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CHANGE HISTORY LOG

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1. **SCOPE**

This document describes the procedure followed for qualification testing of the LAT FSW. This Qualification Test Procedure document describes one of the qualification tests executed to verify compliance with the requirements defined in the “Flight Software Specification – Level III” (LAT-SS-00399).

1.1 **Test Suite**

FSWINI

The Test Suite is a logical grouping of a set of tests based on common functionalities and can be executed as a suite of tests in some order when the pre-conditions and post-conditions for each test within the suite have been met successfully.

This test procedure *FSWINI_009* belongs in the Test Suite *FSWINI* under the *FST* Project.

1.2 **Test ID**

FSWINI_009

Test *FSWINI_009* contains one main script, *FSWINI_009*, which can be run when the SIU is unpowered.

The following telecommands and telemetry are used in this test:

Telemetry

APID	Tlm. Packet (L)	Description (L)
<u>0x200</u>	LBTHKP	Boot housekeeping telemetry

1.3 **Requirement(s) Tested**

The Qualification Test Procedure described herein is performed to verify that the FSW satisfies the following requirement(s), quoted from the Flight Software Specification – Level III:

Requirement Number	Requirement Name	Requirement	Level of Requirements Verification in This Test
5.3.1.8	Boot Status	SIU FSW shall indicate boot status over the discrete interface lines. The value states of the discrete lines and their meanings are defined in Table 5-1.	Full
5.3.1.9	Boot Housekeeping	During primary boot of a unit, the FSW shall send Boot Housekeeping telemetry to the spacecraft via the CTDB, as defined in (9)	Full

If the requirement(s) quoted above cite tables, figures, or external documents (e.g., "...Further details are provided in [11]"), consult LAT-SS-00399 for the details or list of citations.

2. DEFINITIONS AND ACRONYMS

The following terms, abbreviations, and acronyms are used in this document:

2.1 Definitions

Hz	Hertz, unit of frequency
s, sec	seconds
V	Volt
W	Watt
s, sec	seconds

2.2 Acronyms

CAL	Calorimeter
EGSE	Electrical Ground Support Equipment
GASU	Global trigger Anti-collision Spacecraft Unit
PBC	Primary Boot Code
PID	Programming Input/output Discrete
PTR	Post Test Review
TEM	Tower Electronics Module
TKR	Tracker
TPS	Tower Power Supply
TRR	Test Readiness Review
QAE	Quality Assurance Engineer
TE	Test Engineer
VSC	Virtual Spacecraft

3. REFERENCES

The list below provides documents that are to be used as references for this procedure:

3.1 **Applicable Documents**

<u>Document Number</u>	<u>Description</u>
<u>SPECIFICATIONS</u>	
LAT-SS-00399	LAT Flight Software Level III Specification
1196 EI-S46310-000	GLAST 1553 Bus Protocol Interface Control
LAT-TD-02659	LAT Flight Software Telecommand and Telemetry Formats
LAT-TD-0561	The Virtual Spacecraft (VSC)
<u>PROCEDURES</u>	
N/A	
<u>PLANS</u>	
LAT-MD-00039	Performance Assurance Implementation Plan
LAT-MD-00078	GLAST LAT System Safety Program Plan
LAT-MD-00404	LAT Contamination Control Plan
LAT-MD-00408	LAT Program Instrument Performance Verification Plan
LAT-SS-00296	T & DF Test Plan
LAT-TD-00297	LAT Electronics Test Plan
LAT-TD-00786	LAT Flight Software Test Plan
<u>OTHER</u>	
LAT-MD-00091	GLAST Quality Manual
LAT-MD-00471	Control of Nonconforming Product
LAT-MD-00472	Corrective and Preventative Action

4. REQUIREMENTS

This section lists the requirements that shall be followed during the LAT FSW Qualification Testing process.

The Performance Assurance Implementation Plan, LAT-MD-00039, shall be utilized to ensure that the products produced by the GLAST LAT project intended for design qualification, flight and critical ground support equipment usage meet the required levels of quality and functionality for their intended purposes.

The LAT Program Instrument Performance Verification Plan, LAT-MD-00408, shall be utilized to address the testing to be performed at the unit/subsystem and instrument level for flight qualification, proto-flight and acceptance testing phases. Also included are the necessary processes/procedures and systems assurance activities.

4.1 Test Data, Equipment and Software

This procedure shall follow the requirements found in the Control of Nonconforming Product, LAT-MD-00471. This document establishes the method to identify and control nonconforming product developed by the LAT project team.

4.2 Quality Assurance

This procedure shall follow the requirements found in the Corrective and Preventative Action document, LAT-MD-00472 and the GLAST Quality Manual, LAT-MD-00091.

The Corrective and Preventative Action document establishes the method to be used to initiate, implement, evaluate and record corrective and preventive actions. The GLAST Quality Manual defines the methods implemented by the GLAST LAT project to ensure consistent quality of all processes for procurement, design, development and production of flight hardware, flight software and all associated ground support equipment interfacing with flight hardware and software.

4.3 Safety

This procedure shall follow the requirements found in the GLAST LAT System Safety Program Plan, LAT-MD-00078. This document defines all phases of the LAT program including: design, development, fabrication, handling, transportation, storage, test, assembly and operation.

WARNING: When high voltages are present extreme care should be exercised.

4.4 Warnings, Cautions, and Notes

The following SAFETY ALERTS are intended to create awareness of the potential safety hazards and the steps that must be taken to avoid accidents. These same alerts are used throughout this document to identify specific hazards that may endanger personnel and/or equipment.

Identification of every conceivable hazardous situation is impossible. Therefore, all personnel have the responsibility to diligently exercise safe practices whenever exposed to this equipment.

WARNING: Indicates a potential hazardous situation which, if not avoided, could result in death or injury.

CAUTION: Indicates a potential hazardous situation which, if not avoided, could result in damage to equipment.

Note: Indicates a notification of information that is important, but not hazard related.

4.5 General Instructions

This qualification test procedure shall be conducted on a formal basis to its latest approved and released version. The designated Software QAE shall be notified 24 hours prior to the start of this procedure. Software QAE may monitor the execution of all or part of this procedure should they elect to do so.

The Test Engineer conducting this test shall read this document in its entirety and resolve any apparent ambiguities before beginning the procedures described herein.

Deviations from the procedures described in this document and breaks in hardware or software configuration can only be initiated by the Test Engineer, must be approved by QA, and must be documented in Appendix A.

Any nonconformance/defect/anomaly is to be reported in JIRA. Refer to the LAT Flight Software Test Plan LAT-TD-00786 for guidance. Do not alter or break configuration if a failure occurs. Notify Software Quality Assurance.

All success conditions for a test must be met for the test to pass.

5. SETUP

This section describes the hardware and software configuration used for the qualification test described later in this document. Any break from configuration or deviation from a particular procedure must be authorized by the Quality Assurance Engineer and documented in Appendix A.

5.1 Hardware Setup

The list below indicates the equipment that is used to execute the tests described in this document.

Hardware Unit	Manufacturer	GLAT Number (and Hardware Sub-Units by GLAT Number)	Firmware Version (where applicable)
Virtual Spacecraft (VSC)	SLAC		
Spacecraft Interface Unit (SIU)	SLAC		
1553 cables and couplers	SLAC		
Unix or Linux Host			
Power supply for SIU	SLAC		

The Figure below depicts the Testbed on which this qualification test is performed. The particular hardware units utilized in this test are itemized by GLAT number and firmware version in the preceding table.

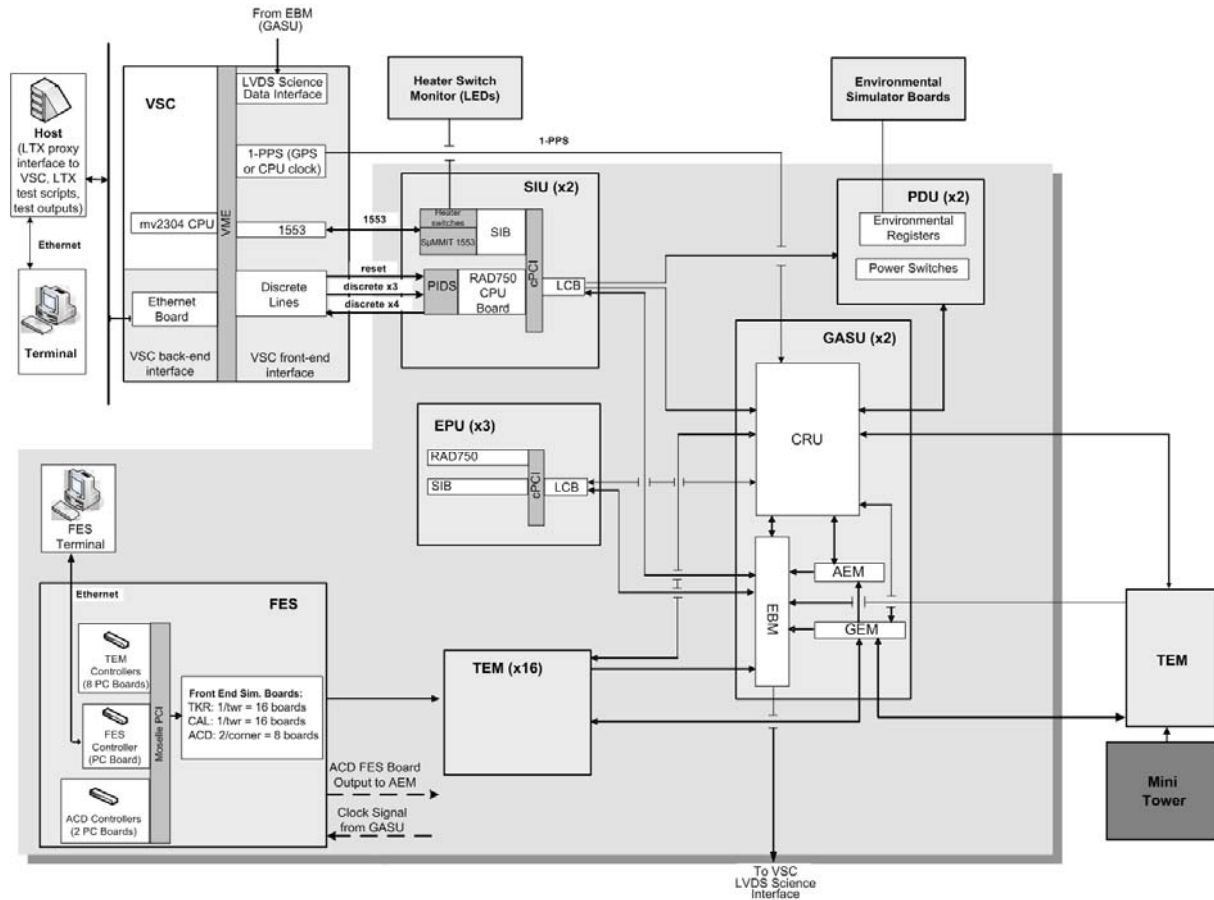


Figure 1. FSW Testbed

5.2 Software Setup

The software required to prepare for and execute the tests described in this Qualification Test Procedure document is itemized in this section.

5.2.1 Test Tools

The following table specifies the test executive used to run this qualification test, and identifies the other software tools used to support the execution of the test. The “Software Version Number” column identifies the version number of the test tool being used; alternatively, this column identifies the hardcopy attachment to this document that records the version of the tool being used (e.g., “Attachment 1”). The “Path to Attachment” column identifies the directory in which the electronic copy of any hardcopy attachment is saved (if applicable).

Software	Description of Software	Software Version Number (or Specify Attachment Number)	Path to Attachment (If Applicable)
LTX	LAT Test Executive		
FMX	File Management Extra		
VSC	Virtual Spacecraft system software		
VPI	VSC Python/Proxy Interface		

5.2.2 Test Scripts

The following table identifies the test scripts that are run to execute this qualification test. The “Script Version Number” column identifies which version of the script is being used; alternatively, this column identifies the hardcopy attachment to this document that records the version of the script being used (e.g., “Attachment 1”). The “Path to Attachment” column identifies the directory in which the electronic copy of any hardcopy attachment is saved (if applicable).

Test Script	Description of Test Script	Script Version Number (or Specify Attachment Number)	Path to Attachment (If Applicable)
FSWINI_009.py	Main LTX qualification test execution script. This script must be run during the SIU RAD750 crate primary boot process. This script verifies the pre-conditions for some tests that need to be conducted in the Boot Mode only. This test does not alter the state of the CPU. It leaves the CPU in Boot Mode.		
FSWINI_009.xml	LTX test description file for test FSWINI_009.		
test_ram_failure.test_ff	test code that corrupts the spare RAM column configuration		

5.2.3 Flight Software

This qualification test is performed on a complete, integrated Candidate Release of FSW. All FSW libraries under test are final Flight Unit Candidate versions. The test described in this document is

designed to evaluate the particular FSW packages and constituents listed in the following table; for clarity, only those constituents that are the focus of the test are listed below.

FSW Package	Constituent(s)
PBC	

The Candidate Release into which these FSW constituents are integrated is identified in the following table. The “Candidate Release Build Number” column specifies the build number of the FSW Candidate Release under test (e.g., “B0-0-1”). The “Candidate Release Attachment Number” column identifies which hardcopy attachment to this document confirms the name and version number of the full set of FSW packages and constituents used in the test (e.g., “Attachment 2”). The “Path to Attachment” column specifies where in the test repository an electronic copy of the hardcopy attachment has been saved.

Candidate Release Build Number	Candidate Release Attachment Number	Path to Attachment

5.3 Setup Validation

5.3.1 Hardware Validation

The following signatures confirm that the Test Engineer and Quality Assurance Engineer have verified the GLAT numbers, firmware version numbers, and the proper connection of all hardware listed in the table in Section 5.1.

 Date Time Test Engineer QAE

5.3.2 Software Validation

The Test Engineer performs the following procedure to validate the software setup for this qualification test and records completion of the setup validation steps in the space provided.

Step No.	Description of Step	Step Outcome
1	Obtain version numbers of the test tools used to perform this qualification test by running the xxxx script. Pick up and label the hardcopy report generated by the xxxx script and attach it to this test procedure	Complete/ Not Complete

	document. Record (1) the label for the attachment in table and (2) the directory location to which an electronic copy of the report was saved in Section 5.2.1.	
2	Obtain version numbers of the tesc scripts used to perform this qualification test by running the xxxx script. Pick up and label the hardcopy report generated by the xxxx script and attach it to this test procedure document. Record (1) the label for the attachment and (2) the directory location to which an electronic copy of the report was saved in Section 5.2.2.	Complete/ Not Complete
3	Obtain the versions of the FSW packages loaded on the targets by running the <i>version_test</i> script in the Boot mode . Pick up and label the hardcopy report generated by the <i>version_test</i> script and attach it to this test procedure document. Record (1) the label for the attachment and (2) the directory location to which an electronic copy of the report was saved in Section 5.2.3.	Complete/ Not Complete

The following signatures confirm that, using the procedure described in the previous table, the Test Engineer and Quality Assurance Engineer have verified that all versions of test support software, test scripts, and FSW constituents match those identified in Section 5.2.

 Date Time Test Engineer QAE

6. TEST PROCEDURE FOR FSWINI_009

6.1 Test Objective

This test verifies that FSW signals the status of the primary boot process using discrete lines connecting the LAT to the Spacecraft and FSW sends boot housekeeping telemetry to the spacecraft via the CTDB.

This Test Objective is broken down into the following Test Sub-Objectives.

Number	Test Sub-Objective
1	Verify all operations on SIU running the PBC.
2	Verify all operations in both the Primary and Redundant SIUs.
3	Verify the status of discrete lines and Boot Housekeeping telemetry when spacecraft sends the Warm Reboot command.
4	Verify the status of discrete lines and Boot Housekeeping telemetry with the Watchdog type of Reset.
5	Verifies the status of discrete lines and Boot Housekeeping telemetry with the Exception type of Reset.

6.2 Test Input Files

The following table identifies all auxiliary files (e.g., Front End Simulator data files, GLEAM data files) used as inputs to this qualification test. Note that not all qualification tests use input data of this type. The “Input File Version Number” column identifies the version number of the auxiliary file being used; alternatively, this column identifies the hardcopy attachment to this document that records the version of the file being used (e.g., “Attachment 1”). The “Path to Attachment” column specifies where in the test repository an electronic copy of the hardcopy attachment has been saved .

Input File	Description of Input File	Input File Version Number (or Specify Attachment Number)	Path to Attachment (If Applicable)
N/A	N/A	N/A	N/A

6.3 Test Preparation

After the hardware and software setup has been validated, steps may be required to place the hardware and FSW in an operational mode in which the qualification test can be performed or otherwise complete preparations for the test to begin.

The Test Engineer carries out the following procedure to prepare for qualification testing and records completion of the test preparation steps in the space provided.

Step No.	Description of Step	Step Outcome
1	Power up the Virtual Spacecraft.	Complete/ Not Complete
2	Confirm that the SIU crate is ready for power up and discrete lines are connected.	Complete/ Not Complete
3	Start CMX by issuing the following command from the host machine: \$ cmx start	Complete/ Not Complete
4	On the host machine, change directory to the location of the test scripts by issuing the following command: \$ cd /afs/slac.stanford.edu/g/glast/flight/FST/source/FSWINI/Vx-x-x/FSWINI_009/	Complete/ Not Complete

The Test Engineer and Quality Assurance Engineer verify that all test preparation steps are complete.

Date	Time	Test Engineer	QAE
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6.4 Test Procedure

After the test setup has been validated, and test preparation steps are complete, the Test Engineer proceeds with the qualification test procedure itself, as described below, and records the outcome of each step during test execution. The outcome of each step is either “Complete” or “Not Complete” (for steps which involve no analysis or verification); or, “Pass” or “Fail” (for steps involved in verifying completion of test objectives and sub-objectives).

Step No.	Description of Step	Step Outcome
1	Power up the SIU	Complete/ Not Complete
2	Run the FSWINI_009 test script by typing the following command at the shell: \$ ltx run <FSWINI_009	Complete/ Not Complete
3	LTX automatically sends several output files to the nfs file space. Print the /nfs/slac/g/glast/ltx000/ltx_repos/FST/FSWINI/Vx-xx/FSWINI_0xx/mmdyy_hhmmss log file, retrieve it from the printer, label it, and attach it to this test procedure. Record the label written on the printed log file: _____ Record the full nfs path and filename of the soft copy of this output file: _____ _____	Complete/ Not Complete
4	Review the xxx output file and verify that the following entry appears: FSWINI_009:(1) Pass Verifies external reset by sending the LPBCRESET (Warm Reboot) command. When the PBC restarts, it will run the RAM test, report an error at address 0xff80, and turn on the PID . SIU boot housekeeping telemetry indicates that the COMMANDED type of reboot occurred in the LPBCBOOTYPE field. This step completes sub-objectives 1 – 3.	Pass/ Fail

Step No.	Description of Step	Step Outcome
5	<p>Review the xxx output file and verify that the following entry appears:</p> <p style="text-align: center;">FSWINI_009:(2) Pass</p> <p>Verifies internal reset with the Watchdog type of Reset. MEMLOADMEM command to the address 0xBF880058 with value 0 initiates this type of reset. When the PBC restarts, it will run the RAM test, report an error at address 0xff80, and turn on the PID. Boot Housekeeping Telemetry is checked to verify that the WATCHDOG type of reboot occurred in the LPBCBOOTYPE field.</p> <p>This step completes sub-objectives 4.</p>	Pass/ Fail
6	<p>Review the xxx output file and verify that the following entry appears:</p> <p style="text-align: center;">FSWINI_009:(3) Pass</p> <p>Verifies internal reset with the Exception type of Reset.</p> <p>Send MEMLOADREG command to the Register address 0x9c with a value of 0x00000400 initiates this type of reset. When the PBC restarts, it will run the RAM test, report an error at address 0xff80, and turn on the PID. Resultant Boot Housekeeping Telemetry is checked to verify that the EXCEPTION type of reboot occurred in the LPBCBOOTYPE field.</p> <p>This step completes sub-objectives 5.</p>	Pass/ Fail

Initial to confirm.

Date Time Test Engineer QAE

7. TEST POST-CONDITIONS AND OVERALL OUTCOME

7.1 Test Post-Conditions

The expected state of the FSW and/or Testbed at the conclusion of this qualification test is indicated in the following table.

No.	Post-Condition	Post-Condition Met? (Yes/No)
1	Primary boot is performed and SIU is ready for the secondary boot process.	

The Test Engineer and Quality Assurance Engineer verify that all test post-conditions are met.

Date

Time

Test Engineer

QAE

7.2 Overall Outcome of FSWINI_009

Based on the analysis of the test results, the overall outcome of Test FSWINI_009 is as follows:

Passed - all of the expected outcomes for the test were confirmed

Failed - one or more of the test outcomes were not confirmed

Date

Test Engineer

QAE

APPENDIX A: DEVIATIONS FROM THE QUALIFICATION TEST PROCEDURE

This section details any deviations from the hardware configuration, software configuration, or test procedure followed during the execution of the test or tests described in this Qualification Test Procedure document. All deviations from the approved procedure are agreed to by the Test Engineer and the Software Quality Engineer during the test execution session. All deviations must be reported during the Post Qualification Test Review, where their impact on the test results will be evaluated.

Hardware Deviations

Describe any deviations from the hardware configuration defined in Section 5.1. Name the hardware that was modified and describe the modifications. If hardware is *replaced* during execution of the test, name the replaced hardware, the manufacturer, and list an identification number (e.g., GLAT ID number).

Software Deviations

Describe any changes made to the software configuration under test or the software configuration used to support test execution, as defined in Section 5.2. Give version numbers of all FSW packages and test packages that were modified. Describe how the contents of the modified software load were verified. Describe these deviations for each test that was modified.

Procedural Deviations

Specify any deviations from the test procedure for the test being executed. If this document contains more than one test procedure, list the procedure by number (e.g., “MEMMGT_001”). List by number the steps modified or skipped. Provide a numbered sequence listing any added steps. Describe these deviations for each test that was modified.
