A Gentle Intro to Radio Communications

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Recipe Approach to Subject

- Big Concepts
  - Regulations
  - Frequencies
  - Bands and channels
  - How Radio Waves work
  - Modulation
  - Antennas
  - Basic Electronics

Regulations

- Transmitting of radio waves is regulated by the FCC
  - Set up in 1934 (coincident with bottom of the Great Depression)
  - Controlled all radio spectrum among various user groups
    - Commercial broadcasters
    - Ham radio operators
    - Government & Military
    - Specialized services

Regulation Drift

FCC has been decreasing regulation of ham radio for numerous reasons:

1. Ham radio growth has slowed
2. Shortwave listening is static
3. AM broadcast audience share is declining
4. In general COMPETITION IS UP

Manage Spectrum Mandated

- Balance the public need, interest and concern against limited spectrum while encouraging the state of the art.
  - AM superseded by stereo FM explosion in the 1960's
  - Color TV over black and white
  - Satellite services and cable over open air
  - And the Internet provides nearly instant distribution of anything as do cell phones with built-in cameras

Why Mess with Ham Radio?

- National security: hams are a pool of very talented communications operators
  - Examples:
    - Military Affiliate Radio System (MARS)
    - SKYWARN: Tornado spotters
    - Pool of electronics techs for many uses.
- Ham radio is robust (relatively) compared to single-point-of-failure technologies
- Ham radio really is fun

What Ham Radio Can Do

- For family use: replace the kid's cell phones. Wide area dependable keep-in-touch.
- Talk to the space shuttle and ISS
- Bounce signals off the moon (and meteor showers and more)
- Keep moving text, data, and even pictures when the internet goes down
- Provide emergency communications after earthquakes, floods, and tornadoes.

Licenses

- There are several grades of license
- Starting February 23rd, no Morse Code
- Three main classes of license are
  - Technician (the starter license)
  - General (the most common license)
  - Extra Class (the serious hobbyist)

Do you need a License?

- Only if you intend *transmitting*.
- No license needed for shortwave listening
- No license needed for listening to police and fire scanners.
  - Some municipalities have rules which may conflict with the FCC's rules about things like listening to police and fire radio systems while in a car. You probably are within your rights to challenge such rules, but do you really want to be a "test case?"

The Art of Listening

- Radio is largely about being an information sponge.
- Most people get into it slowly by starting off listening to far away radio stations at night.
- With a good radio at night, every channel on the AM band and almost everything on the FM band is occupied!

The Jump to Shortwave

- The “second step” for a lot of people is to either start chatting on a citizens band radio, or start listening to shortwave.
- Shortwave stations can generally be heard 24/7 but you need to know which bands work best and why. This is where we start the technical discussion.

This Won't Hertz

- Radio waves as a high frequency alternating current – or AC.
- Each cycle is called a Hertz. It used to be a cycle but that was too simple.
- Middle C on a Piano is 440 Hz. A Kilohertz being 1,000 Hertz, Middle C is 0.44 Kilohertz.
- You can't hear above 20 Kilohertz although bats and dogs can.
- "Longwave" radio begins around 30 Kilohertz

Now We're in the Radio Spectrum

- "Medium Wave" is the AM broadcast band. That's .5 to 3 Megahertz but the AM stations end at 1.7 Megahertz.
- "Shortwave" is from 3 to 30 Megahertz.
- "Very High Frequency" goes from 30 Megahertz to 300 Megahertz.
- "Ultra High Frequency" goes from 300 Megahertz to 3,000 Megahertz (up through channel 83 or so on TV)
- The we bump into Super High Frequency services like radars and such.

Bands and Channels

- A “band” is a range of frequencies. Like the “shortwave bands”

Meter Band	Frequency Range	Remarks
120 m	2,300 - 2,495 kHz	tropic band
90 m	3,200 - 3,400 kHz	tropic band
75 m	3,900 - 4,000 kHz	shared with the amateur radio 75/80 meter band
60 m	4,750 - 5,060 kHz	tropic band
49 m	5,900 - 6,200 kHz	
40 m	7,100 - 7,300 kHz	shared with the amateur radio 40 meter band
41 m	7,300 - 7,350 kHz	
31 m	9,400 - 9,900 kHz	
25 m	11,600 - 12,100 kHz	
22 m	13,570 - 13,870 kHz	
19 m	15,100 - 15,800 kHz	
16 m	17,480 - 17,900 kHz	
15 m	18,900 - 19,020 kHz	
13 m	21,450 - 21,850 kHz	
11 m	25,600 - 26,100 kHz	

A channel is a single frequency

The channel is always the carrier frequency, or the implied carrier frequency is using a suppressed carrier which we'll explain in a minute.

Police and fire has "channels" and these are within the UHF and VHF "public service" bands

Propagation

LF Low Frequency 30 - 300 kHz - Guided between the earth and the ionosphere

- Ground Waves

MF Medium Frequency 300 - 3000 kHz - Ground waves

- E layer ionospheric refraction at night, when D layer absorption disappears

HF High Frequency (Short Wave) 3 - 30 MHz - E layer ionospheric refraction

- F layer ionospheric refraction

VHF Very High Frequency 30 - 300 MHz - Line-of-sight

Listening Rules

- High frequencies (above 10 Mhz) work well in daytime.
- Lower frequencies work well at night.
- Line of sight is the same day or night.
- “Gray line” propagation is interesting because that’s when “band conditions change” (twilight zone propagation)
- MUF is “Maximum Useable Frequency”

Modulation Types

- CW – Continuous Wave
- AM - Amplitude Modulation
  - Center carrier wave (on 1 MHz for example)
  - A 1 KHz audio tone will produce an upper and a lower “sideband”. These “beat” against the carrier and you hear the tone.
- FM - Frequency Modulation
  - A center carrier “deviates” around a center frequency (such as 100 MHz) The width of the carrier deviation determines the volume and how fast is goes back and forth determines the frequency.

Single Sideband

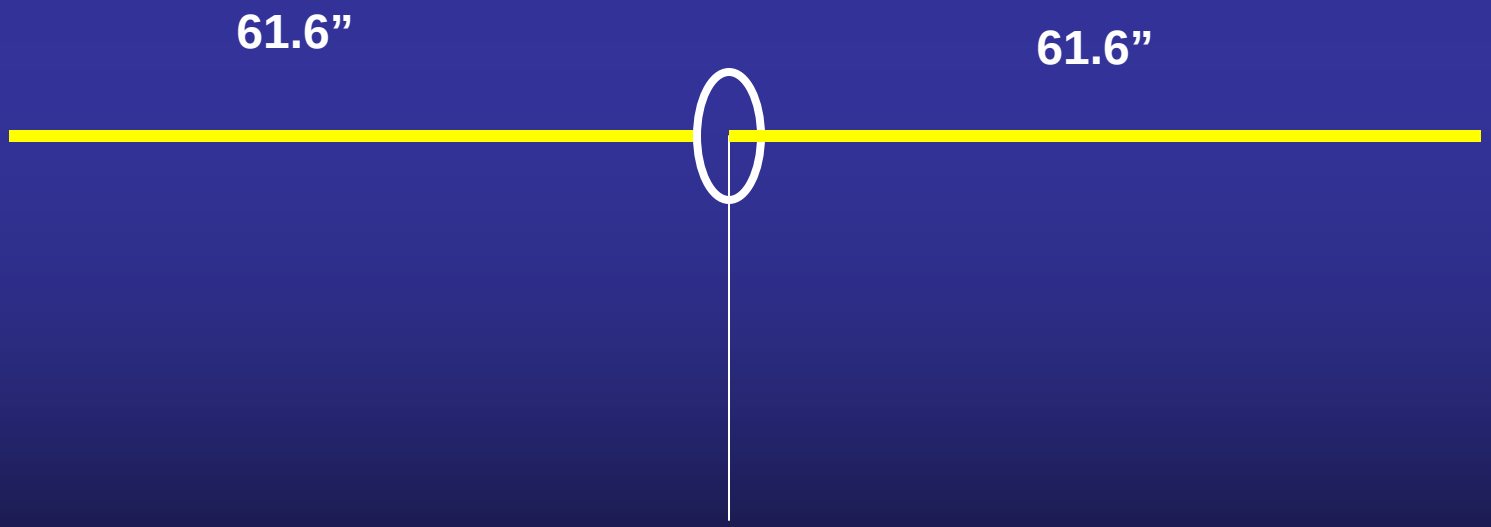
- AM radio rolls off above about 5 KHz, and is pretty well gone at 10 KHz due to channel spacing.
  - A 10 KHz tone produces a sideband 10 KHz above the carrier center frequency and then another one below the carrier. These are “upper” and Lower Sidebands
  - In Single sideband (SSB), the highs are limited to about 3.5 kilohertz, the low roll off under 300 Hz, the carrier is done away with, and one sideband is suppressed.
  - As a result, a ham radio SSB transmitter putting out 1.2 kilowatts has about the same “talk power” as a 5 kilowatt (5,000 watt) AM radio station

Antennas

- The one rule to remember is that a half wavelength antenna is 468 divided by frequency in Megaherz.
- The most common antenna is a “dipole” with a quarter wavelength on either side of a center feed point.

Sample Dipole

- At 3.8 MHz, each side of a dipole is about 61.5’ long



AM, FM, and VHF Antennas

- A quarter wave at 600 on AM is about 390 feet.
- A quarter wave at 1500 on AM is about 156 feet.
- At 100 MHz it's about 28"
- At 144 MHz, which is the 2 Meter ham band, a line of sight band, you're looking at about 19 ½ inches.

Exotic Antennas

- Loops can be any size – Art Bell has one of the largest, and you can see pictures at http://www.smeter.net/w6obb/antenna-farm.php
- Man good manufacturers such as Hy-Gain antennas

  http://www.hy-gain.com/manuals.php

Basic Electronic Components

- Resistors (heater element)
- Capacitor (stores energy)
- Transformer (steps AC up or Down)
- Chips and tubes
  - Allow a very small voltage to control a big voltage
  - Small voltage controlling big voltage is how all amplifiers work.

Basic Electronics

- Ohm's Law
- E= I * R where E = Voltage, I= Current in Amps, and R = Resistance in Ohms

SAMPLE

12 volt battery
Divided by 10 ohm resistor
Draws 1.2 Amps

Basic Electronics

- The Power Law
- P= I * E where P = Power in Watts, I = current in Amps, and E = Voltage

SAMPLE

1500 Watt Heater
Divided by 120 Volts
Draws 12.5 Amps

Equipment

- Might want to start with a $100 class shortwave radio.
- http://www.radiolabs.com/products/radio/shortwave.php?PHPSESSID=a375ecd74e0644b11ba3f09d7ab6d16d
- I personally like the Kaito 1102 (which I have) and the Kaito 1103. Why? Under $100, good shortwave listening, portable, rechargable, and can get Morse Code and SSB with a little paitience.

First real Ham Rig

- Icom 718 is a good starter unit. Get it with the UT-106 digital signal processor installed for under $600.
- Sample site: http://www.twowayradioonline.com/IC718.asp

Where Does the Hobby Take You?

- Broadcast engineering
- Cell Phone engineer
- Shipboard electronics officer
- Electronics tech of all stripes
- Ham radio contests
- Ham radio satellites (www.amsat.org)
- The International Morse Code Preservation Society (www.fists.org)

The Big National Organization

- American Radio Relay League
- www.arrl.org
- Lots of licensing, books, studies, lists of ham fests and so forth.