Technician License Course
Chapter 2

Lesson Plan Module 3 –
Modulation and Bandwidth

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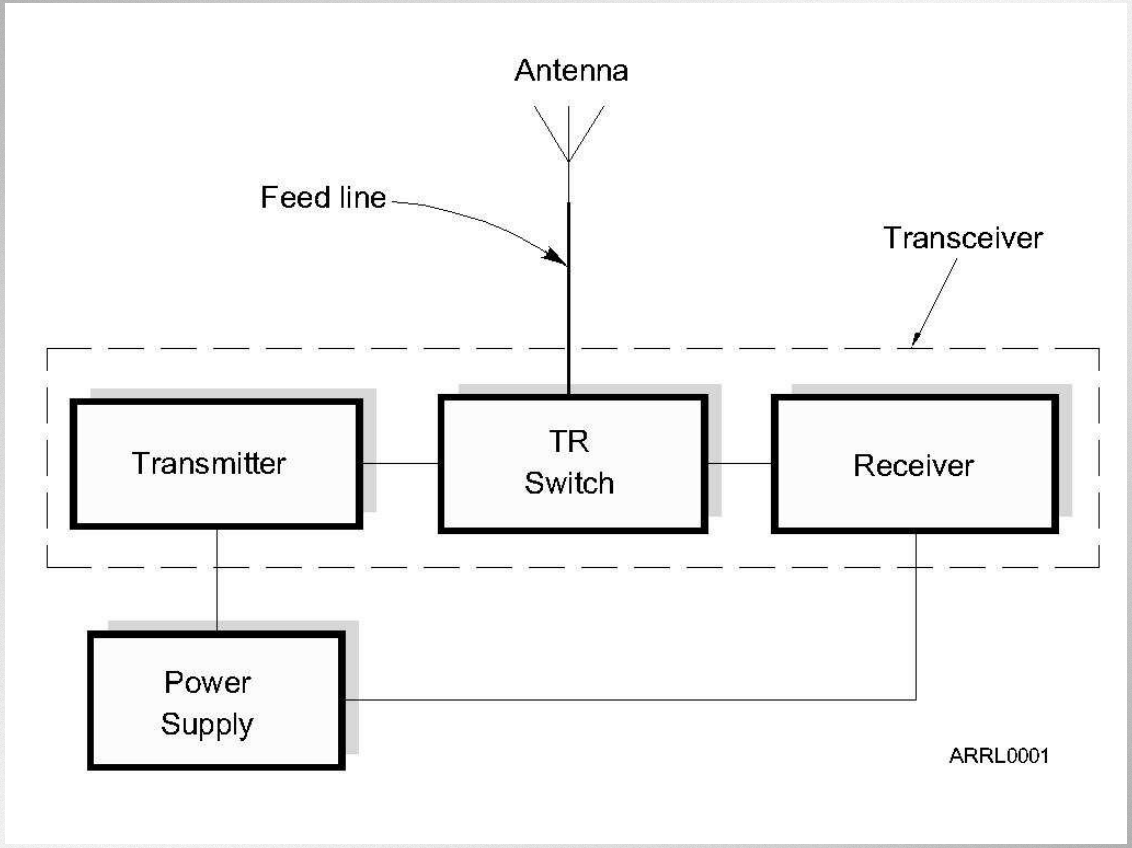
The Basic Radio Station



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What Happens During Radio Communication?

- Transmitting (sending a signal):
  - Information (voice, data, video, commands, etc.) is converted to electronic form.
  - The information in electronic form is added to a radio wave.
  - The radio wave carrying the information is sent from the station antenna into space.

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What Happens During Radio Communication?

- Receiving:
  - The radio wave carrying the information is intercepted by the receiving station's antenna.
  - The receiver extracts the information from the received wave.
  - The information is then presented to the user in a format that can be understood (sound, picture, words on a computer screen, response to a command, etc.).

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What Happens During Radio Communication?

- Adding and extracting the information can be simple or complex.
- This makes ham radio fun…learning all about how radios work.
- Don’t be intimidated. You will be required to only know the basics, but you can learn as much about the “art and science” of radio as you want.

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Adding Information – Modulation

- When we add some information to the radio wave, (the *carrier*) we *modulate* the wave.
  - Turn the wave on and off (Morse code)
  - Speech or music
  - Data
- Different modulation techniques vary different properties of the wave to add the information:
  - Amplitude, frequency, or phase

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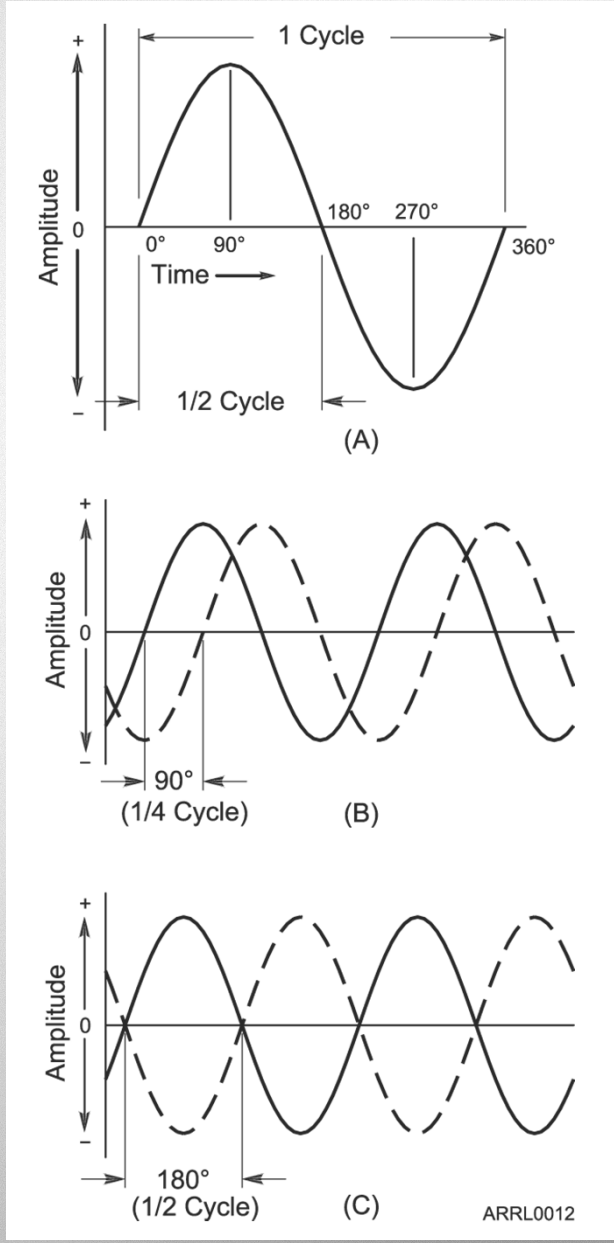
Phase

- Along with frequency and period, another important property of waves is *phase*.
- Phase is a position within a cycle.
- Phase is also a relative position between two waves.



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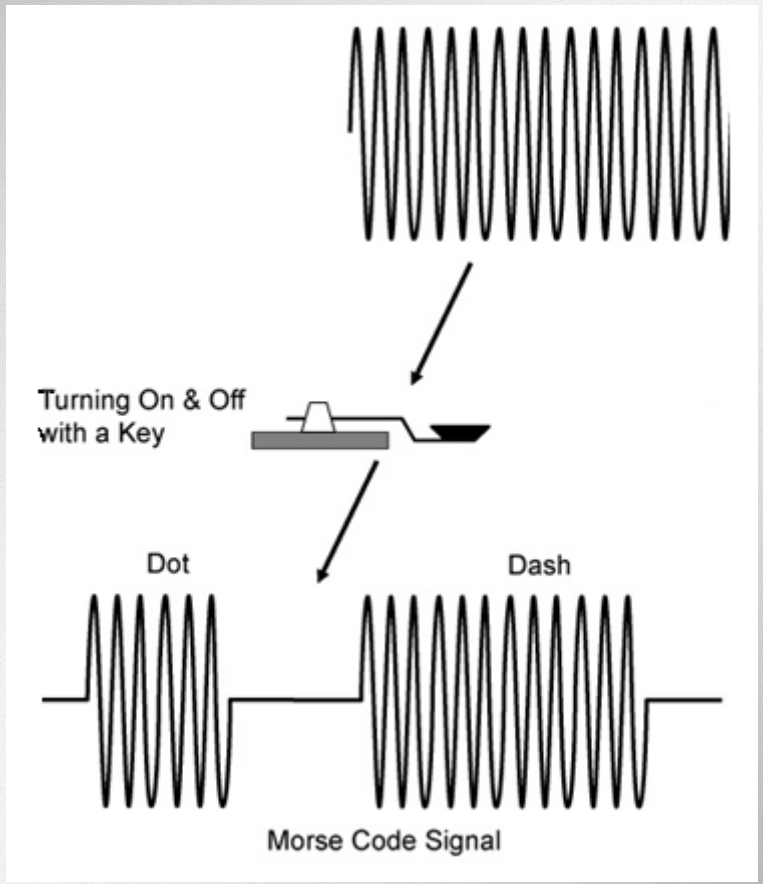
CW - Morse Code – On and Off



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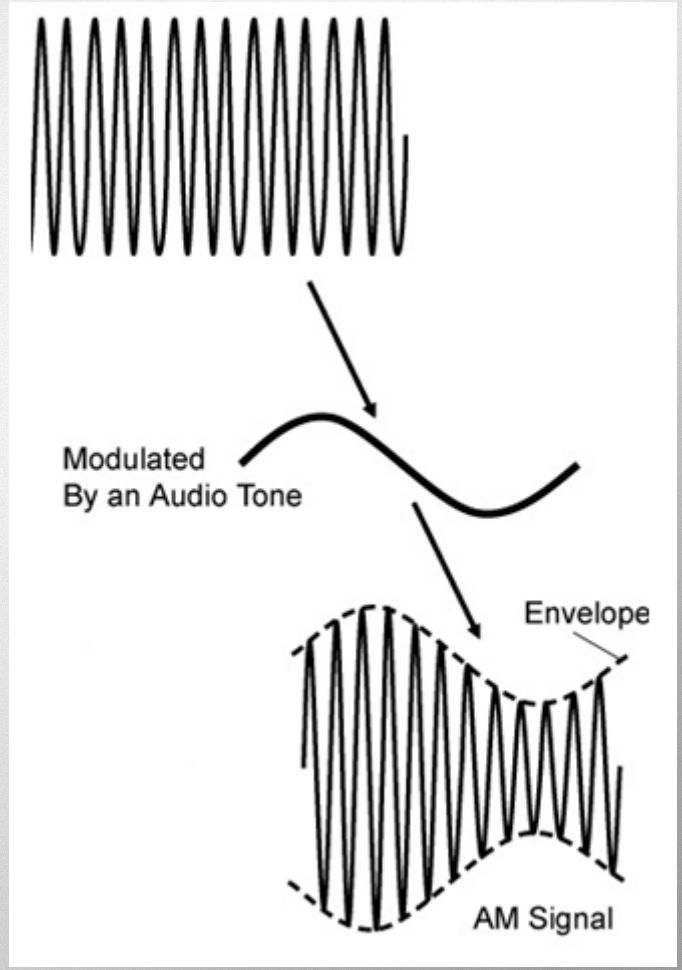
Amplitude Modulation (AM)

- In AM, the amplitude of the carrier wave is modified in step with the waveform of the information (the tone shown here).



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Composite Signals

- The process of adding information to an unmodulated radio wave creates additional signals called *sidebands*.
- The sidebands and carrier work together to carry the information.
- The combination of carrier and sidebands creates a *composite signal*.

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Bandwidth

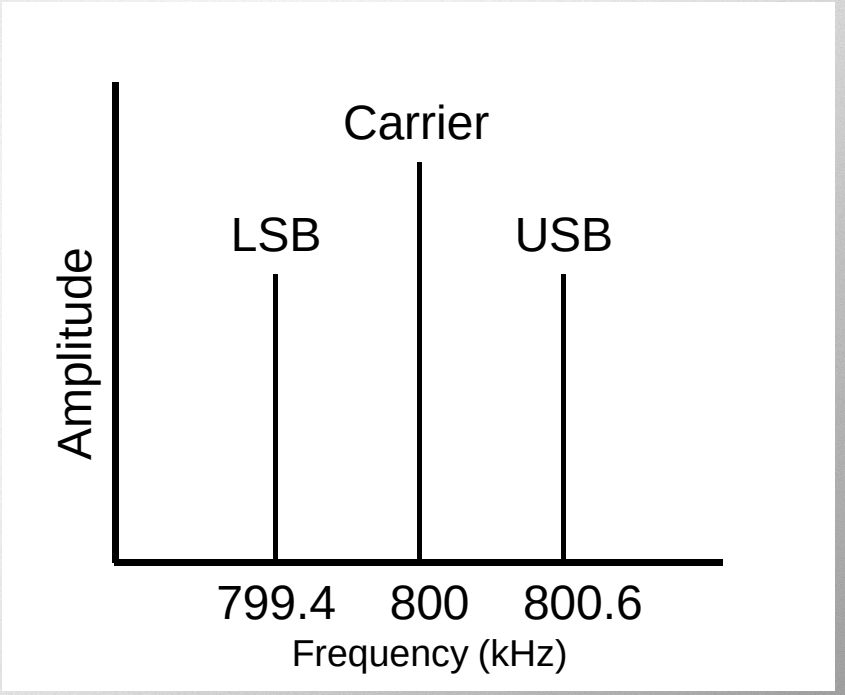
- The carrier and sidebands have different frequencies, occupying a range of spectrum space.
- The occupied range is the composite signal's *bandwidth.*
- Different types of modulation and information result in different signal bandwidths.

Characteristics of Voice AM

AM signals consist of three components:

- Carrier
- Lower sideband (LSB)
- Upper sideband (USB)

- AM bandwidth is twice the information bandwidth.



AM signal being modulated by a 600 Hz tone

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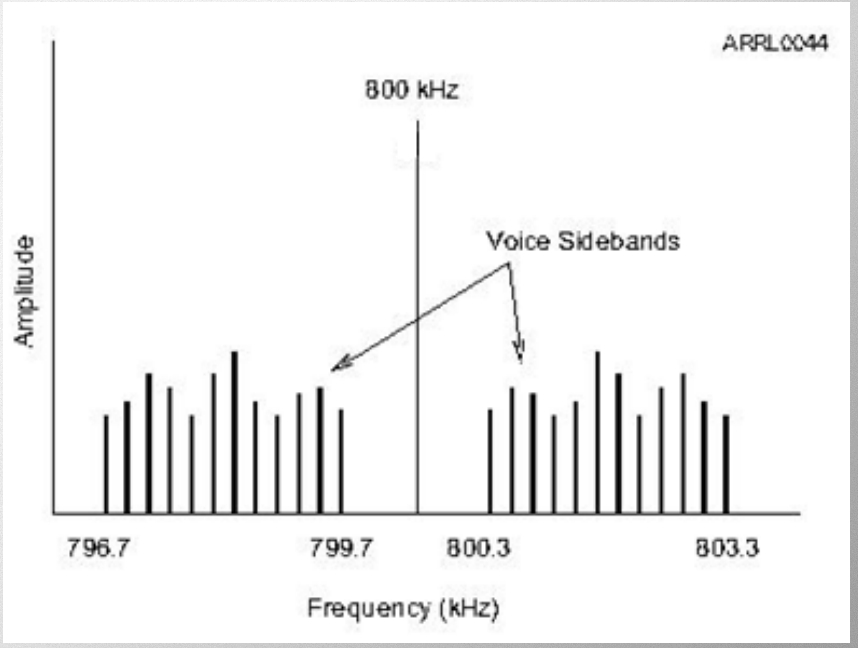
Characteristics of Voice Information

- Sounds that make up voice are a complex mixture of multiple frequencies from 300–3000 Hz
- Two mirror-image sets of sidebands are created, each up to 3000 Hz wide.
- AM voice signal bandwidth 2 x 3000 Hz = 6000 Hz



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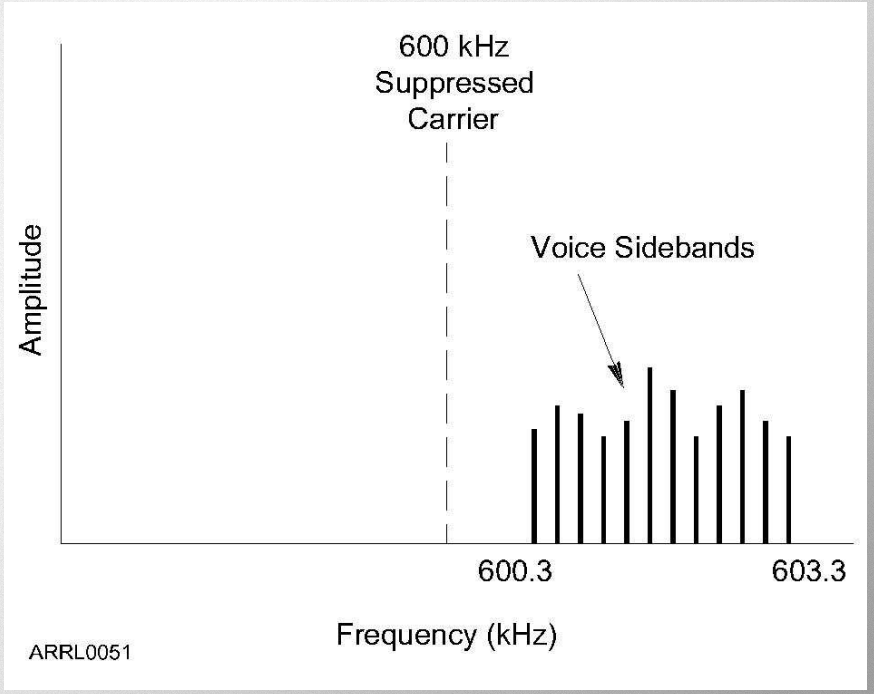
Single Sideband Modulation (SSB)

- The two sets of voice sidebands carry duplicate information.
- We can improve efficiency by transmitting only one sideband and reconstructing the missing carrier in the receiver.
- SSB bandwidth is only 3000 Hz for voice signals.



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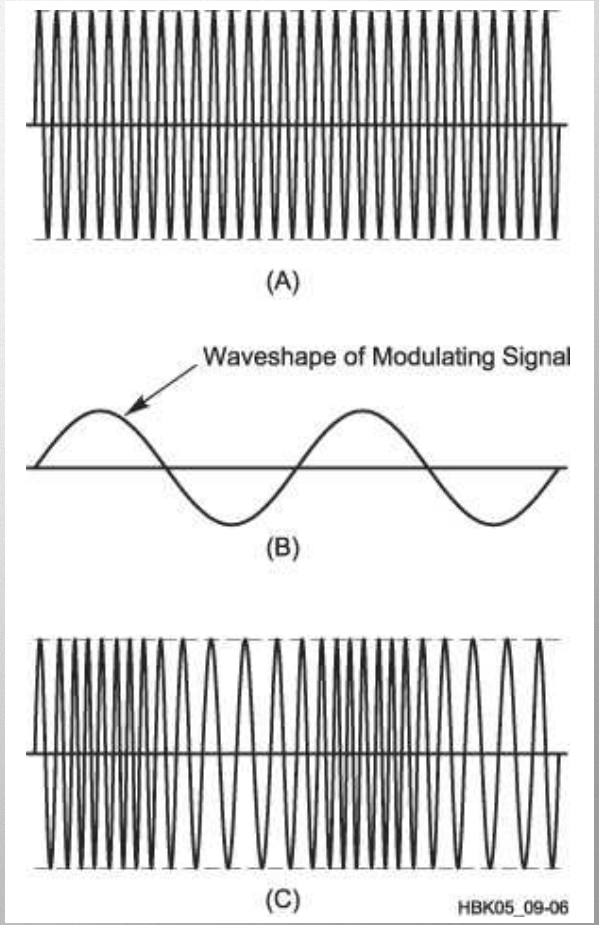
Frequency and Phase Modulation (FM and PM)

- Instead of varying amplitude, if we use the information to vary the carrier's frequency, *frequency modulation (FM)* is produced.
- FM bandwidth (for voice) is between 5 and 15 kHz.
- We can also shift the signal's phase back and forth, creating *phase modulation (PM)* that is very similar to FM.



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Typical Signal Bandwidths

Signal Bandwidths

Type of Signal	*Typical Bandwidth*
AM voice	6 kHz
AM broadcast	10 kHz
Commercial video broadcast	6 MHz
SSB voice	2 to 3 kHz
SSB digital	500 to 3000 Hz (0.5 to 3 kHz)
CW	150 Hz (0.15 kHz)
FM voice	10 to 15 kHz
FM broadcast	150 kHz

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Practice Questions

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

A. To allow for calibration error in the transmitter frequency display

B. So that modulation sidebands do not extend beyond the band edge

C. To allow for transmitter frequency drift

D. All of these choices are correct

FCC Rule: [97.101(a), 97.301(a-e)] T1B09 HRLM (2-10)

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What determines the amount of deviation of an FM (as opposed to PM) signal?

A. Both the frequency and amplitude of the modulating signal

B. The frequency of the modulating signal

C. The amplitude of the modulating signal

D. The relative phase of the modulating signal

T2B05 HRLM (2-10)

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T2B05 HRLM (2-10)

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What happens when the deviation of an FM transmitter is increased?

A. Its signal occupies more bandwidth

B. Its output power increases

C. Its output power and bandwidth increases

D. Asymmetric modulation occurs

T2B06 HRLM (2-9)

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T2B06 HRLM (2-9)

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Which of the following is a form of amplitude modulation?

A. Spread spectrum
B. Packet radio
C. Single sideband
D. Phase shift keying

T8A01 HRLM (2-9)

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Which of the following is a form of amplitude modulation?

A. Spread spectrum

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T8A01 HRLM (2-9)

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What type of modulation is most commonly used for VHF packet radio transmissions?

A. FM

B. SSB

C. AM

D. Spread spectrum

T8A02 HRLM (2-10)

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What type of modulation is most commonly used for VHF packet radio transmissions?

A. FM

B. SSB

C. AM

D. Spread spectrum

T8A02 HRLM (2-10)

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Which type of voice modulation is most often used for long-distance or weak signal contacts on the VHF and UHF bands?

A. FM

B. DRM

C. SSB

D. PM

T8A03 HRLM (2-11)

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A. FM

B. DRM

C. SSB

D. PM

T8A03 HRLM (2-11)

Which type of modulation is most commonly used for VHF and UHF voice repeaters?

A. AM

B. SSB

C. PSK

D. FM

T8A04 HRLM (2-10)

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Which type of modulation is most commonly used for VHF and UHF voice repeaters?

A. AM

B. SSB

C. PSK

D. FM

T8A04 HRLM (2-10)

Which of the following types of emission has the narrowest bandwidth?

A. FM voice

B. SSB voice

C. CW

D. Slow-scan TV

T8A05 HRLM (2-10)

Which of the following types of emission has the narrowest bandwidth?

A. FM voice

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C. CW

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T8A05 HRLM (2-10)

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Which sideband is normally used for 10 meter HF, VHF and UHF single-sideband communications?

A. Upper sideband

B. Lower sideband

C. Suppressed sideband

D. Inverted sideband

T8A06 HRLM (2-11)

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T8A06 HRLM (2-11)

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What is the primary advantage of single sideband over FM for voice transmissions?

A. SSB signals are easier to tune

B. SSB signals are less susceptible to interference

C. SSB signals have narrower bandwidth

D. All of these choices are correct

T8A07 HRLM (2-11)

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What is the primary advantage of single sideband over FM for voice transmissions?

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B. SSB signals are less susceptible to interference

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D. All of these choices are correct

T8A07 HRLM (2-11)

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What is the approximate bandwidth of a single sideband voice signal?

A. 1 kHz

B. 3 kHz

C. 6 kHz

D. 15 kHz

T8A08 HRLM (2-5)

What is the approximate bandwidth of a single sideband voice signal?

A. 1 kHz

B. 3 kHz

C. 6 kHz

D. 15 kHz

T8A08 HRLM (2-5)

What is the approximate bandwidth of a VHF repeater FM phone signal?

A. Less than 500 Hz

B. About 150 kHz

C. Between 10 and 15 kHz

D. Between 50 and 125 kHz

T8A09 HRLM (2-5)

ARRL The national association for AMATEUR RADIO

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C. Between 10 and 15 kHz

D. Between 50 and 125 kHz

T8A09 HRLM (2-5)

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

A. More than 10 MHz

B. About 6 MHz

C. About 3 MHz

D. About 1 MHz

T8A10 HRLM (2-5)

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

A. More than 10 MHz

B. About 6 MHz

C. About 3 MHz

D. About 1 MHz

T8A10 HRLM (2-5)

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What is the approximate maximum bandwidth required to transmit a CW signal?

A. 2.4 kHz

B. 150 Hz

C. 1000 Hz

D. 15 kHz

T8A11 HRLM (2-5)

What is the approximate maximum bandwidth required to transmit a CW signal?

A. 2.4 kHz

B. 150 Hz

C. 1000 Hz

D. 15 kHz

T8A11 HRLM (2-5)

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