



This guide provides a short description of how to use the PacSat mode with the CubeSatSim. For full details see <https://CubeSatSim.org/pacsat>

What it is:

PacSat is a new CubeSatSim mode. PacSat is short for Packet Satellite, and is a type of amateur radio digital store-and-forward satellite that has been around for decades.

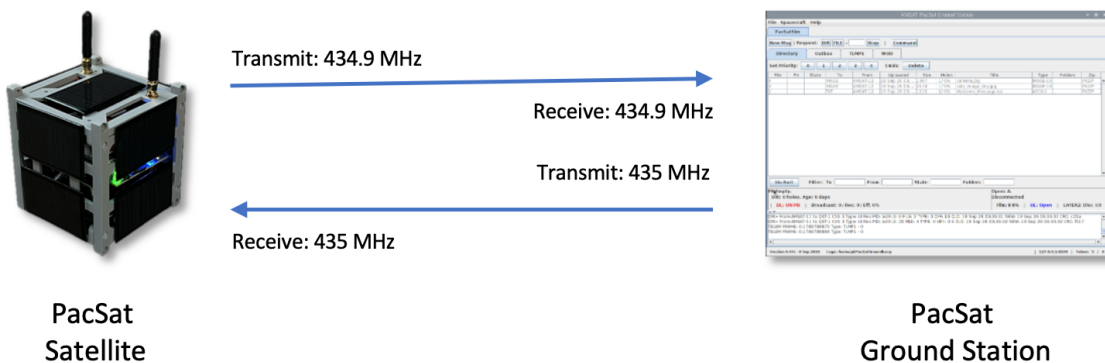
PacSat mode uses 1200 bps AFSK AX.25 transmissions which sound like APRS packets but are a different format. A PacSat system has two components: a satellite and a ground station. The satellite functions as a store and forward file server in space, like an old fashioned Bulletin Board Service (BBS). Using a transmitting ground station, users can request a directory of available files, and download and upload files to the satellite.

What You Need:

- A CubeSatSim or CubeSatSim Lite running version the latest software version v2.3. Any v2 software can be upgraded.
- A Pacsat Ground Station. For example, you can use the Raspberry Pi Ground Station FIABv4 with a RTL-SDR dongle. However, to do all of the functions, you need a ground station that transmits such as:
 - A Pacsat Ground Station running Direwolf connected to a radio transceiver with PTT control
 - A second CubeSatSim or CubeSatSim Lite which can function as a transmitting ground station.

How to Configure PacSat Frequencies:

The PacSat satellite and Pacsat Ground Station need to be configured so they each receive the other's transmitted signals. If you are using the defaults, the satellite should transmit on 434.9 MHz and receive on 435 MHz. The Ground Station should then transmit on 435 MHz and receive on 434.9 MHz.



The configuration can be done using the **CubeSatSim/config-F** command, or by running the *Pacsat Ground Station* desktop icon, then select *Configure the Pacsat Ground Station* and then select *Set Frequencies*. On the PacSat satellite, you can change the frequencies using the Dashboard in your browser under *Settings* and select *Change TX and RX Frequency*.

How to Set the PacSat Mode in the Satellite:

PacSat mode 8 makes the CubeSatSim emulate a PacSat satellite. It will transmit 1200 bps AFSK AX.25 packets every 10 seconds or so. There are several ways you can set this mode:

- Press and hold the pushbutton until the green Power LED blinks 8 times, then release it.
- Log into the Pi Zero 2 and type this command **CubeSatSim/config -G**
- Access the Dashboard using your browser. Under *Mode Changes* select *Change Mode to Pacsat*

After a reboot, you should hear the packets being transmitted.

How to Run the Pacsat Ground Station:

You can receive PacSat packets using just Direwolf, but to decode the AX.25 messages, you need to run the Pacsat Ground Station. You can download the latest version on Chris Thompson's website: <https://www.gOkla.com/pacsat/downloads/test/> It runs on Windows, Mac, and Linux. If you install it yourself, you will need to configure Direwolf and your radio. Alternatively, if you run the FIABv4 on a Raspberry Pi 4 or 5, the Pacsat Ground Station and Direwolf is installed and configured.

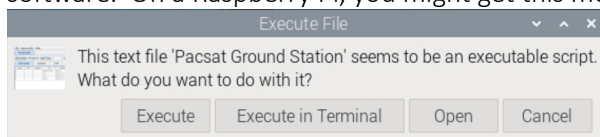
If you only have an RTL-SDR radio dongle, you can receive PacSat telemetry and other packets, but you can't request a directory, request to download files, or upload files. To do this, you need a transceiver interfaced to the computer running the Pacsat Ground Station software. The setup is the same as for a transmit and receive Direwolf APRS station. For instance, a UHF FM radio connected to your computer using a sound card with a PTT (Push To Talk) interface so that the Pacsat Ground Station can control the transmitter. On a Pi 4 or 5 running the FIABv4, this is also fully configured. You could connect a digirig using a USB cable and connect the digirig to your radio (using a K-1 cable to a Baofeng or similar).

You can also use another CubeSatSim or CubeSatSim Lite as a Pacsat Ground Station. You will need to access the GUI Desktop on the Raspberry Pi. You can do this by:

- Connecting a HDMI monitor (using an HDMI adapter) and mouse (you will need a USB hub so you can still plug in the USB sound card) to the Raspberry Pi
- Logging into the Pi on your Wi-Fi using VNC (logging in via ssh will not work since you need the Desktop)
- Logging into the Pi using Raspberry Pi Connect with your browser <https://connect.raspberrypi.com>

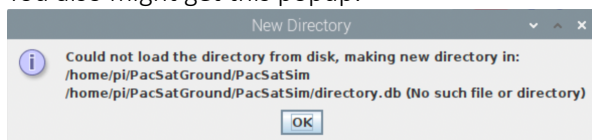
Using the Pacsat Ground Station:

The first time you run the Pacsat Ground Station, you might get some popups about installing and configuring the software. On a Raspberry Pi, you might get this message:



You can select either *Execute* or *Execute in Terminal* - either option will work. You can get rid of this popup by opening the File Manager then opening the *Edit* menu then *Preferences* and check the box *Don't ask options on launch executable file* then select *Close*.

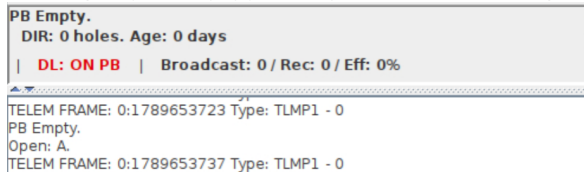
You also might get this popup:



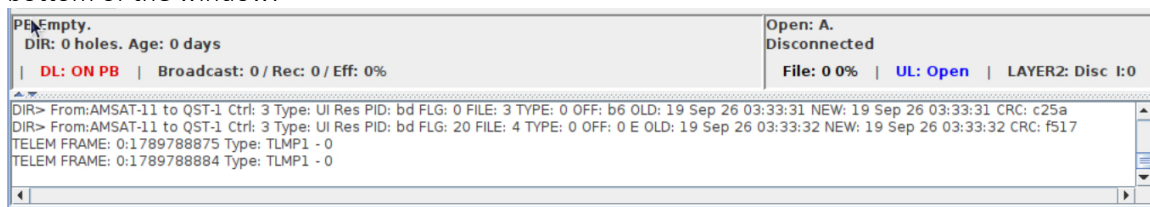
This warning is normal the first time you run the ground station. Select *OK* and the Pacsat Ground Station will load.

The first time you run the ground station, you should go under the *File* menu then *Settings* and set your callsign. You will also have to put in latitude and longitude or a grid square to save your changes when you select *Save*.

If your PacSat is transmitting packets on the frequency that your Pacsat Ground Station is receiving, you should see this at the bottom of the window indicating that telemetry messages are being received (*TELEM FRAME*) and Pacsat Broadcast messages (*PB Empty*) and uplink status messages (*Open: A*):



The Ground Station should automatically request the directory when it receives an *Open: A* message from the PacSat indicating that upload channel A is open for requests. You can also request the directory by selecting the *DIR* button. If your PacSat is receiving on the frequency your ground station is transmitting, you will see messages such as this at the bottom of the window:



You should see several files in the directory after a few moments. One should be a welcome message (*Welcome_Message.txt*) and others will be images (a stored image *sstv_image_tiny.jpg* and Pi Camera image *camera.jpg*). You can download them by selecting the filename then selecting the *FILE* button or the *Set Priority* number 1- 4 (0 will not download the file).

How to Reset the PacSat Satellite

To clear out old files or if the satellite and your ground station become out of sync, you can reset the PacSat satellite. This command must be done on the CubeSatSim acting as the satellite – executing them on the ground station will have no effect. You reset the PacSat by logging into the CubeSatSim Raspberry Pi and typing the command **CubeSatSim/config -k** or in the Dashboard using the *Reset the Pacsat Configuration* button under *Settings*. This reset does not reset the callsign. To reset the callsign, use the command to change the callsign.

How to Reset the Pacsat Ground Station

To clear out old files in the directory or if the satellite and your ground station become out of sync, you can reset the Pacsat Ground Station. This command must be done on the ground station computer – executing them on the PacSat satellite will have no effect. Restart the Pacsat Ground Station and select *Configure the Pacsat Ground Station* then select *Set Pacsat Ground Station Configuration* then select *Reset Pacsat Ground Station configuration*. You will get the popups again the next time you run the ground station.

If you had set your callsign in the Pacsat Ground Station, you will need to set it again. If you set a callsign for the PacSat satellite, you will also need to set that callsign again in the Pacsat Ground Station. Restart the Pacsat Ground Station and select *Configure the Pacsat Ground Station* then select *Set Pacsat Ground Station Configuration* then select *Set Remote PacSat Satellite Callsign in Ground Station* then enter the callsign of your CubeSatSim. The next time you run the Pacsat Ground Station, the new satellite callsign will be in effect. You can see the satellite callsign in the Pacsat Ground station by selecting the *spacecraft* menu then *PacSatSim*. Under *Fixed Parameters*, you will see the callsign.

Troubleshooting:

Here are some possible problems and resolutions:

1. I can't put my CubeSatSim into PacSat mode
 - a. If mode 8 (8 blinks) is not an available option, that means you aren't running v2.3 or later software. You need to upgrade your software or flash a new micro SD card for your Raspberry Pi.
2. My CubeSatSim is in PacSat mode but I don't hear or see any packets
 - a. Are you sure that you are in Pacsat mode? You can check the mode using the Dashboard (select *Show Configuration* then *Show CubeSatSim Config*) or type the command **CubeSatSim/config** and it should say it is in PacSat Mode. Note Pacsat Ground Station mode won't transmit anything unless the ground station is running.
 - b. Are you listening on the right frequency? The default transmit frequency is 434.9 MHz. You can check it using the configuration options in the previous section. If you have simulated Doppler enabled, the transmit frequency might be different - turn off Doppler mode until you have things working.
3. When I start the Pacsat Ground Station, I get a "New Directory" error
 - a. This is not an error – it is a warning. Just select *OK* and the ground station will load
4. When I start the Pacsat Ground Station, I get an Error "IO Error connecting to the TNC"
 - a. This means that Direwolf is not running for some reason. It could be because the window with the Direwolf logs and messages has been closed. Or it could be that Direwolf encountered an error and closed. Look at the messages in the Direwolf log for clues to what has gone wrong. Make sure the USB sound card is plugged in.
5. I see and hear packets transmitted by my CubeSatSim but nothing decodes on my Pacsat Ground Station
 - a. Is the Pacsat Ground Station running with Direwolf and a radio or RTL-SDR? If you are running on a Raspberry Pi, look at the window with the Direwolf logs - you should see messages about Direwolf and received packets
 - b. If you are using a radio receiver, is the squelch off? You should always run without squelch to avoid missing or clipping packets. Is the volume set high enough?
 - c. If you are using a radio receiver, is it in FM mode?
 - d. If you are using a radio receiver, is it receiving on the frequency that your PacSat is transmitting?
6. I see packets being received by the Pacsat Ground Station, but I don't see the right messages, just random characters.
 - a. Is the CubeSatSim in APRS mode instead of PacSat? If so, you will see packets decoded but they won't be right.
 - b. Is the satellite callsign set in the Pacsat Ground Station the same as the PacSat? They both default to AMSAT, but if you set your callsign on your CubeSatSim, you need to set that callsign in the Pacsat Ground Station. Restart the Pacsat Ground Station and select *Configure the Pacsat Ground Station* then select *Set Pacsat Ground Station Configuration* then select *Set Remote PacSat Satellite Callsign in Ground Station* then enter the callsign of your CubeSatSim.
7. I see decoded Pacsat packets but I don't see any files in the directory even after 30 seconds
 - a. Do you see a "PB Closed" message? If so, you should reset the PacSat using the commands described in an earlier section of this document.
 - b. Do you see any "Open: A" messages? If you don't, you should reset the PacSat using the commands described in an earlier section of this document.
 - c. Check the PacSat receive frequency. Check the PacSat logs on the CubeSatSim to see if packets are received.
8. If I click on the *DIR* or *FILE* buttons, I get a "Transmit Disabled" popup message
 - a. If you are running on the FIABv4 Raspberry Pi Ground Station with the RTL-SDR radio dongle, then this message is correct – your ground station can't transmit.
 - b. If you get this and you have a radio connected to your computer or a CubeSatSim Lite board plugged into your computer, then you need to enable transmit. Enable transmit by going under the *File* menu then *Settings* then uncheck the box *Inhibit Transmitter*.
9. My Pacsat Ground Station keeps requesting directory files over and over again. The PacSat satellite sends them, but the ground station just requests them again.
 - a. The satellite and ground station directories are probably out of sync. You should reset the Pacsat Ground Station using the commands described in an earlier section of this document.
10. My directory is full of files I don't want anymore
 - a. You can reset the Pacsat Ground Station using the commands described in an earlier section of this document. You should probably also reset the PacSat using the commands described in an earlier section of this document.