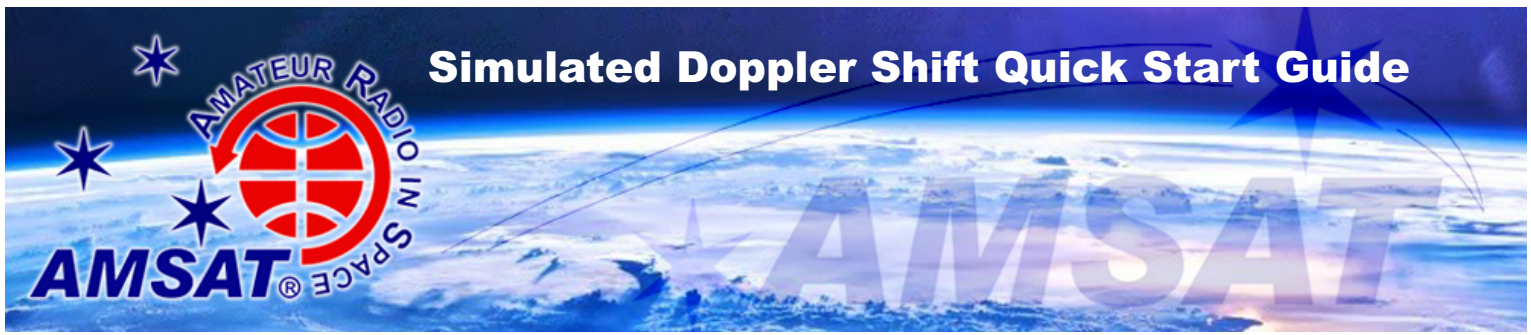




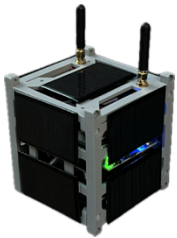
This guide provides a short description of how to use the simulated Doppler shift mode with the CubeSatSim.

What it is:

Doppler frequency shift occurs if there is a speed difference between a transmitter and a receiver, such as an orbiting satellite and a ground station on the earth. On a satellite signal, you can see this shift on an SDR waterfall and sometimes hear it in the radio signal. This principle in reverse is how Doppler weather radar and radar speed guns work.

The CubeSatSim can simulate Doppler shift for APRS, CW, SSTV, PacSat, and Cross Band Repeater modes. For continuous transmission modes such as FSK, BPSK, and FUNcube, the CubeSatSim can't simulate Doppler shift and turning it on will have no effect.

What You Need:



- A CubeSatSim or CubeSatSim Lite running version the latest software version v2.3
- A Ground Station with SDR waterfall. For example, you can use the Raspberry Pi Ground Station FIABv4 (FIABv3 works too)
- A radio can also be used, but an SDR with waterfall is better as you can see the simulated Doppler shift

How to Turn Simulated Doppler ON and OFF:

By default, simulated Doppler is OFF on the CubeSatSim. You turn it on and off using the Dashboard or by typing a command line on your Pi Zero 2. To log into your Pi Zero 2 (see <https://cubesatsim.org/download/cubesatsim-readme.pdf> for how to do this) then type the command **CubeSatSim/config -K** and then type **y** to turn it on. You then type **sim** to select Simulated Doppler Mode. There is also an experimental **rig** Radio Control Doppler mode. To use that mode, there are instructions here: <https://CubeSatSim.org/doppler>

These instructions describe how to use the **sim** Simulated Doppler Mode: In this mode the CubeSatSim can simulate Doppler shift by simulating an orbit, calculating the Doppler frequency shift, then applying that new frequency each time the CubeSatSim begins a transmission.

How to See and Hear Doppler Shift:

You can experience simulated Doppler shift in the following modes: APRS, CW, SSTV, PacSat, and Cross-Band Repeater. The best way to see and hear it is to use CW mode and an SDR Ground Station with a waterfall.

To switch to CW (Morse code) mode, press and hold the pushbutton until the green LED blinks 5 times, then release the button. Or, you can use the Dashboard or log into your Raspberry Pi Zero and type this command: **CubeSatSim/config -m**

After the restart or reboot, the sound of the CW will change. If you are still listening using FM, instead of tones you will hear clicks. If you are looking on an SDR waterfall, the signal will be much skinnier. To hear the Doppler shift, you will need

a 70cm SSB radio or an SDR such as the RTL-SDR and the Raspberry Pi Ground Station (FIABv4) or your computer. On an SDR, if you select USB decoding and tune or click just to the left of the signal, you should hear the Morse Code tone again. The blue transmit LED will also blink on and off with each dot and dash when Simulated Doppler Mode is enabled. The frequency will be slightly shifted from your 434.9 MHz default (or another frequency if you used the **CubeSatSim/config -F** command to change it). The frequency will initially be close to 434.909 MHz, but it will decrease over time to as low as 434.891 MHz.

As you listen over time, you should hear the note of the CW tone decrease. After a minute or two, the tone might go away as the frequency has shifted below where you are tuned. Tune again to just to lower your listening frequency, and you will hear it again. About 5 minutes since you enabled simulated Doppler, the frequency will be at 434.9 MHz, but it will also be changing rapidly. If you zoom into the waterfall (if you are using OpenWebRX, click on the magnifier plus icon in the lower right box a few times, you might be able to see that the signal is not a vertical line, but slanting slightly as the frequency bends over time.

In APRS, SSTV, PacSat mode, you won't hear any difference in the Doppler shifted packets, but each packet will be transmitted on a slightly different frequency.

In Cross-Band Repeater mode, you will notice that the transmitted signal on the 2m band will be different each time you break the squelch. The Doppler shift in the 2m band will be less than what you see in the 70cm band since the shift is proportional to the frequency. You will also need to change your transmit frequency as the uplink frequency is also Doppler shifted.

You can monitor the real-time transmit and receive frequencies by using the Dashboard or by typing this command:
CubeSatSim/log -f r

Troubleshooting:

Here are some possible problems and resolutions:

1. I can't tell if simulated Doppler is enabled.
 - a. One easy way is to put your CubeSatSim into Morse code mode 5 (press and hold pushbutton and release at five blinks). If simulated Doppler is enabled, the blue transmit LED will flash on and off with each dot and dash. If it doesn't, simulated Doppler isn't enabled.
 - b. You can check the configuration using the Dashboard under Show Configuration
 - c. You can log into your Pi Zero 2 and the **CubeSatSim/config** command will tell you if Doppler is enabled and if Simulated (sim) mode is set or Radio Control (rig) mode is set.
2. Doppler is enabled, but I don't see any change in frequency
 - a. Are you in APRS, SSTV, Morse, PacDat, or Cross-Band Repeater mode? These are the only modes where you will see and hear simulated Doppler shift. If you are in FSK, BPSK, or FUNcube mode, you won't see any frequency change.
 - b. At the start of a simulated pass, the frequency won't change very much - just a few hundred Hz at a time. If you wait a few minutes for the middle of the simulated pass, the frequency will change much more frequently
 - c. Are you in the Simulated Doppler (**sim**) mode? If you are in the Radio Control Doppler (**rig**) mode, the frequency won't change unless you have configured Gpredict and Engaged Radio Control and are Tracking a satellite. Try switching to Simulated Doppler mode or follow the Radio Control Doppler instructions at <https://CubeSatSim/pacsat>
3. I see the transmit frequency changing, but I don't hear it the audio.
 - a. Are you in CW (Morse Code) mode? Only in CW mode 5 will you actually hear the frequency shift in the demodulated audio. Also, in Doppler Morse Code mode, the Morse mode is true CW, not FM audio frequency CW. You need to demodulate using SSB (such as USB) or CW (although CW mode usually has a very narrow bandwidth which is not good for a Doppler shifted signal).