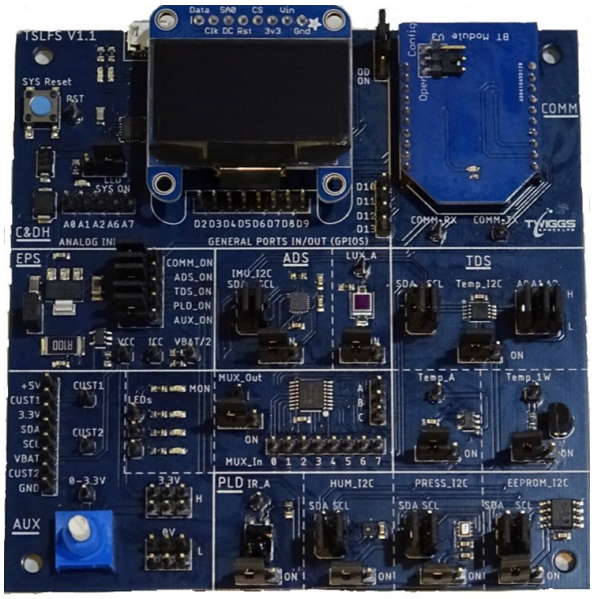
TSL FlatSat

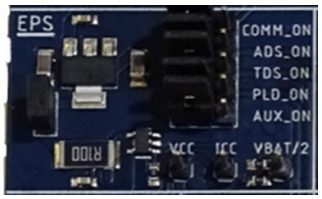
Learning Satellite Subsystems

Company Overview: **Twiggs Space Lab, LLC** ("TSL") is focused on creating STEAM based products and curriculum to stimulate, engage, and encourage students to pursue interests in science, technology, engineering, arts, and math. Our company's mission is to inspire future generations of engineers and scientists to make the world a better place through innovative research in space. The FlatSat provides students with a hands-on opportunity to learn about satellite subsystems and systems engineering.

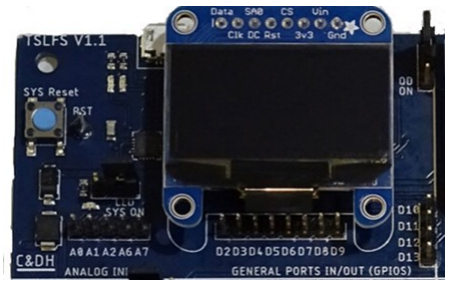
FlatSat: Students are introduced to sensors, coding, software, electronics, and data collection methods. The students design, construct and test various configurations of a desktop satellite ("FlatSat"). The FlatSat provides for student learning opportunities with respect to instruments, satellite subsystems (including communications), and systems engineering. Custom payload boards with sensors can be created by students and connected to the FlatSat AUX jumpers to emulate an operational satellite with a functioning mission payload. Students use the FlatSat to collect satellite subsystem operational data, atmospheric data, implement data collection methods and apply data analytics techniques to interpret the data. The data is displayed on a local computer terminal where students can review data output and chart data received from the FlatSat or using the TSL Data Viewer tool to download the data into a CSV file and import into analytical programs such as Excel or MATLAB. There are electronic resources available to assist the teachers and enhance the student learning experience.

FlatSat Kit: The FlatSat is a hardware platform that includes the most common nanosatellite subsystems with the flexibility to incorporate additional subsystems such as solar panels, batteries, GPS, secure digital card, additional communications hardware (Bluetooth Low Energy ("BLE"), WiFi and LoRa radio), a custom developed payload, and other components using the auxiliary connector. The TSLFS kit includes hard case, FlatSat, USB flash drive with software libraries and User's Manual, jumper wires and needle-nose pliers for removing jumpers. The FlatSat subsystems includes: (1) EPS – (Electrical Power Subsystem); (2) C&DH – (Command and Data Handling); (3) ADS – (Attitude Determination Subsystem); (4) TDS – (Thermal Determination Subsystem); (5) COMM – (Communication Subsystem); (6) PLD – (Payload); and (7) AUX – (Auxiliary Subsystem).

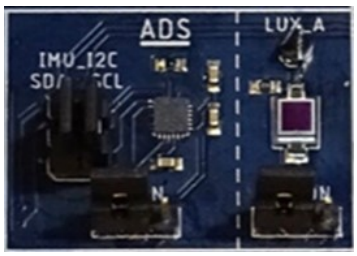




EPS: The Electrical Power Subsystem ("EPS") on a satellite generates, stores, conditions and distributes electrical power as necessary to enable the satellite to fulfill the mission requirements during all phases and expected modes of operation.



C&DH: Command and Data Handling Subsystem ("C&DH"), also knowing as the On-Board Computer ("OBC"), processes the information relating to health, safety and status of the spacecraft as well as the rest of the subsystems. It receives, processes, and transmits data among the several spacecraft subsystems. In addition, the C&DH can store data on-board. The C&DH has an ATmega328P microcontroller (100% compatible with the Arduino Pro Mini 3.3V).



ADS: Attitude Determination Subsystem ("ADS") defines a satellite's orientation in space. Nadir direction is when the satellite is "down toward Earth" and Zenith direction is the opposite direction. The primary function of the ADS is to provide information to the Attitude Control Subsystem ("ACS") to keep the satellite pointed in the right direction. By comparing the strength of the local magnetic field with a high-fidelity model of Earth's magnetic field, the magnetic sensor (Magnetometer) can determinate the orientation of the satellite with respect to the Earth. Magnetometer are more useful for satellites operating in Low Earth Orbit.

TDS: Thermal Determination Subsystem ("TDS") provides the proper information to the Temperature Control Subsystem ("TCS") to keep the satellite subsystems in a range of operational temperature. This is a critical function because the satellite will operate in space where extreme temperature changes occur during each orbit.

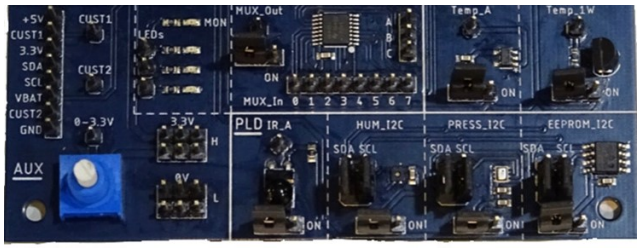
COMM: The Communication Subsystem ("COMM") (also commonly referred to as the Telemetry, Tracking & Command Subsystem ("TT&C") for the spacecraft) provides the conditioning, transmission, reception, routing of attitude, spacecraft health telemetry and some mission data signals.

The FlatSat COMM provides an Xbee socket in which the appropriate transceiver can be attached (Xbee, Bluetooth, BLE, WiFi, LoRa Radio, etc.). The standard FlatSat kit includes the Bluetooth module.

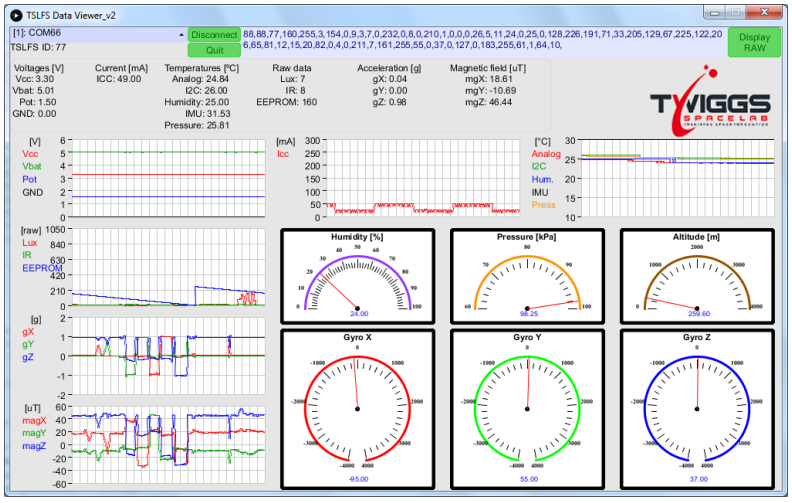
PLD: The FlatSat Payload Subsystem ("PLD") contains the sensors, instruments, or other equipment required to meet the objectives of the satellite mission. The size and specification of the satellite are driven by the payload requirements. The FlatSat includes four sensors that can be used as test payloads in near-Earth environment scenarios (ex. above desktop in lab, flying on a drone, or on a high-altitude balloon).

AUX: The Auxiliary Subsystem ("AUX") is included on the FlatSat to provide for the expansion of applications and use of other useful tools such as a monitor display, variable and fixed voltage sources, LEDs, and an analog multiplexer.

MUX: Analog Multiplexer ("MUX") is an Auxiliary Subsystem to provide for a more robust experience and expanded learning opportunities for the user. The Auxiliary Subsystem includes fixed and variable power supplies, LED monitor, an analog eight channel multiplexer, a monitor display and an expansion connector to use customized signals and/or add additional modules.



FlatSat Data Viewer: The Data Viewer is a software application on the TSL USB drive which can be downloaded to a local computer terminal. The students use the Data Viewer to see data output from the FlatSat in a real-time environment. Sensor data is transmitted to a local terminal during use, including: running test procedures, normal operation of the FlatSat, and testing other modules or payloads. Students can quickly visualize the effects of their actions on the FlatSat by monitoring the charts and meters on the Data Viewer. The electronic guides provide extensive testing procedures for student to check subsystems and sensors to enhance the student learning experience.



About Us: ***Twiggs Space Lab, LLC*** was founded by Professor Bob Twiggs and Matt Craft to develop inspirational STEAM based products with an emphasis on systems engineering and space technologies. Professor Twiggs is the co-inventor of the CubeSat and inventor of the PocketQube. In 2010 he was selected by the Space News publication as one of 10 space professionals "That Made a Difference in Space."

Contact: For more information on the FlatSats or other TSL products contact Matt Craft at matt.craft@twiggsspacelab.com.

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