Gamma-ray Large Area Space Telescope (GLAST)
Large Area Telescope (LAT)
Integration and Test Subsystem (I&T)
Testing Requirements Document
## CHANGE HISTORY LOG

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<th>Description of Changes</th>
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<tr>
<td>01</td>
<td>January 13, 2004</td>
<td>Initial draft distributed to subsystems for their input</td>
</tr>
<tr>
<td>02</td>
<td>March 11, 2004</td>
<td>Added CAL contributions received thus far</td>
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<tr>
<td>03</td>
<td>May 5, 2004</td>
<td>Added ACD and TKR contributions received thus far</td>
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8. File formats

8.1. Schema and configuration files

8.2. Calibration files

8.2.1. XML

8.2.2. FITS binary tables

8.3. Event data files

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Hard copies of this document are for REFERENCE ONLY and should not be considered the latest revision.
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
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
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:
  o Electronics - Component name (e.g., Power supplies, TEM, PSA, etc.)
  o ACD
  o Calorimeter
  o Tracker
  o 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
  o Type, e.g., calibration, configuration…
  o Format, e.g., XML, FITS…
• Generated output data/files
  o Type, e.g., event data, calibration…
  o 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)

### Tracker Power Consumption

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**Synopsis**

**AUTHOR**
TBD

**OWNER/MAINTAINER/CONTACT PERSON**
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 subsystem before tower assembly.

**Required EGSE**

**Required Input Data or Files**

- Configuration file

**Generated Output Files**

- Test report

**Completion Status**

**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
### Tracker Temperature

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#### MOTIVATION
Verify that the Tracker built-in temperature sensors work.

#### PREREQUISITES
TKR101

#### REQUIRED EGGTE

- **Configuration file**
- **Test Report**

#### 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**

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**SYNOPSIS**

**AUTHOR**

TBD

**OWNER/MAINTAINER/CONTACT PERSON**

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**

Configuration file

**GENERATED OUTPUT FILES**

Test Report

**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**

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**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

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**SYNOPSIS**

**AUTHOR**

TBD

**OWNER/MAINTAINER/CONTACT PERSON**

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**

Configuration file

**GENERATED OUTPUT FILES**

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

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### 7.1.6. GTFE split configuration

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</table>

**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

<table>
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<tbody>
<tr>
<td>TkrNoiseAndGain</td>
<td>TKR301</td>
<td></td>
</tr>
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<table>
<thead>
<tr>
<th>ALIASES</th>
<th>SUPERCEDES</th>
<th>CATEGORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>TE301</td>
<td>None</td>
<td>TKR</td>
</tr>
</tbody>
</table>

**SYNOPSIS**

**AUTHOR**

TBD

**OWNERS/MAINTAINERS/CONTACT PERSON**

TBD

**MOTIVATION**

Secondary calibration of the noise performance and threshold stability.

**PREREQUISITES**

TKR203

**REQUIRED EGSE**

**REQUIRED INPUT DATA OR FILES**

Configuration file

**GENERATED OUTPUT FILES**

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

<table>
<thead>
<tr>
<th>NAME</th>
<th>TEST ID</th>
<th>SVAC ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>TkrTriggerRate</td>
<td>TKR302</td>
<td></td>
</tr>
</tbody>
</table>

**ALIASES**

None

**SUPERCEDES**

None

**CATEGORY**

TKR

**SYNOPSIS**

**AUTHOR**

TBD

**OWNER/MAINTAINER/CONTACT PERSON**

TBD

**MOTIVATION**

Test layer self trigger and GTFEs trigger lines

**PREREQUISITES**

TE301

**REQUIRED EGSE**

**REQUIRED INPUT DATA OR FILES**

Configuration file

**GENERATED OUTPUT FILES**

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

<table>
<thead>
<tr>
<th>NAME</th>
<th>TEST ID</th>
<th>SVAC ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>TkrTotTest</td>
<td>TKR303</td>
<td>C11, C12</td>
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<table>
<thead>
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<th>ALIASES</th>
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</thead>
<tbody>
<tr>
<td>TE303</td>
<td>TKR206</td>
<td>TKR</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SYNONYM</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>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.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional and performance test applied to each single layer</td>
</tr>
</tbody>
</table>
### 7.1.10. Tracker single strip noise occupancy

<table>
<thead>
<tr>
<th>NAME</th>
<th>TkrNoiseOccupancy</th>
<th>TEST ID</th>
<th>TKR304</th>
<th>SVAC ID</th>
<th>C10</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALIASES</td>
<td>TE304</td>
<td>SUPERCEDES</td>
<td>TKR501</td>
<td>CATEGORY</td>
<td>TKR</td>
</tr>
</tbody>
</table>

**SYNOPSIS**

**AUTHOR**

TBD

**OWNER/MAINTAINER/CONTACT PERSON**

TBD

**MOTIVATION**

Noisy channel search

**PREREQUISITES**

None

**REQUIRED EGSE**

**REQUIRED INPUT DATA OR FILES**

Configuration file

**GENERATED OUTPUT FILES**

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

<table>
<thead>
<tr>
<th>NAME</th>
<th>TEST ID</th>
<th>SVAC ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>TkrLayerNoiseOccupancy</td>
<td>TKR501</td>
<td>C10</td>
</tr>
</tbody>
</table>

**Aliases**

- TE501
- TKR502

**Supercedes**

- TKR502

**Category**

- TKR

**Synopsis**

**Author**

TBD

**Owner/Maintainer/Contact Person**

TBD

**Motivation**

Check the noise performance and determine working point for data taking

**Prerequisites**

None

**Required EGSE**

**Required Input Data or Files**

- Configuration file

**Generated Output Files**

- 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, occurring 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

<table>
<thead>
<tr>
<th>NAME</th>
<th>TEST ID</th>
<th>SVAC ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>TkrDetectionEfficiency</td>
<td>TKR503</td>
<td>?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ALIASES</th>
<th>SUPERCEDES</th>
<th>CATEGORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>TE503</td>
<td>None</td>
<td>TKR</td>
</tr>
</tbody>
</table>

#### SYNOPSIS

#### AUTHOR

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

- Configuration file

#### GENERATED OUTPUT FILES

- 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

<table>
<thead>
<tr>
<th>NAME</th>
<th>TEST ID</th>
<th>SVAC ID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TKR504</td>
<td>C9</td>
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</table>

<table>
<thead>
<tr>
<th>ALIASES</th>
<th>SUPERCEDES</th>
<th>CATEGORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>TKR503</td>
<td>TKR</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>SYNOPIS</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>AUTHOR</th>
<th>OWNER/MAINTAINER/CONTACT PERSON</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBD</td>
<td>TBD</td>
</tr>
</tbody>
</table>

**MOTIVATION**

Exercise the system in working conditions for medium-long term periods

**PREREQUISITES**

None

**REQUIRED EGSE**

<table>
<thead>
<tr>
<th>REQUIRED INPUT DATA OR FILES</th>
<th>GENERATED OUTPUT FILES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configuration file</td>
<td>Test Report</td>
</tr>
</tbody>
</table>

**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 Environmental 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'm not very familiar with rules so please correct any mistakes or misconceptions. I plan to implement temperature monitoring in a similar manner.

<table>
<thead>
<tr>
<th>NAME</th>
<th>TEST ID</th>
<th>SVAC ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALIASES</td>
<td>None</td>
<td>CATEGORIES</td>
</tr>
</tbody>
</table>

**SYNOPSIS**

Monitor CAL Power Consumption

**AUTHOR**

NRL/Code 7650/B. Leas

**OWNER/MAINTAINER/CONTACT PERSON**

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**

Schema describing Calorimeter voltage/current monitor rules and limit settings which could vary by TEM (see description) :

$CAL\_ROOT\FMx\Configurations\calvcMonConfig.xml

**GENERATED OUTPUT FILES**

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

---

Hard copies of this document are for REFERENCE ONLY and should not be considered the latest revision.
<class>glRule.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>glRule.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>glRule.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>

<rule>
</rules>

<GLAT>
<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 consumption description.

<table>
<thead>
<tr>
<th>NAME</th>
<th>TEST ID</th>
<th>SVAC ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>CAL</td>
<td></td>
</tr>
</tbody>
</table>

**ALIASES**

None

**SUPERCEDES**

None

**CATEGORY**

CAL

**SYNOPSIS**

Monitor CAL Temperatures

**AUTHOR**

NRL/Code 7650/B. Leas

**OWNER/MAINTAINER/CONTACT PERSON**

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**

Schema describing Calorimeter temperature monitor rules and limit settings which could vary by TEM (see description):

$CAL_ROOT\FMx\Configurations\calvcMonConfig.xml

**GENERATED OUTPUT FILES**

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
<?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>
      </parameters>
    </rule>
  </rules>
</configuration>
```
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

<table>
<thead>
<tr>
<th>NAME</th>
<th>TEST ID</th>
<th>SVAC ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calu_init</td>
<td>CAL</td>
<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
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<th>SUPERCEDES</th>
<th>CATEGORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>None</td>
<td>CAL</td>
</tr>
</tbody>
</table>

**SYNOPSIS**

**AUTHOR**
NRL/Code 7650/B. Leas

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

**MOTIVATION**
TBD

**PREREQUISITES**
- TEMPowerUp
- 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**
- Configuration file

**GENERATED OUTPUT FILES**
- 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...
<table>
<thead>
<tr>
<th><strong>startRun:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Update CAL configuration parameters with batch values</td>
</tr>
<tr>
<td>Initialize report structure</td>
</tr>
<tr>
<td>Disable triggers</td>
</tr>
<tr>
<td>Set trigger mask to no triggers</td>
</tr>
</tbody>
</table>

**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

<table>
<thead>
<tr>
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</thead>
<tbody>
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<td>CALU_PEDESTALS_CI</td>
<td>CAL</td>
<td>C18</td>
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</thead>
<tbody>
<tr>
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<td>None</td>
<td>CAL</td>
</tr>
</tbody>
</table>

#### SYNOPTIS

Determine CAL Noise Pedestals

#### AUTHOR

NRL/Code 7650/B. Leas

#### OWNER/MAINTAINER/CONTACT PERSON

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

- Schema describing Calorimeter: $CAL_ROOT\FMx\Configurations\FMx_schema.xml
- CAL Configuration file: $CAL_ROOT\FMx\Configurations\calParams.cfg

#### GENERATED OUTPUT FILES

- Test Report: yymmdhhmmss_FMx_calu_collect_ci.html
- Register Snapshot: yymmdhhmmss_FMx_calu_collect_ci.xml
- Noise Pedestals Table: yymmdhhmmss_FMx_pedestals.fits
- Noise Pedestal Statistics: yymmdhhmmss_FMx_pedestal_stats.csv

#### COMPLETION STATUSES

- PASS
- IPASS *(Incomplete Pass – partial system...only applicable to development*)
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,layerid,eidx,logidx]
Compute Centroid[gainidx,rangeidx,layerid,eidx,logidx]
Compute FWHM[gainidx,rangeidx,layerid,eidx,logidx]
Compute Area[gainidx,rangeidx,layerid,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 suppression 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 and 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**
- Calf_gain_p01

**TEST ID**
- CAL

**SVAC ID**
- C19

**ALIASES**
- None

**SUPERCEDES**
- None

**CATEGORY**
- CAL

**SYNOPSIS**

Characterize and evaluate CAL charge amplifier gain capabilities

**AUTHOR**
- NRL/Code 7650/B. Leas

**OWNER/MAINTAINER/CONTACT PERSON**
- 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**
- Schema describing Calorimeter: $CAL_ROOT\FMx\Configurations\FMx_schema.xml
- CAL Configuration file: $CAL_ROOT\FMx\Configurations\calParams.cfg

**GENERATED OUTPUT FILES**
- Test Report: yymmddhhmss_FMx_calf_gain_p01.htm
- Register Snapshot: yymmddhhmss_FMx_calf_gain_p01.xml
- Events File: yymmddhhmss_FMx_calf_gain_p01.fit
- relative gain Table:
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**

<table>
<thead>
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</thead>
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<td>C19</td>
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</table>

**ALIASES**
None

**SUPERcedes**
None

**CATEGORY**
CAL

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

**AUTHOR**
NRL/Code 7650/B. Leas

**OWNER/MAINTAINER/CONTACT PERSON**
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**
Schema describing Calorimeter:
$CAL_ROOT\FMx\Configurations\FMx_schema.xml$

CAL Configuration file:
$CAL_ROOT\FMx\Configurations\calParams.cfg$

**GENERATED OUTPUT FILES**
Test Report:
ymmdhhmmss_FMx_calf_gain_p02.htm l

**COMPLETION STATUSES**

Hard copies of this document are for REFERENCE ONLY and should not be considered the latest revision.
<table>
<thead>
<tr>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Algorithm</strong></td>
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<tr>
<td>TBD</td>
</tr>
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| 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

<table>
<thead>
<tr>
<th>NAME</th>
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</tr>
</tbody>
</table>

**SYNOPSIS**
Collect event data generated using

**AUTHOR**
NRL/Code 7650/B. Leas

**OWNER/MAINTAINER/CONTACT PERSON**
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, cDAC,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

<table>
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<tr>
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<td>CAL</td>
<td>C20</td>
</tr>
</tbody>
</table>

**Aliases**
None

**SUPERCEDES**
None

**CATEGORY**
CAL

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

**AUTHOR**
NRL/Code 7650/B. Leas

**OWNER/MAINTAINER/CONTACT PERSON**
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. \[b\] 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.
<table>
<thead>
<tr>
<th>Level IV: 9.2.1.3 The maximum non-linearity of the ADC shall be 0.5% of full range.</th>
</tr>
</thead>
</table>

**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:
  - yymmdhhmmss_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:
  - yymmdhhmmss_FMx_calf_adc_p02.html

- Noise Pedestals Table:
  - yymmdhhmmss_FMx_pedestals.fits

- Noise Pedestal Statistics:
  - yymmdhhmmss_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

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</thead>
<tbody>
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<td>None</td>
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</tr>
</tbody>
</table>

**SYNOPSIS**
Evaluate channel droop.

**AUTHOR**
NRL/Code 7650/B. Leas

**OWNER/MAINTAINER/CONTACT PERSON**
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**
Test Report:
yymmddhhmmss_FMx_calf_adc_p03.html
Plots file:
yymmddhhmmss_FMx_calf_adc_p03.pdf

**DESCRIPTION**
Algorithm
Setup

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

**COMPLETION STATUSES**
PASS
IPASS (Incomplete Pass - partial system..only applicable to development phase)
FAIL
ABORT
**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.

---

**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

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</tbody>
</table>

**SYNOPSIS**

Manual procedure to generate/update CAL noisy channels list

**AUTHOR**
NRL/Code 7650/B. Leas

**OWNER/MAINTAINER/CONTACT PERSON**
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**
- Yymmddhhmmss_FMx_calf_adc_p02.html
- Yymmddhhmmss_FMx_calf_supp_p01.html
- Yymmddhhmmss_FMx_calf_trg_p03.html

**GENERATED OUTPUT FILES**
- 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

<table>
<thead>
<tr>
<th>NAME</th>
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<th>SVAC ID</th>
</tr>
</thead>
<tbody>
<tr>
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</thead>
<tbody>
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<td>None</td>
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</tr>
</tbody>
</table>

SYNOPSIS
Manual procedure to generate/update CAL dead channels list

AUTHOR
NRL/Code 7650/B. Leas

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

MOTIVATION
SVAC C23

PREREQUISITES
Calf_adc_p02
Calf_exr_p01

REQUIRED EGSE

REQUIRED INPUT DATA OR FILES
Yymmddhhmss_FMx_calf_adc_p02.html
Yymmddhhmss_FMx_calf_exr_p01.html

GENERATED OUTPUT FILES
CAL Dead Channel File:
Yymmddhhmss_calu_dead_channels_list.xml
(actual format TBD)

COMPLETION STATUSES
Not Applicable (manual procedure)

DESCRIPTION
This is a manual procedure (for now)

4. Evaluate Yymmddhhmss_FMx_calf_adc_p02.html reports for unresponsive channels and add them to dead channel list
5. Evaluate Yymmddhhmss_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.

<table>
<thead>
<tr>
<th>NAME</th>
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<td>CALF_TRG_P03</td>
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</tbody>
</table>

### SYNONYM

Characterize the CAL Low Energy Discriminator wrt ADC settings

### AUTHOR

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. | yymmddhhmmss_FMx_calf_trg_p03.html |
| Pedestals Table | Register Snapshot: yymmddhhmmss_FMx_calf_trg_p03.xml |
| Relative Gain Table | FLE to ADC conversion Table: yymmddhhmmss_FMx_fle2dac.fits |
| Note: Tests can be run without the above mentioned information, but characterization in energy terms cannot be performed | 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 , \( \text{adc}[\text{fstDacidx},4,8,2,12]=\text{adc} \)
Save FST to ADC conversion table, \( \text{adc}[128,4,8,2,12]\), 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*

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<tbody>
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</table>

**SYNOPSIS**

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

**AUTHOR**

NRL/Code 7650/B. Leas

**OWNER/MANAGEMENT/CONTACT PERSON**

NRL/Code 7650/B. Leas

**MOTIVATION**

LAT-MD-0446-05 GLAST LAT Science Verification Analysis and Calibration (SVAC) Plan, section 5.3 SVAC Compilance, 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**

- ADC to Energy Conversion Table.
- Pedestals Table
- Relative Gain Table
- calParams.cfg (Calorimeter environment configuration file)

**GENERATED OUTPUT FILES**

- FLE Trigger Threshold Table: yymmddhhmss_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, FLEThreshold[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"
### 7.2.13.3. **CAL LO Discriminator 3**

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</thead>
<tbody>
<tr>
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<td>None</td>
<td>CAL</td>
</tr>
</tbody>
</table>

#### SYNOPSIS
Test trigger enable/disables for functionality and independent operation.

#### AUTHOR
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
- **Test Report:** yymmddhhmss_FMx_calf_trg_p01.html
- **Register Snapshot:** yymmddhhmss_FMx_calf_trg_p01.xml
- **Trigger Enable Table:** Yymmddhhmss_FMx_calu_trg.xml

#### GENERATED OUTPUT FILES

#### 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)
  \[ \text{temb} = \text{lat.allTEM()} \]
  For \( \text{trgMode} (0=LE \text{ triggers, } 1 = HE \text{ trigger}) \)
  For \( \text{ccIdx} = 0 \text{ to } 3 \)
    \[ \text{cc} = \text{temb.downCCC(ccIdx)} \]
    If \( \text{cc} \) is valid
      For \( \text{rcIdx} = 0 \text{ to } 3 \)
        \[ \text{rc} = \text{cc.downCRC(rcIdx)} \]
        If \( \text{rc} \) is valid
          For \( \text{feIdx} = 0 \text{ to } 3 \)
            \[ \text{fe} = \text{rc.downCFE(feIdx)} \]
            If \( \text{fe} \) is valid
              Clear lrs_counters (broadcast temb.gtic.lrs_counters=0)
              Verify counters are zeros
                For \( \text{temIdx} = 0 \text{ to } 15 \)
                  \[ \text{lat.downTEM(temIdx).downTIC().lrs_counters <> 0} \]
                    Passflag[trgMode,temIdx,ccIdx,rcIdx,feIdx]=FAILED
              Enable trigger \( \text{fe.config}_1 = 0x380 \mid \text{trgMode} << 1 \)
              Inject Charge \( \text{rc.calStrobe}=1 \)
              Wait for fast shaper peak logic to complete (.01 seconds)
              Read and verify trigger counters
                For \( \text{temIdx} = 0 \text{ to } 15 \)
                  \[ \text{lat.downTEM(temIdx).downTIC().lrs_counters <= 0} \]
                    Passflag[trgMode,temIdx,ccIdx,rcIdx,feIdx]=FAILED
                  \[ \text{lat.downTEM(temIdx).downTIC().lrs_counters > 1} \]
                    MultipleTriggerflag[trgMode,temIdx,ccIdx,rcIdx,feIdx]=TRUE
              Clear lrs_counters (broadcast temb.gtic.lrs_counters=0)
              Verify counters are zeros
                For \( \text{temIdx} = 0 \text{ to } 15 \)
                  \[ \text{lat.downTEM(temIdx).downTIC().lrs_counters <> 0} \]
                    Passflag[trgMode,temIdx,ccIdx,rcIdx,feIdx]=FAILED
              Disable trigger \( \text{fe.config}_1 = 0x380 \)
              Inject Charge \( \text{rc.calStrobe}=1 \)
              Wait for fast shaper peak logic to complete (.01 seconds)
              Read and verify trigger counters
                For \( \text{temIdx} = 0 \text{ to } 15 \)
                  \[ \text{lat.downTEM(temIdx).downTIC().lrs_counters > 0} \]
                    Passflag[trgMode,temIdx,ccIdx,rcIdx,feIdx]=FAILED
### 7.2.13.4. CAL LO Discriminator 4

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</table>

**SYNOPSIS**
Characterize trigger arrival time

**AUTHOR**
NRL/Code 7650/B. Leas

**OWNER/MAINTAINER/CONTACT PERSON**
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**
IC_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

**GENERATED OUTPUT FILES**
Test Report: yymmddhhmss_FMx_calf_trg_p04.html
Register Snapshot: yymmddhhmss_FMx_calf_trg_p04.xml
Events File: yymmddhhmss_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:
**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(feldx).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

<table>
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<tbody>
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**ALIASES**

- None

**SUPERCEDES**

- None

**CATEGORY**

- CAL

**SYNOPSIS**

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

**AUTHOR**

NRL/Code 7650/B. Leas

**OWNER/MAINTAINER/CONTACT PERSON**

NRL/Code 7650/B. Leas

**MOTIVATION**

LAT-MD-0446-05 GLAST LAT Science Verification Analysis and Calibration (SVAC) Plan, section 5.3 SVAC Compliance, 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**

- ADC to Energy Conversion Table.
- Pedestals Table
- Relative Gain Table

**GENERATED OUTPUT FILES**

- **Test Report:**
  - yymmddhhmmss_FMx_calu_fle.xml
- **Register Snapshot:**
  - yymmddhhmmss_FMx_calu_fle.xml
- **Events File:**
  - yymmddhhmmss_FMx_calu_fle.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

---

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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

<table>
<thead>
<tr>
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**CATEGORY**

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</thead>
</table>

**SYNOPSIS**

Characterize the CAL High Energy Discriminator wrt ADC settings

**AUTHOR**

NRL/Code 7650/B. Leas

**OWNER/MAINTAINER/CONTACT PERSON**

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**

ADC to Energy Conversion Table.

Pedestals Table

Relative Gain Table

**GENERATED OUTPUT FILES**

Test Report:

<table>
<thead>
<tr>
<th>yymmdhhmms_FMx_calf_trg_p03.html</th>
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</table>

Register Snapshot:

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</thead>
</table>

FHE to ADC conversion Table:

<table>
<thead>
<tr>
<th>yymmdhhmms_FMx_fhe2dac.fits</th>
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</thead>
</table>

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| Note: Tests can be run without the above mentioned information, but characterization in energy terms cannot be performed |
| FHE DAC characterization Plots: yymmddhhmss_FMx_calf_trg_p03.pdf |

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<thead>
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<tr>
<td>FAIL</td>
</tr>
<tr>
<td>ABORT</td>
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<table>
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<th>DESCRIPTION</th>
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<tbody>
<tr>
<td><strong>Setup:</strong></td>
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</tr>
<tr>
<td>Tack Delay setting = CI_TIMED_PEAK</td>
</tr>
<tr>
<td>GLT data suppress = TRUE</td>
</tr>
<tr>
<td>Gain setting = Nominal</td>
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</table>

**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
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

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<td></td>
<td></td>
</tr>
</tbody>
</table>

**SYNOPSIS**

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

**AUTHOR**
NRL/Code 7650/B. Leas

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

**MOTIVATION**

LAT-MD-0446-05 GLAST LAT Science Verification Analysis and Calibration (SVAC) Plan, section 5.3 SVAC Compilance, 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**
ADC to Energy Conversion Table.
Pedestals Table
Relative Gain Table
calParams.cfg (Calorimeter environment configuration file)

**GENERATED OUTPUT FILES**
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, FHEThreshold[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"
### 7.2.14.3. **CAL HI Discriminator 3**

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**SYNOPSIS**
Test trigger enable/disables for functionality and independent operation.

**AUTHOR**
NRL/Code 7650/B. Leas

**OWNER/MAINTAINER/CONTACT PERSON**
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**:

---

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**Sequence thru each FE (all TEMs at once)**

```plaintext
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_counts=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
                  PassflagtrgMode,[temIdx,ccIdx,rcIdx,feIdx]=FAILED
                If lat.downTEM(temIdx).downTIC().lrs_counters >1
                  MultipleTriggerflag[trgMode,temIdx,ccIdx,rcIdx,feIdx]=TRUE
              Clear lrs_counters (broadcast temb.gtic.lrs_counts=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
                  PassflagtrgMode,[temIdx,ccIdx,rcIdx,feIdx]=FAILED
```

**COMMENTS**
### 7.2.14.4. CAL HI Discriminator 4

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**SYNOPSIS**
Characterize trigger arrival time

**AUTHOR**
NRL/Code 7650/B. Leas

**OWNER/MAINTAINER/CONTACT PERSON**
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**
CI_TIMED_TRIGGER (expected trigger primitive present)
Tack delay value for timed Charge Injection stimulus

**GENERATED OUTPUT FILES**

- Test Report: yymmddhmmss_FMx_calf_trg_p04.html
- Register Snapshot: yymmddhmmss_FMx_calf_trg_p04.xml
- Events File: yymmddhmmss_FMx_calf_trg_p04.fits

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

Note: Tests can be run without the above mentioned information, but characterization in energy terms cannot be performed.
**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(feldx).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, trgdIdx, ccIdx, rcIdx, endIdx, feIdx, tackDelaySetting])

**Process Data:**
- Convert trigger count array into trigger percentage (trgPct=triggers[…]/nsamples)
- Convert trgPct array to triggered array (trg[d[…]] = 1 if trgPct[…]>90%)
- Look for “dropouts”
- Generate distribution of trigger tack delays (trgTime[…]=min(where trg[d[…]]>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 trg[d[…]]>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

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**Aliases**
- None

**Supercedes**
- None

**Category**
- CAL

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

**Author**
NRL/Code 7650/B. Leas

**Owner/Maintainer/Contact Person**
NRL/Code 7650/B. Leas

**Motivation**
LAT-MD-0446-05 GLAST LAT Science Verification Analysis and Calibration (SVAC) Plan, section 5.3 SVAC Compliance, 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**
- 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*

**Generated Output Files**
- Test Report: yymmddhhmss_FMx_calf_trg_p05.html
- Register Snapshot: yymmddhhmss_FMx_calf_trg_p05.xml
- Events File: yymmddhhmss_FMx_calf_trg_p05.fits
- FHE Trigger Noise Pedestal Threshold Discriminator Table: yymmddhhmss_FMx_calu_fhe.xml

**Completion Statuses**
- PASS
- IPASS (Incomplete Pass - partial system...only applicable to development phase)
- FAIL
- ABORT

**Description**
TBD
7.2.15. CAL Zero-Suppress Thresh.
Below is a draft of the CAL zero-suppress threshold procedures. It consists of 3 procedures:
cal_u_supp_p01 to characterize the data suppress DAC
cal_u_genLacTable to use that characterization table to produce a threshold table
cal_u_supp_p02 to generate a noise pedestal threshold table
cal_u_genLacTable is dependent on cal_u_supp_p01 as stated in its prerequisites

7.2.15.1. CAL Zero-Suppress Thresh. 1

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<td>Characterize the Log Accept Discriminator wrt ADC settings</td>
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<td>NRL/Code 7650/B. Leas</td>
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<tr>
<td>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.</td>
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<td>Dislin package (if hardcopy plots are desired)</td>
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<td>LAT TestStand (includes TEM?)</td>
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<td>ADC to Energy Conversion Table.</td>
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<tr>
<td>LAC 2 ADC conversion Table: yymmddhhmmss_FMx_lac2dac.fits</td>
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<td>LAC DAC characterization Plots: yymmddhhmmss_FMx_calf_supp_p01.pdf</td>
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Note: Tests can be run without the above mentioned information, but characterization in energy terms cannot be performed
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<td>Tack Delay setting = CI_TIMED_PEAK</td>
</tr>
<tr>
<td>GLT data suppress = TRUE</td>
</tr>
<tr>
<td>Gain setting = Nominal</td>
</tr>
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**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.
### 7.2.15.2. **CAL Zero-Suppress Thresh. 2**

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</table>

**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**
NRL/Code 7650/B. Leas

**OWNER/MAINTAINER/CONTACT PERSON**
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**
- ADC to Energy Conversion Table.
- Pedestals Table
- Relative Gain Table

**GENERATED OUTPUT FILES**
- LAC 2 ADC conversion Table: $yymmddhhmss_FMx_lac.xml$

**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, LACThreshold{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”
### 7.2.15.3. CAL Zero-Suppress Thresh. 3

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**Aliases**
- None

**Supercedes**
- None

**Category**
- CAL

**Synopsis**
Generate a pedestal noise threshold Data Suppression Table.

**Author**
NRL/Code 7650/B. Leas

**Owner/Maintainer/Contact Person**
NRL/Code 7650/B. Leas

**Motivation**
LAT-MD-0446-05 GLAST LAT Science Verification Analysis and Calibration (SVAC) Plan, section 5.3 SVAC Compilance, 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**
- 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

**Generated Output Files**
- 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:**

---

Hard copies of this document are for REFERENCE ONLY and should not be considered the latest revision.
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 LACThreshold[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, LACThreshold[4,8,2,12] = lacDacidx

**Check against Criteria**

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

**Save LAC noise pedestal threshold table**

Adjust LACThresholds for a minimum LAC setting of 0 (change -1 to 0)

Save LAC noise pedestal threshold table, LACThreshold[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**

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**SYNOPSIS**

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**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 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
### Power-on AEM electronics

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**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

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**ALIASES**

- None

**SUPERCEDES**

- None

**CATEGORY**

- ACD

**SYNOPSIS**

**AUTHOR**

TBD

**OWNER/MAINTAINER/CONTACT PERSON**

TBD

**MOTIVATION**

TBD

**PREREQUISITES**

None

**REQUIRED EGSE**

None

**REQUIRED INPUT DATA OR FILES**

- Configuration file

**GENERATED OUTPUT FILES**

- Test Report

**COMPLETION STATUSES**

**DESCRIPTION**

**COMMENTS**
### 7.3.4. **GAFE and GARC configure & readback**

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**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

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### MOTIVATION

TBD

### PREREQUISITES

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### REQUIRED EGSE

None

### REQUIRED INPUT DATA OR FILES

- Configuration file

### GENERATED OUTPUT FILES

- Test Report

### COMPLETION STATUSES

None

### DESCRIPTION

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### COMMENTS

None
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#### MOTIVATION

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#### PREREQUISITES

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#### COMPLETION STATUSES

#### DESCRIPTION

#### COMMENTS
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**SYNOPSIS**

**AUTHOR**

TBD

**OWNER/MAINTAINER/CONTACT PERSON**

TBD

**MOTIVATION**

TBD

**PREREQUISITES**

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**COMPLETION STATUSES**

**DESCRIPTION**

**COMMENTS**
### 7.3.8. **ACD HLD Threshold**

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**Synopsis**

**Author**

TBD

**Motivation**

TBD

**Prerequisites**

None

**Required EGSE**

**Required Input Data or Files**

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**Generated Output Files**

- Test Report

**Completion Statuses**

**Description**

**Comments**
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**SYNOPSIS**

**AUTHOR**

TBD

**OWNER/MAINTAINER/CONTACT PERSON**

TBD

**MOTIVATION**

TBD

**PREREQUISITES**

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**DESCRIPTION**

**COMMENTS**

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### 7.3.10. ACD Low Range PHA

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**SYNOPSIS**

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TBD

**OWNER/MAINTAINER/CONTACT PERSON**

TBD

**MOTIVATION**

TBD

**PREREQUISITES**

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**REQUIRED EGSE**

**REQUIRED INPUT DATA OR FILES**

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**COMMENTS**
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**OWNER/MAINTAINER/CONTACT PERSON**

TBD

**MOTIVATION**

TBD

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**COMMENTS**
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### 7.3.13. ACD Non-linearity

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- Test Report

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#### COMMENTS

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## 7.3.15. ACD Power-On High Voltage

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### Aliases

- None

### Supercedes

- None

### Category

- ACD

### Synopsis

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<th>Owner/Maintainer/Contact Person</th>
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### Motivation

- TBD

### Prerequisites

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### Required EGSE

- TBD

### Required Input Data or Files

- Configuration file

### Generated Output Files

- Test Report

### Completion Statuses

### Description

### Comments
### 7.3.16. ACD Raise/Lower High Voltage

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**ALIASES**
- None

**SUPERCEDES**
- None

**CATEGORY**
- ACD

**SYNOPSIS**

**AUTHOR**
- TBD

**OWNER/MAINTAINER/CONTACT PERSON**
- TBD

**MOTIVATION**
- TBD

**PREREQUISITES**
- None

**REQUIRED EGSE**

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**GENERATED OUTPUT FILES**
- Test Report

**COMPLETION STATUS**

**DESCRIPTION**

**COMMENTS**
### 7.3.17. ACD pedestal calculation

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**SYNOPSIS**

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TBD

**OWNER/MAINTAINER/CONTACT PERSON**
TBD

**MOTIVATION**
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**PREREQUISITES**
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**SYNOPSIS**

**AUTHOR**

TBD

**OWNER/MAINTAINER/CONTACT PERSON**

TBD

**MOTIVATION**

TBD

**PREREQUISITES**

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**REQUIRED EGSE**

**REQUIRED INPUT DATA OR FILES**

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- Test Report

**COMPLETION STATUSES**

**DESCRIPTION**

**COMMENTS**
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**SYNOPSIS**

**AUTHOR**

TBD

**OWNER/MAINTAINER/CONTACT PERSON**

TBD

**MOTIVATION**

TBD

**PREREQUISITES**

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**REQUIRED EGSE**

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- Test Report

**COMPLETION STATUSES**

**DESCRIPTION**

**COMMENTS**
### 7.3.20. ACD False VETO

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**ALIASES**

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**SUPERCEDES**

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**CATEGORY**

| ACD |

**SYNOPSIS**

**AUTHOR**

| TBD |

**OWNER/MAINTAINER/CONTACT PERSON**

| TBD |

**MOTIVATION**

| TBD |

**PREREQUISITES**

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**GENERATED OUTPUT FILES**

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**COMPLETION STATUSES**

**DESCRIPTION**

**COMMENTS**
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**SYNOPSIS**

**AUTHOR**
TBD

**OWNER/MAINTAINER/CONTACT PERSON**
TBD

**MOTIVATION**
TBD

**PREREQUISITES**
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**REQUIRED EGSE**
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Test Report

**COMPLETION STATUSES**

**DESCRIPTION**

**COMMENTS**
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### 7.3.23. ACD Gain Calibration

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#### 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

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**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

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**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

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**SYNOPSIS**

**AUTHOR**
TBD

**OWNER/MAINTAINER/CONTACT PERSON**
TBD

**MOTIVATION**
TBD

**PREREQUISITES**
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**REQUIRED EGSE**
None

**REQUIRED INPUT DATA OR FILES**
Configuration file

**GENERATED OUTPUT FILES**
Test Report

**COMPLETION STATUSES**

**DESCRIPTION**

**COMMENTS**
### 7.3.27. ACD Timing

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**Synopsis**

**Author**

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

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**Aliases**

- None

**Synopsis**

**Author**

- 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

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**SYNOPSIS**
PSA voltage test

**AUTHOR**
TBD

**OWNER/MAINTAINER/CONTACT PERSON**
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**
Configuration file

**GENERATED OUTPUT FILES**
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

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### Synopsis

**AUTHOR**

TBD

**OWNER/MAINTAINER/CONTACT PERSON**

TBD

**MOTIVATION**

TBD

**PREREQUISITES**

None

**REQUIRED EGSE**

None

**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

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**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

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**Aliases**

None

**Supersedes**

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

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**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 STATUS**

**DESCRIPTION**

**COMMENTS**
### 7.4.6. Voltage margin test

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**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 separately?
### 7.4.7. SysClk margin test

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**ALIASES**

| None |

**SUPERCEDES**

| None |

**CATEGORY**

| Electronics |

**SYNOPSIS**

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**AUTHOR**

| TBD |

**MOTIVATION**

| TBD |

**PREREQUISITES**

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**REQUIRED EGSE**

| Configuration file |

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**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

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#### Synopsis

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#### 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

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**SYNOPSIS**
Test writeable 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 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

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**SYNOPSIS**

Test readable registers

**AUTHOR**

TBD

**OWNER/MAINTAINER/CONTACT PERSON**

TBD

**MOTIVATION**

TBD

**PREREQUISITES**

None

**REQUIRED EGSE**

None

**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

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**ALIASES**

None

**SUPERCEDES**

None

**CATEGORY**

Electronics

### SYNOPSIS

**AUTHOR**

TBD

**OWNER/MAINTAINER/CONTACT PERSON**

TBD

**MOTIVATION**

TBD

**PREREQUISITES**

None

**REQUIRED EGSE**

None

**REQUIRED INPUT DATA OR FILES**

Configuration file

**GENERATED OUTPUT FILES**

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**

Hard copies of this document are for REFERENCE ONLY and should not be considered the latest revision.
### 7.4.12. Event path tests

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#### SYNOPSIS

- **AUTHOR**: TBD
- **OWNER/MAINTAINER/CONTACT PERSON**: TBD
- **MOTIVATION**: TBD
- **PREREQUISITES**: None
- **REQUIRED EGSE**: None
- **REQUIRED INPUT DATA OR FILES**: Configuration file
- **GENERATED OUTPUT FILES**: Test Report

#### 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

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**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

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#### MOTIVATION

TBD

#### PREREQUISITES

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#### 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

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**SYNOPSIS**

**AUTHOR**
TBD

**MOTIVATION**
TBD

**PREREQUISITES**
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**REQUIRED EGSE**

**REQUIRED INPUT DATA OR FILES**
Configuration file

**GENERATED OUTPUT FILES**
Test Report

**COMPLETION STATUSES**

**DESCRIPTION**
- Booting tests

**COMMENTS**
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### 7.5.4. Narrowband Telemetry

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**SYNOPSIS**

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TBD

**OWNER/MAINTAINER/CONTACT PERSON**
TBD

**MOTIVATION**
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**PREREQUISITES**
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**COMPLETION STATUSES**

**DESCRIPTION**

**COMMENTS**
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**SYNOPSIS**

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TBD

**OWNER/MAINTAINER/CONTACT PERSON**

TBD

**MOTIVATION**

TBD

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- Test Report

**COMPLETION STATUSES**

**DESCRIPTION**

**COMMENTS**

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### 7.5.6. Vehicle Signals Interface

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| COMMENTS | |
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### 7.5.8. EPU Internal Configuration

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**SYNOPSIS**

**AUTHOR**

TBD

**OWNER/MAINTAINER/CONTACT PERSON**

TBD

**MOTIVATION**

TBD

**PREREQUISITES**

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**REQUIRED EGSE**

**REQUIRED INPUT DATA OR FILES**

- Configuration file

**GENERATED OUTPUT FILES**

- Test Report

**COMPLETION STATUSES**

**DESCRIPTION**

**COMMENTS**
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**SYNOPSIS**

**AUTHOR**

TBD

**MOTIVATION**

TBD

**PREREQUISITES**

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Test Report

**COMPLETION STATUSES**

**DESCRIPTION**

**COMMENTS**
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**SYNOPSIS**

**AUTHOR** TBD  
**OWNER/MAINTAINER/CONTACT PERSON** TBD  

**MOTIVATION** TBD  

**PREREQUISITES** None  

**REQUIRED EGSE**

**REQUIRED INPUT DATA OR FILES**
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**COMPLETION STATUSES**

**DESCRIPTION**

**COMMENTS**
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**SYNOPSIS**

**AUTHOR**

TBD

**OWNER/MAINTAINER/CONTACT PERSON**

TBD

**MOTIVATION**

TBD

**PREREQUISITES**

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**REQUIRED EGSE**

**REQUIRED INPUT DATA OR FILES**

- Configuration file

**GENERATED OUTPUT FILES**

- Test Report

**COMPLETION STATUSES**

**DESCRIPTION**

**COMMENTS**
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**Synopsis**

**Author**

TBD

**Motivation**

TBD

**Prerequisites**

None

**Required EGSE**

**Required Input Data or Files**

- Configuration file

**Generated Output Files**

- Test Report

**Completion Statuses**

**Description**

**Comments**
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**SYNOPSIS**

**AUTHOR**

TBD

**OWNER/MAINTAINER/CONTACT PERSON**

TBD

**MOTIVATION**

TBD

**PREREQUISITES**

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**REQUIRED EGSE**

None

**REQUIRED INPUT DATA OR FILES**

- Configuration file

**GENERATED OUTPUT FILES**

- Test Report

**COMPLETION STATUSES**

**DESCRIPTION**

**COMMENTS**
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**SYNOPSIS**

- **AUTHOR**: TBD
- **OWNER/MAINTAINER/CONTACT PERSON**: TBD

**MOTIVATION**: TBD

**PREREQUISITES**: None

**REQUIRED EGSE**: None

**REQUIRED INPUT DATA OR FILES**: Configuration file

**GENERATED OUTPUT FILES**: Test Report

**COMPLETION STATUSES**

**DESCRIPTION**

**COMMENTS**
7.5.16. **FSW and LAT recovery**

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**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**
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**Synopsis**

**Author**

TBD

**Motivation**

TBD

**Prerequisites**

None

**Required EGSE**

**Required Input Data or Files**

- Configuration file

**Generated Output Files**

- Test Report

**Completion Statuses**

**Description**

**Comments**
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**SYNOPSIS**

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- TBD

**OWNER/MAINTAINER/CONTACT PERSON**
- TBD

**MOTIVATION**
- TBD

**PREREQUISITES**
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**REQUIRED EGSE**
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TBD

**OWNER/MAINTAINER/CONTACT PERSON**

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**MOTIVATION**

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**PREREQUISITES**

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**SYNOPSIS**

**AUTHOR**

TBD

**OWNER/MAINTAINER/CONTACT PERSON**

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**MOTIVATION**

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**REQUIRED EGSE**

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TBD

**OWNER/MAINTAINER/CONTACT PERSON**

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**MOTIVATION**

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**PREREQUISITES**

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**GENERATED OUTPUT FILES**

- Test Report

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#### 7.6.1. Inter-subsystem timing-in script

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### 7.6.2. Inter-subsystem cross talk test

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**MOTIVATION**

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### 7.6.3. Data taking

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**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 STATUS**

**DESCRIPTION**

**COMMENTS**

- Muons
  - External trigger
  - External trigger with lead
- Van de Graaff
### 7.6.4. Comprehensive test

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**SYNOPSIS**

**AUTHOR**

TBD

**OWNER/MAINTAINER/CONTACT PERSON**

TBD

**MOTIVATION**

TBD

**PREREQUISITES**

None

**REQUIRED EGSE**

None

**REQUIRED INPUT DATA OR FILES**

- Configuration file

**GENERATED OUTPUT FILES**

- Test Report

**COMPLETION STATUSES**

**DESCRIPTION**

**COMMENTS**
### 7.6.5. Limited performance test

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#### SYNOPSIS

#### AUTHOR

TBD

#### MOTIVATION

TBD

#### PREREQUISITES

None

#### REQUIRED EGSE

#### REQUIRED INPUT DATA OR FILES

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#### COMPLETION STATUSES

#### DESCRIPTION

#### COMMENTS
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**SUPERCEDES**

None

**CATEGORY**

I&T

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7.6.7. *Single contributor trigger*

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**SYNOPSIS**
Check the relative efficiency of the 3-in-a-row trigger

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**MOTIVATION**
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**PREREQUISITES**
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**REQUIRED EGSE**
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**REQUIRED INPUT DATA OR FILES**

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**GENERATED OUTPUT FILES**

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**COMPLETION STATUSES**

**DESCRIPTION**

**COMMENTS**
### 7.6.8. Single contributor synchronization

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**ALIASES**  
None

**SUPERCEDES**  
None

**CATEGORY**  
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

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**Aliases**

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**Supercedes**

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**Category**

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**Synopsis**

TKR tray-to-tray alignment and CDE performance

**Author**

<table>
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**Motivation**

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**Prerequisites**

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**Required EGSE**

**Required Input Data or Files**

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**Generated Output Files**

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**Completion Statuses**

**Description**

**Comments**
### 7.6.10. Multi-contributor synchronization

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**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**

---

Hard copies of this document are for REFERENCE ONLY and should not be considered the latest revision.
### 7.6.11. Multi-contributor high rate trigger

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**SYNOPSIS**
Check high rate trigger data integrity

**AUTHOR**
TBD

**OWNER/MAINTAINER/CONTACT PERSON**
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.