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	Author(s) Richard Claus	Supersedes
	Subsystem/Office I&T	
Document Title **GLAST LAT I&T Testing Requirements Document**		

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DRAFT

Gamma-ray Large Area Space Telescope (GLAST)

Large Area Telescope (LAT)

Integration and Test Subsystem (I&T)

Testing Requirements Document

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
01	January 13, 2004	Initial draft distributed to subsystems for their input
02	March 11, 2004	Added CAL contributions received thus far
03	May 5, 2004	Added ACD and TKR contributions received thus far

TABLE OF CONTENTS

1. Purpose

This document outlines the testing requirements to be carried out by the GLAST LAT I&T subsystem.

2. Scope

The scope of this document covers EM-2 and LAT integration. The goal is to have a comprehensive set of scripts ready for LAT integration after the end of EM-2. This document covers both *functional tests* and *calibration procedures* that are run on-line using *LATTE*. Offline calibration procedures are covered under a separate document (LAT-TD-???). Both individual *subsystem* tests as well as *system* level tests are covered.

3. Definitions

3.1. Acronyms

ACD	Anti-coincidence subsystem
AEM	ACD Electronics Module
API	Application Program Interface
CAL	Calorimeter subsystem
COMM	Communications Module
cPCI	Compact PCI
EEPROM	Electrically Erasable Programmable Read Only Memory
EGSE	Electronic Ground Support Equipment
ELX	Electronics subsystem
EM	Engineering Model
EPU	Event Processor Unit
FITS	Flexible Image Transport System
FSW	Flight software
FU	Flight Unit
GUI	Graphical User Interface
I&T	Integration and Test
IDL	Interactive Data Language
ISOC	Instrument Science Operations Center
LAN	Local Area Network
LAT	Large Area Telescope
LATTE	LAT Test Executive

LCB	LAT Communications Board
MB	Mega bytes
NFS	Network File System
ODBC	Open DataBase Connectivity
PCI	Peripheral Communications Interface
PPC	Power PC
PSA	Power Supply Assembly
QU	Qualification Unit
RAM	Random Access Memory
ROOT	Rene's (?) Object Oriented Tool
RTE	Real Time Engine
SBC	Single Board Computer
SCL	Spacecraft Control Language
TBR	To Be Reviewed
TKR	Tracker subystem
TCP/IP	Transmission Control Protocol/Internet Protocol
TEM	Tower Electronics Module
VME	Versa Module Eurocard

3.2. Definitions

Flash Memory	A type of memory that retains its contents when powered off. It is normally read only but can be written by a special software procedure.
Functional test	A test that produces a go/no-go result.
Calibration procedure	A procedure whose product is a set of constants.
Subsystem	One of ACD, CAL, TKR, ELX or FSW
System	Something that crosses subsystem boundaries
Test-stand	The combination of a workstation, embedded system, electronics and sensor under test, with corresponding software
Single Contributor	A single contributor system, includes integrated TKR, CAL, TEM, PSA
Multi-contributor	Can include any subset of entire LAT system

4. Applicable Documents

- LAT-MD-00408 LAT Program Instrument Performance Verification Plan
- LAT-TD-00191 Tracker Tower Electrical Tests
- LAT-SS-00231 Calorimeter Performance Acceptance Standard and Tests

- LAT-TD-01112 ACD Functional Test Plans
- LAT-TD-00786 LAT Flight Software Test Plan
- LAT-MD-00676 LAT Assembly Sequence
- LAT-MD-00466 LAT I&T SVAC Plan
- LAT-MD-00440 LAT Beam Test Plan
- LAT-MD-01055 LAT Electrical Performance Test Plan
- LAT-SS-00XXX-XX LAT Electrical Ground Support Equipment Level 3 Specification
- LAT-SS-00586 Online Software Validation and Verification

5. Description

This document describes testing to be carried out as LAT components are received by I&T from the subsystems. In many cases, corresponding test software will also be received. This software is used by the subsystem to carry out the pre-ship testing and by a combination of the subsystem and I&T to determine the acceptance of the component by I&T.

The delivered software will undergo scrutiny by I&T before being accepted, version controlled and released into the I&T repertoire of tests to be carried out during integration. If it follows I&T requirements, the test is to be listed in this document. If it doesn't, and I&T and the subsystem cannot agree on making a common test, I&T will develop its own version of the test. The project should strive to avoid the latter situation to prevent having to resolve discrepancies between the results of the subsystem's version and I&T's version of the test. As well, handling the divergence of the independent development and maintenance paths is potentially difficult.

I&T will be the main source of the system level tests, in collaboration with the System Engineering department.

6. Necessary infrastructure

- Certified Test Stand (LAT-TD-00861).
  I&T will certify, validate and establish a pedigree of the test stand hardware and the associated flight software. These will be maintained under configuration control.
- Certified version of LATTE (LAT-SS-00586).
  I&T will certify LATTE using the LAT Test Bed. LATTE core software is version controlled and released.

7. Test Scripts

Each test listed in this section is described on an integer number of pages (usually one). The test descriptions are formatted in the form of a table. The table contains:

- The test script's name
- The test's TEST ID
- The test's SVAC ID, if applicable

- Any aliases the test script goes by
- Test script(s) this script supercedes, if any
- Category, from:
    - Electronics - Component name (e.g., Power supplies, TEM, PSA, etc.)
    - ACD
    - Calorimeter
    - Tracker
    - I&T
- Short description (synopsis)
- Author. May be useful if a question occurs and contact with the original author is desired to find the intention of something.
- Owner/maintainer. Likely to change with time or involve multiple people and won't be updated in this document.
- Test description version number.
- Motivation (e.g. answers a requirement in some LAT document)
- Prerequisites: Script(s) that must be run before this one can be expected to succeed (e.g., to generate some input file for this script
- Required EGSE
- Required input data/files
    - Type, e.g., calibration, configuration…
    - Format, e.g., XML, FITS…
- Generated output data/files
    - Type, e.g., event data, calibration…
    - Format, e.g., XML, FITS…
- Possible completion statuses, e.g., PASSED, FAILED, other
- Long description of the test
- Additional comments, perhaps to list quirks or observations?

A subsection is devoted to each test script table.

7.1. TKR (WBS 4.1.4)

7.1.1. Tracker Power Consumption

NAME	TEST ID	SVAC ID
TkrPowerConsumptionTest	TKR101	
ALIASES	SUPERCEDES	CATEGORY
TE101	None	TKR

SYNOPSIS

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
TBD	TBD

MOTIVATION

Measure the Tracker readout-electronics power consumption

PREREQUISITES

Testing of TEM and power supplies before mating to flight hardware. Individual trays tested by TKR subsytem before tower assembly.

REQUIRED EGSE

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Configuration file	Test report

COMPLETION STATUSES

DESCRIPTION

The digital power (2.5 V), analog high (2.5 V), and analog low (1.5 V) supplies are successively turned on, and a clock is supplied to the Tower by the TEM. The resulting current draw and power-supply voltages are checked to be within specifications and are recorded. The current and voltage measurements are made using the monitoring built into the TEM and supplies. Following the measurement with clock only (no commands) the data mask is loaded such that all channels are disabled. Trigger-acknowledge signals, followed by readout, are sent at a rate of 1 kHz, and the power measurement is repeated.

COMMENTS

TO BE REVIEWED – TEM V and I monitors functionalities need to be assessed

7.1.2. Tracker Temperature

NAME	TEST ID	SVAC ID
	TKR102	
ALIASES	SUPERCEDES	CATEGORY
TE102	None	TKR

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION Verify that the Tracker built-in temperature sensors work.	
PREREQUISITES TKR101	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION All supplies, except the SSD bias voltage, are turned on and delivered to the tower module. The temperature from each of the 16 sensors is recorded at 5-minute intervals for an hour. A plot of temperature versus time is made for each sensor.	
COMMENTS Tower-level test	

7.1.3. Tracker Leakage Current

NAME	TEST ID	SVAC ID
	TKR103	
ALIASES	SUPERCEDES	CATEGORY
TE103	None	TKR

SYNOPSIS	
AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
TBD	TBD
MOTIVATION	
Measure the Tracker SSD bias current and monitor the Tracker internal temperature with SSD biased.	
PREREQUISITES	
TKR102	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Configuration file	Test Report
COMPLETION STATUSES	
DESCRIPTION	
With the Tracker module powered and clocked, the SSD bias supply is turned on and ramped step by step (5 V steps) to a voltage sufficient to deplete all SSDs in the tower module (according to information from the tower module assembly database) and within the specified maximum range. The Tracker temperature is monitored and recorded (from the internal sensors), as is the room temperature. The supply current is recorded at each step, and a plot of current versus voltage is made. The measurement is made with room lights on and off, to verify the light shielding. The results are compared with the sum of leakage current measurements of the trays from which the tower module was assembled.	
COMMENTS	
TO BE REVIEWED – TEM V and I monitors functionalities need to be assessed	

7.1.4. GTRC configuration

NAME	TEST ID	SVAC ID
TkrGTRCConfiguration	TKR201	
ALIASES	SUPERCEDES	CATEGORY
TE201	None	TKR

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION Test loading and readback of the controller-chip configuration register, including broadcast mode	
PREREQUISITES TKR101	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES Pass/fail	
DESCRIPTION The GTRC chips are sequentially addressed and their configuration registers loaded with a bit pattern. Each time the register is read back and checked for errors. The test is repeated with the complement of the bit pattern. The test then is repeated with a broadcast address for writing the register, followed by sequential readback.	
COMMENTS Functional test applied to each single layer	

7.1.5. GTFE registers load and read-back

NAME	TEST ID	SVAC ID
TkrGTFECheck	TKR202	
ALIASES	SUPERCEDES	CATEGORY
TE202	None	TKR

SYNOPSIS

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
TBD	TBD

MOTIVATION

Test loading and readback of the 5 readout-chip configuration registers, including broadcast mode

PREREQUISITES

TKR201

REQUIRED EGSE

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Configuration file	Test Report

COMPLETION STATUSES

Pass/fail

DESCRIPTION

The GTFE chips are sequentially addressed via the low-side GTRC and their mask (TRIGGER, DATA, CALIB) and DAC registers are sequentially loaded with a bit pattern. In each case the register then is read back and checked for errors. The MODE register then is loaded to switch the chips to the high-side controller and the MODE register is read back via the right GTRC. The MASK and DAC registers then are loaded with the complement bit pattern and read back via the right GTRC and checked.

The GTFE MODE registers are set to split them equally between the two sides in each layer. GTFE MASK and DAC registers are simultaneously loaded with bit patterns via a broadcast command, and then sequentially read back and checked.

COMMENTS

Functional test applied to each single layer

7.1.6. GTFE split configuration

NAME	TEST ID	SVAC ID
TkrReadingConfigurationTest	TKR203	
ALIASES	SUPERCEDES	CATEGORY
TE203	None	TKR

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION Test redundancy of layer readout configurations, test charge injection system and data path	
PREREQUISITES TKR202	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES Pass/fail	
DESCRIPTION The redundancy of the readout configuration is tested by running the same test of the charge injection system for three layer configurations, i.e. i) all GTFEs readout on the low-side GTRC, ii) all GTFEs readout on the high-side GTRC, iii) default configuration with 12 GTFEs on each side. In each configuration all the channels in the layer are enabled for data taking and triggering, and the signal threshold is set high enough to cut out noise; two random channels per GTFE are pulsed with enough charge to cross the threshold. The layer is readout and the channels above threshold are compared with the pulsed one. In case the default configuration is not working, all possible configurations with any number of GTFE on each side are scanned in order to define the optimal split point, which is the one that minimizes the number of GTFEs isolated from the readout.	
COMMENTS Functional test applied to each single layer	

7.1.7. Tracker Gain and Noise

NAME	TEST ID	SVAC ID
TkrNoiseAndGain	TKR301	
ALIASES	SUPERCEDES	CATEGORY
TE301	None	TKR

SYNOPSIS

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
TBD	TBD

MOTIVATION

Secondary calibration of the noise performance and threshold stability.

PREREQUISITES

TKR203

REQUIRED EGSE

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Configuration file	Test Report. Data files with gain and noise for each channel and list of dead channels (both amplifiers and disconnected strips)

COMPLETION STATUSES

DESCRIPTION

The GTFEs mode registers and the GTRCs control register are set according to the optimal split point from test TKR203 (see 7.1.6). The calibration DAC is set in each chip to about 1 fC injection, and the calibration and data masks are set to select in each layer a set of non-adjacent channels smaller in number than the GTRC buffer size. The threshold is scanned over a range about 1 fC, with about 100 events per setting taken. For each setting the occupancy is calculated, and the data are used to fit for each channel the gain and noise. Channels having too low a gain are listed as dead amplifiers, and channels with a noise comparable with the average noise level from a bare MCM are listed as disconnected strips. The procedure is repeated for different mask settings until all live channels are analyzed. The results are stored in a database. A list of gain and noise for each channel is generated, as well as a list of dead channels.

COMMENTS

Functional and performance test applied to each single layer

7.1.8. Tracker Threshold Scan

NAME	TEST ID	SVAC ID
TkrTriggerRate	TKR302	
ALIASES	SUPERCEDES	CATEGORY
None	None	TKR

SYNOPSIS

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
TBD	TBD

MOTIVATION

Test layer self trigger and GTFEs trigger lines

PREREQUISITES

TE301

REQUIRED EGSE

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Configuration file	Test Report

COMPLETION STATUSES

Pass/fail

DESCRIPTION

The GTFEs mode registers and the GTRCs control register are set according to the optimal split point from test TKR203 (see 7.1.6). The calibration masks are all disabled. The trigger in the TEM is set to the standard 3-in-a-row self trigger, enabling the combination of layers that includes the tray under test; the other five missing silicon layers are faked by forcing the corresponding trigger lines in the combination to be always on. One GTFE at a time is enabled for triggering and data. The threshold DAC is set at a low value, the TEM LRS counters are monitored and each single FE must provide high rate trigger primitives at sufficiently low threshold. The threshold is increased in steps until while the trigger rate decreases to cosmic rays levels at a reasonably high threshold.

COMMENTS

Functional and performance test applied to each single layer

7.1.9. Tracker ToT Test with charge injection

NAME	TEST ID	SVAC ID
TkrTotTest	TKR303	C11, C12
ALIASES	SUPERCEDES	CATEGORY
TE303	TKR206	TKR

SYNOPSIS

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
TBD	TBD

MOTIVATION

Calibration of the TOT gain. Explore full range of calibration DAC

PREREQUISITES

TE302

REQUIRED EGSE

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Configuration file	Test Report

COMPLETION STATUSES

Pass/fail, TOT time_vs_charge calibration factor

DESCRIPTION

The GTFEs mode registers and the GTRCs control register are set according to the optimal split point from test TKR203 (see 7.1.6). The calibration and data masks in each layer are set to enable a maximum of 30 channels randomly chosen for each GTRC to be strobed and readout. The threshold is fixed at a low value, and the calibration DAC is scanned over its whole range, with about 100 events per setting taken. The TOT value at both GTRC is read for each setting and the data are used to calibrate the TOT. The results are stored in the calibration database.

COMMENTS

Functional and performance test applied to each single layer

7.1.10. Tracker single strip noise occupancy

NAME	TEST ID	SVAC ID
TkrNoiseOccupancy	TKR304	C10
ALIASES	SUPERCEDES	CATEGORY
TE304	TKR501	TKR

SYNOPSIS

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
TBD	TBD

MOTIVATION
Noisy channel search

PREREQUISITES
None

REQUIRED EGSE

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Configuration file	Test Report plus list of noisy channels

COMPLETION STATUSES

DESCRIPTION
The GTFEs mode registers and the GTRCs control register are set according to the optimal splitting point from test TKR203 (see 7.1.6). The data and trigger masks in the layer are set to enable all channels to be readout. The threshold is fixed around a working point value (about ¼ MIP, THR_DAC = 35). 100,000 random triggers are issued and the single strip noise occupancy (hits/triggers) is recorded. Any channel with a noise occupancy larger than 10^{-3} is considered as noisy and recorded in a database.

COMMENTS
Functional and performance test applied to each single layer

7.1.11. Tracker layer noise occupancy

NAME	TEST ID	SVAC ID
TkrLayerNoiseOccupancy	TKR501	C10
ALIASES	SUPERCEDES	CATEGORY
TE501	TKR502	TKR

SYNOPSIS

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
TBD	TBD

MOTIVATION

Check the noise performance and determine working point for data taking

PREREQUISITES

None

REQUIRED EGSE

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Configuration file	Test Report

COMPLETION STATUSES

DESCRIPTION

The GTFEs mode registers and the GTRCs control register for all layers are set to the standard configuration for data taking (i.e. 12 FEs on each GTRC), unless otherwise specified as a result of test TKR203 (see 7.1.6). The data and trigger masks in the layer are set to enable all channels to be readout except the noisy channels, as from test TKR304 (see 7.1.10). Random triggers are issued at various threshold values, scanning the full range 0 of the threshold DAC register, and the strips above threshold are readout. At each data point the layer noise occupancy is calculated as the ratio of the number of strips above threshold divided by the number of strips enabled. The threshold gets incremented until a plateau is reached, which is the result of cosmic rays crossing the tower in accidental coincidence with random triggers. The average values expected are a few 10^{-4} for the occupancy plateau, occuring at a threshold DAC larger than ~30 (range 0). The threshold DAC corresponding to the requirements layer noise occupancy of 10^{-4} is extrapolated from the plot and is defined as the working point for that layer for subsequent tests. The efficiency at that threshold or higher will be evaluated in the efficiency scan.

COMMENTS

Functional and performance test applied to each single layer

7.1.12. Efficiency, resolution and alignment

NAME	TEST ID	SVAC ID
TkrDetectionEfficiency	TKR503	?
ALIASES	SUPERCEDES	CATEGORY
TE503	None	TKR

SYNOPSIS

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
TBD	TBD

MOTIVATION

Verification of the single layer detection and trigger efficiency, spatial resolution, and tower alignment requirements.

PREREQUISITES

None

REQUIRED EGSE

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Configuration file	Test Report. Efficiency scans for all layers, alignment constants, single-hit resolution for all layers

COMPLETION STATUSES

DESCRIPTION

The mode-registers, masks, and threshold DACs are set as determined by test TKR501 (see 7.1.11). The trigger is set to the standard 3-in-a-row and all combinations are enabled. Detection efficiency is studied for each layer independently: the trigger line from the layer under study is forced to 1 and cosmic ray data are taken for at least 12 hours. The data are analyzed as follows. Tracks are found and fit to straight lines with the layer under study omitted from the pattern recognition. Events are selected with a single, good-quality track that passes through all the other tracker layers. The projection of the track onto the selected layer is calculated, and a search is made for a hit cluster close to the track, if the extrapolation shows that the particle, to high confidence, passed through a live detector region. The efficiency for finding a hit cluster is calculated from the full data set and recorded for each of the 16 SSDs in the layer. The threshold DAC is then varied and the efficiency measurement is repeated until the threshold range 0 has been explored. The same measurement is then repeated for all the layers in the tracker tower.

For each trigger in the above procedure, the status of all Layer-ORs is recorded, and the efficiency of each Layer-OR is calculated in the same manner as for the data readout.

During the same procedure, when a cluster is found close to the track in the selected layer, its distance from the track intersection is calculated and a histogram of that residual is made on a layer-by-layer basis. The width of the distribution is a measure of the resolution (with some bias from the track fit), and the mean of the distribution gives an indication of the alignment quality.

The number of triggers registered in every combination of 3 x-y- layers is recorded as to check that every combination works with good efficiency.

COMMENTS

Performance test applied to tower only

7.1.13. Tracker Muon Scan

NAME	TEST ID	SVAC ID
	TKR504	C9
ALIASES	SUPERCEDES	CATEGORY
None	TKR503	TKR
SYNOPSIS		
AUTHOR	OWNER/MAINTAINER/CONTACT PERSON	
TBD	TBD	
MOTIVATION		
Exercise the system in working conditions for medium-long term periods		
PREREQUISITES		
None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES	
Configuration file	Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.2. CAL (WBS 4.1.5)

7.2.1. CAL Power Consumption

Below is a draft of the CAL power consumption procedures. It relies heavily upon LATTE's rule capability and RunControl's Environemental Monitor and Housekeeping capabilities. Please review it and let me know if it's the way to go or if there is a better way. I not very familiar with rules so please correct any mistakes or misconceptions. I plan to implement temperature monitoring in a similar manner.

NAME	TEST ID CAL	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY CAL

SYNOPSIS
Monitor CAL Power Consumption

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION
TBD

PREREQUISITES
Environmental Monitoring “enabled”
HouseKeeping enabled

REQUIRED EGSE
LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Schema describing Calorimeter voltage/current monitor rules and limit settings which could vary by TEM (see description) : $CAL_ROOT\FMx\Configurations\calvcMonConfig.xml	Housekeeping File: Session Log: Alarms Display: (Not an output file but don’t know where else to put it)

COMPLETION STATUSES
Red/Yellow ALARMS

DESCRIPTION

```
<?xml version='1.0' encoding='UTF-8'?>
<configuration name='CAL current/voltage Monitoring Rules' version='1.0'>
  <rules>
    <rule name='voltageMonitor'>
```

```
  <class>gRule.GruleAlarms</class>
  <parameters>
    <name>voltageMonitor</name>
    <subsystem>CAL</subsystem>
    <category>voltage</category>
    <enabled>1</enabled>
    <continuous>1</continuous>
    <yellowLowerLimit>TBD</yellowLowerLimit>
    <yellowUpperLimit>TBD</yellowUpperLimit>
    <yellowAction>None</yellowAction>
    <redLowerLimit>TBD</redLowerLimit>
    <redUpperLimit>TBD</redUpperLimit>
    <redAction>disablePower</redAction>
  </parameters>
</rule>
<rule name='currentMonitor'>
  <class>gRule.GruleAlarms</class>
  <parameters>
    <name>currentMonitor</name>
    <subsystem>CAL</subsystem>
    <category>current</category>
    <enabled>1</enabled>
    <continuous>1</continuous>
    <yellowLowerLimit>TBD</yellowLowerLimit>
    <yellowUpperLimit>TBD</yellowUpperLimit>
    <yellowAction>None</yellowAction>
    <redLowerLimit>TBD</redLowerLimit>
    <redUpperLimit>TBD</redUpperLimit>
    <redAction>disablePower</redAction>
  </parameters>
</rule>
<rule name='biasVoltageMonitor'>
  <class>gRule.GruleAlarms</class>
  <parameters>
    <name>voltageMonitor</name>
    <subsystem>CAL</subsystem>
    <category>voltage</category>
    <enabled>1</enabled>
    <continuous>1</continuous>
    <yellowLowerLimit>TBD</yellowLowerLimit>
    <yellowUpperLimit>TBD</yellowUpperLimit>
    <yellowAction>None</yellowAction>
    <redLowerLimit>TBD</redLowerLimit>
    <redUpperLimit>TBD</redUpperLimit>
    <redAction>disableHV</redAction>
  </parameters>
</rule>
```

```
  <rule name='biasCurrentMonitor'>
   <class>gRule.GruleAlarms</class>
   <parameters>
    <name>currentMonitor</name>
    <subsystem>CAL</subsystem>
    <category>current</category>
    <enabled>1</enabled>
    <continuous>1</continuous>
    <yellowLowerLimit>TBD</yellowLowerLimit>
    <yellowUpperLimit>TBD</yellowUpperLimit>
    <yellowAction>None</yellowAction>
    <redLowerLimit>TBD</redLowerLimit>
    <redUpperLimit>TBD</redUpperLimit>
    <redAction>disablePower</redAction>
   </parameters>
  </rule>
 </rules>
 <GLAT>
  <GTEM ID='0-15'>
   <GTIC>
    <adc_cal_digital_3_3v egu="CAL Digital 3.3 Voltage",rule="voltageMonitor"/>
    <adc_cal_digital_3_3i egu="CAL Digital 3.3 Current",rule="currentMonitor"/>
    <adc_cal_analog_3_3v egu="CAL Analog 3.3 Voltage",rule="voltageMonitor"/>
    <adc_cal_analog_3_3i egu="CAL Analog 3.3 Current",rule="currentMonitor"/>
    <adc_cal_bias_v egu="CAL Bias Voltage",rule="biasVoltageMonitor"/>
    <adc_cal_bias_i egu="CAL Bias Current",rule="biasCurrentMonitor"/>
    <adc_tkr_c7_t1 egu="Temperature"/>
   </GTIC>
  </GTEM>
 </GLAT>
</configuration>
```


COMMENTS

The objective is to use RunControl provided capabilities to monitor power consumption and take appropriate action. The RunControl capabilities to be used are:

1. Rule definition and assignment to telemetry items
2. Environmental monitoring
3. Housekeeping

It would be convenient if uniform limits could be applied across all TEMs, however, this is dependent upon the capabilities of the TEM current/voltage monitoring circuitry and will require some analysis before actual limits can be determined.

7.2.2. CAL Temperature

Below is a draft of the CAL temperatures procedure. Same comments are with CAL power comsumption description.

NAME	TEST ID	SVAC ID
	CAL	
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS
Monitor CAL Temperatures

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION
TBD

PREREQUISITES
Environmental Monitoring "enabled"
HouseKeeping enabled

REQUIRED EGSE
LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Schema describing Calorimeter temperature monitor rules and limit settings which could vary by TEM (see description) : $CAL_ROOT\FMx\Configurations\calvcMonConfig.xml	Housekeeping File: Session Log: Alarms Display: (Not an output file but don't know where else to put it)

COMPLETION STATUSES
Red/Yellow ALARMS

DESCRIPTION

```
<?xml version='1.0' encoding='UTF-8'?>
<configuration name='CAL Temperature Monitoring Rules' version='1.0'>
 <rules>
  <rule name='temperatureMonitor'>
   <class>gRule.GruleAlarms</class>
   <parameters>
    <name>temperatureMonitor</name>
    <subsystem>CAL</subsystem>
    <category>temperature</category>
```

```
      <enabled>1</enabled>
      <continuous>1</continuous>
      <yellowLowerLimit>TBD</yellowLowerLimit>
      <yellowUpperLimit>TBD</yellowUpperLimit>
      <yellowAction>None</yellowAction>
      <redLowerLimit>TBD</redLowerLimit>
      <redUpperLimit>TBD</redUpperLimit>
      <redAction>disablePower</redAction>
    </parameters>
  </rules>
  <GLAT>
   <GTEM ID='0-15'>
    <GTIC>
      <adc_afee0_t0  egu="Temperature",rule="temperatureMonitor"/>
      <adc_afee0_t1  egu="Temperature"",rule="temperatureMonitor"/>
      <adc_afee1_t0  egu="Temperature"",rule="temperatureMonitor"/>
      <adc_afee1_t1  egu="Temperature"",rule="temperatureMonitor"/>
      <adc_afee2_t0  egu="Temperature"",rule="temperatureMonitor"/>
      <adc_afee2_t1  egu="Temperature"",rule="temperatureMonitor"/>
      <adc_afee3_t0  egu="Temperature"",rule="temperatureMonitor"/>
      <adc_afee3_t1  egu="Temperature"",rule="temperatureMonitor"/>
    </GTIC>
   </GTEM>
  </GLAT>
 </configuration>
```

COMMENTS

The objective is to use RunControl provided capabilities to monitor CAL temperatures and take appropriate action. The RunControl capabilities to be used are:

4. Rule definition and assignment to telemetry items
5. Environmental monitoring
6. Housekeeping

It would be convenient if uniform limits could be applied across all TEMs, however, this is dependent upon the capabilities of the TEM current/voltage monitoring circuitry and will require some analysis before actual limits can be determined.

7.2.3. GCRC configuration

See AFEE Configuration, Section 7.2.5

7.2.4. GCFE configuration

See AFEE Configuration, Section 7.2.5

7.2.5. AFEE configuration

NAME	TEST ID	SVAC ID
Calu_init	CAL	
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION
TBD

PREREQUISITES
TEMPowerUp

REQUIRED EGSE
LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Configuration file	Test Report: yymmddhhmmss_FMx_calu_init.html Register Snapshot: yymmddhhmmss_FMx_calu_init.xml

COMPLETION STATUSES
PASS
IPASS (Incomplete Pass – partial system…only applicable to development phase)
FAIL
ABORT

DESCRIPTION

Procedure

Init:
Read CAL parameters configuration file
Obtain Calorimeter unit identifier: try configuration file first else use runControl preferences instrumenttype value.
Update default runControl Preferences paths with calorimeter unit identifier (assumes subdirectories already exist)
Turn of Schema reuse flag (can be overridden from a test suite)

Setup:
(runControl.rcSetup does schema processing)
Turn on schema reuse flag (all following application runs use this schema)
Set power up flag based on whether “all” calorimeters defined in schema are powered up
Set current configuration parameter values which include: TBD
If interactive mode:
    Display current configuration parameter values
    Prompt operator for configuration parameters
Else if batch

Update CAL configuration parameters with batch values

startRun:

Initialize report structure

Disable triggers

Set trigger mask to no triggers

Running:

Set PDU registers based on configuration values

Set HV bias DAC value

Power Calorimeters

Wait for HV to settle

Initialize GCCCs

Initialize GCRCs with configuration values

Initialize GCFEs with configuration values

Initialize FLE,FHE,LAC,ULD DACs from tables contained in files if available

Take register configuration snapshot and save filename to be used by all following application runs as the initial instrument state.

Report:

TBD

COMMENTS

Comment [MSOffice1]: OBE when TEMPowerUp is implemented

7.2.6. CAL reset

See AFEE Configuration, Section 7.2.5

7.2.7. CAL Pedestals

NAME	TEST ID	SVAC ID
CALU_PEDESTALS_CI	CAL	C18
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS
Determine CAL Noise Pedestals

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION

Level IV: 9.1.14.1 The equivalent noise (RMS) on the low energy slow shaped signal paths (LEX8, LEX1) shall be less than 2000 e-.

Level IV: 9.1.14.2 The equivalent noise (RMS) on the high energy slow shaped signal paths (HEX8, HEX1) shall be less than 2000 e-.

PREREQUISITES

Estimate of electrons per ADC bin for LEX and HEX slow shaping circuits (see TBD).

Note: Tests can be run without the above mentioned information, but requirements for absolute noise cannot be tested.

REQUIRED EGSE

LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Schema describing Calorimeter: $CAL_ROOT\FMx\Configurations\FMx_schema.xml CAL Configuration file: $CAL_ROOT\FMx\Configurations\calParams.cfg	Test Report: yymmddhhmmss_FMx_calu_collect_ci.html Register Snapshot: yymmddhhmmss_FMx_calu_collect_ci.xml Noise Pedestals Table: yymmddhhmmss_FMx_pedestals.fits Noise Pedestal Statistics: yymmddhhmmss_FMx_pedestal_stats.csv

COMPLETION STATUSES

PASS
IPASS (Incomplete Pass – partial system…only applicable to development

```
        phase)
  FAIL
  ABORT
```

DESCRIPTION

Algorithm

Setup:

Nominal with the following changes:
Tack Delay setting = CI_TIMED_PEAK
Disable calibration injection to all FEs (config_1 = 0x80)

Collect noise data

For each operational gain setting plus the muon gain setting, *gainidx = 0 to 8* (9 settings)
For N samples (default = 1000)
Use GLT self trigger to inject charge (FEs accept no charge however), delay, and read 4 range event data
Compute Mode for each component and energy range, mode[*gainidx*, 4,8,2,12]
Compute Mean for each component and energy range, mean[*gainidx*, 4,8,2,12]
Compute standard deviation for each component and energy range, std[*gainidx*,4,8,2,12]
Save Pedestals table, mode[9,4,8,2,12], in FITS format to file

Histogram noise samples and fit gaussian

For each gain, gainidx = 0 to 8
For LEX8 and HEX8 ranges, rangeidx = 1,3 (LEX1 and HEX1 range data does not have enough points to fit curve)
For each layer, layeridx = 0 to 7 (SLAC numbering 0-3=X layers, 4-7=Y layers)
For each logend, eidx = 0 to 1
For each log, logidx=0 to 11
Histogram noise ADC settings using mode[gainidx,rangeidx,layerid,eidx,logidx] +/- offset (default = 30) as histogram lower/upper boundaries.
Fit gaussian to histogram
Find Peak[gainidx,rangeidx,layeridx,eidx,logidx]
Compute Centroid[gainidx,rangeidx,layeridx,eidx,logidx]
Compute FWHM[gainidx,rangeidx,layeridx,eidx,logidx]
Compute Area[gainidx,rangeidx,layeridx,eidx,logidx]

Save pedestals statistics, mode, peak, centroid, fwhm, area in FITS file format (to support utilities needing noise threshold data, low and high trigger DAC settings, data suppresion DAC settings).
Save pedestals statistics, mode, peak, centroid, fwhm, area in CSV file format suitable for database entry (trend analysis support)

Requirements checks/sanity checks

If Area[…] does not equal 80 to 100% of N samples then PASS[…]= FALSE (failed check)

COMMENTS

7.2.8. CAL Electronic Gain

Attached is a draft of the CAL Electronic Gain procedures. It consists of 2 procedures;
calf_gain_p01 to characterize evaluate the selectable Low and High Energy gain settings.
calf_gain_p02 to characterize and evaluate the "times 8" and "times 1" gain ratios for both low and high energy.

7.2.8.1. CAL Electronic Gain 1

NAME	TEST ID	SVAC ID
Calf_gain_p01	CAL	C19
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS
Characterize and evaluate CAL charge amplifier gain capabilities

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION

Level IV: 9.1.1.6	The gain of the low energy channels shall be adjustable by a) at least a factor of 2 b) in steps of approximately 10%-25%.
Level IV: 9.1.2.5	The gain of the high energy channels shall be adjustable by a) at least a factor of 2 b) in steps of approximately 10%-25%. c) An additional gain setting shall be used for ground liveness testing.
Level IV: 9.1.11.4	The high energy charge amplifier shall provide a test gain to be used in ground aliveness test with cosmic muons. The test gain shall increase the nominal gain by a factor of approximately 10. The test gain configuration is pre-selected by command input to the ASIC.

PREREQUISITES
Calu_init

REQUIRED EGSE
LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Schema describing Calorimeter: $CAL_ROOT\FMx\Configurations\FMx_schema.xml CAL Configuration file: $CAL_ROOT\FMx\Configurations\calParams.cfg	Test Report: yymmddhhmmss_FMx_calf_gain_p01.html Register Snapshot: yymmddhhmmss_FMx_calf_gain_p01.xml Events File: yymmddhhmmss_FMx_calf_gain_p01.fits relative gain Table:

	`yymmddhhmmss_FMx_relgain.fits`

COMPLETION STATUSES

```
PASS
IPASS (Incomplete Pass - partial system…only applicable to development
       phase)
FAIL
ABORT
```

DESCRIPTION

Algorithm

Setup:

Nominal with the following changes:
Tack Delay setting = CI_TIMED_PEAK

Collect gain data

For each energy range, *rangeidx = 0 to 3*
Find minimum globally useable DAC setting
Find maximum globally useable DAC setting
Using mid DAC setting
For each operational gain setting plus the muon gain setting, *gainidx = 0 to 8* (9 settings)

For N samples, default = 1000
Use GLT self trigger to inject charge, delay, and read 4 range event data

Compute Mean for each component and energy range, mean[*gainidx*, 4,8,2,12]
Compute standard deviation for each component and energy range, std[*gainidx*,4,8,2,12]

Calculate relative gains wrt nominal gain setting

For each gain setting, gainidx = 0 to 8
Compute relative gain at gain setting gainidx as ratio of value at gain setting gainidx over value at nominal, relGain = mean[gainidx…]/mean[5,…]
Save relative gain table, relgain[9,4,8,2,12], in FITS format to file
For relative gains 7 to 1
If ratio between previous relative gain and current relative gain is not between 10 to 25% then fail component
If relative gain 0 is not 2 times greater than relative gain 7 then fail component
If relative gain 8 is not 10 time greater than relative gain 7 for the HEX1 range then fail component

COMMENTS

1. While this test supports subsets of the LAT hardware, it expects the existent TEMs to have identical configurations. In LAT systems where the existing TEMs are not identical, groups of identical TEMs should be identified and individual tests run on each identical TEM subgroup(see Test Preparation)

2. It is sufficient to use for each ranges, one Charge Injection value for relative gain testing if chosen appropriately. For each range, this test will find the minimum and maximum Charge Injection value that produces ADC results above pedestal and below saturation respectively and choose the middle value from this interval as the Charge Injection value for relative gain testing.

3. Nominal gain setting for the LEX8/LEX1 ranges is gain setting 5.

4. Nominal gain setting for the HEX8/HEX1 ranges is gain setting 13.

5. “steps of approximately 10%-25%.” referred to in requirements Level IV 9.1.1.6 and 9.1.2.5 will be interpreted for testing purposes to be 9% to 27.5% i.e. 10% tolerance assigned to approximately.

7.2.8.2. CAL Electronic Gain 2

NAME	TEST ID	SVAC ID
Calf_gain_p02	CAL	C19
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS

Characterize and evaluate the “times 8” to “times 1” gain ratios for both the Low and High Energy Paths

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION

Level IV: 9.1.3.6	The LEX1 amplifier of the low energy channel shall process the entire low energy charge amplifier range, i.e. nominally 1.6 GeV maximum energy.
Level IV: 9.1.3.7	The LEX8 amplifier of the low energy channel shall process the lowest eighth of the low energy charge amplifier range, i.e. nominally 200 MeV maximum energy.
Level IV: 9.1.3.8	The HEX1 amplifier of the high energy channel shall process the entire high energy charge amplifier range, i.e. nominally 100 GeV maximum energy.
Level IV: 9.1.3.9	The HEX8 amplifier of the high energy channel shall process the lowest eighth of the high energy charge amplifier range, i.e. nominally 12.5 GeV maximum energy.

PREREQUISITES

Calu_collect_ci

REQUIRED EGSE

LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Schema describing Calorimeter: $CAL_ROOT\FMx\Configurations\FMx_schema.xml CAL Configuration file: $CAL_ROOT\FMx\Configurations\calParams.cfg	Test Report: yymmddhhmmss_FMx_calf_gain_p02.html

COMPLETION STATUSES

```
PASS
IPASS (Incomplete Pass - partial system…only applicable to development
       phase)
FAIL
ABORT
```

DESCRIPTION

Algorithm

TBD

COMMENTS

7.2.9. CAL Integral non-linearity

Below is a draft of the CAL Integral non-linearity test procedures. It consists of 3 procedures;
Calu_collect_singlex16 to collect charge injected event data by column.
calf_adc_p02 to evaluate integral non-linearity, noise, and range coverage by channel.
calf_adc_p05 to evaluate droop

7.2.9.1. CAL Integral non-linearity 1

NAME	TEST ID	SVAC ID
calu_collect_ci_singlex16	CAL	C20
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS
Collect event data generated using

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION
Prerequisite for calf_adc procedures

PREREQUISITES
calu_init

REQUIRED EGSE
LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
	Test Report: yymmddhhmmss_FMx_calu_collect_ci_singlex16.html Register Snapshot: yymmddhhmmss_FMx_calu_collect_ci_singlex16.xml Events File: yymmddhhmmss_FMx_calu_collect_ci_singlex16.fits

COMPLETION STATUSES
PASS
IPASS (Incomplete Pass – partial system…only applicable to development phase)
FAIL
ABORT

DESCRIPTION

Algorithm

Setup

Obtain collection parameters (range order, channel columns, charge Injection DAC sequence, number of samples, gains)

Collect data

For each range order, (default ridx = 0)
  For each column, (default colIdx = 0,11)
    For each Charge Injection (CI) setting; cidx = bDAC, eDAC,iDAC (default cidx = 0,4096,16)
      For N samples, sidx=0,199 (default = 200)
        Use GLT self trigger to inject charge, delay, and read 4 range event data
        Archive event

COMMENTS

Charge Injection is done one column at a time to better simulate the operational environment. Events from simultaneous charge injection to multiple channels in a layer shows some dependency on number of channels injected.

7.2.9.2. CAL Integral non-linearity 2

NAME	TEST ID	SVAC ID
calf_adc_p02	CAL	C20
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS

Evaluate channel integral non-linearity, noise, and energy range.

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION

Level IV: 9.1	a)The GCFE shall perform spectroscopic measurements over a range from 0.4 MeV to 100 GeV…c)The dynamic range shall be divided into two independent signal chains, one for low energy range, one for the high energy range.
Level IV: 9.1.1.1	The low energy charge amplifier shall process energy depositions in the 2 MeV to 1.6 GeV range. The characteristics of the inputs to the low energy range are summarized in Table 9.3.
Level IV: 9.1.2.1	The high energy charge amplifier shall process energy depositions in the 100 MeV to 100 GeV range. The characteristics of the inputs to the low energy range are summarized in Table 9.3.
Level IV: 9.1.11	The GCFE ASIC shall accept a precision calibration voltage from an external DAC as a reference voltage for a calibration charge injection system.
Level IV: 9.1.11.1	The test charge injection system shall be capable of testing the entire dynamic range of the GCFE ASIC.
Level IV: 9.1.3.6	The LEX1 amplifier of the low energy channel shall process the entire low energy charge amplifier range, i.e. nominally 1.6 GeV maximum energy.
Level IV: 9.1.3.7	The LEX8 amplifier of the low energy channel shall process the lowest eighth of the low energy charge amplifier range, i.e. nominally 200 MeV maximum energy.
Level IV: 9.1.3.8	The HEX1 amplifier of the high energy channel shall process the entire high energy charge amplifier range, i.e. nominally 100 GeV maximum energy.
Level IV: 9.1.3.9	The HEX8 amplifier of the high energy channel shall process the lowest eighth of the high energy charge amplifier range, i.e. nominally 12.5 GeV maximum energy.
Level IV: 9.1.5	The maximum non-linearity in each of the four ranges: LEX8, LEX1, HEX8, and HEX1 shall be 1% of full range.
Level IV: 9.1.14.3	a)The output of the buffer amplifier for each of the four amplifier ranges shall be monotonically increasing with charge input over the top 99.9% of the energy range. b)The integral non-linearity shall be less than +/- 0.5% of full scale. This is the deviation of the best fit

	straight line from the measured amplitudes over the top 99% of the energy range.
Level IV: 9.2.1.3	The maximum non-linearity of the ADC shall be 0.5% of full range.

PREREQUISITES

`calu_collect_ci_singlex16 with full four range readout`

REQUIRED EGSE

LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES

`Events File:`
yymmddhhmmss_FMx_calu_collect_ci_singlex16.fits

Note: Tests can be run without the following information, but characterization in energy terms cannot be performed

ADC to Energy Conversion Table.

Pedestals Table

Relative Gain Table

GENERATED OUTPUT FILES

`Test Report:`
`yymmddhhmmss_FMx_calf_adc_p02.html`

`Noise Pedestals Table:`
`yymmddhhmmss_FMx_pedestals.fits`
`Noise Pedestal Statistics:`
`yymmddhhmmss_FMx_pedestals_stats.csv`

COMPLETION STATUSES

```
PASS
IPASS (Incomplete Pass - partial system…only applicable to development
       phase)
FAIL
ABORT
```

DESCRIPTION

Algorithm

Setup

Collect data

For each Charge Injection (CI) setting; cidx = bDAC, eDAC,iDAC (default cidx = 0,4096,16)
  For N samples, sidx=0,199 (default = 200)
    read 4 range event data, data[4,8,2,12,sidx]
  Compute Mean for each component and energy range, mean[4,8,2,12,cidx]
  Compute standard deviation for each component and energy range, noise[4,8,2,12,cidx]
  Check for railed component, *if data = 0xfff, then upper limit (ul) = previous cidx*
  Check for plateaued component, if mean[…,cidx] – mean[…cidx-1] < tolerance, upper limit (ul) = previous cidx

Analyze

Using least squares method, fit line to mean
Generate distribution of deviation of mean values to fitted line, non-linearity measurements

Extract max non-linearity and average non-linearity and compare to criteria
Extract max noise and average noise measures from the noise distribution and compare to criteria

If gain of the component at which the data was taken the lowest setting and if the ADC to energy conversion table is available, then compute maximum energy value for each range and compare against criteria

COMMENTS

Assumptions?

1. To minimize mean and noise statistic skewing, this test defines the upper ADC range limit for any FE to be the maximum ADC mean value for which none of the samples contributing to this mean are railed ADC values (4096). The result of this definition is that "noisy" FEs may be assigned a lower maximum ADC value that affects the maximum energy determination.

2. For some FE energy ranges, the maximum input analog (reference DAC or Charge Injection) does not rail the ADC but instead the ADC result "plateaus" after some input analog interval. To make non-linearity evaluation practical, this test defines the upper ADC range limit for FE energy range in this case to be the maximum ADC mean value which does not deviate more than 10% from a line obtained from a linear fit of all the previous ADC mean values. The method for determining an upper limit will be referred to as the ADC "plateau" method.

3. The test for Integral non-linearity is not gain specific. To test integral non-linearity for a given gain involves collecting event data at the requested gain and then applying the integral non-linearity test procedure to that data. A "suite" for testing integral non-linearity over one or more gains can be formed by "chaining" test procedure calf_adc_p02 along with calu_collect_ci for each gain setting. The report from that test would reference the individual calu_collect_ci and calf_adc_p02 reports.

7.2.10. Evaluate channel droop

NAME	TEST ID	SVAC ID
calf_adc_p05	CAL	
ALIASES	**SUPERCEDES**	**CATEGORY**
None	None	CAL

SYNOPSIS

Evaluate channel droop.

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION

Level IV: 9.1.4.3 The T&H circuit shall be capable of holding a constant signal amplitude for > 100 usec with less than 0.1% droop for a signal amplitude dynamic range of 500 (TBR).

PREREQUISITES

calu_collect_ci_singlex16 with full four range readout and all 4 range first combinations.

REQUIRED EGSE

LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Events File: yymmddhhmmss_FMx_calu_collect_ci_singlex16.fits Note: Tests can be run without the following information, but characterization in energy terms cannot be performed ADC to Energy Conversion Table. Pedestals Table Relative Gain Table	Test Report: yymmddhhmmss_FMx_calf_adc_p03.html Plots file: yymmddhhmmss_FMx_calf_adc_p03.pdf

COMPLETION STATUSES

PASS
IPASS (Incomplete Pass – partial system…only applicable to development phase)
FAIL
ABORT

DESCRIPTION

Algorithm

Setup

Collect data

For each Range order, ridx = 0,3
  For each Charge Injection (CI) setting; cidx = bDAC, eDAC,iDAC (default cidx = 0,4096,16)
    For N samples, sidx=0,199 (default = 200)
      read 4 range event data, data[4,8,2,12,ridx,sidx]
  Compute Mean for each component and energy range, mean[4,8,2,12,cidx]
  Compute standard deviation for each component and energy range, noise[4,8,2,12,cidx]
  Check for railed component, *if data = 0xfff, then upper limit (ul) = previous cidx*
  Check for plateaued component, *if mean[…,cidx] – mean[…cidx-1] < tolerance, upper limit (ul) = previous cidx*

Analyze

Normalize means.
Compare normalized range order mean value differences to criteria.

COMMENTS

Assumptions?

1. Processing each range of a four range readout requires approximately 14 usec at a clock frequency of 20 Mhz. This time factor is assumed in the droop evaluation algorithm and means that a droop check over more than 56 usec with this test is not possible.

7.2.11. CAL Noisy Channels

NAME	TEST ID	SVAC ID
	CAL	C22
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS
Manual procedure to generate/update CAL noisy channels list

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION
SVAC C22

PREREQUISITES
Calf_adc_p02

Calf_trg_p03

Calf_supp_p01

REQUIRED EGSE

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Yymmddhhmmss_FMx_calf_adc_p02.html Yymmddhhmmss_FMx_calf_supp_p01.html Yymmddhhmmss_FMx_calf_trg_p03.html	CAL Noisy Channel File: Yymmddhhmmss_calu_noisy_channel_list.xml (actual format TBD)

COMPLETION STATUSES
Not Applicable (manual procedure)

DESCRIPTION
This is a manual procedure (for now)

1. Evaluate Yymmddhhmmss_FMx_calf_adc_p02.html reports for noisy channels and add them to noisy channel list
2. Evaluate Yymmddhhmmss_FMx_calf_supp_p01.html reports for channels which do not suppress data over a required range and add them to the noisy channel list for at least the LEX8 energy channel and possibly more.
3. Evaluate Yymmddhhmmss_FMx_calf_trg_p03.html reports for channels which do not trigger data over a required range and add them to the noisy channel list for at least the LEX8 energy channel and possibly more.

COMMENTS

1. CAL defines a channel to be one energy range from a crystal front end (FE). Therefore each crystal FE represents 4 channels for a total of 768 channels per Calorimeter (4 x 8 x 2 x 12).
2. Format of CAL's contribution to the noisy channel file needs to be defined.

7.2.12. CAL Dead Channels

NAME	TEST ID	SVAC ID
	CAL	C23
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS
Manual procedure to generate/update CAL dead channels list

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION
SVAC C23

PREREQUISITES
Calf_adc_p02

Calf_exr_p01

REQUIRED EGSE

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Yymmddhhmmss_FMx_calf_adc_p02.html Yymmddhhmmss_FMx_calf_exr_p01.html	CAL Dead Channel File: Yymmddhhmmss_calu_dead_channels_list.xml (actual format TBD)

COMPLETION STATUSES
Not Applicable (manual procedure)

DESCRIPTION
This is a manual procedure (for now)

4. Evaluate Yymmddhhmmss_FMx_calf_adc_p02.html reports for unresponsive channels and add them to dead channel list
5. Evaluate Yymmddhhmmss_FMx_calf_exr_p01.html reports for commanding problems and add them to the dead channel list.

COMMENTS

3. CAL defines a channel to be one energy range from a crystal front end (FE). Therefore each crystal FE represents 4 channels for a total of 768 channels per Calorimeter (4 x 8 x 2 x 12).
4. Format of CAL's contribution to the dead channel file needs to be defined.

7.2.13. CAL LO Discriminator

Attached is a draft of the CAL LO Discriminator procedures. It consists of 5 procedures;
calf_trg_p03 to characterize the Low Energy Discriminator DAC
calu_genFleTable to use that characterization table to produce an FLE trigger threshold table
calf_trg_p05 to generate an FLE trigger threshold table based on noise pedestals
calf_trg_p01 to evaluate the independence of the trigger enable/disable logic
calf_trg_p04 to characterize and evaluate the trigger arrival time behavior

calu_genLacTable is dependent on calf_supp_p01 as stated in its prerequisites

The same issues that Eduardo had with the zero data-suppression procedures also exist with these procedures.

7.2.13.1. CAL LO Discriminator 1

NAME	TEST ID	SVAC ID
CALF_TRG_P03	CAL	C24
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS
Characterize the CAL Low Energy Discriminator wrt ADC settings

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION

Level III: 5.9	Low Energy Trigger Signal: CAL to provide low energy trigger signal to the LAT trigger system..
Level IV: 9.1.10	The outputs of the two 0.5 usec shaping amplifiers (FHE and FLE) are connected to discriminators. The two outputs of the trigger discriminators logic are provided to external logic which forms the calorimeter trigger request inputs to the GLAST trigger system.
Level IV: 9.1.10.3	The low energy trigger (FLE) discriminator level shall be adjustable by command input to DACs inside the ASIC. Two adjustment ranges shall be provided: lowest energies (<~60 MeV) with ~ 1 MeV resolution and moderate energies (<~400 MeV) with ~ 5 MeV resolution.

PREREQUISITES
CALU_INIT

REQUIRED EGSE
LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
	Test Report:

ADC to Energy Conversion Table.
 	
Pedestals Table
 	
Relative Gain Table
 	
Note: Tests can be run without the above mentioned information, but characterization in energy terms cannot be performed
	`yymmddhhmmss_FMx_calf_trg_p03.html`
	`Register Snapshot:`
	`yymmddhhmmss_FMx_calf_trg_p03.xml`
	`FLE to ADC conversion Table:`
	`yymmddhhmmss_FMx_fle2dac.fits`
	`FLE DAC characterization Plots:`
	`yymmddhhmmss_FMx_calf_trg_p03.pdf`

COMPLETION STATUSES

```
PASS
IPASS (Incomplete Pass - partial system…only applicable to development
       phase)
FAIL
ABORT
```

DESCRIPTION

Setup:

Nominal with the following changes:
Tack Delay setting = CI_TIMED_PEAK
GLT data suppress = TRUE
Gain setting = Nominal

Collect FLE/FHE DAC characterization data

For each of 2 cases (case 0 = FLE DAC)
(case 1 = FHE DAC)
For each FST DAC setting, *fstDacidx = 0 to 127 default*
For each column, colidx = 0 to 11
For each charge injection (CI) setting, cidx=0 to 4095 and component are still suppressed
For N samples, sidx = 0 to ? default = 0
Use GLT self trigger to inject charge, delay, read event data with trigger primitive diagnostic data
If 90% of the samples had triggers from a component and , adc[fstDacidx,4,8,2,12]=adc
Save FST to ADC conversion table, adc[128,4,8,2,12], in FITS format to file

Validate FST DAC operation against criteria

Check range and resolution against criteria (by using low energy lowest gain setting or by converting collected ADC data to lowest gain equivalent)

Check linearity of DAC?

COMMENTS

7.2.13.2. CAL LO Discriminator 2

NAME	TEST ID	SVAC ID
calu_genFleTable	CAL	C26
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS

Generate an appropriate Low Energy Discriminator threshold Table given a “target” threshold energy usin an appropriate FLE Discriminator Characterization Table

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION

LAT-MD-0446-05 GLAST LAT Science Verification Analysis and Calibration (SVAC) Plan, section 5.3 SVAC Complicance, Table item C24

PREREQUISITES

CALF_TRG_P03

REQUIRED EGSE

LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
ADC to Energy Conversion Table. Pedestals Table Relative Gain Table calParams.cfg (Calorimeter environment configuration file)	FLE Trigger Threshold Table: yymmddhhmmss_FMx_fle.xml

COMPLETION STATUSES

PASS
IPASS (Incomplete Pass - partial system…only applicable to development phase)
FAIL
ABORT

DESCRIPTION

Setup:

Read fle2adc characterization table

Read ADC 2 Energy Conversion table
Read relative gain table

Obtain (from operator?) energy (MeV) to use for data suppression threshold
Obtain (from operator?) LE gain to be used.
Process:
Using the relative gain table, adjust the fle2dac characterization values to the requested gain.
Using the relative gain table, adjust the Energy to ADC conversion table to reflect the requested gain.
Using the adjusted Energy to ADC conversion table, convert the fle2dac characterization table to anfle2nrg (FLE to Energy) characterization table.
For each FE, find the minimum FLE setting whose corresponding energy in the fle2nrg characterization table is above the request energy threshold (FLE trigger threshold table, FLEThreshold[4,8,2,12])
Save FLE trigger threshold table
Save threshold table, FLEThreshhold[4,8,2,12], in xml format to file with appropriate documentation to include:

- Requested Energy Threshold
- Requested Gain
- FLE to ADC characterization table filename
- ADC to Energy conversion table filename
- Relative gain table filename
- Data generated
- Application Name “calu_genFleTable”

COMMENTS

7.2.13.3. CAL LO Discriminator 3

NAME	TEST ID	SVAC ID
CALF_TRG_P01	CAL	C24
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS

Test trigger enable/disables for functionality and independent operation.

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION

Level III: 5.9	Low Energy Trigger Signal: CAL to provide low energy trigger signal to the LAT trigger system..
Level IV: 9.1.10.2	Each of the two trigger signals shall be individually enabled or disabled by command input to the ASIC.

PREREQUISITES

calu_init

REQUIRED EGSE

LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
	Test Report: yymmddhhmmss_FMx_calf_trg_p01.html Register Snapshot: yymmddhhmmss_FMx_calf_trg_p01.xml Trigger Enable Table: Yymmddhhmmss_FMx_calu_trg.xml

COMPLETION STATUSES

PASS
IPASS (Incomplete Pass – partial system…only applicable to development phase)
FAIL
ABORT

DESCRIPTION

Setup:

Nominal with the following changes:
Tack Delay setting = CI_TIMED_PEAK
GLT trigger mask = Disabled
Enable LRS counting for everything (lrs_counter_mask = 0)

Process:

Sequence thru each FE (all TEMs at once)

```
temb = lat.allTEM()
For trgMode (0=LE triggers, 1 = HE trigger)
  For ccIdx =0 to 3
    cc = temb.downCCC(ccIdx)
    If  cc is valid
      For rcIdx=0 to 3
        rc = cc.downCRC(rcIdx)
        If rc is valid
          For feIdx=0 to 3
            fe = rc.downCFE(feIdx)
            if fe is valid
              Clear lrs_counters (broadcast temb.gtic.lrs_counters=0)
               Verify counters are zeros
                For temIdx=0 to 15
                If lat.downTEM(temIdx).downTIC().lrs_counters <>0
                    PassflagtrgMode,[temIdx,ccIdx,rcIdx,feIdx]=FAILED
                Enable trigger (fe.config_1 = 0x380 | trgMode <<1)
                Inject Charge (rc.calStrobe=1)
                Wait for fast shaper peak logic to complete (.01 seconds)
                Read and verify trigger counters
                For temIdx=0 to 15
                If lat.downTEM(temIdx).downTIC().lrs_counters <=0
                    Passflag[trgMode,temIdx,ccIdx,rcIdx,feIdx]=FAILED
                  If lat.downTEM(temIdx).downTIC().lrs_counters >1
                    MultpleTriggerflag[trgMode,temIdx,ccIdx,rcIdx,feIdx]=TRUE
              Clear lrs_counters (broadcast temb.gtic.lrs_counters=0)
               Verify counters are zeros
                For temIdx=0 to 15
                If lat.downTEM(temIdx).downTIC().lrs_counters <>0
                    PassflagtrgMode,[temIdx,ccIdx,rcIdx,feIdx]=FAILED
                Disable trigger (fe.config_1 = 0x380)
                Inject Charge (rc.calStrobe=1)
                Wait for fast shaper peak logic to complete (.01 seconds)
                 Read and verify trigger counters
                 For temIdx=0 to 15
                If lat.downTEM(temIdx).downTIC().lrs_counters >0
                    Passflag[trgMode,temIdx,ccIdx,rcIdx,feIdx]=FAILED
```

COMMENTS

7.2.13.4. CAL LO Discriminator 4

NAME	TEST ID	SVAC ID
CALF_TRG_P04	CAL	C24
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS
Characterize trigger arrival time

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION

Level III: 5.9	Low Energy Trigger Signal: CAL to provide low energy trigger signal to the LAT trigger system..
Level IV: 9.1.3.1	The low energy fast shaped signals shall peak at 0.5 +/- 0.2 usec.
Level IV: 9.1.10.1	The variation in time of the leading edge of the trigger output from the time of energy deposition shall be less than +/- 0.2 usec.

PREREQUISITES
calu_init

REQUIRED EGSE
LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
CI_TIMED_TRIGGER (expected trigger primitive present Tack delay value for timed Charge Injection stimulus) Note: Tests can be run without the above mentioned information, but characterization in energy terms cannot be performed	Test Report: yymmddhhmmss_FMx_calf_trg_p04.html Register Snapshot: yymmddhhmmss_FMx_calf_trg_p04.xml Events File: yymmddhhmmss_FMx_calf_trg_p04.fits

COMPLETION STATUSES
PASS
IPASS (Incomplete Pass – partial system…only applicable to development phase)
FAIL
ABORT

DESCRIPTION
Setup:
Nominal with the following changes:

Tack Delay setting = CI_TIMED_PEAK
Setup for trigger primitive acquisition
Use one range readout suppressed data mode

Collect Data:

For temIdx=0 to 15
For feIdx=0 to 11
Enable triggers for this "column" of FEs (lat.downTEM(temIdx).allCCC().allCRC(),downCFE(feIdx).config_1= 0x3E)
For tackDelaySetting = 0 to 255
Set tack delay (tem.cal_trgSeq = tackDelaySetting
For nsamples
Use Timed trigger to inject charge and acquire event data
Decom event data and get trigger primitive state
Count triggers (increment triggers[temIdx,trgIdx,ccIdx,rcIdx,endIdx,feIdx,tackDelaySetting]

Process Data:

Convert trigger count array into trigger percentage (trgPct=triggers[…]/nsamples)
Convert trgPct array to triggered array (trgd[…] = 1 if trgPct[…] > 90%)
Look for "dropouts"
Generate distribution of trigger tack delays (trgTime[...] = min(where trgd[…]>0]
Compute the mode of the triggered tack delay times (trgMode =stats.mode(trgTime))
Compare mode to expected value (if abs(trgMode -CI_TIMED_TRIGGER) > tolerance then FAILED)
Compare each FEs triggered time to trgMode (if abs(trgTime[…]-trgMode)>.2usec then FAILED)
Convert trgPct array to untriggered array(untrgd[…] = 1 if trgPct[…] < 10%)
Look for "dropouts"
Generate distribution of untrigger tack delays (untrgTime[...] = max(where trgd[…]>1]
Generate distribution of trigger uncertainty times (diff = trgTime[]-untrgTime[])
Compute mean and standard deviation of trigger uncertainty time and evaluate individual FE responses based on these statistics

COMMENTS

7.2.13.5. CAL LO Discriminator 5

NAME	TEST ID	SVAC ID
CALF_TRG_P05	CAL	C24
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS

Generate an FLE trigger discriminator table using noise pedestals as thresholds.

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION

LAT-MD-0446-05 GLAST LAT Science Verification Analysis and Calibration (SVAC) Plan, section 5.3 SVAC Complicance, Table item C24

PREREQUISITES

calu_init

REQUIRED EGSE

LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
ADC to Energy Conversion Table. Pedestals Table Relative Gain Table Note: Tests can be run without the above mentioned information, but characterization in energy terms cannot be performed	Test Report: yymmddhhmmss_FMx_calf_trg_p05.html Register Snapshot: yymmddhhmmss_FMx_calf_trg_p05.xml Events File: yymmddhhmmss_FMx_calf_trg_p05.fits FLE Trigger Noise Pedestal Threshold Discriminator Table: yymmddhhmmss_FMx_calu_fle.xml

COMPLETION STATUSES

PASS
IPASS (Incomplete Pass - partial system…only applicable to development phase)
FAIL
ABORT

DESCRIPTION

TBD

COMMENTS

7.2.14. CAL HI Discriminator

Below is a draft of the CAL HI Discriminator procedures. It consists of 5 procedures;
calf_trg_p03 to characterize the High Energy Discriminator DAC
calu_genFheTable to use that characterization table to produce an FHE trigger threshold table
calf_trg_p05 to generate an FHE trigger threshold table based on noise pedestals
calf_trg_p01 to evaluate the independence of the trigger enable/disable logic
calf_trg_p04 to characterize and evaluate the trigger arrival time behavior

calu_genFheTable is dependent on calf_trg_p03 as stated in its prerequisites

As you can see, the same procedures are used for low and high energy trigger processing. The procedures are written to allow processing low and/or high triggers.

7.2.14.1. CAL HI Discriminator 1

NAME	TEST ID	SVAC ID
CALF_TRG_P03	CAL	C24
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS
Characterize the CAL High Energy Discriminator wrt ADC settings

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION

Level III: 5.10	High Energy Trigger Signal: CAL to provide high energy trigger signal to the LAT trigger system.
Level IV: 9.1.10.4	The high energy trigger (FHE) discriminator level shall be adjustable by command input to DACs inside the ASIC. The range of adjustment shall include the lowest 25% of the high energy charge amplifier range (<~25 GeV) and have ~ 200 MeV resolution.

PREREQUISITES
CALU_INIT

REQUIRED EGSE
LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
ADC to Energy Conversion Table. Pedestals Table Relative Gain Table	Test Report: yymmddhhmmss_FMx_calf_trg_p03.html Register Snapshot: yymmddhhmmss_FMx_calf_trg_p03.xml FHE to ADC conversion Table: yymmddhhmmss_FMx_fhe2dac.fits

Note: Tests can be run without the above mentioned information, but characterization in energy terms cannot be performed	FHE DAC characterization Plots: yymmddhhmmss_FMx_calf_trg_p03.pdf

COMPLETION STATUSES

PASS
IPASS (Incomplete Pass - partial system…only applicable to development phase)
FAIL
ABORT

DESCRIPTION

Setup:

Nominal with the following changes:
Tack Delay setting = CI_TIMED_PEAK
GLT data suppress = TRUE
Gain setting = Nominal

Collect FLE/FHE DAC characterization data

For each of 2 cases (case 0 = FLE DAC)
(case 1 = FHE DAC)
For each FST DAC setting, *fstDacidx = 0 to 127 default*
For each column, colidx = 0 to 11
For each charge injection (CI) setting, cidx=0 to 4095 and component are still suppressed
For N samples, sidx = 0 to ? default = 0
Use GLT self trigger to inject charge, delay, read event data with trigger primitive diagnostic data
If 90% of the samples had triggers from a component and , adc[fstDacidx,4,8,2,12]=adc
Save FST to ADC conversion table, adc[128,4,8,2,12], in FITS format to file

Validate FST DAC operation against criteria

Check range and resolution against criteria (by using low energy lowest gain setting or by converting collected ADC data to lowest gain equivalent)
Check linearity of DAC?

COMMENTS

7.2.14.2. CAL HI Discriminator 2

NAME	TEST ID	SVAC ID
calu_genFheTable	CAL	C26
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS

Generate an appropriate High Energy Discriminator threshold Table given a "target" threshold energy using an appropriate FHE Discriminator Characterization Table

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION

LAT-MD-0446-05 GLAST LAT Science Verification Analysis and Calibration (SVAC) Plan, section 5.3 SVAC Complicance, Table item C24

PREREQUISITES

CALF_TRG_P03

REQUIRED EGSE

LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
ADC to Energy Conversion Table. Pedestals Table Relative Gain Table calParams.cfg (Calorimeter environment configuration file)	FHE Trigger Threshold Table: yymmddhhmmss_FMx_calu_fhe.xml

COMPLETION STATUSES

PASS
IPASS (Incomplete Pass - partial system…only applicable to development phase)
FAIL
ABORT

DESCRIPTION

Setup:

Read fhe2adc characterization table

Read ADC 2 Energy Conversion table
Read relative gain table

Obtain (from operator?) energy (MeV) to use for data suppression threshold
Obtain (from operator?) HE gain to be used.
Process:
Using the relative gain table, adjust the fhe2dac characterization values to the requested gain.
Using the relative gain table, adjust the Energy to ADC conversion table to reflect the requested gain.
Using the adjusted Energy to ADC conversion table, convert the fhe2dac characterization table to anfhe2nrg (FHE to Energy) characterization table.
For each FE, find the minimum FHE setting whose corresponding energy in the fhe2nrg characterization table is above the request energy threshold (FHE trigger threshold table, FHEThreshold[4,8,2,12])
Save FHE trigger threshold table
Save threshold table, FHEThreshhold[4,8,2,12], in xml format to file with appropriate documentation to include:

- Requested Energy Threshold
- Requested Gain
- FHE to ADC characterization table filename
- ADC to Energy conversion table filename
- Relative gain table filename
- Data generated
- Application Name “calu_genFheTable”

COMMENTS

7.2.14.3. CAL HI Discriminator 3

NAME	TEST ID	SVAC ID
CALF_TRG_P01	CAL	C24
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS

Test trigger enable/disables for functionality and independent operation.

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION

Level III: 5.10	High Energy Trigger Signal: CAL to provide high energy trigger signal to the LAT trigger system.
Level IV: 9.1.10.2	Each of the two trigger signals shall be individually enabled or disabled by command input to the ASIC.

PREREQUISITES

calu_init

REQUIRED EGSE

LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
	Test Report: yymmddhhmmss_FMx_calf_trg_p01.html Register Snapshot: yymmddhhmmss_FMx_calf_trg_p01.xml Trigger Enable Table: Yymmddhhmmss_FMx_calu_trg.xml

COMPLETION STATUSES

PASS
IPASS (Incomplete Pass – partial system…only applicable to development phase)
FAIL
ABORT

DESCRIPTION

Setup:

Nominal with the following changes:
Tack Delay setting = CI_TIMED_PEAK
GLT trigger mask = Disabled
Enable LRS counting for everything (lrs_counter_mask = 0)

Process:

Sequence thru each FE (all TEMs at once)

```
temb = lat.allTEM()
For trgMode (0=LE triggers, 1 = HE trigger)
  For ccIdx =0 to 3
    cc = temb.downCCC(ccIdx)
    If  cc is valid
      For rcIdx=0 to 3
        rc = cc.downCRC(rcIdx)
        If rc is valid
          For feIdx=0 to 3
            fe = rc.downCFE(feIdx)
            if fe is valid
              Clear lrs_counters (broadcast temb.gtic.lrs_counters=0)
               Verify counters are zeros
                For temIdx=0 to 15
                If lat.downTEM(temIdx).downTIC().lrs_counters <>0
                    PassflagtrgMode,[temIdx,ccIdx,rcIdx,feIdx]=FAILED
                Enable trigger (fe.config_1 = 0x380 | trgMode <<1)
                Inject Charge (rc.calStrobe=1)
                Wait for fast shaper peak logic to complete (.01 seconds)
                Read and verify trigger counters
                For temIdx=0 to 15
                If lat.downTEM(temIdx).downTIC().lrs_counters <=0
                    Passflag[trgMode,temIdx,ccIdx,rcIdx,feIdx]=FAILED
                  If lat.downTEM(temIdx).downTIC().lrs_counters >1
                    MultpleTriggerflag[trgMode,temIdx,ccIdx,rcIdx,feIdx]=TRUE
              Clear lrs_counters (broadcast temb.gtic.lrs_counters=0)
               Verify counters are zeros
                For temIdx=0 to 15
                If lat.downTEM(temIdx).downTIC().lrs_counters <>0
                    PassflagtrgMode,[temIdx,ccIdx,rcIdx,feIdx]=FAILED
                Disable trigger (fe.config_1 = 0x380)
                Inject Charge (rc.calStrobe=1)
                Wait for fast shaper peak logic to complete (.01 seconds)
                 Read and verify trigger counters
                 For temIdx=0 to 15
                If lat.downTEM(temIdx).downTIC().lrs_counters >0
                    Passflag[trgMode,temIdx,ccIdx,rcIdx,feIdx]=FAILED
```

COMMENTS

7.2.14.4. CAL HI Discriminator 4

NAME	TEST ID	SVAC ID
CALF_TRG_P04	CAL	C24
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS
Characterize trigger arrival time

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION

Level IV: 9.1.3.3	The high energy fast shaped signals shall peak at 0.5 +/- 0.2 usec.
Level IV: 9.1.10	The outputs of the two 0.5 usec shaping amplifiers (FHE and FLE) are connected to discriminators. The two outputs of the trigger discriminators logic are provided to external logic which forms the calorimeter trigger request inputs to the GLAST trigger system.
Level IV: 9.1.10.1	The variation in time of the leading edge of the trigger output from the time of energy deposition shall be less than +/- 0.2 usec.
Level IV: 9.5	The calorimeter shall provide a prompt (within 2 us of an event) high-energy trigger signal with a detection efficiency of 90% (TBR) for 50 GeV gamma rays entering the calorimeter from the LAT field of view with a trajectory which traverses at least 8 RL of CsI.

PREREQUISITES
calu_init

REQUIRED EGSE
LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
CI_TIMED_TRIGGER (expected trigger primitive present Tack delay value for timed Charge Injection stimulus) Note: Tests can be run without the above mentioned information, but characterization in energy terms cannot be performed	Test Report: yymmddhhmmss_FMx_calf_trg_p04.html Register Snapshot: yymmddhhmmss_FMx_calf_trg_p04.xml Events File: yymmddhhmmss_FMx_calf_trg_p04.fits

COMPLETION STATUSES
PASS
IPASS (Incomplete Pass – partial system…only applicable to development

```
        phase)
  FAIL
  ABORT
```

DESCRIPTION

Setup:

Nominal with the following changes:
Tack Delay setting = CI_TIMED_PEAK
Setup for trigger primitive acquisition
Use one range readout suppressed data mode

Collect Data:

For temIdx=0 to 15
For feIdx=0 to 11
Enable triggers for this "column" of FEs (lat.downTEM(temIdx).allCCC().allCRC(),downCFE(feIdx).config_1= 0x3E)
For tackDelaySetting = 0 to 255
Set tack delay (tem.cal_trgSeq = tackDelaySetting
For nsamples
Use Timed trigger to inject charge and acquire event data
Decom event data and get trigger primitive state
Count triggers (increment triggers[temIdx,trgIdx,ccIdx,rcIdx,endIdx,feIdx,tackDelaySetting]

Process Data:

Convert trigger count array into trigger percentage (trgPct=triggers[…]/nsamples)
Convert trgPct array to triggered array (trgd[…] = 1 if trgPct[…] > 90%)
Look for "dropouts"
Generate distribution of trigger tack delays (trgTime[...] = min(where trgd[…]>0]
Compute the mode of the triggered tack delay times (trgMode =stats.mode(trgTime))
Compare mode to expected value (if abs(trgMode -CI_TIMED_TRIGGER) > tolerance then FAILED)
Compare each FEs triggered time to trgMode (if abs(trgTime[…]-trgMode)>.2usec then FAILED)
Convert trgPct array to untriggered array(untrgd[…] = 1 if trgPct[…] < 10%)
Look for "dropouts"
Generate distribution of untrigger tack delays (untrgTime[...] = max(where trgd[…]>1]
Generate distribution of trigger uncertainty times (diff = trgTime[]-untrgTime[])
Compute mean and standard deviation of trigger uncertainty time and evaluate individual FE responses based on these statistics

COMMENTS

7.2.14.5. CAL HI Discriminator 5

NAME	TEST ID	SVAC ID
CALF_TRG_P05	CAL	C24
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS

Generate an FHE trigger discriminator table using noise pedestals as thresholds.

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION

LAT-MD-0446-05 GLAST LAT Science Verification Analysis and Calibration (SVAC) Plan, section 5.3 SVAC Complicance, Table item C24

PREREQUISITES

calu_init

REQUIRED EGSE

LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
ADC to Energy Conversion Table. Pedestals Table Relative Gain Table Note: Tests can be run without the above mentioned information, but characterization in energy terms cannot be performed	Test Report: yymmddhhmmss_FMx_calf_trg_p05.html Register Snapshot: yymmddhhmmss_FMx_calf_trg_p05.xml Events File: yymmddhhmmss_FMx_calf_trg_p05.fits FHE Trigger Noise Pedestal Threshold Discriminator Table: yymmddhhmmss_FMx_calu_fhe.xml

COMPLETION STATUSES

PASS
IPASS (Incomplete Pass - partial system…only applicable to development phase)
FAIL
ABORT

DESCRIPTION

TBD

COMMENTS

7.2.15. CAL Zero-Suppress Thresh.

Below is a draft of the CAL zero-suppress threshold procedures. It consists of 3 procedures;
calf_supp_p01 to characterize the data suppress DAC
calu_genLacTable to use that characterization table to produce a threshold table
calf_supp_p02 to generate a noise pedestal threshold table

calu_genLacTable is dependent on calf_supp_p01 as stated in its prerequisites

7.2.15.1. CAL Zero-Suppress Thresh. 1

NAME	TEST ID	SVAC ID
CALF_SUPP_P01	CAL	C26
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS
Characterize the Log Accept Discriminator wrt ADC settings

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION

Level IV: 9.1.9.1	The amplitude of the LEX8 output shall be compared with a programmable threshold, the accept lower level discriminator, to identify CsI crystals with measurable energy depositions. This crystal-accept signal shall be transmitted to external logic for determination of crystals to be included in the event readout message.
Level IV: 9.1.9.2	The accept discriminator level shall be adjustable by command to the ASIC a) with adjustment resolution of ~0.25 MeV b) over the lowest approximately 10% of the LEX8 energy range.

PREREQUISITES
CALU_INIT

REQUIRED EGSE
LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
ADC to Energy Conversion Table. Pedestals Table Relative Gain Table Note: Tests can be run without the above mentioned information, but characterization in energy terms cannot be performed	Test Report: yymmddhhmmss_FMx_calf_supp_p01.html Register Snapshot: yymmddhhmmss_FMx_calf_supp_p01.xml LAC 2 ADC conversion Table: yymmddhhmmss_FMx_lac2dac.fits LAC DAC characterization Plots: yymmddhhmmss_FMx_calf_supp_p01.pdf

COMPLETION STATUSES

```
PASS
IPASS (Incomplete Pass - partial system…only applicable to development
       phase)
FAIL
ABORT
```

DESCRIPTION

Setup:

Nominal with the following changes:

Tack Delay setting = CI_TIMED_PEAK
GLT data suppress = TRUE
Gain setting = Nominal

Collect suppression data

For each of 3 cases (case 0 = + LAC DACs set to maximum, - LAC DACs varied)
(case 1 = - LAC DACs set to maximum, + LAC DACs varied)
(case 2 = -/+ LAC DACs varied; result should be equal to the lower threshold of cases 0 & 1)

For each LAC DAC setting, *lacDacidx = 0 to 127 default*
For each charge injection (CI) setting, cidx=0 to 4095 and not all component thresholds found
For N samples, default = 10?
Use GLT self trigger to inject charge, delay, read event data
For each channel (FE), save the average ADC reading obtained from the first charge injection setting, cidx, that causes data from that channel to be present in the event readouts for 90% of the samples,
adc[lacDacidx,4,8,3,12] = ADC
Save LAC to ADC conversion table, ADC[128,4,8,2,12], in FITS format to file.

Validate LAC DAC operation against criteria

Check range and resolution against criteria (by using low energy lowest gain setting or by converting collected ADC data to lowest gain equivalent?)
Verify case 2 results equal minimum of case0 and case 1 results.

COMMENTS

7.2.15.2. CAL Zero-Suppress Thresh. 2

NAME	TEST ID	SVAC ID
calu_genLacTable	CAL	C26
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS

Generate an appropriate Data Suppression Table for a specified energy given a LAC Discriminator Characterization Table and corresponding ADC to Energy Conversion Table

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION

LAT-MD-0446-05 GLAST LAT Science Verification Analysis and Calibration (SVAC) Plan, section 5.3 SVAC Complicance, Table item C26

PREREQUISITES

CALF_SUPP_P01

REQUIRED EGSE

LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
ADC to Energy Conversion Table. Pedestals Table Relative Gain Table	LAC 2 ADC conversion Table: yymmddhhmmss_FMx_lac.xml

COMPLETION STATUSES

PASS
IPASS (Incomplete Pass – partial system…only applicable to development phase)
FAIL
ABORT

DESCRIPTION

Setup:

Read Lac2ADC characterization

Read ADC 2 Energy Conversion table
Read relative gain table
Obtain (from operator?) energy (MeV) to use for data suppression threshold
Obtain (from operator?) LE gain to be used.

Process:

Using the relative gain table, adjust the lac2ADC characterization values to the requested gain.
Using the relative gain table, adjust the Energy to ADC conversion table to reflect the requested gain.
Using the adjusted Energy to ADC conversion table, convert the Lac2ADC characterization table to an Lac2NRG (LAC to Energy) characterization table.
For each FE, find the minimum LAC setting whose corresponding energy in the Lac2NRG characterization table is above the request energy threshold (LAC threshold table, LACThreshold[4,8,2,12])

Save LAC threshold table

Save threshold table, LACThreshhold[4,8,2,12], in xml format to file with appropriate documentation to include:

- Requested Energy Threshold
- Requested Gain
- LAC to ADC characterization table filename
- ADC to Energy conversion table filename
- Relative gain table filename
- Data generated
- Application Name “calu_genLacTable”

COMMENTS

7.2.15.3. CAL Zero-Suppress Thresh. 3

NAME	TEST ID	SVAC ID
CALF_SUPP_P02	CAL	C26
ALIASES	SUPERCEDES	CATEGORY
None	None	CAL

SYNOPSIS

Generate a pedestal noise threshold Data Suppression Table.

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
NRL/Code 7650/B. Leas	NRL/Code 7650/B.Leas

MOTIVATION

LAT-MD-0446-05 GLAST LAT Science Verification Analysis and Calibration (SVAC) Plan, section 5.3 SVAC Complicance, Table item C26

PREREQUISITES

calu_init

REQUIRED EGSE

LATTE (latest?)
SciPy package
Dislin package (if hardcopy plots are desired)
LAT TestStand (includes TEM?)
Calorimeter
Schema describing Calorimeter ($CAL_ROOT\FMx\Configurations\FMx_schema.xml)

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
ADC to Energy Conversion Table. Pedestals Table Relative Gain Table Note: Tests can be run without the above mentioned information, but characterization in energy terms cannot be performed	Test Report: yymmddhhmmss_FMx_calf_supp_p02.html Register Snapshot: yymmddhhmmss_FMx_calf_supp_p02.xml Events File: yymmddhhmmss_FMx_calf_supp_p02.fits LAC Noise Pedestal Threshold Discriminator Table: yymmddhhmmss_FMx_lac.xml

COMPLETION STATUSES

PASS
IPASS (Incomplete Pass – partial system…only applicable to development phase)
FAIL
ABORT

DESCRIPTION

Setup:

Nominal with the following changes:
Tack Delay setting = CI_TIMED_PEAK
GLT data suppress = TRUE
Gain setting = Nominal
Disable calibration enable bits (config_1 = 0x80)

Collect suppression data

Initialize LACThreshhold[4,8,2,12] = -1
For each of 2 cases (case 0 = + LAC DACs set to maximum, - LAC DACs varied)
(case 1 = - LAC DACs set to maximum, + LAC DACs varied)

For each LAC DAC setting, *lacDacidx = 63 to 0*
For N samples, default = 10?
Use GLT self trigger inject no charge, delay, read event data
For each channel (FE), save the LAC reading obtained from the first charge injection setting, cidx, that causes data from that channel to be present in the event readouts for 90% of the samples, LACThreshhold[4,8,2,12] = lacDacidx

Check against Criteria

Flag channels with LACThreshhold = -1 for not having a range low enough to allow the most-probable pedestal

Save LAC noise pedestal threshold table

Adjust LACThreshholds for a minimum LAC setting of 0 (change -1 to 0)
Save LAC noise pedestal threshold table, LACThreshhold[4,8,2,12], in xml format to file with appropriate documentation to include:

- Requested Energy Threshold
- Requested Gain
- LAC to ADC characterization table filename
- ADC to Energy conversion table filename
- Relative gain table filename
- Data generated
- Application Name “calf_supp_p02”

COMMENTS

CAL High Rate Trigger

NAME	TEST ID CAL	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY CAL
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.3. ACD (WBS 4.1.6)

7.3.1. ACD Test Script Outline (This section from D. Thompson)

ACD Functional Tests (not a single script) – **The following items must be set before starting this test: voltage (3.3V nominal), system clock frequency (20 MHz nominal).**

(Indentation indicates nested scripts – suites?)
Normal text – G2 script exists, not necessarily debugged; *Underlined italics* – Script outline exists;
Bold underlined text – Script does not exist

ACD Comprehensive Performance Test

ACD Short Functional (goal: 2 hours for this test)

ACD Electronics Short Functional (12 iterations of the Chassis Short Functional)

Chassis Short Functional (Unless otherwise noted , run with both A & B interfaces.)

1 Initial Current Measurements
GARC Registers Initial Reset Test
Initial GAFE Logic Reset Test (18)

2 Power Consumption Tests
GARC/GAFE Register Read/Write Tests (multiple small scripts)
Parity Error Detection by GARC
Maximum PHA Return Test
PHA Enable/Disable Test
PHA Threshold Test
GAFE Register Tests (18)
GAFE Broadcast Command Verification

Characterization of GAFE chips (18, A interface only)

GAFE BIAS_DAC Calibration
GAFE Hold Delay Optimization using TCI
GAFE HitMap Delay Test
GAFE VETO Calibration (using GASU hardware scalers)
GAFE Noise Test (using GASU hardware scalers)
GAFE HLD Calibration (using GASU hardware scalers)
GAFE Discriminator Enable/Disable Test (using GASU hardware scalers)
GAFE TCI Regular Range Tests
GAFE TCI High Range Tests
GAFE Parity Error Test
HitMap Width Test
HitMap Deadtime Stretch Test
VETO and ADC Crosstalk Test
ADC Start Time (TACQ) Test
TCI Comparison of VETO, Hitmap, and PHA
HVBS and PMT Aliveness
HVBS DAC Commands and HV Monitor Differential Drivers
SAA/HV Normal Modes
PMT Aliveness
Test of Look-At-Me Circuitry

7.3.2. Power-on AEM electronics

NAME	TEST ID	SVAC ID
	ACD	
ALIASES	SUPERCEDES	CATEGORY
None	None	ACD

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.3.3. Power-on FREE cards

NAME	TEST ID ACD	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY ACD
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.3.4. GAFE and GARC configure & readback

NAME	TEST ID ACD	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY ACD
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.3.5. ACD pedestal readback

NAME	TEST ID	SVAC ID
	ACD	
ALIASES	SUPERCEDES	CATEGORY
None	None	ACD

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.3.6. ACD Strobe

NAME	TEST ID	SVAC ID
	ACD	
ALIASES	SUPERCEDES	CATEGORY
None	None	ACD

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.3.7. ACD Veto Threshold

NAME	TEST ID	SVAC ID
	ACD	
ALIASES	SUPERCEDES	CATEGORY
None	None	ACD

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.3.8. ACD HLD Threshold

NAME	TEST ID	SVAC ID
	ACD	
ALIASES	SUPERCEDES	CATEGORY
None	None	ACD

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.3.9. ACD Trigger

NAME	TEST ID	SVAC ID
	ACD	
ALIASES	SUPERCEDES	CATEGORY
None	None	ACD

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.3.10. ACD Low Range PHA

NAME	TEST ID ACD	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY ACD
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.3.11. ACD High Range PHA

NAME	TEST ID	SVAC ID
	ACD	
ALIASES	SUPERCEDES	CATEGORY
None	None	ACD

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.3.12. ACD Zero-Suppress

NAME	TEST ID ACD	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY ACD
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.3.13. ACD Non-linearity

NAME	TEST ID	SVAC ID
	ACD	
ALIASES	SUPERCEDES	CATEGORY
None	None	ACD

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.3.14. ACD light tightness

NAME	TEST ID ACD	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY ACD
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.3.15. ACD Power-On High Voltage

NAME	TEST ID ACD	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY ACD
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.3.16. ACD Raise/Lower High Voltage

NAME	TEST ID ACD	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY ACD
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.3.17. ACD pedestal calculation

NAME	TEST ID ACD	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY ACD
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.3.18. ACD MIP threshold

NAME	TEST ID ACD	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY ACD
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.3.19. ACD pedestal measurement

NAME	TEST ID ACD	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY ACD
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.3.20. ACD False VETO

NAME	TEST ID ACD	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY ACD
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.3.21. ACD discriminator mask

NAME	TEST ID	SVAC ID
	ACD	
ALIASES	SUPERCEDES	CATEGORY
None	None	ACD

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.3.22. ACD Limit Check

NAME	TEST ID	SVAC ID
	ACD	
ALIASES	SUPERCEDES	CATEGORY
None	None	ACD

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.3.23. ACD Gain Calibration

NAME	TEST ID ACD	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY ACD
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.3.24. ACD SAA Mode

NAME	TEST ID ACD	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY ACD
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.3.25. ACD Operating Power Consumption

NAME	TEST ID ACD	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY ACD
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.3.26. ACD Efficiency

NAME	TEST ID	SVAC ID
	ACD	
ALIASES	SUPERCEDES	CATEGORY
None	None	ACD

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.3.27. ACD Timing

NAME	TEST ID	SVAC ID
	ACD	
ALIASES	SUPERCEDES	CATEGORY
None	None	ACD

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.3.28. ACD High Rate Trigger

NAME	TEST ID	SVAC ID
	ACD	
ALIASES	SUPERCEDES	CATEGORY
None	None	ACD

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.4. ELX (WBS 4.1.7)

7.4.1. Power Supply Assembly voltage measurement test

NAME	TEST ID	SVAC ID
PSAtest.py	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Electronics – Power supplies

SYNOPSIS
PSA voltage test

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
TBD	TBD

MOTIVATION
TBD

PREREQUISITE SUCCESSFULLY COMPLETED TEST SCRIPTS
None

REQUIRED EGSE
- GPIB
- Model ??? DVM with GPIB option
- Dummy load module

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Configuration file	Test Report

COMPLETION STATUSES
- PASSED
- FAILED

DESCRIPTION
This test measures the voltages produced by the tower Power Supply Assembly using a calibrated GPIB readable DVM and compares the result with limit values found in the configuration file. If any of the values are found to be outside of the red limits, the test fails. Bias voltages are measured against their set points as given in the configuration file. [Perhaps we should consider ramping the bias voltages and testing against several set points?] This test must be carried out using an appropriate dummy load that mimics the TEM. [Should this test perform a single measurement and/or sample (randomly?) over a configurable time period?] Results of all voltages are reported in the test report. [How do we handle the input voltage from the spacecraft battery? Do we need to carry out margin testing by ramping the battery up and down or is that already guaranteed to be okay when the PSA is delivered from ELX to I&T (e.g., by design)?]

COMMENTS
This test is normally carried out when a PSA unit is received by I&T and before a PSA unit is to be integrated with a TEM unit.

The idea of this test is to qualify a PSA unit. As described below, it is done using a dummy load and a calibrated GPIB voltmeter. Possibly an alternative way to do it is to use a "standard" TEM, perhaps not fully functional, and use its environmental quantity measurement features to satisfy this test's intention. Dummy loads would have to be applied to the TEM's cable connectors to simulate the current draw of the front ends. The "standard" TEM would have to undergo some sort of certification procedure to ensure that its calibration is correct. What do we want to do?

7.4.2. Power Supply Assembly current limit test

NAME	TEST ID ELX	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY Electronics – Power supplies
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.4.3. Power Distribution Unit voltage measurement test

NAME	TEST ID ELX	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY Electronics – Power supplies
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.4.4. Power Distribution Unit current limit test

NAME	TEST ID ELX	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY Electronics – Power supplies
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.4.5. Power Distribution Unit voltage sequencing test

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Electronics – Power supplies

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.4.6. Voltage margin test

NAME	TEST ID ELX	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY Electronics – Power supplies
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

Done by ELX? Determined by design, or needed for every component instance? Any component requiring a power supply for input voltages needs this test. List each one seperately?

7.4.7. SysClk margin test

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Electronics

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

Same comments as for voltage margin test. Also useful for each component because it can help shake out incorrect loading of electronic components like resistors, capacitors, etc.

7.4.8. Environmental monitoring test

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Electronics

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	

DESCRIPTION

Vary measured item (voltage, current, temperature, etc) over range of device and verify digitized value matches. Checks constants for converting to engineering units as well.

Probably this is design/layout dependent, but may be cabling dependent as well, so test cross talk with power glitches, other environmental quantities, command/event/trigger path activity?

Test stability of each quantity over time. Also against environment temperature?

COMMENTS

7.4.9. Writeable register test

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Electronics

SYNOPSIS
Test writeable registers

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
TBD	TBD

MOTIVATION
TBD

PREREQUISITES
None

REQUIRED EGSE

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Configuration file	Test Report

COMPLETION STATUSES

DESCRIPTION

To be done for each component having writable registers:

- walking ones
- walking zeros
- 0's
- f's
- a's
- 5's
- addressing check
- MBZ recognition check
- Parity test
- Other error testing

COMMENTS

7.4.10. Read-only register test

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Electronics

SYNOPSIS Test readable registers	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	

DESCRIPTION

To be done for each component having read-only registers:

- Recognize MBZ fields
- Verify response to stimuli
- Parity test
- Other error testing

COMMENTS

7.4.11. Dataless command tests

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Electronics

SYNOPSIS	
AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
TBD	TBD
MOTIVATION	
TBD	
PREREQUISITES	
None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Configuration file	Test Report
COMPLETION STATUSES	

DESCRIPTION

To be done for each component having dataless commands:

- Test whether corresponding effect is initiated
- Parity test
- Other error testing

COMMENTS

7.4.12. Event path tests

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Electronics

SYNOPSIS	
AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
TBD	TBD
MOTIVATION	
TBD	
PREREQUISITES	
None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Configuration file	Test Report
COMPLETION STATUSES	

DESCRIPTION

- Bit path liveness [verify all bits in the path work independently (no 0s, 1s, shorted together bits)]
- Cross talking bits in the bit path? [Different from detector crosstalk test?]
- Data bit liveness (PHAs, Log End values & ranges, TOTs) [verify ADCs work]
- Error reporting for each error type [can we induce each error type?]
- Event path parity error test
- Other error reporting
- Diagnostic reporting [determine whether trigger primitives are being reported correctly; ensure all bits are working (all trigger primitive messages can be generated)]
- FIFO and other memory tests
- Backpressure/Rate tests

COMMENTS

7.4.13. Trigger path tests

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Electronics

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	

DESCRIPTION

- Test of trigger types
- Trigger type cross-talk test?
- Veto cross-talk test?
- Timing in (TACK delay, etc.) [also provides delay register values for configuration file]
- Zero suppression test
- Marker test
- Other modes

COMMENTS

7.4.14. Detector (sensor?) tests

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Electronics

SYNOPSIS

AUTHOR	OWNER/MAINTAINER/CONTACT PERSON
TBD	TBD

MOTIVATION
TBD

PREREQUISITES
None

REQUIRED EGSE

REQUIRED INPUT DATA OR FILES	GENERATED OUTPUT FILES
Configuration file	Test Report

COMPLETION STATUSES

DESCRIPTION

- Dead channels [also supplies bad channel list]
- Noisy channels [also supplies bad channel list]
- Cross talking channels
- Thresholds [also supplies threshold list]
- Pedestals [also supplies pedestal list]
- Linearity
- Noise & Gain
- Inter-layer TKR alignment
- Detection efficiency test

COMMENTS

7.5. FSW (WBS 4.1.7)

7.5.1. 1553 Interface Test

NAME	TEST ID ELX	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY Flight Software
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION • Booting tests		
COMMENTS		

7.5.2. Command Functional

NAME	TEST ID ELX	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY Flight Software
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.5.3. Memory Upload and Dump

NAME	TEST ID ELX	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY Flight Software
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.5.4. Narrowband Telemetry

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Flight Software

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.5.5. Wideband Telemetry

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Flight Software

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.5.6. Vehicle Signals Interface

NAME	TEST ID ELX	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY Flight Software
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.5.7. CPU-CPU Communications

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Flight Software

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.5.8. EPU Internal Configuration

NAME	TEST ID ELX	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY Flight Software
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.5.9. T&DF Internal Configuration

NAME	TEST ID ELX	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY Flight Software
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.5.10. TKR Internal Configuration

NAME	TEST ID ELX	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY Flight Software
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.5.11. CAL Internal Configuration

NAME	TEST ID ELX	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY Flight Software
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.5.12. ACD Internal Configuration

NAME	TEST ID ELX	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY Flight Software
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.5.13. Event Filtering

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Flight Software

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.5.14. Electronic Calibration

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Flight Software

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.5.15. FSW and LAT Initialization

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Flight Software

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.5.16. FSW and LAT recovery

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Flight Software

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.5.17. LAT Pointing Calculations

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Flight Software

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.5.18. GRB Handling

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Flight Software

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.5.19. GRB Detection

NAME	TEST ID ELX	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY Flight Software
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.5.20. Repointing Logic

NAME	TEST ID ELX	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY Flight Software
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.5.21. Safe Modes

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Flight Software

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.5.22. Science Modes

NAME	TEST ID ELX	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY Flight Software
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.5.23. Diagnostic and Calibration Modes

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Flight Software

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.5.24. Thermal Control System

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Flight Software

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.5.25. LAT On-Orbit Initialization

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Flight Software

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.5.26. Sky Survey Mode

NAME	TEST ID ELX	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY Flight Software
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.5.27. Pointed Observation Mode

NAME	TEST ID ELX	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY Flight Software
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.5.28. LAT Performance Verification

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Flight Software

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.5.29. LAT Airborne End-to-End Test

NAME	TEST ID	SVAC ID
	ELX	
ALIASES	SUPERCEDES	CATEGORY
None	None	Flight Software

SYNOPSIS	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.6. I&T (WBS 4.1.9) System level tests

7.6.1. Inter-subsystem timing-in script

NAME	TEST ID INT	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY I&T
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.6.2. Inter-subsystem cross talk test

NAME	TEST ID INT	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY I&T
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.6.3. Data taking

NAME	TEST ID INT	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY I&T
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

- Muons
  - External trigger
  - External trigger with lead
- Van de Graaff

7.6.4. Comprehensive test

NAME	TEST ID INT	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY I&T
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.6.5. Limited performance test

NAME	TEST ID INT	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY I&T
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.6.6. Aliveness test

NAME	TEST ID INT	SVAC ID
ALIASES None	SUPERCEDES None	CATEGORY I&T
SYNOPSIS		
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD	
MOTIVATION TBD		
PREREQUISITES None		
REQUIRED EGSE		
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report	
COMPLETION STATUSES		
DESCRIPTION		
COMMENTS		

7.6.7. Single contributor trigger

NAME	TEST ID	SVAC ID
	INT101	
ALIASES	SUPERCEDES	CATEGORY
None	None	I&T

SYNOPSIS Check the relative efficiency of the 3-in-a-row trigger	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES None	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.6.8. Single contributor synchronization

NAME	TEST ID	SVAC ID
	INT102	
ALIASES	SUPERCEDES	CATEGORY
None	None	I&T

SYNOPSIS Check for integrity of the combined tracker and calorimeter data from a single tower	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES TKR504	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.6.9. Single contributor muon survey

NAME	TEST ID	SVAC ID
	INT103	
ALIASES	SUPERCEDES	CATEGORY
None	None	I&T

SYNOPSIS TKR tray-to-tray alignment and CDE performance	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES TKR503	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.6.10. Multi-contributor synchronization

NAME	TEST ID	SVAC ID
	INT301	
ALIASES	SUPERCEDES	CATEGORY
None	None	I&T

SYNOPSIS Check for synchronization of the event data	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES INT200-INT215	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

7.6.11. Multi-contributor high rate trigger

NAME	TEST ID	SVAC ID
	INT302	
ALIASES	SUPERCEDES	CATEGORY
None	None	I&T

SYNOPSIS Check high rate trigger data integrity	
AUTHOR TBD	OWNER/MAINTAINER/CONTACT PERSON TBD
MOTIVATION TBD	
PREREQUISITES INT301	
REQUIRED EGSE	
REQUIRED INPUT DATA OR FILES Configuration file	GENERATED OUTPUT FILES Test Report
COMPLETION STATUSES	
DESCRIPTION	
COMMENTS	

8. File formats

Files used as input or generated as output will have well known formats. There are only two acceptable storage protocols: XML and FITS.

8.1. Schema and configuration files

Schema and configuration files are XML files. They contain several blocks denoted by XML tags:

- schema
- configuration
- engineering units conversion (egu)
- rules
- constraints

These files are shared with Flight Software.

8.2. Calibration files

8.2.1. XML

- Dead tracker strips
- Noisy tracker strips
- Threshold data

8.2.2. FITS binary tables

- Calorimeter pedestal data
- ACD pedestal data
- TKR ToT calibration constants

8.3. Event data files

Event data is a FITS file containing event data in binary images. The event data topology is described in LAT-TD-01546.