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CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
1	08/15/05	Original
2	01/04/06	Updates for FSW B0-6-1 interfaces

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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***EVTFIL***

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 *EVTFIL_004* belongs in the Test Suite *EVTFIL* under the *FST* Project. The *EVTFIL* tests verify the functionality of the LAT onboard event filter software.

1.2 Test ID***EVTFIL_004***

Test *EVTFIL_004* contains one main test script, *evtfil_004.py*, which can be run when the SIU and EPU are operating in Boot Mode.

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
5.3.9.3	Event Filter Bypass	The event filtering software shall be capable of passing a pre-scaled sample of unfiltered events for monitoring and analysis, upon request.

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:

2.1Definitions

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

2.2Acronyms

CAL	Calorimeter
EGSE	Electrical Ground Support Equipment
FOV	Field of View
GASU	Global trigger Anti-collision Spacecraft Unit
GBM	Gamma-ray Burst Monitor
GRB	Gamma Ray Bust
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

3.REFERENCES

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

3.1Applicable Documents

<u>Document Number</u>	<u>Description</u>
<u>SPECIFICATIONS</u>	
LAT-SS-00399	LAT Flight Software Level III Specification
LAT-TD-02659	LAT Flight Software Telecommand and Telemetry Formats
LAT-TD-0561	The Virtual Spacecraft (VSC)
<u>PROCEDURES</u>	
<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
LAT-MD-00104	LAT Flight Software Management Plan
<u>DRAWINGS</u>	
<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.

5.1Hardware Setup

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

Hardware Unit	Manufacturer	GLAT Number	Firmware Version (where applicable)
Front End Simulator (FES): 1	SLAC		
Virtual Spacecraft (VSC): 1	SLAC		
Spacecraft Interface Unit (SIU): 1	SLAC		
Event Processing Unit (EPU): 2	SLAC		
Tower Electronics Module (TEM): 16	SLAC		
Global Trigger AEM Signal distribution unit (GASU): 1	SLAC		
Power Distribution Unit (PDU):1	SLAC		
Unix or Linux host Establishes connection between VSC and the terminal from which the test is run.			

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.

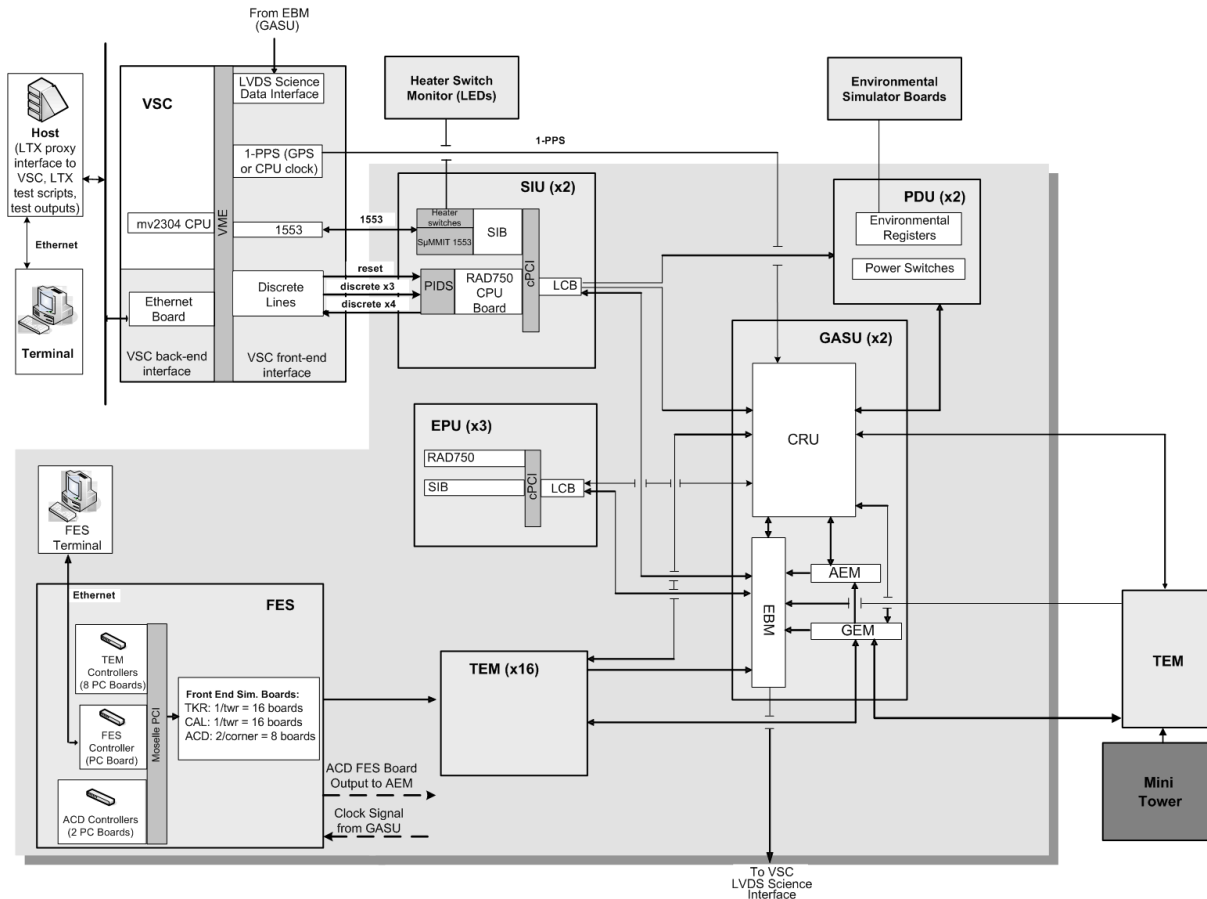


Figure 1. FSW Testbed

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		

Software	Description of Software	Software Version Number (or Specify Attachment Number)	Path to Attachment (If Applicable)
LCAT	Telecommand creation and telemetry decoding software		
FMX	File Management Extra		
VPI	VSC Proxy Interface		
VSCP	Python API for Virtual Spacecraft software		
STU	Standard Test Utilities		

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)
evtfil_004.py	Main LTX qualification test execution script for EVTFIL_004		
EVTFIL_004.xml	LTX test description file for EVTFIL_004		
evtfil_004_analyze.py	Test data/results analysis script for EVTFIL_004		

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)
EFC	
GFC_DB	

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
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 EVTFIL_004

6.1Test Objective

This test verifies that the filter code can be configured to pass a pre-scaled sample of unfiltered events.

The test runs simulated cosmic ray data through the Front End Simulator three times. The first time, the filter is used in its default configuration, and the number of events passed by the filter is used as a reference for subsequent runs. During the second and the third simulation runs, the filter is configured to pass unfiltered events with different prescale values. For these runs, the number of events passing the filter is compared to the reference.

The expected increase in the number of events, N_{diff} , for the given prescale factor f is estimated from the following formula:

$$N_{diff} = (N_0 - N_A)/f \pm \sqrt{(N_A(N_0 - N_A)/(f N_0))}$$

where N_0 is the number of events caused LAT trigger in the simulation and N_A is the number of events accepted by the filter in the reference run. This formula represents the mean and the standard deviation of a binomial distribution with N_0/f trials and $(N_0 - N_A)/N_0$ probability to increase the output event sample by one.

At the time of this writing the prescale factor equals to prescale setting in the filter configuration file plus one. This “plus one” is likely to be removed in the future.

This Test Objective is broken down into the following Test Sub-Objective(s).

Number	Test Sub-Objective
1	Configure the filter and take the data for each of the three testbed runs.
2	Verify that the number of events passed in the three runs are all different from each other, and that the increase in the number of passed events above the reference number is compatible with the increase expected for the prescale value used in the run.

6.2Test 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)
orbit_15min.txt	Simulated orbit data file		
gammaNormal100MeV_v7r3p4	FES file simulating cosmic ray data		
libgfc_db_normal.o	Default filter configuration file (no bypass).		
libgfc_db_fswtest0.o	Filter configuration file with bypass prescale set to 15.		
libgfc_db_fswtest1.o	Filter configuration file with bypass prescale set to 30.		
latc_daq.xml	LATC configuration file		
latc_ignore.lat	LATC ignore map		

6.3 Test Output Files

The following table identifies the log files, data dump files, and other output files generated by the test scripts executed during this qualification test. The “Output File Attachment Number” column identifies which attachment to this document is the hardcopy record of this script output data. 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 Attachment Number	Path to Attachment
bg_default.lsf	Science data telemetry, LSF format file for the reference run		
bg_default.txt	Text file which contains FES and VSC configuration information for the above run		
bg_bypass_15.lsf	Science data telemetry, LSF format file for the run with bypass prescale of 15		
bg_bypass_15.txt	Text file which contains FES and VSC configuration information for the above run		
bg_bypass_30.lsf	Science data telemetry, LSF format file for the run with bypass prescale of 30.		
bg_bypass_30.txt	Text file which contains FES and VSC configuration information for the above run		

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 tested 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: -- The VSC GPS module should display time since last reset.	Complete/ Not Complete
2	Confirm that the Front End Simulator is powered up: -- The power LED on all FES computers (lat-ent1, lat-ent2, ..., lat-ent11) should be on. -- The voltage indicator on the Xantrex power supply marked "FES-FEED" should display $48 \pm 0.5V$, and the current should be above 5A. -- The state indicators on all FES electronic boards should be flashing.	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 $28 \pm 0.2V$. -- 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 $28 \pm 0.2V$. 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 $28 \pm 0.2V$.	Complete/ Not Complete

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

Date Time Test Engineer QAE

6.5 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	Verify presence of the simulated science data on the FES nodes. On a Linux host, run the command fesdata show hibg6min_v7r3p4 It should display Directory : 1955625085 23-Dec-2005 10:32:48 ffffffff hibg6min v7r3p4	Complete / Not Complete

Step No.	Description of Step	Step Outcome
2	<p>Launch the data acquisition script. The expected run time for this script is 30 min:</p> <p>ltx run EVTFIL_004 --ips=lat-hobbit2,lat-elf21,lat-ent1,lat-elf23,lat-elf24,lat-elf25 --prot=ethernet,xyplex,xyplex,xyplex,xyplex,xyplex</p> <p>The data acquisition script performs three testbed runs using the same set of Monte Carlo events and generates three LSF files listed in the table in Section 6.3. The following sequence of operations is performed for each testbed run:</p> <ol style="list-style-type: none"> 1) A set of spacecraft timestamped coordinates and attitudes is scheduled for simulation on the VSC using the VSC interface M7 (“magic seven”) class. The orbit file format is described at http://confluence.slac.stanford.edu/display/DC2/Orbit+and+Pointing+History 2) The physics run is configured using two or more LPACONFIGURE telecommands. 3) The LPASTART telecommand is sent to the spacecraft. This changes the LAT Instrument Manager operation mode from QUIESCENT to PHYSICS and initiates data taking by the LAT. 4) The LIM “State” telemetry packets are received. The LPA task state, as identified by the LIMLPASTATE field, is required to be “Running”. The LIM operation mode, as identified by the LIMTOPMODE field, is required to be PHYSICS. The "CmdConfirm" command validation telemetry packet with successful status is expected after the LIM “State” packet with the right properties. The timeout for “CmdConfirm” telemetry reception after the LPASTART telecommand is set to 30 seconds. 5) The FES run is started by talking to the FES system via the LTX interface. FES timing is periodic for all runs with 100 Hz frequency (to avoid deadtime). 6) After a waiting period, the FES run is stopped. The length of the waiting period is set to the number of events in the simulation divided by the FES period plus 1 second. 7) The LPASTOP telecommand is sent to the spacecraft. 8) The "CmdConfirm" command validation telemetry packet is expected. After receiving “CmdConfirm”, one or more LIM “State” telemetry packets is received, until the LIMLPASTATE field of the LIM “State” packet indicates that that the state of the LPA task is “Idle” and the LIMTOPMODE field indicates that the instrument operation mode is QUIESCENT. The timeout for reception of LIM “State” telemetry with right properties is set to 30 seconds after the LPASTOP telecommand. <p>During each run all packets received by the proxy on the VSC science stream are written to an LSF file on a hard disk.</p> <p>Upon successful completion of the data acquisition stage, the script displays</p> <p>DAQ script finished YYYY-MM-DD HH:MM:SS.UUUUUU</p>	Complete / Not Complete
3	<p>The data acquisition script automatically runs the data analysis script when all testbed runs are complete. The data analysis script counts the number of events obtained in each testbed run. Then it checks whether the number of events has changed according to expectations, as described in Section 6.1. The number of events is required to be distinct in each run, and compliance with the expected N_{diff} is required within 5 standard deviations.</p>	Complete/ Not Complete
4	<p>Review the outputs of the data analysis script on the test terminal. The test passes if every line of the output contains the word “PASS”. Successful completion of this step fulfills all test objectives and sub-objectives. Example data analysis script output is shown below:</p> <p>The number of events in all runs is distinct : PASS</p> <p>Additional events passed with bypass prescale setting 15 : 1930 : PASS</p> <p>Additional events passed with bypass prescale setting 30 : 965 : PASS</p> <p>Combined test status : PASS</p>	Pass/ Fail

Step No.	Description of Step	Step Outcome
5	Press "Enter" in the terminal to end the test	Complete/ Not Complete

Initial to confirm.

_____ Date _____ Time _____ Test Engineer _____ QAE

7.TEST POST-CONDITIONS AND OVERALL OUTCOME

7.1Test Post-Conditions

The following post-conditions are analyzed and verified by the test script:

No.	Post-Condition	Post-Condition Met? (Yes/No)
1	Upon successful completion of the data acquisition stage, LAT flight software is in BOOT mode	

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

_____ Date _____ Time _____ Test Engineer _____ QAE

7.2Overall Outcome of EVTFIL_004

Based on the analysis of the test results, the overall outcome of Test EVTFIL_004 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., “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.
