LAT PROJECT DOCUMENT CHANGE NOTICE (DCN)

DCN No. LAT-XR-07131-01

SHEET 1 **OF** 2

ORIGINATOR: Mike DeKlotz	**PHONE:** 650-926-4752	**DATE:** 8/16/05
CHANGE TITLE: DCN for LAT Flight Software Test Procedures		**ORG.:**

DOCUMENT NUMBER	TITLE	NEW REV.
LAT-TD-07126	LAT FSW Qualification Test Procedure: DCMODE_001: ACD Diagnostics & Calibration	01
LAT-TD-07127	LAT FSW Qualification Test Procedure: DCMODE_002: ACD Diagnostics & Calibration	01
LAT-TD-07128	LAT FSW Qualification Test Procedure: DCMODE_003: TKR Diagnostics & Calibration	01
LAT-TD-07129	LAT FSW Qualification Test Procedure: NBTLMV_001: Narrowband Telemetry Housekeeping & Low-rate Science Data Verificaiton	01
LAT-TD-07130	LAT FSW Qualification Test Procedure: NBTLMV_002: Diagnostic Telemetry Verification	01

CHANGE DESCRIPTION (FROM/TO):

LAT-TD-07132-01- LAT FSW Qualification Test Procedure: FSWINI_001: FSW Initialization-SIU Primary Boot
LAT-TD-07133-01 -LAT FSW Qualification Test Procedure: FSWINI_002: FSW & LAT Initialization- Boot Self-Test & Boot Housekeeping Telemetry
LAT-TD-07134-01- LAT FSW Qualification Test Procedure: FSWINI_003: FSW & LAT Initialization- Multiple Boot Images
LAT-TD-07135-01- LAT FSW Qualification Test Procedure: FSWINI_004: FSW & LAT Initialization- SIU Hardware Reboot in response to the Signal on the Discrete Lines
LAT-TD-07136-01- LAT FSW Qualification Test Procedure: FSWINI_005: FSW Initialization- EPU Primary Boot
LAT-TD-07137-01- LAT FSW Qualification Test Procedure: FSWINI_006: FSW & LAT initialization- Reset Source
LAT-TD-07138-01- LAT FSW Qualification Test Procedure: FSWINI_007: FSW & LAT Initialization- Storage & Retrieval of System Errors During SIU Primary Boot
LAT-TD-07139-01- LAT FSW Qualification Test Procedure: FSWINI_008: FSW & LAT Initialization- Storage & Retrieval of System Errors During EPU Primary Boot
LAT-TD-07140-01- LAT FSW Qualification Test Procedure: FSWINI_009: FSW & LAT Initialization- SIU Boot Status on Discrete Lines & SISU Boot Housekeeping Telemetry
LAT-TD-07141-01- LAT FSW Qualification Test Procedure: FSWINI_010: FSW & LAT Initialization- SIU & EPU Secondary Boot
LAT-TD-07142-01- LAT FSW Qualification Test Procedure: FSWINI_011: FSW & LAT Initialization- SIU & EPU Secondary Boot Error Mitigation
LAT-TD-07143-01- LAT FSW Qualification Test Procedure: FSWINI_012: FSW & LAT Initialization- LAT SEU Protection
LAT-TD-07144-01- LAT FSW Qualification Test Procedure: FSWINI_013: FSW & LAT Initialization- LAT Memory Scrubbing
LAT-TD-07145-01- LAT FSW Qualification Test Procedure: FSWINI_014: FSW & LAT Initialization- Watchdog Management During Boot
LAT-TD-07146-01- LAT FSW Qualification Test Procedure: FSWINI_015: FSW & LAT Initialization- Soft Reset
LAT-TD-07152-01 - LAT FSW Qualification Test Procedure:FECALB_001: Charge Injection Calibration – TOT Measurements
LAT-TD-07153-01- LAT FSW Qualification Test Procedure:FECALB_002: Charge Injection Calibration – TKR Threshold and Charge Scans
LAT-TD-07154-01- LAT FSW Qualification Test Procedure: FECALB_003: Charge Injection Calibration – TKR Trigger Check
LAT-TD-07155-01- LAT FSW Qualification Test Procedure: FECALB_004: Charge Injection Calibration – ACD Charge Injection
LAT-TD-07156-01- LAT FSW Qualification Test Procedure: FECALB_005: Charge Injection Calibration – CAL Charge Injection
LAT-TD-07157-01- LAT FSW Qualification Test Procedure: WBTLMV_001: Wideband Telemetry Verification – Science Data Format and Volume

REASON FOR CHANGE:

ACTION TAKEN: ☒ **Change(s) included in new release** ☐ **DCN attached to document(s), changes to be included in next revision**
☐ **Other (specify):**

DISPOSITION OF HARDWARE (IDENTIFY SERIAL NUMBERS):	**DCN DISTRIBUTION:**
☒ **No hardware affected (record change only)**	
☐ **List S/Ns which comply already:**	
☐ **List S/Ns to be reworked or scrapped:**	
☐ **List S/Ns to be built with this change:**	
☐ **List S/Ns to be retested per this change:**	
☐	

SAFETY, COST, SCHEDULE, REQUIREMENTS IMPACT? ☐ **YES** ☒ **NO**
If yes, CCB approval is required. Enter change request number:

APPROVALS	DATE	OTHER APPROVALS (specify):	DATE
ORIGINATOR: M. DeKlotz (signature on file)	8/16/05		
ORG. MANAGER: D. Horn (signature on file)	8/16/05		
PSA- K. Burlingham (signature on file)	8/16/05		
DCC RELEASE: Natalie Cramar (signature on file)	8/16/05	Doc. Control Level: ☒ Subsystem ☐ LAT IPO ☐ GLAST Project	

Continuation:

LAT-TD-07158-01- LAT FSW Qualification Test Procedure: FILMGT_001: File Management Verification

LAT-TD-07159-01- LAT FSW Qualification Test Procedure: MEMMGT_002: Memory Load Data

LAT-TD-07160-01- LAT FSW Qualification Test Procedure: NBTLMV_003: ACD HSK Anomaly Response and Alert Telemetry Verification

LAT-TD-07161-01- LAT FSW Qualification Test Procedure: OPMODE_001: LAT Operational Mode Control

LAT-TD-07162-01- LAT FSW Qualification Test Procedure: THRMCS_001: LAT Thermal Control System

LAT-TD-07163-01- LAT FSW Qualification Test Procedure: VSGIFV_001: Discrete Signal Interfaces

LAT-TD-07164-01- LAT FSW Qualification Test Procedure: CMDFNC_003: 1553 Interface and Command Functional Verification

LAT-TD-07054-01- LAT FSW Qualification Test Procedure: EVTPMO_001: Event Performance Monitoring and Verification – Software-Related Deadtime

LAT-TD-07055-01- LAT FSW Qualification Test Procedure: EVTPMO_002: Event Performance Monitoring and Verification –Acquisition of VETO Rates from the GEM

LAT-TD-07056-01- LAT FSW Qualification Test Procedure: EVTPMO_003: Event Performance Monitoring and Verification – Level 1 Trigger Rates

LAT-TD-07057-01- LAT FSW Qualification Test Procedure: EVTPMO_004: Event Performance Monitoring and Verification – Monitor CNO Rates

LAT-TD-07112-01- LAT FSW Qualification Test Procedure: EVTFIL_001: Event Filtering – Interface from the Event Builder

LAT-TD-07113-01- LAT FSW Qualification Test Procedure: EVTFIL_002: Event Filtering – Event Filter Rates and Capacity

LAT-TD-07114-01- LAT FSW Qualification Test Procedure: EVTFIL_003: Event Filtering – Event Filter Reprogramming

LAT-TD-07115-01- LAT FSW Qualification Test Procedure: EVTFIL_004: Event Filtering – Event Filter Bypass

	Document #	Date effective
	**LAT-TD-07161-01**	8/16/05
	Author(s) Sergio Maldonado	Supersedes
	Subsystem/Office Electronics & DAQ Subsystem	

Document Title

LAT FSW Qualification Test Procedure:

OPMODE_001: LAT Operational Mode Control

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
01	8/16/05	Original

TABLE OF CONTENTS

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

OPMODE

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. The OPMODE suite tests the LAT operational mode controller.

1.2 Test ID

OPMODE_001

OPMODE_001 verifies that FSW supports the observatory modes of (1) sky survey, (2) pointed observation, and (3) repointed observation, and supports the necessary commanded, autonomous, and GRB-driven transition among these observatory modes. Further, this test verifies that FSW supports all required safety modes, and can correctly control the transition to LAT safe mode, correctly respond to load shedding messages from the spacecraft, and correctly manage entry into SAA and subsequent recovery from SAA. This test confirms proper operation of the LAT in these observatory and safety modes, and proper reporting of mode changes in telemetry.

1.2.1 Operating Mode Correlations

From the perspective of the LAT, there is no distinction between "Sky Survey" and "Pointed" observation modes. These are observatory modes that the LAT supports in "PHYSICS" mode.

Both safing and load shed requirements are satisfied by the load shed response of powering down all instruments, and rebooting the SIU. The mode entered after a load shed or safe command is processed is BOOT.

Just as the spacecraft implemented a single load shed command to satisfy its requirements to send commands to the LAT to 1) initiate load shed and 2) notify the LAT of impending safe mode transition, so the LAT FSW meets its requirements for responding to load shed and safe mode notification commands by processing the single load shed command.

Operating Mode Correlations

External Mode/State	FSW Mode
Load Shed	Boot
Safe	Boot
SAA Transit	Supported in all FSW modes
Sky Survey	Physics
Pointed Observation	Physics
Repointed Observation: ToO	ToO
Repointed Observation: ARR	ARR

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
5.3.15	Mode Control	[1] (3.1.2.2, 3.3.2.2.7, 3.3.2.3.10), [3] (5.3.5) The FSW shall support the observatory modes of (1) sky survey, (2) pointed observation, and (3) repointed observation.	Full
5.3.15.1	Ground Commanded Repointing	[1] (3.1.2.3, 3.3.2.1.1, 3.3.2.4.2) Upon command, the FSW shall support transition to repointed observation mode from sky survey and pointed observation modes	Full

Requirement Number	Requirement Name	Requirement	Level of Requirements Verification in This Test
5.3.15.2	Sequences of Observations	[1] (3.3.2.1.3) The FSW shall support execution of sequences of pointed and sky survey observations from on-board command storage.	Full
5.3.15.4	Mode Reporting	[Derived] The FSW shall report current mode and mode changes in telemetry.	Full
5.3.15.6	Responding to Previously Planned Commands	[3] 5.4.8.2.3.4 While in Repointed mode, the FSW shall ignore or defer commands to perform charge injection calibration, diagnostics, sky survey observations, and pointed observations.	Full
5.3.16.1.1	Safe Mode Notification from SC	[2] (3.2.8.2) [3] (5.3.5) The SIU FSW shall receive and process a safe-mode notification message from the SC, then execute a set of actions designed to place the LAT in a predetermined LAT Safe Mode within 15 seconds.	Full
5.3.16.1.2	Safe Mode Notification to Ground	[1] (3.3.4.3) Assuming that power is available, the SIU FSW shall put a notification of transition to LAT Safe Mode as alert telemetry to the ground prior to entering LAT Safe Mode.	Full
5.3.16.2.1	Load Shedding Notification from SC	[2] (3.2.8.3) [3] (5.3.5) The SIU FSW shall receive and process a load shedding notification message from the SC, then execute the necessary configuration commands within 15 seconds to power off all SIU-controlled LAT components and prepare for shutdown.	Full

Requirement Number	Requirement Name	Requirement	Level of Requirements Verification in This Test
5.3.16.2.2	Load Shedding Notification to Ground	[Derived] Assuming that power is maintained during the 15 seconds, the SIU FSW shall put a notification of powering off due to load shedding into the telemetry stream to the ground, prior to powering off.	Full
5.3.18.1	Configure ACD for SAA	[1] (3.3.5.1.2), [2] (3.2.6.6) [4] (5.5.6) Prior to SAA transit, the FSW shall configure the ACD as described in the ACD-LAT ICD.	Full
5.3.18.3	Post-SAA Recovery	[2] (3.2.6.6) [4] (5.5.6) The FSW shall support recovery from SAA transits to ensure that science data collected after SAA transit is performed with the planned configuration.	Full

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

2.2 Acronyms

ADC	Analog-to-Digital-Converter
CAL	Calorimeter
EGSE	Electrical Ground Support Equipment
GASU	Global trigger Anti-collision Spacecraft Unit
LIM	LAT Instrument Manager (Mode Controller)
LHK	LAT Housekeeping
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
1 PPS	One Pulse per Second

3. REFERENCES

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

3.1 Applicable Documents

Document Number	Description
SPECIFICATIONS	
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)
LAT-SS-00363	ACD LAT ICD
PROCEDURES	
N/A	
PLANS	
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
LAT-MD-00104	LAT FSW Management Plan
DRAWINGS	
N/A	
OTHER	
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		
Global Trigger AEM Signal Distribution Unit (GASU)	SLAC		
Power Distribution Unit (PDU)	SLAC		
Tower Electronics Modules (TEM) x 16	SLAC		
Event Processing Unit (EPU)	SLAC		
Front End Simulator (FES)	SLAC		
1553 cables and couplers	SLAC		
Unix or Linux Host Establishes connection between VSC and the terminal from which the test is run.			
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.

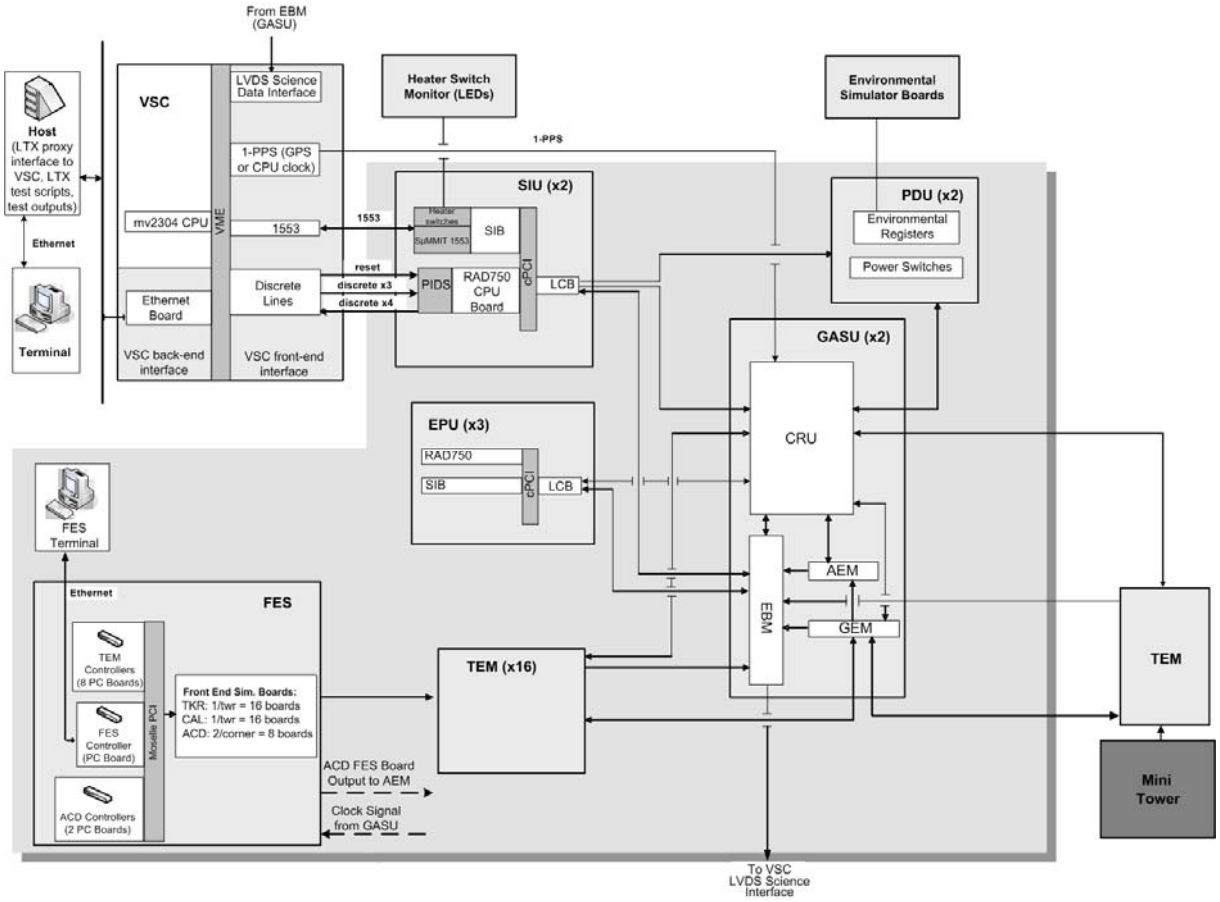

Figure 1. FSW Testbed

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		
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)
OPMODE_001.py	This script, the main test execution script, tests FSW operating in Application Mode. It executes tests of SIU FSW. The script controls the entire test process, detecting the state of the hardware and FSW and advancing SIU FSW through the different necessary operational modes required to execute the test.		
OPMODE_001_analyze.py	Post-processing result analysis script.		

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 packages and constituents that are the focus of the test are listed below.

FSW Package	Constituent(s)
LIM	

FSW Package	Constituent(s)

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	Record the version numbers of all test tools used to perform this qualification test in the table in Section 5.2.1	Complete/ Not Complete

Step No.	Description of Step	Step Outcome
2	Record the version numbers of all test scripts used to perform this qualification test in the table in Section 5.2.2	Complete/ Not Complete
3	Record the version numbers of the FSW constituents and the Candidate Release on which this test is performed 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 OPMODE_001

6.1 Test Objective

To verify the proper functionality of the instrument mode control software, the LAT must be configured to take physics, diagnostic, and calibration data. The basic steps are as follows:

1. Send command to enter desired mode – possibly involves data taking
2. Send command to transition to desired mode
3. Observe transition to expected mode and execution of required operational directives (if any) – this includes setting instrument power states, telemetry notification, and/or resumption/cancellation of data taking

Number	Test Sub-Objective
1	Verify support of sky survey and pointed observatory modes
2	Verify successful transitioning to repointed mode from sky survey and pointed observation modes
3	Verify successful execution of sequenced pointed and sky survey observations
4	Verify successful reporting of all mode states and transitions in telemetry
5	Verify rejection of calibration and observation commands while in Repointed mode
6	Verify successful processing of safe mode notifications from the SC
7	Verify successful processing of load shedding notifications from the SC
8	Verify successful configuration of the ACD prior to entering SAA mode
9	Verify successful recovery from SAA mode

Analysis of results is performed as and when data arrives in telemetry. Typically analysis includes verifying the telemetry values against expected values and tagging the sub-objectives as either "PASS" or "FAIL".

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)
TBD0.f	FES input file simulating cosmic ray background		
VPI_lim_mne.txt	VPI input file with LIM specific telemetry mnemonic logging enabled		
TBD2.f	LATC configuration file with nominal settings		
TBD3.f	Event filter configuration file with nominal settings		
TBD4.f	LATC configuration file for SAA		

6.3 Test Output Files

The following table identifies all files used as outputs to this qualification test. Note that not all qualification tests use output data of this type. The "Output 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.

Output File	Description of Output File	Output File Version Number (or Specify Attachment Number)	Path to Attachment (If Applicable)
VPI_lim_mne_mmddyy_hhmmss.csv	Telemetry mnemonic archive file generated by VSC proxy interface (VPI)		
TBD5.ldf	Science data output, LDF format, generated by VSC proxy interface (VPI)		

6.4 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	Confirm that the VSC is powered up.	Complete/ Not Complete
2	Confirm that the Front End Simulator is powered up and files loaded: The power LED on all FES computers (latent1,latent2, ..., latent11) should be on. The voltage indicator on the Xantrex power supply marked "FESFEED"should display 48 ± 0.5V, and the current should be above 5A.The state indicators on all FES electronic boards should be flashing. Load FES input file TBD1.f and initialize run.	Complete/ Not Complete
3	Confirm that the SIU and the GASU are powered up: The voltage indicator on the SIU/GASU Xantrex power supply should display 28 ± 0.2V. The SIU feed "POWER ON" switch on the regulated feeds bus protection unit (BPU) should be flipped "ON". The SIU voltage indicator on the BPU should display 28 ± 0.2V. The SIU current as shown by the BPU indicator should be above 0.4A The DAQ feed "POWER ON" switch on the BPU should be flipped "ON". The DAQ voltage indicator on the BPU should display 28 ± 0.2V.	Complete/ Not Complete

6.5 Test Procedure

This section describes the step by step procedure performed once the test preparation is 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).

The following LIM telecommands and telemetry are used in this test:

LIM Telecommands

APID	FC	Cmd. Packet	Description
0x663	0	LIMTOOSTART	Start a target of opportunity observation
0x662	1	LIMLOADSHED	Shed LAT instrument power loads
0x663	4	LIMMAINFEEDON	Enable main power feed
0x663	6	LIMPOWERON	Enable power to LAT electronic modules
0x663	8	LIMSAAENTER	Indication that the LAT has entered the South Atlantic Anomaly
0x663	9	LIMSAAEXIT	Indication that the LAT has exited the South Atlantic Anomaly

LIM Telemetry

APID	Tlm. Packet	Description
0x30f	LIM State	Lim State Telemetry

Step No.	Description of Step	Step Outcome
1	At the test terminal, run the script *OPMODE_001* under LTX through the VSC with the following command: **$ ltx run OPMODE_001**	Complete/ Not Complete

Step No.	Description of Step	Step Outcome
2	The test script determines whether the SIU is powered on by checking whether SIU boot housekeeping telemetry is being transmitted. Regardless of the SIU's current operational mode, the script sends the SIU the LPBCRESET telecommand to reboot the unit. The script then checks whether the SIU FSW is operating in Boot Mode by detecting if boot housekeeping is being transmitted. If not, the script sends the LPBCRESET command and checks again. If the SIU FSW cannot be placed in Boot Mode, LTX prints an error message to the screen and exits, aborting the test. If the test is NOT aborted, mark "Complete" for the Step Outcome.	Complete/ Not Complete
3	The script initializes the VSC software and starts proxy interface using the input file VPI_lim_mne.txt telemetry configuration file. Output file VPI_lim_mne_mmddyy_hhmmss.csv is created in the test session directory and the full path and filename of the soft copy of this output file is recorded in section 6.3 of the procedure document.	Complete/ Not Complete
4	With FSW on the SIU in Boot Mode, send PBCRTOSEXEC telecommand to advance to secondary boot.	N/A
5	After completion of secondary boot, FSW modules are loaded and the SIU is placed in TERMINAL mode.	N/A
6	Send telecommand LIMMAINFEEDON to initialize the LCB, PDU, and GASU. Housekeeping telemetry Send telecommand LIMPOWERON with parameters set to enable power of all TEMs, CAL, TKR, ACD and EPU electronics modules. Diagnostic telemetry LIMTOPMODE shows LIM reporting QUIESCENT mode.	N/A
7	Telecommand LPAxxx with parameters specifying LATC configuration file TBD2.f and event filter file TBD3.f is issued to commence data taking. The LAT is placed in mode PHYSICS, which is consistent with "Sky Survey" and "Pointed" observation modes. Diagnostic telemetry LIMTOPMODE shows LIM reporting PHYSICS. At the first exection of this step, output file TBD5.ldf is created in the test session directory and the full path and filename of the soft copy of this output file is recorded in section 6.3 of the procedure document.	Complete/ Not Complete
8	Telecommand LIMTOOSTART is issued with a time parameter of 30 seconds to place the LAT in TOO mode, which is consistent with the repointed observation mode. Diagnostic telemetry LIMTOPMODE shows LIM reporting TOO mode. (30 seconds after the TOO command was issued, PHYSICS mode is resumed, and the previous data taking operation is reestablished. Diagnostic telemetry LIMTOPMODE shows LIM reporting PHYSICS mode. The data taking operation completes and diagnostic telemetry LIMTOPMODE shows LIM reporting QUIESCENT mode.)	N/A
9	While in repointed mode, telecommand LPAxxx is issued to attempt a physics run consistent with Sky Survey and Pointed observation modes.	N/A
10	While in repointed mode, telecommand LCIxxx is issued to attempt charge injection calibration.	N/A
11	To demonstrate support of sequences of observations, procedure step 7 is repeated 3 times sequentially.	N/A

Step No.	Description of Step	Step Outcome
12	Procedure step 7 is repeated. Telecommand LATCxxx is issued to dump the current PHYSICS configuration in telemetry. While in PHYSICS mode, telecommand LIMSAAENTER is issued it elicit the ACD configuration response. Diagnostic telemetry LIMTOPMODE shows LIM reporting SAA transit. The data taking operation ceases for the duration of SAA. Telecommand LATCxxx with file TBD3.f is sent to load an alternate configuration during SAA. Telecommand LATCxxx is issued to dump the current SAA configuration in telemetry. 30 seconds later, telecommand LIMSAAEXIT is issued to initiate the post-SAA recovery actions. Diagnostic telemetry LIMTOPMODE shows LIM reporting PHYSICS mode, indication resumption of previous data collection configuration. Telecommand LATCxxx is issued to dump the current RECOVERED configuration in telemetry. At the completion of the data taking operation, diagnostic telemetry LIMTOPMODE shows LIM reporting QUIESCENT.	N/A
13	While in QUIESCENT mode, telecommand LIMLOADSHED is issued to initiate powering off all SIU-controlled LAT components and placing the LAT in a predetermined safe mode	N/A

Initial to confirm.

_____	_____	_____	_____
Date	Time	Test Engineer	QAE

6.6 Test Analysis

The analysis for each of the sub-objectives is conducted by the main analysis script OPMODE_xxx. “Pass” or “Fail” is specified for steps involved in verifying completion of test objectives and sub-objectives.

Step No.	Description of Step	Step Outcome
1	At the conclusion of the test run, the analysis script *OPMODE_001_analyze.py* is autonomously executed: Review the terminal output of the analysis script for: **Analyzing test output**	Complete/ Not Complete
2	Telemetry data archive file VPI_lim_mne_mmddyy_hhmmss.csv is loaded. Mnemonic values for LIMTOPSTATE are extracted. These values represent the complete state transitions of the LAT for the duration of the test. Science data output file TBD4.ldf is loaded and parsed for event record data. Event records with timestamps corresponding to the data collection operation initiated in procedure step 7 is extracted. Presence of this data in the event stream, along with the LIMTOPMODE telemetry reporting PHYSICS mode, confirms support of sky survey and pointed observations modes, thereby verifying sub-objective 1. Review the terminal output of the analysis script for: **Sky Survey and Pointed Observation mode support validated in PHYSICS MODE: 0: PASS**	Pass/ Fail

Step No.	Description of Step	Step Outcome
3	The LIMTOPMODE telemetry reporting TOO mode, along with the presence of TOO specific event data not associated with the normal PHYSICS data taking operation, for the ensuing 30 seconds, demonstrates successful transitioning from PHYSICS mode to TOO mode. Telemetry LIMTOOACTIVE is set to 1. This supports transitioning to repointed observation mode from sky survey and pointed observation modes, thereby verifying sub-objective 2. Review the terminal output of the analysis script for: **Repointed mode transition validated in TOO mode: 0: PASS**	Pass/ Fail
4	The LIMTOPMODE telemetry reporting TOO mode, along with the presence of TOO specific event data not associated with the normal PHYSICS data taking operation, for the ensuing 30 seconds, demonstrates successful transitioning from PHYSICS mode to TOO mode. This supports transitioning to repointed observation mode from sky survey and pointed observation modes, thereby verifying sub-objective 2. Review the terminal output of the analysis script for: **Resumption of sky survey and pointed observations in PHYSICS mode from repointed observations in TOO mode validated: 0: PASS**	Pass/ Fail
5	Timestamps associated with LIMTOPMODE telemetry reporting transitions into TOO mode and out of TOO mode, initiated in procedure step 8, are extracted. The presence of TOO specific event data not associated with the normal PHYSICS or CALIBRATION data taking operations for the time the LAT was in TOO mode demonstrates rejection of diagnostic calibration, sky survey, or pointed observation requests, thereby verifying sub-objective 5. Review the terminal output of the analysis script for: **Rejection of commands in TOO mode validated: 0: PASS**	Pass/ Fail
6	Presence of event data records for the timestamps representing the data collection specified in procedure step 11, along with LIMTOPMODE telemetry reporting PHYSICS mode, demonstrates support for sequenced observations, thereby verifying sub-objective 3 **Sequenced observation support validated: 0: PASS**	Pass/ Fail

Step No.	Description of Step	Step Outcome
7	The LIMTOPMODE telemetry reporting SAA mode after the LIMSAAENTER command was issued in procedure step 12, along with telemetry LIMSAATRANSIT set to 1, indicates successful transitioning to SAA mode. Monitoring of LHK telemetry apid 0x226 LHKAEMFRxVD, where x=[0:11] for a drop in voltage demonstrates configuration of the ACD, thereby verifying sub-objective 8 SSR output telemetry file TBD4.ldf is parsed for all LATC dump telemetry. This amounts to a total of 3 dump records, elicited by the 3 LATC dump telecommands sent in procedure step 12. The dump record corresponding to the pre-SAA dump is verified to be the same as the dump record corresponding to the post-SAA dump. The dump that was issued during SAA is validated to be distinct from the pre-SAA and post-SAA dumps. Event record data collected after SAA mode was exited, corresponding to the PHYSICS operations active before SAA was entered, is validated to ensure that the pre-SAA data taking configuration was successfully restored. LIMTOPMODE telemetry reporting PHYSICS mode after the LIMSAAEXIT command was issued in procedure step 12, along with telemetry LIMSAATRANSIT set to 0, indicates successful recovery from SAA mode. Monitoring of LHK telemetry apid 0x226 LHKAEMFRxVD, where x=[0:11] for a rise in voltage demonstrates d configuration of the ACD, thereby verifying sub-objective 9. **SAA Mode Control Validated 0: PASS**	Pass/ Fail
8	The timestamp associated with the LIMTOPMODE telemetry reporting LOADSHED mode after the LOADSHED command was issued in procedure step 13, is extracted. Alert telemetry packet TDB associated with the transition to LOADSHED is also extracted. LHK telemetry mnemonics are monitored for instrument related voltage and current drops signifying power shedding from all instruments. At the completion of the LOADSHED operation, the SIU is rebooted, and PBC telemetry is extracted and validated. The timestamps in the LOADSHED notifications, and the appearance of the first PBC boot packet are determined to be less than 15 seconds apart. These actions support transitioning to a safe mode and executing the required power load shedding, thereby verifying sub-objectives 6 and 7. Review the terminal output of the analysis script for: **Safe mode actions executed within 15 seconds validated: 0: PASS** **Load shed actions executed within 15 seconds validated:: 0: PASS**	Pass/ Fail
9	A passing outcome of analysis steps 2 through 8 demonstrate successful reporting of all mode transitions in telemetry, thereby verifying sub-objective 4. Review the terminal output of the analysis script for: **Mode transition telemetry validated: 0: PASS**	Pass/ Fail

7. TEST POST_CONDITIONS AND OVERALL OUTCOME

7.1 Test Post-Conditions

The following post-conditions are analyzed and verified by the test script as described in "Test Procedure and Test Analysis":

No.	Post-Condition	Post-Condition Met? (Yes/No)
1	LAT flight software is in QUIESCIENT mode as reported by telemetry apid 0x30f mnemonic LIMTOPMODE Terminal displays **LAT MODE: QUIESCIENT**	

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 OPMODE_001

Based on the analysis of the test results, the overall outcome of Test OPMODE_001 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

8. CERTIFICATION

I certify that the information obtained under this test procedure is as represented and the information recorded in this document is complete and correct. Any deviations from test procedures described herein are identified in Appendix A.

_____ _____ _____

Date Test Engineer (Print Name) Test Engineer (Signature)

I certify that the information obtained through execution of this test procedure is as represented and the information recorded in this document is complete and correct. Execution of the test, storage of the results, and verification of outcomes were carried out in accordance with quality standards defined in the GLAST Quality Manual (LAT-MD-00091).

_____ _____ _____

Date Software QA Engineer (Print Name) Software QA Engineer (Sign)

I certify that the information obtained under this test procedure is as represented and the information recorded in this document is complete and correct. The test procedure, as designed and executed, does indeed verify that the FSW functionality under test satisfies the corresponding requirements from the Flight Software Specification – Level III.

_____ _____ _____

Date FSW Manager (Print Name) FSW Manager (Signature)

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., "OPMODE_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.