Radio Merit Badge
Boy Scouts of America

Module 2
Electronics, Safety & Careers
2009

Key Topics in This Module

- **How Radio Carries Information**
- **Radio Block Diagrams**
- **Radio Schematic Diagrams**
- **Electronic Components & Symbols**
- **Types of Electrical Circuits**
- **Radio Safety**
- **Careers in Radio**

How Do Radio Waves Carry Sounds or Information?

FM

Frequency Modulation

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AM

Amplitude Modulation

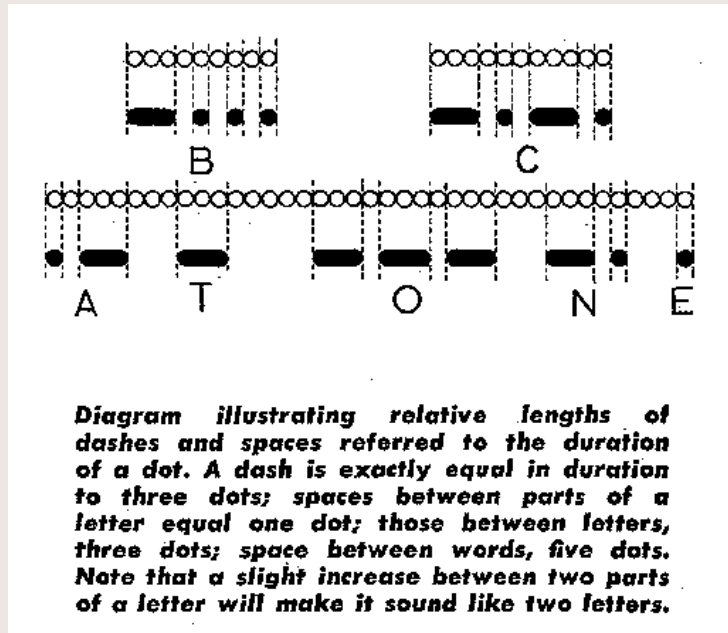©2000 How Stuff Works

PM

Pulse Modulation

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Requirement 4

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".
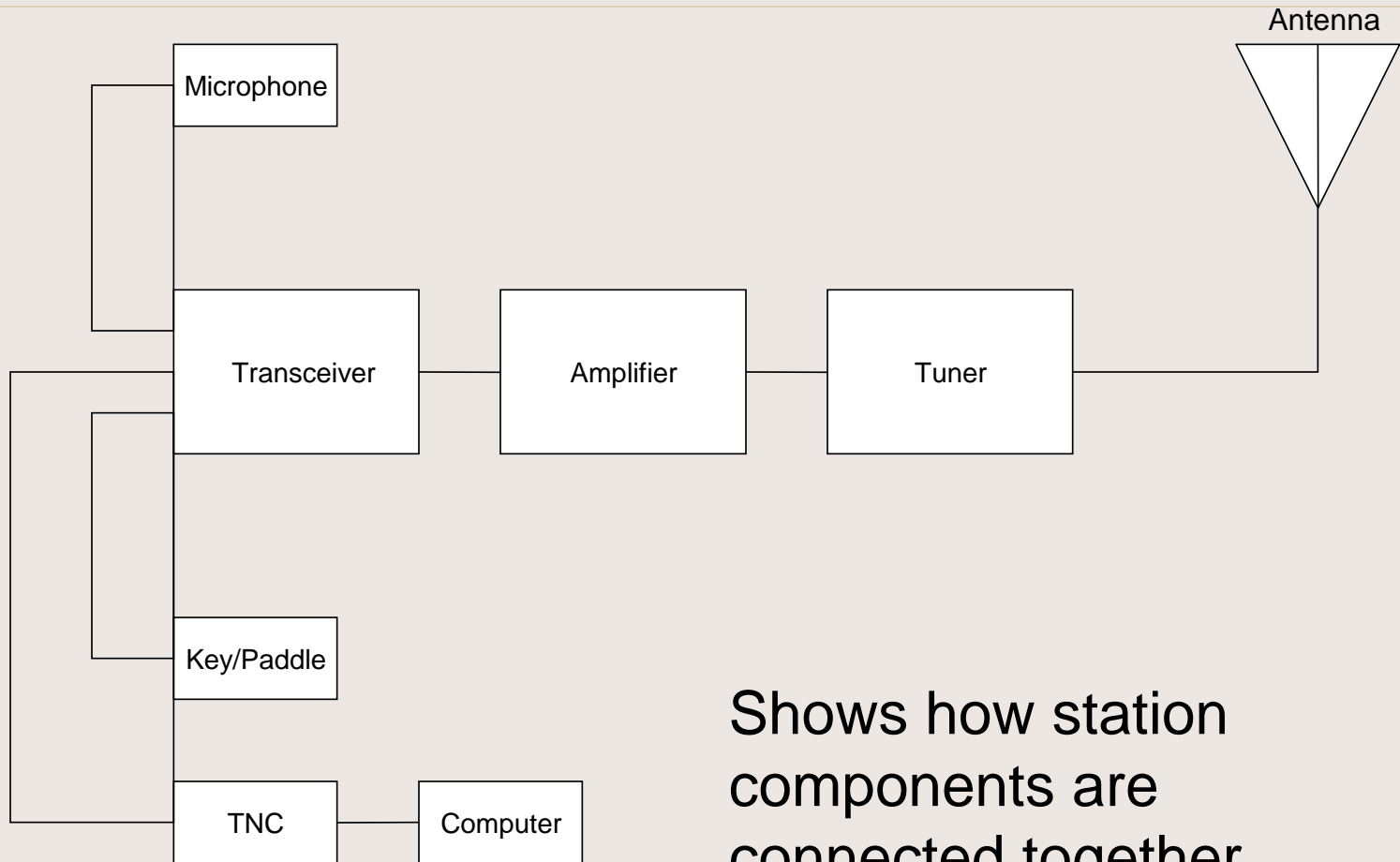

Figure 1

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.

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
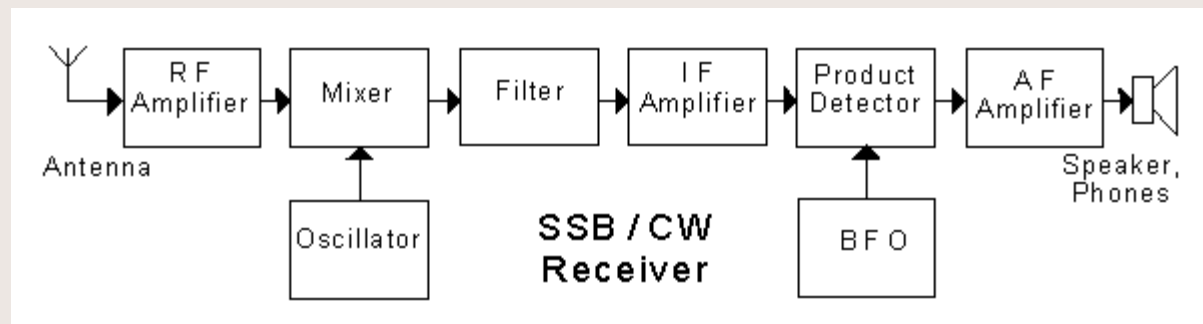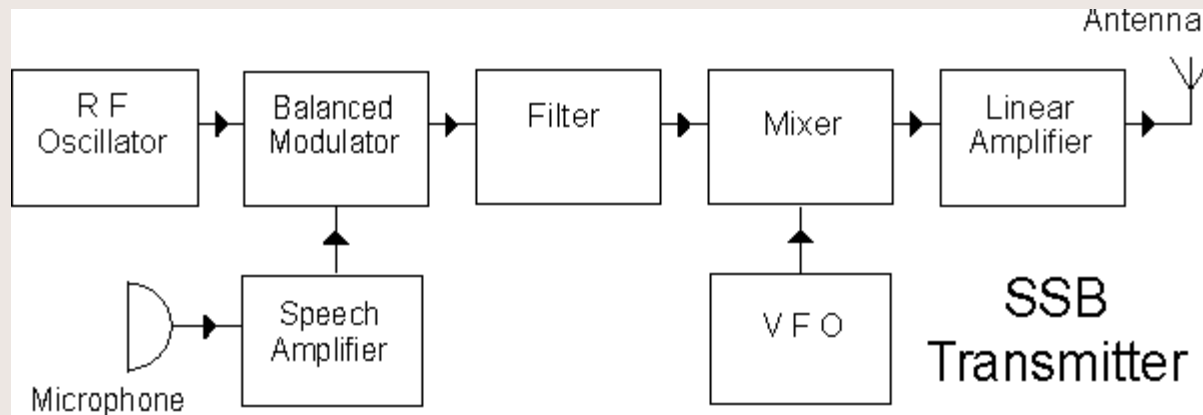- **TNC (Terminal Node Controller)**
  - A computers "Radio Modem"

Microphone

Transceiver — Amplifier — Tuner

Key/Paddle

TNC — Computer

Requirement 4
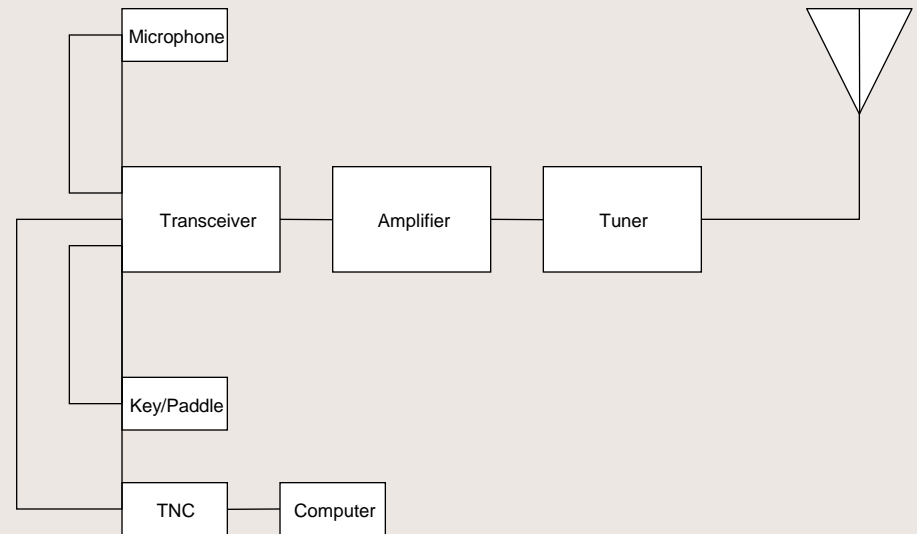
Simplified Block Diagram

Antenna

Microphone

Transceiver — Amplifier — Tuner

Key/Paddle

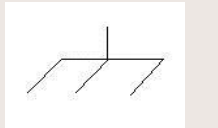TNC — Computer

Shows how station components are connected together.

Detailed Block Diagram

Shows how the radio works.

Schematic Diagram

Shows how to build a radio from components.
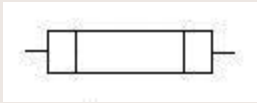
Schematic Symbols

Represent Individual Electronic Parts ("Components")
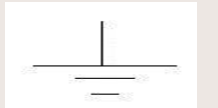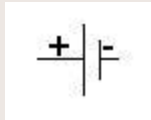
	Fuse	Contains a thin wire which is made to melt which protects the rest of the circuit from damage if there is too much current from a short circuit.
	Battery	Stores electric energy.
	Resistor	Resists the flow of electric current, reducing its flow.
	Variable resistor	Like a regular resistor, but adjustable. 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.)
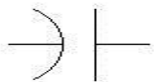
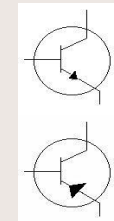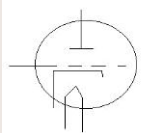|	Capacitor	Gets and stores an electric charge. Lets alternating current (AC - like in your house) flow but stops direct current (DC - like from a battery).
	Variable capacitor	Same as a regular capacitor, but adjustable.
	NPN transistor	Amplifies a current.
	PNP transistor	Amplifies a current.
	Coil	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.
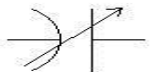
Schematic Symbols (cont.)
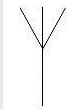
	Antenna	Sends radio frequency signals into the air.
	SPST switch	Single-pole single-throw switch. Has two positions, on and off. Like most light switches
	DPDT switch	Double-pole double-throw switch. A double-throw switch has three positions. It can switch one input to one of two outputs - sort of like 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.
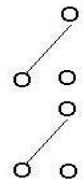
Types of Electrical Circuits

Closed Circuit

- Circuit is <u>complete</u>.
- Electricity flows like it should.

Open Circuit

- Circuit is <u>incomplete</u>.
- Electricity doesn't flow.

Short Circuit

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

Requirement 5

Radio Safety

- Electrical shock can hurt or kill - make sure the **power is disconnected** before working.

- 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.

- Radio Frequency (RF) can burn - **keep antennas out of reach** .

- **Strong RF radiation can be unhealthy** - Don't use a radio when it is not completely assembled. The case keeps the RF radiation in.

- Make sure **antennas can't touch any power lines** or you could be electrocuted when using the radio.

- **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.

- **Be careful working on towers and roofs** so you don't 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.
  - Disconnect antennas when not in use.
  - Do not operate during thunderstorms.

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.