Electrical Power Subsystem

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Top Level Requirements

- Supply Electrical Power to All Spacecraft Subsystems During All Mission Phases
- Provide Sufficient Solar Array to Support Loads and Battery Charge
- Provide Energy Storage to Operate During Seasonal Eclipse Periods, to Support Transient Loads and to Clear Fault Loads
- Limit Battery Depth of Discharge and Overcharge; Provide for System Survival With Undervoltage Detection and Non-Critical Load Shed
- Drive CG Trim Mass and Radiation Trim Tab Motors for Precession Control
- Automatically Reject Excess Solar Array Energy
- Maintain Spacecraft Bus Voltage at 30 +/- 6 Vdc
- Design for Autonomous Operation to Limit Ground Intervention; Provide Manual Override of the Autonomous Functions
- Install Fault Protection on Non-Critical Loads and Redundant Critical Loads
- Distribute Unswitched Power to Critical Bus Subsystems and Switched Power to All Spacecraft Subsystems
- Monitor EPS Health and Provide EPS Parameters to Telemetry

Top Level Requirements

- Provide Ordnance for Satellite and Interstage Separation, Solar Array Release and Apogee Kick Motor
- Ordnance Design Will Meet Safety Requirements As Specified in NASA Document 127-1 for Non-Manned Flights
- Minimize Magnetic Moments
- Design and Fabricate Spacecraft Harness Meeting Requirements As Specified in GSFC311-INST-001
- Design for 5 Year Mission; Parts Will Handle Temperature, Radiation and Mechanical Extremes; Parts Will Meet Mil Class B Program Requirements

Current Baseline/Approach

- GaInP/GaAs/Ge Solar Cells Arranged on Six Deployable Panels With Each Panel Having Twelve Strings; EOL Power Sufficient to Support All Phases of a 5 Year Mission (Trade Study)
- Connect Solar Array Strings, As Needed, Leaving Excess Energy at Solar Array; Strings to Be Symmetrical About Spacecraft Center of Rotation to Avoid Perturbing Precession
- 22 Cell NiH_2 CPV Battery With Eleven Pressure Vessels, Each With a 25 Ah Capacity (Trade Study)
- Motor Drive Electronics to Sequentially Drive Six CG Trim Mass Motors in Pairs and Six Radiation Trim Tab Stepper Motors (Trade Study)
- Isolated, Secondary Voltages Available for IMUs and All Other Loads As Needed
- Fuses to Protect Against Load Faults (Trade Study)
- High Level Solar Array and Total Load Current Monitors to Be Non-Invasive to Eliminate Power Loss and Critical Bus In-Line Part Reliability; Each Load Current Monitor Will Use Standard In-Line Redundant Sense Resistors
- Load Switching to Be Performed Using Electromechanical, Latching Relays (Trade Study)

Current Baseline/Approach

- Heater Switching to Be Controlled Electronically
- Use Heritage EPS and Ordnance Design/Hardware If Possible
- Choose Electrical Parts Using Selection, Screening and Qualification Guidelines As Specified in GSFC311-INST-001, Rev A
- All Electronic Designs Capable of Performing Adequately Over Temperature Range of 0C to +40C; Solar Array From -100C to +120C; Battery From -10C to +20C
- Ordnance Box, Located on Interstage Deck, to Be Jettisoned After Final Ordnance Event
- Non-Explosive Release Devices Will Be Used for Solar Array Deployment; Pyros Required for SRM Ignition and for Satellite & Interstage Separation; Paraffin Actuators Used for Star Tracker Covers
- Power and Ordnance Box Designs Will Be Based on NRL Standard Box and/or Clementine Style Box in Order to take Advantage of Heritage Hardware and to Minimize Deck Area Requirements
- Harness Will Be Designed to Handle High Speed Data Lines From the Instrument, 1553 Bus Lines, Battery and Solar Array Power Cables, Ordnance Cables and Power,Command and Data Lines for All Subsystems

Current Baseline/Approach

Subsystem/Unit	Qty	Launch	Initial Acq/GTO	GEO/Ops	Safe/Hold Mode
CT&DH	1	24.1	36.5	24.1	24.1
ADCS					
• IMU	2	0	20	10	10
• Sun Sensor & Elect.	1	1	1	1	1
• Star Tracker	2	0	20	10	0
RF Subsystem					
• Receiver	2	7.9	7.6	7.6	7.6
• Transmitter	2	0	24	24	24
• Power Amplifier	2	0	0	58	0
Mechanisms					
• S/A Trim Tabs	6	0	0	0	0
• Trim Mass Motors	6	0	0	0	0
EPS					
• PCDU	1	15	15	15	15
• Battery	1	0	0	0	0
S/C Heater Power		0	57.5	23.5	90.5
Instrument					
• Electronics		0	0	99	0
• Operational Heater		0	0	80	0
• Survival Heater Feed		0	20	0	60
Subtotal by Operational Phase		47.7	201.6	352.2	232.2
(50% Instrument Margin)		0.0	10.0	89.5	30.0
(25% Design Margin)		11.9	45.4	43.3	43.1
Totals w/ Margins		59.7	257.0	485.0	305.3

Trade Studies

- NiH_2 vs. Li-Ion Battery – Which Is Best Suited for FAME's Power/Mass Requirements?
- Spare Battery Cell – Is It Needed and, If So, How Does It Get Implemented?
- Body Mounted Solar Array Panels for GTO and Initial Orbit – Is Implementation Feasible? What Are the Savings/Benefits vs. Only Deployed Solar Arrays?
- PCDE Box Design – Is Design Based on the NRL Standard Box the Best or Is a Clementine Type Design Preferable?
- Trim Tab Stepper Motors vs. Precession Trim Heaters – Which Is the Best Method to Control Spacecraft Precession? Decision Will Drive EPS Controller Design
- Load Protection/Load Switching – Are Space Qualified Solid State Controllers Available That Could Replace Fuses and/or Electromechanical Relays?

Issues

- **Switching Solar Array Strings, Leaving Excess Energy at the Solar Array Panels – Does This Cause Problems for the Instrument/Experiment That Is Not Presently Recognized?**

- **EPS Redundancy – Are Redundant Circuits Desirable in Any Part of the EPS? Battery Charge/Solar Array Control? Motor Drive?**

Top Level Schedule

- Parts Orders That Could Impact Overall Schedule
  - Solar Array
  - Battery Cells
  - DC-DC Converters