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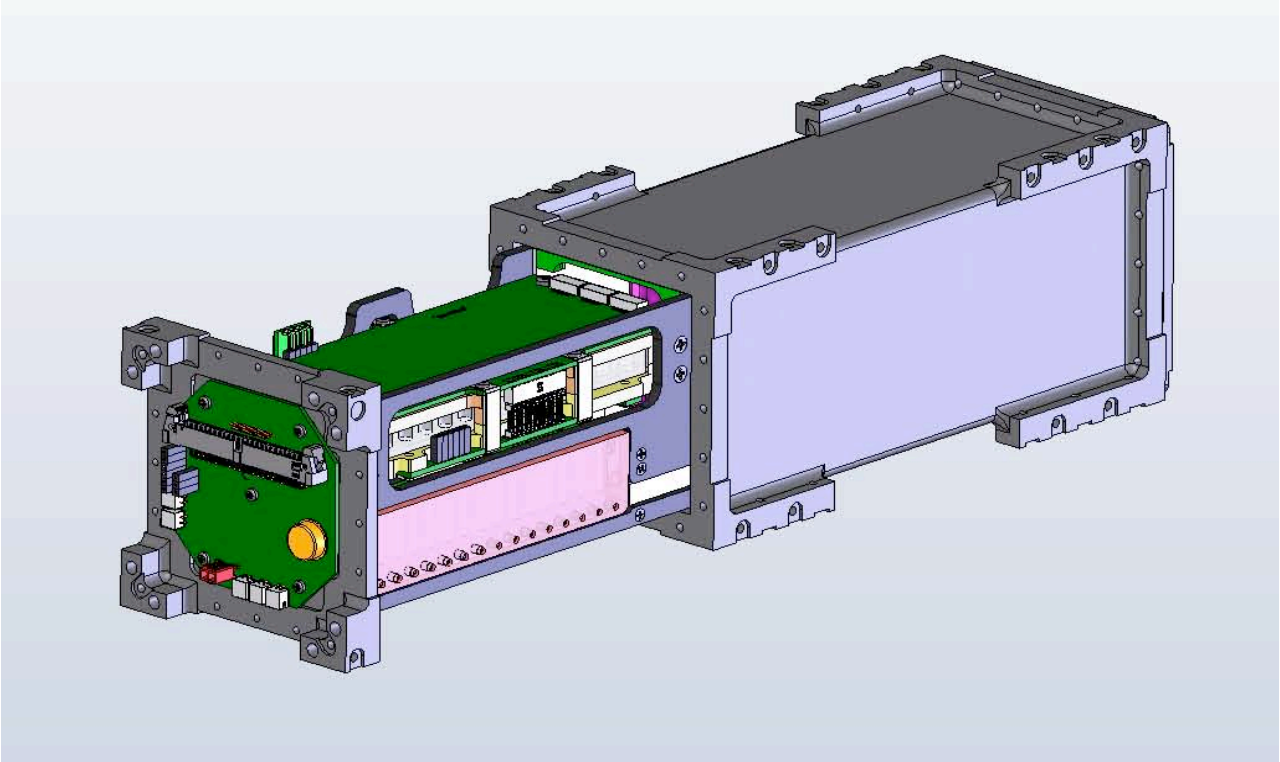

Figure 1.0-1. PharmaSat Payload System

1.0 HARDWARE CONFIGURATION

The PharmaSat Payload System, as shown in Figure 1.0-1, is made up of the following components:

- PC Boards (Payload, Detector, Valve)
- Pumps 1 Bidirectional (DC) Pump & 1 Stepper Pump
- Valves 3 Way Valves
- Fluidic Card 60 Well Card
- Fluidic Bags Fluidic Bag 25mL & 35mL Bags

- Bubble Trap Assy
- Tubing
- Heaters

Figures 1.0-2, a and b, show the two assemblies that together comprise the PharmaSat Payload Assembly. The Bio Module Assembly shown in Figure 1.0-2a, houses the Fluidics and Electronics subsystems. The Bio Module Assembly is integrated into the Pressure Enclosure, shown in Figure 1.0-2b, which then becomes the PharmaSat Payload Assembly.

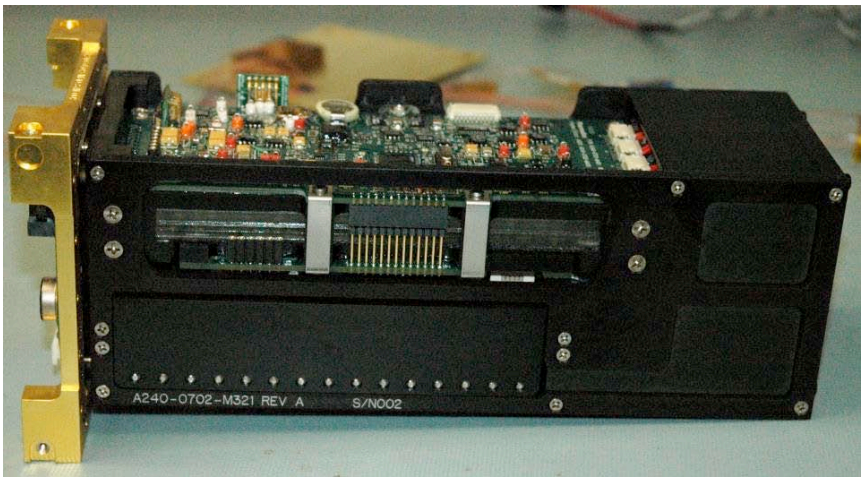

Figure 1.0-2a. Bio Module Assembly

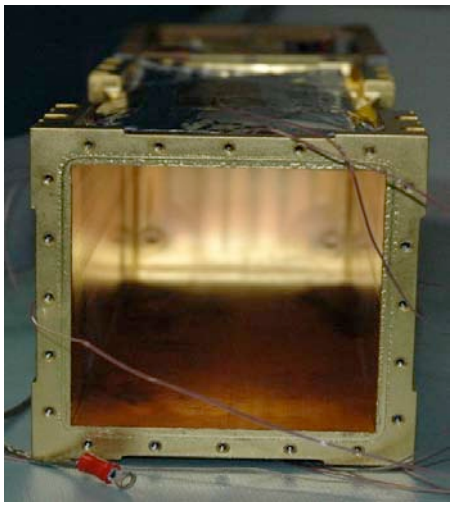

Figure 1.0-2b Pressure Enclosure Assembly

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

2.0 FLUIDIC SUBSYSTEM

The primary function of the Fluidic Subsystem is to contain biological samples in an array of twelve by four assay wells and allow fluid delivery to the assay wells through micro-fluidic channels. The forty-eight wells contain biological samples in three banks of twelve plus a reference bank that receive different concentrations of inoculants. Eleven of the wells contain optical calibration material. The fluidic card is illustrated in Figure 2.0-1.

For the PharmaSat experiment, samples of Yeast 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 Society for Biomolecular Screening (SBS) standard microtiter plates. After Yeast 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 Yeast from escaping through the micro-fluidic channels.

During experiment initiation, nutrient media required for Yeast 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 that exits the assay well. Filters prevent cells from flushing out of the sample chamber.

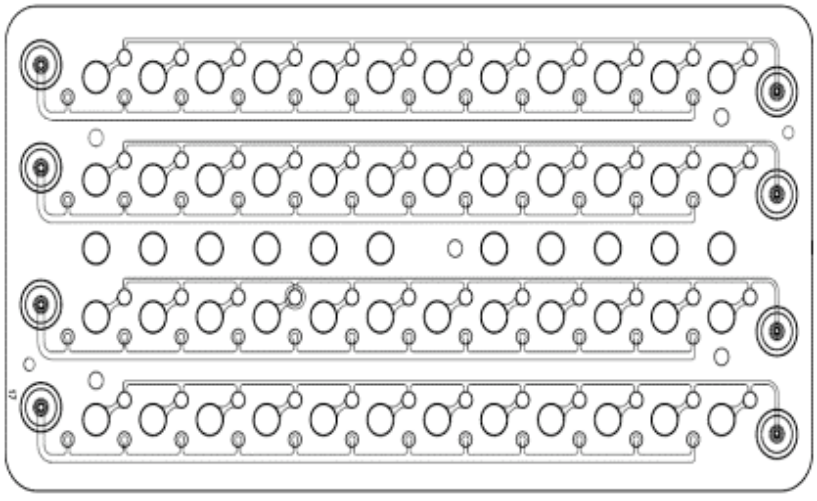

Figure 2.0-1. Fluidics Card

Figure 2.0-2 provides a schematic of the fluidics system. At the heart of PharmaSat's fluidics management system is a stepper pump (P-2) that allows dispensing resolution down to 0.1uL, enabling precise real-time and autonomous dilution preparation. At present the fluidics system is configured to accomodate a single reagent at up to three preset concentrations. The 48 well assay is configured into three individual banks of twelve wells plus a reference bank. All wells in a particular bank receive the same preset concentration of reagent as prescribed by the protocol. A second pump (P-1) is used for higher flow processes such as to purge/prime tubes and also for mixing. Effective mixing is achieved by recirculating fluid in and out of a particular reservoir bag for a specified period. There are a total of 9 fluidic reservoir bags totaling a hold-up volume of approximately 100mL. The system contains a total of 14 two way valves, 13 of which are used in PharmaSat and are configured specifically for its mission objectives. A bubble trap was also developed for the system and ensures bubble free delivery to the bio-cassette which harbors the microorganism. In addition, the bubble trap can potentially be used to prepare bubble free reconstitutions of desiccated powders contained within the reservoir bags. The overall system is highly flexible and can be reconfigured and orchestrated to meet various objectives. The system is governed by a microcontroller which allows for easy and fast programming of the entire system. The bio-cartridge is not system specific and allows for flexibility in its design.

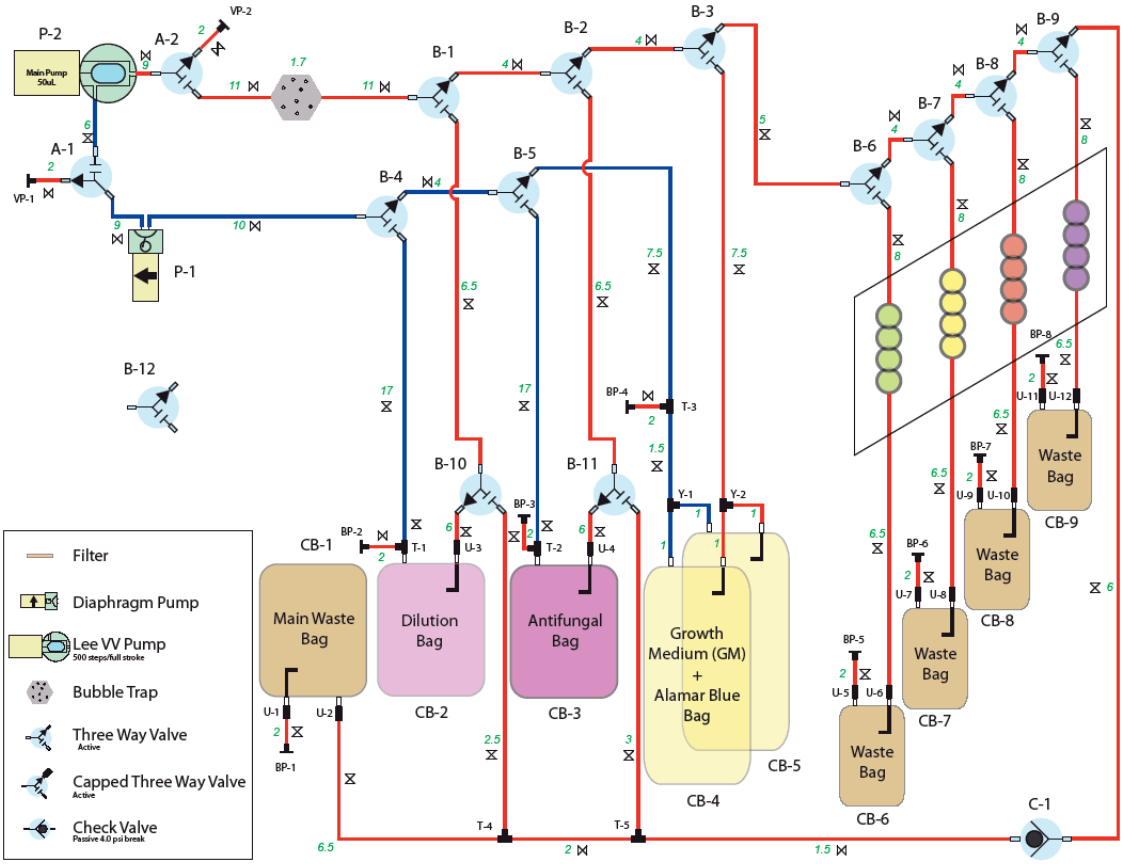

Figure 2.0-2 Fluidic System Schematic

3.0 OPTICS MODULE

The PharmaSat experimental payload was designed to perform both colorimetric and optical density assays of biological specimens in an automated fashion. Figure 3.0-1 shows the integrated optics and fluidic card assembly.

The biological sample of interest, in this case Yeast, is placed inside the fluidic card wells. Light is passed through the wells for making observations of optical density (OD) and color change. To evaluate OD variations, the sample is illuminated with blue light at a peak wavelength of 470 nm. Colorimetric changes are measured by observing absorbance of wavelengths with peaks of 525 nm (green) and 615 nm (red) for each experiment well. Optical density measurements provide indication of organism growth and cell division rates. Variations in colorimetric measurements are indications of the viability, or metabolism of the organism.

TAOS™ light-to-frequency converters translate the unabsorbed light energy to a representative frequency (counts per second). This frequency represents the relative absorbance result and varies over time as optical density and color change.

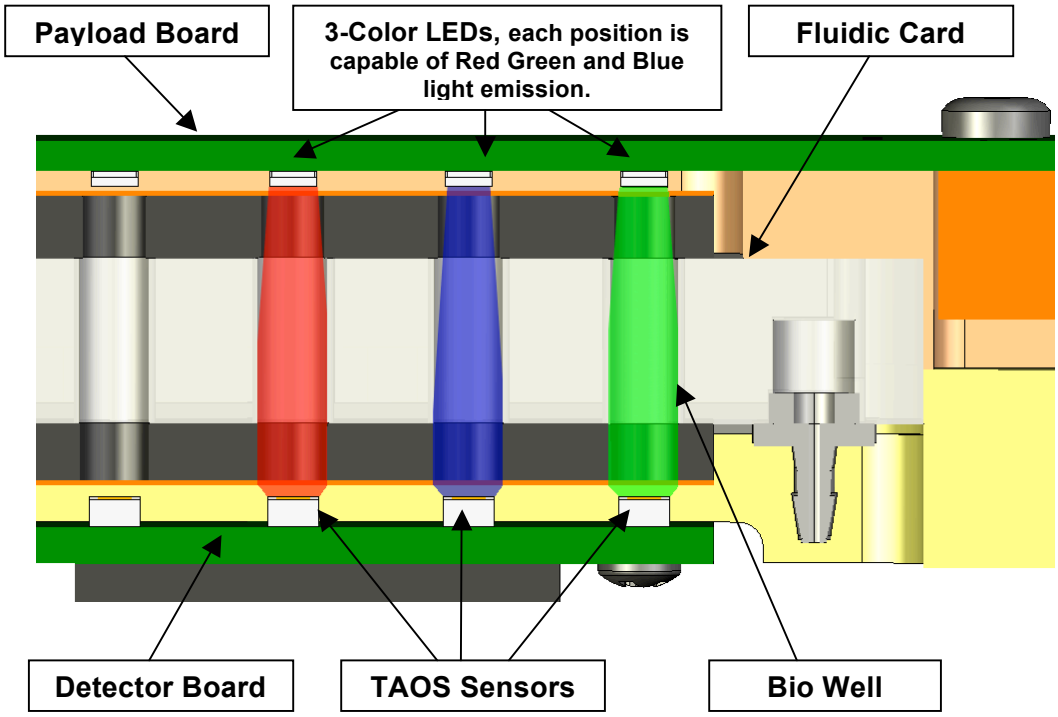

Figure 3.0-1. Cross Section of Fluidic Card, Payload & Detector Boards, showing LED illumination.

Figure 3.0-2 provides a representative plot showing time variation of optical data. Analysis will be performed to evaluate the statistical differences between data collected from orbit and that provided by the ground control experiment(s).

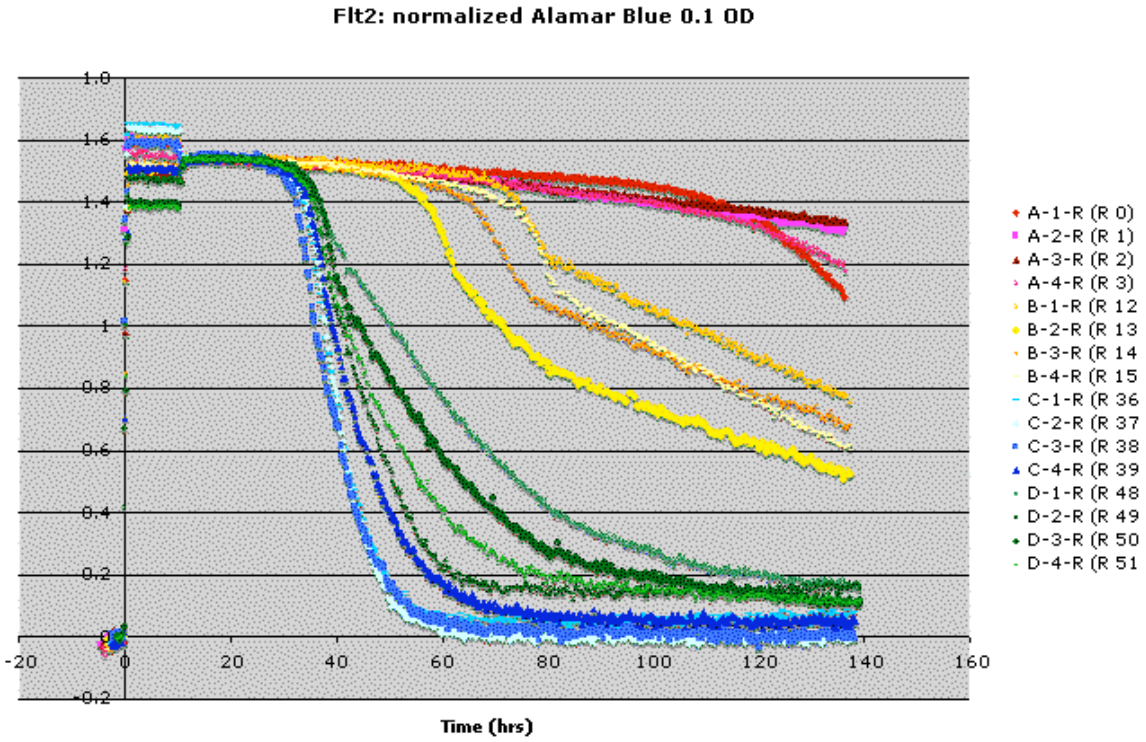

Figure 3.0-2. Representative Optical Density (OD) and Colorimetric Measurement of Yeast with antifungal agent added.

4.0 THERMAL INSULATION

The payload thermal insulation system is made up of multiple elements described as follows and illustrated in Figures 4.0-1 and 4.0-2.

4.1 Pressure Enclosure Interface Insulators

The Payload Enclosure is insulated from the Bus & Solar Panels with Ultem Standoffs and Titanium screws. The internal fluidic card assembly is insulated from the Payload Enclosure with Delran. This is illustrated in Figures 4.0-1 and 4.0-2.

4.2 External Insulation

The payload external insulation is made of a 39 layer MLI Blanket which is wrapped around the Payload Enclosure and taped in place. This blanket is made by alternating single layers of Aluminized Mylar and Dacron netting except for layer 1 and 39 which are reinforced Mylar. This is illustrated in Figure 4.0-1.

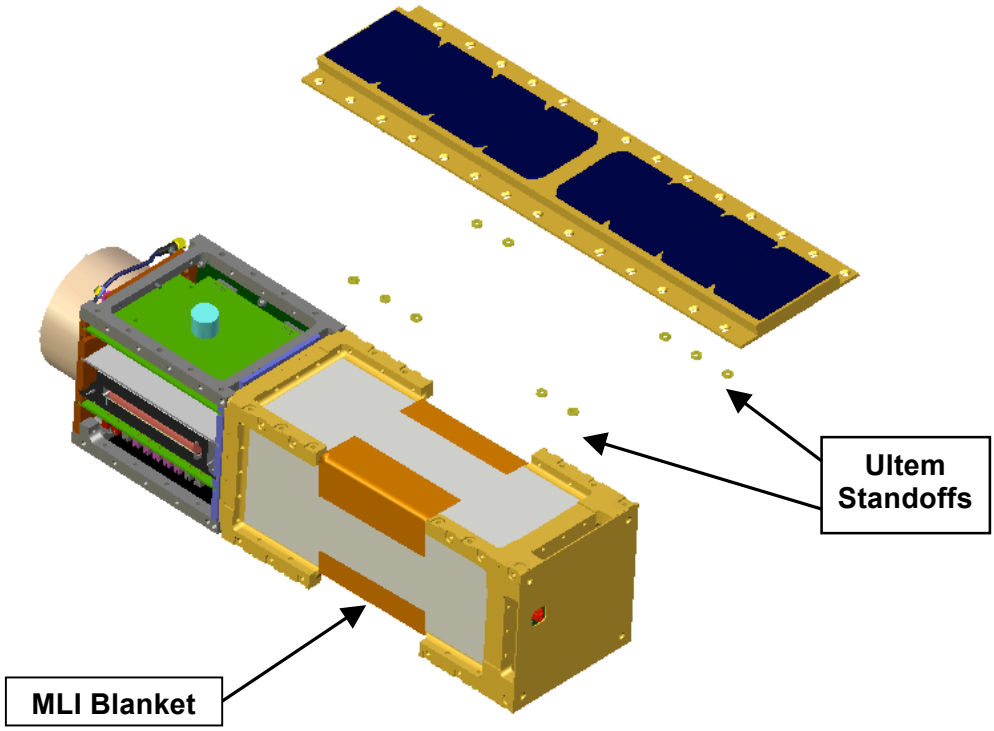

Figure 4.0-1. MLI & Ultem™ Standoffs (External insulation not shown)

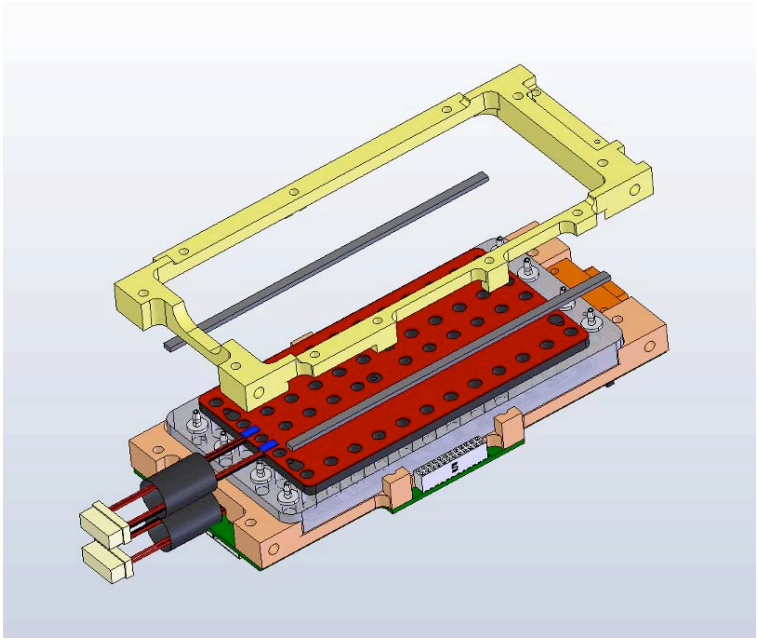

Figure 4.0-2 Fluidic Card Assembly & Delrin™ Insulators

5.0 ELECTRICAL CONFIGURATION

The payload system depicted by Figure 5.0-1 includes a bus interface and PIN diode radiation detection card (Interface—PINRad PCB); payload PCB with emitter LEDs and micro controller for data handling functions and control of the fluidic card temperature; detector PCB with a light-to-frequency converters and a microcontroller for control of the fluidics system and experiment sequence; fluidic card; pumps; valves; fluidic card heaters, and fluid reservoir heater. This system can maintain the temp of the fluidic card as high 30°C depending on orbit conditions.

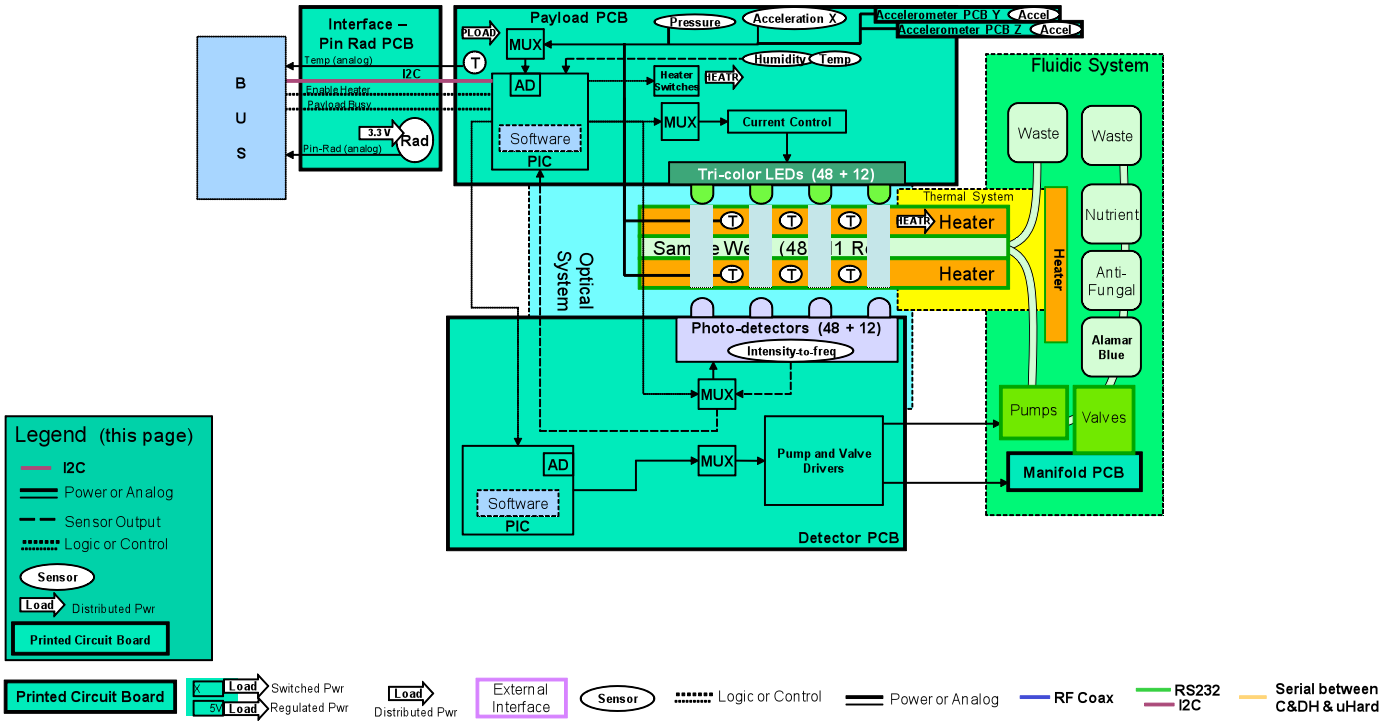

Figure 5.0-1. Payload Electronics Functional Block Diagram