Chapter 4 - SRP4 Electrical System Interfaces

The various electrical modules in the electrical system must be interconnected to operate as a system. This section addresses the cables and connectors that are required to integrate each electrical module into the system and discusses the power and data inputs and outputs of each module.

4.1 Umbilical System

4.1.1 Umbilical System Functional Requirements

The umbilical system permits the rocket to be recharged and controlled while on the launch rail. The main components of the umbilical system are: a battery charger, an umbilical box, an umbilical cable, and an umbilical block. The umbilical block defines the interface between the umbilical system and the rocket payload. The auxiliary components of the umbilical system are: a DC supply for the umbilical box, a DC supply for the charger, and a computer that controls and monitors data from the rocket. A connection diagram for the umbilical system is shown in Figure 4.1.1.1.

4.1.2 Umbilical System Interfaces

DC Supply to Charger (C1)

A DC supply must provide the voltage needed by the charger to charge the rocket batteries. This interface consists of two patch cords which will plug into banana jacks on the charger. The DC supply must be capable of supplying 40 Volts.

Charger to Umbilical Box (C2)

The charger will interface with the umbilical box through a four pin Molex Microfit ™ connector. Two lines will provide DC voltage and ground to the umbilical box for charging the rocket battery pack and one line will provide the rocket battery sensing voltage needed by the charger.

DC Supply to Umbilical Box (C3)

The umbilical box can be powered through an external supply. This supply interfaces with the umbilical box through two patch cords which plug into two banana jacks on the box.

Control Computer to Umbilical Box (C4)

A laptop computer will be able to access data from the rocket through the umbilical box. The computer connects to the umbilical box through a serial cable which plugs into a DB9 connector on the box.

Umbilical Box to Umbilical Cable (C5)

The umbilical box connects to the Poker Flat umbilical cable through a custom made high density DB15-to-Cannon plug adapter cable. This cable will plug into a high density DB15 connector on the umbilical box and a Cannon plug on the Poker Flat umbilical cable.

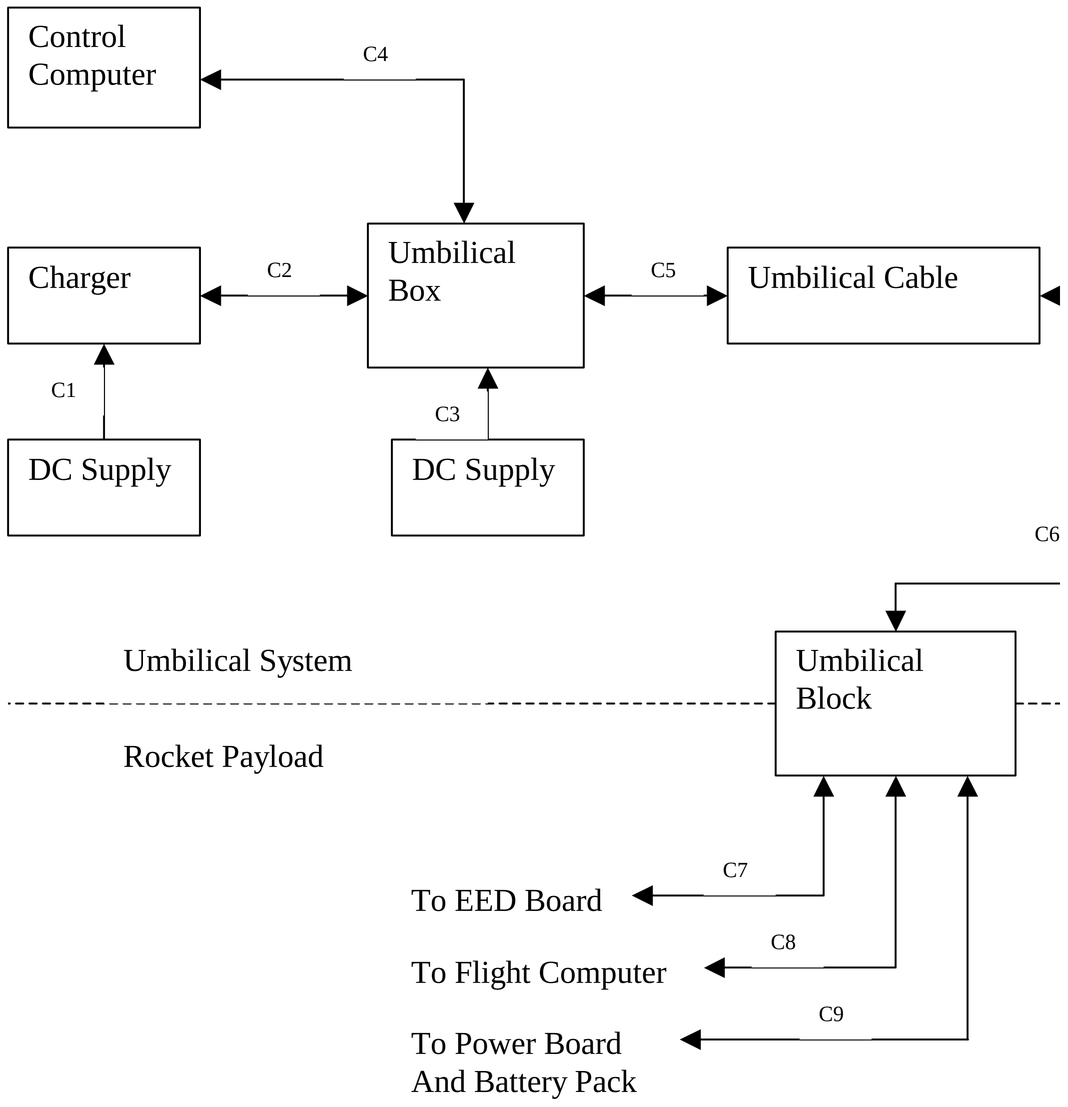

Figure 4.1.1.1 - Umbilical System Interface Diagram

Umbilical Cable to Umbilical Block (C6)

A custom Cannon-to-DB15 adapter cable joins the umbilical cable to the rocket's umbilical block. This cable must be long enough to reach the umbilical block when the rocket is vertical on the launch rail. The cable plugs into a Cannon plug on the umbilical cable and into a high density DB15 connector on the umbilical block.

Umbilical Block to EED Board (C7)

Three signal lines connect the EED board to the umbilical block. One line will be used by the umbilical box to turn on the EED board immediately prior to launch. The second line will be used by the umbilical box to detect that the EED board is on. The third line will enable the EED board to detect launch. These lines will connect to the high density DB15 connector on the umbilical block and to a four pin Molex header on the EED board.

Umbilical Block to Flight Computer (C8)

Five signal lines connect the umbilical block to the flight computer. This will enable RS422 serial data from the flight computer to be read by an external computer by a direct connection to the umbilical block or through the umbilical box. These five lines will connect to the high density DB15 on the umbilical block and to an 8-pin Molex header on the flight computer.

Umbilical Block to Battery Pack and Power Board (C9)

Three lines connect the umbilical block to the battery pack. Two of the lines supply DC voltage and GND from the charger. The third line is the voltage sense line from the battery pack to the charger. These three lines connect to the high density DB15 on the umbilical block and to a 6-pin Molex Microfit ™ connector on the battery pack. Two additional lines connect the umbilical block to the power board. One of these lines is for power board activation through the umbilical box and the second line is for the power board "ON" signal needed by the umbilical box. These lines connect to the high density DB15 connector on the umbilical block and to a Molex header on the power board.

4.2 Power System

4.2.1 Power System Functional Requirements

The power system converts the battery voltage into the voltage levels required by the electrical system modules and distributes these voltages throughout the payload by a power bus. Electrical modules can then connect directly to the power bus to acquire the voltages that they need. Figure 4.2.1.1 shows the power system connections.

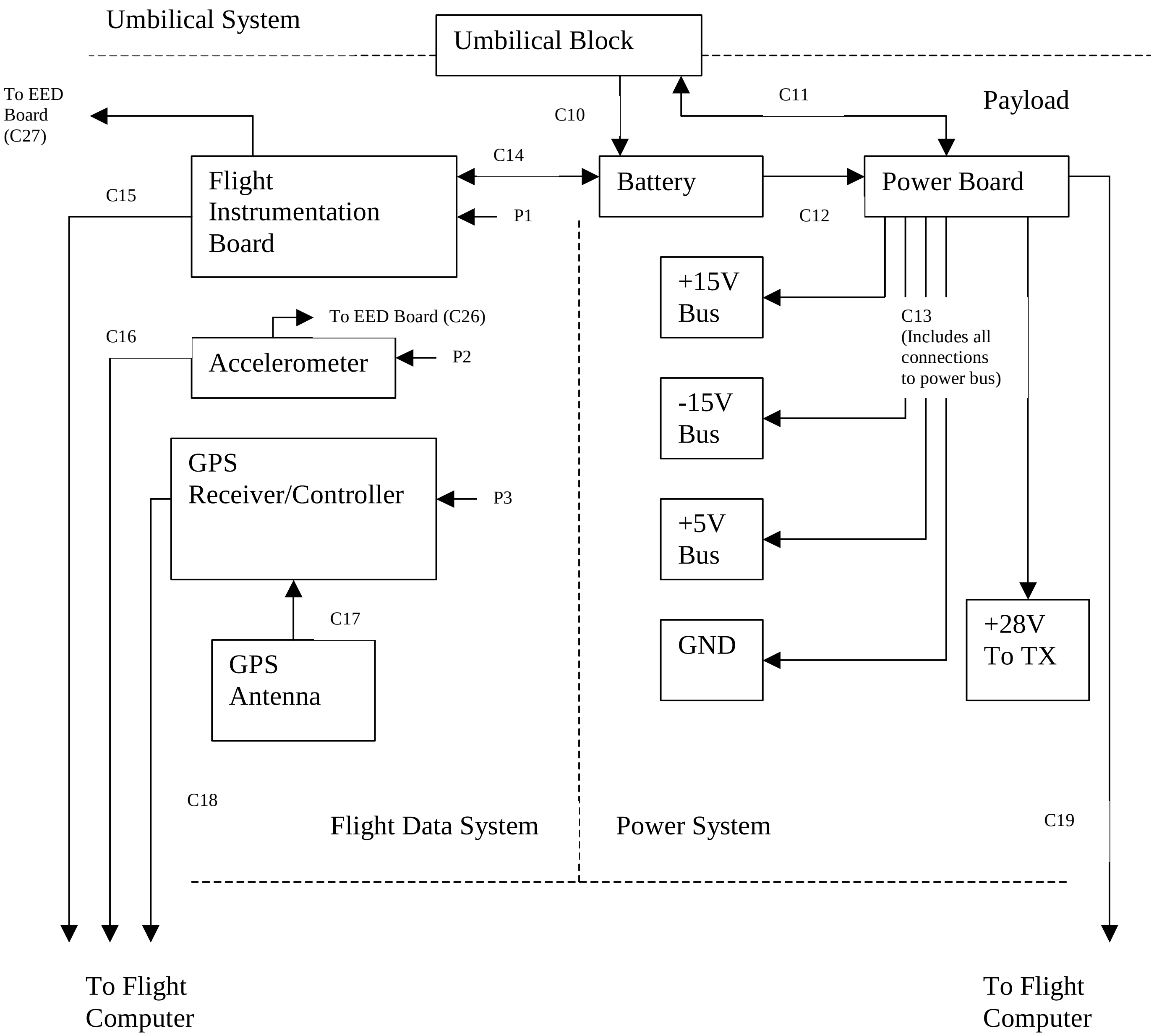

Figure 4.2.2.1 - Power System and Flight Data System Connection Diagram

4.2.2 Power System Interfaces

Umbilical Block to Battery (C10)

This connection is discussed in section 4.1.2 as part of the umbilical system connection C9.

Umbilical Block to Power Board (C11)

This connection is discussed in Section 4.1.2 as part of the umbilical system connection C9.

Battery to Power Board (C12)

Two lines provide power from the battery to the power board. One line is +28.8VDC and the second line is GND. These lines connect to a Molex Microfit ™ 6-pin header on the battery pack and to a Molex Microfit ™ 2-pin header on the power board.

Power Board to Power Bus (C13)

The power board must connect to the +15V, -15V, +5V, and GND busses in order to distribute these voltages throughout the payload. One line from the power board to the appropriate voltage bus is required, for a total of four lines. The lines will be connected to a 6-pin Molex Microfit™ connector on the power board and to screw down ring connectors which will be attached to the power bus. One additional line will be needed to supply 28.8 V from the power board to the S-band transmitter. This line will be connected to the 6-pin Molex Microfit connector on the power board and to a DB9 connector on the S-band transmitter.

Power Board to Flight Computer (C19)

Eight data lines will be required for the interface between the power board and the flight computer. Four of the data lines will allow the flight computer to sample the voltages on the power board and four lines will allow the flight computer to sample the power board currents.

4.3 Flight Data System

4.3.1 Flight Data System Functional Requirements

The flight data system measures data pertaining to the rocket itself and converts these measurements into a form that be sampled by the flight computer. Figure 4.2.1.1 shows the Flight Data System connections.

4.3.2 Flight Data System Interfaces

Battery to Flight Instrumentation Board (C14)

Two lines connect the battery and the flight instrumentation board. One line supplies +5V to a temperature sensor within the battery pack. The second line provides an analog signal from this sensor to the flight instrumentation board where it is scaled before being sampled by the flight computer. These lines connect to a two pin Molex header on the battery pack and a two pin Molex header on the flight instrumentation board.

Power Bus to Flight Instrumentation Board (P1)

Two lines connect the flight instrumentation board to the power bus. One line provides +5V and the second line provides GND to the flight instrumentation board. Both lines will connect to the appropriate voltage bus through a ring connector and to the flight instrumentation board through a four pin Molex header.

Flight Instrumentation Board to Flight Computer (C15)

Five data lines are required for the interface between the flight instrumentation board and the flight computer. A standard 8-conductor data cable will be used with 8-pin Molex connectors at each end.

Flight Instrumentation Board to EED (C27)

One line is required for the interface between the EED board and the flight instrumentation board. Four pin Molex headers will be used at each end of this connection.

Power Bus to Accelerometer Board (P2)

The accelerometer requires three lines that connect to the power bus. One will connect to the +15V bus, the second will connect to the +5V bus, and the third will connect to the GND bus. The three lines will connect to a 4-pin Molex header on the accelerometer and each line will connect to a ring connector on the power bus.

Accelerometer Board to Flight Computer (C16)

Five data lines are required for the interface between the accelerometer and the flight computer. A standard 8-conductor data cable will be used with 8-pin Molex connectors on each end.

Accelerometer to EED Board (C26)

Three data lines will be required for the interface between the accelerometer and the EED board. A standard 4-conductor data cable will be used with 4-pin Molex connectors on each end.

Power Bus to GPS Receiver (P3)

Two lines are required to connect the GPS receiver to the power bus. One line will connect to the +5V bus and the second line will connect to the GND bus. Both lines will connect to a 4-pin Molex connector on the GPS receiver and each line will connect to a ring terminal on the power bus.

GPS Antenna to GPS Receiver (C17)

The GPS antenna connection to the GPS computer uses a coaxial cable with an SMA connector at the antenna and a TNC connector at the receiver.

GPS Receiver to Flight Computer (C18)

Two lines are needed for the interface between the GPS receiver and the flight computer. A four conductor standard data cable will be used with 4-pin Molex connectors at each end.

4.3 Science Data System

4.3.1 Science Data System Functional Requirements

The science data system measures phenomena which are external to the rocket and converts these measurements into voltages which are sampled by the flight computer.

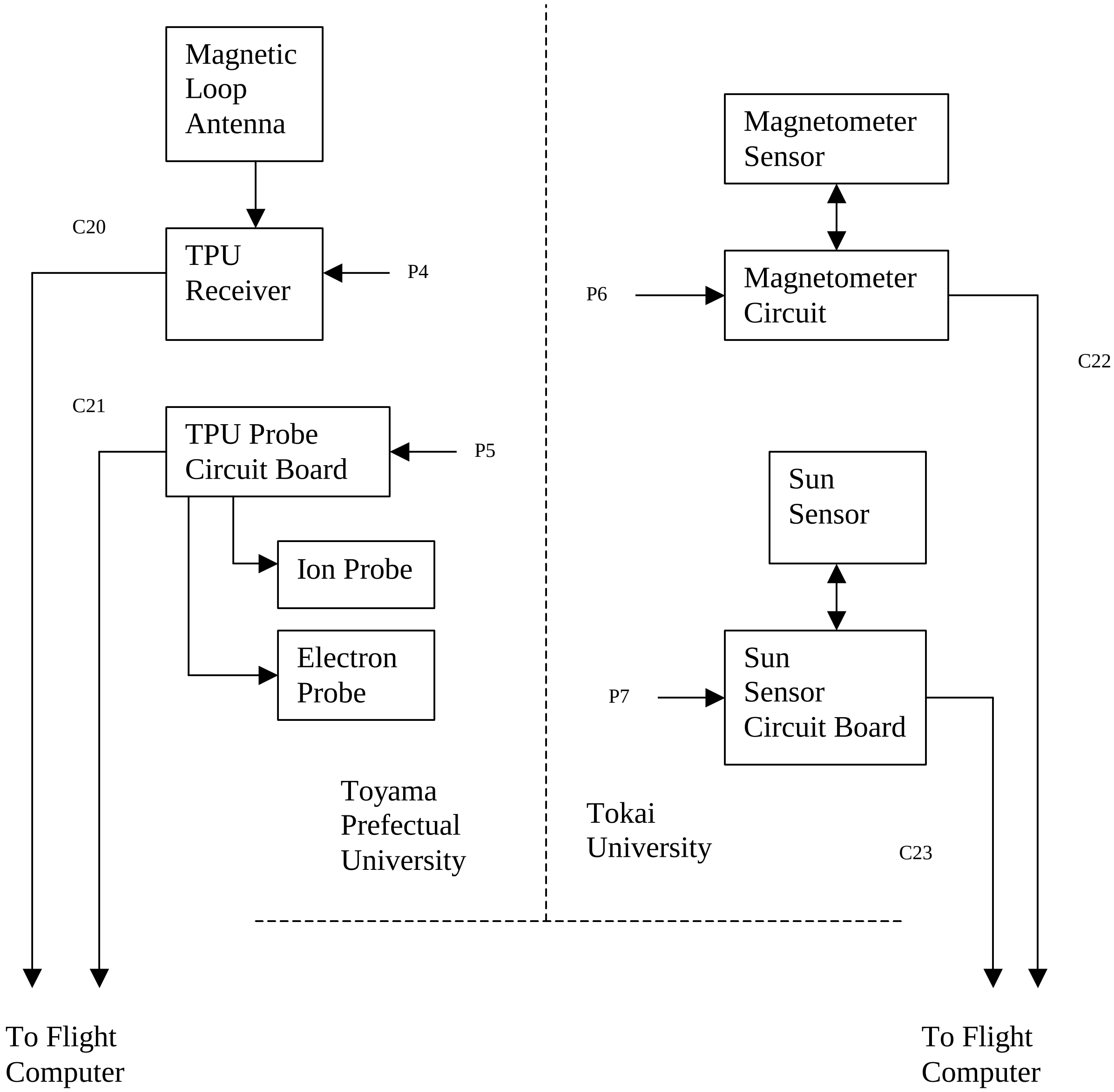

Figure 4.3.1.1 - Science Data System Connection Diagram

4.3.2 Science Data System Interfaces

Power Bus to TPU Receiver (P4)

Four lines are required for the interface between the power bus and the TPU receiver. These lines connect to the +15V, -15V, +5V, and GND busses using ring connectors. All four lines connect to the TPU receiver through a Molex 4-pin connector.

TPU Receiver to Flight Computer (C20)

Six lines are required for the interface between the TPU receiver and the flight computer. All all these lines are data lines which will be providing analog voltages which will be sampled by the flight computer. A standard 8-conductor data cable will be used with 8-pin Molex connectors at each end. The unassigned conductors will be used as signal grounds.

Power Bus to TPU Probe Circuit Board (P5)

Four lines are required for the interface between the power bus and the TPU probe circuit board. Ring connectors will be used to connect these lines to the +15V, -15V, +5V, and GND busses. All of the lines connect to the probe circuit board through a 4-pin Molex connector.

TPU Probe Circuit to Flight Computer (C21)

Four lines connect the TPU probe circuit to the flight computer. These lines will provide analog data to the flight computer for sampling. An 8-conductor standard data cable will be used with 8-pin Molex connectors at each end. The unassigned conductors in the cable will be used as signal grounds.

Power Bus to Magnetometer Circuit Board (P6)

Three lines connect the magnetometer circuit board to the +15V, -15V, and GND busses through ring connectors. The three lines are connected to the magnetometer circuit board through a 4-pin Molex connector.

Magnetometer Circuit Board to Flight Computer (C22)

Three lines are required for the analog data from the magnetometer which will be sampled by the flight computer. A 8-conductor standard data cable with 8-pin Molex connectors at each end has been requested by Tokai. The unassigned conductors will be used as signal grounds.

Power Bus to Sun Sensor Circuit Board (P7)

Three lines are required for the interface between the power bus and the sun sensor circuit board. These lines will connect to the +15V, -15V, and GND busses through ring connectors. All of the lines will connect to the sun sensor circuit board through a 4-pin Molex connector

Sun Sensor Circuit Board to Flight Computer (C23)

One line is required for the interface between the sun sensor circuit board and the flight computer. A standard 4-conductor data cable will be used with 4-pin Molex connectors at each end. The unassigned conductors can be used as signal grounds.

4.4 Flight Computer

4.4.1 Flight Computer Functional Requirements

The flight computer samples, packetizes, and adds error correction coding to the data provided by the various data producing systems. Then it sends this data to the S-band transmitter in the form of a serial bit stream.

The connection diagram for the flight computer is shown in Figure 4.4.1.1.

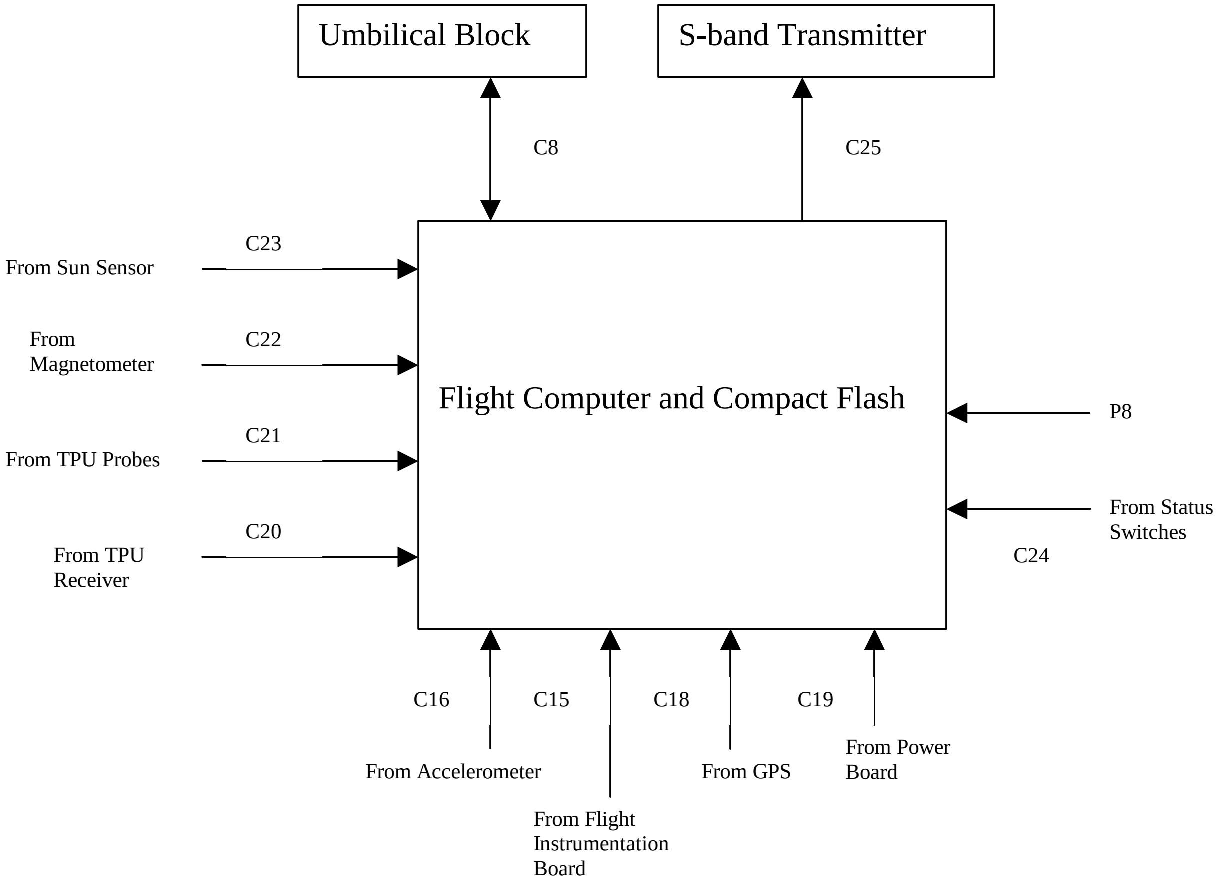

Figure 4.4.1.1 - Flight Computer and Compact Flash Connection Diagram

4.4.2 Flight Computer Interfaces

Umbilical Block to Flight Computer (C8)

As discussed in Section 4.1.2, five lines connect the flight computer to the umbilical block. These lines connect to a high-density DB15 on the umbilical block and to an 8-pin connector on the flight computer.

Power Bus to Flight Computer (P8)

Four lines connect the flight computer to the +15V, -15V, +5V, and GND busses using ring connectors. All of the lines connect to the flight computer through a 4-pin Molex connector.

TPU Receiver to Flight Computer (C20)

Refer to Section 4.3.2 for details on this interface.

TPU Probes to Flight Computer (C21)

Refer to Section 4.3.2 for details on this interface.

Magnetometer to Flight Computer (C22)

Refer to Section 4.3.2 for details on this interface.

Sun Sensor to Flight Computer (C23)

Refer to Section 4.3.2 for details on this interface.

Accelerometer to Flight Computer (C16)

Refer to Section 4.3.2 for details on this interface.

Flight Instrumentation Board to Flight Computer (C15)

Refer to Section 4.3.2 for details on this interface.

GPS to Flight Computer (C18)

Refer to Section 4.3.2 for details on this interface.

Power Board to Flight Computer (C19)

Refer to Section 4.2.2 for details on this interface.

Status Switches to Flight Computer (C24)

Four lines will be necessary for the interface between the status switches and the flight computer. Each of the four lines will connect to a Winchester connector, and all of the lines will connect to the flight computer through a 4-pin Molex header.

Flight Computer to S-Band Transmitter (C25)

The flight computer will send a serial bit stream to the S-band transmitter through a coaxial cable. SMA connectors will be used at each end. The 0V to 5V signal from the flight computer must be attenuated to a maximum of 2V peak-to-peak before it is sent to the transmitter.

4.5 EED Board

4.5.1 EED Board Functional Requirements

The EED board begins an algorithm after launch is detected that determines whether or not the rocket is flying along its expected trajectory. The EED board then sends firing signals to the motor/payload separation mechanism and to the recovery system deployment mechanism at the appropriate times.

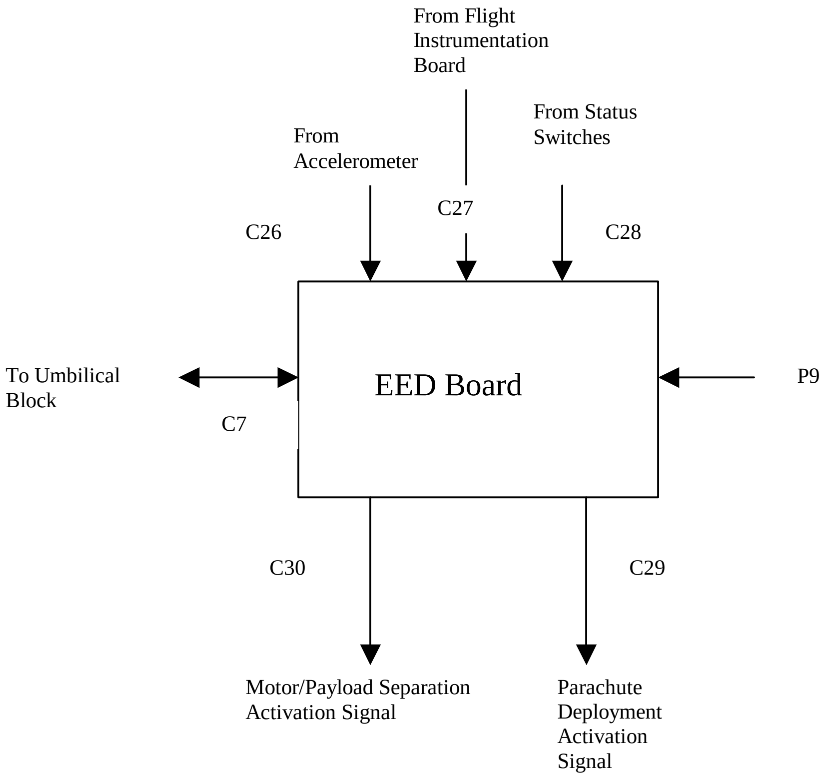

Figure 4.5.1.1 - EED Board Connection Diagram

4.5.2 EED Board Interfaces

EED Battery to EED Board (P9)

The EED board will connect to a +18V battery pack which will power the board, and to a +9V battery pack which will be used by the firing circuit. Connections to the batteries will be made with 9V battery connectors.

Accelerometer to EED Board (C26)

Three lines are required for the interface between the EED board and the accelerometer. These lines allow the EED board to monitor the longitudinal, radial, and tangential acceleration outputs. A 4-conductor standard data cable will be used with 4-pin Molex connectors at each end.

Flight Instrumentation Board to EED Board (C27)

One line is required for the interface between the EED board and the flight instrumentation board. This allows the EED board to monitor the ambient air pressure measured by the flight instrumentation board. A standard 4-conductor data cable will be used with 4-pin Molex connectors at each end.

Status Switches to EED Board (C28)

Two lines are required for the interface between the EED board and the status switches. This allows the EED board to determine if the payload has separated from the motor, and if the recovery system deployed. Each of the lines will connect to a Winchester connector, and both of the lines will connect to a 4-pin Molex header on the EED board.

EED Board Activation Signals (C29, C30)

The EED board will connect to a motor/payload separation activator and to a parachute deployment activator through a 4-pin Molex Microfit connector.

EED Board to Umbilical Block (C7)

Refer to Section 4.1.2 for details on this interface.

4.6 Communication System

4.6.1 Communication System Functional Requirements

The communication system transfers data from the flight computer to the ground support system. The ground support system archives and processes that data. Figure 4.6.1.1 is a connection diagram for the communication system.

4.6.2 Communication System Interfaces

Flight Computer to S-band Transmitter (C25)

Refer to Section 4.4.2.12 for details on this interface.

Power Board to S-band Transmitter (C13)

Refer to Section 4.2.2.4 for details on this interface.

S-band Transmitter to Power Splitter (C31)

Coaxial cable will connect the output of the transmitter to a 4-way power splitter. SMA connectors will be used on each end.

Power Splitter to Transmit Antenna (C32)

Coaxial cable will connect each of the four outputs of the power splitter to one of four transmit antenna patches. SMA connectors will be used at both ends of each cable.

Ground Station Receive Antenna to LNA (C33)

The receive antenna will connect to a low noise amplifier (LNA) through a coaxial cable. SMA connectors will be used on each end of the cable.

DC Supply to LNA (P10)

The LNA must be powered by a +15VDC supply.

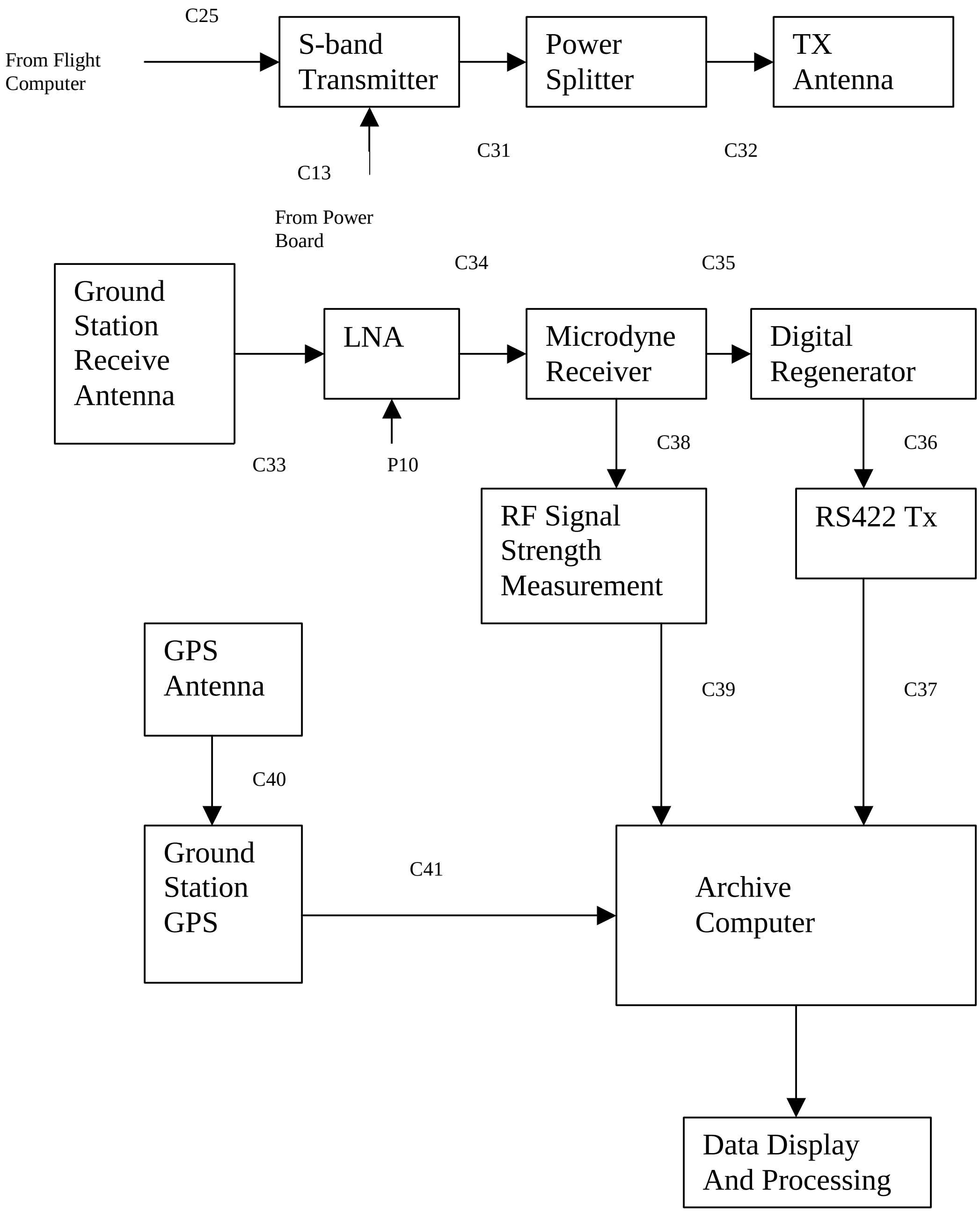

Figure 4.6.1.1 - Communication System Connection Diagram

LNA to Microdyne Receiver (C34)

The LNA will interface with the receiver through approximately 75 ft. of RG-8 coaxial cable. N-type connectors will be used at each end.

Microdyne Receiver to Digital Regenerator (C35)

The output of the receiver will interface with the digital regenerator through an RG-58 coaxial cable. BNC connectors will be used at each end of the cable.

Digital Regenerator to RS422 Transmitter (C36)

RS422 Transmitter to Archive Computer (C37)

The RS422 transmitter will interface with the archive computer through a serial cable. The serial cable will plug into a serial port on the archive computer.

GPS Antenna to Ground Station GPS (C40)

The GPS antenna will interface with the ground station GPS through a coaxial cable. The cable will have an SMA connector at the antenna end and will connect to the ground station GPS receiver through a TNC connector.

Ground Station GPS to Archive Computer (C41)

The ground station GPS will interface to the archive computer through a serial cable with DB9 connectors at both ends.

4.7 Standard Data Cables

4.7.1 Purpose

Using a standard data cable allows the same cables to be used to connect any module using standard headers to any other module that uses standard headers. Standard data cables of the proper length may be used without modification to connect different modules on future payloads. Using standard data cables eliminates the need to modify a wiring harness every time a module is added or removed from the existing payload electrical system design.

4.7.2 Data Cable Standard

The data cable standard is the BICCGeneral Non-Plenum Multi-Conductor Cable (Digikey Part # W508-X-ND and #W504-X-ND). This cable contains either 8 or 4 conductors, respectively, of 22AWG stranded wire. The cable is "overall foil shielded" meaning that the cable, but not the individual conductors within the cable, is shielded from noise with metallic foil. The cable also has a bare copper drain wire. The cable is specifically designed for use with computers and instrumentation. The outside diameter of the 8 conductor cable is approximately 6 mm and the outside diameter of the 4 conductor cable is approximately 4.8 mm. Different brands of similar type can also be used.

4.7.3 Labeling

Each end of each cable should be labeled near each connector with the name of the module that it connects to, the signals names, and their corresponding pin numbers.

4.8 Power Bus Connections

4.8.1 Purpose

The power bus distributes power from the power board to each deckplate. Each module will connect directly to the power bus. The power busses on each deckplate have redundant connections to the power board.

4.8.2 Power Bus Terminal Blocks

The AMP Flexi-Block Terminal Block system will be used to create four voltage busses on each deckplate. One terminal block will be used for each of the voltages (and ground) provided by the power board. The #6 Block assembly (Digikey Part # AO130-ND) will be used. Ring jumper tabs (Digikey Part #A0139-ND) will distribute the respective voltage along one side of the terminal strip. Modules will connect to any point on the other side of the strip using tab connector (Digikey Part #AO137-ND). The wire from each module will be inserted through the hole in the tab and soldered. All wires connecting to the GND bus will be black. All wires connecting to the +5V bus will be red. All wires connecting to the +15V bus will be orange. All wires connecting to the –15V bus will be brown.

4.8.3 Connecting the Terminal Blocks to the Power Board

Each terminal block will be connected to the power board through two electrical paths. One path will start at the power board and go sequentially to every terminal block for that voltage (i.e. to every deckplate). Another path will begin on the opposite side of the last terminal block reached by the first path and go sequentially to every terminal block towards the power board. Between terminal blocks, the two paths will be twisted and tie-wrapped together.

Chapter 5 – Vibration And Payload Test Plan

5.1 Design Verification Test Plan

The design verification test plan is intended to demonstrate that each component of the payload subsystem modules operate as designed. There are two types of testing, individual system level tests (SLT) and payload integration tests (PIT). Individual component testing plans are located in the previous chapters under the specific component sections. Section 3.1 will cover the general system level vibration test steps and the payload level vibration specifications. Section 3.2 will cover the payload level tests.

5.2 Vibration Tests

All system component designers must provide confidence that the system components can withstand the vibration stressing that is expected during launch and flight. This assures that all electrical solder joints and mechanical welded or fastened joints will not loosen during the mission. Table 5.2.2.1 provides the design qualification specifications provided by NASA for previously unqualified components (system level) to be flown on an Orion vehicle. After payload integration, the principal investigator, PI, must provide confidence that the system components function properly when vibrated as an integrated system. Table 5.2.2.2 provides the vibration test levels for new design payloads flown on an Orion vehicle.

Table 5.2.2.1: General Component (System Level) Design Qualification Specifications for flight on an Orion Vehicle.

Sine		
Sweep Rate	4 Octaves/min	
Three Axis	7.3 IPS Constant Velocity	5-89 Hz
	10.5 G	89-800 Hz
	15 G	800-2,000 Hz
Random		
Duration	20 sec/ axis	
Three Axis	20.4 G-RMS	
	0.115 G^2/Hz-0.225 G^2/Hz	20-1000 Hz @ 0.52 dB/octave
	0.225G^2/Hz	1000-2000 Hz @ 0.52 dB/octave

Table 5.2.2.2: New Design Payload Vibration Test Levels for flight on an Orion Vehicle

Sine			
Sweep Rate	4 Octaves/min		
Thrust Axis	+/-12.37 cm/sec (+/-4.87 in/sec)		10-50 Hz
	+/-4.0 G		50-2,000 Hz
Lateral Axis	Same as Thrust Axis		
Random			
Duration	20 sec/axis		
Thrust Axis	6 G-RMS	0.018 G^2/Hz	20-2,000 Hz
Lateral Axis	Same as Thrust Axis		

5.2.1 Mechanical System Level Component Vibration Test

Description

This SLT determines the mechanical system's ability to withstand the expected vibration stress.

Success Criterion.

The payload architecture and separation mechanism system must each maintain integrity during the component vibration test. Design qualification specifications are defined in Table 5.2.2.1

Procedure

- Attach the system to the vibrator.
- Attach the recording apparatus.
- Perform the three-axis sine test with a 4-octaves/minute sweep rate.
- Check all connections and joints.
- Perform the three-axis random test for 20 seconds/axis.
- Check all connections and joints.

Result Report

- Write a test summary.
- Include graphs and tables.

5.2.2 Electrical System Level Component Vibration Test

Description

This SLT determines the electrical system's ability to withstand and produce the desired outputs during the expected vibration stress.

Success Criterion

Each electrical PCB and subsystem must maintain integrity and accurate signal outputs during the component vibration test. Vibration design qualification specifications are defined in Table 5.2.2.1. For details on the desired subsystem outputs, see the subsystem electrical test that applies in the following sections.

Procedure

- Attach the system or PCB to the vibrator.
- Attach the system or PCB to an appropriate voltage supply.
- Attach appropriate loads.
- Attach appropriate measuring apparatus (oscilloscope, voltage meter, ammeter, etc.)
- Turn on power supply and measuring apparatus.
- Perform the three-axis sine test with a 4-octaves/minute sweep rate.
- Perform all subsystem checks listed in the individual subsystem module test sections that apply.
- Record all measurements.
- When done, check all connections and joints.
- Perform the three-axis random test for 20 seconds/axis.
- Perform all subsystem checks listed in the individual subsystem module test sections that apply.
- Record all measurements.
- When done, check all connections and joints.

Result Report

- Write a test summary.

- Include graphs and tables.

5.3 Payload Integration Tests

5.3.1 Integration Testing

Description

This PIT procedure identifies the order of payload assembly and verifies the functions of each module as they are added to the payload.

Success Criteria

The entire system must function correctly

Procedure

- Verify battery box output voltage is 36 V +/-10%.
- Attach umbilical box to the umbilical module.
- Attach umbilical module to the battery box.
- Verify that the main power bus can be switched on and off from the umbilical box.
- Attach power regulator module to the umbilical module switched +36 V output.
- Turn main power on via the umbilical box.
- Verify that each regulated output is +/- 5% of the nominal value.
- Attach GPS antenna to GPS receiver module.
- Attach GPS receiver module to the power regulator module.
- Verify the regulator + 5 V output again.
- Probe GPS time mark pulse output and serial data outputs with an oscilloscope to verify the GPS receiver is operating.
- Attach flight computer assembly to the power regulator module.
- Verify the +5 V, + 28 V, and +15 V regulator output voltages.
- Probe flight computer serial data output with an oscilloscope to verify the flight computer is operating.
- Attach the GPS time mark pulse output and serial data to the flight computer.
- Using the umbilical attach the flight computer serial data output to the archive computer. Verify that the flight computer is sending telemetry data correctly.
- Attach the instrumentation board(s) to the power module.
- Verify the power regulator output voltages.
- Attach sensors to the instrumentation boards.
- Verify all instrumentation board output voltages are within the 0-5 V range while exercising each sensor.
- Attach each instrumentation board output to its respective A/D input.
- Exercise each sensor to verify that its telemetry data is correctly updated in the telemetry data stream.
- Attach the magnetometer board to the power regulator.
- Verify the regulator output voltages.
- Exercise the magnetometer sensors in all 3 ax ices and verify the output voltage ranges.
- Connect the magnetometer to the flight computer.
- Exercise the magnetometer sensors to verify that its telemetry data is correctly updated in the telemetry data stream.
- Connect the science data probe board and probes to the power regulator.
- Verify the regulator output voltages.

- Verify the probe operations and the probe board output voltage ranges.
- Attach the probe board to the flight computer.
- Verify that the probe data is captured correctly in the telemetry data stream.
- Attach the magnetic loop antenna to the nose cone.
- Attach the magnetic loop antenna to the science data receiver.
- Attach the science data receiver to the power regulator.
- Verify the regulator output voltages.
- Transmit and cutoff each of the 3 frequencies of the receiver.
- Verify that the antenna picks up the signal and the receiver detects it.
- Verify the receiver output voltage range.
- Attach the receiver output to the flight computer.
- Transmit and cutoff each of the 3 frequencies of the receiver.
- Verify that the frequency data is captured correctly in the telemetry data stream.
- Attach EED equivalent circuit loads to the outputs of the EED driver module.
- Attach the EED driver module to the power regulator board and to the umbilical board.
- Trigger each EED circuit.
- Turn off the main power from the umbilical box.
- Attach the jumper wires to the lanyard switch and separation inputs.
- Turn on the main power from the umbilical box.
- Verify that the flight computer is sending all telemetry data.
- Trigger the EED timing sequence and verify the logic sequence operation.
- Observe the telemetry data and verify that the telemetry mode changes correctly.

Result Report

- Write a test summary.
- Include graphs and tables.

5.3.2 RFI Susceptibility Testing

Description

This PIT must prove that the transmitters, power supply and magnetometer do not adversely effect the payload operation.

Success Criterion

The GPS receiver, science data receivers and flight computers must operate correctly with all on board transmitters keyed and the magnetometer operating.

Procedure

- Hang the payload in a fashion similar to the under-parachute data
- collection configuration.
- Place receiving sense antenna near the transmitter dummy load.
- Attach receiving sense antenna to the ground station receiver.
- Attach ground station receiver to the ground station.
- Start ground station computer.
- Turn on payload electronics.
- Verify correct telemetry including GPS and science data.
- Alter the position of the payload.

- Verify that the magnetometer does not interfere with the flight computer or magnetic loop antenna and science data receiver.
- Key the recovery beacon and verify correct telemetry.

Result Report

1. Write a test summary.
2. Include graphs and tables.

5.3.3 Temperature Cycle Testing

Description

This PIT subjects the payload electronics and structure to the extreme limits of operating temperature. It also subjects the payload electronics to thermal expansion stress in order to break any marginal solder joints or components before actual mission flight.

Success Criterion

Payload electronics must operate correctly for the duration of the test. The payload structure must maintain integrity during the test.

Procedure

- Attach the payload assembly to a 28 V 3 A power supply.
- Attach a 50 Ω dummy load to the transmitter.
- Place receiving sense antenna near the transmitter dummy load.
- Attach receiving sense antenna to the ground station computer.
- Attach ground station receiver to the ground station computer.
- Start the ground station computer telemetry monitor program.
- Turn on the payload.
- Chill the payload assembly to – 45° C.
- Heat payload assembly to 65° C.
- Repeat steps 8 and 9 for at least 72 hours.

Result Report

- Write a test summary.
- Include graphs and tables.

5.3.4 Pressure Test

Description

This PIT subjects the payload electronics to the pressures expected during flight.

Success Criterion

Payload electronics must operate correctly for the duration of the test. The results must show that out gassing of components must not impair the data to be gathered during flight.

Procedure

- Attach the payload assembly to a 28 V 2 A power supply.
- Attach a 50 Ω dummy load to the transmitter.
- Place receiving sense antenna near the transmitter dummy load.

- Attach receiving sense antenna to the ground station computer.
- Attach ground station receiver to the ground station computer.
- Start the ground station computer telemetry monitor program.
- Turn on the payload.
- Subject the payload to a pressure range of 14.7 psi at the earth's surface to 0.15 psi at 100,000 ft.

Result Report

- Write a test summary.
- Include graphs and tables.

5.3.5 Payload Vibration Test

Description

This PIT subjects the payload electronics to the expected vibration during flight. It also subjects the payload electronics to vibration stresses in order to break any marginal solder joints or components before actual mission flight.

Success Criterion

Payload electronics must operate correctly for the duration of the test.

Procedure

- Attach the payload assembly to a 28 V 3 A power supply.
- Attach a 50 Ω dummy load to the transmitter.
- Place receiving sense antenna near the transmitter dummy load.
- Attach receiving sense antenna to the ground station computer.
- Attach ground station receiver to the ground station computer.
- Start the ground station computer telemetry monitor program.
- Turn on the payload.
- Subject the payload to the sine vibration levels defined in Table 5.2.2.2 above. Each of these tests will be performed at 4 Octaves/minute.
- For each test record the data record interval, bandwidth, signal strength, minimum signal and packet errors.
- Subject the payload to the random vibration levels defined in Table 5.2.2.2 above. Each of these tests will last 20 seconds per axis.
- For each test, record the data record interval, bandwidth, signal strength, and minimum signal and packet errors.

Result Report

- Write a test summary.
- Include graphs and tables.