

**E7D17. Review
action if you have
difficulty.**

HIGH VOLTAGE TECHNIQUES

The construction of high-voltage supplies poses special considerations in addition to the normal design and construction practices used for lower-voltage supplies. In general, remember that physical spacing between leads, connections, parts and the chassis must be sufficient to prevent arcing. Also, the series connection of components such as capacitor and resistor strings needs to be done with consideration for voltage stresses in the components.

Capacitors

Capacitors are often connected in series strings to form an equivalent capacitor with the capability to withstand the applied voltage. When this is done, equal-value resistors need to be connected across each capacitor in the string in order to distribute the voltage equally across each capacitor. The equalizing resistors should have a value low enough to equalize differences in capacitor leakage resistance between the capacitors, while high enough not to dissipate excessive power. The equalizing resistors also serve as a bleeder resistor (see below) and place a constant, light load on the supply to prevent excessive voltage with no load connected to the supply.

Capacitor bodies and cases in high-voltage strings need to be insulated from the chassis and from each other by mounting them on insulating panels to prevent arcing to the chassis or other capacitors in the string.

In order to reduce stress on the power supply high-voltage transformer and rectifier circuits when the supply is turned on, a "step-start" function is often used to charge the filter capacitors gradually. This consists of a resistor in the primary circuit of the power transformer that limits the input current to the supply. After a short period of a second or two, the resistor is switched out with a relay and the supply charges to its full output.

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For high voltage supplies, oil-filled paper-dielectric capacitors are superior to electrolytics because they have lower internal impedance at high frequencies, lower leakage resistance and are available with higher working voltages. These capacitors are available in values of several microfarads and have working voltage ratings of thousands of volts.

Avoid older oil-filled capacitors. They may contain polychlorinated biphenyls (PCBs), a known cancer-causing agent. Newer capacitors have eliminated PCBs and have a notice on the case to that effect. Should you encounter old oil-filled capacitors, contact your local power utility as they often have the means to safely dispose of them.

Bleeder Resistors

Bleeder resistors provide protection against shock when the power supply is turned off and dangerous wiring is exposed because they "bleed off" the stored charge in the filter capacitors. Bleeder resistors also place a constant load on the supply. Most high-voltage supplies in amateur equipment are not regulated, so a string of bleeder resistors across the filter capacitors improves output regulation of an otherwise unregulated high voltage supply.

A general rule is that the bleeder resistor should be designed to reduce the output voltage to 30 V or less within 2 seconds of turning off the power supply. Take care to ensure that the maximum voltage and power rating of the resistor is not exceeded. The bleeder resistor will probably consist of several individual resistors in series. An additional recommendation is that two separate bleeder strings be used, to provide safety in the event one of the strings fails.