ThinSat-2 Mission Technical Description

The overall goal of the ThinSat-2 mission, is to orbit small experiment payloads to advance STEM education, and promote space science research and systems engineering for grades 4 – 12 and universities, from a number of states and the District of Columbia. The student teams will analyze the data collected by their experiment and submit a report detailing their findings. The students will track their experiment and receive data in near real time through the Globalstar network and the Space Data Dashboard website. Online content and resources will enhance the educational experience.

The experiments will be deployed aboard 9 satellites, ThinSat-2A through ThinSat-2I, launched as a secondary payload aboard the NG15 on the Antares second stage, from the mid-Atlantic Regional Spaceport, Wallops Island, Virginia, Q1 2021. The satellites will be inserted into Low Earth Orbit (LEO), at 260 km apogee and 180 km perigee, on an inclination from the equator of 51.6 degrees. They are deployed from 2 Canisterized Satellite Dispensers (CSDs) mounted on the second stage of the launch vehicle. The ThinSats unfold accordion style as they exit the CSD. Transmission will begin upon deployment, and cease within about a week, when de-orbiting occurs. See the Orbital Debris Assessment Report for details.

Each spacecraft is comprised of one or multiple ThinSat units, one or more units per experiment. Each spacecraft will deploy a drag instead of a foldout panel, from the "end" unit. The drag will provide aerodynamic stabilization of the spacecraft, to maintain the long axis in the RAM direction.

Figure 1 shows a typical single unit. Some of the units have two or more frames layered together containing a single payload, as in Figures 3 and 9. Figures 2, 3, 4, 5, 6, 7, 8 and 9 show the composition and dimensions in mm of each spacecraft type, and identify the spacecraft associated with the type.

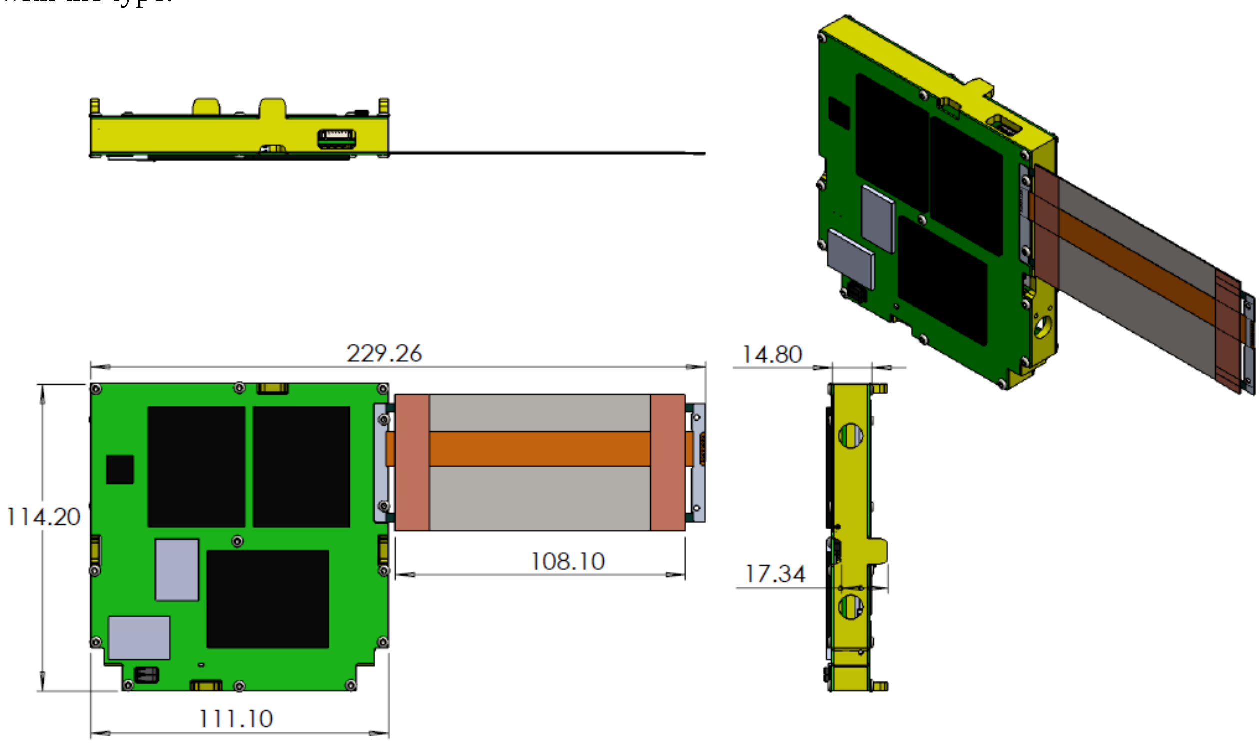


Figure 1 Single Frame ThinSat Unit Detail

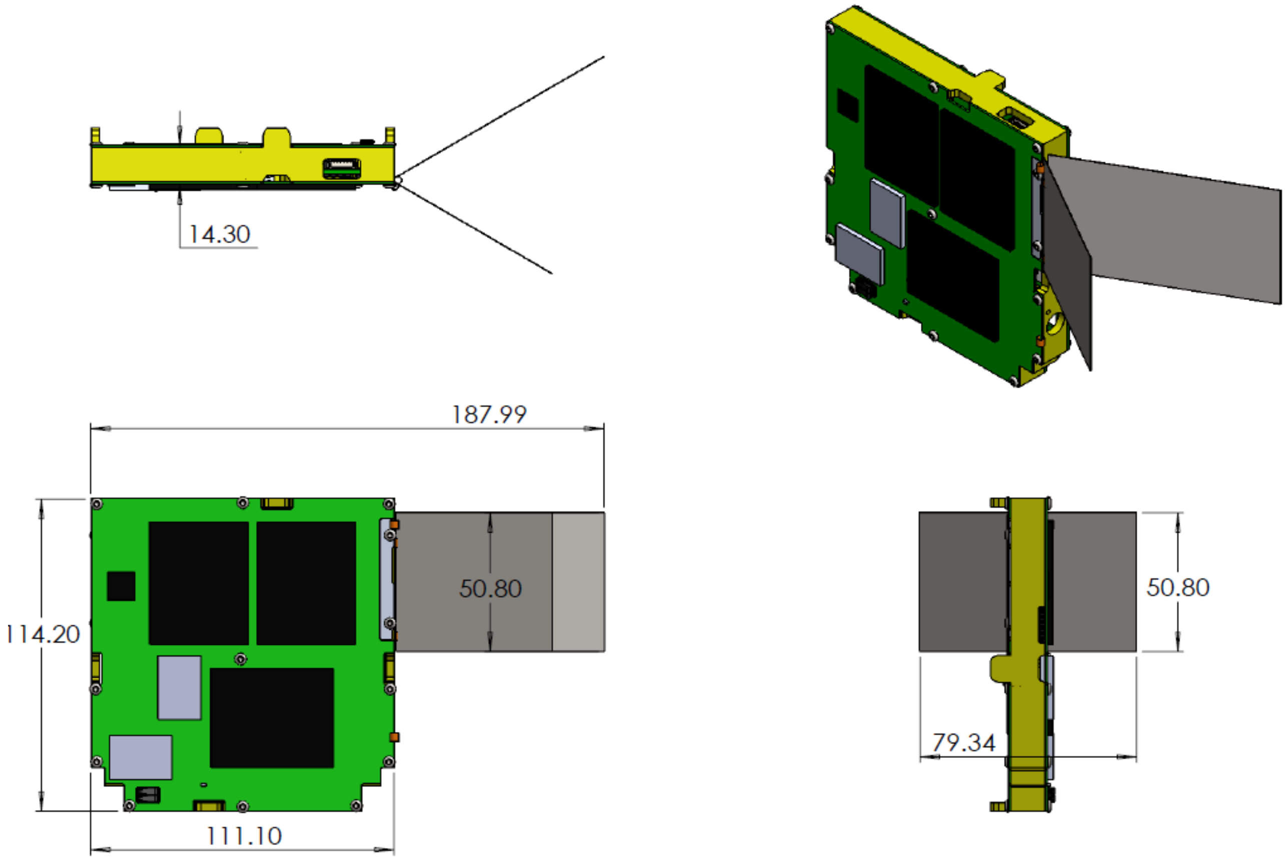


Figure 2 Single Frame ThinSat 2G, 2H and 2I, 1 Unit, Showing Drag Detail
Max Mass 285g

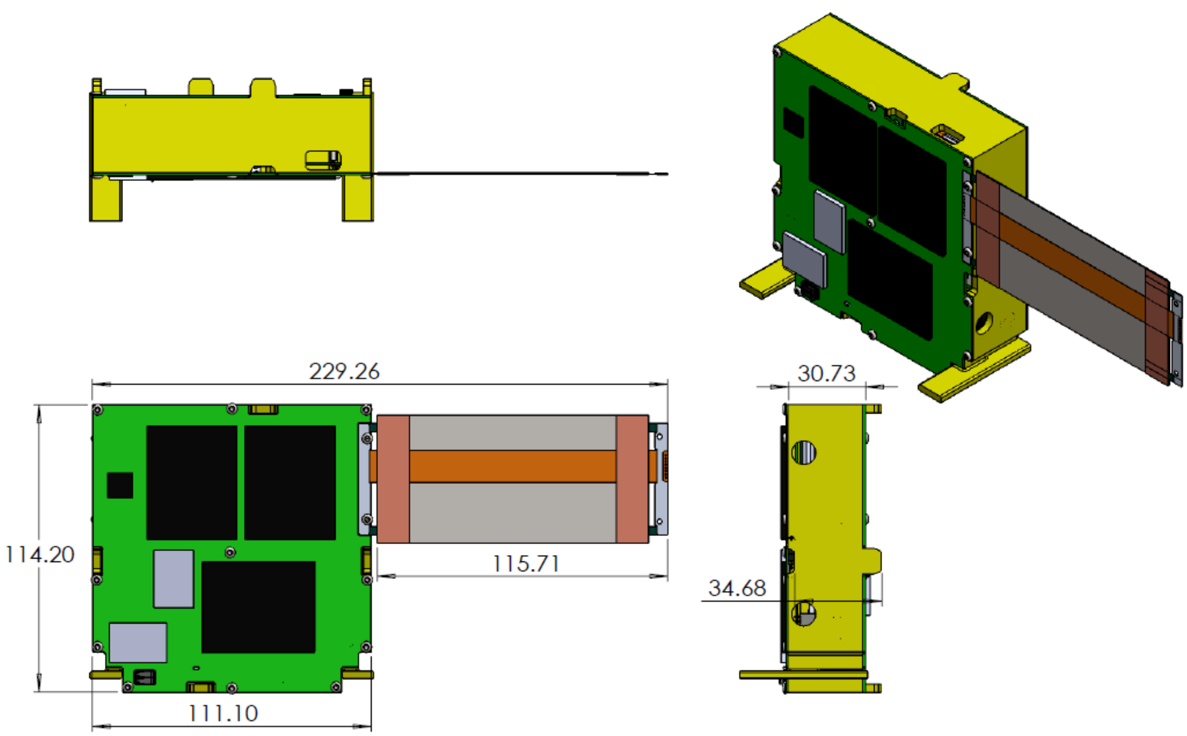
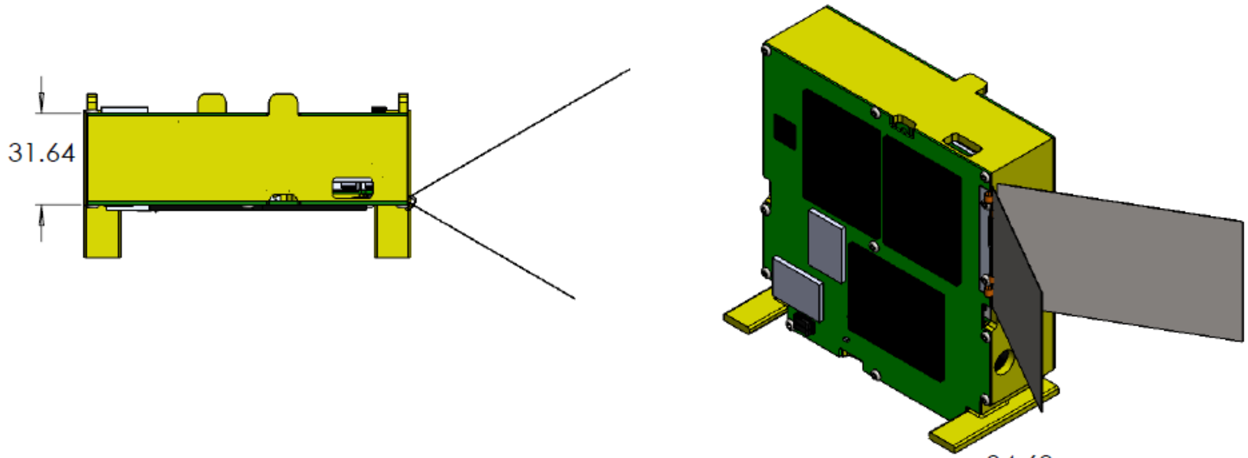


Figure 3 Double Frame ThinSat Unit Detail



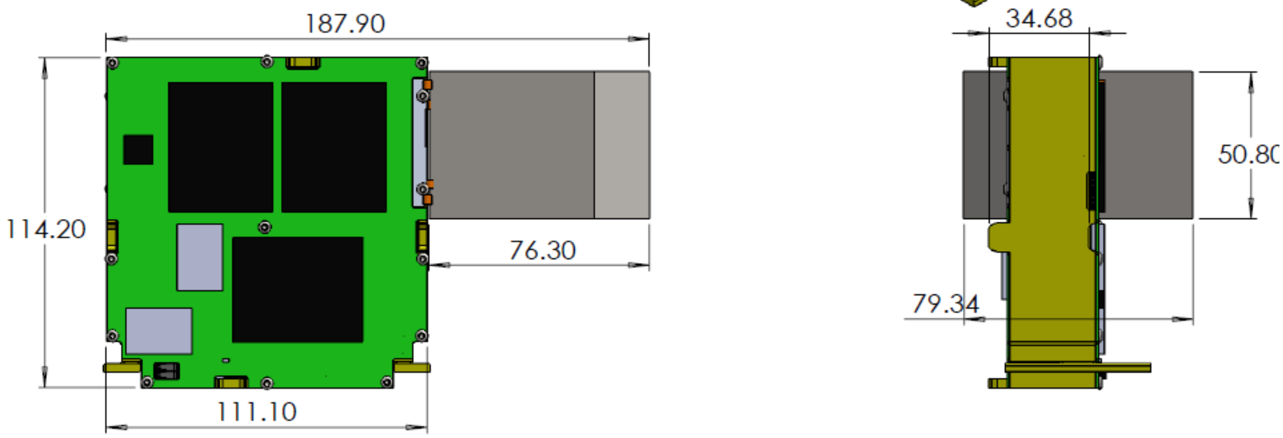


Figure 4 Double Frame ThinSat Unit with Drag Detail

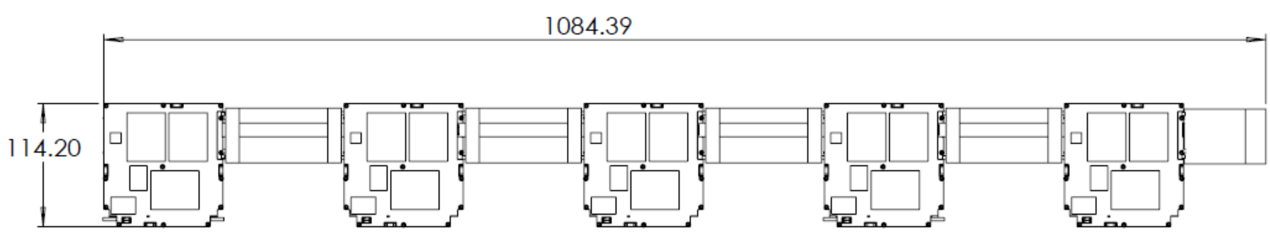


Figure 5 ThinSats 2B and 2C, 2x 2Ts and 3x 1Ts
Max Mass 1995g

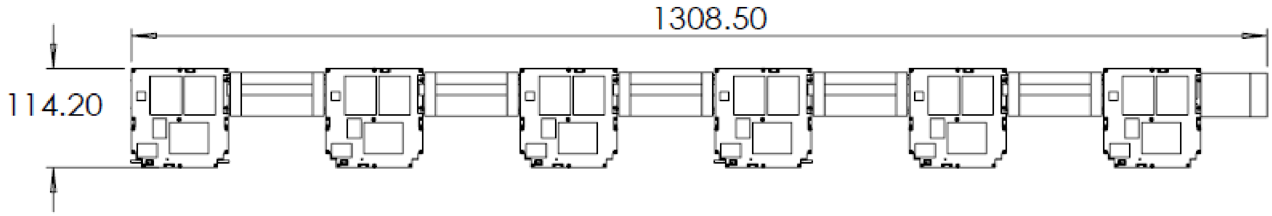


Figure 6 ThinSat 2A, 1x 2T and 5x 1Ts
Max Mass 1995g

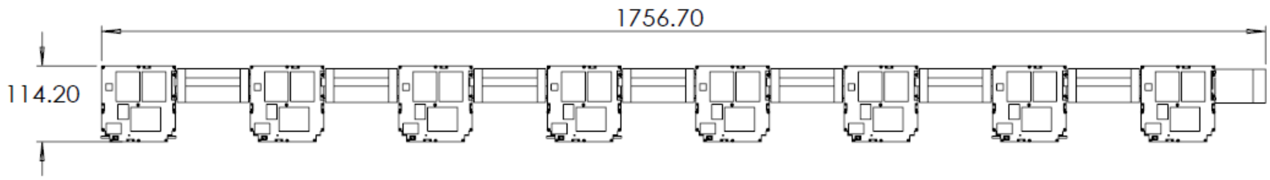


Figure 7 ThinSat 2D, 1x 2T and 7x 1Ts
Max Mass 2565g

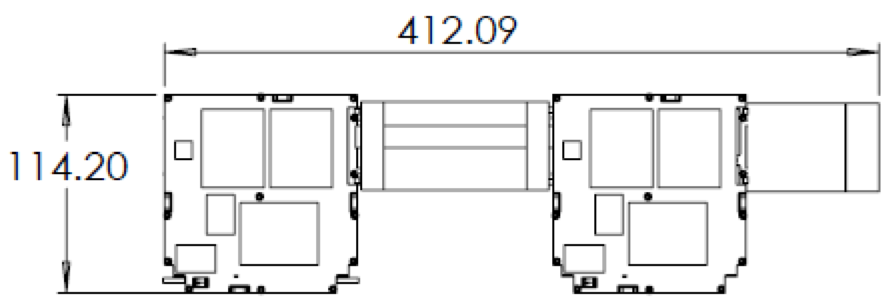


Figure 8 ThinSat 2F, 1x 2T and 1x 1T
Max Mass 855g

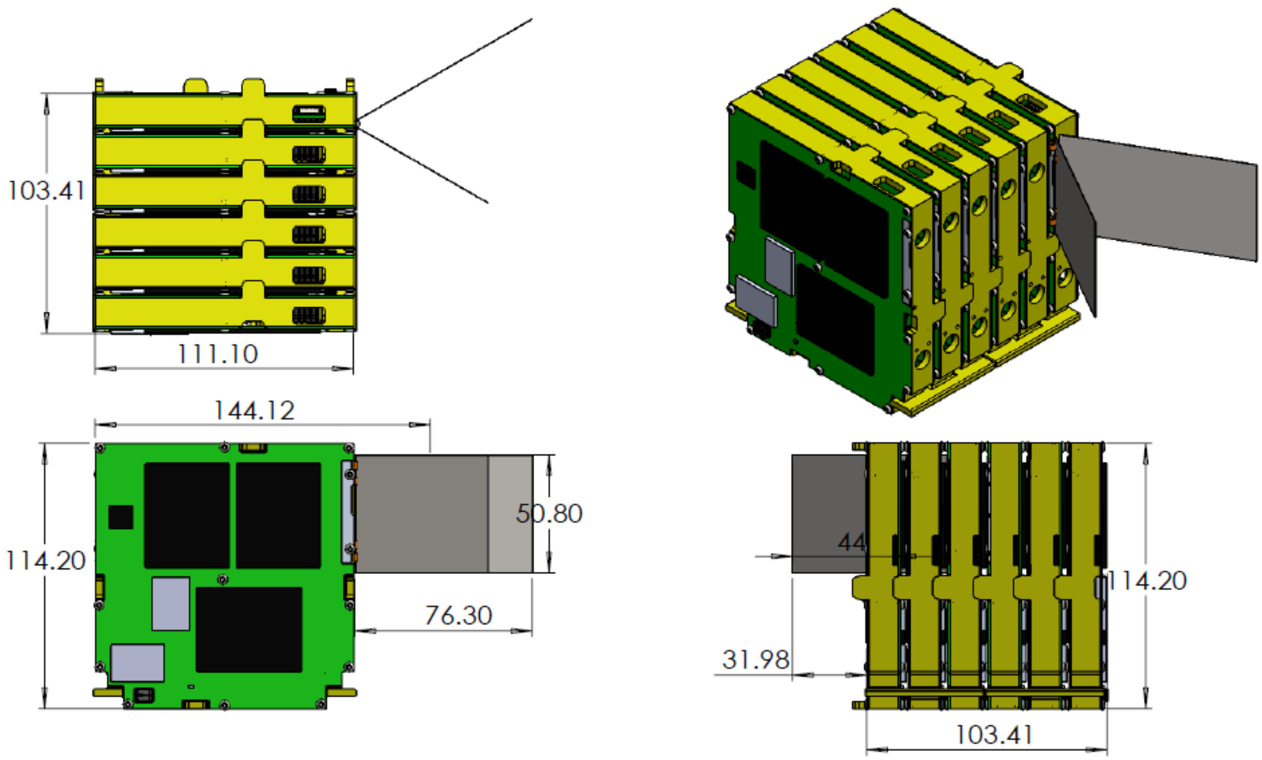


Figure 9 ThinSat 2E, 1x 6T
Max Mass 1725g

1T Ortho Profile	Normal Area cm^2	Area with Drag cm^2	Ratio
Top	15.9	15.9	1.0
Front	181.8	16.6	0.9
Side (Ram)	16.3	78.9	4.8
2T Ortho Profile	Normal Area cm^2	Area with Drag cm^2	Ratio
Top	35.1	35.1	1.0
Front	181.8	165.6	0.9
Side (Ram)	39.5	62.3	1.6
6T Ortho Profile	Normal Area cm^2	Area with Drag cm^2	Ratio
Top	114.9	114.9	1.0
Front	126.9	165.6	1.3
Side (Ram)	118.1	143.9	1.2

Table 1 Effect of Drag on Cross Sectional Areas

Subsystem Description:

Each spacecraft will carry the following subsystems, as well as experiment-specific components. See the ODAR for a complete list of all components in each spacecraft.

Guidance, Navigation and Control (GNC) Subsystem: Navigation sensors consist of the VEML3328 Single Pixel IR Horizon sensor on each unit, a Grid IR 8x8 Pixel Sensor on some spacecraft, a High Quality 32x24 Pixel, Infrared sensor on some spacecraft, and a GPS unit on each spacecraft.

All spacecraft will use a drag surface. Aerodynamic pressure will cause the spacecraft to orient in an "arrowhead and tail" configuration in the ram direction, with the drag on the minus RAM end, restricting 2 axes of movement along the velocity vector.

Additional attitude controls are used on some spacecraft.

- Mu metal plates will dampen the tumbling rate, and magnetorquers will be used for attitude control. The magnetorquer coil is capable of producing up to 0.2 A*m^2 of magnetic moment. These magnetorquers will act upon the earth's magnetic field to restrict the rotation of the spacecraft about the velocity vector, aligning the Simplex transmitter antenna to face in the zenith direction.
- A single axis reaction wheel will be present in order to stabilize the tumble, and point normal to the orbit plane.

A NovAtel OEM719 GPS is used on ThinSat 1A, while the other spacecraft will include an NSL proprietary GPS.

Command and Data Handling (CDH) Subsystem: Consists of two microprocessors which facilitate data transfer between the payload and the COMMS subsystem. The CDH can receive serial data packets, or sample dedicated analog and digital input lines.

Communications Subsystem (COMMS): Each module in each spacecraft, will contain one EyeStar-S3F transmitter, transmitting to the Globalstar constellation; an S3F antenna; and VEML3328 single pixel IR horizon sensor associated with the transmission enable logic. Each spacecraft will contain an S band receiver to support command and control, including command termination of transmission if necessary. Command and control is done through the NSL ground station.

Electrical Power Subsystem (EPS): Includes mechanical RBF switch, deployment switch, and solar detection circuit which inhibit power from the battery. Charging circuit supplies solar power to the battery and a regulator transfers battery power to the rest of the system. E-fuses limit current supplied to the payload to 100 mA per line.

Thermal Control Subsystem (TCS): Al 7075 unit body frame thermally shorts internal and external surfaces. Copper ground planes in external PCBs, including solar arrays, provides good radiation surfaces.

Structure Subsystem: The external frame structures are fabricated of 7075 aluminum.

Propulsion Subsystem: No propulsion subsystem is included.

Payload Subsystem: The payloads include printed circuit boards of varying design, to conduct experiments for the participating schools and universities, as well as some electromechanical devices.

In addition, the "ThickSat" payload from Virginia Tech on ThinSat 2E (see Figure 9 above), is a passive deployer mechanism for a 18mm x 39mm x 750mm high-strain composite boom. The technology demonstration will test and confirm the deployment of the boom. A camera will document the deployment activity.