

General Licensing Class

“G8”



Presented by the
Renton Emergency Communications Services

June 6, 2011



General Class Element 3 Course Presentation

➤ **ELEMENT 3 SUB-ELEMENTS**

G1 – Commission's Rules

G2 – Operating Procedures

G3 – Radio Wave Propagation

G4 – Amateur Radio Practices

G5 – Electrical Principles

G6 – Circuit Components

G7 – Practical Circuits

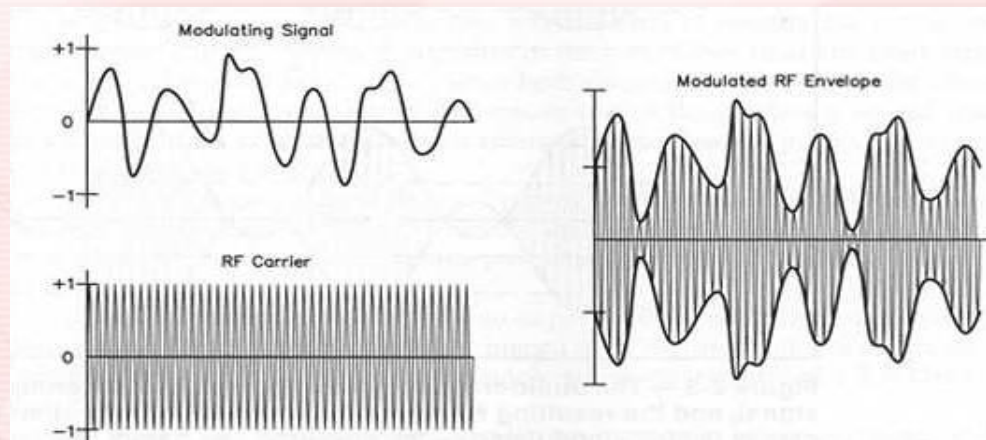
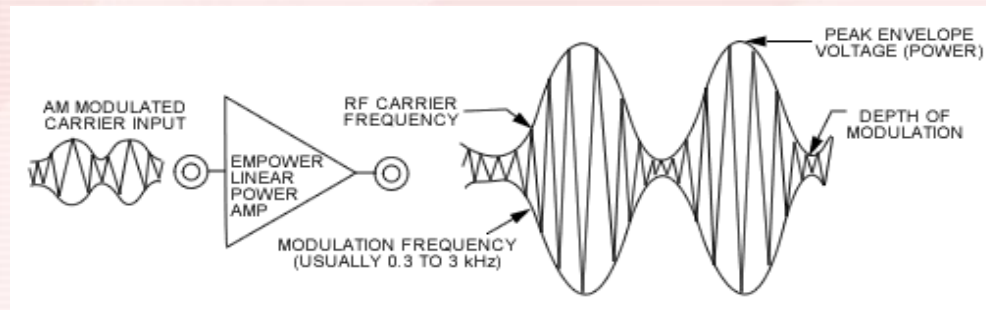
G8 – Signals and Emissions

G9 – Antennas

G0 – Electrical and RF Safety

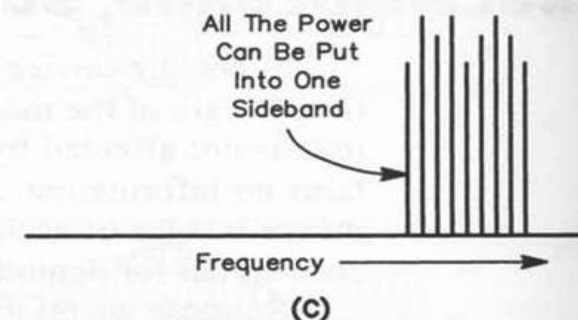
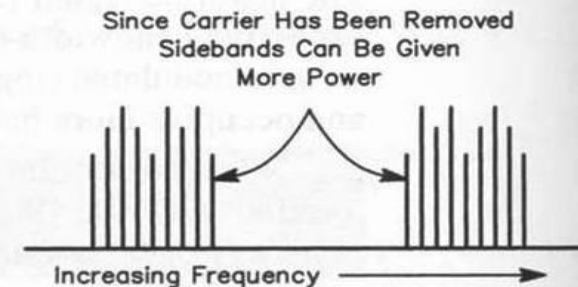
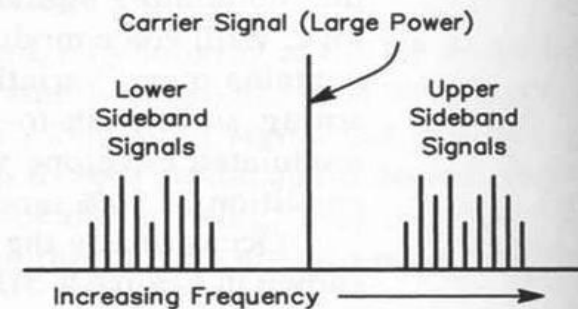
Carriers and modulation: AM

- **Amplitude modulation (AM) is the name of the process that changes the envelope of an RF wave to convey information.**
- **Amplitude modulation type of transmission varies the instantaneous power level of the RF signal to convey information.**

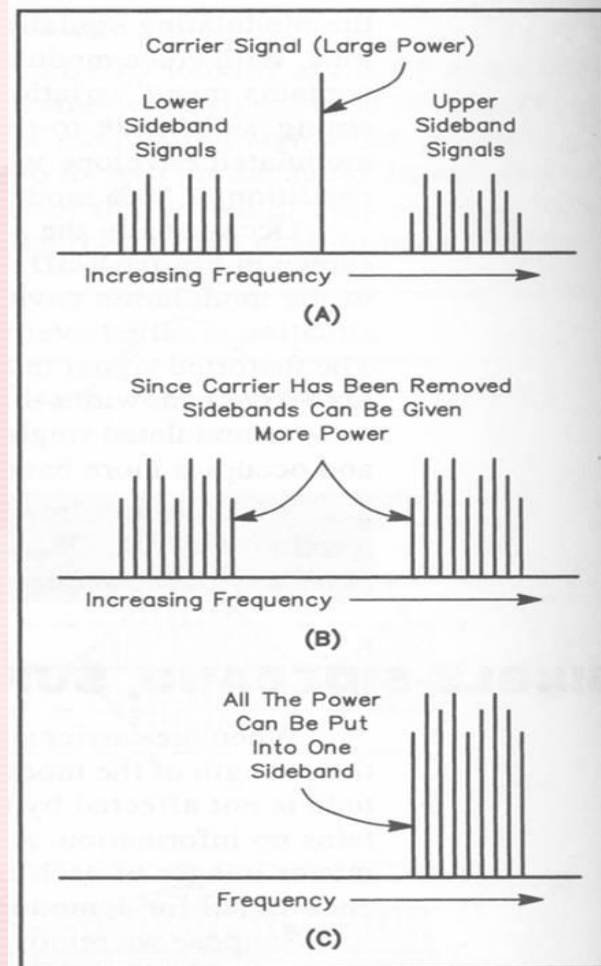
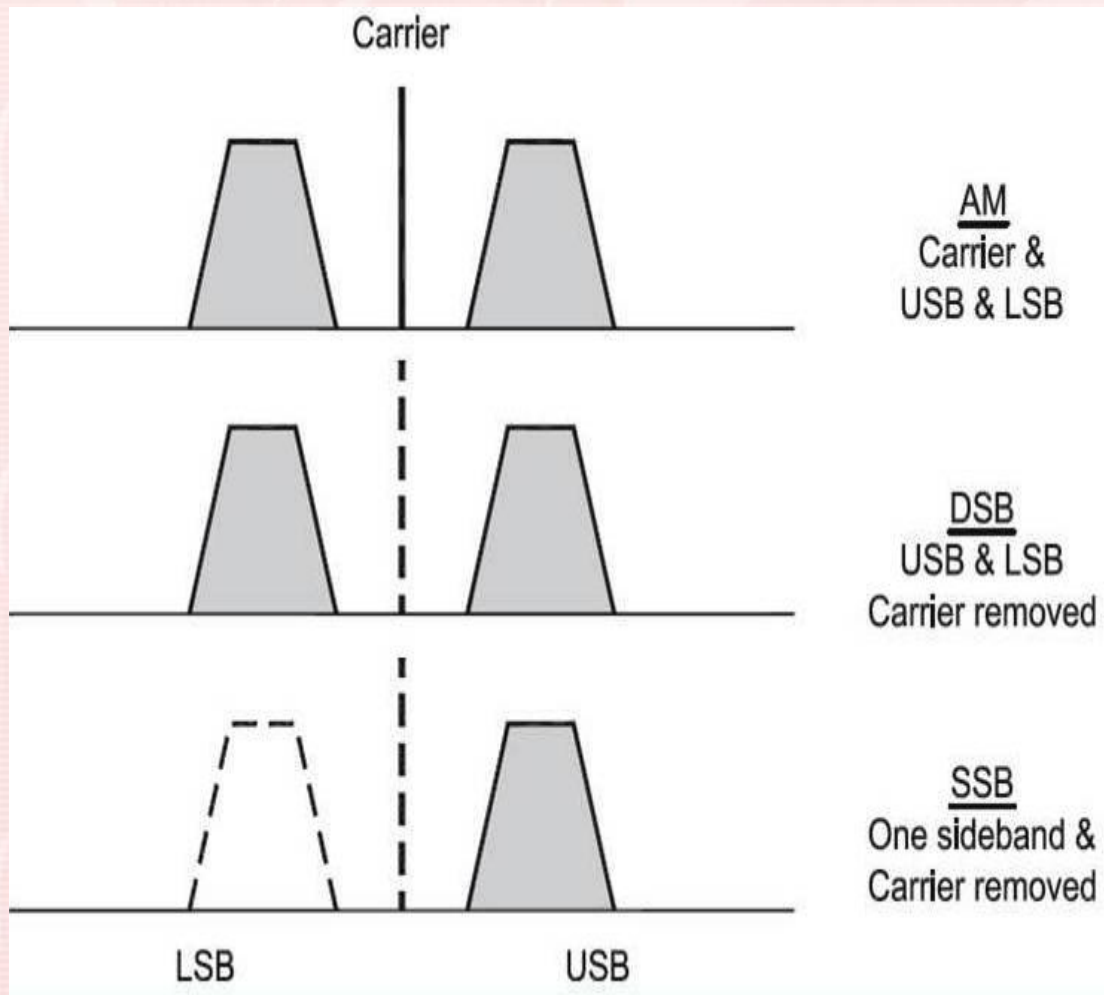


➤ Carriers and modulation: AM (cont)

- Normal amplitude modulation of a signal contains three basic components
 - The three components are:
 - the carrier frequency
 - the upper sideband
 - The lower sideband.
- Suppression of two of the three components:
 - Allows more energy to be transmitted in the remaining one.
 - Hence, SSB operation or DSB has more “punch” than normal AM signals.

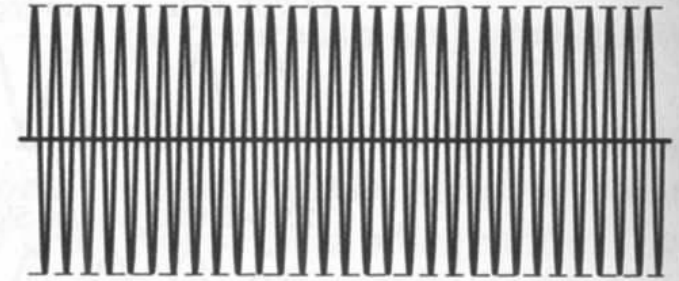


➤ Carrier and Modulation

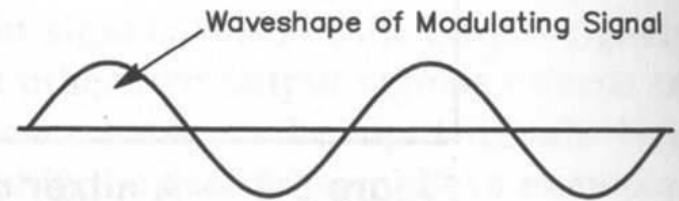


➤ Carriers and modulation: FM

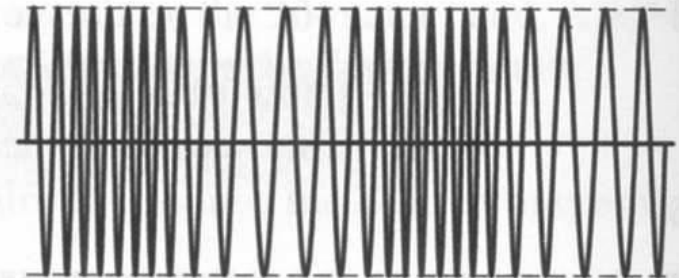
- **Frequency modulation is the name of the process, which changes the frequency of an RF wave to convey information.**
- **When a modulating audio signal is applied to an FM transmitter the carrier frequency changes proportionally to the instantaneous amplitude of the modulating signal.**



(A)



(B)



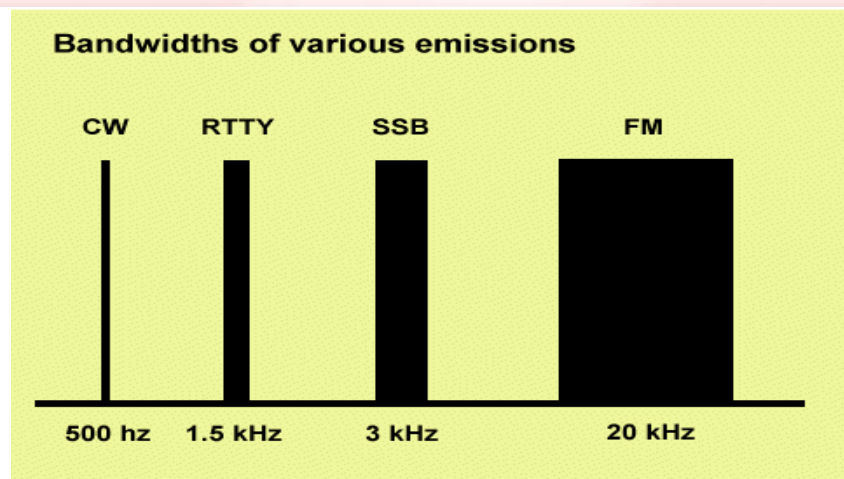
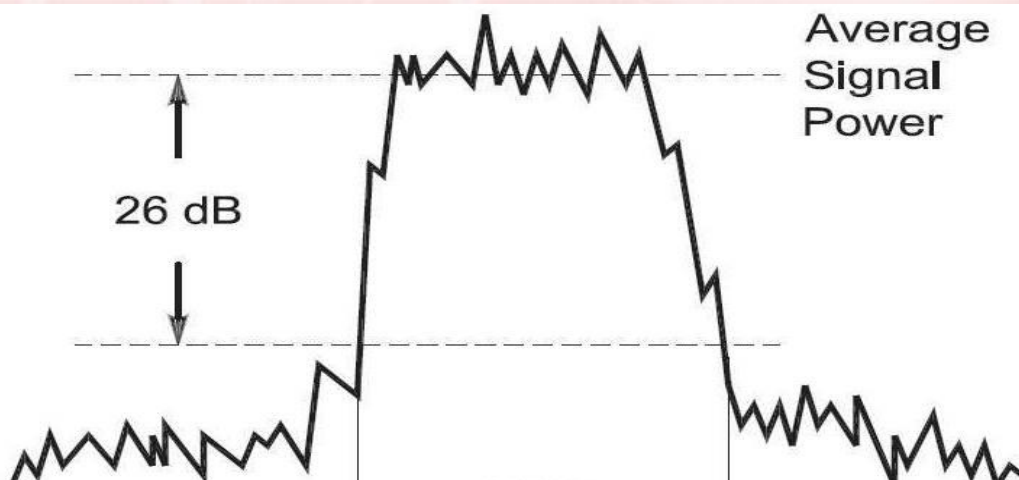
(C)

➤ **Carriers and modulation: FM** (cont)

- **Frequency modulation**
 - **Has the advantage of eliminating much of the noise with AM mode**
 - **Has the disadvantage of occupying a very large portion of the band, ie, bandwidth.**

➤ Carriers and modulation: FM_(cont)

- That is why FM is not used on the lower frequency HF bands which are so narrow and crowded.



➤ **Carriers and modulation: Phase Modulation**

- **Phase modulation is the name of the process that changes the phase angle of an RF wave to convey information.**
- **Phase modulation emission is produced by a reactance modulator connected to an RF power amplifier.**

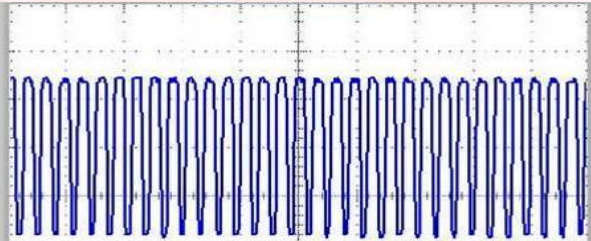
➤ **Modulation envelope; Deviation**

- **The Audio or microphone gain control is typically adjusted for proper ALC setting on an amateur single sideband transceiver.**

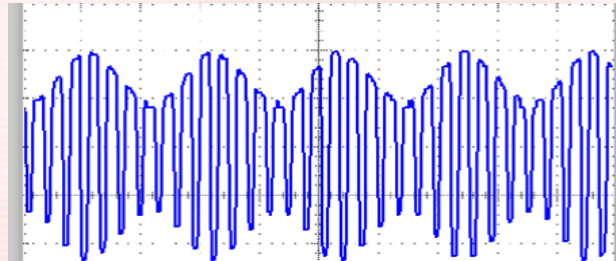
➤ Modulation envelope: Overmodulation

- The signal of an *over-modulated* single-sideband phone transmitter becomes distorted and occupies more bandwidth. [BAD]
- *Flat-topping* of a single-sideband phone transmission is signal distortion caused by excessive drive.

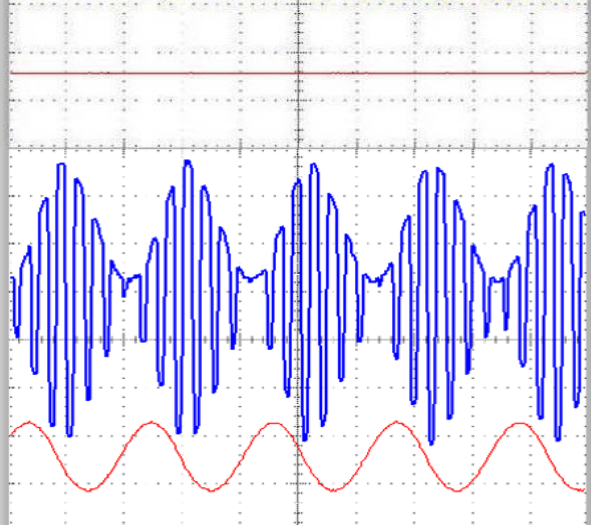
0% Modulation
(CW)



50% Modulation



100% Modulation

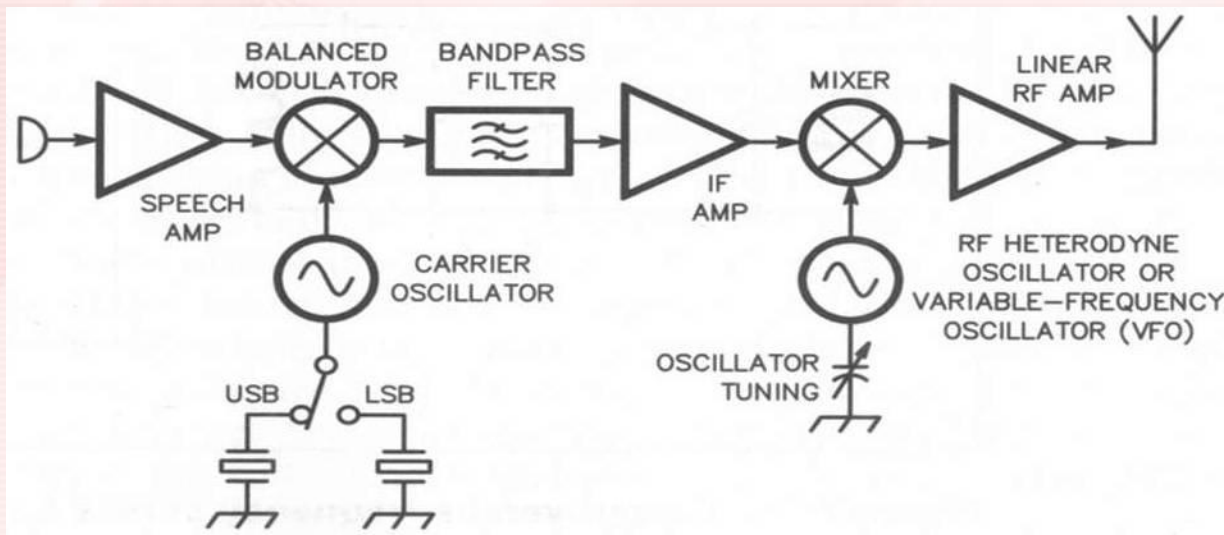


Over Modulation



➤ Carriers and modulation: Single and double sideband

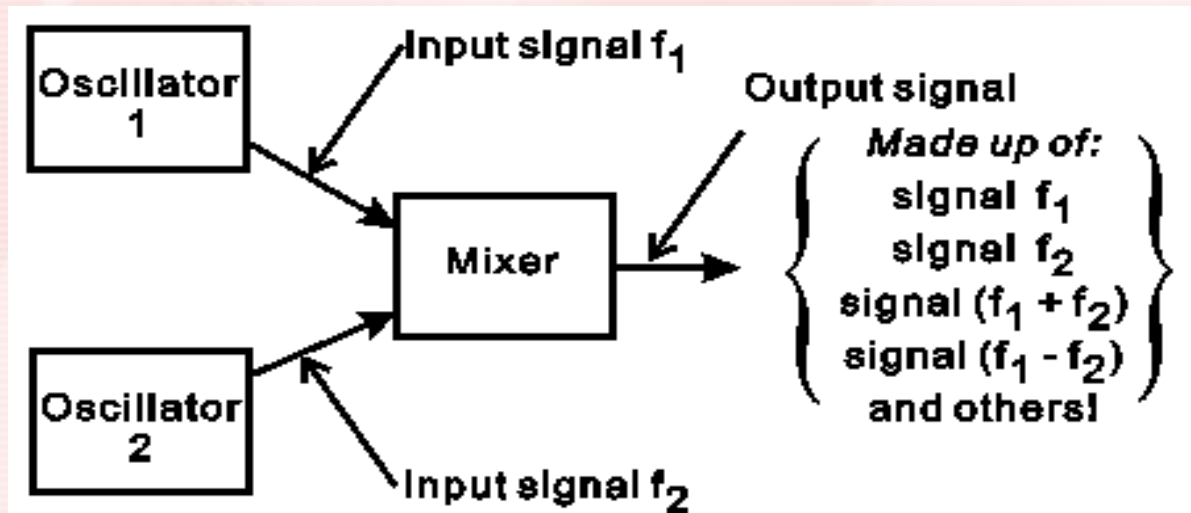
- **One advantage of carrier suppression in a single-sideband phone transmission is more transmitter power can be put into the remaining sidebands.**
- **Single sideband phone emissions use the narrowest frequency bandwidth of any *phone* transmission.**
- **Both upper and lower sideband signal(s) would be found at the output of a properly adjusted balanced modulator.**



➤ Frequency mixing

- A mixer stage in a transmitter would change a 5.3 MHz input signal to 14.3 MHz.
- Heterodyning is another term for the mixing of two RF signals.

Example: The strongest combination of mixing a 2 MHz signal with a 3 MHz signal would be both 5 MHz and 1 MHz signals.



➤ **Frequency mixing** (cont)

- **The Mixer stage in a receiver combines a 14.250 MHz input signal with a 13.795 MHz oscillator signal to produce a 455 kHz intermediate frequency (IF) signal.**

$$\text{Sum} \rightarrow 14.250 \text{ MHz} + 13.795 \text{ MHz} = 28.045 \text{ MHz}$$

$$\text{Difference} \rightarrow 14.250 \text{ MHz} - 13.795 \text{ MHz} = 0.455 \text{ MHz or } 455 \text{ kHz}$$

➤ **Frequency mixing** (cont)

- **VFO receiving 14.255 MHz.**
- **Local Oscillator is 13.800 MHz**
- **Producing a 455 kHz Intermediate Frequency (IF)**

$$13.800 - 14.255 = 0.455 \text{ absolute}$$

- **A 13.345 MHz signal will produce Image Response interference in the receiver.**

$$13.800 - 13.345 = 0.455$$

➤ Multiplication

- **The Multiplier stage in a VHF FM transmitter selects a harmonic of an HF signal to reach the desired operating frequency.**

Example:

The fourth harmonic of a 2.50 MHz signal is $4 \times 2.50 =$

10.0 MHz or 4 times the original signal.

➤ HF data communications

- The frequency shift is related to keying speed in an FSK signal in that greater keying speeds require greater frequency shifts.
- RTTY, Morse code, PSK31 and packet communications are all digital modes.
- The part of the 20 meter band most commonly used for PSK31 operation is below the RTTY segment, near 14.070 MHz.
- When transmitting a data mode signal, it is important to know the duty cycle of the mode you are using to prevent damage to your transmitter's final output stage.

➤ Bandwidths of various modes

- **The total bandwidth of an FM-phone transmission having a 5 kHz deviation and a 3 kHz modulating frequency is 16 kHz.**

Total Bandwidth = 2 * (Deviation + Modulating Frequency)

Total Bandwidth = 2 * (5 kHz + 3 kHz) = 16 kHz

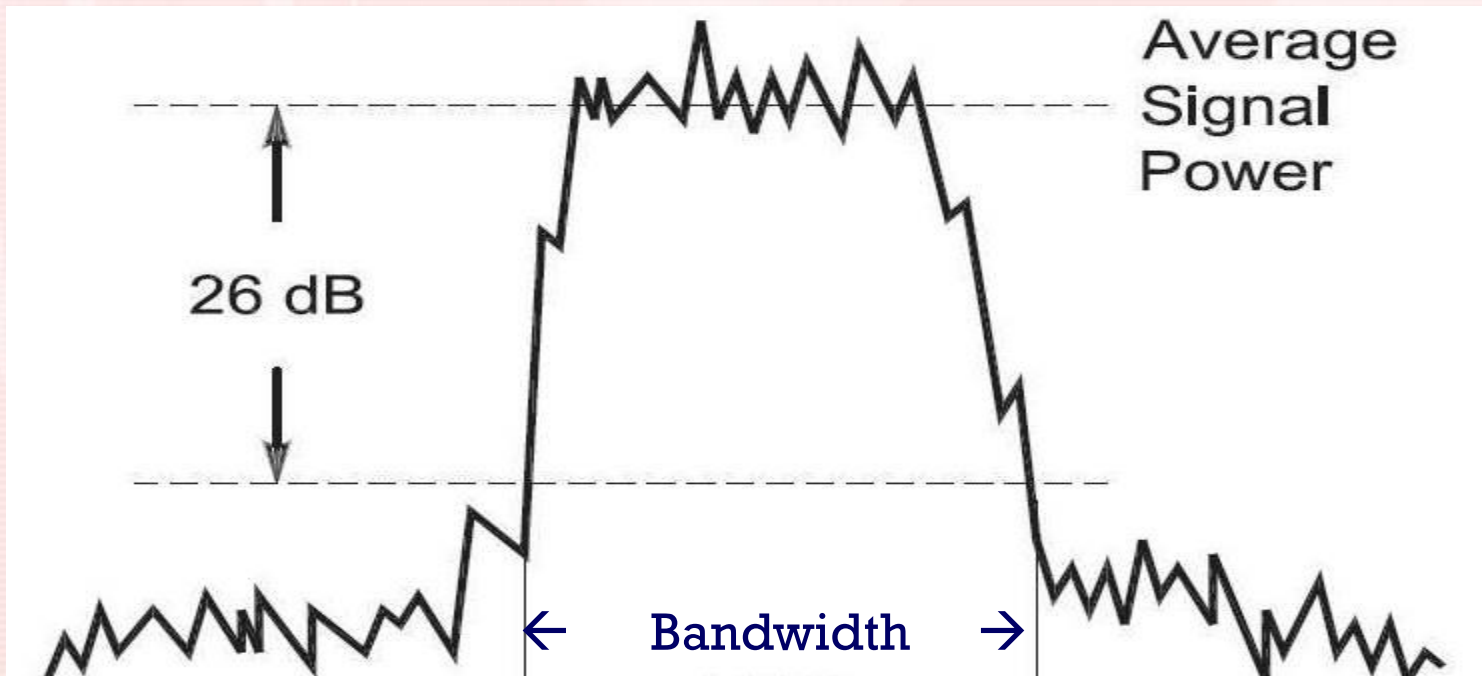
- **For a 12.21-MHz reactance-modulated oscillator in a 5-kHz deviation, 146.52-MHz FM-phone transmitter, the frequency deviation is 416.7 Hz.**

146.52 MHz / 12.21 MHz = 12 (Multiplier stage in the transmitter.)

Therefore → 5 kHz / 12 = 0.41666 kHz or 416.7 Hz

➤ **Bandwidths of various modes** (cont)

- **Frequency modulated (FM) phone isn't used below 29.5 MHz because the bandwidth would exceed FCC limits.**



G8 ... Signals and Emissions

➤ **Bandwidths of various modes** (cont)

Amateur Signal Bandwidths

<i>Type of Signal</i>	<i>Typical Bandwidth</i>
AM voice	6 kHz
Amateur television	6 MHz
SSB voice	2 to 3 kHz
Digital using SSB	500 to 3000 Hz (0.5 to 3 kHz)
CW	100 to 300 Hz (0.1 to 0.3 kHz)
FM voice	5 to 15 kHz

Element 3 General Class Question Pool

Valid July 1, 2007

Through

June 30, 2011



G8A01 What is the name of the process that changes the envelope of an RF wave to convey information?

- A.** Phase modulation
- B.** Frequency modulation
- C.** Spread Spectrum modulation
- D.** Amplitude modulation

G8A02 What is the name of the process that changes the phase angle of an RF wave to convey information?

- A. Phase convolution
- B. Phase modulation
- C. Angle convolution
- D. Radian Inversion

G8A03 What is the name of the process which changes the frequency of an RF wave to convey information?

- A.** Frequency convolution
- B.** Frequency transformation
- C.** Frequency conversion
- D.** Frequency modulation

G8A04 What emission is produced by a reactance modulator connected to an RF power amplifier?

- A.** Multiplex modulation
- B.** Phase modulation
- C.** Amplitude modulation
- D.** Pulse modulation

G8A05 What type of transmission varies the instantaneous power level of the RF signal to convey information?

- A.** Frequency shift keying
- B.** Pulse modulation
- C.** Frequency modulation
- D.** Amplitude modulation

G8A06 What is one advantage of carrier suppression in a single-sideband phone transmission?

- A.** Audio fidelity is improved
- B.** Greater modulation percentage is obtainable with lower distortion
- C.** More transmitter power can be put into the remaining sidebands
- D.** Simpler receiving equipment can be used

G8A07 Which of the following phone emissions uses the narrowest frequency bandwidth?

- A.** Single sideband
- B.** Double sideband
- C.** Phase modulation
- D.** Frequency modulation

G8A08 What happens to the signal of an over-modulated single-sideband phone transmitter?

- A.** It becomes louder with no other effects
- B.** It occupies less bandwidth with poor high frequency response
- C.** It has higher fidelity and improved signal to noise ratio
- D.** It becomes distorted and occupies more bandwidth

G8A09 What control is typically adjusted for proper ALC setting on an amateur single sideband transceiver?

- A.** The RF Clipping Level
- B.** Audio or microphone gain
- C.** Antenna inductance or capacitance
- D.** Attenuator Level

G8A10 What is meant by flat-topping of a single-sideband phone transmission?

- A.** Signal distortion caused by insufficient collector current
- B.** The transmitter's automatic level control is properly adjusted
- C.** Signal distortion caused by excessive drive
- D.** The transmitter's carrier is properly suppressed

G8A11 What happens to the RF carrier signal when a modulating audio signal is applied to an FM transmitter?

- A.** The carrier frequency changes proportionally to the instantaneous amplitude of the modulating signal
- B.** The carrier frequency changes proportionally to the amplitude and frequency of the modulating signal
- C.** The carrier amplitude changes proportionally to the instantaneous frequency of the modulating signal
- D.** The carrier phase changes proportionally to the instantaneous amplitude of the modulating signal

G8A12 What signal(s) would be found at the output of a properly adjusted balanced modulator?

- A.** Both upper and lower sidebands
- B.** Either upper or lower sideband, but not both
- C.** Both upper and lower sidebands and the carrier
- D.** The modulating signal and the unmodulated carrier

G8B01 What receiver stage combines a 14.250 MHz input signal with a 13.795 MHz oscillator signal to produce a 455 kHz intermediate frequency (IF) signal?

A. Mixer

B. BFO

C. VFO

D. Multiplier

G8B02 If a receiver mixes a 13.800 MHz VFO with a 14.255 MHz received signal to produce a 455 kHz intermediate frequency (IF) signal, what type of interference will a 13.345 MHz signal produce in the receiver?

- A. Local oscillator**
- B. Image response**
- C. Mixer interference**
- D. Intermediate interference**

G8B03 What stage in a transmitter would change a 5.3 MHz input signal to 14.3 MHz?

- A.** A mixer
- B.** A beat frequency oscillator
- C.** A frequency multiplier
- D.** A linear translator

G8B04 What is the name of the stage in a VHF FM transmitter that selects a harmonic of an HF signal to reach the desired operating frequency?

A. Mixer

B. Reactance modulator

C. Pre-emphasis network

D. Multiplier

G8B05 Why isn't frequency modulated (FM) phone used below 29.5 MHz?

- A.** The transmitter efficiency for this mode is low
- B.** Harmonics could not be attenuated to practical levels
- C.** The bandwidth would exceed FCC limits
- D.** The frequency stability would not be adequate

G8B06 What is the total bandwidth of an FM-phone transmission having a 5 kHz deviation and a 3 kHz modulating frequency?

A. 3 kHz

B. 5 kHz

C. 8 kHz

D. 16 kHz

G8B07 What is the frequency deviation for a 12.21-MHz reactance-modulated oscillator in a 5-kHz deviation, 146.52-MHz FM-phone transmitter?

A. 101.75 Hz

B. 416.7 Hz

C. 5 kHz

D. 60 kHz

G8B08 How is frequency shift related to keying speed in an FSK signal?

- A.** The frequency shift in hertz must be at least four times the keying speed in WPM
- B.** The frequency shift must not exceed 15 Hz per WPM of keying speed
- C.** Greater keying speeds require greater frequency shifts
- D.** Greater keying speeds require smaller frequency shifts

G8B09 What do RTTY, Morse code, PSK31 and packet communications have in common?

- A.** They require the same bandwidth
- B.** They are digital modes
- C.** They use on/off keying
- D.** They use phase shift modulation

G8B10 When transmitting a data mode signal, why is it important to know the duty cycle of the mode you are using?

- A.** To aid in tuning your transmitter
- B.** To prevent damage to your transmitter's final output stage
- C.** To allow time for the other station to break in during a transmission
- D.** All of these choices are correct

G8B11 What part of the 20 meter band is most commonly used for PSK31 operation?

- A.** At the bottom of the slow-scan TV segment, near 14.230 MHz
- B.** At the top of the SSB phone segment, near 14.325 MHz
- C.** In the middle of the CW segment, near 14.100 MHz
- D.** Below the RTTY segment, near 14.070 MHz

G8B12 What is another term for the mixing of two RF signals?

A. Heterodyning

B. Synthesizing

C. Cancellation

D. Multiplying