

Radio Merit Badge

Boy Scouts of America



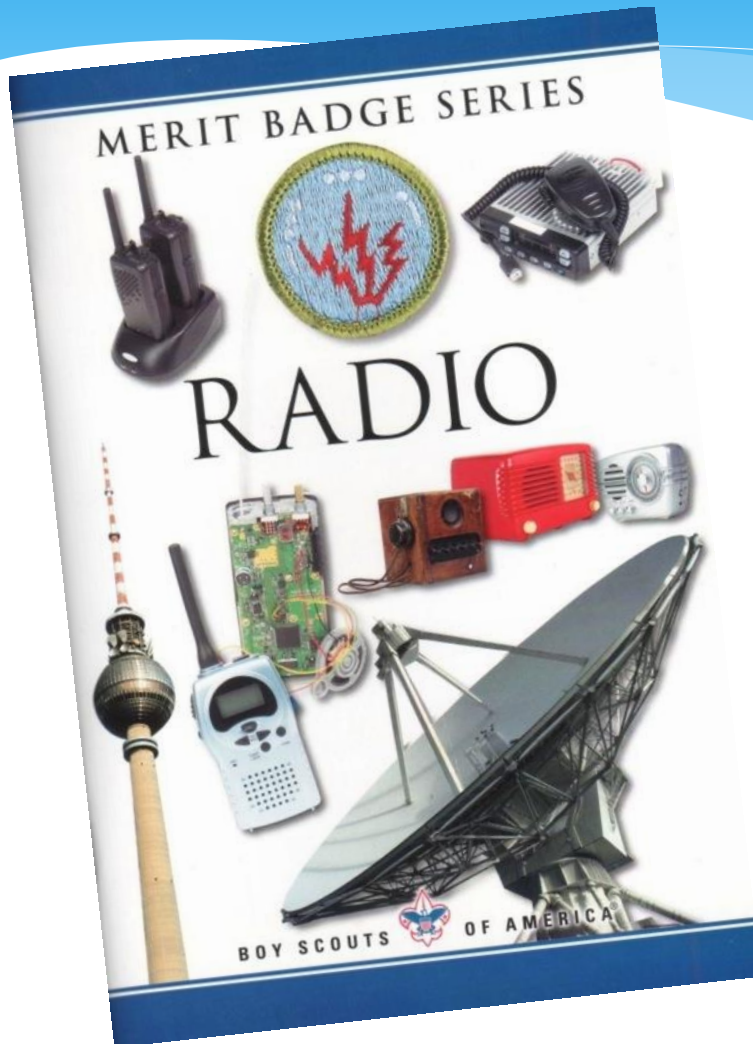
Module 2

Electronics, Safety & Careers

BSA National Radio Scouting Committee 2012



Class Format



- * **Three modules – any order**
- * Module 1 – Intro To Radio
- * **Module 2 – Electronic Components & Safety**
- * Module 3 – Amateur Radio & Emergency Communications

Key Topics in This Module

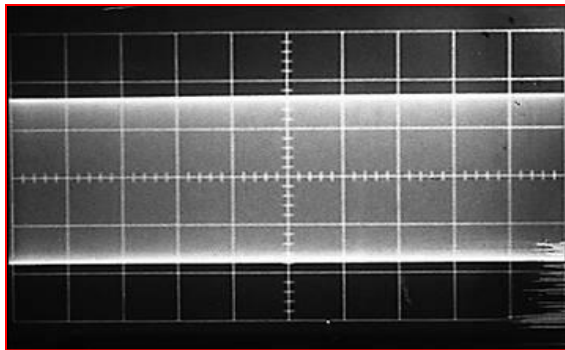
- * **4 – How Radio Carries Information**
- * **5a – Radio Schematic Diagrams**
- * **5a, 5b – Radio Block Diagrams**
- * **5c – Types of Electrical Circuits**
- * **5d – Electronic Components & Symbols**
- * **6 – Radio Safety**
- * **8 – Careers in Radio**



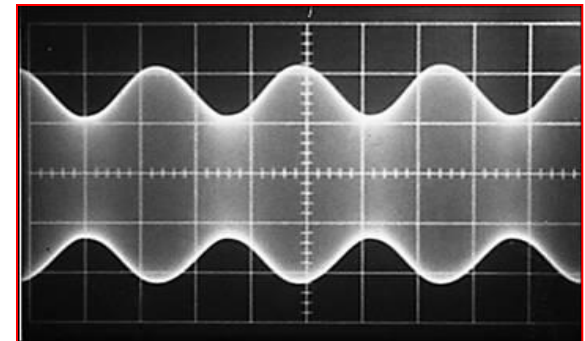
Modulation

Modulation – Superimposing information (audio, data, video)
onto a radio signal

Un-modulated radio carrier



Carrier modulated with audio



How Do Radio Waves Carry Sounds or Information?

FM



AM



PM



Continuous Wave (CW)

The Oldest Digital Mode

Works by simply turning the transmitter on and off in a pattern called Morse Code.

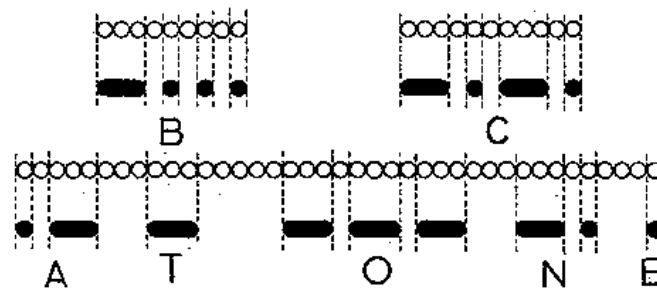


Diagram illustrating relative lengths of dashes and spaces referred to the duration of a dot. A dash is exactly equal in duration to three dots; spaces between parts of a letter equal one dot; those between letters, three dots; space between words, five dots. Note that a slight increase between two parts of a letter will make it sound like two letters.

“CW” or Morse Code

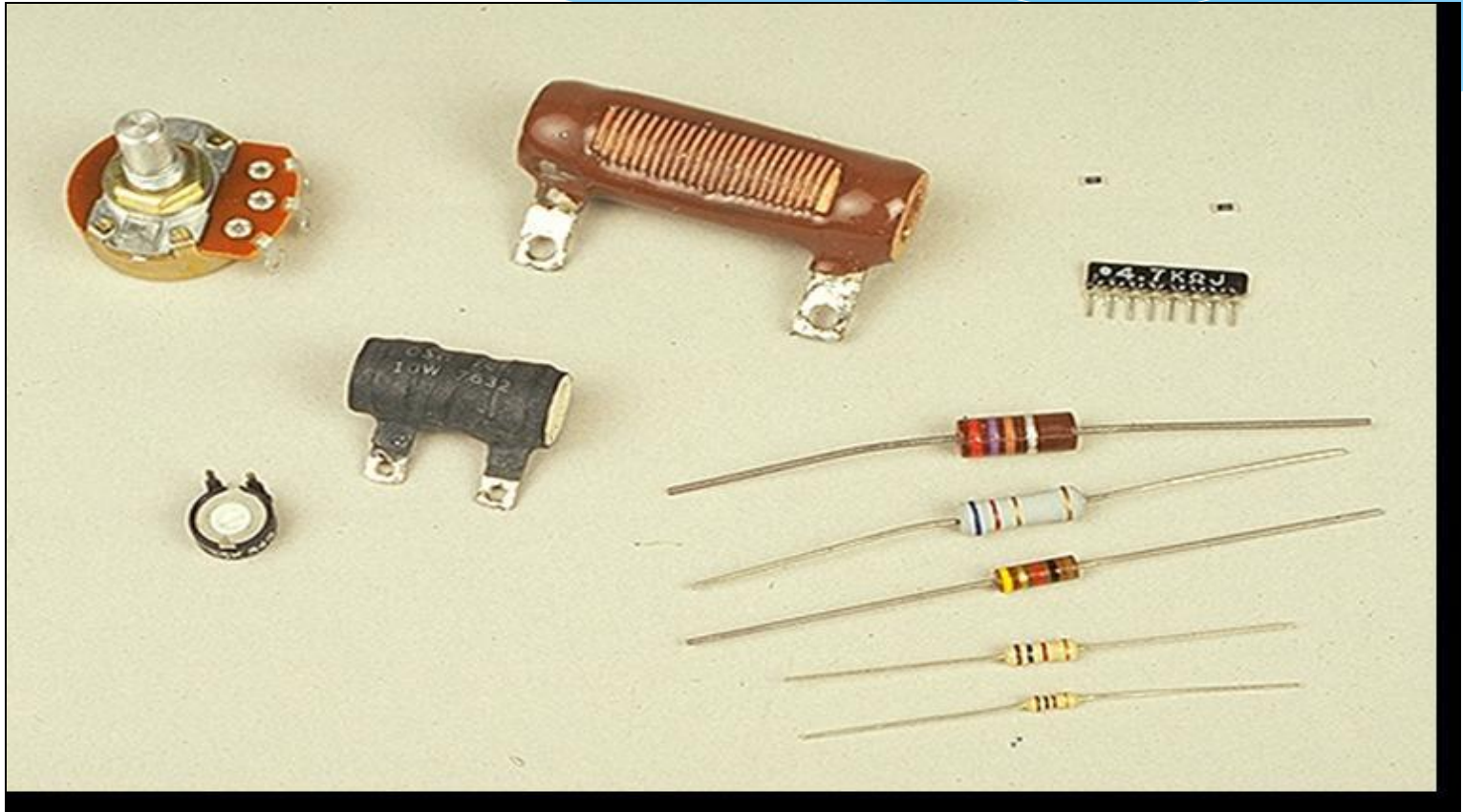
No longer required to know, but still popular among ham radio operators. Needs less power and bandwidth than other ‘modes’.

| | | | | | |
|--------------------|---------------|-------------------------------|-------------------|---|-------------|
| A | • — | N | — • | 1 | • — — — — |
| B | • — • • | O | — — — | 2 | • • — — — |
| C | • — • — | P | • — — • | 3 | • • • — — |
| D | • — • | Q | — — • — | 4 | • • • • — |
| E | • | R | • — • | 5 | • • • • • |
| F | • • — • | S | • • • | 6 | — • • • • |
| G | — — • | T | — | 7 | — — — • • |
| H | • • • • | U | • • — | 8 | — — — • • • |
| I | • • | V | • • • — | 9 | — — — — • |
| J | • — — — | W | • — — | 0 | — — — — — |
| K | — • — | X | — • • — | Ø MEANS ZERO, AND IS WRITTEN IN THIS WAY TO DISTINGUISH IT FROM THE LETTER 'O' IT OFTEN IS TRANSMITTED INSTEAD AS ONE LONG DASH (EQUIVALENT TO 5 DOTS) | |
| L | • — • • | Y | — • — — | | |
| M | — — • | Z | — — • • | | |
| PERIOD (.) | • — • • — — | WAIT SIGN (AS) | • • • • • | | |
| COMMA (,) | — — — • — — | DOUBLE DASH (BREAK) | — — • • — — | | |
| INTERROGATION (?) | • • — — • • | ERROR (ERASE SIGN) | • • • • • • | | |
| QUOTATION MARK (") | • — • • — — | FRACTION BAR (/) | — • • • — — | | |
| COLON (:) | — — — — • • | END OF MESSAGE (AR) | • • — — • • | | |
| SEMICOLON (;) | — • — • — • | END OF TRANSMISSION (SK) | • • • • • • | | |
| PARENTHESIS () | — • • — — • — | INTERNAT. DISTRESS SIG. (SOS) | • • • — — — • • • | | |

Figure 1

The Continental (or International Morse) Code is used for substantially all non-automatic radio communication. DO NOT memorize from the printed page; code is a language of SOUND, and must not be learned visually; learn by listening as explained in the text.

Modern Components



Older Components



***Record These In
Your Workbook***

Properties

Resistor – opposes or “resists” current flow
measured in *ohms*

Capacitor – stores energy in electric field
measured in *farads*

Inductor – stores energy in a magnetic field
measured in *henries*

Conductors & Insulators

- * **Conductors** conduct (carry) electricity.
 - * Most metals (gold, silver, aluminum, copper)
 - * Many liquids (water)
- * **Insulators** insulate (don't carry) electricity.
 - * Air
 - * Most rubbers and plastics
 - * Most ceramics
 - * Wood and cloth (when dry and at low voltage)

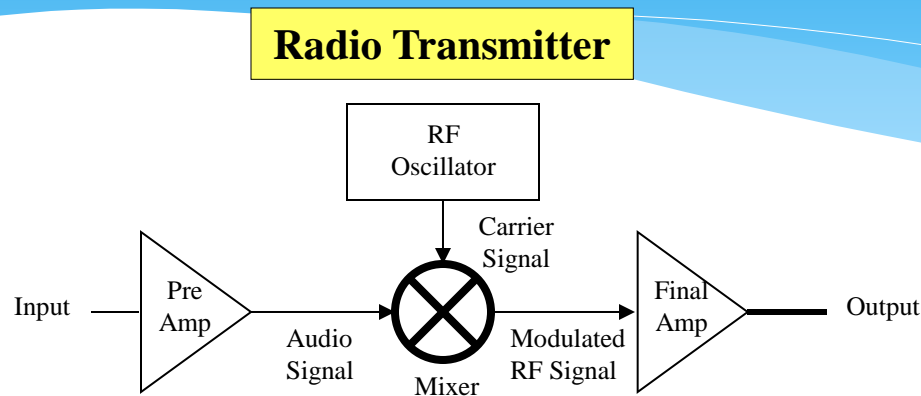
Types of Electrical Current

- * **Direct Current (DC)** – flows only one direction; produced by battery
- * **Alternating Current (AC)** – flows in first one direction then another; found in our home electrical outlets

Basic Electrical Terms

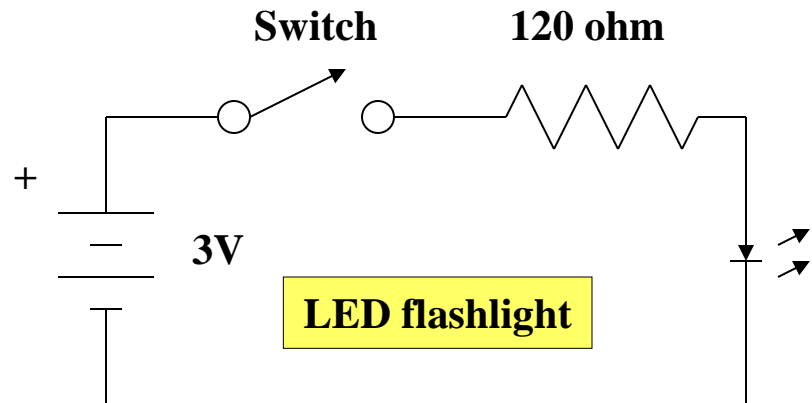
- * **Voltage** – electrical pressure (volts)
- * **Current** – the flow of electricity through a circuit (amps)
- * **Power** – the ability to do work (watts)

Block Diagram vs. Schematic

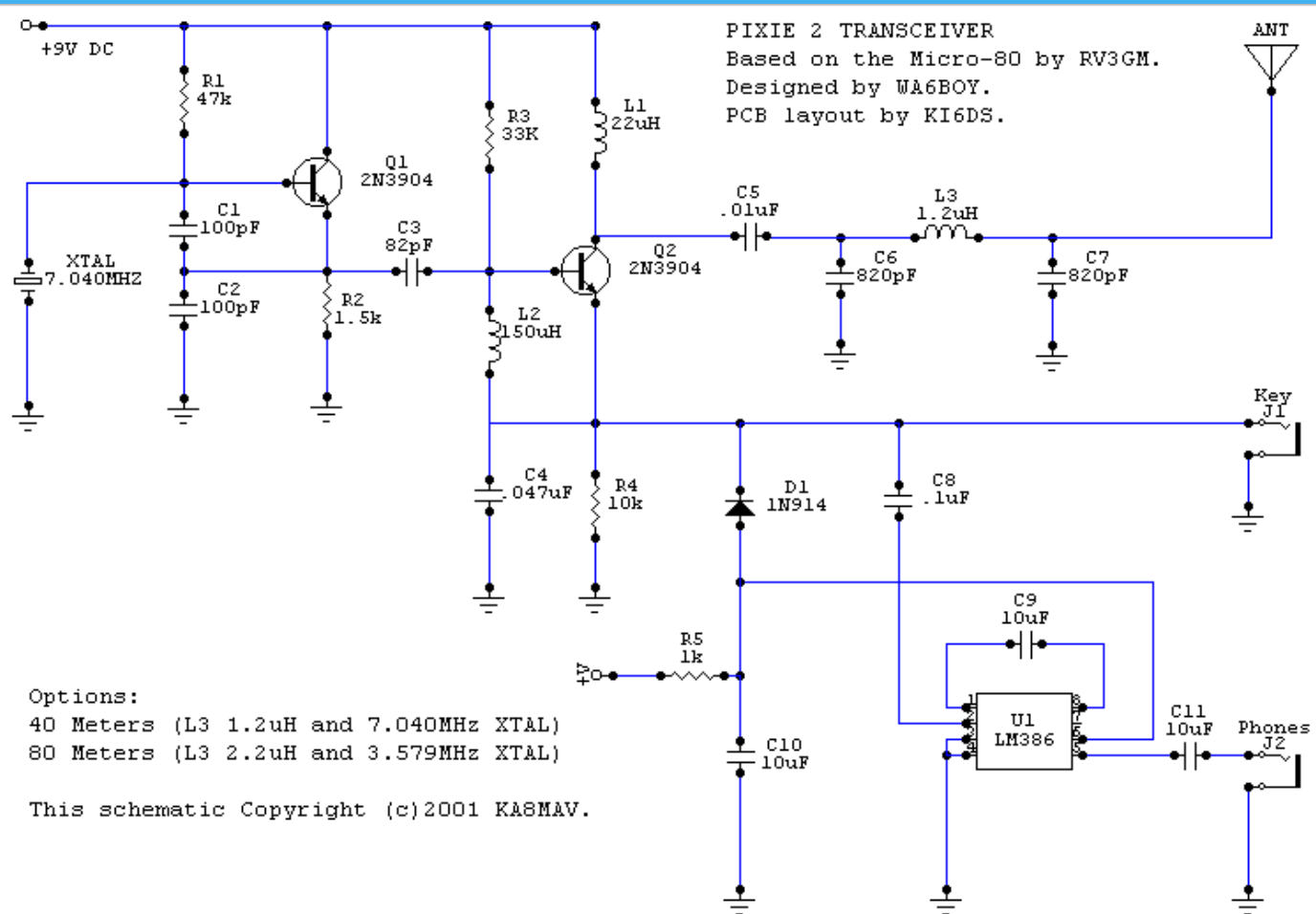


Block Diagram:
Outlines the various functions within an electronic device

Schematic Diagram: Uses standard electrical symbols to describe an electrical circuit in detail



Schematic Diagram



Shows how to build a radio from components.

Schematic Symbols

Represent Individual Electronic Parts (“Components”)



Fuse

Contains a thin wire which is made to melt which protects the rest of the circuit from damage if there is too much current from a short circuit.



Battery

Stores electric energy.



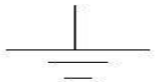
Resistor

Resists the flow of electric current, reducing its flow.



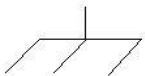
Variable resistor

Like a regular resistor, but adjustable. For example, the volume knob on your stereo.



Earth ground

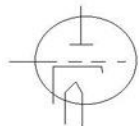
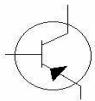
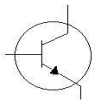
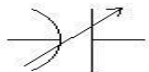
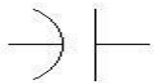
A connection between the equipment (radio) and the earth, usually through a copper pipe driven into the soil.



Chassis ground

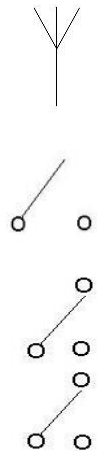
A connection of the negative side of the electronic circuit to the chassis, or steel frame, of the equipment.

Schematic Symbols (cont.)



| | |
|--------------------|--|
| Capacitor | Gets and stores an electric charge. Lets alternating current (AC - like in your house) flow but stops direct current (DC - like from a battery). |
| Variable capacitor | Same as a regular capacitor, but adjustable. |
| NPN transistor | Amplifies a current. |
| PNP transistor | Amplifies a current. |
| Coil | Also called a choke, it works the opposite of a capacitor. It lets DC flow but stops AC. |
| Tube | A vacuum tube made of glass with wire filaments inside. Amplifies a current. It has been replaced by transistors in most home equipment, but is still found in some high power radio transmitters. |

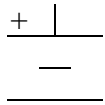
Schematic Symbols (cont.)



| | |
|-------------|---|
| Antenna | Sends radio frequency signals into the air. |
| SPST switch | Single-pole single-throw switch. Has two positions, on and off. Like most light switches |
| DPDT switch | Double-pole double-throw switch. A double-throw switch has three positions. It can switch one input to one of two outputs - sort of like the switch you put on your television to switch between watching TV and playing your video game. The double-pole means it can switch a pair of inputs to either of two pairs of outputs. |

Draw Schematic Symbols In Your Workbook

Schematic Symbols



Battery



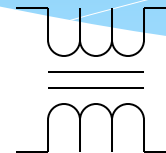
Resistor



Capacitor



Inductor



Transformer



SPDT Switch



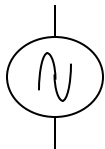
N.O. Push button



SPST Switch



Light-Emitting
Diode



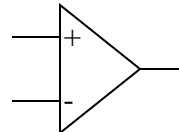
AC Voltage
Source



Variable
Resistor
(Potentiometer)



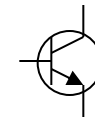
Variable
Capacitor



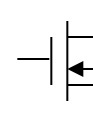
OpAmp



Diode



NPN
Bipolar
Transistor
(BJT)



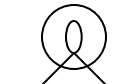
PMOS
Field Effect
Transistor
(FET)



Earth
Ground



Circuit
Ground

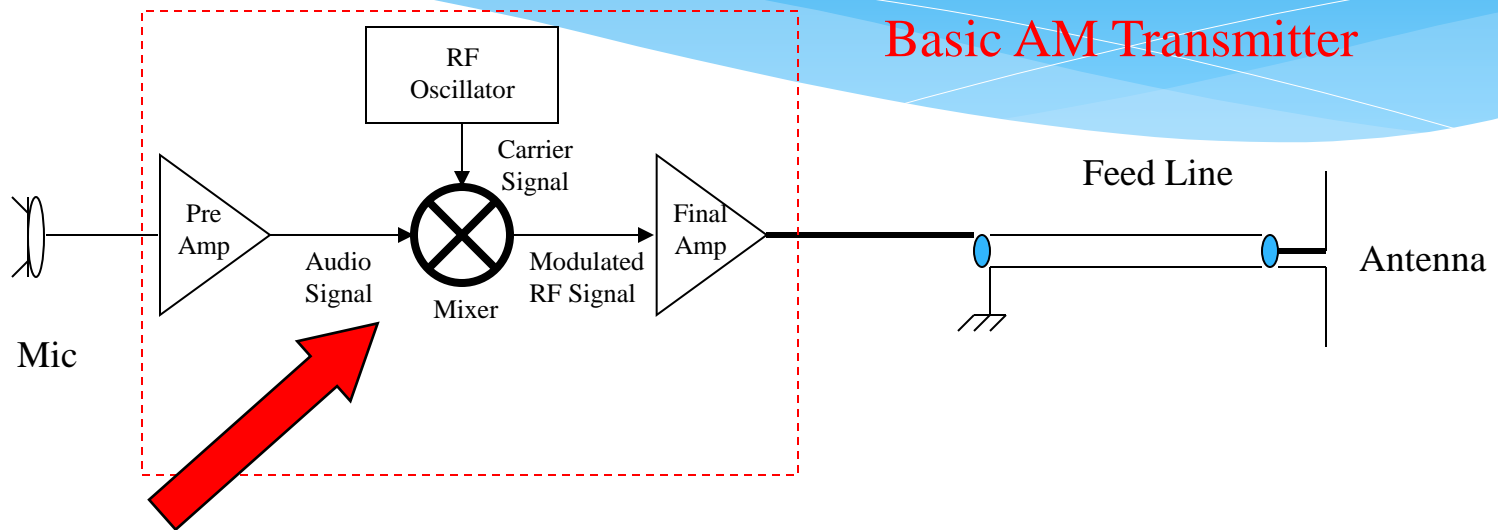


Incandescent
Lamp



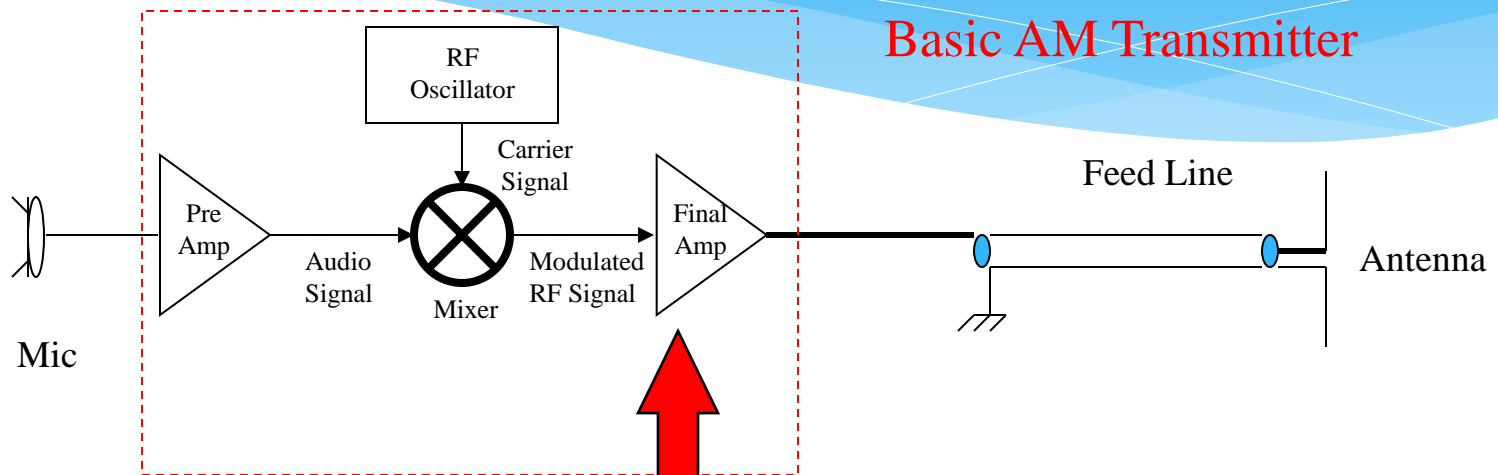
Speaker/Mic

How Radio Waves Are Created



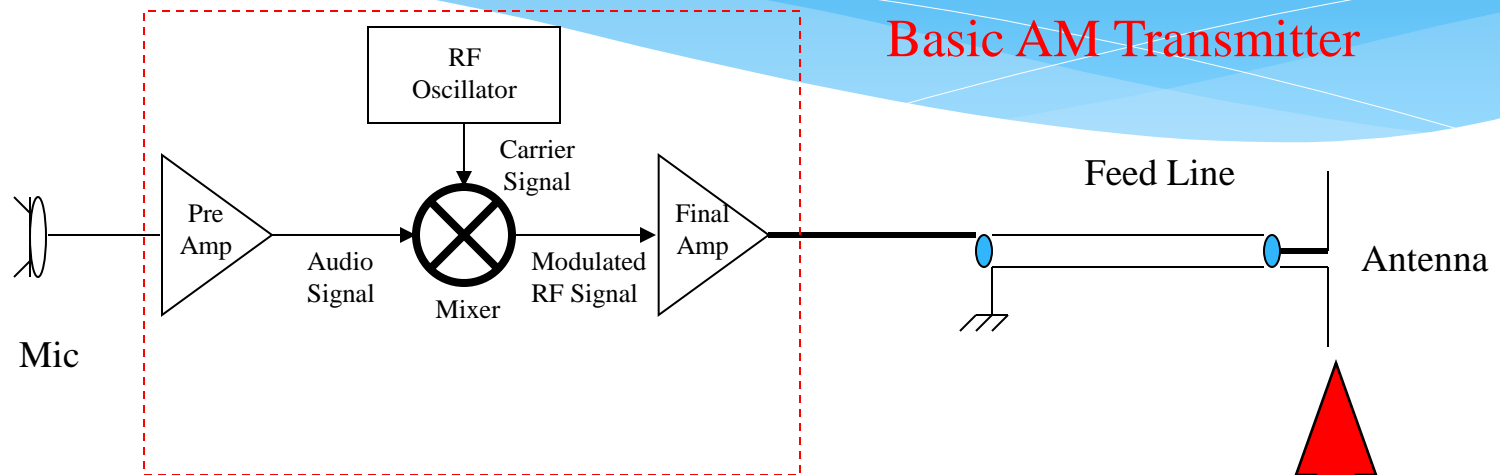
- **Transmitter** - Generates radio frequency (RF) signal
- **Amplifier** - Makes the signal stronger and drives feed line
- **Antenna** - Launches the electromagnetic wave into the air

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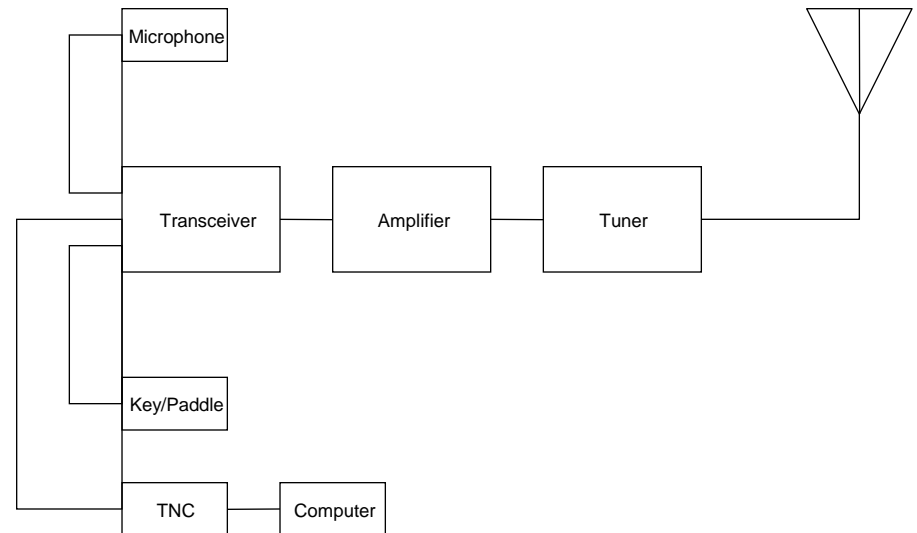
How Radio Waves Are Created



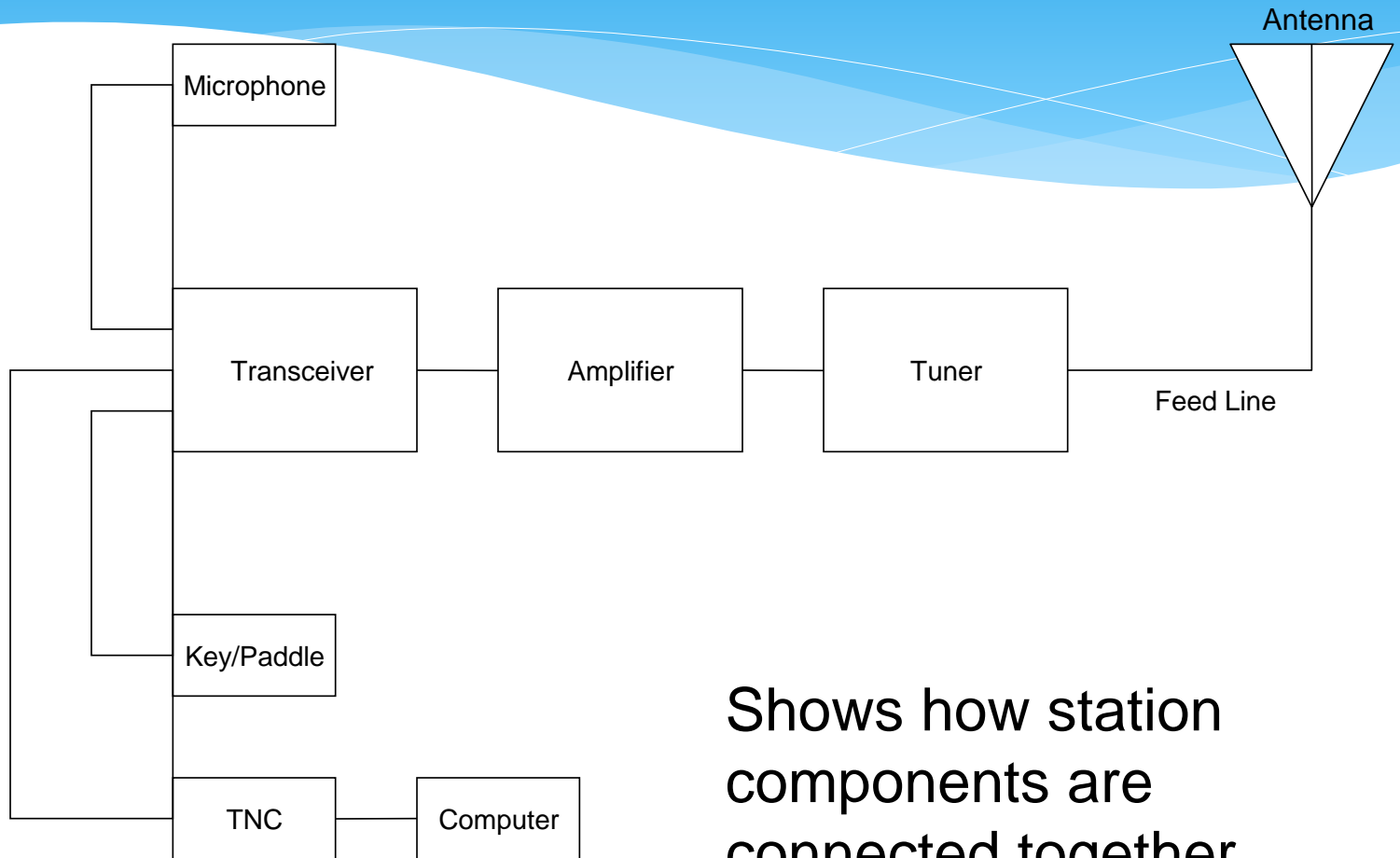
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How Radios Send and Receive Information

- * **Microphone**
 - * Takes in Audio or Digital signal input
- * **Transmitter**
 - * Creates an RF “carrier”
 - * Modulates the carrier
- * **Receiver**
 - * Receives a radio signal
 - * Demodulates the carrier
- * **Transceiver**
 - * Both a transmitter and receiver in one box
- * **Amplifier**
 - * Increases RF signal power
- * **Tuner**
 - * Matches transmitter to antenna
- * **Feed line**
 - * Provides path to antenna
- * **Antenna**
 - * Radiates the RF signal
- * **Key or Paddle**
 - * For sending Morse code
- * **TNC (Terminal Node Controller)**
 - * A computers “Radio Modem”

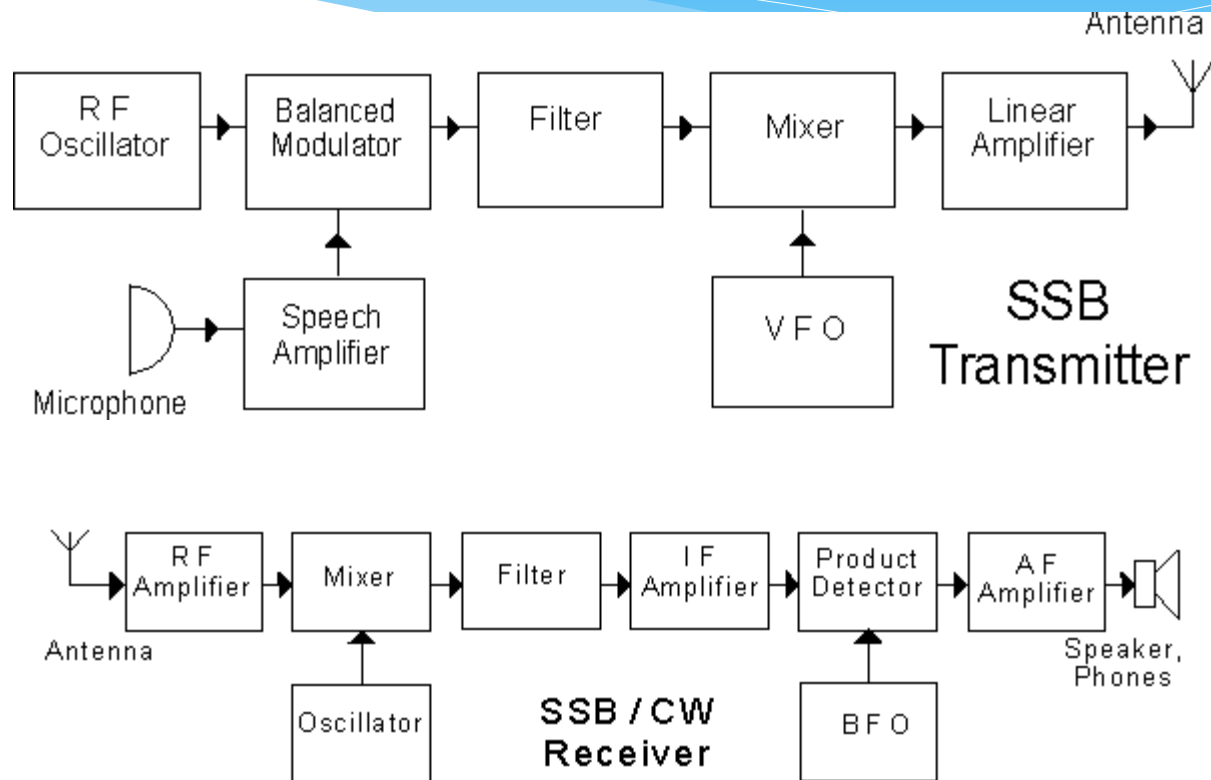


Simplified Block Diagram



Shows how station components are connected together.

Detailed Block Diagram

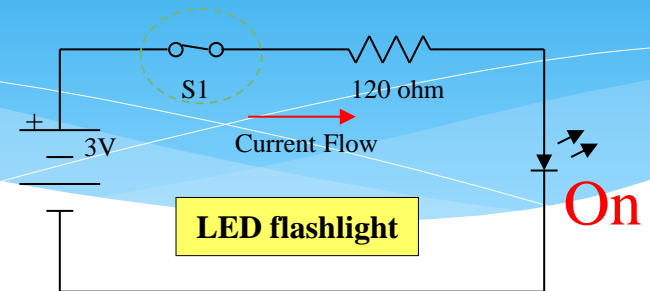


Shows how the radio works.

Types of Electrical Circuits

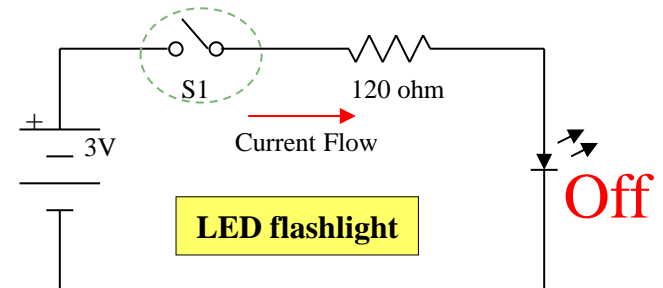
Closed Circuit

- * Circuit is complete.
- * Electricity flows like it should.



Open Circuit

- * Circuit is incomplete.
- * Electricity doesn't flow.



Short Circuit

- * Circuit is complete through an unplanned shortcut.
- * Electricity flows where it shouldn't!
- * Dangerous – parts can get hot, start fires or even explode!



Fuse

Safety With RF Energy

- * Never operate radios with the cover off.
 - * The case keeps the RF radiation in.
- * Exposure to high levels of RF can cause burns
 - * Human eyes especially sensitive to RF.
 - * Keep antennas out of reach.
- * Hams required to conduct a “routine station evaluation” to verify safe operation
 - * Usually done by consulting a chart.

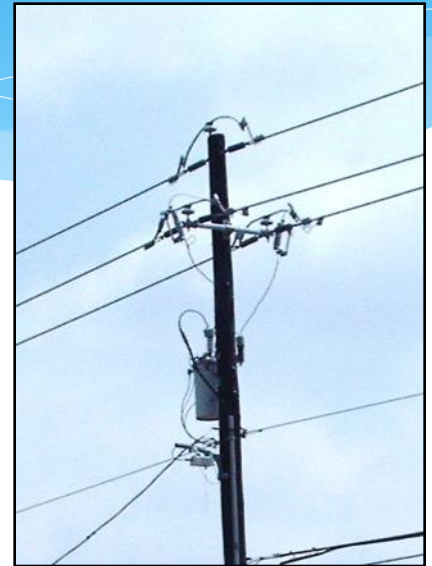
Radio Safety

- * Make sure the power is disconnected before working.
 - * Electric shock can hurt or kill.
- * Even with the power off, some parts inside the radio can hold a dangerous charge.
 - * If you don't know what you are doing, get help.
- * Disconnect radios when not in use
- * Connect antennas to ground when not in use

Antennas & Towers



- * Make sure antennas cannot touch power lines
 - * you could be electrocuted when using the radio.
 - * **NEVER** OVER or UNDER power lines
 - * Where they could fall on a power line in any direction
- * Where a person could touch the antenna
- * Be careful working on towers and roofs
 - * You could fall or hurt someone on the ground.



Grounding

* AC Outlet Grounding

- * Ground wire connected to house wiring.
- * Equipment uses 3 prong plugs to ground equipment case.
- * If wire inside touches case, house circuit breaker is opened.

* Direct Current Grounding

- * Hams add another ground rod and connect all of their station equipment cases to it as well.
- * Provides additional safety and grounds any stray RF.

* Antenna Grounding

- * Use lightning protectors where antennas enter the house.
- * These bleed off static electricity.
- * No protection to a direct strike.

Lightning Protection

- * Antenna pole connected to ground rod
- * Disconnect radios if lightning is in the area
- * **Lightning** can hit your antenna and travel down your lines to the radio.
- * Make sure your antenna and radio are grounded to a good earth ground.
- * **Don't operate in thunderstorms.**



Safety With Electricity

- * Minimum fatal voltage – 30 volts
- * Minimum fatal current if passed through the human heart – $1/10^{\text{th}}$ of an amp
- * Power lines are un-insulated and carry thousands of volts – never touch them!

Radio Careers

- * **Broadcasting**
 - * Announcer/Personality
 - * Station Manager/Program Director/ Music Director
- * **Technical**
 - * Radio Engineer
 - * Radio Technician
 - * Cellular Phone Technician
- * **Operators**
 - * Public Safety Dispatcher
 - * Military Radio Operator

Education for Radio Careers

- * Most jobs require high school diploma.
- * Colleges offer courses in broadcasting and communications.
- * Gain broadcasting experience at college radio stations.
- * Radio technicians attend trade schools or community colleges.
- * Radio engineers study electrical engineering at college.
- * Organizations such as APCO and NARTE offer radio licensing training courses and certifications.