GLAST Large Area Telescope

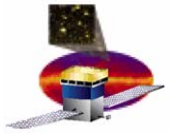
Instrument to Spacecraft Interface Simulator (ISIS) Training

March 2005

Jana Thayer
Stanford Linear Accelerator Center

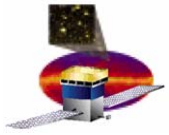
jana@slac.stanford.edu
(650) 926-4956

http://www-glast.slac.stanford.edu/Elec_DAQ/ELX_test/content/isis_documentation.htm



ISIS Training - Agenda

- Overview
- References
- Bringing Up the ISIS
- Command Examples
- More On Commands
- Troubleshooting
- Outstanding Issues
- Summary



Objectives

- **You will be able to—**
  - **Power up the ISIS**
  - **Select appropriate commands and parameters**
  - **Send commands**
  - **Analyze output**
  - **Correct minor errors**
  - **Find more information**

ISIS Training - Overview

- **Overview**
  - **Purpose**
  - **Functionality**
  - **Requirements**
  - **Hardware**
  - **Flight Software (FSW)**
- **References**
- **Bringing Up the ISIS**
- **Command Examples**
- **More On Commands**
- **Troubleshooting**
- **Outstanding Issues**
- **Summary**

Purpose

- **The purpose of the ISIS is to—**
  - **Assist the development of electrical interfaces and LAT (Large Area Telescope) – Spacecraft (SC) interaction**
  - **Provide a high-fidelity simulator of the primary-side LAT instrument**
  - **Present a flight-like hardware and FSW interface for testing and integration of the spacecraft**

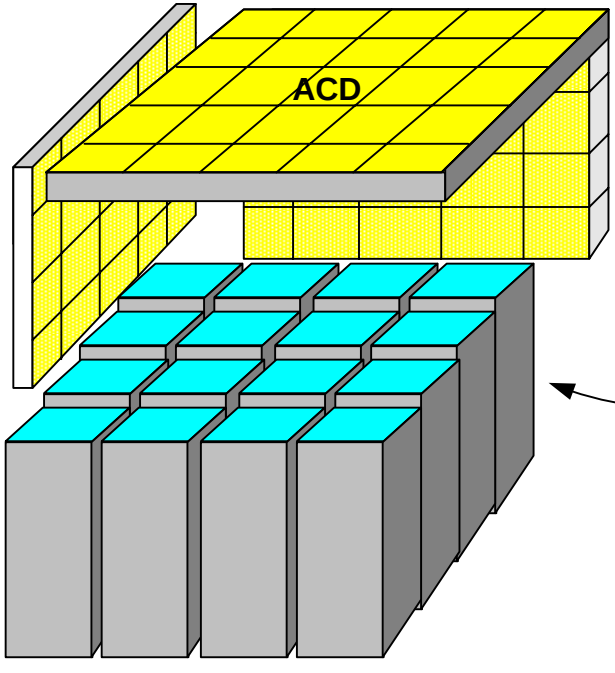
Functionality

- The ISIS provides the following functionality:
  - LAT simulator
    - Power management on the ISIS
    - Power draw
    - Ability to monitor temperatures and voltages
  - ISIS/Spacecraft interface
    - Reset
    - Discretes
    - Science data
  - ISIS/Spacecraft communication
    - Exchange of telecommands and telemetry across 1553

ISIS and the LAT

ACD (Anti-Coincidence Detector)
Not included. Not simulated.

Note: ACD front and right side tiles not shown



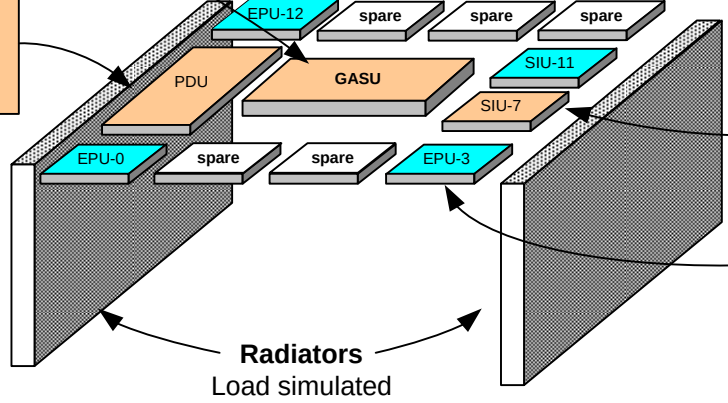
16 Towers
- TEM (Tower Electronics Module)
- TRK (Tracker)
- CAL (Calorimeter)

Load simulated

GASU (Global Trigger/AEM/ Signal Distribution Unit)*

PDU (Power-Distribution Unit)*
- Spacecraft interface, power
- LAT power distribution
- LAT health monitoring

* Primary and Redundant shown in one chassis



2 SIUs (Spacecraft Interface Units)
- SIB (Storage Interface Board): Spacecraft interface, control, and telemetry
- LAT control CPU
- LCB (LAT Communication Board): LAT command and data interface

Only 1 SIU provided.

3 EPUs (Event Processing Units)
Load simulated

Radiators
Load simulated

Requirements Tested

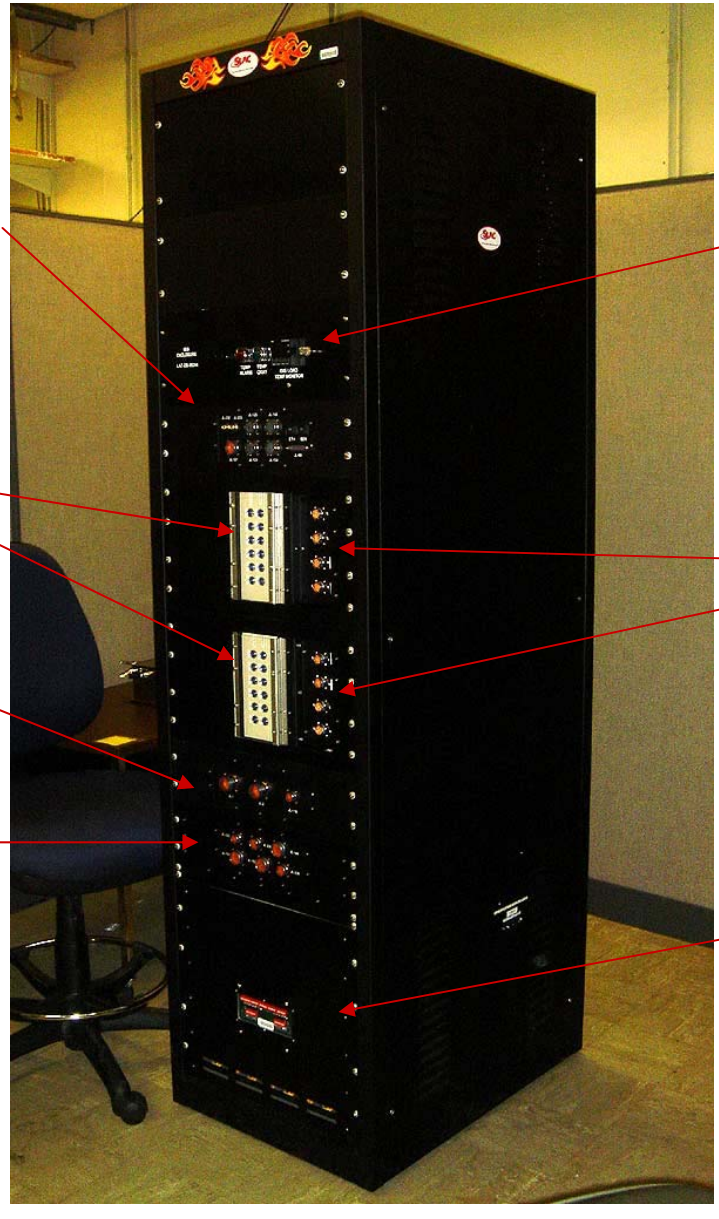
- **1553 Bus Communication/LAT Telemetry**
  - **Alert Telemetry**
  - **Spacecraft Commands**
  - **Routing of Commands**
  - **No-op Commands/Counting of No-op Commands**
  - **Ancillary Commands/Counting Ancillary Commands**
  - **Attitude Commands/Counting of Attitude Commands**
  - **Time Tone Commands/Counting of Time Tone Commands**
  - **Automatic Repoint Requests**
  - **GBM (Gamma-ray Burst Monitor) Signals**

- **Discrete Control**
  - **Output Discrete Lines**
  - **Input Discrete Lines**
  - **Reset Signal**

Requirements Tested (continued)

- Science Data Interface
  - Hardware Interface
  - Science Data Patterns
  - Science Data Rate
  - Science Packet Length
  - Transmission Duration
- CPU Boot Process
- Power
  - Power Control/Power Draw
  - Analog Temperatures/Voltages

Hardware


Connections to SC Simulator:
1553, SSR, and Discretes
Ethernet and Serial
Connections
Heater Loads
Heater
Controls
Power feeds :
SIU (Spacecraft Interface Unit)
PDU (Power Distribution Unit)
Environmental
Simulator
PDU Load Box

Front Panel: Temp Alarms

- LAT-DS-05244: Refers to ISIS Enclosure Assembly Drawing
- Speaker
- TEMP ALARM
- TEMP OKAY
  - TEMP OKAY (Green light) = Good. Normal operation.
  - TEMP ALARM (Red light) = Warning. Overheating.
  - TEMP ALARM (Red light) + alarm = Shut down ISIS now!
- ISIS LOAD TEMP MONITOR

Front Panel: 1553, Discretes, LGIO

- **JL-232, JL-233: 1553 interface**
- **JL-121: SIU/Spacecraft Discretes**
- **JL-125, JL-145, JL-124, JL-138: LGIO (Science Data Interface)**
- **ETH: Ethernet connection**
- **SER: Serial port connection**
- **JL-69: External crate connector (for SLAC debugging only)**

Front Panel: Heater Control (+X)

- **Heater Load Indicators: Lit = heaters on**
- **JL-127, JL-129: Heater Control**

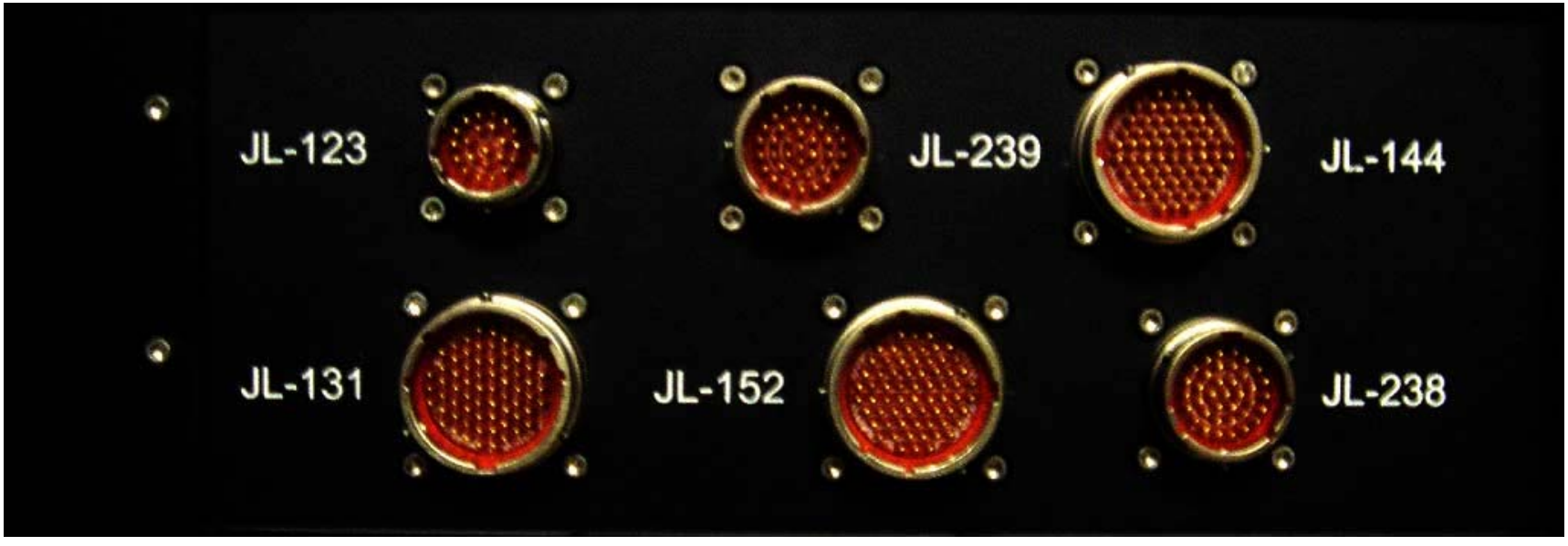
Front Panel: Heater Control (-X)

- **Heater Load Indicators: Lit = heaters on**
- **JL-140, JL-142: Heater Control**

Front Panel: Power Feed

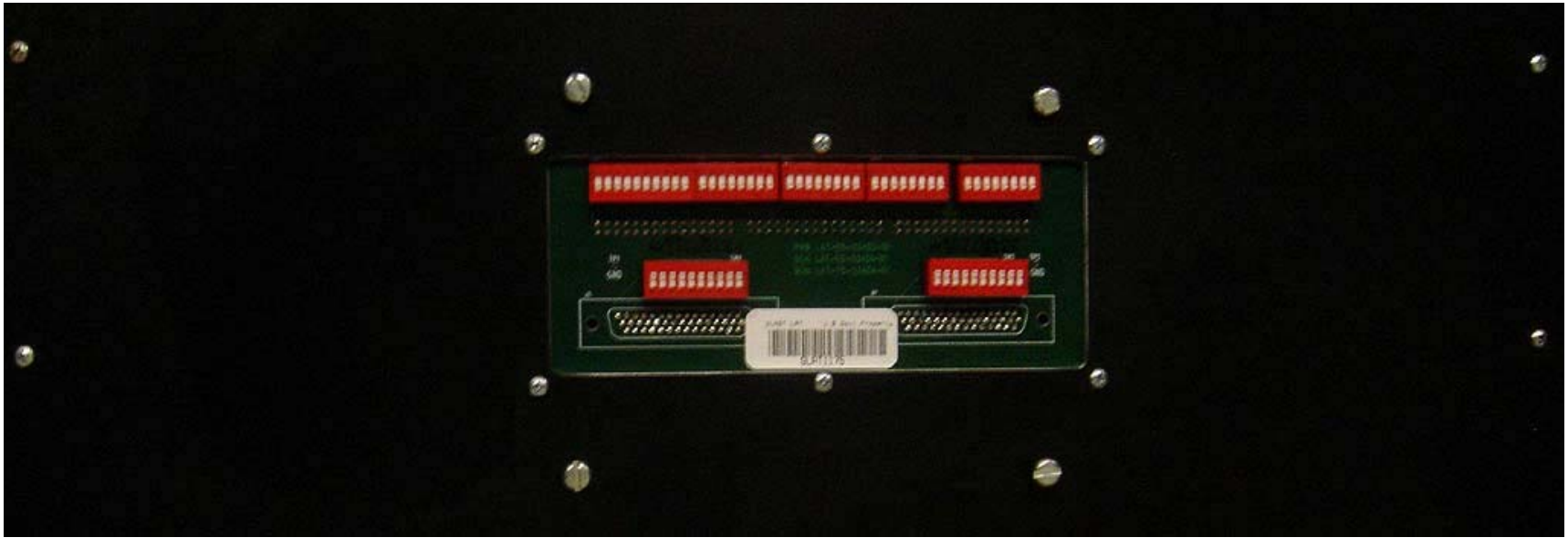
- **JL-1, JL-2: Main Power Feed (primary and redundant)**
- **JL-119: SIU Power Feed**

Front Panel: Environmental Simulator



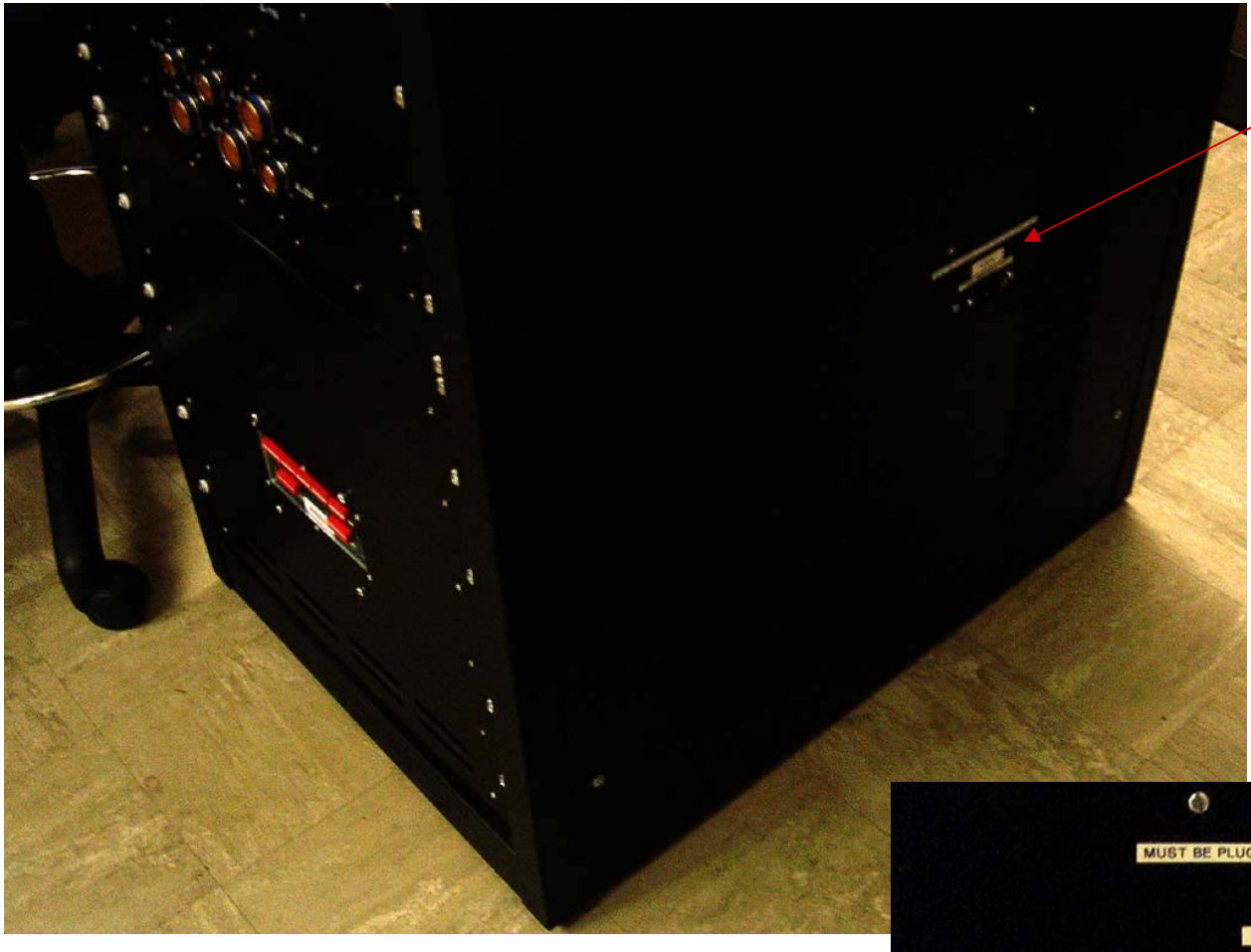
JL-123, JL-239, JL-144, JL-131, JL-152, JL-238: Environmental Simulator

Front Panel: PDU Load Box



- **Backside of PDU Load Box: *Do not touch!***
  - **Switch settings will override commanded power settings**
  - **For SLAC debugging only**

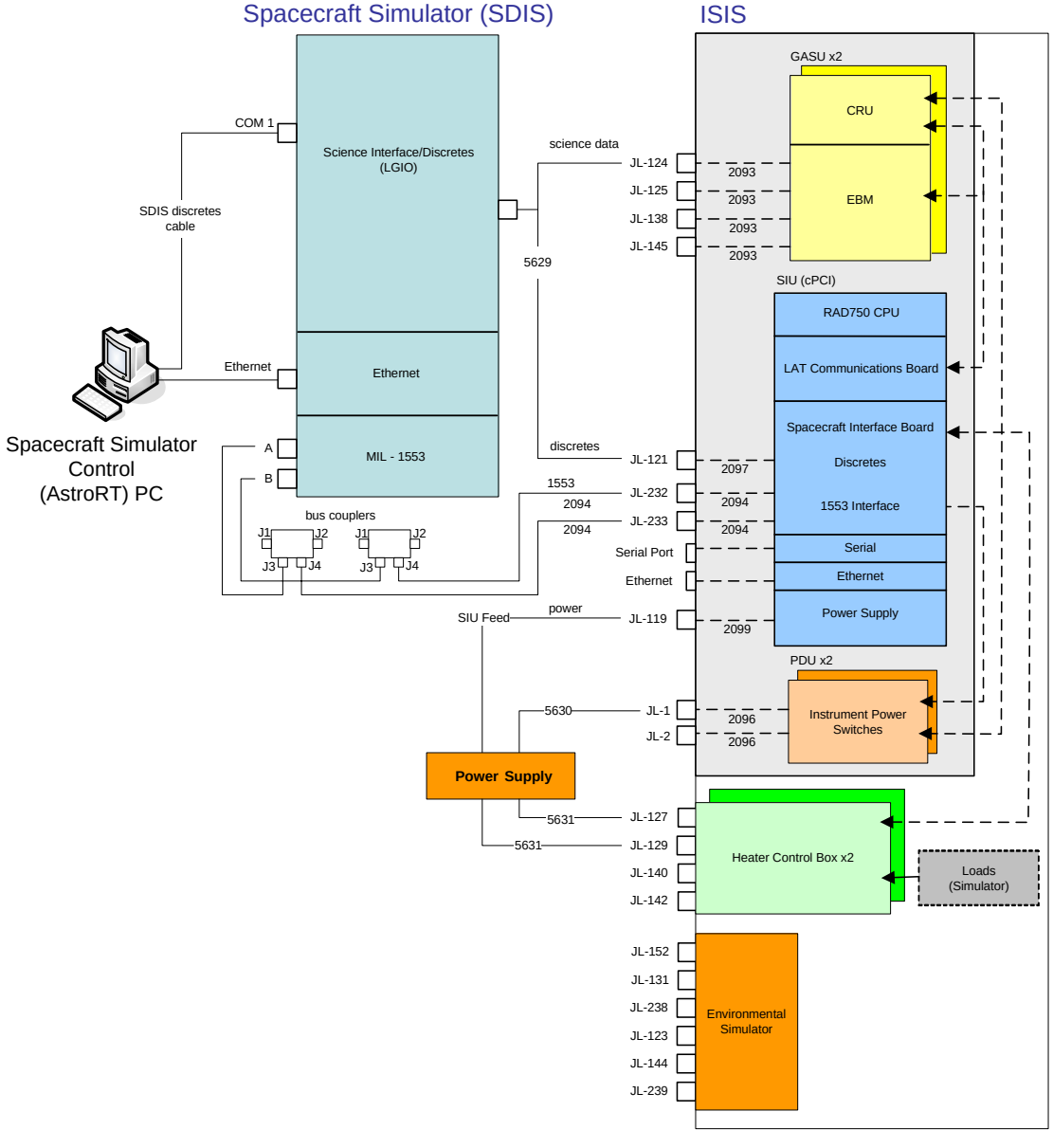
Hardware: Fan Power Input



Fan Power Input

Must be plugged in to 120V outlet during operation!

Hardware Configuration



FSW Libraries Installed on ISIS

FSW Package	Constituent	Version
VXW	vxw_tornado	V6-3-0
VXW	vxw_flight	V6-3-0
VXW	vxw_symbol	V6-3-0
SBC	sbc_nominal	V1-0-0
RAD750	rad750_reboot	V1-3-2
CMX	cmx_asBuiltSpy	V2-2-4
PBS	pbs	V2-6-0
MSG	msg_mt	V2-0-1
MSG	msg_print	V2-0-1
CCSDS	ccsds_pkt	V3-3-0
CCSDS	ccsds_dump	V3-3-0
CCSDS	ccsds_swap	V3-3-0
SIB	sib	V1-2-1
CTDB	sumt_rt_sib	V5-2-0
ITC	itc_dump	V2-1-6
ITC	itc	V2-1-6
CTS	ctx_lcp_sumt	V1-0-6
CTS	cts_lcp	V1-0-6

FSW Libraries Installed on ISIS (continued)

FSW Package	Constituent	Version
FILE	file_hdr	V2-3-2
FILE	file_path	V2-3-2
FILE	file_sys	V2-3-2
FILE	file_upl	V2-3-2
FILE	file_lcp	V2-3-2
LCBD	lcbd	V1-2-6
LEM	lem	V1-2-8
LEM	lem_cli	V1-2-8
PIG	pig_power	V5-1-0
PIG	pig_flying	V5-1-0
LCM	lcm	V0-0-0
LHK	lhk_cfg	V2-5-8
LHK	lhk_slv	V2-5-8
LHK	lhk	V2-5-8
LCBT	trace	V1-4-1
LCBT	lcbt	V1-4-1
LCBT	ssrsim	V1-4-1
ISIS	isisLAT	V0-1-1
LHK	enabrpdu	V2-5-8
LHK	tablrpdu	V2-5-8

Test Scripts

Test Name	Script
Alert Telemetry	ISIS_Alert.pl
Automatic Repoint Requests (ARRs)	ISIS_AutoRepoint.pl
Discrete Read Request	ISIS_DiscreteRead.pl
Set Discretes	ISIS_DiscreteSet.pl
GBM Signals	ISIS_GBM_Messages.pl
Ancillary, Attitude, and Time Tone (Magic 7) Commands	ISIS_Magic7.pl
No-op Commands	ISIS_Noop.pl
Power	ISIS_Power.pl
CPU Boot Process and Reset Signal	ISIS_ResetSignal.pl
Routing of Commands	ISIS_Routing_Cmds.pl
Science Data Patterns	ISIS_SciDataPatterns.pl

More information:

- **LAT ISIS Acceptance Test Plan (LAT-MD-04086) Appendix B**

Test Support Files

File	Purpose
AstroRT_cmd_init.pl	
HTML_Table_Intf.pl	
ISIS_PowerOffLAT.pl	Used in Power Draw and LAT Voltage Monitoring tests
ISIS_PowerOnLAT.pl	Used in Power Draw and LAT Voltage Monitoring tests
ISIS_PowerOnPrimGasu.pl	Used in Power Draw and LAT Voltage Monitoring tests
ISIS_PowerOnRdntGasu.pl	Used in Power Draw and LAT Voltage Monitoring tests
ISIS.db	Support text file for getting HW and FSW versions
KnightRider.pl	Heater control sample script
LVDS_DAQ_Main.pl	
SIIS_LVDS_DISCRETES_CONTROL.vi	
ISIS_Alert_AstroRTBugs.pl	

Preliminary Command and Telemetry Files

- FILE_cmd_itos.dbx
- ISIS_cmd_itos.dbx
- ISIS_tlm_itos.dbx
- ITC_cmd_itos.dbx
- ITC_tlm_itos.dbx
- ITOS_Translation.txt
- LFS_cmd_itos.dbx
- LFS_tlm_itos.dbx
- LHK_cmd_itos.dbx
- LHK_tlm_itos.dbx
- MEM_cmd_itos.dbx
- MEM_tlm_itos.dbx
- PBC_cmd_itos.dbx
- PBC_tlm_itos.dbx
- itos-dbx-param.dbx
- itos-dbx-tc.dbx
- itos-dbx-tlm.dbx

Miscellaneous Include Files (AstroRT Specific)

- AstroRT_SubScripts.pl
- Decode_View_Command_Messages.pl
- Decode_View_Command_Messages.vi
- Decode_View_Raw_Packets.pl
- Decode_View_Raw_Packets.vi
- Utilities.pl
- SIIS_LVDS_DISCRETES_CONTROL.vi
- LVDS_DAQ_Main.pl

ISIS Training - References

- Overview
- References
  - ISIS Documents
  - LAT ICDs
  - Other Sources
- Bringing Up the ISIS
- Command Examples
- More On Commands
- Troubleshooting
- Outstanding Issues
- Summary

References: ISIS Documents

- **Specifications/Plans**
  - LAT-SS-03975 LAT ISIS Requirements Specification
  - LAT-MD-04086 LAT ISIS Acceptance Test Plan
- **Procedures**
  - LAT-TD-03541 ISIS Safe Connection Procedure
  - ❖ LAT-TD-05398 LAT ISIS Acceptance Test Procedure

❖ = Documents most useful for learning how the ISIS works and how to operate it.

References: ISIS Documents (continued)

- Other
  - ❖ LAT-TD-05426 ISIS FSW Build Description
  - – LAT-TD-02659 FSW Telecommand and Telemetry Formats
  - – LAT-DS-03400 PDU Test Box Assembly
- Drawings
  - – LAT-DS-04439 ISIS DAQ Hardware Mounting Plate
  - – LAT-DS-04440 ISIS GASU Mounting Rail
  - – LAT-DS-04441 ISIS PDU Mounting Rail
  - – LAT-DS-04461 ISIS +X Connector Panel
  - – LAT-DS-04489 ISIS -X Connector Panel
  - – LAT-DS-04593 ISIS Temperature Sensor Enclosure
  - – LAT-DS-04594 ISIS PDU Test Box Front Panel
  - – LAT-DS-04610 ISIS Heater Control Box and VHCP Load Box Mounting and Front Panels
  - – LAT-DS-05147 ISIS SIU Adapter Plate EGSE
  - – LAT-DS-05235 ISIS Enclosure Blank Panel EGSE
  - – LAT-DS-05244 ISIS Enclosure Assembly EGSE
  - – LAT-DS-05245 ISIS Enclosure Panel Temp Monitor EGSE
  - – LAT-DS-05297 ISIS Grounding Diagram
  - – LAT-DS-05444 ISIS 264 Temperature Sensor CCA

References: LAT ICDs

- LAT-TD-00639 ACD Electronics Module (AEM)
- LAT-TD-01547 The Command/Response Unit (CRU)
- LAT-TD-01546 The Event Builder Module (EBM)
- LAT-TD-03664 GASU Based Teststands
- LAT-TD-01545 The GLT Electronics Module (GEM)
- LAT-TD-00606 LAT Inter-module Communications
- LAT-TD-00860 The LAT Communications Board (LCB)
- LAT-TD-01543 The Power Distribution Unit (PDU)
- LAT-TD-00605 The Tower Electronics Module (TEM)

Resources: Other Sources

- **FSW Traveler (package-specific) Documents:**
  - www.slac.stanford.edu/exp/glast/flight/web/FSW_traveler.shtml
- **FSW in Doxygen**
  - www.slac.stanford.edu/exp/glast/flight/doxygen/Doxyidx.htm
- **LATDocs**
  - https://oraweb.slac.stanford.edu:8080/pls/slacquery/DOCUMENTS.STARTUP?PROJECT=GLAST

Acronyms

- ACD: Anti-Coincidence Detector
- AEM: ACD Electronics Module
- CRU: Command/Response Unit
- EBM: Event Builder Module
- EPU: Event Processing Unit
- FSW: Flight Software
- GASU: Global Trigger/AEM/Signal Distribution Unit
- GBM: Gamma-ray Burst Monitor
- GEM: Global Trigger Electronics Module
- GLAST: Gamma-ray Large Area Space Telescope
- ISIS: Instrument to Spacecraft Interface Simulator
- LAT: Large Area Telescope
- LCB: LAT Communications Board
- PDU: Power Distribution Unit
- SC: Spacecraft
- SDIS: Spacecraft Data Interface Simulator
- SIB: Spacecraft Interface Board
- SIIS: Spacecraft to Instrument Interface Simulator
- SIU: Spacecraft Interface Unit
- TEM: Tower Electronics Module
- TPS: Tower Power Supply

ISIS Training - Bringing Up the ISIS

- Overview
- References
- **Bringing Up the ISIS**
  - **Initial Setup—FSW**
  - **Initial Setup—Hardware**
  - **Power on the ISIS**
- Command Examples
- More On Commands
- Troubleshooting
- Outstanding Issues
- Summary

Initial Setup—FSW

1. **Prepare the AstroRT PC**

2. **Download the Files from the ISIS_ATP CD**
   a) **Create this directory for test scripts and results:**
      c:\AstroRT\scripts\hansene
   b) **Copy the files as shown in the table below:**

From ISIS_download/ …	Copy these files…	To c:\AstroRT\ …
SCRIPTS	.pl files and ISIS.db (22 files)	scripts\hansene
SCRIPTS/DBX	all files (17 files)	Catdb\GLAST\ITOS_DB
SCRIPTS/AstroRT_Specific	AstroRT_SubScripts.pl	scripts
SCRIPTS/AstroRT_Specific	Decode_* (4 files)	source\GLAST\Telemetry\Decode
SCRIPTS/AstroRT_Specific	Utilities.pl	source\Common\Script\PERL
SCRIPTS/AstroRT_Specific	SIIS_LVDS_DISCRETES_CONTROL.vi	Documents and Settings\Spectrum\Desktop
SCRIPTS/AstroRT_Specific	LVDS_DAQ_Main.pl	source\GLAST\Telemetry\Science_DAQ

Initial Setup—FSW (continued)

3. Regenerate the Telemetry Database

4. Regenerate the Command Database

Initial Setup—Hardware

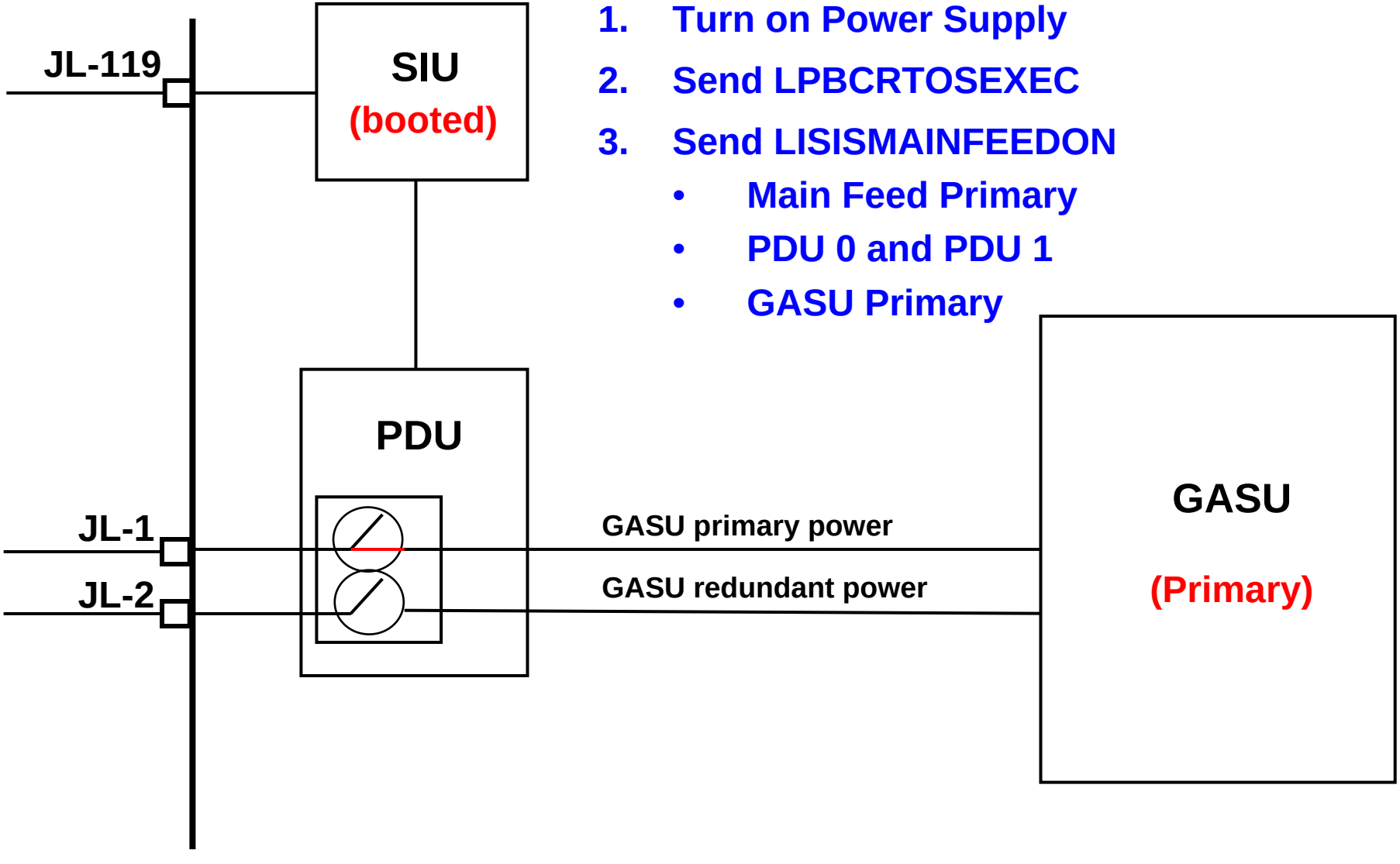
1. **Before plugging in any power cables, ensure that the SIU and DAQ Main Feed power supplies are set to 28V.**
   - **The SIU and PDU voltage must be 28 ± 1V at all times.**
     - **There is no undervoltage protection on this hardware.**
     - **If the voltage drops below 27V for more than 10 seconds, transistors may overheat and burn out.**
2. **Connect JL-124 (SC science data) and JL-121 (SC Discretes) on the ISIS to your Science Interface/Discretes connector.**
3. **Connect your 1553 lines to JL-232 and JL-233 on the ISIS.**
4. **Connect your Power Supply to JL-1 (DAQ Main Feed - primary) and JL-119 (SIU power) on the ISIS.**
5. **Power on the SDIS and verify the 1553 interface is enabled.**

Power on the ISIS

1. Primary Boot
2. Secondary Boot
3. Turn on the Main Feed
4. Initialize LAT Housekeeping

ISIS Internal Power On Sequence

1. Turn on Power Supply
2. Send LPBCRTOSEXEC
3. Send LISISMAINFEEDON
   - Main Feed Primary
   - PDU 0 and PDU 1
   - GASU Primary



ISIS Front panel

Power on the ISIS (Primary Boot)

1. **Initiate the primary boot process:**
   a) **Turn on the ISIS Power Supply.**
   b) **Verify that the voltage is 28V.**

2. **Verify that the primary boot is progressing:**
   a) **In the AstroRT GLAST Main Menu window, from the menu, select Subsystem, then Subsystem Displays, and then FSW.**
   b) **In the Subsystem Menu window, double-click BCI 1553.**
   c) **In the BCI_1553 window, observe the Telemetry Housekeeping in the LAT column.**

      When the number begins to increment, the boot is finished.

- **The primary boot takes approximately 3 minutes.**

Power on the ISIS (Secondary Boot)

1. **Send the LPBCRTOSEXEC command with these parameters:**

Parameter	Data Value
LPBCSBCFLAGSHI	0x5400
LPBCSBCFLAGSL	0xC000

2. **Verify that the secondary boot is progressing:**
   - **In the BCI_1553 window, observe the Telemetry Housekeeping in the LAT column.**
     - **The number does not increment during the boot.**
     - **When the number begins to increment, the boot is finished.**

- **The secondary boot takes approximately 45 seconds.**

Turn on the Main Feed

1. **Send the LISISMAINFEEDON command with these parameters:**

Parameter	Data Value
LISISSIUID	SIU_0
LISISMF	MF_PRIMARY
LISISPDU_0	ON
LISISPDU_1	ON
LISISDAB	PRIMARY
LISISPPS_I	OFF
LISISPPS	PRIMARY
LISISGBM	PRIMARY

2. **Verify that the command is sent by observing the current on the ISIS Power Supply.**

   Current increases from 0.5-0.6 Amps to 1.0 Amps.

Turn the ISIS Off and On

- **To turn the ISIS off**
  1. **Turn off the TEMs, ACD, and EPUs using LISISPOWEROFF.**
  2. **Power off the Power Supply connected to the ISIS.**

- **To turn the ISIS on (after initial setup)**
  1. **Before turning on the power, ensure that the power supply connected to the ISIS SIU and PDU is set to 28V.**
     - **The SIU and PDU voltage must be 28 ± 1V at all times.**
       - **There is no undervoltage protection on this hardware.**
       - **If the voltage drops below 27V for more than 10 seconds, transistors may overheat and burn out.**
  2. **Power on the SDIS and verify the 1553 interface is enabled.**
  3. **Continue with the steps to Power on the ISIS.**

Initialize LAT Housekeeping

- **Send the LHKSYSRESET command with these parameters:**

Parameter	Data Value
LHKCFGFILE0	0x41000000
LHKCFGFILE1	0x41000001

- **Initializing LAT Housekeeping will ensure that HSK telemetry will contain measured values for TEM, ACD, and EPU voltages and switch settings.**

ISIS Training - Command Examples

- Overview
- References
- Bringing Up the ISIS
- **Command Examples**
  - **Request Alert Telemetry**
  - **Science Data Generation**
  - **Auto Repoint Requests (ARR)**
  - **Power Management**
- More On Commands
- Troubleshooting
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Request Alert Telemetry (LISISRQALRTGEN)

- **Generates ISIS alert telemetry:**
  1. **The spacecraft sends the Request Alert Telemetry command to the LAT.**
  2. **The command requests the LAT to send an alert telemetry packet to the spacecraft.**
  3. **The LAT sends the alert telemetry packet.**
  4. **The alert telemetry packet echoes the data contained in the request.**

- **Use it to:**
  - **Request Alert Telemetry from the ISIS on APID 842**

- **ISIS test script that exercises this telecommand:**
  - **ISIS_alert.pl**

Request Alert Telemetry Parameters

Name	Mnuemonic	Value
Alert Data	LISISALERTDATA	Arbitrary value (U32) to be reflected in an alert telemetry packet

Request Alert Telemetry Procedure

1. **Set up feedback windows:**
   a) **In a Telemetry Table Template, select this mnemonic for display: LALERTDATA**
      - **The value sent to the spacecraft/ground in the alert telemetry packet**
      - **After the command is sent, this value should correspond to the value sent in the request for an alert telemetry packet**
   b) **In the Raw Packet Count window—**
      - **Enter APID 842**
      - **Clear all other APIDs that appear in the window**
2. **Send the LISISRQALERTGEN command with this parameter (example):**

Parameter	Data Value
LISISALERTDATA	0xbeefcafe

Request Alert Telemetry Procedure (continued)

3. **Observe the feedback windows:**

   a) **In the Telemetry Table Template, the telemetry value should echo the value sent in the command:**

Parameter	Data Value
LISISALERTDATA	0xbeefcafe

   b) **In the Raw Packet Count window, the telemetry packet should arrive with APID 842.**

   - **APID 842 (0x34A) is within the defined range for alert telemetry for the LAT, per the LAT-SC ICD**

Science Data Generation (LISISSCIDATAGEN)

- Initiates simulated science data to be output on the prevailing science data interface

- Use it to:
  - Send science data with these specifications:
    - Rate
    - Duration
    - Packet size
    - Pattern
      - Increment
      - Constant
      - Random
      - Walking 1's
      - Transition to all 1’s
      - Transition to all 0’s

- ISIS test script that exercises this command:
  - ISIS_SciDataPatterns.pl

Science Data Generation Parameters

Mnuemonic	Name	Value
LISISPATTYPE	Pattern Type	Specifies the science data generation type.
LISISPARAM	Pattern Parameter	The contents of the Pattern Parameter field are based on the setting for the Pattern Type field.
LISISDURATION	Duration	Duration of generation in seconds. A -1 causes generation of infinite length. The generation can be terminated by issuing the LISISSTOPSCI command
LISISPACKETSIZE	Packet Size	Desired packet size in bytes. Range is 44 to 4095. The packet size is constrained by the data rate and the bandwidth. If the value of the data rate multiplied by the packet size exceeds the bandwidth limit, the packet size will be adjusted downward until the bandwidth limit is not violated.
LISISDATARATE	Data Rate	Desired data rate in hertz. Range is 0.033 to 10000.00.
LISISRSRVD		Must be zero
LISISPAD		Must be zero

Sci Data Generation Parameters (continued)

Pattern Types (LISISPATTYPE)

Pattern Type	Patern #	Resulting pattern
INCREMENT	0	Packet contents increment by one, starting with the value provided by the LISISPARAM parameter
CONSTANT	1	Packet contents repeat the constant value provided by the LISISPARAM parameter
RANDOM	2	Pseudo-random packet contents provided by the following algorithm: a) Take seed from LISISPARAM value b) Ensure that the value is odd c) Multiply the value by 69069 d) Perform a bitwise AND operation using the value obtained in step c and 65535 (0xffff) e) Repeat steps c and d using the value obtained in step d as the seed.
WALK1	3	Walking 1's, where the range of the walk is determined by LISISPARAM (8,16,32).
TRAN01	4	Transition from 0's to 1's, where the number of 0's prior to transition is set by LISISPARAM.
TRAN10	5	Transition from 1's to 0's, where the number of 1's prior to transition is set by LISISPARAM.

Science Data Generation Procedure

1. **Set up LVDS DAQ Main window**
   a) **Initialize the LVDS DAQ Main window.**
   b) **Ensure LVDS DAQ is connected over TCP/IP to the device containing the LVDS receiver.**
   c) **On the LVDS DAQ Main interface, ensure that the “Save to file” option is selected.**
   d) **Verify the existence of the path displayed.**

2. **Send the following sequence of commands (no parameters necessary)**
   a) **SDILVDSRESET**
   b) **SDILVDSFLUSH**
   c) **SDILVDSENABLE**

Sci Data Generation Procedure (continued)

3. **Send the LISISSCIDATAGEN command with these parameters (example):**
   - **In this example, the ISIS generates Science Data packets with a constant pattern of 0xBEEF for 180 seconds, with 512 byte payloads.**

Row	Data Value
LISISPATTYPE	1
LISISRSRVD	0
LISISPAD	0
LISISPARAM	0xBEEF
LISISDURATION	180
LISISPACKETSIZE	512
LISISDATARATE	2000.00

- **The packet size and data rate are mutable, depending on the maximum bandwidth restrictions. So the packet size is adjusted downward to achieve the desired data rate.**

Other Science Data Commands

- **Science Data Cease Transmission (LISISSTOPSCI)**
  - **Sent on the 1553 interface to the LAT**
  - **Terminates transmission of simulated science data**

- **Science Data Interface Select (LISISSELSCIIF)**
  - **Select primary or secondary interface for output of simulated science data**
  - **Parameter**

Name	Mnuemonic	Value
Select Secondary		0 = select primary interface non-zero = select secondary interface

Get Science Data Generation Status (LISISCLRSCISTATS)

- **Telecommand**
  - **Sent from the spacecraft side to the LAT**
  - **Requests diagnostic telemetry containing status counts maintained by the simulated science data generation function**

- **ISIS**
  - **Accepts the message**
  - **Sends a diagnostic telemetry packet containing the status counts**

Clear Science Data Generation Status (LISISCLRSCISTATS)

- **Telecommand**
  - **Sent from the spacecraft side to the LAT**
  - **Requests clearing of status counts maintained by the simulated science data generation function**

- **ISIS**
  - **Accepts the message**
  - **Clears the status counts**

Request ARR Generation (LISISRPTGEN)

- Issues a request for an ARR (Autonomous Re-point Request)
  - Initiates output of an ARR from the ISIS to the spacecraft on the 1553 interface
  - Contains parameter values that are echoed back to the spacecraft in the ARR

- Use it to:
  - Generate a sample Autonomous Re-point Request from the ISIS to the spacecraft.

- ISIS test script that exercises this command:
  - ISIS_AutoRepoint.pl

Request ARR Generation Parameters

Mnuemonic	Name	Value
SCCLK_SEC	LISISSEC	Time seconds.
SCCLK_SUBSECS	LISISSUBSEC	Time sub-seconds.
TRANSACTION_ID	LISISTRANID	Command identification code.
DWELL_TIME	LISISDWELLTM	Seconds to remain in re-point mode.
RA	LISISRA	RA coordinate of re-point position in C double format.
DEC	LISISDEC	DEC coordinate of re-point position in C double format.

Request ARR Generation Procedure

1. **Send the CMDRESPONSE command with these parameters:**
   - **Ensures appropriate command response level is set**

Row	Data Value
LCM_NODEID	0
LCM_TASKID	20
LCM_CMDCLASS	0
LCM_CMDACTION	0
LCM_CMDLEVEL	0

- **This modifies the command response level in the Intertask Communications Package (ITC) to always confirm a command executed by the ISIS task.**

Request ARR Gen Procedure (continued)

2. In a Telemetry Table Template, select the following mnemonics for display
   - H720SCNT
   - LCM_CMDHDRAPID
   - LCM_CMDHDRFUNC
   - LCM_EXESTATUS

Request ARR Gen Procedure (continued)

3. **Send the LISISRPTGEN command with these parameters (example):**
   - **In this example, … .**

Row	Data Value
LISISSEC	3333333
LISISSUBSEC	55555555
LISISTRANID	0x12345
LISISDWELLTM	0x98765
LISISRA	93482.29349
LISISDEC	222.44444

Request ARR Gen Procedure (continued)

3. **Observe the feedback**

   a) **In the Telemetry Table Template, the telemetry value should echo the value sent in the command:**

Parameter	Data Value
H720SCNT	0x?? (one more than at template creation)
LCM_CMDHDRAPID	0x688
LCM_CMDHDRFUNC	0x3
LCM_EXESTATUS	0x2e8333a8

   b) **In the Raw Packet Count window, examine the contents of the raw packets on APID 45.**

   - **Command will also appear in packet with**
     - **APID 600**
     - **Function Code 2**
     - **Payload echoes payload data entered in the command.**

Request ARR Gen Procedure (continued)

c) As of this writing, the SDIS is unable to correctly process the ARR command.

- Errors indicate that SDIS received a command with
  - APID 600
  - Function Code 2

Autonomous Re-point Reply

- **Command:**
  - **Provides acceptance status on an ARR received from the LAT**
  - **Values from this command are output via telemetry**

- **Output**

Output	Description
TRANSACTION_ID	Command identification code for ARR
STATUS	0 = ARR rejected 1 = ARR accepted

PDU-Based Power On (LISISPOWERON)

- Provides capability to turn on the simulated power load for:
  - 16 Towers (TEMs + TKR + CAL)
  - ACD
  - 3 EPUs
- Simulated power loads are monitored via housekeeping telemetry
- Use it to:
  - Simulate the power draw of the full LAT
  - Power individual elements of the LAT on
- ISIS test script that exercises this command:
  - ISIS_Power.pl

PDU-Based Power On Parameters

Mnuemonic	Name	Value
LISISTEMPWRON	TEM On Mask	Set 2^{TEM} bit to turn on selected TEM (0-15) Example: To turn on TEM 3, set parameter to 2^3 = 8
LISISTEMPDUON	TEM PDU Mask	Set 2^{TEM} bit to turn on selected TEM (0-15) from PDU Example: To turn on TEM 3 from PDU 1, set parameter to 2^3 = 8 To power a TEM load from PDU 0, set this parameter to zero.
LISISTEMCALON		Must be zero
LISISTEMTKRON		Must be zero
LISISEPUPWRON	EPU On Mask	Set 2^{EPU} bit to turn on selected EPU (0-2) Example: To turn on EPU 1, set parameter to 2^1 = 2
LISISEPUPDUON	EPU PDU	Set 2^{EPU} bit to turn on selected EPU (0-2) from PDU 1 Example: To turn on EPU 1 from PDU 1, set parameter to 2^1 = 2. To power an EPU load from PDU 0, set this parameter to zero.

PDU-Based Power On Parameters (continued)

Mnuemonic	Name	Value
LISISEPUSECCON	EPU CNV	Set 2^{EPU} bit to turn on selected EPU (0-2) using the secondary power converter Example: To turn on EPU 1 using the secondary power converter, set paramter to $2^1 = 2$. To power an EPU load from the primary power converter, set this parameter to zero.
LPAD_NOTUSED		Must be zero
LISISACDPWRON	ESP	Set to OFF
LISISACDPDUON	ACD	Irrelevant to ISIS. Recommend PDU_0
LISISACDSECCON	AP	Irrelevant to ISIS. Recommend PRIMARY
LISISACDSECSUP	ASP	Irrelevant to ISIS. Recommend PRIMARY
LISISACDFREEON	FREE Mask	Must be zero

PDU-Based Power On Procedure

1. **In a Telemetry Table Template, select the following mnemonics for display:**

Mnemonic	Explanation
LHKP0TEM0PM	Status of the power switch for TEM 0 as read from PDU 0.
LHKP0TEM033V	ADC reading of the voltage monitor for TEM 0 on PDU 0
LHKP0TEM033VST	Status of the ADC read for the above value: 0: Status OK 1: Acquisition timeout or other failure 2: Value masked as disabled
LHKP0EPU0PM	Status of the power switch for EPU 0 as read from PDU 0.
LHKP0EPU033V	ADC reading of the voltage monitor for EPU 0 on PDU 0
LHKP0EPU033VST	Status of the ADC read for the above value: 0: Status OK 1: Acquisition timeout or other failure 2: Value masked as disabled

PDU-Based Power On Procedure (continued)

2. **Send the LISISPOWERON command with these parameters:**
   - **This example turns on TEM 0.**

Row	Data Value
LISISTEMPWRON	1
LISISTEMPDUON	0
LISISTEMCALON	0
LISISTEMTKRON	0
LISISEPUPWRON	0
LISISEPUPDUON	0
LISISEPUSECCON	0
LPAD_NOTUSED	0
LISISACDPWRON	0
LISISACDPDUON	0
LISISACDSECCON	0
LISISACDSECSUP	0
LISISACDFREEON	0

PDU-Based Power On Procedure (continued)

3. **Observe the feedback**

   a) **In the Telemetry Table Template, the first three values should be:**

Mnemonic	Explanation
LHKP0TEM0PM	LPDUTEMPWRON or 1
LHKP0TEM033V	3.2766E+0 to 3.65E+0 or 2684 to 3068
LHKP0TEM033VST	LHKSTATOK or 0

   b) **If possible, verify that the current draw on the power supply has increased by approximately 1 amp (0.9-1.0) .**

PDU-Based Power On Procedure (continued)

4. **Send the LISISPOWERON command with these parameters:**
   - **This example turns on EPU 0.**

Row	Data Value
LISISTEMPWRON	0
LISISTEMPDUON	0
LISISTEMCALON	0
LISISTEMTKRON	0
LISISEPUPWRON	1
LISISEPUPDUON	0
LISISEPUSECCON	0
LPAD_NOTUSED	0
LISISACDPWRON	0
LISISACDPDUON	0
LISISACDSECCON	0
LISISACDSECSUP	0
LISISACDFREEON	0

PDU-Based Power On Procedure (continued)

5. **Observe the feedback**

   a) **In the Telemetry Table Template, the last three values should be:**

Mnemonic	Explanation
LHKP0EPU0PM	LPDUEPUPWRON or 1
LHKP0EPU033V	3.2766E+0 to 3.65E+0 or 2684 to 3068
LHKP0EPU033VST	LHKSTATOK or 0

   b) **If possible, verify that the current draw on the power supply has increased by approximately 0.7 amp.**

PDU-Based Power Off (LISISPOWEROFF)

- Provides capability to turn off the simulated power load for:
  - 16 TEMs
  - ACD
  - 3 EPUs
- Simulated power loads are monitored via housekeeping telemetry
- Use it to:
  - Power individual elements of the LAT off
- ISIS test script that exercises this command:
  - ISIS_Power.pl

PDU-Based Power Off Parameters

Mnuemonic	Name	Value
LISISTEMPWROFF	TEM Off Mask	Set 2^{TEM} bit to turn off selected TEM (0-15) Example: To turn off TEM 3, set paramter to $2^3 = 8$
LISISTEMCALOFF		Must be zero
LISISTEMTKROFF		Must be zero
LISISTEMPADOFF		Must be zero
LISISEPUPWROFF	EPU Off Mask	Set 2^{EPU} bit to turn off selected EPU (0-2) Example: To turn off EPU 1, set paramter to $2^1 = 2$
LISISEPAD		Must be zero
LISISACDPWROFF		Must be zero
LISISACDFREEOFF		Must be zero
LISISEPAD		Must be zero

ISIS Training - More On Commands

- Spacecraft Load Shed Notification (LISISLDSHED)
- Command HP Heater On or Off (LISISHTROFF)
- Drive Discrete Lines (LISISDRVDSCRT)
- Monitor Discrete Lines (LISISMNDSCRT
- No-Op (LISISNOOP)
- Reboot (LISISREBOOT)
- Main Feed On (LISISMAINFEEDON)
- GBM Calculated Information (LISISGBMINFO)
- GBM Re-point Recommendation (LISISGBMREPTREC)
- GBM Closeout (LISISGBMCLOSEOUT)
- Monitor Command Counts (LISISMNCMDCNTS)
- Get Hardware Configuration (LISISGETHWCNFIG)
- Get Software Configuration (LISISGETSWCNFIG)

Spacecraft Load Shed Notification (LISISLDSHED)

- Notifies LAT operational power to the SIU and DAQ going down
  - Sent from the spacecraft to the LAT
  - Sent no less than 15 seconds prior to removing operational power to the SIU and DAQ
- ISIS software shows status in telemetry that command was received
- No parameters

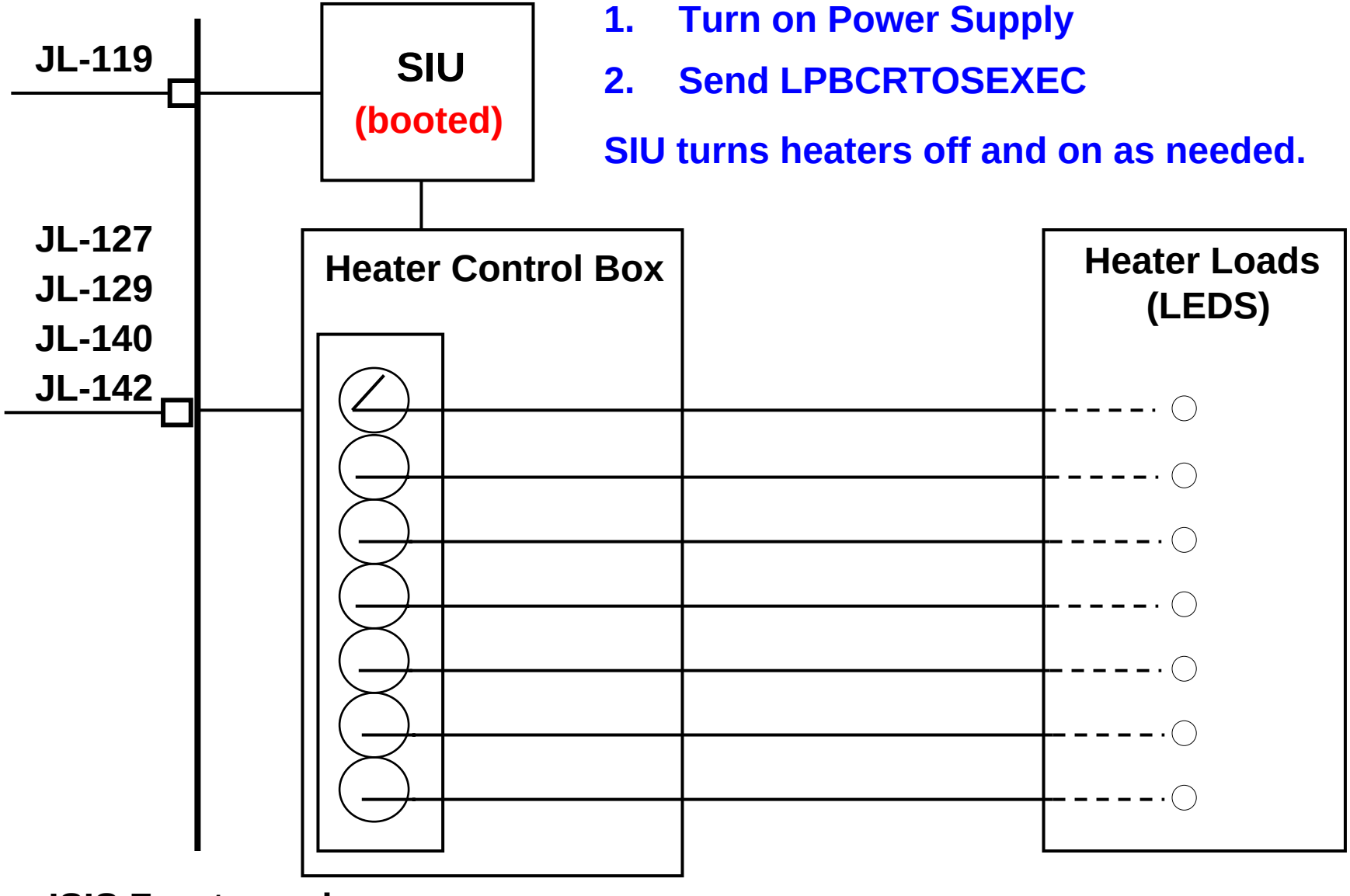
Command VCHP Heater On or Off (LISISHTROFF)

- Provides capability to set VCHP heater switches on or off
- Heater switches are repeatedly commanded on or off
  - Every second
  - As specified by the ISIS software
  - Until the refresh stop bit is set to one (RS)
- Bit masks contained in the command payload are written to the SIB heater control register, individually turning on/off the six +Y radiators and the six -Y radiators.

ISIS Heater Controls

1. Turn on Power Supply
2. Send LPBCRTOSEXEC

SIU turns heaters off and on as needed.



ISIS Front panel

Command HP Heater On or Off Parameters

Mnemonic	Name	Value
RS		01: Stop updating the heater control register. Heater watchdog time will expire and turn the heaters on. 00: Continue updating the heater control register and setting the heaters on or off according to the Off masks.
+Y Off Mask	LISISYPOFF	Setting bit 2^n to one or zero turns +Y-radiator heater switch n off or on, respectively. For example, setting the Y Off Mask parameter equal to 3 (2^0=1, 2^1=1) would turn off +Y-radiator switches 0 and 1, and leaving switches 2 – 5 on.
-Y Off Mask	LISISYMOFF	Setting bit 2^n to one or zero turns -Y-radiator heater switch n off or on, respectively. For example, setting the -Y Off Mask parameter equal to 3 (2^0=1, 2^1=1) would turn off –Y-radiator switches 0 and 1, leaving switches 2 – 5 on.

n = Heater number. In this context, the six heaters are numbered 0 to 5.

Command HP Heater Parameters (continued)

- **Off Masks**
  - **Value set by selecting the ±Y heater(s) to turn on or off**
  - **Correct value for + or –Y heaters is obtained as follows:**
    - **Decide which heaters 0 to 5, you want to turn off**
    - **Form the value 2^n for each heater, where *n* is the number of the heater from zero to five that will be turned off**
    - **Calculate the sum of the values determined above.**
    - **Set the parameter LISISYPOFF or LISISYMOFF to this value and issue the LISISHTROFF command**
  - **Example:**
    - **To turn off heater load number two on both the +Y and -Y sides, enter 2^2=4 for both off mask parameters**
    - **This will leave the remaining five heaters on each box ON.**

- **You can combine any number of heaters in any order by forming the superposition of several individual heaters. For example, to turn heaters 2,3,5 off: $2^2+2^3+2^5$=44.**

Drive Discrete Lines (LISISDRVDSCRT)

- Causes a 1 or 0 to be output on the two PIDs (5 and 6) connected to the spacecraft
- Used for
  - Causing the ISIS to drive its discrete outputs, the discrete signals sent to the spacecraft
- ISIS test script that exercises this command:
  - ISIS_DiscreteSet.pl

Drive Discrete Lines Parameters

Mnuemonic	Name	Value
PID_5_VALUE	LISISPID5VAL	Value to set PID 5 to, 0 or 1
PID_6_VALUE	LISISPID6VAL	Value to set PID 6 to, 0 or 1

Monitor Discrete Lines (LISISMNDSCRT)

- PIDs contained on the SIB (#23, #24 and #25) read once
- Values (1 or 0) output via telemetry

- Used for
  - Issuing a telecommand to the ISIS to read back its discrete input lines

- ISIS test script that exercises this command:
  - ISIS_DiscreteRead.pl

No-Op (LISISNOOP)

- **No-op (no operation) command**
  - **Sent from the spacecraft side to the LAT**
  - **Verifies SC-LAT interface is established**

- **ISIS software shows status in telemetry via command counters from ITC**

- **ISIS test script that exercises this command:**
  - **ISIS_noop.pl**

Reboot (LISISREBOOT)

- Sent from the spacecraft to the LAT
- Performs a soft reboot of the SIU processor

- Difference between hard reboot and soft reboot:
  - Soft reboot does not repeat the memory check or primary boot. The SIU immediately returns to the state in which it awaits the boot command that initiates the secondary boot.
  - Hard reboot is the equivalent to issuing a power on reset. The rad750 will perform its memory check and primary boot, where it will await the boot command that initiates the secondary boot.

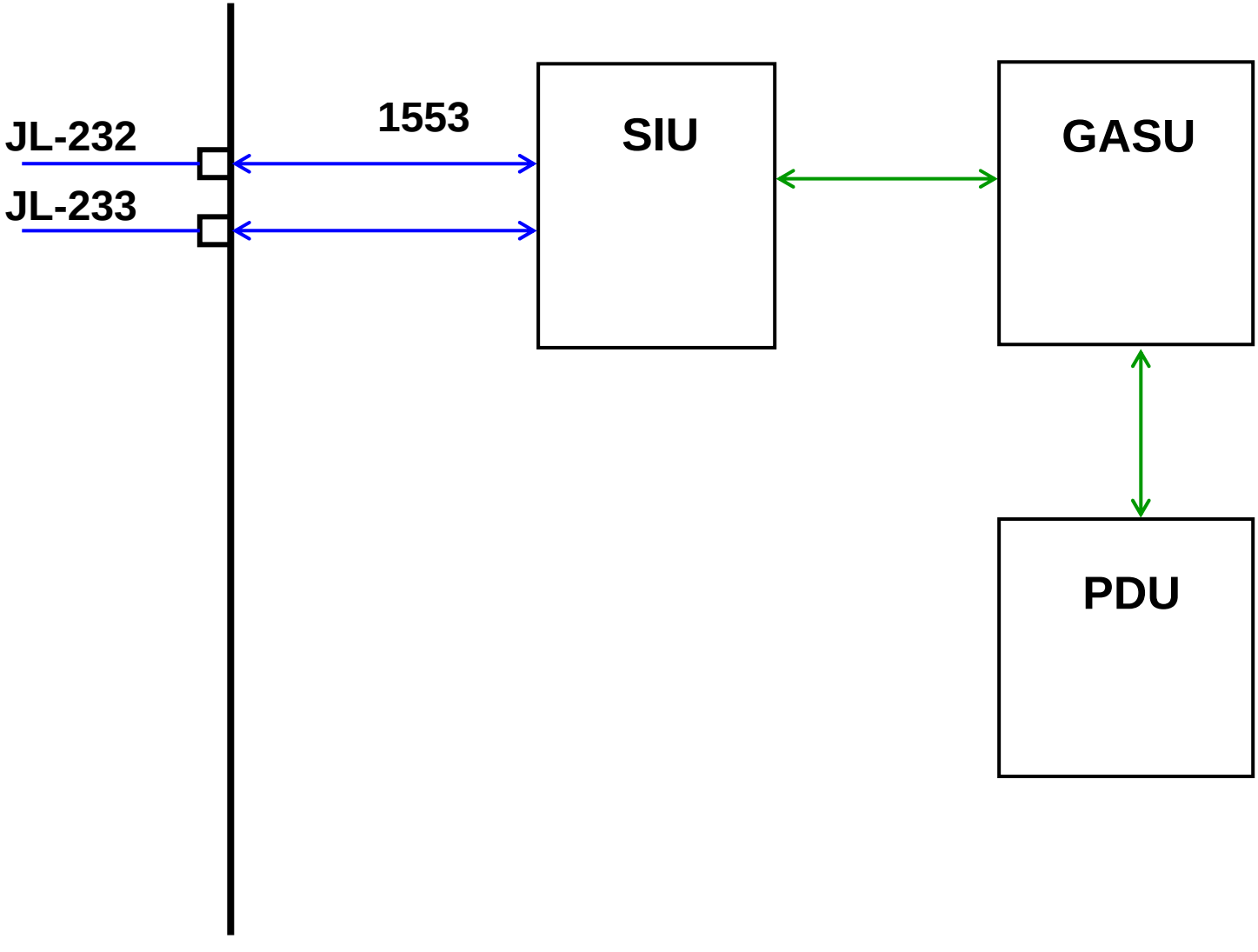
- ISIS test script that exercises this command:
  - ISIS_ResetSignal.pl

Main Feed On (LISISMAINFEEDON)

- Sent from the spacecraft to the LAT
- Powers on and initializes PDU and GASU
- In response, the LAT—
  - Initializes hardware
  - Starts housekeeping telemetry

- Operating Hint!
  - Can't issue ISIS Main Feed On more than once.
  - Need to power cycle to change the state
    - Main Feed affects GASU and PDU power (primary and redundant, on or off)
    - You can't switch from primary to redundant GASU without cycling the DAQ main power feed.
  - You *can* turn TEMs and EPUs on and off through commands

ISIS Internal Communications



Main Feed On Parameters

Mnuemonic	Name	Value
LISISSIUID	SIU	Must be zero
LISISMF	MF	Selects main feed to use: MF_PRIMARY = JL-1 feed MF_SECONDARY = JL-2 feed
LISISPDU_0	PDU	Primary PDU on/off selector
LISISPDU_1		Redundant PDU on/off selector
LISISDAB	DB	GASU selector: PRIMARY SECONDARY
LISISPPS_I	PPS	Must be zero
LISISPPS		Must be zero
LISISGBM	G	Must be zero
LISISSSR	S	Primary/Secondary selector for the Science Data interface PRIMARY SECONDARY

Main Feed On (LISISMAINFEEDON)

- **LISISMAINFEEDON allows the user a one-time capability to select which**
  - **DAQ Main Feed to draw from (primary or redundant)**
  - **PDU is powered (0, 1, or both)**
  - **GASU is powered (primary or redundant)**
  - **SSR spigot the data will come from (primary or redundant):**

	Primary GASU	Redundant GASU
Primary SSR	JL-124	JL- 138
Redundant SSR	JL-125	JL-145

NOTE: Until GASU and PDU are turned on, you will not be able to

- **Power TEMs and EPUs on or off**
- **Generate Science Data**
- **Read back housekeeping telemetry dealing with values measured on the PDU or GASU.**

GBM Calculated Information (LISISGBMINFO)

- **Command**
  - **Sent from the spacecraft side to the LAT**
  - **Specifies information about a burst sequence**
- **ISIS—**
  - **Accepts the message**
  - **Prints the contents on the serial connection**

- **Use it to:**
  - **Verify the ability of the ISIS to receive and count GBM-specific telecommands.**
  - **ISIS will keep a count of GBM Calculated Information telecommands received and will return this count when it is requested by the spacecraft**

- **ISIS test script that exercises this command:**
  - **ISIS_GBM_Messages.pl**

GBM Calculated Information Parameters

Mnuemonic	Name	Value
LISISSECTENTHS	Time Tenth Of Sec	Time of detected burst in 10^{ths} of a second
LISISSECS2US	Time Tenth In 2Usec	Time of detected burst in 2 microseconds
LISISSEQNUM	Sequence Number	A counter value of the number of GBMINFO commands sent to the LAT for any given sequence of GBM telecommands
LISISVERNUM	Rec Type-Version	Record type and version number
LISISLOCRA	Location RA	Right Ascension coordinate of the detected burst (J2000)
LISISLOCDEC	Location DEC	Declination coordinate of the detected burst (J2000)
LISISLOCERROR	Error	Statistical error for the detected location
LISISLOCALGO	Location Algorithm	Location algorithm used
LISISRELIABILITY	Classification-Reliability	Classification and reliability of classification
LISISREASON0	Trigger Reason	Reason for trigger, first 32 bits
LISISREASON1		Reason for trigger, second 32 bits
LISISREASON2		Reason for trigger, third 32 bits
LISISREASON3		Reason for trigger, fourth 32 bits

GBM Re-point Recommendation (LISISGBMREPTREC)

- **Command**
  - **Sent from the spacecraft side to the LAT**
  - **Recommends and provide information for a re-point request from the LAT to the spacecraft**
- **ISIS—**
  - **Accepts the message**
  - **Keeps a count of GBM messages received**

- **Use it to:**
  - **Verify the ability of the ISIS to receive and count GBM-specific telecommands.**
  - **ISIS will keep a count of GBM Repoint Recommendation telecommands received and will return this count when it is requested by the spacecraft**

- **ISIS test script that exercises this command:**
  - **ISIS_GBM_Messages.pl**

GBM Re-point Recommendation Parameters

Mnuemonic	Name	Value
LISISSECTENTHS	Time Tenth Of Sec	Time of detected burst in 10^{ths} of a second
LISISSECS2US	Time Tenth In 2Usec	Time of detected burst in 2usec
LISISSEQNUM	Sequence Number	A counter value of the number of GBM Repoint Recommendation commands sent to the LAT for any given sequence of GBM telecommands
LISISVERNUM	Rec Type-Version	Record type and version number
LISISFILL		Must be zero.
LISISREPOINTREC	Re-point Recommendation	0= Do not recommend repoint, 1= Recommend repoint
LISISLOCRA	Location RA	Right Ascension coordinate of the detected burst (J2000)
LISISLOCDEC	Location DEC	Declination coordinate of the detected burst (J2000)
LISISLOCERROR	Error	Statistical error for the detected location
LISISLOCALGO	Location Algorithm	Location algorithm used

GBM Closeout (LISISGBMCLOSEOUT)

- **Command**
  - **Sent from the spacecraft side to the LAT**
  - **Closes out processing for a burst**
- **ISIS—**
  - **Accepts the message**
  - **Keeps a count of GBM messages received**

- **Use it to:**
  - **Verify the ability of the ISIS to receive and count GBM-specific telecommands.**
  - **ISIS will keep a count of GBM Closeout telecommands received and will return this count when it is requested by the spacecraft**

- **ISIS test script that exercises this command:**
  - **ISIS_GBM_Messages.pl**

GBM Closeout Parameters

Mnuemonic	Name	Value
LISISSECTENTHS	Time Tenth Of Sec	Time of detected burst in 10^{ths} of a second
LISISSECS2US	Time Tenth In 2 Usec	Time of detected burst in 2 usec
LISISSEQNUM	Sequence Number	A counter value of the number of GBM Repoint Recommendation commands sent to the LAT for any given sequence of GBM telecommands
LISISVERNUM	Rec Type-Version	Record type and version number

Monitor Command Counts (LISISMNCMDCNTS)

- **Telecommand**
  - **Sent from the spacecraft side to the LAT**
  - **Requests generation of diagnostic telemetry containing the receive counts for these commands**
    - **No-op**
    - **Ancillary Message**
    - **Attitude Message**
    - **Time Tone**

- **ISIS**
  - **Accepts the message**
  - **Sends back a diagnostic telemetry message containing the prevailing counts**

Get Hardware Configuration (LISISGETHWCNFIG)

- **Telecommand**
  - **Sent from the spacecraft side to the LAT**
  - **Requests download via diagnostic telemetry of the prevailing hardware configuration**

- **ISIS**
  - **Accepts the message**
  - **Sends a diagnostic telemetry packet containing FPGA version numbers for the hardware residing in the ISIS system**

Get Software Configuration (LISISGETSWCNFIG)

- **Telecommand**
  - **Sent from the spacecraft side to the LAT**
  - **Requests download via diagnostic telemetry of the prevailing software configuration**

- **ISIS**
  - **Accepts the message**
  - **Sends a diagnostic telemetry packet containing the file and module ID numbers for the loaded application software**

Get Software Configuration Parameters

- **Parameters**

Mnemonic	Name	Value
LISISDEVICE		Specifies the device type
LISISDIRNUM		Directory number of which to dump the file keys. For ISIS, this is limited to 0-4.

- **Device Types**

Device Type	Description
BOOT	Raw boot partition where the Primary Boot Code (PBC) files are stored
RAM	Self-describing
EE0	Primary partition (0) on the SIB EEPROM
EE1	Secondary partition (1) on the SIB EEPROM
TMP	Debug-only partition that routes to a /tmp/ partition on a UNIX host. This functionality is absent in the ISIS build.

Operating Hints!

- When in doubt, run LAT-TD-05398, ISIS Acceptance Test Procedure, Section 5.3.4, Test Setup Procedure

- Boot problems:
  - Verify that SIU is powered
    - Check that JL-119 is plugged in
    - Power supply reads 28V and 0.5 – 0.7 A (SIU alone)
  - Check that PBC flags are set correctly (see LAT-TD-05398)
    - LPBCSBCFLAGSHI = 0x5400
    - LPBCSBCFLAGSLO = 0xC000
- No communication with ISIS:
  - Verify that SIU is powered
  - Is 1553 interface enabled?
- No science data:
  - Reboot entire system, reissuing LISISMAINFEEDON with parameters specified in Section 5.3.4 of LAT-TD-05398
  - Plugged into JL-124?

Summary

- **When in doubt, run LAT-TD-05398, ISIS Acceptance Test Procedure, Section 5.3.4, Test Setup Procedure**

- **The ISIS power supply should always be set to 28V ± 1V**

- **If all else fails, call Jana:**
  Jana Thayer
  (650) 926-4956
  jana@slac.stanford.edu

Send a Command

1. In the AstroRT GLAST Main Menu window, from the menu, select Commanding and then Select/Send Command.
   - The Command Selection window appears.
2. In the Command Selection window, double-click the mnemonic.
   - If the command has parameters, the Enter Parameter Values window appears.
3. Enter the parameter values in the Data Value column.

Row	Data Value
PARAMETER	*value*
PARAMETER	*value*

4. Click OK.
   - The Command Selection window appears.
5. Click Send.