Amateur Radio
Technician Class Training

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Based on the No-Nonsense Technician Class Study Guide by Dan Romanchik, KB6NU

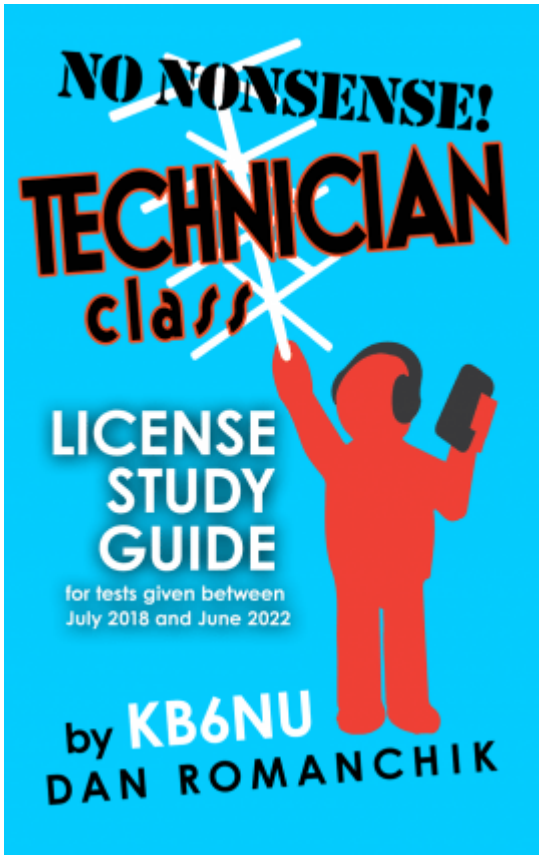
Updates by Rebecca Mercuri, Ph.D., K3RPM

Welcome to Session 3

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)

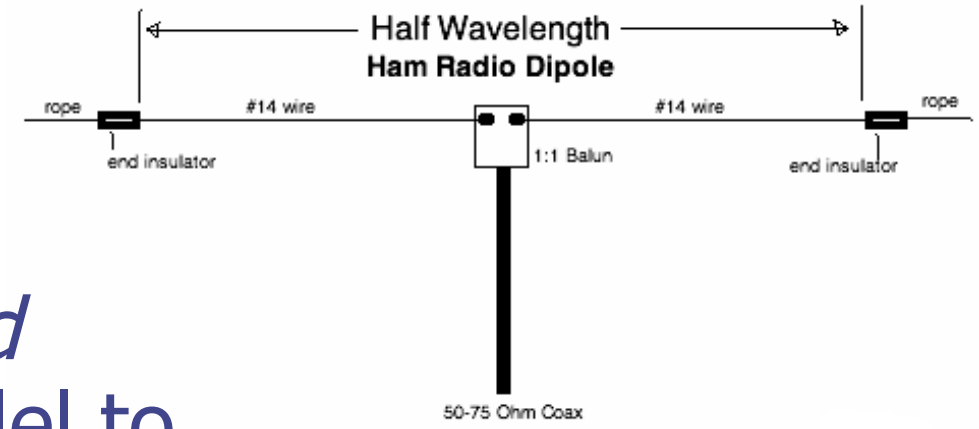


Antennas & Feedlines (AFL)

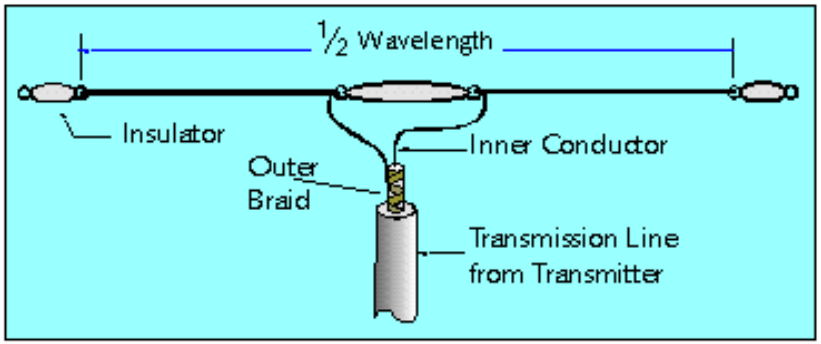
- Types & Polarization
- Feedlines & Connectors
- SWR & Measurements

Antennas & Feedlines

- Most Common: **Half-wave dipole**
- Horizontally *polarized* when mounted parallel to earth
- Radiation is broadside to antenna



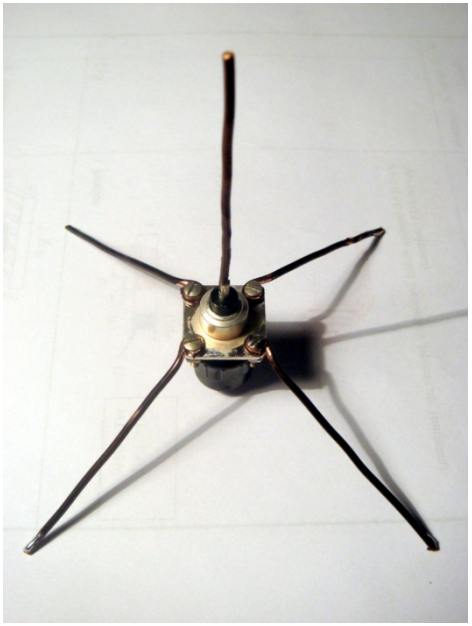
Half-Wave Dipole Details



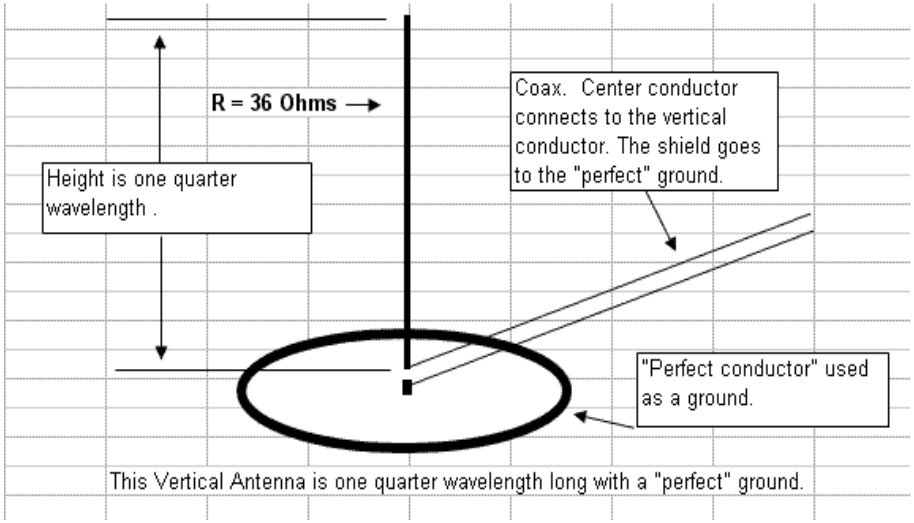
dipole antenna

- About 5% shorter than free-space half-wavelength
- Example: a *6m* dipole is about *112"* long
- To make it *resonant* on a *higher* frequency, you would *shorten* it
- L(ft) = 468 / F(MHz)

Vertical Antennas



- Typically ¼ wavelength tall
- Vertically polarized, meaning the electric field is perpendicular to the earth
- A *2m* vertical is ~*19″* long
- L(ft) = 234 / F(MHz)

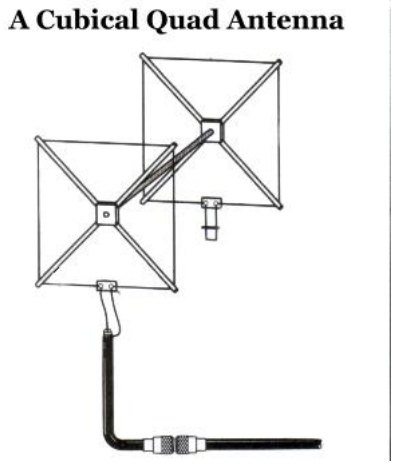


HF Antennas

- Can be very long!
- Loading is often used to physically shorten an antenna
  - Inductors *(in series with radiating element)*
  - Capacitors
- Loaded antenna not as efficient as full size

Beam Antennas

- Concentrates energy in *one* direction
- *Quad*, ***Yagi*** and *Dish* are all **directional** antennas
- **Gain** is the increase in signal strength w.r.t. a reference antenna



“Rubber Duck” Antenna

- Flexible antenna on most handheld transceivers (HTs)
- *Disadvantage:* not as efficient as a full sized antenna
- Good reason **not** to use in a car is that the signals will be much **weaker** as compared to outside the vehicle

A properly mounted 5/8-wavelength antenna provides lower radiation angle and more gain than ¼ wavelength antenna for mobile use

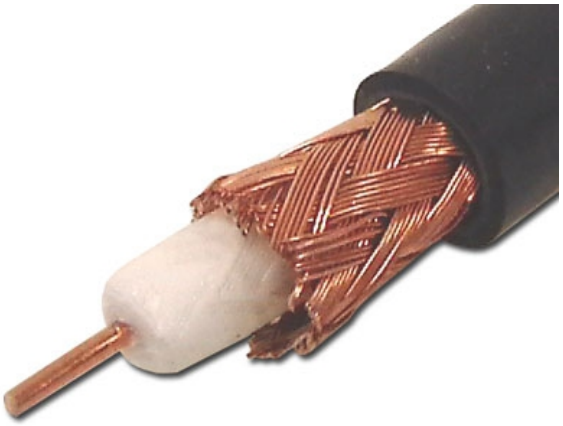
Feedlines

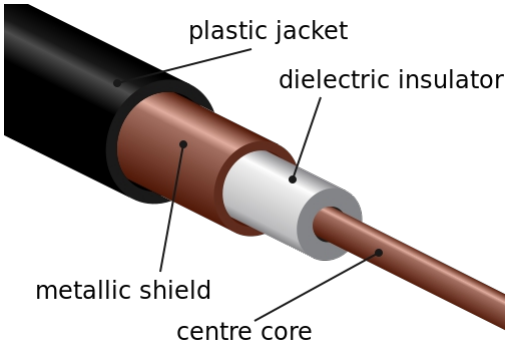
- **Coaxial** cable is used most often because

  It is easy to use

  Requires few special installation considerations

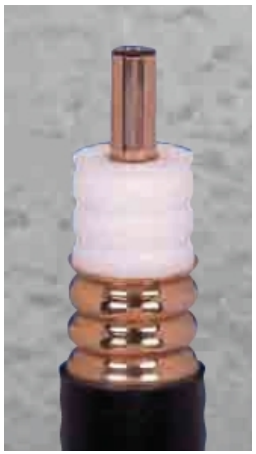
- Mainly used to *carry RF* between *radio* and *antenna*
- **Loss** in cable increases as frequency increases
- **Impedance** of feedline ideally matches the impedance of the transmitter and antenna – most common is **50 ohms**

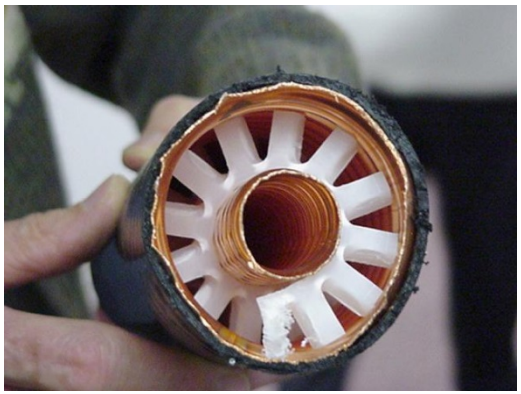




Common Coax Types

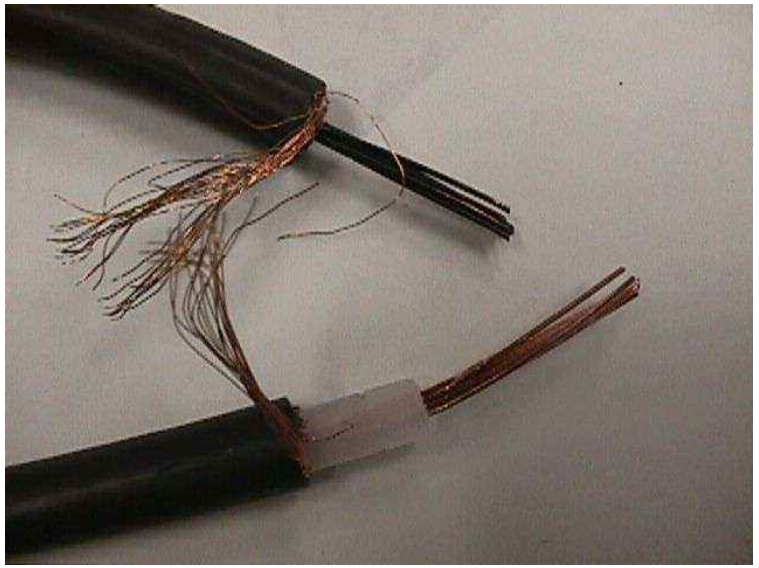
- **RG-58** and **RG-8** are the most common
- *Both* are 50 ohms
- RG-58 is thinner, but *higher loss* that RG-8
- Coax with lowest loss for **VHF** and **UHF** is *air-insulated hardline*





Common Coax Failure Modes

- **Moisture contamination**
  - Cracks in jacket
  - Around connections
- Jacket needs to be **UV resistant** to prevent cracking
- Air-Core coax requires special techniques to prevent water absorption



Common Coax Failure Modes

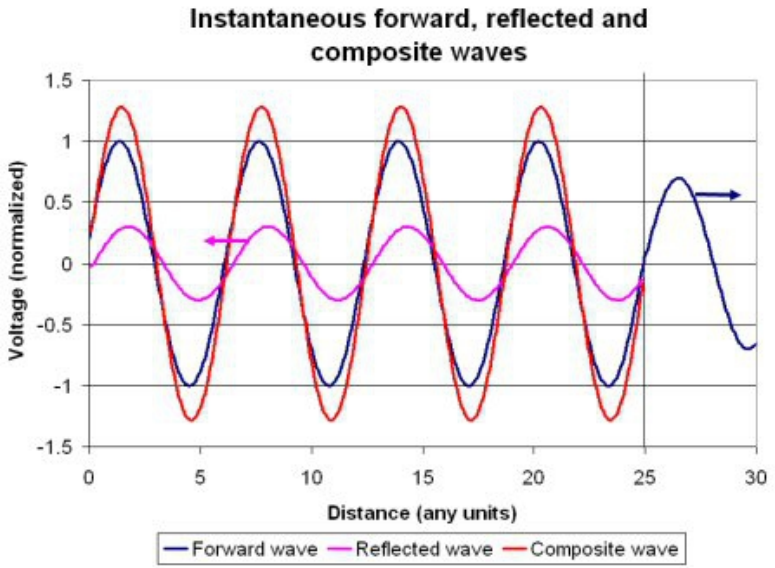
- **PL-259** is most common for **HF frequency** use
- PL-259 is not the most suitable at higher frequencies
- **Type-N** connector is most suitable above 400MHz
- Take care to *seal against water intrusion* to prevent increase in feedline loss
- **Keep 'em tight** – loose connections can cause *erratic SWR* readings

Standing Wave Ratio (SWR)

- A measure of how well **matched** a *load* is to the *transmission line*
- *Low SWR needed* with coax feedlines:

  Efficient power transfer

  Minimize losses
- Power *lost* in a feedline is converted to **heat**



SWR Measurement

- SWR is measured with an **SWR meter**
- SWR meter is connected between the *transmitter* and *feedline*
- A **Directional Wattmeter** can also be used to determine if a feedline and antenna are matched properly
- **SWR** of 1 to 1, or 1.0:1 is a **perfect match**
- SWR of 2:1 or more is where *protection circuits* in most solid-state transmitters will *reduce power to protect output transistors*
- *SWR of 4:1* means there is a large **impedance mismatch**
- An **antenna tuner** is used to match the antenna system impedance to the transmitter

More Measurements

- An **antenna analyzer** is commonly used to measure:
  - SWR
  - Antenna resonant frequency
  - Capacitance
  - Inductance

Dummy Load

- A Dummy Load is just a big 50Ω resistor
- Used to *prevent putting signal on the air when testing*
- It is a *non-inductive resistor* and a *heat sink*

Antennas & Feedlines
Chapter End

Questions?

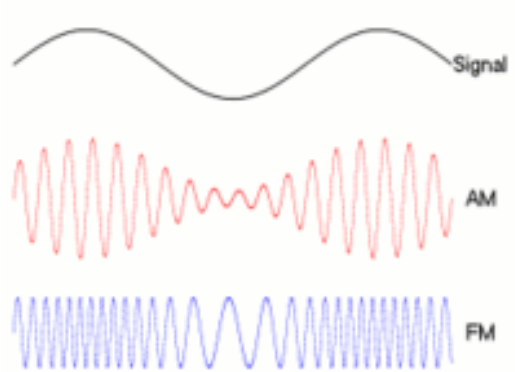
Let's Practice for the Exam!

Amateur Radio Signals (ARS)

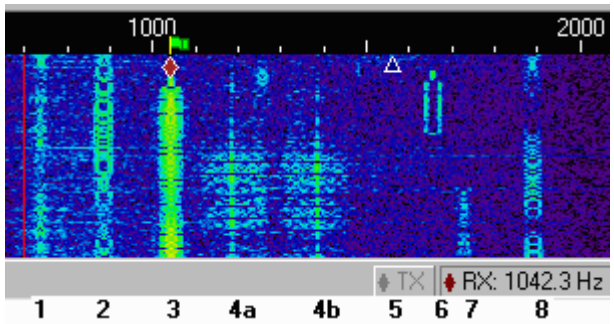
- Modulation & Bandwidth
- Digital Modes

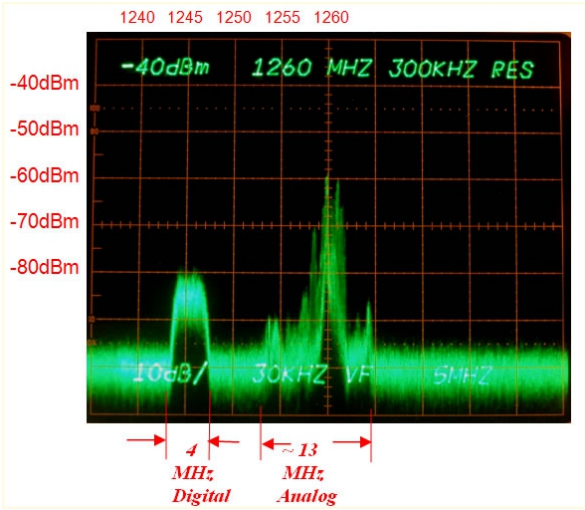
Amateur Radio Signals

Modulation Modes



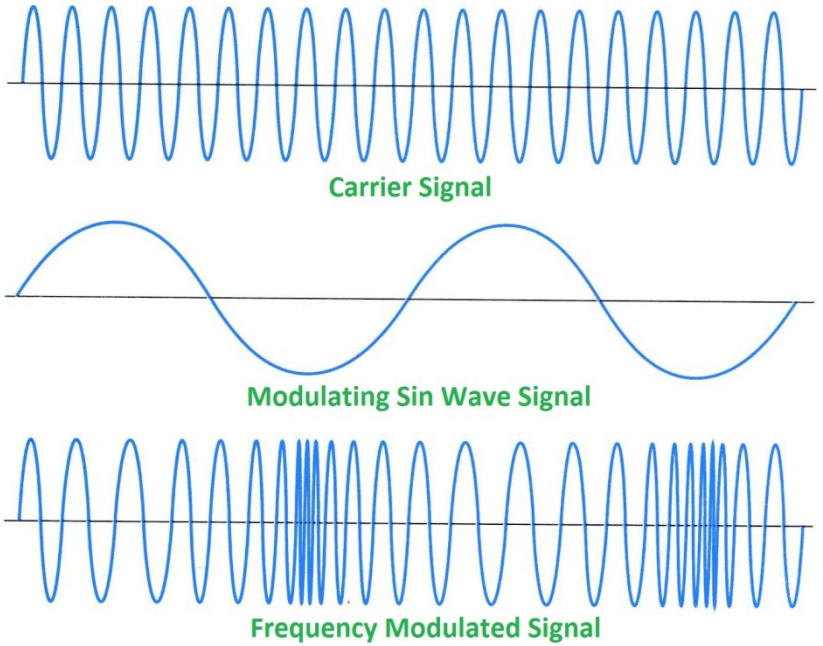
Signal Bandwidth





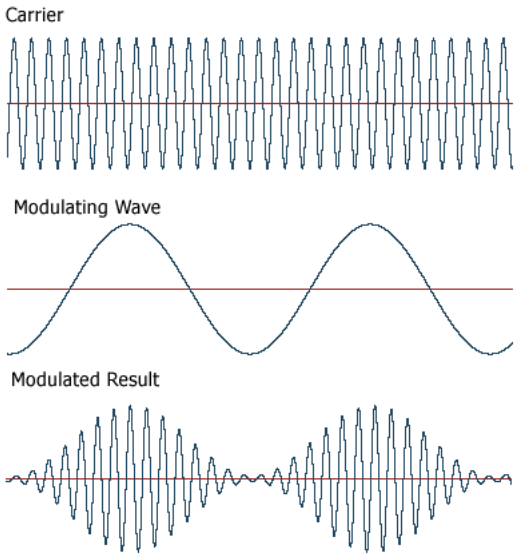
Modulation Modes: FM

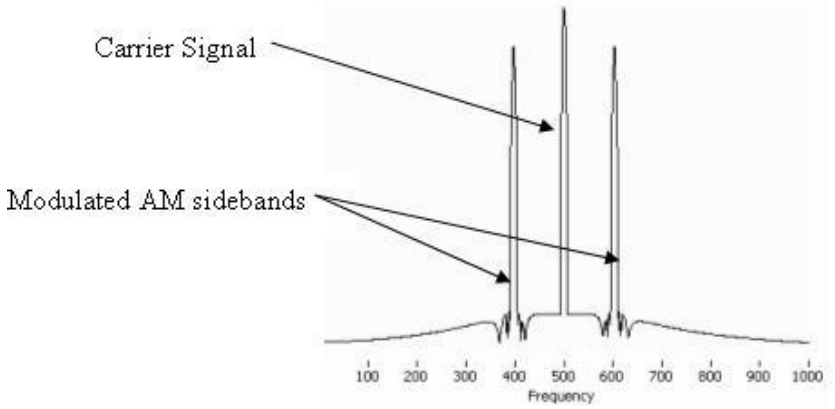
- **FM** is Frequency Modulation
- Most common on *VHF and UHF voice* repeaters
- Also used for *VHF packet radio* transmissions



Modulation Modes: AM

- **AM** is **A**mplitude **M**odulation
- AM is one of the simplest modulation modes
- The *amplitude* (size) of the RF carrier is varied
- Energy is present at the carrier frequency and in sidebands on either side of the carrier



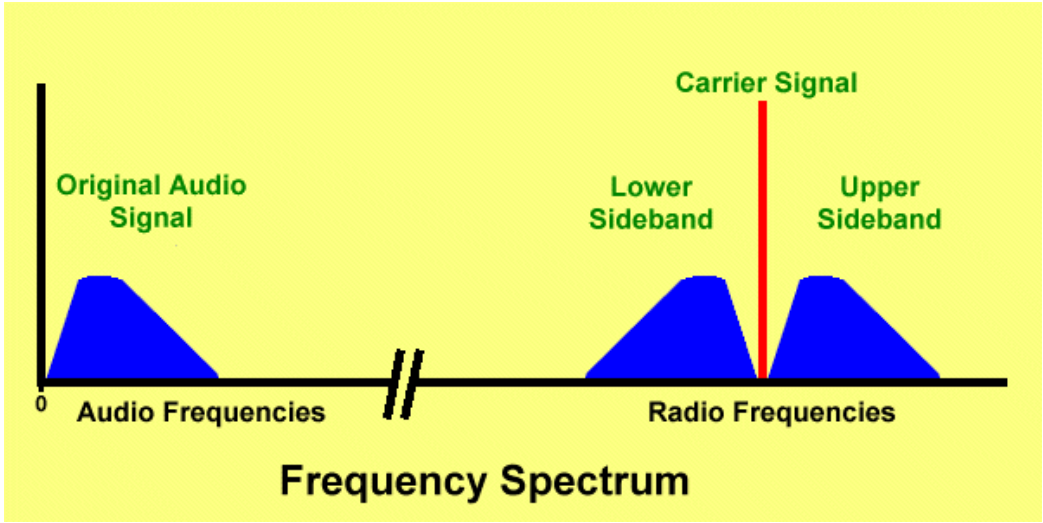


Single Sideband (SSB)

- **SSB** is a form of *Amplitude Modulation*
- Used for *long distance* and *weak-signal* contacts on *VHF & UHF*
- May be Upper or Lower (USB or LSB)
- **USB** used for 10m HF, and *VHF & UHF*

SSB Properties

- Advantage:
  narrower bandwidth vs. FM for voice
- Typically *~3kHz for SSB* vs. 5-15kHz for FM



Continuous Wave (CW) Mode

Narrowest bandwidth (not really) about **150Hz**

International Morse Code is commonly used by Hams

CW can be sent using:

- Straight Key
- Electronic Keyer
- Computer Keyboard

International Morse Code

- 1 dash = 3 dots.
- The space between parts of the same letter = 1 dot.
- The space between letters = 3 dots.
- The space between words = 7 dots.

A	·−	V	···−
B	−···	W	·−−
C	−·−·	X	−··−
D	−··	Y	−·−−
E	·	Z	−−··
F	··−·	.	·−·−·−
G	−−·	,	−−··−−
H	····	?	··−−··
I	··	/	−··−·
J	·−−−	@	·−−·−·
K	−·−	1	·−−−−
L	·−··	2	··−−−
M	−−	3	···−−
N	−·	4	····−
O	−−−	5	·····
P	·−−·	6	−····
Q	−−·−	7	−−···
R	·−·	8	−−−··
S	···	9	−−−−·
T	−	0	−−−−−
U	··−		

Amateur Television Modes

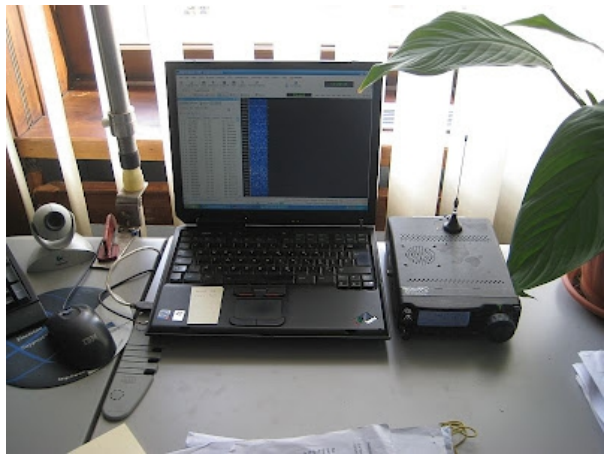
- TV signals can be sent in slow-scan and fast-scan modes.
- **Analog fast-scan TV** on 70cm band occupies *6MHz of bandwidth*
- **NTSC** refers to the encoding type of analog fast scan color TV signal transmission

Digital Modes

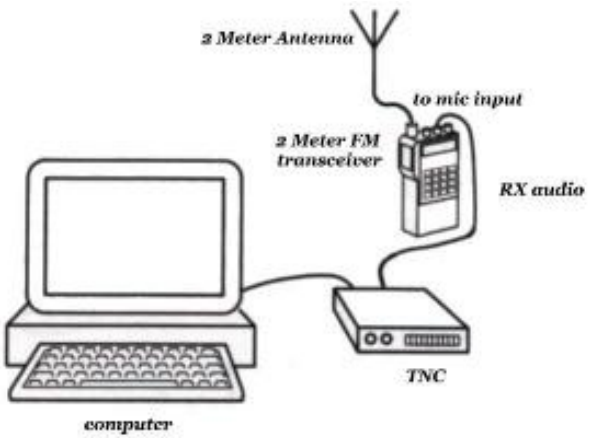
- Usually uses a computer and radio to communicate
- Data (not voice) is sent back and forth
- *Technician Class* can use **Digital** transmission on **219-220MHz**
- Some digital modes include **parity** – *an extra code element used to detect errors in reception*

Examples of Digital Modes:

- *Packet*
- *IEEE 802.11*
- *JT65*
- PSK31
- MFSK



Packet Radio



- One of the first digital modes
- Data grouped and sent in "packets"
- Packet radio includes:

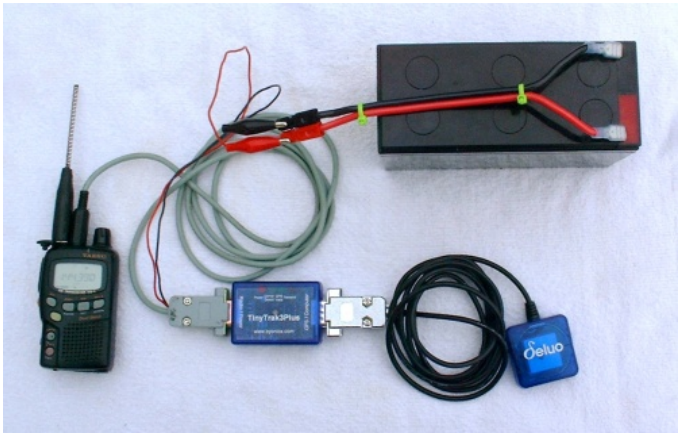
  A **check sum** which permits error detection

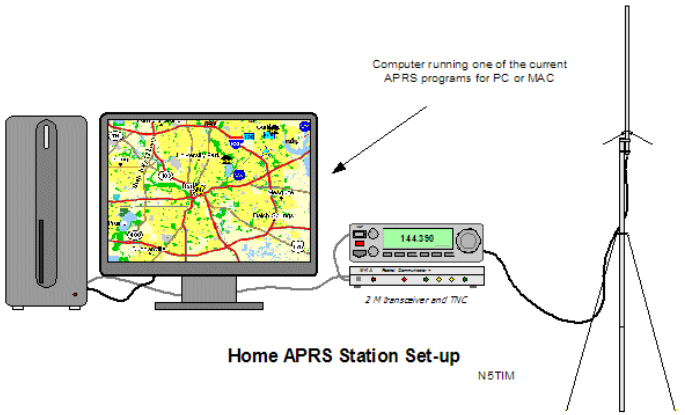
  A **header** containing call sign of recipient

  Automatic Repeat Request (ARQ) in case of an error

APRS

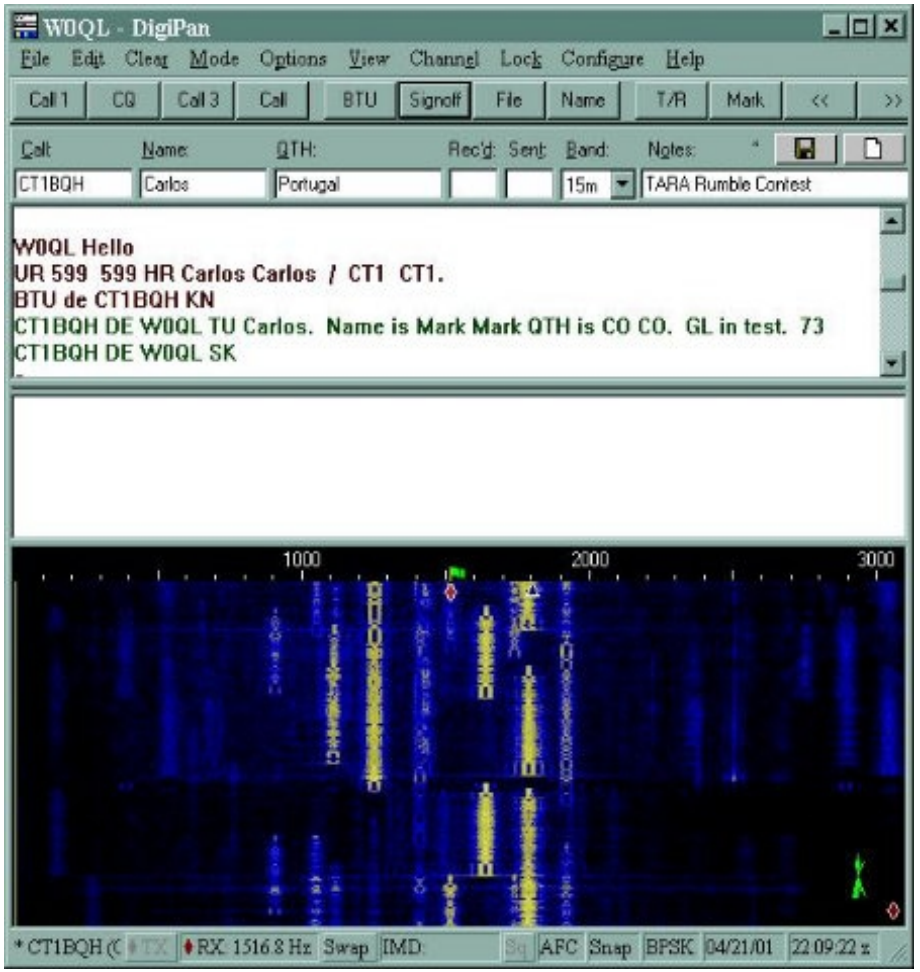
- **Automatic Packet Reporting System**
- Uses Packet radio
- A **GPS** *(Global Positioning System)* receiver is used when sending position reports
- *Real-time tactical digital communications* along with *Map* showing location of stations





Phase Shift Keying (PSK)

- A digital modulation process that conveys data by changing the phase of the carrier wave
- Popular in HF band
- **PSK31** has *low-rate data transmission*



Digital Mobile Radio (DMR)

- FM Digital communications

  Multiplexes two signals on a single 12.5kHz channel

- **Talk Groups**

  Virtual channel – only heard by group of users in the channel

  You *program* a **Group ID** into your radio to *join* the group

Weak Signal Modes

- **WSJT**

  Weak Signal Joe Taylor

  Slow transmission

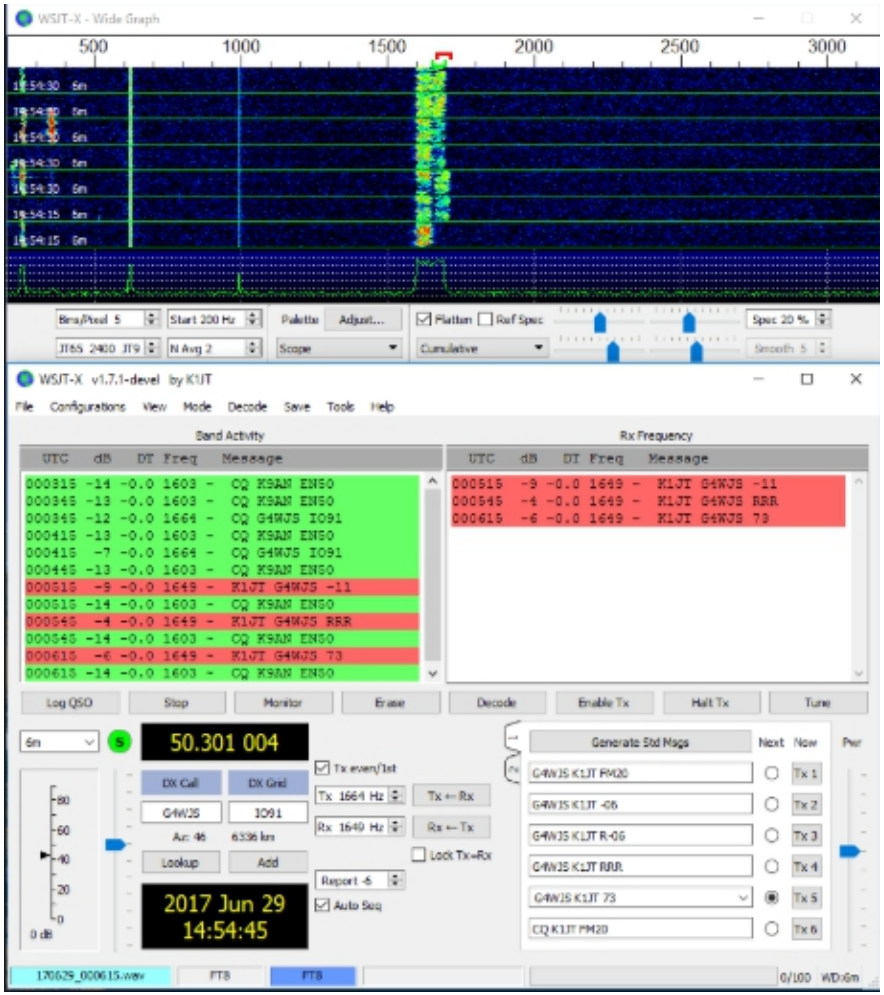
  Many applications:

  Moonbounce (EME)

  Propagation beacons

  Meteor Scatter

- **FT8** is a weak signal that transmits on 15-second intervals



Mesh Networking

- Uses **WiFi** frequencies in 2.4, 3.4 and 5.8GHz amateur bands

  Broadband-Hamnet

  AREDN: Amateur Radio Emergency Data Network

- Uses *WiFi hardware* with *modified firmware*

Amateur Radio Signals
Chapter End

Questions?

Let's Practice for the Exam!