Communications: Radio Basics & Handheld Radios
GOALS/OBJECTIVES:

- Basic understanding of radio waves.
- Basic understanding of the types of handheld radio technology.
- Understanding of the legal requirements for this technology.
- Be aware of HAM radio education resources.
- Access to HAM radio testing sessions.
- Be able to make a decision regarding your family or local community communication needs.
- Get your questions answered about handheld radio technology.
- This presentation will NOT involve programming the radios. There are instructions in PDF format at corac.co in the Communications Team Forum. Understanding some of the concepts can help with programming.
- THIS PRESENTATION IS NOT INCLUSIVE OF EVERYTHING CONCERNING RADIO WAVES AND RADIOS, THIS INFORMATION IS SIMPLY TO “SHORTEN YOUR LEARNING CURVE”
• Part of the electromagnetic spectrum (EMS)
• EMS comprised of many different types of waves
• EMS waves can be controlled by electricity and magnets or their fields
• Consists of the longest waves of the EMS; according to NASA, ranging from more than 62 miles (100 kilometers) long down to @ 0.04 inches (1 millimeter)
• EMS organized by 2 measurements: wavelength and frequency
RADIO WAVE COMPONENTS

Amplitude: height
Frequency: rate of occurrence
Wavelength: length

Measured in hertz
1 hertz (Hz) is one cycle per second
A cycle is measured from crest to crest of a wave
1000 Hz = 1 kilohertz (kHz)
1000000 Hz = 1000 kHz = 1 megahertz (MHz)

The longer the wavelength
the lower the frequency and energy.

The shorter the wavelength
the higher the frequency and energy.
A radio that sends radio waves is a transmitter.
A radio that receives radio waves is a receiver.
Radio waves can be produced by radio transmitters and received by radio receivers because of antennas.
A single radio that can transmit and receive radio waves is called a transceiver.
To send information by radio waves, it has to be coded in some way.
Requires two different waves
  - The carrier wave
  - The information bearing wave (the modulated or modified radio wave)
There are two main methods:
  - Amplitude modulation (AM) encodes the information by varying or modifying the amplitude, or height, of the waves
  - Frequency modulation (FM) encodes the information by varying or modifying the number of waves per second.
AM waves are impacted by environmental factors that affect sound quality.
FM waves have better sound quality because they are not impacted by environmental factors as much.
Radio waves of different frequencies contain various characteristics of propagation (behavior as they travel) along the Earth's surface and in the Earth’s atmosphere.

• Longer waves (LW & MW) can bend around different obstacles and follow the outline of the horizon
• Shorter waves (SW) reflect off the ionosphere and get back over the horizon of sky waves (HF).

**REMEMBER:**
The longer the wavelength the lower the frequency and energy, lower energy waves bend more.
The shorter the wavelength the higher the frequency and energy, higher energy waves bend less.

*Shortwave radio can be used for very long distance communication (HF), in contrast to radio waves of higher frequency (VHF/UHF) that travel in straight lines (line-of-sight propagation).*
RADIO WAVES ARE GROUPED INTO BANDS OF RELATED WAVES & FREQUENCIES

<table>
<thead>
<tr>
<th>Band</th>
<th>Frequency range</th>
<th>Wavelength range</th>
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<tbody>
<tr>
<td>Extremely Low Frequency (ELF)</td>
<td>&lt;3 kHz</td>
<td>&gt;100 km</td>
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<tr>
<td>Very Low Frequency (VLF)</td>
<td>3 to 30 kHz</td>
<td>10 to 100 km</td>
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<tr>
<td>Low Frequency (LF)</td>
<td>30 to 300 kHz</td>
<td>1 m to 10 km</td>
</tr>
<tr>
<td>Medium Frequency (MF)</td>
<td>300 kHz to 3 MHz</td>
<td>100 m to 1 km</td>
</tr>
<tr>
<td>High Frequency (HF)</td>
<td>3 to 30 MHz</td>
<td>10 to 100 m</td>
</tr>
<tr>
<td>Very High Frequency (VHF)</td>
<td>30 to 300 MHz</td>
<td>1 to 10 m</td>
</tr>
<tr>
<td>Ultra High Frequency (UHF)</td>
<td>300 MHz to 3 GHz</td>
<td>10 cm to 1 m</td>
</tr>
<tr>
<td>Super High Frequency (SHF)</td>
<td>3 to 30 GHz</td>
<td>1 to 1 m</td>
</tr>
<tr>
<td>Extremely High Frequency (EHF)</td>
<td>30 to 300 GHz</td>
<td>1 mm to 1 cm</td>
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</table>

Bands do not mix with each other.
HF radios cannot pick up VHF/UHF signals.
VHF/UHF radios cannot pick up HF signals.
Your radio is designed for picking up specific bands.
A HAM operator may have his or her “radio station or HAM shack” set up with equipment to transmit or pick up the different bands (HF/VHF/UHF).
AMATEUR RADIO BANDS ARE REFERRED TO BY THEIR:

- Wavelength:
  - 70cm for UHF
  - 2M for VHF
  - 20M, 40M for HF
- Frequency (FQ):
  - 420 MHz for UHF
  - 144 MHz for VHF
  - 14 MHz, 7 MHz for HF

Notice that as wavelength increases frequency decreases.

20M – 14 MHz
40M – 7 MHz
80M – 3.5 MHz

Frequency (FQ):
- 70cm for UHF
- 420 MHz for UHF
- 2M for VHF
- 144 MHz for VHF
- 20M, 40M for HF
- 14 MHz, 7 MHz for HF

*Geographical and power restrictions may apply in all bands. Consult ARRL's Limited Edition Radio Regulations for additional information.*
INTERFERENCE/NOISE WITH AMATEUR RADIO SIGNALS

“One man’s noise is another man’s signal.” Dave Casler KE0OG

Purpose of this information is to show there are many reasons a person can have the best equipment and yet have problems sending or receiving a radio signal.
Is he EVER gonna talk about the radios?
WHAT IS MOST IMPORTANT WITH A RADIO?

Power or wattage of the radio
Antenna
Why?
Both can increase the effective range of the radio!
SINGLE BAND/DUAL BAND

A radio designed for only operation on the UHF frequencies is known as a single band radio. A radio designed for operation on VHF/UHF frequencies is known as a dual band radio. As a general rule, radios with access to VHF and/or UHF frequencies work best outdoors.

Which band is better?
DEPENDS ON YOUR NEEDS.

UHF vs VHF
• Works slightly better indoors
• Possible to penetrate walls
• Travel shorter distance
• Better in urban areas

VHF vs UHF
• Works slightly better outdoors
• No possibility to penetrate walls
• Travel farther distance
• Better in suburban and rural areas
FRS Radios

• FRS is the abbreviation for Family Radio Services
• "Walkie-talkies", mobile radios designed to be used for family activities
• No test or license required by the FCC
• Power output is 0.5 Watts to 2 Watts
• Operates on FM UHF band (SINGLE BAND)
• Work on dedicated frequencies called channels
• 22 FRS channels available
• Shares channels 1-7 and 15-22 with GMRS since 2017
• Many FRS radios only work on Channels 8-14 but may be numbered 1 – 7
• NOAA Weather alert
• Typical communication distance is 0.5-2 miles
• Requires a fixed antenna (stubby antenna due to limited range)
• Great for short distances, dense woods or around buildings
• About $50.00 per two pack
GMRS is the abbreviation for General Mobile Radio Services
"Walkies-talkies", mobile radios designed to be used for family, group, or business activities
No test BUT license required by the FCC (good for the whole family for 10 years)
Currently license is $70 but FCC is working to reduce to $35 (waiting for @ 1 year)
Power output is 0.5 Watts to 5 Watts
Operates on FM UHF band (SINGLE BAND)
Work on dedicated frequencies called channels
30 GMRS channels available
Channels 15-22 are GMRS-FRS and GMRS Repeater outputs
NOAA Weather alert
Typical communication distance achieved is 2-6 miles
Better for slightly longer distances and few obstructions
Usually a fixed antenna (stubby antenna due to limited range)
About $70.00 per two pack
# FRS/GMRS Channels & Frequencies

<table>
<thead>
<tr>
<th>Channel</th>
<th>Frequency</th>
<th>Description</th>
<th>Channel</th>
<th>Frequency</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>462.5625 MHz</td>
<td>GMRS/FRS</td>
<td>12</td>
<td>467.6625 MHz</td>
<td>FRS</td>
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<tr>
<td>2</td>
<td>462.5875 MHz</td>
<td>GMRS/FRS</td>
<td>13</td>
<td>467.6875 MHz</td>
<td>FRS</td>
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<tr>
<td>3</td>
<td>462.6125 MHz</td>
<td>GMRS/FRS</td>
<td>14</td>
<td>467.7125 MHz</td>
<td>FRS</td>
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<tr>
<td>4</td>
<td>462.6375 MHz</td>
<td>GMRS/FRS</td>
<td>15</td>
<td>462.5500 MHz</td>
<td>GMRS</td>
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<td>5</td>
<td>462.6625 MHz</td>
<td>GMRS/FRS</td>
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<td>6</td>
<td>462.6875 MHz</td>
<td>GMRS/FRS</td>
<td>17</td>
<td>462.6000 MHz</td>
<td>GMRS</td>
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<td>7</td>
<td>462.7125 MHz</td>
<td>GMRS/FRS</td>
<td>18</td>
<td>462.6250 MHz</td>
<td>GMRS</td>
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<td>8</td>
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<td>19</td>
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<td>GMRS</td>
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<tr>
<td>9</td>
<td>467.5875 MHz</td>
<td>FRS</td>
<td>20</td>
<td>462.6750 MHz</td>
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<td>10</td>
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<td>FRS</td>
<td>21</td>
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<td>11</td>
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<td>FRS</td>
<td>22</td>
<td>462.7250 MHz</td>
<td>GMRS</td>
</tr>
</tbody>
</table>
How to apply for a GMRS license and receive your FCC call sign | RadioReference.com Forums

A search of the above link gives very detailed instructions for applying.

1) Create an FCC Universal Licensing System account
2) Log in to the ULS
3) Begin application for a GMRS license
4) Submit the application & fee
5) Receive call sign and download authorization documents
HT Radios

• HT is the abbreviation for Handheld Transceiver HAM Radios.
• “Handy-talkies”, mobile radios designed to be used on VHF/UHF HAM bands
• A radio with access to VHF/UHF is a DUAL BAND radio
• Test AND license required by the FCC (good for an individual for 10 years)
• Requires at least a Technician license to transmit
• No license required to listen, but DO NOT PRESS THE PTT (push-to-talk) BUTTON
• Can transmit if emergency exists without a license
• If used and no emergency exists other HAMS can & will report you
• FCC penalty for unauthorized use can include seizure of equipment, fines and other civil and criminal penalties.
HTs continued

- Works on some dedicated frequencies called channels and free frequencies
- Can not be used on FRS/GMRS channels
- NOAA Weather alert
- Typical communication distance 2-6 miles without a repeater, 6-30 miles with a repeater.
- Comes with a “rubber-duck” antenna
- “Your radio is only as good as your antenna”
- To improve reception upgrade antenna(s)
• Power output of **Yaesu FT-60R** is 5 Watts
• Japanese made radio
• Cost: FT-60R @ $155.00 + tax, shipping & accessories
• Sturdy, well built radio

Package usually comes with the radio, one battery, standard “rubber duck” antenna, a standard battery charger, USB cable, belt clip, warranty card and instruction manual.

**BE SURE TO CHECK WHAT IS INCLUDED IN YOUR RADIO PURCHASE.**

**Vendors:** dxengineering.com or gigaparts.com

**Recommended minimum:**
• The radio
• One or more extra batteries
• **Upgraded antenna to increase range of radio (Diamond SRH77CA)**

Consider adding one or more of the following:
• Rapid charger (normal charger takes @ 9 hours to fully charge battery, @ 3 hours with this)
• Car charger (allows the vehicle battery to charge the transceiver battery)
• Solar battery bank (allows the battery to be charged directly with solar battery)
• Cloning cable if two or more of the same radios are purchased. (Allows you to easily clone additional similar radios once you program the initial radio.)
• Power output of **Yaesu FT-70DR** is 5 Watts
• Japanese made radio
• Cost: FT-70DR @$175.00 + tax, shipping & accessories
• Sturdy, well built radio

Package usually comes with the radio, one battery, standard “rubber duck” antenna, a standard battery charger, USB cable, belt clip, warranty card and instruction manual. BE SURE TO CHECK WHAT IS INCLUDED IN YOUR RADIO PURCHASE.

**Vendors:** dxengineering.com or gigaparts.com

Recommended minimum:
• The radio
• One or more extra batteries
• **Upgraded antenna to increase range of radio (Diamond SRH77CA)**

Consider adding one or more of the following:
• Rapid charger (normal charger takes @ 9 hours to fully charge battery, @ 3 hours with this)
• Car charger (allows the vehicle battery to charge the transceiver battery)
• Solar battery bank (allows the battery to be charged directly with solar battery)
• Cloning cable if two or more of the same radios are purchased. (Allows you to easily clone additional similar radios once you program the initial radio.)
- Power output of **BAOFENG BF-F8HP** is 8 Watts
- Chinese made radio
- Cost: FT-60R @$65.00 + tax, shipping & accessories
- Relatively inexpensive radio

Package usually comes with the radio, one 2100 mAh battery (small battery), standard “rubber duck” antenna, a standard battery charger with wall adapter plug, single PTT OEM earpiece kit, belt clip, warranty card and instruction manual.

**BE SURE TO CHECK WHAT IS INCLUDED IN YOUR RADIO PURCHASE.**

**Vendor:** baofengtech.com

**Recommended minimum:**
- The radio
- One or more extra batteries (BL-5L 3800 mAh battery, large battery)
- **Upgraded antenna to increase range of radio (Nygoya NA-771)**

Consider adding one or more of the following:
- USB to 10V Smart Charger (allows the battery charger dock to be used with a USB solar battery)
- BT1013 USB Direct Battery Charger Cable (allows the battery to be charged directly with a USB solar battery)
- BL-5 AA Battery Pack (allows the use of AA batteries, standard or rechargeable)
- BL-5 Battery Eliminator Car Charger (does not charge the battery, allows the radio to use the vehicle’s battery to power the transceiver)
- PC03 programming cable (will need to download CHIRP software, which is FREE)  

**Be careful of counterfeits**
HAM RADIO EDUCATION RESOURCES

ONLINE:
- hamtestonline.com ($24.95 for 6 months access)
- hamradioprep.com ($35.00 for lifetime access)
- hamradioschool.com (best coupled with the book)
- others

PHONE APPS (recommend for Q&A)
HAM RADIO EDUCATION RESOURCES

Various books from
- arrl.org
- Gordon West Technician Class
- HAM Radio School (hamradioschool.com)

Manual with Q&As
Q&As only
Manual with Q&As
Manual with Q&As
TESTING SESSIONS

Find an Amateur Radio License Exam in Your Area (arrl.org)
http://www.arrl.org/find-an-amateur-radio-license-exam-session

Online or in person
### What to do after you get your license?

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<th>Phonetic</th>
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<th>Phonetic</th>
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The International Telecommunications Union
Standard Phonetic Alphabet

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Learn the phonetic alphabet to give your call sign

**Whiskey Tango Foxtrot?**

WTF = WHERE’S THE FUN?!