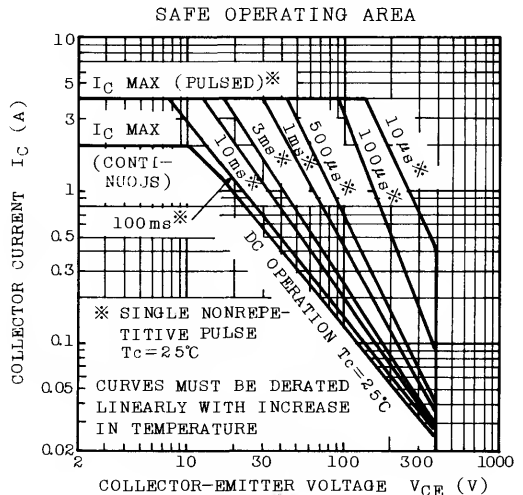
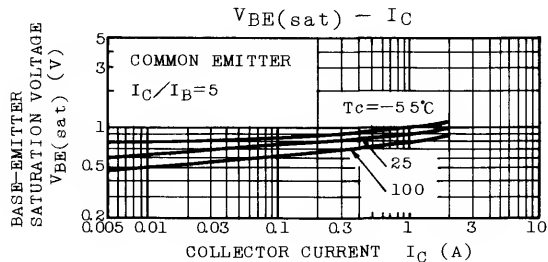
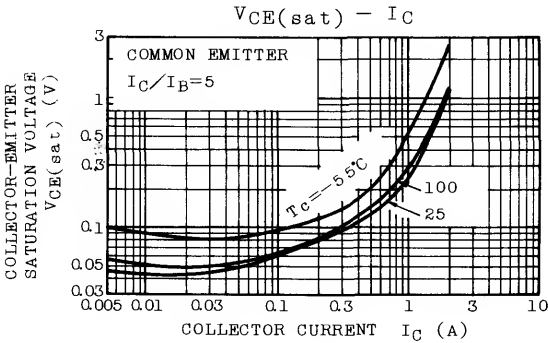
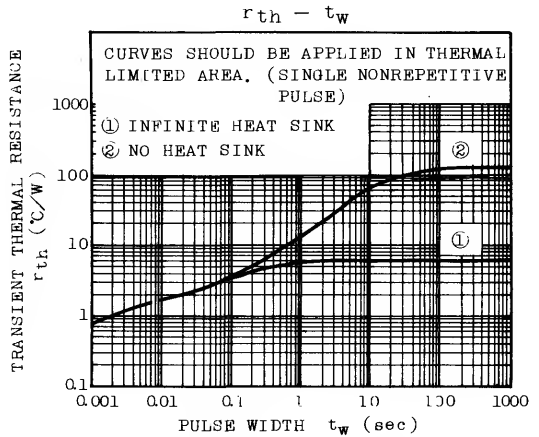
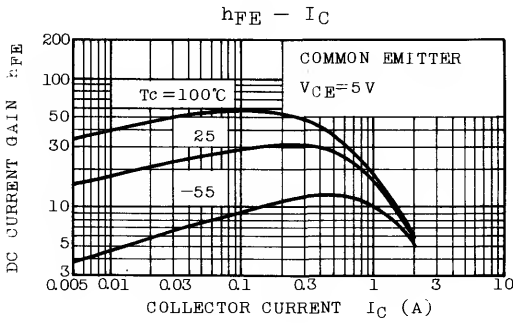
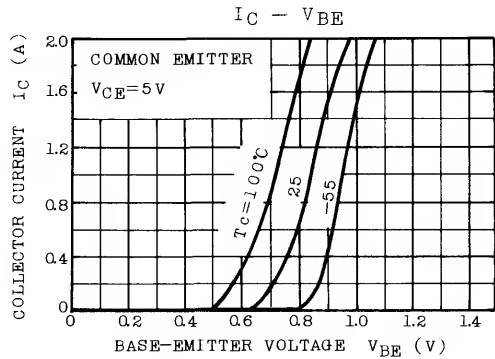
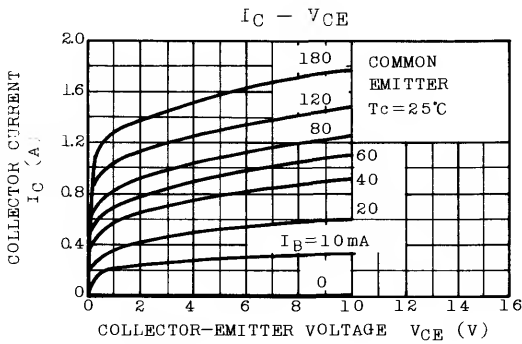
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB0}	500	V
Collector-Emitter Voltage		V_{CE0}	400	V
Emitter-Base Voltage		V_{EB0}	7	V
Collector Current		I_C	2	A
Base Current		I_B	0.5	A
Collector Power Dissipation	$T_a=25^\circ C$	P_C	1.0	W
	$T_c=25^\circ C$		20	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$



Weight : 0.36g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=400V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	400	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=0.1A$	20	-	-	
			$V_{CE}=5V, I_C=1A$	8	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=1A, I_B=0.2A$	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=1A, I_B=0.2A$	-	-	1.5	V
Switching Time	Rise Time	t_r	<p>$I_{B1} = -I_{B2} = 0.08A$ DUTY CYCLE < 1%</p>	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.0	



2SC3235

INDUSTRIAL APPLICATIONS

Unit in mm

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

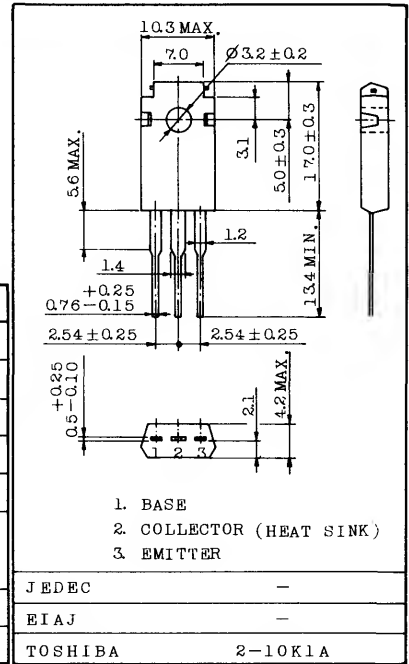
HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

- Excellent Switching Times
 $t_r=1.0\mu s(\text{Max.})$, $t_f=1.0\mu s(\text{Max.})$ at $I_C=0.8A$
- High Collector Breakdown Voltage : $V_{CEO}=400V$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	500	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	2	A
Base Current	I_B	0.5	A
Collector Power Dissipation	P_C	$T_a=25^\circ C$	1.7
		$T_c=25^\circ C$	20
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$

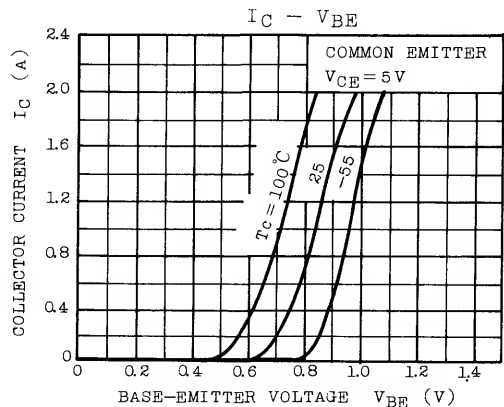
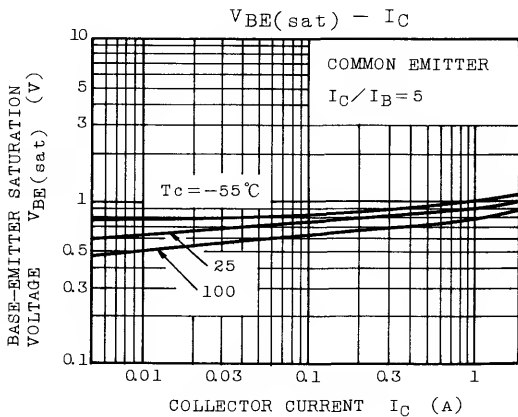
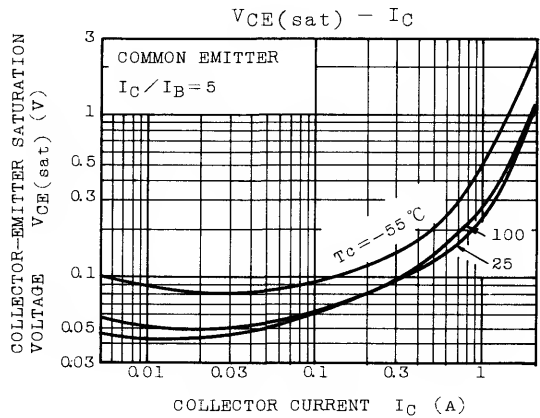
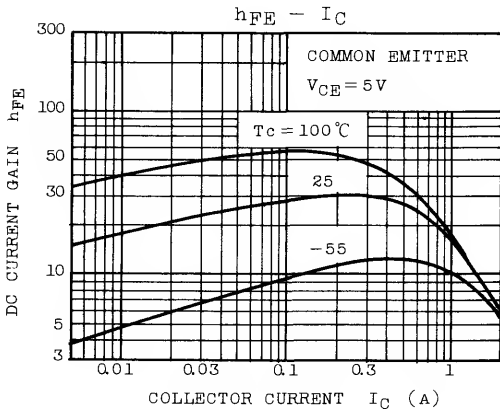
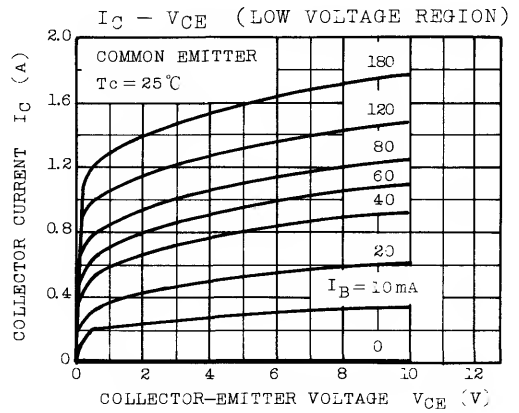
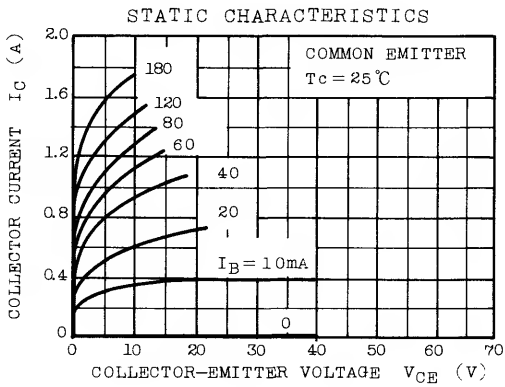


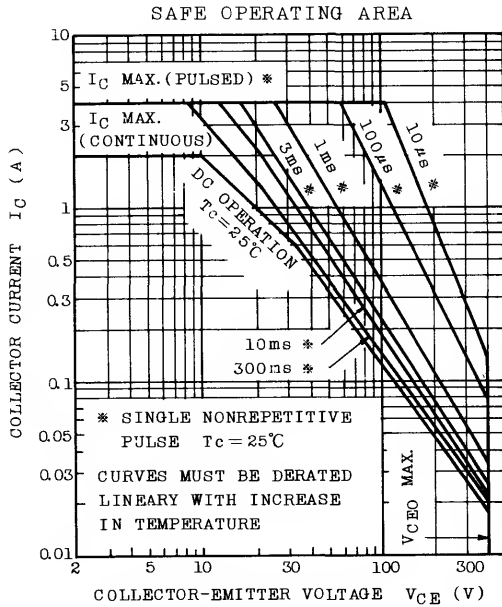
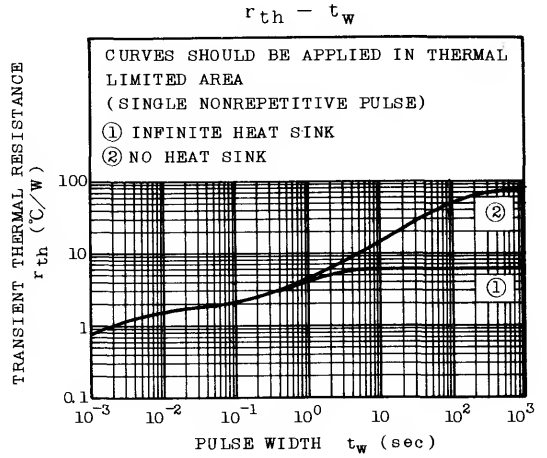
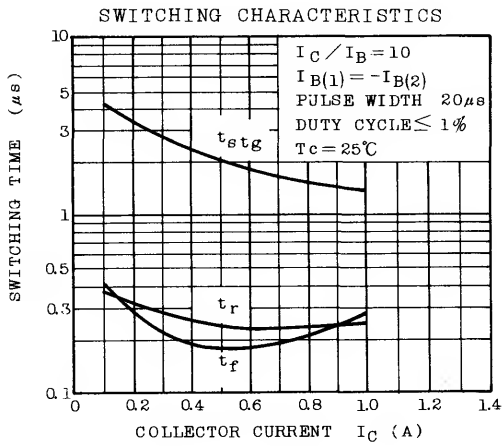
Weight : 2.0g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=400V$, $I_E=0$	-	-	100	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V$, $I_C=0$	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1mA$, $I_E=0$	500	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA$, $I_B=0$	400	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=0.1A$	20	-	-	
		$V_{CE}=5V$, $I_C=1A$	8	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=1A$, $I_B=0.2A$	-	-	1.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=1A$, $I_B=0.2A$	-	-	1.5	V
Switching Time	Rise Time	t_r	-	-	1.0	μs
	Storage Time	t_{stg}	-	-	2.5	
	Fall Time	t_f	-	-	1.0	

2SC3235





2SC3236

SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

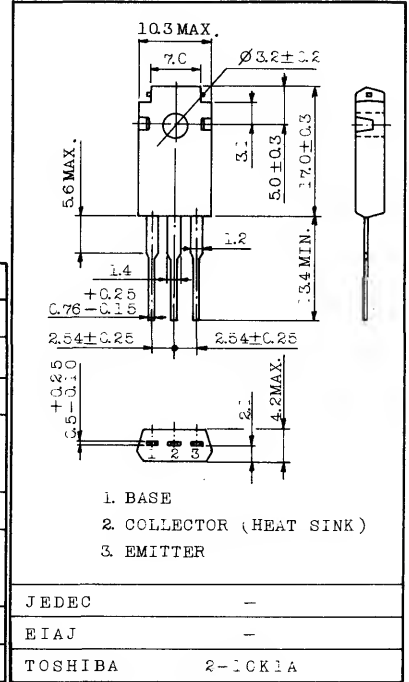
HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

- Excellent Switching Times
: $t_r=1.0\mu s(\text{Max.})$, $t_f=1.0\mu s(\text{Max.})$ at $I_C=4A$
- High Collector Breakdown Voltage : $V_{CEO}=400V$

INDUSTRIAL APPLICATIONS

Unit in mm



MAXIMUM RATINGS ($T_a=25^\circ C$)

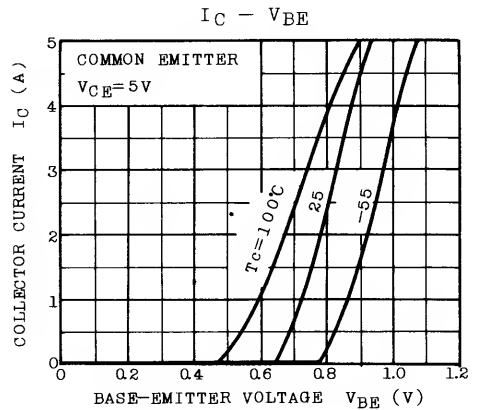
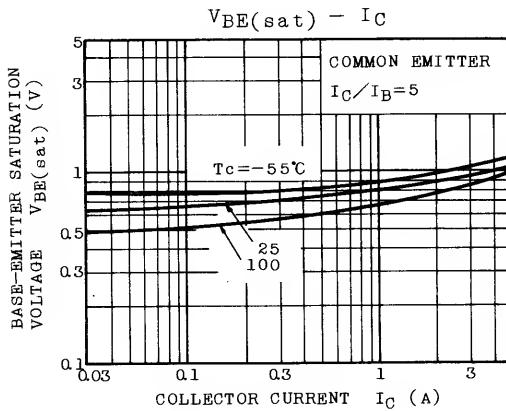
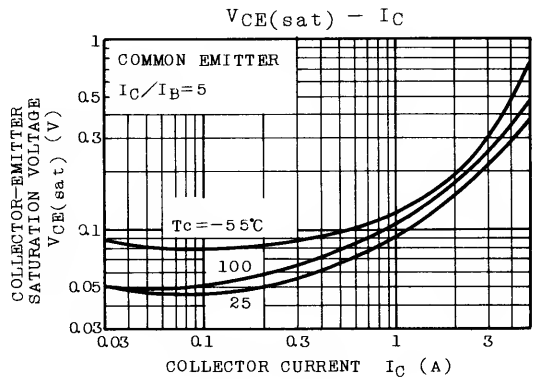
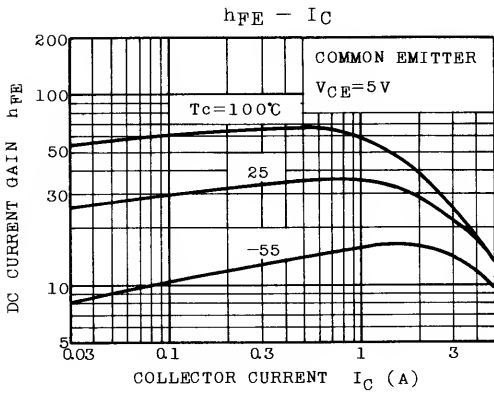
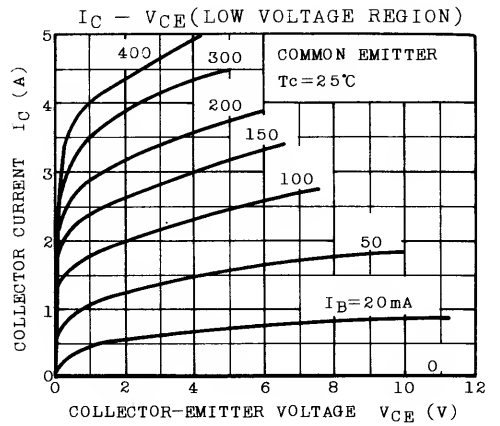
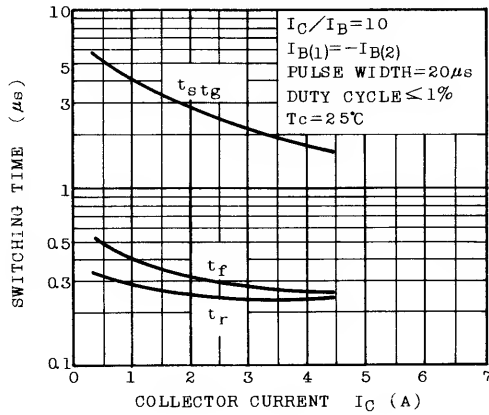
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	500	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	5	A
	Pulse	I_{CP}	7	
Base Current		I_B	1	A
Collector Power Dissipation	$T_a=25^\circ C$	P_C	1.7	W
	$T_c=25^\circ C$		60	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$

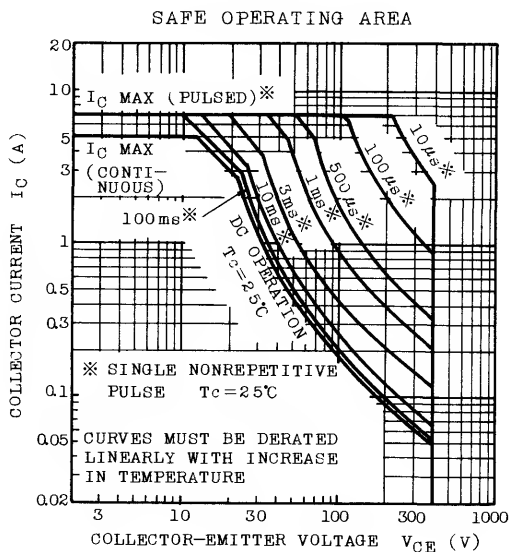
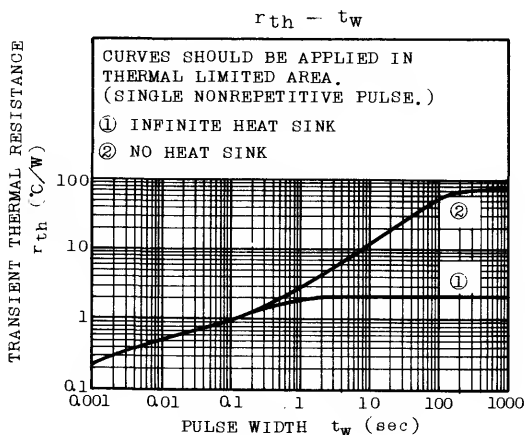
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Collector Cut-off Current	I_{CBO}	$V_{CB}=400V, I_E=0$	-	-	100	μA	
Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA	
Collector-Base Breakdown Voltage	$V(BR)_{CBO}$	$I_C=1mA, I_E=0$	500	-	-	V	
Collector-Emitter Breakdown Voltage	$V(BR)_{CEO}$	$I_C=10mA, I_B=0$	400	-	-	V	
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=3A$	12	-	-		
		$V_{CE}=5V, I_C=5A$	8	-	-		
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=5A, I_B=1A$	-	-	1.0	V	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=5A, I_B=1A$	-	-	1.5	V	
Switching Time	Rise Time	t_r			-	1.0	μs
	Storage Time	t_{stg}			-	2.5	
	Fall Time	t_f	$I_{B1} = -I_{B2} = 0.4A$ $V_{CC} = 200V$ DUTY CYCLE < 1%		-	1.0	

TOSHIBA CORPORATION

SWITCHING CHARACTERISTICS





HIGH CURRENT SWITCHING APPLICATIONS.

INDUSTRIAL APPLICATIONS

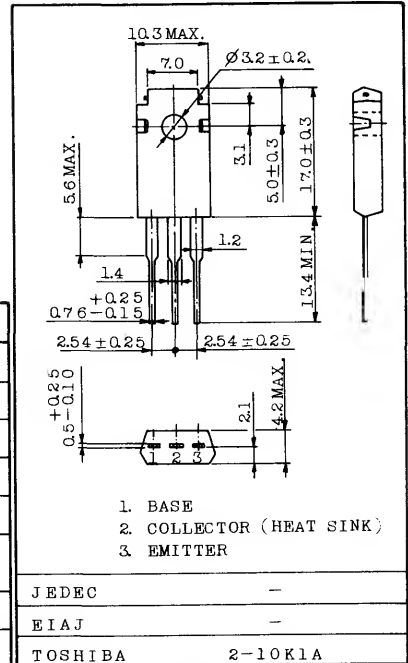
Unit in mm

FEATURES:

- Low Collector Saturation Voltage
: $V_{CE(sat)}=0.4V(\text{Max.})$ (at $I_C=3A$)
- High Speed Switching Time : $t_{stg}=1.0\mu s(\text{Typ.})$
- Complementary to 2SA1279

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CEO}	50	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	5	A
Base Current	I_B	1	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	25	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$

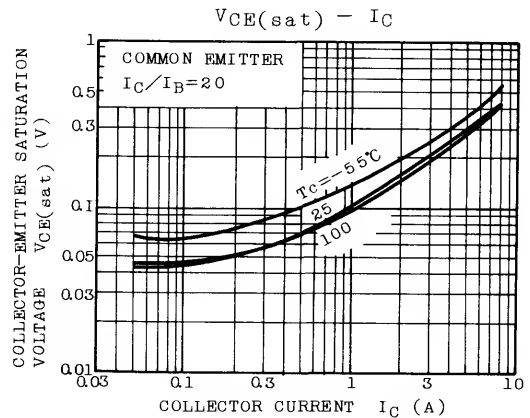
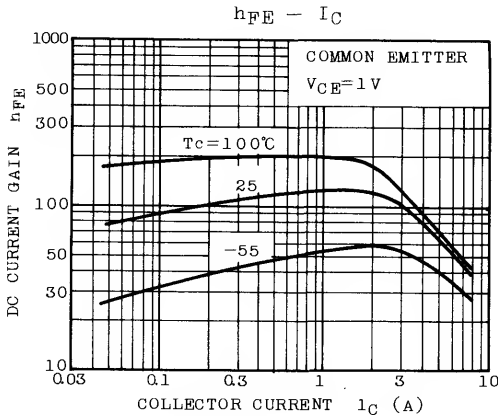
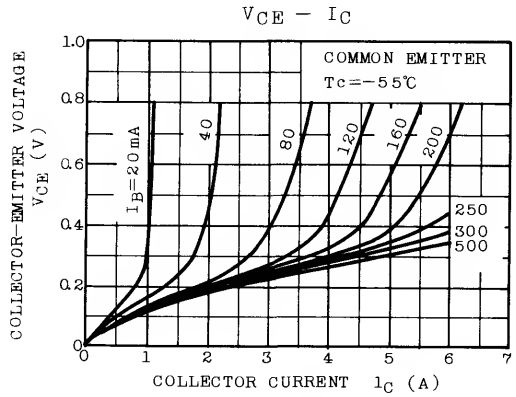
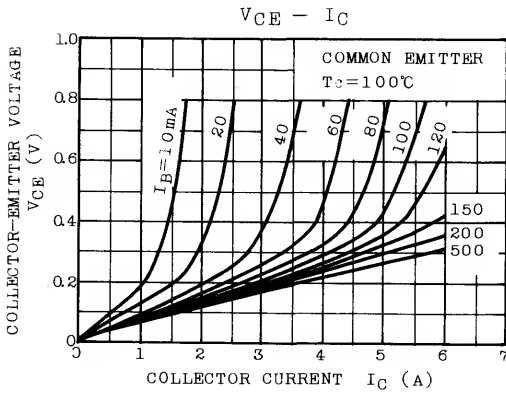
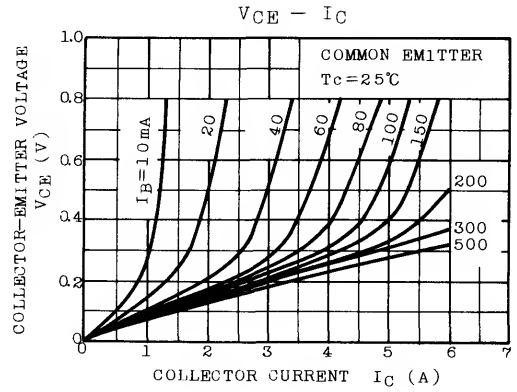
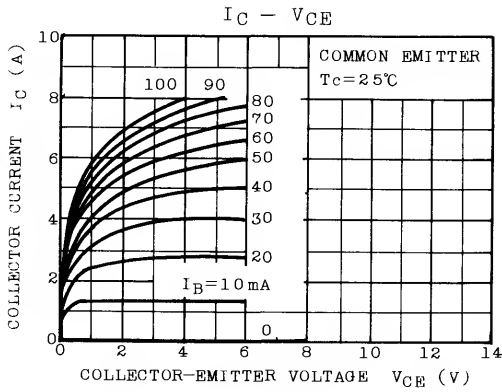


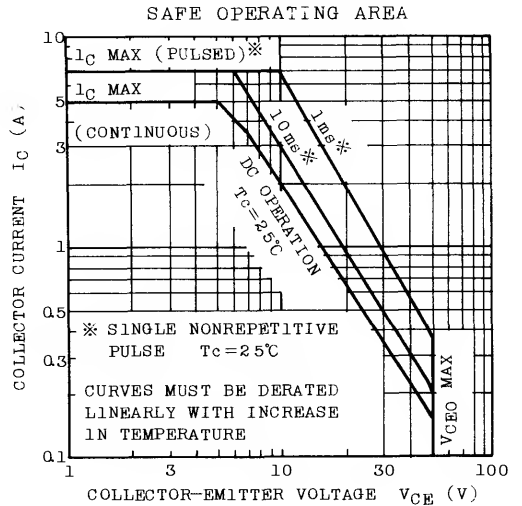
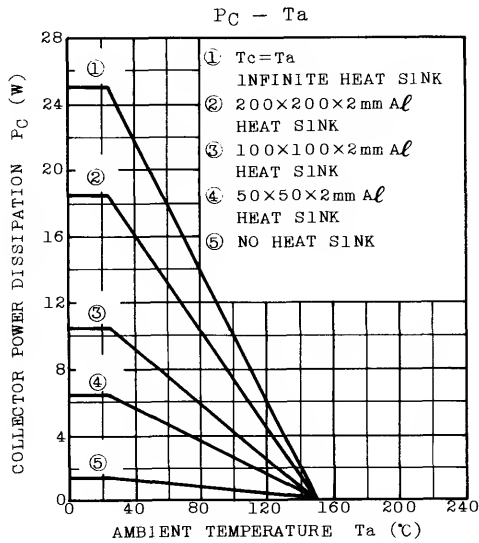
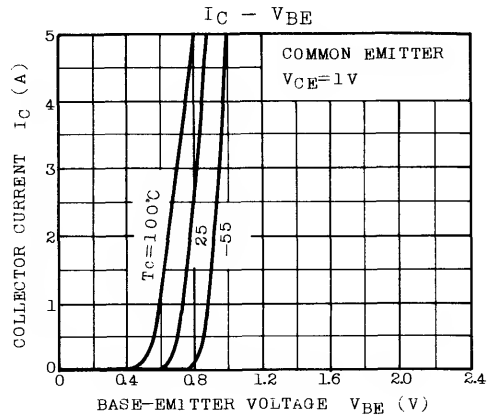
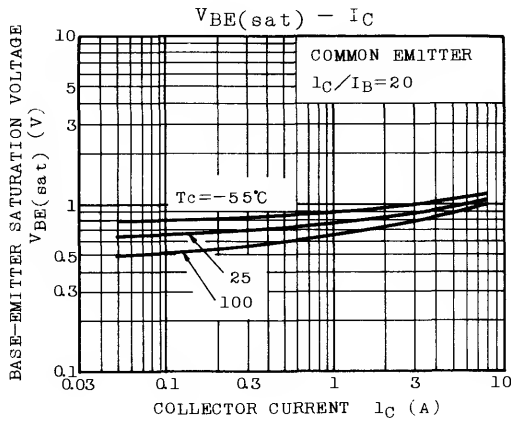
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

Weight : 2.0g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=50V, I_E=0$	-	-	1	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=1V, I_C=1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=1V, I_C=3A$	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=3A, I_B=0.15A$	-	0.2	0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=3A, I_B=0.15A$	-	0.9	1.2	
Transition Frequency		f_T	$V_{CE}=4V, I_C=1A$	-	120	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	80	-	MHz
Switching Time	Turn-on Time	t_{on}		-	0.1	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

Note : $h_{FE(1)}$ Classification 0 : 70 ~ 140, Y : 120 ~ 240





2SC3257

SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

INDUSTRIAL APPLICATIONS

Unit in mm

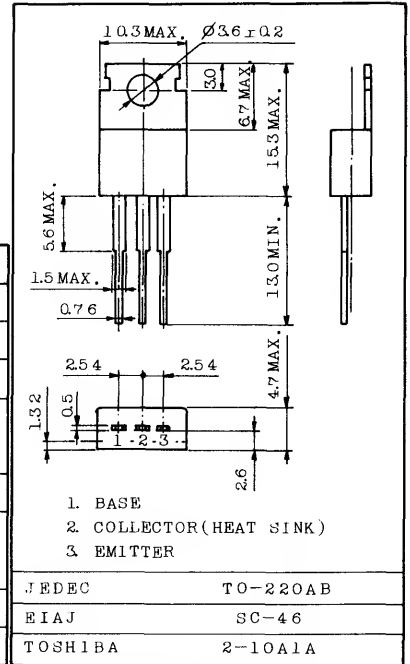
HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

- Excellent Switching Times
: $t_r=1.0\mu s(\text{Max.})$, $t_f=1.0\mu s(\text{Max.})$ at $I_C=6A$
- High Collector Breakdown Voltage : $V_{CE0}=200V$

MAXIMUM RATINGS ($T_a=25^\circ C$)

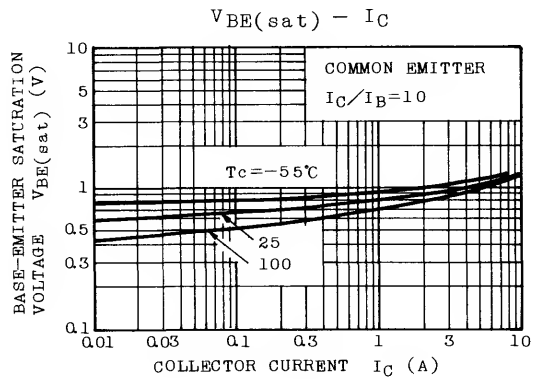
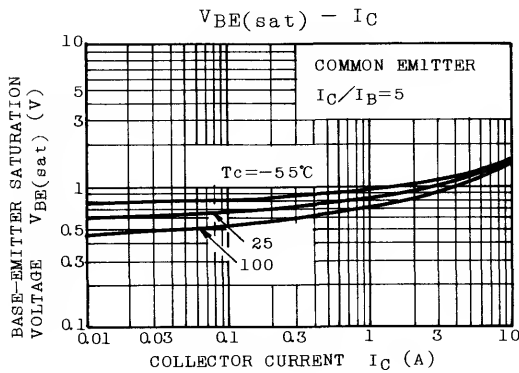
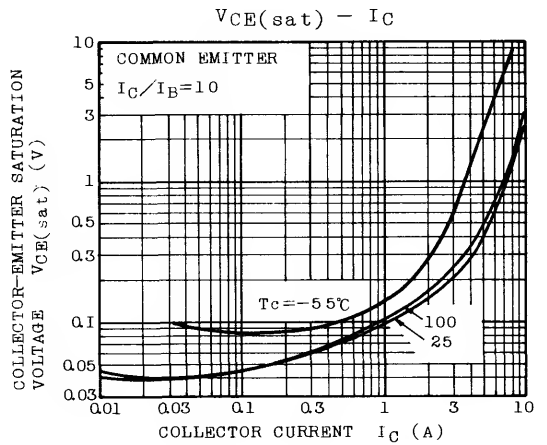
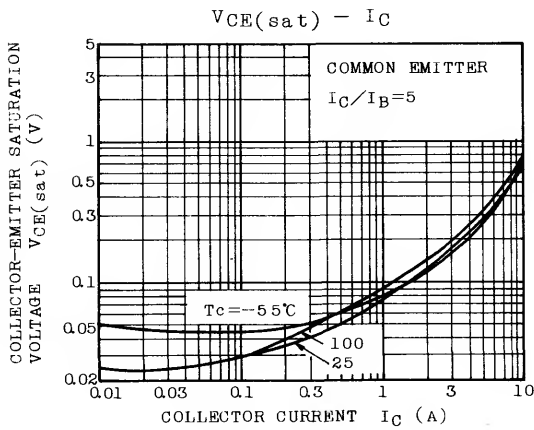
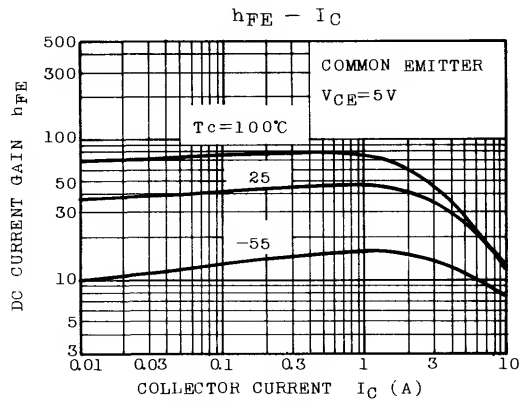
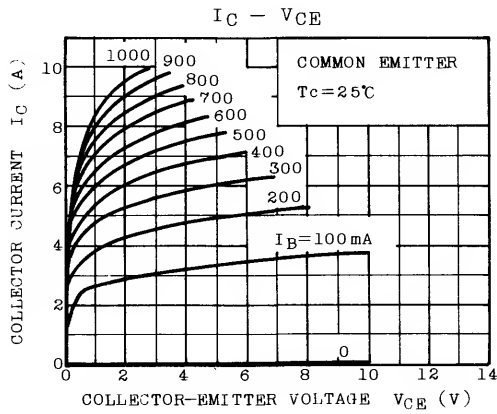
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	250	V
Collector-Emitter Voltage		V_{CEO}	200	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	10	A
	Pulse	I_{CP}	15	A
Base Current		I_B	2	A
Collector Power Dissipation	$T_a=25^\circ C$	P_C	1.5	W
	$T_c=25^\circ C$		40	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$

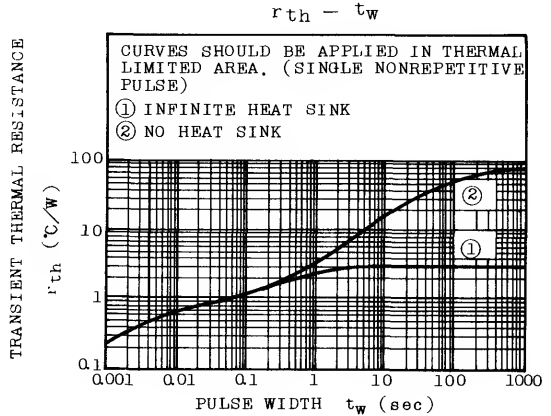
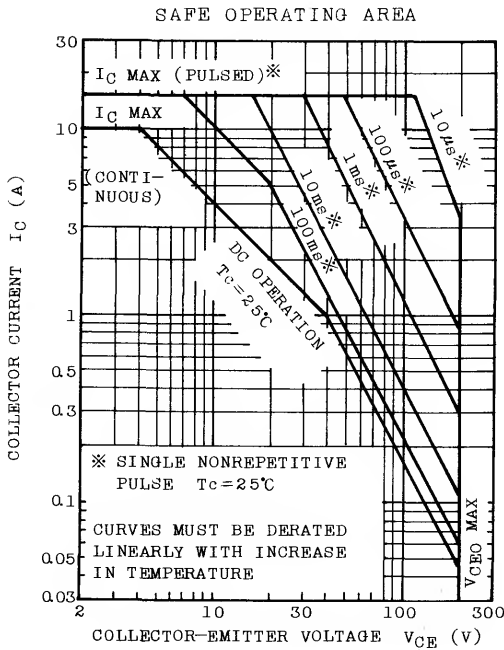
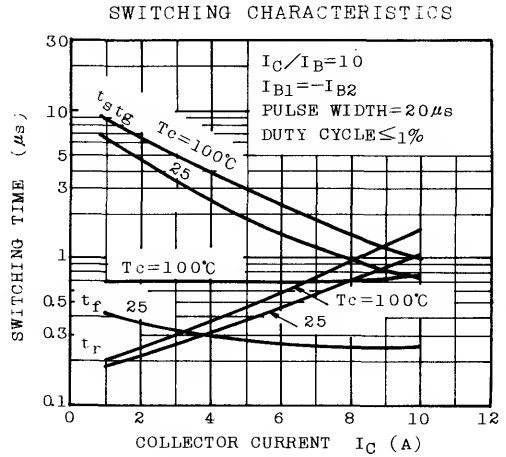
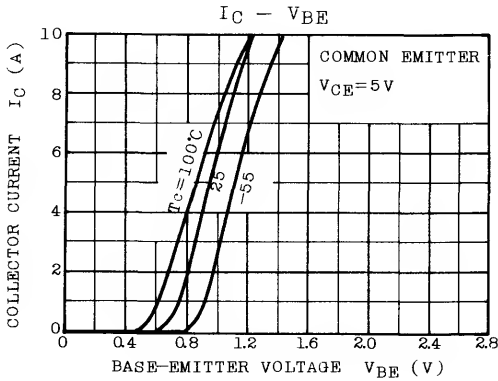


ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

Mounting Kit No. AC75
Weight : 1.9g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=200V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	250	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	200	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=10mA$	15	-	-	
			$V_{CE}=5V, I_C=5A$	20	-	80	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=5A, I_B=0.5A$	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=5A, I_B=0.5A$	-	-	1.5	V
Switching Time	Rise Time	t_r		-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.0	





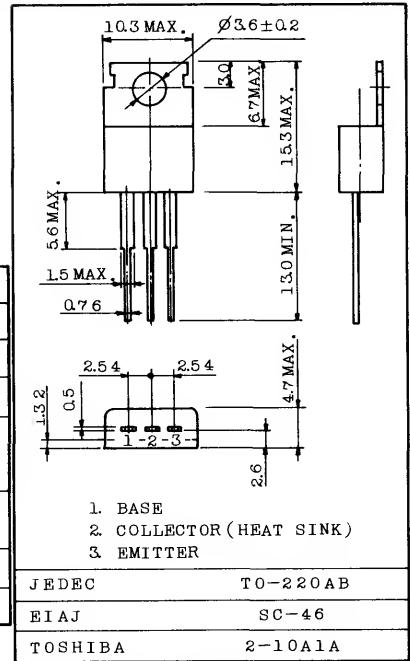
INDUSTRIAL APPLICATIONS

Unit in mm

HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- . Low Collector Saturation Voltage
: $V_{CE(sat)}=0.4V(\text{Max.})$ at $I_C=3A$
- . High Speed Switching Time : $t_{stg}=1.0\mu s(\text{Typ.})$
- . Complementary to 2SA1293.



MAXIMUM RATINGS ($T_a=25^\circ C$)

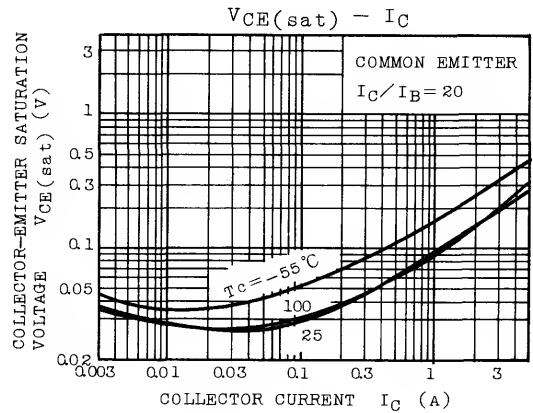
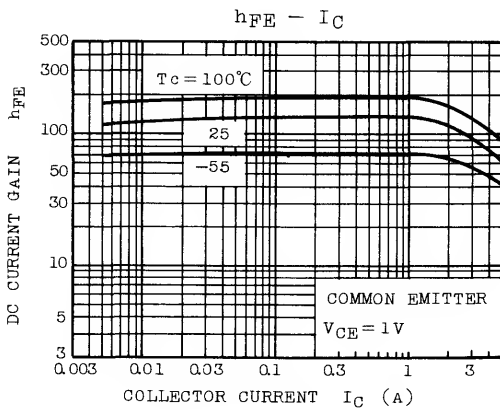
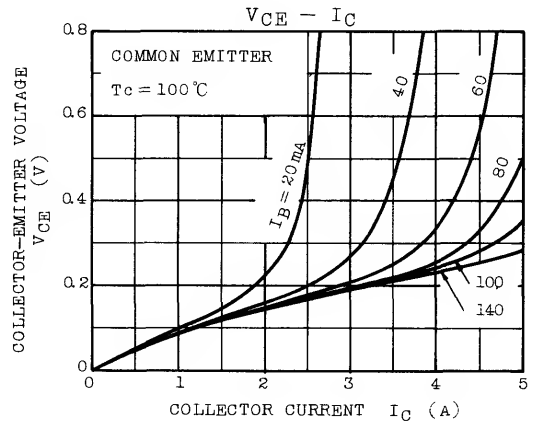
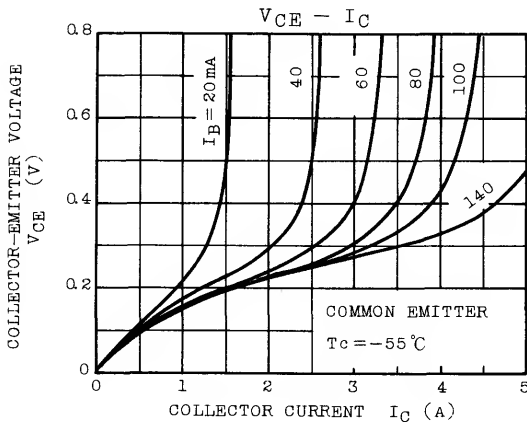
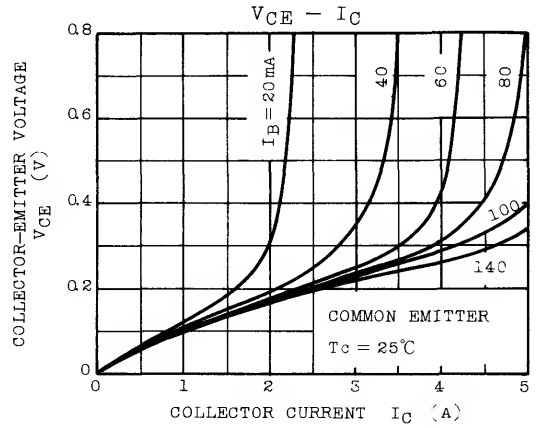
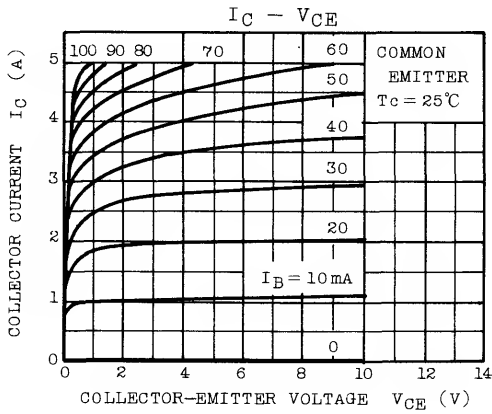
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	100	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	DC	I_C	5
	Pulse	I_{CP}	8
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	30	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$

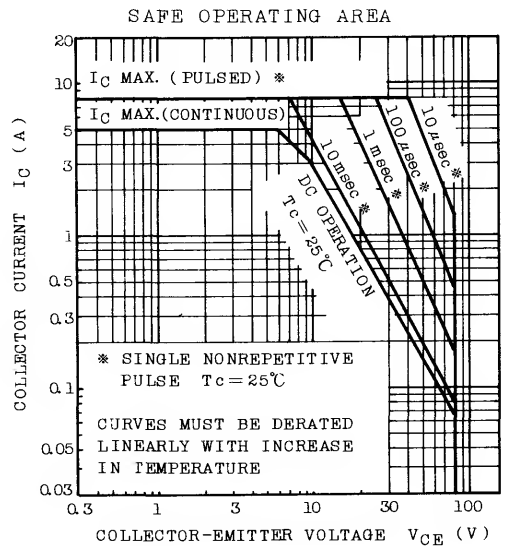
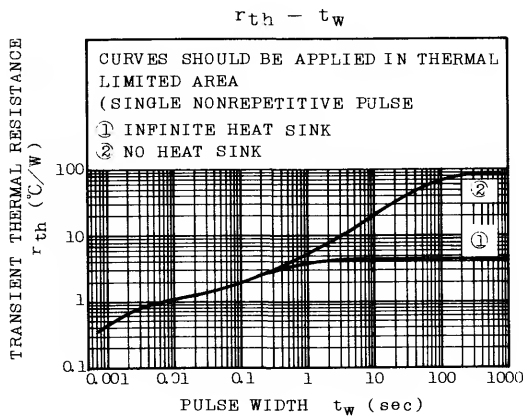
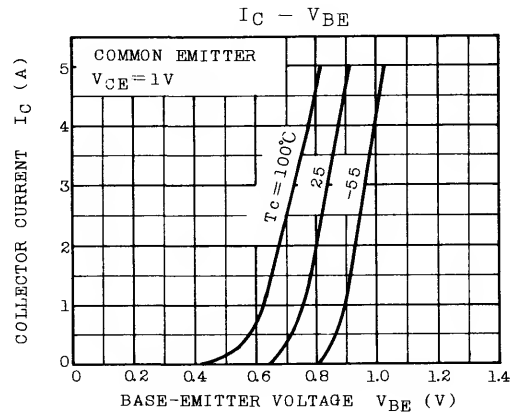
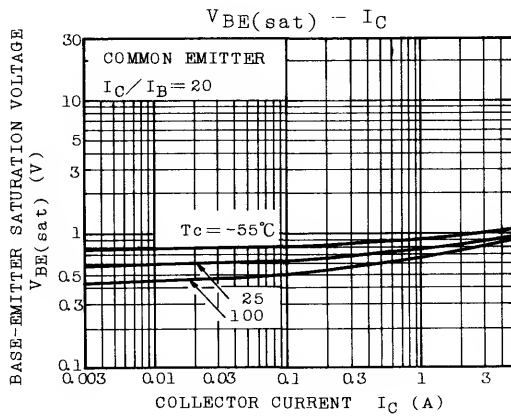
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Collector Cut-off Current	I_{CBO}	$V_{CB}=100V, I_E=0$	-	-	1	μA	
Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	μA	
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	80	-	-	V	
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=1V, I_C=1A$	70	-	240	V	
	$h_{FE(2)}$	$V_{CE}=1V, I_C=3A$	40	-	-		
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$ $I_C=3A, I_B=0.15A$	-	0.2	0.4	V	
	Base-Emitter	$V_{BE(sat)}$	-	0.9	1.2		
Transition Frequency	f_T	$V_{CE}=4V, I_C=1A$	-	120	-	MHz	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	80	-	pF	
Switching Time	Turn-on Time	t_{on}		-	0.2	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

Note : $h_{FE(1)}$ Classification 0 : 70 ~ 140, Y : 120 ~ 240

2SC3258





2SC3280

SILICON NPN TRIPLE DIFFUSED TYPE

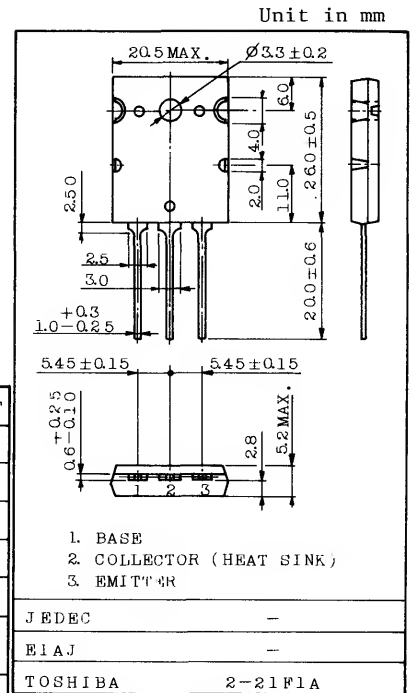
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SA1301
- Recommend for 80W High Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	160	V
Collector-Emitter Voltage	V _{CE0}	160	V
Emitter-Base Voltage	V _{EB0}	5	V
Collector Current	I _C	12	A
Base Current	I _B	1.2	A
Collector Power Dissipation (Tc=25°C)	P _C	120	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55 ~ 150	°C



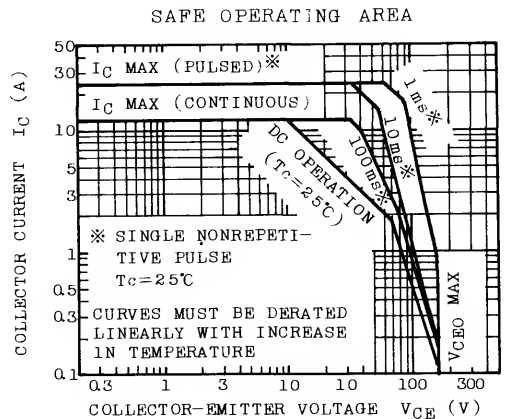
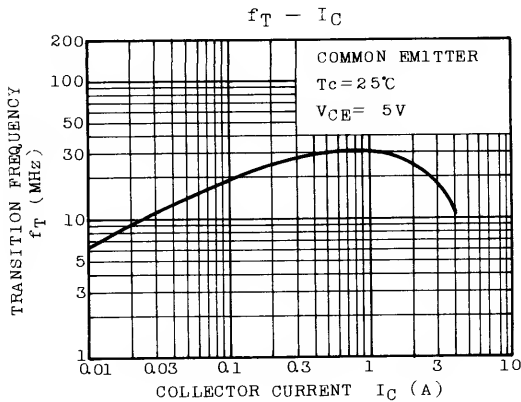
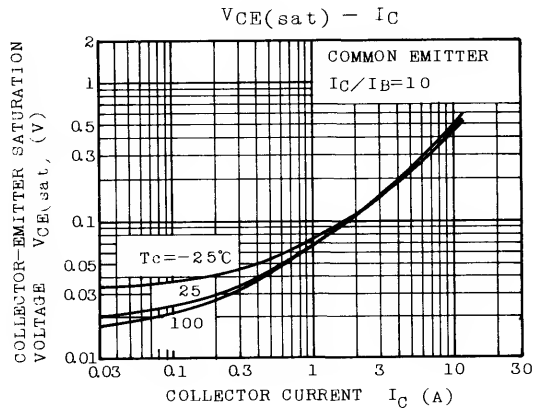
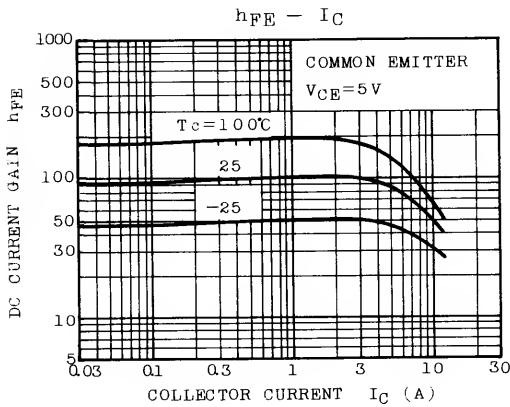
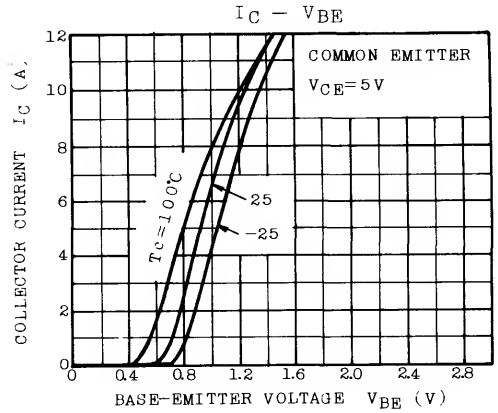
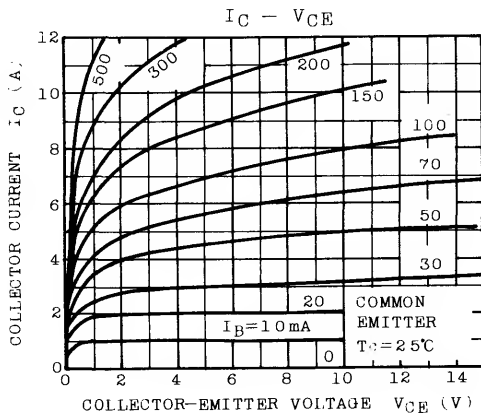
JEDEC	-
EIAJ	-
TOSHIBA	2-21F1A

Weight : 9.75g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =160V, I _E =0	-	-	5.0	μA
Emitter Cut-off Current	I _{EB0}	V _{EB} =5V, I _C =0	-	-	5.0	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CEO}	I _C =50mA, I _B =0	160	-	-	V
DC Current Gain	h _{FE} (1) (Note)	V _{CE} =5V, I _C =1A	55	-	160	
	h _{FE} (2)	V _{CE} =5V, I _C =6A	35	74	-	
Collector Emitter Saturation Voltage	V _{CE(sat)}	I _C =8A, I _B =0.8A	-	0.35	2.0	V
Base-Emitter Voltage	V _{BE}	V _{CE} =5V, I _C =6A	-	1.0	1.5	V
Transition Frequency	f _T	V _{CE} =5V, I _C =1A	-	30	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	220	-	pF

Note : h_{FE}(1) Classification R : 55 ~ 110, O : 80 ~ 160



2SC3281

SILICON NPN TRIPLE DIFFUSED TYPE

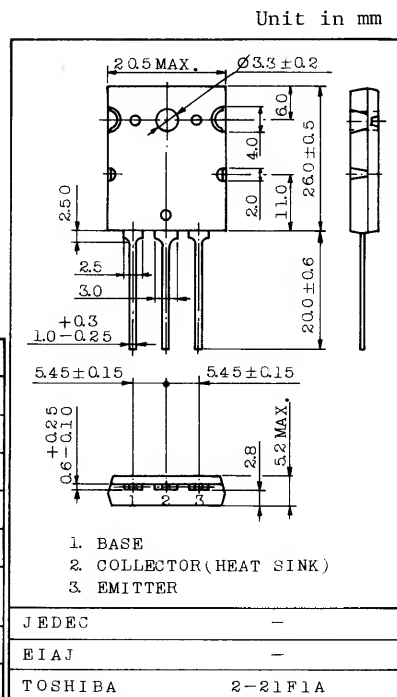
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SA1302
- Recommend for 100W High Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CBO}	200	V
Collector-Emitter Voltage	V _{CEO}	200	V
Emitter-Base Voltage	V _{EB0}	5	V
Collector Current	I _C	15	A
Base Current	I _B	1.5	A
Collector Power Dissipation (Tc=25°C)	P _C	150	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55 ~ 150	°C

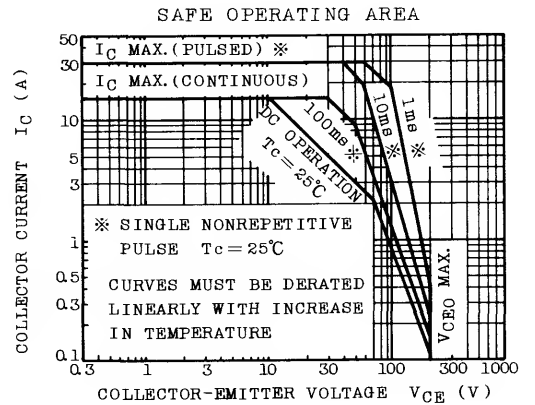
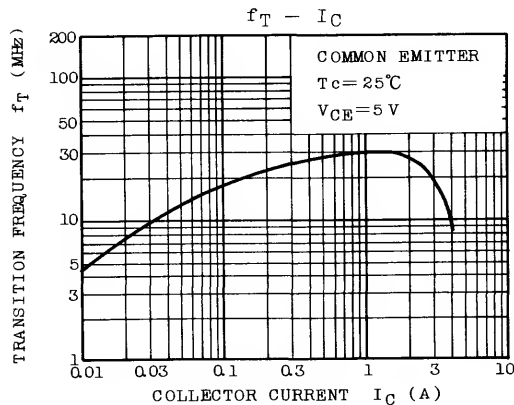
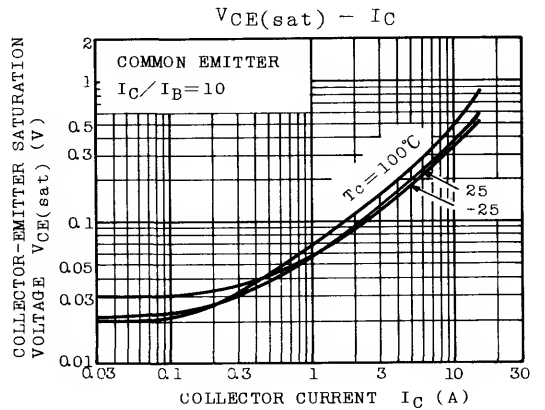
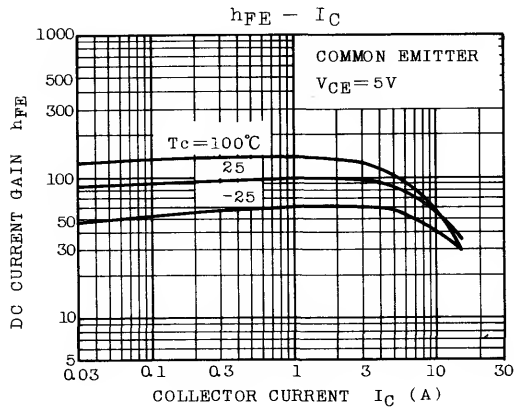
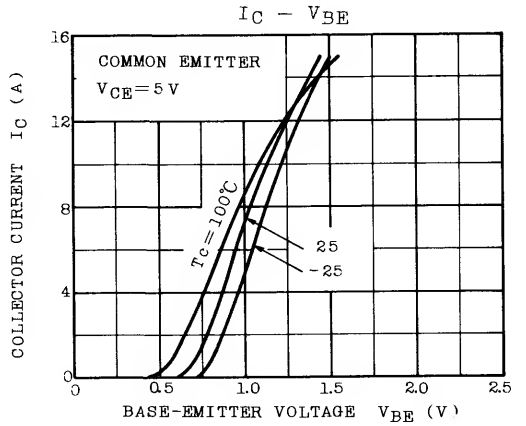
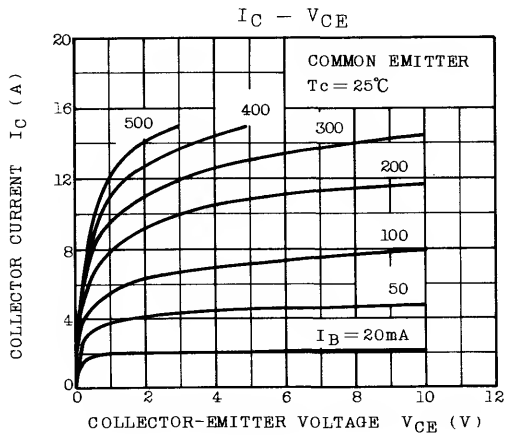


Weight : 9.75g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CBO}	V _{CB} =200V, I _E =0	-	-	5.0	μA
Emitter Cut-off Current	I _{EB0}	V _{EB} =5V, I _C =0	-	-	5.0	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CEO}	I _C =50mA, I _B =0	200	-	-	V
DC Current Gain	h _{FE} (1) (Note)	V _{CE} =5V, I _C =1A	55	-	160	-
	h _{FE} (2)	V _{CE} =5V, I _C =8A	35	60	-	
Collector Emitter Saturation Voltage	V _{CE(sat)}	I _C =10A, I _B =1A	-	0.40	3.0	V
Base-Emitter Voltage	V _{BE}	V _{CE} =5V, I _C =8A	-	1.0	1.5	V
Transition Frequency	f _T	V _{CE} =5V, I _C =1A	-	30	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	270	-	pF

Note : h_{FE}(1) Classification R : 55 ~ 110, 0 : 80 ~ 160



2SC3297

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

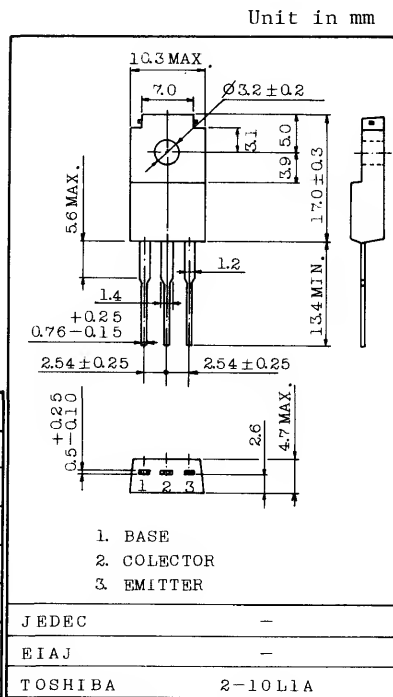
POWER AMPLIFIER APPLICATIONS.
CAR RADIO, CAR STEREO OUTPUT STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- Good Linearity of f_{FE}
- Complementary to 2SA1305 and 5W Output Applications.

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	30	V
Collector-Emitter Voltage	V_{CE0}	30	V
Emitter-Base Voltage	V_{EB0}	5	V
Collector Current	I_C	3	A
Base Current	I_B	0.3	A
Collector Power Dissipation ($T_c=25^{\circ}C$)	P_C	15	W
Junction Temperature	T_j	150	$^{\circ}C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^{\circ}C$

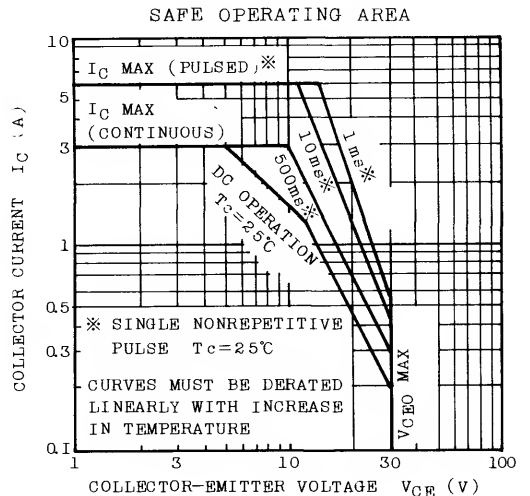
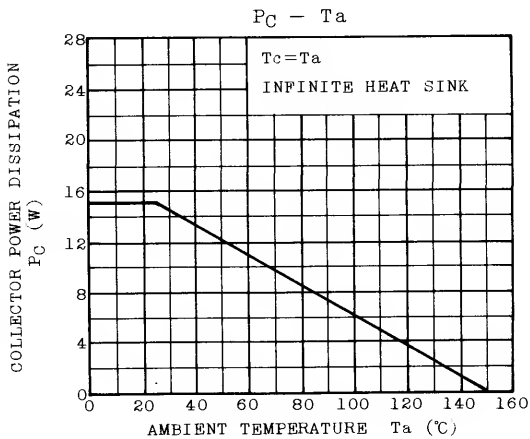
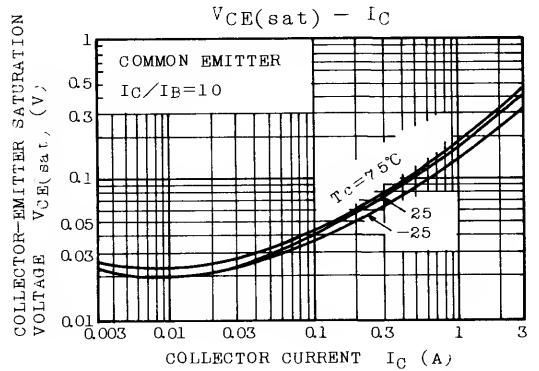
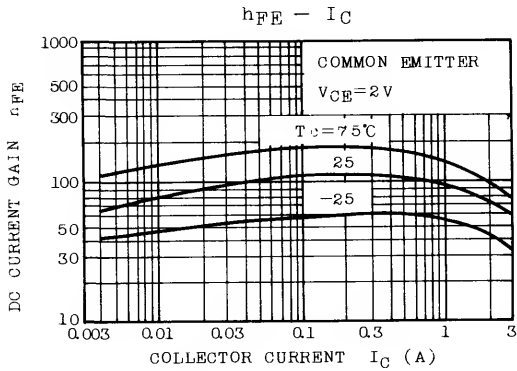
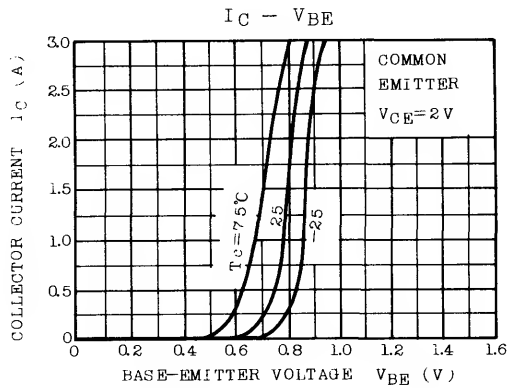
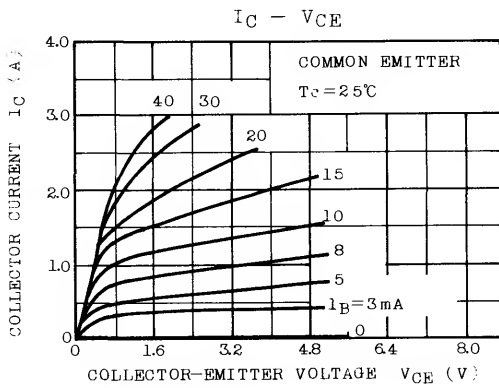


Weight : 2.1g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=20V, I_E=0$	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	30	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=2V, I_C=0.5A$	70	-	240	
	$h_{FE(2)}$	$V_{CE}=2V, I_C=2.5A$	25	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=2A, I_B=0.2A$	-	0.3	0.8	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=2V, I_C=0.5A$	-	0.75	1.0	V
Transition Frequency	f_T	$V_{CE}=2V, I_C=0.5A$	-	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	35	-	pF

Note : $h_{FE(1)}$ Classification 0 : 70 ~ 140, Y : 120 ~ 240



2SC3298 2SC3298A 2SC3298B

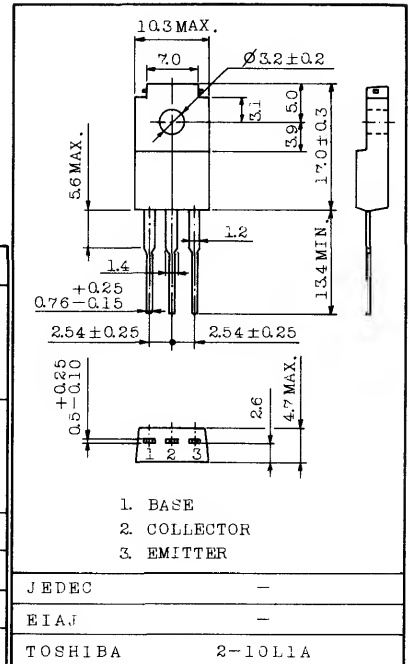
SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

- High Transition Frequency : $f_T=100\text{MHz}$ (Typ.)
- Complementary to 2SA1306, 2SA1306A, 2SA1306B

Unit in mm



Weight : 2.1g

MAXIMUM RATINGS

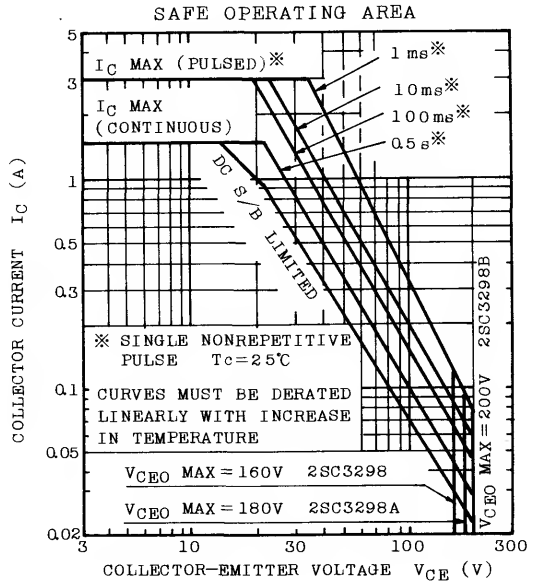
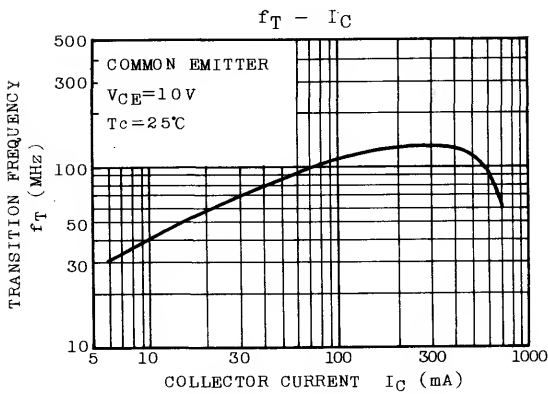
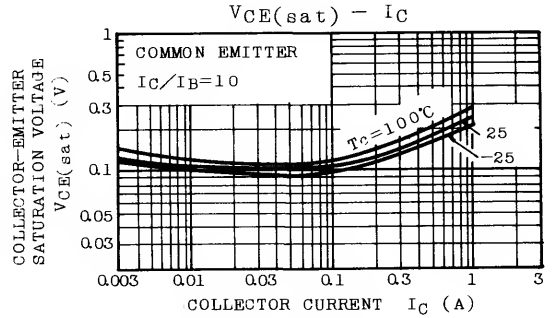
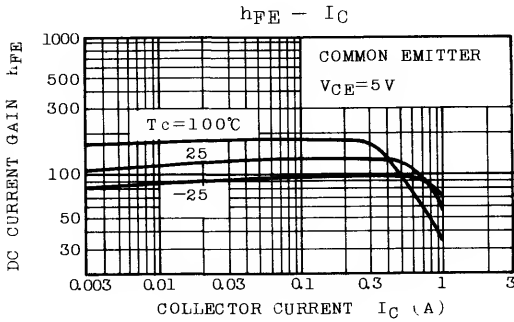
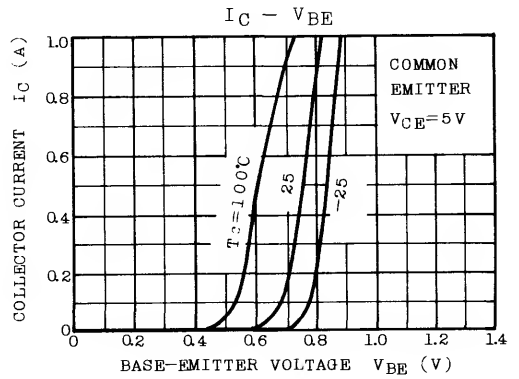
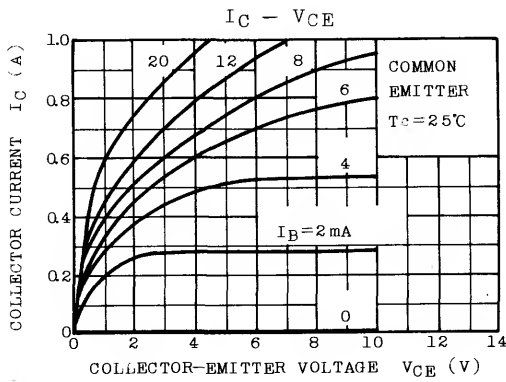
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	2SC3298	160	V
	2SC3298A	180	
	2SC3298B	200	
Collector-Emitter Voltage	2SC3298	160	V
	2SC3298A	180	
	2SC3298B	200	
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	1.5	A
Base Current	I_B	0.15	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	20	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ\text{C}$

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=160\text{V}, I_E=0$	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5\text{V}, I_C=0$	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	2SC3298	$V_{(BR)CEO}, I_C=10\text{mA}, I_B=0$	160	-	-	V
	2SC3298A		180	-	-	
	2SC3298B		200	-	-	
DC Current Gain	h_{FE} (Note)	$V_{CE}=5\text{V}, I_C=100\text{mA}$	70	-	240	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=500\text{mA}, I_B=50\text{mA}$	-	-	1.5	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5\text{V}, I_C=500\text{mA}$	-	-	1.0	V
Transition Frequency	f_T	$V_{CE}=10\text{V}, I_C=100\text{mA}$	-	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10\text{V}, I_C=0, f=1\text{MHz}$	-	25	-	pF

Note : h_{FE} Classification 0 : 70 ~ 140, Y : 120 ~ 240

2SC3298 · 2SC3298A · 2SC3298B



2SC3299

SILICON NPNEPITAXIAL TYPE (PCT PROCESS)

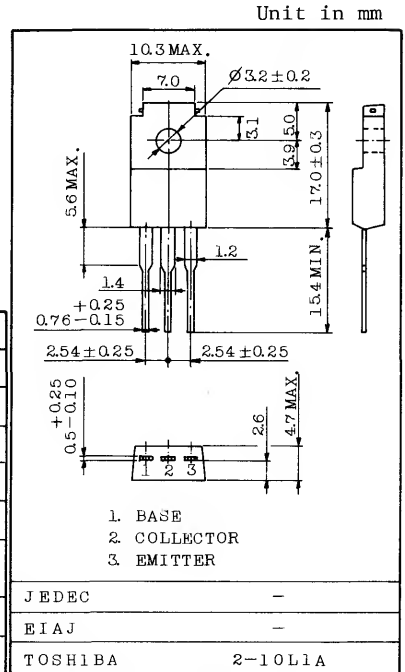
HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
: $V_{CE(sat)}=0.4V(\text{Max.})$ at $I_C=3A$
- High Speed Switching Time : $t_{stg}=1.0\mu s(\text{Typ.})$
- Complementary to 2SA1307

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	60	V
Collector-Emitter Voltage	V_{CEO}	50	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	5	A
Base Current	I_B	1	A
Collector Power Dissipation	P_C	$T_a=25^\circ C$	2.0
		$T_c=25^\circ C$	20
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$



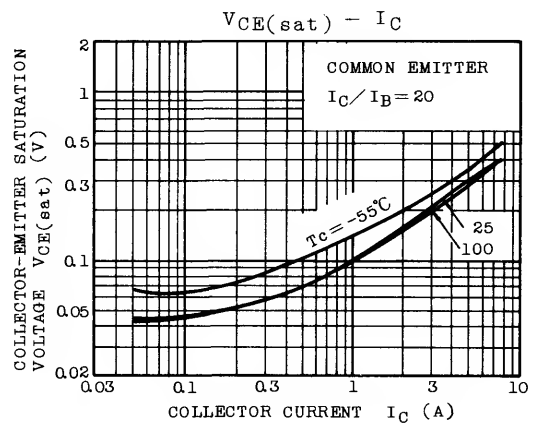
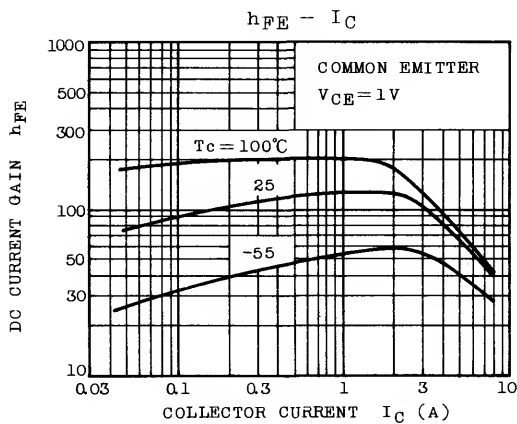
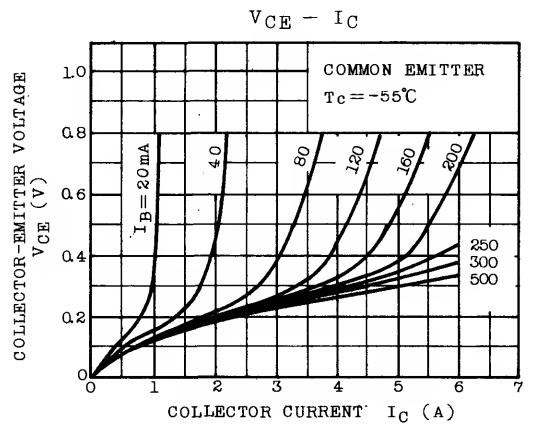
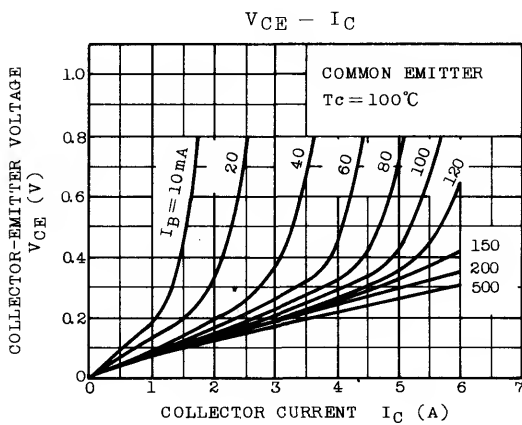
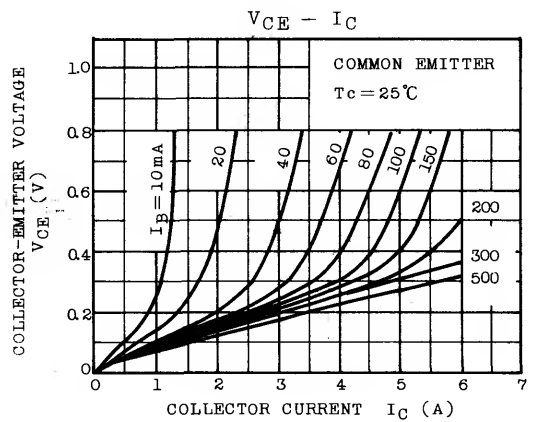
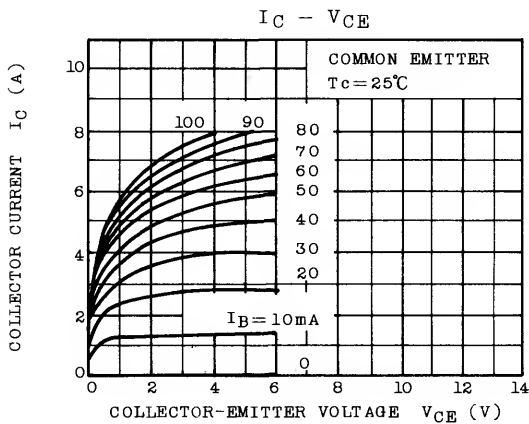
Weight : 2.1g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

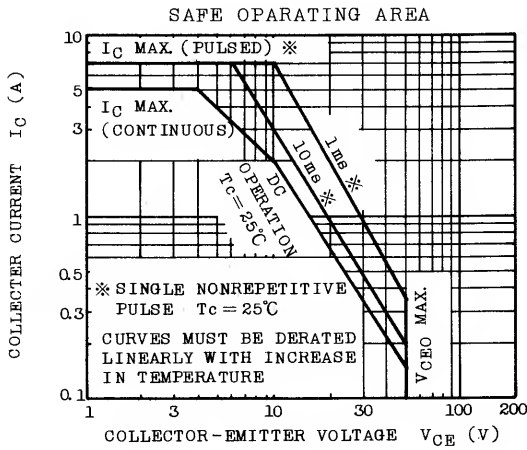
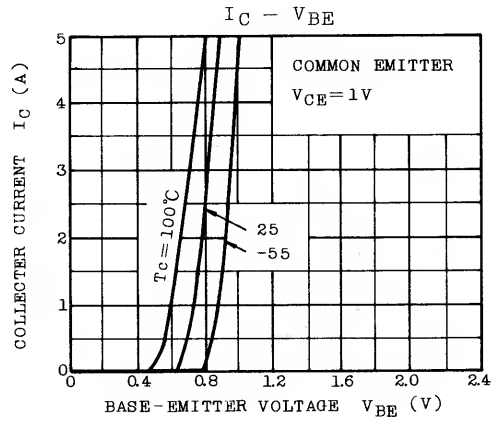
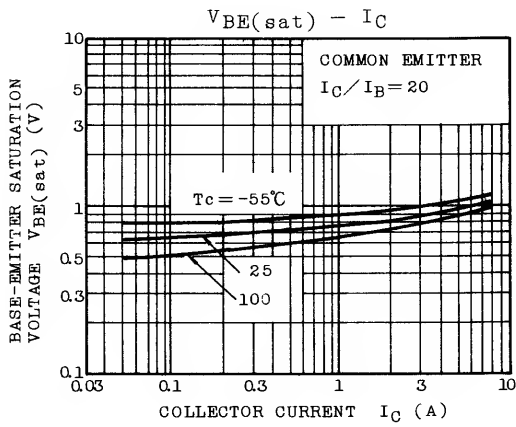
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Collector Cut-off Current	I_{CB0}	$V_{CB}=50V, I_E=0$	-	-	1	μA	
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1	μA	
Collector-Emitter Breakdown Voltage	$V(BR)_{CEO}$	$I_C=10mA, I_B=0$	50	-	-	V	
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=1V, I_C=1A$	70	-	240		
		$V_{CE}=1V, I_C=3A$	30	-	-		
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	-	0.2	0.4	V	
	Base-Emitter	$V_{BE(sat)}$	-	0.9	1.2		
Transition Frequency	f_T	$V_{CE}=4V, I_C=1A$	-	120	-	MHz	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	80	-	pF	
Switching Time	Turn-on Time		-	0.1	-	μs	
	Storage Time		t_{stg}	-	1.0		-
	Fall Time		t_f	-	0.1		-

$I_{B1} = -I_{B2} = 0.15A$
 $V_{CC} = 30V$
DUTY CYCLE $\leq 1\%$

Note : $h_{FE(1)}$ Classification O : 70 ~ 140, Y : 120 ~ 240



2SC3299



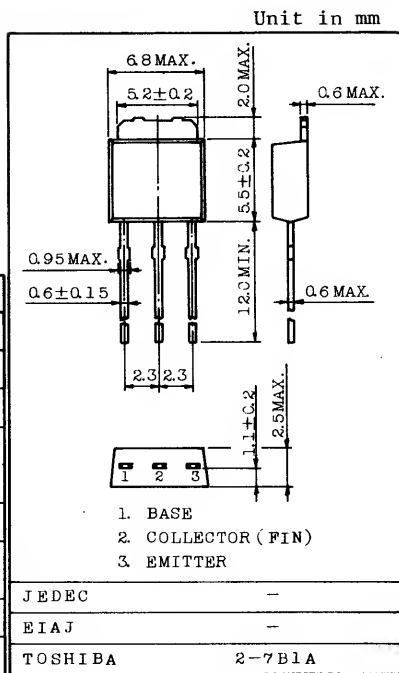
HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
: $V_{CE(sat)}=0.4V$ (Max.) at $I_C=3A$
- High Speed Switching Time : $t_{stg}=1.0\mu s$ (Typ.)

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	100	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EB0}	7	V
Collector Current	DC	I_C	5
	Pulse	I_{CP}	8
Base Current	I_B	1	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	20	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$



Weight : 0.36g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CB0}	$V_{CB}=100V, I_E=0$	-	-	1	μA
Emitter Cut-off Current		I_{EB0}	$V_{EB}=7V, I_C=0$	-	-	1	μA
Collector-Emitter Breakdown Voltage		$V(BR)_{CEO}$	$I_C=10mA, I_B=0$	80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=1V, I_C=1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=1V, I_C=3A$	40	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=3A, I_B=0.15A$	-	0.2	0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=3A, I_B=0.15A$	-	0.9	1.2	
Transition Frequency		f_T	$V_{CE}=4V, I_C=1A$	-	120	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	80	-	pF
Switching Time	Turn-on Time	t_{on}	<p>$I_{B1} = -I_{B2} = 0.15A$ DUTY CYCLE $\leq 1\%$ $V_{CE} = 30V$</p>	-	0.2	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.1	-	

Note : $h_{FE(1)}$ Classification O : 70~140, Y : 120~240

2SC3306

SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

HIGH SPEED DC-DC CONVERTER APPLICATIONS.

FEATURES:

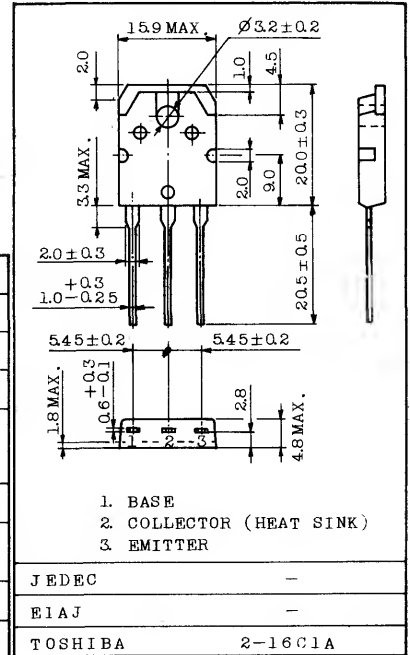
- Excellent Switching Times
: $t_r=1.0\mu s$ (Max.), $t_f=1.0\mu s$ (Max.) ($I_C=5A$)
- High Collector Breakdown Voltage : $V_{CEO}=400V$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	500	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	10	A
	Pulse	I_{CP}	15	
Base Current		I_B	5	A
Collector Power Dissipation ($T_c=25^\circ C$)		P_C	100	W
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55~150	$^\circ C$

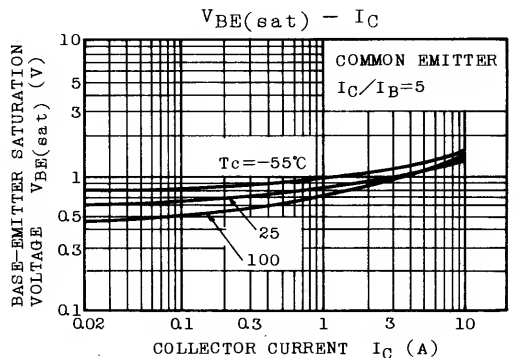
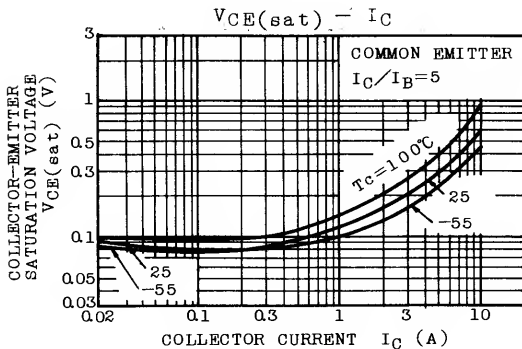
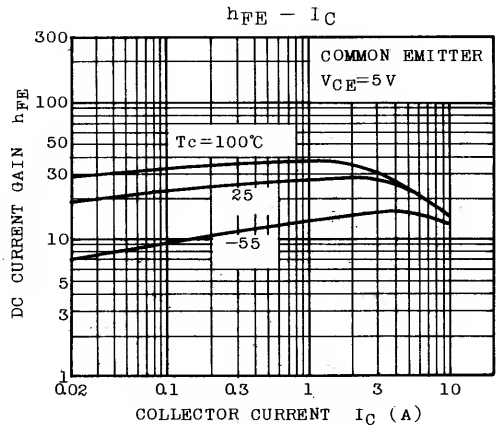
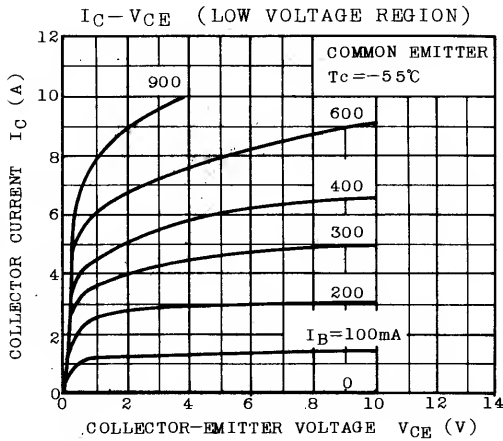
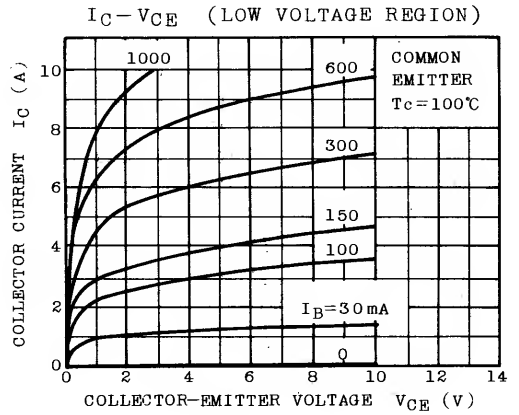
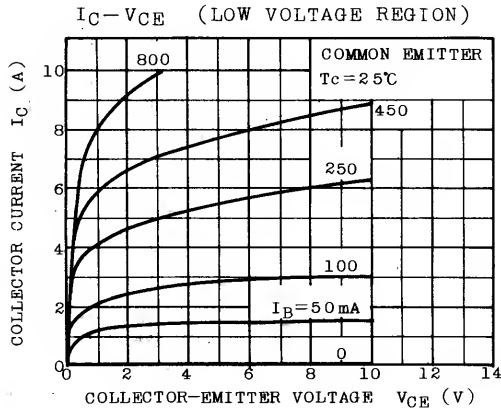
INDUSTRIAL APPLICATIONS

Unit in mm

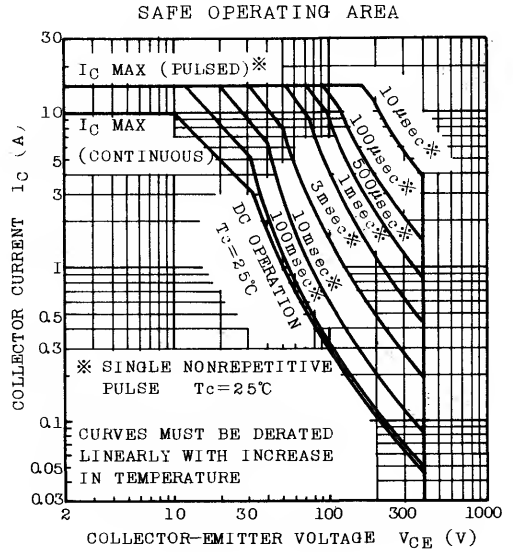
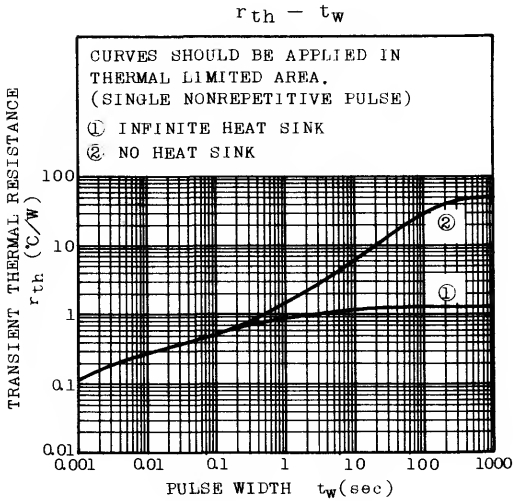
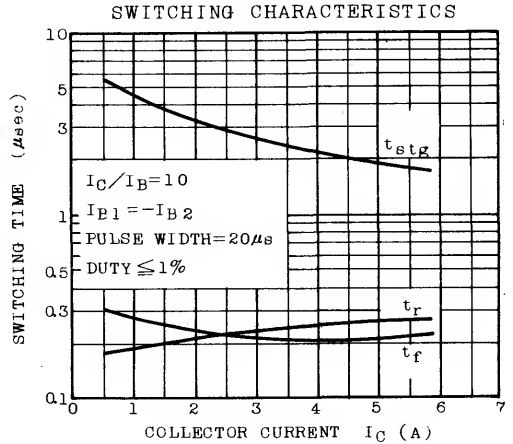
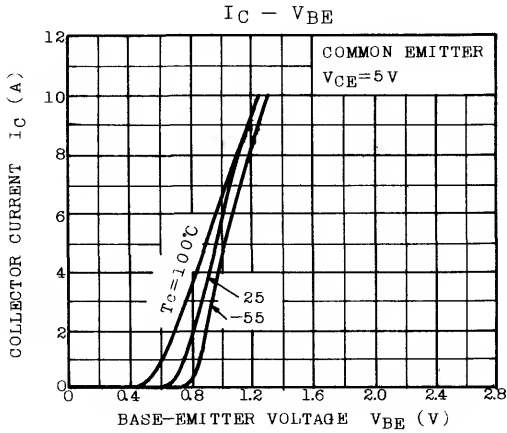


ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=400V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	400	-	-	V
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	$I_E=1mA, I_C=0$	7	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=5A$	10	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=5A, I_B=0.5A$	-	-	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=5A, I_B=0.5A$	-	-	2.0	V
Switching Time	Rise Time	t_r		-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		-	-	1.0	



2SC3306



INDUSTRIAL APPLICATIONS

Unit in mm

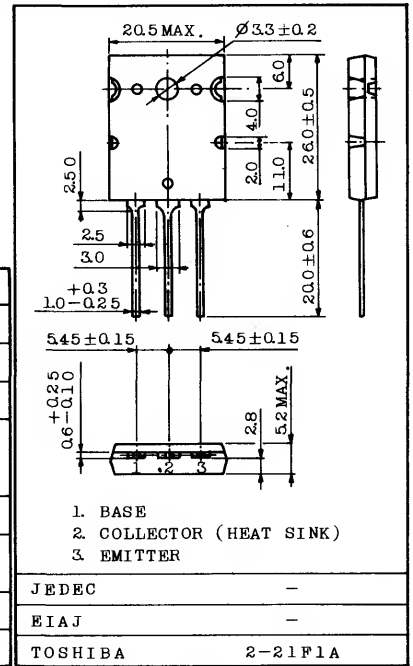
HIGH SPEED AND HIGH VOLTAGE SWITCHING APPLICATIONS.
 SWITCHING REGULATOR APPLICATIONS.
 HIGH SPEED DC-DC CONVERTER APPLICATIONS.

FEATURES:

- . Excellent Switching Times
 : $t_r=1.0\mu s$ (Max.), $t_f=1.0\mu s$ (Max.) ($I_C=5A$)
- . High Collector Breakdown Voltage : $V_{CE0}=800V$

MAXIMUM RATINGS ($T_a=25^\circ C$)

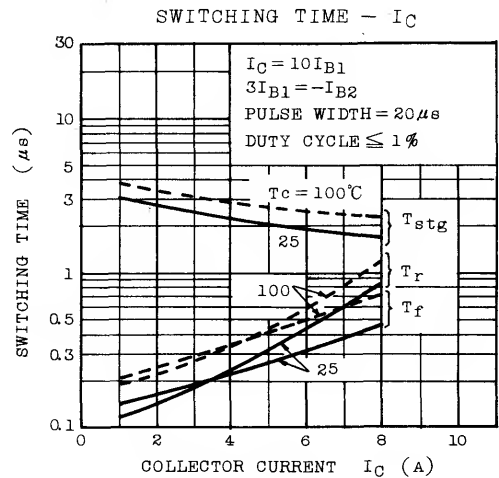
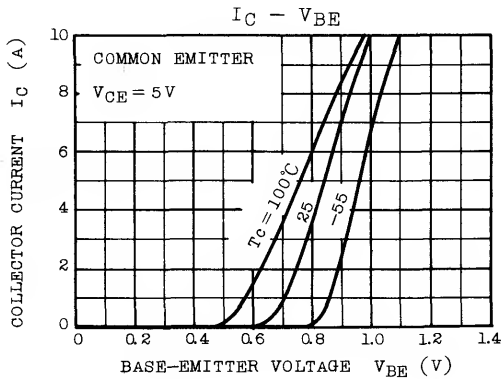
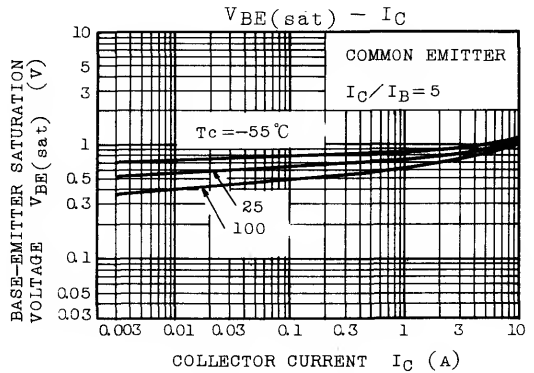
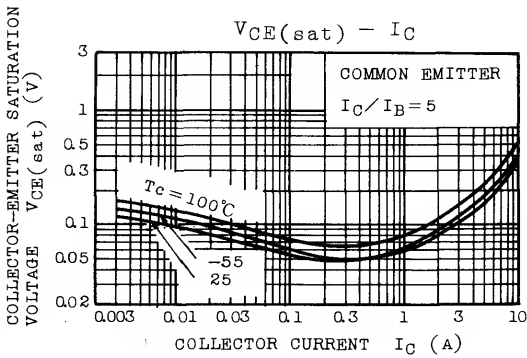
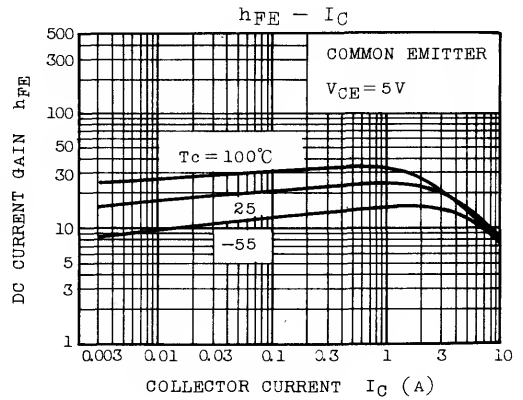
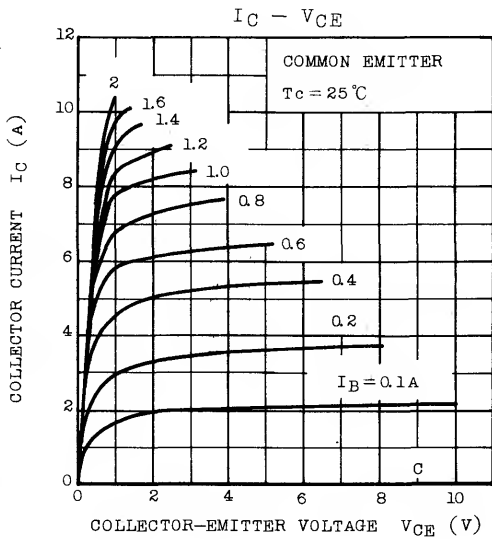
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	900	V
Collector-Emitter Voltage		V_{CEO}	800	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	10	A
	Pulse	I_{CP}	15	
Base Current		I_B	3	A
Collector Power Dissipation ($T_c=25^\circ C$)		P_C	150	W
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55~150	$^\circ C$

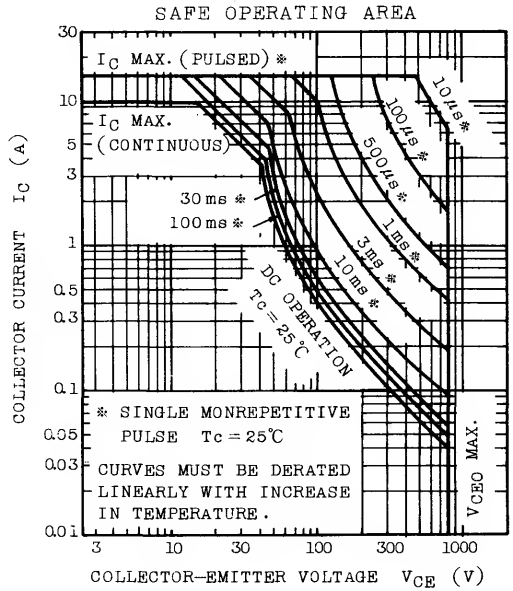
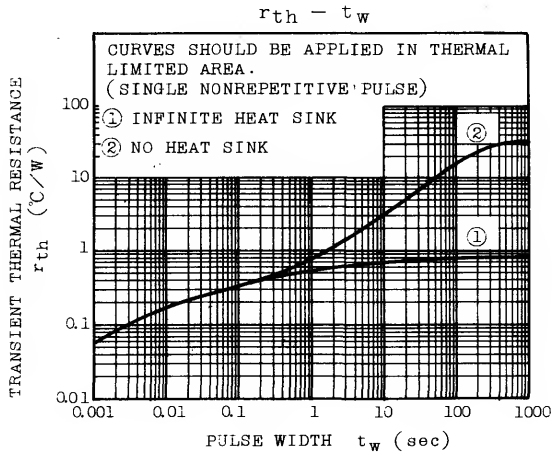


ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

Weight : 9.8g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=800V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	900	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	800	-	-	V
DC Current Gain		$h_{FE(1)}$	$V_{CE}=5V, I_C=10mA$	10	-	-	-
		$h_{FE(2)}$	$V_{CE}=5V, I_C=5A$	10	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=5A, I_B=1A$	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=5A, I_B=1A$	-	-	1.5	V
Switching Time	Rise Time	t_r		-	-	1.0	μs
	Storage Time	t_{stg}		-	-	3.0	
	Fall Time	t_f		-	-	1.0	





2SC3308

SILICON NPNEPITAXIAL TYPE (PCT PROCESS)

HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

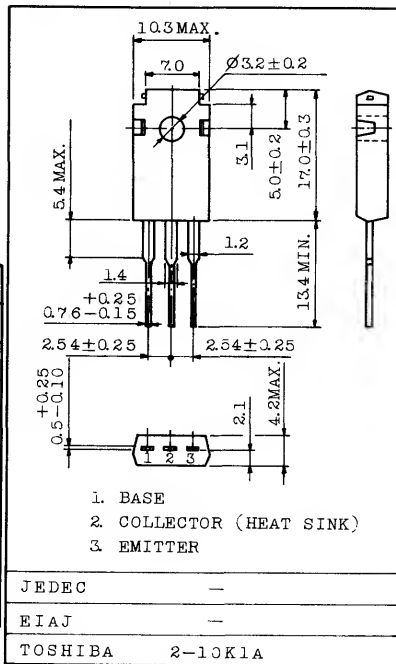
- Low Collector Saturation Voltage
: $V_{CE(sat)} = 0.4V(\text{Max.})$ at $I_C = 3A$
- High Speed Switching Time : $t_{stg} = 1.0\mu s(\text{Typ.})$
- Complementary to 2SA1308.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	100	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EB0}	7	V
Collector Current	DC	I_C	5
	Pulse	I_{CP}	8
Collector Power Dissipation (Tc=25°C)	P_C	30	V
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~ 150	°C

INDUSTRIAL APPLICATIONS

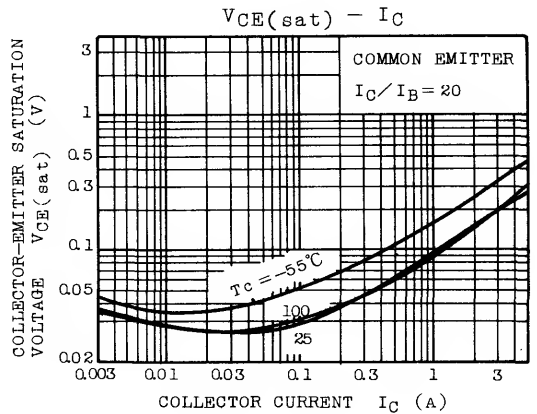
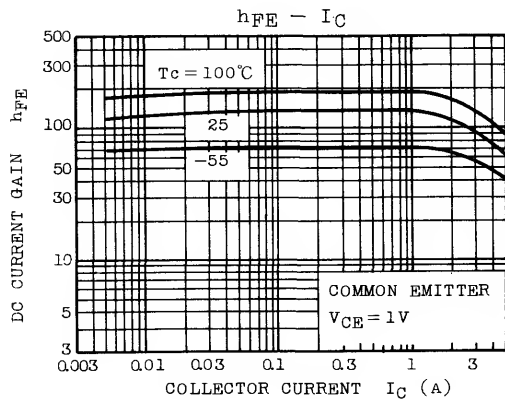
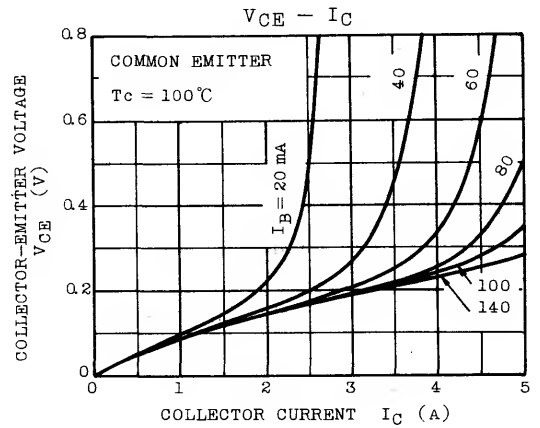
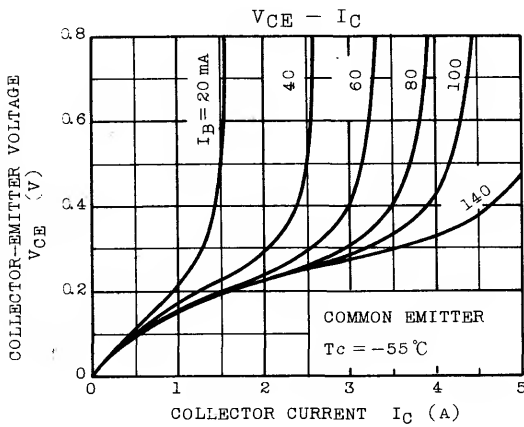
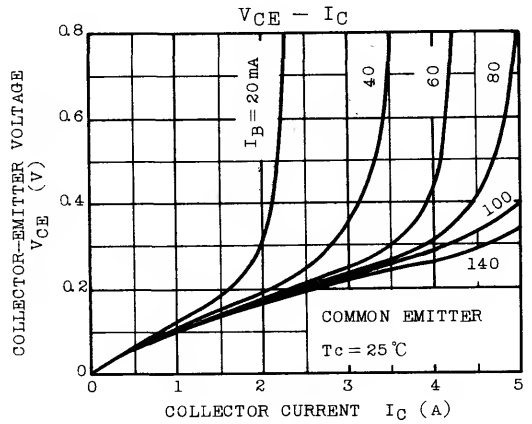
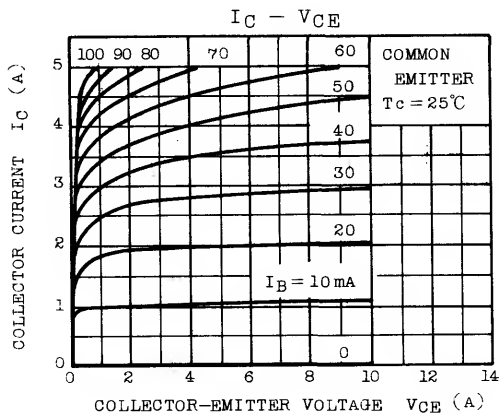
Unit in mm



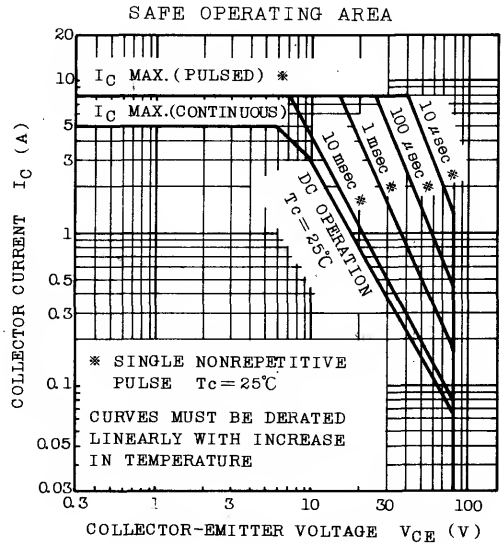
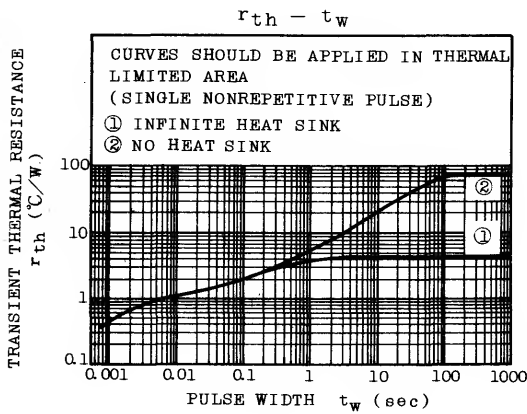
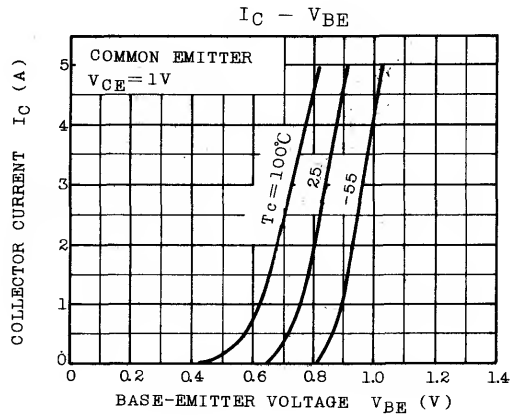
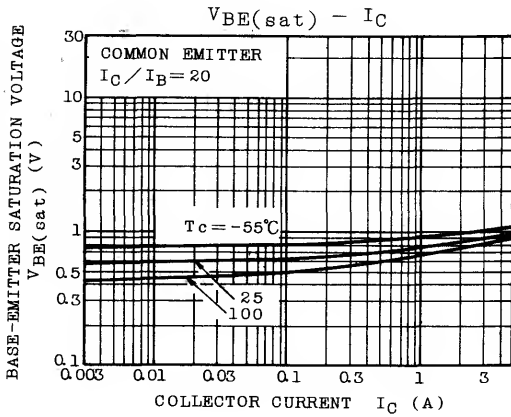
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB} = 100V, I_E = 0$	-	-	1	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB} = 7V, I_C = 0$	-	-	1	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C = 10mA, I_B = 0$	80	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE} = 1V, I_C = 1A$	70	-	240	
	$h_{FE(2)}$	$V_{CE} = 1V, I_C = 3A$	40	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	-	0.2	0.4	V
	Base-Emitter	$V_{BE(sat)}$	-	0.9	1.2	
Transition Frequency	f_T	$V_{CE} = 4V, I_C = 1A$	-	120	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB} = 10V, I_E = 0, f = 1MHz$	-	80	-	pF
Switching Time	Turn-on Time	t_{on}	-	0.2	-	μs
	Storage Time	t_{stg}	-	1.0	-	
	Fall Time	t_f	$I_{B1} = -I_{B2} = 0.15A$ DUTY CYCLE $\leq 1\%$	-	0.1	

Note : $h_{FE(1)}$ Classification 0 : 70~140, Y : 120~240



2SC3308



INDUSTRIAL APPLICATIONS

Unit in mm

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

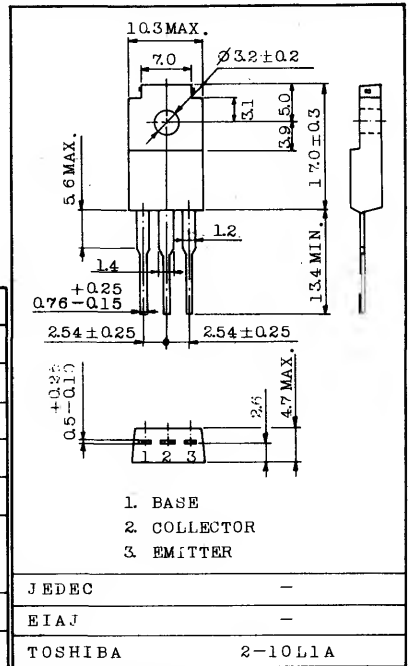
HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

- Excellent Switching Times
 $t_r=1.0\mu s(\text{Max.})$, $t_f=1.0\mu s(\text{Max.})$ at $I_C=0.8A$
- High Collector Breakdown Voltage : $V_{CE0}=400V$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	500	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	2	A
Base Current		I_B	0.5	A
Collector Power Dissipation	$T_a=25^\circ C$	P_C	2.0	W
	$T_c=25^\circ C$		20	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$

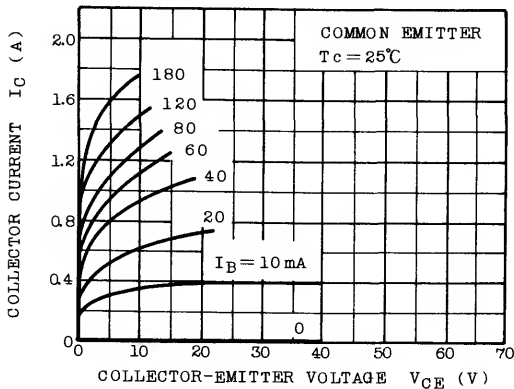


Weight : 2.1g

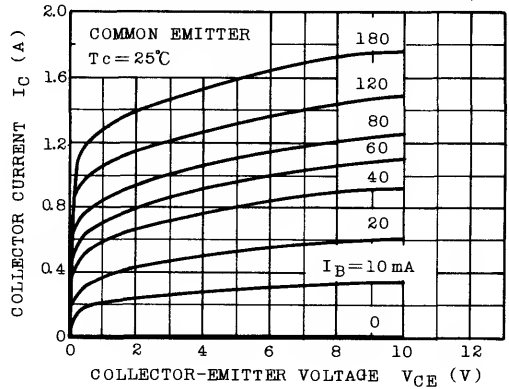
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=400V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	400	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=0.1A$	20	-	-	
			$V_{CE}=5V, I_C=1A$	8	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=1A, I_B=0.2A$	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=1A, I_B=0.2A$	-	-	1.5	V
Switching Time	Rise Time	t_r		-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		$I_{B1}=-I_{B2}=0.08A$ DUTY CYCLE < 1%	-	-	

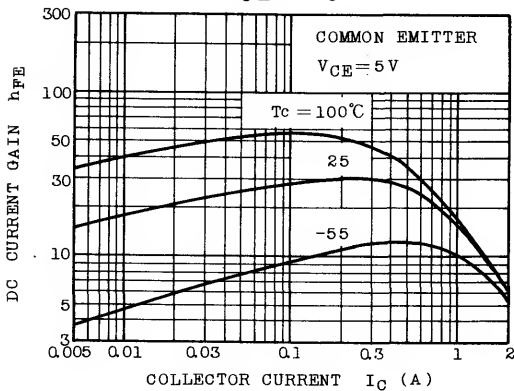
STATIC CHARACTERISTICS



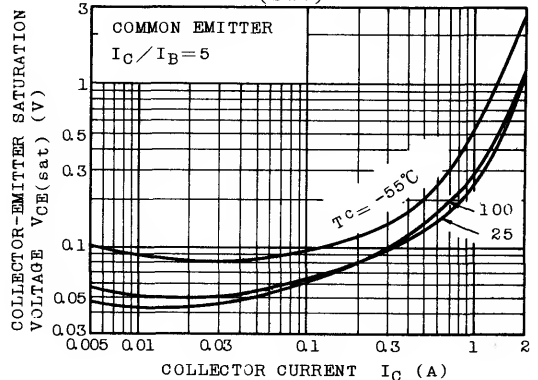
$I_C - V_{CE}$ (LOW VOLTAGE REGION)



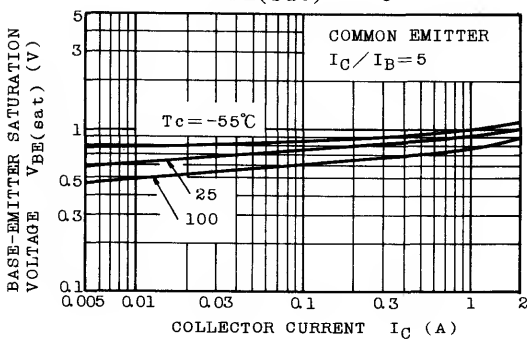
$h_{FE} - I_C$



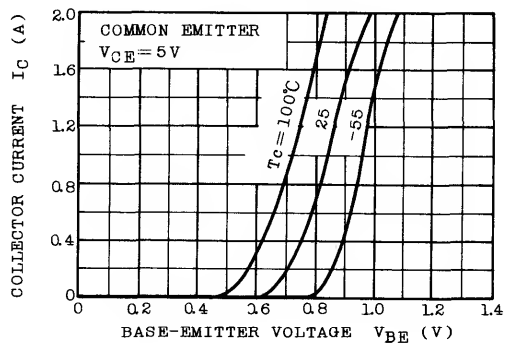
$V_{CE(sat)} - I_C$



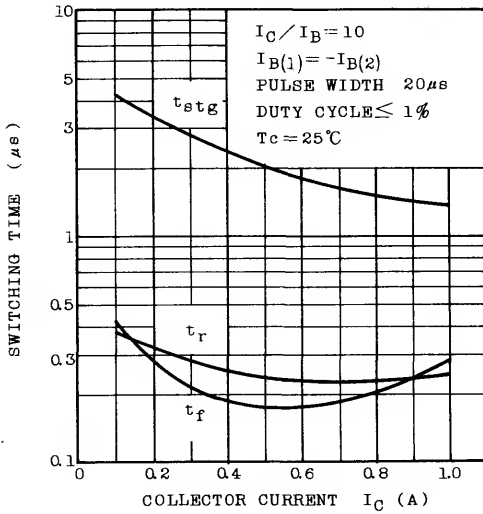
$V_{BE(sat)} - I_C$



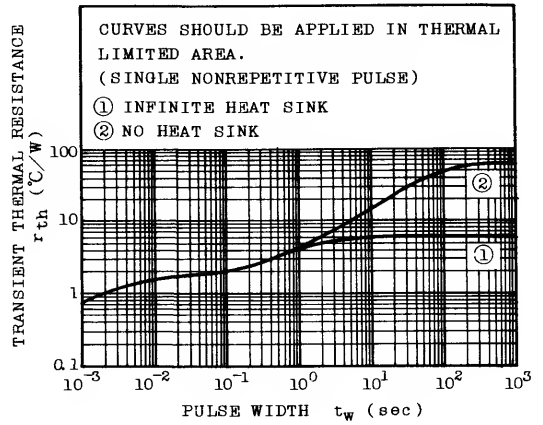
$I_C - V_{BE}$



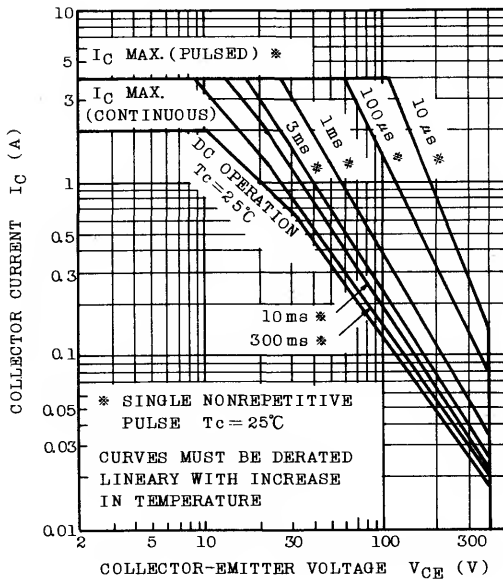
SWITCHING CHARACTERISTICS



$r_{th} - t_w$



SAFE OPERATING AREA



2SC3310

SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

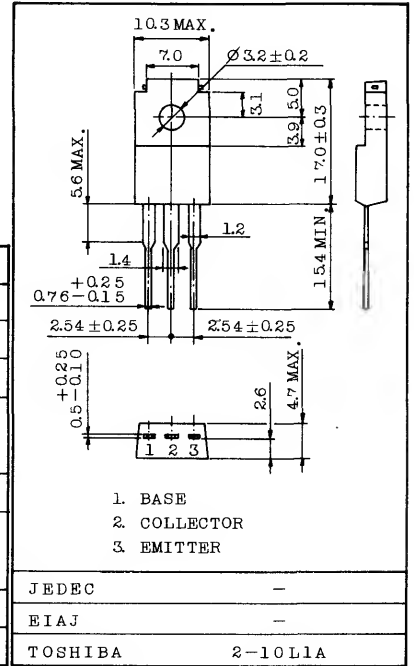
- Excellent Switching Times
: $t_r=1.0\mu s(\text{Max.})$, $t_f=1.0\mu s(\text{Max.})$ at $I_C=4A$
- High Collector Breakdown Voltage : $V_{CE0}=400V$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB0}	500	V
Collector-Emitter Voltage		V_{CE0}	400	V
Emitter-Base Voltage		V_{EB0}	7	V
Collector Current	DC	I_C	5	A
	Pulse	I_{CP}	7	
Base Current		I_B	1	A
Collector Power Dissipation	$T_a=25^\circ C$	P_C	2.0	W
	$T_c=25^\circ C$		30	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$

INDUSTRIAL APPLICATIONS

Unit in mm



Weight : 2.1g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=400V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	500	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	400	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=3A$	12	-	-	
			$V_{CE}=5V, I_C=5A$	8	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=5A, I_B=1A$	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=5A, I_B=1A$	-	-	1.5	V
Switching Time	Rise Time	t_r		-	-	1.0	μs
	Storage Time	t_{stg}		-	-	2.5	
	Fall Time	t_f		$I_{B1}=-I_{B2}=0.4A$ DUTY CYCLE < 1%	-	-	

2SC3335

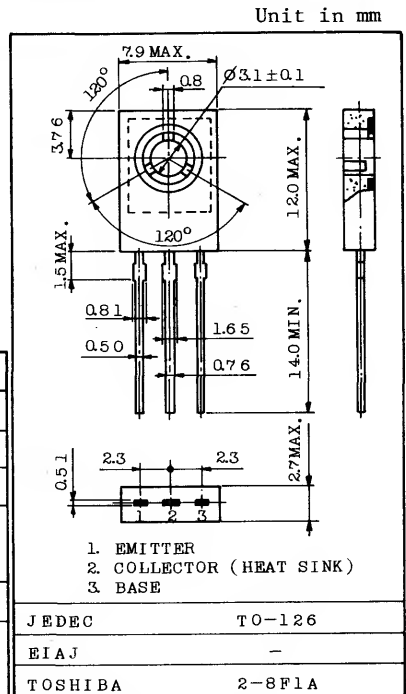
HIGH VOLTAGE SWITCHING APPLICATIONS.
 COLOR TV CHROMA OUTPUT APPLICATIONS.

FEATURES:

- . High Voltage : $V_{CE0}=250V$
- . Low C_{re} : $2.0pF(Max.)$
- . Complementary to 2SA1322

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

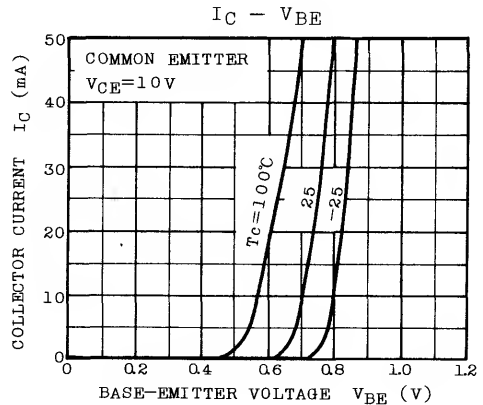
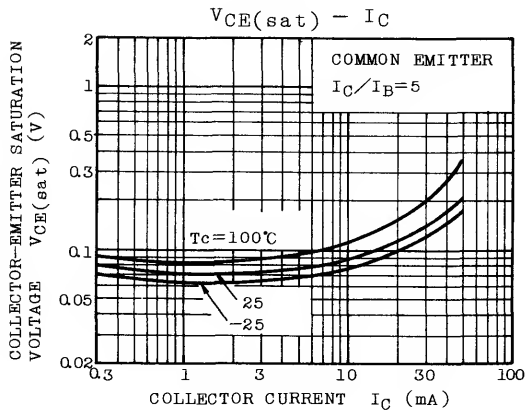
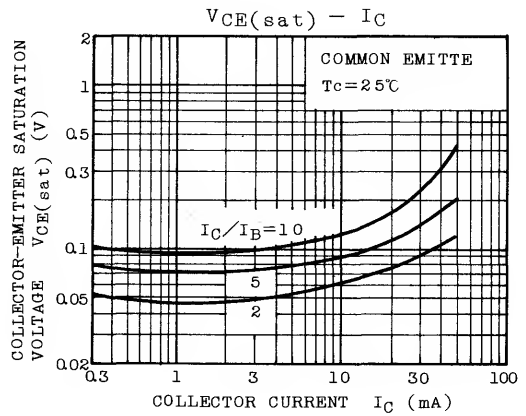
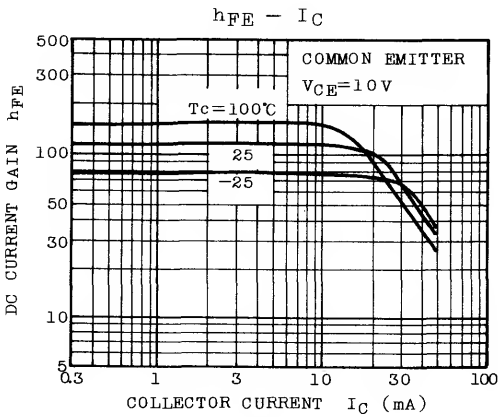
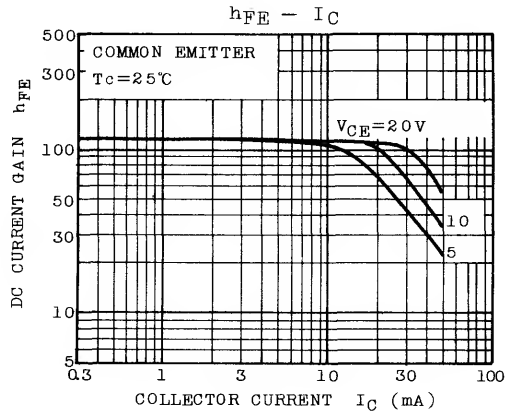
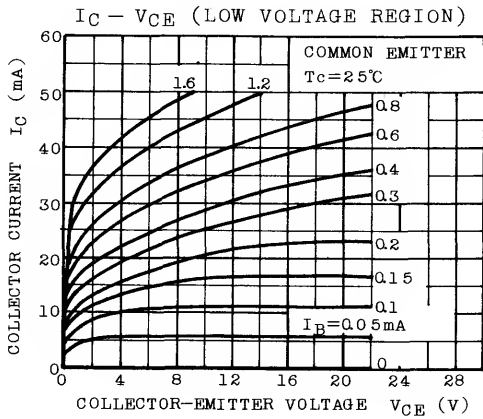
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	250	V
Collector-Emitter Voltage		V_{CEO}	250	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current	DC	I_C	50	mA
	Peak	I_{CP}	100	
Base Current		I_B	20	mA
Collector Power Dissipation	$T_a=25^{\circ}C$	P_C	1.2	W
	$T_c=25^{\circ}C$		10.0	
Junction Temperature		T_j	150	$^{\circ}C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^{\circ}C$

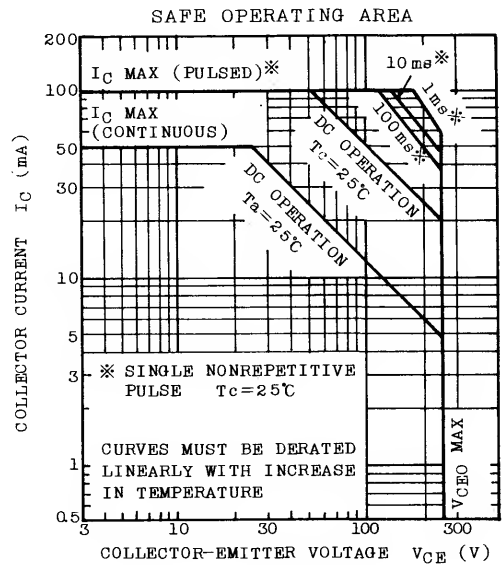
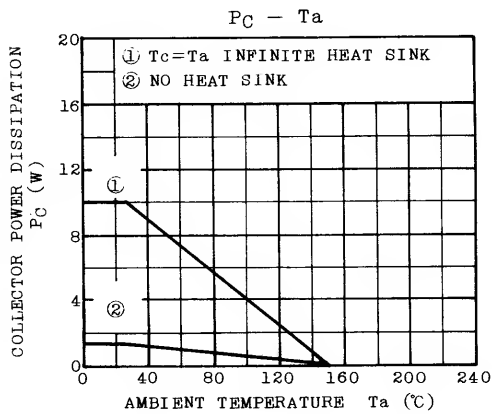
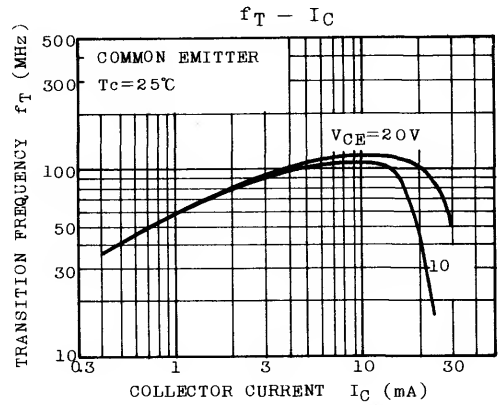
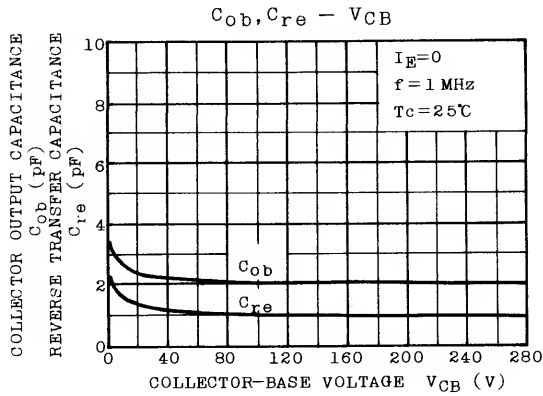


Weight : 0.72g
 Mounting Kit No. AC46C

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=200V, I_E=0$	-	-	1.0	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=1mA, I_B=0$	250	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=20V, I_C=25mA$	50	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=10mA, I_B=1mA$	-	-	1.5	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=20V, I_C=25mA$	-	0.75	-	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=10mA$	60	100	-	MHz
Reverse Transfer Capacitance	C_{re}	$V_{CB}=30V, I_E=0, f=1MHz$	-	-	2.0	pF





2SC3344

SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

HIGH SPEED DC-DC CONVERTER APPLICATION.

FEATURES:

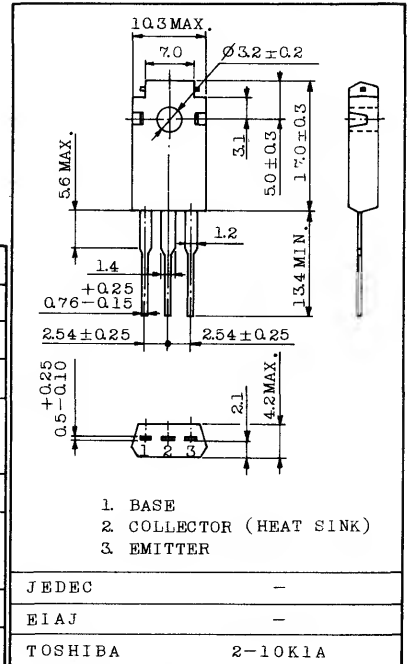
- Excellent Switching Times
: $t_r=1.0\mu s(\text{Max.})$, $t_f=1.0\mu s(\text{Max.})$ at $I_C=4A$
- High Collector Breakdown Voltage : $V_{CE0}=400V$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	500	V
Collector-Emitter Voltage	V_{CE0}	400	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	DC	I_C	8
	Pulse	I_{CP}	10
Base Current	I_B	4	A
Collector Power Dissipation	P_C	$T_a=25^\circ C$	1.7
		$T_c=25^\circ C$	60
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$

INDUSTRIAL APPLICATIONS

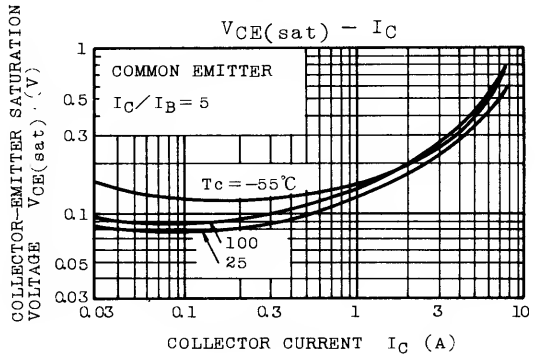
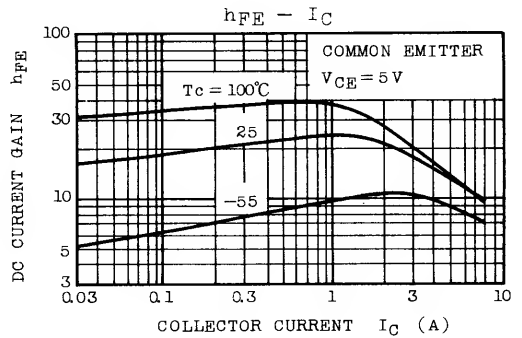
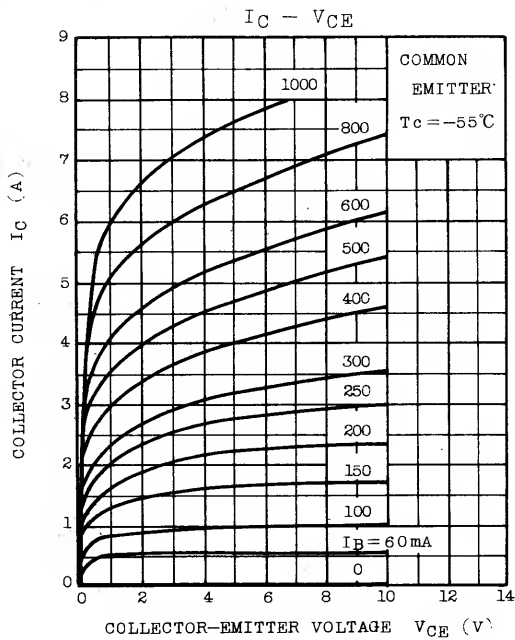
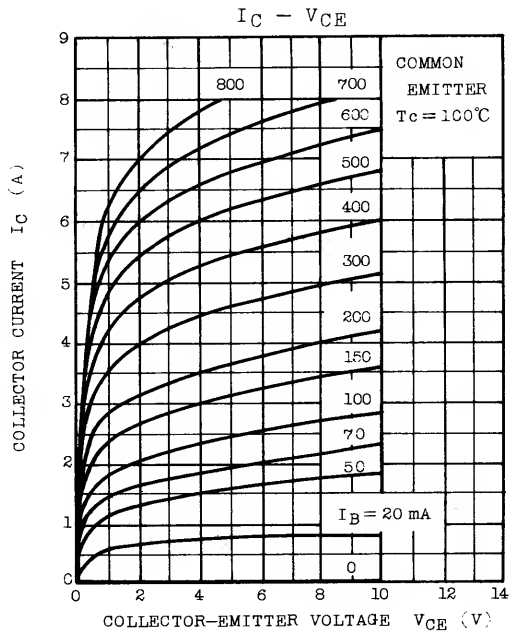
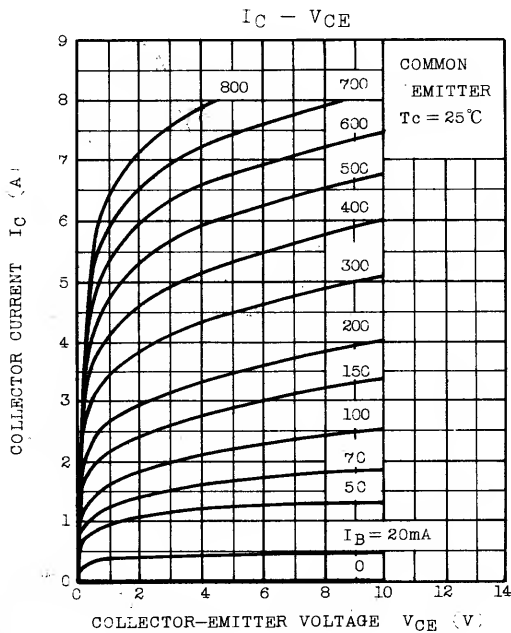
Unit in mm



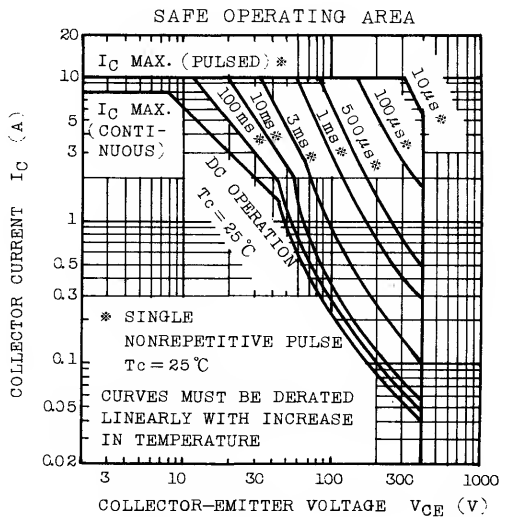
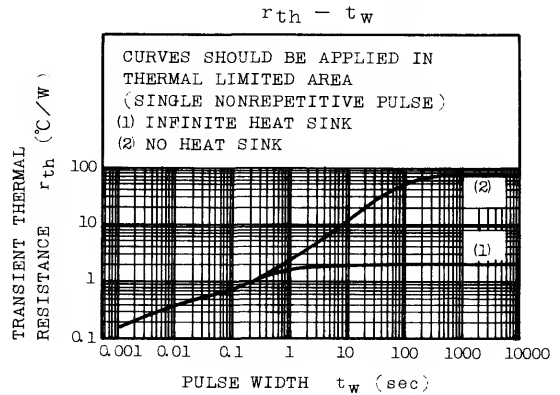
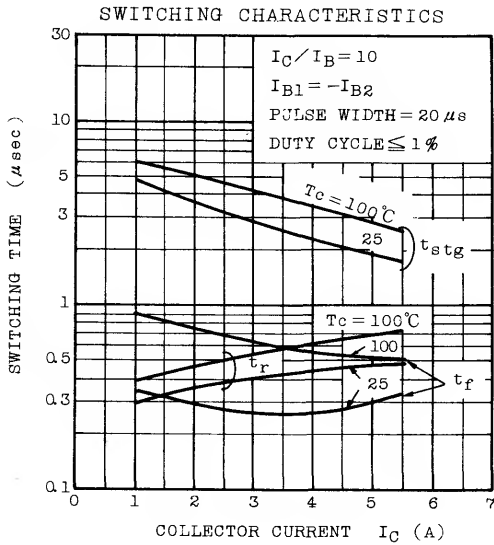
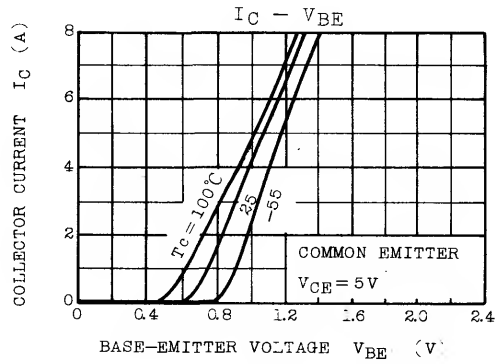
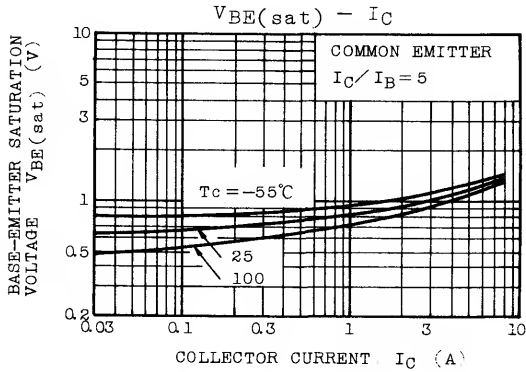
Weight : 2.0g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=400V, I_E=0$	-	-	100	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	500	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	400	-	-	V
DC Current Gain	$h_{FE}(1)$	$V_{CE}=5V, I_C=1A$	15	-	-	
	$h_{FE}(2)$	$V_{CE}=5V, I_C=4A$	10	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A, I_B=0.8A$	-	-	1.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4A, I_B=0.8A$	-	-	1.5	V
Switching Time	Rise Time	t_r	-	-	1.0	μs
	Storage Time	t_{stg}	-	-	2.5	
	Fall Time	t_f	-	-	1.0	



2SC3344



Unit in mm

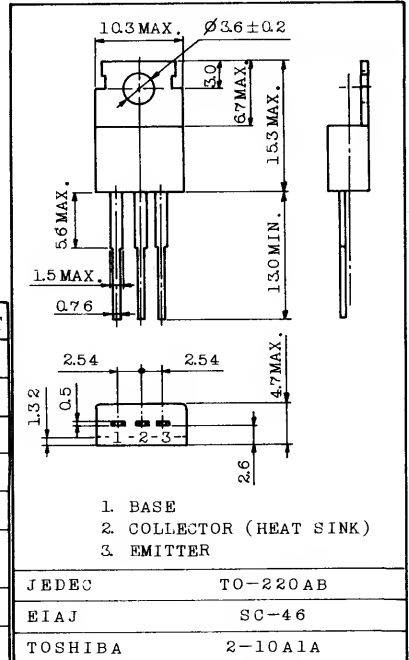
HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
: $V_{CE(sat)}=0.4V(\text{Max.})$ (at $I_C=6A$)
- High Speed Switching Time : $t_{stg}=1.0\mu s(\text{Typ.})$
- Complementary to 2SA1328

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CEO}	50	V
Emitter-Base Voltage	V_{EBO}	6	V
Collector Current	I_C	12	A
Base Current	I_B	2	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	40	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$



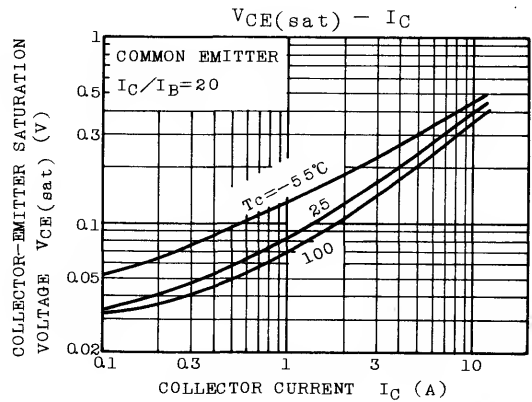
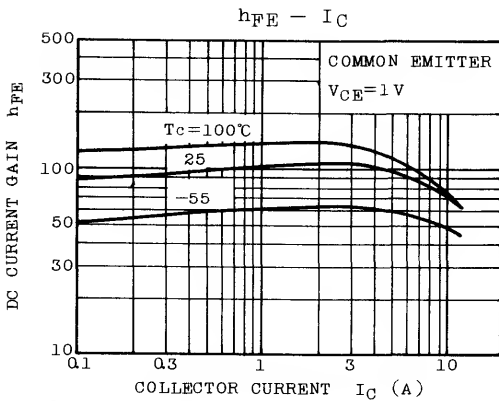
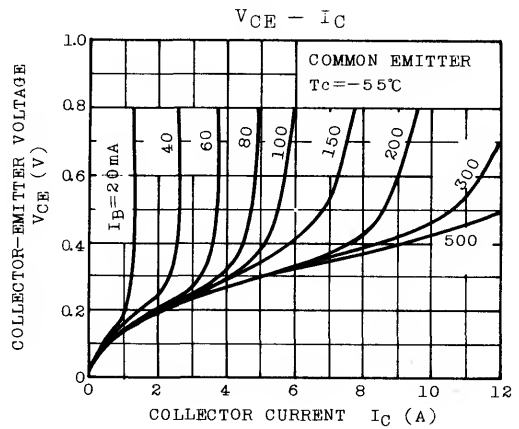
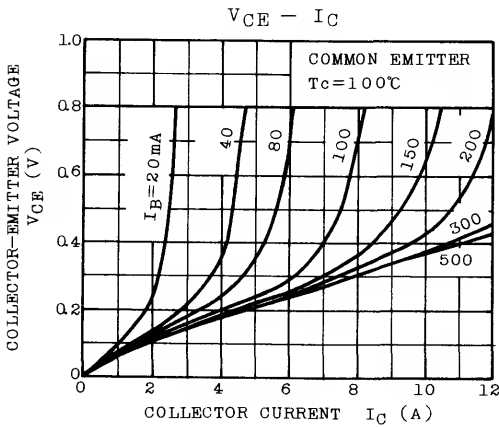
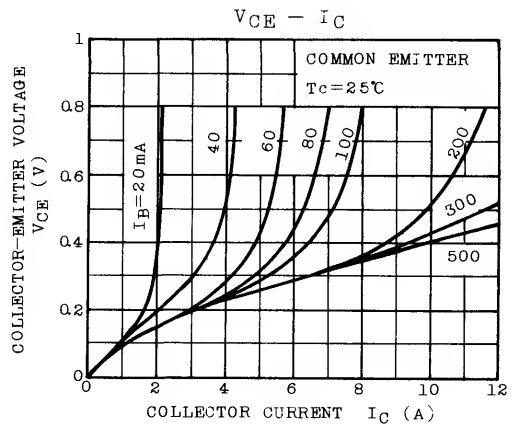
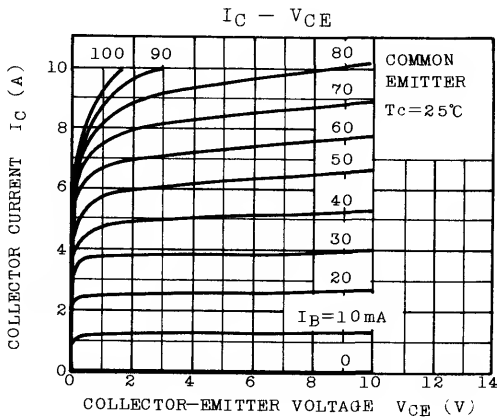
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

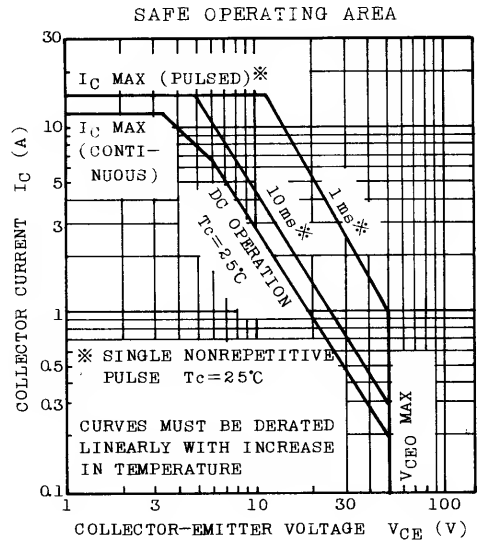
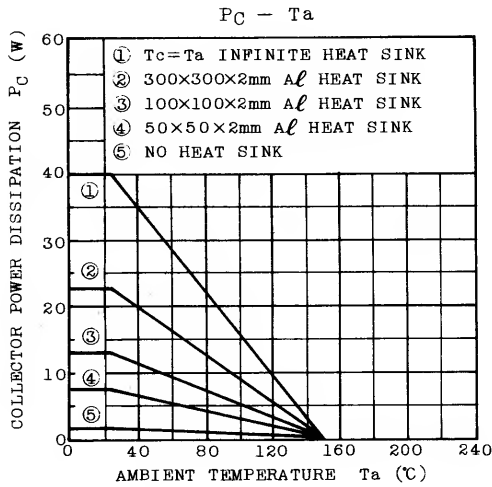
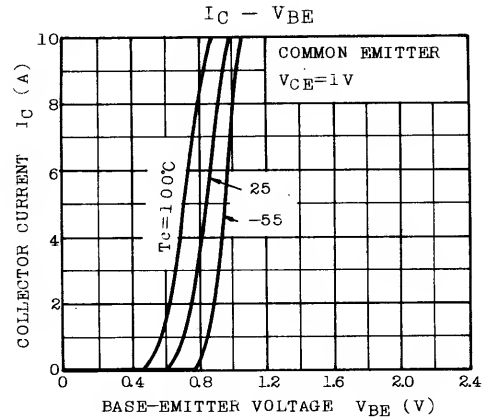
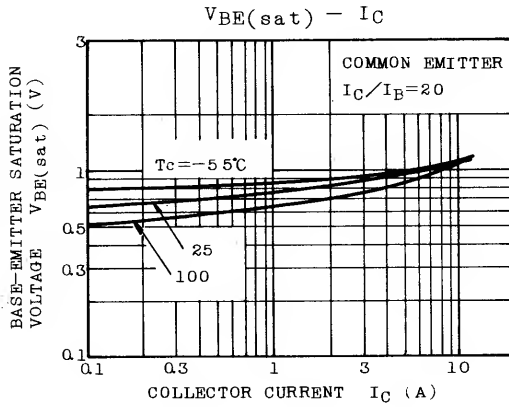
Mounting Kit No. AC75
Weight : 1.9g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=60V, I_E=0$	-	-	10	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=6V, I_C=0$	-	-	10	μA
Collector-Emitter Breakdown Voltage		$V(BR)_{CEO}$	$I_C=50mA, I_B=0$	50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=1V, I_C=1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=1V, I_C=6A$	40	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=6A, I_B=0.3A$	-	0.25	0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=6A, I_B=0.3A$	-	0.9	1.2	
Transition Frequency		f_T	$V_{CE}=5V, I_C=1A$	-	90	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	180	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.2	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		$I_{B1}=-I_{B2}=0.3A$ DUTY CYCLE $\leq 1\%$	-	0.2	

Note : $h_{FE(1)}$ Classification 0 : 70 ~ 140, Y : 120 ~ 240

2SC3345





2SC3346

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

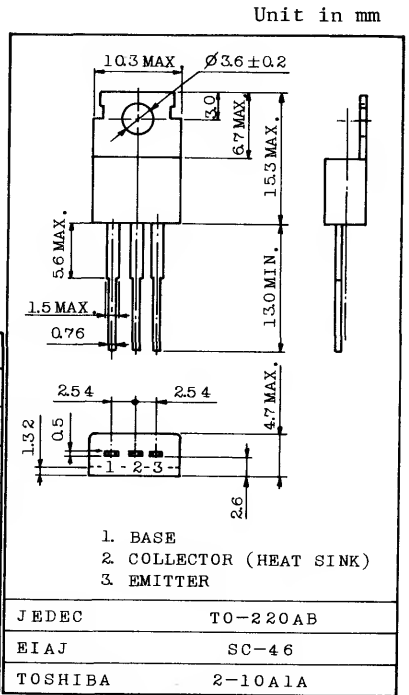
HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
: $V_{CE(sat)}=0.4V$ (Max.) (at $I_C=6A$)
- High Speed Switching Time : $t_{stg}=1.0\mu s$ (Typ.)
- Complementary to 2SA1329

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EB0}	6	V
Collector Current	I_C	12	A
Base Current	I_B	2	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	40	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$



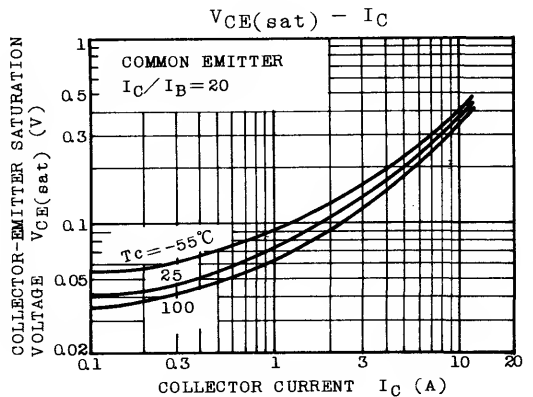
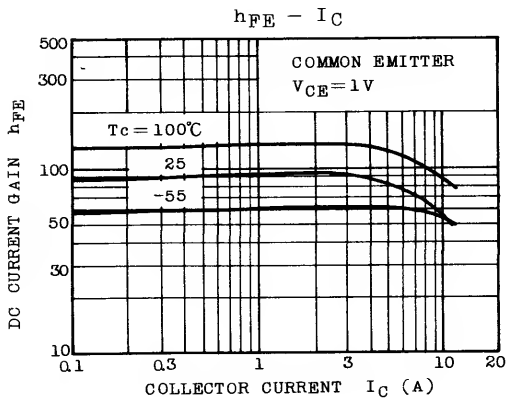
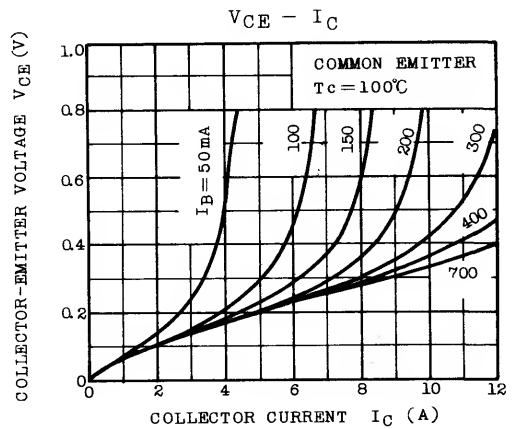
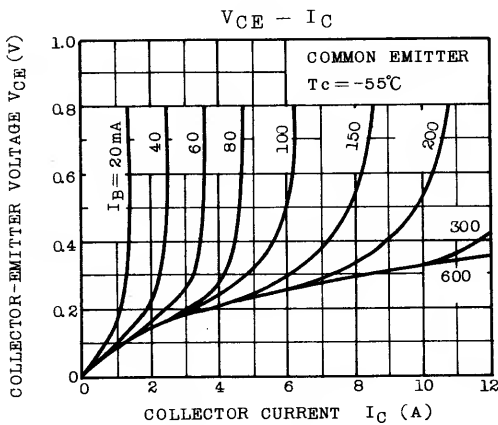
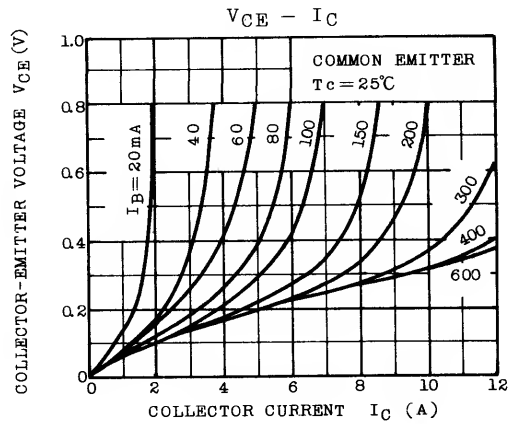
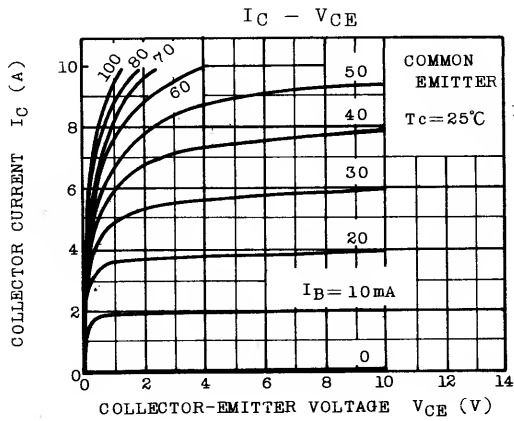
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

Mounting Kit No. AC75
Weight : 1.9g

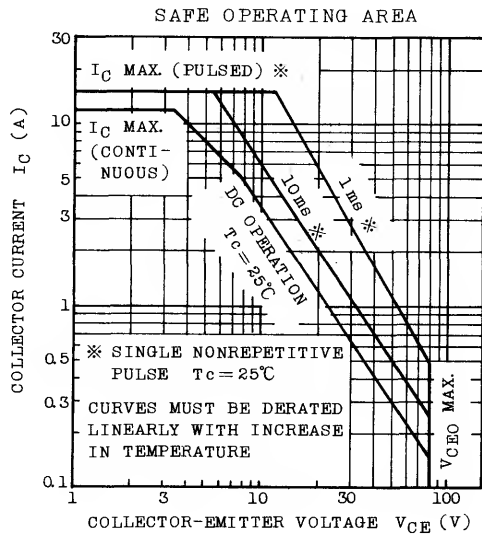
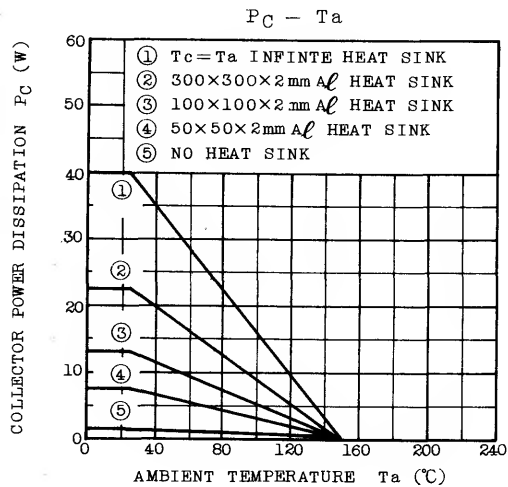
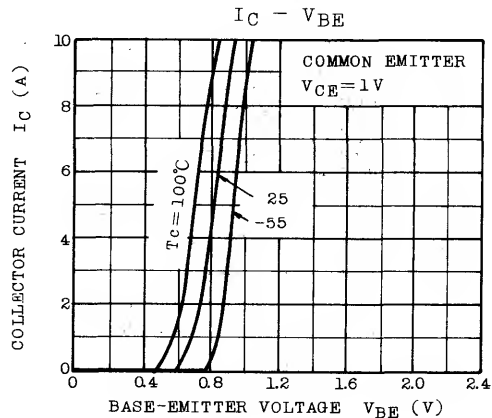
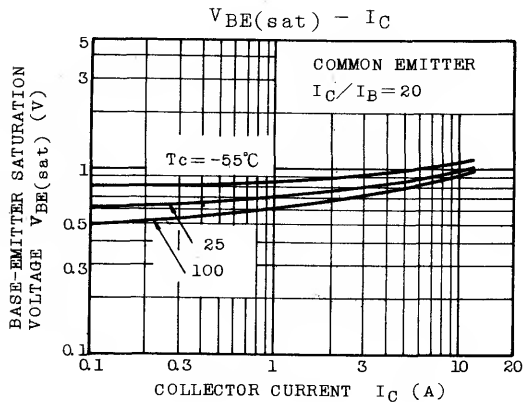
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=80V, I_E=0$	-	-	10	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=6V, I_C=0$	-	-	10	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=1V, I_C=1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=1V, I_C=6A$	40	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=6A, I_B=0.3A$	-	0.2	0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=6A, I_B=0.3A$	-	0.9	1.2	
Transition Frequency		f_T	$V_{CE}=5V, I_C=1A$	-	80	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	220	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.2	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		-	0.2	-	

Note : $h_{FE(1)}$ Classification O : 70~140, Y : 120~240

TOSHIBA CORPORATION



2SC3346



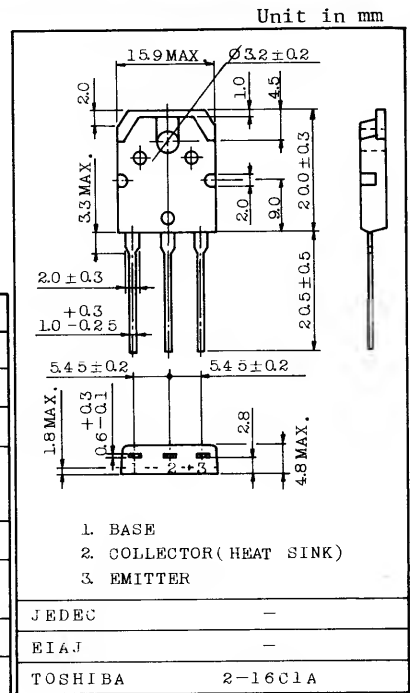
SWITCHING REGULATOR AND HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

- Excellent Switching Times ($I_C=0.8A$)
: $t_r=1.0\mu s$ (Max.), $t_f=1.0\mu s$ (Max.)
- High Collector-Emitter Breakdown Voltage : $V_{CE0}=800V$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB0}	900	V
Collector-Emitter Voltage		V_{CE0}	800	V
Emitter-Base Voltage		V_{EB0}	7	V
Collector Current	DC	I_C	3	A
	Pulse	I_{CP}	5	
Base Current		I_B	1	A
Collector Power Dissipation ($T_c=25^\circ C$)		P_C	60	W
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$



Weight : 4.6g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=800V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	900	-	-	V
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	800	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=0.8A$	10	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=0.8A, I_B=0.16A$	-	-	0.6	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=0.8A, I_B=0.16A$	-	-	1.2	V
Switching Time	Rise Time	t_r		-	-	1.0	μs
	Storage Time	t_{stg}		-	-	4.0	
	Fall Time	t_f		-	-	1.0	



2SD
SERIES

HIGH POWER SWITCHING APPLICATIONS.

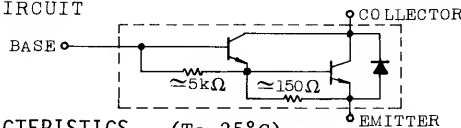
FEATURES:

- High DC Current Gain
: $h_{FE}=2000$ (Min.) ($V_{CE}=3V, I_C=3A$)
- Low Saturation Voltage
: $V_{CE(sat)}=1.5V$ (Max.) ($I_C=3A$)
- Monolithic Construction With Built-In Base-Emitter Shunt Resistor.

MAXIMUM RATINGS ($T_a=25^\circ C$)

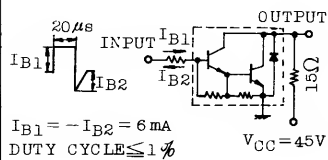
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	7	A
Base Current	I_B	0.2	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	50	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^\circ C$

EQUIVALENT CIRCUIT



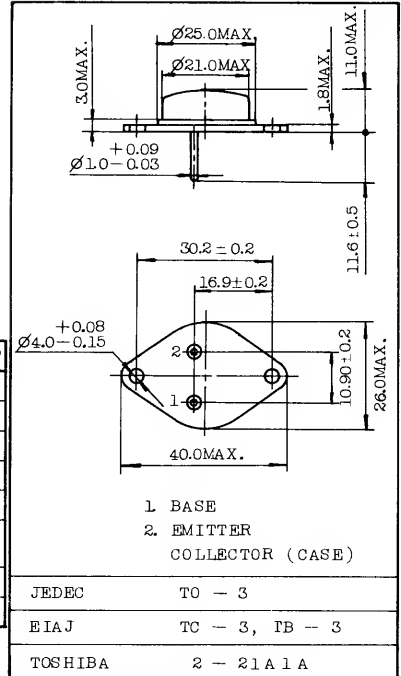
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=80V, I_E=0$	-	-	100	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	3	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	80	-	-	V
DC Current Gain	$h_{FE(1)}$	$V_{CE}=3V, I_C=3A$	2000	-	15000	
	$h_{FE(2)}$	$V_{CE}=3V, I_C=7A$	1000	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)1}$	$I_C=3A, I_B=6mA$	-	0.9	1.5	V
	$V_{CE(sat)2}$	$I_C=7A, I_B=14mA$	-	1.2	2.0	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=3A, I_B=6mA$	-	1.5	2.5	V
Switching Time	Turn-On Time	t_{on}	-	0.8	-	μs
	Storage Time	t_{stg}	-	3.0	-	
	Fall Time	t_f	-	2.5	-	



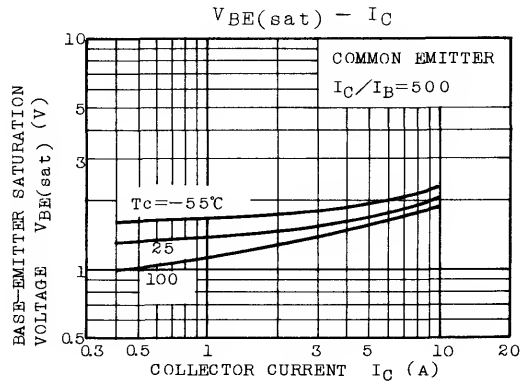
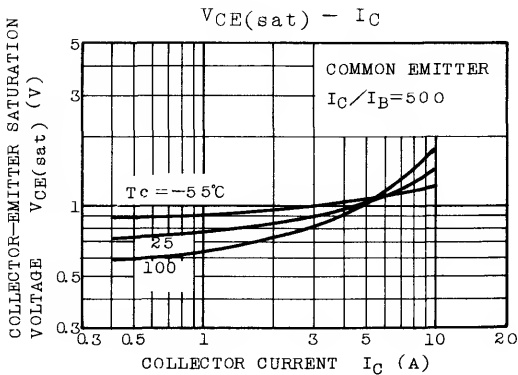
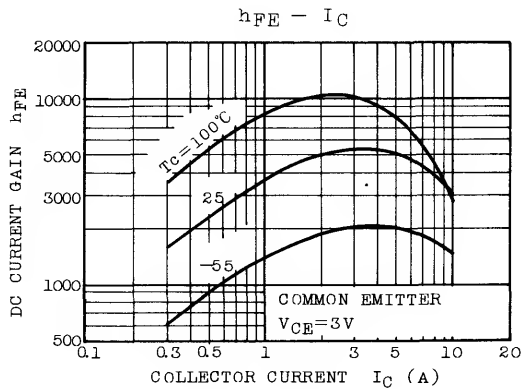
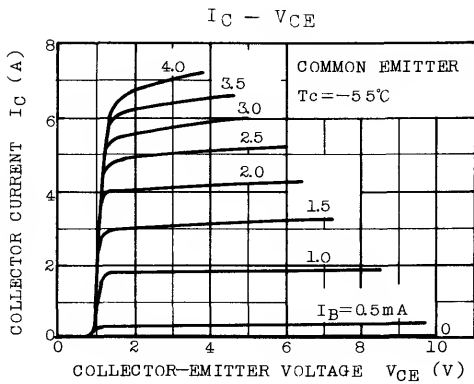
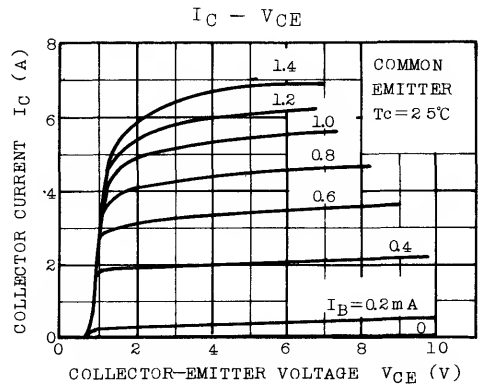
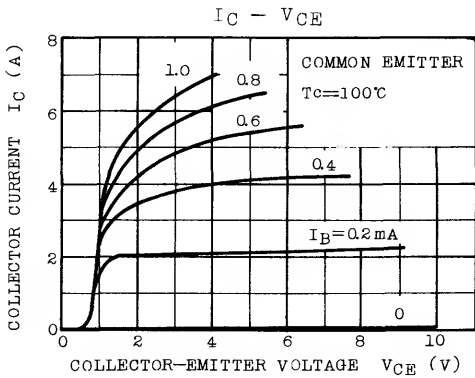
INDUSTRIAL APPLICATIONS

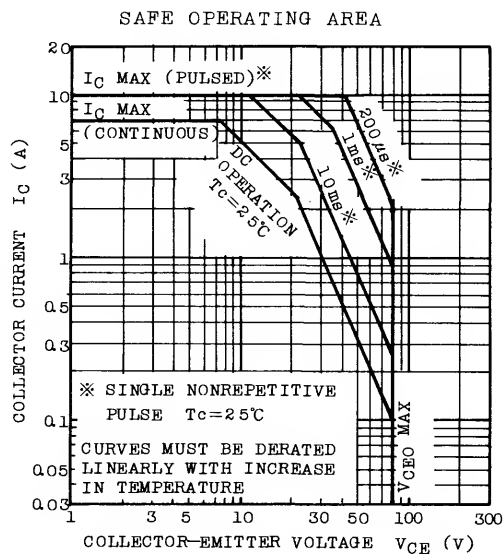
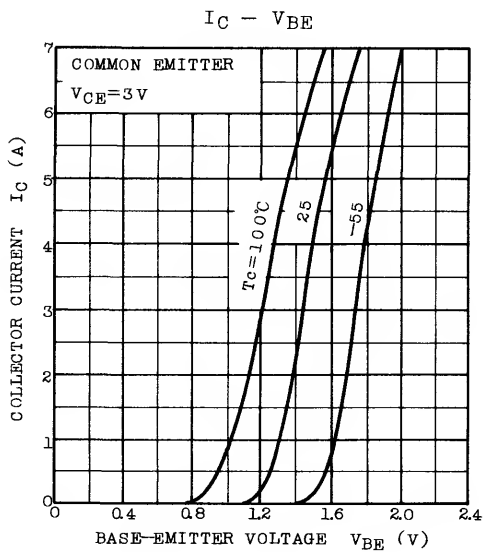
Unit in mm



Mounting Kit No. AC73
Weight : 12g

2SD523





2SD524

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

INDUSTRIAL APPLICATIONS

HIGH POWER SWITCHING APPLICATIONS.

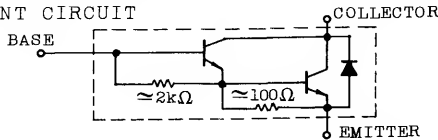
FEATURES:

- High DC Current Gain
: $h_{FE}=2000$ (Min.) ($V_{CE}=3V, I_C=5A$)
- Low Saturation Voltage
: $V_{CE(sat)}=1.5V$ (Max.) ($I_C=5A$)
- Monolithic Construction With Built-In Base-Emitter Shunt Resistor.

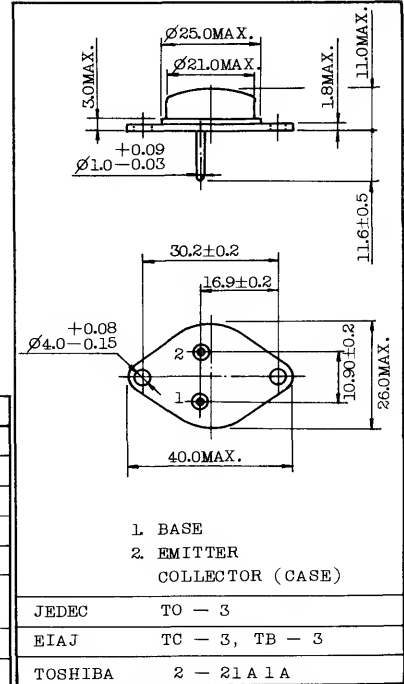
MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	15	A
Base Current	I_B	0.2	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	100	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^\circ C$

EQUIVALENT CIRCUIT



Unit in mm



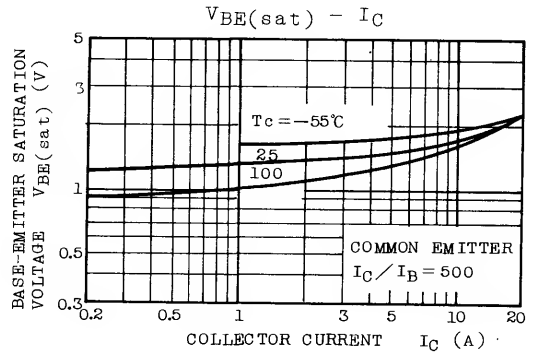
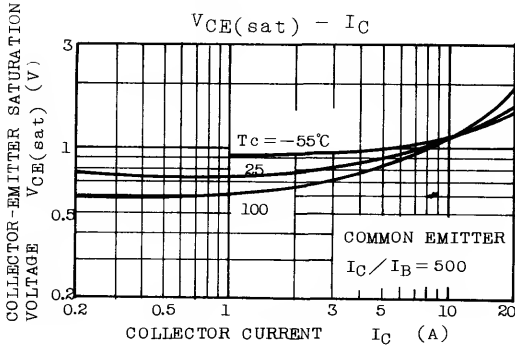
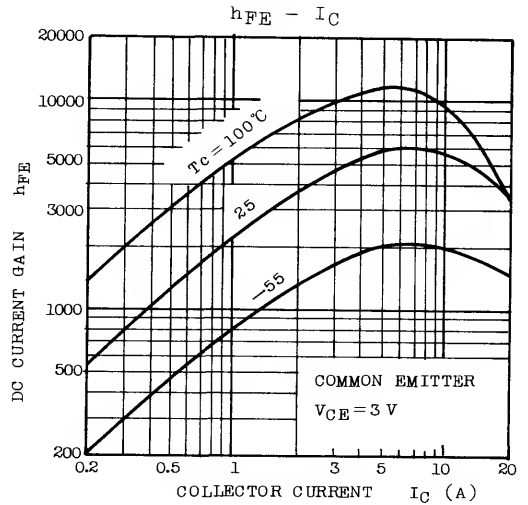
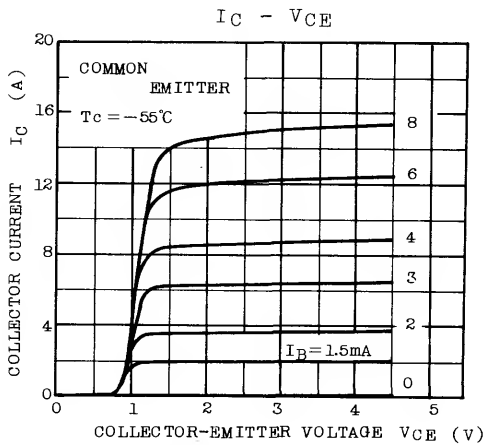
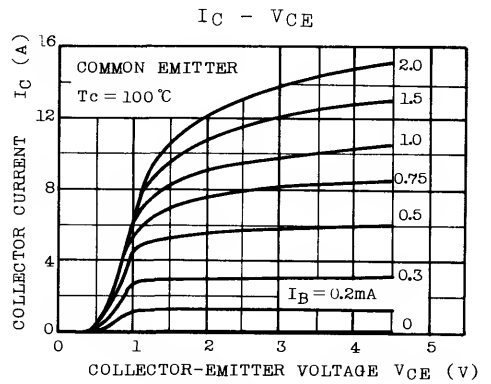
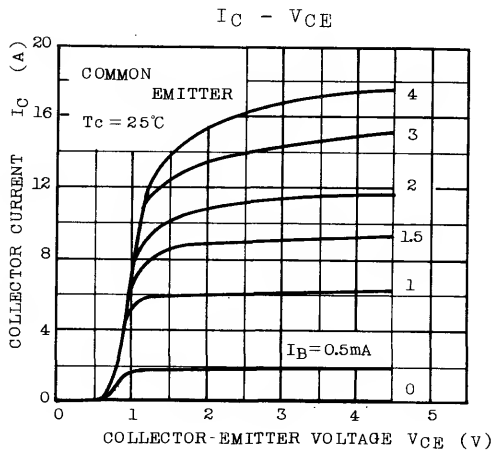
Mounting Kit No. AC73

Weight : 12.9g

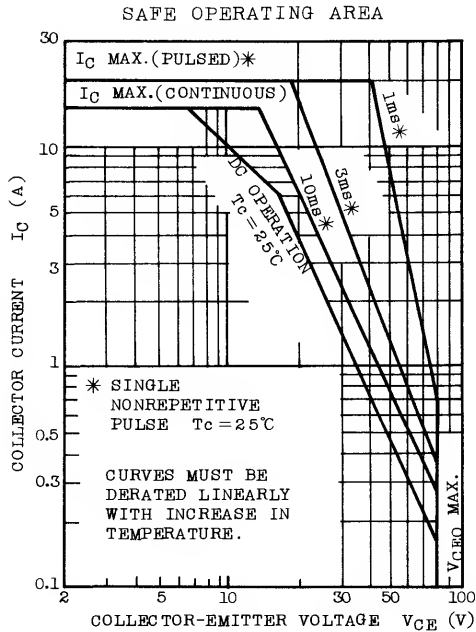
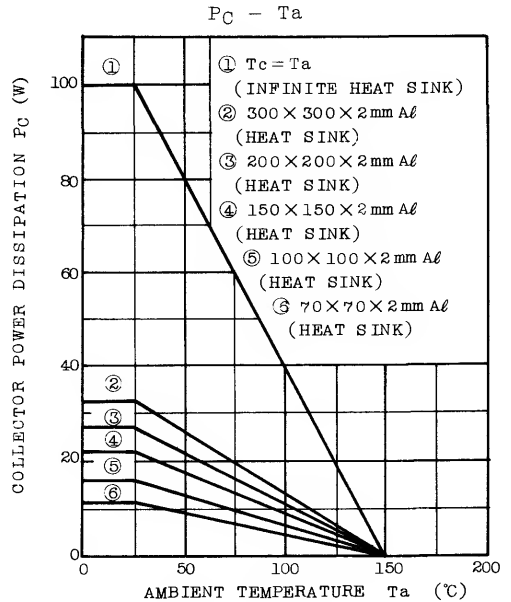
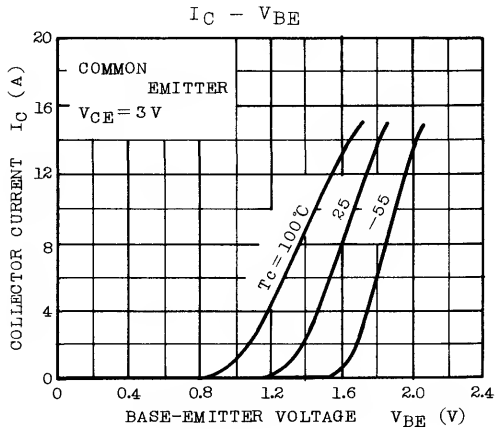
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Collector Cut-off Current	I_{CBO}	$V_{CB}=80V, I_E=0$	-	-	100	μA	
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	10	mA	
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	80	-	-	V	
DC Current Gain	$h_{FE}(1)$	$V_{CE}=3V, I_C=5A$	2000	-	-		
	$h_{FE}(2)$	$V_{CE}=3V, I_C=15A$	1000	-	-		
Collector-Emitter Saturation Voltage	$V_{CE(sat)}(1)$	$I_C=5A, I_B=10mA$	-	-	1.5	V	
	$V_{CE(sat)}(2)$	$I_C=15A, I_B=30mA$	-	-	2.0	V	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=5A, I_B=10mA$	-	-	2.5	V	
Switching Time	Turn-on Time	t_{on}			0.8	-	μs
	Storage Time	t_{stg}			4.0	-	
	Fall Time	t_f			3.0	-	

$I_{B1} = -I_{B2} = 10mA$
DUTY CYCLE $\leq 1\%$
 $V_{CC} = 50V$



2SD524



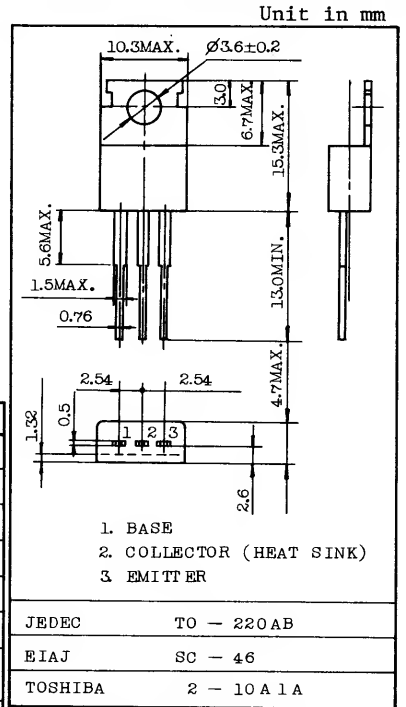
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : $V_{CE0}=100V$
- Low Collector Saturation Voltage : $V_{CE(sat)}=2.0V(\text{Max.})$
- Complementary to 2SB595.
- Recommended for 30W High Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	100	V
Collector-Emitter Voltage	V_{CE0}	100	V
Emitter-Base Voltage	V_{EB0}	5	V
Collector Current	I_C	5	A
Emitter Current	I_E	-5	A
Base Current	I_B	4	A
Collector Power Dissipation (Tc=25°C)	P_C	40	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C



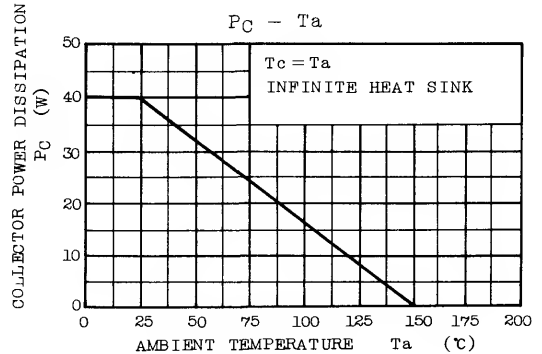
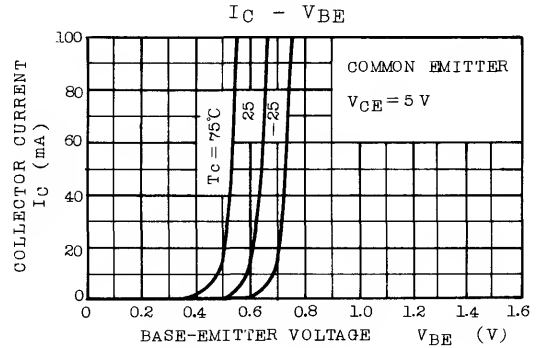
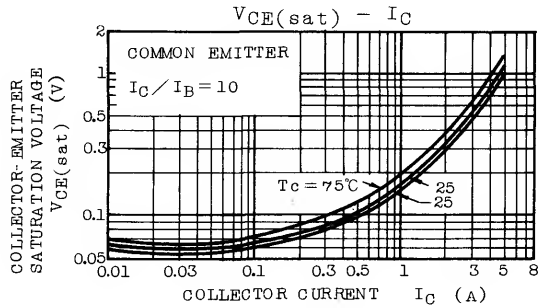
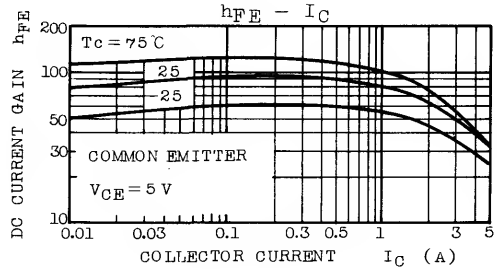
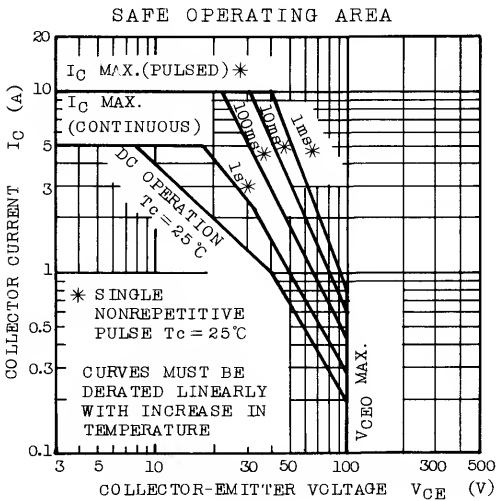
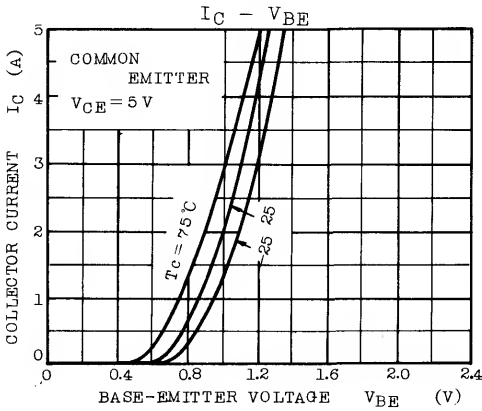
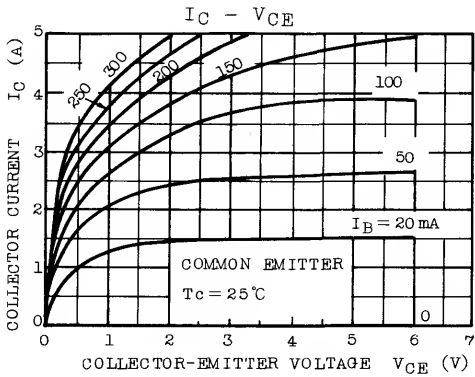
Mounting Kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=100V, I_E=0$	-	-	100	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=5V, I_C=0$	-	-	1	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C=50mA, I_B=0$	100	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=10mA, I_C=0$	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=5V, I_C=1A$	40	-	240	
	$h_{FE(2)}$	$V_{CE}=5V, I_C=4A$	20	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A, I_B=0.4A$	-	-	2.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5V, I_C=1A$	-	-	1.5	V
Transition Frequency	f_T	$V_{CE}=5V, I_C=1A$	-	12	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	100	-	pF

Note : $h_{FE(1)}$ Classification R : 40~80, 0 : 70~140, Y : 120~240

2SD525



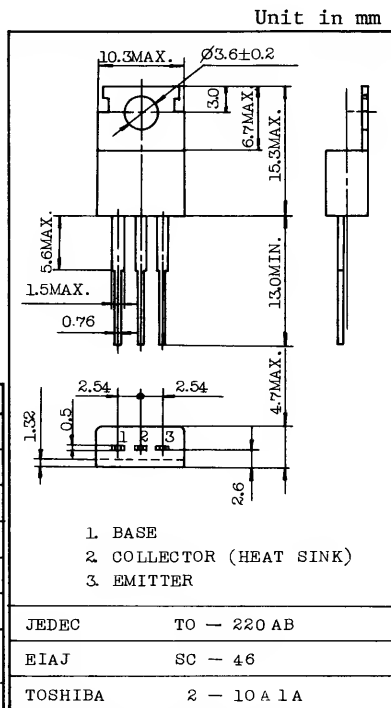
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Power Dissipation : $P_C=30W$ ($T_c=25^\circ C$)
- Good Linearity of h_{FE} .
- Complementary to 2SB596.
- Recommended for 20 ~ 25W High Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	4	A
Emitter Current	I_E	-4	A
Base Current	I_B	3	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	30	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55~150	$^\circ C$

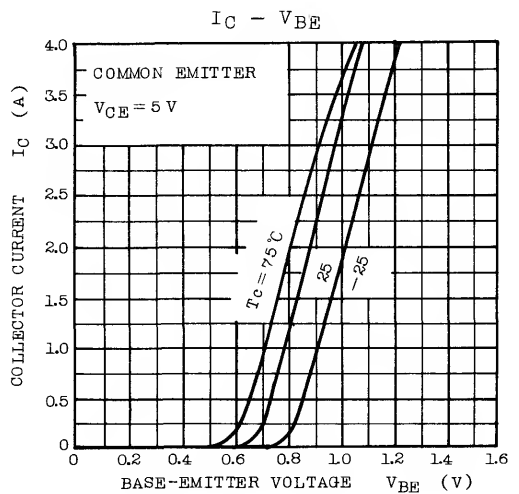
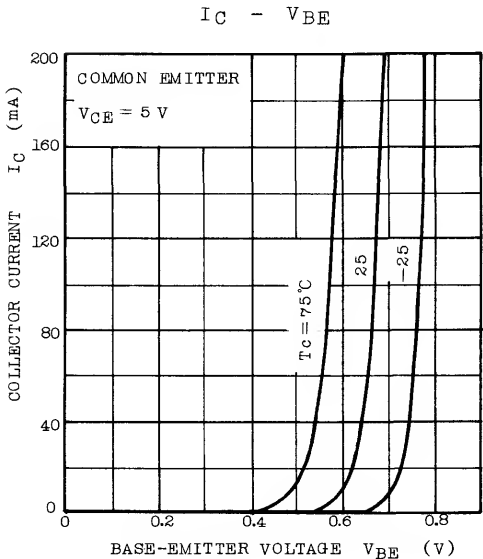
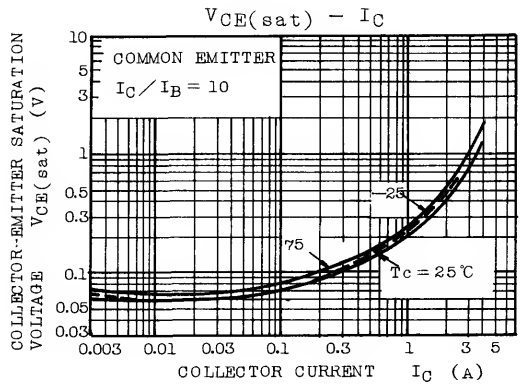
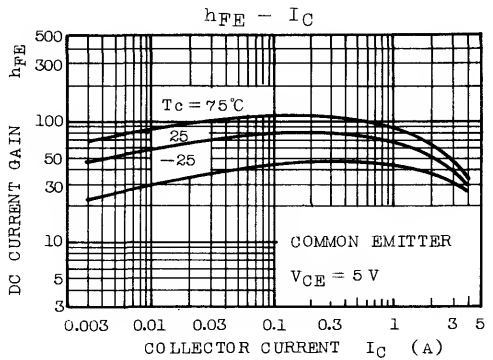
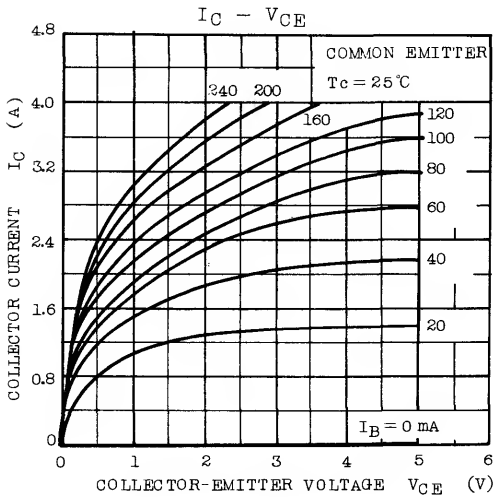


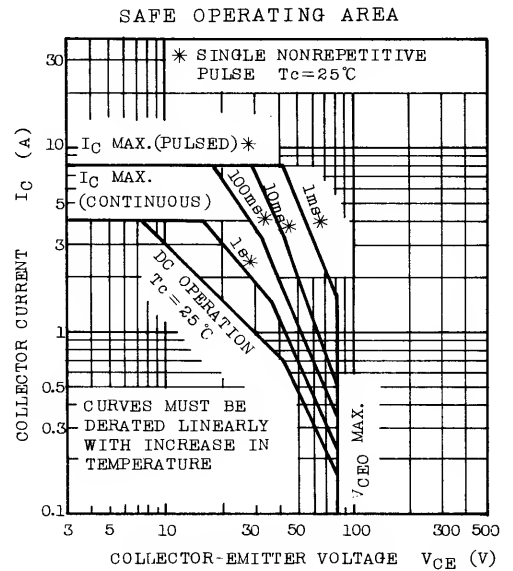
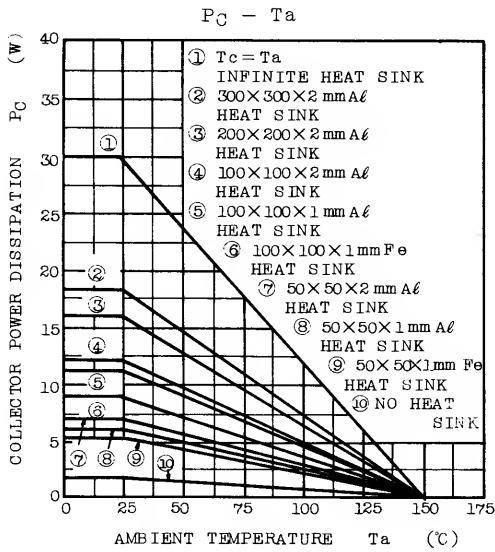
Mounting Kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=80V, I_E=0$	-	-	30	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	80	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=10mA, I_C=0$	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=5V, I_C=0.5A$	40	-	240	
	$h_{FE(2)}$	$V_{CE}=5V, I_C=3A$	15	50	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=3A, I_B=0.3A$	-	0.45	1.5	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5V, I_C=3A$	-	1.0	1.5	V
Transition Frequency	f_T	$V_{CE}=5V, I_C=0.5A$	3	8.0	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	90	-	pF

Note : $h_{FE(1)}$ Classification R : 40~80, 0 : 70~140, Y : 120~240





2SD548

SILICON NPN TRIPLE DIFFUSED MESA TYPE
(DARLINGTON POWER)

INDUSTRIAL APPLICATIONS

Unit in mm

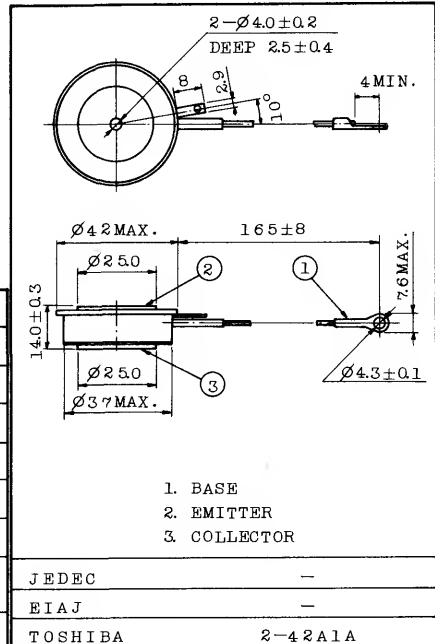
HIGH POWER SWITCHING APPLICATIONS.
DC-AC POWER INVERTER APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

FEATURES:

- . High Voltage : $V_{CEO(SUS)}=450V$
- . Triple Diffused Design.
- . Darlington Design

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	$V_{CEO(SUS)}$	450	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	120	A
Emitter Current	I_E	-120	A
Base Current	I_B	8	A
Thermal Resistance (Double Side Cooling)	$R_{th(j-c)}$	0.13	$^{\circ}C/W$
Junction Temperature	T_j	125	$^{\circ}C$
Storage Temperature Range	T_{stg}	-40~150	$^{\circ}C$
Mounting Force Required	F	400 \pm 40	kg



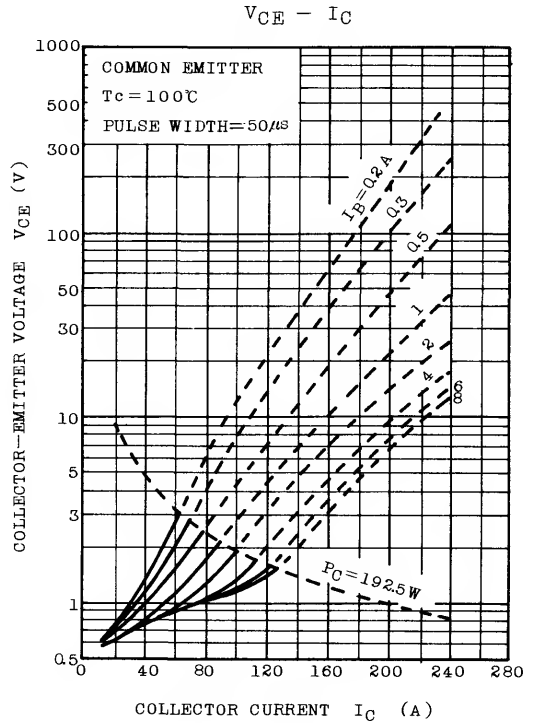
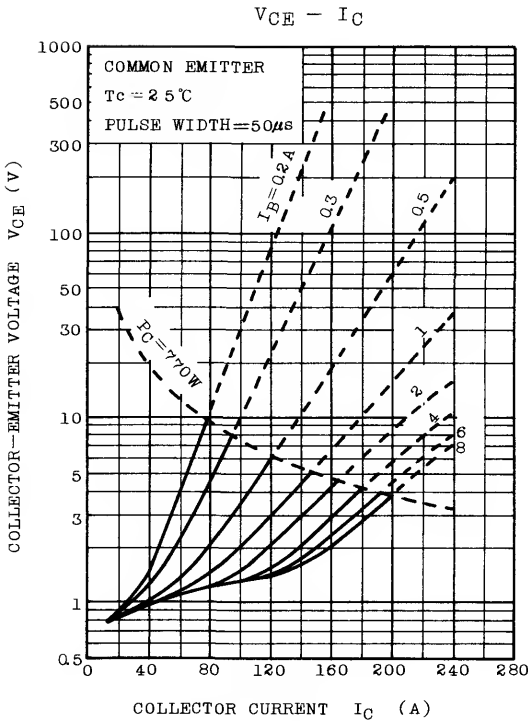
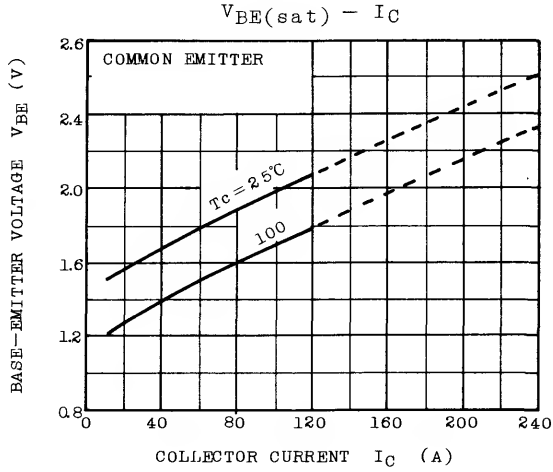
Weight : 70g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

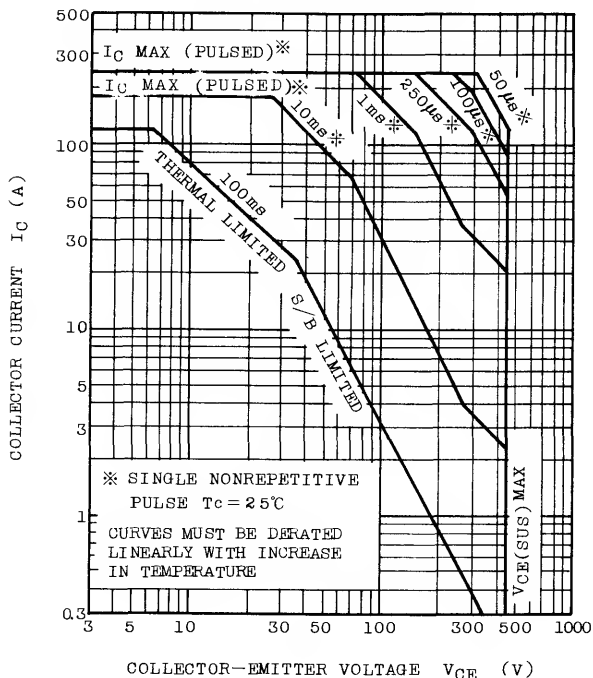
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=120A$	150	—	—	
		$V_{CE}=5V, I_C=60A$	—	500	—	
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	$I_C=0.5A, L=40mH$	450	—	—	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=120A, I_B=2.4A$ (Note)	—	—	2.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$		—	—	2.5	V
Collector Cut-off Current	I_{CBO}	$V_{CB}=600V, I_E=0$	—	—	2	mA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	—	—	150	mA
Switching Time	Turn-on Time	$I_C=120A, I_{B1}=2.4A, -I_{B2}=2.4A, V_C=300V$	—	3	—	μs
	Storage Time		—	12	—	μs
	Fall Time		—	8	—	μs

Note : Pulse Test; Pulse Width $\leq 300\mu s$, Duty Cycle $\leq 3\%$
Mounting Force; F=400kg

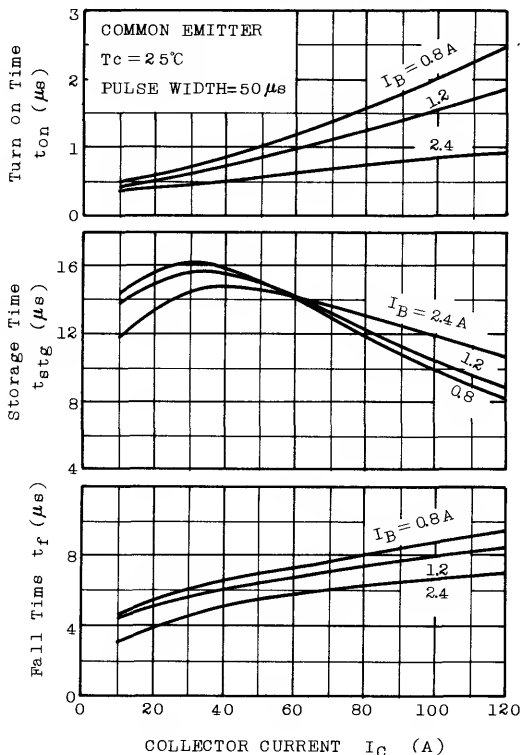
TOSHIBA CORPORATION



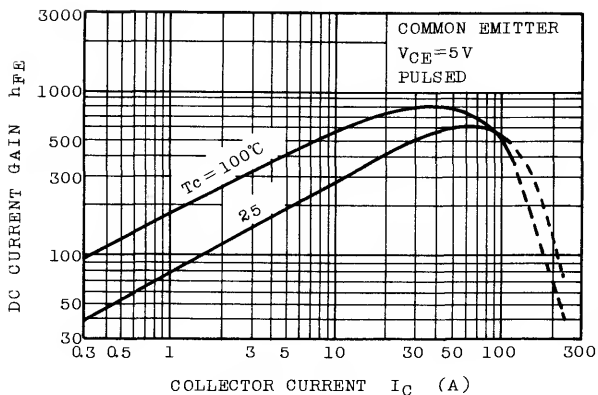
SAFE OPERATING AREA



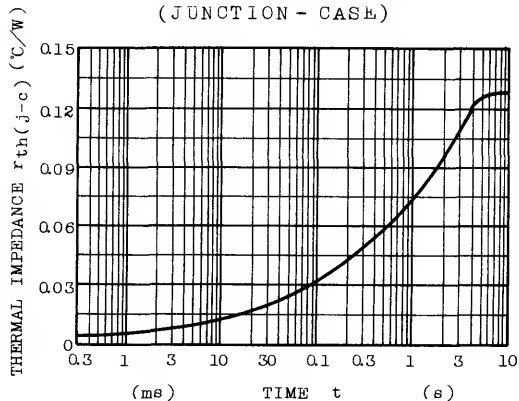
SWITCHING CHARACTERISTICS



$h_{FE} - I_C$



TRANSIENT THERMAL IMPEDANCE (JUNCTION - CASE)



Unit in mm

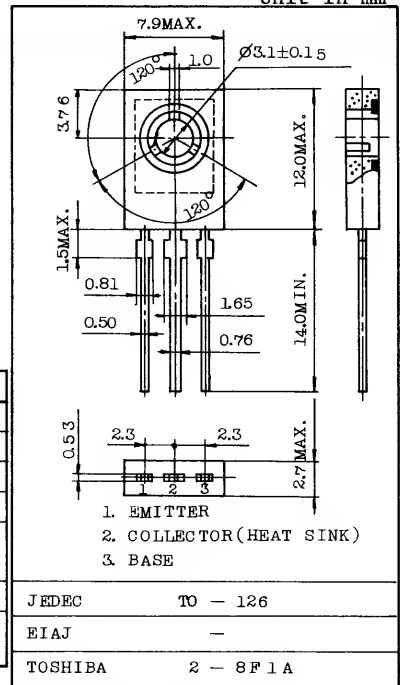
PULSE MOTOR DRIVE, HAMMER DRIVE APPLICATIONS.
SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

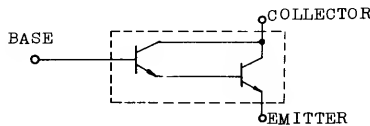
- High DC Current Gain
: $h_{FE}=4000$ (Min.) ($V_{CE}=2V$, $I_C=150mA$)
- Low Saturation Voltage
: $V_{CE(sat)}=1.5V$ (Max.) ($I_C=1A$, $I_B=1mA$)

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	30	V
Collector-Emitter Voltage	V_{CEO}	30	V
Emitter-Base Voltage	V_{EBO}	10	V
Continuous Collector Current	I_C	1.5	A
Collector Power Dissipation ($T_a=25^\circ C$)	P_C	1.0	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55~150	$^\circ C$



EQUIVALENT CIRCUIT

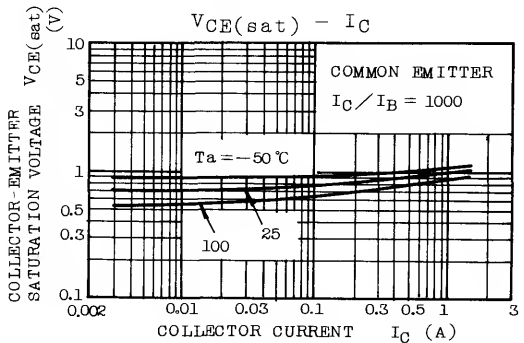
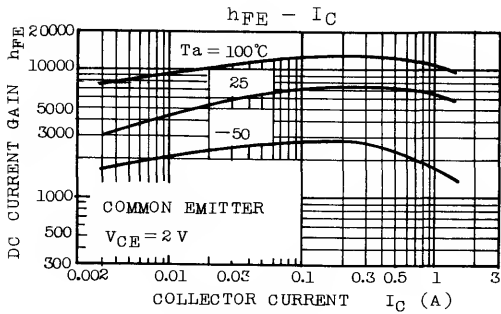
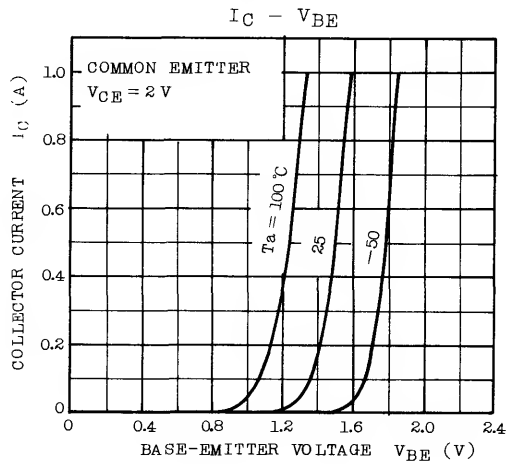
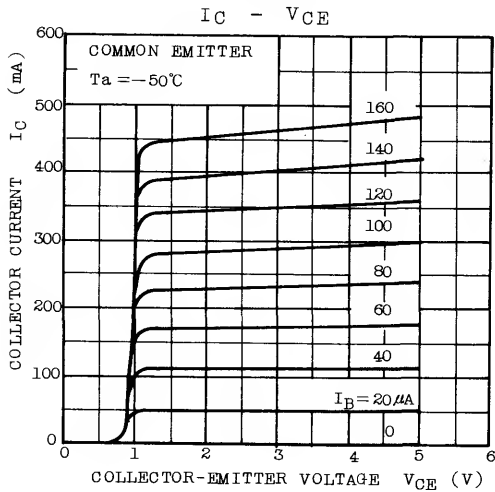
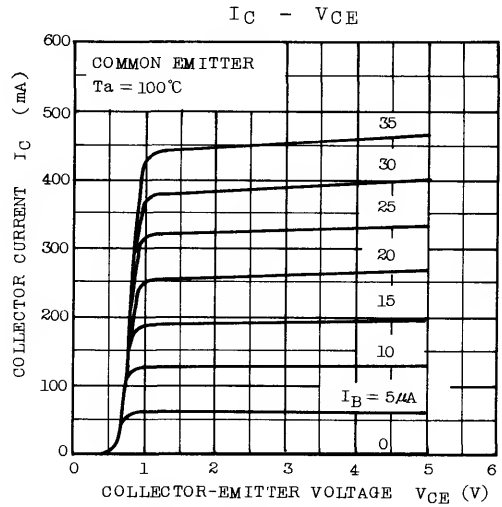
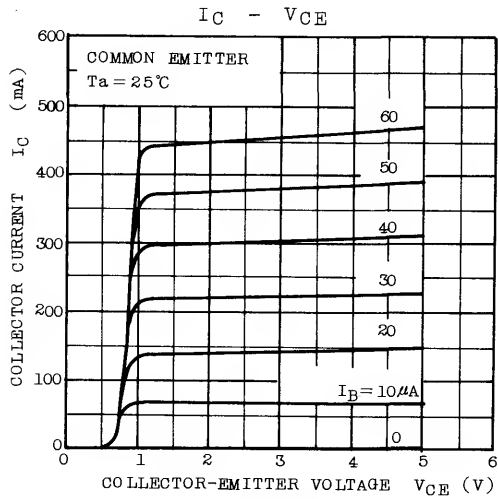


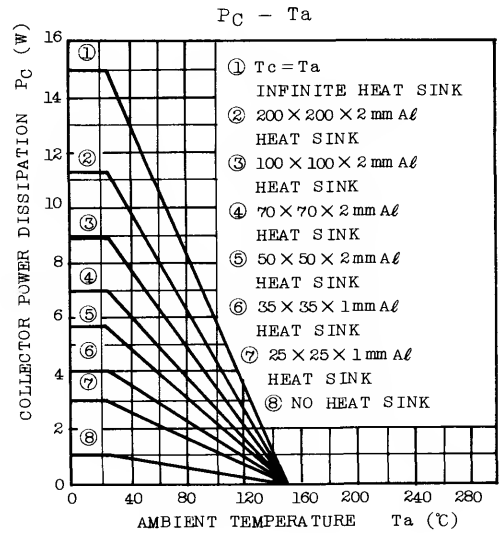
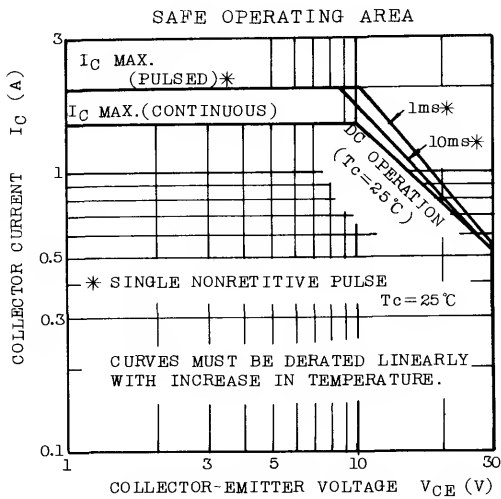
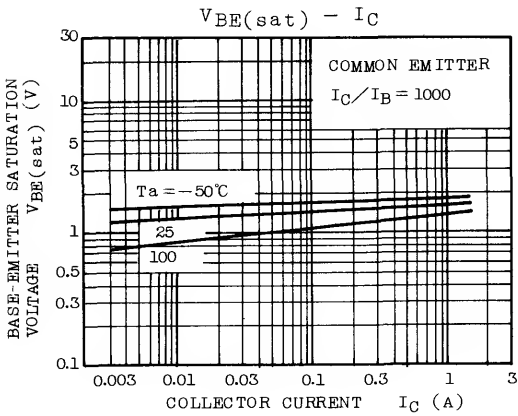
Mounting Kit No. AC46C
Weight : 0.72g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=30V$, $I_E=0$	-	-	10	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=10V$, $I_C=0$	-	-	10	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA$, $I_B=0$	30	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=2V$, $I_C=150mA$	4000	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=1A$, $I_B=1mA$	-	-	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=1A$, $I_B=1mA$	-	-	2.2	V
Switching Time	Turn-on Time	t_{on}		-	0.18	-	μs
	Storage Time	t_{stg}		-	0.6	-	
	Fall Time	t_f		-	0.3	-	

2SD549





2SD552

SILICON NPN TRIPLE DIFFUSED TYPE

HIGH POWER AMPLIFIER APPLICATIONS.
HIGH POWER SWITCHING APPLICATIONS.
DC-DC CONVERTER APPLICATIONS.
REGULATOR APPLICATIONS.

FEATURES:

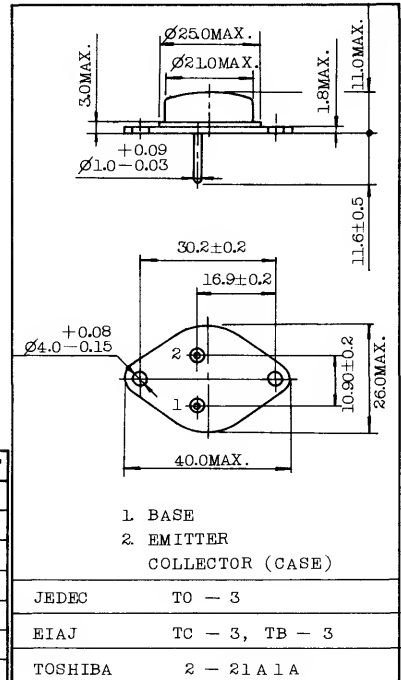
- High Power Dissipation : $P_C=150W$ ($T_C=25^\circ C$)
- High Collector Current : $I_C=15A$
- High Voltage : $V_{CE0}=180V$
- Complementary to 2SB552.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	220	V
Collector-Emitter Voltage	V_{CE0}	180	V
Emitter-Base Voltage	V_{EB0}	5	V
Collector Current	I_C	15	A
Base Current	I_B	3	A
Collector Power Dissipation ($T_C=25^\circ C$)	P_C	150	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-65~150	$^\circ C$

INDUSTRIAL APPLICATIONS

Unit in mm



1. BASE
2. EMITTER
COLLECTOR (CASE)

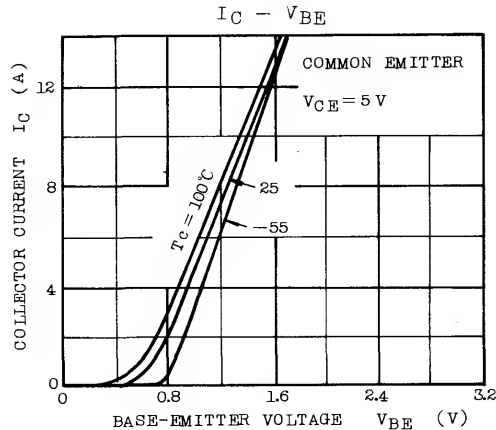
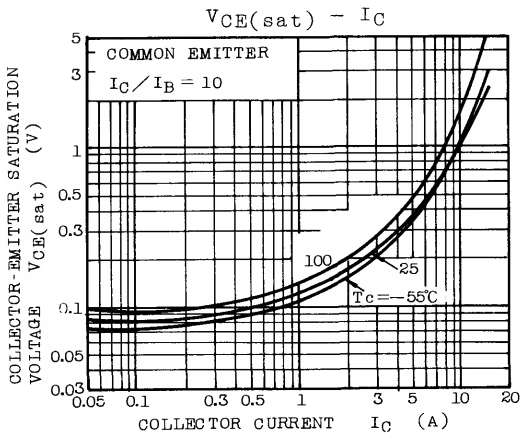
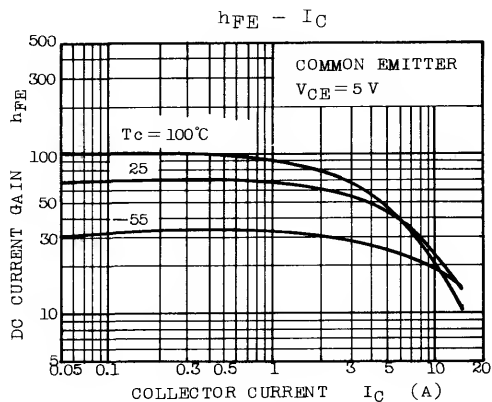
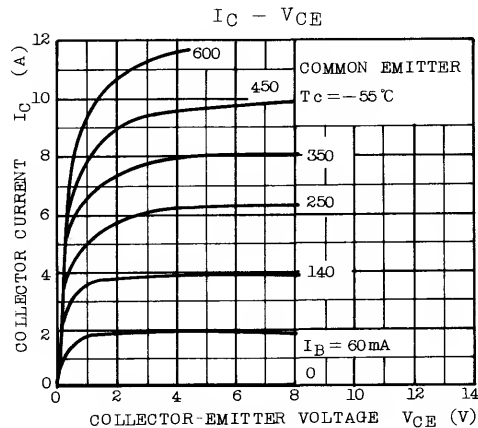
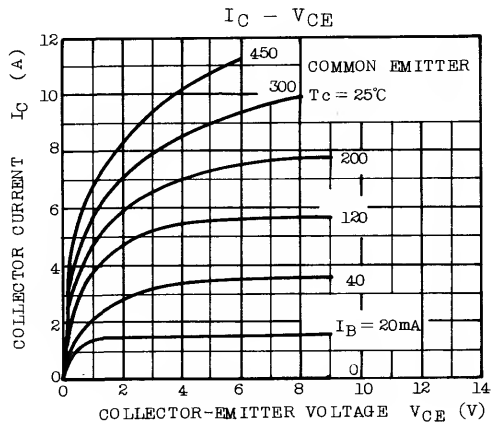
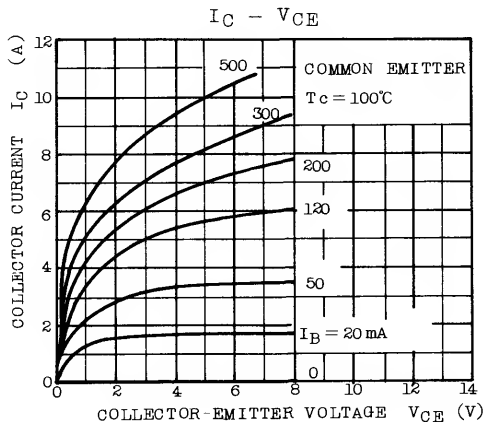
JEDEC	TO - 3
BIAJ	TC - 3, TB - 3
TOSHIBA	2 - 21A1A

Mounting Kit No. AC73
Weight : 12.9g

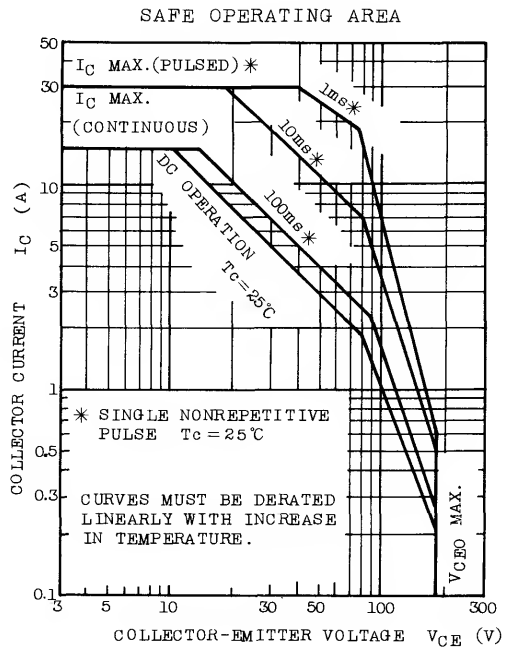
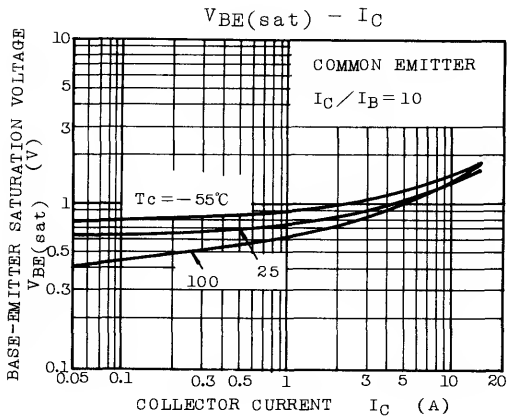
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=150V, I_E=0$	-	-	100	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	180	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=5V, I_C=5A$	25	-	80	
	$h_{FE(2)}$	$V_{CE}=5V, I_C=15A$	10	15	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=10A, I_B=1A$	-	-	2.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$		-	1.5	2.5	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=1A$	-	4	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=50V, I_E=0, f=1MHz$	-	160	-	pF
Switching Time	Turn-on Time	t_{on}				μs
	Storage Time	t_{stg}				
	Fall Time	t_f				

Note : $h_{FE(1)}$ Classification BN : 25~50, R : 40~80



2SD552



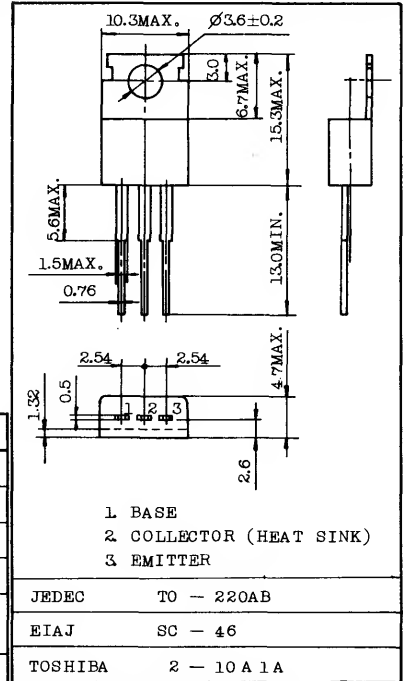
INDUSTRIAL APPLICATIONS

Unit in mm

HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Low Saturation Voltage
: $V_{CE(sat)}=0.4V$ (Max.) (at $I_C=4A$)
- Complementary to 2SB553.



JEDEC	TO - 220AB
EIAJ	SC - 46
TOSHIBA	2 - 10A 1A

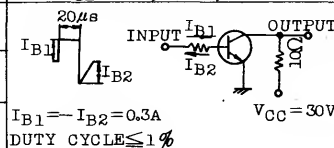
Mounting Kit No. AC75
Weight : 1.9g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	70	V
Collector-Emitter Voltage	V_{CEO}	50	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	7	A
Collector Power Dissipation	P_C	Ta=25°C	1.5
		Tc=25°C	40
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

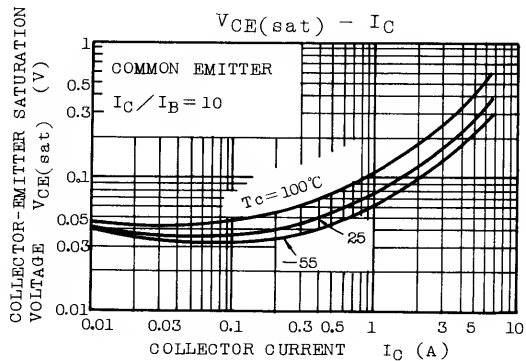
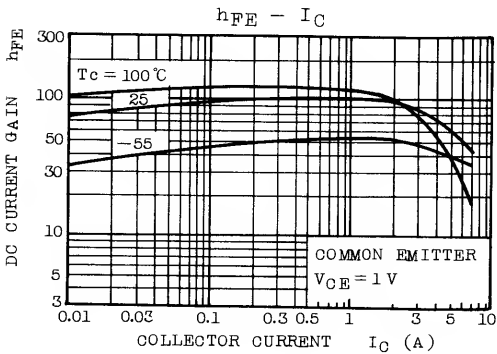
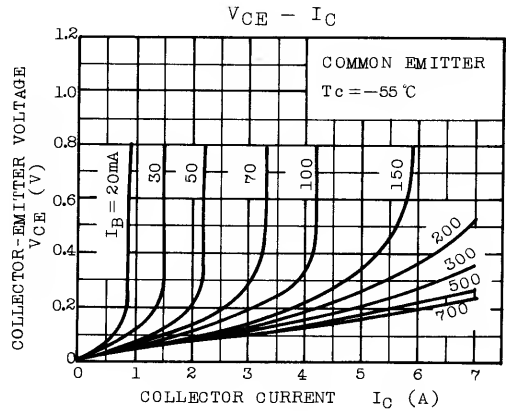
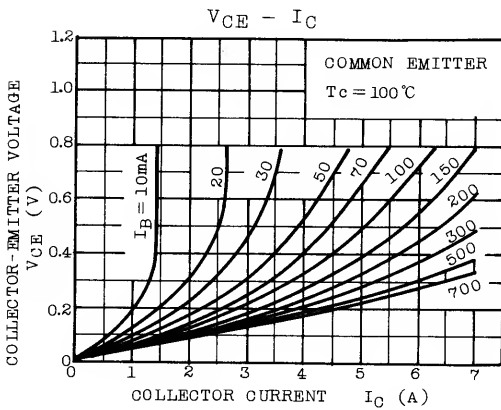
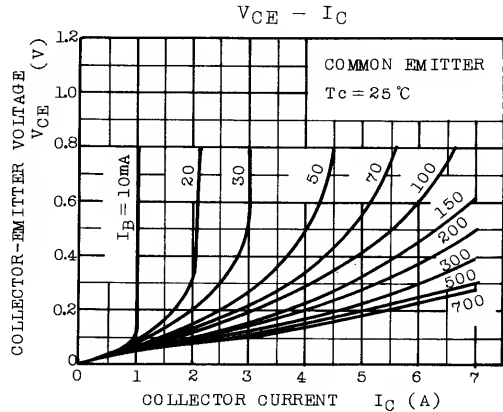
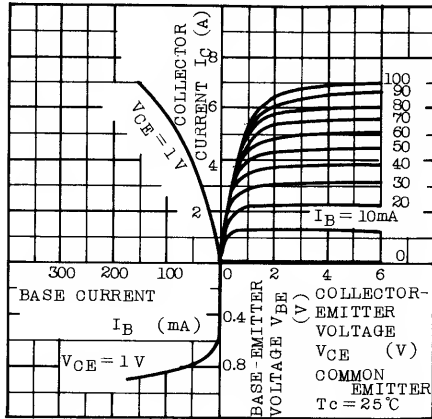
ELECTRICAL CHARACTERISTICS (Ta=25°C)

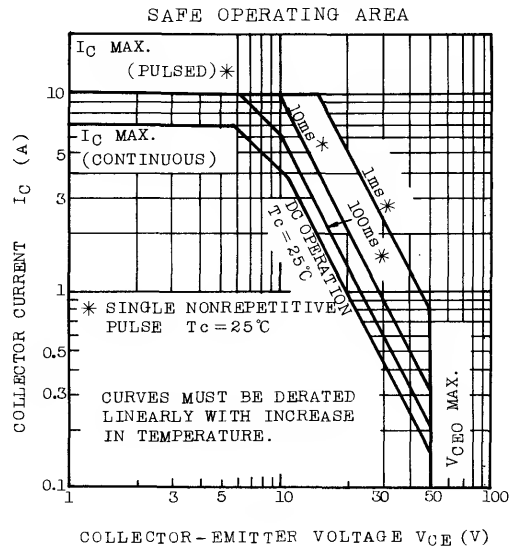
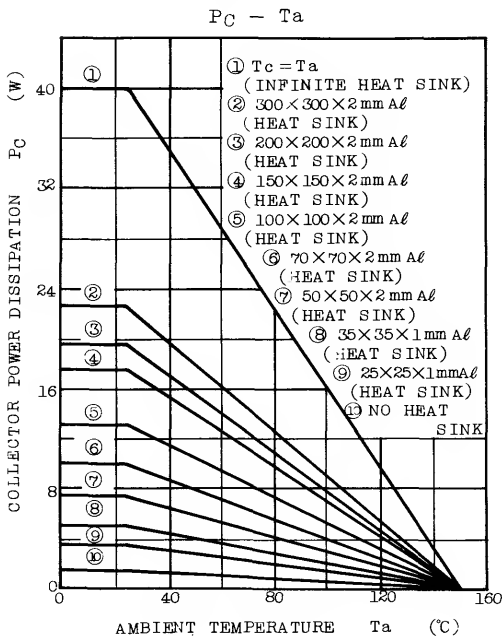
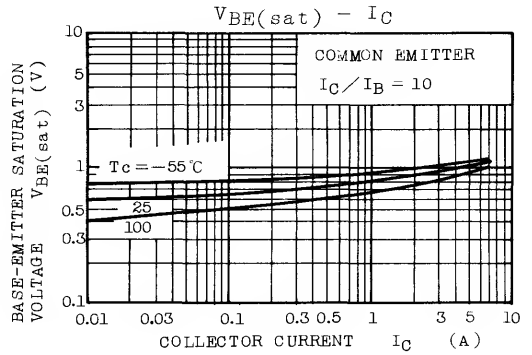
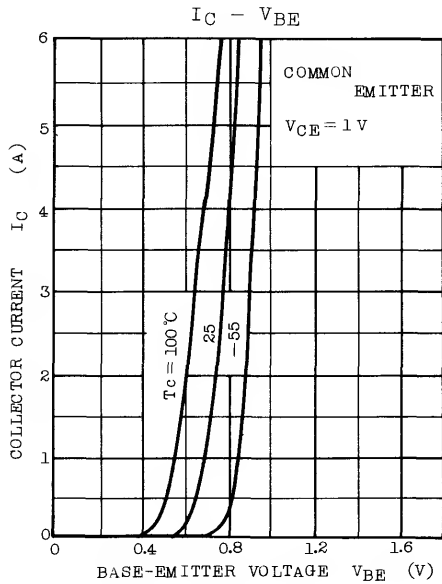
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=70V, I_E=0$	-	-	30	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	50	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	50	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=1V, I_C=1A$	70	-	240	
		$V_{CE}=1V, I_C=4A$	30	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A, I_B=0.4A$	-	0.2	0.4	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4A, I_B=0.4A$	-	0.9	1.2	V
Transition Frequency	f_T	$V_{CE}=4V, I_C=1A$	-	10	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	250	-	pF
Switching Time	Turn-on Time	t_{on}	-	0.2	-	μs
	Storage Time	t_{stg}	-	2.5	-	
	Fall Time	t_f	-	0.5	-	



Note: $h_{FE(1)}$ Classification 0 : 70~140. Y : 120~240

STATIC CHARACTERISTICS





2SD633
2SD634
2SD635

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

INDUSTRIAL APPLICATIONS

Unit in mm

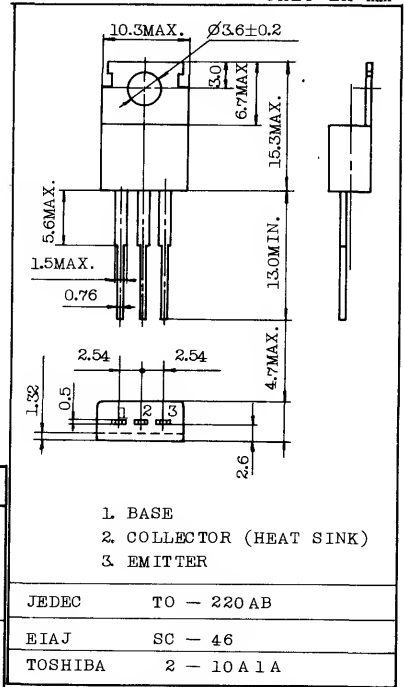
HIGH POWER SWITCHING APPLICATIONS.
HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.

FEATURES:

- High DC Current Gain
: $h_{FE}=2000$ (Min.) ($V_{CE}=3V$, $I_C=3A$)
- Low Saturation Voltage
: $V_{CE(sat)}=1.5V$ (Max.), ($I_C=3A$)
- Complementary to 2SB673, 2SB674, and 2SB675.

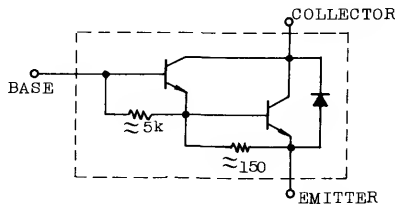
MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	2SD633	100	V
	2SD634	80	
	2SD635	60	
Collector-Emitter Voltage	2SD633	100	V
	2SD634	80	
	2SD635	60	
Emitter-Base Voltage	V_{EBO}	5	V
Continuous Collector Current	I_C	7	A
Continuous Base Current	I_B	0.2	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	40	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55~150	$^\circ C$

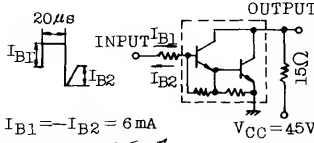


Mounting Kit No. AC75
Weight : 1.9g

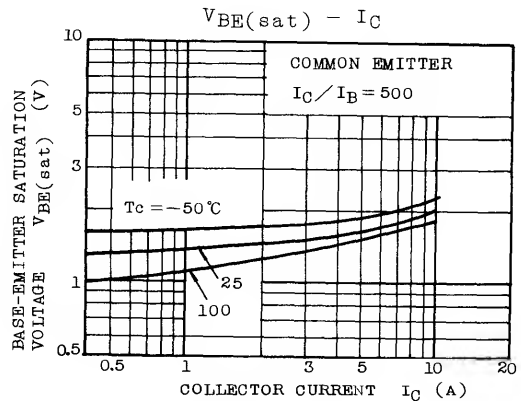
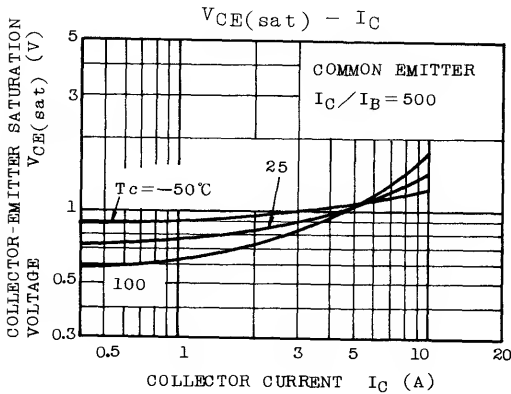
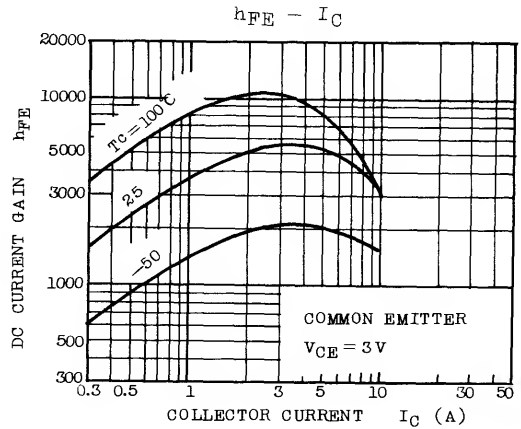
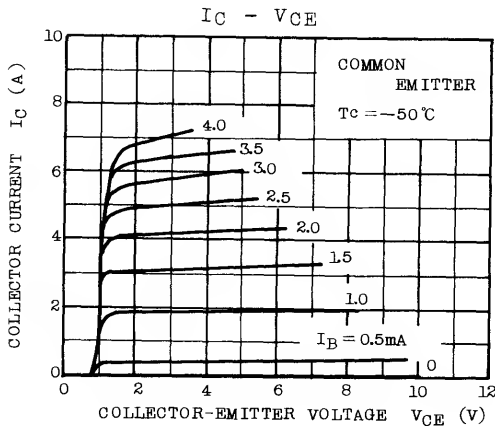
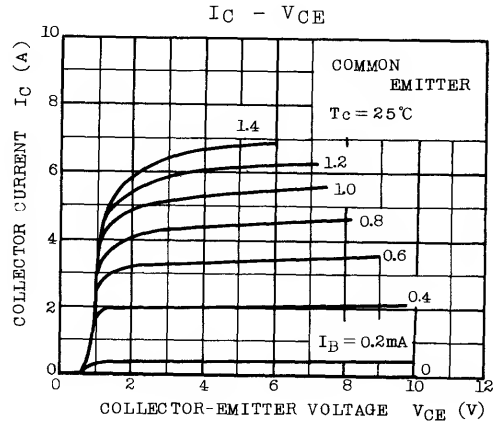
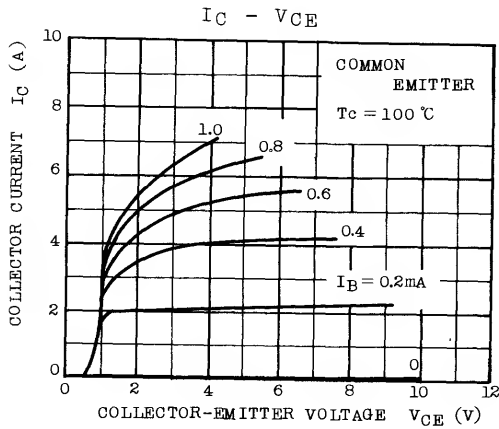
EQUIVALENT CIRCUIT

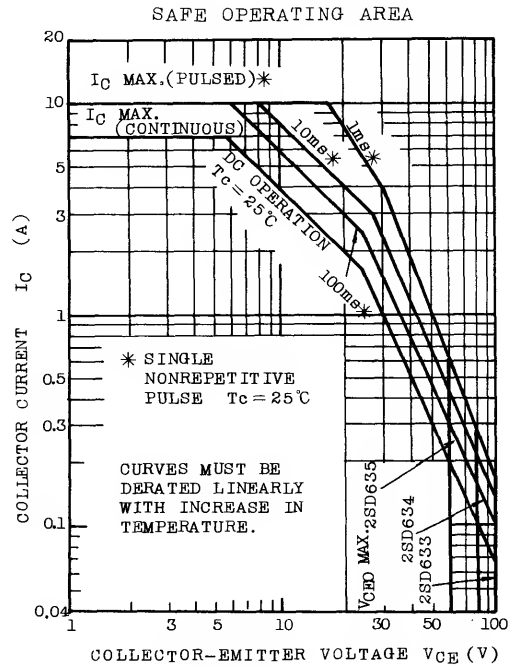
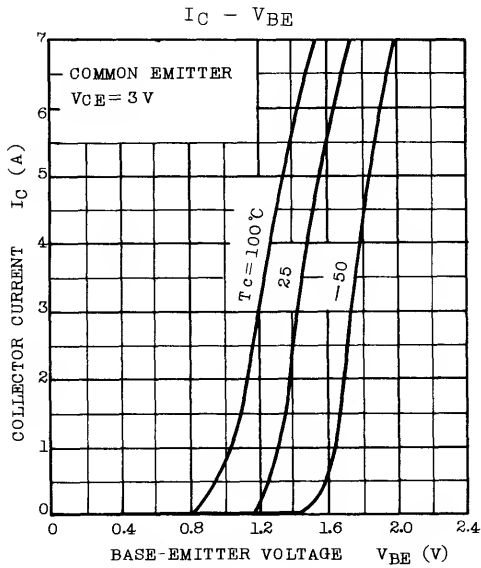


ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	2SD633	I _{CBO}	V _{CB} =100V, I _E =0	-	-	100	μA
	2SD634		V _{CB} =80V, I _E =0	-	-	100	
	2SD635		V _{CB} =60V, I _E =0	-	-	100	
Emitter Cut-off Current		I _{EBO}	V _{EB} =5V, I _C =0	-	-	3.0	mA
Collector-Emitter Breakdown Voltage	2SD633	V _{(BR)CEO}	I _C =50mA, I _B =0	100	-	-	V
	2SD634			80	-	-	
	2SD635			60	-	-	
DC Current Gain		h _{FE} (1)	V _{CE} =3V, I _C =3A	2000	-	15000	
		h _{FE} (2)	V _{CE} =3V, I _C =7A	1000	-	-	
Collector-Emitter Saturation Voltage		V _{CE(sat)} (1)	I _C =3A, I _B =6mA	-	0.9	1.5	V
		V _{CE(sat)} (2)	I _C =7A, I _B =14mA	-	1.2	2.0	
Base-Emitter Saturation Voltage		V _{BE(sat)}	I _C =3A, I _B =6mA	-	1.5	2.5	V
Switching Time	Turn-on Time	t _{on}	 <p style="font-size: small;"> $I_{B1} = -I_{B2} = 6\text{mA}$ DUTY CYCLE $\leq 1\%$ </p>	-	0.8	-	μs
	Storage Time	t _{stg}		-	3.0	-	
	Fall Time	t _f		-	2.5	-	

2SD633 · 2SD634 · 2SD635





2SD640

SILICON NPN TRIPLE DIFFUSED TYPE

INDUSTRIAL APPLICATIONS

HIGH VOLTAGE SWITCHING APPLICATIONS.

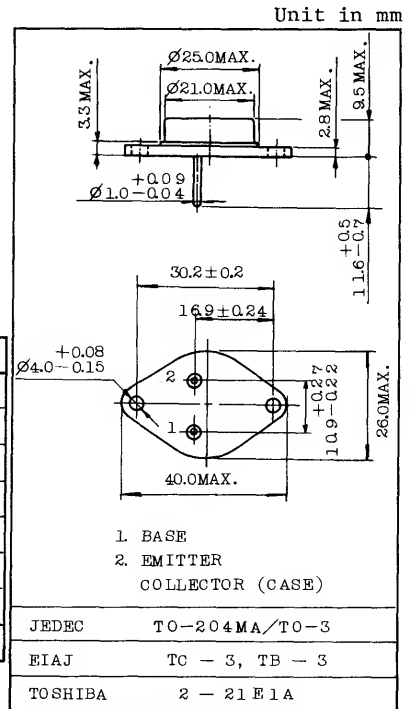
HIGH POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Voltage : $V_{CEO}=400V$
- Low Saturation Voltage : $V_{CE(sat)}=1.5V$ (Max.)
($I_C=5A, I_B=1A$)

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	7	A
Base Current	I_B	2	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	100	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	$-65\sim 150$	$^\circ C$



Mounting Kit No.AC73

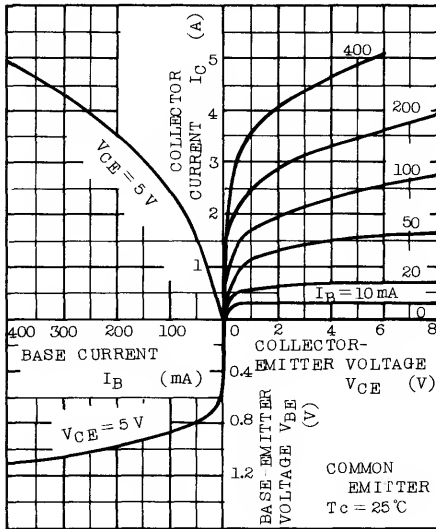
Weight : 15.8g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

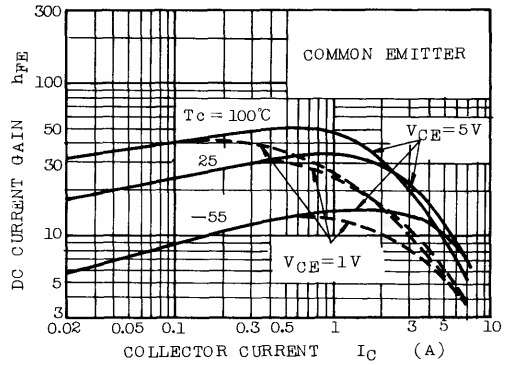
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=500V, I_E=0$	-	-	100	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	400	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=1A$	25	-	140	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=5A, I_B=1A$	-	-	1.5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=5A, I_B=1A$	-	-	2.0	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.5A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=50V, I_E=0, f=1MHz$	-	70	-	pF
Switching Time	Turn-on Time	t_{on}	-	1.0	-	μs
	Storage Time	t_{stg}	-	3.0	-	
	Fall Time	t_f	-	0.6	-	

$I_{B1} = -I_{B2} = 0.3A$
DUTY CYCLE: $\approx 1\%$

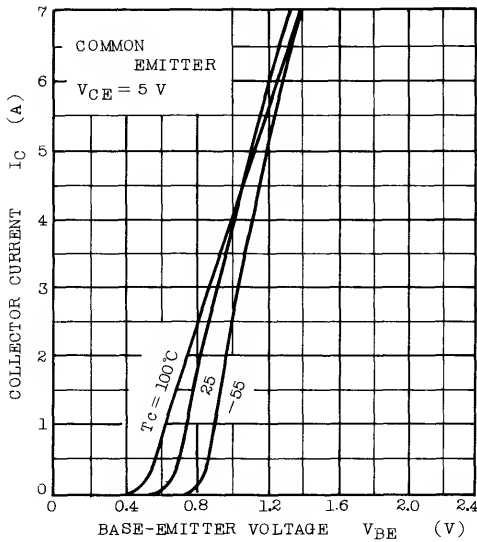
STATIC CHARACTERISTICS



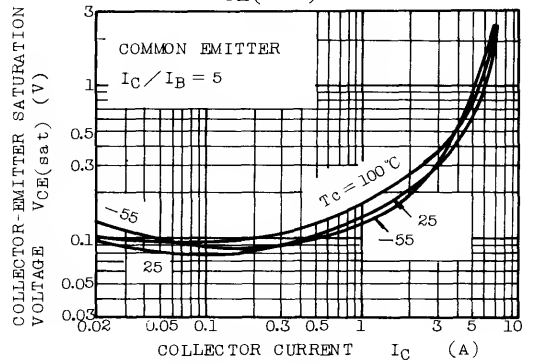
$h_{FE} - I_C$



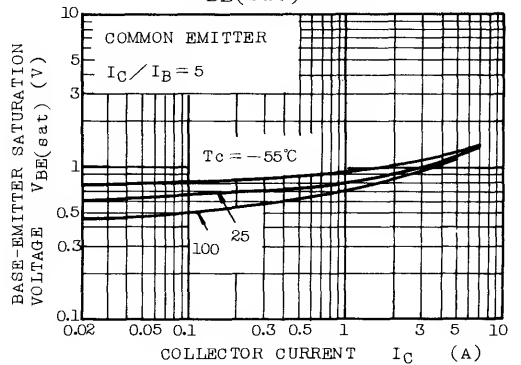
$I_C - V_{BE}$

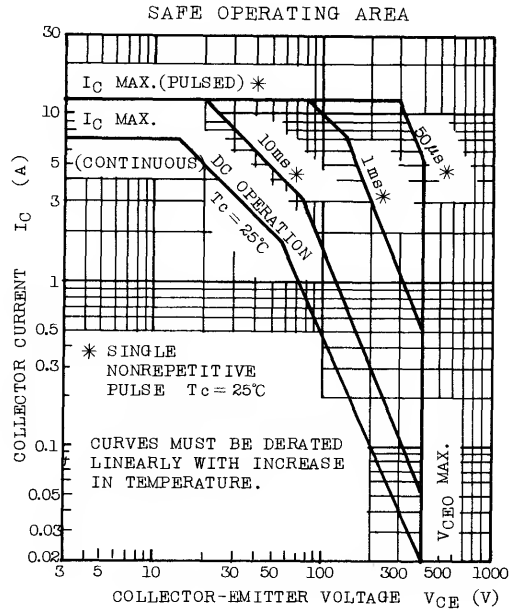
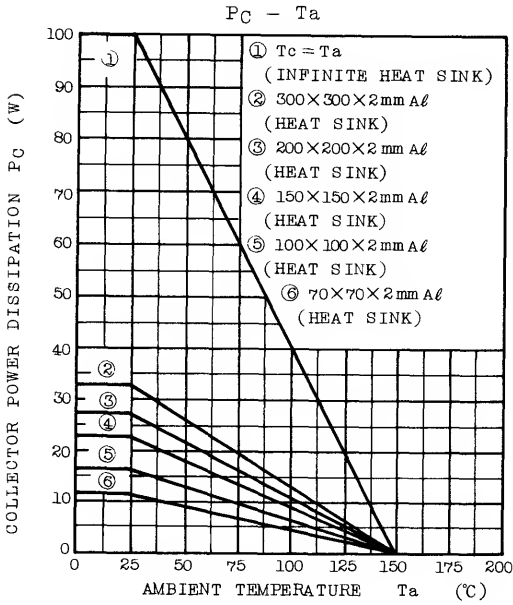


$V_{CE(sat)} - I_C$



$V_{BE(sat)} - I_C$





HIGH VOLTAGE SWITCHING APPLICATIONS.
HIGH POWER AMPLIFIER APPLICATIONS.

FEATURES:

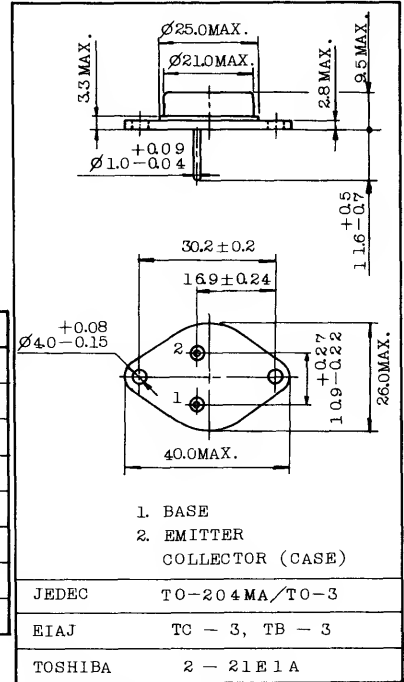
- High Voltage : $V_{CE0}=400V$
- Low Saturation Voltage : $V_{CE(sat)}=1.5V$ (Max.)
($I_C=10A, I_B=2A$)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	15	A
Base Current	I_B	5	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	150	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65~150	°C

INDUSTRIAL APPLICATIONS

Unit in mm

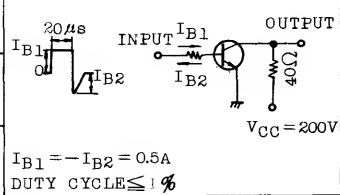


Mounting Kit No. AC73

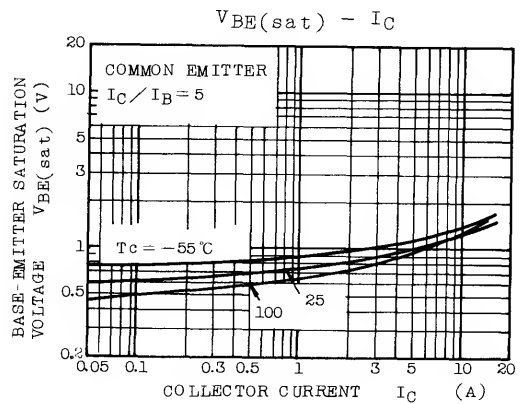
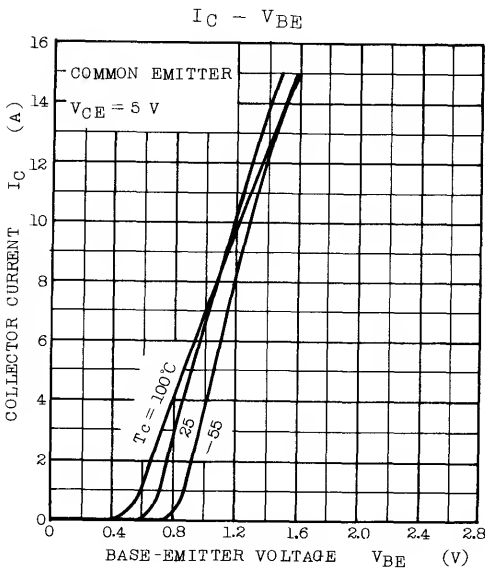
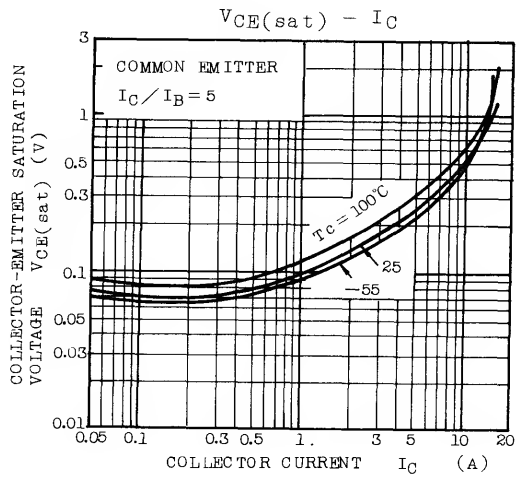
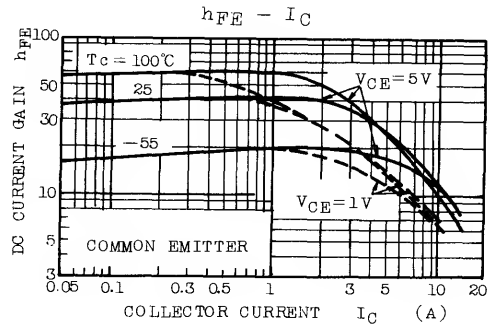
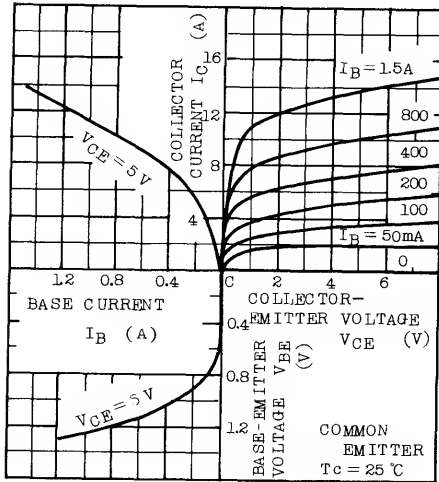
Weight : 15.8g

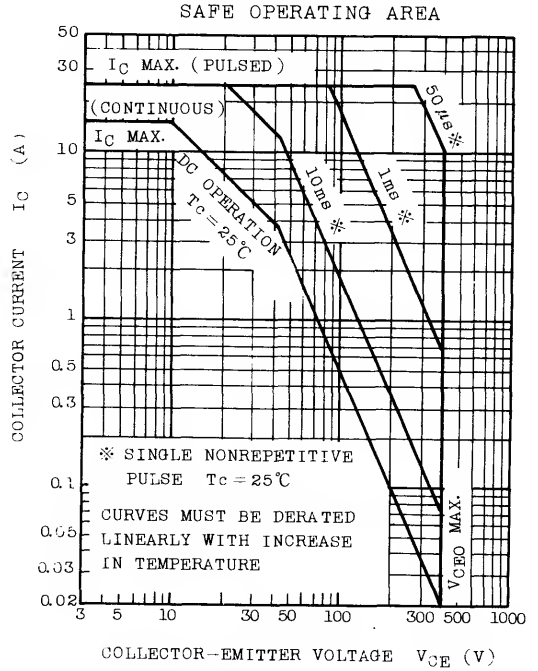
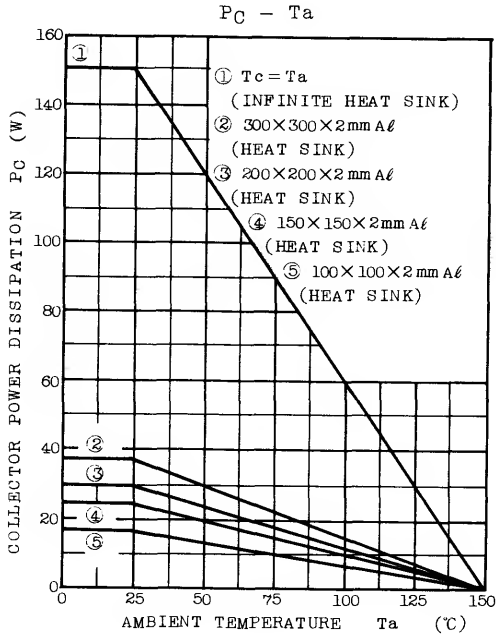
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=500V, I_E=0$	-	-	0.5	mA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=20mA, I_B=0$	400	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=5A$	20	-	140	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=10A, I_B=2A$	-	-	1.5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=10A, I_B=2A$	-	-	2.0	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.5A$	-	4	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=50V, I_E=0, f=1MHz$	-	150	-	pF
Switching Time	Turn-on Time	t_{on}	-	0.8	-	μs
	Storage Time	t_{stg}	-	3.5	-	
	Fall Time	t_f	-	0.6	-	



STATIC CHARACTERISTICS





2SD647A 2SD697A

SILICON NPN TRIPLE DIFFUSED MESA TYPE (DARLINGTON POWER)

INDUSTRIAL APPLICATIONS

Unit in mm

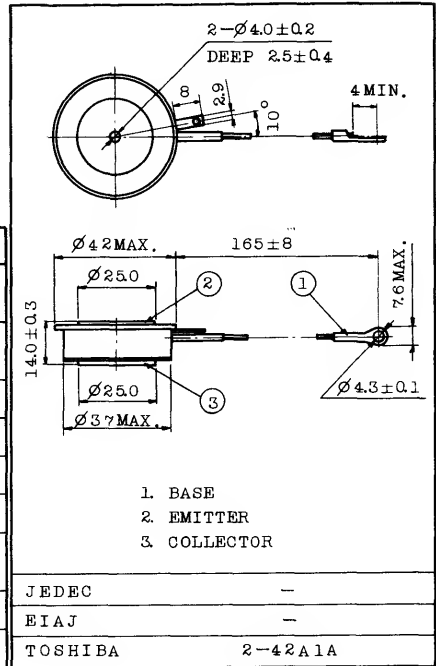
HIGH POWER SWITCHING APPLICATIONS.
DC-AC POWER INVERTER APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

FEATURES:

- High Voltage : $V_{CE0(SUS)} \geq 450V$ (2SD697A)
- Triple Diffused Design.
- Darlington Design.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	2SD647A	V_{CBO}	800	V
	2SD697A		500	
Collector-Emitter Voltage	2SD647A	$V_{CE0(SUS)}$	600	V
	2SD697A		450	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	100	A
Emitter Current		I_E	-100	A
Base Current		I_B	6	A
Thermal Resistance (Double Side Cooling)		$R_{th(j-c)}$	0.13	$^\circ C/W$
Junction Temperature		T_j	125	$^\circ C$
Storage Temperature Range		T_{stg}	-40 ~ 150	$^\circ C$
Mounting Force Required		F	400 \pm 40	kg



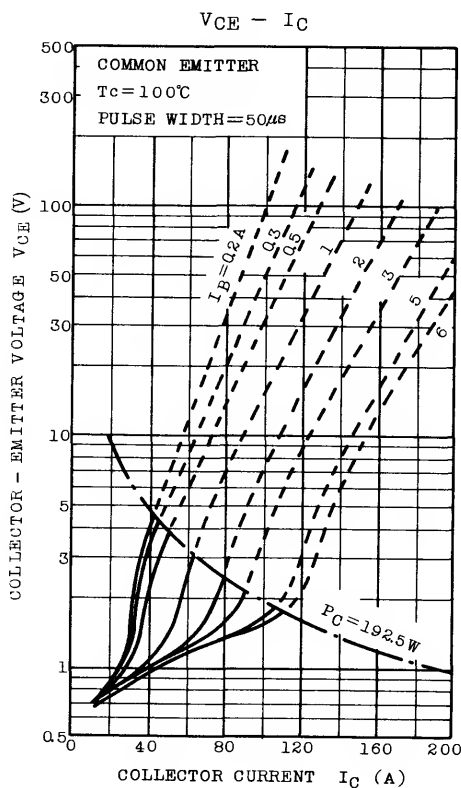
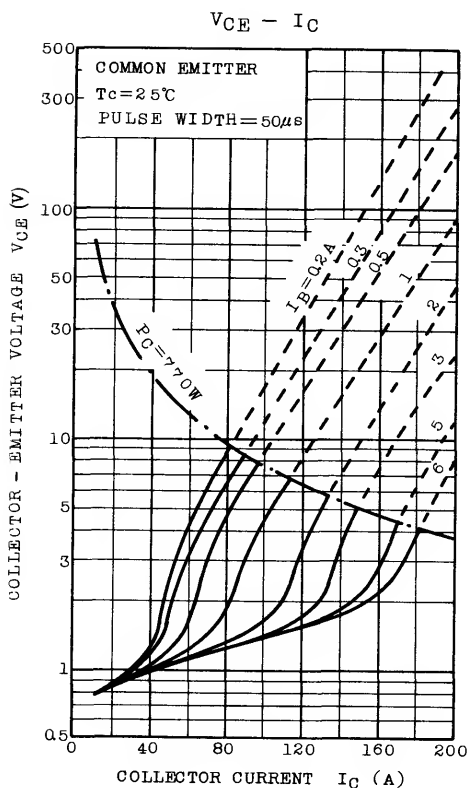
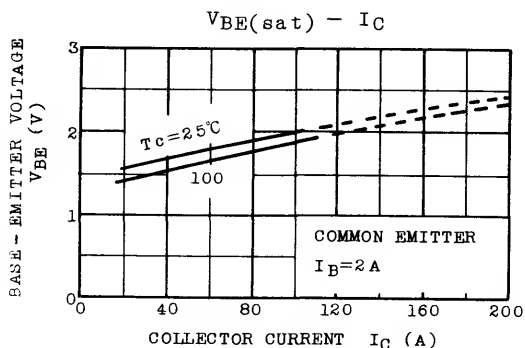
Weight : 70g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=100A$	100	-	-	
			$V_{CE}=5V, I_C=50A$	-	500	-	
Collector-Emitter Sustaining Voltage	2SD647A	$V_{CE0(SUS)}$	$I_C=0.5A, L=40mH$	600	-	-	V
	2SD697A			450			
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=100A, I_B=2A$ (Note)	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Collector Cut-off Current	2SD647A	I_{CBO}	$V_{CB}=800V, I_E=0$	-	-	2	mA
	2SD697A		$V_{CB}=500V, I_E=0$	-	-	2	
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	200	mA
Switching Time	Turn-on Time	t_{on}	$I_C=100A, I_{B1}=2A, -I_{B2}=2A, V_C=300V$	-	2.5	-	μs
	Storage Time	t_{stg}		-	20	-	μs
	Fall Time	t_f		-	4	-	μs

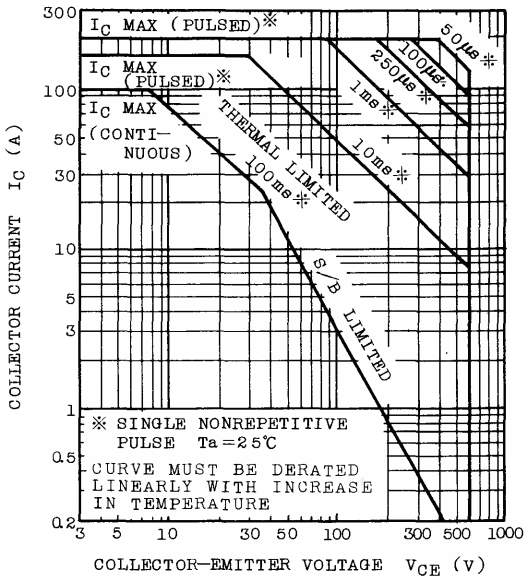
Note : Pulse Test; Pulse Width $\leq 300\mu s$, Duty Cycle $\leq 3\%$
Mounting Force; F=400kg

TOSHIBA CORPORATION

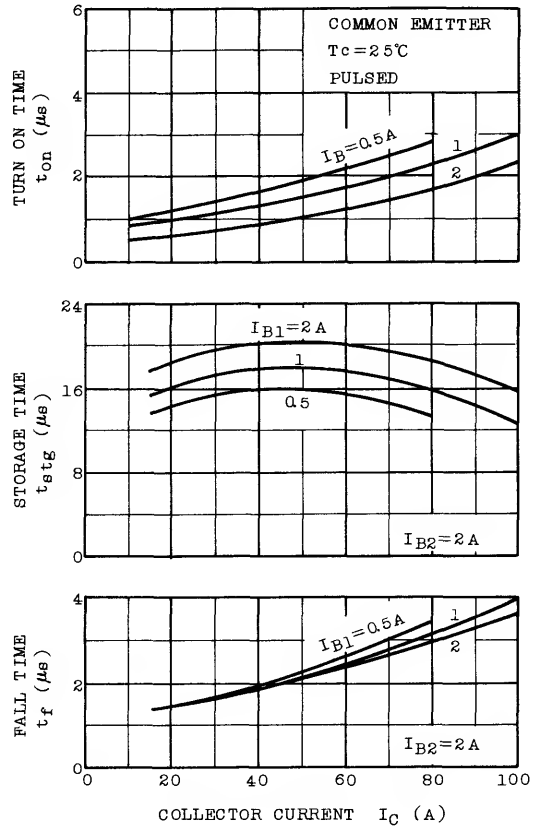


2SD647A • 2SD697A

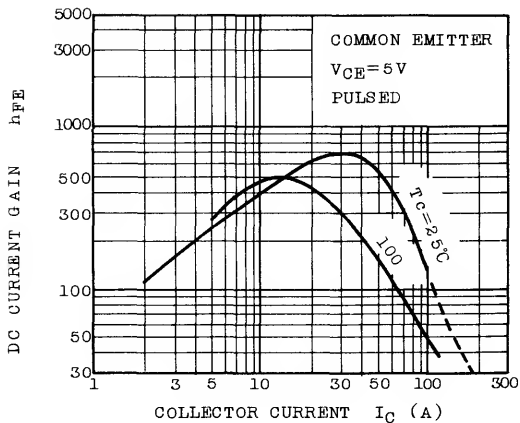
SAFE OPERATING AREA



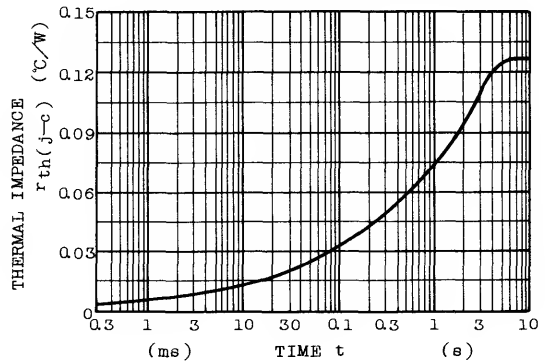
SWITCHING CHARACTERISTICS



$h_{FE} - I_C$



MAXIMUM TRANSIENT THERMAL IMPEDANCE (JUNCTION - CASE)



SILICON NPN TRIPLE DIFFUSED MESA TYPE
(DARLINGTON POWER)

2SD648A

INDUSTRIAL APPLICATIONS

Unit in mm

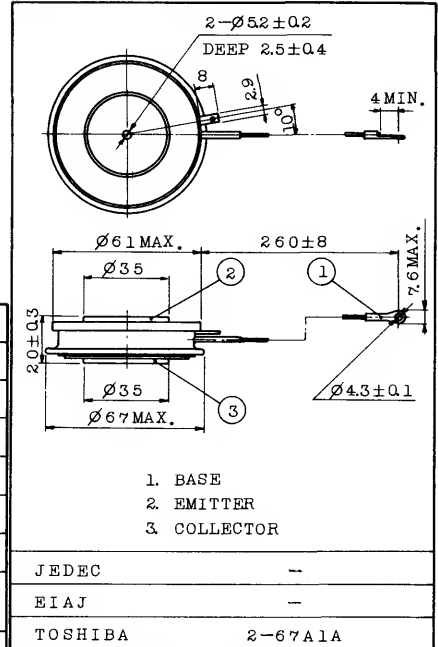
HIGH POWER SWITCHING APPLICATIONS.
DC MOTOR CONTROL APPLICATIONS.
ELECTRIC CAR APPLICATIONS.

FEATURES:

- . High Voltage : $V_{CEO(SUS)}=300V$
- . Triple Diffused Design.
- . Darlington Design.

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	300	V
Collector-Emitter Voltage	$V_{CEO(SUS)}$	300	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	400	A
Emitter Current	I_E	-400	A
Base Current	I_B	12	A
Thermal Resistance (Double Side Cooling)	$R_{th(j-c)}$	0.04	$^{\circ}C/W$
Junction Temperature	T_j	125	$^{\circ}C$
Storage Temperature Range	T_{stg}	-40 ~ 150	$^{\circ}C$
Mounting Force Required	F	1000±100	kg



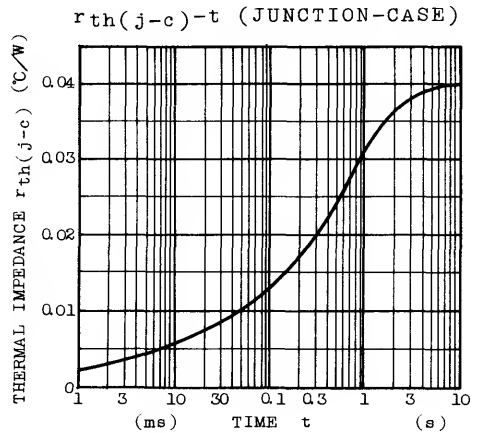
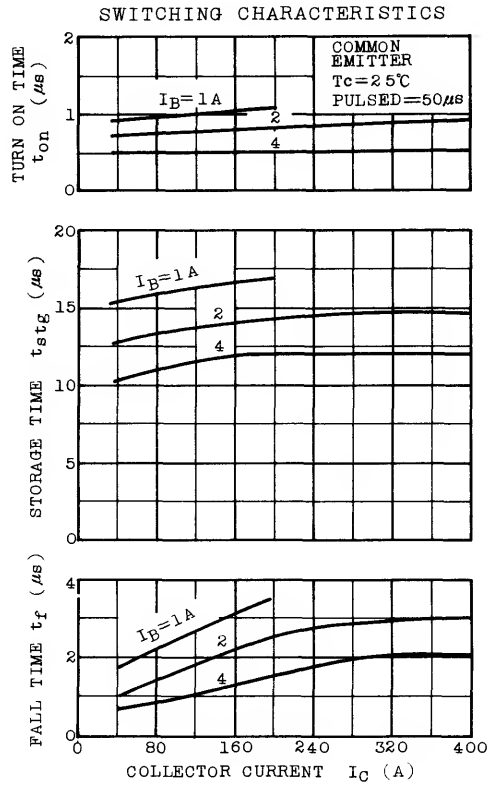
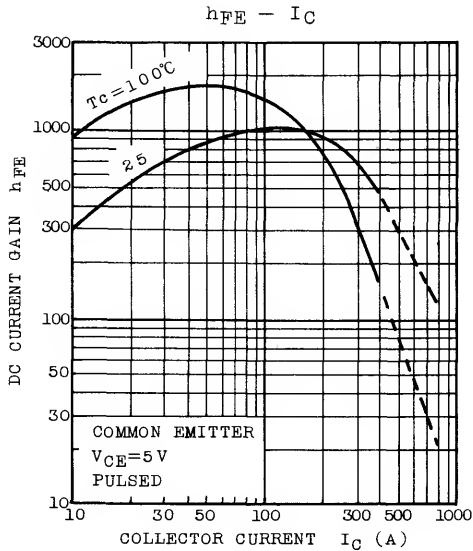
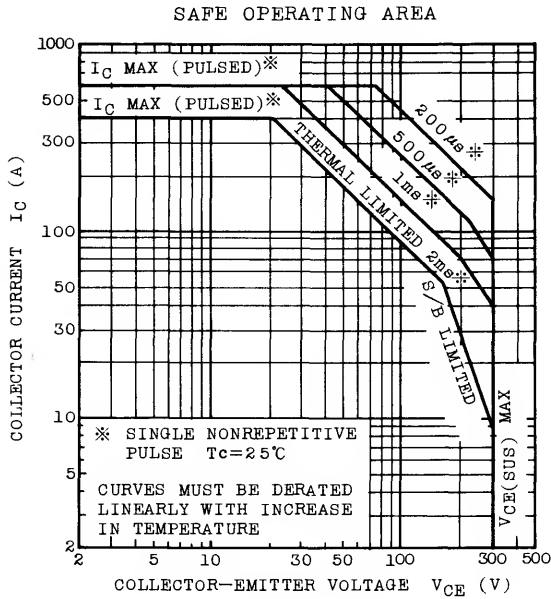
Weight : 250g

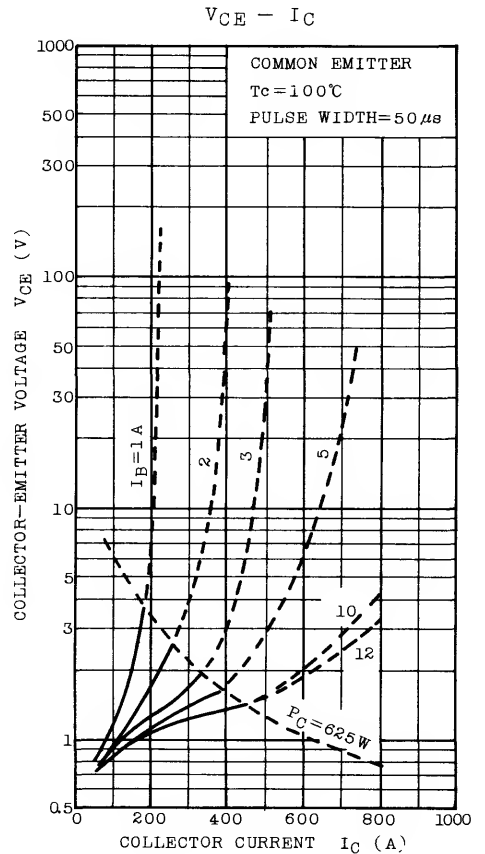
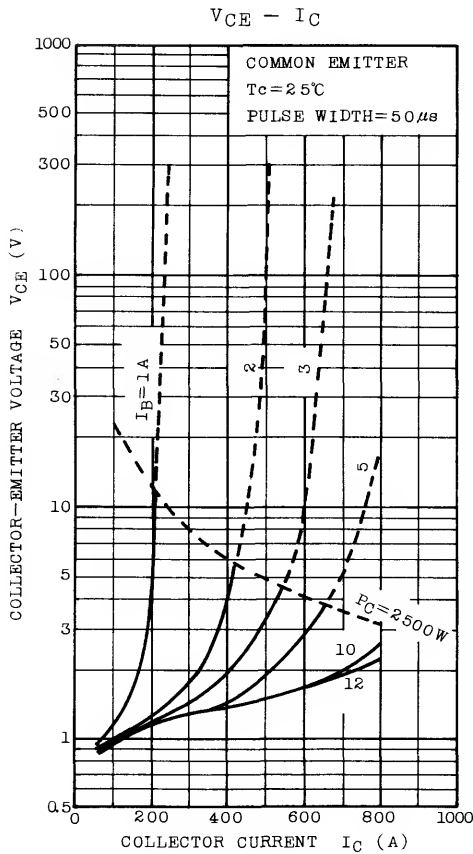
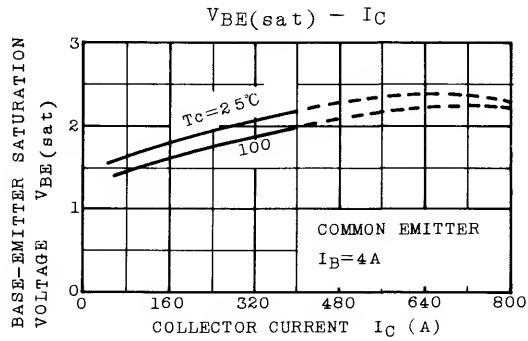
ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=400A$	100	400	-	
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	$I_C=0.5A, L=40mH$	300	-	-	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=400A, I_B=8A$ (Note)	-	-	2.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=400A, I_B=8A$ (Note)	-	-	2.5	V
Collector Cut-off Current	I_{CEO}	$V_{CE}=300V, I_B=0$	-	1.0	10	mA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=4V, I_C=0$	-	50	250	mA
Switching Time	Turn-on Time	t_{on}	-	1.0	3.0	μs
	Storage Time	t_{stg}	-	8	13	μs
	Fall Time	t_f	-	2	3.0	μs

Note: Pulse Test, Pulse Width $\leq 300\mu s$, Duty Cycle $\leq 3\%$
Mounting Force; F=1000kg

2SD648A





2SD664

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

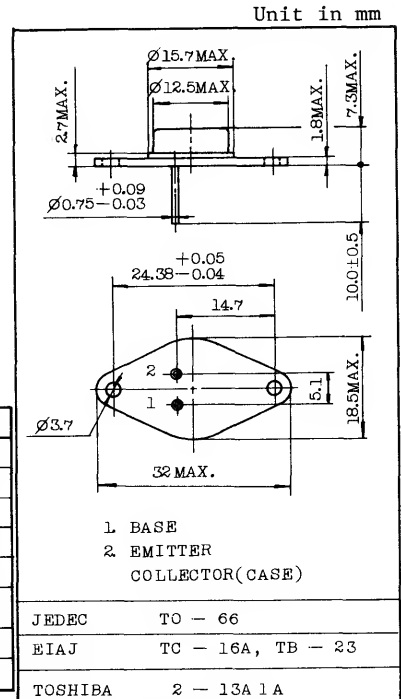
HIGH POWER SWITCHING APPLICATIONS.

FEATURES:

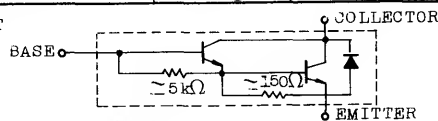
- High DC Current Gain
: $h_{FE}=2000(\text{Min.})(V_{CE}=3V, I_C=3A)$
- Low Saturation Voltage
: $V_{CE}(\text{sat})=1.5V(\text{Max.})(I_C=3A)$
- Monolithic Construction with Built-In Base-Emitter Shunt Resistor.

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	7	A
Base Current	I_B	0.2	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	40	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	$-65\sim 150$	$^\circ\text{C}$



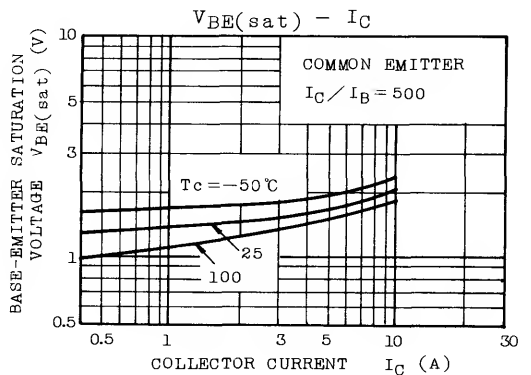
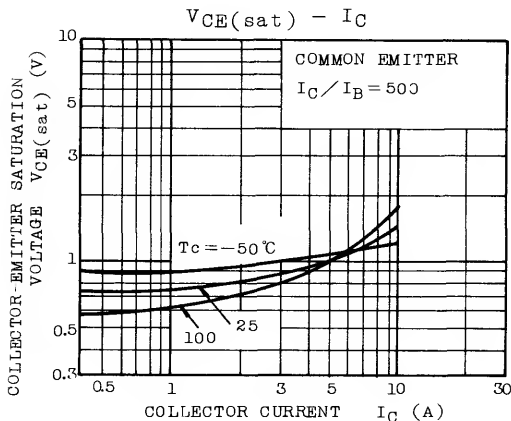
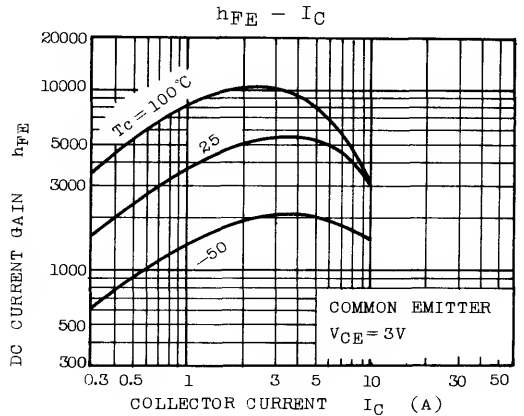
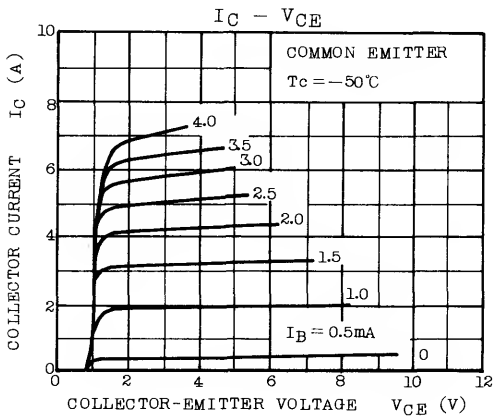
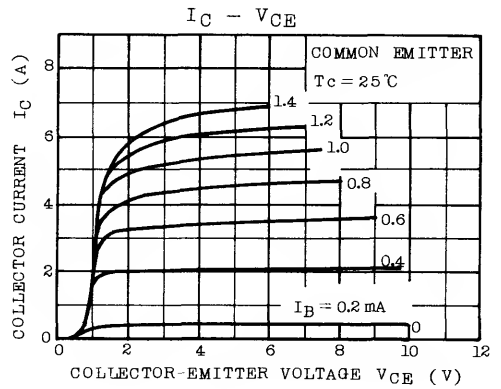
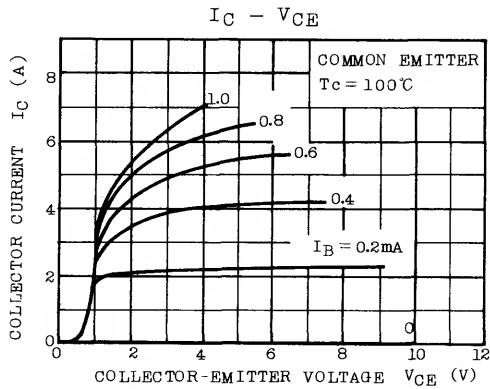
EQUIVALENT CIRCUIT



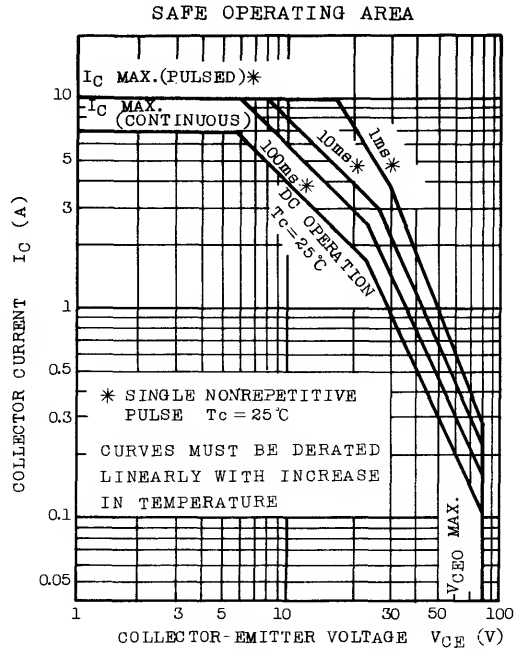
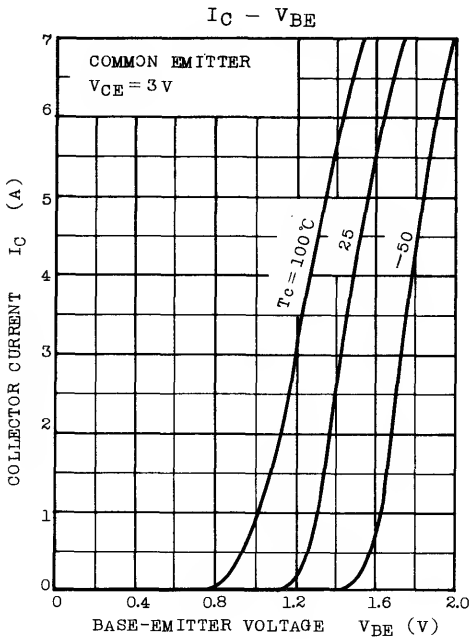
Mounting Kit No. AC74
Weight : 5.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=80V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	3	mA
Collector-Emitter Breakdown Voltage		$V(\text{BR})_{CEO}$	$I_C=50\text{mA}, I_B=0$	80	-	-	V
DC Current Gain		$h_{FE}(1)$	$V_{CE}=3V, I_C=3A$	2000	-	15000	
		$h_{FE}(2)$	$V_{CE}=3V, I_C=7A$	1000	-	-	
Collector-Emitter Saturation Voltage		$V_{CE}(\text{sat})(1)$	$I_C=3A, I_B=6\text{mA}$	-	0.9	1.5	V
		$V_{CE}(\text{sat})(2)$	$I_C=7A, I_B=14\text{mA}$	-	1.2	2.0	
Base-Emitter Saturation Voltage		$V_{BE}(\text{sat})$	$I_C=3A, I_B=6\text{mA}$	-	1.5	2.5	V
Switching Time	Turn-on Time	t_{on}	<p>$I_{B1} = -I_{B2} = 6\text{mA}$ DUTY CYCLE $\leq 1\%$</p>	-	0.8	-	μs
	Storage Time	t_{stg}		-	3.0	-	
	Fall Time	t_f		-	2.5	-	



2SD664



SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

2SD683
2SD683A

HIGH VOLTAGE AND HIGH POWER SWITCHING APPLICATIONS.
MOTOR DRIVE APPLICATIONS.

INDUSTRIAL APPLICATIONS

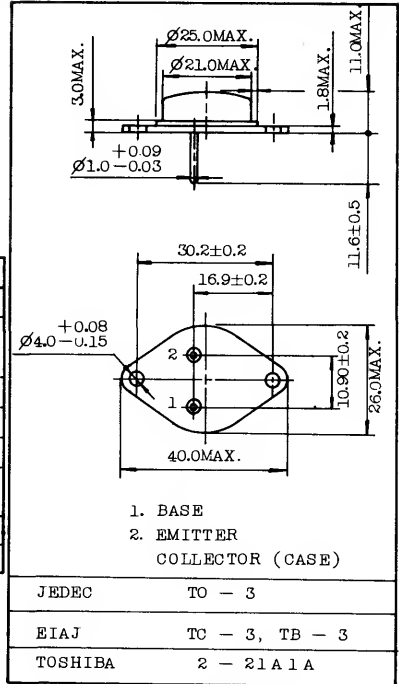
Unit in mm

FEATURES :

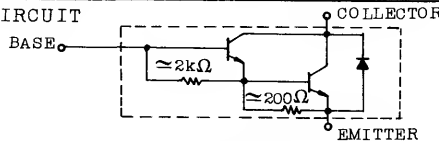
- High DC Current Gain : $h_{FE}=500(\text{Min.}) (V_{CE}=5V, I_C=5A)$
- High Voltage : $V_{CEO}(\text{SUS})=450V (2SD683A)$
- Monolithic Construction With Built-In Base-Emitter Shunt Resistor.

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	V_{CEO}	400	V
		450	
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	15	A
Base Current	I_B	2	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	150	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	$-65\sim 150$	$^\circ\text{C}$



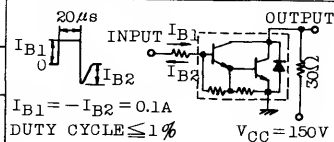
EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

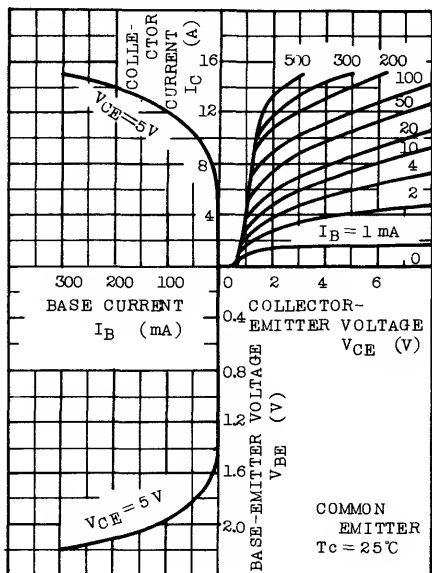
Mounting Kit No. AC73
Weight : 12.9g

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=600V, I_E=0$	-	-	0.5	mA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	30	mA
Collector-Emitter Sustaining Voltage	$V_{CEO}(\text{SUS})$	$I_C=5A, L=10mH$	400	-	-	V
			450	-	-	
DC Current Gain	$h_{FE}(1)$	$V_{CE}=5V, I_C=5A$	500	-	-	
	$h_{FE}(2)$	$V_{CE}=5V, I_C=15A$	30	-	-	
Collector-Emitter Saturation Voltage	$V_{CE}(\text{sat})$	$I_C=10A, I_B=0.2A$	-	-	2.0	V
Base-Emitter Saturation Voltage	$V_{BE}(\text{sat})$	$I_C=10A, I_B=0.2A$	-	-	2.5	V
Emitter-Collector Forward Voltage	V_{ECF}	$I_E=10A, I_B=0$	-	-	3.0	V
Collector Output Capacitance	C_{ob}	$V_{CB}=50V, I_E=0, f=1MHz$	-	100	-	pF
Switching Time	Turn-on Time	t_{on}	-	0.4	-	μs
	Storage Time	t_{stg}	-	15	-	
	Fall Time	t_f	-	3	-	

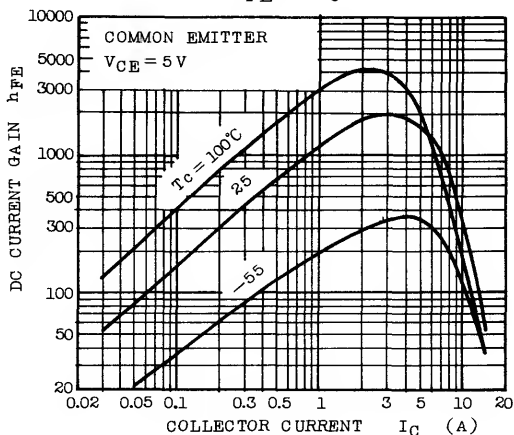


2SD683 · 2SD683A

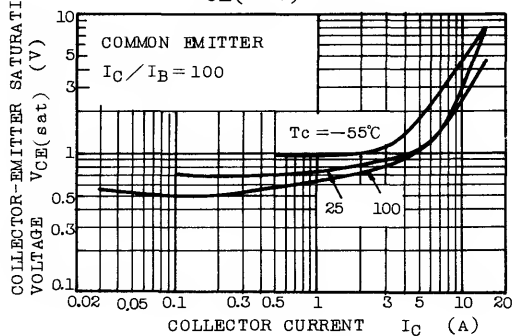
STATIC CHARACTERISTICS



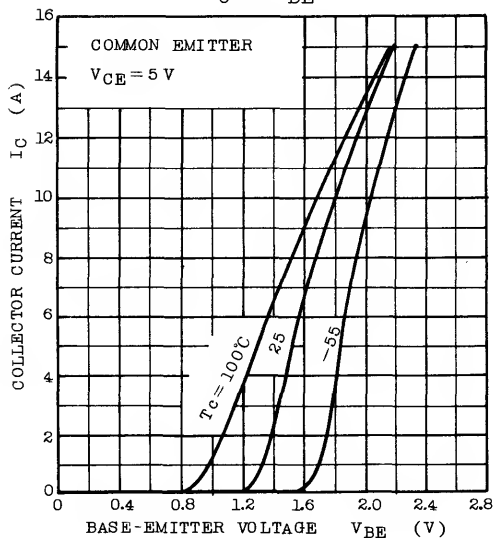
$h_{FE} - I_C$



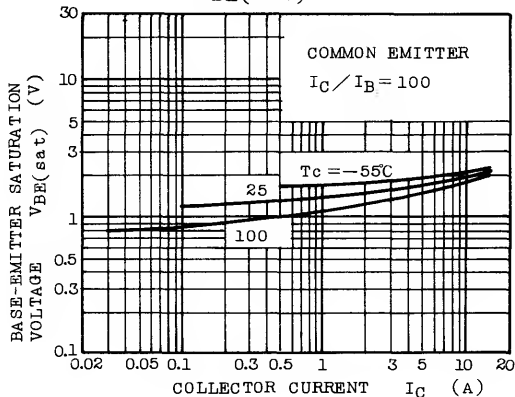
$V_{CE(sat)} - I_C$

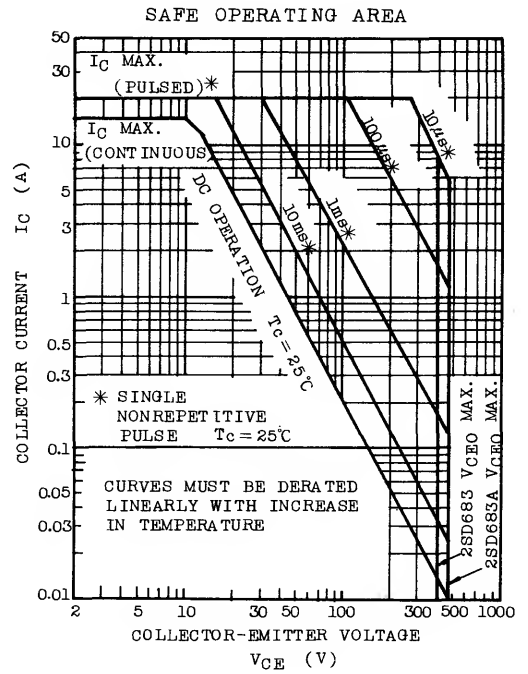
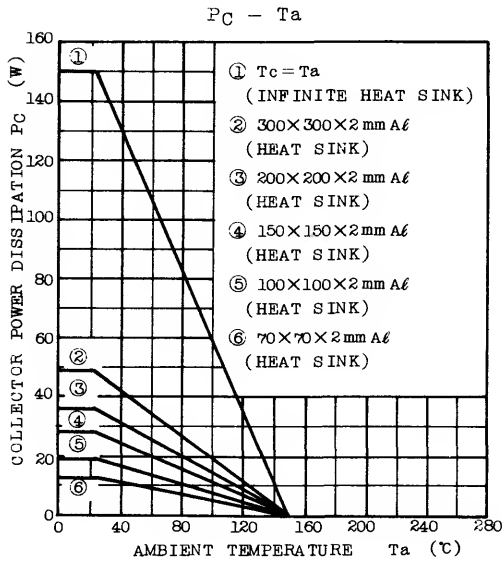


$I_C - V_{BE}$



$V_{BE(sat)} - I_C$





2SD684

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

IGNITER APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.

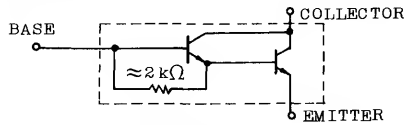
FEATURES:

- High DC Current Gain
: $h_{FE}=1500$ (Min.) ($V_{CE}=2V$, $I_C=2A$)

MAXIMUM RATINGS ($T_a=25^\circ C$)

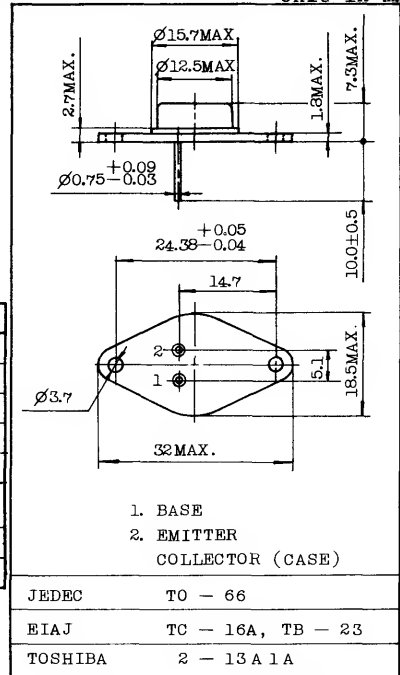
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	V_{CEO}	300	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Base Current	I_B	1	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	30	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-65~150	$^\circ C$

EQUIVALENT CIRCUIT



INDUSTRIAL APPLICATIONS

Unit in mm

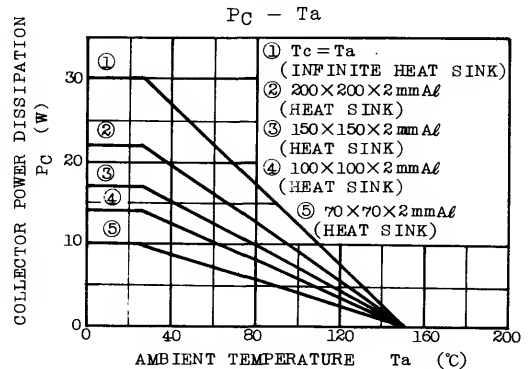
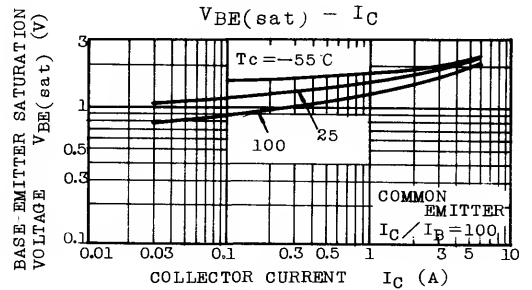
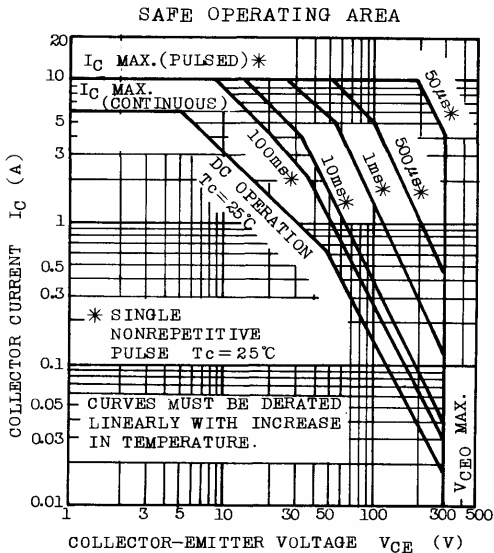
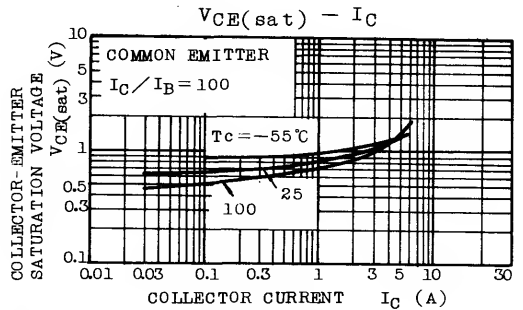
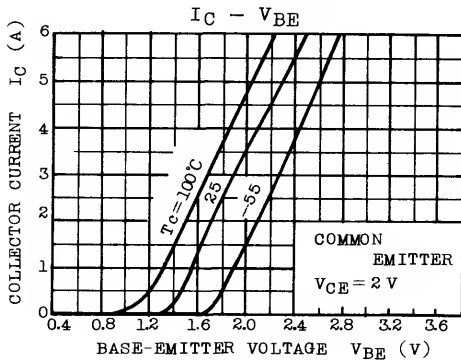
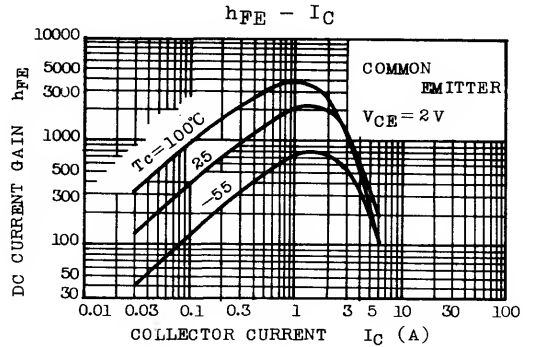
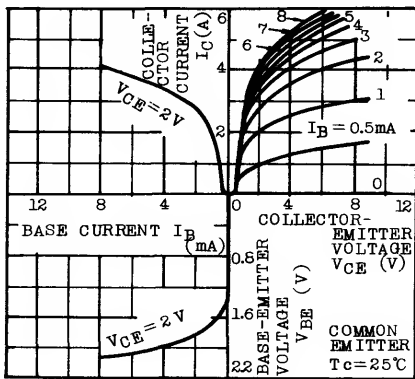


Mounting Kit No. AC74
Weight : 5.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=600V, I_E=0$	-	-	0.5	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	0.5	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	$I_C=0.5A, L=40mH$	300	-	-	V
DC Current Gain		$h_{FE(1)}$	$V_{CE}=2V, I_C=2A$	1500	-	-	
		$h_{FE(2)}$	$V_{CE}=2V, I_C=4A$	200	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=4A, I_B=0.04A$	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=4A, I_B=0.04A$	-	-	2.5	V
Collector Output Capacitance		C_{ob}	$V_{CB}=50V, I_E=0, f=1MHz$	-	35	-	pF
Switching Time	Turn-on Time	t_{on}		-	1	-	µs
	Storage Time	t_{stg}		-	8	-	
	Fall Time	t_f		-	5	-	

STATIC CHARACTERISTICS



2SD684A

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

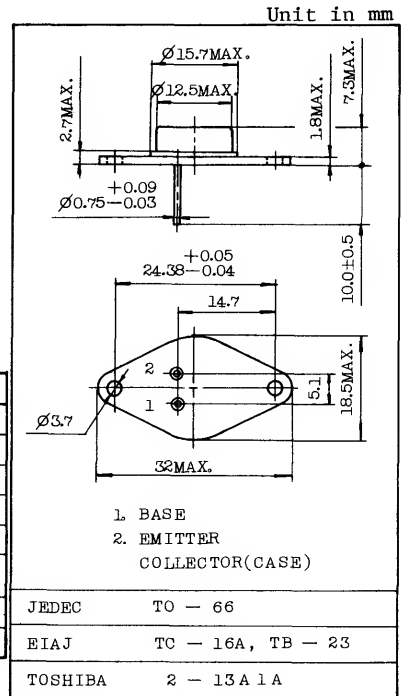
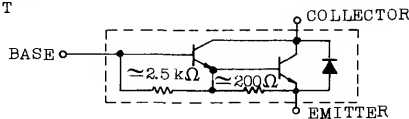
IGNITER APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.
FEATURES:

- High DC Current Gain
: $h_{FE}=600$ (Min.) ($V_{CE}=2V$, $I_C=2A$)
- Monolithic Construction With Built-In Base-Emitter Shunt Resistor.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	600	V
Collector-Emitter Voltage	V_{CE0}	400	V
Emitter-Base Voltage	V_{EB0}	5	V
Collector Current	I_C	6	A
Base Current	I_B	1	A
Collector Power Dissipation ($T_c=25^\circ C$)	PC	30	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-65~150	$^\circ C$

EQUIVALENT CIRCUIT

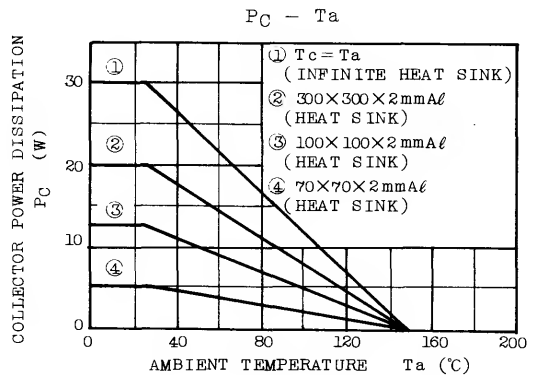
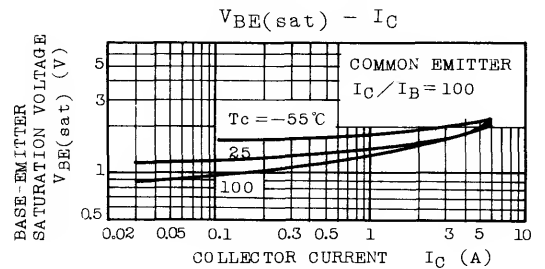
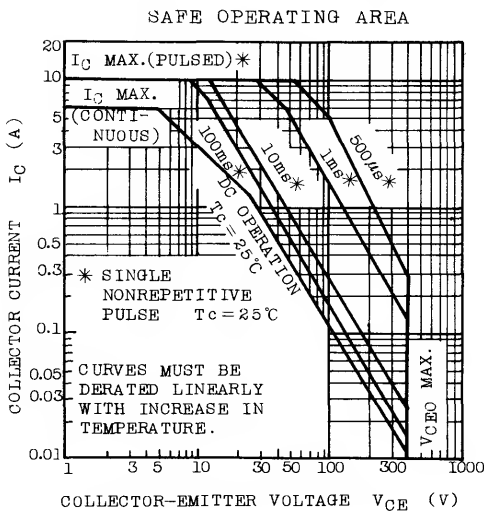
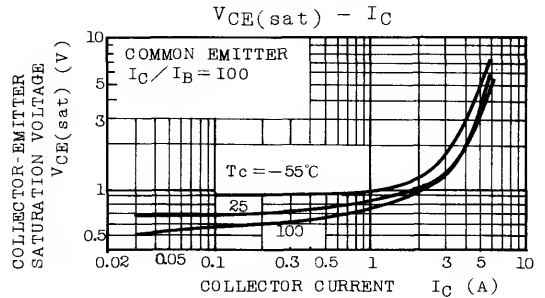
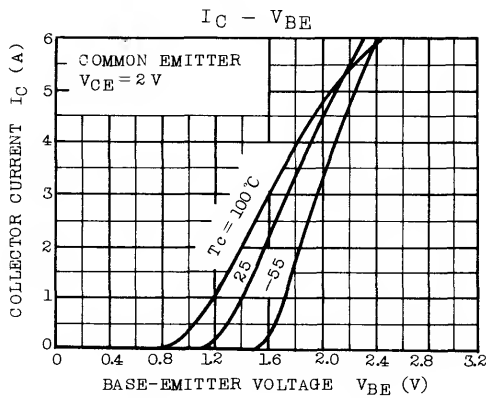
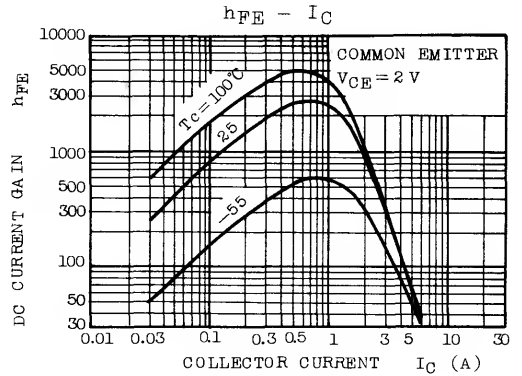
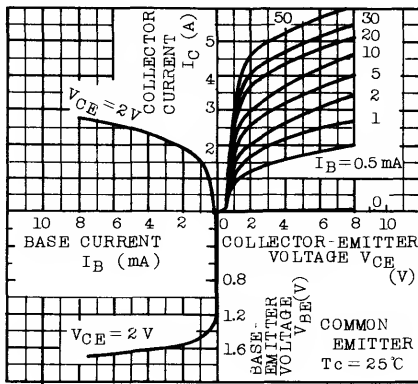


Mounting kit No.AC74
Weight : 5.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=600V$, $I_E=0$	-	-	0.5	mA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=5V$, $I_C=0$	-	-	3	mA
Collector-Emitter Breakdown Voltage	$V(BR)_{CEO}$	$I_C=10mA$, $I_B=0$	400	-	-	V
DC Current Gain	$h_{FE}(1)$	$V_{CE}=2V$, $I_C=2A$	600	-	-	
	$h_{FE}(2)$	$V_{CE}=2V$, $I_C=4A$	100	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A$, $I_B=0.04A$	-	-	2.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4A$, $I_B=0.04A$	-	-	2.5	V
Emitter-Collector Forward Voltage	V_{ECF}	$I_E=4A$, $I_B=0$	-	-	3.0	V
Collector Output Capacitance	C_{ob}	$V_{CB}=50V$, $I_E=0$, $f=1MHz$	-	35	-	pF
Switching Time	Turn-on Time	t_{on}	-	1	-	
	Storage Time	t_{stg}	-	8	-	μs
	Fall Time	t_f	$I_{B1}=-I_{B2}=0.04A$ DUTY CYCLE $\leq 1\%$ $V_{CC}=100V$	-	5	-

STATIC CHARACTERISTICS



2SD685

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

IGNITER APPLICATIONS.

HIGH VOLTAGE AND HIGH POWER SWITCHING APPLICATIONS.

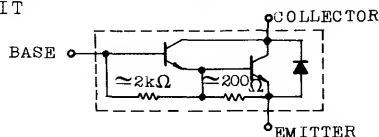
FEATURES :

- . High DC Current Gain
: $h_{FE}=400$ (Min.) ($V_{CE}=2V$, $I_C=4A$)
- . High Reverse Energy : $E_{S/B}=245mJ$ (Min.)
- . Monolithic Construction With Built-In Base-Emitter Shunt Resistor.

MAXIMUM RATINGS ($T_a=25^\circ C$)

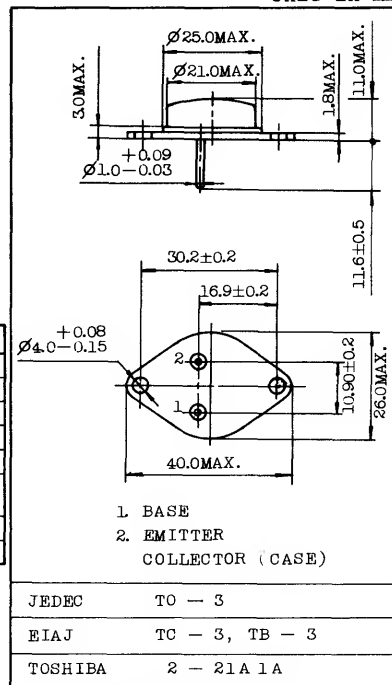
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	10	A
Base Current	I_B	2	A
Collector Power Dissipation ($T_c=25^\circ C$)	PC	100	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^\circ C$

EQUIVALENT CIRCUIT



INDUSTRIAL APPLICATIONS

Unit in mm



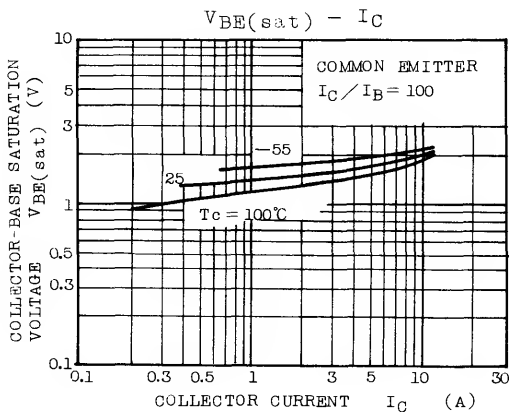
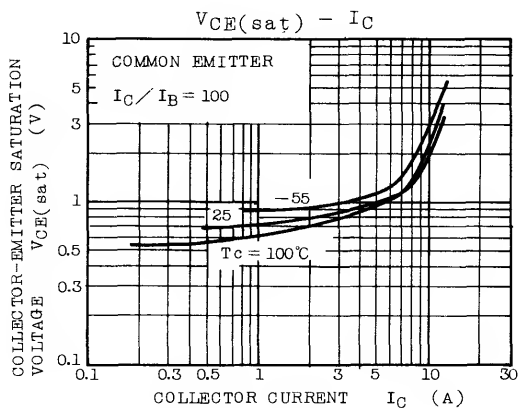
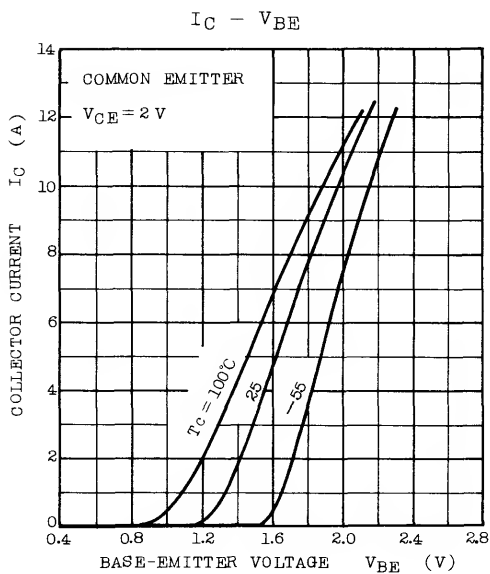
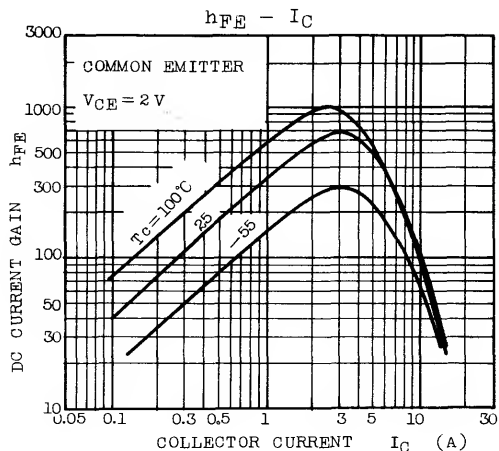
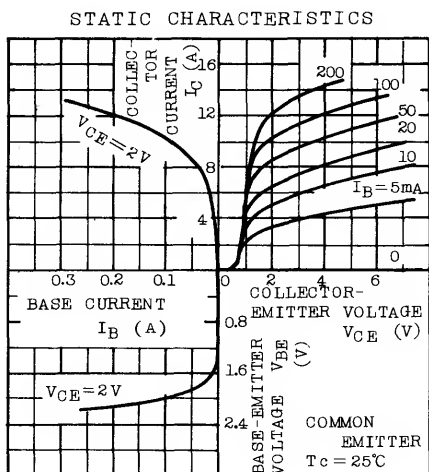
JEDEC	TO - 3
EIAJ	TC - 3, TB - 3
TOSHIBA	2 - 21A 1A

Mounting kit No. AC73
Weight : 12.9g

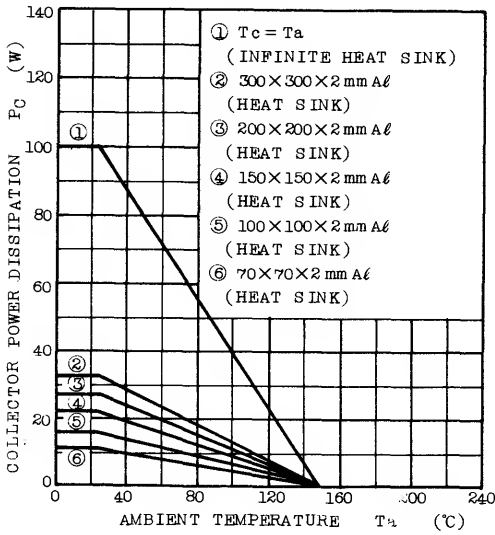
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=600V$, $I_E=0$	-	-	0.5	mA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V$, $I_C=0$	-	-	20	mA
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$	$I_C=6A$, $L=10mH$	400	-	-	V
Reverse Energy	$E_{S/B}$	$L=10mH$, $I_{CP}=7A$ (Note)	245	-	-	mJ
DC Current Gain	$h_{FE}(1)$	$V_{CE}=2V$, $I_C=4A$	400	-	-	
		$V_{CE}=2V$, $I_C=8A$	100	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=8A$, $I_B=0.08A$	-	-	2.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=8A$, $I_B=0.08A$	-	-	2.5	V
Emitter-Collector Forward Voltage	V_{ECF}	$I_E=10A$, $I_B=0$	-	-	3.0	V
Collector Output Capacitance	C_{ob}	$V_{CB}=50V$, $I_E=0$, $f=1MHz$	-	90	-	pF
Switching Time	Turn-on Time	t_{on}	-	1.0	-	μs
	Storage Time	t_{stg}	-	12	-	μs
	Fall Time	t_f	-	5	-	μs

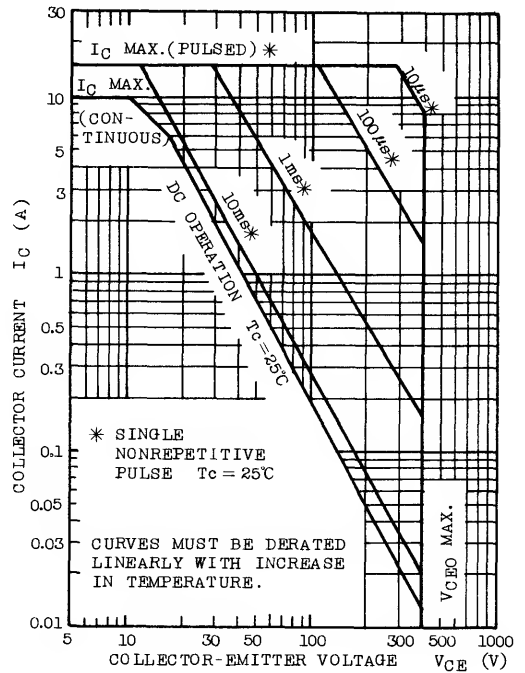
Note: $E_{S/B}$ is defined as the energy at which second breakdown occurs under the base open circuit. $E_{S/B}=1/2L I_{CP}^2$, Where L is a series load or leakage inductance and



$P_C - T_a$



SAFE OPERATING AREA



SWITCHING APPLICATIONS.
 HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.
 POWER AMPLIFIER APPLICATIONS.

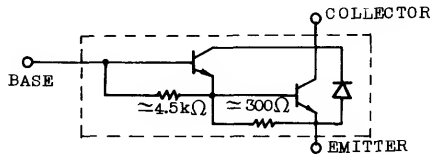
FEATURES:

- High DC Current Gain : $h_{FE}=2000$ (Min.) ($V_{CE}=2V, I_C=1A$)
- Complementary to 2SB676.

MAXIMUM RATINGS ($T_a=25^\circ C$)

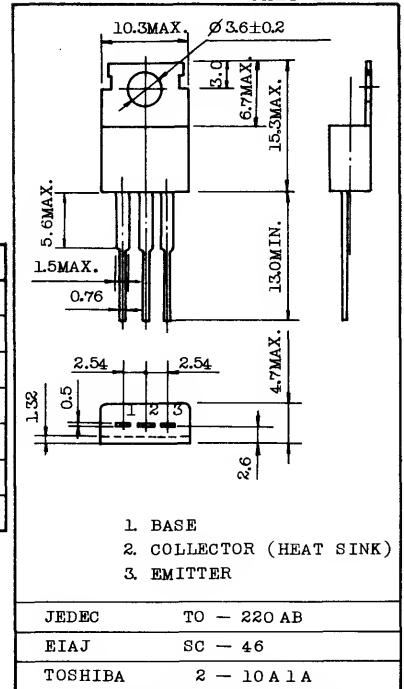
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	100	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Continuous Collector Current	I_C	4	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	30	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	$-55 \sim 150$	$^\circ C$

EQUIVALENT CIRCUIT



INDUSTRIAL APPLICATIONS

Unit in mm

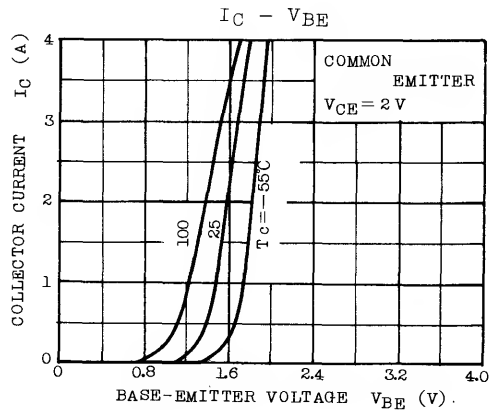
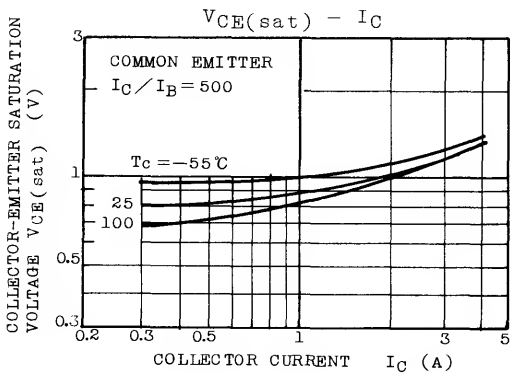
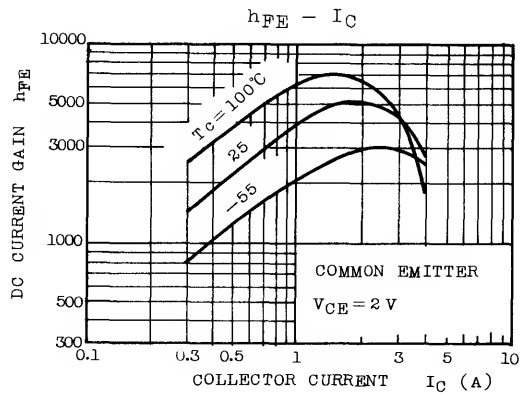
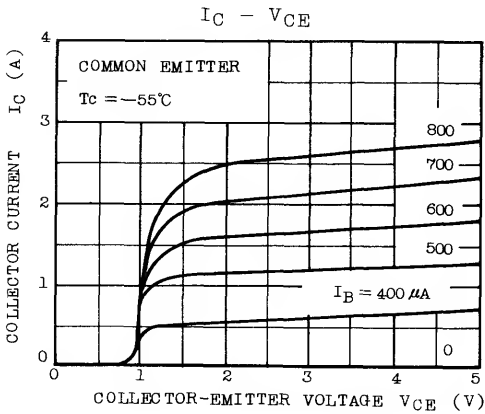
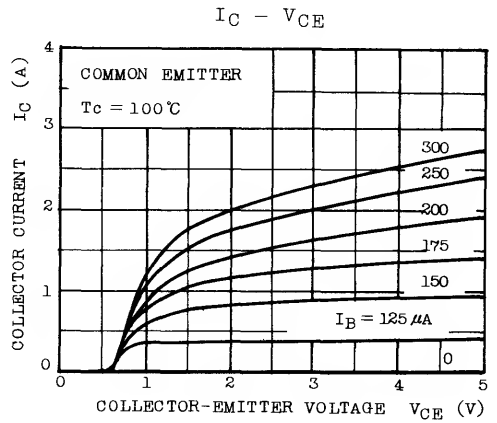
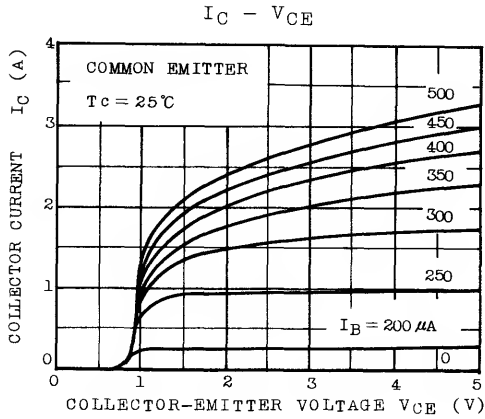


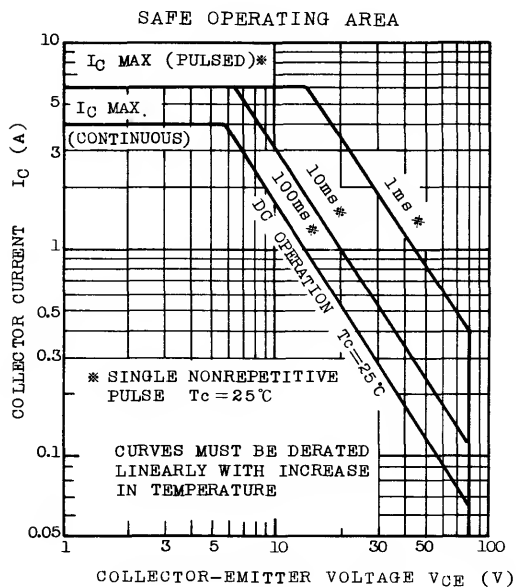
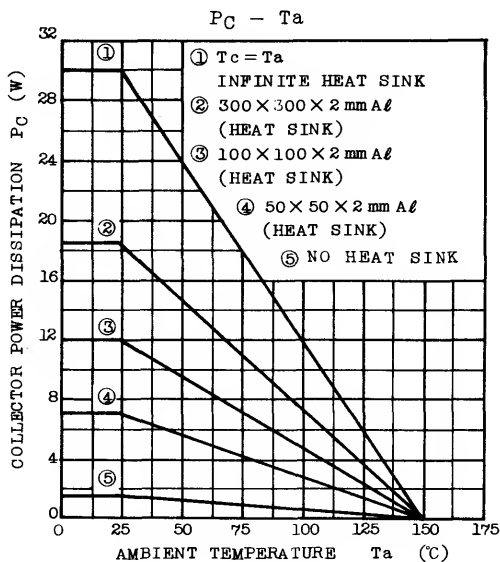
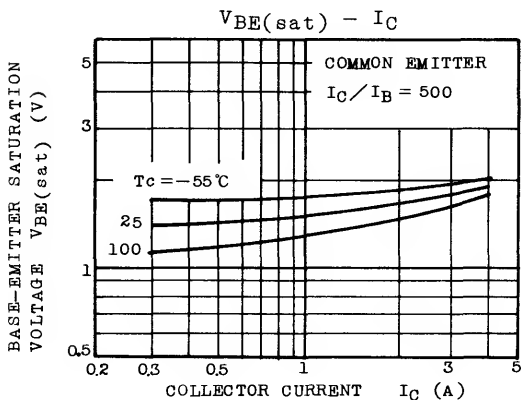
1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

Mounting Kit No. AC75
 Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=100V, I_E=0$	-	-	20	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	2.5	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	80	-	-	V
DC Current Gain		$h_{FE}(1)$	$V_{CE}=2V, I_C=1A$	2000	-	-	
		$h_{FE}(2)$	$V_{CE}=2V, I_C=3A$	1000	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=3A, I_B=6mA$	-	-	1.5	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=3A, I_B=6mA$	-	-	2.0	
Switching Time	Turn-on Time	t_{on}		-	0.2	-	μs
	Storage Time	t_{stg}		-	1.5	-	
	Fall Time	t_f		-	0.6	-	





2SD687

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

SWITCHING APPLICATIONS.

HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.

POWER AMPLIFIER APPLICATIONS.

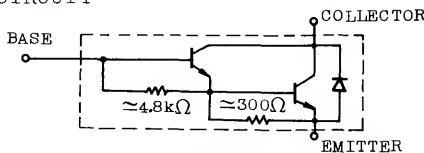
FEATURES :

- . High DC Current Gain
: $h_{FE}=2000(\text{Min.})(V_{CE}=2V, I_C=1A)$
- . Low Saturation Voltage
: $V_{CE(\text{sat})}=1.5V(\text{Max.})(I_C=2A)$

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

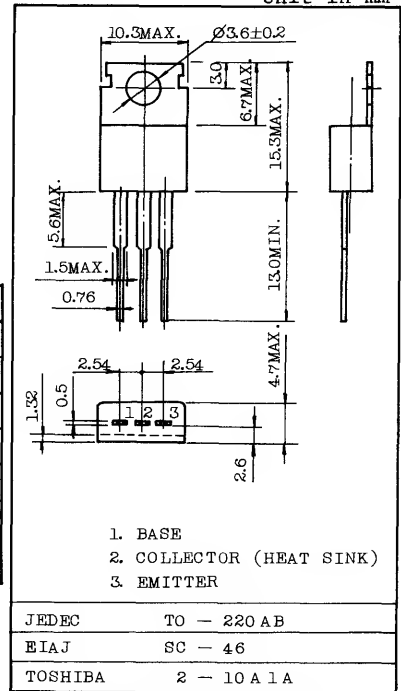
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	60	V
Collector-Emitter Voltage	V_{CEO}	40	V
Emitter-Base Voltage	V_{EB0}	5	V
Continuous Collector Current	I_C	3	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	25	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	$-55\sim 150$	$^\circ\text{C}$

EQUIVALENT CIRCUIT



INDUSTRIAL APPLICATIONS

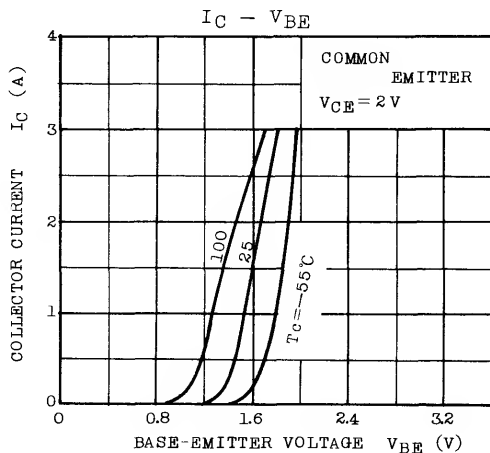
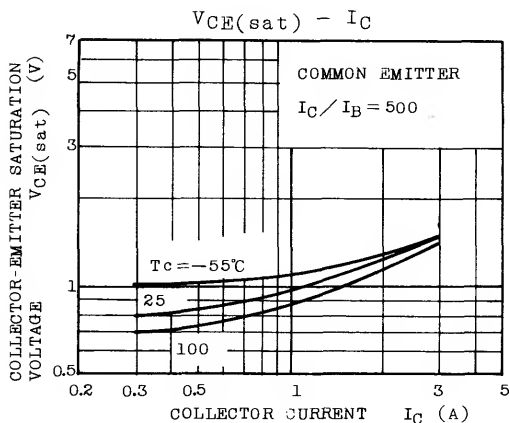
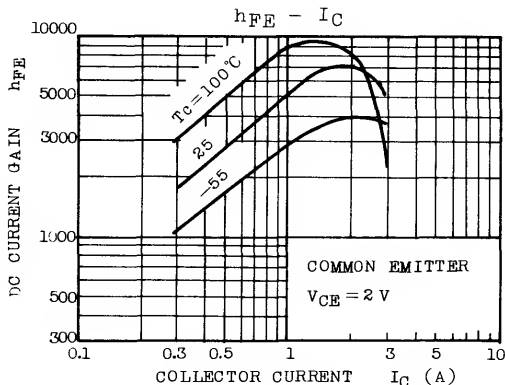
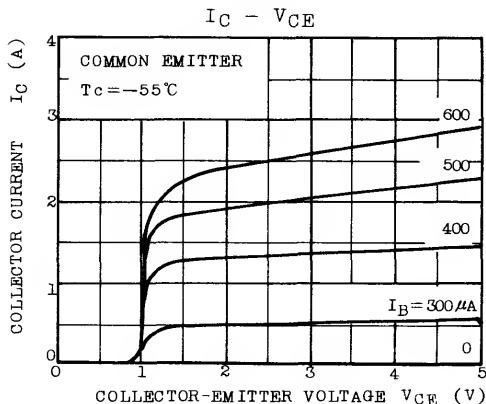
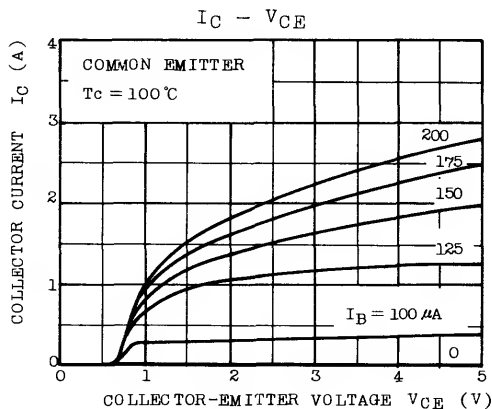
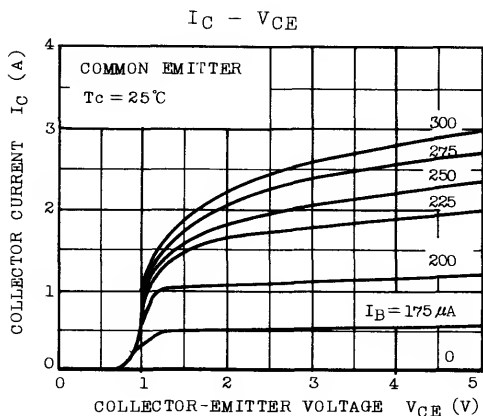
Unit in mm

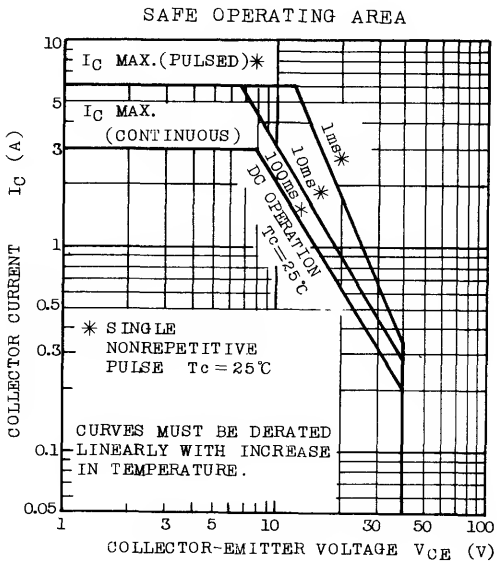
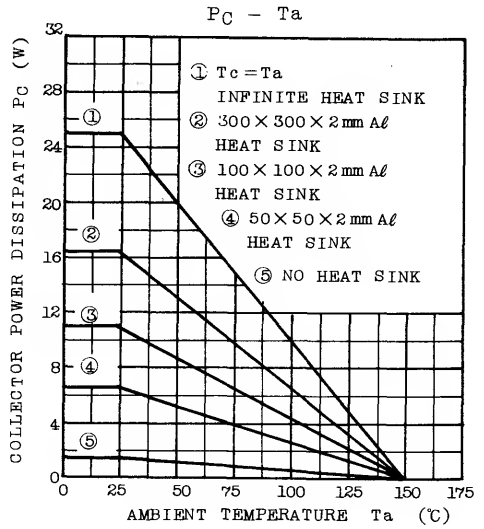
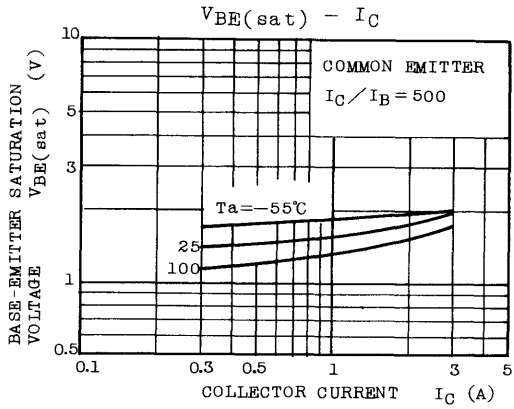


Mounting Kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CB0}	$V_{CB}=60V, I_F=0$	-	-	20	μA
Emitter Cut-off Current		I_{EB0}	$V_{EB}=5V, I_C=0$	-	-	2.5	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=25\text{mA}, I_B=0$	40	-	-	V
DC Current Gain		$h_{FE(1)}$	$V_{CE}=2V, I_C=1A$	2000	-	-	
		$h_{FE(2)}$	$V_{CE}=2V, I_C=3A$	1000	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(\text{sat})}$	$I_C=2A, I_B=4\text{mA}$	-	-	1.5	V
	Base-Emitter	$V_{BE(\text{sat})}$	$I_C=2A, I_B=4\text{mA}$	-	-	2.0	
Switching Time	Turn-on Time	t_{on}		-	0.1	-	μs
	Storage Time	t_{stg}		-	1.0	-	
	Fall Time	t_f		$I_{B1}=-I_{B2}=6\text{mA}$ DUTY CYCLE $\leq 1\%$	-	0.2	





SILICON NPN EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

2SD688

Unit in mm

LOW FREQUENCY MEDIUM POWER AMPLIFIER AND
MEDIUM SPEED SWITCHING APPLICATIONS.

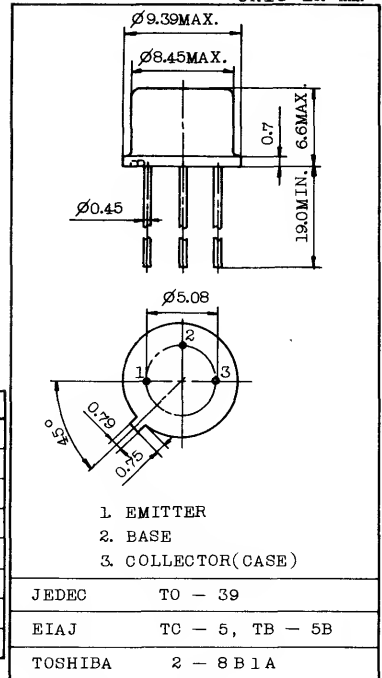
PULSE MOTOR DRIVE, RELAY DRIVE AND HAMMER
DRIVE APPLICATIONS.

FEATURES:

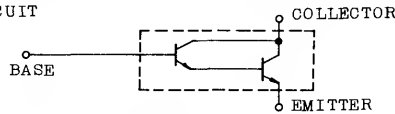
- High DC Current Gain
: $h_{FE}=1000$ (Min.) ($V_{CE}=2V, I_C=1A$)
- Low Saturation Voltage
: $V_{CE(sat)}=1.5V$ (Max.) ($I_C=1A$)
- Complementary to 2SB678

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	100	V
Collector-Emitter Voltage		V_{CEO}	100	V
Emitter-Base Voltage		V_{EBO}	10	V
Continuous Collector Current		I_C	1.5	A
Collector Power Dissipation	$T_a=25^\circ C$	P_C	0.8	W
	$T_c=25^\circ C$		8	W
Junction Temperature		T_j	175	$^\circ C$
Storage Temperature Range		T_{stg}	$-65 \sim 175$	$^\circ C$



EQUIVALENT CIRCUIT



Weight : 1.13g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=100V, I_E=0$	-	-	10	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=10V, I_C=0$	-	-	10	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	100	-	-	V
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	$I_E=5mA, I_C=0$	10	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=2V, I_C=0.1A$	2000	-	-	
			$V_{CE}=2V, I_C=1A$	1000	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=1A, I_B=2mA$	-	-	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=1A, I_B=2mA$	-	-	2.5	V
Switching Time	Turn-on Time	t_{on}		-	0.3	-	μs
	Storage Time	t_{stg}		-	2.0	-	
	Fall Time	t_f		$I_{B1} = -I_{B2} = 2mA$ $DUTY\ CYCLE \le 1\%$	-	0.7	

2SD689

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

LOW FREQUENCY MEDIUM POWER AMPLIFIER AND
MEDIUM SPEED SWITCHING APPLICATIONS.
PULSE MOTOR DRIVE, RELAY DRIVE AND HAMMER
DRIVE APPLICATIONS.

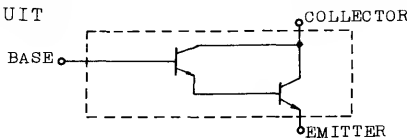
FEATURES:

- . High DC Current Gain : $h_{FE}=1000(\text{Min.})(V_{CE}=2V, I_C=1A)$
- . Low Saturation Voltage : $V_{CE}(\text{sat})=1.5V(\text{Max.})(I_C=1A)$
- . Complementary to 2SB679.

MAXIMUM RATINGS (Ta=25°C)

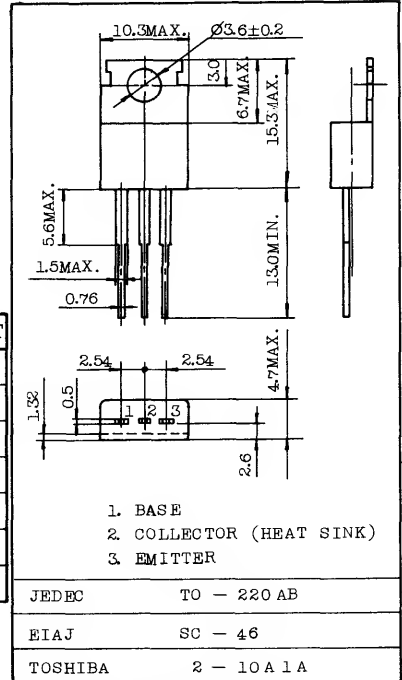
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	100	V
Collector-Emitter Voltage	V_{CEO}	100	V
Emitter-Base Voltage	V_{EBO}	10	V
Continuous Collector Current	I_C	1.5	A
Collector Power Dissipation (Tc=25°C)	P_C	10	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

EQUIVALENT CIRCUIT



INDUSTRIAL APPLICATIONS

Unit in mm



Mounting Kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=100V, I_E=0$	-	-	10	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=10V, I_C=0$	-	-	10	μA
Breakdown Voltage	Collector-Emitter	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	100	-	-	V
	Emitter-Base	$V_{(BR)EBO}$	$I_E=5mA, I_C=0$	10	-	-	V
DC Current Gain		$-h_{FE}$	$V_{CE}=2V, I_C=0.1A$	2000	-	-	
			$V_{CE}=2V, I_C=1A$	1000	-	-	
Collector-Emitter Saturation Voltage		$V_{CE}(\text{sat})$	$I_C=1A, I_B=2mA$	-	-	1.5	V
Base-Emitter Saturation Voltage		$V_{BE}(\text{sat})$	$I_C=1A, I_B=2mA$	-	-	2.5	V
Switching Time	Turn-on Time	t_{on}		-	0.3	-	μs
	Storage Time	t_{stg}		-	2.0	-	
	Fall Time	t_f		-	0.7	-	

SILICON NPN TRIPLE DIFFUSED MESA TYPE
(DARLINGTON POWER)

2SD698

INDUSTRIAL APPLICATIONS

Unit in mm

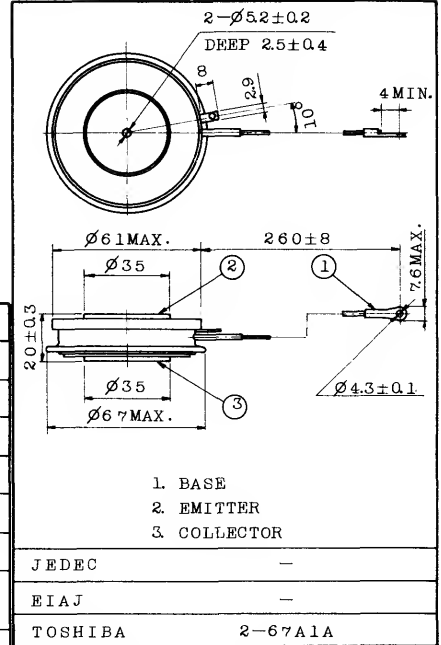
HIGH POWER SWITCHING APPLICATION.
DC MOTOR CONTROL APPLICATION.
ELECTRIC CAR APPLICATION.

FEATURES:

- . High Voltage : $V_{CE(SUS)} > 200V$
- . Triple Diffused Design.
- . Darlington Design.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	200	V
Collector-Emitter Voltage	$V_{CE(SUS)}$	200	V
Emitter-Base Voltage	V_{EB0}	4	V
Collector Current	I_C	600	A
Emitter Current	I_E	-600	A
Base Current	I_B	12	A
Thermal Resistance (Double Side Cooling)	$R_{th(j-c)}$	0.04	$^\circ C/W$
Junction Temperature	T_j	125	$^\circ C$
Storage Temperature Range	T_{stg}	-40~150	$^\circ C$
Mounting Force Required	F	1000±100	kg



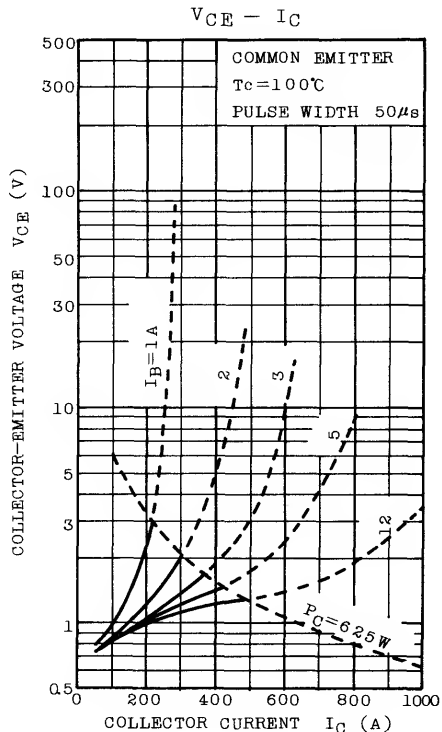
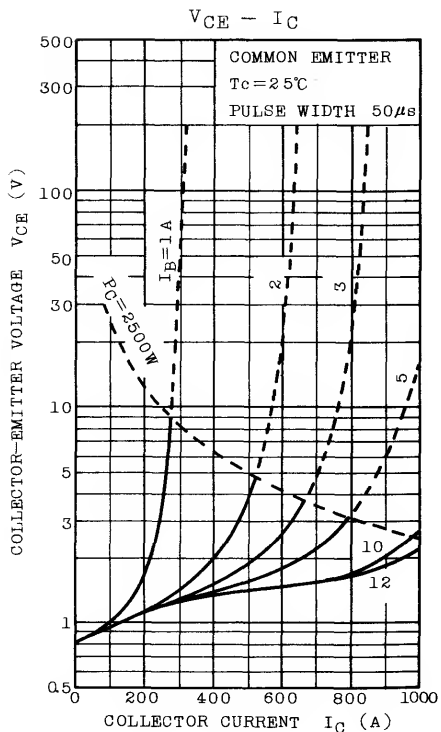
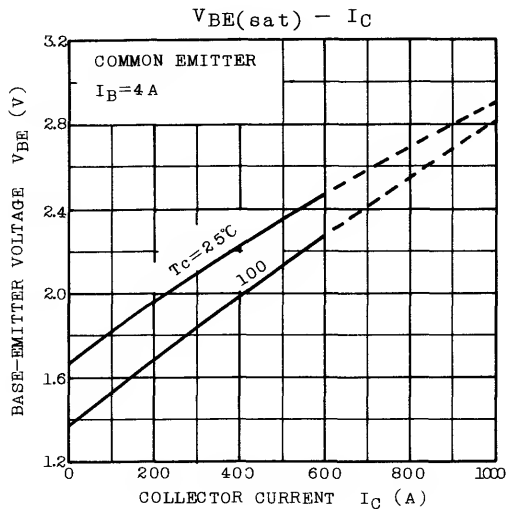
Weight : 250g

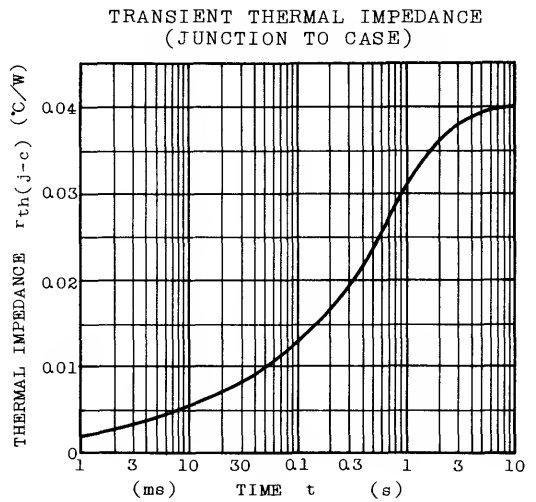
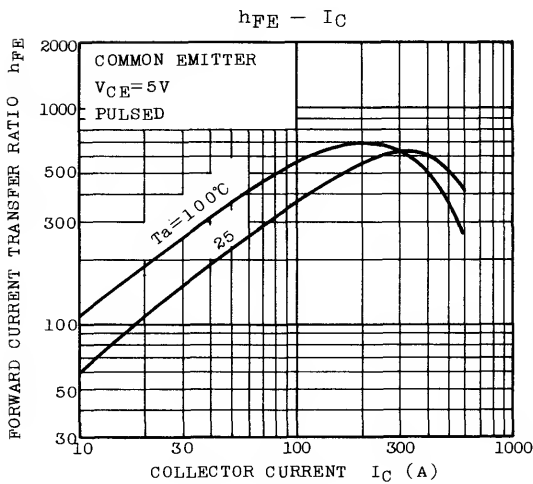
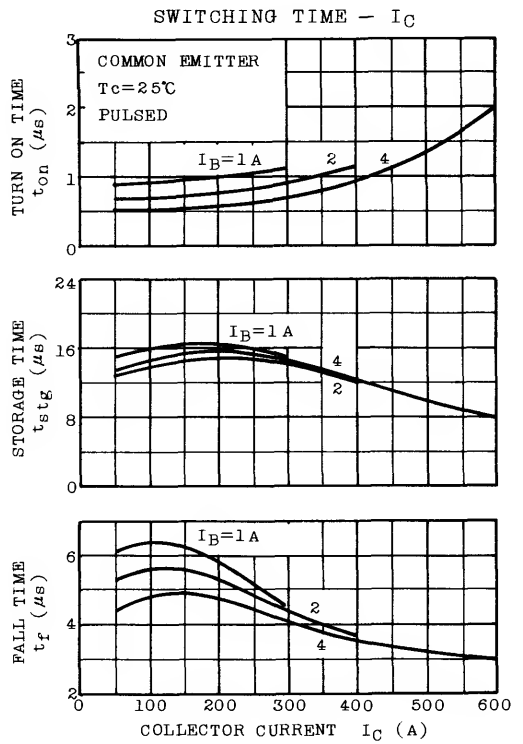
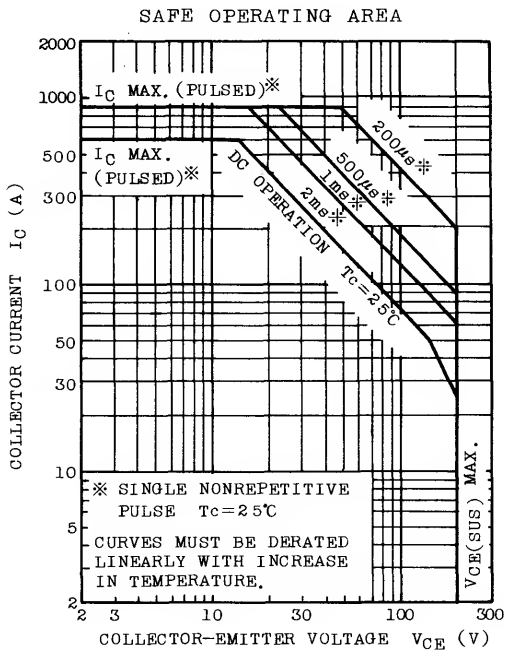
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=600A$	150	400	-	
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	$I_C=0.5A, L=40mH$	200	-	-	V
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=600A, I_B=8A$ (Note)	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Collector Cut-off Current		I_{CEO}	$V_{CE}=200V, I_B=0$	-	1.0	10	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=4V, I_C=0$	-	50	250	mA
Switching Time	Turn on Time	t_{on}	$I_C=600A, I_{B1}=4A, -I_{B2}=4A, V_C=100V$	-	2.0	-	μs
	Storage Time	t_{stg}		-	8	-	μs
	Fall Time	t_f		-	3	-	μs

Note : Pulse Test; Pulse Width $\leq 300\mu s$ Duty Cycle $\leq 3\%$
Mounting Force; $F=1000kg$

TOSHIBA CORPORATION





2SD700

SILICON NPN TRIPLE DIFFUSED MESA TYPE (DARLINGTON POWER)

INDUSTRIAL APPLICATIONS

Unit in mm

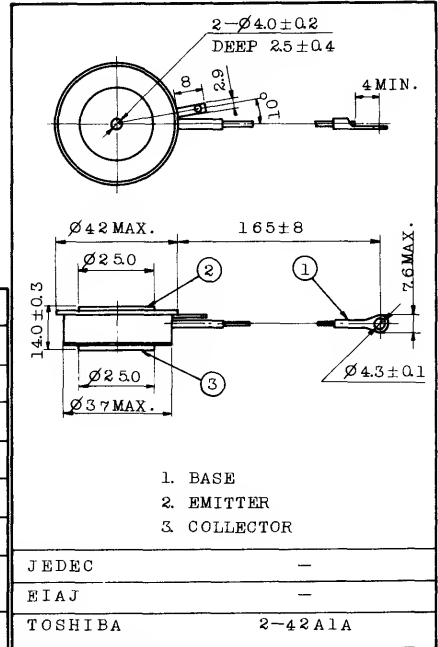
HIGH POWER SWITCHING APPLICATIONS.
DC-AC POWER INVERTER APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

FEATURES:

- . High Voltage : $V_{CEO(SUS)}=200V$
- . Triple Diffused Design.
- . Darlington Design.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector Base Voltage	V_{CBO}	300	V
Collector Emitter Voltage	$V_{CEO(SUS)}$	200	V
Emitter Base Voltage	V_{EBO}	5	V
Collector Current	I_C	200	A
Emitter Current	I_E	-200	A
Base Current	I_B	12	A
Thermal Resistance (Double Side Cooling)	$R_{th(j-c)}$	0.13	$^\circ C/W$
Junction Temperature	T_j	125	$^\circ C$
Storage Temperature Range	T_{stg}	-40~150	$^\circ C$
Mounting Force Required	F	400±40	kg

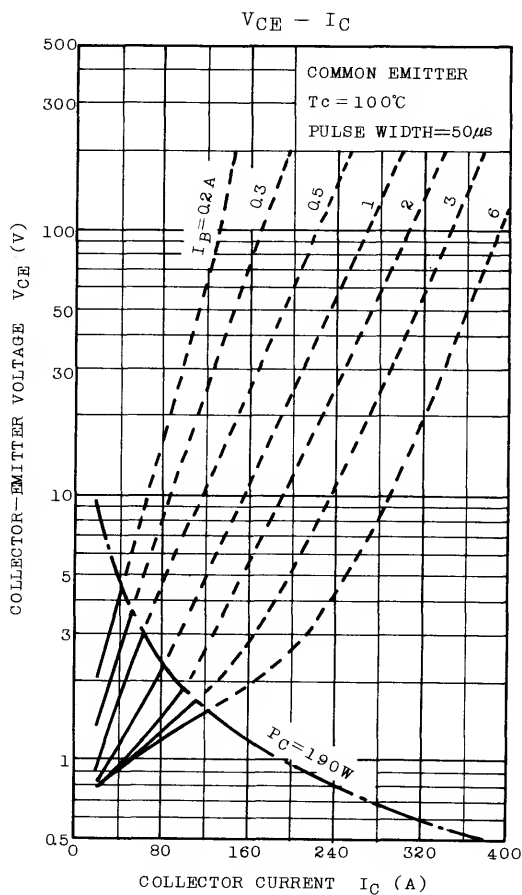
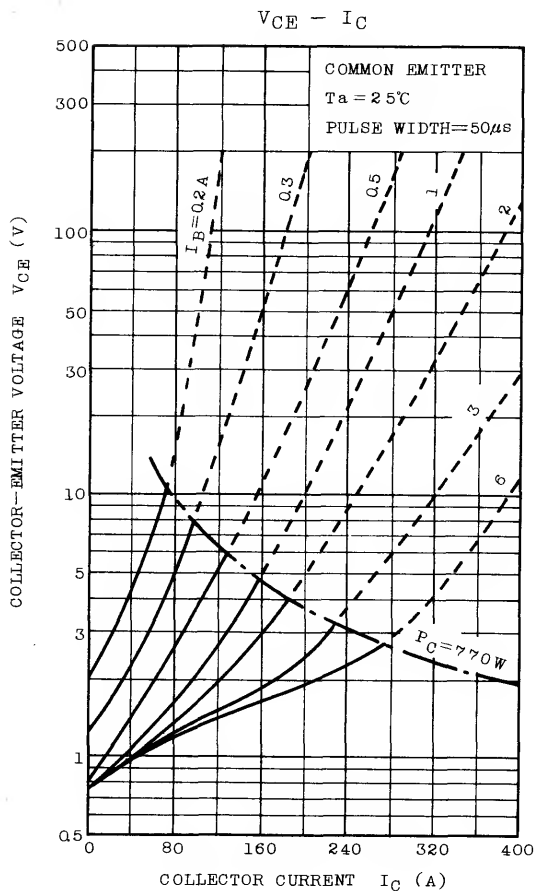
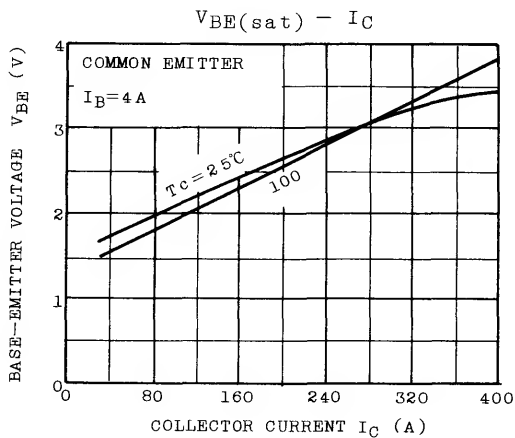


ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

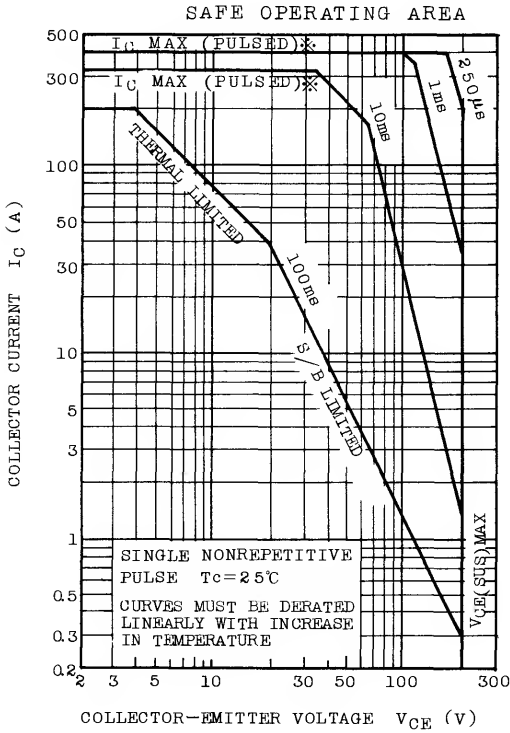
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=200A$	150	-	-		
		$V_{CE}=5V, I_C=100A$	-	700	-		
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	$I_C=0.5A, L=40mH$	200	-	-	V	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=200A, I_B=4A$ (Note)	-	-	2.0	V	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$		-	-	2.5	V	
Collector Cut-off Current	I_{CBO}	$V_{CB}=300V, I_E=0$	-	-	1.0	mA	
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	200	mA	
Switching Time	Turn-on Time	t_{on}	$I_C=200A, I_{B1}=4A, -I_{B2}=4A, V_C=100V$	-	1.0	-	μs
	Storage Time	t_{stg}		-	4.5	-	μs
	Fall Time	t_f		-	8.0	-	μs

Note : Pulse Test; Pulse Width $\leq 300\mu s$, Duty Cycle $\leq 3\%$
Mounting Force; $F=400kg$

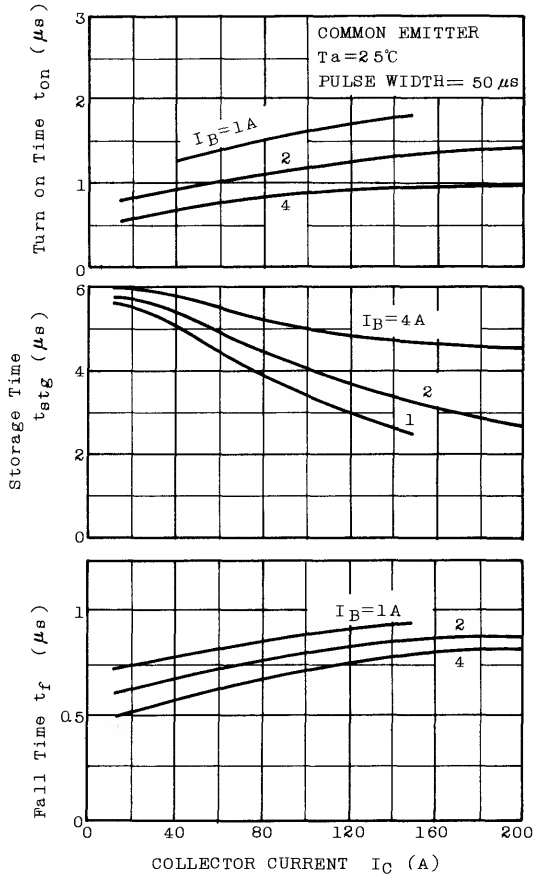
TOSHIBA CORPORATION



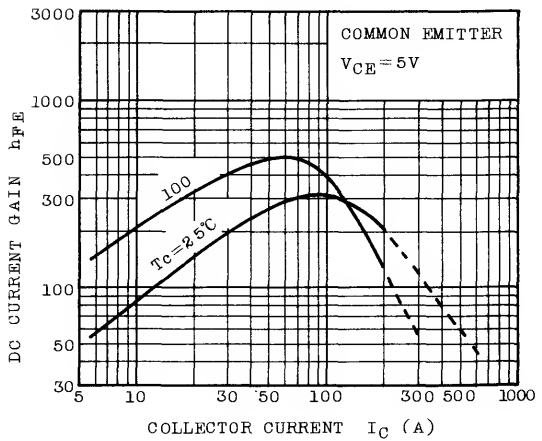
2SD700



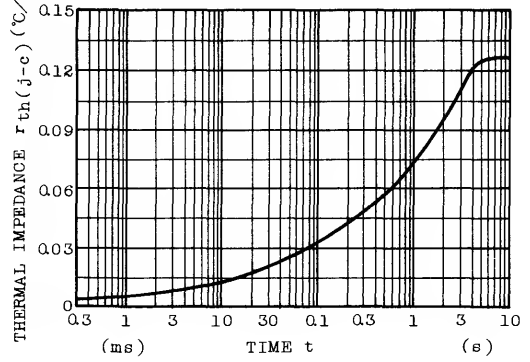
SWITCHING CHARACTERISTICS



$h_{FE} - I_C$



TRANSIENT THERMAL IMPEDANCE (JUNCTION - CASE)

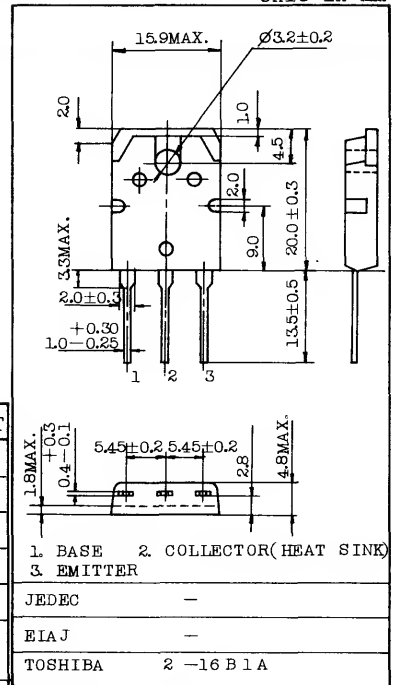


Unit in mm

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SB686.
- Recommended for 30 ~ 35W High-Fidelity Audio Frequency Amplifier Output Stage.



MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CBO}	100	V
Collector-Emitter Voltage	V _{CEO}	100	V
Emitter-Base Voltage	V _{EBO}	5	V
Collector Current	I _C	6	A
Emitter Current	I _E	-6	A
Collector Power Dissipation (T _c =25°C)	P _C	60	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55~150	°C

Weight : 4.6g

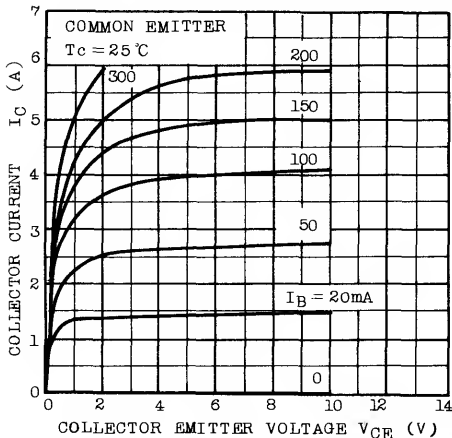
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CBO}	V _{CB} =100V, I _E =0	-	-	10	μA
Emitter Cut-off Current	I _{EBO}	V _{EB} =5V, I _C =0	-	-	10	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CEO}	I _C =50mA, I _B =0	100	-	-	V
Emitter-Base Breakdown Voltage	V _{(BR)EBO}	I _E =10mA, I _C =0	5	-	-	V
DC Current Gain	h _{FE} (Note)	V _{CE} =5V, I _C =1A	55	-	160	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =4A, I _B =0.4A	-	-	2.0	V
Base-Emitter Voltage	V _{BE}	V _{CE} =5V, I _C =4A	-	-	1.5	V
Transition Frequency	f _T	V _{CE} =5V, I _C =1A	-	12	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	100	-	pF

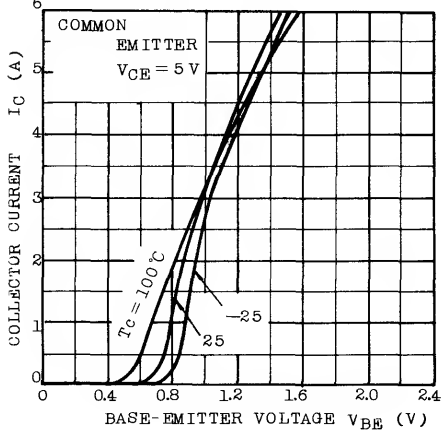
Note : h_{FE} Classification R : 55~110, O : 80~160

2SD716

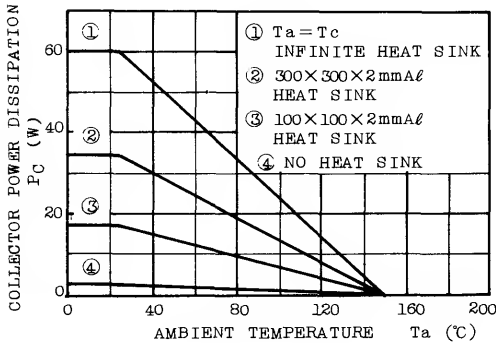
$I_C - V_{CE}$ (LOW VOLTAGE REGION)



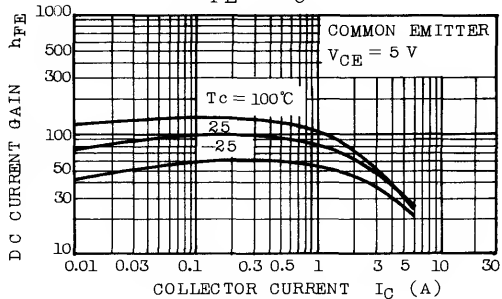
$I_C - V_{BE}$



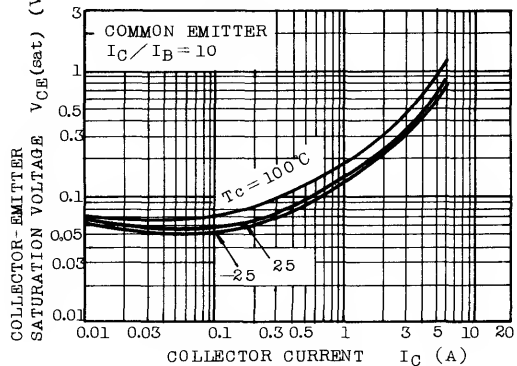
$P_C - T_a$



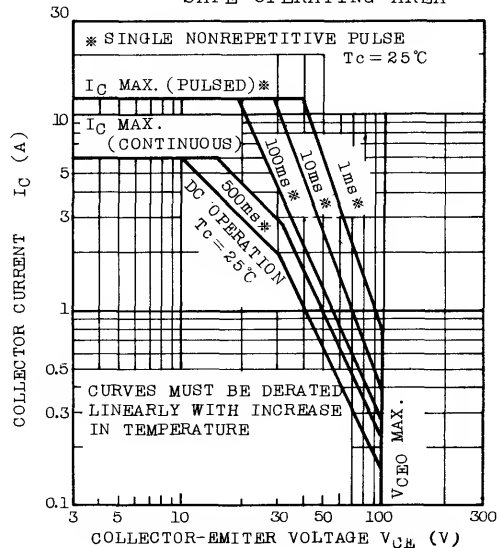
$h_{FE} - I_C$



$V_{CE(sat)} - I_C$



SAFE OPERATING AREA



Unit in mm

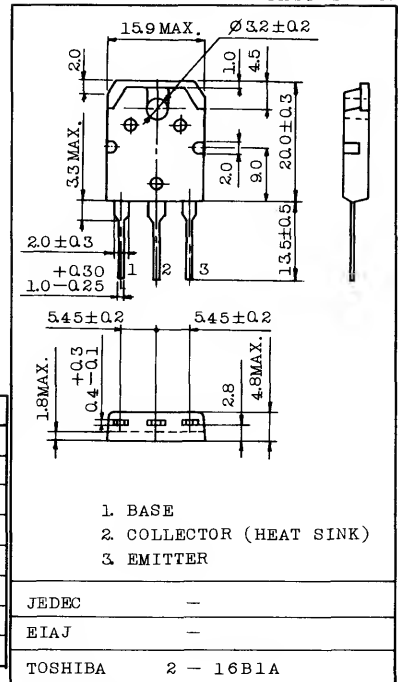
HIGH POWER SWITCHING APPLICATIONS.
DC-DC CONVERTER AND DC-AC INVERTER APPLICATIONS.

FEATURES:

- Low Collector Saturation Voltage
: $V_{CE(sat)}=0.4V$ (Max.), ($I_C=6A$)
- High Collector Power Dissipation : $P_C=80W$ ($T_c=25^\circ C$)

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	70	V
Collector-Emitter Voltage	V_{CEO}	50	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	10	A
Base Current	I_B	2	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	80	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55~150	$^\circ C$



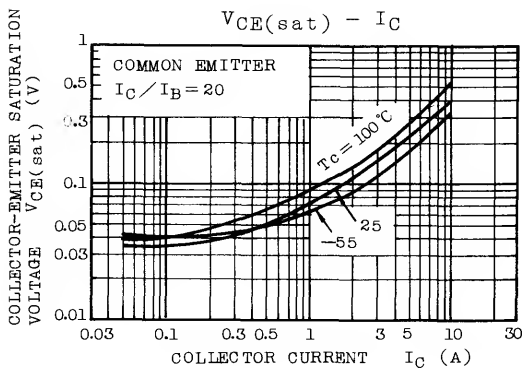
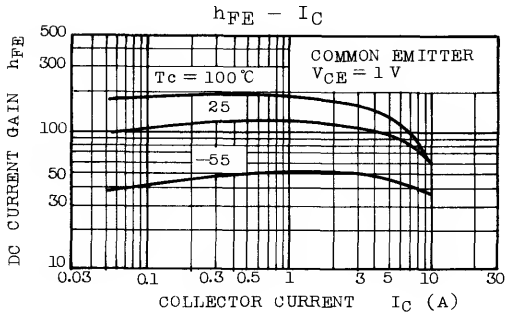
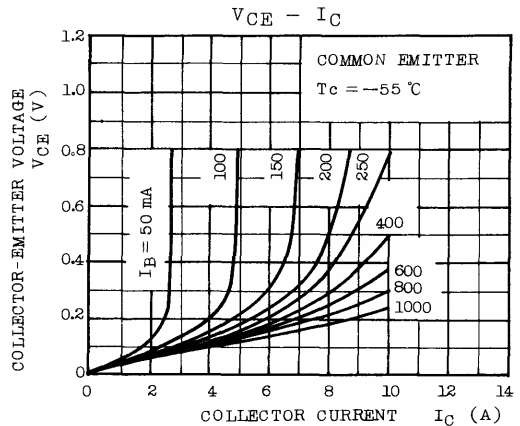
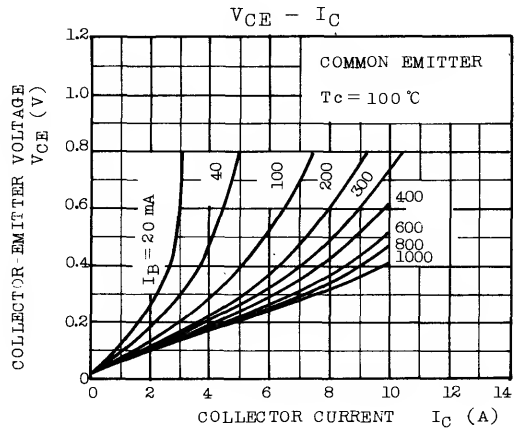
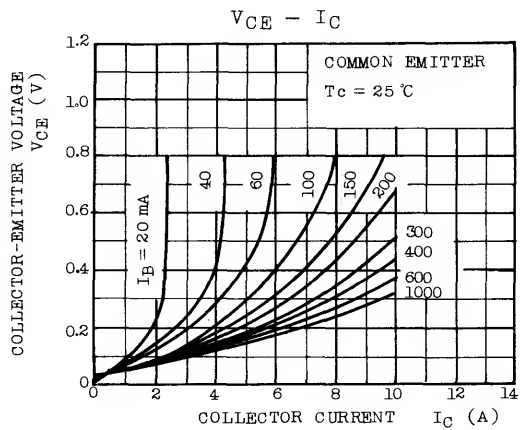
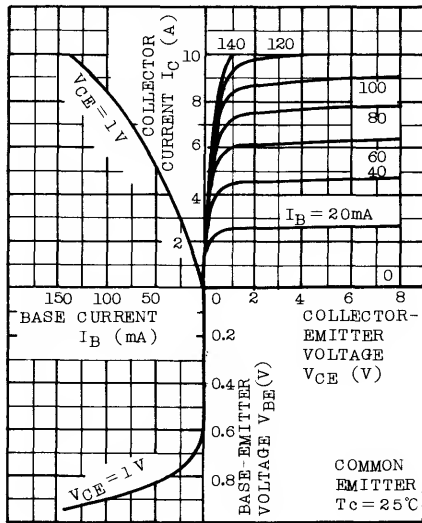
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

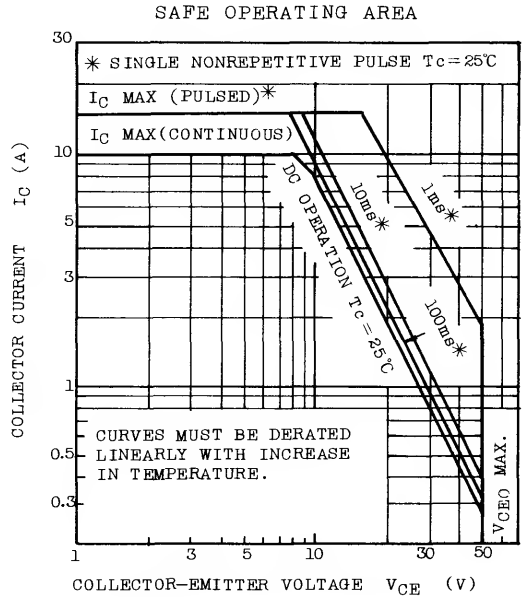
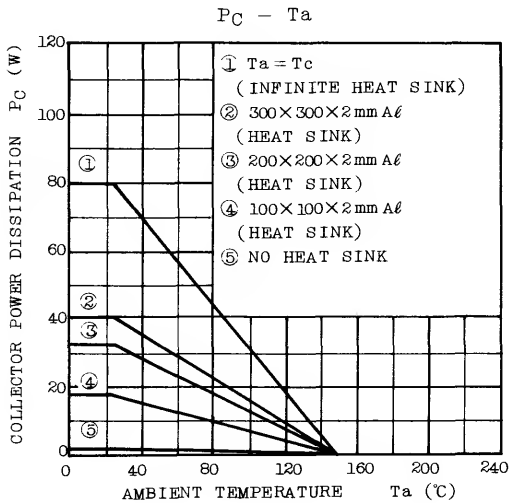
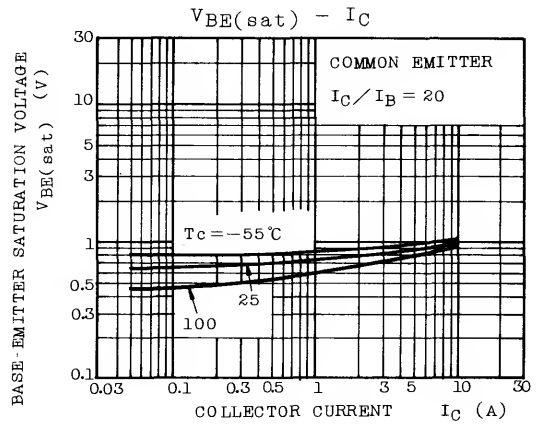
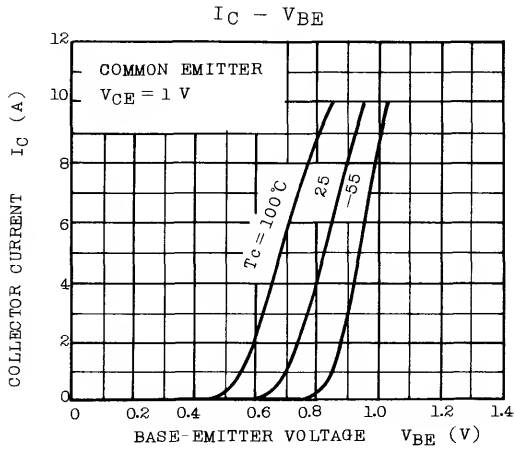
Weight : 4.6 g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=70V, I_E=0$	-	-	10	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	10	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=1V, I_C=1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=1V, I_C=6A$	30	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=6A, I_B=0.3A$	-	0.25	0.4	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=6A, I_B=0.3A$	-	0.9	1.2	V
Transition Frequency		f_T	$V_{CE}=4V, I_C=1A$	-	10	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	350	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.3	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		$I_{B1}=-I_{B2}=0.3A$ DUTY CYCLE $\leq 1\%$	-	0.4	

Note : $h_{FE(1)}$ Classification 0 : 70~140, Y : 120~240

STATIC CHARACTERISTICS





2SD718

SILICON NPN TRIPLE DIFFUSED TYPE

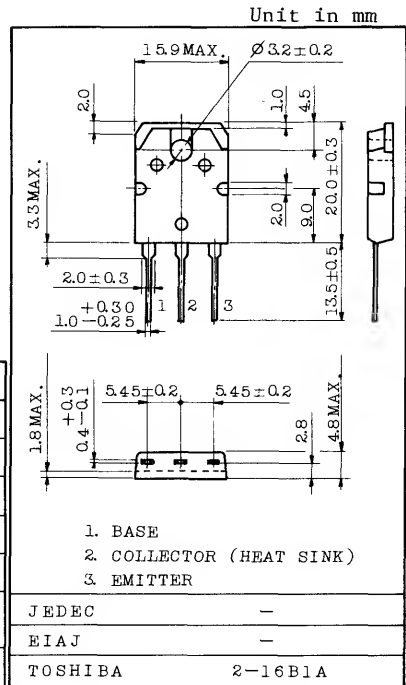
AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SB688.
- Recommended for 45~50W audio frequency amplifier output stage.

MAXIMUM RATINGS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	120	V
Collector-Emitter Voltage	V_{CE0}	120	V
Emitter-Base Voltage	V_{EB0}	5	V
Collector Current	I_C	8	A
Base Current	I_B	0.8	A
Collector Power Dissipation ($T_c=25^{\circ}\text{C}$)	P_C	80	W
Junction Temperature	T_j	150	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	-55~150	$^{\circ}\text{C}$

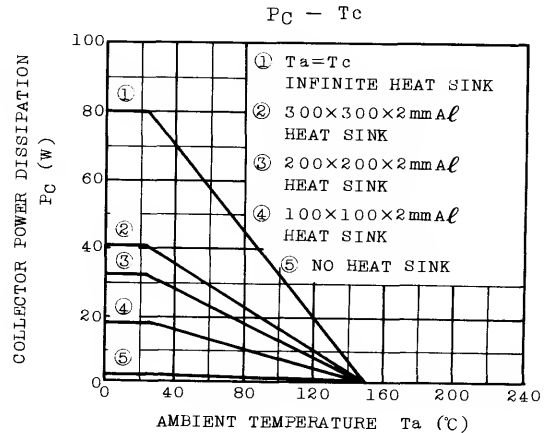
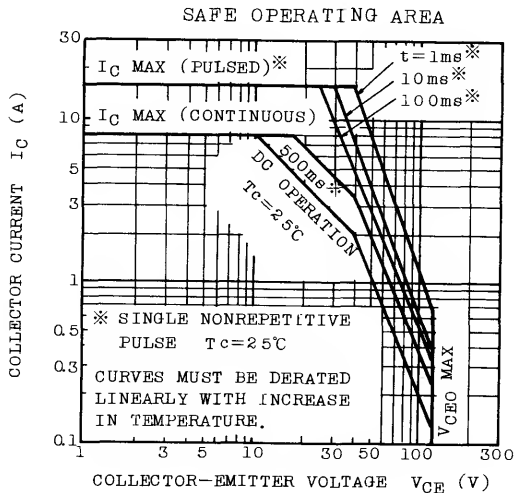
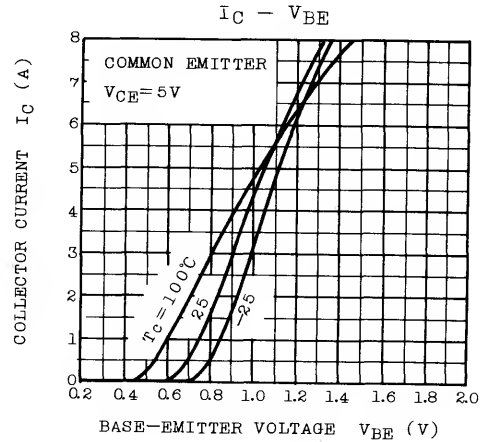
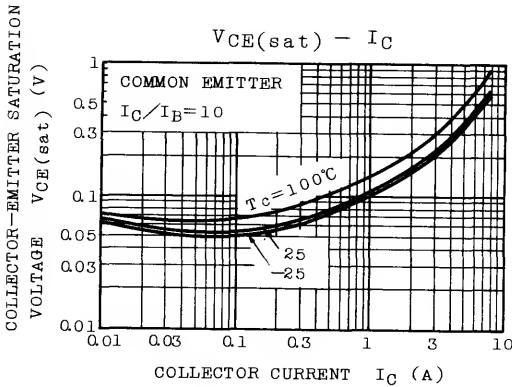
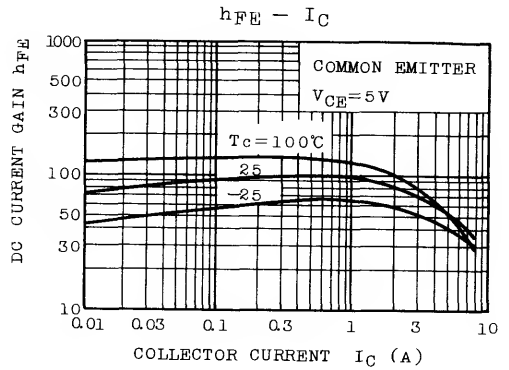
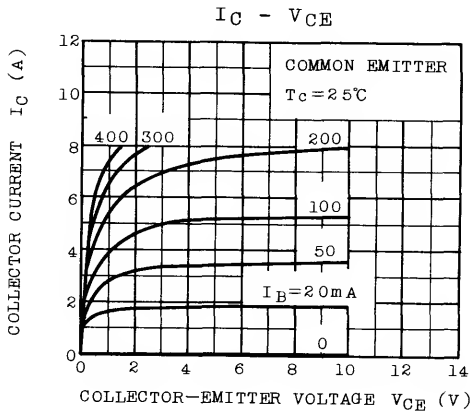


Weight : 4.6g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=120\text{V}, I_E=0$	-	-	10	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=5\text{V}, I_C=0$	-	-	10	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C=50\text{mA}, I_B=0$	120	-	-	V
DC Current Gain	h_{FE} (Note)	$V_{CE}=5\text{V}, I_C=1\text{A}$	55	-	160	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=5\text{A}, I_B=0.5\text{A}$	-	-	2.5	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5\text{V}, I_C=5\text{A}$	-	-	1.5	V
Transition Frequency	f_T	$V_{CE}=5\text{V}, I_C=1\text{A}$	-	12	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10\text{V}, I_E=0, f=1\text{MHz}$	-	170	-	pF

Note: h_{FE} Classification R:55~110, O:80~160



2SD777

SILICON NPN DOUBLE DIFFUSED TYPE
(PCT PROCESS)

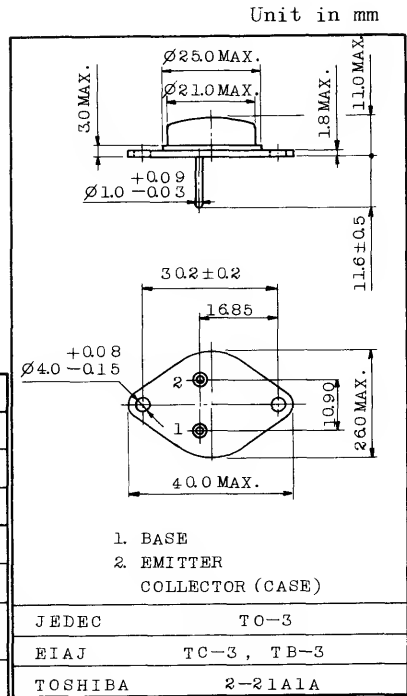
POWER REGULATOR FOR LINE OPERATED
TV APPLICATIONS.

FEATURES:

- Excellent Wide Safe Operating Area
(100 W.S at $T_c=25^\circ\text{C}$).
- Included Abalanche Diode. : $V_Z=55\pm 10\text{V}$
- High D.C Current Gain. : $h_{FE} \geq 500$
- High Collector Power Dissipation Capability :
100 W at 25°C Case Temperature.

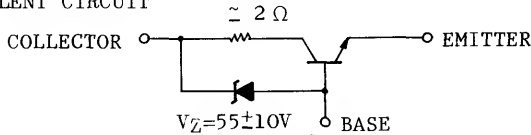
MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	55 ± 10	V
Collector-Emitter Voltage	V_{CE0}	55 ± 10	V
Emitter-Base Voltage	V_{EB0}	6	V
Collector Current(Continuous)	I_C	4	A
Collector Current (Peak)	I_{CP}	20	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	100	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	$-65\sim 150$	$^\circ\text{C}$



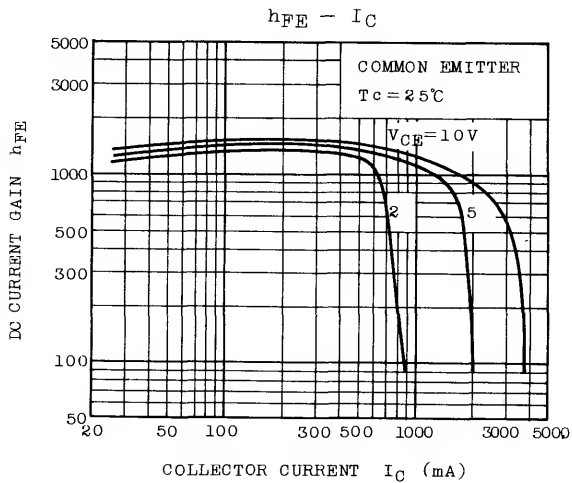
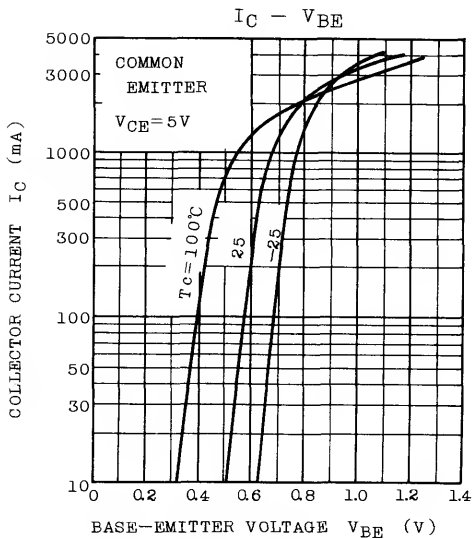
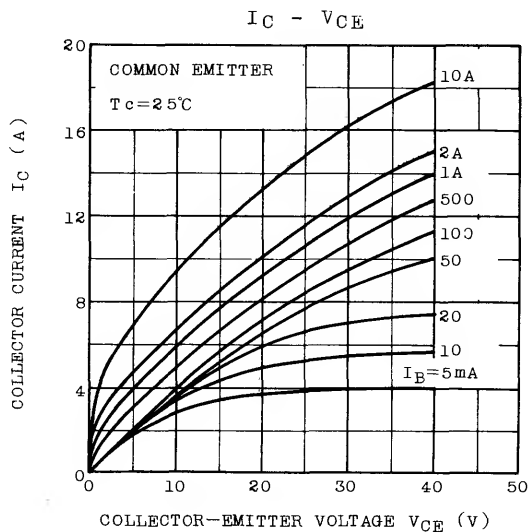
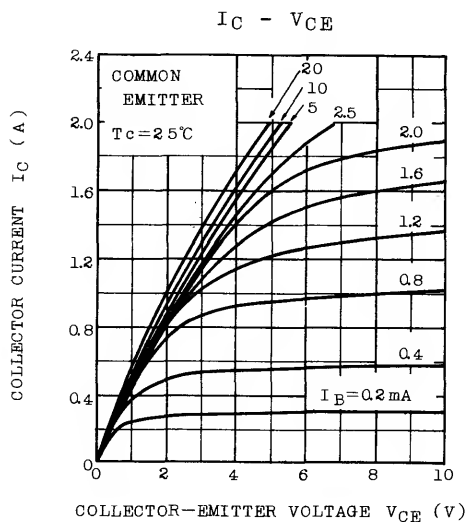
Mounting kit No. AC73
Weight:12.0g

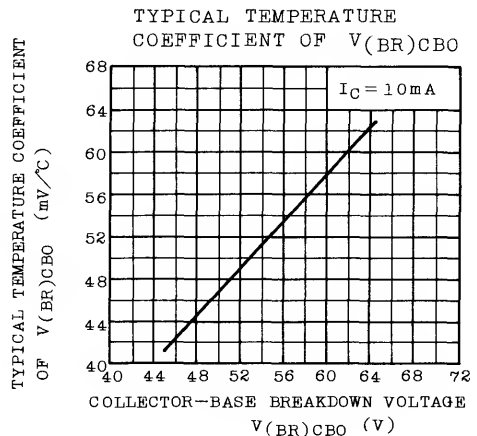
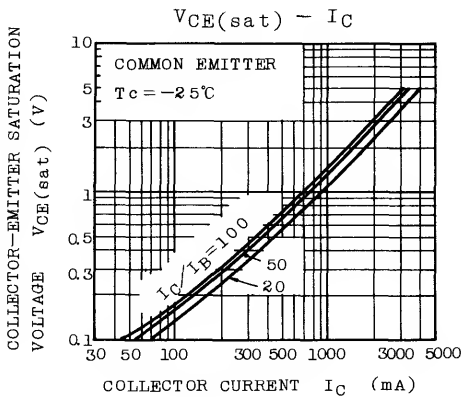
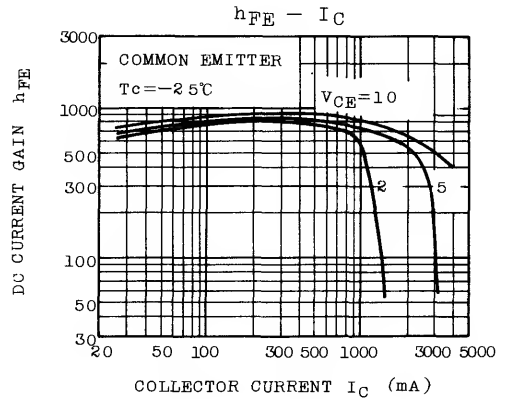
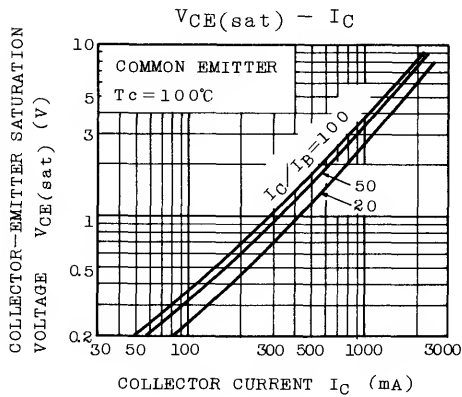
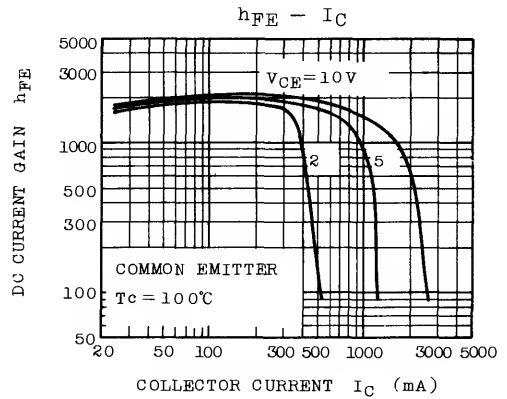
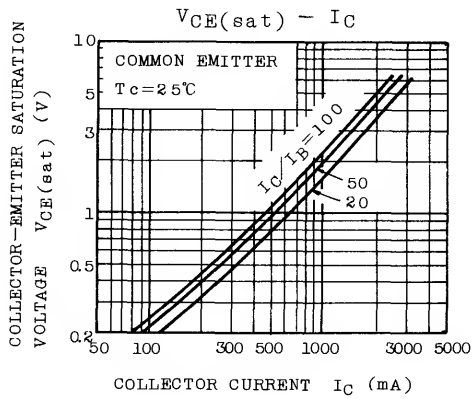
EQUIVALENT CIRCUIT

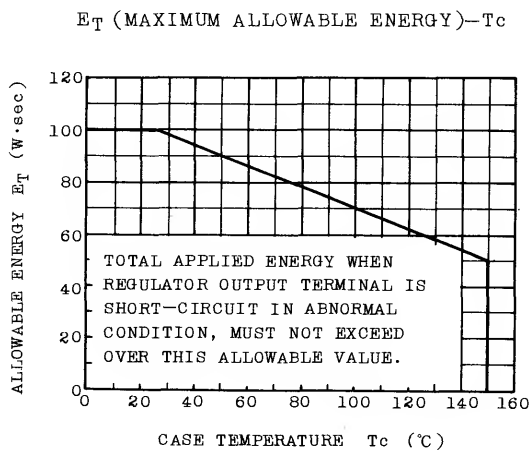
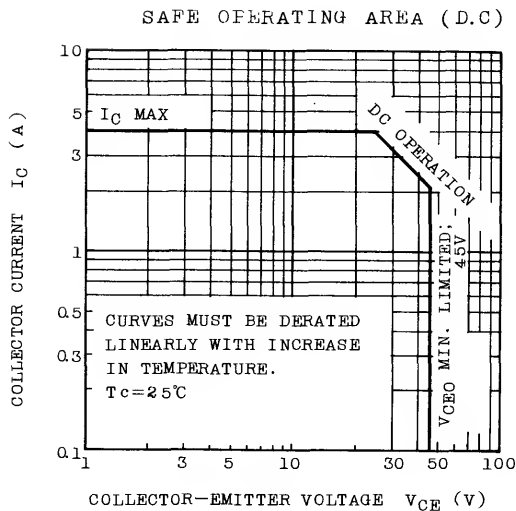
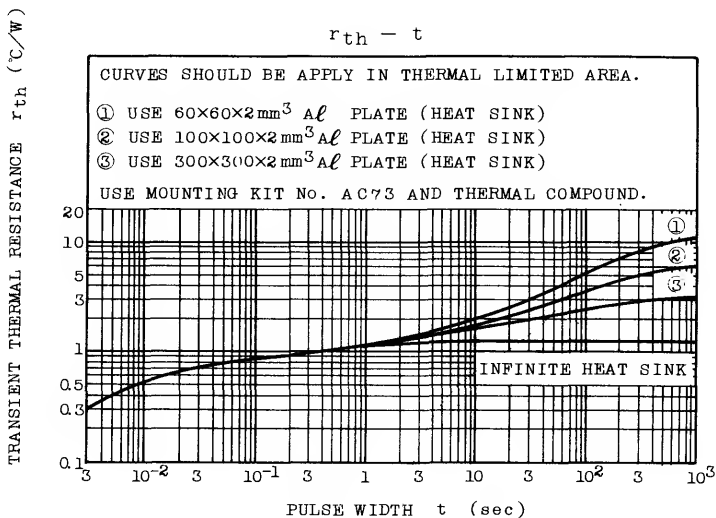


ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=10\text{mA}, I_E=0$	45	55	65	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=100\text{mA}, I_B=0$	45	55	65	V
Emitter Cut-off Current	I_{EBO}	$V_{EB}=6\text{V}, I_C=0$	-	-	10	μA
DC Current Gain	h_{FE}	$V_{CE}=5\text{V}, I_C=500\text{mA}$	500	1000	2500	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}^{(1)}$	$I_C=500\text{mA}, I_B=2\text{mA}$	-	-	2.0	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}^{(2)}$	$I_C=1.0\text{A}, I_B=20\text{mA}$	1.0	2.0	3.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5\text{V}, I_C=500\text{mA}$	0.50	0.65	0.80	V
Allowable Energy ($T_c=25^\circ\text{C}$)	E_T	Application Circuit	100	-	-	W·sec

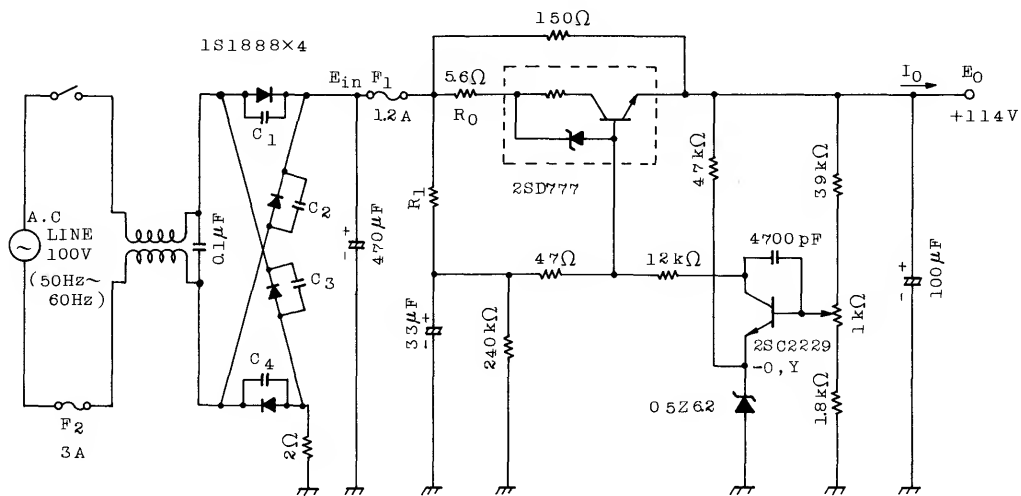






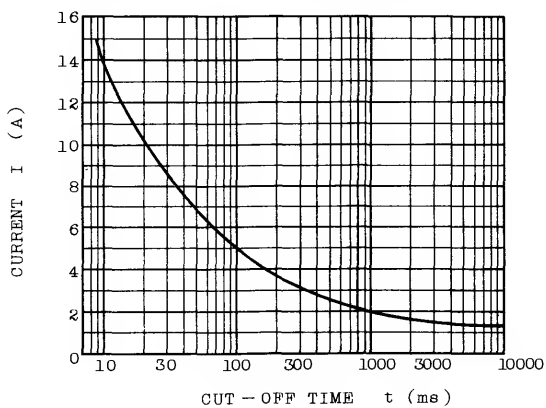
2SD777

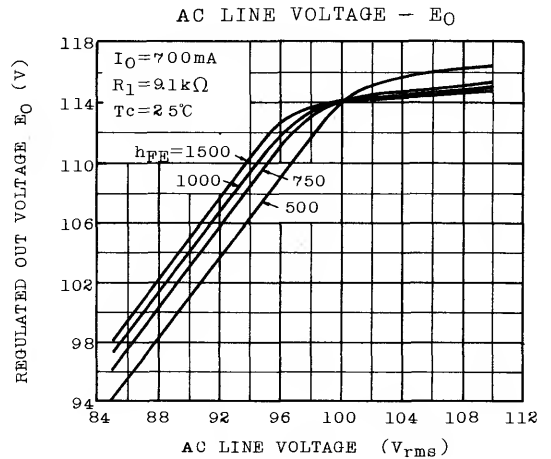
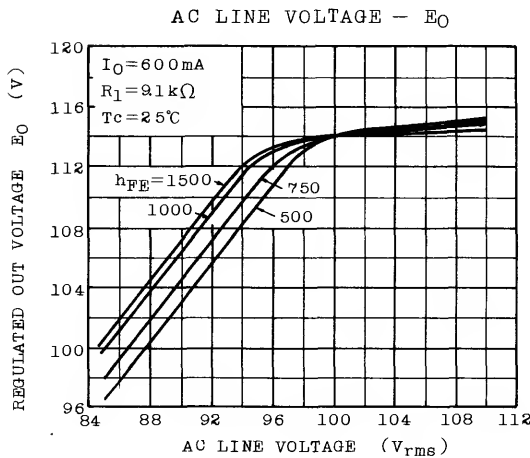
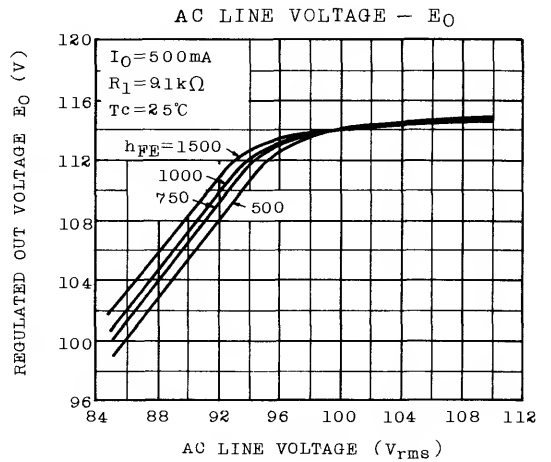
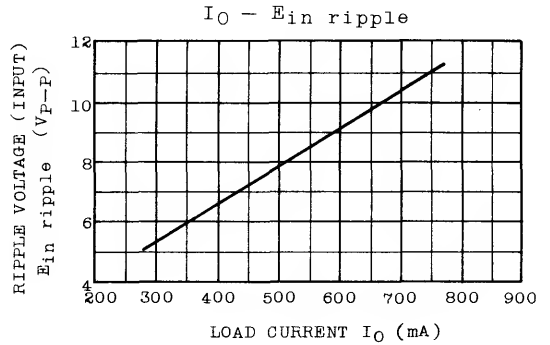
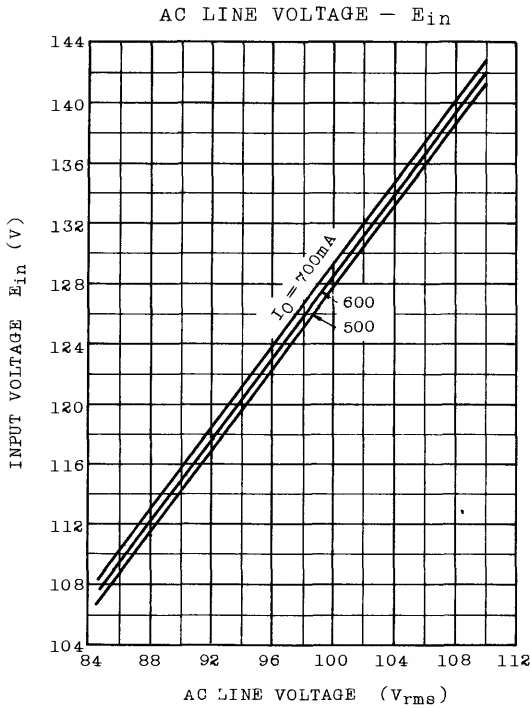
APPLICATION CIRCUIT



$C_1, C_2, C_3, C_4 : 0.0047\mu F$

FUSE F_1 ; I-t CHARACTERISTIC





2SD797

SILICON NPN TRIPLE DIFFUSED TYPE

INDUSTRIAL APPLICATIONS

Unit in mm

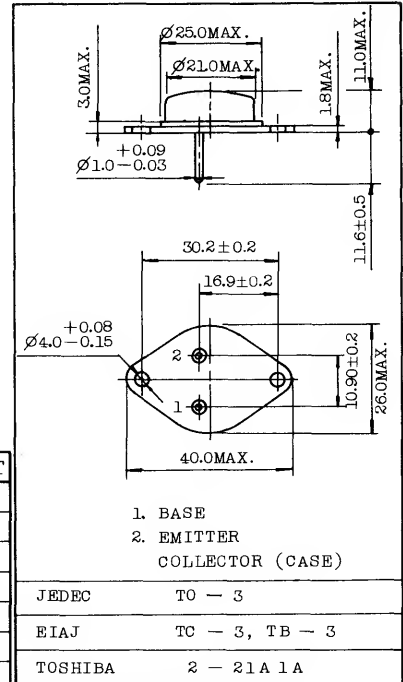
HIGH POWER AMPLIFIER APPLICATIONS.
HIGH POWER SWITCHING APPLICATIONS.
DC-DC CONVERTER APPLICATIONS.
REGULATOR APPLICATIONS.

FEATURES:

- High Power Dissipation : $P_C=200W$ ($T_c=25^\circ C$)
- High Collector Current : $I_C=30A$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	100	V
Collector-Emitter Voltage	V_{CE0}	80	V
Emitter-Base Voltage	V_{EB0}	7	V
Collector Current	I_C	30	A
Base Current	I_B	8	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	200	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65~175	$^\circ C$

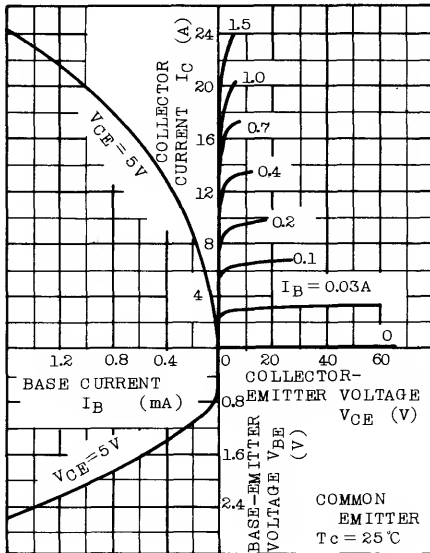


Mounting Kit No. AC73
Weight : 12.9g

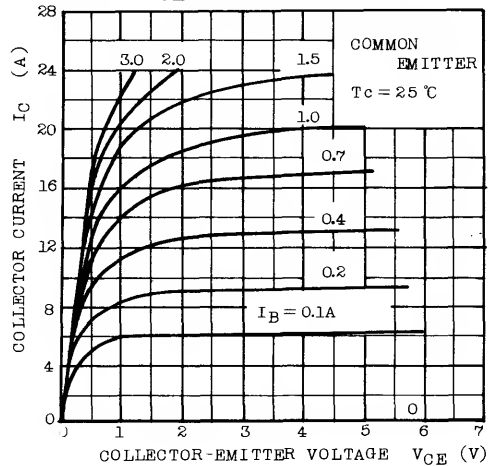
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Collector Cut-off Current	I_{CBO}	$V_{CB}=100V, I_E=0$	-	-	100	μA	
Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	100	μA	
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	80	-	-	V	
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=5V, I_C=1A$	60	-	200		
	$h_{FE(2)}$	$V_{CE}=5V, I_C=15A$	10	-	-		
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=15A, I_B=3A$	-	0.6	1.5	V	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$		-	1.4	2.5	V	
Transition Frequency	f_T	$V_{CE}=5V, I_C=1A$	-	1.5	-	MHz	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	400	-	pF	
Switching Time	Turn-on Time	t_{on}			-	2.5	-
	Storage Time	t_{stg}			-	6	-
	Fall Time	t_f			-	1.5	-

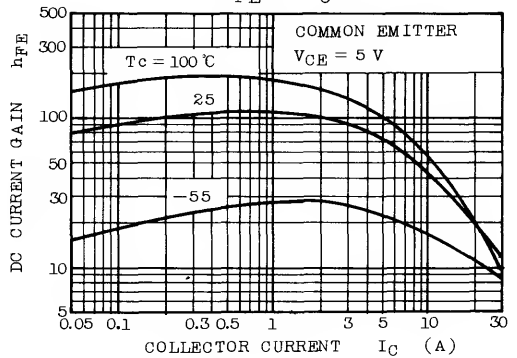
STATIC CHARACTERISTICS



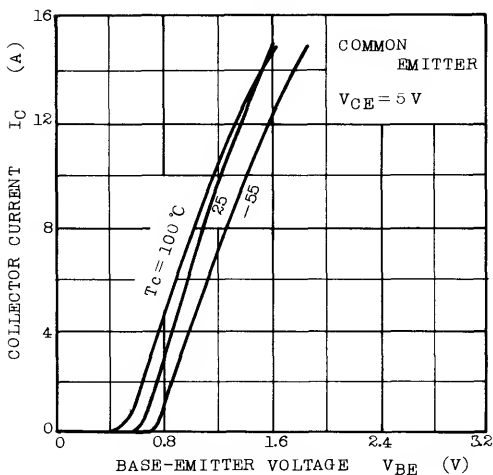
$I_C - V_{CE}$ (LOW VOLTAGE REGION)



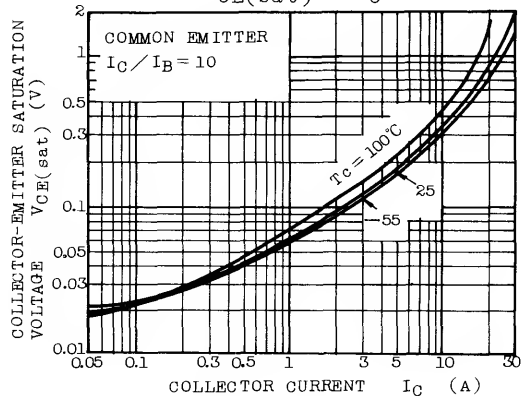
$h_{FE} - I_C$

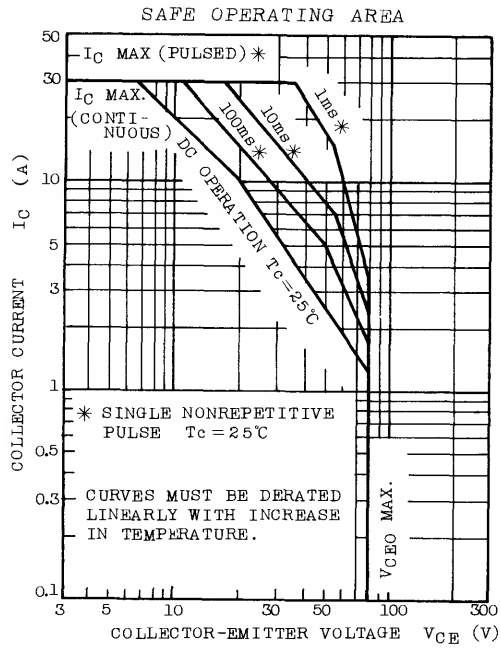
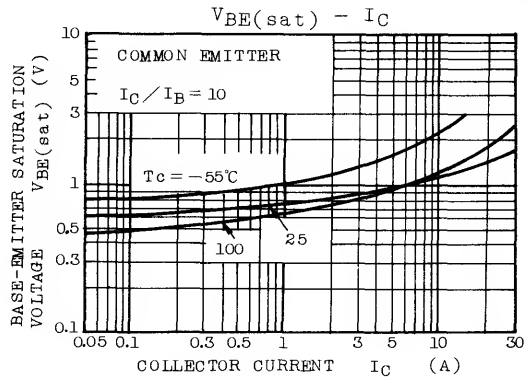
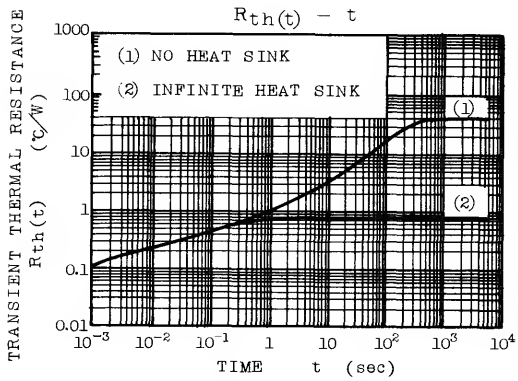


$I_C - V_{BE}$



$V_{CE(sat)} - I_C$





IGNITER APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.

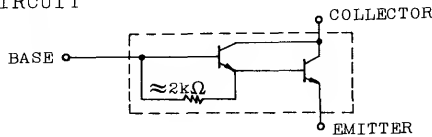
FEATURES:

- High DC Current Gain
- $h_{FE}=1500$ (Min.) ($V_{CE}=2V, I_C=2A$)

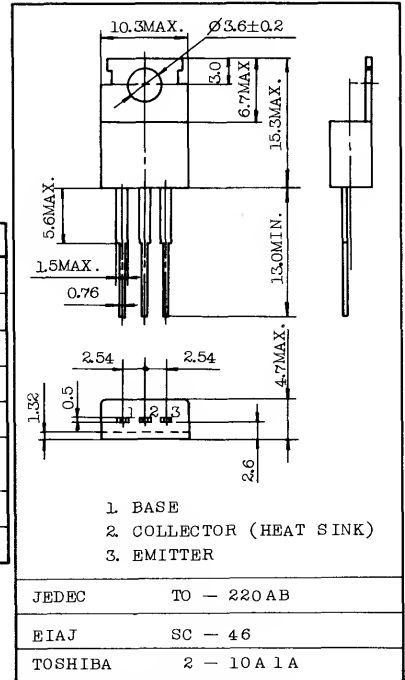
MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	V_{CEO}	300	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Base Current	I_B	1	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	30	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55~150	$^\circ C$

EQUIVALENT CIRCUIT



INDUSTRIAL APPLICATIONS.
Unit in mm

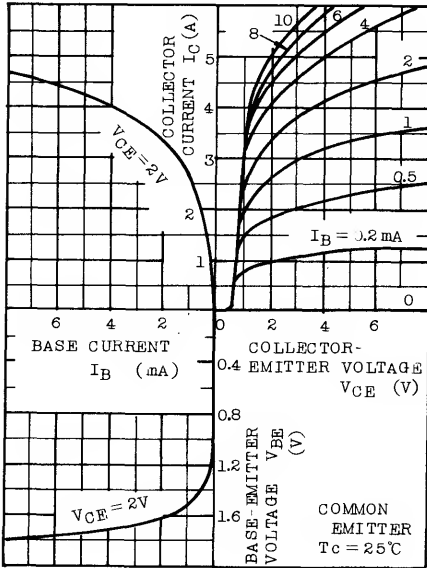


Mounting Kit No. AC75
Weight : 1.9g

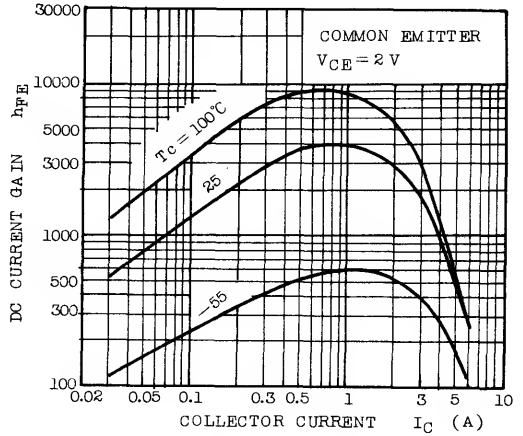
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=600V, I_E=0$	-	-	0.5	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	0.5	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	$I_C=0.5A, L=40mH$	300	-	-	V
DC Current Gain		$h_{FE(1)}$	$V_{CE}=2V, I_C=2A$	1500	-	-	
		$h_{FE(2)}$	$V_{CE}=2V, I_C=4A$	200	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=4A, I_B=0.04A$	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=4A, I_B=0.04A$	-	-	2.5	V
Collector Output Capacitance		C_{ob}	$V_{CB}=50V, I_E=0, f=1MHz$	-	35	-	pF
Switching Time	Turn-on Time	t_{on}		-	1	-	μs
	Storage Time	t_{stg}		-	8	-	
	Fall Time	t_f		-	5	-	

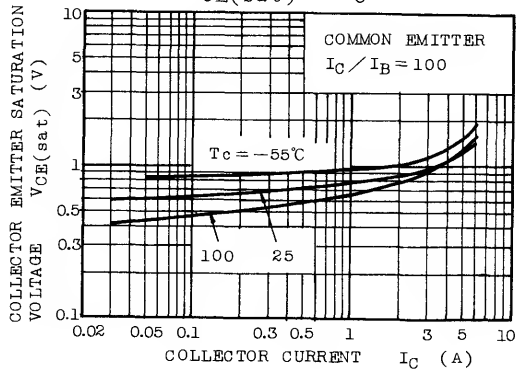
STATIC CHARACTERISTICS



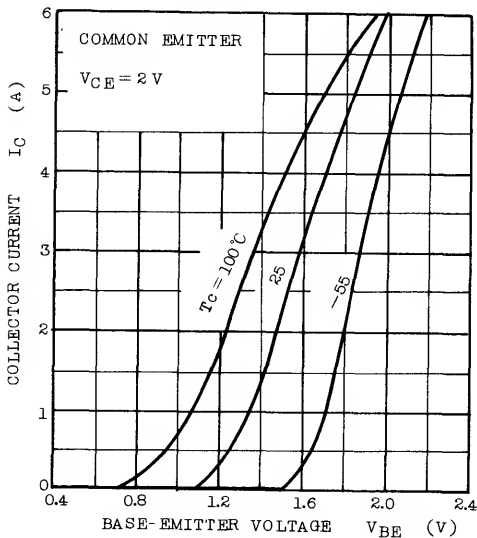
$h_{FE} - I_C$



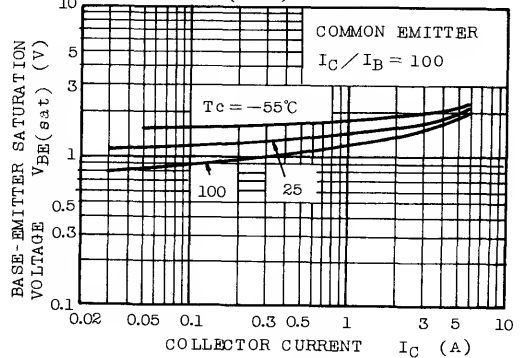
$V_{CE(sat)} - I_C$

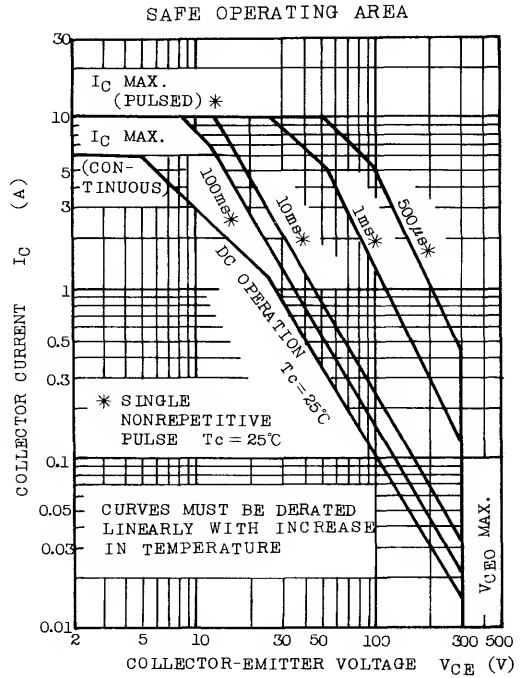
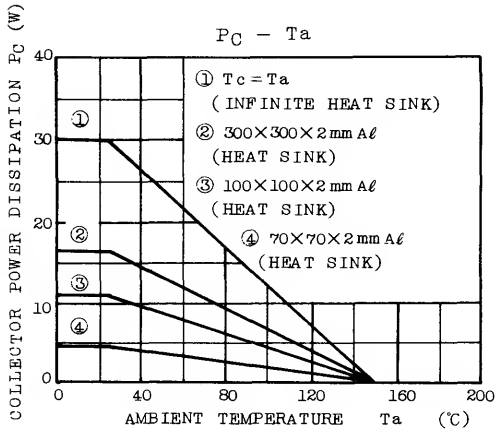


$I_C - V_{BE}$



$V_{BE(sat)} - I_C$





2SD799

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

INDUSTRIAL APPLICATIONS

Unit in mm

IGNITER APPLICATIONS.

HIGH VOLTAGE SWITCHING APPLICATIONS.

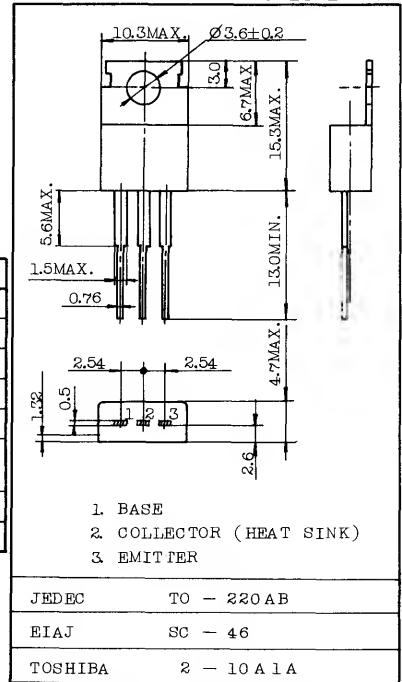
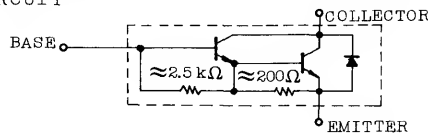
FEATURES:

- High DC Current Gain : $h_{FE}=600(\text{Min.}) (V_{CE}=2V, I_C=2A)$
- Monolithic Construction with Built-In Base-Emitter Shunt Resistor.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Base Current	I_B	1	A
Collector Power Dissipation (Tc=25°C)	P_C	30	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C

EQUIVALENT CIRCUIT



JEDEC TO - 220 AB

EIAJ SC - 46

TOSHIBA 2 - 10 A 1 A

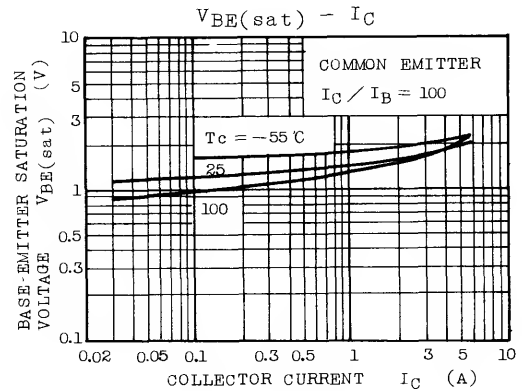
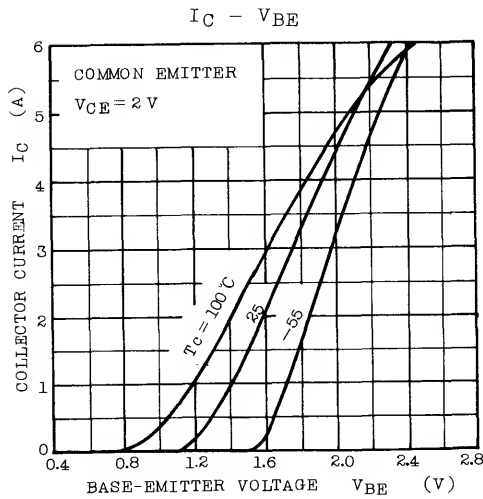
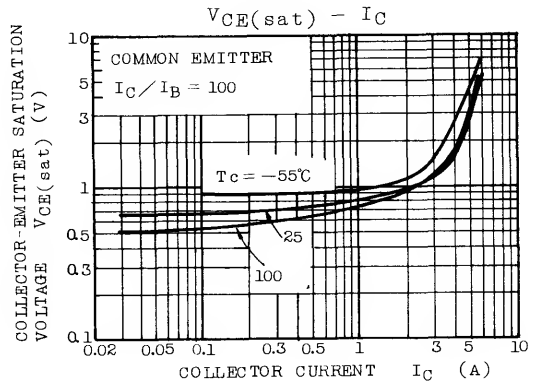
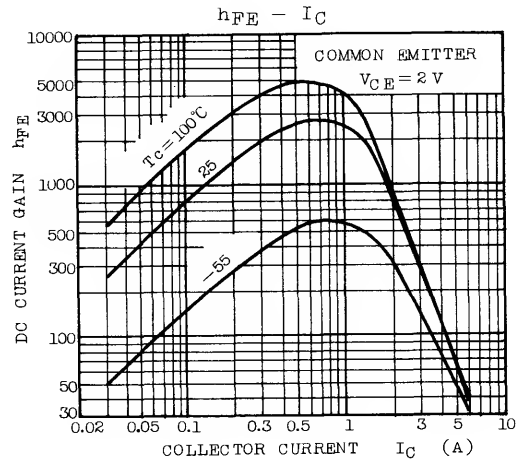
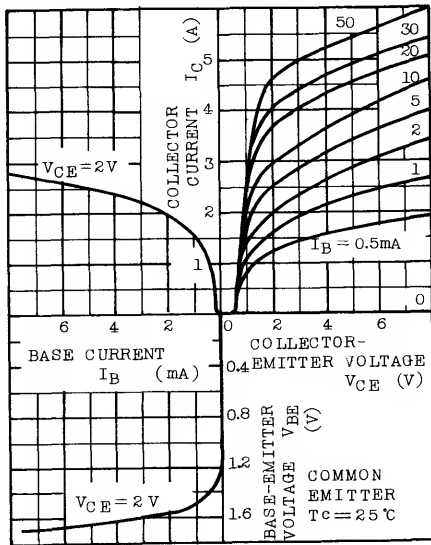
Mounting Kit No. AC75

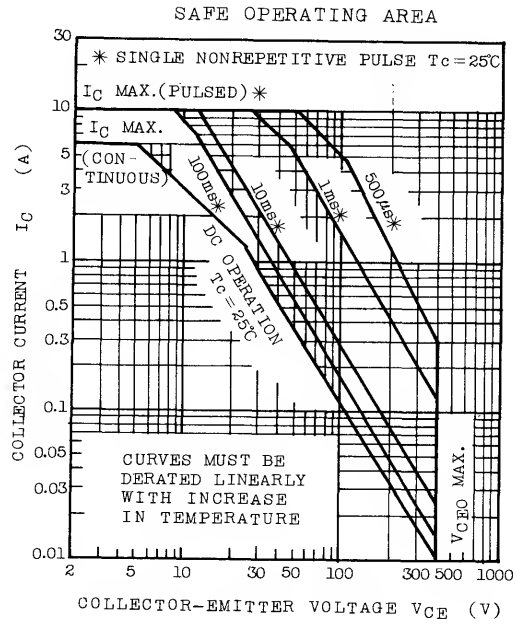
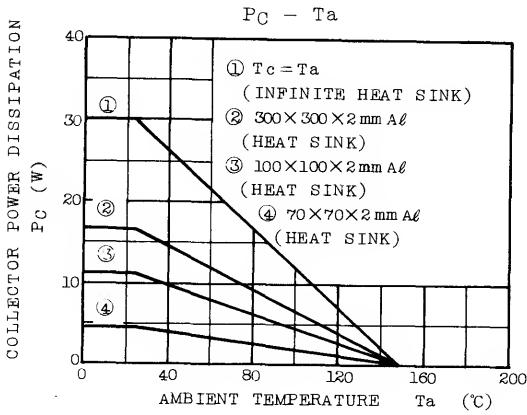
Weight : 1.9g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=600V, I_E=0$	-	-	0.5	mA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	3	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	400	-	-	V
DC Current Gain	$h_{FE}(1)$	$V_{CE}=2V, I_C=2A$	600	-	-	
	$h_{FE}(2)$	$V_{CE}=2V, I_C=4A$	100	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A, I_B=0.04A$	-	-	2.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4A, I_B=0.04A$	-	-	2.5	V
Emitter-Collector Forward Voltage	V_{ECF}	$I_E=4A, I_B=0$	-	-	3.0	V
Collector Output Capacitance	C_{ob}	$V_{CB}=50V, I_E=0, f=1MHz$	-	35	-	pF
Switching Time	Turn-on Time	t_{on}	-	1	-	μs
	Storage Time	t_{stg}	-	8	-	
	Fall Time	t_f	-	5	-	

STATIC CHARACTERISTICS





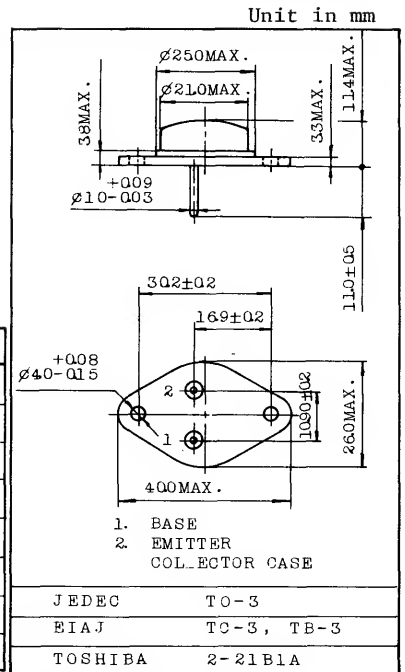
HIGH POWER SWITCHING REGULATOR APPLICATIONS.

FEATURES:

- High Voltage : $V_{CBO}=900V$
- High Peak Current Capability : $I_C(\text{Peak})=10A$
- High Speed Switching : $t_f=0.5\mu s$ (Max.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	900	V
Collector-Emitter Voltage	V_{CEO}	400	V
Collector-Base Voltage	V_{EBO}	7	V
Collector Current (DC)	I_C	6	A
Peak Collector Current	$I_C \text{ peak}$	10	A
Collector Power Dissipation (Tc=25°C)	P_C	50	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-65~150	°C

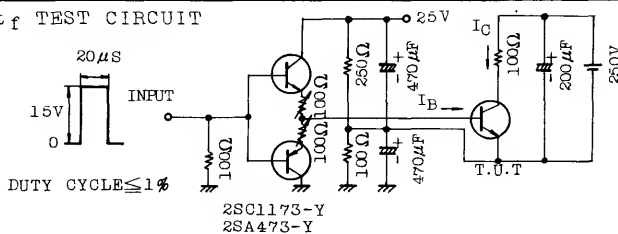


ELECTRICAL CHARACTERISTICS (Ta=25°C)

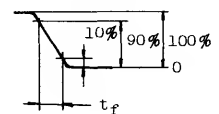
Mounting kit No. AC42C
Weight : 17g

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=900V, I_E=0$	-	-	1	mA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
DC Current Gain	$h_{FE}(1)$	$V_{CE}=5V, I_C=10mA$	8	-	-	
	$h_{FE}(2)$	$V_{CE}=5V, I_C=0.6A$	10	-	40	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=2.5A, I_B=0.5A$	-	-	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=2.5A, I_B=0.5A$	-	-	1.5	V
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	75	-	pF
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.1A$	-	5	-	MHz
Fall Time	t_f	$I_C=2.5A, I_{B1}=0.5A, I_{B2}=-1A$ (Fig.)	-	-	0.5	μs

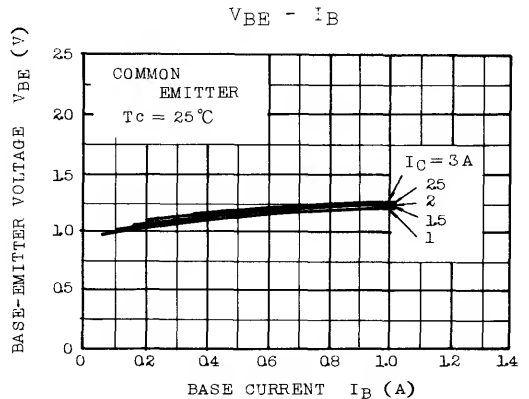
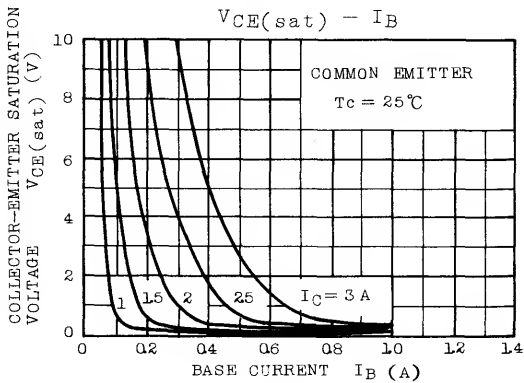
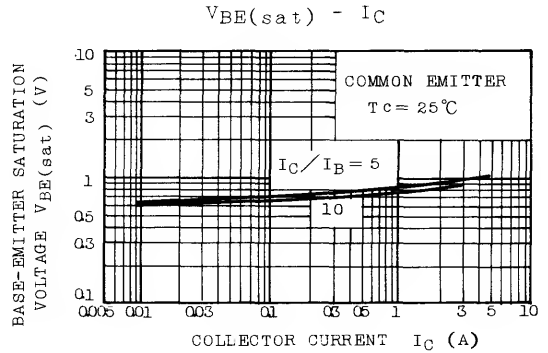
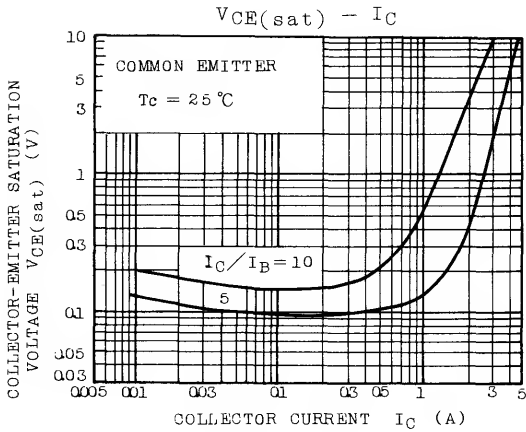
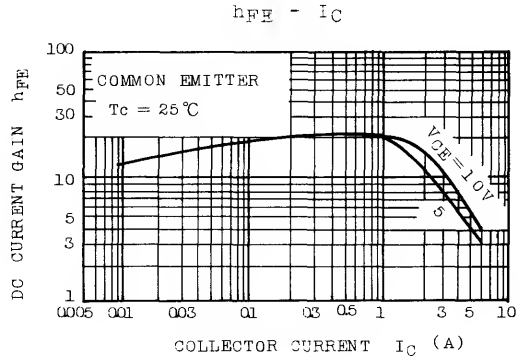
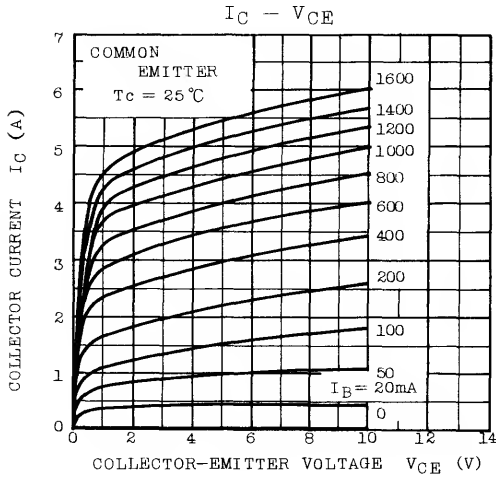
Fig. t_f TEST CIRCUIT



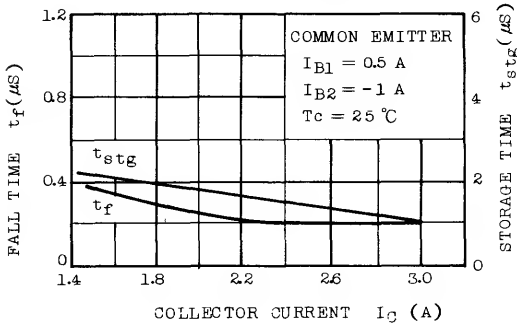
COLLECTOR CURRENT WAVEFORM



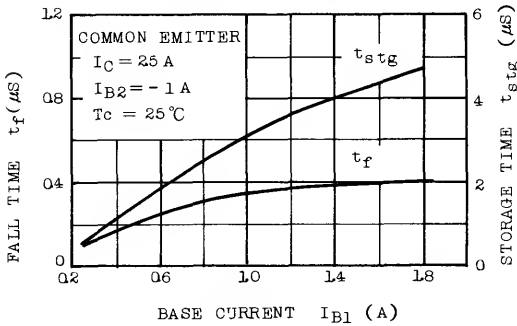
2SD811



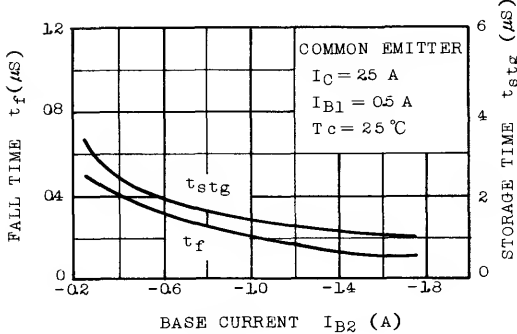
SWITCHING CHARACTERISTICS



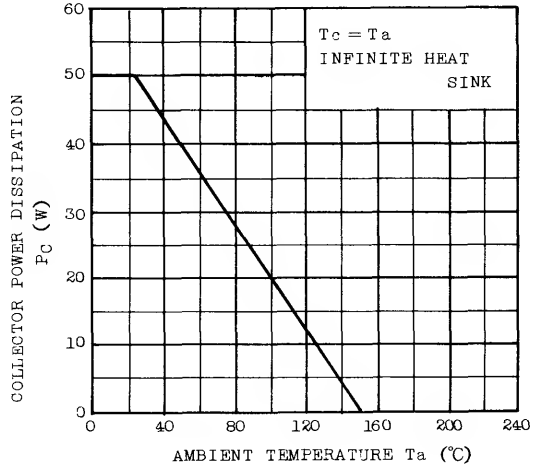
SWITCHING CHARACTERISTICS



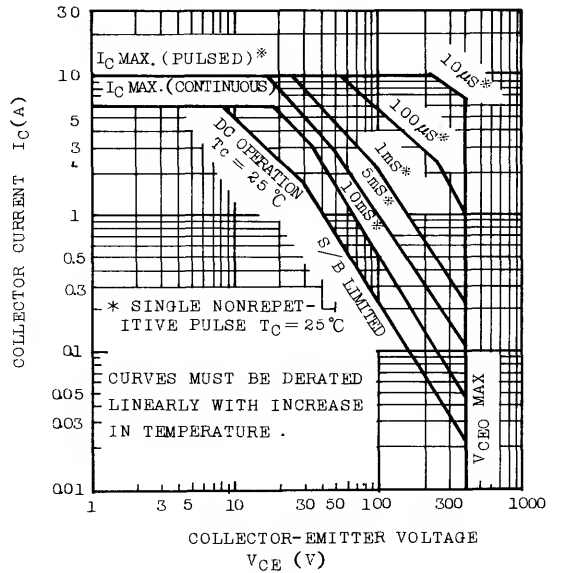
SWITCHING CHARACTERISTICS



$P_C - T_a$



SAFE OPERATING AREA



2SD818

SILICON NPN TRIPLE DIFFUSED MESA TYPE

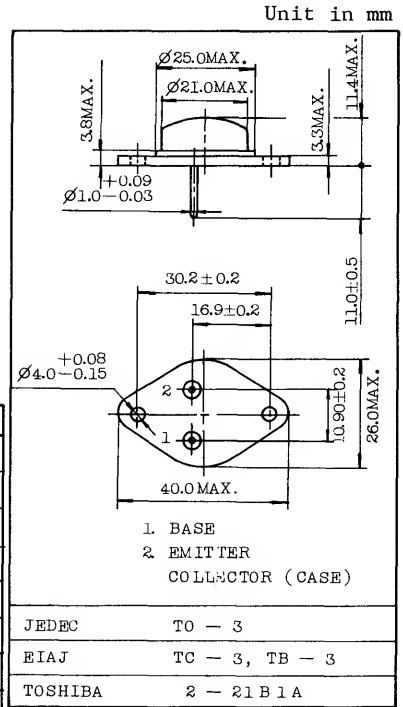
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : $V_{CB0}=1500V$
- Low Saturation Voltage : $V_{CE(sat)}=4V$ (Typ.)
- High speed : $t_f=0.5\mu s$ (Typ.)
- Glass Passivated Collector-Base Junction.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector Base Voltage	V_{CB0}	1500	V
Collector Emitter Voltage	V_{CEO}	600	V
Emitter Base Voltage	V_{EBO}	5	V
Collector Current	I_C	2.5	A
Emitter Current	I_E	-2.5	A
Collector Power Dissipation ($T_c=25^\circ C$)	PC	50	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-65~150	$^\circ C$

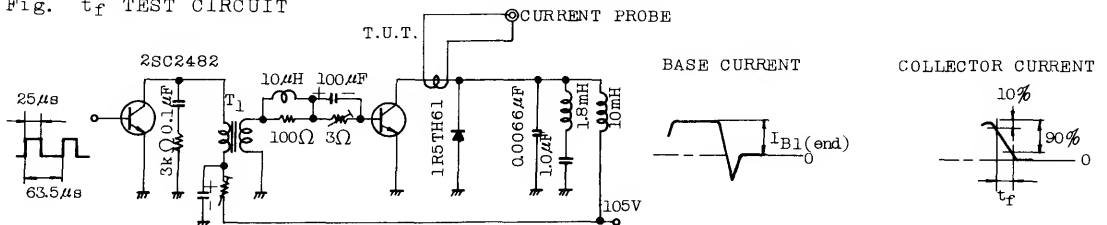


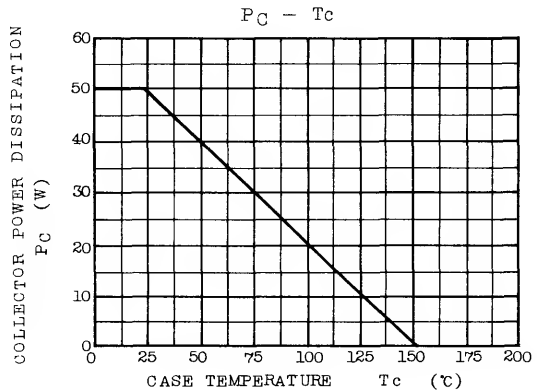
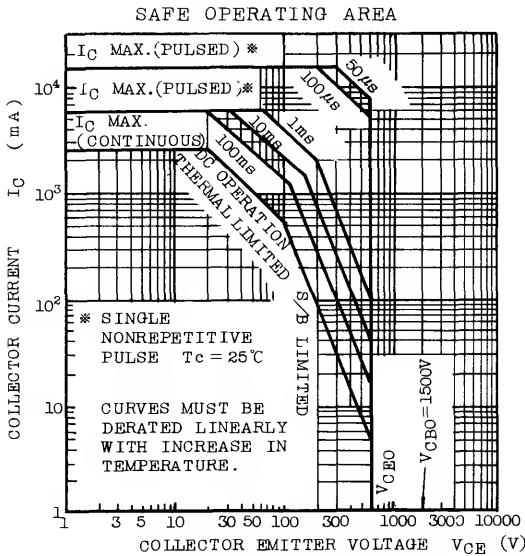
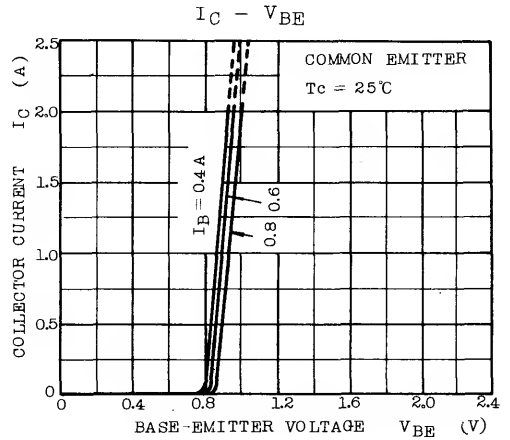
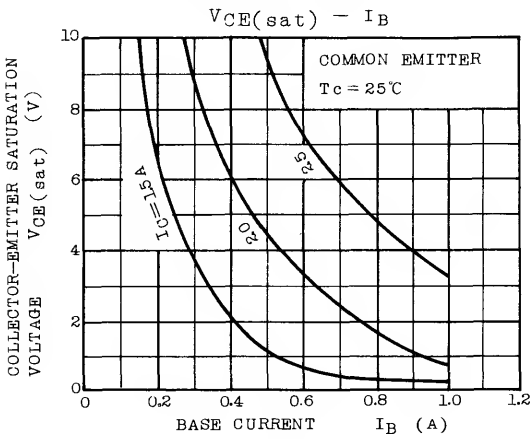
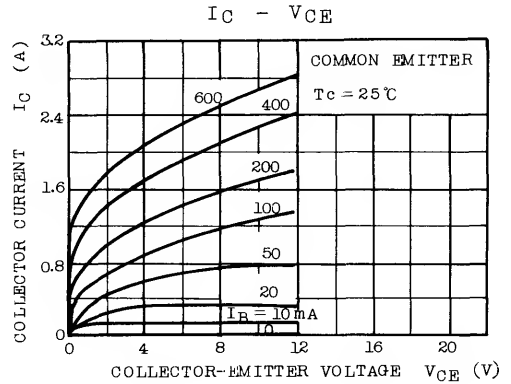
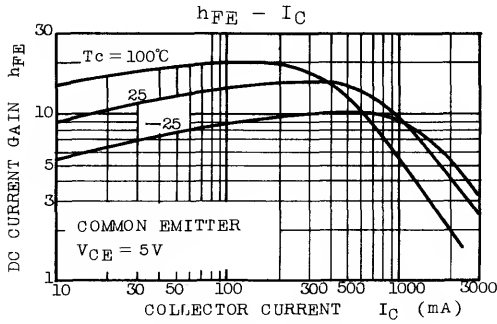
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

Mounting kit No. AC42C
Weight : 17g

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=500V, I_E=0$	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1	mA
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=0.5A$	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=2.0A, I_B=0.6A$	-	4	8	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=2.0A, I_B=0.6A$	-	-	1.5	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.1A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	95	-	pF
Fall Time	t_f	$I_{CP}=2.0A, I_{B1}(end)=0.6A$ (Fig.)	-	0.5	1.0	μs

Fig. t_f TEST CIRCUIT





2SD819

SILICON NPN TRIPLE DIFFUSED MESA TYPE

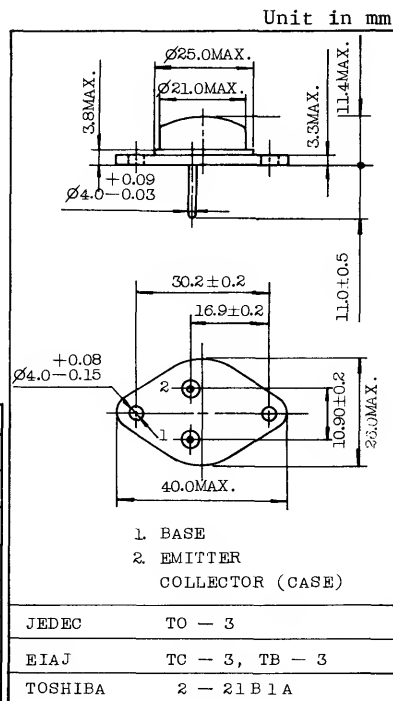
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : $V_{CBO}=1500V$
- Low Saturation Voltage : $V_{CE(sat)}=4V$ (Typ.)
($I_C=3A, I_B=0.8A$)
- High Speed : $t_f=1.0\mu s$ (Max.)
($I_{CP}=3A, I_{B1(end)}=0.8A$)
- Glass Passivated Collector-Base Junction.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTICS	SYMBOL	RATING	UNIT
Collector Base Voltage	V_{CBO}	1500	V
Collector Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	3.5	A
Emitter Current	I_E	-3.5	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	50	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 150	$^\circ C$

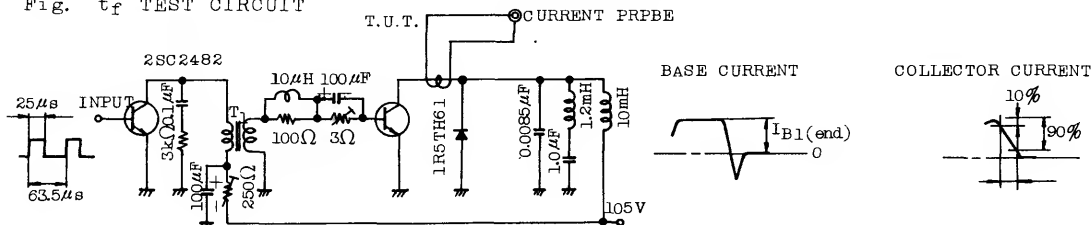


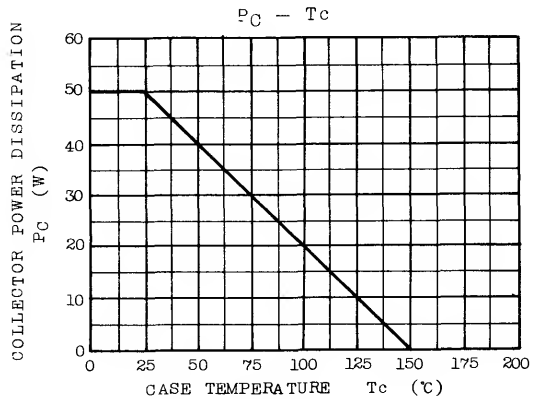
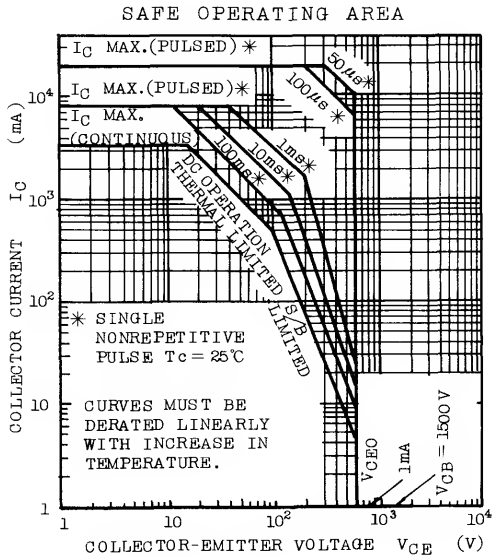
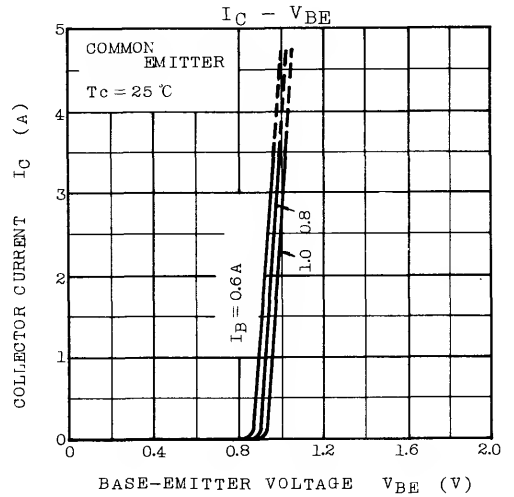
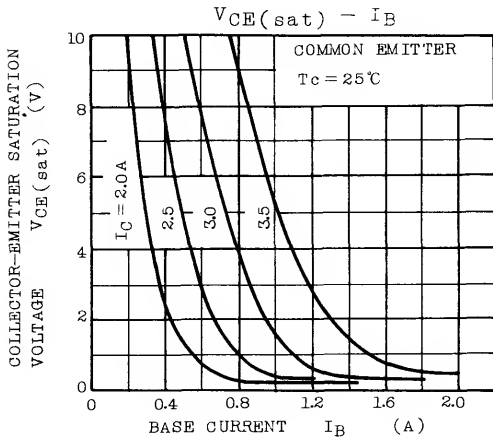
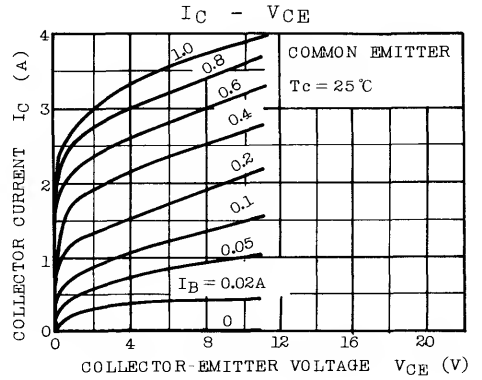
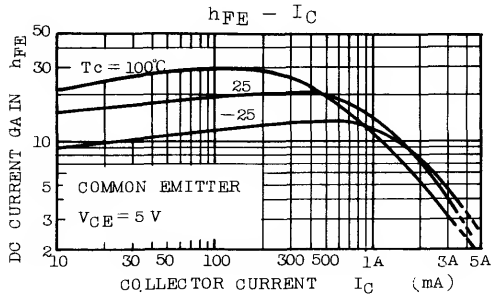
Mounting kit No. AC42C
Weight : 17g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=500V, I_E=0$	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1	mA
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=0.5A$	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=3A, I_B=0.8A$	-	4	8	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=3A, I_B=0.8A$	-	-	1.5	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.1A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	95	-	pF
Fall Time	t_f	$I_{CP}=3A, I_{B1(end)}=0.8A$ (Fig.)	-	0.5	1.0	μs

Fig. t_f TEST CIRCUIT





2SD820

SILICON NPN TRIPLE DIFFUSED MESA TYPE

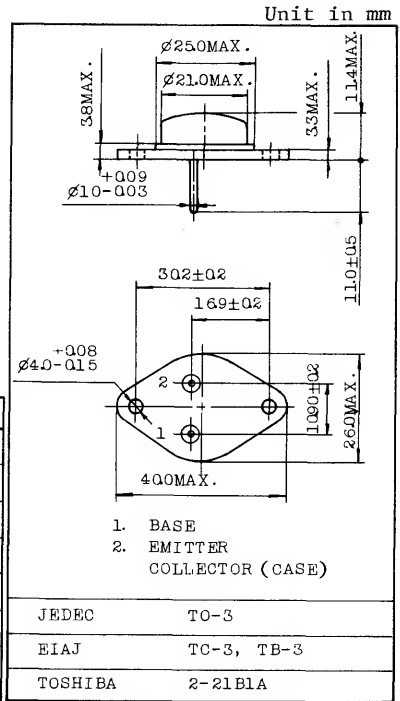
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : $V_{CB0}=1500V$
- Low Saturation Voltage
: $V_{CE(sat)}=5V$ (Max.) ($I_C=4A$, $I_B=0.8A$)
- High Speed : $t_f=1.0\mu s$ (Max.)
- Glass Passivated Collector-Base Junction.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	5	A
Emitter Current	I_E	-5	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	50	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-65~150	$^\circ C$

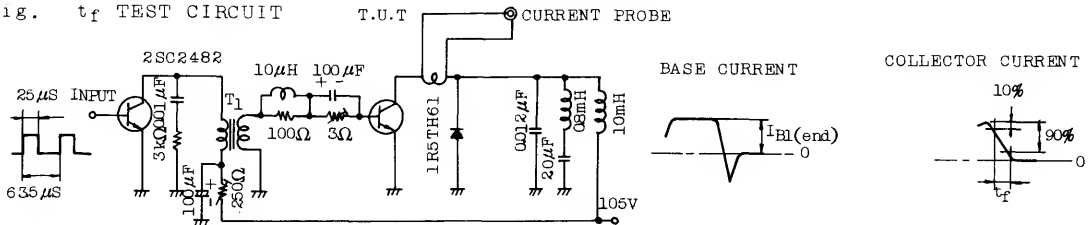


Mounting kit No. AC42C
Weight : 17g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=500V$, $I_E=0$	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V$, $I_C=0$	-	-	1	mA
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=1A$	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A$, $I_B=0.8A$	-	3	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4A$, $I_B=0.8A$	-	-	1.5	V
Transition Frequency	f_T	$V_{CE}=10V$, $I_C=0.1A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	165	-	pF
Fall Time (Fig.)	t_f	$I_{CP}=4A$, $I_{B1}(end)=0.8A$	-	0.5	1.0	μs

Fig. t_f TEST CIRCUIT T.U.T CURRENT PROBE



Unit in mm

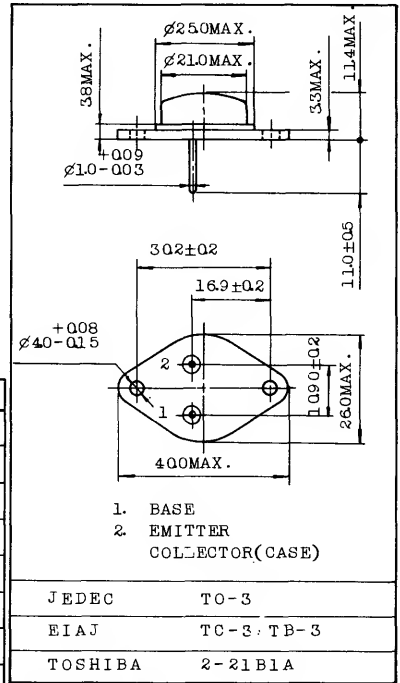
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : $V_{CB0}=1500V$
- Low Saturation Voltage
: $V_{CE(sat)}=5V$ (Max.) ($I_C=5A, I_B=1A$)
- High Speed : $t_f=1.0\mu s$ (Max.)
- Glass Passivated Collector-Base Junction.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Emitter Current	I_E	-6	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	50	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-65~150	$^\circ C$



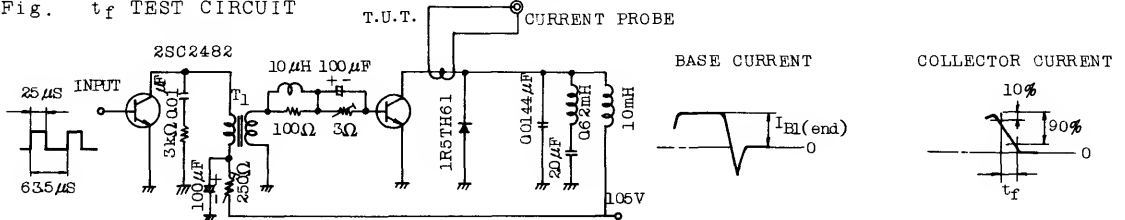
Mounting kit No. AC42C

Weight : 17g

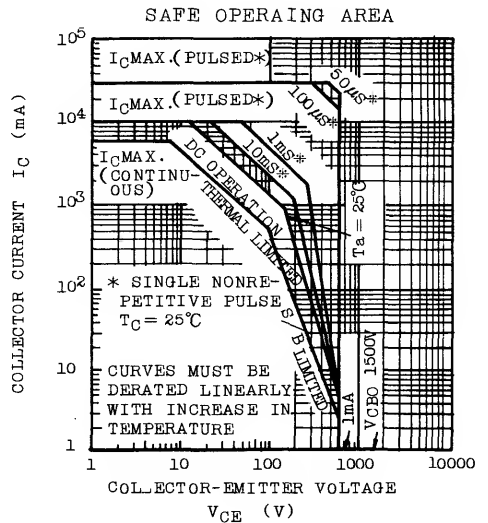
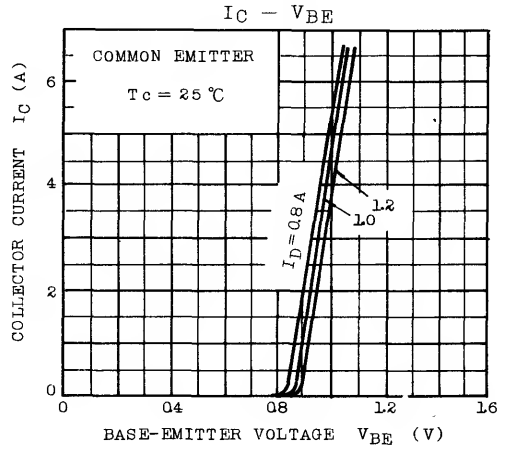
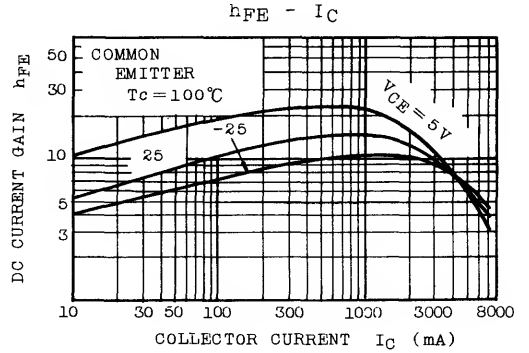
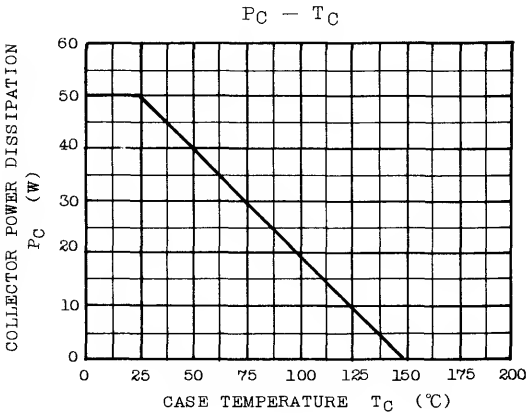
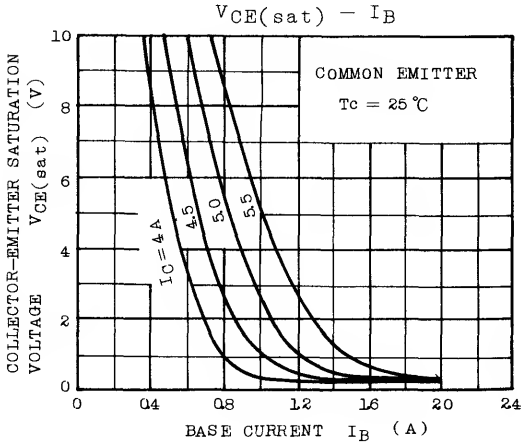
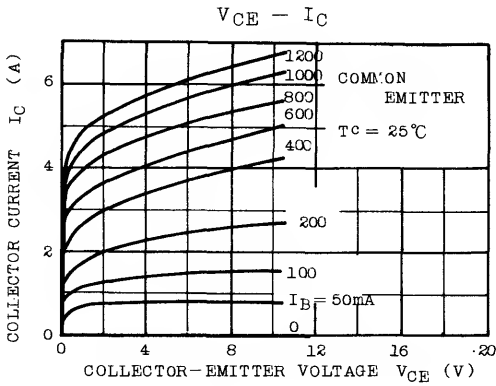
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=500V, I_E=0$	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1	mA
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=1A$	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=5A, I_B=1A$	-	3	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=5A, I_B=1A$	-	-	1.5	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.1A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	165	-	pF
Fall Time (Fig.)	t_f	$I_{CP}=5A, I_{B1}(end)=1A$	-	0.5	1.0	μs

Fig. t_f TEST CIRCUIT



2SD821



Unit in mm

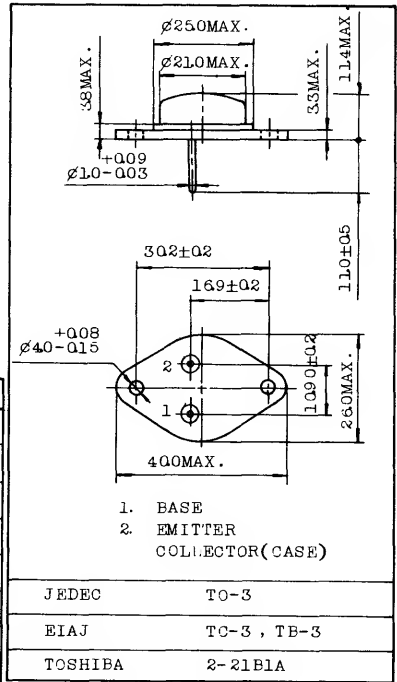
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : $V_{CBO}=1500V$
- Low Saturation Voltage
: $V_{CE(sat)}=5V$ (Max.) ($I_C=6A, I_B=1.2A$)
- High Speed ; $t_f=1.0\mu s$ (Max.)
- Glass Passivated Collector-Base Junction.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	7	A
Emitter Current	I_E	-7	A
Collector power Dissipation ($T_c=25^\circ C$)	P_C	50	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55~150	$^\circ C$

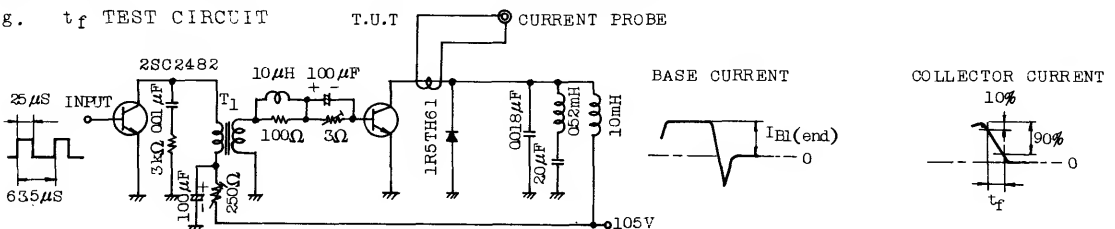


Mounting kit No. AC42C
Weight : 17g

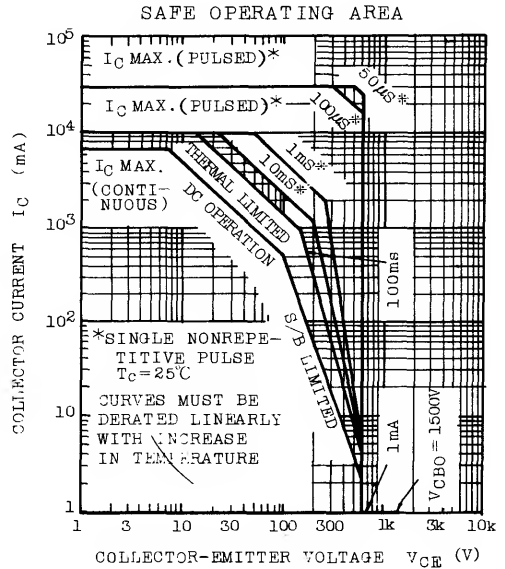
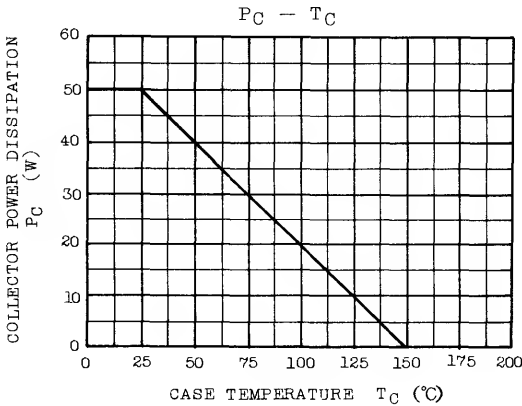
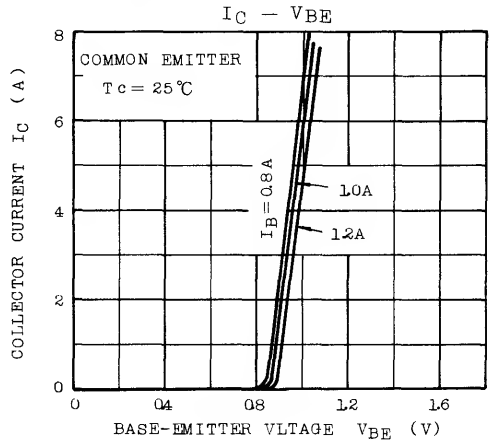
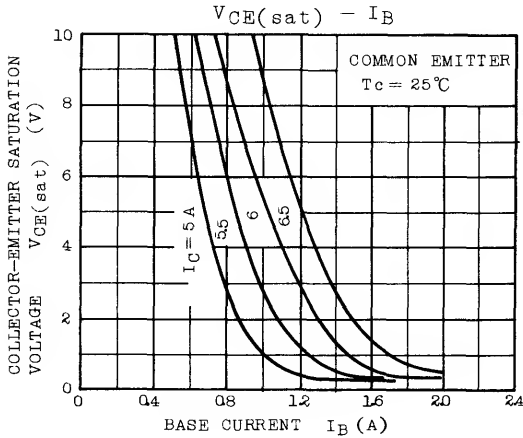
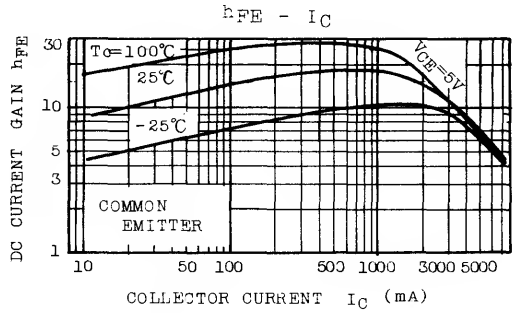
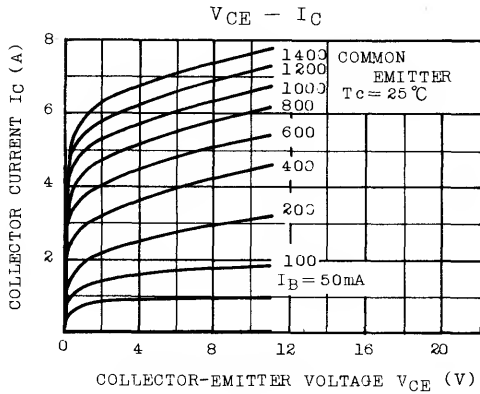
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=500V, I_E=0$	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1	mA
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=1A$	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=6A, I_B=1.2A$	-	3	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=6A, I_B=1.2A$	-	-	1.5	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.1A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	165	-	pF
Fall Time (Fig.)	t_f	$I_{CP}=6A, I_{B1}(end)=1.2A$	-	0.5	1.0	μs

Fig. t_f TEST CIRCUIT



2SD822



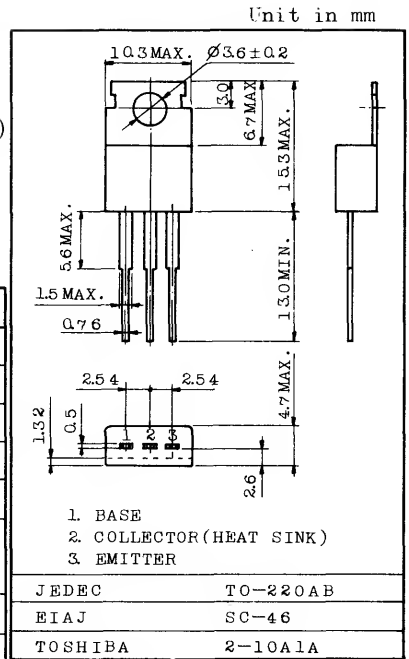
HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

- . High Voltage : $V_{CB0}=800V$
- . Low $V_{CE(sat)}$: $V_{CE(sat)}=1.0V(\text{Max.})(I_C=0.5A, I_B=0.05A)$
- . High Speed Switching : $t_f=1.0\mu s$ (Max.)
- . Glass Passivated Collector-Base Junction.

MAXIMUM RATINGS (Ta=25°C)

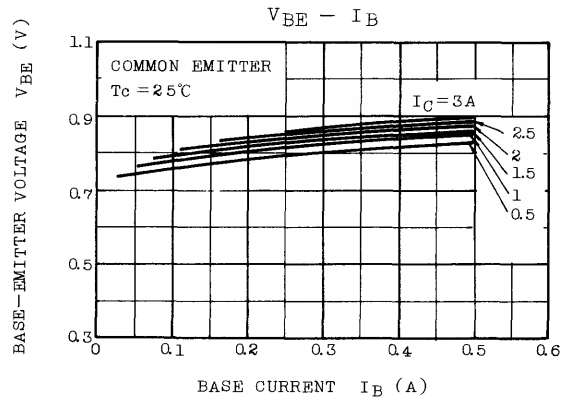
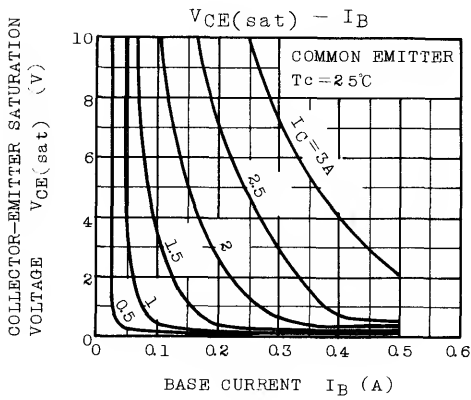
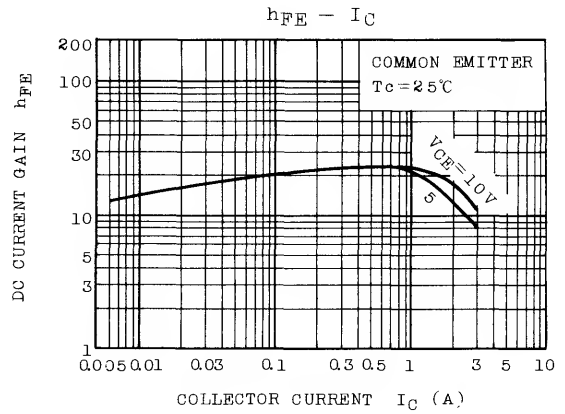
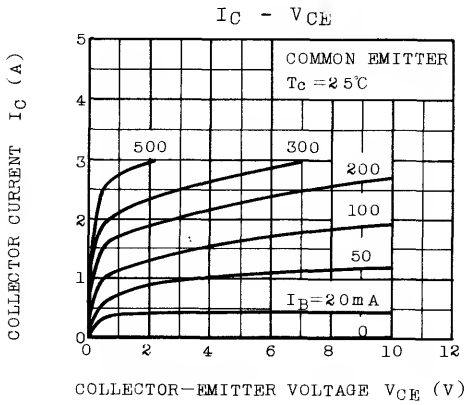
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB0}	800	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	3	A
Base Current		I_B	1.5	A
Collector Power Dissipation	Ta=25°C	P_C	1.5	W
	Tc=25°C		40	
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_{stg}	-55~150	°C



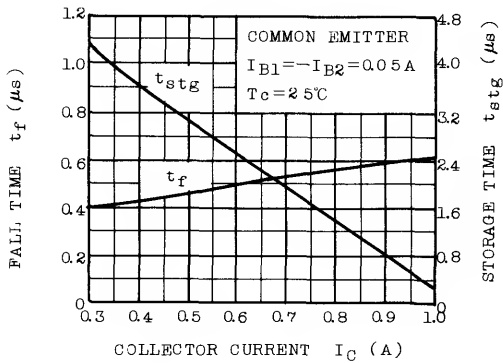
Weight : 1.9g
Mounting kit No. AC75

ELECTRICAL CHARACTERISTICS (Ta=25°C)

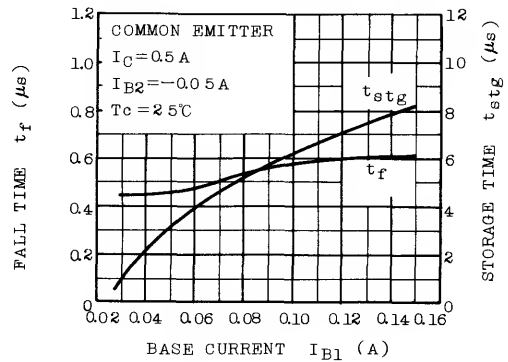
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=800V, I_E=0$	-	-	1	mA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	400	-	-	V
DC Current Gain	$h_{FE(1)}$	$V_{CE}=5V, I_C=10mA$	8	-	-	
	$h_{FE(2)}$	$V_{CE}=5V, I_C=0.5A$	10	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=0.5A, I_B=0.05A$	-	-	1.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=0.5A, I_B=0.05A$	-	-	1.5	V
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	75	-	pF
Transition Frequency	f_T	$V_{CE}=10V, I_E=-0.1A$	-	4	-	MHz
Fall Time	t_f	<p>DUTY CYCLE < 2% $I_C=0.5A, I_{B1}=-I_{B2}=0.05A$</p>	-	-	1.0	µs

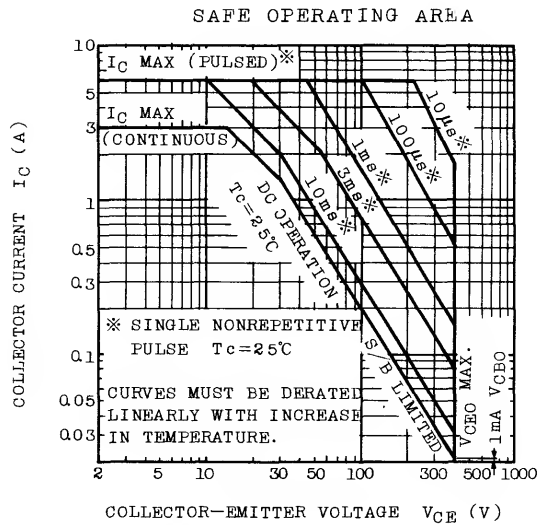
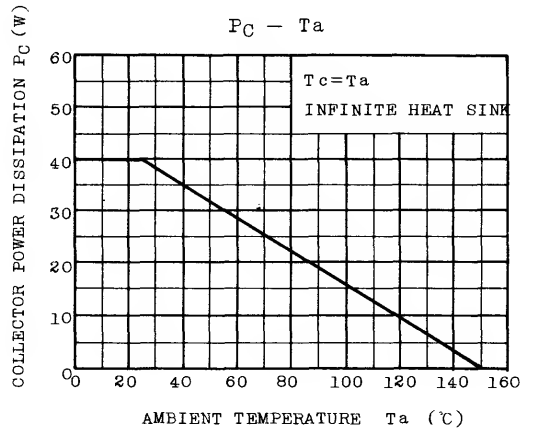
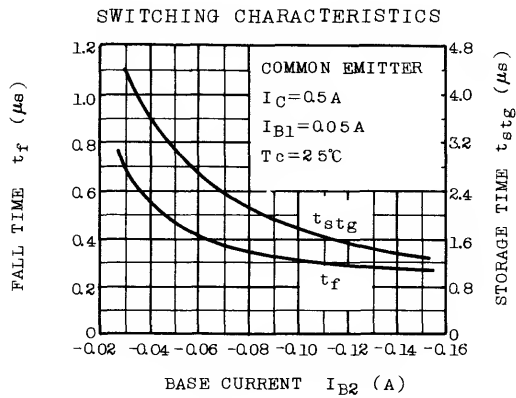


SWITCHING CHARACTERISTICS



SWITCHING CHARACTERISTICS





2SD842

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

HIGH CURRENT SWITCHING APPLICATIONS.

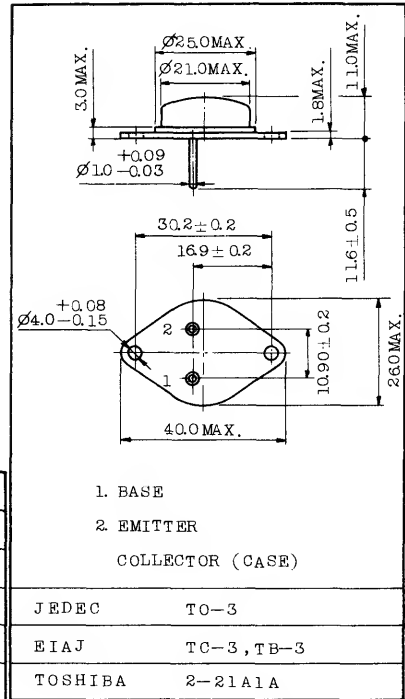
FEATURES:

- . High Collector Current : $I_C = 30A$
- . High DC Current Gain
: $h_{FE}=1000$ (Min.), ($V_{CE}=5V, I_C=20A$)
- . Monolithic Construction with Built-In Base-Emitter Shunt Resistor.

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

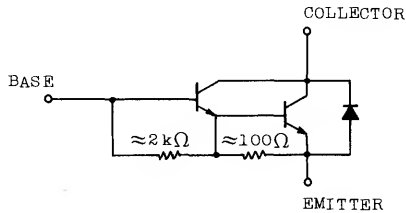
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	30	A
Base Current	I_B	1	A
Collector Power Dissipation ($T_c=25^{\circ}C$)	P_C	150	W
Junction Temperature	T_j	150	$^{\circ}C$
Storage Temperature Range	T_{stg}	-65 ~ 150	$^{\circ}C$

Unit in mm



Mounting kit No. AC73
Weight : 12.9g

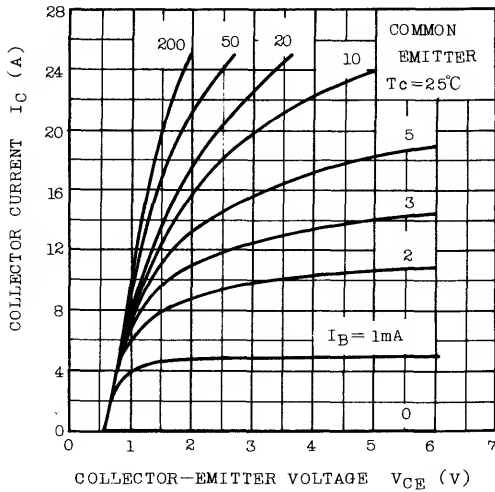
EQUIVALENT CIRCUIT



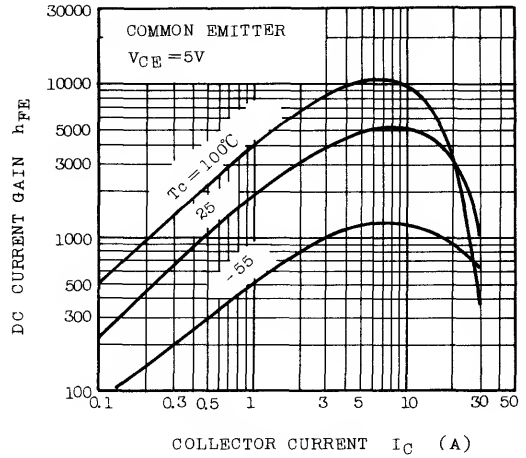
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		ICB0	V _{CB} =80V, I _E =0	-	-	100	μA
Emitter Cut-off Current		I _{EBO}	V _{EB} =5V, I _C =0	-	-	10	mA
Collector-Emitter Breakdown Voltage		V(BR)CEO	I _C =50mA, I _B =0	80	-	-	V
DC Current Gain		hFE(1)	V _{CE} =5V, I _C =20A	1000	-	-	
		hFE(2)	V _{CE} =5V, I _C =30A	200	-	-	
Collector-Emitter Saturation Voltage		V _{CE(sat)}	I _C =20A, I _B =0.2A	-	-	3	V
Base-Emitter Saturation Voltage		V _{BE(sat)}		-	-	3.5	V
Emitter-Collector Forward Voltage		V _{ECF}	I _E =10A, I _B =0	-	-	3	V
Transition Frequency		f _T	V _{CE} =5V, I _C =1A	-	14	-	MHz
Collector Output Capacitance		C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	280	-	pF
Switching Time	Turn-on Time	t _{on}	<p style="text-align: center;"> $V_{CC} = 50V$ $R = 10\Omega$ $I_{B1} = - I_{B2} = 0.01A$ $DUTY\ CYCLE \leq 1\%$ </p>	-	0.7	-	μs
	Storage Time	t _{stg}		-	8	-	
	Fall Time	t _f		-	2.5	-	

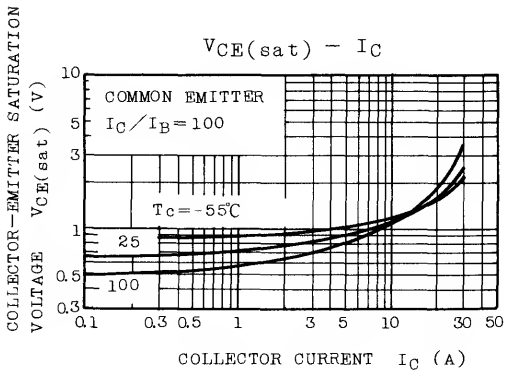
$I_C - V_{CE}$



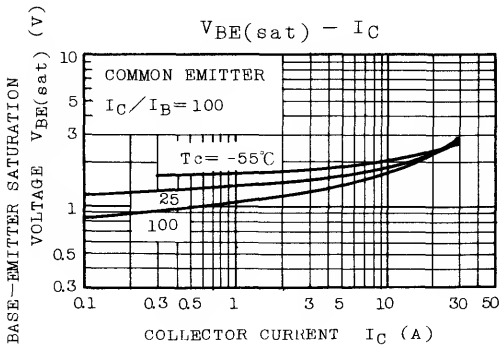
$h_{FE} - I_C$



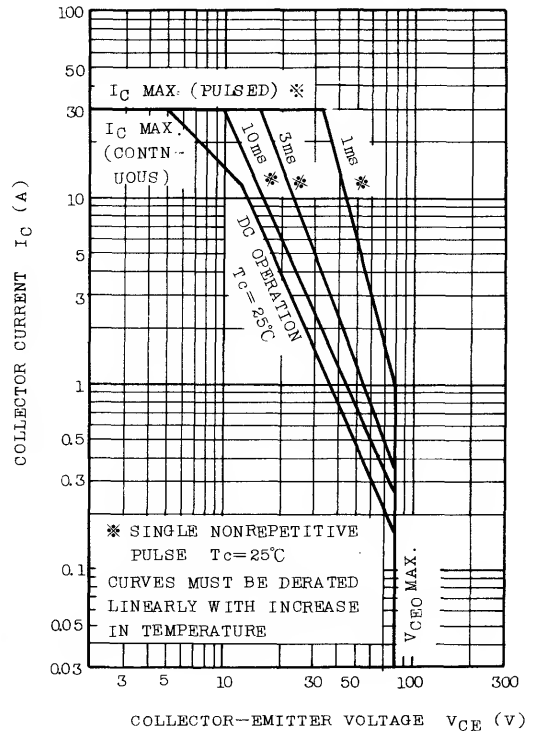
$V_{CE(sat)} - I_C$



$V_{BE(sat)} - I_C$



SAFE OPERATING AREA



INDUSTRIAL APPLICATIONS

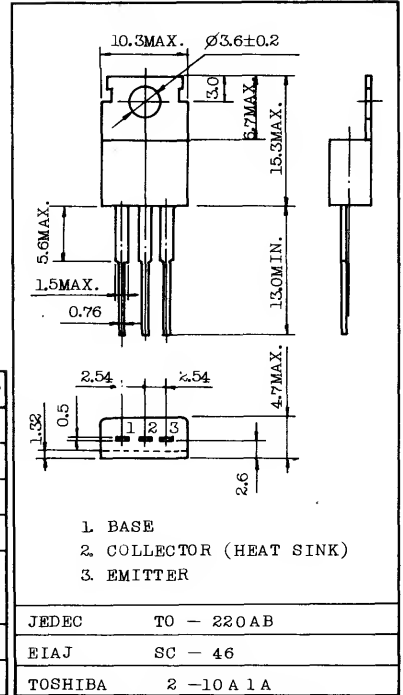
Unit in mm

HIGH CURRENT SWITCHING APPLICATIONS.

POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Low Saturation Voltage
: $V_{CE(sat)}=0.5V$ (Max.) (at $I_C=4A$)
- Complementary to 2SB753.



MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	100	V
Collector-Emitter Voltage		V_{CEO}	80	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	7	A
Collector Power Dissipation	Ta=25°C	PC	1.5	W
	Tc=25°C		40	
Junction Temperature		Tj	150	°C
Storage Temperature Range		Tstg	-55~150	°C

Mounting Kit No. AC75

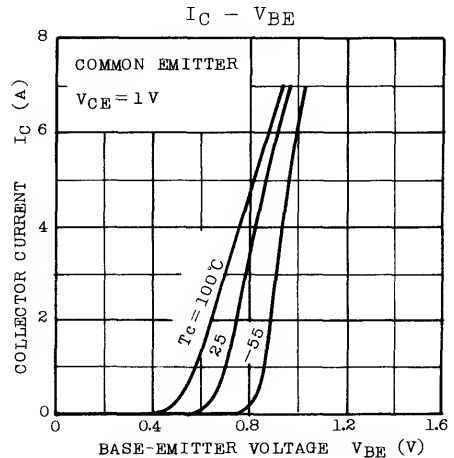
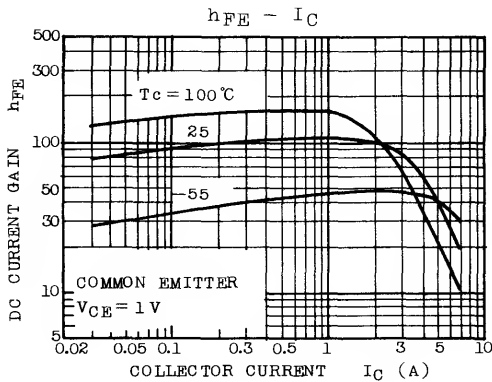
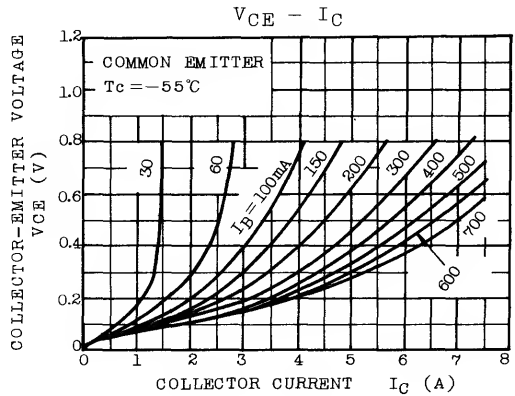
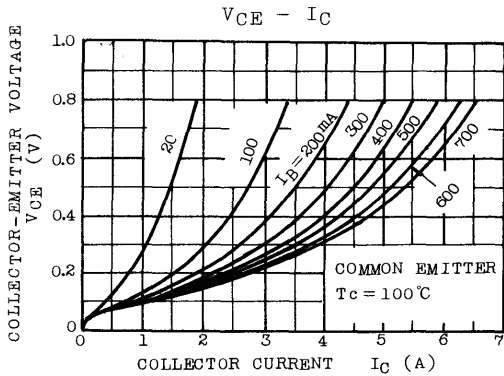
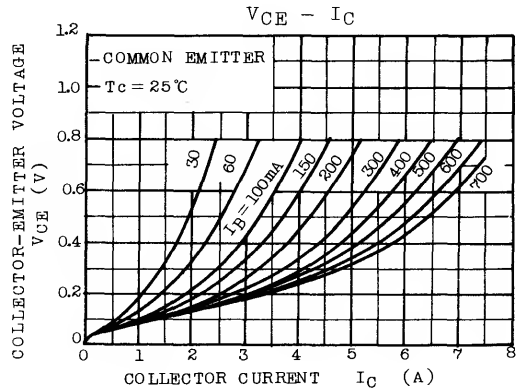
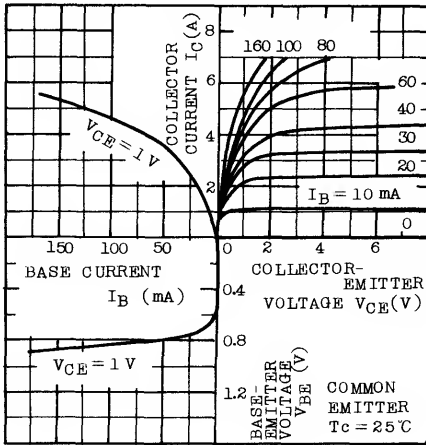
Weight : 1.9g

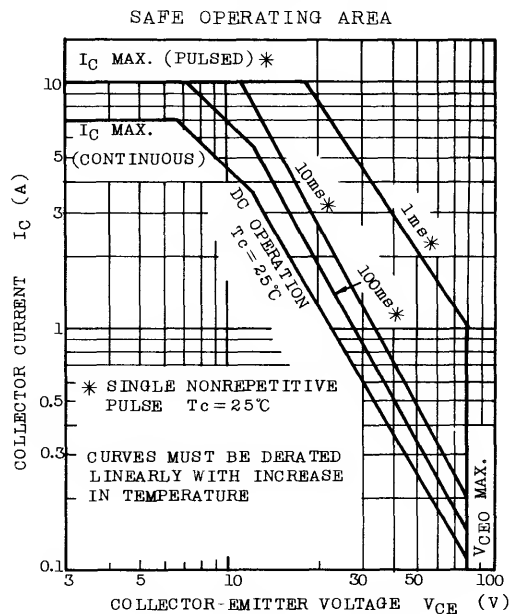
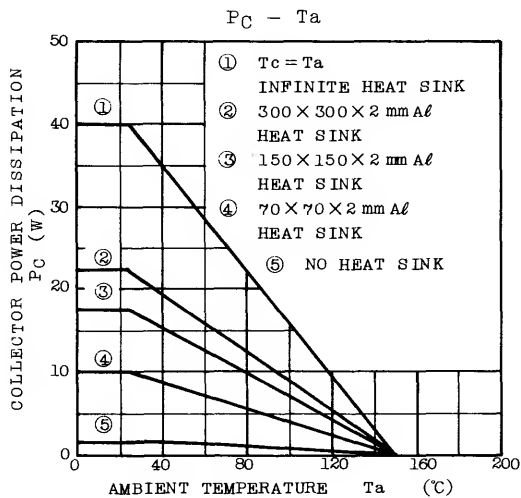
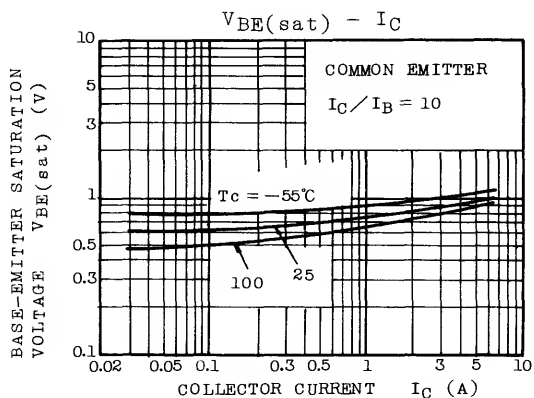
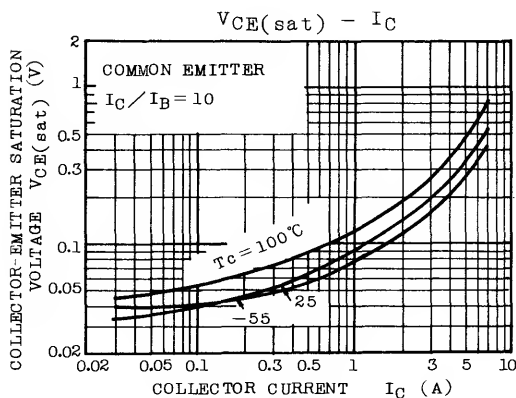
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=100V, I_E=0$	-	-	5	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	5	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	80	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	PC	$V_{CE}=1V, I_C=1A$	70	-	240	
	$h_{FE(2)}$		$V_{CE}=1V, I_C=4A$	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=4A, I_B=0.4A$	-	0.25	0.5	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=4A, I_B=0.4A$	-	0.9	1.4	
Transition Frequency		f_T	$V_{CE}=4V, I_C=1A$	-	10	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	250	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.4	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		-	0.5	-	

Note : $h_{FE(1)}$ Classification 0 : 70~140, Y : 120~240

STATIC CHARACTERISTICS





2SD844

SILICON NPN TRIPLE DIFFUSED TYPE

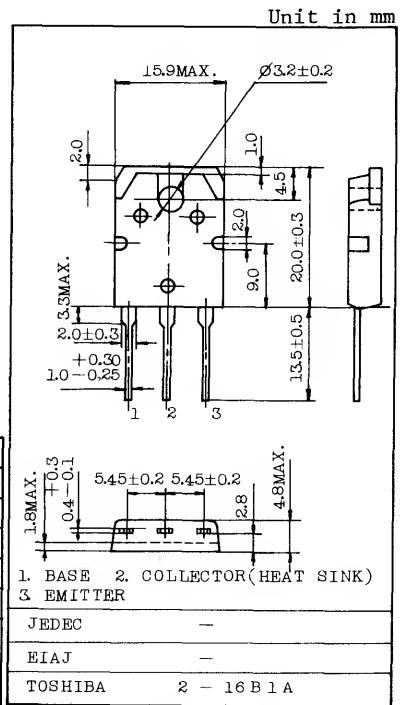
HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATION.

FEATURES:

- High Collector Current : $I_C=7A$
- Low Collector Saturation Voltage
: $V_{CE(sat)}=0.4V(\text{Max.})$ (at $I_C=4A$)
- High Power dissipation : $P_C=60W$ (at $T_c=25^\circ C$)
- Complementary to 2SB754.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	50	V
Collector-Emitter Voltage	V_{CEO}	50	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	7	A
Emitter Current	I_E	-7	A
Collector Power Dissipation	P_C	Ta=25°C	2.5
		Tc=25°C	60
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55~150	°C



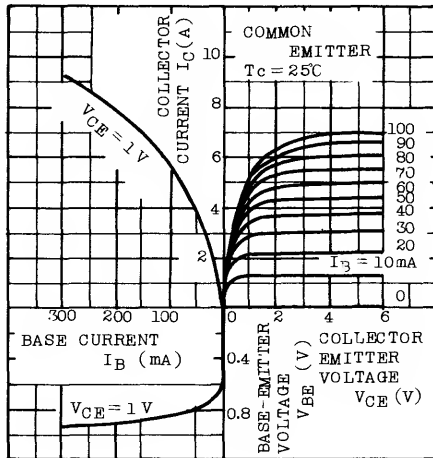
Weight : 4.6g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

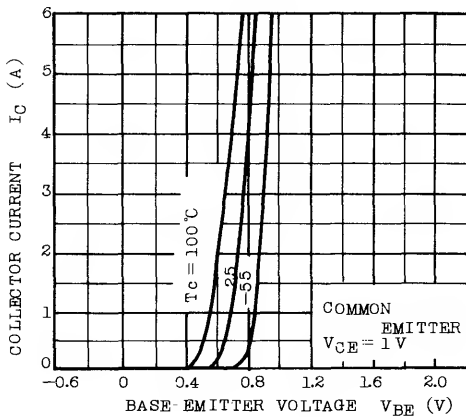
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=50V, I_E=0$	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	10	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	50	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=10mA, I_C=0$	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=1V, I_C=1A$	70	-	240	
	$h_{FE(2)}$	$V_{CE}=1V, I_C=4A$	30	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A, I_B=0.4A$	-	0.2	0.4	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=1V, I_C=4A$	-	0.9	1.2	V
Transition Frequency	f_T	$V_{CE}=5V, I_C=1A$	-	15	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	250	-	pF

Note : $h_{FE(1)}$ Classification O : 70 ~ 140, Y : 120 ~ 240

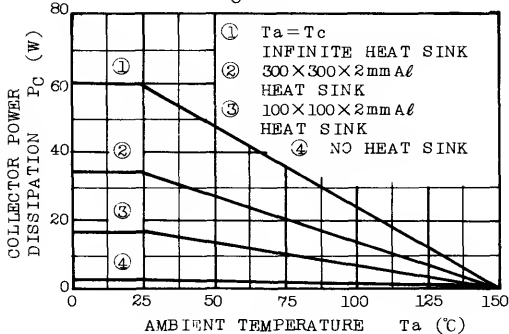
STATIC CHARACTERISTICS



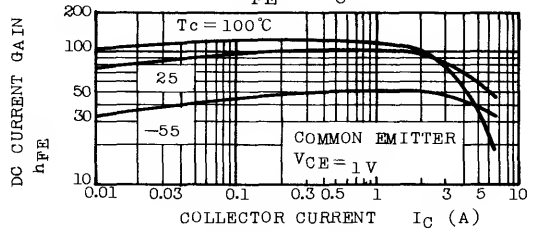
$I_C - V_{BE}$



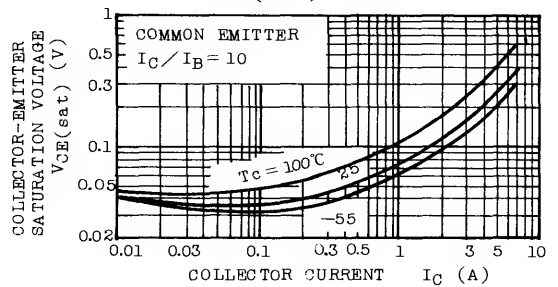
$P_C - T_a$



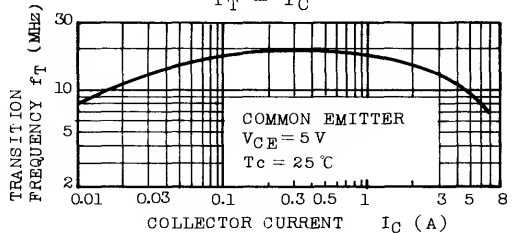
$h_{FE} - I_C$



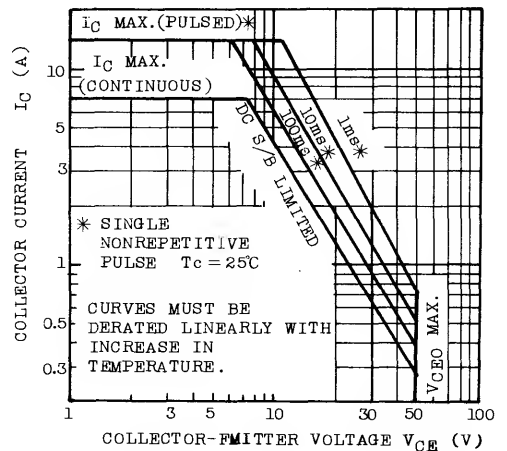
$V_{CE(sat)} - I_C$



$f_T - I_C$



SAFE OPERATING AREA



2SD845

SILICON NPN TRIPLE DIFFUSED TYPE

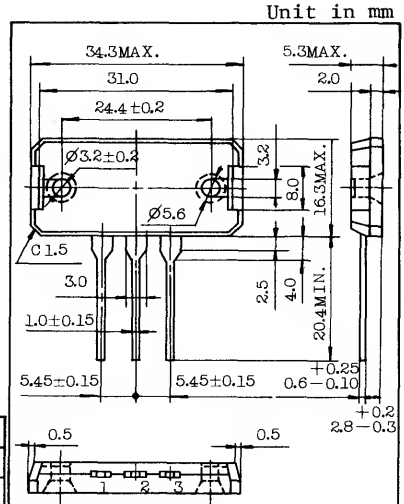
POWER AMPLIFIER APPLICATION,

FEATURES:

- High Breakdown Voltage : $V_{CEO}=150V$ (Min.)
- High Transition Frequency : $f_T=20MHz$ (Typ.)
- Complementary to 2SB755.
- Recommended for 80W High-Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	150	V
Collector-Emitter Voltage	V_{CEO}	150	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	12	A
Emitter Current	I_E	-12	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	120	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55~150	$^\circ C$



1. BASE
2. COLLECTOR(HEAT SINK)
3. EMITTER

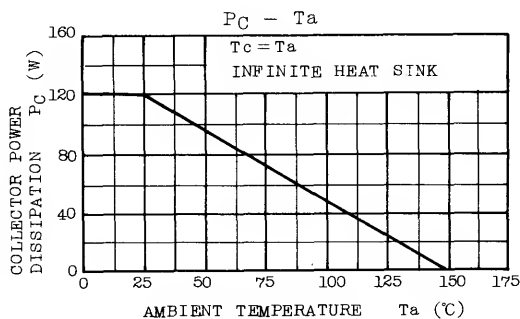
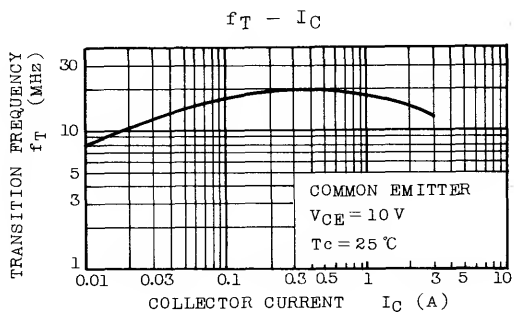
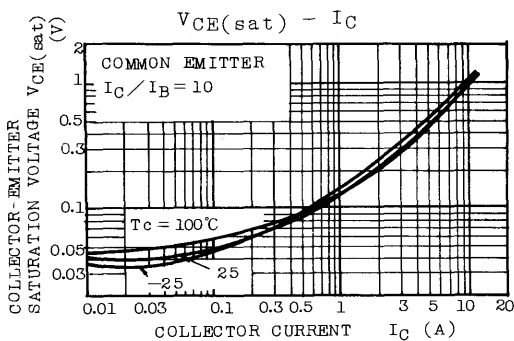
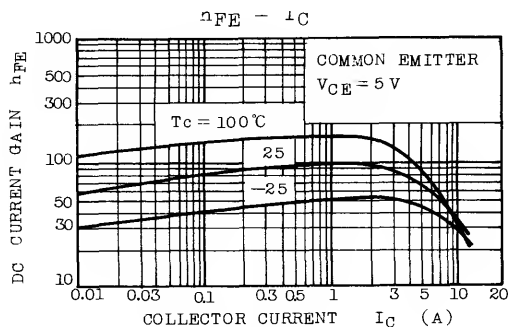
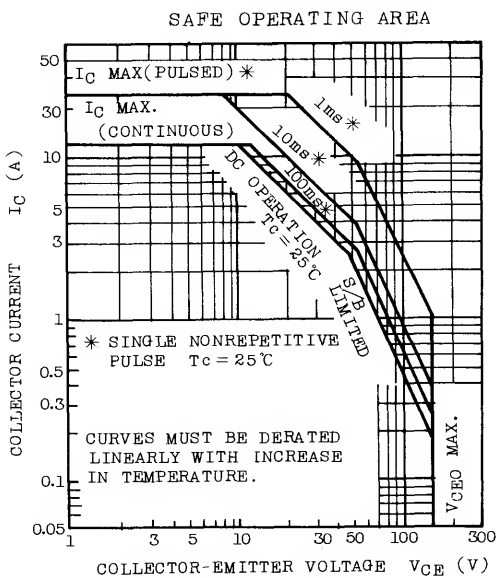
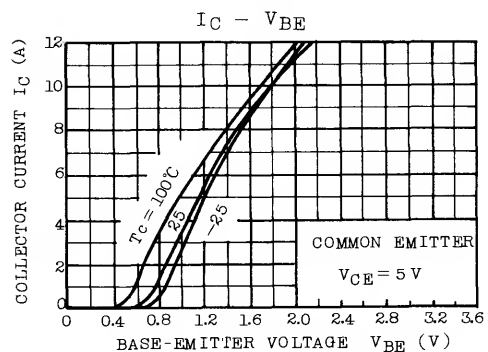
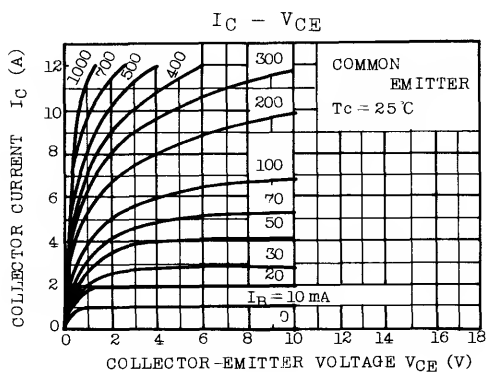
JEDEC	—
EIAJ	—
TOSHIBA	2 - 34 A 1 A

Weight : 10.8g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=150V, I_E=0$	—	—	50	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	—	—	50	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=0.1A, I_B=0$	150	—	—	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=10mA, I_C=0$	5	—	—	V
DC Current Gain	h_{FE} (Note)	$V_{CE}=5V, I_C=1A$	55	—	160	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=5A, I_B=0.5A$	—	—	2.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5V, I_C=5A$	—	—	1.5	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=1A$	—	20	—	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	—	200	—	pF

Note : h_{FE} Classification R : 55~110, 0 : 80~160



2SD867

SILICON NPN TRIPLE DIFFUSED TYPE

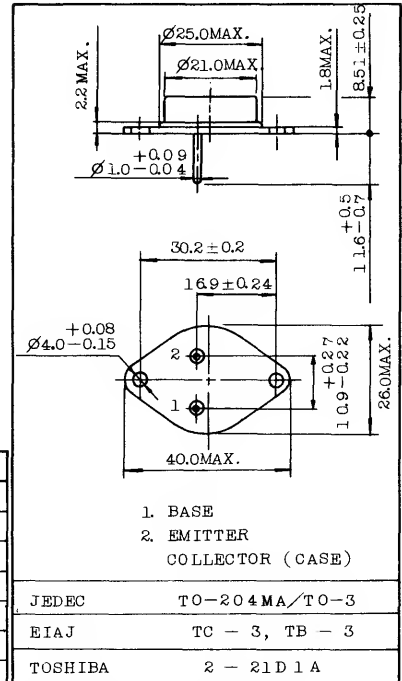
INDUSTRIAL APPLICATIONS

HIGH POWER AMPLIFIER APPLICATIONS.
 HIGH POWER SWITCHING APPLICATIONS.
 DC-DC CONVERTER APPLICATIONS.
 REGULATOR APPLICATIONS.

FEATURES:

- High Power Dissipation : $F_C=100W(T_c=25^\circ C)$
- High Collector Current : $I_C=10A$
- Low Saturation Voltage : $V_{CE(sat)}=0.5V$ (Typ.) ($I_C=5A$)

Unit in mm



MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTICS	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	130	V
Collector-Emitter Voltage	V_{CE0}	110	V
Emitter-Base Voltage	V_{EB0}	7	V
Collector Current	I_C	10	A
Base Current	I_B	5	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	100	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_{stg}	-65~175	°C

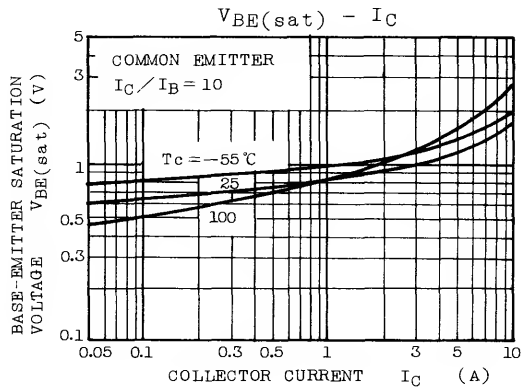
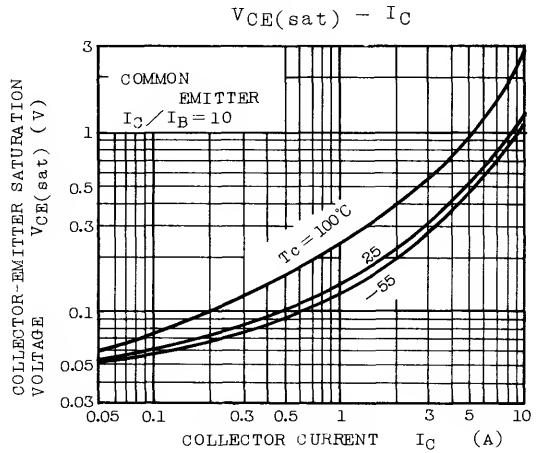
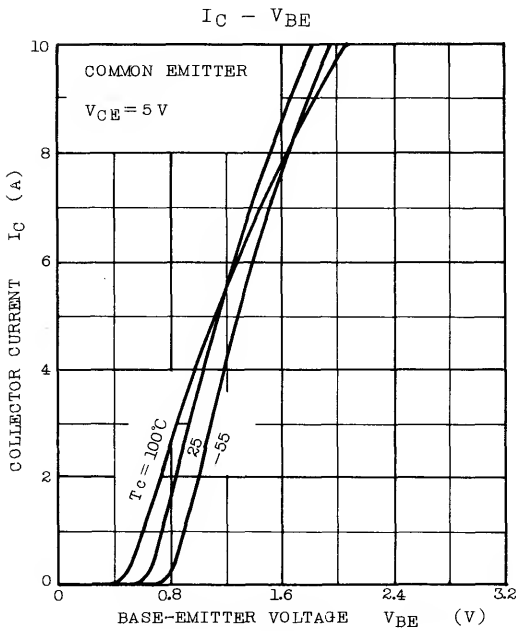
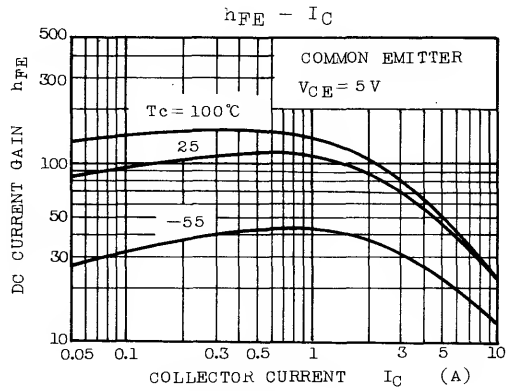
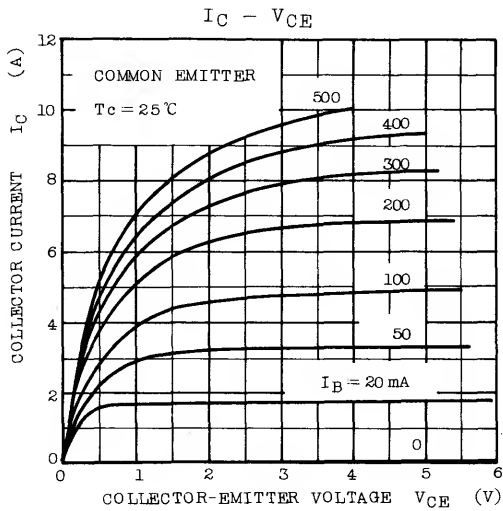
Mounting Kit No. AC73

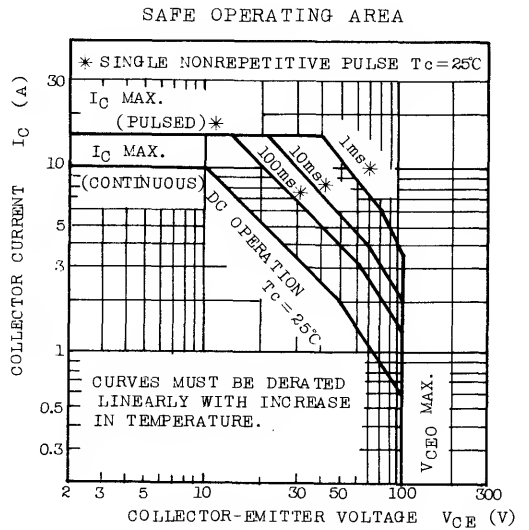
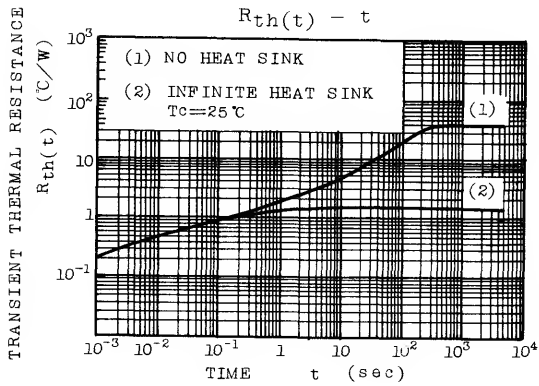
Weight : 12.6g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=130V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	110	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=5V, I_C=1A$	50	-	200	
		$h_{FE(2)}$	$V_{CE}=5V, I_C=5A$	20	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=5A, I_B=1A$	-	0.5	1.5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	1.2	2.5	V
Transition Frequency		f_T	$V_{CE}=5V, I_C=1A$	-	1.5	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	200	-	pF
Switching Time	Turn-on Time	t_{on}	<p>I_{B1} INPUT I_{B2} OUTPUT $V_{CC}=50V$</p>	-	2.5	-	μs
	Storage Time	t_{stg}		-	4.0	-	
	Fall Time	t_f		$I_{B1} = -I_{B2} = 0.5A$ DUTY CYCLE ≤ 1%	-	1.2	

Note : $h_{FE(1)}$ Classification 0 : 50~120, Y : 100~200





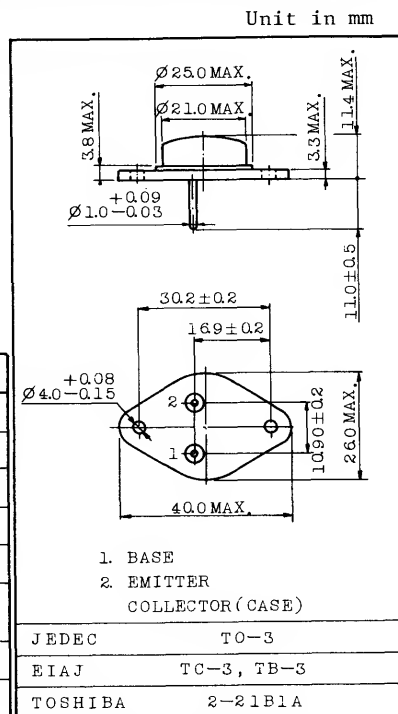
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

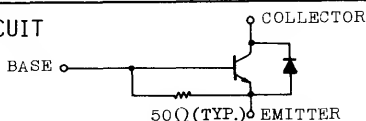
- . High Voltage : $V_{CB0}=1500V$
- . Low Saturation Voltage : $V_{CE(sat)}=5V(Typ.)$
($I_C=2A, I_B=0.6A$)
- . High Speed : $t_f=1.0\mu s(Max.)$
($I_{CP}=2A, I_{B1}(end)=0.6A$)
- . Built-in Damper Type
- . Glass Passivated Collector-Base Junction.

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	1500	V
Collector-Emitter Voltage	V_{CE0}	600	V
Emitter-Base Voltage	V_{EB0}	5	V
Collector Current	I_C	2.5	A
Emitter Current	I_E	-2.5	A
Collector Power Dissipation ($T_c=25^{\circ}C$)	P_C	50	W
Junction Temperature	T_j	150	$^{\circ}C$
Storage Temperature	T_{stg}	-65 ~ 150	$^{\circ}C$



EQUIVALENT CIRCUIT



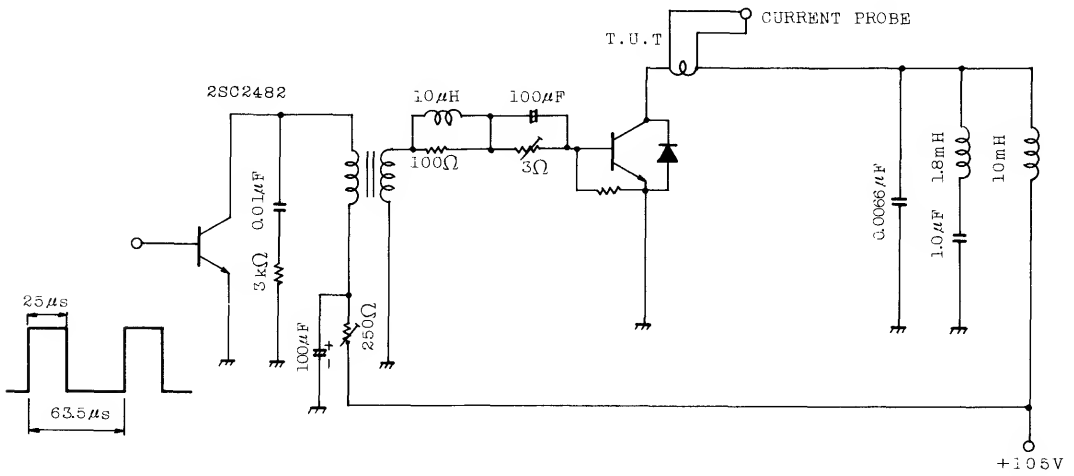
Mounting Kit No. AC42C
Weight : 17g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

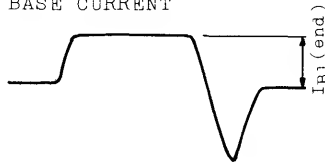
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=500V, I_E=0$	-	-	10	μA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=200mA, I_C=0$	5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=0.5A$	8	12	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=2A, I_B=0.6A$	-	5	8	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=2A, I_B=0.6A$	-	-	1.5	V
Forward Voltage (Damper Diode)	$-V_F$	$I_F=2.5A$	-	1.6	2.0	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.1A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	95	-	pF
Fall Time	t_f	$I_{CP}=2A, I_{B1}(end)=0.6A$	-	0.5	1.0	μs

2SD868

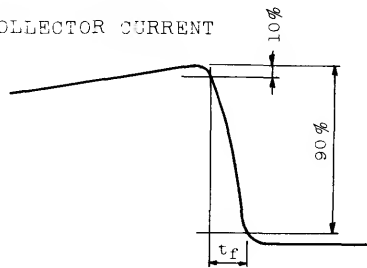
t_f TEST CIRCUIT

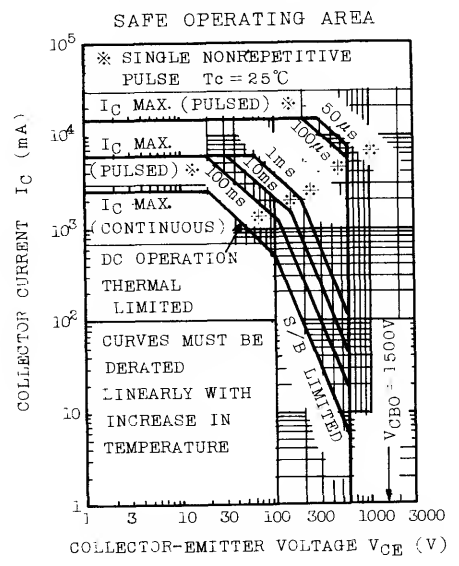
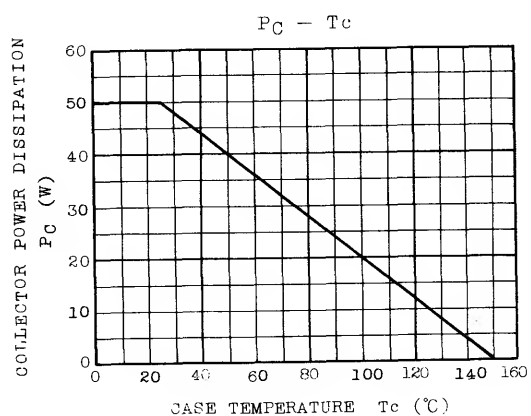
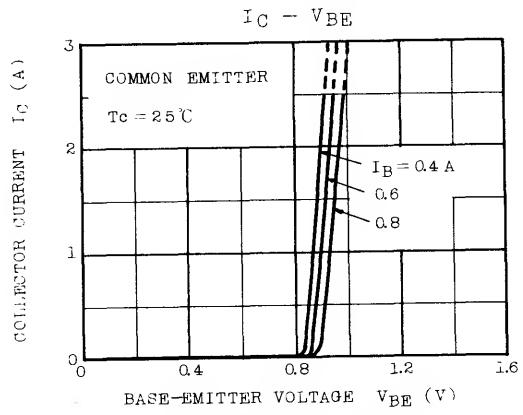
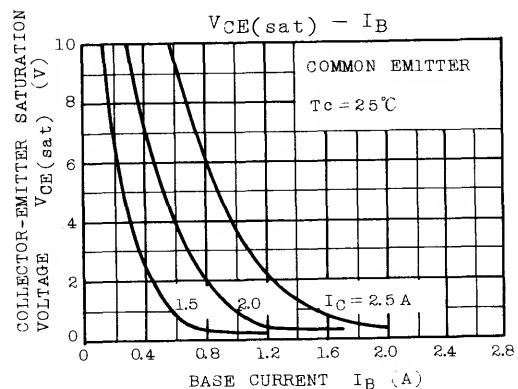
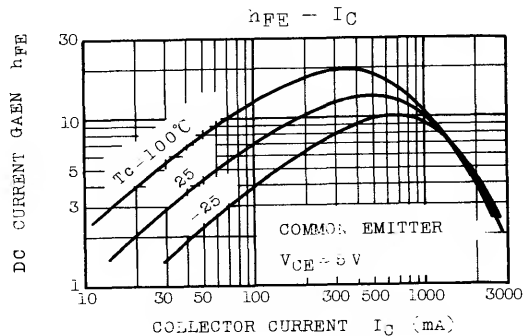
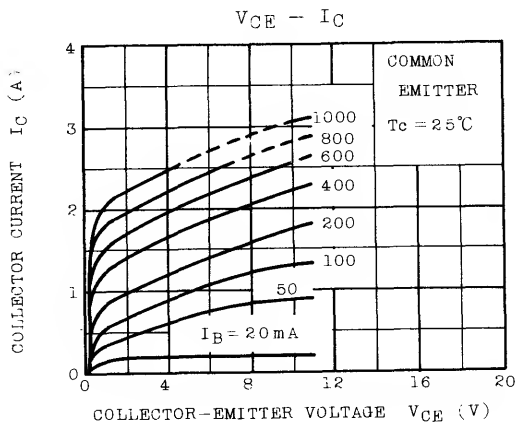


BASE CURRENT



COLLECTOR CURRENT





2SD869

SILICON NPN TRIPLE DIFFUSED MESA TYPE

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

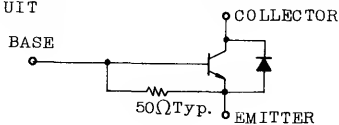
FEATURES:

- High Voltage : $V_{CBO}=1500V$
- Low Saturation Voltage
: $V_{CE(sat)}=5V$ (Typ.) ($I_C=3A, I_B=0.8A$)
- High Speed : $t_f=1.0\mu s$ (Max.)
($I_{CP}=3A, I_{B1(end)}=0.8A$)
- Built-in Damper Type.
- Glass Passivated Collector-Base Junction.

MAXIMUM RATINGS ($T_a=25^\circ C$)

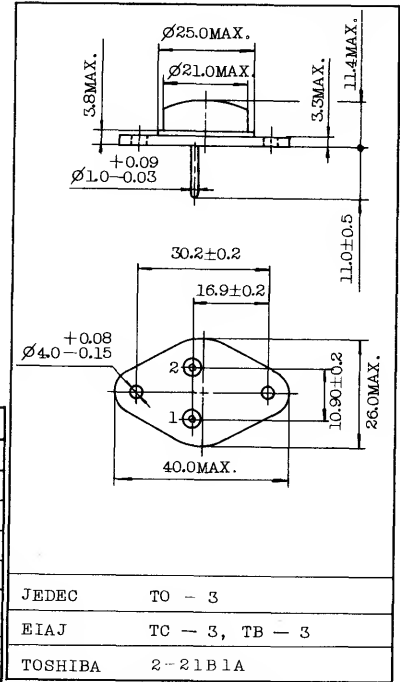
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	3.5	A
Emitter Current	I_E	-3.5	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	50	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-65~150	$^\circ C$

EQUIVALENT CIRCUIT



INDUSTRIAL APPLICATIONS

Unit in mm

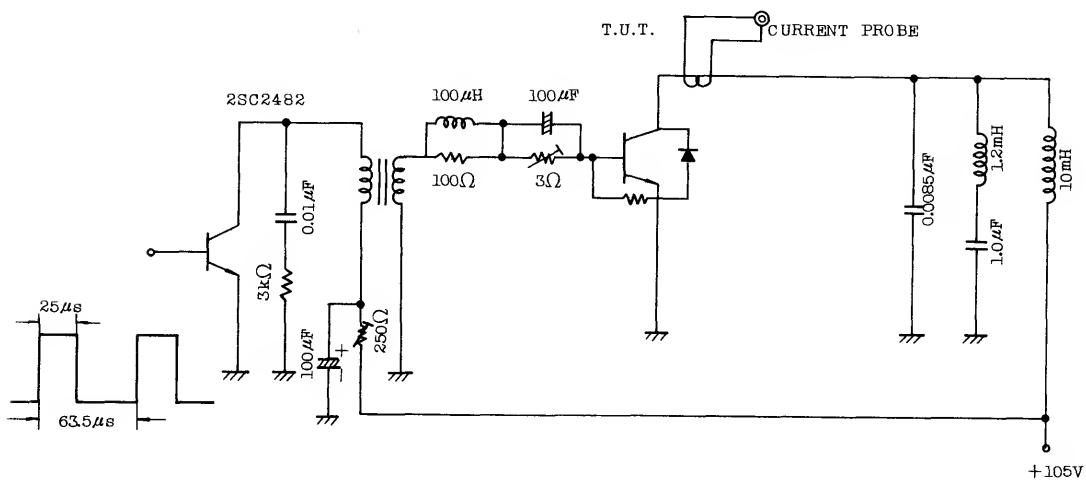


Mounting Kit No. AC42C
Weight : 17g

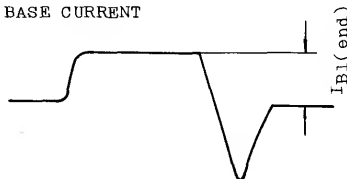
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=500V, I_E=0$	-	-	10	μA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=200mA, I_C=0$	5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=0.5A$	8	12	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=3A, I_B=0.8A$	-	5	8	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=3A, I_B=0.8A$	-	-	1.5	V
Forward Voltage(Damper Diode)	$-V_F$	$I_F=3.5A$	-	1.6	2.0	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.1A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	95	-	pF
Fall Time (Fig.)	t_f	$I_{CP}=3A, I_{B1(end)}=0.8A$	-	0.5	1.0	μs

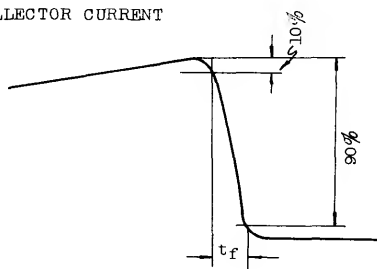
Fig. t_f TEST CIRCUIT



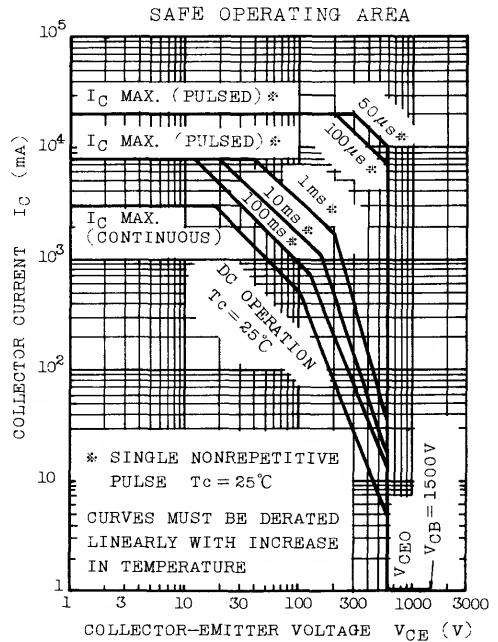
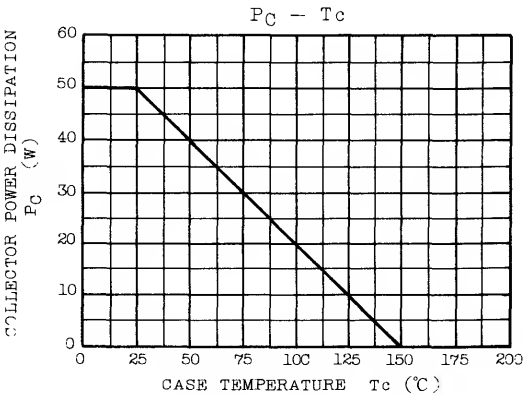
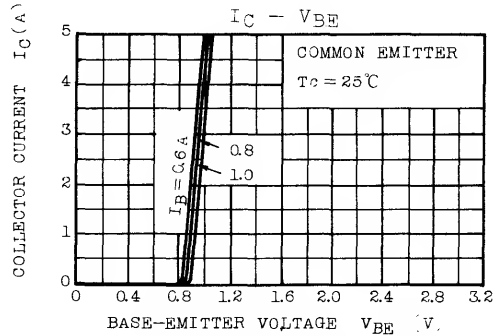
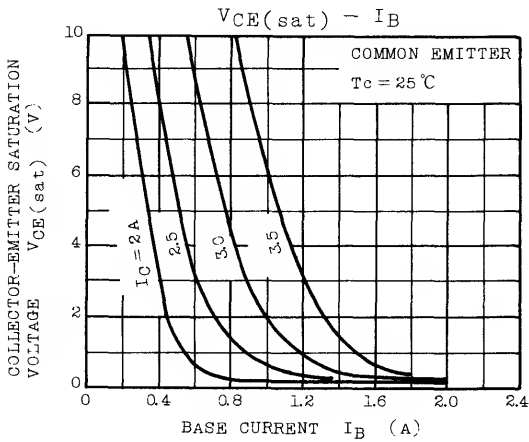
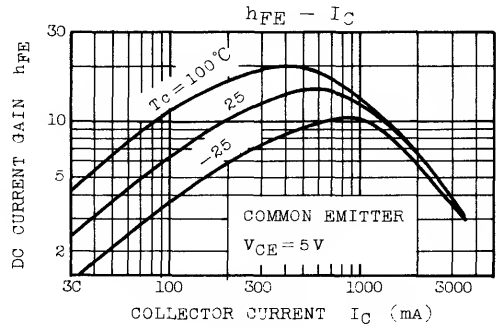
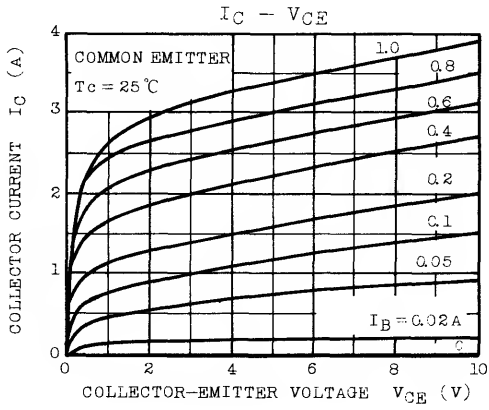
BASE CURRENT



COLLECTOR CURRENT



2SD869



COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

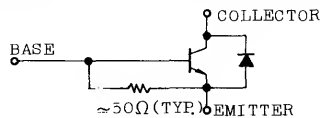
FEATURES:

- High Voltage : $V_{CBO}=1500V$
- Low Saturation Voltage
: $V_{CE(sat)}=5V$ (Max.) ($I_C=4A, I_B=0.8A$)
- High Speed ; $t_f=1.0\mu s$ (Max.) ($I_{CP}=4A, I_{B1(end)}=0.8A$)
- Built-in Damper Type.
- Glass Passivated Collector-Base Junction.

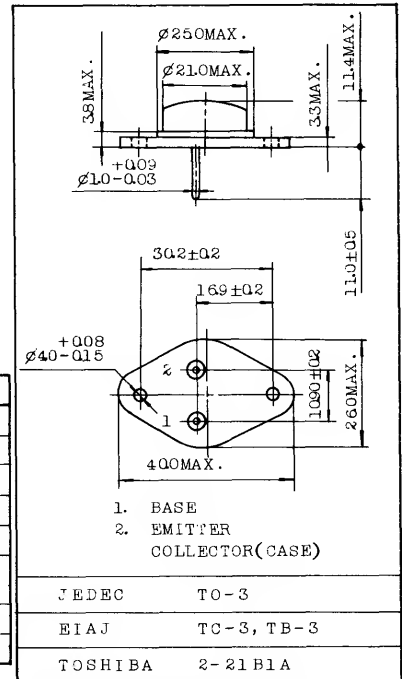
MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	5	A
Emitter Current	I_E	-5	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	50	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-65~150	$^\circ C$

EQUIVALENT CIRCUIT



Unit in mm



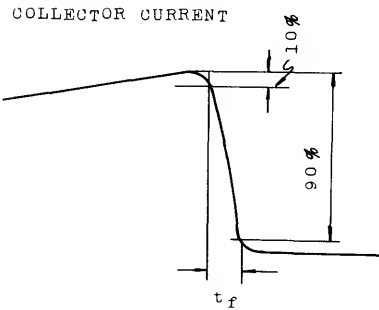
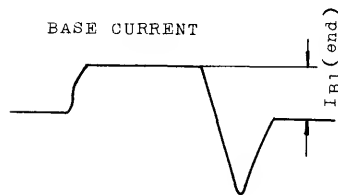
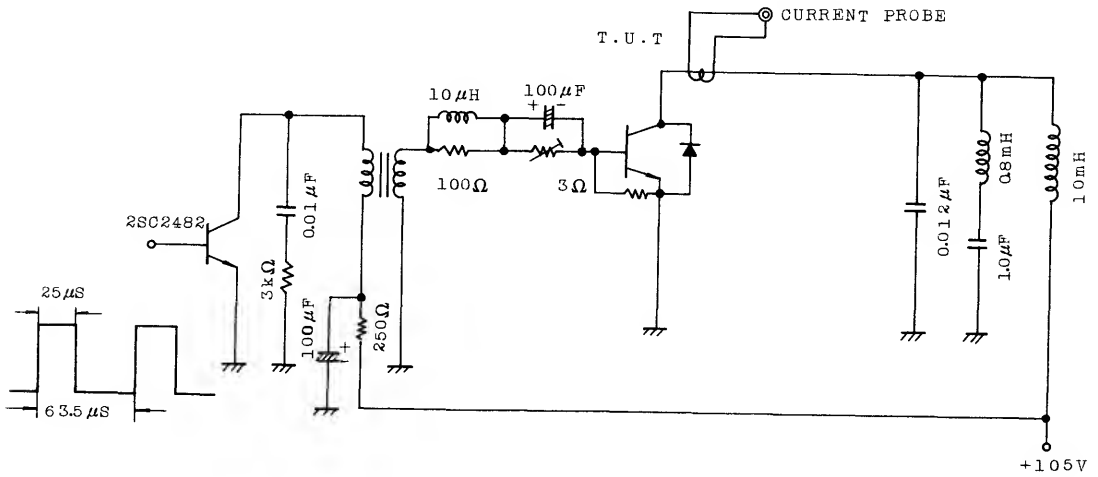
Mounting kit No. AC42C
Weight : 17g

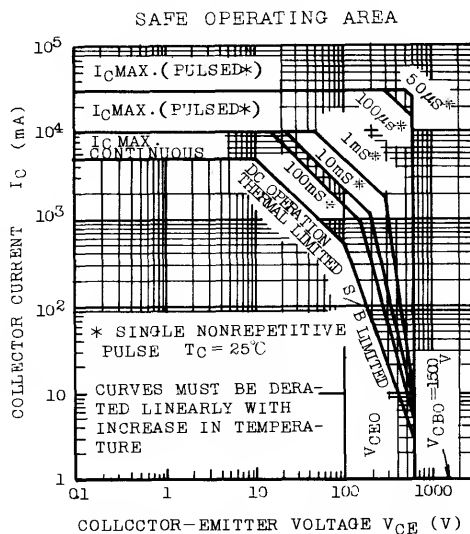
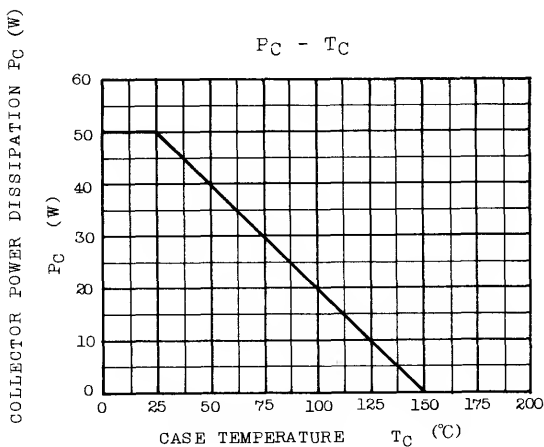
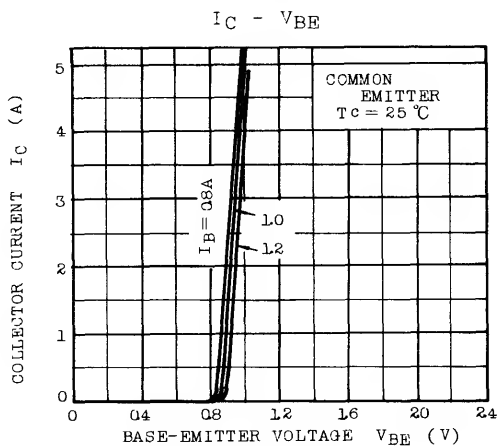
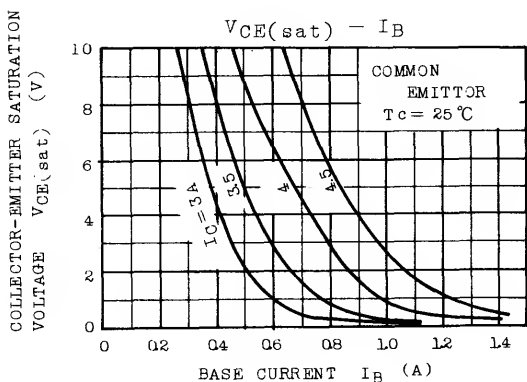
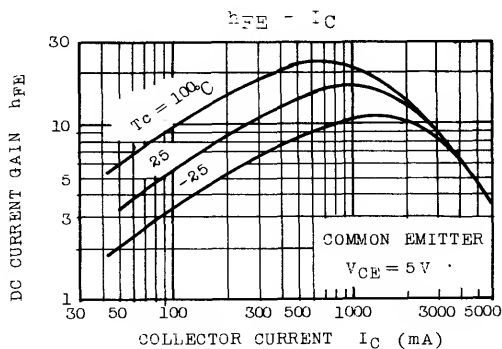
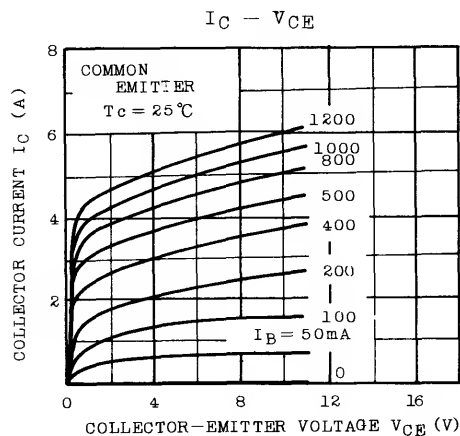
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=500V, I_E=0$	-	-	10	μA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=200mA, I_C=0$	5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=1.0A$	8	12	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A, I_B=0.8A$	-	3	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4A, I_B=0.8A$	-	-	1.5	V
Forward Voltage (Damper Diode)	$-V_F$	$I_F=5A$	-	1.6	2.0	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.1A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	165	-	pF
Fall Time (Fig.)	t_f	$I_{CP}=4A, I_{B1(end)}=0.8A$	-	0.5	1.0	μs

2SD870

Fig. t_f TEST CIRCUIT





2SD871

SILICON NPN TRIPLE DIFFUSED MESA TYPE

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

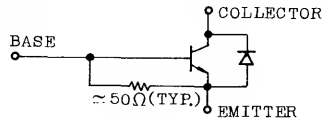
FEATURES:

- High Voltage : $V_{CBO}=1500V$
- Low Saturation Voltage
: $V_{CE(sat)}=5V$ (Max.) ($I_C=5A, I_B=1A$)
- High Speed ; $t_f=1.0\mu s$ (Max.) ($I_{CP}=5A, I_{B1}(end)=1A$)
- Built-in Damper Type.
- Glass Passivated Collector-Base Junction.

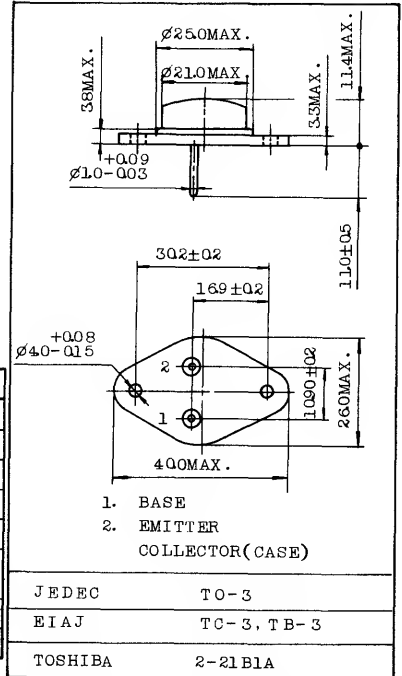
MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Emitter Current	I_E	-6	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	50	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-65~150	$^\circ C$

EQUIVALENT CIRCUIT



Unit in mm

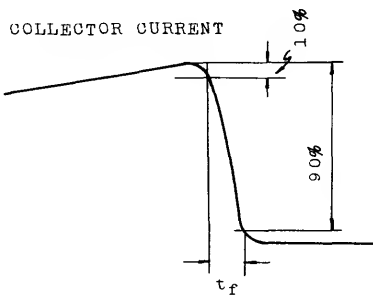
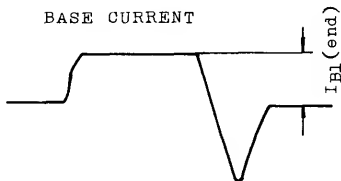
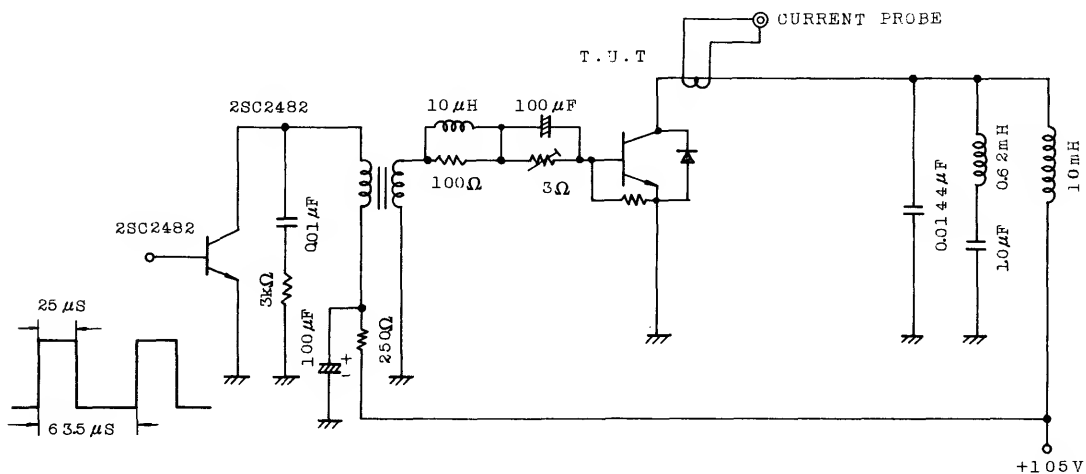


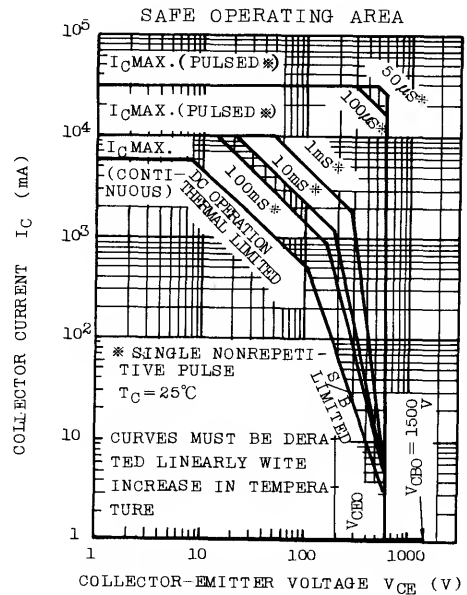
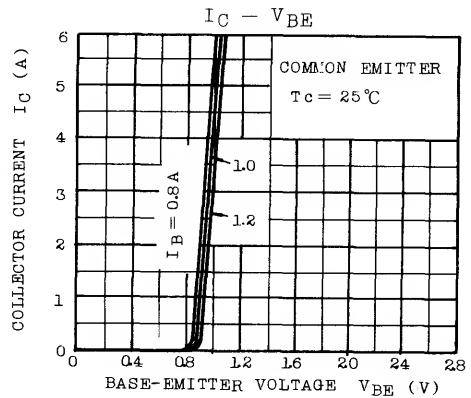
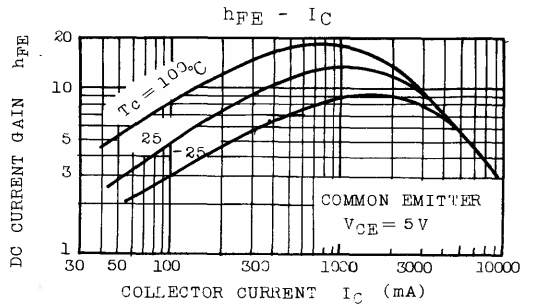
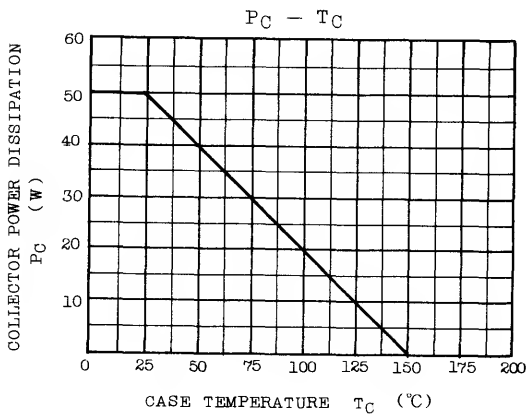
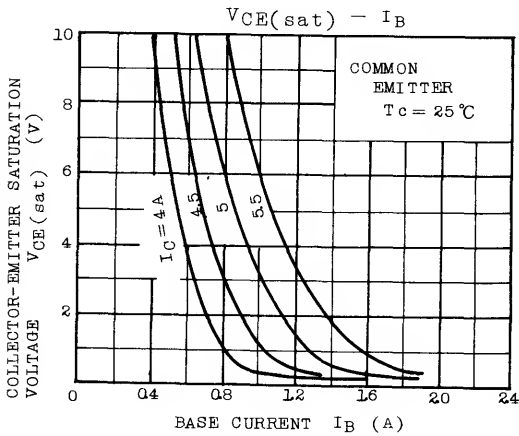
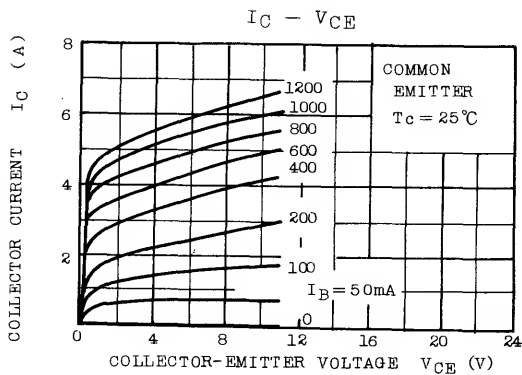
Mounting kit No. AC42C
Weight : 17g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=500V, I_E=0$	-	-	10	μA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=200mA, I_C=0$	5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=1A$	8	12	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=5A, I_B=1A$	-	3	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=5A, I_B=1A$	-	-	1.5	V
Forward Voltage (Damper Diode)	$-V_F$	$I_F=6A$	-	1.6	2.0	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.1A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	165	-	pF
Fall Time (Fig.)	t_f	$I_{CP}=5A, I_{B1}(end)=1A$	-	0.5	1.0	μs

Fig. t_f TEST CIRCUIT





INDUSTRIAL APPLICATIONS.

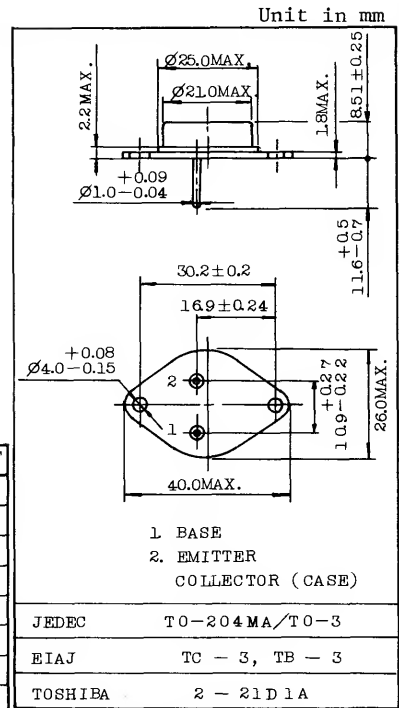
HIGH POWER AMPLIFIER APPLICATIONS.
 HIGH POWER SWITCHING APPLICATIONS.
 DC-DC CONVERTER APPLICATIONS.
 REGULATOR APPLICATIONS.

FEATURES:

- High Power Dissipation : $P_C=150W$ ($T_c=25^\circ C$)
- High Collector Current : $I_C=16A$
- Low Saturation Voltage : $V_{CE(sat)}=0.4V$ (Typ.) ($I_C=8A$)

MAXIMUM RATINGS ($T_a=25^\circ C$)

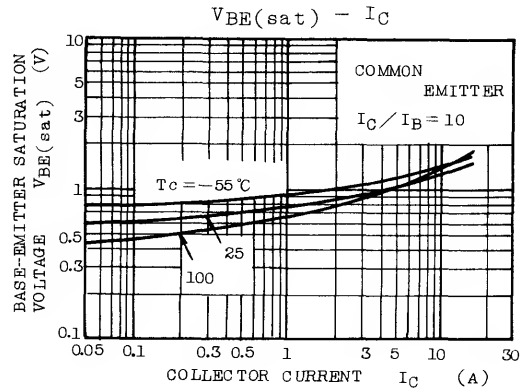
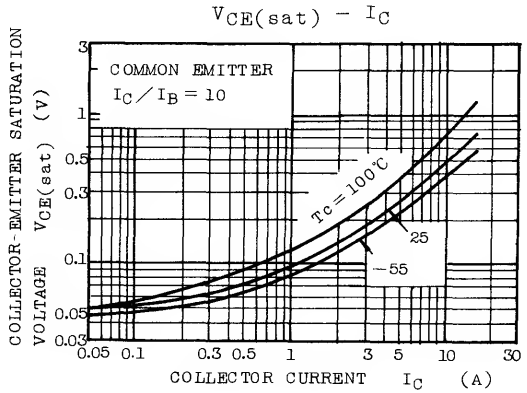
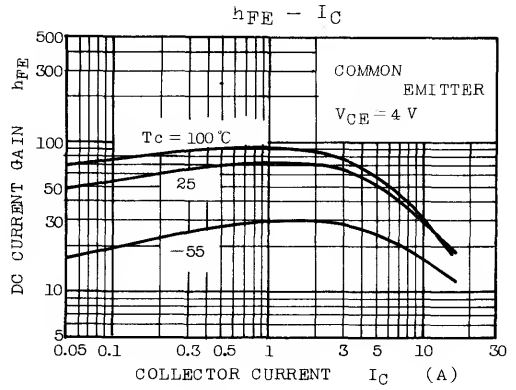
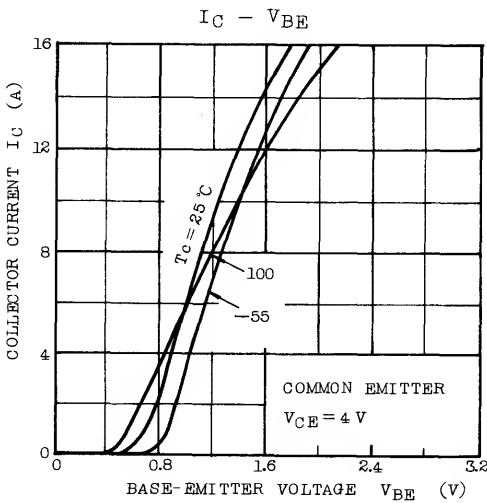
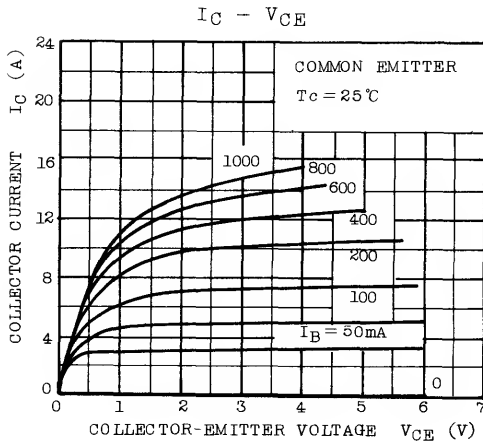
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	160	V
Collector-Emitter Voltage	V_{CEO}	140	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	16	A
Base Current	I_B	4	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	150	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65~175	$^\circ C$

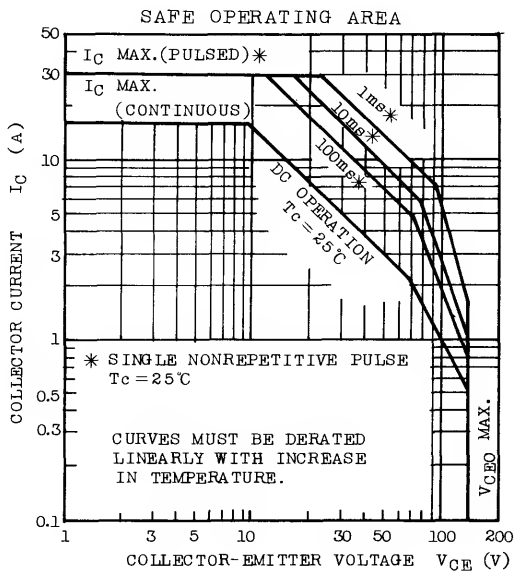
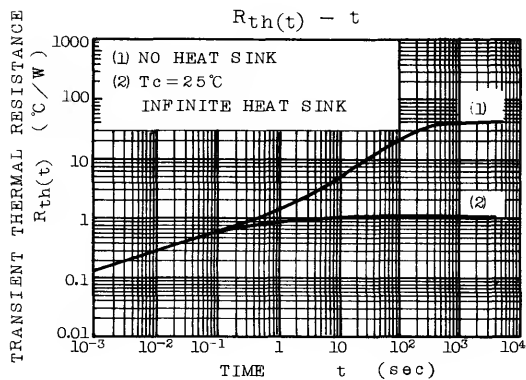


Mounting Kit No. AC73
 Weight : 12.6g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=140V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	100	μA
Collector-Emitter Breakdown Voltage		$V(BR)_{CEO}$	$I_C=50mA, I_B=0$	140	-	-	V
DC Current Gain	$h_{FE}(1)$		$V_{CE}=4V, I_C=8A$	15	-	60	
	$h_{FE}(2)$		$V_{CE}=4V, I_C=16A$	5	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=8A, I_B=0.8A$	-	0.4	1.4	V
Base-Emitter Voltage		V_{BE}	$V_{CE}=4V, I_C=8A$	-	1.2	2.2	V
Transition Frequency		f_T	$V_{CE}=4V, I_C=1A$	-	1.5	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	350	-	pF
Switching Time	Turn-on Time	t_{on}	<p>$I_{B1} = -I_{B2} = 0.5A$ $DUTY\ CYCLE \leq 1\%$</p>	-	2.5	-	μs
	Storage Time	t_{stg}		-	4.5	-	
	Fall Time	t_f		-	1.4	-	





2SD877

SILICON NPN TRIPLE DIFFUSED TYPE

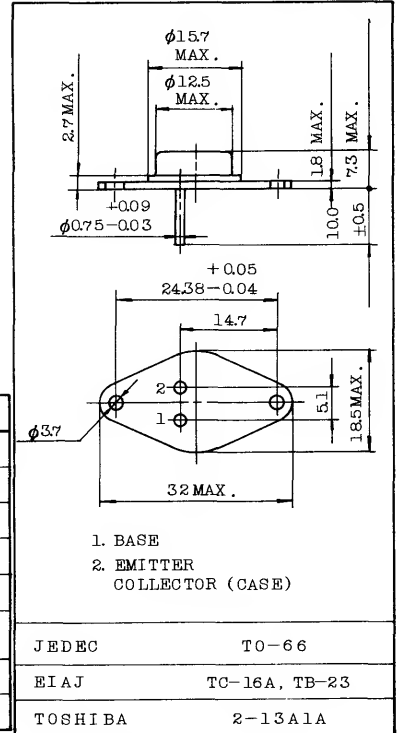
INDUSTRIAL APPLICATIONS

Unit in mm

HIGH POWER AMPLIFIER APPLICATIONS.
HIGH POWER SWITCHING APPLICATIONS.
DC-DC CONVERTER APPLICATIONS.
REGULATOR APPLICATIONS.

FEATURES:

- Low Saturation Voltage : $V_{CE(sat)} = 0.5V$ (Typ.) ($I_C = 3A$)



MAXIMUM RATINGS ($T_a = 25^\circ C$)

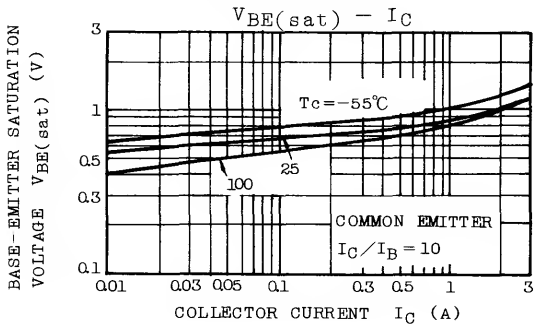
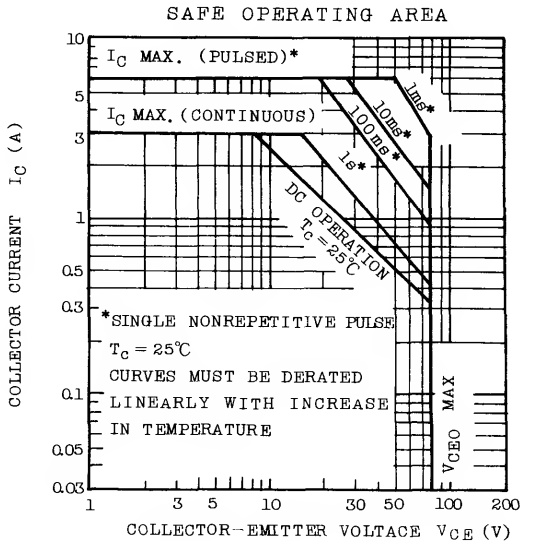
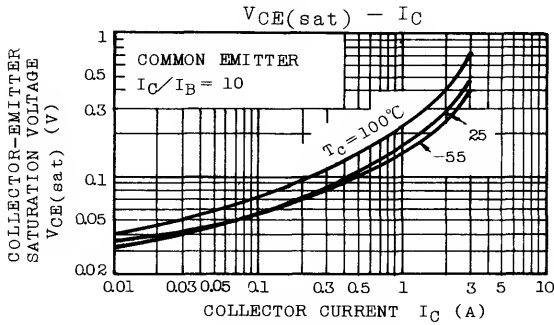
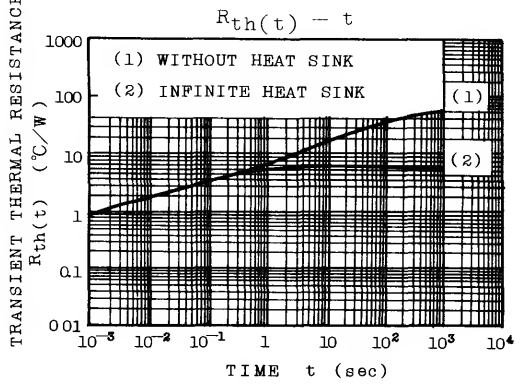
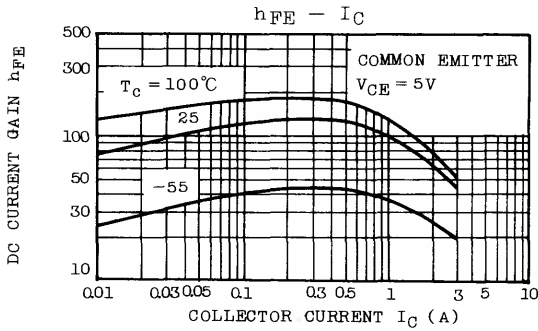
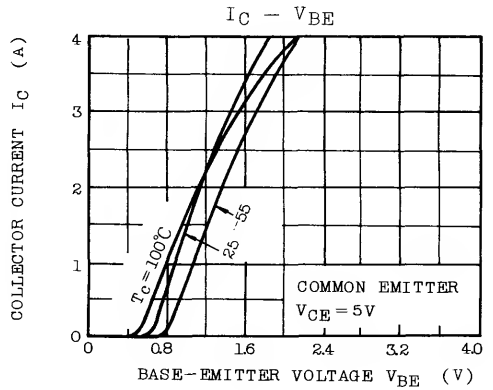
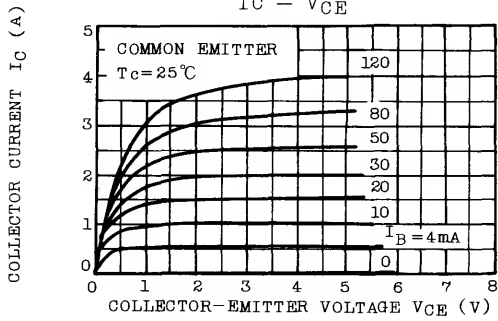
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	110	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EB0}	7	V
Collector Current	I_C	3	A
Base Current	I_B	1	A
Collector Power Dissipation ($T_c = 25^\circ C$)	P_C	25	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	-65~175	$^\circ C$

Mounting kit No. AC74
Weight : 5.9g

ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB} = 110V, I_E = 0$	-	-	100	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB} = 7V, I_C = 0$	-	-	100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C = 50mA, I_B = 0$	80	-	-	V
DC Current Gain	$h_{FE(1)}$	$V_{CE} = 5V, I_C = 0.5A$ (Note)	60	-	300	V
	$h_{FE(2)}$	$V_{CE} = 5V, I_C = 2.5A$	20	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = 3A, I_B = 0.3A$	-	0.5	1.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$		-	1.2	1.5	
Transition Frequency	f_T	$V_{CE} = 5V, I_E = -0.5A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB} = 10V, I_E = 0, f = 1MHz$	-	85	-	PF
Switching Time	Turn-on Time		-	1.5	-	us
	Storage Time		-	5.0	-	
	Fall Time		-	2.0	-	

Note : h_{FE} Classification : 0 : 60 ~ 120, Y : 100 ~ 200, GR : 150 ~ 300



2SD878

SILICON NPN TRIPLE DIFFUSED TYPE

INDUSTRIAL APPLICATIONS

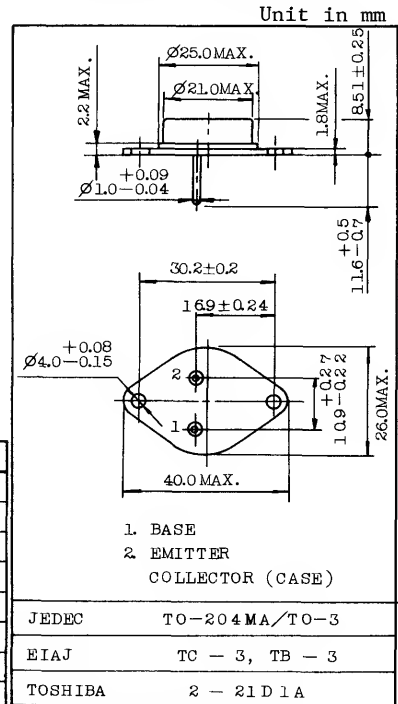
HIGH POWER AMPLIFIER APPLICATIONS.
 HIGH POWER SWITCHING APPLICATIONS.
 DC-DC CONVERTER APPLICATIONS.
 REGULATOR APPLICATIONS.

FEATURES:

- High Power Dissipation : $P_C=115W$ ($T_c=25^\circ C$)
- High Collector Current : $I_C=15A$
- Low Saturation Voltage : $V_{CE(sat)}=0.3V$ (Typ.) ($I_C=4A$)

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	100	V
Collector-Emitter Voltage	V_{CE0}	60	V
Emitter-Base Voltage	V_{EB0}	7	V
Collector Current	I_C	15	A
Base Current	I_B	7	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	115	W
Junction Temperature	T_j	175	$^\circ C$
Storage Temperature Range	T_{stg}	$-65 \sim 175$	$^\circ C$



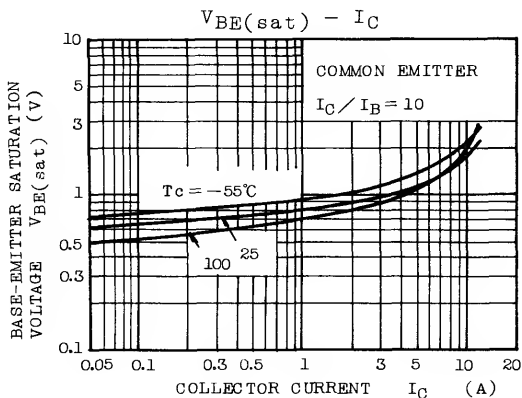
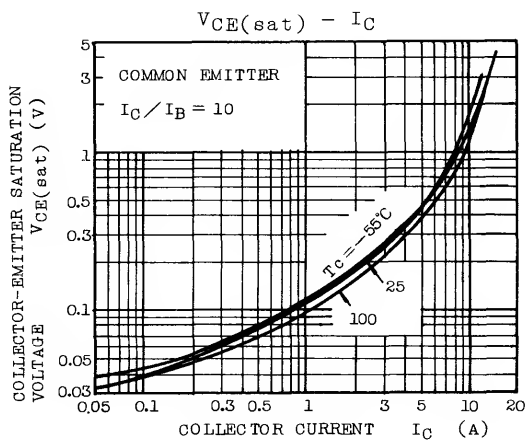
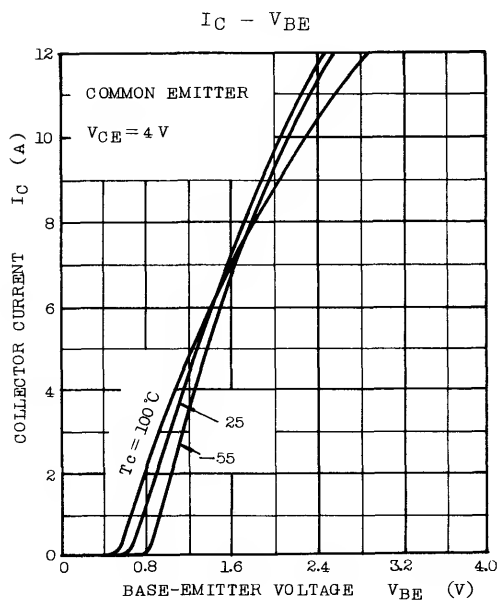
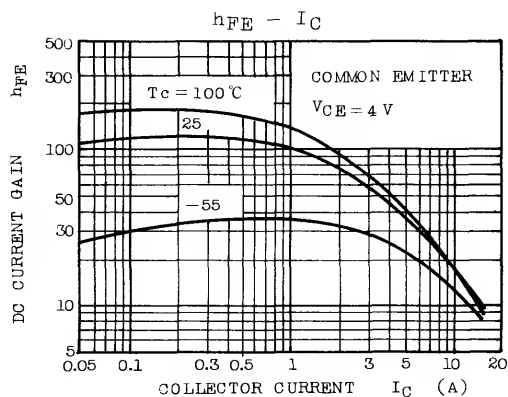
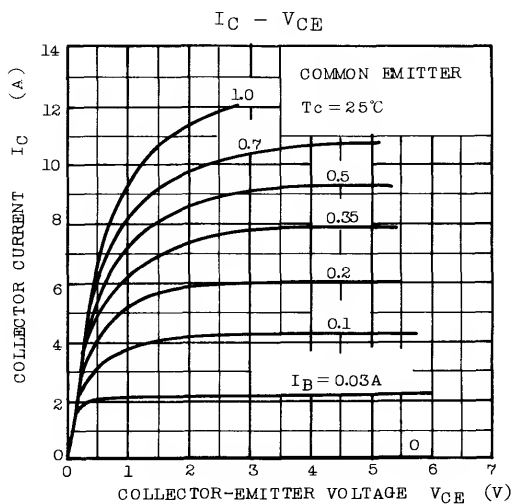
Mounting Kit No. AC73

Weight : 12.6g

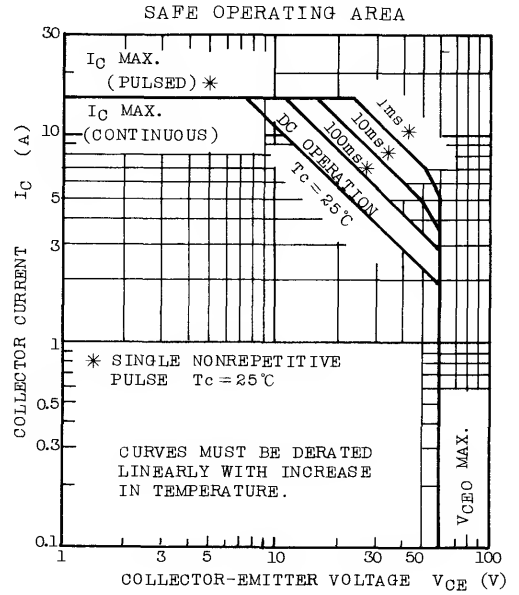
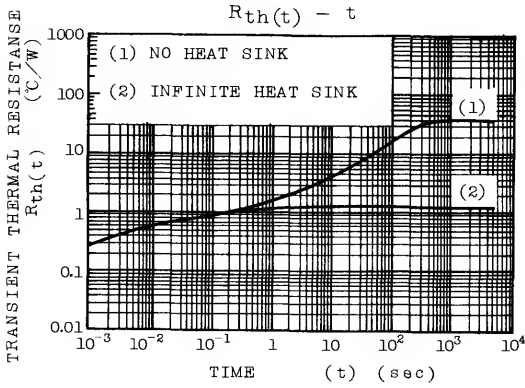
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=100V, I_E=0$	-	-	100	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	60	-	-	V
DC Current Gain	$h_{FE(1)}$	$V_{CE}=4V, I_C=4A$	20	-	70	
	$h_{FE(2)}$	$V_{CE}=4V, I_C=10A$	5	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A, I_B=0.4A$	-	0.3	1.1	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=4V, I_C=4A$	-	1.1	1.8	V
Transition Frequency	f_T	$V_{CE}=4V, I_C=1A$	-	1.5	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	150	-	pF
Switching Time	Turn-on Time	t_{on}	-	2.5	-	μs
	Storage Time	t_{stg}	-	3.5	-	
	Fall Time	t_f	-	1.2	-	

$I_{B1} = -I_{B2} = 0.5A$
 DUTY CYCLE $\leq 1\%$
 $V_{CC} = 50V$



2SD878



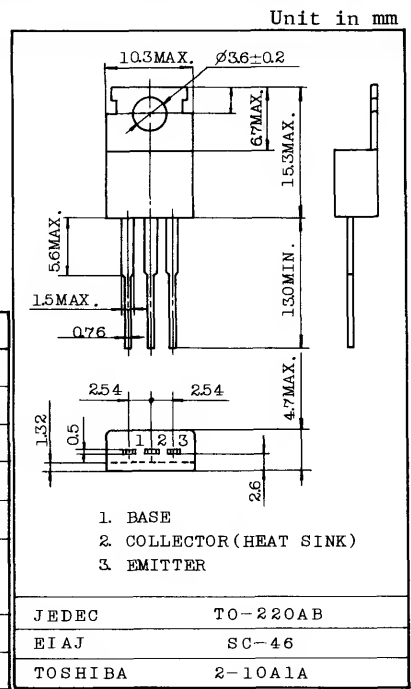
AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES :

- . High DC Current Gain
: $h_{FE}=300(\text{Max.})(V_{CE}=5V, I_C=0.5A)$
- . Low Saturation Voltage
: $V_{CE}(\text{sat})=1.0V(\text{Max.})(I_C=3A, I_B=0.3A)$
- . High Power Dissipation : $P_C=30W (T_c=25^\circ C)$
- . Complementary to 2SB834.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	60	V
Collector-Emitter Voltage		V_{CEO}	60	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	3	A
Base Current		I_B	0.5	A
Collector Power Dissipation	$T_a=25^\circ C$	T_j	1.5	W
	$T_c=25^\circ C$		30	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55~150	$^\circ C$



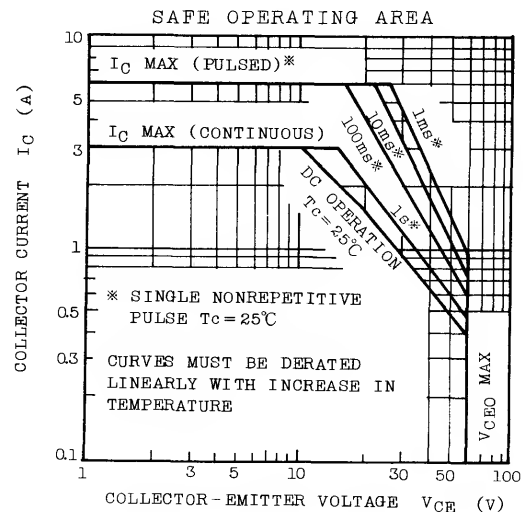
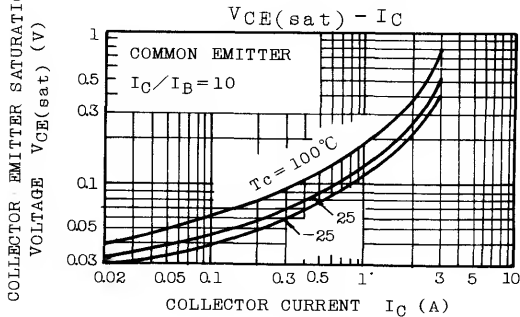
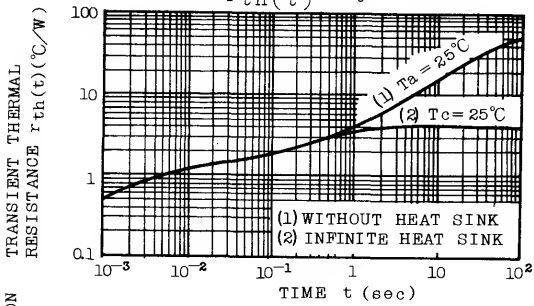
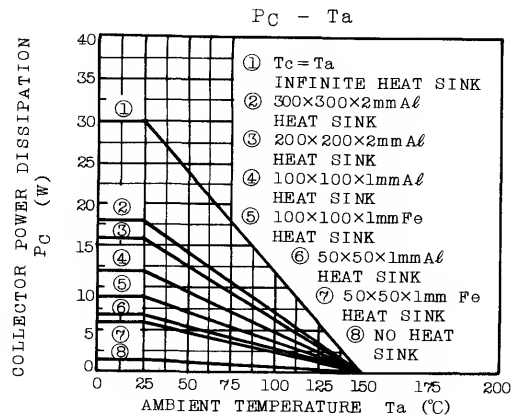
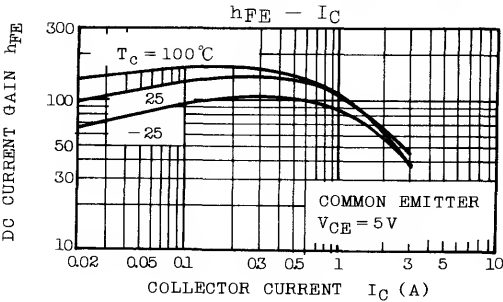
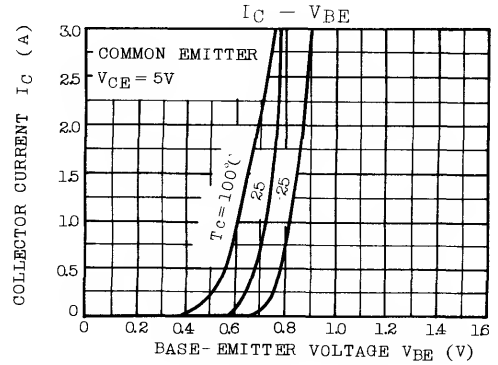
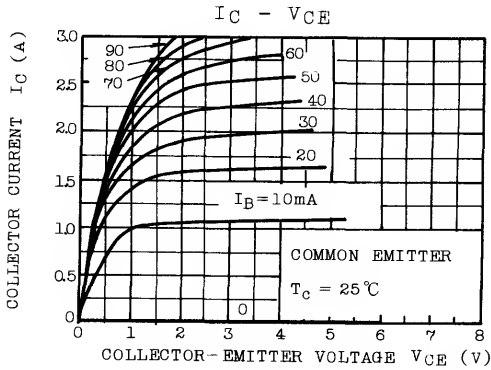
Mounting kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=60V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	60	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=0.5A$ (Note)	60	-	300	
Collector Emitter Saturation Voltage		$V_{CE}(\text{sat})$	$I_C=3A, I_B=0.3A$	-	0.25	1.0	V
Base-Emitter Voltage		V_{BE}	$V_{CE}=5V, I_C=0.5A$	-	0.7	1.0	V
Transition Frequency		f_T	$V_{CE}=5V, I_C=0.5A$	-	3.0	-	MHz
Collector Output Capacitance		C_{cb}	$V_{CB}=10V, I_E=0, f=1MHz$	-	70	-	pF
Switching Time	Turn-on Time	t_{on}	<p>$I_{B1} = -I_{B2} = 0.2A$ DUTY CYCLE < 1%</p>	-	0.8	-	μs
	Storage Time	t_{stg}		-	1.5	-	
	Fall Time	t_f		-	0.8	-	

Note: h_{FE} Classification 60~120, Y : 100~200, GR: 150~300.

2SD880



HIGH POWER SWITCHING APPLICATIONS.
DC-AC POWER INVERTER APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

FEATURES:

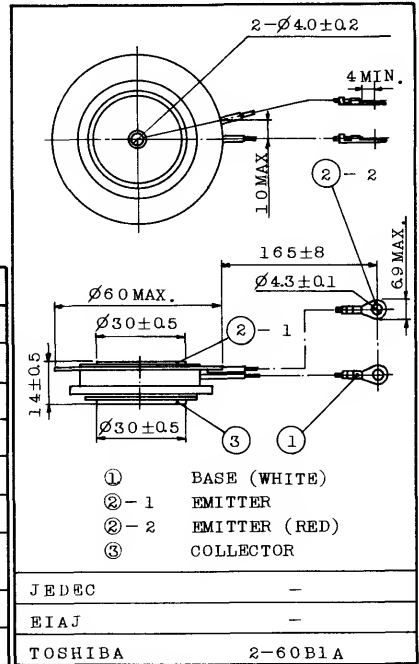
- . High Voltage : $V_{CEO(SUS)}=450V$
- . Triple Diffused Design.
- . Darlington Design.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	600	V
Collector-Emitter Voltage	$V_{CE0(SUS)}$	450	V
Emitter-Base Voltage	V_{EB0}	6	V
Collector Current	I_C	300	A
Emitter Current	I_E	-300	A
Base Current	I_B	12	A
Thermal Resistance (Double Side Cooling)	$R_{th(j-c)}$	0.08	$^\circ C/W$
Junction Temperature	T_j	125	$^\circ C$
Storage Temperature Range	T_{stg}	-40 ~ 150	$^\circ C$
Mounting Force Required	F	500±50	kg

INDUSTRIAL APPLICATION

Unit in mm



JEDEC	-
EIAJ	-
TOSHIBA	2-60B1A

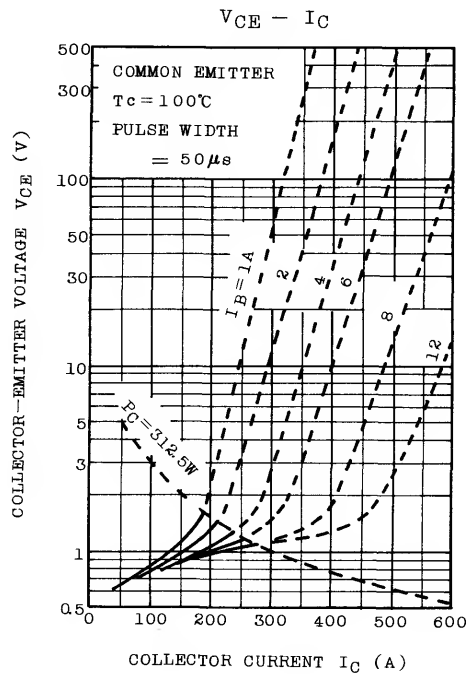
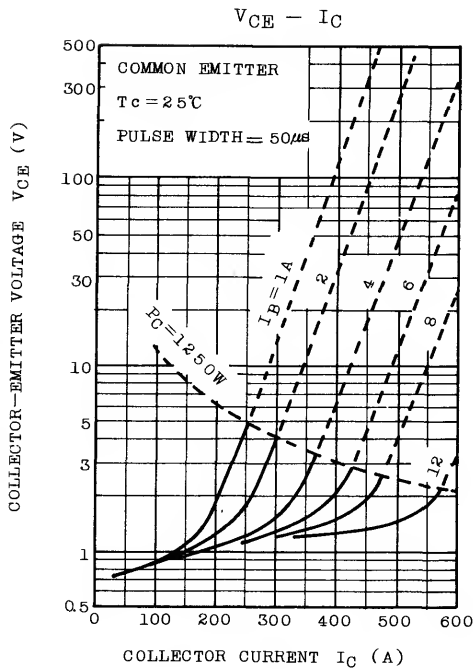
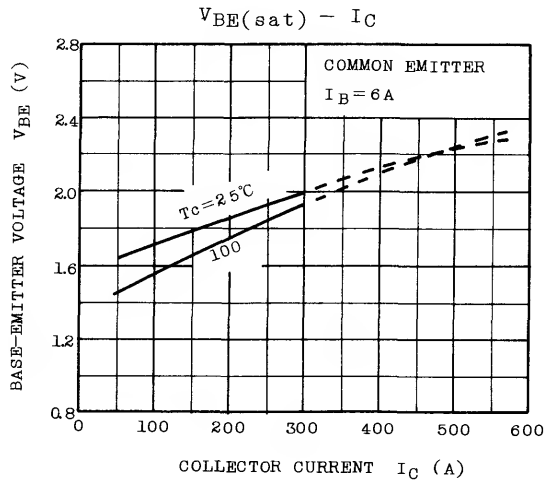
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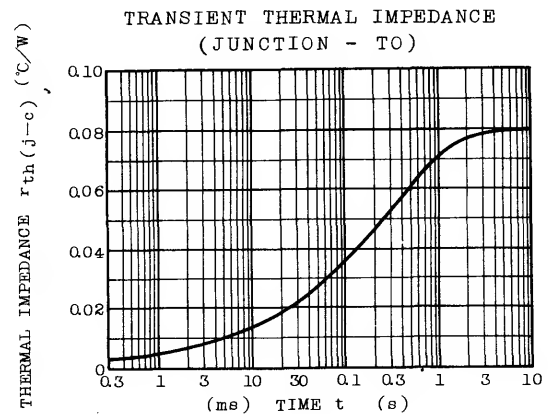
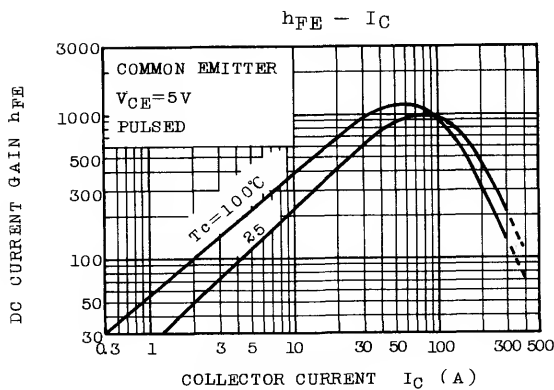
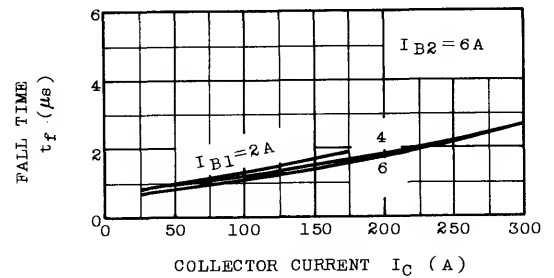
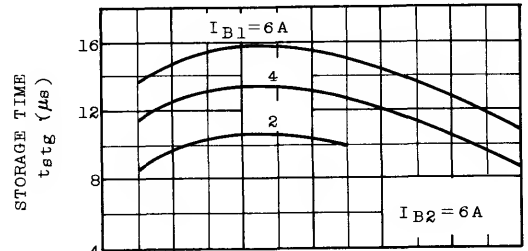
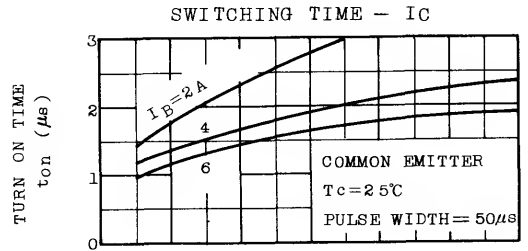
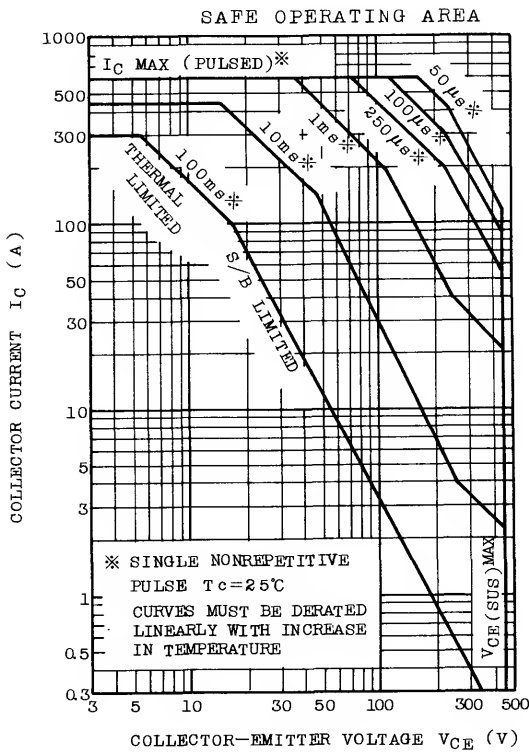
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=300A$	150	-	-	
		$V_{CE}=5V, I_C=150A$	-	500	-	
Collector-Emitter Sustaining Voltage	$V_{CE0(SUS)}$	$I_C=0.5A, L=40mH$	450	-	-	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=300A, I_B=6A$ (Note)	-	-	2.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$		-	-	2.5	V
Collector Cut-off Current	I_{CB0}	$V_{CB}=600V, I_E=0$	-	-	2	mA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=6V, I_C=0$	-	-	600	mA
Switching Time	Turn-on Time	$I_C=300A, I_{B1}=6A, -I_{B2}=16A, V_C=300V$	-	1	2	μs
	Storage Time		-	13	16	
	Fall Time		-	2.5	4	

Note : Pulse Test; Pulse width $\leq 300\mu s$, Duty Cycle $\leq 3\%$
Mounting Force; $F=500kg$

2SD1034A





2SD1052

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

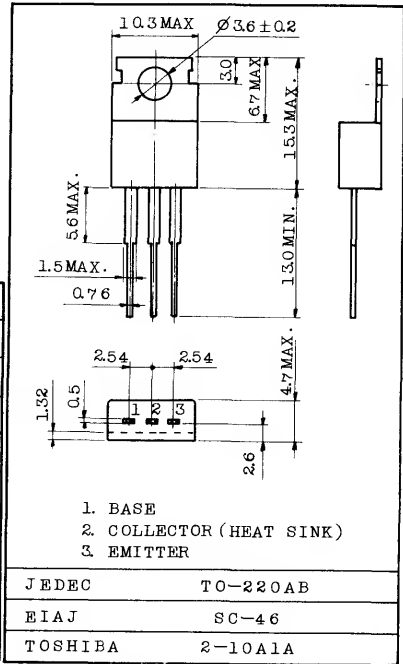
FEATURES :

- High DC Current Gain of 250 to 750 at $V_{CE}=5V, I_C=0.5A$
- Low $V_{CE(sat)}$ of 1.0V (MAX.) at $I_C=1A, I_B=0.02A$
- Collector Power Dissipation of 30W at $T_c=25^\circ C$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT	
Collector-Base Voltage	V_{CB0}	50	V	
Collector-Emitter Voltage	V_{CE0}	50	V	
Emitter-Base Voltage	V_{EB0}	7	V	
Collector Current	I_C	3	A	
Base Current	I_B	0.5	A	
Collector Power Dissipation	P_C	$T_a=25^\circ C$	1.5	W
		$T_c=25^\circ C$	30	
Junction Temperature	T_j	150	$^\circ C$	
Storage Temperature Range	T_{stg}	-55~150	$^\circ C$	

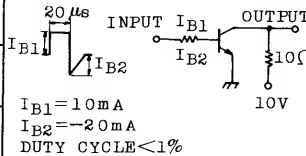
Unit in mm

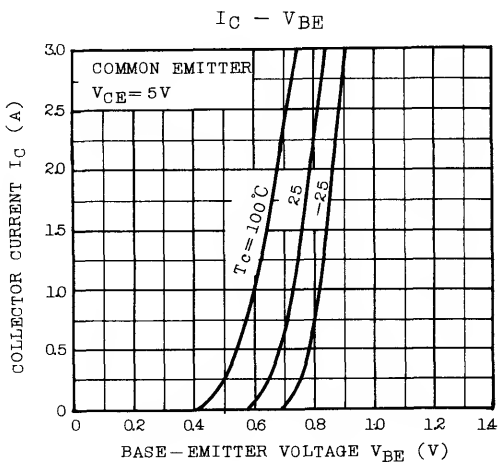
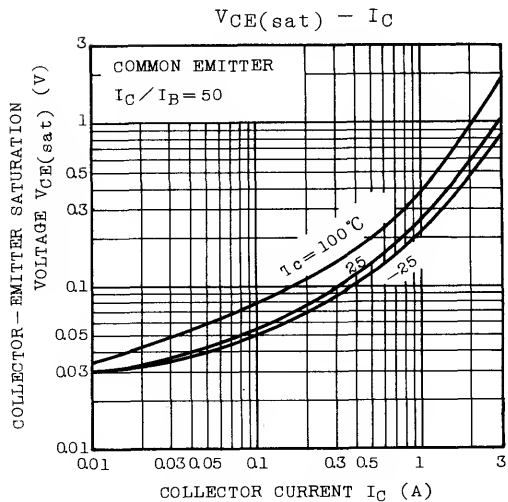
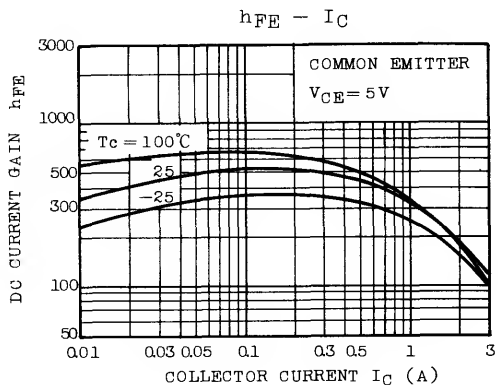
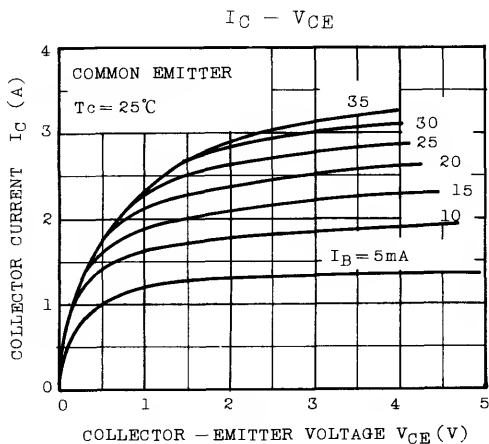


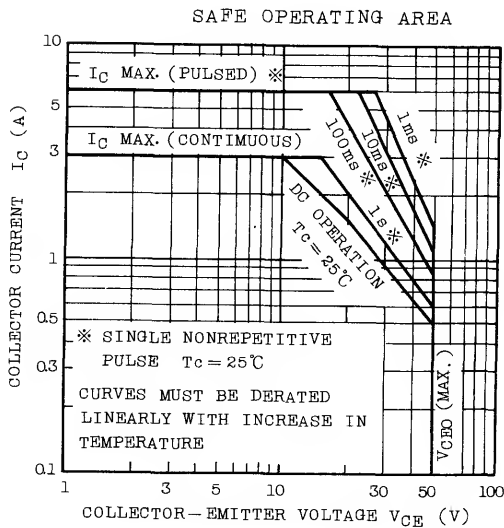
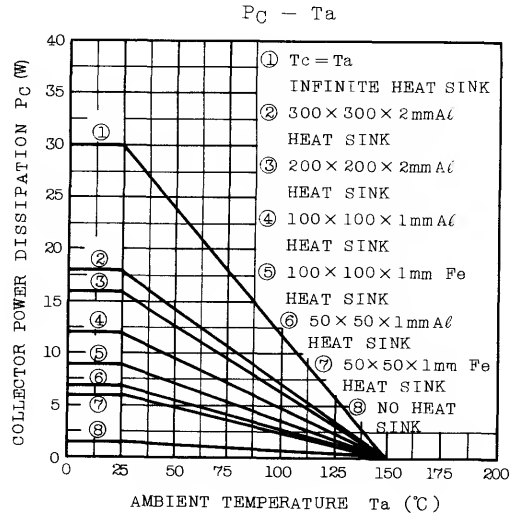
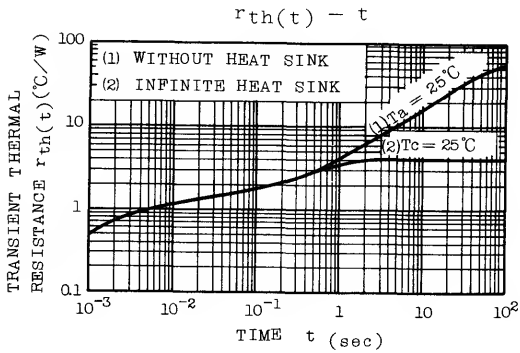
Mounting kit No.AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=50V, I_E=0$	-	-	100	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=7V, I_C=0$	-	-	100	μA
Collector-Emitter Breakdown Voltage	$V(BR)_{CEO}$	$I_C=50mA, I_B=0$	50	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=0.5A$	250	-	750	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=1.0A, I_B=0.02A$	-	0.25	1.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5V, I_C=0.5A$	-	0.7	1.0	V
Transition Frequency	f_T	$V_{CE}=5V, I_C=0.5A$	-	5.0	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	70	-	pF
Switching Time	Turn-on Time	T_{on}	-	1.5	-	μs
	Storage Time	T_{stg}	-	4.5	-	
	Fall Time	T_f	-	3.0	-	





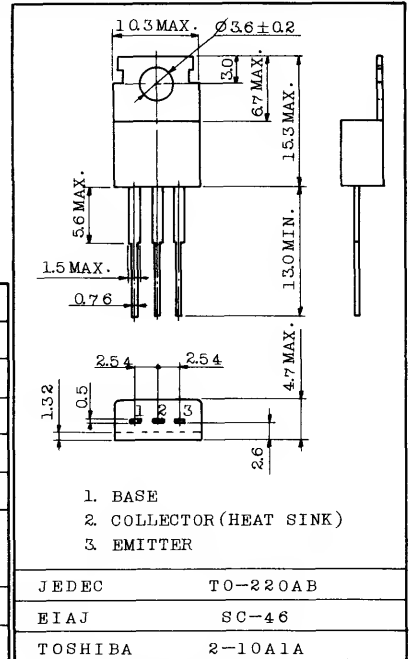


AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES :

- High DC Current Gain of 400 to 1200 at $V_{CE}=5V, I_C=0.5A$
- Low $V_{CE(sat)}$ of 1.0V (MAX.) at $I_C=1A, I_B=0.02A$
- Collector Power Dissipation of 30W at $T_c=25^{\circ}C$

Unit in mm



MAXIMUM RATINGS ($T_a=25^{\circ}C$)

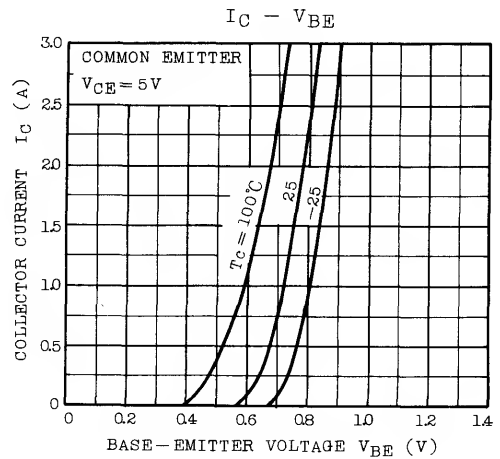
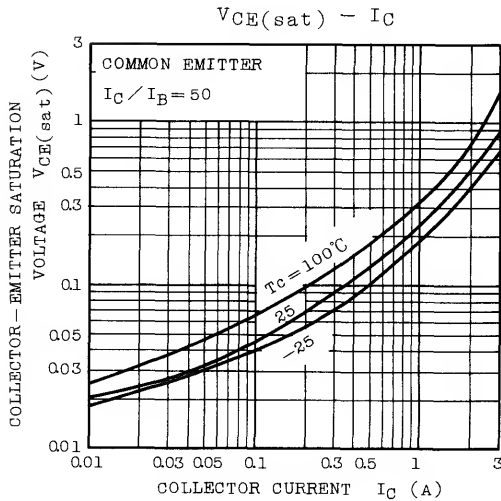
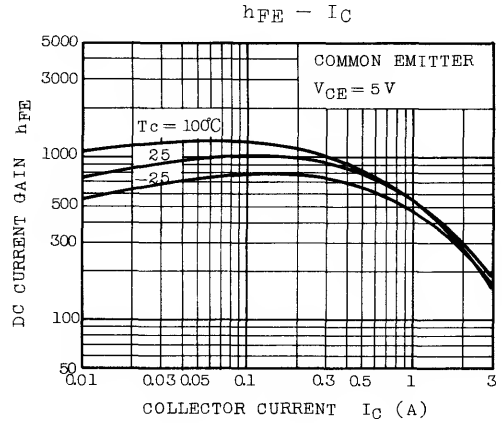
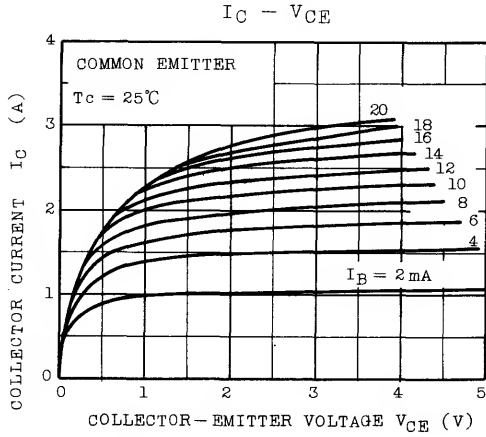
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	50	V
Collector-Emitter Voltage		V_{CEO}	50	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	3	A
Base Current		I_B	0.5	A
Collector Power Dissipation	$T_a=25^{\circ}C$	P_C	1.5	W
	$T_c=25^{\circ}C$		30	
Junction Temperature		T_j	150	$^{\circ}C$
Storage Temperature Range		T_{stg}	-55~150	$^{\circ}C$

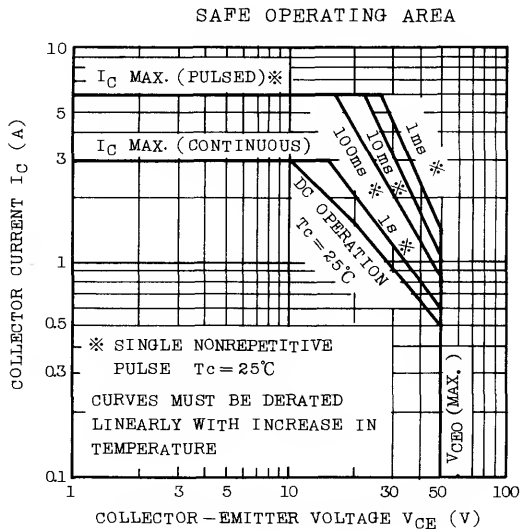
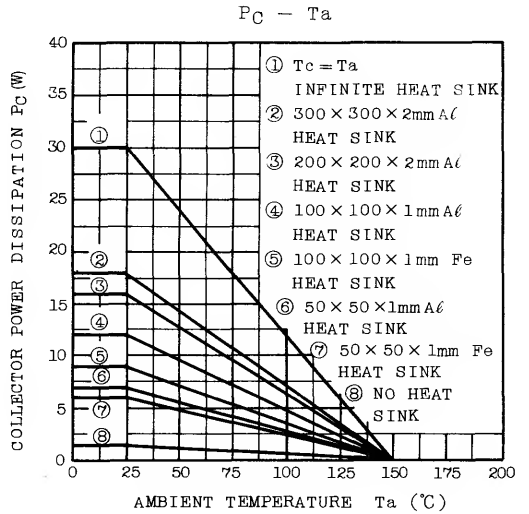
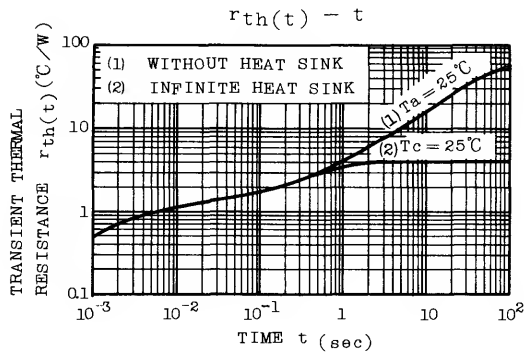
Mounting kit No.AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=50V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	50	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=0.5A$	400	-	1200	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=1A, I_B=0.02A$	-	0.25	1.0	V
Base-Emitter Voltage		V_{BE}	$V_{CE}=5V, I_C=0.5A$	-	0.7	1.0	V
Transition Frequency		f_T	$V_{CE}=5V, I_C=0.5A$	-	5.0	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	70	-	pF
Switching Time	Turn-on Time	T_{on}	<p>$I_{B1}=10mA$ $I_{B2}=-20mA$ DUTY CYCLL < 1%</p>	-	2.0	-	μs
	Storage Time	T_{stg}		-	5.0	-	
	Fall Time	T_f		-	3.0	-	

2SD1052A





2SD1069

SILICON NPN DOUBLE DIFFUSED TYPE (PCT PROCESS)

Unit in mm

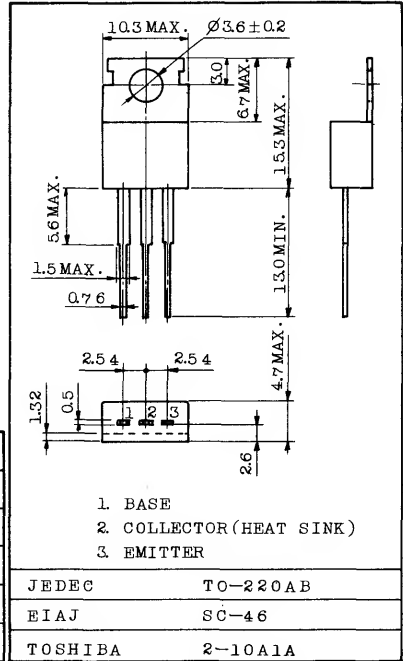
TV HORIZONTAL DEFLECTION OUTPUT APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

- . Built in Damper Type.
- . High Collector Current Capability.
- . High Collector Power Dissipation Capability.

MAXIMUM RATINGS (Ta=25°C)

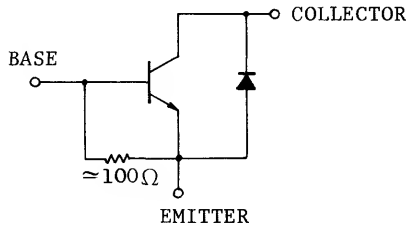
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V _{CB0}	300	V
Collector-Emitter Voltage		V _{CE0}	150	V
Emitter-Base Voltage		V _{EB0}	6	V
Collector Current		I _C	7	A
Collector Current (Peak)		I _{CP}	15	A
Base Current		I _{BM}	2	A
Collector Power Dissipation	T _a =25°C	P _C	1.75	W
	T _c =25°C		40	
Junction Temperature		T _j	150	°C
Storage Temperature Range		T _{stg}	-55~150	°C



Mounting kit No. AC75

Weight : 1.9 g

EQUIVALENT CIRCUIT

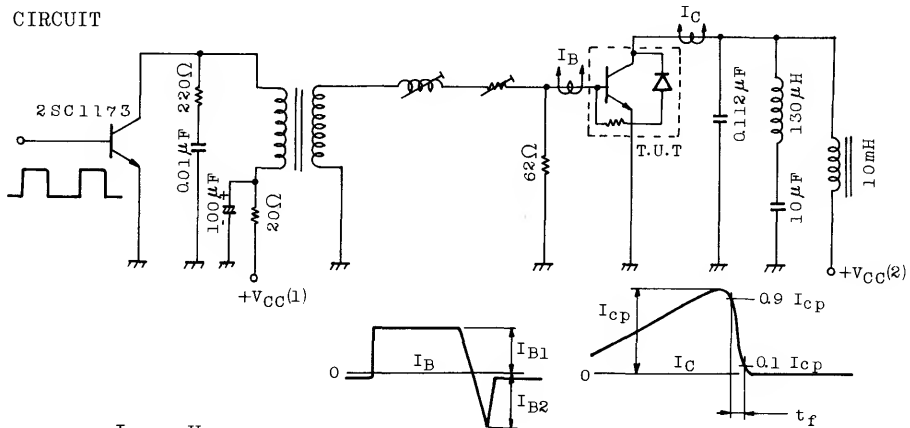


ELECTRICAL CHARACTERISTICS (Ta=25°C)

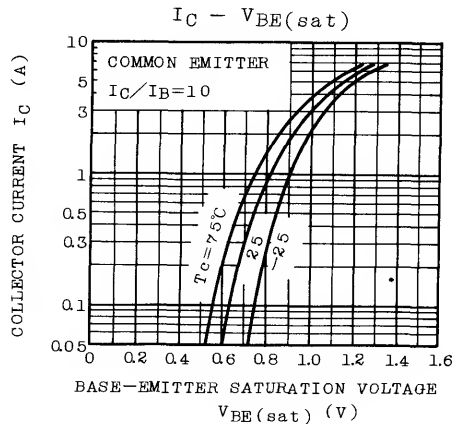
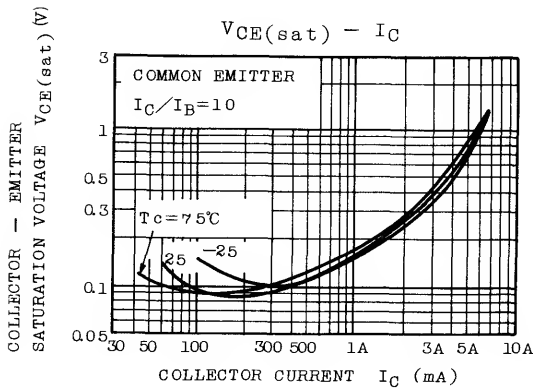
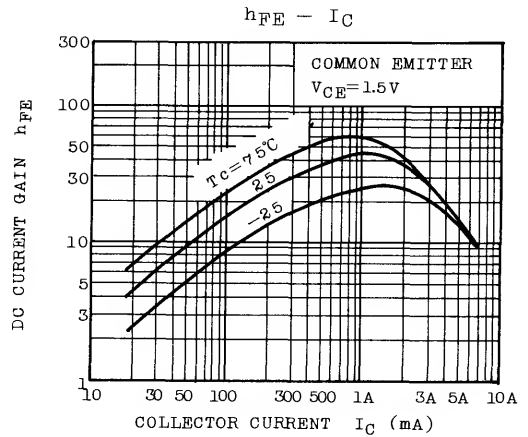
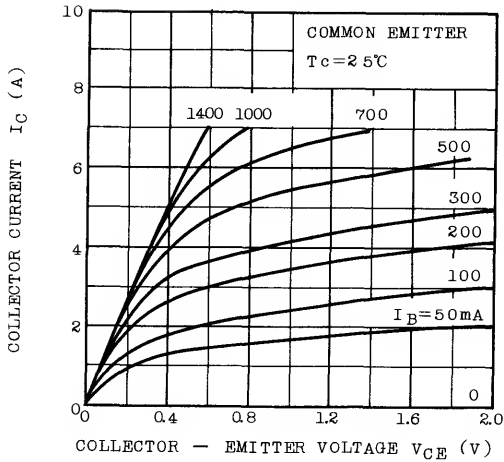
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CES}	$V_{CE}=250V, V_{BE}=0$	-	-	1.0	mA
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	$I_C=0.1A, L=50mH$	150	-	-	V
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	300	-	-	V
Emitter-Base Breakdown Voltage	V_{EBO}	$I_E=0.1A, I_C=0$	6	-	-	V
DC Forward Current Transfer Ratio	h_{FE}	$V_{CE}=1.5V, I_C=5A$	10	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=5A, I_B=0.5A$	-	-	1.5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=5A, I_B=0.5A$	-	-	1.5	V
Damper Diode Forward Voltage	$-V_F$	$I_C=-6A$	-	-	1.8	V
Collector Current Fall Time	t_f	$I_{cp}=5A, I_{B1}(end)=0.5A$	-	-	1.0	μs
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.2A$	-	18	-	MHz

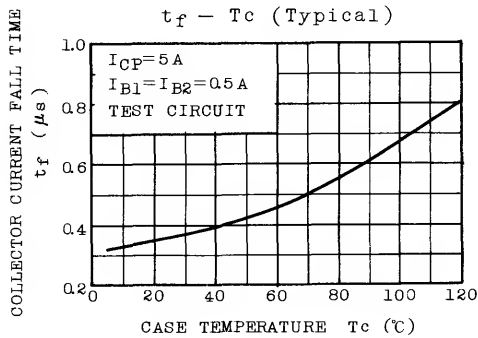
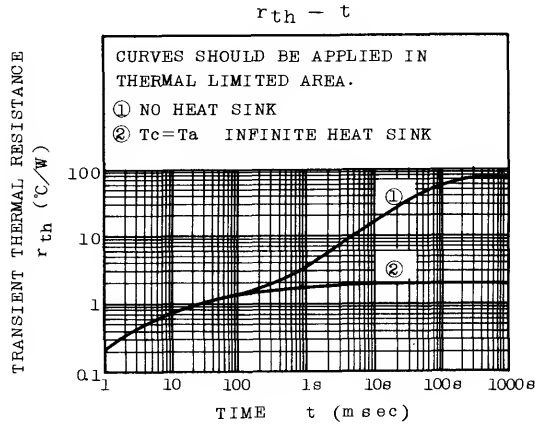
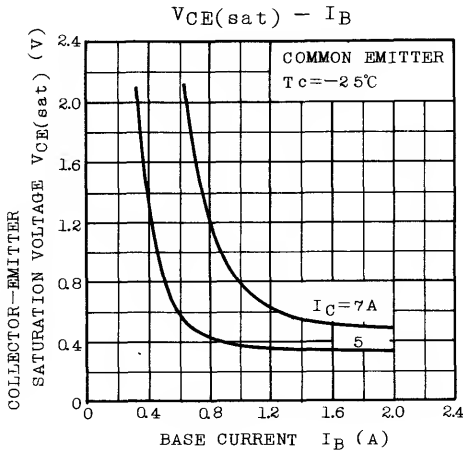
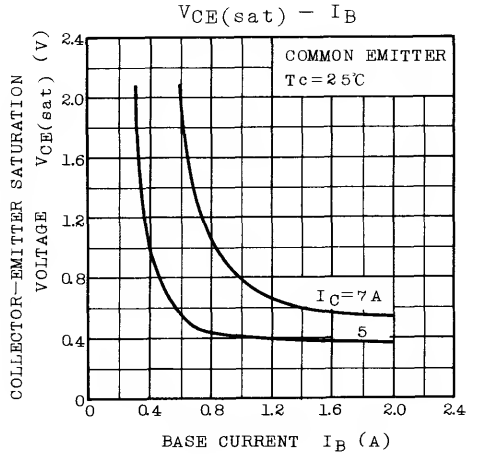
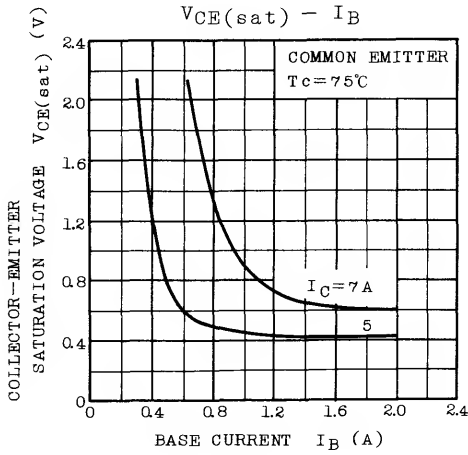
2SD1069

TEST CIRCUIT



$I_C - V_{CE}$





2SD1087

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

HIGH CURRENT SWITCHING APPLICATIONS.

FEATURES

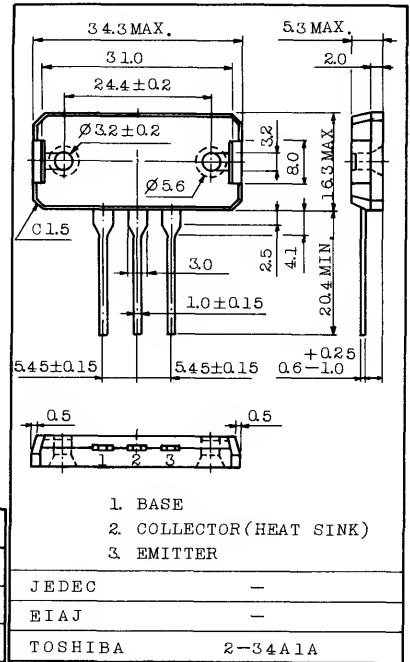
- . High DC Current Gain
: $h_{FE}=1000$ (Min.) ($V_{CE}=3V$, $I_C=15A$)
- . Low Collector Saturation Voltage
: $V_{CE(sat)}=1.5V$ (Max.) ($I_C=15A$)
- . Monolithic Construction with Built-In Base-Emitter Shunt Resistor.

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	100	V
Collector-Emitter Voltage	V_{CEO}	100	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	15	A
Base Current	I_B	1	A
Collector Power Disipation ($T_c=25^{\circ}C$)	P_C	100	W
Junction Temperature	T_j	150	$^{\circ}C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^{\circ}C$

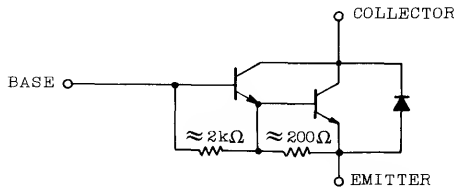
INDUSTRIAL APPLICATIONS

Unit in mm



Weight : 10.8g

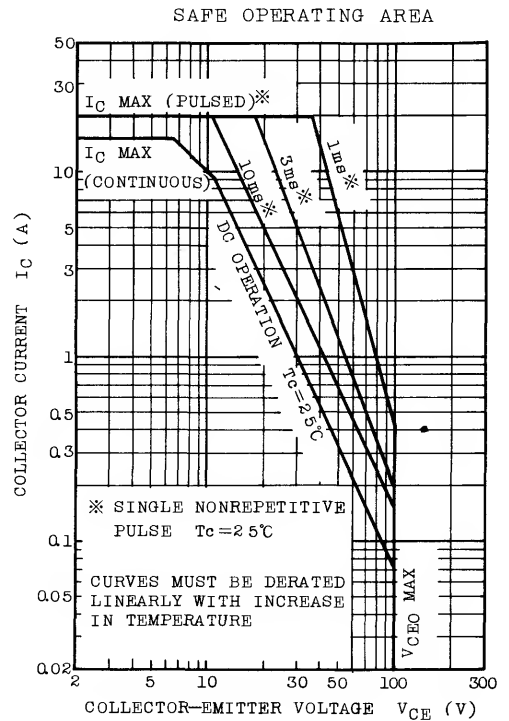
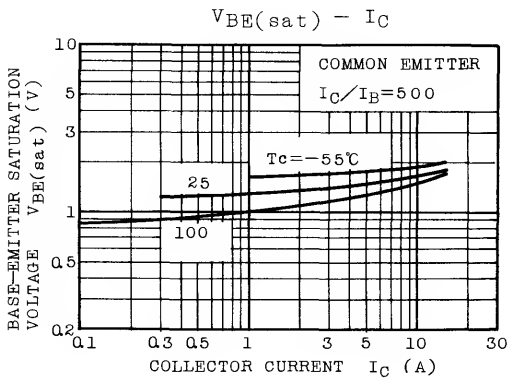
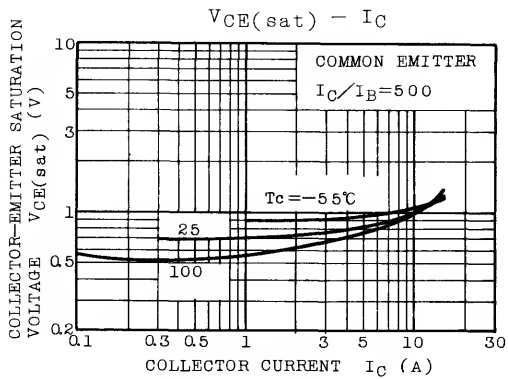
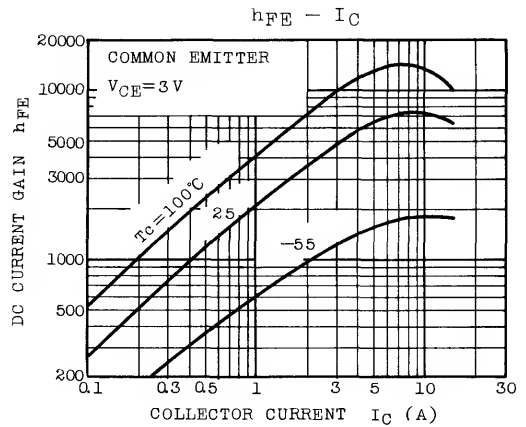
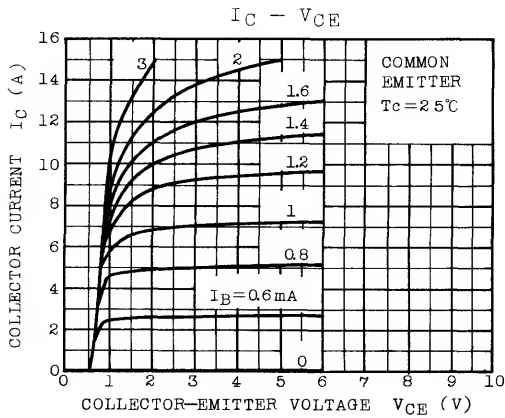
EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		ICBO	V _{CB} =100V, I _E =0	-	-	100	μA
Emitter Cut-off Current		IEBO	V _{EB} =5V, I _C =0	-	-	10	mA
Collector-Emitter Breakdown Voltage		V(BR)CEO	I _C =50mA, I _B =0	100	-	-	V
DC Current Gain		h _{FE}	V _{CE} =3V, I _C =15A	1000	-	-	
Collector-Emitter Saturation Voltage		V _{CE(sat)}	I _C =15A, I _B =0.025A	-	-	1.5	V
Base-Emitter Saturation Voltage		V _{BE(sat)}		-	-	2.2	V
Emitter-Collector Forward Voltage		V _{ECF}	I _E =10A, I _B =0	-	-	3	V
Transition Frequency		f _T	V _{CE} =5V, I _C =1A	-	14	-	MHz
Collector Output Capacitance		Cob	V _{CB} =10V, I _E =0, f=1MHz	-	280	-	pF
Switching Time	Turn-on Time	t _{on}	<p style="text-align: center;"> $V_{CC}=50V$ $R=10\Omega$ I_{B1} IN I_{B1} I_{B2} I_{E2} P_{UT} $OUTPUT$ </p> <p style="text-align: center;"> $I_{B1} = -I_{B2} = 0.01A$ DUTY CYCLE ≤ 1% </p>	-	0.7	-	μs
	Storage Time	t _{stg}		-	8	-	
	Fall Time	t _f		-	2.5	-	

2SD1087



INDUSTRIAL APPLICATIONS

Unit in mm

IGNITER APPLICATIONS.

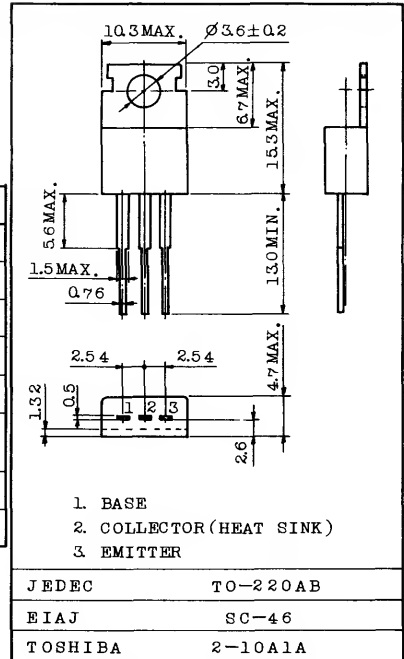
HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

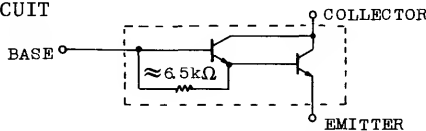
- High DC Current Gain
- $h_{FE}=2000$ (Min.) ($V_{CE}=2V, I_C=2A$)

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	300	V
Collector-Emitter Voltage	V_{CEO}	250	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Base Current	I_B	1	A
Collector Power Dissipation ($T_c=25^{\circ}C$)	P_C	30	W
Junction Temperature	T_j	150	$^{\circ}C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^{\circ}C$



EQUIVALENT CIRCUIT

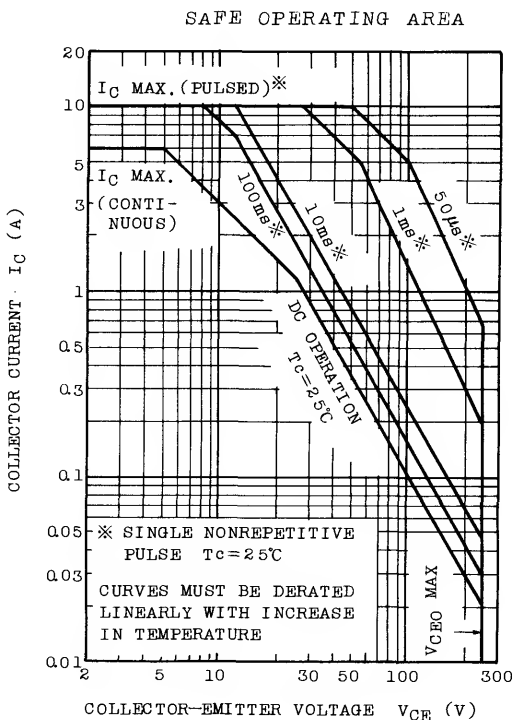
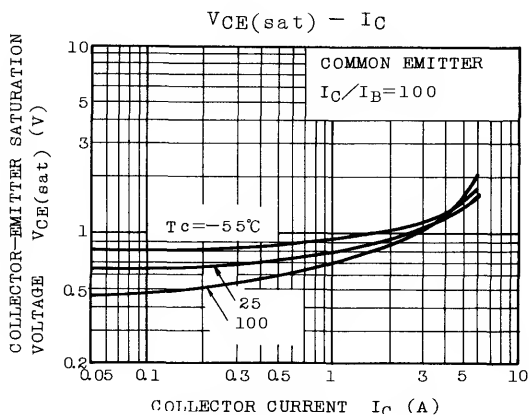
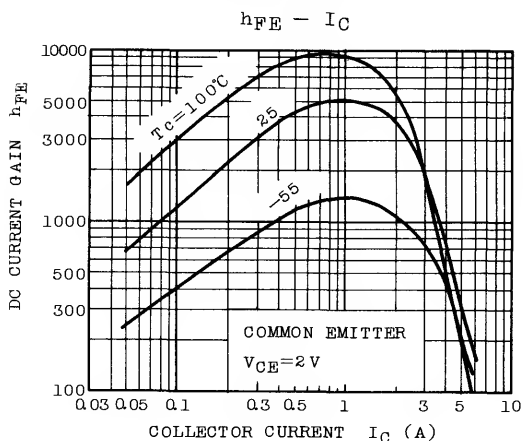
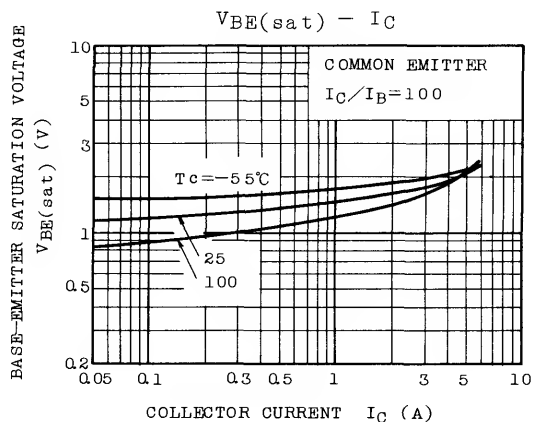
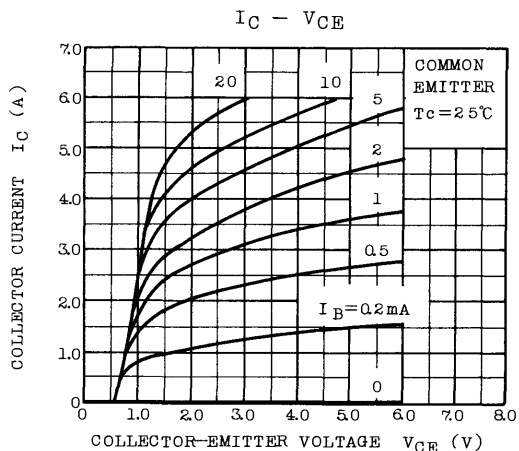


Mounting kit No. AC75
Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=300V, I_E=0$	-	-	0.5	mA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	0.5	mA
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	$I_C=0.5A, L=40mH$	250	-	-	V
DC Current Gain	$h_{FE(1)}$	$V_{CE}=2V, I_C=2A$	2000	-	-	
	$h_{FE(2)}$	$V_{CE}=2V, I_C=4A$	200	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A, I_B=0.04A$	-	-	2.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4A, I_B=0.04A$	-	-	2.5	V
Collector Output Capacitance	C_{ob}	$V_{CB}=50V, I_E=0, f=1MHz$	-	35	-	pF
Switching Time	Turn-on Time	t_{on}	-	1	-	μS
	Storage Time	t_{stg}	-	8	-	
	Fall Time	t_f	-	5	-	

2SD1088



Unit in mm

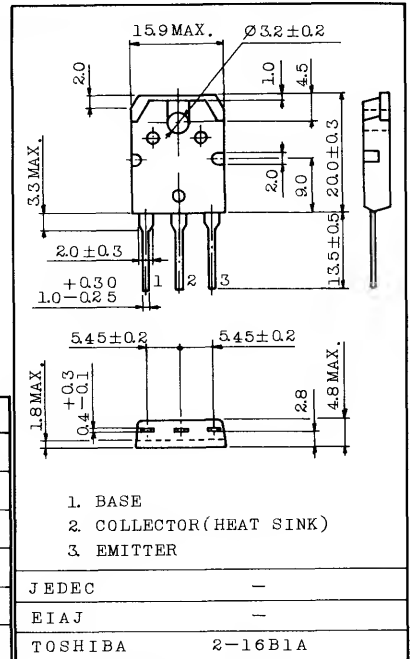
COLOR TV POWER REGULATOR APPLICATIONS.

FEATURES:

- . High Voltage : $V_{CE0}=180V$
- . High DC Current Gain : $h_{FE}=500(\text{Min.})$
- . Large Collector Power Dissipation Capability : $P_C=80W$

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	200	V
Collector-Emitter Voltage	V_{CEO}	180	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	5	A
Base Current	I_B	2	A
Collector Power Dissipation ($T_c=25^{\circ}C$)	P_C	80	W
Junction Temperature	T_j	150	$^{\circ}C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^{\circ}C$

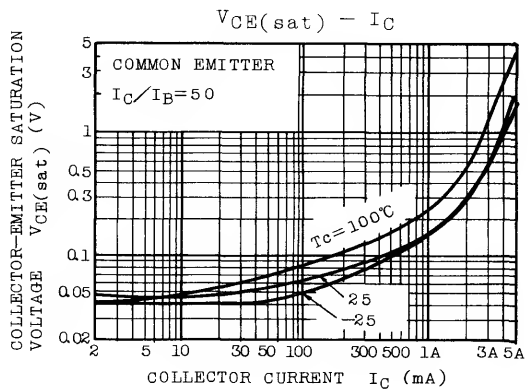
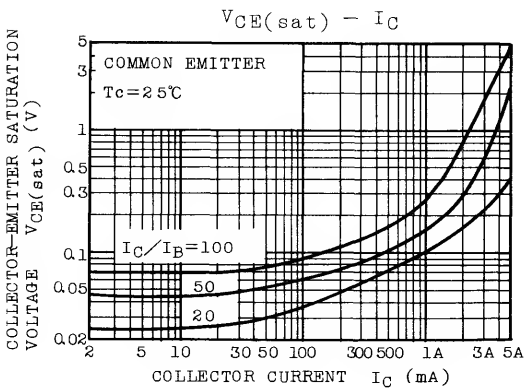
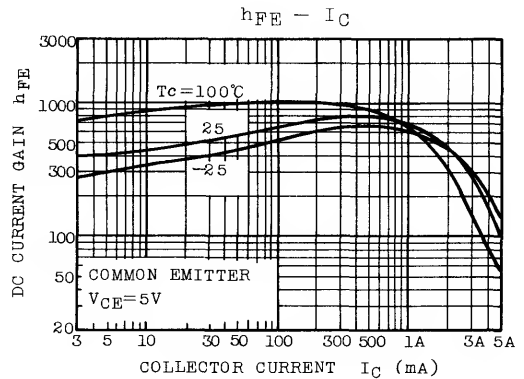
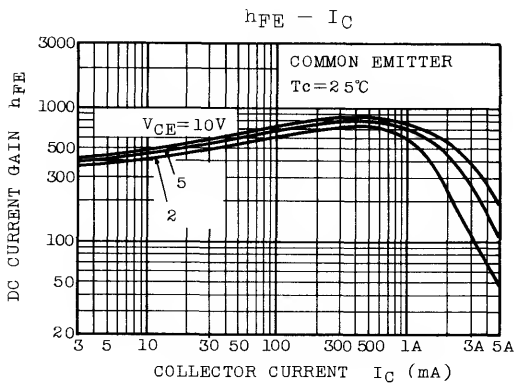
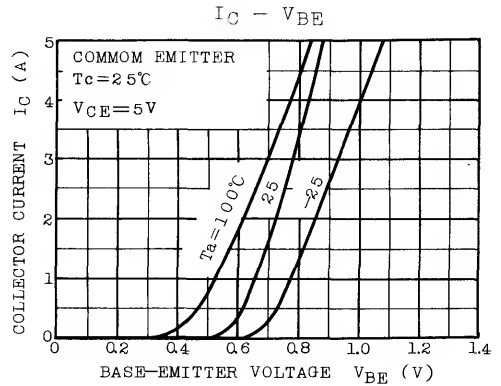
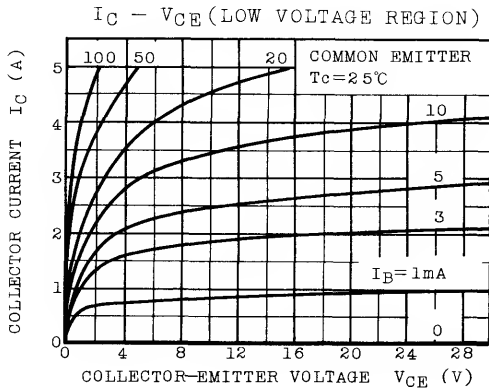


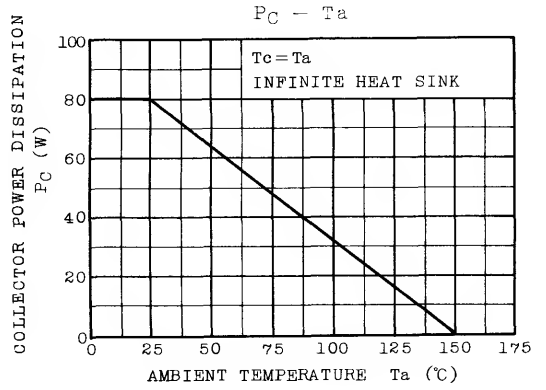
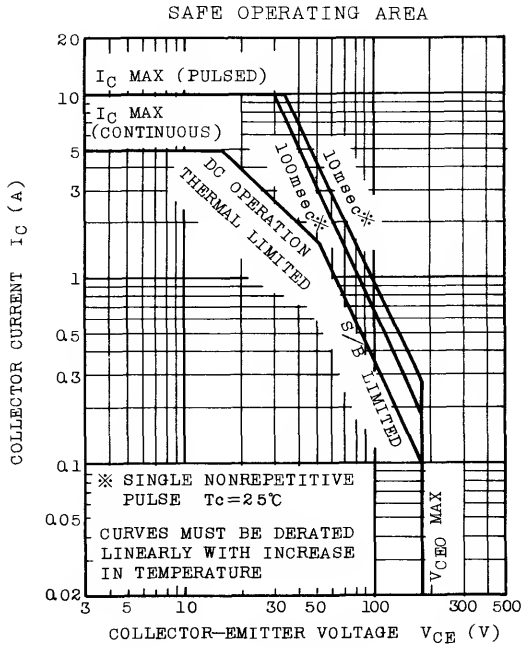
Weight : 4.6g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=200V, I_E=0$	-	-	100	μA
	I_{CEO}	$V_{CE}=180V, I_B=0$	-	-	10	mA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	100	μA
Collector-Emitter Breakdown Voltage	$V(BR)_{CEO}$	$I_C=50mA, I_B=0$	180	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=1A$	500	-	2000	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=1A, I_B=20mA$	-	-	1.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5V, I_C=1A$	0.60	0.70	0.80	V

2SD1090





2SD1092

SILICON NPN DOUBLE DIFFUSED TYPE (PCT PROCESS)

POWER REGULATOR FOR LINE OPERATED TV.

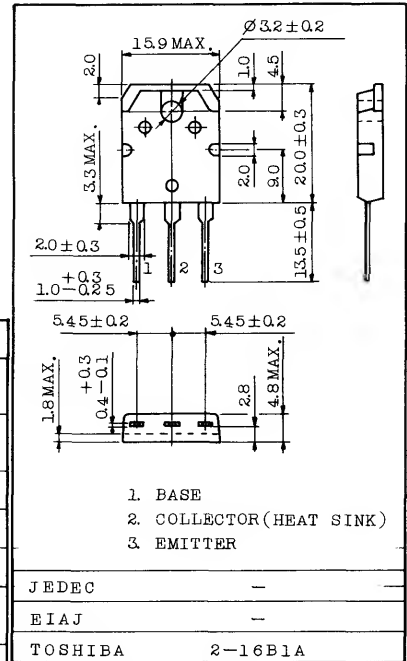
FEATURES:

- Excellent Wide Safe Operating Area
(80 W.Sec at $T_c=25^{\circ}\text{C}$)
- Included Abalanche Diode: $V_Z=55^{+15}_{-10}\text{V}$
- High DC Current Gain : $h_{FE} \geq 500$
- High Collector Power Dissipation Capability
: 80W at 25°C Case Temperature

MAXIMUM RATINGS ($T_a=25^{\circ}\text{C}$)

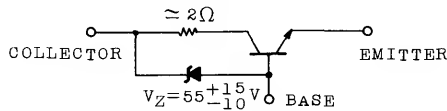
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	55^{+15}_{-10}	V
Collector-Emitter Voltage	V_{CEO}	55^{+15}_{-10}	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current (Continuous)	I_C	4	A
Collector Current (Peak)	I_{CP}	20	A
Collector Power Dissipation ($T_c=25^{\circ}\text{C}$)	P_C	80	W
Junction Temperature	T_j	150	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	$-55 \sim 150$	$^{\circ}\text{C}$

Unit in mm



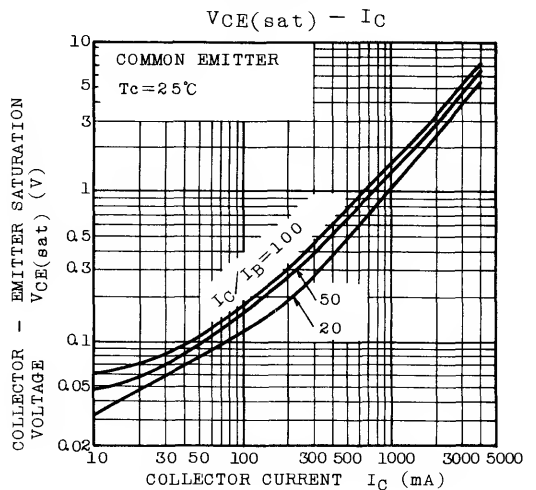
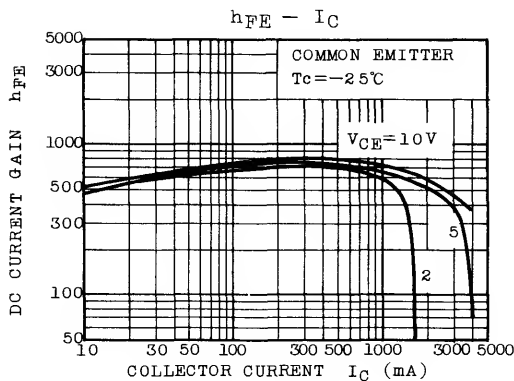
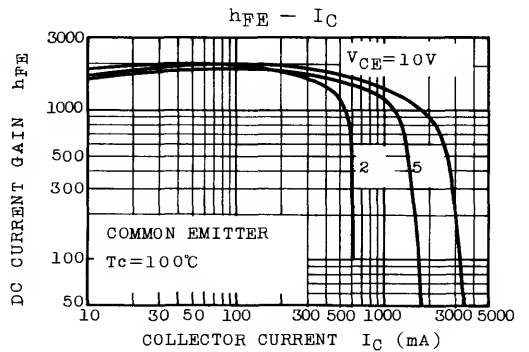
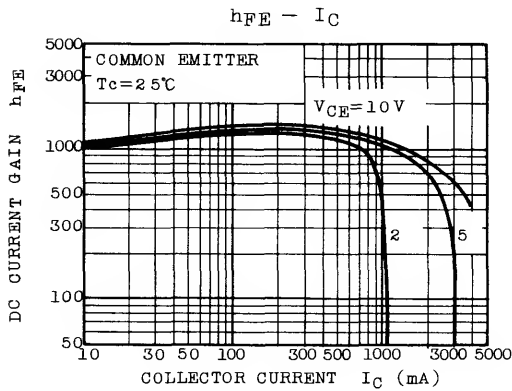
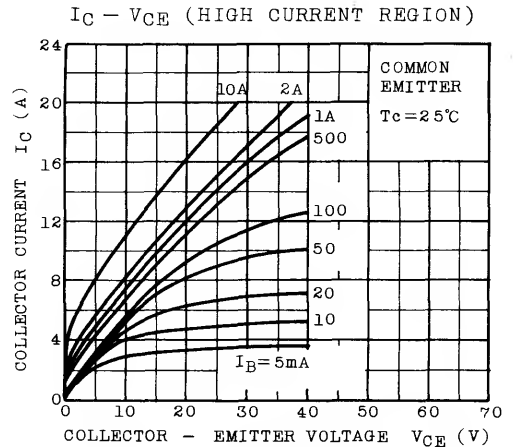
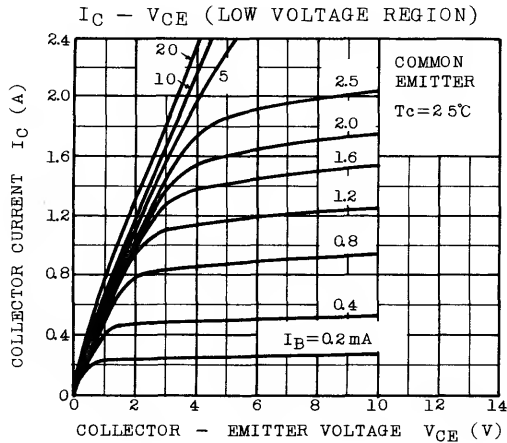
Weight: 4.6g

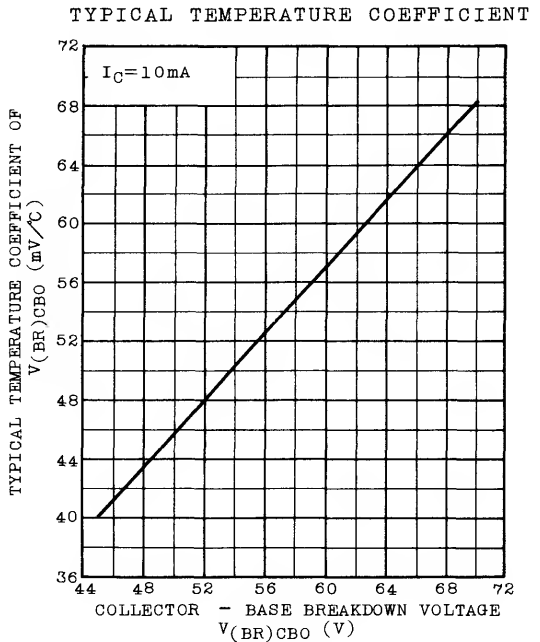
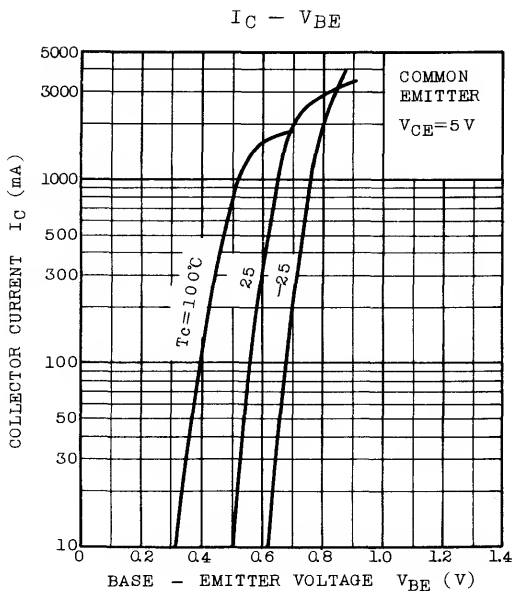
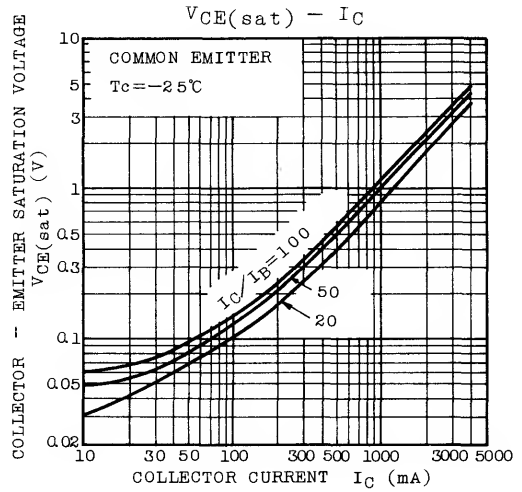
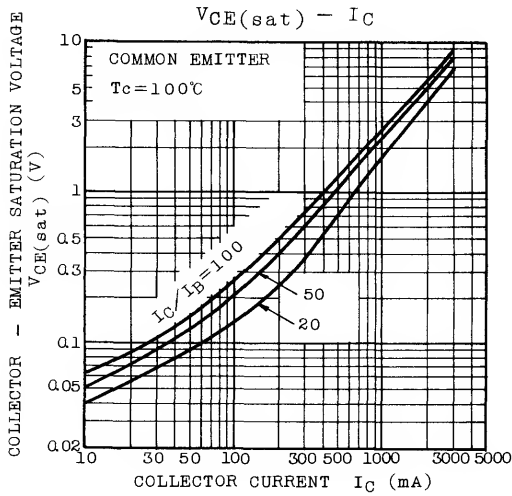
EQUIVALENT CIRCUIT

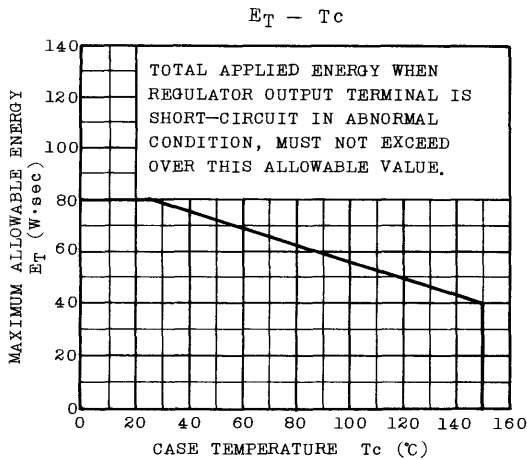
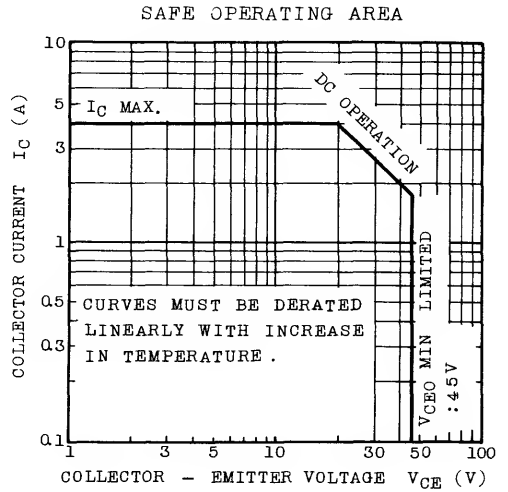
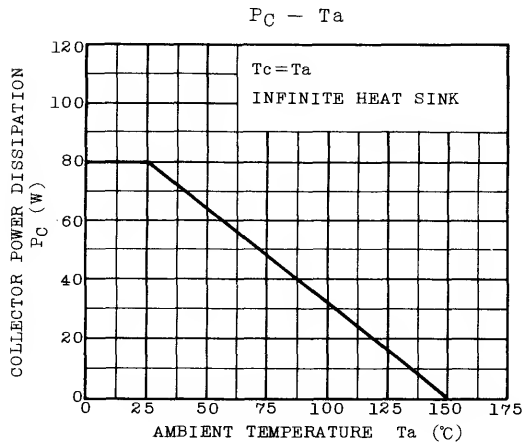


ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=10\text{mA}, I_E=0$	45	55	70	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=100\text{mA}, I_B=0$	45	55	70	V
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5\text{V}, I_C=0$	-	-	10	μA
DC Current Gain	h_{FE}	$V_{CE}=5\text{V}, I_C=500\text{mA}$	500	1000	2500	
Collector-Emitter Saturation Voltage	$V_{CE(sat)(1)}$	$I_C=500\text{mA}, I_B=2\text{mA}$	-	-	2.0	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)(2)}$	$I_C=1.0\text{A}, I_B=20\text{mA}$	-	-	3.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5\text{V}, I_C=500\text{mA}$	0.50	0.65	0.80	V
Allowable Energy ($T_c=25^{\circ}\text{C}$)	E_T	Application Circuit	80	-	-	W.sec

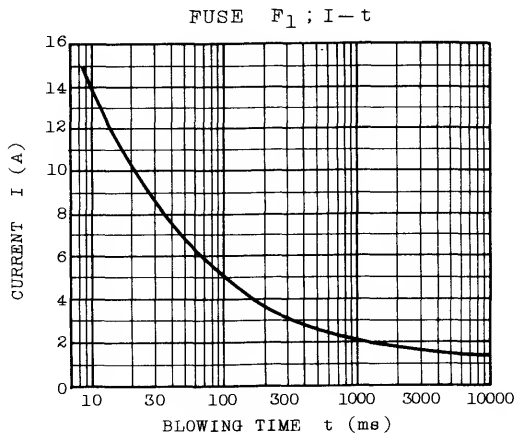
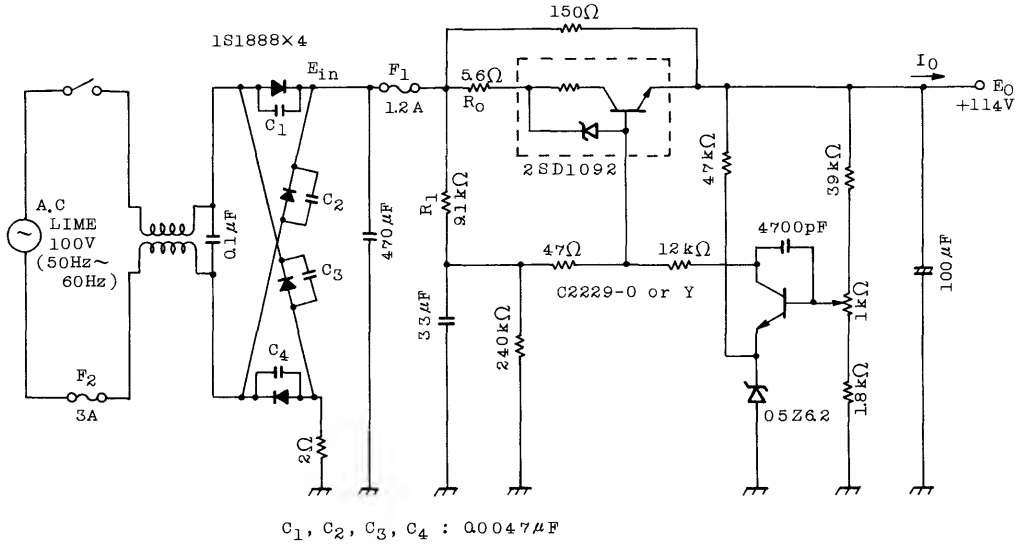


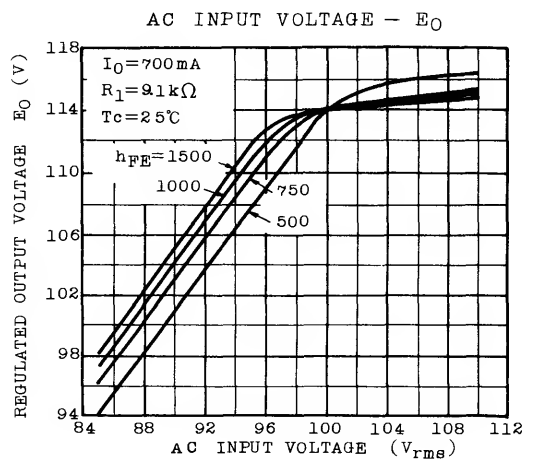
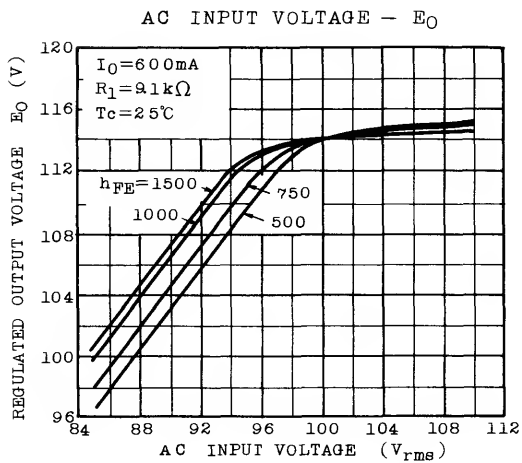
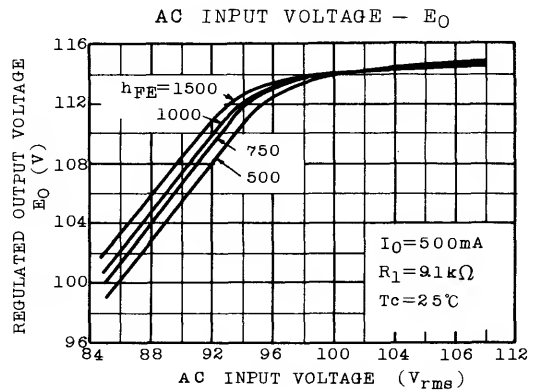
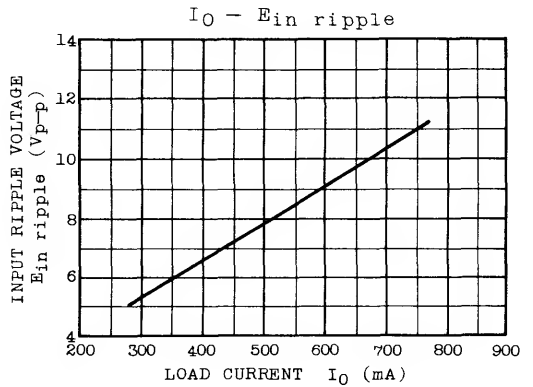
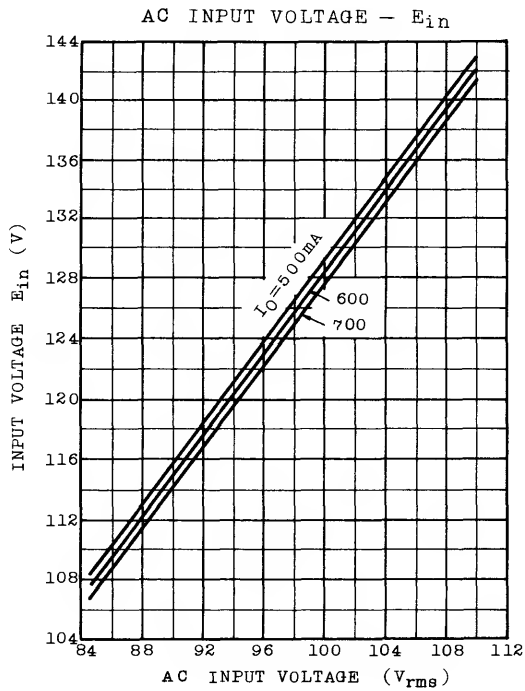




2SD1092

APPLICATION CIRCUIT





2SD1148

SILICON NPN TRIPLE DIFFUSED TYPE

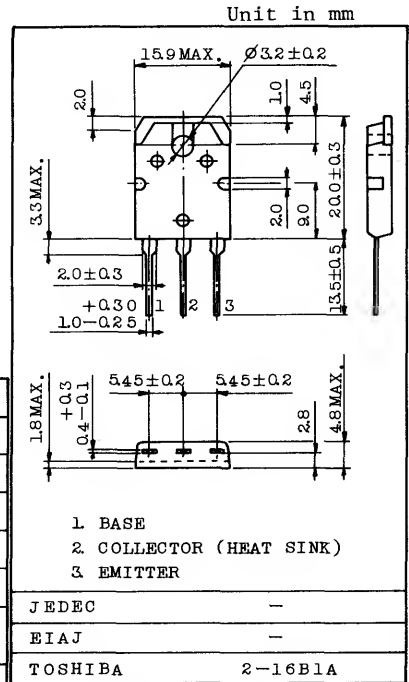
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SB863.
- Recommend for 70W High Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	140	V
Collector-Emitter Voltage	V _{CE0}	140	V
Emitter-Base Voltage	V _{EB0}	5	V
Collector Current	I _C	10	A
Base Current	I _B	1	A
Collector Power Dissipation (Tc=25°C)	P _C	100	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55 ~ 150	°C

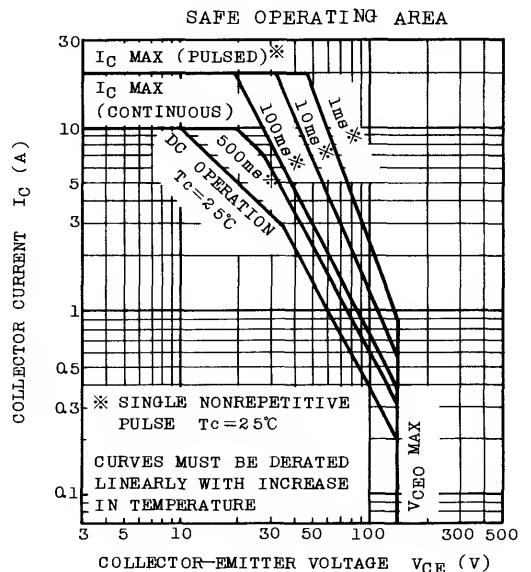
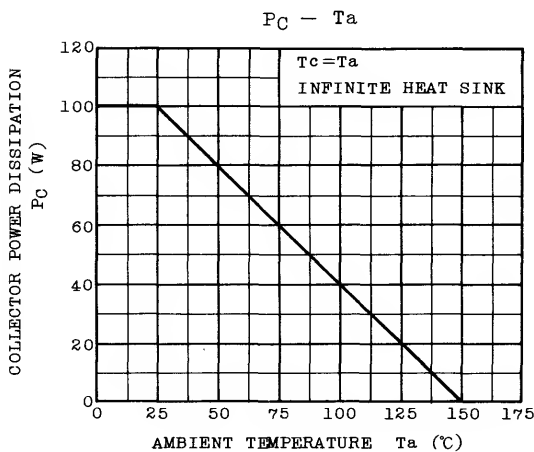
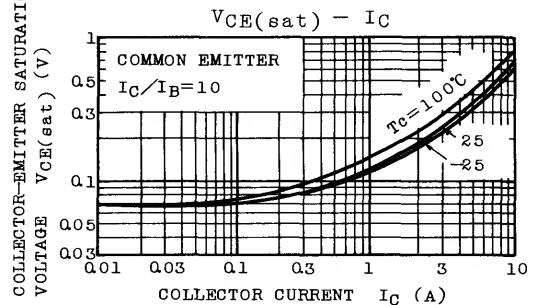
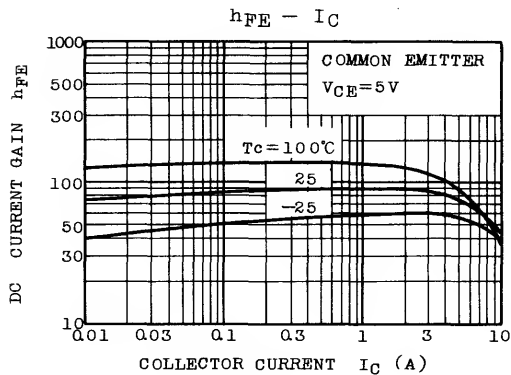
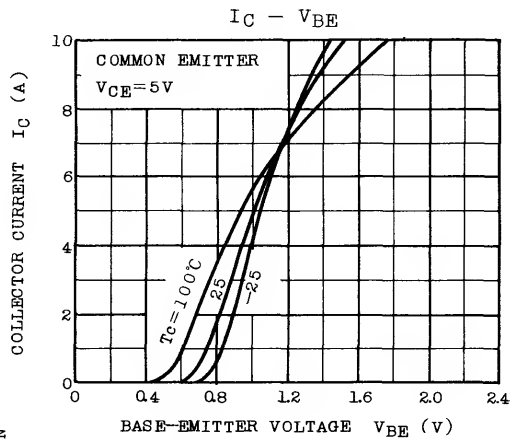
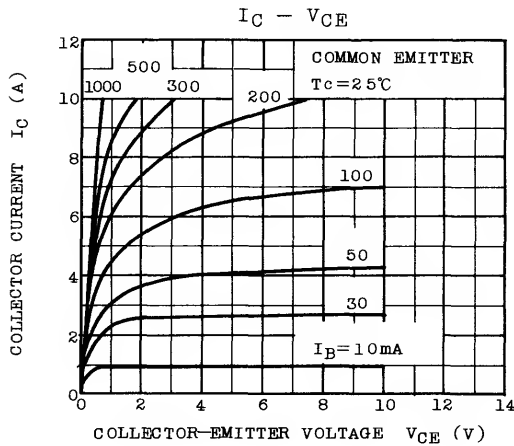


Weight : 4.6g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =140V, I _E =0	-	-	5.0	μA
Emitter Cut-off Current	I _{EB0}	V _{EB} =5V, I _C =0	-	-	5.0	μA
Collector-Emitter Breakdown Voltage	V(BR)CE0	I _C =50mA, I _B =0	140	-	-	V
DC Current Gain	h _{FE} (1) (Note)	V _{CE} =5V, I _C =1A	55	-	160	
		V _{CE} =5V, I _C =5A	25	-	-	
Collector Emitter Saturation Voltage	V _{CE(sat)}	I _C =5A, I _B =0.5A	-	0.4	2.0	V
Base-Emitter Voltage	V _{BE}	V _{CE} =5V, I _C =5A	-	0.96	1.5	V
Transition Frequency	f _T	V _{CE} =10V, I _C =1A	-	20	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	200	-	pF

Note: h_{FE}(1) Classification, R : 55~110 0 : 80~160



2SD1160

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

SWITCHING APPLICATIONS.

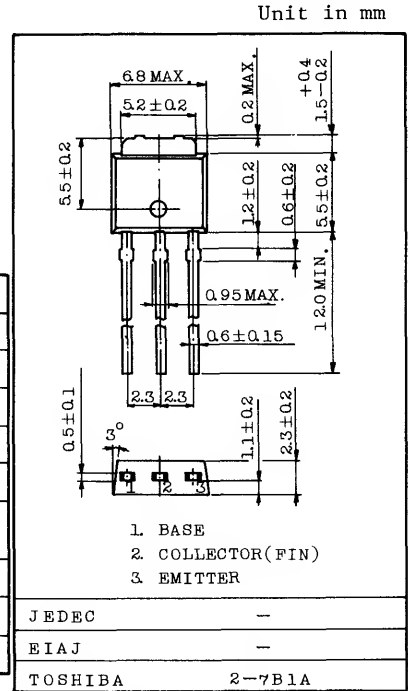
SUITABLE FOR MOTOR DRIVE APPLICATIONS.

FEATURES:

- High DC Current Gain
- Low Saturation Voltage : 0.6V MAX. @ $I_C=2A$, $I_B=40mA$
- Built-in Free Wheel Diode

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	50	V
Collector-Emitter Voltage	V_{CE0}	20	V
Emitter-Base Voltage	V_{EB0}	6	V
Collector Current	(DC)	I_C	2 A
	(Peak)	I_{CP}	4 A
Diode Forward Surge Current ($t=1sec$)	I_{FP}	1	A
Collector Power Dissipation	P_C	1	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature	T_{stg}	-55 ~ 150	$^\circ C$



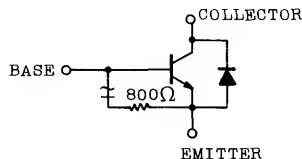
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

Weight : 0.36g

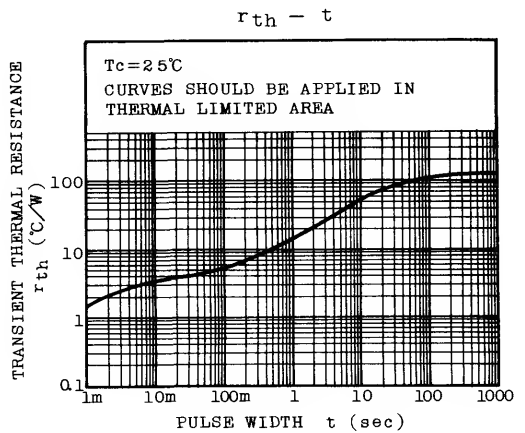
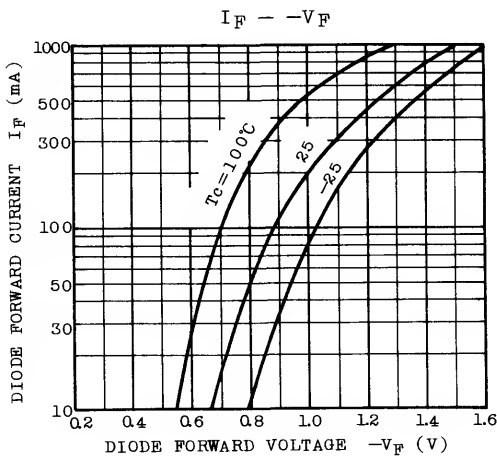
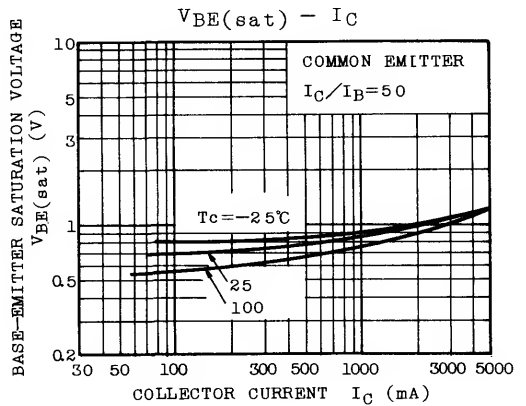
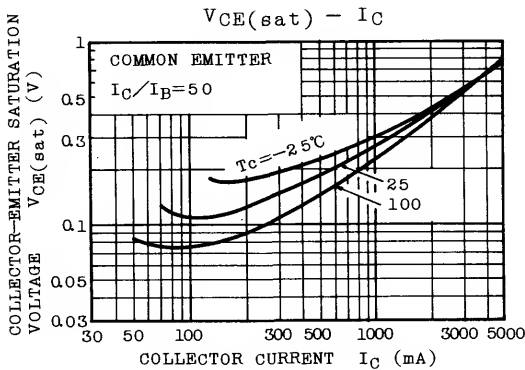
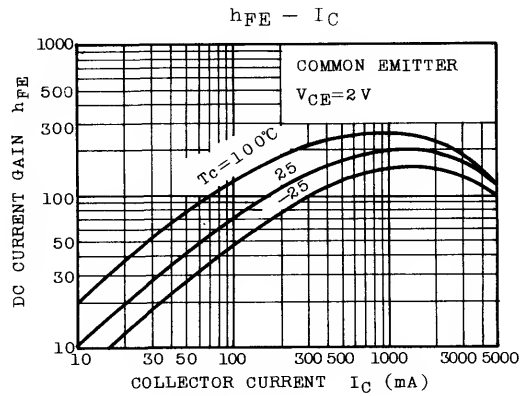
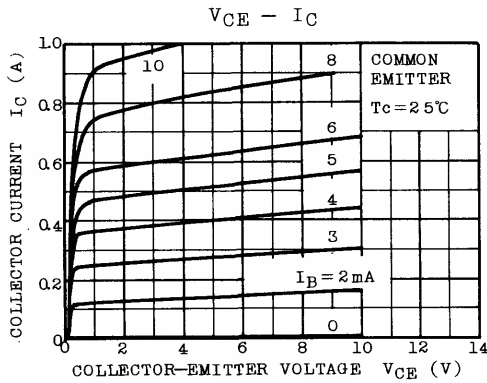
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=50V$, $I_E=0$	-	-	1	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=5V$, $I_C=0$	2.5	6.25	15	mA
Collector-Emitter Sustaining Voltage	$V_{CE0(SUS)}$	$I_C=20mA$, $L=40mH$	20	-	-	V
DC Current Gain (Note 1)	$h_{FE(1)}$	$V_{CE}=2V$, $I_C=1A$	100	-	300	
DC Current Gain	$h_{FE(2)}$	$V_{CE}=2V$, $I_C=2A$	60	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=2A$, $I_B=40mA$	-	0.4	0.6	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=2A$, $I_B=40mA$	-	-	1.5	V
Diode Forward Voltage	$-V_F$	$I_F=1A$, $I_B=0$	-	-	2.0	V

EQUIVALENT CIRCUIT

Note 1 : According to the value of $h_{FE(1)}$, 2SD1160 is classified as follows.

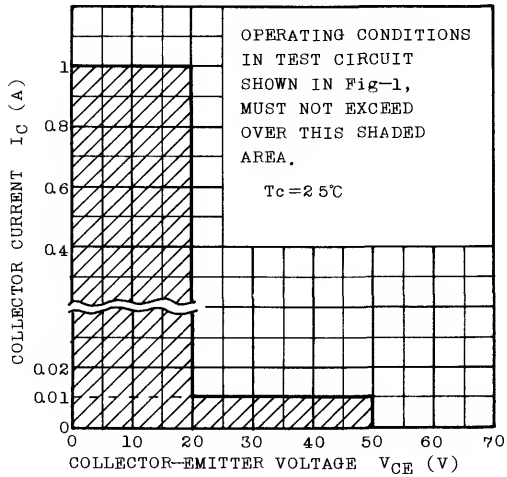


CLASSIFICATION	MIN.	MAX.
2SD1160-0	100	200
2SD1160-Y	150	300

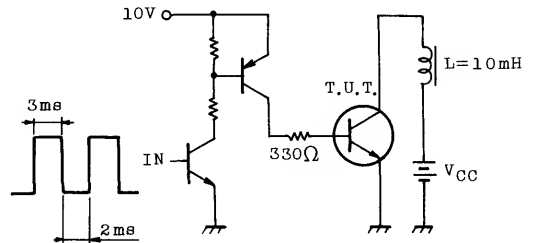


2SD1160

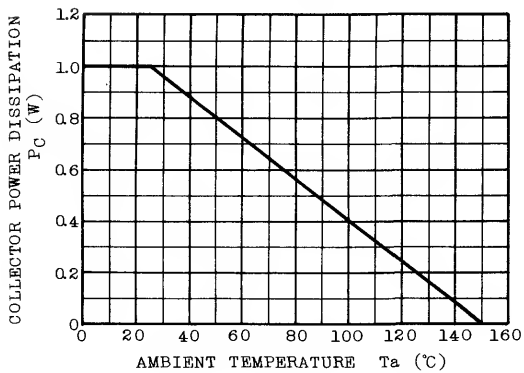
SAFE OPERATING AREA



TEST CIRCUIT



$P_C - T_a$



INDUSTRIAL APPLICATIONS

Unit in mm

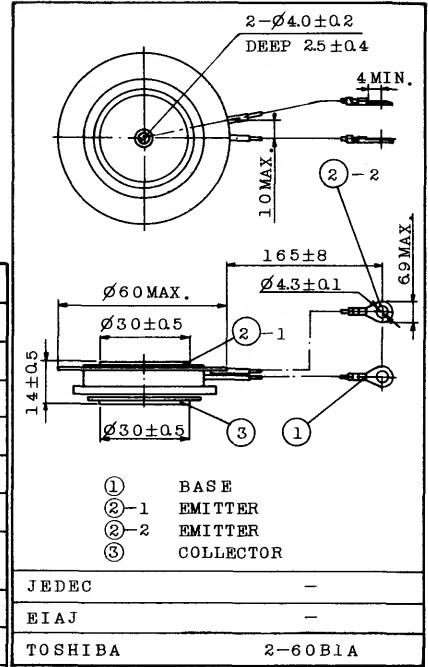
HIGH POWER SWITCHING APPLICATION.
DC-AC POWER INVERTER APPLICATION.
MOTOR CONTROL APPLICATION.

FEATURES:

- . High Voltage : $V_{CEO(SUS)} > 900V$
- . Triple Diffused Design
- . Darlington Design

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	1000	V
Collector-Emitter Voltage	$V_{CEO(SUS)}$	900	V
Emitter-Base Voltage	V_{EB0}	6	V
Collector Current	I_C	100	A
Emitter Current	I_E	-100	A
Base Current	I_B	12	A
Thermal Resistance (Double Side Cooling)	$R_{th(j-c)}$	0.08	$^\circ C/W$
Junction Temperature	T_j	125	$^\circ C$
Storage Temperature	T_{stg}	-40 ~ 150	$^\circ C$
Mounting Force Required	F	500 \pm 50	kg

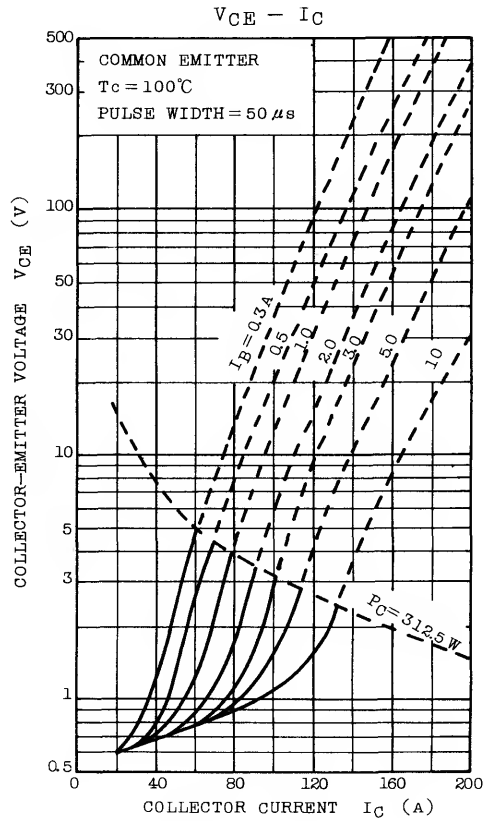
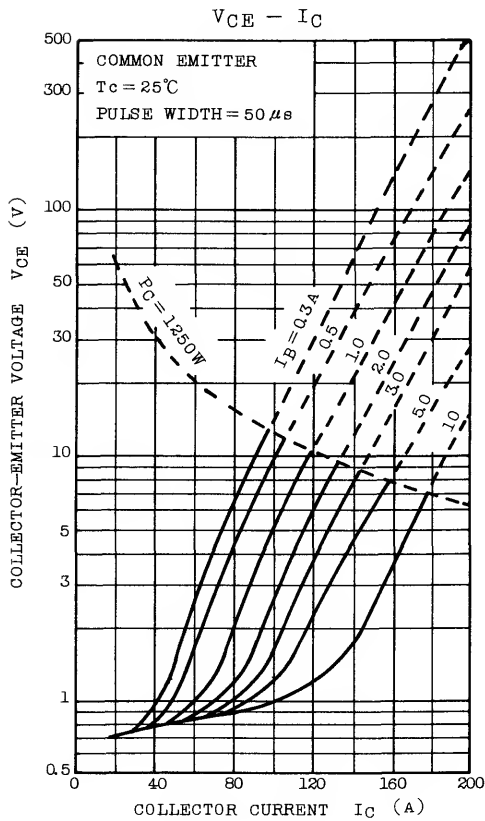
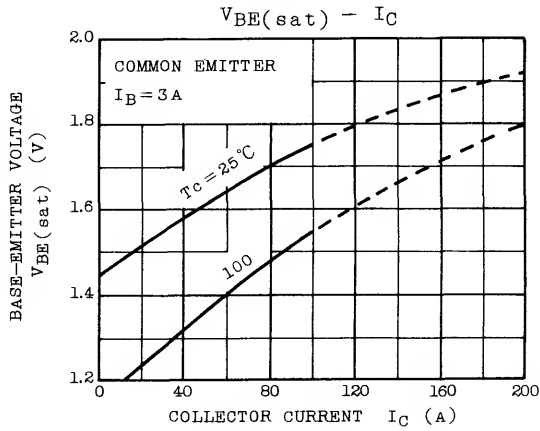


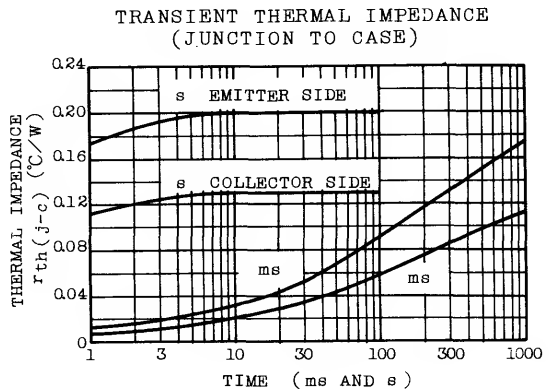
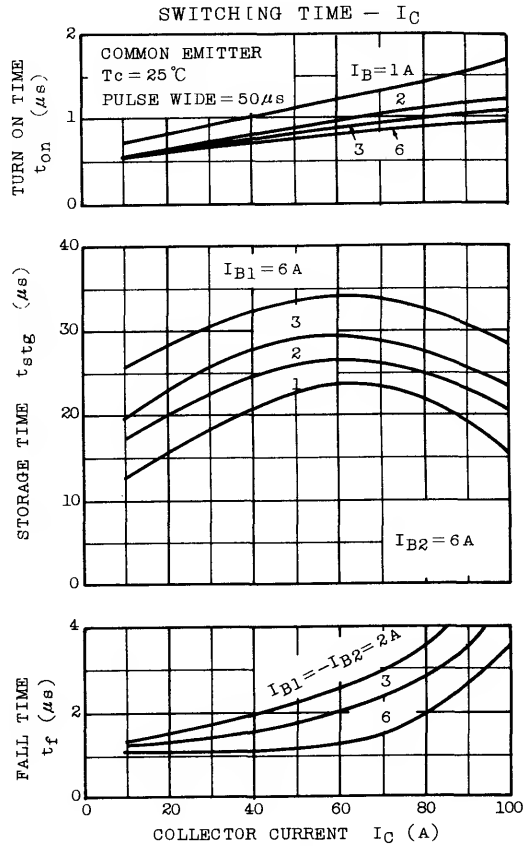
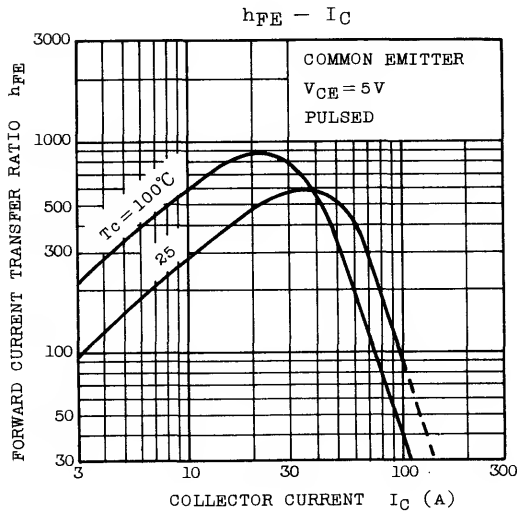
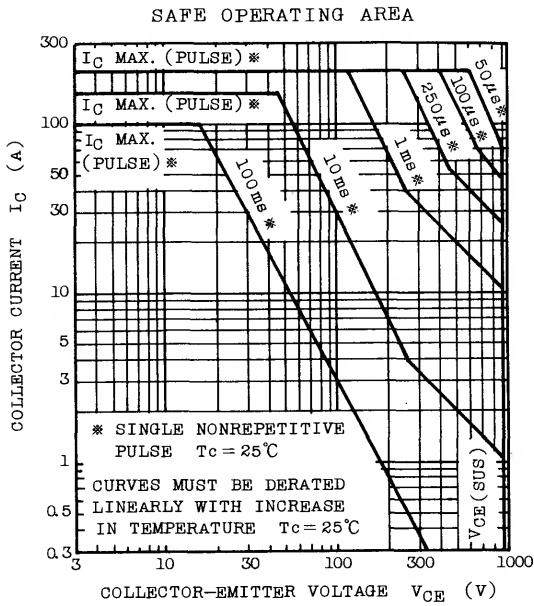
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Forward Current Transfer Ratio	h_{FE}		$V_{CE}=5V, I_C=100A$	60	-	-	
			$V_{CE}=5V, I_C=50A$	-	500	-	
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$		$I_C=0.5A, L=40mH$	900	-	-	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$		$I_C=100A, I_B=3A$ (Note)	-	-	2.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			-	-	2.5	V
Collector Cut-off Current	I_{CB0}		$V_{CB}=1000V, I_E=0$	-	-	2	mA
Emitter Cut-off Current	I_{EB0}		$V_{EB}=6V, I_C=0$	-	-	1000	mA
Switching Time	Turn-on Time	t_{on}	$I_C=100A, I_{B1}=3A,$	-	1.0	2.0	μs
	Storage Time	t_{stg}	$-I_{B2}=6A, V_C=600V,$	-	20	25	μs
	Fall Time	t_f	$R_L=6\Omega$	-	3.0	5.0	μs

Note : Pulse Test: Pulse Width $\leq 300\mu s$ Duty Cycle $\leq 3\%$
 Mounting Force; F=500kg

2SD1165A





2SD1166

SILICON NPN TRIPLE DIFFUSED MESA TYPE
(DARLINGTON POWER)

HIGH POWER SWITCHING APPLICATION
AC & DC MOTOR CONTROL APPLICATION
INVERTER APPLICATION

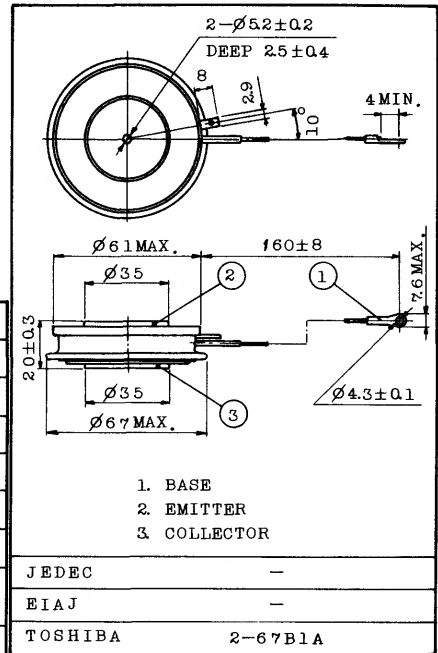
FEATURES:

- . High Voltage : $V_{CEO(SUS)} > 900V$
- . Triple Diffused Design
- . Darlington Design

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1000	V
Collector-Emitter Voltage	$V_{CEO(SUS)}$	900	V
Emitter-Base Voltage	V_{EBO}	6	V
Collector Current	I_C	200	A
Emitter Current	I_E	-200	A
Base Current	I_B	12	A
Thermal Resistance (Double Side Cooling)	$R_{th(j-c)}$	0.04	$^{\circ}C/W$
Junction Temperature	T_j	125	$^{\circ}C$
Storage Temperature	T_{stg}	-40 ~ 150	$^{\circ}C$
Mounting Force Required	F	1000±100	kg

Unit in mm

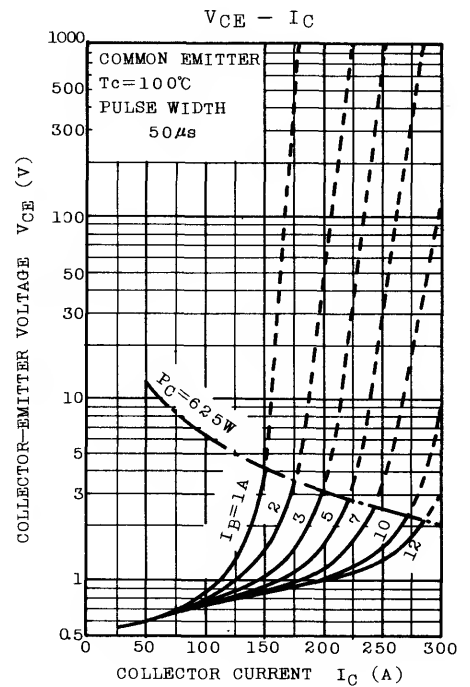
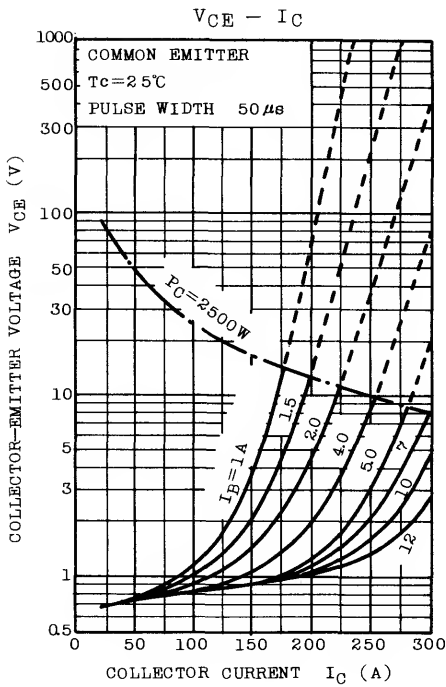
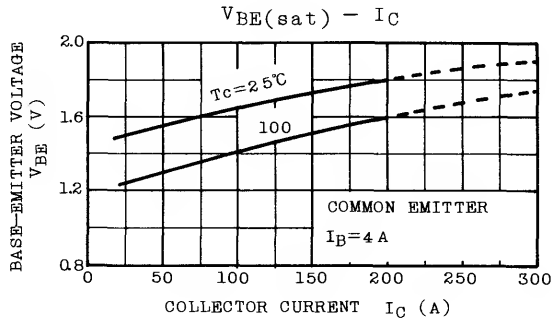


Weight : 250g

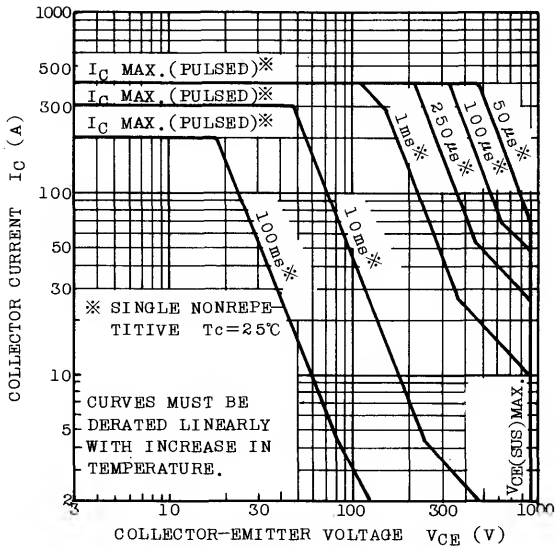
ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Forward Current Transfer Ratio	h_{FE}	$V_{CE}=5V, I_C=200A$	80	200	-	
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	$I_C=0.5A, L=40mH$	900	-	-	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=200A, I_B=5A$ (Note)	-	-	2.0	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$		-	-	2.5	V
Collector Cut-off Current	I_{CEO}	$V_{CE}=900V, I_B=0$	-	1.0	3.0	mA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=6V, I_C=0$	-	300	2000	mA
Switching Time	Turn-on Time	$I_C=200A, I_{B1}=4A, I_{B2}=8A, V_C=600V$	-	1.8	3.0	μs
	Storage Time		-	24	30	μs
	Fall Time		-	4.0	8.0	μs

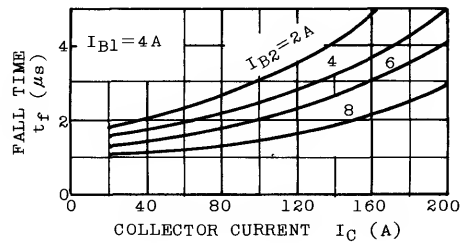
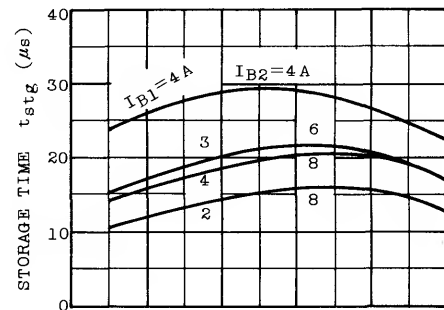
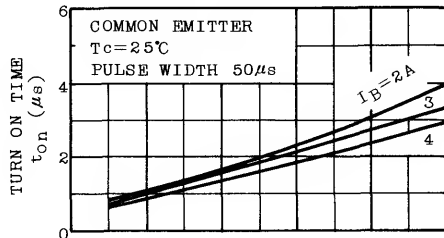
Note: Pulse Test; Pulse Width $\leq 300\mu s$ Duty Cycle $\leq 3\%$
Mounting Force; $F=1000kg$



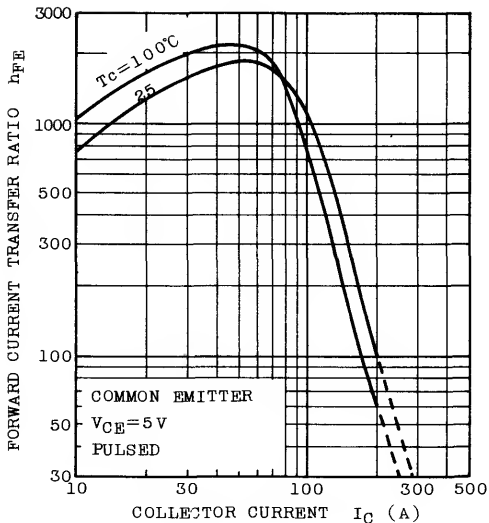
SAFE OPERATING AREA



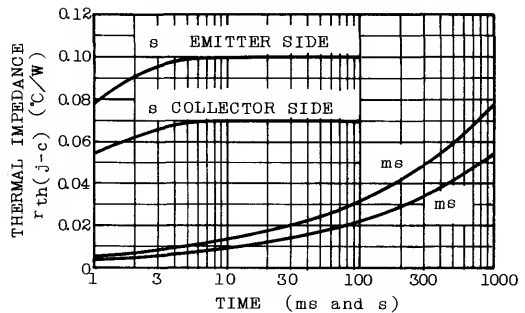
SWITCHING TIME - I_C



$h_{FE} - I_C$



TRANSIENT THERMAL IMPEDANCE (JUNCTION TO CASE)



INDUSTRIAL APPLICATIONS

HIGH POWER SWITCHING APPLICATIONS
DC-DC CONVERTER AND DC-AC INVERTER APPLICATIONS

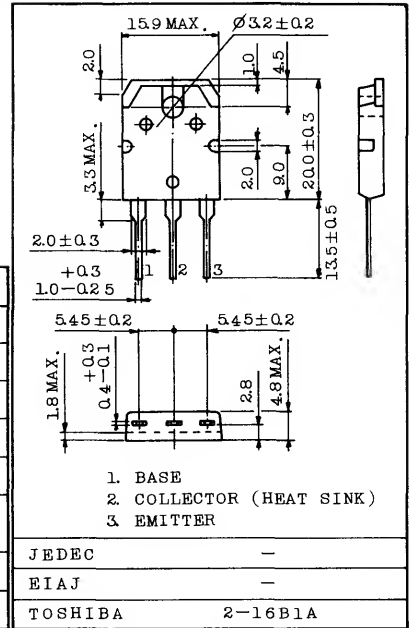
Unit in mm

FEATURES:

- Low Collector-Emitter Saturation Voltage
: $V_{CE(sat)}=0.5V$ (Max.) ($I_C=6A$)
- High Collector Power Dissipation: $P_C=80W$ ($T_c=25^\circ C$)

MAXIMUM RATINGS ($T_a=25^\circ C$)

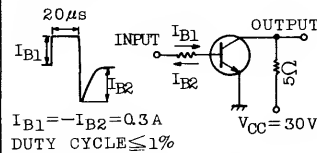
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	100	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EB0}	5	V
Collector Current	I_C	10	A
Base Current	I_B	2	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	80	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$



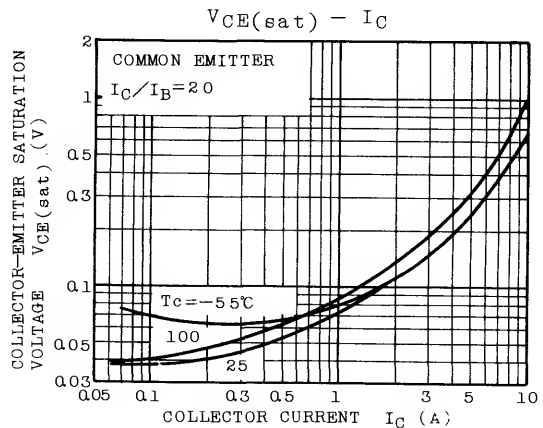
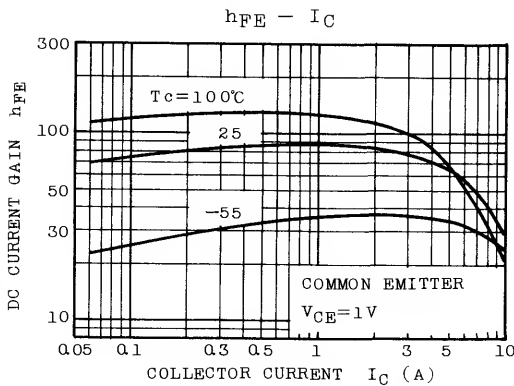
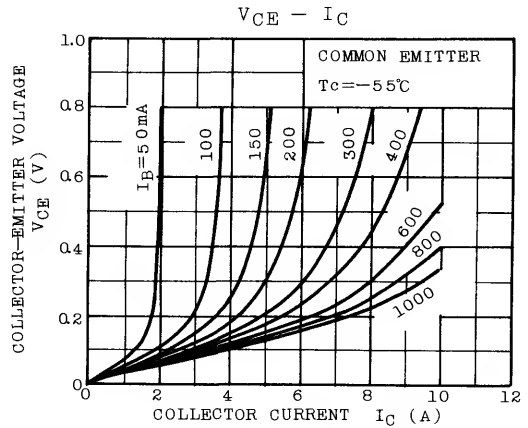
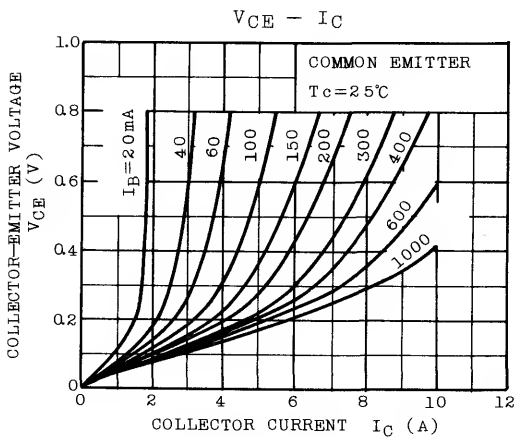
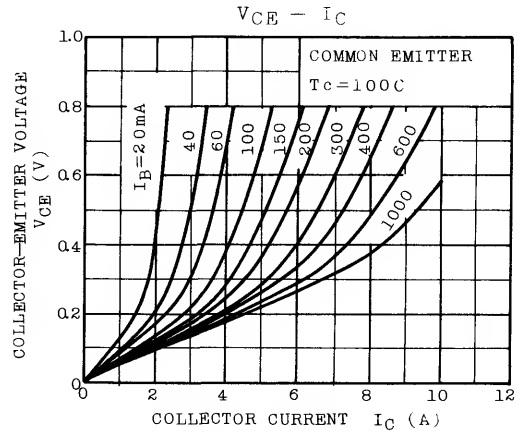
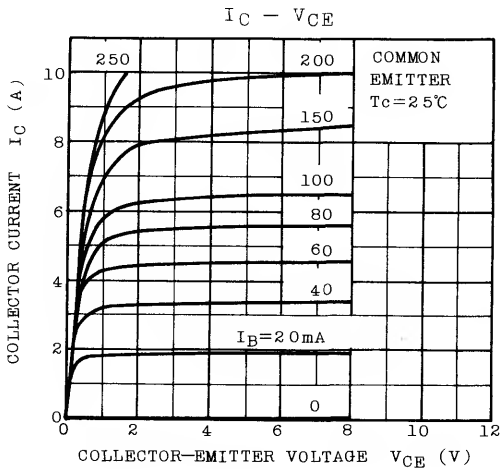
Weight : 4.6g

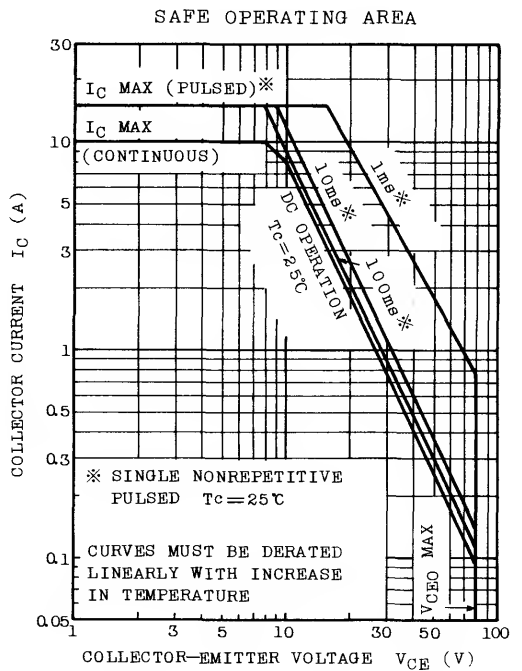
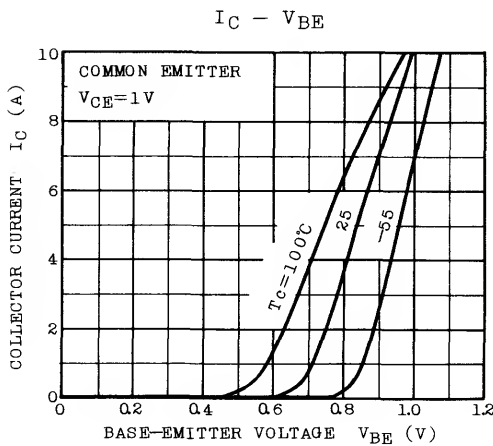
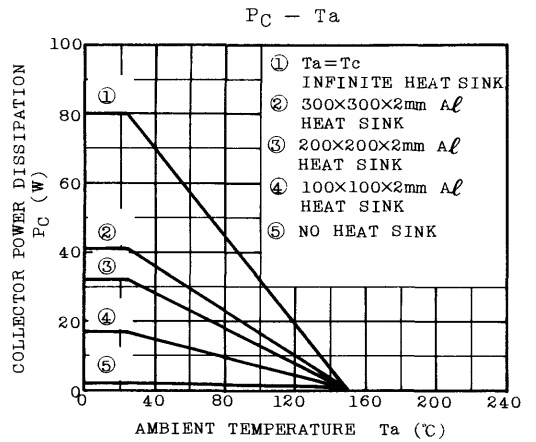
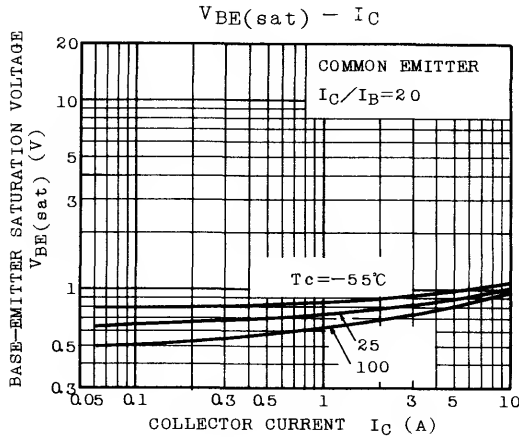
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cutoff Current	I_{CB0}	$V_{CB}=100V, I_E=0$	-	-	10	μA
Emitter Cutoff Current	I_{EB0}	$V_{EB}=5V, I_C=0$	-	-	10	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	80	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=1V, I_C=1A$	70	-	240	
	$h_{FE(2)}$	$V_{CE}=1V, I_C=6A$	30	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=6A, I_B=0.3A$	-	0.3	0.5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=6A, I_B=0.3A$	-	0.9	1.4	V
Transition Frequency	f_T	$V_{CE}=4V, I_C=1A$	-	10	-	MHz
Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	350	-	pF
Switching Time	Turn-on Time	t_{on}	-	0.5	-	μs
	Storage Time	t_{stg}	-	2.5	-	
	Fall Time	t_f	-	0.8	-	



Note: $h_{FE(1)}$ Classification O : 70 ~ 140, Y : 120 ~ 240





2SD1208

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

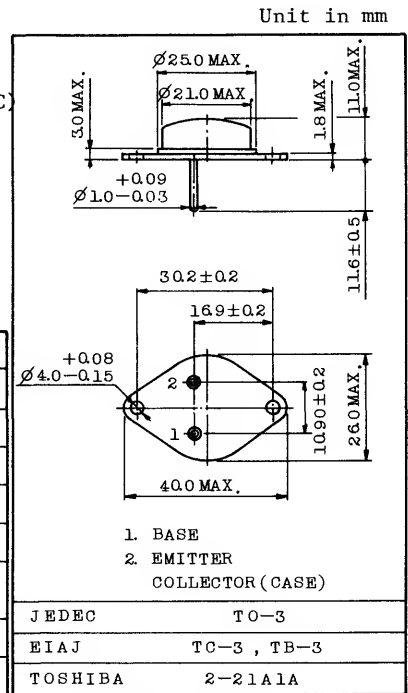
POWER REGULATOR FOR LINE OPERATED TV.

FEATURES:

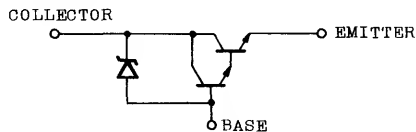
- . Excellent Wide Safe Operating Area (100W.Sec at $T_c=25^{\circ}\text{C}$)
- . Included Abalanche Diode : $V_Z=60\pm 15\text{V}$
- . High DC Current Gain : $h_{FE}=2000 \sim 20000$
- . Darlington Connected Type.

MAXIMUM RATINGS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	60 ± 15	V
Collector-Emitter Voltage	V_{CE0}	60 ± 15	V
Emitter-Base Voltage	V_{EB0}	6	V
Collector Current(Continuous)	I_C	5	A
Collector Current (Peak)	I_{CP}	20	A
Collector Power Dissipation ($T_c=25^{\circ}\text{C}$)	P_C	100	W
Junction Temperature	T_j	150	$^{\circ}\text{C}$
Storage Temperature	T_{stg}	$-65 \sim 150$	$^{\circ}\text{C}$



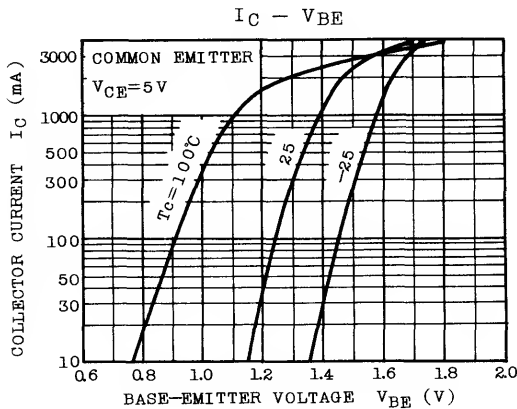
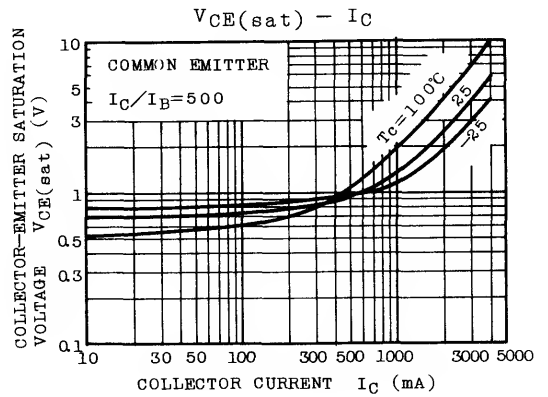
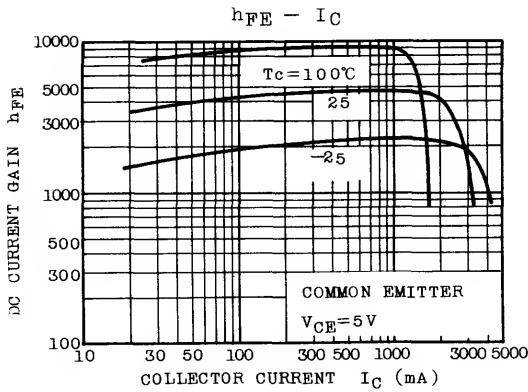
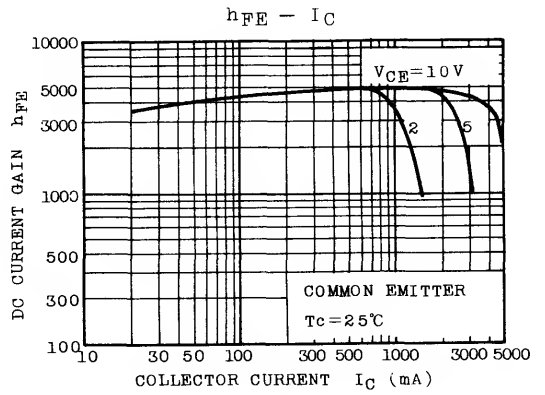
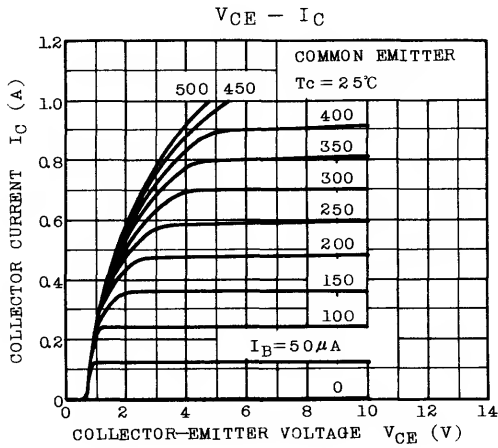
EQUIVALENT CIRCUIT



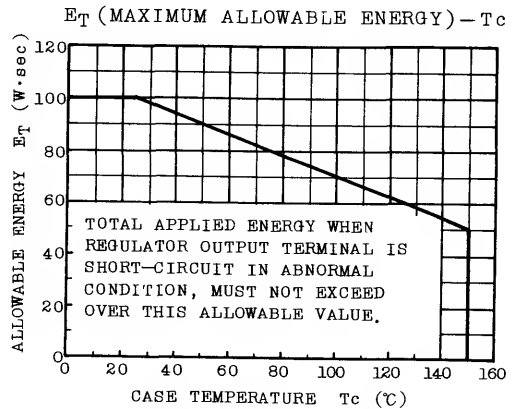
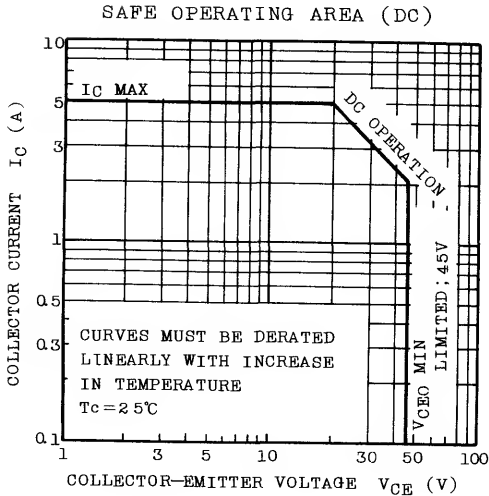
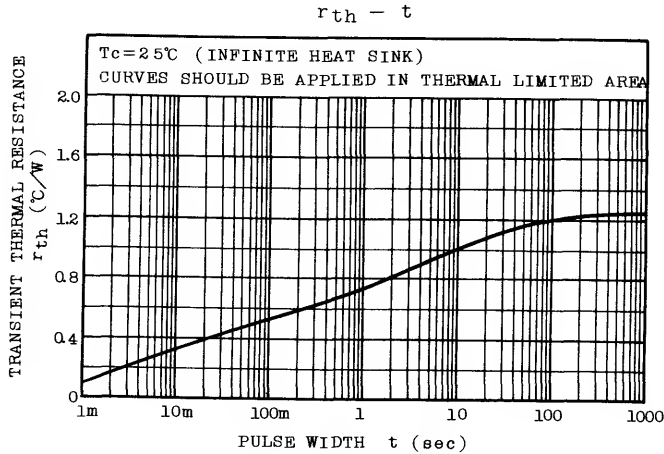
Weight : 12.0g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}\text{C}$)

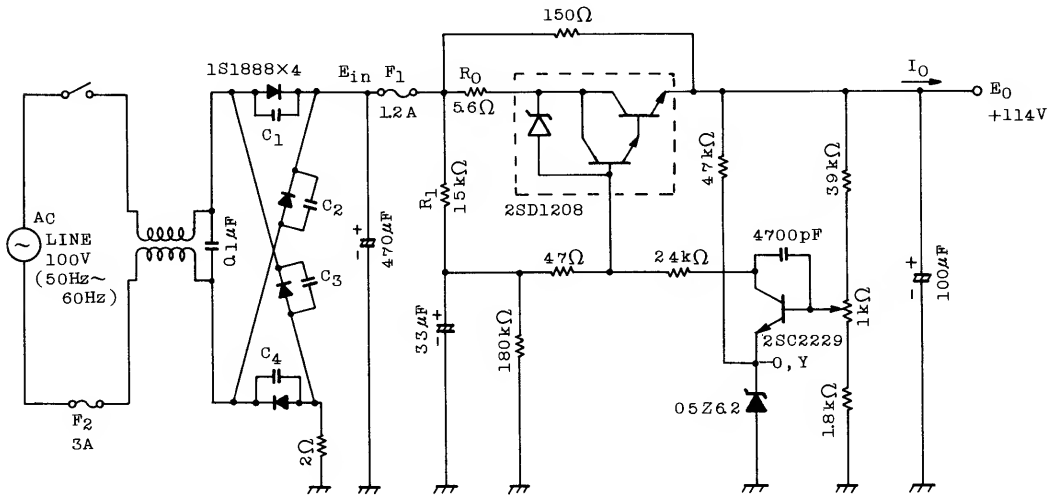
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Base Breakdown Voltage	$V_{(BR)CB0}$	$I_C=10\text{mA}, I_E=0$	45	60	75	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C=100\text{mA}, I_B=0$	45	60	75	V
Emitter Cut-off Current	I_{EBO}	$V_{EB}=6\text{V}, I_C=0$	-	-	100	μA
DC Current Gain	h_{FE}	$V_{CE}=5\text{V}, I_C=0.5\text{A}$	2000	-	20000	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}^{(1)}$	$I_C=0.5\text{A}, I_B=1\text{mA}$	-	-	1.5	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}^{(2)}$	$I_C=1\text{A}, I_B=1\text{mA}$	-	-	2.5	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5\text{V}, I_C=0.5\text{A}$	-	-	1.8	V
Allowable Energy ($T_c=25^{\circ}\text{C}$)	E_T	Application Circuit	100	-	-	W·sec



2SD1208

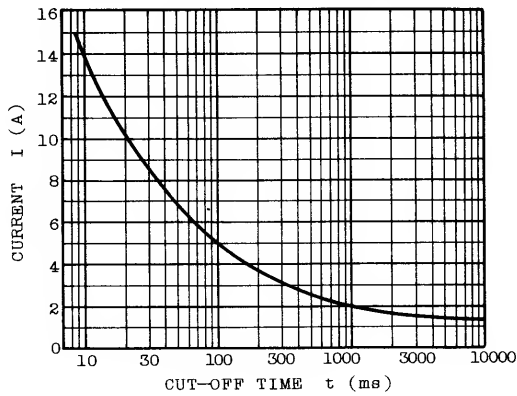


APPLICATION CIRCUIT

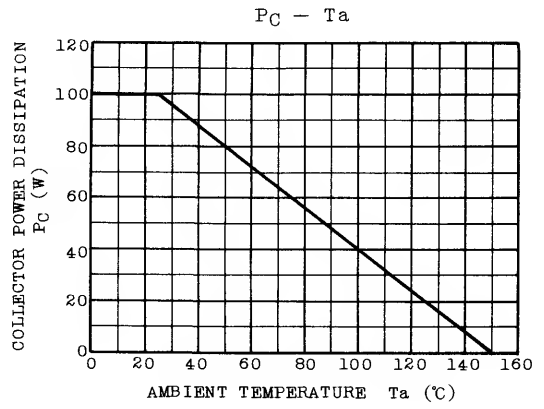
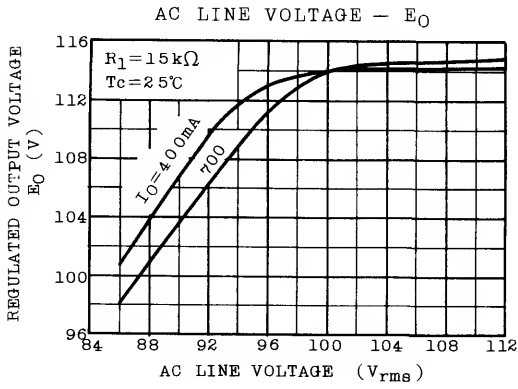


$C_1, C_2, C_3, C_4 : 0.0047\mu\text{F}$

FUSE F_1 ; I-t CHARACTERISTIC



2SD1208



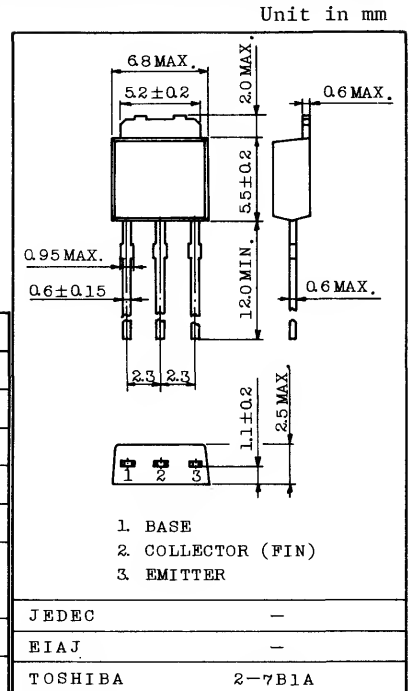
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Complementary to 2SB905

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	150	V
Collector-Emitter Voltage	V _{CE0}	150	V
Emitter-Base Voltage	V _{EB0}	6	V
Collector Current	I _C	1.5	A
Base Current	I _B	1.0	A
Collector Power Dissipation	P _C	Ta=25°C	1.0
		Tc=25°C	10
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55 ~ 150	°C

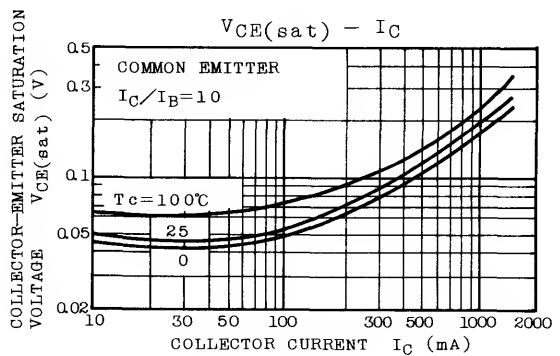
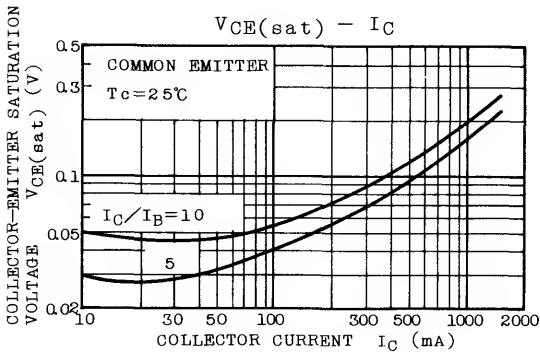
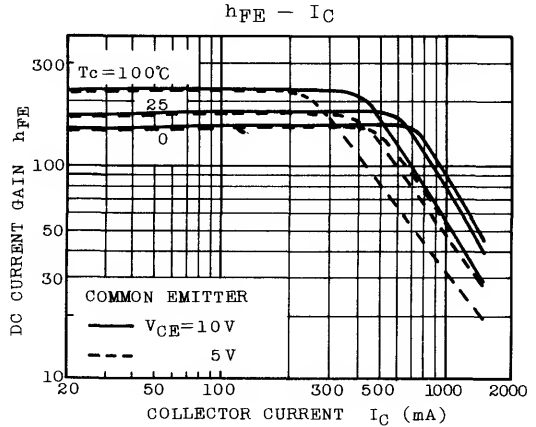
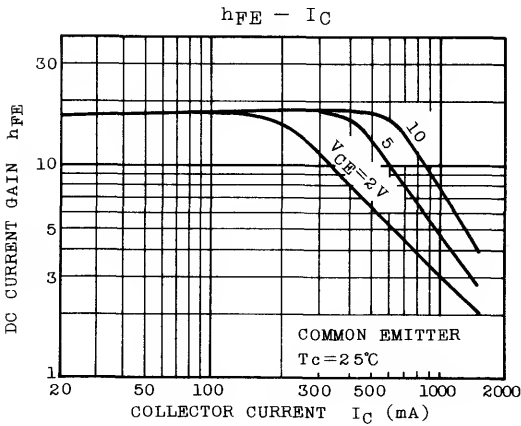
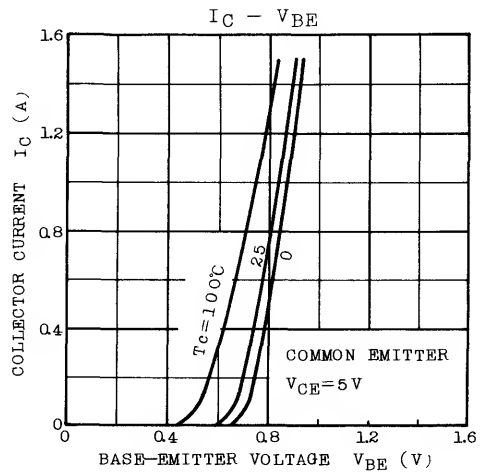
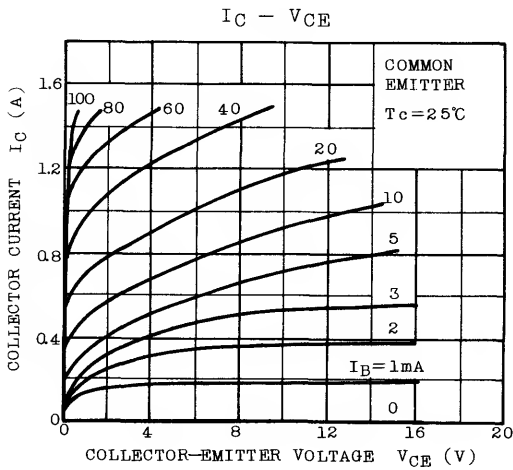


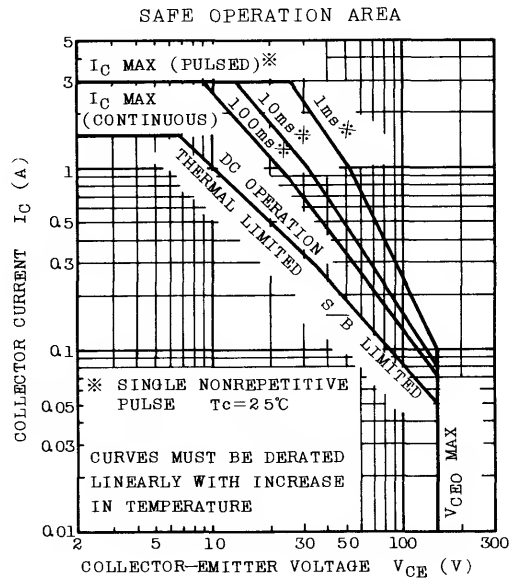
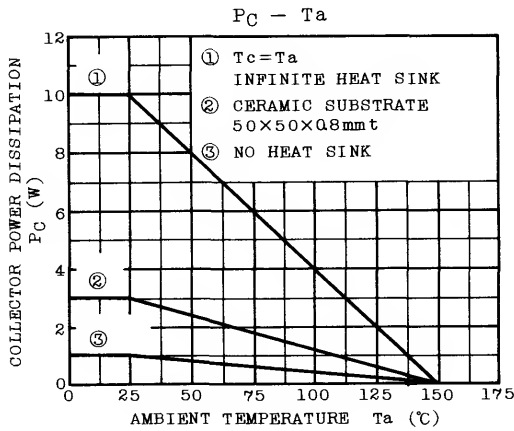
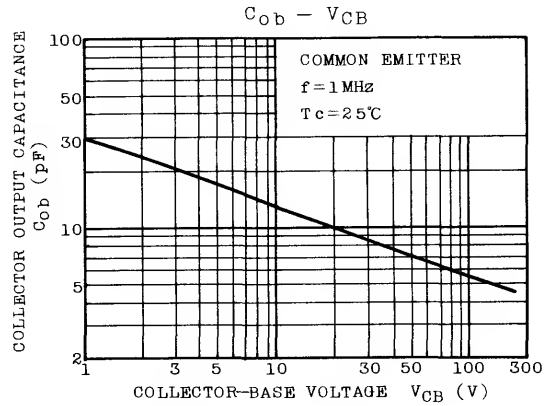
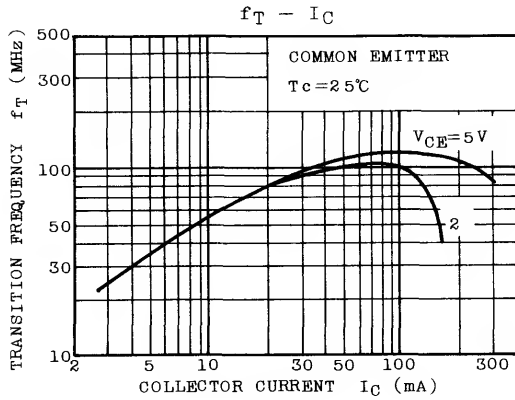
Weight : 0.36g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =150V, I _E =0	-	-	1.0	μA
Emitter Cut-off Current	I _{EB0}	V _{EB} =6V, I _C =0	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	V(BR)CE0	I _C =10mA, I _B =0	150	-	-	V
DC Current Gain	h _{FE} (Note)	V _{CE} =5V, I _C =200mA	60	-	320	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =500mA, I _B =50mA	-	-	1.5	V
Base-Emitter Voltage	V _{BE}	V _{CE} =5V, I _C =5mA	0.5	-	0.8	V
Transition Frequency	f _T	V _{CE} =5V, I _C =200mA	20	100	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	13	20	pF

Note: h_{FE} Classification R : 60 ~ 120, O : 100 ~ 200, Y : 160 ~ 320





2SD1221

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

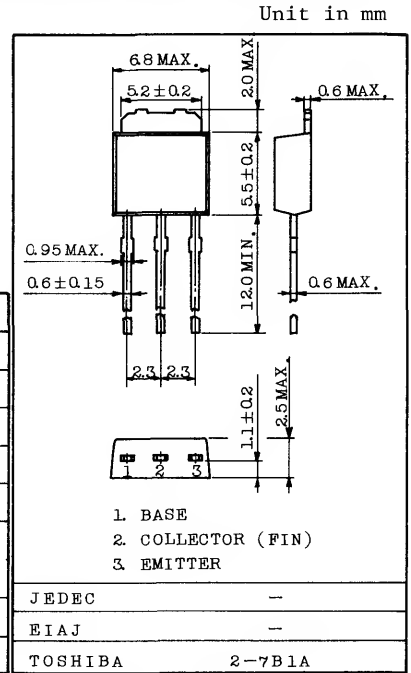
AUDIO FREQUENCY POWER AMPLIFIER APPLICATION.

FEATURES:

- Low Collector Saturation Voltage
: $V_{CE(sat)}=0.4V$ (Typ.) ($I_C=3A, I_B=0.3A$)
- High Power Dissipation : $P_C=20W$ ($T_c=25^{\circ}C$)
- Complementary to 2SB906

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	60	V
Collector-Emitter Voltage		V_{CEO}	60	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	3	A
Base Current		I_B	0.5	A
Collector Power Dissipation	$T_a=25^{\circ}C$	P_C	1.0	W
	$T_c=25^{\circ}C$		20	
Junction Temperature		T_j	150	$^{\circ}C$
Storage Temperature		T_{stg}	-55 ~ 155	$^{\circ}C$

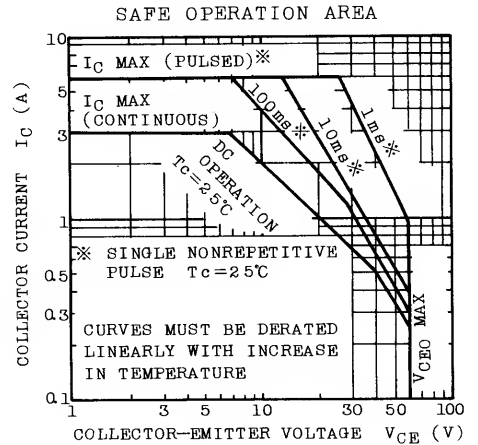
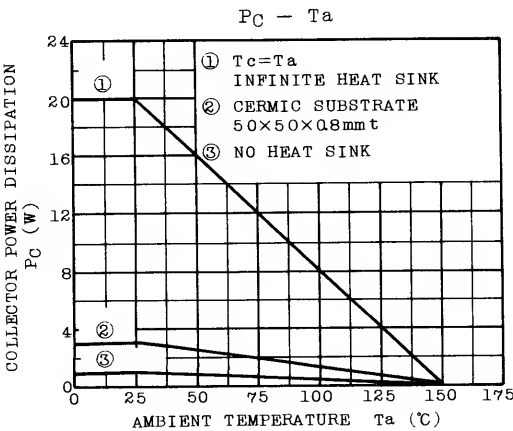
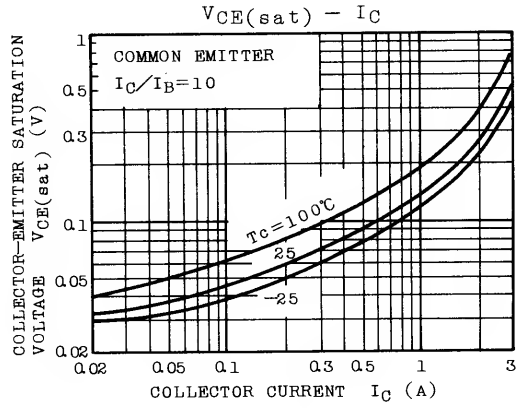
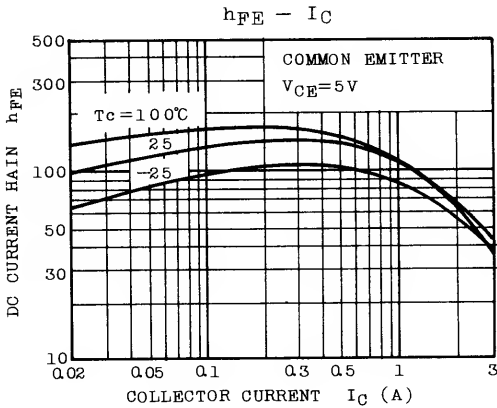
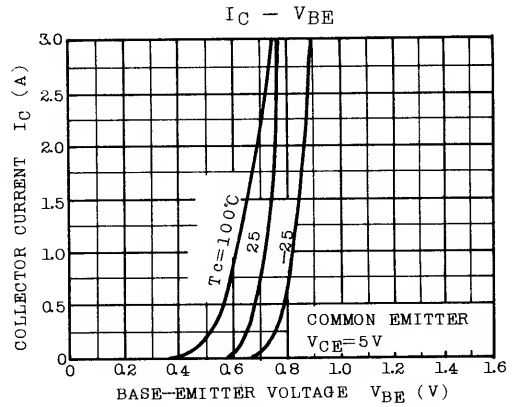
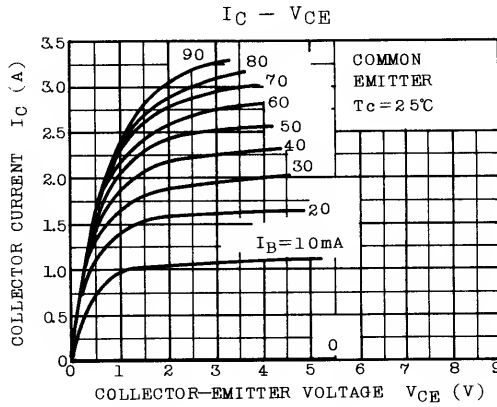


ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

Weight : 0.36g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=60V, I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	60	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=5V, I_C=0.5A$	60	-	300	
		$h_{FE(2)}$	$V_{CE}=5V, I_C=3A$	20	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=3A, I_B=0.3A$	-	0.4	1.0	V
Base-Emitter Voltage		V_{BE}	$V_{CE}=5V, I_C=0.5A$	-	0.7	1.0	V
Transition Frequency		f_T	$V_{CE}=5V, I_C=0.5A$	-	3.0	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	70	-	pF
Switching Time	Turn-On Time	t_{on}		-	0.8	-	μs
	Storage Time	t_{stg}		-	1.5	-	
	Fall Time	t_f		-	0.8	-	

Note: h_{FE} Classification 0 : 60 ~ 120, Y : 100 ~ 200, GR : 150 ~ 300



2SD1222

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

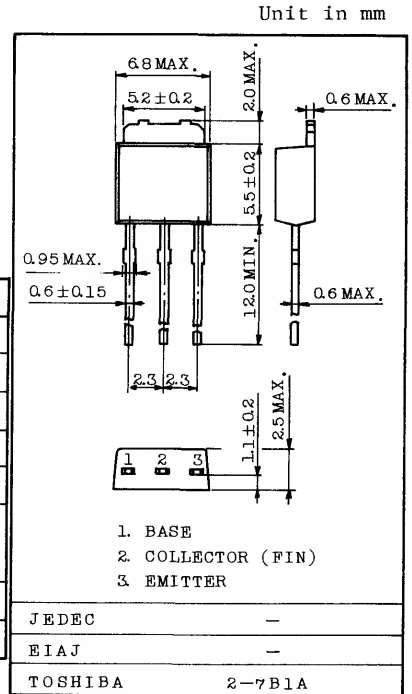
SWITCHING APPLICATIONS.
HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . High DC Current Gain
: $h_{FE(1)}=2000(\text{Min.})$ ($V_{CE}=2V, I_C=1A$)
- . Low Saturation Voltage
: $V_{CE(\text{sat})}=1.5V(\text{Max.})$ ($I_C=2A$)
- . Complementary to 2SB907.

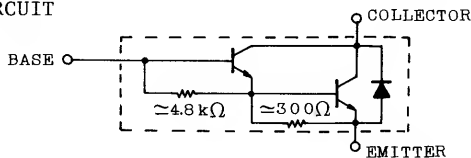
MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	60	V
Collector-Emitter Voltage	V_{CE0}	40	V
Emitter-Base Voltage	V_{EB0}	5	V
Collector Current	I_C	3	A
Base Current	I_B	0.3	A
Collector Power Dissipation	P_C	$T_a=25^\circ\text{C}$	1.0
		$T_c=25^\circ\text{C}$	15
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ\text{C}$



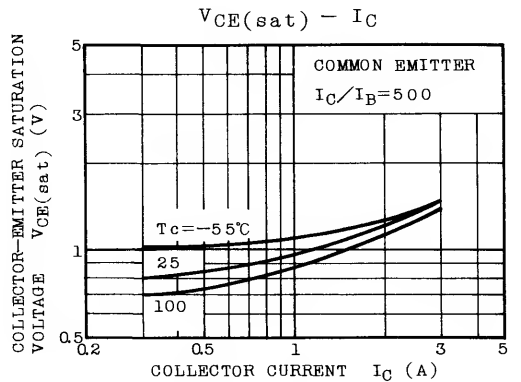
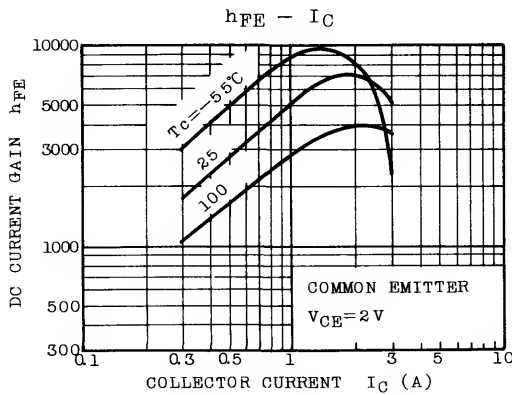
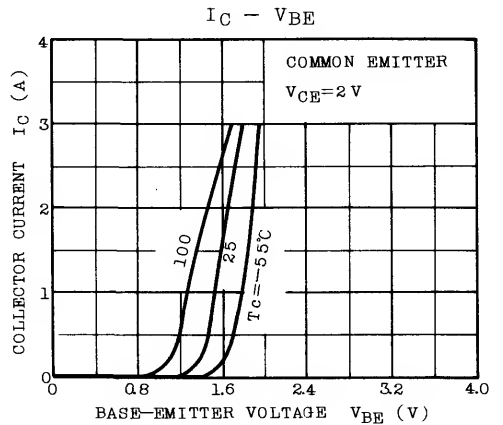
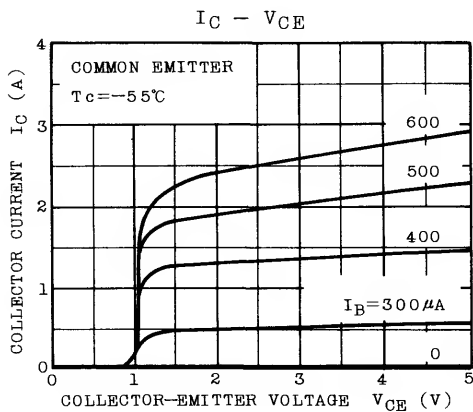
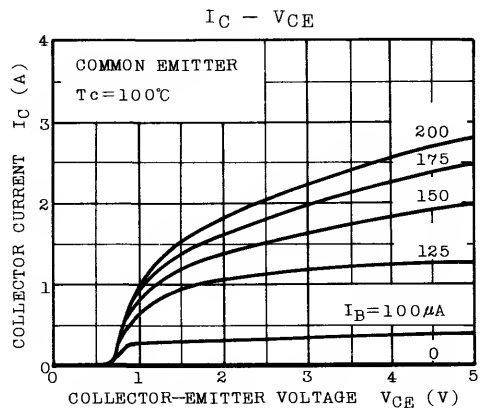
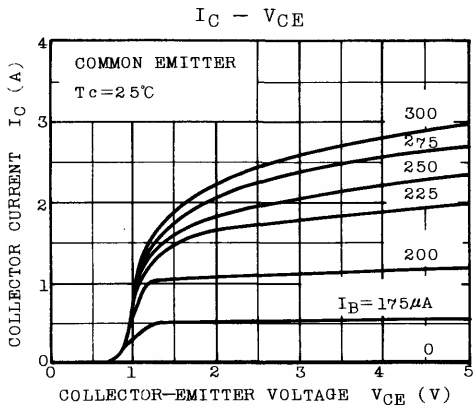
Weight : 0.36g

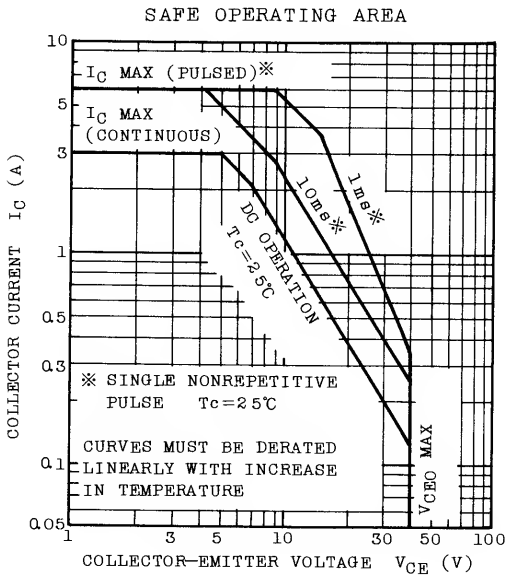
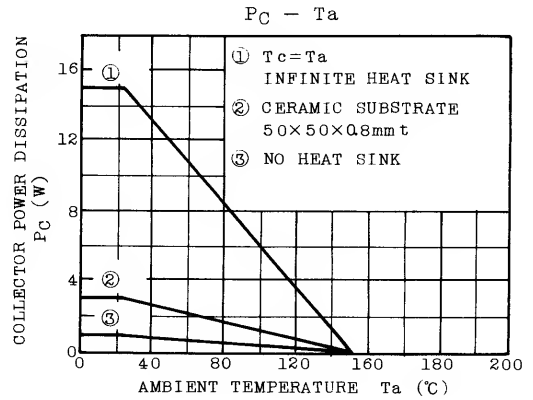
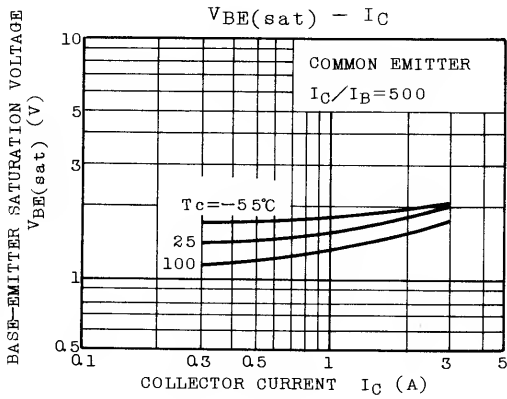
EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=60V, I_E=0$	-	-	20	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=5V, I_C=0$	-	-	2.5	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C=25mA, I_B=0$	40	-	-	V
DC Current Gain	$h_{FE(1)}$	$V_{CE}=2V, I_C=1A$	2000	-	-	
	$h_{FE(2)}$	$V_{CE}=2V, I_C=3A$	1000	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(\text{sat})}$ $I_C=2A, I_B=4mA$	-	-	1.5	V
	Base-Emitter	$V_{BE(\text{sat})}$ $I_C=2A, I_B=4mA$	-	-	2.0	
Switching Time	Turn-on Time	t_{on}	-	0.1	-	μs
	Storage Time	t_{stg}	-	1.0	-	
	Fall Time	t_f	-	0.2	-	





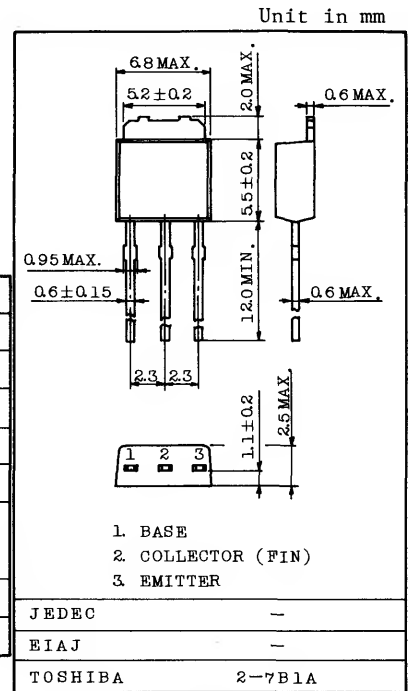
SWITCHING APPLICATIONS.
HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . High DC Current Gain
: $h_{FE(1)}=2000(\text{Min.})$ ($V_{CE}=2V, I_C=1A$)
- . Low Saturation Voltage
: $V_{CE(\text{sat})}=1.5V(\text{Max.})$ ($I_C=3A$)
- . Complementary to 2SB908.

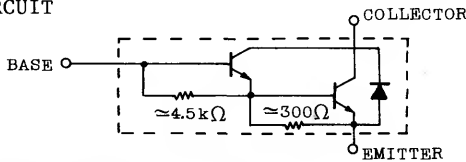
MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB0}	100	V
Collector-Emitter Voltage		V_{CEO}	80	V
Emitter-Base Voltage		V_{EB0}	5	V
Collector Current		I_C	4	A
Base Current		I_B	0.4	A
Collector Power Dissipation	$T_a=25^\circ\text{C}$	P_C	1.0	W
	$T_c=25^\circ\text{C}$		15	
Junction Temperature		T_j	150	$^\circ\text{C}$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ\text{C}$



Weight : 0.36g

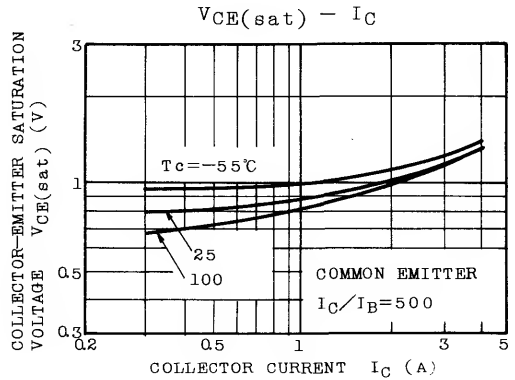
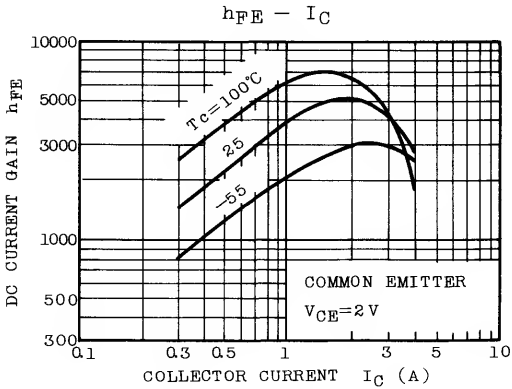
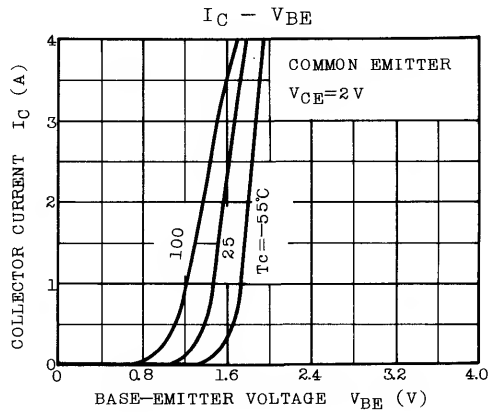
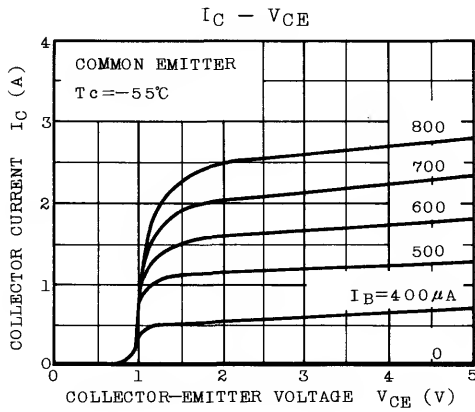
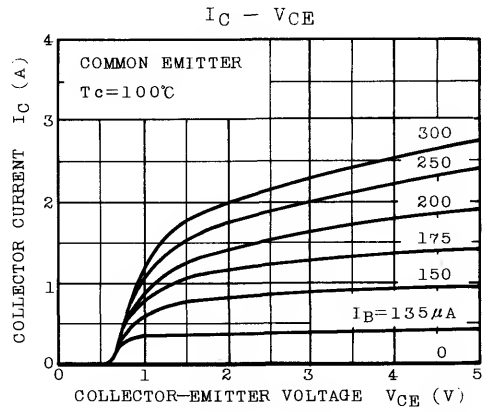
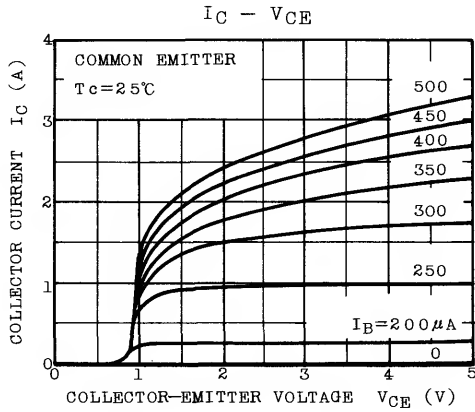
EQUIVALENT CIRCUIT

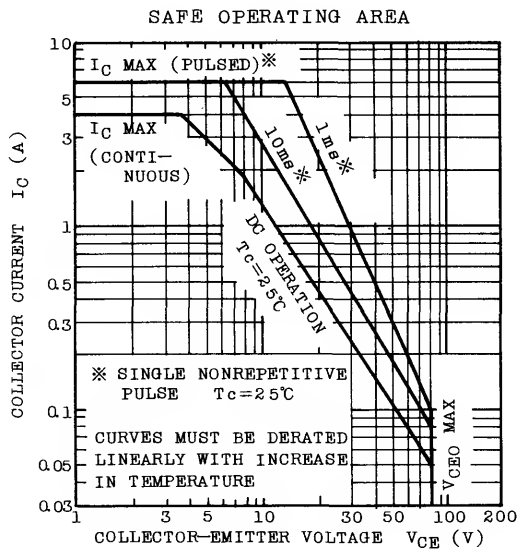
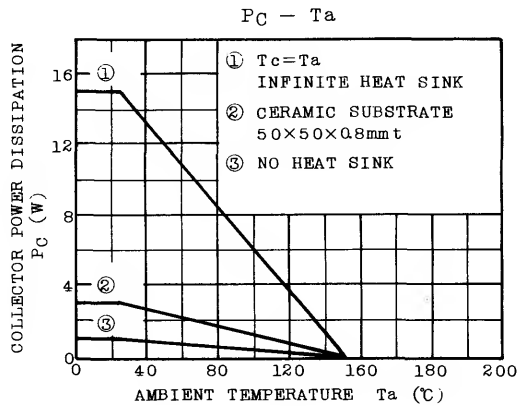
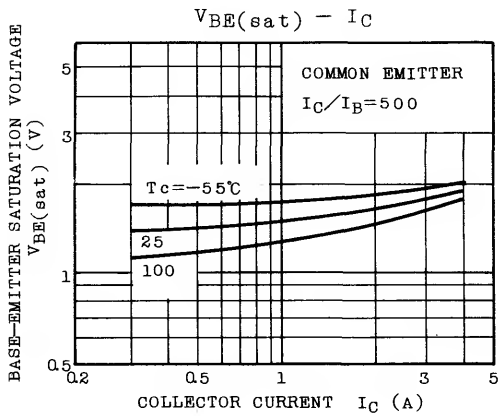


ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CB0}	$V_{CB}=100V, I_E=0$	-	-	20	μA
Emitter Cut-off Current		I_{EB0}	$V_{EB}=5V, I_C=0$	-	-	2.5	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10\text{mA}, I_B=0$	80	-	-	V
DC Current Gain		$h_{FE(1)}$	$V_{CE}=2V, I_C=1A$	2000	-	-	
		$h_{FE(2)}$	$V_{CE}=2V, I_C=3A$	1000	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(\text{sat})}$	$I_C=3A, I_B=6\text{mA}$	-	-	1.5	V
	Base-Emitter	$V_{BE(\text{sat})}$	$I_C=3A, I_B=6\text{mA}$	-	-	2.0	
Switching Time	Turn-on Time	t_{on}		-	0.2	-	μs
	Storage Time	t_{stg}		-	1.5	-	
	Fall Time	t_f		$I_{B1}=-I_{B2}=6\text{mA}$ DUTY CYCLE $\leq 1\%$	-	0.6	

2SD1223





2SD1224

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)
(DARLINGTON POWER)

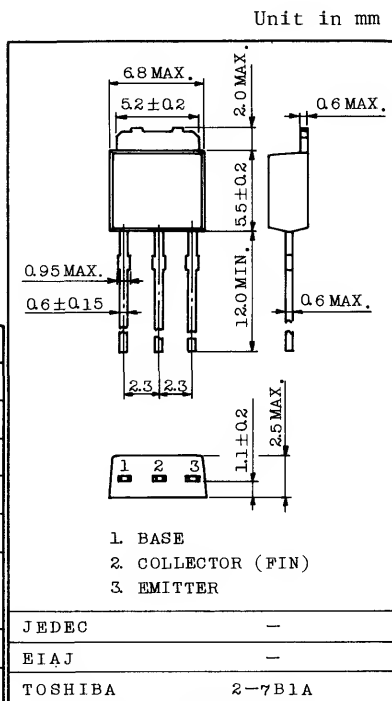
PULSE MOTOR DRIVE, HAMMER DRIVE APPLICATIONS.
SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

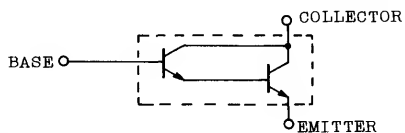
- High DC Current Gain
: $h_{FE}=4000(\text{Min.})$ ($V_{CE}=2V, I_C=150\text{mA}$)
- Low Saturation Voltage
: $V_{CE}(\text{sat})=1.5V(\text{Max.})$ ($I_C=1A, I_B=1\text{mA}$)

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	30	V
Collector-Emitter Voltage		V_{CEO}	30	V
Emitter-Base Voltage		V_{EBO}	10	V
Collector Current		I_C	1.5	A
Base Current		I_B	0.15	A
Collector Power Dissipation	$T_a=25^\circ\text{C}$	P_C	1.0	W
	$T_c=25^\circ\text{C}$		10	
Junction Temperature		T_j	150	$^\circ\text{C}$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ\text{C}$



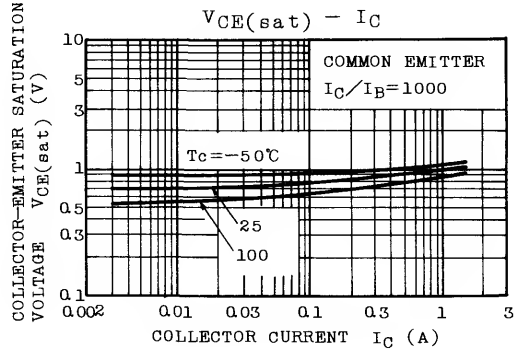
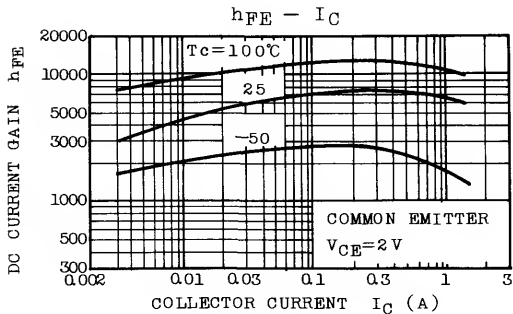
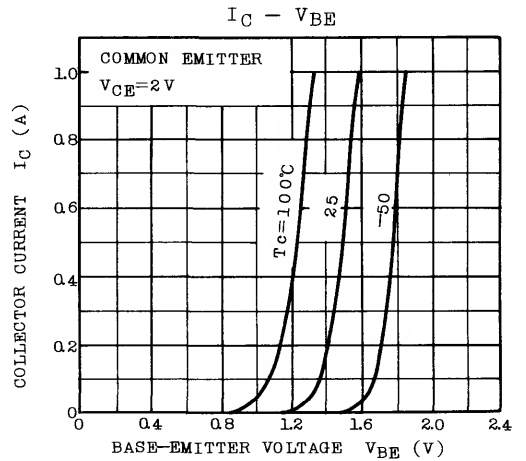
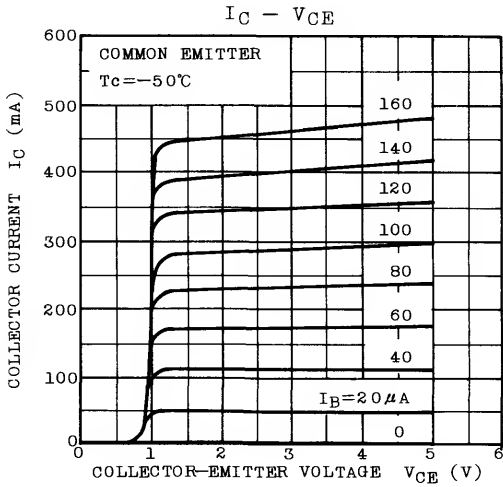
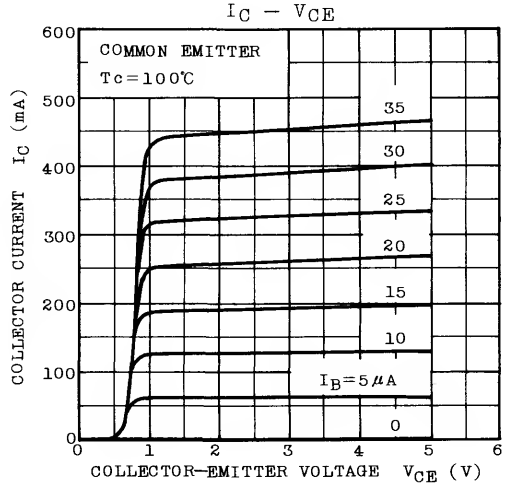
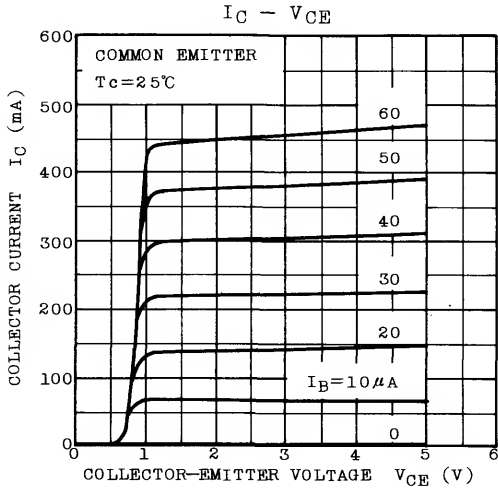
EQUIVALENT CIRCUIT



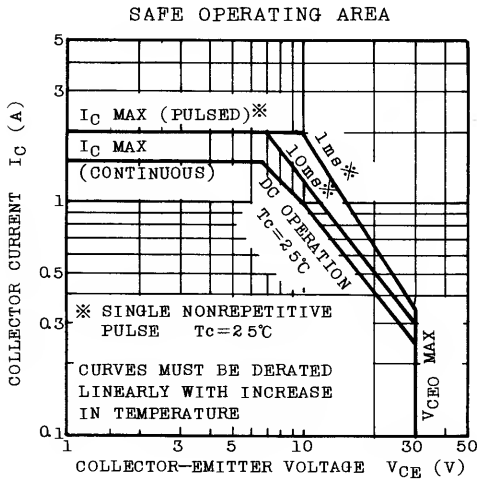
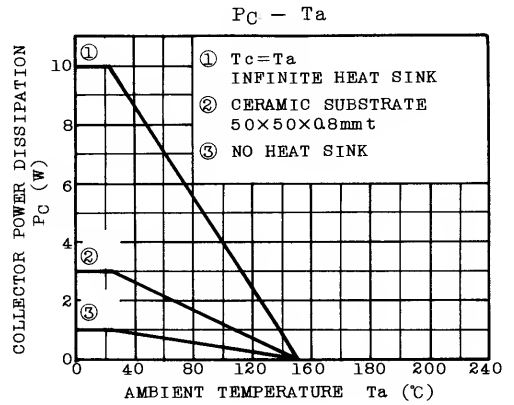
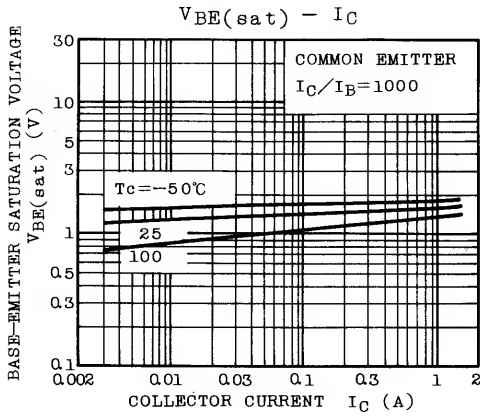
Weight : 0.36g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=30V, I_E=0$	-	-	10	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=10V, I_C=0$	-	-	10	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10\text{mA}, I_B=0$	30	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=2V, I_C=150\text{mA}$	4000	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE}(\text{sat})$	$I_C=1A, I_B=1\text{mA}$	-	-	1.5	V
	Base-Emitter	$V_{BE}(\text{sat})$	$I_C=1A, I_B=1\text{mA}$	-	-	2.2	
Switching Time	Turn-on Time	t_{on}	$20\mu\text{s}$ INPUT I_{B1} I_{B2} OUTPUT 15Ω	-	0.18	-	μs
	Storage Time	t_{stg}	$I_{B1}=-I_{B2}=1\text{mA}$	-	0.6	-	
	Fall Time	t_f	DUTY CYCLE $\leq 1\%$ $V_{CC}=15V$	-	0.3	-	



2SD1224



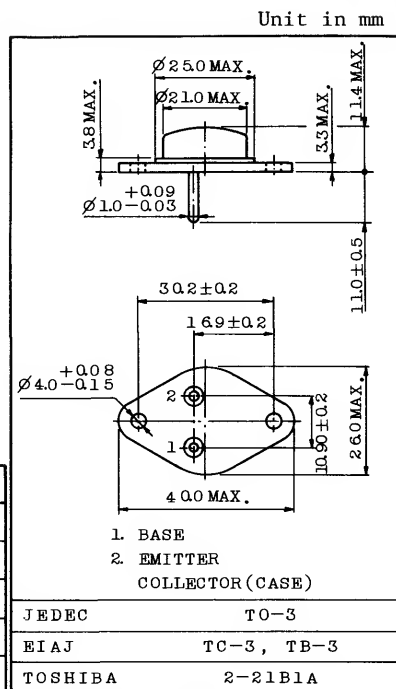
COLOR TV HORIZ. DEFLECTION OUTPUT APPLICATIONS.
SWITCHING REGULATOR APPLICATIONS.

FEATURES:

- . High Voltage : $V_{CB0}=1400V$
- . Low Saturation Voltage
: $V_{CE(sat)}=5V(\text{Max.})$ ($I_C=8A$, $I_B=2A$)
- . High Speed : $t_f=1.0\mu s(\text{Max.})$
- . Glass Passivated Collector-Base Junction.

MAXIMUM RATINGS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	1400	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	10	A
Base Current	I_B	5	A
Collector Power Dissipation	P_C	50	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-65~150	$^\circ C$

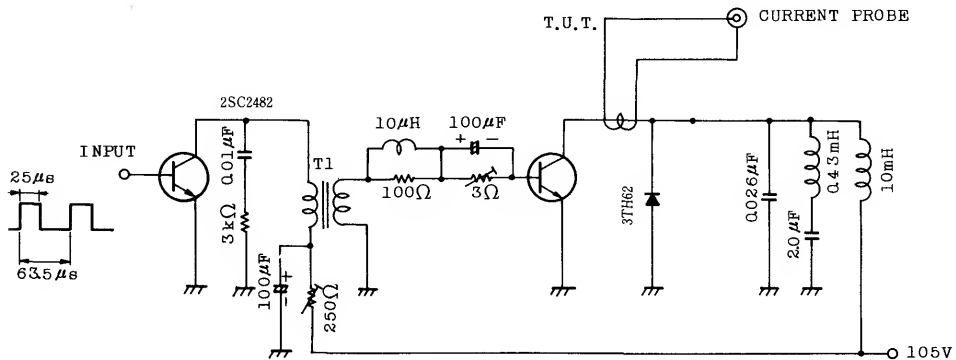


Weight : 17.0g

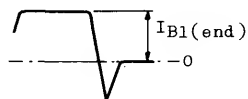
ELECTRICAL CHARACTERISTICS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=500V$, $I_E=0$	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V$, $I_C=0$	-	-	1	mA
DC Current Gain	h_{FE}	$V_{CE}=5V$, $I_C=2A$	8	22	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=8A$, $I_B=2A$	-	-	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=8A$, $I_B=2A$	-	-	1.6	V
Transition Frequency	f_T	$V_{CE}=10V$, $I_C=0.1A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	165	-	pF
Collector Current Fall Time	t_f	$I_{CP}=7A$, $I_{B1}(\text{end})=1.5A$ (Fig.)	-	-	1.0	μs

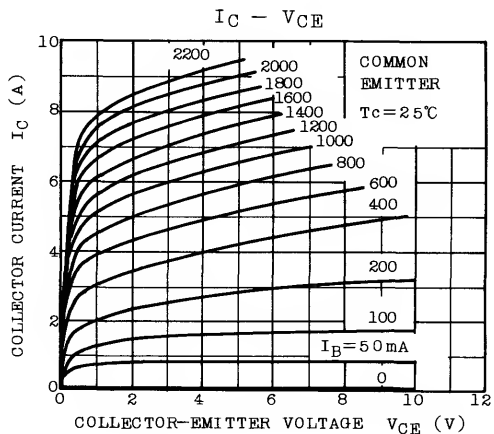
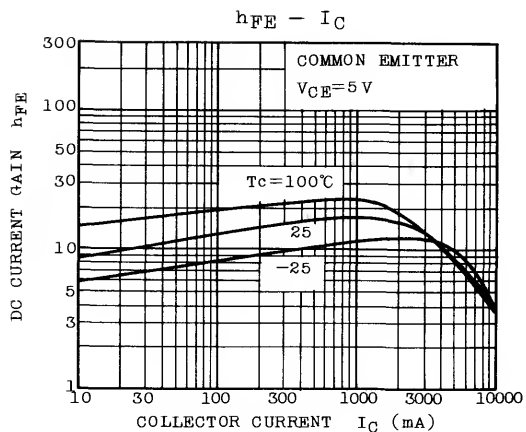
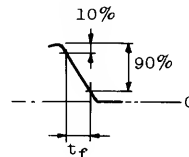
Fig. t_f TEST CIRCUIT

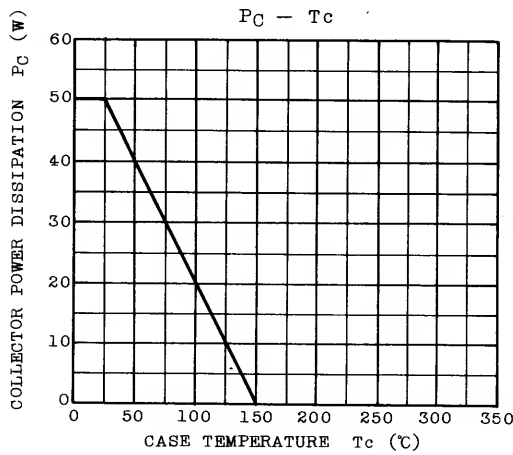
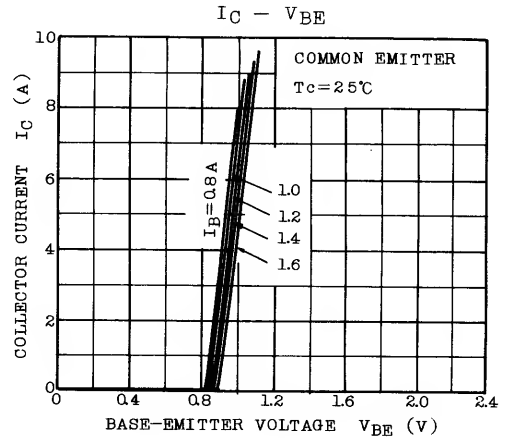
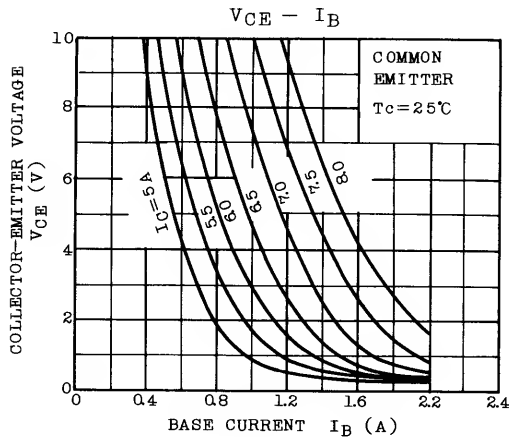


BASE CURRENT



COLLECTOR CURRENT





2SD1294

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)
(DARLINGTON POWER)

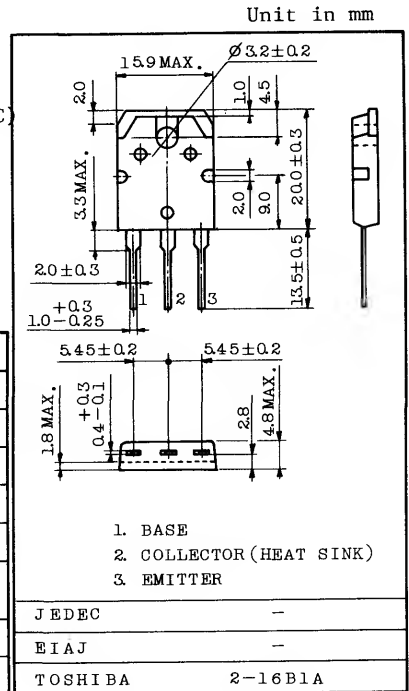
POWER REGULATOR FOR LINE OPERATED TV.

FEATURES:

- . Excellent Wide Safe Operating Area (80 W.sec at $T_c=25^\circ\text{C}$)
- . Included Abalanche Diode : $V_Z=60\pm 15\text{V}$
- . High DC Current Gain : $h_{FE}=2000\sim 20000$
- . Darlington Connected Type.

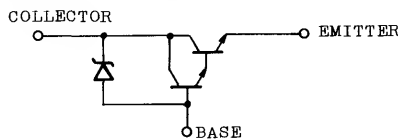
MAXIMUM RATINGS ($T_c=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60 ± 15	V
Collector-Emitter Voltage	V_{CEO}	60 ± 15	V
Emitter-Base Voltage	V_{EBO}	6	V
Collector Current (Continuous)	I_C	5	A
Collector Current (Peak)	I_{CP}	20	A
Collector Power Dissipation	P_C	80	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	$-55\sim 150$	$^\circ\text{C}$



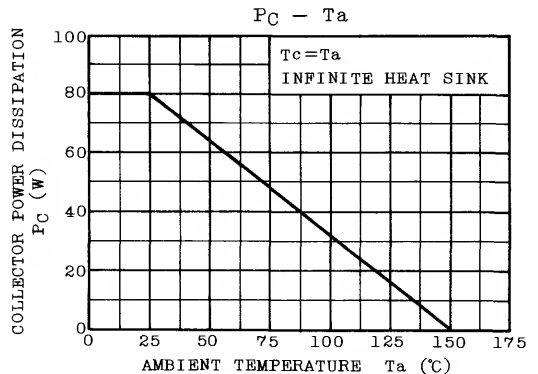
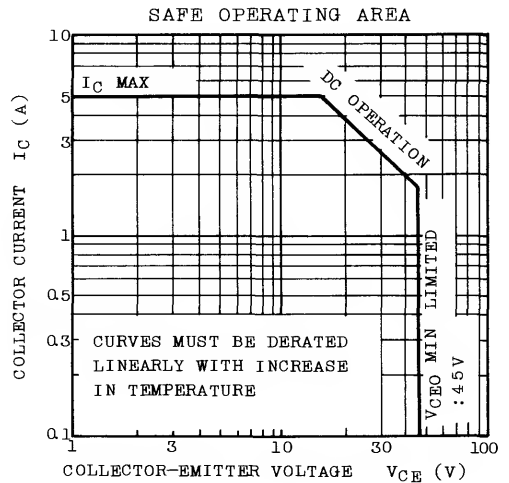
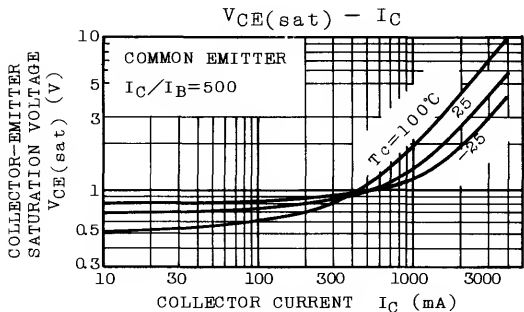
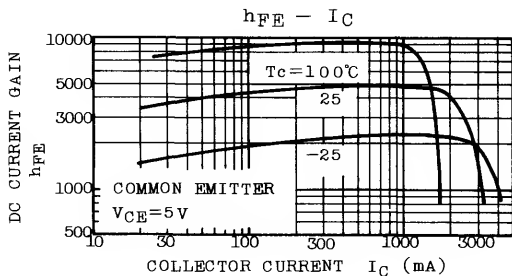
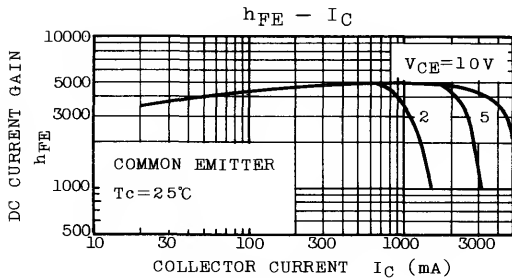
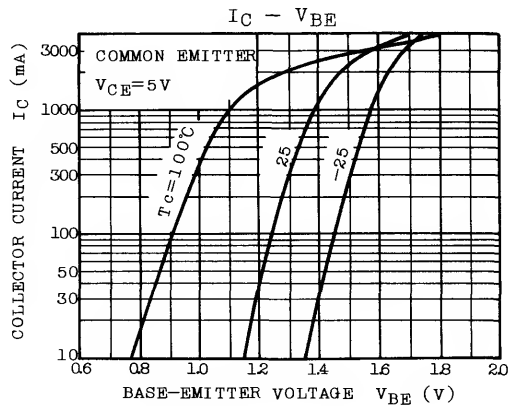
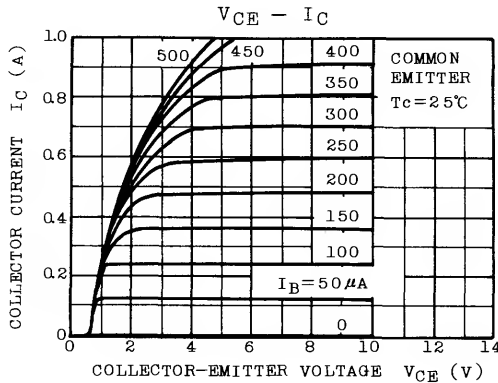
Weight : 4.6g

EQUIVALENT CIRCUIT



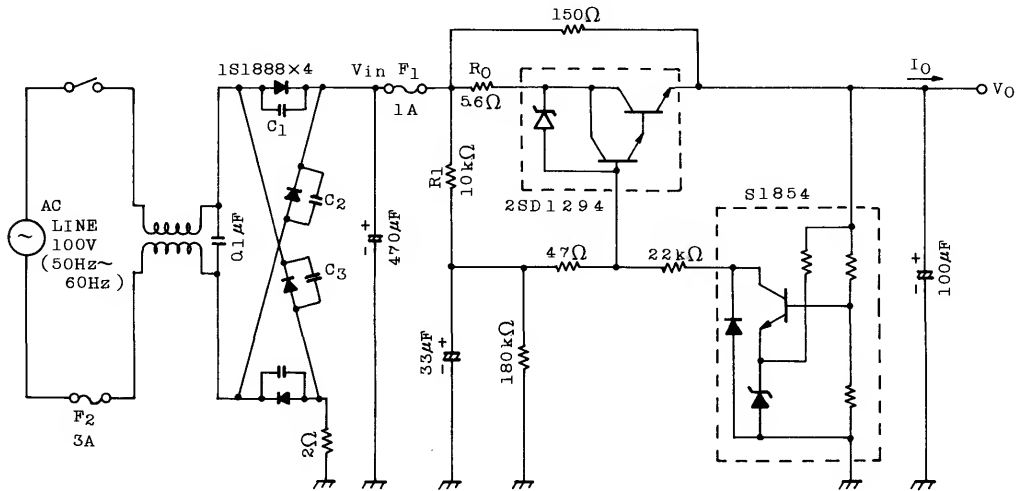
ELECTRICAL CHARACTERISTICS ($T_c=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=10\text{mA}, I_E=0$	45	60	75	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=100\text{mA}, I_B=0$	45	60	75	V
Emitter Cut-off Current	I_{EBO}	$V_{EB}=6\text{V}, I_C=0$	-	-	100	μA
DC Current Gain	h_{FE}	$V_{CE}=5\text{V}, I_C=0.5\text{A}$	2000	-	20000	
Collector-Emitter Saturation Voltage (1)	$V_{CE(sat)}(1)$	$I_C=0.5\text{A}, I_B=1\text{mA}$	-	-	1.5	V
Collector-Emitter Saturation Voltage (2)	$V_{CE(sat)}(2)$	$I_C=1\text{A}, I_B=1\text{mA}$	-	-	2.5	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5\text{V}, I_C=0.5\text{A}$	-	-	1.8	V
Allowable Energy	E_T	Application Circuit	80	-	-	W·sec



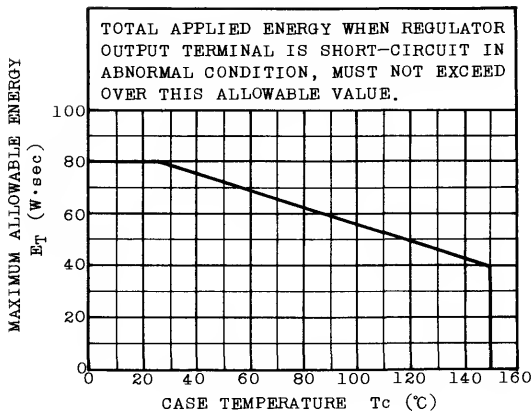
2SD1294

APPLICATION CIRCUIT

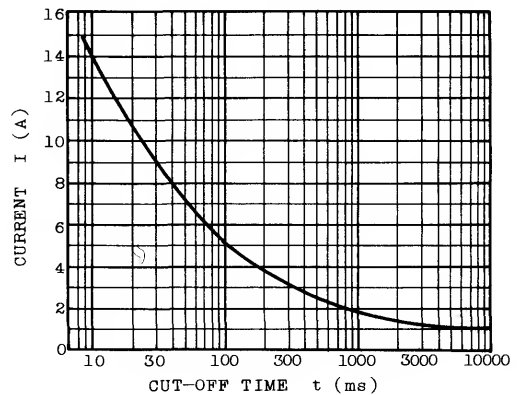


$C_1, C_2, C_3, C_4 : 0.0047 \mu F$

$E_T - T_c$



FUSE F_1 : I - t CHARACTERISTIC



2SD1313

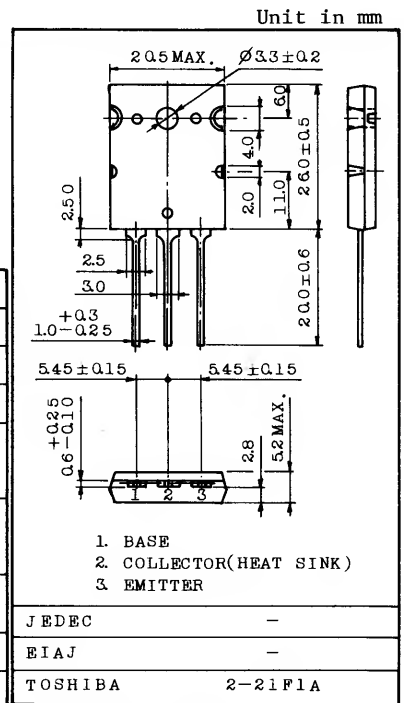
HIGH POWER AMPLIFIER APPLICATIONS.
HIGH POWER SWITCHING APPLICATIONS.

FEATURES:

- High Power Dissipation : $P_C=200W$ ($T_c=25^{\circ}C$)
- High Collector Current : $I_C=25A$ (DC)
- High Speed Switching : $t_f=0.5\mu s$ (Typ.) ($I_C=15A$)
- Low Saturation Voltage : $V_{CE(sat)}=1.0V$ (Max.) ($I_C=15A$)

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	800	V
Collector-Emitter Voltage		V_{CEO}	350	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	25	A
	Pulse	I_{CP}	35	.
Base Current	DC	I_B	10	A
	Pulse	I_{BP}	15	.
Collector Power Dissipation ($T_c=25^{\circ}C$)		P_C	200	W
Junction Temperature		T_j	150	$^{\circ}C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^{\circ}C$

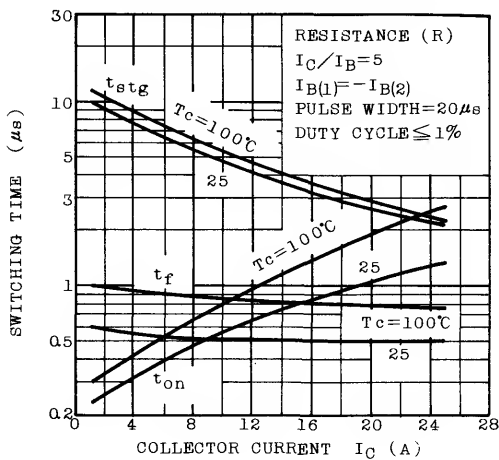


Weight : 9.75g

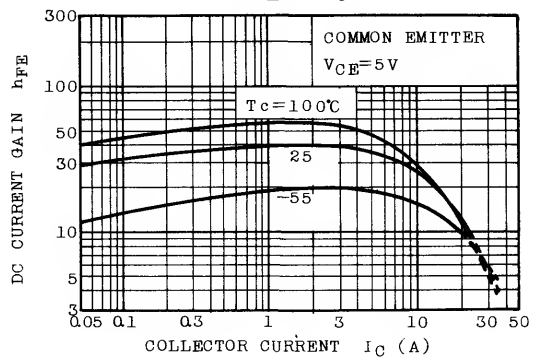
ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=800V, I_E=0$	-	-	1	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	1	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	350	-	-	V
DC Current Gain		$h_{FE(1)}$	$V_{CE}=5V, I_C=1A$	15	-	-	
		$h_{FE(2)}$	$V_{CE}=5V, I_C=25A$	6	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=15A, I_B=3A$	-	-	1.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=15A, I_B=3A$	-	-	1.7	V
Collector Output Capacitance		C_{ob}	$V_{CB}=50V, I_E=0, f=1MHz$	-	170	-	pF
Transition Frequency		f_T	$V_{CE}=10V, I_E=1A$	-	6	-	MHz
Switching Time	Turn-on Time	t_{on}		-	0.8	-	μs
	Storage Time	t_{stg}		-	3.0	-	
	Fall Time	t_f		-	0.5	-	

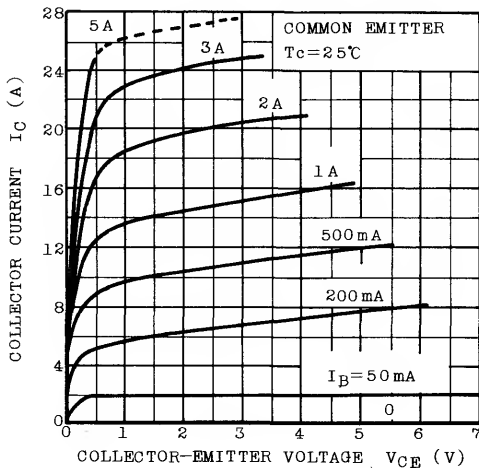
SWITCHING APPLICATIONS



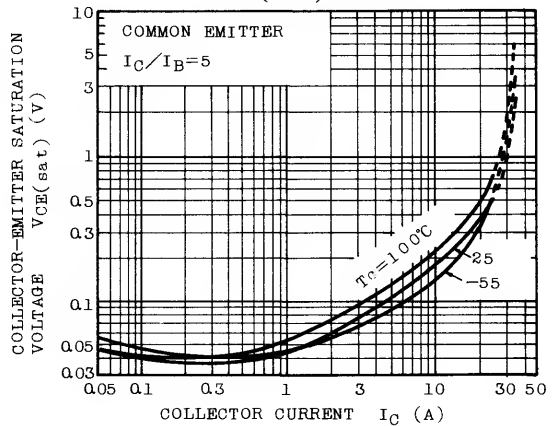
$h_{FE} - I_C$



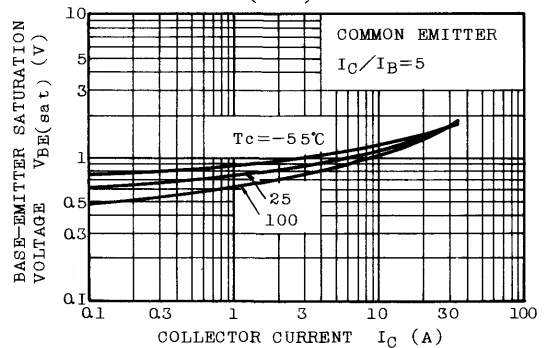
$I_C - V_{CE}$

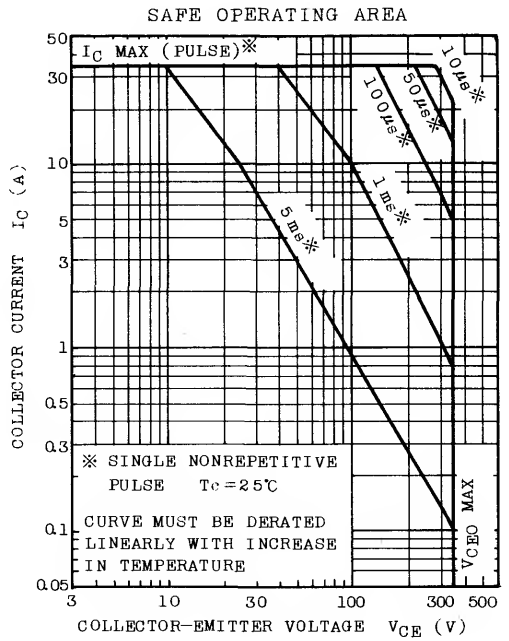
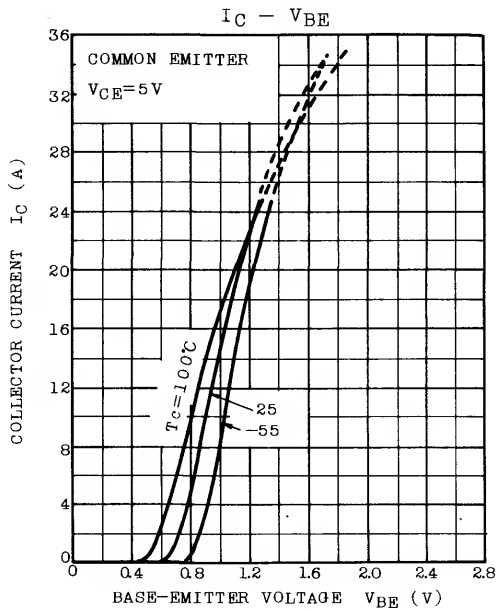


$V_{CE(sat)} - I_C$



$V_{BE(sat)} - I_C$





2SD1314

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

HIGH POWER SWITCHING APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

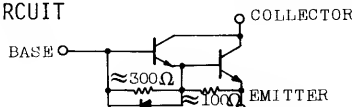
FEATURES:

- . High DC Current Gain : $h_{FE}=100(\text{Min.}) (I_C=15\text{A})$
- . Low Saturation Voltage : $V_{CE(\text{sat})}=2\text{V}(\text{Max.}) (I_C=15\text{A})$
- . High Speed : $t_f=3\mu\text{s}(\text{Max.}) (I_C=15\text{A})$

MAXIMUM RATINGS ($T_c=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	600	V
Collector-Emitter Voltage		$V_{CEO(\text{SUS})}$	450	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current	DC	I_C	15	A
	1ms	I_C	30	
Base Current		I_B	1	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)		P_C	150	W
Junction Temperature		T_j	150	$^\circ\text{C}$
Storage Temperature Range		T_{stg}	-40 ~ 150	$^\circ\text{C}$

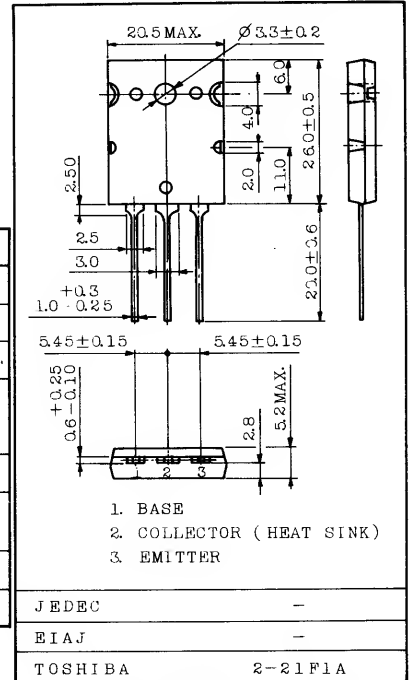
EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=600\text{V}, I_E=0$	-	-	1.0	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=6\text{V}, I_C=0$	-	-	20C	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(\text{SUS})}$	$I_C=0.5\text{A}, L=40\text{mH}$	450	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5\text{V}, I_C=15\text{A}$	100	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(\text{sat})}$	$I_C=15\text{A}, I_B=0.4\text{A}$	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(\text{sat})}$		-	-	2.5	V
Collector Output Capacitance		C_{ob}	$V_{CB}=50\text{V}, I_E=0, f=1\text{MHz}$	-	150	-	pF
Switching Time	Turn-on Time	t_{on}		-	-	1.0	μs
	Storage Time	t_{stg}		-	-	12	
	Fall Time	t_f		-	-	3.0	

Unit in mm



1. BASE
2. COLLECTOR (HEAT SINK)
3. EMITTER

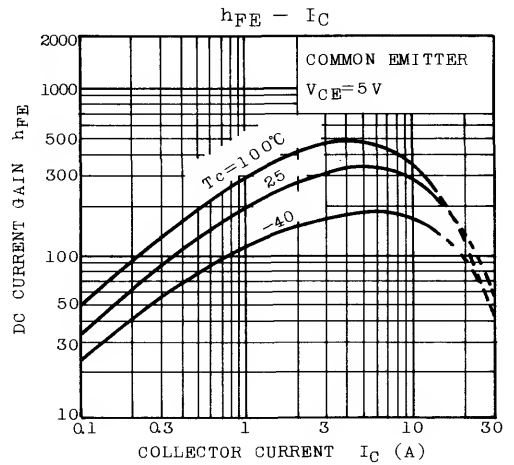
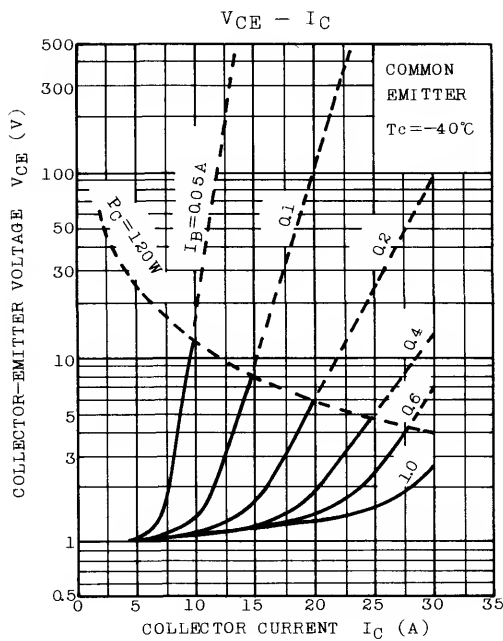
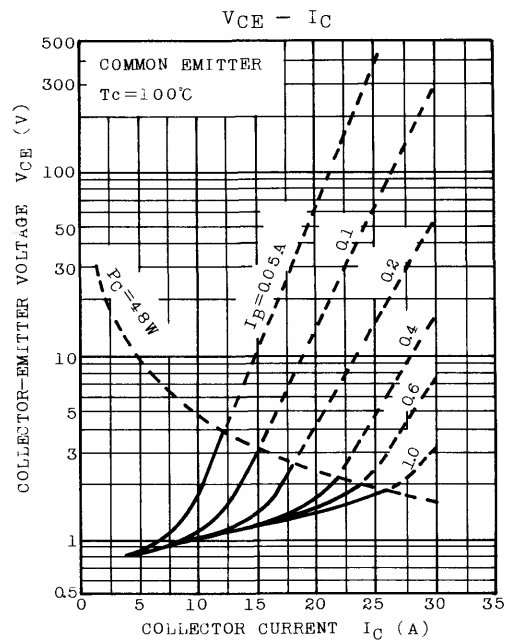
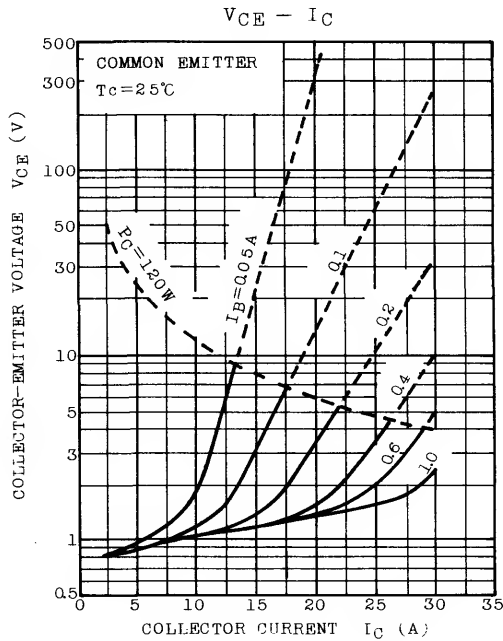
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EIAJ

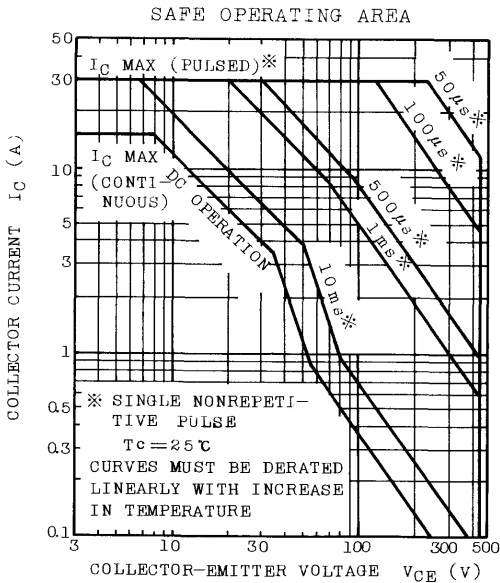
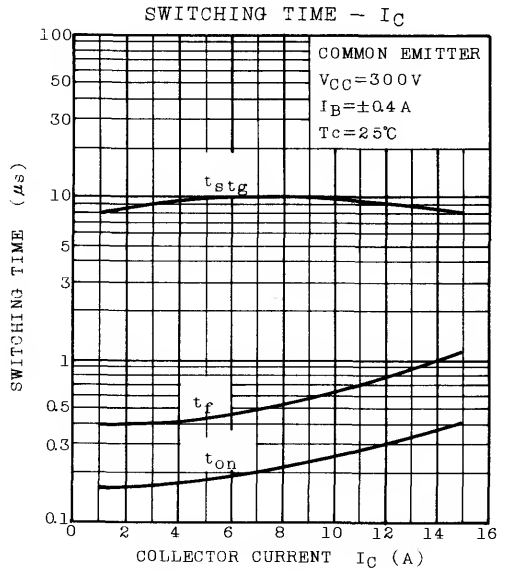
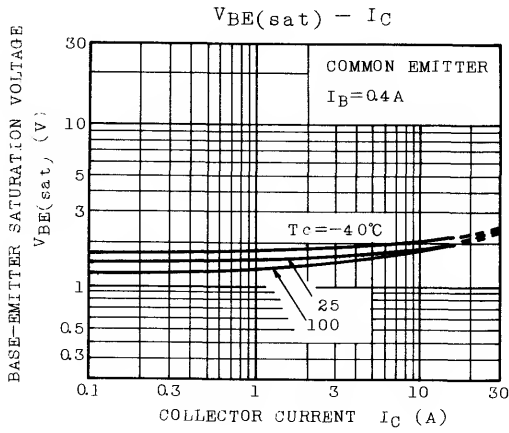
TOSHIBA

2-21F1A

Weight : 9.75g



2SD1314

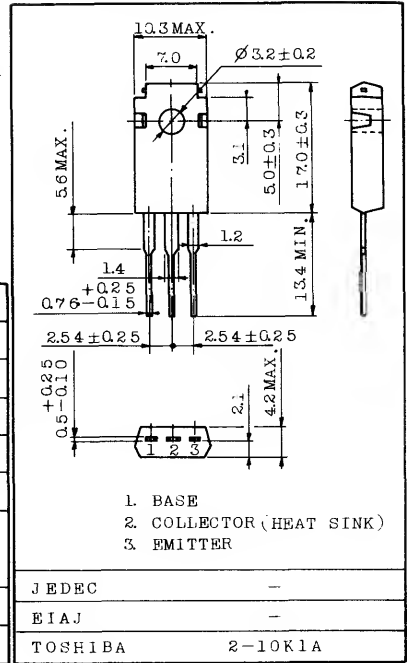


AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . High DC Current Gain of 200 to 1200 at $V_{CE}=5V$, $I_C=0.5A$
- . Low $V_{CE(sat)}$ of 1.0V (Max.) at $I_C=1A$, $I_B=0.02A$
- . Collector Power Dissipation of 30W at $T_c=25^{\circ}C$

Unit in mm



MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	50	V
Collector-Emitter Voltage		V_{CEO}	50	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current		I_C	3	A
Base Current		I_B	0.5	A
Collector Power Dissipation	$T_a=25^{\circ}C$	P_C	1.5	W
	$T_c=25^{\circ}C$		30	
Junction Temperature		T_j	150	$^{\circ}C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^{\circ}C$

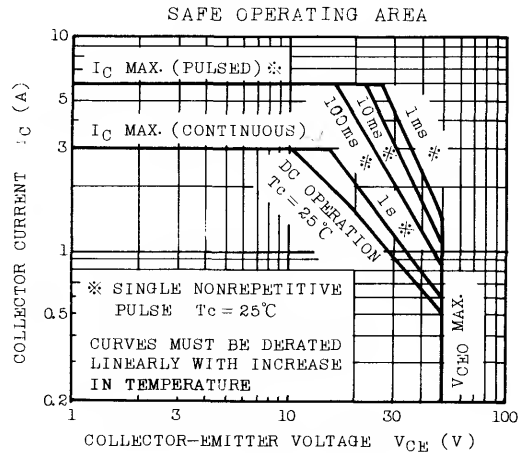
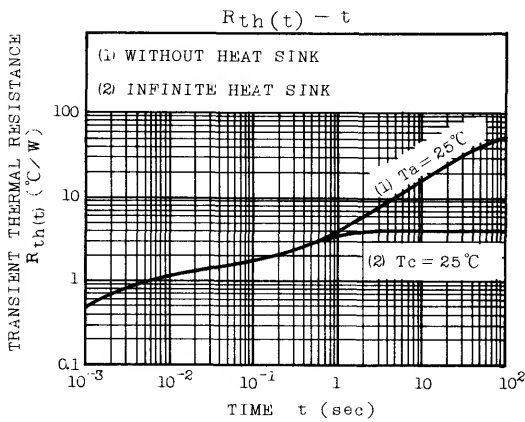
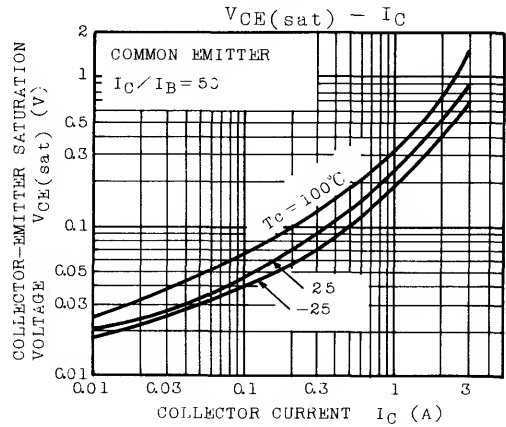
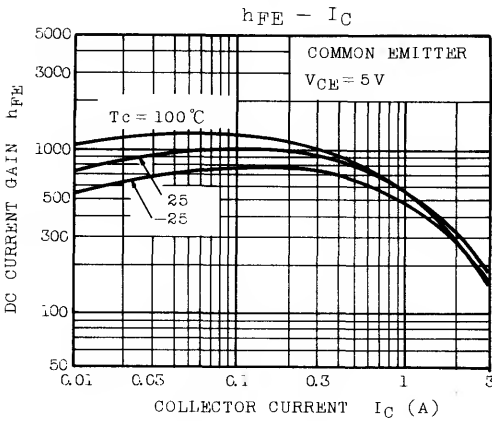
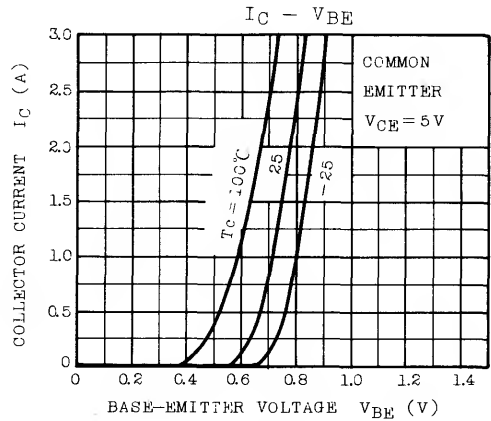
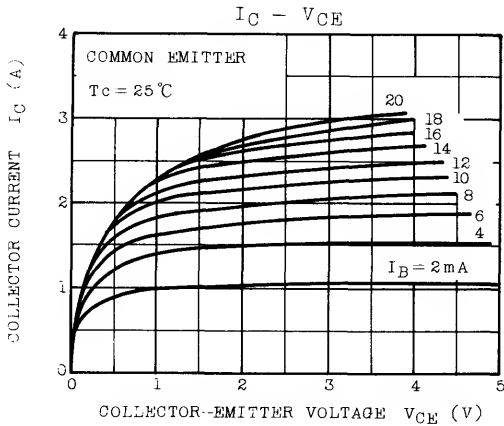
Weight : 2.0g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=50V$, $I_E=0$	-	-	100	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=7V$, $I_C=0$	-	-	100	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=50mA$, $I_B=0$	50	-	-	V
DC Current Gain		h_{FE} (Note)	$V_{CE}=5V$, $I_C=0.5A$	200	-	1200	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=1A$, $I_B=0.02A$	-	0.25	1.0	V
Base-Emitter Voltage		V_{BE}	$V_{CE}=5V$, $I_C=0.5A$	-	0.7	1.0	V
Transition Frequency		f_T	$V_{CE}=5V$, $I_C=0.5A$	-	5.0	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	70	-	pF
Switching Time	Turn-on Time	t_{on}		-	2.0	-	μs
	Storage Time	t_{stg}		-	5.0	-	
	Fall Time	t_f		-	3.0	-	

Note : h_{FE} Classification GR : 200 ~ 400, BL : 350 ~ 700, V : 600 ~ 1200

2SD1353



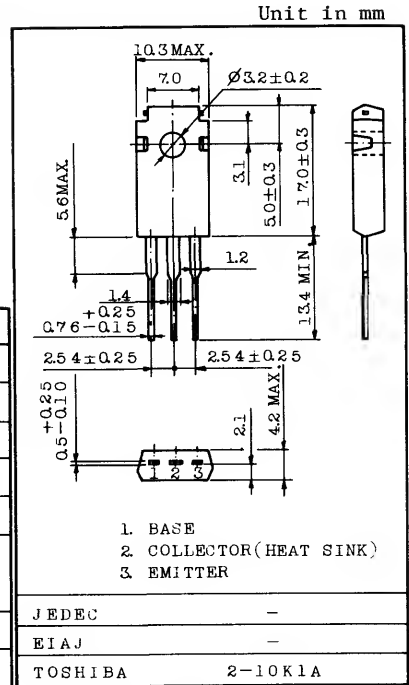
AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High DC Current Gain : $h_{FE}=300(\text{Max.})(V_{CE}=5V, I_C=0.5A)$
- Low Saturation Voltage
: $V_{CE(\text{sat})}=1.0V(\text{Max.})(I_C=3A, I_B=0.3A)$
- High Power Dissipation : $P_C=30W (T_c=25^\circ\text{C})$
- Complementary to 2SB994

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CEO}	60	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	3	A
Base Current	I_B	0.5	A
Collector Power Dissipation	P_C	$T_a=25^\circ\text{C}$	1.5
		$T_c=25^\circ\text{C}$	30
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ\text{C}$



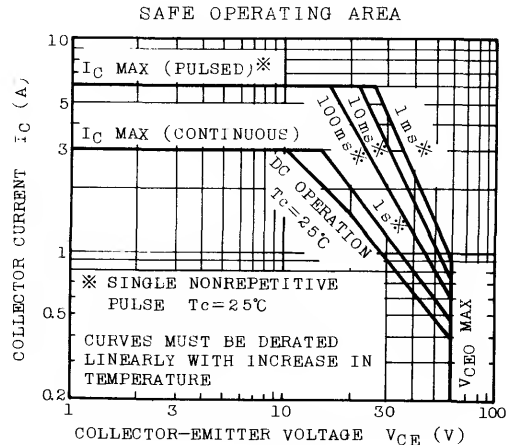
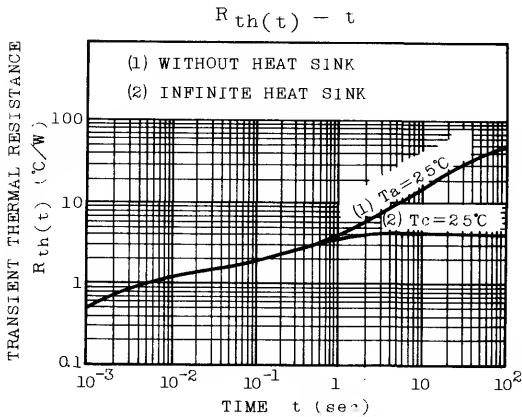
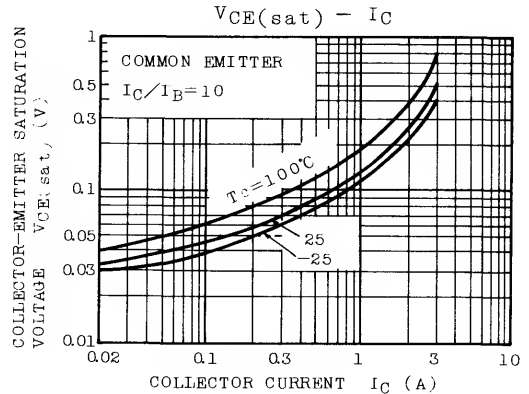
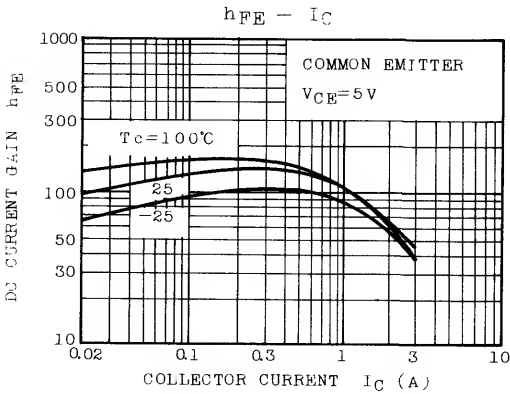
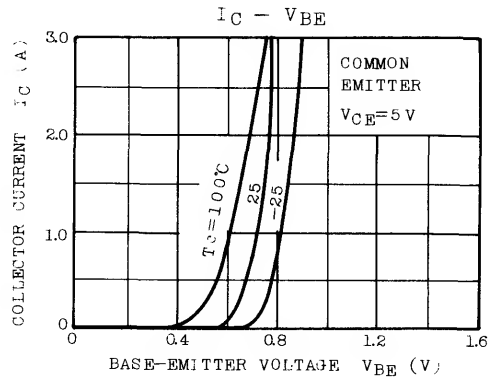
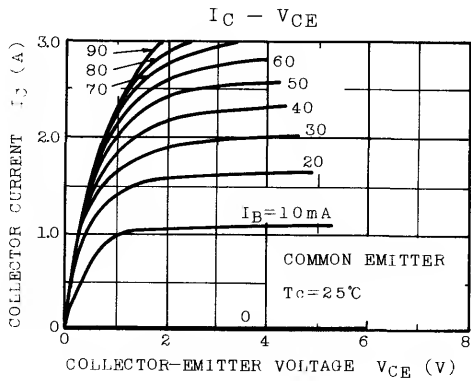
Weight : 2.0g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Collector Cut-off Current	I_{CBO}	$V_{CB}=60V, I_E=0$	-	-	100	μA	
Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	100	μA	
Collector-Emitter Breakdown Voltage	$V(\text{BR})_{CEO}$	$I_C=50\text{mA}, I_B=0$	60	-	-	V	
DC Current Gain	$h_{FE}(\text{Note})$	$V_{CE}=5V, I_C=0.5A$	60	-	300		
Collector Emitter Saturation Voltage	$V_{CE(\text{sat})}$	$I_C=3A, I_B=0.3A$	-	0.25	1.0	V	
Base-Emitter Voltage	V_{BE}	$V_{CE}=5V, I_C=0.5A$	-	0.7	1.0	V	
Transition Frequency	f_T	$V_{CE}=5V, I_C=0.5A$	-	3.0	-	MHz	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1\text{MHz}$	-	70	-	pF	
Switching Time	Turn-on Time	t_{on}			-	0.8	-
	Storage Time	t_{stg}	-	1.5	-	μs	
	Fall Time	t_f	$I_{B1}=-I_{B2}=0.2A$ DUTY CYCLE<1%	-	0.8	-	

Note : h_{FE} Classification 0 : 60 ~ 120, Y : 100 ~ 200, GR : 150 ~ 300

2SD1354



POWER AMPLIFIER APPLICATIONS.

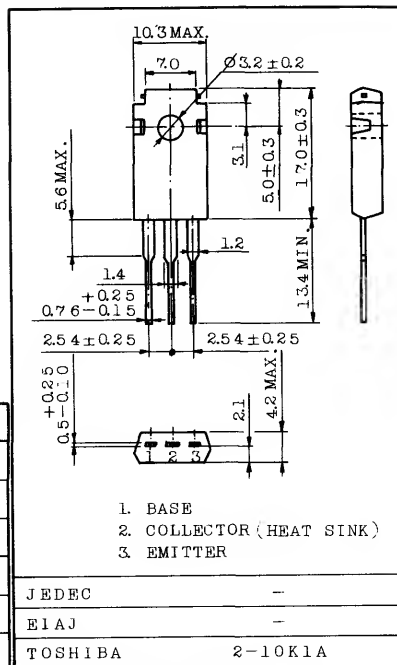
FEATURES:

- . High Breakdown Voltage : $V_{CE0}=100V$
- . Low Collector Saturation Voltage : $V_{CE(sat)}=2.0V(\text{Max.})$
- . Complementary to 2SB995
- . Recommended for 30W High Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	100	V
Collector-Emitter Voltage	V_{CEO}	100	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	5	A
Base Current	I_B	0.5	A
Collector Power Dissipation ($T_c=25^{\circ}C$)	P_C	40	W
Junction Temperature	T_j	150	$^{\circ}C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^{\circ}C$

Unit in mm

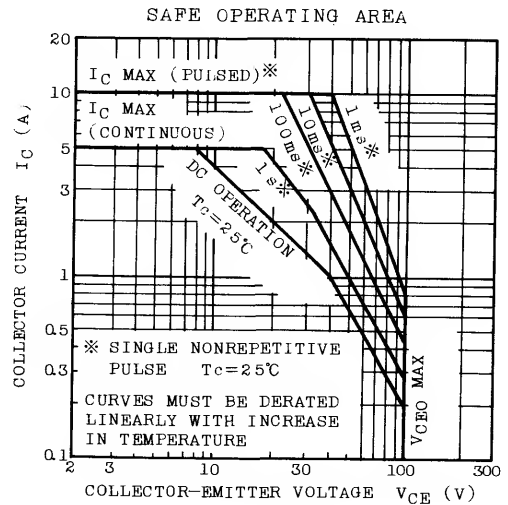
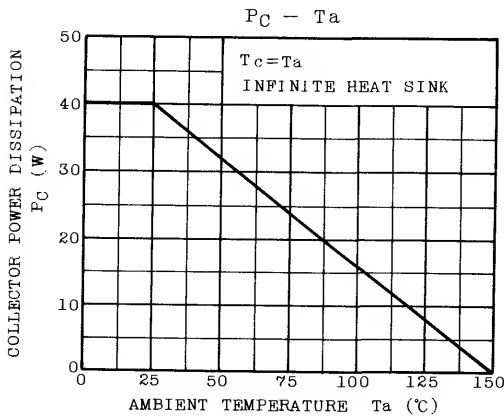
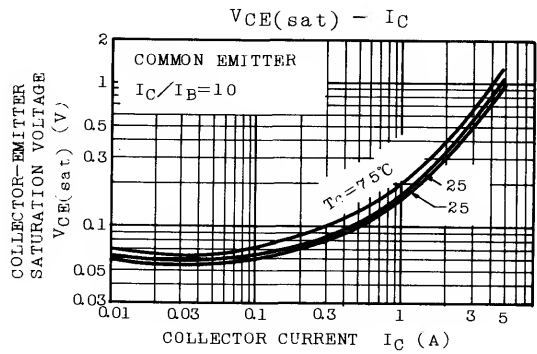
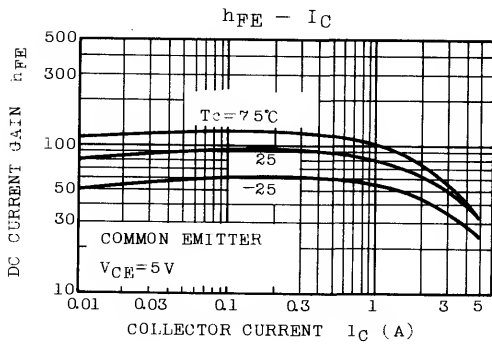
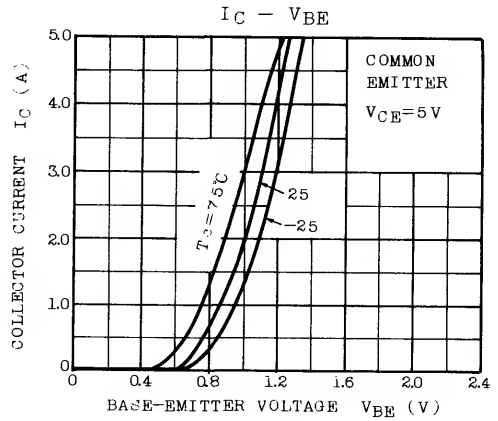
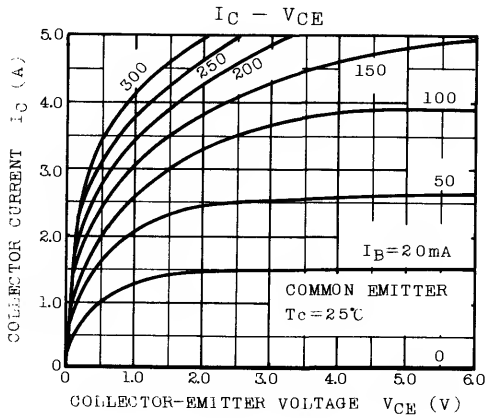


Weight : 2.0g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=100V, I_E=0$	-	-	100	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1	mA
Collector-Emitter Breakdown Voltage	$V(BR)_{CEO}$	$I_C=50mA, I_B=0$	100	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=5V, I_C=1A$	40	-	240	
	$h_{FE(2)}$	$V_{CE}=5V, I_C=4A$	20	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A, I_B=0.4A$	-	-	2.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5V, I_C=1A$	-	-	1.5	V
Transition Frequency	f_T	$V_{CE}=5V, I_C=1A$	-	12	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	100	-	pF

Note : $h_{FE(1)}$ Classification R : 40 ~ 80, O : 70 ~ 140, Y : 120 ~ 240



POWER AMPLIFIER APPLICATIONS.

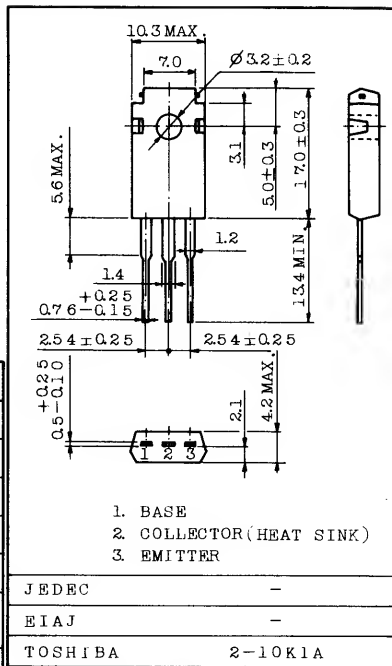
FEATURES:

- . High Power Dissipation : $P_C=30W$ ($T_c=25^{\circ}C$)
- . Good Linearity of h_{FE}
- . Complementary to 2SB996
- . Recommended for 20 ~ 25W High Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	80	V
Collector-Emitter Voltage	V_{CE0}	80	V
Emitter-Base Voltage	V_{EB0}	5	V
Collector Current	I_C	4	A
Base Current	I_B	0.4	A
Collector Power Dissipation ($T_c=25^{\circ}C$)	P_C	30	W
Junction Temperature	T_j	150	$^{\circ}C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^{\circ}C$

Unit in mm



JEDEC	-
EIAJ	-
TOSHIBA	2-10K1A

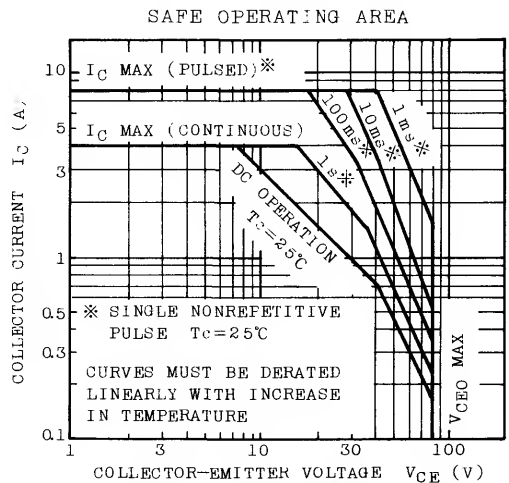
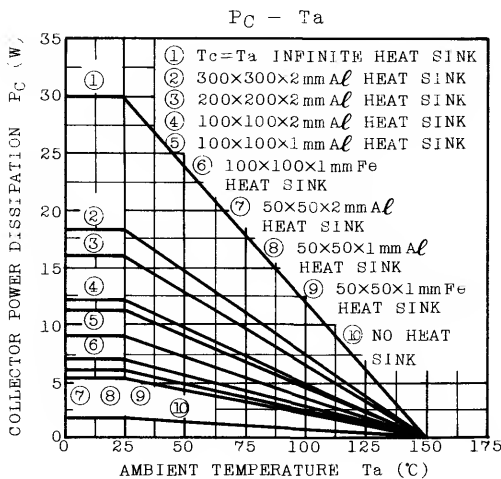
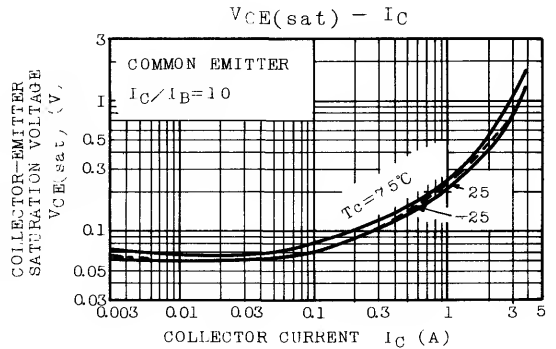
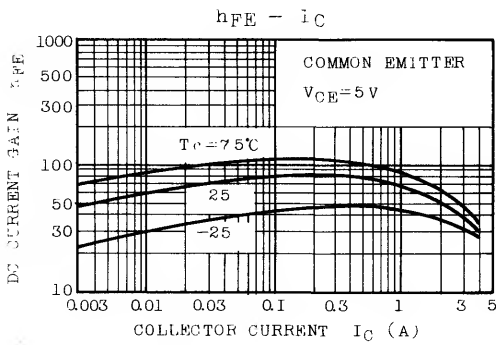
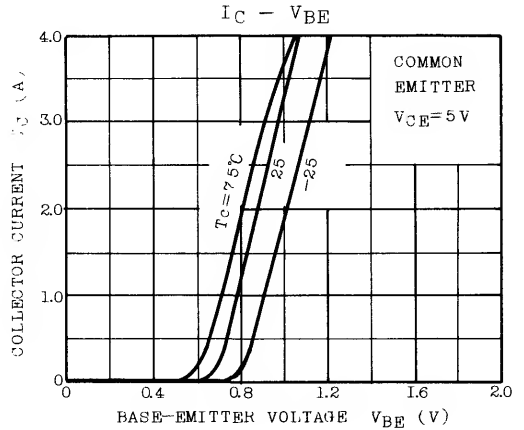
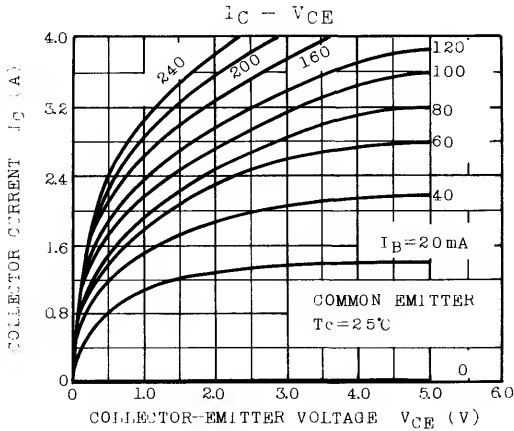
Weight : 2.0g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=80V, I_E=0$	-	-	30	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=5V, I_C=0$	-	-	100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	80	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=10mA, I_C=0$	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=5V, I_C=0.5A$	40	-	240	
	$h_{FE(2)}$	$V_{CE}=5V, I_C=3A$	15	50	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=3A, I_B=0.3A$	-	0.45	1.5	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5V, I_C=3A$	-	1.0	1.5	V
Transition Frequency	f_T	$V_{CE}=5V, I_C=0.5A$	-	8.0	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	90	-	pF

Note : $h_{FE(1)}$ Classification R : 40 ~ 80, O : 70 ~ 140, Y : 120 ~ 240

2SD1356



SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

2SD1357
2SD1358
2SD1359

HIGH POWER SWITCHING APPLICATIONS.
HAMMER DRIVE, PULSE MOTOR DRIVE APPLICATIONS.

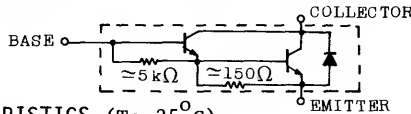
FEATURES:

- . High DC Current Gain: $h_{FE}=2000(\text{Min.})$ (at $V_{CE}=3V, I_C=3A$)
- . Low Saturation Voltage: $V_{CE}(\text{sat})=1.5V(\text{Max.})$ (at $I_C=3A$)
- . Complementary to 2SB997, 2SB998, 2SB999

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

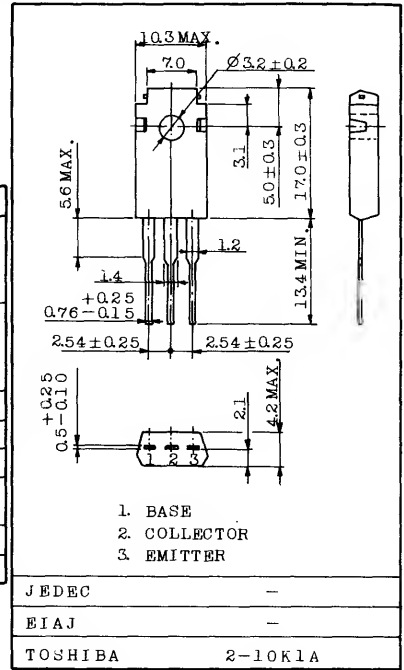
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	2SD1357	100	V
	2SD1358	80	
	2SD1359	60	
Collector-Emitter Voltage	2SD1357	100	V
	2SD1358	80	
	2SD1359	60	
Emitter-Base Voltage	V_{EB0}	5	V
Collector Current	I_C	7	A
Base Current	I_B	0.2	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	40	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ\text{C}$

EQUIVALENT CIRCUIT



INDUSTRIAL APPLICATIONS

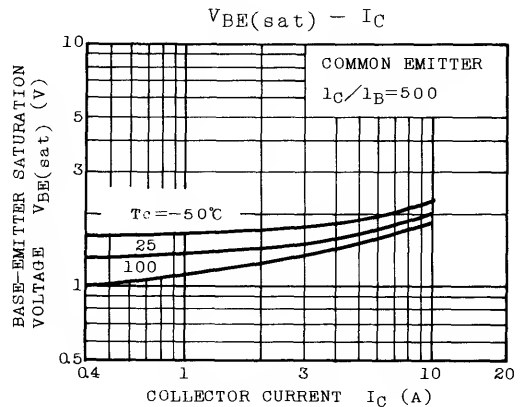
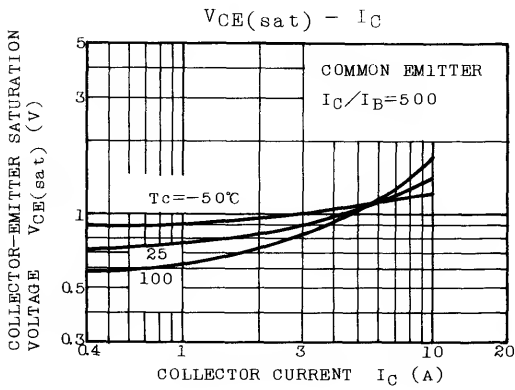
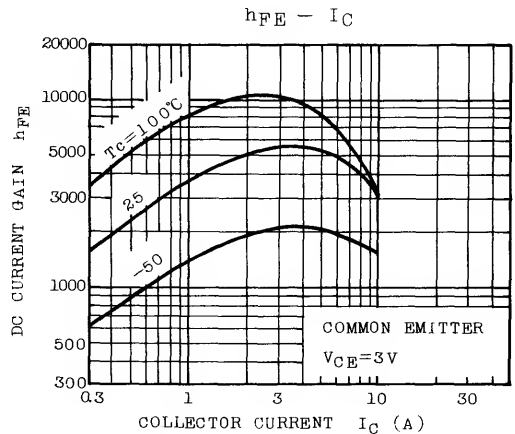
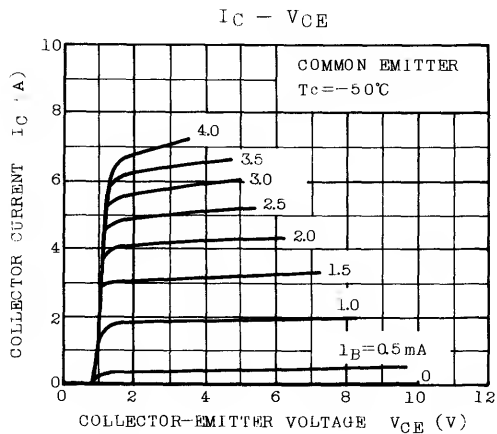
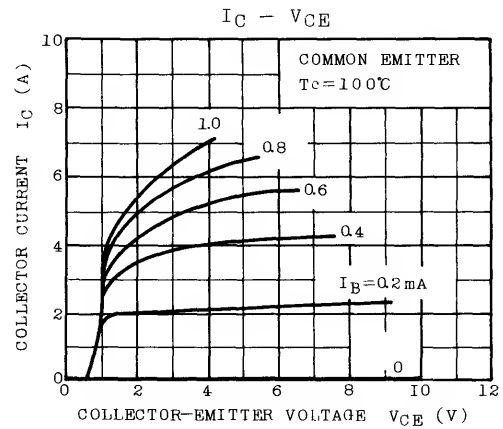
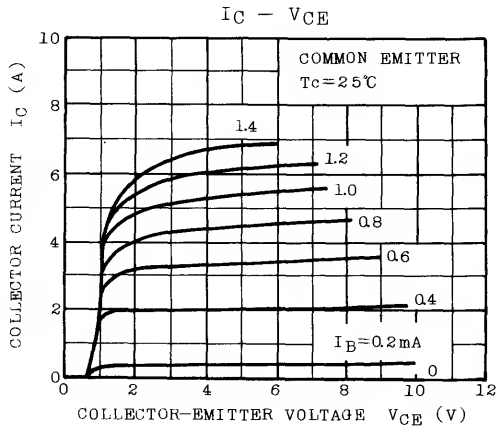
Unit in mm



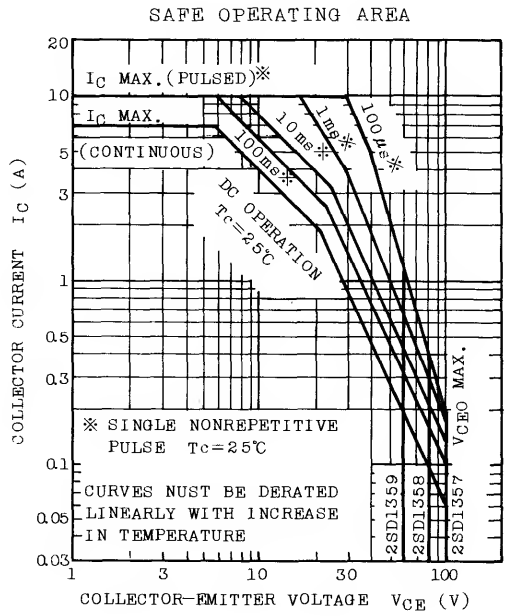
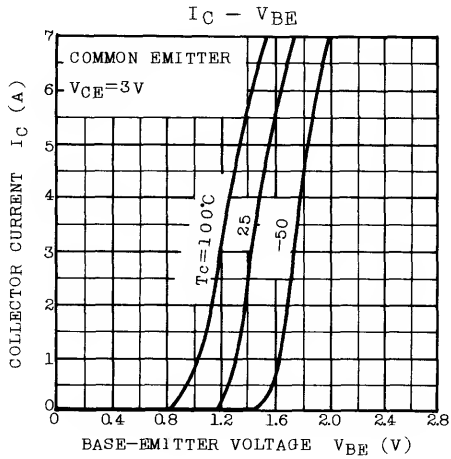
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	2SD1357	$V_{CB}=100V, I_E=0$	-	-	100	μA
	2SD1358	$V_{CB}=80V, I_E=0$	-	-	100	
	2SD1359	$V_{CB}=60V, I_E=0$	-	-	100	
Emitter Cut-off Current	I_{E0}	$V_{EB}=5V, I_C=0$	-	-	3.0	mA
Collector-Emitter Breakdown Voltage	2SD1357	$I_C=50\text{mA}, I_B=0$	100	-	-	V
	2SD1358		80	-	-	
	2SD1359		60	-	-	
DC Current Gain	$h_{FE}(1)$	$V_{CE}=3V, I_C=3A$	2000	-	15000	
	$h_{FE}(2)$	$V_{CE}=3V, I_C=7A$	1000	-	-	
Collector-Emitter Saturation Voltage	$V_{CE}(\text{sat})1$	$I_C=3A, I_B=6\text{mA}$	-	0.9	1.5	V
	$V_{CE}(\text{sat})2$	$I_C=7A, I_B=14\text{mA}$	-	1.2	2.0	
Base-Emitter Saturation Voltage	$V_{BE}(\text{sat})$	$I_C=3A, I_B=6\text{mA}$	-	1.5	2.5	V
Switching Time	Turn-on Time	t_{on}	-	0.8	-	μs
	Storage Time	t_{stg}	-	3.0	-	
	Fall Time	t_f	-	2.5	-	

2SD1357 • 2SD1358 • 2SD1359



2SD1357·2SD1358·2SD1359



2SD1360

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

IGNITER APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

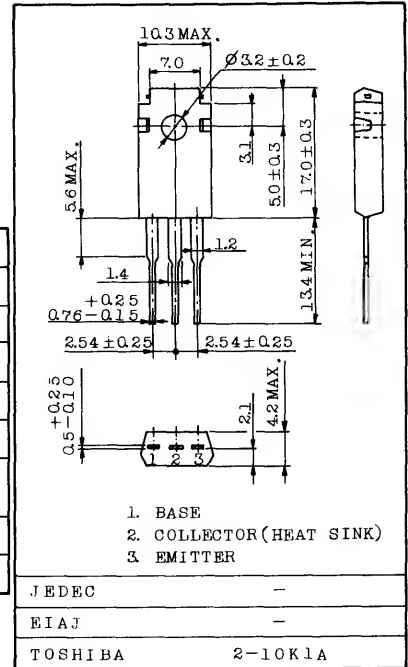
- High DC Current Gain : $h_{FE}=600(\text{Min.})$ (at $V_{CE}=2V, I_C=2A$)
- Monolithic Construction with Built-In Base-Emitter Shunt Resistor.

INDUSTRIAL APPLICATIONS

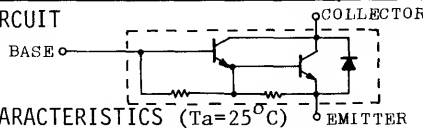
Unit in mm

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Base Current	I_B	1	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	30	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ\text{C}$



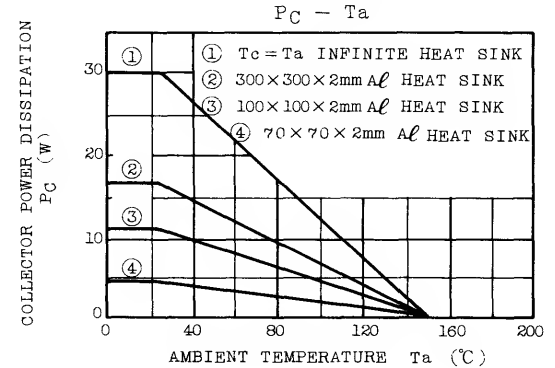
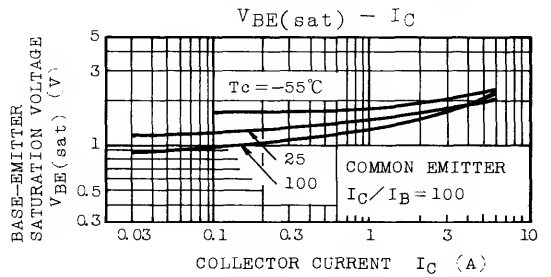
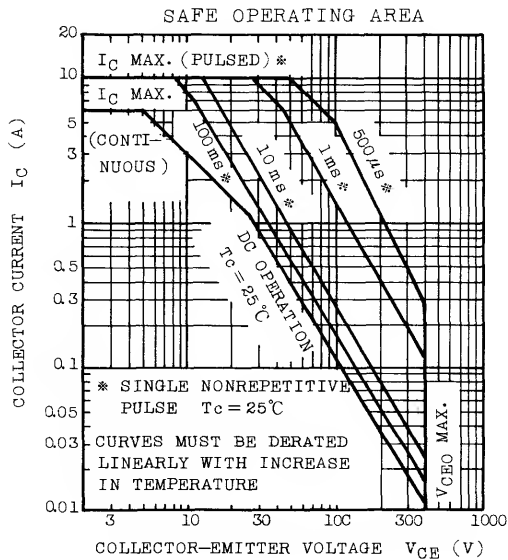
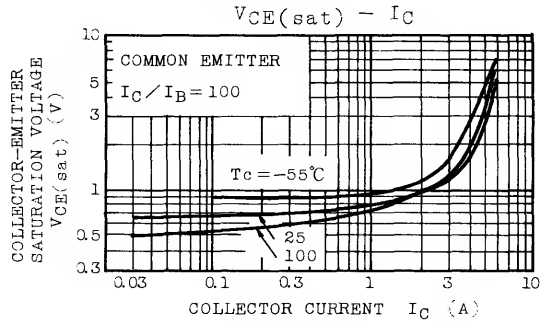
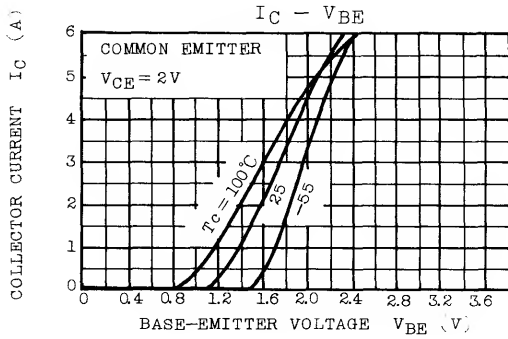
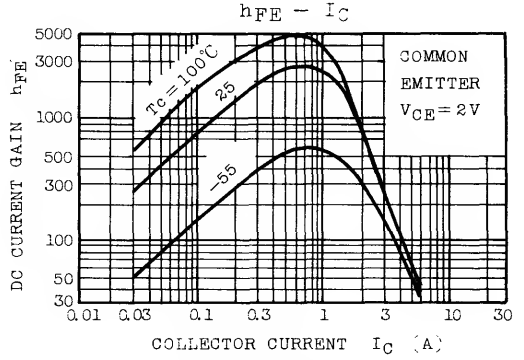
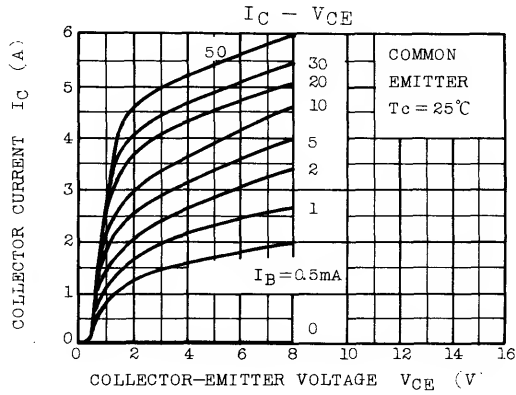
EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=600V, I_E=0$	-	-	0.5	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	3	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	400	-	-	V
DC Current Gain		$h_{FE(1)}$	$V_{CE}=2V, I_C=2A$	600	-	-	
		$h_{FE(2)}$	$V_{CE}=2V, I_C=4A$	100	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=4A, I_B=0.04A$	-	-	2.0	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=4A, I_B=0.04A$	-	-	2.5	
Emitter-Collector Forward Voltage		V_{ECF}	$I_E=4A, I_B=0$	-	-	3.0	V
Collector Output Capacitance		C_{ob}	$V_{CB}=50V, I_E=0, f=1\text{MHz}$	-	35	-	pF
Switching Time	Turn-on Time	t_{on}		-	1	-	μs
	Storage Time	t_{stg}		-	8	-	
	Fall Time	t_f		-	5	-	

Weight : 2.0g



2SD1361

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

IGNITER APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.

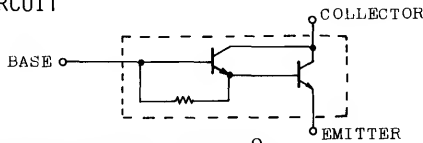
FEATURES:

. High DC Current Gain : $h_{FE}=2000(\text{Min.})(V_{CE}=2V, I_C=2A)$

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	300	V
Collector-Emitter Voltage	V_{CEO}	250	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Base Current	I_B	1	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	30	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ\text{C}$

EQUIVALENT CIRCUIT

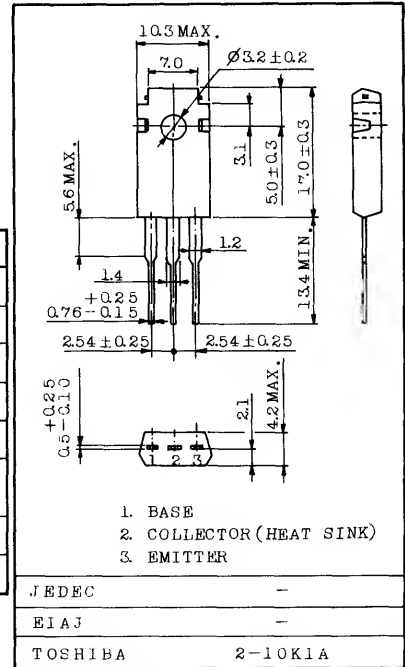


ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=300V, I_E=0$	-	-	0.5	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	0.5	mA
Collector-Emitter Sustaining Voltage		$V_{CEO}(\text{SUS})$	$I_C=0.5A, L=40\text{mH}$	250	-	-	V
DC Current Gain		$h_{FE}(1)$	$V_{CE}=2V, I_C=2A$	2000	-	-	
		$h_{FE}(2)$	$V_{CE}=2V, I_C=4A$	200	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE}(\text{sat})$	$I_C=4A, I_B=0.04A$	-	-	2.0	V
	Base-Emitter	$V_{BE}(\text{sat})$	$I_C=4A, I_B=0.04A$	-	-	2.5	
Collector Output Capacitance		C_{ob}	$V_{CB}=50V, I_E=0, f=1\text{MHz}$	-	35	-	pF
Switching Time	Turn-on Time	t_{on}		-	1	-	μs
	Storage Time	t_{stg}		-	8	-	
	Fall Time	t_f		$I_{B1}=-I_{B2}=0.04A$ DUTY CYCLE $\leq 1\%$	-	5	

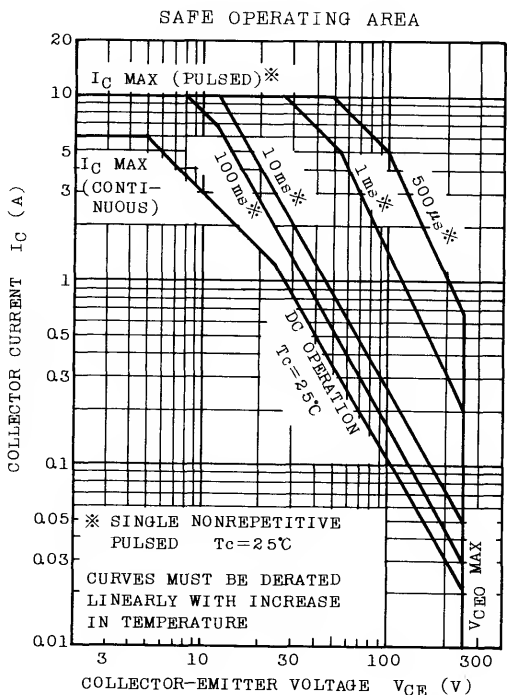
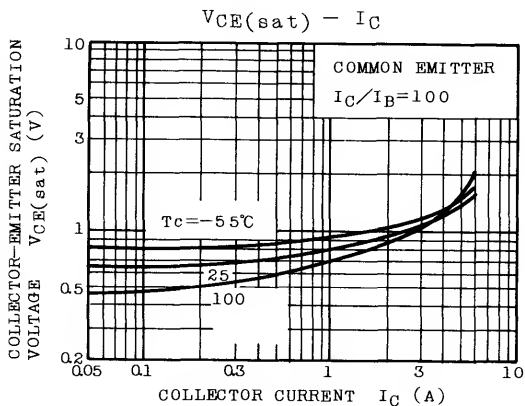
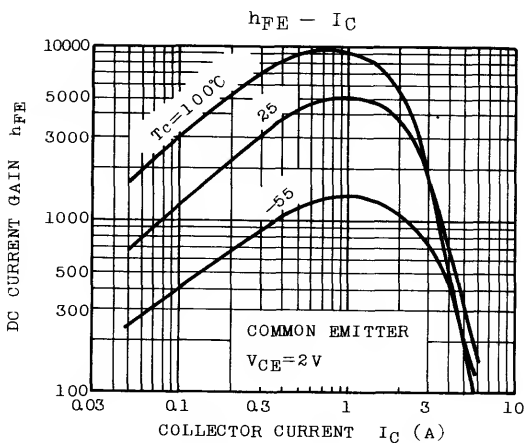
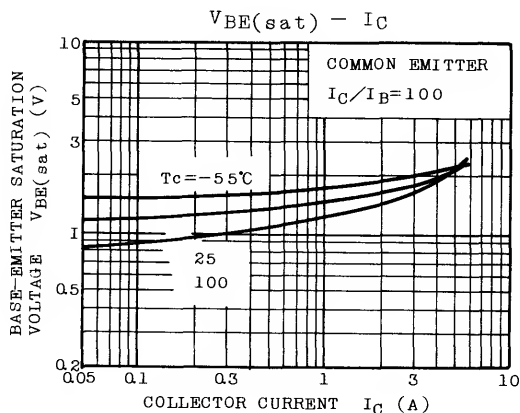
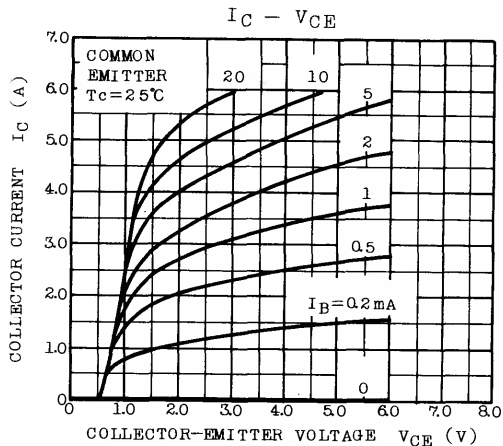
INDUSTRIAL APPLICATIONS

Unit in mm



JEDEC	-
EIAJ	-
TOSHIBA	2-10K1A

Weight : 2.0g



2SD1362

SILICON NPN TRIPLE DIFFUSED TYPE

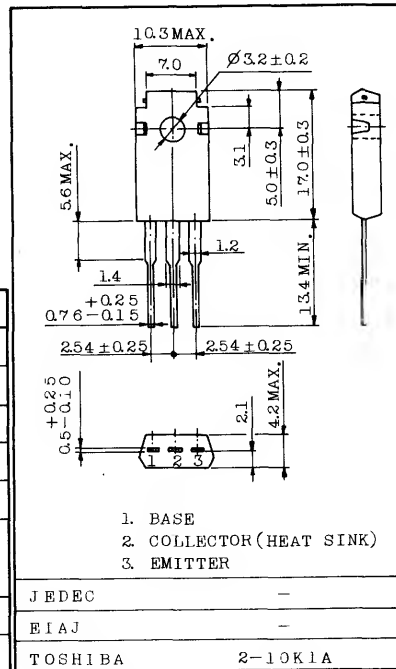
HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Collector Current : $I_C=7A$
- Low Saturation Voltage : $V_{CE(sat)}=0.5V(\text{Max.})$ (at $I_C=4A$)
- High Collector Power Dissipation : $P_C=40W$ (at $T_c=25^\circ C$)
- Complementary to 2SB992

INDUSTRIAL APPLICATIONS

Unit in mm



MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB0}	100	V
Collector-Emitter Voltage		V_{CEO}	80	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	7	A
Base Current		I_B	1	A
Collector Power Dissipation	$T_a=25^\circ C$	P_C	1.5	W
	$T_c=25^\circ C$		40	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$

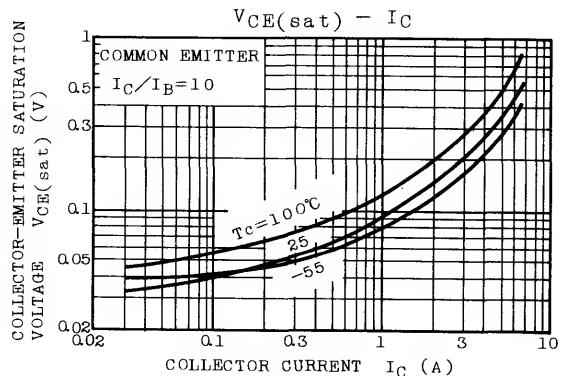
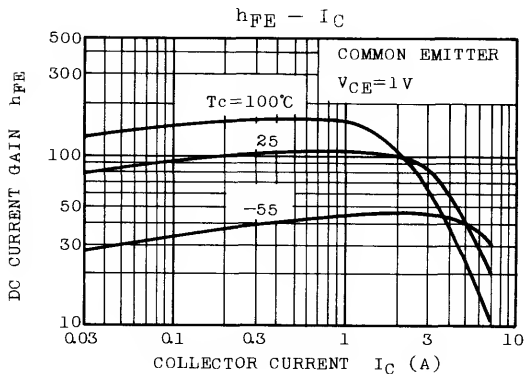
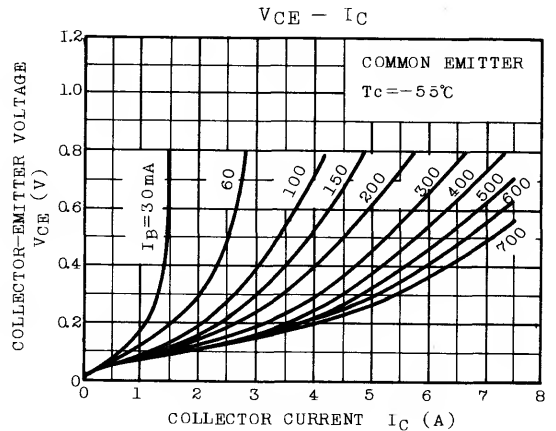
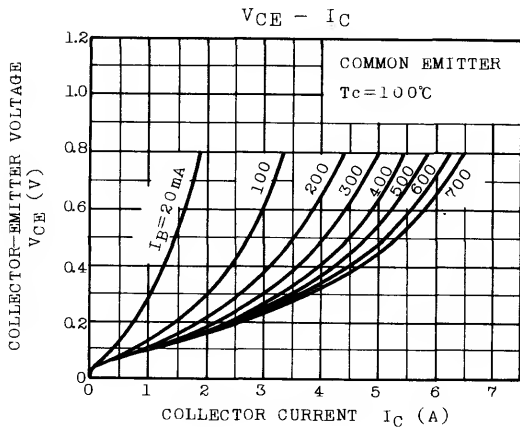
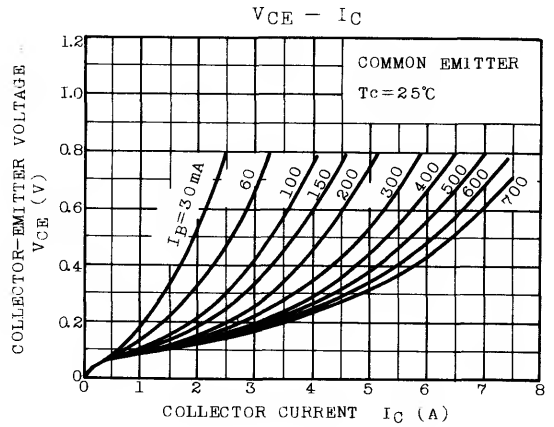
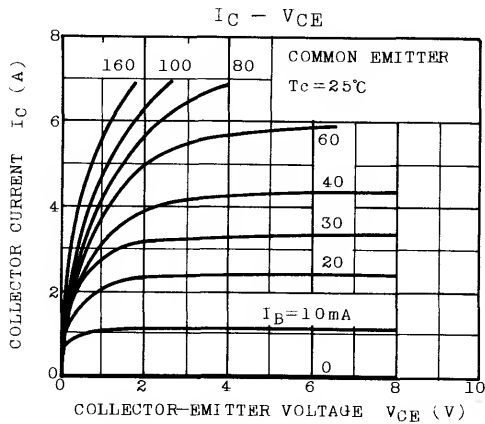
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

Weight : 2.0g

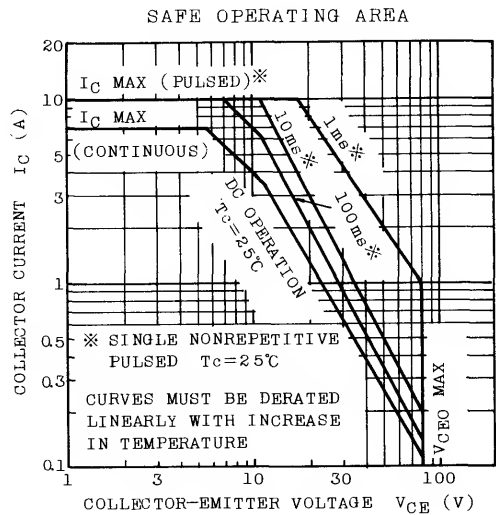
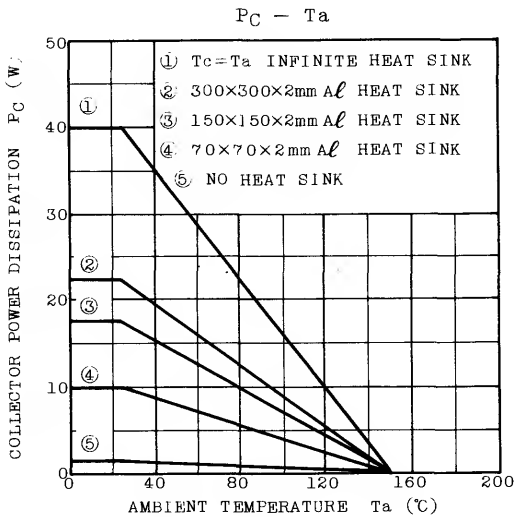
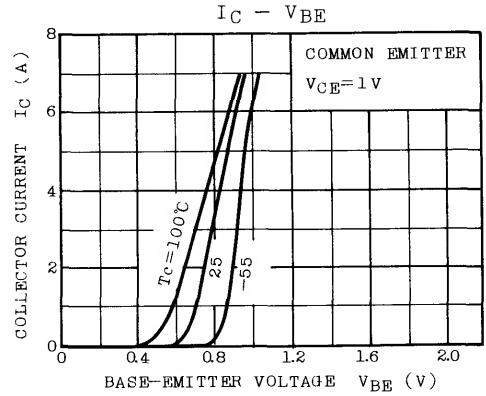
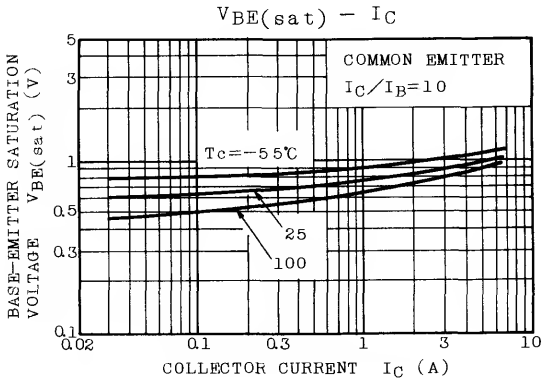
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CB0}	$V_{CB}=100V, I_E=0$	-	-	5	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	5	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=1V, I_C=1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=1V, I_C=4A$	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=4A, I_B=0.4A$	-	0.25	0.5	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=4A, I_B=0.4A$	-	0.9	1.4	
Transition Frequency		f_T	$V_{CE}=4V, I_C=1A$	-	10	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	250	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.4	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		-	0.5	-	

Note : $h_{FE(1)}$ Classification 0 : 70~140, Y : 120~240

TOSHIBA CORPORATION



2SD1362

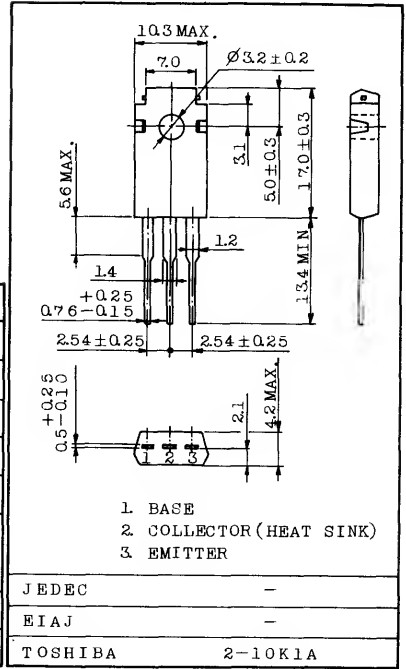


HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

INDUSTRIAL APPLICATIONS
Unit in mm

FEATURES:

- . High Collector Current : $I_C=7A$
- . Low Saturation Voltage
: $V_{CE(sat)}=0.4V(Max.)$ (at $I_C=4A$)
- . High Collector Power Dissipation
: $P_C=40W$ (at $T_c=25^{\circ}C$)
- . Complementary to 2SB993



MAXIMUM RATINGS ($T_a=25^{\circ}C$)

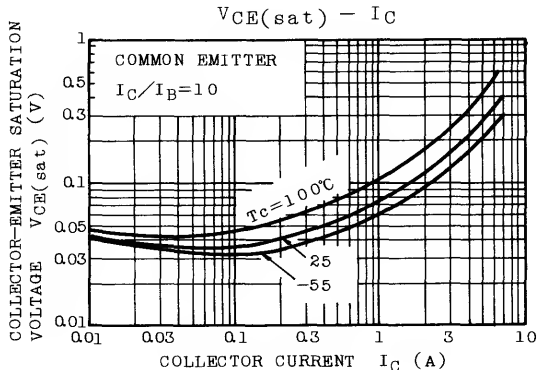
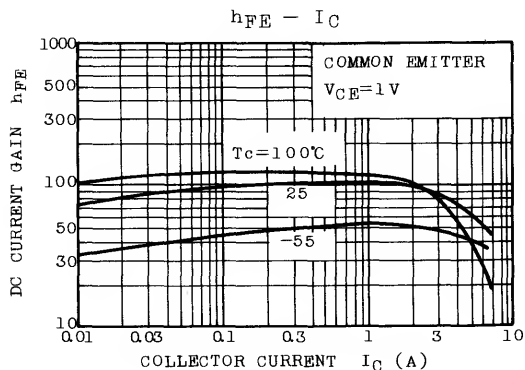
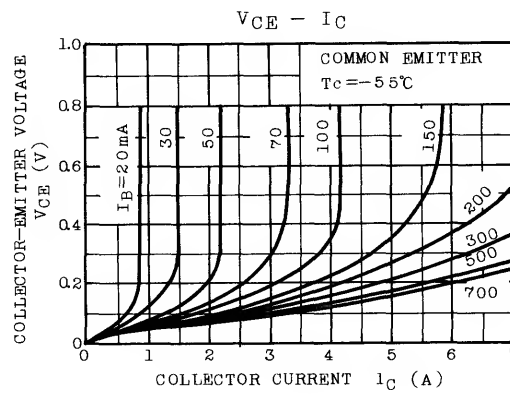
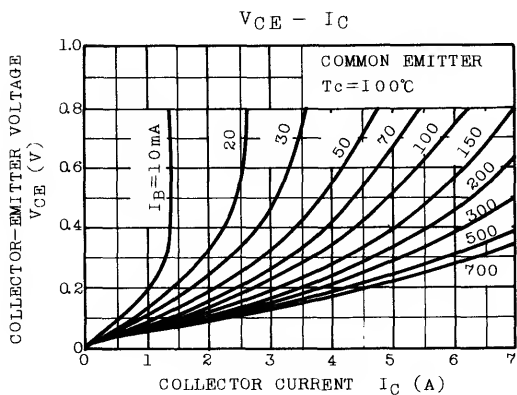
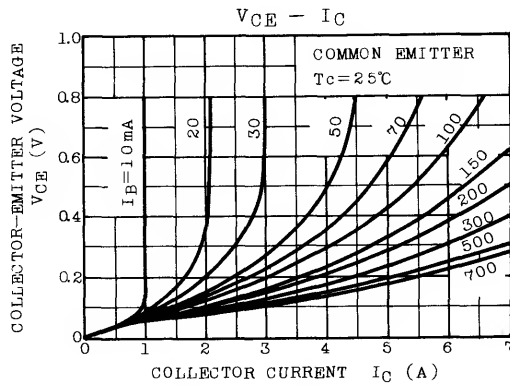
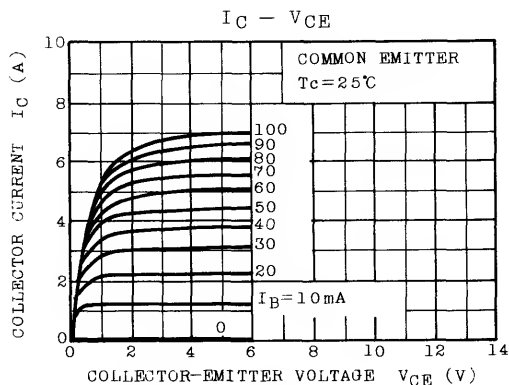
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	70	V
Collector-Emitter Voltage		V_{CEO}	50	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	7	A
Base Current		I_B	1	A
Collector Power Dissipation	$T_a=25^{\circ}C$	P_C	1.5	W
	$T_c=25^{\circ}C$		40	
Junction Temperature		T_j	150	$^{\circ}C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^{\circ}C$

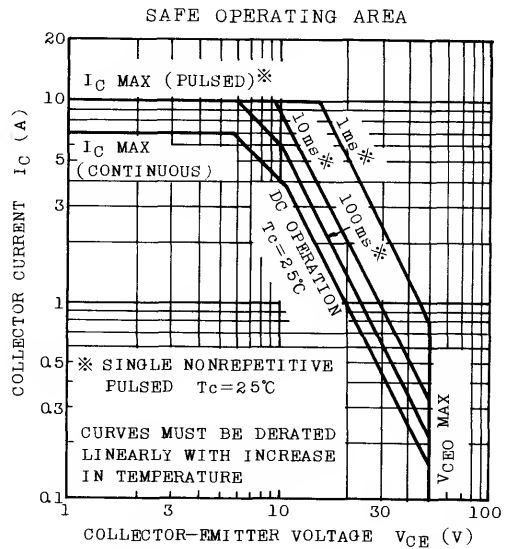
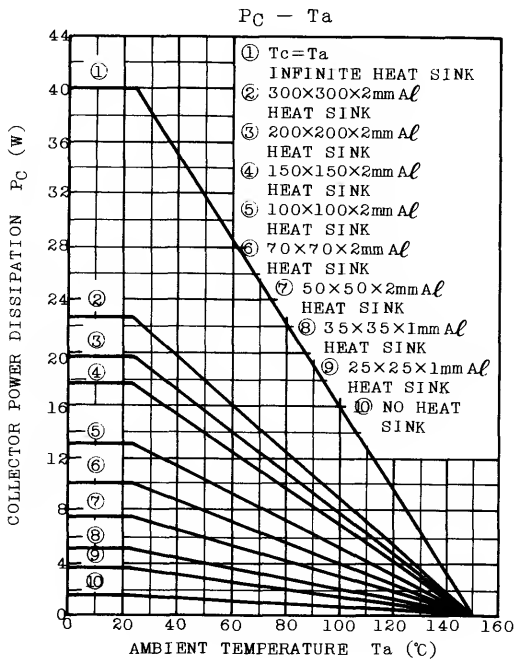
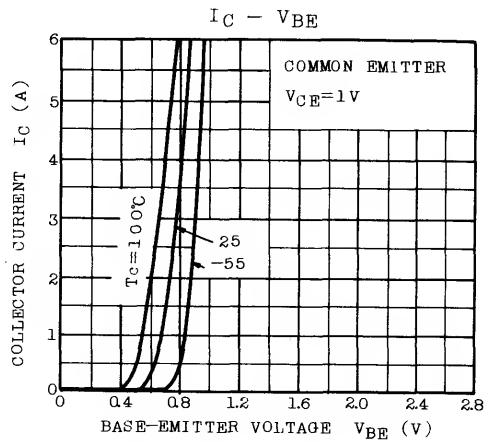
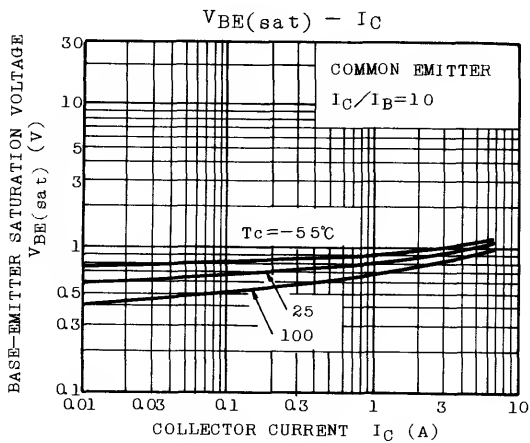
ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

Weight : 2.0g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=70V, I_E=0$	-	-	30	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	50	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=1V, I_C=1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=1V, I_C=4A$	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=4A, I_B=0.4A$	-	0.2	0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=4A, I_B=0.4A$	-	0.9	1.2	
Transition Frequency		f_T	$V_{CE}=4V, I_C=1A$	-	10	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	250	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.2	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		-	0.5	-	

Note : $h_{FE(1)}$ Classification 0 : 70 ~ 140, Y : 120 ~ 240





2SD1405

SILICON NPN TRIPLE DIFFUSED TYPE

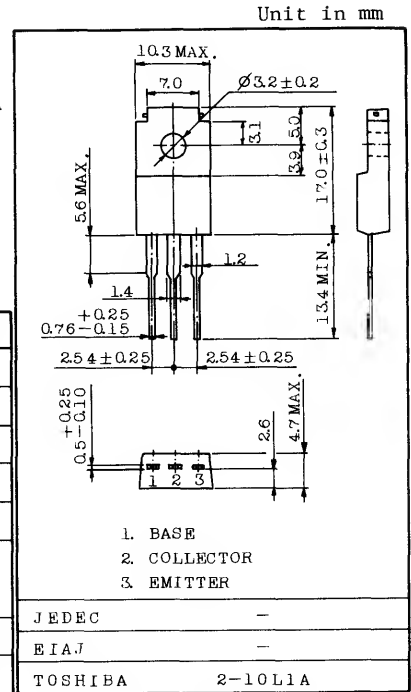
AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . High DC Current Gain of 200 to 1200 at $V_{CE}=5V$, $I_C=0.5A$
- . Low $V_{CE(sat)}$ of 1.0V (Max.) at $I_C=1A$, $I_B=0.02A$
- . Collector Power Dissipation of 25W at $T_c=25^\circ C$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	50	V
Collector-Emitter Voltage	V_{CEO}	50	V
Emitter-Base Voltage	V_{EB0}	7	V
Collector Current	I_C	3	A
Base Current	I_B	0.5	A
Collector Power Dissipation	P_C	$T_a=25^\circ C$	2.0
		$T_c=25^\circ C$	25
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$



Weight : 2.1g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

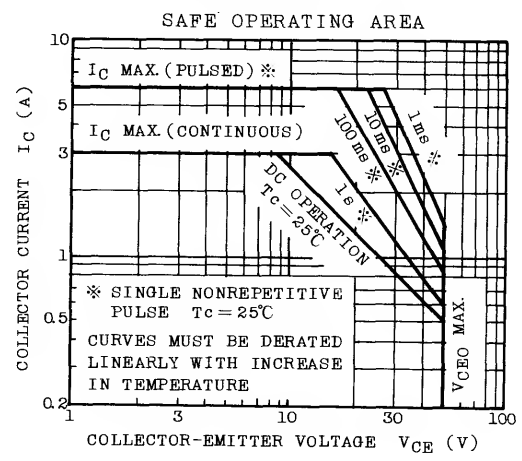
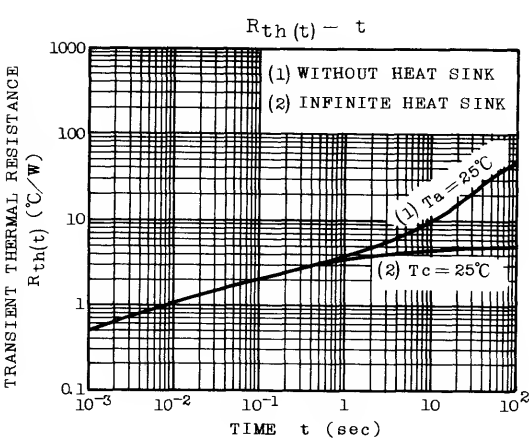
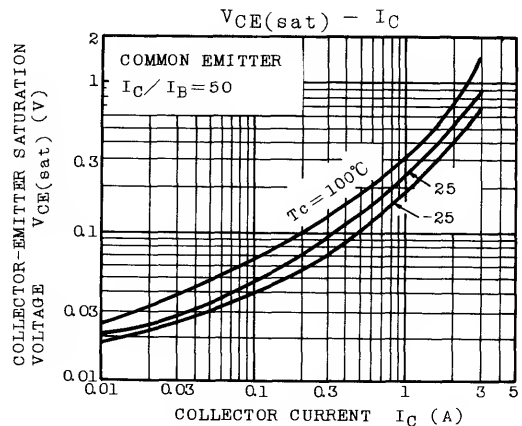
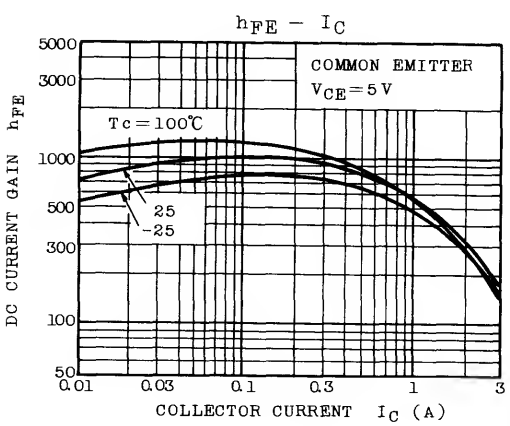
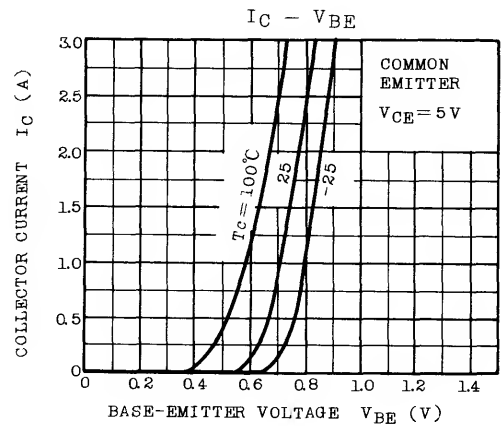
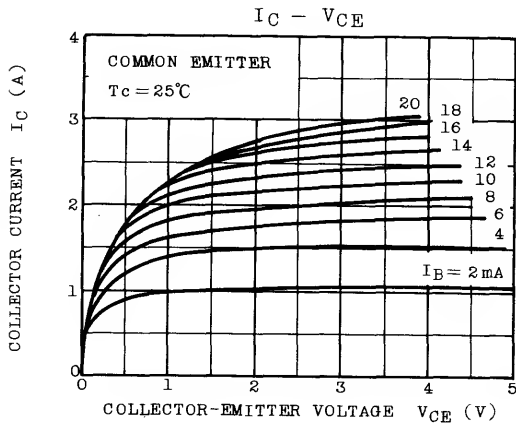
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Collector Cut-off Current	I_{CB0}	$V_{CB}=50V$, $I_E=0$	-	-	100	μA	
Emitter Cut-off Current	I_{EB0}	$V_{EB}=7V$, $I_C=0$	-	-	100	μA	
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=50mA$, $I_B=0$	50	-	-	V	
DC Current Gain	h_{FE} (Note)	$V_{CE}=5V$, $I_C=0.5A$	200	-	1200		
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=1A$, $I_B=0.02A$	-	0.25	1.0	V	
Base-Emitter Voltage	V_{BE}	$V_{CE}=5V$, $I_C=0.5A$	-	0.7	1.0	V	
Transition Frequency	f_T	$V_{CE}=5V$, $I_C=0.5A$	-	5.0	-	MHz	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V$, $I_E=0$, $f=1MHz$	-	70	-	pF	
Switching Time	Turn-on Time	t_{on}			-	2.0	-
	Storage Time	t_{stg}			-	5.0	-
	Fall Time	t_f			-	3.0	-

$I_{B1}=10mA$
 $I_{B2}=-20mA$
DUTY CYCLE < 1%

$V_{CC}=10V$

Note : h_{FE} Classification GR : 200 ~ 400, BL : 350 ~ 700, V : 600 ~ 1200

TOSHIBA CORPORATION



2SD1406

SILICON NPN TRIPLE DIFFUSED TYPE

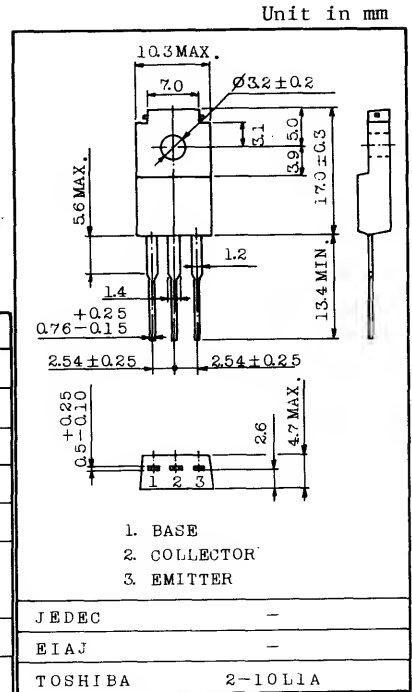
AUDIO FREQUENCY POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High DC Current Gain : $h_{FE}=300(\text{Max.})(V_{CE}=5V, I_C=0.5A)$
- Low Saturation Voltage
: $V_{CE}(\text{sat})=1.0V(\text{Max.})(I_C=3A, I_B=0.3A)$
- High Power Dissipation : $P_C=25W (T_c=25^\circ\text{C})$
- Complementary to 2SB1015

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

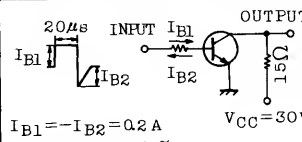
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	60	V
Collector-Emitter Voltage	V_{CE0}	60	V
Emitter-Base Voltage	V_{EB0}	7	V
Collector Current	I_C	3	A
Base Current	I_B	0.5	A
Collector Power Dissipation	P_C	$T_a=25^\circ\text{C}$	2.0
		$T_c=25^\circ\text{C}$	25
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ\text{C}$



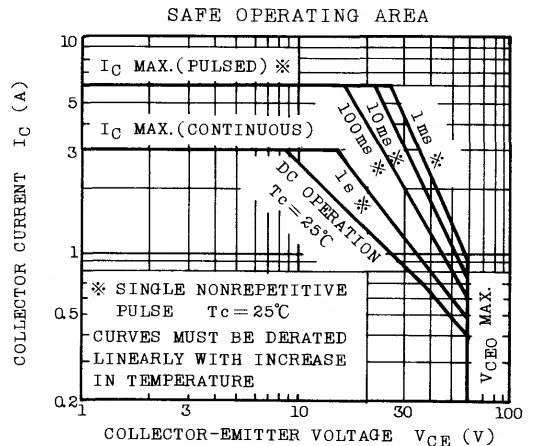
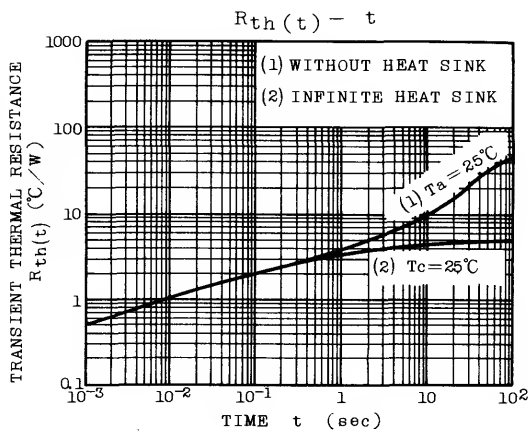
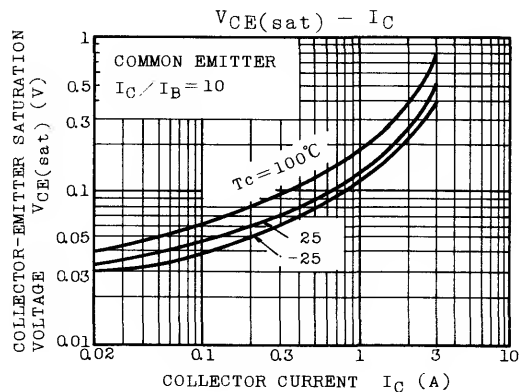
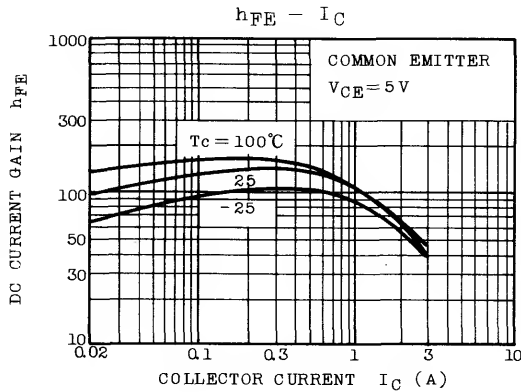
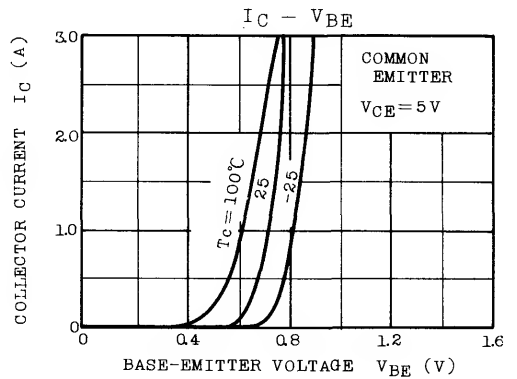
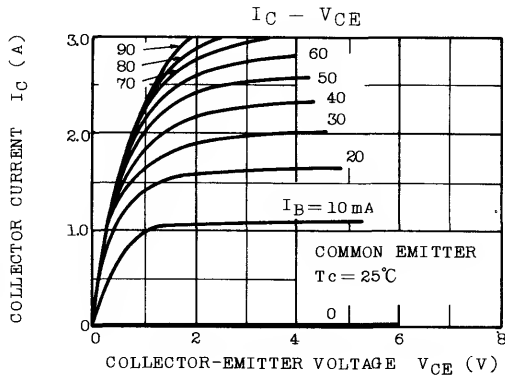
Weight : 2.1g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{C0}	$V_{CB}=60V, I_E=0$	-	-	100	μA
Emitter Cut-off Current	I_{E0}	$V_{EB}=7V, I_C=0$	-	-	100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C=50\text{mA}, I_B=0$	60	-	-	V
DC Current Gain	$h_{FE}(\text{Note})$	$V_{CE}=5V, I_C=0.5A$	60	-	300	-
Collector Emitter Saturation Voltage	$V_{CE}(\text{sat})$	$I_C=3A, I_B=0.3A$	-	0.25	1.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5V, I_C=0.5A$	-	0.7	1.0	V
Transition Frequency	f_T	$V_{CE}=5V, I_C=0.5A$	-	3.0	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1\text{MHz}$	-	70	-	pF
Switching Time	Turn-on Time	t_{on}	-	0.8	-	μs
	Storage Time	t_{stg}	-	1.5	-	
	Fall Time	t_f	-	0.8	-	



Note : h_{FE} Classification O : 60~120, Y : 100~200, GR : 150~300



2SD1407

SILICON NPN TRIPLE DIFFUSED TYPE

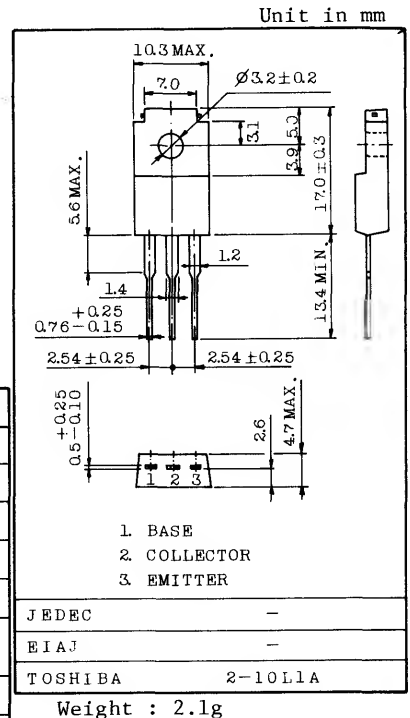
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Breakdown Voltage : $V_{CE0}=100V$
- Low Collector Saturation Voltage : $V_{CE(sat)}=2.0V(\text{Max.})$
- Complementary to 2SB1016
- Recommended for 30W High Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS ($T_a=25^\circ C$)

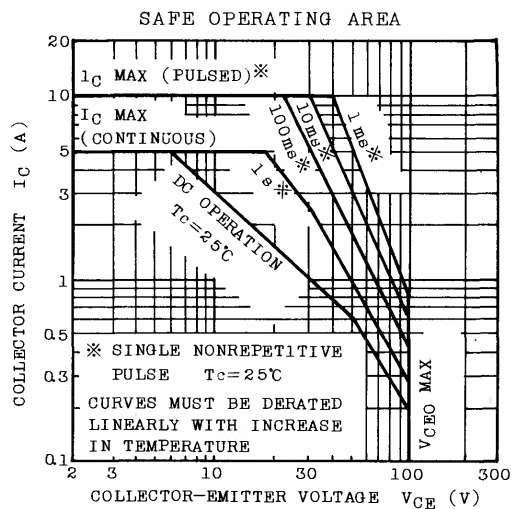
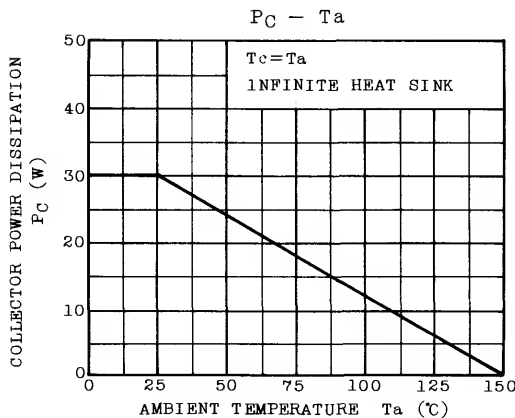
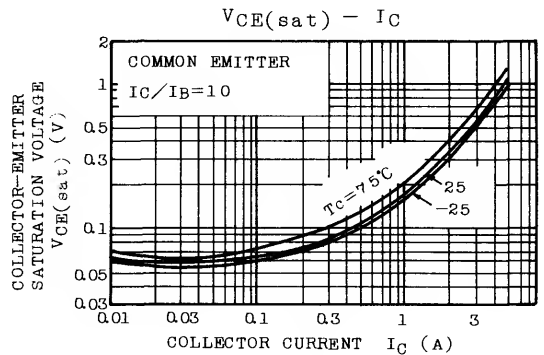
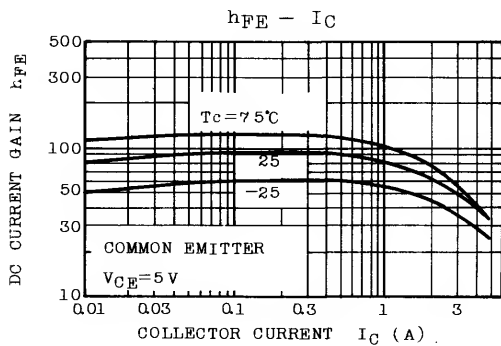
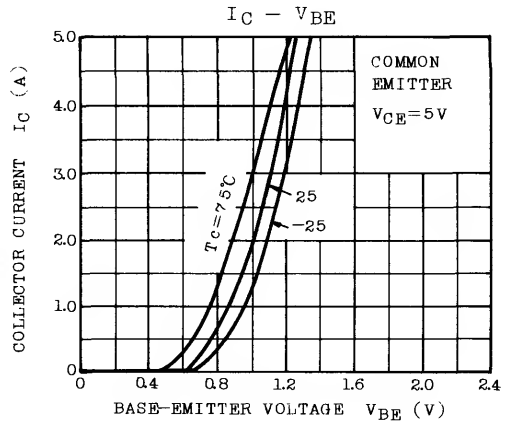
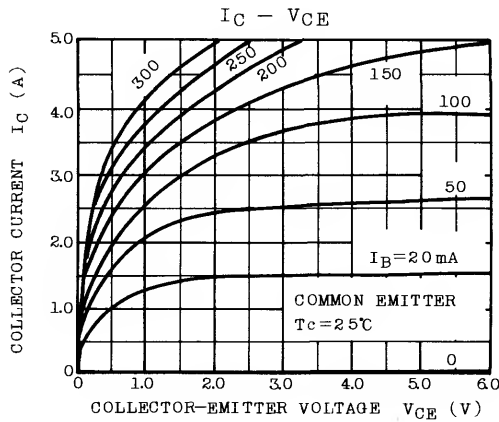
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	100	V
Collector-Emitter Voltage	V_{CE0}	100	V
Emitter-Base Voltage	V_{EB0}	5	V
Collector Current	I_C	5	A
Base Current	I_B	0.5	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	30	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$



ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=100V, I_E=0$	-	-	100	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1	mA
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C=50mA, I_B=0$	100	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=5V, I_C=1A$	40	-	240	
	$h_{FE(2)}$	$V_{CE}=5V, I_C=4A$	20	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A, I_B=0.4A$	-	-	2.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5V, I_C=1A$	-	-	1.5	V
Transition Frequency	f_T	$V_{CE}=5V, I_C=1A$	-	12	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	100	-	pF

Note : $h_{FE(1)}$ Classification R : 40~80, O : 70~140, Y : 120~240



2SD1408

SILICON NPN TRIPLE DIFFUSED TYPE

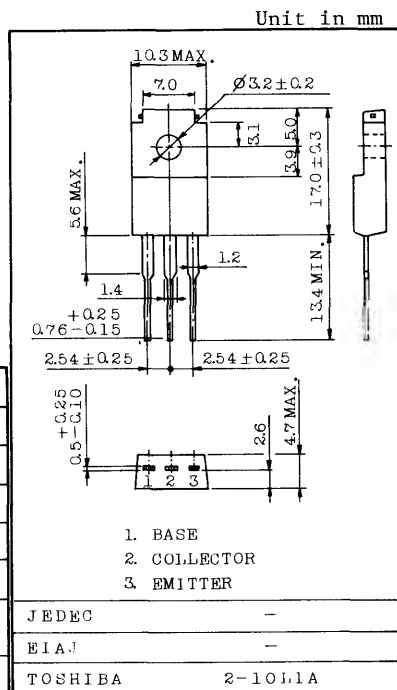
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- High Power Dissipation : $P_C=25W$ ($T_c=25^{\circ}C$)
- Good Linearity of h_{FE}
- Complementary to 2SB1017
- Recommended for 20~25W High Fidelity Audio Frequency Amplifier Output Stage.

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	4	A
Base Current	I_B	0.4	A
Collector Power Dissipation ($T_c=25^{\circ}C$)	P_C	25	W
Junction Temperature	T_j	150	$^{\circ}C$
Storage Temperature Range	T_{stg}	-55~150	$^{\circ}C$

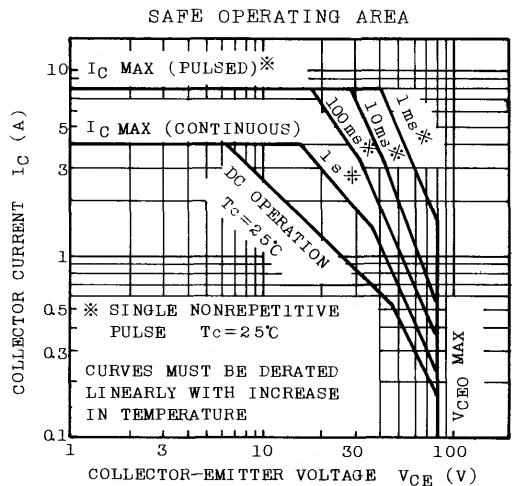
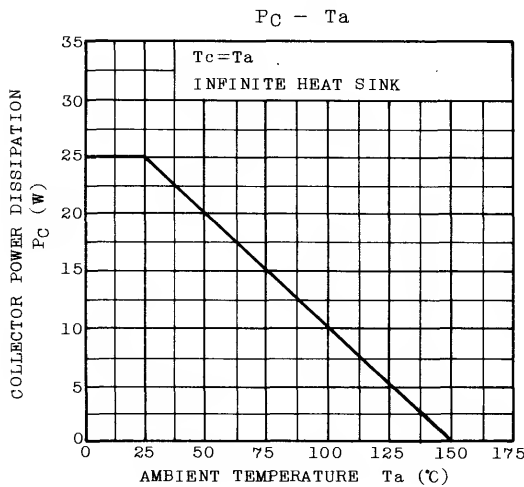
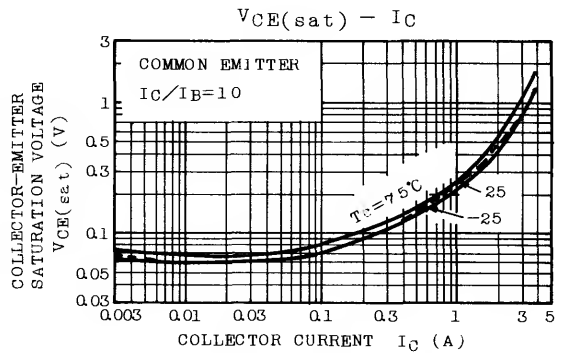
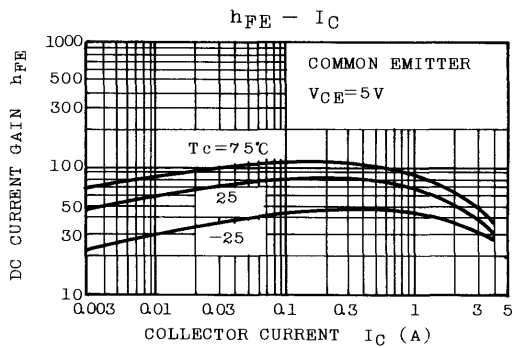
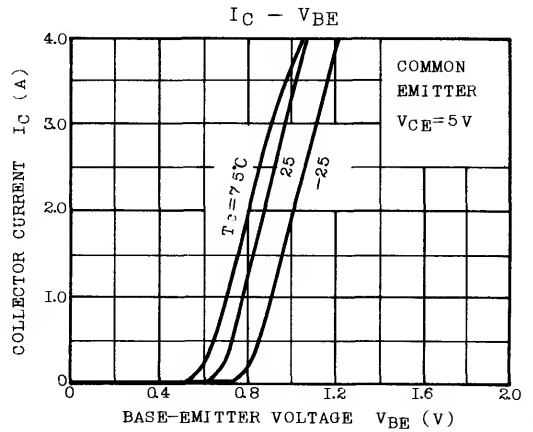
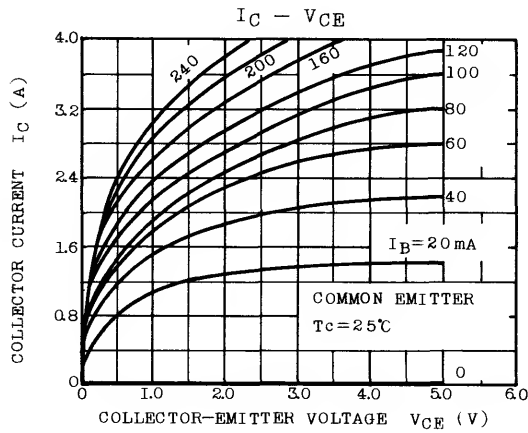


Weight : 2.1g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=80V, I_E=0$	-	-	30	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	100	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	80	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=10mA, I_C=0$	5	-	-	V
DC Current Gain	$h_{FE(1)}$ (Note)	$V_{CE}=5V, I_C=0.5A$	40	-	240	
	$h_{FE(2)}$	$V_{CE}=5V, I_C=3A$	15	50	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=3A, I_B=0.3A$	-	0.45	1.5	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5V, I_C=3A$	-	1.0	1.5	V
Transition Frequency	f_T	$V_{CE}=5V, I_C=0.5A$	-	8.0	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	90	-	pF

Note : $h_{FE(1)}$ Classification R : 40~80, O : 70~140, Y : 120~240



2SD1409

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

IGNITER APPLICATIONS.

HIGH VOLTAGE SWITCHING APPLICATIONS.

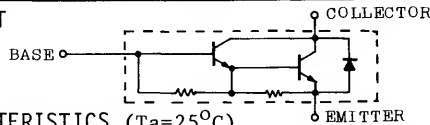
FEATURES:

- High DC Current Gain : $h_{FE}=600(\text{Min.})$ ($V_{CE}=2V, I_C=2A$)
- Monolithic Construction with Built-In Base-Emitter Shunt Resistor.

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	V_{CEO}	400	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Base Current	I_B	1	A
Collector Power Dissipation	P_C	$T_a=25^\circ\text{C}$	2.0
		$T_c=25^\circ\text{C}$	25
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ\text{C}$

EQUIVALENT CIRCUIT

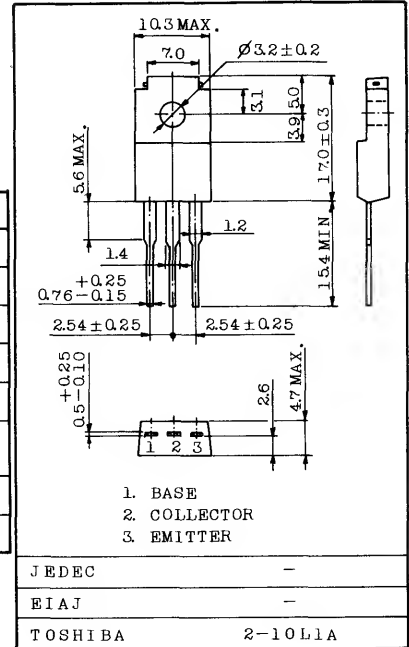


ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

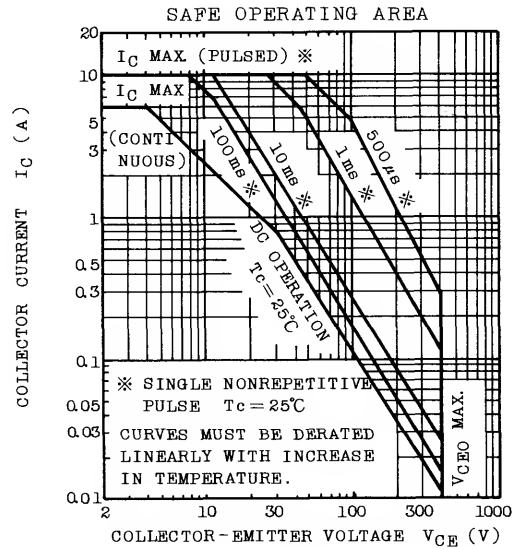
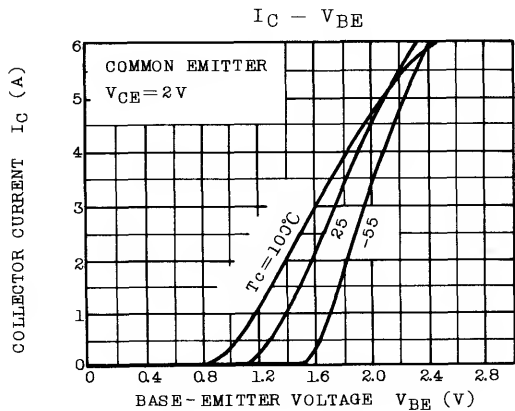
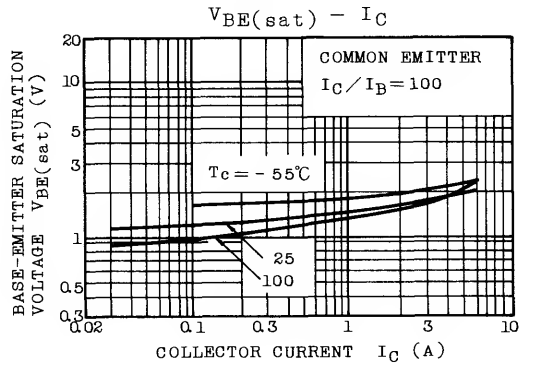
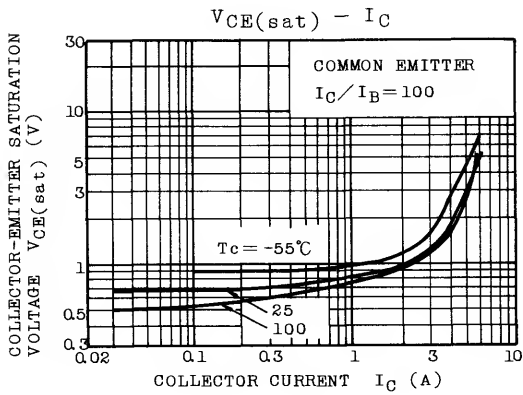
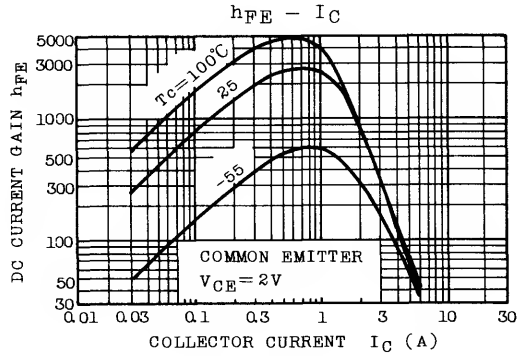
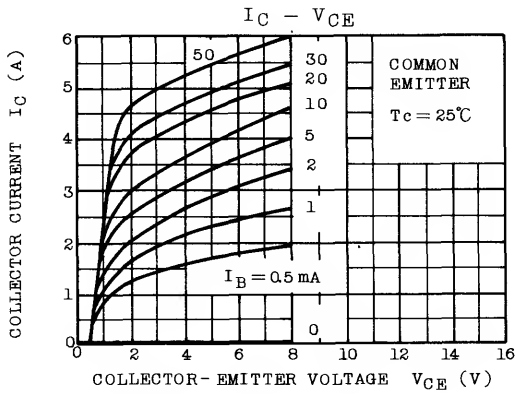
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Collector Cut-off Current	I_{CBO}	$V_{CB}=600V, I_E=0$	-	-	0.5	mA	
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	3	mA	
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	400	-	-	V	
			DC Current Gain	$h_{FE}(1)$	$V_{CE}=2V, I_C=2A$	600	-
	$h_{FE}(2)$	$V_{CE}=2V, I_C=4A$	100	-	-		
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A, I_B=0.04A$	-	-	2.0	V	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4A, I_B=0.04A$	-	-	2.5	V	
Emitter-Collector Forward Voltage	V_{ECF}	$I_E=4A, I_B=0$	-	-	3.0	V	
Collector Output Capacitance	C_{ob}	$V_{CB}=50V, I_E=0, f=1MHz$	-	35	-	pF	
Switching Time	Turn-on Time	t_{on}			-	1	-
	Storage Time	t_{stg}	-	-	8	-	
	Fall Time	t_f	-	-	5	-	

INDUSTRIAL APPLICATIONS

Unit in mm



Weight : 2.1g



2SD1410

SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER)

IGNITER APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

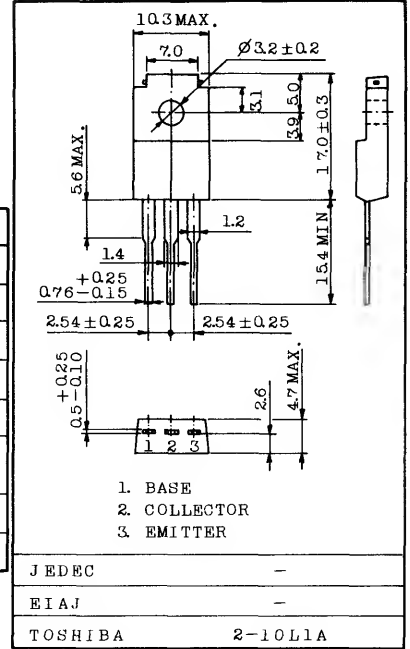
. High DC Current Gain : $h_{FE}=2000(\text{Min.})$ ($V_{CE}=2V$, $I_C=2A$)

INDUSTRIAL APPLICATIONS

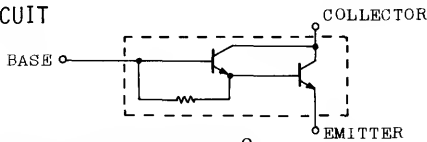
Unit in mm

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	300	V
Collector-Emitter Voltage	V_{CEO}	250	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Base Current	I_B	1	A
Collector Power Dissipation	P_C	$T_a=25^\circ\text{C}$	2.0
		$T_c=25^\circ\text{C}$	25
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ\text{C}$

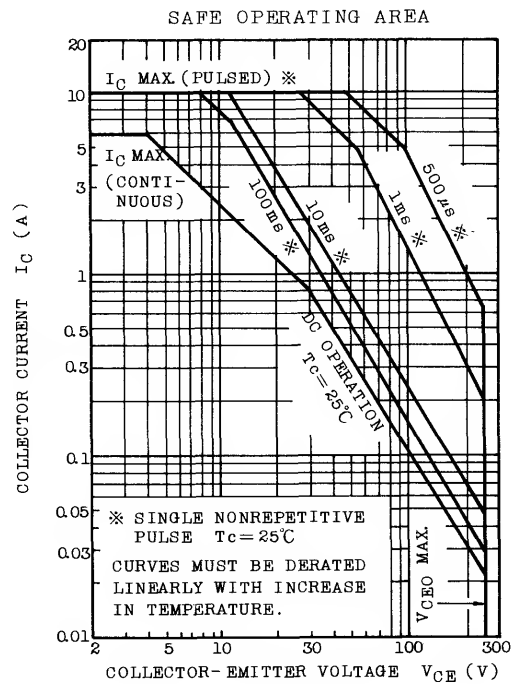
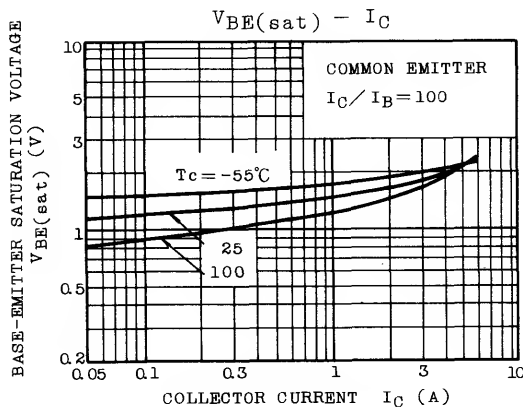
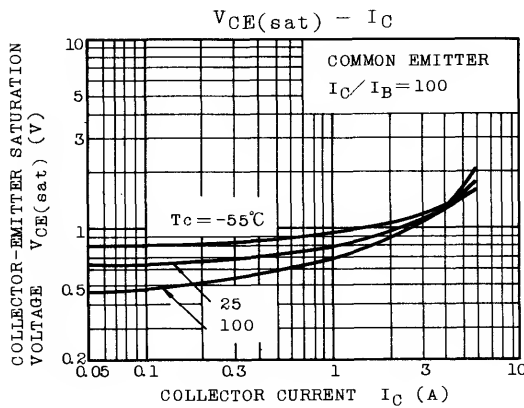
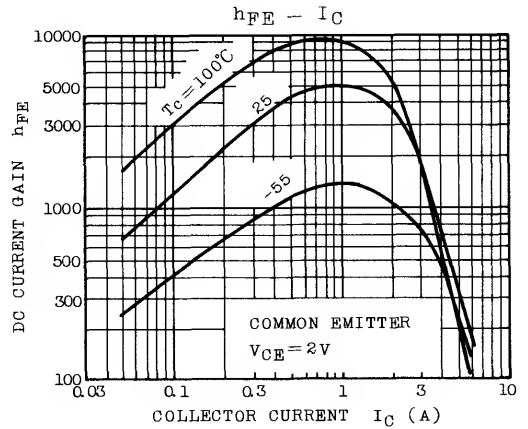
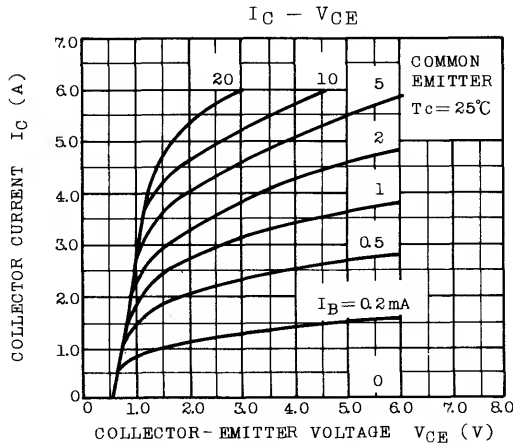


EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Collector Cut-off Current	I_{CBO}	$V_{CB}=300V$, $I_E=0$	-	-	0.5	mA	
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V$, $I_C=0$	-	-	0.5	mA	
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	$I_C=0.5A$, $L=40mH$	250	-	-	V	
DC Current Gain	$h_{FE(1)}$	$V_{CE}=2V$, $I_C=2A$	2000	-	-		
	$h_{FE(2)}$	$V_{CE}=2V$, $I_C=4A$	200	-	-		
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A$, $I_B=0.04A$	-	-	2.0	V	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4A$, $I_B=0.04A$	-	-	2.5	V	
Collector Output Capacitance	C_{ob}	$V_{CB}=50V$, $I_E=0$, $f=1MHz$	-	35	-	pF	
Switching Time	Turn-on Time	t_{on}			-	1	-
	Storage Time	t_{stg}			-	8	-
	Fall Time	t_f			-	5	-



2SD1411

SILICON NPN TRIPLE DIFFUSED TYPE

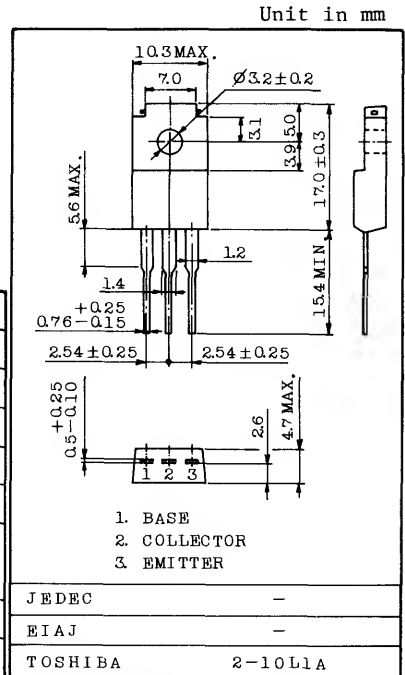
HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- Low Saturation Voltage
: $V_{CE(sat)}=0.5V(\text{Max.})$ at $I_C=4A$
- Complementary to 2SB1018

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	100	V
Collector-Emitter Voltage		V_{CEO}	80	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	7	A
Base Current		I_B	1	A
Collector Power Dissipation	$T_a=25^\circ C$	P_C	2.0	W
	$T_c=25^\circ C$		30	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$



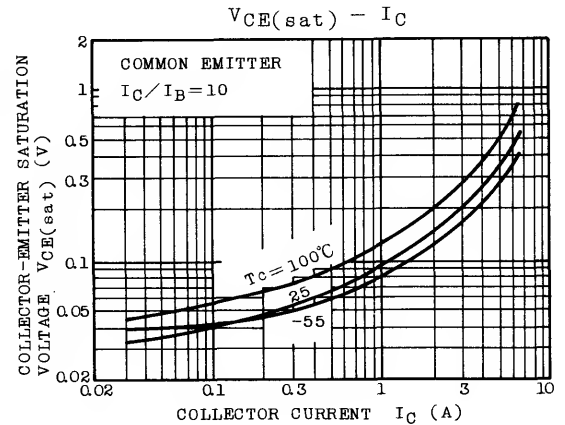
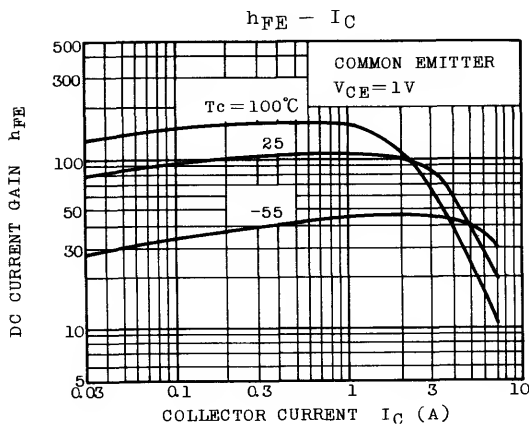
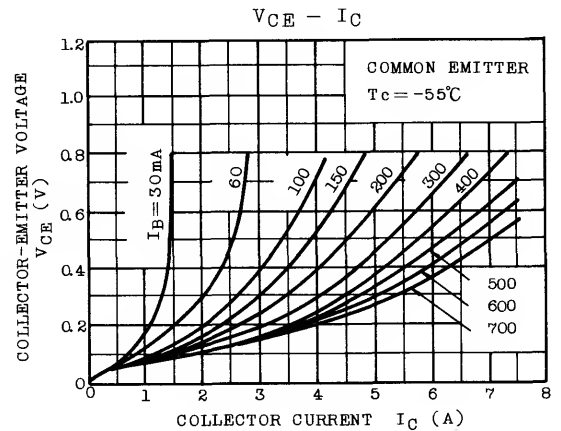
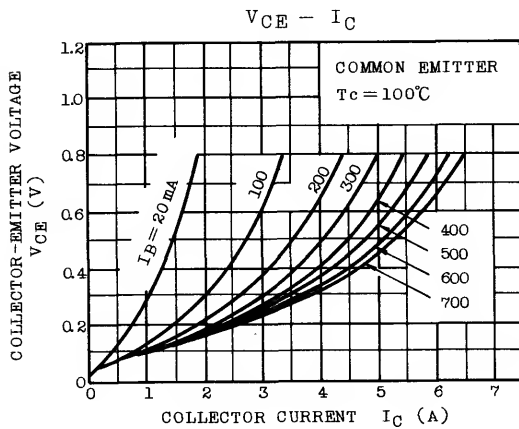
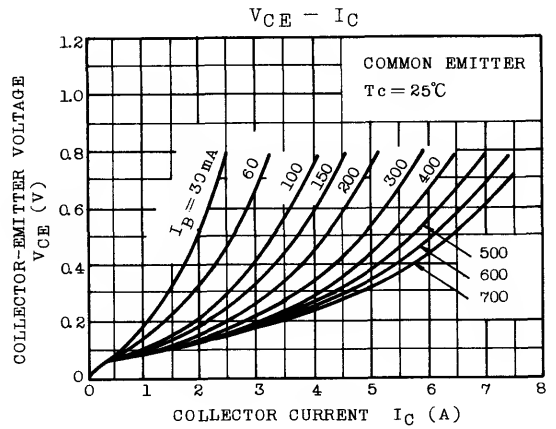
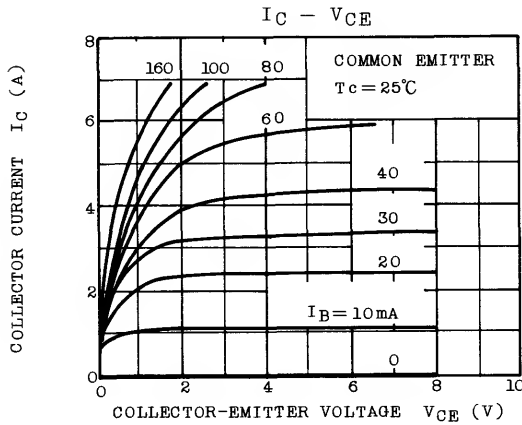
Weight : 2.1g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

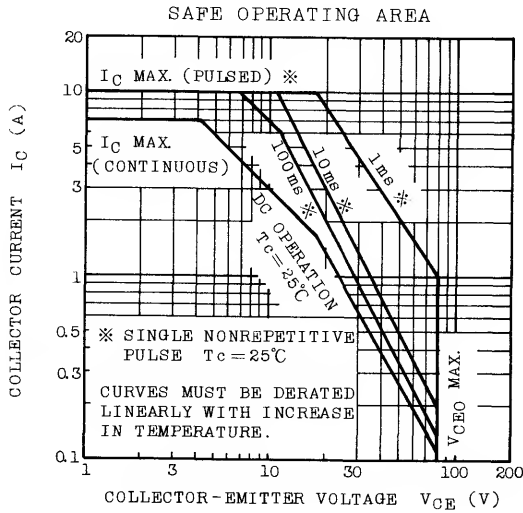
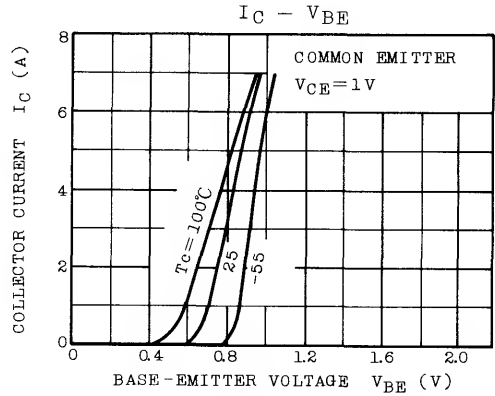
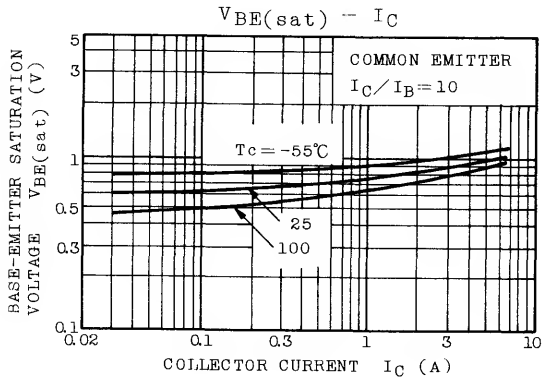
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=100V, I_E=0$	-	-	5	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	5	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	80	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=1V, I_C=1A$	70	-	240	-
		$h_{FE(2)}$	$V_{CE}=1V, I_C=4A$	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=4A, I_B=0.4A$	-	0.25	0.5	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=4A, I_B=0.4A$	-	0.9	1.4	
Transition Frequency		f_T	$V_{CE}=4V, I_C=1A$	-	10	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	250	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.4	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		-	0.5	-	

Note : $h_{FE(1)}$ Classification 0 : 70 ~ 140, Y : 120 ~ 240

TOSHIBA CORPORATION



2SD1411



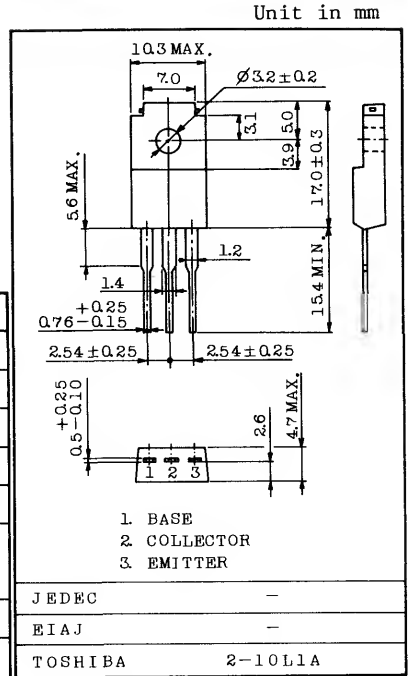
HIGH CURRENT SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Low Saturation Voltage : $V_{CE(sat)}=0.4V(\text{Max.})$ at $I_C=4A$
- . Complementary to 2SB1019

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CB0}	70	V
Collector-Emitter Voltage		V_{CEO}	50	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_C	7	A
Base Current		I_B	1	A
Collector Power Dissipation	$T_a=25^\circ C$	P_C	2.0	W
	$T_c=25^\circ C$		30	
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$

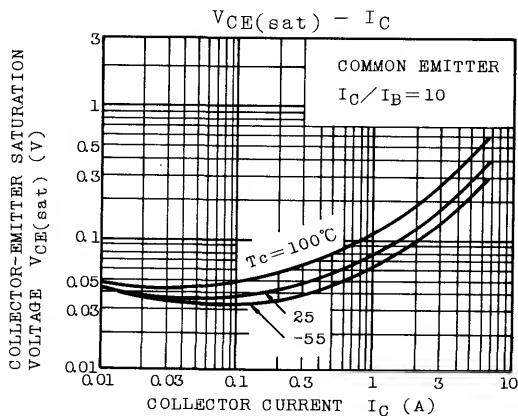
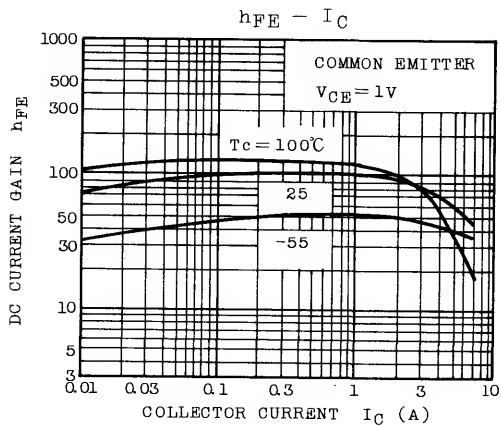
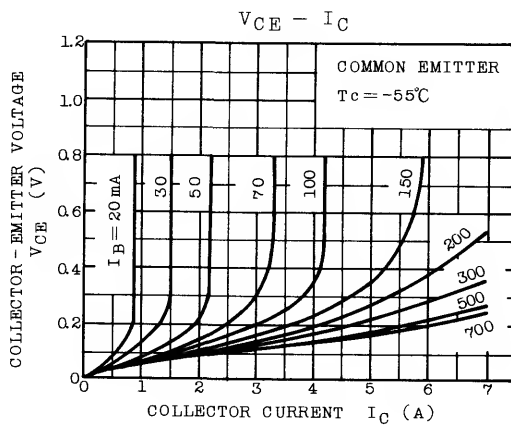
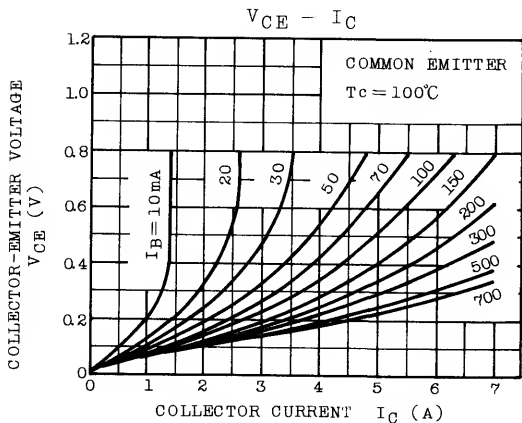
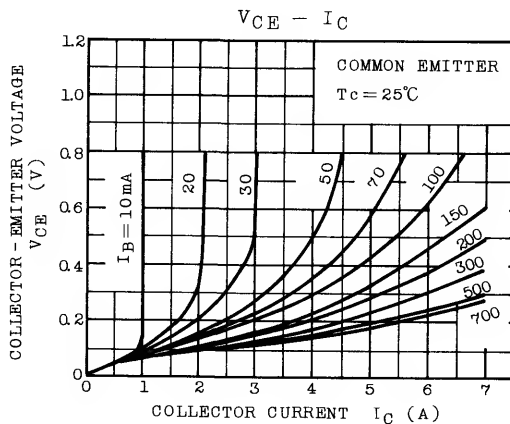
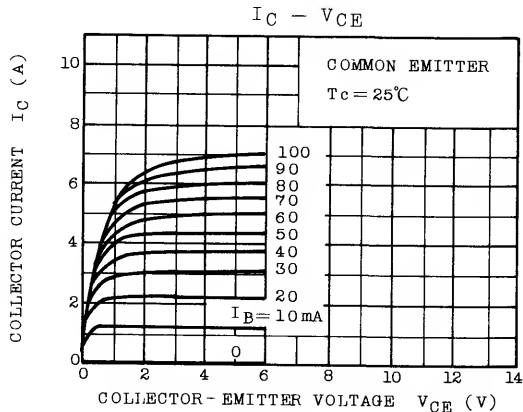


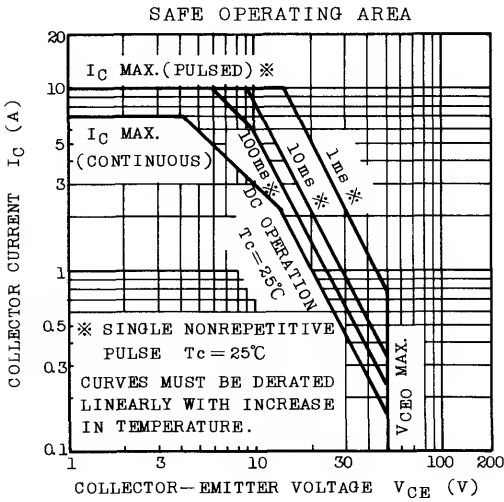
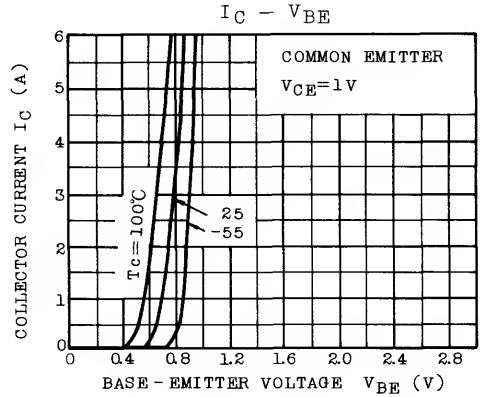
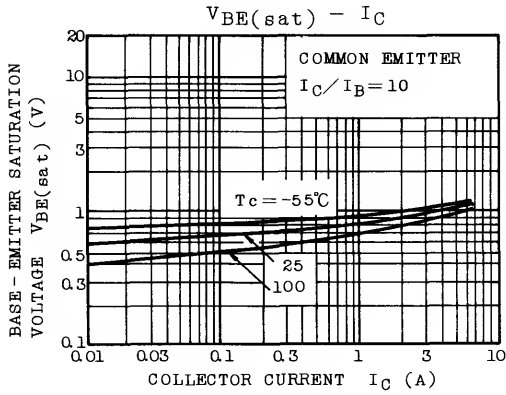
Weight : 2.lg

ELECTRICAL CHARACTERISTIC ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=70V, I_E=0$	-	-	30	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	50	μA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	50	-	-	V
DC Current Gain		$h_{FE(1)}$ (Note)	$V_{CE}=1V, I_C=1A$	70	-	240	
		$h_{FE(2)}$	$V_{CE}=1V, I_C=4A$	30	-	-	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=4A, I_B=0.4A$	-	0.2	0.4	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=4A, I_B=0.4A$	-	0.9	1.2	
Transition Frequency		f_T	$V_{CE}=4V, I_C=1A$	-	10	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	250	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.2	-	μs
	Storage Time	t_{stg}		-	2.5	-	
	Fall Time	t_f		$I_{B1}=-I_{B2}=0.3A$ DUTY CYCLE $\leq 1\%$	-	0.5	

Note : $h_{FE(1)}$ Classification O : 70 ~ 140, Y : 120 ~ 240





2SD1425

SILICON NPN TRIPLE DIFFUSED MESA TYPE

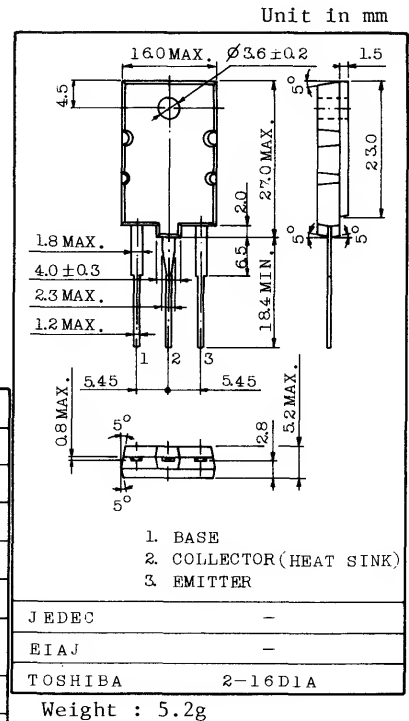
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

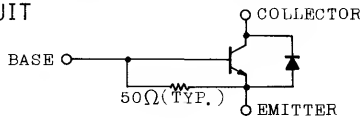
- High Voltage : $V_{CBO}=1500V$
- Low Saturation Voltage : $V_{CE(sat)}=5V(Typ.) (I_C=2A, I_B=0.6A)$
- High Speed : $t_f=1.0\mu s(Max.) (I_{CP}=2A, I_{B1}(end)=0.6A)$
- Built-in Damper Type
- Glass Passivated Collector-Base Junction

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	2.5	A
Emitter Current	I_E	-2.5	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	80	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$



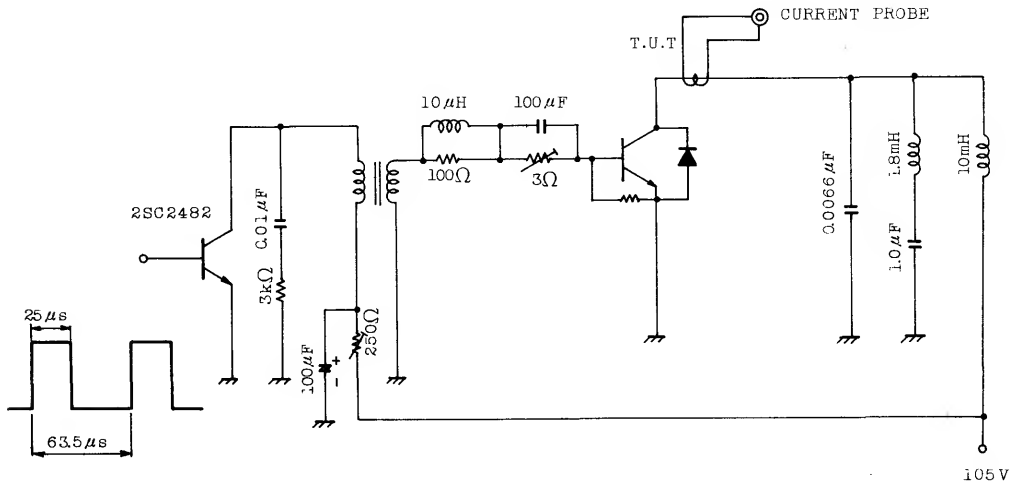
EQUIVALENT CIRCUIT



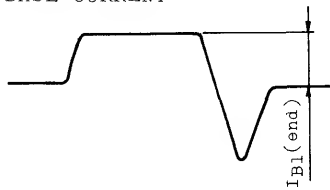
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=500V, I_E=0$	-	-	10	μA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=200mA, I_C=0$	5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=0.5A$	8	12	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=2A, I_B=0.6A$	-	5	8	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=2A, I_B=0.6A$	-	-	1.5	V
Forward Voltage (Damper Diode)	$-V_F$	$I_F=2.5A$	-	1.6	2.0	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.1A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	95	-	pF
Fall Time (Fig.)	t_f	$I_{CP}=2A, I_{B1}(end)=0.6A$	-	0.5	1.0	μs

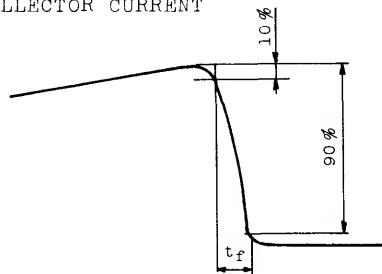
Fig. t_f TEST CIRCUIT



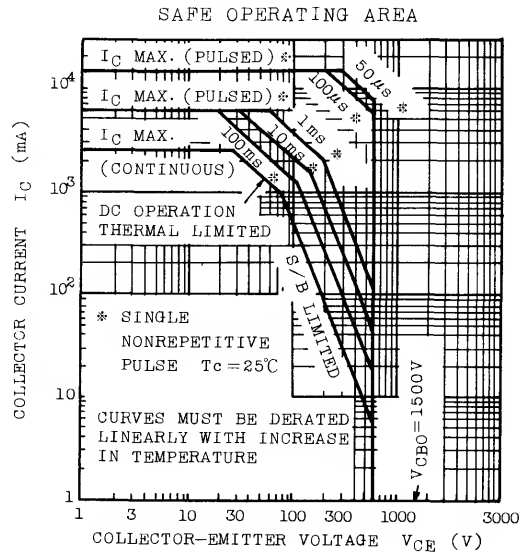
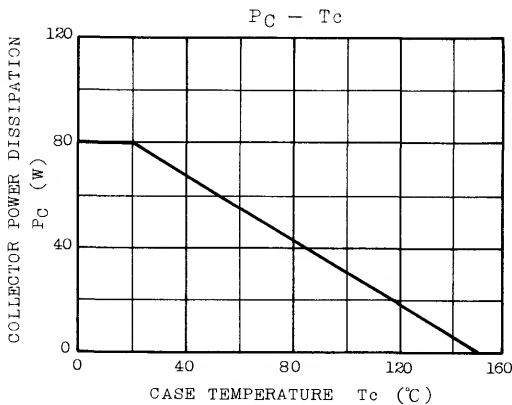
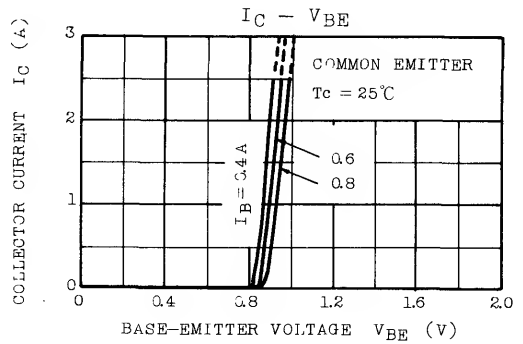
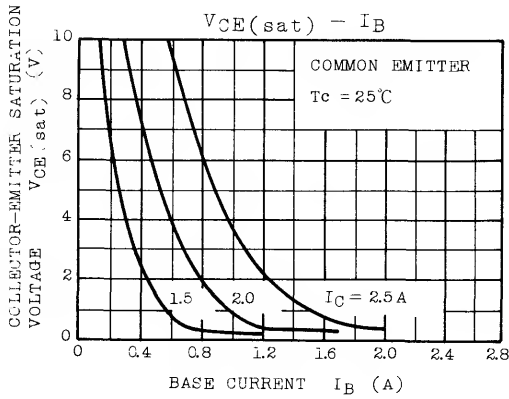
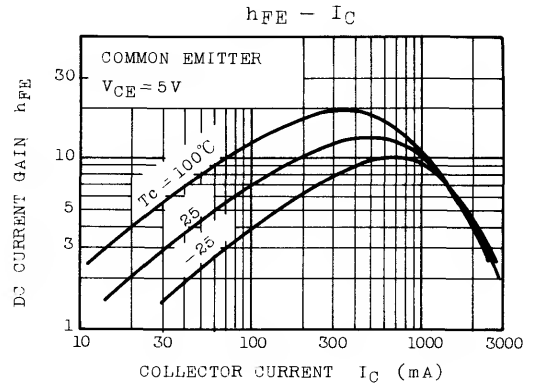
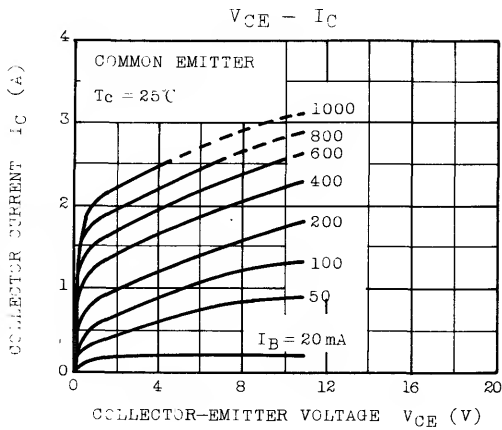
BASE CURRENT



COLLECTOR CURRENT



2SD1425



Unit in mm

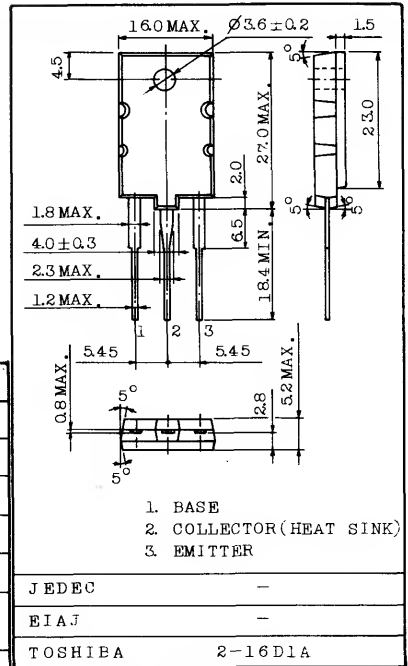
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

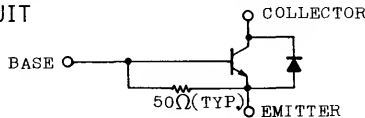
- . High Voltage : $V_{CB0}=1500V$
- . Low Saturation Voltage : $V_{CE(sat)}=5V(Typ.)$ ($I_C=3A, I_B=0.8A$)
- . High Speed : $t_f=1.0\mu s(Max.)$ ($I_{CP}=3A, I_{B1}(end)=0.8A$)
- . Built-in Damper Type
- . Glass Passivated Collector-Base Junction

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	3.5	A
Emitter Current	I_E	-3.5	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	80	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$



EQUIVALENT CIRCUIT

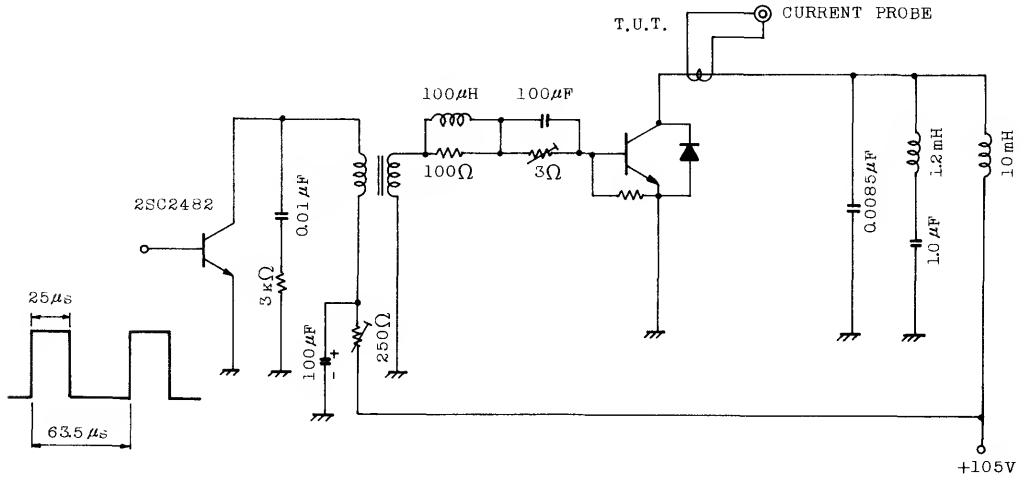


ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

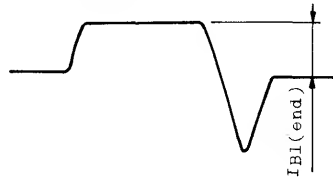
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=500V, I_E=0$	-	-	10	μA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=200mA, I_C=0$	5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=0.5A$	8	12	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=3A, I_B=0.8A$	-	5	8	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=3A, I_B=0.8A$	-	-	1.5	V
Forward Voltage (Damper Diode)	$-V_F$	$I_F=3.5A$	-	1.6	2.0	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.1A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	95	-	pF
Fall Time (Fig.)	t_f	$I_{CP}=3A, I_{B1}(end)=0.8A$	-	0.5	1.0	μs

2SD1426

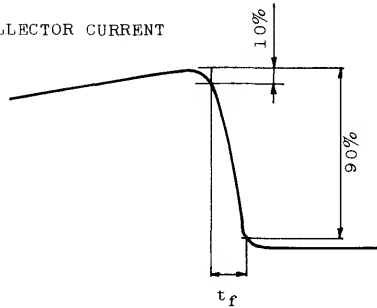
Fig. t_f TEST CIRCUIT

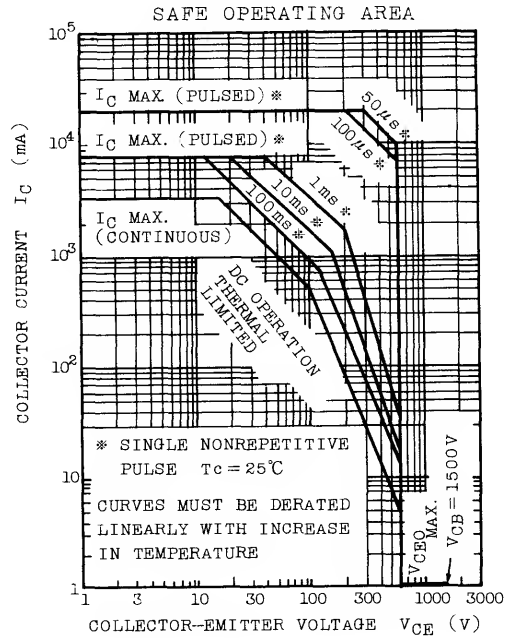
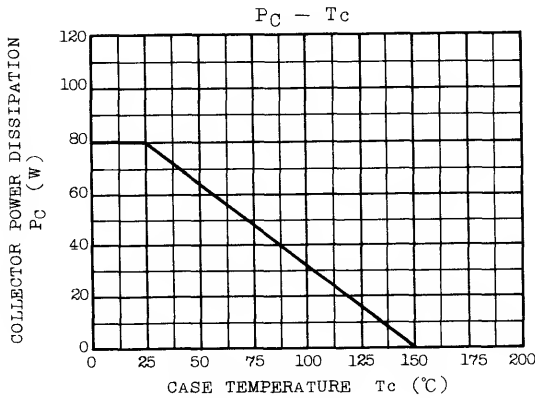
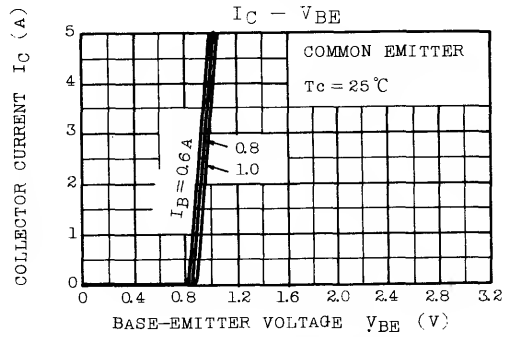
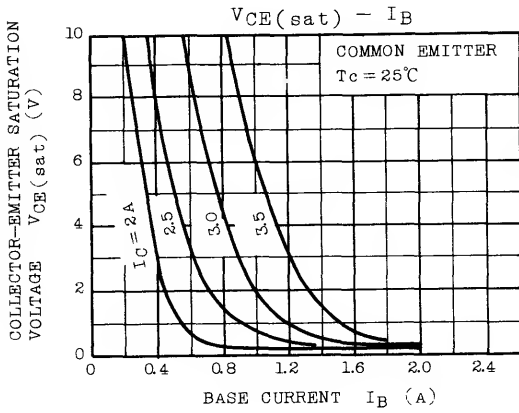
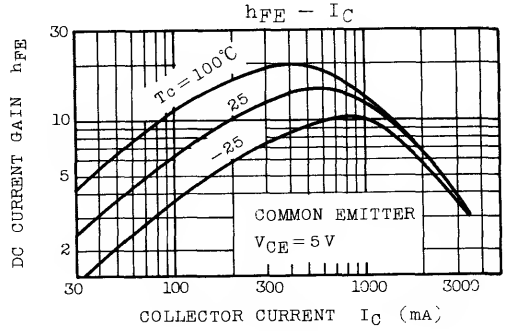
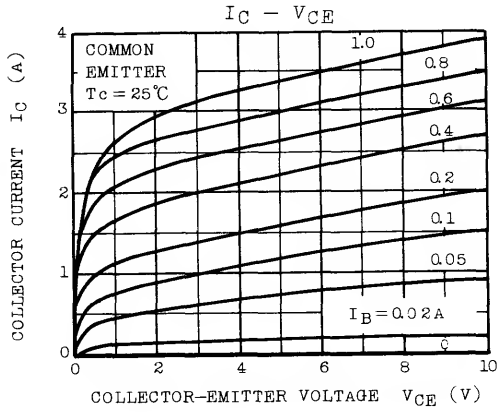


BASE CURRENT



COLLECTOR CURRENT





2SD1427

SILICON NPN TRIPLE DIFFUSED MESA TYPE

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

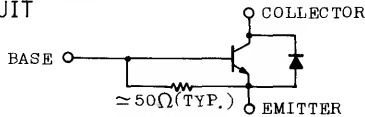
FEATURES:

- . High Voltage : $V_{CB0}=1500V$
- . Low Saturation Voltage : $V_{CE(sat)}=5V(\text{Max.})$ ($I_C=4A, I_B=0.8A$)
- . High Speed : $t_f=1.0\mu s(\text{Max.})$
- . Built-in Damper Type
- . Glass Passivated Collector-Base Junction

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	5	A
Emitter Current	I_E	-5	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	80	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$

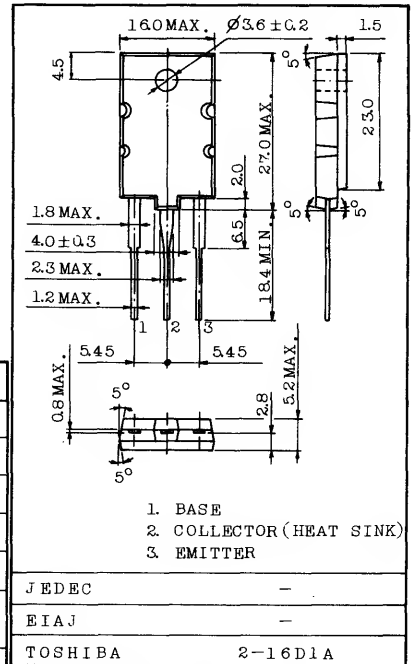
EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

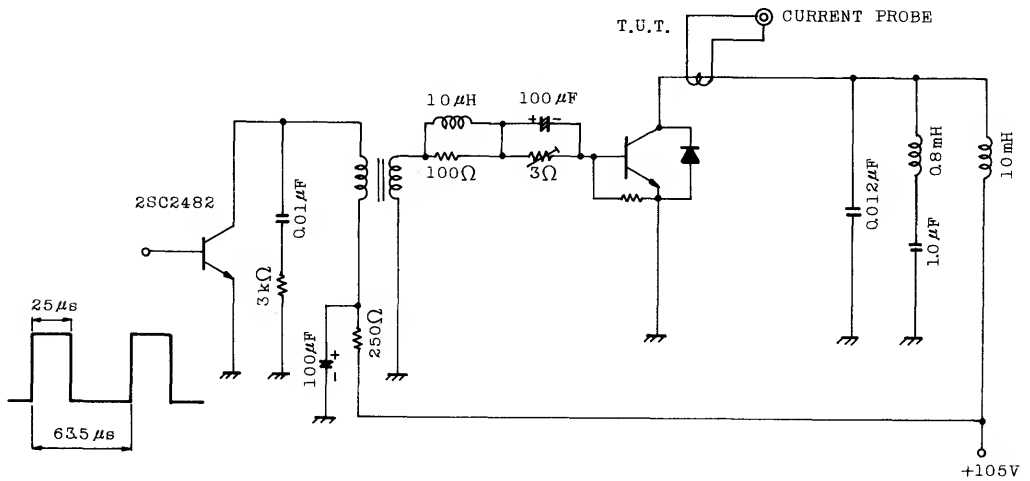
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=500V, I_E=0$	-	-	10	μA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=200mA, I_C=0$	5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=1.0A$	8	12	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A, I_B=0.8A$	-	3	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4A, I_B=0.8A$	-	-	1.5	V
Forward Voltage (Damper Diode)	$-V_F$	$I_F=5A$	-	1.6	2.0	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.1A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	165	-	pF
Fall Time (Fig.)	t_f	$I_{CP}=4A, I_{B1}(\text{end})=0.8A$	-	0.5	1.0	μs

Unit in mm

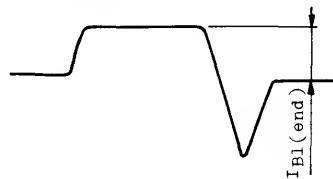


Weight : 5.2g

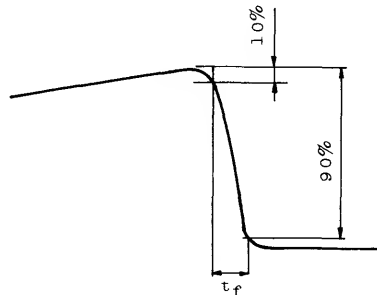
Fig. t_f TEST CONDITION



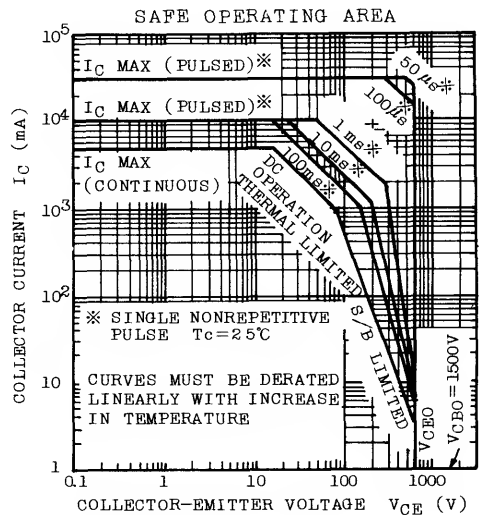
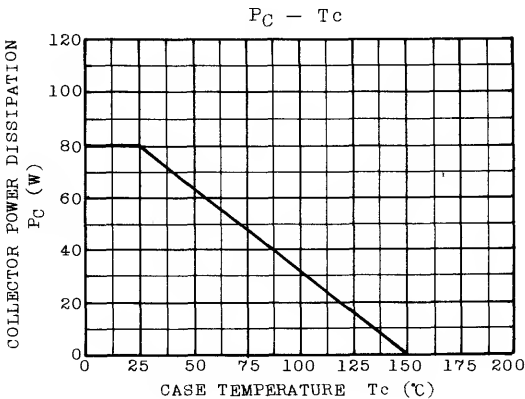
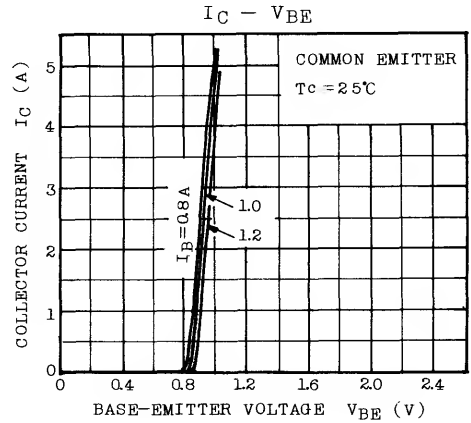
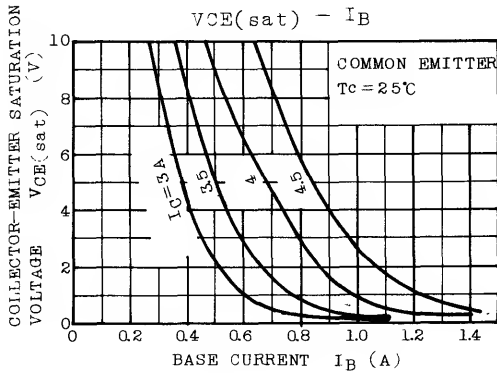
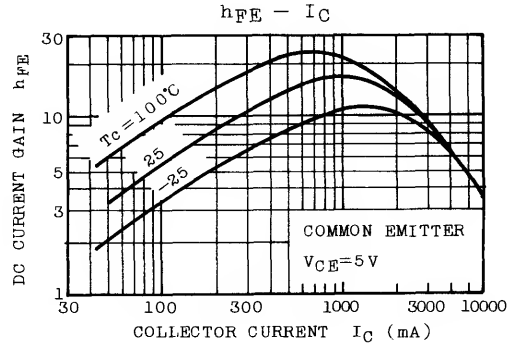
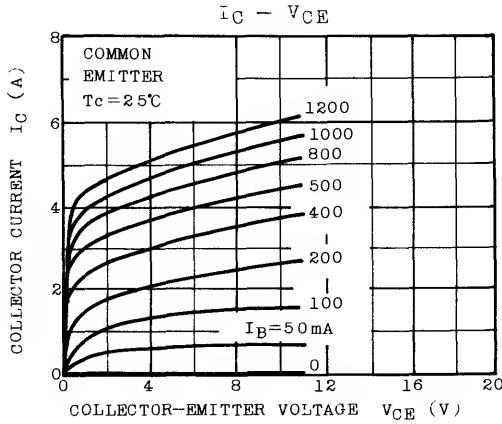
BASE CURRENT



COLLECTOR CURRENT

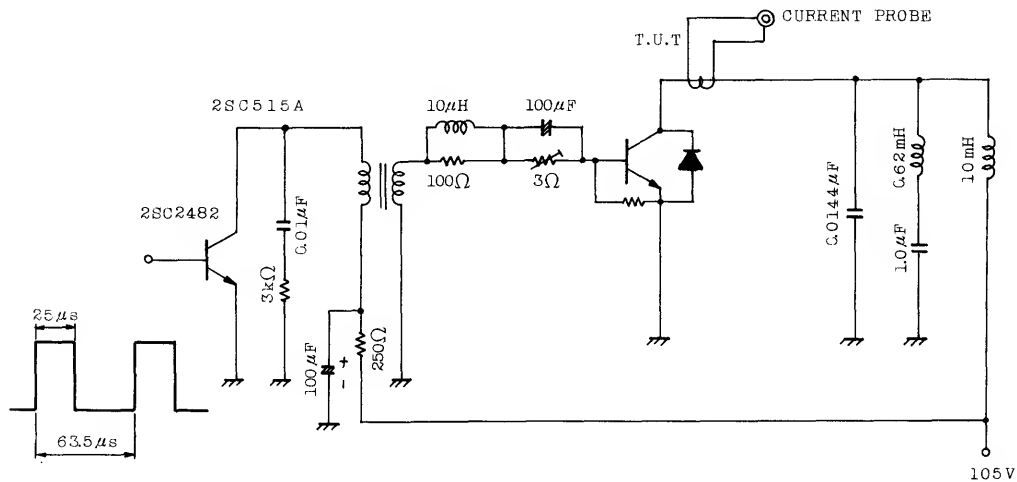


2SD1427

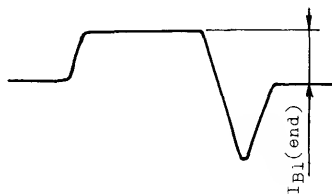


2SD1428

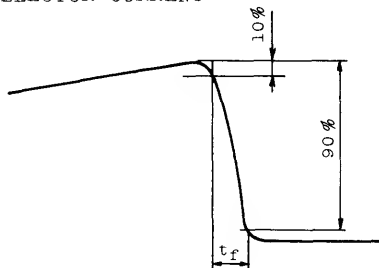
Fig. tf TEST CIRCUIT

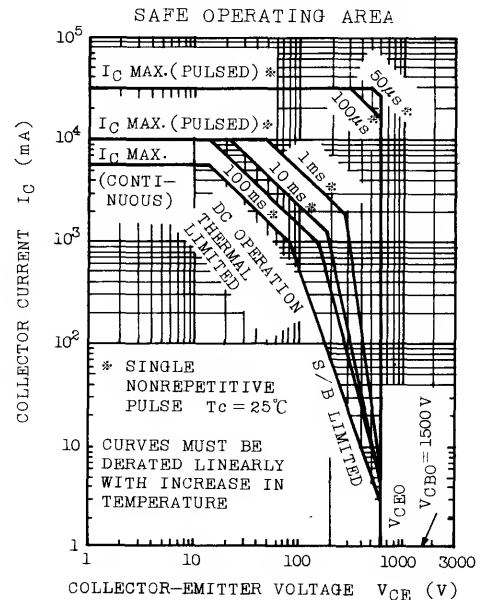
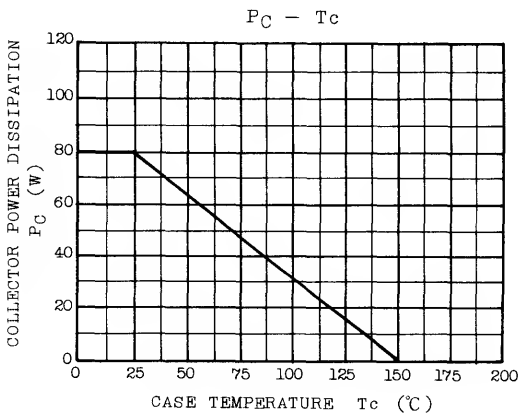
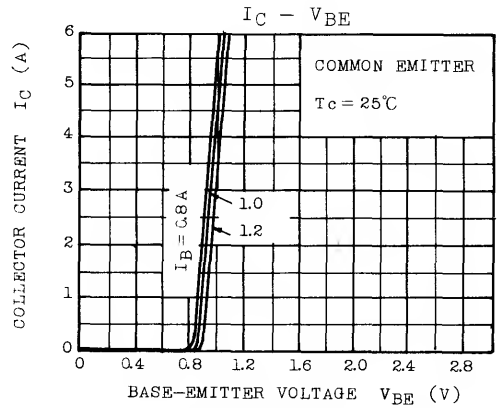
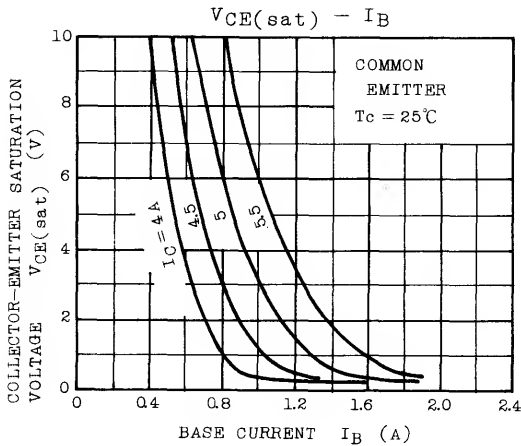
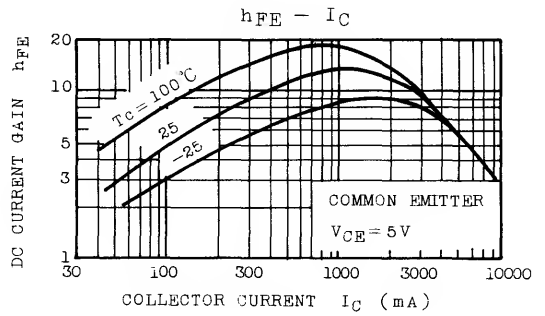
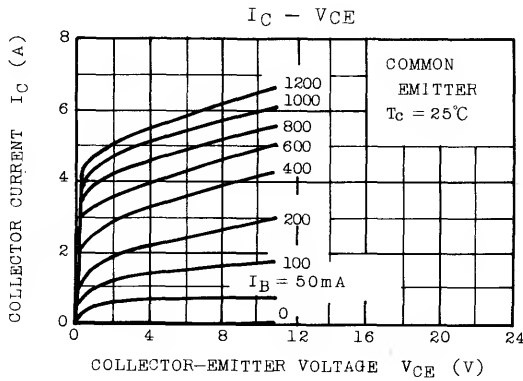


BASE CURRENT



COLLECTOR CURRENT





2SD1429

SILICON NPN TRIPLE DIFFUSED MESA TYPE

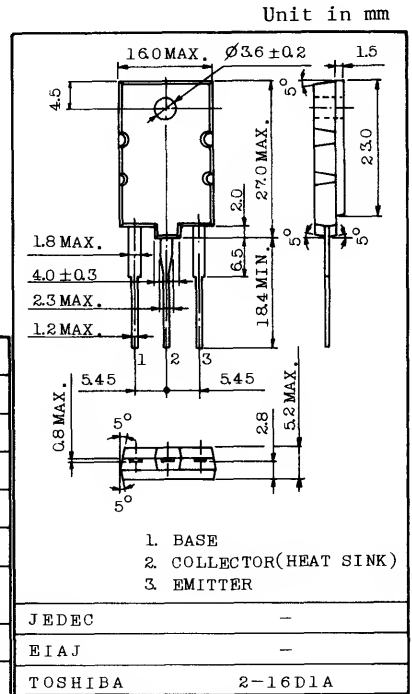
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- . High Voltage : $V_{CB0}=1500V$
- . Low Saturation Voltage : $V_{CE(sat)}=4V$ (Typ.)
- . High Speed : $t_f=0.5\mu s$ (Typ.)
- . Glass Passivated Collector-Base Junction

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	2.5	A
Emitter Current	I_E	-2.5	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	80	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$

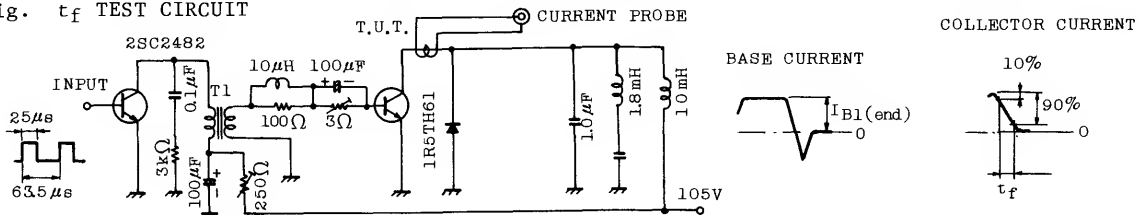


Weight : 5.2g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=500V, I_E=0$	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1	mA
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=0.5A$	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=2.0A, I_B=0.6A$	-	4	8	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=2.0A, I_B=0.6A$	-	-	1.5	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.1A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	95	-	pF
Fall Time (Fig.)	t_f	$I_{CP}=2.0A, I_{B1}(end)=0.6A$	-	0.5	1.0	μs

Fig. t_f TEST CIRCUIT



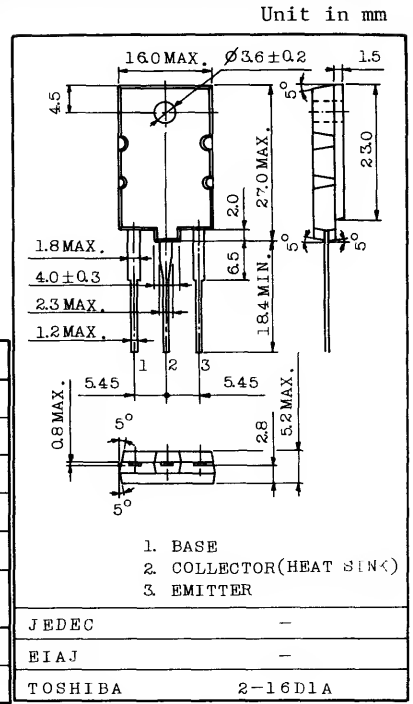
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- . High Voltage : $V_{CB0}=1500V$
- . Low Saturation Voltage : $V_{CE(sat)}=4V$ (Typ.) ($I_C=3A, I_B=0.8A$)
- . High Speed : $t_f=1.0\mu s$ (Max.) ($I_{CP}=3A, I_{B1}(end)=0.8A$)
- . Glass Passivated Collector-Base Junction

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	3.5	A
Emitter Current	I_E	-3.5	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	80	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$

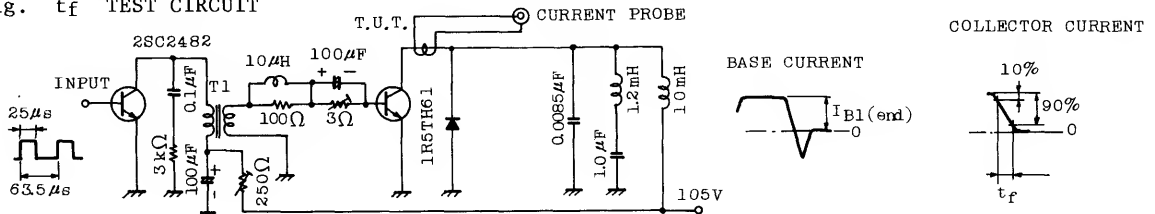


Weight : 5.2g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=500V, I_E=0$	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1	mA
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=0.5A$	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=3A, I_B=0.8A$	-	4	8	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=3A, I_B=0.8A$	-	-	1.5	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.1A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	95	-	pF
Fall Time (Fig.)	t_f	$I_{CP}=3A, I_{B1}(end)=0.8A$	-	0.5	1.0	μs

Fig. t_f TEST CIRCUIT



2SD1431

SILICON NPN TRIPLE DIFFUSED MESA TYPE

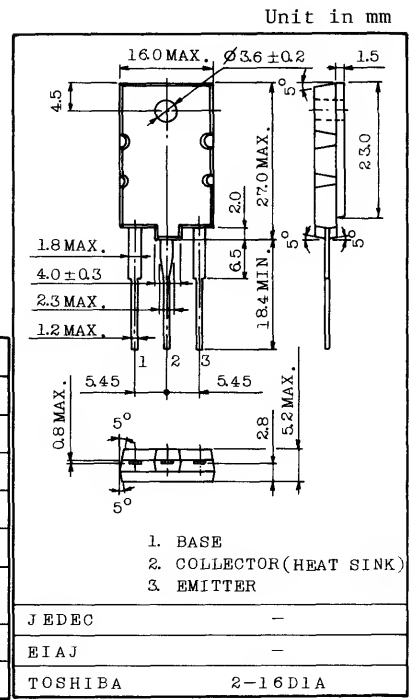
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : $V_{CB0}=1500V$
- Low Saturation Voltage : $V_{CE(sat)}=5V(\text{Max.})$ ($I_C=4A, I_B=0.8A$)
- High Speed : $t_f=1.0\mu s(\text{Max.})$
- Glass Passivated Collector-Base Junction

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EB0}	5	V
Collector Current	I_C	5	A
Emitter Current	I_E	-5	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	80	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$

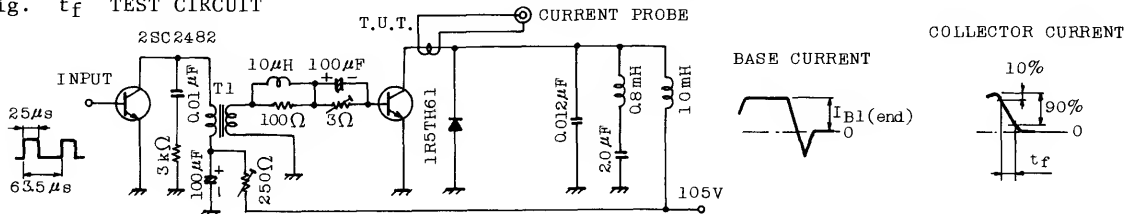


Weight : 5.2g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=500V, I_E=0$	-	-	10	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=5V, I_C=0$	-	-	1	mA
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=1A$	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A, I_B=0.8A$	-	3	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4A, I_B=0.8A$	-	-	1.5	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.1A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	165	-	pF
Fall Time (Fig.)	t_f	$I_{CP}=4A, I_{B1}(\text{end})=0.8A$	-	0.5	1.0	μs

Fig. t_f TEST CIRCUIT



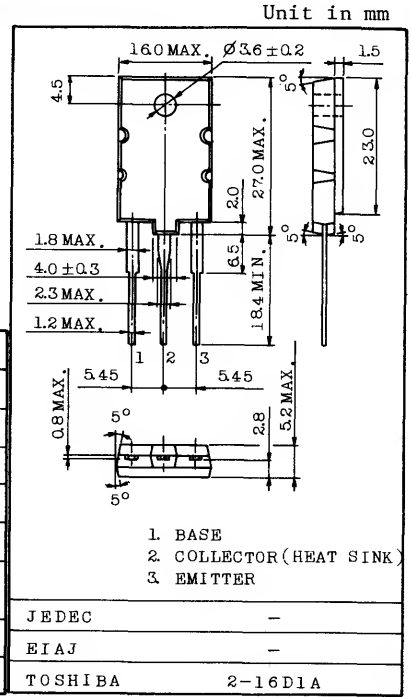
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : $V_{CB0}=1500V$
- Low Saturation Voltage : $V_{CE(sat)}=5V$ (Max.) ($I_C=5A, I_B=1A$)
- High Speed : $t_f=1.0\mu s$ (Max.)
- Glass Passivated Collector-Base Junction

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	6	A
Emitter Current	I_E	-6	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	80	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$

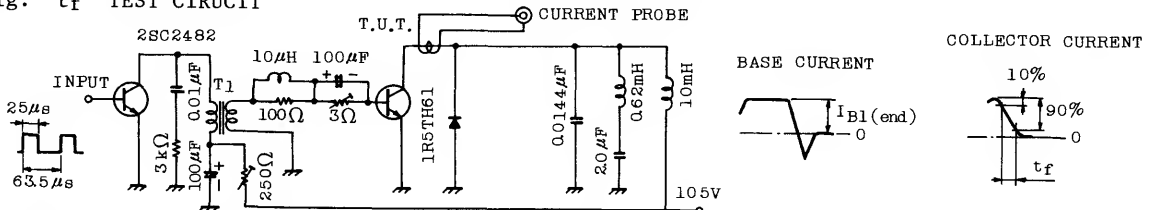


Weight : 5.2g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=500V, I_E=0$	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1	mA
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=1A$	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=5A, I_B=1A$	-	3	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=5A, I_B=1A$	-	-	1.5	V
Transition Frequency	f_t	$V_{CE}=10V, I_C=0.1A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	165	-	pF
Fall Time (Fig.)	t_f	$I_{CP}=5A, I_{B1}(end)=1A$	-	0.5	1.0	μs

Fig. t_f TEST CIRCUIT



2SD1433

SILICON NPTRIPLE DIFFUSED MESA TYPE

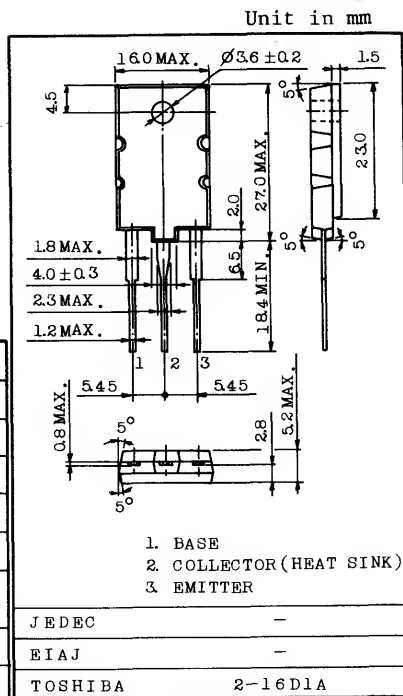
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- . High Voltage : $V_{CBO}=1500V$
- . Low Saturation Voltage : $V_{CE(sat)}=5V$ (Max.) ($I_C=6A, I_B=1.2A$)
- . High Speed : $t_f=1.0\mu s$ (Max.)
- . Glass Passivated Collector-Base Junction

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	1500	V
Collector-Emitter Voltage	V_{CEO}	600	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	7	A
Emitter Current	I_E	-7	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	80	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$

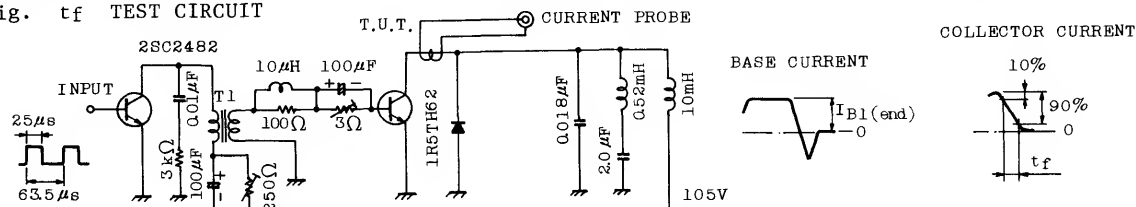


Weight : 5.2g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=500V, I_E=0$	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	1	mA
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=1A$	8	20	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=6A, I_B=1.2A$	-	3	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=6A, I_B=1.2A$	-	-	1.5	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.1A$	-	3	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	165	-	pF
Fall Time (Fig.)	t_f	$I_{CP}=6A, I_{B1}(end)=1.2A$	-	0.5	1.0	μs

Fig. t_f TEST CIRCUIT



INDUSTRIAL APPLICATIONS

Unit in mm

MICRO MOTOR DRIVE, HAMMER DRIVE APPLICATIONS.
SWITCHING APPLICATIONS.
POWER AMPLIFIER APPLICATIONS.

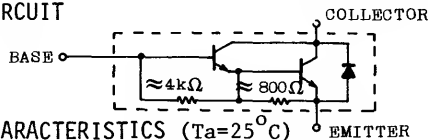
FEATURES:

- High DC Current Gain
: $h_{FE}=2000(\text{Min.})$ ($V_{CE}=2V, I_C=1A$)
- Low Saturation Voltage
: $V_{CE}(\text{sat})=1.5V(\text{Max.})$ ($I_C=1A, I_B=1mA$)

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

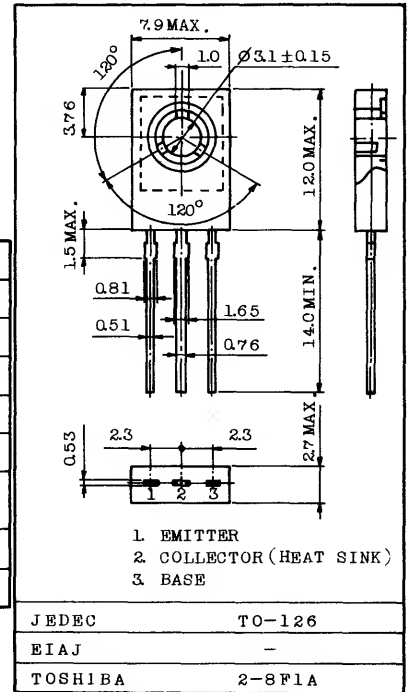
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	8	V
Collector Current	I_C	2	A
Base Current	I_B	0.5	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	15	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ\text{C}$

EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

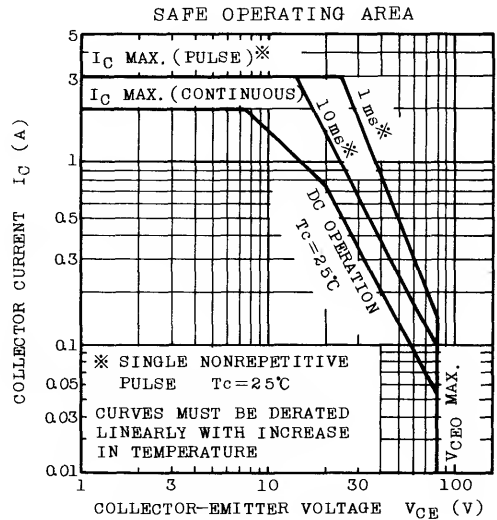
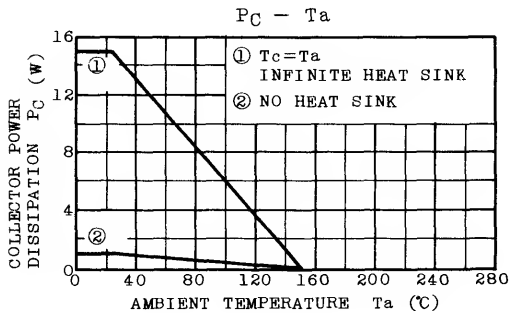
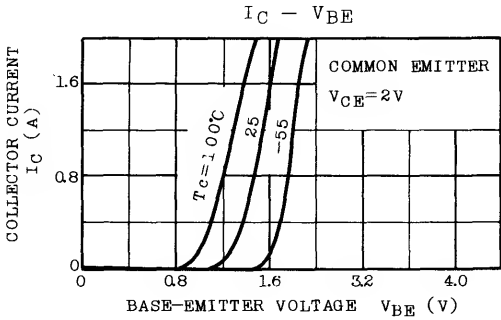
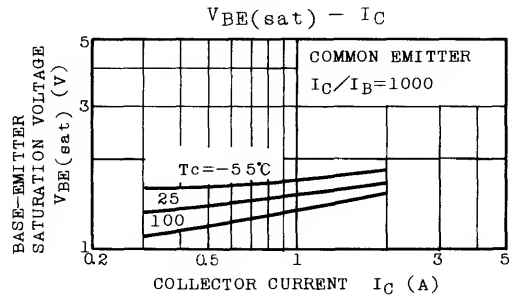
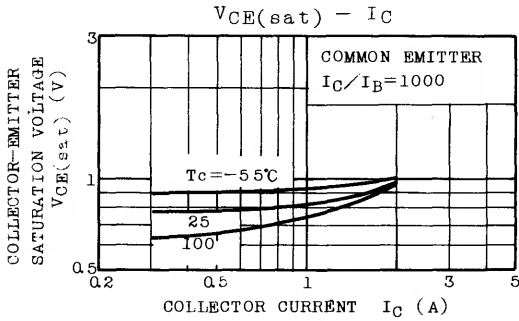
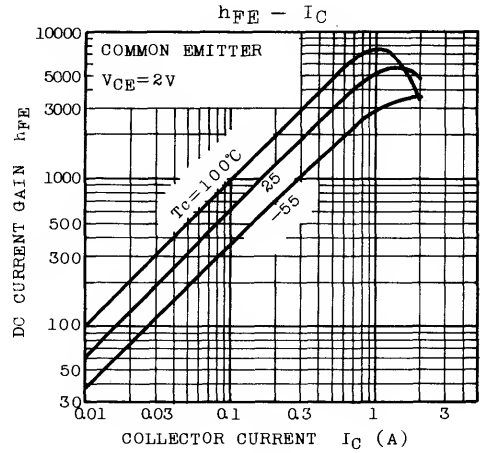
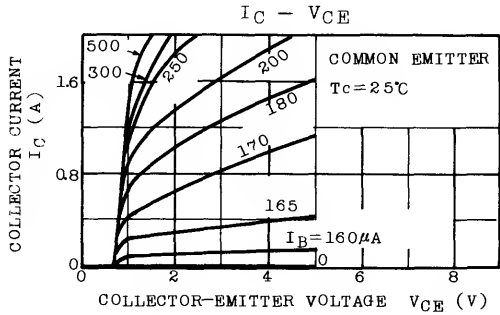
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=80V, I_E=0$	-	-	10	μA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=8V, I_C=0$	-	-	4	mA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	80	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=2V, I_C=1A$	2000	-	-	
Collector-Emitter Saturation Voltage		$V_{CE}(\text{sat})$	$I_C=1A, I_B=1mA$	-	-	1.5	V
Base-Emitter Saturation Voltage		$V_{BE}(\text{sat})$	$I_C=1A, I_B=1mA$	-	-	2.0	V
Transition Frequency		f_T	$V_{CE}=2V, I_C=0.5A$	-	100	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1\text{MHz}$	-	20	-	pF
Switching Time	Turn-on Time	t_{on}		-	0.4	-	μs
	Storage Time	t_{stg}		-	4.0	-	
	Fall Time	t_f		$I_{B1}=-I_{B2}=1mA$ DUTY CYCLE $\leq 1\%$	-	0.6	



JEDEC	T0-126
EIAJ	-
TOSHIBA	2-8F1A

Mounting Kit No. AC46C

Weight : 0.72g



HIGH CURRENT SWITCHING APPLICATIONS.

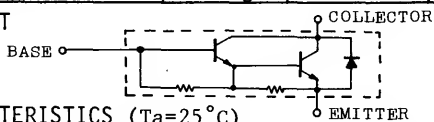
FEATURES:

- High Collector Current : $I_C=30A$
- High DC Current Gain : $h_{FE}=1000(\text{Min.})(V_{CE}=5V, I_C=20A)$
- Monolithic Construction with Built-In Base-Emitter Shunt Resistor.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	100	V
Collector-Emitter Voltage	V_{CEO}	100	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	30	A
Base Current	I_B	5	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	200	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 150	$^\circ C$

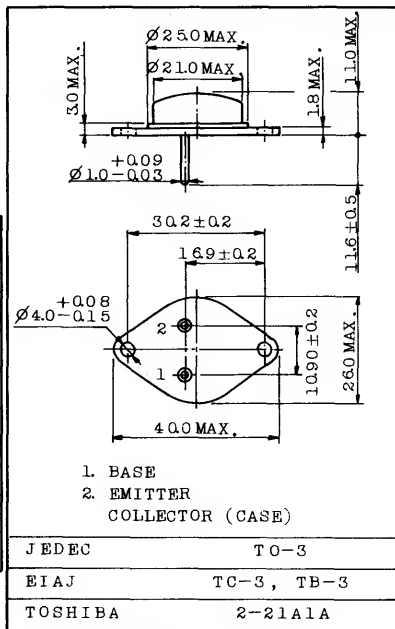
EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Collector Cut-off Current	I_{CBO}	$V_{CB}=100V, I_E=0$	-	-	100	μA	
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	10	mA	
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=50mA, I_B=0$	100	-	-	V	
DC Current Gain	$h_{FE(1)}$	$V_{CE}=5V, I_C=20A$	1000	-	-		
	$h_{FE(2)}$	$V_{CE}=5V, I_C=30A$	200	-	-		
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=20A, I_B=0.2A$	-	-	1.5	V	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$		-	-	2.0	V	
Emitter-Collector Forward Voltage	V_{ECF}	$I_E=10A, I_B=0$	-	-	3	V	
Transition Frequency	f_T	$V_{CE}=5V, I_C=1A$	-	10	-	MHz	
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	500	-	pF	
Switching Time	Turn on Time	t_{on}		-	1.5	-	μs
	Storage Time	t_{stg}		-	10	-	
	Fall Time	t_f		$I_{B1}=-I_{B2}=0.01A$ DUTY CYCLE $\leq 1\%$	-	1.5	

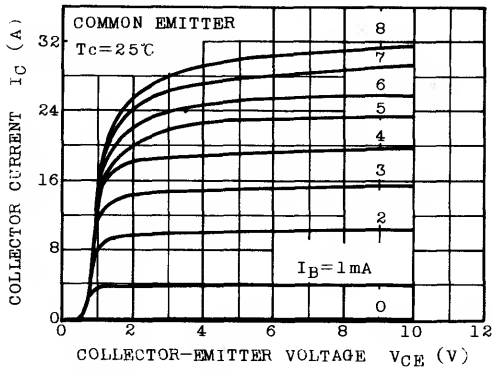
Unit in mm



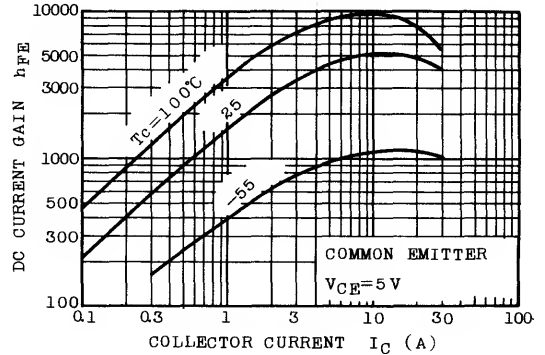
J EDEC T O-3
E IAJ TC-3, TB-3
TOSHIBA 2-21A1A

Mounting Kit No. AC73
Weight : 13g

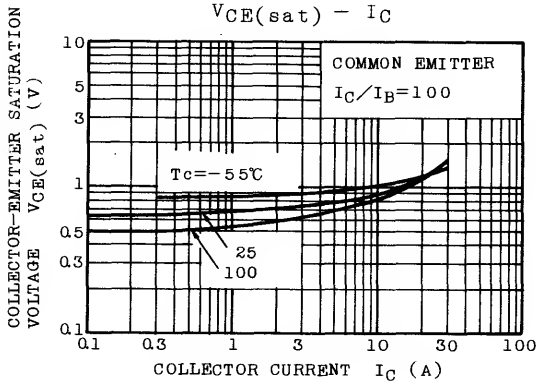
$I_C - V_{CE}$



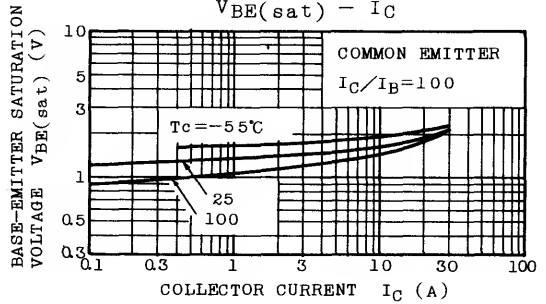
$h_{FE} - I_C$



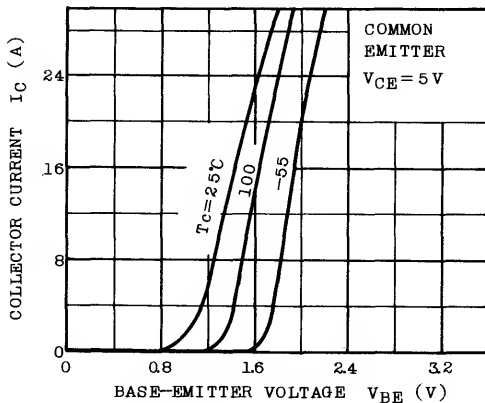
$V_{CE(sat)} - I_C$



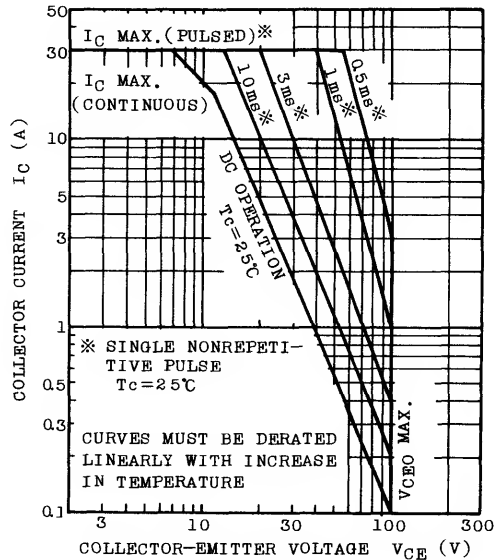
$V_{BE(sat)} - I_C$



$I_C - V_{BE}$



SAFE OPERATING AREA





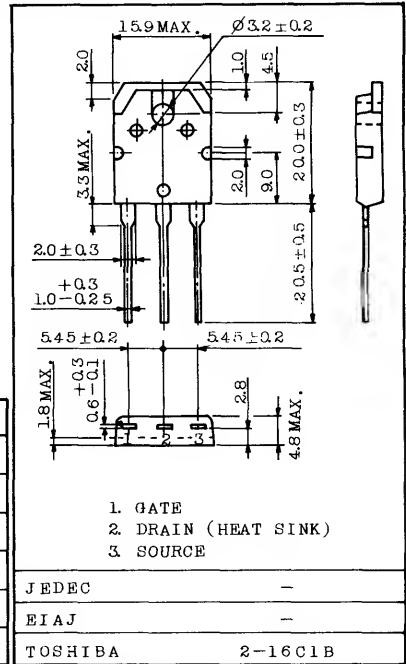
2SJ
SERIES

AUDIO FREQUENCY POWER AMPLIFIER APPLICATION.

Unit in mm

FEATURES:

- . High Breakdown Voltage : $V_{DSS}=-160V$
- . High Forward Transfer Admittance : $|Y_{fs}|=2.0S$ (Typ.)
- . Complementary to 2SK405



Weight : 4.6g

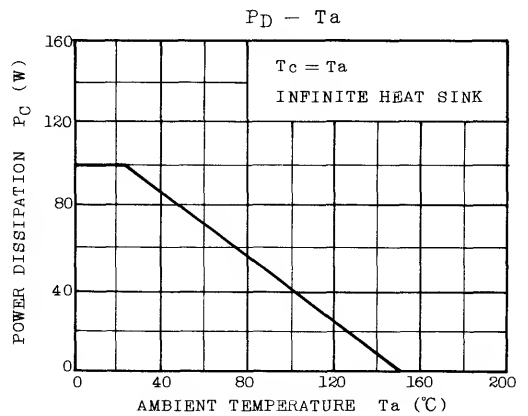
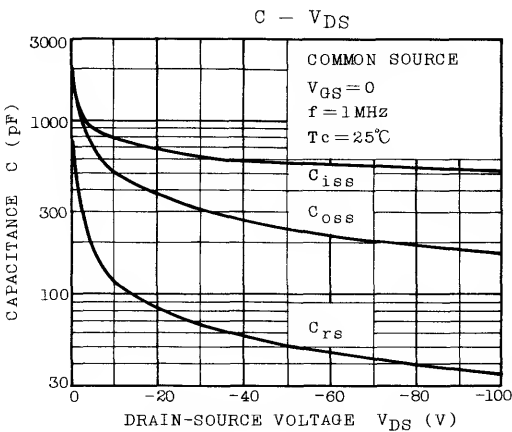
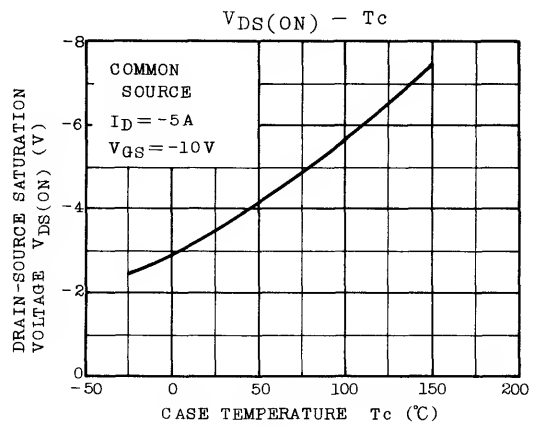
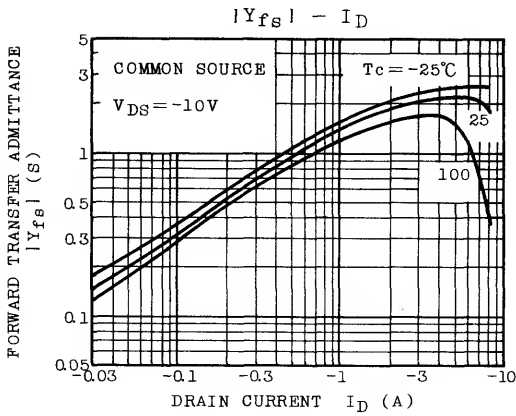
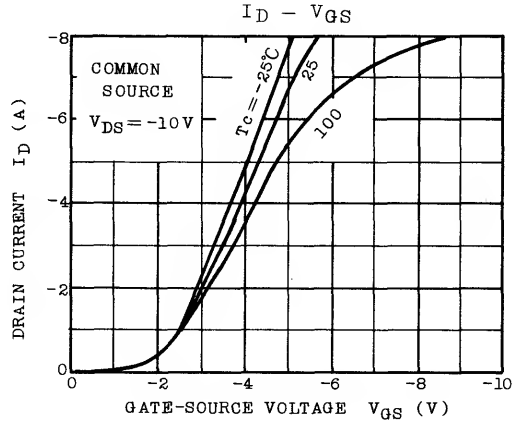
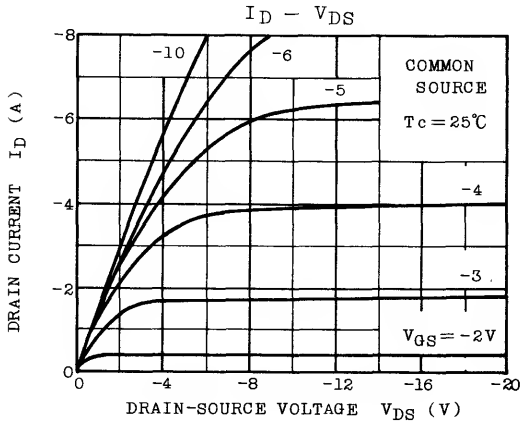
MAXIMUM RATINGS ($T_a=25^\circ C$)

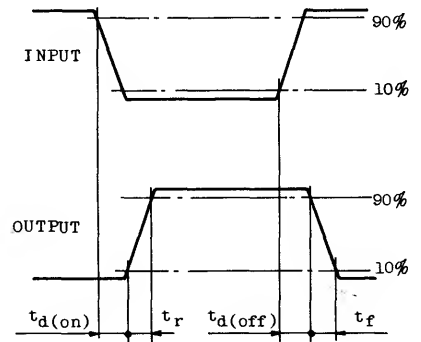
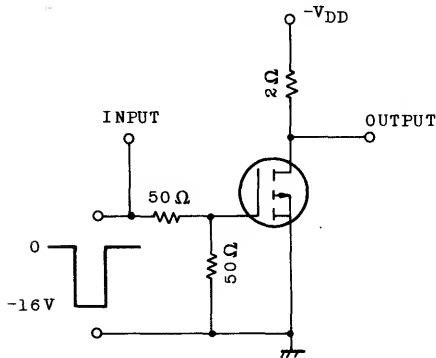
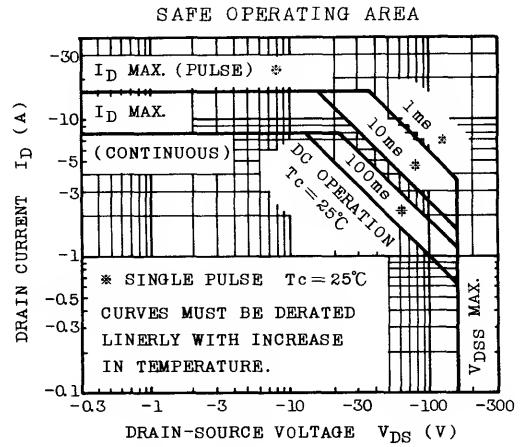
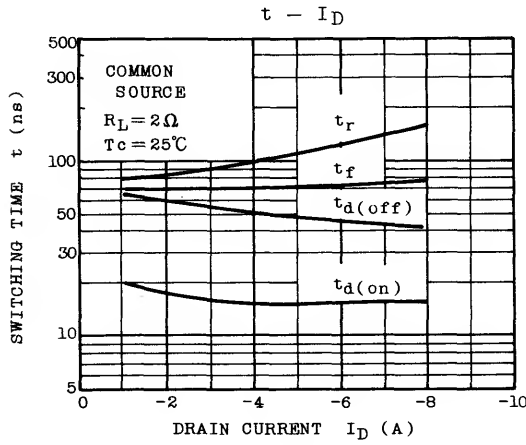
CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DSS}	-160	V
Gate-Source Voltage	V_{GSS}	± 20	V
Drain Current	I_D	-8	A
Power Dissipation ($T_c=25^\circ C$)	P_D	100	W
Channel Temperature	T_{ch}	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current	I_{GSS}	$V_{DS}=0, V_{GS}=\pm 20V$	-	-	± 1.0	μA
Drain-Source Breakdown Voltage	$V(BR)_{DSS}$	$I_D=-5mA, V_{GS}=0$	-160	-	-	V
Gate-Source Cut-off Voltage	$V_{GS(OFF)}$ (Note)	$V_{DS}=-10V, I_D=-0.1A$	-0.8	-	-2.8	V
Drain-Source Saturation Voltage	$V_{DS(ON)}$	$I_D=-5A, V_{GS}=-10V$	-	-3.5	-7.0	V
Forward Transfer Admittance	$ Y_{fs} $	$V_{DS}=-10V, I_D=-2A$	1.0	2.0	-	S
Input Capacitance	C_{iss}	$V_{DS}=-10V, V_{GS}=0, f=1MHz$	-	800	-	pF
Output Capacitance	C_{oss}	$V_{DS}=-10V, V_{GS}=0, f=1MHz$	-	500	-	pF
Reverse Transfer Capacitance	C_{rs}	$V_{DS}=-10V, V_{GS}=0, f=1MHz$	-	110	-	pF

Note : $V_{GS(OFF)}$ Classification O : -0.8 ~ -1.6, Y : -1.4 ~ -2.8







2SK
SERIES

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.
SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

FEATURES:

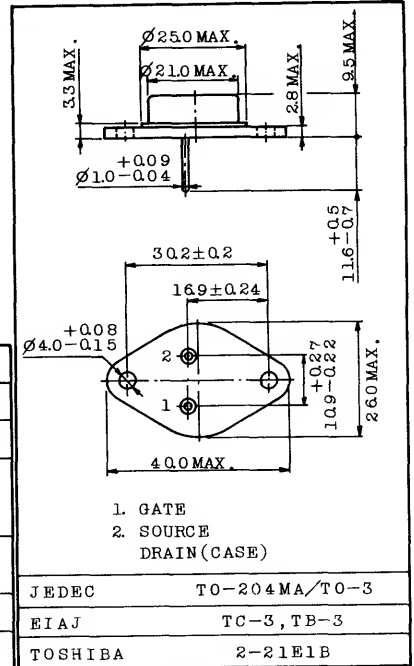
- High Breakdown Voltage : $V_{(BR)DSS}=400V$
- High Forward Transfer Admittance : $|Y_{fs}|=5S(Typ.)$
- Low Leakage Current : $I_{GSS}=\pm 100nA(Max.) @ V_{GS}=\pm 20V$
 $I_{DSS}=1mA(Max.) @ V_{DS}=400V$
- Enhancement-Mode : $V_{th}=1.5 \sim 3.5V @ I_D=1mA$

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DSX}	400	V
Gate-Source Voltage	V_{GSS}	± 20	V
Drain Current	DC	I_D	10
	Pulse	I_{DP}	15
Drain Power Dissipation (Tc=25°C)	P_D	120	W
Channel Temperature	T_{ch}	150	°C
Storage Temperature Range	T_{stg}	-65 ~ 150	°C

INDUSTRIAL APPLICATIONS

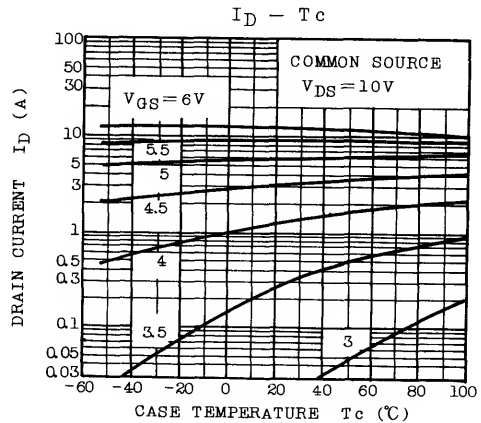
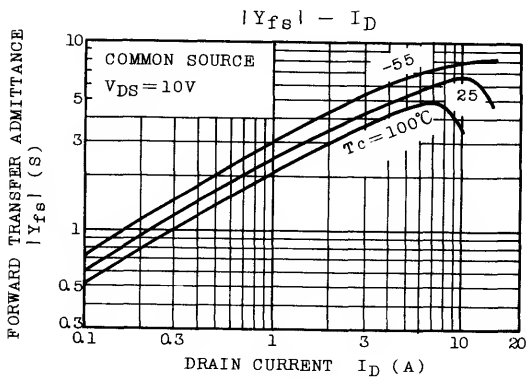
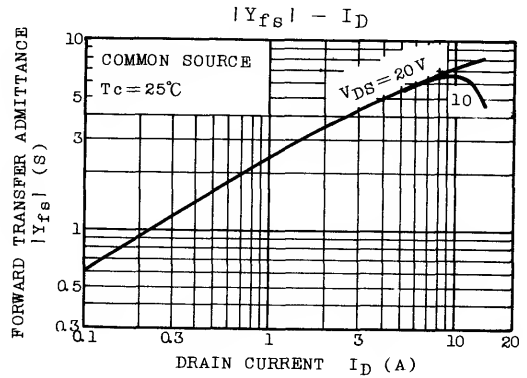
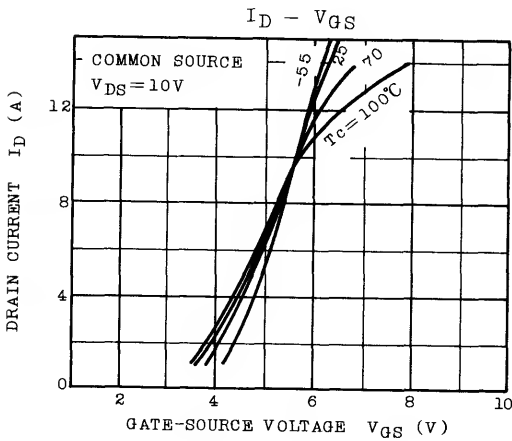
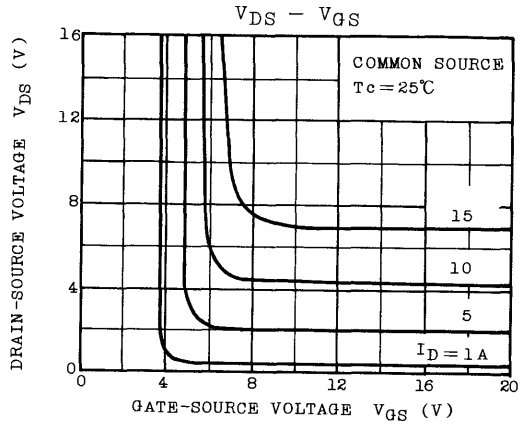
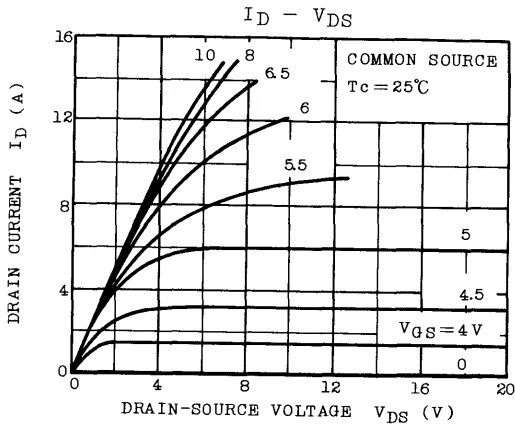
Unit in mm

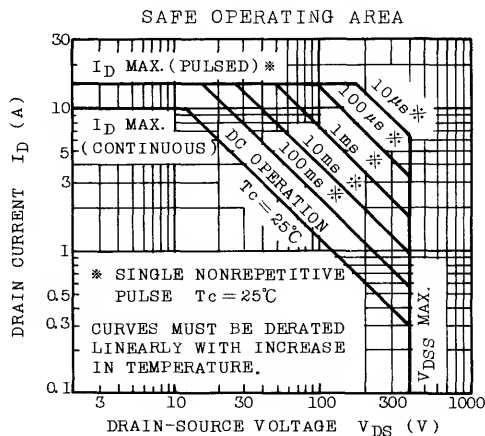
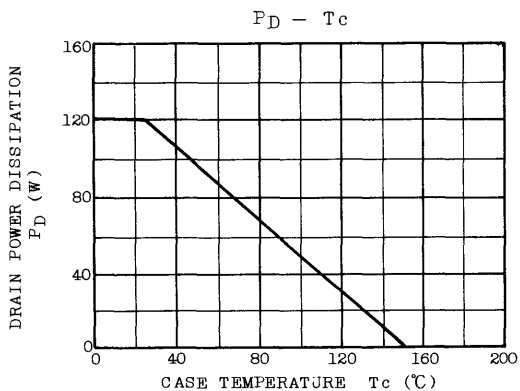
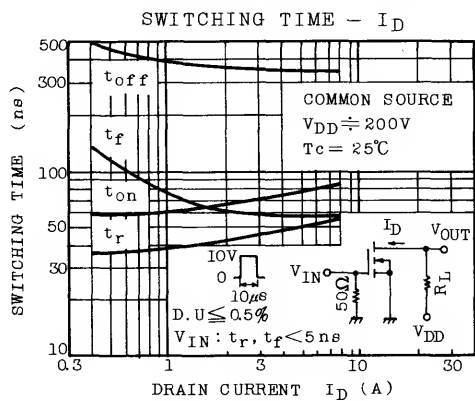
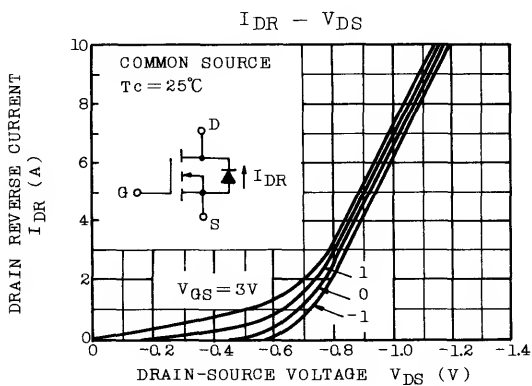
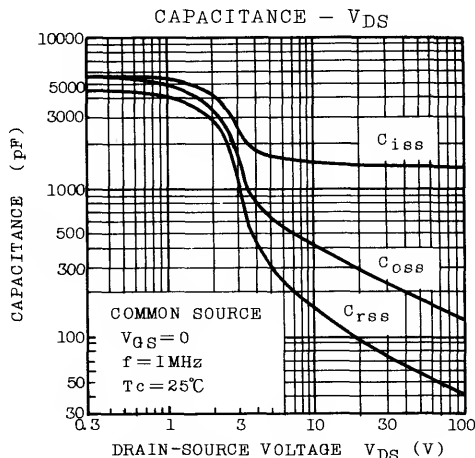
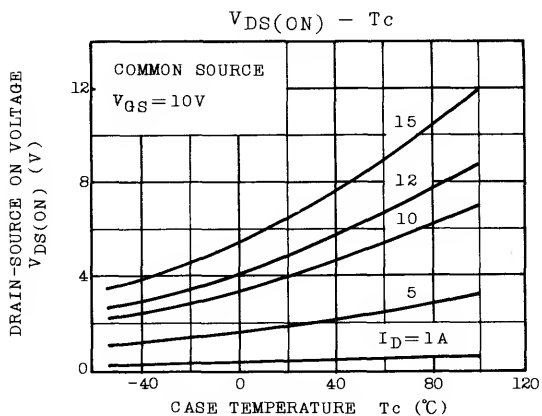


Weight : 15.8g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Gate Leakage Current	I_{GSS}	$V_{GS}=\pm 20V, V_{DS}=0$	-	-	± 100	nA	
Drain Cut-off Current	I_{DSS}	$V_{DS}=400V, V_{GS}=0$	-	-	1.0	mA	
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	$I_D=10mA, V_{GS}=0$	400	-	-	V	
Gate Threshold Voltage	V_{th}	$V_{DS}=10V, I_D=1mA$	1.5	-	3.5	V	
Forward Transfer Admittance	$ Y_{fs} $	$V_{DS}=10V, I_D=5A$	3.0	5.0	-	S	
Drain-Source ON Resistance	$R_{DS(ON)}$	$I_D=5A, V_{GS}=10V$	-	0.45	0.6	Ω	
Drain-Source ON Voltage	$V_{DS(ON)}$	$I_D=10A, V_{GS}=10V$	-	5	7	V	
Input Capacitance	C_{iss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	1500	2000	pF	
Reverse Transfer Capacitance	C_{rss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	140	300	pF	
Output Capacitance	C_{oss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	400	600	pF	
Switching Time	Rise Time	t_r		-	50	100	ns
	Turn-on Time	t_{on}		-	80	150	ns
	Fall Time	t_f		-	80	150	ns
	Turn-off Time	t_{off}		-	350	700	ns





2SK325

SILICON N CHANNEL MOS TYPE (7-MOS)

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.
SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

FEATURES:

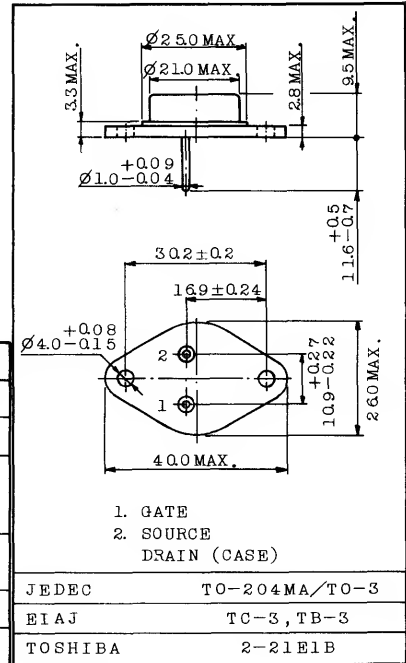
- High Breakdown Voltage : $V_{(BR)DSS}=450V$
- High Forward Transfer Admittance : $|Y_{fs}|=5S(\text{Typ.})$
- Low Leakage Current : $I_{GSS}=\pm 100nA(\text{Max.}) @ V_{GS}=\pm 20V$
 $I_{DSS}=1mA(\text{Max.}) @ V_{DS}=450V$
- Enhancement-Mode : $V_{th}=1.5 \sim 3.5V @ I_D=1mA$

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	450	V
Gate-Source Voltage		V_{GSS}	± 20	V
Drain Current	DC	I_D	10	A
	Pulse	I_{DP}	15	
Drain Power Dissipation (Tc=25°C)		P_D	120	W
Channel Temperature		T_{ch}	150	°C
Storage Temperature Range		T_{stg}	-65 ~ 150	°C

INDUSTRIAL APPLICATIONS

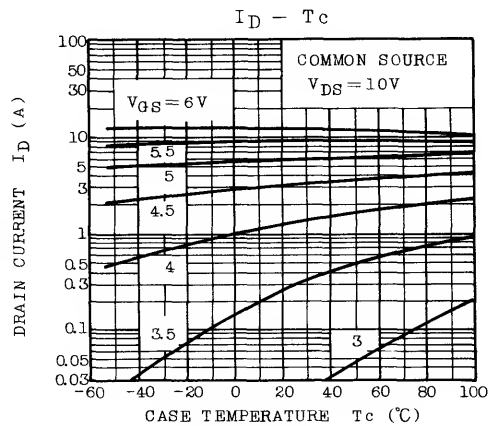
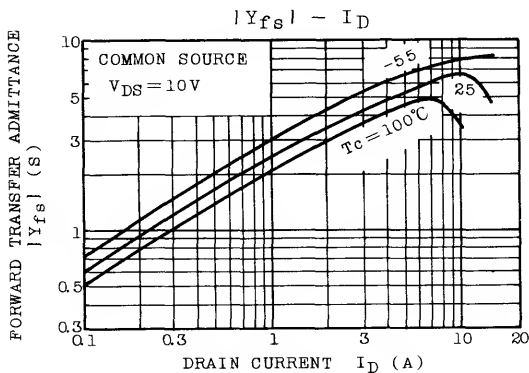
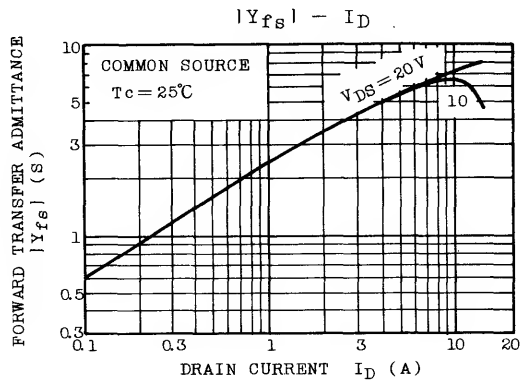
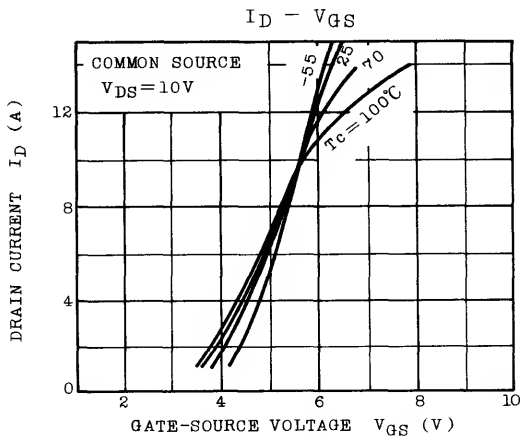
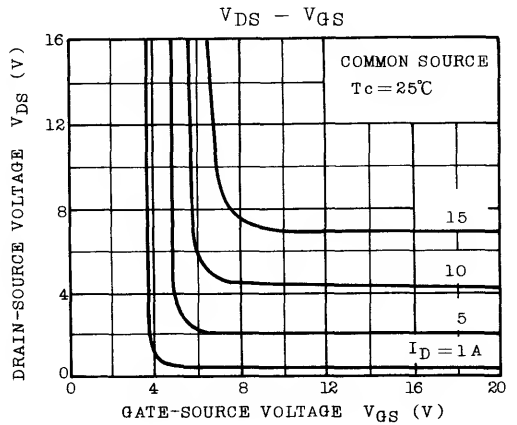
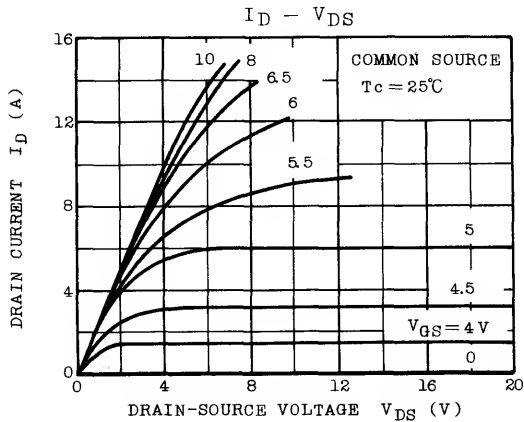
Unit in mm



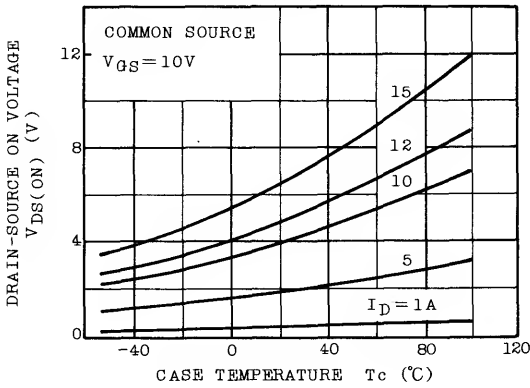
Weight : 15.8g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

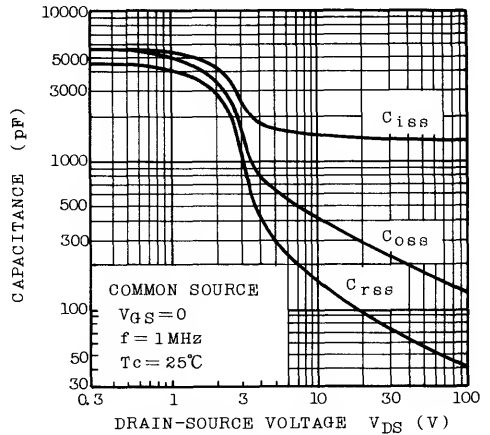
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	$V_{GS}=\pm 20V, V_{DS}=0$	-	-	± 100	nA
Drain Cut-off Current		I_{DSS}	$V_{DS}=450V, V_{GS}=0$	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	$I_D=10mA, V_{GS}=0$	450	-	-	V
Gate Threshold Voltage		V_{th}	$V_{DS}=10V, I_D=1mA$	1.5	-	3.5	V
Forward Transfer Admittance		$ Y_{fs} $	$V_{DS}=10V, I_D=5A$	3.0	5.0	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	$I_D=5A, V_{GS}=10V$	-	0.5	0.7	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	$I_D=10A, V_{GS}=10V$	-	5.5	8	V
Input Capacitance		C_{iss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	1500	2000	pF
Reverse Transfer Capacitance		C_{rss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	140	300	pF
Output Capacitance		C_{oss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	400	600	pF
Switching Time	Rise Time	t_r		-	50	100	ns
	Turn-on Time	t_{on}		-	80	150	ns
	Fall Time	t_f		-	80	150	ns
	Turn-off Time	t_{off}		-	350	700	ns



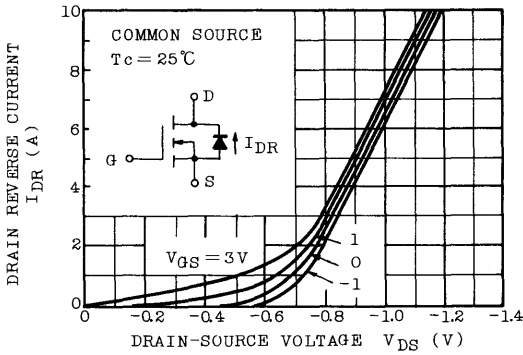
$V_{DS(ON)} - T_c$



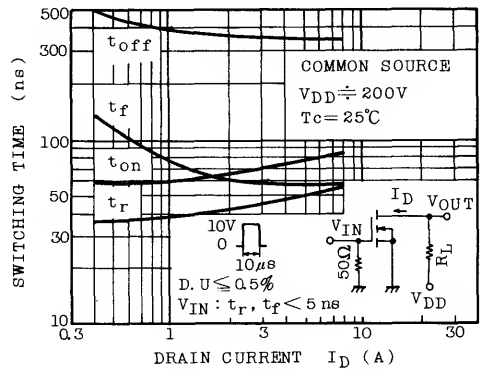
CAPACITANCE - V_{DS}



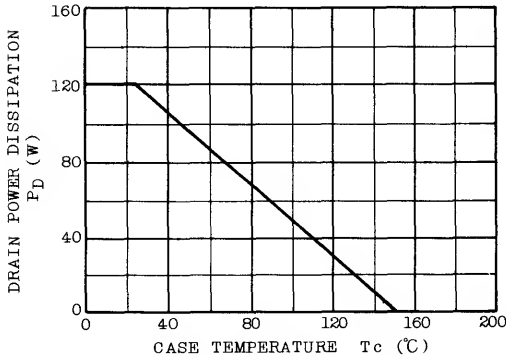
$I_{DR} - V_{DS}$



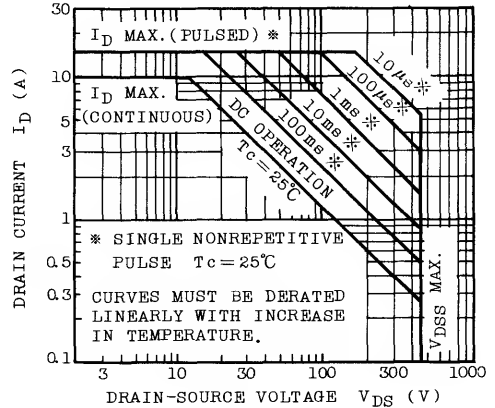
SWITCHING TIME - I_D



$P_D - T_c$



SAFE OPERATING AREA



HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.
 SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

FEATURES:

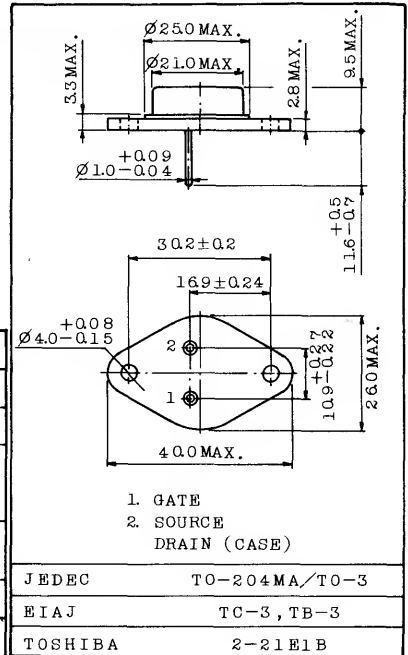
- . Low Drain-Source ON Resistance : $R_{DS(ON)}=0.12\Omega(\text{Typ.})$
- . High Forward Transfer Admittance : $|Y_{fs}|=6S(\text{Typ.})$
- . Low Leakage Current : $I_{GSS}=\pm 100\text{nA}(\text{Max.})$ @ $V_{GS}=\pm 20V$
 $I_{DSS}=1\text{mA}(\text{Max.})$ @ $V_{DS}=150V$
- . Enhancement-Mode : $V_{th}=1.5\sim 3.5V$ @ $I_D=1\text{mA}$

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V _{DSX}	150	V
Gate-Source Voltage	V _{GSS}	±20	V
Drain Current	DC	I _D	12
	Pulse	I _{DP}	40
Drain Power Dissipation (Tc=25°C)	P _D	120	W
Channel Temperature	T _{ch}	150	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C

INDUSTRIAL APPLICATIONS

Unit in mm



Weight : 15.8g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current	I _{GSS}	V _{GS} =±20V, V _{DS} =0	-	-	±100	nA
Drain Cut-off Current	I _{DSS}	V _{DS} =150V, V _{GS} =0	-	-	1.0	mA
Drain-Source Breakdown Voltage	V(BR) _{DSS}	I _D =10mA, V _{GS} =0	150	-	-	V
Gate Threshold Voltage	V _{th}	V _{DS} =10V, I _D =1mA	1.5	-	3.5	V
Forward Transfer Admittance	Y _{fs}	V _{DS} =10V, I _D =10A	3	6	-	S
Drain-Source ON Resistance	R _{DS(ON)}	I _D =10A, V _{GS} =10V	-	0.12	0.18	Ω
Drain-Source ON Voltage	V _{DS(ON)}	I _D =10A, V _{GS} =10V	-	1.2	1.8	V
Input Capacitance	C _{iss}	V _{DS} =10V, V _{GS} =0, f=1MHz	-	1600	2200	pF
Reverse Transfer Capacitance	C _{rss}	V _{DS} =10V, V _{GS} =0, f=1MHz	-	350	600	pF
Output Capacitance	C _{oss}	V _{DS} =10V, V _{GS} =0, f=1MHz	-	800	1300	pF
Switching Time	Rise Time	t _r	-	120	260	ns
	Turn-on Time	t _{on}	-	150	300	ns
	Fall Time	t _f	-	120	240	ns
	Turn-off Time	t _{off}	-	300	600	ns

2SK356

SILICON N CHANNEL MOS TYPE (π -MOS)

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.
SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR
DRIVE APPLICATIONS.

FEATURES:

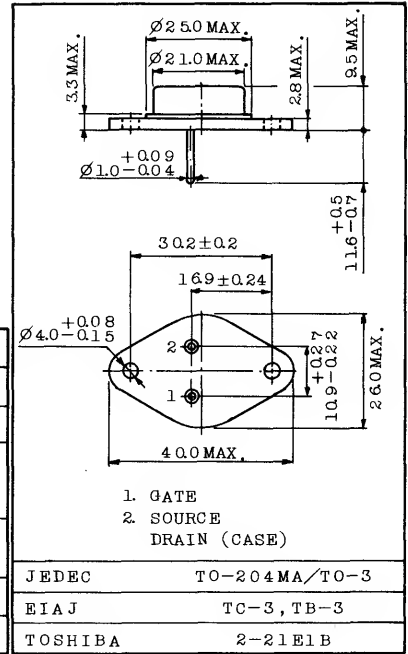
- Low Drain-Source ON Resistance : $R_{DS(ON)}=0.2\Omega$ (Typ.)
- High Forward Transfer Admittance : $|Y_{fs}|=6S$ (Typ.)
- Low Leakage Current : $I_{GSS}=\pm 100nA$ (Max.) @ $V_{GS}=\pm 20V$
 $I_{DSS}=1mA$ (Max.) @ $V_{DS}=250V$
- Enhancement-Mode : $V_{th}=1.5\sim 3.5V$ @ $I_D=1mA$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	250	V
Gate-Source Voltage		V_{GSS}	± 20	V
Drain Current	DC	I_D	12	A
	Pulse	I_{DP}	30	
Drain Power Dissipation ($T_c=25^\circ C$)		P_D	120	W
Channel Temperature		T_{ch}	150	$^\circ C$
Storage Temperature Range		T_{stg}	-65 ~ 150	$^\circ C$

INDUSTRIAL APPLICATIONS

Unit in mm



Weight : 15.8g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	$V_{GS}=\pm 20V, V_{DS}=0$	-	-	± 100	nA
Drain Cut-off Current		I_{DSS}	$V_{DS}=250V, V_{GS}=0$	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V(BR)_{DSS}$	$I_D=10mA, V_{GS}=0$	250	-	-	V
Gate Threshold Voltage		V_{th}	$V_{DS}=10V, I_D=1mA$	1.5	-	3.5	V
Forward Transfer Admittance		$ Y_{fs} $	$V_{DS}=10V, I_D=10A$	3	6	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	$I_D=10A, V_{GS}=10V$	-	0.2	0.25	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	$I_D=10A, V_{GS}=10V$	-	2.0	2.5	V
Input Capacitance		C_{iss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	1600	2000	pF
Reverse Transfer Capacitance		C_{rss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	220	320	pF
Output Capacitance		C_{oss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	570	700	pF
Switching Time	Rise Time	t_r	<p>$I_D=10A$ $V_{IN}: t_r, t_f < 5ns$ $V_{DD}=200V$ $D, U \le 1\%$ ($Z_{OUT}=50\Omega$)</p>	-	110	220	ns
	Turn-on Time	t_{on}		-	130	260	ns
	Fall Time	t_f		-	100	200	ns
	Turn-off Time	t_{off}		-	320	640	ns

INDUSTRIAL APPLICATIONS

Unit in mm

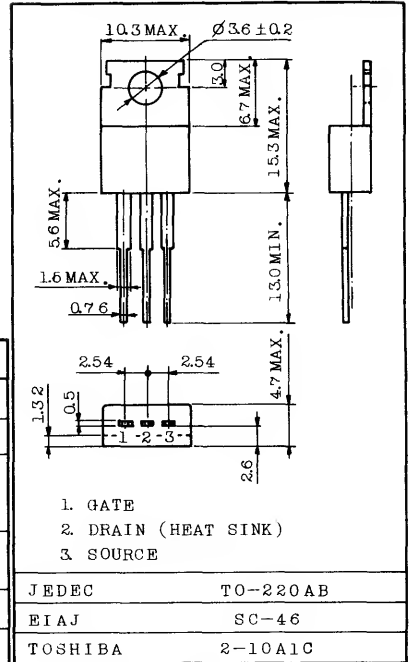
HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.
DC-DC CONVERTER, MOTOR AND SOLENOID DRIVE APPLICATIONS.

FEATURES:

- Low Drain-Source ON Resistance : $R_{DS(ON)}=0.6\Omega$ (Typ.)
- High Forward Transfer Admittance: $|Y_{fs}|=1.8S$ (Typ.)
- High Drain Current : $I_{DP}=8A$ (Max.)
- Low Leakage Current: $I_{GSS}=\pm 100nA$ (Max.) @ $V_{GS}=\pm 20V$
 $I_{DSS}=1mA$ (Max.) @ $V_{DS}=150V$
- Enhancement-Mode : $V_{th}=1.5 \sim 3.5V$ @ $I_D=1mA$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	150	V
Gate-Source Voltage		V_{GSS}	± 20	V
Drain Current	DC	I_D	5	A
	Pulse	I_{DP}	8	
Drain Power Dissipation ($T_c=25^\circ C$)		P_D	40	W
Channel Temperature		T_{ch}	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$

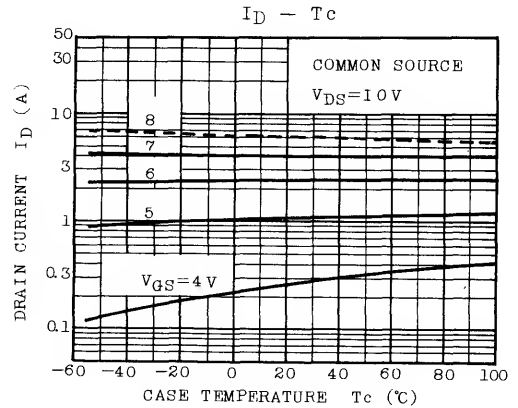
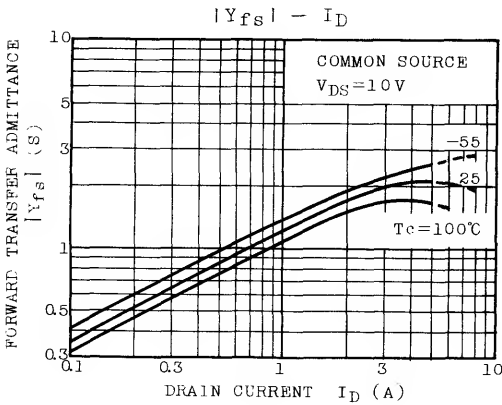
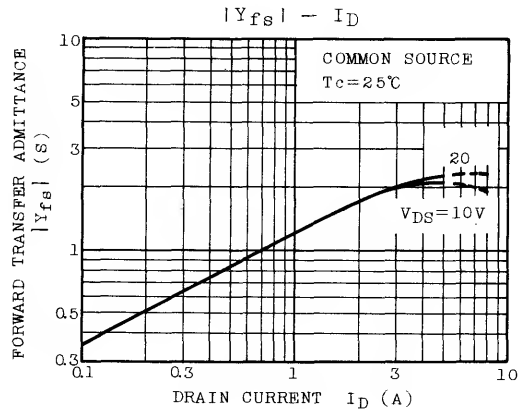
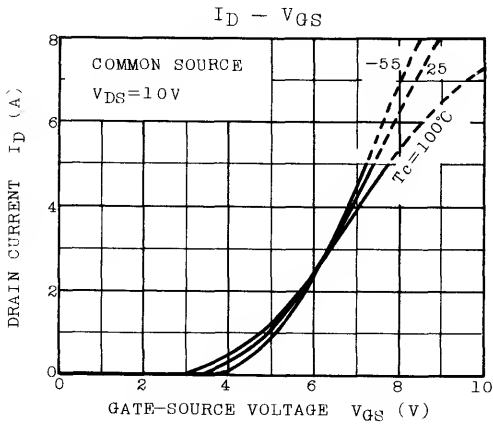
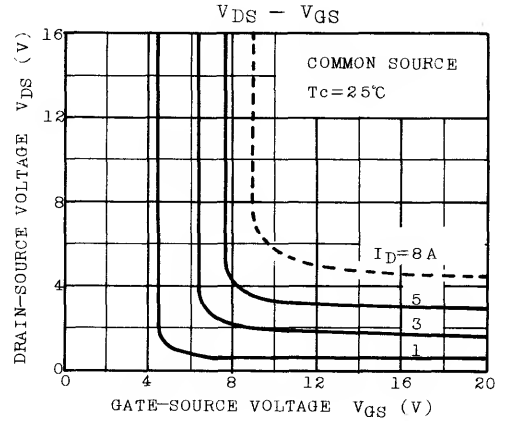
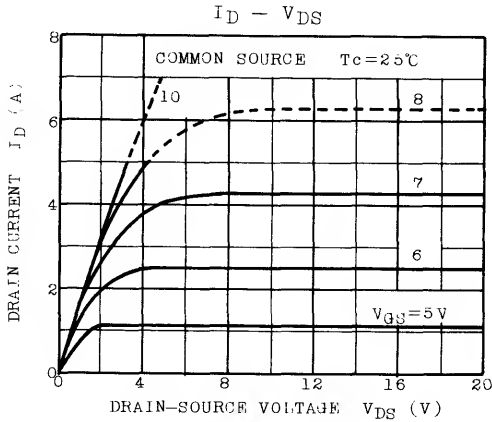


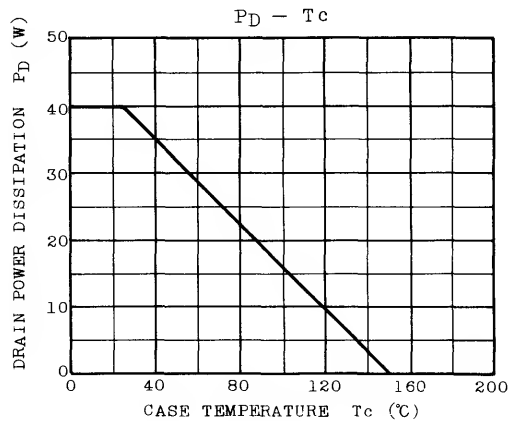
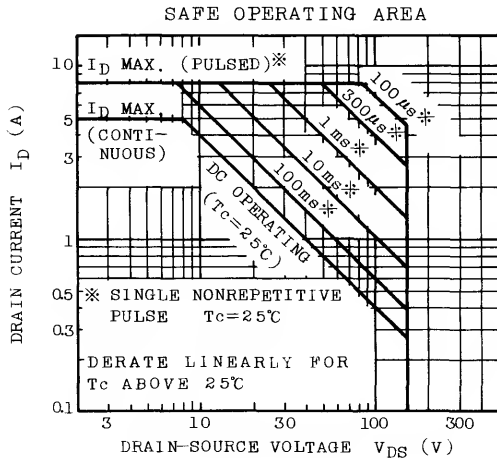
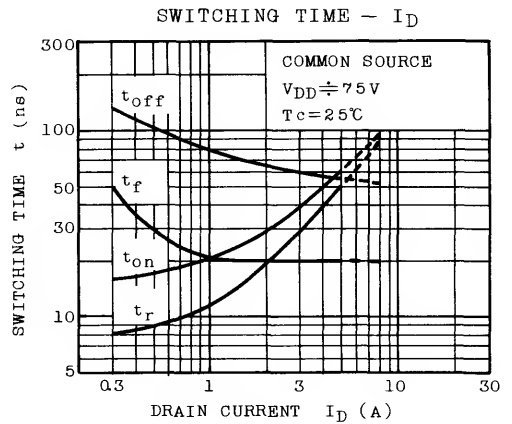
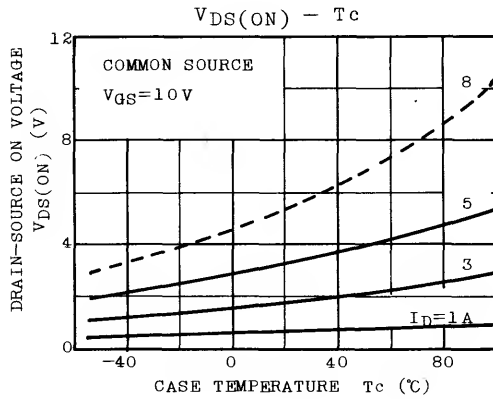
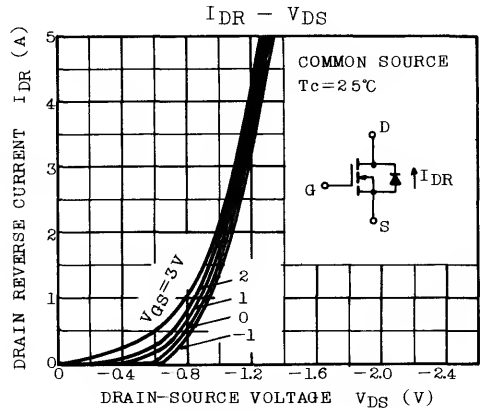
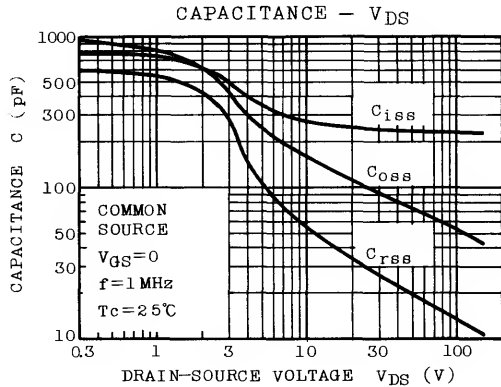
Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	$V_{GS}=\pm 20V, V_{DS}=0$	-	-	± 100	nA
Drain Cut-off Current		I_{DSS}	$V_{DS}=150V, V_{GS}=0$	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	$I_D=10mA, V_{GS}=0$	150	-	-	V
Gate Threshold Voltage		V_{th}	$V_{DS}=10V, I_D=1mA$	1.5	-	3.5	V
Forward Transfer Admittance		$ Y_{fs} $	$V_{DS}=10V, I_D=3A$	0.8	1.8	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	$I_D=3A, V_{GS}=10V$	-	0.6	0.9	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	$I_D=8A, V_{GS}=10V$	-	5.5	9.5	V
Input Capacitance		C_{iss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	260	350	pF
Reverse Transfer Capacitance		C_{rss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	50	100	pF
Output Capacitance		C_{oss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	160	250	pF
Switching Time	Rise Time	t_r		-	30	60	ns
	Turn-on Time	t_{on}		-	40	80	
	Fall Time	t_f		-	20	50	
	Turn-off Time	t_{off}		-	60	120	

THIS TRANSISTOR IS THE ELECTROSTATIC SENSITIVE DEVICE. PLEASE HANDLE WITH CAUTION.





2SK358

SILICON N CHANNEL MOS TYPE (π -MOS)

INDUSTRIAL APPLICATIONS

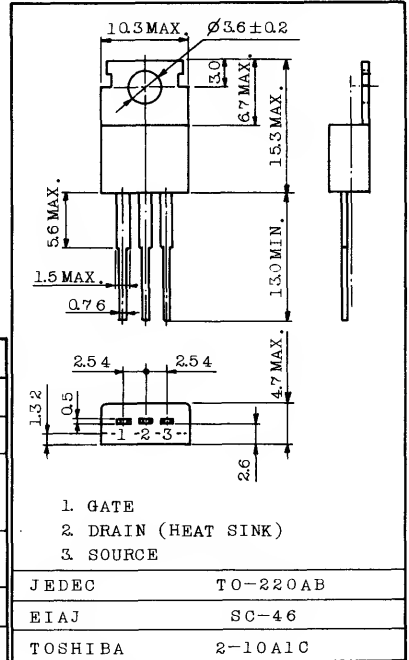
Unit in mm

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.

DC-DC CONVERTER, MOTOR AND SOLENOID DRIVE APPLICATIONS.

FEATURES:

- . Low Drain-Source ON Resistance : $R_{DS(ON)}=0.7\Omega$ (Typ.)
- . High Forward Transfer Admittance : $|Y_{fs}|=2.3S$ (Typ.)
- . High Drain Current : $I_{DP}=8A$ (Max.)
- . Low Leakage Current: $I_{GSS}=\pm 100nA$ (Max.) @ $V_{GS}=\pm 20V$
 $I_{DSS}=1mA$ (Max.) @ $V_{DS}=250V$
- . Enhancement-Mode : $V_{th}=1.5\sim 3.5V$ @ $I_D=1mA$



MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	250	V
Gate-Source Voltage		V_{GSS}	± 20	V
Drain Current	DC	I_D	5	A
	Pulse	I_{DP}	8	
Drain Power Dissipation ($T_c=25^\circ C$)		P_D	40	W
Channel Temperature		T_{ch}	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$

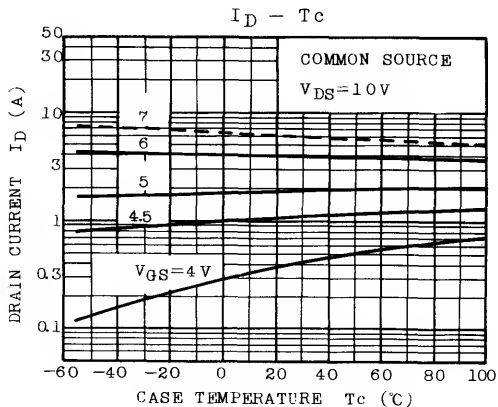
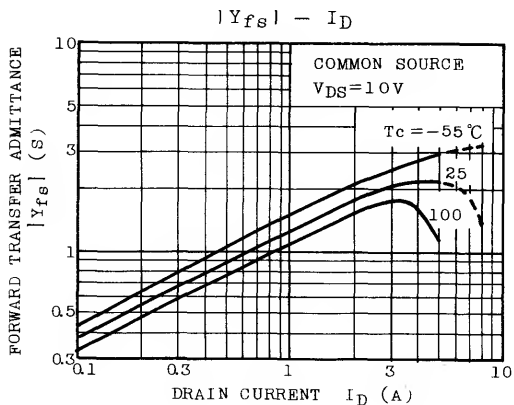
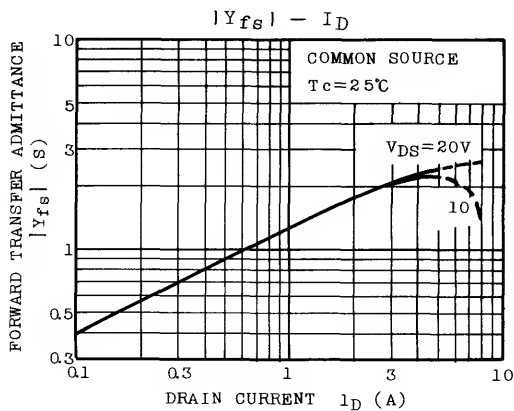
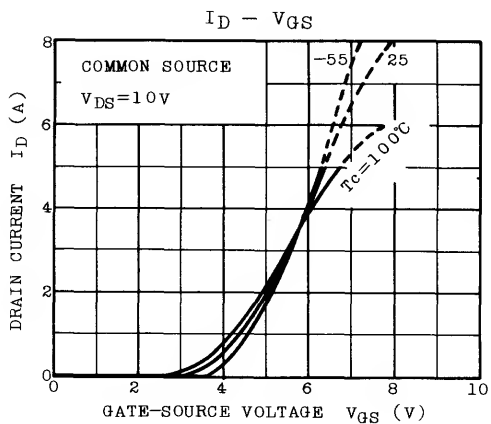
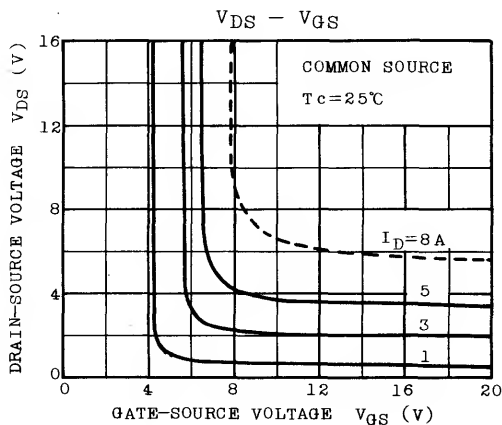
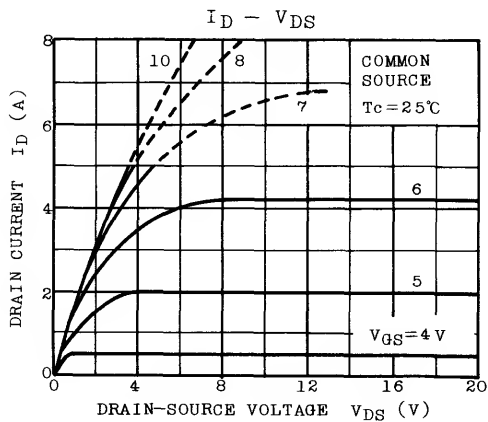
Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

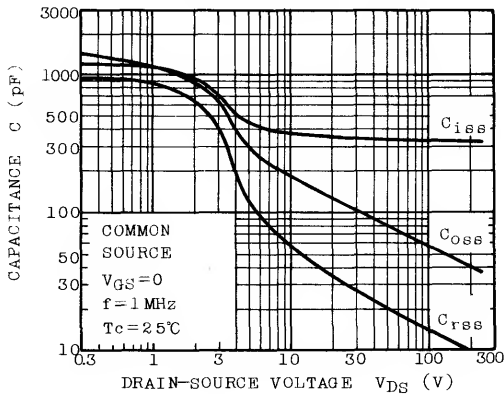
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	$V_{GS}=\pm 20V, V_{DS}=0$	-	-	± 100	nA
Drain Cut-off Current		I_{DSS}	$V_{DS}=250V, V_{GS}=0$	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	$I_D=10mA, V_{GS}=0$	250	-	-	V
Gate Threshold Voltage		V_{th}	$V_{DS}=10V, I_D=1mA$	1.5	-	3.5	V
Forward Transfer Admittance		$ Y_{fs} $	$V_{DS}=10V, I_D=3A$	1.0	2.3	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	$I_D=3A, V_{GS}=10V$	-	0.7	1.0	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	$I_D=8A, V_{GS}=10V$	-	6.5	12	V
Input Capacitance		C_{iss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	380	500	pF
Reverse Transfer Capacitance		C_{rss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	60	120	pF
Output Capacitance		C_{oss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	185	300	pF
Switching Time	Rise Time	t_r		-	20	40	ns
	Turn-on Time	t_{on}		-	30	60	
	Fall Time	t_f		-	30	60	
	Turn-off Time	t_{off}		-	80	160	

THIS TRANSISTOR IS THE ELECTROSTATIC SENSITIVE DEVICE. PLEASE HANDLE WITH CAUTION.

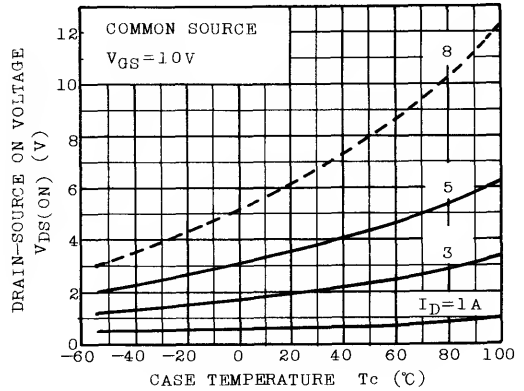
TOSHIBA CORPORATION



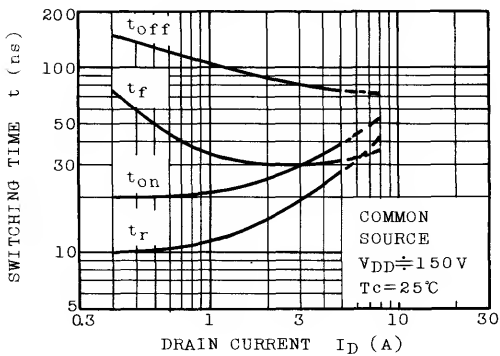
CAPACITANCE - V_{DS}



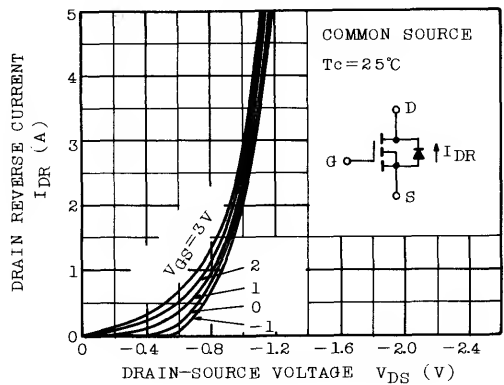
$V_{DS(ON)} - T_c$



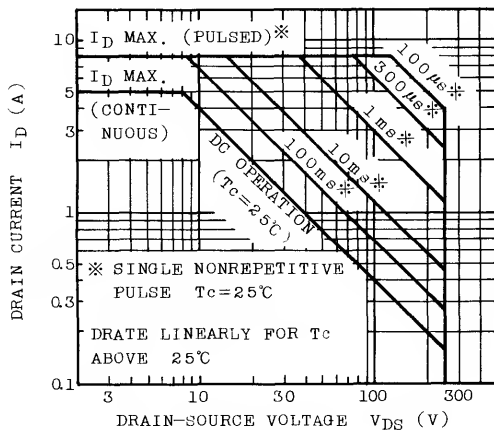
SWITCHING TIME - I_D



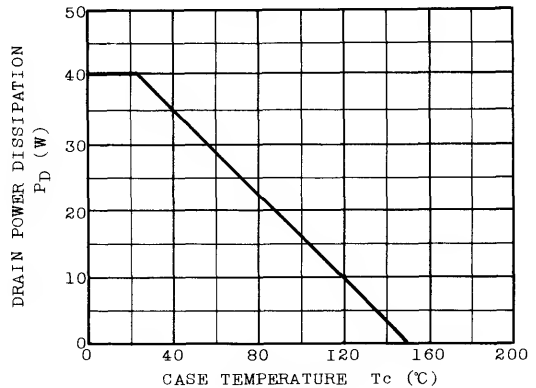
$I_{DR} - V_{DS}$



SAFE OPERATING AREA



$P_D - T_c$



HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.
SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

FEATURES:

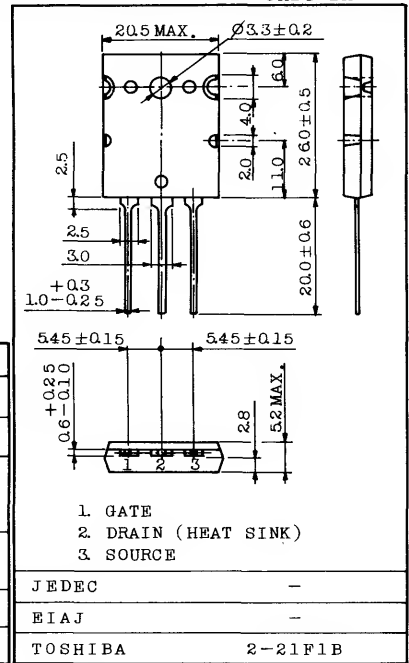
- . High Breakdown Voltage : $V_{(BR)DSS}=400V$
- . High Forward Transfer Admittance : $|Y_{fs}| = 5S$ (Typ.)
- . Low Leakage Current : $I_{GSS}=\pm 100nA$ (Max.) @ $V_{GS}=\pm 20V$
 $I_{DSS}=1mA$ (Max.) @ $V_{DS}=400V$
- . Enhancement-Mode : $V_{th}=1.5 \sim 3.5V$ @ $I_D=1mA$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	400	V
Gate-Source Voltage		V_{GSS}	± 20	V
Drain Current	DC	I_D	10	A
	Pulse	I_{DP}	15	A
Drain Power Dissipation ($T_c=25^\circ C$)		P_D	120	W
Channel Temperature		T_{ch}	150	$^\circ C$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^\circ C$

INDUSTRIAL APPLICATIONS

Unit in mm



Weight : 9.7g

ELECTRICAL CHARACTERISTICS $T_a=25^\circ C$

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	$V_{GS}=\pm 20V, V_{DS}=0$	-	-	± 100	nA
Drain Cut-off Current		I_{DSS}	$V_{DS}=400V, V_{GS}=0$	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	$I_D=10mA, V_{GS}=0$	400	-	-	V
Gate Threshold Voltage		V_{th}	$V_{DS}=10V, I_D=1mA$	1.5	-	3.5	V
Forward Transfer Admittance		$ Y_{fs} $	$V_{DS}=10V, I_D=5A$	3.0	5.0	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	$I_D=5A, V_{GS}=10V$	-	0.45	0.6	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	$I_D=10A, V_{GS}=10V$	-	5	7	V
Input Capacitance		C_{iss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	1500	2000	pF
Reverse Transfer Capacitance		C_{rss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	150	300	pF
Output Capacitance		C_{oss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	400	600	pF
Switching Time	Rise Time	t_r		-	50	100	ns
	Turn-on Time	t_{on}		-	80	150	ns
	Fall Time	t_f		-	80	150	ns
	Turn-off Time	t_{off}		-	350	700	ns

$V_{IN}: t_r, t_f < 5ns$
 $D, U \leq 1\%$ ($Z_{OUT}=50\Omega$)

2SK386

SILICON N CHANNEL MOS TYPE (π -MOS)

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.
SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

FEATURES:

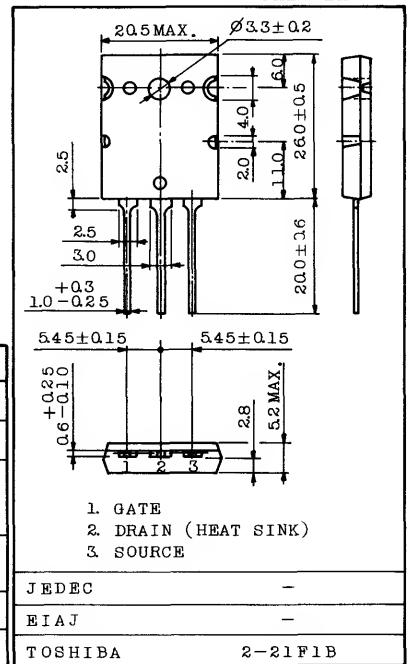
- High Breakdown Voltage : $V_{(BR)DSS}=450V$
- High Forward Transfer Admittance : $|Y_{fs}|=5S$ (Typ.)
- Low Leakage Current : $I_{GSS}=\pm 100nA$ (Max.) @ $V_{GS}=\pm 20V$
 $I_{DSS}=1mA$ (Max.) @ $V_{DS}=450V$
- Enhancement-Mode : $V_{th}=1.5\sim 3.5V$ @ $I_D=1mA$

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	450	V
Gate-Source Voltage		V_{GSS}	± 20	V
Drain Current	DC	I_D	10	A
	Pulse	I_{DP}	15	
Drain Power Dissipation (Tc=25°C)		P_D	120	W
Channel Temperature		T_{ch}	150	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

INDUSTRIAL APPLICATIONS

Unit in mm



Weight : 9.7g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	$V_{GS}=\pm 20V, V_{DS}=0$	-	-	± 100	nA
Drain Cut-off Current		I_{DSS}	$V_{DS}=450V, V_{GS}=0$	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	$I_D=10mA, V_{GS}=0$	450	-	-	V
Gate Threshold Voltage		V_{th}	$V_{DS}=10V, I_D=1mA$	1.5	-	3.5	V
Forward Transfer Admittance		$ Y_{fs} $	$V_{DS}=10V, I_D=5A$	3.0	5.0	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	$I_D=5A, V_{GS}=10V$	-	0.5	0.7	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	$I_D=10A, V_{GS}=10V$	-	5.5	8	V
Input Capacitance		C_{iss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	1600	2000	pF
Reverse Transfer Capacitance		C_{rss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	140	300	pF
Output Capacitance		C_{oss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	400	600	pF
Switching Time	Rise Time	t_r		-	50	100	ns
	Turn-on Time	t_{on}		-	80	150	ns
	Fall Time	t_f		-	80	150	ns
	Turn-off Time	t_{off}		-	350	700	ns

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.
 SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

FEATURES:

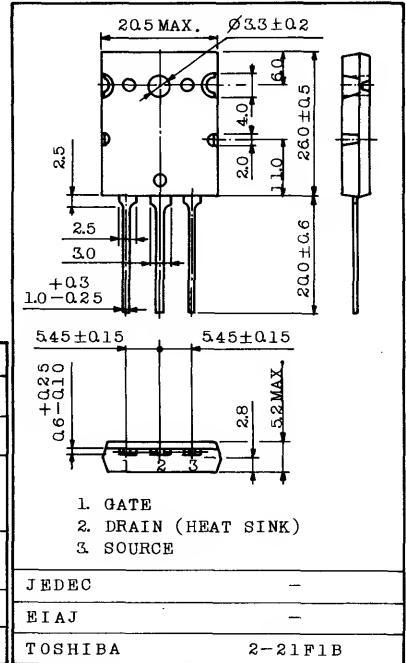
- . Low Drain-Source ON Resistance : $R_{DS(ON)}=0.12\Omega$ (Typ.)
- . High Forward Transfer Admittance : $|Y_{fs}|=6S$ (Typ.)
- . Low Leakage Current : $I_{GSS}=\pm 100nA$ (Max.) @ $V_{GS}=\pm 20V$
 $I_{DSS}=1mA$ (Max.) @ $V_{DS}=150V$
- . Enhancement-Mode : $V_{th}=1.5\sim 3.5V$ @ $I_D=1mA$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	150	V
Gate-Source Voltage		V_{GSS}	± 20	V
Drain Current	DC	I_D	12	A
	Pulse	I_{DP}	40	
Drain Power Dissipation ($T_c=25^\circ C$)		P_D	150	W
Channel Temperature		T_{ch}	150	$^\circ C$
Storage Temperature Range		T_{stg}	$-55\sim 150$	$^\circ C$

INDUSTRIAL APPLICATIONS

Unit in mm



Weight : 9.7g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	$V_{GS}=\pm 20V, V_{DS}=0$	-	-	± 100	nA
Drain Cut-off Current		I_{DSS}	$V_{DS}=150V, V_{GS}=0$	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	$I_D=10mA, V_{GS}=0$	150	-	-	V
Gate Threshold Voltage		V_{th}	$V_{DS}=10V, I_D=1mA$	1.5	-	3.5	V
Forward Transfer Admittance		$ Y_{fs} $	$V_{DS}=10V, I_D=10A$	3	6	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	$I_D=10A, V_{GS}=10V$	-	0.12	0.18	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	$I_D=10A, V_{GS}=10V$	-	1.2	1.8	V
Input Capacitance		C_{iss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	1600	2200	pF
Reverse Transfer Capacitance		C_{rss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	350	600	pF
Output Capacitance		C_{oss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	800	1300	pF
Switching Time	Rise Time	t_r		-	120	260	ns
	Turn-on Time	t_{on}		-	150	300	ns
	Fall Time	t_f		-	120	240	ns
	Turn-off Time	t_{off}		-	300	600	ns

2SK388

SILICON N CHANNEL MOS TYPE (π -MOS)

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.
SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

FEATURES:

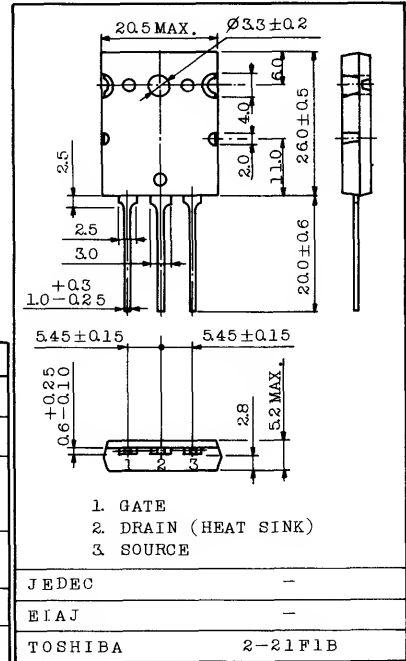
- Low Drain-Source ON Resistance : $R_{DS(ON)}=0.2\Omega$ (Typ.)
- High Forward Transfer Admittance : $|Y_{fs}|=6S$ (Typ.)
- Low Leakage Current : $I_{GSS}=\pm 100nA$ (Max.) @ $V_{GS}=\pm 20V$
 $I_{DSS}=1mA$ (Max.) @ $V_{DS}=250V$
- Enhancement-Mode : $V_{th}=1.5\sim 3.5V$ @ $I_D=1mA$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	250	V
Gate-Source Voltage		V_{GSS}	± 20	V
Drain Current	DC	I_D	12	A
	Pulse	I_{DP}	30	
Drain Power Dissipation ($T_c=25^\circ C$)		P_D	150	W
Channel Temperature		T_{ch}	150	$^\circ C$
Storage Temperature Range		T_{stg}	$-55\sim 150$	$^\circ C$

INDUSTRIAL APPLICATIONS

Unit in mm



Weight : 9.7g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

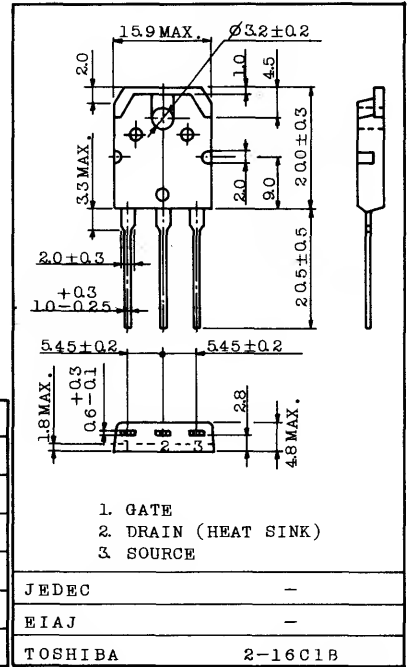
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	$V_{GS}=\pm 20V, V_{DS}=0$	-	-	± 100	nA
Drain Cut-off Current		I_{DSS}	$V_{DS}=250V, V_{GS}=0$	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V(BR)_{DSS}$	$I_D=10mA, V_{GS}=0$	250	-	-	V
Gate Threshold Voltage		V_{th}	$V_{DS}=10V, I_D=1mA$	1.5	-	3.5	V
Forward Transfer Admittance		$ Y_{fs} $	$V_{DS}=10V, I_D=10A$	3	6	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	$I_D=10A, V_{GS}=10V$	-	0.20	0.25	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	$I_D=10A, V_{GS}=10V$	-	2.0	2.5	V
Input Capacitance		C_{iss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	1600	2000	pF
Reverse Transfer Capacitance		C_{rss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	220	320	pF
Output Capacitance		C_{oss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	570	700	pF
Switching Time	Rise Time	t_r		-	110	220	ns
	Turn-on Time	t_{on}		-	130	260	ns
	Fall Time	t_f		-	100	200	ns
	Turn-off Time	t_{off}		-	320	640	ns

AUDIO FREQUENCY POWER AMPLIFIER APPLICATION.

Unit in mm

FEATURES:

- . High Breakdown Voltage : $V_{DSS}=160V$
- . High Forward Transfoer Admittance : $|Y_{fs}|=2.0S$ (Typ.)
- . Complementary to 2SJ115



MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DSS}	160	V
Gate-Source Voltage	V_{GSS}	± 20	V
Drain Current	I_D	8	A
Power Dissipation ($T_c=25^\circ C$)	P_D	100	W
Channel Temperature	T_{ch}	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$

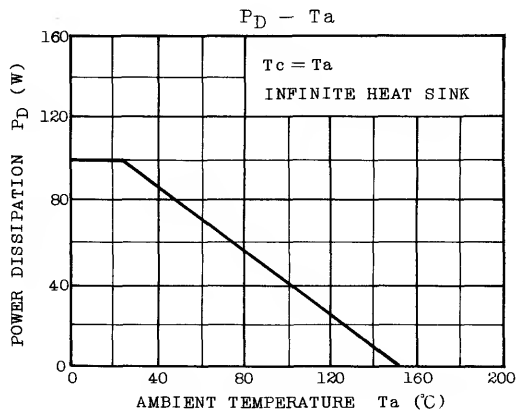
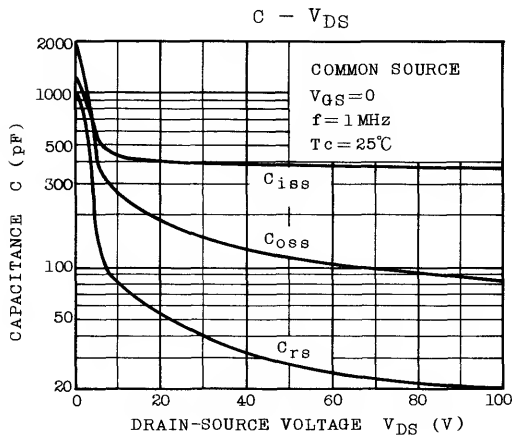
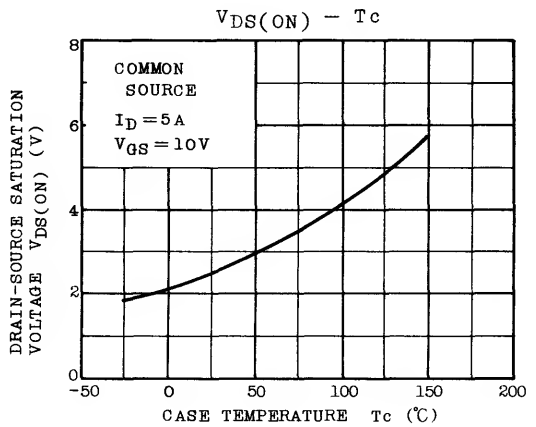
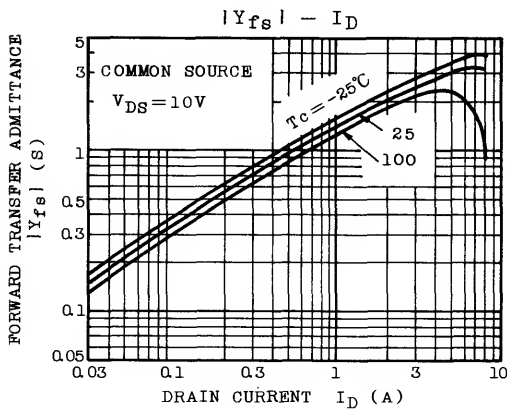
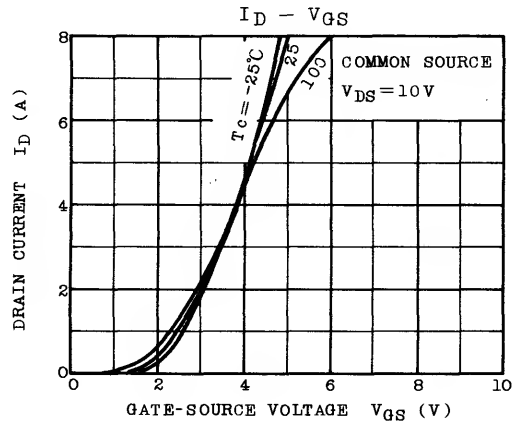
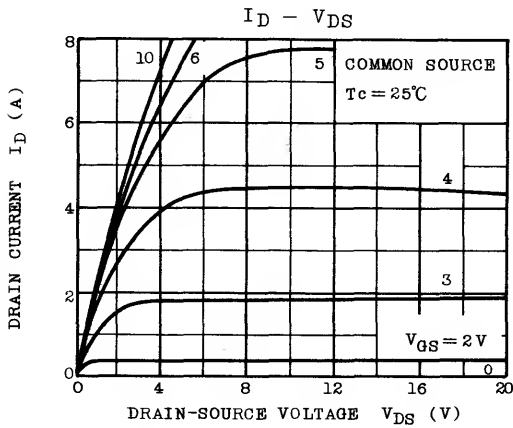
Weight : 4.6g

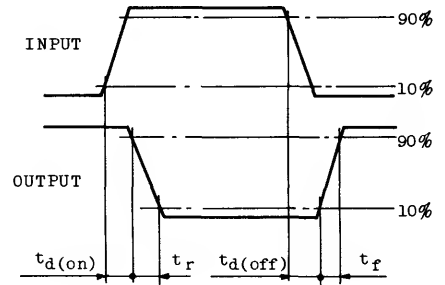
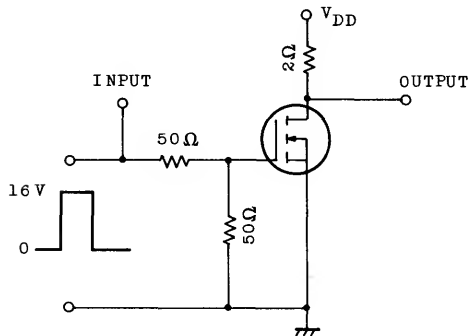
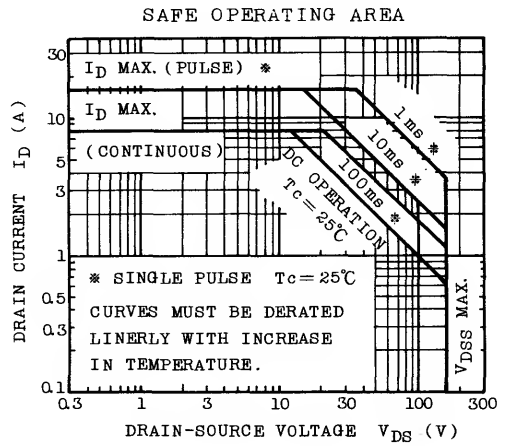
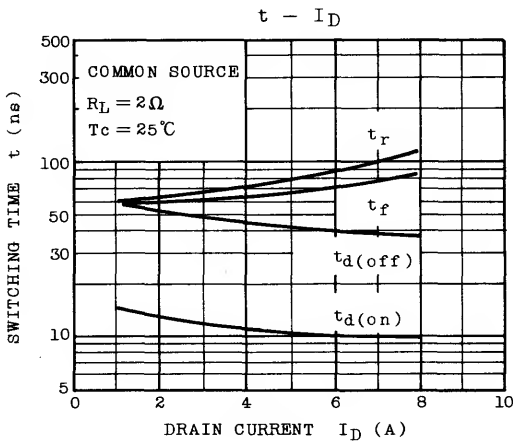
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current	I_{GSS}	$V_{DS}=0, V_{GS}=\pm 20V$	-	-	± 1.0	μA
Drain-Source Breakdwon Voltage	$V(BR)_{DSS}$	$I_D=5mA, V_{GS}=0$	160	-	-	V
Gate-Source Cut-off Voltage	$V_{GS(OFF)}$ (Note)	$V_{DS}=10V, I_D=0.1A$	0.8	-	2.8	V
Drain-Source Saturation Voltage	$V_{DS(ON)}$	$I_D=5A, V_{GS}=10V$	-	2.5	7.0	V
Forward Transfer Admittance	$ Y_{fs} $	$V_{DS}=10V, I_D=2A$	1.0	2.0	-	S
Input Capacitance	C_{iss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	430	-	pF
Output Capacitance	C_{oss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	260	-	pF
Reverse Transfer Capacitance	C_{rs}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	80	-	pF

Note : $V_{GS(OFF)}$ Classification O : 0.8 ~ 1.6, Y : 1.4 ~ 2.8

2SK405





2SK417

SILICON N CHANNEL MOS TYPE (π -MOS)

HIGH SPEED SWITCHING APPLICATIONS.

SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

FEATURES:

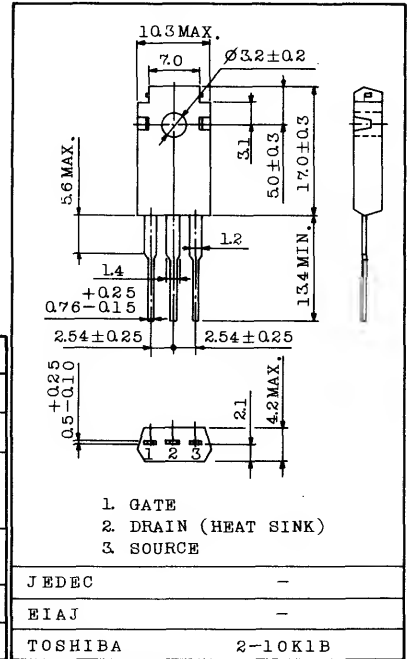
- Low Drain-Source ON Resistance : $R_{DS(ON)}=0.1\Omega$ (Typ.)
- High Forward Transfer Admittance : $|Y_{fs}|=4S$ (Typ.)
- Low Leakage Current : $I_{GSS}=\pm 100nA$ (Max.) @ $V_{GS}=\pm 20V$
 $I_{DSS}=1mA$ (Max.) @ $V_{DS}=60V$
- Enhancement-Mode : $V_{th}=1.5\sim 3.5V$ @ $I_D=1mA$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DSX}	60	V
Gate-Source Voltage	V_{GSS}	± 20	V
Drain Current	DC	I_D	10
	Pulse	I_{DP}	15
Drain Power Dissipation ($T_c=25^\circ C$)	P_D	60	W
Channel Temperature	T_{ch}	150	$^\circ C$
Storage Temperature Range	T_{stg}	$-55\sim 150$	$^\circ C$

INDUSTRIAL APPLICATIONS

Unit in mm



Weight : 2.0g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Gate Leakage Current	I_{GSS}	$V_{GS}=\pm 20V, V_{DS}=0$	-	-	± 100	nA	
Drain Cut-off Current	I_{DSS}	$V_{DS}=60V, V_{GS}=0$	-	-	1.0	mA	
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	$I_D=10mA, V_{GS}=0$	60	-	-	V	
Gate Threshold Voltage	V_{th}	$V_{DS}=10V, I_D=1mA$	1.5	-	3.5	V	
Forward Transfer Admittance	Y_{fs}	$V_{DS}=10V, I_D=5A$	2	4	-	S	
Drain-Source ON Resistance	$R_{DS(ON)}$	$I_D=5A, V_{GS}=10V$	-	0.10	0.14	Ω	
Drain-Source ON Voltage	$V_{DS(ON)}$	$I_D=10A, V_{GS}=10V$	-	1.0	1.5	V	
Input Capacitance	C_{iss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	850	1100	pF	
Reverse Transfer Capacitance	C_{rss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	370	600	pF	
Output Capacitance	C_{oss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	800	1100	pF	
Switching Time	Rise Time	t_r		-	100	200	ns
	Turn-on Time	t_{on}		-	120	240	ns
	Fall Time	t_f		-	85	170	ns
	Turn-off Time	t_{off}		-	160	320	ns

THIS TRANSISTOR IS THE ELECTROSTATIC SENSITIVE DEVICE. PLEASE HANDLE WITH CAUTION.

TOSHIBA CORPORATION

INDUSTRIAL APPLICATIONS

Unit in mm

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.

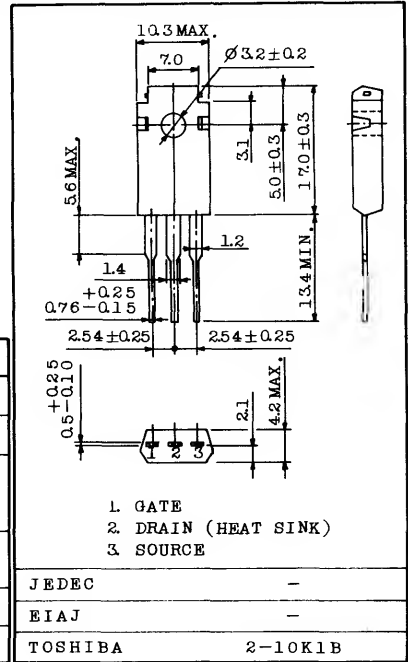
SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

FEATURES:

- . High Breakdown Voltage : $V_{(BR)DSS}=400V$
- . High Forward Transfer Admittance : $|Y_{fs}|=1.2S$ (Typ.)
- . Low Leakage Current : $I_{GSS}=\pm 100nA$ (Max.) @ $V_{GS}=\pm 20V$
 $I_{DSS}=1mA$ (Max.) @ $V_{DS}=400V$
- . Enhancement-Mode : $V_{th}=1.5 \sim 3.5V$ @ $I_D=1mA$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	400	V
Gate-Source Voltage		V_{GSS}	± 20	V
Drain Current	DC	I_D	2	A
	Pulse	I_{DP}	4	
Drain Power Dissipation ($T_c=25^\circ C$)		P_D	50	W
Channel Temperature		T_{ch}	150	$^\circ C$
Storage Temperature Range		T_{stg}	$-55 \sim 150$	$^\circ C$



Weight : 2.0g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	$V_{GS}=\pm 20V, V_{DS}=0$	-	-	± 100	nA
Drain Cut-off Current		I_{DSS}	$V_{DS}=400V, V_{GS}=0$	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	$I_D=10mA, V_{GS}=0$	400	-	-	V
Gate Threshold Voltage		V_{th}	$V_{DS}=10V, I_D=1mA$	1.5	-	3.5	V
Forward Transfer Admittance		$ Y_{fs} $	$V_{DS}=10V, I_D=1A$	0.6	1.2	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	$I_D=1A, V_{GS}=10V$	-	1.6	2.2	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	$I_D=4A, V_{GS}=10V$	-	8.5	12	V
Input Capacitance		C_{iss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	410	600	pF
Reverse Transfer Capacitance		C_{rss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	35	70	pF
Output Capacitance		C_{oss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	115	170	pF
Switching Time	Rise Time	t_r		-	15	30	ns
	Turn-on Time	t_{on}		-	30	60	ns
	Fall Time	t_f		-	30	60	ns
	Turn-off Time	t_{off}		-	100	200	ns

THIS TRANSISTOR IS THE ELECTROSTATIC SENSITIVE DEVICE. PLEASE HANDLE WITH CAUTION.

2SK419

SILICON N CHANNEL MOS TYPE (π -MOS)

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.
SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

FEATURES:

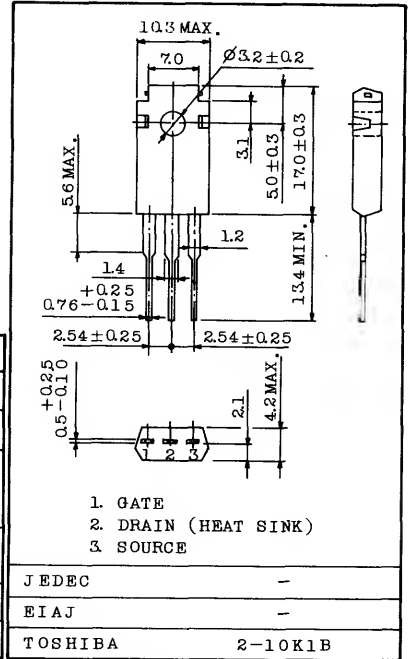
- High Brakdwon Voltage : $V_{(BR)DSS}=450V$
- High Forward Transfer Admittance : $|Y_{fs}|=1.2S$ (Typ.)
- Low Leakage Current : $I_{GSS}=\pm 100nA$ (Max.) @ $V_{GS}=\pm 20V$
 $I_{DSS}=1mA$ (Max.) @ $V_{DS}=450V$
- Enhancement-Mode : $V_{th}=1.5\sim 3.5V$ @ $I_D=1mA$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	450	V
Gate-Source Voltage		V_{GSS}	± 20	V
Drain Current	DC	I_D	2	A
	Pulse	I_{DP}	4	
Drain Power Dissipation ($T_c=25^\circ C$)		P_D	50	W
Channel Temperature		T_{ch}	150	$^\circ C$
Storage Temperature Range		T_{stg}	$-55\sim 150$	$^\circ C$

INDUSTRIAL APPLICATIONS

Unit in mm



Weight : 2.0g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	$V_{GS}=\pm 20V, V_{DS}=0$	-	-	± 100	nA
Drain Cut-off Current		I_{DSS}	$V_{DS}=450V, V_{GS}=0$	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	$I_D=10mA, V_{GS}=0$	450	-	-	V
Gate Threshold Voltage		V_{th}	$V_{DS}=10V, I_D=1mA$	1.5	-	3.5	V
Forward Transfer Admittance		$ Y_{fs} $	$V_{DS}=10V, I_D=1A$	0.6	1.2	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	$I_D=1A, V_{GS}=10V$	-	1.8	2.5	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	$I_D=4A, V_{GS}=10V$	-	9.0	14	V
Input Capacitance		C_{iss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	410	600	pF
Reverse Transfer Capacitance		C_{rss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	35	70	pF
Output Capacitance		C_{oss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	115	170	pF
Switching Time	Rise Time	t_r		-	15	30	ns
	Turn-on Time	t_{on}		-	30	60	ns
	Fall Time	t_f		-	30	60	ns
	Turn-off Time	t_{off}		-	100	200	ns

THIS TRANSISTOR IS THE ELECTROSTATIC SENSITIVE DEVICE. PLEASE HANDLE WITH CAUTION.

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.
 SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR
 DRIVE APPLICATIONS.

FEATURES:

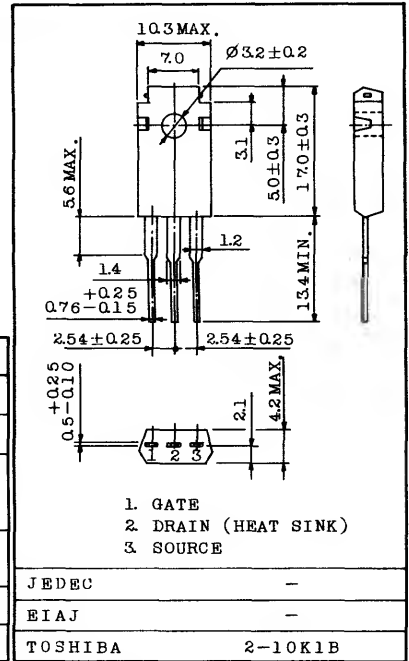
- . High Breakdown Voltage : $V_{(BR)DSS}=400V$
- . High Forward Transfer Admittance : $|Y_{fs}|=2.5S$ (Typ.)
- . Low Leakage Current : $I_{GSS}=\pm 100nA$ (Max.) @ $V_{GS}=\pm 20V$
 $I_{DSS}=1mA$ (Max.) @ $V_{DS}=400V$
- . Enhancement-Mode : $V_{th}=1.5 \sim 3.5V$ @ $I_D=1mA$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DSX}	400	V
Gate-Source Voltage	V_{GSS}	± 20	V
Drain Current	DC	I_D	5
	Pulse	I_{DP}	8
Drain Power Dissipation ($T_c=25^\circ C$)	P_D	60	W
Channel Temperature	T_{ch}	150	$^\circ C$
Storage Temperature Range	T_{stg}	$-55 \sim 150$	$^\circ C$

INDUSTRIAL APPLICATIONS

Unit in mm



Weight : 2.0g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Gate Leakage Current	I_{GSS}	$V_{GS}=\pm 20V, V_{DS}=0$	-	-	± 100	nA	
Drain Cut-off Current	I_{DSS}	$V_{DS}=400V, V_{GS}=0$	-	-	1.0	mA	
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	$I_D=10mA, V_{GS}=0$	400	-	-	V	
Gate Threshold Voltage	V_{th}	$V_{DS}=10V, I_D=1mA$	1.5	-	3.5	V	
Forward Transfer Admittance	$ Y_{fs} $	$V_{DS}=10V, I_D=3A$	1.0	2.5	-	S	
Drain-Source ON Resistance	$R_{DS(ON)}$	$I_D=3A, V_{GS}=10V$	-	1.0	1.4	Ω	
Drain-Source ON Voltage	$V_{DS(ON)}$	$I_D=8A, V_{GS}=10V$	-	10	18	V	
Input Capacitance	C_{iss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	670	900	pF	
Reverse Transfer Capacitance	C_{rss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	50	90	pF	
Output Capacitance	C_{oss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	180	250	pF	
Switching Time	Rise Time	t_r		-	25	50	ns
	Turn-on Time	t_{on}		-	40	80	ns
	Fall Time	t_f		-	35	70	ns
	Turn-off Time	t_{off}		-	140	280	ns

THIS TRANSISTOR IS THE ELECTROSTATIC SENSITIVE DEVICE. PLEASE HANDLE WITH CAUTION.

2SK421

SILICON N CHANNEL MOS TYPE (π -MOS)

HIGH SPEED, HIGH VOLTAGE SWITCHING APPLICATIONS.
SWITCHING REGULATOR, DC-DC CONVERTER AND MOTOR DRIVE APPLICATIONS.

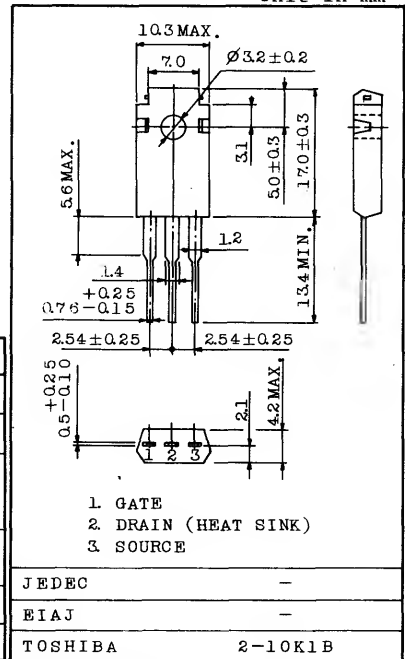
FEATURES:

- High Breakdown Voltage : $V_{(BR)DSS}=450V$
- High Forward Transfer Admittance : $|Y_{fs}|=2.5S$ (Typ.)
- Low Leakage Current : $I_{GSS}=\pm 100nA$ (Max.) @ $V_{GS}=\pm 20V$
 $I_{DSS}=1mA$ (Max.) @ $V_{DS}=450V$
- Enhancement-Mode : $V_{th}=1.5\sim 3.5V$ @ $I_D=1mA$

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Drain-Source Voltage		V_{DSX}	450	V
Gate-Source Voltage		V_{GSS}	± 20	V
Drain Current	DC	I_D	5	A
	Pulse	I_{DP}	8	
Drain Power Dissipation (Tc=25°C)		P_D	60	W
Channel Temperature		T_{ch}	150	°C
Storage Temperature Range		T_{stg}	-55 ~ 150	°C

INDUSTRIAL APPLICATIONS
Unit in mm



Weight : 2.0g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current		I_{GSS}	$V_{GS}=\pm 20V, V_{DS}=0$	-	-	± 100	nA
Drain Cut-off Current		I_{DSS}	$V_{DS}=450V, V_{GS}=0$	-	-	1.0	mA
Drain-Source Breakdown Voltage		$V_{(BR)DSS}$	$I_D=10mA, V_{GS}=0$	450	-	-	V
Gate Threshold Voltage		V_{th}	$V_{DS}=10V, I_D=1mA$	1.5	-	3.5	V
Forward Transfer Admittance		$ Y_{fs} $	$V_{DS}=10V, I_D=3A$	1.0	2.5	-	S
Drain-Source ON Resistance		$R_{DS(ON)}$	$I_D=3A, V_{GS}=10V$	-	1.1	1.6	Ω
Drain-Source ON Voltage		$V_{DS(ON)}$	$I_D=8A, V_{GS}=10V$	-	12	22	V
Input Capacitance		C_{iss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	670	900	pF
Reverse Transfer Capacitance		C_{rss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	50	90	pF
Output Capacitance		C_{oss}	$V_{DS}=10V, V_{GS}=0, f=1MHz$	-	180	250	pF
Switching Time	Rise Time	t_r		-	25	50	ns
	Turn-on Time	t_{on}		-	40	80	ns
	Fall Time	t_f		-	35	70	ns
	Turn-off Time	t_{off}		-	140	280	ns

THIS TRANSISTOR IS THE ELECTROSTATIC SENSITIVE DEVICE. PLEASE HANDLE WITH CAUTION.

TOSHIBA CORPORATION

2N
SERIES

GENERAL PURPOSE POWER TRANSISTOR.

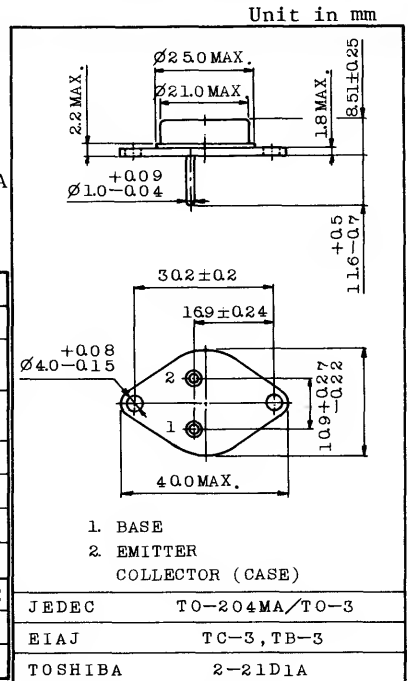
POWER REGULATOR, SWITCHING AND SOLLENOID DRIVES APPLICATIONS.

FEATURES:

- . High Gain at High Current
- . Low Saturation Voltage : $V_{CE(sat)} < 1.1V$, @ $I_C=4A, I_B=0.4A$
- . Excellent Area of Safe Operatings

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
* Collector-Base Voltage	V_{CBO}	100	V
* Collector-Emitter Sustaining Voltage ($R_{\theta\theta}=100 \Omega$)	$V_{CER(SUS)}$	70	V
* Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	60	V
* Emitter-Base Voltage	V_{EBO}	7	V
* Collector Current	I_C	15	A
* Base Current	I_B	7	A
* Collector Power Dissipation ($T_c=25^\circ C$) Derate Linearly	P_C	115	W
		0.66	W / $^\circ C$
* Junction Temperature	T_j	200	$^\circ C$
* Storage Temperature Range	T_{stg}	-65 ~ 200	$^\circ C$



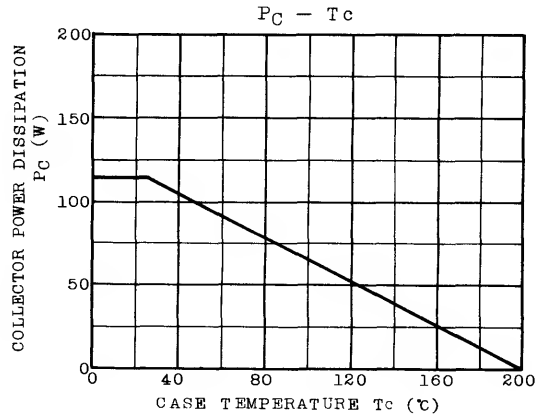
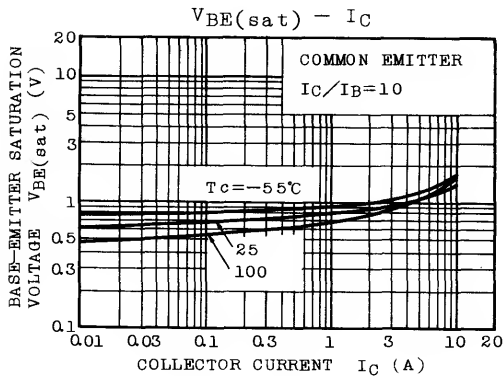
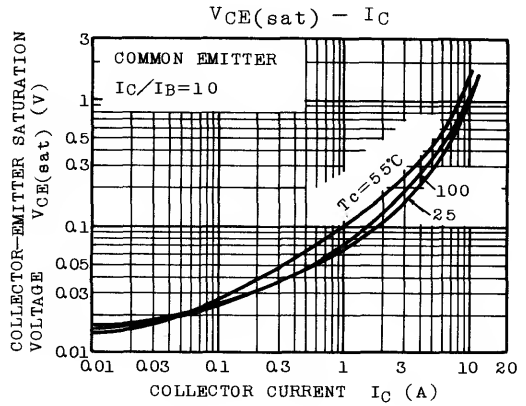
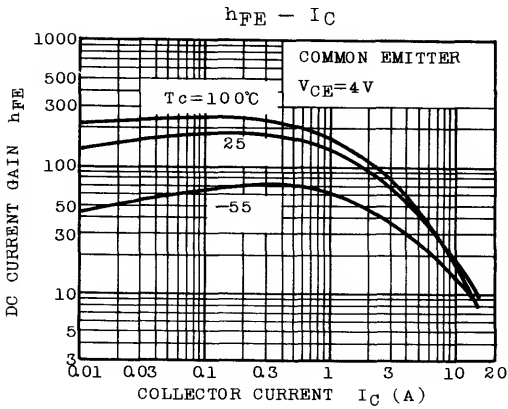
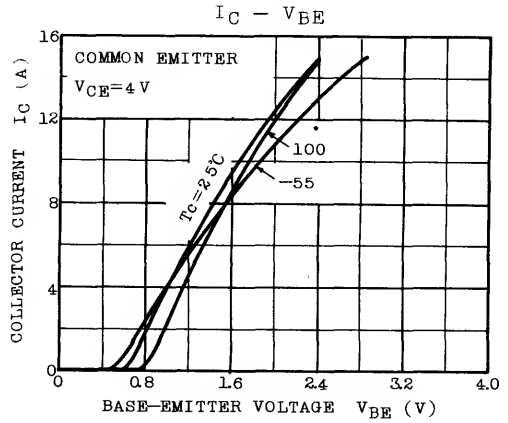
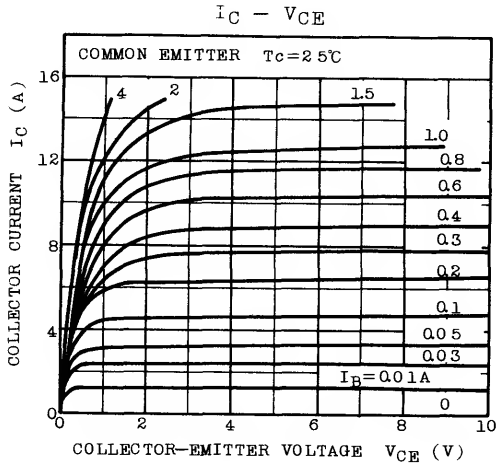
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

Weight : 12.6g

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
* Collector Cut-off Current	I_{CEX}	$V_{CE}=100V, V_{BE}=-1.5V$	-	-	5	mA
* Collector Cut-off Current	I_{CEX}	$V_{CE}=100V, V_{BE}=-1.5V, T_c=150^\circ C$	-	-	30	mA
* Collector Cut-off Current	I_{CEO}	$V_{CE}=30V, I_B=0$	-	-	0.7	mA
* Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	5	mA
* Collector-Emitter Sustaining Voltage	$V_{CER(SUS)}$ **	$I_C=0.2A, R_{\theta\theta}=100 \Omega$	70	-	-	V
* Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$ **	$I_C=0.2A, I_B=0$	60	-	-	V
* DC Current Gain	h_{FE}	$V_{CE}=4V, I_C=4A$	20	-	70	
		$V_{CE}=4V, I_C=10A$	5	-	-	
* Base-Emitter Voltage	V_{BE}	$V_{CE}=4V, I_C=4A$	-	-	1.8	V
* Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A, I_B=0.4A$	-	-	1.1	V
		$I_C=10A, I_B=3.3A$	-	-	8	V
* Small Signal Current Gain Cut-off Frequency	f_{hfe}	$V_{CE}=4V, I_C=1A, f=10kHz$	20	-	-	kHz
* Small Signal Current Gain	$ h_{fe} $	$V_{CE}=4V, I_C=1A, f=1MHz$	2.5	-	-	
* Second Breakdown Collector Current (Base Forward Bias)	$I_{s/h}$	$V_{CE}=40V, t=1s$ (non repetitive)	2.87	-	-	A

* In Accordance With JEDEC Registration Data.

** The sustaining voltages $V_{CER(SUS)}$ and $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.



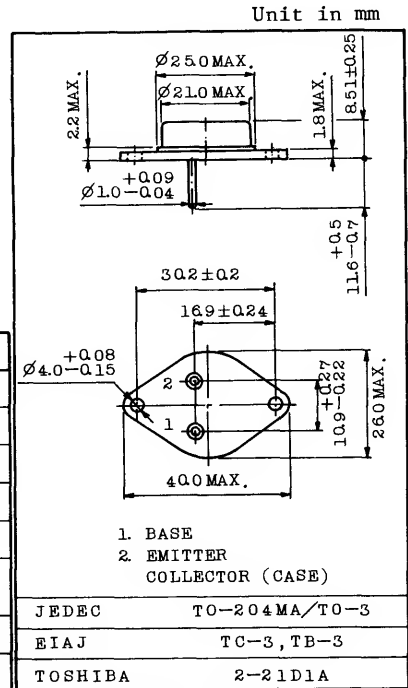
GENERAL PURPOSE POWER TRANSISTOR.
 POWER REGULATOR, SWITCHING AND SOLENOID DRIVES
 APPLICATIONS.

FEATURES:

- . High Gain at High Current
- . Low Saturation Voltage : $V_{CE(sat)}=1.0V$ (Max.)
 @ $I_C=5A, I_B=0.5A$
- . Excellent Area of Safe Operatings

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
* Collector-Base Voltage	V_{CBO}	80	V
* Collector-Emitter Voltage	V_{CEO}	60	V
* Emitter-Base Voltage	V_{EBO}	7	V
* Collector Current	I_C	10	A
* Base Current	I_B	4	A
* Collector Power Dissipation ($T_c=25^\circ C$)	P_C	150	W
* Thermal Resistance	θ_{jc}	1.17	$^\circ C/W$
* Junction Temperature	T_j	200	$^\circ C$
* Storage Temperature Range	T_{stg}	-65 ~ 200	$^\circ C$



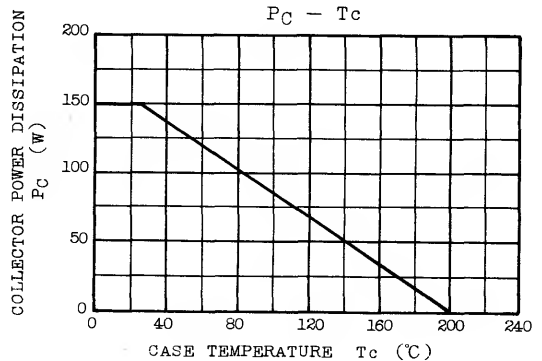
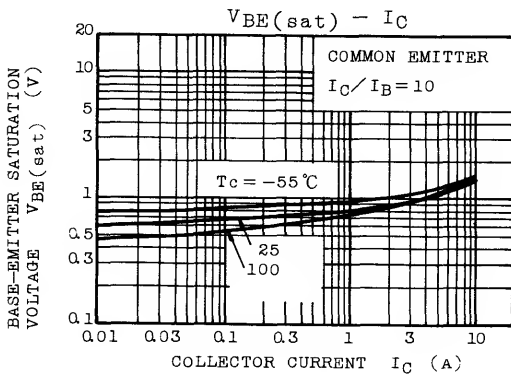
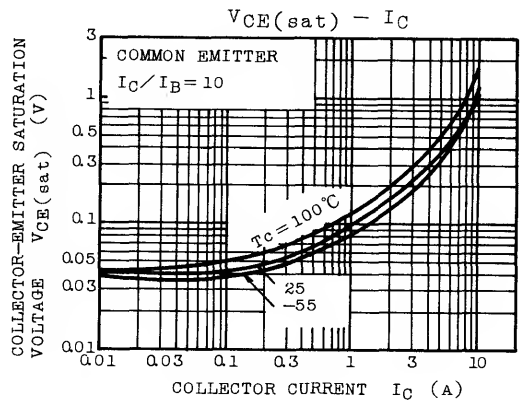
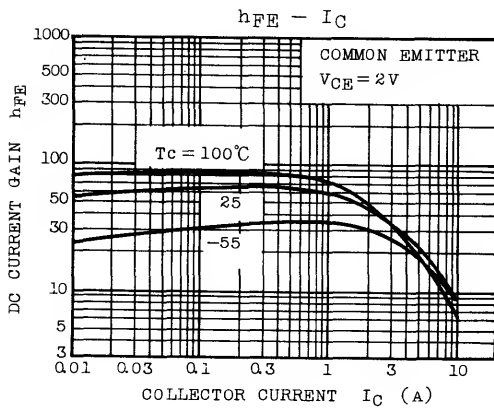
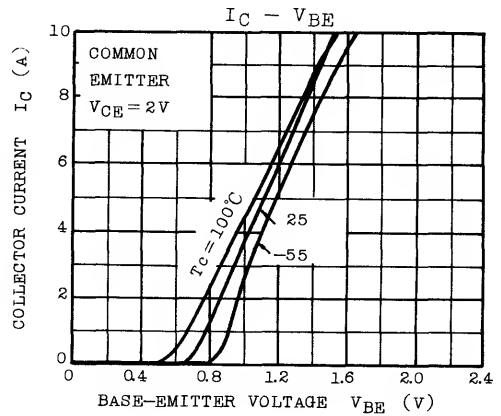
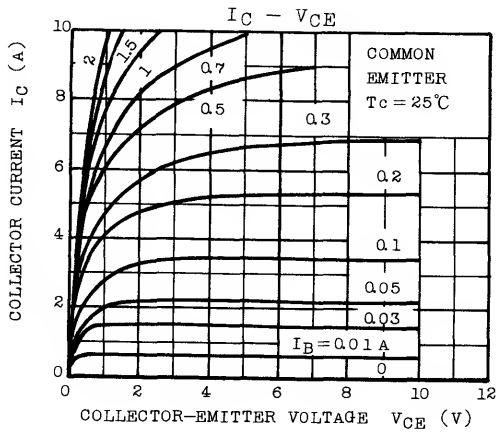
Weight : 12.6g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
* Collector Cut-off Current	I_{CEX}	$V_{CE}=80V, V_{BE}=-1.5V$	-	-	1	mA	
* Collector Cut-off Current	I_{CEX}	$V_{CE}=60V, V_{BE}=-1.5V$ $T_c=150^\circ C$	-	-	10	mA	
* Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	5	mA	
* Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$ **	$I_C=200mA, I_B=0$	60	-	-	V	
* DC Current Gain	h_{FE}	$V_{CE}=2V, I_C=1A$	25	-	90		
		$V_{CE}=2V, I_C=3A$	15	-	-		
* Base-Emitter Voltage	V_{BE}	$V_{CE}=2V, I_C=3A$	-	-	1.5	V	
* Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=5A, I_B=0.5A$	-	-	1.0	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=5A, I_B=0.5A$	-	-	2.0	V
Small Signal Forward Current Transfer Ratio	$ h_{fe} $	$V_{CE}=10V, I_C=0.5A$ $f=1MHz$	4	-	-		

* In accordance with JEDEC registration data.

** The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.



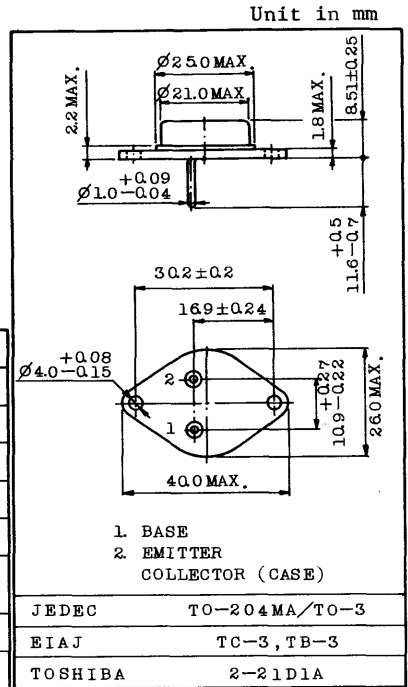
GENERAL PURPOSE POWER TRANSISTOR.
 POWER REGULATOR, SWITCHING AND SOLENOID DRIVES
 APPLICATIONS.

FEATURES:

- . High Gain at High Current
- . Low Saturation Voltage: $V_{CE(sat)}=1.0V$ (Max.)
 @ $I_C=5A, I_B=0.5A$
- . Excellent Area of Safe Operatings

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
* Collector-Base Voltage	V_{CBO}	100	V
* Collector-Emitter Voltage	V_{CEO}	80	V
* Emitter-Base Voltage	V_{EBO}	7	V
* Collector Current	I_C	10	A
* Base Current	I_B	4	A
* Collector Power Dissipation ($T_c=25^\circ C$)	P_C	150	W
* Thermal Resistance	θ_{jc}	1.17	$^\circ C/W$
* Junction Temperature	T_j	200	$^\circ C$
* Storage Temperature Range	T_{stg}	-65 ~ 200	$^\circ C$



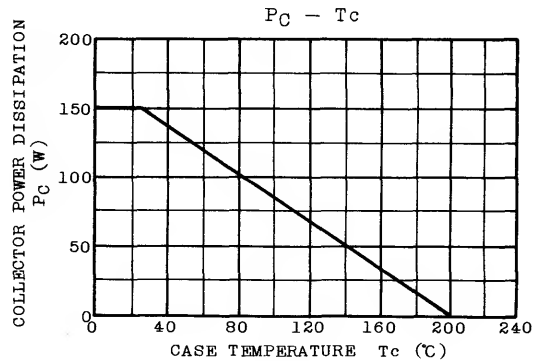
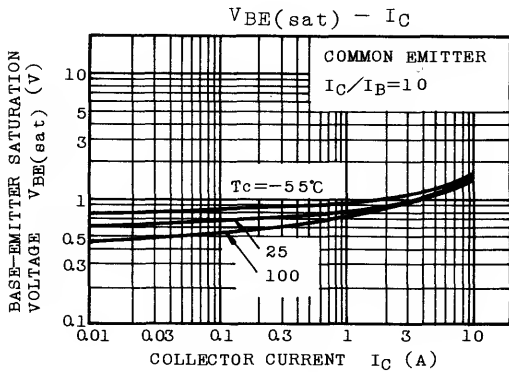
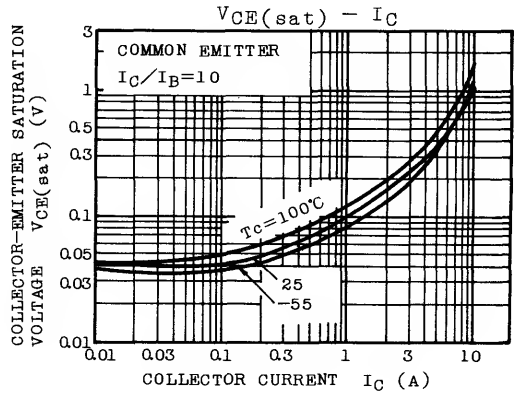
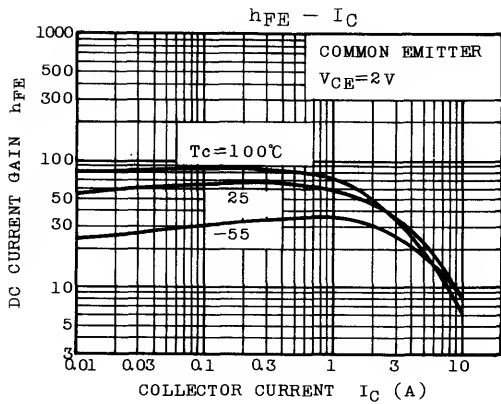
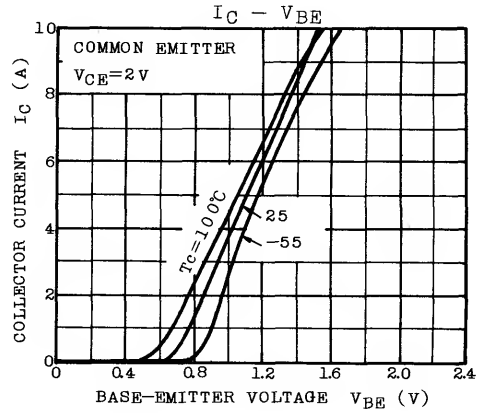
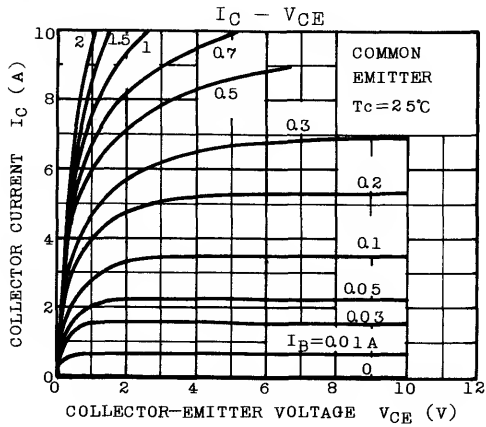
Weight : 12.6g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
* Collector Cut-off Current	I_{CEX}	$V_{CE}=100V, V_{BE}=-1.5V$	-	-	1	mA	
* Collector Cut-off Current	I_{CEX}	$V_{CE}=80V, V_{BE}=-1.5V$ $T_c=150^\circ C$	-	-	10	mA	
* Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	5	mA	
* Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}^{**}$	$I_C=200mA, I_B=0$	80	-	-	V	
* DC Current Gain	h_{FE}	$V_{CE}=2V, I_C=1A$	25	-	90		
		$V_{CE}=2V, I_C=3A$	15	-	-		
* Base-Emitter Voltage	V_{BE}	$V_{CE}=2V, I_C=3A$	-	-	1.5	V	
* Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=5A, I_B=0.5A$	-	-	1.0	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=5A, I_B=0.5A$	-	-	2.0	V
Small Signal Forward Current Transfer Ratio	$ h_{fe} $	$V_{CE}=10V, I_C=0.5A$ $f=1MHz$	4	-	-		

* In accordance with JEDEC registration data.

** The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.



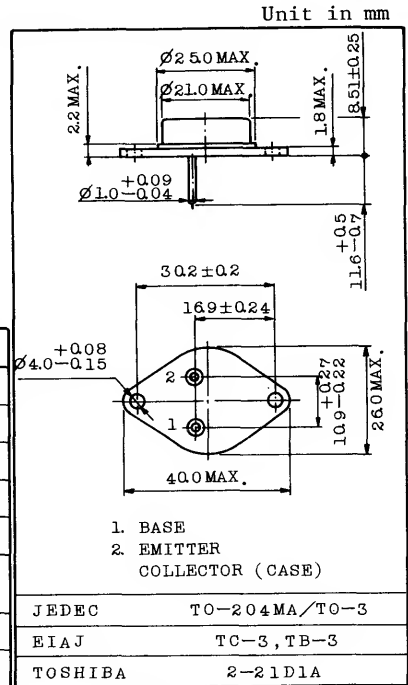
GENERAL PURPOSE POWER TRANSISTOR.
POWER REGULATOR, SWITCHING AND SOLENOID DRIVES
APPLICATIONS.

FEATURES:

- . High Gain at High Current
- . Low Saturation Voltage : $V_{CE(sat)}=0.8V$ (Max.)
@ $I_C=5A, I_B=0.5A$
- . Excellent Area of Safe Operatings

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
* Collector-Base Voltage	V_{CBO}	80	V
* Collector-Emitter Voltage	V_{CEO}	60	V
* Emitter-Base Voltage	V_{EBO}	7	V
* Collector Current	I_C	10	A
* Base Current	I_B	4	A
* Collector Power Dissipation ($T_c=25^\circ C$)	P_C	150	W
* Thermal Resistance	θ_{jc}	1.17	$^\circ C/W$
* Junction Temperature	T_j	200	$^\circ C$
* Storage Temperature Range	T_{stg}	-65 ~ 200	$^\circ C$



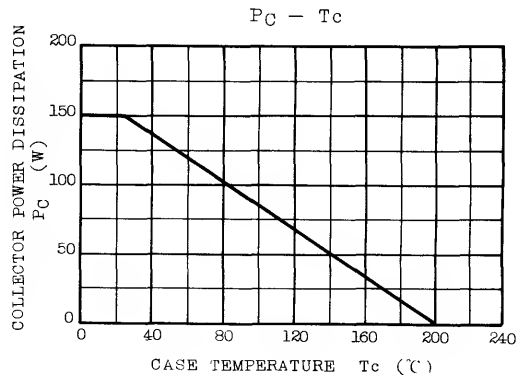
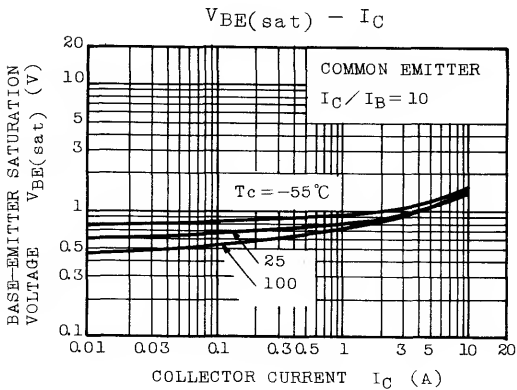
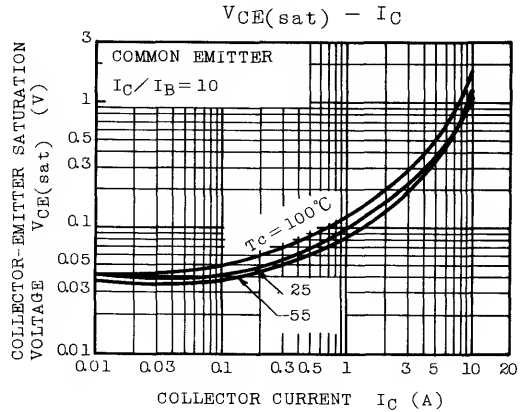
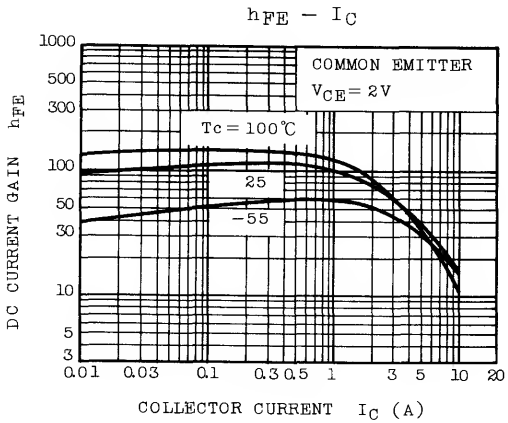
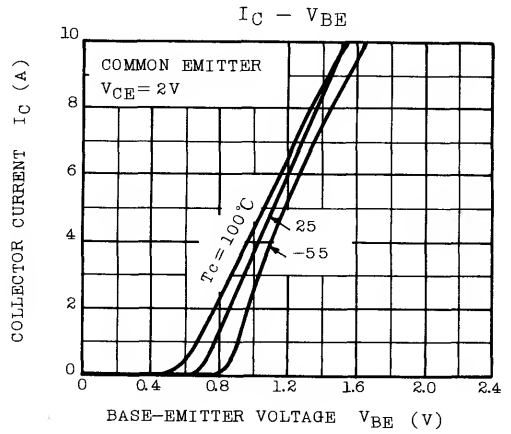
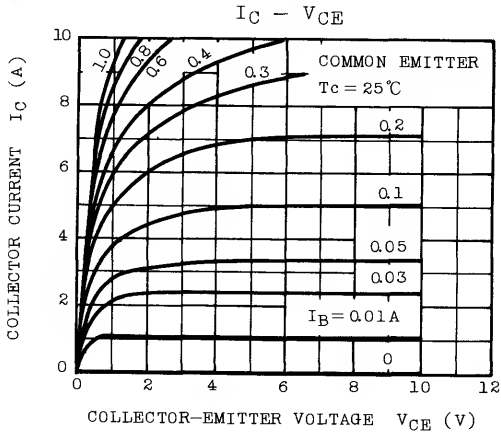
Weight : 12.6g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
* Collector Cut-off Current	I_{CEX}	$V_{CE}=80V, V_{BE}=-1.5V$	-	-	1	mA	
* Collector Cut-off Current	I_{CEX}	$V_{CE}=60V, V_{BE}=-1.5V$ $T_c=150^\circ C$	-	-	10	mA	
* Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	5	mA	
* Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	$I_C=200mA, I_B=0$	60	-	-	V	
* DC Current Gain	h_{FE}	$V_{CE}=2V, I_C=1A$	50	-	150		
		$V_{CE}=2V, I_C=3A$	30	-	-		
* Base-Emitter Voltage	V_{BE}	$V_{CE}=2V, I_C=3A$	-	-	1.5	V	
Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=5A, I_B=0.5A$	-	-	0.8	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=5A, I_B=0.5A$	-	-	1.5	V
Small Signal Forward Current Transfer Ratio	$ h_{fe} $	$V_{CE}=10V, I_C=0.5A$ $f=1MHz$	4	-	-		

* In accordance with JEDEC registration data.

** The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.



GENERAL PURPOSE POWER TRANSISTOR.
 POWER REGULATOR, SWITCHING AND SOLENOID
 DRIVE APPLICATIONS.

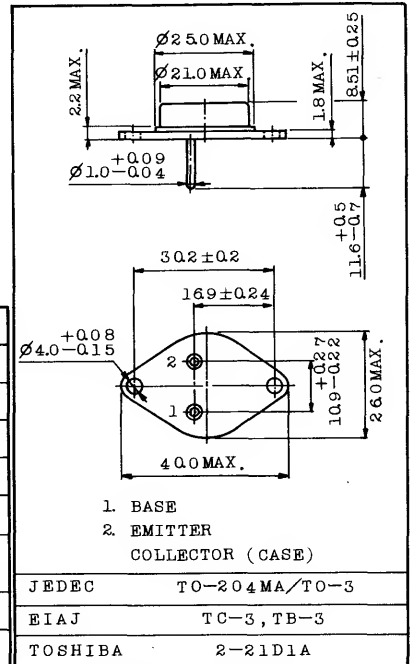
FEATURES:

- . High Gain at High Current
- . Low Saturation Voltage : $V_{CE(sat)}=0.8V$
 @ $I_C=5A, I_B=0.5A$
- . Excellent Area of Safe Operatings

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
* Collector-Base Voltage	V_{CBO}	100	V
* Collector-Emitter Voltage	V_{CEO}	80	V
* Emitter-Base Voltage	V_{EBO}	7	V
* Collector Current	I_C	10	A
* Base Current	I_B	4	A
* Collector Power Dissipation ($T_c=25^\circ C$)	P_C	150	W
* Thermal Resistance	θ_{jc}	1.17	$^\circ C/W$
* Junction Temperature	T_j	200	$^\circ C$
* Storage Temperature Range	T_{stg}	-65 ~ 200	$^\circ C$

Unit in mm



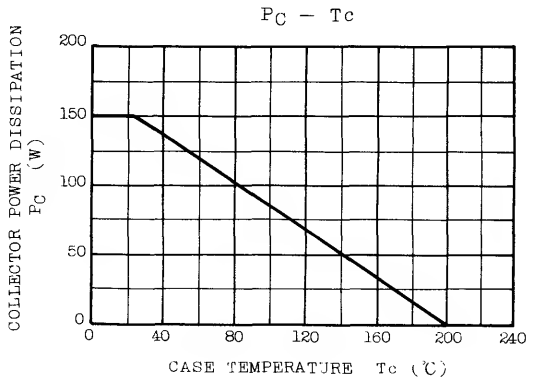
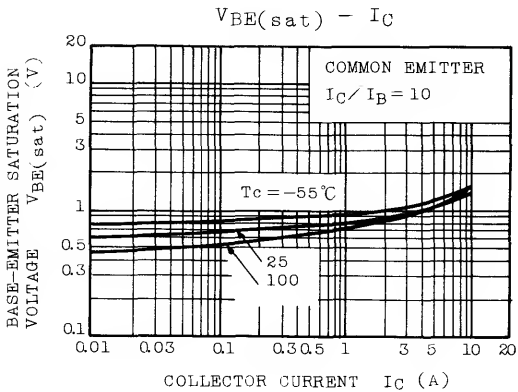
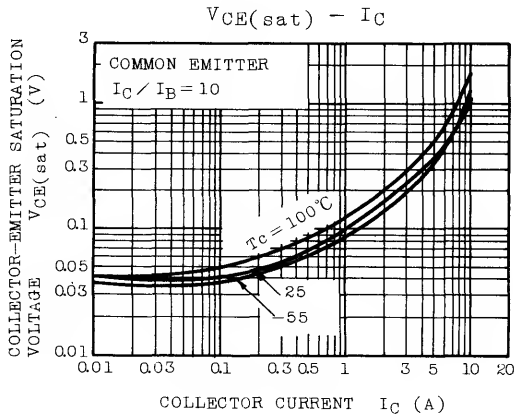
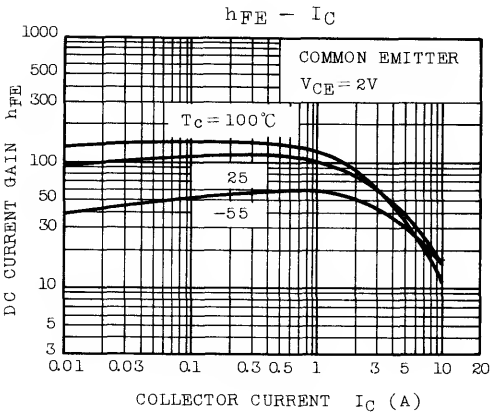
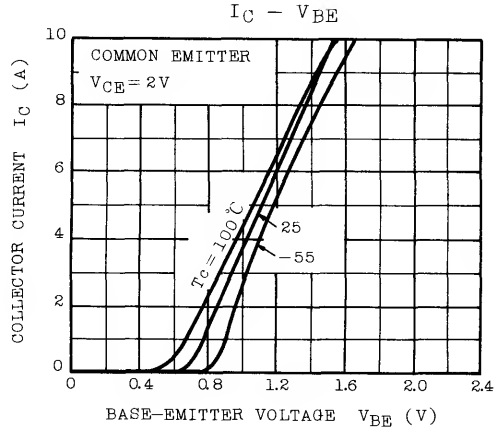
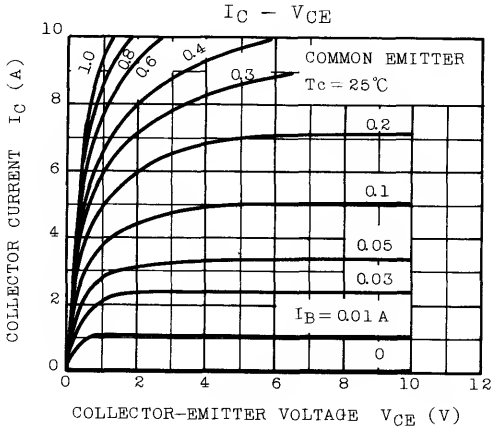
Weight : 12.6g

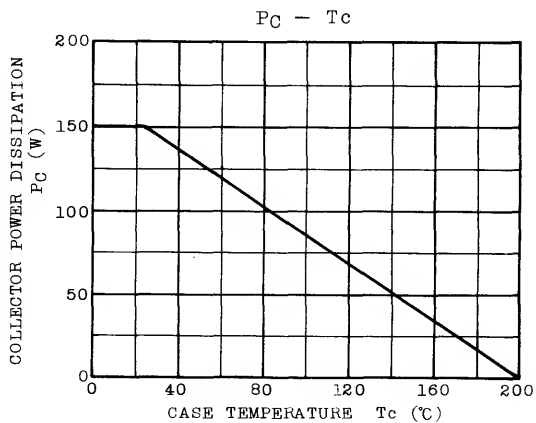
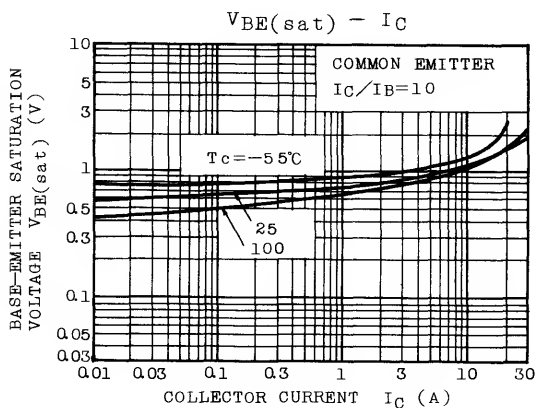
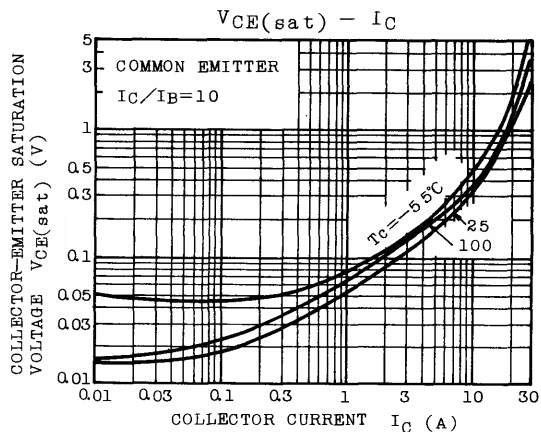
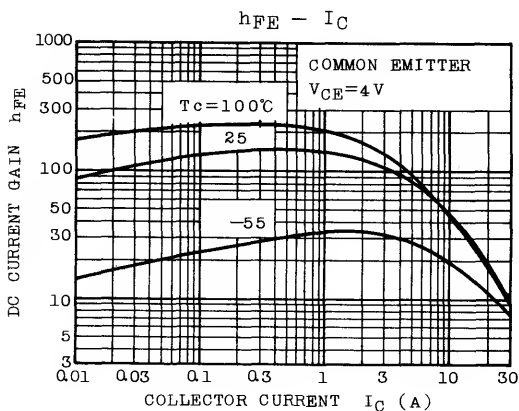
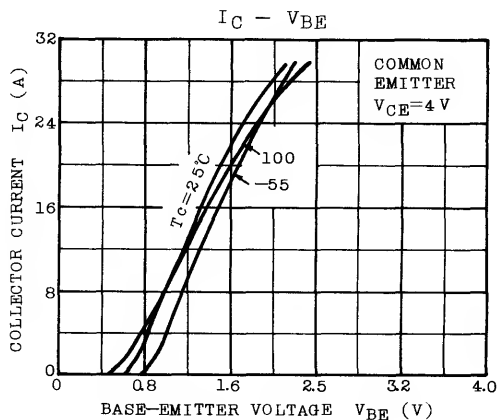
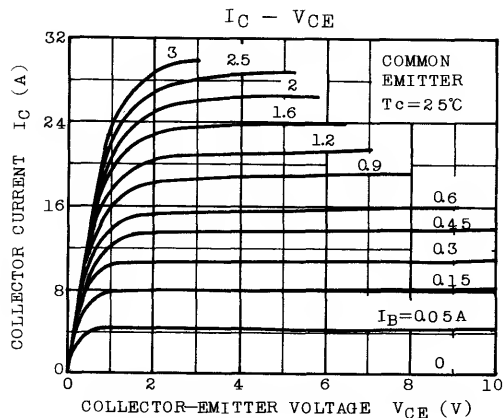
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
* Collector Cut-off Current	I_{CEX}	$V_{CE}=100V, V_{BE}=-1.5V$	-	-	1	mA
* Collector Cut-off Current	I_{CEX}	$V_{CE}=80V, V_{BE}=-1.5V$ $T_c=150^\circ C$	-	-	10	mA
* Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	5	mA
* Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}^{**}$	$I_C=200mA, I_B=0$	80	-	-	V
* DC Current Gain	h_{FE}	$V_{CE}=2V, I_C=1A$	50	-	150	
		$V_{CE}=2V, I_C=3A$	30	-	-	
* Base-Emitter Voltage	V_{BE}	$V_{CE}=2V, I_C=3A$	-	-	1.5	V
* Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	-	-	0.8	V
	Base-Emitter	$V_{BE(sat)}$	-	-	1.5	V
Small Signal Forward Current Transfer Ratio	$ h_{fe} $	$V_{CE}=10V, I_C=0.5A$ $f=1MHz$	4	-	-	

* In Accordance with JEDEC Registration Data.

** The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.





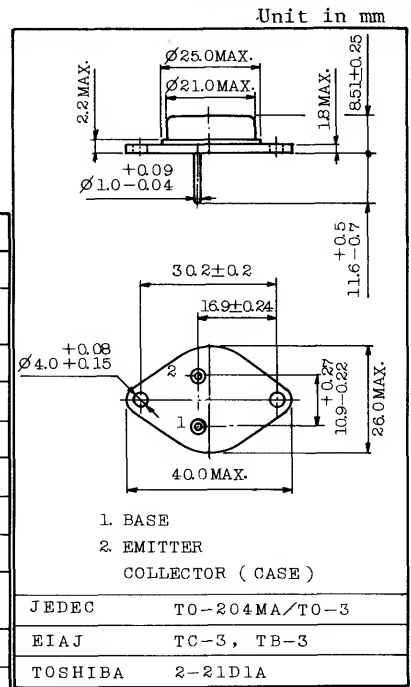
HIGH POWER AMPLIFIER, POWER SWITCHING
DC-DC CONVERTER AND REGULATOR APPLICATIONS

FEATURES:

- High Collector Dissipation : $P_C=150W$ ($T_c=25^\circ C$)
- High Collector Current : $I_C=20A$ (D.C)

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT	
※	Collector-Base Voltage	V_{CB0}	100	V	
※	Collector-Emitter Voltage ($V_{BE}=-1.5V, R_{BE}=100\Omega$)	V_{CEX}	100	V	
※	Collector-Emitter Voltage	V_{CEO}	60	V	
※	Emitter-Base Voltage	V_{EBO}	7	V	
※	Collector Current	DC	I_C	20	A
		Peak	I_{CM}	30	A
※	Base Current	DC	I_B	5	A
		Peak	I_{BM}	15	A
※	Collector Power Dissipation ($T_c=25^\circ C$)	P_C	150	W	
※	Junction Temperature	T_j	200	$^\circ C$	
※	Storage Temperature Range	T_{stg}	-65 ~ 200	$^\circ C$	

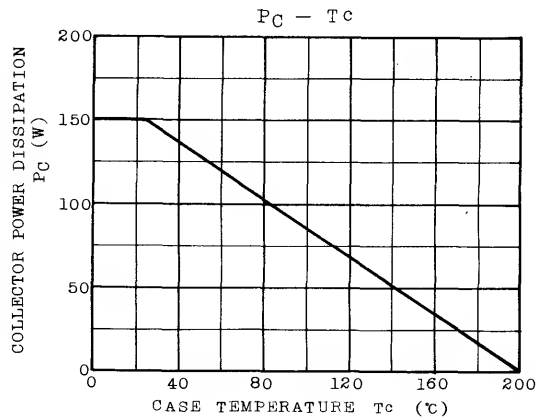
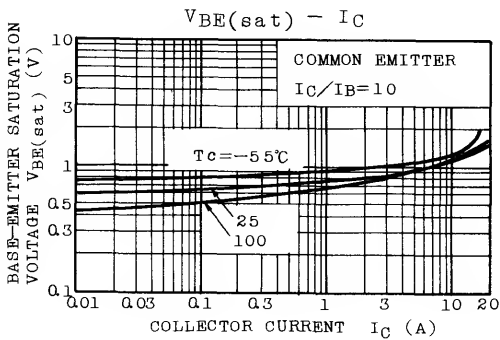
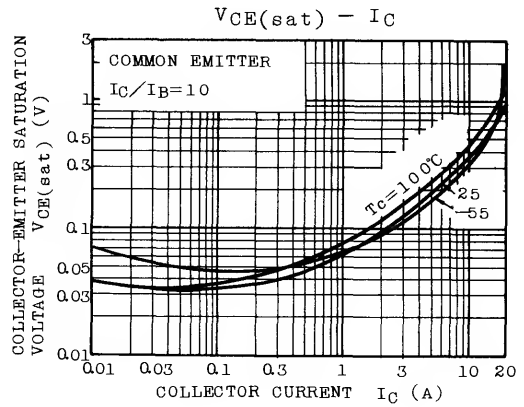
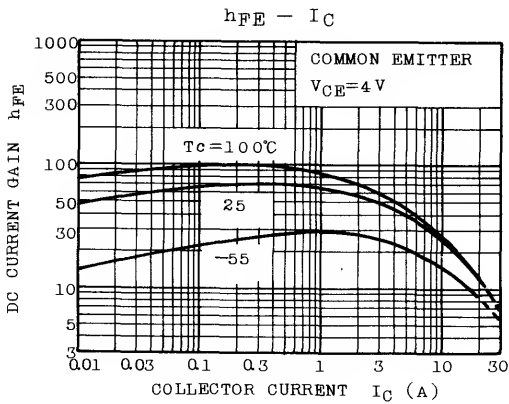
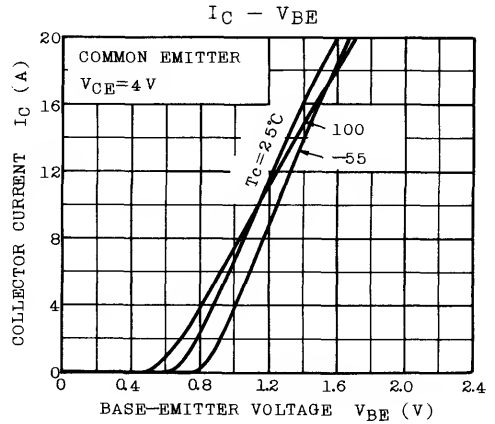
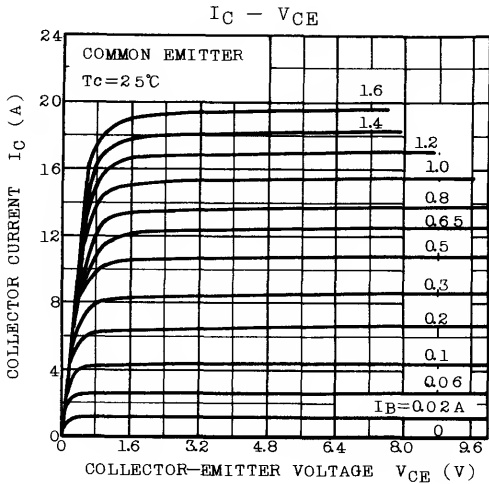


Weight : 12.6g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
※	Collector Cut-off Current	$V_{CB}=100V, I_E=0$	-	-	5	mA
※	Collector Cut-off Current	$V_{CE}=100V, V_{BE}=-1.5V$	-	-	5	mA
※	Collector Cut-off Current	$V_{CE}=30V, V_{BE}=-1.5V$ $T_c=150^\circ C$	-	-	10	mA
※	Collector Cut-off Current	$V_{CE}=50V, I_B=0$	-	-	10	mA
※	Emitter Cut-off Current	$V_{EB}=7V, I_C=0$	-	-	5	mA
※	Collector-Emitter Breakdown Voltage	$V(BR)_{CEO}$ $I_C=200mA, I_B=0$	60	-	-	V
※	DC Current Gain	$V_{CE}=4V, I_C=10A$	15	-	60	
		$V_{CE}=4V, I_C=20A$	5	-	-	
※	Base-Emitter Voltage	$V_{CE}=4V, I_C=10A$	-	1.0	2.2	V
※	Collector-Emitter Saturation Voltage	$I_C=10A, I_B=1A$	-	0.3	1.4	V
		$I_C=20A, I_B=4A$	-	-	4	V
※	Transition Frequency	$V_{CE}=4V, I_C=1A$	0.2	-	-	MHz
※	Small Signal Current Gain	$V_{CE}=4V, I_C=1A, f=1kHz$	40	-	-	

※ In Accordance with JEDEC Registration Data.



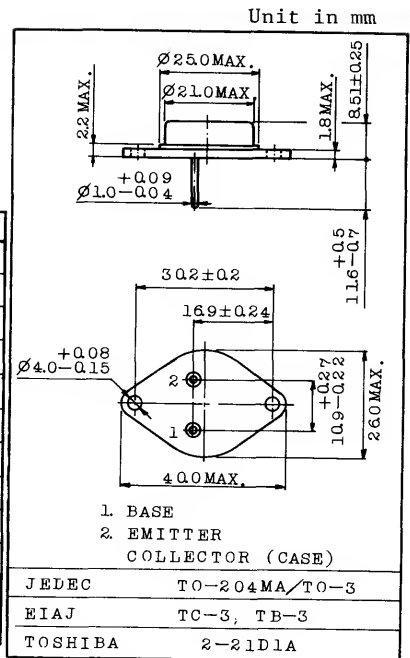
HIGH POWER AMPLIFIER, POWER SWITCHING,
DC-DC CONVERTER AND REGULATOR APPLICATIONS

FEATURES:

- High Collector-Emitter Sustaining Voltage:
V_{CEO(SUS)}=140V (Min.) @I_C=0.2A, I_B=0
- Excellent Area of Safe Operatings.

MAXIMUM RATINGS (T_a=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	160	V
Collector-Emitter Voltage	V _{CEX}	160	V
Collector-Emitter Voltage	V _{CEO}	140	V
Emitter-Base Voltage	V _{EB0}	7	V
Collector Current	DC	I _C	16
	Peak	I _{CM}	30
Base Current	DC	I _B	4
	Peak	I _{BM}	15
Collector Power Dissipation (T _c =25°C) Derate Linearly above 25°C	P _C	150	W
		0.855	W/°C
Junction Temperature	T _j	200	°C
Storage Temperature	T _{stg}	-65 ~ 200	°C



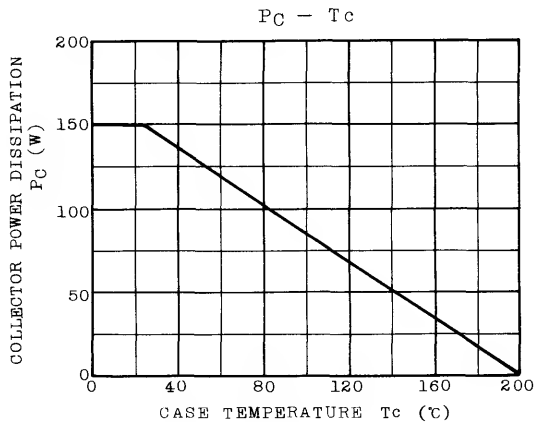
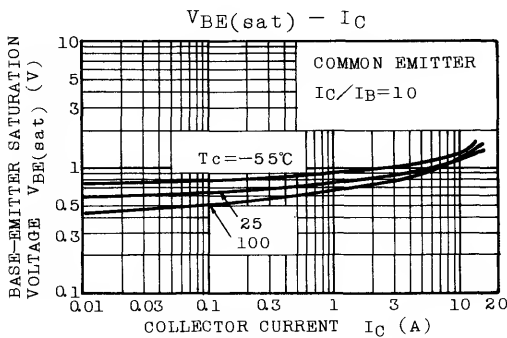
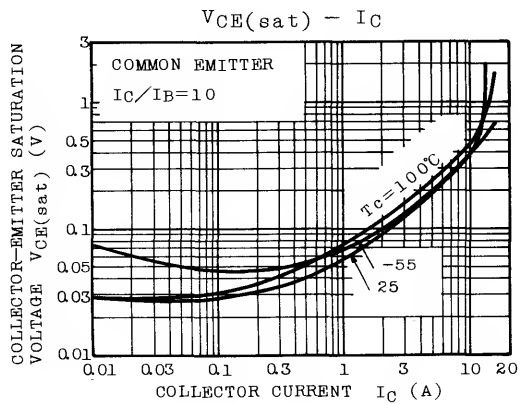
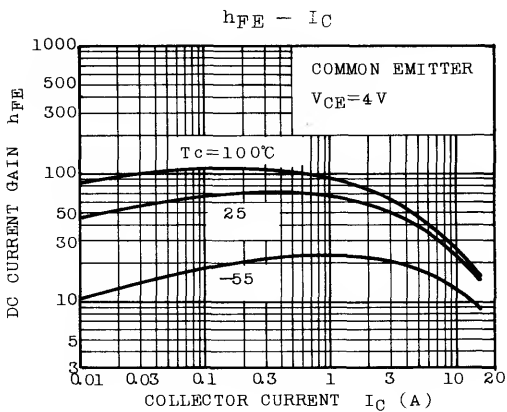
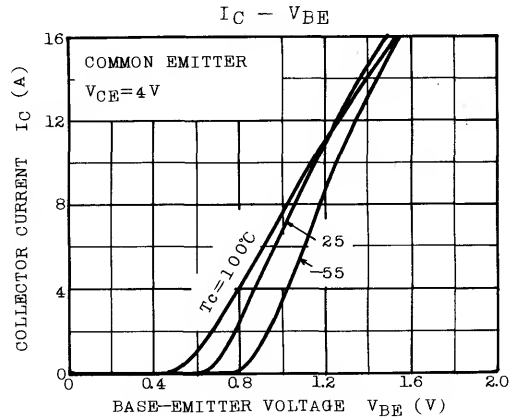
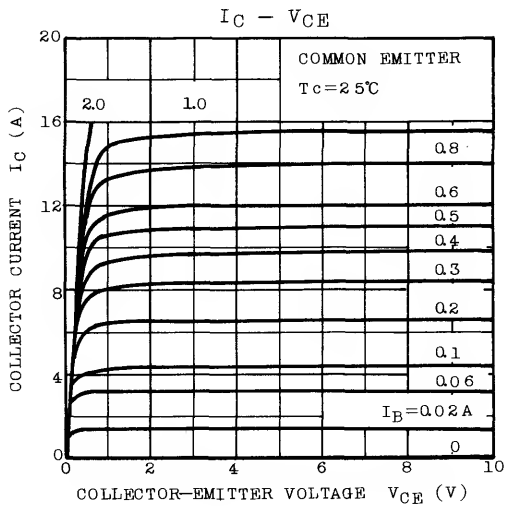
ELECTRICAL CHARACTERISTICS (T_a=25°C)

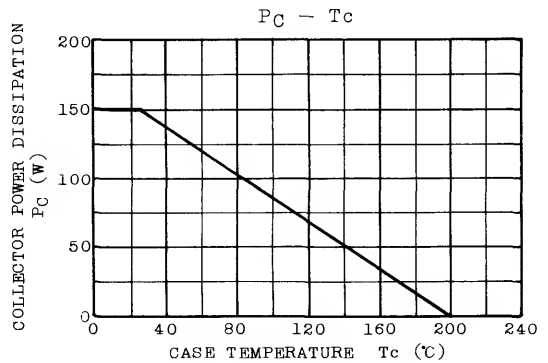
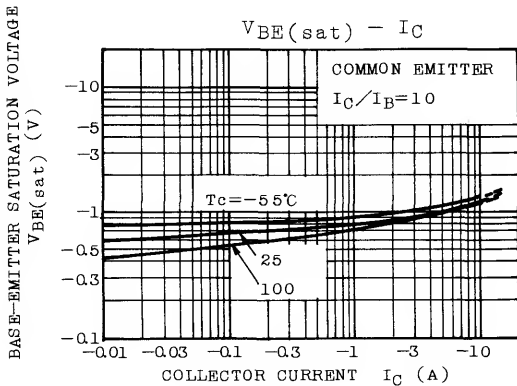
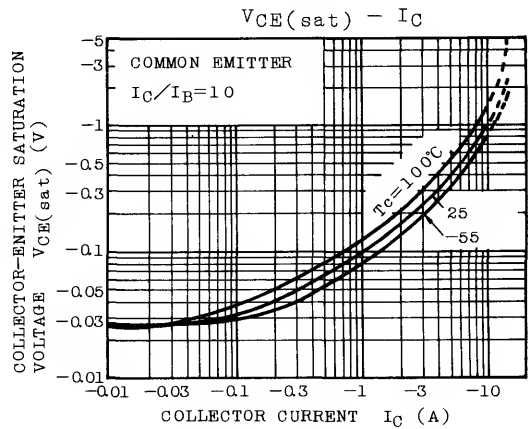
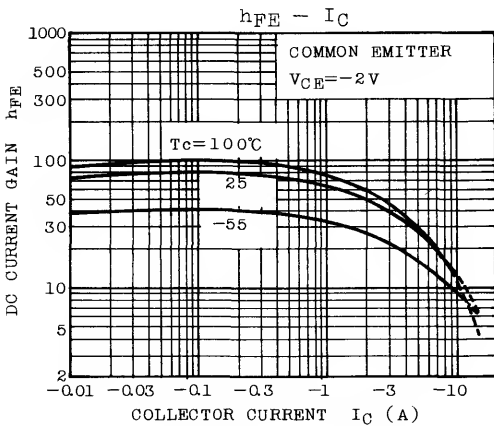
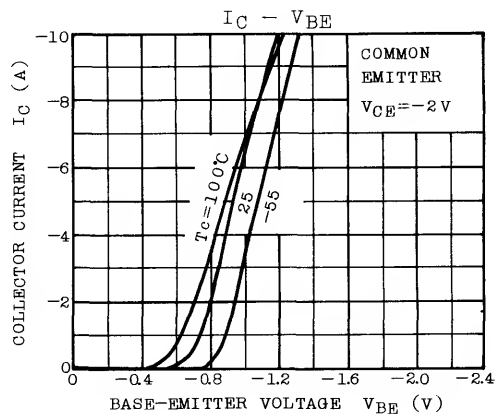
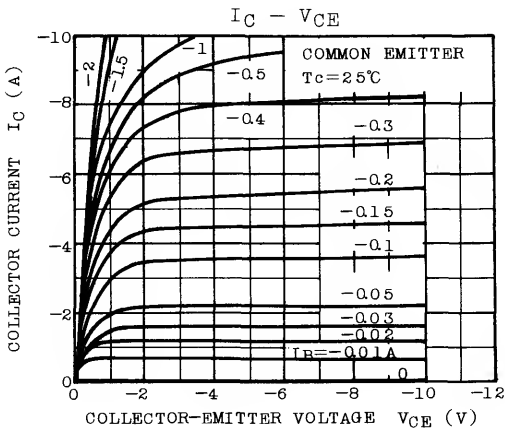
Weight : 12.6g

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =140V, I _E =0	-	-	2.0	mA
Collector Cut-off Current	I _{CEX}	V _{CE} =140V, V _{BE} =-1.5V	-	-	2.0	mA
Collector Cut-off Current	I _{CEX}	V _{CE} =140V, V _{BE} =-1.5V, T _c =150°C	-	-	10	mA
Collector Cut-off Current	I _{CE0}	V _{CE} =120V, I _B =0	-	-	10	mA
Emitter Cut-off Current	I _{EB0}	V _{EB} =7V, I _C =0	-	-	5.0	mA
Collector-Emitter Sustaining Voltage	V _{CEX(SUS)}	I _C =0.1A, V _{BE} =-1.5V R _{BE} =100 Ω	160	-	-	V
Collector-Emitter Sustaining Voltage	V _{CER(SUS)}	I _C =0.2A, R _{BE} =100 Ω	150	-	-	V
Collector-Emitter Sustaining Voltage	V _{CEO(SUS)}	I _C =0.2A, I _B =0	140	-	-	V
DC Current Gain	h _{FE}	V _{CE} =4.0V, I _C =8A	15	-	60	
		V _{CE} =4.0V, I _C =16A	5	-	-	
Base-Emitter Voltage	V _{BE}	V _{CE} =4.0V, I _C =8A	-	-	2.2	V
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =8A, I _B =0.8A	-	-	1.4	V
		I _C =16A, I _B =3.2A	-	-	4.0	V
Small Signal Current Gain	h _{fe}	V _{CE} =4V, I _C =1.0A, f=1kHz	40	-	-	
Small Signal Forward Current Transfer Ratio	h _{fe}	V _{CE} =4V, I _C =1.0A, f=50kHz	4	-	-	

*In Accordance with JEDEC Registration Data.

**The sustaining voltages V_{CEX(SUS)}, V_{CER(SUS)} and V_{CEO(SUS)} MUST NOT be measured on a curve tracer.





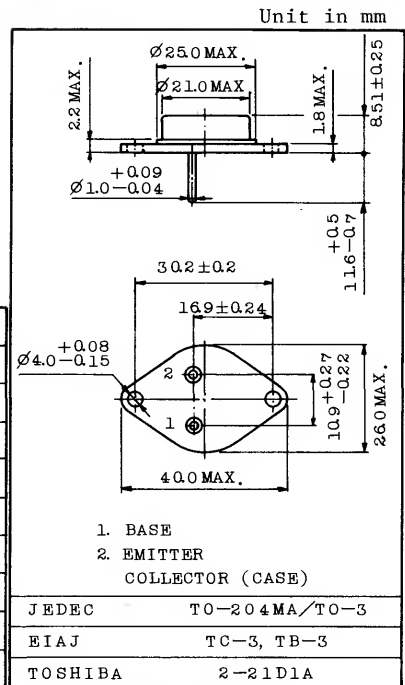
POWER AMPLIFIER, SWITCHING CIRCUIT AND REGULATOR APPLICATIONS.

FEATURES:

- . High Gain and Excellent h_{FE} Linearity:
 $h_{FE}=15(\text{Min.})$ @ $V_{CE}=-2V, I_C=-3A$
- . Low Saturation Voltage:
 $V_{CE}(\text{sat})=-1.0V(\text{Max.})$ @ $I_C=-4A, I_B=-0.4A$

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
* Collector-Base Voltage		V_{CBO}	-80	V
* Collector-Emitter Voltage		V_{CEO}	-80	V
* Emitter-Base Voltage		V_{EBO}	-7	V
* Collector Current	DC	I_C	-10	A
	Peak	I_{CM}	-15	A
* Base Current		I_B	-4	A
* Collector Power Dissipation ($T_c=25^\circ\text{C}$) Derate Linearly above 25°C		P_C	150	W
			0.86	W/ $^\circ\text{C}$
* Junction Temperature		T_j	200	$^\circ\text{C}$
* Storage Temperature Range		T_{stg}	-65 ~ 200	$^\circ\text{C}$



Weight : 12.6g

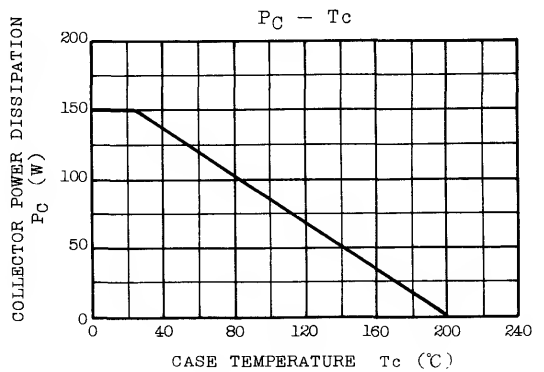
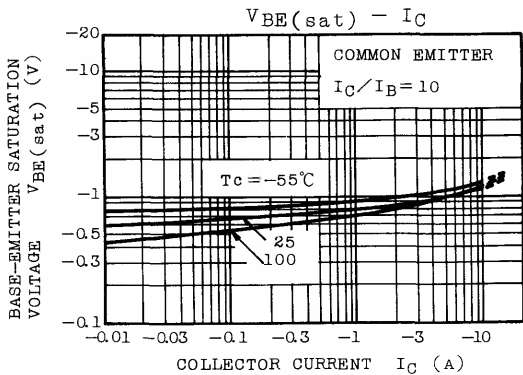
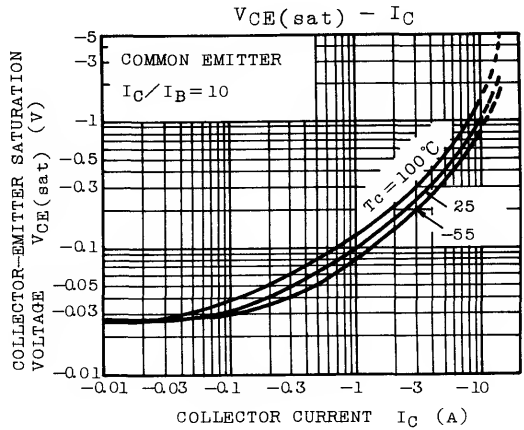
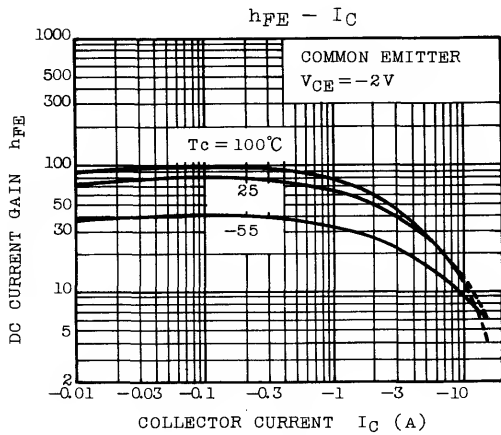
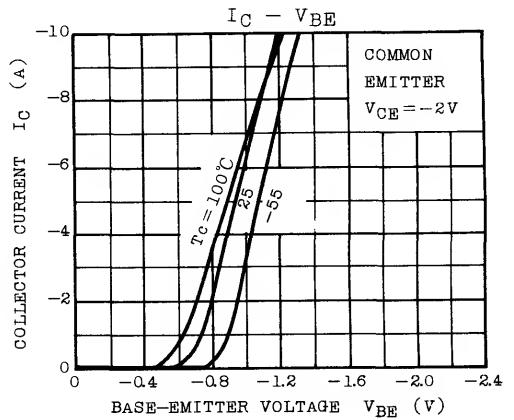
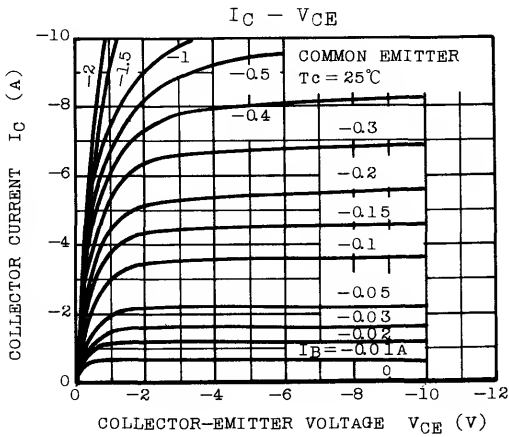
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
* Collector Cut-off Current		I_{CEX}	$V_{CE}=-80V, V_{BE}=1.5V$	-	-	-1	mA
* Collector Cut-off Current		I_{CEX}	$V_{CE}=-80V, V_{BE}=1.5V$ $T_c=150^\circ\text{C}$	-	-	-5	mA
* Collector Cut-off Current		I_{CEO}	$V_{CE}=-40V, I_B=0$	-	-	-10	mA
* Emitter Cut-off Current		I_{EBO}	$V_{EB}=-7V, I_C=0$	-	-	-5	mA
* Collector-Emitter Sustaining Voltage		V_{CEO}^{**}	$I_C=-0.2A, I_B=0$	-80	-	-	V
* DC Current Gain		h_{FE}	$V_{CE}=-2V, I_C=-1A$	25	-	90	
			$V_{CE}=-2V, I_C=-3A$	15	-	-	
* Saturation Voltage	Collector-Emitter	$V_{CE}(\text{sat})$	$I_C=-4A, I_B=-0.4A$	-	-	-1.0	V
	Base-Emitter	$V_{BE}(\text{sat})$	$I_C=-4A, I_B=-0.4A$	-	-	-2.0	V
* Transition Frequency		f_T	$V_{CE}=-10V, I_C=-0.5A, f=1\text{MHz}$	4	-	-	MHz
* Collector Output Capacitance		C_{ob}	$V_{CB}=-10V, I_E=0, f=1\text{MHz}$	-	-	500	pF

*In accordance with JEDEC registration data.

**The sustaining voltage $V_{CEO}(\text{SUS})$ MUST NOT be measured on a curve tracer.

2N3790



POWER AMPLIFIER, SWITCHING CIRCUIT AND
REGULATOR APPLICATIONS

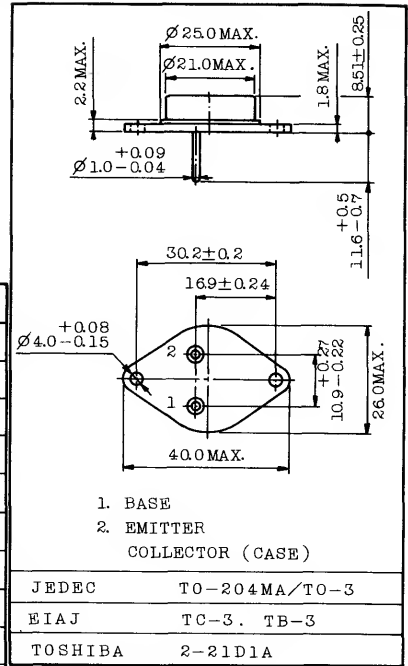
Unit in mm

FEATURES:

- High Gain and Excellent h_{FE} Linearity:
 $h_{FE}=30$ (Min.) @ $V_{CE}=-2V, I_C=-3A$
- Low Saturation Voltage:
 $V_{CE(sat)}=-1.0V$ (Max.) @ $I_C=-5A, I_B=-0.5A$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
* Collector-Base Voltage		V_{CBO}	-60	V
* Collector-Emitter Voltage		V_{CEO}	-60	V
* Emitter-Base Voltage		V_{EBO}	-7	V
* Collector Current	DC	I_C	-10	A
	Peak	I_{CM}	-15	A
* Base Current		I_B	-4	A
* Collector Power Dissipation ($T_c=25^\circ C$) Derate Linearly above $25^\circ C$		P_C	150	W
			0.86	W/ $^\circ C$
* Junction Temperature		T_j	200	$^\circ C$
* Storage Temperature Range		T_{stg}	-65 ~ 200	$^\circ C$



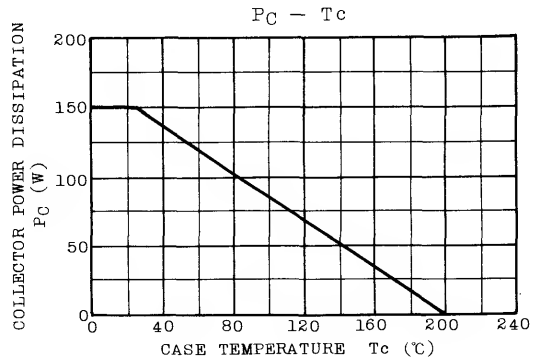
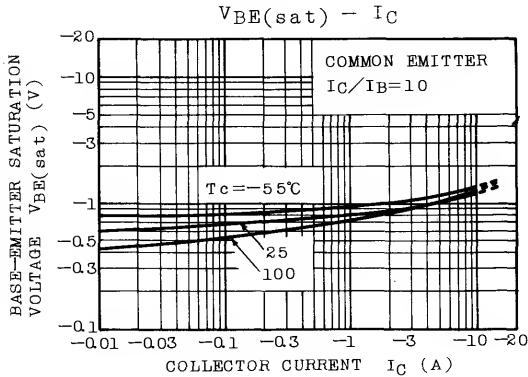
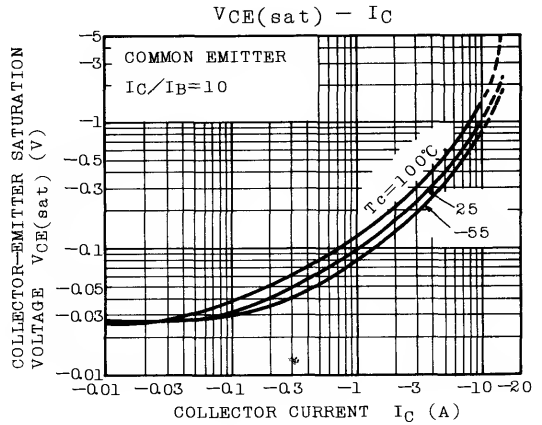
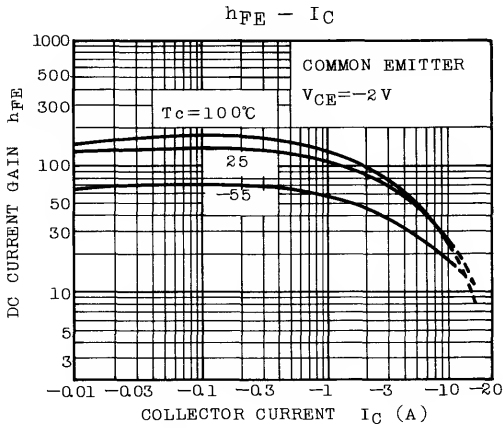
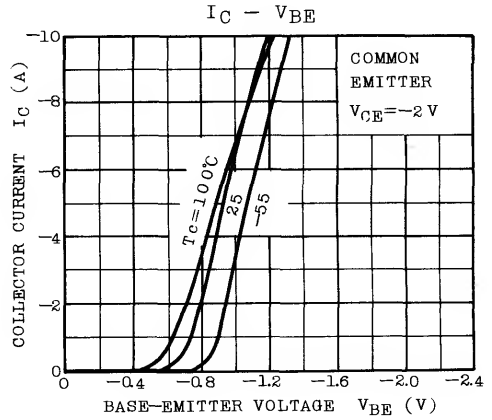
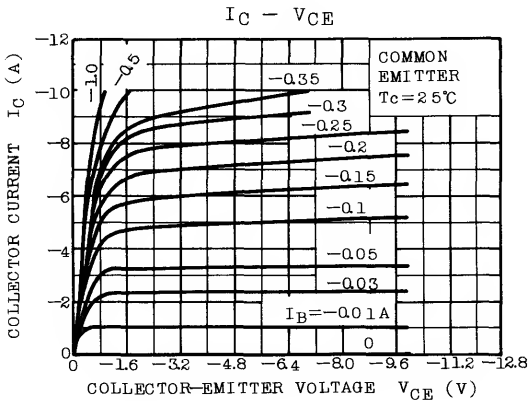
Weight : 12.6g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
* Collector Cut-off Current		I_{CEX}	$V_{CE}=-60V, V_{BE}=1.5V$	-	-	-1	mA
* Collector Cut-off Current		I_{CEX}	$V_{CE}=-60V, V_{BE}=1.5V, T_c=150^\circ C$	-	-	-5	mA
* Collector Cut-off Current		I_{CEO}	$V_{CE}=-30V, I_B=0$	-	-	-10	mA
* Emitter Cut-off Current		I_{EBO}	$V_{EB}=-7V, I_C=0$	-	-	-5	mA
* Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$ **	$I_C=-0.2A, I_B=0$	-60	-	-	V
* DC Current Gain		h_{FE}	$V_{CE}=-2V, I_C=-1A$	50	-	150	
			$V_{CE}=-2V, I_C=-3A$	30	-	-	
* Saturation Voltage	Collector-Emitter	$V_{CE(sat)}$	$I_C=-5A, I_B=-0.5A$	-	-	-1.0	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=-5A, I_B=-0.5A$	-	-	-1.5	V
* Transition Frequency		f_T	$V_{CE}=-10V, I_C=-0.5A, f=1MHz$	4	-	-	MHz
* Collector Output Capacitance		C_{ob}	$V_{CB}=-10V, I_E=0, f=1MHz$	-	-	500	pF

* In Accordance with JEDEC Registration Data.

** The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.



POWER AMPLIFIER, SWITCHING CIRCUIT AND
REGULATOR APPLICATIONS.

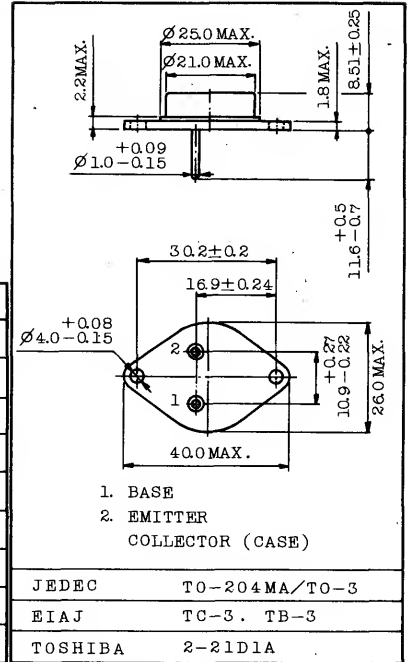
Unit in mm

FEATURES:

- High Gain and Excellent h_{FE} Linearity:
 $h_{FE}=30$ (Min.) @ $V_{CE}=-2V, I_C=-3A$
- Low Saturation Voltage:
 $V_{CE(sat)}=-1.0V$ (Max.) @ $I_C=-5A, I_B=-0.5A$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
*	Collector-Base Voltage	V_{CBO}	-80	V
*	Collector-Emitter Voltage	V_{CEO}	-80	V
*	Emitter-Base Voltage	V_{EBO}	-7	V
*	Collector Current	DC I_C	-10	A
		Peak I_{CM}	-15	A
*	Base Current	I_B	-4	A
*	Collector Power Dissipation ($T_c=25^\circ C$) Derate Linearly above $25^\circ C$	P_C	150 0.86	W W/ $^\circ C$
*	Junction Temperature	T_j	200	$^\circ C$
*	Storage Temperature Range	T_{stg}	-65 ~ 200	$^\circ C$



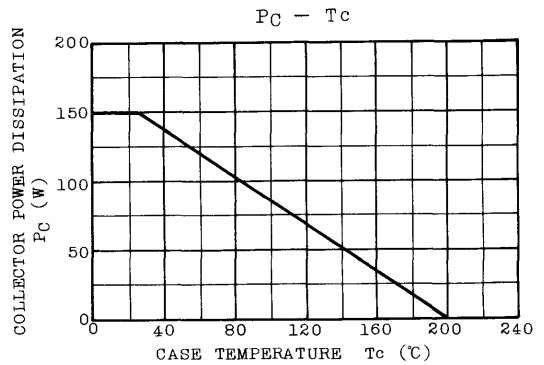
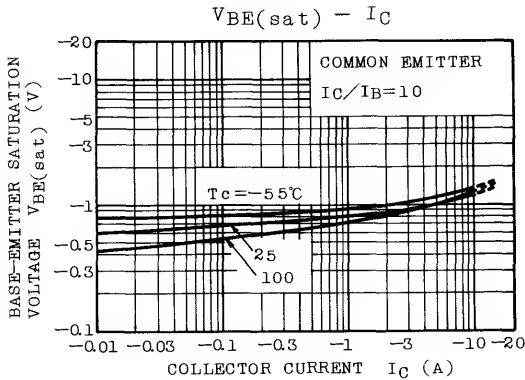
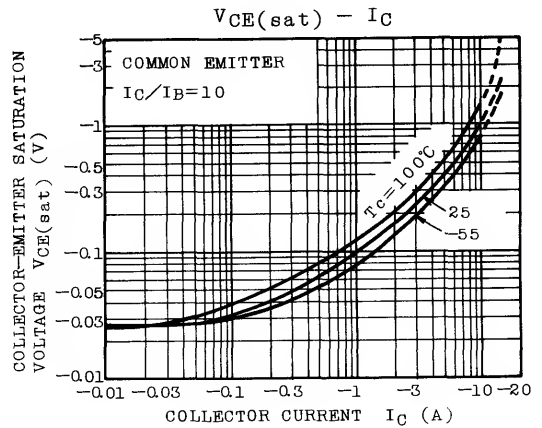
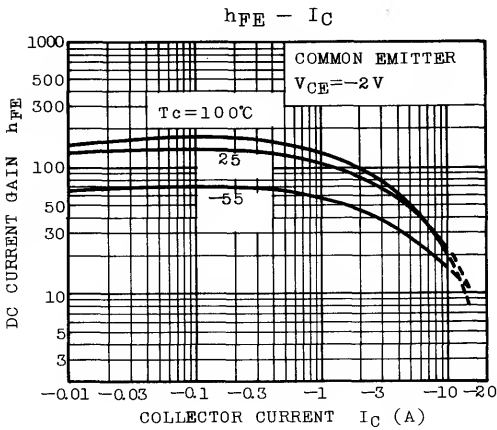
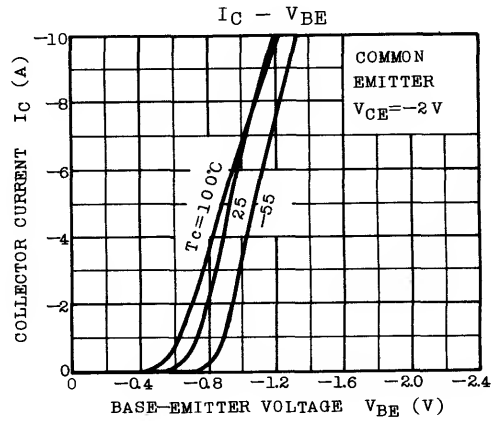
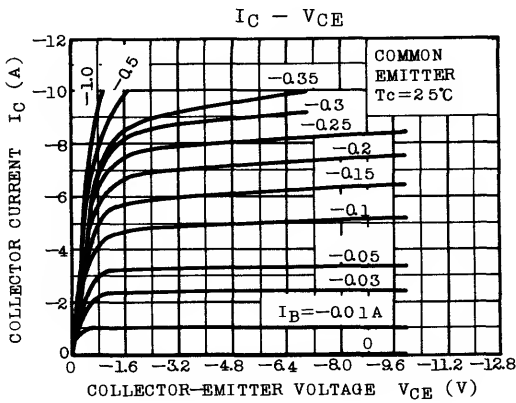
Weight : 12.6g

ELECTRICAL CHARACTERISTICS ($t_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
*	Collector Cut-off Current	I_{CEX}	$V_{CE}=-80V, V_{BE}=1.5V$	-	-	-1	mA
*	Collector Cut-off Current	I_{CEX}	$V_{CE}=-80V, V_{BE}=1.5V$ $T_c=150^\circ C$	-	-	-5	mA
*	Collector Cut-off Current	I_{CEO}	$V_{CE}=-40V, I_B=0$	-	-	-10	mA
*	Emitter Cut-off Current	I_{EBO}	$V_{EB}=-7V, I_C=0$	-	-	-5	mA
*	Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}^{**}$	$I_C=-0.2A, I_B=0$	-80	-	-	V
*	DC Current Gain	h_{FE}	$V_{CE}=-2V, I_C=-1A$	50	-	150	
			$V_{CE}=-2V, I_C=-3A$	30	-	-	
*	Collector-Emitter Voltage	$V_{CE(sat)}$	$I_C=-5A, I_B=-0.5A$	-	-	-1.0	V
	Base-Emitter	$V_{BE(sat)}$	$I_C=-5A, I_B=-0.5A$	-	-	-1.5	V
*	Transition Frequency	f_T	$V_{CE}=-10V, I_C=-0.5A$ $f=1MHz$	4	-	-	MHz
	Collector Output Capacitance	C_{ob}	$V_{CB}=-10V, I_E=0, f=1MHz$	-	-	500	pF

* In Accordance with JEDEC Registration Data.

** The sustaining voltage $V_{CE(SUS)}$ MUST NOT be measured on a curve tracer.

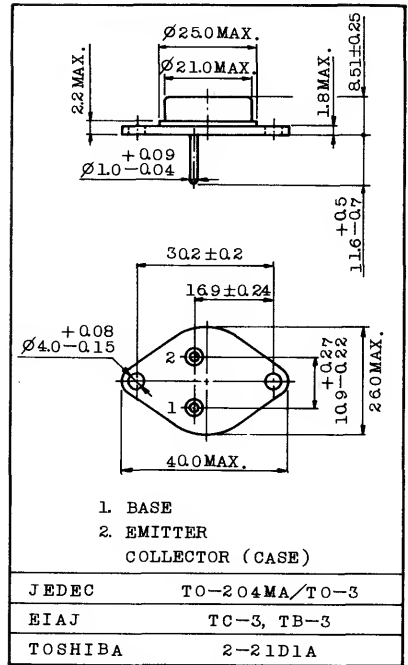


HIGH POWER SWITCHING, AMPLIFIER, DC-DC CONVERTER, INVERTER AND REGULATOR APPLICATIONS

FEATURES:

- . Specification for h_{FE} and $V_{CE(sat)}$ Up to 30A:
 $h_{FE}=5.0$ (Min.) @ $V_{CE}=-4.0V$, $I_C=-30A$
 $V_{CE(sat)}=-4.0V$ (Max.) @ $I_C=-30A$, $I_B=-6A$
- . Low Saturation Voltage:
 $V_{CE(sat)}=-0.75V$ (Max.) @ $I_C=-10A$, $I_B=-1.0A$
 $V_{BE(sat)}=-1.6V$ (Max.) @ $I_C=-10A$, $I_B=-1.0A$
- . High Collector Power Dissipation Capability:
 $P_C=200W$ (Max.)
- . Complementary to 2N5301

Unit in mm



Weight : 12.6g

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
※	Collector-Base Voltage	V_{CBO}	-40	V
※	Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	-40	V
※	Emitter-Base Voltage	V_{EBO}	-5.0	V
※	Collector Current	DC	-30	A
		Peak	-50	A
※	Base Current	DC	-7.5	A
		Peak	-15	A
※	Collector Power Dissipation	$T_a=25^{\circ}C$	P_C 5.0	W
		Derate above $25^{\circ}C$		$mW/^{\circ}C$
		$T_c=25^{\circ}C$	P_C 200	W
		Derate above $25^{\circ}C$		$W/^{\circ}C$
※	Junction Temperature	T_j	200	$^{\circ}C$
※	Storage Temperature Range	T_{stg}	-65 ~ 200	$^{\circ}C$

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP	MAX.	UNIT	
* Collector Cut-off Current	I _{CBO}	V _{CB} =-40V, I _E =0	-	-	-1.0	mA	
* Collector Cut-off Current	I _{CEX}	V _{CE} =-40V, V _{BE} =1.5V	-	-	-5.0	mA	
* Collector Cut-off Current	I _{CEX}	V _{CE} =-30V, V _{BE} =1.5V, T _c =150°C	-	-	10	mA	
* Collector Cut-off Current	I _{CEO}	V _{CE} =-40V, I _B =0	-	-	-5.0	mA	
* Emitter Cut-off Current	I _{EBO}	V _{EB} =-5V, I _C =0	-	-	-5.0	mA	
* Collector-Emitter Sustaining Voltage	V _{CEO(SUS)} **	I _C =-200mA, I _B =0	-40	-	-	V	
* DC Current Gain	h _{FE}	V _{CE} =-2.0V, I _C =-1.0A	40	-	-		
		V _{CE} =-2.0V, I _C =-15A	15	-	60		
		V _{CE} =-4.0V, I _C =-30A	5.0	-	-		
* Base-Emitter Voltage	V _{BE}	V _{CE} =-2.0V, I _C =-15A	-	-	-1.7	V	
		V _{CE} =-4.0V, I _C =-30A	-	-	-3.0	V	
* Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =-10A, I _B =-1.0A	-	-	-0.75	V	
		I _C =-15A, I _B =-1.5A	-	-	-1.0	V	
		I _C =-20A, I _B =-2.0A	-	-	-2.0	V	
		I _C =-30A, I _B =-6.0A	-	-	-4.0	V	
* Base-Emitter Saturation Voltage	V _{BE(sat)}	I _C =-10A, I _B =-1.0A	-	-	-1.6	V	
		I _C =-15A, I _B =-1.5A	-	-	-1.85	V	
		I _C =-20A, I _B =-2.0A	-	-	-2.5	V	
* Transition Frequency	f _T	V _{CE} =-10V, I _C =-1.0A, f=1.0MHz	2.0	-	-	MHz	
* Small-Signal Current Gain	h _{fe}	V _{CE} =-10V, I _C =-1.0A, f=1.0kHz	40	-	-		
* Switching Time	Rise Time	t _r	See Fig.1-1	-	-	0.4	μs
	Storage Time	t _{stg}	See Fig.1-2	-	-	1.5	μs
	Fall Time	t _f		-	-	0.6	μs

* In Accordance with JEDEC Registration Data.

** The sustaining voltage V_{CEO(SUS)} MUST NOT be measured on a curve tracer.

Fig. 1 SWITCHING TIME EQUIVALENT TEST CIRCUITS

Fig.1-1 TURN-ON TIME

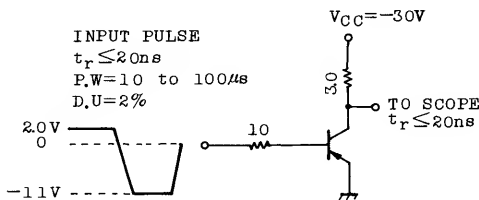
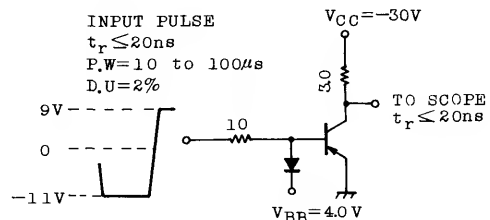
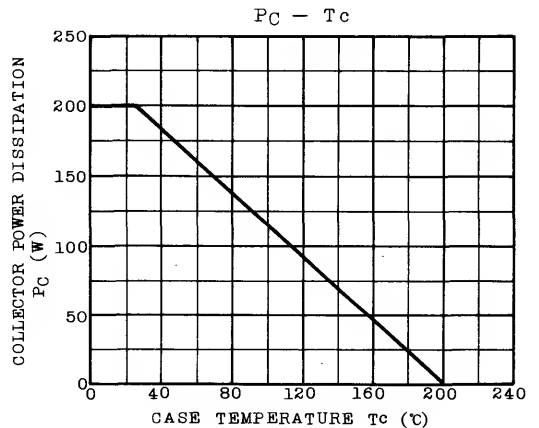
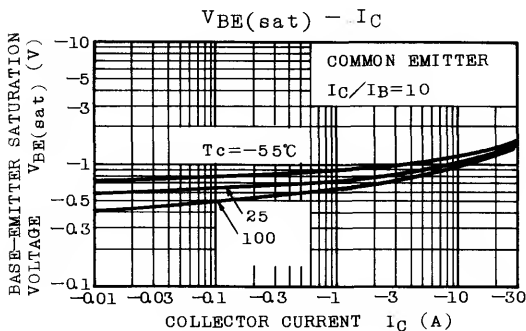
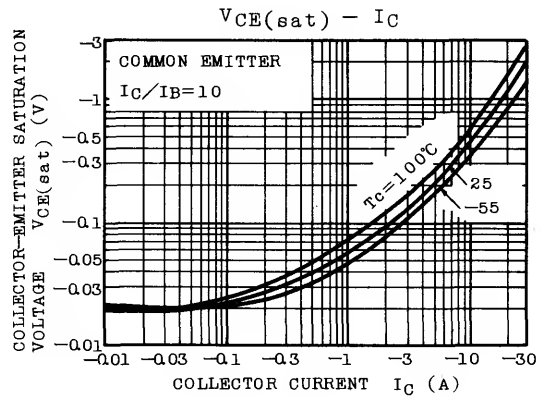
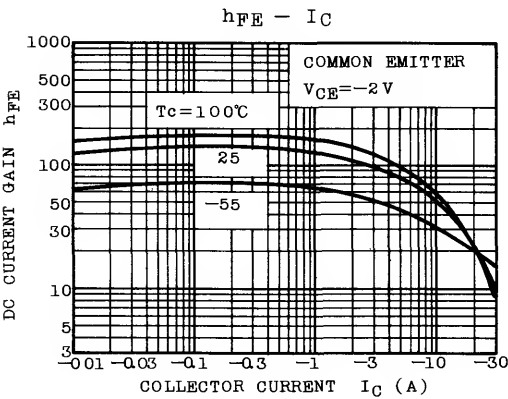
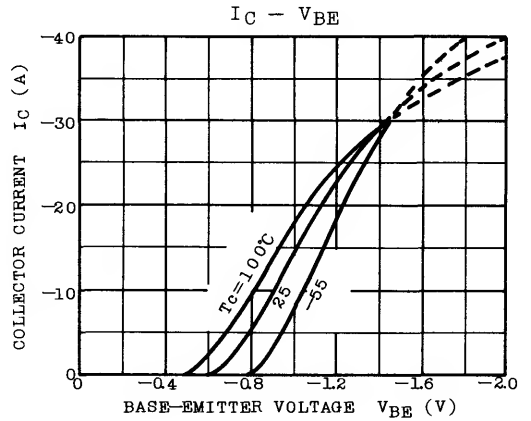
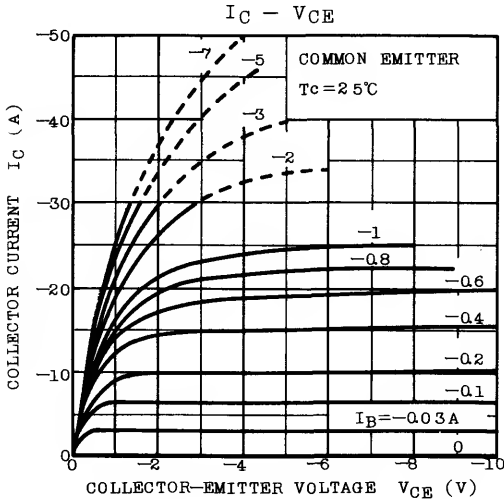


Fig.1-2 TURN-OFF TIME





2N4399

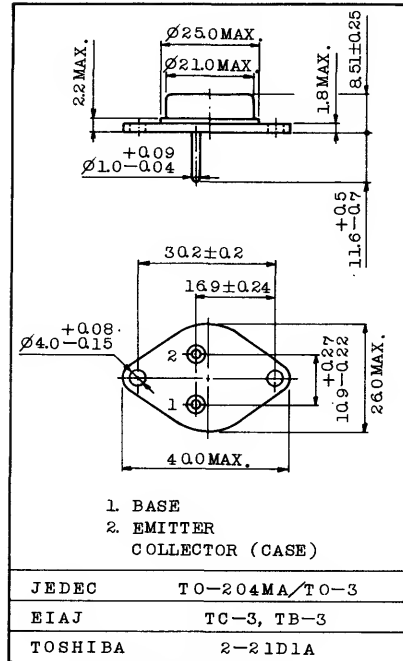
SILICON PNP TRIPLE DIFFUSED TYPE

HIGH POWER SWITCHING, AMPLIFIER, DC-DC CONVERTER, INVERTER AND REGULATOR APPLICATIONS

FEATURES:

- . Specification for h_{FE} and $V_{CE(sat)}$ Up to 30A :
 $h_{FE}=5.0$ (Min.) @ $V_{CE}=-4.0V$, $I_C=-30A$
 $V_{CE(sat)}=-4.0V$ (Max.) @ $I_C=-30A$, $I_B=-6A$
- . Low Saturation Voltage :
 $V_{CE(sat)}=-0.75V$ (Max.) @ $I_C=-10A$, $I_B=-1.0A$
 $V_{BE(sat)}=-1.6V$ (Max.) @ $I_C=-10A$, $I_B=-1.0A$
- . High Collector Power Dissipation Capability :
 $P_C=200W$ (Max.)
- . Complementary to 2N5302

Unit in mm



Weight : 12.6g

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT	
* Collector-Base Voltage		V_{CBO}	-60	V	
* Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	-60	V	
* Emitter-Base Voltage		V_{EBO}	-5.0	V	
* Collector Current	DC	I_C	-30	A	
	Peak		-50	A	
* Base Current	DC	I_B	-7.5	A	
	Peak		-15	A	
* Collector Power Dissipation	$T_a=25^{\circ}C$		P_C	5.0	W
	Derate above $25^{\circ}C$			28.6	mW/ $^{\circ}C$
	$T_c=25^{\circ}C$		P_C	200	W
	Derate above $25^{\circ}C$			1.15	W/ $^{\circ}C$
* Junction Temperature		T_j	200	$^{\circ}C$	
* Storage Temperature Range		T_{stg}	-65 ~ 200	$^{\circ}C$	

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
※ Collector Cut-off Current	ICBO	V _{CB} =-60V, I _E =0	-	-	-1.0	mA
※ Collector Cut-off Current	ICEX	V _{CE} =-60V, V _{BE} =1.5V	-	-	-5.0	mA
※ Collector Cut-off Current	ICEX	V _{CE} =-30V, V _{BE} =1.5V, T _c =150°C	-	-	-10	mA
※ Collector Cut-off Current	ICEO	V _{CE} =-60V, I _B =0	-	-	-5.0	mA
※ Emitter Cut-off Current	I _{EBO}	V _{EB} =-5V, I _C =0	-	-	-5.0	mA
※ Collector-Emitter Sustaining Voltage	V _{CEO(SUS)} ※※	I _C =-200mA, I _B =0	-60	-	-	V
※ DC Current Gain	h _{FE}	V _{CE} =-2.0V, I _C =-1.0A	40	-	-	
		V _{CE} =-2.0V, I _C =-15A	15	-	60	
		V _{CE} =-4.0V, I _C =-30A	5.0	-	-	
※ Base-Emitter Voltage	V _{BE}	V _{CE} =-2.0V, I _C =-15A	-	-	-1.7	V
		V _{CE} =-4.0V, I _C =-30A	-	-	-3.0	V
※ Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =-10A, I _B =-1.0A	-	-	-0.75	V
		I _C =-15A, I _B =-1.5A	-	-	-1.0	V
		I _C =-20A, I _B =-2.0A	-	-	-2.0	V
		I _C =-30A, I _B =-6.0A	-	-	-4.0	V
※ Base-Emitter Saturation Voltage	V _{BE(sat)}	I _C =-10A, I _B =-1.0A	-	-	-1.6	V
		I _C =-15A, I _B =-1.5A	-	-	-1.85	V
		I _C =-20A, I _B =-2.0A	-	-	-2.5	V
※ Transition Frequency	f _T	V _{CE} =-10V, I _C =-1.0A, f=1.0MHz	2.0	-	-	MHz
※ Small-Signal Current Gain	h _{fe}	V _{CE} =-10V, I _C =-1.0A, f=1.0kHz	40	-	-	
※ Switching Time	Rise Time	t _r	See Fig. 1-1		0.4	μs
	Storage Time	t _{stg}	See Fig.1-2		1.5	μs
	Fall Time	t _f	-	-	0.6	μs

※In Accordance with JEDEC Registration Data.

※※The sustaining voltage V_{CEO(SUS)} MUST NOT be measured on a curve tracer.

Fig. 1 SWITCHING TIME EQUIVALENT TEST CIRCUITS

Fig. 1-1 TURN-ON TIME

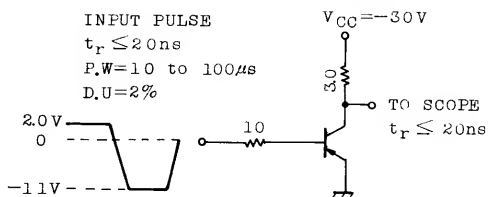
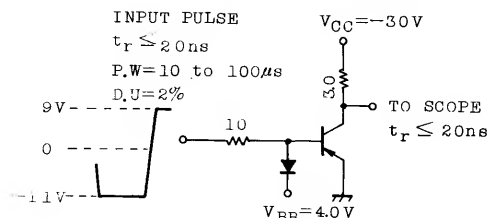
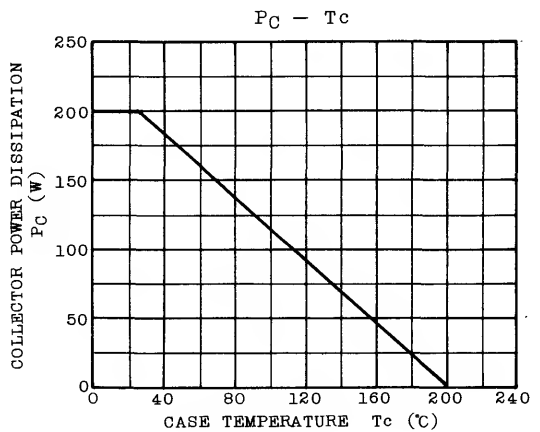
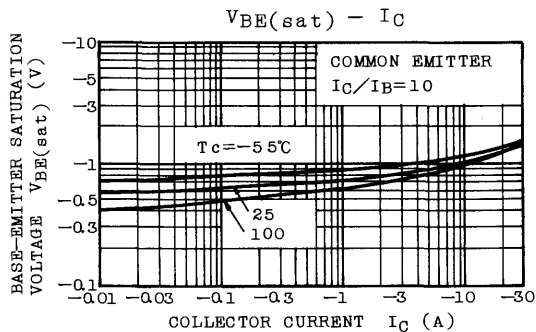
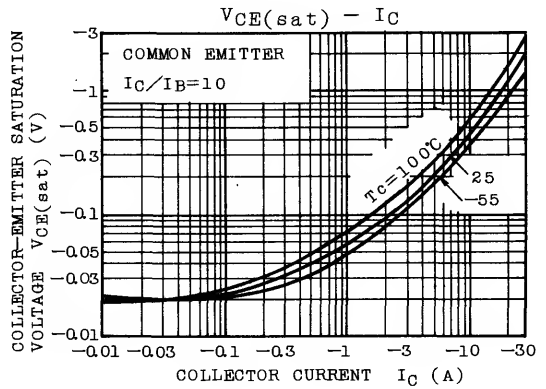
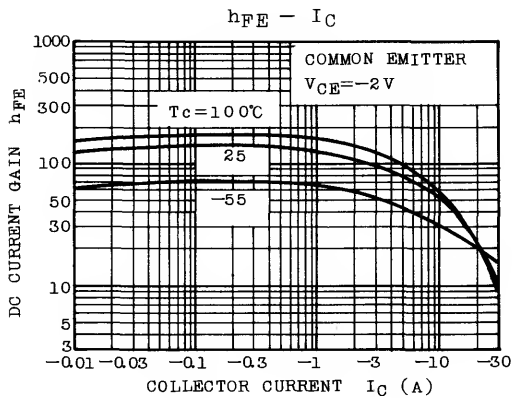
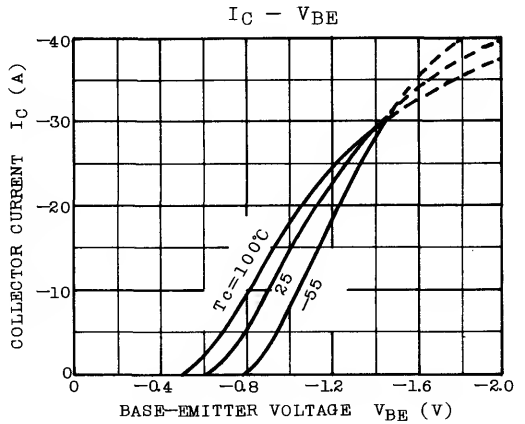
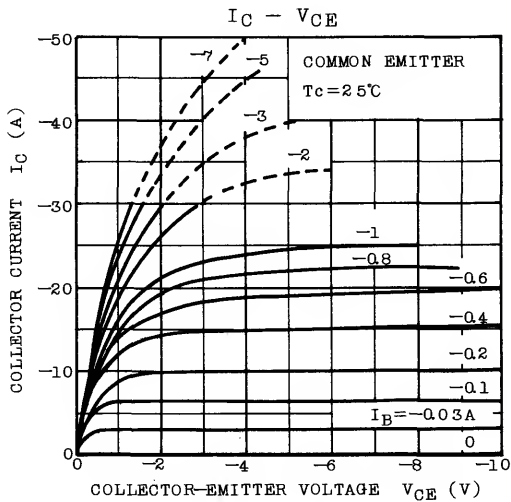


Fig. 1-2 TURN-OFF TIME





DC-DC CONVERTER, SWITCHING REGULATOR AND HIGH POWER AMPLIFIER APPLICATIONS.

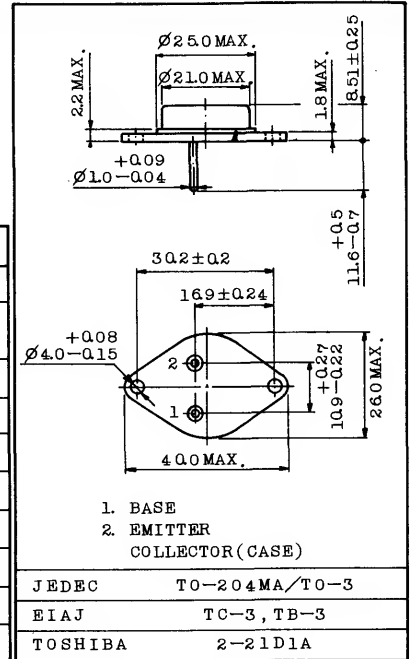
Unit in mm

FEATURES:

- Excellent Switching Times
: $t_r < 0.5\mu s$, $t_f < 0.5\mu s$ @ $I_C=12A$, $I_B=1.2A$
- Low Saturation Voltage
: $V_{CE(sat)} < 2.5V$ @ $I_C=20A$, $I_B=5A$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
* Collector-Base Voltage		V_{CBO}	150	V
Collector-Emmitter Sustaining Voltage ($V_{BE}=-1.5V$, $R_{BE}=100\Omega$)		$V_{CEX(SUS)}$	150	V
* Emmitter-Base Voltage		V_{EBO}	7	V
* Collector Current	DC	I_C	20	A
	Peak	I_{CM}	30	A
* Base Current		I_B	5	A
* Collector Power Dissipation ($T_c=25^\circ C$) Derate Linearly above $25^\circ C$		P_C	140	W
			0.8	W/ $^\circ C$
* Junction Temperature		T_j	200	$^\circ C$
* Storage Temperature Range		T_{stg}	-65 ~ 200	$^\circ C$



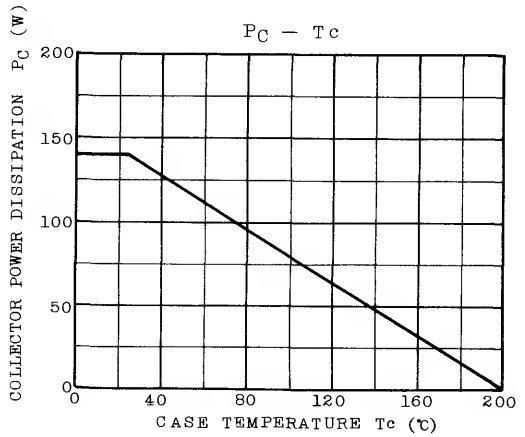
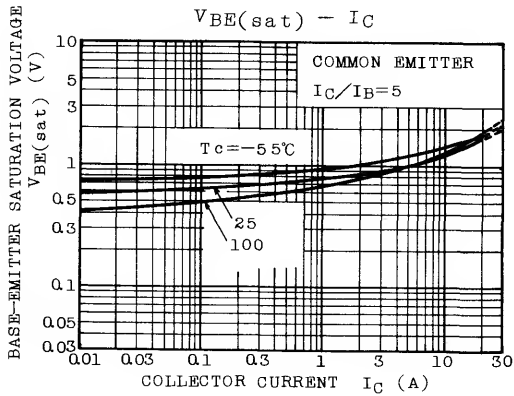
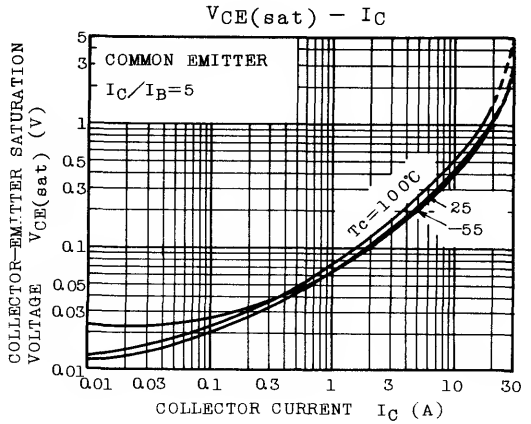
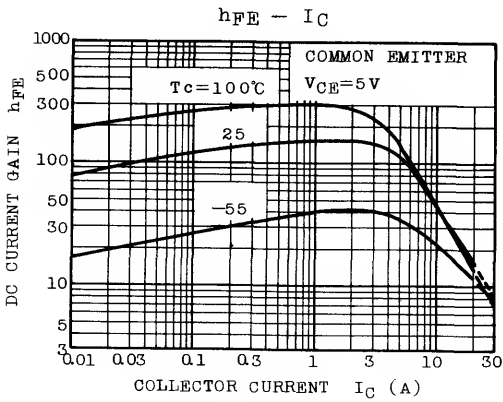
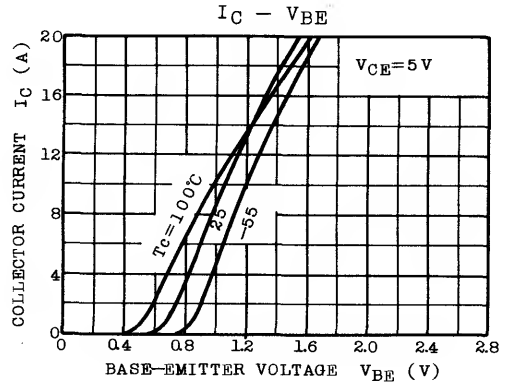
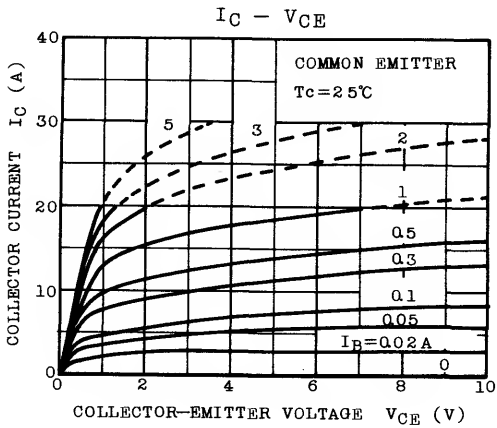
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

Weight : 12.6g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
* Collector Cut-off Current		I_{CEX}	$V_{CE}=140V$, $V_{BE}=-1.5V$	-	-	50	mA
* Collector Cut-off Current		I_{CEX}	$V_{CE}=100V$, $V_{BE}=-1.5V$, $T_c=150^\circ C$	-	-	10	mA
* Emmitter Cut-off Current		I_{EBO}	$V_{EB}=5V$, $I_C=0$	-	-	5	mA
			$V_{EB}=7V$, $I_C=0$	-	-	50	mA
* Collector-Emmitter Sustaining Voltage		$V_{CEO(SUS)}$ **	$I_C=0.2A$, $I_B=0$	90	-	-	V
* DC Current Gain		h_{FE}	$V_{CE}=5V$, $I_C=2A$	50	-	250	
			$V_{CE}=5V$, $I_C=12A$	20	-	100	
* Saturation Voltage	Collector-Emmitter	$V_{CE(sat)}$	$I_C=20A$, $I_B=5A$	-	-	2.5	V
	Base-Emmitter	$V_{BE(sat)}$	$I_C=20A$, $I_B=5A$	-	-	3.3	V
* Small Signal Forward Current Transfer Ratio		$ h_{fe} $	$V_{CE}=10V$, $I_C=2A$, $f=5MHz$	12	-	-	
* Switching Time	Rise Time	t_r		-	-	0.5	μs
	Storage Time	t_{stg}		-	-	1.5	μs
	Fall Time	t_f		-	-	0.5	μs

* In accordance with JEDEC registration data.

** The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.



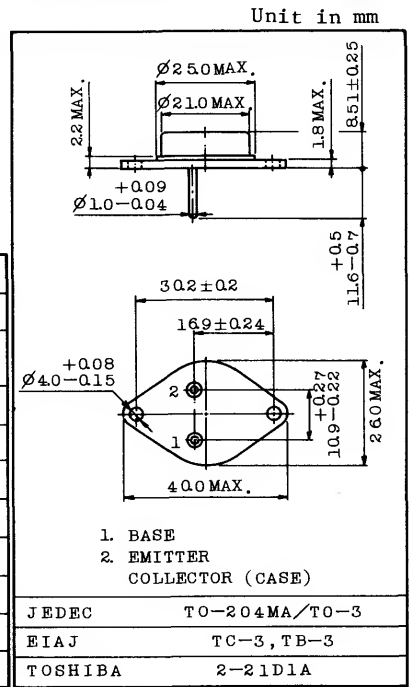
DC-DC CONVERTER, SWITCHING REGULATOR AND HIGH POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Excellent Switching Times
: $t_r < 0.5\mu s$, $t_f < 0.5\mu s$ @ $I_C=10A$, $I_B=1A$
- . Low Saturation Voltage
: $V_{CE(sat)} < 2.5V$ @ $I_C=20A$, $I_B=5A$

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
* Collector-Base Voltage		V _{CB0}	120	V
Collector-Emmitter Sustaining Voltage (V _{BE} =-1.5V, R _{BE} =100Ω)		V _{CES(SUS)}	120	V
* Emmitter-Base Voltage		V _{EB0}	7	V
* Collector Current	DC	I _C	20	A
	Peak	I _{CM}	30	A
* Base Current		I _B	5	A
* Collector Power Dissipation (T _c =25°C) Derate Linearly 25°C		P _C	140	W
			0.8	W/°C
* Junction Temperature		T _j	200	°C
* Storage Temperature Range		T _{stg}	-65 ~ 200	°C

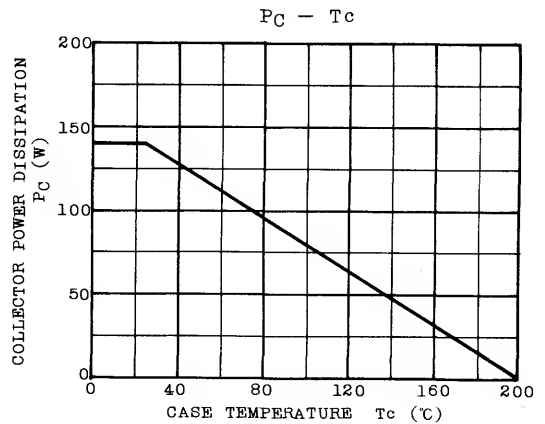
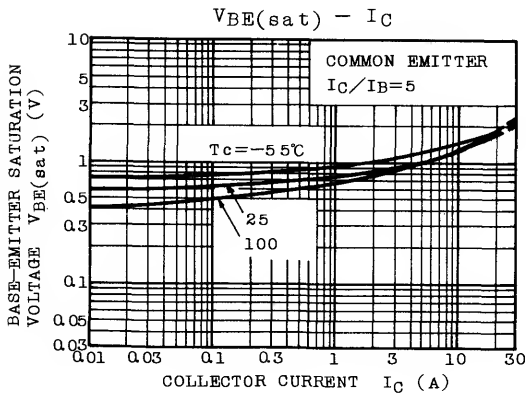
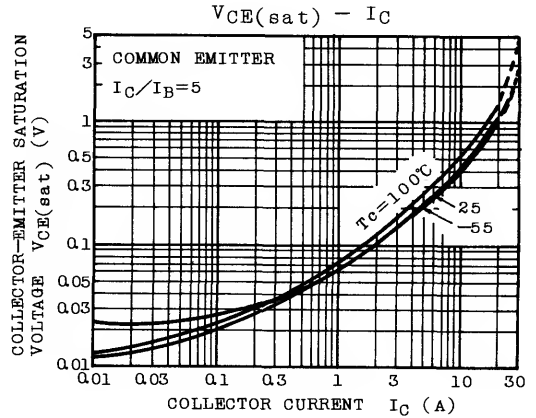
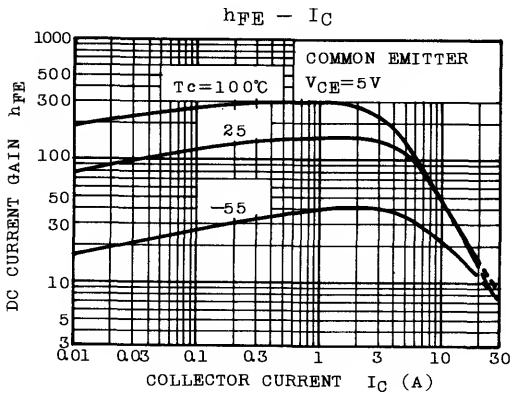
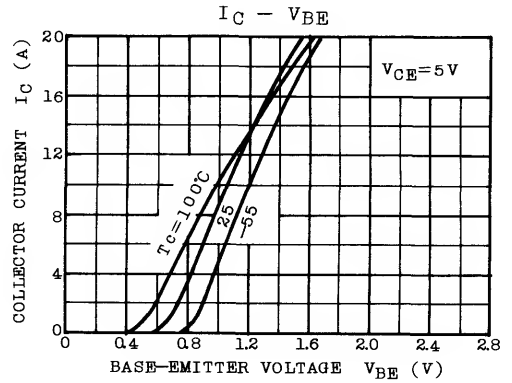
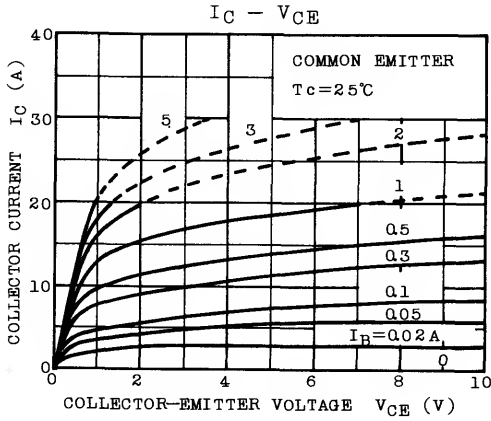


Weight : 12.6g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
* Collector Cut-off Current		I _{CES}	V _{CE} =110V, V _{BE} =-1.5V	-	-	50	mA
* Collector Cut-off Current		I _{CES}	V _{CE} =85V, V _{BE} =-1.5V, T _c =150°C	-	-	10	mA
* Emmitter Cut-off Current		I _{EB0}	V _{EB} =5V, I _C =0	-	-	15	mA
			V _{EB} =7V, I _C =0	-	-	50	mA
* Collector-Emmitter Sustaining Voltage		V _{CEO(SUS)} **	I _C =0.2A, I _B =0	75	-	-	V
* DC Current Gain		h _{FE}	V _{CE} =5V, I _C =2A	30	-	250	
			V _{CE} =5V, I _C =10A	20	-	100	
* Saturation Voltage	Collector-Emmitter	V _{CE(sat)}	I _C =20A, I _B =5A	-	-	2.5	V
	Base-Emmitter	V _{BE(sat)}	I _C =20A, I _B =5A	-	-	3.3	V
* Small Signal Forward Current Transfer Ratio		h _{fe}	V _{CE} =10V, I _C =2A, f=5MHz	12	-	-	
* Switching Time	Rise Time	t _r		-	-	0.5	μs
	Storage Time	t _{stg}		-	-	1.5	μs
	Fall Time	t _f		-	-	0.5	μs

* In accordance with JEDEC registration data.
** The sustaining voltage V_{CEO(SUS)} MUST NOT be measured on a curve tracer.

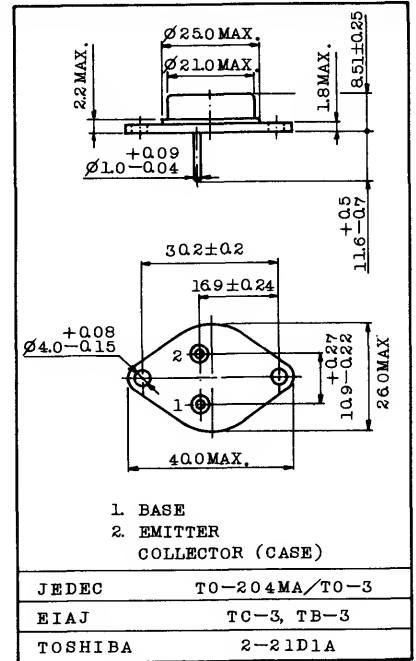


HIGH POWER SWITCHING, AMPLIFIER, DC-DC CONVERTER, INVERTER AND REGULATOR APPLICATIONS

FEATURES:

- . Specification for h_{FE} and $V_{CE(sat)}$ Up to 30A:
 $h_{FE}=5.0$ (Min.) @ $V_{CE}=4.0V$, $I_C=30A$
 $V_{CE(sat)}=3.0V$ (Max.) @ $I_C=30A$, $I_B=6A$
- . Low Saturation Voltage:
 $V_{CE(sat)}=0.75V$ (Max.) @ $I_C=10A$, $I_B=1.0A$
 $V_{BE(sat)}=1.7V$ (Max.) @ $I_C=10A$, $I_B=1.0A$
- . High Collector Power Dissipation Capability:
 $P_C=200W$ (Max.)
- . Complementary to 2N4398

Unit in mm



Weight : 12.6g

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
※ Collector-Base Voltage	V_{CBO}	40	V
※ Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	40	V
※ Emitter-Base Voltage	V_{EBO}	5	V
※ Collector Current	DC	I_C	30
	Peak	I_{CM}	50
※ Base Current	I_B	7.5	A
※ Collector Power Dissipation ($T_c=25^{\circ}C$)	P_C	200	W
Derate above $25^{\circ}C$		1.14	W/ $^{\circ}C$
※ Junction Temperature	T_j	200	$^{\circ}C$
※ Storage Temperature Range	T_{stg}	-65 ~ 200	$^{\circ}C$

※ In Accordance with JEDEC Registration Data format JS-6 RDF-2.

2N5301

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
* Collector Cut-off Current	ICBO	V _{CB} =40V, I _E =0	-	-	1.0	mA	
* Collector Cut-off Current	ICEX	V _{CE} =40V, V _{BE} =-1.5V	-	-	1.0	mA	
* Collector Cut-off Current	ICEX	V _{CE} =40V, V _{BE} =-1.5V, T _c =150°C	-	-	10	mA	
* Collector Cut-off Current	ICEO	V _{CE} =40V, I _B =0	-	-	5.0	mA	
* Emitter Cut-off Current	IEBO	V _{EB} =5V, I _C =0	-	-	5.0	mA	
* Collector-Emitter Sustaining Voltage	V _{CEO(SUS)} ***	I _C =200mA, I _B =0	40	-	-	V	
* DC Current Gain	h _{FE}	V _{CE} =2.0V, I _C =1.0A	40	-	-		
		V _{CE} =2.0V, I _C =15A	15	-	60		
		V _{CE} =4.0V, I _C =30A	5.0	-	-		
* Base-Emitter Voltage	V _{BE}	V _{CE} =2.0V, I _C =15A	-	-	1.7	V	
		V _{CE} =4.0V, I _C =30A	-	-	3.0	V	
* Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =10A, I _B =1.0A	-	-	0.75	V	
		I _C =20A, I _B =2.0A	-	-	2.0	V	
		I _C =30A, I _B =6.0A	-	-	3.0	V	
* Base-Emitter Saturation Voltage	V _{BE(sat)}	I _C =10A, I _B =1.0A	-	-	1.7	V	
		I _C =15A, I _B =1.5A	-	-	1.8	V	
		I _C =20A, I _B =2.0A	-	-	2.5	V	
* Transition Frequency	f _T	V _{CE} =10V, I _C =1.0A, f=1.0MHz	2.0	-	-	MHz	
* Small-Signal Current Gain	h _{fe}	V _{CE} =10V, I _C =1.0A, f=1.0kHz	40	-	-		
* Switching Time	Rise Time	t _r	See Fig.1-1	-	-	1.0	μs
	Storage Time	t _{stg}	See Fig.1-2	-	-	2.0	μs
	Fall Time	t _f		-	-	1.0	μs

* In Accordance with JEDEC Registration Data Format JS-6 RDF-1.

***The sustaining voltage V_{CEO(SUS)} MUST NOT be measured on a curve tracer.

Fig. 1 SWITCHING TIME EQUIVALENT TEST CIRCUITS

Fig.1-1 TURN-ON TIME

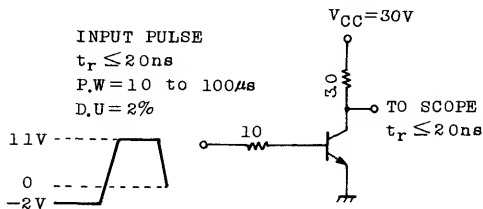
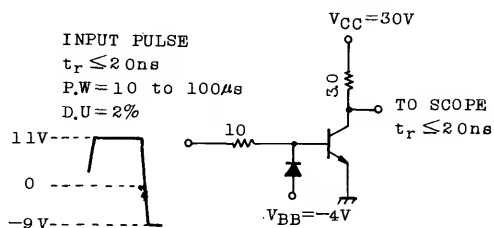
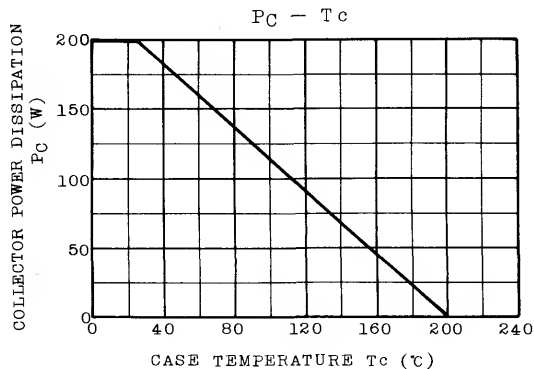
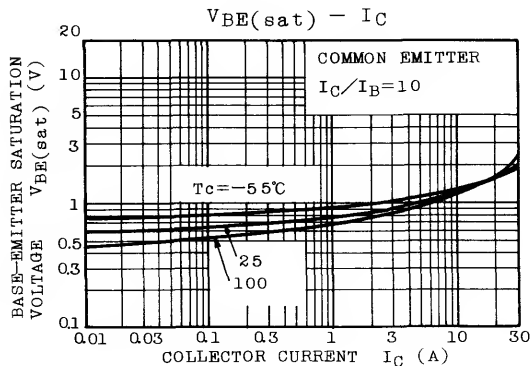
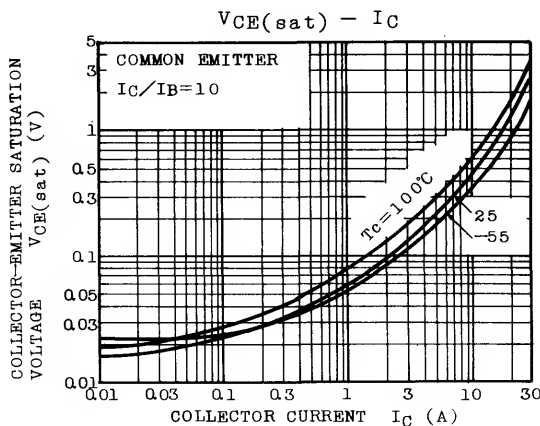
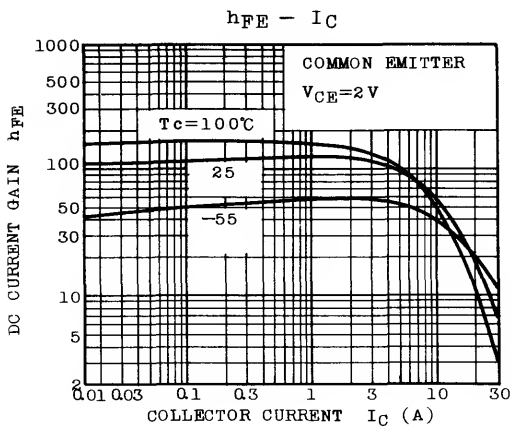
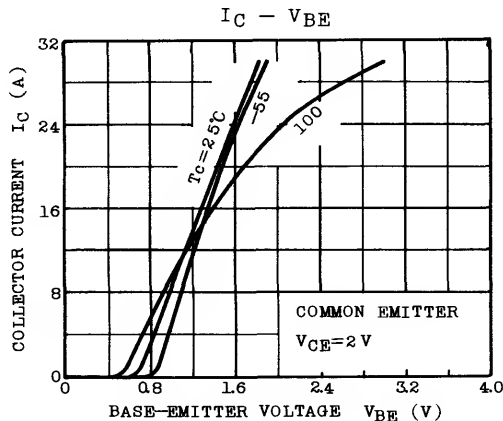
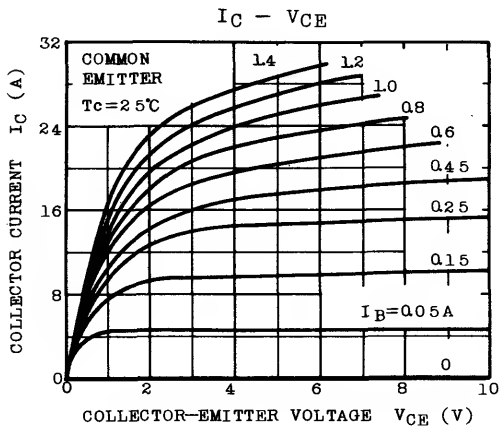


Fig.1-2 TURN-OFF TIME





2N5302

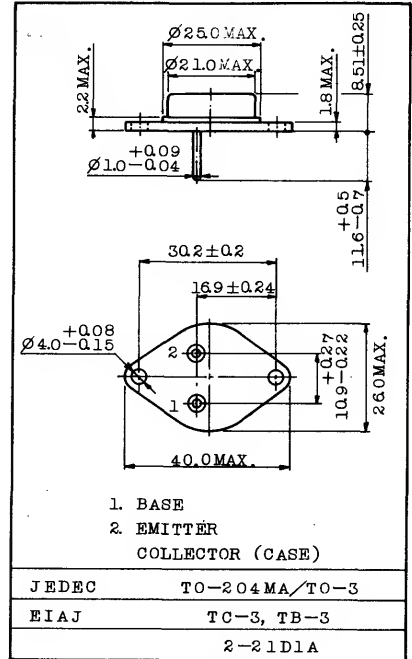
SILICON NPN TRIPLE DIFFUSED TYPE

HIGH POWER SWITCHING, AMPLIFIER, DC-DC CONVERTER,
INVERTER AND REGULATOR APPLICATIONS

FEATURES:

- . Specification for h_{FE} and $V_{CE(sat)}$ Up to 30A:
 $h_{FE}=5.0$ (Min.) @ $V_{CE}=4.0V$, $I_C=30A$
 $V_{CE(sat)}=3.0V$ (Max.) @ $I_C=30A$, $I_B=1.0A$
- . Low Saturation Voltage:
 $V_{CE(sat)}=0.75V$ (Max.) @ $I_C=10A$, $I_B=1.0A$
 $V_{CE(sat)}=1.7V$ (Max.) @ $I_C=10A$, $I_B=1.0A$
- . High Collector Power Dissipation Capability:
 $P_C=200W$ (Max.)
- . Complementary to 2N4399

Unit in mm



Weight : 12.6g

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	60	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	DC	I_C	30
	Peak	I_{CM}	50
Base Current	I_B	7.5	A
Collector Power Dissipation ($T_c=25^{\circ}C$)	P_C	200	W
Derate above $25^{\circ}C$		1.14	W/ $^{\circ}C$
Junction Temperature	T_j	200	$^{\circ}C$
Storage Temperature Range	T_{stg}	-65 ~ 200	$^{\circ}C$

*In Accordance with JEDEC Registration Data format JS-6 RDF-2.

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
※ Collector Cut-off Current	I_{CBO}	$V_{CB}=60V, I_E=0$	-	-	1.0	mA
※ Collector Cut-off Current	I_{CEX}	$V_{CE}=60V, V_{BE}=-1.5V$	-	-	1.0	mA
※ Collector Cut-off Current	I_{CEX}	$V_{CE}=60V, V_{BE}=-1.5V, T_c=150^\circ C$	-	-	10	mA
※ Collector Cut-off Current	I_{CEO}	$V_{CE}=60V, I_B=0$	-	-	5.0	mA
※ Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	5.0	mA
※ Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	$I_C=200mA, I_B=0$	60	-	-	V
※ DC Current Gain	h_{FE}	$V_{CE}=2.0V, I_C=1.0A$	40	-	-	
		$V_{CE}=2.0V, I_C=15A$	15	-	60	
		$V_{CE}=4.0V, I_C=30A$	5.0	-	-	
※ Base-Emitter Voltage	V_{BE}	$V_{CE}=2.0V, I_C=15A$	-	-	1.7	V
		$V_{CE}=4.0V, I_C=30A$	-	-	3.0	V
※ Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=10A, I_B=1.0A$	-	-	0.75	V
		$I_C=20A, I_B=2.0A$	-	-	2.0	V
		$I_C=30A, I_B=6.0A$	-	-	3.0	V
※ Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=10A, I_B=1.0A$	-	-	1.7	V
		$I_C=15A, I_B=1.5A$	-	-	1.8	V
		$I_C=20A, I_B=2.0A$	-	-	2.5	V
※ Transition Frequency	f_T	$V_{CE}=10V, I_C=1.0A, f=1.0MHz$	2.0	-	-	MHz
※ Small-Signal Current Gain	h_{fe}	$V_{CE}=10V, I_C=1.0A, f=1.0kHz$	40	-	-	
※ Switching Time	Rise Time	t_r	See Fig.1-1	-	-	1.0 μs
	Storage Time	t_{stg}	See Fig.1-2	-	-	2.0 μs
	Fall Time	t_f		-	-	1.0 μs

※ In Accordance with JEDEC Registration Data Format JS-6 RDF-1.

※※ The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.

Fig. 1 SWITCHING TIME EQUIVALENT TEST CIRCUITS

Fig.1-1 TURN-ON TIME

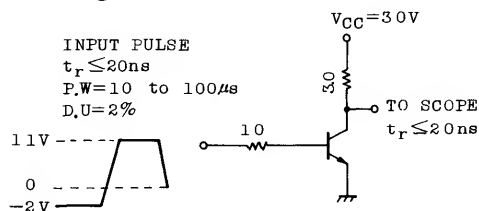
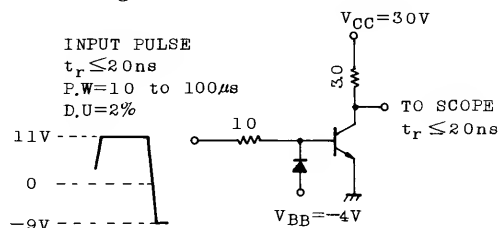
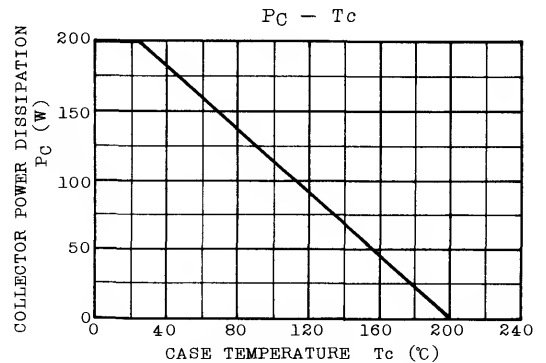
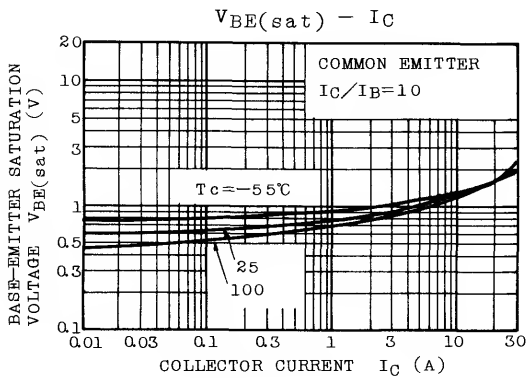
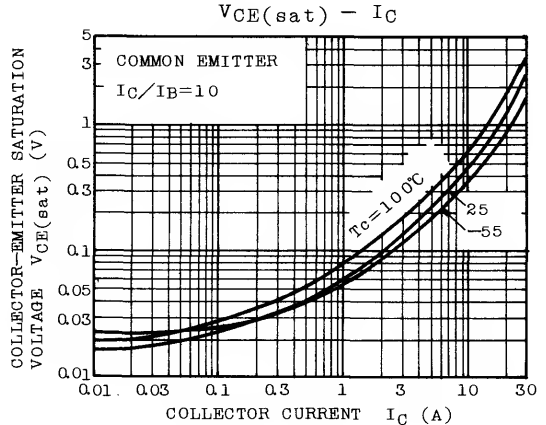
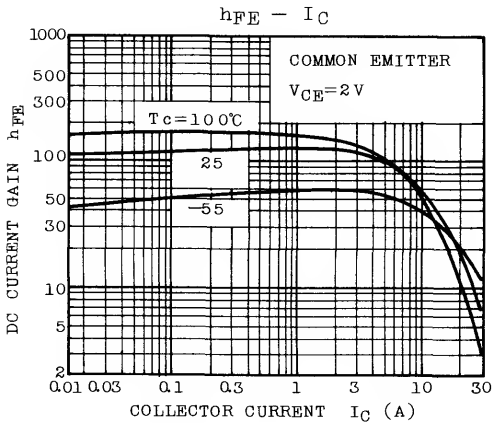
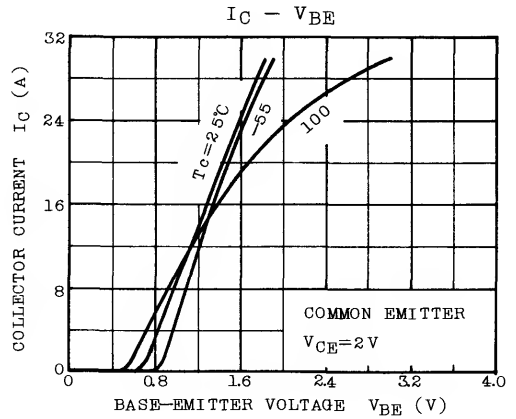
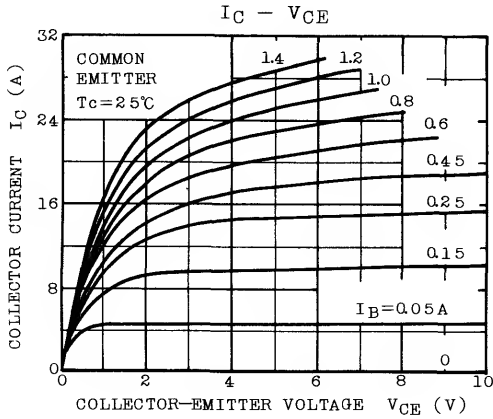


Fig.1-2 TURN-OFF TIME





2N5303

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
*	Collector Cut-off Current	ICBO	V _{CB} =80V, I _E =0	-	-	1.0	mA	
*	Collector Cut-off Current	ICEX	V _{CE} =80V, V _{BE} =-1.5V	-	-	1.0	mA	
*	Collector Cut-off Current	ICEX	V _{CE} =80V, V _{BE} =-1.5V, T _c =150°C	-	-	10	mA	
*	Collector Cut-off Current	ICEO	V _{CE} =80V, I _B =0	-	-	5.0	mA	
*	Emitter Cut-off Current	I _{EBO}	V _{EB} =5V, I _C =0	-	-	5.0	mA	
*	Collector-Emitter Sustaining Voltage	V _{CEO(SUS)} ***	I _C =200mA, I _B =0	80	-	-	V	
*	DC Current Gain	h _{FE}	V _{CE} =2.0V, I _C =1.0A	40	-	-		
			V _{CE} =2.0V, I _C =10A	15	-	60		
			V _{CE} =4.0V, I _C =20A	5.0	-	-		
*	Base-Emitter Voltage	V _{BE}	V _{CE} =2.0V, I _C =10A	-	-	1.5	V	
			V _{CE} =4.0V, I _C =20A	-	-	2.5	V	
*	Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =10A, I _B =1.0A	-	-	1.0	V	
			I _C =15A, I _B =1.5A	-	-	1.5	V	
			I _C =20A, I _B =4.0A	-	-	2.0	V	
*	Base-Emitter Saturation Voltage	V _{BE(sat)}	I _C =10A, I _B =1.0A	-	-	1.7	V	
			I _C =15A, I _B =1.5A	-	-	2.0	V	
			I _C =20A, I _B =4.0A	-	-	2.5	V	
*	Transition Frequency	f _T	V _{CE} =10V, I _C =1.0A, f=1.0MHz	2.0	-	-	MHz	
*	Small-Signal Current Gain	h _{fe}	V _{CE} =10V, I _C =1.0A, f=1.0kHz	40	-	-		
*	Switching Time	Rise Time	t _r	See Fig.1-1	-	-	1.0	μs
		Storage Time	t _{stg}	See Fig.1-2	-	-	2.0	μs
		Fall Time	t _f		-	-	1.0	μs

*In Accordance with JEDEC Registration Data Format JS-6 RDF-1.

***The sustaining voltage V_{CEO(SUS)} MUST NOT be measured on a curve tracer.

Fig.1 SWITCHING TIME EQUIVALENT TEST CIRCUITS

Fig.1-1 TURN-ON TIME

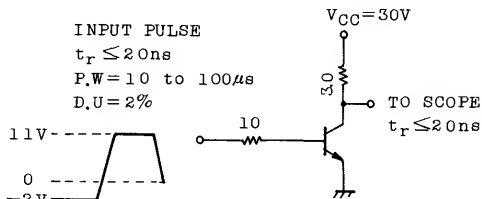
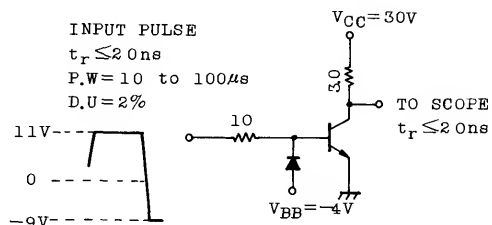
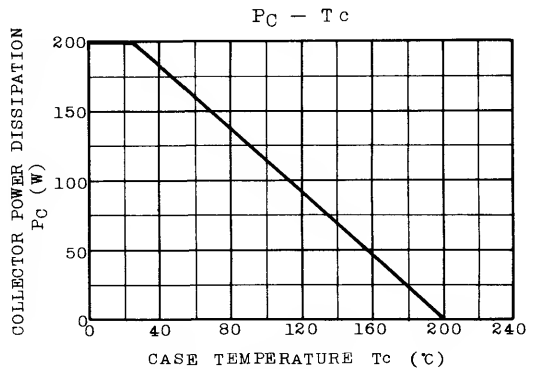
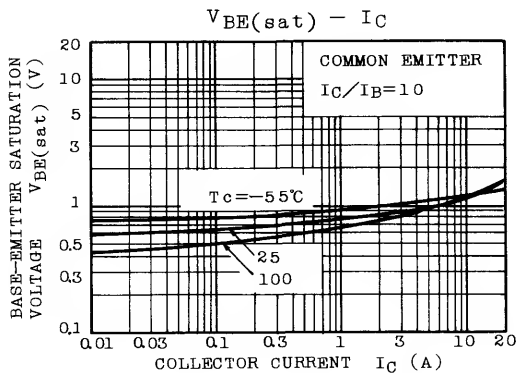
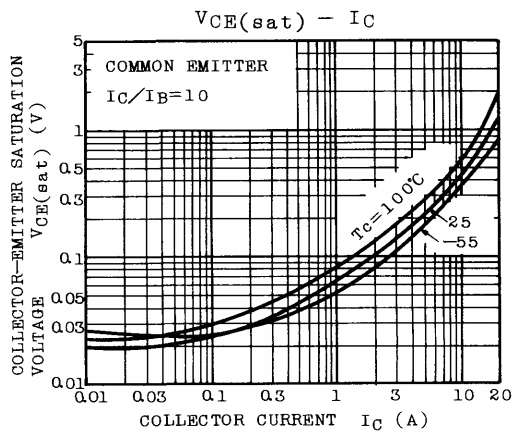
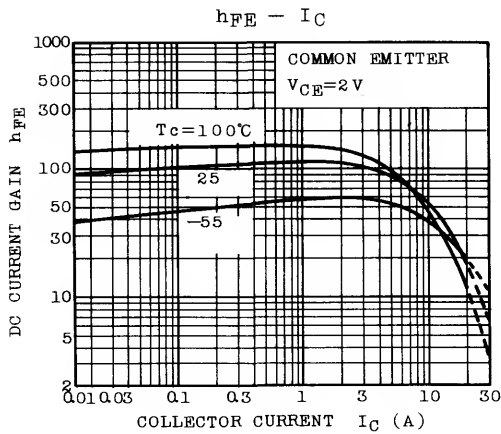
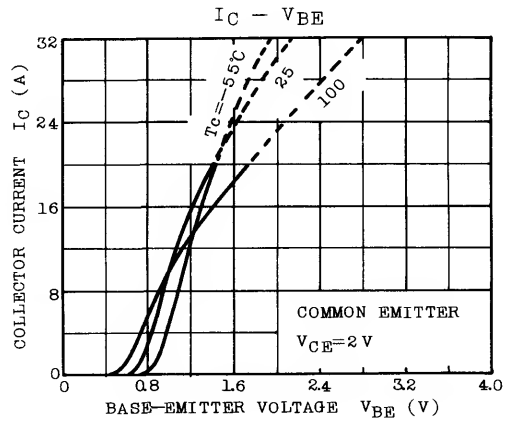
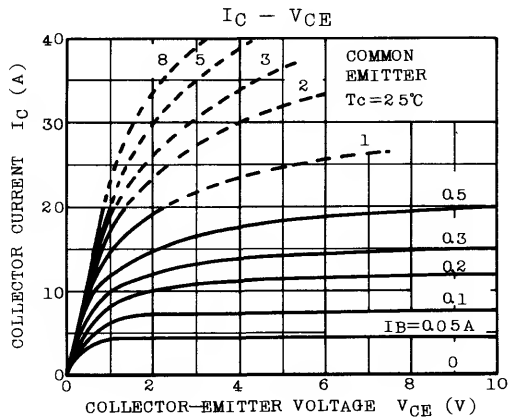


Fig.1-2 TURN-OFF TIME





2N6249

SILICON NPN TRIPLE DIFFUSED TYPE

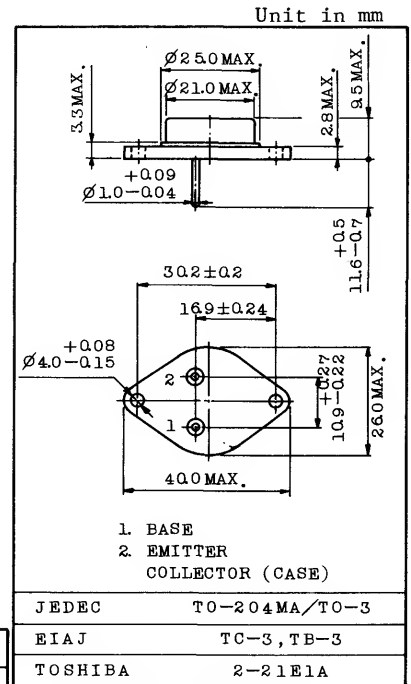
HIGH POWER AMPLIFIER, POWER SWITCHING AND DC-DC CONVERTER APPLICATIONS.

FEATURES:

- . High Collector-Emitter Sustaining Voltage
: $V_{CE(SUS)}=200V$ (Min.)
- . Low Saturation Voltage : $V_{CE(sat)} < 1.5V$
@ $I_C=10A, I_B=1A$
- . Excellent Switching Times : $t_r < 2.0\mu s, t_f < 1.0\mu s$
@ $I_C=10A, I_B=\pm 1A$
- . High Collector Power Dissipation Capacity
: $P_C=175W$ (Max.)
- . Excellent Area of Safe Operatings

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT	
*	Collector-Base Voltage	V_{CBO}	300	V	
	Collector-Emitter Sustaining Voltage (RBE=50Ω)	$V_{CER(SUS)}$	225	V	
*	Collector-Emitter Sustaining Voltage ($V_{BE}=0$)	$V_{CEX(SUS)}$	225	V	
	Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	200	V	
*	Emitter-Base Voltage	V_{EBO}	6	V	
*	Collector Current	DC	I_C	10	A
		Peak	I_{CM}	30	A
*	Base Current	I_B	10	A	
*	Collector Power Dissipation	$T_c=25^\circ C$	P_C	175	W
		$T_c=100^\circ C$		100	W
		Derate Linearly above 25°C		1.0	W/°C
*	Junction Temperature	T_j	200	°C	
*	Storage Temperature Range	T_{stg}	-65 ~ 200	°C	
*	Lead Temperature (0.8mm from case for 10s)	T_L	230	°C	



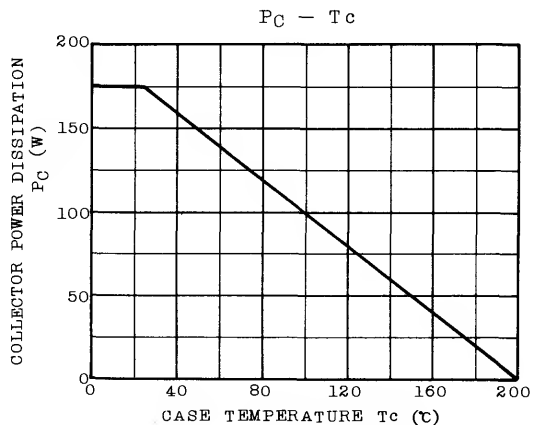
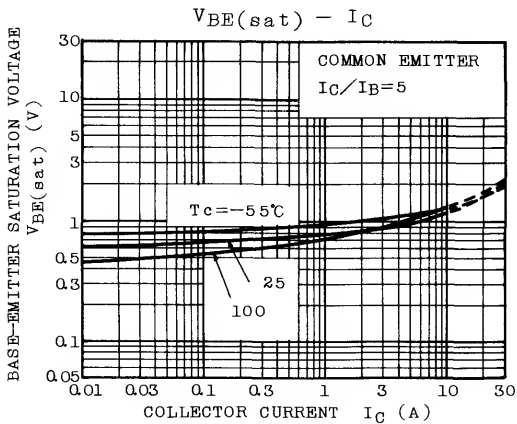
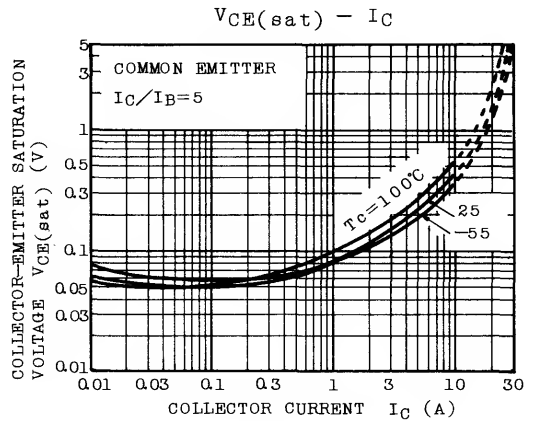
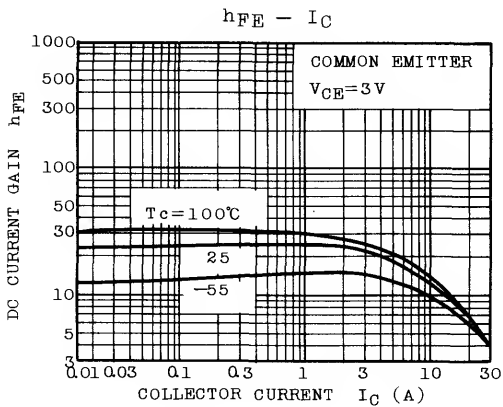
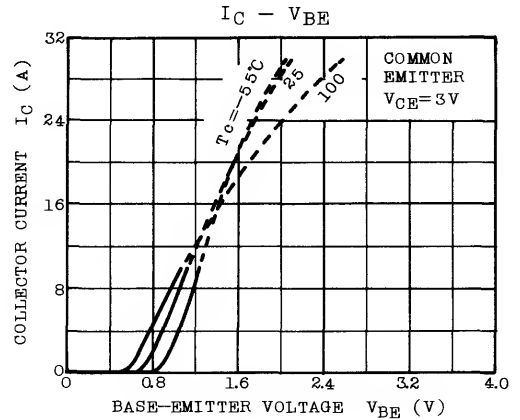
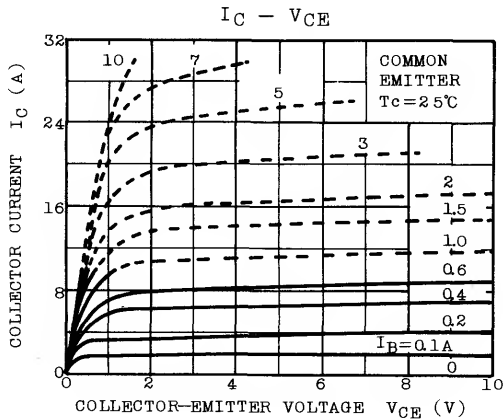
Weight : 15.8g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
*	Collector Cut-off Current	ICEV	VCE=225V, VBE=-1.5V	-	-	5	mA	
*	Collector Cut-off Current	ICEV	VCE=225V, VBE=-1.5V Tc=125°C	-	-	10	mA	
	Collector Cut-off Current	ICEO	VCE=150V, IB=0	-	-	5	mA	
*	Emitter Cut-off Current	IEBO	VEB=6V, IC=0	-	-	1	mA	
*	Collector-Emitter Sustaining Voltage	V _{CER(SUS)} **	IC=0.2A, RBE=50Ω	225	-	-	V	
*	Collector-Emitter Sustaining Voltage	V _{CEO(SUS)} **	IC=0.2A, IB=0	200	-	-	V	
*	Emitter-Base Breakdown Voltage	V(BR)EBO	IE=1mA, IC=0	6	-	-	V	
*	DC Current Gain	hFE	VCE=3V, IC=10A	10	-	50		
*	Saturation Voltage	Collector-Emitter	VCE(sat)	IC=10A, IB=1A	-	-	1.5	V
		Base-Emitter	VBE(sat)	IC=10A, IB=1A	-	-	2.25	V
*	Small Signal Current Gain	hfe	VCE=10V, IC=1A f=1MHz	2.5	-	-		
*	Rise Time	tr		-	-	2.0	µs	
	Storage Time	tstg		-	-	3.5	µs	
	Fall Time	tf		IB1=-IB2=1A DUTY CYCLE ≤ 2%	-	-	1.0	µs
*	Second Breakdown Collector Current (Base Forward Bias)	IS/b	VCE=30V, t=1s (non-repetitive)	5.8	-	-	A	
*	Second Breakdown Energy (Base Reverse Bias)	ES/b	IC=10A, VBE=-4V, L=50µH	2.5	-	-	mJ	

* In accordance with JEDEC registration data.

** The sustaining voltages V_{CER(SUS)} and V_{CEO(SUS)} MUST NOT be measured on a curve tracer.



DC-DC CONVERTER, SWITCHING REGULATOR
AND HIGH POWER AMPLIFIER APPLICATIONS.

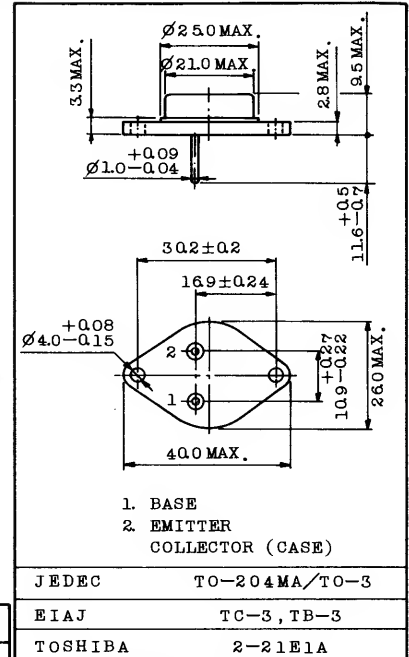
FEATURES:

- . High Collector-Emitter Sustaining Voltage
: $V_{CEO(SUS)}=275V$ (Min.)
- . Low Saturation Voltage : $V_{CE(sat)} < 1.5V$
@ $I_C=10A, I_B=1.25A$
- . Excellent Switching Times : $t_r < 2.0\mu s, t_f < 1.0\mu s$
@ $I_C=10A, I_B=\pm 1.25A$
- . High Collector Power Dissipation Capacity
: $P_C=175W$ (Max.)
- . Excellent Area of Safe Operatings

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT	
*	Collector-Base Voltage	V_{CB0}	375	V	
	Collector-Emitter Sustaining Voltage ($R_{BE}=50\Omega$)	$V_{CER(SUS)}$	300	V	
*	Collector-Emitter Sustaining Voltage ($V_{BE}=0$)	$V_{CEX(SUS)}$	300	V	
	Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	275	V	
*	Emitter-Base Voltage	V_{EB0}	6	V	
*	Collector Current	DC	I_C	10	A
		Peak	I_{CM}	30	A
*	Base Current	I_B	10	A	
*	Collector Power Dissipation	$T_c=25^\circ C$	P_C	175	W
		$T_c=100^\circ C$		100	W
	Derate Linearly above $25^\circ C$		1.0	W/ $^\circ C$	
*	Junction Temperature	T_j	200	$^\circ C$	
*	Storage Temperature Range	T_{stg}	-65 ~ 200	$^\circ C$	
*	Lead Temperature (0.8mm from case for 10s)	T_L	230	$^\circ C$	

Unit in mm



Weight : 15.8g

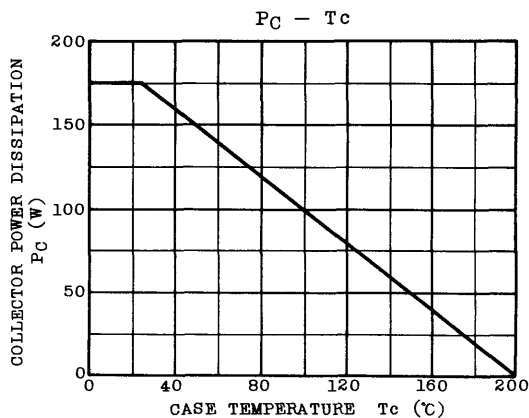
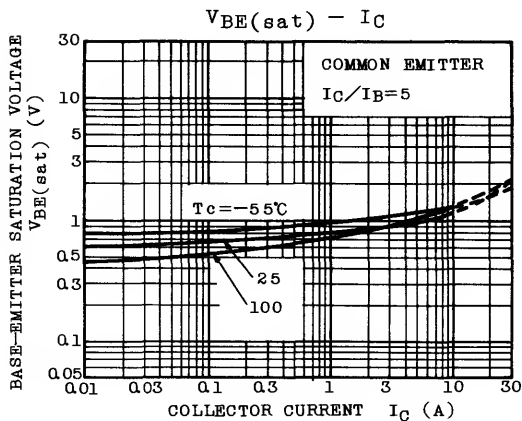
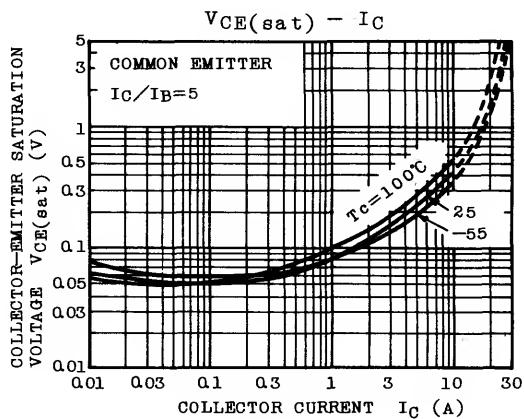
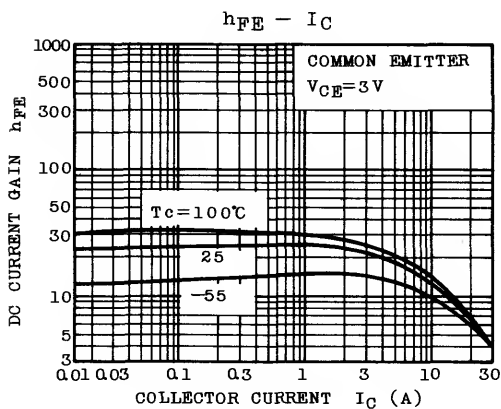
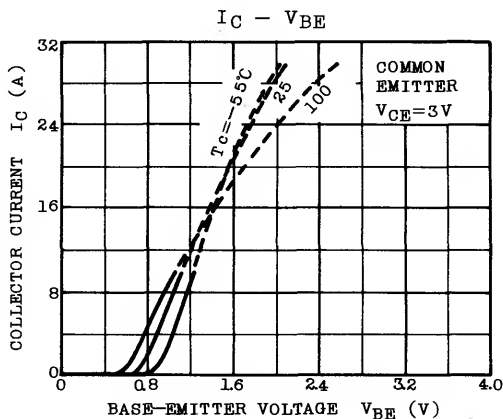
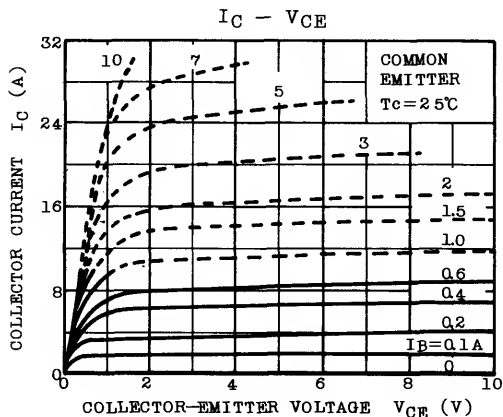
2N6250

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
*	Collector Cut-off Current	ICEV	VCE=300V, VBE=-1.5V	-	-	5	mA	
*	Collector Cut-off Current	ICEV	VCE=300V, VBE=-1.5V Tc=125°C	-	-	10	mA	
	Collector Cut-off Current	ICEO	VCE=225V, IB=0	-	-	5	mA	
*	Emitter Cut-off Current	IEBO	VEB=6V, IC=0	-	-	1	mA	
*	Collector-Emitter Sustaining Voltage	V _{CER(SUS)} **	IC=0.2A, R _{BE} =50Ω	300	-	-	V	
*	Collector-Emitter Sustaining Voltage	V _{CEO(SUS)} **	IC=0.2A, IB=0	275	-	-	V	
*	Emitter-Base Breakdown Voltage	V(BR)EBO	IE=1mA, IC=0	6	-	-	V	
*	DC Current Gain	hFE	VCE=3V, IC=10A	8	-	50		
*	Saturation Voltage	Collector-Emitter	VCE(sat)	IC=10A, IB=1.25A	-	-	1.5	V
		Base-Emitter	VBE(sat)	IC=10A, IB=1.25A	-	-	2.25	V
*	Small Signal Current Gain	hfe	VCE=10V, IC=1A f=1MHz	2.5	-	-		
*	Rise Time	tr		-	-	2.0	µs	
	Storage Time	ts		-	-	3.5	µs	
	Fall Time	tf		IB1=-IB2=1.25A DUTY CYCLE ≤ 2%	-	-	1.0	µs
*	Second Breakdown Collector Current (Base Forward Bias)	Is/b	VCE=30V, t=1s (non-repetitive)	5.8	-	-	A	
*	Second Breakdown Energy (Base Reverse Bias)	Es/b	IC=10A, VBE=-4V L=50µH	2.5	-	-	mJ	

* In accordance with JEDEC registration data.

** The sustaining voltages VCER(SUS) and VCEO(SUS) MUST NOT be measured on a curve tracer.



2N6251

SILICON NPN TRIPLE DIFFUSED TYPE

DC-DC CONVERTER, SWITCHING REGULATOR
AND HIGH POWER AMPLIFIER APPLICATIONS.

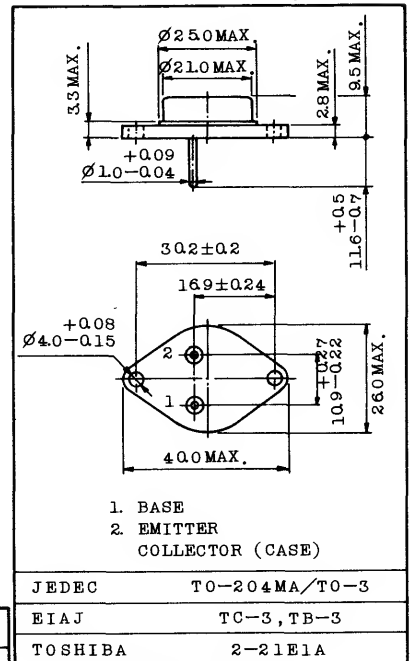
FEATURES:

- High Collector-Emitter Sustaining Voltage
: $V_{CEO(SUS)}=350V$ (Min.)
- Low Saturation Voltage : $V_{CE(sat)} < 1.5V$
@ $I_C=10A, I_B=1.67A$
- Excellent Switching Times : $t_r < 2.0\mu s, t_f < 1.0\mu s$
@ $I_C=10A, I_B=\pm 1.67A$
- High Collector Power Dissipation Capacity
: $P_C=175W$ (Max.)
- Excellent Area of Safe Operatings

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT	
*	Collector-Base Voltage	V_{CBO}	450	V	
	Collector-Emitter Sustaining Voltage (RBF=50%)	$V_{CER(SUS)}$	375	V	
*	Collector-Emitter Sustaining Voltage ($V_{BE}=0$)	$V_{CEX(SUS)}$	375	V	
	Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	350	V	
*	Emitter-Base Voltage	V_{EBO}	6	V	
*	Collector Current	DC	I_C	10	A
		Peak	I_{CM}	30	A
*	Base Current	I_B	10	A	
*	Collector Power Dissipation	$T_c=25^\circ C$	P_C	175	W
		$T_c=100^\circ C$		100	W
	Derate Linearly above $25^\circ C$			1.0	W/ $^\circ C$
*	Junction Temperature	T_j	200	$^\circ C$	
*	Storage Temperature Range	T_{stg}	-65 ~ 200	$^\circ C$	
*	Lead Temperature (0.8mm from case for 10s)	T_L	230	$^\circ C$	

Unit in mm



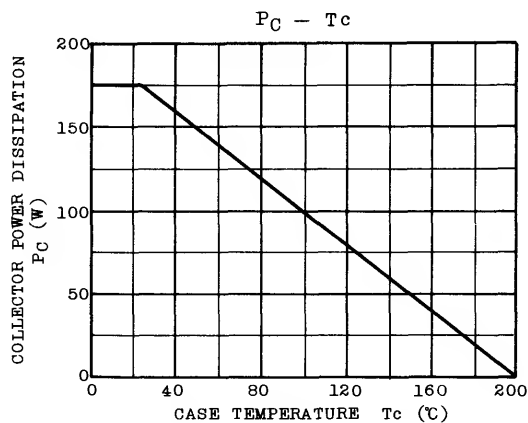
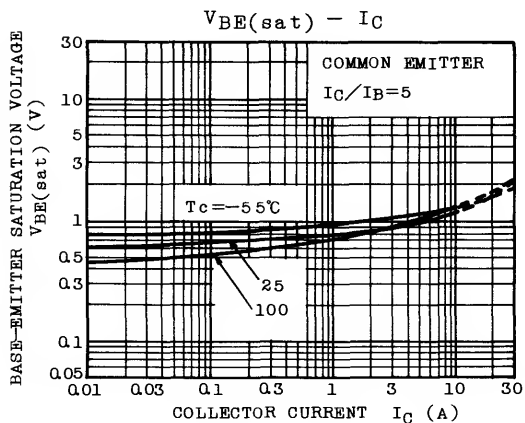
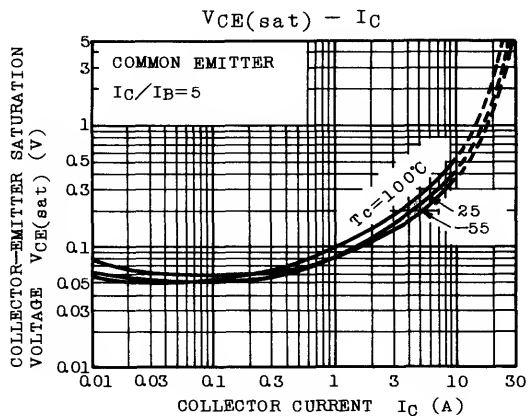
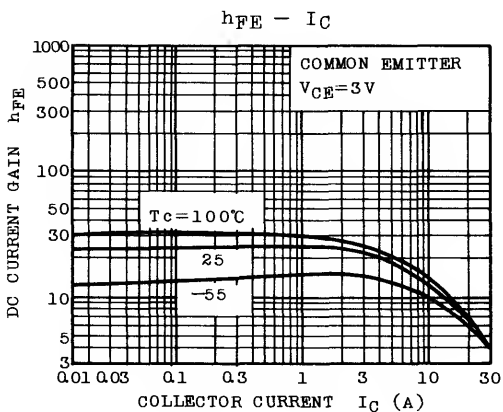
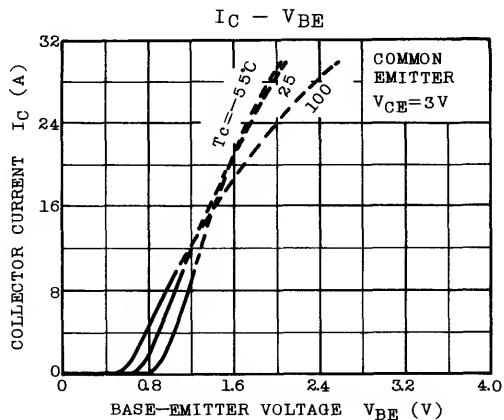
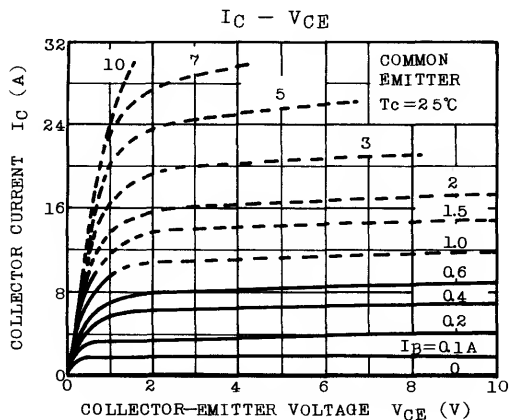
Weight : 15.8g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT		
* Collector Cut-off Current	ICEV	VCE=375V, VBE=-1.5V	-	-	5	mA		
* Collector Cut-off Current	ICEV	VCE=375V, VBE=-1.5V Tc=125°C	-	-	10	mA		
Collector Cut-off Current	ICEO	VCE=300V, IB=0	-	-	5	mA		
* Emitter Cut-off Current	IEBO	VEB=6V, IC=0	-	-	1	mA		
* Collector-Emitter Sustaining Voltage	V _{CER(SUS)} **	IC=0.2A, RBE=50Ω	375	-	-	V		
* Collector-Emitter Sustaining Voltage	V _{CEO(SUS)} **	IC=0.2A, IB=0	350	-	-	V		
* Emitter-Base Breakdown Voltage	V(BR)EBO	IE=1mA, IC=0	6	-	-	V		
* DC Current Gain	hFE	VCE=3V, IC=10A	6	-	50			
* Saturation Voltage	Collector-Emitter	VCE(sat)	IC=10A, IB=1.67A	-	-	1.5	V	
	Base-Emitter	VBE(sat)	IC=10A, IB=1.67A	-	-	2.25	V	
* Small Signal Current Gain	hfe	VCE=10V, IC=1A f=1MHz	2.5	-	-			
* Switching Time	Rise Time	tr			-	-	2.0	μs
	Storage Time	ts			-	-	3.5	μs
	Fall Time	tf			IB1=-IB2=1.67A DUTY CYCLE ≤ 2%	-	-	1.0
* Second Breakdown Collector Current (Base Forward Bias)	Is/b	VCE=30V, t=1s (non-repetitive)	5.8	-	-	A		
* Second Breakdown Energy (Base Reverse Bias)	Es/b	IC=10A, VBE=-4V L=50μH	2.5	-	-	mJ		

* In accordance with JEDEC registration data.

** The sustaining voltages VCER(SUS) and VCEO(SUS) MUST NOT be measured a curve tracer.



SWITCHING REGULATOR AND HIGH VOLTAGE
SWITCHING APPLICATIONS.
HIGH SPEED DC-DC CONVERTER, RELAY AND SOLENOID
DRIVER APPLICATIONS.

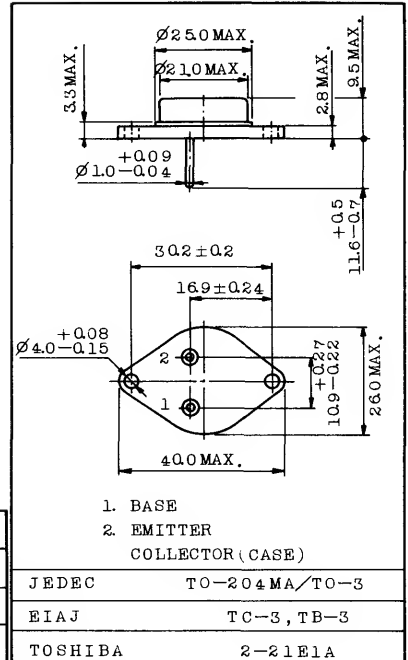
FEATURES:

- . High Sustaining Voltage : $V_{CEO(SUS)}=300V$ (Min.)
- . High Collector Current : $I_C=15A$ (Max.)
- . Excellent Switching Times

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	650	V
* Collector-Emitter Voltage	V_{CEV}	650	V
* Collector-Emitter Sustaining Voltage	$V_{CEX(SUS)}$	350	V
* Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	300	V
* Emitter-Base Voltage	V_{EBO}	9	V
* Collector Current	DC	I_C	15 A
	Peak	I_{CM}	30 A
* Base Current	I_B	10	A
* Emitter Current	I_E	- 25	A
* Collector Power Dissipation	$T_c=25^{\circ}C$		175 W
		$T_c=100^{\circ}C$	100 W
	Derate Linearly above $25^{\circ}C$		1 W/ $^{\circ}C$
* Junction Temperature	T_j	200	$^{\circ}C$
* Storage Temperature Range	T_{stg}	-65 ~ 200	$^{\circ}C$
* Thermal Resistance	θ_{jc}	1	$^{\circ}C/W$
* Lead Temperature (3.17mm from case for 5s)	T_L	275	$^{\circ}C$

Unit in mm



Weight : 15.8g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

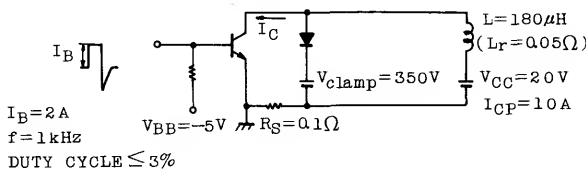
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT		
* Collector Cut-off Current	ICEV	VCE=650V, VBE=-1.5V	-	-	1	mA		
* Collector Cut-off Current	ICEV	VCE=650V, VBE=-1.5V; Tc=100°C	-	-	4	mA		
* Collector Cut-off Current	ICER	VCE=650V, RBE=50Ω, Tc=100°C	-	-	5	mA		
* Emitter Cut-off Current	IEBO	VEB=9V, IC=0	-	-	1	mA		
* Collector-Emitter Sustaining Voltage (Note:1)	VCEX(SUS)**	IC=8A, Vclamp=350V, Tc=100°C	350	-	-	V		
		IC=15A, Vclamp=200V, Tc=100°C	200	-	-	V		
* Collector-Emitter Sustaining Voltage	VCEO(SUS)**	IC=0.1A, IB=0	300	-	-	V		
* DC Current Gain	hFE	VCE=2V, IC=5A	12	-	60			
		VCE=2V, IC=10A	6	-	30			
* Collector-Emitter Saturation Voltage	VCE(sat)	IC=10A, IB=2A	-	-	1.5	V		
		IC=15A, IB=3A	-	-	5	V		
		IC=10A, IB=2A, Tc=100°C	-	-	2.5	V		
* Base-Emitter Saturation Voltage	VBE(sat)	IC=10A, IB=2A	-	-	1.6	V		
		IC=10A, IB=2A, Tc=100°C	-	-	1.6	V		
* Transition Frequency	fT	VCE=10V, IC=0.5A, f=1MHz	6	-	28	MHz		
* Collector Output Capacitance	Cob	VCB=10V, IE=0, f=1MHz	125	-	500	pF		
* Switching Time	Delay Time	td		-	-	0.05	µs	
	Rise Time	tr		-	-	1.0	µs	
	Storage Time	tstg		-	-	4.0	µs	
	Fall Time	tf		-	-	0.7	µs	
	Storage Time	tstg		See Fig.1	-	-	5.0	µs
	Fall Time	tf		Tc=100°C	-	-	1.5	µs
* Second Breakdown Collector Current(Base forward biased)	IS/b	VCE=100V, t=1s (non repetitive)	0.2	-	-	A		

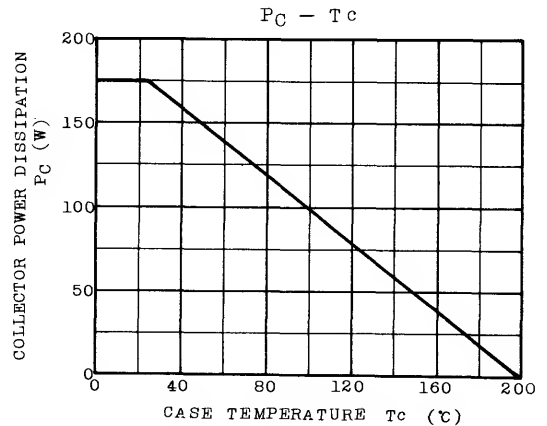
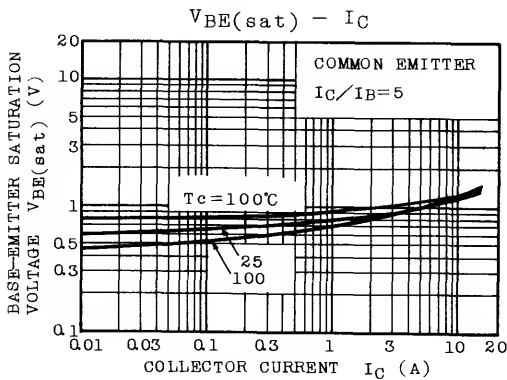
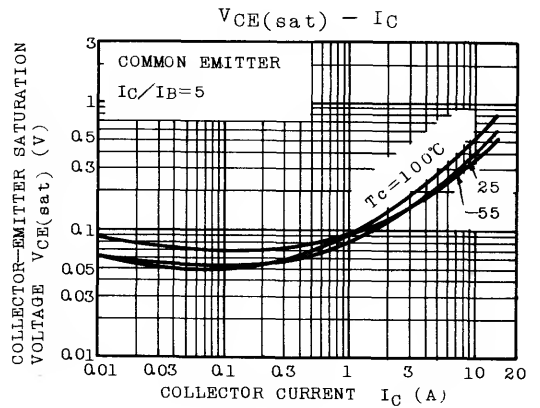
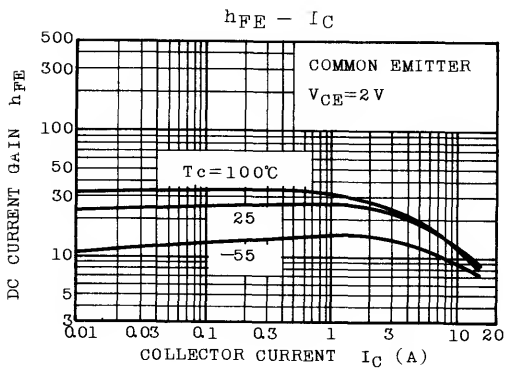
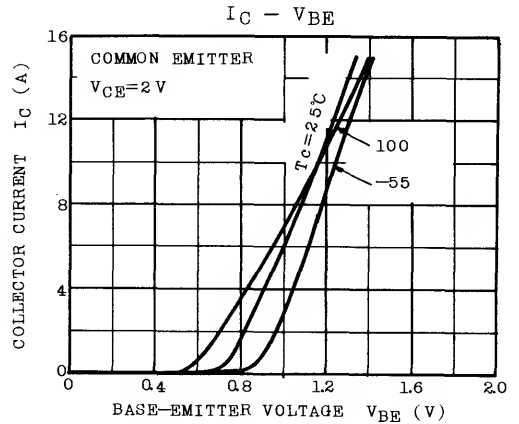
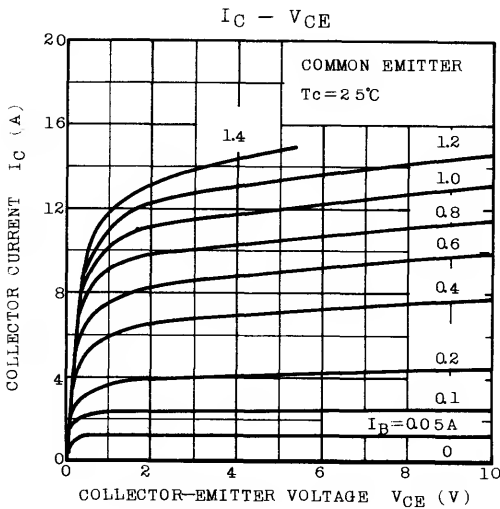
* In Accordance with JEDEC Registration Data.

** The sustaining voltages VCEX(SUS) and VCEO(SUS) MUST NOT be measured on a curve tracer.

Note 1 : Test condition VCC=20V, L=180µH, (LR=0.05Ω)

Fig.1 : Inductive Load Switching Time Test Circuit.





2N6547

SILICON NPN TRIPLE DIFFUSED TYPE

SWITCHING REGULATOR AND HIGH VOLTAGE
SWITCHING APPLICATIONS.
HIGH SPEED DC-DC CONVERTER, RELAY AND SOLENOID
DRIVER APPLICATIONS.

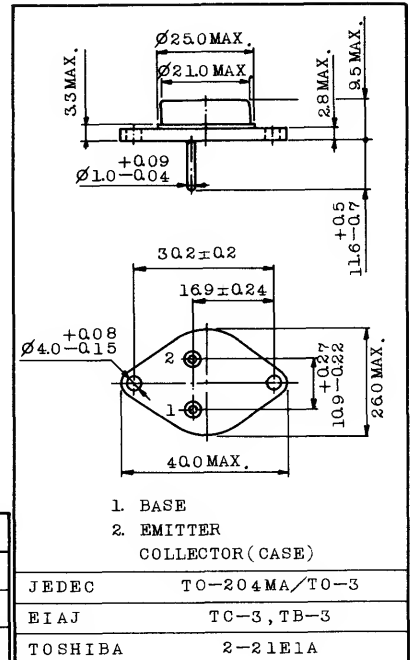
FEATURES:

- . High Sustaining Voltage : $V_{CEO(SUS)}=400V$ (Min.)
- . High Collector Current : $I_C=15A$ (Max.)
- . Excellent Switching Times

MAXIMUM RATINGS ($T_a=25^{\circ}C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT	
Collector-Base Voltage		V_{CBO}	850	V	
*	Collector-Emitter Voltage	V_{CEV}	850	V	
*	Collector-Emitter Sustaining Voltage	$V_{CEX(SUS)}$	450	V	
*	Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	400	V	
Emitter-Base Voltage		V_{EBO}	9	V	
*	Collector Current	DC	I_C	15	A
		Peak	I_{CM}	30	A
Base Current		I_B	10	A	
Emitter Current		I_E	- 25	A	
*	Collector Power Dissipation	$T_c=25^{\circ}C$	175	W	
		$T_c=100^{\circ}C$	100	W	
Derate Linearly above $25^{\circ}C$			1	W/ $^{\circ}C$	
Junction Temperature		T_j	200	$^{\circ}C$	
Storage Temperature Range		T_{stg}	-65 ~ 200	$^{\circ}C$	
Thermal Resistance		θ_{jc}	1	$^{\circ}C/W$	
Lead Temperature (3.17mm from case for 5s)		T_L	275	$^{\circ}C$	

Unit in mm



Weight : 15.8g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

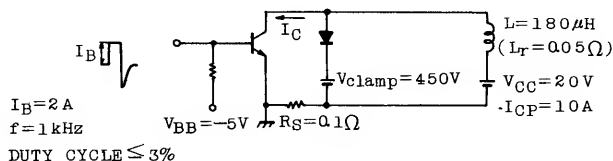
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
* Collector Cut-off Current	ICEV	VCE=850V, VBE=-1.5V	-	-	1	mA
* Collector Cut-off Current	ICEV	VCE=850V, VBE=-1.5V, Tc=100°C	-	-	4	mA
* Collector Cut-off Current	ICER	VCE=850V, RBE=50Ω, Tc=100°C	-	-	5	mA
* Emitter Cut-off Current	IEBO	VEB=9V, IC=0	-	-	1	mA
* Collector-Emitter Sustaining Voltage (Note:1)	VCEX(SUS)**	IC=8A, Vclamp=450V, Tc=100°C	450	-	-	V
		IC=15A, Vclamp=300V, Tc=100°C	300	-	-	V
* Collector-Emitter Sustaining Voltage	VCEO(SUS)**	IC=0.1A, IB=0	400	-	-	V
* DC Current Gain	hFE	VCE=2V, IC=5A	12	-	60	
		VCE=2V, IC=10A	6	-	30	
* Collector-Emitter Saturation Voltage	VCE(sat)	IC=10A, IB=2A	-	-	1.5	V
		IC=15A, IB=3A	-	-	5	V
		IC=10A, IB=2A, Tc=100°C	-	-	2.5	V
* Base-Emitter Saturation Voltage	VBE(sat)	IC=10A, IB=2A	-	-	1.6	V
		IC=10A, IB=2A, Tc=100°C	-	-	1.6	V
* Transition Frequency	fT	VCE=10V, IC=0.5A, f=1MHz	6	-	28	MHz
* Collector Output Capacitance	Cob	VCB=10V, IE=0, f=1MHz	125	-	500	pF
* Switching Time	Delay Time	td				
	Rise Time	tr				
	Storage Time	tstg				
	Fall Time	tf				
	Storage Time	tstg				
	Fall Time	tf				
* Second Breakdown Collector Current (Base forward biased)	Is/b	VCE=100V, t=1s (non repetitive)	0.2	-	-	A

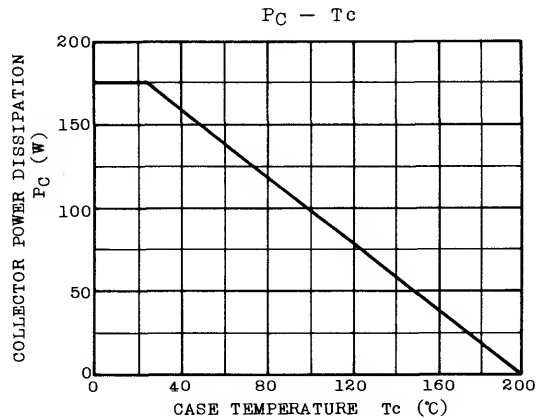
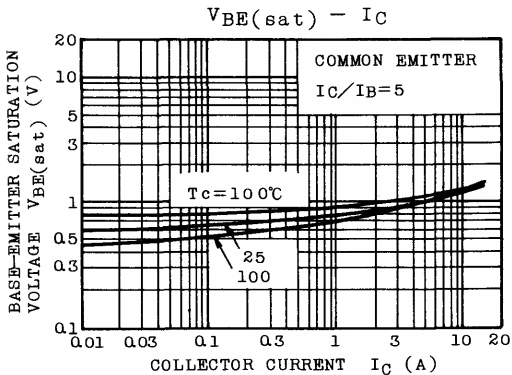
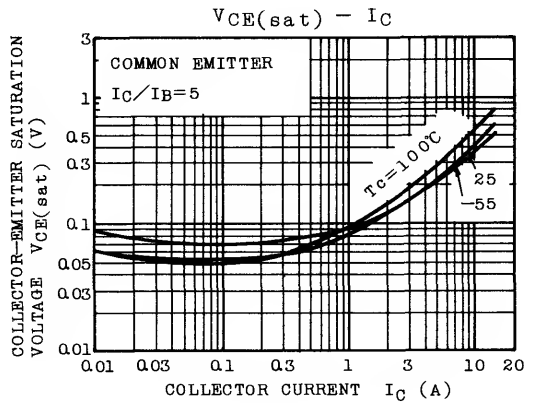
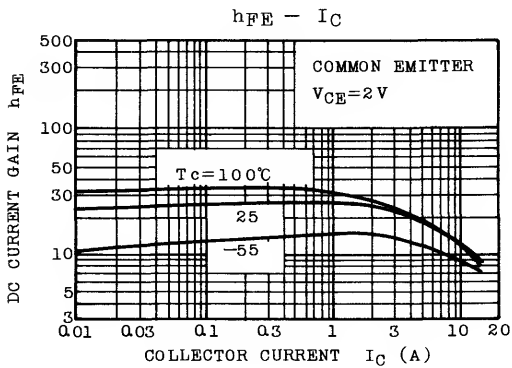
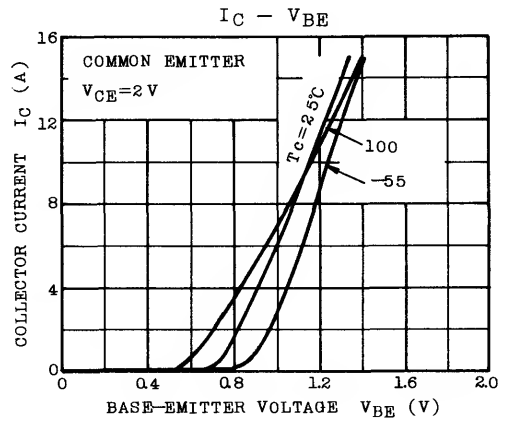
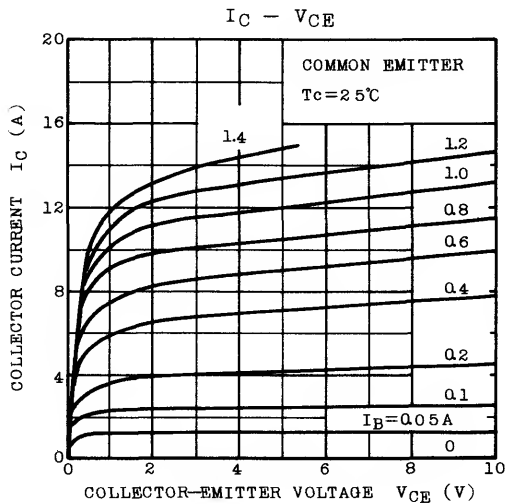
* In Accordance with JEDEC Registration Data.

** The sustaining voltages VCEX(SUS) and VCEO(SUS) MUST NOT be measured on a curve tracer.

Note.1 : Test condition VCC=20V, L=180μH (LR=0.05Ω)

Fig. 1 : Inductive Load Switching Time Test Circuit





BD
SERIES





MEDIUM POWER AMPLIFIER APPLICATIONS.

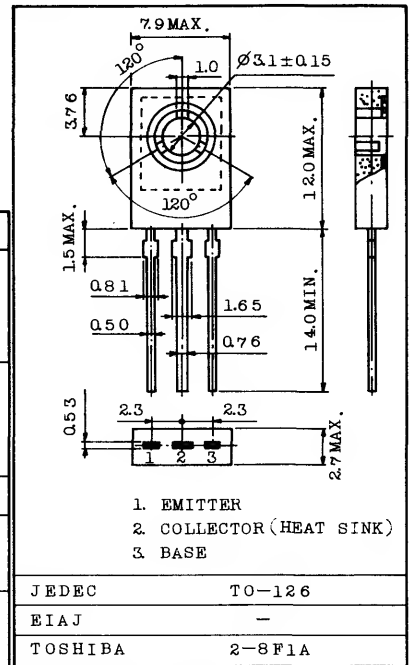
Unit in mm

FEATURES:

- Designed for Complementary Use with BD136, BD138 and BD140.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	BD135	V _{CB0}	45	V
	BD137		60	
	BD139		80	
Collector-Emitter Voltage	BD135	V _{CEO}	45	V
	BD137		60	
	BD139		80	
Emitter-Base Voltage		V _{EB0}	5	V
Collector Current	DC	I _C	0.5	A
	Peak	I _{CM}	1.5	
Collector Power Dissipation	Ta=25°C	P _C	1	W
	Tc≤60°C		6.5	
Junction Temperature		T _j	150	°C
Storage Temperature Range		T _{stg}	-55 ~ 150	°C



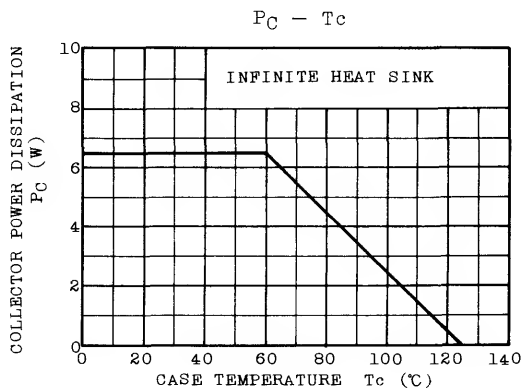
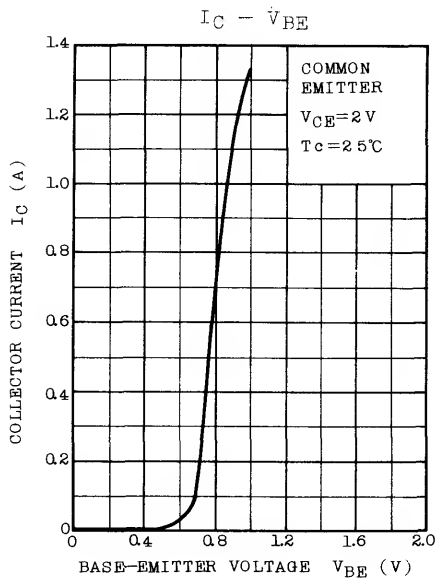
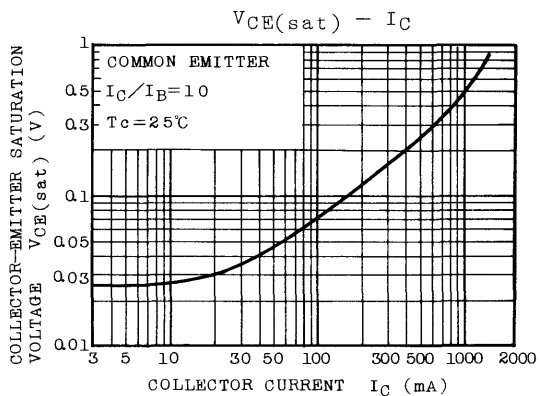
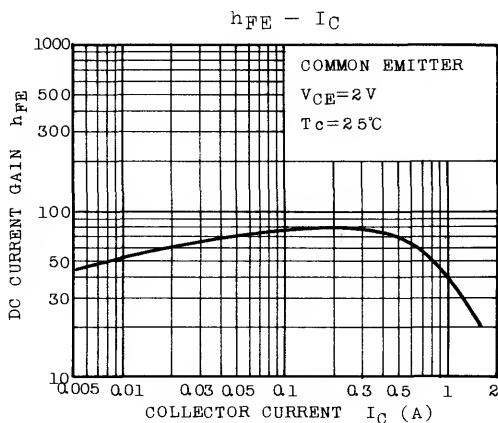
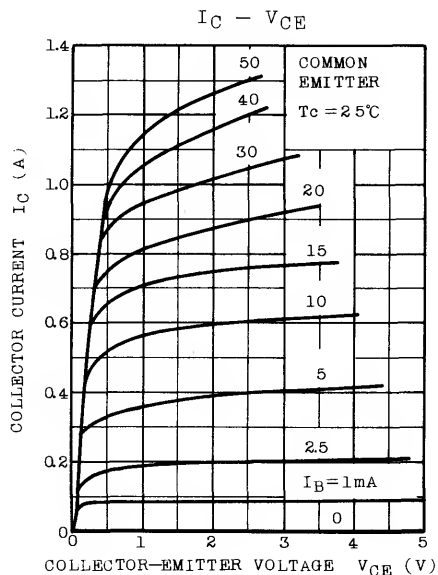
JEDEC	TO-18
EIAJ	-
TOSHIBA	2-8F1A

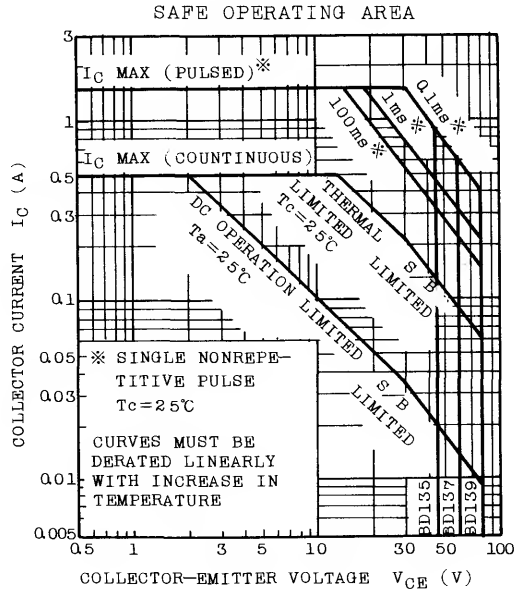
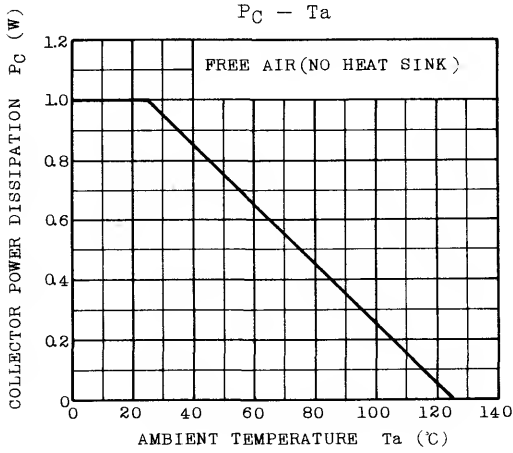
Weight : 0.72g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I _{CB0}	V _{CB} =30V, I _E =0	-	-	0.1	μA
			V _{CB} =30V, I _E =0, Ta=125°C	-	-	10	
Emitter Cut-off Current		I _{EB0}	V _{EB} =5V, I _C =0	-	-	10	μA
Collector-Emitter Breakdown Voltage	BD135	V(BR)CEO	I _C =30mA, I _B =0	45	-	-	V
	BD137			60	-	-	
	BD139			80	-	-	
DC Current Gain			h _{FE} (1)	V _{CE} =2V, I _C =5mA	25	-	
			h _{FE} (2)	V _{CE} =2V, I _C =150mA	40	-	
			h _{FE} (3)	V _{CE} =2V, I _C =500mA	25	-	
Collector-Emitter Saturation Voltage		V _{CE(sat)}	I _C =500mA, I _B =50mA	-	-	0.5	V
Base-Emitter Voltage		V _{BE}	V _{CE} =2V, I _C =500mA	-	-	1.0	V
Transition Frequency		f _T	V _{CE} =2V, I _C =50mA	50	250	-	MHz

BD135·BD137·BD139





BD136 BD138 BD140

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

MEDIUM POWER AMPLIFIER APPLICATIONS.

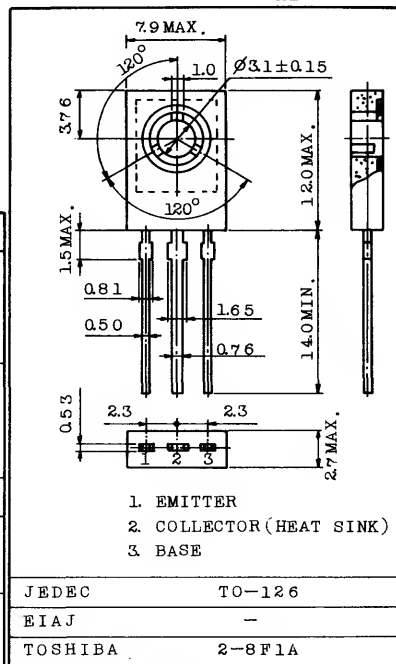
FEATURES:

- Designed for Complementary Use with BD135, BD137 and BD139

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	BD136	V _{CB0}	-45	V
	BD138		-60	
	BD140		-80	
Collector-Emitter Voltage	BD136	V _{CEO}	-45	V
	BD138		-60	
	BD140		-80	
Emitter-Base Voltage		V _{EB0}	-5	V
Collector Current	DC	I _C	-0.5	A
	Peak	I _{CM}	-1.5	
Collector Power Dissipation	Ta=25°C	P _C	1	W
	Tc≤60°C		6.5	
Junction Temperature		T _j	150	°C
Storage Temperature Range		T _{stg}	-55 ~ 150	°C

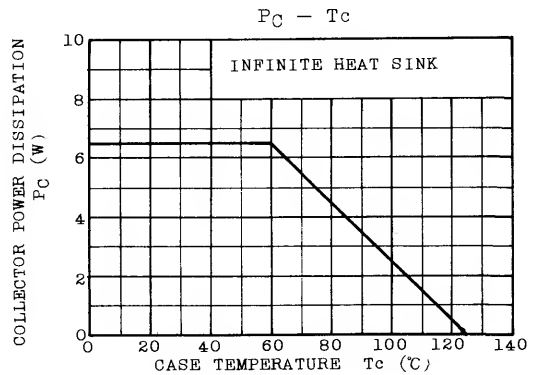
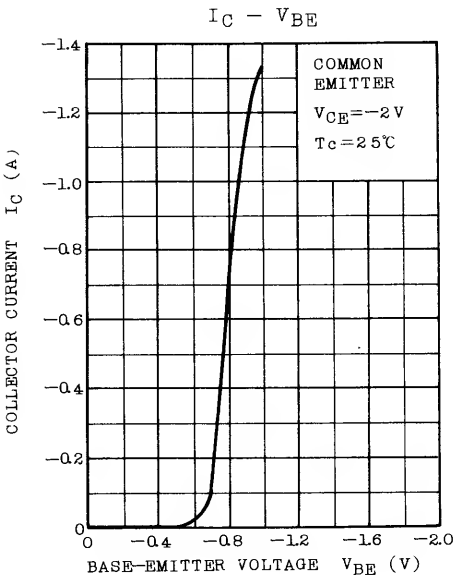
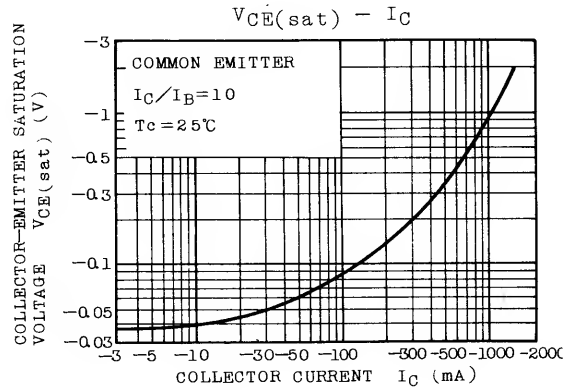
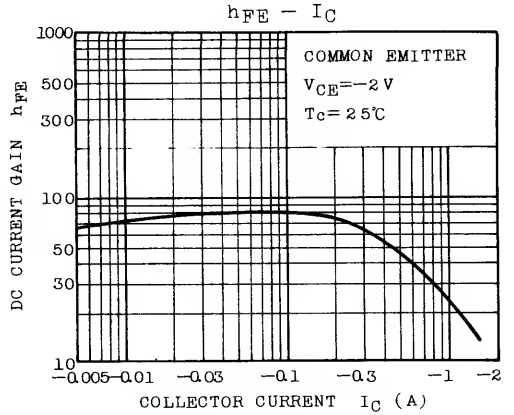
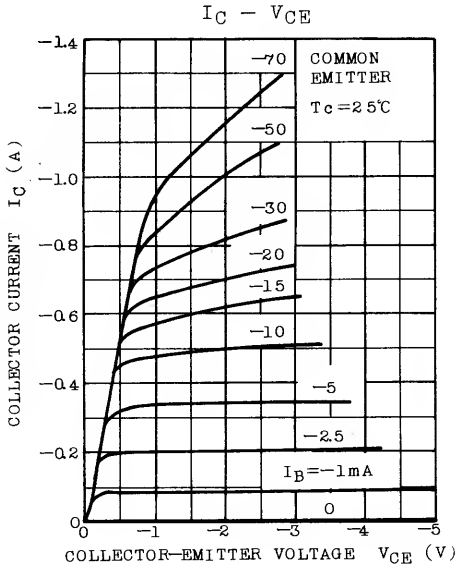
Unit in mm



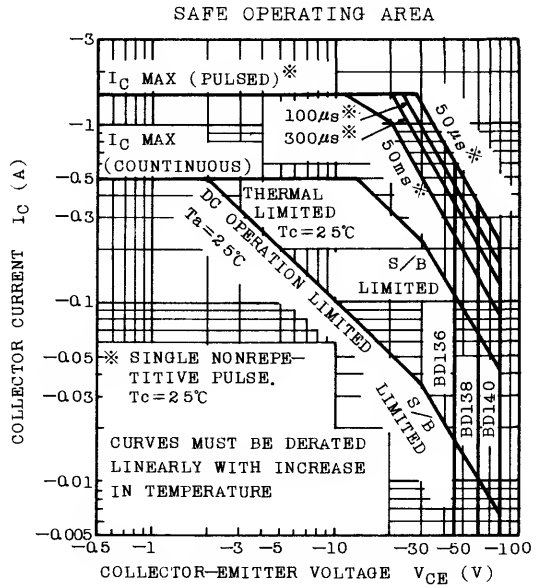
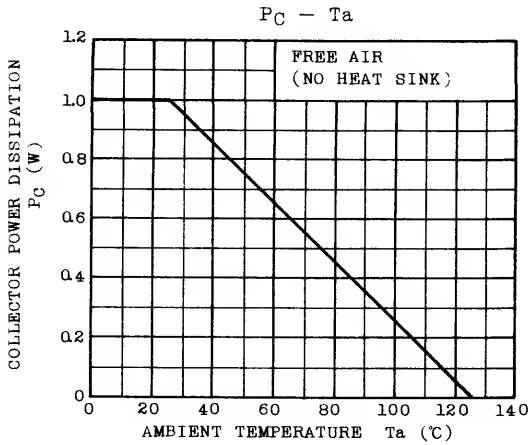
Weight : 0.72g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Collector Cut-off Current		I _{CBO}	V _{CB} =-30V, I _E =0	-	-	-0.1	μA	
			V _{CB} =-30V, I _E =0, Ta=125°C	-	-	-10		
Emitter Cut-off Current		I _{EBO}	V _{EB} =-5V, I _C =0	-	-	-10	μA	
Collector-Emitter Breakdown Voltage	BD136	V(BR)CEO	I _C =-30mA, I _B =0	-45	-	-	V	
	BD138			-60	-	-		
	BD140			-80	-	-		
DC Current Gain		h _{FE} (1)	V _{CE} =-2V, I _C =-5mA	25	-	-		
			h _{FE} (2)	V _{CE} =-2V, I _C =-150mA	40	-		250
			h _{FE} (3)	V _{CE} =-2V, I _C =-500mA	25	-		-
Collector-Emitter Saturation Voltage		V _{CE(sat)}	I _C =-500mA, I _B =-50mA	-	-	-0.5	V	
Base-Emitter Voltage		V _{BE}	V _{CE} =-2V, I _C =-500mA	-	-	-1.0	V	
Transition Frequency		f _T	V _{CE} =-2V, I _C =-50mA	-	100	-	MHz	



BD136 • BD138 • BD140



AUDIO POWER AMPLIFIER APPLICATIONS.
VERTICAL DEFLECTION OUTPUT APPLICATION IN TV.

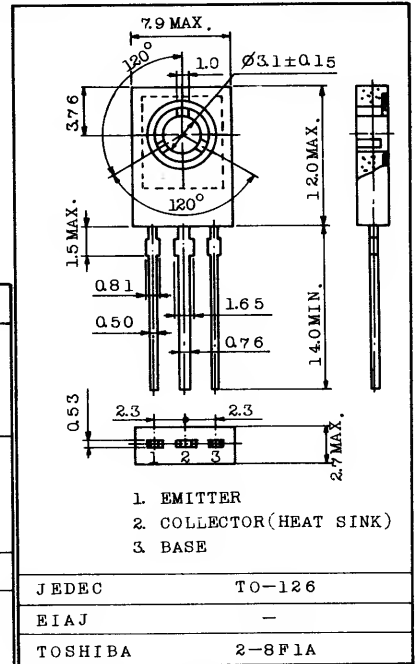
Unit in mm

FEATURES:

- Designed for Complementary Use with BD234, BD236 and BD238

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT	
Collector-Base Voltage	BD233	45	V	
	BD235	60		
	BD237	100		
Collector-Emitter Voltage	BD233	45	V	
	BD235	60		
	BD237	80		
Emitter-Base Voltage	VEBO	5	V	
Collector Current	DC	IC	2	A
	Peak	ICM	6	
Base Current	IB	2	A	
Collector Power Dissipation (Tc=25°C)	PC	25	W	
Junction Temperature	Tj	150	°C	
Storage Temperature Range	Tstg	-55 ~ 150	°C	

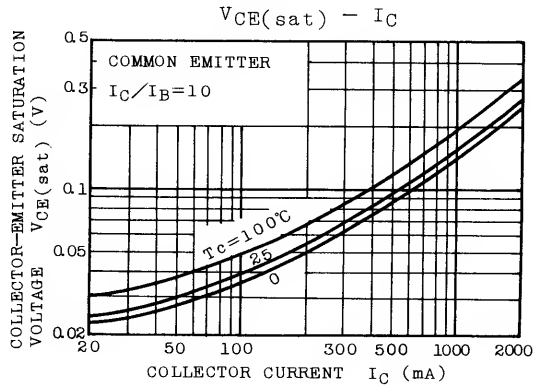
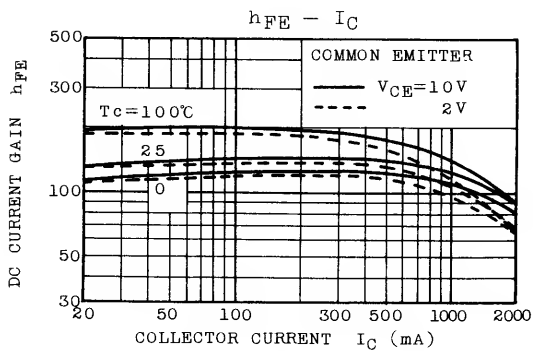
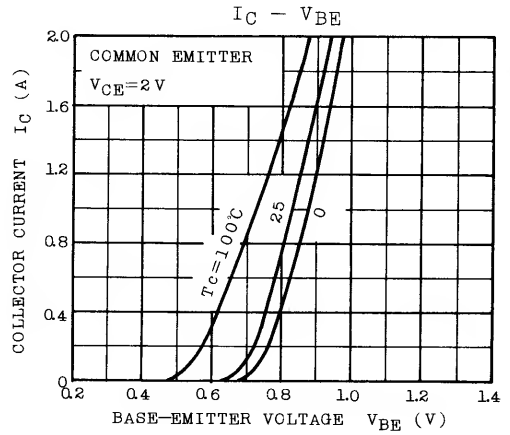
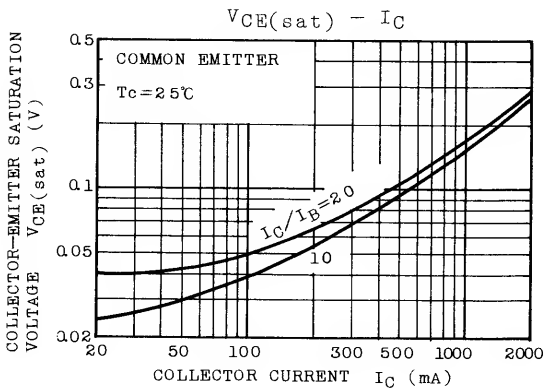
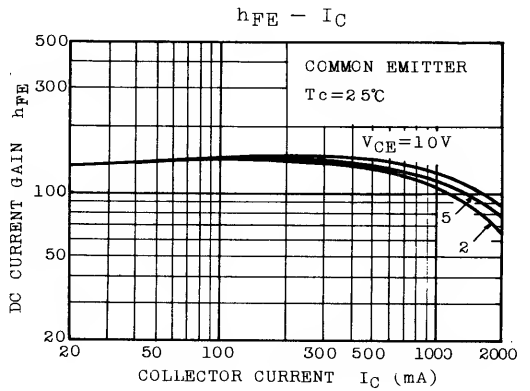
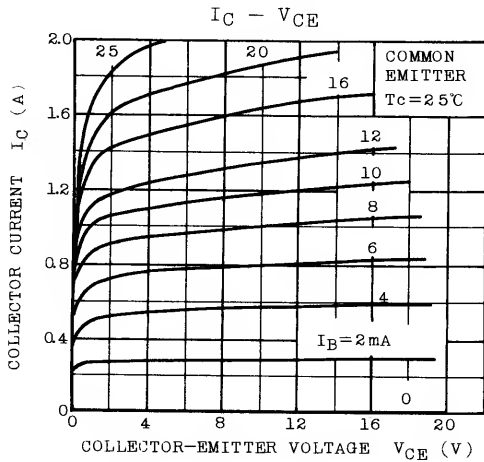


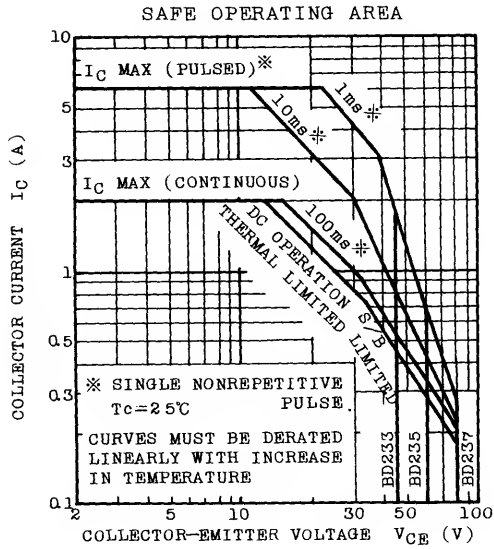
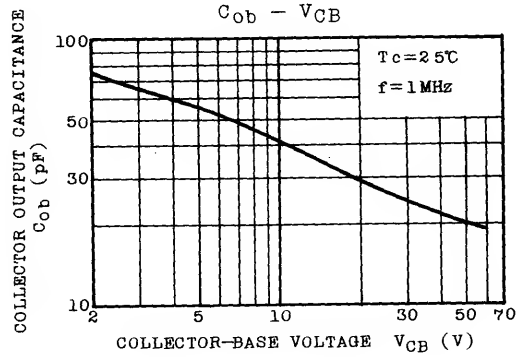
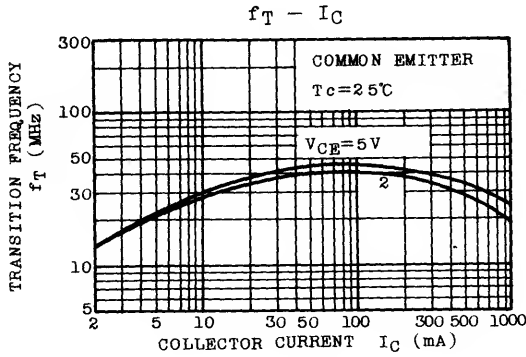
Weight : 0.72g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	BD233	V _{CB} =45V, I _E =0	-	-	100	μA
	BD235	V _{CB} =60V, I _E =0				
	BD237	V _{CB} =100V, I _E =0				
Emitter Cut-off Current	I _{EBO}	V _{EB} =5V, I _C =0	-	-	1	mA
DC Current Gain	h _{FE} (1)	V _{CE} =2V, I _C =150mA	40	-	-	
	h _{FE} (2)	V _{CE} =2V, I _C =1A	25	-	-	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =1A, I _B =0.1A	-	-	0.6	V
Base-Emitter Voltage	V _{BE}	V _{CE} =2V, I _C =1A	-	-	1.3	V
Transition Frequency	f _T	V _{CE} =10V, I _C =250mA	3	40	-	MHz

BD233 • BD235 • BD237





BD234 BD236 BD238

SILICON PNP EPITAXIAL BASE MESA TYPE

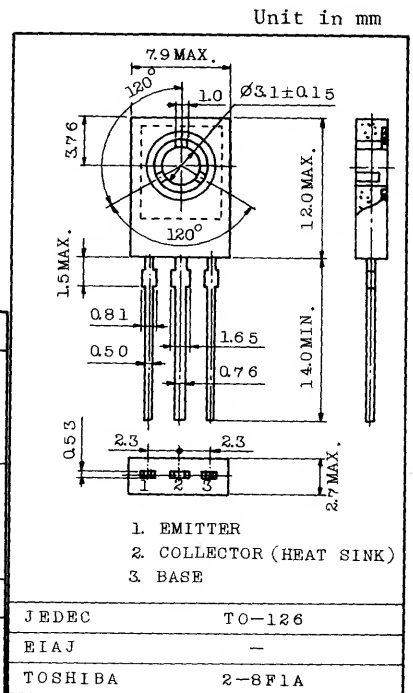
AUDIO POWER AMPLIFIER APPLICATIONS.
VERTICAL DEFLECTION OUTPUT APPLICATIONS IN TV.

FEATURES:

- Designed for Complementary Use with BD233, BD235 and BD237

MAXIMUM RATINGS ($T_a=25^{\circ}\text{C}$)

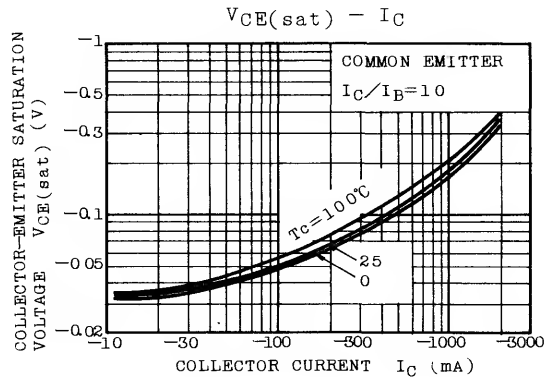
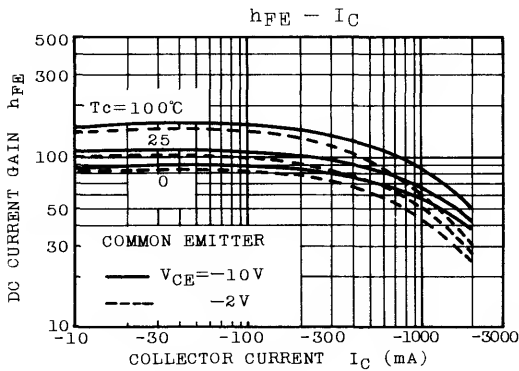
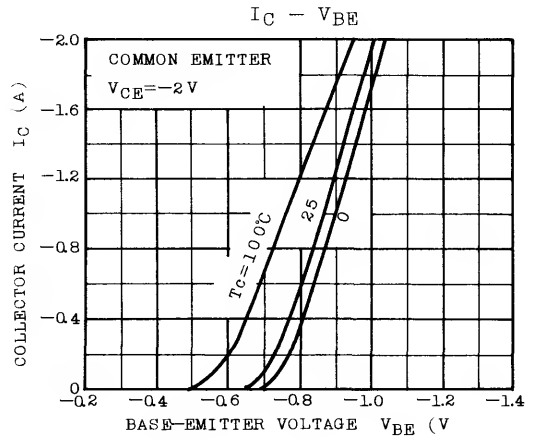
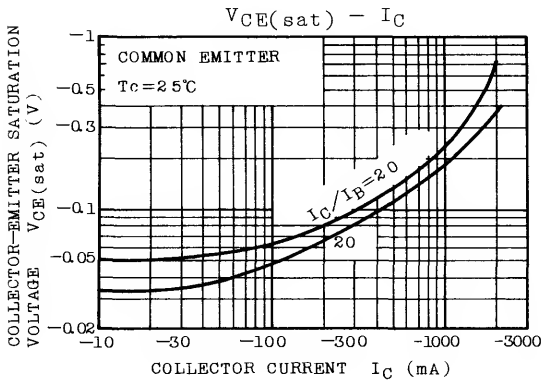
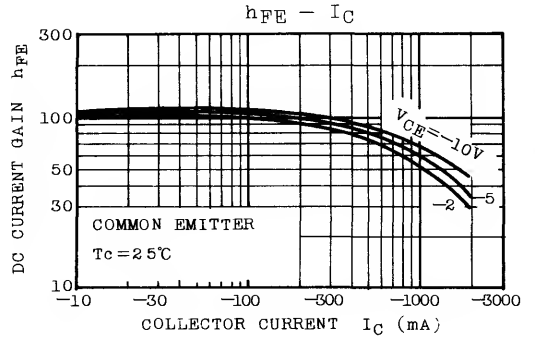
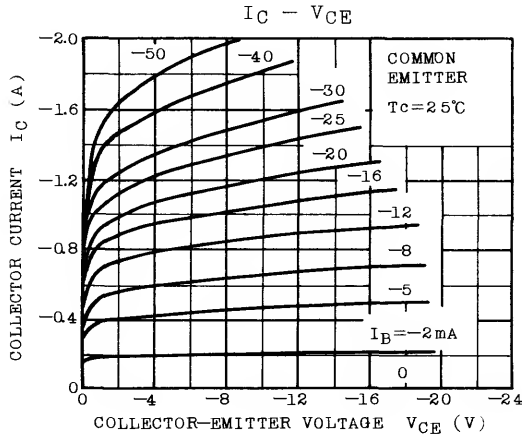
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	BD234	V_{CB0}	-45	V
	BD236		-60	
	BD238		-100	
Collector-Emitter Voltage	BD234	V_{CE0}	-45	V
	BD236		-60	
	BD238		-80	
Emitter-Base Voltage		V_{EB0}	-5	V
Collector Current	DC	I_C	-2	A
	Peak	I_{CM}	-6	
Base Current		I_B	-2	A
Collector Power Dissipation ($T_c=25^{\circ}\text{C}$)		P_C	25	W
Junction Temperature		T_j	150	$^{\circ}\text{C}$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^{\circ}\text{C}$



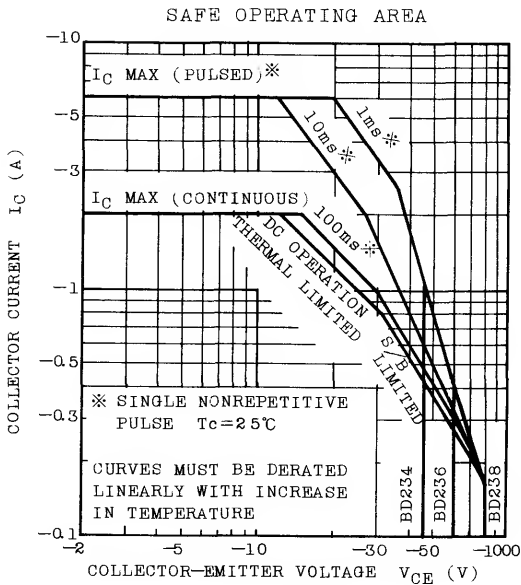
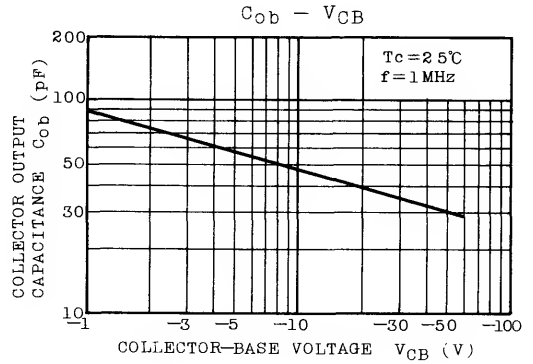
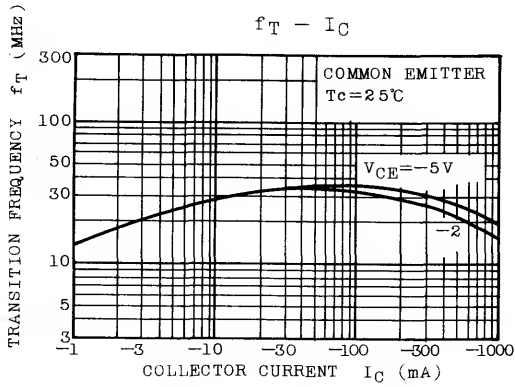
Weight : 0.72g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	BD234	I_{CBO}	$V_{CB}=-45\text{V}, I_E=0$	-	-	-100	μA
	BD236		$V_{CB}=-60\text{V}, I_E=0$				
	BD238		$V_{CB}=-100\text{V}, I_E=0$				
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-5\text{V}, I_C=0$	-	-	-1	mA
DC Current Gain	$h_{FE}(1)$		$V_{CE}=-2\text{V}, I_C=-150\text{mA}$	40	-	-	
	$h_{FE}(2)$		$V_{CE}=-2\text{V}, I_C=-1\text{A}$	25	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=-1\text{A}, I_B=-0.1\text{A}$	-	-	-0.6	V
Base-Emitter Voltage		V_{BE}	$V_{CE}=-2\text{V}, I_C=-1\text{A}$	-	-	-1.3	V
Transition Frequency		f_T	$V_{CE}=-10\text{V}, I_C=-250\text{mA}$	3	35	-	MHz



BD234 • BD236 • BD238



BF
SERIES

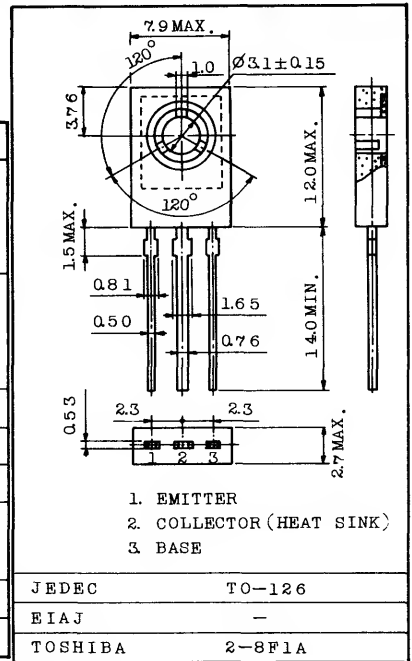


COLOR TV VIDEO AND CHROMA OUTPUT APPLICATIONS.
COLOR TV HORIZONTAL DRIVER APPLICATIONS.

Unit in mm

MAXIMUM RATINGS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	BF457	V_{CBO}	160	V
	BF458		250	
	BF459		300	
Collector-Emitter Voltage	BF457	V_{CEO}	160	V
	BF458		250	
	BF459		300	
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current		I_{C}	100	mA
Base Current		I_{B}	50	mA
Collector Power Dissipation	$T_a=25^{\circ}\text{C}$	P_{C}	1.2	W
	$T_c=25^{\circ}\text{C}$		8.3	
Junction Temperature		T_{j}	150	$^{\circ}\text{C}$
Storage Temperature Range		T_{stg}	-55 ~ 150	$^{\circ}\text{C}$

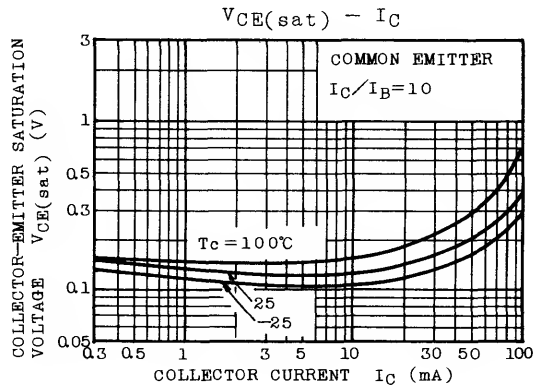
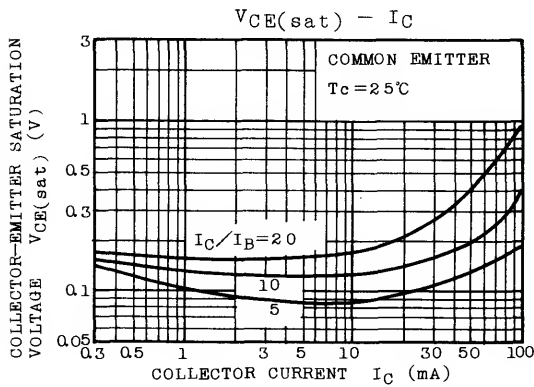
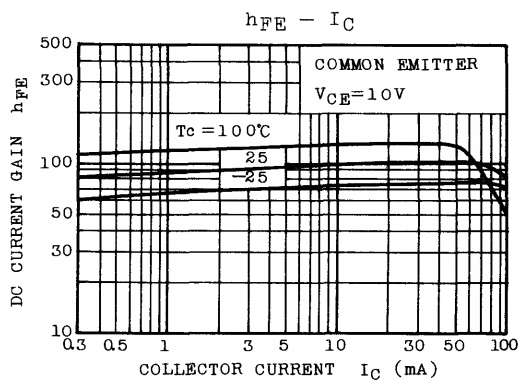
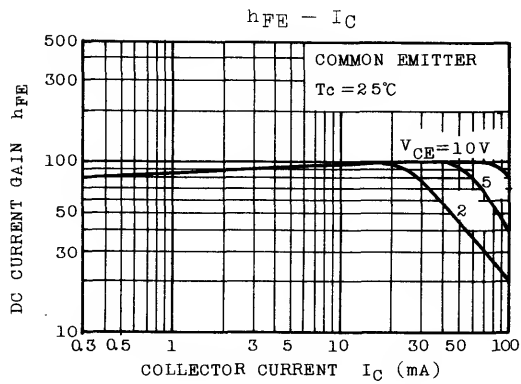
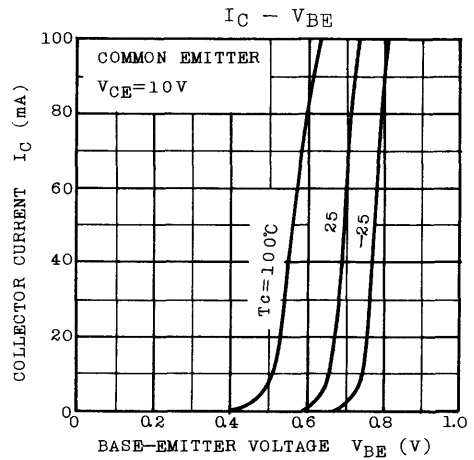
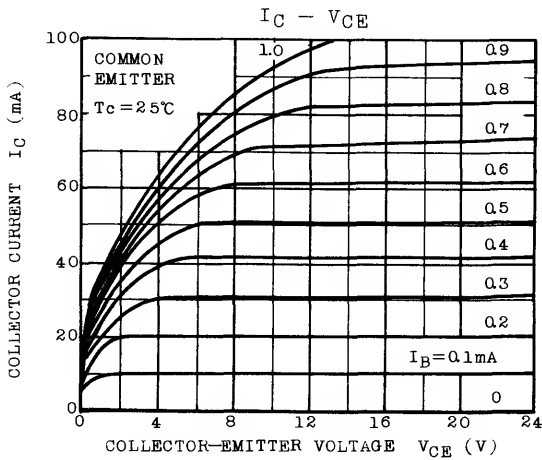


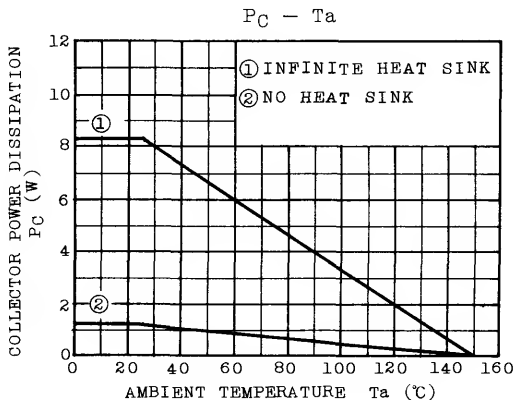
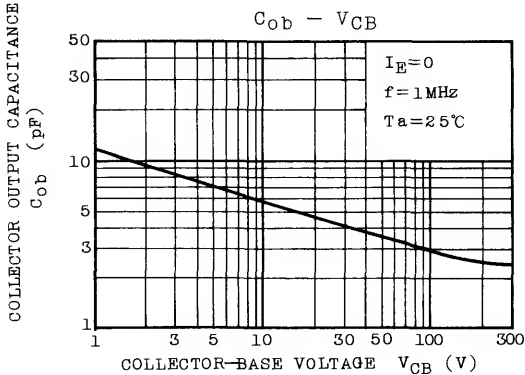
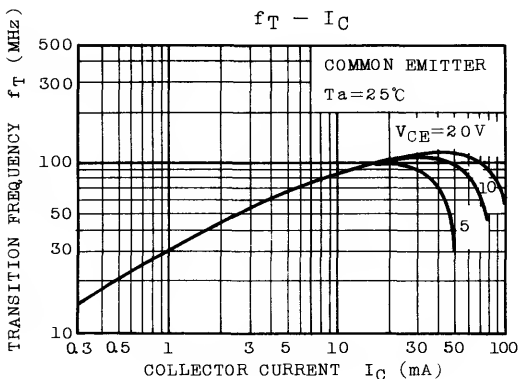
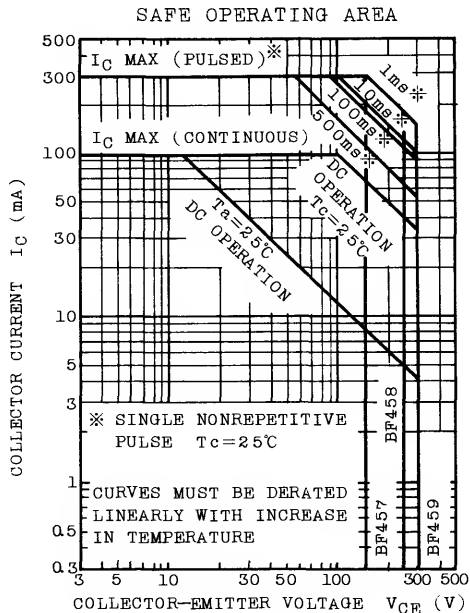
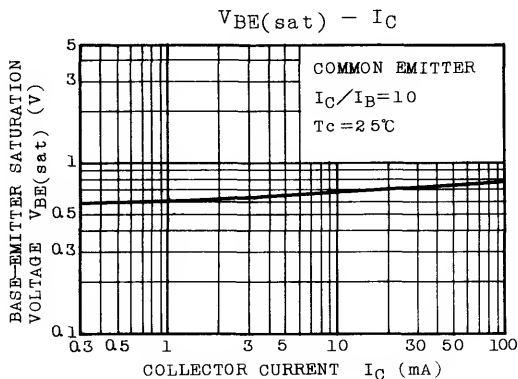
ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}\text{C}$)

Weight : 0.72g

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	BF457	I_{CBO}	$V_{\text{CB}}=100\text{V}, I_{\text{E}}=0$	-	-	50	nA
	BF458		$V_{\text{CB}}=200\text{V}, I_{\text{E}}=0$				
	BF459		$V_{\text{CB}}=250\text{V}, I_{\text{E}}=0$				
Collector-Base Breakdown Voltage	BF457	$V_{\text{(BR)CBO}}$	$I_{\text{C}}=100\mu\text{A}, I_{\text{E}}=0$	160	-	-	V
	BF458			250	-	-	
	BF459			300	-	-	
Emitter-Base Breakdown Voltage		$V_{\text{(BR)EBO}}$	$I_{\text{E}}=100\mu\text{A}, I_{\text{C}}=0$	5	-	-	V
Collector-Emitter Breakdown Voltage	BF457	$V_{\text{(BR)CEO}}$	$I_{\text{C}}=10\text{mA}, I_{\text{E}}=0$	160	-	-	V
	BF458			250	-	-	
	BF459			300	-	-	
DC Current Gain		h_{FE}	$V_{\text{CE}}=10\text{V}, I_{\text{C}}=30\text{mA}$	25	-	240	
Collector-Emitter Saturation Voltage		$V_{\text{CE(sat)}}$	$I_{\text{C}}=30\text{mA}, I_{\text{B}}=6\text{mA}$	-	-	1	V
Transition Frequency		f_{T}	$V_{\text{CE}}=10\text{V}, I_{\text{C}}=15\text{mA}$	-	100	-	MHz
Collector Output Capacitance		C_{ob}	$V_{\text{CB}}=30\text{V}, I_{\text{E}}=0, f=1\text{MHz}$	-	4	-	pF

BF457 • BF458 • BF459

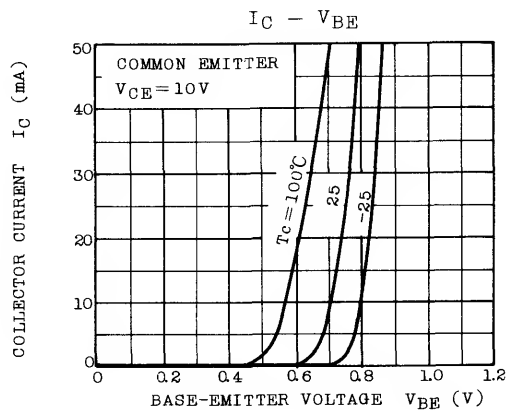
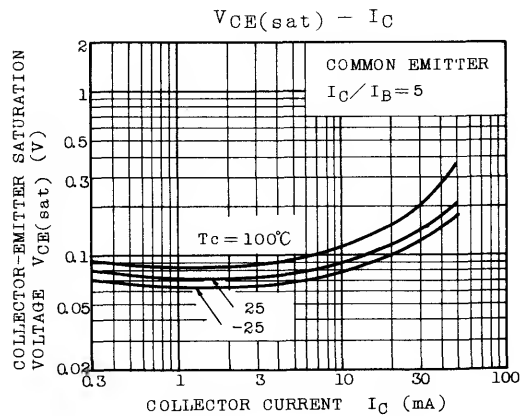
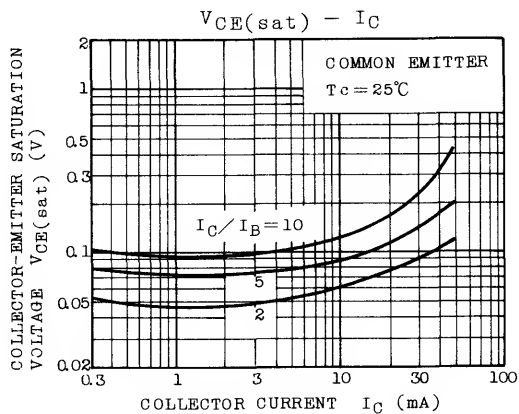
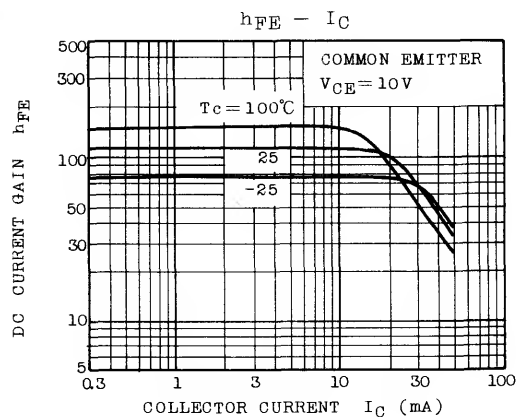
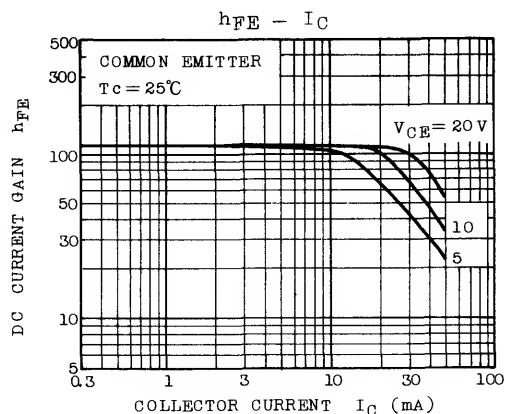
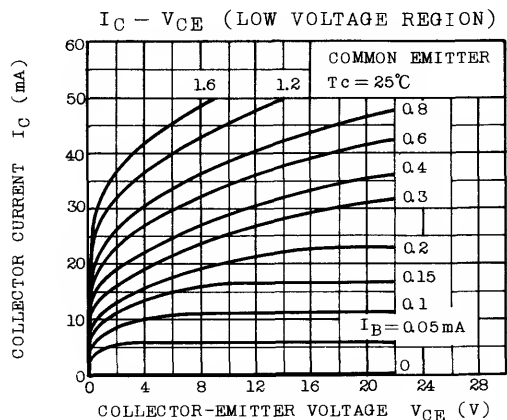


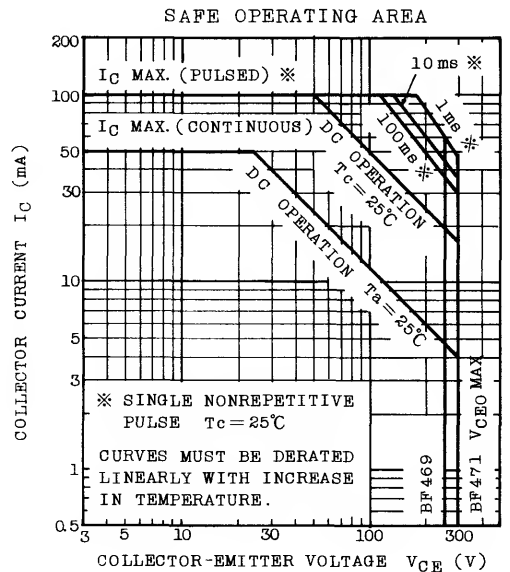
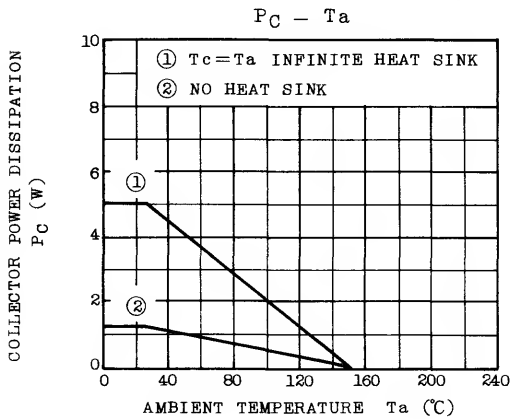
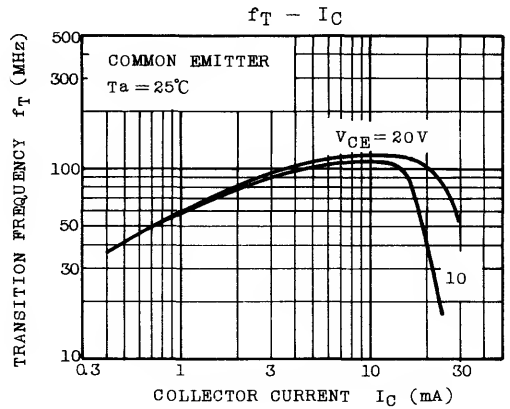
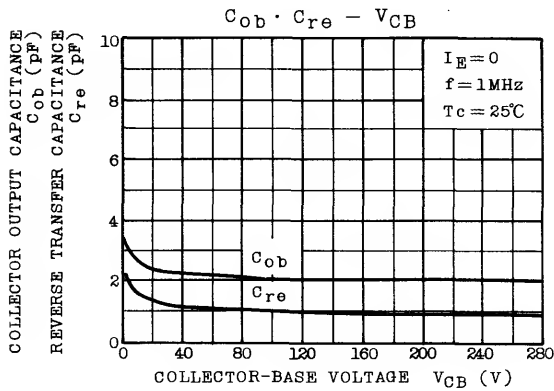


ELECTRICAL CHARACTERISTICS (Ta=25°C Unless otherwise specified)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	BF469	I_{CBO}	$V_{CB}=200V, I_E=0$	-	-	0.1	μA
	BF471	I_{CER}	$V_{CE}=250V, R_{BE}=2.7k\Omega$	-	-	0.05	
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	10	μA
Collector-Emitter Breakdown Voltage	BF469	$V_{(BR)CEO}$	$I_C=1mA, I_B=0$	250	-	-	V
	BF471	$V_{(BR)CER}$	$I_C=1\mu A, R_{BE}=2.7k\Omega$	300	-	-	
High Temperature Collector Cut-off Current		I_{CER}	$V_{CE}=200V, R_{BE}=2.7k\Omega$ $T_j=150^\circ C$	-	-	10	μA
DC Current Gain		h_{FE}	$V_{CE}=20V, I_C=25mA$	50	-	-	
Collector-Emitter RF Saturation Voltage		$V_{CE(sat)}$ RF	$I_C=25mA, T_j=150^\circ C$	-	20	-	V
Base-Emitter Voltage		V_{BE}	$V_{CE}=20V, I_C=25mA$	-	0.75	-	V
Transition Frequency		f_T	$V_{CE}=10V, I_C=10mA$	60	100	-	MHz
Reverse Transfer Capacitance		C_{re}	$V_{CB}=30V, I_E=0, f=1MHz$	-	-	1.8	pF

BF469·BF471





BF470 BF472

SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

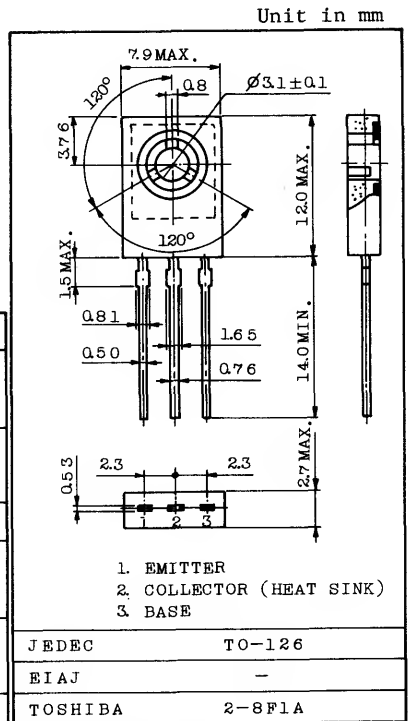
HIGH VOLTAGE SWITCHING AND AMPLIFIER APPLICATIONS.
COLOR TV CHROMA OUTPUT APPLICATIONS.

FEATURES:

. NPN Complements are BF469, and BF471

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT	
Collector-Base Voltage	BF470	-250	V	
	BF472	-300		
Collector-Emitter Voltage	BF470	-250	V	
	BF472	-300		
Emitter-Base Voltage	VEBO	-5	V	
Collector Current	DC	IC	-50	mA
	Peak	ICP	-100	
Total Power Dissipation	Ta=25°C	Ptot	1.2	W
	Tc=25°C		5	
Base Current	IB	-20	mA	
Junction Temperature	Tj	150	°C	
Storage Temperature Range	Tstg	-65~150	°C	
Solder Temperature, 1.5mm from Case for 10 Seconds	-	350	°C	



Weight : 0.72g

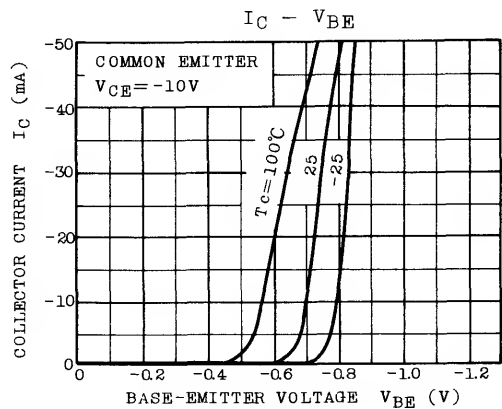
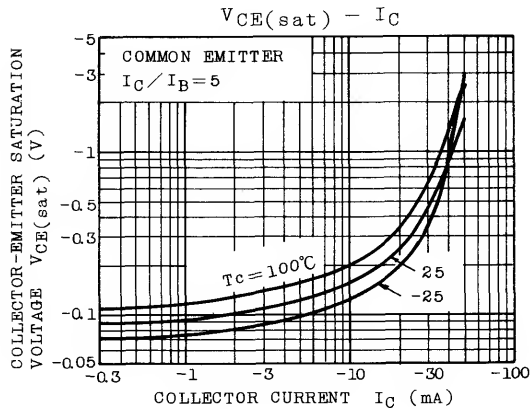
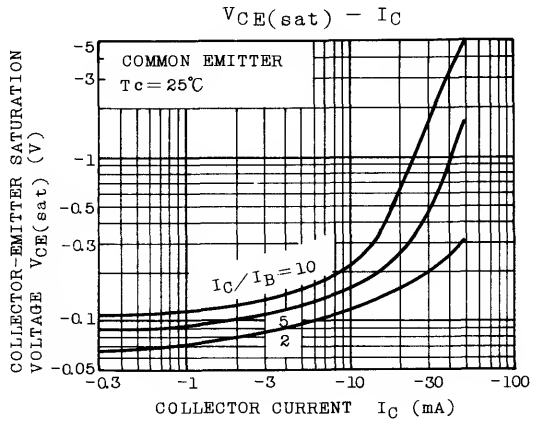
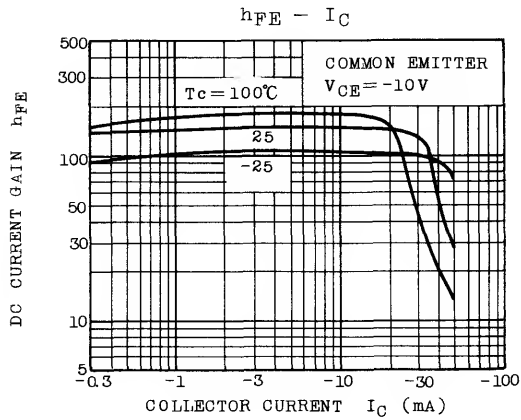
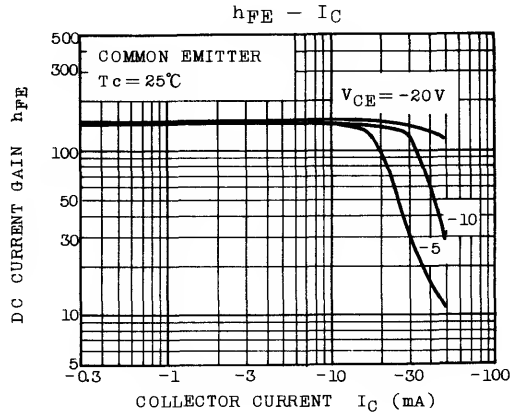
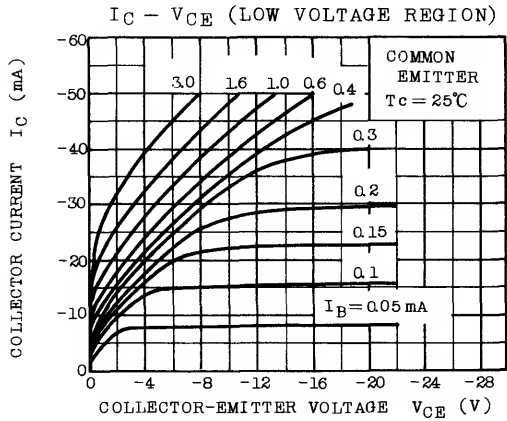
THERMAL CHARACTERISTICS

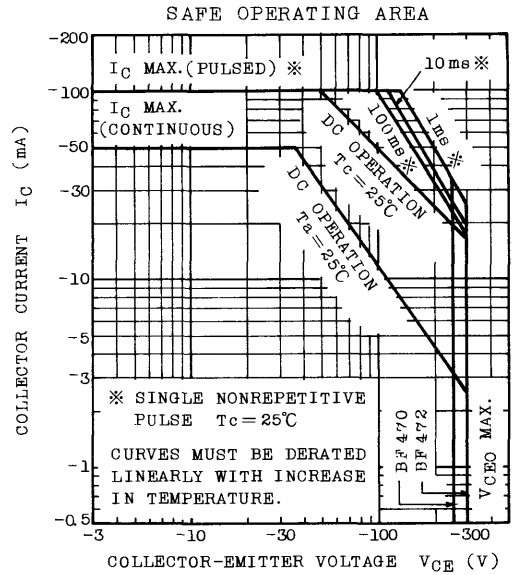
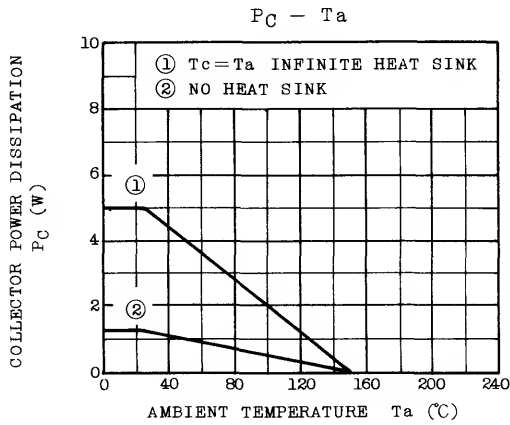
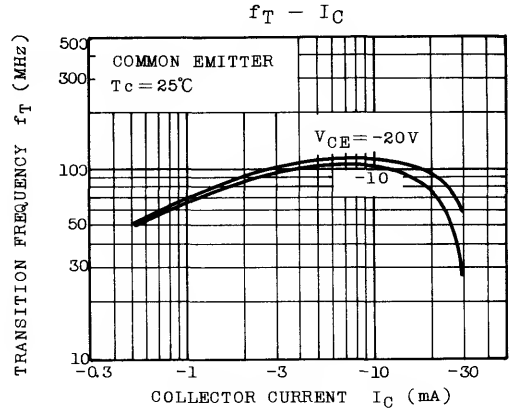
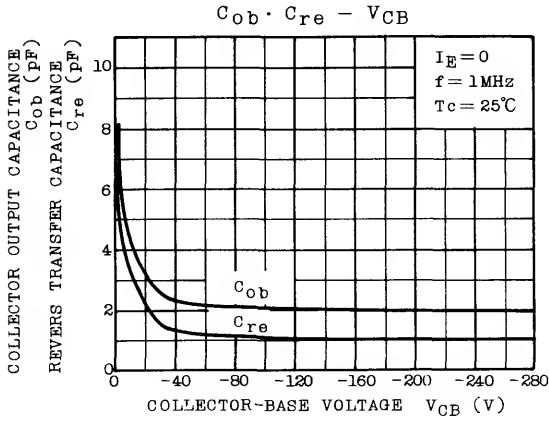
CHARACTERISTIC	SYMBOL	RATING	UNIT
Thermal Resistance (Junction to Ambient)	RθJA	104	°C/W
Thermal Resistance (Junction to Case)	RθJC	12.5	°C/W

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}\text{C}$ Unless otherwise specified)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	BF470	I_{CBO}	$V_{CB}=-200\text{V}$, $I_E=0$	-	-	-0.1	μA
	BF472	I_{CER}	$V_{CE}=-250\text{V}$, $R_{BE}=2.7\text{k}\Omega$	-	-	-0.05	
Emitter Cut-off Current		I_{EBO}	$V_{EB}=-5\text{V}$, $I_C=0$	-	-	-10	μA
Collector-Emitter Breakdown Voltage	BF470	$V(\text{BR})_{CEO}$	$I_C=-1\text{mA}$, $I_B=0$	-250	-	-	V
	BF472	$V(\text{BR})_{CER}$	$I_C=-1\mu\text{A}$, $R_{BE}=2.7\text{k}\Omega$	-300	-	-	
High Temperature Collector Cut-off Current		I_{CER}	$V_{CE}=-200\text{V}$, $R_{BE}=2.7\text{k}\Omega$ $T_j=150^{\circ}\text{C}$	-	-	-10	μA
DC Current Gain		h_{FE}	$V_{CE}=-20\text{V}$, $I_C=-25\text{mA}$	50	-	-	
Collector-Emitter Saturation Voltage RF		$V_{CE(\text{sat})_{RF}}$	$I_C=-25\text{mA}$, $T_j=150^{\circ}\text{C}$	-	-20	-	V
Base-Emitter Voltage		V_{BE}	$V_{CE}=-20\text{V}$, $I_C=-25\text{mA}$	-	-0.75	-	V
Transition Frequency		f_T	$V_{CE}=-10\text{V}$, $I_C=-10\text{mA}$	60	80	-	MHz
Reverse Transfer Capacitance		C_{re}	$V_{CB}=-30\text{V}$, $I_E=0$, $f=1\text{MHz}$	-	-	1.8	pF

BF470 • BF472





BU
SERIES



HIGH VOLTAGE NPN SILICON POWER TRANSISTOR INTENDED FOR USE IN THE SWITCHED MODE POWER SUPPLY OF TELEVISION RECEIVERS.

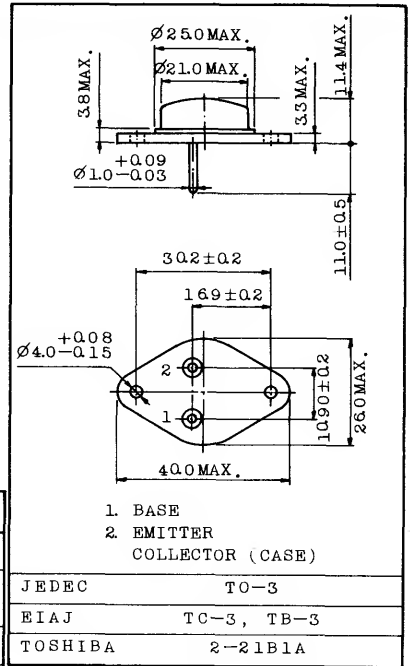
FEATURES:

- High Breakdown Voltage : $V_{CES}=750V$
- Low Saturation Voltage
: $V_{CE(sat)}=5V(\text{Max.})$ at $I_C=4A, I_B=1A$
- High speed : $t_f=0.15\mu s$ (Typ.)

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Emitter Voltage		V_{CES}	750	V
		V_{CEX} ($-V_{BE}=1.5V$)	750	V
		V_{CEO}	300	V
Collector Current	DC	I_C	3	A
	Peak	I_{CM}	6	A
		$-I_{CM}$	3	A
Base Current	DC	I_B	2	A
	Peak	I_{BM}	2	A
		$-I_B(AV)$	100	mA
		(DC or averaged over any 20mS period)		
		$-I_{BM}$	1.5	A
		(turn-off current)		
Total Collector Power Dissipation ($T_c=25^\circ C$)		P_{tot}	50	W
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-65 ~ 150	$^\circ C$
Thermal Resistance		$R_{th(j-c)}$	2.5	$^\circ C/W$

Unit in mm



Mounting Kit No. AC42C

Weight : 17.0g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		$I_{CES(1)}$	$V_{CE}=750V, V_{BE}=0$	-	-	0.5	mA
		$I_{CES(2)}$	$V_{CE}=750V, V_{BE}=0$ $T_j=125^{\circ}C$	-	-	2	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=6V, I_C=0$	-	-	5	mA
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=1A$	15	-	60	
Collector-Emitter Saturation Voltage		$V_{CE(sat)(1)}$	$I_C=2.5A, I_B=0.25A$	-	-	10	V
		$V_{CE(sat)(2)}$	$I_C=4A, I_B=1A$	-	-	5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=2.5A, I_B=0.25A$	-	-	1.5	V
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	Fig. 1	300	-	-	V
Transition Frequency		f_T	$V_{CE}=10V, I_C=0.2A,$ $f=1MHz$	-	8	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0,$ $f=1MHz$	-	85	-	pF
Emitter Capacitance		C_{TE}	$V_{EB}=2V, I_C=0,$ $f=1MHz$	-	1.4	-	nF
Switching Time	Fall Time	t_f	Fig. 2	-	0.15	-	μs
	Storage Time	t_{stg}		-	1.2	-	μs

BU204·BU205

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CES}	$V_{BE}=0, V_{CE}=V_{CES}$	-	-	1	mA
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=2A$	2	-	-	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	$I_E=100mA, I_C=0$	5	-	-	V
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=2A, I_B=1A$	-	-	5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=2A, I_B=1A$	-	-	1.5	V
Collector-Emitter Sustaining Voltage	BU204	$V_{CEO(SUS)}$	$I_C=100mA, L=25mH$	600	-	-	V
	BU205			700	-	-	
Fall Time		t_f	$I_{CP}=2A, I_B(end)=1A$	-	0.75	-	μs
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	95	-	pF
Transition Frequency		f_T	$V_{CE}=5V, f=5MHz$ $I_C=0.1A$	-	3	-	MHz

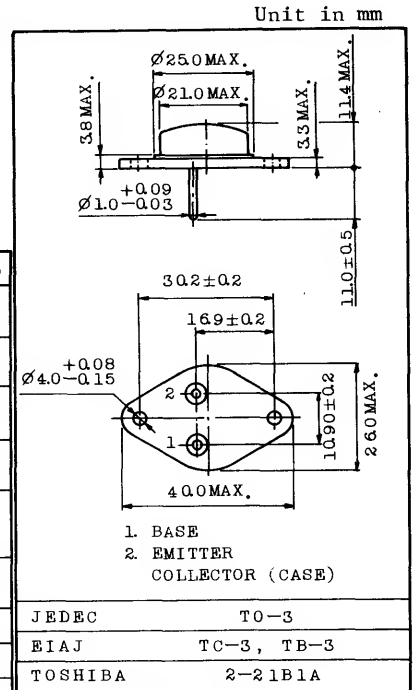
TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- . High Voltage : $V_{CES}=1300V$
- . High Speed : $t_f=0.7\mu s$ (Typ.)
- . Glass Passivated Collector-Base Junction.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Emitter Voltage ($V_{BE}=0V$)		V_{CES}	1300	V
Collector-Emitter Voltage ($R_{BE}=100\Omega$)		V_{CER}	1300	V
Transient Collector-Emitter Voltage (Flash-over)		V_{CE} (Flash-over)	1500	V
Collector-Emitter Voltage (Open Base)		V_{CEO}	600	V
Collector Current	DC	I_C	5	A
	Peak	I_{CM}	7.5	
Transient Collector Current (Flash-over)		I_C (Flash-over)	10	A
Base Current (Peak)		I_{BM}	4	A
Reverse Base Current	DC	$-I_B$	100	mA
	Peak	$-I_{BM}$	2.5	A
Collector Power Dissipation ($T_c \leq 95^\circ C$)		P_C	12.5	W
Junction Temperature		T_j	115	$^\circ C$
Storage Temperature Range		T_{stg}	-65 ~ 115	$^\circ C$



Weight : 17.0g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CES}	$V_{CE}=1300V, V_{BE}=0V$	-	-	1	mA
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=4.5A$	2.25	-	-	
Emitter-Base Breakdown Voltage	$V(BR)EBO$	$I_E=100mA, I_C=0$	5	-	-	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4.5A, I_B=2.0A$	-	-	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4.5A, I_B=2.0A$	-	-	1.5	V
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	$I_C=100mA, L=25mH$	600	-	-	V
Fall Time	t_f	$I_C=4.5A, I_B(end)=1.8A$	-	0.7	1	μs
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	165	-	pF
Transition Frequency	f_T	$V_{CE}=5V, f=5MHz, I_C=0.1A$	-	3	-	MHz

BU208

SILICON NPN TRIPLE DIFFUSED MESA TYPE

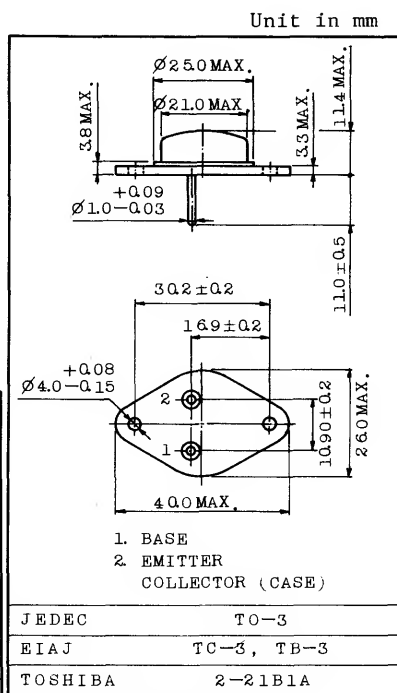
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.
 COLOR TV SWITCHING REGULATOR APPLICATIONS.

FEATURES:

- High Voltage : $V_{CES}=1500V$
- Low Saturation Voltage : $V_{CE(sat)}=5V$ (Max.)
- Fall Time : $t_f=0.7\mu s$ (Typ.)
- Glass Passivated Base-Collector Junction

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Emitter Voltage	V_{CES}	1500	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	DC	I_C	5 A
	Peak	I_{CM}	7.5 A
Base Current (Peak)	I_{BM}	4	A
Total Power Dissipation ($T_c \leq 95^\circ C$)	P_{tot}	12.5	W
Junction Temperature	T_j	+115	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 115	$^\circ C$
Thermal Resistance	$R_{th(j-c)}$	1.6	$^\circ C/W$

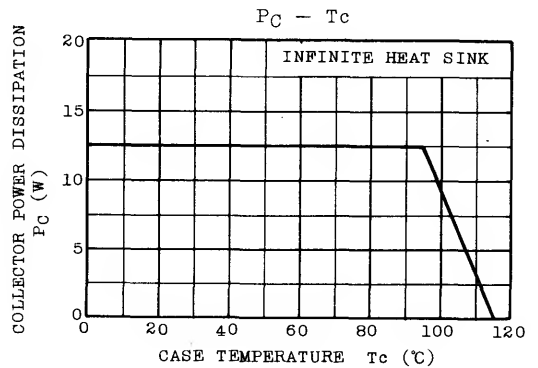
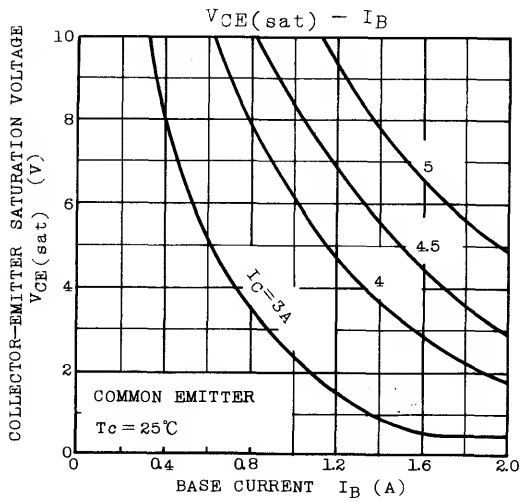
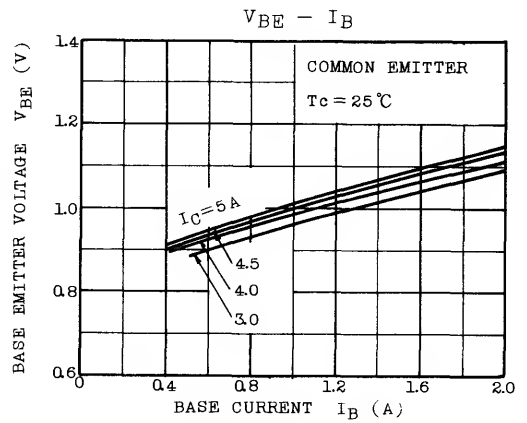
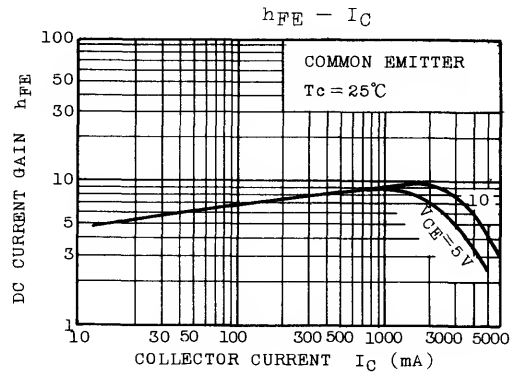
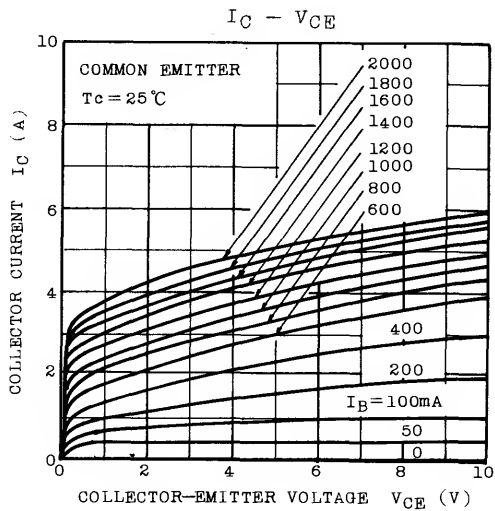


Mounting Kit No. AC42C

Weight : 17.0g

ELECTRICAL CHARACTERISTICS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CES}	$V_{CE}=1500V, V_{BE}=0$	-	-	1	mA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA, I_C=0$	5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=4.5A$	2.25	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4.5A, I_B=2A$	-	-	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4.5A, I_B=2A$	-	-	1.5	V
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	$I_C=100mA, I_B=0, L=25mH$	700	-	-	V
Transition Frequency	f_T	$V_{CE}=5V, I_C=0.1A$	-	7	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	125	-	pF
Switching Time	Fall Time	$I_{CM}=4.5A, I_B(end)=1.8A$	-	0.7	-	μs
	Storage Time	$I_{CM}=4.5A, I_B(end)=1.8A$	-	10	-	μs



BU208A

SILICON NPN TRIPLE DIFFUSED MESA TYPE

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.
 COLOR TV SWITCHING REGULATOR APPLICATIONS.

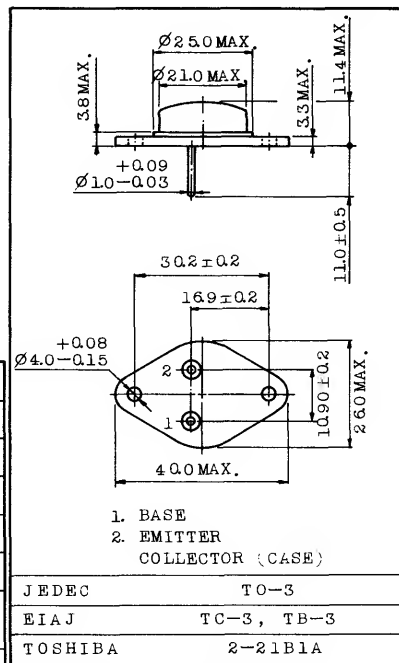
Unit in mm

FEATURES:

- . High Voltage : $V_{CES}=1500V$
- . Low Saturation Voltage : $V_{CE(sat)}=1V$ (Max.)
- . Fall Time : $t_f=0.7\mu s$ (Typ.)
- . Glass Passivated Collector-Base Junction

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Emitter Voltage	V_{CES}	1500	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	DC	I_C	5 A
	Peak	I_{CM}	7.5 A
Base Current (Peak)	I_{BM}	4	A
Total Power Dissipation ($T_c \leq 95^\circ C$)	P_{tot}	12.5	W
Junction Temperature	T_j	+115	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ +115	$^\circ C$
Thermal Resistance	$R_{th(j-c)}$	1.6	$^\circ C/W$

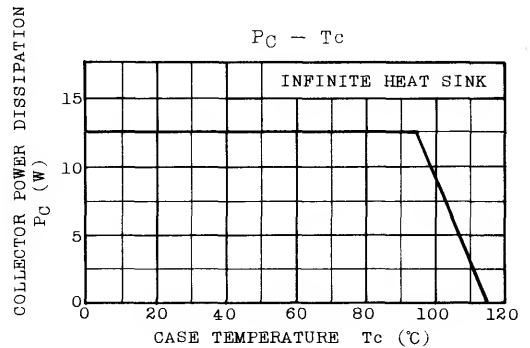
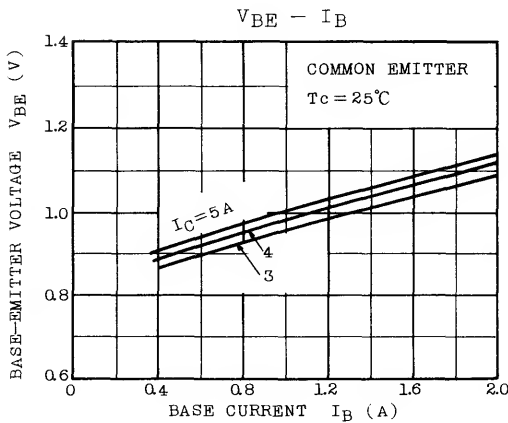
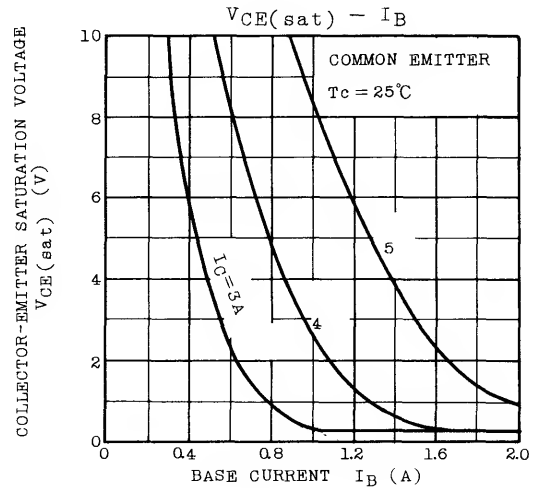
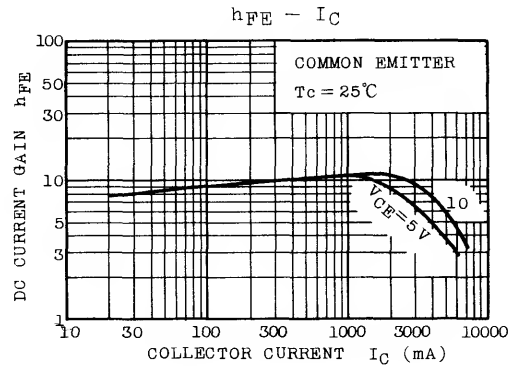
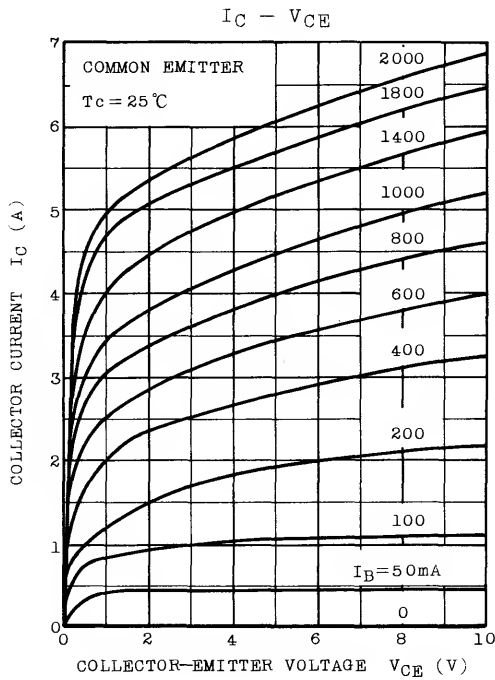


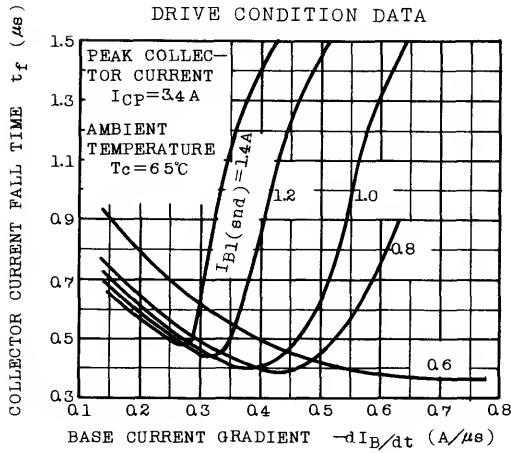
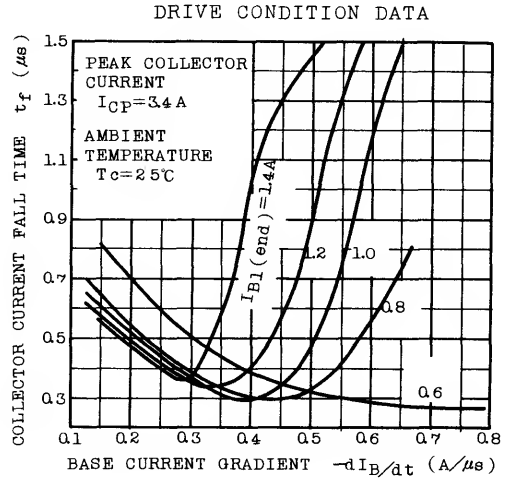
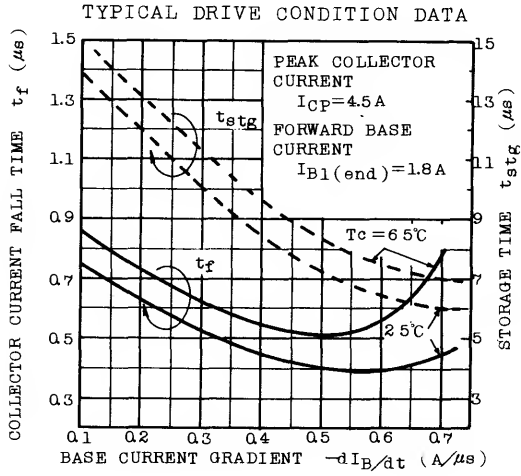
Mounting Kit No. AC42C

Weight : 17.0g

ELECTRICAL CHARACTERISTICS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CES}	$V_{CE}=1500V, V_{BE}=0$	-	-	1	mA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA, I_C=0$	5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=4.5A$	2.25	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4.5A, I_B=2A$	-	-	1	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4.5A, I_B=2A$	-	-	1.5	V
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	$I_C=100mA, I_B=0$ $L=25mH$	700	-	-	V
Transition Frequency	f_T	$V_{CE}=5V, I_C=0.1A$	-	7	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	125	-	pF
Switching Time	Fall Time	t_f	-	0.7	-	μs
	Storage Time	t_{stg}	-	10	-	μs





HIGH POWER SWITCHING REGULATOR APPLICATIONS.

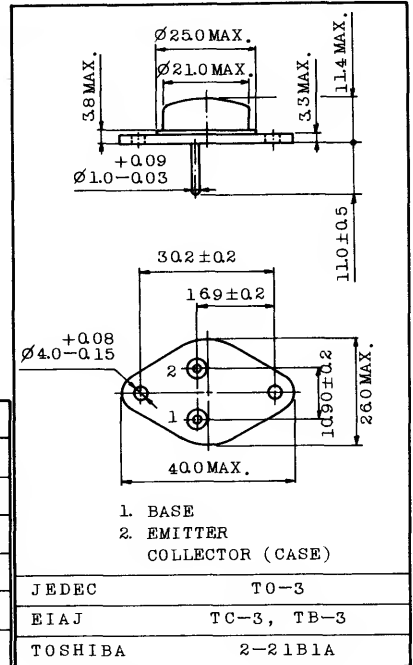
FEATURES:

- . High Voltage : $V_{CBO}=900V$
- . High Peak Current Capability : $I_C(\text{Peak})=8A$
- . Fall Time : $t_f=0.5\mu s$ (Max.)
- . Glass Passivated Collector-Base Junction.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	900	V
Collector-Emitter Voltage		V_{CEO}	400	V
Emitter-Base Voltage		V_{EBO}	7	V
Collector Current	DC	I_C	6	A
	Peak	I_{CP}	8	A
Collector Power Dissipation ($T_c=25^\circ C$)		P_C	60	W
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-65 ~ 150	$^\circ C$

Unit in mm



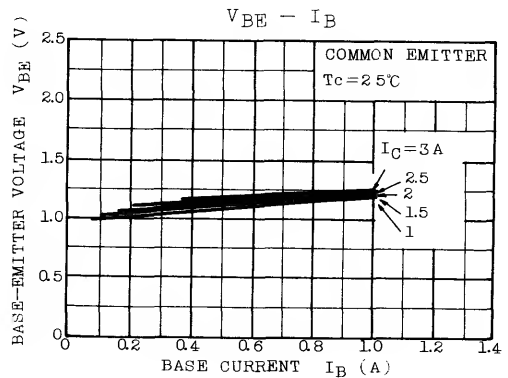
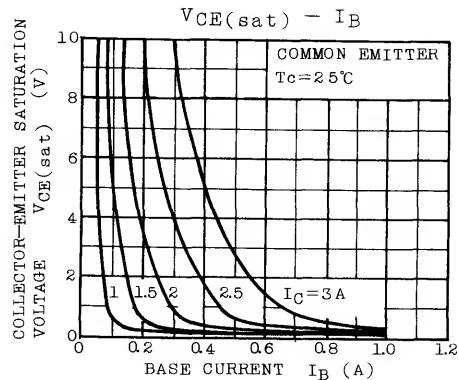
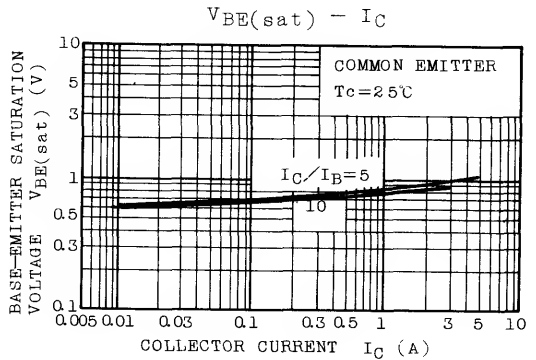
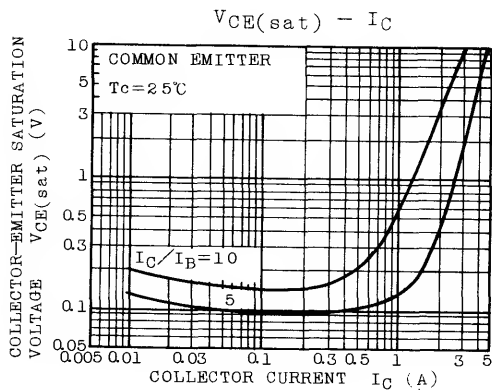
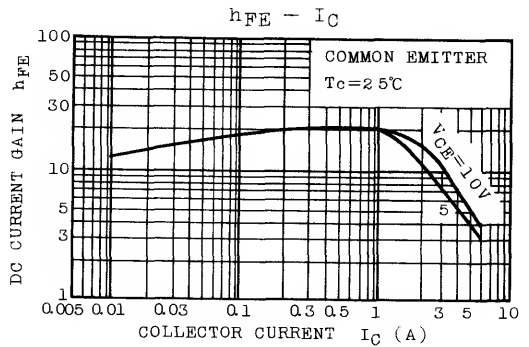
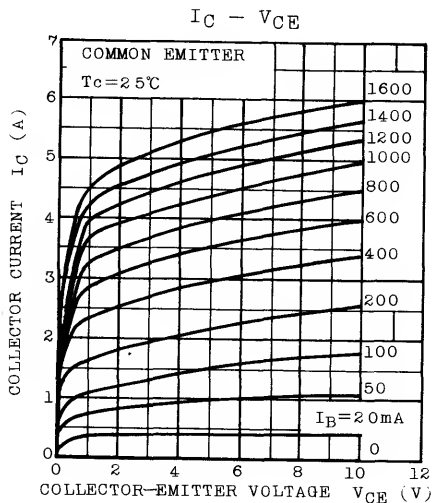
Mounting Kit No. AC42C

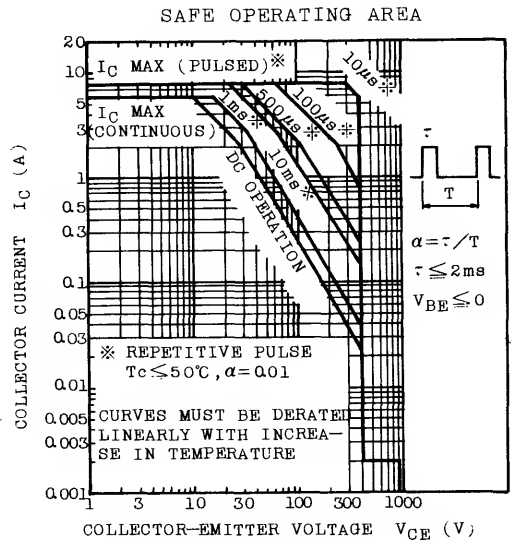
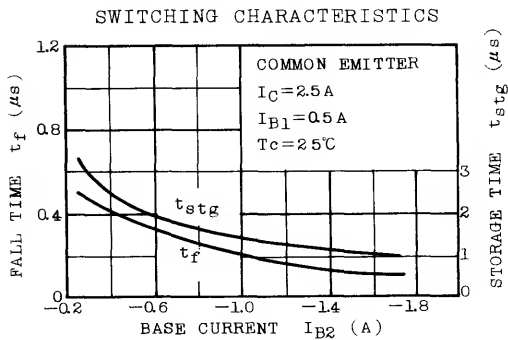
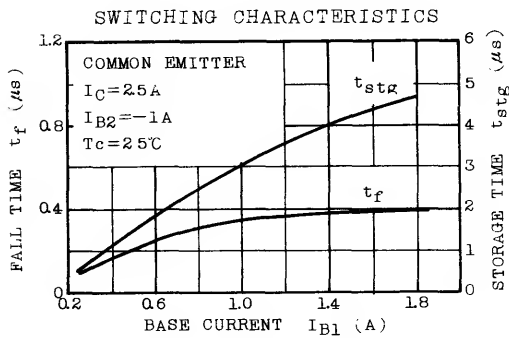
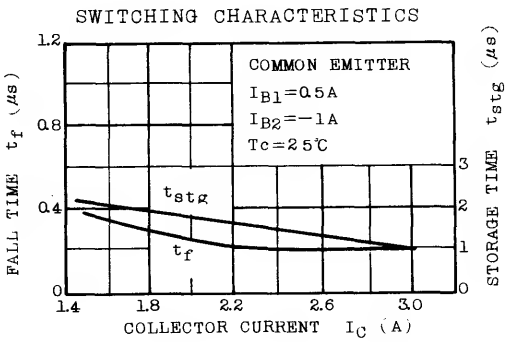
Weight : 17.0g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C=1mA, I_E=0$	900	-	-	V
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=10mA, I_B=0$	400	-	-	V
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=5mA, I_C=0$	7	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=4A$	3.5	-	12	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A, I_B=1.25A$	-	-	3	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4A, I_B=1.25A$	-	-	1.5	V
Fall Time	t_f	$I_{CP}=2.5A, I_{B1}=0.5A, I_{B2}=-1A$	-	-	0.5	μs
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.1A$	-	5	-	MHz

BU326A





BU407D

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

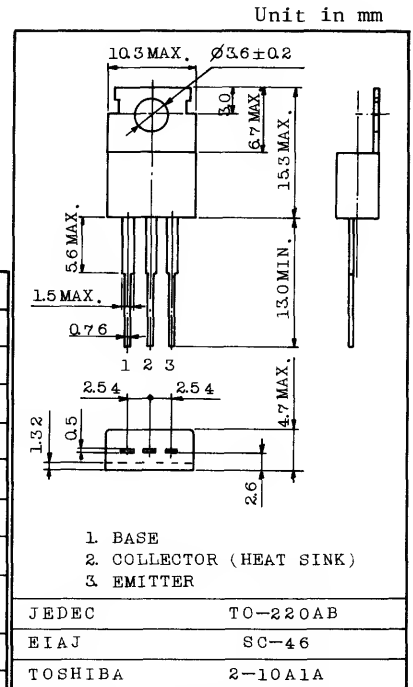
TV HORIZONTAL DEFLECTION OUTPUT APPLICATIONS.
HIGH VOLTAGE SWITCHING APPLICATIONS.

FEATURES:

- . Built in Damper Type
- . High Collector Current Capability
- . High Collector Power Dissipation Capability

MAXIMUM RATINGS (Ta=25°C)

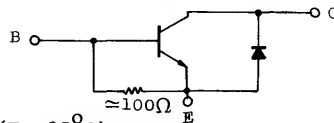
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	330	V
Collector-Emitter Voltage	V _{CE0}	150	V
Emitter-Base Voltage	V _{EB0}	6	V
Collector Current	DC	I _C	7 A
	Repetitive	I _{CM}	10 A
	Peak	I _{CP}	15 A
Base Current (Repetitive)	I _{BM}	2	A
Collector Power Dissipation (T _c =25°C)	P _C	60	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55 ~ 150	°C



Mounting Kit No. AC75

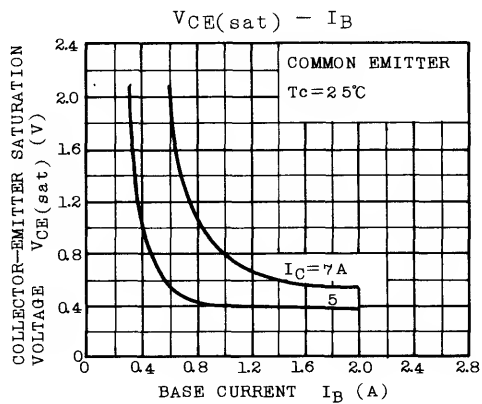
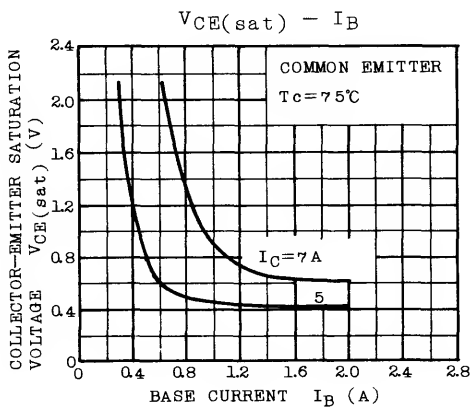
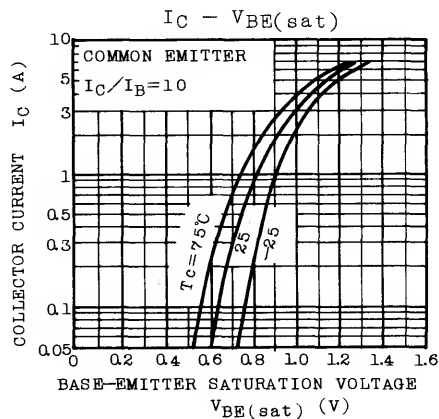
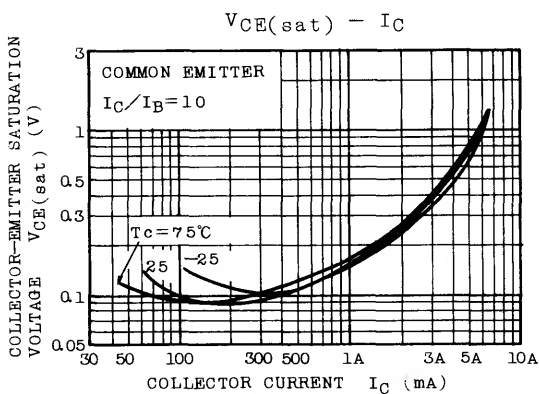
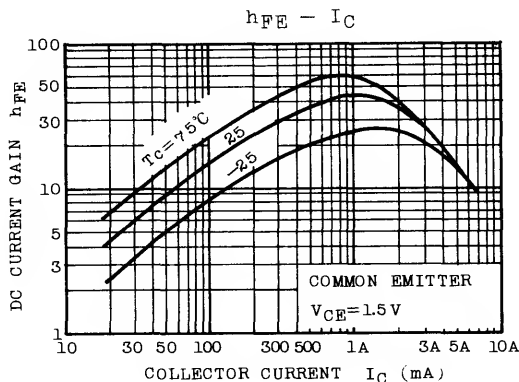
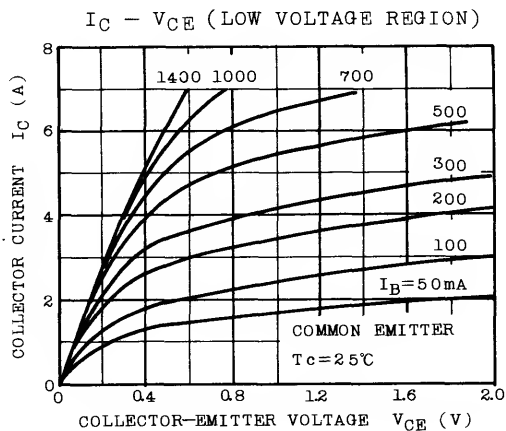
Weight : 1.9g

EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CEs}	V _{CE} =250V, V _{BE} =0	-	-	1.0	mA
Collector-Emitter Sustaining Voltage	V _{CE0(SUS)}	I _C =0.1A, L=50mH	150	-	-	V
Collector-Base Breakdown Voltage	V _{(BR)CBO}	I _C =1mA, I _E =0	330	-	-	V
Emitter-Base Breakdown Voltage	V _{(BR)EBO}	I _E =0.1A, I _C =0	6	-	-	V
DC Current Gain	h _{FE}	V _{CE} =1.5V, I _C =5A	10	-	-	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =5A, I _B =0.5A	-	-	1.5	V
Base-Emitter Saturation Voltage	V _{BE(sat)}	I _C =5A, I _B =0.5A	-	-	1.5	V
Forward Voltage (Diode)	-V _F	I _C =-6A	-	-	1.8	V
Fall Time	t _f	I _{CP} =5A, I _{B1} =-I _{B2} =0.5A	-	-	1.0	μS
Transition Frequency	f _T	V _{CE} =10V, I _C =0.2A	-	18	-	MHz



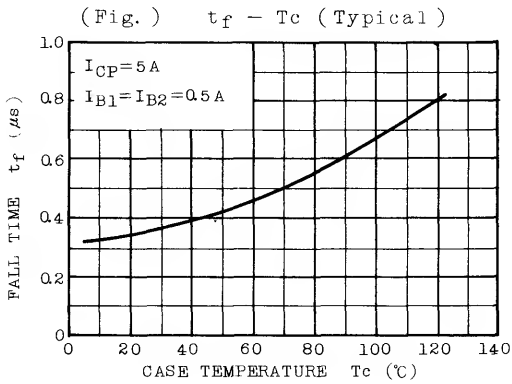
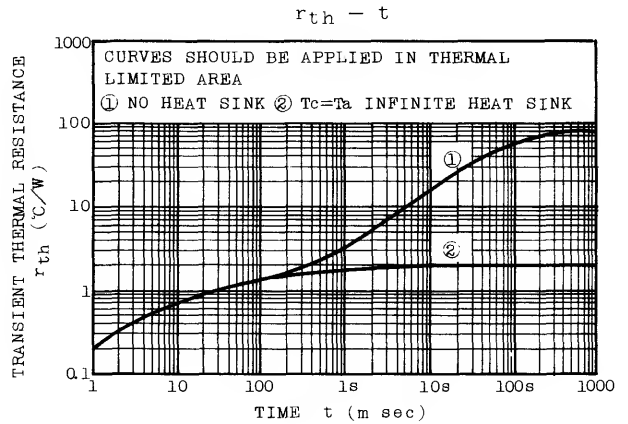
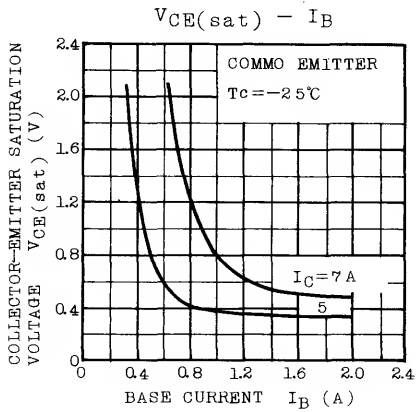
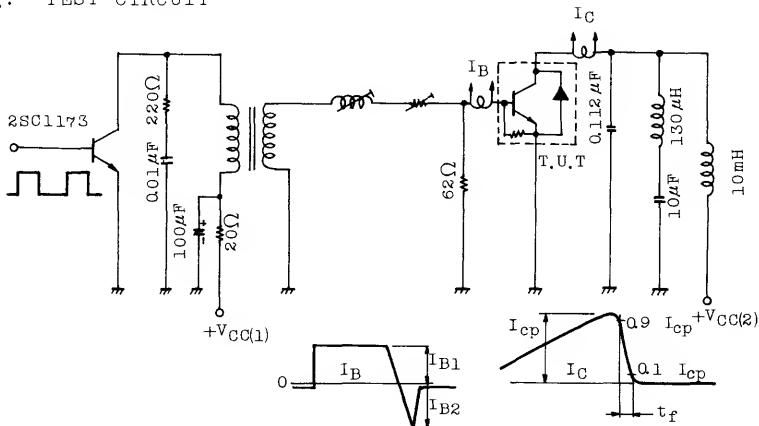


Fig. TEST CIRCUIT



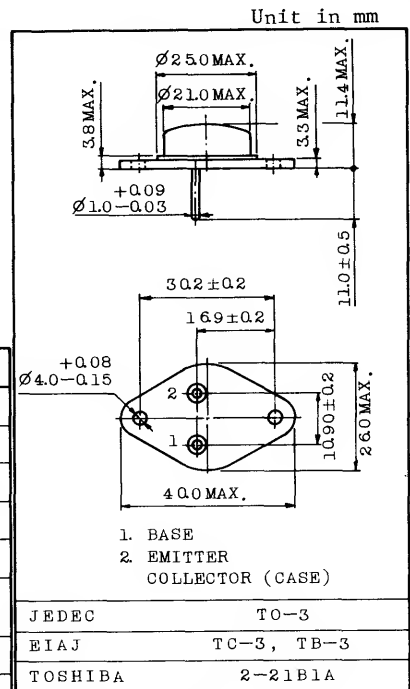
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- . High Voltage : $V_{CES}=1500V$
- . Low Saturation Voltage : $V_{CE(sat)}=1V$ (Max.)
- . Fall Time : $t_f=0.7\mu s$ (Typ.)
- . Glass Passivated Base-Collector Junction.

MAXIMUM RATINGS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Emitter Voltage	V_{CES}	1500	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	DC	I_C	5 A
	Peak	I_{CM}	7.5 A
Base Current (Peak)	I_{BM}	4	A
Total Power Dissipation ($T_c=95^\circ C$)	P_{tot}	12.5	W
Junction Temperature	T_j	+115	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 115	$^\circ C$
Thermal Resistance	$R_{th(j-c)}$	1.6	$^\circ C/W$



Mounting Kit No. AC42

Weight : 17.0g

ELECTRICAL CHARACTERISTICS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CES}	$V_{BE}=0, V_{CE}=1500V$	-	-	1	mA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_C=0, I_E=1mA$	5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, V_{CIC}=4.5A$	2.25	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4.5A, I_B=2A$	-	-	1	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4.5A, I_B=2A$	-	-	1.5	V
Collector-Emitter Sustaining Voltage	$V_{CE(SUS)}$	$I_B=0, I_C=100mA, L=25mH$	700	-	-	V
Transition Frequency (at $f=5MHz$)	f_T	$V_{CE}=5V, V_{IC}=0.1A$	-	7	-	MHz
Collector Output Capacitance (at $f=1MHz$)	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	125	-	pF
Switching Time	Fall Time	t_f	-	0.7	-	μs
	Storage Time	t_s	-	10	-	μs

BUY
SERIES



TV HORIZONTAL OUTPUT APPLICATION.

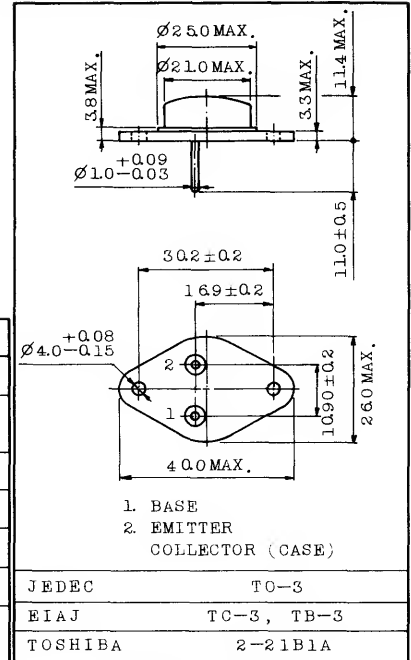
FEATURES:

- . High Voltage : $V_{CEX}=2200V$
- . Fast Switching : $t_f=0.7\mu s$ (Typ.)

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	2200	V
Peak Collector-Emitter Voltage	V_{CEX}	2200	V
Collector-Emitter Voltage	V_{CEO}	800	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	2	A
Base Current	I_B	2	A
Collector Power Dissipation ($T_c \leq 80^\circ C$)	P_C	10	W
Junction Temperature	T_j	100	$^\circ C$
Storage Temperature Range	T_{stg}	-60 ~ 100	$^\circ C$

Unit in mm

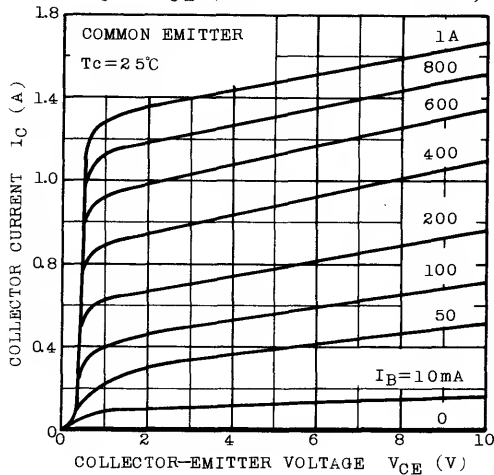


Weight : 17.0g

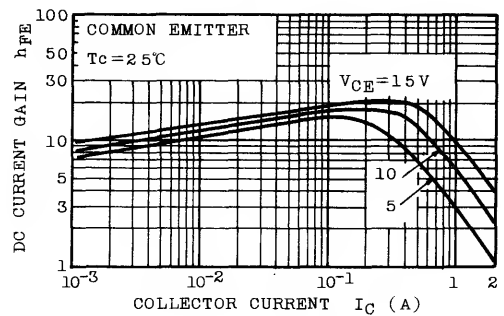
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector-Emitter Cut-off Current	I_{CEX}	$V_{CE}=2200V, V_{BE}=-2V$	-	-	1	mA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=100mA, I_C=0$	5	-	-	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=1.5A, I_B=1.5A$	-	-	10	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=1.5A, I_B=1.5A$	-	-	1.5	V
Transition Frequency	f_T	$V_{CE}=5V, I_C=0.1A$	-	4	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1.0MHz$	-	50	-	pF
Fall Time	t_f	$I_{cp}=1.2A$ $I_{BL(end)}=0.55A$	-	0.7	-	μs

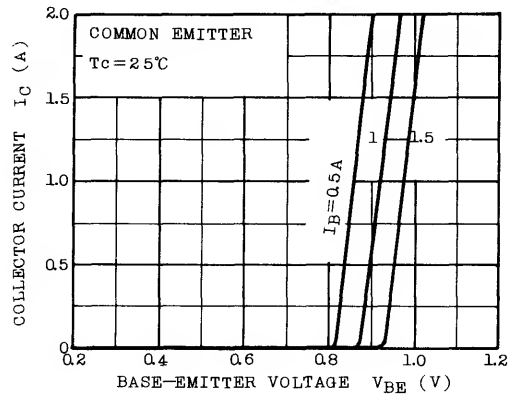
$I_C - V_{CE}$ (LOW VOLTAGE REGION)



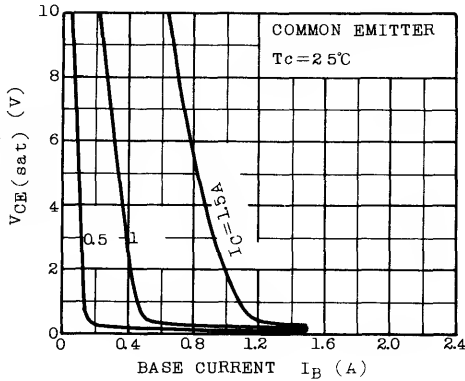
$h_{FE} - I_C$



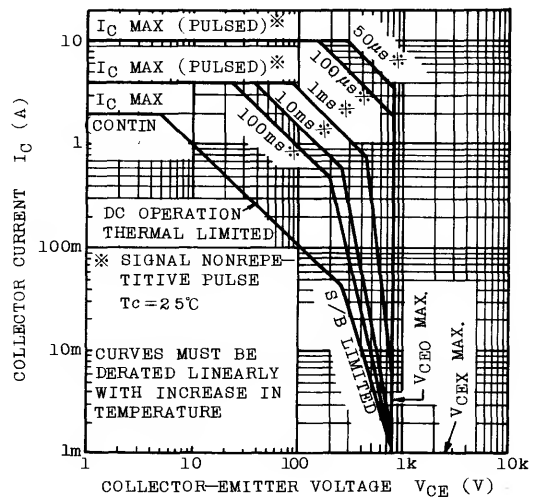
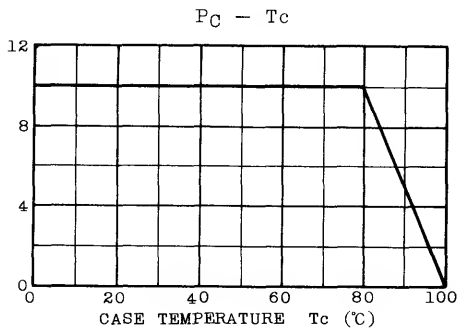
$I_C - V_{BE}$



COLLECTOR-EMITTER SATURATION



COLLECTOR POWER DISSIPATION



TBF
SERIES





TBF869 TBF871

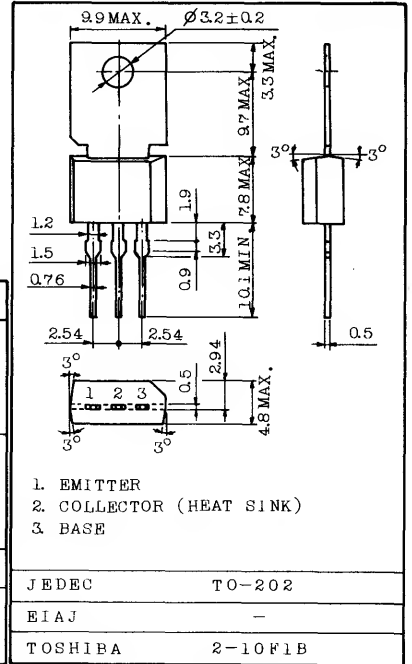
HIGH VOLTAGE SWITCHING AND AMPLIFIER APPLICATIONS.
COLOR TV CHROMA OUTPUT APPLICATIONS.

. PNP Complements are TBF870 and TBF872.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	TBF869	V _{CBO}	250	V
	TBF871		300	
Collector-Emitter Voltage	TBF869	V _{CEO}	250	V
	TBF871		300	
Emitter-Base Voltage		V _{EB0}	5	V
Collector Current	DC	I _C	50	mA
	Peak	I _{CP}	100	
Total Power Dissipation		P _{tot}	1.6	W
			5.0 (T _c =25°C)	
Base Current		I _B	20	mA
Junction Temperature		T _j	150	°C
Storage Temperature Range		T _{stg}	-65 ~ 150	°C
Solder Temperature, 1.5mm from Case for 10 Seconds		-	350	°C

Unit in mm



1. EMITTER
2. COLLECTOR (HEAT SINK)
3. BASE

JEDEC	TO-202
EIAJ	-
TOSHIBA	2-10F1B

Weight : 1.4g

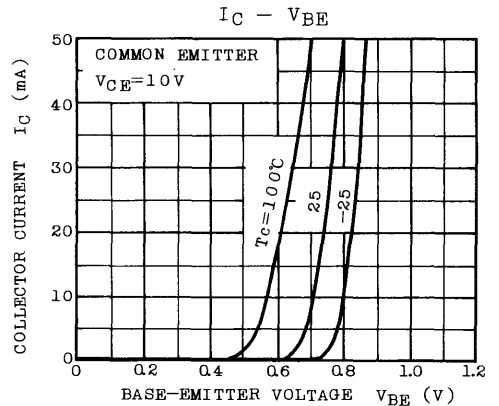
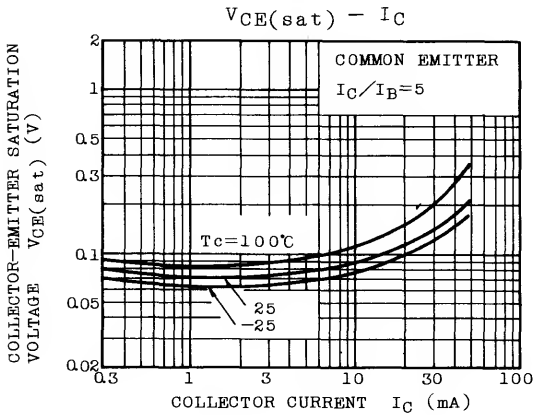
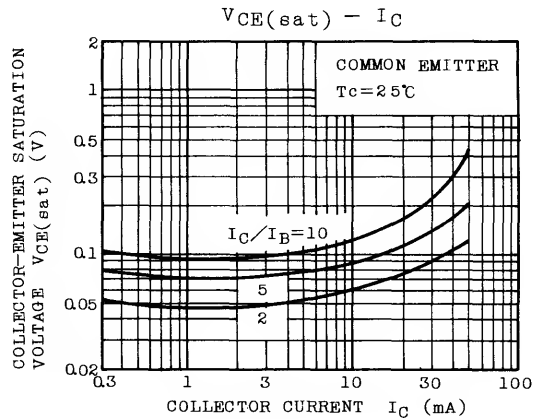
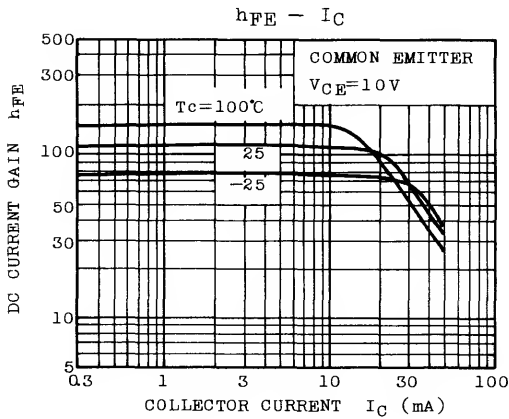
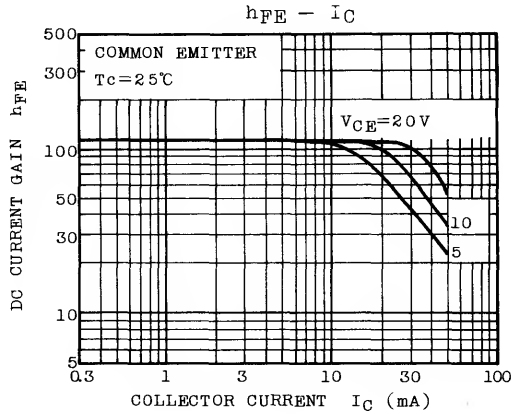
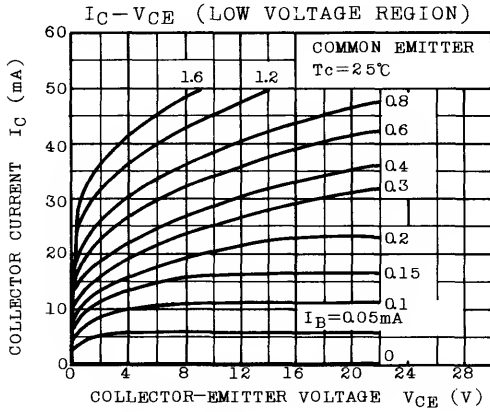
THERMAL CHARACTERISTICS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Thermal Resistance (Junction-Ambient)	R _{θJA}	78.3	°C/W
Thermal Resistance (Junction-Case)	R _{θJC}	25	°C/W

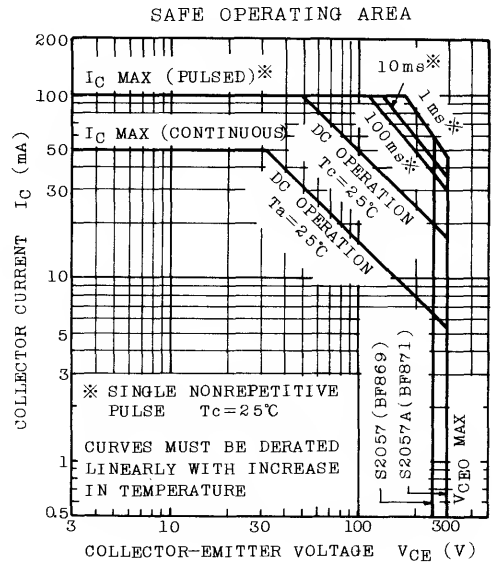
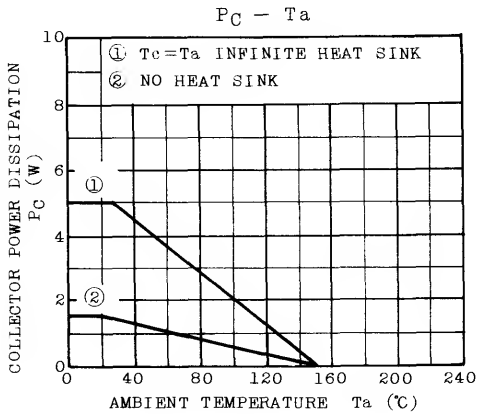
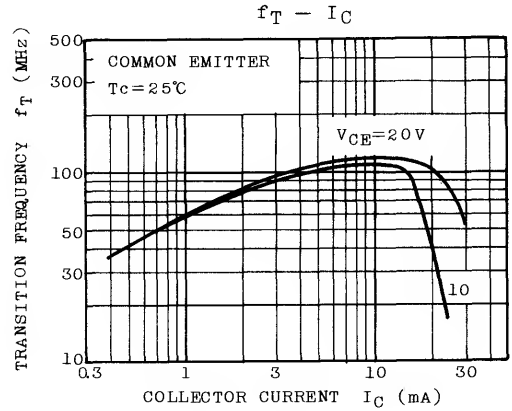
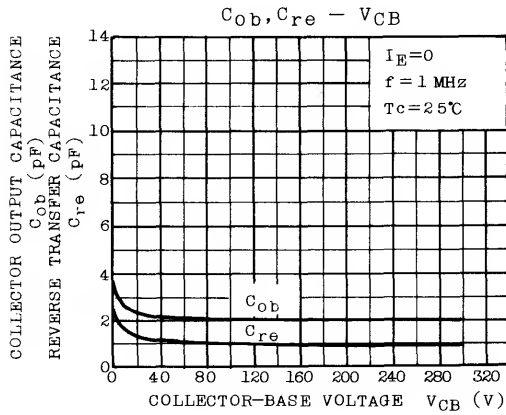
TBF869 • TBF871

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}\text{C}$ Unless otherwise specified)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	TBF869	I_{CBO}	$V_{CB}=200\text{V}, I_E=0$	-	-	0.1	μA
	TBF871	I_{CER}	$V_{CE}=250\text{V}, R_{BE}=2.7\text{k}\Omega$	-	-	0.05	
Emitter Cut-off Current		I_{EBO}	$V_{EB}=5\text{V}, I_C=0$	-	-	10	μA
Collector-Emitter Breakdown Voltage	TBF869	$V_{(BR)CEO}$	$I_C=1\text{mA}, I_B=0$	250	-	-	V
	TBF871	$V_{(BR)CER}$	$I_C=1\mu\text{A}, R_{BE}=2.7\text{k}\Omega$	300	-	-	
High Temperature Collector Cut-off Current		I_{CER}	$V_{CE}=200\text{V}, R_{BE}=2.7\text{k}\Omega$ $T_j=150^{\circ}\text{C}$	-	-	10	μA
DC Current Gain		h_{FE}	$V_{CE}=20\text{V}, I_C=25\text{mA}$	50	-	-	
Collector-Emitter RF Saturation Voltage		$V_{CE(sat)RF}$	$I_C=25\text{mA}, T_j=150^{\circ}\text{C}$	-	20	-	V
Base-Emitter Voltage		V_{BE}	$V_{CE}=20\text{V}, I_C=25\text{mA}$	-	0.75	-	V
Transition Frequency		f_T	$V_{CE}=10\text{V}, I_C=10\text{mA}$	60	100	-	MHz
Reverse Transfer Capacitance		C_{re}	$V_{CB}=30\text{V}, I_E=0, f=1\text{MHz}$	-	1.3	1.8	pF



TBF869 • TBF871



TBF870 TBF872

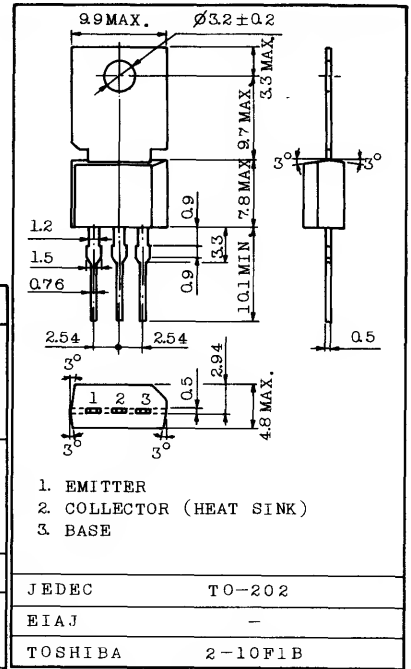
Unit in mm

HIGH VOLTAGE SWITCHING AND AMPLIFIER APPLICATIONS.
COLOR TV CHROMA OUTPUT APPLICATIONS.

. NPN Complements are TBF869 and TBF871.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage	TBF870	V _{CBO}	-250	V
	TBF872		-300	
Collector-Emitter Voltage	TBF870	V _{CEO}	-250	V
	TBF872		-300	
Emitter-Base Voltage		V _{EB0}	-5	V
Collector Current	DC	I _C	-50	mA
	Peak	I _{CP}	-100	
Total Power Dissipation		P _{tot}	1.6	W
			5.0 (T _c =25°C)	
Base Current		I _B	-20	mA
Junction Temperature		T _j	150	°C
Storage Temperature Range		T _{stg}	-65 ~ 150	°C
Solder Temperature, 1.5mm from Case for 10 Seconds		-	350	°C



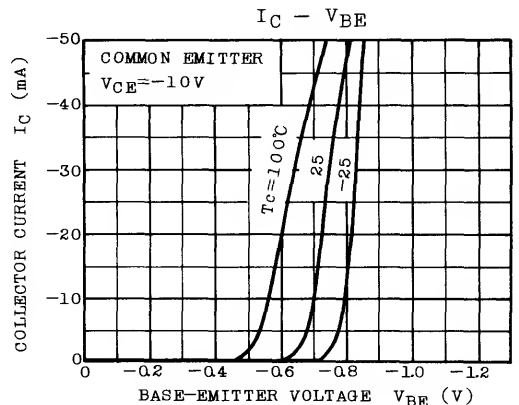
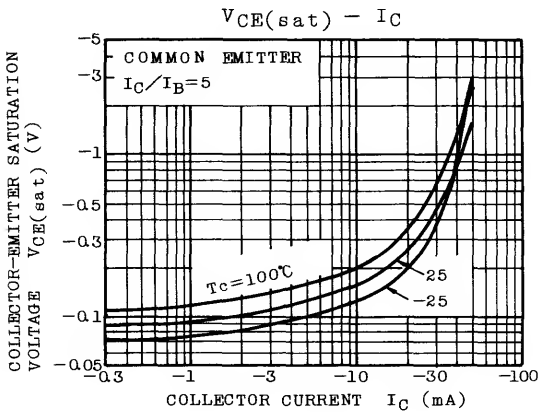
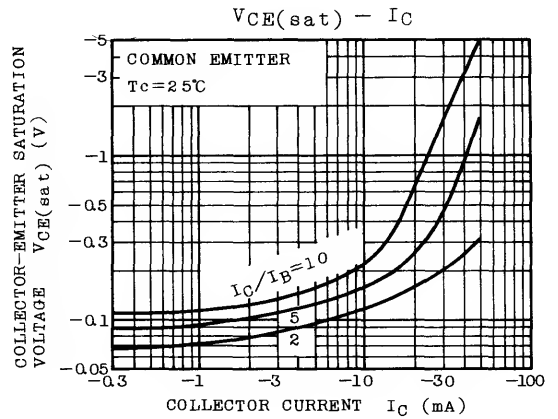
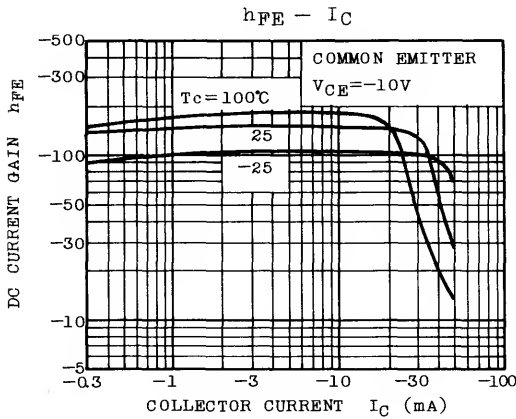
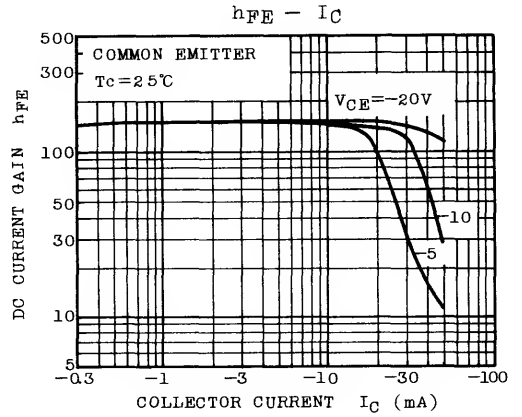
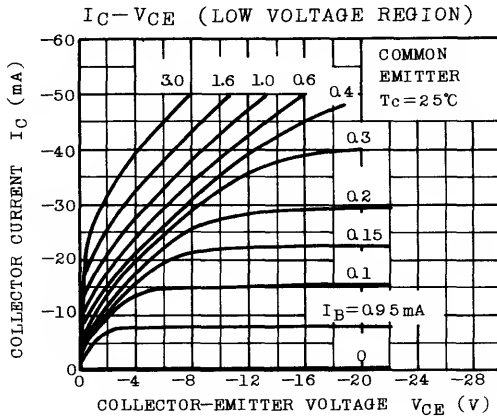
THERMAL CHARACTERISTICS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Thermal Resistance (Junction-Ambient)	R _{θJA}	78.3	°C/W
Thermal Resistance (Junction-Case)	R _{θJC}	25	°C/W

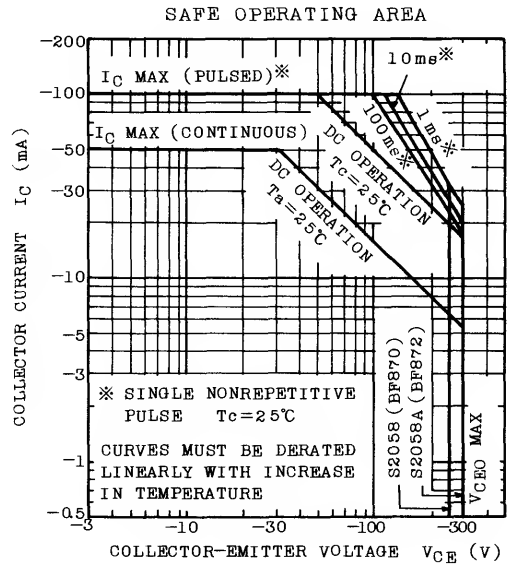
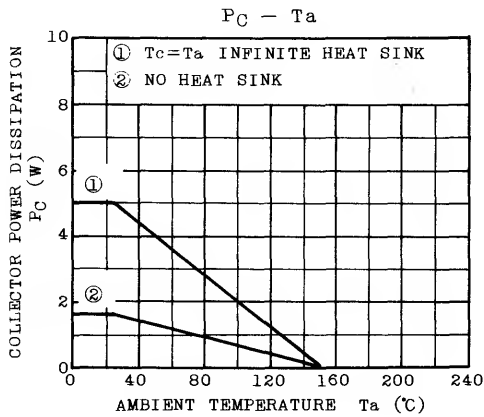
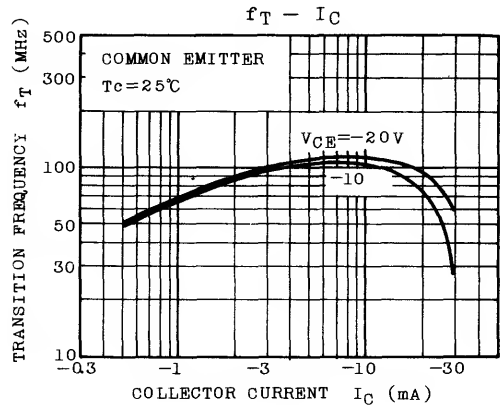
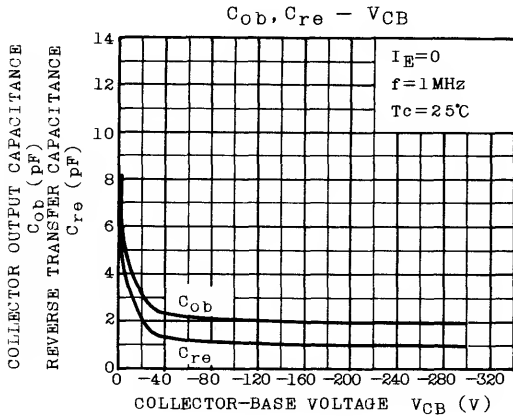
TBF870 • TBF872

ELECTRICAL CHARACTERISTICS (Ta=25°C Unless otherwise specified)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	TBF870	ICBO	V _{CB} =-200V, I _E =0	-	-	-0.1	μA
	TBF872	ICER	V _{CE} =-250V, R _{BE} =2.7kΩ	-	-	-0.05	
Emitter Cut-off Current		IEBO	VEB=-5V, IC=0	-	-	-10	μA
Collector-Emitter Breakdown Voltage	TBF870	V(BR)CEO	IC=-1mA, IB=0	-250	-	-	V
	TBF872	V(BR)CER	IC=-1μA, R _{BE} =2.7kΩ	-300	-	-	
High Temperature Collector Cut-off Current		ICER	V _{CE} =-200V, R _{BE} =2.7kΩ T _j =150°C	-	-	-10	μA
DC Current Gain		hFE	V _{CE} =-20V, IC=-25mA	50	-	-	
Collector-Emitter RF Saturation Voltage		V _{CE(sat)} RF	IC=-25mA, T _j =150°C	-	-20	-	V
Base-Emitter Voltage		VBE	V _{CE} =-20V, IC=-25mA	-	-0.75	-	V
Transition Frequency		f _T	V _{CE} =-10V, IC=-10mA	60	80	-	MHz
Reverse Transfer Capacitance		C _{re}	V _{CB} =-30V, I _E =0, f=1MHz	-	1.7	2.0	pF



TBF870 · TBF872



TSB
SERIES





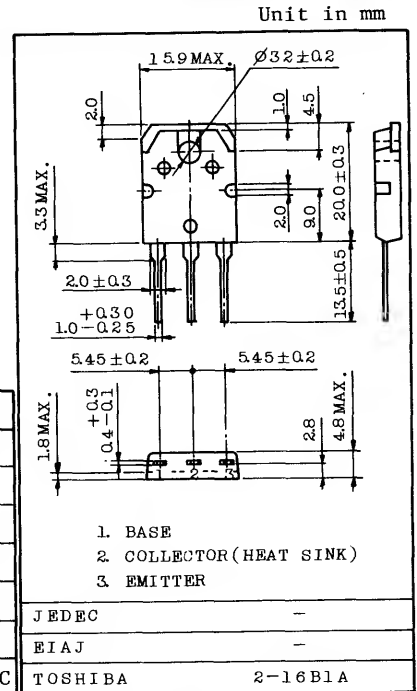
GENERAL PURPOSE TRANSISTOR
 POWER REGULATOR, SWITCHING AND SOLENOID
 DRIVE APPLICATIONS.

FEATURES:

- . Convenient MOLD Package : Useless Insulation Bushing
- . High Gain at High Current
 : $h_{FE}=20\sim 100$ @ $V_{CE}=4V, I_C=4A$
- . Low Saturation Voltage
 : $V_{CE(sat)} < 1.1V$ @ $I_C=4A, I_B=0.4A$

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CEO}	80	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	10	A
Base Current	I_B	6	A
Collector Power Dissipation ($T_c=25^\circ C$) Derate above $25^\circ C$	P_C	70	W
		0.56	W/ $^\circ C$
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^\circ C$



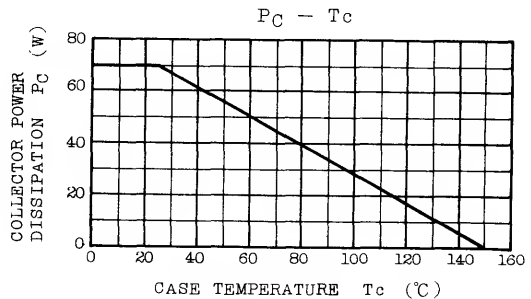
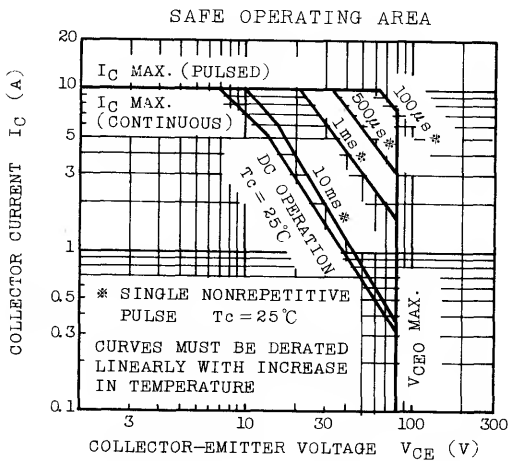
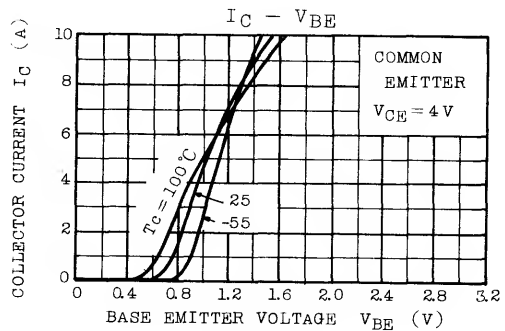
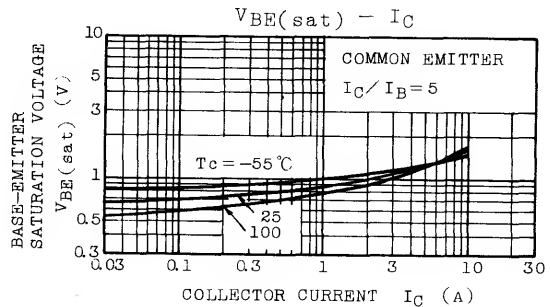
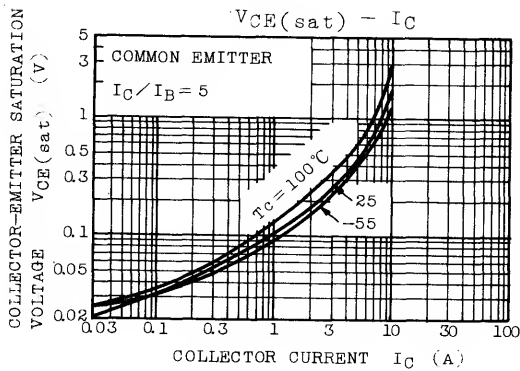
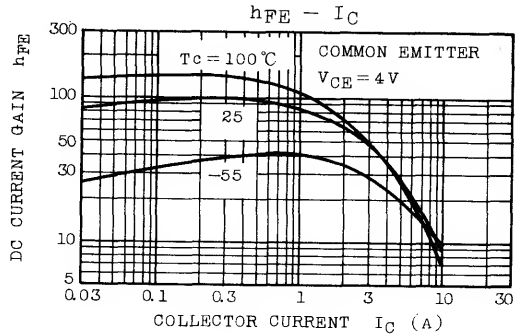
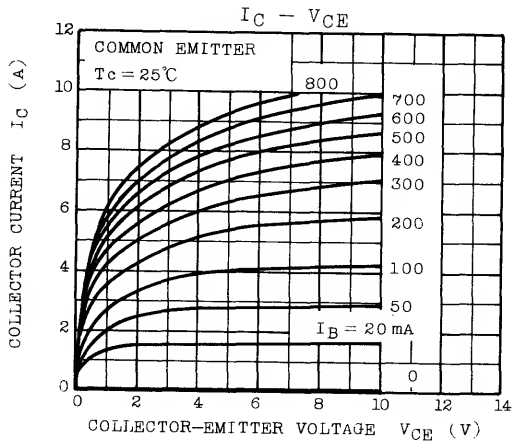
Weight : 4.6g

Notice ; Maximum torque applied to mounting flange is 8 kg·cm

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CEX}	$V_{CE}=80V, V_{BE}=-1.5V$	-	-	1.0	mA
Collector Cut-off Current	I_{CEO}	$V_{CE}=80V, I_B=0$	-	-	0.7	mA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=5V, I_C=0$	-	-	5	mA
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$ *	$I_C=200mA, I_B=0$	80	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=4V, I_C=4A$	20	-	100	
		$V_{CE}=4V, I_C=10A$	5	-	-	
Base-Emitter Voltage	V_{BE}	$V_{CE}=4V, I_C=4A$	-	-	1.8	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4A, I_B=0.4A$	-	-	1.1	V
		$I_C=10A, I_B=3.3A$	-	-	8.0	
Transition Frequency	f_T	$V_{CE}=10V, I_C=0.5A, f=1MHz$	3.0	8.0	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	70	-	pF

* The sustaining voltage $V_{CEO(SUS)}$ MUST NOT be measured on a curve tracer.



S
SERIES



POWER AMPLIFIER APPLICATIONS.
TV VERTICAL OUTPUT APPLICATIONS.

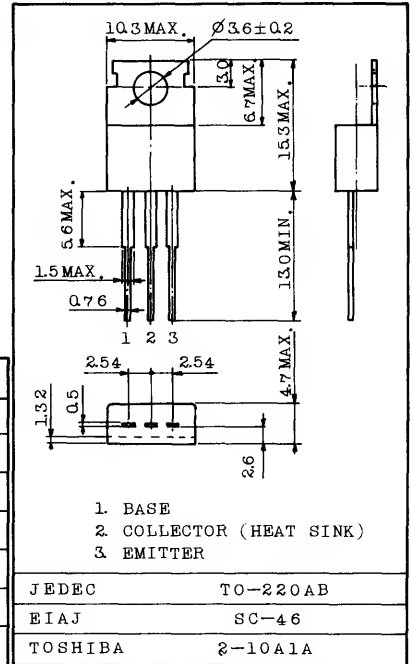
FEATURES:

- . Good Linearity of h_{FE}
- . Complementary to S1237

MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	90	V
Collector-Emitter Voltage	V_{CE0}	90	V
Emitter-Base Voltage	V_{EB0}	5	V
Collector Current	I_C	4	A
Emitter Current	I_E	-4	A
Base Current	I_B	3	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	40	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature	T_{stg}	-55 ~ 150	$^\circ\text{C}$

Unit in mm

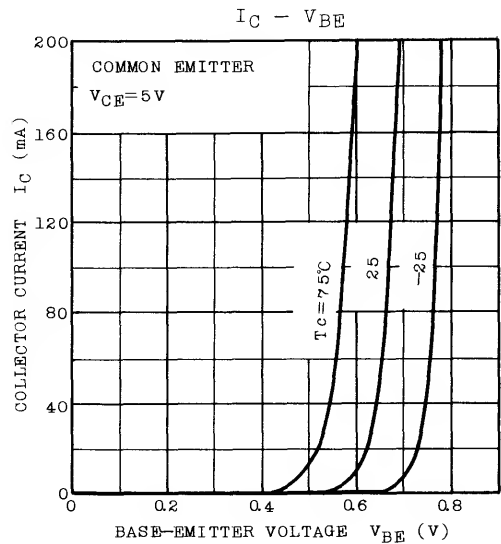
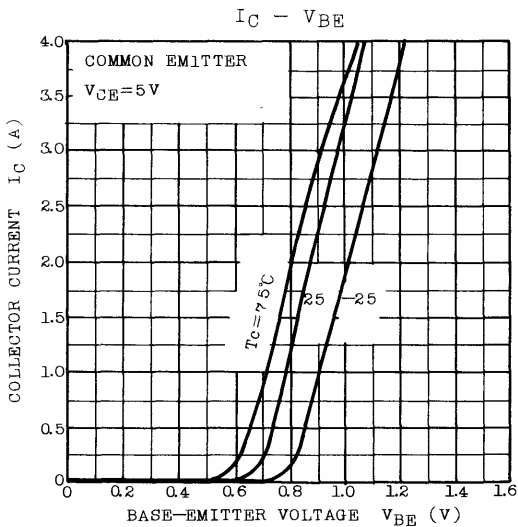
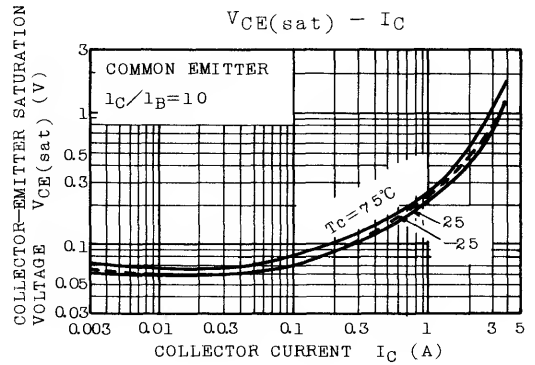
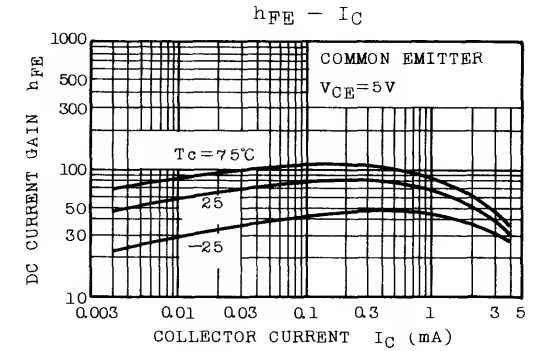
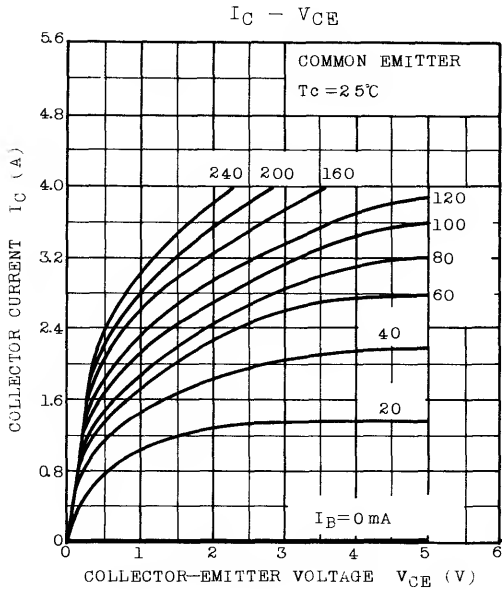


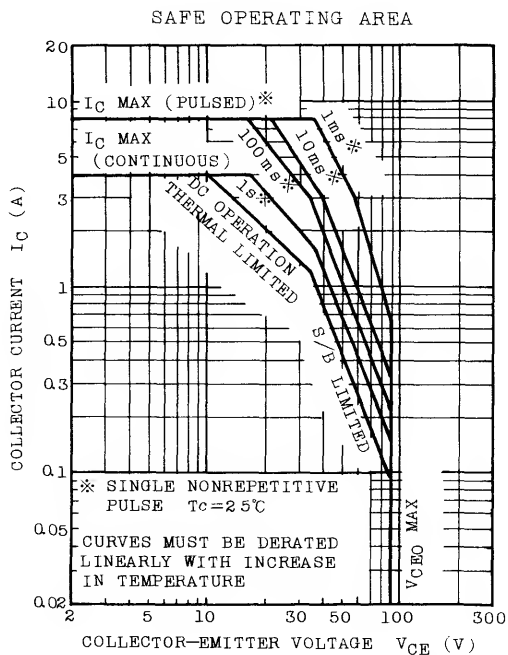
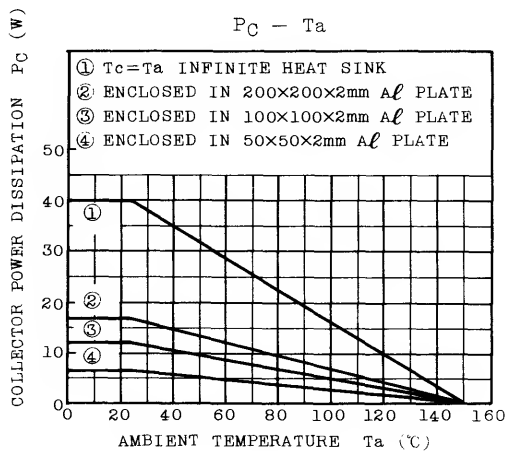
Mounting Kit No. AC75

Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=90\text{V}, I_E=0$	-	-	20	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=5\text{V}, I_C=0$	-	-	10	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C=50\text{mA}, I_B=0$	90	-	-	V
DC Current Gain	$h_{FE(1)}$	$V_{CE}=5\text{V}, I_C=0.5\text{A}$	40	-	200	
	$h_{FE(2)}$	$V_{CE}=5\text{V}, I_C=3\text{A}$	15	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=3\text{A}, I_B=0.3\text{A}$	-	-	1.5	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=5\text{V}, I_C=3\text{A}$	-	-	1.5	V
Transition Frequency	f_T	$V_{CE}=5\text{V}, I_C=0.5\text{A}$	3	8	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10\text{V}, I_E=0, f=1\text{MHz}$	-	85	-	pF





S1237

SILICON PNP TRIPLE DIFFUSED TYPE (PCT PROCESS)

POWER AMPLIFIER APPLICATIONS.
TV VERTICAL OUTPUT APPLICATIONS.

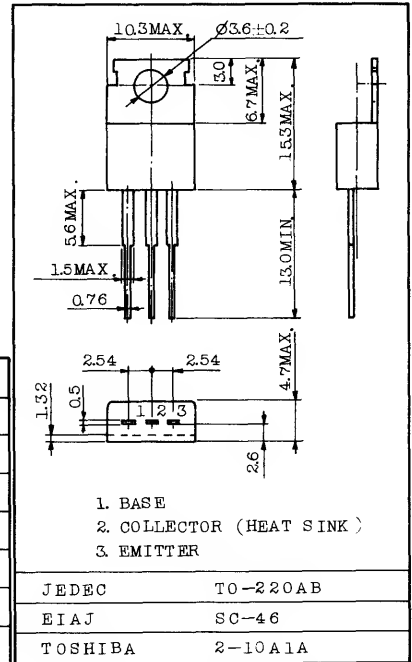
FEATURES:

- . Good Linearity of h_{FE}
- . Complementary to S1236

MAXIMUM RATINGS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-90	V
Collector-Emitter Voltage	V_{CE0}	-90	V
Emitter-Base Voltage	V_{EB0}	-5	V
Collector Current	I_C	-4	A
Emitter Current	I_E	4	A
Base Current	I_B	-3	A
Collector Power Dissipation ($T_c=25^{\circ}\text{C}$)	P_C	40	W
Junction Temperature	T_j	150	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^{\circ}\text{C}$

Unit in mm

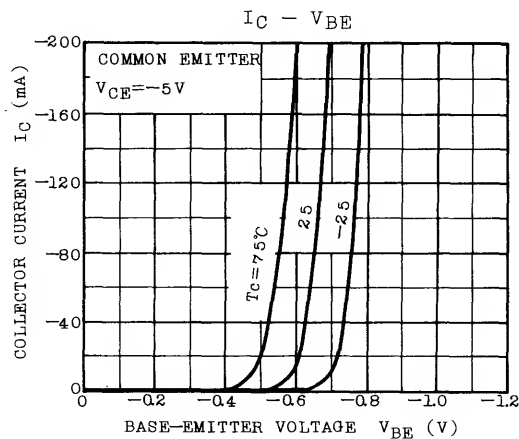
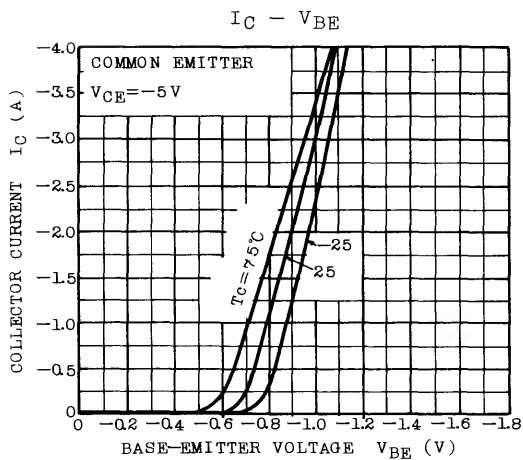
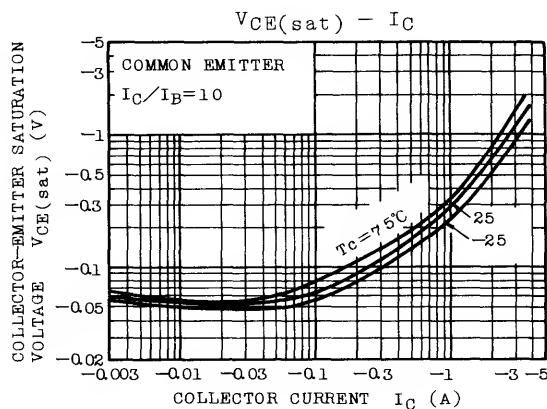
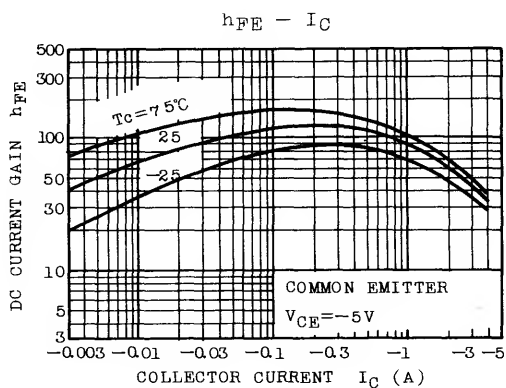
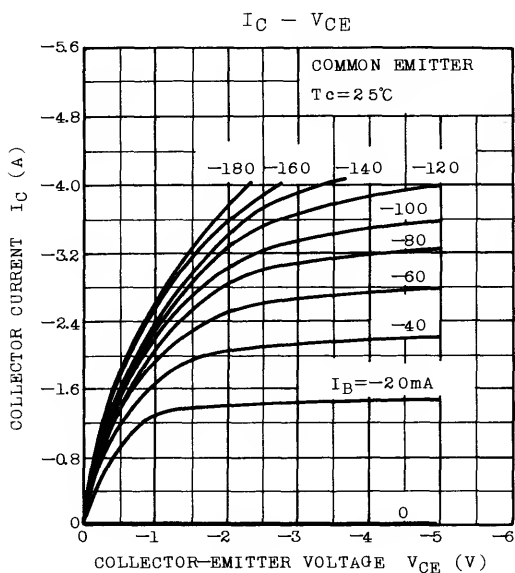


Mounting Kit No. AC75

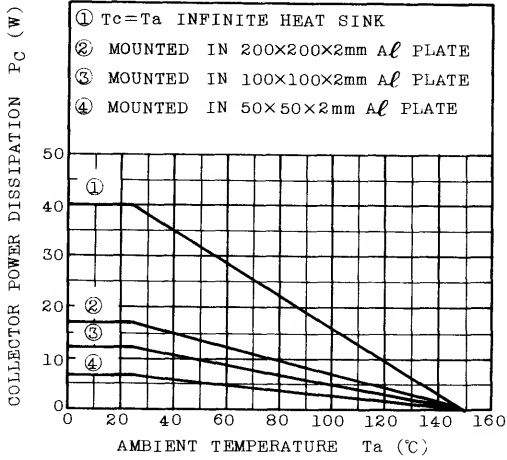
Weight : 1.9g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}\text{C}$)

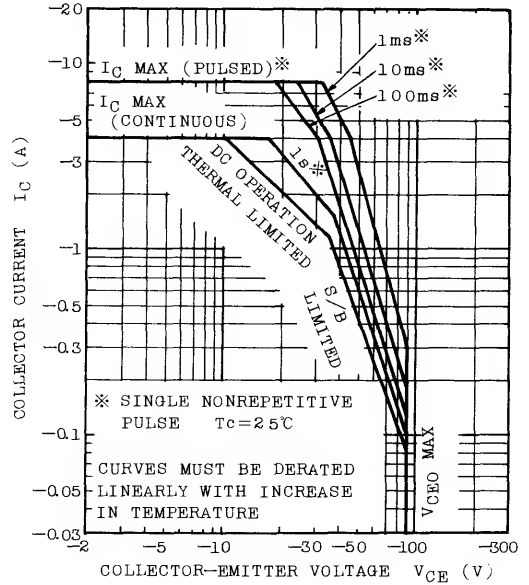
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=-90\text{V}, I_E=0$	-	-	-20	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=-5\text{V}, I_C=0$	-	-	-10	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C=-50\text{mA}, I_B=0$	-90	-	-	V
DC Current Gain	$h_{FE(1)}$	$V_{CE}=-5\text{V}, I_C=-0.5\text{A}$	40	-	200	
	$h_{FE(2)}$	$V_{CE}=-5\text{V}, I_C=-3\text{A}$	15	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-3\text{A}, I_B=-0.3\text{A}$	-	-	-1.7	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-5\text{V}, I_C=-3\text{A}$	-	-	-1.5	V
Transition Frequency	f_T	$V_{CE}=-5\text{V}, I_C=-0.5\text{A}$	3	5	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10\text{V}, I_E=0, f=1\text{MHz}$	-	130	-	pF



$P_C - T_a$



SAFE OPERATING AREA

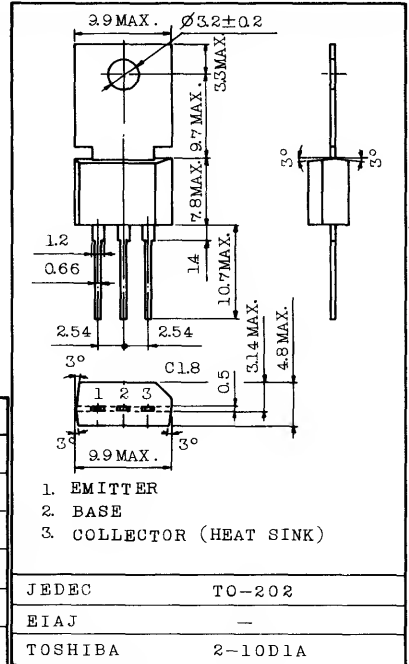


COLOR TV CHROMA OUTPUT APPLICATIONS.

FEATURES:

- . High Collector-Emitter Breakdown Voltage : $V_{CEO}=300V$
- . Low C_{cb} (2.5pF Typ.)

Unit in mm



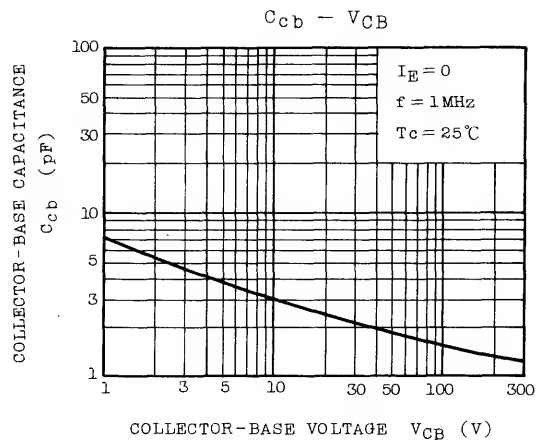
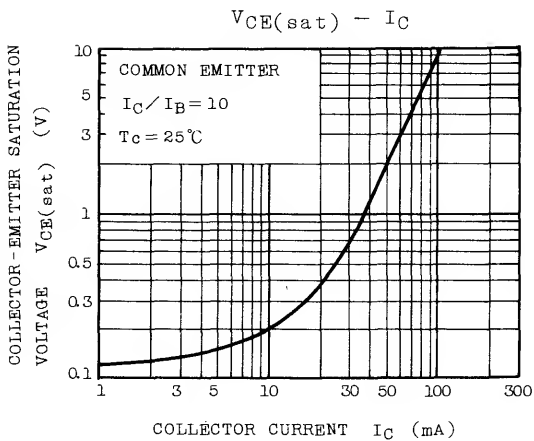
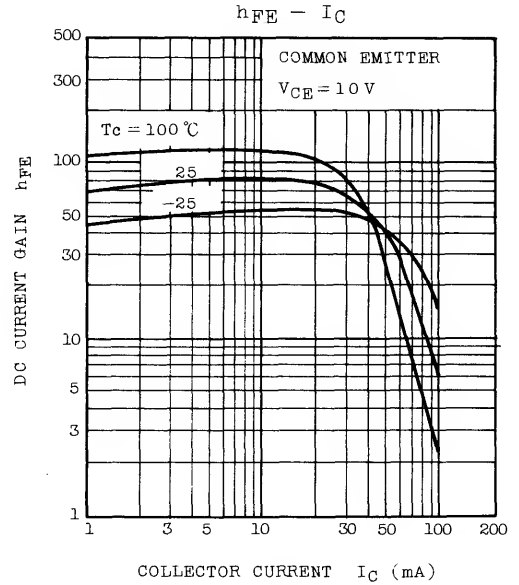
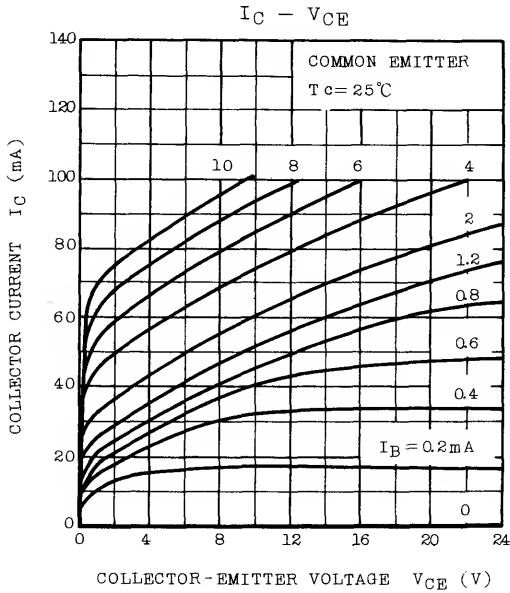
Weight : 1.4g

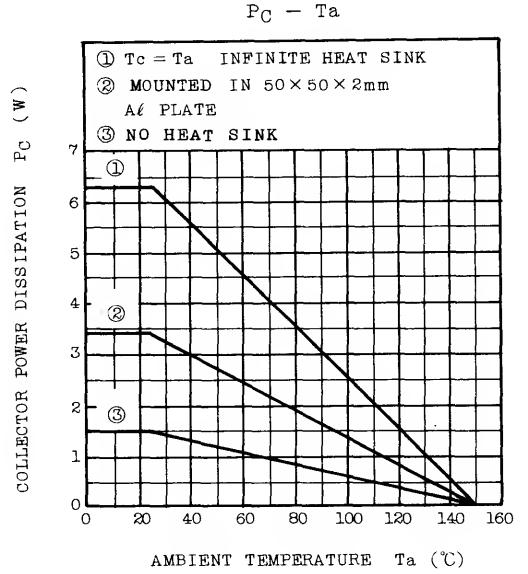
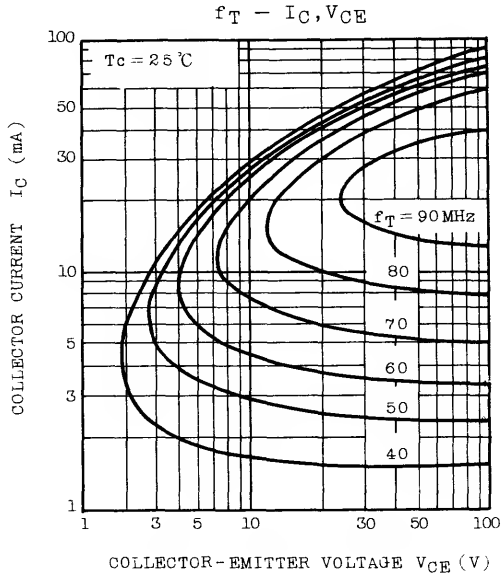
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	300	V
Collector-Emitter Voltage	V_{CEO}	300	V
Emitter-Base Voltage	V_{EBO}	7	V
Collector Current	I_C	100	mA
Base Current	I_B	50	mA
Collector Power Dissipation	P_C	Ta=25°C	1.5
		Tc=25°C	6.25
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~ 150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=300V, I_E=0$	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=7V, I_C=0$	-	-	10	μA
DC Current Gain	$h_{FE}(1)$	$V_{CE}=10V, I_C=4mA$	20	-	-	
	$h_{FE}(2)$	$V_{CE}=10V, I_C=20mA$	30	-	150	
Collector-Emitter Saturation Voltage	$V_{CE}(sat)$	$I_C=10mA, I_B=1mA$	-	-	1.0	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=20mA$	50	70	-	MHz
Collector-Base Capacitance	C_{cb}	$V_{CB}=20V, I_E=0, f=1MHz$	-	2.5	3.0	pF





S1375

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

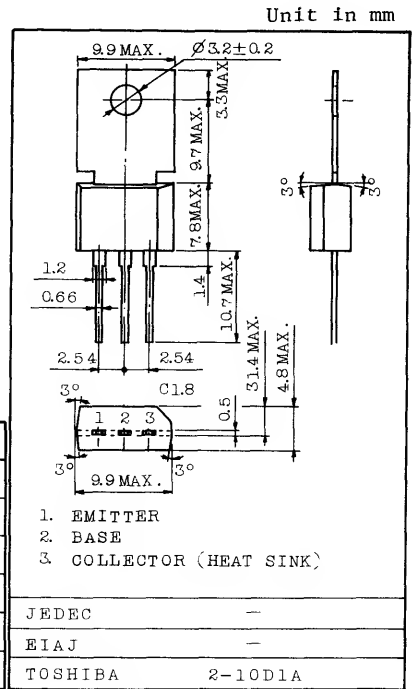
MEDIUM POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

. Complementary to S1376

MAXIMUM RATINGS ($T_a=25^{\circ}\text{C}$)

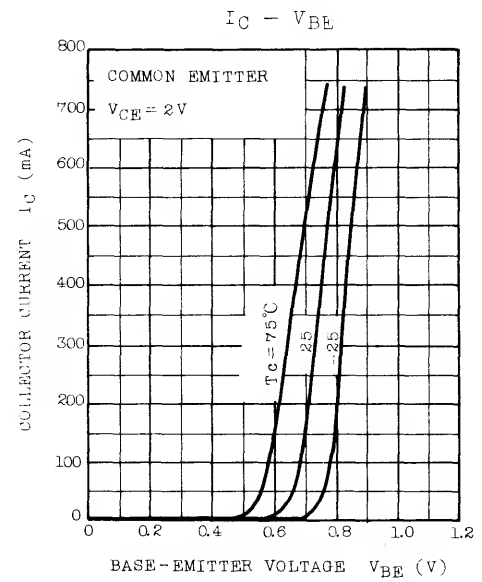
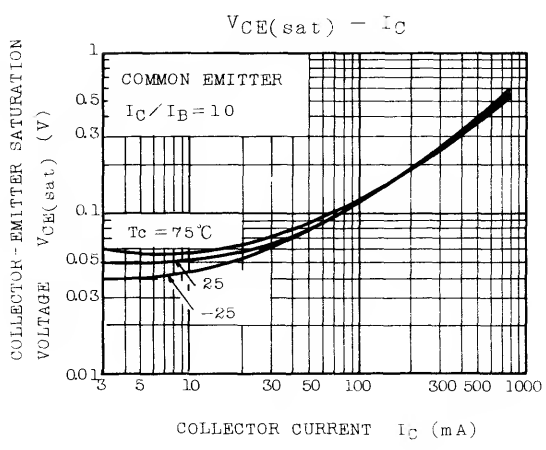
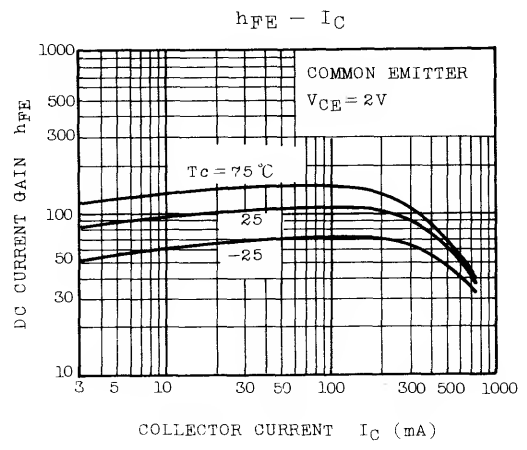
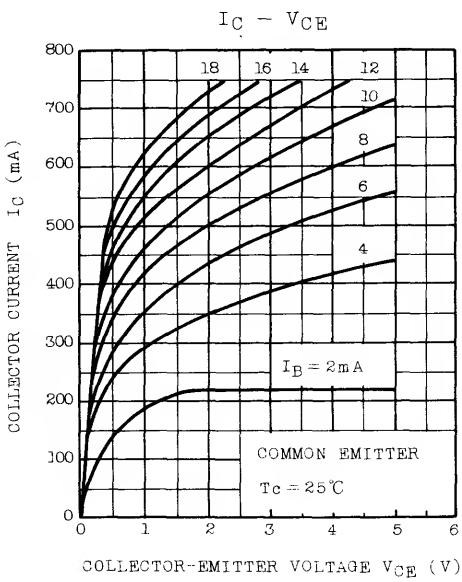
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	80	V
Collector-Emitter Voltage	V_{CE0}	80	V
Emitter-Base Voltage	V_{EB0}	5	V
Collector Current	I_C	750	mA
Base Current	I_B	500	mA
Collector Power Dissipation	P_C	1.5	W
Junction Temperature	T_j	150	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^{\circ}\text{C}$



Weight : 1.4g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=30\text{V}, I_E=0$	-	-	0.5	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=5\text{V}, I_C=0$	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C=10\text{mA}, I_B=0$	80	-	-	V
DC Current Gain	$h_{FE(1)}$	$V_{CE}=2\text{V}, I_C=150\text{mA}$	70	-	240	
	$h_{FE(2)}$	$V_{CE}=2\text{V}, I_C=500\text{mA}$	40	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=500\text{mA}, I_B=50\text{mA}$	-	-	0.5	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=2\text{V}, I_C=500\text{mA}$	-	-	1.0	V
Transition Frequency	f_T	$V_{CE}=2\text{V}, I_C=150\text{mA}$	50	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10\text{V}, I_E=0, f=1\text{MHz}$	-	15	-	pF



S1376

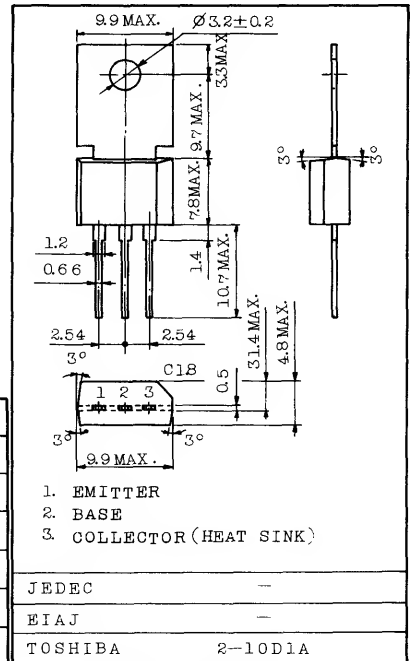
SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

MEDIUM POWER AMPLIFIER APPLICATIONS.
DRIVER STAGE AMPLIFIER APPLICATIONS.

FEATURES:

. Complementary to S1375

Unit in mm



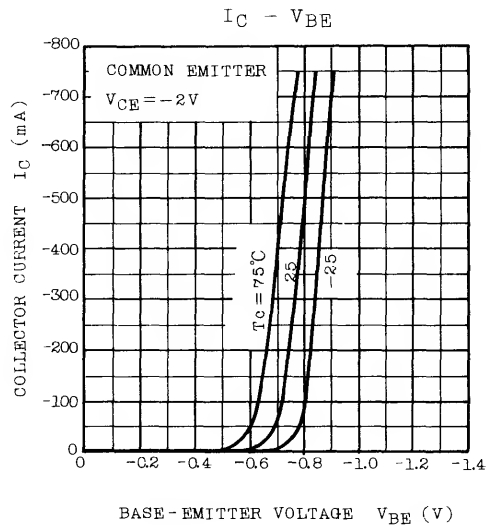
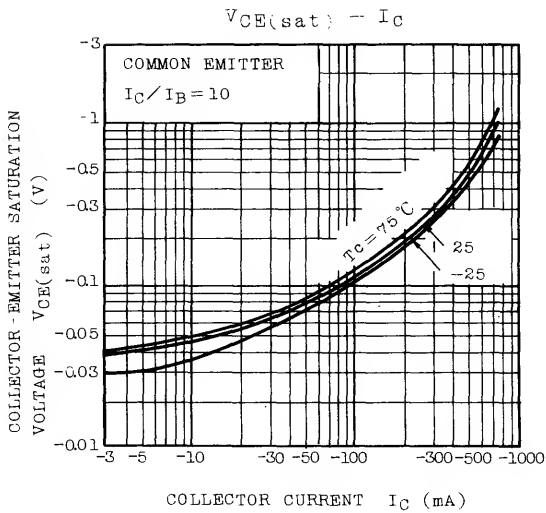
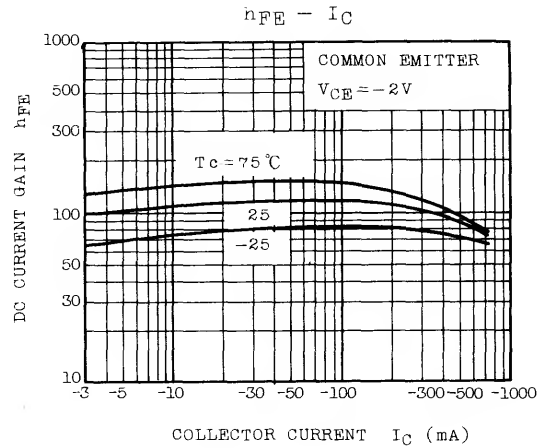
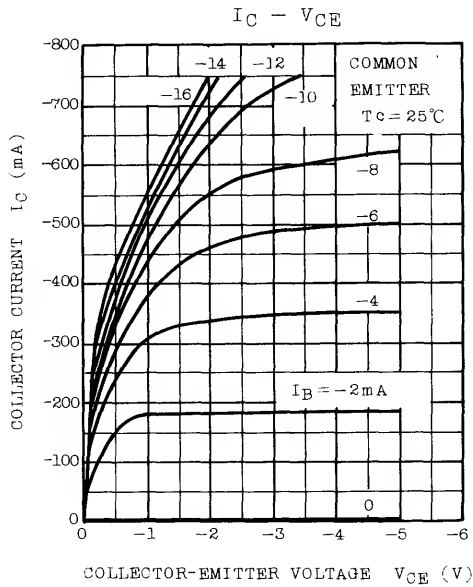
Weight : 1.4g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	-80	V
Collector-Emitter Voltage	V _{CEO}	-80	V
Emitter-Base Voltage	V _{EB0}	-5	V
Collector Current	I _C	-750	mA
Base Current	I _B	-500	mA
Collector Power Dissipation	P _C	1.5	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =-30V, I _E =0	-	-	-0.5	μA
Emitter Cut-off Current	I _{EB0}	V _{EB} =-5V, I _C =0	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CEO}	I _C =-10mA, I _B =0	80	-	-	V
DC Current Gain	h _{FE} (1)	V _{CE} =-2V, I _C =-150mA	70	-	240	
	h _{FE} (2)	V _{CE} =-2V, I _C =-500mA	40	-	-	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =-500mA, I _B =-50mA	-	-	-0.5	V
Base-Emitter Voltage	V _{BE}	V _{CE} =-2V, I _C =-500mA	-	-	-1.0	V
Transition Frequency	f _T	V _{CE} =-2V, I _C =-150mA	50	100	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =-10V, I _E =0, f=1MHz	-	20	-	pF



S1377

SILICON NPN TRIPLE DIFFUSED TYPE (PCT PROCESS)

MEDIUM POWER AMPLIFIER APPLICATIONS.
TV HORIZONTAL DRIVER APPLICATIONS.

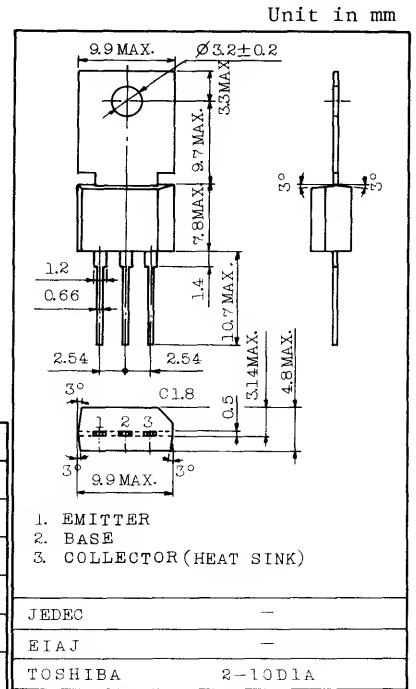
FEATURES:

- High Collector to Emitter Breakdown Voltage

$$V_{CEO}=250V$$

MAXIMUM RATINGS (Ta=25°C)

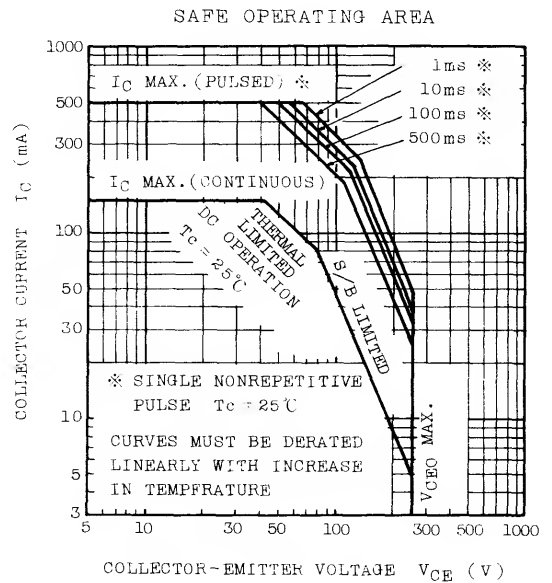
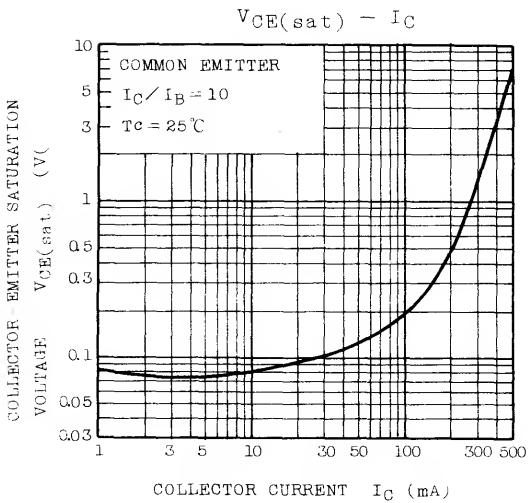
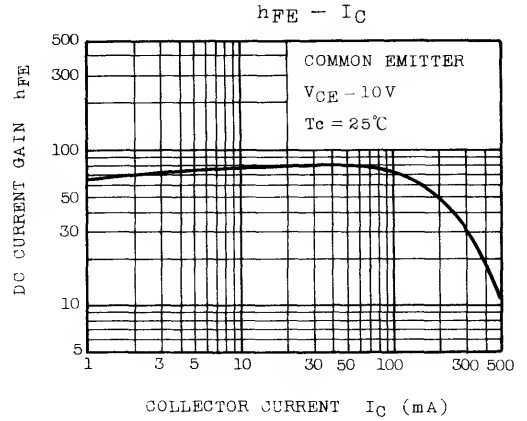
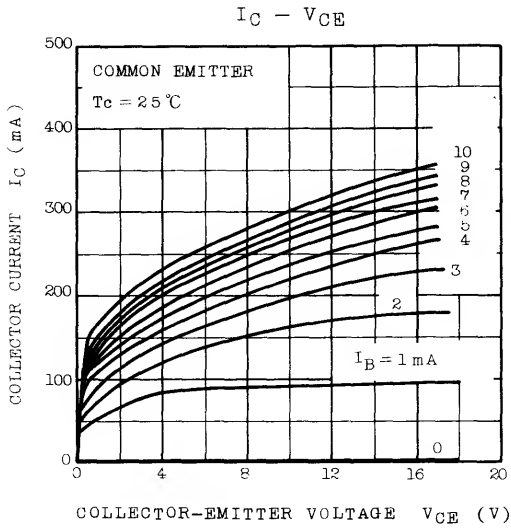
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	250	V
Collector-Emitter Voltage	V_{CEO}	250	V
Emitter-Base Voltage	V_{EBO}	6	V
Collector Current	I_C	500	mA
Base Current	I_B	250	mA
Collector Power Dissipation	P_C	Ta=25°C	1.5
		Tc=25°C	6.25
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_{stg}	-55 ~ 150	°C



Weight : 1.4g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CBO}	$V_{CB}=250V, I_E=0$	-	-	10	μA
Emitter Cut-off Current	I_{EBO}	$V_{EB}=6V, I_C=0$	-	-	10	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C=5mA, I_B=0$	250	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=10V, I_C=100mA$	30	-	200	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=200mA, I_B=20mA$	-	-	3	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=200mA, I_B=20mA$	-	-	1.2	V
Transition Frequency	f_T	$V_{CE}=10V, I_C=100mA$	40	60	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=20V, I_E=0, f=1MHz$	-	-	7	pF



S1732

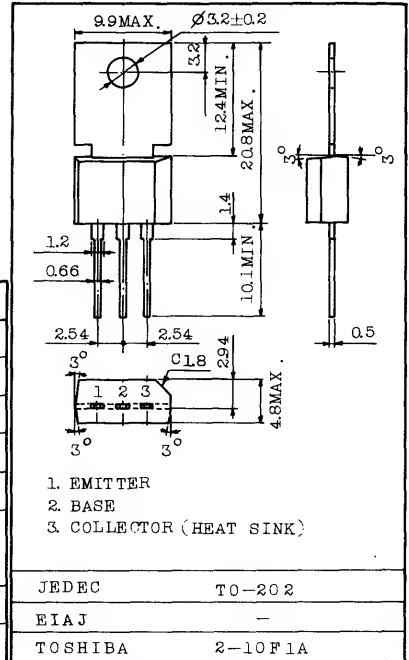
SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

MEDIUM POWER AMPLIFIER APPLICATIONS.
TV HORIZONTAL DRIVER APPLICATIONS.

Unit in mm

MAXIMUM RATINGS (Ta=25°C)

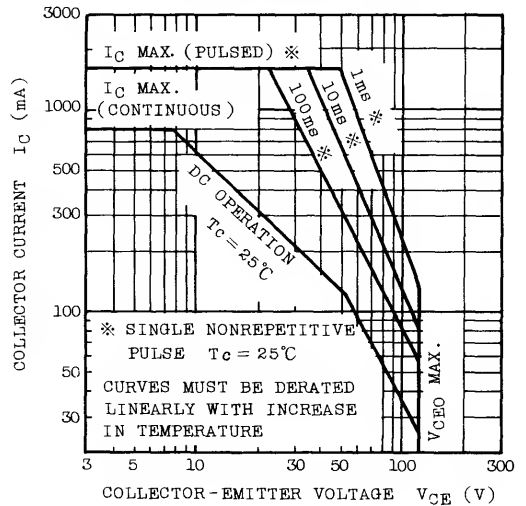
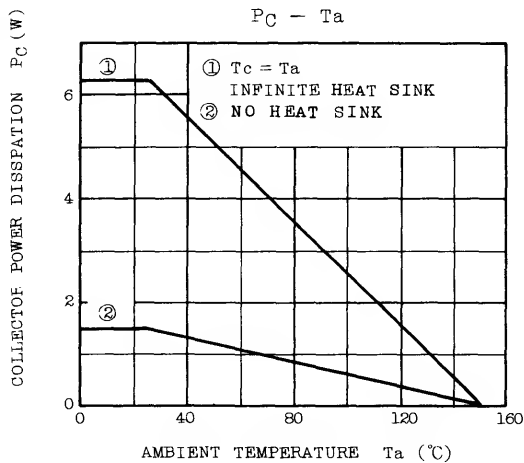
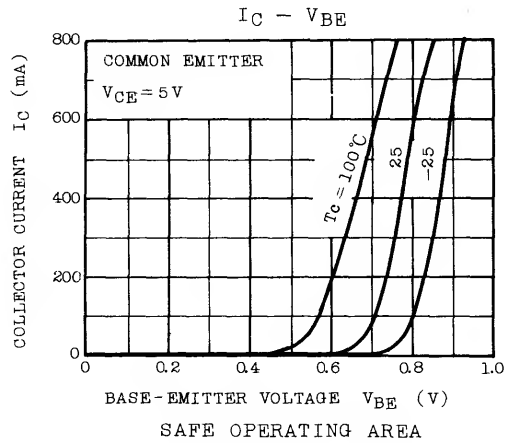
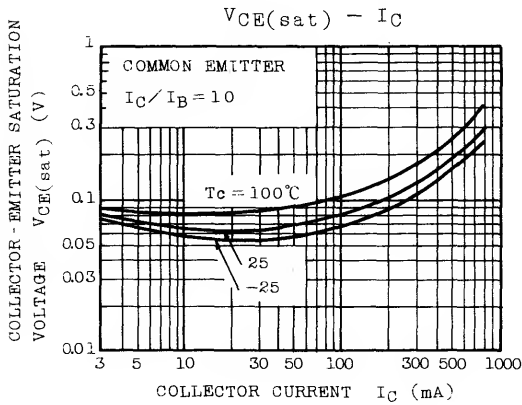
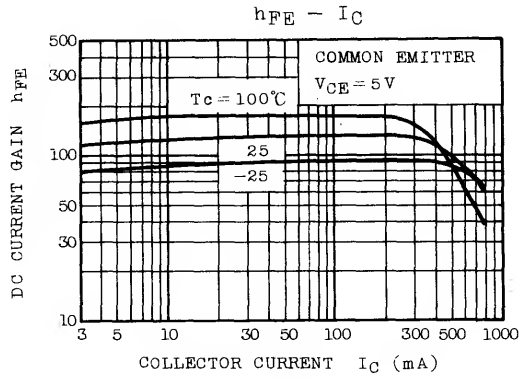
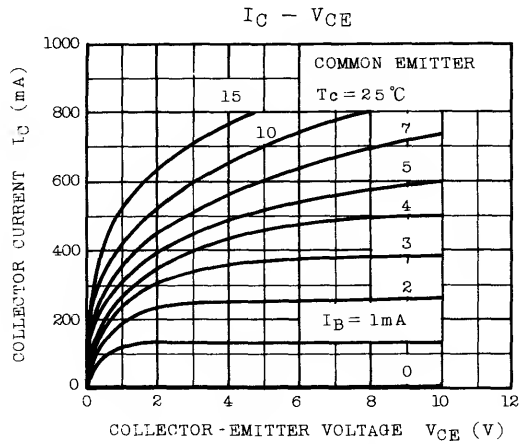
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	200	V
Collector-Emitter Voltage	V _{CEO}	120	V
Emitter-Base Voltage	V _{EBO}	6	V
Collector Current	I _C	800	mA
Base Current	I _B	500	mA
Collector Power Dissipation	P _C	Ta=25°C	1.5
		Tc=25°C	6.25
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55 ~ 150	°C



Weight : 1.4g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =200V, I _E =0	-	-	10	μA
Emitter Cut-off Current	I _{EBO}	V _{EB} =6V, I _C =0	-	-	1	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CEO}	I _C =10mA, I _B =0	120	-	-	V
DC Current Gain	h _{FE} (1)	V _{CE} =5V, I _C =100mA	60	-	250	
	h _{FE} (2)	V _{CE} =5V, I _C =400mA	40	-	-	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =500mA, I _B =50mA	-	-	1	V
Base-Emitter Saturation Voltage	V _{BE(sat)}	I _C =500mA, I _B =50mA	-	-	1.5	V
Transition Frequency	f _T	V _{CE} =5V, I _E =100mA	30	50	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	-	30	pF



S1954

SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

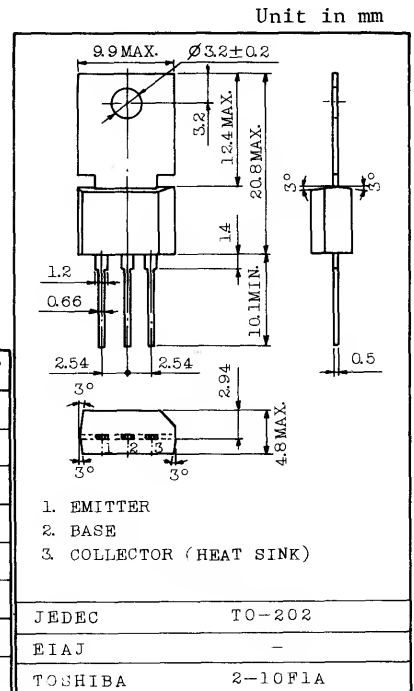
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Suitable for TV Sound Output, Vert. Deflection Output.
- . Designed for Complementary Use with S1955.

MAXIMUM RATINGS (Ta=25°C)

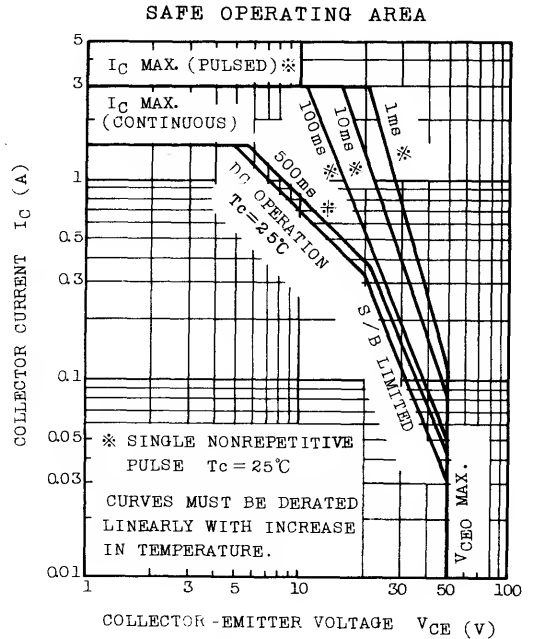
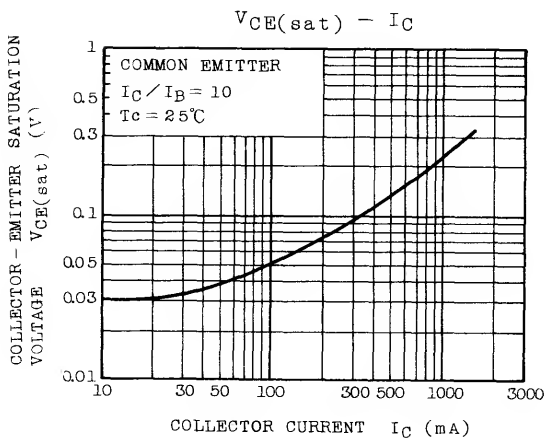
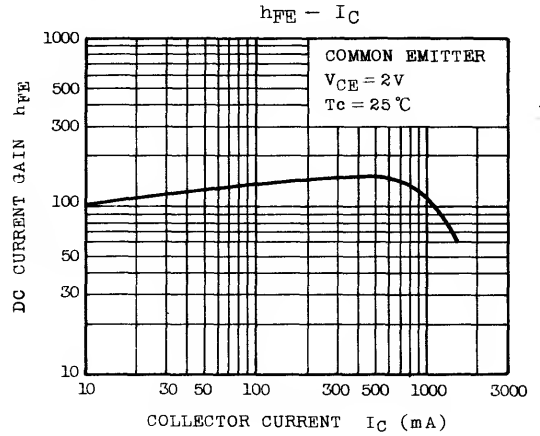
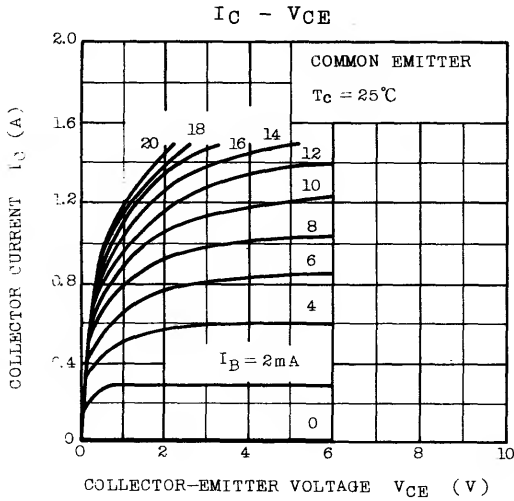
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CB0}	60	V
Collector-Emitter Voltage	V _{CEO}	50	V
Emitter-Base Voltage	V _{EB0}	5	V
Collector Current	I _C	1.5	A
Emitter Current	I _E	-1.5	A
Collector Power Dissipation	P _C	1.5	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-55 ~ 150	°C



Weight : 1.4g

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I _{CB0}	V _{CB} =50V, I _E =0	-	-	1.0	μA
Emitter Cut-off Current	I _{EB0}	V _{EB} =5V, I _C =0	-	-	1.0	μA
Collector-Emitter Breakdown Voltage	V _{(BR)CEO}	I _C =10mA, I _B =0	50	-	-	V
DC Current Gain	h _{FE}	V _{CE} =2V, I _C =150mA	70	-	240	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C =1A, I _B =0.1A	-	-	1.0	V
Base-Emitter Voltage	V _{BE}	V _{CE} =10V, I _C =10mA	0.50	0.60	0.70	V
Transition Frequency	f _T	V _{CE} =10V, I _C =100mA	50	100	-	MHz
Collector Output Capacitance	C _{ob}	V _{CB} =10V, I _E =0, f=1MHz	-	20	-	pF



S1955

SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

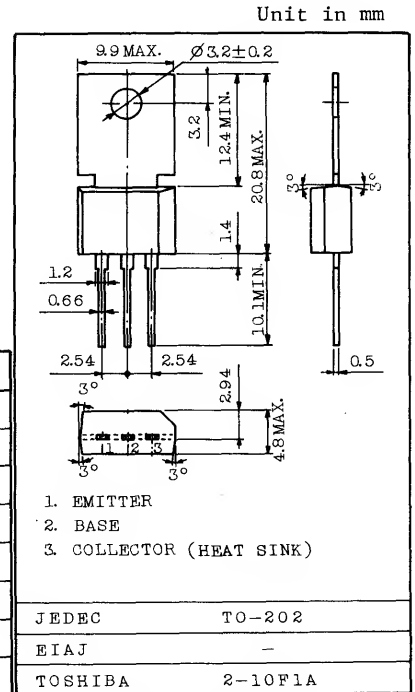
POWER AMPLIFIER APPLICATIONS.

FEATURES:

- . Suitable for TV Sound Output, Vert. Deflection Output.
- . Designed for Complementary Use with S1954.

MAXIMUM RATINGS ($T_a=25^{\circ}\text{C}$)

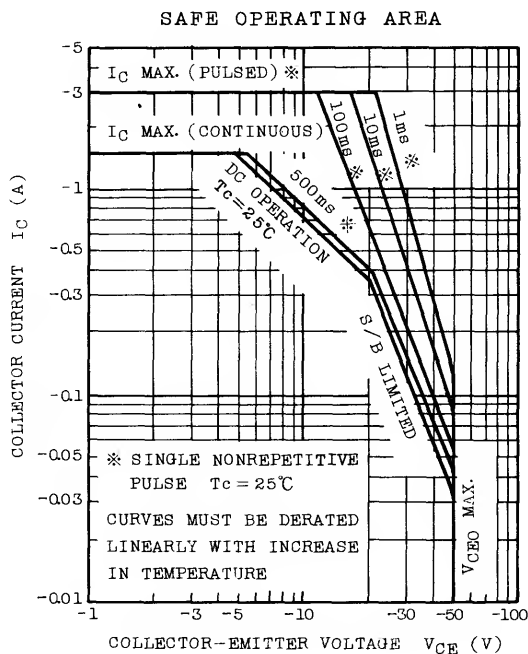
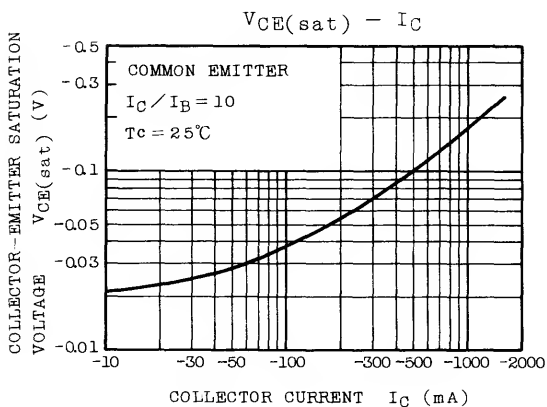
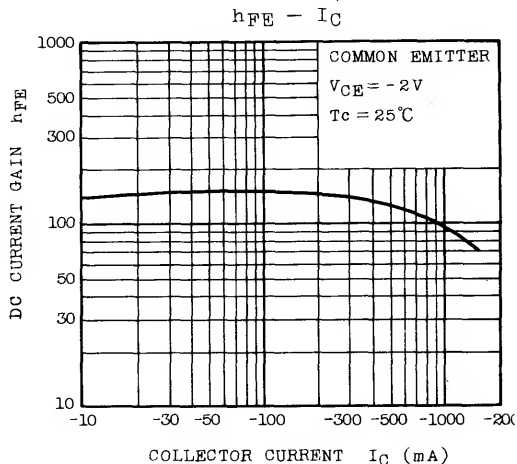
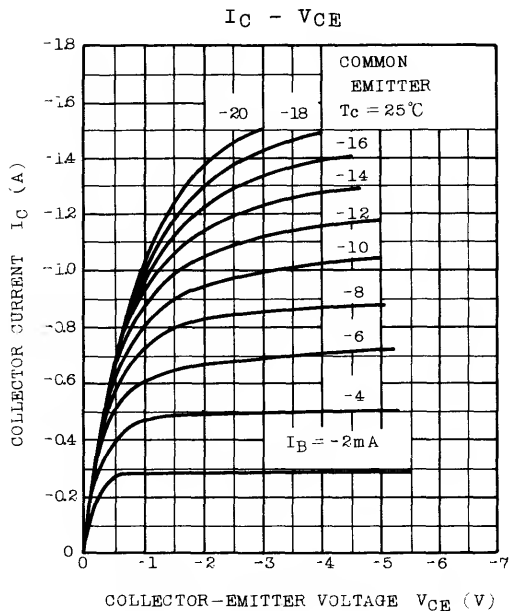
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	-60	V
Collector-Emitter Voltage	V_{CE0}	-50	V
Emitter-Base Voltage	V_{EB0}	-5	V
Collector Current	I_C	-1.5	A
Emitter Current	I_E	1.5	A
Collector Power Dissipation	P_C	1.5	W
Junction Temperature	T_j	150	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	-55 ~ 150	$^{\circ}\text{C}$



Weight : 1.4g

ELECTRICAL CHARACTERISTICS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CB0}	$V_{CB}=-50\text{V}, I_E=0$	-	-	-1.0	μA
Emitter Cut-off Current	I_{EB0}	$V_{EB}=-5\text{V}, I_C=0$	-	-	-1.0	μA
Collector-Emitter Breakdown Voltage	$V_{(BR)CE0}$	$I_C=-10\text{mA}, I_B=0$	-50	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=-2\text{V}, I_C=-150\text{mA}$	70	-	240	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=-1\text{A}, I_B=-0.1\text{A}$	-	-	-1.0	V
Base-Emitter Voltage	V_{BE}	$V_{CE}=-10\text{V}, I_C=-10\text{mA}$	-0.50	-0.60	-0.70	V
Transition Frequency	f_T	$V_{CE}=-10\text{V}, I_C=-100\text{mA}$	50	100	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=-10\text{V}, I_E=0, f=1\text{MHz}$	-	30	-	pF



S2000

SILICON NPNTRIPL E DIFFUSED MESA TYPE

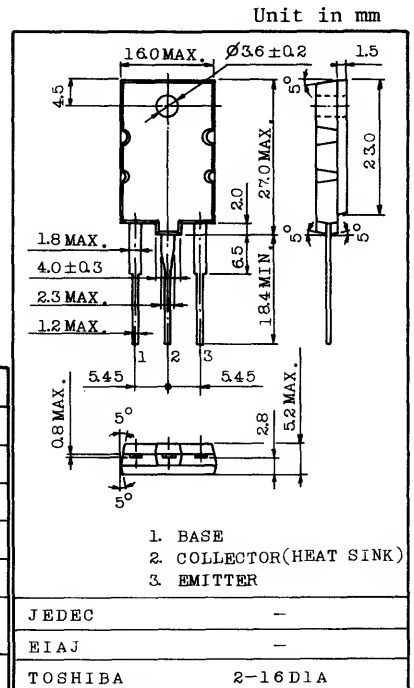
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.
 COLOR TV SWITCHING REGULATOR APPLICATIONS.

FEATURES:

- High Voltage : $V_{CES}=1500V$
- Low Saturation Voltage : $V_{CE(sat)}=5V$ (Max.)
- Fall Time : $t_f=0.7\mu s$ (Typ.)
- Glass Passivated Collector-Base Junction

MAXIMUM RATINGS ($T_a=25^\circ C$)

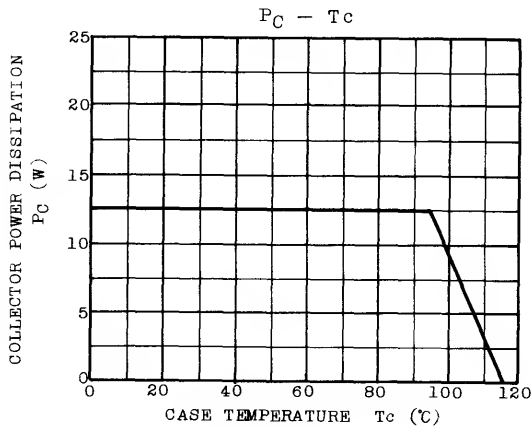
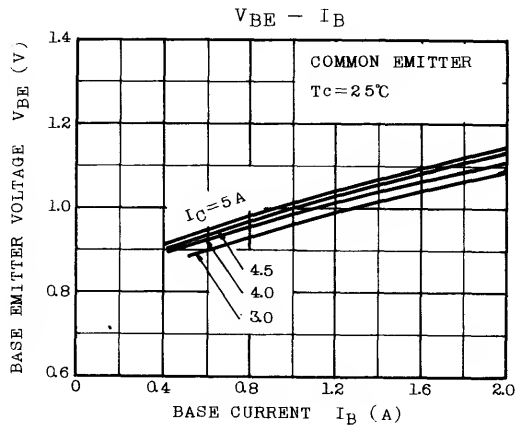
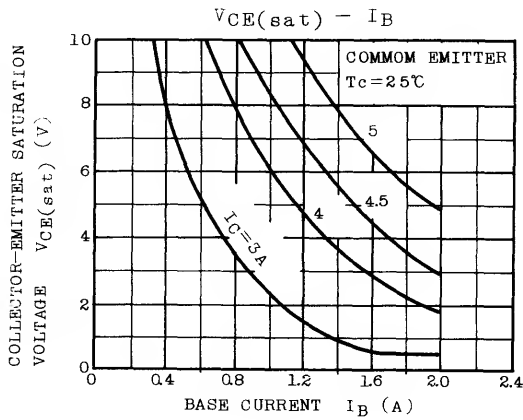
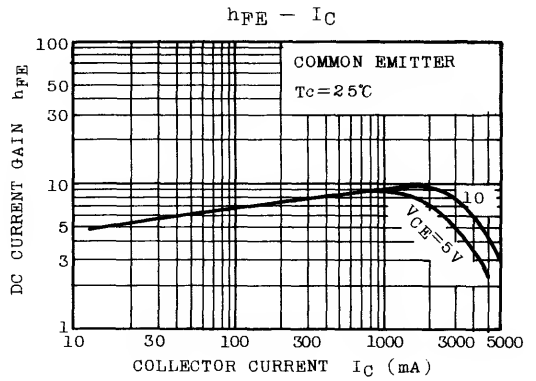
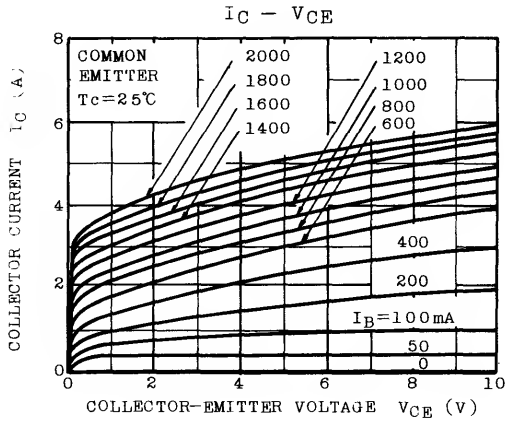
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Emitter Voltage	V_{CES}	1500	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	DC	I_C	5 A
	Peak	I_{CM}	7.5 A
Base Current (Peak)	I_{BM}	4	A
Total Power Dissipation ($T_c \leq 95^\circ C$)	P_{tot}	12.5	W
Junction Temperature	T_j	+115	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ 115	$^\circ C$
Thermal Resistance	$R_{th(j-c)}$	1.6	$^\circ C/W$



Weight : 5.2g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CES}	$V_{CE}=1500V, V_{BE}=0$	-	-	1	mA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA, I_C=0$	5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=4.5A$	2.25	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4.5A, I_B=2A$	-	-	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4.5A, I_B=2A$	-	-	1.5	V
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	$I_C=100mA, I_B=0, L=25mH$	700	-	-	V
Transition Frequency	f_T	$V_{CE}=5V, I_C=0.1A$	-	7	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	125	-	pF
Switching Time	Fall Time	t_f	-	0.7	-	μs
	Storage Time	t_{stg}	-	10	-	μs



S2000A

SILICON NPN TRIPLE DIFFUSED MESA TYPE

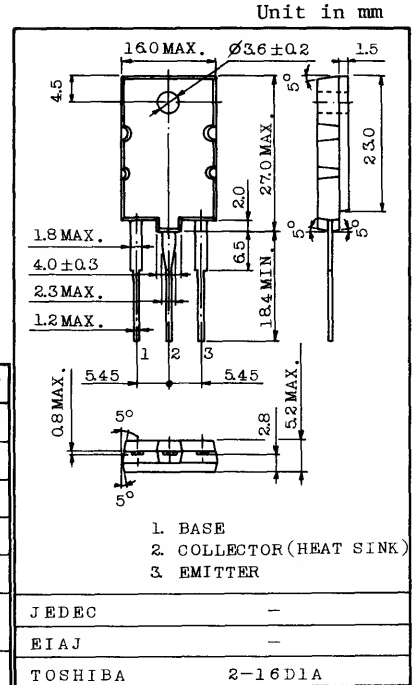
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.
 COLOR TV SWITCHING REGULATOR APPLICATIONS.

FEATURES:

- . High Voltage : $V_{CES}=1500V$
- . Low Saturation Voltage : $V_{CE(sat)}=1V$ (Max.)
- . Fall Time : $t_f=0.7\mu s$ (Typ.)
- . Glass Passivated Collector-Base Junction

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Emitter Voltage	V_{CES}	1500	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	DC	I_C	5 A
	Peak	I_{CM}	7.5 A
Base Current (Peak)	I_{BM}	4	A
Total Power Dissipation ($T_c \leq 95^\circ C$)	P_{tot}	12.5	W
Junction Temperature	T_j	+115	$^\circ C$
Storage Temperature Range	T_{stg}	-55 ~ +115	$^\circ C$
Thermal Resistance	$R_{th(j-c)}$	1.6	$^\circ C/W$

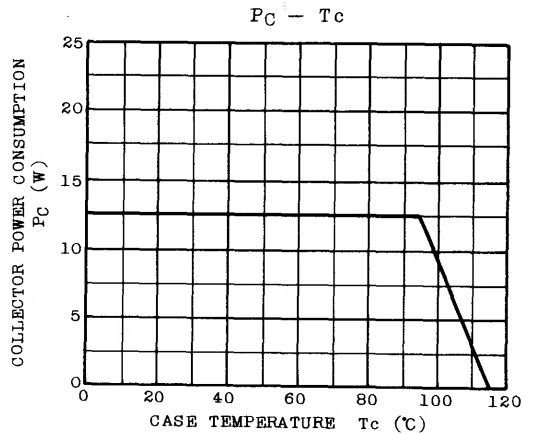
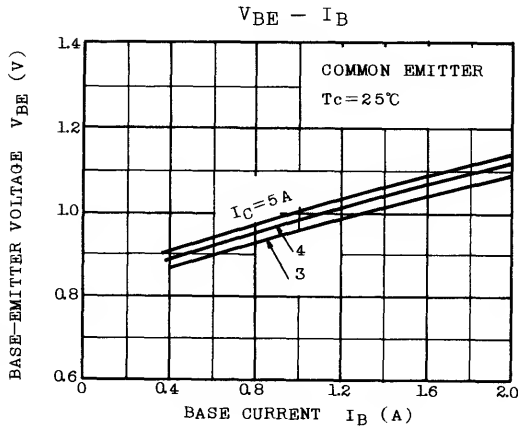
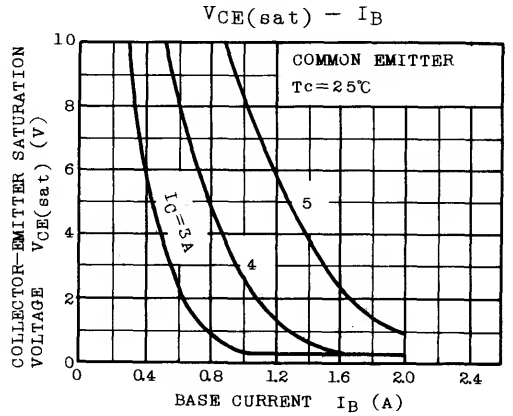
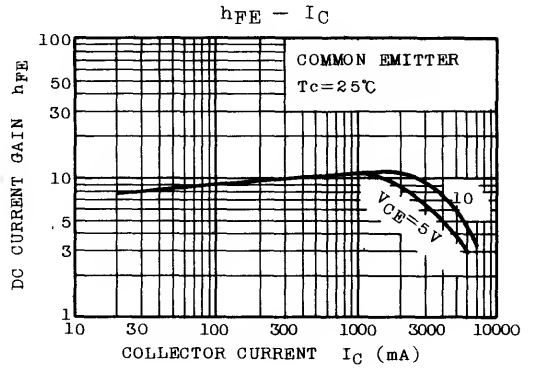
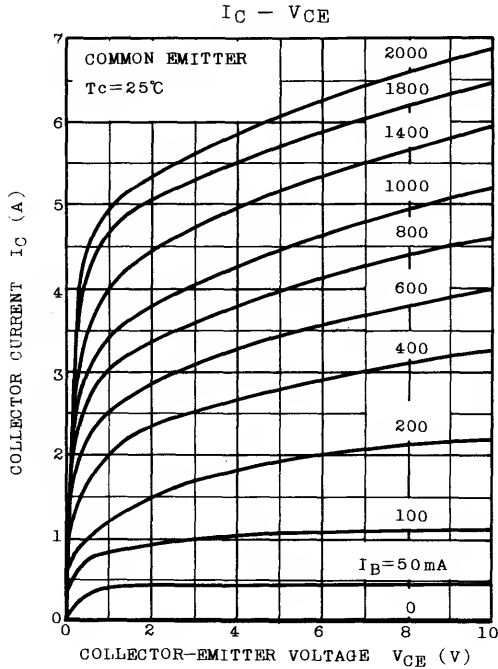


JEDEC	-
EIAJ	-
TOSHIBA	2-16D1A

Weight : 5.2g

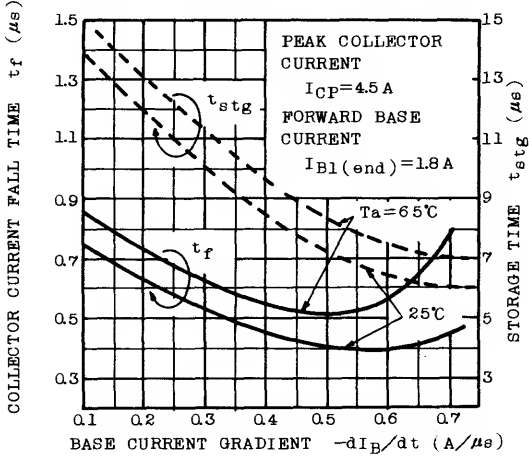
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CES}	$V_{CE}=1500V, V_{BE}=0$	-	-	1	mA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=1mA, I_C=0$	5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=4.5A$	2.25	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4.5A, I_B=2A$	-	-	1	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4.5A, I_B=2A$	-	-	1.5	V
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	$I_C=100mA, I_B=0, L=25mH$	700	-	-	V
Transition Frequency	f_T	$V_{CE}=5V, I_C=0.1A$	-	7	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	125	-	pF
Switching Time	Fall Time	t_f	-	0.7	-	μs
	Storage Time	t_{stg}	-	10	-	μs

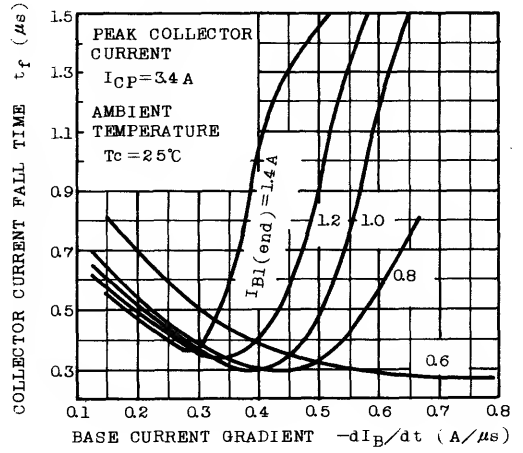


S2000A

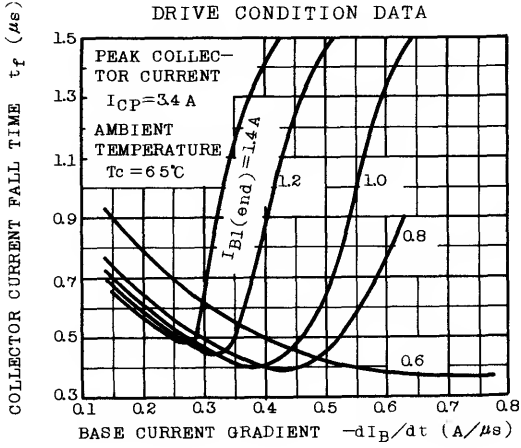
TYPICAL DRIVE CONDITION DATA



DRIVE CONDITION DATA



DRIVE CONDITION DATA



S2054

SILICON NPN TRIPLE DIFFUSED MESA TYPE

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

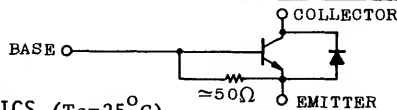
FEATURES:

- . High Voltage : $V_{CES}=1500V$
- . Low Saturation Voltage : $V_{CE(sat)}=4V(\text{Typ.})$
- . High Speed : $t_f=0.7\mu s(\text{Typ.})$
- . Built-in Damper Type.
- . Glass Passivated Base-Collector Junction.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Emitter Voltage		V_{CES}	1500	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current	DC	I_C	3.5	A
	Peak	I_{CM}	4	A
Base Current (Peak)		I_{BM}	2	A
Total Power Dissipation ($T_c \leq 95^\circ C$)		P_{tot}	10	W
Junction Temperature		T_j	+115	$^\circ C$
Storage Temperature Range		T_{stg}	-65 ~ 115	$^\circ C$
Thermal Resistance		$R_{th(j-c)}$	1.6	$^\circ C/W$

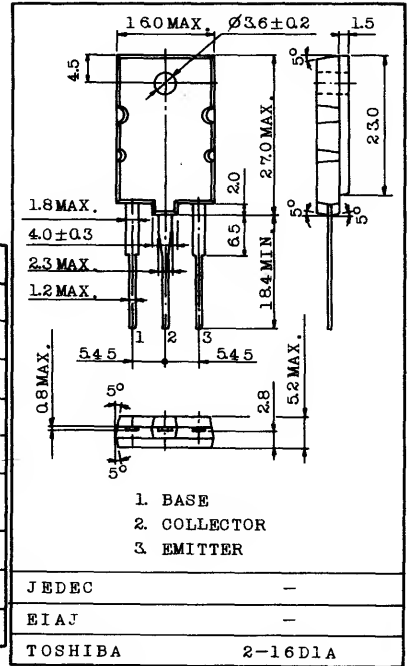
EQUIVALENT CIRCUIT

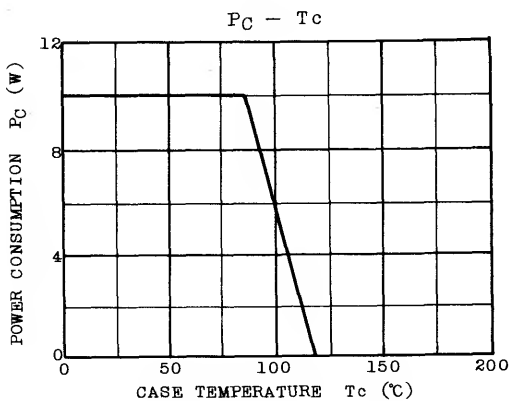
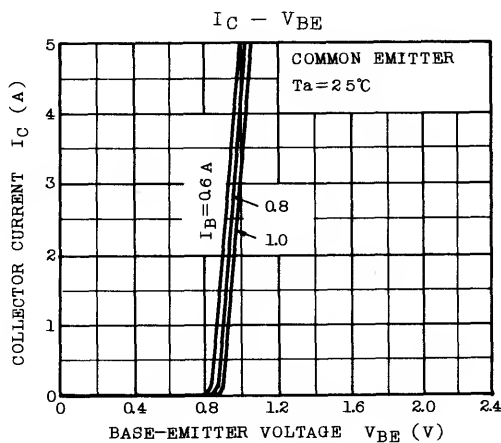
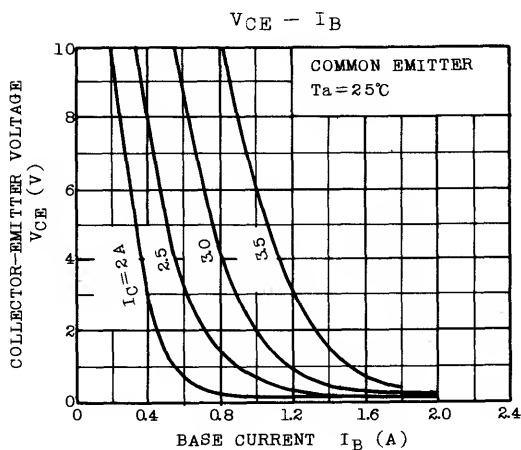
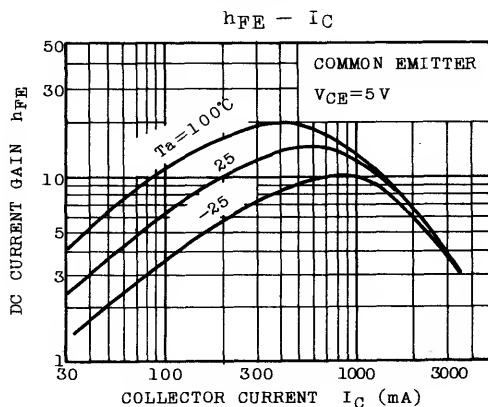
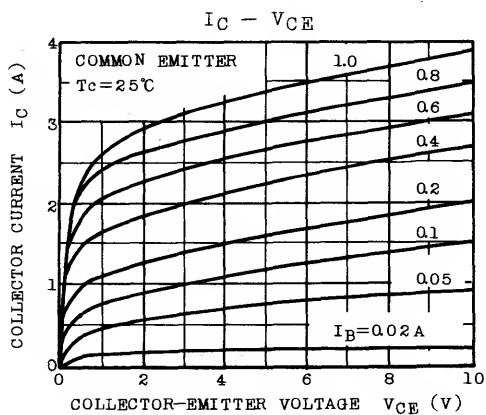


ELECTRICAL CHARACTERISTICS ($T_c=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CES}	$V_{BE}=0, V_{CE}=1500V$	-	-	1	mA
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	$I_C=0, I_E=200mA$	5	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=0.5A$	8	12	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=3A, I_B=0.8A$	-	4	8	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=3A, I_B=0.8A$	-	-	1.5	V
Forward Voltage (Diode)		$-V_F$	$I_F=3.5A$	-	1.4	2.0	V
Collector-Emitter Sustaining Voltage		$V_{CE(SUS)}$	$I_B=0, I_C=100mA, L=25mH$	700	-	-	V
Transition Frequency		f_T	$V_{CE}=5V, V_{IC}=0.1A$	-	7	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	95	-	pF
Switching Time	Fall Time	t_f	$I_{CM}=3A, I_{B(end)}=0.8A$	-	0.7	1.0	μs
	Storage Time	t_{stg}		-	7	-	

Unit in mm





S2055 S2055A

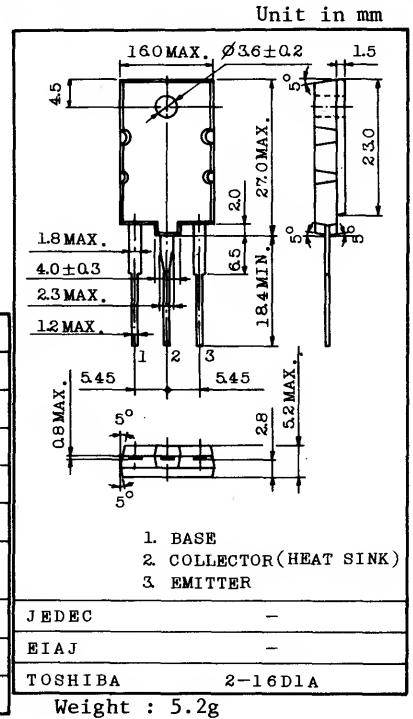
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

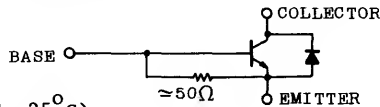
- . High Voltage : $V_{CES}=1500V$
- . Low Saturation Voltage : $V_{CE(sat)}=1V(\text{Max.})$ (S2055A)
- . Fall Time : $t_f=0.7\mu s$ (Typ.)
- . Built-in Damper Type
- . Glass Passivated Collector-Base Junction

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Emitter Voltage	V_{CES}	1500	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	DC	I_C	5 A
	Peak	I_{CM}	7.5 A
Base Current (Peak)	I_{BM}	4	A
Total Power Dissipation ($T_c \leq 95^\circ C$)	P_{tot}	12.5	W
Junction Temperature	T_j	+115	$^\circ C$
Storage Temperature Range	T_{stg}	-65 ~ 115	$^\circ C$
Thermal Resistance	$R_{th(j-c)}$	1.6	$^\circ C/W$



EQUIVALENT CIRCUIT



ELECTRICAL CHARACTERISTICS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CES}	$V_{CE}=1500V, V_{BE}=0$	-	-	1	mA
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=200mA, I_C=0$	5	-	-	V
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=4.5A$	2.25	-	-	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=4.5A, I_B=2A$	-	-	5	V
			-	-	1	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=4.5A, I_B=2A$	-	-	1.5	V
Forward Voltage (Diode)	$-V_F$	$I_F=5A$	-	1.4	2.0	V
Collector-Emitter Sustaining Voltage	$V_{CE(SUS)}$	$I_C=100mA, I_B=0$ $L=25mH$	700	-	-	V
Transition Frequency	f_T	$V_{CE}=5V, I_C=0.1A$	-	7	-	MHz
Collector Output Capacitance	C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	125	-	pF
Switching Time	Fall Time	t_f	-	0.7	-	μs
	Storage Time	t_{stg}	-	10	-	μs

S2056

SILICON NPN TRIPLE DIFFUSED MESA TYPE

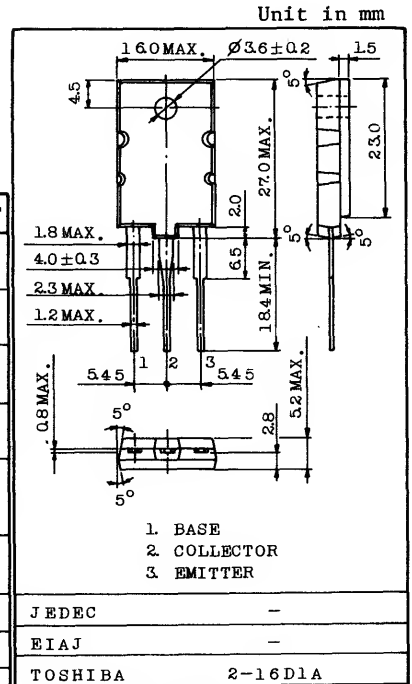
TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

- High Voltage : $V_{CES}=1500V$
- High Speed : $t_f=0.75\mu s$ (Typ.)
- Glass Passivated Collector-Base Junction

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Emitter Voltage ($V_{BE}=0V$)		V_{CES}	1500	V
Collector-Emitter Voltage ($R_{BE}=100\Omega$)		V_{CER}	1500	V
Transient Collector-Emitter Voltage (Flash-over)		V_{CE} (Flash-over)	1650	V
Collector-Emitter Voltage (Open Base)		V_{CEO}	700	V
Collector Current	DC	I_C	2.5	A
	Peak	I_{CM}	3	A
Transient Collector Current (Flash-over)		I_C (Flash-over)	5	A
Base Current (Peak)		I_{BM}	2.5	A
Reverse Base Current	DC	$-I_B$	100	mA
	Peak	$-I_{BM}$	1.5	A
Collector Power Dissipation ($T_c \leq 90^\circ C$)		P_C	10	W
Junction Temperature		T_j	115	$^\circ C$
Storage Temperature Range		T_{stg}	-65 ~ 115	$^\circ C$



ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current	I_{CES}	$V_{BE}=0, V_{CE}=V_{CES}$	-	-	1	mA
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=2A$	2	-	-	
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E=100mA$	5	-	-	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=2A, I_B=1A$	-	-	5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C=2A, I_B=1A$	-	-	1.5	V
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	$I_C=100mA, L=25mH$	700	-	-	V
Fall Time	t_f	$I_{CP}=2A, I_B(end)=1A$	-	0.75	-	μs
Collector Output Capacitance	C_{Ob}	$V_{CB}=10V, f=1MHz$	-	95	-	pF
Transition Frequency	f_T	$V_{CE}=5V, f=5MHz, I_C=0.1A$	-	3	-	MHz

COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

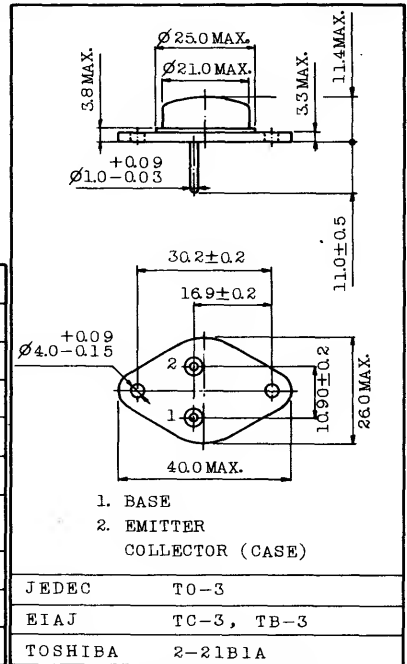
Unit in mm

FEATURES:

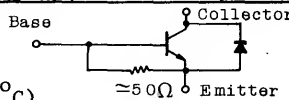
- . High Voltage : $V_{CES}=1500V$
- . Low Saturation Voltage : $V_{CE(sat)}=1V$ (Max.) (S2818A)
- . High Speed : $t_f=0.7\mu s$ (Typ.)
- . Built-in Damper Type.
- . Glass Passivated Collector-Base Junction.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Emitter Voltage		V_{CES}	1500	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current	DC	I_C	5	A
	Peak	I_{CM}	7.5	A
Base Current (Peak)		I_{BM}	4	A
Total Power Dissipation ($T_c \leq 95^\circ C$)		P_{tot}	12.5	W
Junction Temperature		T_j	+115	$^\circ C$
Storage Temperature Range		T_{stg}	-65 ~ 115	$^\circ C$
Thermal Resistance		$R_{th(j-c)}$	1.6	$^\circ C/W$



EQUIVALENT CIRCUIT



Mounting Kit No. AC42C

Weight : 17.0g

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CES}	$V_{CE}=1500V, V_{BE}=0$	-	-	1	mA
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	$I_E=200mA, I_C=0$	5	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=4.5A$	2.25	-	-	
Collector-Emitter Saturation Voltage	S2818	$V_{CE(sat)}$	$I_C=4.5A, I_B=2A$	-	-	5	V
	S2818A			-	-	1	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=4.5A, I_B=2A$	-	-	1.5	V
Forward Voltage (Diode)		$-V_F$	$I_F=5A$	-	1.4	2.0	V
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	$I_C=100mA, I_B=0, L=25mH$	700	-	-	V
Transition Frequency		f_T	$V_{CE}=5V, I_C=0.1A$	-	7	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	125	-	pF
Switching Time	Fall Time	t_f	$I_{CM}=4.5A, I_{B(end)}=1.8A$	-	0.7	-	μs
	Storage Time	t_{stg}	$I_{CM}=4.5A, I_{B(end)}=1.8A$	-	10	-	μs

S2824

SILICON NPN TRIPLE DIFFUSED MESA TYPE

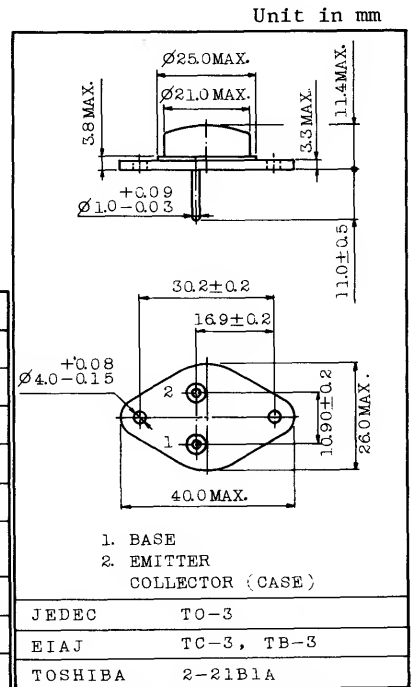
COLOR TV HORIZONTAL OUTPUT APPLICATIONS.

FEATURES:

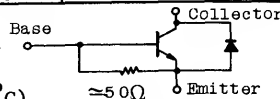
- High Voltage : $V_{CES}=1500V$
- Low Saturation Voltage : $V_{CE(sat)}=5V(\text{Max.})$
- High Speed : $t_f=0.7\mu s(\text{Typ.})$
- Built-in Damper Type.
- Glass Passivated Collector-Base Junction.

MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Emitter Voltage		V_{CES}	1500	V
Emitter-Base Voltage		V_{EBO}	5	V
Collector Current	DC	I_C	2.5	A
	Peak	I_{CM}	3	A
Base Current (Peak)		I_{BM}	2.5	A
Total Power Dissipation ($T_c \leq 95^\circ C$)		P_{tot}	10	W
Junction Temperature		T_j	+115	$^\circ C$
Storage Temperature Range		T_{stg}	-65 ~ 115	$^\circ C$
Thermal Resistance		$R_{th(j-c)}$	1.6	$^\circ C/W$



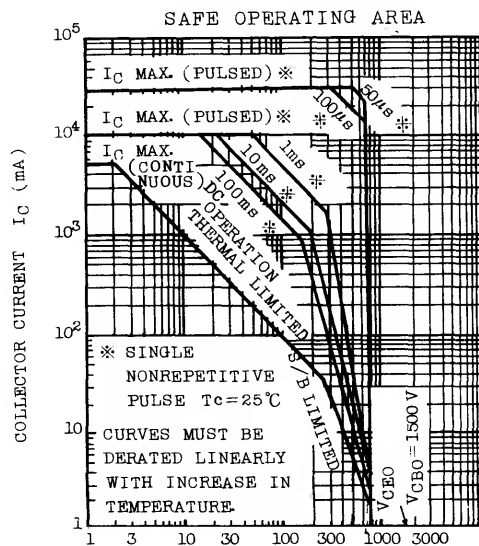
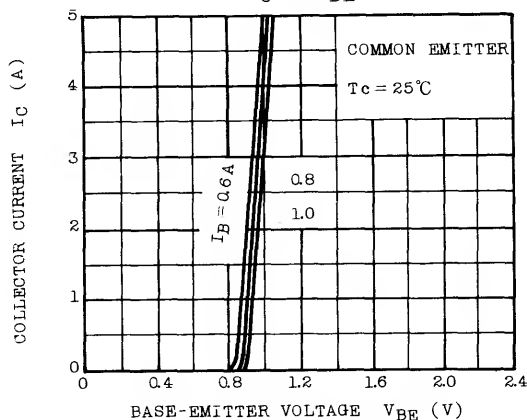
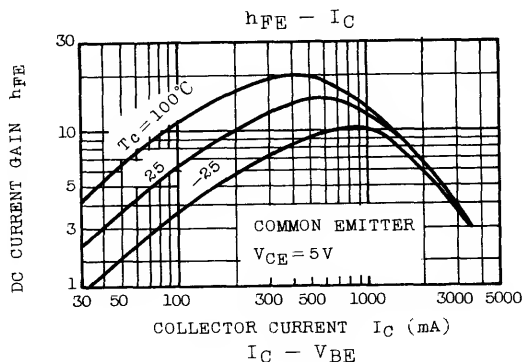
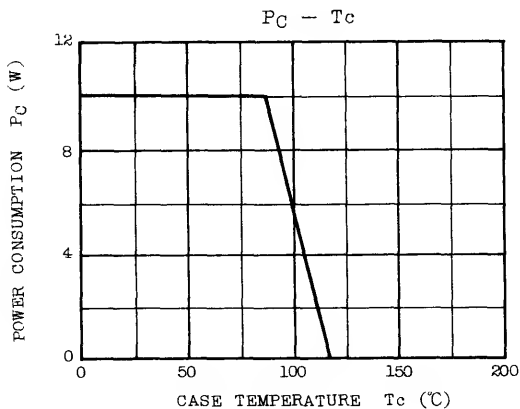
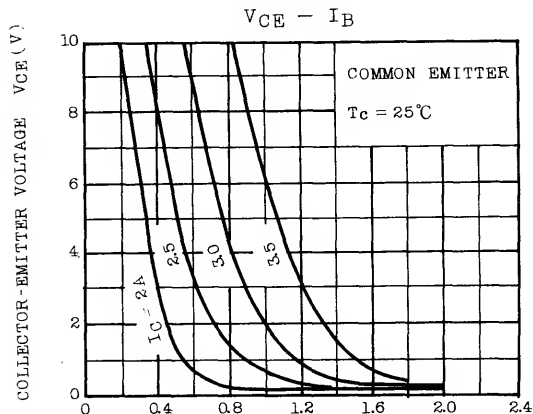
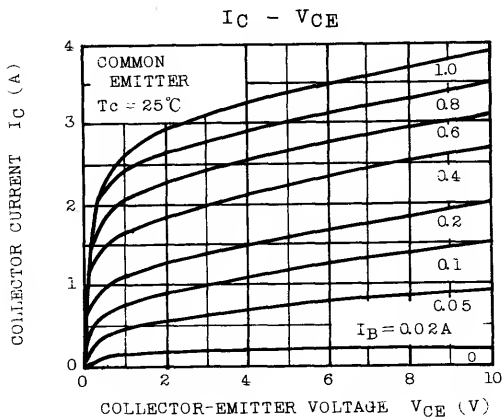
EQUIVALENT CIRCUIT



Mounting Kit No. AC42C
Weight : 17.0g

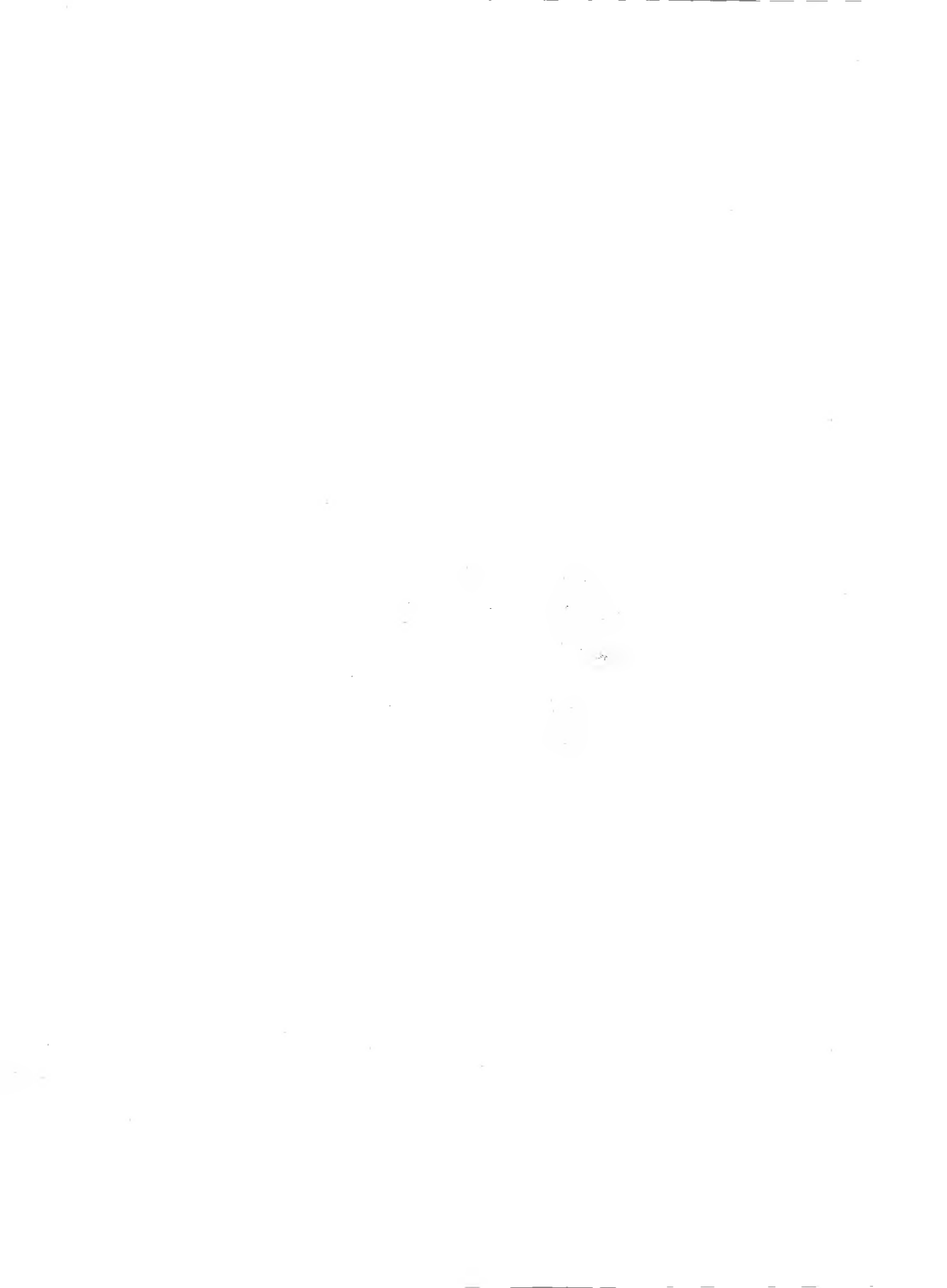
ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CES}	$V_{CE}=1500V, V_{BE}=0$	-	-	1	mA
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	$I_F=200mA, I_C=0$	5	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=2A$	2	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=2A, I_B=1A$	-	-	5	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	$I_C=2A, I_B=1A$	-	-	1.5	V
Forward Voltage (Diode)		$-V_F$	$I_F=3.5A$	-	1.4	2.0	V
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	$I_C=100mA, I_B=0, L=25mH$	700	-	-	V
Transition Frequency		f_T	$V_{CE}=5V, I_C=0.1A$	-	7	-	MHz
Collector Output Capacitance		C_{ob}	$V_{CB}=10V, I_E=0, f=1MHz$	-	95	-	pF
Switching Time	Fall Time	t_f	$I_{CM}=2A, I_B(\text{end})=1A$	-	0.7	1.0	μs
	Storage Time	t_{stg}	$I_{CM}=2A, I_B(\text{end})=1A$	-	7	-	μs





S-AU
SERIES



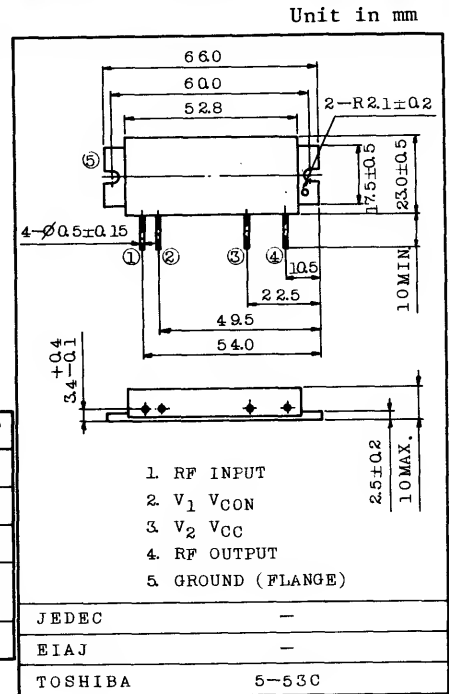
UHF POWER AMPLIFIER MODULE (HAM FM)

FEATURES:

- . Output Power : $P_o \cong 15W$
- . Minimum Gain : $G_p=18.7dB$
- . Efficiency : $\eta_T \cong 40\%$
- . 50Ω Input/Output Impedance
- . Guaranteed Stability

MAXIMUM RATINGS ($T_c=25^\circ C$)

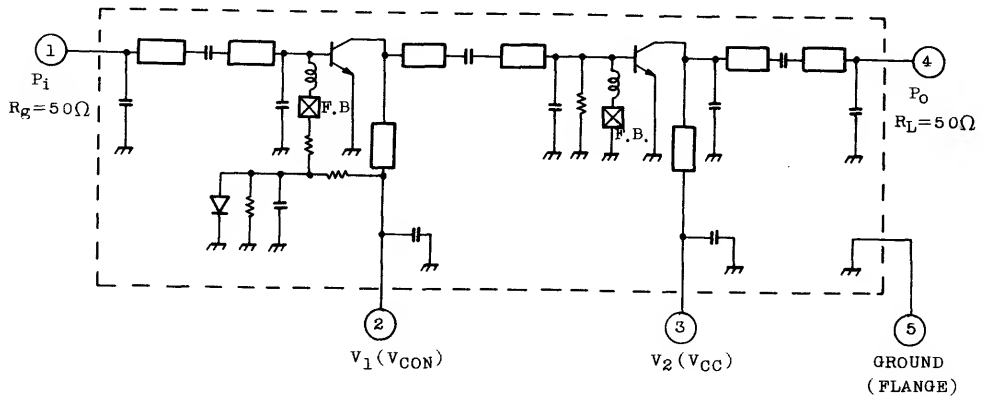
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{CC}	16	V
DC Supply Voltage	V_{CON}	16	V
RF Input Power	P_i	300	mW
Operating Case Temperature Range	$T_c(OP)$	-30 ~ 100	$^\circ C$
Storage Temperature Range	T_{stg}	-40 ~ 110	$^\circ C$



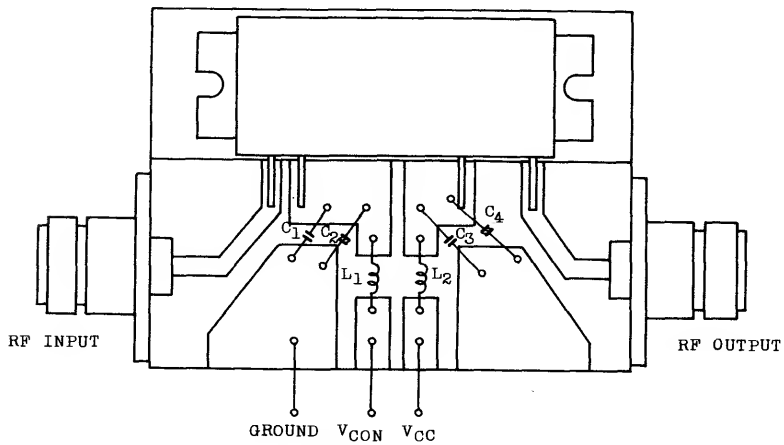
CHARACTERISTICS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range	f _{range}	-	430	-	450	MHz
Output Power	P_o	$P_i=200mW$ $V_{CC}=12.5V, V_{CON}=12.5V$ $Z_g=Z_1=50\Omega$	15	17	-	W
Power Gain	G_p		18.7	19.2	-	dB
Total Efficiency	η_T		40	50	-	%
Input VSWR	$VSWR_{in}$		-	1.5	2	-
Harmonics	HRM		-	-30	-25	dB
Load Mismatch	-	$V_{CC}=15V, V_{CON}=12.5V$ $P_i=200mW$ VSWR load 20:1 all phase	No Degradation			-
Stability	-	$V_{CC}=12.5V, P_i=200mW$ $V_{CON}=0 \sim 12.5V$ VSWR Load 3:1 all phase	All spurious output than 60dB below desired signal			-

SCHEMATIC



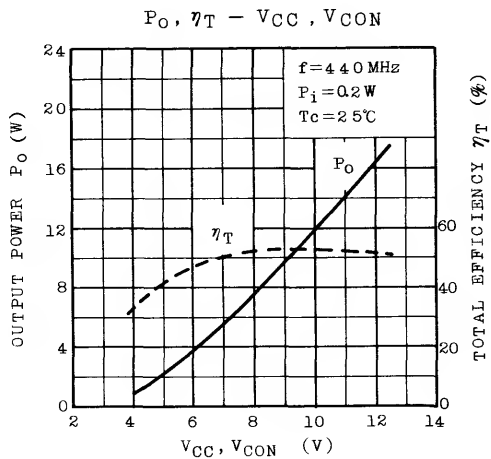
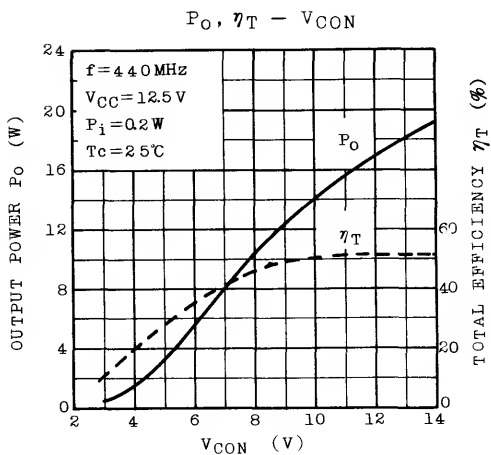
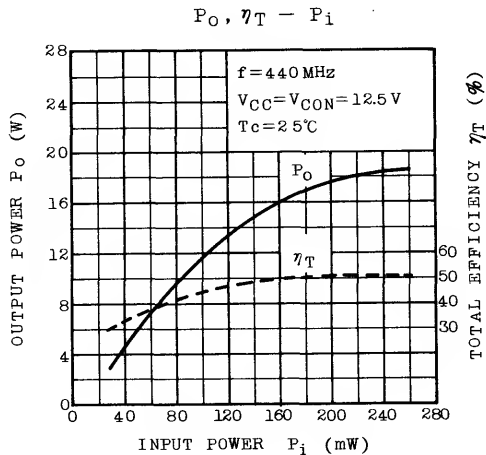
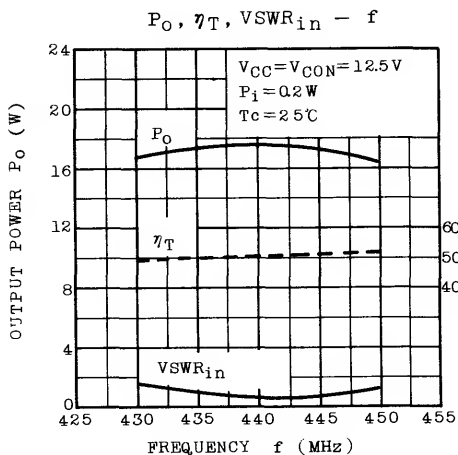
TEST MOUNT



$C_1, C_3 : 15000pF$

$C_2, C_4 : 1\mu F$

$L_1, L_2 : \varnothing 0.8$ COPPER WIRE 8T, 51D



S-AU4

TOSHIBA RF POWER AMPLIFIER MODULE

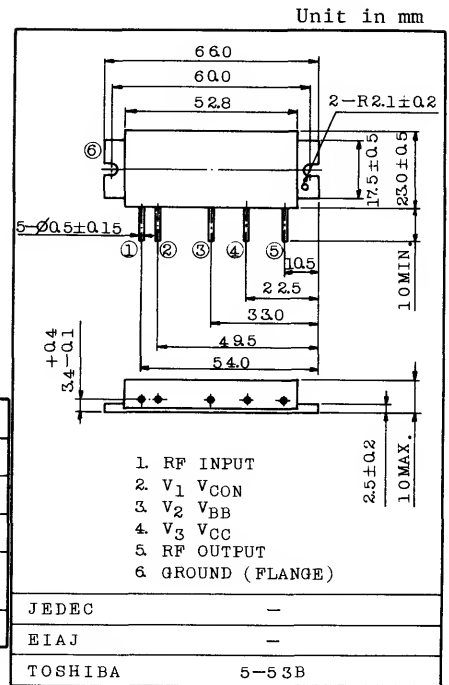
UHF POWER AMPLIFIER MODULE (HAM SSB/FM)

FEATURES:

- Output Power : $P_o \geq 17W$
- Minimum Gain : $G_p = 19.2dB$
- Efficiency : $\eta_T \geq 35\%$
- 50Ω Input/Output Impedance
- Guaranteed Stability

MAXIMUM RATINGS ($T_c = 25^\circ C$)

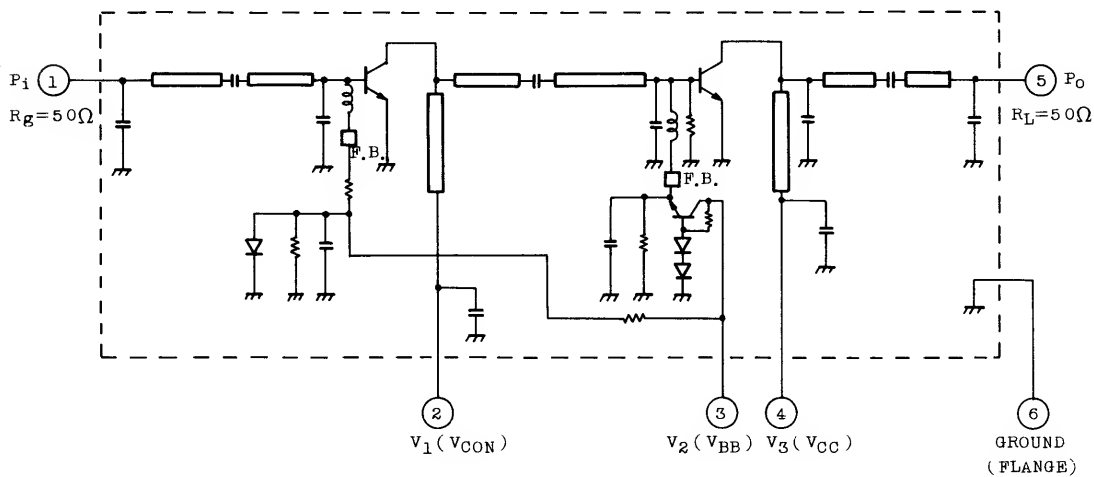
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{CC}	16	V
DC Supply Voltage	V_{CON}	16	V
RF Input Power	P_i	300	mW
Operating Case Temperature Range	$T_c(OP)$	-30 ~ 100	$^\circ C$
Storage Temperature Range	T_{stg}	-40 ~ 110	$^\circ C$



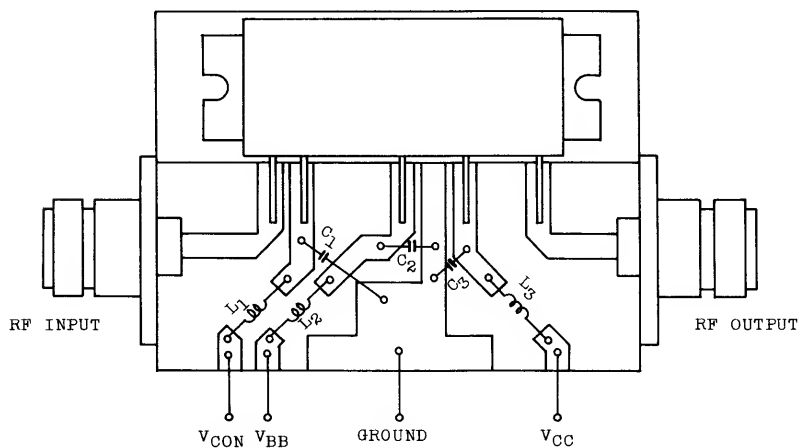
CHARACTERISTICS ($T_c = 25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range	f_{range}	-	430	-	450	MHz
Output Power	P_o	$P_i = 200mW$ $V_{CC} = 12.5V, V_{CON} = 12.5V$ $Z_g = Z_1 = 50\Omega$	17	20	-	W
Power Gain	G_p		19.2	20	-	dB
Total Efficiency	η_T		35	45	-	%
Input VSWR	$VSWR_{in}$		-	1.5	2	-
Harmonics	HRM		-	-30	-25	dB
Load Mismatch	-	$V_{CC} = 15V, V_{CON} = 12.5V$ $P_o = 20W$ VSWR load 20:1 all phase	No Degradation			-
Stability	-	$V_{CC} = 12.5V, P_i = 200mW$ $V_{CON} = 0 \sim 12.5V$ VSWR Load 3:1 all phase	All spurious output than 60dB below desired signal			-
Intermodulation Distortion Ratio	IMD	$f_1 = 440.000MHz, f_2 = 440.002MHz$ $V_{CC} = V_{CON} = 12.5V, V_{BB} = 9V$ $P_o = 13W_{pEP}$	-	-32	-	dB

SCHEMATIC

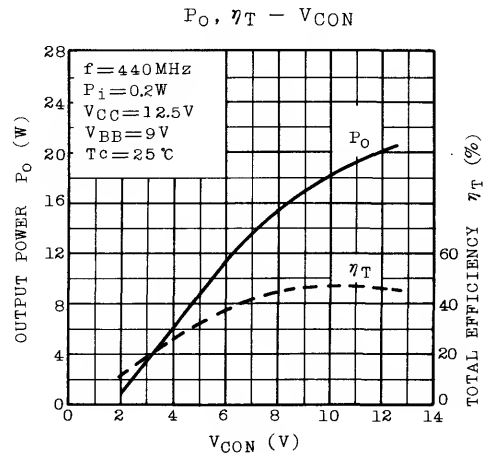
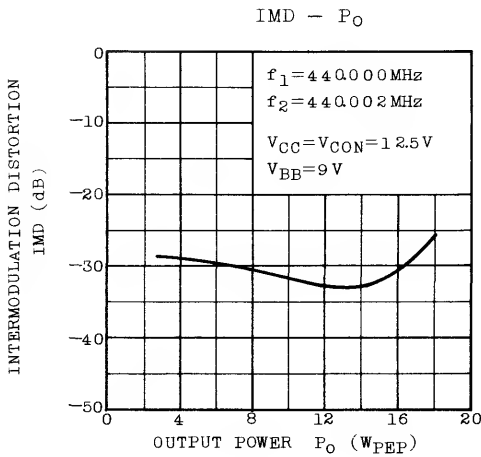
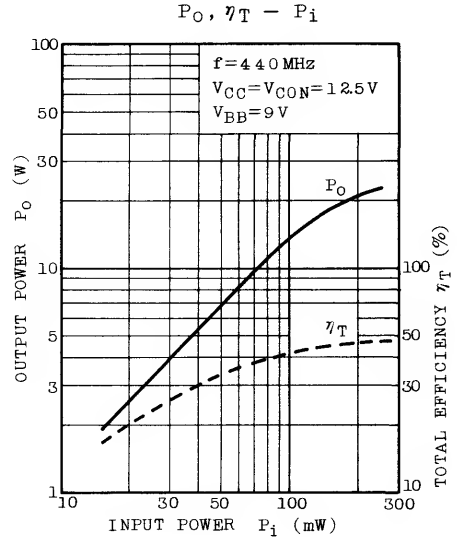
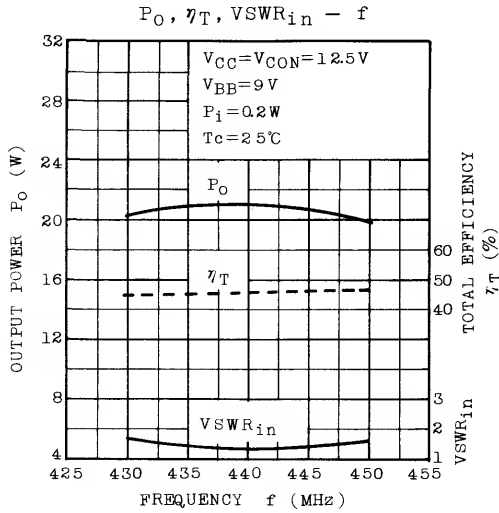


TEST MOUNT



C_1, C_2, C_3 : 1500pF, 10 μ F

L_1, L_2, L_3 : $\phi 0.8$ COPPER WIRE , 8T, 5ID



S-AU5L S-AU5M S-AU5H

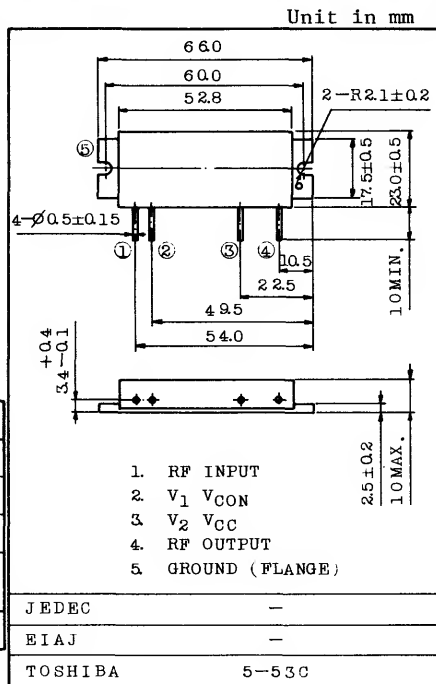
UHF POWER AMPLIFIER MODULE

FEATURES:

- . Output Power : $P_o \geq 7W$
- . Minimum Gain : $G_p = 15.4dB$
- . Efficiency : $\eta_T \geq 40\%$
- . 50Ω Input/Output Impedance
- . Guaranteed Stability

MAXIMUM RATINGS ($T_c = 25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{CC}	16	V
DC Supply Voltage	V _{CON}	16	V
RF Input Power	P _i	300	mW
Operating Case Temperature Range	T _c (OP)	-30 ~ 100	°C
Storage Temperature Range	T _{stg}	-40 ~ 110	°C



CHARACTERISTICS ($T_c = 25^\circ C$)

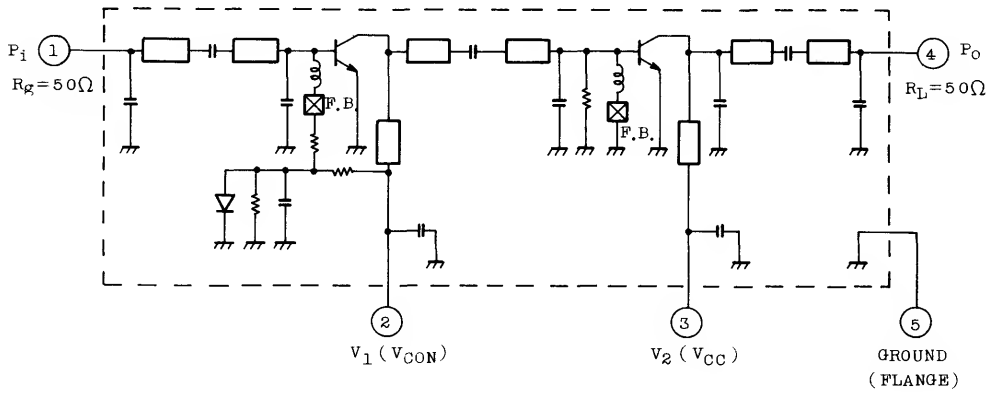
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range (1)	f _{range}	-	400	-	512	MHz
Output Power	P _o	P _i =200mW V _{CC} =12.5V, V _{CON} =12.5V Z _g =Z ₁ =50Ω	7	-	-	W
Power Gain	G _p		15.4	-	-	dB
Total Efficiency	η_T		40	48	-	%
Input VSWR	VSWR _{in}		-	1.5	2	-
Harmonics	HRM		-	-30	-25	dB
Load Mismatch	-	V _{CC} =15V, V _{CON} =12.5V P _i =200mW VSWR load 20:1 all phase	No Degradation			-
Stability	-	V _{CC} =12.5V, P _i =200mW V _{CON} =0 ~ 12.5V VSWR Load 3:1 all phase	All spurious output than 60dB below desired signal			-

(1) Frequency range is covered in three bands

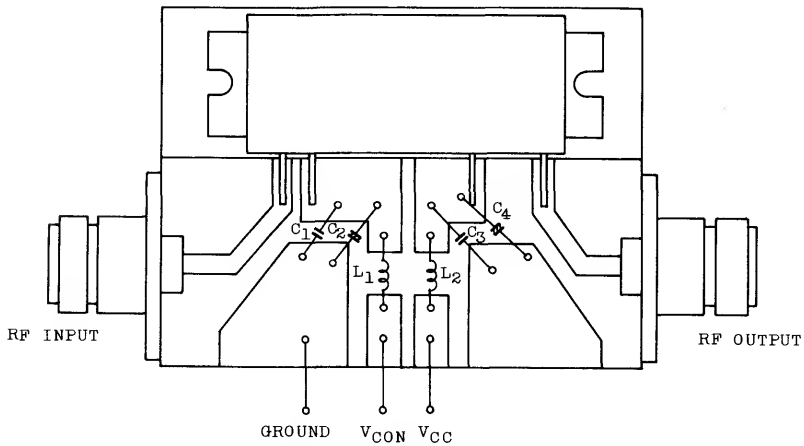
S-AU5L	400-440MHz
S-AU5M	440-480MHz
S-AU5H	480-512MHz

S-AU5L • S-AU5M • S-AU5H

SCHEMATIC



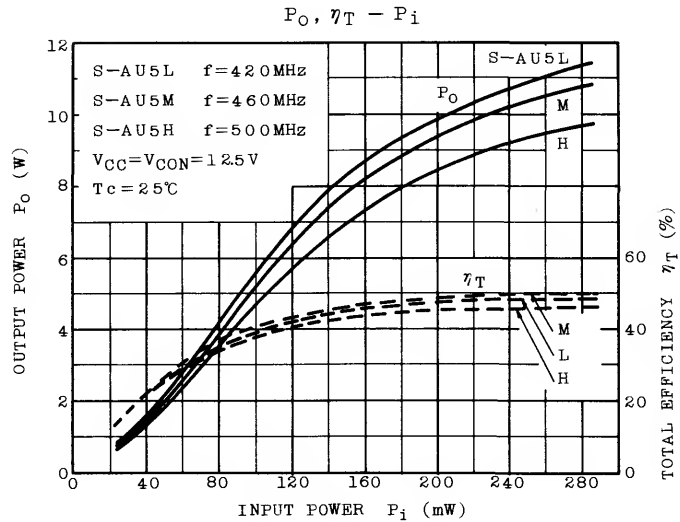
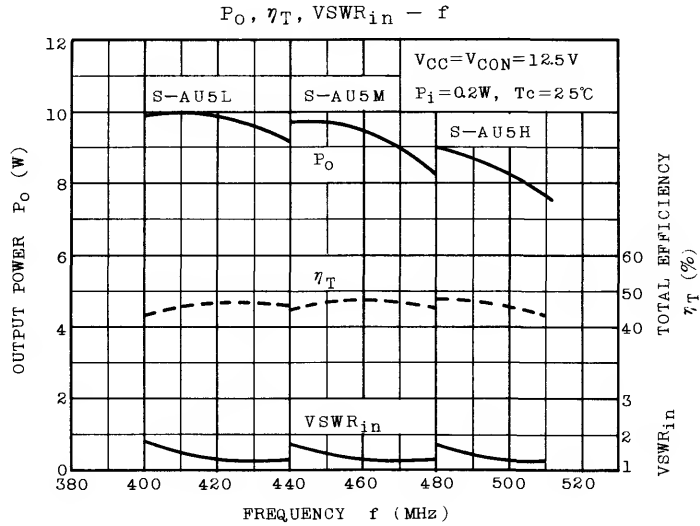
TEST MOUNT



C_1, C_3 : 15000pF

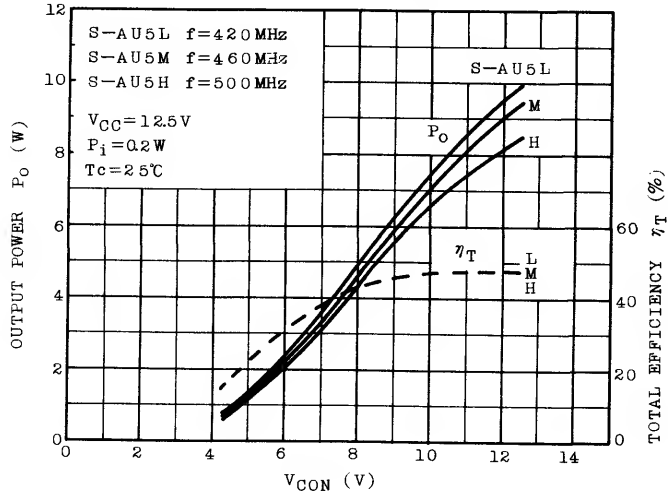
C_2, C_4 : 1 μ F

L_1, L_2 : $\varnothing 0.8$ COPPER WIRE 8T, 5ID

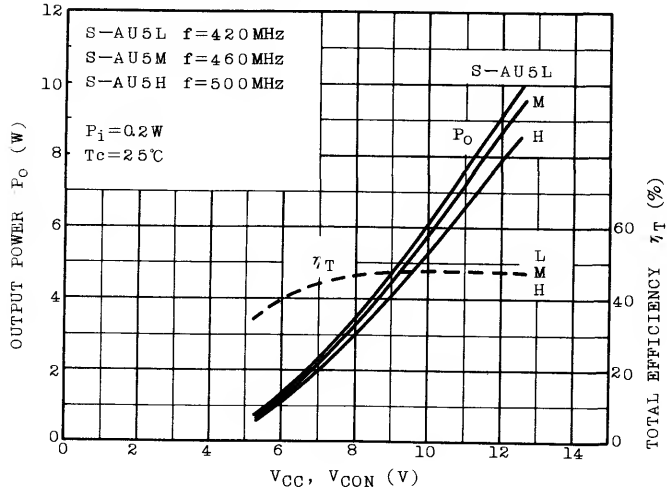


S-AU5L · S-AU5M · S-AU5H

$P_o, \eta_T - V_{CON}$



$P_o, \eta_T - V_{CC}, V_{CON}$





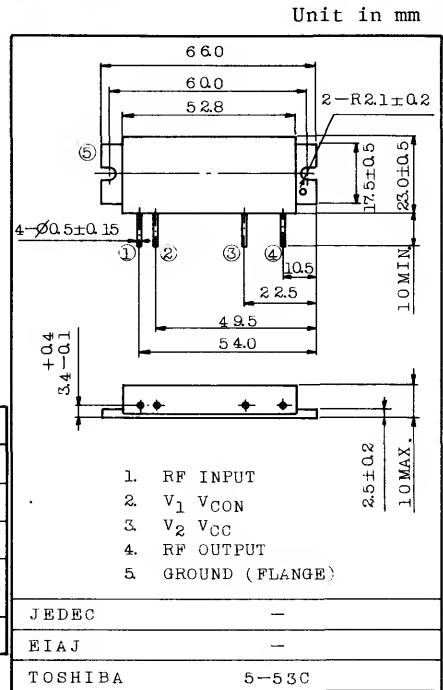
UHF POWER AMPLIFIER MODULE

FEATURES:

- . Output Power : $P_o \geq 13W$
- . Minimum Gain : $G_p = 18.1dB$
- . Efficiency : $\eta_T \geq 40\%$
- . 50Ω Input/ Output Impedance
- . Guaranteed Stability

MAXIMUM RATINGS ($T_c = 25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{CC}	16	V
DC Supply Voltage	V _{CON}	16	V
RF Input Power	P _i	300	mW
Operating Case Temperature Range	T _c (OP)	-30 ~ 100	°C
Storage Temperature Range	T _{stg}	-40 ~ 110	°C



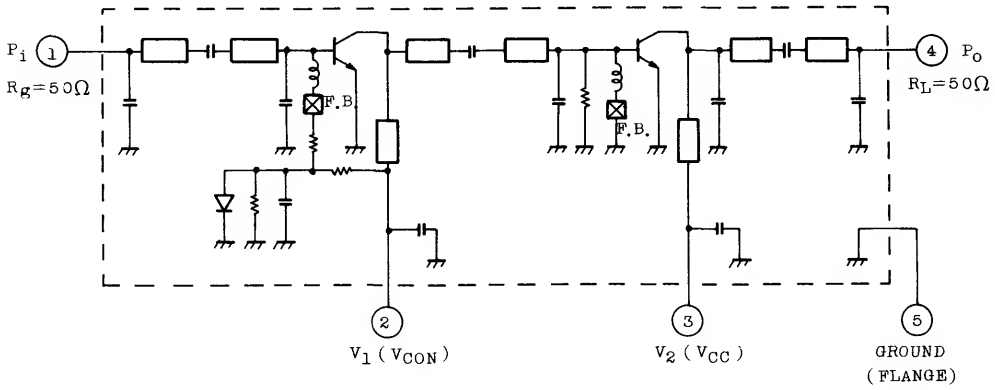
CHARACTERISTICS ($T_c = 25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range (1)	f _{range}	-	400	-	512	MHz
Output Power	P _o	P _i =200mW V _{CC} =12.5V, V _{CON} =12.5V Z _g =Z _l =50Ω	13	-	-	W
Power Gain	G _p		18.1	-	-	dB
Total Efficiency	η_T		40	50	-	%
Input VSWR	VSWR _{in}		-	1.5	2	-
Harmonics	HRM		-	-30	-25	dB
Load Mismatch	-	V _{CC} =15V, V _{CON} =12.5V P _i =200mW VSWR load 20:1 all phase	No Degradation			-
Stability	-	V _{CC} =12.5V, P _i =200mW V _{CON} =0 ~ 12.5V VSWR Load 3:1 all phase	All spurious output than 60dB below desired signal			-

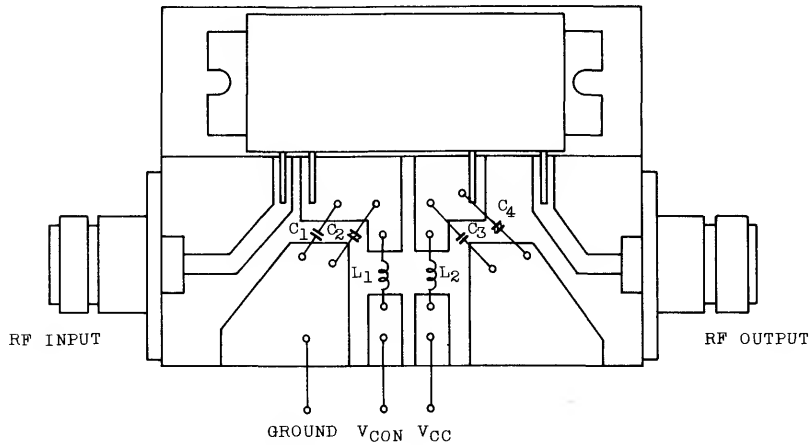
(1) Frequency range is covered in three bands
 S-AU6L 400-440MHz
 S-AU6M 440-480MHz
 S-AU6H 480-512MHz

S-AU6L • S-AU6M • S-AU6H

SCHEMATIC



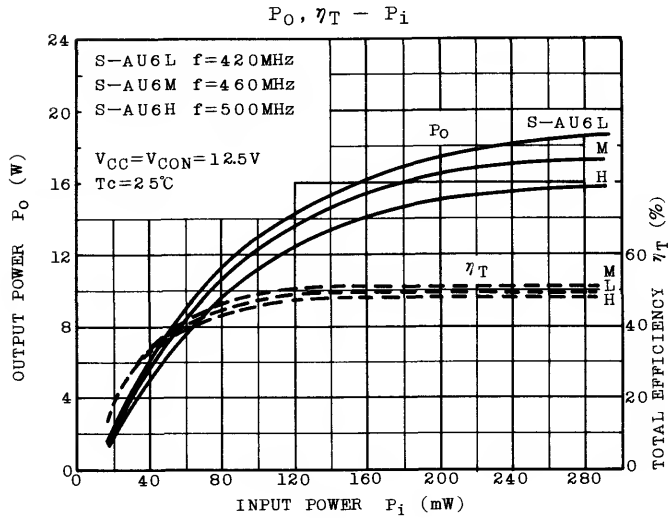
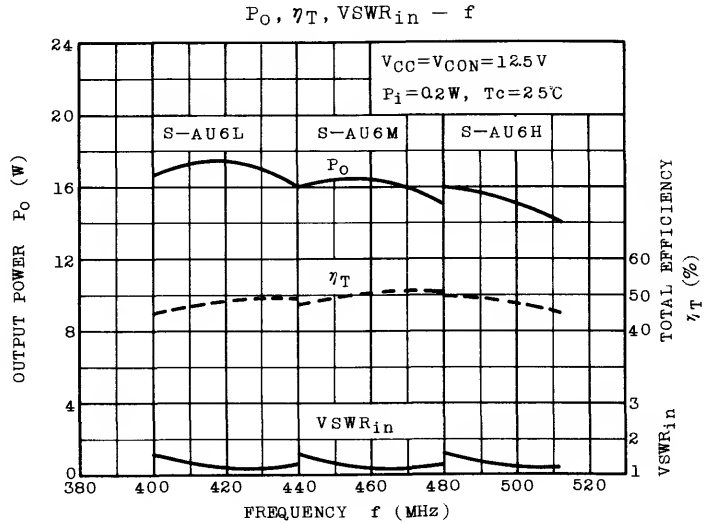
TEST MOUNT



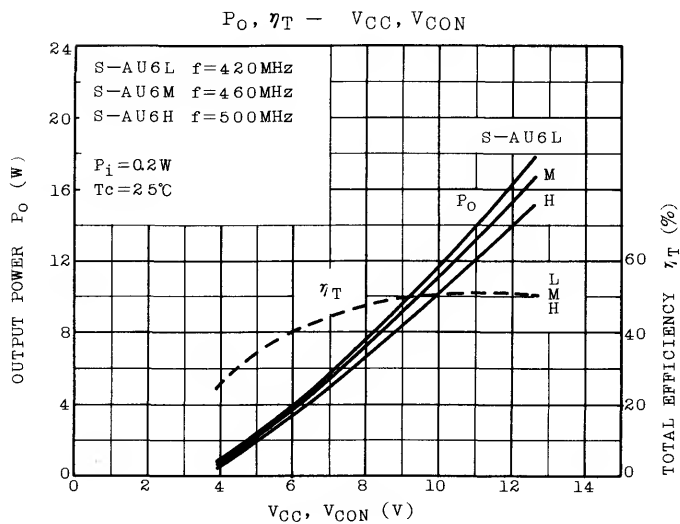
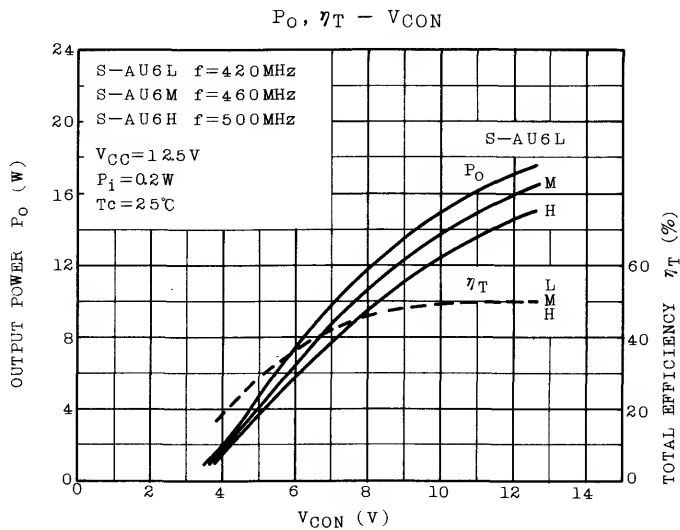
$C_1, C_3 : 15000\text{pF}$

$C_2, C_4 : 1\mu\text{F}$

$L_1, L_2 : \varnothing 0.8 \text{ COPPER WIRE } 8\text{T}, 5 \text{ ID}$



S-AU6L · S-AU6M · S-AU6H

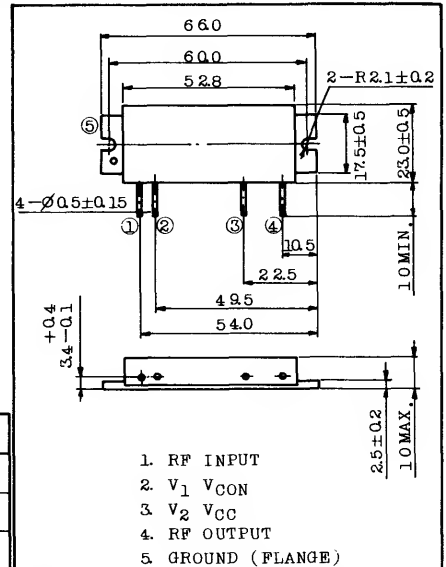


800MHZ UHF POWER AMPLIFIER MODULE (FM)

Unit in mm

FEATURES:

- . Output Power : $P_o \geq 15W$
- . Minimum Gain : $G_p = 18.7dB$
- . Efficiency : $\eta_T \geq 30\%$
- . 50Ω Input/Output Impedance
- . Guaranteed Stability



MAXIMUM RATINGS (Tc=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	VCC	15	V
DC Supply Voltage	VCON	15	V
RF Input Power	Pi	300	mW
Operating Case Temperature Range	Tc(OP)	-30 ~ 100	°C
Storage Temperature Range	Tstg	-40 ~ 110	°C

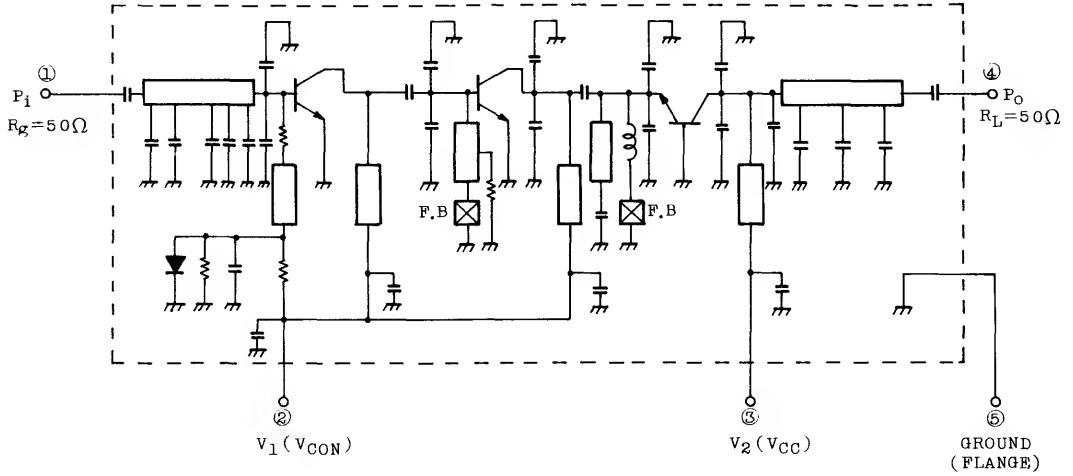
JEDEC	-
EIAJ	-
TOSHIBA	5-53

CHARACTERISTICS (Tc=25°C)

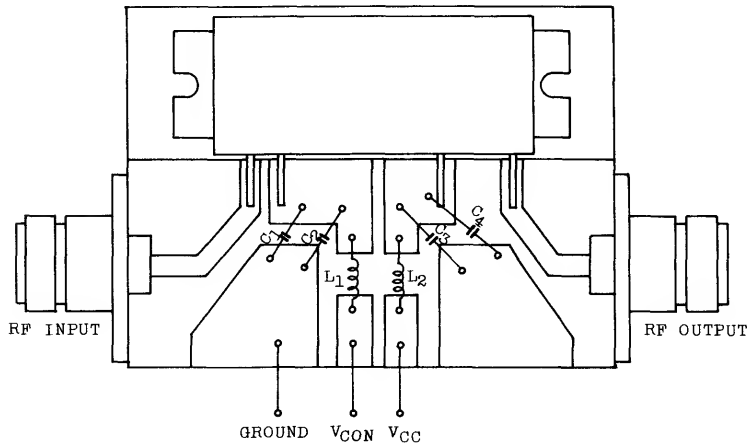
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range	f _{range}	-	806	-	825	MHz
Output Power	P _i	P _o =15W VCC=12.5V, VCON=1.25V Z _g =Z _l =50Ω	-	80	200	mW
Power Gain	G _p		18.7	22.7	-	dB
Total Efficiency	η _T		30	35	-	%
Input VSWR	VSWR _{in}		-	1.5	2.5	-
Harmonics	HRM		-	-30	-25	dB
Load Mismatch	-	VCC=15V, VCON=15V P _o =18W VSWR load 20:1 all phase	No Degradation			-
Stability	-	VCC=12.5V, P _i =100 to 200mW VCON=0 ~ 15V VSWR load 3:1 all phase	All spurious output than 60dB below desired signal			-

S-AU7

SCHEMATIC



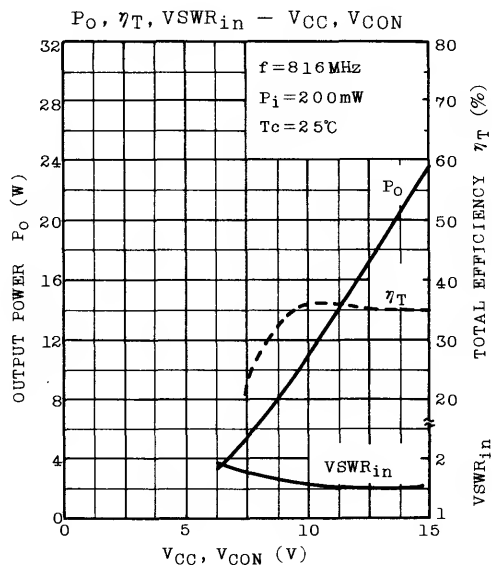
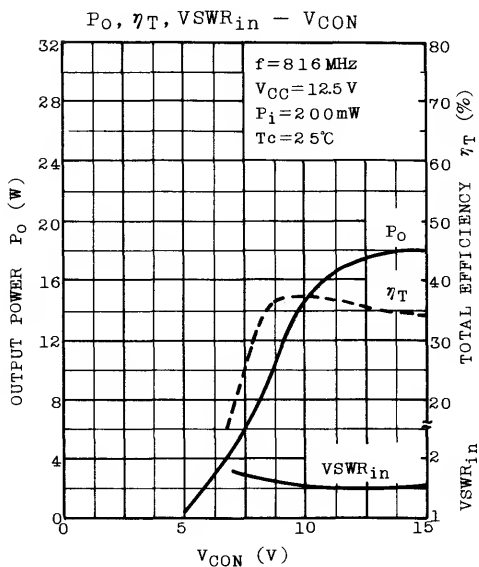
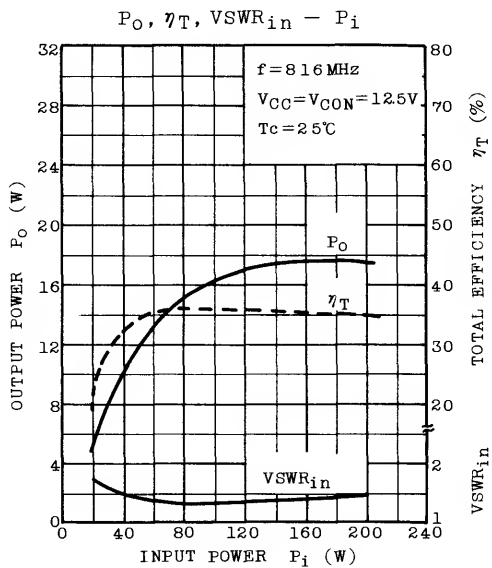
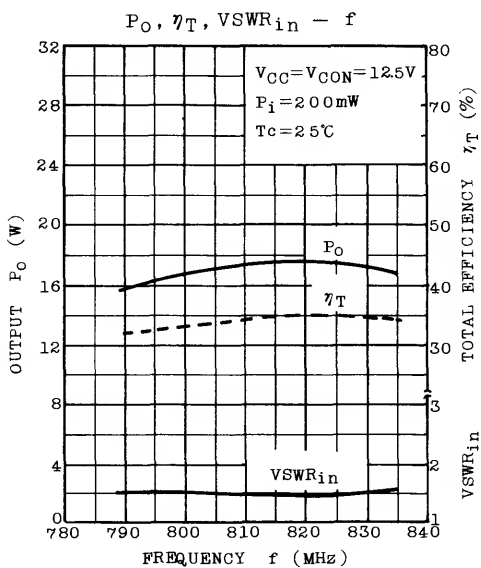
TEST MOUNT



$C_1, C_3 : 1500 \text{ pF}$

$C_2, C_4 : 1 \mu\text{F}$

$L_1, L_2 : \varnothing 0.8 \text{ Ag PLATED WIRE, 8T 5ID}$





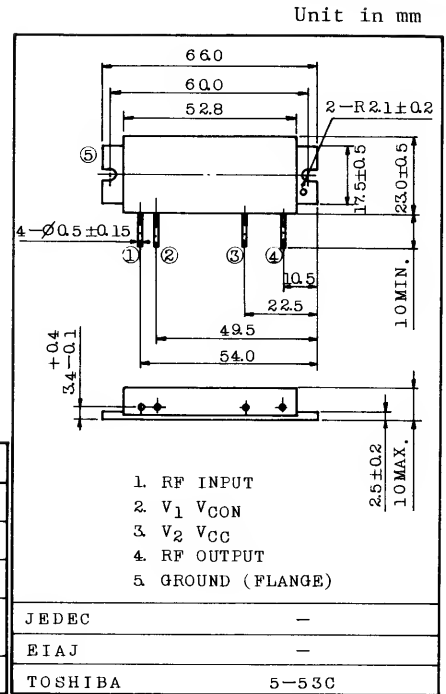
S-AV
SERIES



VHF POWER AMPLIFIER MODULE (HAM FM)

FEATURES:

- . Output Power : $P_o \cong 15W$
- . Minimum Gain : $G_p \cong 18.7dB$
- . Efficiency : $\eta_T \cong 48\%$
- . 50Ω Input/Output Impedance
- . Guaranteed Stability



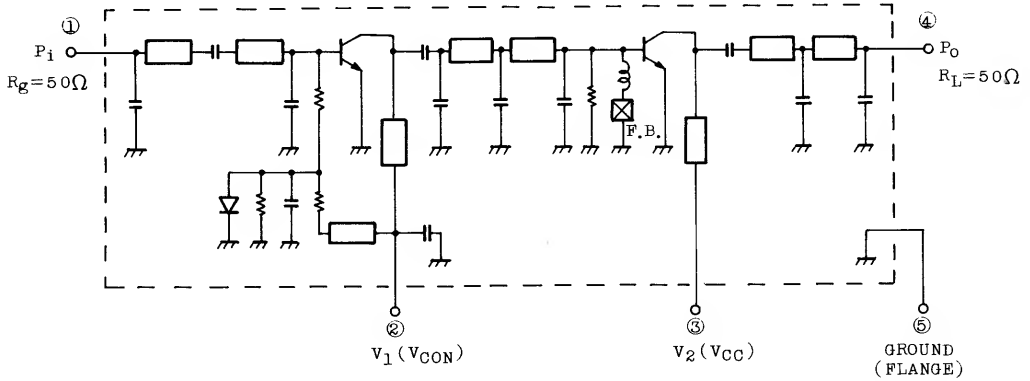
MAXIMUM RATINGS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	VCC	16	V
DC Supply Voltage	VCON	16	V
RF Input Power	P_i	300	mW
Operating Case Temperature Range	$T_c(OP)$	-30 ~ 100	$^\circ C$
Storage Temperature Range	T_{stg}	-40 ~ 110	$^\circ C$

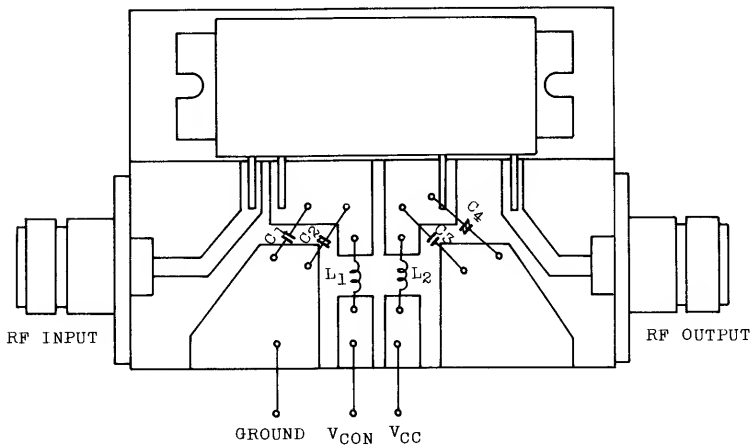
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range	f_{range}	-	144	-	148	MHz
Output Power	P_o	$P_i=200mW$ $V_{CC}=12.5V, V_{CON}=12.5V$ $Z_g=Z_l=50\Omega$	15	20	-	W
Power Gain	G_p		18.7	20	-	dB
Total Efficiency	η_T		48	53	-	%
Input VSWR	VSWR _{in}		-	1.5	2	-
Harmonics	HRM		-	-30	-25	dB
Load Mismatch	-	$V_{CC}=15V, V_{CON}=12.5V$ $P_o=18W$ VSWR load 20:1 all phase	No Degradation			-
Stability	-	$V_{CC}=12.5V, P_i=200mW$ $V_{CON}=0 \sim 12.5V$ VSWR load 3:1 all phase	All spurious output than 60dB below desired signal			-

S-AV5

SCHEMATIC



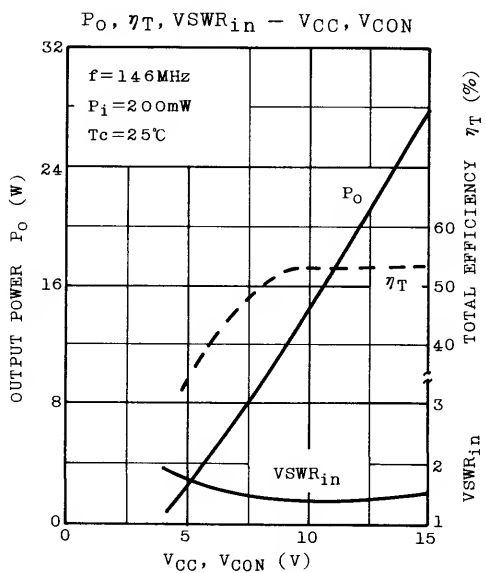
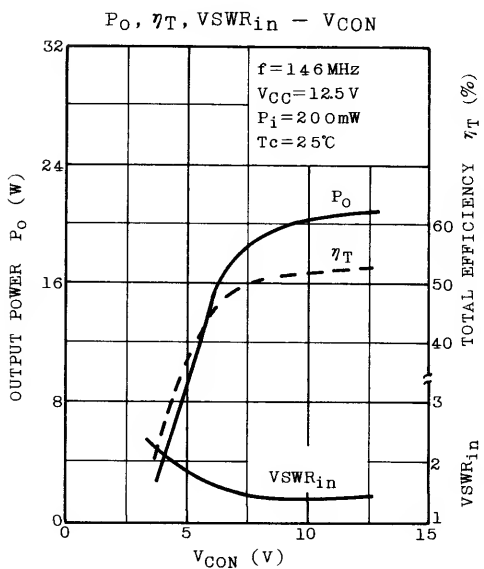
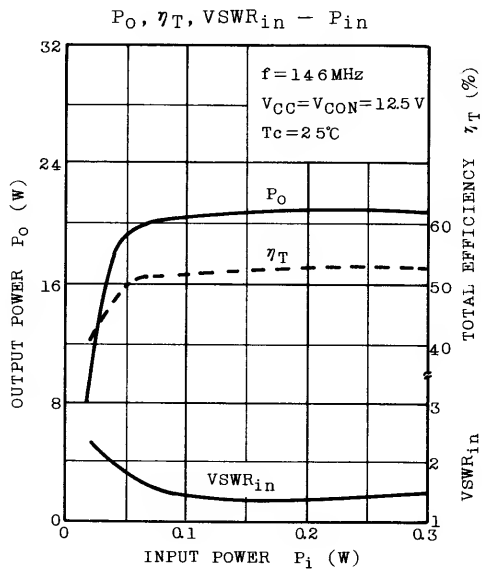
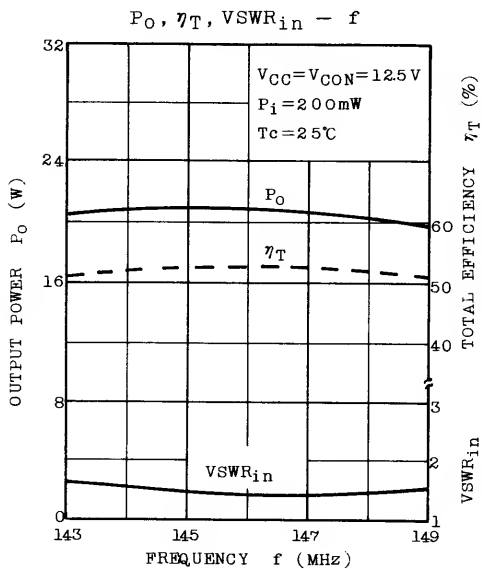
TEST MOUNT



C₁, C₃ : 15000pF

C₂, C₄ : 1 μF

L₁, L₂ : ∅0.8 Ag PLATED WIRE, 8T, 51D



S-AV6

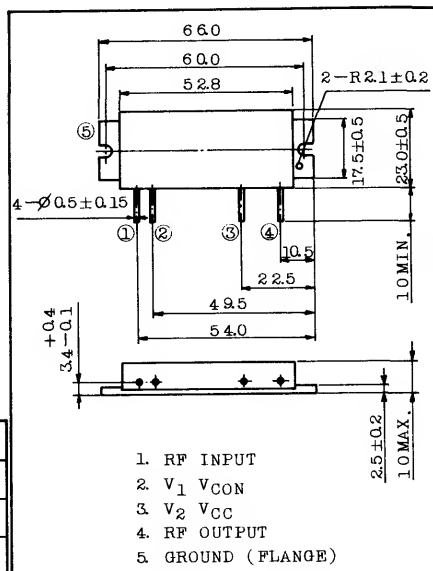
TOSHIBA RF POWER AMPLIFIER MODULE

VHF POWER AMPLIFIER MODULE (MARINE FM)

Unit in mm

FEATURES:

- . Output Power : $P_o \cong 28W$
- . Minimum Gain : $G_p=21.4dB$
- . Efficiency : $\eta_T \geq 45\%$
- . 50Ω Input/Output Impedance
- . Guaranteed Stability



MAXIMUM RATINGS ($T_c=25^\circ C$)

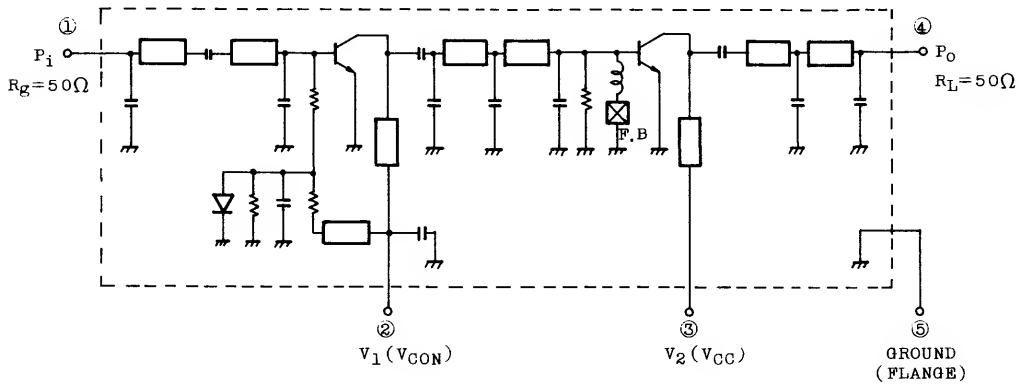
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	VCC	16	V
DC Supply Voltage	VCON	16	V
RF Input Power	P _i	300	mW
Operating Case Temperature Range	T _{c(OP)}	-30 ~ 100	°C
Storage Temperature Range	T _{stg}	-40 ~ 110	°C

J EDEC	-
E I A J	-
TOSHIBA	5-53C

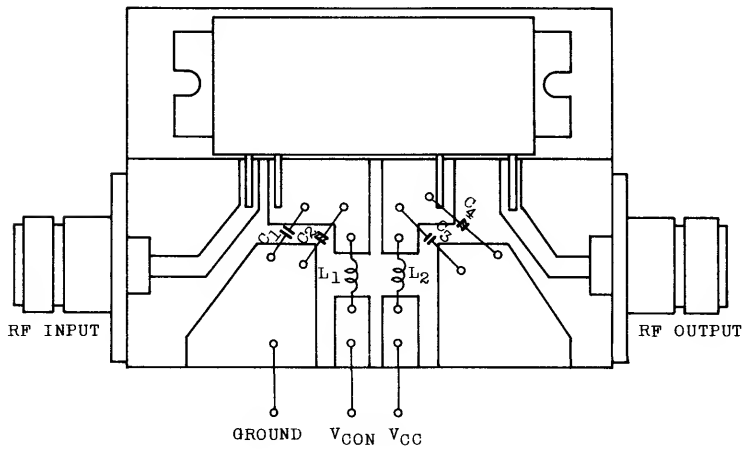
CHARACTERISTICS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range	f _{range}	-	154	-	162	MHz
Output Power	P _o	P _i =200mW VCC=12.5V, VCON=12.5V Z _g =Z _l =50Ω	28	33	-	W
Power Gain	G _p		21.4	22.2	-	dB
Total Efficiency	η_T		45	50	-	%
Input VSWR	VSWR _{in}		-	1.5	2	-
Harmonics	HRM		-	-30	-25	dB
Load Mismatch	-	VCC=15V, VCON=12.5V P _o =30W VSWR load 20:1 all phase	No Degradation			-
Stability	-	VCC=12.5V, P _i =200mW VCON=0 ~ 12.5V VSWR load 3:1 all phase	All spurious output than 60dB below desired signal			-

SCHEMATIC



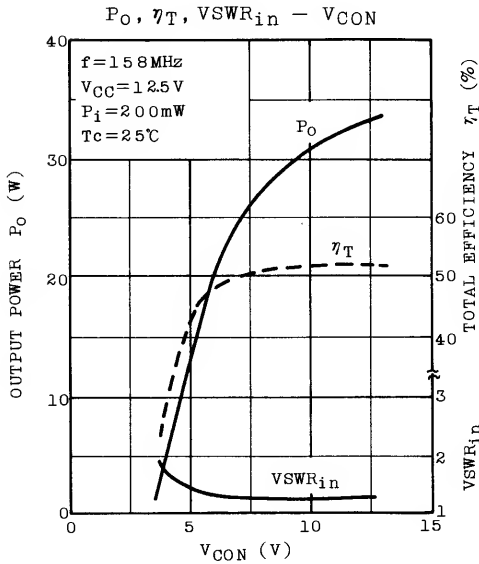
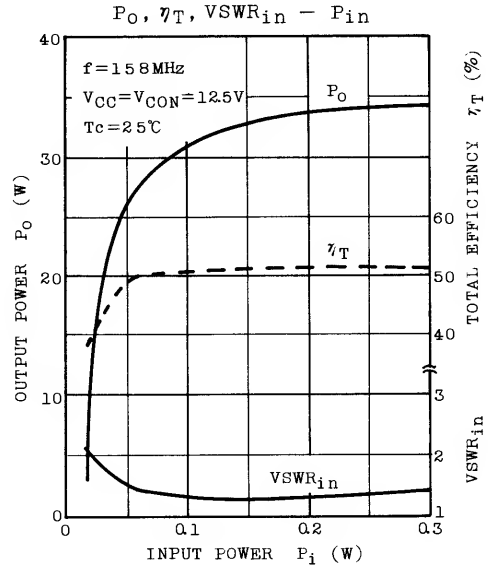
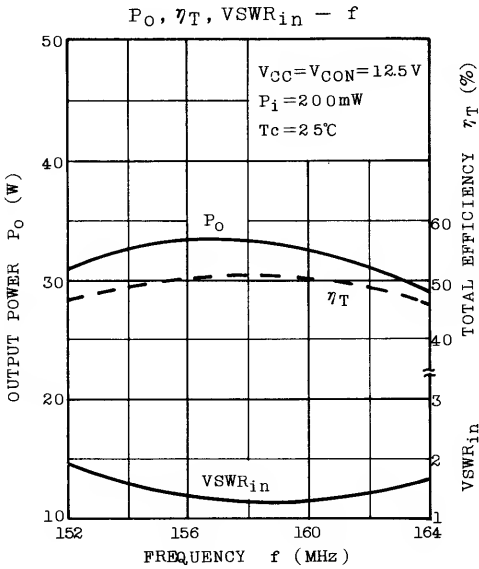
TEST MOUNT



C₁, C₃ : 15000pF

C₂, C₄ : 1μF

L₁, L₂ : ∅0.8 Ag PLATED WIRE, 8T, 5ID



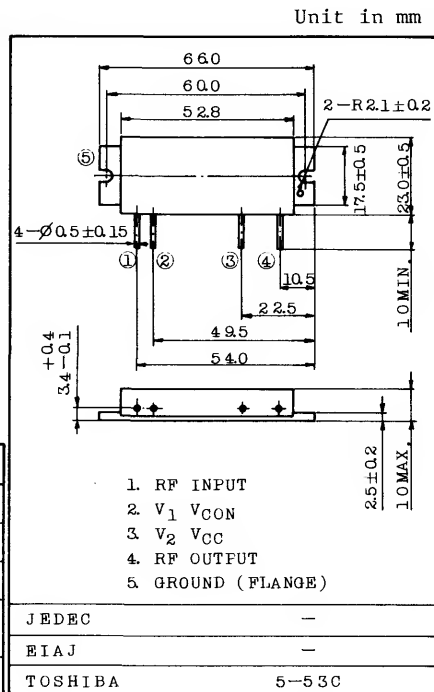
VHF POWER AMPLIFIER MODULE (HAM FM)

FEATURES:

- . Output Power : $P_o \geq 28W$
- . Minimum Gain : $G_p = 21.4dB$
- . Efficiency : $\eta_T \geq 45\%$
- . 50Ω Input/Output Impedance
- . Guaranteed Stability

MAXIMUM RATINGS ($T_c = 25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{CC}	16	V
DC Supply Voltage	V_{CON}	16	V
RF Input Power	P_i	300	mW
Operating Case Temperature Range	$T_c(OP)$	-30 ~ 100	$^\circ C$
Storage Temperature Range	T_{stg}	-40 ~ 110	$^\circ C$

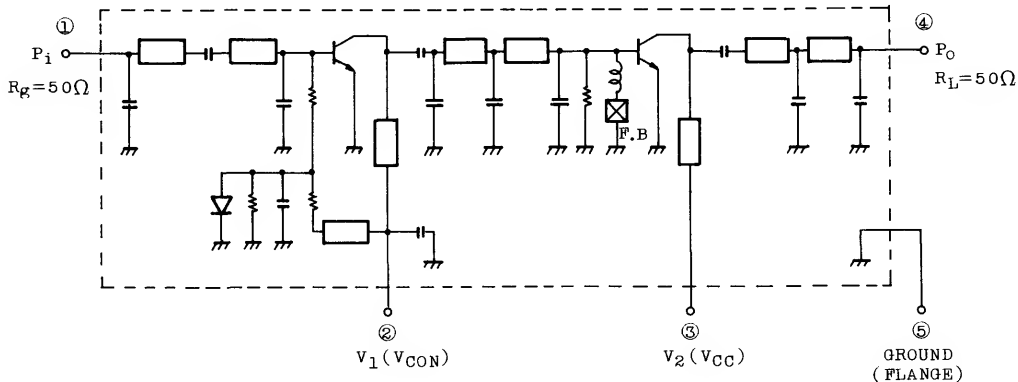


CHARACTERISTICS ($T_c = 25^\circ C$)

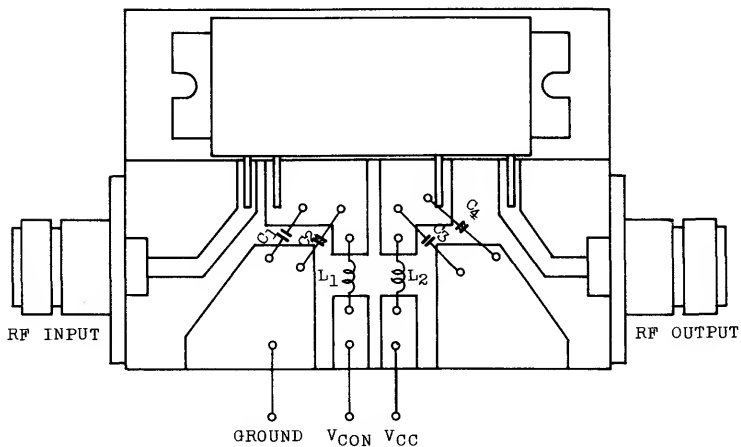
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range	f_{range}	-	144	-	148	MHz
Output Power	P_o	$P_i = 200mW$ $V_{CC} = 12.5V, V_{CON} = 1.25V$ $Z_g = Z_l = 50\Omega$	28	33	-	W
Power Gain	G_p		21.4	22.2	-	dB
Total Efficiency	η_T		45	52	-	%
Input VSWR	$VSWR_{in}$		-	1.5	2	-
Harmonics	HRM		-	-30	-25	dB
Load Mismatch	-	$V_{CC} = 15V, V_{CON} = 12.5V$ $P_o = 30W$ VSWR load 20:1 all phase	No Degradation			
Stability	-	$V_{CC} = 12.5V, P_i = 200mW$ $V_{CON} = 0 \sim 12.5V$ VSWR load 3:1 all phase	All spurious output than 60dB below desired signal			

S-AV7

SCHEMATIC



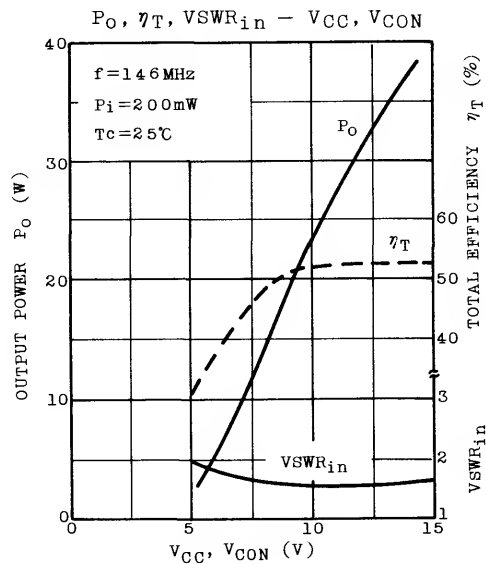
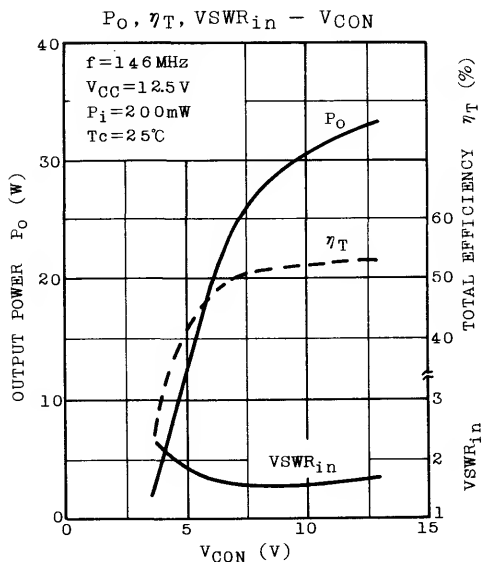
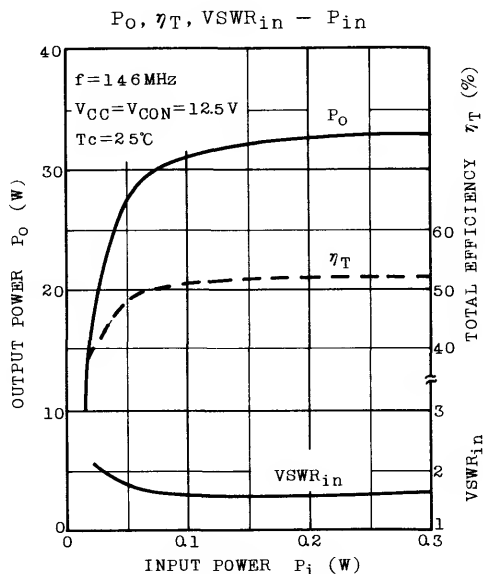
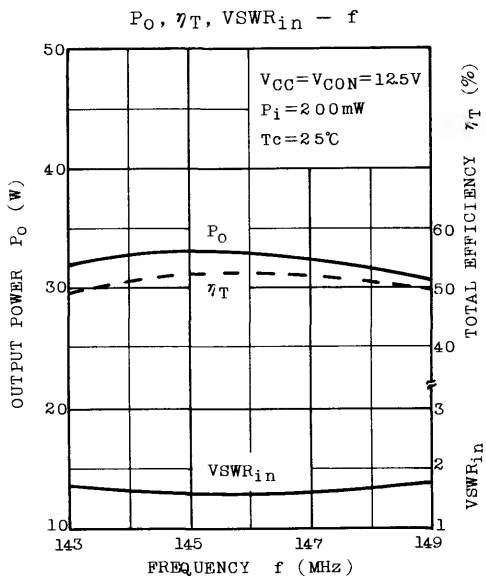
TEST MOUNT



$C_1, C_3 : 15000\text{pF}$

$C_2, C_4 : 1\mu\text{F}$

$L_1, L_2 : \varnothing 0.8 \text{ Ag PLATED WIRE, } 8\text{T, } 5 \text{ ID}$



S-AV8

TOSHIBA RF POWER AMPLIFIER MODULE

VHF POWER AMPLIFIER MODULE (HAM SSB/FM)

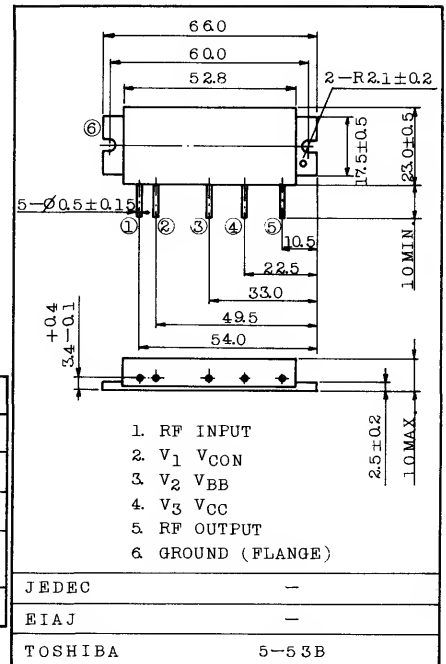
Unit in mm

FEATURES:

- . Output Power : $P_o \geq 17W$
- . Minimum Gain : $G_p = 19.2dB$
- . Efficiency : $\eta_T \leq 40\%$
- . 50Ω Input/Output Impedance
- . Guaranteed Stability

MAXIMUM RATINGS ($T_c = 25^\circ C$)

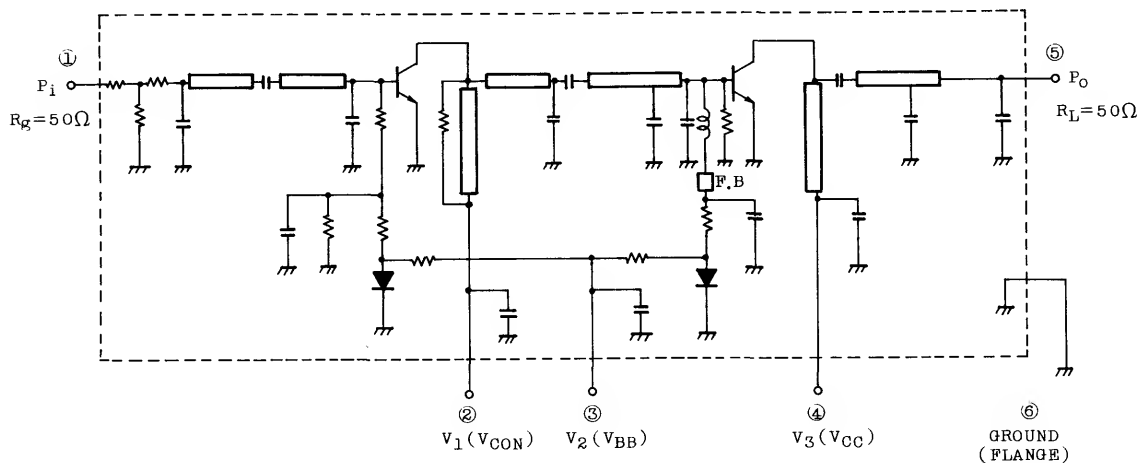
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{CC}	16	V
DC Supply Voltage	V_{CON}	16	V
RF Input Power	P_i	300	mW
Operating Case Temperature Range	$T_c(OP)$	-30 ~ 100	$^\circ C$
Storage Temperature Range	T_{stg}	-40 ~ 110	$^\circ C$



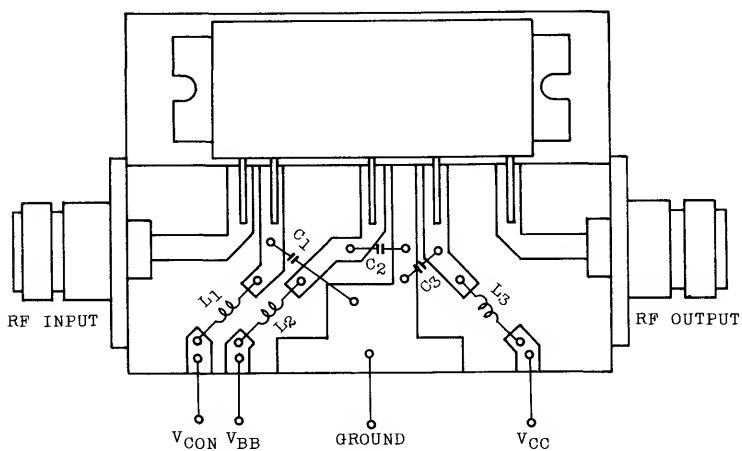
CHARACTERISTICS ($T_c = 25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range	f_{range}	-	144	-	148	MHz
Output Power	P_o	$P_i = 200mW$ $V_{CC} = 12.5V, V_{CON} = 12.5V$ $Z_g = Z_1 = 50\Omega, V_{BB} = 9V$	17	22	-	W
Power Gain	G_p		19.2	20.4	-	dB
Total Efficiency	η_T		40	50	-	%
Input VSWR	$VSWR_{in}$		-	1.5	2	-
Harmonics	HRM		-	-30	-25	dB
Load Mismatch	-		$V_{CC} = 15V, V_{CON} = 12.5V$ $P_o = 18W, V_{BB} = 9V$ VSWR load 20:1 all phase	No Degradation		
Stability	-	$V_{CC} = 12.5V, P_i = 200mW$ $V_{CON} = 0 \sim 12.5V, V_{BB} = 9V$ VSWR Load 3:1 all phase	All spurious output than 60dB below desired signal			-
Intermodulation Distortion Ratio	IMD	$f_1 = 440.000MHz, f_2 = 440.002MHz$ $V_{CC} = V_{CON} = 12.5V, V_{BB} = 9V$ $P_o = 13W_{PEP}$	-	-32	-	dB

SCHEMATIC

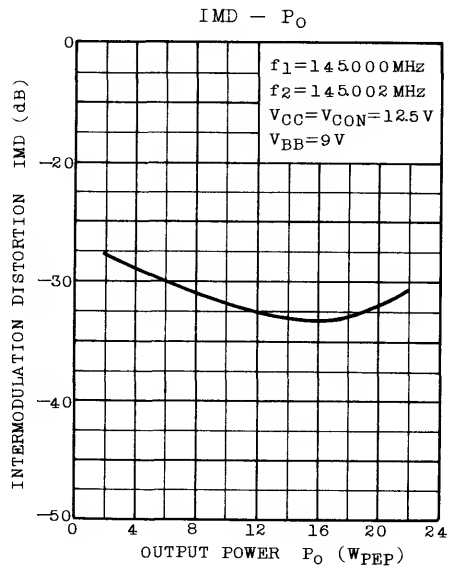
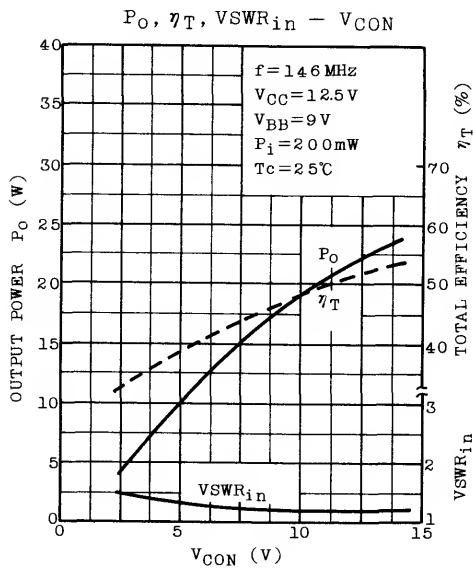
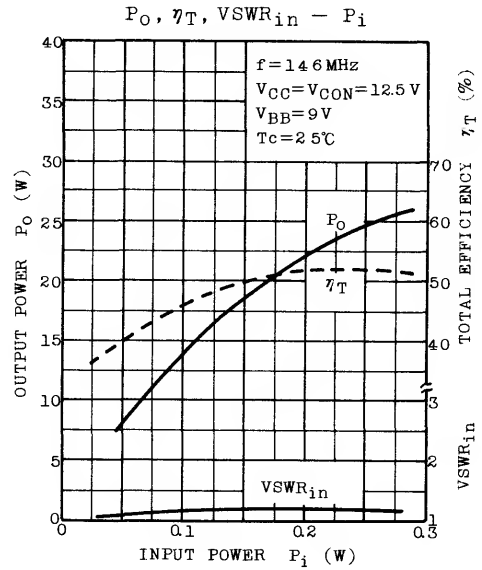
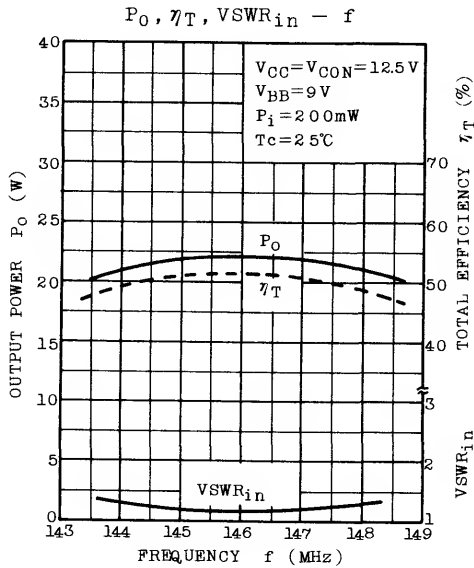


TEST MOUNT



C_1, C_2, C_3 : 1500pF, 10 μ F PARALLEL

L_1, L_2, L_3 : $\varnothing 0.8$ Ag PLATED WIRE, 8T, 5ID



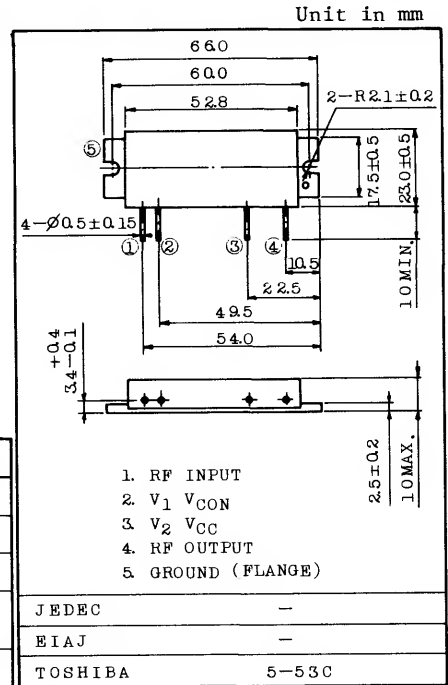
VHF POWER AMPLIFIER MODULE

FEATURES:

- Output Power : $P_o \geq 8W$
- Minimum Gain : $G_p = 16dB$
- Efficiency : $\eta_T \geq 40\%$
- 50Ω Input and Output Impedance
- Guaranteed Stability

MAXIMUM RATINGS ($T_c = 25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{CC}	16	V
DC Supply Voltage	V _{CON}	16	V
RF Input Power	P _i	300	mW
Operating Case Temperature Range	T _{C(OP)}	-30 ~ 100	°C
Storage Temperature Range	T _{stg}	-40 ~ 110	°C



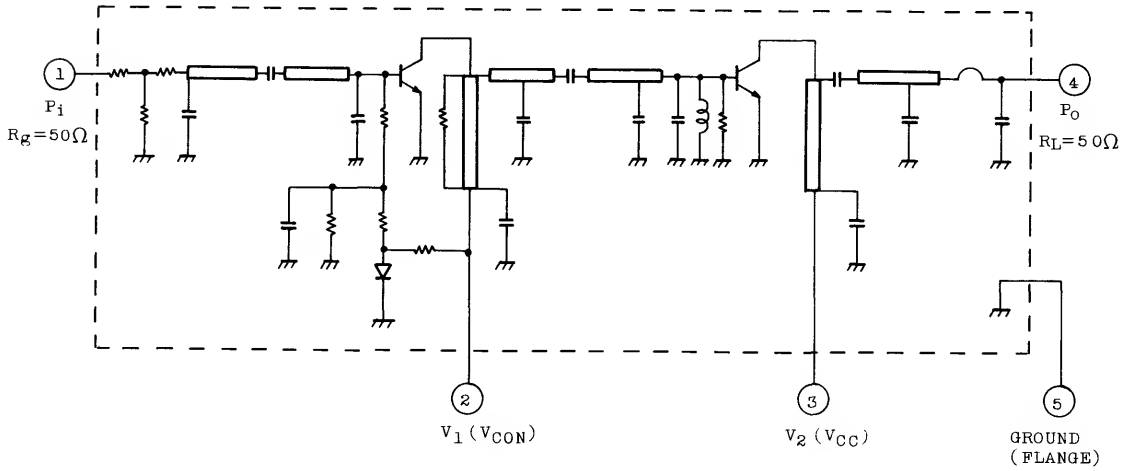
CHARACTERISTICS ($T_c = 25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range (1)	f _{range}	-	135	-	175	MHz
Output Power	P _o	P _i =200mW V _{CO} =12.5V, V _{CON} =12.5V Z _g =Z _l =50Ω	8	-	-	W
Power Gain	G _p		16	-	-	dB
Total Efficiency	η_T		40	-	-	%
Input VSWR	VSWR _{in}		-	-	2	-
Harmonics	HRM		-	-	-25	dB
Load Mismatch	-	V _{CC} =15V, V _{CON} =12.5V P _o =12W VSWR load 20:1 all phase	No Degradation			-
Stability	-	V _{CC} =12.5V, P _i =200mW V _{CON} =0~12.5V VSWR Load 3:1 all phase	All spurious output than 60dB below desired signal			-

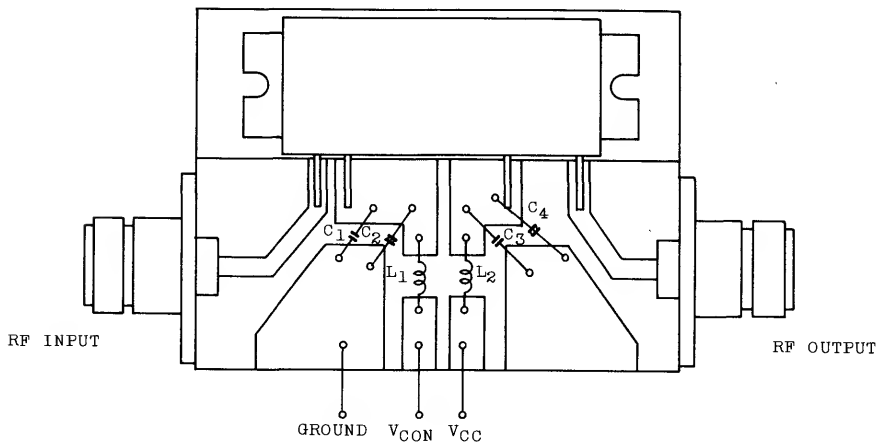
(1) Frequency range is covered in two bands S-AV9L 135-155MHz
S-AV9H 150-175MHz

S-AV9L · S-AV9H

SCHEMATIC

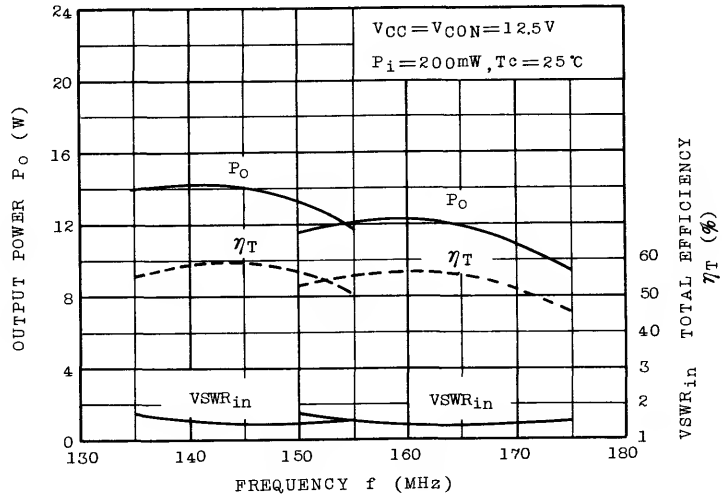


TEST MOUNT

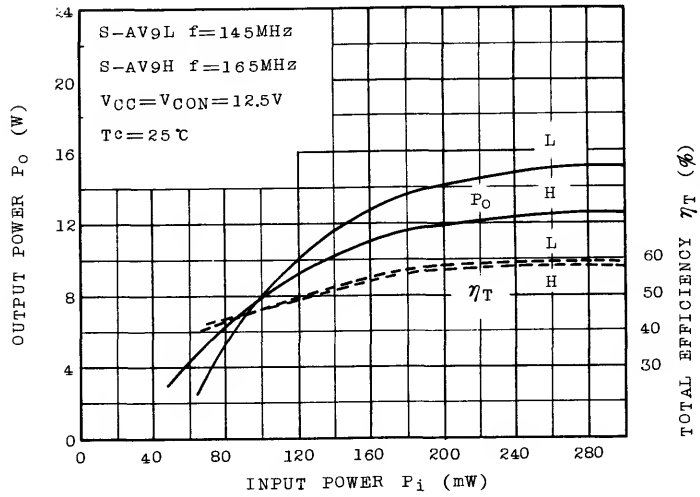


C_1, C_3	15000pF
C_2, C_4	1 μ F
L_1, L_2	$\varnothing 0.8$ COPPER WIRE 8T 51D

$P_o, \eta_T, VSWR_{in} - f$

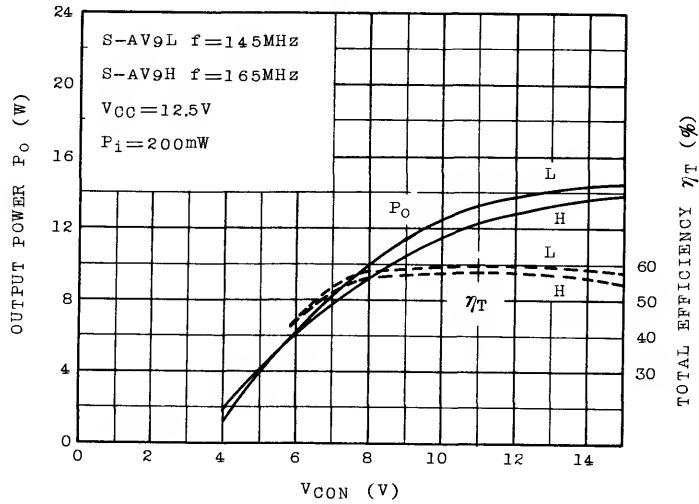


$P_o, \eta_T - P_i$

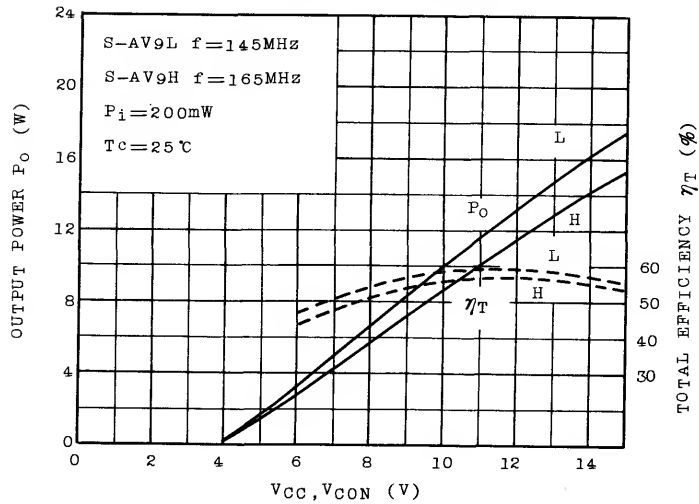


S-AV9L • S-AV9H

$P_o, \eta_T - V_{CON}$



$P_o, \eta_T - V_{CC}, V_{CON}$



S-AV10L S-AV10H

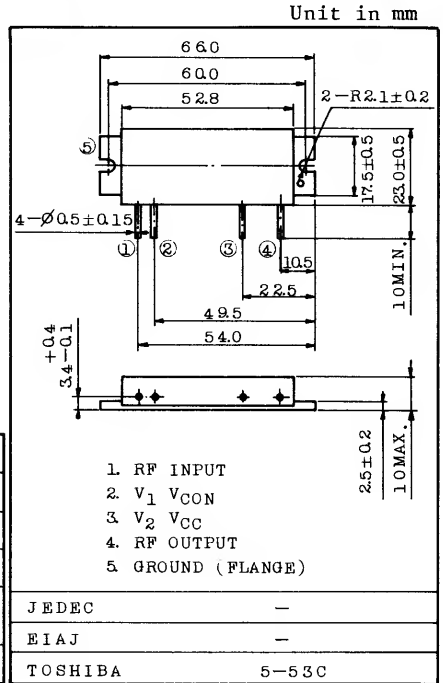
VHF POWER AMPLIFIER MODULE

FEATURES:

- . Output Power : $P_o \geq 14W$
- . Minimum Gain : $G_p=18.5dB$
- . Efficiency : $\eta_T \geq 40\%$
- . 50Ω Input and Output Impedance
- . Guaranteed Stability

MAXIMUM RATINGS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{CC}	16	V
DC Supply Voltage	V_{CON}	16	V
RF Input Power	P_i	300	mW
Operating Case Temperature Range	$T_{C(OP)}$	-30 ~ 100	$^\circ C$
Storage Temperature Range	T_{stg}	-40 ~ 110	$^\circ C$



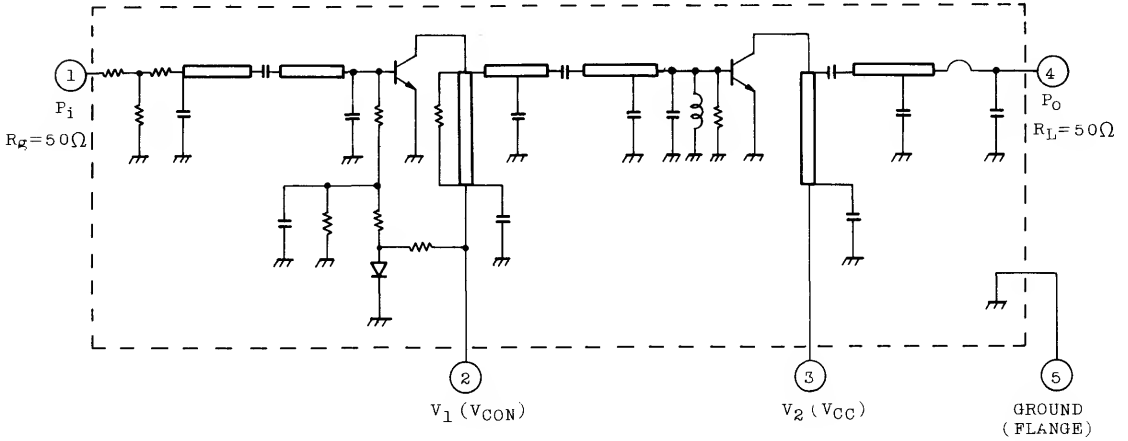
CHARACTERISTICS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Range (1)	f_{range}	-	135	-	175	MHz
Output Power	P_o	$P_i=200mW$ $V_{CC}=12.5V, V_{CON}=12.5V$ $Z_g=Z_1=50\Omega$	14	-	-	W
Power Gain	G_p		18.5	-	-	dB
Total Efficiency	η_T		40	-	-	%
Input VSWR	V_{SWRin}	$V_{CC}=15V, V_{CON}=12.5V$ $P_o=15W$ VSWR load 20:1 all phase	-	-	2	-
Harmonics	HRM		-	-	-25	dB
Load Mismatch	-	$V_{CC}=12.5V, P_i=200mW$ $V_{CON}=0 \sim 12.5V$ VSWR Load 3:1 all phase	No Degradation			-
Stability	-		All spurious output than 60dB below desired signal	-		

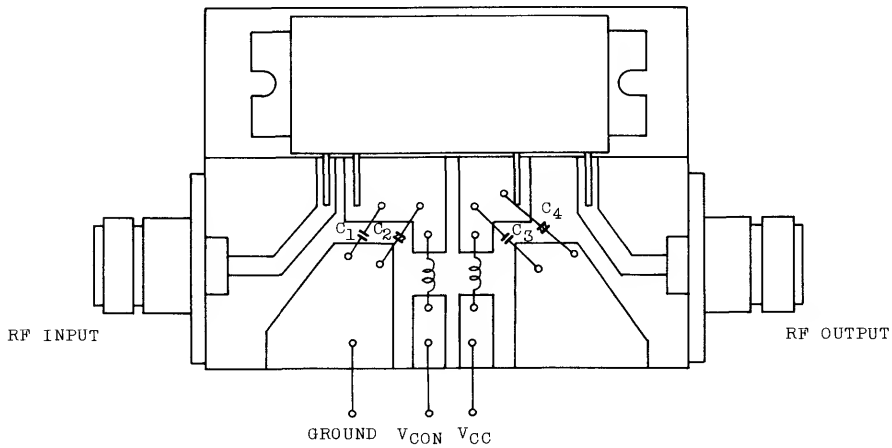
(1) Frequency range is covered in two bands S-AV10L 135-155MHz
S-AV10H 150-175MHz

S-AV10L • S-AV10H

SCHEMATIC

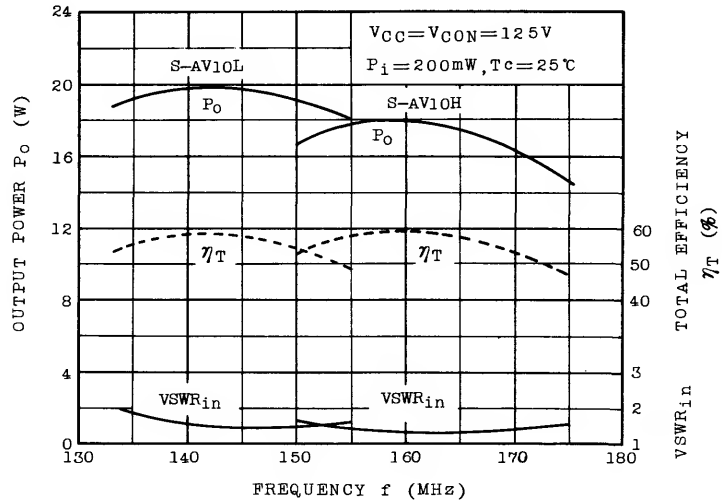


TEST MOUNT

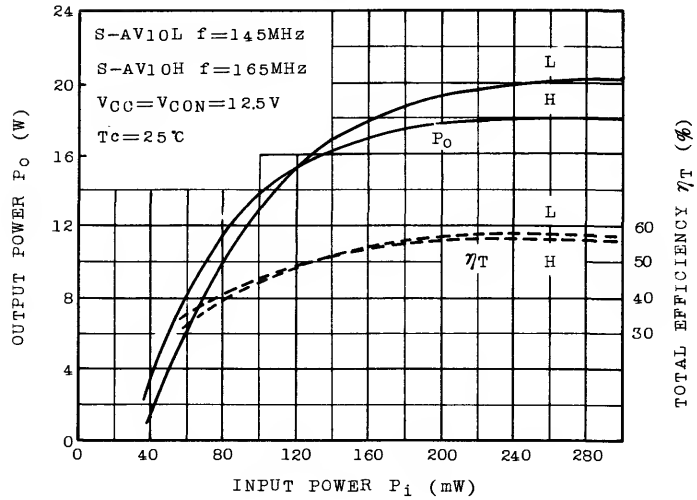


- C₁, C₃ 15000pF
- C₂, C₄ 1μF
- L₁, L₂ ∅0.8 COPPER WIRE 8T 5ID

$P_o, \eta_T, VSWR_{in} - f$

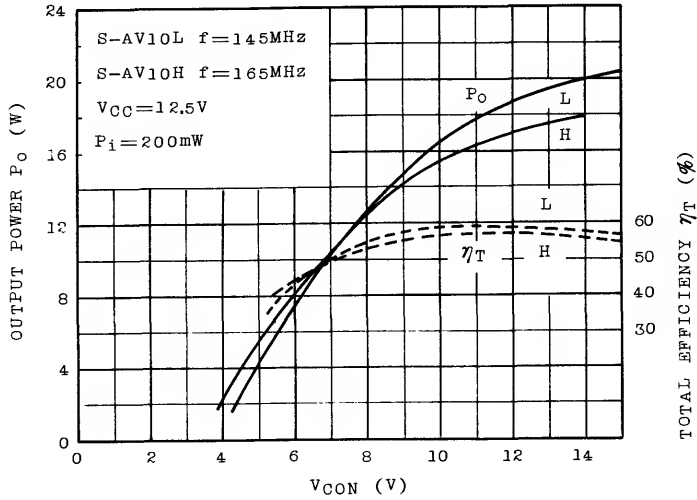


$P_o, \eta_T - P_i$

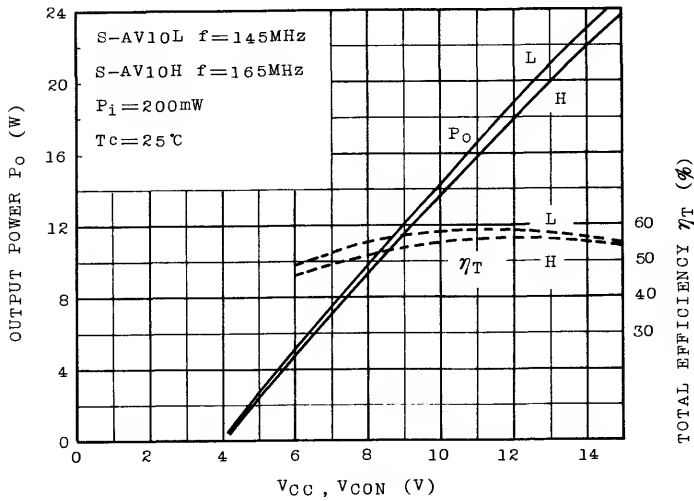


S-AV10L · S-AV10H

$P_o, \eta_T - V_{CON}$



$P_o, \eta_T - V_{CC}, V_{CON}$

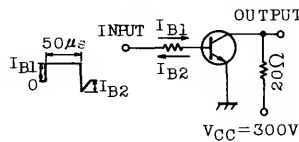


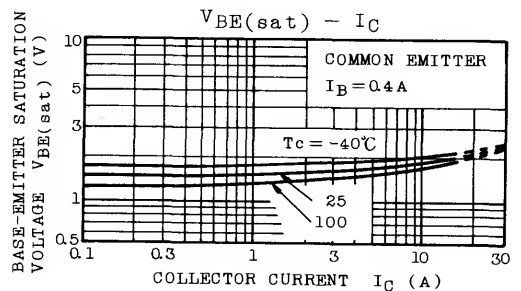
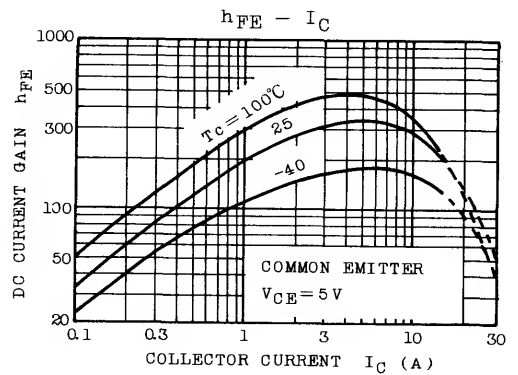
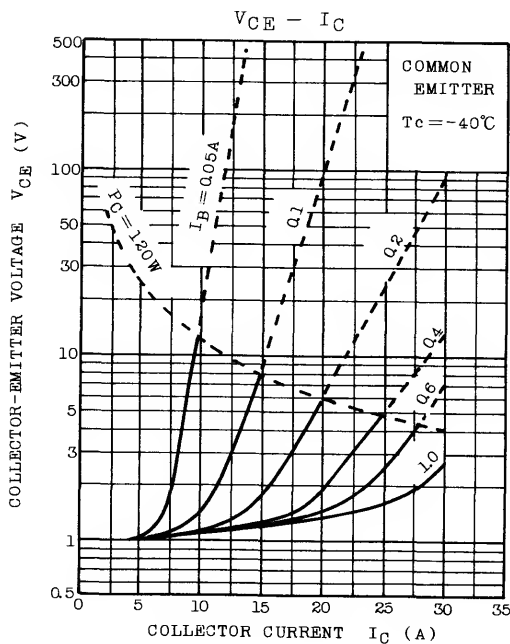
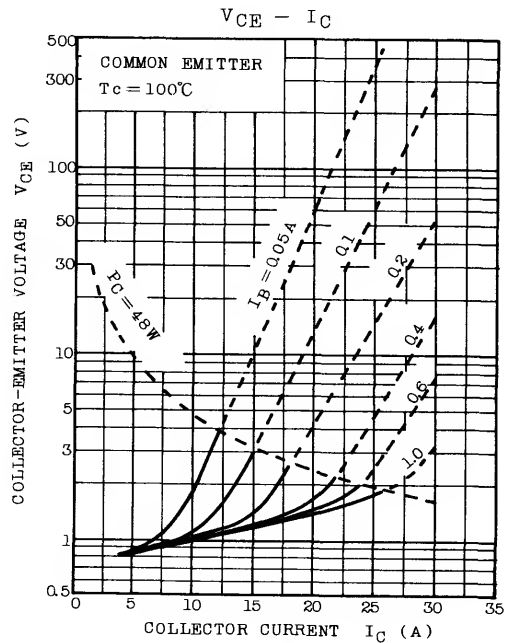
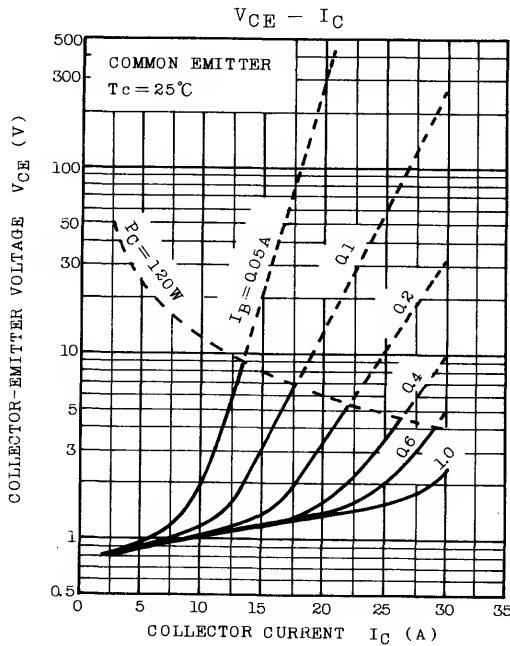
MG
SERIES



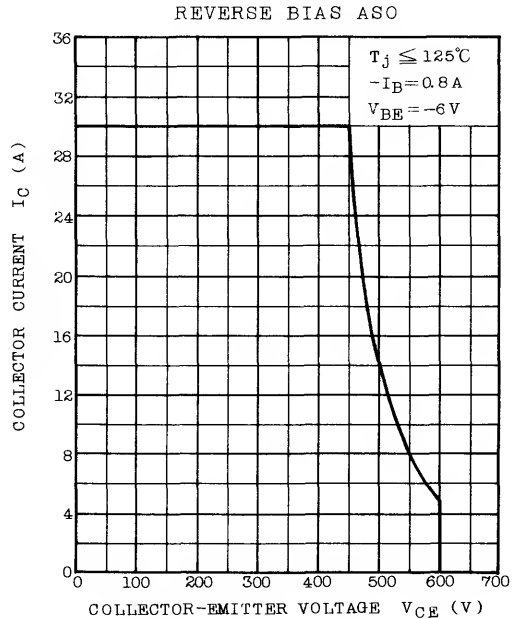
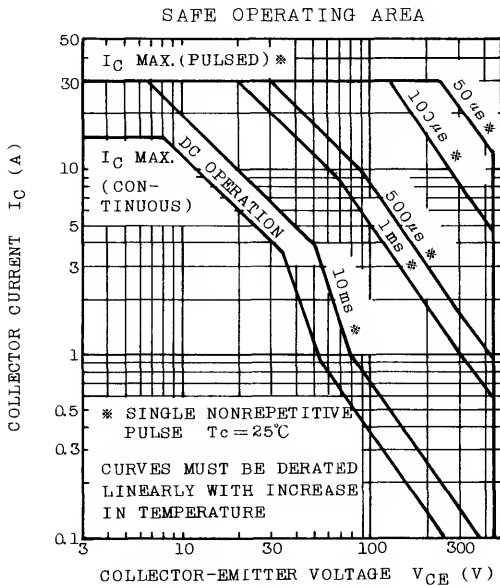
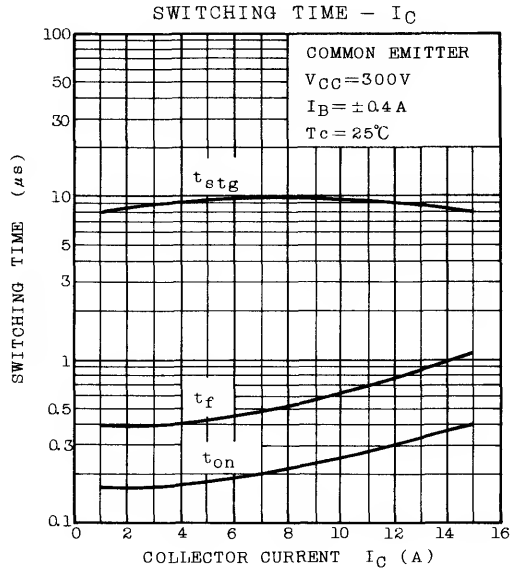
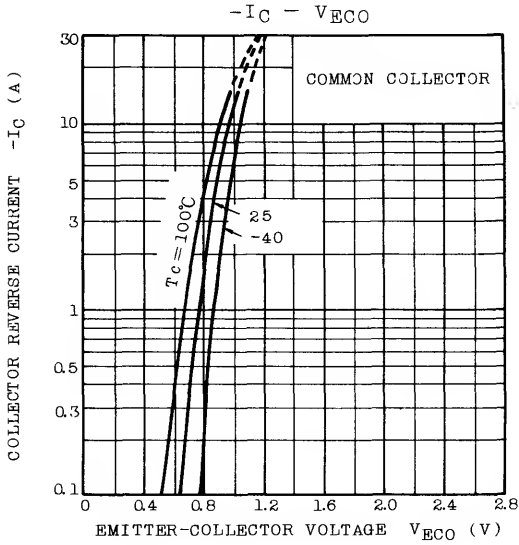
MG15G1AL3

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=600V, I_E=0$	-	-	1.0	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=6V, I_C=0$	-	-	100	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	$I_C=0.5A, L=40mH$	450	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=15A$	100	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=15A, I_B=0.4A$	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Emitter-Collector Voltage		V_{ECO}	$I_E=15A, I_B=0$	-	-	1.5	V
Reverse Recovery Time		t_{rr}	$-I_C=15A, V_{EB}=3V$ $V_{CE}=300V$	-	-	2.0	μs
Collector Output Capacitance		C_{ob}	$V_{CB}=50V, I_E=0, f=1MHz$	-	190	-	pF
Switching Time	Turn-on Time	t_{on}	 <p>$I_{B1} = -I_{B2} = 0.4A$ DUTY CYCLE = 0.5%</p>	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	12	
	Fall Time	t_f		-	-	2.0	
Thermal Resistance (Junction to Case)		$R_{th(j-c)}$	Transistor	-	-	1.0	°C/W
			Diode	-	-	3.5	



MG15G1AL3



SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER MODULE)

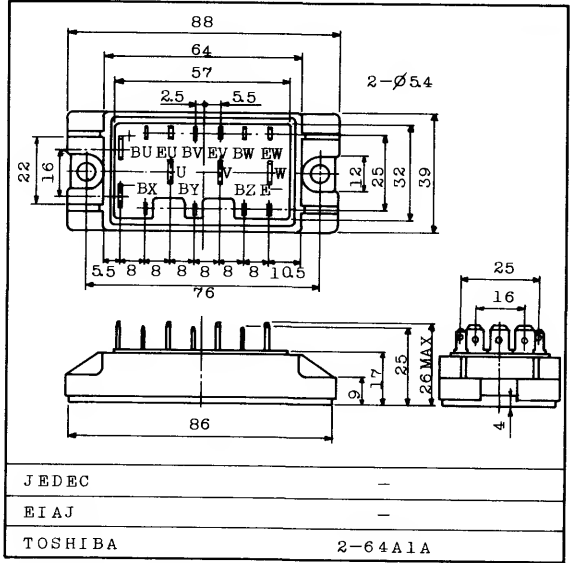
MG15G6EL1

HIGH POWER SWITCHING APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

Unit in mm

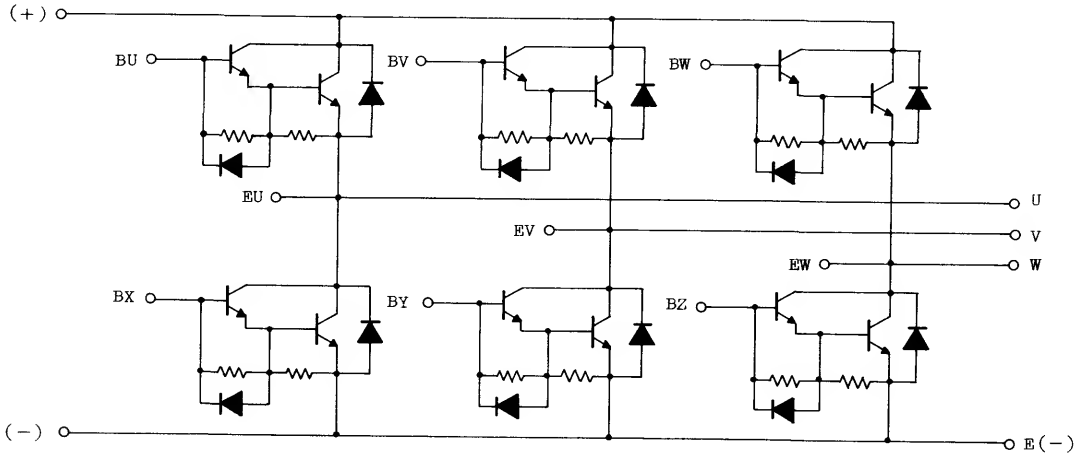
FEATURES:

- . The Collector is Isolated from Case.
- . 6 Darlington Transistor are Built-In to 1 Package.
- . With Built-in Free Wheeling Diode.
- . High DC Current Gain
: $h_{FE}=100(\text{Min.}) (I_C=15A)$
- . Low Saturation Voltage
: $V_{CE(\text{sat})}=2V(\text{Max.}) (I_C=15A)$
- . High Speed : $t_f=2\mu s(\text{Max.}) (I_C=15A)$



Weight : 180g

EQUIVALENT CIRCUIT



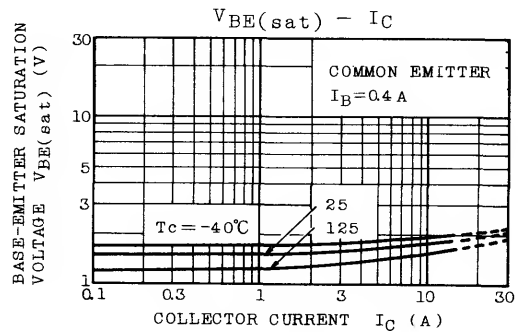
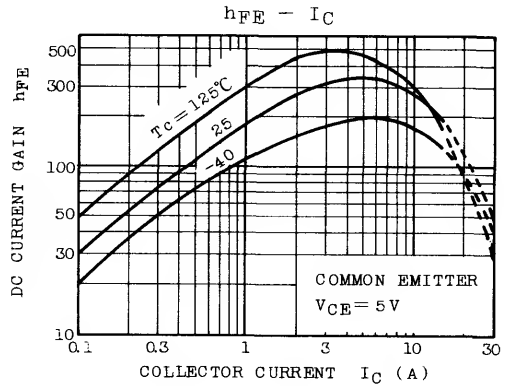
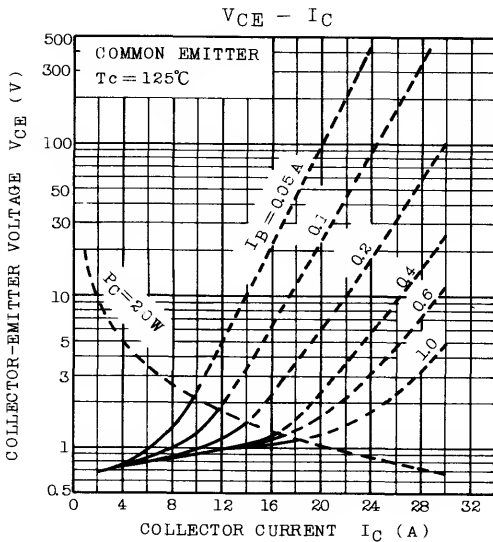
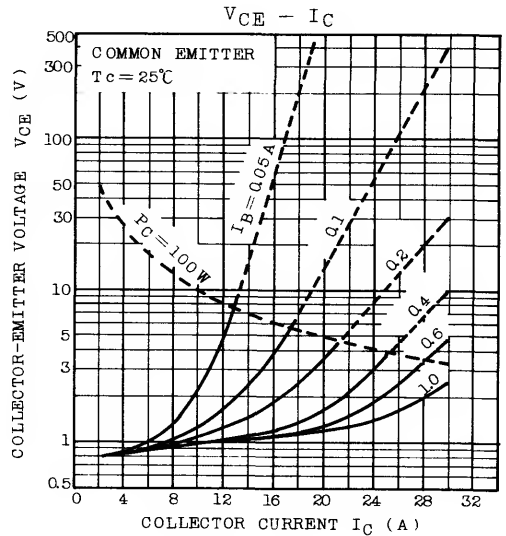
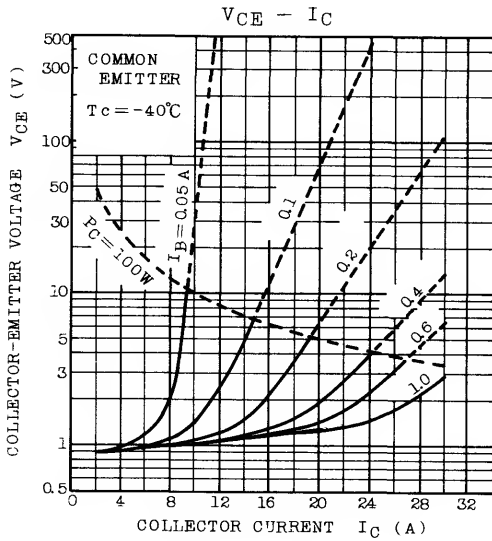
MG15G6EL1

MAXIMUM RATINGS (Tc=25°C)

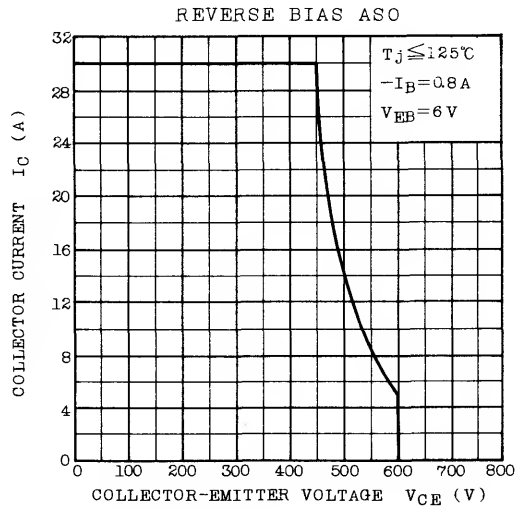
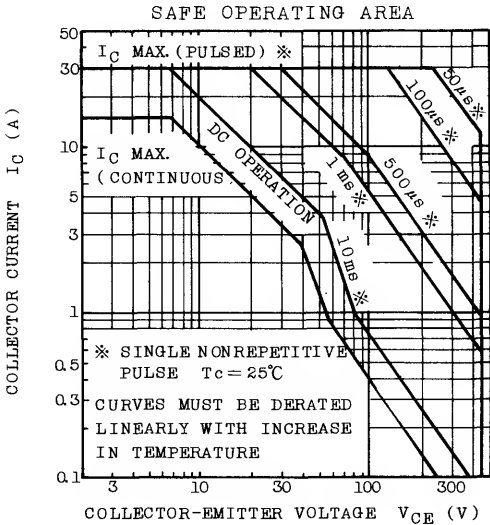
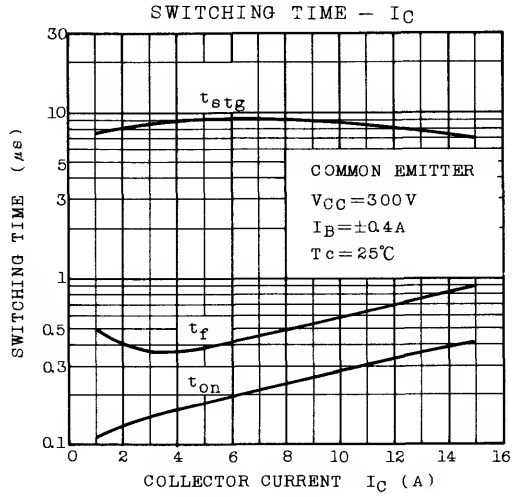
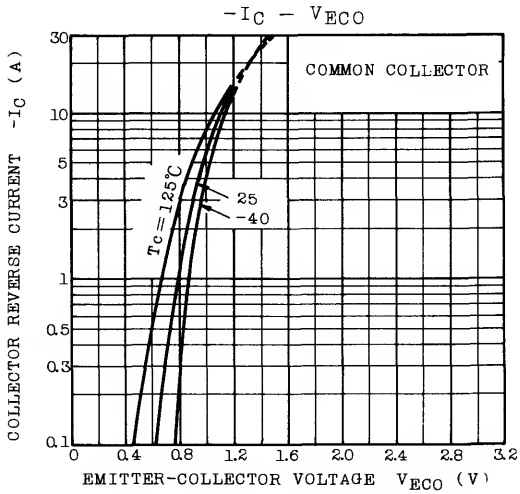
CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V _{CB0}	600	V
Collector-Emitter Voltage		V _{CEO}	600	V
Collector-Emitter Sustaining Voltage		V _{CEO(SUS)}	450	V
Emitter-Base Voltage		V _{EB0}	6	V
Collector Current	DC	I _C	15	A
	lms	I _C	30	A
	DC	-I _C	15	A
Base Current		I _B	1	A
Collector Power Dissipation (Tc=25°C)		P _C	100	W
Junction Temperature		T _j	150	°C
Storage Temperature Range		T _{stg}	-40 ~ 125	°C
Isolation Voltage		V _{Isol}	2000(AC 1 Minute)	V
Screw Torque			30	kg·cm

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I _{CB0}	V _{CB} =600V, I _E =0	-	-	1.0	mA
Emitter Cut-off Current		I _{EB0}	V _{EB} =6V, I _C =0	-	-	100	mA
Collector-Emitter Sustaining Voltage		V _{CEO(SUS)}	I _C =0.5A, L=40mH	450	-	-	V
DC Current Gain		h _{FE}	V _{CE} =5V, I _C =15A	100	-	-	
Collector-Emitter Saturation Voltage		V _{CE(sat)}	I _C =15A, I _B =0.4A	-	-	2.0	V
Base-Emitter Saturation Voltage		V _{BE(sat)}		-	-	2.5	V
Emitter-Collector Voltage		V _{ECO}	I _E =15A, I _B =0	-	-	1.6	V
Reverse Recovery Time			-I _C =15A, V _{EB} =2V, V _{CE} =300V	-	-	2.0	μs
Collector Output Capacitance		C _{ob}	V _{CB} =50V, I _E =0, f=1MHz	-	400	-	pF
Switching Time	Turn-on Time	t _{on}	<p>50 μs INPUT I_{B1} I_{B2} OUTPUT 20 Ω V_{CC}=300V</p>	-	-	1.0	μs
	Storage Time	t _{stg}		-	-	12	
	Fall Time	t _f		I _{B1} = -I _{B2} = 0.4 A DUTY CYCLE=0.5%	-	-	
Thermal Resistance (Junction to Case)		R _{th(j-c)}		-	-	1.25	°C/W



MG15G6EL1



SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER MODULE)

MG30G1BL2

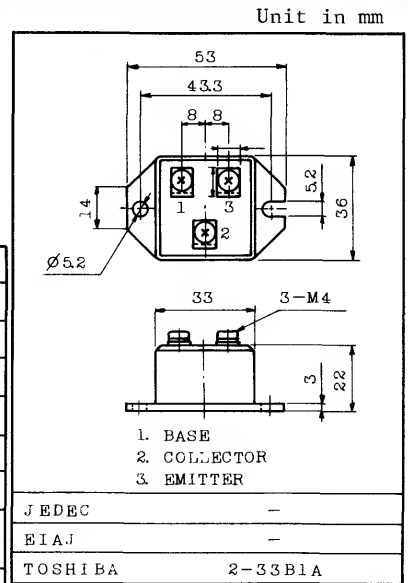
HIGH POWER SWITCHING APPLICATIONS.

FEATURES:

- The Collector is Isolated from Ground.
- High DC Current Gain : $h_{FE}=100(\text{Min.})$ ($I_C=30A$)
- Low Saturation Voltage : $V_{CE(sat)}=2V(\text{Max.})$ ($I_C=30A$)
- High Speed : $t_f=2\mu s(\text{Max.})$ ($I_C=30A$)

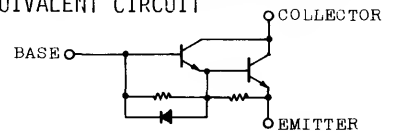
MAXIMUM RATINGS ($T_c=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB0}	600	V
Collector-Emitter Voltage	$V_{CEO(SUS)}$	450	V
Emitter-Base Voltage	V_{EBO}	6	V
Collector Current	DC	I_C	30 A
	Pulse	I_{CP}	60 A
Base Current	I_B	2	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	250	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-40 ~ 125	$^\circ C$
Isolation Voltage	V_{Isol}	2000 (AC 1minute)	V
Screw Torque		20	kg·cm



Weight : 98g

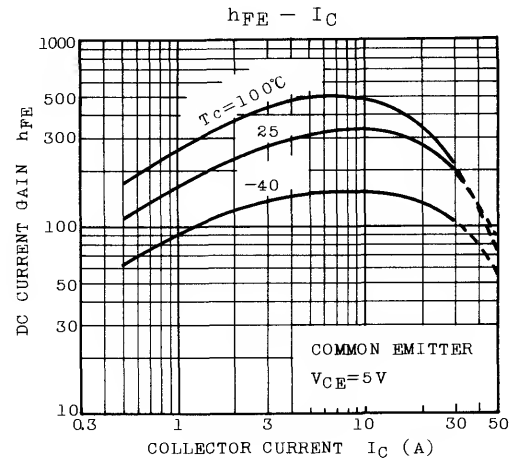
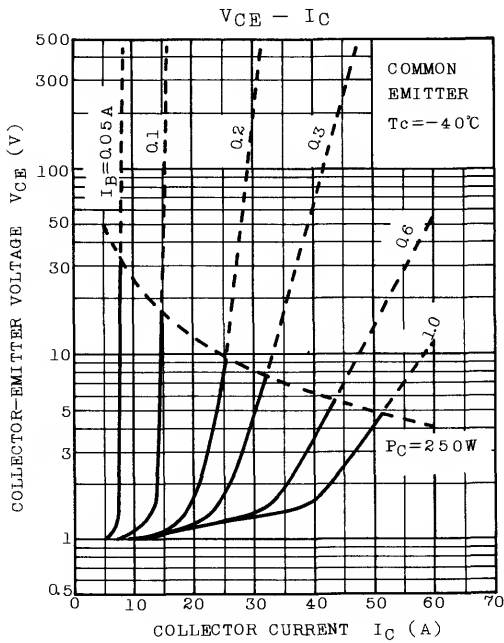
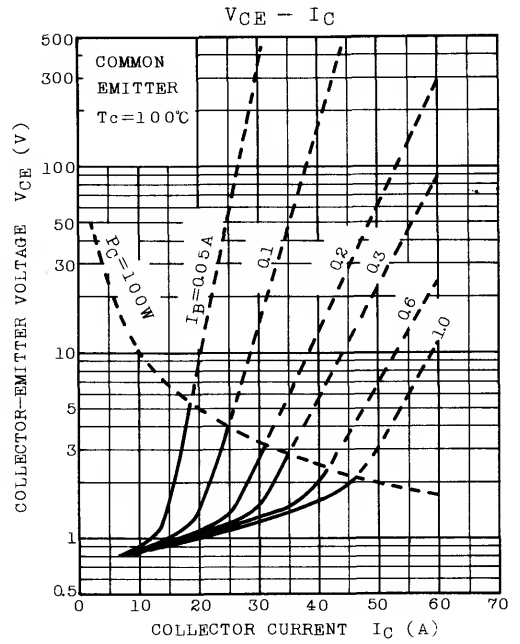
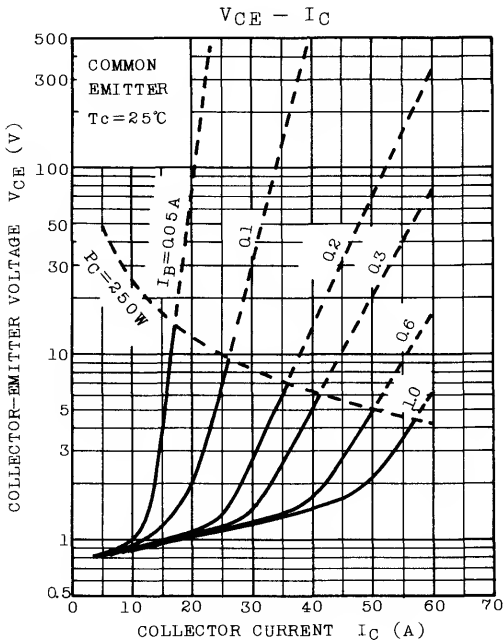
EQUIVALENT CIRCUIT

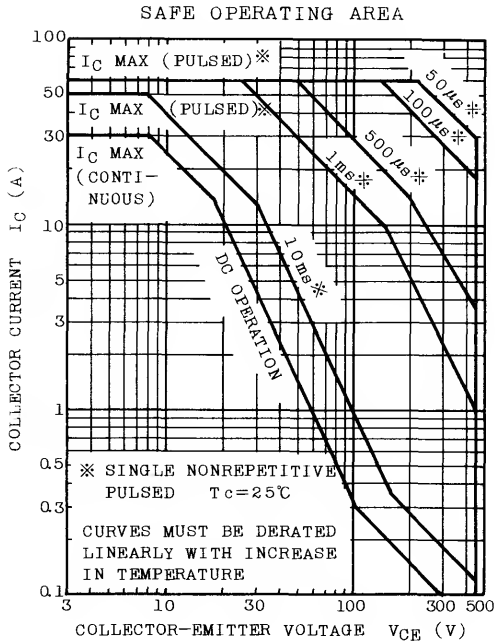
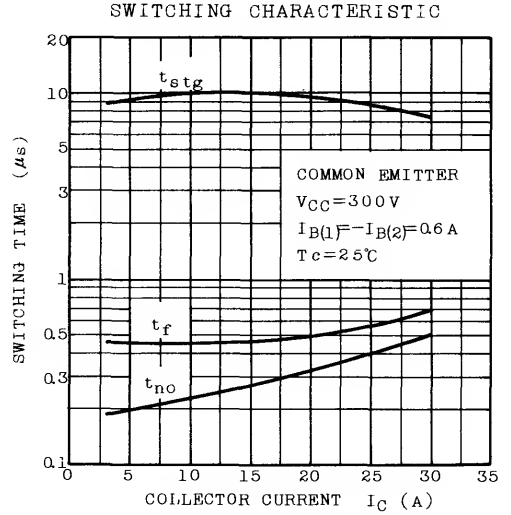
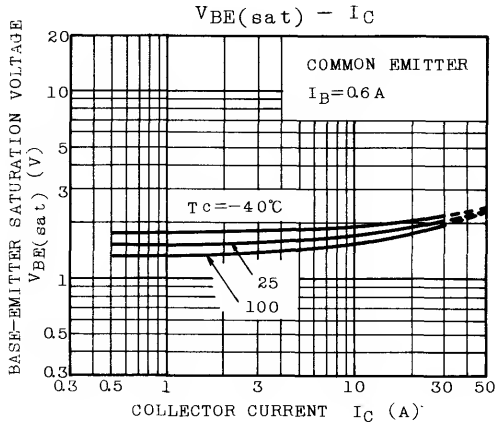


ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Collector Cut-off Current	I_{CBO}	$V_{CB}=600V, I_E=0$	-	-	1.0	mA	
Emitter Cut-off Current	I_{EBO}	$V_{EB}=6V, I_C=0$	-	-	200	mA	
Collector-Emitter Sustaining Voltage	$V_{CEO(SUS)}$	$I_C=0.5A, L=40mH$	450	-	-	V	
DC Current Gain	h_{FE}	$V_{CE}=5V, I_C=30A$	100	-	-		
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=30A, I_B=0.6A$	-	-	2.0	V	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$		-	-	2.5	V	
Collector Output Capacitance	C_{ob}	$V_{CB}=50V, I_E=0, f=1MHz$	-	250	-	pF	
Switching Time	Turn-on Time	t_{on}			-	1.0	μs
	Storage Time	t_{stg}			-	12	
	Fall Time	t_f			-	2.0	
Thermal Resistance	$R_{th(j-c)}$	Junction to Case	-	-	0.5	$^\circ C/W$	

MG30G1BL2





MG30G2CL3

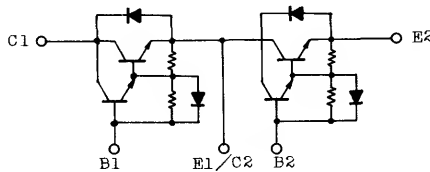
SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER MODULE)

HIGH POWER SWITCHING APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

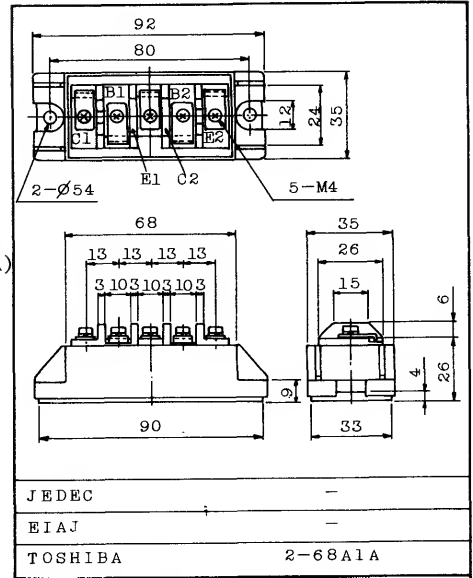
FEATURES:

- . The Collector is Isolated from Case.
- . 2 Power Transistor and 2 Free Wheeling Diodes are Built-in to 1 Package.
- . High DC Current Gain : $h_{FE}=100(\text{Min.}) (I_C=30A)$
- . Low Saturation Voltage : $V_{CE}(\text{sat})=2V(\text{Max.}) (I_C=30A)$
- . High Speed : $t_f=2\mu s(\text{Max.}) (I_C=30A)$

EQUIVALENT CIRCUIT



Unit in mm

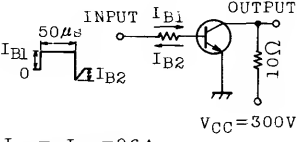


Weight : 210g

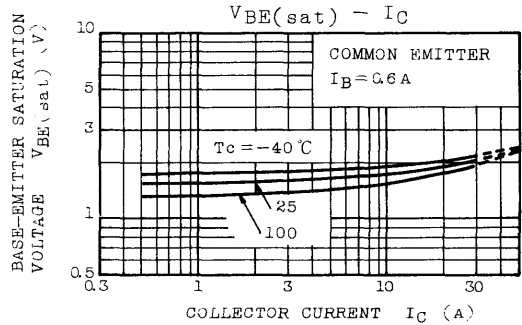
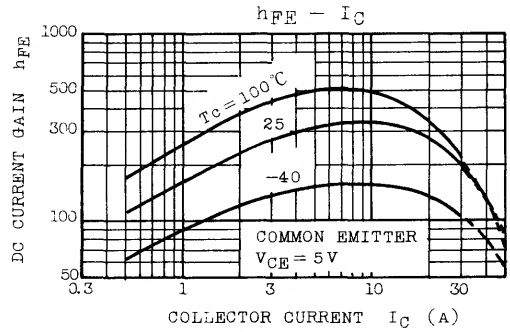
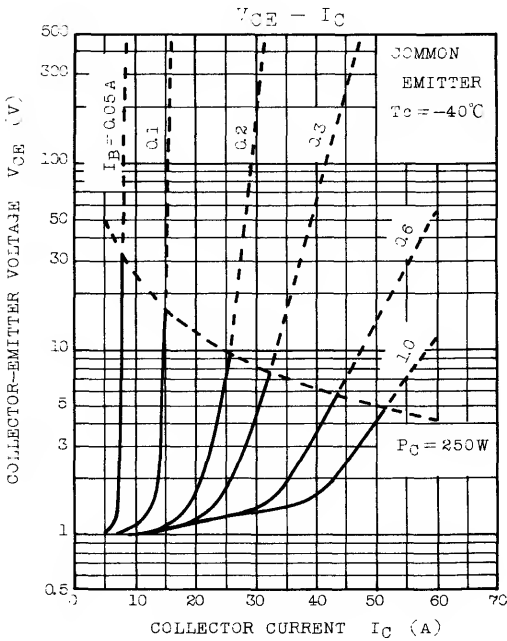
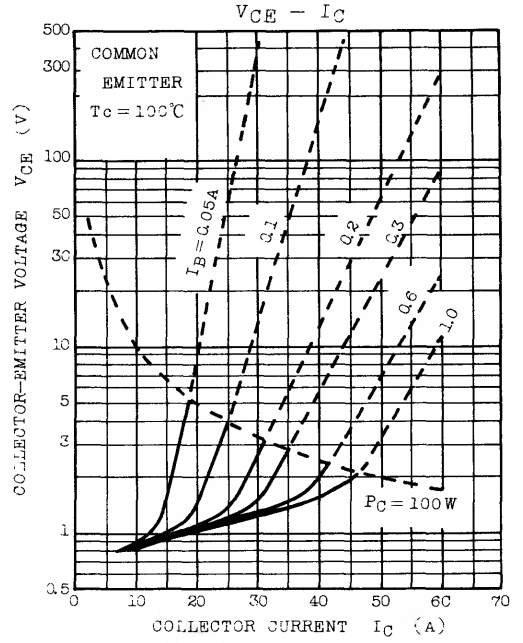
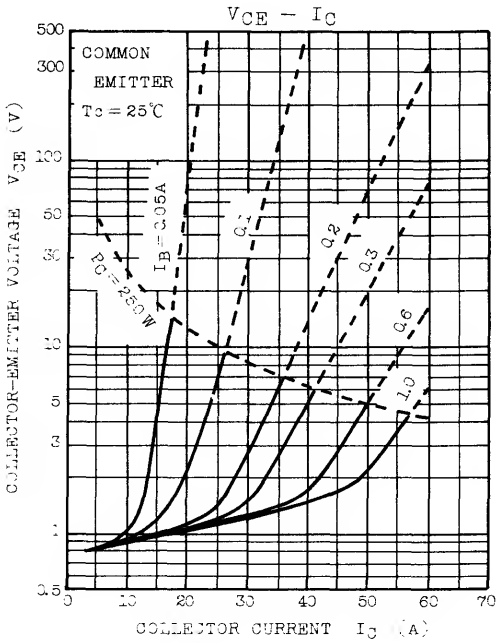
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V _{CBO}	600	V
Collector- Emitter Voltage	V _{CEO}	600	V
Collector-Emitter Sustaining Voltage	V _{CEO(SUS)}	450	V
Emitter-Base Voltage	V _{EBO}	6	V
Collector Current	DC	I _C	30
	lms	I _C	60
	DC	-I _C	30
Base Current	I _B	2.0	A
Collector Power Dissipation (Tc=25°C)	P _C	250	W
Junction Temperature	T _j	150	°C
Storage Temperature Range	T _{stg}	-40 ~ 125	°C
Isolation Voltage	V _{isol}	2000 (AC 1 Minute)	V
Screw Torque (Terminal/Mounting)		20/30	kg·cm

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		ICBO	V _{CB} =600V, I _E =0	-	-	1.0	mA
Emitter Cut-off Current		IEBO	VEB=6V, IC=0	-	-	200	mA
Collector-Emitter Sustaining Voltage		V _{CEO(SUS)}	IC=0.5A, L=40mH	450	-	-	V
DC Current Gain		h _{FE}	V _{CE} =5V, IC=30A	100	-	-	
Collector-Emitter Saturation Voltage		V _{CE(sat)}	IC=30A, IB=0.6A	-	-	2.0	V
Base-Emitter Saturation Voltage		V _{BE(sat)}		-	-	2.5	V
Emitter-Collector Voltage		VECO	IE=30A, IB=0	-	-	1.5	V
Reverse Recovery Time		t _{rr}	-IC=30A, VEB=3V VCE=300V	-	-	2.0	μs
Collector Output Capacitance		C _{ob}	V _{CB} =50V, IE=0, f=1MHz	-	350	-	pF
Switching Time	Turn-on Time	t _{on}	 <p style="text-align: center;"> $I_{B1} = -I_{B2} = 0.6\text{ A}$ DUTY CYCLE=0.5% </p>	-	-	1.0	μs
	Storage Time	t _{stg}		-	-	12	
	Fall Time	t _f		-	-	2.0	
Thermal Resistance (Junction to Case)		R _{th(j-c)}	Transistor	-	-	0.5	°C/W
			Diode	-	-	1.8	

MG30G2CL3



MG50G1BL2

SILICON NPN TRIPLE DIFFUSED TYPE (DARLINGTON POWER MODULE)

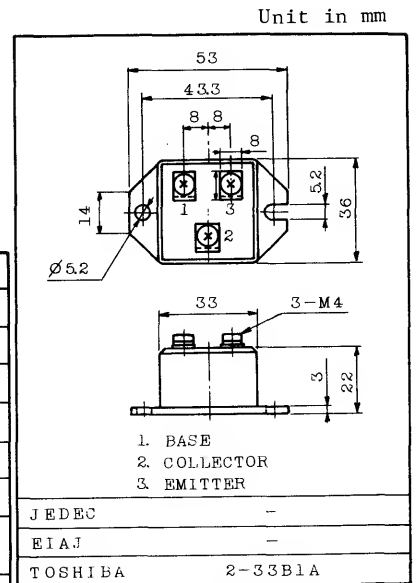
HIGH POWER SWITCHING APPLICATIONS.

FEATURES:

- . The Collector is Isolated from Ground.
- . High DC Current Gain : $h_{FE}=100(\text{Min.})$ ($I_C=50A$)
- . Low Saturation Voltage : $V_{CE}(\text{sat})=2V(\text{Max.})$ ($I_C=50A$)
- . High Speed : $t_f=2\mu s(\text{Max.})$ ($I_C=50A$)

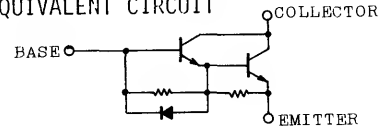
MAXIMUM RATINGS ($T_c=25^\circ C$)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V_{CBO}	600	V
Collector-Emitter Voltage		$V_{CEO}(\text{SUS})$	450	V
Emitter-Base Voltage		V_{EBO}	6	V
Collector Current	DC	I_C	50	A
	Pulse	I_{CP}	100	A
Base Current		I_B	3	A
Collector Power Dissipation ($T_c=25^\circ C$)		P_C	300	W
Junction Temperature		T_j	150	$^\circ C$
Storage Temperature Range		T_{stg}	-40 ~ 125	$^\circ C$
Isolation Voltage		V_{Isol}	2000 (AC 1 Minute)	V
Screw Torque			20	kg·cm



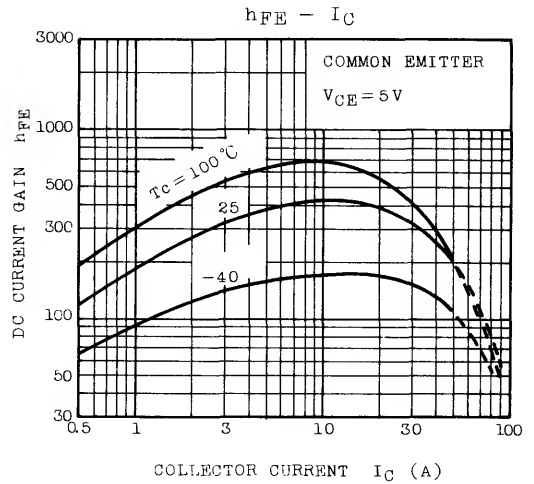
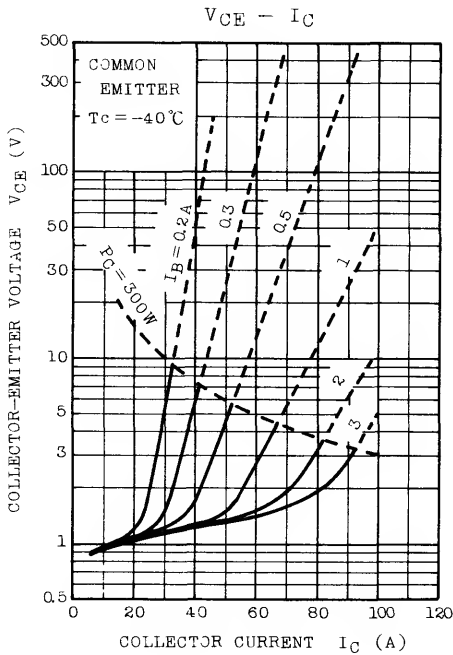
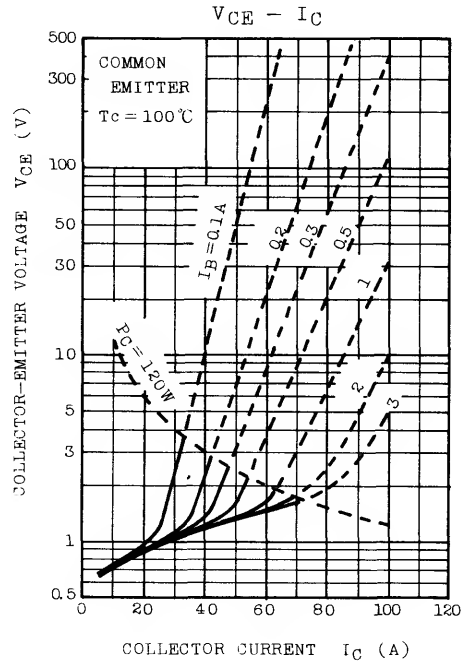
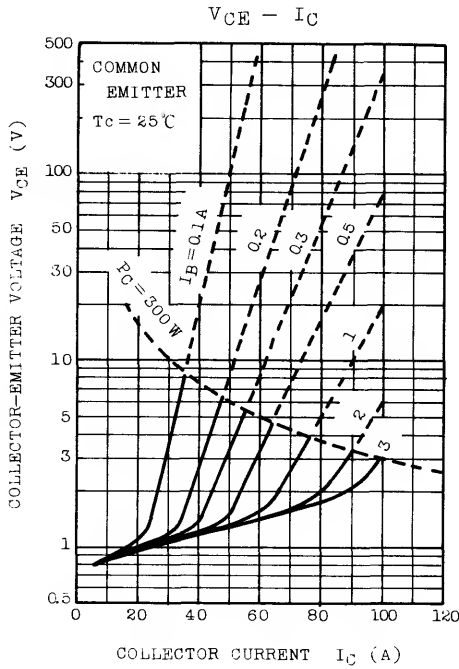
Weight : 98g

EQUIVALENT CIRCUIT

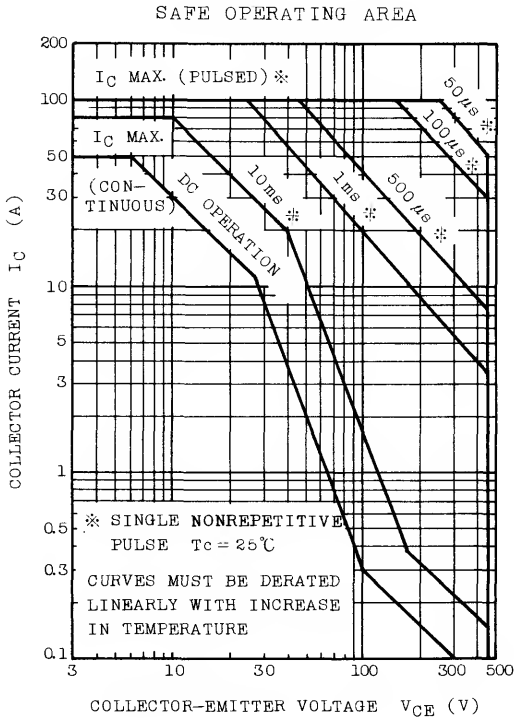
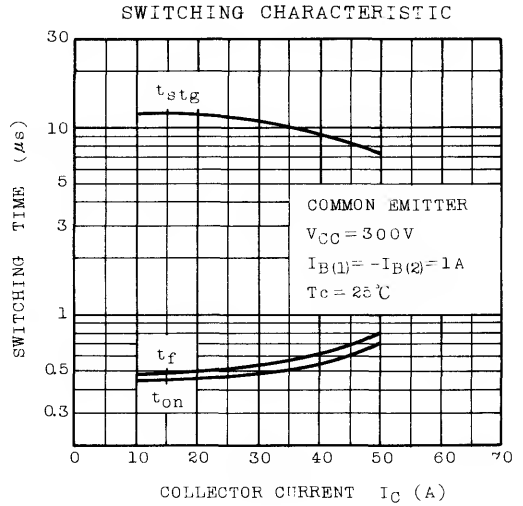
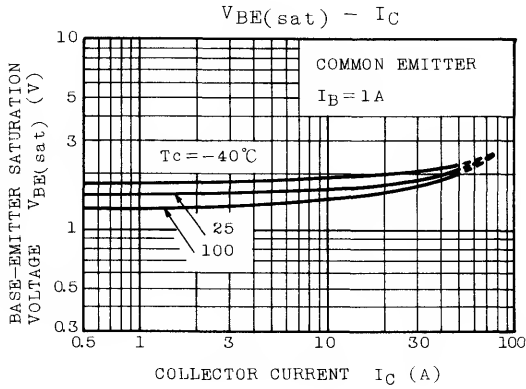


ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=600V, I_E=0$	-	-	1.0	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=6V, I_C=0$	-	-	200	mA
Collector-Emitter Sustaining Voltage		$V_{CEO}(\text{SUS})$	$I_C=0.5A, L=40mH$	450	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=50A$	100	-	-	
Collector-Emitter Saturation Voltage		$V_{CE}(\text{sat})$	$I_C=50A, I_B=1A$	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE}(\text{sat})$		-	-	2.5	V
Collector Output Capacitance		C_{ob}	$V_{CB}=50V, I_E=0, f=1MHz$	-	450	-	pF
Switching Time	Turn-on Time	t_{on}		-	-	1.0	μs
	Storage Time	t_{stg}		-	-	12	
	Fall Time	t_f		$I_{B1}=-I_{B2}=1A$ DUTY CYCLE=0.5%	-	-	
Thermal Resistance		$R_{th(j-c)}$	Junction to Case	-	-	0.41	$^\circ C/W$



MG50G1BL2

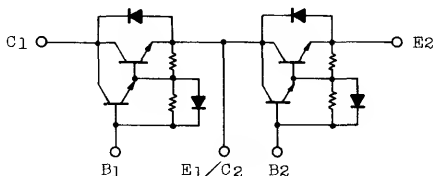


HIGH POWER SWITCHING APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

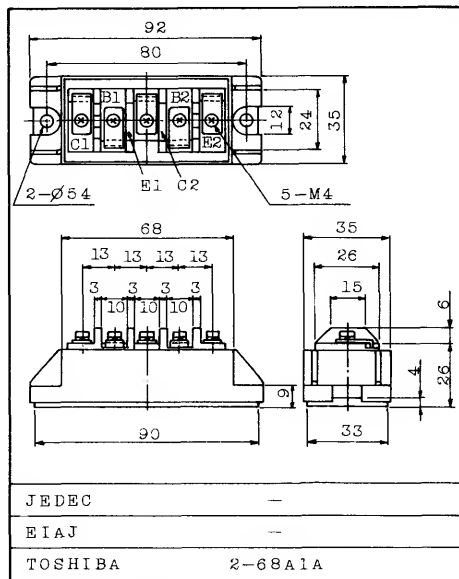
FEATURES:

- . The Collector is Isolated from Case.
- . 2 Power Transistors and 2 Free Wheeling Diodes are Built-in to 1 Package.
- . High DC Current Gain : $h_{FE}=100(\text{Min.})$ ($I_C=50A$)
- . Low Saturation Voltage: $V_{CE}(\text{sat})=2V(\text{Max.})$ ($I_C=50A$)
- . High Speed : $t_f=2\mu s(\text{Max.})$ ($I_C=50A$)

EQUIVALENT CIRCUIT



Unit in mm



Weight : 210g

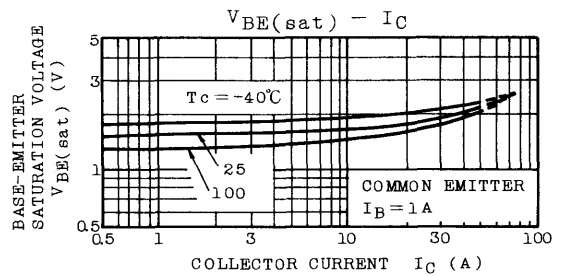
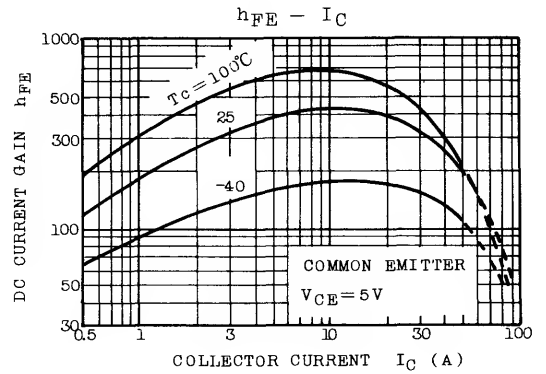
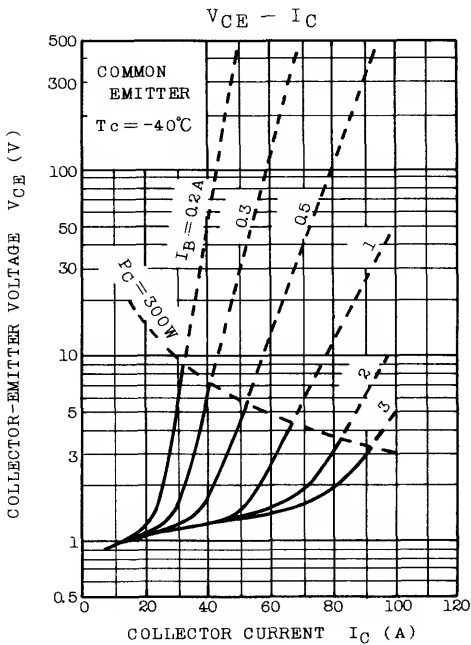
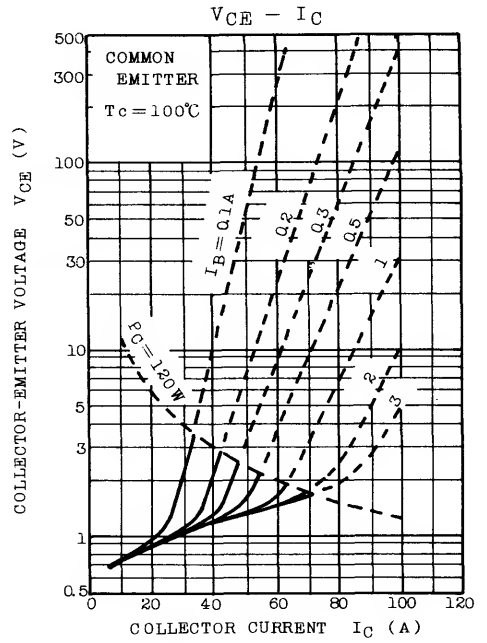
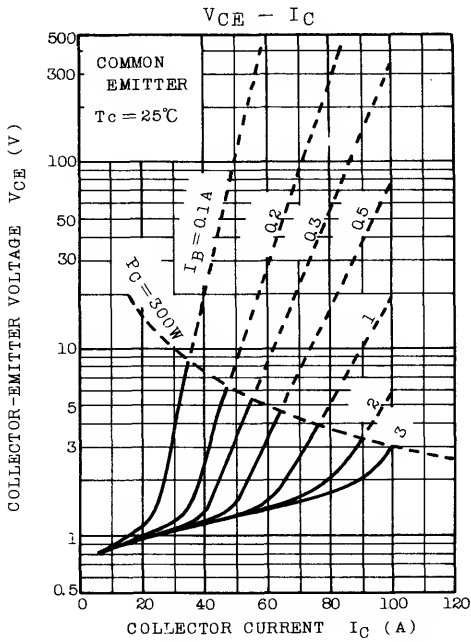
MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	V_{CEO}	600	V
Collector-Emitter Sustaining Voltage	$V_{CEO}(\text{SUS})$	450	V
Emitter-Base Voltage	V_{EBO}	6	V
Collector Current	DC	I_C	50
	lms	I_C	100
	DC	$-I_C$	50
Base Current	I_B	3	A
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	300	W
Junction Temperature	T_j	150	$^\circ C$
Storage Temperature Range	T_{stg}	-40 ~ 125	$^\circ C$
Isolation Voltage	V_{Isol}	2000 (AC 1 Minute)	V
Screw Torque (Terminal/Mounting)		20/30	kg·cm

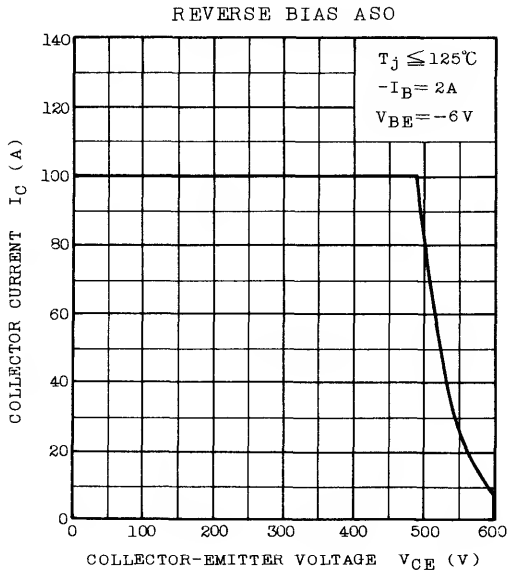
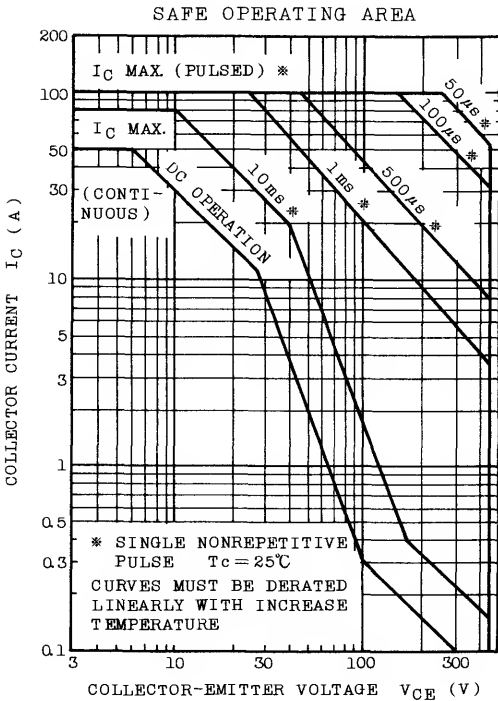
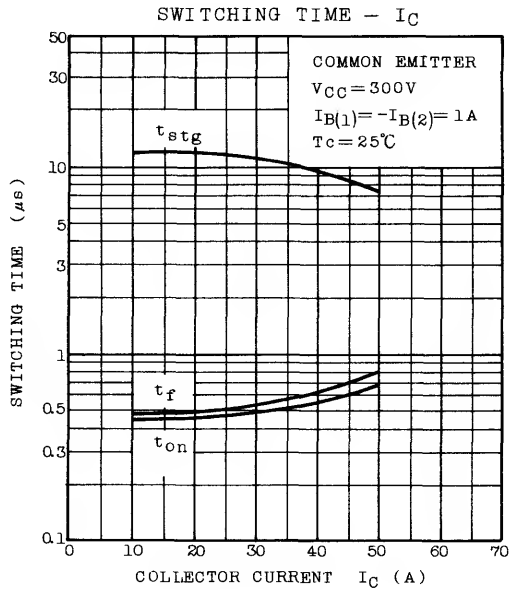
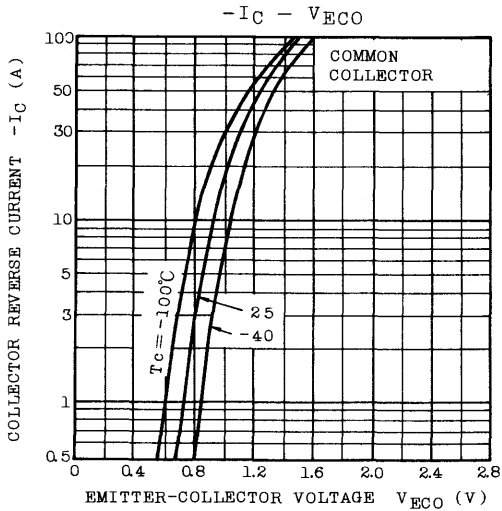
MG50G2CL3

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=600V, I_E=0$	-	-	1.0	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=6V, I_C=0$	-	-	200	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	$I_C=0.5A, L=40mH$	450	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=50A$	100	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=50A, I_B=1A$	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Emitter-Collector Voltage		V_{ECO}	$I_E=50A, I_B=0$	-	-	1.5	V
Reverse Recovery Time		t_{rr}	$-I_C=50A, V_{EB}=3V$ $V_{CE}=300V$	-	-	2.0	μs
Collector Output Capacitance		C_{ob}	$V_{CB}=50V, I_E=0, f=1MHz$	-	520	-	pF
Switching Time	Turn-on Time	t_{on}	<p style="text-align: center;">$V_{CC}=300V$</p>	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	12	
	Fall Time	t_f		$I_{B1}=-I_{B2}=1A$ DUTY CYCLE=0.5%	-	-	
Thermal Resistance (Junction to Case)		$R_{th(j-c)}$	Transistor	-	-	0.41	$^{\circ}C/W$
			Diode	-	-	1.3	



MG50G2CL3



SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER MODULE)

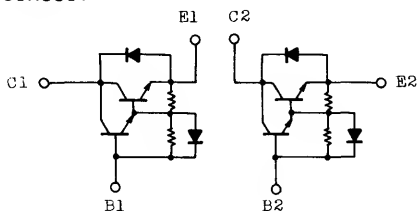
MG75H2DL1

HIGH POWER SWITCHING APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

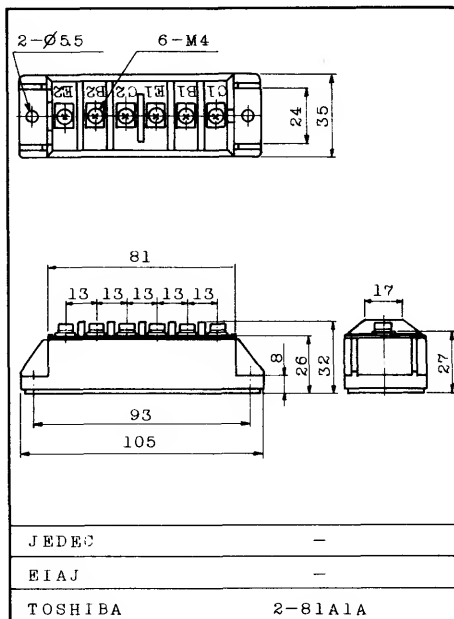
FEATURES:

- . The Collector is Isolated from Case.
- . 2 Power Transistors and 2 Free Wheeling Diodes are Built-in to 1 Package.
- . High DC Current Gain : $h_{FE}=80(\text{Min.})(I_C=75\text{A})$
- . Low Saturation Voltage : $V_{CE(\text{sat})}=2\text{V}(\text{Max.})(I_C=75\text{A})$
- . High Speed : $t_f=4\mu\text{s}(\text{Max.})(I_C=75\text{A})$

EQUIVALENT CIRCUIT



Unit in mm



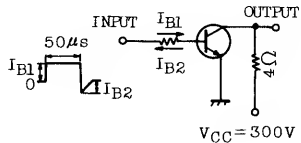
Weight :

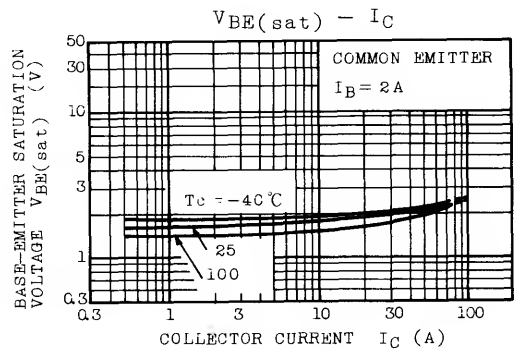
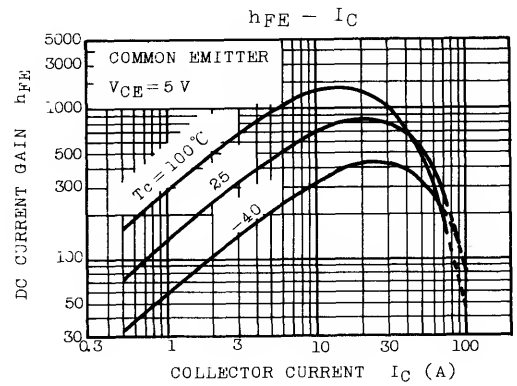
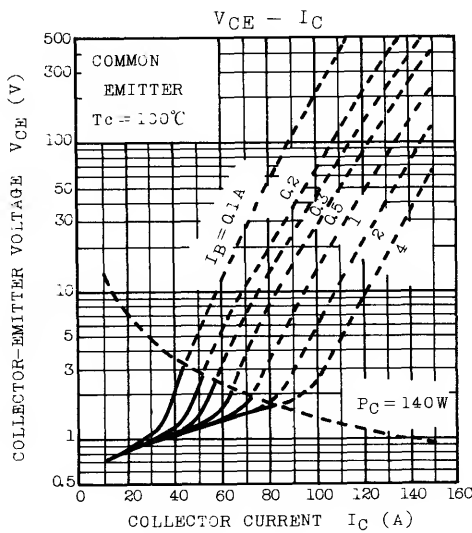
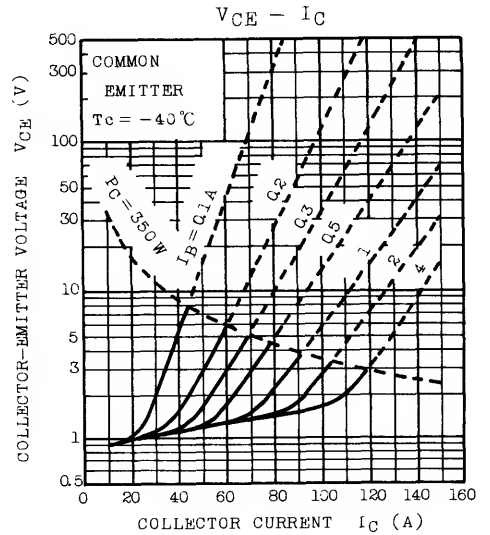
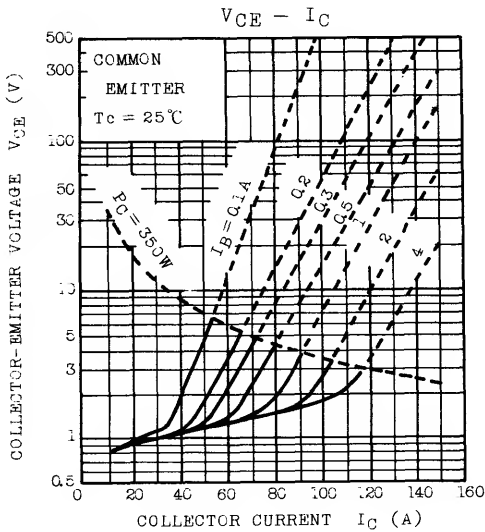
MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	600	V
Collector-Emitter Voltage	$V_{CEO(\text{SUS})}$	500	V
Emitter-Base Voltage	V_{EBO}	6	V
Collector Current	DC	I_C	75
	lms	I_{CP}	150
	DC	$-I_C$	75
Base Current	I_B	4	A
Collector Power Dissipation ($T_c=25^\circ\text{C}$)	P_C	350	W
Junction Temperature	T_j	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-40 ~ 125	$^\circ\text{C}$
Isolation Voltage	V_{Isol}	2000(AC 1 Minute)	V
Screw Torque (Terminal/Mounting)		20/30	kg·cm

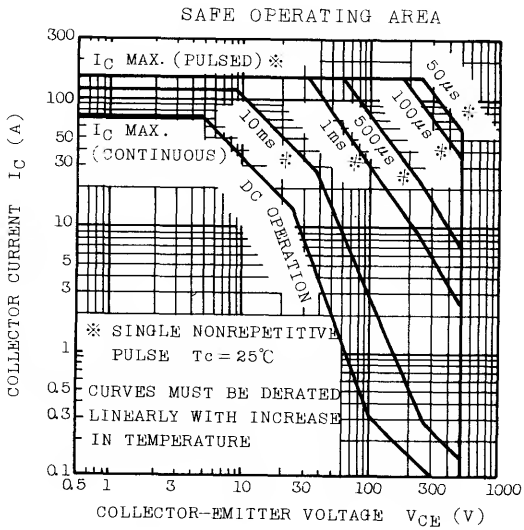
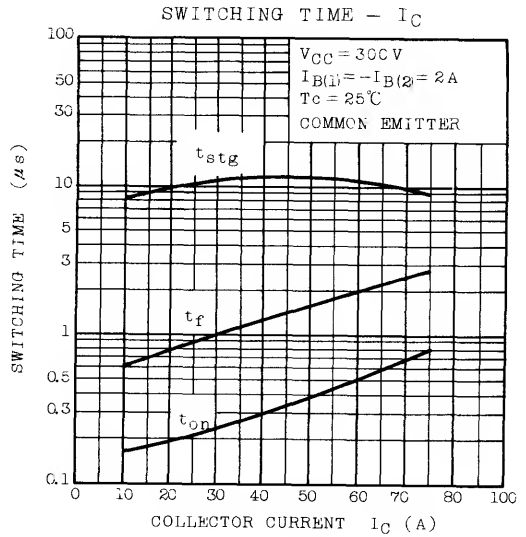
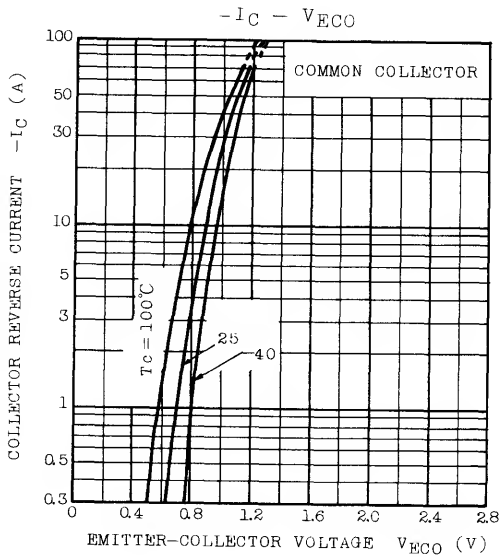
MG75H2DL1

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=600V, I_E=0$	-	-	1.0	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=6V, I_C=0$	-	-	200	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	$I_C=0.5A, L=40mH$	500	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=75A$	80	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=75A, I_B=2A$	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Emitter-Collector Voltage		V_{ECO}	$I_E=75A, I_B=0$	-	-	1.5	V
Reverse Recovery Time		t_{rr}	$-I_C=75A, V_{EB}=3V$ $V_{CE}=300V$	-	-	2.0	μs
Collector Output Capacitance		C_{ob}	$V_{CB}=50V, I_E=0$ $f=1MHz$	-	670	-	pF
Switching Time	Turn-on Time	t_{on}	 <p>$I_{B1} = -I_{B2} = 2A$ DUTY CYCLE=0.5%</p>	-	-	2.0	μs
	Storage Time	t_{stg}		-	-	12	
	Fall Time	t_f		-	-	4.0	
Thermal Resistance (Junction to Case)		$R_{th(j-c)}$	Transistor	-	-	0.36	$^{\circ}C/W$
			Diode	-	-	1.3	



MG75H2DL1

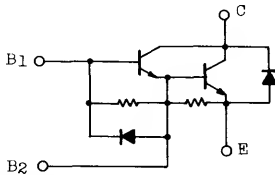


HIGH POWER SWITCHING APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

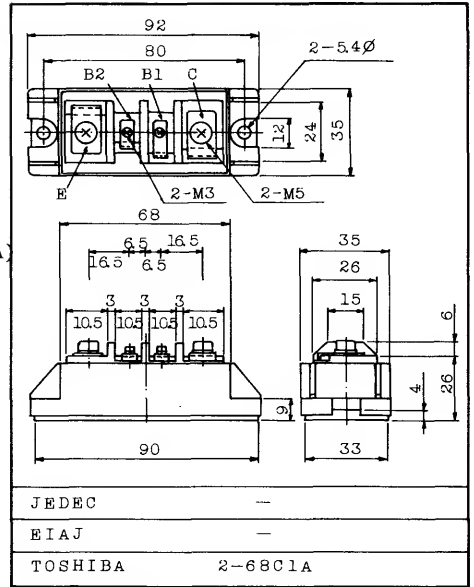
FEATURES:

- . The Collector is Isolated from Case.
- . With Built-in Free Wheeling Diode
- . High DC Current Gain : $h_{FE}=100(\text{Min.}) (I_C=100A)$
- . Low Saturation Voltage : $V_{CE}(\text{sat})=2V(\text{Max.}) (I_C=100A)$
- . High Speed : $t_f=2\mu s(\text{Max.}) (I_C=100A)$

EQUIVALENT CIRCUIT



Unit in mm



Weight : 210g

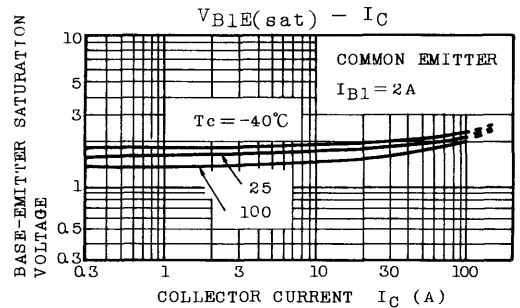
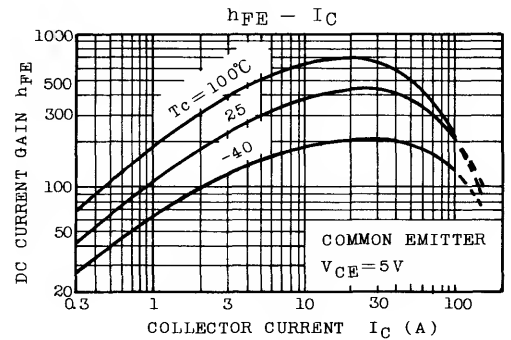
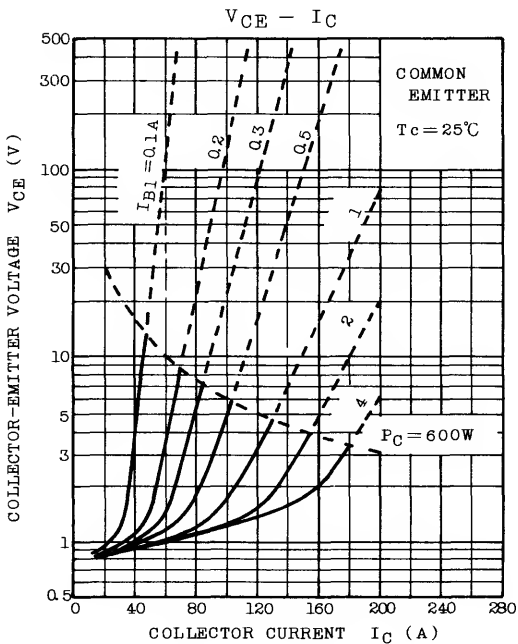
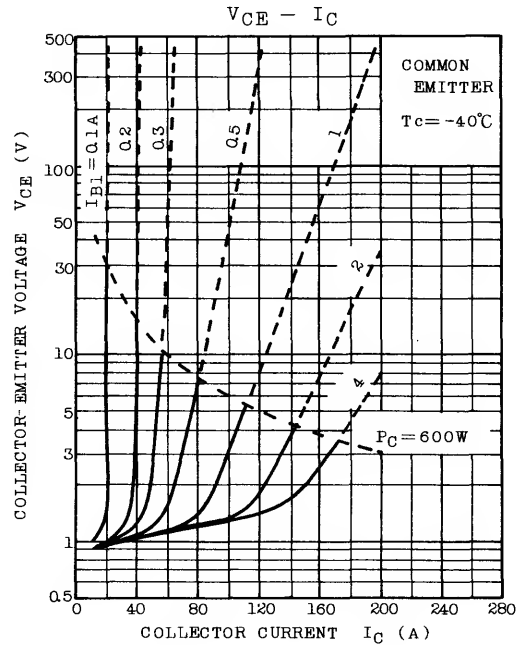
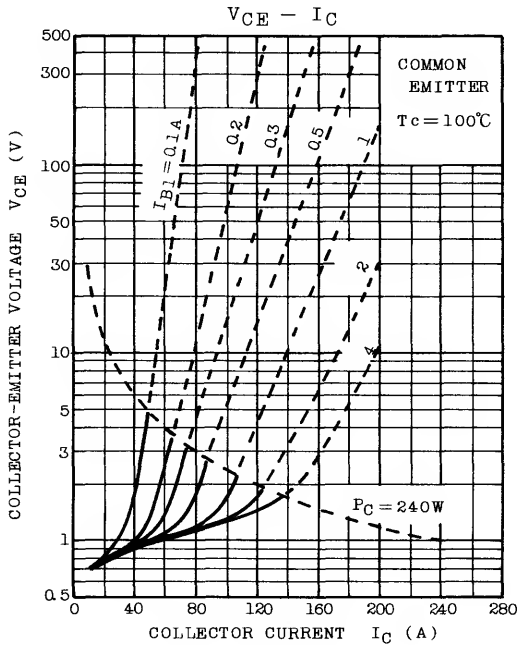
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Collector-Base Voltage		V _{CB10}	600	V
Collector-Emitter Voltage		V _{CEO}	600	V
Collector-Emitter Sustaining Voltage		V _{CEO(SUS)}	450	V
Emitter-Base Voltage		V _{EB10}	6	V
Collector Current	DC	I _C	100	A
	1ms	I _C	200	A
	DC	-I _C	100	A
Base Current		I _{B1}	5	A
Collector Power Dissipation (Tc=25°C)		P _C	600	W
Junction Temperature		T _j	150	°C
Storage Temperature Range		T _{stg}	-40~125	°C
Isolation Voltage		V _{Isol}	2000(AC 1 Minute)	V
Screw Torque	Terminal (M3/M5)		10/30	kg·cm
	Mounting		30	

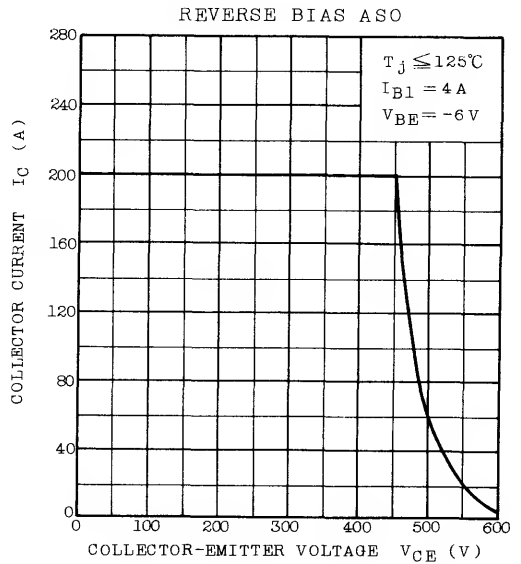
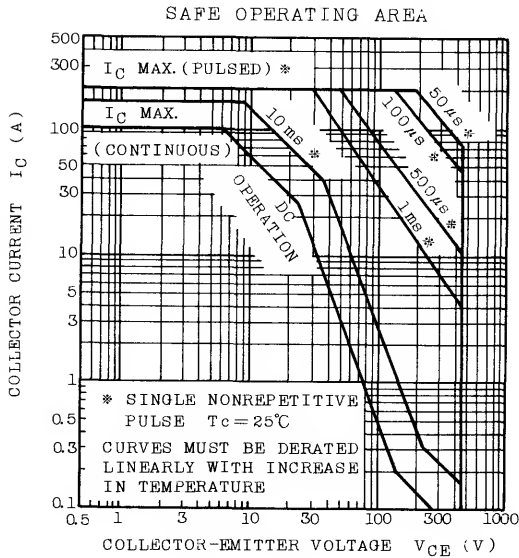
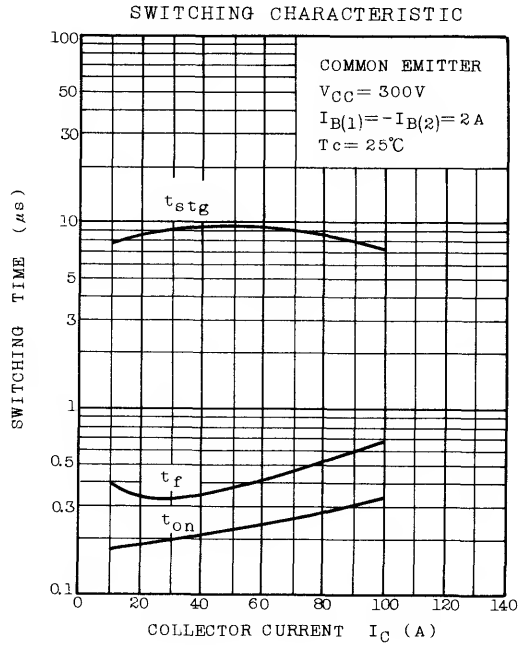
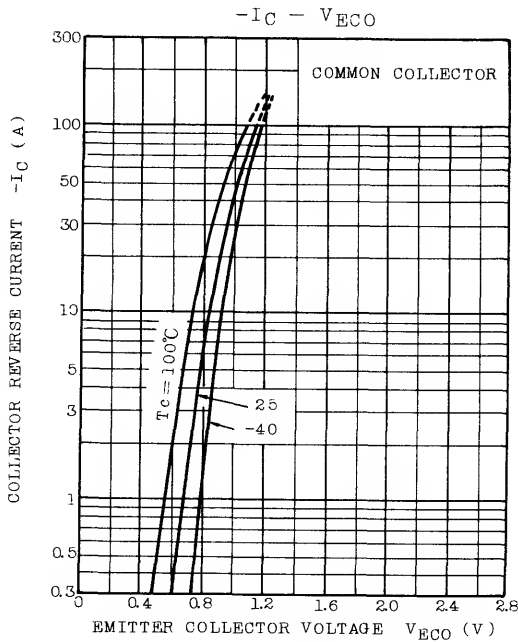
MG100G1FL1

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CB10}	$V_{CB1}=600V, I_E=0$	-	-	2.0	mA
Emitter Cut-off Current		I_{EB10}	$V_{EB1}=6V, I_C=0$	-	-	400	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	$I_C=0.5A, L=40mH$	450	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=100A$	100	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=100A, I_{B1}=2A$	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Emitter-Collector Voltage		V_{ECO}	$I_E=100A, I_B=0$	-	-	1.5	V
Reverse Recovery Time		t_{rr}	$-I_C=100A, V_{EB1}=3V$ $V_{CE}=300V$	-	-	2.0	μs
Collector Output Capacitance		C_{ob}	$V_{CB1}=50V, I_E=0, f=1MHz$	-	1000	-	pF
Switching Time	Turn-on Time	t_{on}	<p> $I_{B(1)} = -I_{B(2)} = 2A$ DUTY CYCLE=0.5% </p>	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	12	
	Fall Time	t_f		-	-	2.0	
Thermal Resistance (Junction to Case)		$R_{th(j-c)}$	Transistor	-	-	0.208	$^{\circ}C/W$
			Diode	-	-	0.65	



MG100G1FL1

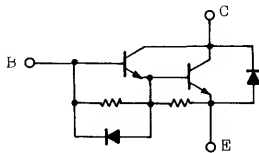


HIGH POWER SWITCHING APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

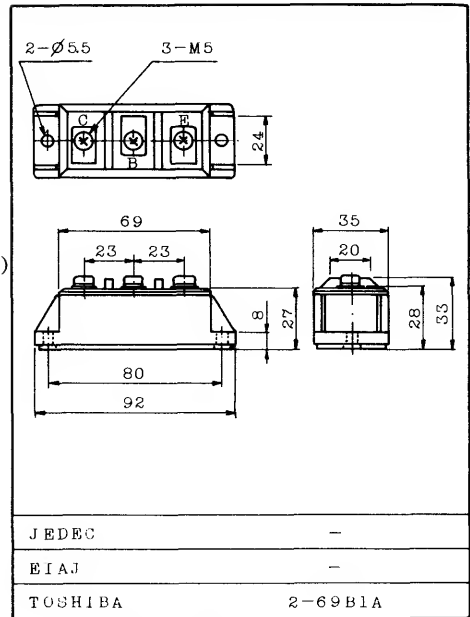
FEATURES:

- . The Collector is Isolated from Case.
- . With Built-in Free Wheeling Diode
- . High DC Current Gain : $h_{FE}=100(\text{Min.})(I_C=100A)$
- . Low Saturation Voltage: $V_{CE(\text{sat})}=2V(\text{Max.})(I_C=100A)$
- . High Speed : $t_f=2\mu s(\text{Max.})(I_C=100A)$

EQUIVALENT CIRCUIT



Unit in mm



Weight : 227g

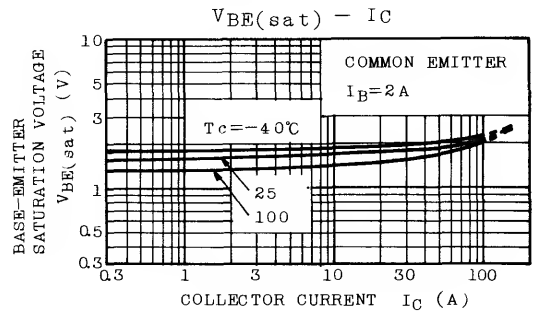
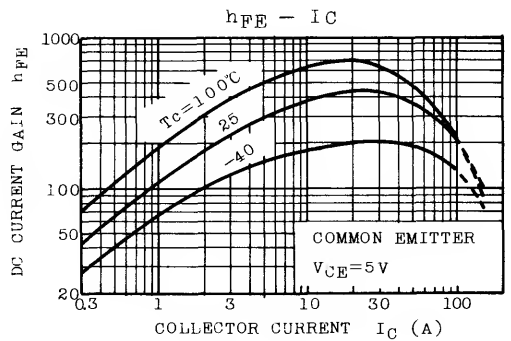
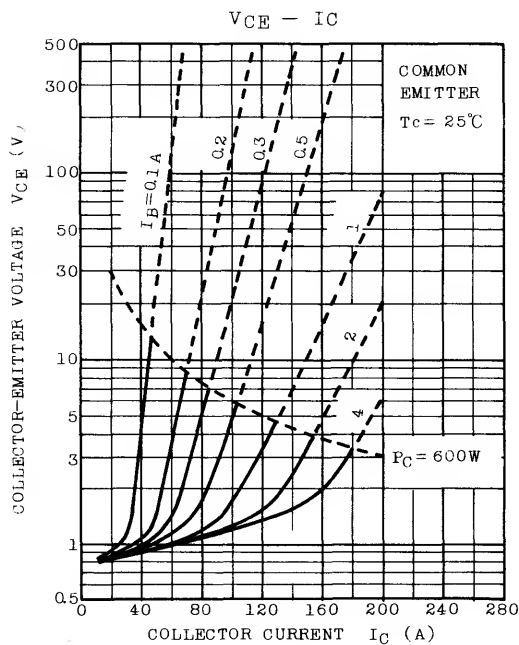
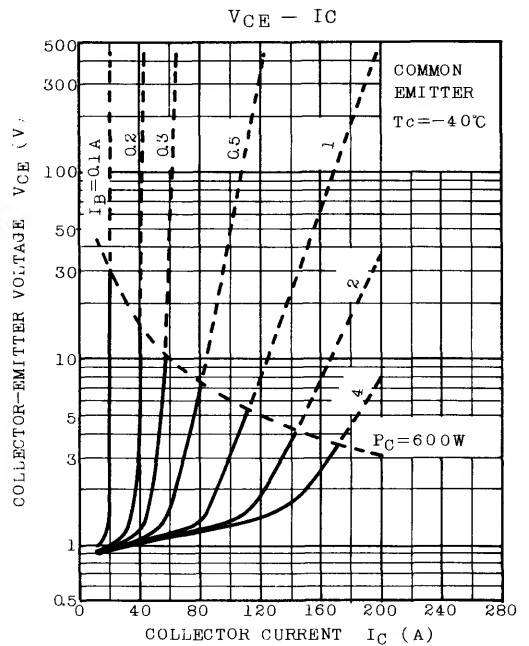
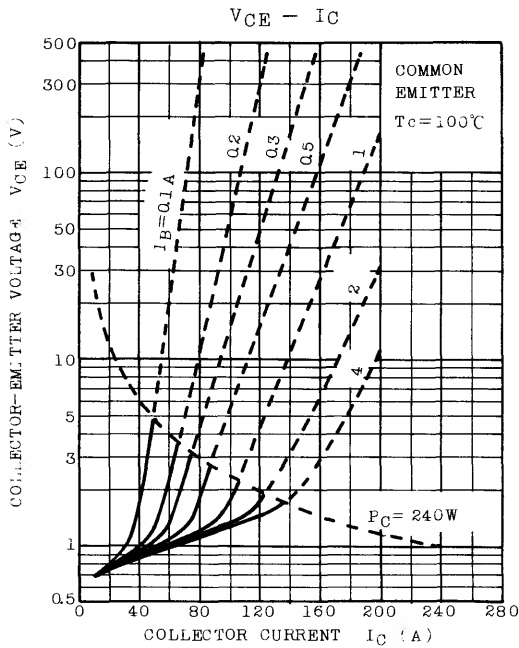
MAXIMUM RATINGS ($T_a=25^\circ C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT	
Collector-Base Voltage	V_{CBO}	600	V	
Collector-Emitter Voltage	$V_{CEO(\text{SUS})}$	450	V	
Emitter-Base Voltage	V_{EBO}	6	V	
Collector Current	DC	I_C	100	A
	1ms	I_{CP}	200	A
	DC	$-I_C$	100	A
Base Current	I_B	5	A	
Collector Power Dissipation ($T_c=25^\circ C$)	P_C	600	W	
Junction Temperature	T_j	150	$^\circ C$	
Storage Temperature Range	T_{stg}	-40 ~ 125	$^\circ C$	
Isolation Voltage	V_{Isol}	2000 (AC 1 Minute)	V	
Screw Torque		30	kg·cm	

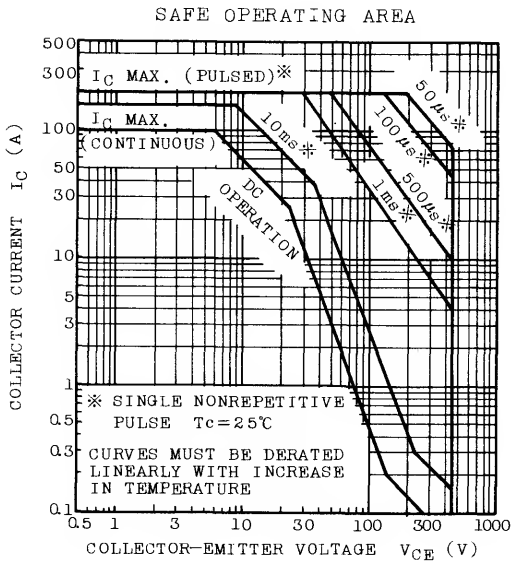
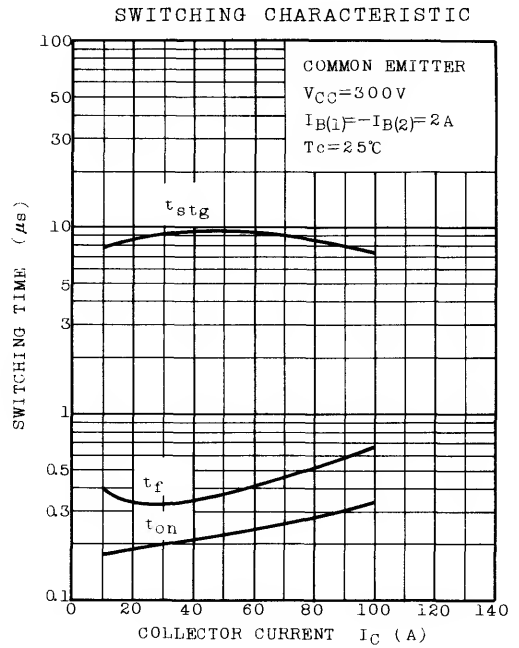
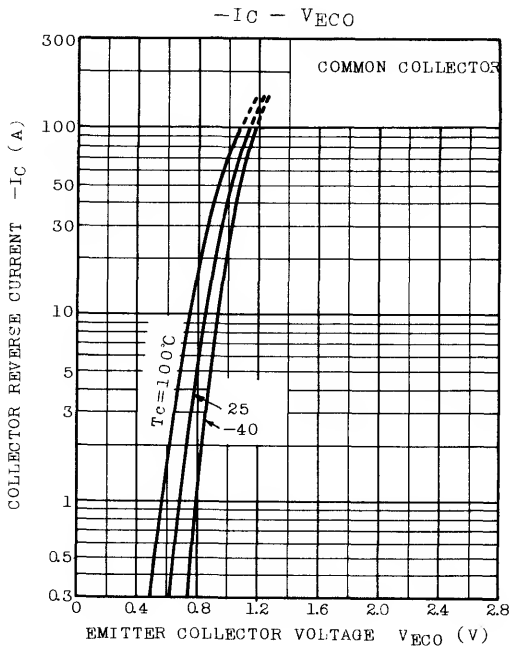
MG100H1AL2

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	$V_{CB}=600V, I_E=0$	-	-	2.0	mA
Emitter Cut-off Current		I_{EBO}	$V_{EB}=6V, I_C=0$	-	-	400	mA
Collector-Emitter Sustaining Voltage		$V_{CEO(SUS)}$	$I_C=0.5A, L=40mH$	450	-	-	V
DC Current Gain		h_{FE}	$V_{CE}=5V, I_C=100A$	100	-	-	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	$I_C=100A, I_B=2A$	-	-	2.0	V
Base-Emitter Saturation Voltage		$V_{BE(sat)}$		-	-	2.5	V
Emitter-Collector Voltage		V_{ECO}	$I_E=100A, I_B=0$	-	-	1.5	V
Reverse Recovery Time		t_{rr}	$-I_C=100A, V_{EB}=3V$ $V_{CE}=300V$	-	-	2.0	μs
Collector Output Capacitance		C_{ob}	$V_{CB}=50V, I_E=0$ $f=1MHz$	-	1000	-	pF
Switching Time	Turn-on Time	t_{on}	<p> $I_{B1} = -I_{B2} = 2A$ DUTY CYCLE = 0.5% $V_{CC} = 300V$ </p>	-	-	1.0	μs
	Storage Time	t_{stg}		-	-	12	
	Fall Time	t_f		-	-	2.0	
Thermal Resistance (Junction to Case)		$R_{th(j-c)}$	Transistor	-	-	0.208	$^{\circ}C/W$
			Diode	-	-	0.65	



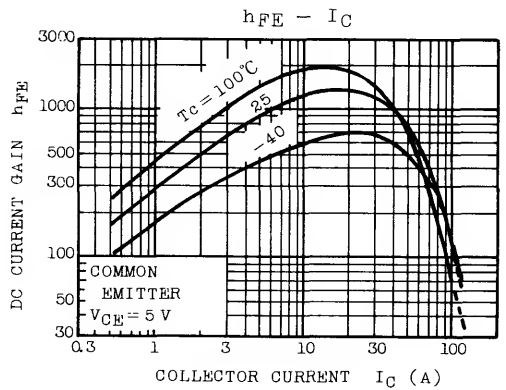
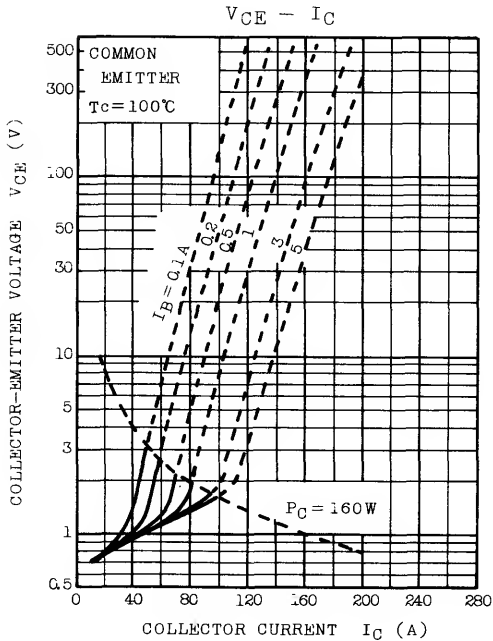
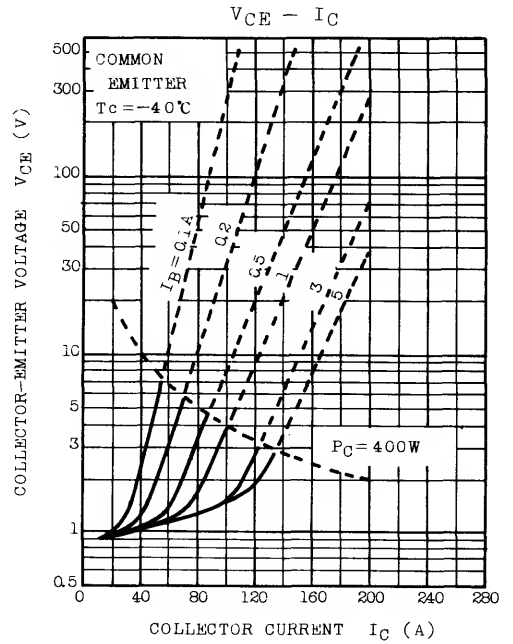
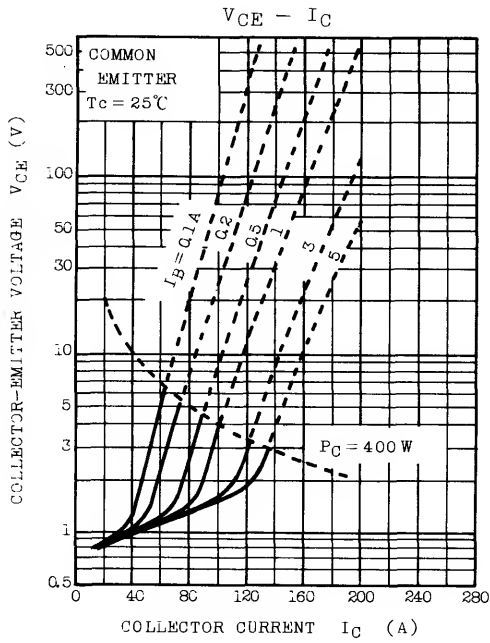
MG100H1AL2



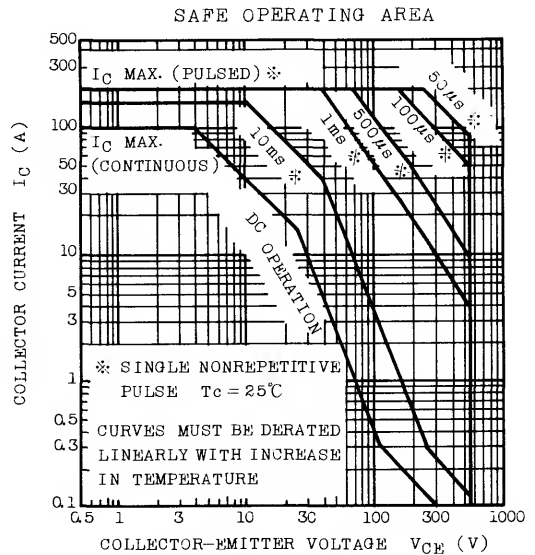
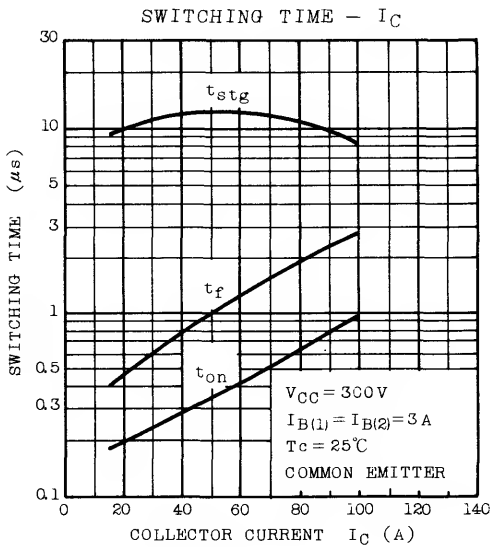
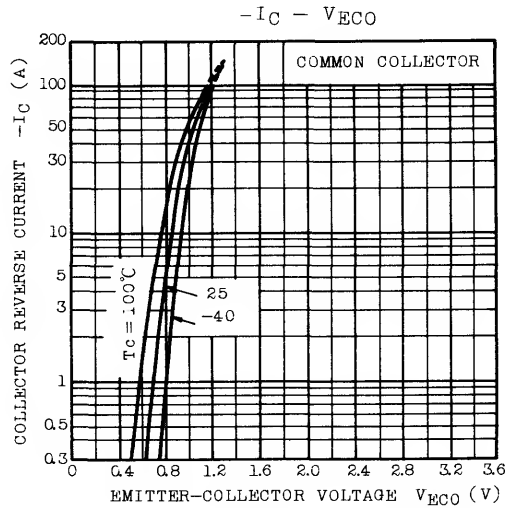
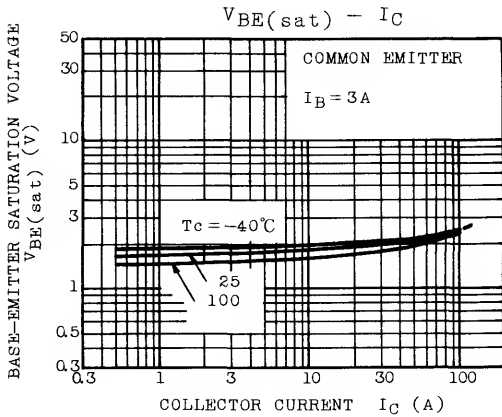
MG100H2DL1

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		ICBO	V _{CB} =600V, I _E =0	-	-	2.0	mA
Emitter Cut-off Current		IEBO	VEB=6V, IC=0	-	-	200	mA
Collector-Emitter Sustaining Voltage		V _{CEO(SUS)}	IC=0.5A, L=40mH	550	-	-	V
DC Current Gain		h _{FE}	V _{CE} =5V, IC=100A	80	-	-	
Collector-Emitter Saturation Voltage		V _{CE(sat)}	IC=100A, IB=3A	-	-	2.0	V
Base-Emitter Saturation Voltage		V _{BE(sat)}		-	-	2.7	V
Emitter-Collector Voltage		VECO	IE=100A, IB=0	-	-	1.5	V
Reverse Recovery Time		t _{rr}	-IC=100A, VEB=3V VCE=300V	-	-	2.0	μs
Collector Output Capacitance		C _{ob}	V _{CB} =50V, IE=0 f=1MHz	-	800	-	pF
Switching Time	Turn-on Time	t _{on}	<p> $I_{B1} = -I_{B2} = 3A$ DUTY CYCLE = 0.5% </p>	-	-	2.0	μs
	Storage Time	t _{stg}		-	-	12	
	Fall Time	t _f		-	-	4.0	
Thermal Resistance (Junction to Case)		R _{th(j-c)}	Transistor	-	-	0.31	°C/W
			Diode	-	-	1.3	



MG100H2DL1



SILICON NPN TRIPLE DIFFUSED TYPE
(DARLINGTON POWER MODULE)

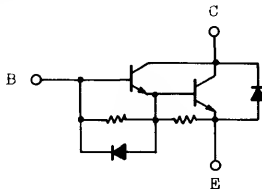
MG200H1AL1

HIGH POWER SWITCHING APPLICATIONS.
MOTOR CONTROL APPLICATIONS.

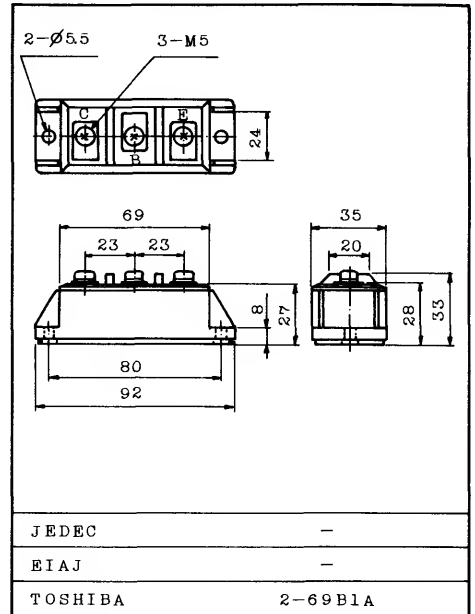
FEATURES:

- . The Collector is Isolated from Case.
- . With Built-in Free Wheeling Diode
- . High DC Current Gain : $h_{FE}=80(\text{Min.}) (I_C=200A)$
- . Low Saturation Voltage: $V_{CE(\text{sat})}=2V(\text{Max.}) (I_C=200A)$
- . High Speed : $t_f=4\mu s(\text{Max.}) (I_C=200A)$

EQUIVALENT CIRCUIT



Unit in mm



Weight : 227g

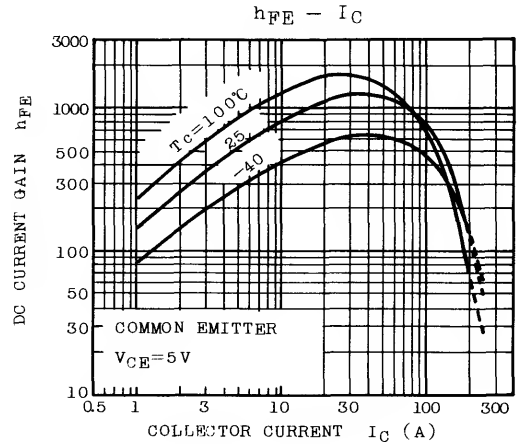
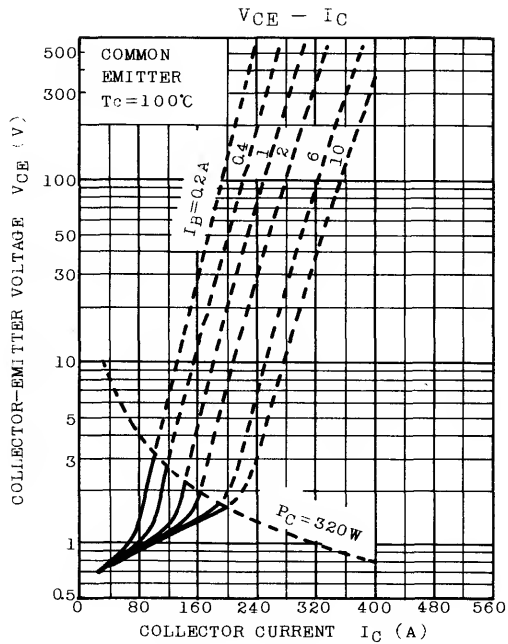
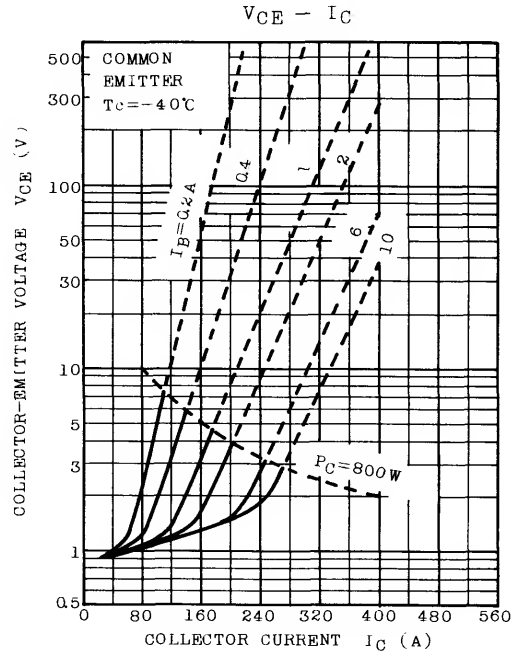
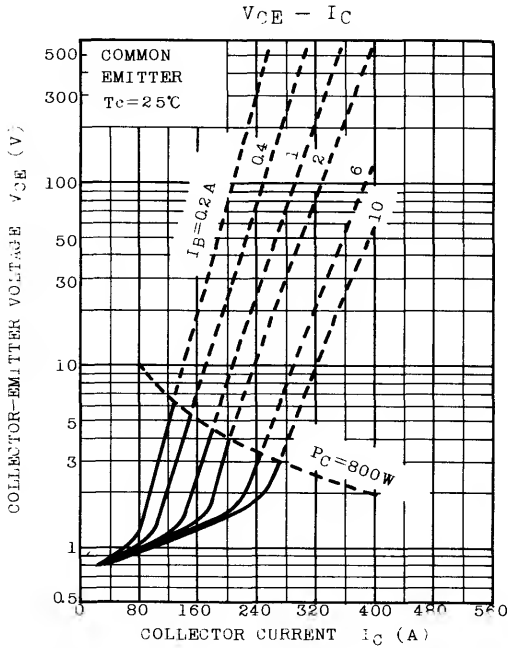
MAXIMUM RATINGS ($T_a=25^{\circ}\text{C}$)

CHARACTERISTIC	SYMBOL	RATING	UNIT	
Collector-Base Voltage	V_{CB0}	600	V	
Collector-Emitter Voltage	$V_{CEO(\text{SUS})}$	550	V	
Emitter-Base Voltage	V_{EB0}	6	V	
Collector Current	DC	I_C	200	A
	Pulse	I_{CP}	400	A
	DC	$-I_C$	200	A
Base Current	I_B	8	A	
Collector Power Dissipation ($T_c=25^{\circ}\text{C}$)	P_C	800	W	
Junction Temperature	T_j	150	$^{\circ}\text{C}$	
Storage Temperature Range	T_{stg}	-40 ~ 125	$^{\circ}\text{C}$	
Isolation Voltage	V_{Isol}	2000(AC 1 Minute)	V	
Screw Torque	-	30	kg·cm	

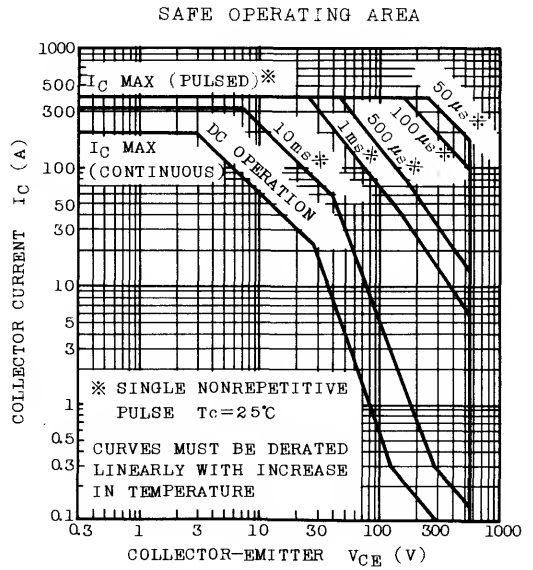
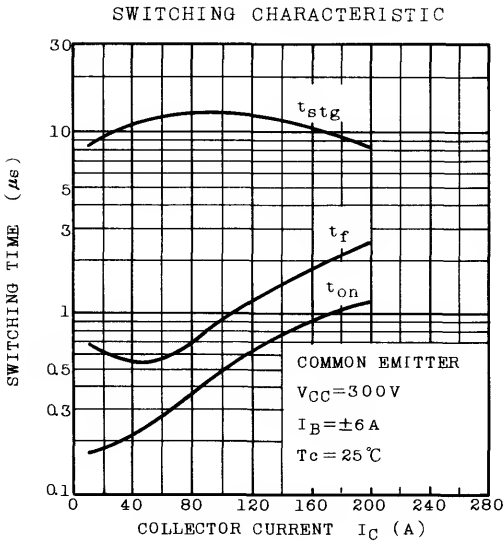
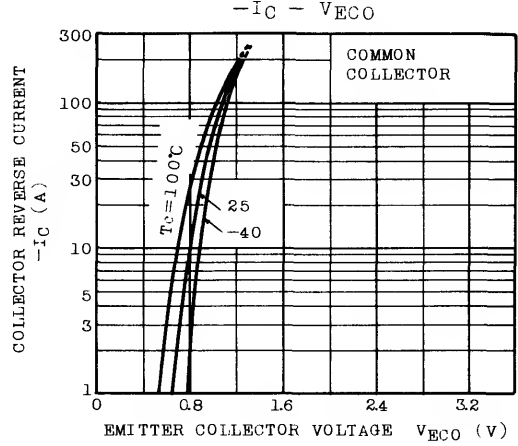
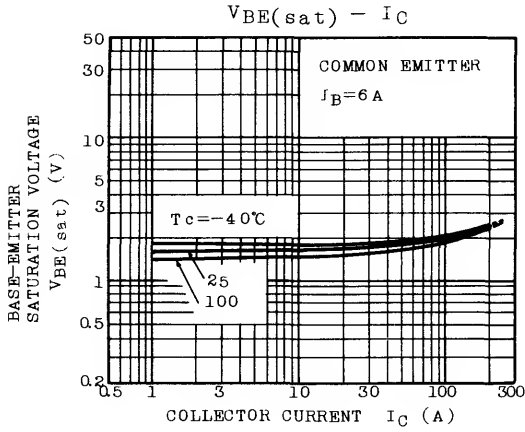
MG200H1AL1

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		ICBO	V _{CB} =600V, I _E =0	-	-	2.0	mA
Emitter Cut-off Current		IEBO	VEB=6V, IC=0	-	-	400	mA
Collector-Emitter Sustaining Voltage		V _{CEO(SUS)}	IC=0.5A, L=40mH	550	-	-	V
DC Current Gain		h _{FE}	V _{CE} =5V, IC=200A	80	-	-	
Collector-Emitter Saturation Voltage		V _{CE(sat)}	IC=200A, IB=6A	-	-	2.0	V
Base-Emitter Saturation Voltage		V _{BE(sat)}		-	-	2.7	V
Emitter-Collector Voltage		V _{ECO}	IE=200A, IB=0	-	-	1.5	V
Reverse Recovery Time		t _{rr}	-IC=200A, VEB=3V VCE=300V	-	-	2.0	μs
Collector Output Capacitance		C _{ob}	V _{CB} =50V, IE=0 f=1MHz	-	1650	-	pF
Switching Time	Turn-on Time	t _{on}	<p> $I_{B1} = -I_{B2} = 6A$ DUTY CYCLE = 0.5% $V_{CC} = 300V$ </p>	-	-	2.0	μs
	Storage Time	t _{stg}		-	-	12	
	Fall Time	t _f		-	-	4.0	
Thermal Resistance (Junction to Case)		R _{th(j-c)}	Transistor	-	-	0.156	°C/W
			Diode	-	-	0.65	



MG200H1AL1

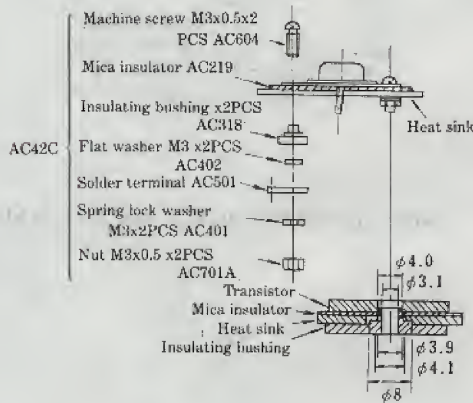


ACCESSORIES

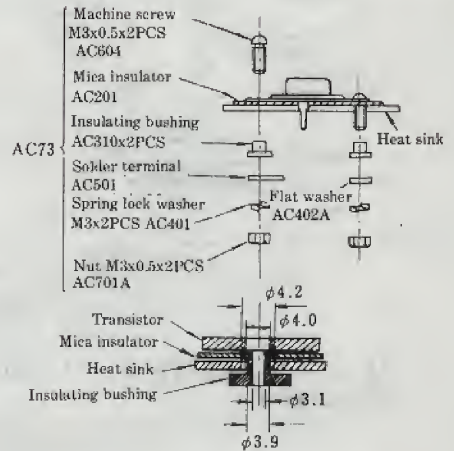
Accessories

Some semiconductors require accessories. Such accessories are listed below the external drawings of each semiconductor standard. Usage of such accessories is shown in the following figures.

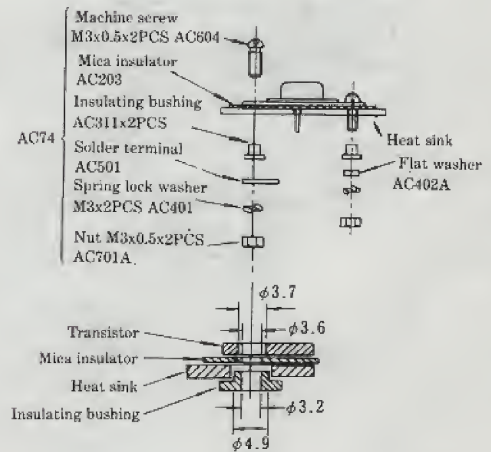
AC42C (to be applied to 2-21B1A and TO-3)



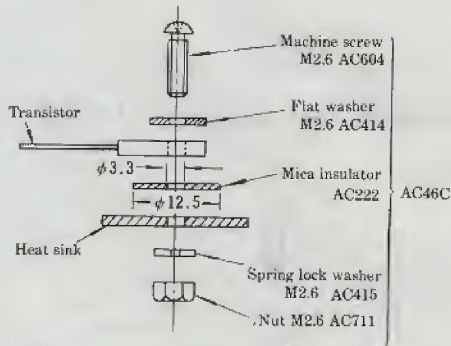
AC73 (to be applied to 2-21D1A, 21E1A, and TO-3)



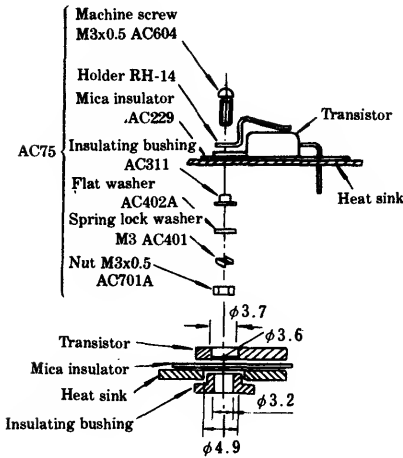
AC74 (to be applied to 2-13A1A and TO-66)



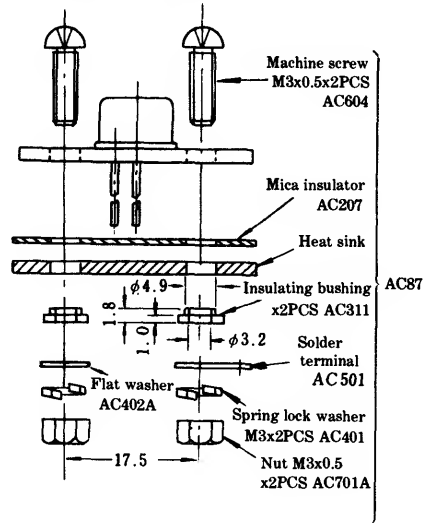
AC46C (to be applied to 2-8F1A)



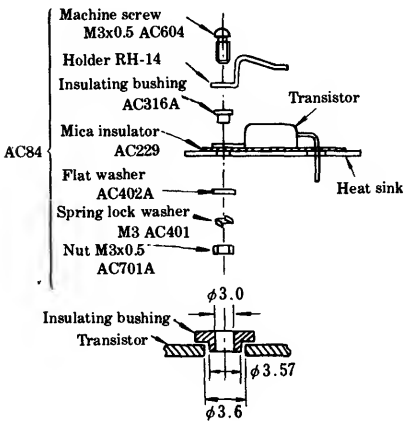
AC75 (to be applied to 2-10A1A and TO-220AB)



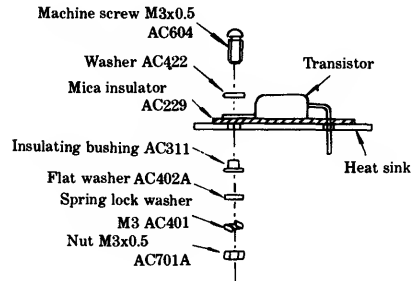
AC87 (to be applied to 2-9A1A)



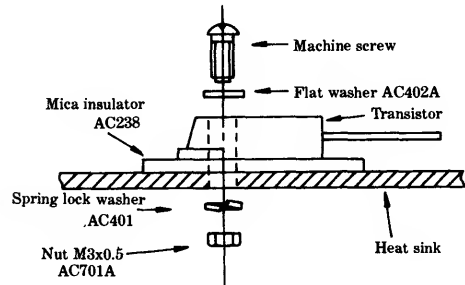
AC84 (to be applied to 2-10A1A and TO-220AB)



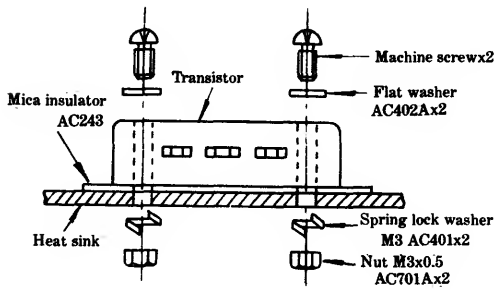
(to be applied to 2-10A1A and TO-220AB)



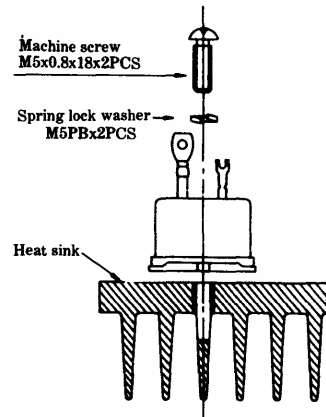
(to be applied to 2-16B1A and 2-16C1A)



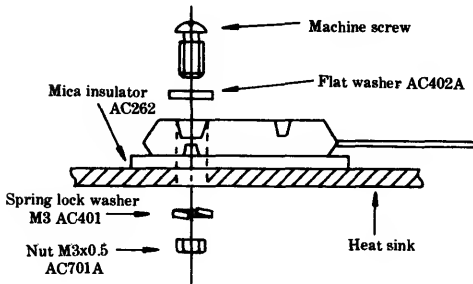
(to be applied to 2-34A1A)



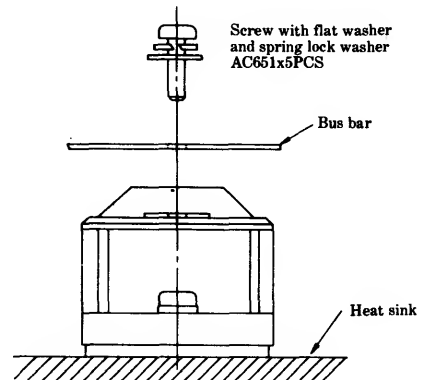
(to be applied to 2-31A1A)



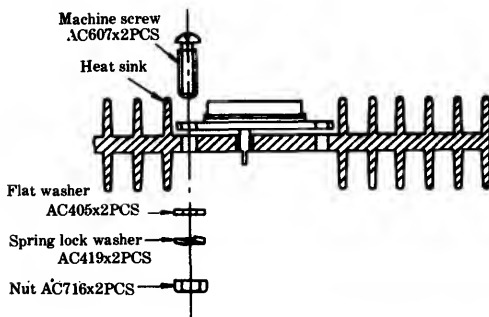
(to be applied to 2-21F1A)



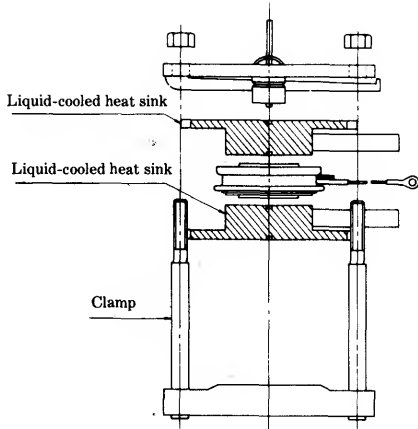
(to be applied to 2-69A1A)



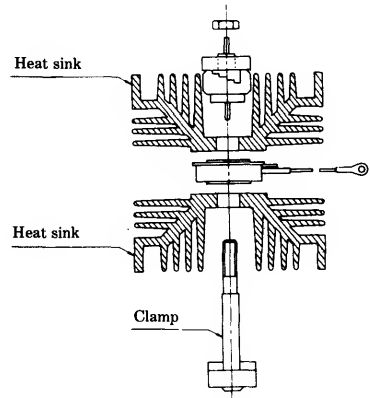
AC63 (to be applied to 2-33B1A)



(to be applied to 2-67A1A)



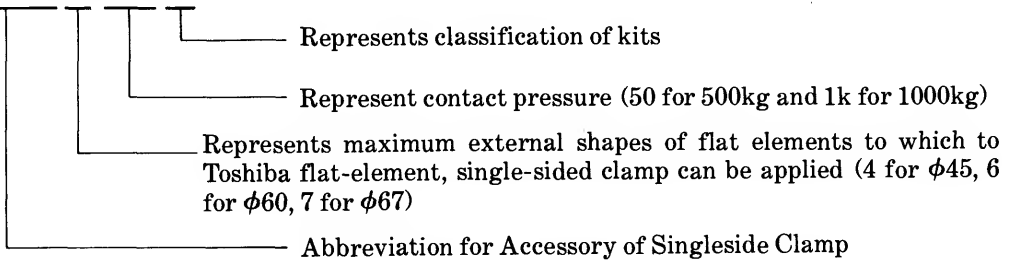
(to be applied to 2-67A1A)



Single-side clamp for G-Tr

1. Identification method

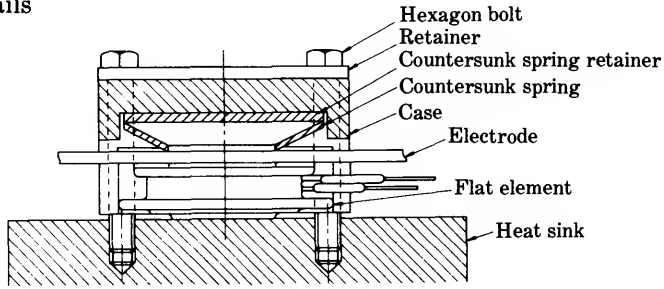
ASC650A



2. Applicable external shapes and accessory name

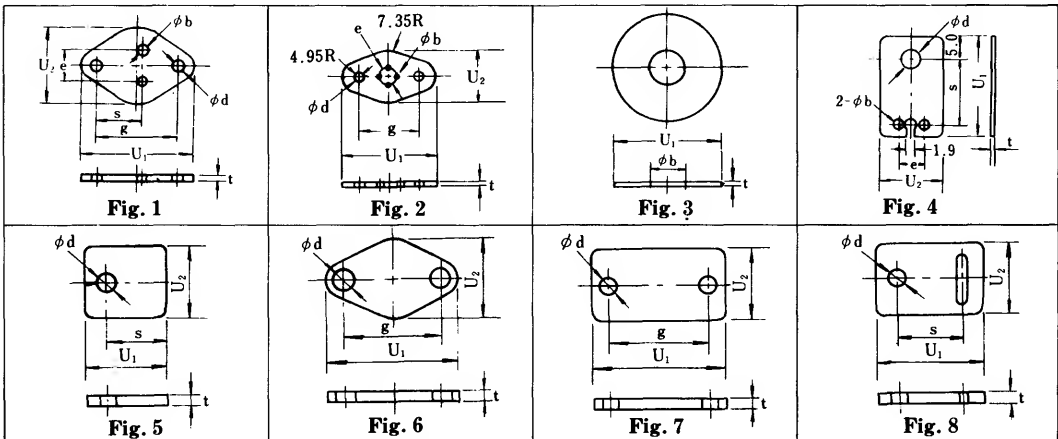
Applicable external shapes	2-42A1A	2-60B1A	2-67A1A
Model	ASC 450A	ASC 650A 1	ASC 71KA
Case	AC 803	AC 804	AC 807
Retainer	AC 425	AC 426	AC 435
Countersunk spring retainer	AC 427	AC 428	AC 436
Countersunk spring	AC 430×2	AC 431	AC 437
Electrode	AC 506	AC 507	AC 507
Hexagon bolt	AC 614×4	AC 614×4	AC 615×4

3. Mounting details



Mica Insulators

No.	Materials	Dimensions (mm)								Applicable transistors No.	Drawing
		ϕb	e	ϕd	g	s	U_1	U_2	t		
AC 201	Mica	2.0	10.9	4.3	30.15	16.87	42.15	28.0	0.05~0.10	2-21D1A	1
AC 203	"	2.0	5.08	3.2	24.38	14.7	36.0	21.8	"	2-13A1A	1
AC 207	"	0.75	5.08	3.3	17.5	—	27.4	14.7	"	2-9A1A	2
AC 219	"	2.0	10.9	4.1	30.15	16.87	50.0	36.0	0.10~0.16	2-21B1A	1
AC 222	"	3.3	—	—	—	—	12.5	—	0.05~0.10	2-8F1A	3
AC 226	"	2.0	10.9	4.3	30.15	16.87	46.0	32.0	"	2-21D1A	1
AC 227	"	5.0	19.0	5.2	43.3	25.0	58.0	40.0	"	2-31B1A	1
AC 229	"	1.8	5.08	3.6	—	14.7	22.0	13.0	"	2-10A1A	4
AC 238	"	—	—	3.3	—	16.0	22.0	18.5	"	2-16B1A	5
AC 240	"	—	—	5.2	43.3	—	58.0	40.0	"	2-31A1A	6
AC 243	"	—	—	3.3	24.4	—	38.0	20.0	"	2-34A1A	7
AC 246	"	—	—	4.0	—	16.9	26.9	18.5	"	2-16B1A	8
AC 252	Silicone rubber	2.0	10.9	4.3	30.2	16.9	42.0	28.0	0.20~0.30	2-21D1A	1
AC 253	"	2.0	5.08	3.2	24.38	14.7	34.0	20.0	"	2-13A1A	1
AC 254	"	—	—	3.6	—	13.8	17.8	12.9	"	2-10A1A	5
AC 255	"	—	—	3.3	24.4	—	38.0	20.0	"	2-34A1A	7
AC 256	"	—	—	3.3	—	16.0	22.0	18.5	"	2-16B1A	5
AC 261	Mica	—	—	3.3	—	24.0	34.0	28.0	0.15~0.25	2-21F1A	5
AC 262	Mica	—	—	3.3	—	21.0	28.0	22.0	0.05~0.10	2-21F1A	5



Insulating Bushing

No.	Materials	Dimensions (mm)								Drawing
		ϕD_1	ϕD_2	ϕD_3	ϕD_4	H	h_1	h_2		
AC310	66 nylon	3.1	3.9	8.0	—	3.0	1.0	—	1	
AC311	"	3.2	4.9	8.0	—	1.8	1.0	—	1	
AC316A	"	3.0	3.57	5.3	—	1.5	0.5	—	1	
AC318	"	3.0	3.9	8.0	12	6.0	2.0	3.5	2	
AC322	"	4.2	5.0	9.0	—	5.5	2.0	—	1	
AC331	Duranex	3.1	3.8	8.0	—	3.3	2.0	—	1	
AC332	"	4.2	5.0	9.0	—	7.5	2.0	—	1	

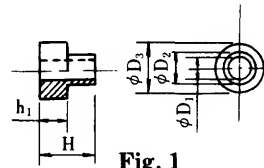


Fig. 1

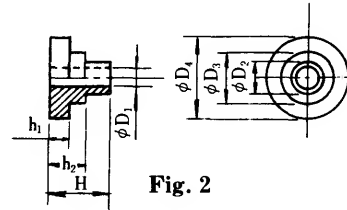


Fig. 2

Solder Terminal

No.	Materials	Dimensions (mm)									JIS naming	Drawing
		ϕb	ϕd	ϕD	E	F	G	K	h	t		
AC501	Nickel-plated brass	2.3	3.5	7.0	4.0	—	3.5	8.5	—	0.3	Similar to JIS C2803 Type ET	1
AC505	"	—	4.3	8.0	5.0	5.0	4.0	10.0	5.0	0.5	—	2

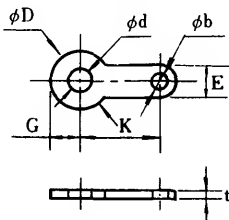


Fig. 1

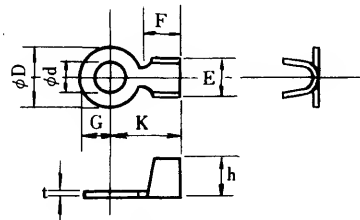


Fig. 2

Flat Washer

No.	Materials	Dimensions (mm)						JIS description	Drawing
		ϕd	ϕD	a	b	c	t		
AC402	Nickel-plated brass	3.3	8	—	—	—	0.5	JIS B1256 Small-sized, round, Class 1 M3BsP	1
AC402A	"	3.3	6	—	—	—	0.5	JIS B1256 Square with a hole, Class 1 M3BsP	1
AC405	"	5.5	12	—	—	—	0.8	JIS B1256 M5BsP	1
AC414	"	2.9	5	—	—	—	0.5	JIS B1256 Square with a hole, Class 1 M2.6BsP	1
AC416	"	4.3	9	—	—	—	0.8	JIS B1256 M4BsP	1
AC422	Nickel-plated soft copper	3.6	—	5.7	10.0	5.0	1.6	JIS G3101	2
AC424	Nickel-plated brass	5.3	7.3	—	—	—	0.8	JIS G3101 —	1

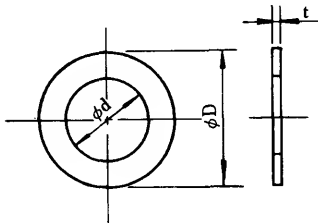


Fig. 1

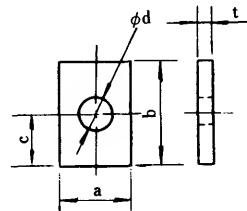
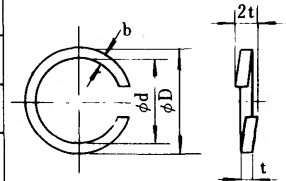


Fig. 2

Spring Lock Washer

No.	Materials	Dimensions (mm)			JIS naming
		ϕd	$b \times t$	ϕD Max	
AC401	Nickel-plated phosphor bronze	3.1	1.1 × 0.7	5.9	JIS B1257 Spring lock washer No. 2 M3PB
AC415	Nickel-plated PHB	2.7	1.0 × 0.6	5.3	JIS B1251 Spring lock washer No. 2 M2.6PB
AC417	Nickel-plated brass	4.1	1.4 × 1.0	7.6	M4PB "
AC419	Nickel-plated phosphor bronze	5.1	1.7 × 1.3	8.5	M5PB "



Machine Screw

No.	Materials	Dimensions (mm)			JIS description	Drawing
		Nominal size × pitch	ℓ	S		
AC604	Nickel-plated brass	M3 × 0.5	12	11	JIS B1111+Cross-recessed head screw M3 × 0.5 × 12Bs	1
AC605	"	M2.6 × 0.45	10	10	M2.6 × 0.45 × 10Bs	
AC606	"	M4 × 0.7	16	15	M4 × 0.7 × 15Bs	
AC607	"	M5 × 0.8	18	17	M5 × 0.8 × 18Bs	
AC651	Iron and iron plating	—	—	—	"	2

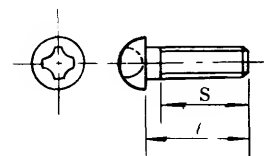


Fig. 1

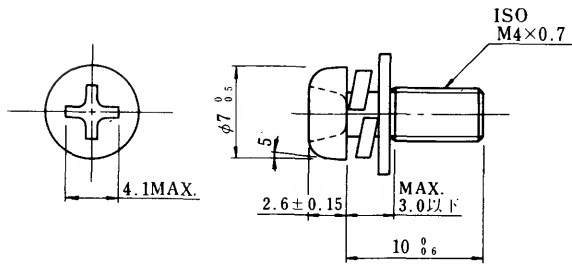
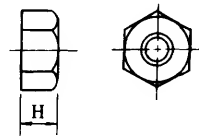


Fig. 2

Nut

No.	Materials	Dimensions (mm)		JIS naming
		Nominal size x pitch	H	
AC701A	Nickel-plated brass	M5×0.5	2.4	JIS B1181 Hexagon nut Class 1A2 M3×0.5×12Bs
AC711	"	M2.6×0.45	2.0	M2.6×0.45Bs
AC714	"	M4×0.7	3.2	M4×0.7Bs
AC716	"	M5×0.8	3.2	M5×0.8Bs



Case

No.	Materials	Dimensions (mm)								Drawing
		U ₁ , U ₂	H, W ₁	W ₂ , D ₁	D ₂ , b	d, e ₁	e ₂ , h ₁	h ₂ , h ₃		
AC803	Premix	56	27.8	27	46	6.5	43	18	1	
		56	27	40.5	5	43	16	4.8		
AC804	"	66	26.8	32	60.3	6.5	48	18.2	1	
		60	32	56.5	6	54	14	3.6		
AC807	"	78	36.6	32	—	10.5	65	26	2	
		85	—	67.5	10	58	—	4.6		

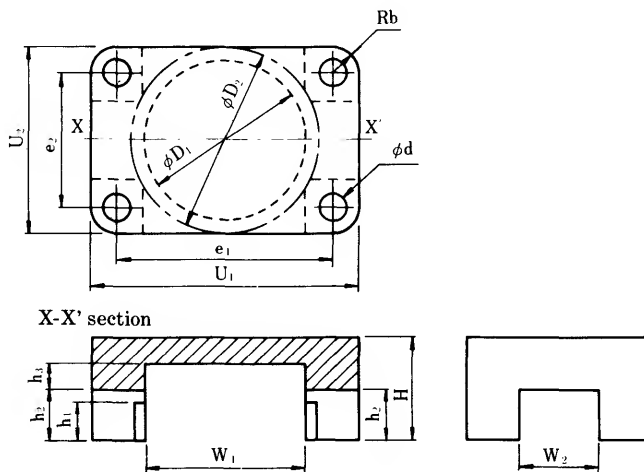


Fig. 1

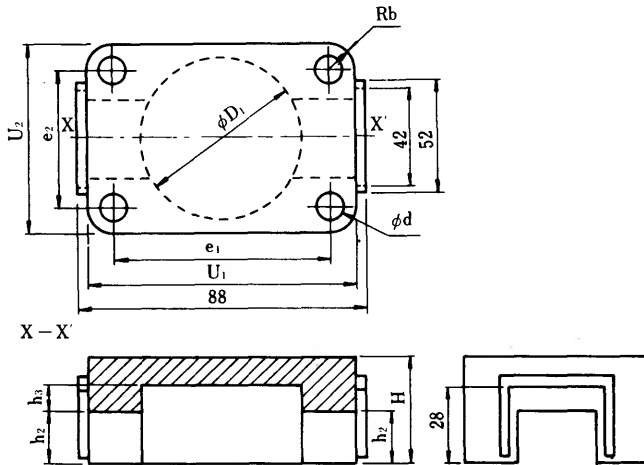


Fig. 2

Retainer

No.	Materials	Dimensions (mm)							Draw- ing
		U ₁	U ₂	t	b	d	e ₁	e ₂	
AC 425	Iron-zinc chromate	56	56	4.5	5	6.5	43	43	1
AC 426	"	66	60	4.5	6	6.5	54	48	
AC 435	"	78	85	5.5	10	10.5	58	65	

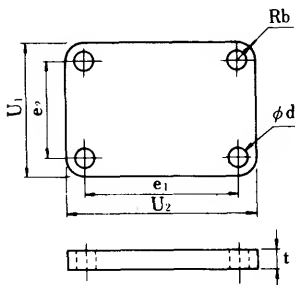


Fig. 1

Retainer

No.	Materials	Dimensions		Draw- ing
		D	t	
AC 427	Iron-zinc chromate	40.4	2.5	2
AC 428	"	56.4	2.5	2
AC 436	"	67.5	2.5	2

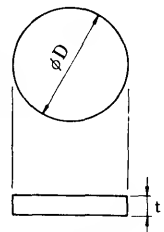
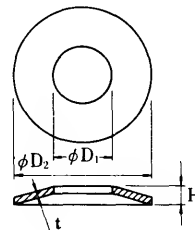


Fig. 2

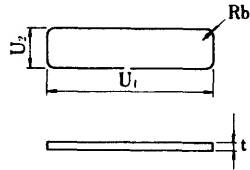
Countersunk spring

No.	Materials	Dimensions (mm)			
		D ₁	D ₂	H	t
AC 430	Iron-zinc chromate	14	40	4.3	2.6
AC 431	"	20	56	4.1	1.8
AC 437	"	24	67	5.4	2.8



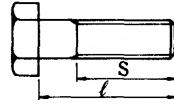
Electrode plate

No.	Materials	Dimensions (mm)			
		U ₁	U ₂	t	b
AC506	Nickel-plated copper	150	25	3	5
AC507	"	150	30	3	5



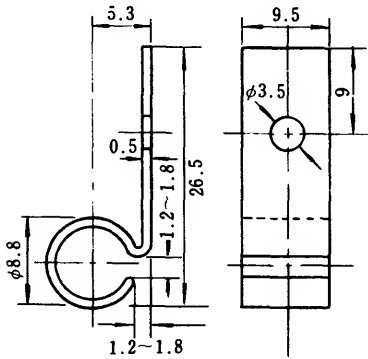
Hexagon bolt

No.	Materials	Dimensions (mm)			JIS description
		Nominal size × pitch	ℓ	S	
AC614	Iron-zinc chromate	M 6 × 1.0	50	48	JIS B1180 Hexagon
AC615	"	M × 1.5	50	48	"



Radiator Holder

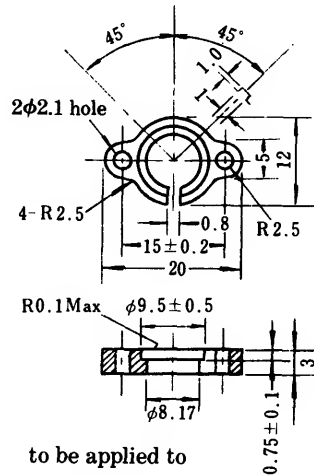
RH-2



to be applied to

JEDEC TO-39
EIAJ TC-5
TOSHIBA TB-5B

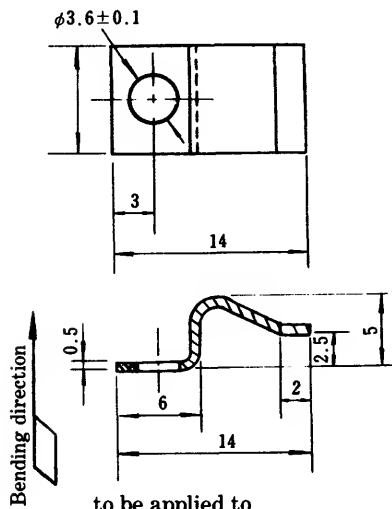
RH-10



to be applied to

JEDEC TO-39
EIAJ TC-5
TOSHIBA TB-5B

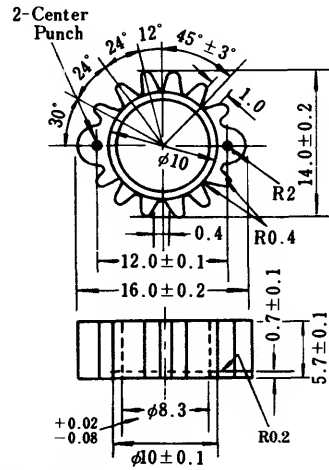
RH-14



to be applied to

- JEDEC TO-220AB
- EIAJ SC-46
- TOSHIBA 2-10A1A

RH-15



to be applied to

- | | |
|---------|-------|
| JEDEC | TO-39 |
| EIAJ | TC-5 |
| TOSHIBA | TB-5B |



**APPLICATION
CIRCUIT**

4. Astable multivibrator circuit	1229
5. Fixed bias-type flip-flop circuit	1230
6. Self-bias-type flip-flop circuit	1230
7. Schmidt circuit	1231
8. Positive pulse amplifier circuit	1231
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10. Indication tube driving circuit	1232
11. UJT application circuit	1233

Dropper Regulator Circuit

1. High-stability reference regulator circuit	1234
2. Constant-voltage regulator circuit (1) 12V, 50mA	1234
3. Constant-voltage regulator circuit (2) 12V, 1A	1234
4. Constant-voltage regulator circuit (3) 24V, 1.5A	1234
5. Constant-voltage regulator circuit (4) 24V, 2A	1235
6. Constant-voltage regulator circuit (5) 0 ~ 30V, 1.5A	1235
7. Constant-voltage regulator circuit	1236
8. Multivibrator-type DC-DC converter circuit (1) 50V, 3W ($V_i = 12V$)	1236
9. Multivibrator-type DC-DC converter circuit (2) 300V, 40W ($V_i = 12V$)	1236
10. Multivibrator-type DC-DC converter circuit (3) 300V, 40W ($V_i = 24V$)	1237
11. Multivibrator-type DC-DC converter circuit (4) 300V, 80W ($V_i = 24V$)	1237
12. Multivibrator-type DC-DC converter circuit (5) 5V, 150W ($V_i = 100V$)	1238
13. Multivibrator-type DC-DC inverter circuit, 100V, 80W ($V_i = 24V$)	1238
14. Example circuit incorporating aringing choke circuit	1239
15. 20V, 2A Output dropper regulator, dropper regulator circuit	1239
16. 12V, 1A Output dropper regulator	1240
17. $\pm 15V$, 2A Output dropper regulator shown below is applied incorporating transistor 2N3771 and 2N4398	1240

Circuit incorporating FET's

1. Amplifier circuit with direct-coupled FET, voltage gain 62dB, min. sensing signal $\sim 1\text{mV}$	1241
2. FET differential amplifier circuit (1) Voltage gain 26dB	1241
3. FET differential amplifier circuit (3) Voltage gain 26dB	1241
4. FET differential amplifier circuit (2) Voltage gain 16dB	1241
5. FET2-stage differential amplifier circuit, voltage gain 34dB (openloop gain: 53dB)	1242
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7. Digital switch	1243
8. Analog switch	1243
9. Sample hold circuit	1243
10. FET chopper amplifier circuit	1244
11. FET flip-flop circuit	1244
12. FET timer circuit (1)	1244
13. FET timer circuit (2), operating time: 10 min.	1244

Low-frequency amplifier circuit

1. RC coupled amplifier circuit	1245
2. Class A single amplifier circuit (1), $P_o = 55\text{mA}$	1245
3. Class A single amplifier circuit (2), $P_o = 75\text{mA}$	1245
4. Class B push-pull amplifier circuit (1), $P_o = 200\text{mW}$	1246
5. Class B push-pull amplifier circuit (2), $P_o = 400\text{mW}$	1246
6. Transformer-coupled Class A power amplifier circuit, $P_o = 5\text{W}$ ($V_i = 0.4\text{V}$)	1246
7. Transformer-coupled Class B power amplifier circuit, $P = 7\text{W}$ ($V_i = 0.6\text{V}$)	1247
8. SEPP power amplifier circuit with input transformer, $P_o = 200\text{W}$ ($V_i = 1.5\text{V}$)	1247

High-frequency power amplifier circuit

1. Coupled-multiplier power amplifier circuit (112.5 MHz \sim 450 MHz)	1248
2. Triple-multiplier 2-stage amplifier circuit (156.6 MHz \sim 470 MHz)	1248
3. Power amplifier circuit (175 MHz, FM 70W)	1249
4. Power amplifier circuit (470 MHz, FM 40W)	1249
5. Power amplifier circuit (430 \sim 450 MHz)	1249

Applied circuit of large-power transistor and transistor modules (motor drive circuit)

1. DC motor control (1)	1250
2. DC motor control (2)	1250
3. AC motor control	1250

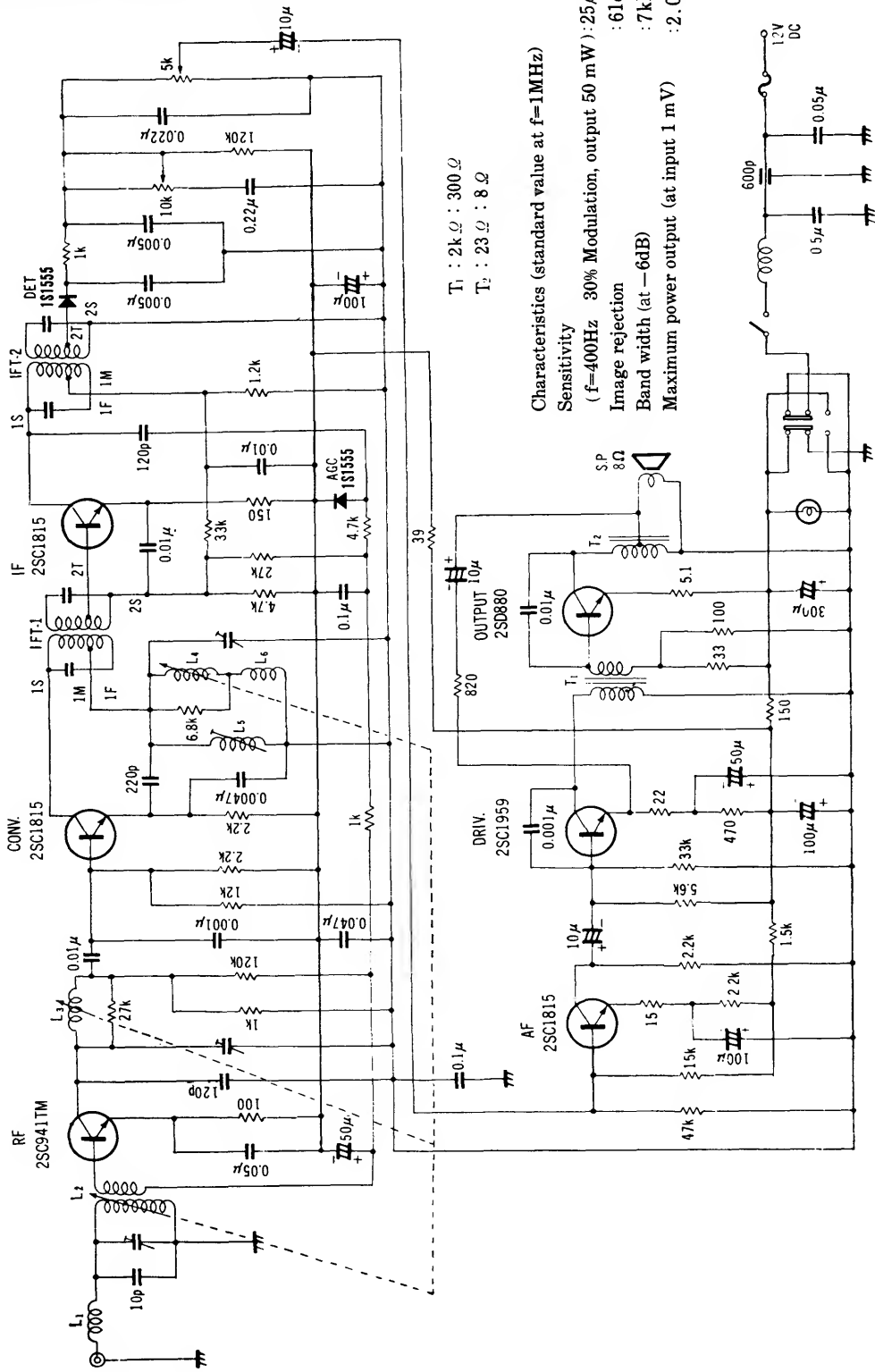
Application of low-saturation voltage transistors

1. Various inductance and lamp drives	1251
2. Wiper control	1251
3. Flasher	1251
4. Ignitor	1251
(1) Battery drive	1251
(2) Magnet drive	1251
5. Electronic fuel injection control	1251

GaAs Hall sensor

1. Example circuit using GaAs Hall sensor (Hall motor)	1252
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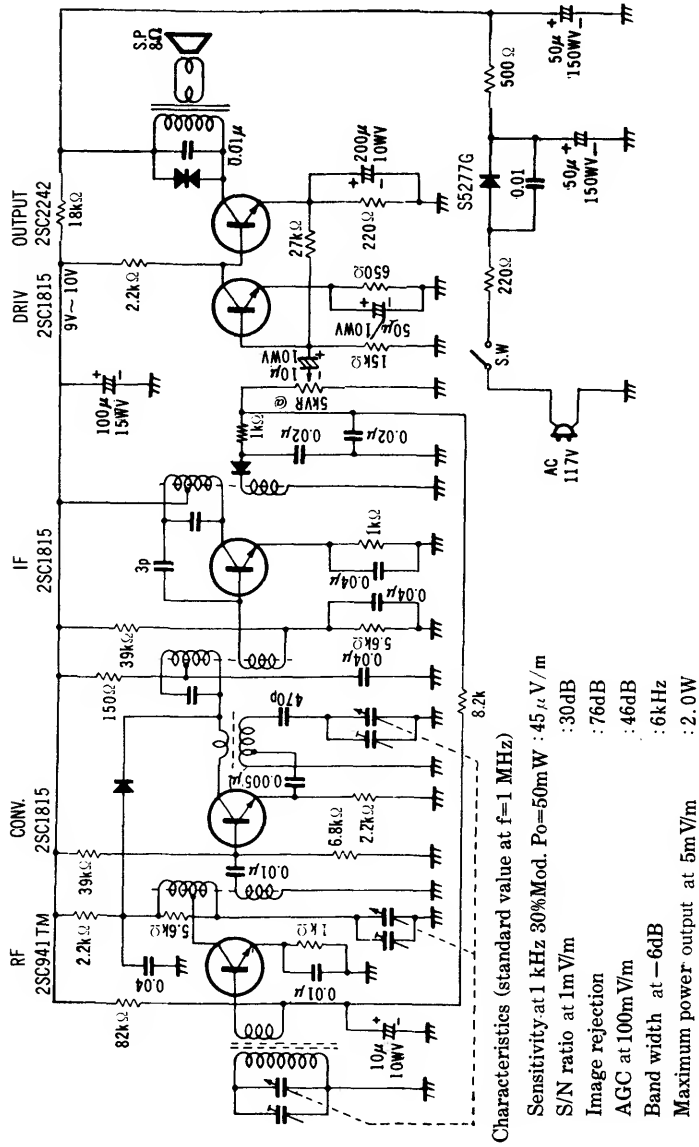
3. 6-transistor car radio circuit



T₁ : 2kΩ : 300Ω
 T₂ : 23Ω : 8Ω

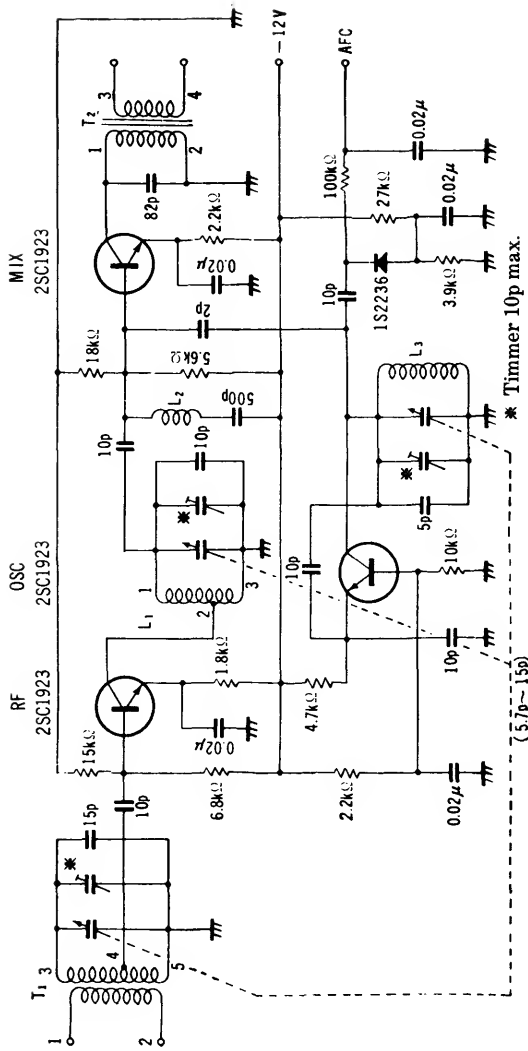
Characteristics (standard value at f=1MHz)
 Sensitivity (f=400Hz 80% Modulation, output 50 mW) : 25μV
 Image rejection : 61dB
 Band width (at -6dB) : 7kHz
 Maximum power output (at input 1 mV) : 2.0W

4. 5-transistor line operate radio circuit



FM stereo unit

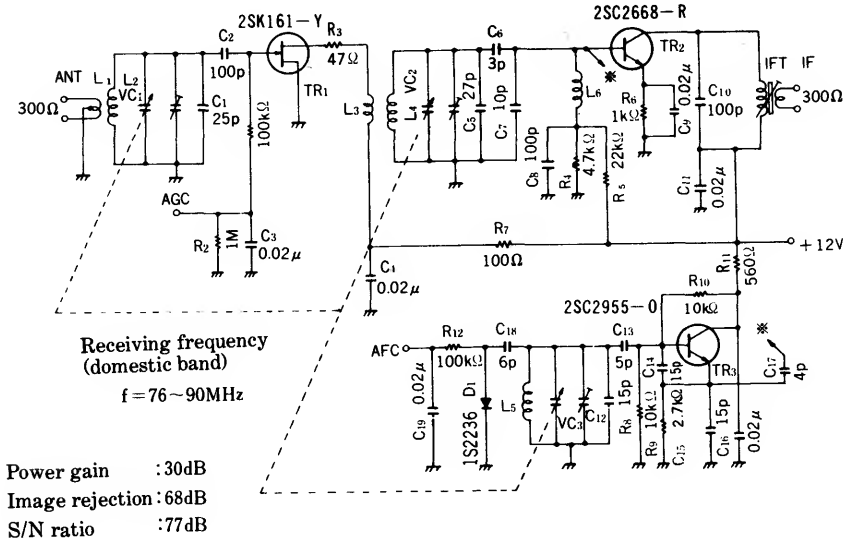
1. FM tuner circuit (1)



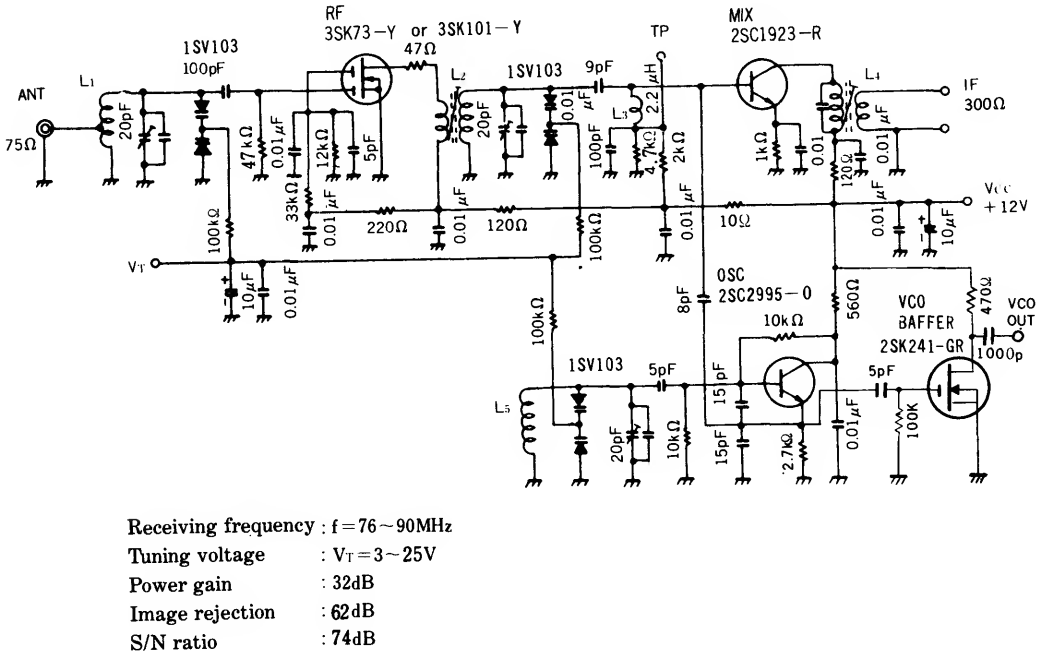
Characteristics (standard value)

Receiving frequency	: 88 ~ 108MHz
Input impedance	: 75Ω
Power gain	: 32dB
Image rejection	: 50dB
Oscillation voltage	: 190mV
Oscillator dropout voltage	: 3.2V

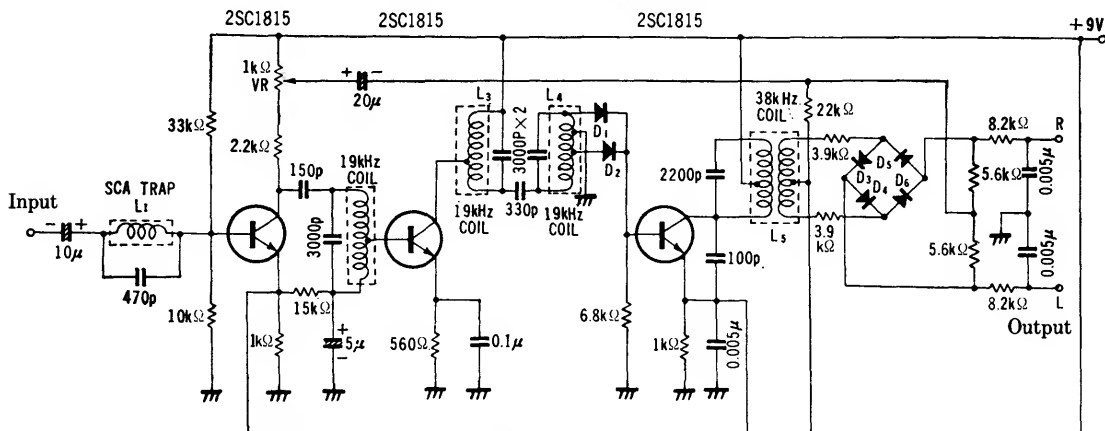
2. FM tuner circuit (2)



3. FM electronic tuner Circuit



8. FM multiplex circuit



Input signal separating characteristics
(standard value)

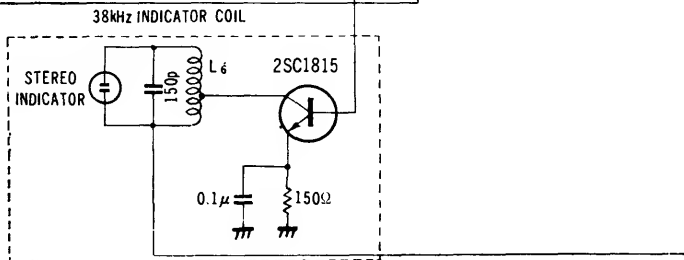
(at 1 kHz at 45% at pilot 10%)

Input voltage	: Separation
30mV	: 32dB
100mV	: 38dB
200mV	: 33dB

Frequency separating characteristics
(standard value)

(at 100 mV input at 45% at pilot 10%)

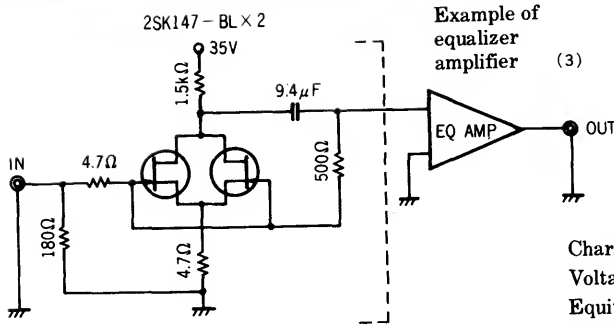
100Hz	: 38dB
1kHz	: 38dB
10kHz	: 24dB



Audio amplifier circuits

1. Preamplifier circuit

(1) MC head amplifier using 2SK147

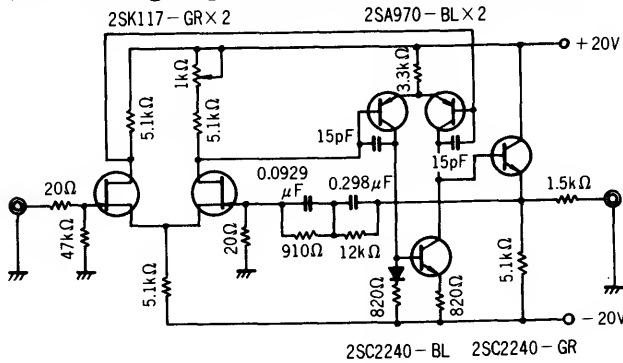


Characteristics

Voltage gain	: f=1kHz (head)	27dB
Equivalent input noise voltage	: Input open	-158.5dBV
S/N	: Vi=0.2mV	84.5dB

2. Preamplifier circuit

(2) First-stage equalizer amplifier using 2SK117

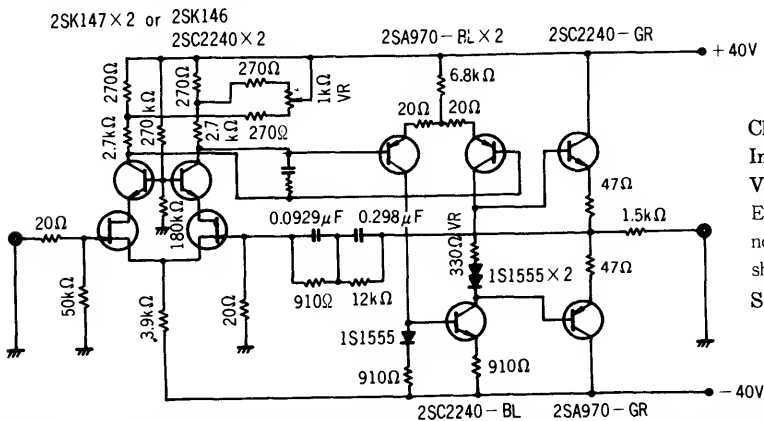


Characteristics

Input impedance	: f=1kHz	47kΩ
Voltage gain	: f=1kHz	35.0dB
Equivalent input noise voltage	: Input short-circuited, IHF A curve	-140.2dBV
S/N	: Vi=2mV	86.2dB

3. Preamplifier circuit

(3) First-stage equalizer amplifier using 2SK147 or 2SK146

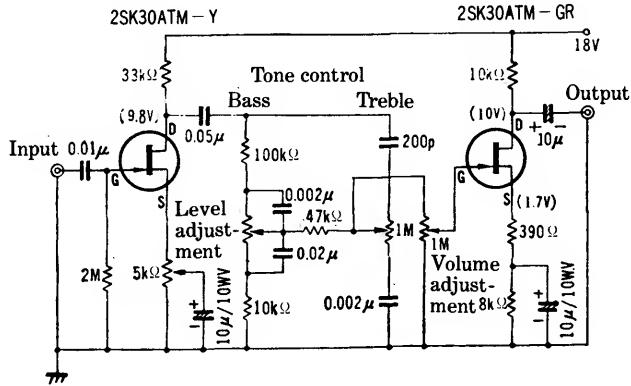


Characteristics

Input impedance	: f=1kHz	50kΩ
Voltage gain	: f=1kHz	35dB
Equivalent input noise voltage	: IHFA curve	
short-circuited	: IHFA curve	-143.8dBV
S/N	: Vi=2mV	89.9dB

4. Preamplifier circuit

(4) Ceramic crystal cartridge application



Item	Level adjustment		Conditions
	Min.	Max.	
Gain	14dB	28dB	Frequency response: flat, volume max.
S/N	70dB or more	80dB or more	Frequency response: flat, volume max. 1kHz, 100mV, Input opened
TOTAL HARMONIC DISTORTION	0.5% or less	3% or less	1kHz, 1V output, volume medium

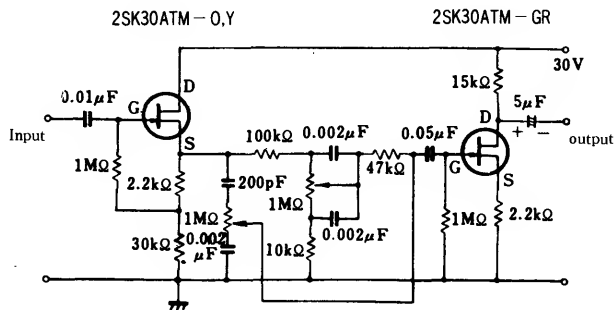
Tone control characteristics

Bass : $\pm 12\text{dB}$ @ 100Hz

Treble : $\pm 12\text{dB}$ @ 10kHz

5. Preamplifier circuit

(5) CR-type tone control circuit

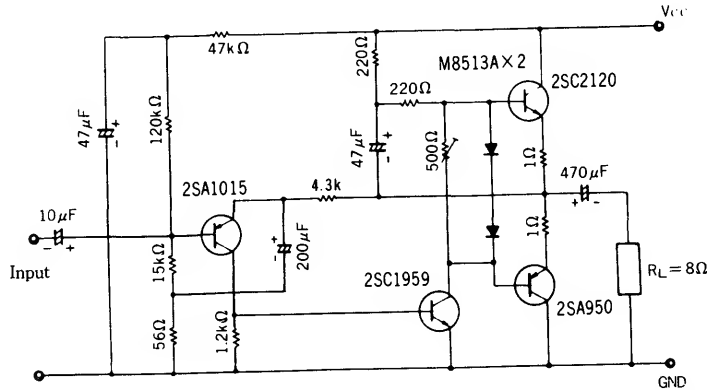


Input impedance : 10kΩ (MIN)

Gain reduction : -8.9dB (f = 1kHz)

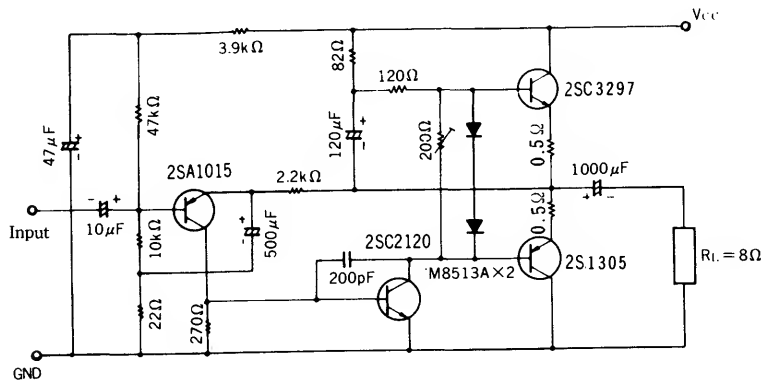
Maximum output voltage : 5V (f = 1kHz)

6. Power amplifier circuit for 1.5W output power



Supply voltage	: 13V
Load impedance	: 8 Ω
Input impedance	: 17k Ω
Voltage gain	: 38dB
Negative feedback	: 28dB
Output power	: 1.5W α KF = 5%, f = 1kHz
Idle current	: 10mA
Frequency response	: 20Hz ~ 50kHz α - 3dB
T. H. D.	: 0.6% α P _o = 0.1W f = 1kHz
	: 1.5% α P _o = 1W f = 1kHz

7. Power amplifier circuit for 5W output power



Supply voltage	: 20V
Load impedance	: 8 Ω
Input impedance	: 15k Ω α f = 1kHz
Voltage gain	: 40dB α f = 1kHz
Negative feedback	: 27.5dB α f = 1kHz
Output power	: 5W α KF = 5%, f = 1kHz
Idle current	: 7mA
Frequency Response	: 20Hz ~ 50kHz α - 3dB
T. H. D.	: 0.3% α 0.1W, f = 1kHz
	: 0.2% α 1W, f = 1kHz
	: 0.5% α 4W, f = 1kHz

8. Power amplifier circuit for 35~80W output power

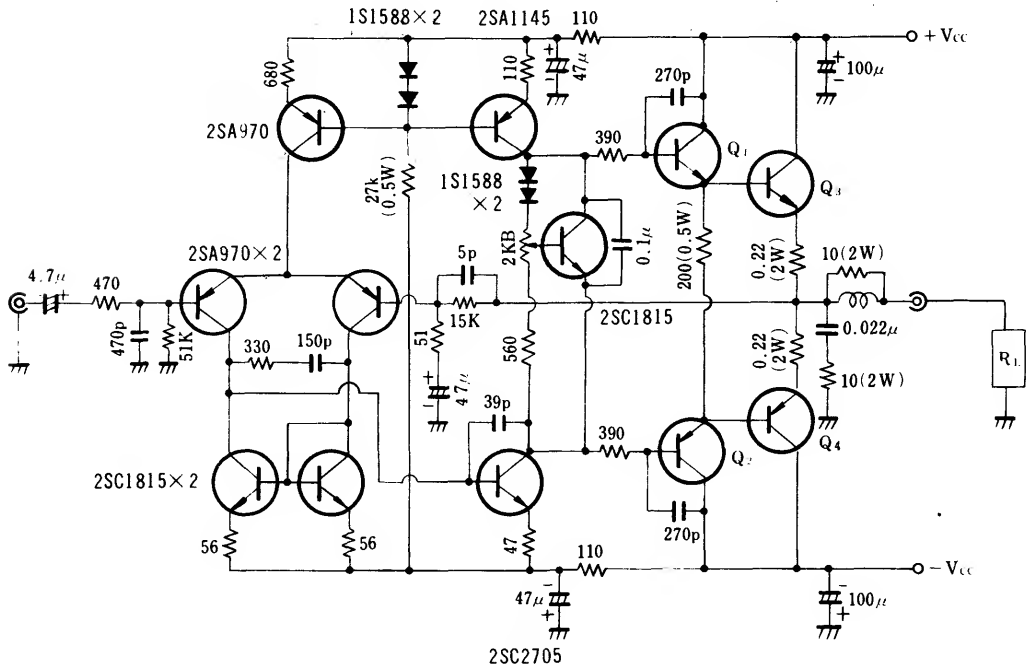


Fig. 1

Output power P_o (W)	Supply voltage $\pm V_{cc}$ (V)	Transistors			
		Q_1	Q_2	Q_3	Q_4
35	± 31	2SC1627A	2SA817	2SC3180	2SA1263
50	± 36	2SC2235	2SA965	2SC3181	2SA1264
70	± 41	2SC2824	2SA1184	2SC3182	2SA1265
80	± 45	2SC3298	2SA1306	2SC3280	2SA1301

Load impedance : 8Ω

Input impedance : $51k\Omega$ @ $f = 1kHz$

Voltage gain : $29.7dB$ @ $f = 1kHz$

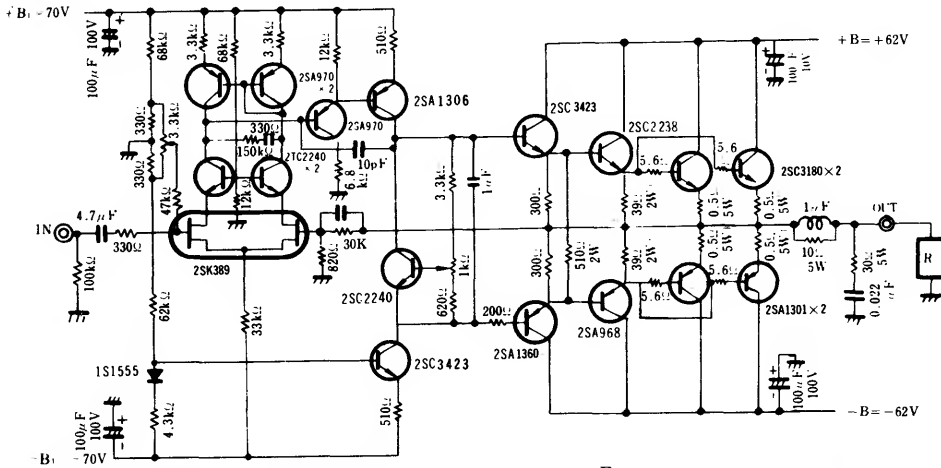
Output power : P_o (See Fig. 1) @ $f = 20 \sim 20kHz$ THD = 0.02%

Idle current : $30mA$

Frequency response : $20 \sim 100kHz$ @ $-1dB$

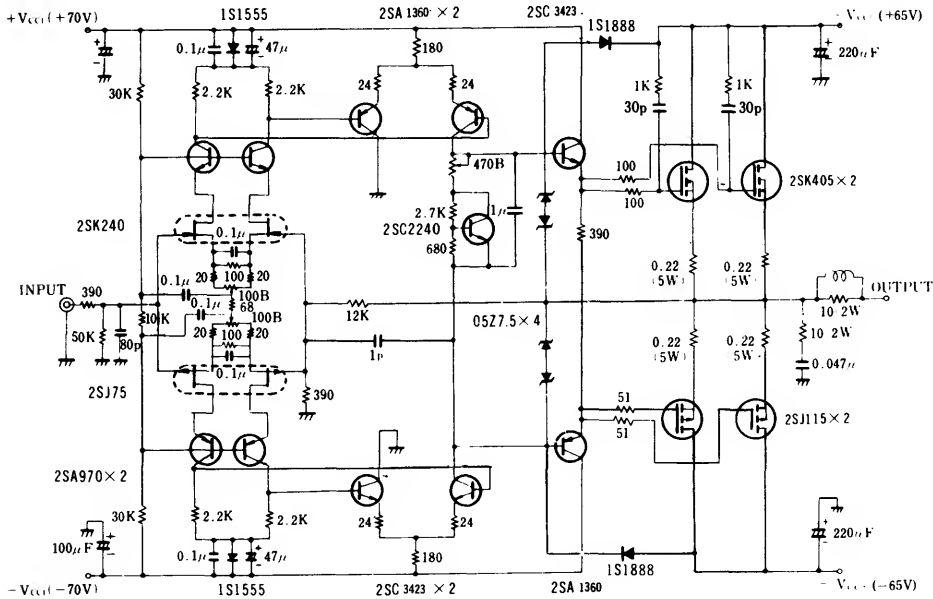
T. H. D. : 0.002% @ $P_o = 30W$ $f = 1kHz$

9. Power amplifier circuit for 120W output power



Supply voltage : $\pm B_1 = \pm 70V$, $\pm B_2 = \pm 62V$ (No Signal) Frequency Response : 20~100kHz $\alpha -1dB$
 Load impedance : 8 Ω
 Input impedance : 32k Ω ($\alpha f = 1kHz$) T. H. D. : 0.0054% ($\alpha P_o = 1W$ $f = 1kHz$)
 Voltage gain : 31dB ($\alpha f = 1kHz$) : 0.0022% ($\alpha P_o = 10W$ $f = 1kHz$)
 Output power : 120W ($\alpha f = 20 \sim 20kHz$ THD=0.01%) : 0.0016% ($\alpha P_o = 30W$ $f = 1kHz$)
 Idle current : 50mA : 0.0015% ($\alpha P_o = 60W$ $f = 1kHz$)
 : 0.0015% ($\alpha P_o = 120W$ $f = 1kHz$)

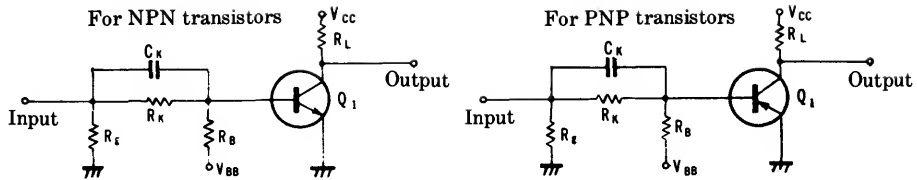
10. Power amplifier circuit for 120W output power (using POWER MOS FET)



Supply voltage : $\pm V_{CC1} = \pm 70V$, $\pm V_{CC2} = \pm 65V$ (No Signal) Frequency response : 20~100kHz $\alpha -1dB$
 Load impedance : 8 Ω T. H. D. : 0.0015 ($\alpha P_o = 120W$ $f = 1kHz$)
 Input impedance : 56k Ω ($\alpha f = 1kHz$) : 0.0025 ($\alpha P_o = 120W$ $f = 20kHz$)
 Voltage gain : 30dB ($\alpha f = 1kHz$) : 0.007 ($\alpha P_o = 120W$ $f = 100kHz$)
 Output power : 120W ($\alpha 20 \sim 100kHz$ THD=0.01%)
 Idle current : 500mA

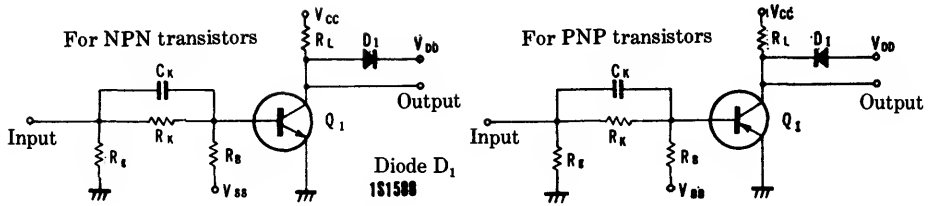
Switching circuits

1. Inverter circuit (1)



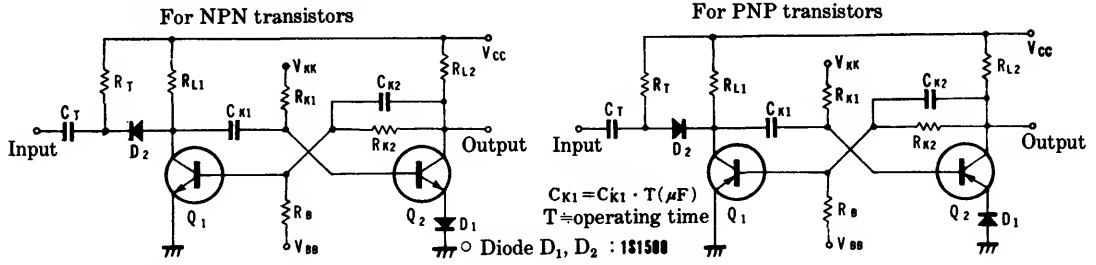
Transistor Q_1 Q	Circuit constant									Switching time (standard value)			
	V_{CC} V	V_{BH} V	V_i (V)	R_i (Ω)	R_N (k Ω)	R_K (k Ω)	R_E (Ω)	C_K (pF)	t_d (ns)	t_r (ns)	t_{off} (ns)	t_f (ns)	
2SA495 C TM	-12	3	-6	1 k	8.2	5.6	50	100	4	4	20	35	
	-	-	-	-	15	10	-	-	-	-	-	-	
2SA499	-12	3	-6	1 k	3.9	2.7	50	100	4	4	20	35	
2SA500	-	-	-	-	6.8	5.1	-	-	-	-	-	-	
	-	-	-	-	12	8.2	-	-	-	-	-	-	
2SC395A	12	-3	6	390	2.2	1.5	50	30	3	3	4	10	
	-	-	-	-	3.9	2.7	-	-	-	-	-	-	
2SC400	12	-3	6	1 k	6.8	5.1	50	100	4	4	20	35	
	-	-	-	-	12	8.2	-	-	-	-	-	-	
	-	-	-	-	18	12	-	-	-	-	-	-	
2SC752 C TM	12	-3	6	1 k	3.9	2.7	50	15	3	3	4	30	
	-	-	-	-	6.8	5.1	-	-	-	-	-	-	
	-	-	-	-	12	8.2	-	-	-	-	-	-	
2SC752 C TM	12	-3	6	390	1.5	1.0	50	20	3	3	3	10	
	-	-	-	-	2.7	1.8	-	-	-	-	-	-	
	-	-	-	-	4.7	3.3	-	-	-	-	-	-	
2SC503	15	3	6	100	2.2	0.39	50	470	20	10	25	30	
2SC504	-	-	-	-	3.9	0.68	-	560	-	-	-	-	
	-	-	-	-	7.5	1.5	-	680	-	-	-	-	
2SC372 C TM	12	3	6	1k	8.2	5.6	50	100	4	4	20	35	
2SC372 C TM	-	-	-	-	15	10	-	-	-	-	-	-	
2SC373 C TM	-	-	-	-	22	15	-	-	-	-	-	-	
2SC980 C TM,	24	3	6	2.2k	6.8	3.9	50	100	5	10	40	70	
A C TM	-	-	-	-	12	6.8	-	-	-	-	-	-	
2SC980 C TM	-	-	-	-	22	12	-	-	-	-	-	-	

2. Inverter circuit (2)



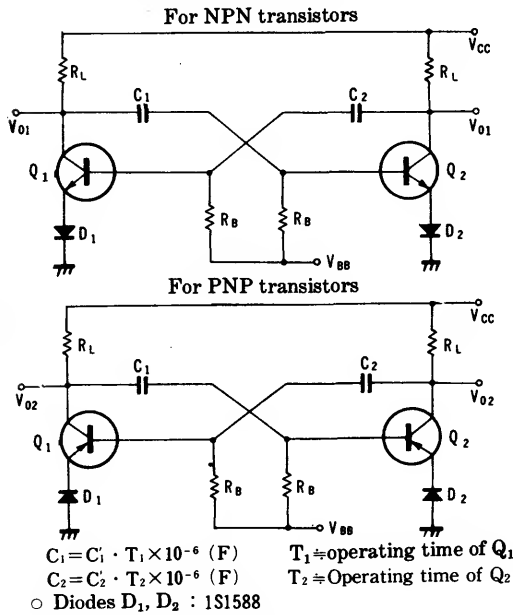
Transistor Q_1	Circuit constant									Switching time			
	V_{cc} (V)	V_{bb} (V)	V_{oo} (V)	R_L (Ω)	R_B (k Ω)	R_K (k Ω)	R_E (Ω)	C_K (pF)	V_i (V)	t_d (ns)	t_r (ns)	t_{sig} (ns)	t_f (ns)
2SA495 \odot TM - O - Y	-12	3	-6	1 k	8.2 15	5.6 10	50	100	-6	4	4	15	10
2SA499 - R - O 2SA500 - Y	-12	3	-6	1 k	3.9 6.8 12	2.7 5.1 8.2	50	100	-6	4	4	15	10
2SC395A - O - Y	12	-3	6	390	2.2 3.9	1.5 2.7	50	30	6	3	3	4	4
2SC752 \odot TM - R - O - Y	12	-3	6	390	1.5 2.7 4.7	1.0 1.8 3.3	50	20	6	3	4	3	4
2SC372 \odot TM - O - Y 2SC373 \odot TM	12	-3	6	1 k	8.2 15 22	5.6 10 15	50	100	6	4	4	15	10
2SC400 - O - Y - GR	12	-3	6	1 k	6.8 12 18	5.1 8.2 12	50	100	6	4	4	15	10

3. Monostable multivibrator circuit



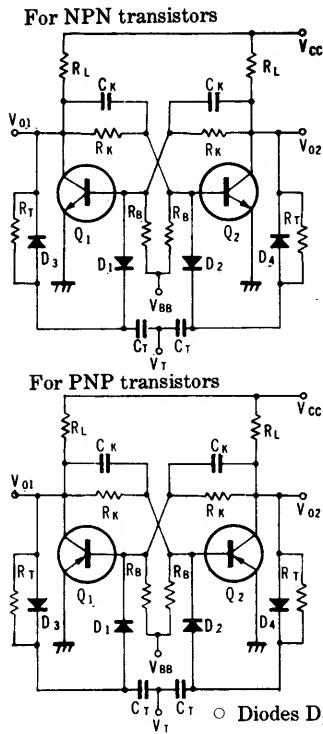
Transistor Q_1, Q_2	Circuit constant												
	V_{CC} (V)	V_{BE} (V)	V_{BH} (V)	V_1 (V)	R_{L1} (Ω)	R_{L2} (Ω)	R_{K1} (Ω)	R_{K2} (k Ω)	R_B (k Ω)	R_T (k Ω)	C_{K1}	C_{K2} (pF)	C_T (pF)
2SA495 © TM - O - Y	-12	-12	12	6	1 k	1 k	22 33	22 33	68 120	10	66 44	50	200
2SA499 - R - O 2SA500 - Y	-12	-12	12	6	1 k	1 k	8.2 15 27	8.2 15 27	27 56 100	10	177 97 54	50	200
2SC372 © TM - O 2SC372 © TM - Y 2SC373 © TM	12	12	-12	-6	1 k	1 k	22 33 56	22 33 56	68 120 180	10	66 44 26	50	200
2SC395A - O - Y	12	12	-12	-6	390	390	6.8 12	6.8 12	68 120	3.9	214 121	20	50
2SC400 - R - O - Y - GR	12	12	-12	-6	1 k	1 k	8.2 15 27 42	8.2 15 27 42	27 56 100 156	10	177 97 54 35	50	200
2SC752 © TM - R - O - Y	12	12	-12	-6	390	390	5.1 8.2 15	5.1 8.2 15	81 52 150	3.9	284 179 97	20	50
2SC980 © TM, A © TM - O 2SC980 © TM - Y	24	24	-12	-6	2.2k	2.2k	33 56 100	27 39 75	68 100 180	22	43 26 15	30	300

4. Astable multivibrator circuit



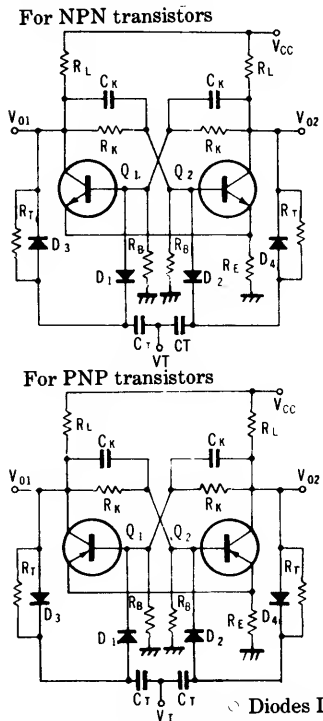
Transistors Q_1, Q_2	Circuit constant					
	V_{CC} (V)	V_{BE} (V)	R_L Ω	R_B k Ω	C_1	C_2
2SA495 © TM - O - Y	-12	-12	1 k	27 47	54 31	54 31
2SA499 - R - O 2SA500 - Y	-12	-12	1 k	12 22 39	121 66 37	121 66 37
2SC395A - O - Y	12	12	390	6.8 12	214 121	214 121
2SC752 © TM - R - O - Y	12	12	390	5.1 8.2 15	284 177 97	284 177 97
2SC372 © TM - O 2SC372 © TM - Y 2SC373 © TM	12	12	1 k	27 47 68	54 31 21	54 1 21
2SC400 - O - Y - GR	12	12	1 k	22 39 56	66 37 26	66 37 26
2SC980 © TM, A © TM - O 2SC980 © TM - Y	24	24	2.2k	33 56 100	44 26 15	44 26 15

5. Fixed-bias type flip-flop circuit



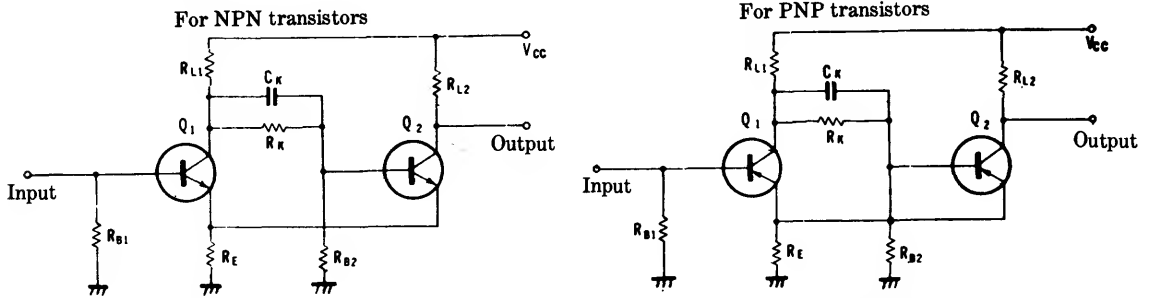
Transistors Q ₁ , Q ₂	Circuit constant									
	V _{CC} (V)	V _{BB} (V)	V _I (V)	R _I (Ω)	R _K (kΩ)	R _B (kΩ)	R _E (kΩ)	R _C (kΩ)	C _K (pF)	C _T (pF)
2SA495 Ⓞ TM - O - Y	-12	12	6	1 k	22	100	10	50	200	
2SA499 - R - O	-12	12	6	1 k	8.2	39	10	50	200	
2SA500 - O - Y	"	"	"	"	18	82	"	"	"	"
	"	"	"	"	33	150	"	"	"	"
2SC395A - O - Y	12	-12	-6	390	6.8	68	10	15	50	
	"	"	"	"	12	120	"	"	"	"
2SC752 Ⓞ TM - O - O	12	-12	-6	390	5.1	56	10	15	50	
2SC752 Ⓞ TM - Y	"	"	"	"	8.2	82	"	"	"	"
	"	"	"	"	15	150	"	"	"	"
2SC372 Ⓞ TM - O - O	12	-12	-6	1 k	22	100	10	50	200	
2SC372 Ⓞ TM - Y	"	"	"	"	39	180	"	"	"	"
2SC373 Ⓞ TM	"	"	"	"	68	270	"	"	"	"
2SC400 - O - Y	12	-12	-6	1 k	18	82	10	50	200	
	"	"	"	"	33	150	"	"	"	"
	"	"	"	"	56	220	"	"	"	"
2SC980 Ⓞ TM, A Ⓞ TM - O 2SC980 Ⓞ TM - Y	24	-12	-6	2.2k	27	68	22	30	250	
	"	"	"	"	39	100	"	"	"	"
	"	"	"	"	75	180	"	"	"	"

6. Self-bias type flip-flop circuit



Transistors Q ₁ , Q ₂	Circuit constant									
	V _{CC} (V)	V _I (V)	R _I (Ω)	R _K (kΩ)	R _B (kΩ)	R _E (Ω)	R _C (kΩ)	R _T (kΩ)	C _K (pF)	C _T (pF)
2SA495 Ⓞ TM - O - Y	-12	6	1 k	15	8.2	120	10	50	200	
	"	"	"	27	18	150	"	"	"	"
2SA499 - R - O	-12	6	1 k	6.8	2.7	56	10	50	200	
2SA500 - O - Y	"	"	"	12	5.6	120	"	"	"	"
	"	"	"	18	10	150	"	"	"	"
2SC395A - O - Y	12	-6	330	4.7	2.7	47	10	20	50	
	"	"	"	8.2	5.6	56	"	"	"	"
2SC752 Ⓞ TM - O - O	12	-6	330	3.3	1.8	33	10	20	50	
2SC752 Ⓞ TM - Y	"	"	"	6.8	5.6	51	"	"	"	"
	"	"	"	10	6.8	56	"	"	"	"
2SC372 Ⓞ TM - O - O	12	-6	1 k	15	8.2	120	10	50	200	
2SC372 Ⓞ TM - Y	"	"	"	27	18	150	"	"	"	"
2SC373 Ⓞ TM	"	"	"	47	27	180	"	"	"	"
2SC400 - O - Y	12	-6	1 k	12	5.6	120	10	50	200	
	"	"	"	18	10	150	"	"	"	"
	"	"	"	33	18	180	"	"	"	"
2SC980 Ⓞ TM, A Ⓞ TM - O 2SC980 Ⓞ TM - Y	24	-6	2.2k	27	18	220	22	30	300	
	"	"	"	39	33	"	"	"	"	"
	"	"	"	68	56	"	"	"	"	"

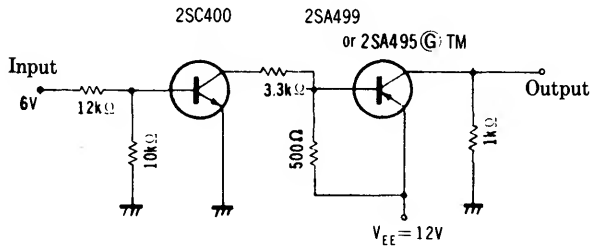
7. Schmidt circuit



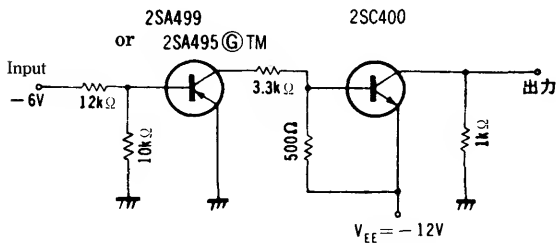
Transistors Q ₁ , Q ₂	Circuit constant										Switching time (standard value)		
	V _{CC} (V)	V _I (V)	R _{L1} (Ω)	R _{L2} (Ω)	R _K (kΩ)	R _K (Ω)	R _{B1} (kΩ)	R _{B2} (kΩ)	C _K (pF)	t _{on} (ns)	t _{off} (ns)	V _H * (V)	
2SA495 Ⓞ TM - O - Y	12	3	1 k	1 k	15 27	180	10 18	10 18	50	60	120	-1.0	
2SA499 - R 2SA500 - O - Y	12	3	1 k	1 k	6.8 15 22	180	5.6 12 15	5.6 12 15	50	60	120	-1.0	
2SC372 Ⓞ TM - O 2SC372 Ⓞ TM - Y 2SC373 Ⓞ TM	12	3	1 k	1k	15 27 47	180	10 18 33	10 18 33	50	60	120	1.0	
2SC395A - O - Y	12	3	330	330	4.7 6.8	68	3.9 5.6	3.9 5.6	20	20	20	-0.5	
2SC400 - O - Y - G/R	12	3	1k	1 k	15 22 39	180	12 15 22	12 15 22	50	60	120	1.0	
2SC752 Ⓞ TM - R - O - Y	12	3	330	330	3.3 5.1 8.2	68	3.3 3.9 5.6	3.3 3.9 5.6	20	20	25	-0.5	

* Hysteresis voltage

8. Positive pulse amplifier circuit



9. Negative pulse amplifier circuit



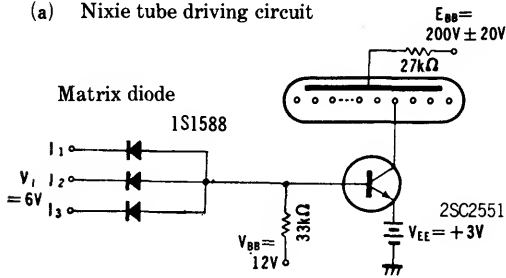
Input/Output switching time. (standard value) unit: ns

	t _d	t _r	t _{stg}	t _f
Positive pulse	110	50	600	45
Negative pulse	125	70	600	45

TOSHIBA CORPORATION

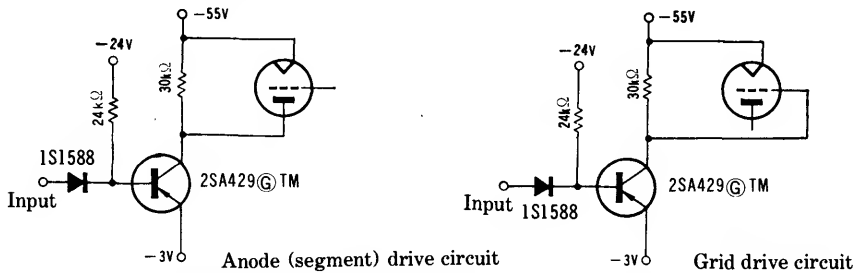
10. Indication tube driving circuit

(a) Nixie tube driving circuit



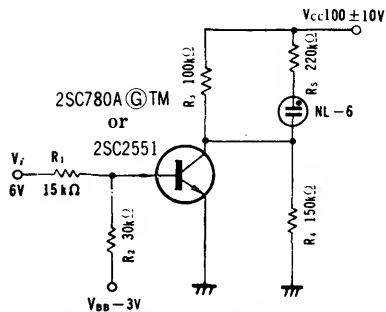
Indicator characteristics	Operating temperature range	-10°C ~ +55°C	
	Minimum input voltage for lighting on	4 V	
	Maximum input voltage for lighting off	2.5 V	
	Discharge sustaining voltage	~140 V	
Allowable average cathode DC current	Figure pole	1.5 ~ 3.0 mA	
	Decimal point pole	0.6 ~ 1.5 mA	

(b) Indication tube driving circuit (Digitron or others)



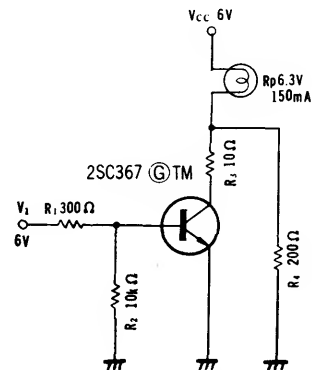
Indicator characteristics	Operating temperature range	-10°C ~ 60°C	
	Minimum input voltage for lighting on	- 4 V	
	Maximum input voltage for lighting off	- 2.5 V	
	Max./min. fluorescent segment voltage	± 20 ~ ± 30 V dc	
Average current for fluorescent. segment	Pole	1 ~ 3 mA	
	Figure	0.1 ~ 0.2 mA	

(c) Neon tube driving circuit



Transistors used : 2SC780A(T)M
 Supply voltage : $V_{cc} = 100 \pm 10$ V
 Input drive voltage : $V_i = 6$ V
 Base bias current : $V_{BB} = -3$ V
 Neon lamp lighting characteristics
 Rated voltage : $V_p = 100$ V
 Rated current : $I_p = 0.3$ A
 Discharge starting voltage : $V_N = 85$ V
 Discharge stopping voltage : $V_F = 55$ V
 External series resistance : $R_s = 220k\Omega$

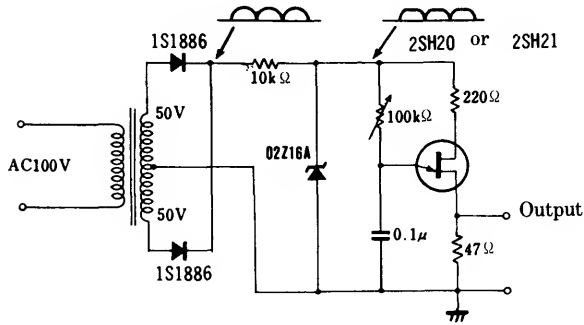
(d) Pilot lamp driving circuit



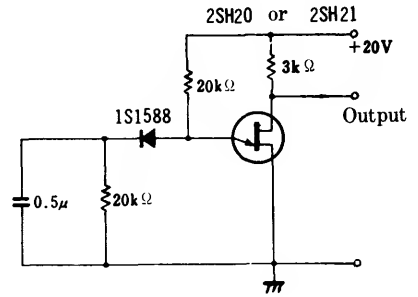
Transistors used : 2SC367(T)M
 Supply voltage : $V_{cc} = 6$ V
 Input drive voltage : $V_i = 6$ V
 Lamp characteristics
 Rated voltage : $V_p = 6.3$ V
 Rated current : $I_p = 150$ mA

11. UJT application circuits

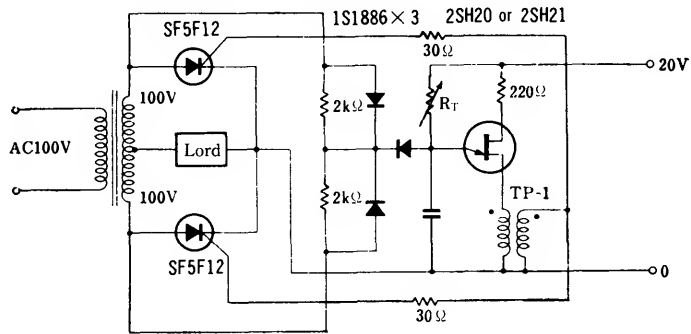
(1) Synchronous circuit with AC power source



(2) Square-wave oscillating circuit

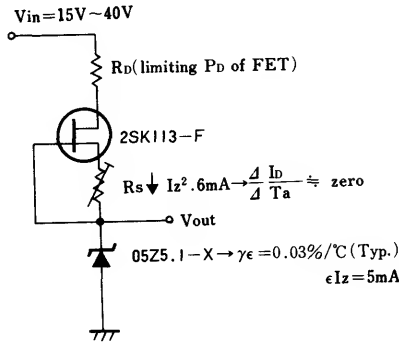


(3) SCR igniting phase controlling circuit

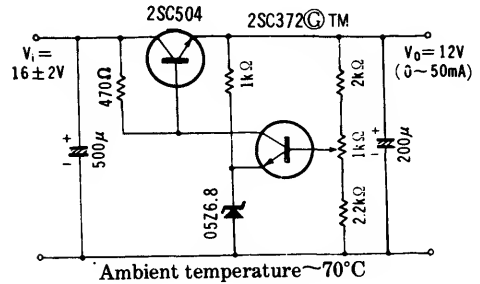


Dropper Regulator Circuit

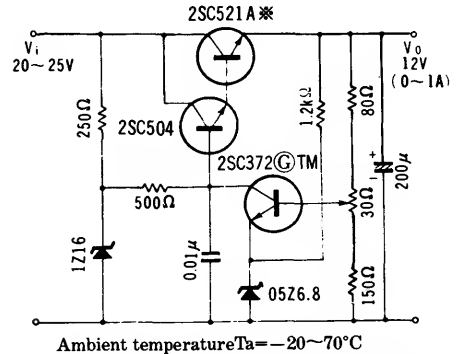
1. High-stability reference regulator circuit



2. Constant-voltage regulator circuit (1) 12V, 50 mA

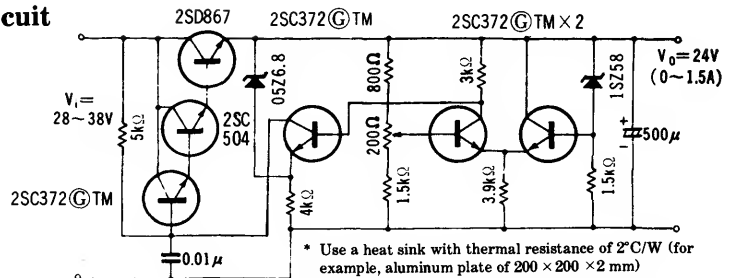


3. Constant-voltage regulator circuit (2) 12V, 1A



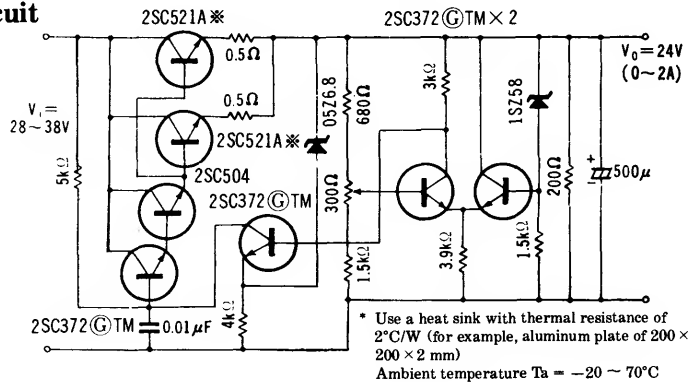
* Use a heat sink with thermal resistance of $2^{\circ}C/W$ (for example, aluminum plate of $200 \times 200 \times 2$ mm)

4. Constant-voltage regulator circuit (3) 24V, 1.5A

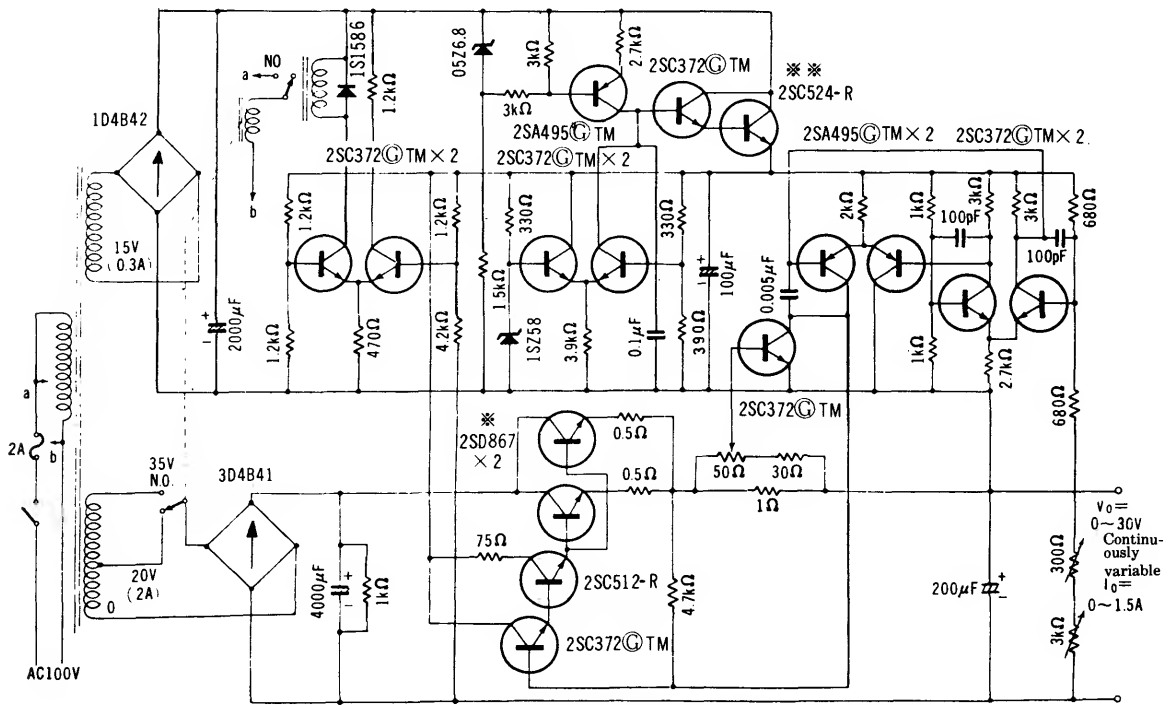


* Use a heat sink with thermal resistance of $2^{\circ}C/W$ (for example, aluminum plate of $200 \times 200 \times 2$ mm)

5. Constant-voltage regulator circuit (4) 24V, 2A



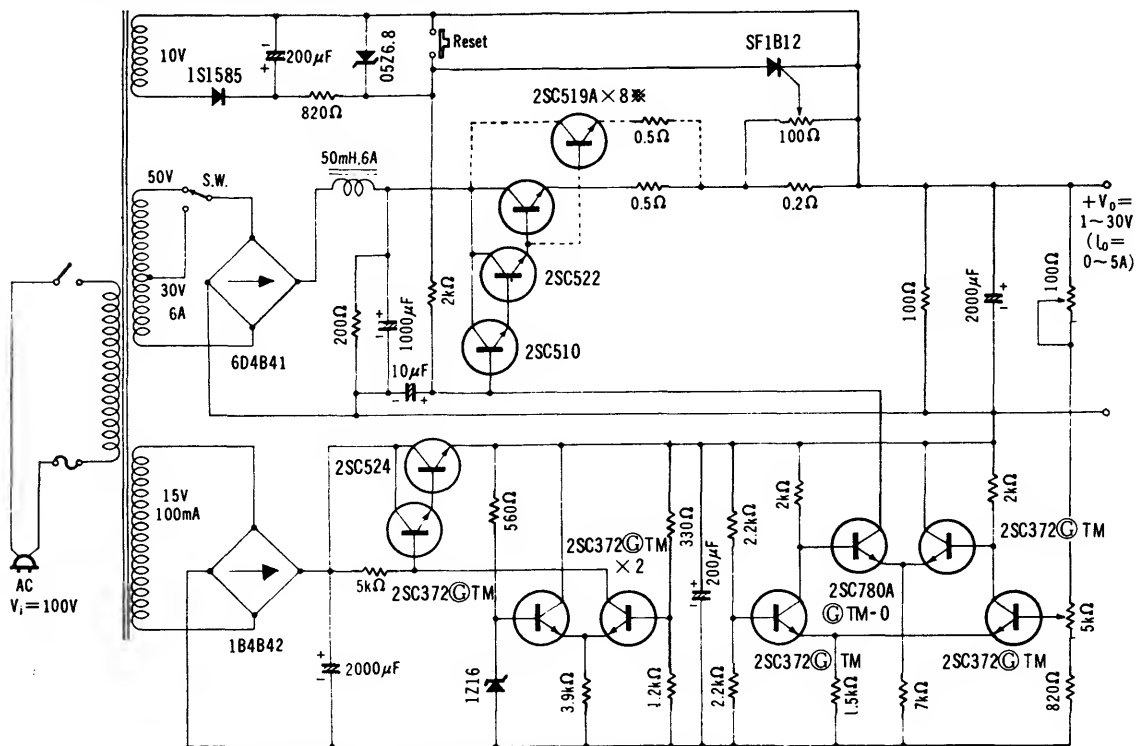
6. Constant-voltage regulator circuit (5) 0 ~ 30V, 1.5A



- * Use a heat sink with thermal resistance of $2^{\circ}\text{C}/\text{W}$ (for example, aluminum plate of $200 \times 200 \times 2$ mm)
 - ** Use a heat sink with thermal resistance of $6^{\circ}\text{C}/\text{W}$ (for example, aluminum plate of $100 \times 100 \times 2$ mm)
- Internal resistance $r_o > 5\text{m}\Omega$

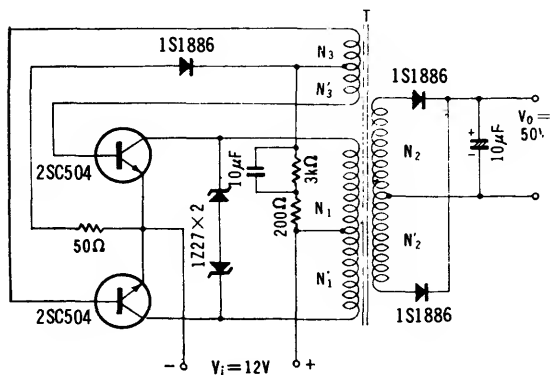
Ripple voltage : $V_{0r} < 1.5\text{mV}$ (p-p)
Output voltage fluctuation ($\pm 10\%$) caused by supply voltage fluctuation $\Delta V_0 < 2.5\text{mV}$
Ambient temperature $T_a = -20 \sim 70^{\circ}\text{C}$

7. Constant-voltage regulator circuit



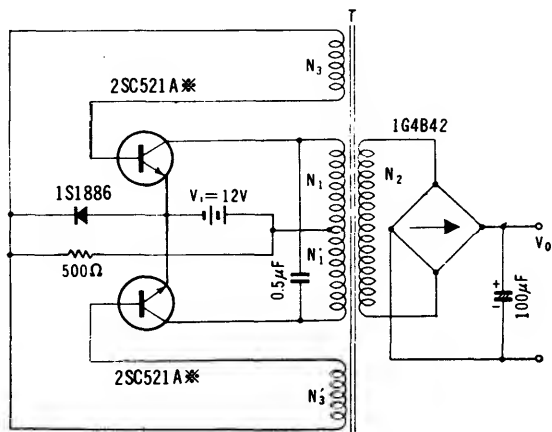
* 200 mm × 200 mm × 2 mm (Aluminum heat sink) (thermal resistance 2°C/W)
 Note: For output voltage of 0 ~ 17V, use 30V tap for S.W. and for 17 ~ 30V use 50V tap.

8. Multivibrator-type DC-DC converter circuit (1), 50V, 3W ($V_i = 12V$)



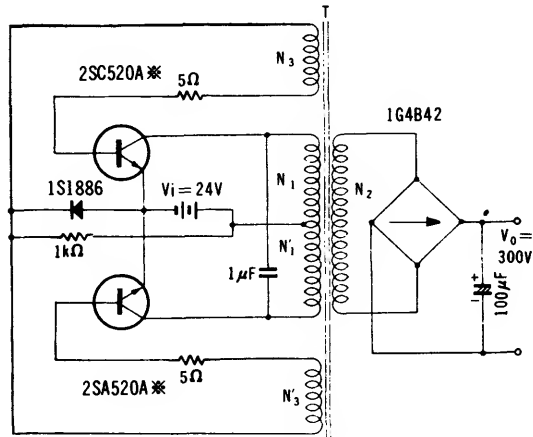
T : TDK ferrite core H₅AP_{30/19}
 N₁, N₄ : 10T φ 0.32mm Oscillating frequency: f = 1kHz
 N₂, N₅ : 43T φ 0.28mm Efficiency: η = 70%
 N₃, N₅ : 2T φ 0.25mm Ambient temperature: Ta = -20 ~ 70°C

9. Multivibrator-type DC-DC converter circuit (2), 300V, 40W ($V_i = 12V$)



T : Toshiba RNE (Rectalloy) Core R-60
 N₁, N₄ : 20T φ 1.0mm TDK ferrite core: H₅AP_{30/19}
 N₂ : 550T φ 32mm Oscillating frequency: f = 10kHz
 N₃, N₅ : 6T φ 0.32mm Efficiency: η = 80%
 Ambient temperature: Ta = -20 ~ 70°C
 * : 100mm × 100mm × 2mm (Aluminum heat sink) T : Toshiba RNE (Rectalloy) Core R-60

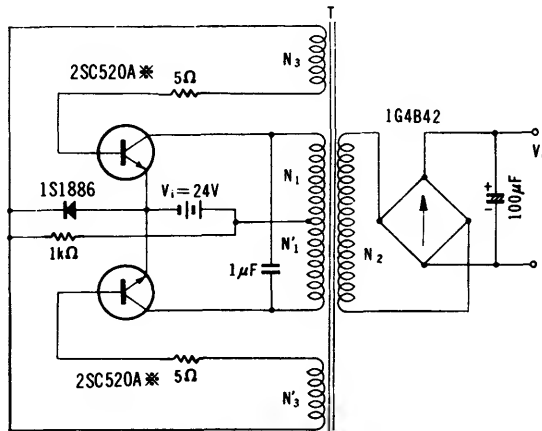
10. Multivibrator-type DC-DC converter circuit (3), 300V, 40W ($V_i = 24V$)



T : Toshiba RNE (Rectalloy) core R-45
 N_1, N_1 : 52T ϕ 0.8mm
 N_2 : 715T ϕ 0.32mm
 N_3, N_3 : 5T ϕ 0.32mm
 * : 100mm \times 100mm \times 2mm (Aluminum heat sink)

Oscillating frequency: $f = 1\text{kHz}$
 Efficiency: $\eta = 80\%$
 Ambient temperature: $T_a = -20 \sim 70^\circ\text{C}$

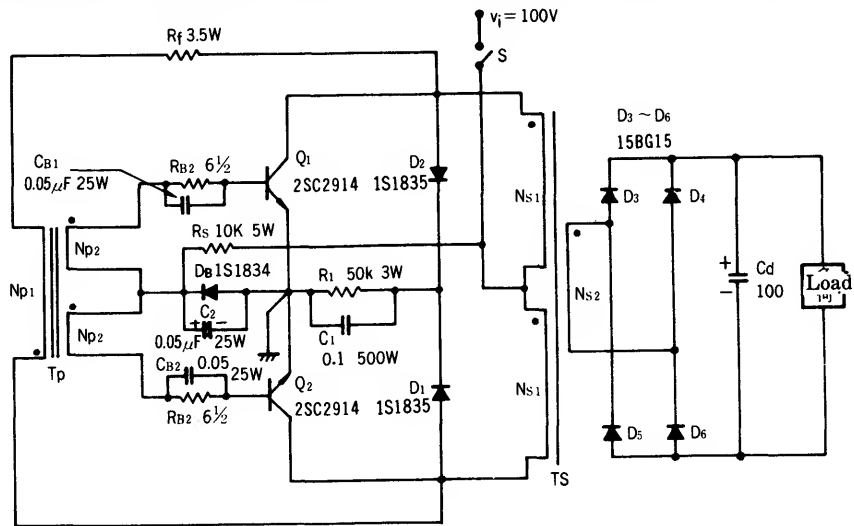
11. Multivibrator-type DC-DC converter circuit (4), 300V, 80W ($V_i = 24V$)



T : Toshiba RNE (Rectalloy) core R-60
 N_1, N_1 : 39T ϕ 1.0mm
 N_2 : 550T ϕ 0.5mm
 N_3, N_3 : 5T ϕ 0.32mm
 * : 100mm \times 100mm \times 2mm (Aluminum heat sink)

Oscillating frequency: $f = 1\text{kHz}$
 Efficiency: $\eta = 80\%$
 Ambient temperature: $T_a = -20 \sim 70^\circ\text{C}$

12. Multivibrator-type DC-DC converter circuit (5), 5V, 150W ($V_i=100V$)



2SC2914: (with heat sink, $\theta_f \leq 2.8^\circ\text{C/W}$)

Tp: TDK H6AT10-20-5 Ferrite core

Ts: TDK EI60 H3C

Np₁: 75T ϕ 0.2mm

Np₂: 8T ϕ 0.5mm

Ns₁: 21T ϕ 1.2mm

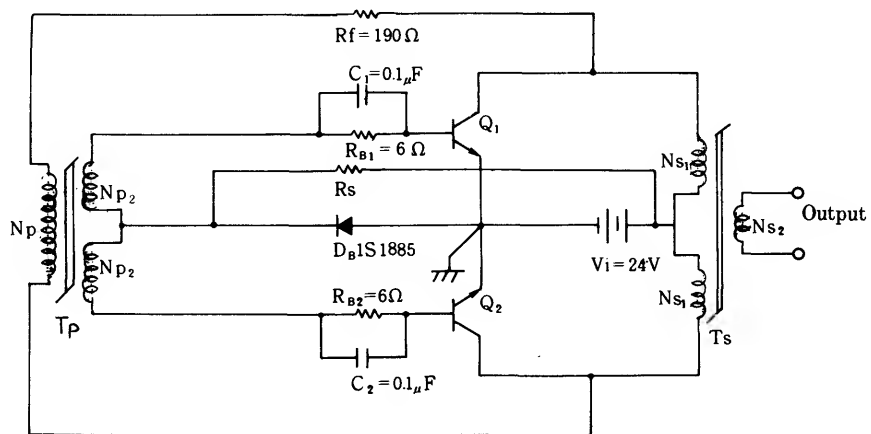
Ns₂: 4T ϕ 2.5mm

Oscillating frequency; $f=20\text{kHz}$

Efficiency: $\eta = 80\%$

Ambient temperature: $T_a = -20 \sim 60^\circ\text{C}$

13. Multivibrator-type DC-AC inverter circuit(6) 100V, 80W, ($V_i=24V$)



Q₁, Q₂: 2SC2913
or 2SC2555

Tp: TDK H7A EE12

Np₁: 29T ϕ 0.35mm

Np₂: 12T ϕ 0.52mm

Ns₁: 6T ϕ 1.8mm

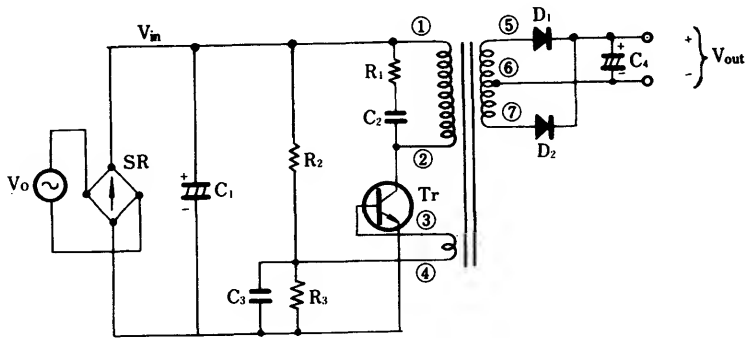
Ns₂: 25T ϕ 0.17mm

Oscillating frequency; $f=25\text{kHz}$

Efficiency: $\eta = 80\%$

Ambient temperature: $T_a = -20^\circ\text{C} \sim 60^\circ\text{C}$

14. Example: Circuit incorporating a ringing choke-converter circuit

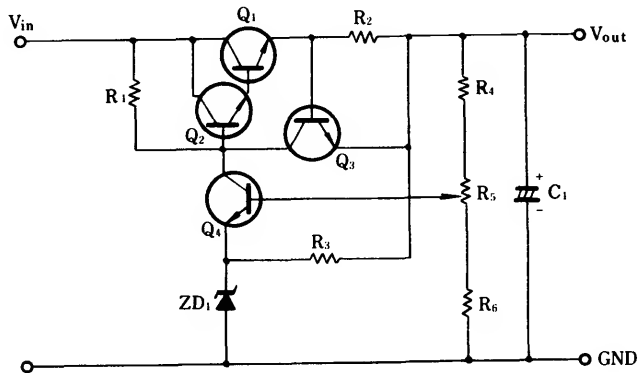


Specifications:

- | | | |
|------------------------------------|---------------------------------------|-------------------------|
| Supply voltage: $V_0 = AC100V$ | Tr: 2SC2552 | C_1 : $4.7\mu F$ 250V |
| Output voltage: $V_{out} = 2.0V$ | SR: 1D4B41 | C_2 : $0.001\mu F$ |
| Output current: $I_{out} = 1.0A$ | Δ_1 : 1S1834 | C_3 : $0.022\mu F$ |
| Oscillating frequency: $f = 22kHz$ | D_2 : 1S1834 | C_4 : $220\mu F$ 35V |
| | R_1 : 220Ω 1W | |
| Oscillating cycle: $T = 45\mu sec$ | T_1 : EE-12.8, TDK H ₃ S | |
| On-time: $t_{on} = 10\mu sec$ | R_2 : 68Ω 1/4W | |
| Off-time: $t_{off} = 35\mu sec$ | R_3 : $1.5k\Omega$ 1/4W | |

Note 1: C_4 is not required if used for battery charger circuit Application

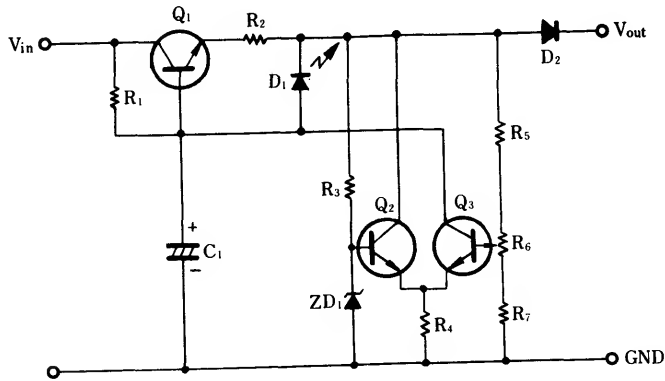
15. 20V, 2A Output dropper regulator, (Dropper regulator circuit application)



Specifications

- | | | |
|--------------------------------------|----------------------------|-----------------------------|
| Output voltage : 20V | Q_1 : 2N3055 | R_1 : $1.2k\Omega$, 1/4W |
| Output current : 2A | Q_2 : 2SD234 © | R_2 : 0.3Ω , 2W |
| Input voltage fluctuation : 25~30V | Q_3, Q_4 : 2SC372 © TM | R_3 : $2.8k\Omega$, 1/4W |
| (Operating temperature) : (-20~60°C) | ZD ₁ : 05Z6.2 | R_4 : $1.2k\Omega$, 1/4W |
| | R_5 : 330Ω , VR | |
| | R_6 : 560Ω , 1/4W | |
| | C_1 : $470\mu F$, 25V | |

16. 12V, 1A Output dropper regulator



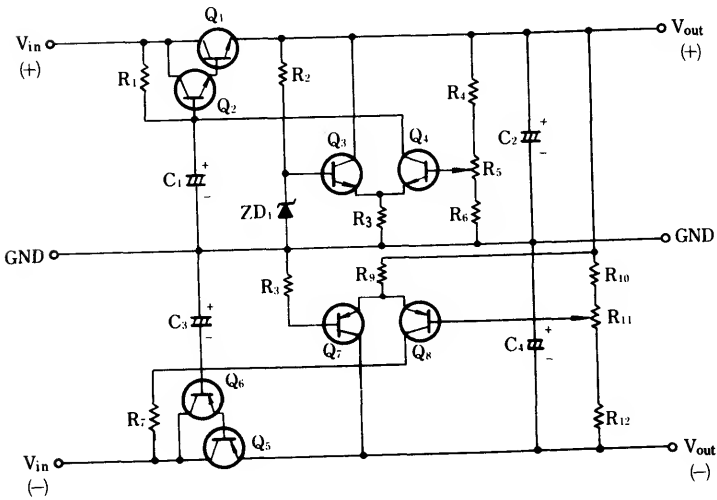
Specifications:
 Output voltage: 12V
 Output current: 1A
 Input voltage fluctuation: 15~18V

Q₁ : 2SD234 © (or 2SD880)
 Q₂, Q₃ : 2SC372 © TM
 ZD₁ : 05Z5.1
 D₁ : TLR103
 D₂ : 1S1885
 C₁ : 10μF, 25V

R₁ : 470Ω, ¼W
 R₂ : 20Ω, 2W
 R₃ : 1.5kΩ, ¼W
 R₄ : 330Ω, ¼W
 R₅ : 680Ω, ¼W
 R₆ : 100Ω, VR
 R₇ : 470Ω, ¼W

17. ±15V, 2A Output dropper regulator

Shown below is applied circuit incorporating transistors 2N3771 and 2N4398.



Specifications
 Output voltage : ±15V
 Output current : 2A
 Input voltage fluctuation : 18~24V

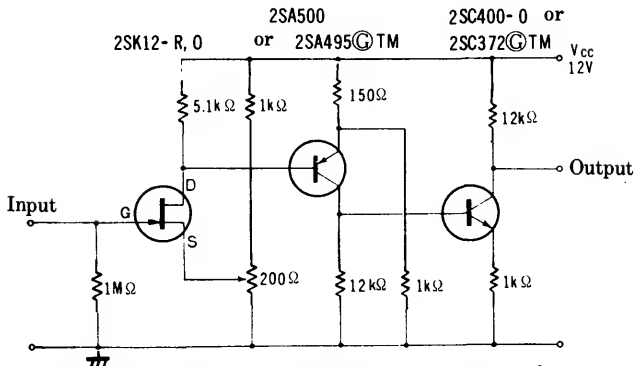
Q₁ : 2N3771
 Q₂ : 2SC2562
 Q₃ : 2SC2240
 Q₄ : 2SC2240
 Q₅ : 2N4398
 Q₆ : 2SA1012
 Q₇, Q₈ : 2SA970

ZD₁ : 05Z5.6
 R₁ : 330Ω, ¼W
 R₂ : 2kΩ, ¼W
 R₃ : 220Ω, ¼W
 R₄ : 680Ω, ¼W
 R₅ : 500Ω, VR
 R₆ : 560Ω, ¼W

R₇ : 330Ω, ¼W
 R₈ : 1kΩ, ¼W
 R₉ : 560Ω, ½W
 R₁₀, R₁₂ : 1kΩ, ¼W
 R₁₁ : 1kΩ, VR
 C₁, C₃ : 10μF, 25V
 C₂, C₄ : 470μF, 25V

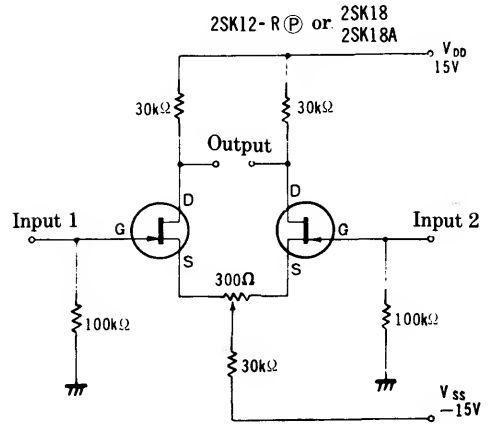
Circuits incorporating FET's

1. Amplifier circuit with direct-coupled FET, voltage gain 62 dB, min. sensing signal $\sim 1\text{mV}$

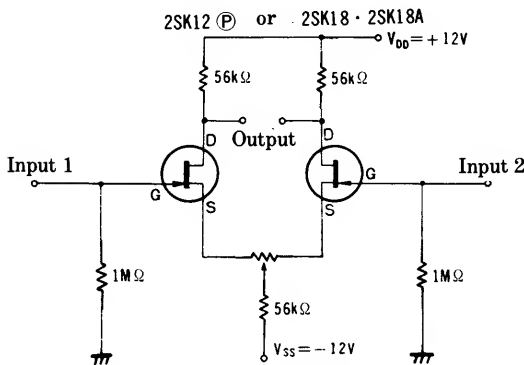


Select as the bias drain current of 2SK12 a value more than that at which the temperature coefficient of drain current may be zero, the drain current thus possessing a negative temperature coefficient. Then compensate the temperature to offset this temperature coefficient with that of V_{BE} of the subsequent stage to reduce the temperature drift of output.

2. FET differential amplifier circuit (1), voltage gain 26 dB



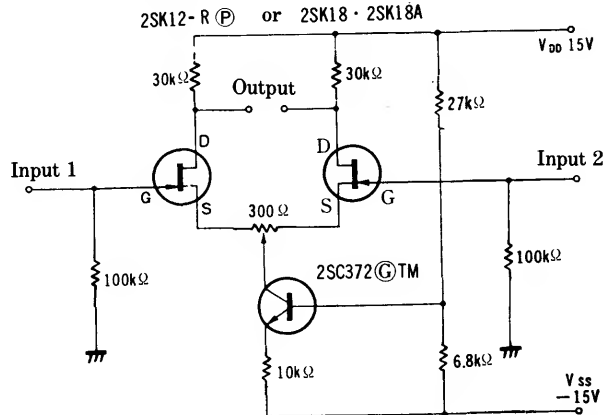
3. FET differential amplifier circuit (2), voltage gain 16 dB



Equivalent input temperature drift voltage
 $(V_D/\Delta T): 40 \mu\text{V}/^\circ\text{C}$
 Voltage drift
 $(V_D/V_{DD}): 0.04\%$

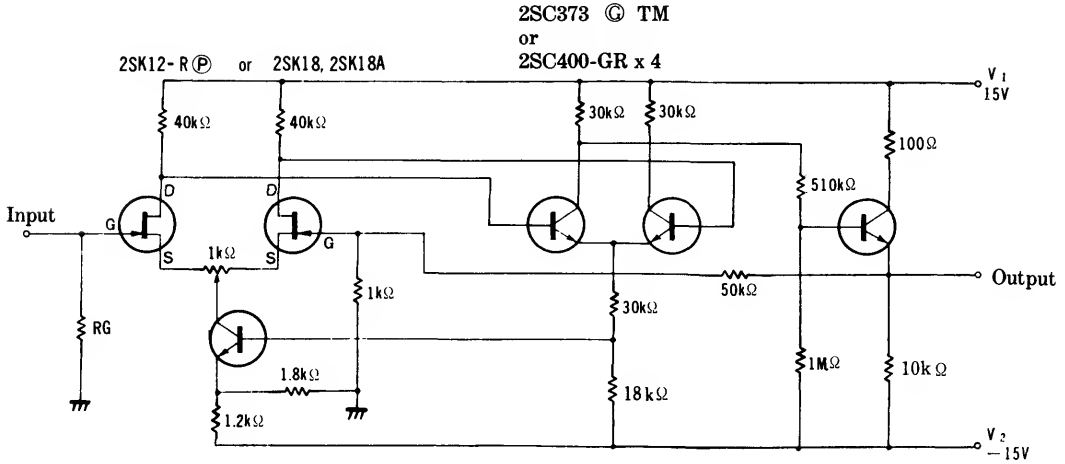
Voltage drift
 $(V_D/V_{SS}): 0.9\%$
 V_D : Equivalent input temperature drift voltage (V)

4. FET differential amplifier circuit (3), voltage gain 26 dB

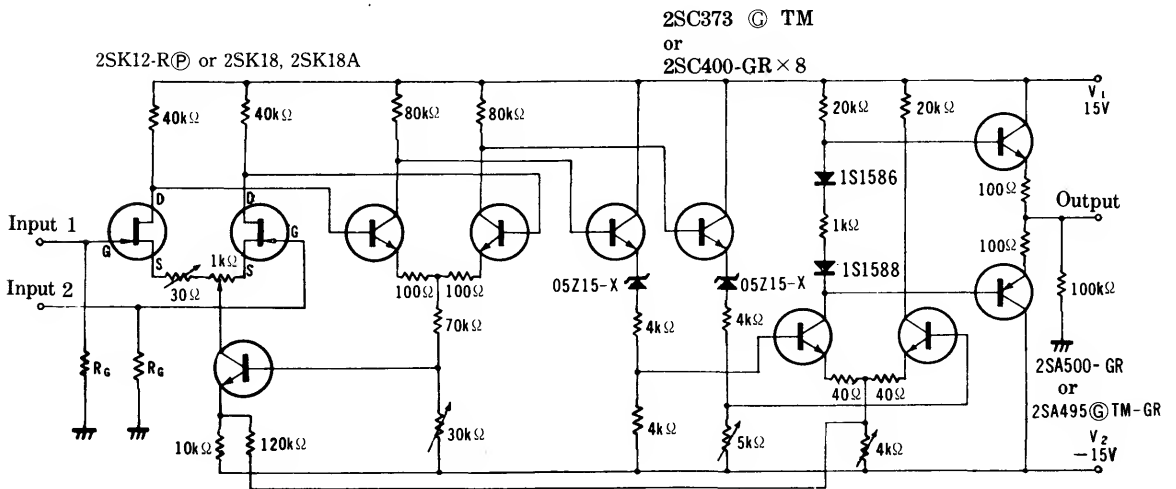


Common mode rejection ratio $\text{CMR} = 76\text{dB}$ ($\Delta I_{DSS}/I_{DSS} = 10\%$)

5.- FET 2-stage differential-amplifier circuit, voltage gain 34 dB (open loop gain: 53 dB)



6. FET 3-stage differential amplifier circuit (open loop gain 98 dB)

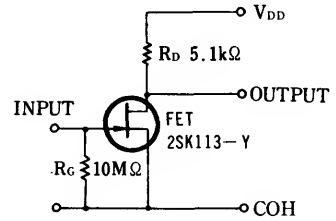


7. Digital switch

Specifications

Supply voltage	: $V_{DD}=20V$
Input drive voltage	: $V_{GS(ON)}=0V$ $V_{GS(OFF)}=-15V$
Input impedance	: $10M\Omega$

Example

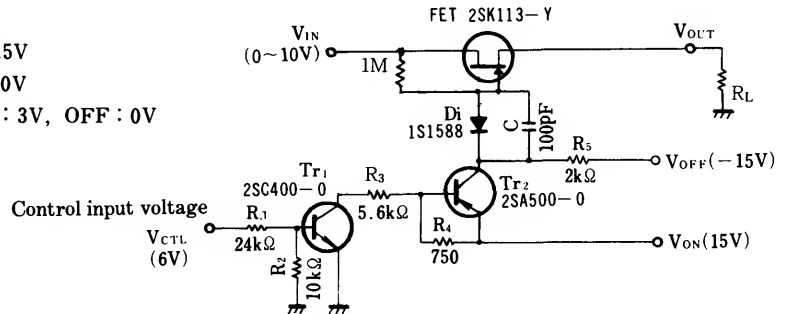


FET used 2SK113-Y
 Operating temperature $T_a = -20^\circ C \sim +100^\circ C$

8. Analog switch

Specifications

Supply voltage	: $V_{ON}=15V$ $V_{OFF}=-15V$
Input voltage	: $V_{IN}=0\sim 10V$
Control voltage	: $V_{CTL}=ON: 3V, OFF: 0V$



9. Sample hold circuit

Example of Circuit

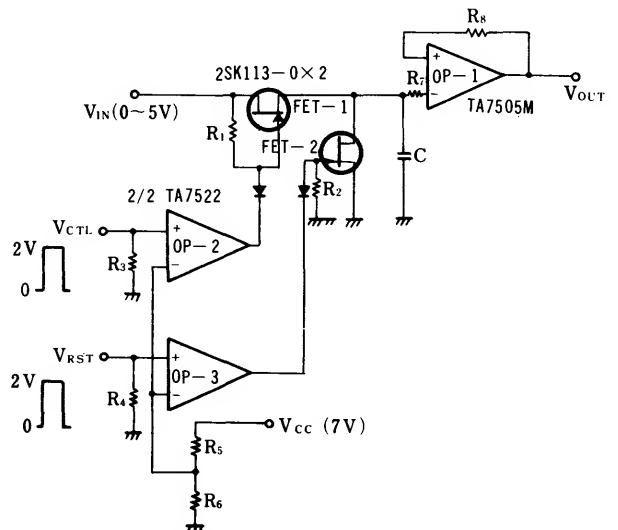
Specifications

Supply voltage	: $V_{CC}=7V, V_{EE}=-9V$
Input voltage	: $V_{IN}=0\sim 5V$
Control voltage	: $V_{CTL}=2V$
Reset voltage	: $V_{RST}=2V$
Sampling time	: 10ms
Retention time	: 10s
Operating temperature	: $-20^\circ C \sim 50^\circ C$

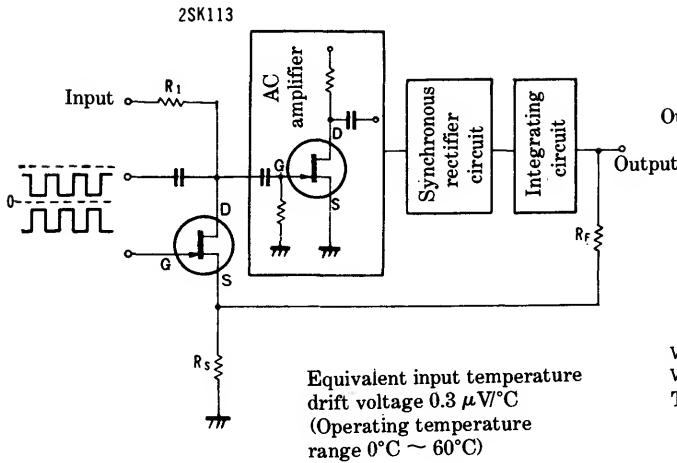
* $R_7 = R_8 = 2\sim 3k\Omega$
 R_7 : OP Amp For input protection
 R_8 : For offsetting output and reducing drift

Transistors used : FET: 2SK113-Y
 Tr_1 : 2SC400-O
 Tr_2 : 2SA500-O

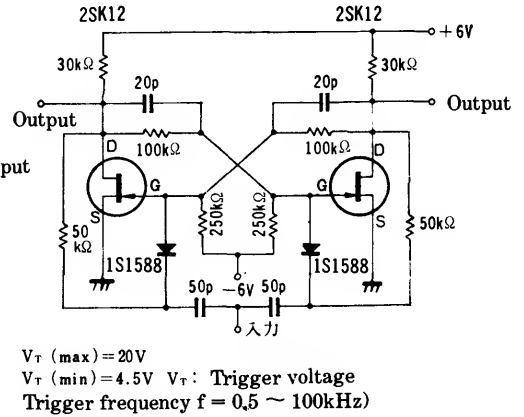
Circuit diagram



10. FET chopper amplifier circuit

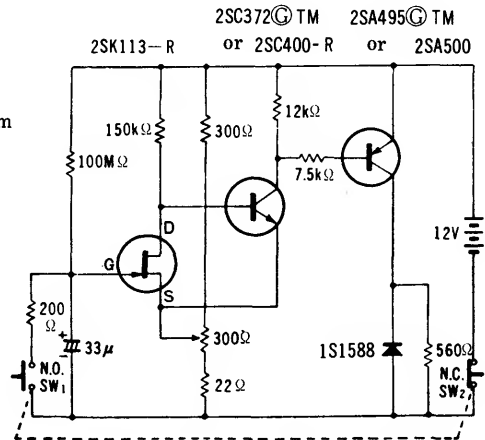
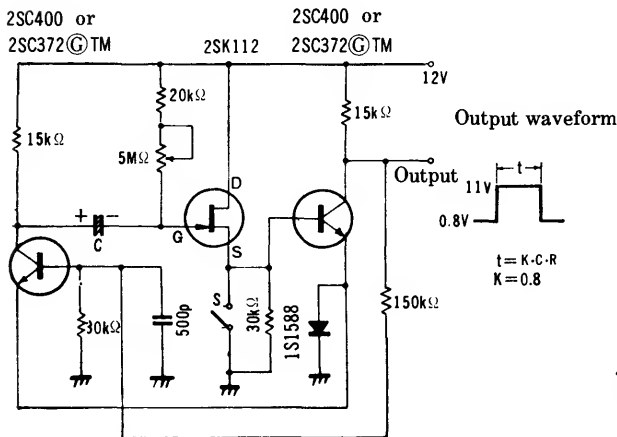


11. FET flip-flop circuit



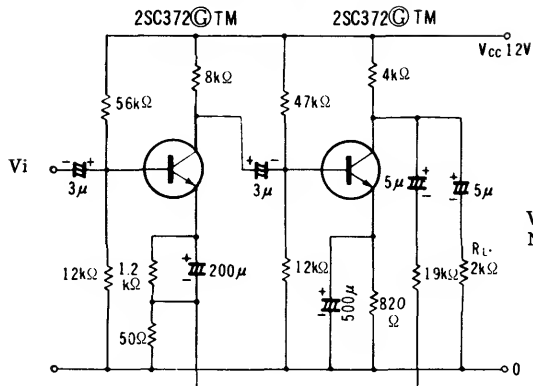
12. FET timer circuit (1)

13. FET timer circuit (2) (operating time: 10 min.)



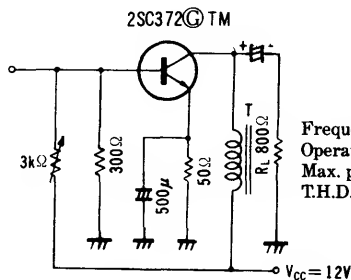
Low-frequency amplifier circuit

1. RC coupled amplifier circuit



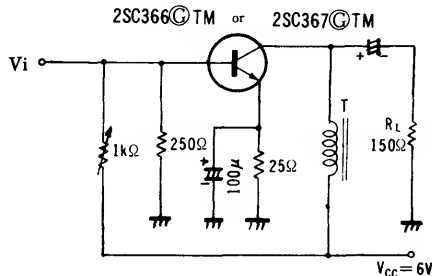
Voltage gain : 48dB ($f = 8\text{Hz} \sim 2\text{MHz}$ $R_g = 1\text{k}\Omega$)
 Negative feedback : 15dB

2. Class A single amplifier circuit (1), $P_o = 55\text{mW}$



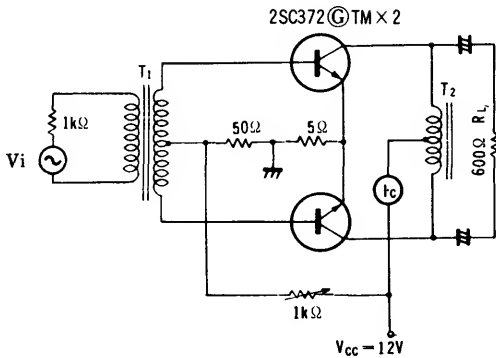
Frequency: $f = 1\text{kHz}$
 Operating current: 15mA
 Max. power gain: 44dB
 T.H.D.: 4.9% (at maximum output)

3. Class A single amplifier circuit (2), $P_o = 75\text{mW}$



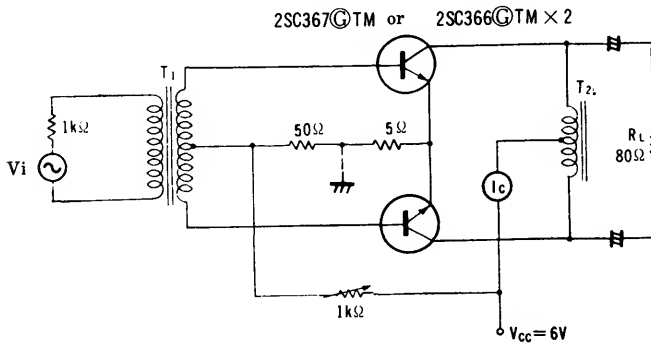
Frequency: $f = 1\text{kHz}$
 Operating current: 22mA
 Max. power gain: 31dB
 T.H.D.: 5.1% (at maximum output power)

4. Class B push-pull amplifier circuit
(1), $P_o = 200\text{mW}$



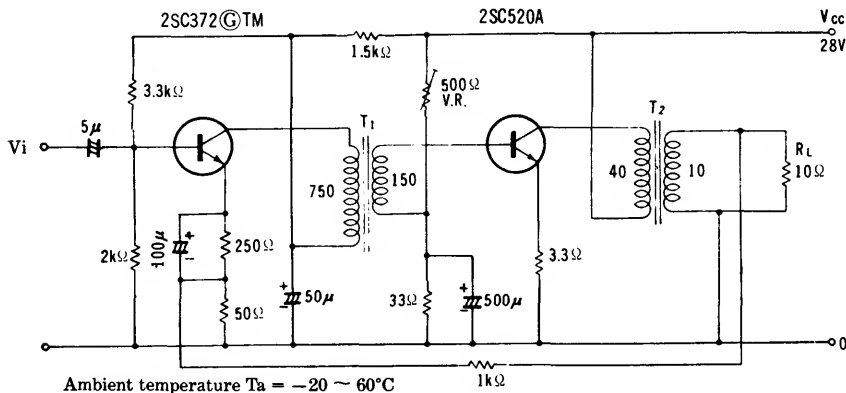
Frequency: $f = 1\text{kHz}$
 Operating current: 20mA
 (average value of the two)
 Max. power gain: 30.1dB
 T.H.D.: 2.8% (at maximum output power)

5. Class B push-pull amplifier circuit
(2), $P_o = 400\text{mW}$



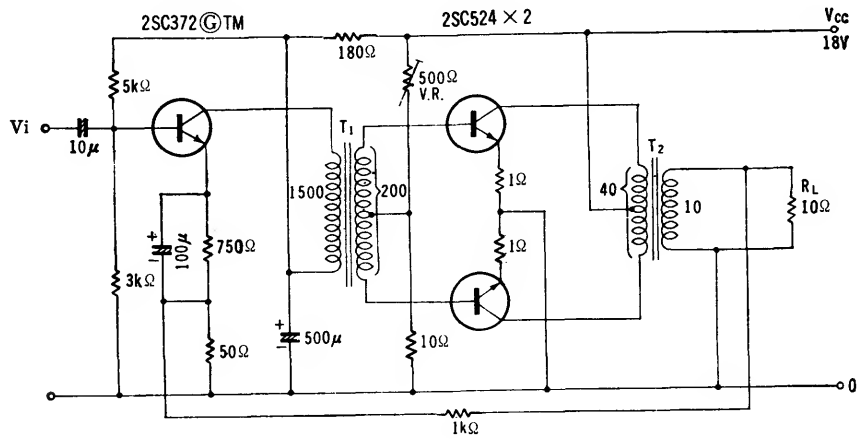
Frequency: $f = 1\text{kHz}$
 Operating current: 140mA
 (average value of the two)
 Max. power gain: 21dB
 T.H.D.: 4.7% at maximum output power

6. Transformer-coupled Class A power amplifier circuit, $P_o = 5\text{W}$ ($V_i = 0.4\text{V}$)



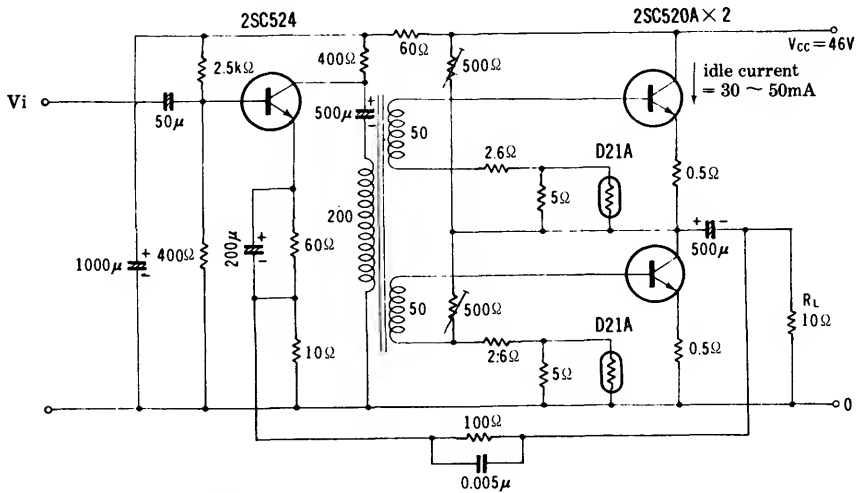
Ambient temperature $T_a = -20 \sim 60^\circ\text{C}$

7. Transformer-coupled Class B power amplifier circuit, $P_o = 7W$ ($V_i = 0.6V$)



Ambient temperature: $T_a = -20 \sim 60^\circ C$

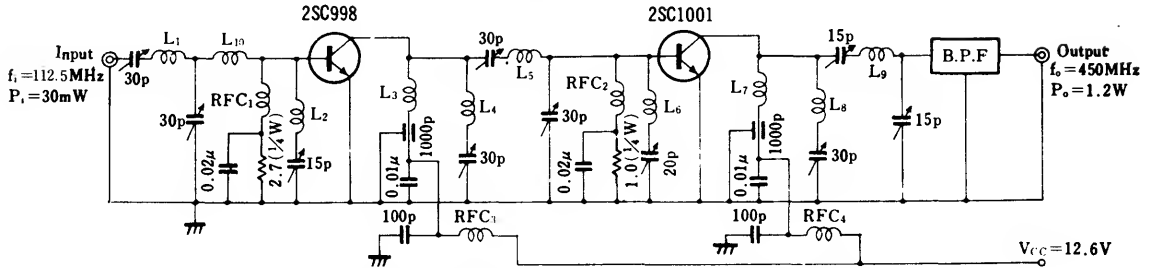
8. SEPP power amplifier circuit with input transformer, $P_o = 200W$ ($V_i = 1.5V$)



Ambient temperature: $T_a = -20 \sim 60^\circ C$

High-frequency power amplifier circuit

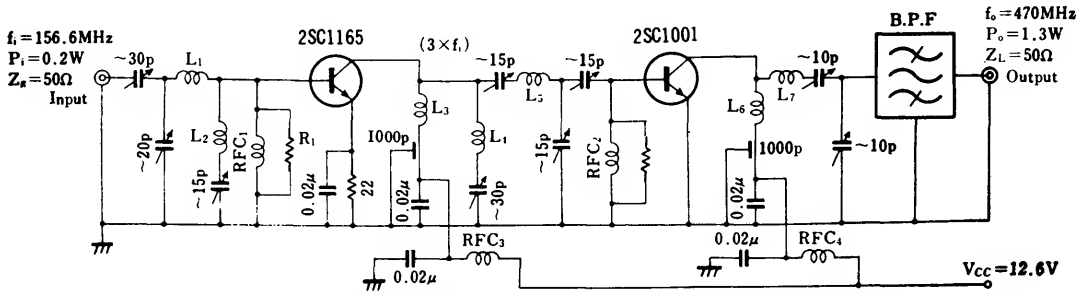
1. Double-multiplier power amplifier circuit (112.5 MHz ~ 450 MHz)



- L₁: φ 0.8mm Silver-plated copper wire, 2T, 7ID, 3P
- L₂: φ 0.8mm Silver-plated copper wire, 2T, 7ID, 2P
- L₃: φ 0.8mm Silver-plated copper wire, 2T, 7ID, 2P
- L₄: φ 0.8mm Silver-plated copper wire, 2T, 7ID, 2P
- L₅: φ 0.8mm Silver-plated copper wire, 2T, 7ID, 2P
- L₆: φ 0.8mm Silver-plated copper wire, 1T, 7ID
- L₇: φ 0.8mm Silver-plated copper wire, 1T, 7ID
- L₈: φ 0.8mm Silver-plated copper wire, 3T, 7ID, 2P

- L₉: φ 0.8mm Enamel-coated copper wire, 2T, 7ID, 2P
- L₁₀: φ 0.8mm Enamel-coated copper wire, 2T, 7ID, 2P
- RFC₁: φ 0.6mm Enamel-coated copper wire, 2T, 7ID, 2P
- RFC₂: φ 0.6mm Enamel-coated copper wire, 2T, 7ID, 2P
- RFC₃: φ 0.6mm Enamel-coated copper wire, 2T, 7ID, 2P
- RFC₄: φ 1.0mm Enamel-coated copper wire, 10T, 5ID,
- B.P.F.: BAND PASS FILTER

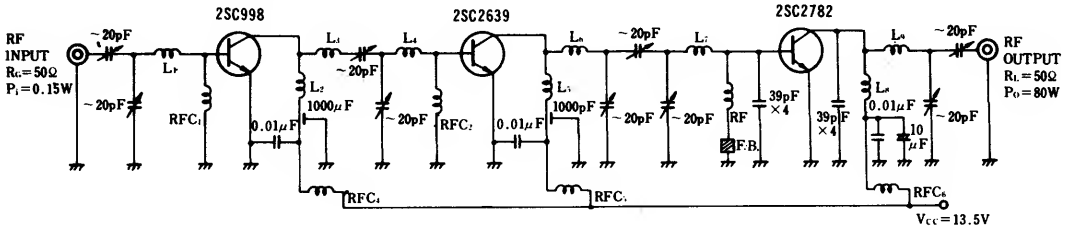
2. Triple-multiplier 2-stage power amplifier circuit (156.6 MHz ~ 470 MHz)



- L₁: φ 0.8mm Silver-plated copper wire, 2T, 10ID, 2P
- L₂: φ 1.2mm Silver-plated copper wire, 1T, 10ID
- L₃, L₄: φ 0.8mm Silver-plated copper wire, 1T, 8ID
- L₅: φ 1.2mm Silver-plated copper wire, 2T, 10ID, 2P
- L₆: φ 1.2mm Silver-plated copper wire, 1T, 8ID

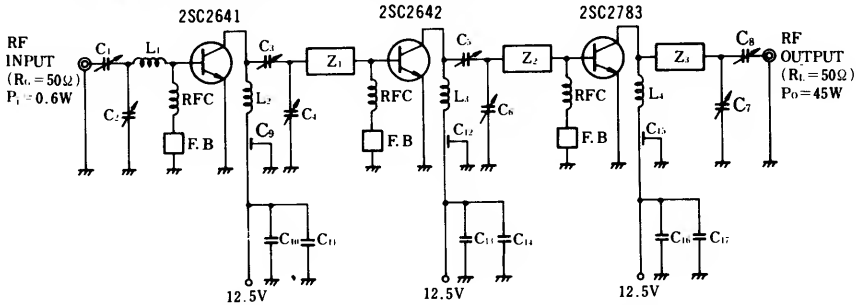
- L₇: φ 1.2mm Silver-plated copper wire, 2T, 8ID, 2P
- RFC₁, RFC₂: φ 0.6mm Enamel-coated copper wire, 15T, 3.5ID
- RFC₃: φ 1.0mm Enamel-coated copper wire, 20T, 8ID
- RFC₄: φ 1.0mm Enamel-coated copper wire, 17T, 8ID
- B.P.F.: BAND PASS FILTER

3. Power amplifier circuit (175 MHz, FM 70W)



- L₁: ϕ 1mm Silver-plated copper wire 1T, 8ID
- L₂: ϕ 1mm Silver-plated copper wire 2T, 8ID
- L₃: ϕ 1mm Silver-plated copper wire 2T, 8ID
- L₄: ϕ 1mm Silver-plated copper wire 2T, 8ID
- L₅: ϕ 1mm Silver-plated copper wire 2T, 8ID
- L₆: ϕ 1mm Silver-plated copper wire 1T, 8ID
- L₇: ϕ 1mm Silver-plated copper wire 1T, 10ID
- L₈: ϕ 1.5mm Silver-plated copper wire 2T, 10ID
- L₉: ϕ 1.5mm Silver-plated copper wire 1T, 10ID
- RFC₁, RFC₂: ϕ 0.5mm enamel wire closely wound around 220 Ω solid resistance
- RFC₃: ϕ 1mm enamel-coated wire 10T, 6ID
- RFC₄, RFC₅: ϕ 1mm enamel-coated wire 10T, 6ID
- RFC₆: ϕ 1.5mm enamel-coated wire 10T, 6ID

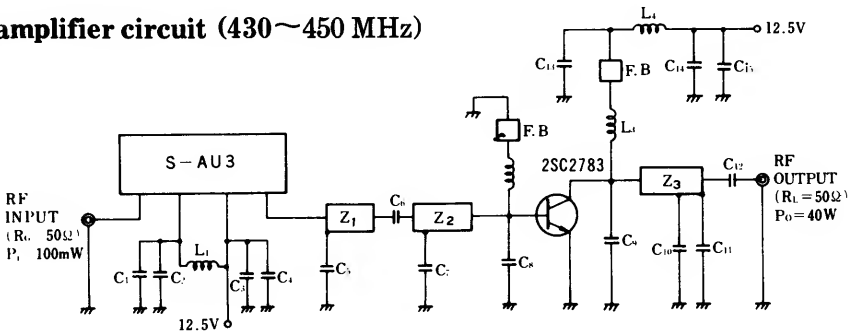
4. Power amplifier circuit (470 MHz, FM 40W)



- C₁, C₂, C₃, C₄, C₅, C₆: \sim 8pF Ceramic trimmer capacitor
- C₇, C₈: \sim 20pF Air trimmer capacitor
- C₉, C₁₃, C₁₅: 1000pF Feedthrough capacitor
- C₁₀, C₁₅, C₁₆: 0.05 μ F Ceramic capacitor
- C₁₁, C₁₄, C₁₇: 10 μ F Electrolytic capacitor

- F.B.: Ferrite bead
- L₁: 0.3 mm-thick copper plate, 4mm wide ϕ 8ID, 1/2T
- L₂, L₃, L₄: ϕ 1mm silver-plated copper wire ϕ 3ID, 2T
- RFC: ϕ 0.8mm Enamel-coated copper wire ϕ 3ID, 10T
- Z₁, Z₂, Z₃: 4x10mm Board pattern
- Board: paper epoxy board

5. Power amplifier circuit (430~450 MHz)



- C₁, C₄, C₁₅: 10 μ F
- C₂, C₃, C₁₃, C₁₄: 0.05 μ F
- C₅, C₇, C₁₀, C₁₁: 5pF Ceramic chip capacitor
- C₆: 240pF Ceramic chip capacitor
- C₈, C₉: 50pF (10pFx5) Ceramic chip capacitor
- C₁₂: 660pF Ceramic chip capacitor

- L₁, L₂, L₄: ϕ 0.5mm copper wire ϕ 2ID, 5T
- L₃: ϕ 0.5mm copper wire ϕ 2ID, 3T
- F.B: Ferrite bead
- Z₁: 5x11mm Microstrip line
- Z₂: 5x29mm Microstrip line
- Z₃: 5x32mm Microstrip line
- Board: $\epsilon_r = 2.7$ t=1.6mm Teflon-glass board

Applied circuit of large-power transistors and transistor modules (motor drive circuit)

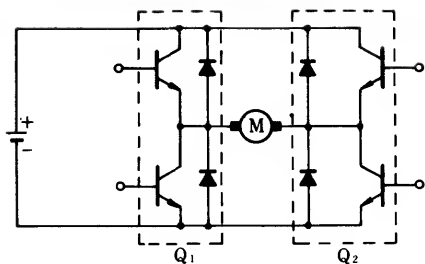


Fig. 1

1. DC motor control (1)

To be employed when using a DC motor control for quick starting/stopping, reverse rotating, and controlling speeds of motors:

Application: Computer-controlled NC machines, machine tools, and spinning and weaving machines

Recommended transistors (Darlington transistors):

Q_1 and Q_2 : MG30G2CL 3, MG50G2CL 3,

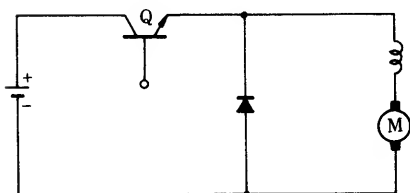


Fig. 2

2. DC motor control (2)

To be employed when controlling DC motor speeds with relative ease

Application: Electric cars, battery-operated vehicles (such as golf carts and fork lifts)

Recommended transistors (Darlington transistors):

$Q = 2SD648, 2SD698$

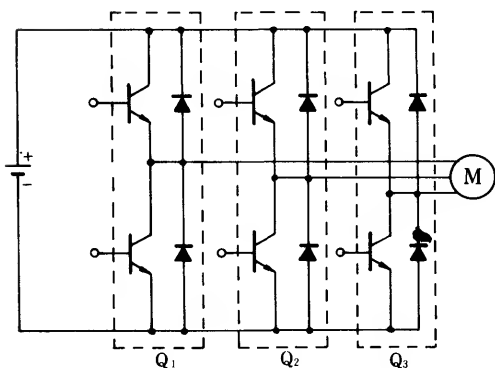


Fig. 3

3. AC motor control

Induction motors which require less maintenance are employed when motor speeds are continuously controlled, thereby not so much time need be allocated to maintenance.

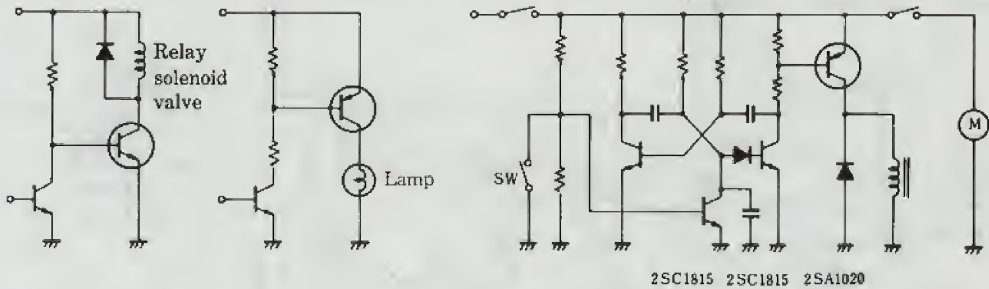
Application: 3-phase induction motor control for brush-less electronic motors, machine tools, marine motors, spinning and weaving machines

Recommended transistors (Darlington transistors):

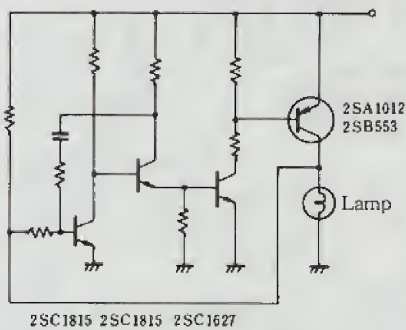
Q_1 and $Q_2 = MG30G2CL2, MG50G2CL2$
MG75H2CL1, MG100H2CL1

Application of low-saturation voltage transistors

1. Various inductance and lamp drives 2. Wiper control



3. Flasher



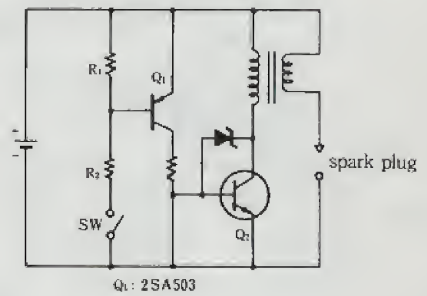
4. Ignitor

Recommended Darlington transistors (Q_2)

Method (1): 2SD685, 2SD799

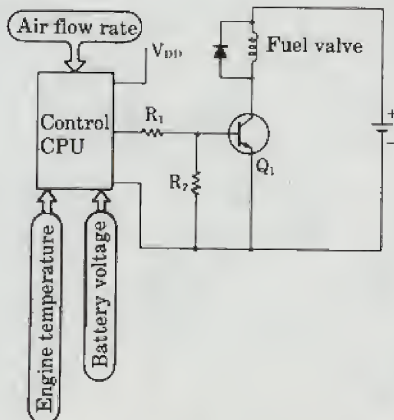
Method (2): 2SD798, 2SD1088

(1) Battery drive

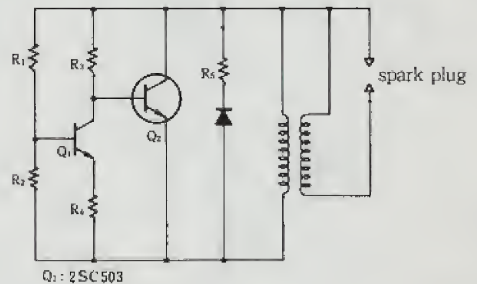


5. Electronic fuel injection control

Recommended Darlington transistors (Q_1): 2SD1087
2SD1500'
2SD633'



(2) Magnet drive



MEMO

MEMO

MEMO



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G-TR



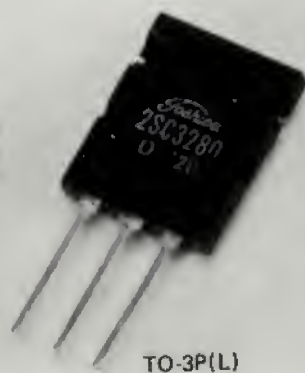
TO-31



TO-66



TO-3P(II)



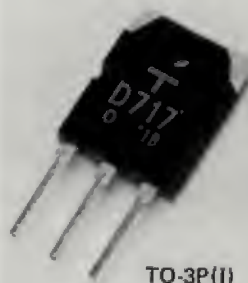
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TO-3P(H)



TO-3P(N)



TO-3P(I)



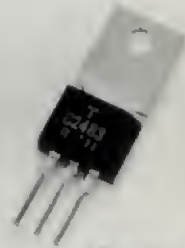
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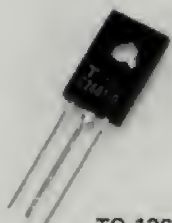
TO-220 (BS)



TO-220AB



TO-202



TO-126



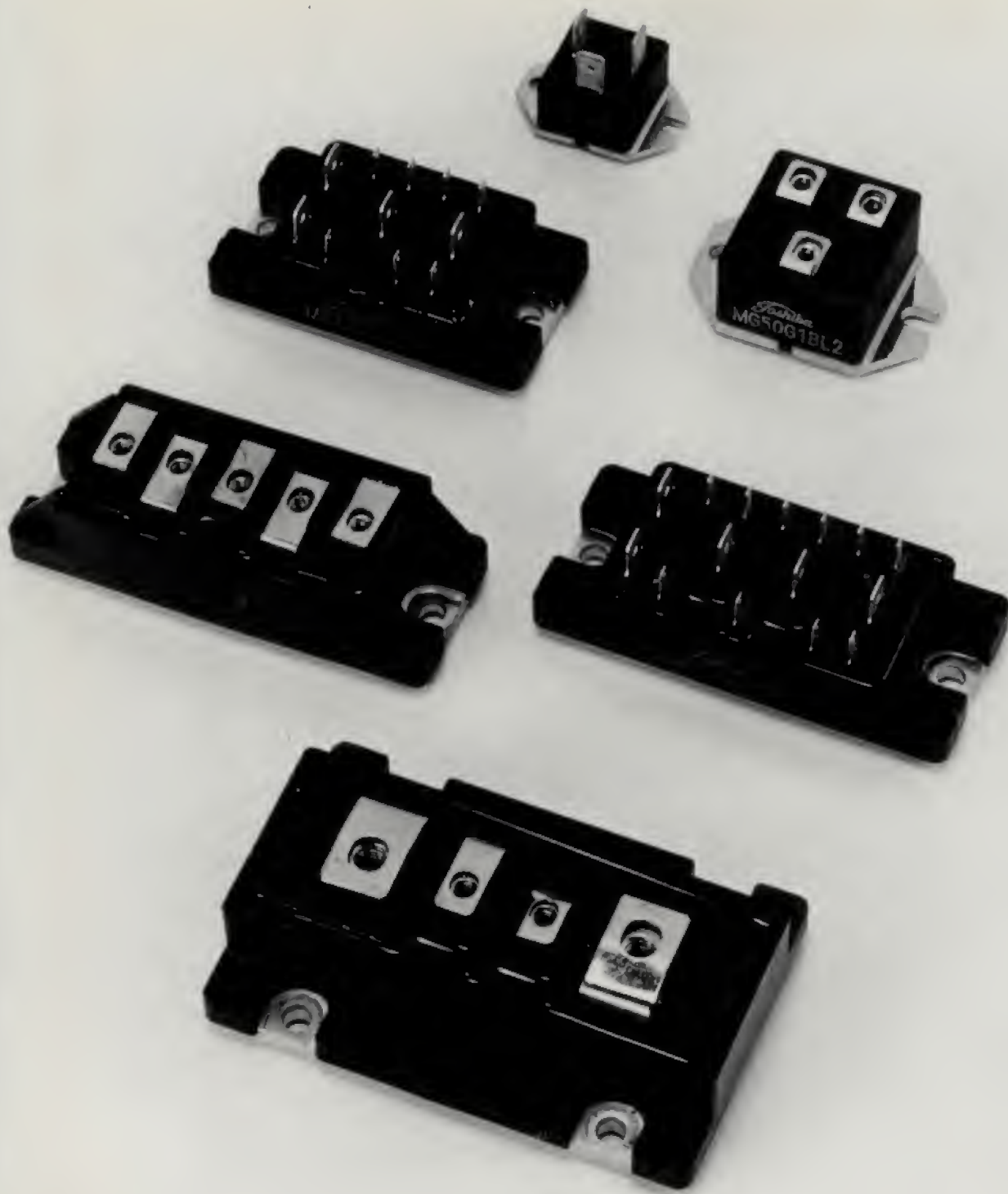
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POWER MOLD



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G-TR MODULE

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POWER TRANSISTOR

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