

Safety Issues when working on electrical devices that contain voltages above 20 volts

All GEAR club projects involving electricity employ voltages below 20 volts. This eliminates the dangers of working with high voltage (for example, 120 volts typical of line voltage in home wiring). As our members become more knowledgeable in electronics, they may have a desire to work on equipment found at home. When that equipment is powered by high voltage (for example, a device plugged into a wall outlet) there are certain procedures that should be followed to insure safety of the individual.

Individuals who have had the experience of receiving an electrical shock from 120 volts can attest to the unpleasant experience. It is common to survive such an experience, which may cause us to be somewhat ambivalent regarding the danger. **IT IS A FACT THAT UNDER CERTAIN CONDITIONS, HIGH VOLTAGE SHOCK CAN BE LETHAL.** Due to this danger, it is imperative that anyone contemplating work on a high voltage device be properly educated regarding safe practices.

This paper will cover some items to consider in developing a strategy for safely working with high voltage devices. It should not be considered exhaustive in treatment of the subject. Links to additional information are provided at the end of the document.

1. GEAR members contemplating work on a high voltage device should consult with a parent first and have permission to proceed.
2. Make sure the device is not connected to the power supply (remove the plug from the wall receptacle). This may seem obvious, but it needs to be listed near the top of this list. Professional electronics technicians will have occasion to work on a device while it is connected to a power supply, but GEAR members should not do this. The first step in rendering the device safe is always to remove the source of electrical supply.
3. Do not work on the device while you are alone. Make sure a parent or responsible adult is nearby and is supervising your work. You will find that similar advice is listed as a safe practice for professional adults. A second pair of eyes is always helpful. And in the unlikely event of an accident, the person observing your work can come to your assistance.
4. Take the time to become familiar with the electrical device you want to work on **BEFORE** you start your work. What voltages are present in the circuits of the device when it is operating? If possible, obtain a schematic of the device before starting your work. This will help identify the parts of the device that operate with high voltage. It will also help you in diagnosing a problem with the device.
5. You must keep in mind that many electronic devices store electrical energy in capacitors. Depending on the circuitry of the device, the electrical energy can be stored for long periods, even after the device is disconnected from the power supply. Therefore, just unplugging the device from the wall is no guarantee that the device is safe and free of harmful voltages. Most modern electronic devices are digital and a large majority of the circuitry is low voltage. However, for devices that utilize a high voltage source for power, a power supply circuit must be included. This is where the voltage is converted to a lower voltage and is one of the locations inside a device that will contain potentially harmful voltage. The power supplies will contain large capacitors (usually 100's or 1000's of microfarads) that can contain potentially lethal levels of electrical energy. **BEFORE YOU EVEN THINK OF PUTTING A HAND NEAR ANY ELECTRICAL CIRCUIT IN THE DEVICE, YOU MUST BE SURE THAT THERE IS NO HARMFUL ELECTRICAL ENERGY REMAINING IN THE DEVICE.** Large capacitors can be checked with a volt meter to determine if

they have any measureable voltage. If you decide to test with a meter, BE VERY SURE OF YOUR ACTIONS. You must avoid short circuiting a capacitor with a meter probe. And of course, if you are touching the metal part of the meter probe, you will get an electrical shock if the capacitor is charged. The safest practice is to just assume that all large capacitors are charged and use the proper procedure to discharge the capacitors. Some of the links below provide guidance on discharging capacitors.

6. Old style TVs that contain cathode ray tubes (CRTs - https://en.wikipedia.org/wiki/Cathode_ray_tube) pose additional high voltage hazards. CRTs require voltages between about 10,000 to 20,000 (or even higher) for operation. This is supplied by a flyback transformer inside the TV. These TVs were sold as consumer electronics devices up to about 2006 to 2008, when they were replaced by newer flat-screen technologies (LCD, LED, plasma). In addition to high voltage hazards, CRTs pose the hazard of implosion due to the fact that the tube contains a vacuum. The stem of the tube where the electron gun is housed is composed of relatively thin glass. If the stem is struck by accident with sufficient force, the glass can break, causing the implosion and subsequent scattering of shards of sharp glass.

There seem to be different views regarding the dangers of CRTs. My personal recommendation would be to avoid these TVs. Nevertheless, some of the links below discuss procedures for discharging CRTs. My personal view is that no one should attempt a repair of a CRT unless they are properly trained (sorry, I am not qualified to provide this training).

7. Keep in mind that some devices may operate on high voltages, above the voltage supplied by the home outlets. For example, microwave ovens have circuits and capacitors that operate at voltages in the thousands. Even some battery operated devices operate with high voltages in the thousands, like electronic flashes for cameras. Again, make sure you educate yourself first before tackling the repair of any electronic or electrical device.

Some helpful links for those contemplating work with high voltage devices

<http://www.repairfaq.org/samnew/tvfaq/tvsafdis.htm> Safe discharging of capacitors in TVs and video monitors

<http://www.repairfaq.org/sam/captest.htm> Capacitor Testing, Safe Discharging and Other Related Information

<http://www.peachpit.com/articles/article.aspx?p=759704&seqNum=2> CRT Safety Procedures

<http://donklipstein.com/safety.htm> Safety Guidelines for High Voltage and/or Line Powered Equipment

<https://youtu.be/QNiBqF3Plw0> discharge caps with 470 ohm 5 watt resistor – watch this video as it is very good

<http://www.digikey.com/product-detail/en/yageo/SQP500JB-470R/470W-5-ND/18695> here is one source for a 470 ohm 5 watt resistor that can be used to make a discharging tool for capacitors