Technician License Course
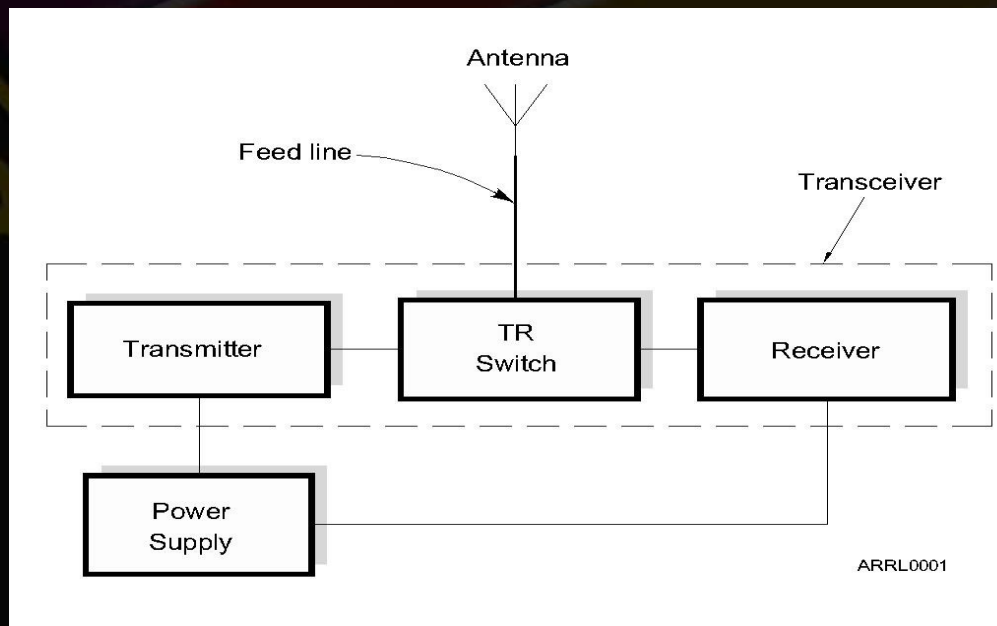
Technician License Course

Chapter 2

Lesson Plan Module - 3

Modulation & Bandwidth
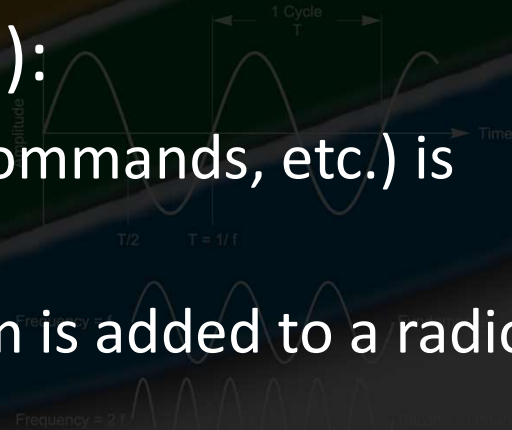
The Basic Radio Station

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.

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.).
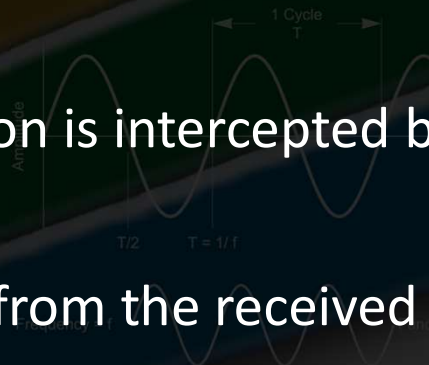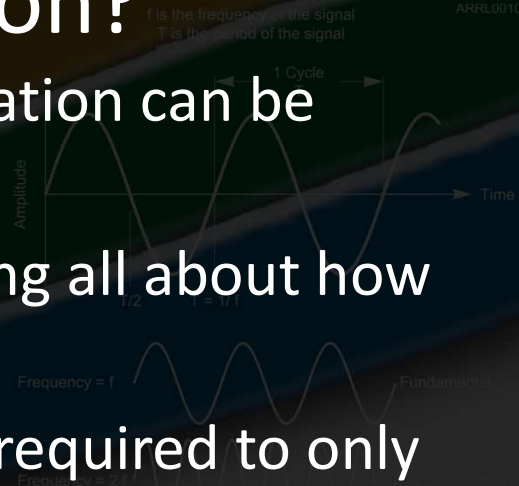
What Happens During Radio Communication?

- 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.

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:
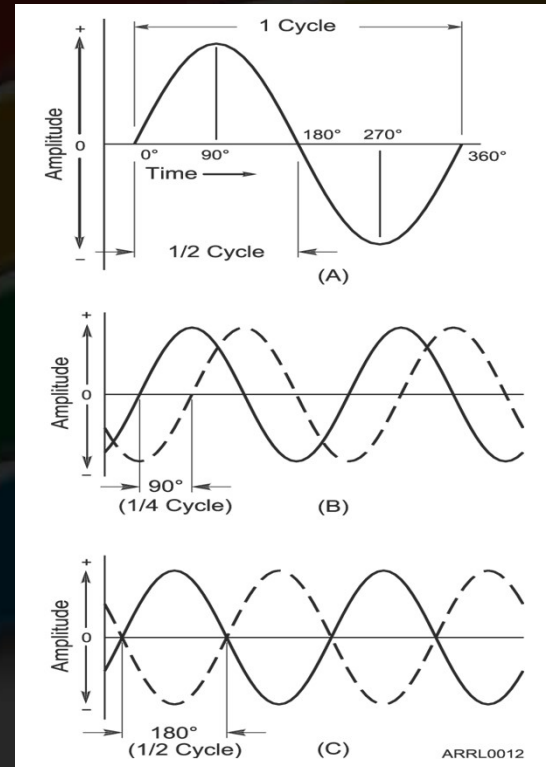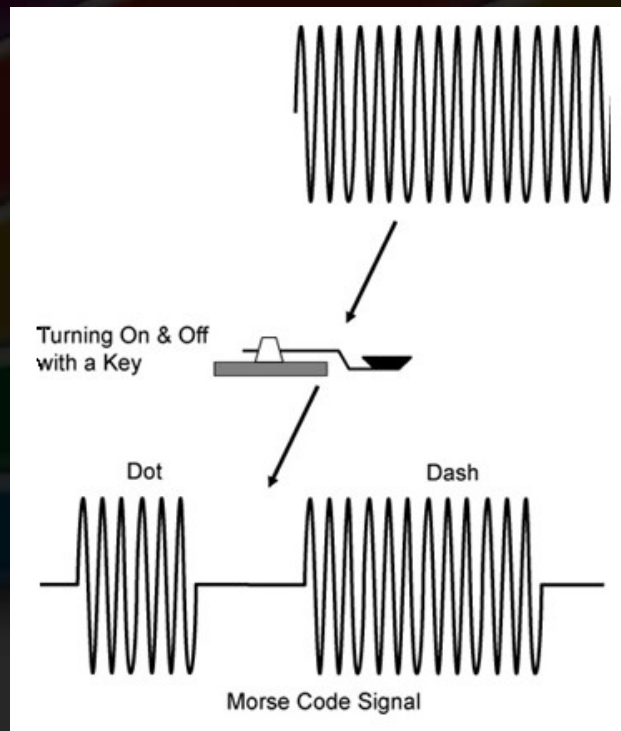 - Amplitude, frequency, or phase
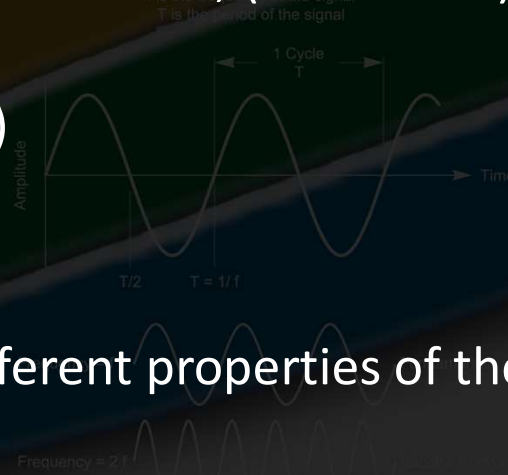
Phase

Phase

- Along with frequency and period, another important property of waves is *phase*.

- Phase is a position within a cycle.

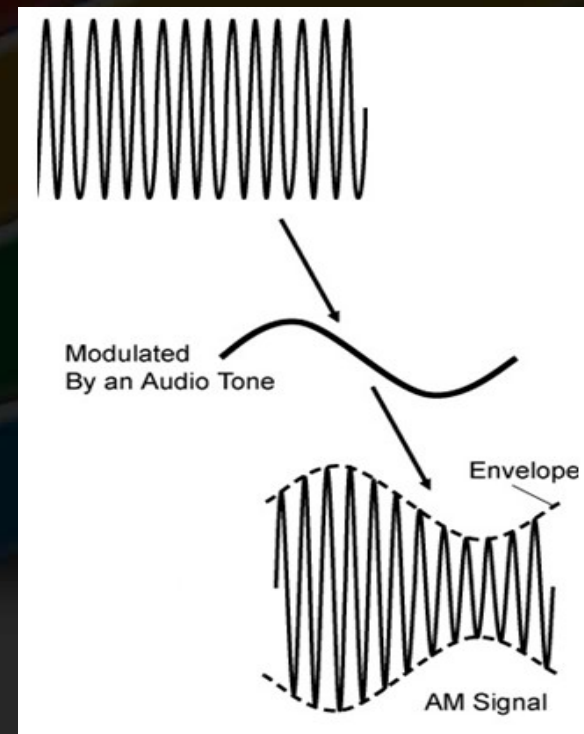- Phase is also a relative position between two waves.

CW - Morse Code – On and Off

Turning On & Off with a Key

Dot   Dash

Morse Code Signal

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).

Modulated By an Audio Tone

Envelope

AM Signal

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*.

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)
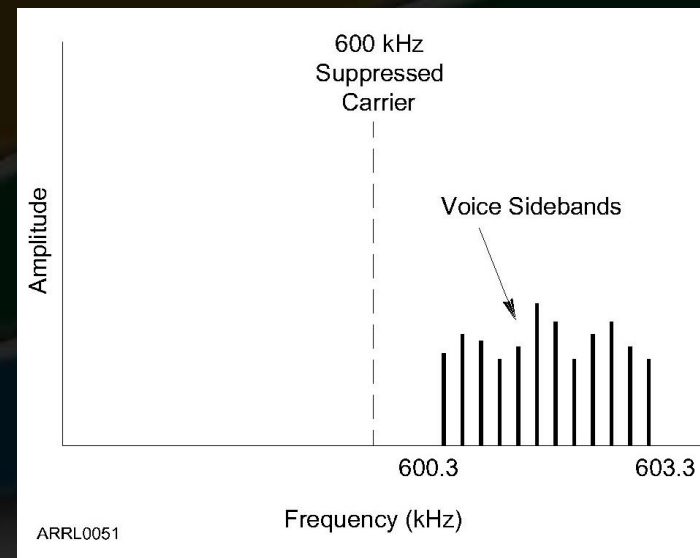- AM bandwidth is twice the information bandwidth.
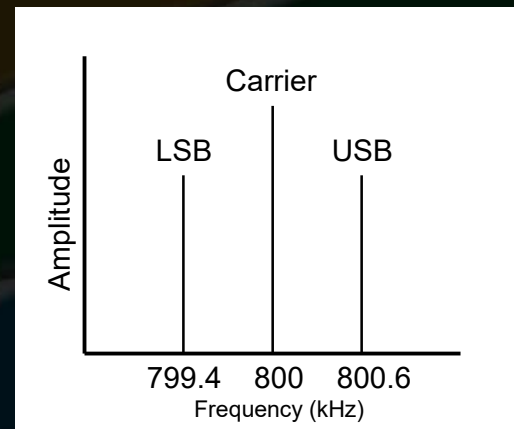
AM signal being modulated by a 600 Hz tone

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.
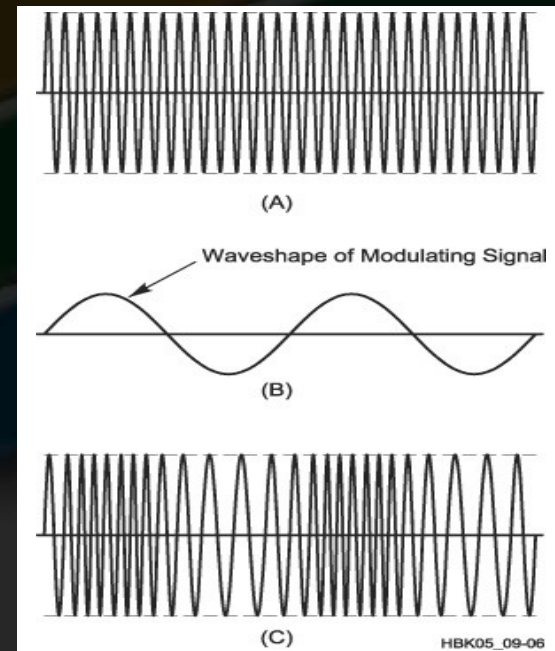
- AM voice signal bandwidth 2 x 3000 Hz = 6000 Hz
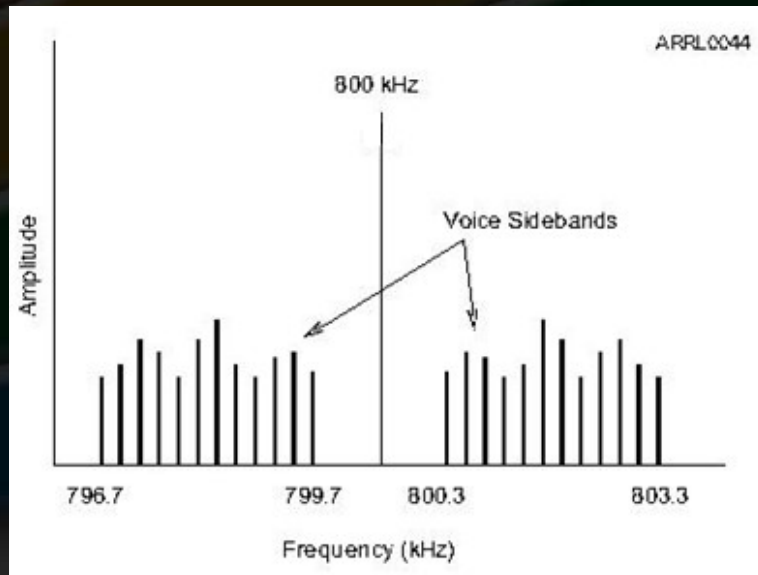
Single Sideband Modulation (SSB)

- 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.

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.

(A)

Waveshape of Modulating Signal

(B)

(C)   HBK05_09-06

Typical Signal Bandwidths
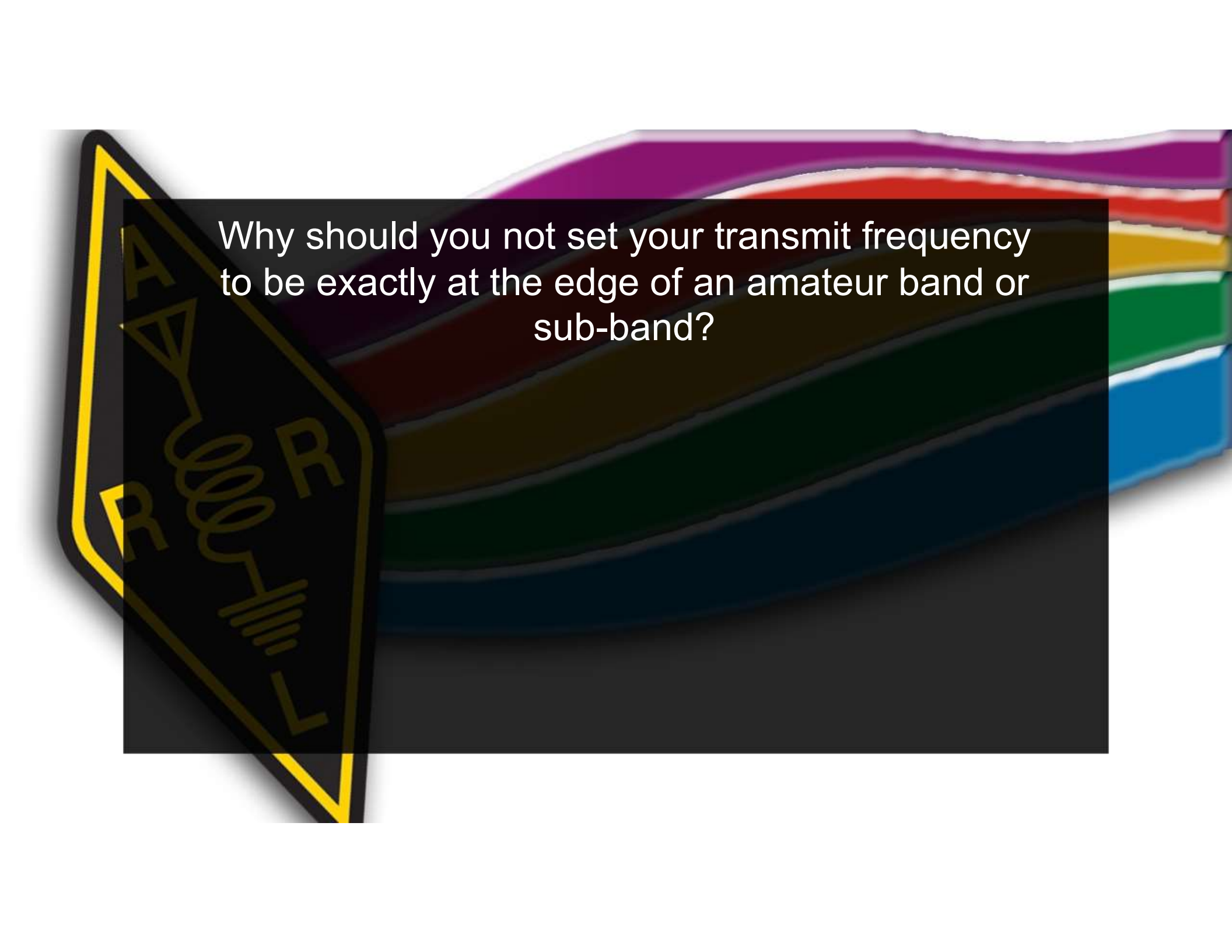
Signal Bandwidths

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
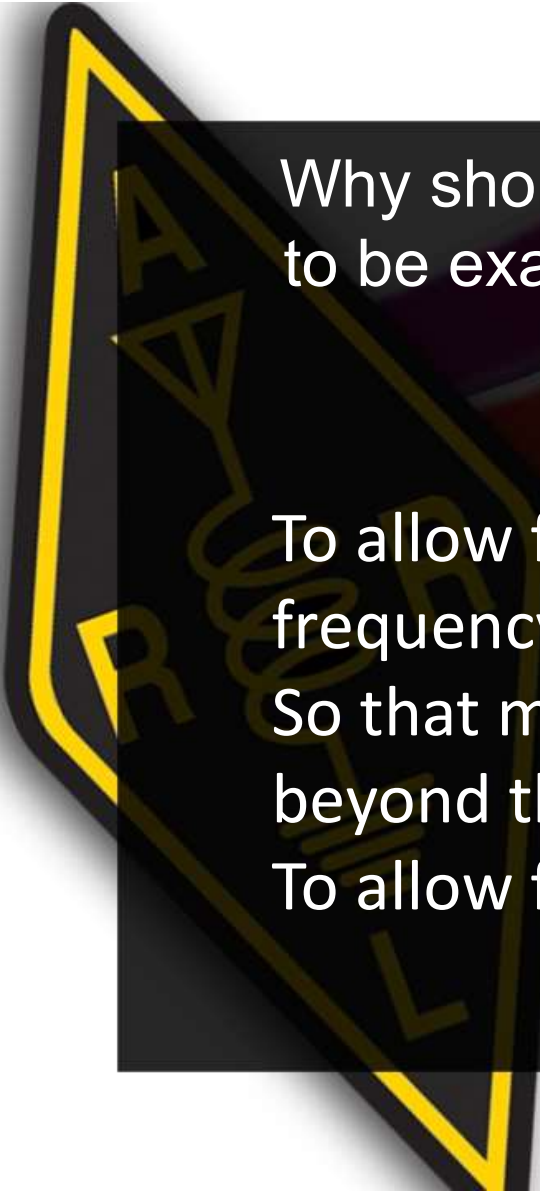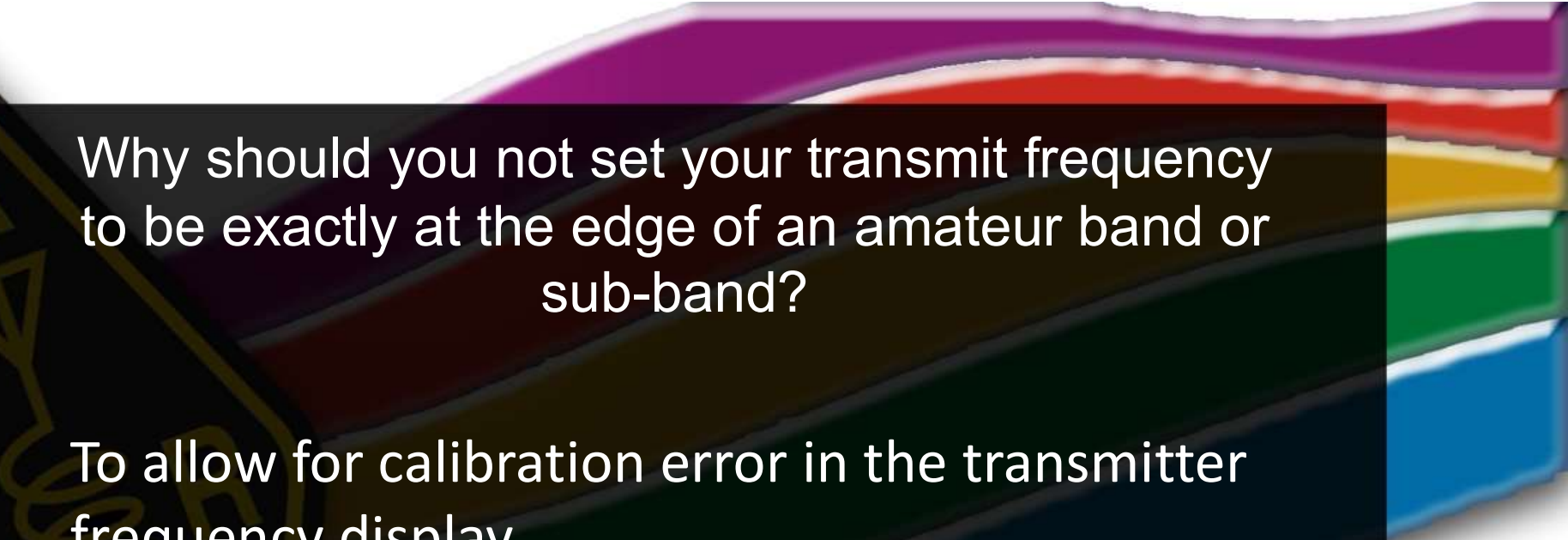
Practice Questions

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

Why should you not set your transmit frequency to be exactly at the edge of an amateur band or sub-band?
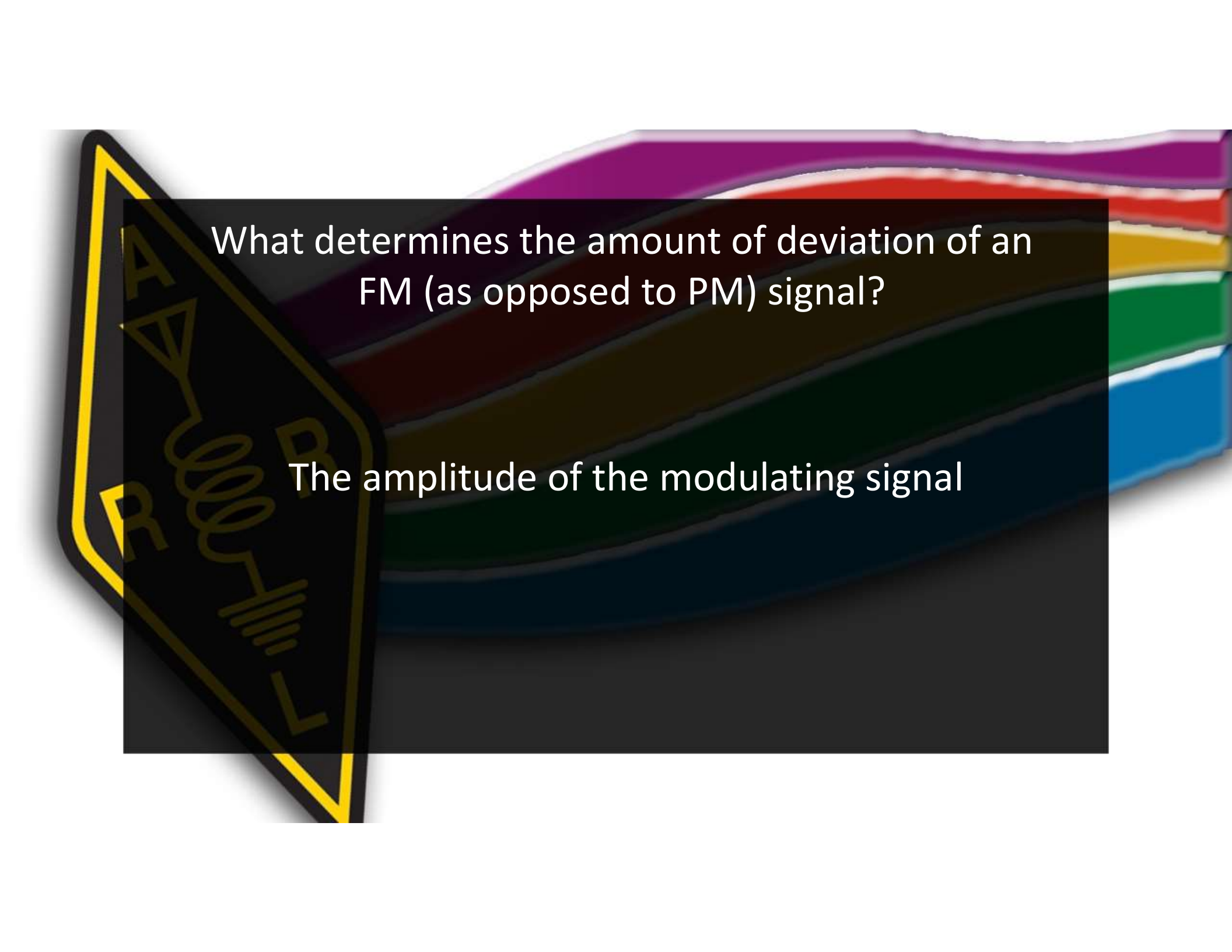
To allow for calibration error in the transmitter frequency display
So that modulation sidebands do not extend beyond the band edge
To allow for transmitter frequency drift
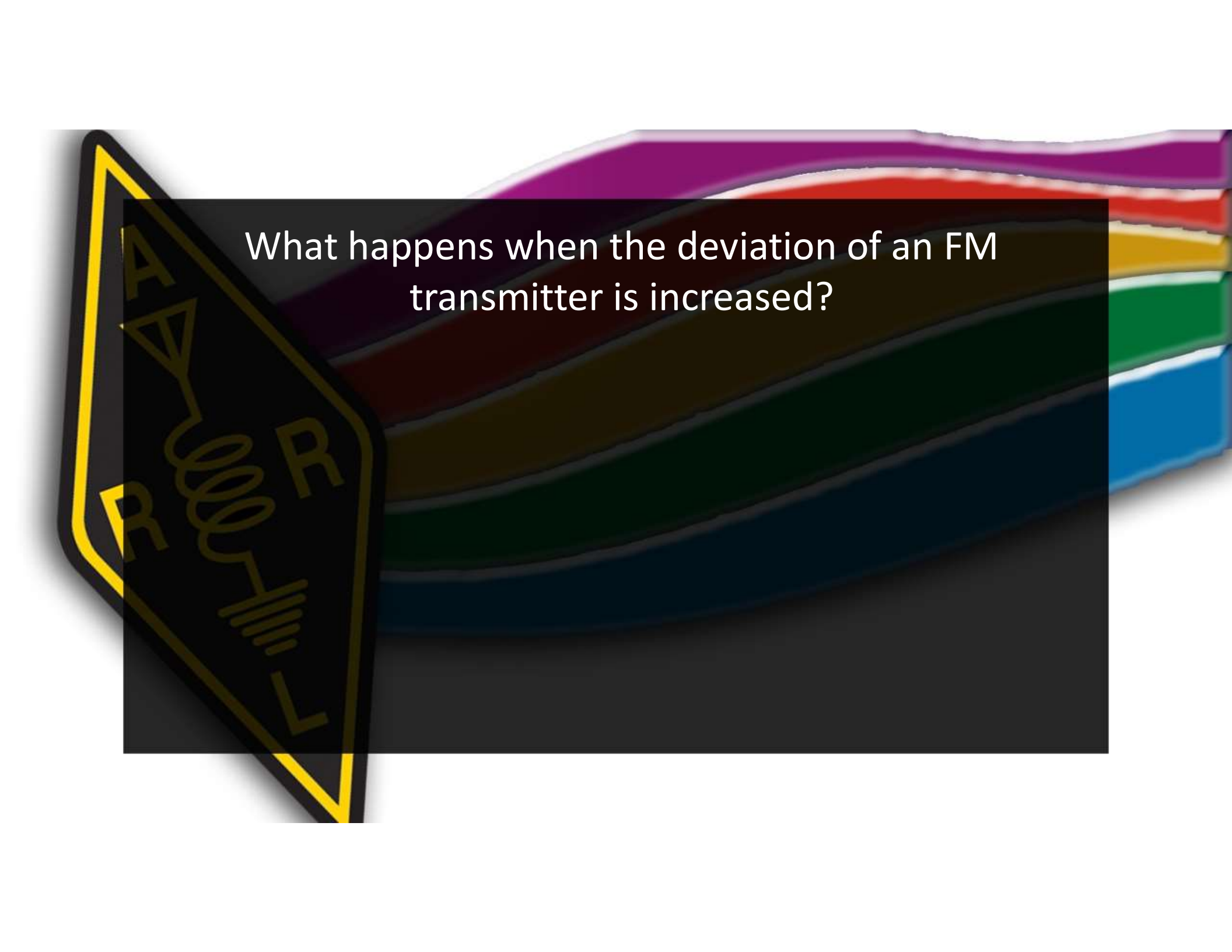
What determines the amount of deviation of an FM (as opposed to PM) signal?
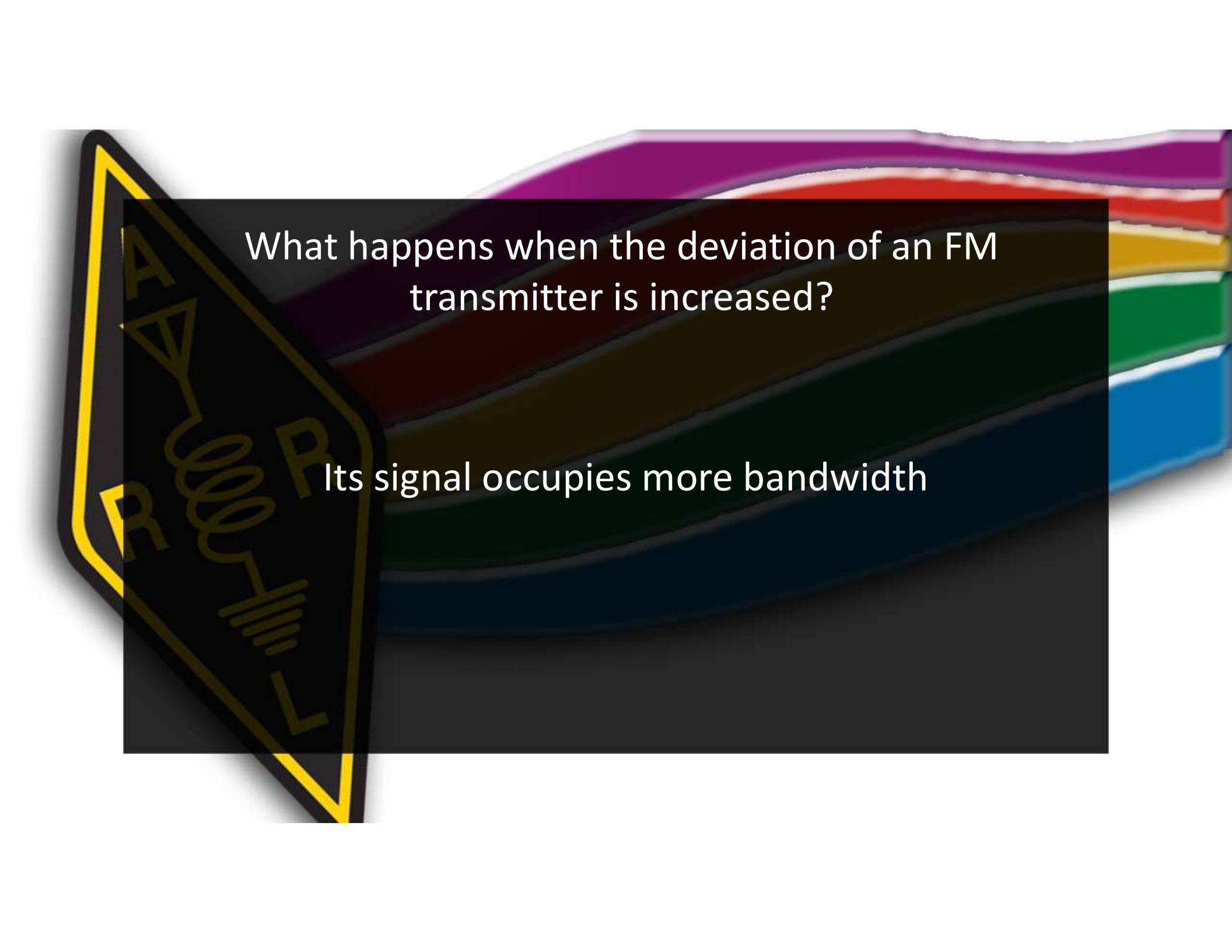
What determines the amount of deviation of an FM (as opposed to PM) signal?

The amplitude of the modulating signal
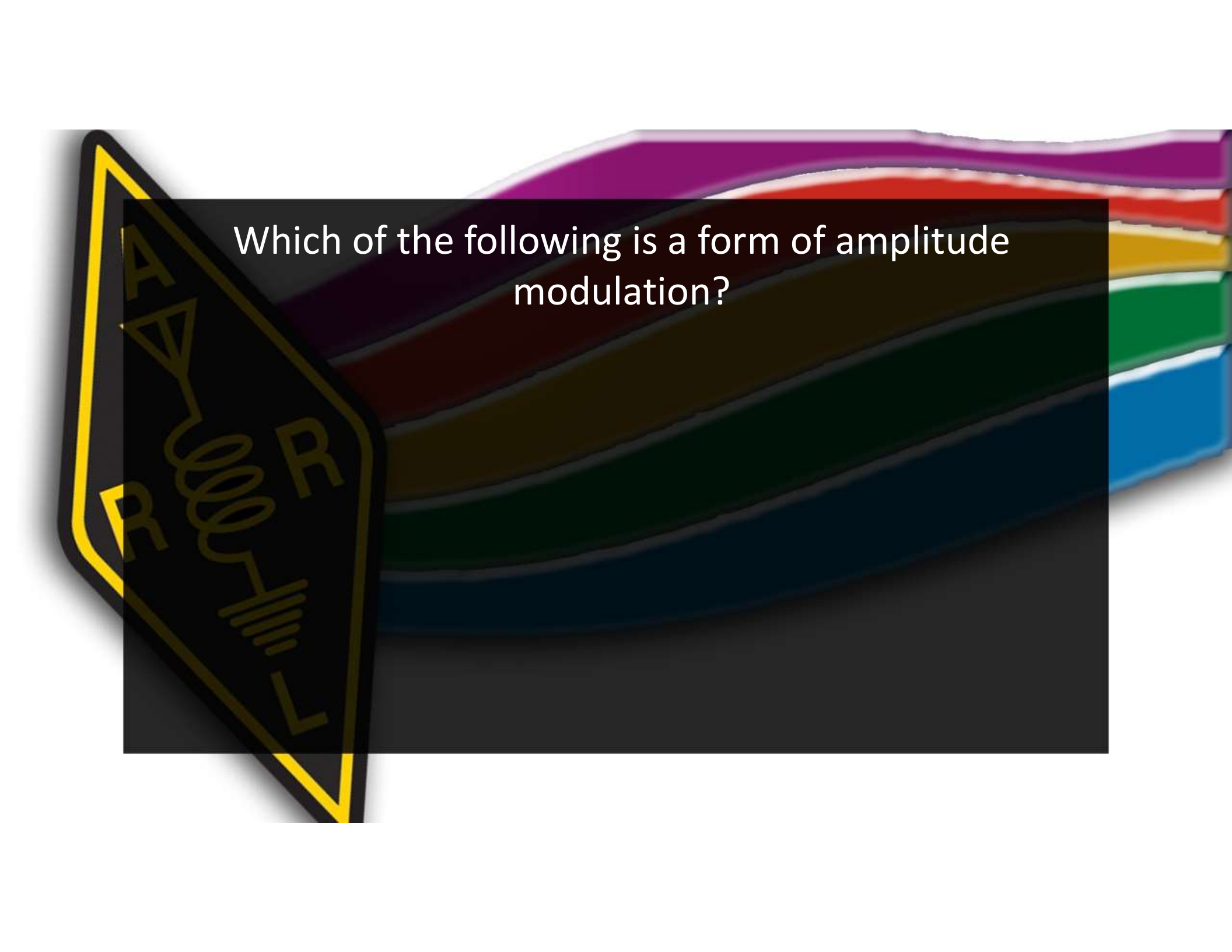
What happens when the deviation of an FM transmitter is increased?
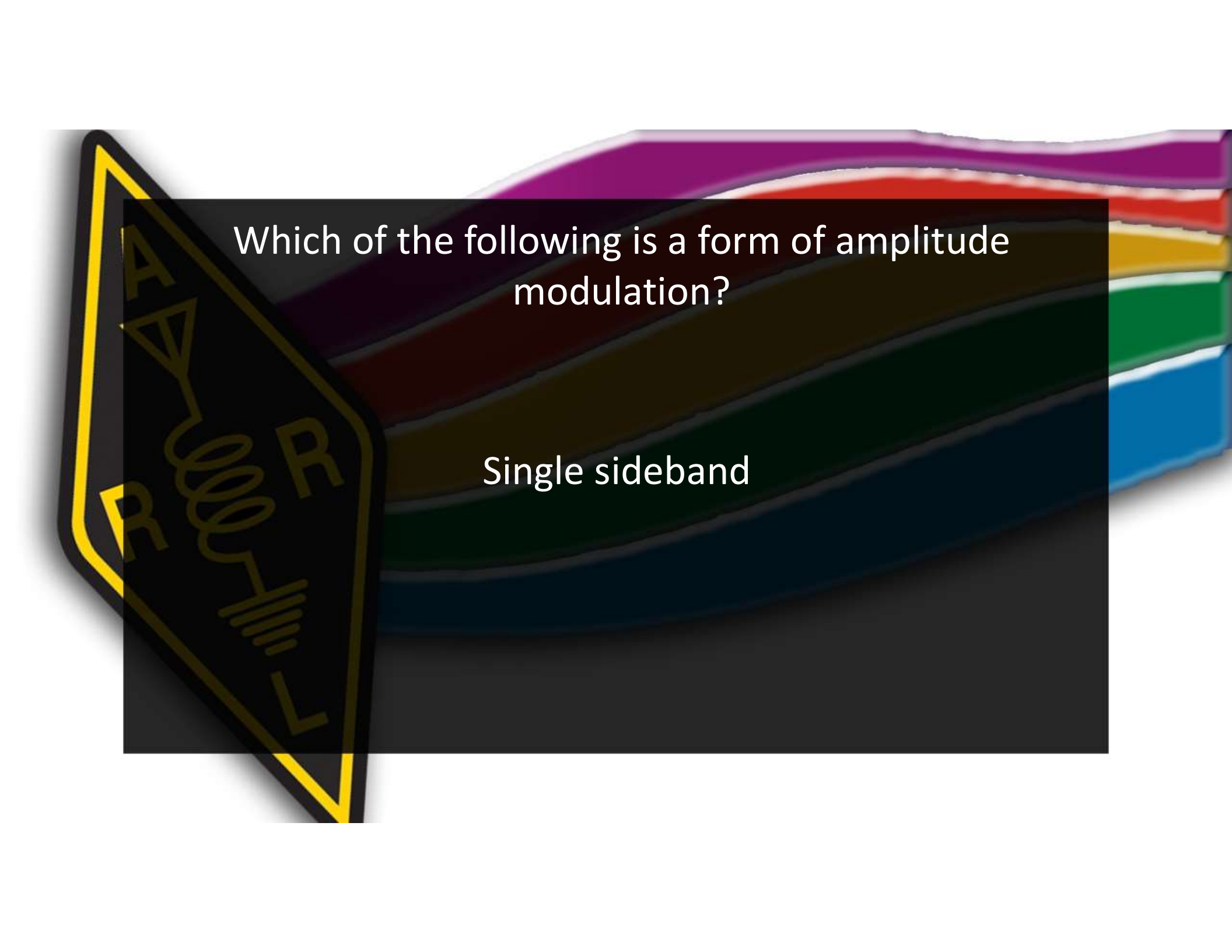
What happens when the deviation of an FM transmitter is increased?
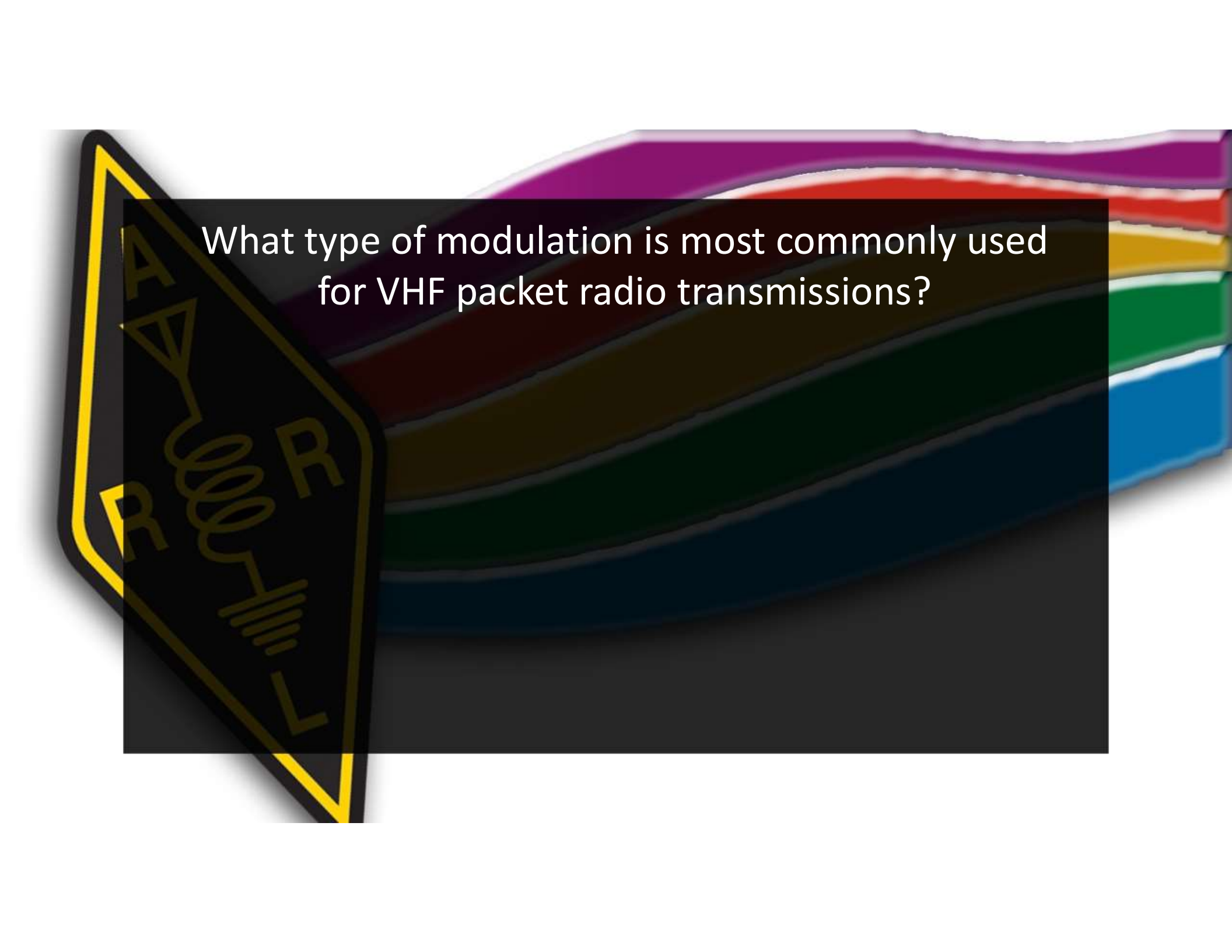
Its signal occupies more bandwidth

Which of the following is a form of amplitude modulation?
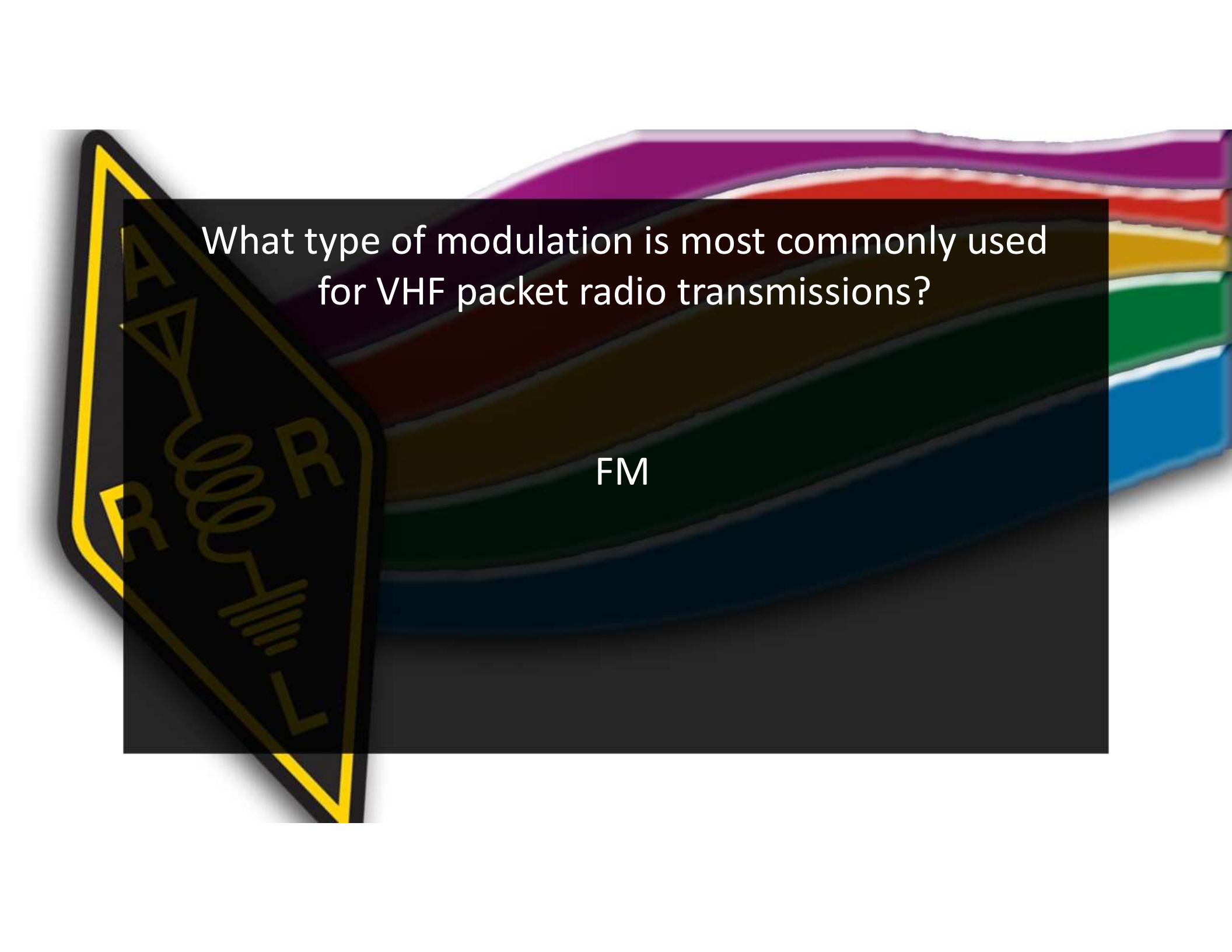
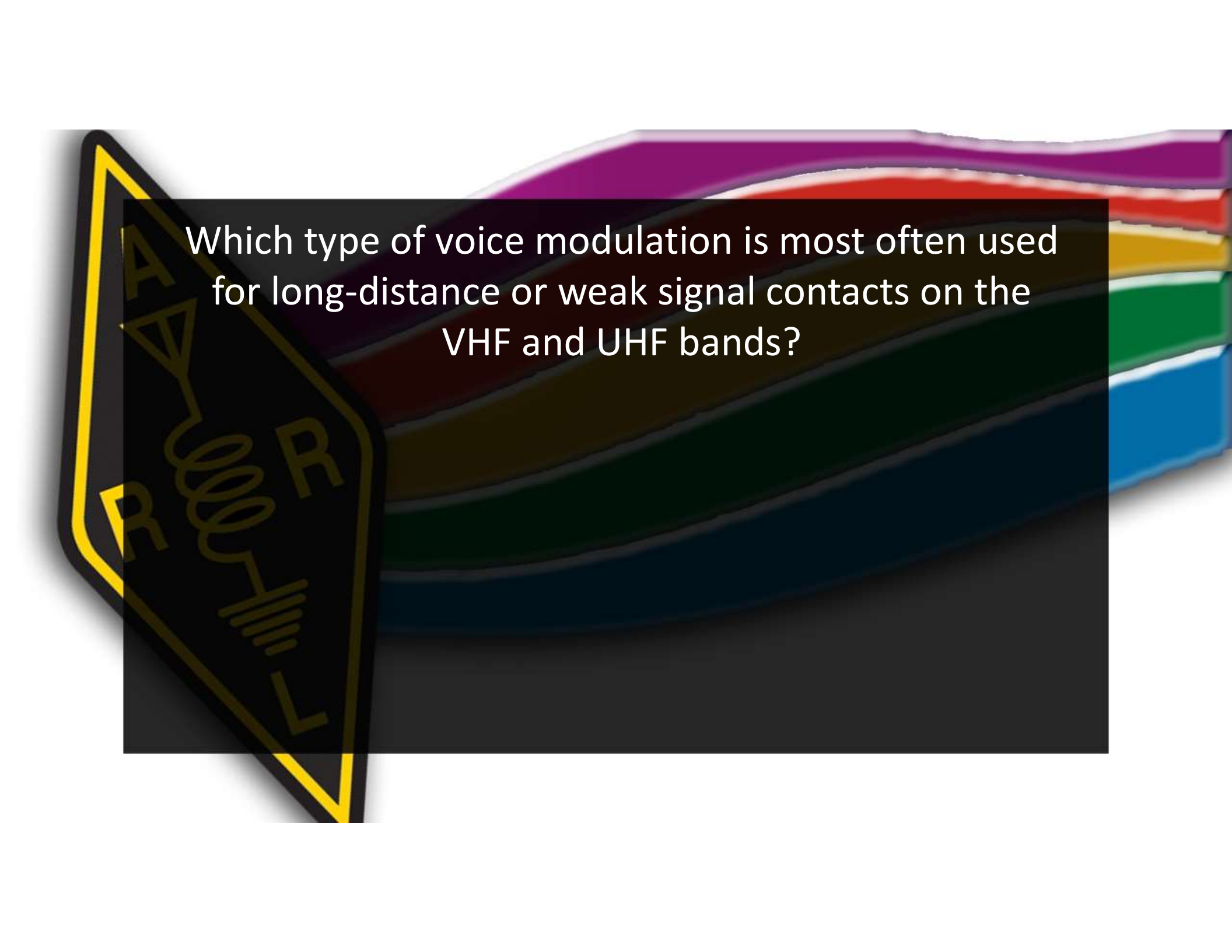Which of the following is a form of amplitude modulation?

Single sideband

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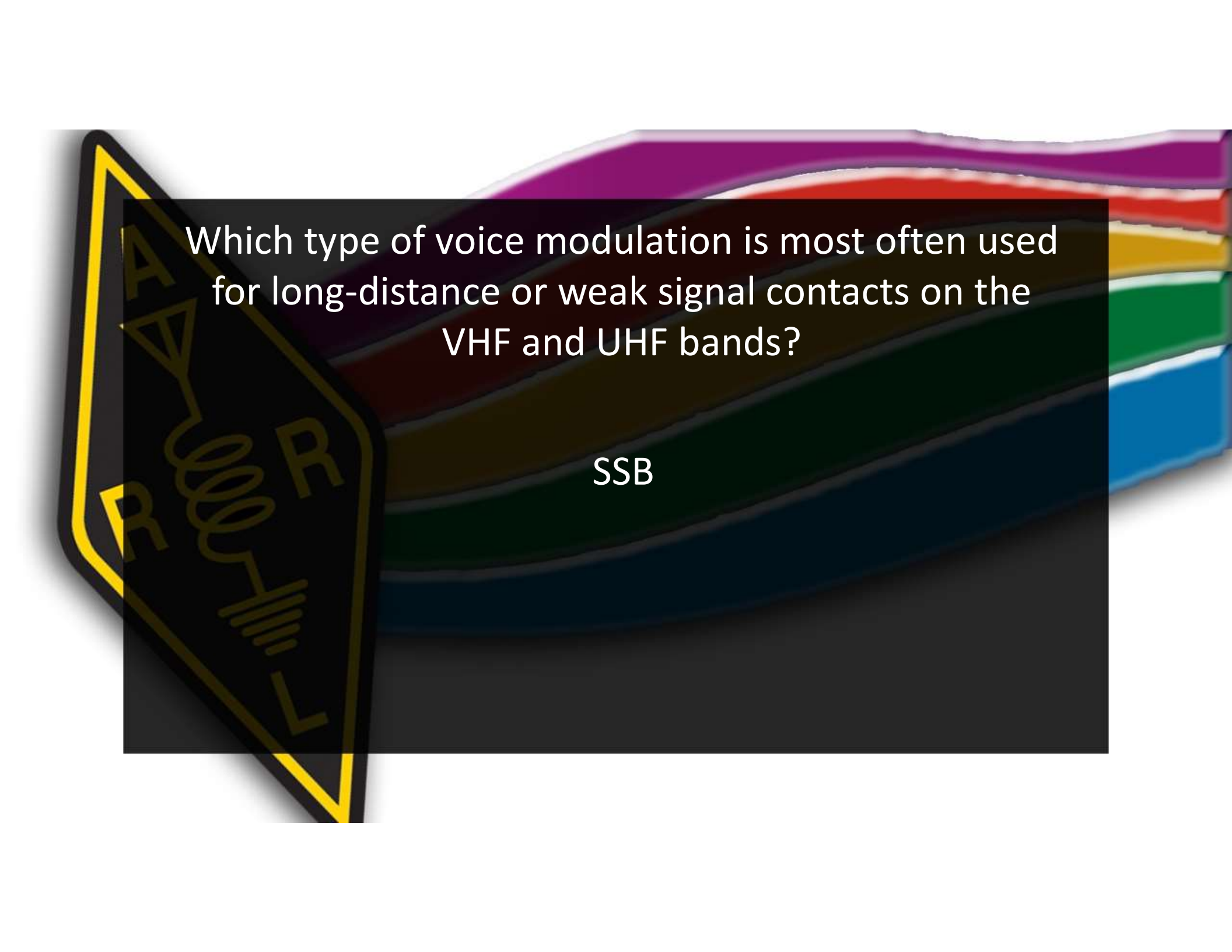
What type of modulation is most commonly used for VHF packet radio transmissions?

FM

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

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

SSB

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

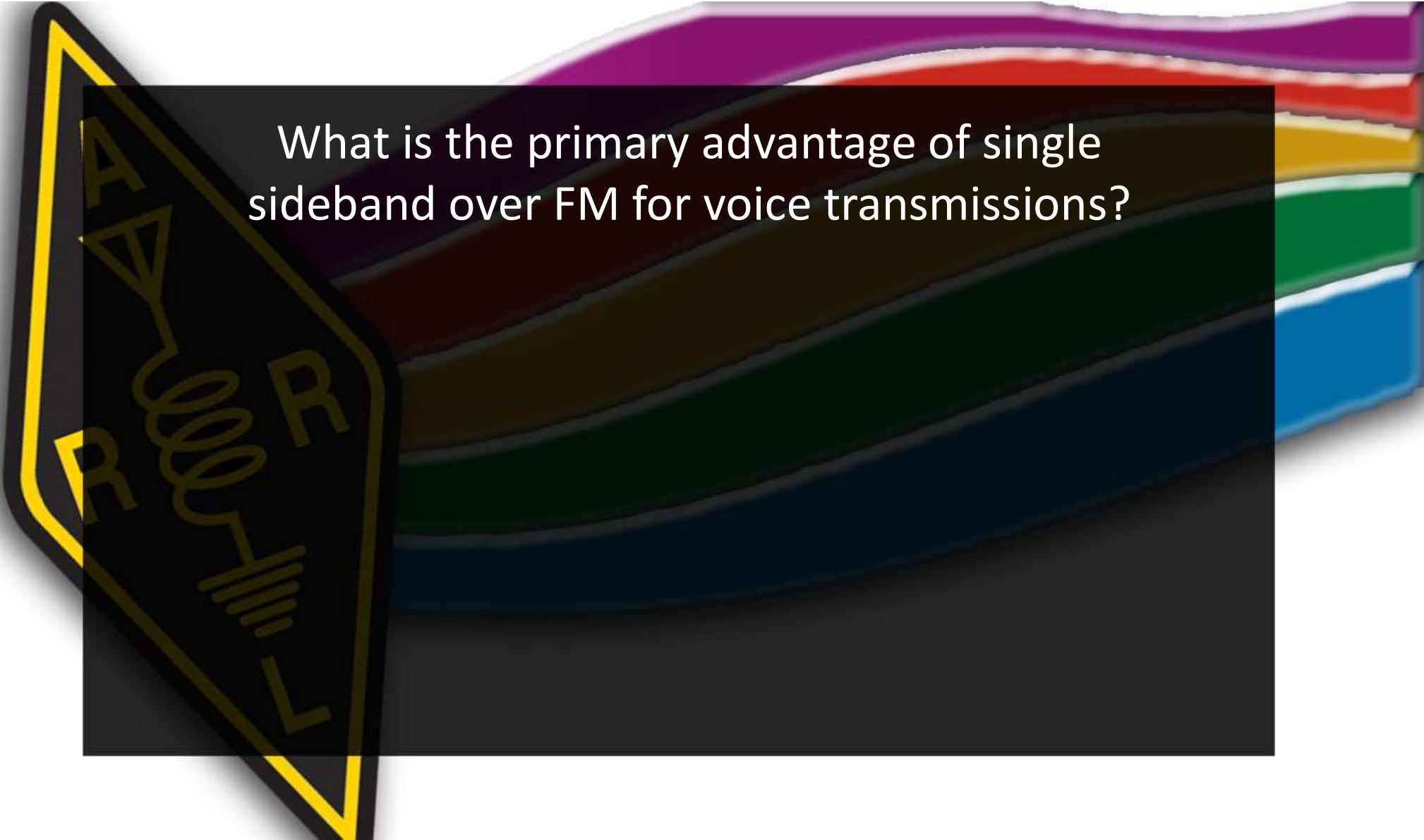Which type of modulation is most commonly used for VHF and UHF voice repeaters?

FM

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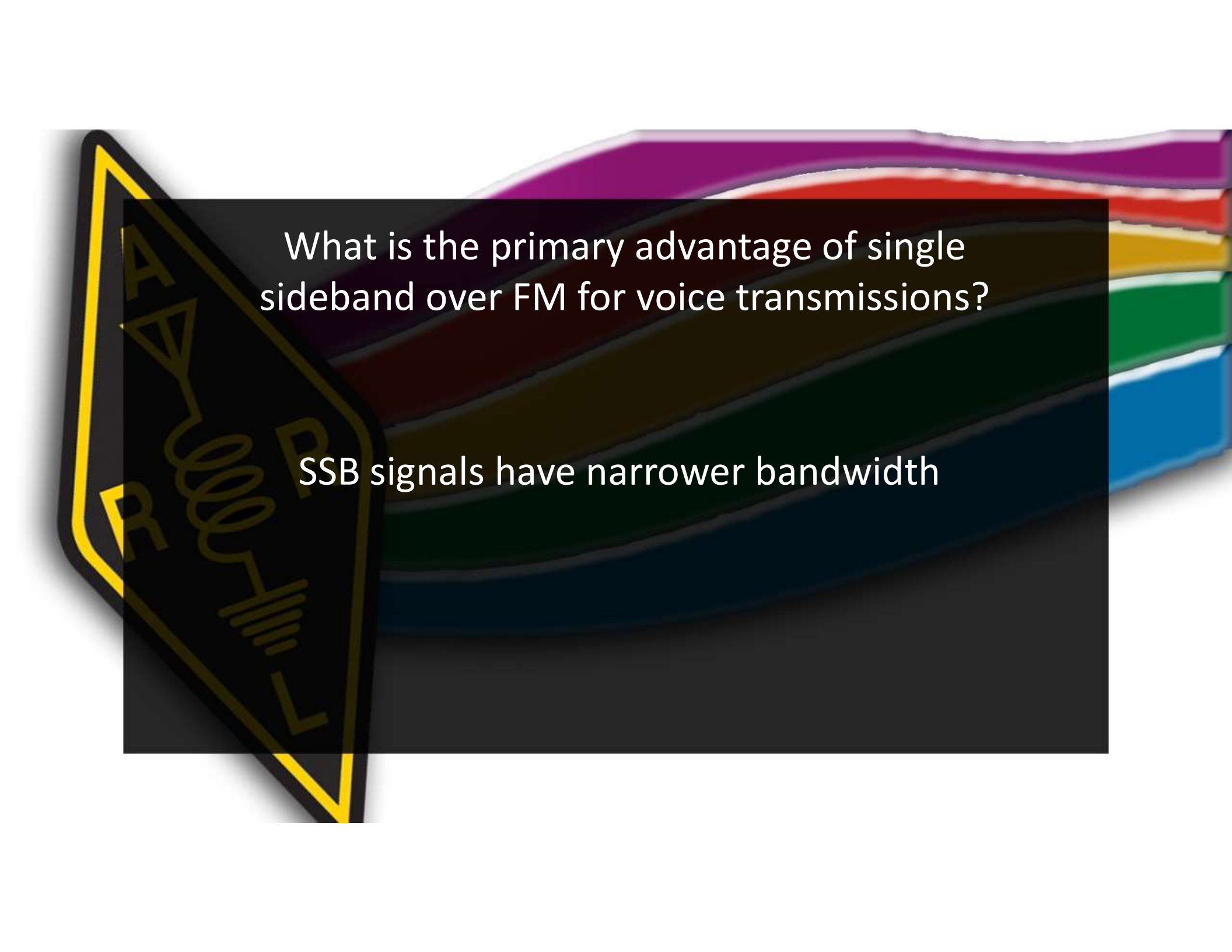
Which sideband is normally used for 10 meter HF, VHF and UHF single-sideband communications?

Upper sideband

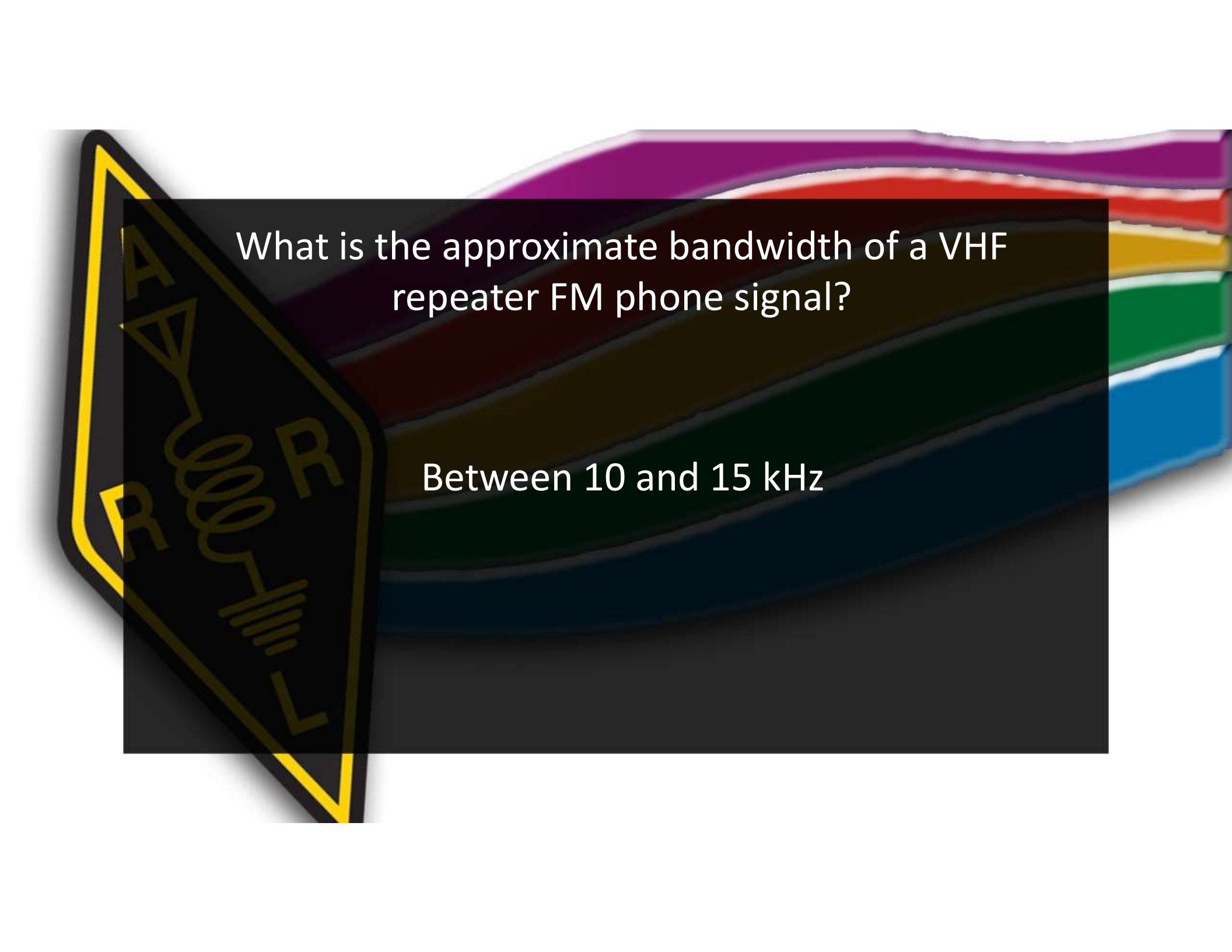What is the primary advantage of single sideband over FM for voice transmissions?

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

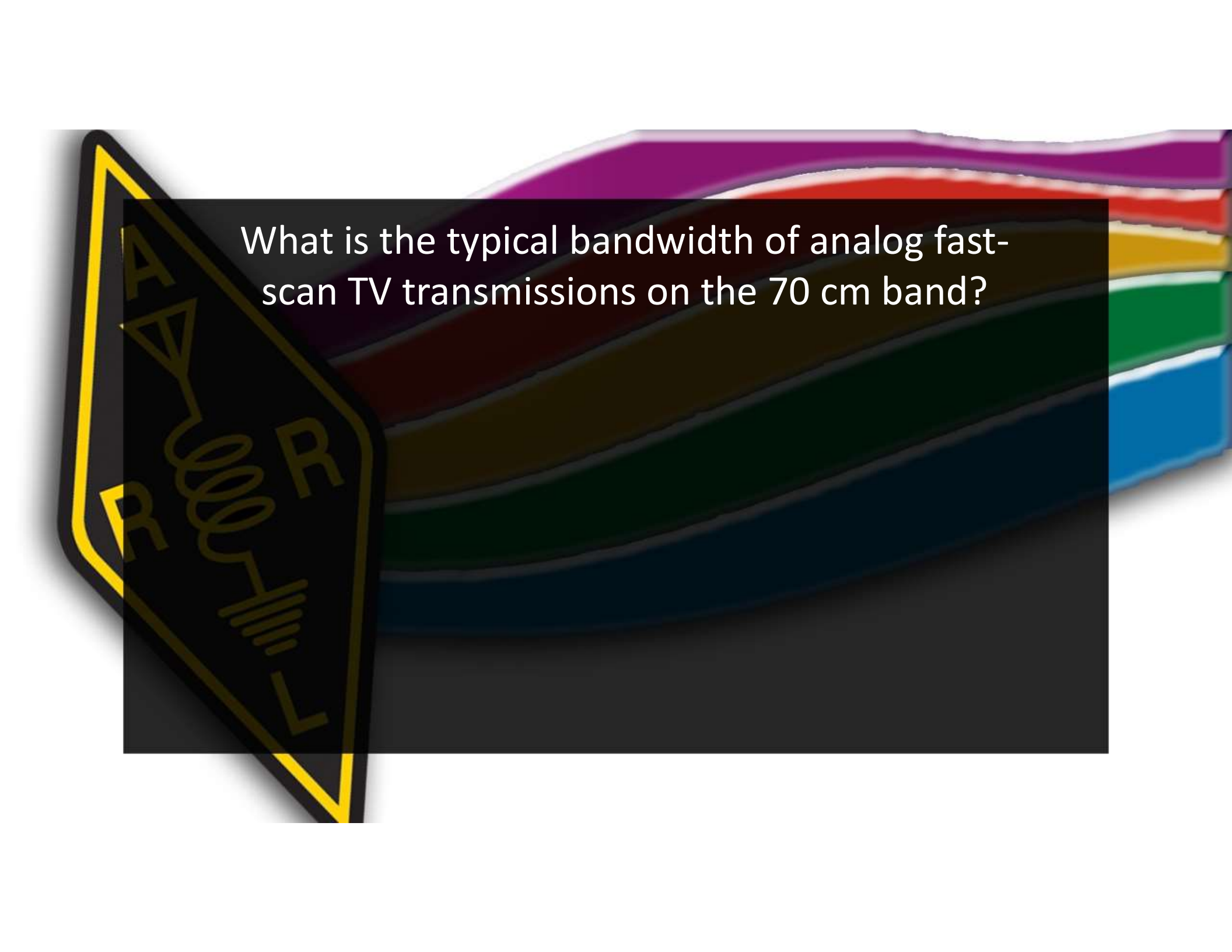SSB signals have narrower bandwidth

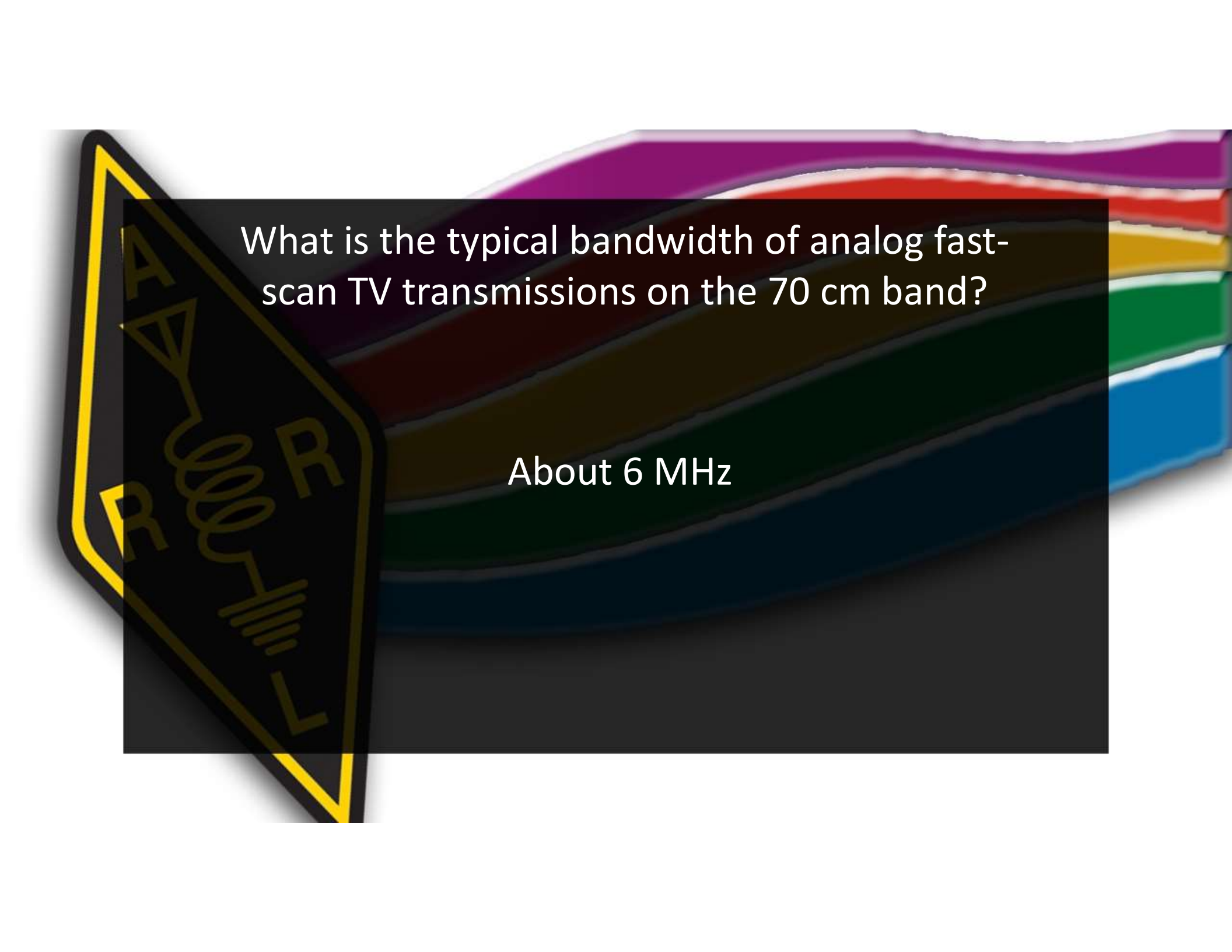What is the approximate bandwidth of a VHF repeater FM phone signal?

What is the approximate bandwidth of a VHF repeater FM phone signal?
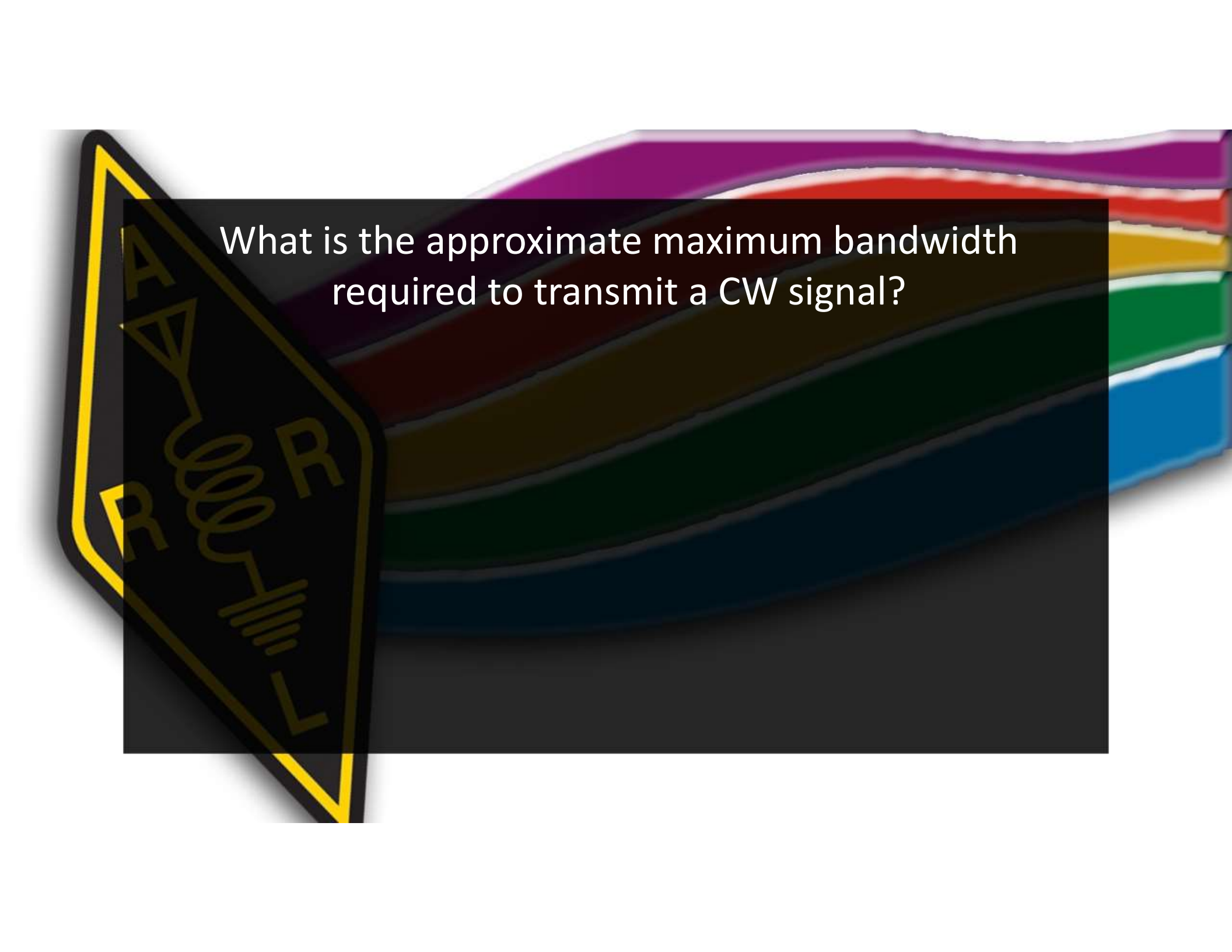
Between 10 and 15 kHz

What is the typical bandwidth of analog fast-scan TV transmissions on the 70 cm band?
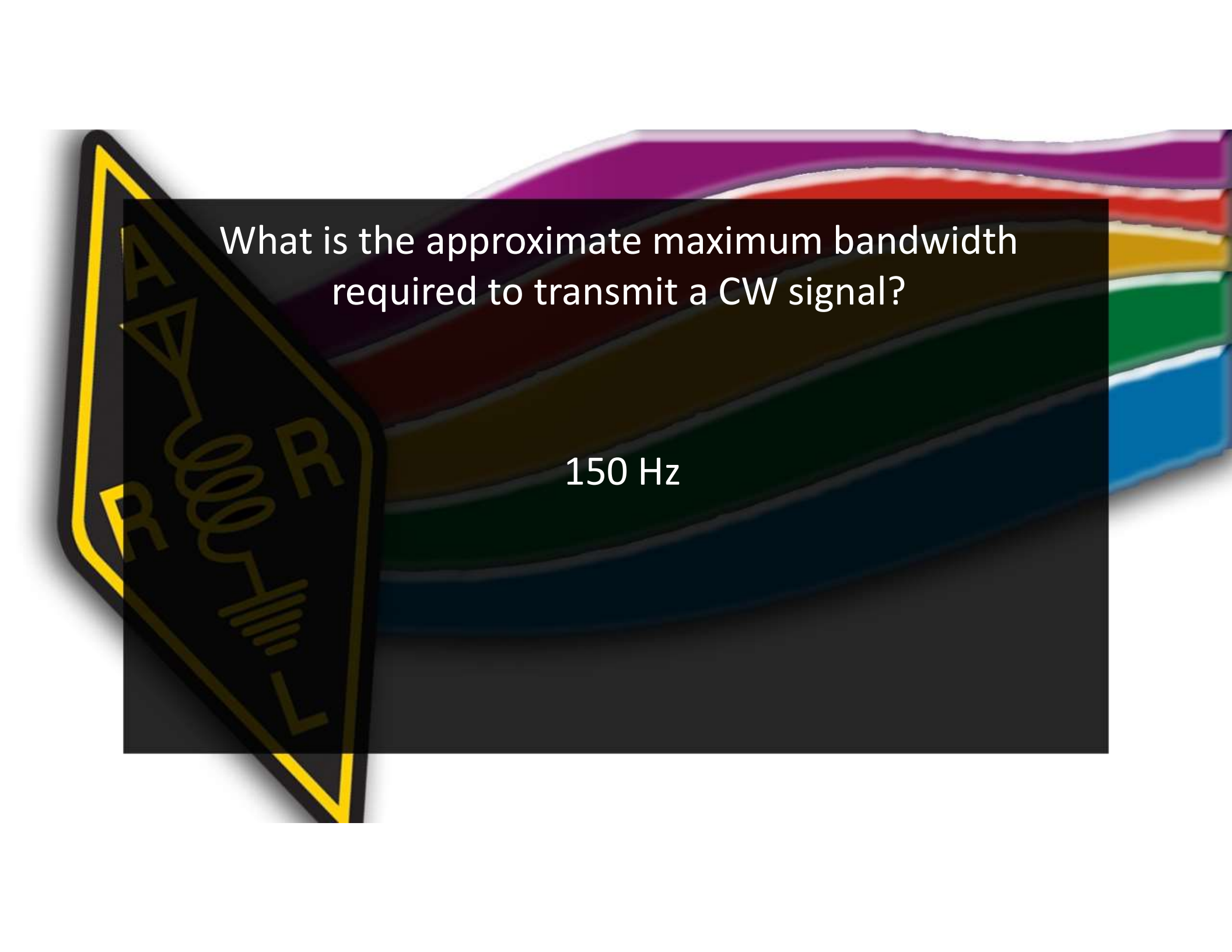
What is the typical bandwidth of analog fast-scan TV transmissions on the 70 cm band?
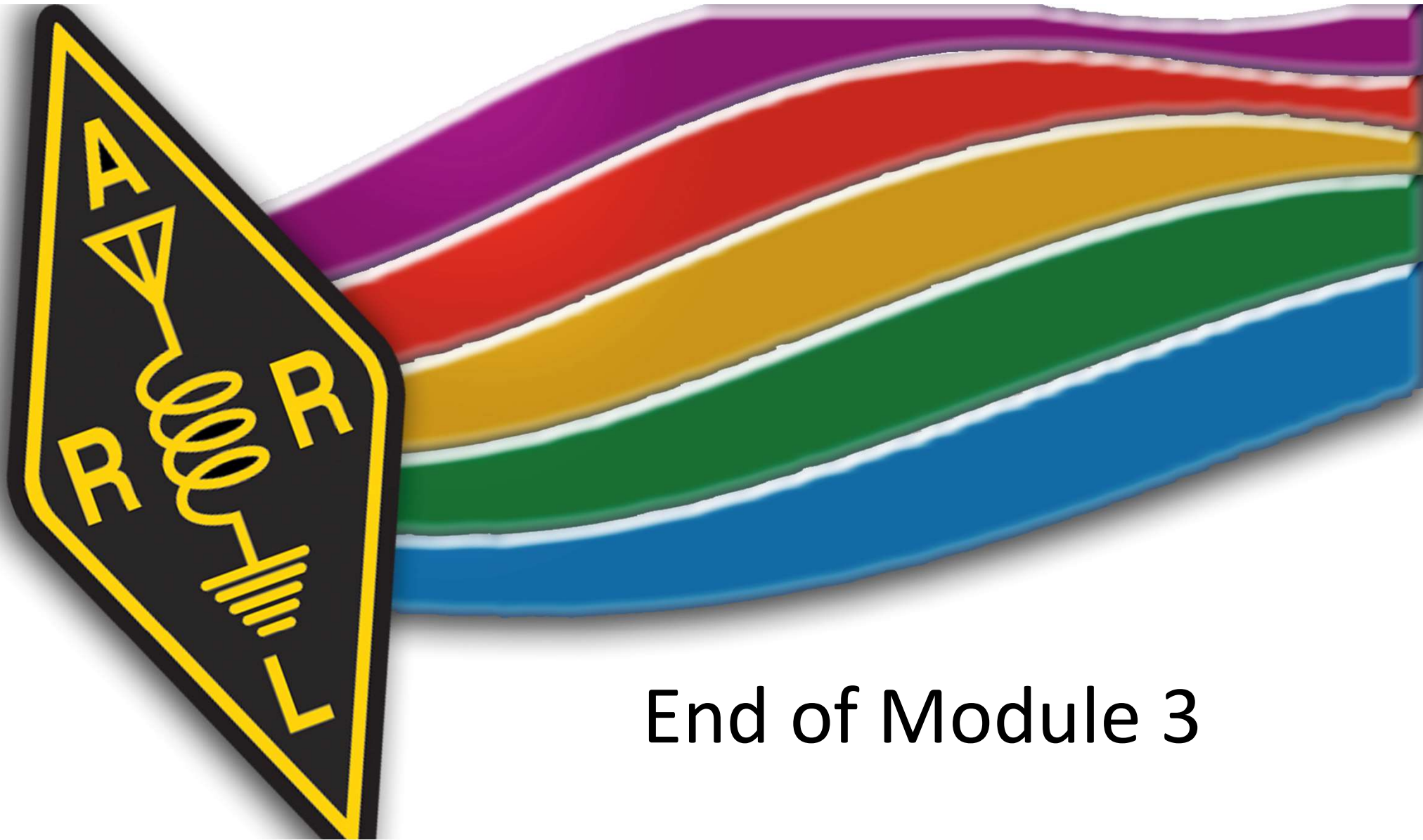
About 6 MHz

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

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

150 Hz

End of Module 3