

# High Voltages and Oscilloscope Probes

## basics

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# Knowledge to be Covered

- **Probes for Oscilloscope Use**
- **Measuring High Voltages**
- **Safety**

# Common Probes

- 1:1 “straight” probe
  - 100V at probe is carried directly to scope input
- 10:1 probe with compensator
  - 100V at probe is reduced by series resistor to 10V at scope
- RF detector probe
  - Simple, has built in RF diode detector and network
  - Usually for low RF voltages <50V peak AC
  - Usually good for DC to 400-600V (capacitor isolated)
  - Often good to 500MHz
  - Detected envelope (e.g. audio) is delivered to scope
  - Not always calibrated for amplitude
- Always use the GND



# Measuring Voltages to 600V

- Be certain of scope input voltage limits
  - Usually stated as peak or DC on front panel near input connector
  - Some are 600V, some are 50V, some special are even 5V
  - If not stated, 250-400V is usually OK on older tube units.
  - Trigger inputs may have different ratings.
  - What is the voltage rating of the probe?
  - Read the manual.
- Always use the GND.



# Measuring High Voltages

- Special Considerations
  - Would you trust the probe in your hand when you touch it to these test points?
    - 5000V pulse in the tube color TV set?
    - 700V DC+AC in a filter's choke input?
  - Anything over 600V peak should never be measured with a standard probe.
    - Arc at the tip.
    - Arc through the probe body
  - Over 600V should only be measured with a probe built or designed for higher voltages.
- Always use the GND.

# Measuring High Voltages

- HV Series Multiplier Probes
  - If scope has 1M input resistance, adding a 9M resistance in series increases resistance to 10M and allows 10X the voltage rating.
  - Commercial series-probes and probe tip adapters are out there. Be aware that if the scope is not grounded to the work, and the tip or probe is not plugged into the scope, arcing may occur.
  - For DIY - Always observe voltage ratings of series resistors.
    - Most resistors are 200-600V, some are less.
    - Use nine 1M resistors in series for example.
  - Or buy a special HV resistor
    - Caddock, OhmCraft, Victoreen, Vishay
  - Remember - no RF compensation with resistors only.
- Always use the GND.

# Measuring High Voltages

- DIY HV Series Multiplier Probes
  - Use nine 1M resistors in series for a 10X example.
  - Slip into a glass tube with a tip at the end.
  - Slip the glass tube inside a (brass) metal tube leaving at least 1” exposed at the tip (‘hot’) end.
  - Run coaxial cable from scope plug to housing.
    - Center to ‘cold’ end of resistor string
    - Shield to tube (housing) and a GND lead
    - Brass tube probe body becomes a metal grounded shield between the high voltage resistor and the operator.
  - ALWAYS have probe attached to scope before probing.
    - Otherwise, HV may arc at loose scope end of cable and back to operator.
- Always use the GND.

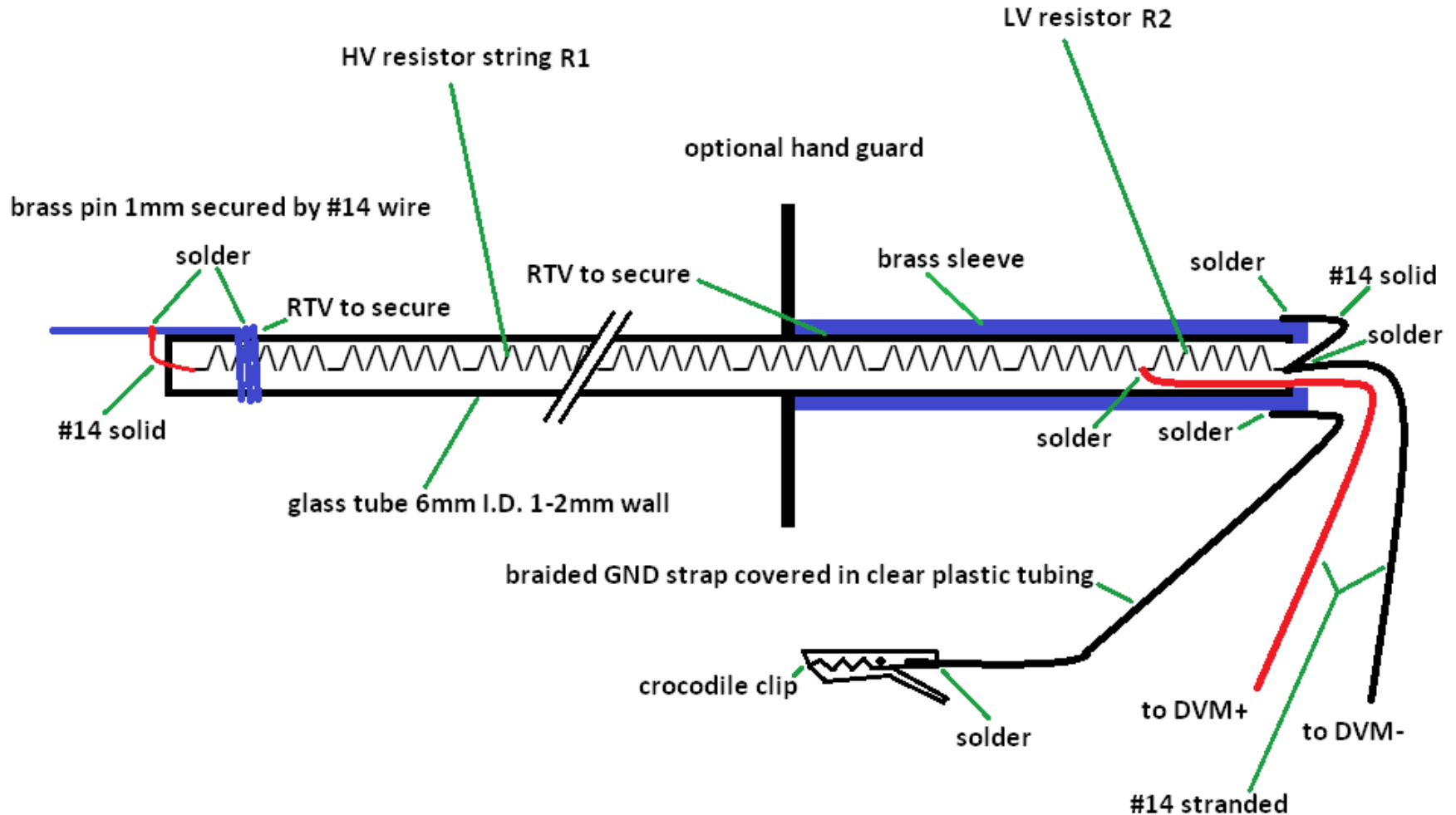
# Measuring High Voltages

- DIY High Voltage Divider Probes
  - Same body construction as series probe
  - Reduce the highest voltage the instrument can receive
  - Increased safety ; integral ground.
  - Assume scope input=1M
  - Use nine 1M resistors in series plus a 500K and a 1M
  - Tip –1-1-1-1-1-1-1-1-1-0.5-tap-1-GND\_lead
  - The scope is tapped to the top of the last 1M resistor.
  - Multiplication is 20:1; 2KV at tip makes 100V at scope.
- Always use the GND.



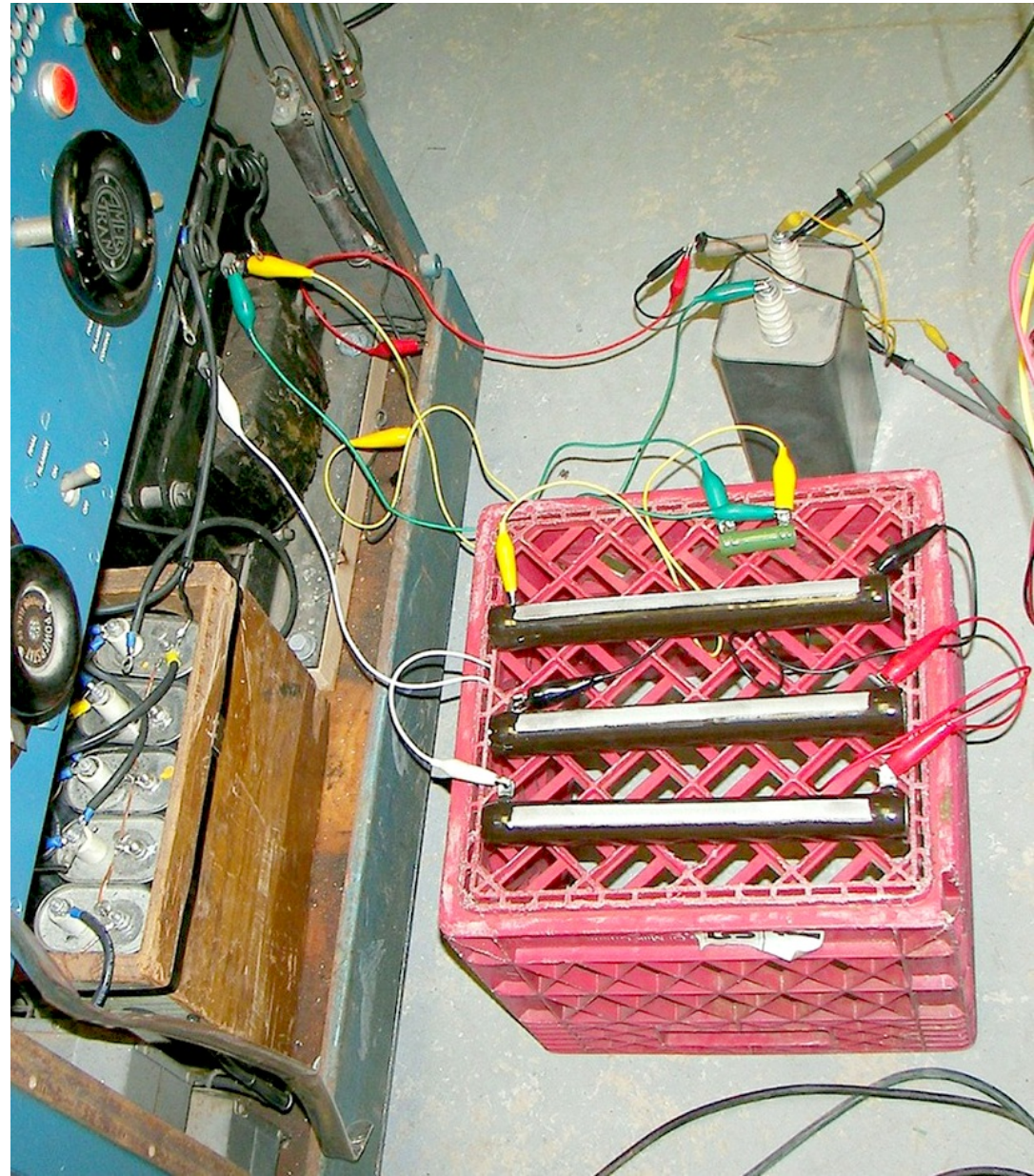
# Measuring High Voltages

- DIY High Voltage Divider Probe



# Measuring Power at Very High Voltages

- The 7575 Ohm “dummy load” attached to the modulator has a 7306V p-p audio signal across it, and is also at 3500VDC above ground. - used a 101:1 divider:
- Tip-2500-2500-2500-Tap-75-GND.
- Power of 890W RMS measured using scope to see clipping level and VOM to read volts.
- Can Do – *with care*.
  - Use external divider and temporarily install to equipment, then attach to tap and GND
  - Space and insulate divider and cables from objects to prevent arcing.
  - Respect wattage and voltage ratings.
- **Always use the GND.**
- **Hands-Off measurement**
- **Kill-Switch on AC Input**
- **Stand well back**
- **Observe from distance**
- **Light fuse and get away.**



# Safety

- Isolation and Grounding
  - Scope should always be grounded using AC grounding plug.
  - Some scopes do not have a grounding cord. Connect proper ground wire between the scope and workbench power ground.
    - Your workbench must have an AC power ground.
  - Use isolation transformer on equipment under test.
  - If not appropriate to isolate gear, check for AC leakage from gear and if OK proceed.
  - Noise from bad grounds and ground loops can obscure weak signals. Not a safety issue but an annoyance.
- Point? Bad things happen to hands, scopes, and signal purity when lots of current flows through the probe ground.