Amateur Radio License

Radios, Power, RFI
Todays Topics

• Types of Modulation : Chapter 2
• Radio Equipment : Chapter 5
  • Radios
  • Digital Communications
  • Power Supplies and Batteries
  • RF Interference, Grounding
Types of Modulation

- Information is encoded in different ways
  - Morse Code (CW)
  - Amplitude Modulation (AM)
  - Frequency Modulation (FM)
  - Phase modulation (PM)
- Many others
**CW (Morse Code)**

- Sequence of Dots and Dashes
- A continuous carrier is gated on and off
Amplitude Modulation (AM)

- The amplitude of a carrier is modulated (multiplied) by the signal we want to transmit.
- Several variations
AM Signal Spectrum

- Carrier
- Upper side band (USB)
- Lower side band (LSB)
- Either sideband sufficient
- Voice bandwidth 300 Hz to 3 kHz, full bandwidth 6 kHz
- With SSB need 3 kHz
- Common for HF
  Also weak signal VHF, UHF
Frequency Modulation

- Information encoded in frequency of carrier
- Wider bandwidth than AM
  Voice 5-15 kHz
- More resistant to propagation effects
- Common for VHF/UHF handhelds and mobiles
- Also digital packet, voice
Typical Questions

• Why should you not set your transmit frequency to be exactly at the edge of an amateur band or sub-band? (T1B09)

• What might be the problem if a repeater user says your transmissions are breaking up on voice peaks? (T2B05)

• Which type of modulation is most commonly used for VHF and UHF voice repeaters? (T8A04)

• Which type of voice modulation is most often used for long-distance or weak signal contacts on the VHF and UHF bands? (T8A03)
# Signal Bandwidths

<table>
<thead>
<tr>
<th>Signal Type</th>
<th>Bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM Voice</td>
<td>6 kHz</td>
</tr>
<tr>
<td>AM Broadcast</td>
<td>10 kHz</td>
</tr>
<tr>
<td>Commercial Video</td>
<td>6 MHz</td>
</tr>
<tr>
<td>SSB Voice</td>
<td>3 kHz</td>
</tr>
<tr>
<td>SSB Digital</td>
<td>0.5-3 kHz</td>
</tr>
<tr>
<td>CW (Morse Code)</td>
<td>150 Hz</td>
</tr>
<tr>
<td>FM Voice</td>
<td>5-15 kHz</td>
</tr>
<tr>
<td>FM Broadcast</td>
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Which of the following types of emission has the narrowest bandwidth? (T8A05)

A. FM voice
B. SSB voice
C. CW
D. Slow-scan TV
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B. SSB voice

C. CW

D. Slow-scan TV
Which sideband is normally used for 10 meter HF, VHF and UHF single-sideband communications? (T8A06)

A. Upper sideband
B. Lower sideband
C. Suppressed sideband
D. Inverted sideband
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*Remember “USB above 10 MHz”*
What is the primary advantage of single sideband over FM for voice transmissions? (T8A07)

A. SSB signals are easier to tune
B. SSB signals are less susceptible to interference
C. SSB signals have narrower bandwidth
D. All of the choices are correct
What is the primary advantage of single sideband over FM for voice transmissions? (T8A07)

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Other Questions

• What is the approximate bandwidth of a single sideband voice signal? (T8A08)

• What is the approximate bandwidth of a VHF repeater FM phone signal? (T8A09)

• What is the typical bandwidth of analog fast-scan TV transmissions on the 70 cm band? (T8A10)

• What is the approximate maximum bandwidth required to transmit a CW signal? (T8A11)
Basic Radio Components

Diagram showing the basic components of a radio system:

- Antenna
- Feed line
- Transmitter
- TR Switch
- Receiver
- Power Supply

ARRL0001
Repeaters

Antenna (shared)

Transmitted signal out

Received signal in

Transmitter

Duplexer

Receiver

Speech from received signal
Radios

• Desktop Radios:
  • Many modes, complex
  • Mostly HF, 100W + Power Amps

• Mobile
  • FM, one or more bands
  • 50 W

• Handheld
  • FM, one or more bands, 5W
  • Simple, but lots of options
Desktop Radio

• HF, may have VHF, UHF

• Lots of modes (FM, SSB, Digital Voice and Data)

• 100 Watts (+ power amps to 1500 W)
Mobile Radio

• Car or fixed
• One, two, more bands VHF, UHF
• 50 Watts
• Always FM, may have digital voice, data
Handheld Radios

- VHF and/or UHF sometimes 220 MHz, 1.2 GHz
- 5 Watts
- Always has FM, may have digital voice and data
- Can be complex to operate
  Every button does three things
  Programmed with a PC, software
SDR’s

- Software defined radios
- USB peripheral
- Chassis + TX/RX daughtercards
- Direct digital synthesis and detection
- Needs amp, antenna, PC

Ettus B100

WRX: 50 MHz to 2.2 GHz
Major Transmitter Controls

• Tuning (VFO Dial, numeric input)

• Mode switch (FM, SSB, etc)

• Microphone: push-to-talk (PTT), voice activated (VOX), key

• Automatic level control

• Morse key
Major Receiver Controls

- Tuning (VFO dial, numeric input)
  May be independent of transmit

- Automatic gain control (AGC), but not for FM

- Squelch control: shuts off speaker if signal too low
  Common for FM

- Noise filters: match bandwidth of signal, suppress
  adjacent signals, blank spike noise

- Signal strength meter: S-meter from 1-9, with additional
  steps. Log scale with 6 dB per S unit (factor of 4 in power)
What term describes the use of a sub-audible tone transmitted along with normal voice audio to open the squelch of a receiver (T2B02)?

A. Carrier squelch
B. Tone burst
C. DTMF
D. CTCSS
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A. Carrier squelch
B. Tone burst
C. DTMF
D. CTCSS or PL code
What is the advantage of having multiple receive bandwidth choices on a multimode transceiver? (T4B08)

A. Permits monitoring several modes at once

B. Permits noise or interference reduction by selecting a bandwidth matching the mode

C. Increases the number of frequencies that can be stored in memory

D. Increases the amount of offset between receive and transmit frequencies
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Which of the following receive filter bandwidths provides the best signal-to-noise ratio for SSB reception? (T4B10)

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B. 1000 Hz
C. 2400 Hz
D. 5000 Hz
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What can you do if you are told your FM handheld or mobile transceiver is over deviating? (T7B01)

A. Talk louder into the microphone
B. Let the transceiver cool off
C. Change to a higher power level
D. Talk farther away from the microphone
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Digital Data Modes

- Modem or sound card generates digital signals
  Terminal Node Controller (TNC)

- Many different modes
  - Radioteletype (RTTY)
  - PSK31
  - Packet AX.25
  - APRS
  - Winlink
Packet Radio

- AX-25: radio version of X-25, packet switched networks

- Packets have headers, checksums, and request for repeats (ARQ)

- Direct connections, or relayed through digipeaters (digital repeaters)

- Lots of packet repeaters around here, with connections to the internet (mail, ftp, etc)

- Your PC, radio, and packet modem software (Direwolf on Linux, for example).
APRS

- Radio + GPS
- Reports your position to internet servers
- Based on AX-25
- APRS: Automatic Position Reporting System
- Also text, email, weather
- iPhone, Android apps (must have license)
High Altitude Balloon Tracking

- icarusIV
- BSS6
- KI7NII-11
- K6RUE-11
- YPADSONDE
- KK6PN-5

0.0 m/s 0.0 m/s
RATE: VH
13,867 m (13,972 m)
ALTITUDE (MAX)
2017-05-25 16:31:06
DATETIME (LOCAL)
28.51567, -97.08033
COORDINATES
12 3.34 -10 13867 281
COMMENT
1 LOCK
12 SATS
3.34 SOLAR (V)
-10 TEMP (C)
Recieved 4h 45m ago via:
APRS, KA5WRY-10

Updated: 9s ago
What Day Was This?
Other Digital Modes

• RTTY : radio teletype, keyboard to keyboard

• PSK31 : low data rate digital mode, mostly HF

• JT65, JT9, FT8, FT4: very low data rate (73 bits/min!) but very sensitive.

• Winlink : radio email systems, used in emergency communications. Radio Message Servers (RMS) relay messages
BPSK31 Waveform
PSK 31 with fldigi
JT65, JT9
Monitoring AG6WH (last heard 4 mins ago). Automatic refresh in 5 minutes. Reception reports for AG6WH are shown as times (show logbook).

There are 875 active monitors: 286 on 20m, 194 on 10m, 83 on 40m, 79 on 15m, 72 on 30m, 26 on 80m, 23 on 12m, 19 on 2200m, 14 on unknown, 12 on 11m, 8 on 600m, 6 on 160m, 5 on 2m, 2 on 6m, 2 on 17m. Legend

Rx at Mon. 03 Nov 2014 18:19:25 GMT
From AG6WH by PY5ELO Loc GI25ar
Frequency: 28.076 MHz (10m), JT65
Distance: 8233 km bearing 108°
Using: JT65-HF 1.0.9.3/Rptr V1.4
200 mW on 40 m
100 mW on 20 m
Internet Gateway
Which of the following is an example of a digital communications method? (T8D01)

A. Packet radio

B. IEEE 802.11

C. JT65

D. All of these choices are correct
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What does the abbreviation PSK mean? (T8D06)

A. Pulse Shift Keying
B. Phase Shift Keying
C. Packet Short Keying
D. Phased Slide Keying
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Which of the following may be included in packet transmissions? (T8D08)

A. A check sum which permits error corrections

B. A header which contains the call sign of the station to which the information is being sent

C. Automatic repeat request in case of error

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Power

- Most radios use 12 Volts
  - DC power supplies
  - Batteries
12 V DC Power Supplies

- Linear: big transformers
  - Heavy: iron core transformers
  - Expensive
  - Very clean power
- Switchers: small transformers
  - High frequency switching before transformer
  - Lightweight, small, inexpensive
  - Often very noisy
Batteries

• Disposable, rechargeable, and storage

• Power storage measured in amps X hours

• Storage batteries (car batteries) have a whole set of potential issues.
# Battery Types

<table>
<thead>
<tr>
<th>Style</th>
<th>Chemistry</th>
<th>Rechargable</th>
<th>Voltage</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
<td>Alkaline</td>
<td>No</td>
<td>1.5 V</td>
<td>1000 mAh</td>
</tr>
<tr>
<td>AA</td>
<td>Alkaline</td>
<td>No</td>
<td>1.5 V</td>
<td>3000 mAh</td>
</tr>
<tr>
<td>AA</td>
<td>Carbon-Zinc</td>
<td>No</td>
<td>1.5 V</td>
<td>600 mAh</td>
</tr>
<tr>
<td>AA</td>
<td>Nickel-Cadmium</td>
<td>Yes</td>
<td>1.2 V</td>
<td>700 mAh</td>
</tr>
<tr>
<td>AA</td>
<td>Nickel-Metal Hydride</td>
<td>Yes</td>
<td>1.2 V</td>
<td>2000 mAh</td>
</tr>
<tr>
<td>C</td>
<td>Alkaline</td>
<td>No</td>
<td>1.5 V</td>
<td>7500 mAh</td>
</tr>
<tr>
<td>D</td>
<td>Alkaline</td>
<td>No</td>
<td>1.5 V</td>
<td>14000 mAh</td>
</tr>
<tr>
<td>9 V</td>
<td>Alkaline</td>
<td>No</td>
<td>9 V</td>
<td>580 mAh</td>
</tr>
<tr>
<td>9 V</td>
<td>Nickel-Cadmium</td>
<td>Yes</td>
<td>9 V</td>
<td>110 mAh</td>
</tr>
<tr>
<td>9 V</td>
<td>Nickel-Metal Hydride</td>
<td>Yes</td>
<td>9 V</td>
<td>150 mAh</td>
</tr>
</tbody>
</table>
Mobile, Storage Batteries

- Large amounts of stored energy
- If shorted, can overheat, produce hydrogen gas, and explode
- Should be well fused (both leads), and well ventilated
Radios in Cars

• Where do you get power, how do you connect
• Where does all the interference come from?
• Where do you put your antenna?
• Are you even allowed to use a radio in a car?
Where should the negative return connection of a mobile transceiver’s power cable be connected? (T4A11)

A. At the battery or engine block ground strap
B. At the antenna mount
C. To any metal part of the vehicle
D. Through the transceiver’s mounting bracket
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Radio Frequency Interference (RFI)

- Two situations:
  - Your radio interfering with other devices
  - Other devices interfering with you
- Many unlicensed RF devices (Part 15)
  - Must not cause interference with licensed users (you)
  - Must accept interference from users of properly operating equipment (you)
- Be diplomatic, first make sure your equipment is working, and then try to help them solve their problems
Types of RFI

- Direct detection – offending signals get into the electronics circuits to cause interference.

- Overload – strong signal that overwhels the weaker, wanted signal.

- Harmonics – multiples of the offending signal that coincide with the wanted signal.
RFI Mitigation

- Filters
  - Highpass: receive
  - Lowpass: transmit, eliminates harmonics
  - Notch: suppress particular signals to reduce overload
- Ferrites
  - RF chokes
RFI Sources

- Electrical arcs (motors, thermostats, electric fences, neon signs).
- Power lines.
- Motor vehicle ignitions or alternators.
- Switching power supplies.
- Computers, networks, and TV sets.
What should you do if something in your neighbor’s home is causing harmful interference to your amateur station? (T7B08)

A. Work with you neighbor to identify the offending device

B. Politely inform your neighbor about the rules that require him to stop using the device if it causes interference

C. Check your station and make sure it meets the standards of good amateur practice

D. All of these choices are correct
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Which of the following actions should you take if a neighbor tells you that your station’s transmissions are interfering with their radio or TV reception? (T7B06)

A. Make sure that your station is functioning properly and that it does not cause interference to your own television

B. Immediately turn off your transmitter and contact the nearest FCC office for assistance

C. Tell them that your license gives you the right to transmit and nothing can be done to reduce the interference

D. Install a harmonic doubler on the output of your transmitter and tune it until the interference is eliminated.
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Electrical Grounding and Circuit Protection (in the home)

- Make sure your home is “up to code.”
- Most ham equipment does not require special wiring or circuits.
- Use 3-wire power cords.
- Use circuit breakers, circuit breaker outlets, or Ground Fault Interrupter (GFI) circuit breakers.
- Use proper fuse or circuit breaker size.
- Don’t overload single outlets.
Next Time

• Safety

• Digital radio