Alpha Magnetic Spectrometer - 02
(AMS-02)
Critical Design Review

Avionics Overview

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L O C K H E E D M A R T I N
Space Operations

Contents

- Power Distribution
  - Power Distribution Box
  - Cryomagnet Avionics Box (and associated hardware)
    - Cryomagnet Current Source (CCS)
    - Cryomagnet Self Protection (CSP) and Uninterruptible Power Source (UPS)
    - Cryomagnet Dump Diodes (CDD)
  - Cryo Cooler Electronics Box (CCEB)
- Interconnect Diagrams
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  - ISS
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- AMS Data Overview
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  - Science Data
- Resource Requirements
- Testing
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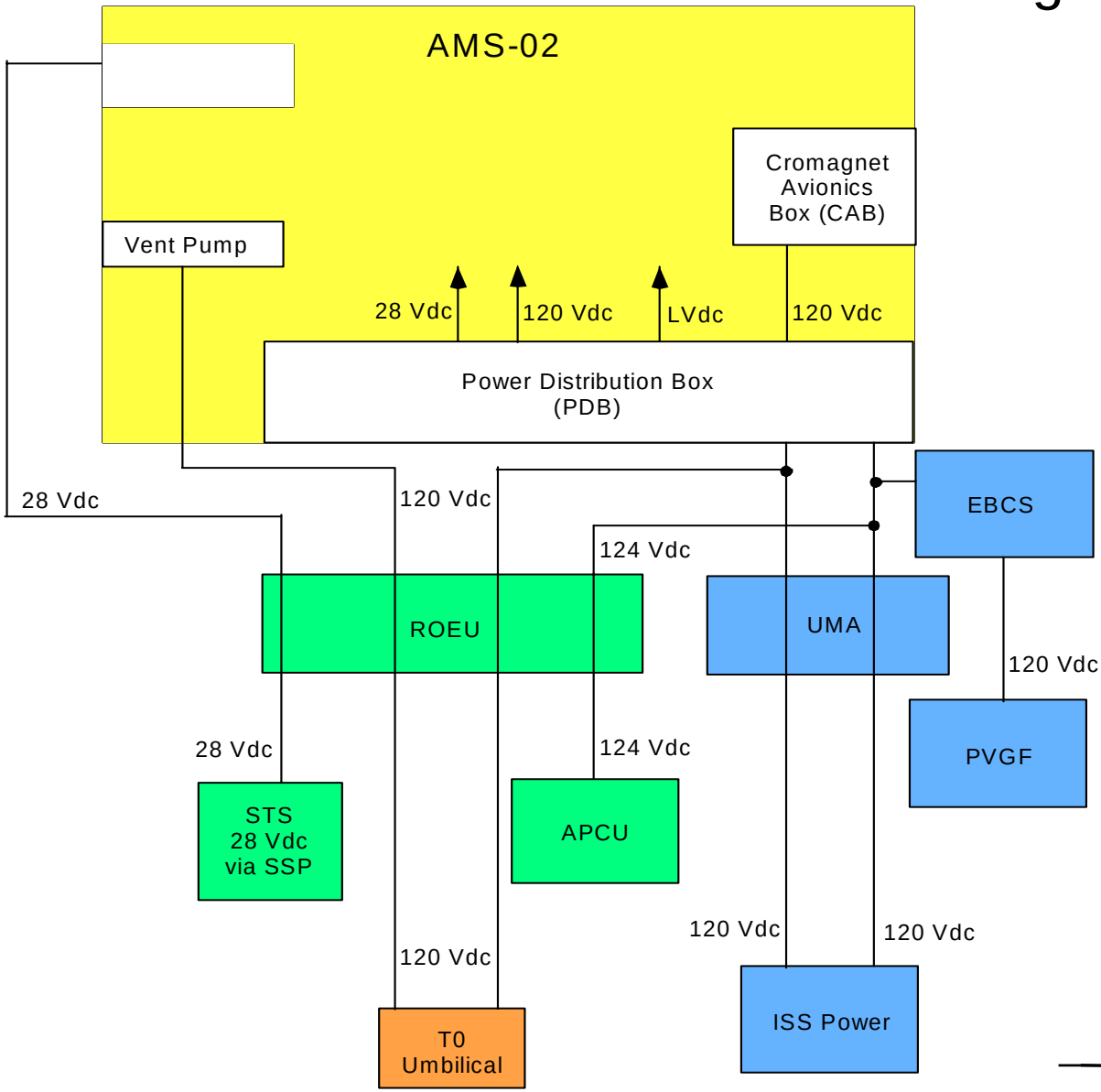
  - Power
  - EMC

Power Distribution

- Payload will meet 1 Megohm isolation requirement
- The AMS Power Distribution Box (PDB) serves as the primary ‘front end’ for power distribution to the subsystems/sensor packages
  - Wire sizing is designed to meet NSTS 1700.7B, "Safety Policy and Requirements For Payloads Using the Space Transportation System", NSTS 1700.7B ISS Addendum, "Safety Policy and Requirements For Payloads Using the International Space Station", and NASA Technical Memorandum #TM 102179, "Selection of Wires and Circuit Protection Devices for NSTS Orbiter Vehicle Payload Electrical Circuits"

AMS-02 STS Power Distribution Block Diagram



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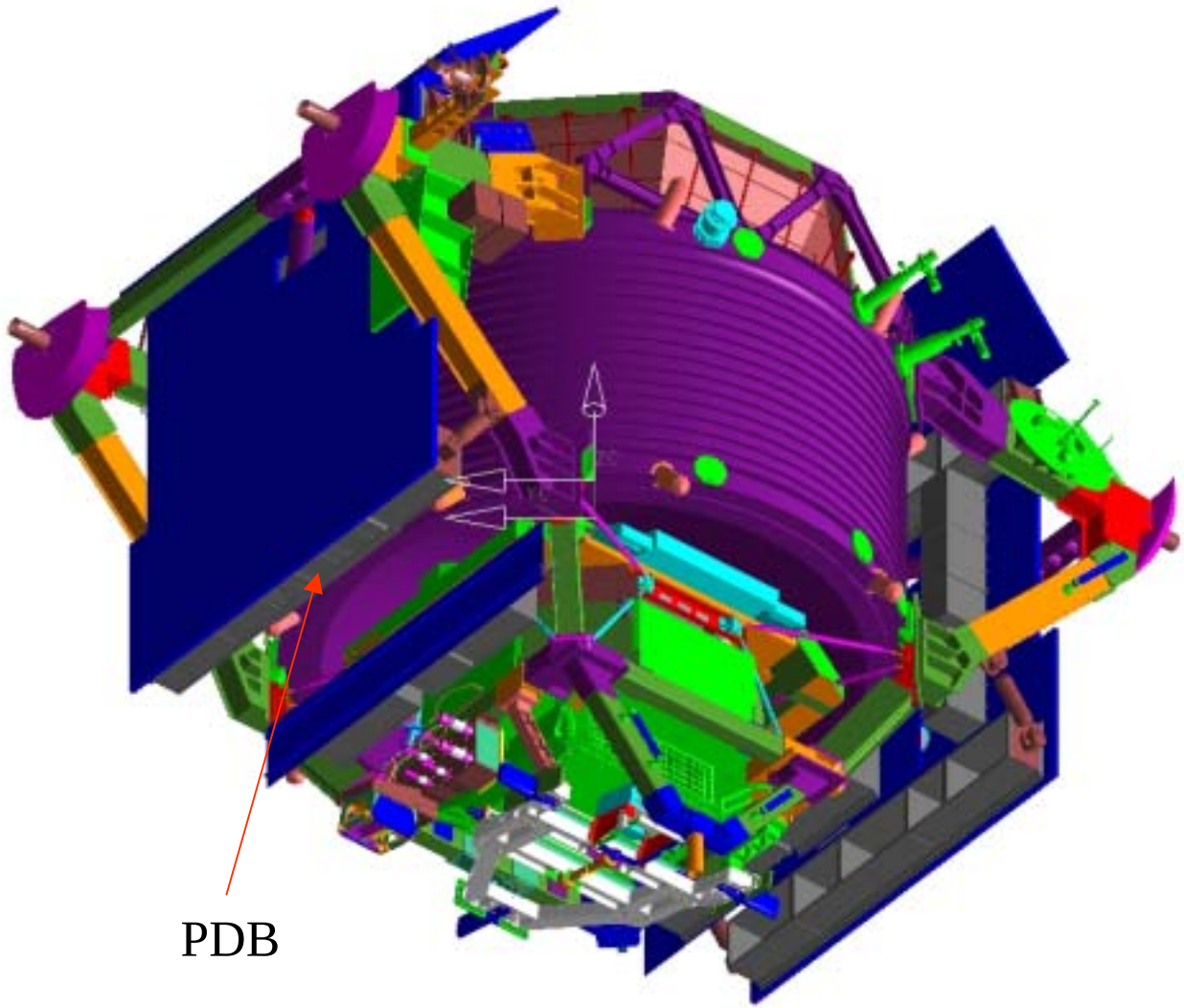
Power Distribution Box

- PDB consists of four sections:
  - 124 Vdc Input
  - 124 Vdc Output
  - 28 Vdc (Isolated) Output
  - Control and Monitor (Isolated Low Voltage)
- All 124Vdc outputs isolation is provided by the end subsystem
- Internal 124Vdc isolation provided by DC to DC Converters

Power Distribution Box

PDB Location



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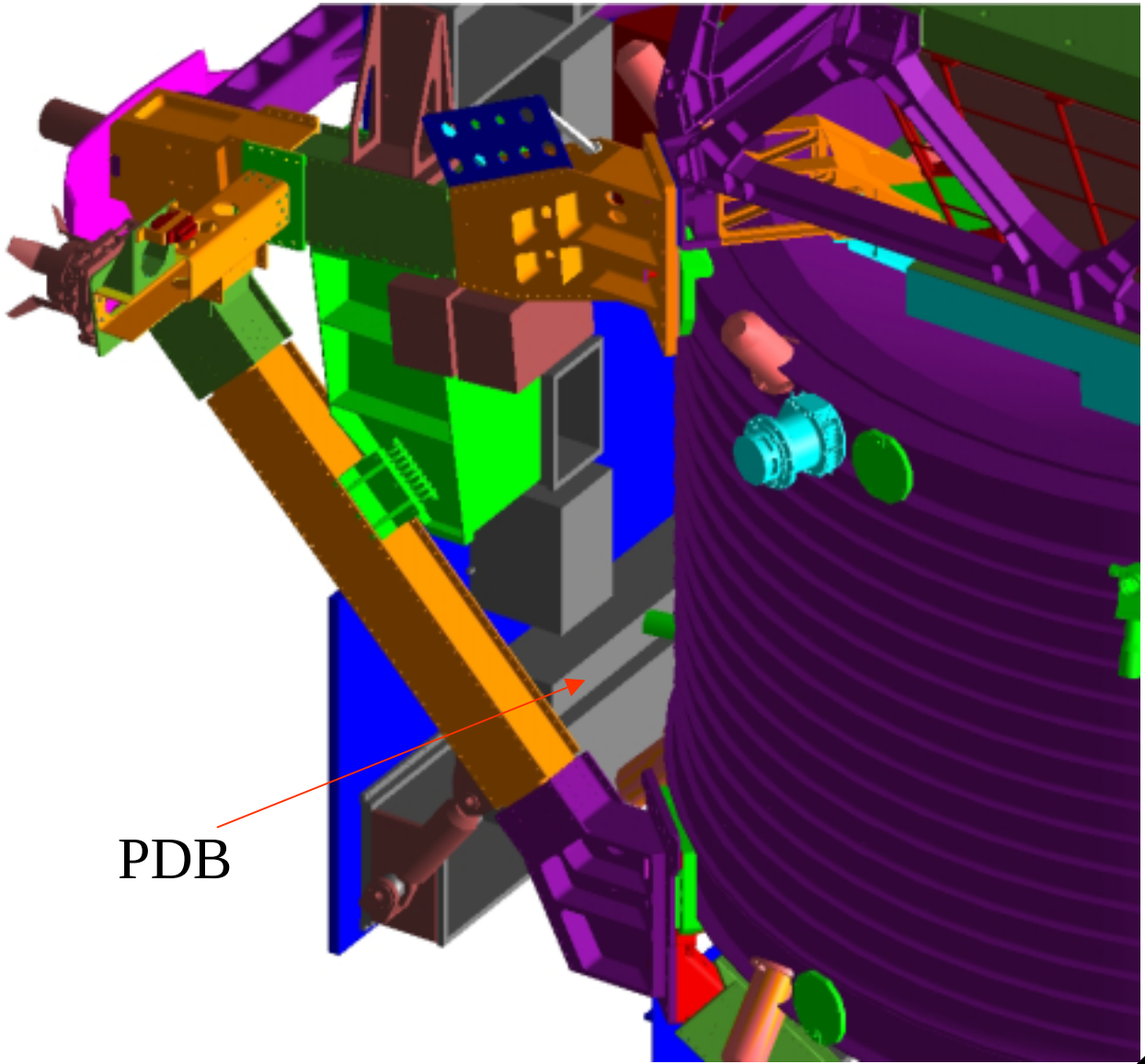

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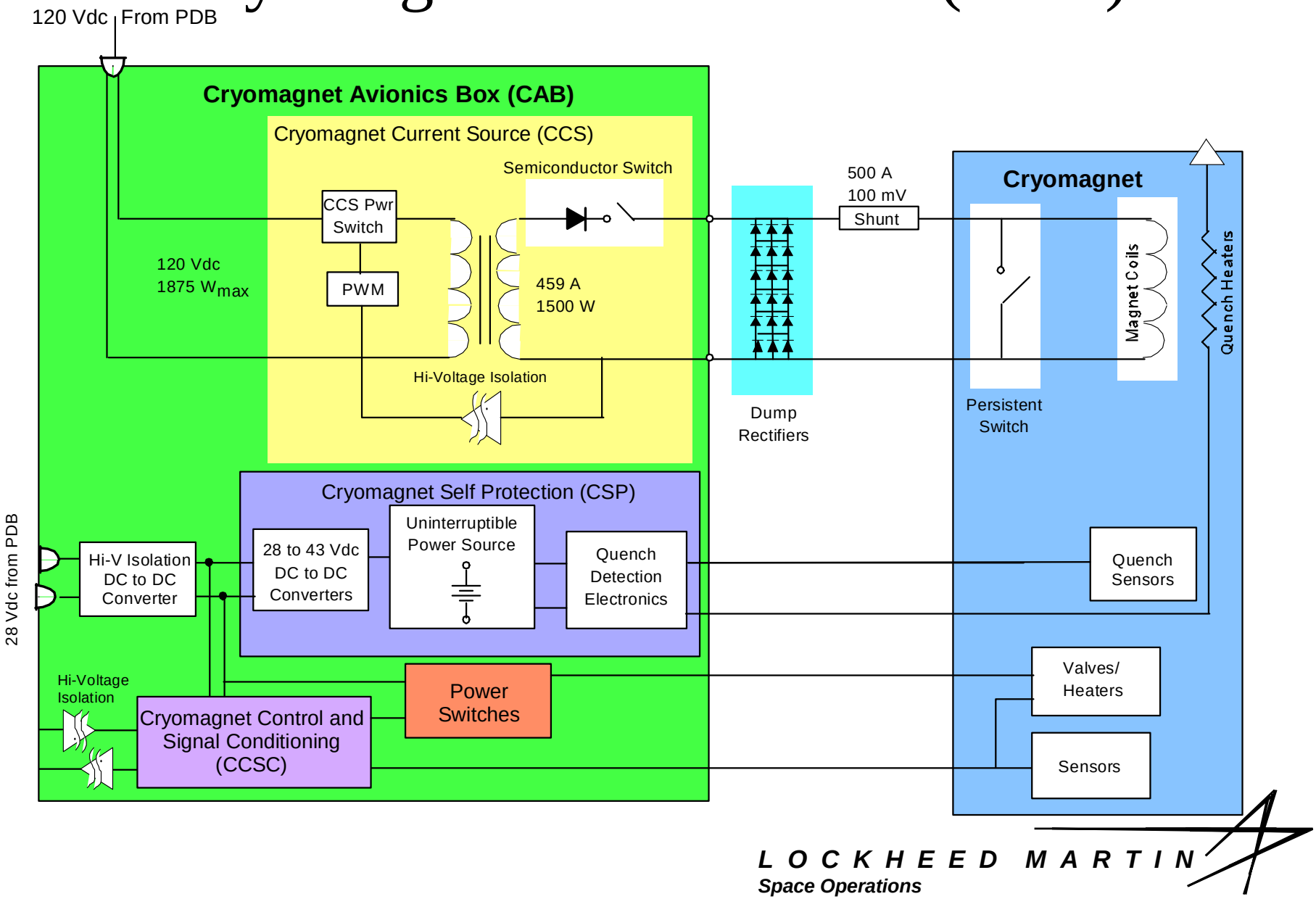
Cryomagnet Avionics Box (CAB)

- The CAB consists of four sections
  - Cryomagnet Current Source (CCS)
  - Cryo Controller and Signal Conditioner (CCSC)
  - Cryomagnet Self Protection (CSP)
  - And, Power Switches
- Magnet Charge/Discharge Circuit consists of:
  - CCS
  - Power Switch
  - Shunt
  - Dump Rectifiers (External to CAB)
  - Magnet Coils
- Isolation for the 124Vdc line (feed thru from PDB) is performed via DC to DC Converters in the CCS

Cryomagnet Avionics Box (CAB)



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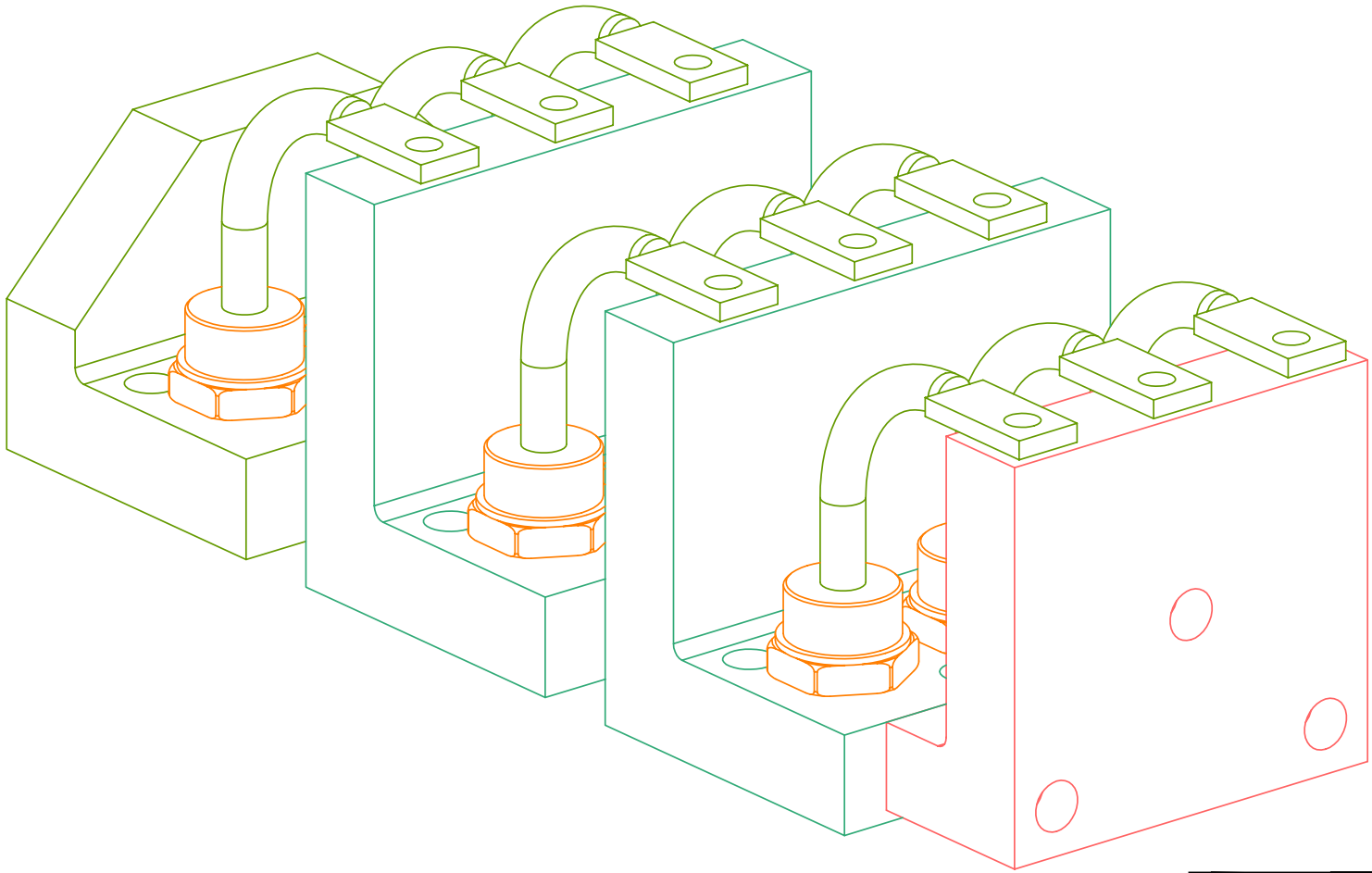
Cryomagnet Dump Diodes (CDD)

- In the event that the magnet must be powered down, the persistent switch will be opened to allow the current in the magnet to be dumped to a bank of 18 rectifiers (six sets in series of three rectifiers in parallel)
- These rectifiers will be protected by a cover to prevent incidental contact
- The rectifiers will be mounted on the two wake-side sill trunnion joints (large thermal mass)

Cryomagnet Dump Diodes (Cont.)

- Worst case thermal analysis reveals that with a continuous load rectifiers will maintain junction temps well below ratings even if one of a parallel series of three fail.
- Dump time is estimated at 80 minutes

Cryomagnet Dump Diodes (Cont.)



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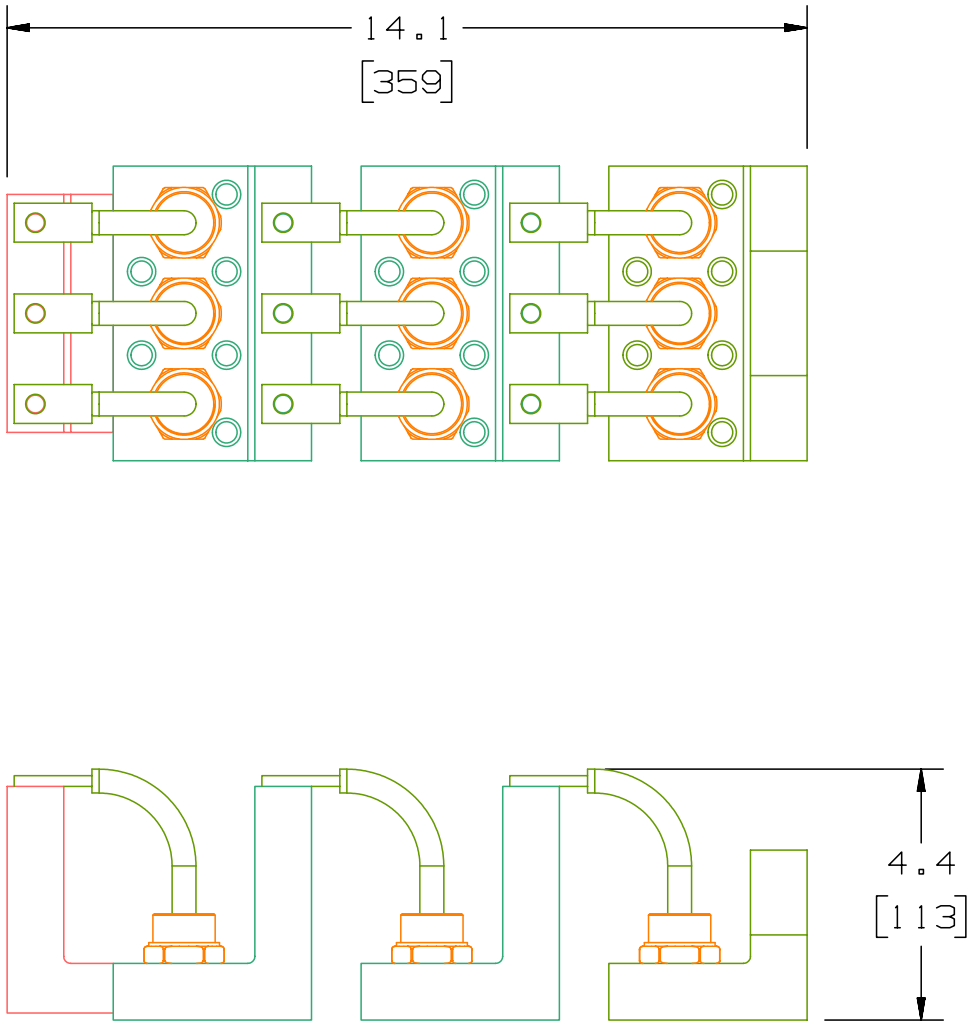
Cryomagnet Dump Diodes (Cont.)



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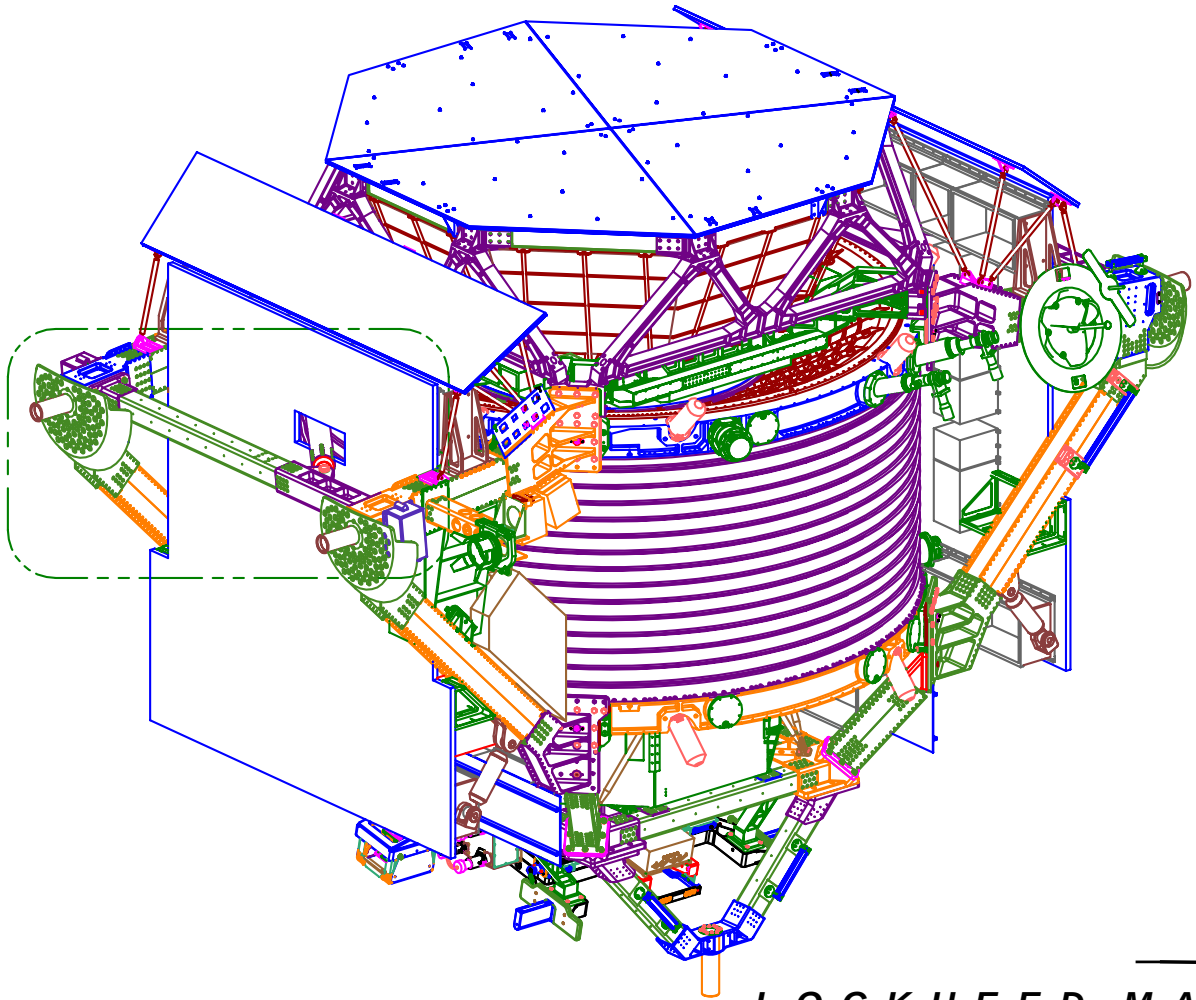
Cryomagnet Dump Diode Mounting Locations



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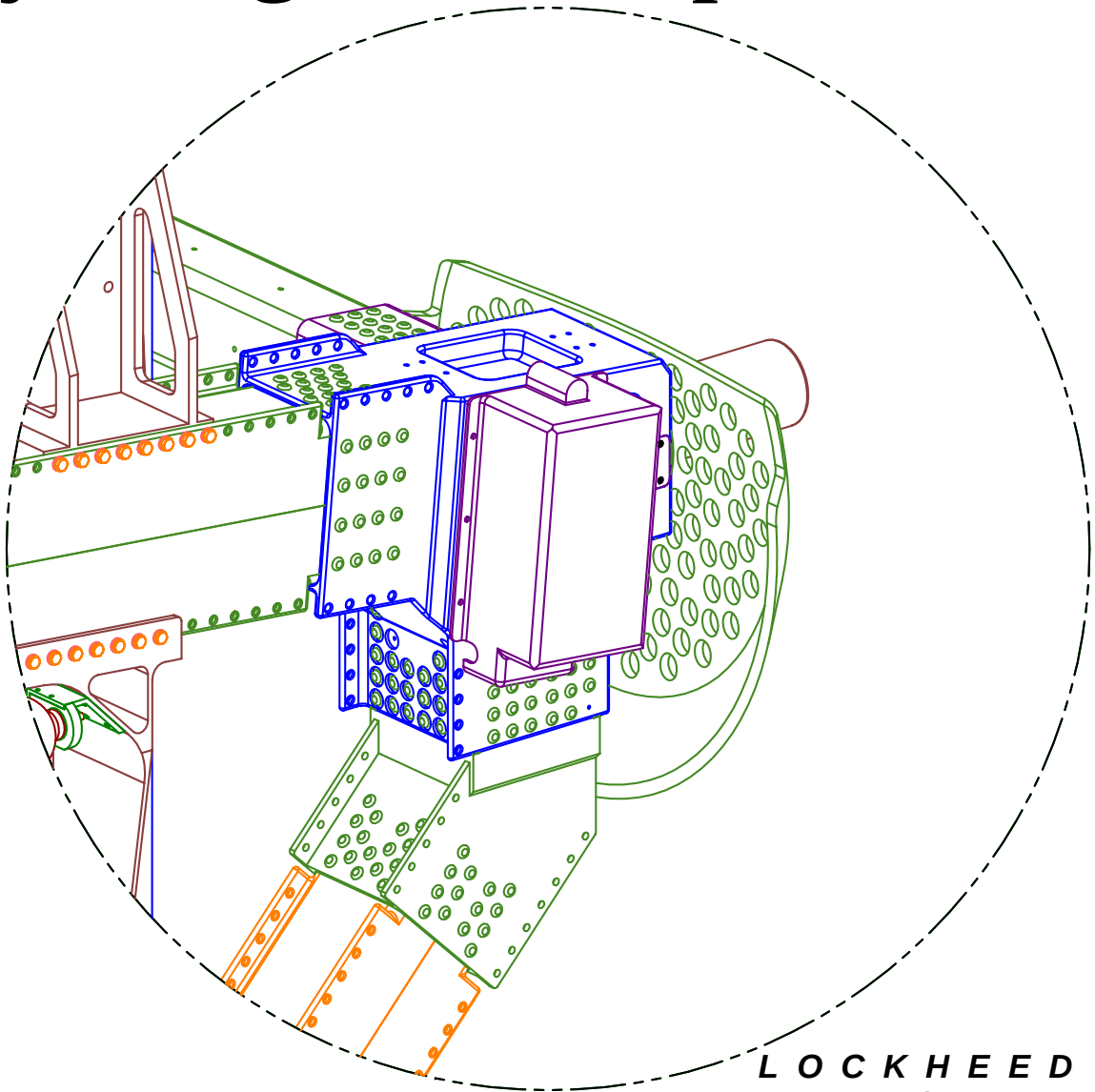
Cryomagnet Dump Diode Cover



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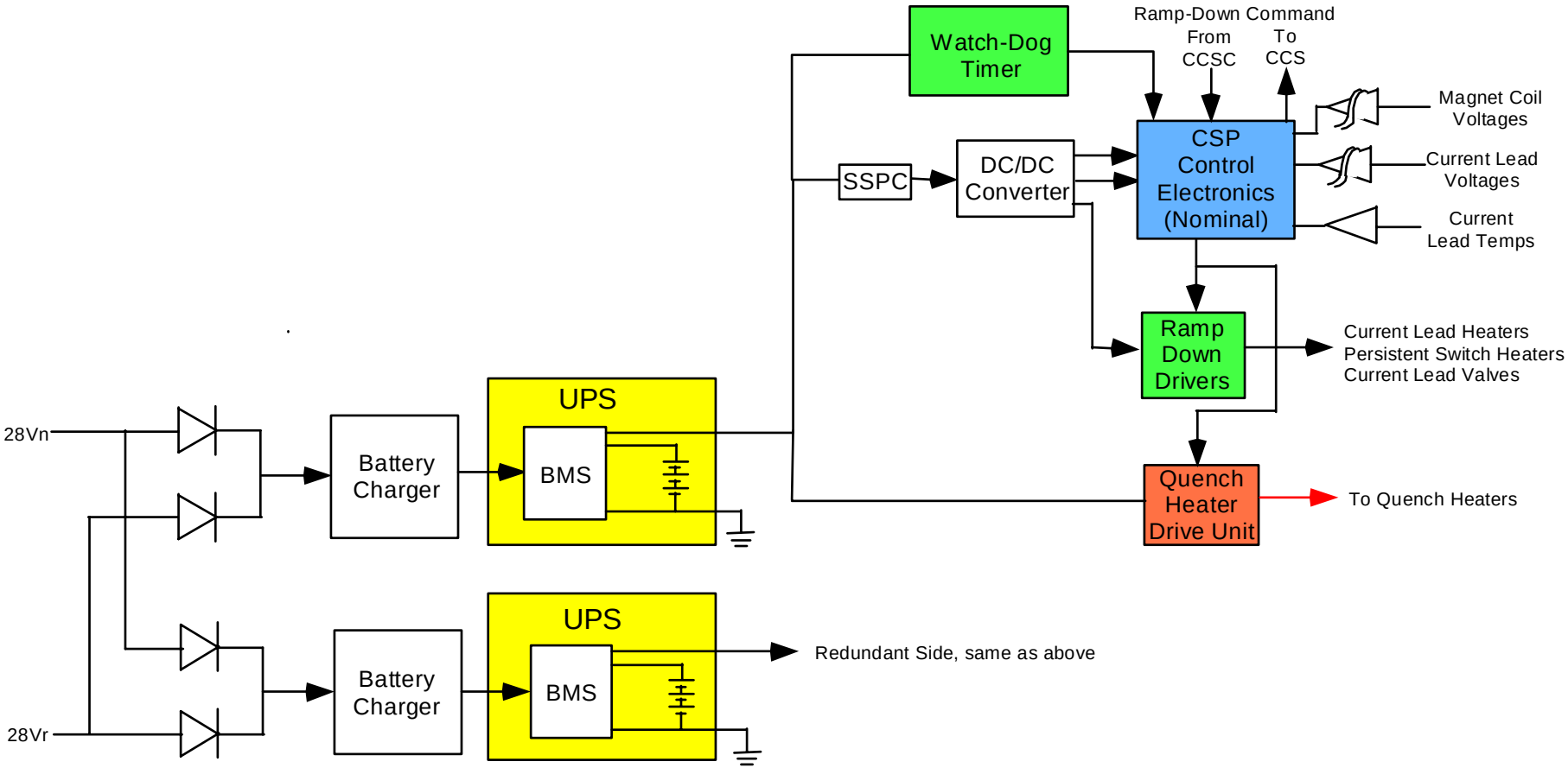
Cryomagnet Self Protection (CSP)

- Designed for mission success purposes only, no safety hazard
- CSP circuitry is designed to identify a quench condition in any individual coil and quench entire magnet evenly
- Redundant heater chains routed to alternating coils (either chain sufficient to quench magnet)
- Protects magnet by ensuring no magnet conductor deformation due to isolated heating, which could result in degraded performance
- The magnet structure will remain safe even if CSP circuitry does not function

CSP Functional Block Diagram



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Uninterruptible Power Source (UPS)

- The UPS will consist of a redundant set of Lithium-Ion batteries
  - To ensure mission success during loss of ISS power or communication, battery will provide control power to payload
    - Watch-dog timer/control circuit
    - Normal Ramp down function
    - Quench monitoring
    - Initiation of quench, 45A pulse

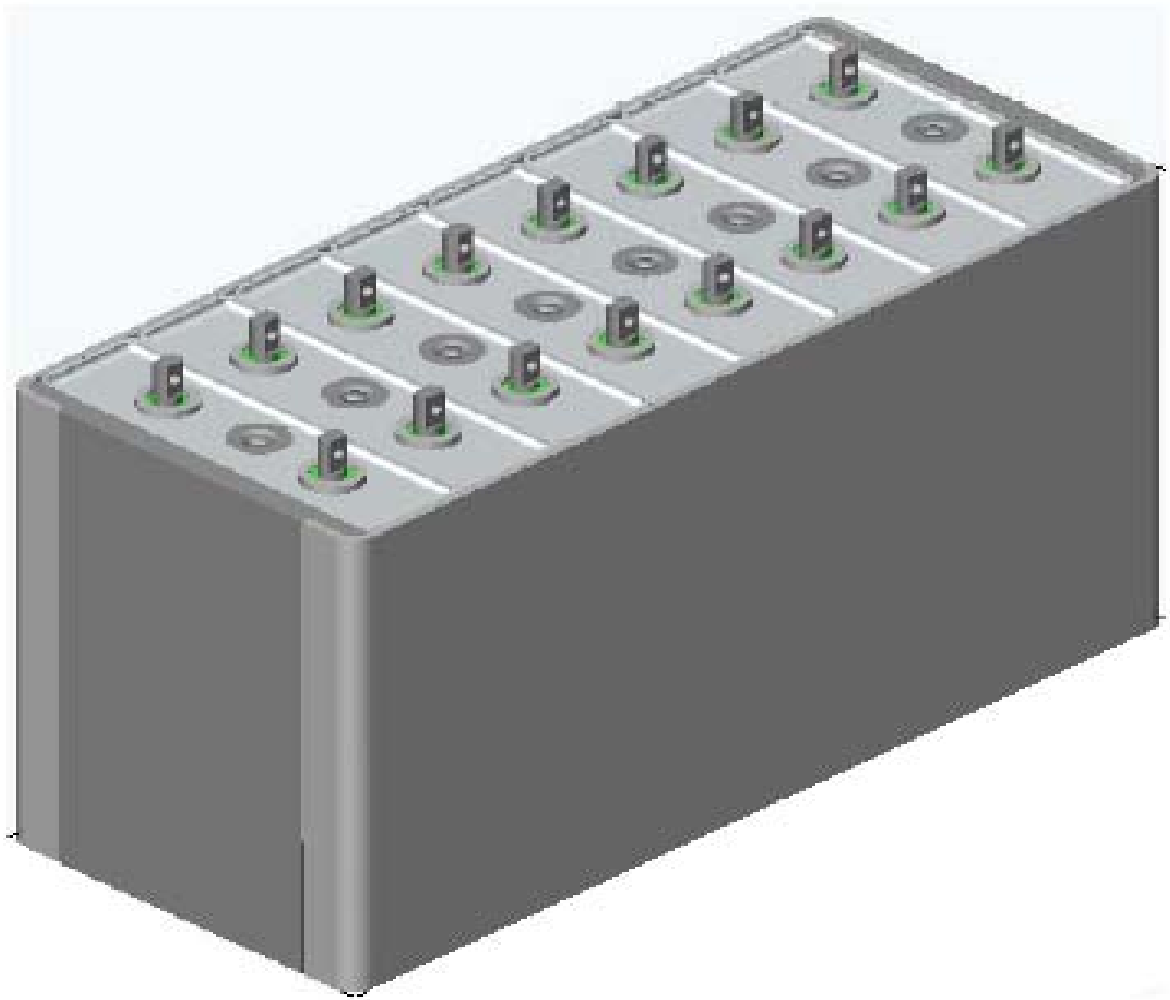
UPS (Continued)

- Battery is designed to meet NSTS 1700.7B, "Safety Policy and Requirements For Payloads Using the Space Transportation System", NSTS 1700.7B ISS Addendum, "Safety Policy and Requirements For Payloads Using the International Space Station", and JSC 20793, "Manned Space Vehicle Battery Safety Handbook“ and will be sized for a minimum of 8 hours of operation, plus ramp-down time

Cell Characteristics

- Manufactured by Yardney/Lithion
  - Prismatic cell
  - Dimensions: 95mm (3.74”) X 27.84mm (1.096”) X 139.7mm (5.500”)
  - Weight: 900g (1.982 lbs)
  - Operational Temperature Range: -30 degC to +50 degC

Battery Configuration



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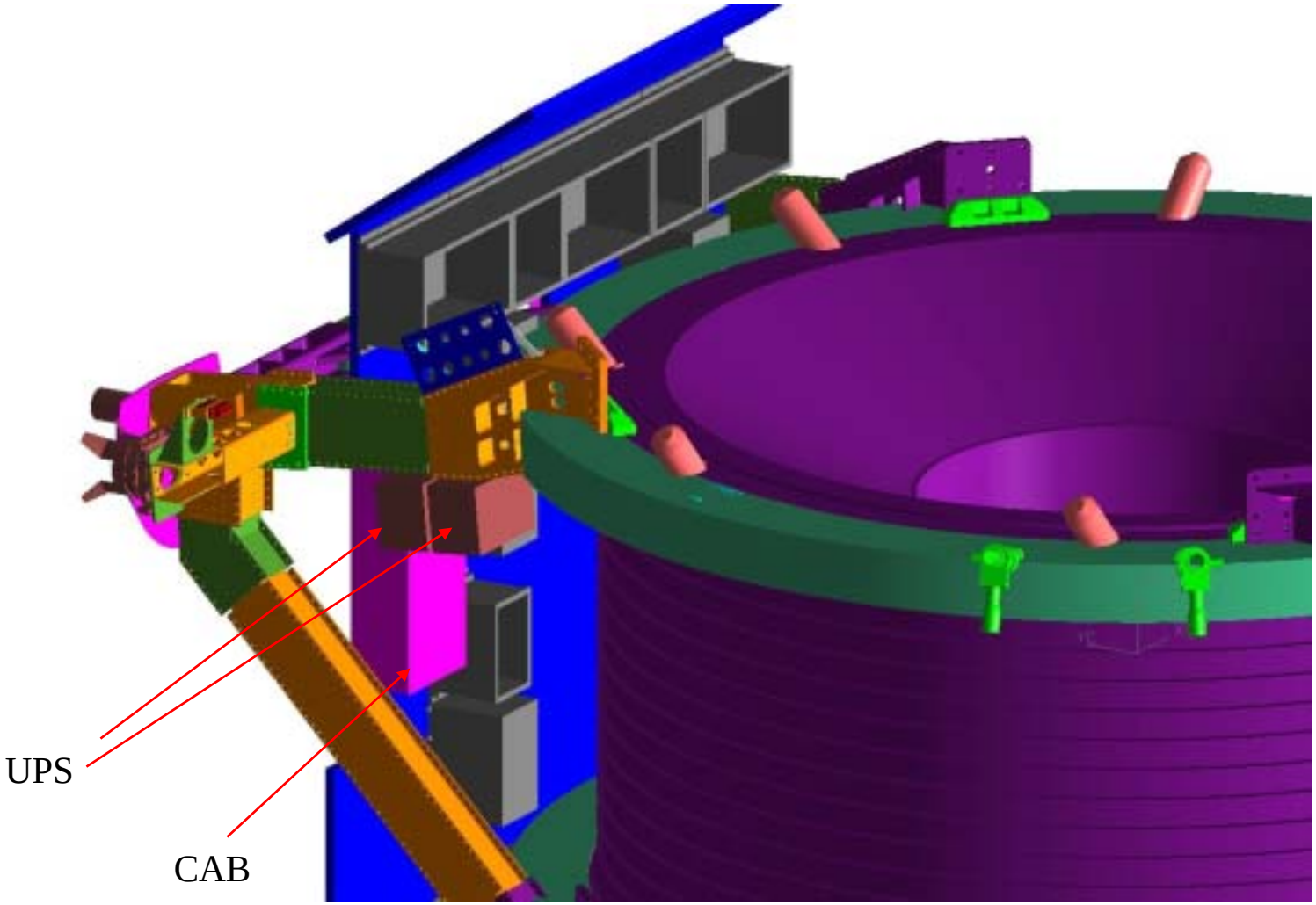
BMS Safety Inhibit Settings

Parameter	Software Limit	Software Delay	Hardware Limit	Hardware Delay
Over-charge	4.2V/cell	2-3 seconds	4.3V/cell	100 μsec
Over-discharge	2.5V/cell	3-4 seconds	2.15V/cell	200 μsec
Over Temperature	80 degC	3-4 seconds	None	None
Over Current	80A	2-3 seconds	170A	100 μsec

CAB and UPS Mounting Locations



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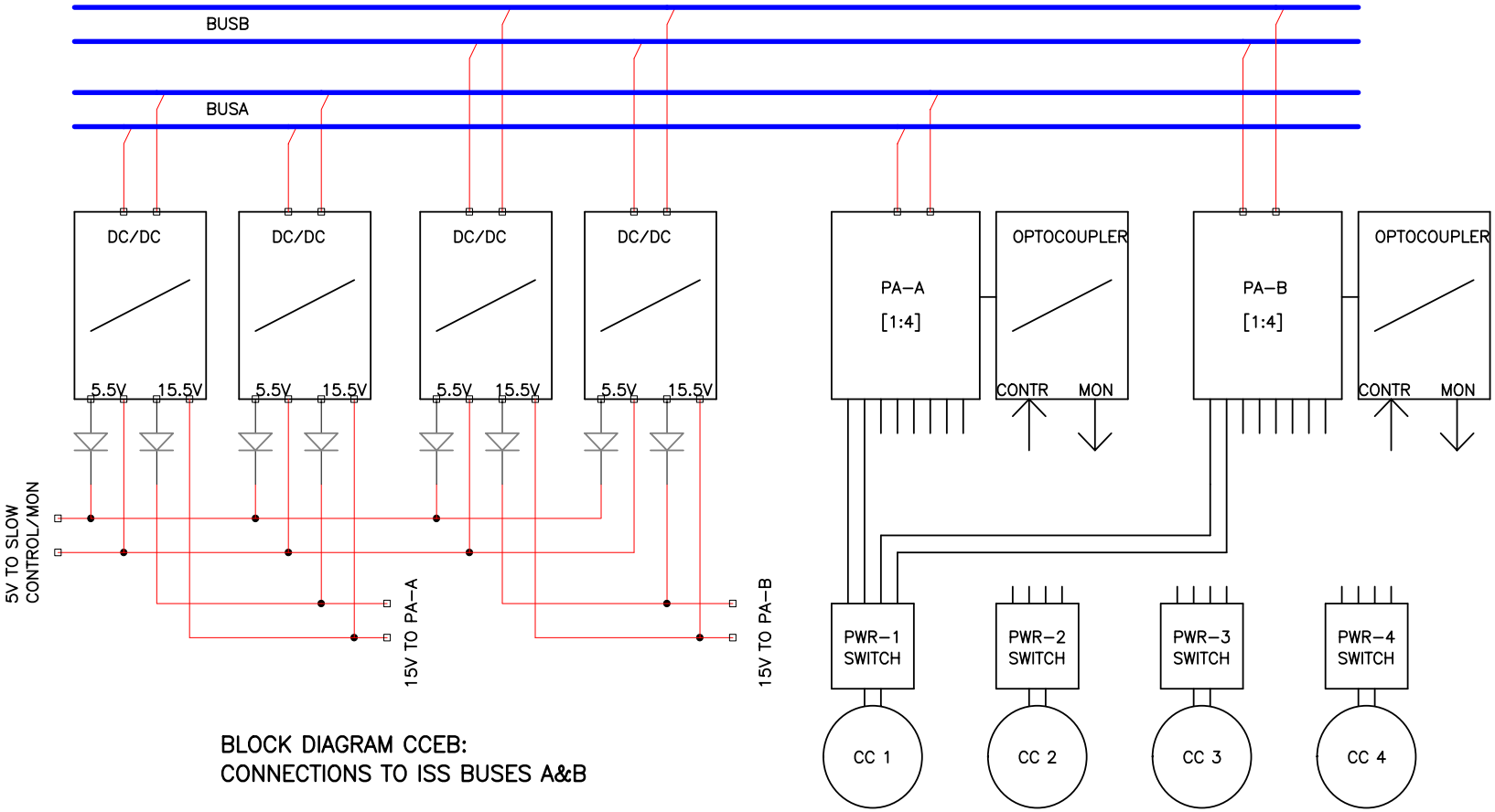
Cryo Cooler Electronics Box (CCEB)

- 124Vdc Bus Isolation provided by relays
- Over current protection provided by dedicated circuitry in all 8 power amplifiers
- Circuit protection provided by SSPC in PDB and fuse (TBR) in CCEB

Cryo Cooler Electronics Box (CCEB)



BLOCK DIAGRAM CCEB:
CONNECTIONS TO ISS BUSES A&B

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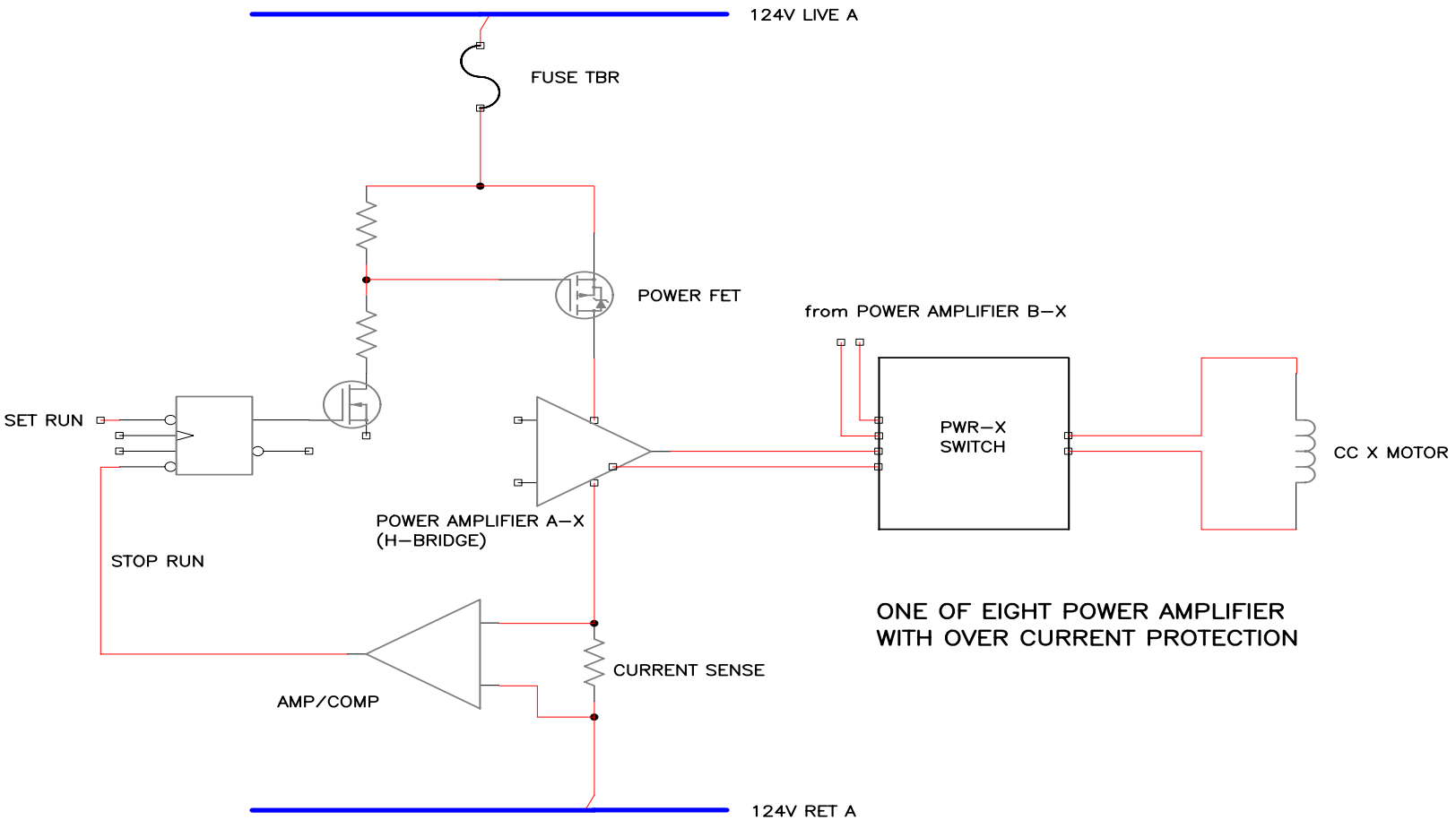
Cryo Cooler Electronics Box(CCEB)



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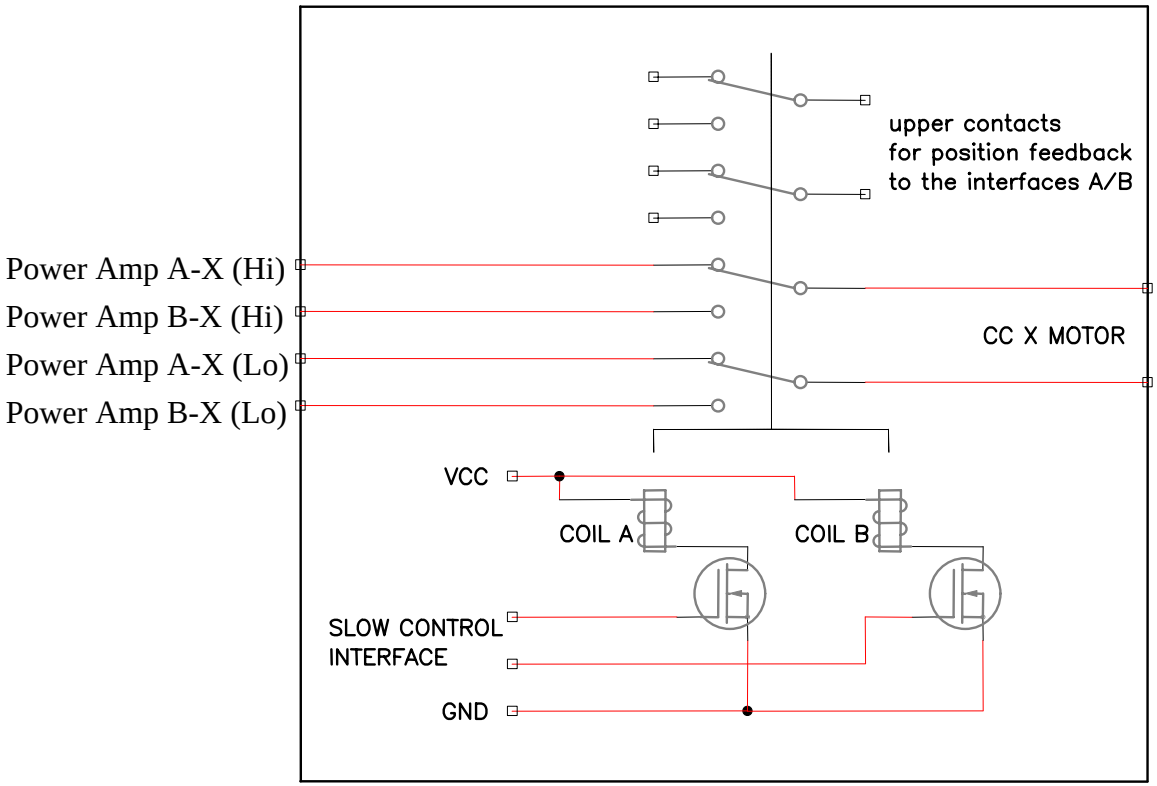
Cryo Cooler Electronics Box(CCEB)



PWR–X–SWITCH: LATCHING RELAY, 4 SWITCHES

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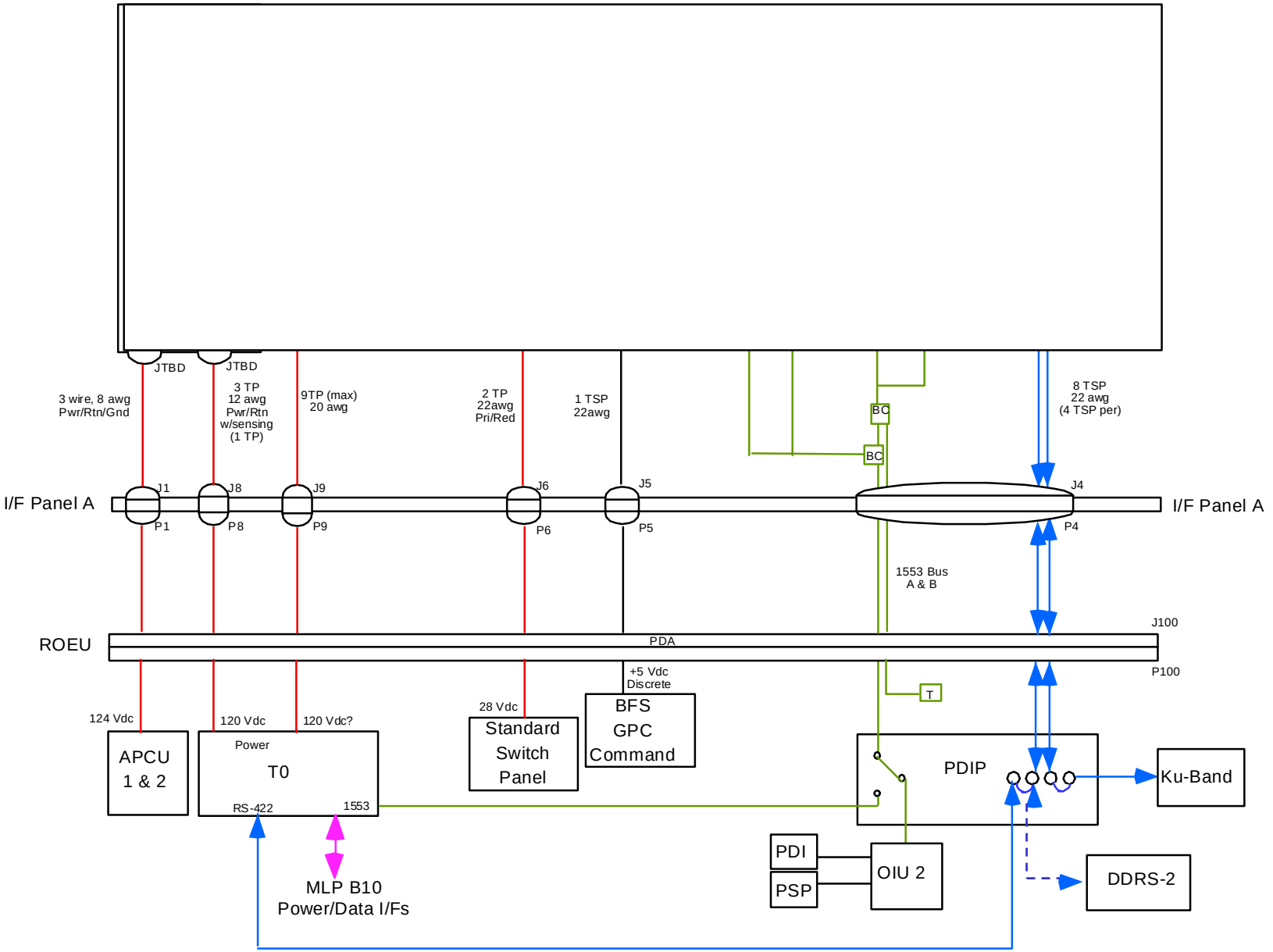
Interconnect Diagrams



Pad & STS Interfaces Interconnect Diagram

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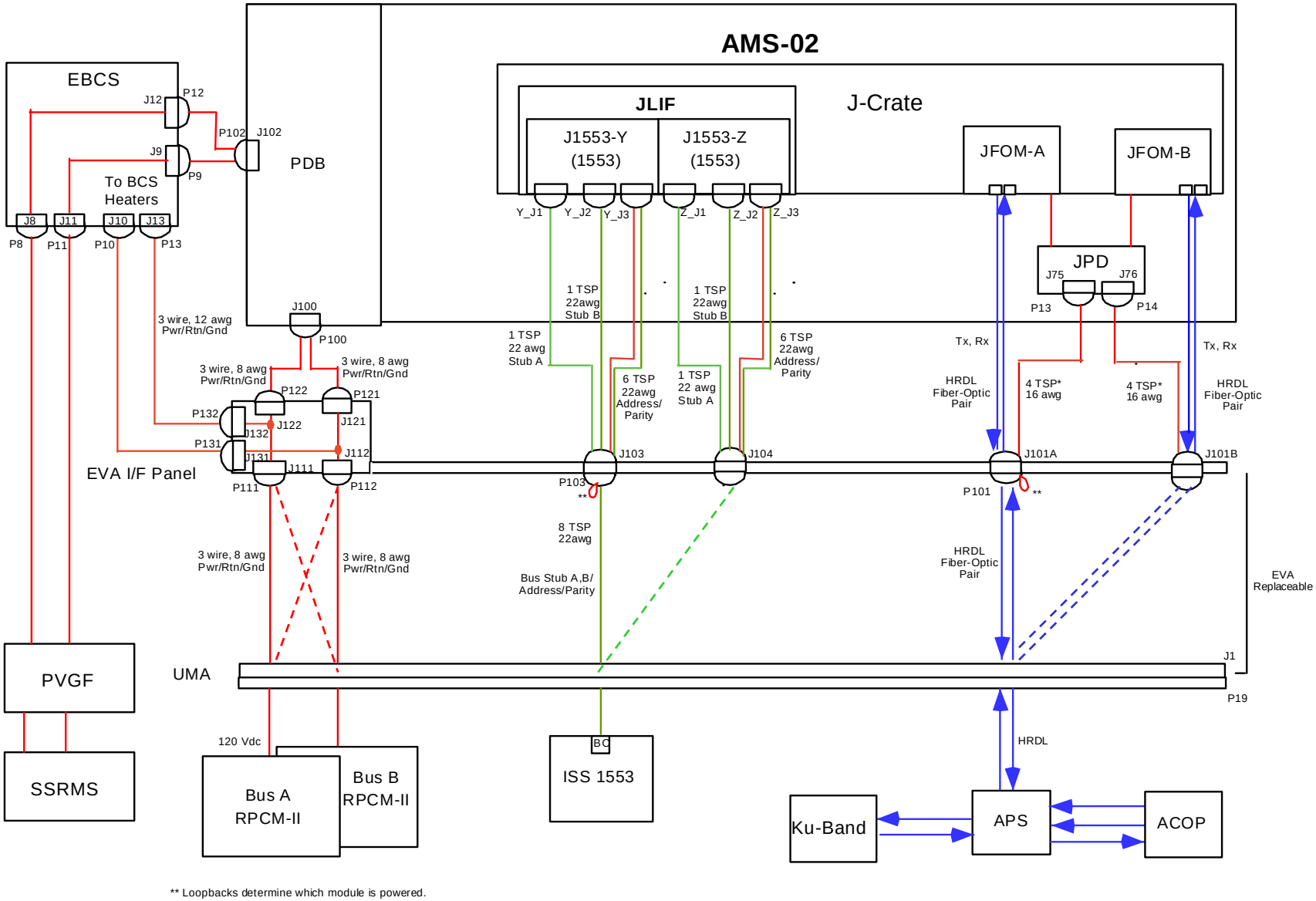

** Loopbacks determine which module is powered.

ISS Interfaces Interconnect Diagram

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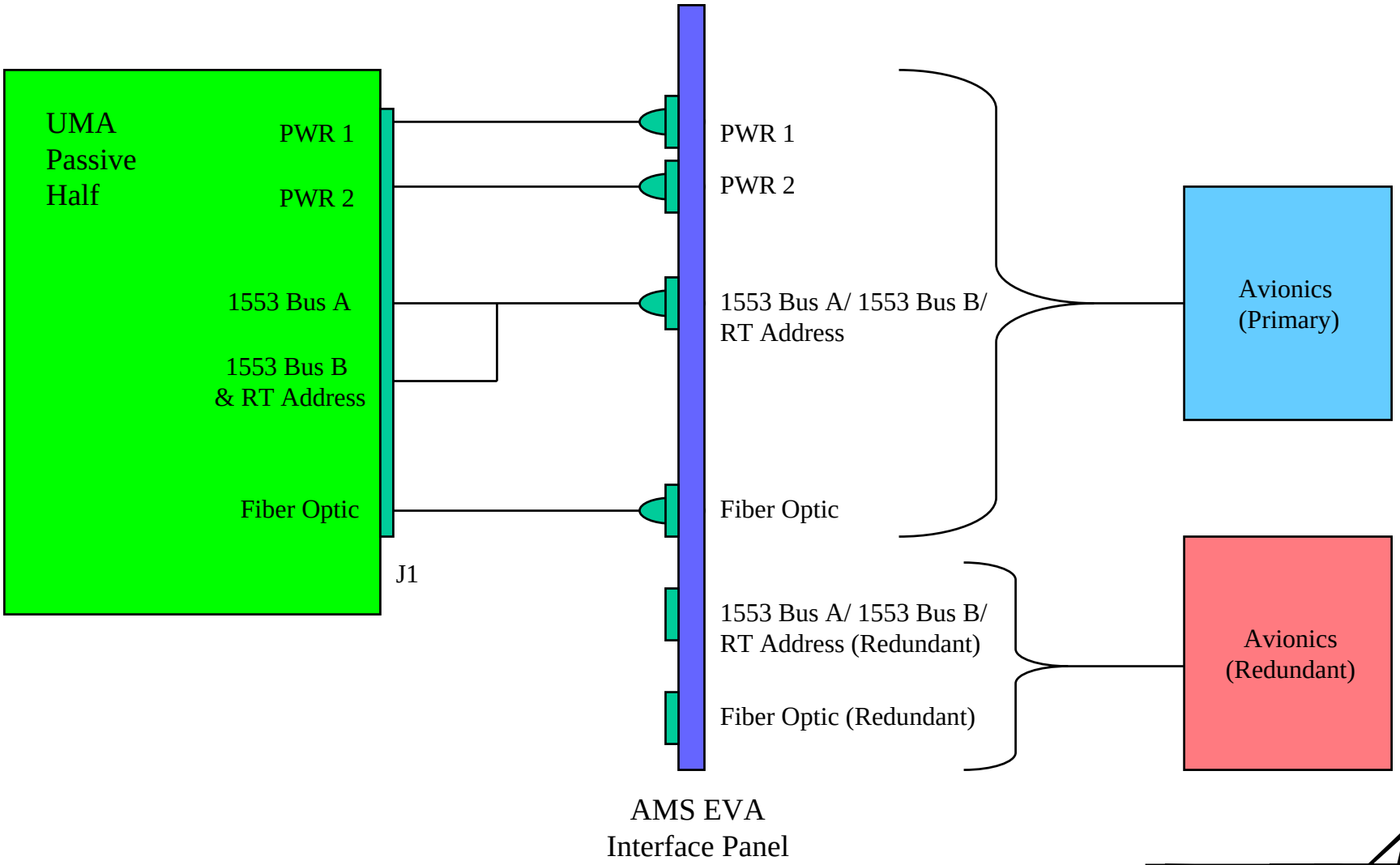
Passive UMA EVA Connector Layout



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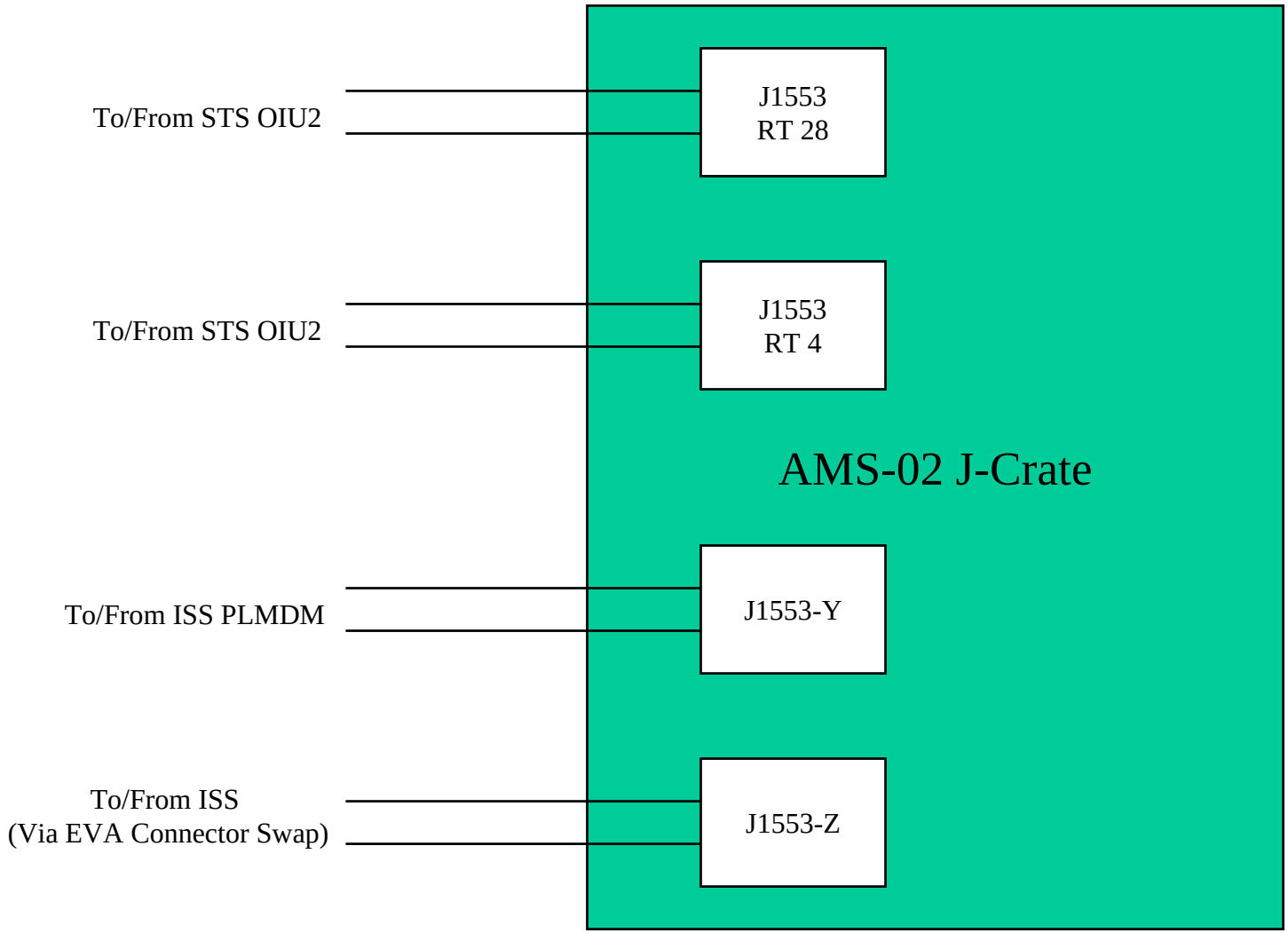
Data Overview

1553 Interface Block Diagram



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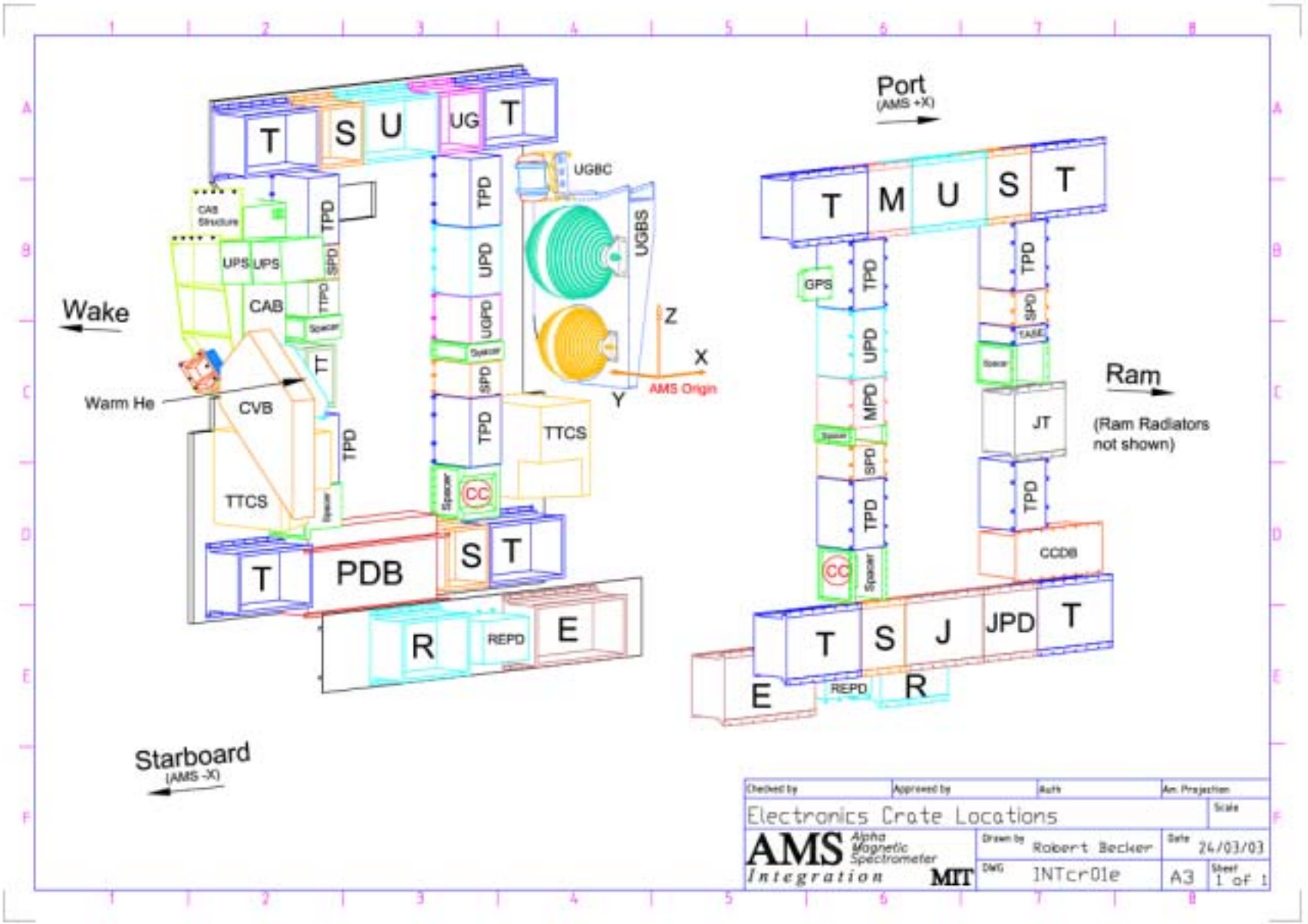
1553 Interface Architecture

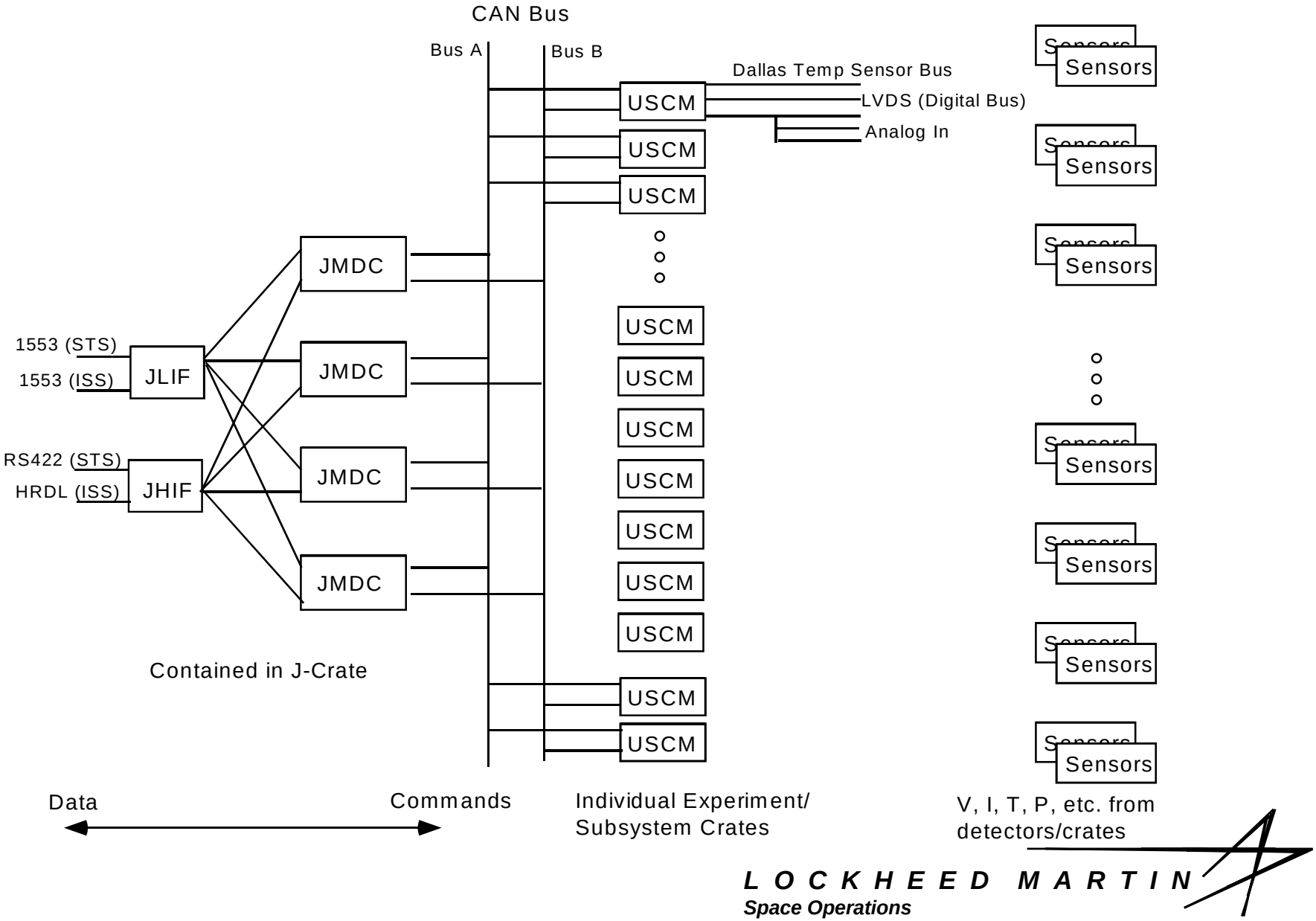
- Separate 1553 Interfaces for STS and ISS
- STS interface includes two Remote Terminals (RTs), addresses 28 and 4
- ISS interface is somewhat unconventional
  - Electrically only one RT
  - Logically reacts as four 1553 Protocol Engines
    - At start-up, all four in Bus-Monitor mode
    - First command to bring up system is not acknowledged (solely used to select which Protocol Engine goes to RT)

Data System Components

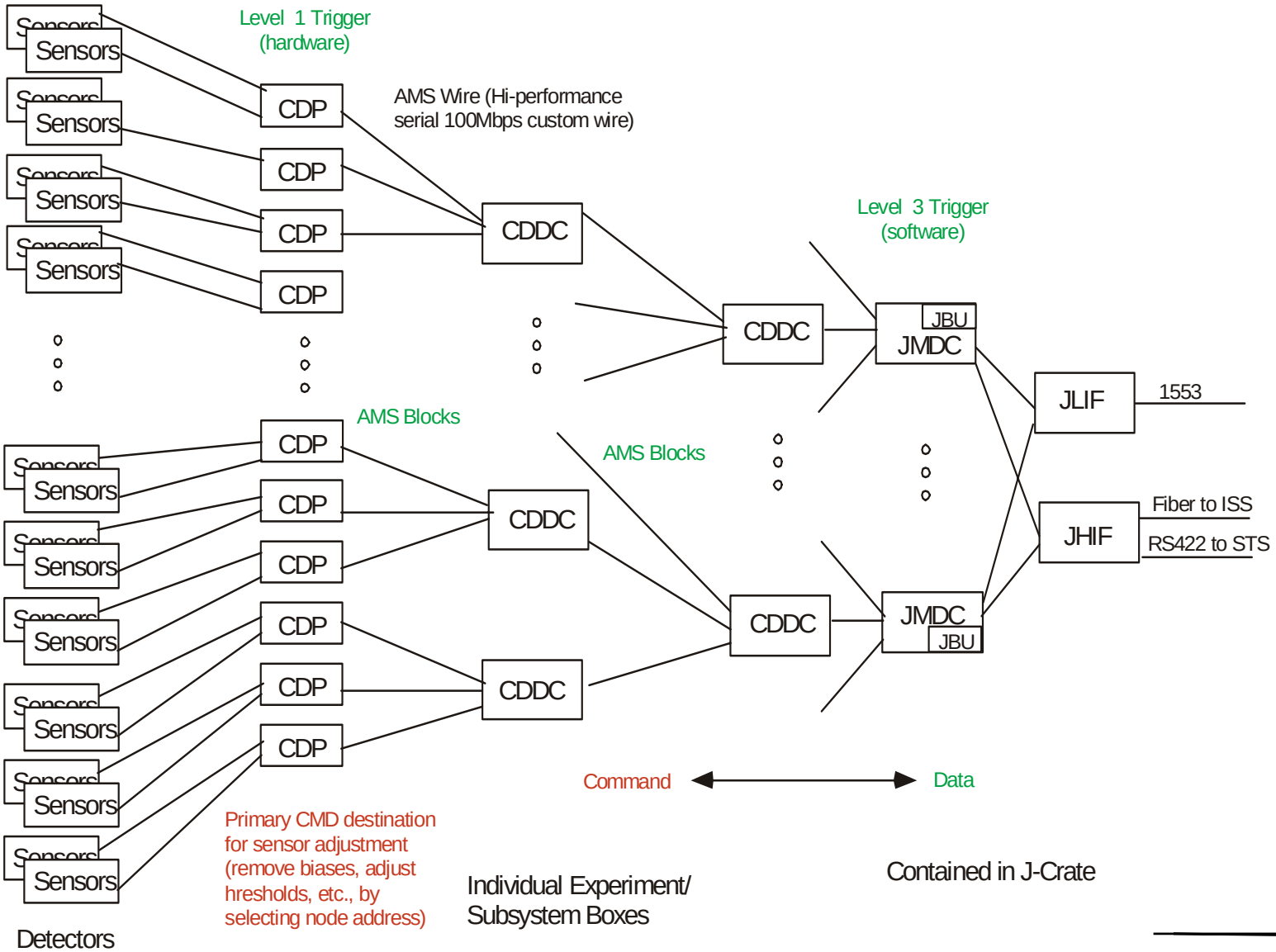
- Crate – Electronics Box
- J-Crate – Performs Top Level DAQ, contains four JMDCs, JLIF, and JHIF
- JMDC – Main Data Computer – Combines Housekeeping data and Science data for distribution, performs minor processing , combines pieces of event data into complete event, converts CAN and AMS Wire to 1553, RS422, and Fiber, also TRD Gas control and TTCS control.
- JBU – Buffer Unit – Contained within JMDC, 2GB buffer (1GB/hr)
- JLIF – Low-rate data Interface – Transceivers for 1553
- JHIF – High-rate data Interface – Fiber Interface and Transceivers for RS422
- USCM – Universal Slow Control Module – 8051 based CPU and O/S with processing s/w (data gathering and blocking into types)
- CDP – Common Digital Part – Gate Array, DSP, Memory,s/w code to communicate on AMS Wire – performs digitizing, blocking and compression
- CDDC – Command Distributor/Data Concentrator – Reads CDP queue/combines pieces of single events, distributes commands to CDPs
- AMS Wire – Hi-performance serial 100Mbps custom wire (similar to ESA Space Wire)
- LVDS – Low Voltage differential signal
- JPD – J-Crate Power Distribution Box


Port
(AMS +X)
Wake
Ram
(Ram Radiators
not shown)
Starboard
(AMS -X)
Warm He
CVB
CAB
TTCS
PDB
UGBC
UGBS
AMS Origin
Z
X
Y
JT
CCDB
REPD
Electronics Crate Locations
AMS
Alpha Magnetic Spectrometer
Integration
MIT
Robert Becker
24/03/03
INTcr01e
A3
1 of 1

Housekeeping Data Overview (equivalent to NASA H&S Data)



Science Data



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Resource Requirements

AMS Resource Requirements

- Power
  - Average 2 kW
  - Max 2.3 kW
- Data
  - Science Data: 2 Mbps (avg)
  - Housekeeping Data: 2 kbps
  - Critical Health Data: 10 Bps

Testing

Data Compatibility Testing

- STEP Testing (May 2003)
- Taxiscope testing (June 2003)
- 1553 RT Validation testing (June 2003)
- APS testing (June 2003)
- OIU Lab Testing
- ESTL testing – RS-422
- PRCU testing at JSC
- PTCS testing at KSC (during on-line processing)
- Orbiter End to End Test

Power Compatibility Testing

- Electrical Power Systems Laboratory (EPSL)
  - Line-to-Ground Resistance & Independent Source Isolation
    - Inrush, Surge, Reverse, and Leakage Currents
    - Steady State Power
  - Current Transients & Steady-state Levels
  - Compatibility with Flight Hardware or Emulators
    - Soft Start/Stop
    - Current Limiting RPC
  - Voltage Range & Transients
    - Normal/Abnormal
    - Ripple Voltage
  - Large Signal Stability
  - Input Impedance / Gain & Phase Margins
  - Common Mode & Input Isolation

EMC Testing

- Conducted Emissions
  - SSP 30237, Rev F
    - CE01, CE03, CE07
- Conducted Susceptibility
  - SSP 30237, Rev F and SSP 30237 SSCN 3282 D.2
    - CS01, CS02, and CS06
- Radiated Emissions
  - SSP 30237, Rev F, RE02
- Radiated Susceptibility
  - SSP 30237, Rev F
    - RS02 and RS03PL (SSCN 3282 PIRN 57003-NA-0023)