MODEL VR-4b

VIDEO MODULE

(FOR USE IN CONJUNCTION WITH MODELS MF-2 AND MF-5 MAIN FRAMES)

Manual No. 110-5089

SINGER
INSTRUMENTATION

INSTRUCTION MANUAL

MODEL VR-4b

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(FOR USE IN CONJUNCTION WITH MODELS MF-2 AND MF-5 MAIN FRAMES)

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SINGER
INSTRUMENTATION

The Singer Company, Palo Alto Operation

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ADDENDUM

for

MODELS VR-4 AND VR-4b

I. PURPOSE.

The purpose of this addendum is to show the difference between the unit supplied and the manual.

II. ADDENDUM.

The following changes have been made to the unit described below:

VR-4 - VR-4b Serial No. ________________
I-F Amplifier/Detector Assembly A2.

a. Change value of R20 from 300 ohms to _______ ohms.
b. Change value of R23 from 430 ohms to _______ ohms.

Addendum No. 632

ADDENDUM

for

MODEL VR-4b

(Effective on Serial No. U31887 and Above)

I. Purpose.

The purpose of this addendum is to reflect design improvements.

II. Addendum.

a. On figure 5-4 resistor R12, 47 ohms has been added between emitter of Q3 and R13.

b. Make the following changes to the parts list:

Ref Symbol	Description	Manufacturer's Part Number	Mfg. Code	Maint Qty
A2R12	SAME AS R21			
A4R12	RESISTOR, FIXED, COMP., 47 OHMS PORM 5 PCT, 1/4W SINGER P/N 151-1002-470J	CB4705	01121	1
A4R36	SAME AS R21			

Addendum No. 633

TABLE OF CONTENTS

Paragraph		Page

SECTION I—INTRODUCTION

1-1	Scope of Manual	1-1
1-5	Purpose and Use of the Equipment	1-1
1-8	General Description	1-1
1-16	Specifications	1-2
1-18	Transistor, Diode and Crystal Complement	1-2

SECTION II—OPERATION

2-1	General	2-1
2-3	Installation	2-1
2-5	Operating Controls, Indicators and Connectors	2-1
2-7	Preliminary Operating Procedure	2-1
2-9	Operation and CRT Interpretation	2-7
2-11	General Considerations	2-7
2-12	Input Signal Classification	2-7
2-15	Maximum Input Voltages	2-8
2-17	Special Considerations	2-9
2-18	Optimum Resolution of Signals Closely Spaced in Frequency	2-9
2-22	Noise Analysis	2-9
2-33	Interpreting CRT Displays	2-10
2-44	Amplitude Measurement of Discrete Signals	2-15
2-45	Frequency Measurement of Discrete Signals	2-16
2-46	Operating Procedures	2-16

SECTION III—THEORY OF OPERATION

3-1	General	3-1
3-3	Simplified Block Diagram Discussion	3-1
3-8	Detailed Theory of Operation	3-2
3-9	General	3-2
3-10	Input Attenuator Assembly A9	3-2
3-11	First Mixer Assembly A8	3-2
3-12	32.328 MHz I-f Ampl/2nd Mixer/29.538 MHz Osc Assembly A3	3-7
3-13	2.7 MHz Crystal Filter Assembly A4	3-7
3-14	I-f Attenuator	3-7
3-15	2.7 MHz I-f Ampl/Detector Assembly A2 and Log/Lin Assembly A6	3-7
3-17	Dc Control Assembly A1	3-8
3-21	Narrow-band Local Oscillator Assembly A7	3-10
3-22	Multivibrator/Marker Assembly A5	3-10
3-24	Power Distribution	3-11

SECTION IV—MAINTENANCE

4-1	General	4-1
4-5	Test Equipment Required	4-1
4-7	Preliminary Inspection	4-3
4-8	Preliminary Inspection Routines	4-3
4-9	Component Locations	4-3
4-10	Minimum Performance Standards Checks	4-3
4-13	Systematic Trouble Localization	4-23

TABLE OF CONTENTS (Cont'd)

Paragraph Page

SECTION IV—MAINTENANCE (Cont'd)

4-16 Alignment Procedures 4-26
4-19 Preliminary Control Settings 4-26
4-20 Horizontal and Vertical Sweep Position Adjustment 4-26
4-21 Marker Frequency Adjustment 4-27
4-22 Preliminary Oscillator and I-f Alignment 4-27
4-23 2.7 MHz Crystal Filter Adjustment 4-27
4-24 Final Oscillator and I-f Alignment 4-28
4-25 26.838 MHz Trap Adjustment 4-28
4-26 Phase Splitter, Balance and Harmonic Distortion Adjustments 4-29
4-27 Sweep Rate Adjustment 4-29
4-28 Amplitude Adjustment 4-29
4-29 Shaping Circuit Adjustment 4-29
4-30 Typical Voltage Measurements 4-31

SECTION V—SCHEMATIC DIAGRAMS

SECTION VI—PARTS LIST

6-1 Introduction 6-1
6-3 Ordering Information 6-1
6-5 How to Use the Parts List 6-1
6-7 Ref Symbol Column 6-1
6-8 Description Column 6-1
6-9 Manufacturer's Part Number Column 6-1
6-10 Manufacturer's Code Column 6-1
6-11 Maint Qty Column 6-1

LIST OF ILLUSTRATIONS

Figure		Page
1-1	Model VR-4b Video Module Installed in Model MF-5 Main Frame	iv
1-2	Typical Resolution Versus Sweep Width	1-3
1-3	Typical Minimum Frequency Separation Required to Measure Amplitude Ratios (Skirt Selectivity)	1-3
2-1	Operating Controls, Indicators and Connectors	2-2
2-2	Typical CRT Displays During Mixer Balancing	2-7
2-3	Peaking of Zero Pip in Search/Lock Mode During Mixer Balancing	2-8
2-4	Typical CRT Displays of Various Noise Signals	2-11
2-5	Typical CRT Displays of Various Discrete Signals	2-13
2-6	Determining Pulse Width and PRF of a Pulsed RF Signal	2-15
2-7	Signal Display in Search/Lock Mode	2-18
3-1	Model VR-4b Video Module, Simplified Block Diagram	3-3
3-2	Model VR-4b Video Module, Detailed Block Diagram	3-5
3-3	Sawtooth Generator, Simplified Block Diagram	3-9
4-1	Extender Board	4-2
4-2	Model VR-4b Video Module, Bottom View	4-4
4-3	Printed Circuit Module Location	4-5
4-4	Dc Control Module A1, Adjustment Locations	4-6
4-5	2.7 MHz I-f Ampl/Detector Module A2, Adjustment Locations	4-6
4-6	32.238 MHz I-f Ampl/2nd Mixer/29.538 MHz Osc Module A3, Adjustment Locations	4-7
4-7	2.7 MHz Crystal Filter Module A4, Adjustment Locations	4-7
4-8	Log-Lin Module A6 and First Mixer A8, Adjustment Locations	4-8
4-9	Multivibrator/Marker Module A5, Adjustment Locations	4-9
4-10	Minimum Performance Standards, Equipment Setup	4-10
5-1	Model VR-4b Video Module, Interconnecting Cabling Diagram	5-3
5-2	Log/Lin Assembly A6, Narrow Band Local Oscillator A7 and First Mixer Assembly A8, Schematic Diagram	5-5
5-3	32.238 MHz I-f Amplifier/Second Mixer/29.538 MHz Oscillator Assembly A3, Schematic Diagram	5-7
5-4	2.7 MHz Crystal Filter Assembly A4, Schematic Diagram	5-9
5-5	2.7 MHz I-f Amplifier/Detector Assembly A2, Schematic Diagram	5-11
5-6	Dc Control Assembly A1, Schematic Diagram	5-13
5-7	Multivibrator/Marker Assembly A5, Schematic Diagram	5-15
6-1	Parts List Sample	6-2

LIST OF TABLES

Table		Page
1-1	Specifications	1-2
1-2	Transistor, Diode and Crystal Complement	1-5
2-1	Operating Controls, Indicators and Connectors	2-2
2-2	Input Voltages (RMS) Required for Full-Scale Deflection	2-8
4-1	Test Equipment Required	4-1
4-2	Preliminary Inspection Routine	4-3
4-3	Minimum Performance Standards Checks	4-10
4-4	Systematic Trouble Localization	4-23
4-5	Shaping Circuit Adjustment Tabulation	4-30
4-6	Voltage Measurements	4-31
6-1	Manufacturer's Code	6-2
6-2	Parts List	6-5

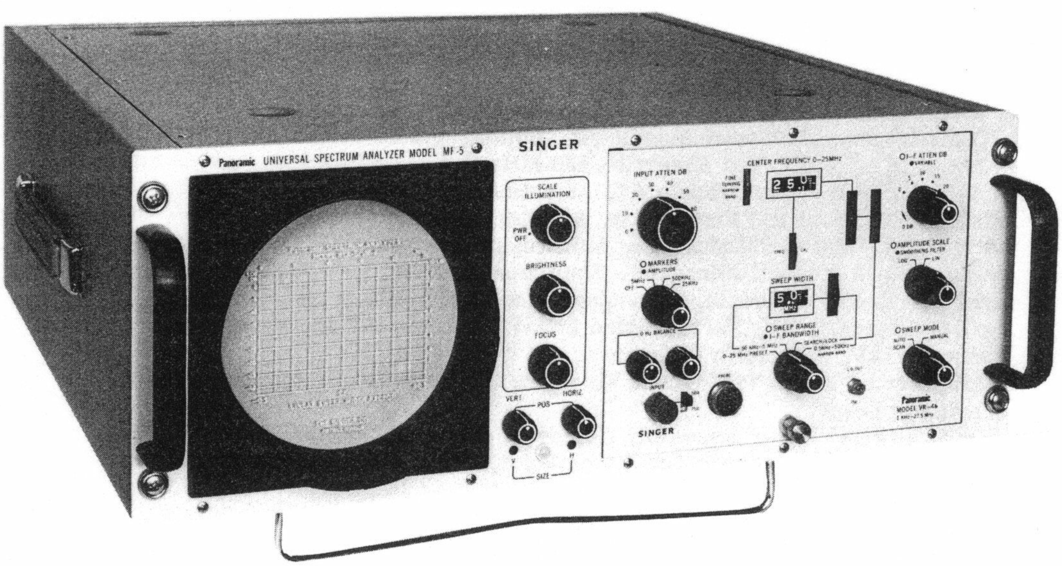

Figure 1-1. Model VR-4b Video Module Installed in Model MF-5 Main Frame

SECTION I
INTRODUCTION

1-1. SCOPE OF MANUAL.

1-2. This instruction manual provides operating and maintenance instructions for the PANORAMIC* Model VR-4b Video Module (see figure 1-1), manufactured by The Singer Company - Instrumentation Division. The Model VR-4b Video Module is used in conjunction with either a PANORAMIC Model MF-2 or MF-5 Main Frame to form either a PANORAMIC Model MF-2/VR-4b (portable) or MF-5/VR-4b (rack or bench mounted) Universal Spectrum Analyzer, respectively.

1-3. Although this manual covers the Model VR-4b Video Module (hereinafter referred to as the VR-4b module), it is assumed that it is installed in one of the two main frames. The main frame functions are described in a separate instruction manual.

1-4. The information contained in this manual refers only to the standard version of the VR-4b module and is current only to the date of publication. Differences in equipment components, specifications and performance resulting from The Singer Company's continuous product improvement program or individual customer design and application requirements are described in addendum sheets.

1-5. PURPOSE AND USE OF THE EQUIPMENT.

1-6. The VR-4b module, in conjunction with an associated main frame, provides a rapid and reliable means of analyzing and monitoring complex, discrete and/or random signals within the frequency range from 1 kHz to 27.5 MHz. The VR-4b module and its appropriate main frame form a spectrum analyzer which displays signal amplitude as a function of frequency for signals within its band. Applications include:

a. Spectrum monitoring of communication channels.

b. Studies of noise spectra.

c. Monitoring of RFI and ECM spectra.

d. Analysis of telemetry subcarriers.

e. Dynamic performance analysis of oscillators, generators, transmitters, etc., operating in the video range.

f. Direct reading of power points and nulls.

g. Analyzing pulse signals.

h. Studies of malfunction in microwave equipment (e.g., spurious signals, instability, microphonics, etc.)

i. Examination of signals for frequency drift, incidental FM, and squegging.

1-7. The PANORAMIC Model MF-5/VR-4b Spectrum Analyzer provides the same capabilities as the portable MF-2/VR-4b in any environment where battery operation is not required. These spectrum analyzers provide a calibrated, graphic representation of the spectral contents in the video frequency range for research or production measurements. Once the norms for an application are established, the operator can rapidly identify and correlate CRT screen deflections. Abnormalities are readily discernible from which a go/no-go or quantitative determination may be made.

1-8. GENERAL DESCRIPTION.

1-9. The VR-4b module is a transistorized, plug-in, broadband swept analyzer module which, in conjunction with PANORAMIC Models MF-2 and MF-5 Main Frames covers the frequency range from 1 kHz to 27.5 MHz. The module performs all signal processing functions including detection and also generates the sawtooth waveform employed by the horizontal deflection amplifier within the main frame.

1-10. The module has three sweep ranges that can be selected by means of a SWEEP RANGE switch: 0-25 MHz PRESET, 50 kHz - 5 MHz, and 0.5 kHz - 50 kHz NARROW BAND. In the first range, the sweep width is fixed at 25 MHz. In the other ranges, the sweep width is continuously variable and can be set at any value in the range. The sweep width is linear in all three ranges.

1-11. The SWEEP WIDTH and CENTER FREQUENCY controls are calibrated precisely on front-panel digital dials. The SWEEP WIDTH dial is calibrated in megahertz in the wide sweep ranges and in kilohertz in the narrow sweep range to provide maximum accuracy; it is inoperative in the 0-25 MHz PRESET mode. The range of the CENTER FREQUENCY dial corresponds to approximately 5 feet of length so that precise adjustment and ease of

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operation is obtained. Thus, the width and center frequency of the CRT display can be ascertained readily.

1-12. A crystal-controlled, internal marker oscillator provides markers at 5-MHz intervals throughout the band of the VR-4b. The output of the marker oscillator is also divided digitally to provide 500 kHz and 25 kHz markers. A front-panel MARKERS switch permits selection of any or none (OFF position) of the markers. An associated MARKERS AMPLITUDE control permits the adjustment of the markers amplitude. All markers are accurate to within ±.02 percent of nominal value. A zero-frequency pip is also provided as an additional calibration reference.

1-13. The VR-4b module provides either a linearly or logarithmically scaled dc output. Signal sensitivity is less than 3 microvolts for full scale linear output and less than 30 microvolts for the logarithmic output. Calibrated r-f (INPUT ATTEN DB control) and i-f (I-F ATTEN DB control) attenuators for adjusting the deflection produced by strong signals are provided; and uncalibrated continuously variable i-f attenuator is also provided. Residual unwanted responses, including those due to hum and harmonic and intermodulation distortion, are suppressed at least 60 dB.

1-14. The VR-4b module has three sweep modes: preset, variable, and manual. These are selected and controlled by a front-panel SWEEP MODE switch and a Sweep Rate (VAR) control, respectively as described in Section III.

1-15. The i-f section of the VR-4b module contains two manually-controlled, variable-bandwidth crystal filters. These filters provide high selectivity so that the resolution (the ability to separate individual frequency components) can be optimized using the front-panel I-F BANDWIDTH control.

1-16. SPECIFICATIONS.

1-17. Table 1-1 lists the specifications and physical characteristics of the VR-4b module.

1-18. TRANSISTOR, DIODE AND CRYSTAL COMPLEMENT.

1-19. The transistor, diode and crystal complement of the VR-4b module is given in table 1-2.

TABLE 1-1. SPECIFICATIONS

Frequency range (includes sweep):	1 kHz - 27.5 MHz
Center frequency range:	1 kHz - 25 MHz
Center frequency accuracy:	±5%, ±10kHz
Sweep Width:	Three ranges: a. 1 kHz - 25 MHz PRESET - accurate to ±5% at all points b. 50 kHz - 5 MHz, continuously variable - accurate to 10%, ±20 kHz of dial reading c. 1.0 kHz - 50 kHz NARROW BAND, continuously variable - accurate to ±10%, ±200 Hz of dial reading
Frequency scale linearity:	±5% on all ranges
I-f bandwidth (Resolution):	I-f bandwidth adjustable from 200 Hz to 18 kHz (typical) at -6 dB points. (Resolution is the frequency separation of two signals of equal amplitude, the deflections of which intersect 3 dB down from their amplitude peaks. Figure 1-2 is a resolution graph for a CRT linear horizontal scan. Figure 1-3 presents the minimum frequency separation required to measure signals of unequal amplitude.) These graphs show typical curves.

(Cont'd)

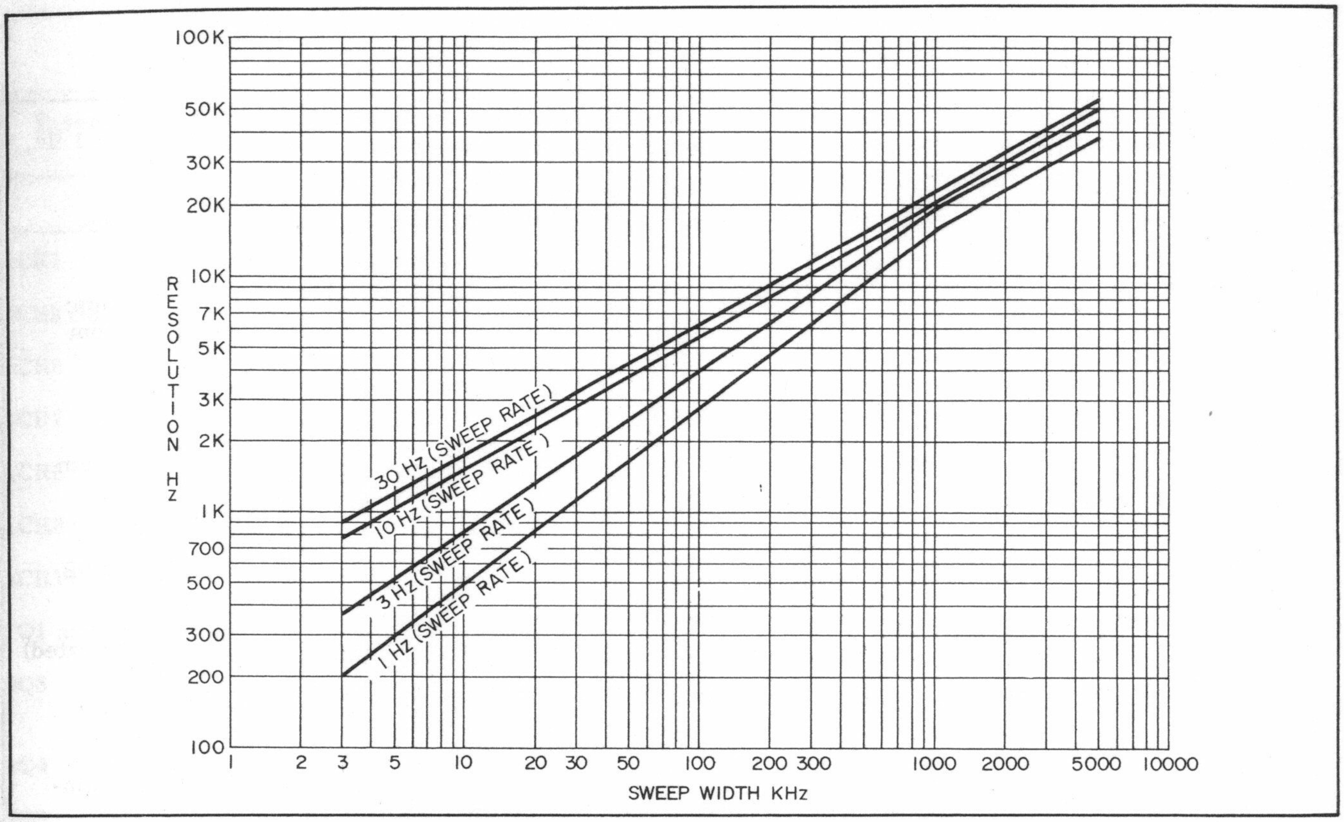

Figure 1-2. Typical Resolution Versus Sweep Width

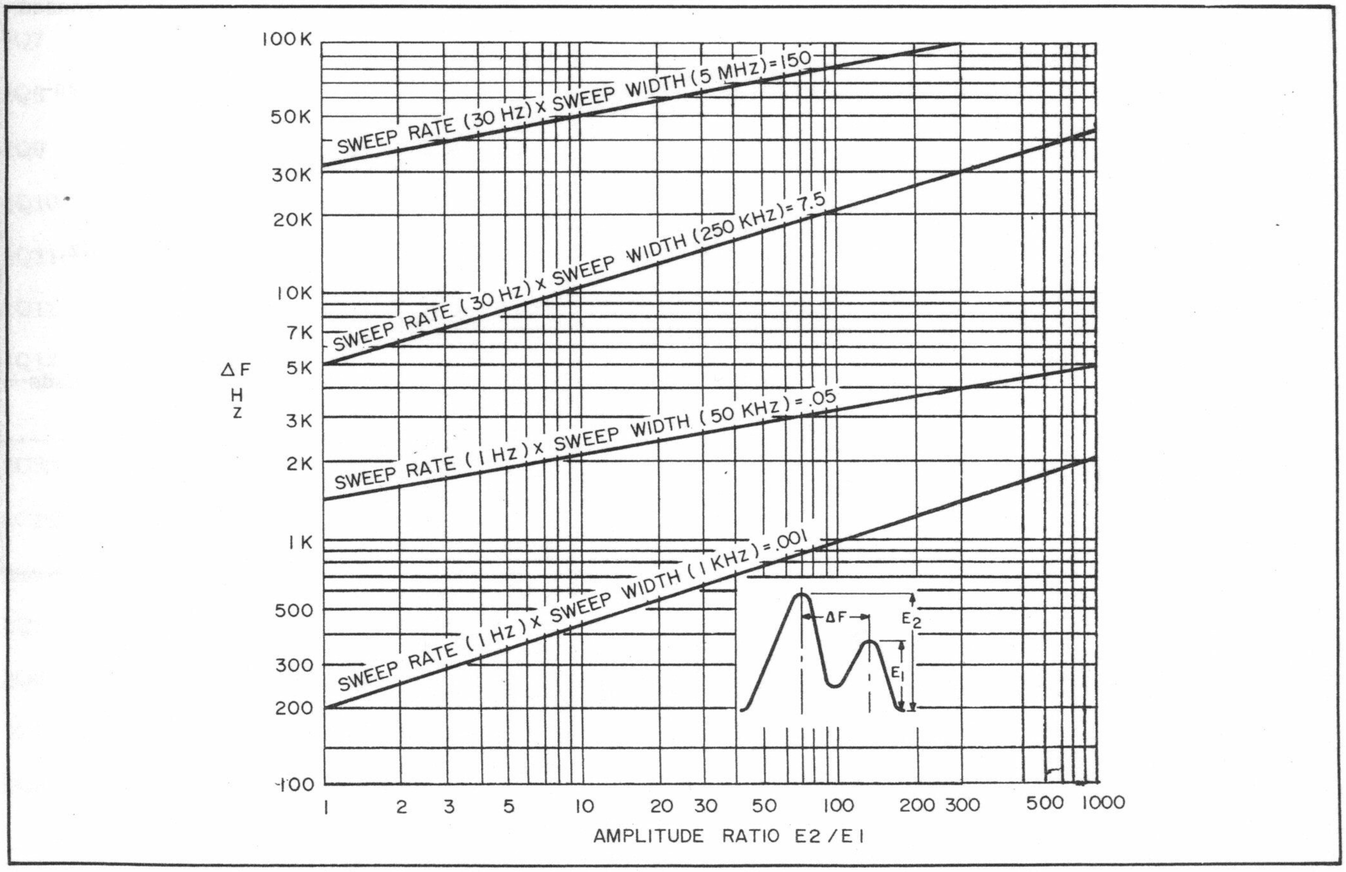

Figure 1-3. Typical Minimum Frequency Separation Required to Measure Amplitude Ratios (Skirt Selectivity)

TABLE 1-1. SPECIFICATIONS (Cont'd)

Scan rate:	Continuously adjustable, 1 to 60 Hz, preset at 1 Hz, or manually controlled
Amplitude scale:	Linear: Calibrated 1 to 10 in 10 percent increments, accuracy ±3%. Log: Calibrated 0 to 40 dB, in 5 dB increments; accuracy ±1 dB, from 0 to -30 dB, ±2 dB from -30 dB to -40 dB.
Sensitivity full scale:	Linear Deflection - 3 microvolts minimum. Logarithmic Deflection - 30 microvolts minimum.
Minimum detectable signal:	0.25 microvolts
Attenuators:	Input: 0 to 70 dB in 10 dB steps ±0.05 dB per dB I-f: 0 to 20 dB in 5 dB steps ±0.2 dB per step. Also 0 - 10 dB continuously variable (uncalibrated)
Input impedance:	50 or 75 ohms switch selectable
Frequency calibration markers:	5 MHz, 500 kHz, or 25 kHz, switch selectable - accurate to ±0.02 percent. Amplitude is continuously variable.
Residual distortion:	Harmonics, intermodulation and hum signals more than 60 dB down; non-harmonic residual responses more than 50 dB below rated sensitivity.
Video filter-smoothing:	Front panel variable control for smoothing of random signal inputs. Adjust time constant to a maximum of 0.05 seconds.
Frequency response:	Flat within ±1 dB from 1 kHz - 27.5 MHz.
Operating power requirements:	105-130 v or 210-260 v single-phase, 50-400 Hz, approx. 35 watts
Operating temperature range:	0 to 55 degrees centigrade
Physical Characteristics:	Weight: Approximately 15 pounds Width: 8 inches Height: 6 inches Depth: 9.5 inches Volume: 456 cubic inches

TABLE 1-2. TRANSISTOR, DIODE AND CRYSTAL COMPLEMENT

Reference Designation Symbol	Type	Function
	DC Control A1	
A1CR1	232 (Diodes, Inc.)	Voltage regulator
A1CR2 thru CR5	1N935	Voltage regulators
A1CR6	232D (Diodes, Inc.)	Voltage regulator
A1CR7	1N935	Voltage regulator
A1CR8	1N251	Constant voltage drop
A1CR9 thru CR13	1N270	Shaping diodes
A1CR14 thru CR16	1N251	Constant voltage drop
A1Q1 and Q2	2N3565	DC amplifier
A1Q3	556146-652 (Singer)	Sawtooth generator
A1Q4	2N2270	Emitter follower
A1Q5	2N3638A	Sawtooth shaping amplifier
A1Q6	2N3565	Emitter follower
A1Q7	2N3638A	P/O Differential emitter follower
A1Q8	2N3565	Emitter follower
A1Q9	2N3638A	P/O Differential emitter follower
A1Q10	2N3565	Emitter follower
A1Q11	2N3565	P/O Complementary amplifier
A1Q12	2N3638A	P/O Complementary amplifier
A1Q13	2N3565	Shaping amplifier
	I-f Amplifier/Detector A2	
A2CR1	1N906	Constant voltage drop
A2CR2 and CR3	1N251	Full-wave detector
A2Q1 thru Q4	2N2188	2.7-MHz i-f amplifiers
A2Q5	2N3638A	Log amplifier
A2Q6	2N2188	P/O Dual emitter follower
A2Q7	2N1091	P/O Dual emitter follower
A2Q8	2N2270	Emitter follower

(Cont'd)

TABLE 1-2. TRANSISTOR, DIODE AND CRYSTAL COMPLEMENT (Cont'd)

Reference Designation Symbol	Type	Function
32.238-MHz I-f Amplifier/Second Mixer/29.538-MHz Oscillator A3		
A3Q1 and Q2	2N4917	32.238-MHz i-f amplifier
A3Q3	2N4917	Second mixer
A3Q4	2N3565	29.538-MHz oscillator
A3Y1	-	29.538-MHz oscillator
2.7-MHz Crystal Filter A4		
A4CR1 and CR2; A4CR3 and CR4	1N906	Full-wave detectors
A4CR5	1N251	Temperature compensation diode
A4Q1	2N3638A	2.7-MHz crystal filter
A4Q2	2N3638A	Emitter follower
A4Q3 and Q4	2N3638A	2.7-MHz i-f amplifiers
A4Q5	2N3638A	2.7-MHz i-f crystal filter
A4Q6	2N3638A	Emitter follower
A4Q7	2N3565	P/O Complementary amplifier
A4Q8	2N3638A	P/O Complementary amplifier
A4Q9	2N3565	2.7-MHz i-f amplifier
A4Q10	2N3638A	Emitter follower
A4Y1 and Y2	-	2.7-MHz filters
Multivibrator/Marker A5		
A5A1	CμL95859 (Fairchild)	Decade divider
A5CR1 thru CR8	1N995	Clamps
A5CR9	1N906	Clamp
A5CR10 and CR11	1N270	Clamp
A5CR12	232 (Diodes, Inc.)	Voltage regulator
A5CR13 and CR14	1N995	Clamps
A5CR15	V-33B (TRW)	Variable capacitor
A5Q1 thru Q4	2N3646	P/O Decade divider
A5Q5 and Q6	2N3563	5-MHz Marker oscillator
A5Q7 thru Q10	2N3646	P/O Decade divider

(Cont'd)

TABLE 1-2. TRANSISTOR, DIODE AND CRYSTAL COMPLEMENT (Cont'd)

Reference Designation Symbol	Type	Function
Multivibrator/Marker A5 (Cont'd)		
A5Q11	2N2188	500-kHz pulse generator
A5Q12	2N2188	25-kHz pulse generator/modulater
A5Q13	2N3563	Emitter follower
A5Q14 and Q15	2N3646	Binary divider
A5Q16	2N3563	Amplifier
A5Q17	2N2996	Amplifier
A5Q18	2N3563	Amplifier
A5Q19 and Q20	2N706A	Wideband local oscillator
A5Y1	—	5-MHz oscillator
Log/Lin A6		
A6CR1 and CR2	HU-10 (Hoffman)	Log shaping diodes
A6VR1	023L13 (Victory)	Log shaping
Narrowband Local Oscillator A7		
A7CR1	V-33B (TRW)	Variable capacitor
A7Q1	2N3563	Narrowband local oscillator
A7Q2 and Q3	2N3563	Amplifier
A7Q4	2N3563	Emitter follower
First Mixer A8		
A8Q1	2N3563	Phase splitter
A8Q2	2N3563	Amplifier
A8Q3 and Q4	2N3563	Balanced mixer

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This scanned document is "FREE" to keep, use, and distribute as long as no changes are made.
It is posted on the internet at www.bunkerofdoom.com and other places. Search the internet for "Singer VR-4b".

I scanned it in the hope that you can use it to fix your Alfred/Panoramic/Singer/Slant-Fin spectrum analyzer's VR-4B module. I paid for an origninal manual in order to do this, since I have two Singer MF-5 mainframes and VR-4B plugins. They are pretty beat up as shown below. The whole manual is in monochrome, except these two pictures to help spot the equipment, should you find one at a hamfest.

About the schematics, they are on some really long paper. I broke them into 8.5x11 overlapping sections. The idea is for you to print them and cut and tape them together. (the best I could do.)

Singer Instrumentation is out of business. No one with true rights to the manual supports this instrument any more. I hope they don't mind that we are using it.

Best Regards,
Patrick J. Jankowiak
KD5OEI

Notice one of the units has a VR-4 and one has a VR-4b. Don't ask, I do not know..

SECTION II
OPERATION

2-1. GENERAL.

2-2. This section contains installation and operating instructions for the VR-4b module and its associated main frame.

2-3. INSTALLATION.

2-4. The procedure for installing a VR-4b module into either the Model MF-2 or MF-5 Main Frame is as follows.

a. With the main frame removed from line power, determine the line voltage and set the 110VAC-220VAC switch to the proper position. On the MF-2, this switch is located at the rear wall of the well into which the VR-4b module is to be placed. On the MF-5, this switch is located on the rear panel.

CAUTION

Be sure that the 110VAC-220VAC switch on the MF-5 rear panel or in the MF-2 module well is set at the position corresponding to the voltage available at the ac source outlet. The ac line fuse for the MF-2 should be rated at 3/8 ampere (delay type) for 110-volt operation or 3/16 ampere (delay type) for 220-volt operation. The a-c line fuse for the MF-5 should be rated at 3/4 ampere (delay type) for 110-volt operation or 3/8 ampere (delay type) for 220-volt operation. The main frame dc fuses need not be changed when the line voltage is changed.

b. Check that the proper value line fuse is employed. If the wrong fuse was installed, replace it with one of the proper rating.

c. Rotate the knurled knob on the VR-4b module front panel fully ccw and carefully slide the plug-in module into the main frame. Push the module firmly into the main frame so that the front panels are flush and then rotate the knurled knob on the VR-4b clockwise to secure the two together.

2-5. OPERATING CONTROLS, INDICATORS AND CONNECTORS.

2-6. The controls, indicators and connectors employed when operating the VR-4b module are all located on the equipment front panel, as illustrated in figure 2-1; their functions are described in table 2-1.

2-7. PRELIMINARY OPERATING PROCEDURE

2-8. To prepare a VR-4b module for operation after it has been installed in a main frame, proceed as directed in the following steps.

a. With the main frame unenergized, set the VR-4b module controls as listed below.

Control	Position
INPUT ATTEN DB	0
I-F ATTEN DB switch	10
I-F ATTEN DB VARIABLE control	0 DB (fully ccw)
MARKERS switch	OFF
MARKERS AMPLITUDE control	Fully ccw
SWEEP RANGE switch	0-25 MHz PRESET
I-F BANDWIDTH control	MAX (fully cw)
AMPLITUDE SCALE switch	LOG
SMOOTHING FILTER control	Fully ccw
SWEEP MODE switch	AUTO SCAN
0 Hz BALANCE controls	Mid-range
INPUT switch	50Ω
Sweep Rate control	VAR (fully cw)

b. Couple the analyzer to line power and energize the equipment. When a Model MF-2 Main Frame is employed, energization is accomplished by rotating the ILLUM control clockwise from its extreme ccw OFF setting; when a Model MF-5 Main Frame is used, clockwise rotation of the SCALE ILLUMINATION control from its extreme ccw PWR OFF setting energizes the equipment. Adjust the ILLUM or SCALE ILLUMINATION control for convenient graticule illumination.

c. Set the BRIGHTNESS (MF-5) or INT (MF-2) control to mid-range and then adjust the VERT POS control (MF-5) or VERT screwdriver control (MF-2) to position the trace on the lowest graticule horizontal line.

d. Adjust the FOCUS control and INT (MF-2) or BRIGHTNESS (MF-5) control to obtain a sharp, clearly-defined trace.

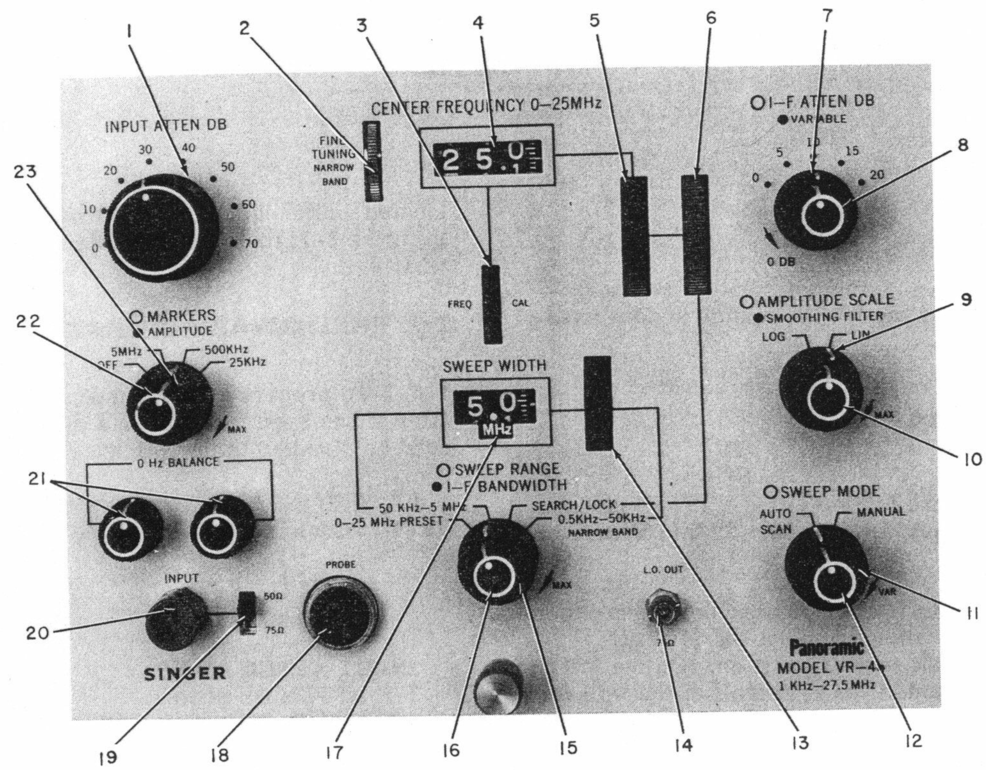


Figure 2-1. Operating Controls, Indicators and Connectors

TABLE 2-1. OPERATING CONTROLS, INDICATORS AND CONNECTORS

Figure 2-1 Index No.	Reference Designation	Name	Function
1	A9S1	INPUT ATTEN DB switch	An eight-position rotary switch that inserts 0 to 70 dB of attenuation (in 10-dB steps) in the signal-input circuitry.
2	R10	FINE TUNING NARROW BAND thumb-wheel control	A potentiometer that provides a fine adjustment of the center frequency on the CRT screen when SWEEP RANGE switch is in NARROW BAND position.
3	R13	FREQ CAL thumb-wheel control	A potentiometer that is used to calibrate the graticule to the CENTER FREQUENCY counter.
4	--	CENTER FREQUENCY dial	A digital counter readout that indicates center frequency of the cathode ray tube (CRT) display in the 50 kHz - 5 MHz position of SWEEP RANGE

(Cont'd)

TABLE 2-1. OPERATING CONTROLS, INDICATORS AND CONNECTORS (Cont'd)

Figure 2-1 Index No.	Reference Designation	Name	Function
4 (Cont'd)			switch; this frequency can be adjusted by CENTER FREQUENCY control and calibrated to frequency markers by FREQ CAL control. After controls have been set in SEARCH/LOCK position, the dial reads center frequency in the NARROW BAND, position if no subsequent retuning (FINE TUNING) occurs. The readout should be disregarded in the 0 - 25 MHz PRESET position; the center frequency is fixed at approximately 12.5 MHz in this switch position.
5	R12	CENTER FREQUENCY thumb-wheel control	A potentiometer that tunes the center frequency of the wide-band local oscillator in the 50 kHz - 5 MHz sweep range.
6	A7L2	SEARCH/LOCK thumb-wheel control	An adjustable inductance (Inductuner) that coarse-tunes the narrow-band local oscillator to obtain zero-beat indication in SEARCH/LOCK.
7	S5	I-F ATTEN DB switch (outer control)	A five-position rotary switch that inserts 0 to 20 dB of attenuation (in 5-dB steps) in i-f circuitry.
8	R20	I-F ATTEN DB VARIABLE control (inner control)	A potentiometer that inserts 0 to 10 dB of attenuation (continuous, uncalibrated) in i-f circuitry.
9	S6	AMPLITUDE SCALE switch (outer control)	A two-position rotary switch that selects either LIN (linear) or LOG (logarithmic) voltage-amplitude scale of CRT display.
10	R14	SMOOTHING FILTER control (inner control)	A potentiometer that provides a continuous, uncalibrated adjustment of a video filter; smooths video output until a single-line presentation (representing the average amplitude of a noise spectrum envelope) is displayed on the CRT screen.
11	S4	SWEEP MODE switch (outer control)	A two-position rotary switch that selects either AUTO SCAN (continuous sweep) or MANUAL (controlled CRT spot position). The SWEEP MODE controls have no effect on the automatic 1-Hz sweep rate in the 0-25 MHz PRESET position or the 60-Hz sweep rate in the SEARCH/LOCK position.

(Cont'd)

TABLE 2-1. OPERATING CONTROLS, INDICATORS AND CONNECTORS (Cont'd)

Figure 2-1 Index No.	Reference Designation	Name	Function
12	R11	Sweep Rate (VAR) control (inner control)	A potentiometer that provides continuous, uncalibrated control of the AUTO SCAN sweep rate between 1 and 60 Hz when SWEEP MODE switch is 50 kHz - 5 MHz or 0.5 kHz - 50 kHz NARROW BAND position, and continuously adjusts the MANUAL CRT spot to any desired horizontal (frequency) position on the screen in these switch positions.
13	R8	SWEEP WIDTH thumb-wheel control	A potentiometer that adjusts the width of frequency segment of spectrum to be displayed on CRT screen in the 50 kHz - 5 MHz and 0.5 kHz - 50 kHz NARROW BAND positions of the SWEEP RANGE switch; provides any sweep width from 50 KHz to 5 MHz or 500 Hz to 50 KHz depending upon mode selected by SWEEP RANGE switch.
14	J7	L.O. OUT jack	A BNC connector (75-ohm impedance) that supplies the swept local oscillator signal as an output to the PANORAMIC Companion Sweep Generator, Model G-6V. Output frequency is 32.238 MHz (i-f frequency) above the input frequency.
15	R9	I-F BANDWIDTH control (inner control)	A potentiometer that adjusts bandwidth of i-f stages and thereby controls resolution on CRT in 50 kHz - 5 MHz and 0.5 kHz - 50 kHz NARROW BAND positions of SWEEP RANGE switch. This control has no effect in other positions; i-f bandwidth is at maximum for these other positions.
16	S3	SWEEP RANGE switch (outer control)	A four position rotary switch that enables inspection of the frequency spectrum in successively smaller windows: 0-25 MHz PRESET position: selects a preset linear frequency display of the entire 0 to 25 MHz frequency range with a fixed scan rate of 1 Hz. 50 kHz - 5 MHz position: selects a linear frequency display in which the center frequency, sweep width, and scan rate are adjustable. (The sweep width is adjustable from 50 kHz to 5 MHz.)

(Cont'd)

TABLE 2-1. OPERATING CONTROLS, INDICATORS AND CONNECTORS (Cont'd)

Figure 2-1 Index No.	Reference Designation	Name	Function
16 (Cont'd)			SEARCH/LOCK position: selects a linear frequency display in which the frequencies of the wide-band and narrow-band local oscillators are compared. This mode is used to lock the narrow-band local oscillator to the same center frequency as the wide-band local oscillator before switching to the NARROW BAND position; this is accomplished by adjusting the SEARCH LOCK and FINE TUNING controls for an indication of zero beat (raised pedestal on CRT). 0.5 kHz - 50 kHz NARROW BAND position: selects a linear frequency display in which the center frequency, sweep width, and scan rate are adjustable. The sweep width is adjustable from 500 Hz to 50 kHz.
17		SWEEP WIDTH dial	A digital counter readout that indicates width of frequency segment selected by SWEEP WIDTH control; indicates sweep width in MHz when SWEEP RANGE switch is positioned to 50 kHz - 5 MHz, and in kHz when the switch is positioned to 0.5 kHz - 50 kHz NARROW BAND.
18	J8	PROBE jack	A special connector supplying -11 and +21 volts for future optional accessories.
19	S1	INPUT switch	A two-position slide switch that sets the input impedance of the VR-4b module to 50 or 75 ohms.
20	J6	INPUT jack	A BNC connector that connects input to VR-4b module.
21	R2, R3	0 Hz BALANCE controls	Two potentiometers that suppress local oscillator leakage through the balanced mixer at zero input frequency.
22	S2	MARKERS switch (outer control)	Four-position rotary switch that selects the frequency markers that appear on the CRT: OFF position: removes all markers. 5 MHz position: markers appear at 5-MHz intervals. Other markers are off.

(Cont'd)

TABLE 2-1. OPERATING CONTROLS, INDICATORS AND CONNECTORS (Cont'd)

Figure 2-1 Index No.	Reference Designation	Name	Function
22 (Cont'd)			500 kHz position: markers appear at 500-kHz intervals with those at 5-MHz intervals larger than intervening ones (an occasional 5 MHz marker may appear weaker than the 500 kHz markers due to out-of-phase combination). 25 kHz position: markers appear at 25-kHz intervals with 500-kHz markers larger and 5-MHz markers largest.
23	R7	MARKERS AMPLITUDE control (inner control)	A potentiometer that adjusts amplitude of crystal-controlled internally generated calibration markers.

e. When employing an MF-2, alternately adjust the HORIZ position screwdriver control and horizontal size screwdriver control (the latter being the lower of the two controls accessible through the plug on the right side of the cabinet) to center the display on the screen and have the display occupy the full screen width. When employing an MF-5, alternately adjust the HORIZ POS control and HORIZ CAL (HORIZ SIZE on early versions of the main frame) screwdriver control to center the display and have it occupy the full screen width. Note the zero-pip appearing on the left side of the trace.

f. Set the MARKERS switch to 5 MHz and adjust the MARKERS AMPLITUDE control to obtain marker pips of convenient amplitude.

g. Note the position of the displayed pips. The zero-pip, 5-MHz marker, 10-MHz marker, 15-MHz marker, 20-MHz marker and 25-MHz marker should be within ±1/2 horizontal division from the first, third, fifth, seventh, ninth and last graticule vertical lines. If they are not, alternately adjust the HORIZ position and horizontal size screwdriver controls of the MF-2 or the HORIZ POS control and HORIZ CAL screwdriver control of the MF-5 to obtain the required display.

h. Set the MARKERS switch to OFF, set the SWEEP RANGE switch to 50 kHz-5 MHz, set the SWEEP WIDTH control to obtain a SWEEP WIDTH dial reading of 0.1 MHz and adjust the CENTER FREQUENCY control to obtain a CENTER FREQUENCY 0-25 MHz dial reading of 00.1.

i. Tune a signal generator (such as a Hewlett-Packard 651B) to 100 kHz and adjust for a cw output of 100 μV. Couple the signal generator to the INPUT jack via a length of 50-ohm coaxial cable.

j. Adjust the signal generator output level to obtain a pip peak coincident with the LOG scale 0 dB line. Note that this is not the uppermost graticule horizontal line.

k. Set the INPUT ATTEN DB switch, in sequence, to 10, 20, 30 and 40 and, at each setting, note the position of the pip peak; it should be within ±0.2 divisions of the LOG scale -10, -20 and -30 dB graticule lines and ±0.4 divisions of the LOG scale -40 dB graticule line, respectively. If the pip peaks are consistently higher than the above amplitude limits, rotate the vertical size screwdriver control on the MF-2 (the upper of the two controls accessible through the plug on the right side of the cabinet) or the VERT CAL screwdriver control on the MF-5 slightly clockwise and then vertically position the display so that the baseline coincides with the lowest graticule horizontal line. Set the INPUT ATTEN DB switch to 0 and repeat steps j and k until no further adjustment of the vertical circuitry is required. Conversely, if the pip peaks are consistently lower than the above amplitude limits, rotate the vertical size screwdriver control of the MF-2 or the VERT CAL screwdriver control of the MF-5 slightly counterclockwise and then vertically position the display so that the baseline coincides with the lowest graticule horizontal line. Set the INPUT ATTEN DB switch to 0 and repeat steps j and k until no further adjustment of the vertical circuitry is required.

l. Set the CENTER FREQUENCY control to obtain a CENTER FREQUENCY 0-25 MHz dial indication of 00.0 and adjust the SWEEP WIDTH control to obtain a SWEEP WIDTH dial indication of 5.0 MHz. Set the I-F ATTEN DB switch to 20.

m. Adjust the FREQ CAL control to position the zero pip at the graticule CF vertical line, as illustrated in figure 2-2a.

n. Set the SWEEP WIDTH control to obtain a SWEEP WIDTH dial indication of 0.0 MHz and repeat step m.

o. Adjust the SWEEP WIDTH control to obtain a SWEEP WIDTH dial indication of 2.0 MHz and observe the position of the zero pip; it should remain at the graticule CF vertical line. If the zero pip shifts, return it to the graticule CF vertical line by adjustment of the HORIZ screwdriver control (MF-2) or HORIZ POS control (MF-5).

p. Alternately adjust each 0 Hz BALANCE control to minimize the zero pip amplitude, as shown in figure 2-2b. The peak of the zero pip should be below 0 DB on the LOG scale. The equipment is now ready for operation in the wideband mode. If narrowband operation is desired, continue through step s.

q. Set the SWEEP RANGE switch to SEARCH/LOCK and adjust the red SEARCH/LOCK control to obtain a display similar to that shown in figure 2-3. Fine tune the control for maximum amplitude of the display.

r. Set the SWEEP RANGE switch to 0.5 kHz-50 kHz NARROW BAND and, if necessary, adjust the FINE TUNING NARROW BAND control to position the zero pip at the graticule CF vertical line.

s. Alternately adjust each 0 Hz BALANCE control to minimize the amplitude of the zero pip. The equipment is now ready for narrowband operation.

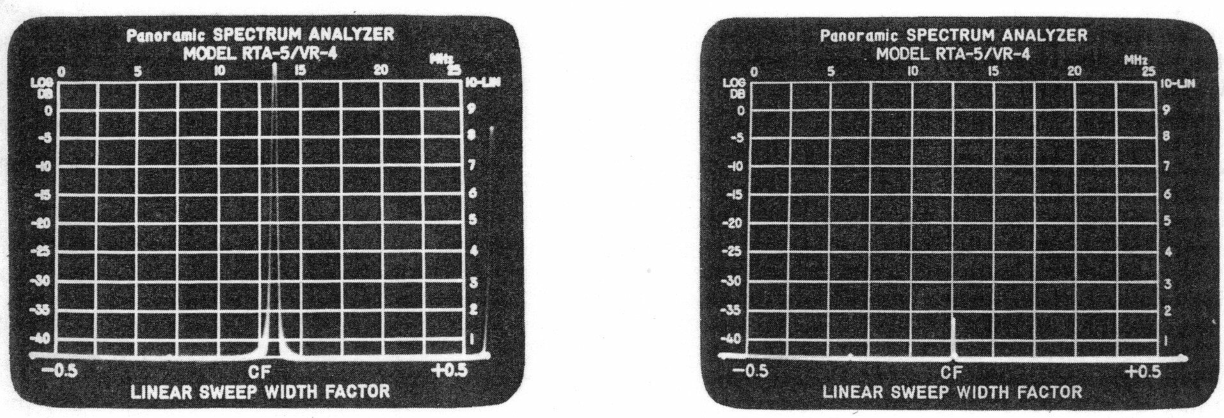
2-9. OPERATION AND CRT INTERPRETATION.

2-10. The following text and procedures provide instructions for the use of the VR-4b module and the way in which the displays should be interpreted. Since the usefullness of the spectrum analyzer is limited only by the ability of the operator to evaluate what is displayed on the cathode ray tube (CRT), it is important for the user to read the text of the following paragraphs before going on to the operating procedures.

2-11. GENERAL CONSIDERATIONS.

2-12. INPUT SIGNAL CLASSIFICATION. In general, input signals to the spectrum analyzer may be divided into two types; discrete and non-discrete. Discrete signals are in the form of periodic waveforms with frequency contents which do not vary appreciably with time. The internally generated markers are typical of such a signal. Although the marker oscillator output consists of several harmonic frequency components, each frequency is discernible as a separate marker pip on the CRT screen (provided the spectrum analyzer resolution (i-f bandwidth) is proper for the frequency difference encountered). In practice, discrete signals are typical of periodic oscillation such a modulated or unmodulated signal generator and oscillator outputs, or transducer outputs if a periodic vibration is encountered; for example, constant-speed rotating machinery with a well-defined resonant vibration.

2-13. Non-discrete signals are typified by random noise in which the input frequency distribution is spread out over a band of the spectrum rather than consisting of line spectra. Random signals have a non-discrete spectrum which varies with time but usually has a definable mean (rms) level. Non-discrete signals are displayed on the spectrum analyzer as a varying envelope of amplitude at each spectrum sample. Several scans through the noise input signal usually are adequate to establish a meaningful relative amplitude-versus-frequency analysis.



Mixer Unbalance Mixer Balance

Figure 2-2. Typical CRT Displays During Mixer Balancing

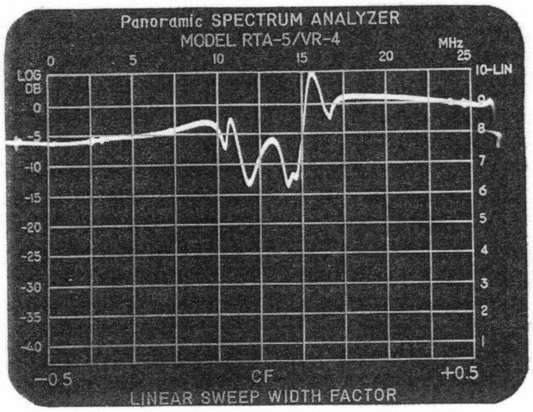


Figure 2-3. Peaking of Zero Pip in Search/Lock Mode During Mixer Balancing

2-14. Both amplitude scales are equally valid for both random and discrete signals. However, the equipment sensitivity for discrete signals is different from that for random signals. Discrete signal levels should be compared to other discrete signal levels, and random signal levels to other random signal levels when relative signal strengths are being determined. For complex signals, where both random and discrete signals are present, the spectrum analyzer correctly indicates the level of noise as well as the correct level of discrete signals. That is, neither the average random or the discrete deflections would change if one or the other were removed from the input signal. The methods used in measuring voltage and frequency (discrete signals) as well as noise and intermodulation distortion (non-discrete signals) are described in the following operating procedures.

2-15. MAXIMUM INPUT VOLTAGES. For correct measurements, limits on signal voltages connected to the INPUT jack must be observed. (Refer to table 2-2.) Failure to limit the level of the indicated voltages may result in incorrect amplitude readings and indications of frequency components which are not present in the input signal. When evaluating the input level, it is necessary to measure the total amplitude present at the input, whether related or extraneous, whether in the frequency range of the equipment, or outside of the equipment frequency range. The input amplitude should be measured with a broadband, fast-responding, peak-level indicator such as an oscilloscope. If the presence of signals not related to the signals of interest are of sufficient amplitude to overload the equipment, it is advisable to use appropriate filters to eliminate the unrelated signals.

TABLE 2-2. INPUT VOLTAGES (RMS) REQUIRED FOR FULL-SCALE DEFLECTION

Total Attenuation (dB)	Full Scale Input Voltage (Minimum Full Scale Sensitivity)*	
	LIN scale	LOG scale
0	3.00 μv	30.0 μv
5	5.33 μv	53.3 μv
10	9.49 μv	94.9 μv
15	16.9 μv	169 μv
20	30.0 μv	300 μv
25	53.3 μv	533 μv
30	94.9 μv	949 μv
35	169 μv	1.69 mv
40	300 μv	3.00 mv
45	533 μv	5.33 mv
50	949 μv	9.49 mv
55	1.69 mv	16.9 mv
60	3.00 mv	30.0 mv
65	5.33 mv	53.3 mv
70	9.49 mv	94.9 mv
75	16.9 mv	169 mv
80	30.0 mv	300 mv

*Full scale deflection sensitivity typically better voltages listed.

2-16. In the case of noise analysis, unless it is definitely known that the level of signal present above the spectrum of interest is negligible, it is good practice to use a low-pass or band-pass filter to attenuate signals outside the spectrum of interest.

Note

Amplitude overloading of the input is determined by the instantaneous peak voltage of the input signal. However, in cases where the peak amplitudes are no greater than 1.4 times the rms amplitude, a broadband rms voltmeter may be used instead of an oscilloscope, if more convenient. Even if large amplitude bursts do occur, if they are of very short time duration, they may be ignored. They will cause spurious response for a very brief period of time and thus will not appear on the CRT for any significant length of time.

2-17. SPECIAL CONSIDERATIONS.

2-18. OPTIMUM RESOLUTION OF SIGNALS CLOSELY SPACED IN FREQUENCY. At full sweep width, test signals having a small frequency difference tend to have their corresponding deflections merge into and mask each other. The ability of the equipment to separate individual signals depends upon two factors: the scanning velocity (product of sweep rate and sweep width) and the bandwidth of the intermediate frequency (i-f) section of the analyzer. For any given scanning velocity, there is a corresponding i-f bandwidth for optimum resolution. The scanning velocity is reduced by increasing the sweep period (reducing the sweep rate) and decreasing the spectrum width scanned within a given time (reducing the sweep width). Reducing the scanning velocity improves the resolution (the ability of the equipment to separate closely spaced frequency components). If a signal of small amplitude is close in frequency to a signal of large amplitude, the pip representing the small amplitude signal will be influenced by the large amplitude signal (the amplitude-versus-frequency response of the i-f section being bell-shaped). As the signals are separated in frequency, the error becomes less.

2-19. The I-F BANDWIDTH control is used to adjust the i-f section bandwidth. Counterclockwise rotation of this control narrows the bandwidth. As this control is adjusted, there may be some change in the sensitivity of the equipment. Narrowing the i-f bandwidth improves resolution until a point of optimum resolution is reached. Further narrowing of the i-f bandwidth decreases resolution beyond this point, and causes a severe reduction of amplitude.

2-20. One way to obtain better resolution is to decrease the sweep speed. The choice of appropriate sweep speed is determined by the nature of the signals being studied. For example, when the test signals are sporadic, it is desirable to operate at high sweep speeds to increase the probability of intercepting the signal. When examining pulse spectra, increasing the sweep speed will reduce the number of pulse lines per scan providing the PRF is less than the i-f bandwidth. (When the PRF is greater than the i-f bandwidth, the number of lines is constant, regardless of sweep rate.)

2-21. Figure 1-2 is a graph that illustrates the relationship between sweep width, resolution, and sweep rate. The graph can be used to determine the best possible resolution for any given combination of sweep width and sweep rate. The figures given in the graph apply only within the limits specified for sweep width, sweep rates and resolution listed in specifications of Section I. To increase the resolution capabilities by reducing sweep width, narrowing the i-f bandwidth, and increasing scanning time, the following procedures are used:

a. Set the I-F BANDWIDTH control completely clockwise for widest i-f bandwidth.

b. Adjust the CENTER FREQUENCY control so that the desired band of signals is at the center of the screen.

c. Spread the band of signals across the screen by reducing the sweep width with the SWEEP WIDTH control. Each frequency calibration mark on the screen represents a frequency separation equal to one-tenth of the reading of the SWEEP WIDTH control dial.

d. Turn the I-F BANDWIDTH control counterclockwise until individual signals are most clearly resolved. If the signals cannot be resolved, a slower sweep rate will be required. Exceeding optimum resolution can be recognized by a severe loss of amplitude which results from using a bandwidth too narrow for a given sweep width and sweep rate; and stretching of the left-hand side of the signal pips.

Note

If it is necessary to observe a given bandwidth with the contained signals closely spaced, the best possible resolution is indicated by the clearest picture. A reasonably accurate measurement of relative amplitudes can be made by reading the center of the beat notes between the adjacent signals.

2-22. NOISE ANALYSIS. In noise analysis (noise being defined as randomly fluctuating signals), the same general techniques are used for setting the equipment for the spectrum of interest as are used for discrete signals. If the input spectrum is broadband, it is very important to monitor the input level to prevent equipment overload. The following special techniques should be noted.

2-23. In general, a fairly wide i-f bandwidth is preferred for noise analysis. This permits relatively rapid scans since a wide i-f bandwidth gives better noise envelope averaging than does a narrow i-f bandwidth. However, if the noise source is highly selective (for example, influenced by a structural resonance), an i-f bandwidth which is narrow compared to the bandwidth of the resonance is required. This permits presentation of fine detail of the noise characteristics. When a narrow i-f bandwidth is used, a low sweep rate is necessary for correct amplitude presentation.

2-24. The appropriateness of the sweep rate can be determined by changing the sweep rate slightly and noting whether or not there is any change in the envelope amplitude. (The portion of envelope having the greatest slope should be watched since the greatest change in envelope will occur here.) The sweep rate should be slow enough so that a small change in sweep rate does not result in an amplitude change. If the sweep rate is at minimum, the sweep width should be reduced and/or the i-f bandwidth increased until it is possible to make a small change in sweep rate without changing the amplitude. Once a sweep which is slow enough to provide correct results has been established, a slower sweep can be set if improved envelope averaging is required.

2-25. In noise analysis, video filtering can be used to obtain averaging of the noise spectrum envelope. It is usually desirable to rotate the SMOOTHING FILTER control clockwise until a single-line presentation is obtained. The video filtering should not be too great (control too far clockwise) for the setting of i-f bandwidth. This can be checked by changing the sweep rate slightly and noting whether or not there is a change in the steepest portion of the presentation.

2-26. In a general sense, the i-f bandwidth, SMOOTHING FILTER control setting, sweep width, and sweep rate should be such that a slight change in sweep rate does not change the slope of the steepest portion of the presentation. If this is not the case, it may be necessary to reduce the sweep rate, sweep width, or video filtering, or to increase the i-f bandwidth.

2-27. As an alternate to envelope averaging by video filtering, photographic averaging can be used. This is simply a matter of taking a composite photograph of a number of successive scans, thereby obtaining an average presentation.

2-28. The equipment sensitivity listed in Section I is applicable only to discrete signals. If absolute noise amplitude measurements are required, a calibration of the spectrum analyzer using a known noise amplitude should be made. Such a calibration must be made at the same scanning velocity (product of sweep width and sweep rate) and i-f bandwidth used for measurement since any change in scanning velocity and/or i-f bandwidth changes the amplitude.

2-29. Typical screen presentations with different control settings and different photograph exposure times of the same noise spectrum are shown in figure 2-4. To obtain a convenient presentation amplitude, the input level and/or input attenuators have been adjusted as required.

2-30. In figure 2-4a, the i-f bandwidth is narrow. The amplitude scale is linear. Since the scale is linear, the range of amplitude variation is emphasized compared to a logarithmic scale. (See figure 2-4b.) The use of a narrow i-f bandwidth also tends to emphasize the range of amplitude variation. The narrow bandwidth increases the likelihood of the equipment response at any given point being caused by a significantly higher or lower than average noise amplitude. If the i-f bandwidth is wide, it is more likely that the equipment response will be caused by a more typical noise amplitude. The result is shown in figure 2-4d.

2-31. Figure 2-4c illustrates the use of extended photographic exposure to provide a better averaging of the noise spectra.

2-32. The use of video filtering to obtain averaging of the noise spectra is illustrated in figures 2-4e and f. With the equipment settings used for e, a slight change of sweep rate caused a significant change in the presentation, thus indicating the unsuitability of the settings. The sweep rate was reduced until no change in the presentation was noted. This is the correct response and is shown in figure 2-4f.

2-33. INTERPRETING CRT DISPLAYS.

2-34. With a little experience, the operator will be able to visually recognize the character of the various types of signals.

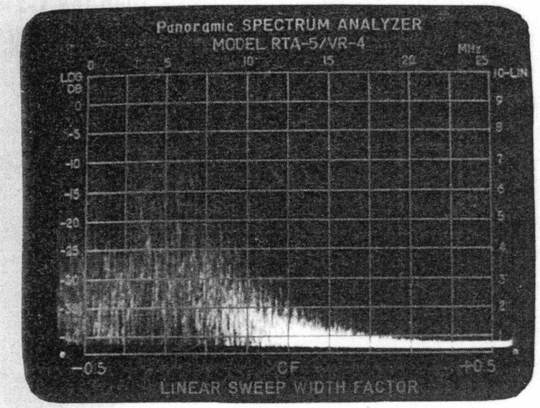
2-35. A constant carrier signal appears as a deflection of fixed height with the nature of presentation depending upon the sweep width. (See figures 2-5a and b.) Deviations of the signal from the true cw will result in displays which will indicate the character of the signal as follows:

a. Oscillator drift - deflection moves slowly across the screen.

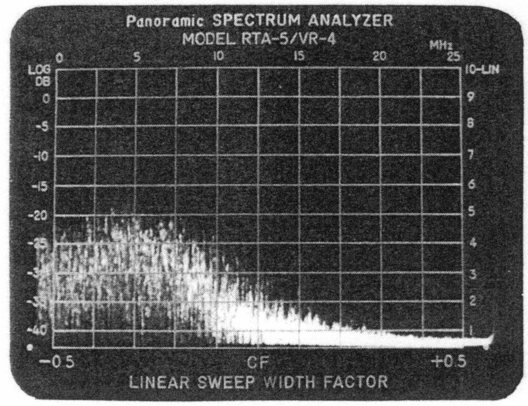
b. Periodic drift - deflection moves back and forth across the screen.

c. Squeeging - interruption of an oscillator at a-f or i-f rate will result in a spectrum display resembling that of a pulse modulated signal. Sideband components will be present in addition to the oscillating frequency.

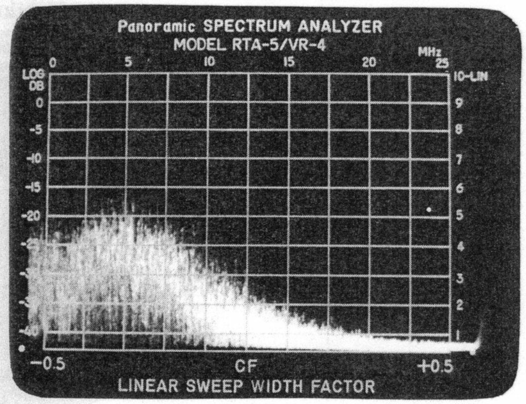
d. Keying - a cw signal appears and disappears in step with the keying of the signal source. During the moments when the signal is off, the frequency sweep axis is closed at the base of the signal. In very rapidly keyed signals the deflection and the baseline are seen simultaneously (on different sweeps).



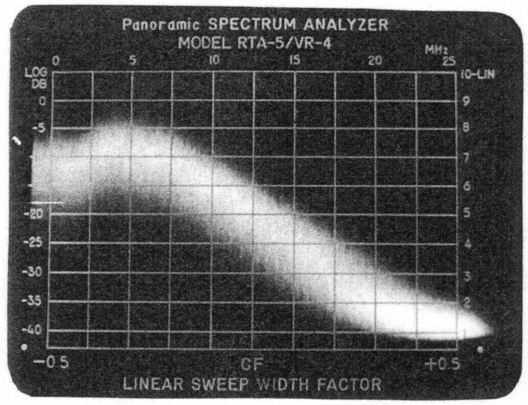
a. LIN Scale, narrow i-f bandwidth, one scan.



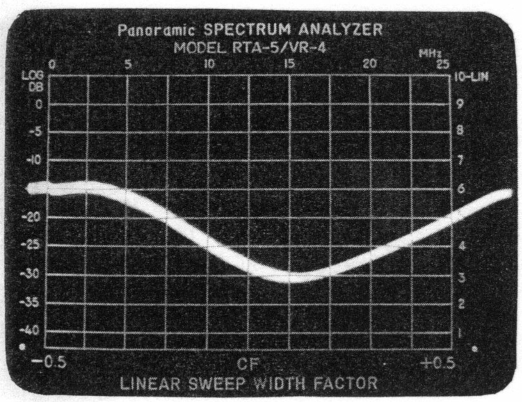
b. Same as "a" on LOG scale.



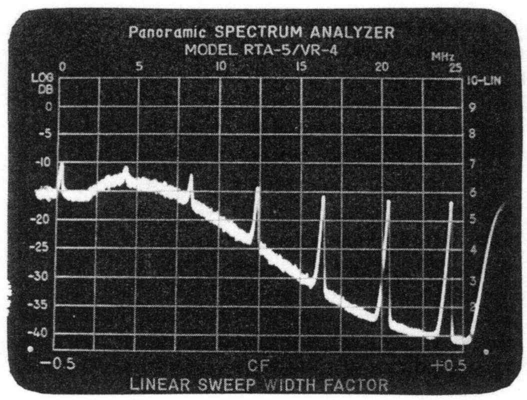
c. Same as "b" with extended photographic exposure.



d. LOG scale, broad i-f bandwidth, one scan.



e. Same as "d" with Smoothing Filter used to obtain single line presentation. Sweep rate too fast.



f. Same as "e" with sweep rate adjusted and markers used to define frequency points.

Figure 2-4. Typical CRT Displays of Various Noise Signals

2-36. Two cw signals which are so close in frequency as to cause aural interference (beats) may appear on the screen as a single signal whose height varies with modulation. As the frequency separation is increased, the signal appears to be modulated on one side only. Further separation will cause a "break" in the apex of the defection. By reducing the sweep width of the analyzer, the two signals will gradually separate. Reducing the sweep width, reducing the sweep rate, and/or narrowing the i-f bandwidth may result in separation into two distinct pips, see figure 2-5c.

2-37. An amplitude-modulated carrier appears as a deflection of variable height, when the modulating frequency is very low. Non-constant tone modulation of low frequency will produce a series of convolutions varying in height along the sides of the carrier pip. The nature of the presentation will depend upon the sweep width. As the modulation frequency increases, the convolutions move toward the two sides of the deflection, and the sidebands become visible. When the modulation frequency is increased, it becomes possible to separate the sidebands by reducing the sweep width of the analyzer. The IF BANDWIDTH control will enable further separation. The higher the frequency of modulation, the farther away those sidebands will move from the center deflection, which represents the carrier. (See figure 2-5d.)

2-38. The appearance of single-sideband signals depends upon the type of modulation employed. Tone-modulated single-sideband signals appear as a carrier (for a single tone), or a series of carriers (for multi-tones) of slightly different frequency. Voice of music-modulated single-sideband signals appear as a "smear" of rapidly varying signals which occupy finite bandwidth. A typical screen presentation of an amplitude-modulated single-sideband signal without carrier suppression is shown in figure 2-5e.

2-39. Frequency-modulated carriers appear as a series of vertical deflections. See figure 2-5f. A carrier that is frequency-modulated at a low rate appears as a carrier which wobbles sideways. The vertical deflections shift rapidly when the carrier is modulated by voice or music. See figure 2-5g.

2-40. A pulse-modulated a-m signal (figure 2-5h) will consist of a pattern of vertical spikes. The number of spikes is dependent on the pulse repetition rate, and the i-f bandwidth and the sweep rate of the equipment. The amplitude of each spike represents the amount of energy present at that particular frequency during one of the pulses. The peak envelope of all the spikes represents the energy-distribution pattern of the signal. To measure the pulse width and PRF of a pulsed a-m signal, proceed as follows:

a. Adjust the SWEEP WIDTH and CENTER FREQUENCY controls so as to obtain one full side lobe with easily resolved spikes on the CRT (see figure 2-6). Record the SWEEP WIDTH dial reading.

b. Verify that the PRF is greater than the i-f bandwidth by changing the setting of the Sweep Rate (VAR) control slightly and observing that the positions and number of pulses on the CRT display do not change.

c. Obtain the pulse width by taking the reciprocal of the recorded SWEEP WIDTH dial setting (from step a, above).

Note

If one side lobe with easily resolved spikes cannot be obtained on CRT display, decrease the setting of the Sweep Rate (VAR) and I-F BANDWIDTH controls until the spikes are resolved to obtain the PRF.

d. Obtain the PRF by dividing the recorded SWEEP WIDTH dial setting by the number of spikes on the CRT display (as in the case of figure 2-6, there are 12).

Example:

SWEEP WIDTH dial setting reading = 0.9 MHz

Spikes on CRT = 12

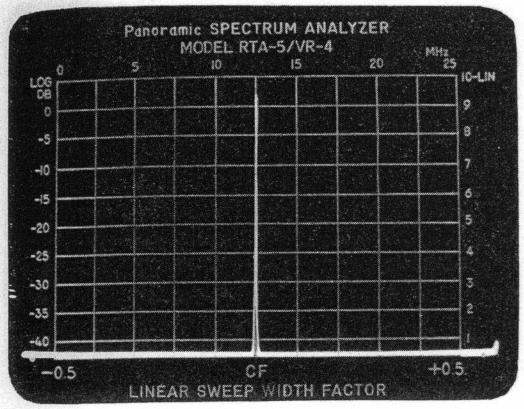
$$\text{Pulse Width} = \frac{1}{0.9\ \text{MHz}} = 1.1\ \mu\text{sec}$$

$$\text{PRF} = \frac{0.9\ \text{MHz}}{12} = 75\ \text{kHz}$$

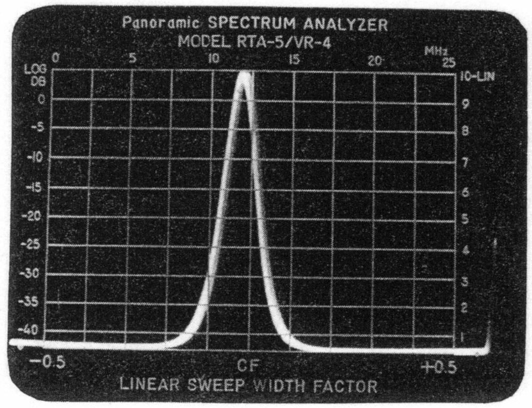
2-41. Square waves can be recognized by a pip at the fundamental frequency and gradually decreasing pips at the odd harmonic frequencies. See figures 2-5i and j.

2-42. Triangular waves can be distinguished from square waves because the amplitudes of the odd harmonics decrease much more rapidly with the seventh just barely discernible. See figure 2-5k.

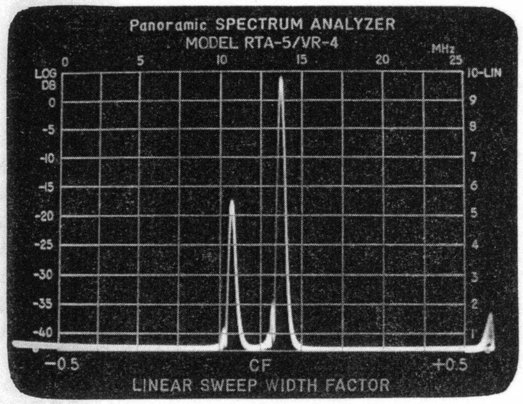
2-43. Radio interference signals of various types may appear on the screen of the spectrum analyzer. Such signals may have broad or narrow spectral distributions, and may occur at constant or at random repetition rates. Signals which occur at a variable repetition rate (such as those produced by accelerating motors, vibrators, buzzers, etc.) may move in one direction or the other along the frequency sweep baseline; this is caused by the fact that the analyzer is sweeping at a fixed rate, whereas the observed signal occurs at a variable rate. The pips stand still on the screen when there is synchronism between the two. Signals produced by such sources as electrical arcing, switching transients, "static," and other short electrical impulses, have broad spectra which may cover the entire frequency range of the analyzer.



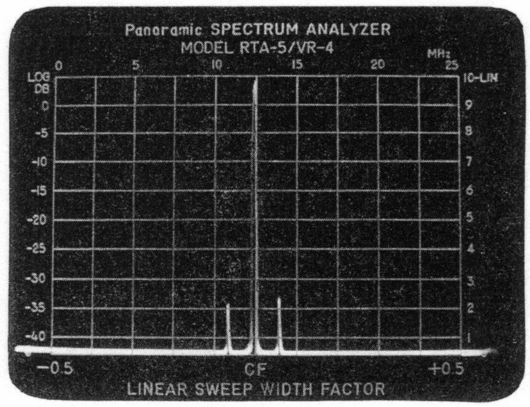
a. Constant carrier signal at approximately maximum sweep width.



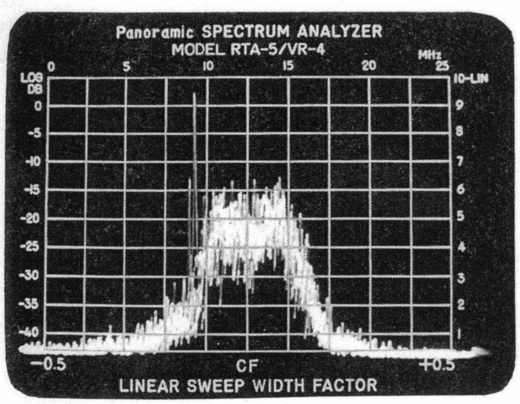
b. Same signal as "a", at reduced sweep width.



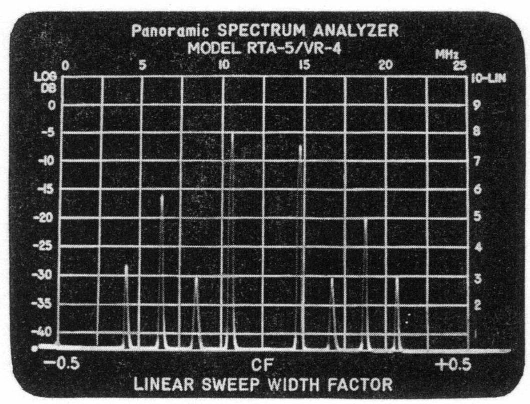
c. Two interfering carriers at optimum resolution.



d. Amplitude-modulated (a-m) signal showing carrier at the center and two sidebands.

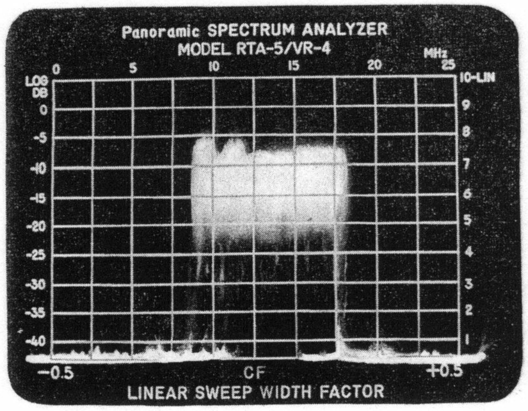


e. Single-sideband signal without carrier suppression.

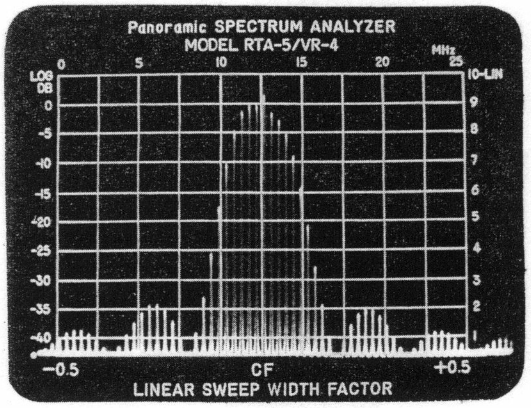


f. Frequency-modulated (f-m) signal with carrier null.

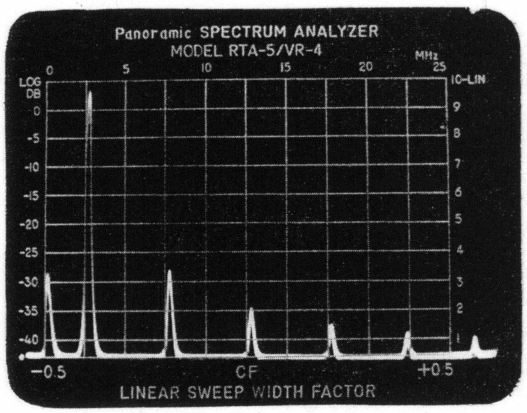
Figure 2-5. Typical CRT Displays of Various Discrete Signals. (Sheet 1 of 2)



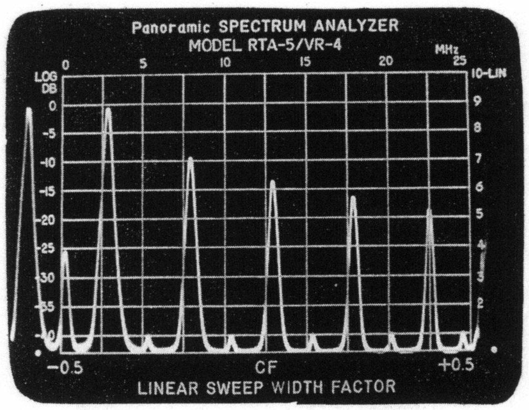
g. Typical sideband energy of f-m signal, speech modulated. (Slow-sweep or long-exposure photography used.)



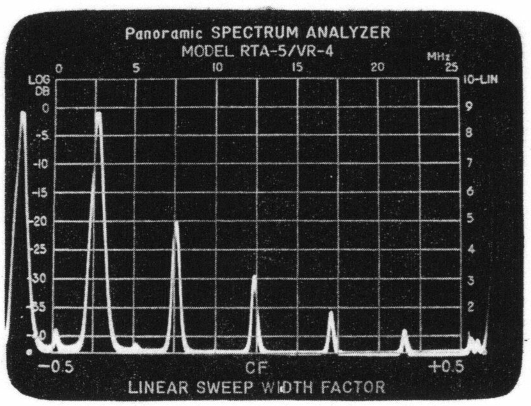
h. Pulsed r-f signal.



i. 100 kHz square-wave, LIN scale.



j. 100 kHz square-wave, LOG scale.



k. 100 kHz triangular wave, LOG scale.

Figure 2-5. Typical CRT Displays of Various Discrete Signals. (Sheet 2 of 2)

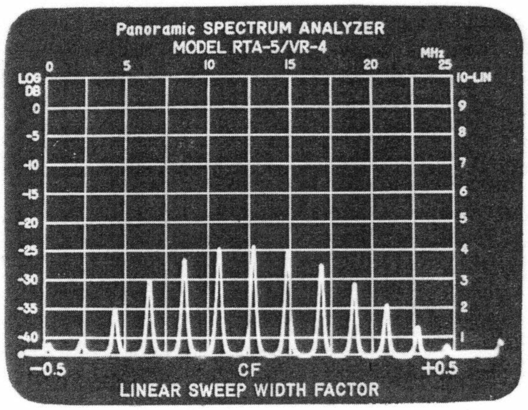


Figure 2-6. Determining Pulse Width and PRF of a Pulsed RF Signal

2-44. AMPLITUDE MEASUREMENT OF DISCRETE SIGNALS. The most accurate method of measuring relative signal strengths that are less than 20 dB apart is to use the linear amplitude presentation on the CRT. When it is necessary to measure two or more signals of widely differing amplitudes (greater than 20 dB but less than 40 dB), the LOG presentation should be viewed on the CRT.

a. Examine the complete spectrum with the SWEEP RANGE switch set to 0-25 MHz PRESET, the AMPLITUDE SCALE set to LOG, the I-F ATTEN DB switch set to 20 and VARIABLE control fully ccw. No pips should exceed full scale (0 DB on LOG scale).

b. Reduce the setting of the INPUT ATTEN DB switch until the largest pip is as large as possible but does not exceed full scale.

Note

Failure to limit the input signal could result in incorrect amplitude readings and indications of frequency components that are not present in the input. Signals outside the 0-25 MHz viewing range of the VR-4b module may also cause distortion and spurious responses. If such signals are known or suspected to be present at excessive levels, a suitable rejection filter should be used at the input to the VR-4b module. For best dynamic range (lowest distortion), the I-F ATTEN DB switch should be kept at the lowest possible position during the measurement.

c. Examine the signal of interest in narrower bands.

Note

Signal levels too low to be analyzed in terms of the sensitivity of the equipment can be examined by amplifying them by means of a preamplifier of low noise and distortion, and known gain. The output of the preamplifier must then be considered the signal being analyzed.

d. It is perfectly normal for the amplitude of the zero frequency pip to vary with time. If the frequency region being examined is sufficiently remote from zero so that the zero frequency pip is not on the screen, it is only necessary to be sure that the zero frequency pip is less than full scale on the LOG scale when the I-F ATTEN DB switch is set to 20. It is good practice to confirm the degree of suppression occasionally. If the equipment is used near enough to zero frequency that the zero frequency pip is on the screen, greater care in suppression may be required. If the zero frequency pip is below full scale on the LOG scale with the I-F ATTEN DB switch set to 20 and the signal pips do not tend to ride on the zero frequency pip, the suppression is satisfactory. If the signal pip amplitudes are being influenced by the zero frequency pip, adjust the equipment to improve the resolving capabilities (reduce the sweep width, reduce the sweep rate, or narrow the i-f bandwidth). If improvement of the resolving capabilities does not sufficiently separate the zero frequency pip from the signal pips, adjust the 0 Hz BALANCE controls for suppression of the zero frequency pip sufficient to prevent its influence on the amplitude of the signal pips.

e. To measure signals of comparable amplitude (0 - 20 dB difference), set the AMPLITUDE SCALE switch to LIN. For greater differences, set the switch to LOG. For amplitude ratios between 40 and 60 dB, set the strongest signal to 0 DB on the LOG scale and then set the I-F ATTEN DB switch to 0. Add 20 dB to the CRT scale indications of on-screen signals to obtain the correct amplitude ratios. The relative heights of the pip deflections are accurate within the limits of flatness of response of the spectrum analyzer. Better accuracy of amplitude ratio measurement is provided in the LIN position of the AMPLITUDE SCALE switch than in the LOG position. The LIN scale, which is on the right side of the graticule, is divided into ten divisions, numbered from 10 to 1. The LOG scale, at the left side of the graticule, is calibrated from 0 dB to -40 dB in 5-dB increments. For greatest accuracy in comparing the amplitude of the signals, set the weaker signal to a convenient reference level on the display (LIN scale of the graticule). With the INPUT ATTENUATOR DB switch, reduce the stronger signal until it appears on the calibrated graticule. The relative signal amplitudes, converted from linear ratio to log ratio (decibels) and added to the increase in the INPUT ATTENUATOR DB setting provides a more accurate measurement than is usually possible from the LOG CRT display.

Note

Full scale LOG does not correspond to full scale LIN on the graticule calibration.

2-45. FREQUENCY MEASUREMENT OF DISCRETE SIGNALS.

a. Repeat steps a and b of paragraph 2-44.

b. Set the SWEEP RANGE switch to 50 kHz - 5 MHz. Adjust the attenuators for a reasonably large signal pip. Set the AMPLITUDE SCALE switch to LIN because the pips are sharper in LIN than in LOG.

c. Reduce sweep width until the display is limited to the signals of interest.

d. Measure frequency to within ±5% by adjusting the CENTER FREQUENCY control until the pip is centered about the CF line. Do not include the ringing pulse as part of the pip width.

e. Frequency measurements of greater accuracy may be made by setting the CENTER FREQUENCY control for a reading equal to the frequency of the marker nearest the signal frequency being measured. If the marker is not precisely centered about the CF line, adjust the FREQ CAL control until the marker is centered. Measure signal frequency as in step d.

f. Estimate the frequency of a pip that is not at the center by adding (if the pip is to the right) or subtracting (if the pip is to the left) the displacement in kHz from the center frequency reading. The displacement is determined by multiplying the number of horizontal divisions from CF by one tenth of the sweep width read on the SWEEP WIDTH dial (each horizontal division is equal to 0.1 of the total sweep width). For example:

CENTER FREQUENCY dial reading = 4.00 MHz
SWEEP WIDTH dial reading = 2.50 MHz, and the pip appears at about -3.5. The frequency is approximately:

$$4.00 - (3.5 \times 0.1 \times 2.5) = 4.00 - .875 = 3.125 \text{ MHz}$$

g. When observing signals in NARROW BAND, do not use the CENTER FREQUENCY control to center pips. Return to 50 kHz - 5 MHz, calibrate the CENTER FREQUENCY dial (step e), center the nearest identifiable marker pip carefully, and return to NARROW BAND (through SEARCH/LOCK). By careful use of the red thumb wheels and by counting markers, it is possible to identify the center frequency at 25-kHz intervals. Note that the CENTER FREQUENCY control and dial are not to be used for adjusting or reading center frequency in the NARROW BAND mode. Adjust the sweep width until the pip and marker are separated by an integral number of divisions and compute the frequency as in step f.

2-46. OPERATING PROCEDURES. The following procedure applies to all applications of the VR-4b module, modified in any given instance by the general and special considerations discussed in paragraphs 2-11 through 2-32. Interpretation of spectrum analyzer displays are covered in paragraphs 2-33 through 2-43. Amplitude and frequency measurements are discussed in paragraphs 2-44 and 2-45. It is imperative for a user to read the aforementioned paragraphs thoroughly until familiarity with the equipment is achieved, before attempting to use either model spectrum analyzer. After performing the preliminary operating procedure in paragraph 2-8, proceed as follows:

a. Set INPUT ATTEN DB switch to 70.

b. Set I-F ATTEN DB switch to 0.

c. Use any a-c vacuum-tube voltmeter (VTVM) with a suitable frequency response to measure the amplitude of the ac signal to be monitored with the spectrum analyzer. If any signal or pulses having a high crest factor occur in the monitored signal, a peak reading VTVM or oscilloscope should be used. The amplitude of the ac signal should not exceed the voltages listed in table 2-2 for any given input and i-f attenuation setting. Be sure to note whether linear (LIN) or logarithmic (LOG) SCALE AMPLITUDE is being used. Table 2-2 gives input voltages providing full-scale deflection at various total attenuation settings (i.e., of INPUT and I-F ATTEN DB switches).

CAUTION

THE MAXIMUM INPUT VOLTAGE MUST NOT EXCEED 5 VOLTS RMS (INCLUDING D-C COMPONENTS). THE MAXIMUM INPUT VOLTAGE FOR ANY INPUT ATTEN DB SETTING SHOULD NOT EXCEED A VALUE EQUAL TO 20 dB GREATER THAN THAT GIVING FULL-SCALE LOG DEFLECTION (ASSUMING THE TOTAL I-F ATTENUATION IS ZERO). EXCEEDING THESE VALUES MAY CAUSE OVERLOADING OF THE INPUT STAGES AND THE GENERATION OF SPURIOUS SIGNAL RESPONSES.

d. Set the I-F ATTEN DB VARIABLE control fully ccw.

e. Set the MARKERS AMPLITUDE control fully cw.

f. Set the CENTER FREQUENCY 0-25 MHz control to obtain a dial indication of 00.0.

g. Set the SWEEP MODE switch to AUTO SCAN.

h. Set the SWEEP RANGE switch to 0-25 MHz PRESET.

i. Set the SWEEP WIDTH control to obtain a dial indication of approximately 1 MHz.

j. Set the SMOOTHING FILTER control fully ccw.

k. Set the INPUT switch to either 50Ω or 75Ω, as determined by the impedance of the signal line being monitored.

l. Set the AMPLITUDE SCALE switch to either LIN or LOG, as required.

m. Set the MARKERS switch to 5 MHz and adjust the MARKERS AMPLITUDE control to obtain marker pips of convenient amplitude.

n. Adjust the FREQ CAL control, if necessary, so that the marker pips most nearly coincide with their respective graticule vertical lines, as indicated on the frequency scale engraved along the top of the graticule.

o. Couple the signal under analysis to the INPUT jack.

p. Set the MARKERS switch to OFF.

q. Set the INPUT ATTEN DB and I-F ATTEN DB switches to obtain a full-scale linear or logarithmic display, using the I-F ATTEN DB VARIABLE control for fine adjustment of the display amplitude.

Note

If possible, use only the INPUT ATTEN DB switch for full scale adjustment, with the I-F ATTEN DB VARIABLE control used as a vernier. This will make resulting measurements more convenient, with less chance of making an error.

r. Locate the signal of interest on the CRT display and determine its center frequency and spectrum width using the frequency scale engraved across the top of the graticule.

s. Set the SWEEP RANGE switch to 50 kHz - 5 MHz.

t. Adjust the FREQ CAL thumbwheel control to center the zero pip at the CF line of the CRT graticule. Using the 0 Hz BALANCE controls, balance the modulator to obtain a zero pip display of minimum amplitude.

u. Adjust the CENTER FREQUENCY control to obtain a CENTER FREQUENCY 0-25 MHz dial indication corresponding to the center frequency determined in step r.

v. Alternately adjust the SWEEP WIDTH and CENTER FREQUENCY controls to obtain a display of desired spectrum width and center frequency.

w. Resolve the display by adjusting the I-F BANDWIDTH control.

x. If the desired sweep width is less than 50 kHz, set the SWEEP RANGE switch to SEARCH/LOCK and continue through step aa.

y. Adjust the SEARCH/LOCK control so that the signal of interest is peaked (see figure 2-7).

Note

The SEARCH/LOCK circuitry is very sensitive and the control must be adjusted very slowly. Also, be certain that the correct signal has been peaked. If several closely spaced signals are present, the flat-topped plateau should be centered on the signal of interest. Its amplitude will be approximately that of the signal pip, simplifying identification of the desired signal. If using the zero frequency pip for lock-on purposes instead of an external signal, the display will look like a portion of a sine-wave signal (as shown in figure 2-3) instead of a flat-topped plateau.

z. Set the SWEEP RANGE switch to 0.5 kHz - 50 kHz NARROW BAND. Alternately adjust the

FINE TUNING NARROW BAND and SWEEP WIDTH controls to obtain a display of desired center frequency and spectrum width.

aa. To resolve closely-spaced pips, adjust the SWEEP WIDTH, sweep rate (VAR) and I-F BANDWIDTH controls as detailed in paragraph 2-18.

Note

See paragraphs 2-33 through 2-45 for information on voltage, frequency, and noise measurements.

ab. For analysis of signals of known frequency, steps a through n may be omitted, in whole or in part, as required.

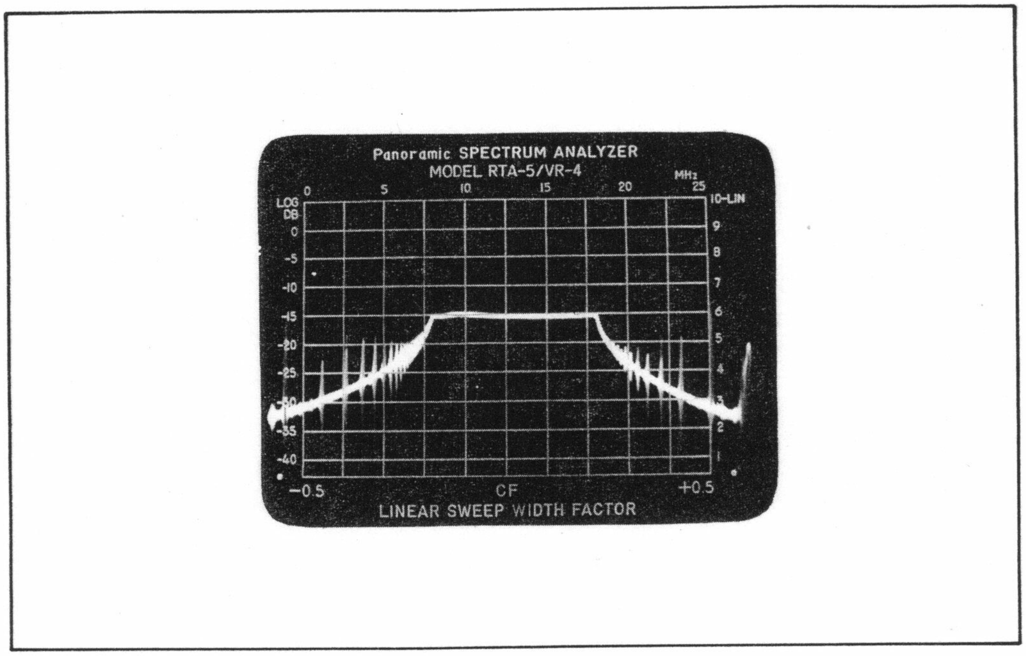


Figure 2-7. Signal Display in Search/Lock Mode.

SECTION III
THEORY OF OPERATION

3-1. GENERAL.

3-2. The Model VR-4b Video Module, used in conjunction with either the Model MF-2 or MF-5 Main Frame, displays the frequency-energy distribution of a signal or group of signals in the range of 1 kHz to 27.5 MHz. It is basically a double-conversion superheterodyne receiver which is automatically and repetitively tuned through a desired portion of the frequency band, with the output displayed as vertical deflections on a CRT screen. Because the horizontal sweep of the CRT is synchronized to the frequency of the swept local oscillator of the receiver, the vertical deflections are automatically positioned along the frequency-calibrated horizontal axis of the CRT screen.

3-3. SIMPLIFIED BLOCK DIAGRAM DISCUSSION.

3-4. The simplified block diagram, figure 3-1, shows the functional relationship of all circuits in the VR-4b module. All front panel controls, indicators and connectors are included in the diagram to thoroughly familiarize the user with the function of each.

3-5. The test signal is applied from the INPUT jack to the input attenuator, which has an input impedance of 75 ohms. When an input impedance of 50 ohms is required, the INPUT switch is placed in the 50 Ω position, thereby shunting the attenuator's input with a suitable resistor. The input attenuation can be adjusted with the INPUT ATTEN DB switch in 10-dB steps from 0 to 70 dB to reduce the level of the input signal and thereby prevent overloading the input circuits of the module. The attenuated signal is applied to the balanced mixer, where it is combined with the swept output of the wide-band local oscillator. The local oscillator operates above the incoming frequency and can be swept from 32.238 MHz to 59.738 MHz. A discrete frequency input combines with the swept local oscillator output to provide a continuously varying difference frequency that is continuously swept from a point somewhat below the i-f frequency to a point somewhat above the i-f frequency; for a finite time during the sweep, the difference frequency will pass through the i-f amplifiers and appear on the CRT screen. At the low-frequency end of the local oscillator sweep, the local oscillator is tuned to the i-f frequency and any imbalance in the balanced mixer will result in an output that passes through the i-f amplifier and appears on the CRT screen as the zero frequency pip. The 0 Hz BALANCE controls adjust the balanced mixer to minimize the local oscillator frequency that appears in the output of the mixer and thereby reduces the zero frequency pip. The i-f output of the mixer is applied through the 32.238 MHz i-f amplifier to the second mixer. This signal is mixed with a fixed 29.538 MHz output of the crystal oscillator, producing the 2.7 MHz i-f frequency. The 2.7 MHz signal is applied to the 2.7 MHz crystal i-f amplifier. The bandwidth of this amplifier is adjusted in the 50 kHz - 5 MHz and 0.5 kHz - 50 kHz NARROW BAND positions of the SWEEP RANGE switch by the I-F BANDWIDTH control which adjusts a dc input to the i-f amplifier. Reducing the i-f bandwidth reduces the portion of the local oscillator sweep that produces a signal within the bandpass of the i-f amplifier; therefore the pip resulting from a discrete frequency input appears narrower on the CRT screen, thereby improving the resolution between two signals that are close in frequency. The output of this i-f amplifier is applied through the i-f step attenuator which is controlled by the IF ATTEN DB switch. The i-f attenuator permits adjustment of the pip amplitudes on the CRT screen. The attenuated signal is applied to the fixed-bandwidth 2.7 MHz i-f amplifier. The gain of this i-f amplifier is continuously adjustable over a range from 0 to 10 dB by the I-F ATTEN DB VARIABLE control. This control sets the pip amplitudes to a convenient height for relative amplitude measurements. The output of this i-f amplifier is developed across a linear of non-linear (log compression) circuit as determined by the position of the AMPLITUDE SCALE switch. The log compression circuit produces an input to the log amplifier whose amplitude is logarithmically related to the amplitude of the input signal to the i-f amplifier. The output of the log amplifier is detected and the video is applied through an emitter follower to another linear or nonlinear network, from which the video output is obtained. When noise signals are being analyzed, a smoothing filter can be used to average the outputs and thereby provide the envelope of the noise pulses to the CRT. The amount of smoothing is continuously controlled by the SMOOTHING FILTER control in all positions of the SWEEP RANGE switch except the SEARCH/LOCK position.

3-6. The sawtooth generator produces the sawtooth sweep voltage that is applied to the horizontal deflection circuits of the main frame and also to the two local oscillators in the VR-4b module. In the 0-25 MHz PRESET position of the SWEEP RANGE switch, the sawtooth voltage is applied to the wide-band local oscillator, while the narrow-band local oscillator is disabled. The wide-band local oscillator is a multivibrator whose free-running frequency is determined by the instantaneous dc voltage applied to the circuit. Because the full sawtooth voltage is applied to the wide-band local oscillator, the oscillator is swept over its full range of frequencies. In the 50 kHz - 5 MHz position of the SWEEP RANGE switch, an adjustable portion of the sawtooth voltage is applied to the wide-band local oscillator so that the oscillator is swept only over a portion of its range while the full sawtooth is applied to the CRT circuits. Thus the full CRT sweep represents a controlled portion of the frequency spectrum. The CENTER FREQUENCY control adjusts the dc level of the sawtooth applied to the wide-band local oscillator in this mode. Because the same dc voltage is applied at both sides of the SWEEP WIDTH potentiometer, adjusting the sawtooth amplitude applied to the wide-band local oscillator does not alter the dc component, and therefore does not affect the center frequency. The FREQ CAL control introduces an additional dc component to the wide-band local oscillator to calibrate the CENTER FREQUENCY dial. In the SEARCH/LOCK position of the SWEEP RANGE switch, a fixed amplitude sawtooth voltage (with a dc level determined by the CENTER FREQUENCY control) is applied to the wide-band local oscillator, while the same dc level is simultaneously applied to the narrow-band local oscillator. The output of the narrow-band local oscillator is a fixed frequency that is applied to the wide-band local oscillator as a synchronizing input. As the wide-band local oscillator is swept through its range by its sawtooth input, it passes through, and is momentarily synchronized to, the fixed frequency of a narrow-band local oscillator. The change in output that results at this instant appears as a flat-top waveform (figure 2-4) on the CRT screen and the waveform indicates the frequency to which the narrow-band local oscillator is tuned; thus the flat-top waveform allows the narrow-band local oscillator to be retuned by the SEARCH/LOCK and FINE TUNING NARROW BAND controls to the center frequency of the wide-band local oscillator. In the 0.5 kHz - 50 kHz NARROW BAND position of the SWEEP RANGE switch, the dc voltage determined by the CENTER FREQUENCY control is applied to the wide-band local oscillator and an adjustable sawtooth voltage is applied to the narrow-band local oscillator. The dc component of this sawtooth is the same in this switch position as it was in the SEARCH/LOCK position so that the narrow-band local oscillator's center frequency remains unchanged. The frequencies generated by the narrow-band local oscillator synchronize the wide-band local oscillator so that it, too, is swept through the same limited frequency range. Although its range of frequencies is limited, the narrow-band local oscillator is used because of its greater stability, which results in reduced jitter; jitter would be most noticeable with narrow sweep widths because small frequency differences result in large horizontal displacements. In the 50 kHz - 5 MHz and the 0.5 kHz - 50 kHz NARROW BAND positions of the SWEEP RANGE switch, the operator can select either AUTO SCAN or MANUAL positions of the SWEEP MODE switch. In the AUTO SCAN position of the switch, the sawtooth generator automatically generates sawtooth voltages which repeatedly sweep the local oscillator and CRT screen. In the MANUAL position of the switch, the Sweep Rate (VAR) control adjusts a dc output, replacing the sawtooth generator so that the "scanning" can be manually controlled. In the 0 - 25 MHz PRESET and SEARCH/LOCK positions, the SWEEP MODE switch has no effect, and the sawtooth generator operates as though in the AUTO SCAN position.

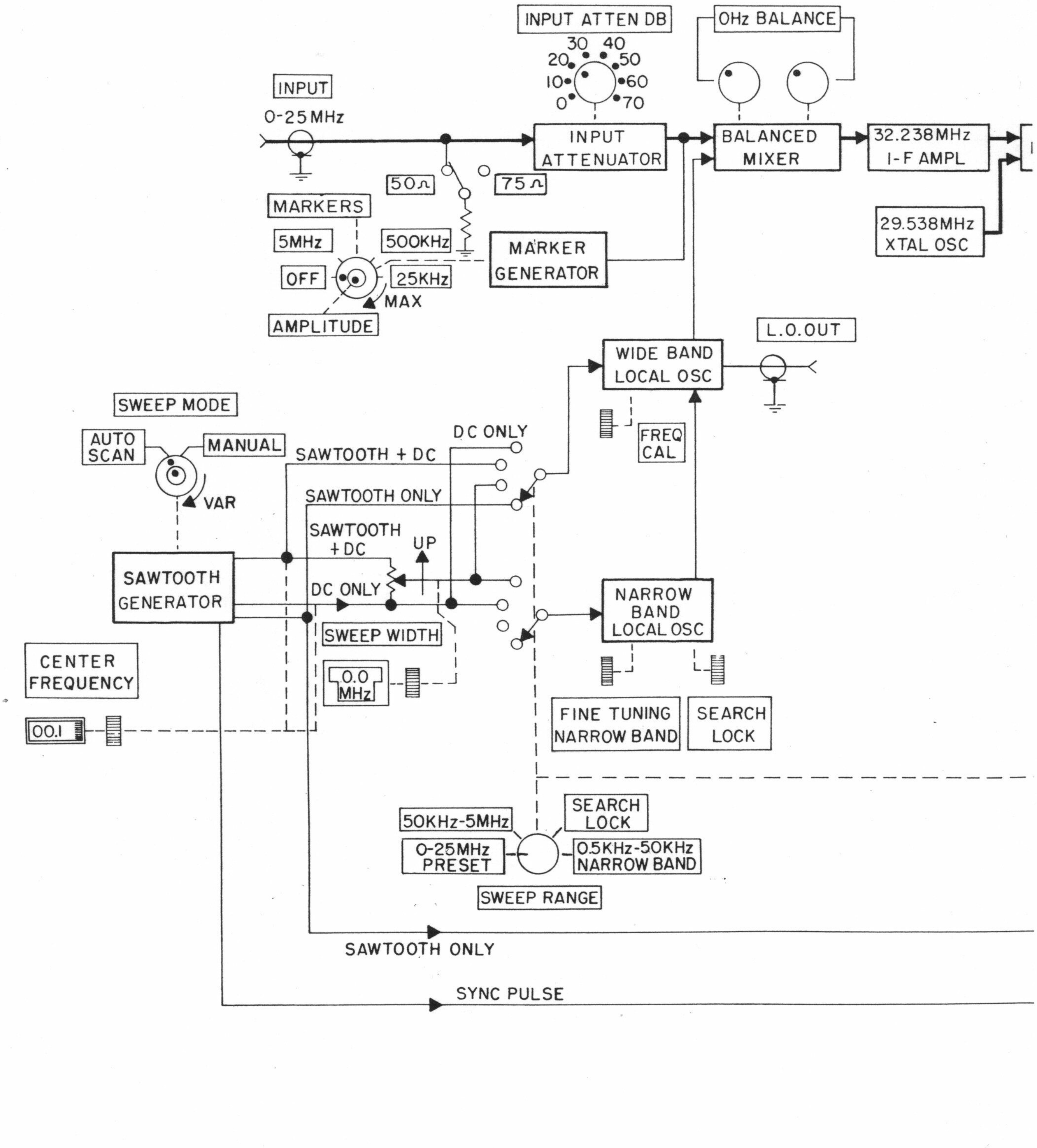
3-7. When improved frequency-determining capabilities are required, marker pips can be introduced to the CRT display. These pips are generated by the marker generator and introduced at the output of the input attenuator, where they are combined with the input signal and treated as other discrete frequency inputs. When the MARKERS switch is in the OFF position, the marker generator is disabled and no markers appear on the CRT screen. When the switch is in the 5 MHz position, markers appearing at 5-MHz intervals are generated. In the 500 kHz position, the marker generator produces markers spaced every 500 kHz and adds to these the markers spaced at 5 MHz. Similarly in the 25 kHz position, all markers are generated and added so that the 5 MHz markers are largest, the 500 kHz markers are the next largest, and the 25 kHz markers are the smallest. The amplitude of all markers is adjustable by the MARKERS AMPLITUDE control.

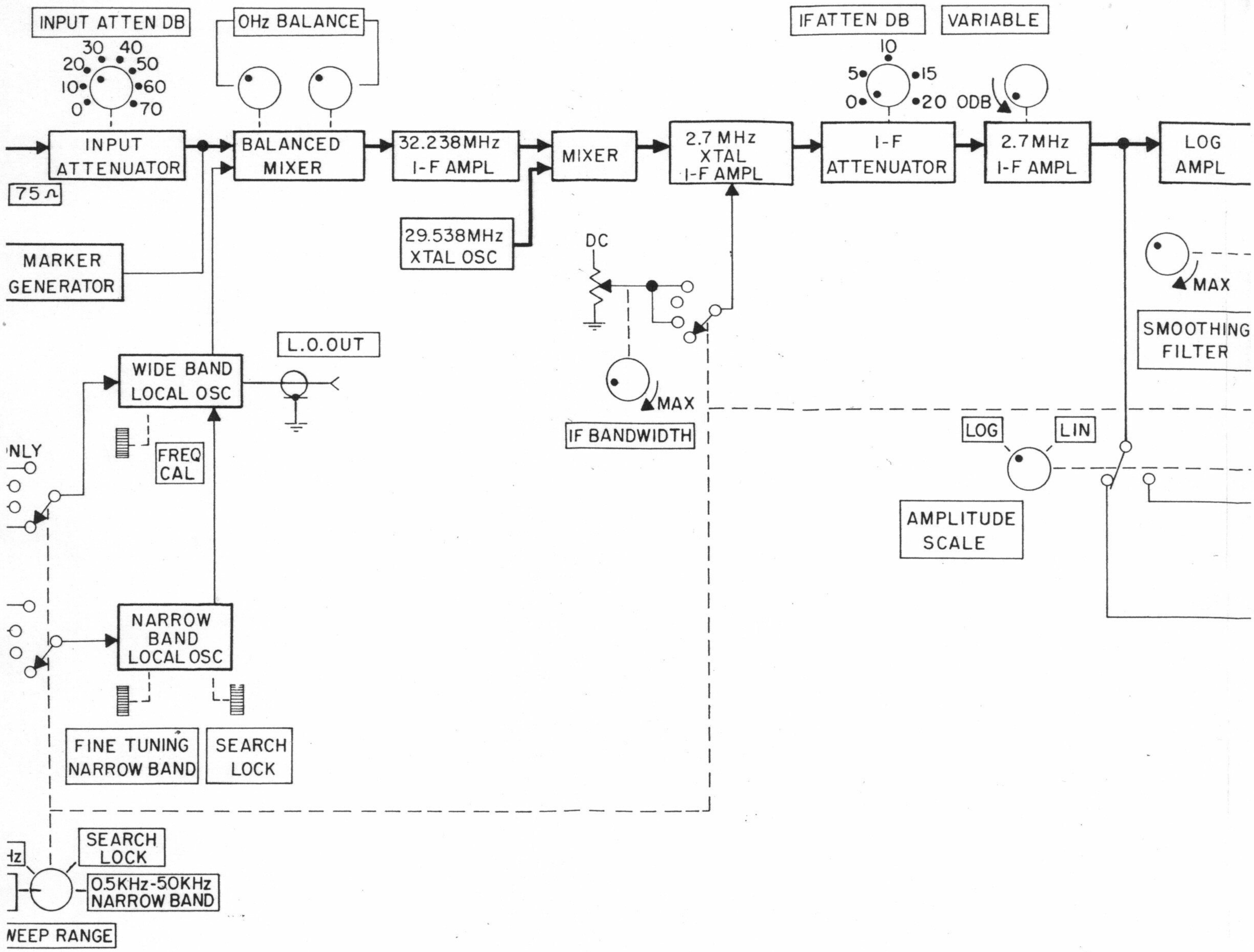
3-8. DETAILED THEORY OF OPERATION.

3-9. GENERAL. The detailed theory of operation is subdivided into nine parts, in which the individual assemblies are described This description is based on the detailed block diagram, figure 3-2, and the individual schematic diagrams, figures 5-1 through 5-7.

3-10. INPUT ATTENUATOR ASSEMBLY A9 (See figure 5-1.) The input signal is applied from INPUT connector J6 to input attenuator assembly A9. The input attenuator consists of three pi-connected resistive attenuators (A9R1 through R3, A9R4 through R6, and A9R7 through R9) that can be inserted or bypassed, depending on the position of INPUT ATTEN DB switch A9S1. The three attenuators can insert 10, 20, and 40 dB attenuation, respectively, so that when all three are inserted in cascade, a total attenuation of 70 dB is introduced in the input circuit.

3-11. FIRST MIXER ASSEMBLY A8 (See figure 5-2.) The output from the attenuator is combined with the output of the marker circuits (paragraph 3-23) and applied to the base of phase splitter Q1. The phase splitter provides two out-of-phase signals of different amplitudes. The amplified signal is applied to one side of balanced mixer Q3/Q4. The other output of the phase splitter, which is not amplified, is applied to the emitter of grounded-base amplifier Q2. DISTORTION ADJ screwdriver control R5 adjusts the dc bias on the amplifier for minimum distortion. LEVEL BALANCING ADJ screwdriver control R11 adjusts the gain of amplifier Q2 so that the amplified output from Q2 is equal to the amplified output from phase splitter Q1.


INPUT ATTEN DB
30 40
20 50
10 60
0 70
0Hz BALANCE
INPUT
0-25 MHz
INPUT ATTENUATOR
BALANCED MIXER
32.238MHz I-F AMPL
50Ω
75Ω
MARKERS
5MHz
500KHz
OFF
25KHz
MAX
AMPLITUDE
MARKER GENERATOR
29.538MHz XTAL OSC
L.O. OUT
WIDE BAND LOCAL OSC
FREQ CAL
SWEEP MODE
AUTO SCAN
MANUAL
VAR
DC ONLY
SAWTOOTH + DC
SAWTOOTH ONLY
SAWTOOTH + DC
UP
SAWTOOTH GENERATOR
DC ONLY
SWEEP WIDTH
0.0 MHz
NARROW BAND LOCAL OSC
CENTER FREQUENCY
00.1
FINE TUNING NARROW BAND
SEARCH LOCK
50KHz-5MHz
SEARCH LOCK
0-25MHz PRESET
0.5KHz-50KHz NARROW BAND
SWEEP RANGE
SAWTOOTH ONLY
SYNC PULSE


INPUT ATTEN DB
0
10
20
30
40
50
60
70
0Hz BALANCE
IF ATTEN DB
VARIABLE
0
5
10
15
20
ODB
INPUT ATTENUATOR
75 Ω
BALANCED MIXER
32.238MHz I-F AMPL
MIXER
2.7 MHz XTAL I-F AMPL
I-F ATTENUATOR
2.7MHz I-F AMPL
LOG AMPL
29.538MHz XTAL OSC
MARKER GENERATOR
DC
MAX
SMOOTHING FILTER
L.O.OUT
WIDE BAND LOCAL OSC
MAX
IF BANDWIDTH
LOG
LIN
NLY
FREQ CAL
AMPLITUDE SCALE
NARROW BAND LOCAL OSC
FINE TUNING NARROW BAND
SEARCH LOCK
SEARCH LOCK
Hz
0.5KHz-50KHz NARROW BAND
WEEP RANGE

: PULSE

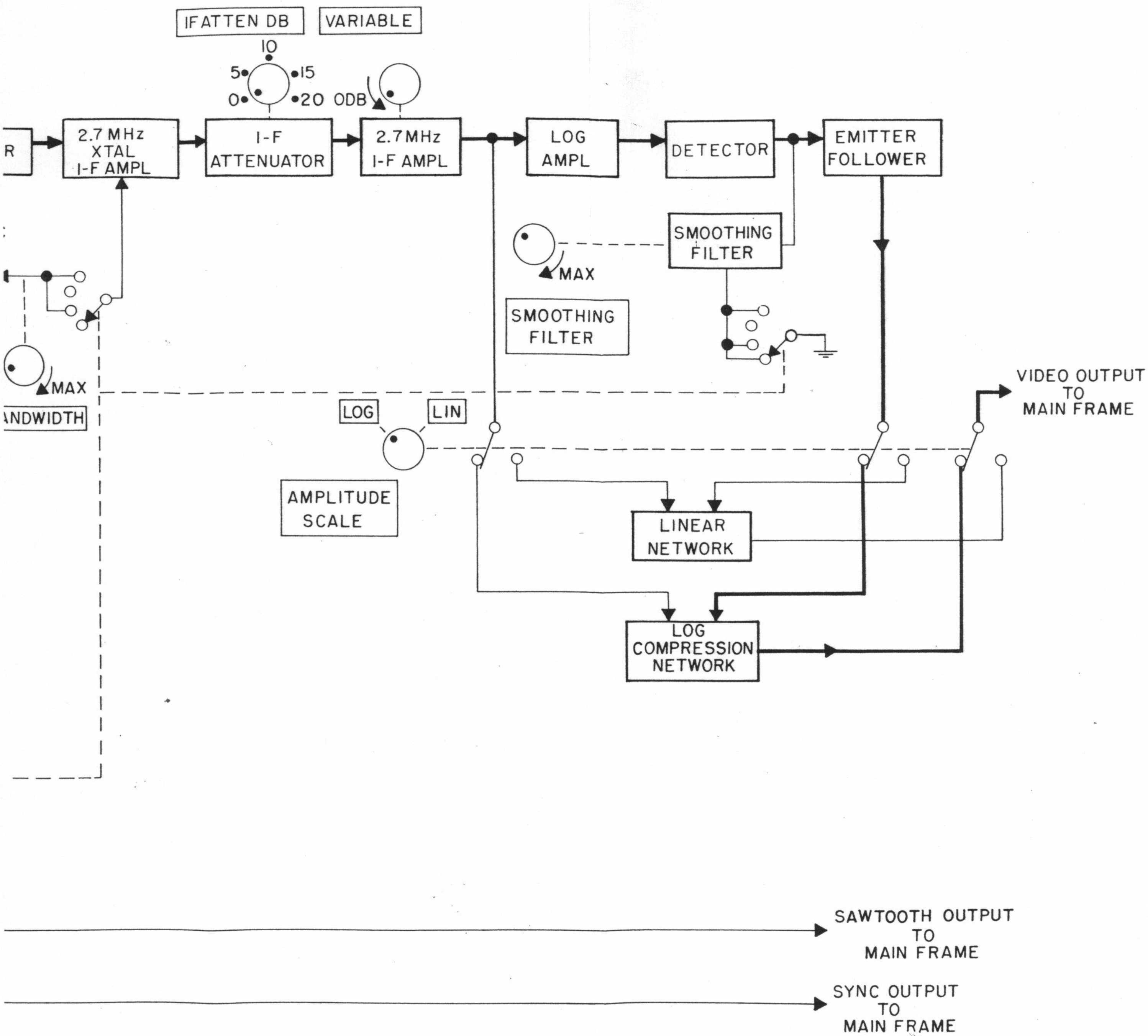
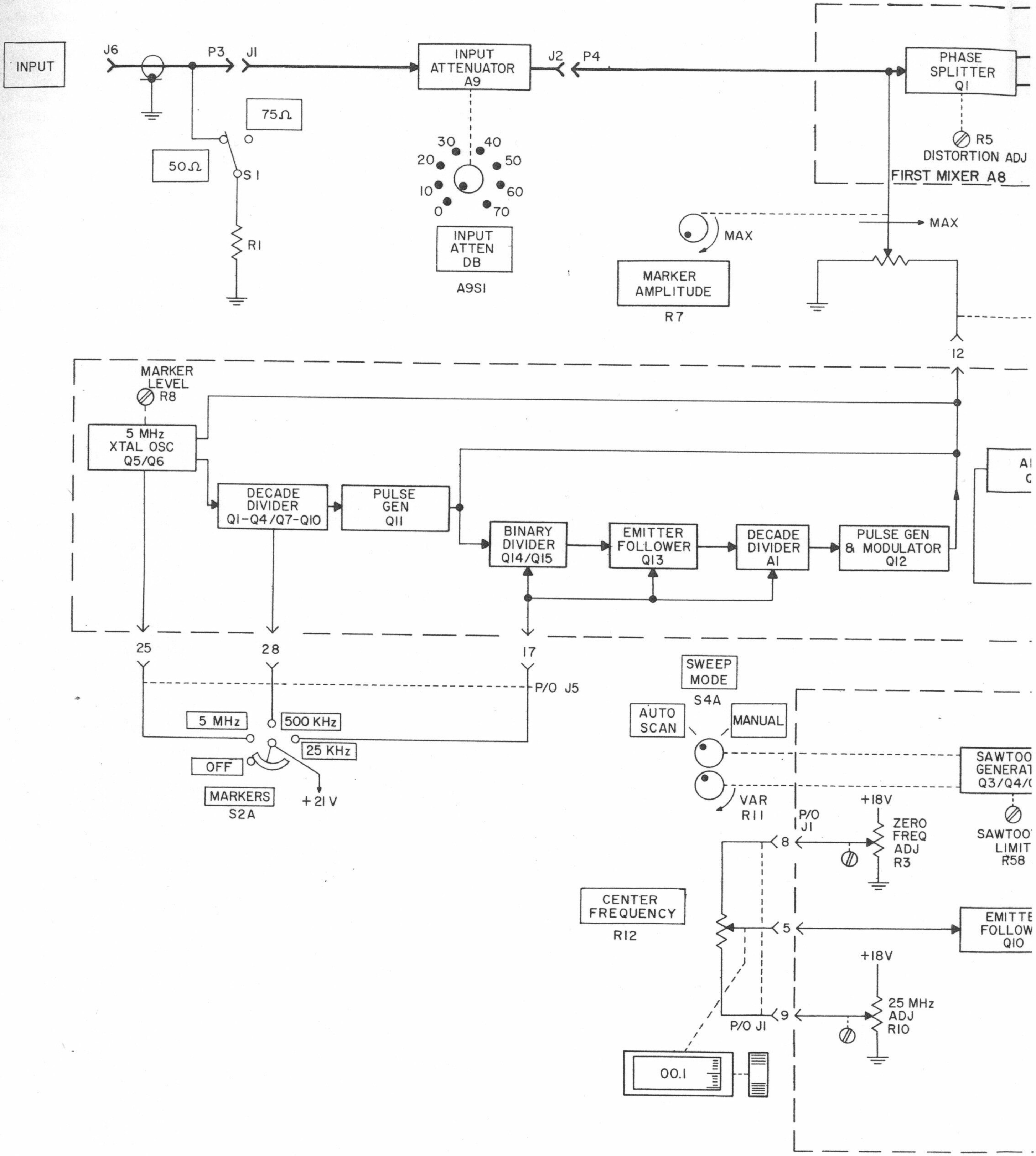
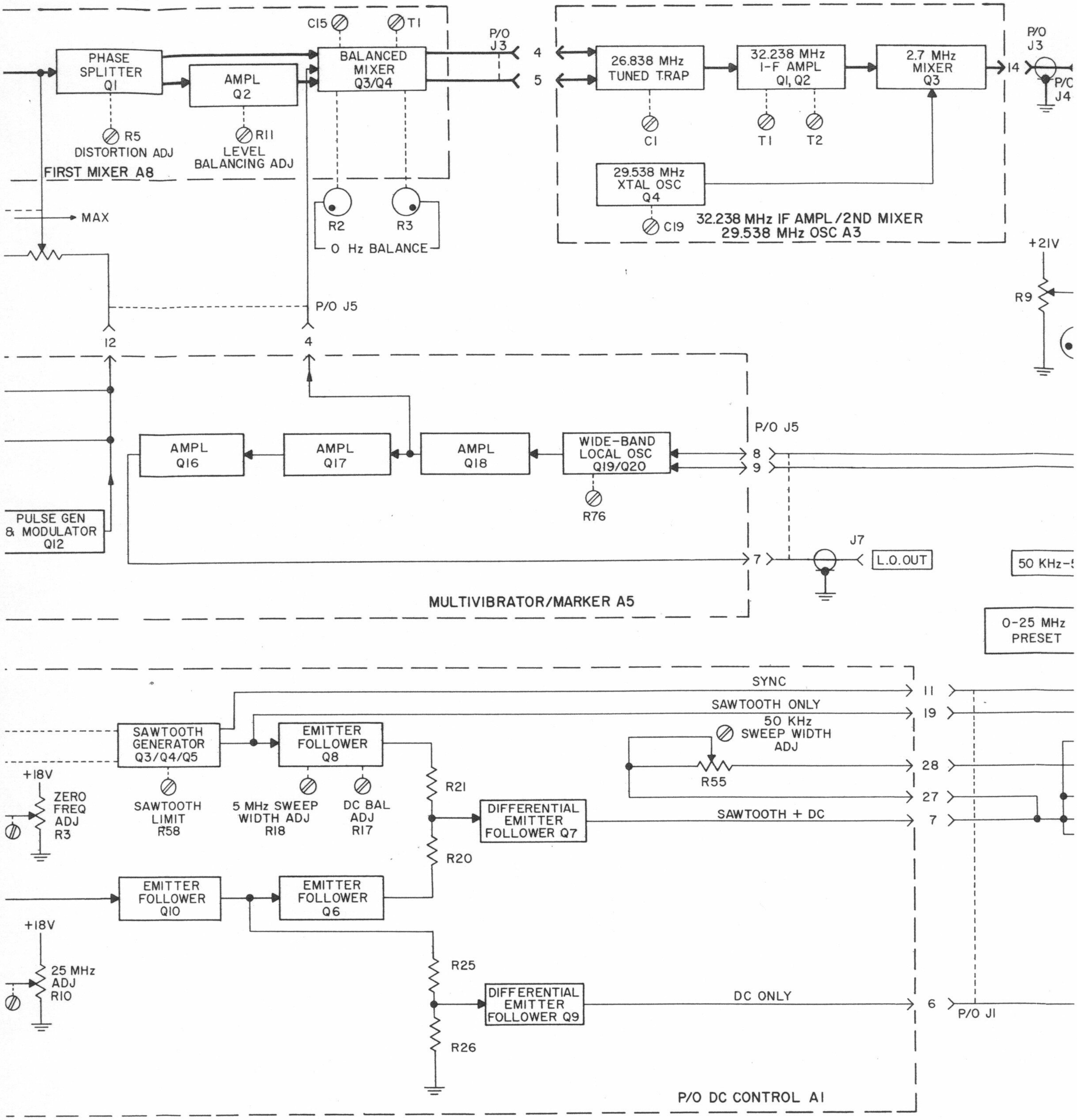


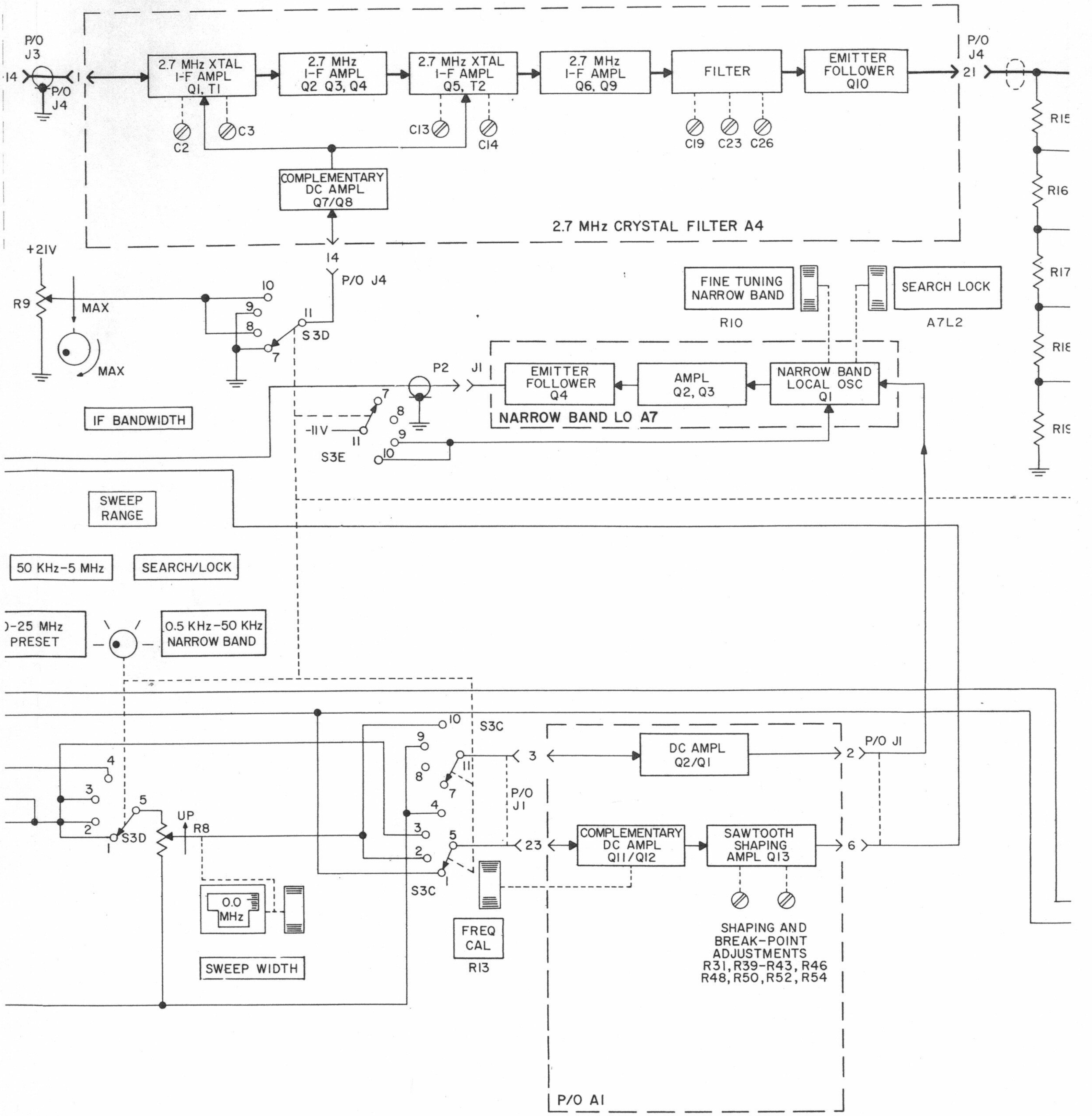
Figure 3-1. Model VR-4b Video Module, Simplified Block Diagram



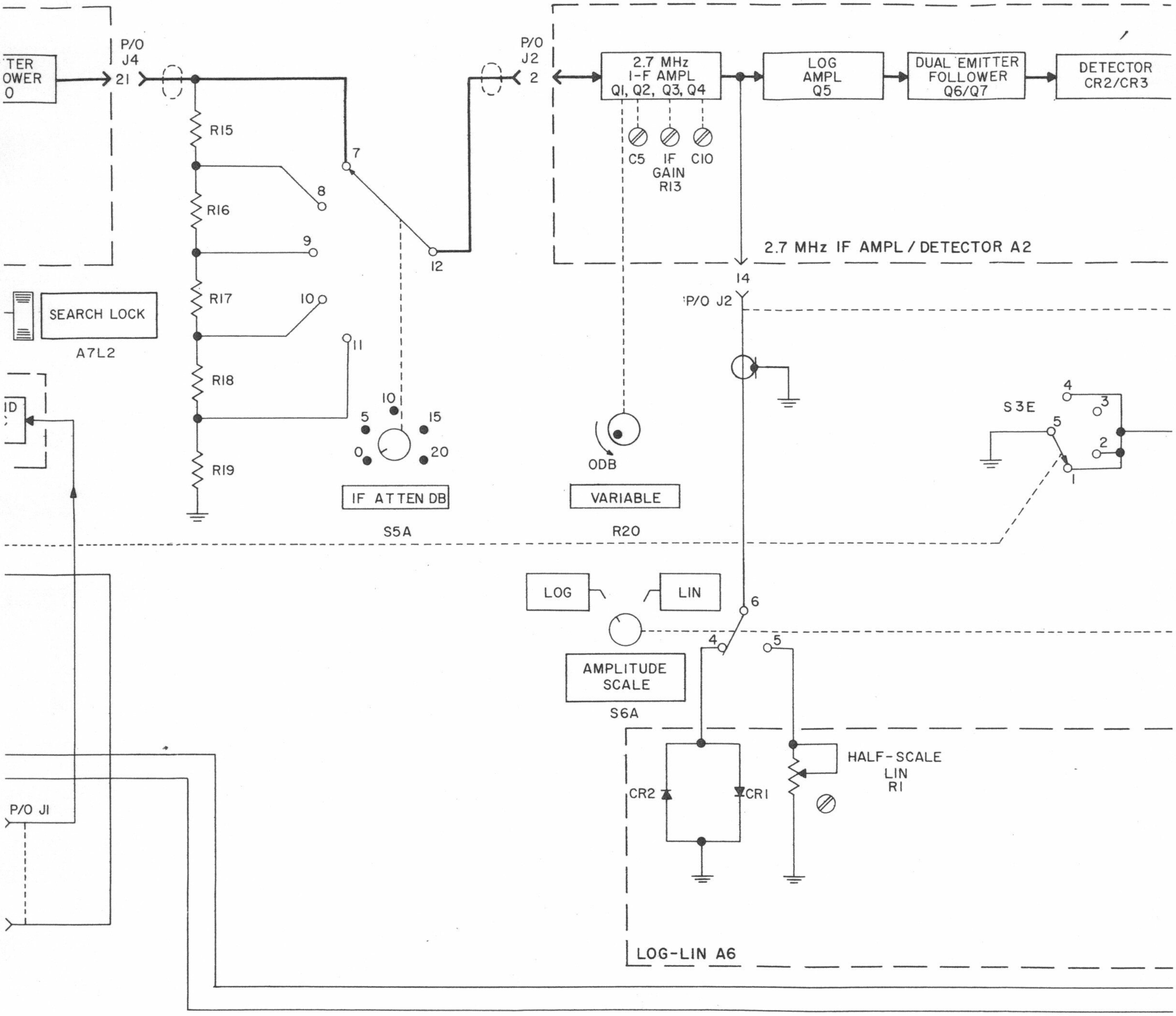
INPUT
J6
P3
J1
75Ω
50Ω
S1
R1
INPUT
ATTENUATOR
A9
J2
P4
30
40
20
50
10
60
0
70
INPUT
ATTEN
DB
A9S1
PHASE
SPLITTER
Q1
R5
DISTORTION ADJ
FIRST MIXER A8
MAX
MAX
MARKER
AMPLITUDE
R7
12
MARKER
LEVEL
R8
5 MHz
XTAL OSC
Q5/Q6
DECADE
DIVIDER
Q1-Q4/Q7-Q10
PULSE
GEN
Q11
BINARY
DIVIDER
Q14/Q15
EMITTER
FOLLOWER
Q13
DECADE
DIVIDER
A1
PULSE GEN
& MODULATOR
Q12
25
28
17
P/O J5
5 MHz
500 KHz
25 KHz
OFF
MARKERS
S2A
+21 V
SWEEP
MODE
S4A
AUTO
SCAN
MANUAL
VAR
R11
+18V
P/O
J1
8
ZERO
FREQ
ADJ
R3
SAWTOO
GENERAT
Q3/Q4/
SAWTOO
LIMIT
R58
CENTER
FREQUENCY
R12
5
EMITTE
FOLLOW
Q10
+18V
9
25 MHz
ADJ
R10
P/O J1
00.1



PHASE SPLITTER Q1
AMPL Q2
BALANCED MIXER Q3/Q4
C15
T1
P/O J3
R5 DISTORTION ADJ
R11 LEVEL BALANCING ADJ
FIRST MIXER A8
MAX
R2
R3
0 Hz BALANCE
P/O J5
26.838 MHz TUNED TRAP
32.238 MHz I-F AMPL Q1, Q2
2.7 MHz MIXER Q3
C1
T1
T2
29.538 MHz XTAL OSC Q4
C19
32.238 MHz IF AMPL/2ND MIXER 29.538 MHz OSC A3
+21V
R9
AMPL Q16
AMPL Q17
AMPL Q18
WIDE-BAND LOCAL OSC Q19/Q20
R76
PULSE GEN & MODULATOR Q12
J7
L.O. OUT
MULTIVIBRATOR/MARKER A5
0-25 MHz PRESET
SYNC
SAWTOOTH ONLY
SAWTOOTH GENERATOR Q3/Q4/Q5
EMITTER FOLLOWER Q8
50 KHz SWEEP WIDTH ADJ
R55
+18V
ZERO FREQ ADJ R3
SAWTOOTH LIMIT R58
5 MHz SWEEP WIDTH ADJ R18
DC BAL ADJ R17
R21
R20
DIFFERENTIAL EMITTER FOLLOWER Q7
SAWTOOTH + DC
EMITTER FOLLOWER Q10
EMITTER FOLLOWER Q6
+18V
25 MHz ADJ R10
R25
R26
DIFFERENTIAL EMITTER FOLLOWER Q9
DC ONLY
P/O J1
P/O DC CONTROL A1



P/O J3
P/O J4
2.7 MHz XTAL I-F AMPL Q1, T1
2.7 MHz I-F AMPL Q2 Q3, Q4
2.7 MHz XTAL I-F AMPL Q5, T2
2.7 MHz I-F AMPL Q6, Q9
FILTER
EMITTER FOLLOWER Q10
C2
C3
C13
C14
C19
C23
C26
COMPLEMENTARY DC AMPL Q7/Q8
2.7 MHz CRYSTAL FILTER A4
R15
R16
R17
R18
R19
+21V
R9
MAX
S3D
IF BANDWIDTH
FINE TUNING NARROW BAND
R10
SEARCH LOCK
A7L2
P2
J1
EMITTER FOLLOWER Q4
AMPL Q2, Q3
NARROW BAND LOCAL OSC Q1
NARROW BAND LO A7
-11V
S3E
SWEEP RANGE
50 KHz-5 MHz
SEARCH/LOCK
0.5 KHz-50 KHz NARROW BAND
PRESET
S3C
UP
R8
P/O J1
DC AMPL Q2/Q1
COMPLEMENTARY DC AMPL Q11/Q12
SAWTOOTH SHAPING AMPL Q13
0.0 MHz
SWEEP WIDTH
FREQ CAL
R13
SHAPING AND BREAK-POINT ADJUSTMENTS R31, R39-R43, R46 R48, R50, R52, R54
P/O A1



TER
OWER
O
P/O
J4
21
R15
R16
R17
R18
R19
7
8
9
10
11
12
P/O
J2
2
2.7 MHz
I-F AMPL
Q1, Q2, Q3, Q4
LOG
AMPL
Q5
DUAL EMITTER
FOLLOWER
Q6/Q7
DETECTOR
CR2/CR3
C5
IF
GAIN
R13
C10
2.7 MHz IF AMPL / DETECTOR A2
14
P/O J2
SEARCH LOCK
A7L2
10
5
15
0
20
IF ATTEN DB
S5A
0DB
VARIABLE
R20
S3E
4
3
5
2
1
LOG
LIN
6
4
5
AMPLITUDE
SCALE
S6A
CR2
CR1
HALF-SCALE
LIN
R1
LOG-LIN A6
P/O J1

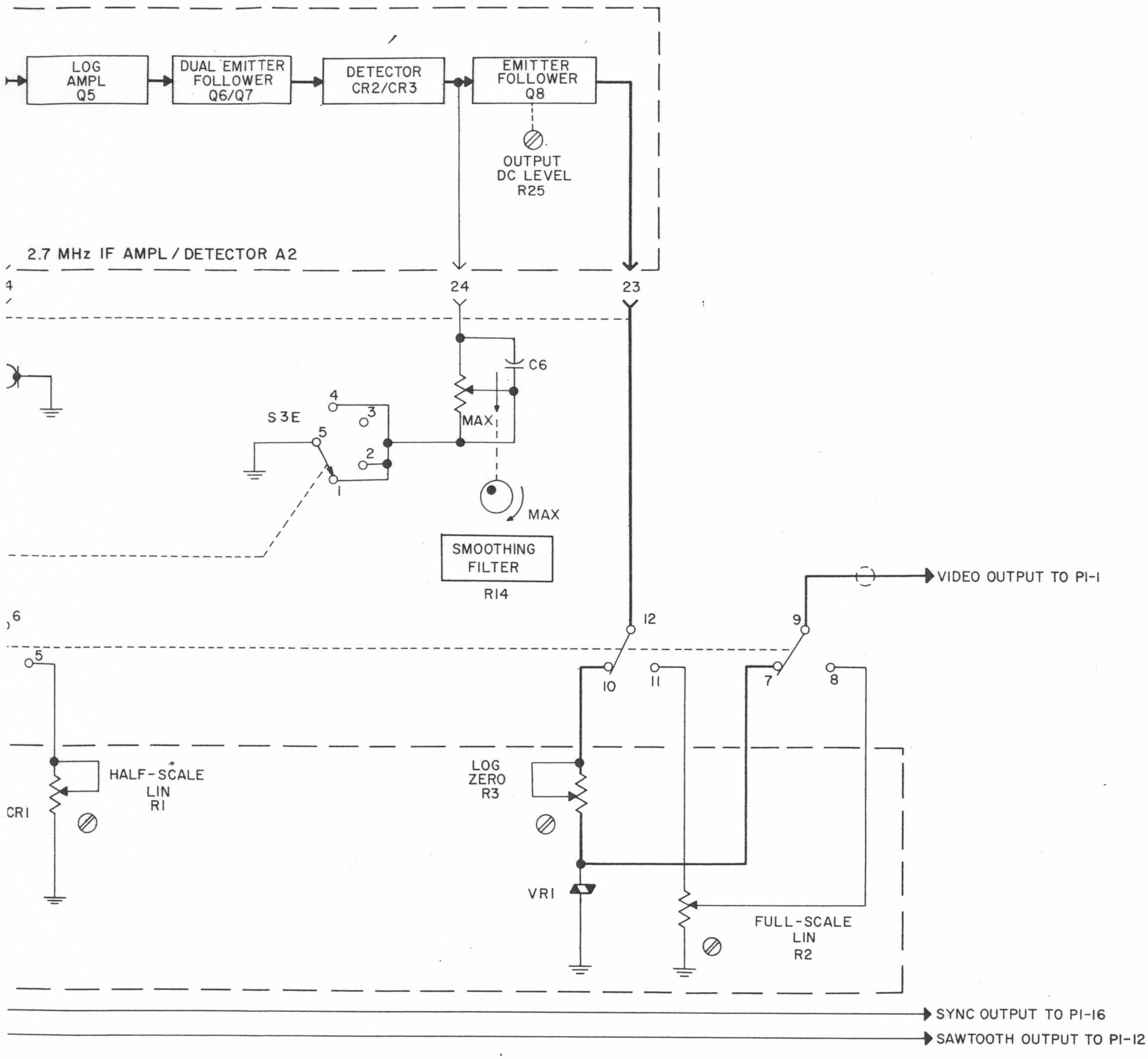


Figure 3-2. Model VR-4b Video Module, Detailed Block Diagram

This amplified output is applied to the other side of balanced mixer Q3/Q4. The inputs to Q3/Q4 are balanced with respect to ground by 0 Hz BALANCE control R2. The local oscillator output is applied to both emitters of the balanced mixer and the voltages at the collectors are developed across the output transformer and across 0 Hz BALANCE control R3. A voltage obtained from R3 is fed back to the input of Q3 and Q4 so that it adds to (is in phase with) the voltage at one base and is simultaneously out-of-phase with the voltage at the other base; this compensates for any imbalance in the circuit. C15 and T1 are adjustable and are tuned to the first i-f frequency, 32.328 MHz.

3-12. 32.328 MHz I-F AMPL/2ND MIXER/29.538 MHz OSC ASSEMBLY A3 (See figure 5-3.) The output of the balanced mixer is applied across a series tuned circuit, the 26.838 MHz tuned trap (L1 and C1). This circuit is tuned by screwdriver adjustment C1 to eliminate the 26.838 MHz components that are generated in the balanced mixer as the local oscillator is swept through its range. The 26.838 MHz components represent the image frequency, which would beat in the second mixer with the output of the 29.538 MHz crystal oscillator to provide an erroneous 2.7 MHz i-f signal. If this frequency were not eliminated in the tuned trap, a discrete frequency input would appear as two pips of different amplitudes spaced 5.4 MHz apart; the lower amplitude pip would be produced first and would result from the 26.838 MHz component which would feed through the 32.238 MHz i-f amplifier Q1, Q2 to produce the lower amplitude output; the second pulse would be the desired pulse resulting from a 32.328-MHz output of the balanced mixer. The 32.328 MHz i-f amplifier is a two-stage amplifier with tunable transformer coupling. Crystal oscillator Q4 is tuned by crystal Y1 and adjustable capacitor C19. The output of the second mixer is tuned to 2.7 MHz by capacitor C15.

3-13. 2.7 MHz CRYSTAL FILTER ASSEMBLY A4 (See figure 5-4.) The output of the 2.7 MHz mixer A3Q3 is applied to the 2.7 MHz crystal i-f amplifier A4Q1, T1. This stage is an emitter follower whose output is coupled through 2.7-MHz crystal Y1, which is utilized in its series-resonant mode. The crystal passes the 2.7 MHz signal through the equivalent series resonant circuit, and also passes signals through the capacitance of its holders. An out-of-phase signal is taken from the collector of Q1 to cancel the signal that is applied through the crystal holders; this balancing signal is adjusted by capacitor C2. The primary winding of transformer T1 is tuned to 2.7 MHz by capacitor C3. One of the secondary windings of transformer T1 is controlled by the I-F BANDWIDTH input. In the 0 - 25 MHz PRESET and SEARCH/LOCK positions of the SWEEP RANGE switch, ground is applied through one section of S3D (figure 5-1) to the complementary dc amplifier Q7/Q8 and has no effect on the dc amplifier. In the other positions of the SWEEP RANGE switch, an adjustable positive dc voltage is applied to the complementary dc amplifier which applies the positive voltage to the secondary windings of transformers T1 and T2. As the voltage from the I-F BANDWIDTH control becomes more positive (the control set for minimum bandwidth), Q8 passes more current through the diodes shunting the controlled transformer windings. This results in greater loading on the two transformers, decreasing the "Q" of the transformers, and decreasing the bandwidth of the circuits. Adjustments C13 and C14 perform the same functions for 2.7 MHz crystal i-f amplifier Q5, T2 as C2 and C3 perform for 2.7 MHz crystal i-f amplifier Q1, T1. The i-f signal from transformer T2 is applied through 2.7 MHz i-f amplifier Q6 and Q9 to a bandpass filter that is tuned to 2.7 MHz by screwdriver adjustments C19, C23, and C26. This filter removes any spurious frequencies passed by crystals Y1 and Y2. The output is connected through emitter follower Q10 to the i-f attenuator.

3-14. I-F ATTENUATOR. The i-f attenuator, which is shown in figure 5-1, consists of a resistive voltage divider (R15 through R19) from which the output is selected by I-F ATTEN DB switch S5A. When the switch is in the 0 position, the full output of emitter follower A4Q10 is applied through the switch to the 2.7 MHz i-f amplifier in assembly A2.

3-15. 2.7 MHz I-F AMPL/DETECTOR ASSEMBLY A2 AND LOG - LIN ASSEMBLY A6 (See figure 5-5 for assembly A2 and figure 5-2 for the log-lin assembly A6). The 2.7 MHz i-f amplifier in assembly A2 consists of emitter follower Q1, tuned amplifiers Q2 and Q3, and untuned amplifier Q4. The gain of amplifier Q2 is adjusted by I-F ATTEN DB VARIABLE control R20, which is part of the degenerative emitter load resistance. The tuned circuit of Q2 is adjusted by capacitor C5; the tuned circuit of Q3 is adjusted by capacitor C10. The gain of amplifier Q3 is adjusted by the I-F GAIN screwdriver control R13, which adjusts the degenerative emitter load resistance for that stage.

3-16. The output of Q4 is applied through the AMPLITUDE SCALE switch S6A (figure 5-1) to log-lin assembly A6. When the switch is in the LIN position, the output of A2Q4 is developed across HALF-SCALE LIN screwdriver control A6R1. When the switch is in the LOG position, the i-f signal is developed across diodes CR1 and CR2; since the diode's current increases exponentially with voltage, the voltage across the diodes is a logarithmic function of the input voltage to A2Q4. The voltage developed in either position of the AMPLITUDE SCALE switch is applied to log amplifier Q5, whose output is applied to dual emitter follower Q6/Q7. The output of the dual emitter follower is coupled through transformer T3 to full-wave detector CR2/CR3. In all positions of the SWEEP RANGE switch except the SEARCH/LOCK position, the output of the detector is developed across the smoothing filter consisting of SMOOTHING FILTER control R14 (figure 5-1). Adjusting R14 changes the loading effect of capacitor C23 and therefore affects the frequency response of the detector circuit. The output of the detector is combined with a dc voltage determined by the setting of OUTPUT DC LEVEL screwdriver control R25 and applied to emitter follower Q8. The output of the emitter follower is applied through the AMPLITUDE SCALE switch to log-lin assembly A6 and from A6 through the switch to the vertical deflection circuits in the main frame. The output level is adjusted in log-lin assembly A6 by LOG ZERO screwdriver control R3 (for the LOG position) or FULL-SCALE LIN screwdriver control R2 (for the LIN position).

3-17. DC CONTROL ASSEMBLY A1 (See figure 3-3 and 5-6.) The sawtooth generator (figure 3-3) consists of a unijunction transistor A1Q3 and charging capacitor A1C4. The voltage at which the unijunction transistor breaks down is determined by the adjustment of SAWTOOTH LIMIT screwdriver control A1R58. When the capacitor is charged to this voltage, the unijunction transistor breaks down and discharges the capacitor, completing one sawtooth cycle. In the 0 - 25 MHz PRESET position of SWEEP RANGE switch S3, capacitor A1C4 charges through Sweep Rate (VAR) control R1, A6R4 and SWEEP RATE screwdriver control R5, A1R14, and sawtooth linearity amplifier A1Q5 If it were not for the effects of the sawtooth linearity amplifier, capacitor A1C4 would charge nonlinearly; that is the charge rate would decrease as the capacitor charges up. The voltage across the capacitor is applied to emitter follower A1Q4. As capacitor A1C4 charges up, emitter follower A1Q4 conducts more heavily and the impedance of sawtooth linearity amplifier A1Q5 decreases. The decreased impedance of A1Q5 tends to increase the charging current above a constant value as A1C4 charges up. (A constant charging current is required for a linear sawtooth to be generated.) Zener diode A1CR6 maintains the collector voltage of A1Q5 at a fixed voltage above the output of emitter follower A1Q4; this difference voltage is also the voltage developed across the charging resistors, and by maintaining this voltage constant, zener diode A1CR6 assures a linear sawtooth. When the SWEEP RANGE switch is set to the 50 KHz - 5 MHz position, A1C4 charges through the SWEEP MODE switch (in AUTO SCAN) and a portion of Sweep Rate (VAR) control R1. Adjusting this control adjusts the charge rate for A1C4 and therefore the sweep rate. When the SWEEP MODE switch is set to MANUAL, the Sweep Rate (VAR) control is connected between 18 volts and ground, and a dc voltage derived from the control is applied to the emitter follower. Capacitor C4 prevents A1C4 from reaching the voltage needed to break down the unijunction transistor, and the sawtooth generator is disabled. When the SWEEP RANGE switch is set to SEARCH/LOCK, A1C4 charges directly through A1R14 and A1Q5, providing a sweep speed equivalent to the fastest speed obtainable in the 50 kHz - 5 MHz position. The circuit functions identically in the 0. 5 kHz - 50 kHz NARROW BAND position and in the 50 kHz - MHz position of the SWEEP RANGE switch.

3-18. The sawtooth output from the sawtooth generator is applied to emitter follower Q8, and to the horizontal deflection circuits in the main frame. The sawtooth voltage applied to the horizontal deflection circuits provides the horizontal sweep on the CRT, while the sawtooth applied to emitter follower Q8 is used to sweep one or the other of the swept local oscillators (except in the 0 - 25 MHz PRESET position of the SWEEP RANGE switch, when the full sawtooth that is applied to the horizontal deflection circuits is used to sweep the wide-band local oscillator). The amplitude of the sawtooth that is applied to emitter follower Q8 is adjusted by the 5 MHz SWEEP WIDTH ADJ screwdriver control R18, and the dc component of the sawtooth applied to emitter follower Q8 is adjusted by DC BAL ADJ screwdriver control R17. Screwdriver control R18, by adjusting the sawtooth amplitude applied to emitter follower Q8, limits the maximum drive that can be applied from the SWEEP WIDTH control to the wide-band local oscillator and therefore sets the maximum sweep width at 5 MHz. Screwdriver control R17 introduces a negative dc voltage to the emitter follower so that the average dc voltage of the sawtooth at Q8 is zero; the dc voltage is important since it determines the center frequency of the swept local oscillators. The desired dc voltage is obtained from CENTER FREQUENCY control R12. The dc voltage across R12 is adjusted by 0 FREQ ADJ screwdriver control R3 and 25 MHz ADJ screwdriver control R7. Screwdriver control R3 determines the voltage that will be obtained from CENTER FREQUENCY control R12 when it is set for 0 center frequency; screwdriver control R7 determines the voltage that will be obtained from CENTER FREQUENCY control R12 when it is set for a center frequency of 25 MHz. The dc voltage from the CENTER FREQUENCY control is applied through emitter follower Q10 and emitter follower Q6. The output of emitter follower Q6 and the sawtooth output from emitter follower Q8 are combined in an averaging circuit consisting of R21 and R20. The output from the averaging circuit, which is equal to half of the sawtooth output of Q8 plus half of the dc output from Q6, is applied to emitter follower Q7. The dc output from emitter follower Q10 is halved by voltage divider R25/R26 and applied to emitter follower Q9. The dc output of Q9 is therefore equal to the dc output of Q7.

3-19. The sawtooth, sawtooth-plus-dc, or dc input to the wide-band local oscillator is controlled by the SWEEP RANGE switch. In the 0 - 25 MHz PRESET position of the switch, the full sawtooth output of the sawtooth generator is applied through terminal 5 of S3C, the complementary dc amplifier Q11/Q12, and sawtooth shaping amplifier Q13 to the wide-band local oscillator. Because the wide-band local oscillator does not provide a linear sweep in frequency for a linear sawtooth input, the linear sawtooth that is applied through the complementary dc amplifier is reshaped to a curve that compensates for the nonlinear frequency-voltage characteristic of the wide-band local oscillator. Reshaping of the linear sawtooth sweep is accomplished by varying the load resistance (and consequently the gain) of Q13 in step with the applied linear sawtooth sweep. With no linear sawtooth sweep applied to Q13, diodes CR9 through CR13 are back-biased to cut-off by screwdriver controls R46, R48, R50, R52, and R54 and the load resistance of Q13 consists of R31 through R37. At a certain level of the applied linear sawtooth sweep, diode CR13 conducts, connecting R43 through R54 in series-parallel with R31 through R37, thereby reducing the load resistance of A1Q13. Similarly, at other points of the applied linear sawtooth sweep, diodes CR12, CR11, CR10, and then

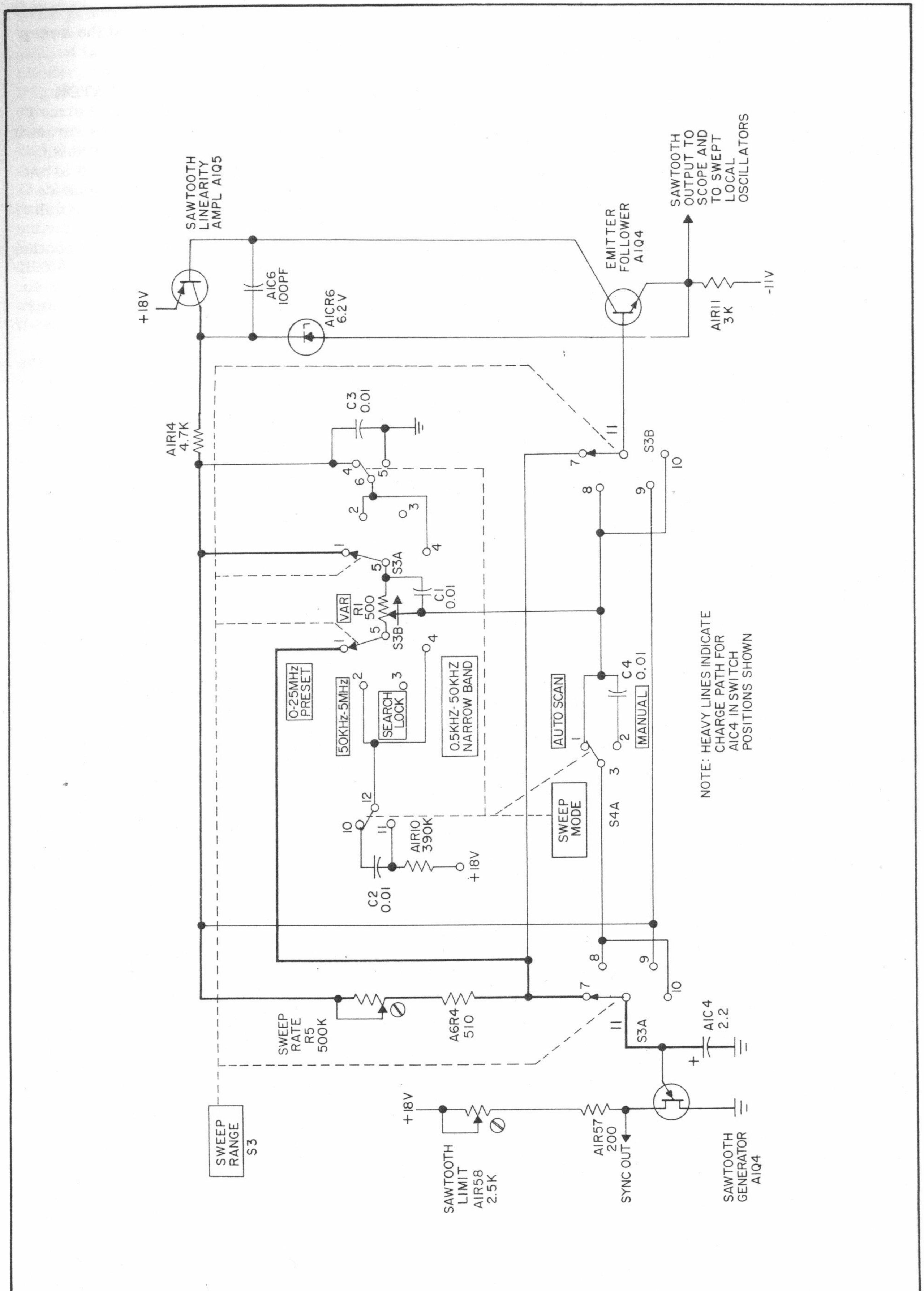


Figure 3-3. Sawtooth Generator, Simplified Block Diagram

CR9 conduct, further reducing the load resistance of Q13, producing a non-linear output (curved waveform) from the applied linear sawtooth waveform. Screwdriver controls R39 through R43 vary the slope of the non-linear output waveform. In the 50 kHz - 5 MHz position of the SWEEP RANGE switch, the sawtooth-plus-dc output of A1Q7 is applied to one side of SWEEP WIDTH control R8 while the dc output from A1Q9 is applied to the opposite side of the SWEEP WIDTH control. Adjusting R8 adjusts the amplitude of the sawtooth that is applied to the complementary dc amplifier; adjusting this control does not affect the dc component since the dc voltage is the same at all points along the control. FREQ CAL control R13 adjusts the dc input to the complementary dc amplifier to calibrate the CENTER FREQUENCY dial. When the SWEEP RANGE switch is set to SEARCH/LOCK, the full sawtooth-plus-dc output of emitter follower A1Q7 is applied to the complementary dc amplifier. This assures a 5-MHz wide sweep of the wide-band local oscillator so that the frequency of the narrow-band local oscillator can be found on the CRT screen. When the SWEEP RANGE switch is set to 0.5 kHz - 50 kHz NARROW BAND, the dc output of A1Q9 is applied to the complementary dc amplifier. As a result of the switching just described, the CENTER FREQUENCY control has no effect on the wide-band local oscillator in the PRESET position and the wide-band local oscillator is swept through its maximum range; in the 50 kHz - 5 MHz position, the wide-band local oscillator is swept about a center frequency determined by the dc component set by the CENTER FREQUENCY control and adjusted by the FREQ CAL control and is swept over a range determined by the SWEEP WIDTH control; in the SEARCH/LOCK position, the wide-band local oscillator is swept over a 5-MHz range, 2.5 MHz either side of the frequency determined by the CENTER FREQUENCY control; in the 0.5 kHz - 50 kHz NARROW BAND position, the wide-band local oscillator receives a dc input (no sawtooth) which controls the center frequency of the wide-band local oscillator to keep it near the frequency of the narrow-band local oscillator.

3-20. The input to the narrow-band oscillator is also controlled by the SWEEP RANGE switch. In the 0 - 25 MHz PRESET and 50 kHz - 5 MHz positions of the switch, operating voltage (-11 vdc) is not applied to the narrow-band local oscillator and the oscillator is disabled. In the SEARCH/LOCK position, the dc voltage from A1Q9 is applied from terminal 11 of S3C through dc amplifier Q1/Q2 to the narrow-band local oscillator. In this position, the CENTER FREQUENCY control determines the frequency of oscillation of the narrow-band local oscillator, and the local oscillator is not swept. In the 0.5 kHz - 50 kHz NARROW BAND position, a portion of the voltage across the SWEEP WIDTH control is applied through the dc amplifier to the narrow-band local oscillator. The voltage across the SWEEP WIDTH control is less than it is in the 50 kHz - 5 MHz position; the voltage is adjusted by the 50 kHz SWEEP WIDTH ADJ screwdriver control A1R55. Since the maximum sweep width voltage is less in this position, the voltage applied to the narrow-band local oscillator is less, and the sweep width is reduced.

3-21. NARROW-BAND LOCAL OSCILLATOR ASSEMBLY A7 (see figure 5-2). The tuned circuit of narrow-band local oscillator Q1 contains varactor CR1, whose capacitance is a function of the instantaneous voltage applied. The voltage applied to one side of the varactor is the dc or sawtooth-plus-dc selected by the SWEEP RANGE switch; the dc voltage applied to the other side of the varactor is derived from FINE TUNING NARROW BAND control R10. In addition, the tuned circuit contains SEARCH/LOCK control L2 which adjusts the tuned circuit so that its center frequency corresponds to the center frequency of the wide-band local oscillator. The output of the local oscillator is applied through amplifiers Q2 and Q3 and emitter follower Q4 to the wide-band local oscillator.

3-22. MULTIVIBRATOR/MARKER ASSEMBLY A5 (see figure 5-7). The wide-band local oscillator (Q19 and Q20) is a free-running multivibrator whose natural frequency of oscillation is affected by the capacitance of varactor A5CR15. The instantaneous voltage across the capacitor is affected by the sawtooth, sawtooth-plus-dc, or dc voltage selected by the SWEEP RANGE switch (which is applied to one side of the varactor) and a fixed dc voltage adjusted by screwdriver control R76 (which is applied to the other side of the varactor). In the SEARCH/LOCK position of the SWEEP RANGE switch, the fixed frequency output of the narrow-band local oscillator is applied to the wide-band local oscillator as a synchronizing input. The wide-band local oscillator is swept by the sawtooth input and, as it approaches the same frequency as the narrow-band local oscillator, is momentarily locked in to the narrow-band frequency. As the sawtooth input increases, a point is reached beyond which synchronization is lost. The wide-band local oscillator then continues to free-run for the remainder of the sweep. The output of the wide-band local oscillator is applied through amplifier Q18 to the balanced mixer and to two-stage amplifier Q17, Q16. The local oscillator signal is applied from the two-stage amplifier to L.O. OUT jack J7 for application to the Model G-6 Companion Sweep Generator.

3-23. The generation of markers is controlled by MARKERS switch S2A. When the switch is in the OFF position, operating voltage is removed from the 5 MHz crystal oscillator, and no markers are generated. In the 5 MHz position of the switch, operating voltage is applied to the oscillator but not to any of the dividers and markers only at 5 MHz and at harmonic-frequency points (10, 15, 20, and 25 MHz) are generated. The amplitude of the 5 MHz markers is adjusted by MARKER LEVEL screwdriver control R8. When the switch is in the 500 kHz position, operating voltage is applied to the crystal oscillator and to decade divider Q1-Q4/Q7-Q10. The 5-MHz output of the crystal oscillator is applied to the decade divider which consists of four flip-flops with appropriate feedback to reduce the recycling count from a normal 16 to 10. The 500-kHz output of the decade divider is applied through pulse generator Q11 to the output. When the switch is in the 25 kHz position, operating voltage is applied to the crystal oscillator and the decade divider, and to binary divider Q14/Q15, emitter follower Q13, and decade divider A5A1. The 500-kHz output of pulse generator Q11 is applied to binary divider Q14/Q15 which reduces the frequency to 250 kHz. This frequency is coupled through emitter follower Q13 to decade divider A1. The 25-kHz output of the decade divider is applied through pulse generator and modulator Q12 to the output, where it is combined with the 500-kHz output of pulse generator Q11 and the 5-MHz output of the crystal oscillator. The output is developed across MARKERS AMPLITUDE control R7 and an adjusted portion of the marker amplitudes is applied from the control to first mixer assembly A8.

3-24. POWER DISTRIBUTION. Dc power for the operation of video module VR 4b is applied from the main frame when the module is inserted. The -11 vdc and +21 vdc are applied from the main frame; several additional voltages are generated internally in dc control assembly A1 (figure 5-6). Zener diode CR7, dropping resistor R12, and filter capacitor C7 form a power supply that provides -9 vdc derived from the -11 vdc input. The zener-controlled voltage is applied to emitter followers A1Q8, Q7, and Q9. Zener diodes CR4 and CR5, dropping resistor R5, and filter capacitor C3 provide a +18.2 vdc output (derived from the +21 vdc input) that is used in the sawtooth generator. In addition this voltage is used for the Sweep Rate (VAR) control in MANUAL. Zener diodes CR2 and CR3, dropping resistor R4, and filter capacitor C2 also derive a +18.2 vdc output from the +21 vdc input; this voltage is used to set the voltage across the CENTER FREQUENCY control and as operating voltage for the narrow-band dc amplifier A1Q1/Q2, emitter followers A1Q6 through Q10, the complementary dc amplifier A1Q11/Q12, sawtooth shaping amplifier A1Q13, and wide-band local oscillator A5Q19/Q20. Zener diode CR1, dropping resistor R2, and filter capacitor C1 provide a +5.1 vdc output from the +21-volt input. This voltage, which is applied back to the main frame via P1-6, has been included for future applications.

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I scanned it in the hope that you can use it to fix your Alfred/Panoramic/Singer/Slant-Fin spectrum analyzer's VR-4B module. I paid for an origninal manual in order to do this, since I have two Singer MF-5 mainframes and VR-4B plugins. They are pretty beat up as shown below. The whole manual is in monochrome, except these two pictures to help spot the equipment, should you find one at a hamfest.

About the schematics, they are on some really long paper. I broke them into 8.5x11 overlapping sections. The idea is for you to print them and cut and tape them together. (the best I could do.)

Singer Instrumentation is out of business. No one with true rights to the manual supports this instrument any more. I hope they don't mind that we are using it.

Best Regards,
Patrick J. Jankowiak
KD5OEI

Notice one of the units has a VR-4 and one has a VR-4b. Don't ask, I do not know..

SECTION IV
MAINTENANCE

4-1. GENERAL.

4-2. This section provides information for testing, troubleshooting, repairing, and aligning the VR-4b module. Procedures are given for visual inspection of the module, for minimum performance tests (to determine whether or not the module is operating within its specifications), for aligning the module, and for locating defective components in the module. Voltage measurements are also included.

4-3. All of the procedures given in this section should be performed with the VR-4b module removed from the main frame, but connected electrically, to it. The extension cable provided with the main frame (both models) should be used for this purpose. Some of the procedures also require that one of the plug-in boards in the VR-4b module be removed from the module, but connected electrically to it. The extender board (figure 4-1) provided with the VR-4b module should be used for this purpose.

4-4. Maintenance of the VR-4b module requires trained personnel and the use of specialized test equipment, both of which are available at The Singer Company. To arrange for factory maintenance or to request assistance with any maintenance problem, contact the Service Department of The Singer Company, Instrumentation, Division, Bridgeport, Conn.

4-5. TEST EQUIPMENT REQUIRED.

4-6. The test equipment required for complete testing of the VR-4b module is given in table 4-1. Equivalent test equipment may be substituted if the specified test equipment is not available.

TABLE 4-1. TEST EQUIPMENT REQUIRED

Type of Equipment	Type or Model	Manufacturer
Counter	5244L	Hewlett-Packard
Oscilloscope	541 with Type L Plug-in Head	Tektronix
Signal Generator, Low Frequency	200 CD	Hewlett-Packard
Signal Generator, High Frequency	606A	Hewlett-Packard
Signal Generator, Two Tone	TTG-2	Singer
Step Attenuator, 50-ohm	30-0	Kay
Stop Watch	Any Commercial Model	
Taper Attenuator, 100:1 (600-ohm to 50-ohm)	Any Commercial Model	
VTVM, AC Low Frequency	300H	Ballantine
VTVM, AC High Frequency	340	Ballantine
VTVM, DC	WV-98C	RCA
Wave Analyzer	302 A	Hewlett-Packard

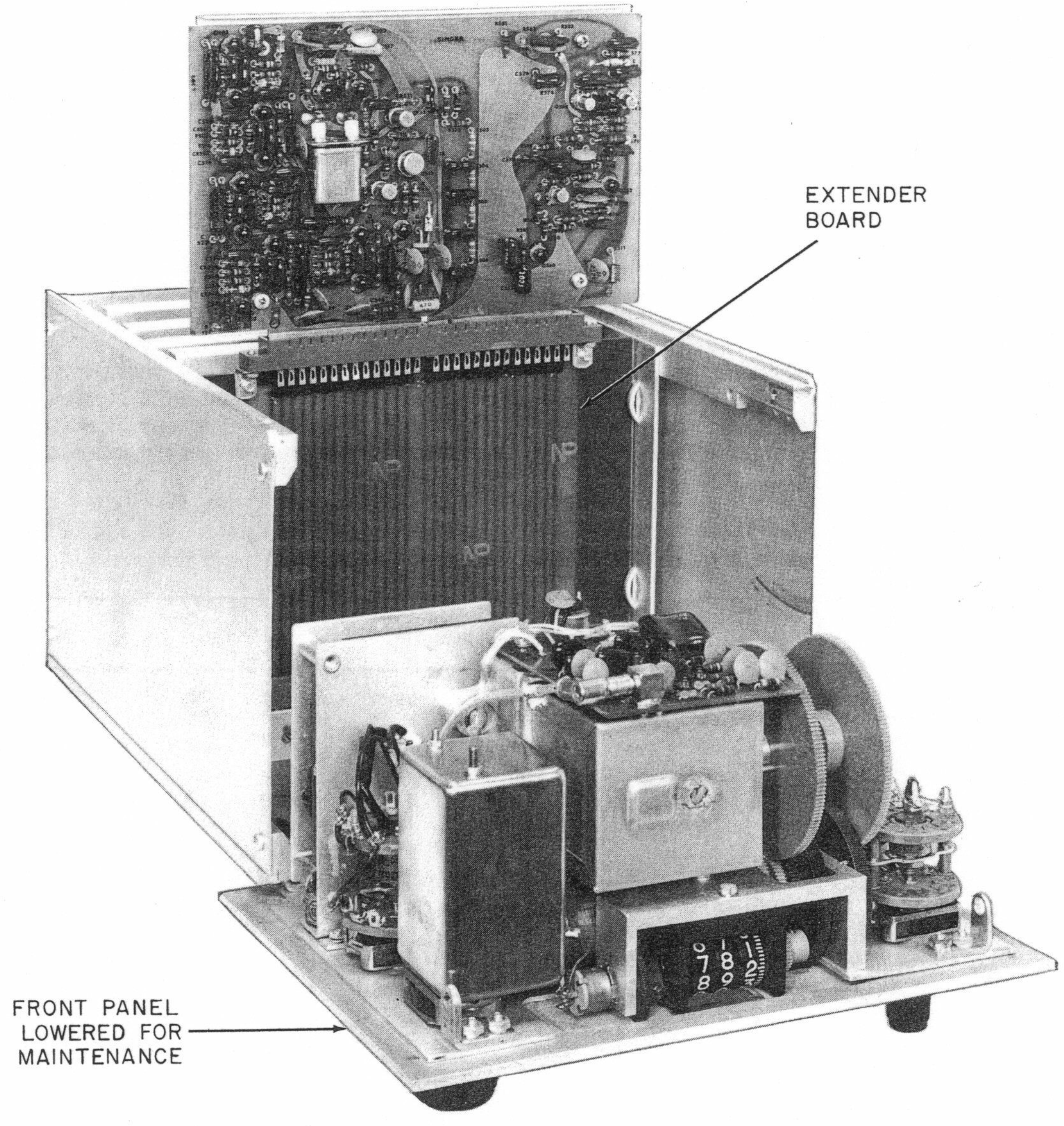

Figure 4-1. Extender Board

4-7. PRELIMINARY INSPECTION.

4-8. PRELIMINARY INSPECTION ROUTINES. The purpose of the preliminary inspection is to detect and correct conditions that might otherwise lead to equipment breakdown. Table 4-2 gives a preliminary inspection routine for the VR-4b module.

4-9. COMPONENT LOCATIONS. Printed circuit boards, all solid-state design, and convenience of maintenance are features of the VR-4b module. The module consists of eight printed-circuit board assemblies and associated chassis-mounted components. The location of these board assemblies and all of the adjustments in the VR-4b module are illustrated in figures 4-2 through 4-9.

4-10. MINIMUM PERFORMANCE STANDARDS CHECKS.

4-11. The minimum performance checks provide a quick and convenient means for determining whether or not the VR-4b module is operating within its specifications. Table 4-3 lists the checks that should be performed, gives the procedure for performing each check, and describes the result that should be obtained from each check. Figure 4-10 shows the test equipment setup for the checks. The minimum performance checks for the VR-4b module assume that the associated main frame is operating within its specifications. Thus, the performance of the main frame should be verified, by means of the tests given in the instruction manual for the main frame, before proceeding.

Notes

1. The VR-4b module must be removed from the main frame, but electrically connected to it for step 2 of the checks. The extension cable provided with the main frame can be used for this purpose.

2. The steps given in the table must be performed in numerical order starting with number 1 and ending with number 16. None of the individual steps is a complete check within itself.

4-12. Before performing the procedure given in table 4-3, set the operator's controls at the preliminary positions described below, and adjust the zero pip as described in Section II.

Note

Allow the equipment (both module and main frame) to warm up for 30 minutes before commencing with the checks.

TABLE 4-2. PRELIMINARY INSPECTION ROUTINE

Item	Inspect For	Corrective Action
Module case and panels	Dirt and corrosion	Clean with cloth moistened with cleaning solvent (trichloroethylene or equivalent).
Knobs, screws, connectors and clamps	Looseness	Tighten.
Wiring	Dirt, dust, and/or corrosion	Clean with cloth, aerosol spray, syringe, or camel's hair brush using trichloroethylene or equivalent cleaning solvent.
Solder joints	Loose or cold solder connections; corrosion	Clean carefully and resolder.
Capacitors	Leaks, bulges, signs of aging	Replace.
All connectors	Looseness, bent or corroded contacts, signs of aging	Clean contacts with cloth moistened with cleaning solvent (trichlorethylene or equivalent).
Resistors	Cracks, chipping, blistering, discoloration, and other signs of overheating.	Replace. NOTE Insure that overheating is not due to other defective components.
Switches	Looseness	Tighten mounting hardware.

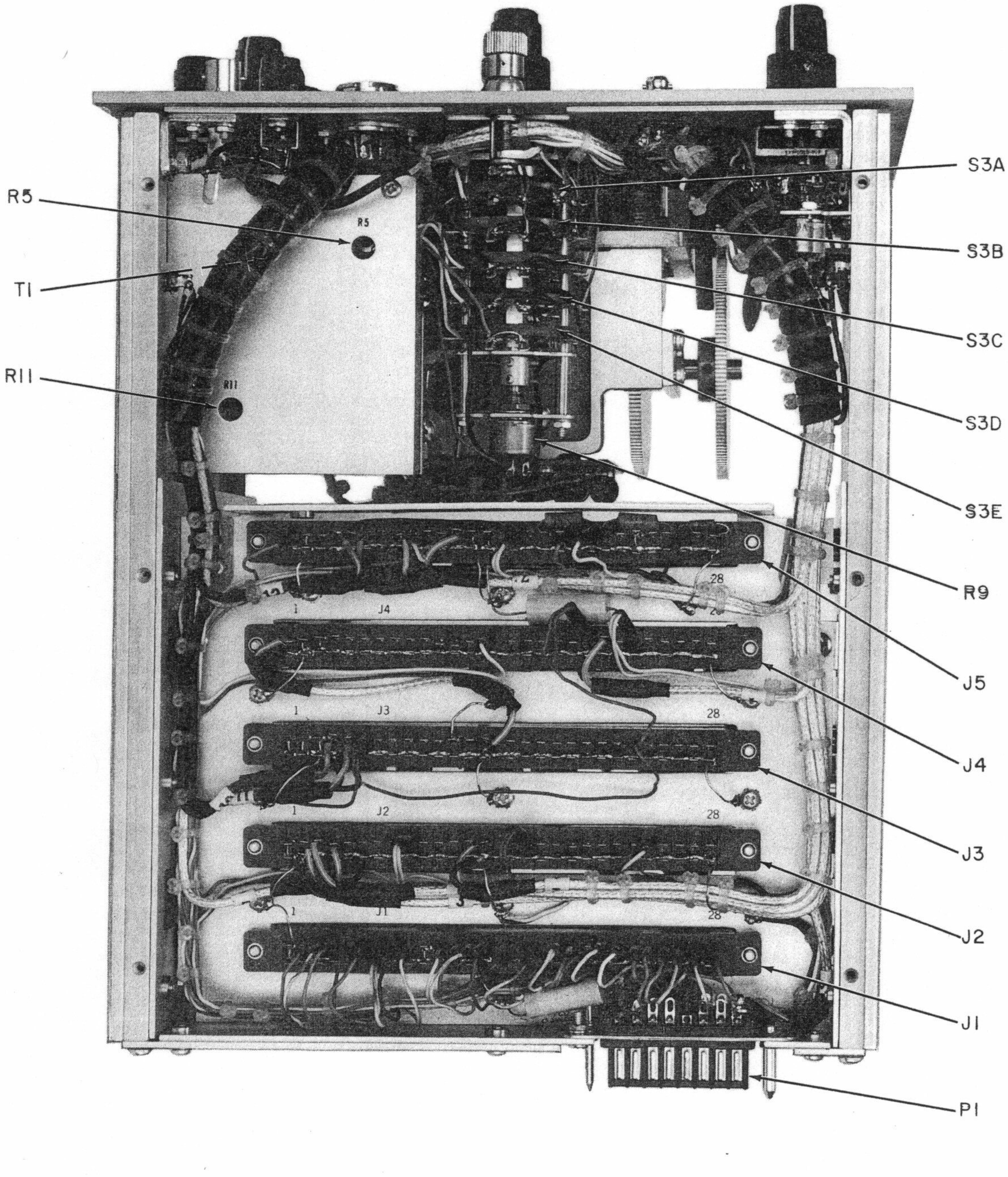

Figure 4-2. Model VR-4b Video Module, Bottom View

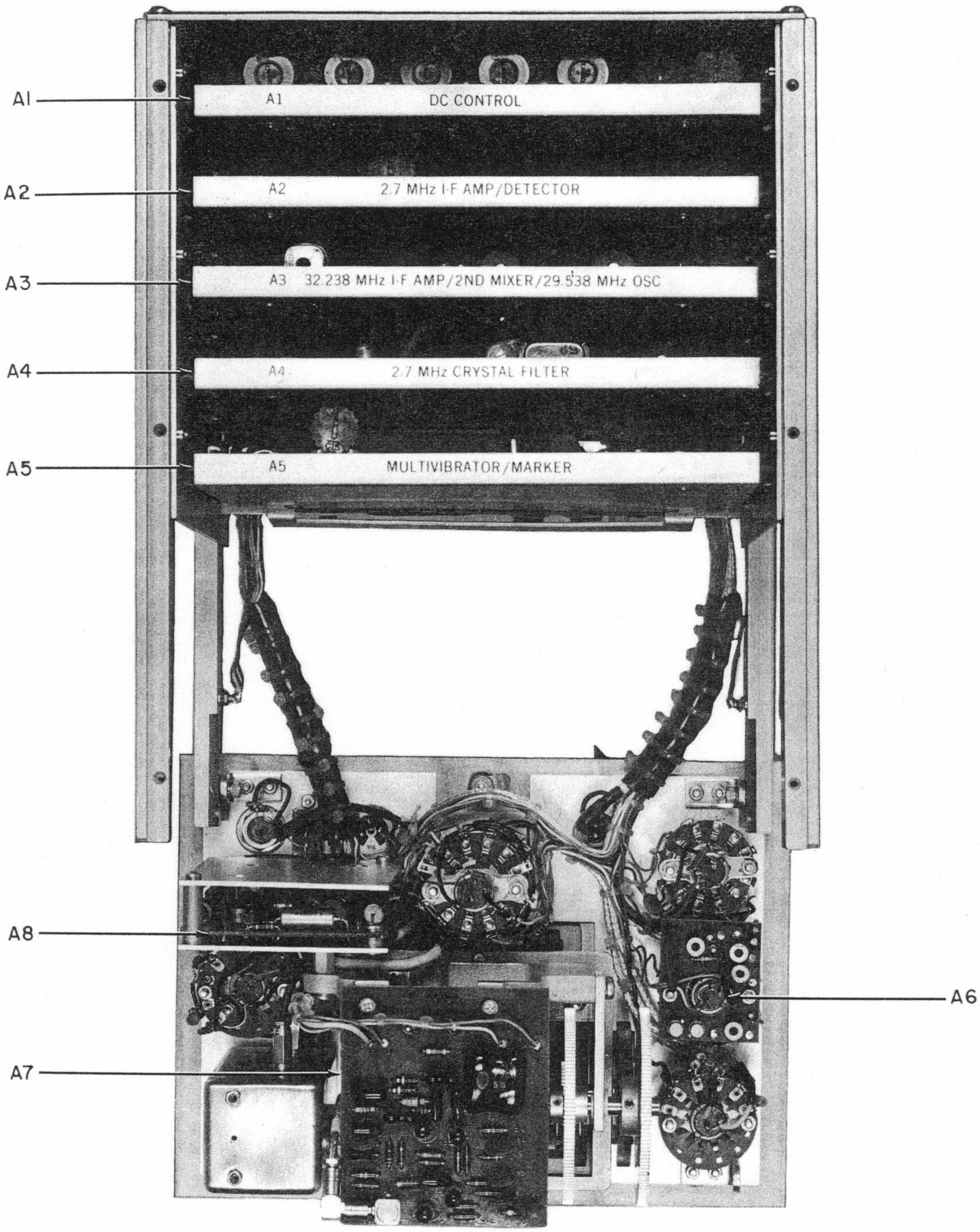

Figure 4-3. Printed Circuit Module Location

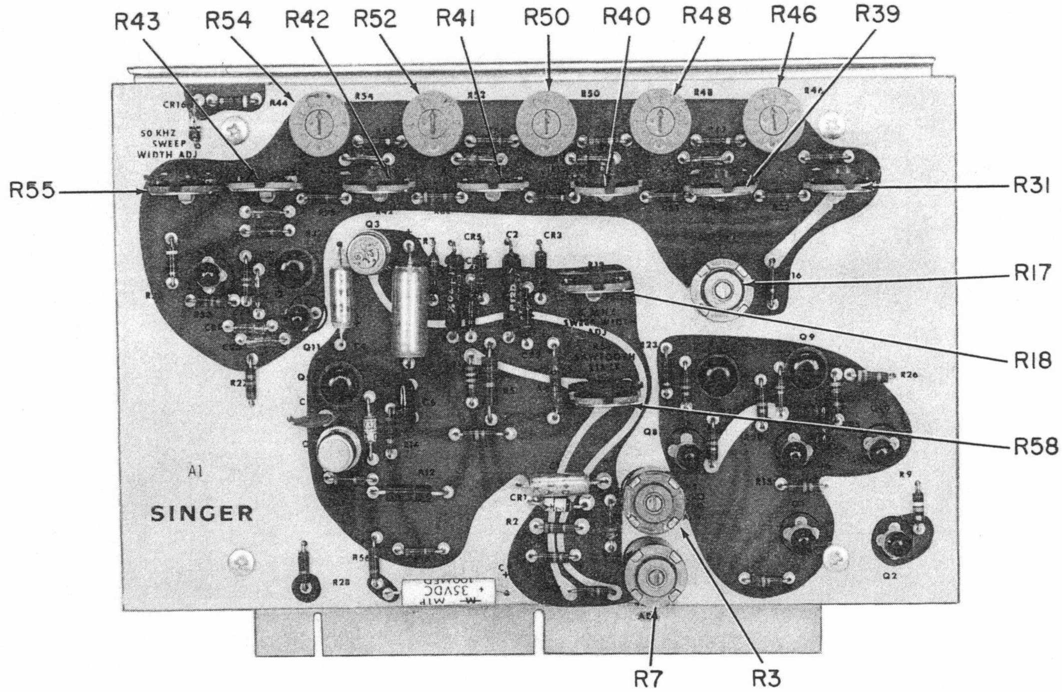

Figure 4-4. DC Control Module A1, Adjustment Locations

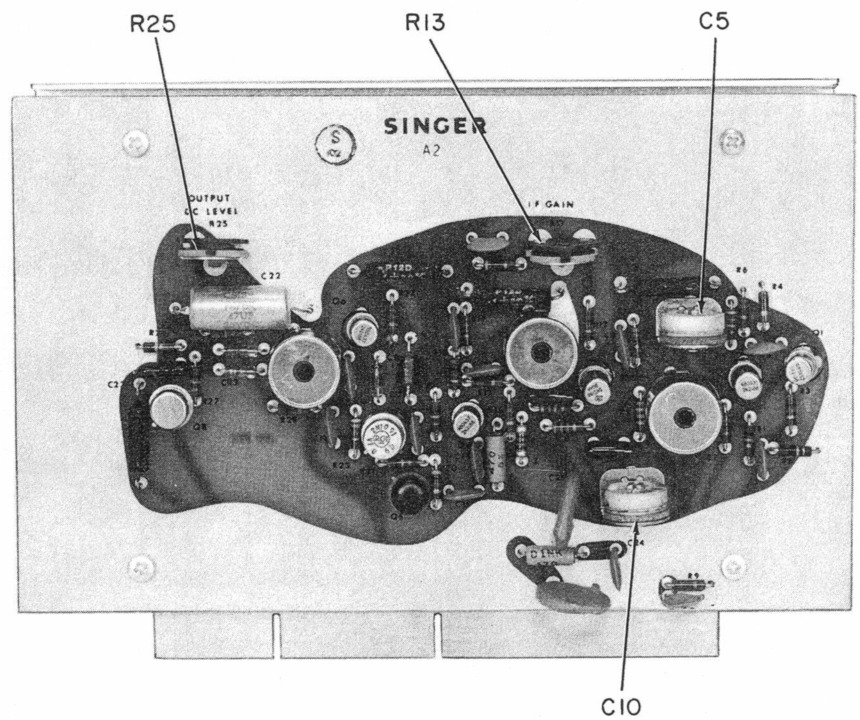

Figure 4-5. 2.7 MHz I-F Ampl/Detector Module A2, Adjustment Location

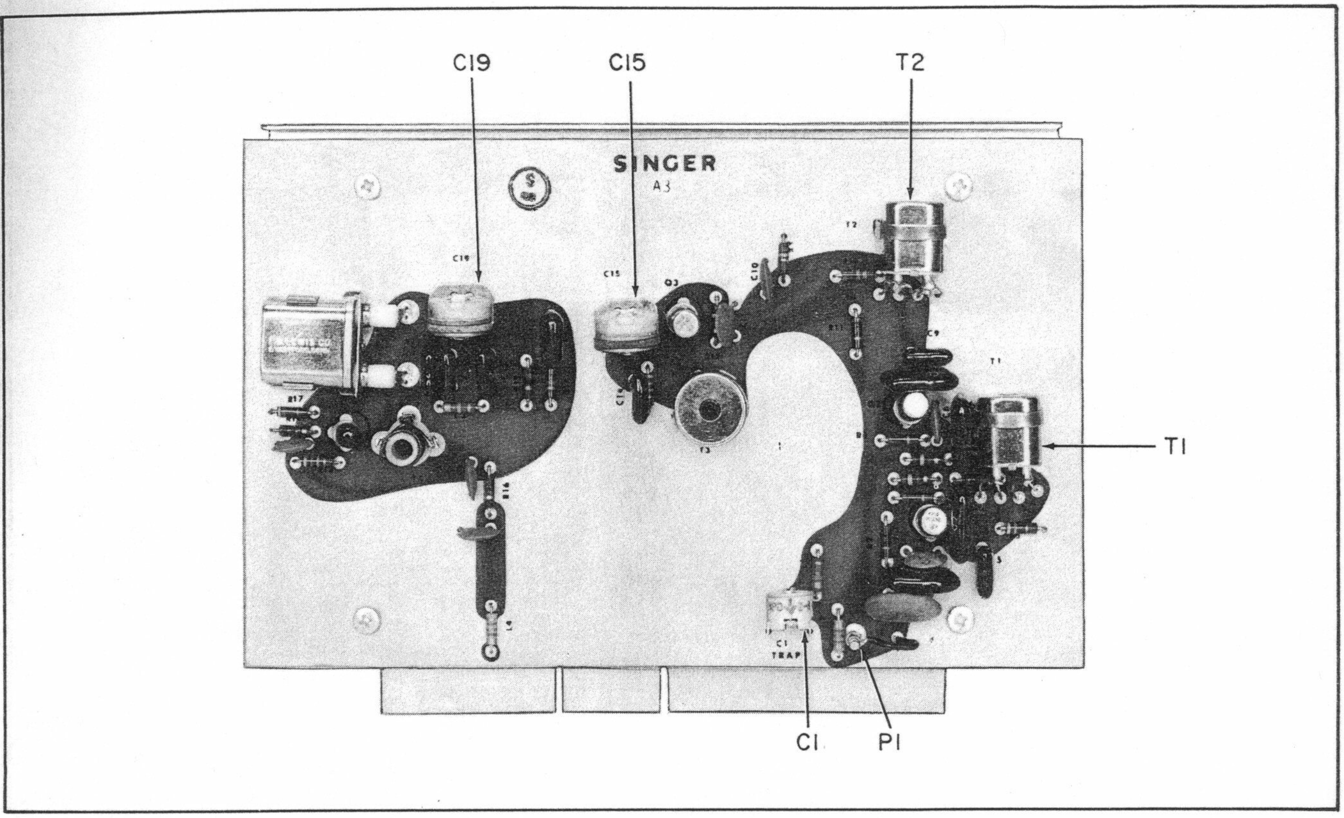

Figure 4-6. 32.238 MHz I-F Ampl/2nd Mixer/29.538 MHz Osc Module A3, Adjustment Locations

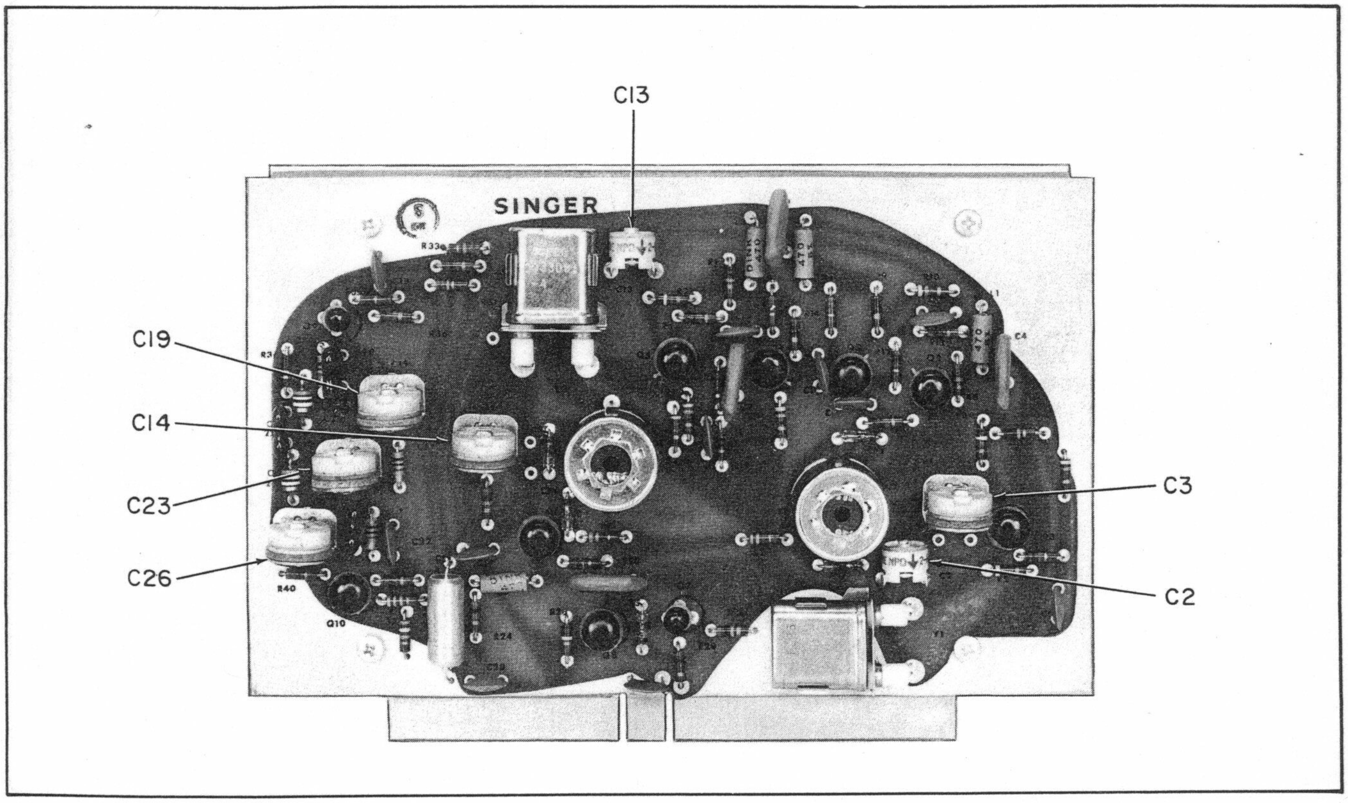

Figure 4-7. 2.7-MHz Crystal Filter Module A4, Adjustment Locations

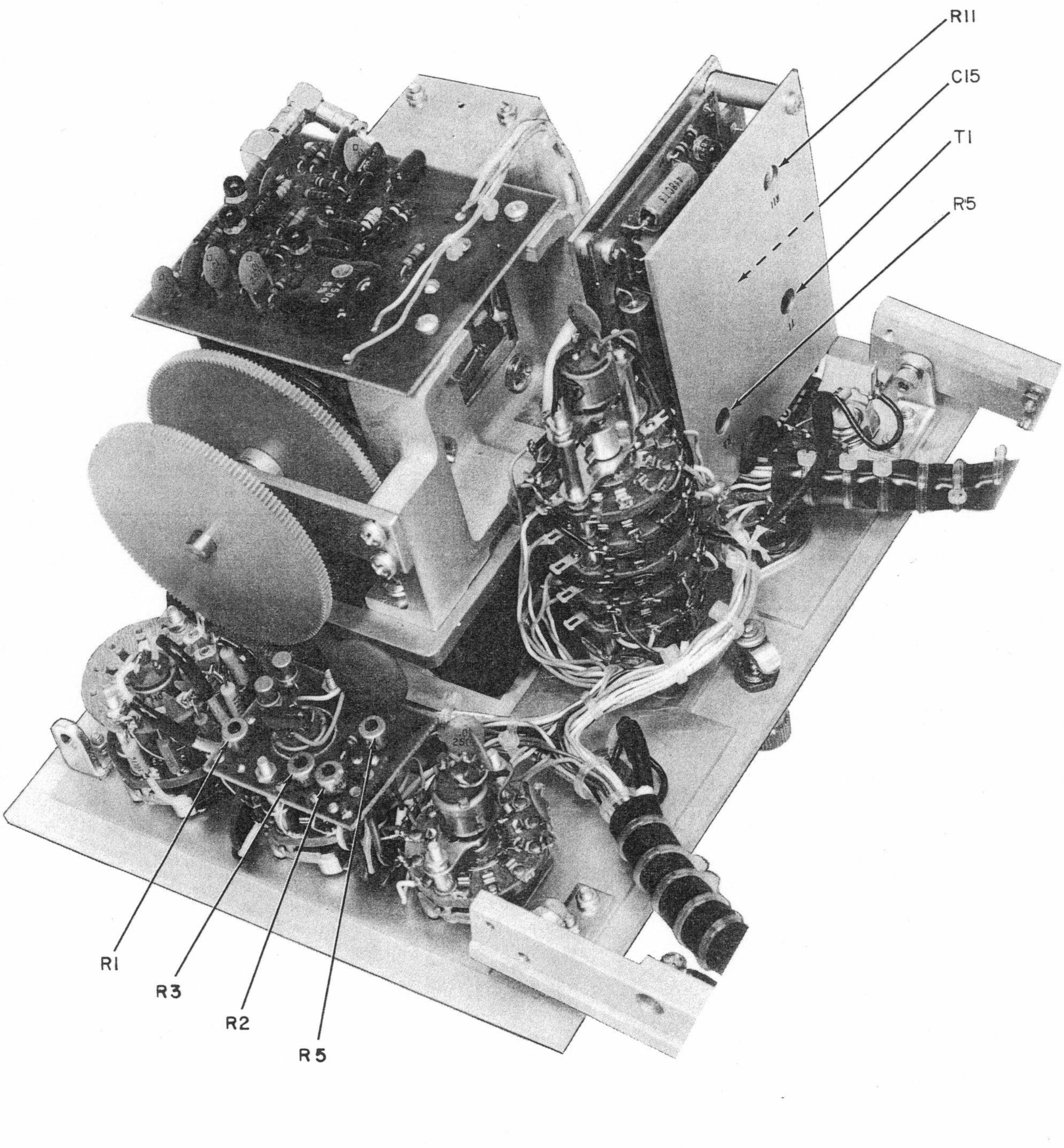

Figure 4-8. Log-Lin Module A6 and First Mixer Module A8, Adjustment Locations

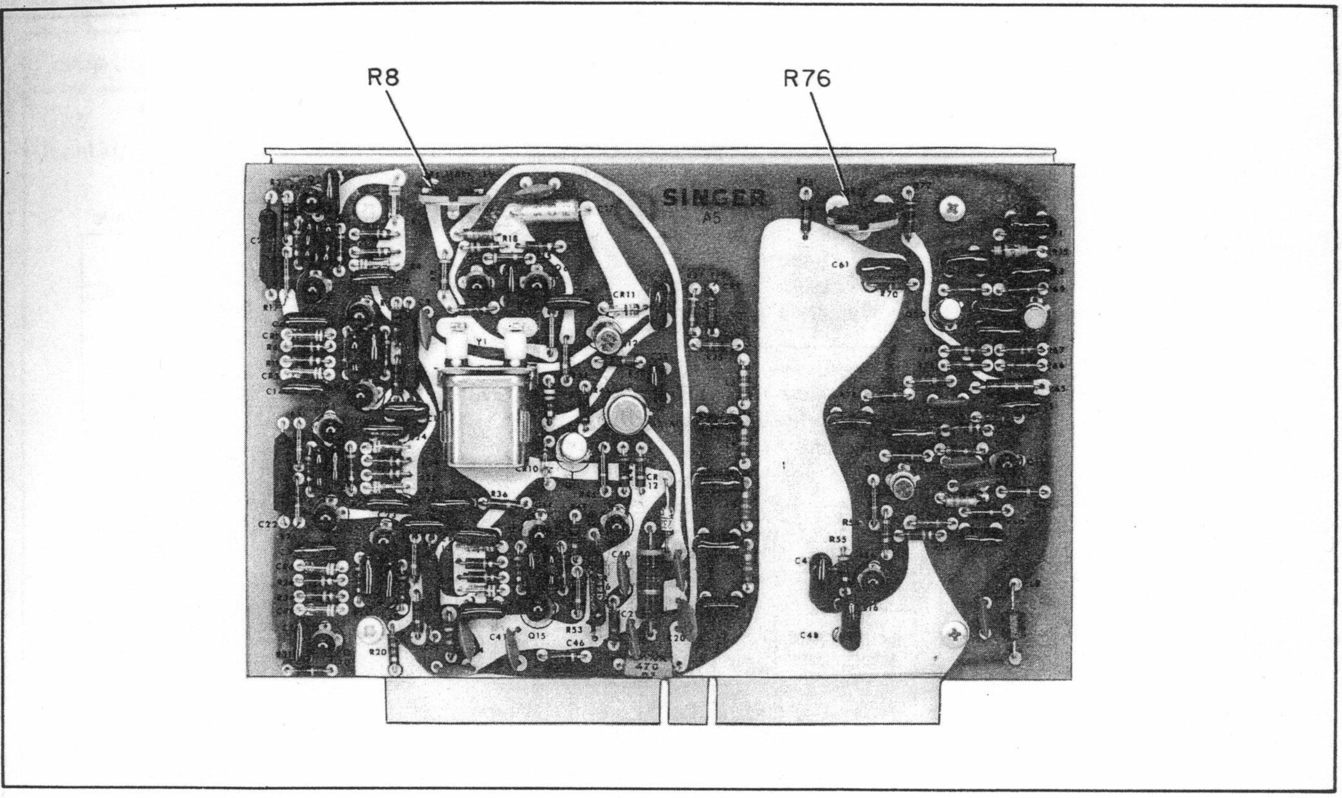

Figure 4-9. Multivibrator/Marker Module A5, Adjustment Locations

a. On the VR-4b module:

INPUT ATTEN DB switch	70
CENTER FREQUENCY	00.0 MHz
I-F ATTEN DB switch	20
I-F ATTEN DB VARIABLE control	fully ccw
MARKERS switch	OFF
SWEEP WIDTH control	5 MHz
SWEEP RANGE switch	50 kHz - 5 MHz
AMPLITUDE SCALE switch	LOG
SMOOTHING FILTER control	fully ccw
I-F BANDWIDTH control	fully cw (See notes below)
SWEEP MODE switch	AUTO SCAN
Sweep Rate (VAR) control	Mid position
All other controls	any

b. On the Main Frame:

All controls	As required to produce a clear sharp trace on the CRT
All controls (Cont'd)	that is centered horizontally and coincides with the baseline on the graticule.

Notes

1. The minimum i-f bandwidth which can be used with any particular set of conditions is a function of both the sweep width and sweep rate. In general, the I-F BANDWIDTH control should be set for optimum resolution for any particular combination of sweep width and sweep rate. Setting the I-F BANDWIDTH control to less than optimum results in a loss of amplitude and resolving capabilities and therefore should be avoided.

2. Since the sweep width, sweep rate, and i-f bandwidth are independently variable in the VR-4b module, it may be necessary to readjust the I-F BANDWIDTH control for optimum (unless otherwise instructed in text) periodically throughout the following procedures.

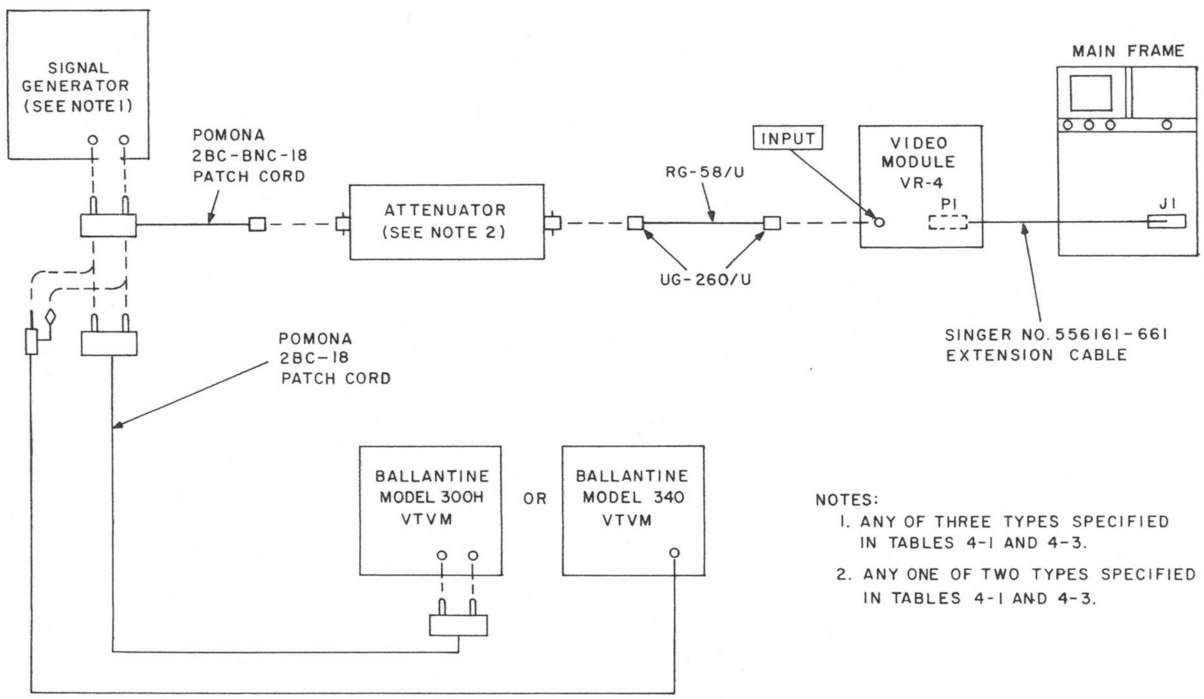

Figure 4-10. Minimum Performance Standards, Equipment Setup

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS

Step	Purpose	Procedure	Acceptable Indication
1	To check the sweep rate in the autoscan, preset, and manual modes.	Set the Sweep Rate (VAR) control fully counter-clockwise.	
		With the stop watch measure the time required for 20 complete scans of the CRT trace.	The time required should be a minimum of 20 seconds.
		Set the Sweep Rate (VAR) control fully clockwise. Connect a frequency counter to X OUTPUT on Main Frame.	The counter should indicate at least 60 Hz.
		Set the SWEEP RANGE switch to 0-25 MHz PRESET.	

(Cont'd)

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS (Cont'd)

Step	Purpose	Procedure	Acceptable Indication
1 (cont'd)		With the stop watch measure the time required for 20 complete scans of the CRT trace.	The time required should be between 18 and 22 seconds (1 Hz ± 10%)
		Set the SWEEP MODE switch to MANUAL and SWEEP RANGE switch to 50 kHz - 5 MHz.	
		Rotate the Sweep Rate (VAR) control first fully counterclockwise and then fully clockwise while observing the spot on the CRT.	The spot should move first to the left of the CRT and then to the right. In each of the extreme positions of the Sweep Rate (VAR) control the spot should be beyond the graticule scale.
2	To check the frequency and amplitude of the markers.	Set the MARKERS switch to 5 MHz.	
		Connect the counter to TP1 on assembly A5.	The counter should read 5 MHz ± 1 kHz.
		Set the MARKERS switch to 500 kHz.	
		Connect the counter to TP2 on assembly A5.	The counter should read 500 kHz ± 100 Hz.
		Set the SWEEP WIDTH control to 0.5 MHz, the MARKERS switch to 25 kHz, the MARKERS AMPLITUDE control fully clockwise, and the Sweep Rate (VAR) control fully counterclockwise.	
		Set the CENTER FREQUENCY control to approximately 00.750 MHz, and then adjust the control so that the 500-kHz marker is under the -0.5 graduation on the graticule and the 1000-kHz marker is under the +0.5 graduation.	
		Set the I-F ATTEN DB control to 0.	
		Adjust the I-F BANDWIDTH control for optimum resolution.	

(Cont'd)

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS (Cont'd)

Step	Purpose	Procedure	Acceptable Indication
2 (cont'd)		Count the number of equally spaced markers between the 500-kHz marker and the 1000-kHz marker. Set the CENTER FREQUENCY control to 25 MHz, the SWEEP WIDTH control to 0.1 MHz, and the I-F ATTEN DB switch to 0. Set the I-F ATTEN DB VARIABLE and MARKERS AMPLITUDE controls fully ccw and cw, respectively. Set the SWEEP RANGE switch to 0-25 MHz PRESET and the MARKER switch to 500 kHz.	The number of markers should be 19. While the I-F BANDWIDTH and Sweep Rate (VAR) controls set for optimum resolution, the 25-kHz markers should be visible on the CRT display. The 500-kHz markers should now be visible over the entire CRT display.
3	To check the linearity of the preset sweep.	Set the SWEEP RANGE switch to 50 kHz - 5 MHz. The CENTER FREQUENCY control to 00.0 MHz, and adjust the FREQ CAL control so that the zero pip is under the CF graduation on the graticule. Set the SWEEP RANGE switch to 0-25 MHz PRESET and the MARKERS switch to 5 MHz.	Each of the 5-MHz markers should appear at the corresponding frequency graduation of the CRT graticule within one-half division.
4	To check the width and linearity of the wideband sweep.	Set the SWEEP RANGE switch to 50 kHz - 5 MHz and the SWEEP WIDTH control to 5 MHz. Set the CENTER FREQUENCY control to approximately 12.5 MHz and then adjust the control to position the 10-MHz marker under the -0.5 graduation on the graticule. Set the MARKERS switch to 500 kHz. Count the number of 500-kHz marker spaces between the -0.5 graduation and the +0.5 graduation on the graticule.	There should be at least 9 and no more than 11 500-kHz marker spacers.

(Cont'd)

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS (Cont'd)

Step	Purpose	Procedure	Acceptable Indication
4 (cont'd)		Readjust the SWEEP WIDTH and CENTER FREQUENCY controls as required to center the tenth marker (15 MHz), counted in the previous step, under the +0.5 graduation while the 10-MHz marker remains under the -0.5 graduation.	The fifth marker to the right of the 10 MHz marker should be within ±1/2 division of the CF graduation on the graticule.
		Note If the tenth marker cannot be positioned as required, use the eighth marker instead Now the fourth marker to the right of the 10-MHz marker should be within ±1/2 division of the CF graduation.	
		Set the CENTER FREQUENCY control to approximately 00.750 MHz and the SWEEP WIDTH control to 0.500 MHz and adjust the CENTER FREQUENCY control so that the 500-kHz marker is under the -0.5 graduation on the graticule.	
		Set the MARKERS switch to 25 kHz.	
		Adjust analyzer for optimum resolution and count the number of 25-kHz marker spaces between the -0.5 graduation and the +0.5 graduation.	There should be at least 18 and no more than 22 25-kHz marker spacers.
		Readjust the SWEEP WIDTH and CENTER FREQUENCY controls as required to center the 1-MHz marker under the +0.5 graduation while the 500-kHz marker remains under the -0.5 graduation.	The tenth marker to the right of the 500-kHz marker should be within ±1/2 division of the CF graduation.
		Set the CENTER FREQUENCY control to 00.500 MHz, the SWEEP WIDTH control to 0.050 MHz, and adjust the I-F BANDWIDTH control for optimum resolution.	

(Cont'd)

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS (Cont'd)

Step	Purpose	Procedure	Acceptable Indication
4 (cont'd)		Adjust the CENTER FREQUENCY control so that the 500-kHz marker is under the -0.5 graduation.	The second marker to the right of the 500-kHz marker should be within ±1 division of the +0.5 graduation.
		Readjust the SWEEP WIDTH and CENTER FREQUENCY controls as required to center the 550-kHz marker under the +0.5 graduation, while the 500 kHz marker remains at the -0.5 graduation.	The center marker (525 kHz) should be within ±1/2 division of the CF graduation.
5	To check the calibration of the CENTER FREQUENCY dial.	Set the SWEEP WIDTH control to 0.1 kHz, the CENTER FREQUENCY control to 00.0 MHz, and set the FREQ CAL control so that the zero pip is under the CF graduation.	The CENTER FREQUENCY dial should read 500 ± 25 kHz.
		Set the MARKERS switch to 500 kHz, and readjust the CENTER FREQUENCY control so that the 500-kHz marker is under the CF graduation.	
		Set the CENTER FREQUENCY control so that the 10-MHz marker is under the CF graduation.	The CENTER FREQUENCY dial should read 10 ± 0.5 MHz.
		Set the CENTER FREQUENCY control so that the 20-MHz marker is under the CF graduation.	The CENTER FREQUENCY dial should read 20 ± 1 MHz.
6	To check the width and linearity of the narrow-band sweep.	Set the CENTER FREQUENCY control to 00.0 MHz, and then adjust the control to position the zero pip under the CF graduation on the graticule.	
		Perform the locking procedure given in paragraph 2-46x to synchronize the wide-band oscillator with the narrow-band oscillator at the zero frequency. Set the SWEEP WIDTH control at 50 kHz.	

(Cont'd)

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS (Cont'd)

Step	Purpose	Procedure	Acceptable Indication
6 (cont'd)		Connect the low-frequency signal generator to INPUT jack J6. Set the generator frequency to approximately 25 kHz and then adjust the generator frequency (and FINE TUNING NARROW BAND control if necessary) to place each 25-kHz pip (both above and below the zero pip) under the corresponding +0.5 and -0.5 graduation on the graticule.	The generator frequency should read 25 kHz ± 2.6 kHz. Also, the zero pip should be within ±1/2 division of the CF graduation.
		Set the SWEEP WIDTH control to 5 kHz.	
		Set the generator frequency to approximately 2.5 kHz and then adjust it to position the two 2.5-kHz pips under the +0.5 and -0.5 graduations respectively.	The generator frequency should read 2.5 kHz ± 350 Hz. Also the zero pip should be within ±1/2 division of the CF graduation.
		Set the SWEEP WIDTH control to 0.5 kHz.	
		Set the generator frequency to approximately 250 Hz and then adjust it to position the two 250 Hz pips under the +0.5 and -0.5 graduations respectively. (It may be necessary to adjust the I-F BANDWIDTH control and to use a slow sweep rate to obtain the optimum resolution.) Use the smoothing filter to remove any beat signals that may appear.	The zero pip should be within ±1/2 division of the CF graduation.
7	To check the i-f bandwidth.	Set the generator frequency to 500 Hz.	
		Set SWEEP RANGE control to 50 kHz - 5 MHz. Adjust the CENTER FREQUENCY control to position the zero pip under the CF graduation on the graticule.	

(Cont'd)

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS (Cont'd)

Step	Purpose	Procedure	Acceptable Indication
7 (cont'd)		Perform the locking procedure given in paragraph 2-46x to synchronize the wide-band oscillator with the narrow-band oscillator. Set the SWEEP RANGE switch to 0.5 kHz - 50 kHz NARROW BAND. Set the SWEEP WIDTH control to position 500-Hz pips under the -0.5 and +0.5 graduations. (This calibrates sweep width to 1 kHz or 100 Hz per division.) Set the FINE TUNE NARROW BAND control to place the right 500-Hz pip under the CF graduation on the graticule. Set the I-F BANDWIDTH and Sweep Rate (VAR) controls fully counterclockwise. Set AMPLITUDE SCALE control to LIN. Set the generator output to obtain exactly full scale deflection of the signal pip. Set the generator frequency to 18 kHz. Set the SWEEP WIDTH control to approximately 36 kHz and then adjust it to position the 18-kHz pips under the -0.5 and +0.5 graduations on the graticule. Without changing the setting of the SWEEP WIDTH control, set the SWEEP RANGE switch to 50 kHz - 5 MHz. Set the generator frequency to 500 kHz.	The width of the pip at 5 divisions of the linear amplitude scale should be 2 divisions (200 Hz) or less.

(Cont'd)

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS (Cont'd)

Step	Purpose	Procedure	Acceptable Indication
7 (cont'd)		Set the CENTER FREQUENCY control to approximately 00.5 MHz and then adjust it to position the signal pip under the CF graduation. Repeat the locking procedure given in the operating section. Set the SWEEP RANGE switch to 0.5 kHz - 50 kHz NARROW BAND and position the signal under the CF graduation with the FINE TUNING NARROW BAND control. Set the I-F BANDWIDTH control fully clockwise. Set the generator output to obtain exactly full scale deflection of the signal pip.	The width of the pip at 5 divisions of the linear amplitude scale should be at least 5 divisions (18 kHz).
8	To check the calibration of the output against the LIN scale on the CRT.	Connect the low-frequency signal generator through the 50-ohm step attenuator to INPUT jack J6. Connect the AC VTVM to monitor the output of the generator. Set the generator frequency to 500 kHz and its output at exactly 1 volt as measured on the VTVM. Set the AMPLITUDE SCALE switch to LIN. Adjust the external attenuator and the I-F ATTEN DB VARIABLE controls so that the signal pip deflects exactly full scale. Reduce the generator output so that the pip deflects exactly 9 divisions of the linear amplitude scale. Repeat above step for deflections of 8 divisions, 7 divisions, etc.	The VTVM should read 0.9 ± 0.03 volts. The corresponding readings on the VTVM should be 0.8 ± 0.03 volts, 0.7 ± 0.03 volts, etc.

(Cont'd)

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS (Cont'd)

Step	Purpose	Procedure	Acceptable Indication
9	To check the range of the I-F ATTEN DB VARIABLE control.	Set the I-F ATTEN DB VARIABLE control fully counterclockwise and adjust the generator output so that the signal pip deflects full scale.	Set the I-F ATTEN DB VARIABLE control fully clockwise. The deflection of the pip should be 3 divisions of the linear amplitude scale or less.
10	To check the overall frequency response of the module.	Set the SWEEP RANGE switch to 50 kHz - 5 MHz and INPUT ATTEN DB switch at 40. Set the CENTER FREQUENCY control to approximately 00.050 MHz. Adjust it to position the upper sideband portion of a 50-kHz signal from the signal generator under the CF graduation. Perform the locking procedure given in the operator's section to synchronize the wide-band oscillator with the narrow-band oscillator. Set the SWEEP RANGE switch to 0.5 kHz - 50 kHz NARROW BAND. Set the SWEEP WIDTH control to 50 kHz. Adjust the I-F BANDWIDTH control for optimum resolution and adjust the generator output so that the signal pip deflects 9 divisions.	
		Slowly adjust the generator frequency to 1 kHz while observing the deflection of the signal pip; it will be necessary to adjust the SEARCH/LOCK control slowly upward to keep the signal pip displayed on the CRT.	The generator output should be kept constant during this step. The maximum variation of the signal pip amplitude should not be more than ±1 division.
		Disconnect the low-frequency signal generator from the module and connect the high-frequency generator through the 50-ohm step attenuator.	

(Cont'd)

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS (Cont'd)

Step	Purpose	Procedure	Acceptable Indication
10 (cont'd)		Set the generator frequency to 50 kHz. Set the SWEEP RANGE switch to 50 kHz - 5 MHz, the SWEEP WIDTH control to 5 MHz, and the I-F BANDWIDTH control for optimum resolution. Adjust the signal generator output level so that the signal pip deflects 9 divisions. Slowly adjust the generator frequency to 27.5 MHz while observing the deflection of the signal pip; it will be necessary to adjust the CENTER FREQUENCY control to keep the signal pip displayed on the CRT.	The generator output should be kept constant during this step. The maximum variation of the signal pip amplitude should not be more than ±1 division.
11	To check the calibration of the INPUT ATTEN DB switch.	Set the generator frequency to 25 MHz and the INPUT ATTEN DB switch to 70. Set the SWEEP WIDTH control to approximately 0.100 MHz and the CENTER FREQUENCY control to 25 MHz. Set the step attenuator for zero attenuation and adjust the generator output for full scale deflection of the signal pip.	
		Set the INPUT ATTEN DB switch to 60 and insert 10 dB of attenuation with the step attenuator.	The amplitude of the signal pip should be within ±1/2 division (±0.5 dB) of full scale deflection.
		Set the generator output for exactly full scale deflection of the signal pip.	
		Repeat the two previous steps for each of the remaining positions of the INPUT ATTEN DB switch. Insert 10 dB of attenuation for each 10 dB removed by the INPUT ATTEN DB switch.	At each setting, the signal pip should be within ±1/2 division of full scale.

(Cont'd)

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS (Cont'd)

Step	Purpose	Procedure	Acceptable Indication
12	To check the calibration of the I-F ATTEN DB switch.	Set the step attenuator for 20 dB of attenuation, the INPUT ATTEN DB switch to 50, the I-F ATTEN DB switch to 0, the I-F ATTEN DB VARIABLE control fully ccw, and adjust the generator output for full scale deflection of the signal pip.	
		Set the I-F ATTEN DB switch to 5 and remove 5 dB of attenuation with the step attenuator.	The amplitude of the signal pip should be within ±0.2 division (±0.2 dB) of full scale deflection.
		Set the generator output for exactly full scale deflection of the signal pip.	
		Repeat the two previous steps for each of the remaining positions of the I-F ATTEN DB switch. Remove 5 dB of attenuation for each 5 dB inserted by the I-F ATTEN DB switch.	At each setting, the signal pip should be within ±0.2 division of full scale.
13	To measure the minimum signal that can be detected by the module (S+N=2N)	Set the INPUT ATTEN DB and I-F ATTEN DB switches to 0, the I-F ATTEN DB VARIABLE control fully ccw, and insert 80 dB of attenuation with the step attenuator.	
		Set the Sweep Rate (VAR) control for a 20-Hz sweep (approximately).	
		Connect the high frequency VTVM to monitor the generator output.	
		Adjust the generator output until the signal pip is barely visible (S+N=2N). Set the I-F BANDWIDTH control for a properly resolved signal pip.	The VTVM should read less than 2.5 millivolts.
14	To check the calibration of the output with the LOG scale of the CRT.	Set the generator frequency to 12.5 MHz and the generator output to 30 microvolts.	

(Cont'd)

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS (Cont'd)

Step	Purpose	Procedure	Acceptable Indication
14 (cont'd)		Set the step attenuator for zero attenuation. Set the INPUT ATTEN DB switch to 0. Set the CENTER FREQUENCY control to approximately 12.5 MHz and then adjust it to position the signal pip under the CF graduation on the graticule. Set the generator output level to obtain a pip indication of 0 db on the LOG scale. With the step attenuator, reduce the level of the signal input in 5-dB steps noting the amplitude of the signal pip after each step.	 The pip amplitude should agree with the input attenuation within ±1 dB from 0 to -30 dB, and within ±2 dB from -30 to -40 dB.
15	To check the magnitude of the harmonic and intermodulation distortion products.	Disconnect the signal generator. Set the CENTER FREQUENCY control to 00.0 MHz and perform the locking procedure given in paragraph 2-46x to synchronize the wide-band oscillator with the narrow-band oscillator. Set the SWEEP RANGE switch to 0.5 kHz - 50 kHz. Set the SWEEP WIDTH control to 20 kHz and adjust the I-F BANDWIDTH and Sweep Speed (VAR) controls for optimum resolution. Slowly adjust the SEARCH/LOCK control downward to position the zero pip under the -0.5 graduation on the CRT graticule. Connect the two-tone test generator through the 100:1 taper attenuator to INPUT jack J6.	

(Cont'd)

TABLE 4-3. MINIMUM PERFORMANCE STANDARDS CHECKS (Cont'd)

Step	Purpose	Procedure	Acceptable Indication
15 (cont'd)		Set the generator frequencies to 6 kHz and 10 kHz and adjust the outputs for equal amplitude.	
		Set the Sweep Rate (VAR) control ccw. Adjust the I-F BANDWIDTH control for optimum resolution of the signal pips.	
		Adjust the amplitude of the composite output of the generator to obtain pip amplitudes of 0 dB on the CRT and then increase the generator input by 20 dB.	All harmonic and intermodulation distortion products should lie below the -40 dB graduation of the graticule.
		Slowly adjust the SWEEP WIDTH control for 50 kHz while also adjusting the SEARCH/LOCK control slowly downward to keep the zero pip under the -0.5 graduation. Watch for higher order components of the input signals.	All higher order components should lie below the -40 dB graduation.
16	To check the magnitude of non-harmonic residual responses.	Disconnect the signal generator. Set the SWEEP RANGE switch to 0-25 MHz PRESET, set the I-F ATTEN DB switch to 20 and examine the display for residual responses.	
		Set the SWEEP RANGE switch to 50 kHz - 5 MHz and center the highest amplitude residual response on the CRT by means of the CENTER FREQUENCY control.	
		Optimize the display using the Sweep Width (VAR) and I-F BANDWIDTH controls.	
		Connect a signal generator to the INPUT jack. Adjust the generator to obtain a second pip adjacent to and of the same amplitude as the residual response.	Signal generator output level is -105 dBm or less.

4-13. SYSTEMATIC TROUBLE LOCALIZATION.

4-14. The key to the systematic localization of troubles within the VR-4b module is understanding the theory of operation of the module. A thorough knowledge of the theory permits the location of any defective component by a series of tests using the operator's controls and a minimum amount of test equipment.

4-15. To demonstrate a logical method of trouble-shooting, four problems have been assumed and a procedure for locating the source of each problem has been devised. In each case, the information that can be derived from the detailed block diagram in Section III and from the operation of the module, is used to localize the trouble before any test equipment is employed. The four problems are:

a. No trace on the CRT.

b. No 25-kHz markers.

c. Normal CRT trace, but low noise and signal.

d. Normal CRT trace with normal noise, but no signal, zero pip, or markers. Table 4-4 gives the procedures for troubleshooting these problems.

TABLE 4-4. SYSTEMATIC TROUBLE LOCALIZATION

No.	Symptom	Test Procedure	If Indication Is Normal	If Indication Is Abnormal
A	No trace on CRT.	a. Check for the presence of a sawtooth waveform on pin 12 of P1.	a. Troubleshoot the main frame as described in its instruction manual.	a. Go to test procedure b.
		b. Check the presence of all power supply inputs at P1.	b. Troubleshoot sawtooth generator A1Q3, A1Q4, and A1Q5 using the voltage measurements given in table 4-6.	b. Troubleshoot the main frame as described in its instruction manual.
B	No 25-kHz markers. (The 5-MHz and 500-kHz markers are present.)	a. Check for the presence of a 250-kHz square wave at the emitter follower A5Q13.	a. Go to test procedure b.	a. Go to test procedure c.
		b. Check for the presence of a 25-kHz square wave at the base of amplifier A5Q12.	b. Replace A5Q12.	b. Replace A5A1.
		c. Check for the presence of a 250-kHz square wave at the base of emitter follower A5Q13.	c. Replace A5Q13.	c. Troubleshoot binary divider A5Q14/A5Q15.
C	Low noise and signal on CRT. **Note** Almost all of the noise generated by the VR-4b is amplified in the A2 and A4 modules; noise that is generated in the earlier stages receives its largest amplification in these modules.	a. Rotate VERT. POS. control R207 and observe that baseline moves.	a. Go to test procedure b.	a. Check V11, VERT. POS. control R207, and VER. ADJ. control R211.

(Cont'd)

TABLE 4-4. SYSTEMATIC TROUBLE LOCALIZATION (Cont'd)

No.	Symptom	Test Procedure	If Indication Is Normal	If Indication Is Abnormal
C (cont'd)	Thus, the problem could be caused by a low gain stage in either of the modules.			
		b. Set the AMPLITUDE SCALE switch to LOG. Switch the I-F ATTEN DB switch from one position to the next and check the CRT to determine that the signal attenuation produced is 5 dB per step. If no signal or noise appears, go to c. **Note** For steps c thru f it is necessary to slightly rock frequency of generator to obtain true baseline rise.	b. Troubleshoot the A2 module using the voltage measurements given in table 4-6.	b. Troubleshoot the A4 module using the voltage measurements given in table 4-6.
		c. Set the AMPLITUDE SCALE switch to LIN and connect a 2.7-MHz, 150-microvolt signal to pin 2 of A2P1. Observe that baseline rises to approximately full scale.	c. Go to test procedure d.	c. Troubleshoot the A2 module using the voltage measurements given in table 4-6.
		d. Connect a 2.7-MHz, 60-microvolt signal to pin 1 of A4P1. Observe that baseline rises to approximately full scale.	d. Go to test procedure e.	d. Troubleshoot the A4 module using the voltage measurements given in table 4-6.
		e. Connect a 32.238-MHz, 20-microvolt signal through a 0.02 microfarad capacitor to pin 4 of A3P1. Observe that baseline rises approximately full scale.	e. Go to test procedure f.	e. Troubleshoot the A3 module using the voltage measurements given in table 4-6.
		f. Connect a 10-MHz, 3-microvolt (rms) signal to P4 (at output of input attenuator). Set the CENTER FREQUENCY control at 10.00 MHz and the MARKERS switch to OFF. Observe that the signal is approximately full scale.	f. Check input attenuator A9.	f. Troubleshoot the A8 module using the voltage measurements given in table 4-6.

(Cont'd)

TABLE 4-4. SYSTEMATIC TROUBLE LOCALIZATION (Cont'd)

No.	Symptom	Test Procedure	If Indication Is Normal	If Indication Is Abnormal
D	Normal noise on CRT, but no signal, zero pip, or markers. **Note** The fact that the CRT trace and noise are normal indicates that the sawtooth generator and the A2 and A4 modules are functioning properly. Thus, the defective component must be in or before the 2.7-MHz mixer. Note, however, that the A8Q1 and A8Q2 stages need not be checked, if the zero pip is not present.	a. Check the operation of the wide-band local oscillator at L.O. OUT jack J7.	a. Go to test procedure b.	a. Go to test procedure c.
		b. Inject a 32.238-MHz signal into pin 4 of J3 through a 0.01 microfarad capacitor, and check for deflection of the CRT baseline.	b. Troubleshoot the balanced mixer A8Q3/A8Q4 using the voltage measurements given in table 4-6.	b. Troubleshoot the A3 module using the voltage measurements given in table 4-6.
		c. Set the SWEEP RANGE switch at 0-25 MHz and check for the presence of a sawtooth waveform at pin 9 of J5 with an oscilloscope.	c. Troubleshoot wide-band local oscillator A5Q19/A5Q20 and buffer amplifier A5Q18 using the voltage measurements given in table 4-6.	c. Go to test procedure d.
		d. Repeat step c with the SWEEP RANGE switch set at 50 kHz - 5 MHz.	d. Troubleshoot emitter follower A1Q8 and A1Q7 using the voltage measurements given in table 4-6.	d. Troubleshoot complementary dc amplifier A1Q11/A1Q12 and sawtooth shaping amplifier Q1Q13 using its voltage measurements given in table 4-6.

4-16. ALIGNMENT PROCEDURES.

4-17. Paragraphs 4-20 through 4-29 give a complete alignment procedure for the VR-4b module. Each of the procedures starts with the operator's controls in the preliminary position given in paragraph 4-19 so that any procedure can be performed independent of the rest. It should be stressed that these procedures should be performed only when a minimum performance standard check is not satisfactory or a component has been replaced in an adjustable circuit.

4-18. The alignment procedures given assume that the main frame in which the VR-4b module is used is operating within its specifications. Therefore, the minimum performance checks given in the instruction manual for the main frame should be performed (also any required alignment) prior to starting the alignment of the VR-4b module.

4-19. PRELIMINARY CONTROL SETTINGS. The preliminary control settings for each of the alignment procedures are given in the following tabulation.

Note

Allow the equipment (both module and main frame) to warm up for 30 minutes before commencing with the alignment.

Control	Position
a. On the VR-4b module.	
INPUT ATTEN DB switch	70
CENTER FREQUENCY control	00.0 MHz
I-F ATTEN DB switch	20
I-F ATTEN DB VARIABLE control	Fully counterclockwise. (0 DB)
MARKERS switch	OFF
SWEEP WIDTH control	5.0 MHz
AMPLITUDE SCALE switch	LOG
SMOOTHING FILTER control	Fully counterclockwise.
0 Hz BALANCE controls	Fully clockwise
SWEEP RANGE switch	0-25 MHz PRESET
I-F BANDWIDTH control	Fully clockwise
SWEEP MODE switch	AUTO SCAN
Sweep Rate (VAR)	Fully clockwise
INPUT switch	50
All others	Any
b. On the main frame	
All controls	As required to produce a clear sharp trace on the CRT that is centered horizontally and coincides with the baseline on the graticule.

4-20. HORIZONTAL AND VERTICAL SWEEP POSITION ADJUSTMENT.

a. Set the operator's controls at the preliminary settings given in paragraph 4-19.

b. Set the SWEEP MODE switch to MANUAL and the SWEEP RANGE switch to 50 kHz - 5 MHz.

c. Set the RCA VTVM to read on the +15 vdc range and connect it between pin 12 of P1 (positive) and ground.

d. Set the Sweep Rate (VAR) control so that the VTVM reads +2.3 vdc.

e. Set the horizontal positioning control on the main frame to position the dot on the CRT under the -0.5 graduation on the graticule.

f. Set the Sweep Rate (VAR) control so that the VTVM reads +8.3 vdc.

g. Set the horizontal size control of the main frame to position the dot under the -0.5 graduation on the CRT graticule.

h. Repeat steps d through g until no further improvement is obtained.

i. Set the SWEEP MODE switch at AUTO SCAN and the Sweep Rate (VAR) control fully clockwise.

j. Switch the AMPLITUDE SCALE switch back and forth between LIN and LOG and note the shift in the position of the base line. Continue switching and adjust OUTPUT DC LEVEL A2R25 for minimum base-line shift. Reposition the baseline on the bottom graduation of the graticule by adjusting the vertical positioning control on the front of the main frame.

k. Set the SWEEP RANGE SWITCH to 0-25 MHz PRESET.

l. Set SAWTOOTH LIMIT A1R58 so that the left end of the CRT trace is 1/8 inch to the left of the graduation.

4-21. MARKER FREQUENCY ADJUSTMENT.

a. Set the operator's controls to the preliminary settings given in paragraph 4-19.

b. Connect the counter to A5TP1.

c. Set the MARKERS switch to 5 MHz and the MARKERS AMPLITUDE control fully clockwise. The frequency counter should read 5 MHz ± 1 kHz.

d. Set the MARKERS switch to 500 kHz.

e. Connect the counter to A5TP2.

f. Adjust MARKER LEVEL A5R8 so that the counter reads 500 kHz ±100 Hz.

g. Set the MARKERS switch to 25 kHz.

h. Connect the counter to A5TP3. The frequency counter should read 25 kHz ± 5 Hz.

4-22. PRELIMINARY OSCILLATOR AND I-F ALIGNMENT.

Note

This alignment is only a preliminary step. The procedures given in paragraph 4-21 must also be performed before the oscillator and i-f alignment is complete.

a. Set the operator's controls to the preliminary settings given in paragraph 4-19.

b. Set the MARKERS switch to 500 kHz, the MARKERS AMPLITUDE control fully clockwise, the SWEEP RANGE switch to 50 kHz - 5 MHz, and the AMPLITUDE SCALE switch to LIN.

c. Unplug A3P1 from A3J1 and look at the CRT. If markers are present, skip steps d through u and proceed with step v. If markers are not present, continue with step d.

d. Connect the high frequency AC VTVM between A3TP1 and ground.

e. Set A3C19 for maximum reading on the VTVM.

f. Look at the CRT. If markers are present, skip steps g through u and proceed with step v. If markers are not present, continue with step g.

g. Set the MARKERS switch to OFF.

h. Connect the high-frequency signal generator through the 0.01 microfarad capacitor to pin 2 of J2. Set the generator frequency at 2.7 MHz and the generator output for a small deflection of the base line.

i. Set A2C5 and A2C10, in that order, for maximum deflection of the base line.

j. Repeat step i until no further improvement is obtained.

k. Connect the signal generator through the capacitor to pin 1 of J4.

l. Set A4C19, A4C23, and A4C26, in that order, for maximum deflection of the base line.

m. Repeat step l until no further improvement is obtained.

n. Set the MARKERS switch to 500 kHz and look at the CRT. If markers are present, skip steps p through u and proceed with step v. If markers are not present, proceed with step p.

o. Set the MARKERS switch to OFF.

p. Set the signal generator frequency to 32.238 MHz. Connect the signal generator through the 0.01 microfarad capacitor to pin 4 of J3 and adjust the generator output for a small deflection of the base line.

q. Set A3C15, A3T1, and A3T2, in that order, for maximum deflection of the base line.

r. Repeat step q until no further improvement is obtained.

s. Connect the signal generator (no capacitor) to INPUT jack J6 and adjust the generator output for a small deflection of the base line.

t. Set A8T1 for maximum deflection of the base line. Disconnect the signal generator.

u. Set the MARKERS switch to 500 kHz and verify that markers appear on the CRT.

v. Set the MARKERS switch to 5 MHz, the CENTER FREQUENCY control at approximately 5 MHz (so that the 5-MHz marker can be seen), and the MARKERS AMPLITUDE control for a small deflection of the 5-MHz marker.

w. Set A3C19, A2C5, A2C10, A3C15, A3T1, A3T2, A8T1, A4C19, A4C23, and A4C26, in that order, for maximum deflection of the 5-MHz marker.

x. Repeat step w until no further improvement is obtained.

4-23. 2.7 MHz CRYSTAL FILTER ADJUSTMENT.

a. Set the operator's controls to the preliminary settings given in paragraph 4-19.

b. Set the SWEEP RANGE switch to 50 kHz - 5 MHz and the FREQ CAL control at the midpoint of its range.

c. Set ZERO FREQ ADJ A1R3 to position the zero pip under the CF graduation on the graticule.

d. Slowly reduce the setting of the SWEEP WIDTH control to 0.050 MHz while adjusting ZERO FREQ ADJ A1R3 as required to keep the zero pip under the CF graduation.

e. Set the SWEEP WIDTH control to 5 MHz.

f. Set DC BAL ADJ A1R17 to position the zero pip under the CF graduation.

g. Set the CENTER FREQUENCY control to 25 MHz.

h. Set the MARKERS switch to 5 MHz.

i. Set 25 MHz ADJ A1R7 to position the 25-MHz marker under the CF graduation.

j. Set the CENTER FREQUENCY control to approximately 5 MHz and adjust it to position the 5-MHz marker under the CF graduation.

k. Perform the locking procedure given in paragraph 2-46x to synchronize the wide-band oscillator with the narrow band oscillator.

l. Set the SWEEP RANGE switch to 0.5 kHz - 50 kHz NARROW BAND, the MARKERS AMPLITUDE control fully clockwise, the Sweep Rate (VAR) control fully counterclockwise, the AMPLITUDE SCALE switch to LIN and the FINE TUNING NARROW BAND control to position the 5-MHz marker under the CF graduation.

m. Remove crystal A4Y1 from its socket.

n. Set the I-F BANDWIDTH control fully clockwise, the Sweep Rate (VAR) control fully cw, and the MARKERS AMPLITUDE control for full scale deflection of the marker.

o. Set A4C13 for the best symmetry of the display and A4C14 for maximum bandwidth. Adjust the MARKERS AMPLITUDE control as required to maintain full scale deflection.

p. Repeat step o until no further improvement is obtained.

q. Set the SWEEP WIDTH control so that the leading edge of the 5-MHz marker crosses the -0.5 frequency graduation at the -20 dB amplitude graduation and the trailing edge crosses the +0.5 frequency graduation at the 5 amplitude graduation. Readjust A4C13, if necessary, to obtain this display.

r. Return the SWEEP WIDTH control to 50 kHz. Slowly rotate the I-F BANDWIDTH control counterclockwise and observe that the amplitude of the center of the marker decreases in a straight line down the CF graduation.

s. Plug in A4Y1 and remove A4Y2.

t. Repeat steps n through r adjusting A4C2 and A4C3 instead of A4C13 and A4C14.

u. Plug in A4Y2.

v. Return the I-F BANDWIDTH control to fully cw. Set the MARKERS AMPLITUDE control for full scale deflection and repeat step q. Trim up A4C3 and/or A4C14, if necessary.

4-24. FINAL OSCILLATOR AND I-F ALIGNMENT.

a. Set the operator's controls to the preliminary settings given in paragraph 4-19.

b. Set the SWEEP RANGE switch to 50 kHz - 5 MHz, the SWEEP WIDTH control to 5 MHz, the CENTER FREQUENCY control to 5 MHz, and the MARKERS switch to 5 MHz.

c. Adjust the CENTER FREQUENCY control to position the 5 MHz marker under the CF graduation.

d. Repeat steps k and l of paragraph 4-23.

e. Set the SWEEP WIDTH control to 0.5 kHz. Set the AMPLITUDE SCALE switch to LIN.

f. Set the MARKERS AMPLITUDE control for a small deflection of the 5-MHz marker. Adjust the FINE TUNING NARROW BAND control for maximum deflection of the base line.

g. Set A3C19, A2C5, A2C10, A3C15, A3T1, A3T2, A8T1, A4C19, A4C23, and A4C26, in that order, for maximum deflection of the base line.

4-25. 26.838 MHz TRAP ADJUSTMENT.

a. Set the operator's controls to the preliminary settings given in paragraph 4-19.

b. Set the SWEEP RANGE switch to 0.5 kHz-50 kHz NARROW BAND, the SWEEP WIDTH to 0.5 kHz, and the AMPLITUDE SCALE switch to LIN.

c. Connect the high-frequency signal generator through the 0.01 microfarad capacitor to pin 4 of J3.

d. Set the generator frequency at 26.838 MHz.

e. Set the generator output for full scale deflection of the signal pip. Readjust generator frequency for maximum deflection of the baseline.

f. Reconnect A3P1 to A3J1. Set A3C1 for minimum deflection of the baseline, adjusting the generator output as required to maintain a display.

4-26. PHASE SPLITTER, BALANCE AND HARMONIC DISTORTION ADJUSTMENTS.

a. Set the operator's controls to the preliminary settings given in paragraph 4-19.

b. Connect the low-frequency signal generator to INPUT jack J6.

c. Set the frequency of the generator to 1 kHz and the output to 5 millivolts. Set the wave analyzer to measure the fundamental signal.

d. Disconnect A8P1 from A8J1. Connect the wave analyzer to A8TP1 and measure the level of the signal.

e. Repeat step d at A8TP2.

f. Adjust A8R11 to obtain equal signal levels at both test points.

g. Set the wave analyzer to measure the second harmonic signal.

h. Repeat steps d and e.

i. Set A8R5 for minimum second harmonic level at both test points.

j. Repeat steps c through i until no further improvement is obtained.

k. Adjust the 0 Hz BALANCE controls until the zero pip is minimum amplitude. (Use IF ATTEN DB control as required.)

l. Adjust A8C15 for minimum zero pip amplitude.

m. Repeat steps k and l until no further improvement is obtained.

4-27. SWEEP RATE ADJUSTMENT.

a. Set the operator's controls to the preliminary settings given in paragraph 4-19.

b. With the stop watch measure the time required for 10 complete scans of the CRT trace.

c. Set A6R5 so that the time required for 10 complete scans is 10 seconds.

4-28. AMPLITUDE ADJUSTMENT.

a. Set the operator's controls to the preliminary settings given in paragraph 4-19.

b. Set the CENTER FREQUENCY control to 12.5 MHz, the FINE TUNING NARROW BAND control to the center of its range, SWEEP RANGE switch to 50 kHz - 5 MHz, and the INPUT ATTEN DB switch to 0.

c. Connect the high-frequency signal generator through the step attenuator to INPUT jack J6. Set step attenuator to 0 dB.

d. Set the generator frequency at 12.5 MHz and the generator output at 300 microvolts.

e. Adjust the CENTER FREQUENCY control to position the signal under the CF graduation on the graticule.

f. Set the SWEEP RANGE switch to SEARCH/LOCK and lock the wideband oscillator to the narrowband oscillator (paragraph 2-46x) and then set the SWEEP RANGE switch at 0.5 kHz to 50 kHz.

g. Adjust the FINE TUNING NARROW BAND control to position the signal under the CF graduation on the graticule.

h. Set the SWEEP WIDTH control to 10 kHz and adjust the Sweep Rate (VAR) and I-F BANDWIDTH controls for optimum resolution of the signal.

i. Set A6R3 so that the amplitude of the signal is 0 dB.

j. Set the step attenuator for 20 dB of attenuation.

k. Adjust I-F GAIN A2R13 so that the signal amplitude is -20 dB.

l. Set the step attenuator for 0 dB attenuation and repeat step i.

m. Repeat steps j, k, and l, until no further improvement is obtained.

n. Set the AMPLITUDE SCALE switch to LIN and set the step attenuator for 20 dB of attenuation.

o. Set A6R2 so that the signal amplitude on the linear scale is 10.

p. Insert another 6 dB with the step attenuator (a total now of 26 dB).

q. Set A6R1 so that the signal amplitude on the linear scale is 5.

r. Remove 6 dB of attenuation with the step attenuator and repeat step o.

s. Repeat steps p, q, and r, until no further improvement is obtained.

4-29. SHAPING CIRCUIT ADJUSTMENT.

a. Set the operator's controls to the preliminary settings given in paragraph 4-19.

b. Set the MARKERS switch at 5 MHz, the CENTER FREQUENCY control at 5 MHz, the SWEEP

RANGE switch to 50 kHz-5MHz, and the I-F ATTEN DB switch to 10.

c. Adjust the FREQ CAL control through its entire range and note the total excursion of the 5 MHz marker on the CRT.

d. Set the FREQ CAL control so that the zero pip is positioned in the middle of its excursion as noted in the previous step.

e. Set the RANGE switch to 0-25 MHz PRESET. The 25-MHz marker should be under the +0.5 graduation of the graticule. If not, select values for A5C56 and A5C57 to position the 25-MHz marker as near the +0.5 graduation as possible. (Equal values should be used for A5C56 and A5C57; the permissible range of values is from 22 to 39 picofarads.) Adjust A5R76 to position the 0-MHz marker under the -0.5 graduation on the graticule.

f. Set A1R46, A1R48, A1R50, A1R52, and A1R54 so that the 20, 15, 10, 5, and 0-MHz markers are under the second, fourth, sixth, eighth and tenth graduations from the +0.5 graduation on the graticule, respectively.

g. Repeat step f until no further improvement is obtained.

h. Set the SWEEP RANGE switch to 50 kHz - 5 MHz and set the CENTER FREQUENCY control to position the 10-MHz marker under the -0.5 graduation on the graticule.

i. Set SWEEP WIDTH ADJ A1R18 to position the 15-MHz marker under the +0.5 graduation on the graticule, while continuously adjusting CENTER FREQUENCY control to keep the 10-MHz marker under the -0.5 graduation.

j. Set the CENTER FREQUENCY control to 00.0 MHz and the SWEEP WIDTH control to 0.05 MHz.

k. Set ZERO FREQ ADJ A1R3 to position the zero pip under the CF graduation on the graticule.

l. Set the SWEEP WIDTH control to 5 MHz.

m. Set DC BAL A1R17 to position the zero pip under the CF graduation on the graticule.

n. Set the CENTER FREQUENCY control to 25 MHz.

o. Set 25-MHz ADJ A1R7 to position the 25-MHz marker under the CF graduation on the graticule.

p. Set the MARKERS switch to 500 kHz.

q. Set A1R31 so that the markers above and below the 25-MHz marker are equally spaced.

r. Adjust 25-MHz ADJ A1R7 to reposition the 25-MHz marker under the CF graduation on the graticule.

s. Adjust the CENTER FREQUENCY control to position the 25-MHz marker under the +0.5 graduation of the CRT graticule.

t. Adjust A1R46 to position the 20-MHz marker under the -0.5 graduation on the graticule.

Note

The five following steps are a general procedure which is to be performed in conjunction with table 4-5. This procedure must be performed four separate times as indicated by the table using the data given in the table.

u. Set the CENTER FREQUENCY control to position the right marker under the +0.5 graduation.

v. Set the adjustment to position the left marker under the -0.5 graduation.

w. Set the linearity adjustment so that the markers either side of the CF graduation on the graticule are evenly spaced.

x. Set the right marker control to reposition the right marker under the +0.5 graduation.

y. Set the left marker control to reposition the left marker under the -0.5 graduation.

z. Repeat steps u through y for the three remaining sets of conditions given in the table. If difficulty is experienced on the achieving dial tracking at low frequencies, set the SWEEP WIDTH control to 0.5 kHz, the MARKERS switch to 500 kHz, and the CENTER FREQUENCY control to 00.5 MHz. Adjust A1R42 to position the 500-kHz marker under the CF graduation on the graticule. Set the CENTER FREQUENCY control to 00.0 MHz and adjust A1R43 to position the zero pip under the CF graduation. Repeat these adjustments until no further improvement can be obtained. Recheck linearity of other markers throughout the frequency range.

aa. Set the SWEEP RANGE switch to 0-25 MHz PRESET and the MARKERS switch to 5 MHz. Check all of the markers for correct positioning with

TABLE 4-5. SHAPING CIRCUIT ADJUSTMENT TABULATION

Procedure	Right Marker	Left Marker	Left Marker Control	Linearity Adjustment	Right Marker Control
1	20 MHz	15 MHz	A1R48	A1R39	A1R46
2	15 MHz	10 MHz	A1R50	A1R40	A1R48
3	10 MHz	5 MHz	A1R52	A1R41	A1R50
4	5 MHz	0 MHz	A1R54	A1R42 and A1R43	A1R52

respect to the graduations on the graticule. All markers should be correctly positioned within ±1/4 graduation. If the markers are correctly positioned, proceed with step ab. If the markers are not correctly positioned, repeat steps e through z.

ab. Set the SWEEP RANGE switch to 50 kHz - 5 MHz and the CENTER FREQUENCY control to 10 MHz. Position the CENTER FREQUENCY control so that the 10-MHz marker is under the CF graduation on the graticule.

ac. Perform the locking procedure given in paragraph 2-46x to synchronize the wide-band oscillator with the narrow-band oscillator and then set the SWEEP RANGE switch to 0.5-50 kHz NARROW BAND.

ad. Set the FINE TUNING NARROW BAND control to position the 10-MHz marker under the CF graduation on the graticule.

ae. Set the Sweep Rate (VAR) control and the I-F BANDWIDTH control for optimum resolution of the signal.

af. Set the MARKERS switch to 25 kHz and the SWEEP WIDTH control to 50 kHz.

ag. Set 50-kHz SWEEP WIDTH ADJ A1R55 to position the 25-kHz markers on either side of the CF graduation under the +0.5 and -0.5 graduation on the graticule.

4-30. TYPICAL VOLTAGE MEASUREMENTS.

4-31. Voltage measurements for each of the transistor stages in the VR-4b module are given in table 4-6. These values were obtained by setting the operator's controls at the positions given below and measuring the voltages with the RCA VTVM listed in table 4-6.

Control	Position
INPUT ATTEN DB switch	0
I-F ATTEN DB switch	0
I-F ATTEN DB VARIABLE control	Fully CW
MARKERS switch	25 kHz
AMPLITUDE SCALE switch	LOG
SWEEP RANGE switch	0-25 MHz PRESET
I-F BANDWIDTH control	Mid-position
INPUT switch	50Ω
All others	Any

TABLE 4-6. VOLTAGE MEASUREMENTS (See Note 1)

Module	Stage	Emitter	Base	Collector
A1	Q1	6.7	7.2	18.0
	Q2	6.2	6.7	10.5
	Q3	5.8	17.3 (Note 2)	0
	Q4	5.2	5.8	17.5
	Q5	18.2	17.5	11.0
	Q6	14.0	14.6	18.2
	Q7	7.8	7.2 (Note 4)	-9.0
	Q8	0.6	1.2 (Note 3)	18.2
	Q9	7.8	7.2	-0.9
	Q10	14.6	15.3	18.2
	Q11	7.4	7.8	17.5
	Q12	18.2	17.5	9.2
	Q13	4.8	5.4	6.5
A2	Q1	-4.7	-5.0	-10.8
	Q2	-1.6	-1.8	-10.8
	Q3	-1.6	-1.8	-10.8
	Q4	-4.8	-5.2	-10.8
	Q5	0.78	0.13	-5.3
	Q6	-5.8	-6.0	-10.8
	Q7	-5.5	-5.3	0
	Q8	0.08	0.8	22.0
A3	Q1	10.4	10.1	0
	Q2	10.4	10.1	0
	Q3	11.5	11.3	0
	Q4	1.5	2.1	13.9

TABLE 4-6. VOLTAGE MEASUREMENTS (See Note 1) (Cont'd)

Module	Stage	Emitter	Base	Collector
A4	Q1	-0.6	-1.2	-8.1
	Q2	0.6	0	-8.4
	Q3	-2.4	-3.1	-6.7
	Q4	-2.4	-3.1	-5.8
	Q5	-0.6	-1.2	-8.1
	Q6	0.6	0	-8.4
	Q7	21.3 (Note 5)	2.0 (Note 5)	21.5 (Note 5)
	Q8	22.0	21.5 (Note 5)	22.0 (Note 5)
	Q9	-6.7	-6.0	0
	Q10	-5.3	-6.0	-11.8
A5	Q1	5.6	6.1	7.8
	Q2	5.6	6.1	7.8
	Q3	0	0.4	2.5
	Q4	0	0.4	2.5
	Q5	-0.4	-0.6	3.9
	Q6	0.3	0	8.8
	Q7	11.3	11.7	13.8
	Q8	11.3	11.7	13.8
	Q9	0	0.4	2.5
	Q10	0	0.4	2.5
	Q11	0	0	-7.2
	Q12	0	-0.1	-9.6
	Q13	20	2.5	5.0
	Q14	0	0.4	2.5
	Q15	0	0.4	2.5
	Q16	-19.0	-17.5	-1.2
	Q17	-3.3	-3.6	-17.5
	Q18	1.2	1.7	9.6
	Q19	4.8	5.2	12.1
	Q20	4.8	5.2	12.1
A7 (Note 7)	Q1	-2.5	-2.2	-0.65
	Q2	-7.9	-7.1	-4.2
	Q3	-7.4	-7.0	-3.7
	Q4	-2.1	-3.7	0
A8	Q1	-0.7	0	8.7
	Q2	-0.7	0	8.7
	Q3	1.4	1.6	8.0
	Q4	1.4	1.6	8.0

Notes

1. All voltages taken with respect to chassis ground with an RCA WV-98C VTVM.
2. Determined by SAWTOOTH LIMIT ADJ A1R58.
3. Determined by 5 MHz SWEEP WIDTH ADJ A1R18 and DC BAL ADJ A1R17.
4. Determined by DC BAL ADJ A1R17.
5. Determined by DC balance voltages for A1Q1 and A1Q2 taken in 0.5 kHz - 50 kHz NARROW BAND position of SWEEP RANGE control.
6. I-F BANDWIDTH control fully CCW.
7. SWEEP RANGE control in SEARCH LOCK position, SEARCH/LOCK thumbwheel in maximum upward position.

SECTION V

SCHEMATIC DIAGRAMS

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NOTICE:
This document is free on the internet.

If you paid someone for it, did you get a square deal on the added services and value they provided? There are a few manual dealers out there who have real nice "reproductions" of the original manual. If you are going to pay for something, pay for one of those, it's worth it.

This scanned document is "FREE" to keep, use, and distribute as long as no changes are made.
It is posted on the internet at www.bunkerofdoom.com and other places. Search the internet for "Singer VR-4b".

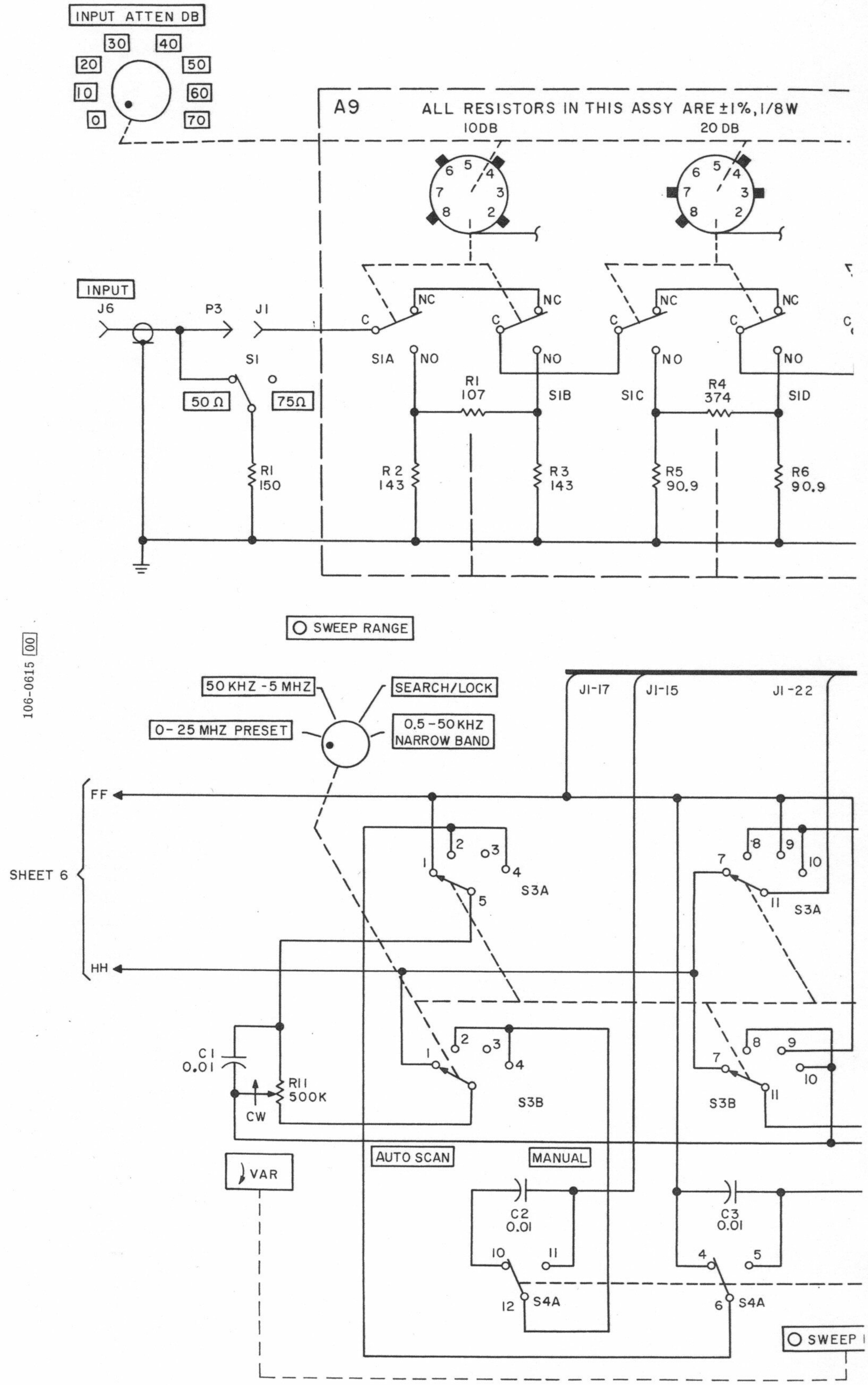
I scanned it in the hope that you can use it to fix your Alfred/Panoramic/Singer/Slant-Fin spectrum analyzer's VR-4B module. I paid for an origninal manual in order to do this, since I have two Singer MF-5 mainframes and VR-4B plugins. They are pretty beat up as shown below. The whole manual is in monochrome, except these two pictures to help spot the equipment, should you find one at a hamfest.

About the schematics, they are on some really long paper. I broke them into 8.5x11 overlapping sections. The idea is for you to print them and cut and tape them together. (the best I could do.)

Singer Instrumentation is out of business. No one with true rights to the manual supports this instrument any more. I hope they don't mind that we are using it.

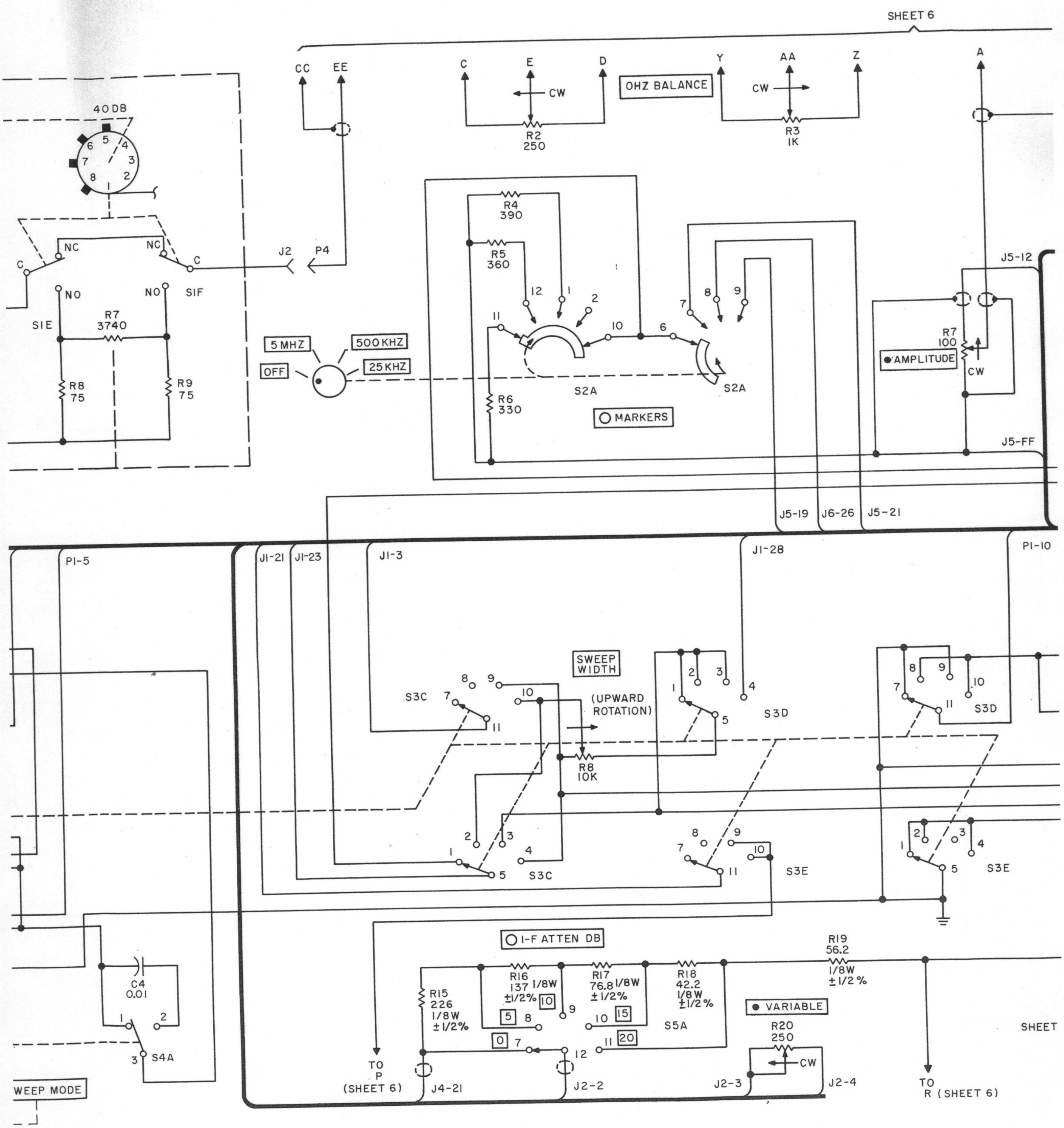
Best Regards,
Patrick J. Jankowiak
KD5OEI

Notice one of the units has a VR-4 and one has a VR-4b. Don't ask, I do not know..

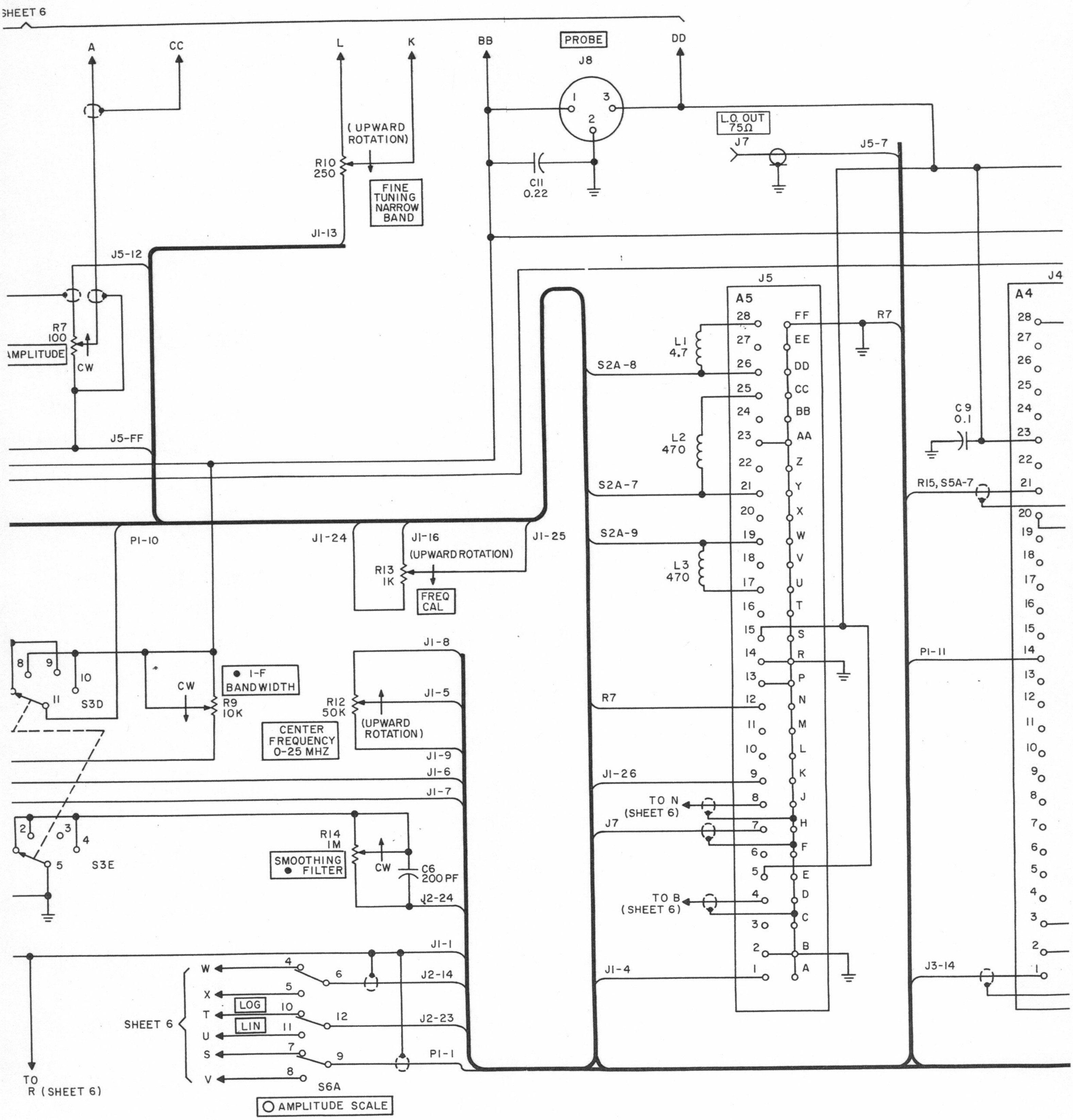


INPUT ATTEN DB
30
40
20
50
10
60
0
70
A9
ALL RESISTORS IN THIS ASSY ARE ±1%, 1/8W
10DB
20 DB
INPUT
J6
P3
J1
S1
50 Ω
75Ω
R1
150
C
NC
NO
S1A
S1B
S1C
S1D
R1
107
R4
374
R 2
143
R 3
143
R5
90.9
R6
90.9
SWEEP RANGE
50 KHZ - 5 MHZ
SEARCH/LOCK
0 - 25 MHZ PRESET
0.5 - 50 KHZ NARROW BAND
J1-17
J1-15
J1-22
FF
HH
SHEET 6
S3A
S3B
C1
0.01
R11
500K
CW
VAR
AUTO SCAN
MANUAL
C2
0.01
C3
0.01
S4A
SWEEP

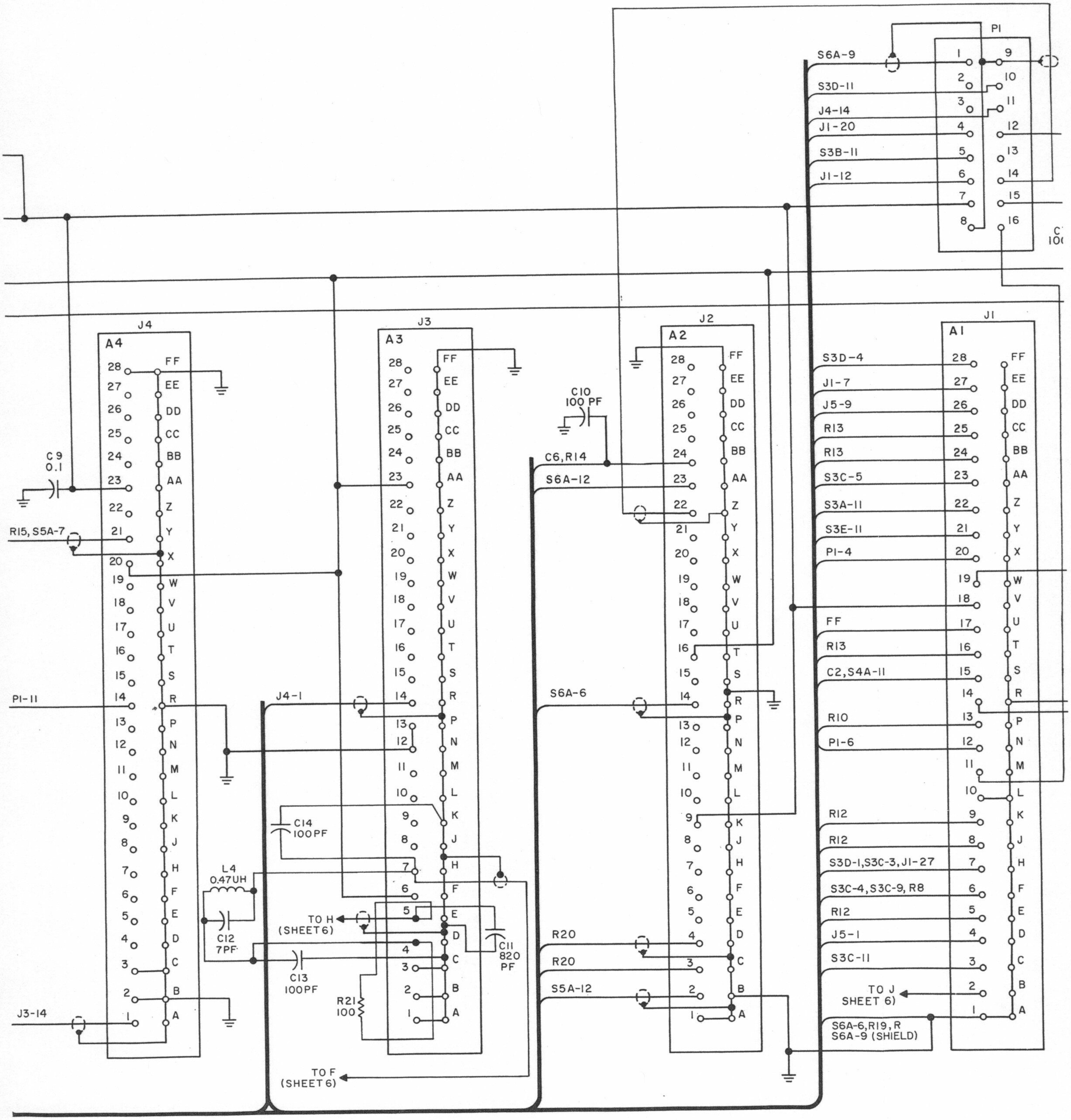
106-0615 00



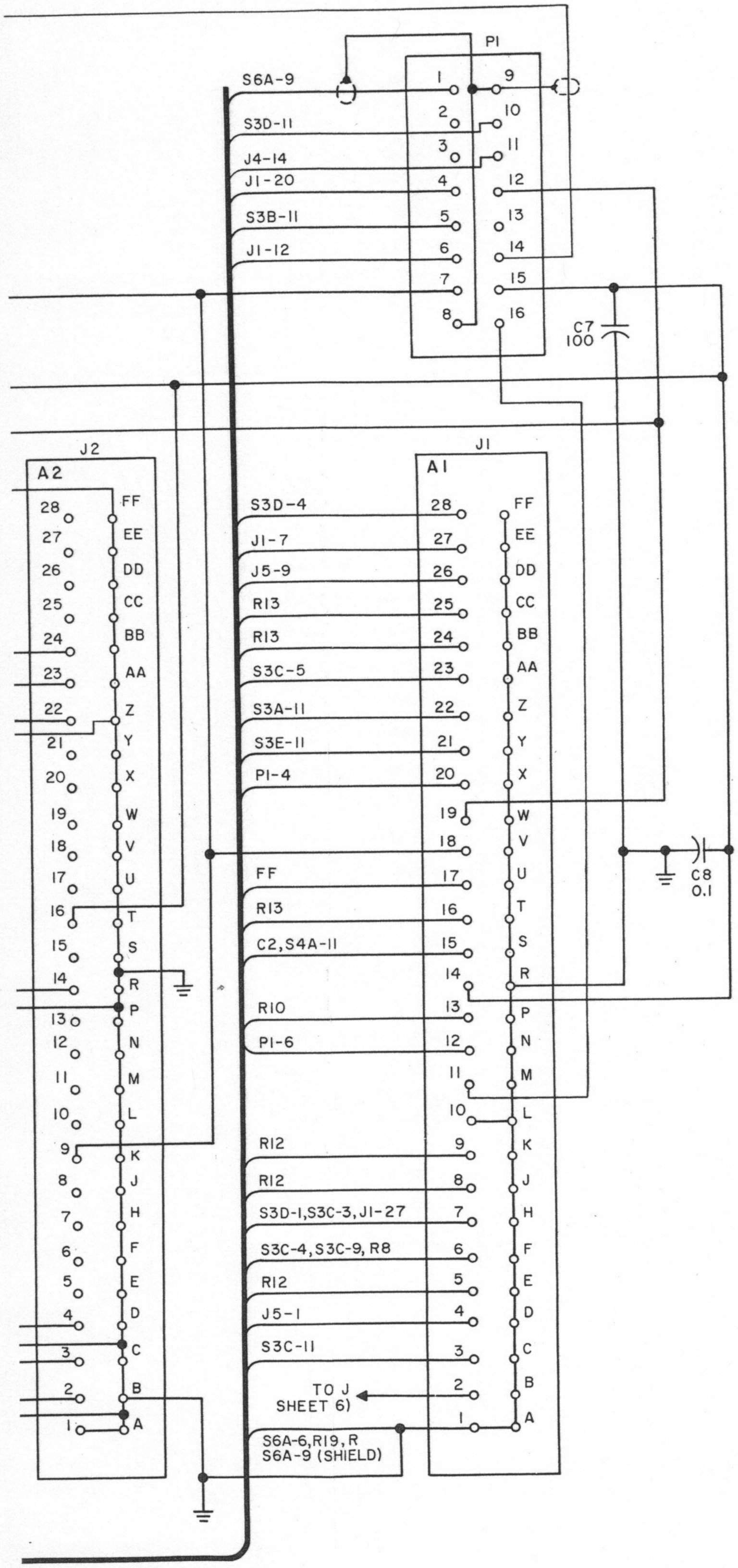
SHEET 6
CC
EE
C
E
D
CW
R2
250
OHZ BALANCE
Y
AA
Z
CW
R3
IK
A
40 DB
NC
NC
C
C
J2
P4
NO
NO
SIF
SIE
R7
3740
R8
75
R9
75
R4
390
R5
360
R6
330
5 MHZ
500 KHZ
OFF
25 KHZ
S2A
S2A
MARKERS
J5-12
R7
100
AMPLITUDE
CW
J5-FF
J5-19
J6-26
J5-21
P1-5
J1-21
J1-23
J1-3
J1-28
P1-10
SWEEP WIDTH
(UPWARD ROTATION)
S3C
S3D
S3D
R8
10K
S3C
S3E
S3E
C4
0.01
S4A
WEEP MODE
I-F ATTEN DB
R15
226
1/8W
±1/2%
R16
137 1/8W
±1/2%
R17
76.8 1/8W
±1/2%
R18
42.2
1/8W
±1/2%
R19
56.2
1/8W
±1/2%
S5A
VARIABLE
R20
250
CW
TO
P
(SHEET 6)
J4-21
J2-2
J2-3
J2-4
TO
R (SHEET 6)
SHEET

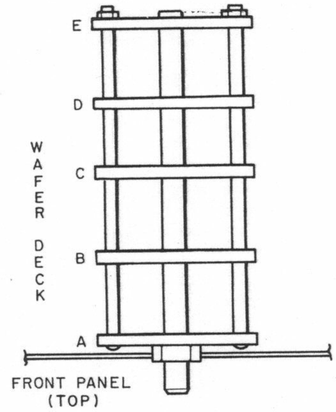


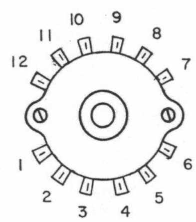
SHEET 6
A
CC
L
K
BB
PROBE
J8
DD
(UPWARD ROTATION)
R10 250
FINE TUNING NARROW BAND
C11 0.22
L.O. OUT 75Ω
J7
J5-7
J1-13
J5-12
R7 100
AMPLITUDE
CW
J5-FF
J5
A5
J4
A4
L1 4.7
L2 470
L3 470
S2A-8
S2A-7
S2A-9
R7
C9 0.1
R15, S5A-7
P1-10
J1-24
J1-16
(UPWARD ROTATION)
J1-25
R13 1K
FREQ CAL
S3D
● I-F BANDWIDTH
R9 10K
J1-8
J1-5
R12 50K
(UPWARD ROTATION)
CENTER FREQUENCY 0-25 MHZ
J1-9
J1-6
J1-7
J1-26
P1-11
TO N (SHEET 6)
J7
R14 1M
SMOOTHING ● FILTER
C6 200 PF
S3E
J2-24
TO B (SHEET 6)
J1-1
J2-14
J1-4
J3-14
LOG
LIN
J2-23
P1-1
TO R (SHEET 6)
S6A
○ AMPLITUDE SCALE



P1
S6A-9
S3D-11
J4-14
J1-20
S3B-11
J1-12
J4
A4
J3
A3
J2
A2
J1
A1
C9
0.1
R15, S5A-7
P1-11
J3-14
J4-1
C14
100PF
L4
0.47UH
C12
7PF
C13
100PF
TO H
(SHEET 6)
C11
820
PF
R21
100
TO F
(SHEET 6)
C10
100 PF
C6, R14
S6A-12
S6A-6
R20
R20
S5A-12
S3D-4
J1-7
J5-9
R13
R13
S3C-5
S3A-11
S3E-11
P1-4
FF
R13
C2, S4A-11
R10
P1-6
R12
R12
S3D-1, S3C-3, J1-27
S3C-4, S3C-9, R8
R12
J5-1
S3C-11
TO J
SHEET 6)
S6A-6, R19, R
S6A-9 (SHIELD)



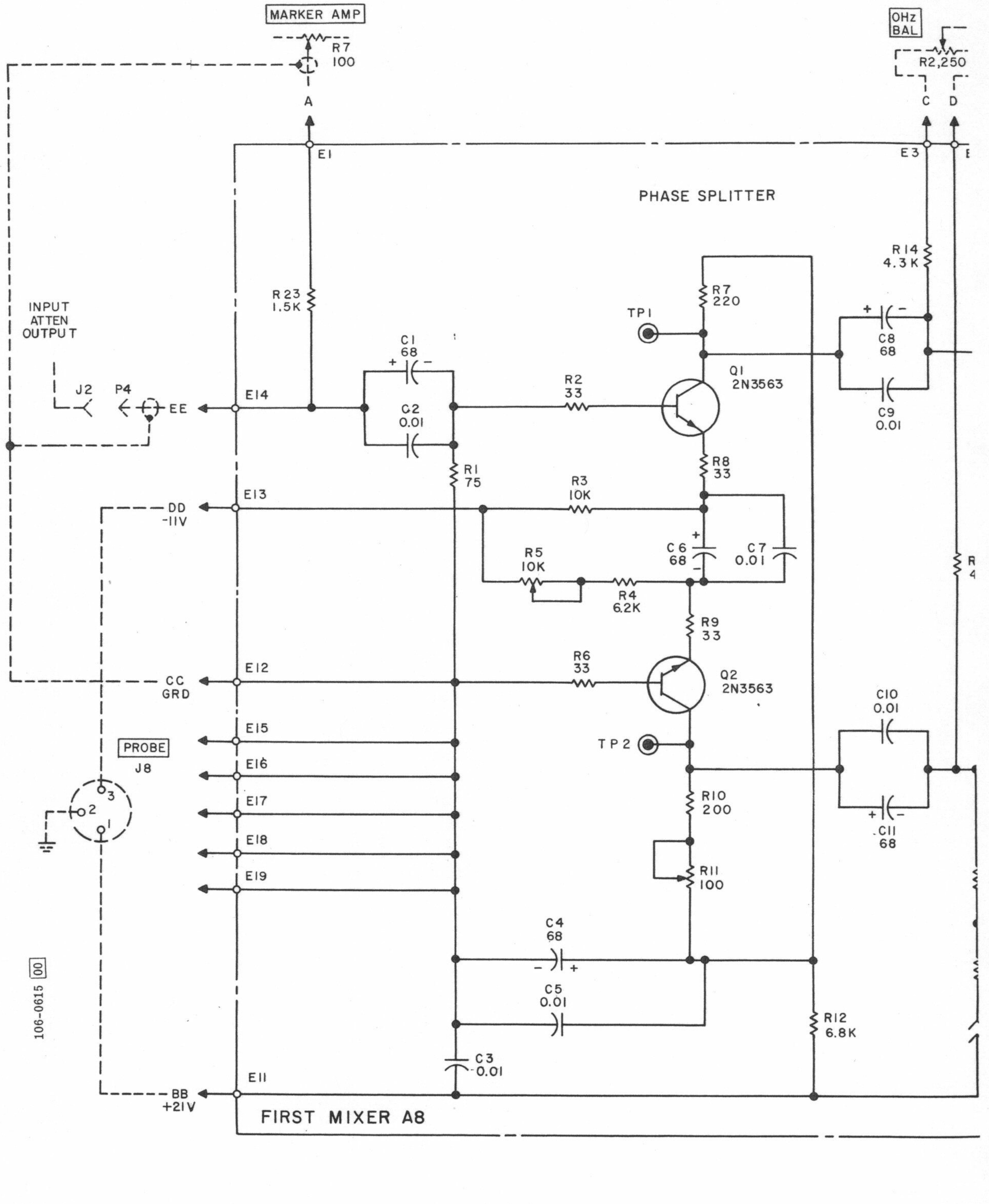




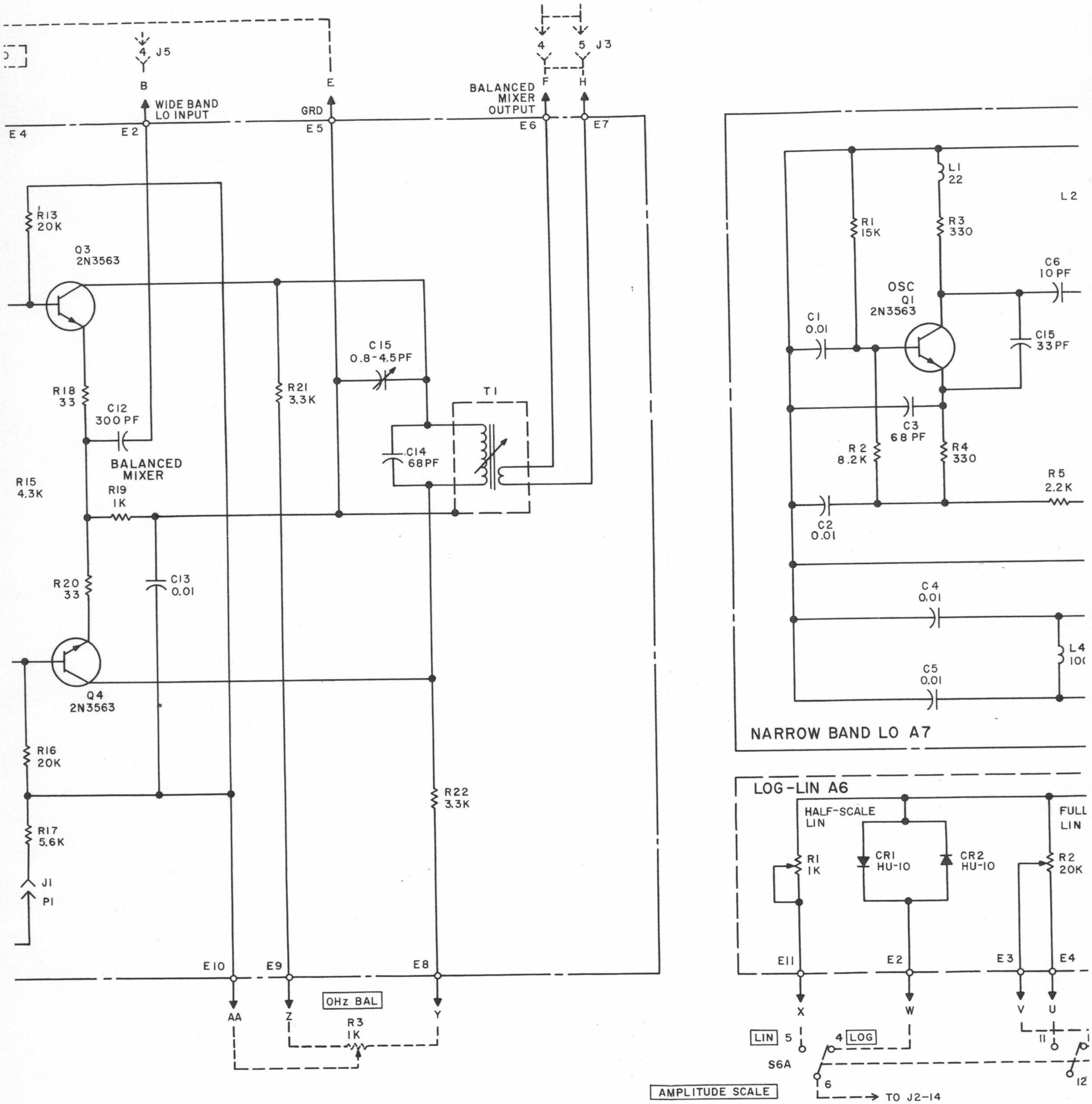
NOTES:

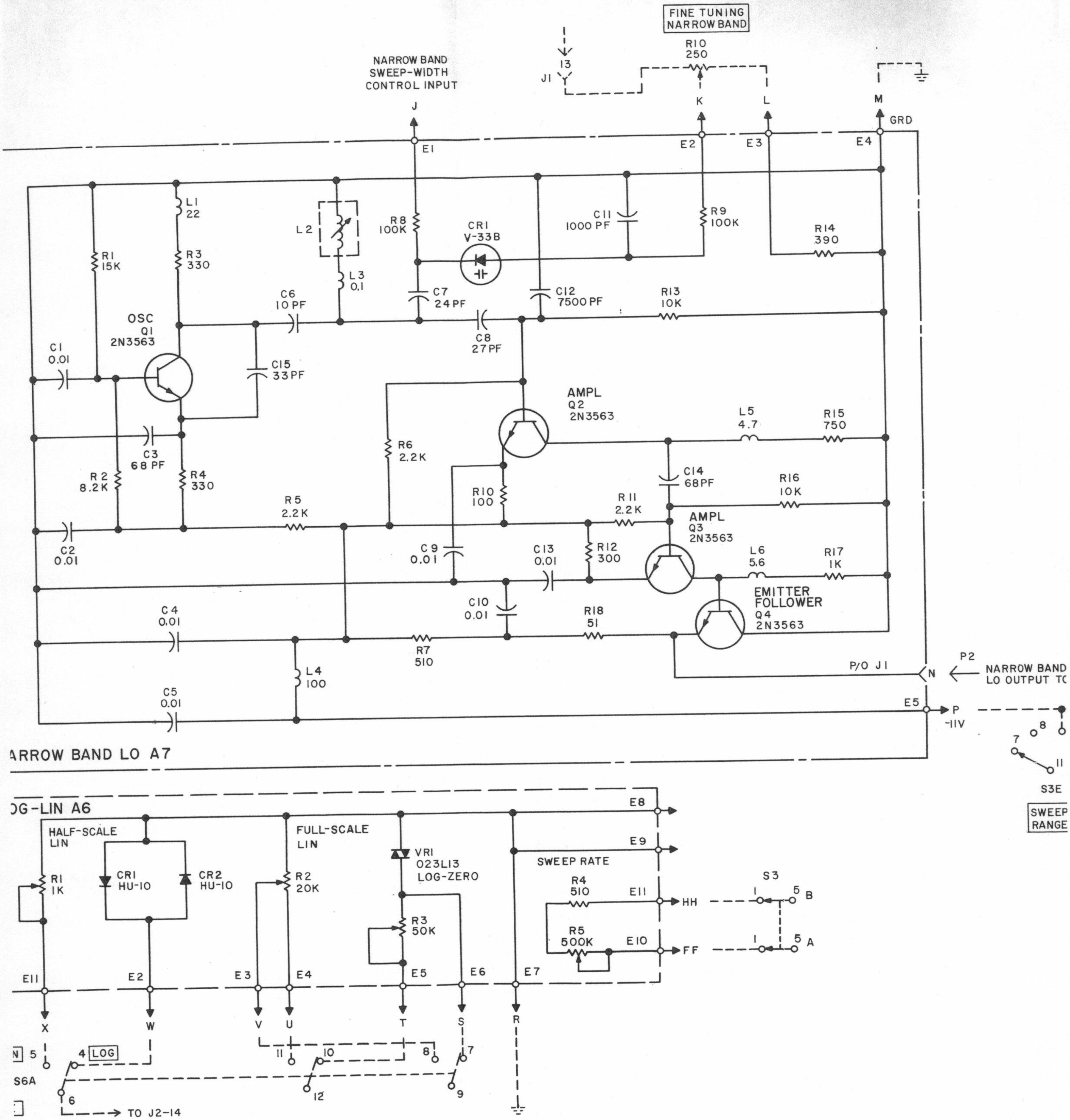
1. ALL WAFER SWITCHES ARE DESIGNATED AS SHOWN ABOVE.
2. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS.
3. ALL CAPACITORS ARE IN MICROFARADS.
4. ALL INDUCTORS ARE IN MICROHENRIES.
5. ▭ INDICATES FRONT PANEL MARKINGS.

Figure 5-1. Video Module Model VR-4,
Schematic of Interconnection

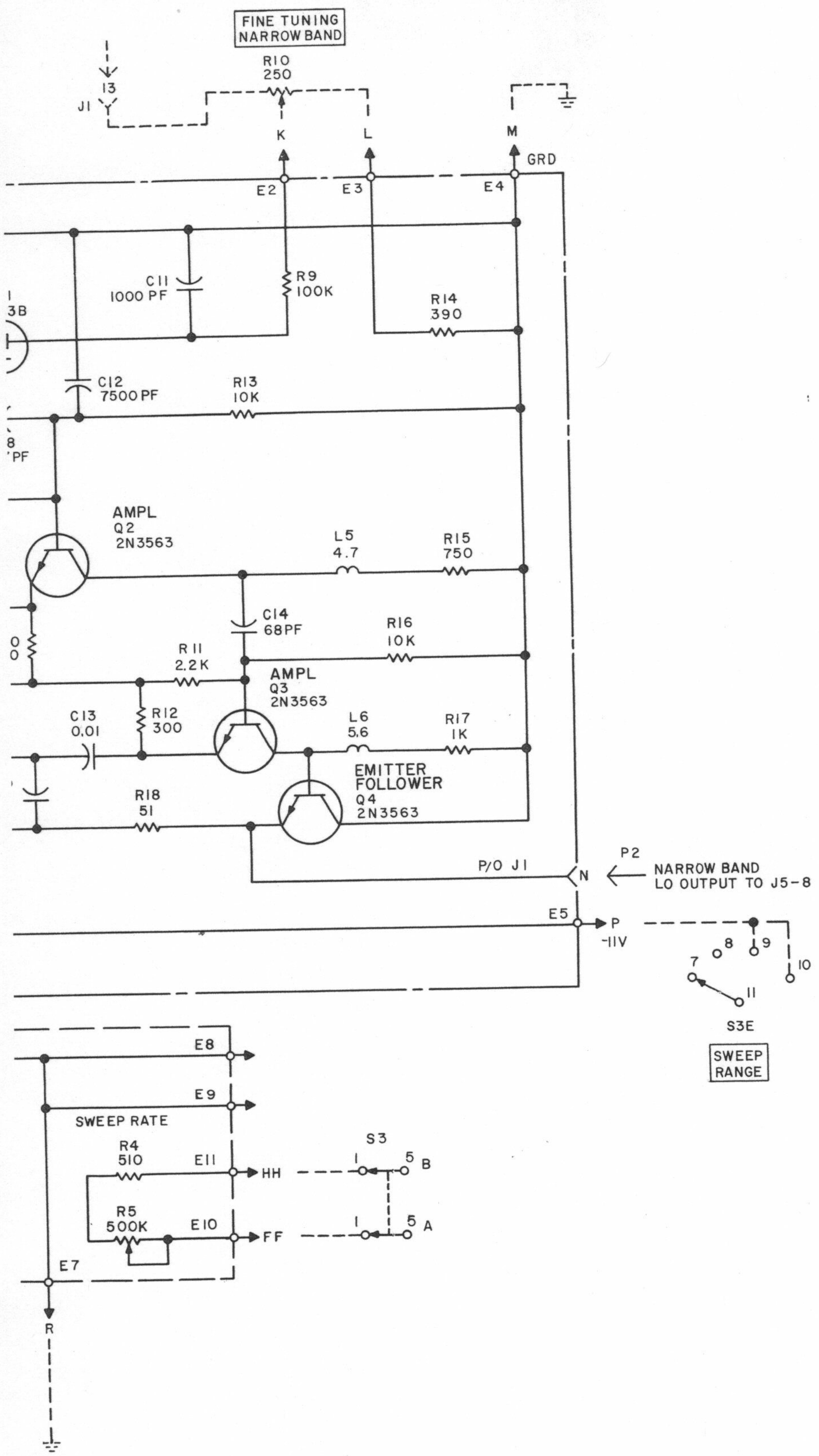


MARKER AMP
R7
100
A
E1
OHz
BAL
R2,250
C
D
E3
PHASE SPLITTER
R14
4.3K
R7
220
TP1
R23
1.5K
INPUT
ATTEN
OUTPUT
C1
68
C8
68
Q1
2N3563
J2
P4
EE
E14
R2
33
C2
0.01
C9
0.01
R8
33
R1
75
R3
10K
E13
DD
-11V
C6
68
C7
0.01
R5
10K
R4
6.2K
R9
33
R6
33
Q2
2N3563
E12
CC
GRD
C10
0.01
E15
PROBE
J8
TP2
E16
E17
R10
200
C11
68
E18
R11
100
E19
C4
68
C5
0.01
R12
6.8K
106-0615 00
C3
0.01
E11
BB
+21V
FIRST MIXER A8


4 J5
B
WIDE BAND
LO INPUT
E4
E2
E
GRD
E5
4
5 J3
F
H
BALANCED
MIXER
OUTPUT
E6
E7
R13
20K
Q3
2N3563
R18
33
C12
300 PF
BALANCED
MIXER
R15
4.3K
R19
1K
R20
33
C13
0.01
Q4
2N3563
R16
20K
R17
5.6K
J1
P1
R21
3.3K
C15
0.8-4.5PF
C14
68PF
T1
R22
3.3K
E10
E9
E8
AA
Z
Y
0Hz BAL
R3
1K
L1
22
L2
R1
15K
R3
330
C6
10 PF
OSC
Q1
2N3563
C1
0.01
C15
33PF
C3
68 PF
R2
8.2K
R4
330
R5
2.2K
C2
0.01
C4
0.01
C5
0.01
L4
NARROW BAND LO A7
LOG-LIN A6
HALF-SCALE
LIN
FULL
LIN
R1
1K
CR1
HU-10
CR2
HU-10
R2
20K
E11
E2
E3
E4
X
W
V
U
LIN 5
4 LOG
S6A
6
11
12
AMPLITUDE SCALE
TO J2-14



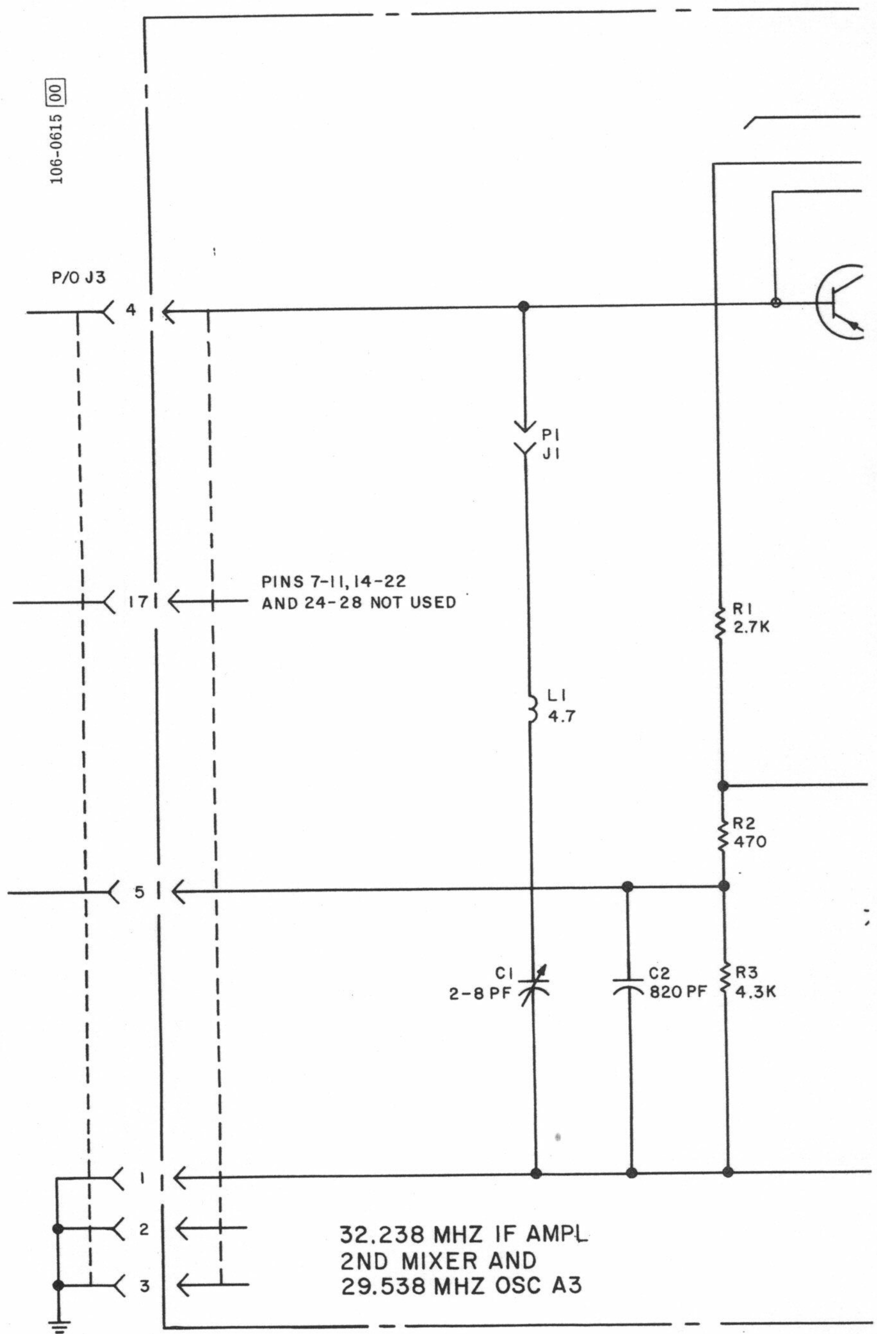
FINE TUNING NARROW BAND
R10 250
NARROW BAND SWEEP-WIDTH CONTROL INPUT
J1 13
J K L M GRD
E1 E2 E3 E4
L1 22
L2
R8 100K
CR1 V-33B
C11 1000 PF
R9 100K
R14 390
R1 15K
R3 330
L3 0.1
C6 10 PF
C7 24 PF
C12 7500 PF
R13 10K
OSC Q1 2N3563
C8 27 PF
C1 0.01
C15 33 PF
AMPL Q2 2N3563
L5 4.7
R15 750
C3 68 PF
R6 2.2K
C14 68PF
R2 8.2K
R4 330
R10 100
R16 10K
R5 2.2K
R11 2.2K
AMPL Q3 2N3563
C2 0.01
C9 0.01
C13 0.01
R12 300
L6 5.6
R17 1K
C10 0.01
EMITTER FOLLOWER Q4 2N3563
C4 0.01
R18 51
R7 510
P/O J1
P2
N
NARROW BAND LO OUTPUT TC
L4 100
C5 0.01
E5
P -11V
8 7 11
S3E
SWEEP RANGE
ARROW BAND LO A7
OG-LIN A6
E8
E9
HALF-SCALE LIN
FULL-SCALE LIN
R1 1K
CR1 HU-10
CR2 HU-10
R2 20K
VR1 023L13 LOG-ZERO
SWEEP RATE
R3 50K
R4 510
E11
HH
S3
1 5 B
R5 500K
E10
FF
1 5 A
E11 E2 E3 E4 E5 E6 E7
X W V U T S R
N 5
4 LOG
11 10 8 7
S6A
12 9
6
TO J2-14

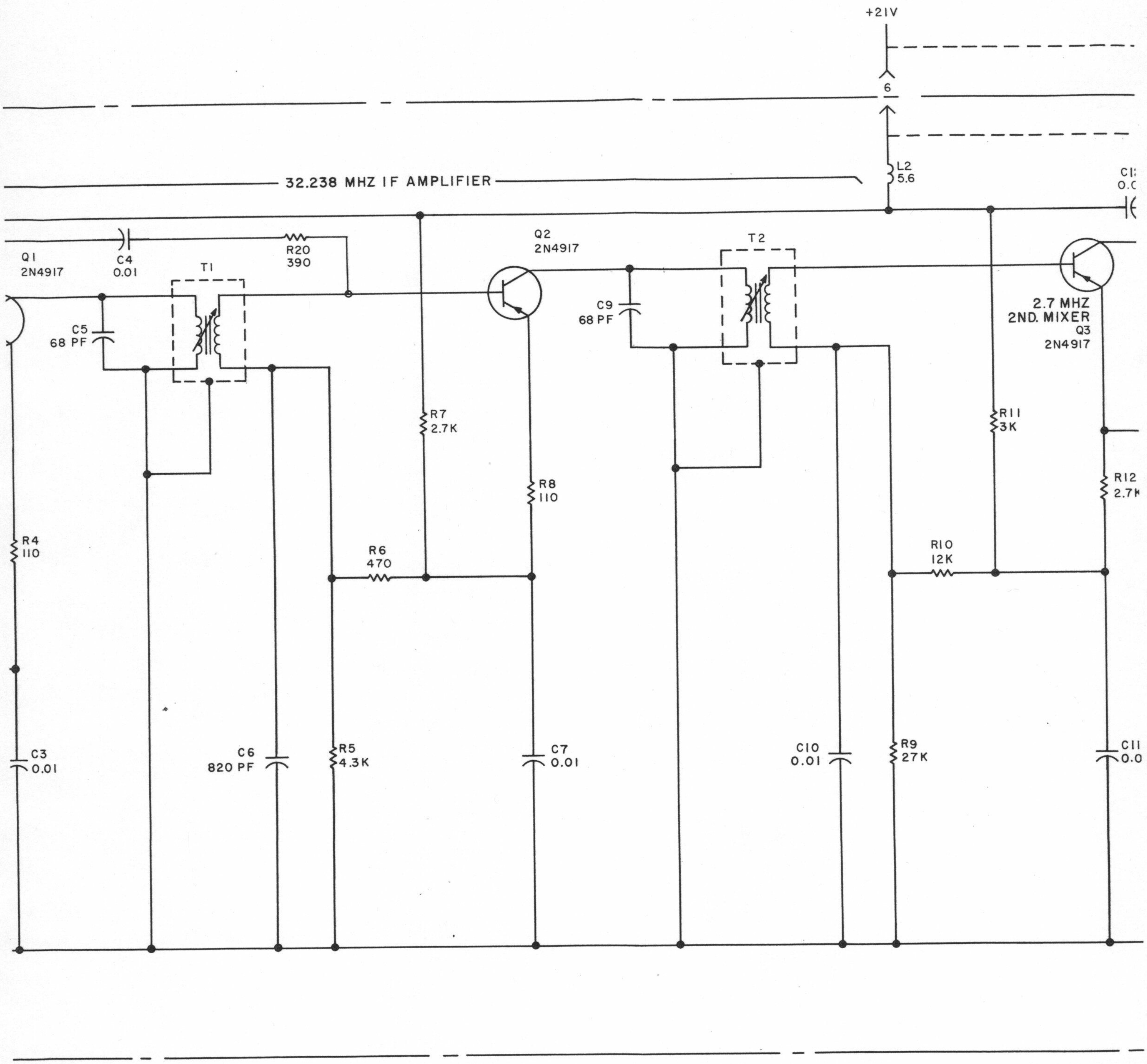


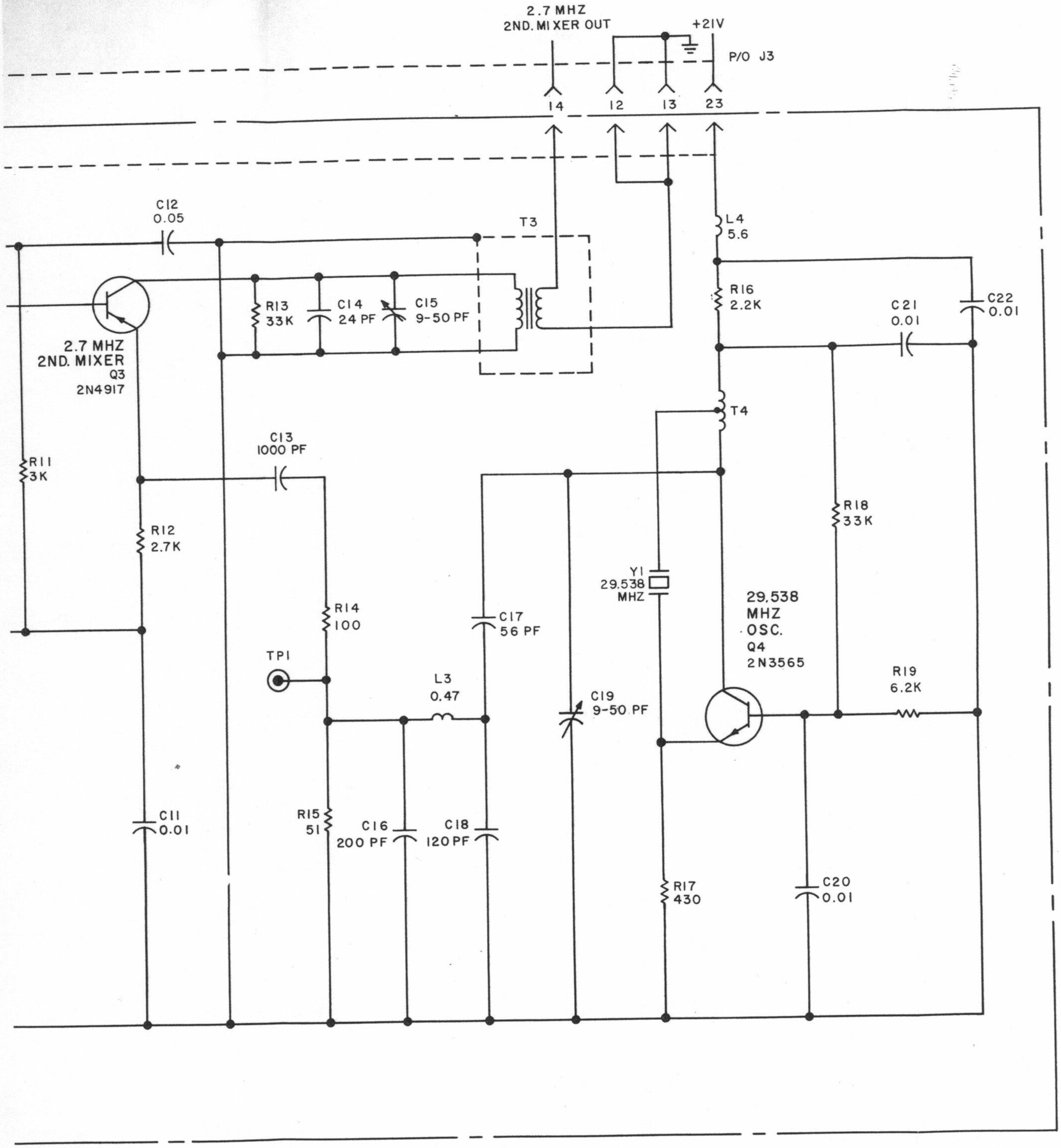
NOTES:
1. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS, 1/4W, ±5%.
2. ALL CAPACITORS ARE IN MICROFARADS.
3. ALL INDUCTORS ARE IN MICROHENRIES.

Figure 5-2. Log/Lin Assembly A6, Narrow Band Local Oscillator Assembly A7, and First Mixer Assembly A8, Schematic Diagram

106-0615 00

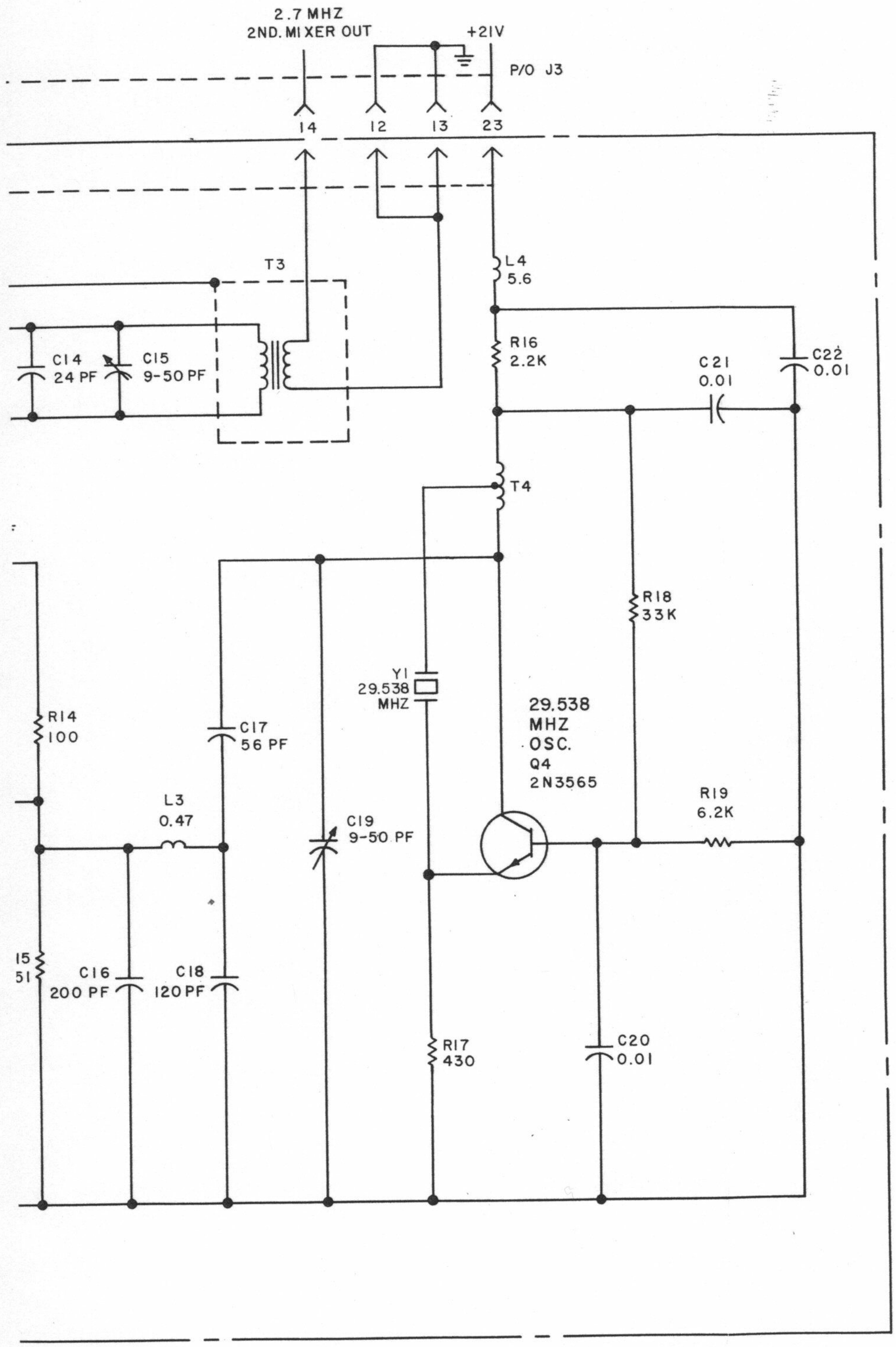

P/O J3
4
17
PINS 7-11, 14-22
AND 24-28 NOT USED
5
1
2
3
P1
J1
L1
4.7
C1
2-8 PF
C2
820 PF
R1
2.7K
R2
470
R3
4.3K
32.238 MHZ IF AMPL
2ND MIXER AND
29.538 MHZ OSC A3


+21V
6
32.238 MHZ IF AMPLIFIER
L2
5.6
C1
0.0
Q1
2N4917
C4
0.01
R20
390
T1
Q2
2N4917
T2
C5
68 PF
C9
68 PF
2.7 MHZ
2ND. MIXER
Q3
2N4917
R7
2.7K
R11
3K
R8
110
R12
2.7K
R4
110
R6
470
R10
12K
C3
0.01
C6
820 PF
R5
4.3K
C7
0.01
C10
0.01
R9
27K
C11
0.0



NOTES:
1. UNLESS
ALL RES
2. ALL CAP
3. ALL IND

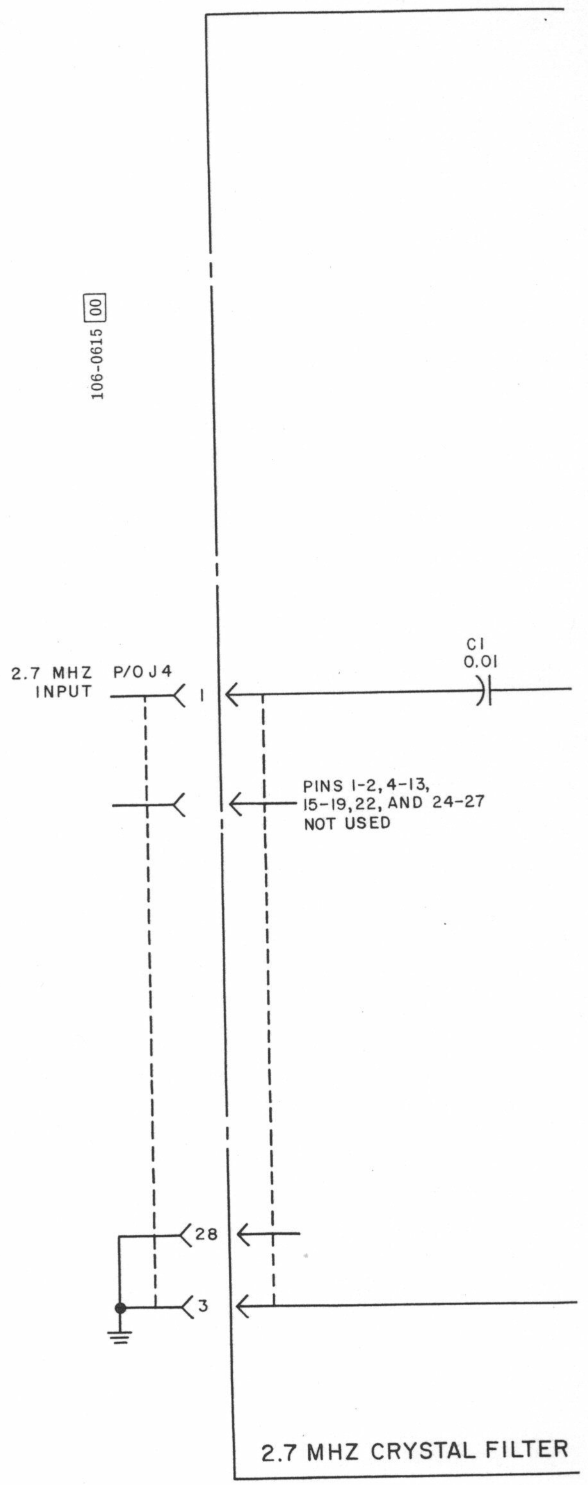
Figure 5-3. 32.238 MH:
Mixer/29.538 MHz Osc
Schematic



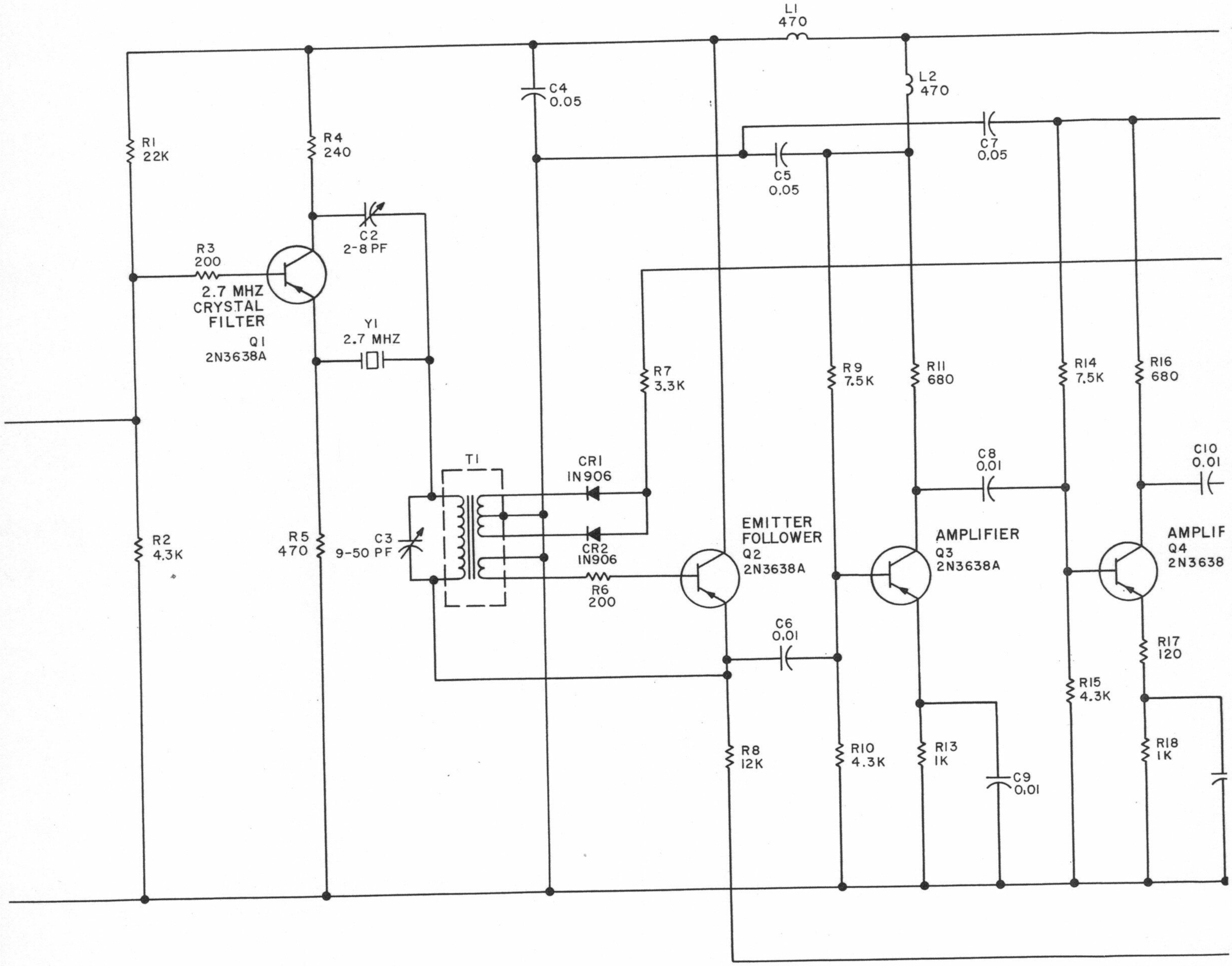
NOTES:
1. UNLESS OTHERWISE SPECIFIED,
ALL RESISTORS ARE IN OHMS, 1/4 W, ±5%.
2. ALL CAPACITORS ARE IN MICROFARADS.
3. ALL INDUCTORS ARE IN MICROHENRIES.

Figure 5-3. 32.238 MHz I-f Amplifier/Second Mixer/29.538 MHz Oscillator Assembly A3, Schematic Diagram

106-0615 00

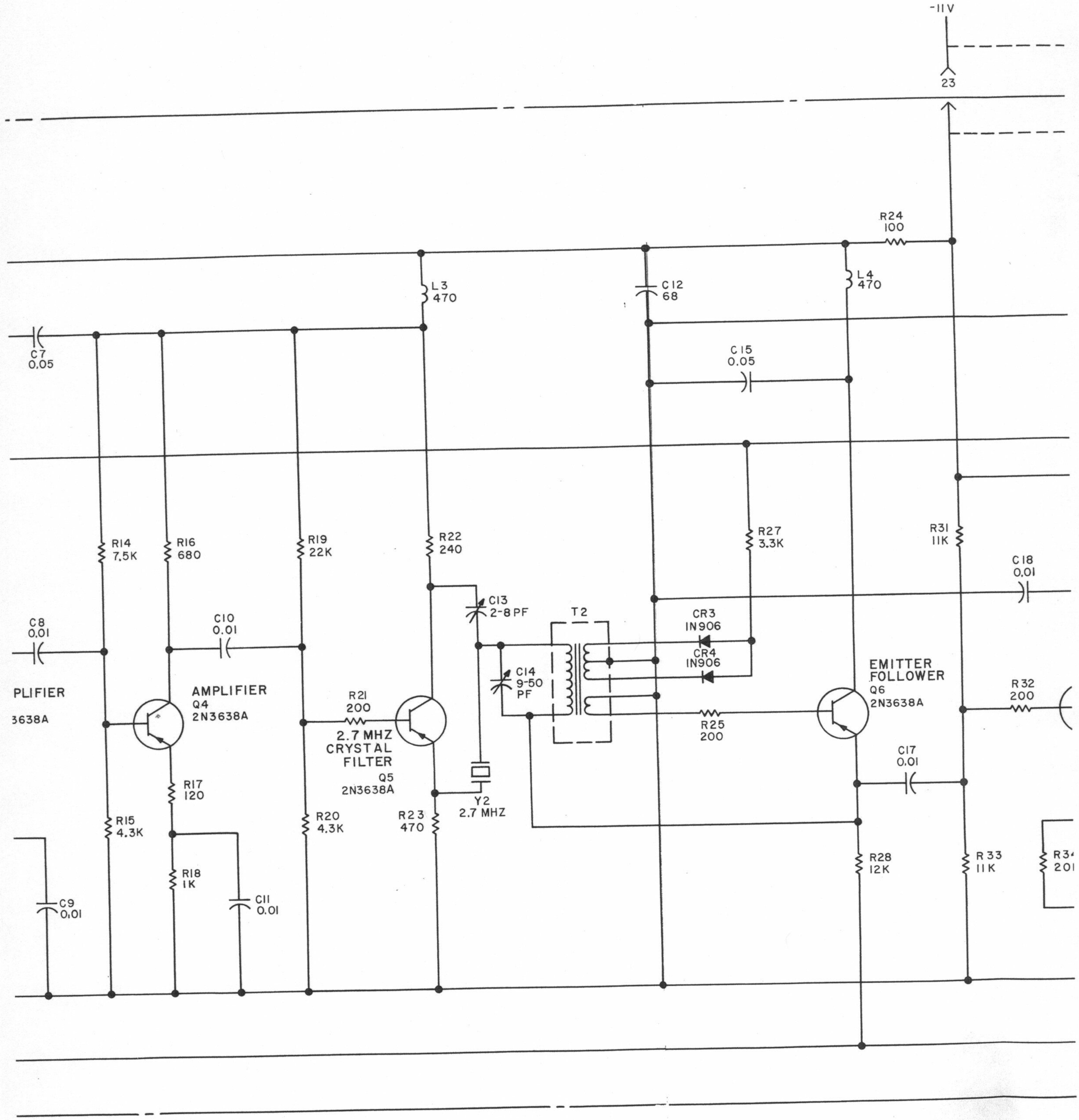


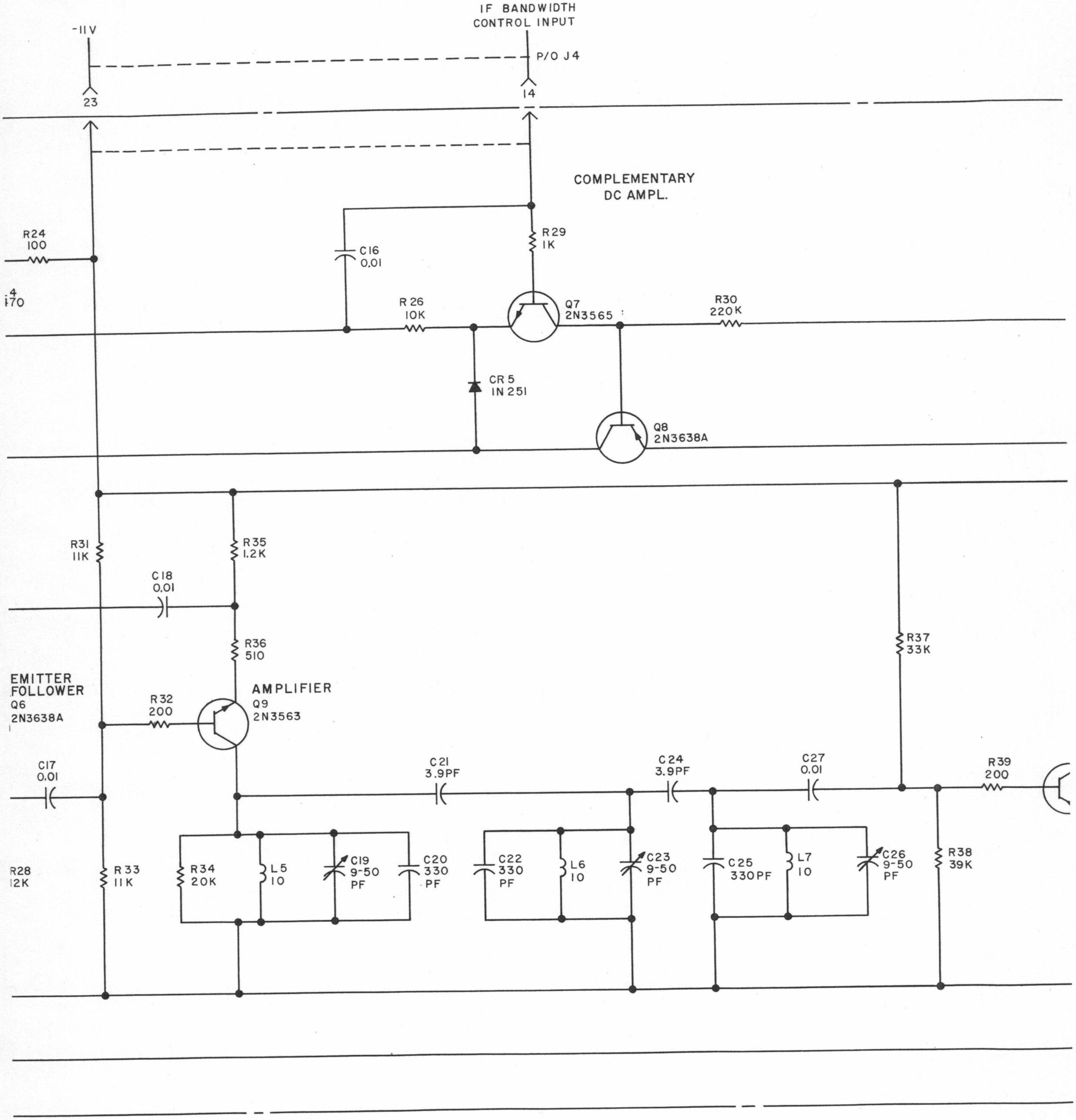
2.7 MHZ INPUT
P/O J4
1
C1
0.01
PINS 1-2, 4-13, 15-19, 22, AND 24-27 NOT USED
28
3
2.7 MHZ CRYSTAL FILTER

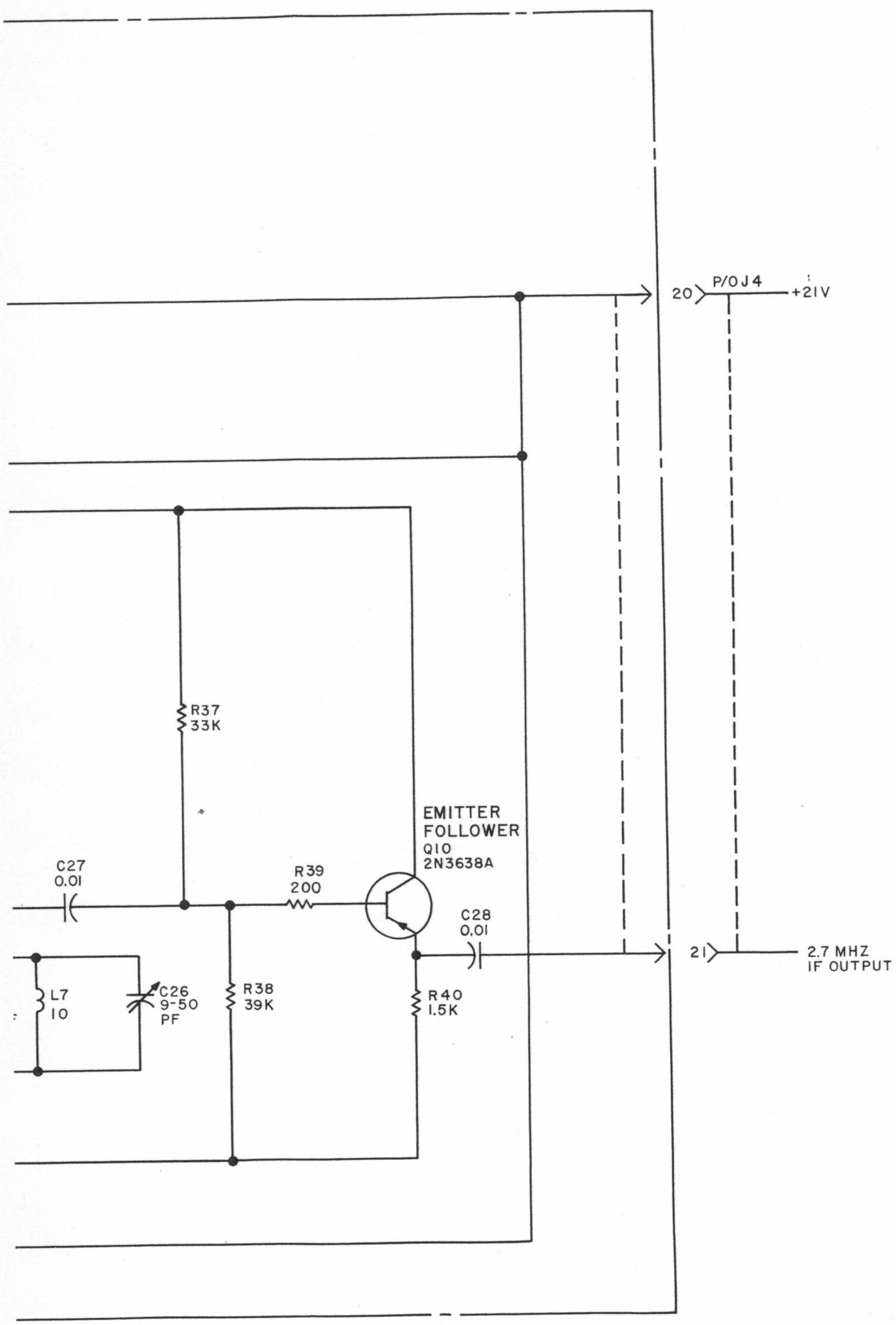


L1
470
L2
470
C4
0.05
C7
0.05
R1
22K
R4
240
C5
0.05
C2
2-8 PF
R3
200
2.7 MHZ
CRYSTAL
FILTER
Q1
2N3638A
Y1
2.7 MHZ
R7
3.3K
R9
7.5K
R11
680
R14
7.5K
R16
680
T1
CR1
1N906
C8
0.01
C10
0.01
R2
4.3K
R5
470
C3
9-50 PF
CR2
1N906
R6
200
EMITTER
FOLLOWER
Q2
2N3638A
AMPLIFIER
Q3
2N3638A
AMPLIF
Q4
2N3638
C6
0.01
R17
120
R15
4.3K
R8
12K
R10
4.3K
R13
1K
C9
0.01
R18
1K

LTER A4

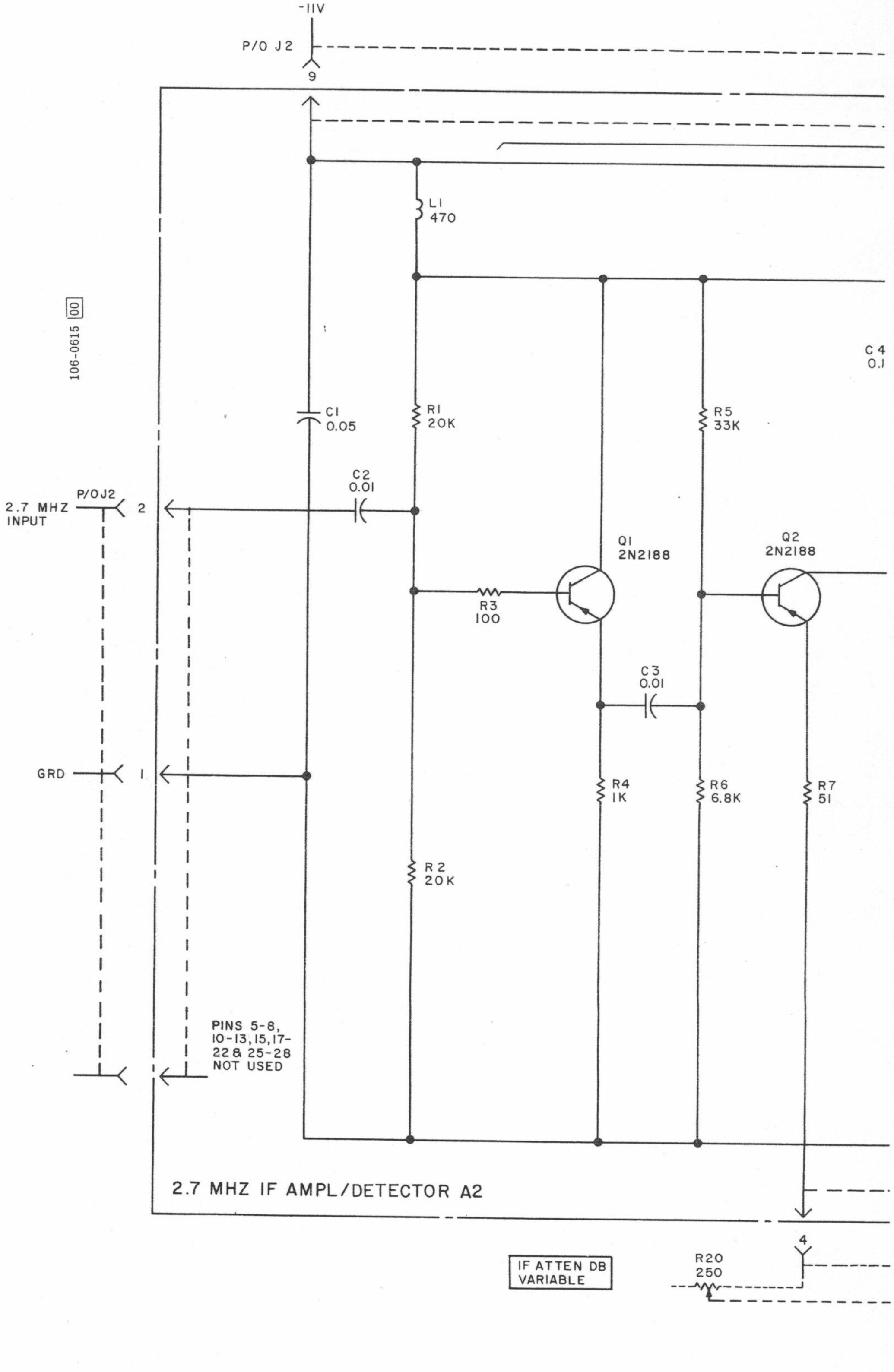

-11V
23
R24
100
L3
470
C12
68
L4
470
C7
0.05
C15
0.05
R14
7.5K
R16
680
R19
22K
R22
240
R27
3.3K
R31
11K
C18
0.01
C8
0.01
C10
0.01
C13
2-8PF
T2
CR3
IN906
CR4
IN906
C14
9-50
PF
EMITTER
FOLLOWER
Q6
2N3638A
R32
200
PLIFIER
3638A
AMPLIFIER
Q4
2N3638A
R21
200
2.7 MHZ
CRYSTAL
FILTER
Q5
2N3638A
R25
200
C17
0.01
R17
120
R15
4.3K
R20
4.3K
R23
470
Y2
2.7 MHZ
R28
12K
R33
11K
R34
20
R18
1K
C9
0.01
C11
0.01


IF BANDWIDTH
CONTROL INPUT
-11V
P/O J4
23
14
COMPLEMENTARY
DC AMPL.
R24
100
170
C16
0.01
R29
1K
R26
10K
Q7
2N3565
R30
220K
CR5
IN251
Q8
2N3638A
R31
11K
R35
1.2K
C18
0.01
R36
510
EMITTER
FOLLOWER
Q6
2N3638A
AMPLIFIER
Q9
2N3563
R32
200
R37
33K
C17
0.01
C21
3.9PF
C24
3.9PF
C27
0.01
R39
200
R28
12K
R33
11K
R34
20K
L5
10
C19
9-50
PF
C20
330
PF
C22
330
PF
L6
10
C23
9-50
PF
C25
330PF
L7
10
C26
9-50
PF
R38
39K

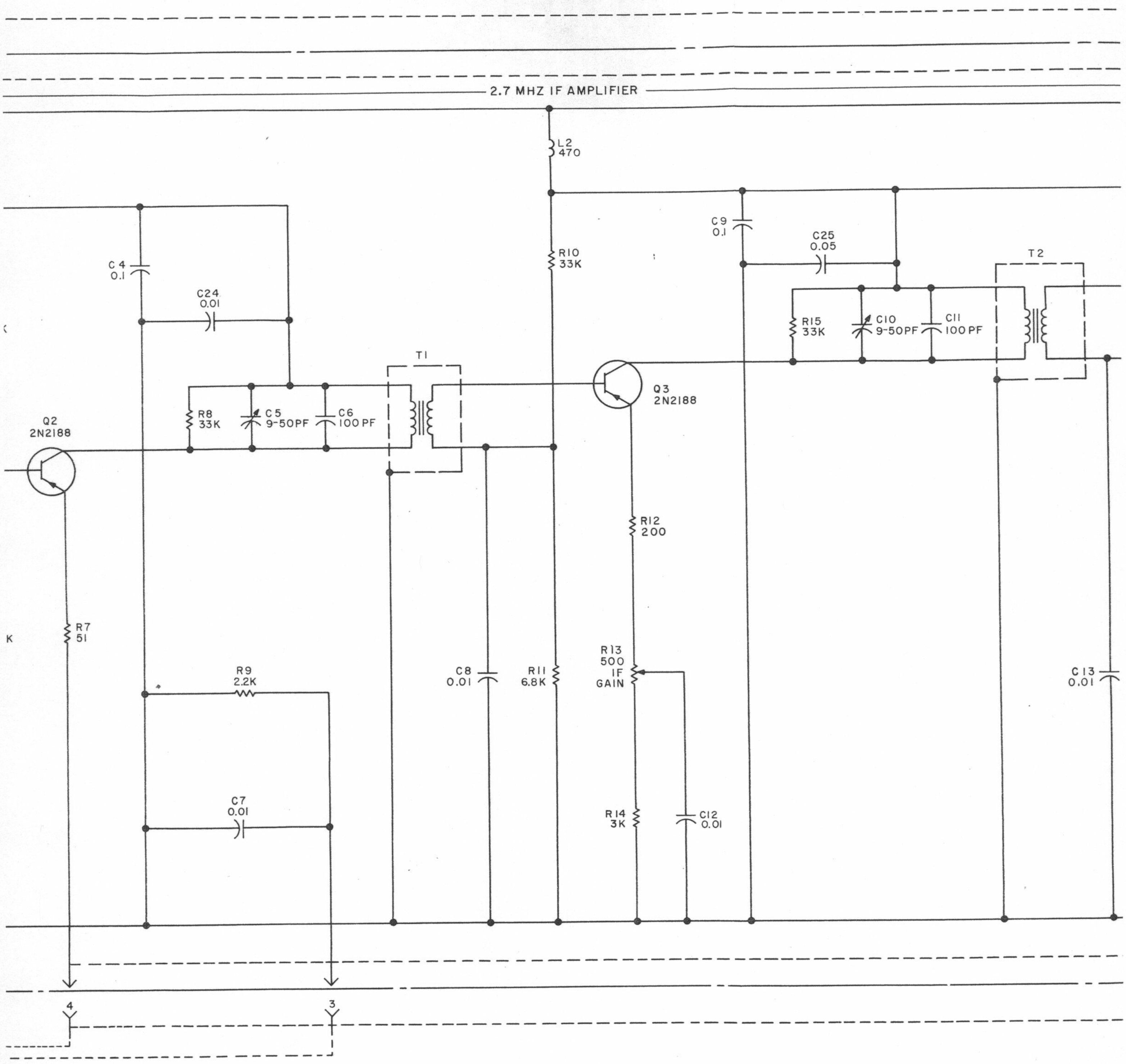


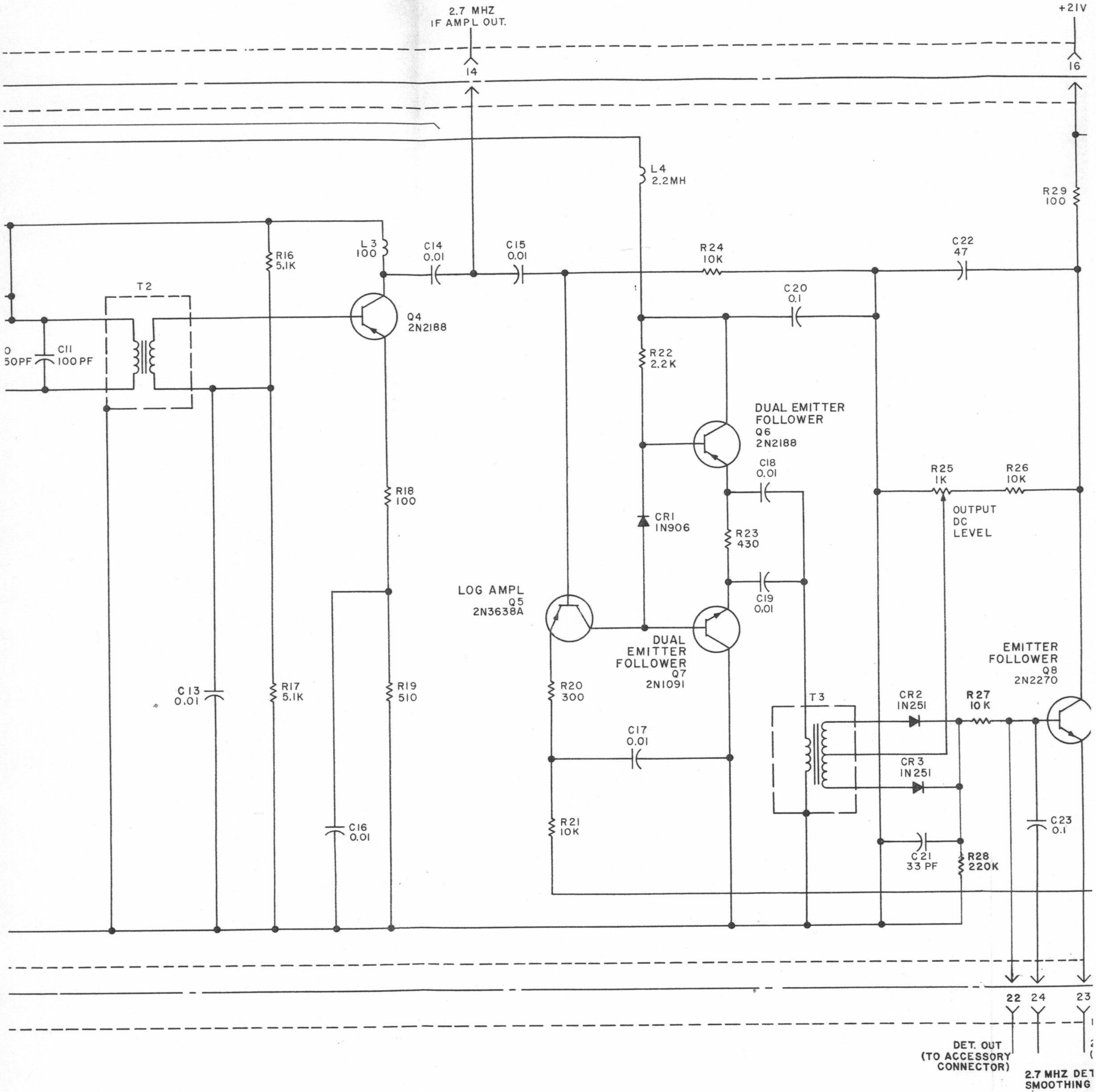
NOTES:
1. UNLESS OTHERWISE SPECIFIED. ALL RESISTORS ARE IN OHMS, 1/4 W, ±5%.
2. ALL CAPACITORS ARE IN MICROFARADS.
3. ALL INDUCTORS ARE IN MICROHENRIES.

Figure 5-4. 2.7 MHz Crystal Filter Assembly A4, Schematic Diagram

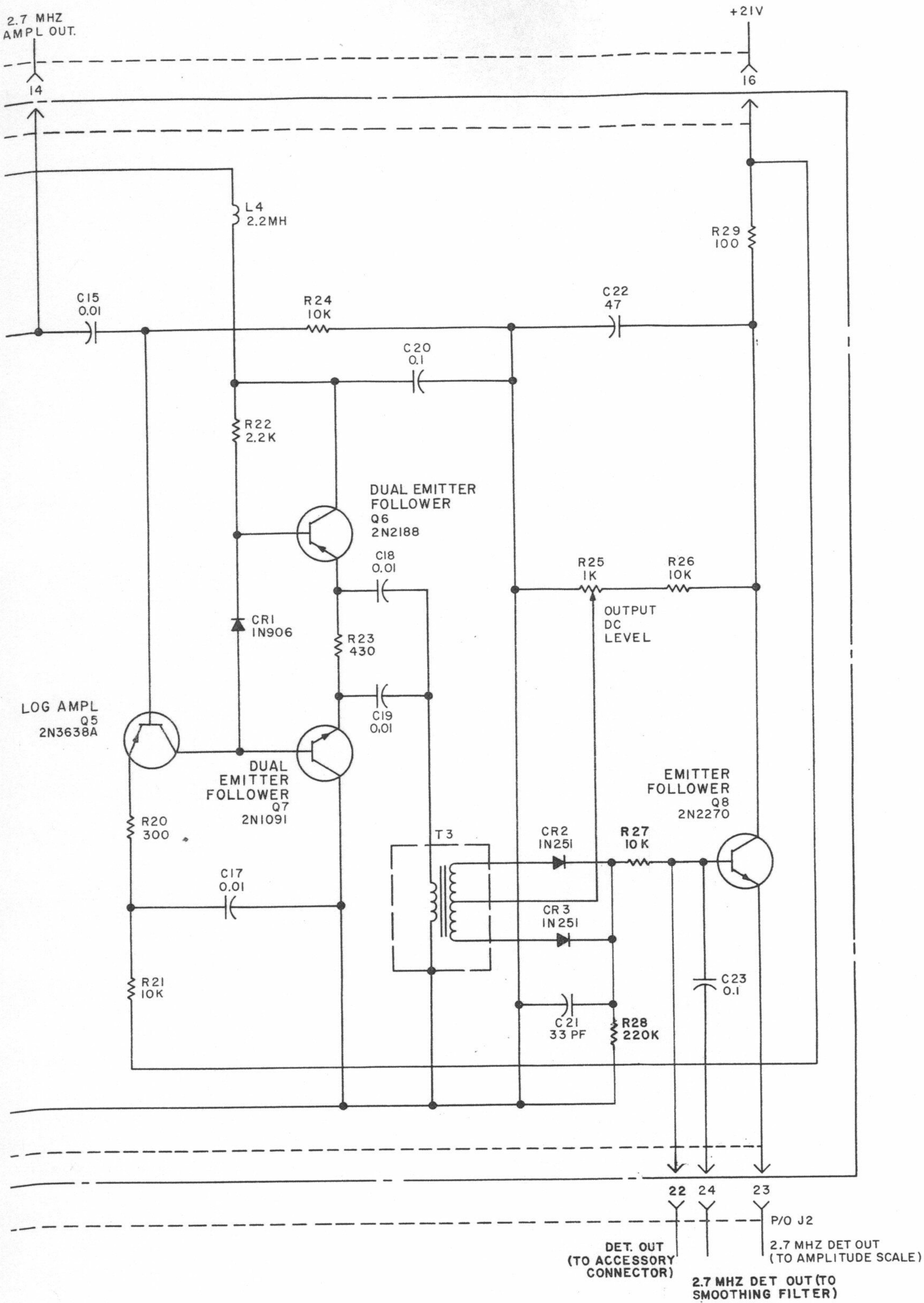


106-0615 00
-11V
P/O J2
9
L1
470
C4
0.1
C1
0.05
R1
20K
R5
33K
C2
0.01
2.7 MHZ
INPUT
P/OJ2
2
Q1
2N2188
Q2
2N2188
R3
100
C3
0.01
GRD
1
R4
1K
R6
6.8K
R7
51
R2
20K
PINS 5-8,
10-13, 15, 17-
22 & 25-28
NOT USED
2.7 MHZ IF AMPL/DETECTOR A2
4
IF ATTEN DB
VARIABLE
R20
250


2.7 MHZ IF AMPLIFIER
L2
470
C4
0.1
C24
0.01
C9
0.1
C25
0.05
T2
R10
33K
R15
33K
C10
9-50PF
C11
100 PF
T1
R8
33K
C5
9-50PF
C6
100 PF
Q2
2N2188
Q3
2N2188
R12
200
R7
51
K
R13
500
IF
GAIN
R9
2.2K
C8
0.01
R11
6.8K
C13
0.01
C7
0.01
R14
3K
C12
0.01
4
3

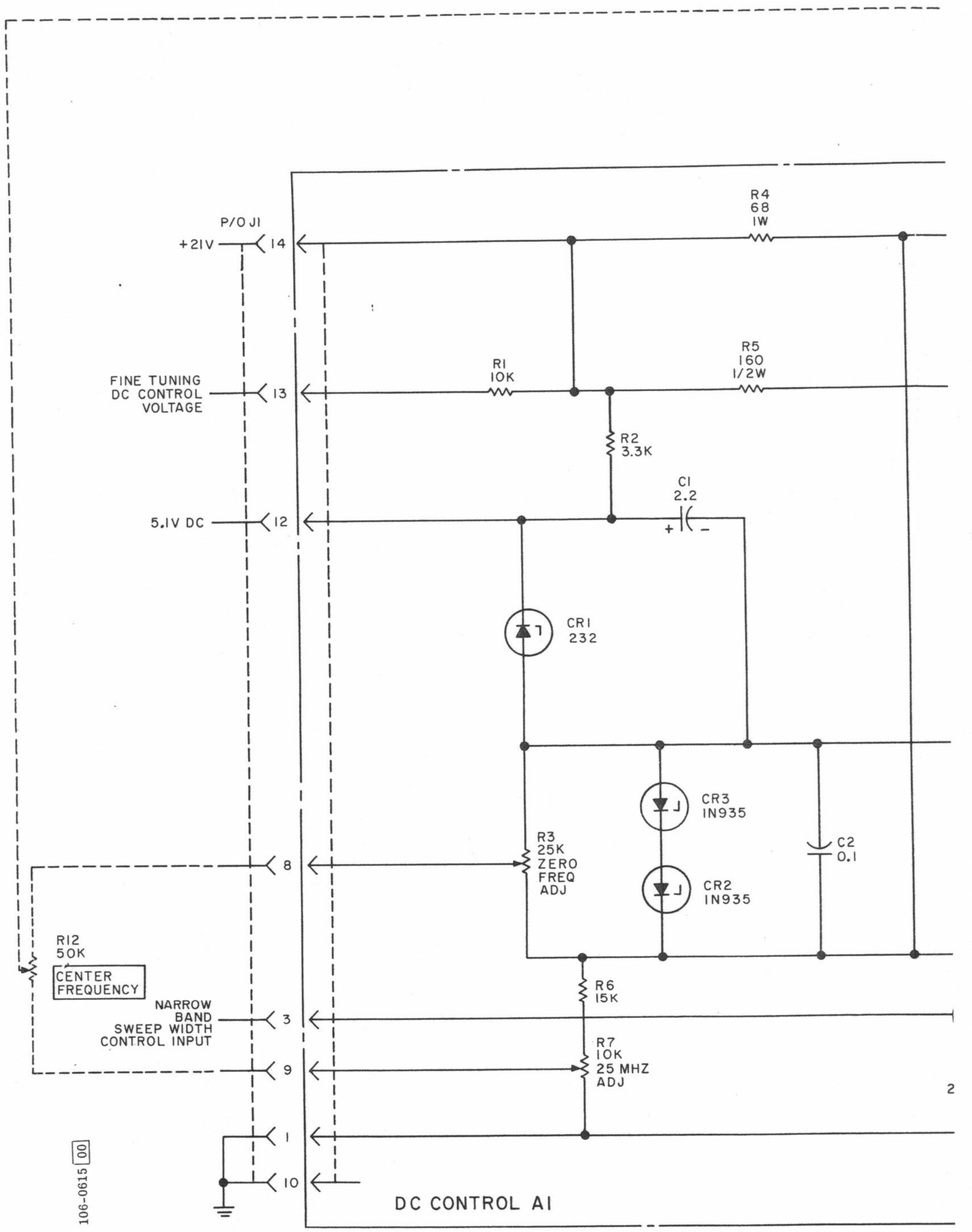

2.7 MHZ
IF AMPL OUT.
14
+21V
16
L4
2.2MH
R29
100
R16
5.1K
L3
100
C14
0.01
C15
0.01
R24
10K
C22
47
T2
Q4
2N2188
C20
0.1
C11
100PF
50PF
R22
2.2K
DUAL EMITTER
FOLLOWER
Q6
2N2188
C18
0.01
R25
1K
R26
10K
R18
100
CR1
1N906
OUTPUT
DC
LEVEL
R23
430
LOG AMPL
Q5
2N3638A
C19
0.01
DUAL
EMITTER
FOLLOWER
Q7
2N1091
EMITTER
FOLLOWER
Q8
2N2270
C13
0.01
R17
5.1K
R19
510
R20
300
T3
CR2
1N251
R27
10K
C17
0.01
CR3
1N251
C16
0.01
R21
10K
C23
0.1
C21
33 PF
R28
220K
22
24
23
DET. OUT
(TO ACCESSORY
CONNECTOR)
2.7 MHZ DET
SMOOTHING

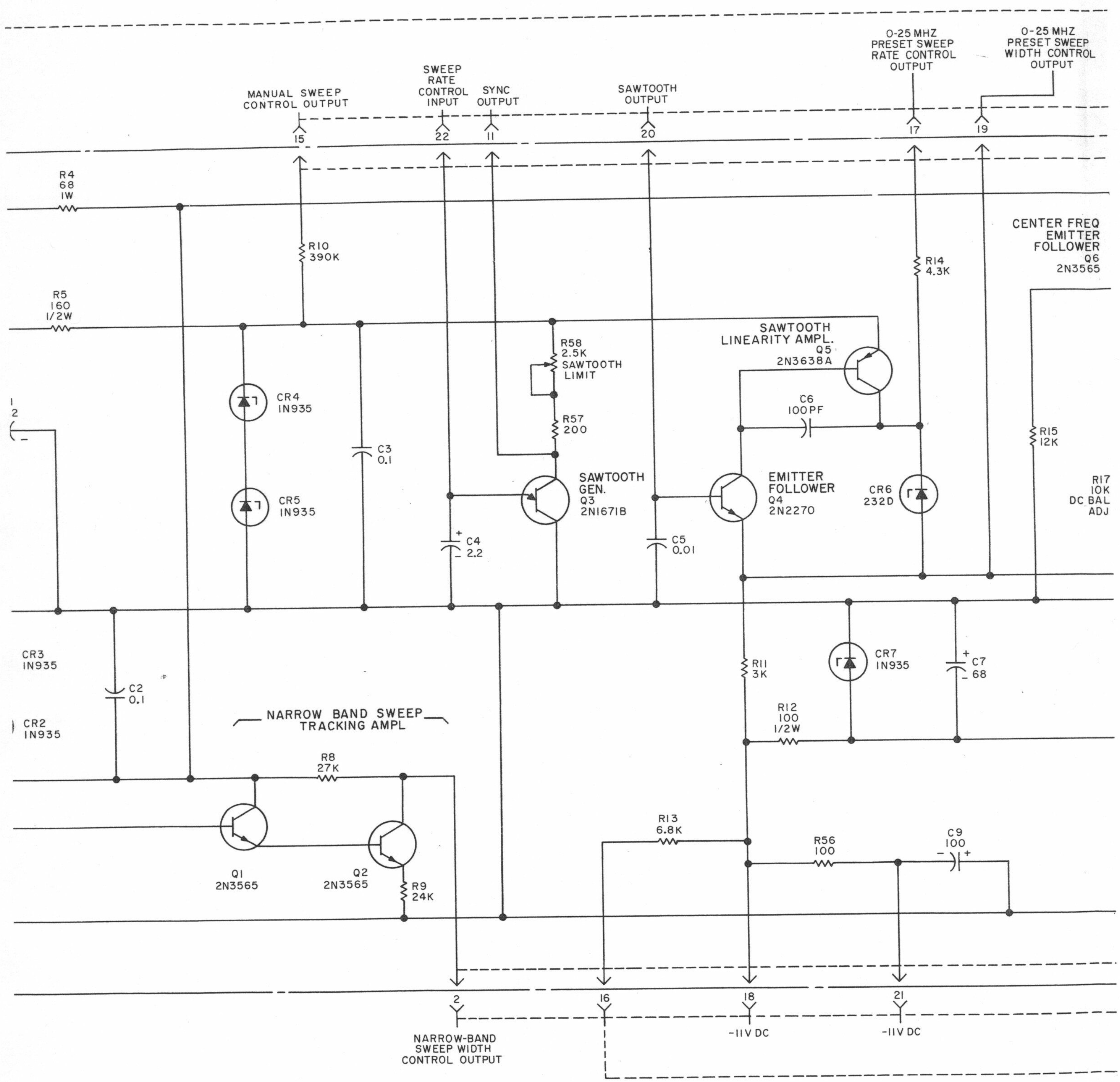
Figur



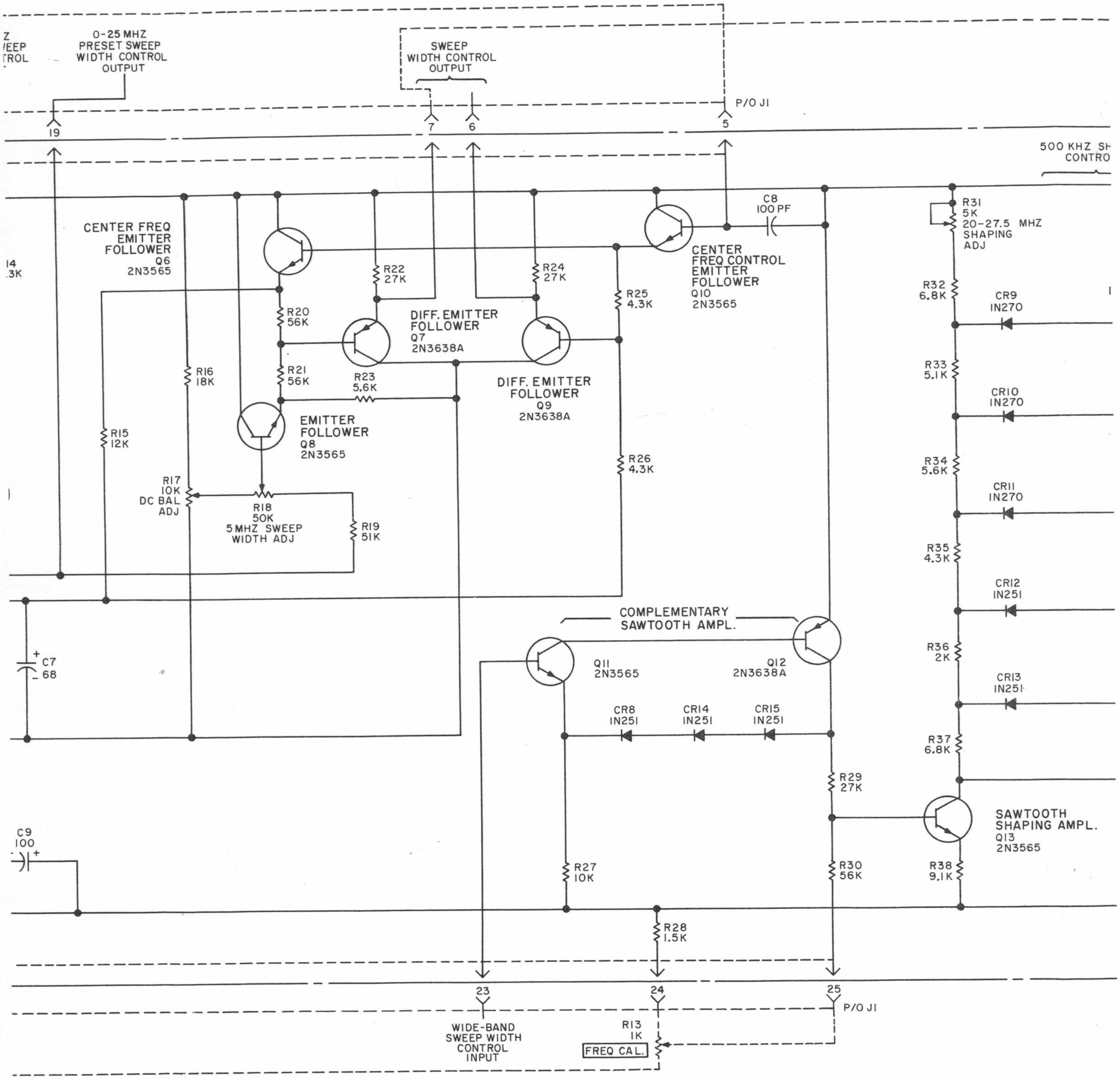
NOTES:
1. UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE IN OHMS, 1/4W, ±5%.
2. ALL CAPACITORS ARE IN MICROFARADS.
3. ALL INDUCTORS ARE IN MICROHENRIES.

Figure 5-5. I-f Amplifier/Detector Assembly A2, Schematic Diagram

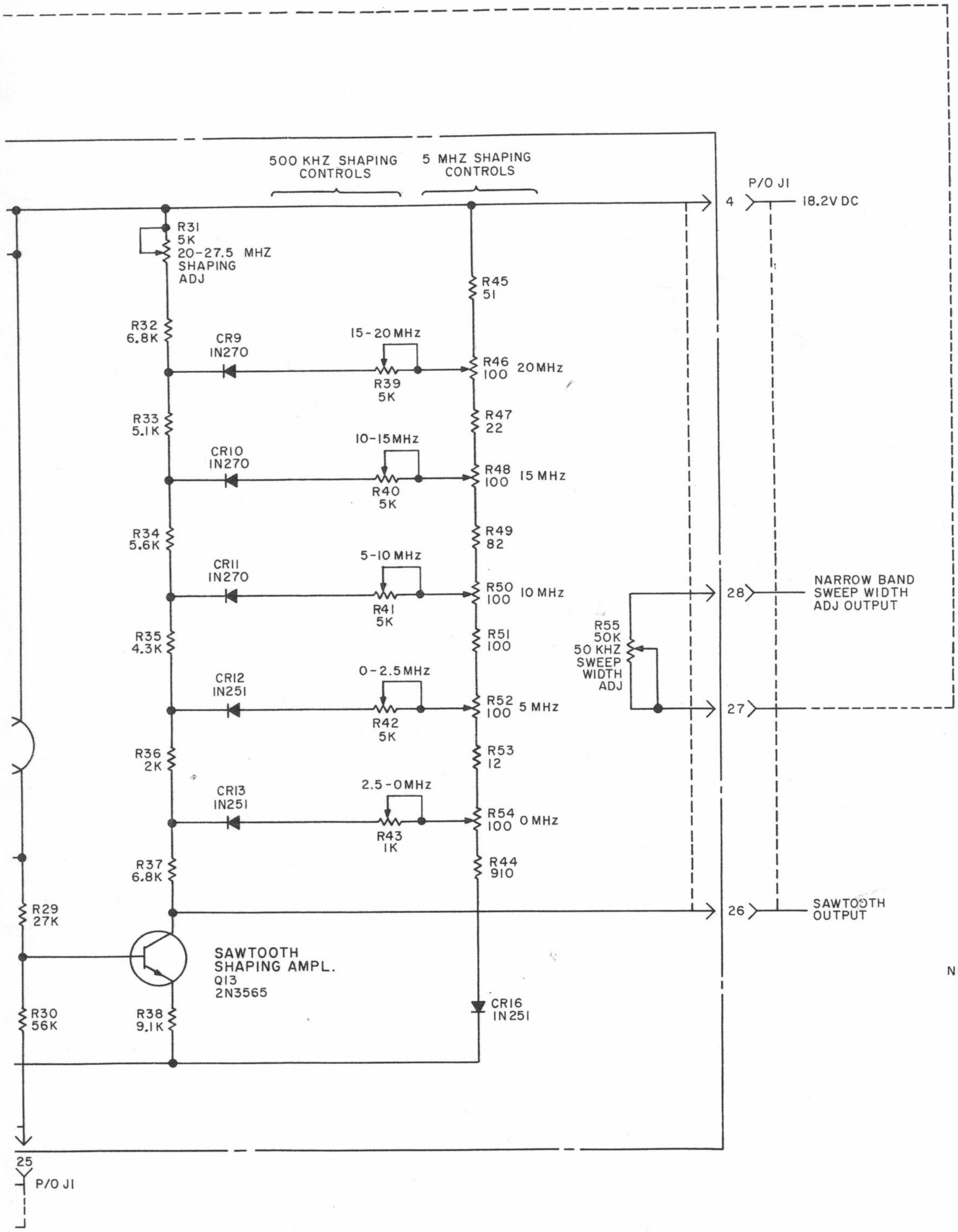

P/O J1
+21V
14
R4
68
1W
FINE TUNING
DC CONTROL
VOLTAGE
13
R1
10K
R5
160
1/2W
R2
3.3K
C1
2.2
5.1V DC
12
CR1
232
CR3
IN935
R3
25K
ZERO
FREQ
ADJ
C2
0.1
8
CR2
IN935
R12
50K
CENTER
FREQUENCY
NARROW
BAND
SWEEP WIDTH
CONTROL INPUT
3
R6
15K
R7
10K
25 MHZ
ADJ
9
2
1
10
DC CONTROL A1
106-0615 00



MANUAL SWEEP CONTROL OUTPUT
SWEEP RATE CONTROL INPUT
SYNC OUTPUT
SAWTOOTH OUTPUT
0-25 MHZ PRESET SWEEP RATE CONTROL OUTPUT
0-25 MHZ PRESET SWEEP WIDTH CONTROL OUTPUT
15
22
11
20
17
19
R4 68 1W
R5 160 1/2W
R10 390K
CENTER FREQ EMITTER FOLLOWER Q6 2N3565
R14 4.3K
SAWTOOTH LINEARITY AMPL. Q5 2N3638A
R58 2.5K SAWTOOTH LIMIT
R57 200
C6 100PF
CR4 IN935
CR5 IN935
C3 0.1
SAWTOOTH GEN. Q3 2N1671B
EMITTER FOLLOWER Q4 2N2270
CR6 232D
R15 12K
R17 10K DC BAL ADJ
C4 2.2
C5 0.01
CR3 IN935
CR2 IN935
C2 0.1
R11 3K
CR7 IN935
C7 68
R12 100 1/2W
NARROW BAND SWEEP TRACKING AMPL
R8 27K
Q1 2N3565
Q2 2N3565
R9 24K
R13 6.8K
R56 100
C9 100
2
16
18
21
-11V DC
-11V DC
NARROW-BAND SWEEP WIDTH CONTROL OUTPUT

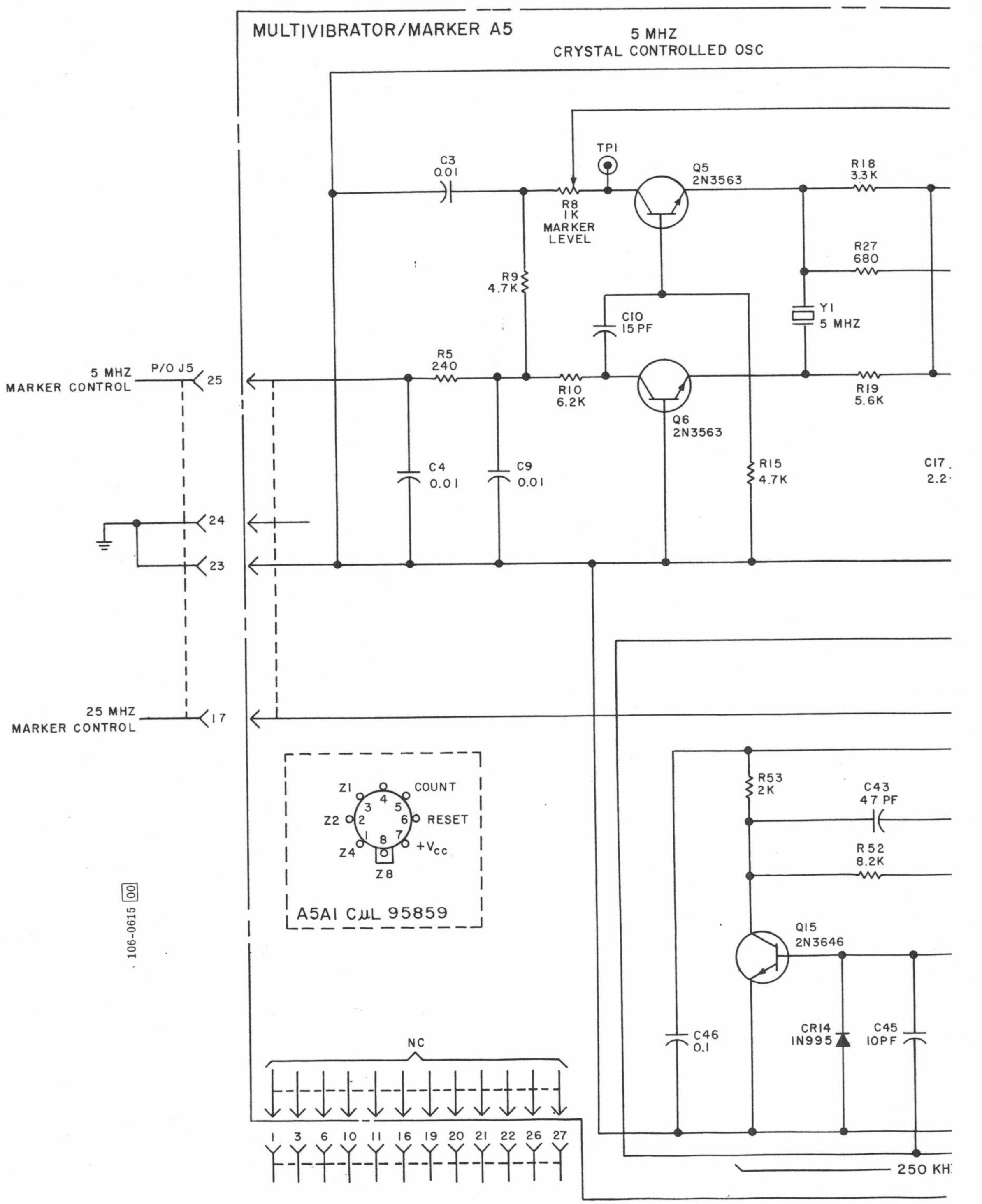


0-25 MHZ PRESET SWEEP WIDTH CONTROL OUTPUT
SWEEP WIDTH CONTROL OUTPUT
P/O J1
19
7
6
5
500 KHZ SH
CONTRO
CENTER FREQ EMITTER FOLLOWER Q6 2N3565
C8 100 PF
R31 5K 20-27.5 MHZ SHAPING ADJ
R22 27K
R24 27K
CENTER FREQ CONTROL EMITTER FOLLOWER Q10 2N3565
R25 4.3K
R32 6.8K
CR9 IN270
R20 56K
DIFF. EMITTER FOLLOWER Q7 2N3638A
R21 56K
R23 5.6K
DIFF. EMITTER FOLLOWER Q9 2N3638A
R33 5.1K
CR10 IN270
R16 18K
R15 12K
EMITTER FOLLOWER Q8 2N3565
R26 4.3K
R34 5.6K
CR11 IN270
R17 10K DC BAL ADJ
R18 50K 5MHZ SWEEP WIDTH ADJ
R19 51K
R35 4.3K
CR12 IN251
COMPLEMENTARY SAWTOOTH AMPL.
C7 68
Q11 2N3565
Q12 2N3638A
R36 2K
CR13 IN251
CR8 IN251
CR14 IN251
CR15 IN251
R37 6.8K
R29 27K
SAWTOOTH SHAPING AMPL. Q13 2N3565
C9 100
R27 10K
R30 56K
R38 9.1K
R28 1.5K
23
24
25
P/O J1
WIDE-BAND SWEEP WIDTH CONTROL INPUT
R13 1K
FREQ CAL.



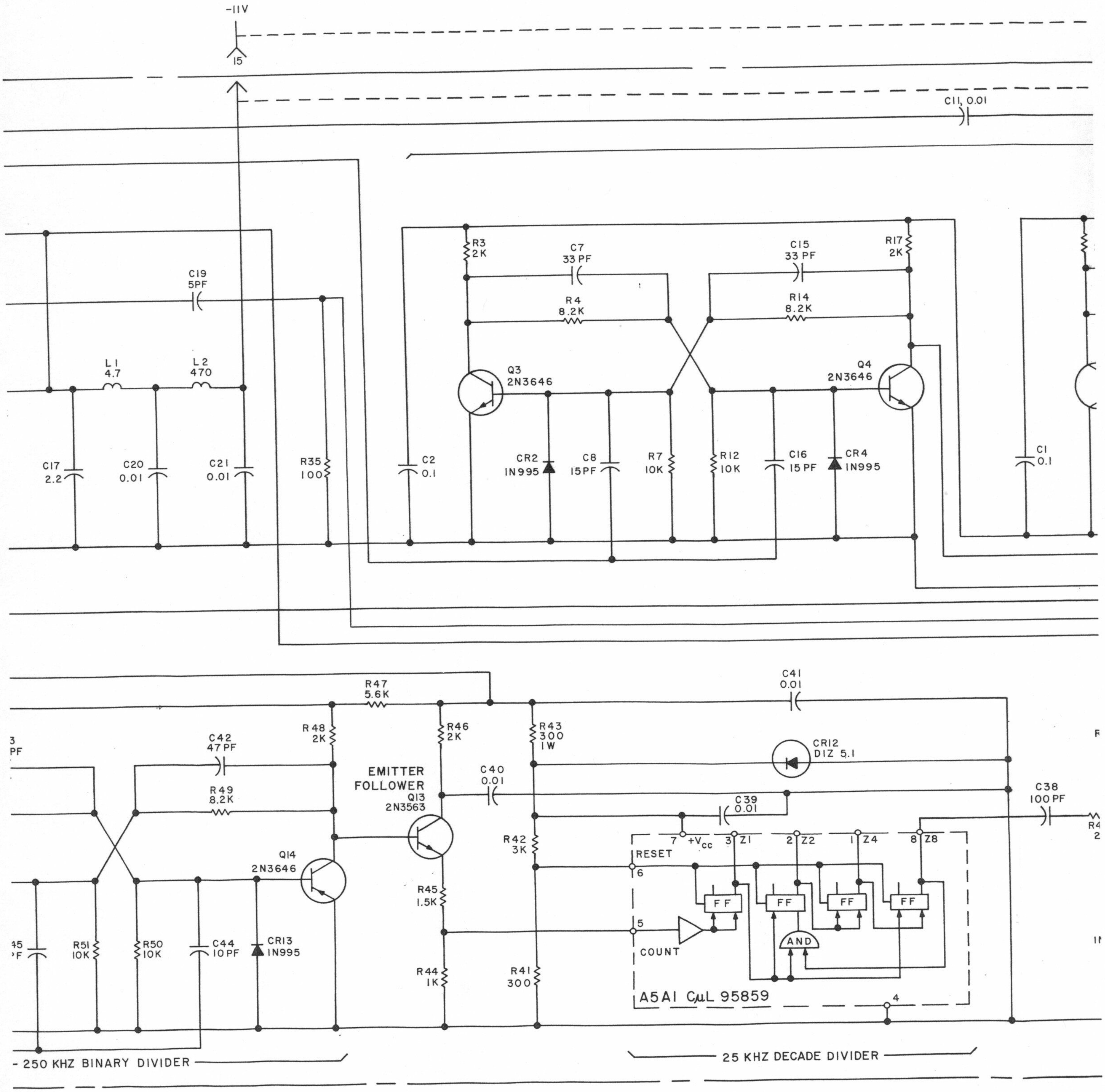
NOTES:
1. UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE IN OHMS, 1/4W, ±5%.
2. ALL CAPACITORS ARE IN MICROFARADS.

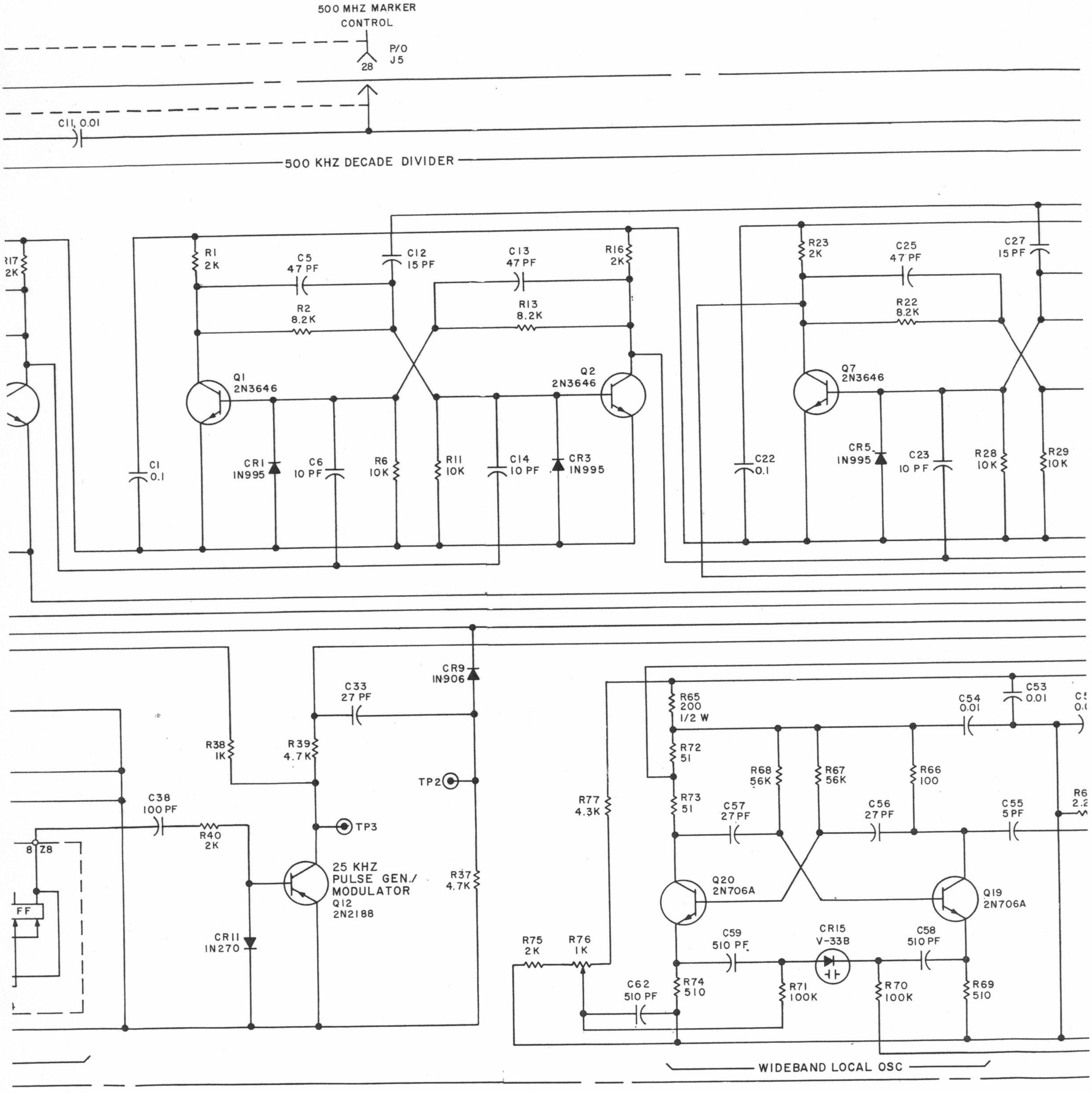
Figure 5-6. DC Control Assembly A1, Schematic Diagram



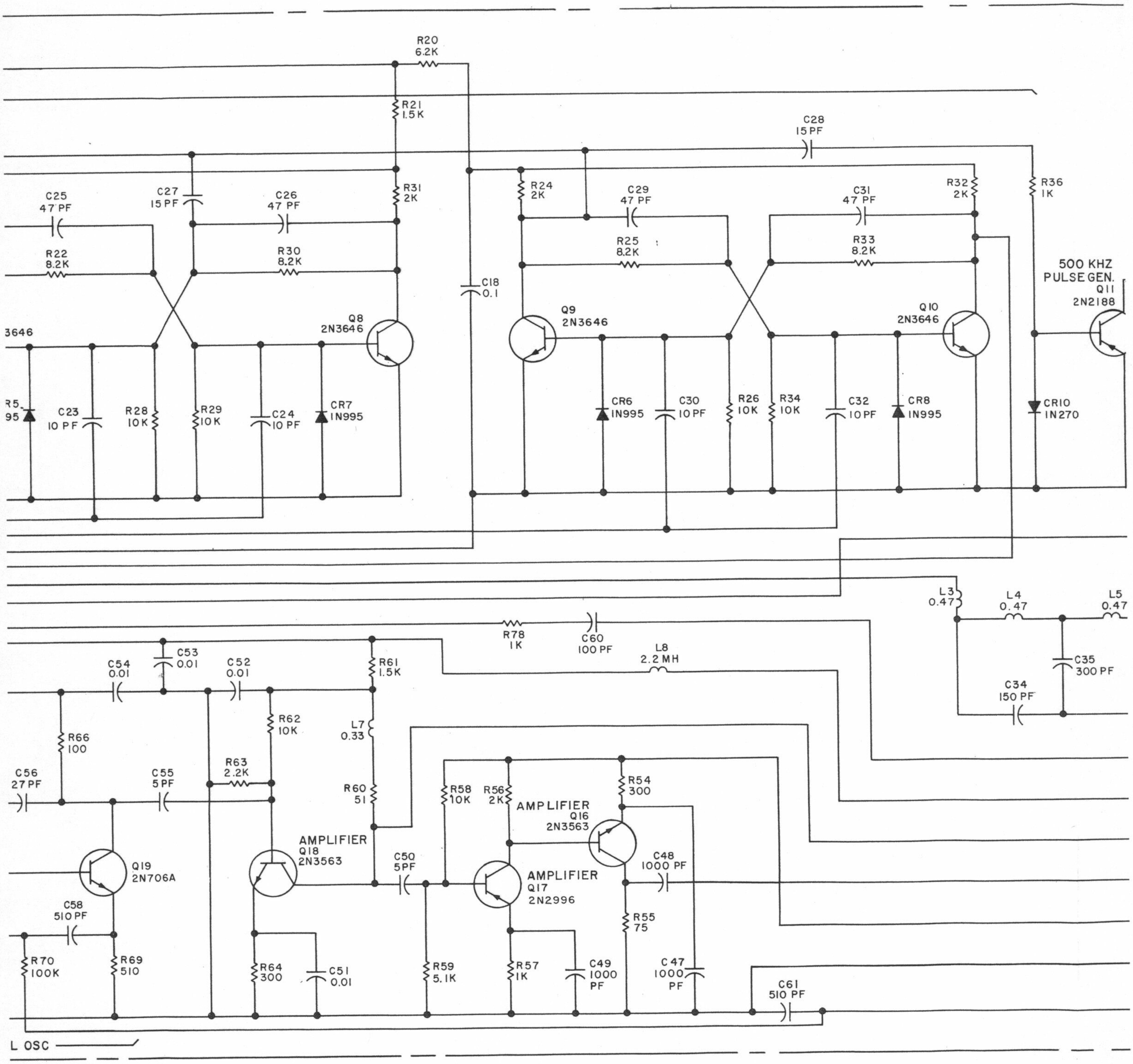
MULTIVIBRATOR/MARKER A5
5 MHZ
CRYSTAL CONTROLLED OSC
C3
0.01
TP1
Q5
2N3563
R18
3.3K
R8
1K
MARKER
LEVEL
R27
680
R9
4.7K
C10
15 PF
Y1
5 MHZ
5 MHZ
MARKER CONTROL
P/O J5
25
R5
240
R10
6.2K
R19
5.6K
Q6
2N3563
C4
0.01
C9
0.01
R15
4.7K
C17
24
23
25 MHZ
MARKER CONTROL
17
Z1
COUNT
Z2
RESET
Z4
+Vcc
Z8
A5A1 C.W.L 95859
R53
2K
C43
47 PF
R52
8.2K
Q15
2N3646
C46
0.1
CR14
IN995
C45
10PF
NC
1 3 6 10 11 16 19 20 21 22 26 27
250 KH

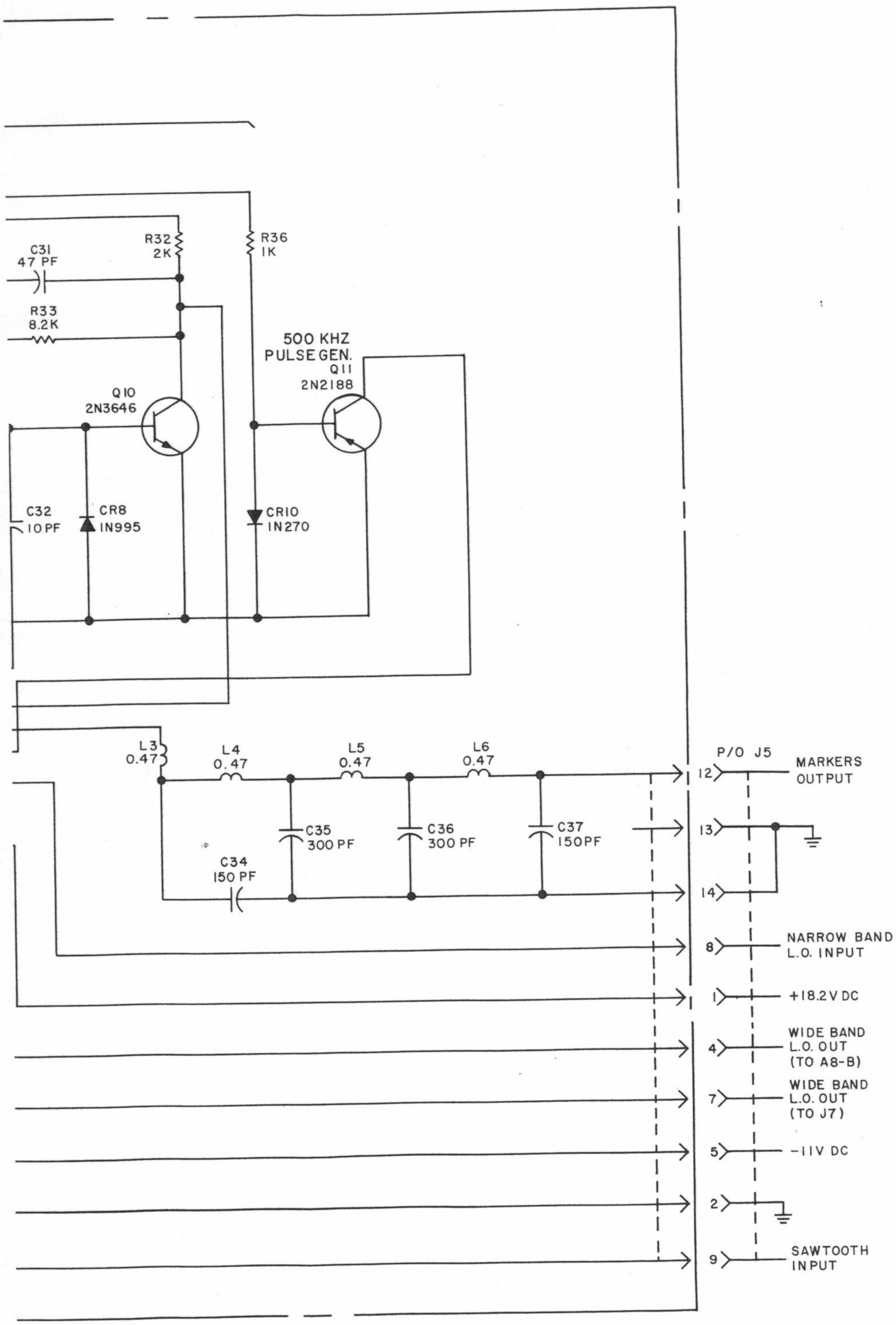
106-0615 00


-11V
15
C11, 0.01
C19
5PF
L1
4.7
L2
470
C17
2.2
C20
0.01
C21
0.01
R35
100
C2
0.1
R3
2K
C7
33 PF
R4
8.2K
Q3
2N3646
CR2
IN995
C8
15PF
R7
10K
R12
10K
C16
15 PF
CR4
IN995
C15
33 PF
R14
8.2K
R17
2K
Q4
2N3646
C1
0.1
R47
5.6K
R48
2K
C42
47 PF
R49
8.2K
Q14
2N3646
R51
10K
R50
10K
C44
10 PF
CR13
IN995
EMITTER
FOLLOWER
Q13
2N3563
R46
2K
C40
0.01
R45
1.5K
R44
1K
R43
300
1W
R42
3K
R41
300
C41
0.01
CR12
DIZ 5.1
C39
0.01
C38
100 PF
7 +V_CC
3 Z1
2 Z2
1 Z4
8 Z8
RESET
6
5
COUNT
FF
AND
4
A5A1 CμL 95859
- 250 KHZ BINARY DIVIDER
25 KHZ DECADE DIVIDER



500 MHZ MARKER CONTROL
P/O J5
28
C11, 0.01
500 KHZ DECADE DIVIDER
R17 2K
R1 2K
C5 47 PF
C12 15 PF
C13 47 PF
R16 2K
R2 8.2K
R13 8.2K
Q1 2N3646
Q2 2N3646
C1 0.1
CR1 IN995
C6 10 PF
R6 10K
R11 10K
C14 10 PF
CR3 IN995
R23 2K
C25 47 PF
C27 15 PF
R22 8.2K
Q7 2N3646
C22 0.1
CR5 IN995
C23 10 PF
R28 10K
R29 10K
CR9 IN906
C33 27 PF
R38 1K
R39 4.7K
TP2
TP3
C38 100 PF
R40 2K
8 Z8
FF
25 KHZ PULSE GEN./ MODULATOR Q12 2N2188
R37 4.7K
CR11 IN270
R65 200 1/2 W
C54 0.01
C53 0.01
R72 51
R68 56K
R67 56K
R66 100
R77 4.3K
R73 51
C57 27 PF
C56 27 PF
C55 5 PF
Q20 2N706A
Q19 2N706A
R75 2K
R76 1K
C59 510 PF
CR15 V-33B
C58 510 PF
C62 510 PF
R74 510
R71 100K
R70 100K
R69 510
WIDEBAND LOCAL OSC


R20
6.2K
R21
1.5K
C28
15 PF
C25
47 PF
C27
15 PF
C26
47 PF
R31
2K
R24
2K
C29
47 PF
C31
47 PF
R32
2K
R36
1K
R22
8.2K
R30
8.2K
R25
8.2K
R33
8.2K
500 KHZ
PULSE GEN.
Q11
2N2188
C18
0.1
Q8
2N3646
Q9
2N3646
Q10
2N3646
3646
R5
95
C23
10 PF
R28
10K
R29
10K
C24
10 PF
CR7
1N995
CR6
1N995
C30
10 PF
R26
10K
R34
10K
C32
10 PF
CR8
1N995
CR10
1N270
L3
0.47
L4
0.47
L5
0.47
R78
1K
C60
100 PF
L8
2.2 MH
C53
0.01
C54
0.01
C52
0.01
R61
1.5K
C35
300 PF
C34
150 PF
R66
100
R62
10K
L7
0.33
C56
27 PF
C55
5 PF
R63
2.2K
R60
51
R58
10K
R56
2K
AMPLIFIER
Q16
2N3563
R54
300
AMPLIFIER
Q18
2N3563
Q19
2N706A
C50
5PF
AMPLIFIER
Q17
2N2996
C48
1000 PF
C58
510 PF
R55
75
R70
100K
R69
510
R64
300
C51
0.01
R59
5.1K
R57
1K
C49
1000
PF
C47
1000
PF
C61
510 PF
L OSC



NOTES:
1. UNLESS OTHERWISE SPECIFIED.
ALL RESISTORS ARE IN OHMS, 1/4 W, ±5%.
2. ALL CAPACITORS ARE IN MICROFARADS
3. ALL INDUCTORS ARE IN MICROHENRIES.

Figure 5-7. Multivibrator/Marker Assembly A5, Schematic Diagram

SECTION VI

PARTS LIST

6-1. INTRODUCTION.

6-2. This parts list section includes all pertinent data necessary to locate, identify, and procure additional parts for the equipment. Parts are listed alpha-numerically by reference symbol and include all replaceable items such as electronic, electro-mechanical, and mechanical parts of the equipment. In some cases, values, ratings and manufacturer sources shown are nominal and variations may be found. Satisfactory replacement may be made with either the listed component or an exact replacement of the part(s) removed from the equipment.

6-3. ORDERING INFORMATION.

6-4. The following instructions will aid in ordering parts from the Parts List, table 6-2:

a. Address all inquiries or orders to:

CUSTOMER SERVICE
Department 500-1
The Singer Company
Instrumentation Division
915 Pembroke Street
Bridgeport, Conn., 06608

b. Include the following information:

1) Model and Serial Number of instrument.
2) Singer Part Number.
3) Reference Symbol Number.
4) Description (as shown on list).

6-5. HOW TO USE THE PARTS LIST.

6-6. Paragraphs 6-7 through 6-11 describe the use and meaning of the five columns included in the parts list, table 6-2 (see figure 6-1).

6-7. REF SYMBOL COLUMN. The Ref Symbol Column (1, figure 6-1) contains an alpha-numerical listing of parts as they appear on equipment chassis, illustration, or schematic. The reference designation identifies the parts as to their component function in the instrument.

6-8. DESCRIPTION COLUMN. The Description Column (2, figure 6-1) contains the identification of component parts including all pertinent specifications and Singer Part Number. When the description column is used for a part which is identical to a part which has already been described; SAME AS (3) is used along with the reference symbol of the previously used part. In these instances, columns 3, 4, 5 are left blank. When the description column is used for a reference symbol for which no part exists; NOT USED (4) is placed in the column. In these instances, columns 3, 4, 5, are left blank.

6-9. MANUFACTURER'S PART NUMBER COLUMN. The Manufacturer's Part Number column (5, figure 6-1) contains the part number as designated by the manufacturer of the part.

6-10. MFR'S CODE COLUMN. The Mfr's Code column (6, figure 6-1) references the manufacturer by an assigned code number as listed in Federal Supply Code Handbook H4-2. For manufacturers not listed in H4-2, a letter code will be assigned. Table 6-1 includes the manufacturer and his code designation.

6-11. MAINT QTY COLUMN. The Maint Qty column, (7, figure 6-1) contains the number of additional components recommended to keep the equipment at an optimum performance level. The recommended number of components in the Maint Qty column is based on 2000 hours of equipment operation.

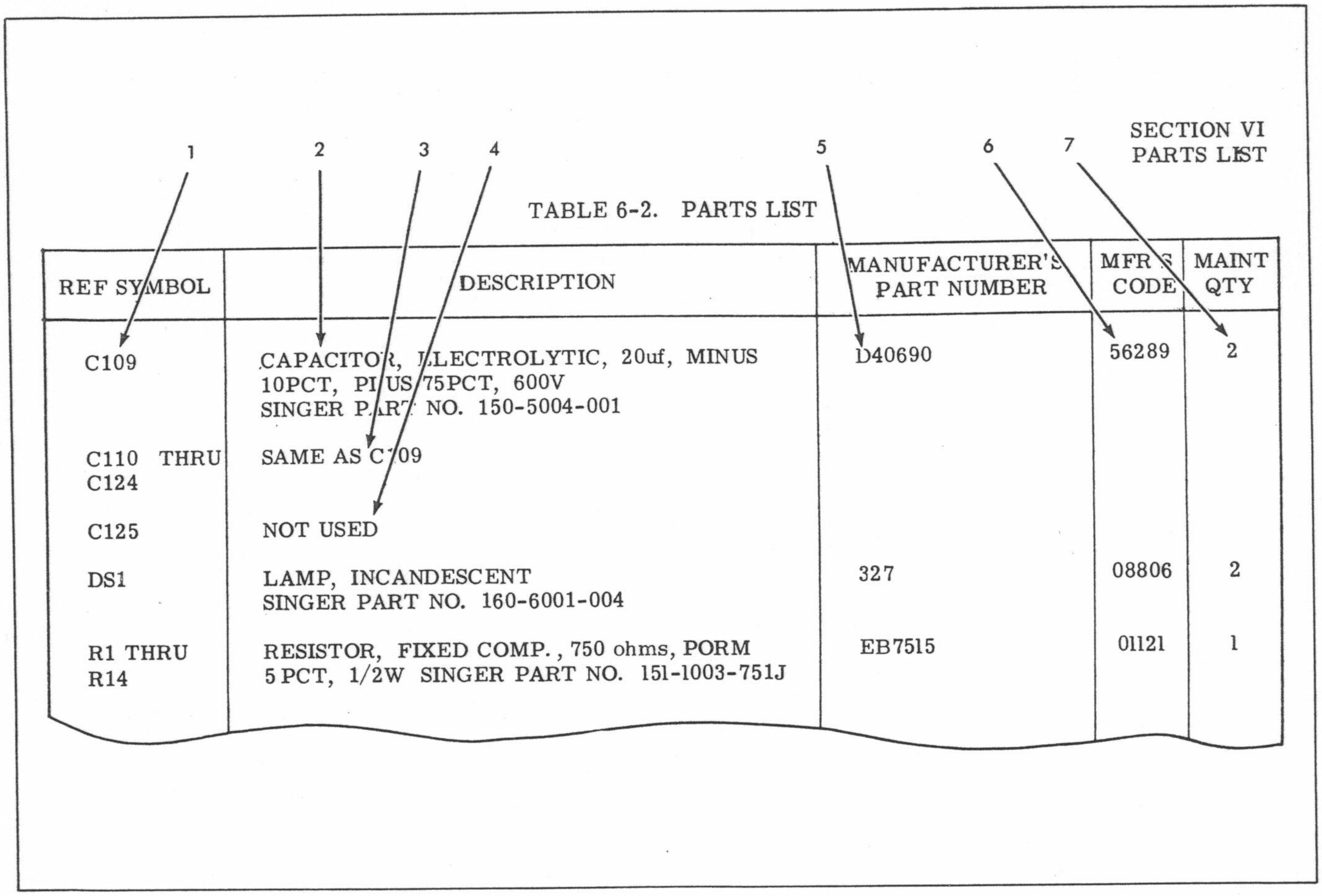


Figure 6-1. Parts List Sample

TABLE 6-1. MANUFACTURER'S CODE

Number	Name
01121	Allen-Bradley Co. Milwaukee, Wis.
01281	TRW Semiconductors, Inc. Lawndale, Calif.
01295	Texas Instruments, Inc. Semiconductor-Components Division Dallas, Texas
02335	Fairchild Controls Corp. Hicksville, Long Island, N.Y.
02660	Amphenol-Borg Electronics Corp. Maywood, Ill.
02777	Hopkins Engineering Co. San Fernando, Calif.
05397	Union Carbide Corp. Linde Division, Kemet Dept. Cleveland, Ohio
07263	Fairchild Camera and Instrument Corp. Semiconductor Division Mountain View, Calif.
07933	Raytheon Co. Semiconductor Operation Components Division Mountain View, Calif.
11236	CTC of Berne Inc. Berne, Ind.
12060	Diodes, Inc. Chatsworth, Calif.
12126	Kidco, Inc. Medford, N.J.
14841	Ward Leonard Electric Co. Hagerstown, Md.

(Cont'd)

TABLE 6-1. MANUFACTURER'S CODE (Cont'd)

Number	Name
14936	General Instrument Corp. Semi-Conductor Division Hicksville, Long Island, N.Y.
16665	The Singer Company Instrumentation Division Bridgeport, Conn.
37942	P.R. Mallory and Co., Inc. Indianapolis, Ind.
44655	Ohmite Mfg. Co. Skokie, Ill.
56289	Sprague Electric Co. North Adams, Mass.
71279	Cambridge Thermonic Corp. Cambridge, Mass.
71450	CTC Corp. Elkhart, Ind.
71590	Centralab Division of Globe-Union, Inc. Milwaukee, Wis.
72136	Electro-Motive Mfg. Co., Inc. Willimantic, Conn.
72928	Gudeman Co. Chicago, Ill.
72982	Erie Technological Products, Inc. Erie, Pa.
73138	Beckman Instruments, Inc. Helipot Division Fullerton, Calif.
73899	J.F.D. Electronics Corp. Brooklyn, N.Y.

Number	Name
74306	Piezo Crystal Co. Carlisle, Pa.
76493	J.W. Miller Co. Los Angeles, Calif.
78488	Stackpole Carbon Co. St. Marys, Pa.
78526	Stanwyck Winding Co., Inc. Newburgh, N.Y.
79727	Continental-Wirt Electronics Corp. Philadelphia, Pa.
80294	Bourns, Inc. Riverside, Calif.
81349	Military Specifications
82142	Jeffers Electronics Division of Speer Carbon Co. Dubois, Pa.
82389	Switchcraft, Inc. Chicago, Ill.
83186	Victory Engineering Corp. Springfield, N.J.
93332	Sylvania Electric Products, Inc. Semiconductor Products Division Woburn, Mass.
95238	Continental Connector Corp. Woodside, N.Y.
98291	Sealectro Corp. Mamaroneck, N.Y.
99942	Hoffman Electronics Corp. Evanston, Ill.

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This document is free on the internet.

If you paid someone for it, did you get a square deal on the added services and value they provided? There are a few manual dealers out there who have real nice "reproductions" of the original manual. If you are going to pay for something, pay for one of those, it's worth it.

This scanned document is "FREE" to keep, use, and distribute as long as no changes are made.
It is posted on the internet at www.bunkerofdoom.com and other places. Search the internet for "Singer VR-4b".

I scanned it in the hope that you can use it to fix your Alfred/Panoramic/Singer/Slant-Fin spectrum analyzer's VR-4B module. I paid for an origninal manual in order to do this, since I have two Singer MF-5 mainframes and VR-4B plugins. They are pretty beat up as shown below. The whole manual is in monochrome, except these two pictures to help spot the equipment, should you find one at a hamfest.

About the schematics, they are on some really long paper. I broke them into 8.5x11 overlapping sections. The idea is for you to print them and cut and tape them together. (the best I could do.)

Singer Instrumentation is out of business. No one with true rights to the manual supports this instrument any more. I hope they don't mind that we are using it.

Best Regards,
Patrick J. Jankowiak
KD5OEI

Notice one of the units has a VR-4 and one has a VR-4b. Don't ask, I do not know..

TABLE 6-2. PARTS LIST

Ref Symbol		Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
C1 C4	THRU	CAPACITOR,FIXED,CERAMIC DISC, 0.01 UF,250V SINGER PART NO. 556060-146	DA140-172B	71590	1
C6		CAPACITOR,MICA,DIPPED, 200 PF,PORM 5 PCT, 500V SINGER PART NO. 150-2002-201EJO	DM15E201J0500WV4CR	72136	1
C7		CAPACITOR,FIXED,ELECTROLYTIC, 100 UF,35V SINGER PART NO. 556146-523	MTP107M035PIC	37942	1
C8 C9	AND	CAPACITOR,FIXED,CERAMIC, 0.1 UF,PORM 20 PCT, 200V SINGER PART NO. 556120-098	338C104N	72928	1
C10		CAPACITOR,FIXED,DIPPED MICA, 100 PF, PORM 5 PCT,500V SINGER PART NO. 150-2002-101FJO	DM15F101J0500WV4CR	72136	1
C11		CAPACITOR,FIXED,MICA, 820 PF, PORM 2 PCT, 300V SINGER PART NO. 150-2002-821FJO	DM15F821G0300WV4CR	72136	1
C12		CAPACITOR,FIXED,DIPPED MICA, 7 PF, PORM 10 PCT,500VDC SINGER PART NO. 151-2002-070CKO	DM15C070K0500WV4CR	72136	1
C13 C14	AND	SAME AS C10			
J1 J5	THRU	CONNECTOR,RECEPTACLE SINGER PART NO. 168-3002-109	K600-13PCGD28	95238	1
J6		CONNECTOR,RECEPTACLE SINGER PART NO. 168-4006-001	UG 1094/U	81349	1
J7		CONNECTOR,JACK SINGER PART NO. 556146-546	460	02660	1
J8		CONNECTOR,FEMALE SINGER PART NO. 556146-560	57HA3F	82389	1
L1		CHOKE,RF, 4.7UH SINGER PART NO. 556012-199	09-4436-8	82142	1
L2 L3	AND	INDUCTOR, 470UH SINGER PART NO. 556012-202	TYPE DINK	78526	1
L4		CHOKE,R.F., 0.47 UH SINGER PART NO. 556012-216	09-4426-2	82142	2
P1		CONNECTOR,MALE SINGER PART NO. 556166-045	26-159-16	02260	1
P2		CONNECTOR,PLUG SINGER PART NO. 556010-266	51-011-0000	98291	1
P3 P4	AND	CONNECTOR,PLUG SINGER PART NO.168-4031-001	51-007-0000	98291	1
R1		RESISTOR,FIXED,CARBON FILM, 1500 OHMS, PORM 1 PCT,1/4W SINGER PART NO. 556146-165	RN60D1500F	81349	1
R2		RESISTOR,VARIABLE, 250 OHMS,PORM 20 PCT,1/2W	151-0001-052	16665	1
R3		RESISTOR,VARIABLE, 1K OHM,PORM 20 PCT,1/2W	151-0001-051	16665	1
R4		RESISTOR,FIXED,WIRE-WOUND, 390 OHMS, PORM 5 PCT,3W SINGER PART NO.151-2001-391J	FR-3-390	14841	1
R5		RESISTOR,FIXED,WIRE-WOUND, 360 OHMS, PORM 5 PCT,3W SINGER PART NO. 151-2001-361J	FR-3-360	14841	1
R6		RESISTOR,FIXED,WIRE-WOUND, 330 OHMS, PORM 5 PCT,3W SINGER PART NO.151-2001-331J	FR-3-330	14841	1
R7		RESISTOR,VARIABLE, 100 OHMS,PORM 20 PCT SINGER PART NO. 556146-511	GA2G200P101MA	01121	1

TABLE 6-2 PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
R8	RESISTOR,VARIABLE, 10K OHMS, PORM 3 PCT, 1/2W SINGER PART NO. 556146-510	3520S-1-103	80294	1
R9	RESISTOR,VARIABLE, 10KOHMS, PORM 10 PCT SINGER PART NO. 556146-512	GA2G028P103BA	01121	1
R10	RESISTOR,VARIABLE, 250 OHMS, PORM 20 PCT SINGER PART NO. 556146-509	TYPE300	71450	1
R11	RESISTOR,VARIABLE, 500K OHMS,PORM 20 PCT, 1/2W SINGER PART NO. 556146-526	GA2G200P504MA	01121	1
R12	RESISTOR,VARIABLE, 50K OHMS,PORM 3 PCT,2W SINGER PART NO. 151-0004-007	3500S-1-503	80294	1
R13	RESISTOR,VARIABLE, 1K OHMS,PORM 20 PCT SINGER PART NO. 556146-508	TYPE GA2	01121	1
R14	RESISTOR,VARIABLE, 1MEGOHM,PORM 20 PCT, 1/2W SINGER PART NO. 556146-525	GA2G200P105TA	01121	1
R15	RESISTOR,FIXED,PREC., 226 OHMS,PORM 0.5 PCT, 1/8W SINGER PART NO. 151-1006-B2260D	C1/8E2260HMPORM.5PCT	12126	1
R16	RESISTOR,FIXED,DEP. CARBON, 137 OHMS,PORM .5 PCT,1/8W SINGER PART NO. 151-1006-B1370D	C1/8E137OHMSPORM.5PC	12126	1
R17	RESISTOR,FIXED,PREC., 76.8 OHMS,PORM .5 PCT, 1/8W SINGER PART NO. 151-1006-B76R8D	C1/8E76.8OHMPORM.5PC	12126	1
R18	RESISTOR,FIXED,PREC., 42.2 OHMS,PORM .5 PCT, 1/8W SINGER PART NO. 151-1006-B42R2D	C1/8E42.2OHMPORM.5PC	12126	1
R19	RESISTOR,FIXED,PREC., 56.2 OHMS,PORM .5 PCT, 1/8W SINGER PART NO. 151-1006-B56R2D	C1/8E56.2OHMPORM.5PC	12126	1
R20	RESISTOR,VARIABLE, 250 OHMS, PORM 20 PCT SINGER PART NO. 556146-513	GA2G200P251MA	01121	1
R21	RESISTOR,FIXED,COMP., 100 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-101J	CB1015	01121	1
S1	SWITCH,INPUT IMPEDANCE SINGER PART NO. 556146-519	G-123	79727	1
S2	SWITCH,ROTARY, 2 POLE 4 POSITION	133-0060-001	16665	1
S3	SWITCH,ROTARY, 10 POLE 4 POSITION	133-0063-001	16665	1
S4	SWITCH,ROTARY, 3 POLE 2 POSITION	133-0059-001	16665	1
S5	SWITCH,ROTARY, 1 POLE 5 POSITION	133-0062-001	16665	1
S6	SWITCH,ROTARY, 3 POLE 2 POSITION	133-0061-001	16665	1
A1	D.C. CONTROL ASSEMBLY	103-1208-001	16665	1
A1CR1	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556146-548	232	12060	1
A1CR2 THRU A1CR5	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556118-202	IN935	81349	1
A1CR6	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556118-195	2320	12060	1
A1CR7	SAME AS A1CR2			

TABLE 6-2 PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A1CR8	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556118-046	IN251	93332	1
A1CR9 THRU A1CR11	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556166-041	IN270	44655	1
A1CR12 THRU A1CR16	SAME AS A1CR8			
A1C1	CAPACITOR,FIXED,ELECTROLYTIC, 2.2UF, 35V SINGER PART NO. 556146-506	K2R2J35KS	05397	1
A1C2 AND A1C3	CAPACITOR,FIXED,PAPER 0.1UF,PORM 20 PCT; 200 VDCW SINGER PART NO. 556120-120	P12D	02777	3
A1C4	SAME AS A1C1			
A1C5	SAME AS C1			
A1C6	SAME AS C10			
A1C7	CAPACITOR,FIXED,ELECTROLYTIC, 68 UF, 15V SINGER PART NO. 556146-504	K47J35S	05397	3
A1C8	SAME AS C10			
A1C9	SAME AS C7			
A1Q1 AND A1Q2	TRANSISTOR SINGER PART NO. 556146-254	2N3565	07263	1
A1Q3	TRANSISTOR	556146-652	16665	1
A1Q4	TRANSISTOR SINGER PART NO. 556166-087	2N2270	07933	1
A1Q5	TRANSISTOR SINGER PART NO. 556146-401	2N3638A	81349	1
A1Q6	SAME AS A1Q1			
A1Q7	SAME AS A1Q5			
A1Q8	SAME AS A1Q1			
A1Q9	SAME AS A1Q5			
A1Q10 AND A1Q11	SAME AS A1Q1			
A1Q12	SAME AS A1Q5			
A1Q13	SAME AS A1Q1			
A1R1	RESISTOR,FIXED,COMP., 10000 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-103J	CB1035	01121	4
A1R2	RESISTOR,FIXED,COMP., 3300 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-332J	CB3325	01121	2
A1R3	RESISTOR,VARIABLE, 25K OHMS SINGER PART NO. 556146-539	FC253M	01121	1
A1R4	RESISTOR,FIXED,WIRE-WOUND, 68 OHMS, PORM 5 PCT,1W SINGER PART NO. 556146-551	239E6805	56289	1
A1R5	RESISTOR,FIXED,COMP., 160 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-161J	EB1615	01121	1

TABLE 6-2 PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A1R6	RESISTOR,FIXED,COMP., 15000 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-153J	CB1535	01121	1
A1R7	RESISTOR,VARIABLE, 10K OHMS, PORM 20 PCT SINGER PART NO. 556146-507	FC103M	01121	1
A1R8	RESISTOR,FIXED,COMP., 27000 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-273J	CB2735	01121	2
A1R9	RESISTOR,FIXED,COMP., 24000 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-243J	CB2435	01121	1
A1R10	RESISTOR,FIXED,COMP., 390000 OHMS,PORM 5 PCT 1/4W SINGER PART NO. 151-1002-394J	CB3945	01121	1
A1R11	RESISTOR,FIXED,COMP., 3000 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-302J	CB3015	01121	2
A1R12	RESISTOR,FIXED,COMP., 100 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-101J	EB1015	01121	1
A1R13	RESISTOR,FIXED,COMP., 6800 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-682J	CB6825	01121	2
A1R14	RESISTOR,FIXED,COMP., 4300 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-432J	CB4325	01121	1
A1R15	RESISTOR,FIXED,COMP., 12000 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-123J	CB1235	01121	2
A1R16	RESISTOR,FIXED,COMP., 18000 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-183J	CB1835	01121	1
A1R17	SAME AS A1R7			
A1R18	RESISTOR,VARIABLE, 50K OHMS,PORM 30 PCT,1/4W SINGER PART NO. 556056-129	X201R503B	71450	1
A1R19	RESISTOR,FIXED,COMP., 51000 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-513J	CB5135	01121	1
A1R20 AND A1R21	RESISTOR,FIXED,COMP., 56000 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-563J	CB5635	01121	2
A1R22	SAME AS A1R8			
A1R23	RESISTOR,FIXED,COMP., 5600 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-562J	CB5625	01121	2
A1R24	SAME AS A1R8			
A1R25 AND A1R26	SAME AS A1R14			
A1R27	SAME AS A1R1			
A1R28	RESISTOR,FIXED,COMP., 1500 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-152J	CB1525	01121	3
A1R29	SAME AS A1R8			
A1R30	SAME AS A1R20			
A1R31	RESISTOR,VARIABLE,5K OHMS SINGER PART NO. 556146-541	XHT2D1-5K	71450	1
A1R32	SAME AS A1R13			

TABLE 6-2 PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A1R33	RESISTOR,FIXED,COMP., 5100 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-512J	CB5125	01121	2
A1R34	SAME AS A1R23			
A1R35	SAME AS A1R14			
A1R36	RESISTOR,FIXED,COMP., 2000 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-202J	CB2025	01121	3
A1R37	SAME AS A1R13			
A1R38	RESISTOR,FIXED,COMP., 9.1K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-912J	CB9125	01121	1
A1R39 THRU A1R42	SAME AS A1R31			
A1R43	RESISTOR,VARIABLE, 1K OHMS, SINGER PART NO. 556056-124	X201R102B	71450	1
A1R44	RESISTOR,FIXED,COMP., 910 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-911J	CB9115	01121	1
A1R45	RESISTOR,FIXED,COMP., 51 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-510J	CB5105	01121	3
A1R46	RESISTOR,VARIABLE, 100 OHMS SINGER PART NO. 556146-549	350PC101A	71450	1
A1R47	RESISTOR,FIXED,COMP., 22 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-220J	CB2205	01121	1
A1R48	SAME AS A1R46			
A1R49	RESISTOR,FIXED,COMP., 82 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-820J	CB8205	01121	1
A1R50	SAME AS A1R46			
A1R51	SAME AS R21			
A1R52	SAME AS A1R46			
A1R53	RESISTOR,FIXED,COMP., 12 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-120J	CB1205	01121	1
A1R54	SAME AS A1R46			
A1R55	SAME AS A1R18			
A1R56	SAME AS R21			
A1R57	RESISTOR,FIXED,COMP., 200 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-201J	CB2015	01121	3
A1R58	RESISTOR,VARIABLE, 2.5K PORM 20 PCT,1/8W SINGER PART NO. 556146-550	XT201	71450	1
A2	2.7MHZ 1-F AMP/DETECTOR ASSEMBLY	103-1210-001	16665	1
A2CR1	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556118-168	IN906	81349	1
A2CR2 AND A2CR3	SAME AS A1CR8			

TABLE 6-2 PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A2C1	CAPACITOR,CERAMIC DISC, 0.05MF, 80 PCT, 200V SINGER PART NO. 556074-057	33C137	56289	1
A2C2 AND A2C3	SAME AS C1			
A2C4	SAME AS A1C2			
A2C5	CAPACITOR,VARIABLE, 9 TO 50 PF, SINGER PART NO. 556146-552	3192-000N750	72928	2
A2C6	SAME AS C10			
A2C7 AND A2C8	SAME AS C1			
A2C9	SAME AS A1C2			
A2C10	SAME AS A2C5			
A2C11	SAME AS C10			
A2C12 THRU A2C19	SAME AS C1			
A2C20	SAME AS A1C2			
A2C21	CAPACITOR,FIXED,MICA, 33 PF, PORM 5 PCT, 500VDC SINGER PART NO. 150-2002-330EJ0	DM15E330J0500WV4CR	72136	1
A2C22	CAPACITOR,FIXED,ELECTROLYTIC, 47UF, 35V SINGER PART NO. 556146-505	K47J35S	05397	1
A2C23	SAME AS A1C2			
A2C24	SAME AS C1			
A2C25	SAME AS A2C1			
A2L1 AND A2L2	SAME AS L2			
A2L3	COIL,RF,100UH SINGER PART NO. 556012-191	1326-7K	82142	1
A2L4	COIL,RF,2.2MH SINGER PART NO. 556012-173	70F223A1	76493	1
A2Q1 THRU A2Q4	TRANSISTOR SINGER PART NO. 556017-059	2N2188	81349	1
A2Q5	SAME AS A1Q5			
A2Q6	SAME AS A2Q1			
A2Q7	TRANSISTOR SINGER PART NO. 556017-057	2N1091	81349	1
A2Q8	SAME AS A1Q4			
A2R1 AND A2R2	RESISTOR,FIXED,COMP., 20000 OHMS, PORM 5 PCT 1/4W SINGER PART NO. 151-1002-203J	CB2035	01121	2
A2R3	SAME AS R21			
A2R4	RESISTOR,FIXED,COMP., 1000 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-102J	CB1025	01121	3
A2R5	RESISTOR,FIXED,COMP., 33000 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-333J	CB3335	01121	3

TABLE 6-2 PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A2R6	SAME AS A1R13			
A2R7	SAME AS A1R45			
A2R8	SAME AS A2R5			
A2R9	RESISTOR,FIXED,COMP., 2200 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-222J	CB2225	01121	3
A2R10	SAME AS A2R5			
A2R11	SAME AS A1R13			
A2R12	SAME AS A1R57			
A2R13	RESISTOR,VARIABLE,MINIATURE, 500 OHMS,PORM 20 PCT,1/4W SINGER PART NO. 556203-010	XHT201-2/500,20PCT	11236	1
A2R14	SAME AS A1R11			
A2R15	SAME AS A2R5			
A2R16 AND A2R17	SAME AS A1R33			
A2R18	SAME AS R21			
A2R19	RESISTOR,FIXED,COMP., 510 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-511J	CB5115	01121	2
A2R20	RESISTOR,FIXED,COMP., 300 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-301J	CB3015	01121	1
A2R21	SAME AS A1R1			
A2R22	SAME AS A2R9			
A2R23	RESISTOR,FIXED,COMP., 430 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-431J	CB4315	01121	1
A2R24	SAME AS A1R1			
A2R25	SAME AS A1R43			
A2R26 AND A2R27	SAME AS A1R1			
A2R28	RESISTOR,FIXED,COMP., 220K OHMS,PORM 5 PCT T 1/4W SINGER PART NO. 151-1002-224J	CB224B	01121	1
A2R29	SAME AS R21			
A2T1 AND A2T2	TRANSFORMER,I-F	132-0111-001	16665	1
A2T3	TRANSFORMER,DETECTOR	132-0113-001	16665	1
A3	32.238MHZ I-F AMP/2ND MIXER/29.538MHZ OSC ASSEMBLY	103-1212-001	16665	1
A3C1	CAPACITOR,VARIABLE,2 TO 8PF, SINGER PART NO. 556146-553	538-006NPO	72982	1
A3C2	SAME AS C11			
A3C3 AND A3C4	SAME AS C1			

TABLE 6-2 PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A3C5	CAPACITOR,MICA,DIPPED, 68 PF,PORM 5 PCT,300V SINGER PART NO. 150-2002-680EJO	DM15E680J0300WV4CR	72136	1
A3C6	SAME AS A3C2			
A3C7	SAME AS C1			
A3C8	SAME AS A3C2			
A3C9	SAME AS A3C5			
A3C10 AND A3C11	SAME AS C1			
A3C12	SAME AS A2C1			
A3C13	CAPACITOR,MICA,DIPPED, 1000 PF,PORM 5 PCT, 100V SINGER PART NO. 150-2002-102EJO	DM15E102J0100WV4CR	72136	1
A3C14	CAPACITOR,FIXED,DIPPED MICA, 24 PF, PORM 5 PCT,500VDC SINGER PART NO. 150-2002-240EJO	DM15E240J0500WV4CR	72136	1
A3C15	SAME AS A2C5			
A3C16	SAME AS C6			
A3C17	CAPACITOR,MICA,DIPPED, 56 PF,PORM 5 PCT,300V SINGER PART NO. 150-2002-560EJO	DM15E560J0300WV4CR	72136	1
A3C18	CAPACITOR,MICA,DIPPED, 120 PF,PORM 5 PCT 500V SINGER PART NO. 150-2002-121EJO	DM15E121J0500WV4CR	72136	1
A3C19	SAME AS A2C5			
A3C20 THRU A3C22	SAME AS C1			
A3J1	CONNECTOR,JACK SINGER PART NO. 556146-441	3320-2-03	71279	1
A3L1	SAME AS L1			
A3L2	CHOKE,RF, 5.6UH SINGER PART NO. 556012-200	09-4446-1	82142	1
A3L3	SAME AS L4			
A3L4	SAME AS A3L2			
A3P1	CONNECTOR,PLUG SINGER PART NO. 556146-440	2971-2	71279	1
A3Q1 THRU A3Q3	TRANSISTOR SINGER PART NO. 556146-923	2N4917	81349	1
A3Q4	SAME AS A1Q1			
A3R1	RESISTOR,FIXED,COMP., 2700 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-272J	CB2725	01121	1
A3R2	RESISTOR,FIXED,COMP., 470 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-471J	CB4715	01121	1
A3R3	SAME AS A1R14			
A3R4	RESISTOR,FIXED,COMP., 110 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-111J	CB1115	01121	1
A3R5	SAME AS A1R14			

TABLE 6-2 PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A3R6	SAME AS A3R2			
A3R7	SAME AS A3R1			
A3R8	SAME AS A3R4			
A3R9	SAME AS A1R8			
A3R10	SAME AS A1R15			
A3R11	SAME AS A1R11			
A3R12	SAME AS A3R1			
A3R13	SAME AS A2R5			
A3R14	SAME AS R21			
A3R15	SAME AS A1R45			
A3R16	SAME AS A2R9			
A3R17	SAME AS A2R23			
A3R18	SAME AS A2R5			
A3R19	RESISTOR,FIXED,COMP., 6200 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-622J	CB6225	01121	2
A3R20	RESISTOR,FIXED,COMP., 390 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-391J	CB3915	01121	1
A3T1 AND A3T2	TRANSFORMER,I-F,ADJUSTABLE CORE	132-0114-001	16665	1
A3T3	TRANSFORMER,I-F	132-0112-001	16665	1
A3T4	AUTOTRANSFORMER	132-0115-001	16665	1
A3Y1	CRYSTAL,29.538MHZ	556146-554	16665	1
A4	2.7MHZ CRYSTAL FILTER ASSEMBLY	103-1211-001	16665	1
A4CR1 THRU A4CR4	SAME AS A2CR1			
A4CR5	SAME AS A1CR8			
A4C1	SAME AS C1			
A4C2	SAME AS A3C1			
A4C3	SAME AS A2C5			
A4C4 AND A4C5	SAME AS A2C1			
A4C6	SAME AS C1			
A4C7	SAME AS A2C1			
A4C8 THRU A4C11	SAME AS C1			
A4C12	SAME AS A1C7			
A4C13	SAME AS A3C1			

TABLE 6-2 PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A4C14	SAME AS A2C5			
A4C15	SAME AS A2C1			
A4C16 THRU A4C18	SAME AS C1			
A4C19	SAME AS A2C5			
A4C20	CAPACITOR,MICA,DIPPED, 330 PF,PORM 5 PCT, 500J SINGER PART NO. 150-2002-331EJ0	DM15E331J0500WV4CR	72136	1
A4C21	CAPACITOR,FIXED,COMP., 3.9PF,PORM 5 PCT, 500VDC SINGER PART NO. 150-4001-3R9J	TYPE GA	78488	1
A4C22	SAME AS A4C20			
A4C23	SAME AS A2C5			
A4C24	SAME AS A4C21			
A4C25	SAME AS A4C20			
A4C26	SAME AS A2C5			
A4C27 AND A4C28	SAME AS C1			
A4L1 THRU A4L4	SAME AS L2			
A4L5 THRU A4L7	CHOKE,RF 10UH SINGER PART NO. 556146-555	09-4446-4K	82142	1
A4Q1 THRU A4Q6	SAME AS A1Q5			
A4Q7	SAME AS A1Q1			
A4Q8	SAME AS A1Q5			
A4Q9	TRANSISTOR SINGER PART NO. 556146-251	2N3563	14936	1
A4Q10	SAME AS A1Q5			
A4R1	RESISTOR,FIXED,COMP., 22000 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-223J	CB2235	01121	1
A4R2	SAME AS A1R14			
A4R3	SAME AS A1R57			
A4R4	RESISTOR,FIXED,COMP., 240 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-241J	CB2415	01121	1
A4R5	SAME AS A3R2			
A4R6	SAME AS A1R57			
A4R7	SAME AS A1R2			
A4R8	SAME AS A1R15			
A4R9	RESISTOR,FIXED,COMP., 7500 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-752J	CB7525	01121	1
A4R10	SAME AS A1R14			

TABLE 6-2 PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A4R11	RESISTOR,FIXED,COMP., 680 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-681J	CB6815	01121	1
A4R12	RESISTOR,FIXED,COMP., 120 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-121J	CB1215	01121	1
A4R13	SAME AS A2R4			
A4R14	SAME AS A4R9			
A4R15	SAME AS A1R14			
A4R16	SAME AS A4R11			
A4R17	RESISTOR,FIXED,COMP., 120 OHMS, PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-121J	CB1215	01121	1
A4R18	SAME AS A2R4			
A4R19	SAME AS A4R1			
A4R20	SAME AS A1R14			
A4R21	SAME AS A1R57			
A4R22	SAME AS A4R4			
A4R23	SAME AS A3R2			
A4R24	SAME AS R21			
A4R25	SAME AS A1R57			
A4R26	SAME AS A1R1			
A4R27	SAME AS A1R2			
A4R28	SAME AS A1R15			
A4R29	SAME AS A2R4			
A4R30	SAME AS A2R28			
A4R31	RESISTOR,FIXED,COMP., 11K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-113J	CB1135	01121	1
A4R32	SAME AS A1R57			
A4R33	SAME AS A4R31			
A4R34	SAME AS A2R1			
A4R35	RESISTOR,FIXED,COMP., 1200 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-122J	CB1225	01121	1
A4R36	SAME AS A2R19			
A4R37	SAME AS A2R5			
A4R38	RESISTOR,FIXED,COMP., 39K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-393J	CB3935	01121	1
A4R39	SAME AS A1R57			
A4R40	SAME AS A1R28			
A4T1 AND A4T2	TRANSFORMER,I-F	132-0110-001	16665	1

TABLE 6-2 PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A4Y1 AND A4Y2	CRYSTAL PAIR, 2.7MHZ EACH,IN HC-6/U HOLDER SINGER PART NO. 556146-593	508-02-37	74306	1
A5	MULTIVIBRATOR/MARKER ASSEMBLY	103-1216-001	16665	1
A5A1	MICRO CKT DIVIDER SINGER PART NO. 556146-522	CVL958	02335	1
A5CR1 THRU A5CR8	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556146-146	IN995	14936	1
A5CR9	SAME AS A2CR1			
A5CR10 AND A5CR11	SAME AS A1CR9			
A5CR12	SAME AS A1CR1			
A5CR13 AND A5CR14	SAME AS A5CR1			
A5CR15	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556146-520	V-33B	01281	1
A5C1 AND A5C2	SAME AS A1C2			
A5C3 AND A5C4	SAME AS C1			
A5C5	CAPACITOR,MICA,DIPPED, 47 PF,PORM 5 PCT,500V SINGER PART NO. 150-2002-470EJO	DM15E470J0500WV4CR	72136	2
A5C6	CAPACITOR,MICA,DIPPED, 10 PF,PORM 5 PCT,500V SINGER PART NO. 150-2002-100CJO	DM15C100J0500WV4CR	72136	2
A5C7	SAME AS A2C21			
A5C8	CAPACITOR,FIXED,DIPPED MICA,15 PF,PORM 5 PCT 500V SINGER PART NO. 556125-007	DM15C150J0500WV	72136	1
A5C9	SAME AS C1			
A5C10	SAME AS A5C8			
A5C11	SAME AS C1			
A5C12	SAME AS A5C8			
A5C13	SAME AS A5C5			
A5C14	SAME AS A5C6			
A5C15	SAME AS A2C21			
A5C16	SAME AS A5C8			
A5C17	SAME AS A1C1			
A5C18	SAME AS A1C2			
A5C19	CAPACITOR,MICA,DIPPED, 5 PF,PORM 0.5 PF,500V SINGER PART NO. 150-2002-5ROCDO	DM15C5RD0500WV4CR	72136	1
A5C20 AND A5C21	SAME AS C1			

TABLE 6-2 PARTS LIST

Ref Symbol		Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A5C22		SAME AS A1C2			
A5C23 A5C24	AND	SAME AS A5C6			
A5C25 A5C26	AND	SAME AS A5C5			
A5C27 A5C28	AND	SAME AS A5C8			
A5C29		SAME AS A5C5			
A5C30		SAME AS A5C6			
A5C31		SAME AS A5C5			
A5C32		SAME AS A5C6			
A5C33		CAPACITOR,MICA,DIPPED, 27 PF,PORM 5 PCT,100V SINGER PART NO. 150-2002-270CJO	DM15C270J0100WV4CR	72136	1
A5C34		CAPACITOR,MICA,DIPPED, 150 PF,PORM 5 PCT, 500V SINGER PART NO. 150-2002-151EJO	DM15E151J0500WV4CR	72136	1
A5C35 A5C36	AND	CAPACITOR,MICA,DIPPED, 300 PF,PORM 1 PCT, 500V SINGER PART NO. 150-2002-301EFO	DM15E301F0500WV4CR	72136	1
A5C37		SAME AS A5C34			
A5C38		SAME AS A1C6			
A5C39 A5C41	THRU	SAME AS C1			
A5C42 A5C43	AND	SAME AS A5C6			
A5C44 A5C45	AND	SAME AS A5C6			
A5C46		SAME AS A1C2			
A5C47 A5C49	THRU	SAME AS A3C13			
A5C50		SAME AS A5C19			
A5C51 A5C54	THRU	SAME AS C1			
A5C55		SAME AS A5C19			
A5C56 A5C57	AND	SAME AS A5C33			
A5C58 A5C59	AND	CAPACITOR,MICA,DIPPED, 510 PF,PORM 5 PCT, 500V SINGER PART NO. 150-2002-511EJO	DM15E511J0500WV4CR	72136	1
A5C60		SAME AS C10			
A5C61 A5C62	AND	SAME AS A5C58			
A5L1		SAME AS L1			
A5L2		SAME AS L2			

TABLE 6-2 PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A5L3 THRU A5L6	SAME AS L4			
A5L7	CHOKE,0.33UH SINGER PART NO. 556012-198	4416-7	82142	1
A5L8	INDUCTOR,2.2MH SINGER PART NO. 556012-217	70F223A1	76493	1
A5Q1 THRU A5Q4	TRANSISTOR SINGER PART NO. 556146-256	2N3646	81349	1
A5Q5 AND A5Q6	SAME AS A4Q9			
A5Q7 THRU A5Q10	SAME AS A5Q1			
A5Q11 AND A5Q12	SAME AS A2Q1			
A5Q13	SAME AS A4Q9			
A5Q14 AND A5Q15	SAME AS A5Q1			
A5Q16	SAME AS A4Q9			
A5Q17	TRANSISTOR SINGER PART NO. 556118-201	2N2996	81349	1
A5Q18	SAME AS A4Q9			
A5Q19 AND A5Q20	TRANSISTOR SINGER PART NO. 556166-086	2N706A	01295	1
A5R1	SAME AS A1R36			
A5R2	RESISTOR,FIXED,COMP., 8200 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-822J	CB8225	01121	3
A5R3	SAME AS A1R36			
A5R4	SAME AS A5R2			
A5R5	RESISTOR,FIXED,COMP., 240 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-241J	CB2415	01121	1
A5R6 AND A5R7	SAME AS A1R1			
A5R8	SAME AS A1R43			
A5R9	RESISTOR,FIXED,COMP., 4.7 KOHMS, PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-472J	151-1002-472J	01121	1
A5R10	SAME AS A3R19			
A5R11 AND A5R12				
A5R13 AND A5R14	SAME AS A5R2			
A5R15	SAME AS A5R9			
A5R16 AND A5R17	SAME AS A1R36			
A5R18	SAME AS A1R2			

TABLE 6-2 PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A5R19	SAME AS A1R23			
A5R20	SAME AS A3R19			
A5R21	SAME AS A1R28			
A5R22	SAME AS A5R2			
A5R23 AND A5R24	SAME AS A1R36			
A5R25	SAME AS A5R2			
A5R26	SAME AS A1R1			
A5R27	SAME AS A4R11			
A5R28 AND A5R29	SAME AS A1R1			
A5R30	SAME AS A5R2			
A5R31 AND A5R32	SAME AS A1R36			
A5R33	SAME AS A5R2			
A5R34	SAME AS A1R1			
A5R35	SAME AS R21			
A5R36	SAME AS A2R4			
A5R37	SAME AS A5R9			
A5R38	SAME AS A2R4			
A5R39	SAME AS A5R9			
A5R40	SAME AS A1R36			
A5R41	SAME AS A2R20			
A5R42	SAME AS A1R11			
A5R43	RESISTOR,FIXED,COMP., 300 OHMS,PORM 5 PCT, 1W SINGER PART NO. 151-1004-301J	GB3015	01121	1
A5R44	SAME AS A2R4			
A5R45	SAME AS A1R28			
A5R46	SAME AS A1R36			
A5R47	SAME AS A1R23			
A5R48	SAME AS A1R36			
A5R49	SAME AS A5R2			
A5R50 AND A5R51	SAME AS A1R1			
A5R52	SAME AS A5R2			
A5R53	SAME AS A1R36			

TABLE 6-2 PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A5R54	SAME AS A2R20			
A5R55	RESISTOR,FIXED,COMP., 75 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-750J	CB7505	01121	1
A5R56	SAME AS A1R36			
A5R57	SAME AS A2R4			
A5R58	SAME AS A1R1			
A5R59	SAME AS A1R33			
A5R60	SAME AS A1R45			
A5R61	SAME AS A1R28			
A5R62	SAME AS A1R1			
A5R63	SAME AS A2R9			
A5R64	SAME AS A2R20			
A5R65	RESISTOR,FIXED,COMP., 200 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-201J	EB2015	01121	1
A5R66	SAME AS R21			
A5R67 AND A5R68	SAME AS A1R20			
A5R69	SAME AS A2R19			
A5R70 AND A5R71	RESISTOR,FIXED,COMP., 100K OHMS,PORM 5 PCT 1/4W SINGER PART NO. 151-1002-104J	CB1045	01121	2
A5R72 AND A5R73	SAME AS A1R45			
A5R74	SAME AS A2R19			
A5R75	SAME AS A1R36			
A5R76	SAME AS A1R43			
A5R77	SAME AS A1R14			
A5R78	SAME AS A2R4			
A5Y1	CRYSTAL,5MHZ	556146-556	16665	1
A6	LOG-LIN ASSEMBLY	103-1215-001	16665	1
A6CR1 AND A6CR2	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556166-034	HU-10	99942	1
A6R1	RESISTOR,VARIABLE, 1K OHMS SINGER PART NO. 556146-516	62PR-1K	73138	1
A6R2	RESISTOR,VARIABLE, 20K OHMS SINGER PART NO. 556146-515	62PR20K	73138	1
A6R3	RESISTOR,VARIABLE, 50 KOHMS,PORM 30 PCT,1/2W SINGER PART NO. 556146-514	62P R50K	73138	1
A6R4	RESISTOR,FIXED,COMP., 510K OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-514J	CB5145	01121	1

TABLE 6-2 PARTS LIST

Ref Symbol		Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A6R5		RESISTOR,VARIABLE, 500 KOHMS,PORM 30 PCT, 1/2W SINGER PART NO. 556146-557	62P R500	73138	1
A6VR1		VARISTOR SINGER PART NO. 151-5001-001	623L13	83186	1
A7		NARROW BAND LO ASSEMBLY	103-1204-001	16665	1
A7CR1		SAME AS A5CR15			
A7C1 A7C2	AND	SAME AS C1			
A7C3		SAME AS A3C5			
A7C4 A7C5	AND	SAME AS C1			
A7C6		SAME AS A5C6			
A7C7		SAME AS A3C14			
A7C8		SAME AS A5C33			
A7C9 A7C10	AND	SAME AS C1			
A7C11		SAME AS A3C13			
A7C12		CAPACITOR,FIXED,DIPPED MICA, 7500 PF, PORM 5 PCT,500V SINGER PART NO. 150-2004-752FJO	DM30F752J0500WV4CR	72136	1
A7C13		SAME AS C1			
A7C14		SAME AS A3C5			
A7C15		SAME AS A2C21			
A7J1		CONNECTOR,JACK SINGER PART NO.168-3003-001	51-053-0000	98291	1
A7L1		CHOKE,RF, 22UF SINGER PART NO. 556012-201	09-1316-4	82142	1
A7L2		INDUCTOR,VARIABLE	132-0191-001	16665	1
A7L3		CHOKE,RF,0.1UH SINGER PART NO. 556012-218	09-4426-2	82142	1
A7L4		SAME AS A2L3			
A7L5		SAME AS L1			
A7L6		SAME AS A3L2			
A7Q1 A7Q4	THRU	SAME AS A4Q9			
A7R1		SAME AS A1R6			
A7R2		SAME AS A5R2			
A7R3 A7R4	AND	RESISTOR,FIXED,COMP., 330 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-331J	CB3315	01121	1
A7R5 A7R6	AND	SAME AS A2R9			
A7R7		SAME AS A2R19			
A7R8 A7R9	AND	SAME AS A5R70			

TABLE 6-2 PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A7R10	SAME AS R21			
A7R11	SAME AS A2R9			
A7R12	SAME AS A2R20			
A7R13	SAME AS A1R1			
A7R14	SAME AS A3R20			
A7R15	RESISTOR,FIXED,COMP., 750 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-751J	CB7515	01121	1
A7R16	SAME AS A1R1			
A7R17	SAME AS A2R4			
A7R18	SAME AS A1R45			
A8	FIRST MIXER ASSEMBLY	103-1207-001	16665	1
A8C1	SAME AS A1C7			
A8C2 AND A8C3	SAME AS C1			
A8C4	SAME AS A1C7			
A8C5	SAME AS C1			
A8C6	SAME AS A1C7			
A8C7	SAME AS C1			
A8C8	SAME AS A1C7			
A8C9 AND A8C10	SAME AS C1			
A8C11	SAME AS A1C7			
A8C12	CAPACITOR,MICA,DIPPED, 300 PF,PORM 5 PCT, 500V SINGER PART NO. 150-2002-301EJO	DM15E301J0500WV4CR	72136	1
A8C13	SAME AS C1			
A8C14	SAME AS A3C5			
A8C15	CAPACITOR,VARIABLE, 0.8 TO 4.5 PF SINGER PART NO. 556146-559	VC-10G	73899	1
A8J1	SAME AS A3J1			
A8P1	SAME AS A3P1			
A8Q1 THRU A8Q4	SAME AS A4Q9			
A8R1	SAME AS A5R55			
A8R2	RESISTOR,FIXED,COMP., 33 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-330J	CB3305	01121	2
A8R3	SAME AS A1R1			
A8R4	SAME AS A3R19			

TABLE 6-2 PARTS LIST

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
A8R5	RESISTOR,VARIABLE, 10K OHMS SINGER PART NO. 556146-527	62PR10K	73138	1
A8R6	SAME AS A8R2			
A8R7	RESISTOR,FIXED,COMP., 220 OHMS,PORM 5 PCT, 1/4W SINGER PART NO. 151-1002-221J	CB2215	01121	1
A8R8 AND A8R9	SAME AS A8R2			
A8R10	SAME AS A1R57			
A8R11	RESISTOR,VARIABLE, 100 OHM SINGER PART NO. 556146-558	62PR100	73138	1
A8R12	SAME AS A1R13			
A8R13	SAME AS A2R1			
A8R14 AND A8R15	SAME AS A1R14			
A8R16	SAME AS A2R1			
A8R17	SAME AS A1R23			
A8R18	SAME AS A8R2			
A8R19	SAME AS A2R4			
A8R20	SAME AS A8R2			
A8R21 AND A8R22	SAME AS A1R2			
A8R23	SAME AS A1R28			
A8T1	SAME AS A3T1			
A9	INPUT ATTENUATOR ASSEMBLY	103-1094-001	16665	1
A9J1 AND A9J2	CONNECTOR,JACK SINGER PART NO. 556010-267	51-047-0000	98291	1
A9R1	RESISTOR,FIXED,PREC., 107 OHMS,PORM 1 PCT, 1/8W SINGER PART NO. 556146-531	C1/8E107OHMPORM1PCT	12126	1
A9R2 AND A9R3	RESISTOR,FIXED,PREC., 143 OHMS,PORM 1 PCT 1/8W SINGER PART NO. 556146-530	CI/8E143OHMPORM1PCT	12126	1
A9R4	RESISTOR,FIXED,PREC., 374 OHMS,PORM 1 PCT, 1/8W SINGER PART NO. 556146-532	CI/8E374OHMPORM1PCT	12126	1
A9R5 AND A9R6	RESISTOR,FIXED,PREC., 90.9 OHMS,PORM 1 PCT, 1/8W SINGER PART NO. 556146-529	CI/8E909OHMPORM1PCT	12126	1
A9R7	RESISTOR,FIXED,PREC., 3740 OHMS,PORM 1 PCT, 1/8W SINGER PART NO. 556146-533	CI/8E3740OHMPORM1PCT	12126	1
A9R8 AND A9R9	RESISTOR,FIXED PREC., 75 OHMS,PORM 1 PCT, 1/8W SINGER PART NO. 556146-528	CI/8E75OHMPORM1PCT	12126	1
A9S1 THRU A9S6	SWITCH	149-0164-001	16665	

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