PROVES KIT

Owner's Manual

The Spacecraft Company LLC

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About your kit

Thank you for your interest in the PROVES KIT and congratulations if you are assembling one for educational or practical use! The PROVES KIT as of writing is a "1u" educational CubeSat kit that has been to space two times. The kit is centered around low cost off the shelf components that allow users to learn how to assemble and operate a real satellite that can go to space. Additionally, the design is completely open-source and updated periodically at www.github.com/proveskit. For specific space missions, users may desire to repurpose some designs to fit mission requirements.

Main Kit Components

The satellite kit contains several printed circuit boards (PCBs), a sheet metal structure, and SLS 3d printed pieces.

Flight Controller or Flight Computer

The Flight Controller (FC) is a custom PCB that maintains an RP2040 microcontroller, and HOPERF RFM98PW radio module. The FC is responsible for mission controls and communications. With an integrated tape measure antenna, the FC can support 430 and 915 MHz communications. (NOTE: the user is required to obtain the proper licensing prior /to utilizing the radio communications, and The Spacecraft Company LLC is in no way liable for violations that occur at the fault of the user)

Electrical Power System

The Electrical Power System (EPS) is a custom PCB that houses the batteries, LT3652 MPPT Solar Charger, voltage regulators, INA219 power monitors, I2C multiplexer, and Power Driver for Solar Faces. The EPS is responsible for facilitating the charging of the batteries, as well as the voltage regulation and power monitoring. With the I2C multiplexer and Driver integrated into

the EPS, the FC is able to take direct control of the Solar Faces from the EPS, obtain data, and delegate power.

Solar Boards
The Solar Boards are separated into two separate categories: XY Faces and Z- Faces.

Structure
The Structure is 0.063 inch thick Aluminum 5052-H32 sheet metal that has been laser cut, bent and anodized. PEM Nuts are pressed into the structure on mounting points where captive nuts won't exist.

Brackets
The PROVES KIT maintains two card brackets for mounting the EPS inside the structure. In addition, the kit maintains four L-Brackets for joining the structure together, and mounting the FC and Z- Solar Boards to the structure.

Cabling
The PROVES KIT utilizes the MOLEX PicoLock Connectors and cables on all of the kit hardware. These connectors and cables ensure solid connections that won't disconnect or fail during the mission. While these connectors can become costly, it is important to be able to maintain strong electrical connections once the satellite enters space.

Feet
The PROVES KIT comes equipped with SLS 3d Printed feet for all 8 positions on the satellite. Two main foot designs are maintained for switch options to inhibit the satellite. The options are granted for two separate approaches. The embedded foot switch is utilized for applications where internal volume must be conserved, and the other foot switch is utilized for its comparative robustness to the prior mentioned foot, but this foot takes up more space.

The PROVES KIT mounts the Remove Before Flight (RBF) Switch to the bottom of the FC. A pin can be inserted to ensure the switch gets depressed, and the satellite remains inhibited.

Firmware

The FC maintains the RP2040 microcontroller, where custom CircuitPython firmware has been flashed. The RP2040 is also capable of running MicroPython and Arduino however these have not been tested in conjunction with the other satellite hardware, so CircuitPython remains the supported firmware for the PROVES KIT at the time of writing.

Software

The FC software is available on the software GitHub repository at www.github.com/proveskit. Examples of full flight software can be found here but note that a radio license is required to operate the satellite communications prior to editing the lines of code that block transmissions from the radio.

Maintenance

Your Satellite will require very little maintenance depending on the application. The batteries are of the most concern when it comes to long term storage of the satellite. To ensure proper function every time the satellite is pulled out for testing, the batteries should be charged to 8V using a power supply and charging through the direct charge port on the FC at least one every three months.

Operations

USB Operation

The PROVES KIT is equipped with a micro type B USB port on the top of the FC that allows for easy interfacing with the

computer. A simple terminal software is needed to view the output of the satellite software. The recommended terminal software is Tabby Terminal, however other terminal software's should be able to display the satellite output.

Radio Operations

As stated before, a radio license will be required before operation of the radio. However, if you the user is licensed, then you may proceed to transmit radio signals from the satellite, and the LoRa signals could be heard on the corresponding frequency. This can ensure the satellite is transmitting all of the correct data without being plugged into a computer and can ensure good signal integrity from the satellite.

Troubleshooting

The GitHub organization (www.github.com/proveskit) is a public organization and issues can be generated for any of the repositories. If any bugs occur with the hardware or software, please do not hesitate to raise an issue on the corresponding repository or email us a support@tsco.space.

Obtaining a Serial Number

To obtain a serial number for a satellite put together by the end user, the end user will need to send an email with the following:

- An image of the completed satellite
- A screenshot from a terminal showing all hardware working properly. With the PROVES KIT Software, this would be the print of the hardware dictionary showing all hardware with a 'TRUE' attached.
- A screenshot showing data from all I2C sensors
- A screenshot showing a received packet on another device from the satellite