Brass Tacks

Technically speaking, an in-depth look at a radio-related topic

AM and FM in a Non-technical Nutshell

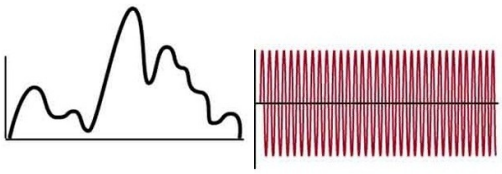
It seems to me that two of the most fundamental aspects of radio are either misunderstood or not understood at all. When most hams hear the words *AM* or *FM*, their eyes kind of gloss over, hoping nobody listening can detect their ignorance, or they nod and somehow try and relate them to broadcast radio. I hope to make at least the concepts of ***amplitude modulation*** and ***frequency modulation*** simple for the average ham. But in each case, that'll have to start with something a little technical. A couple of definitions are in order.

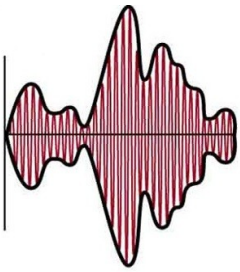
carrier — a simple radio *signal* of one frequency, like an inaudible hum (the frequency we tune to)

modulation — process of *changing* the carrier hum in some way so that it can convey something useful, like the sound of your voice

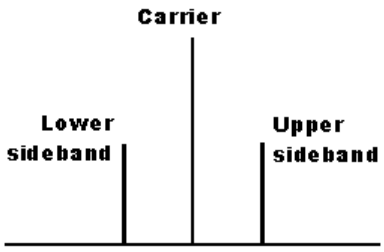
Amplitude Modulation

AM broadcast transmitters use AM to send their signals to an AM receiver to be converted into something we can hear. It's perhaps the simplest way to use a carrier signal to transmit a sound, but to do it effectively we need to transmit the *sound level* (loudness) and the *sound pitch* (high and low notes.) Let's start with an audio signal, like your voice. Next we select a carrier frequency. An AM transmitter contains simple circuitry that can shape the carrier so that, instead of being a constant level, its peaks and valleys (loudness) and sharpness (pitch), match those of your voice. What we end up with is a radio-frequency signal (carrier) that has been changed (modulated) by your voice and can now be transmitted from your radio to many others.




Amplitude modulated

A little less-intuitive, an AM signal can also be graphically viewed by frequency, so that if we're looking at just the carrier, we see only a single spike of a certain level (power.) As it's being modulated by your voice, the frequency graph shows not only the steady carrier, but two smaller spikes on both sides of the carrier identical to each other, jumping around as you speak, moving farther and closer to the carrier with the pitch of your voice, and rising and shrinking with the loudness of your voice. These two little spikes take up a small section or *band* of frequencies beside your carrier as they jump around, so we call them *sidebands*. But wait a minute. If each of the sidebands carries all the voice information, and they're mirror images of each other, why not just transmit one of the sidebands, and let the receiver worry about the rest, conserving transmitter power? Genius! This is exactly what ***HF*** (160 through 10 meters) and 6 meter transceivers do before they transmit their signals, an AM sub-



Brass Tacks, continued

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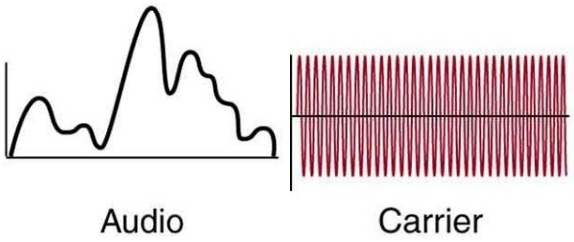
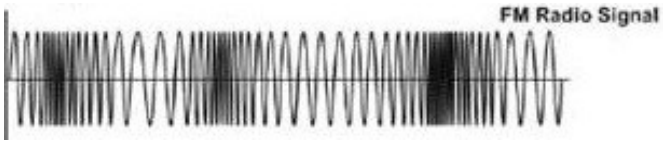
set called *single sideband* (SSB). We refer to the lower-frequency one as *lower sideband* (LSB) and the other as *upper sideband* (USB). When an HF receiver detects our signal, its circuitry knows what the missing carrier should be (because that's the frequency it's tuned to), creates a mirror image of the sideband signal we sent, puts the full AM signal back together, then re-converts it back into our voice for your listener.

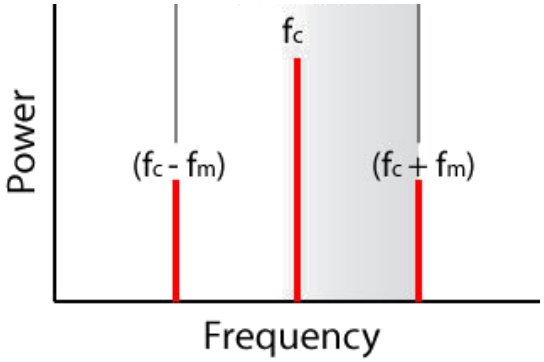
Frequency Modulation

Most of today's handheld transceivers (HTs) use FM to modify the carrier signal in a way that an FM receiver can recognize and convert the signal into a voice we can hear. FM works a little differently from AM, in that the signal amplitude (strength) is always the same, but its frequency is changed according to your voice. We still need to convey the same two pieces of information: loudness and pitch. Once again, we start with the audio (your voice) and a carrier (radio frequency) signal. An FM transmitter contains circuitry that not only changes the carrier frequency, but changes it at a certain rate, which is the frequency of your speech.



Let's re-examine that same frequency-view graph, so we can see how the lines jump around when we're doing FM. At first it looks almost identical to the graph for AM, but this time the little sideband lines behave differently. Instead of getting taller when the sound is louder like with AM, they move farther away from the carrier, and is called your ***deviation***. And the higher in pitch your voice, the faster the little sideband lines jump back and forth from one side of the carrier to the other and back. Unlike with AM, however, the two little lines aren't mirror images of each other, but they're *close*. However, that "close" word is what forces us to have to transmit both sides, and not just one, to fully reproduce the nice, clean signal we're used to hearing on our FM transceivers. This means FM signals take up more frequencies in that little band, or ***bandwidth***.





So, AM is the re-shaping of a carrier amplitude by your voice before sending it out, and FM is the continual modifying of a carrier frequency by your voice.

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