



Technician License Course

Chapter 9

Lesson Module 20: Electrical Safety



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Electrical Safety

Avoiding contact with voltages in circuits is the most effective way of practicing electrical safety. Voltages higher than 30 Volts should be considered dangerous.

- Most modern radio equipments use voltages that are not as dangerous as older equipment but precautions still must be taken.
- 115VAC Power can be the most hazardous.
- RF Amplifiers with tubes use high voltages.
 - Shielding keeps your hands out.
 - Interlocks prevent operation without shielding.
- Transmitting antennas can have high voltages.



Electrical Injuries

Shocks –

- Usually caused by voltages higher than 30 Volts.
- Causes muscles to contract.

Burns –

- Caused by current through skin or tissue.
- Skin condition can increase current.

Table 7-1

Effects of Electric Current Through the Body of an Average Person

Current *Effect*
(1 Second Contact)

1 mA	Just Perceptible.
5 mA	Maximum harmless current.
10 - 20 mA	Lower limit for sustained muscular contractions.
30 - 50 mA	Pain
50 mA	Pain, possible fainting. "Can't let go" current.
100 - 300 mA	Normal heart rhythm disrupted. Electrocutation if sustained current.
6 A	Sustained heart contractions. Burns if current density is high.



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Mitigating Electrical Hazards

Following safety rules is important to avoid shocks.

- Turn off power when working inside equipment!
- Make sure the power is off.
- Large power supplies (and small ones) have power stored in capacitors. Know how to discharge them.
- Don't depend on interlocks and don't bypass them!
- Keep one hand in your pocket when probing in energized high voltage circuits.
- Batteries can deliver lots of energy when shorted.
- Remove rings and jewelry, especially around RF.
- Avoid working alone on energized equipment.



Responding to Electrical Injury

REMOVE POWER if you can! You don't want to become part of the incident.

- ON/OFF switches and circuit breakers should be clearly marked.
- A single master switch is the best insurance.

Remove the victim from the power if you can't turn it off.

- Call for help.
- Learn CPR and first aid.



AC Power and Safety Grounding

Not all homes are wired to current NEC codes but even old wiring can be made safe. Most ham equipment does not require special wiring or circuits.

- Use 3-wire power cords. If your outlets are 2-wire, you can change them to a GFCI outlet but ...
- Use circuit breakers, circuit breaker outlets, or Ground Fault Circuit Interrupter (GFCI) circuit breakers or outlets of the proper size.
- Don't overload single outlets.
- If your house wiring isn't adequate, scale down your station or re-wire.

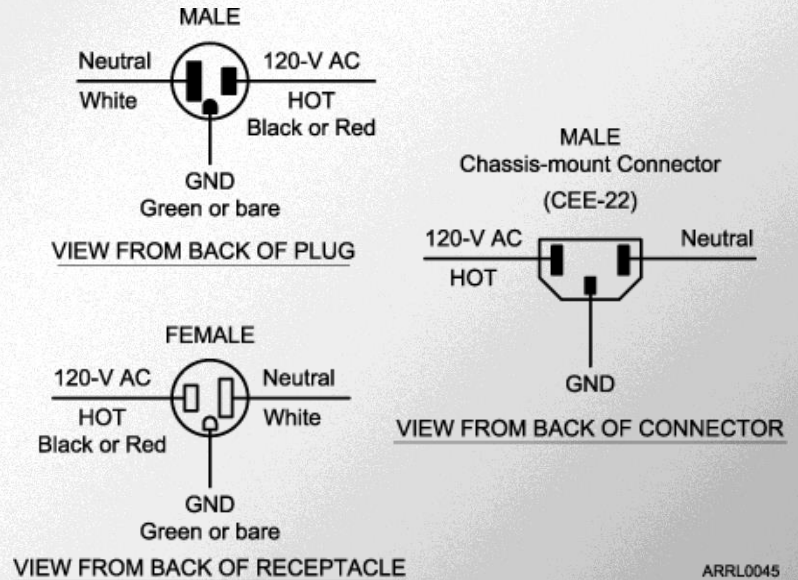


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AC Power Wiring

- The hot wire should include a fuse or circuit breaker.
- Neutral wire is the “grounded conductor” and is connected to house ground at the CB panel.
- Hot wire and neutral wire must have the same current. A ground fault current will cause a difference.
- The ground wire should be the same size as hot and neutral.



Note that the Ground wire is Green or Bare.

AWG Wire Size:	#14	#12
Maximum Current:	15 Amps	20 Amps



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Lightning Safety

Antennas are not struck any more frequently than trees or tall structures. Lightning protection can protect your house and equipment.

- Ground all towers, masts, and antenna mounts to ground rods with short direct large conductors.
- Use lightning arrestors on antenna and power cables at the entrance to the station.
 - Mount arrestors on a metal ground plate.
 - Ground all equipment to the ground plate.
 - Connect the ground plate to station ground.
- Disconnect antenna cables, telephone lines, and power cords during storms.



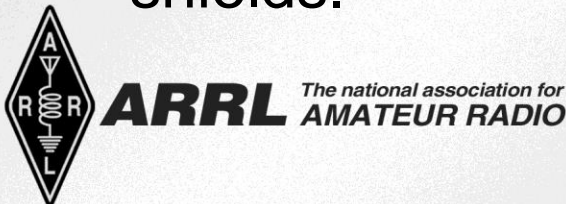
Radio Frequency Interference (RFI)

- RFI is an unwanted, unintentional signal that interferes with radio reception by your station or your neighbors equipment.
- RFI caused by your station can be minimized by proper design of shielding, filtering, grounding, and layout.
- RFI to your receiving equipment can come from your residence or from your neighbors.
 - Light dimmers
 - Computers and TV
 - Motor controllers



RFI Mitigation

- Filters attenuate interfering signals.
 - High-pass – used at the antenna input of TV or Stereo.
 - Low-pass – used at the transmitter output.
 - Band-Reject – used at the station receiver, TV, or Stereo antenna input.
 - Band-pass – used within radio equipment.
- Shielding and Grounding reduce radiation from equipment.
- Ferrite chokes and Baluns reduce RF current on cable shields.



Causes of RFI

Direct detection – offending signals get into the electronics circuits to cause interference.

- Fundamental Overload – strong signal that overwhelms the weaker, wanted signal or causes changes in the biasing of transistor circuits.
- Harmonics – multiples of the transmitter frequency that are close to the frequency of the desired signal.
- Products – Mixtures of several frequencies that occur when the outputs of two or more transmitters mix in a non-linear circuit.



Cable TV Interference

Cable interference is usually caused by broken shielding somewhere in the cable.

- Loose, broken, or corroded connections.
- Unterminated or illegal connections.
- Usually solved by proper cable maintenance by cable supplier.

If the cable can interfere with you, you can possibly interfere with the cable. Some CATV channels use Amateur frequencies



Sources of Radio Noise

- Electrical arcs (motors, thermostats, electric fences, neon signs).
- Fluorescent lamps and dimmers
- Power lines.
- Motor vehicle ignitions or alternators.
- Switching power supplies.
- Computers and networks
- TV sets.



Dealing with RFI Complaints

Take interference complaints seriously.

Make sure you operate your equipment properly.

Eliminate interference in your own home first.

Make sure that you're really not the cause

- Does the interference occur when you are not transmitting?
- Enlist a third party to perform tests.
- Try to maintain a civil and friendly relationship with the complainant.
- Offer to help eliminate the RFI, even if you are not at

fault.



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Dealing with Part 15 Interference

FCC Part 15 includes wireless phones, intercomms, routers, door openers, lighting controls, etc., which use radio frequencies. RFI from and to unlicensed devices is the responsibility of the users of such devices.

- Bottom line – If your station is operating properly, you are protected against interference complaints
- BUT – Be a good neighbor because they may (probably) not be familiar with Part 15 rules and regulations



Basics of Grounding in the Station

The AC Power Ground lead is not an RF ground. An Earth connection may not be necessary but all equipments should be bonded together. This will avoid shock hazards when touching equipments and may reduce damage due to lightning.

Each equipment is bonded to a common ground bar with a separate large conductor.

- Solid flat copper strap is best.
- Make connections with clamps or screws.
- Long wires may be useless at RF.

The ground bar may be connected to an Earth Ground rod but the ground rod must be bonded to the AC Power Ground.



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RF Effects of Grounding Problems

You might receive reports of “RF Feedback” while operating on HF Voice – a distortion which occurs on voice peaks or totally distorted voice signals.

- RF currents in the Microphone cable.
- Signal Hum from AC in common ground.
- RF Burns from touching Mike or Transceiver.

Sometimes a Balun or feedline choke at the antenna is necessary to keep RF current off the feedline shield.

Shield currents can also be a reason for TV or telephone interference.

