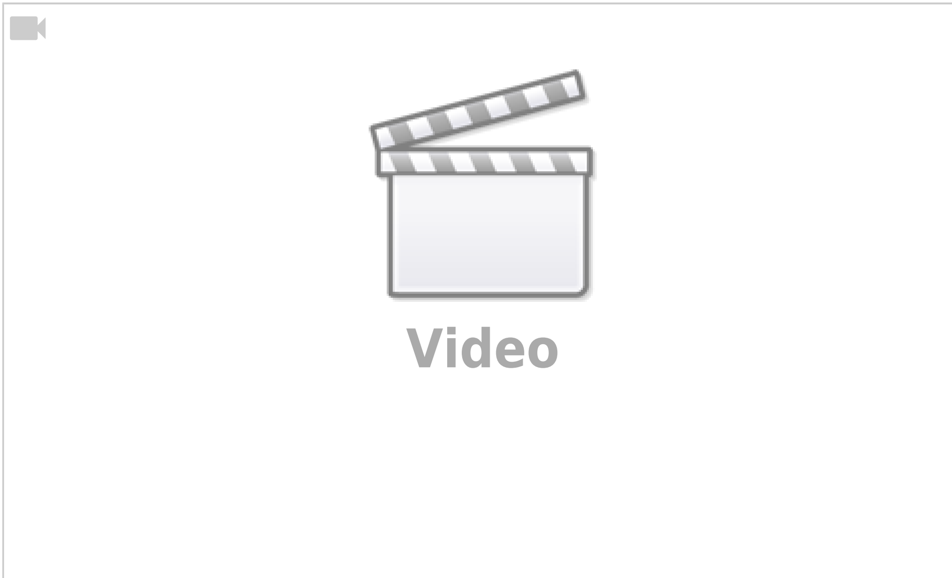
Block Diagrams

The next few sections use block diagrams to illustrate the configuration of various pieces of equipment. Here's an excellent introduction that should help with what follows:



HF Station

Some of the components shown above may be integrated into one device, and others may be optional. But if all are included, this is how they should be connected.

- The **transceiver** takes the audio from the microphone and creates a modulated radio signal. Typical HF radios can output about 100W of power. Hams with their advanced ticket can feed that into…
- The **amplifier** takes the radio signal from the transceiver and amplifies its power to 1 kW or even 1.5 kW.
- From there, the signal may contain higher frequencies (called harmonics) that are not desirable, so it goes through a **Low Pass Filter**, which passes low frequencies and filters out high ones.
- After that, the **SWR Bridge** measures how much of the signal is reflected back toward the radio from the antenna system. We saw earlier that the length of the antenna needs to match the frequency we use. When the match isn't perfect, some of the radio signal “bounces” at the antenna back to the radio, which isn't good for the equipment. The **SWR Bridge** measures this.
- A trick we use to protect the radio equipment is to add a **Tuner**. This device uses varying combinations of capacitors and inductors (more on this later) to match the impedance of the antenna system to the radio (more on that later). Although there is still reflection at the antenna back toward the radio system, the tuner will “protect” the radio from it.
- An **Antenna Switch** is a handy piece of equipment to quickly switch between antennas without having to disconnect and connect coax connectors.
- Because of their size difference, it's usual to have a multiband antenna that will work on 20m, 17m, 15m, 12m, and 10m (and maybe even 6m), and a second antenna for 40m, 80m (and maybe even 160m).

- Where as a **tuner** for the upper band is optional if the antenna is well designed, the lower bands (specially 80m) are very wide compared to their frequencies so it's practically impossible to have an antenna that will work over the entire band. For that reason, a tuner for these bands is pretty much mandatory.
- The **Dummy Load** is a 50Ω resistor that can dissipate all the power from the radio without converting any of it into a radio waves. It's useful for test purposes or to tune an amplifier.

All that being said, it's possible to go on HF with a transceiver that has a small integrated tuner in it, and a single antenna. It'll just be a matter of knowing which frequencies your system can transmit on, and stay within that range.

Transmitters

Review the Wave Modulation page. You should:

- understand the difference between the *baseband* signal and the *carrier*, and how they combine to form the *modulated* signal.
- understand the difference between *AM* and *FM*.

CW Transmitter

- The **master oscillator** generates a stable sine wave signal at the rest frequency.
- The **driver / buffer** is the first stage in the amplification process.
- The **key** is basically an on/off switch used to let the signal through to the amplifier or block it.
- The **power amplifier** is the last stage of amplification before the signal is released to the antenna.

FM Transmitter

- The **microphone** picks up the sound waves carried by the air and converts them into a weak electrical signal that becomes the *baseband*.
- The **speech amplifier** increases the strength of the baseband signal before it can modulate the carrier.
- The **modulator** uses the baseband signal to change the carrier oscillator frequency in the next stage.
- The **oscillator** generates a stable sine wave signal at the rest frequency when no modulation is applied. Its frequency changes linearly when fully modulated with no measurable change in amplitude. Note that the oscillator frequency can be much lower than the final transmitted frequency.
- The **frequency multiplier** increases the frequency of the modulated signal by a factor of 2, 3, or 4. This is so that the oscillator frequency can be lower than the frequency transmitted at the antenna.

- The **amplifier** increases the power of the signal to be transmitted by the antenna.

SSB Transmitter

- The **microphone** picks up the sound waves carried by the air and converts them into a weak electrical signal that becomes the *baseband*.
- The **speech amplifier** increases the strength of the baseband signal before it can modulate the carrier.
- The **RF oscillator** generates a stable sine wave signal at the rest frequency. Note that the oscillator frequency can be much lower than the final transmitted frequency.
- The outputs of the speech amplifier and the RF oscillator are mixed together in the **balanced modulator**. This produces a signal with two side bands, only one of which we want to keep.
- The **filter** only lets one sideband through.
- The **VFO** creates a sine wave frequency that can be varied.
- The **mixer** uses the output from the filter and the VFO to generate a higher frequency signal.
- The **linear amplifier** increases the power of the signal to be transmitted by the antenna.

Note that a Frequency Mixer *multiplies* two signals together, which usually results in a total of four (or more) frequencies. This is not to be confused with an Audio Mixer, which *adds* different signals together. See the optional Wave Modulation Math page for more details.

Receivers

FM Receiver

Before we look at individual components, there's an important step we should highlight: The received radio frequency (RF) is converted down to a predetermined intermediate frequency (IF) before being processed further. This solves a lot of problems that plague simpler receivers. Now let's look at the details.

- The **RF amplifier** increases the strength of the weak radio signal received by the antenna.
- The **local oscillator** creates pure sine wave that can be tuned by the listener.
- The **mixer** takes in the RF signal and mixes it with the pure sine wave from the local oscillator. This produces two frequencies: one is the sum of both input frequencies, the other is the difference. Only one of these is the IF that we want to keep.
- The **filter** removes unwanted frequency created by the mixer and lets the IF pass through to the next stage.
- The **IF amplifier** increases the strength of the IF signal.

- At this point, the signal's amplitude may vary due to noise. The **limiter** removes these amplitude modulations before the next stage.
- The **frequency discriminator** extracts the baseband signal.
- The **audio amplifier** increases the strength of the baseband signal before passing it to the speaker.

SSB/CW Receiver

- The first part is the same as the FM Receiver above.
- The **Beat Frequency Oscillator**: restores the carrier that was suppressed to create the SSB signal.
- The **Product Detector** mixes the IF and the BF together to extract the audio frequency (AF = |IF - BF|).
- The **audio amplifier** increases the strength of the baseband signal before passing it to the speaker.

Digital System

- The important conceptual leap here that we want the computer to be able to transmit something. That something could be a Winlink message, APRS telemetry, a live JS8 chat, or any other kind of data.
- That data needs to be modulated into a sound that can then be transmitted by the radio.
- A modem (MOdulator/DEModulator) or a soundcard like the Signalink can do that. But some radios like the IC-7300 can connect directly to the computer using a USB cable.

Regulated Power Supply

The goal of a regulated power supply is to convert household voltage (120 VAC) into DC voltage for the radio (13.8 VDC).

- The transformer converts 120 VAC to 12 VAC
- The rectifier takes the negative values of the sign waves and flips them up.
- The filter removes the small oscillations still present.
- The regulator ensures that when there's a power draw, the voltage doesn't drop too much.

Questions

- B-003-001-001 → B-003-008-006