Ham Radio School Visualization Apps
Hints and Tips

Our apps are designed to just be *fiddled with,* and you can dive right into any of them. But you may find these hints and tips helpful if you do not yet have familiarity with the related concepts.

AM Simulator:

- Simulates amplitude modulation of an RF carrier by a baseband signal such as audio.
- Global Controls: Adjusts the simulated RF carrier frequency and amplitude, and the apparent propagation speed of both baseband and carrier. Pauses waveforms and downloads a .png snapshot of the waveform displays.
- Modulation Source: Selects either audio 'tone' source as the modulating baseband or activates your microphone for live audio input as the modulating baseband. (Note: No audio tones are actually emitted by the tone generator. Rather, the simulated waveform of a pure sine wave tone is visually added to the modulating signal.)
- Tone Generator Source: When using the tone generator source, the Modulating Signals (The Rack) allows you to add more sine waveforms that sum together into the modulating signal and produce more complex baseband waveforms. Each added sine wave can be adjusted in frequency and amplitude.
- Live Microphone Source: This option may require you to tell your browser to allow the app to access your microphone. Allowance controls are browser specific.
    - Speak into your microphone to view real-time modulation of the complex audio baseband.
    - Freeze the display during audio input for analysis of the waveforms.
    - Adjust the microphone gain to view effects of amplification.

FM Simulator:

- Simulates frequency modulation of an RF carrier by a baseband signal such as audio.
- Global Controls: Similar to the AM Simulator global functions. The FM Deviation control changes how much the baseband amplitude affects the changes in frequency of the carrier.
- The Modulation Sources and the Modulating Signals rack function the same as the AM Simulator.

CW Simulator:

- Simulates CW signals, translated from your input text in the upper Text Entry field.
- Enter text and click 'Start Send.'
- The continuous waveform will flow across the display, underscored by the represented text characters.
- Tones are emitted, and the tone frequency can be adjusted with the lower right slider.
- Send speed can be adjusted, and the words per minute of the selected send speed is displayed.
- A cumulative text read out is also provided as the send proceeds.

FSK Digital Mode Simulator:

- Simulates frequency shift keying encoded with standard 8-bit ASCII binary code.
- Enter text into the upper window and click 'Start Send.'
- The FSK signal is represented in multiple forms: 1) Each unique audio frequency tone is emitted. 2) The waveform is color-coded to indicate the different audio tone frequencies. 3) The binary representation of each tone "symbol" is presented under the waveform (zoom as required to view). 4) A stairstep function represents each of the tones. 5) The alphanumeric character is presented at the bottom for each 8-bit sequence.
- A cumulative message window presents the sent characters as the send is proceeding.
- Tone Legend: Provides the color code and binary representation for each tone.
- Modulation: Select the type of FSK desired, either 2, 4, or 16 tones. Note how the number of bits (binary digits) changes for each tone as the FSK type is changed.
- Symbol Speed: Adjusts the send speed.
- Zoom: Allows zooming in or out to view the details of the signals and characters.
- Data Rate and Baud Displays: The baud is the symbols (individual tones) per second. The Data Rate is the bits per second. Note how the data rate increases even though the baud remains constant when you select a higher FSK type. This is because each symbol (each tone) represents a greater number of bits as the FSK type is increased to a greater number of tones. The code is more efficient as tone quantity increases.

Time & Frequency Domain FFT Analyzer:

- Illustrates the relationship between time domain signal representations and frequency domain representations. The lower frequency domain view display is a spectrum analyzer display of the frequencies comprising the input signal, as determined by fast Fourier transformation (FFT) of the blue-shaded window range in the time domain view (oscilloscope) display. Scroll down to see a graphic that illustrates the relationship between the time domain view and the frequency domain view of a complex signal comprised of a band of frequencies.
- Input Source: Select one of the pre-canned signal options or the live microphone input for a complex audio signal. When using the live microphone, click the 'Start Microphone' button to activate it as the source, and click again to record 2 seconds of audio input.
- Time Zoom: Allows zooming for detailed analysis of the time domain view of the input.
- FFT Window Size: Changes the number of discrete samples comprising the blue-shaded window in the time domain view display. Greater numbers of samples provide greater resolution of the frequency domain display.
- Display Mode: Select either a line graph or a bar graph for the frequency domain display.
- Play Button: Plays the selected audio input (2 seconds nominally).
- Playback Speed: Reduce the playback speed to get a slower playback of the input source. The tone of the input source will be preserved but slowed in time.

Filter Simulator:

- Illustrates the effects on audio signals of various types of filters. Simulates typical real-world (imperfect) filter effects. Similar user interface as the Time & Frequency Domain FFT Analyzer, depicting a time domain view and a frequency domain view. The filter effects are illustrated in the frequency domain view display.
- Select an input source, either a pre-canned signal or a microphone recording (5 seconds).
- Select a filter type and adjust its characteristics. A bandpass filter is recommended to begin.
    - Adjust the Center Freq control to move the filter center frequency across the spectrum display. Note the effect on the yellow band of frequencies.
    - Note the filter passband as the red-shaded region of the spectrum display. The frequencies outside the red-shaded region of the spectrum are filtered entirely, while the filter shape (red curve) proportionally shapes the frequency response under the red curve.
    - Adjust the bandwidth of the filter to broaden or narrow it across the spectrum, and note the effects on the yellow frequencies.
    - Adjust the sharpness of the filter and observe the effects.
    - Notice the 'ghost' display of the unfiltered signal on the spectrum display and the effect that the filter is having relative to that ghost presentation.
- Other controls are identical to the Time and Frequency Domain FFT Analyzer app, including the playback of audio. Filter the spectrum and then play the audio to hear the impact. A loop function is provided for continuous playback of the audio.

SWR Wave Simulator:

- Illustrates the voltage traveling waveforms within a transmission line that can result in standing waves and increased SWR when an impedance mismatch is present in the transmission line or at the antenna feed point.
- Select a forward signal amplitude, a reflected signal amplitude, propagation speed and a frequency.
    - A blue forward signal will propagate left to right.
    - A red reflected signal will propagate right to left.
    - A black summation of the two signals will be computed and displayed – the 'standing wave.'
        - Notice how the summation wave has a maximum voltage when the forward and reflected signals are in-phase (aligned).
        - Notice how the summation wave has a minimum voltage when the forward and reflected signals exactly out of phase.
- SWR is computed as the ratio of the maximum voltage to the minimum voltage of the summation or standing wave (black waveform). SWR is numerically displayed at the lower right.
- Optionally turn on/off each wave with the check box selections.
- Pause the simulation as desired for analysis.