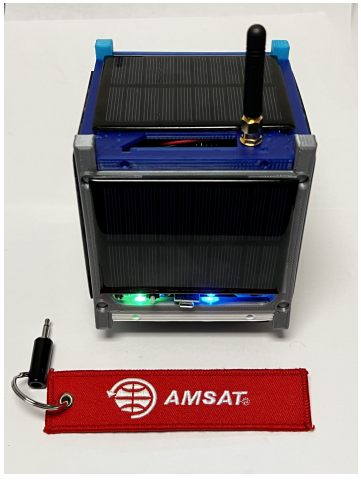
AMSAT® CubeSatSim

The AMSAT CubeSatSim, the CubeSat Simulator is a tool for satellite and space technology education and demonstrations. Designed for educators, students, Amateur Radio operators ("hams") and the general public to help demystify and explore how a real satellite works in Low Earth Orbit (LEO).

The CubeSatSim is a low cost satellite emulator that runs on solar panels and batteries, transmits UHF radio telemetry data on the 70cm band, has a 3D-printed life-size 1U frame, and can be extended by additional sensors and modules.



A Satellite in Your Hand!

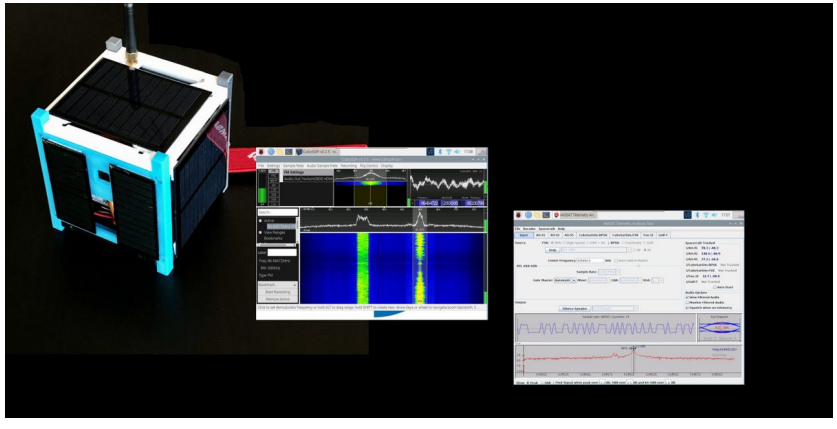
A series of articles in the *AMSAT Journal* describe the design and development of the CubeSatSim.

A variety of educational activities can be performed with the CubeSat Simulator including the activities of the original ARRL ETP CubeSat Simulator from ten years ago as described by Mark Spencer, WA8SME, in his earlier *AMSAT Journal* articles.

STEM (Science, Technology, Engineering and Math) principles can be demonstrated* including power, efficiency and data analysis.

You can **BUILD** your own AMSAT CubeSatSim using the Wiki instructions* and published code – the design is fully open source. AMSAT has built CubeSat Simulators available to **BORROW**. Email Alan ku2y@arrl.net to learn about how to bring a satellite into your classroom or your next club meeting! Inspire! Engage! **EXPLORE** STEM!

- **Learn how to Use FoxTelem to decode satellite telemetry**
- **Send and receive SSTV images**
- **Extend with your own sensors for STEM education**
- **Hone your soldering and 3D printing skills**



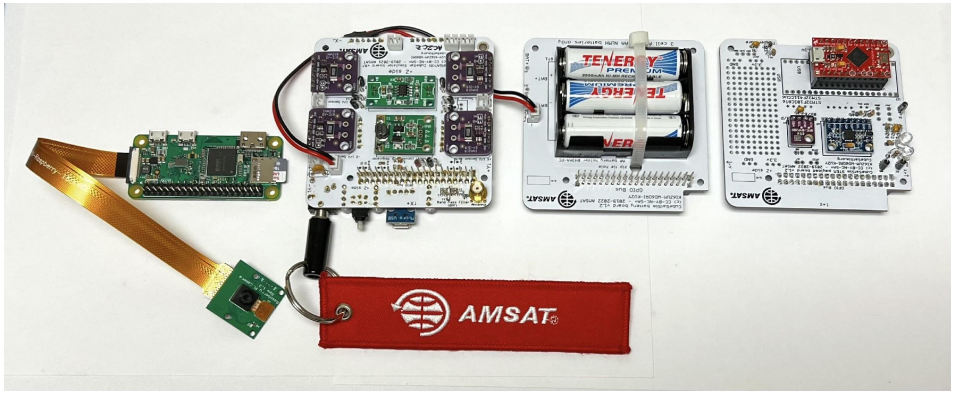
*** ONE-STOP LINK**

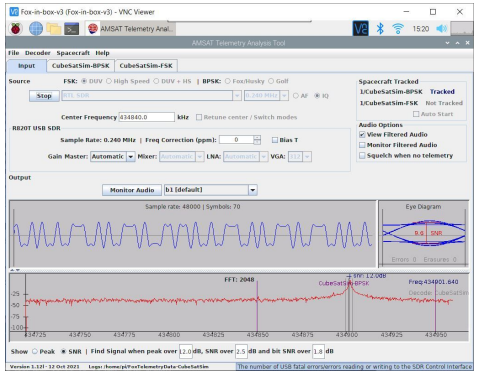
https://CubeSatSim.org

for

Step-by-Step Instructional Wiki
Published Papers
Open Source Software
Bill of Materials

AMSAT® CubeSatSim – Under the Hood

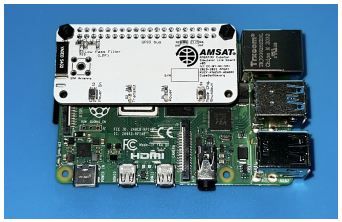




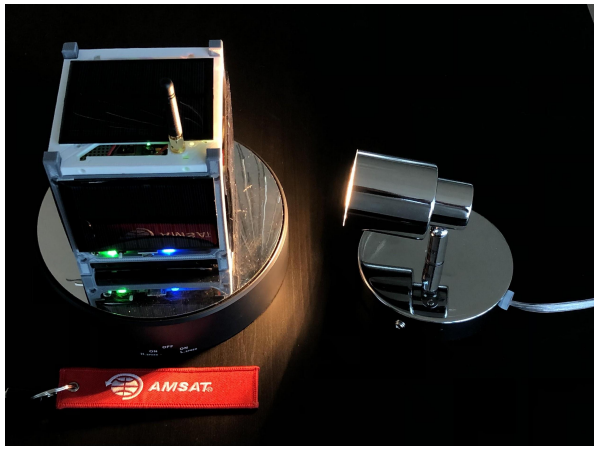
Telemetry Analysis using AMSAT FoxTelem

Raspberry Pi Zero	Main Board	Battery Board	STEM Payload Board
Single Board Computer (SBC) runs C and Python open source software to generate telemetry in five different modes: APRS, FSK/DUV, BPSK, SSTV, and CW. Uses Pi Camera to transmit SSTV images in Scottie 2 format.	A Low Pass Filter (LPF) for the transmitter, battery charger, 5V boost converter, and current and voltage monitoring sensors.	3 cell AA nickel-metal hydride battery pack (NiMH). NiMH was chosen to simplify shipping and for safety during building – accidental short circuits do not cause fires.	Arduino compatible microcontroller interfaced to a BME-280 temperature, pressure, and humidity sensor and a MPU6050 IMU (Inertial Measurement Unit)/gyro 3-axis accelerometer and rotation.

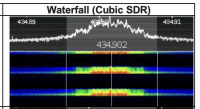
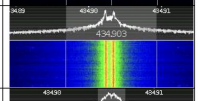
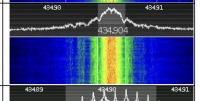
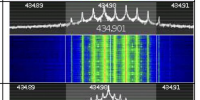
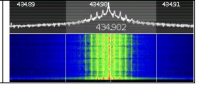
Three Custom Boards and a Raspberry Pi Zero SBC



Low Cost “Lite” Version with Simulated Telemetry



Turntable and Lamp used to Simulate the Sun and on Orbit Rotation

Blinks	Mode	Description	Decoding	Command	Audio	Waterfall (Cubic SDR)
1	APRS	Automatic Packet Reporting System. This digital mode sends a packet of data with AFSK or Audio Frequency Shift Keying modulation.	Windows: SoundModem or Direwolf Raspberry Pi/Linux: OpenWebRX or Direwolf with spreadsheet http://cubesatsim.org/telem	`config -a`	CubeSatSim.org/a	
2	FSK	Frequency Shift Keying. This mode transmits a continuous signal that makes a rumbling sound that emulates the AMSAT Fox CubeSats such as Fox-1C or AO-95. Also known as DUV or Data Under Voice.	Windows/Raspberry Pi/Linux: FoxTelem	`config -f`	CubeSatSim.org/f	
3	BPSK	Binary Phase Shift Keying. This mode transmits a continuous signal that sounds like noise that emulates the AMSAT Fox-1E or HuskSat-1 CubeSats. You need to demodulate using USB.	Windows/Raspberry Pi/Linux: FoxTelem	`config -b`	CubeSatSim.org/b	
4	SSTV	Slow Scan TeleVision. This mode transmits stored images in Scottie 2 format which sounds like a series of tones.	Windows: MMSSTV Raspberry Pi/Linux: QSSTV	`config -s`	CubeSatSim.org/s	
5	CW	Continuous Wave or Morse Code. This mode transmits a FM modulated tone at 20 words per minute Morse Code telemetry.	Windows/Raspberry Pi/Linux: fldigi with spreadsheet http://cubesatsim.org/telem	`config -m`	CubeSatSim.org/m	

Five Telemetry Modes