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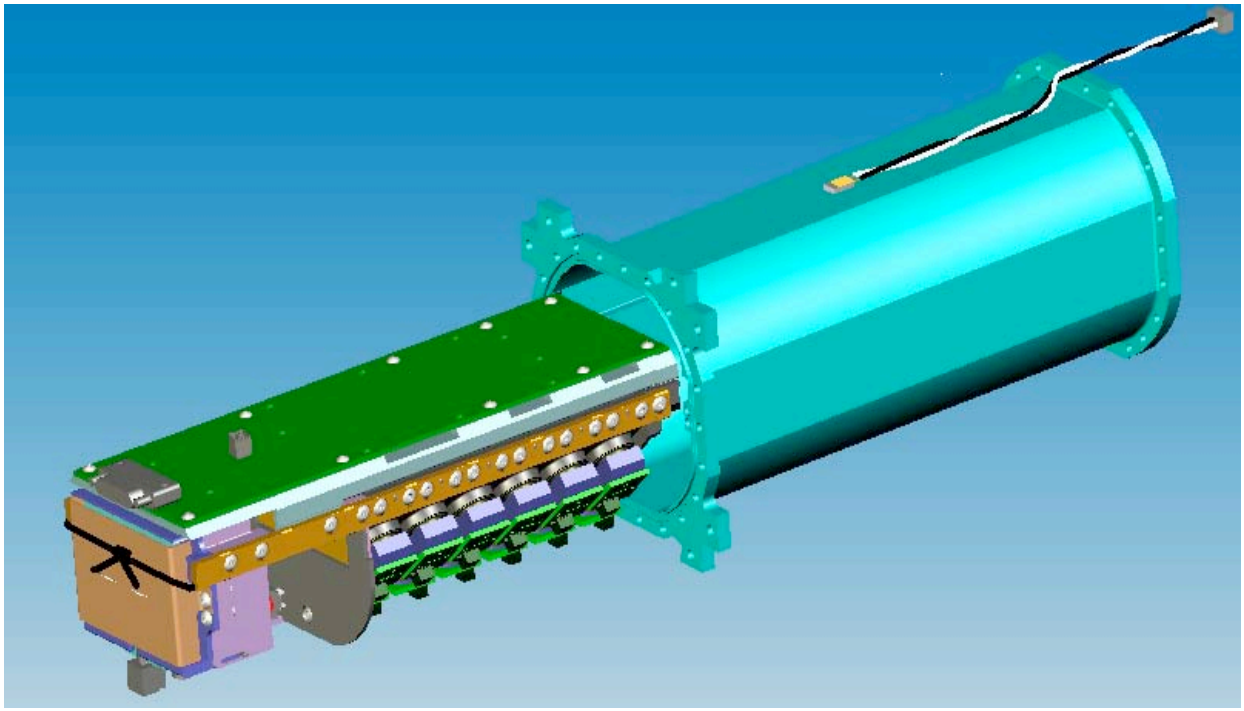


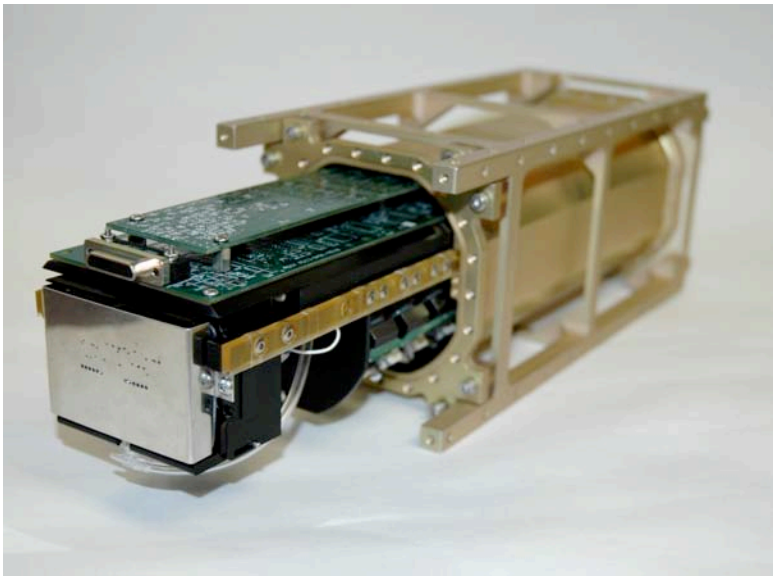
Figure 1 GeneSat Payload System

1.0 HARDWARE CONFIGURATION

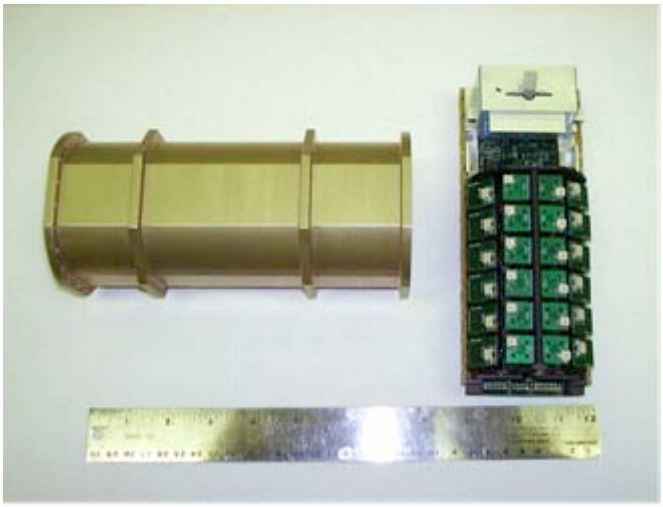
The GeneSat Payload System, as shown in Figure 1, is made up of the following components:

- PC Board — Payload PCB (With 2 M612 Accelerometer PCB attached)
- Pump — 1 Spring Pressure Pump
- Valve — 3 Way Valve
- Fluidic Card — 12 Well Card
- Fluidic Bag — Fluidic Bag 10ml. EVA
- Optics Module Assy
- Heaters

Figure 2 (a, b) shows the GeneSat payload engineering development unit. The payload system is the primary science payload and all of its integrated subsystems. This system is integrated into the Spacecraft which is subsequently integrated into the Spacecraft Deployment System (on-orbit deployer) and then the Launch Vehicle.



(a), Payload Assembly Partially in Pressure Vessel



(b), EDU Pressure Vessel and Payload Assembly Separated

Figure 2, GeneSat EDU Payload

The GeneSat Payload Assembly is then integrated into the Bus, which provides all power and uplink/downlink communications.

1.1 Fluidic Subsystem

The primary function of the Fluidic Subsystem is to contain biological samples in an array of twelve assay wells and allow fluid delivery to the assay wells through micro-fluidic channels. Ten wells contain biological samples and two wells contain optical calibration material. The fluidic system is illustrated in Figure 3.

Samples of *E. coli* are dispensed into an assay well with a 6.5 mm diameter and 3.0 mm depth. The assay wells are spaced on an 18 mm grid to facilitate ground-based studies using laboratory equipment that can read SBS standard microtiter plates. After *E. coli* introduction, the assay well is sealed with a membrane using a pressure-sensitive adhesive, and the assay wells are filled with stasis media via the micro-fluidic channels. The fluidic card features one inlet micro-fluidic channel and one outlet micro-fluidic channel per assay well. Membranes across the micro-fluidic channels on either side of the assay well allow fluid flow but prevent *E. coli* from escaping through the micro-fluidic channels.

During experiment initiation, nutrient media required for E. coli growth is delivered to each well through the micro-fluidic channels using a pump and valve system which drives fluid from a media bag to the card via tubing and fluidic connectors (the pump system is part of the mechanical subsystem). The stasis media is displaced by the nutrient media and exits the assay well.

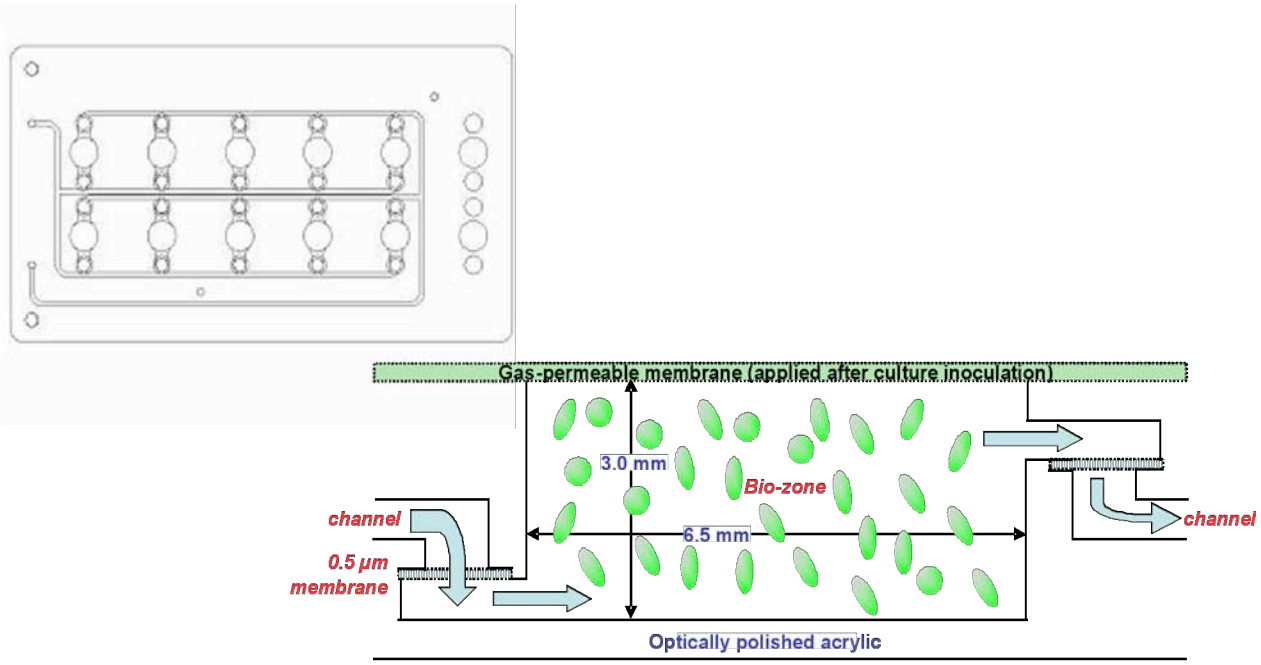


Figure 3, Fluidic Card and Single Well Cross-section

1.2 Optics Module

The GeneSat experimental payload was designed to perform both fluorescence and optical density assays of biological specimens in an automated fashion. Please refer to Figure 4 below.

The biological sample of interest, in this case E. coli, is placed inside the fluidic card wells. A complete optics unit sits below each well for a fully redundant assay system. The sample is excited with blue light (wavelengths of approximately 460 - 490 nm). The tagged fluorescent proteins of the sample respond by emitting green light (wavelengths of approx. 505 - 530 nm) which is detected by a photodiode. A set of off-the-shelf lenses and color filters ensure that only blue light of the desired wavelengths reaches the sample and only green light of the desired wavelengths reaches the detector.

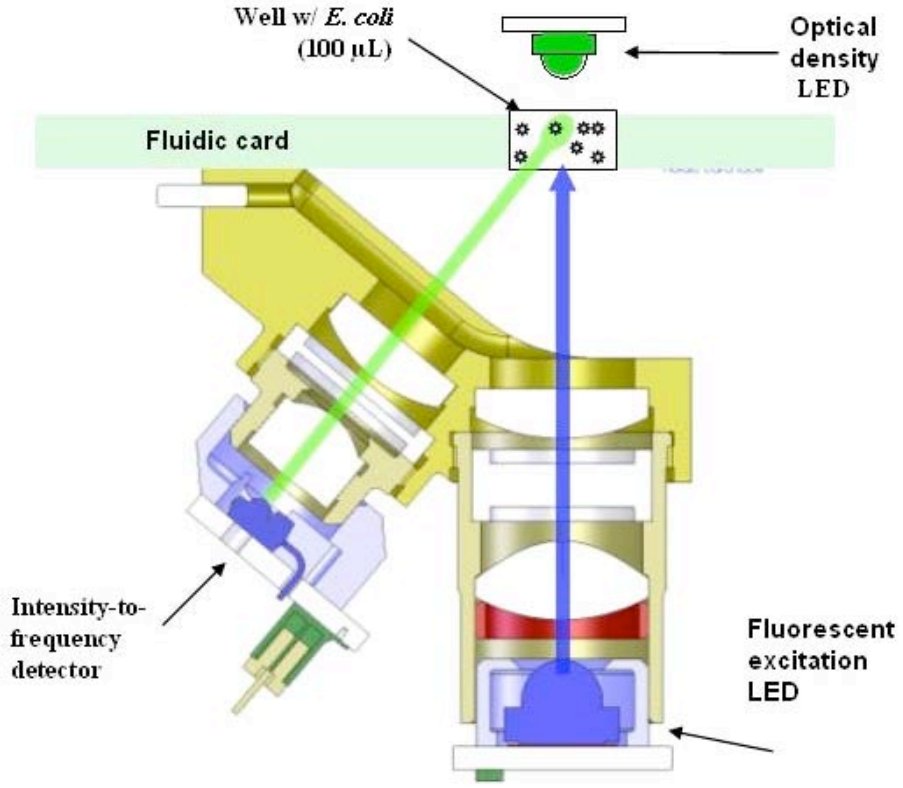


Figure 4, Separately packaged illumination and collection legs allow for minimal background signal on the detector, increasing sensitivity.

An optical density (light scattering) measurement is taken by placing a green LED atop the fluidic card well and again using the collection optics to measure light scattered by the sample.

The goal for both the fluorescence and optical density measurement techniques is to achieve a detection sensitivity comparable to the bench top equipment. Results for the fluorescence assay are shown in Figure 5.

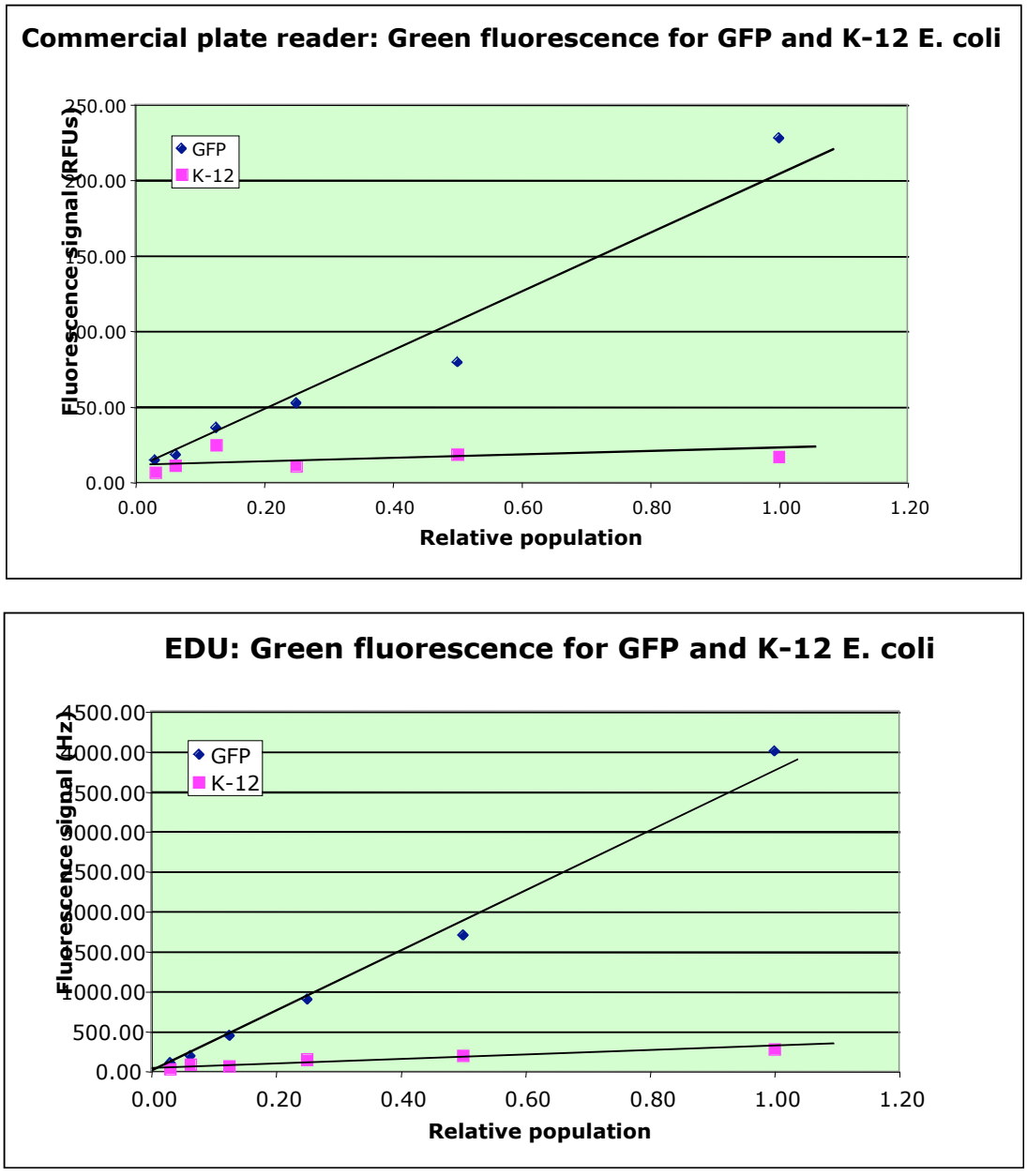


Figure 5, Fluorescence emission of GFP vs. non-GFP E. coli. The top plot shows data recorded by a full-size bench top Molecular Devices Gemini fluorometer. The bottom plot shows the same measurements taken by our EDU (engineering design unit).

1.3 Thermal Insulation

The payload thermal insulation system is made up of multiple elements described as follows and illustrated in Figures 6 & 7.

1.3.1 Frame and Pressure Vessel interface insulators

The payload pressure vessel is insulated from the main payload external frame structure with mounting brackets made of Ultem™. The internal wellplate assembly is also insulated from the pressure vessel with Ultem™. This is illustrated in Figure 6 & 7.

1.3.2 External insulation

The payload external insulation covering is made of two components. First a layer of Aerogel™ is wrapped over the surface of the payload pressure vessel. Then a 10-layer Multi-layer Insulation (MLI) blanket is wrapped over the top (Figure 6) of the Aerogel™.

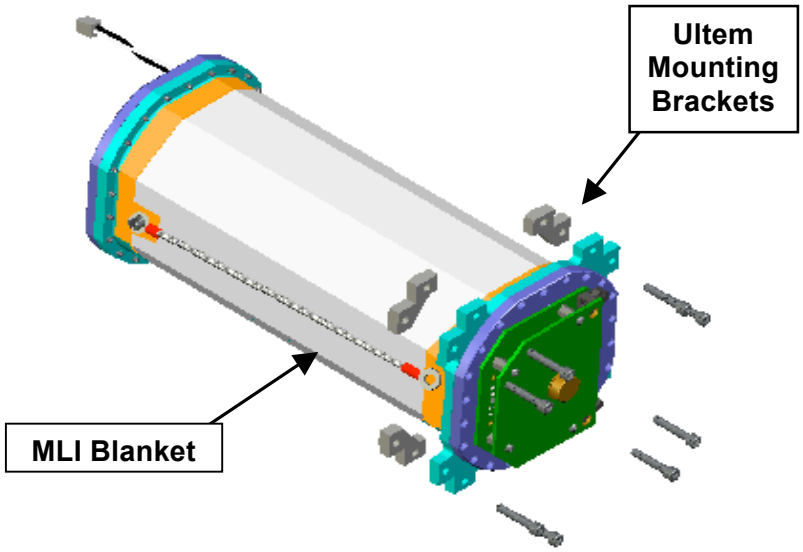


Figure 6 MLI Blanket & Ultem™ Mounting Brackets

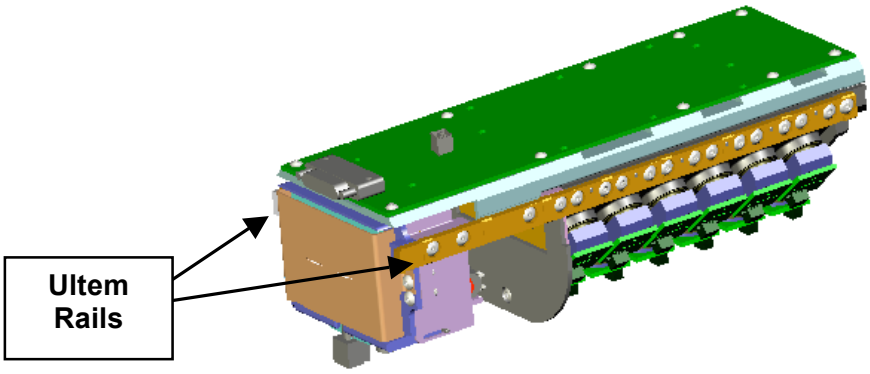


Figure 7 Bio Module Assembly with Ultem™ Insulation Rails

2.0 ELECTRICAL CONFIGURATION

Figure 8 illustrates the major functional blocks of the GeneSat electronic systems. The large block to the left represents the spacecraft bus with electrical power subsystem (EPS), micro-controller, attitude determination system (ADS) and communications subsystem (COMM). Memory is not represented here, but is a significant block of the bus electronics. The larger block to the right represents the payload electronics subsystem. The interconnection between the systems contains power and serial data lines.

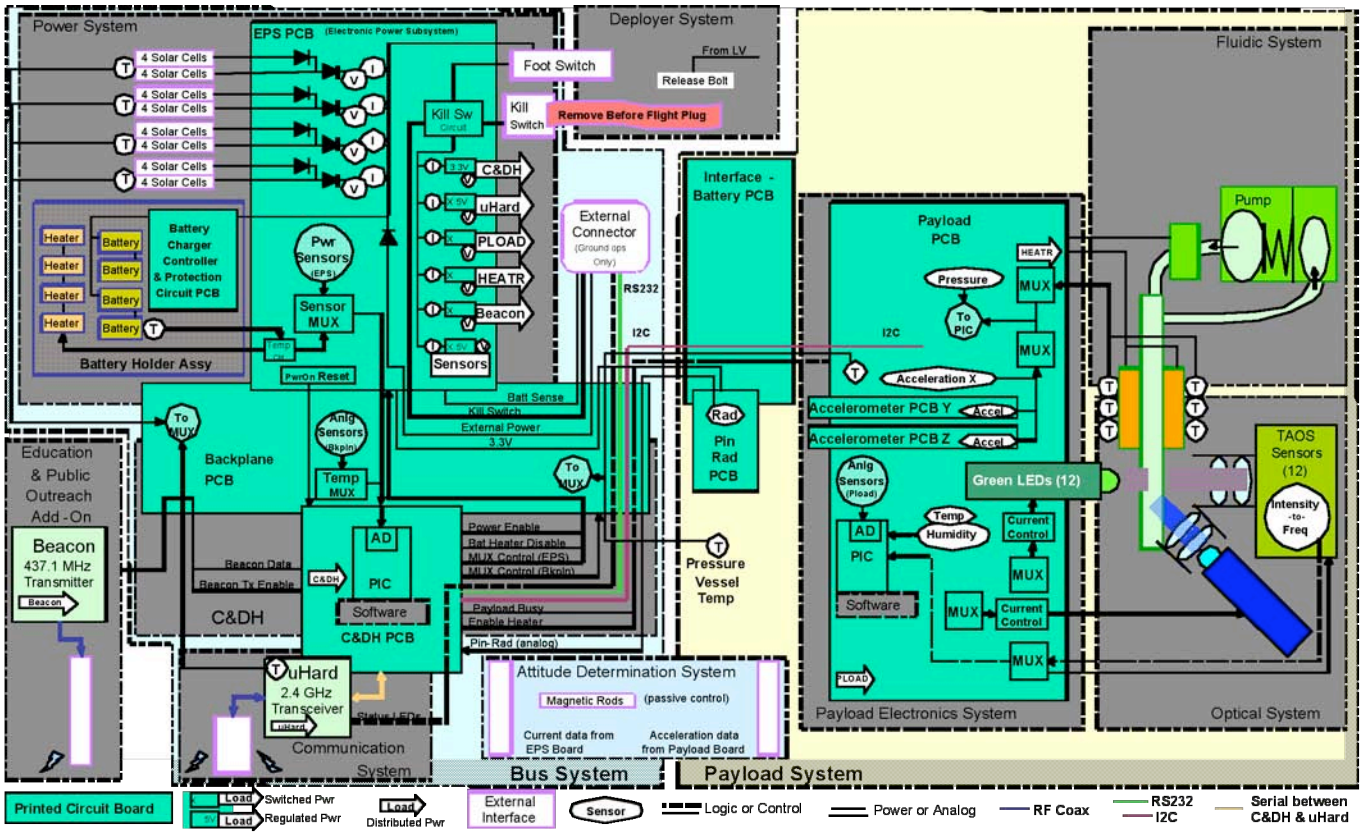


Figure 8 Satellite Electronics Functional Block Diagram