

# Amateur Radio Technician Class Training

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Permission granted for use by the MORE Project

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AMATEUR RADIO DIGITAL COMMUNICATIONS

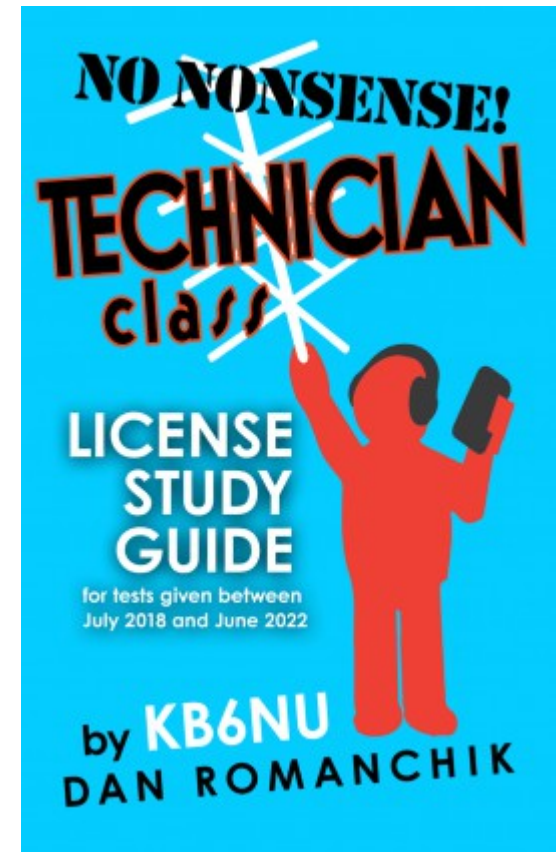


**Welcome to Session 4**

**Any Questions Before We Start?**

# Agenda

- Introduction
- Radio Wave Characteristics (RWC)
- Electronic Components and Circuits (ECCD)
- Electrical Principles (EP)
- Antennas and Feed Lines (AFL)
- Amateur Radio Signals (ARS)
- **Electrical Safety (ES)**
- **Radio Practices and Station Setup (RPSS)**
- Station Equipment (SE)
- Operating Procedures (OP)
- Rules and Regulations (RR)



# Electrical Safety (ES)

- Hazards & Grounding
- Antenna & Tower Safety
- RF Hazards & Radiation

# Safety Concepts

- AC Power
- Hazardous Voltages
- Fuses
- Circuit Breakers
- Battery Safety
- Antennas & Towers
- Power Lines
- RF Safety



# General Electrical Safety

- Easy to come in contact with dangerous voltages
- **30 Volts** or more can result in dangerous shock
- **100mA** flowing through body can cause death

## How does current flowing in the body cause harm?

- *Heating tissue*
- *Disrupts electrical function of cells*
- *Involuntary muscle contractions*



# AC Power Safety

- 3-wire outlets and plugs are safer than 2-wire
- 3rd wire is a **Safety Ground** (aka Equipment Ground)
- **Safety Ground** is often connected with a **green** wire
- Building or room outlets may not be properly grounded (check!)



- Good ways to guard against electric shock:
  - *Use 3-wire cords & plugs for all AC eqpt.*
  - *Connect all AC powered eqpt. to a common safety ground*
  - *Use circuit protected by a ground-fault interrupter*



# Fuses & Circuit Breakers



- *Interrupts power* in case of an overload
- Always replace fuses with *same type and rating*
- Putting a 20A fuse in place of a 5A fuse can cause a *fire* from excessive current flow
- Always include fuse or circuit breaker in home-made equipment
- Fuses in 120V AC powered equipment are used in the “hot” lead.

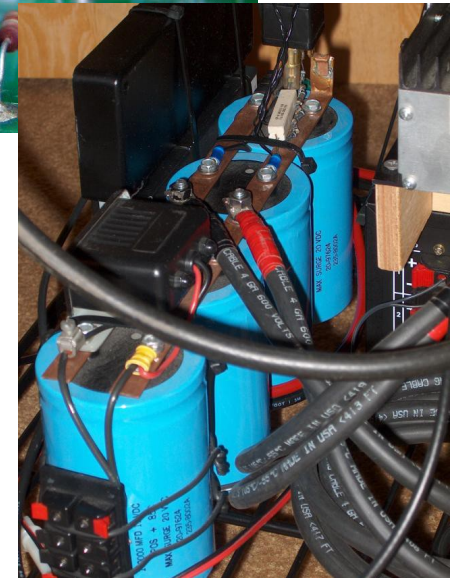
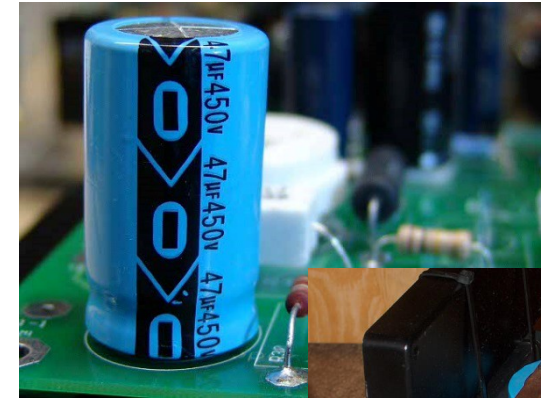


# Working on Equipment

Disconnect from power

**Capacitors** in power supplies can *store charge and shock you* – **even when disconnected!!!**

Work with one hand



# Battery Safety



- 12V Lead-Acid Battery Hazards

Explosive gas can collect if not vented

*Shorting terminals can cause burns, fire, explosion*

If charged/discharged too quickly – can overheat and give off flammable gas or explode

- If power is out, re-charge 12V battery by connecting to car battery and running the engine (in a well ventilated area)

# Antenna Safety: Installation

- Look for and stay clear of overhead electrical wires
- Keep 10ft of clearance to power lines, even if the antenna should fall
- Never use a utility pole as a support



What's wrong in this picture?

# Antenna Placement

- Position antenna so no one can come in contact when transmitting
- RF burns can be painful and dangerous





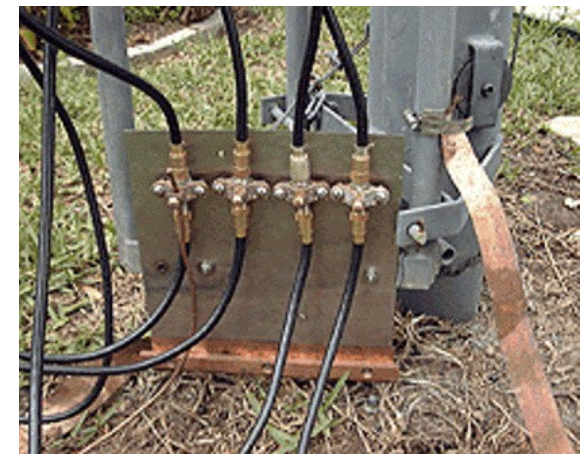
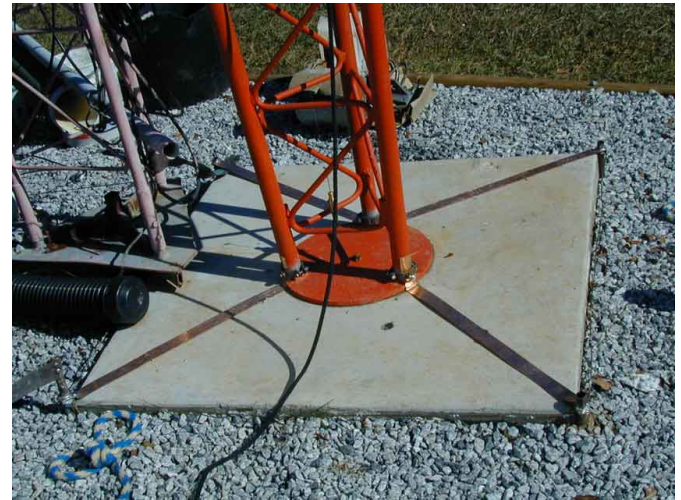
# Tower Work

- Use a **gin pole** to lift tower sections or antennas
- Always use **climbing harness**
- *Everyone* at the site wears **hard hat** and **safety glasses**
- ***Never climb alone***
- Crank-up towers must be fully *retracted* before climbing
- Use *safety wires* in turnbuckles to tension guy lines to prevent loosening



# Tower Grounding

- Very important – the tower is a *big lightning rod!*
- **Local electrical codes** should be consulted
- Separate 8' ground rods per tower leg is good practice
- Bond all legs and rods together
- Short / direct connections
- Avoid sharp bends
- All feedline lightning protection devices should be mounted to a common plate and connected to an external ground





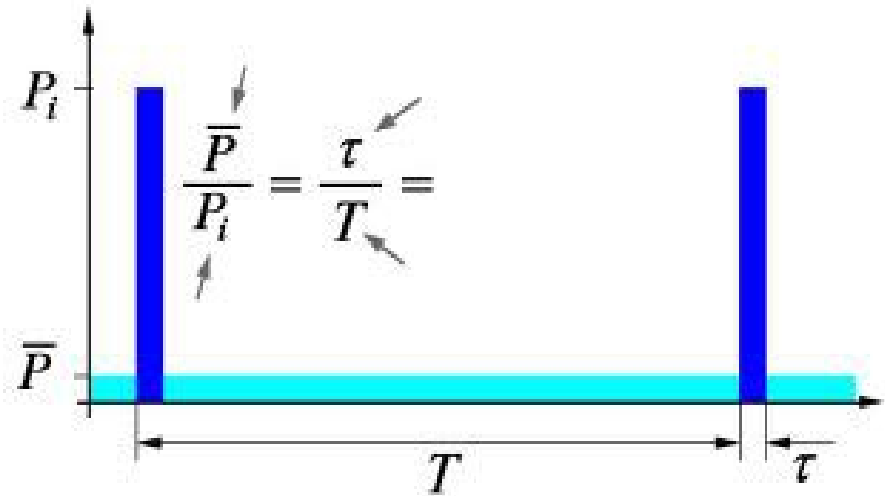
# RF Exposure



- When using high power:
  - you are *required* to perform an **RF Exposure evaluation**
  - even though VHF & UHF are **non-ionizing radiation** (ionizing radiation can cause genetic damage)
- On *VHF* you can run up to **50W PEP** at the antenna without performing an exposure evaluation
- RF Exposure Evaluation can be performed:
  - *Calculation based on FCC OET Bulletin 65*
  - *Calculation based on computer modeling*
  - *By measurement of field strength using calibrated equipment*

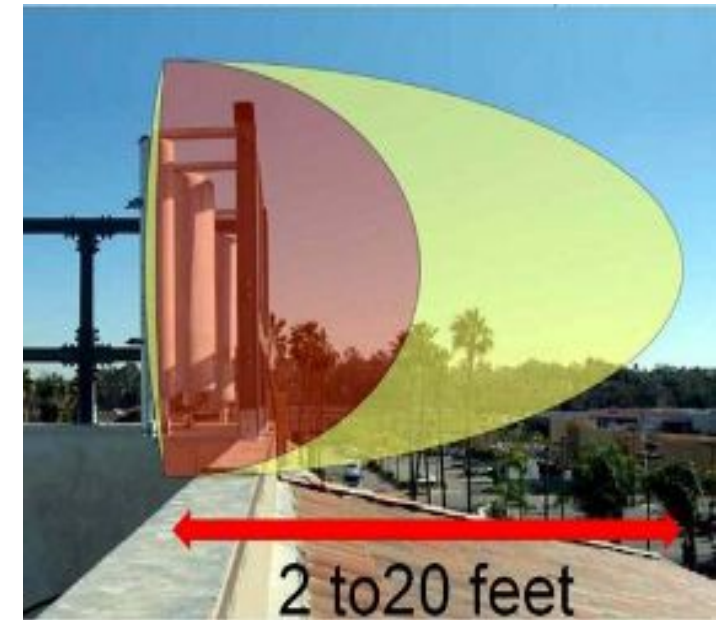
# RF Exposure: Duty Cycle

- Percentage of time the transmitter is transmitting
- **Duty Cycle** is factored into exposure because affects the *average exposure level*



# RF Exposure Limits

- Vary with Frequency
- The human body absorbs more energy at some frequencies than others
- The **50MHz** band has the *lowest Maximum Permitted Exposure Limit*



## Factors that Affect Exposure:

- Frequency & Power level of RF Field
- Distance from antenna to person
- Radiation pattern of antenna

# Keeping Exposure Safe



- Relocate antennas
- Lower power levels
- Transmit less
- Re-evaluate if you make any changes in station or antenna setup



# Electrical Safety

## Chapter End

Questions?

Let's Practice for the Exam!

# Radio Practices & Station Setup (RPSS)

- Station Setup
- Operating Controls



# Radio Practices & Station Setup (RPSS)

- Station accessories
- Dealing with Interference
- Grounding
- Operating controls
- Station Equipment
- Troubleshooting
- Repair & Testing



# Station Accessories

- Power Supply
  - Use *heavy gauge wire* to avoid voltage drop that would prevent proper operation
  - Minimum current capacity:
    - Transmitter efficiency, receiver and control circuit power, regulation and heat dissipation



- Headphones
  - Helps copy in *noisy areas*
- Microphone
  - Rig connector includes push-to-talk and maybe power for mic

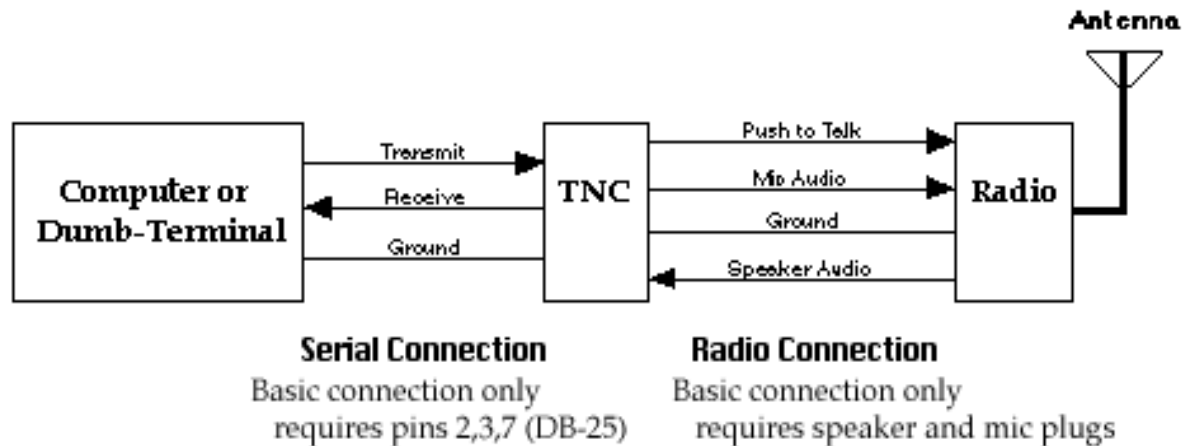


# Computer in the Hamshack

- Logging contacts
- Looking up info
- Sending and receiving CW
- Generating and decoding digital signals



# Digital Mode Accessories



- **Packet**

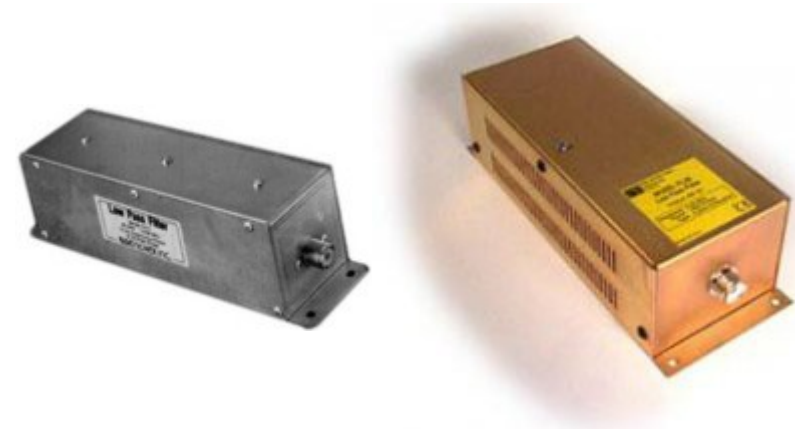
- Terminal Node Controller (TNC)
- Converts 1's and 0's to audio tones

- **RTTY or PSK31**, etc.

- *Sound card* often performs TNC/modem function
- Provides audio to microphone input, converts received audio to digital
- Often an audio interface is used to adjust audio levels and provide some ground isolation

# Interference Killers

- Ferrite chokes
  - *Help eliminate stray RF from audio, power supply and other cables*
  - *Reduce RF flowing on shield of audio cables*
- Low Pass Filter
  - *Used between the transmitter and antenna to eliminate harmonic emissions*





# More Interference Killers

- TV Interference
  - *Band-Reject* filter at TV input
  - Helps prevent overload from nearby transmitter





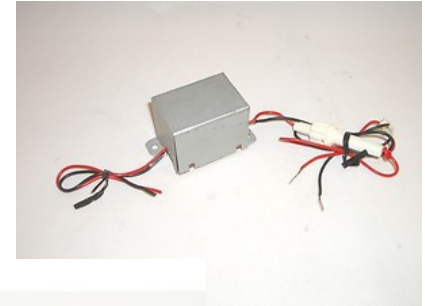
# Grounding helps too...

- Flat strap is best
- Connect all equipment to a common ground
- Car installations
  - Radio ground connection to chassis or engine block strap
  - Bond all grounds



# More Car Installation Tips

- Positive supply
  - Direct to battery
  - Unused fusebox terminal
- Alternator noise/whine
  - *Varies with RPM*
  - *Filters help*
- Ignition noise
  - *Pulsing/ticking*
  - *Noise Blanker helps*



# Operating Controls

**RIT:** *Receive Incremental Tuning* used to fine tune receive frequency (not transmit frequency). Sometimes called *Clarifier*. Helpful if a SSB signal is high or low pitched.

**AF:** Audio Frequency gain – just a fancy name for Volume control

**AGC:** Keeps received audio relatively constant



Sets RF power output

**Microphone Gain:** *too high and your signal will be distorted*

Adjusts Receiver gain

**Squelch:** *mutes the receiver when no signal is being received. Don't set it too high, or you'll miss weak signals!*

# Operating Controls (cont'd)

HF Transceivers often have a selection of filters which *permits noise or interference reduction by selecting a filter bandwidth that matches the mode.*

*Examples:*

**2400Hz for SSB**

**500Hz for CW**

## **Operating Frequency**

*is set by VFO knob  
or keypad entry*

*Favorite frequencies  
can be stored in a  
memory channel for  
easy access*





# Operating Controls

**Offset Frequency:** *the difference between a repeater's transmit and receive frequencies*

The transceiver's offset is set by an Offset or Shift control.

The REVERSE control toggles between transmit and receive frequencies



# Radio Practices & Station Setup

## Chapter End

Questions?

Let's Practice for the Exam!