

Radio Merit Badge



Radio Merit Badge

- Session 1 – Radio basics, safety, and amateur radio
- Session 2 – Amateur radio operating experience
- Session 3 – Electromagnetic spectrum, components, careers, amateur radio licensing, and emergencies

Radio Merit Badge

Session 1 – Radio basics,
safety, and amateur radio

Radio

- Radio is a way to electronically communicate from one place to another without wires
- Radio is used in broadcasting, two way radios, television, mobile telephones, wireless LANs, garage door openers, car locks, EZpass, satellites, pagers, radar, microwave ovens, etc.

The differences between Broadcast & Hobby Radio

- Broadcast radio sends information to many people at the same time.
 - Examples: talk radio, music, or television.
- Hobby Radio is used by amateur radio & citizens band operators and people that engage in activities where radio is helpful
 - Examples: controlling models or tracking balloons or Family Radio Service (FRS) radios when camping

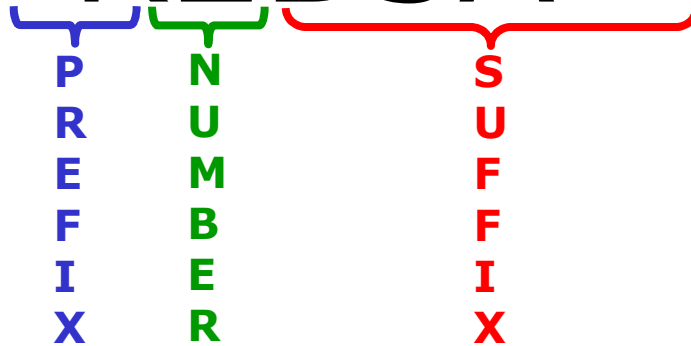
Differences between Broadcasting & Two-Way Radio

- **Broadcasting is one-way communication from a transmitter to many receivers.** It is usually planned programming and may be commercial with music, news, sports and advertising or non-commercial from schools, community radio stations, or National Public Radio (NPR).
- **Two-way radio uses both a transmitter and receiver at both ends.** Examples are walkie-talkies, amateur radio, mobile telephones, fire and police, taxis, aviation, ships, military, etc.

Radio Station Call Signs

- Call signs are a unique identification for a licensed radio station.
- Broadcast radio station call signs are three or four letters.
 - WABC, WLS, KNBC, KCMO
- U.S. Amateur radio station call signs are letters and a number beginning with W, K, A, or N.
 - W1AW, K9BR, KB3BOY, WW9Y, N3YVH, K2BSA
- Create Your Imaginary Call Sign
 - Pick K, N, or W, a number, and add your initials

K2BSA



K
PREFIX

W, K, N, A – USA
 VE, VO, XJ – Canada
 XE – Mexico
 PY – Brazil
 G – Great Britain

F – France
 I – Italy
 4X, 4Z – Israel
 JA – Japan
 ZL – New Zealand

2
ORIGINAL
CALL SIGN
DISTRICT



BSA
SUFFIX

N1RY = "1 X 2"

NK8W = "2 X 1"

AE5BT = "2 X 2"

K2BSA = "1 X 3"

KD4MML = "2 X 3"

K7S = "1 X 1"

(SPECIAL EVENT STATION)

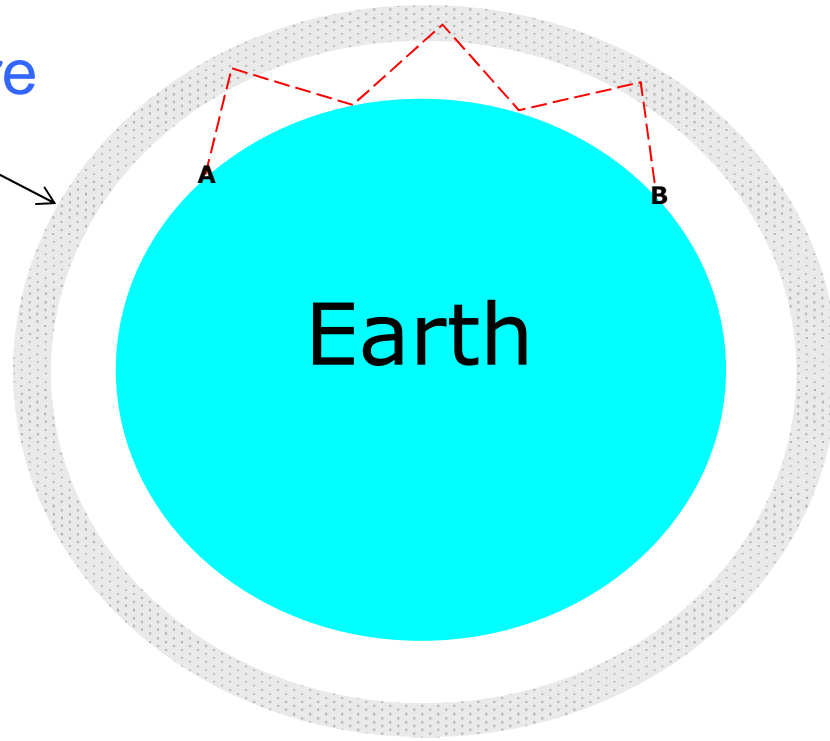
Phonetic Alphabet

- Many letters sound similar.
- Over the radio, the letter C, E, V or Z might sound the same.
- Weak radio signals and noise might make it difficult to hear voices.
- An operator for whom English is not a native language may alter letter pronunciation.
- **Radio operators use a phonetic alphabet to improve understanding and avoid communication errors.**

Phonetic Alphabet

- **Alfa** (AL FAH)
- **Bravo** (BRA VOH)
- **Charlie** (CHAR LEE)
- **Delta** (DELL TAH)
- **Echo** (ECK OH)
- **Foxtrot** (FOKS TROT)
- **Golf** (GOLF)
- **Hotel** (HOH TELL)
- **India** (IN DEE AH)
- **Juliette** (JEW LEE ETT)
- **Kilo** (KEY LOH)
- **Lima** (LEE MAH)
- **Mike** (MIKE)
- **November** (NO VEM BER)
- **Oscar** (OSS CAH)
- **Papa** (PAH PAH)
- **Quebec** (KEH BECK)
- **Romeo** (ROW ME OH)
- **Sierra** (SEE AIR RAH)
- **Tango** (TANG OH)
- **Uniform** (YOU NEE FORM)
- **Victor** (VIK TAH)
- **Whiskey** (WISS KEY)
- **X-ray** (ECKS RAY)
- **Yankee** (YANG KEY)
- **Zulu** (ZOO LOO)

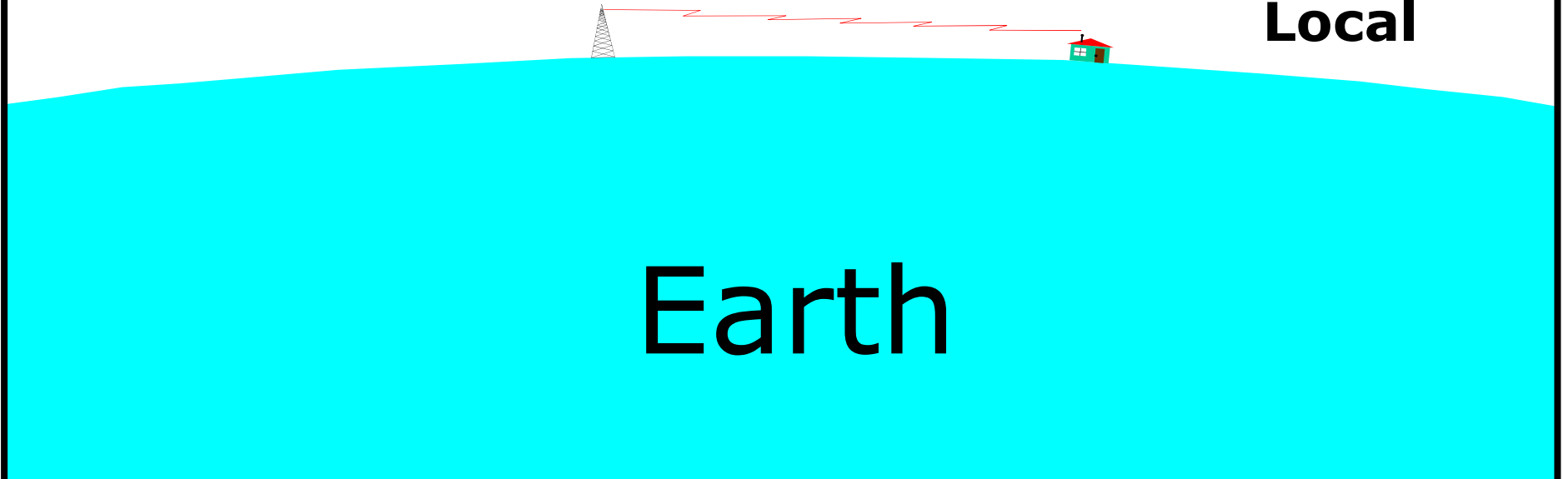
Ionosphere



Earth

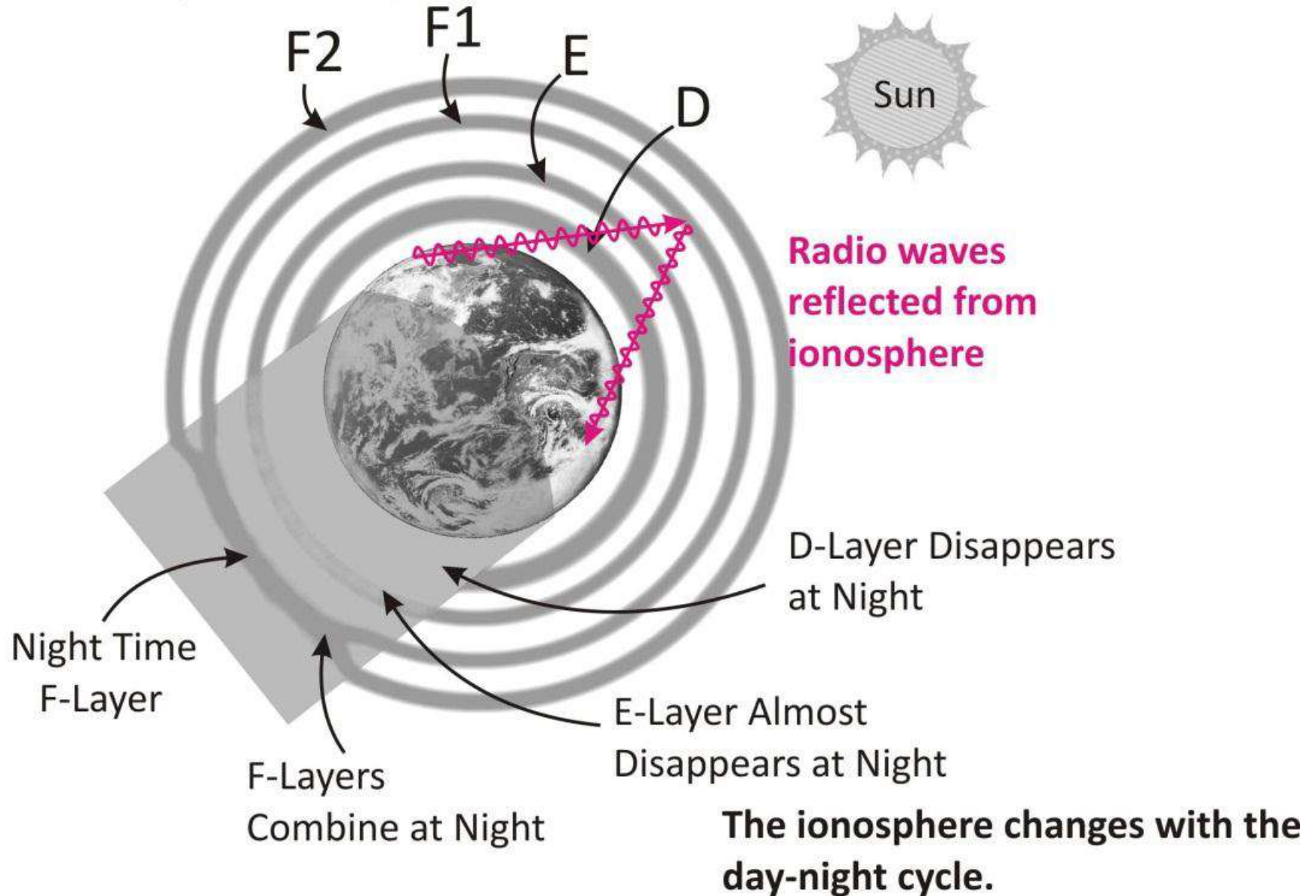
Around the World

Local



Earth

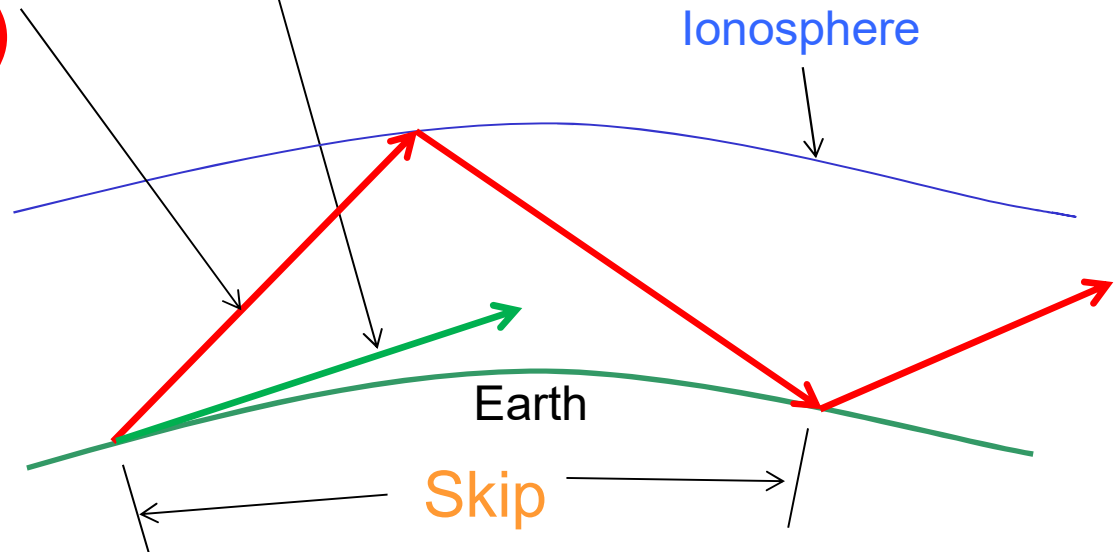
The Layers of Ionosphere



Drawing from WØSTU

How High Frequency (HF) Radio Waves Travel

- Ionosphere
- Ground Wave (Local)
- Sky Wave (DX)
- Skip
- Local
- DX

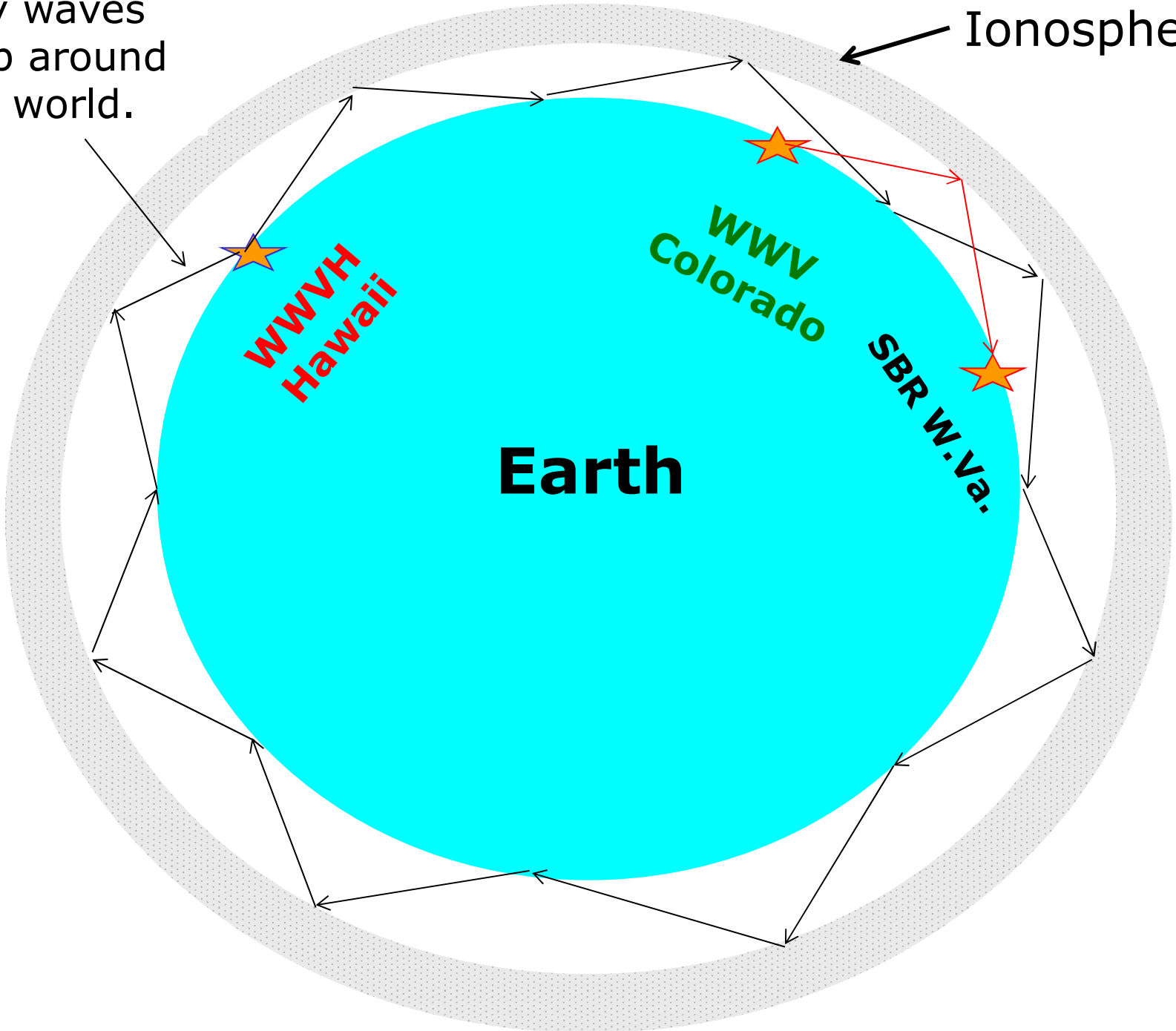


WWV and WWVH

- National Bureau of Standard radio stations that provide accurate frequencies, time, and HF propagation forecasts.
- WWV & WWVH transmit on 2.5, 5, 10, 15 and 20 MHz.
- WWV is in Ft Collins, Colorado and WWVH is in Kauai, Hawaii.
- Listening to WWV or WWVH provides an indication of the radio frequencies that are being reflected from the ionosphere and the locations from which you may hear radio stations for each frequency.

Sky waves skip around the world.

Ionosphere

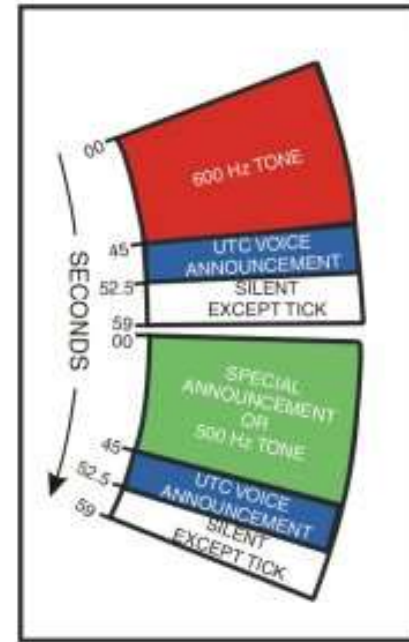
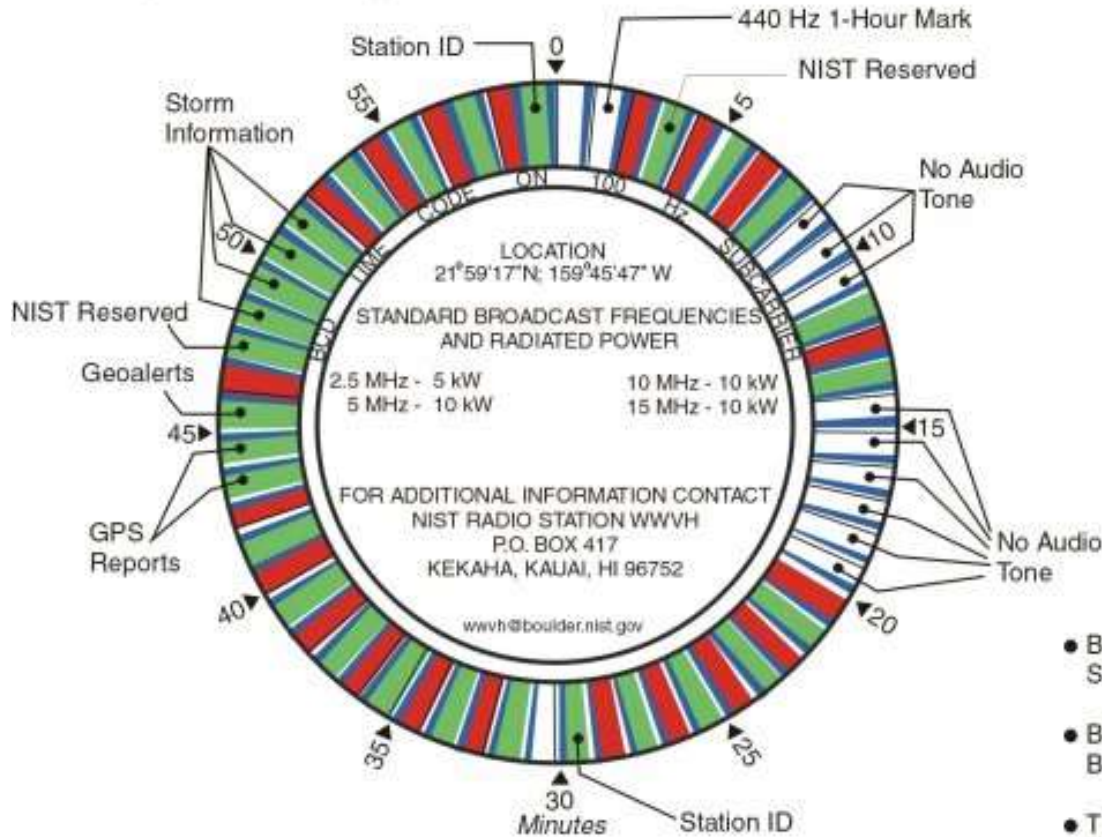


WWV in Ft. Collins, CO



WWV and WWVH

WWVH
 Broadcast Format
 Via telephone (808)335-4363
 (Not a Toll-Free Number)



- BEGINNING OF EACH HOUR IS IDENTIFIED BY 0.8 SECOND LONG, 1500 Hz TONE.
- BEGINNING OF EACH MINUTE IDENTIFIED BY 0.8 SECOND LONG, 1200 Hz TONE.
- THE 29TH AND 59TH SECOND PULSES OF EACH MINUTE ARE OMITTED.
- 440 Hz TONE IS OMITTED DURING FIRST HOUR OF EACH DAY.

DX and Local Stations

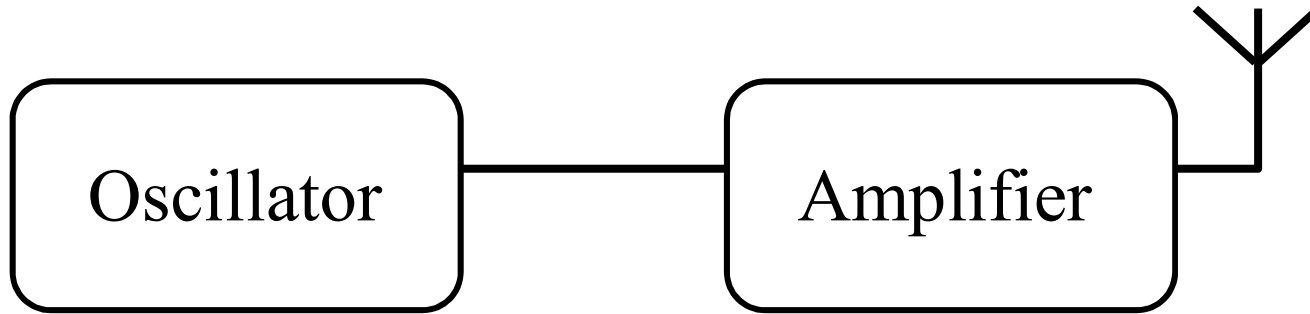
- A DX station is a distant station usually located in another country.
 - DX is the old Morse code abbreviation for distance. It refers to hearing or communicating with a radio station that is far away.
- A local radio station is located in the nearby community or region.

FCC – Federal Communications Commission

- The FCC sets and enforces technical standards for devices that produce radio frequencies and issues licenses for radio stations, transmitters and operators.
- The FCC does not have any authority outside of the United States.

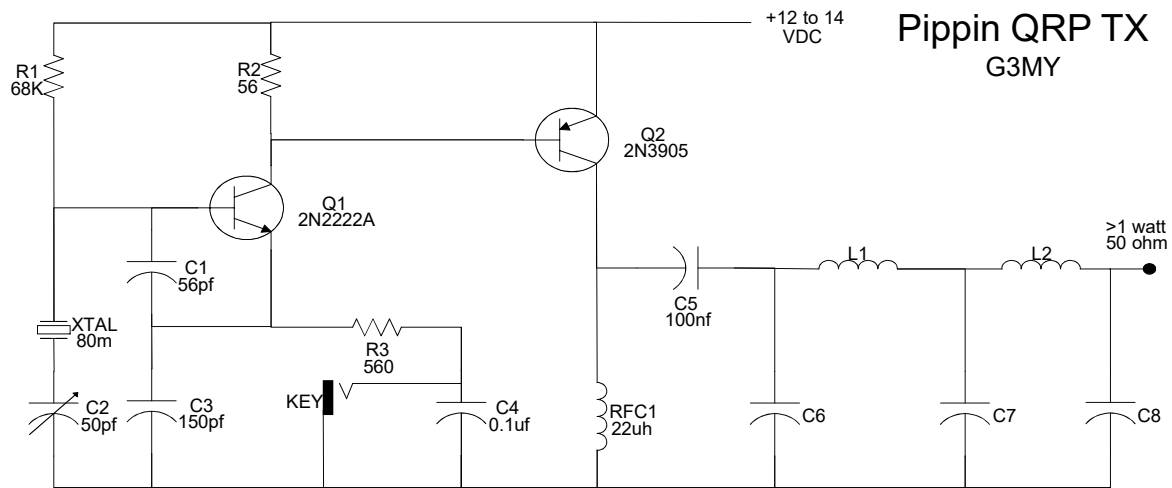
ITU – International Telecommunications Union

- The ITU coordinates global telecommunications networks and services including management of radio frequency spectrum and satellite orbits.
- The ITU tries to prevent harmful interference between radio stations but it depends upon cooperation among countries as it does not have the ability to enforce actions.



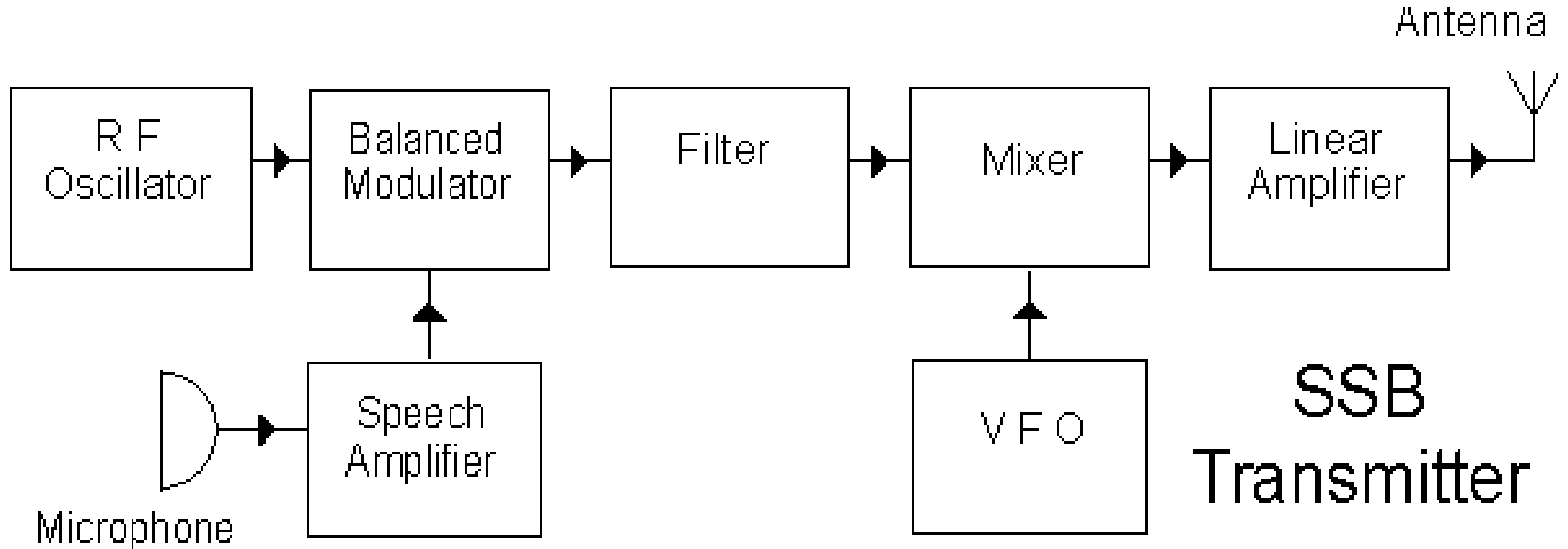
Simple Block Diagram

A block diagram shows a system as a series of connected boxes.

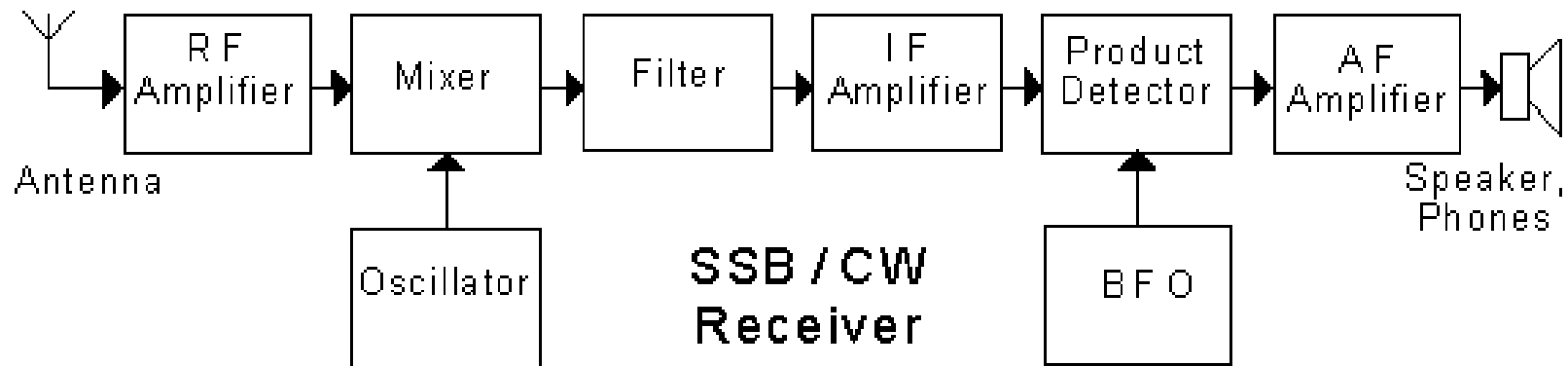


Schematic Diagram

A schematic diagram of an electrical circuit is a drawing that shows how the circuit is built.

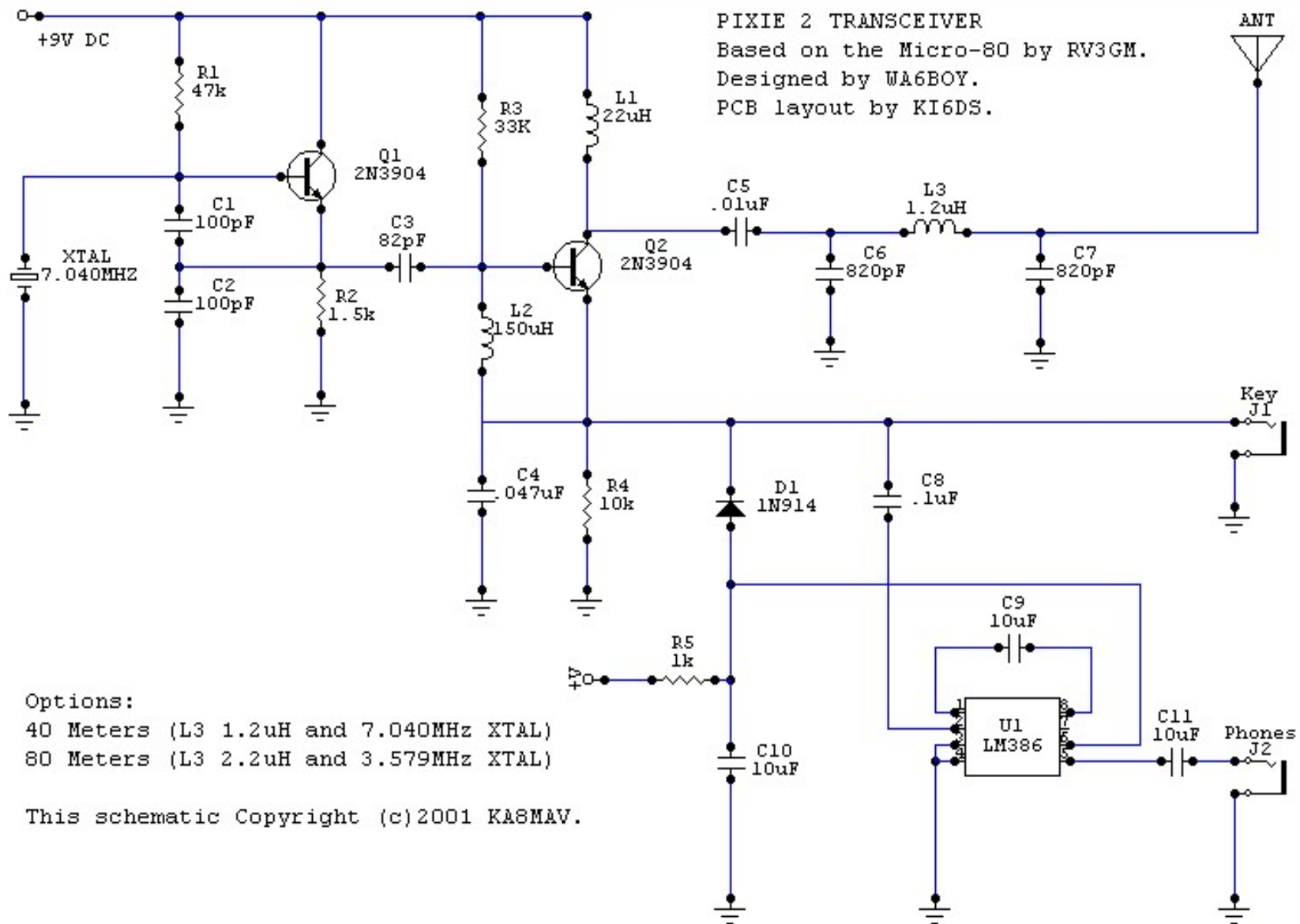


SSB Transmitter



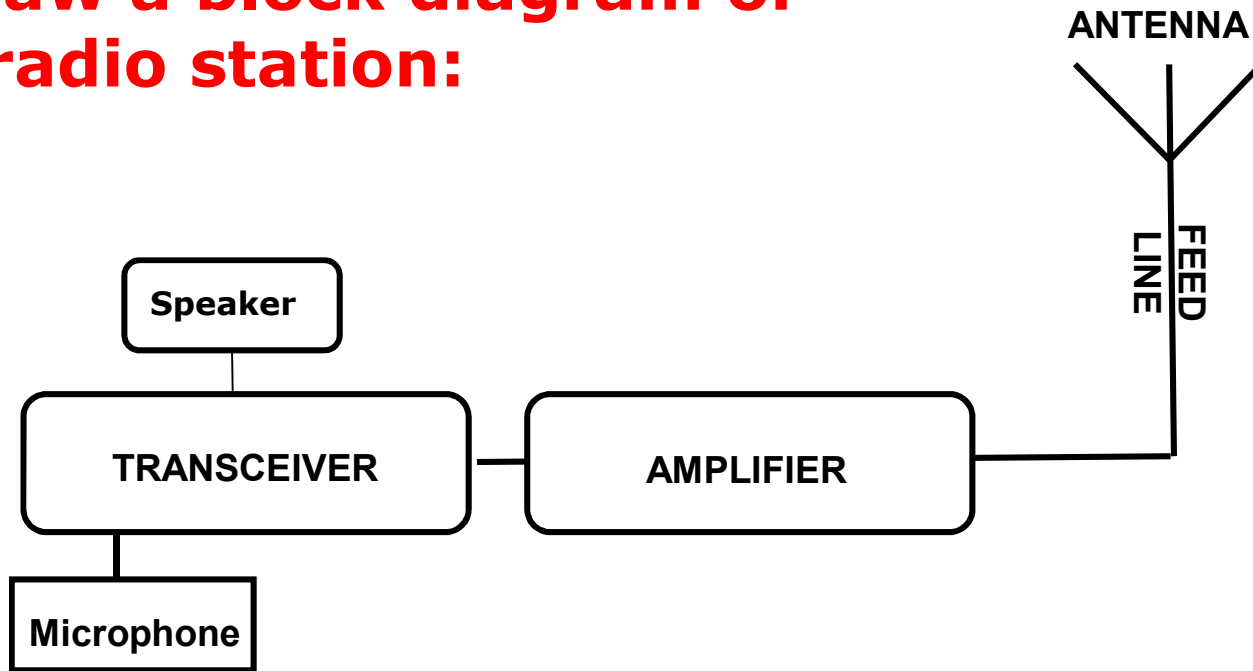
SSB / CW Receiver

Shows more about how radios work

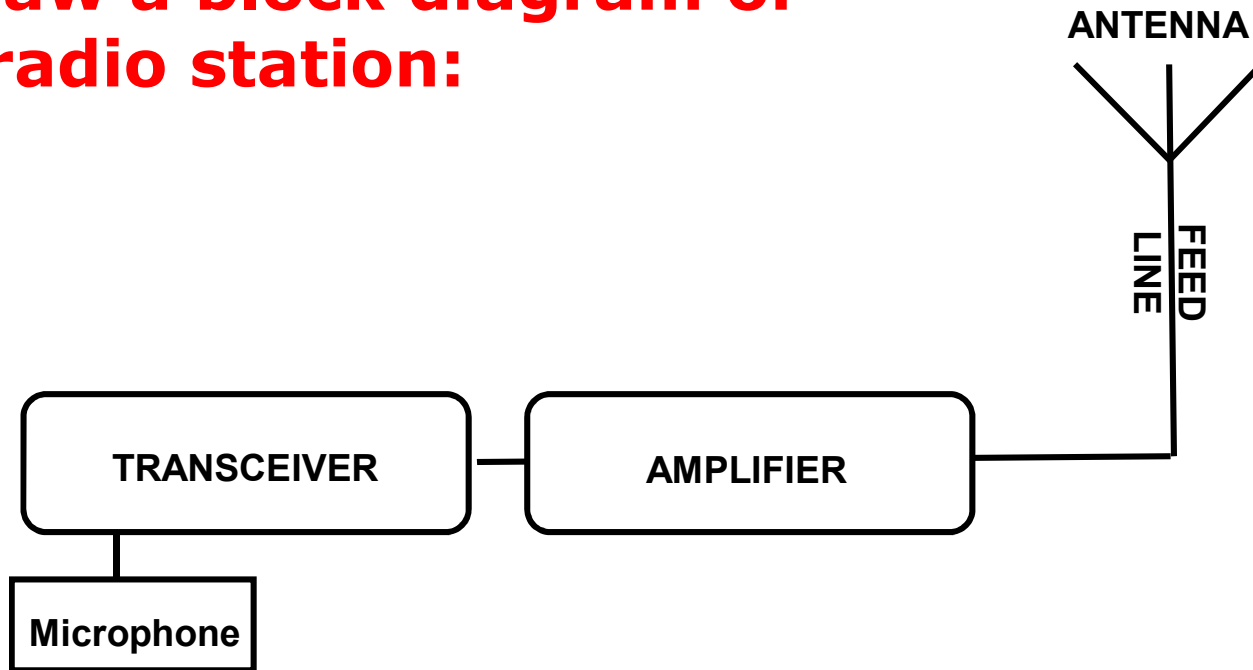


Shows how to build a radio from components

Draw a block diagram of a radio station:



Draw a block diagram of a radio station:



Safety

Electricity Safety

- Electricity can kill you.
- Minimum fatal voltage – 30 volts.
- Minimum fatal current if passed through the human heart – $1/10^{\text{th}}$ of an ampere.
- Power lines are often suspended in the air and not insulated.
- Power lines carry thousands of volts – never touch them.



Radio Safety Precautions

- Unplug equipment before working on it.
- Never let anyone turn the power on and off for you.
- Don't work on a radio when you are tired.
- Don't use your bare hands to adjust components.
- Don't let your body be a ground path by touching grounded metal or standing in water.
- Never wear headphones while working on a radio.
- "Keep one hand in your pocket" so electricity can't travel through your chest.
- Tell your family how to turn off the power.
- Be careful; death is permanent.

Radio Frequency (RF) Energy

- Exposure to high levels of radio frequency (RF) energy can be unhealthy. Direct contact can cause burns; human eyes are sensitive to RF energy.
- Don't use a radio when it is not completely assembled as the cabinet shields the RF radiation.
- Keep antennas out of reach.

Direct Current Circuit Grounding

- “Grounding” means establishing an electrical connection to an “electrically neutral” object that is at “0” Volts electric potential.
 - A “ground” is often a long metal rod driven into the earth.
 - Grounding is a safety measure to prevent electric shock and equipment damage.
- **Direct Current Circuits in radio equipment are grounded to prevent electric shock. The circuit is connected to the metal cabinet or “chassis” and the chassis is connected to a ground.**

Power Outlet Grounding

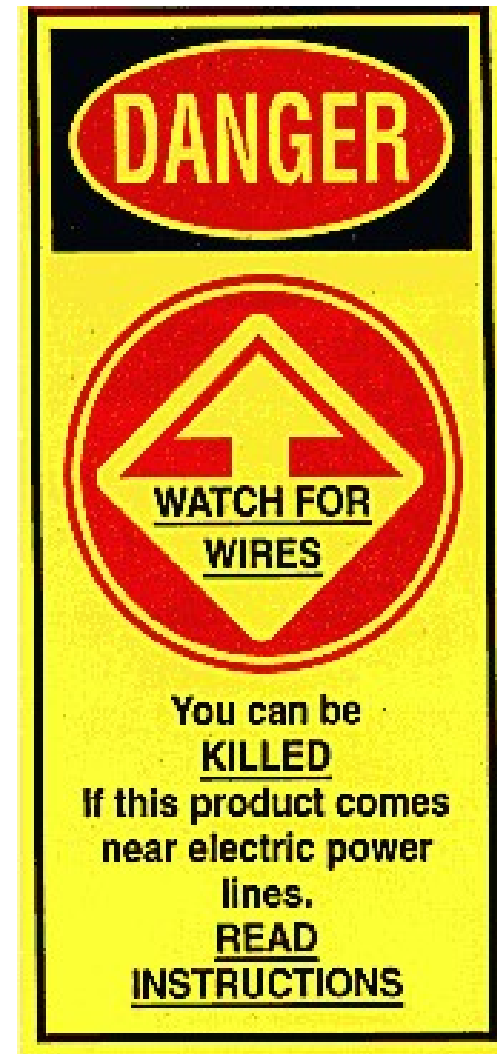
- Electric power enters a house through a box of circuit breakers. A metal ground rod is driven into the earth near where power enters the house to establish a Ground.
- Power Outlets are connected to the circuit breaker box with three wire cable and one of the wires is connected to Ground.
- Equipment is connected to Power Outlets with three prong plugs and one prong is connected to the Ground.
 - The equipment case is then grounded to prevent electric shock.

Antenna System Grounding

- Antenna systems often include tall towers or objects that might be struck by lightning.
- Antenna systems include transmission lines connecting the antenna to radio equipment.
- Lightning arrestors are devices inserted into transmission line with a spark gap or gaseous discharge to ground.
- **Antenna system grounding should include both a ground connection for the antenna tower and a lightning arrestor in the transmission line where it enters the house.**
- The lightning arrestor may discharge static electricity but likely offers little protection from a direct strike.

Antennas and Towers

- Never install an antenna over, under, or very near a power line.
- Avoid the possibility of the antenna falling on the power line or the power line falling on the antenna.



Antennas and Towers

- Never install an antenna where a person could touch the antenna.
- Be careful working on towers and roofs.
 - Protect yourself from falling.
 - Protect people below you from falling objects.
 - Use safety harnesses, belts, tethers, and hard-hats.

Lightning Protection

- Antenna support poles and towers should be connected to a ground rod.
- Disconnect radios if lightning is in the area.
- Lightning could strike your antenna and travel down the transmission line to the radio.
- Make sure your antenna and radio are grounded to a good earth ground.
- Never operate your radio in thunderstorms.

Amateur Radio

What is Amateur Radio?

- A type of two-way radio. A place to learn about radio.
- Called the “Amateur Radio Service” because it can’t be used for profit.
- Also known as “Ham Radio”.
- An important part of disaster response.
- A lot of fun!

Why does the FCC have an Amateur Radio Service?

- **Public service** - community service and disaster help (*A Scout does a good turn daily – here is another way*).
- **International goodwill** - A great way to talk to people in other countries.
- **Experimentation** - Hams have made inventions like FM, SSB, Packet Radio, Automatic Position Reporting Systems.
- **Communication skills** - Many people trained to communicate.

Amateur Radio Activities

- **Jamboree On The Air (JOTA)**

- The third weekend every October.
- Scouts all over the world talk to each other on ham radio. Largest annual scouting event.



- **DX (Long Distance Communication)**

- Talk to other hams around the world.
- Collect QSL cards (postcards) to prove contact (Collect countries!).
- Great way to have fun and learn geography.



- **Contests**

- Held many weekends to contact as many people as possible from a certain place or in a certain way.

Amateur Radio Activities

- **Skywarn**
 - National Weather Service uses Hams to report severe weather
- **“Fox” hunting (Radio Direction Finding)**
 - Hidden transmitters
 - Tagged wildlife
 - Downed aircraft
 - Life rafts
 - Stolen cars
- **Packet radio**
 - Sending electronic messages (e-mail, text) via radio



Amateur Radio Activities



- **Public Service.**
 - Parades & special events from small carnivals to the Rose Bowl Parade.
 - Help with communication at large community events, marathons, bike-a-thons, etc.

Amateur Radio Activities

- **Disaster Communication**
 - Hams help during fires, floods, earthquakes, and other disasters.
 - At these times, telephone lines and cell phone sites are often damaged or overloaded.
 - Ham radio is the only reliable form of communication.

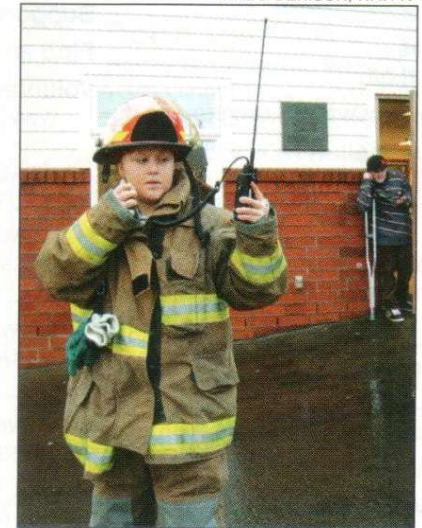
Oregon Hams of all Ages Respond to Devastating Windstorm

HAL J. DENISON, WA7FIV

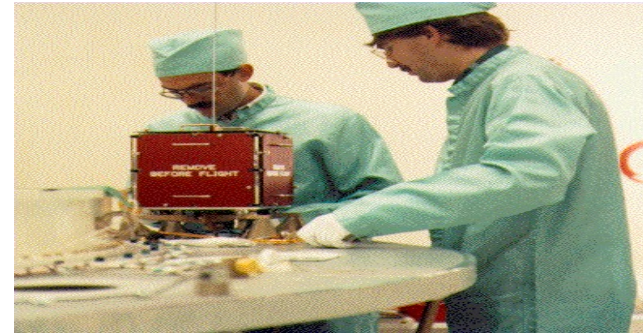
Among the 60 or so local hams who responded to a December windstorm that had peak gusts of 147 mph two young men stood out as heroes. They convinced their parents to deliver them, early in the storm's heavy wind, to the Seaside Fire Department where they took up positions ready to pass all communications from the Fire Department to the County EOC. Nick, KE7NIT, and his friend Tommy, KE7OUD, both 12 years old, ran out in the wind and rain to find the best spot to reach the County EOC on their handhelds.

They both passed messages, and provided help to Senior Citizens at the nearby Chisolm Senior Center.

Both boys are members of the newly formed STARS (Seaside Tsunami Amateur Radio Society, WA7VE) in Seaside. — Hal J. Denison, WA7FIV



In Seaside, Oregon, Nick, KE7NIT, provides communications support with Tommy, KE7OUD, monitoring.



OSCAR



Foxhunting



Morse Code



Bicycle Station



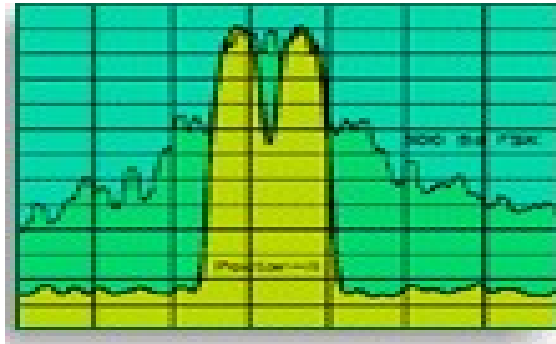
Mobile



Kit Building



Moonbounce



Digital Modes



Slow Scan TV image from MIR



Field Operating



Emergency Communications

QRM	Interference (Your radio signal is being interfered with.)
QRN	Static (Your radio signal is being interfered with by static.)
QRP	Low power radio operation
QRS	Send your Morse code more slowly.
QRT	Leaving the air (I'm stopping my radio activity.)
QRX	Wait a few minutes.
QRZ?	Who is calling?
QSB	Your signals are fading.
QSL	A card sent to indicate you've talked to or heard a radio station; also, as a Q signal that means (Received OK)
QSO	A conversation.
QSY	I am moving to another radio frequency. . .
QTH	My location is. . .
73	Best regards
RST	Readability, Strength, Tone (Signal report)
CQ	I am calling...

Radio Merit Badge

**Session 2 – Amateur radio
operating experience**

Make a Ham Radio Contact

- Listen and call another ham radio station
- Talk with the other Radio Station Operator.
 - Relax and have fun
 - Your name
 - Where you live
 - Describe your school
 - Talk about Scout camp
- Use Q-signals
- Log your contact

Log Your Contact

- His Name _____
- His Call _____
- His QTH (location) _____
- Frequency _____
- Mode _____
- His RST (signal report) _____
- My RST (signal report) _____
- Comments _____

Radio Merit Badge

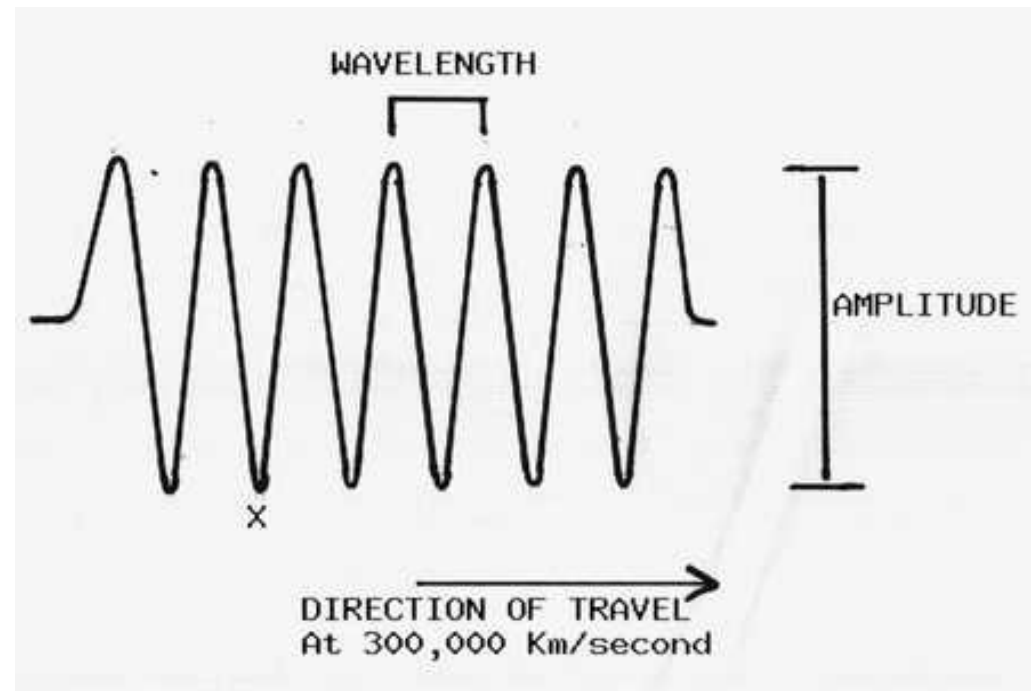
Session 3 – Electromagnetic spectrum, components, careers, amateur radio licensing, and emergencies

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RST	Readability, Strength, Tone (Signal report)
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The Electromagnetic Spectrum

Radio Waves

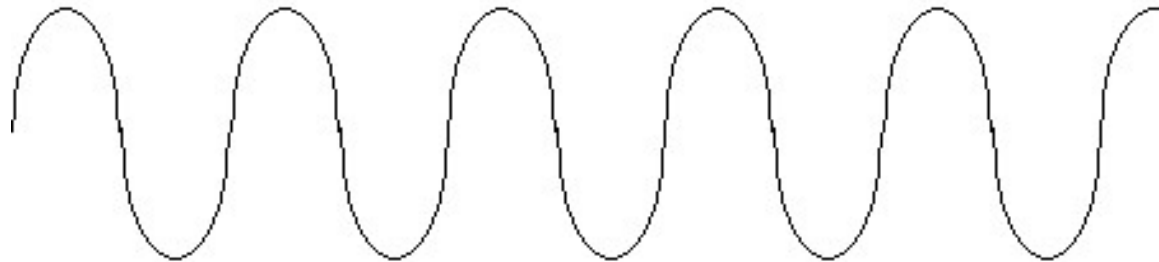
- Electromagnetic energy
- Travels at the speed of light



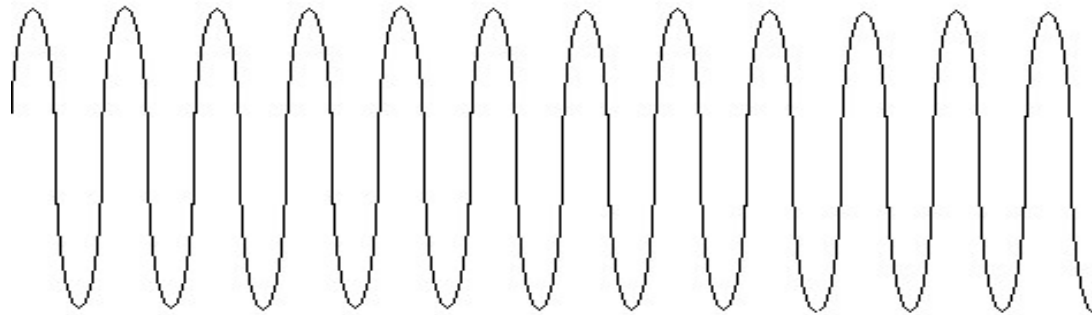
Radio Waves



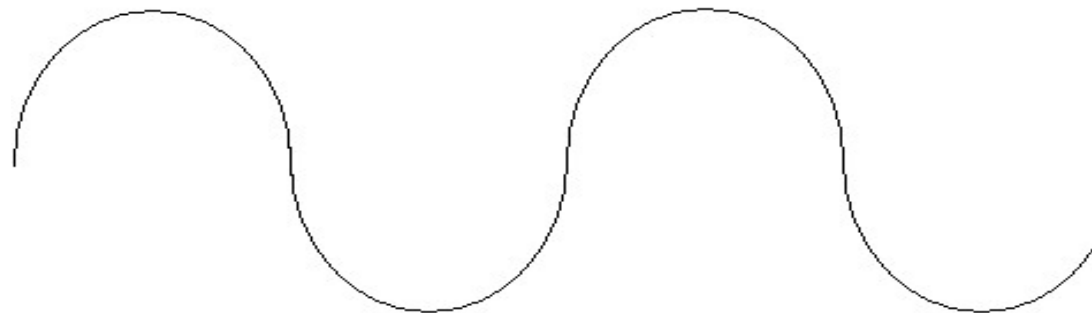
Low Amplitude
Radio Waves



High Amplitude
Radio Waves



High
frequency
radio waves



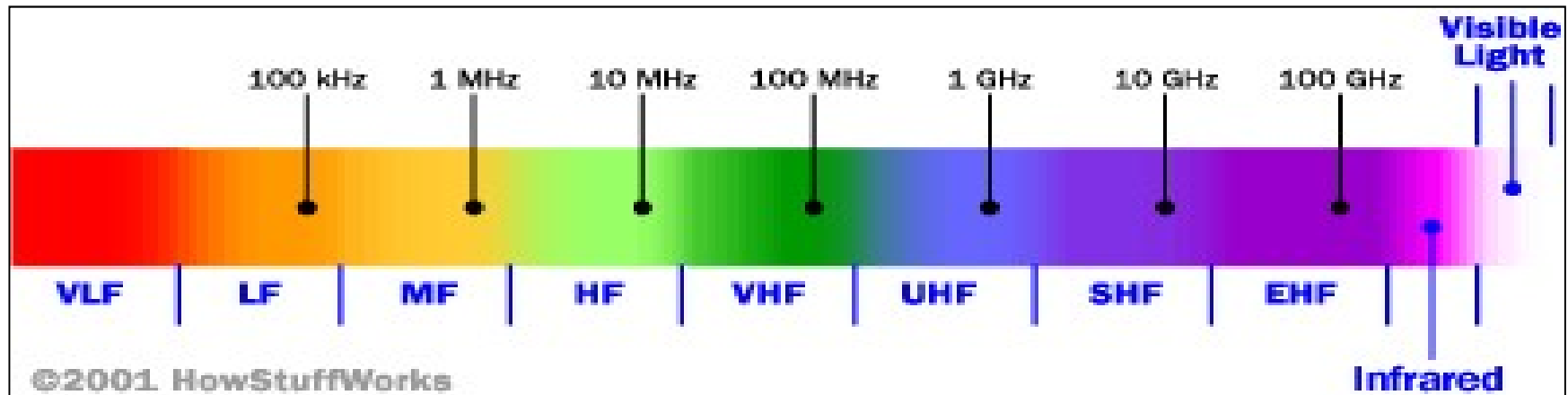
Low
frequency
radio waves

Frequencies

(One Hertz is one cycle per second)

- Direct Current0 Hertz (goes in only one direction)
- Alternating Current ..60 Hertz (Hz)
- Audio (Sound).....100 Hz to 20 kHz (100-20,000 Hz)
- LF.....30-300 kHz (30,000-300,000 Hz)
- MF.....0.3-3 MHz (300,000-3,000,000 Hz)
- HF or Shortwave.....3-30 MHz (3,000,000-30,000,000 Hz)
- VHF30-300 MHz (30,000,000-300,000,000 Hz)
- UHF.....300-3,000 MHz (well, you get the idea)
- Microwave.....Frequencies above 500 MHz
- Visible Light.....400-800 THz (400,000,000-800,000,000 MHz)

The Electromagnetic Spectrum



Sound

Long Radio
Wavelengths

Short Radio
Wavelengths

Microwaves

Frequency - Measured in Hertz (kilohertz, megahertz, gigahertz)

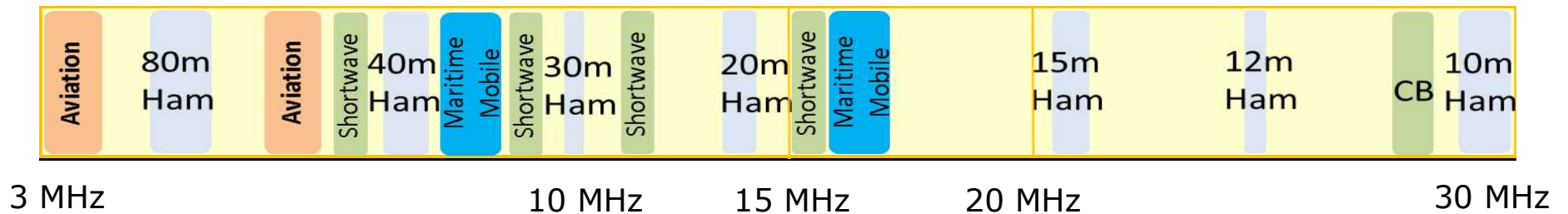
Wavelength - Measured in meters (cm)

Inverse relationship between frequency and wavelength

Medium Frequencies (MF) – 300 kHz to 3 MHz



High Frequencies (HF) – 3 MHz to 30 MHz



Very High Frequencies (VHF) – 30 MHz to 300 MHz

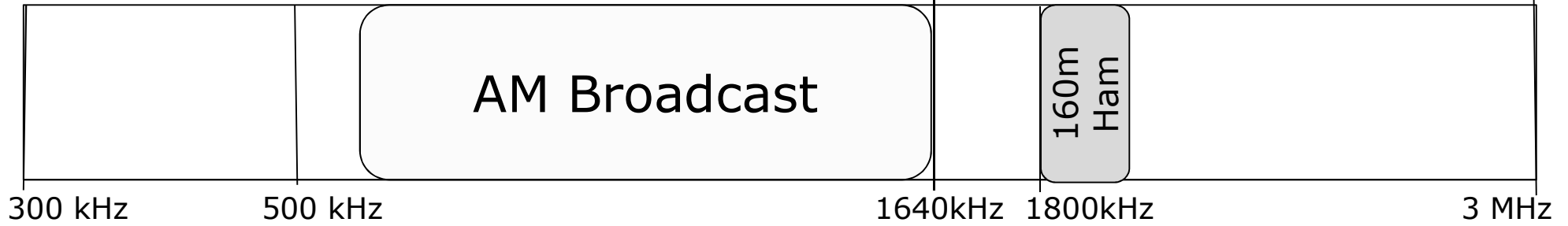


Ultra High Frequencies (UHF) – 300 MHz to 3000 MHz

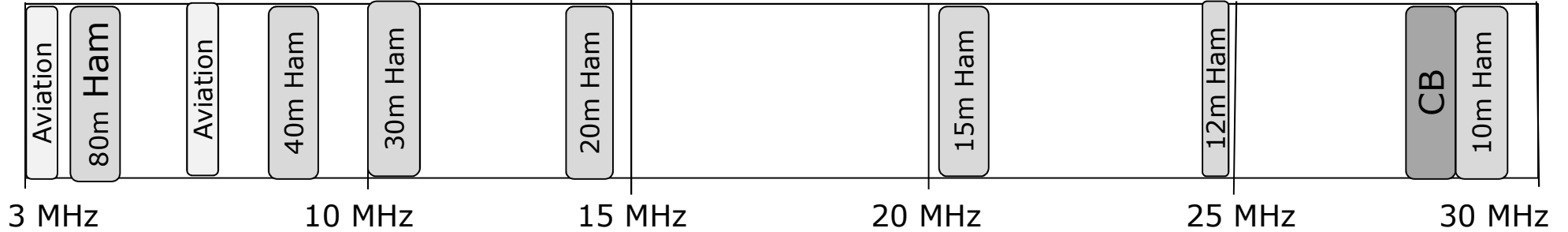


Chart adapted from WØSTU

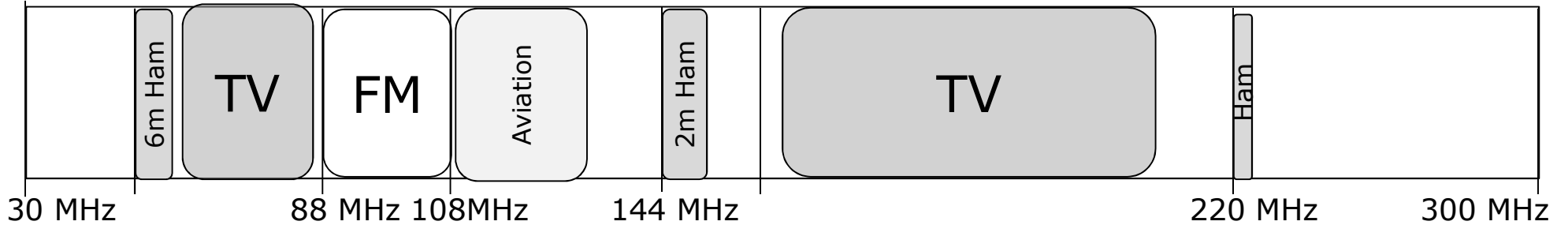
Medium Frequencies (MF) – 300 kHz to 3 MHz



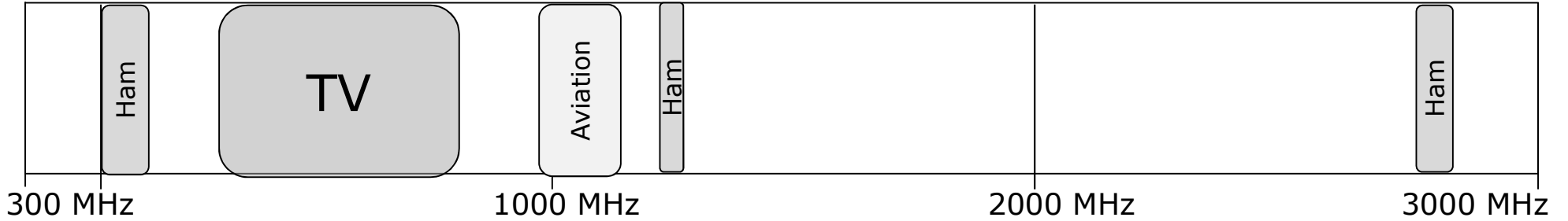
High Frequencies (HF) – 3 MHz to 30 MHz



Very High Frequencies (VHF) – 30 MHz to 300 MHz



Ultra High Frequencies (UHF) – 300 MHz to 3000 MHz



Frequency Assignments

- AM Broadcast Radio 540 - 1600 kHz
- FM Broadcast Radio 88 - 108 MHz
- Short Wave Broadcast 5 - 22 MHz
- Television Broadcast Channel 2 = 54-60 MHz
- CB Radio 27 MHz
- Police Radio 450-470 MHz
- **Amateur Radio** 3.5, 7, 10, 14, 21, 28, 50, 144 MHz
80, 40, 30, 20, 15, 10, 6, 2 meters
- Mobile Telephone 850 - 900 MHz, 1800 – 1900 MHz
- Wi-Fi 2400 – 2470 MHz

How Radio Waves Carry Information

- A pure radio wave does not convey information.
- Radio waves carry information when they are changed by a process called modulation.
- Modulation
 - Continuous wave (CW)
 - Amplitude (AM)
 - Frequency (FM)



Radio signals are modulated(changed) with information.

- Morse Code uses dots and dashes
- Voice, images – AM, FM, TV
- Digital modes – 1s and 0s



Continuous Wave (CW)

The Oldest Digital Mode

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

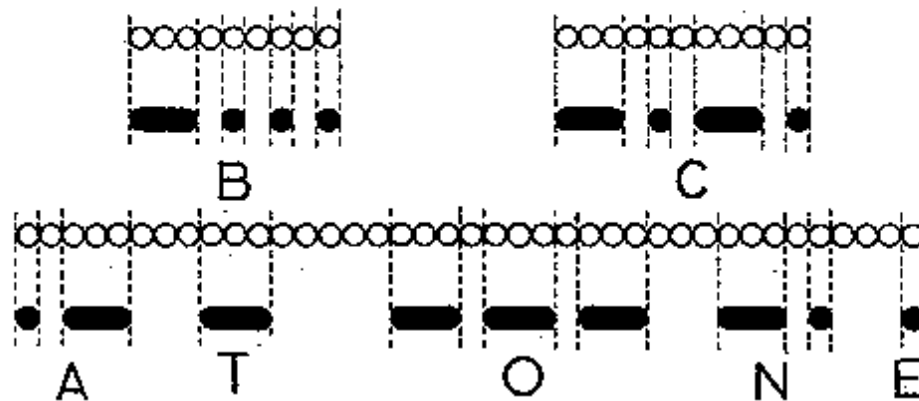



























Diagram illustrating relative lengths of dashes and spaces referred to the duration of a dot. A dash is exactly equal in duration to three dots; spaces between parts of a letter equal one dot; those between letters, three dots; space between words, five dots. Note that a slight increase between two parts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








“CW” or Morse Code








A 
 B 
 C 
 D 
 E 
 F 
 G 
 H 
 I 
 J 
 K 
 L 
 M 

N 
 O 
 P 
 Q 
 R 
 S 
 T 
 U 
 V 
 W 
 X 
 Y 
 Z 

1 
 2 
 3 
 4 
 5 
 6 
 7 
 8 
 9 
 0 

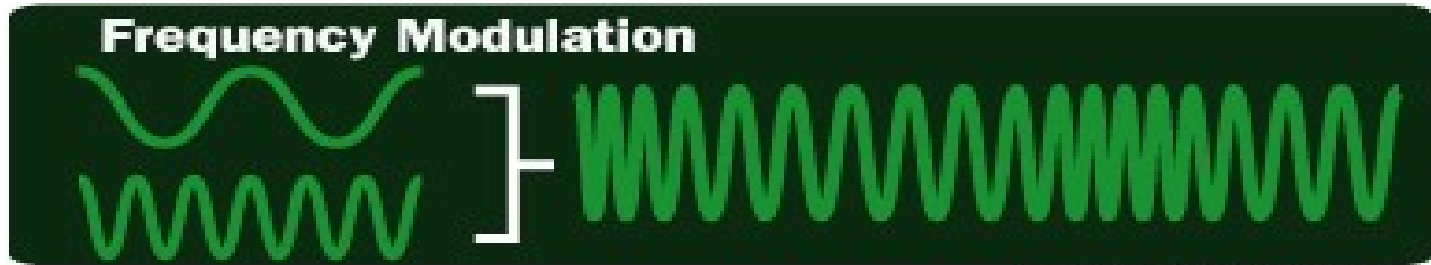
0 MEANS ZERO, AND IS WRITTEN IN THIS WAY TO DISTINGUISH IT FROM THE LETTER 'O'. IT OFTEN IS TRANSMITTED INSTEAD AS ONE LONG DASH (EQUIVALENT TO 5 DOTS)

PERIOD (.) 
 COMMA (,) 
 INTERROGATION (?) 
 QUOTATION MARK (") 
 COLON (:) 
 SEMICOLON (;) 
 PARENTHESIS () 

WAIT SIGN (AS) 
 DOUBLE DASH (BREAK) 
 ERROR (ERASE SIGN) 
 FRACTION BAR (/) 
 END OF MESSAGE (AR) 
 END OF TRANSMISSION (SK) 
 INTERNAT. DISTRESS SIG. (SOS) 

Modulation

FM



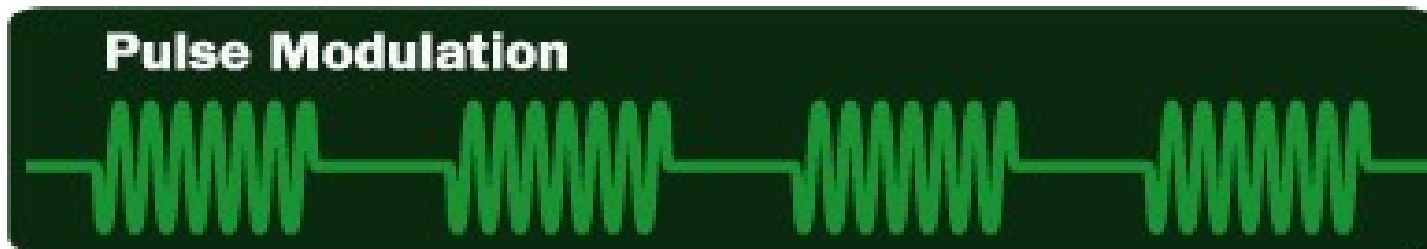
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AM



©2000 How Stuff Works

PM



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Basic Radio Equipment

- A Transmitter sends radio signals using modulation to convey information.
- A Receiver converts (demodulates) very weak radio signals into audio.



Basic Radio Equipment

- A Transceiver combines the transmitter and receiver in one unit.
- An Amplifier increases the strength of the radio wave produced by the transmitter.
- The Antenna sends radio signals out into the air and captures received radio signals.

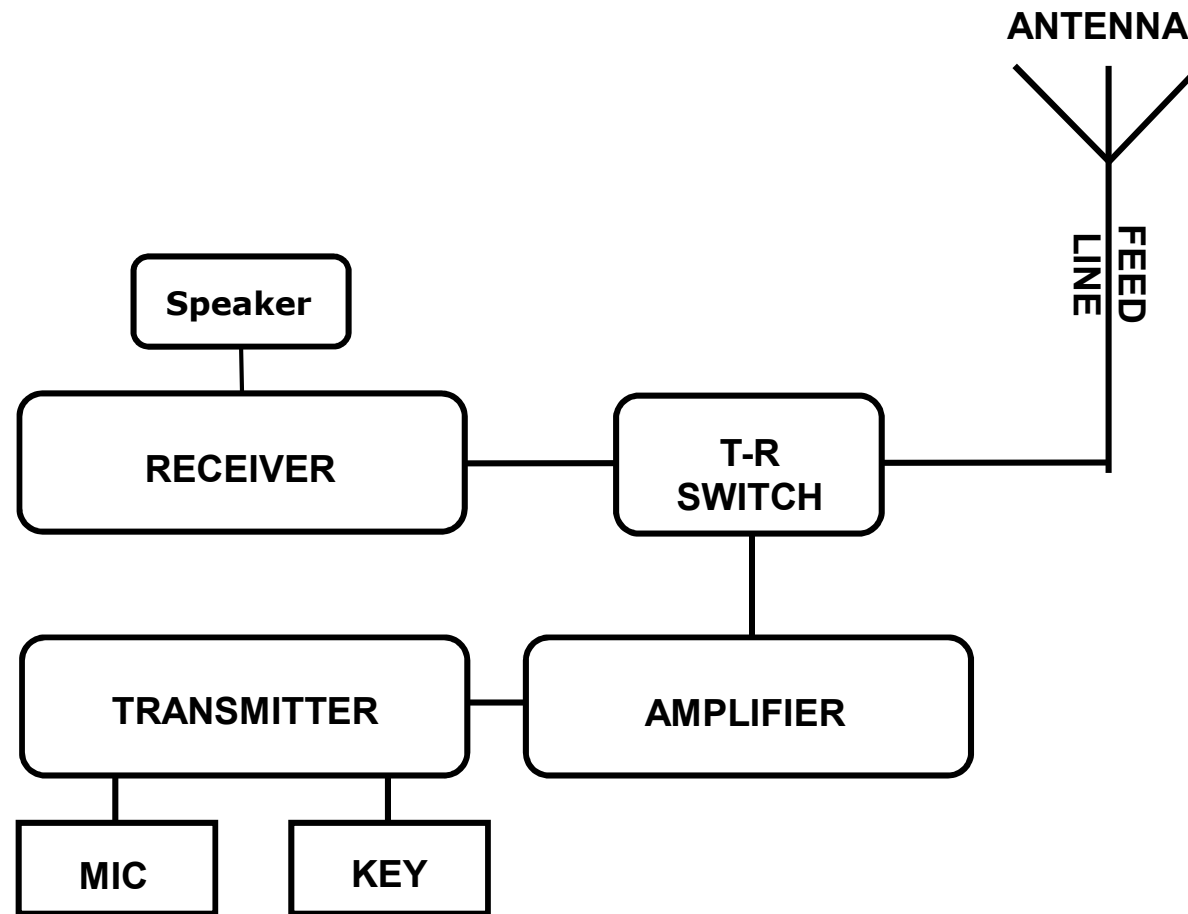


Transceivers

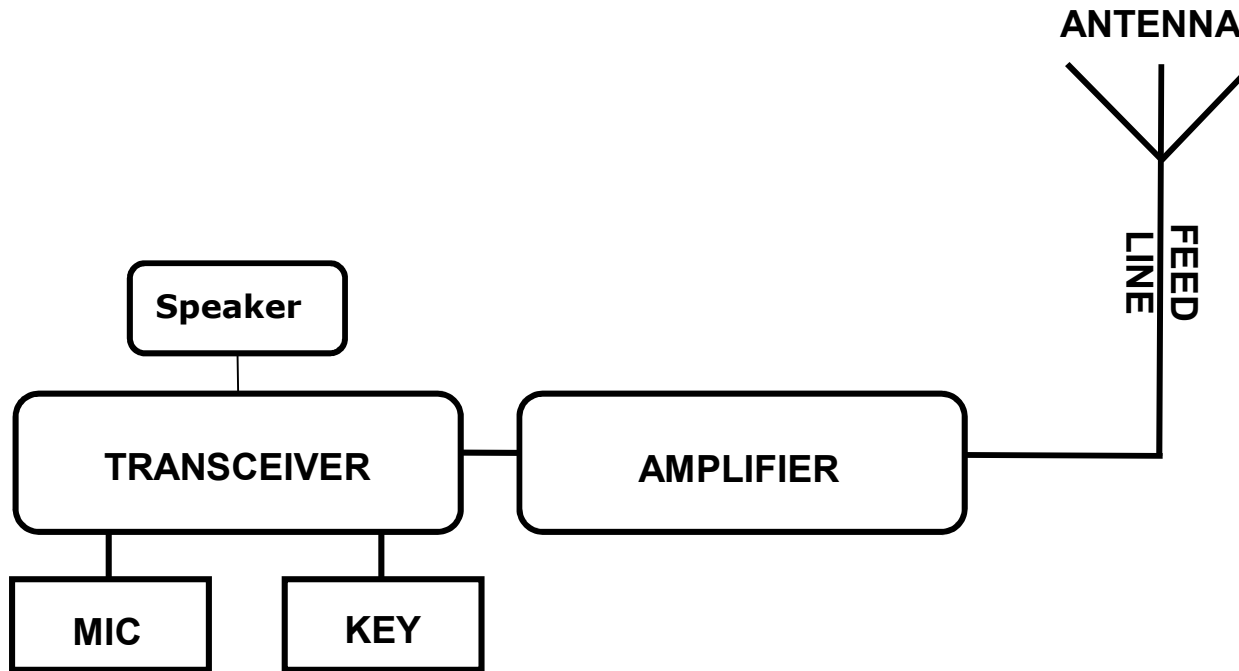


Antenna

Radio Station Block Diagram



Radio Station Block Diagram

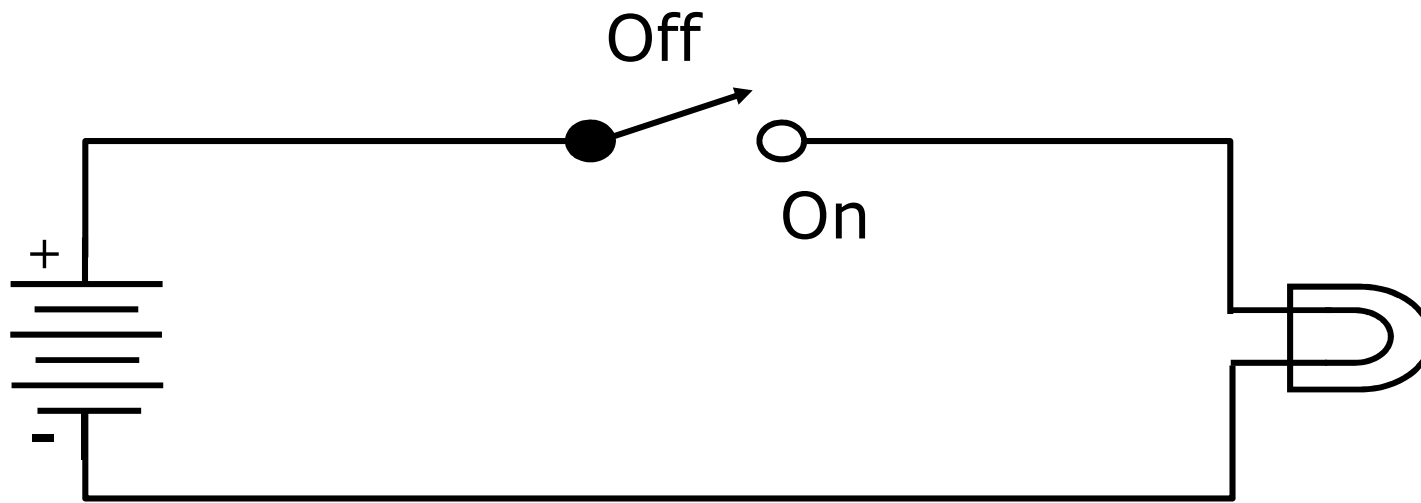


Open Circuit



Flashlight

An open circuit exists when the path for electricity is incomplete as when the flashlight switch is off.

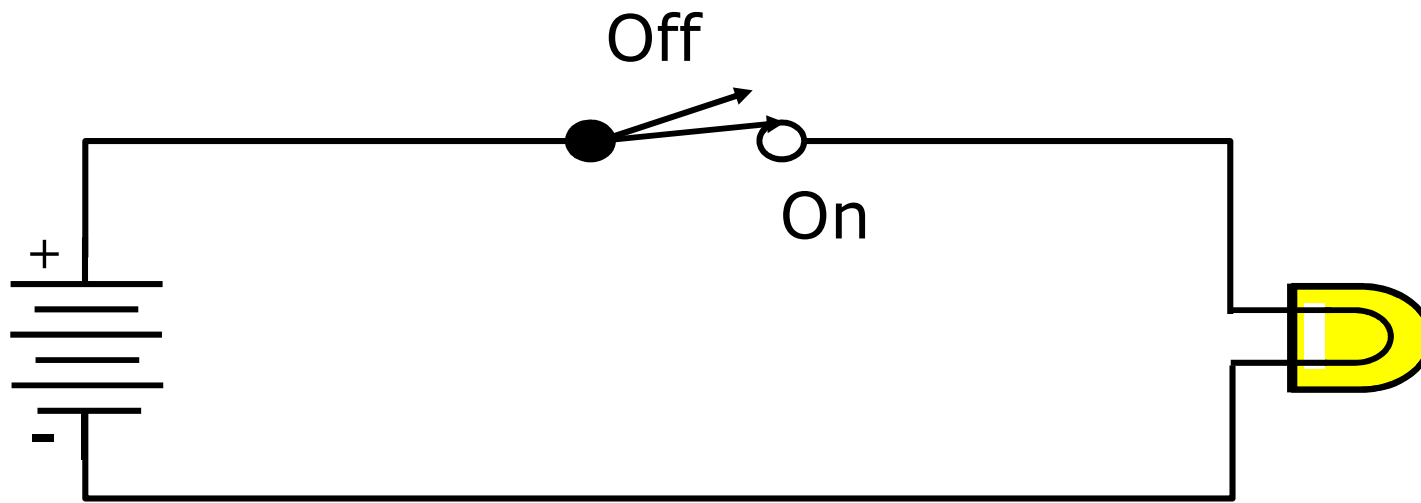


Closed Circuit



Flashlight

A closed circuit exists when the path for electricity is complete as when the flashlight switch is on.

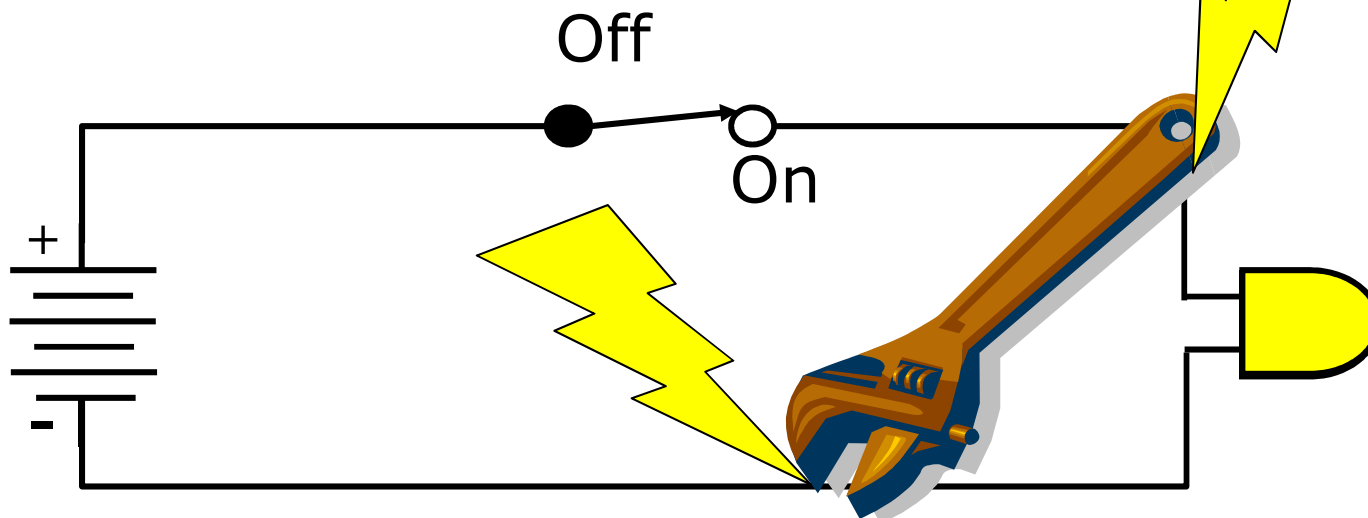


Short Circuit



Flashlight

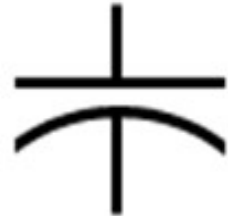
A short circuit exists when the path for electricity is completed in an unplanned way like when a tool "shorts" the circuit.



Draw Schematic Symbols



Resistor



Capacitor



Variable Capacitor

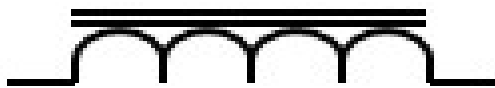


Diode

Draw Schematic Diagrams



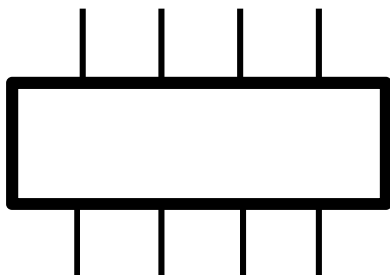
Transistor



Inductor



Switch



Integrated Circuit

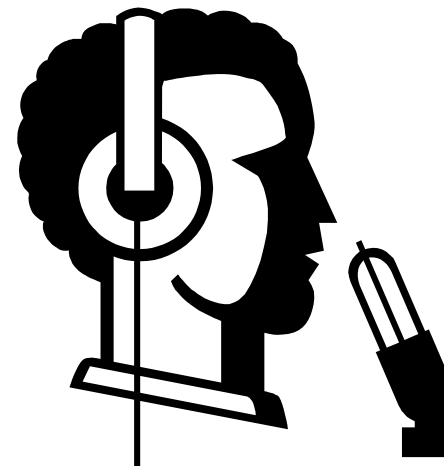
Describe Your **K2BSA** Visit

- What equipment did you see?
- How was the equipment used?
- What licenses are required to operate and maintain the equipment?
- What is the purpose of the radio station?



Radio Careers

- Technical Careers
- Broadcasting Careers
- Operator Careers



Technical Radio Careers

- A ***Design Engineer*** develops the block diagrams and schematics to create a radio.
- A ***Design Technician*** selects the actual parts and determines the physical arrangement of those parts on the printed circuit board.
- A ***Manufacturing Engineer*** determines how to purchase the parts and assemble the radio.
- A ***Radio Station Engineer*** operates and maintains the radio station equipment.
- An ***Electronics Technician*** repairs radio equipment.

Broadcasting Careers

- ***Announcers and Radio/TV Personalities*** perform the on-the-air communication at a radio or TV station.
- The ***Station Manager*** is responsible for the overall operation of the radio or TV station.
- The ***Program Director*** or ***Music Director*** will be responsible for the content of the broadcast material.
- A ***Program Writer*** will be responsible for producing for some programs the actual text read by the ***Announcers*** or ***Personalities***.

Radio Operator Careers

- Radio communication systems are everywhere in our culture.
- Many careers include radio operation incidental to the main career role. For example, radio communication is essential for policemen to function effectively.
- All public safety functions like fire and ambulance services require radio communication operations.
- Aviation traffic management relies on very extensive radio communication networks.
- Military operations rely upon radio networks.

Education for Radio Careers

- Most jobs require high school diploma.
- Radio engineers generally study electrical engineering at college.
- Colleges offer courses in broadcasting and communications.
- Gain broadcasting experience at college radio stations.
- Radio technicians attend trade schools or community colleges.
- Many organizations offer radio license training courses and certifications.

Amateur Radio Licenses

- Technician Class
 - Elementary operating procedures.
 - Radio regulations.
 - Beginning electronics.
 - Emphasis on VHF and UHF.
- General Class
 - Intermediate practices, regulations, theory.
 - Operating privileges in all amateur bands with some limits on frequencies.
 - Emphasis on HF.
- Amateur Extra Class
 - Advanced theory and practices.
 - All operating privileges in all bands.
 - Administer license exams.

Technician Class License

- No age restriction
- Elementary operating procedures
- Radio regulations
- Beginning electronics
- Emphasis on VHF and UHF
- 35-question, multiple-choice written examination
- Minimum passing score is 26 correct answers – 74%



Amateur Radio License Exams

- Amateur radio license exams are given by Hams called "Volunteer Examiners"
- Exams and free study classes are given by local radio clubs
- More information about ham radio can be found at the ARRL web page:
www.arrl.org



Emergency Calls

- You may use any radio at any time to get help during an emergency.
- “Break” “Break” followed by your call sign to interrupt a radio conversation in progress.
- “MAYDAY” is the international word for requesting help by radio – “EMERGENCY” also works.
- Speak clearly and give a complete location and information like a 911 call.
- You might have to climb higher up a hill with an FRS radio or cell phone.
- In Morse code you would slowly send SOS (••• — — — •••) and give the same information.

Radio Station Types

- Handheld radios (HT): **Small, light, portable, but not much power**
Some can fit in your pocket. With repeaters they can be quite useful and they can easily be carried on a hike.



- Base station radios: **Permanent station in a building. More power, easier to use, more features.**



- Mobile radios: **Permanent station in a vehicle. More power.**

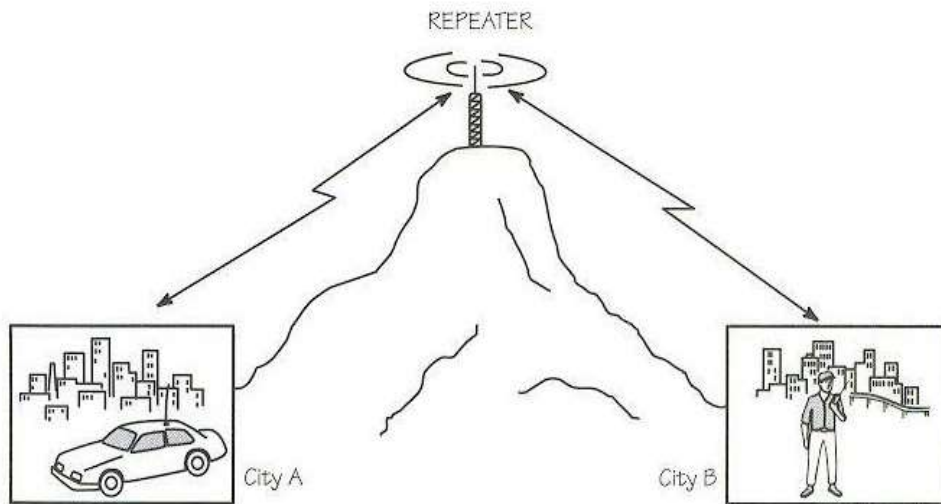


- Which kind of radio is best? It depends on what you want to do.

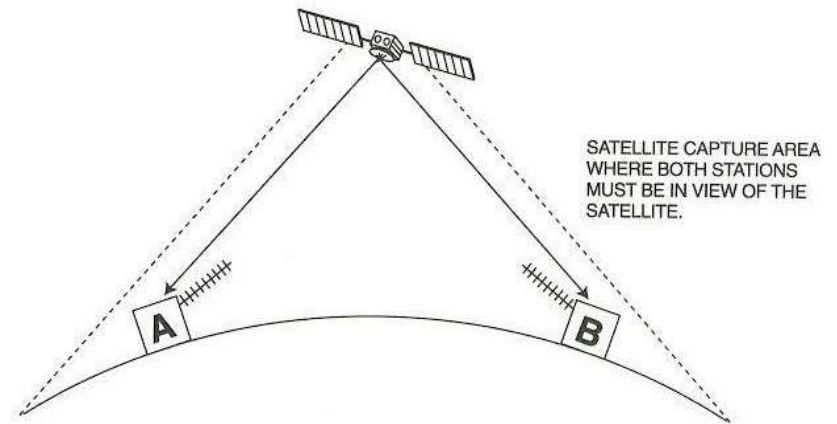
Repeaters

- Repeaters are transceivers located on high points (Mountains, tall buildings, satellites) to automatically relay radio signals. Some have connections to the telephone system.
- A repeater receive on one frequency and re-transmits on another.
- A repeater extends the range of a handheld transceiver.

VHF Propagation with Repeaters



You can use a handheld radio while walking or driving to send your signal through a repeater. By using repeaters, you can talk to people farther away.



Successful Earth-to-Satellite Communications

Radio Merit Badge

