Amateur Radio Technician Class Training (Question Pool July 2018 – June 2022)

Slideset created by Alan Wolke, W2AEW
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Based on the No-Nonsense Technician Class Study Guide by Dan Romanchik, KB6NU

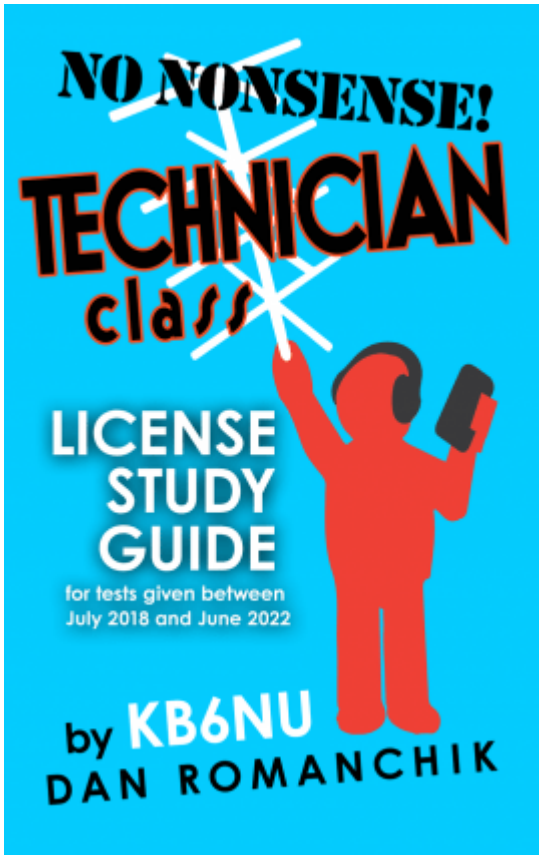
Updates by Rebecca Mercuri, Ph.D., K3RPM

Welcome to Session 2

Any Questions Before We Start?

Agenda

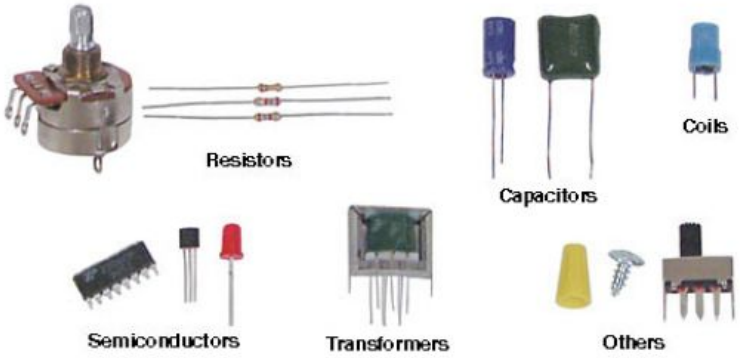
- Introduction
- Electrical Principles (EP)
- **Electronic Components and Circuits (ECCD)**
- **Radio Wave Characteristics (RWC)**
- Antennas and Feed Lines (AFL)
- Amateur Radio Signals (ARS)
- Electrical Safety (ES)
- Radio Practices and Station Setup (RPSS)
- Station Equipment (SE)
- Operating Procedures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

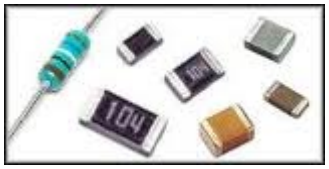


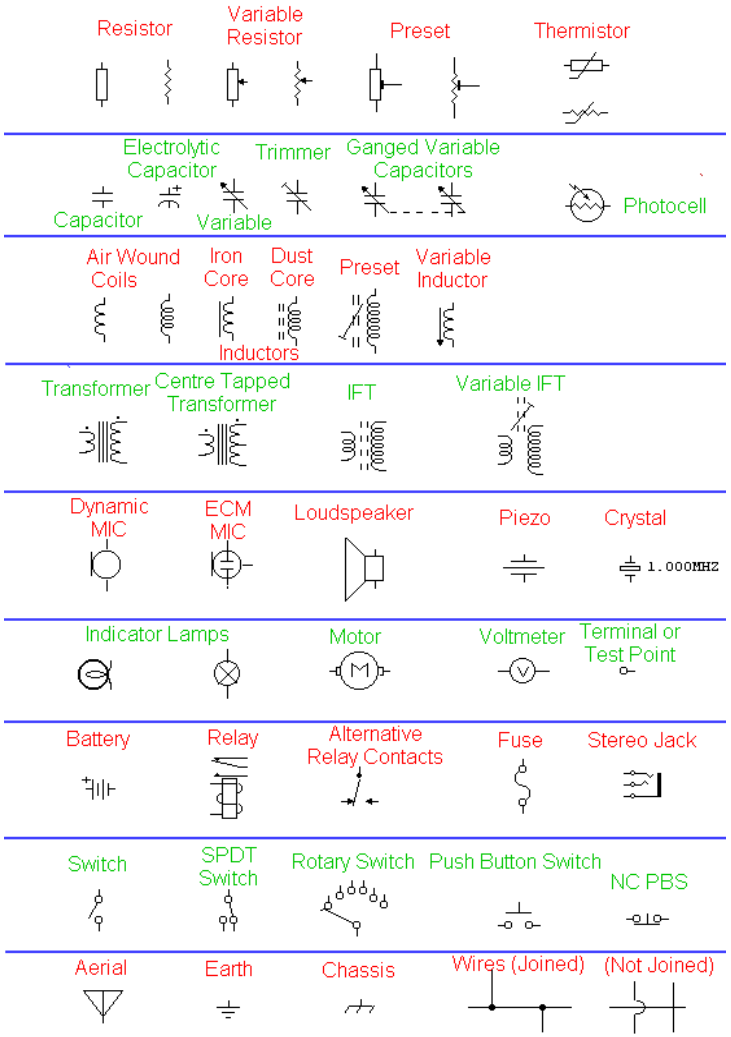
Electronic Components & Circuit Diagrams (ECCD)

- Resistors, Capacitors, ...
- Semiconductors
- Circuit Diagrams
- Other Components

Electronic Components & Circuit Diagrams (ECCD)

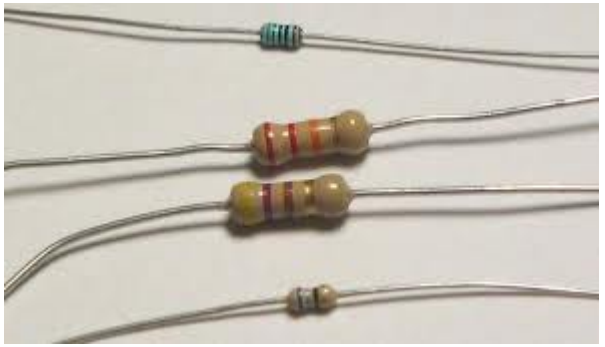




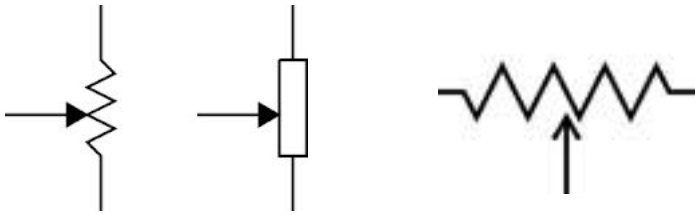


Resistors

Passive Components



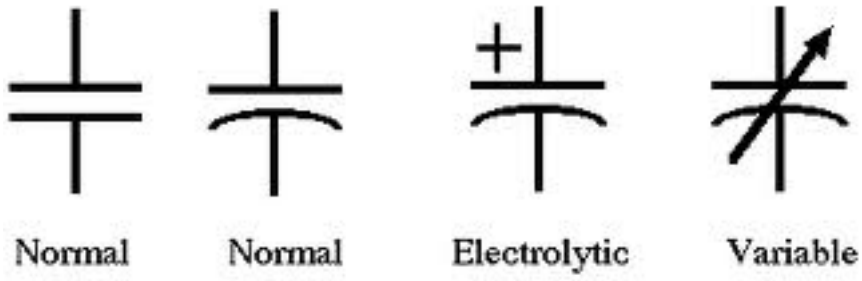
- **Resistors** oppose the flow of current
- Variable resistors are called **Potentiometers** (or **Rheostats**)
- Resistor value expressed in **ohms**



Capacitors

Passive Components

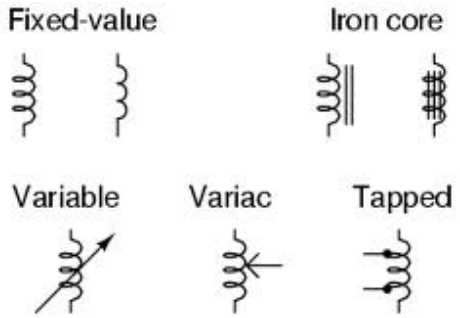
- Two conductors separated by an insulator (or dielectric) is a **Capacitor**
- Stores energy in an *electric* field
- Capacitance is the ability to store energy in an electric field
- The unit of measure is the **Farad**



Inductors

Passive Components

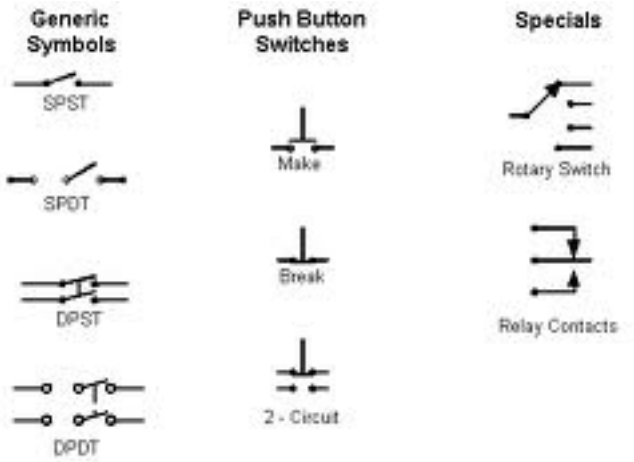
- An **inductor** stores energy in a *magnetic* field
- Often just a coil of wire!
- The ability to store energy in a magnetic field is called **Inductance**
- Unit of measure is **Henry**



Switches

Passive Components

- Used to connect and disconnect electrical circuits
- **Pole**: "movable part"
- **Throw**: where the pole can get moved to
- SPST: single-pole, single-throw
- DPDT: double-pole, double-throw



Fuses

Passive Components

- Protects circuits from overload (excessive current)
- "Blown" fuse – breaks and has to be replaced, but circuit should be checked first to see what caused the overload
- Rated in **Amps**

Batteries

Primary batteries are not rechargeable:

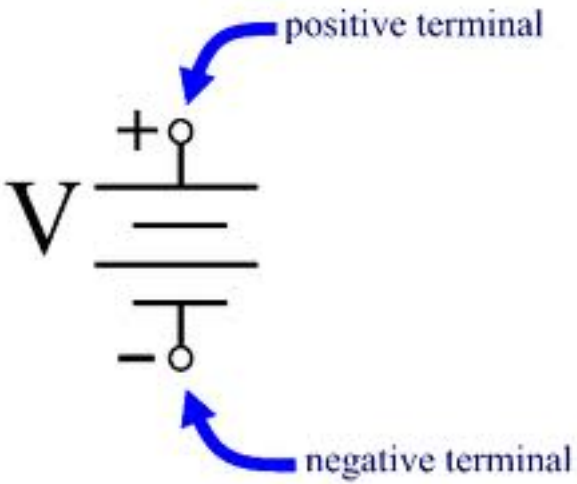
Carbon Zinc, Alkaline

Secondary batteries are rechargeable:

NiCad, NiMH, Lithium-ion, LiFePO4

Different types have different voltages

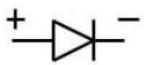
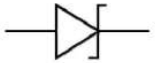
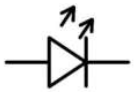
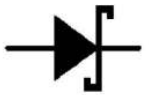
NiCad typically 1.2V



Diodes

Semiconductors

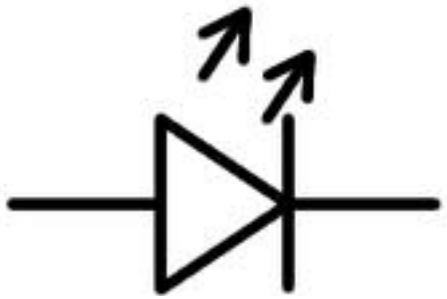
- Allows current to flow in only one direction
- Terminals are:
  - *Anode (+)*
  - *Cathode (-)*
- Cathode has the *stripe*
- Often called **Rectifier**

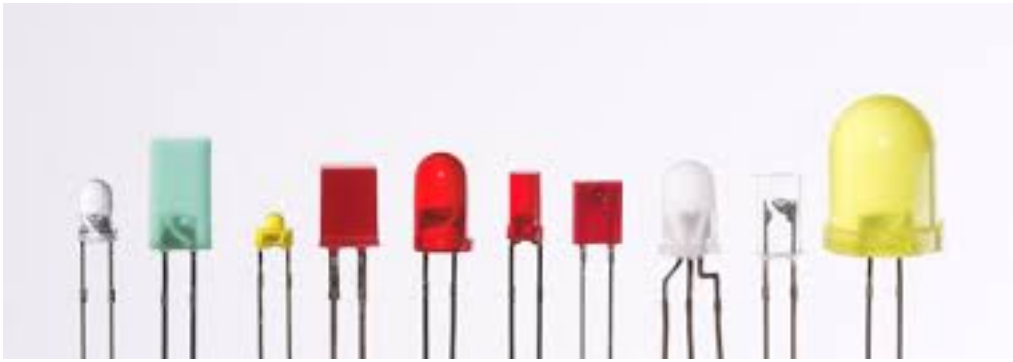
Name	Symbol	Image
Diode		
Zener Diode		
LED (Light Emitting Diode)		
Schottky Diode		

Light Emitting Diodes (LEDs)

Semiconductors

- A diode that creates light when current passes through it
- Commonly used as a *visual indicator*





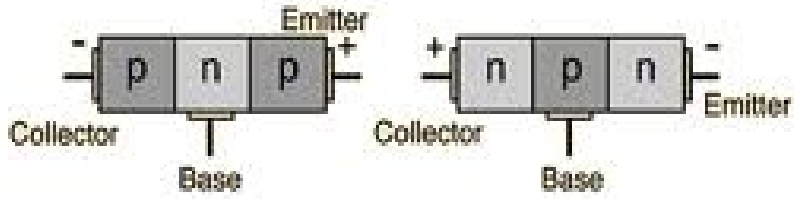
Transistors

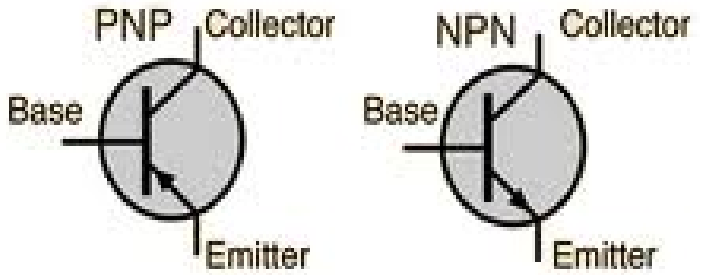
Semiconductors

- Component where *current* flow is controlled by another *current or voltage*
- Used as a *switch* or *amplifier*
- **Gain** is a measure of the ability to amplify
- Ratio of output to input current (for example)

Some Transistor Types

- **Bipolar transistors** are made of *three layers* of semiconductor
  - NPN or PNP
- Terminals are:
  - Base
  - Collector
  - Emitter

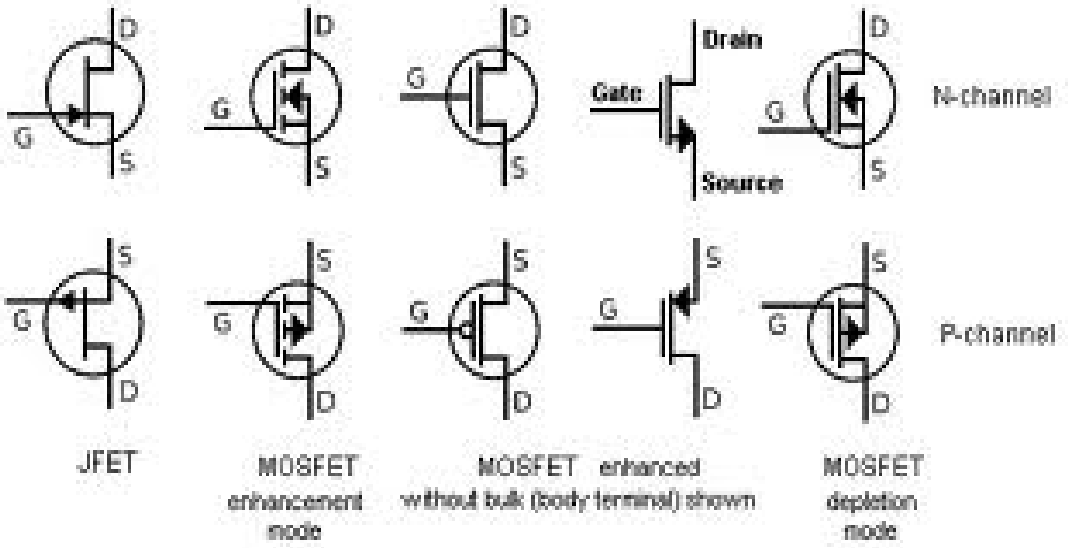




More Transistor Types

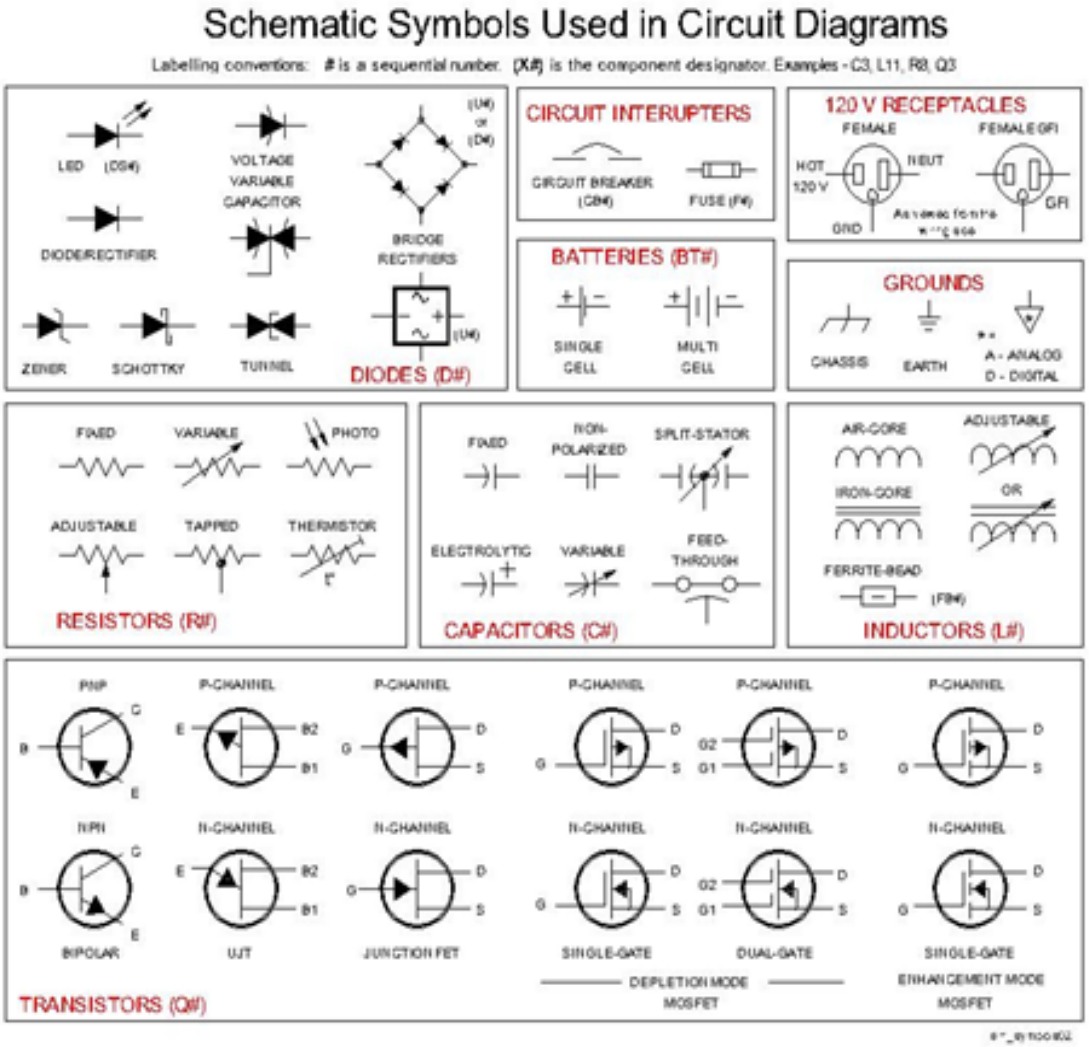
Field Effect Transistor (FET)

- Current is controlled by voltage on the Gate
- Terminals are:
  - Gate
  - Drain
  - Source



Schematic Symbols

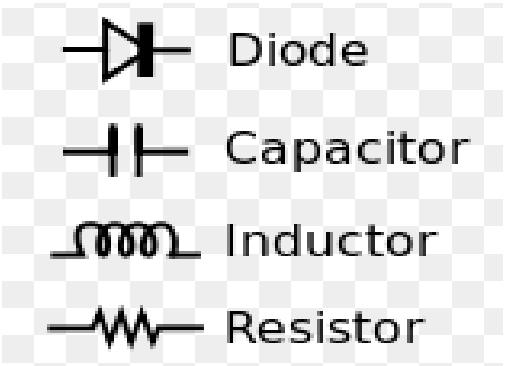
Circuit Diagrams

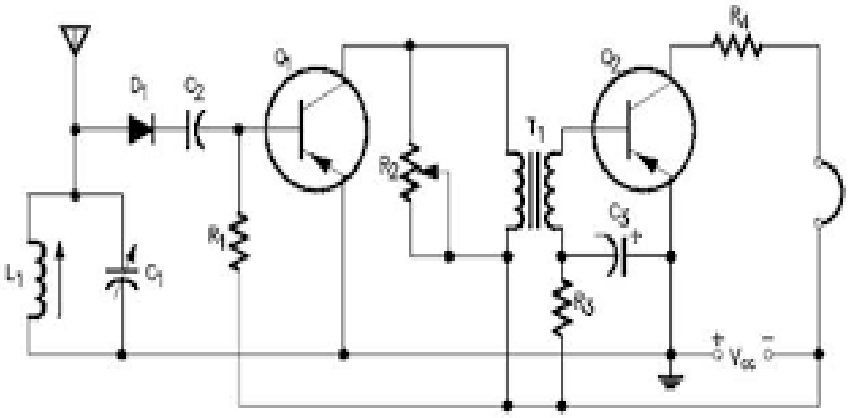


Schematic Symbols

Circuit Diagrams

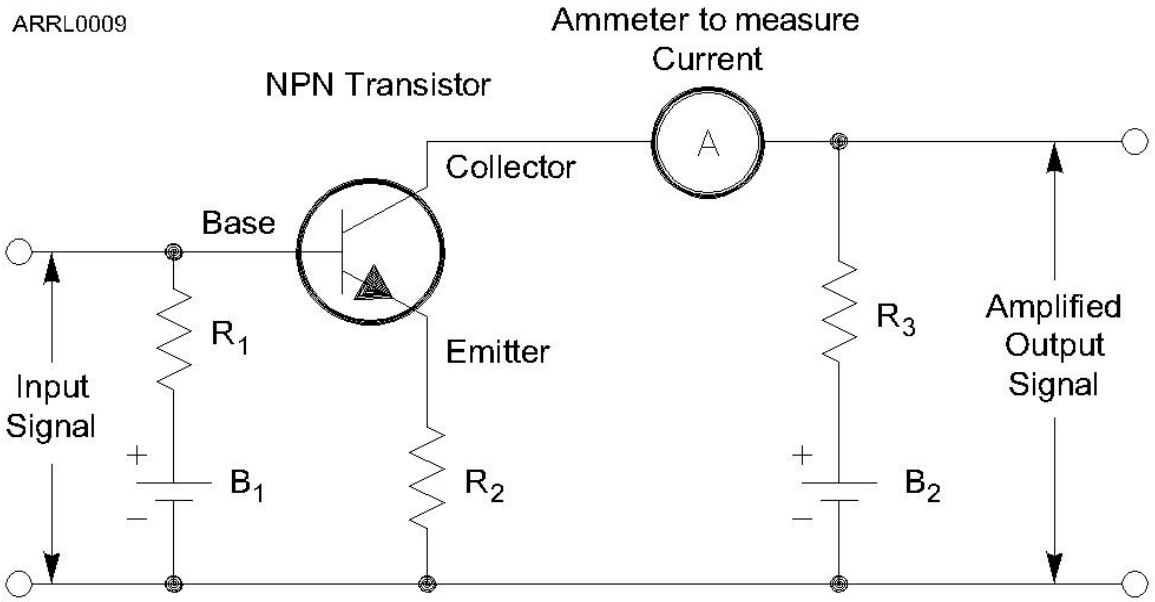
- Schematic **symbols** are standardized representations for *components*
- Schematic **diagram** depicts the *interconnections* between components that make up a circuit





Schematic Diagrams

Circuit Diagrams



Schematic Diagram Examples

Circuit Diagrams

1: **Resistor**, used to limit input current

2: **Transistor**, controls the flow of current through the lamp

3: **Lamp**

4: **Battery**, supplies current to light the lamp

5: **Ground** to chassis

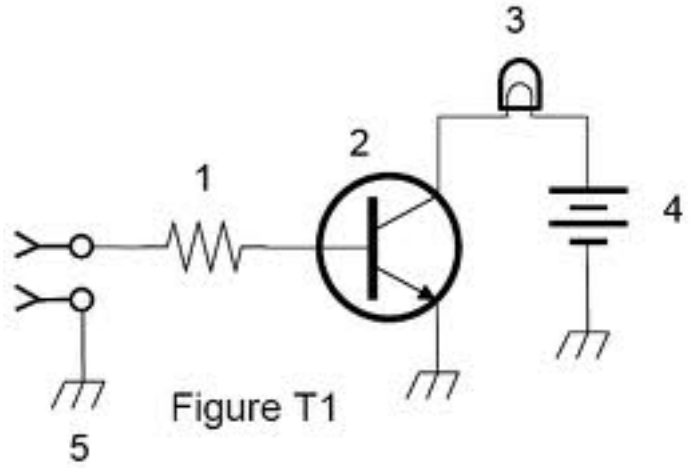


Figure T1

Turns on a light when a positive voltage is applied to the input

Schematic Diagram Examples

Circuit Diagrams

1: **Power Connector**

2: **Fuse**

3: **Single Pole, Single Throw switch** (SPST) to turn the power supply on/off

4: **Transformer**, used to change 120VAC to lower AC voltage

5: **Rectifier diode** to change AC to a varying DC signal

6: **Capacitor** helps to remove the 60Hz variation in the signal (filter)

8: **LED** – pilot light to show it is on

9: **Variable Resistor** to vary the output current

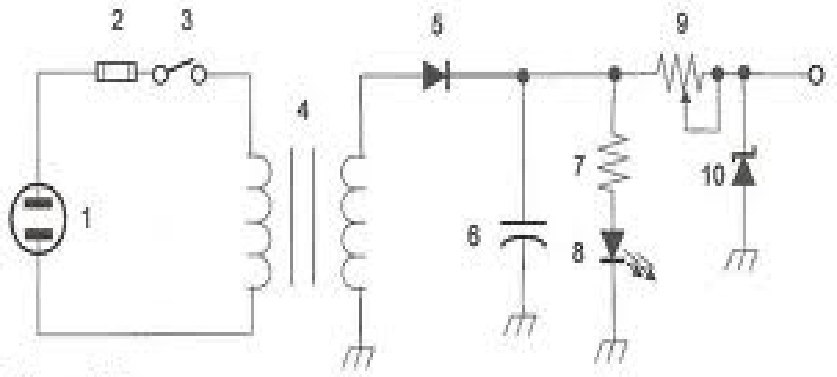


Figure T2

Simple AC – DC Power Supply

Schematic Diagram Examples

Circuit Diagrams

2: **Variable Capacitor**

3: **Variable Inductor**

The variable capacitors together with the variable inductor together create a *tuned circuit*

Capacitors and inductors connected together are often filters or tuned/resonant circuits

4: **Antenna**

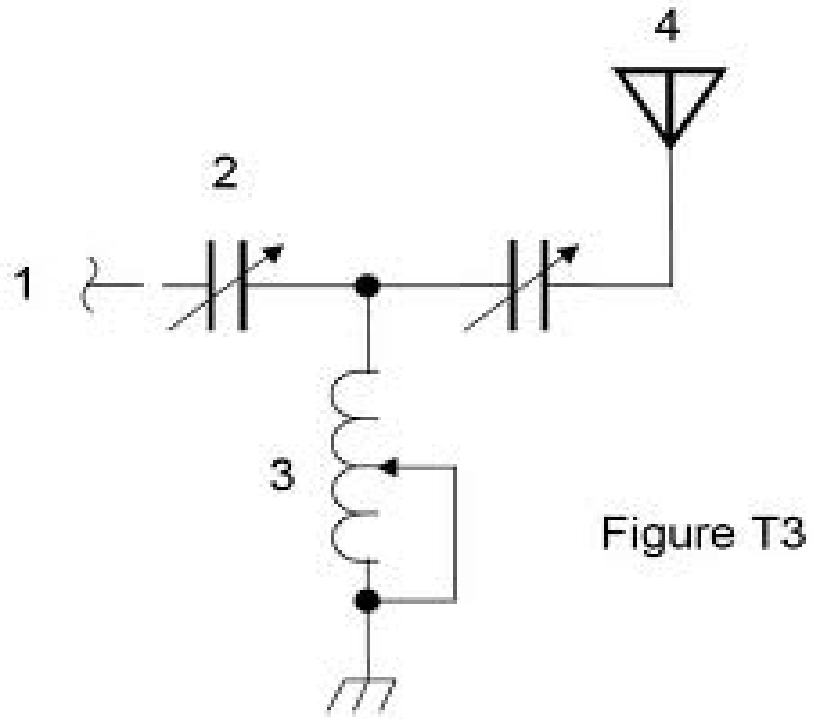


Figure T3

Output circuit of a transmitter

Other Components

Circuit Diagrams

Relay: a switch controlled by an electromagnet

Meter: used to display a electrical quantity on a numeric scale

Shielded Wire: prevents coupling of unwanted signals to/from the wire

Regulator: controls the amount of voltage from a power supply

Integrated Circuit: combines many parts in one package, performs analog and/or digital functions

Electronic Components & Circuit Diagrams Chapter End

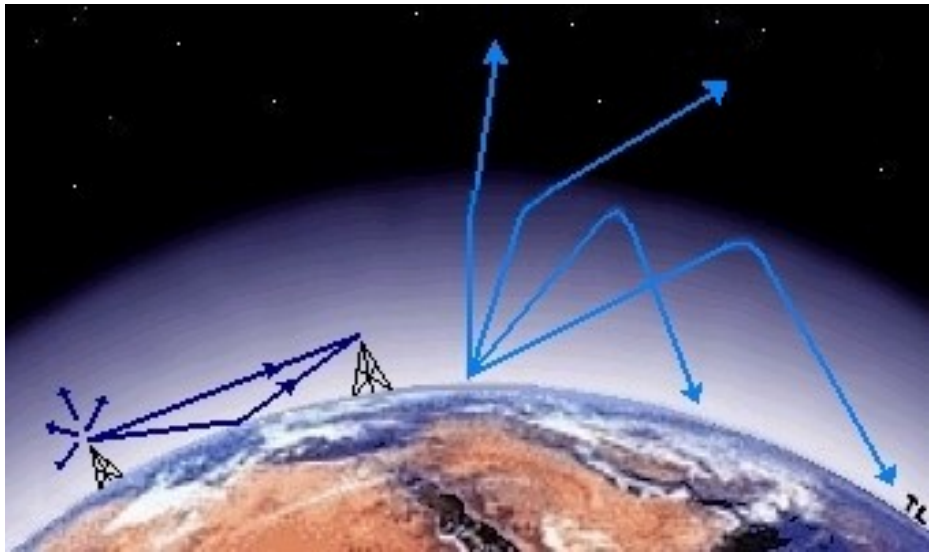
Questions?

Let's Practice for the Exam!

Radio Wave Characteristics (RWC)

- Frequency, Wavelength
- Radio Wave Properties
- HF Propagation

Radio Wave Characteristics (RWC)

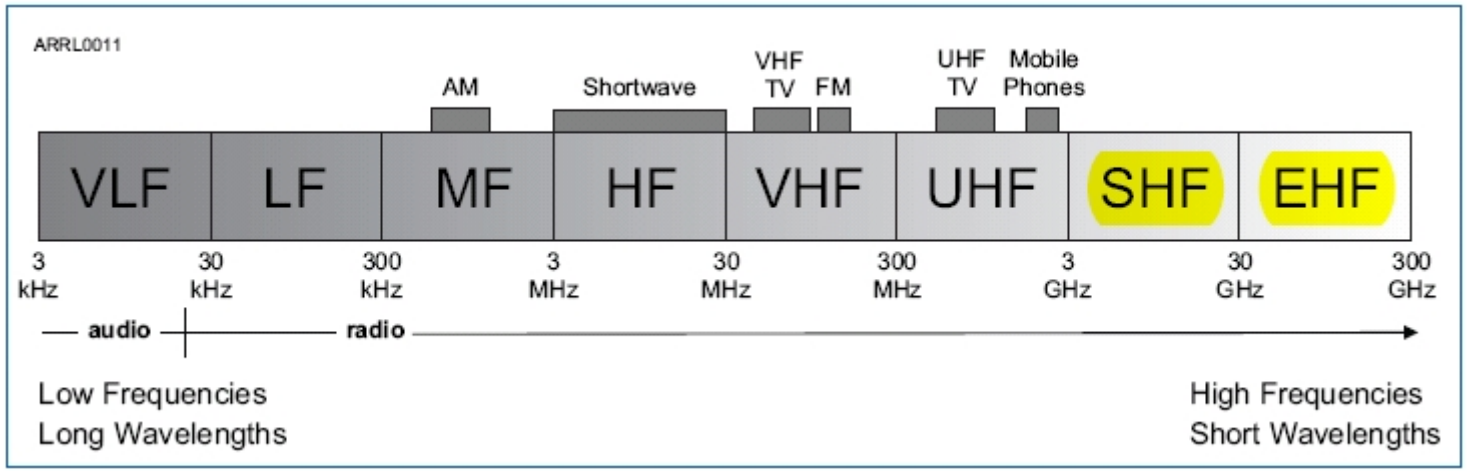


Frequency

Wavelength

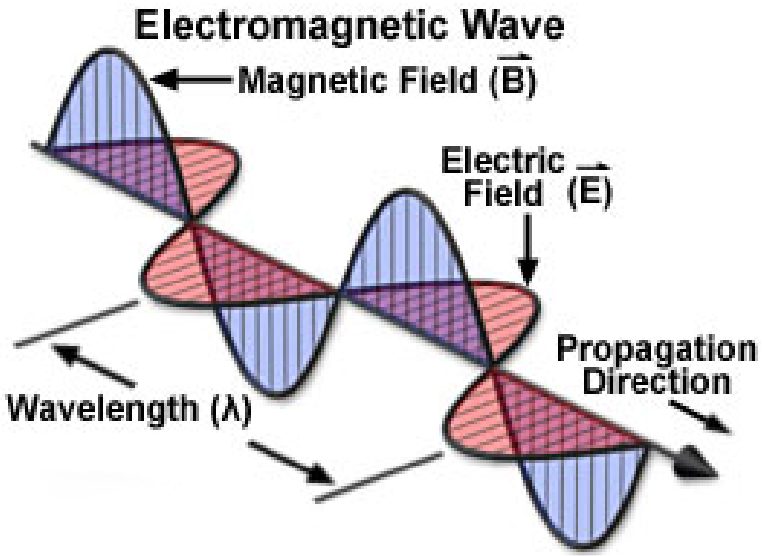
Spectrum

Propagation



Radio Waves

- Radio waves are **Electromagnetic**
- Have *electric* and *magnetic* field components
- *Radio waves* travel through space and they carry signals from transmitter to receiver

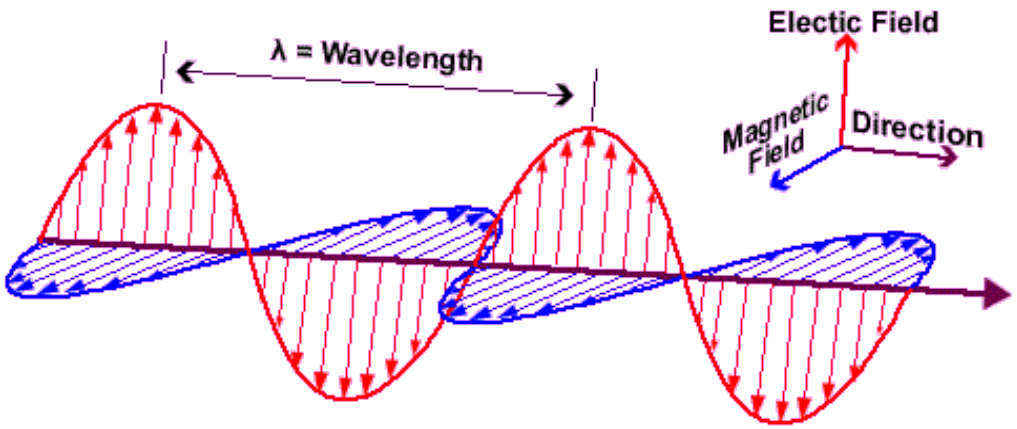


Frequency and Wavelength

Frequency: number of times per second the signal repeats (cycles) {exam may say reverses…}

Frequency measured in **Hertz** (cycles/second)

Wavelength: how far the wave travels during one cycle



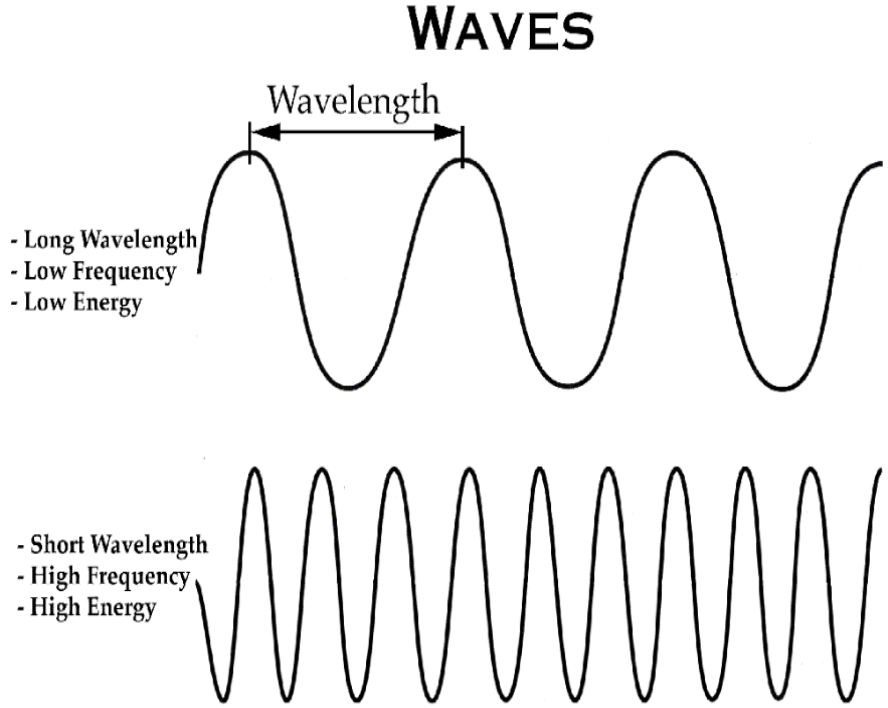
Radio Wave Facts

- Travels at *speed of light* in free space

  …about **300,000,000 meters per second**!

  …regardless of frequency

- Wavelength gets *shorter* as frequency *increases*
- *Wavelength in meters is equal to 300 / frequency in MHz*



Radio Frequency Bands

- The **approximate wavelength** of radio waves is used to identify different bands
- Examples:

  The 2m band spans 144 - 148MHz

  The 40m band spans 7.000 – 7.300MHz

It's not always "exact"…

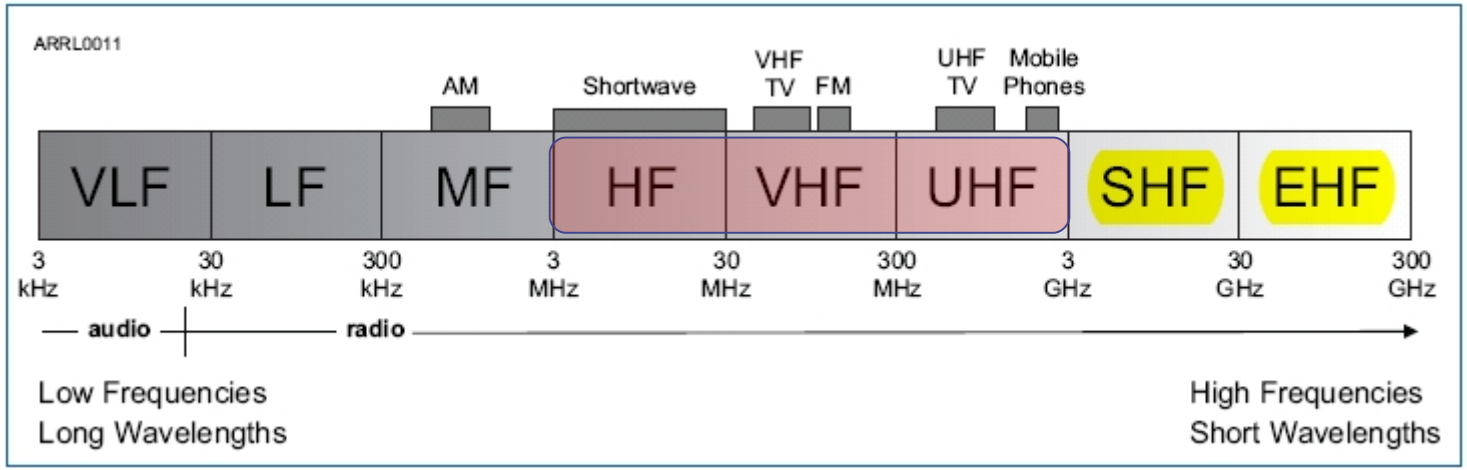
The RF Spectrum

RF = Radio Frequency

The full range of frequencies are divided into sub-ranges for convenience

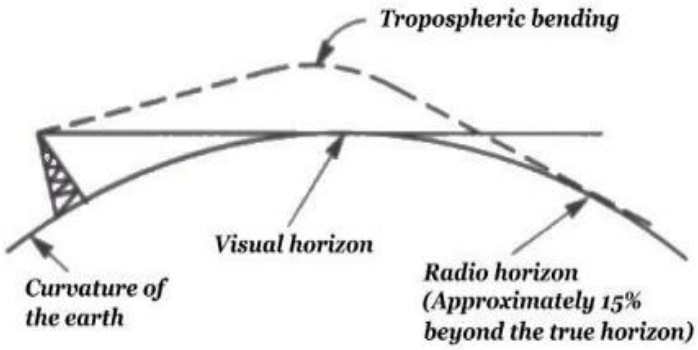
Most common for Amateur Radio: **HF**, **VHF** & **UHF**

HF 3-30MHz *VHF 30-300MHz* *UHF 300-3000MHz*



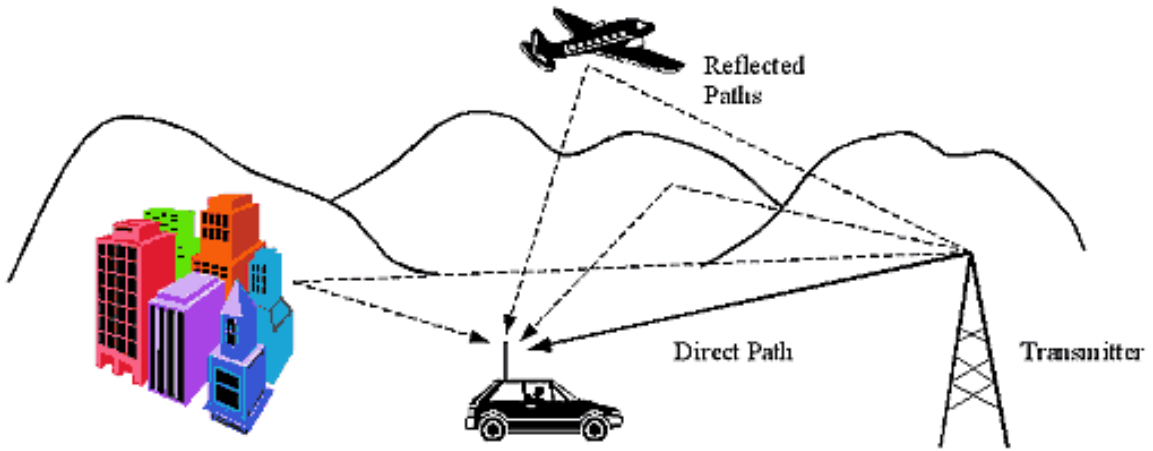
Frequency Band Properties

- Different bands have different propagation properties – thus different use cases
- **VHF & UHF** are typically **line-of-sight**
  Not reflected off of the ionosphere
  Rarely heard outside of local area
- *Radio horizon* is where the radio signals are blocked by the curvature of the earth
  Although earth "seems" slightly less curved to RF, so the radio horizon is usually a little greater than the visual horizon



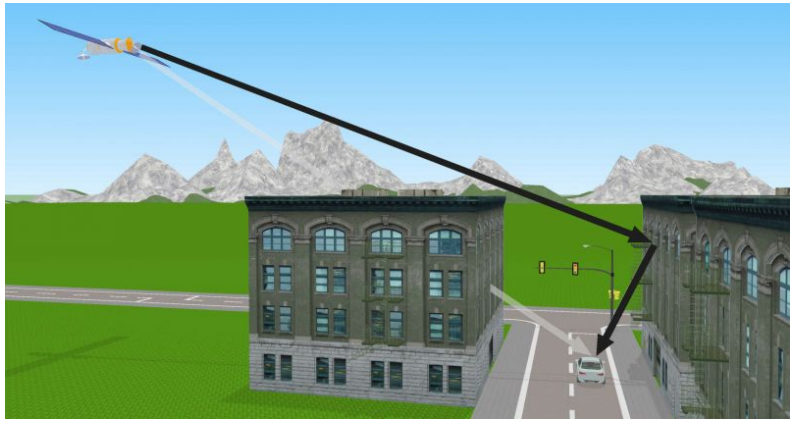
Multipath

- VHF & UHF often affected by **Multipath**
- Signals from different paths may be in or out of phase
  - They can add to each other, or cancel each other out
- If you're affected by *multipath, try moving a few feet!*
- Multipath can affect digital signal *error rates*



Signal Reflections

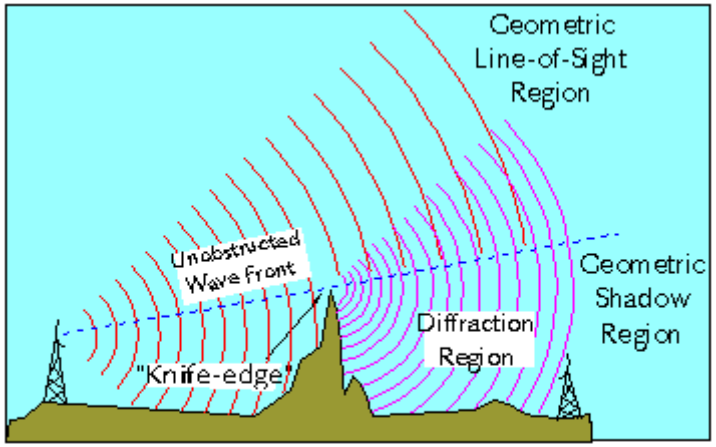
- If you can't reach a VHF / UHF station, try directing your antenna to a reflecting path if the direct path is blocked



- Multiple / changing reflections due to being in a moving vehicle can often cause rapid fading or fluttering known as **"Picket Fencing"**

More on VHF and UHF

- **UHF** is better at penetrating building structures than VHF – so is better suited for use inside or around buildings
- *Knife Edge* diffraction helps radio waves "bend" around "sharp" objects
- Range is better in Winter, less *absorption by vegetation*



knife-edge effect

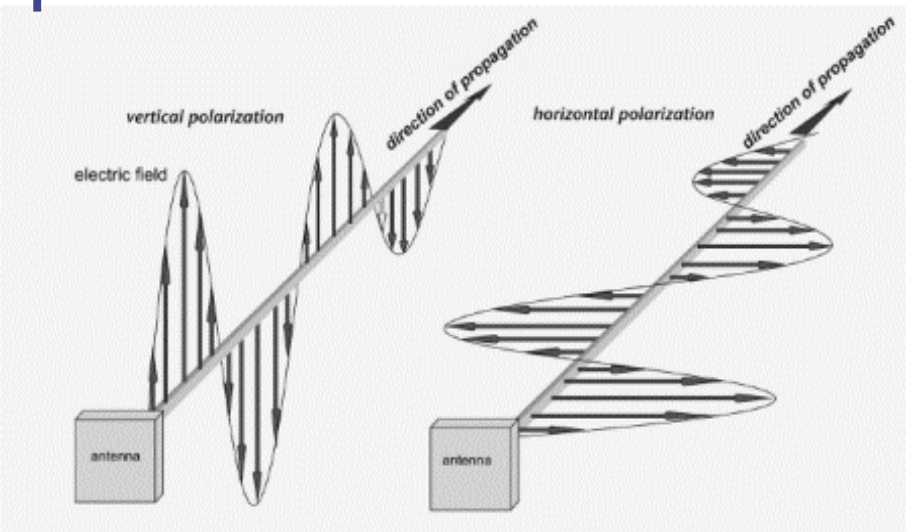
Signal Polarization

- **Polarization** is important for VHF / UHF

  Vertical polarization often used for repeaters
  - Handheld radio has vertical antenna

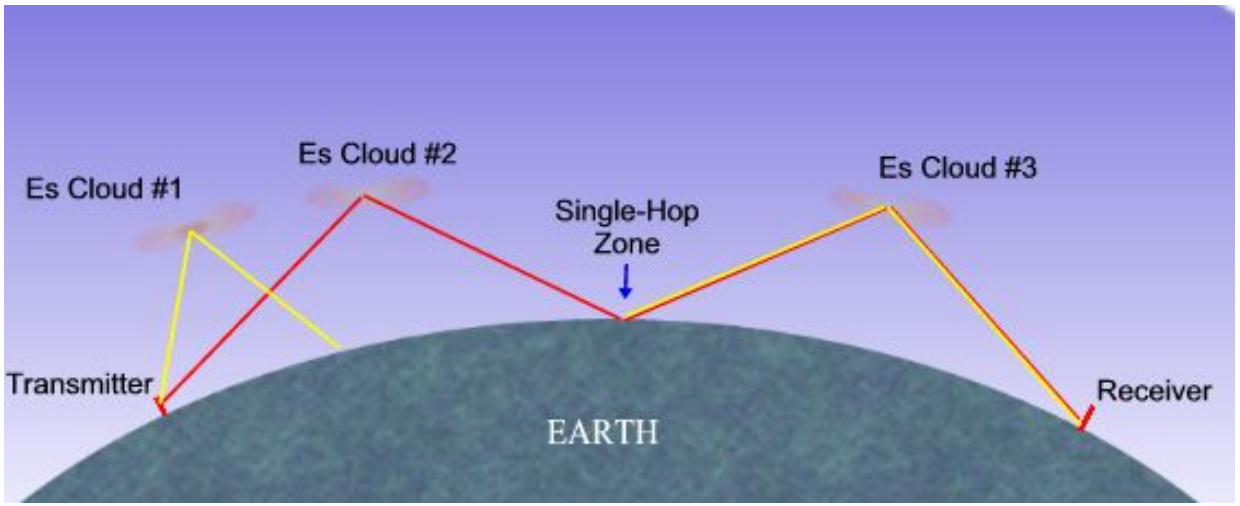
  Horizontal often used for weak-signal operation
  - Beam antenna is aimed horizontally

- Signals will be much *weaker* if you don't use the same polarization at both ends



Long Distance VHF: Sporadic-E

- Sometimes signals are refracted by the E-Layer of the ionosphere – this is called **Sporadic-E**
- Results in strong over-the-horizon signals on 10m, 6m and 2m



More Long Distance VHF

- Note that Fog and Rain have little effect on 10m and 6m signals
- Other long distance phenomenon (not in the exam):

Auroral reflected signals often have a lot of fluctuations in strength and sound distorted

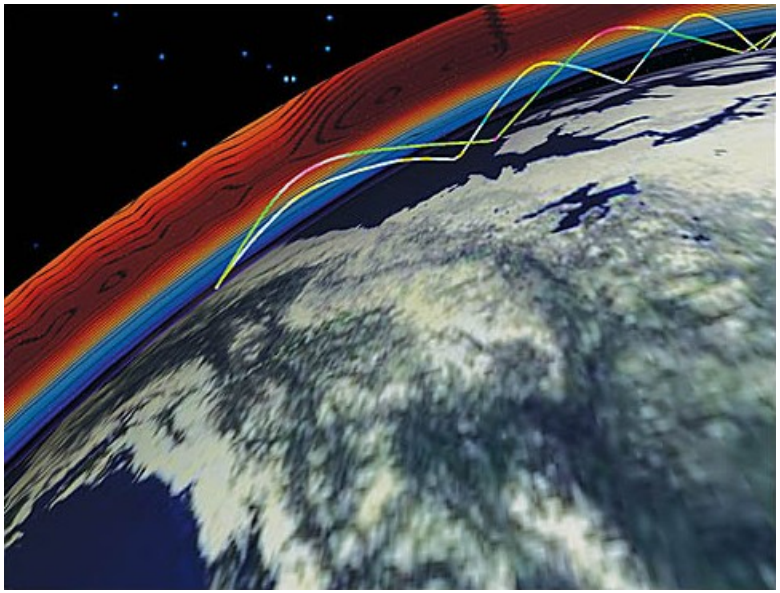
Meteor Scatter is popular on 6m

Tropospheric scatter results in VHF/UHF propagation up to 300 miles

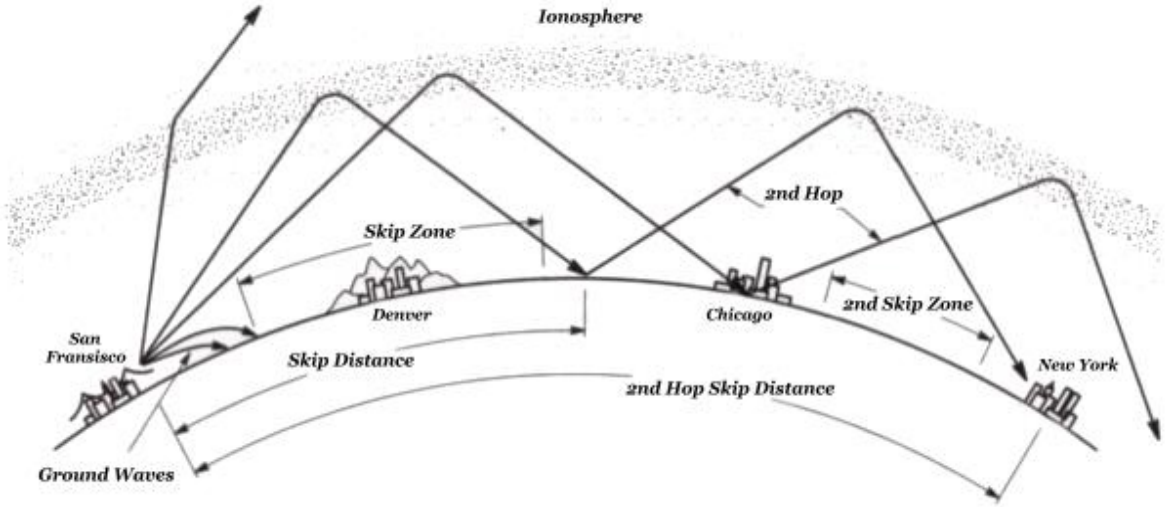
Temperature inversions result in **Tropospheric Ducting** – VHF propagation for hundreds of miles

HF Propagation

- HF signals can be reflected by the ionosphere
- The **ionosphere** is what enables worldwide radio propagation



Ionospheric Skip



- *Fading* is common, due to random combinations of signals arriving from different path lengths
- *Polarization* is not so important, the signal gets *randomized* by the reflection

Variations in Ionosphere

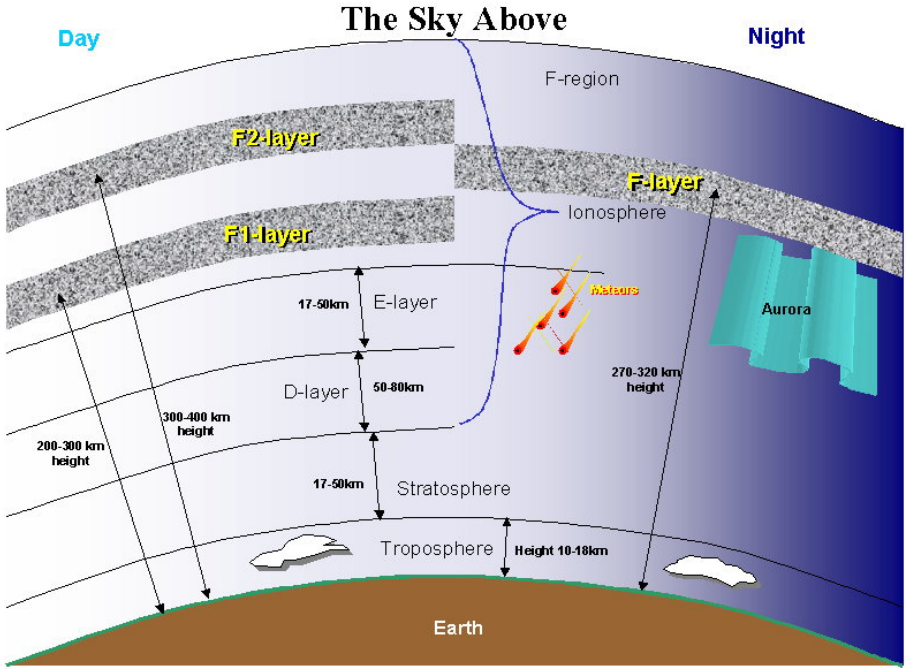
- Daily variations:

  Higher bands like 10m, 15m, and 20m better during day

  Lower bands like 40m, 80m, 160m better at night

- 11 year sunspot cycle affects ionization – thus propagation

- At *peak* of the 11yr cycle, *6m and 10m* bands provide long distance communication



Radio Wave Characteristics
Chapter End

Questions?

Let's Practice for the Exam!