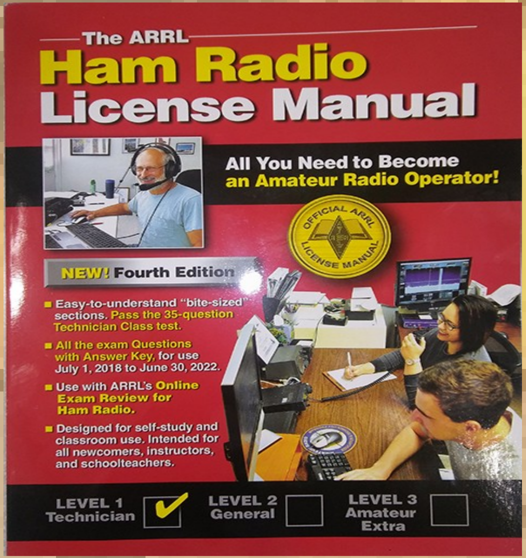
FCC Technician License Course



2018-2022 FCC Element 2
Technician Class Question Pool

Presented by:

Tamiami Amateur Radio Club (TARC)

Tamiami Amateur Radio Club
Venice, Florida

WELCOME

- To the third of 3, 4-hour classes presented by TARC to prepare you for the FCC Technician Class Amateur Radio Service license test.
- Today we will cover Chapter 4, 7, 8, and 9 of the ARRL Ham Radio License Manual, 4th Ed.
- Everything you need to know is in this manual

Meet Your Instructors

Andy Durette

KB1HIP

Extra Class

Paul Nienaber

KN4BAR

Extra Class

Chet Fennell

KG4IYS

Extra Class

Course Outline

- Welcome to amateur radio
- Radio and Signals Fundamentals
- Amateur Radio Equipment (HT & 2M, 70cm)
- Electricity, Components and Circuits
- Propagation, Antennas and Feedlines
- Communicating with other hams
- Amateur Radio Equipment (HF)
- Licensing regulations
- Operating regulations
- Safety
- Test preparation and review

Radio Wave Propagation

- **How signals travel (propagation)**
- **Antenna Basics**
- **Feed Lines**
- **What is SWR?**
- **How to build a practical antenna**

Getting from Point A to B

- **Radio waves propagate by many mechanisms**
- **The science of wave propagation has many facets**
- **We will discuss 3 basic ways:**
  - **Line of sight (VHF and UHF)**
  - **Ground wave**
  - **Sky wave (HF)**

Line of Sight

- **If a source of radio energy can be seen by the receiver, then the radio energy will travel in a straight line from transmitter to receive**
- **There is some attenuation of the signal as the radio wave travels**
- **This is the primary propagation mode for VHF and UHF signals**

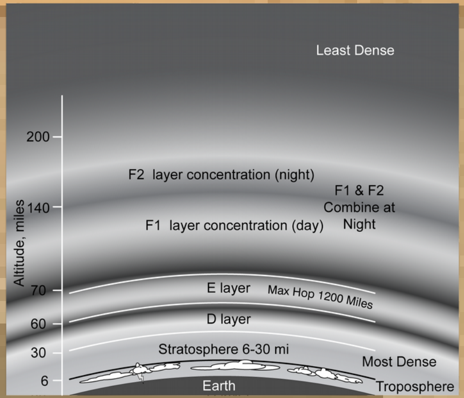
Ground Wave

- **Some radio frequency ranges (lower HF frequencies) will hug the earth's surface as they travel**
- **These waves will travel beyond the range of line-of-sight up to a few hundred miles**

The Ionosphere

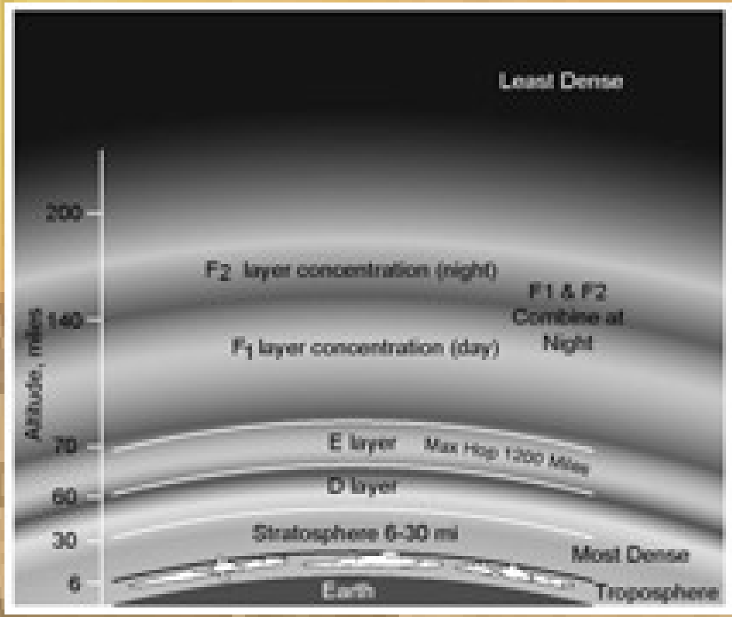
- Radiation from the sun momentarily will strip electrons away from the parent atom in the upper reaches of the atmosphere
- This creates ions of positive and negative charged (electrons) particles

- The region where ionization occurs is called the **Ionosphere** (60 to 260 miles above earth's surface



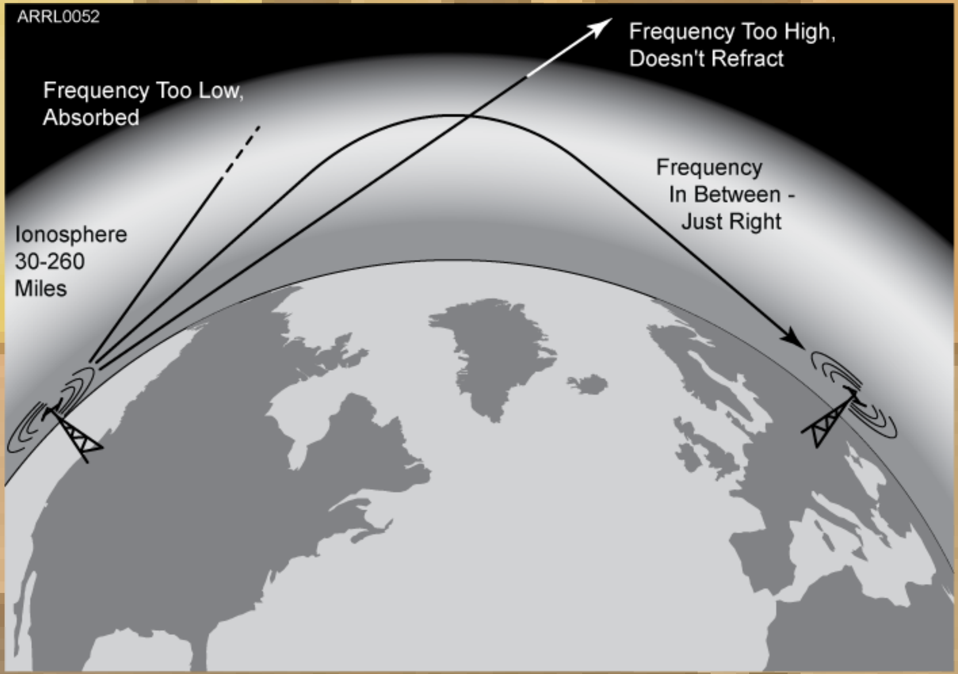
Layers of Atmosphere

- **D layer** – 30 to 60 miles above surface
- **E layer** – 60 to 70 miles above surface
- **F1 layer** – 70 to 140 miles above surface
- **F2 layer** – 140 to 260 miles above surface



Sky Wave Propagation

- **The ionized layers of the atmosphere actually act as an RF mirror that reflect certain frequencies back to earth**
- **Sky-wave propagation is responsible for most long-range, over the horizon communication**
- **Reflection depends on frequency and angle of incidence**



MUF and LUF

- **Lowest Usable Frequency (LUF)**
- **Maximum Usable Frequency (MUF)**
-
- **If too low => absorbed**
- **If too high => goes into space**
- **Just right => bounces back to earth miles and miles away**

Sun Spot Cycles

- **The level of ionization depends of the radiation intensity of the sun**
- **Radiation from the sun is related to the number of sun spots on the sun’s surface**
- **High number of sun spots, high ionizing radiation emitted from the sun**
- **Sun spot activity follows an 11-year cycle**
- **We are currently at or near the low point of the cycle!**

Which of the following is a likely cause of irregular fading of signals received by ionospheric reflections? (T3A08)

- A Frequency shift due to Faraday rotation
- B Interference from thunderstorms
- C Random combining of signals arriving via different paths
- D Intermodulation distortion

Which of the following is a likely cause of irregular fading of signals received by ionospheric reflections? (T3A08)

- A Frequency shift due to Faraday rotation
- B Interference from thunderstorms
- **C Random combining of signals arriving via different paths**
- D Intermodulation distortion

Which part of the atmosphere enables the propagation of radio signals around the world? (T3A11)

A. The stratosphere

B. The troposphere

C. The Ionosphere

D. The magnetosphere

Which part of the atmosphere enables the propagation of radio signals around the world? (T3A11)

A. The stratosphere

B. The troposphere

C. The Ionosphere

D. The magnetosphere

Which of the following propagation types is most commonly associated with occasional strong over-the-horizon signals on the 10, 6, and 2 meter bands? (T3C04)

A. Backscatter
B. Sporadic E
C. D layer absorption
D. Gray-line propagation

Which of the following propagation types is most commonly associated with occasional strong over-the-horizon signals on the 10, 6, and 2 meter bands? (T3C04)

A. Backscatter
B. Sporadic E
C. D layer absorption
D. Gray-line propagation

How does the wavelength of a radio wave relate to its frequency? (T3B05)

A. The wavelength gets longer as its frequency increases

B. The wavelength gets shorter as the frequency increases

C. There is no relationship between wavelength and frequency

D. The wavelength depends on the bandwidth of the signal

How does the wavelength of a radio wave relate to its frequency? (T3B05)

A. The wavelength gets longer as its frequency increases

B. The wavelength gets shorter as the frequency increases

C. There is no relationship between wavelength and frequency

D. The wavelength depends on the bandwidth of the signal

What property of radio waves is often used to identify the different frequency bands? (T3B07)

A. The approximate wavelength

B. The magnet intensity of waves

C. The times it takes the waves to travel one mile

D. The voltage standing wave ratio of waves

What property of radio waves is often used to identify the different frequency bands? (T3B07)

A. The approximate wavelength

B. The magnet intensity of waves

C. The times it takes the waves to travel one mile

D. The voltage standing wave ratio of waves

Which of the following is an advantage of HF vs VHF and higher frequencies? (T3C02)

A. HF antennas are generally smaller
B. HF accommodates wider bandwidth signals
C. Long distance ionospheric propagation is far more common on HF
D. There is less atmospheric interference (static) on HF

Which of the following is an advantage of HF vs VHF and higher frequencies? (T3C02)

A. HF antennas are generally smaller
B. HF accommodates wider bandwidth signals
C. Long distance ionospheric propagation is far more common on HF
D. There is less atmospheric interference (static) on HF

Why are direct (not via repeater) UHF signals rarely heard from stations outside your local coverage area? (T3C01)

A They are too weak to go very far

B FCC regulations prohibit them from going more than 50 miles

C UHF signals are usually not reflected by the ionosphere

D They collide with trees and shrubbery and fade out

Why are direct (not via repeater) UHF signals rarely heard from stations outside your local coverage area? (T3C01)

A They are too weak to go very far

B FCC regulations prohibit them from going more than 50 miles

C UHF signals are usually not reflected by the ionosphere

D They collide with trees and shrubbery and fade out

The Antenna System

- **Antenna:** Facilitates the sending of your signal to some distant station
- **Feed line:** Connects your station to the antenna
- **Test and matching equipment:** Allows you to monitor antenna performance

- **More than anything else, the antenna determines how well your radio station performs!**

Antenna Vocabulary

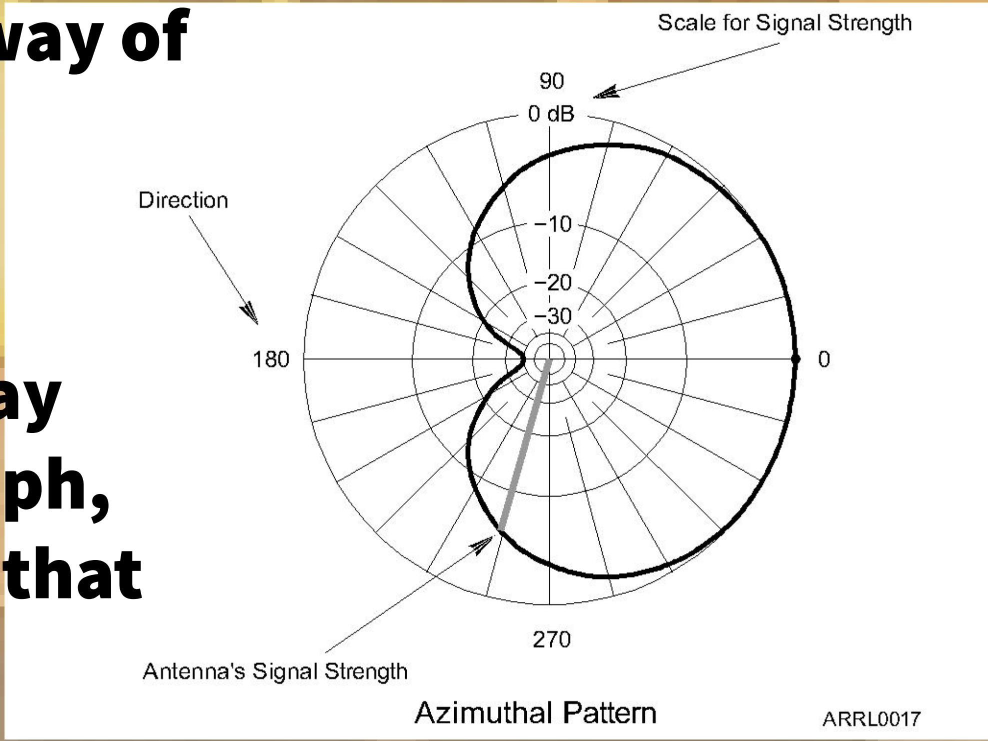
- **Driven element**: where the transmitted energy enters the antenna
- **Polarization**: the direction of the electric field relative to the surface of the earth
  - Same as the physical direction
  - **Vertical – Horizontal - Circular**

Antenna Vocabulary

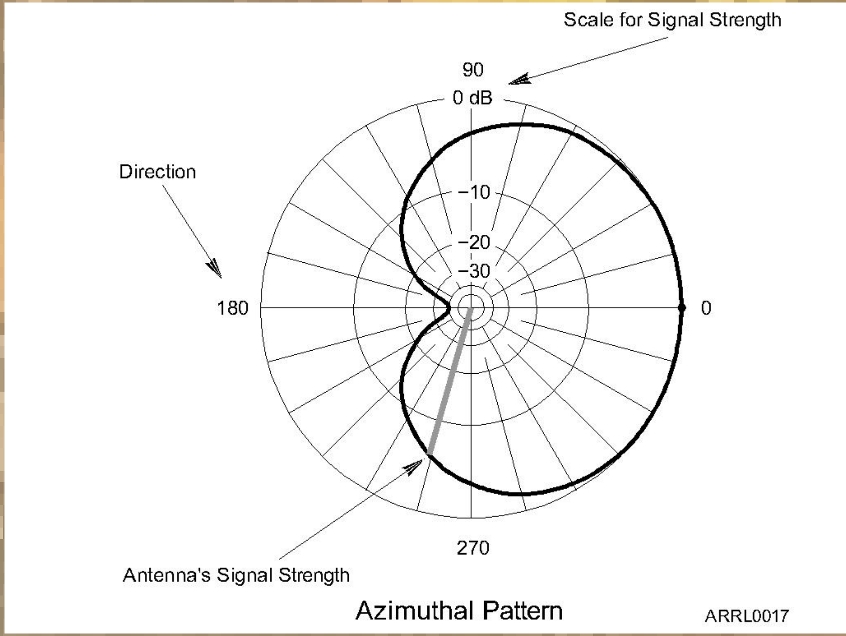
- **Omni-directional** - radiates in all directions
- **Directional beam** – focuses radiation in specific directions
- **Gain** – apparent increase in power in a particular direction because energy is focused in that direction
- Measured in **decibels (dB)**

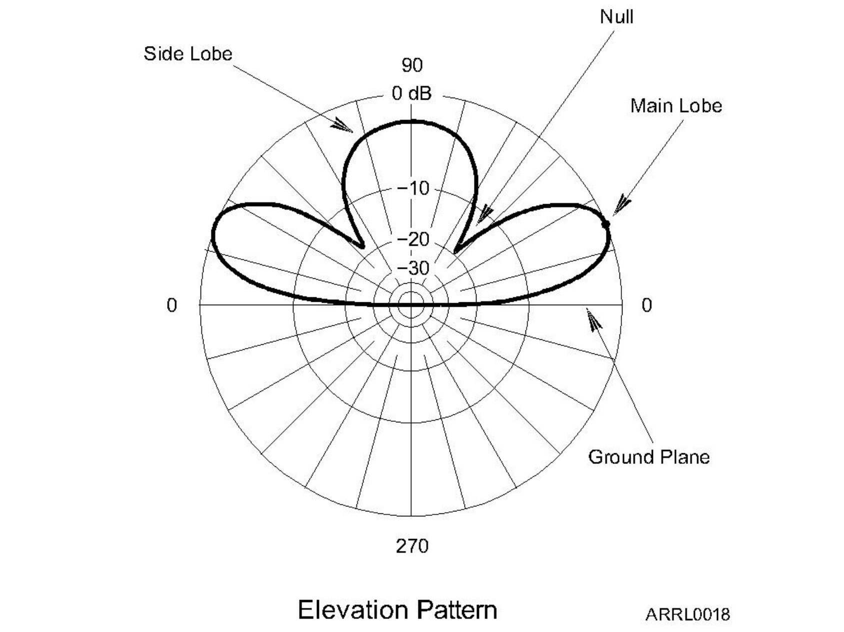
Antenna Radiation Patterns

- **Radiation patterns are a way of visualizing antenna performance**
- **The further the line is away from the center of the graph, the stronger the signal at that point**



Antenna Radiation Patterns





HORIZONTAL

VERTICAL

Impedance – AC Resistance

- A quick review of a previous concept: **impedance**
- Antennas have characteristics of capacitors, inductors, and resistors
- The combined response of these component parts to alternating currents (radio waves) is called **Impedance**

Antenna Impedace

- Antennas have a characteristic impedance
- Expressed in Ohms – common value is 50 Ohms
- Depends on:
  - Antenna design
  - Height above the ground
  - Distance from surrounding obstacles
  - Frequency of operation
  - Other factors

What are the two components of a radio wave? (T3B03)

A. AC and DC
B. Voltage and current
C. Electric and magnetic fields
D. Ionizing and non-ionizing radiation

What are the two components of a radio wave? (T3B03)

A. AC and DC
B. Voltage and current
C. Electric and magnetic fields
D. Ionizing and non-ionizing radiation

What is the gain of an antenna? (T9A11)

A. The additional power that is added to the transmitter power
B. The additional power that is lost in the antenna when transmitting on higher frequency
C. The increase in signal strength in a specified direction when compared to a reference antenna
D. The increase in impedance on receive or transmit compared to a reference antenna

What is the gain of an antenna? (T9A11)

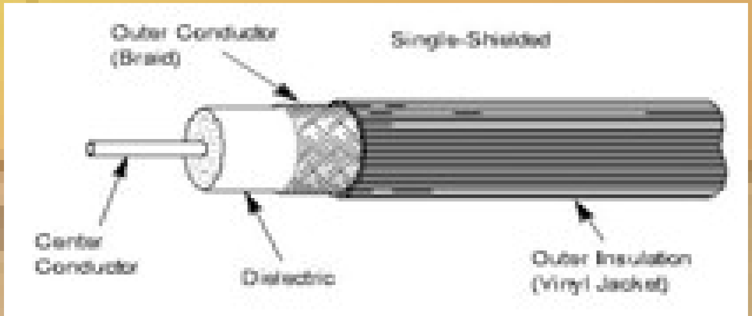
A. The additional power that is added to the transmitter power
B. The additional power that is lost in the antenna when transmitting on higher frequency
C. The increase in signal strength in a specified direction when compared to a reference antenna
D. The increase in impedance on receive or transmit compared to a reference antenna

Feed Line Types

- **The purpose of the feed line is to get energy from your station to the antenna**
- **Basic feed line types**
  - **Coax cable**
  - **Open-wire or ladder line**
  - **Hardline**
- **Each has a characteristic impedance, each has its unique application**

Coaxial Cable (Coax)

- **Most common feed line**
- **Easy to use**
- **Matches impedance of modern radio equipment (50 Ohms)**
- **Some loss of signal depending on type of coax cable used**



Types of Coax and Connectors

Coax

- RG-58
- RG-8
- RG-213
- RG-174
- Hardline

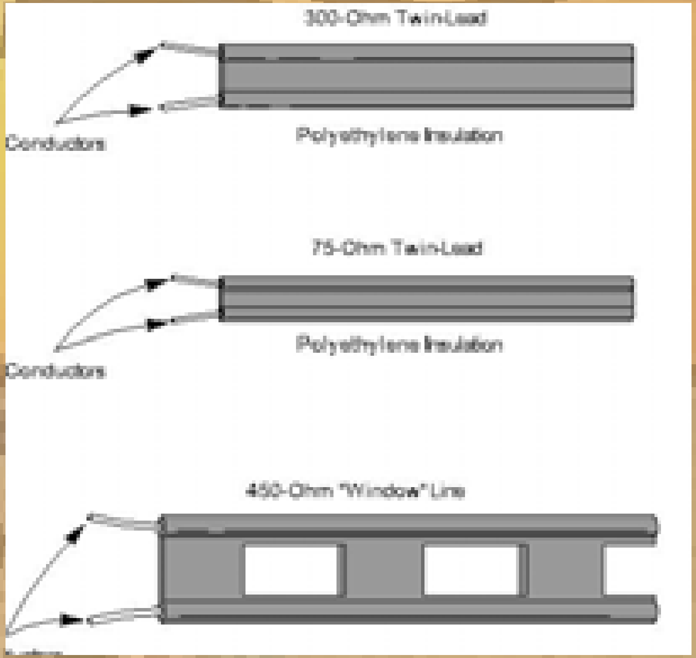
Connectors

- SO-239/PL259
- BNC
- N
- SMA

Open-wire / Ladder Line

- Used in special applications
- Need an antenna tuner to make impedance match but allows a lot of flexibility

- Theoretically a very low loss



Which of the following is the most common cause for failure of coaxial cable? (T7C09)

A. Moisture contamination
B. Gamma rays
C. The velocity factor exceeds 1.0
D. Overloading

Which of the following is the most common cause for failure of coaxial cable? (T7C09)

A. **Moisture contamination**
B. Gamma rays
C. The velocity factor exceeds 1.0
D. Overloading

Feed Line & Antenna Matching

- **For efficient transfer of energy from the transmitter to the feed line and from the feed line to the antenna, the impedances need to match**
- **When there is mismatch of impedances, things may still work, but not as effectively as they could**
- **If the antenna and feed line impedances are not perfectly matched, some RF energy is not radiated into space and is returned (reflected) back to the source**

Test and Matching Equipment

- **Proper impedance matching is important enough to deserve some simple test equipment as you develop your station repertoire**

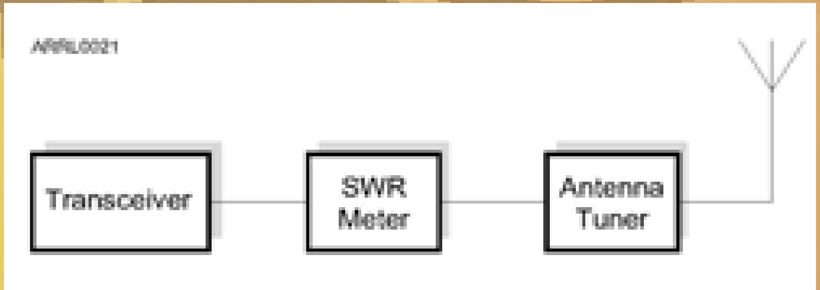
- **Basic Test Equipment: SWR meter**
- **Matching Equipment: Antenna Tuner**

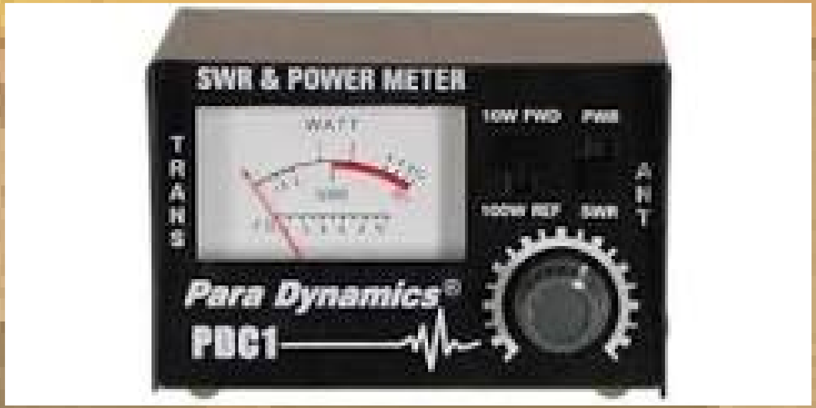
Standing Wave Ratio (SWR)

- **Reflected energy must go somewhere**
- **Usually it is converted into heat**
- **Sometimes it just floats around looking for somewhere to go**
- **If the energy is not going out the antenna, it is wasted and may cause damage to the transmitter**

SWR Meter

- **The SWR meter is inserted in the feed line and indicates the reflected energy**
- **Measures the mismatch between feed line impedance and antenna impedance as SWR**
- **You make adjustments to the antenna to minimize the reflected energy (minimum SWR)**





Nothing is Perfect

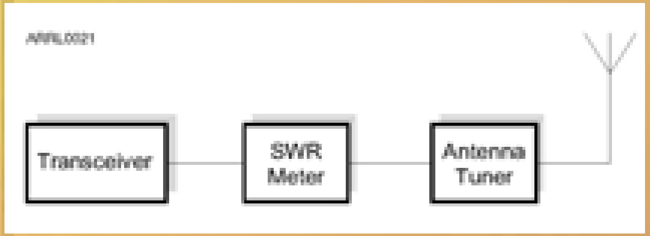
- Although the goal is to get 100% of your radio energy radiated into space, that is virtually impossible
- What is an acceptable level of loss (reflected power or SWR?)
  - 1:1 is perfect
  - 2:1 should be the max you accept (general rule)
  - 3:1 modern radios begin to reduce power to protect power transistors from failure

Antenna Tuner

- **One way to make antenna matching adjustments is to use an antenna tuner**
- **Antenna tuners are impedance transformers (they actually do not tune the antenna)**
- **When used appropriately they are effective**
- **When used inappropriately they just make a bad antenna look good to the transmitter…a bad antenna is still bad**

Using the Tuner

- **Monitor the SWR meter**
- **Make adjustments on the tuner until the minimum SWR is achieved**
- **The impedance of the antenna is transformed to more closely match the impedance of the transmitter**



Why do most solid-state amateur radio transmitters reduce output power as SWR increases? (T7C12)

A. To protect the output amplifier transistors
B. To comply with FCC rules on spectral purity
C. Because power supplies cannot supply enough current at high SWR
D. To improve the impedance match to the feed line

Why do most solid-state amateur radio transmitters reduce output power as SWR increases? (T7C12)

A. To protect the output amplifier transistors

B. To comply with FCC rules on spectral purity

C. Because power supplies cannot supply enough current at high SWR

D. To improve the impedance match to the feed line

What reading on an SWR meter indicates a perfect impedance match between the antenna and the feed line? (T7C04)

A. 2 to 1
B. 1 to 3
C. 1 to 1
D. 10 to 1

What reading on an SWR meter indicates a perfect impedance match between the antenna and the feed line? (T7C04)

A. 2 to 1
B. 1 to 3
C. 1 to 1
D. 10 to 1

Why is it important to have a low SWR in an antenna system that uses coaxial cable feed line? (T9B01)

A. To reduce television interference
B. To allow the efficient transfer of power and reduce losses
C. To prolong antenna life
D. All of these choices are correct

Why is it important to have a low SWR in an antenna system that uses coaxial cable feed line? (T9B01)

A. To reduce television interference

B. To allow the efficient transfer of power and reduce losses

C. To prolong antenna life

D. All of these choices are correct

Which of the following types of feed line has the lowest loss at VHF and UHF? (T9B11)

A. 50-ohm flexible coax
B. Multi-conductor unbalanced cable
C. Air-insulated hard line
D. 75-ohm flexible coax

Which of the following types of feed line has the lowest loss at VHF and UHF? (T9B11)

A. 50-ohm flexible coax
B. Multi-conductor unbalanced cable
C. Air-insulated hard line
D. 75-ohm flexible coax

Practical Antenna Systems

Dipoles,
Ground-Planes,
and Directionals

How Long Should Antenna Be ?

- **When working with antennas, it is important to know how long ?**
- **Antenna length is based on the wavelength that we want to use**
- **There is a relationship between frequency and wavelength**
- **Antennas can be full or fractional wavelengths long**

Symbol and Formula

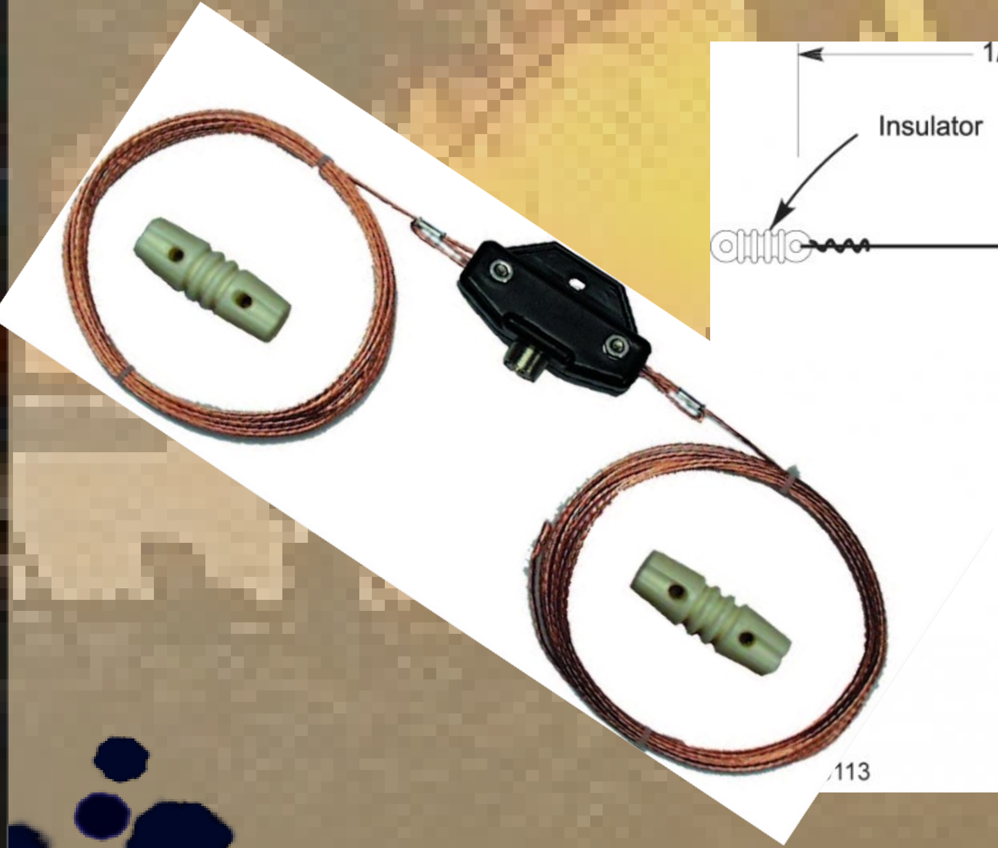
- λ = Wavelength

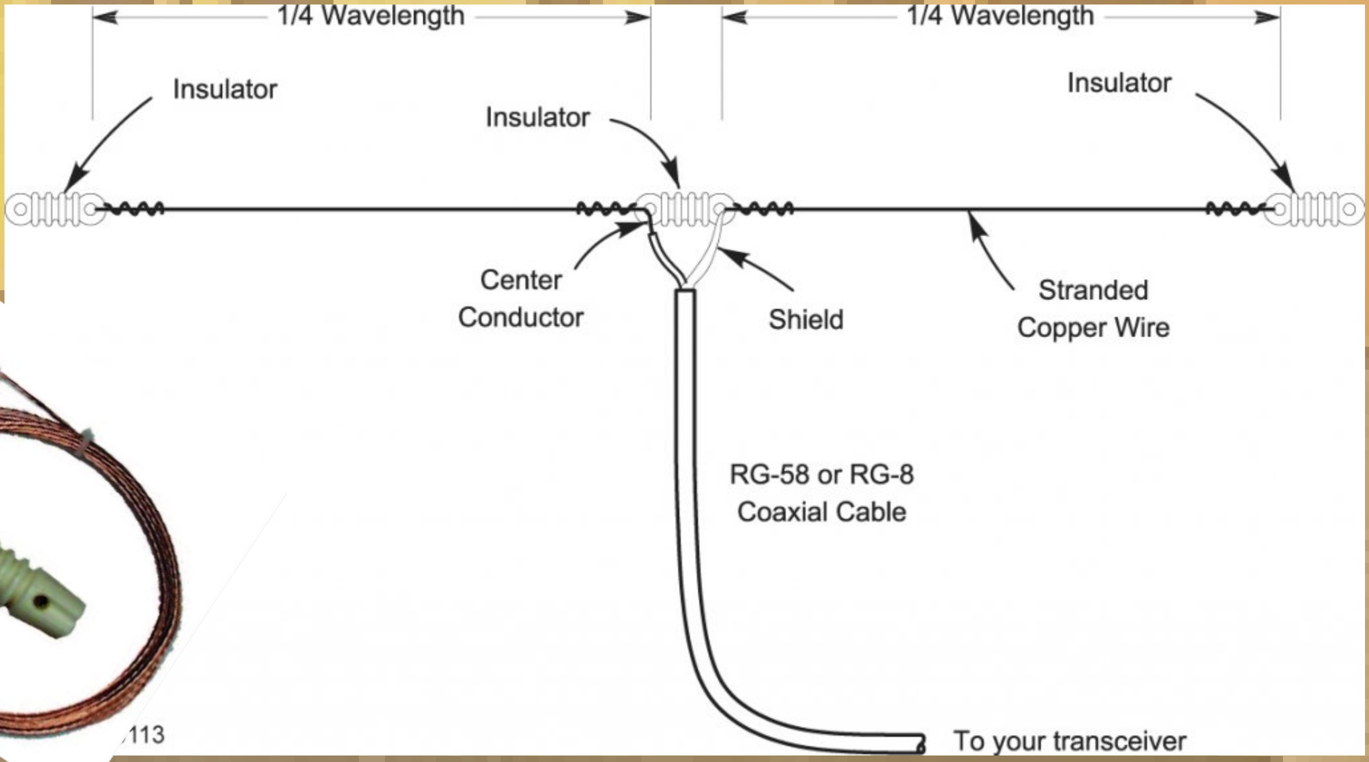
- ½ Wave antenna length in Feet is 468 divided by the Frequency in MHz
- ¼ Wavelength is 234 divided by the Frequency in MHz

The Dipole Antenna

- **A basic antenna**
  - **Two conductive, equal length parts**
  - **Feed line connected in the middle**
  - **Total length is ½ wavelength (1/2 λ)**
- **Dipole Length (in feet) = 468 / Frequency (in MHz)**

The Dipole Antenna





The Ground-Plane Antenna

- **Simply a dipole that is oriented perpendicular (vertical to the earth's surface)**
- **One half of the dipole is replaced by the ground-plane**
  - **Earth**
  - **Car roof or trunk lid - or other metal surface**
  - **Radial wires on or under the ground**

Ground-Plane Antenna

Length (in feet) = 234 / Frequency (in MHz)

½ Wavelength – Dipole but Ground-Plane is ½ that

¼ Wavelength – Ground plane above ground

Directional Antennas

- **Beam antennas focus or direct RF energy in a desired direction**
- **Gain - An apparent increase in power in the desired direction (both transmit and receive)**
- **Yagi (rod like elements – TV antennas)**
- **Quad (square wire loop elements)**
- **Dish antennas – used at frequencies above 1 GHz**

What is the approximate length, in inches, of a 6 meter 1/2-wavelength wire dipole antenna? (T9A9)

A. 6
B. 50
C. 112
D. 236

What is the approximate length, in inches, of a 6 meter 1/2-wavelength wire dipole antenna? (T9A9)

A. 6
B. 50
C. 112 (6m = 50MHz so, 468/50 = 9.36 ft = 112.3 in)
D. 236

In which direction does a half-wave dipole antenna radiate the strongest signal? (T9A10)

A. Equally in all directions
B. Off the ends of the antenna
C. Broadside to the antenna
D. In the direction of the feed line

In which direction does a half-wave dipole antenna radiate the strongest signal? (T9A10)

A. Equally in all directions
B. Off the ends of the antenna
C. Broadside to the antenna
D. In the direction of the feed line

What type of antennas are the quad, Yagi, and dish? (T9A06)

A. Non-resonant antennas
B. Loop antennas
C. Directional antennas
D. Isotropic antennas

What type of antennas are the quad, Yagi, and dish? (T9A06)

A. Non-resonant antennas
B. Loop antennas
C. Directional antennas
D. Isotropic antennas

How would you change a dipole antenna to make it resonant on a higher frequency? (T9A05)

A. Lengthen it
B. Insert coils in series with radiating wires
C. Shorten it
D. Add capacity hats to the ends of the radiating wires

How would you change a dipole antenna to make it resonant on a higher frequency? (T9A05)

A. Lengthen it
B. Insert coils in series with radiating wires
C. Shorten it
D. Add capacity hats to the ends of the radiating wires

Which of the following describes a simple dipole mounted so the conductor is parallel to the Earth's surface? (T9A03)

A. A ground wave antenna
B. A horizontally polarized antenna
C. A rhombic antenna
D. A vertically polarized antenna

Which of the following describes a simple dipole mounted so the conductor is parallel to the Earth's surface? (T9A03)

A. A ground wave antenna

B. A horizontally polarized antenna

C. A rhombic antenna

D. A vertically polarized antenna

End of Introduction

QUESTIONS ?