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CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
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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

EVTPMO

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 *EVTPMO_004* belongs in the Test Suite *EVTPMO* under the *FST* Project. The *EVTPMO* tests verify the ability of LAT flight software to collect and transmit to the ground a set of statistics related to in-flight performance of the detector subsystems and data acquisition.

1.2 Test ID

EVTPMO_004

Test *EVTPMO_004* contains one main test script, *evtpmo_004.py*, which can be run when the SIU and EPU are operating in Application 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
5.3.8.2.3	Monitor CNO rates	The FSW shall provide the rate of CNO signals that appear in the CNO vector of the Event Summary from the GEM by counting the non-zero elements from the 12 CNO channels over a commandable accumulation period.

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-SS-00019	LAT Trigger & Dataflow Subsystem Specification
LAT-TD-01545	The GLT Electronics Module Programming ICD
LAT-TD-05601	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
<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, ACD, DAQ, and 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.

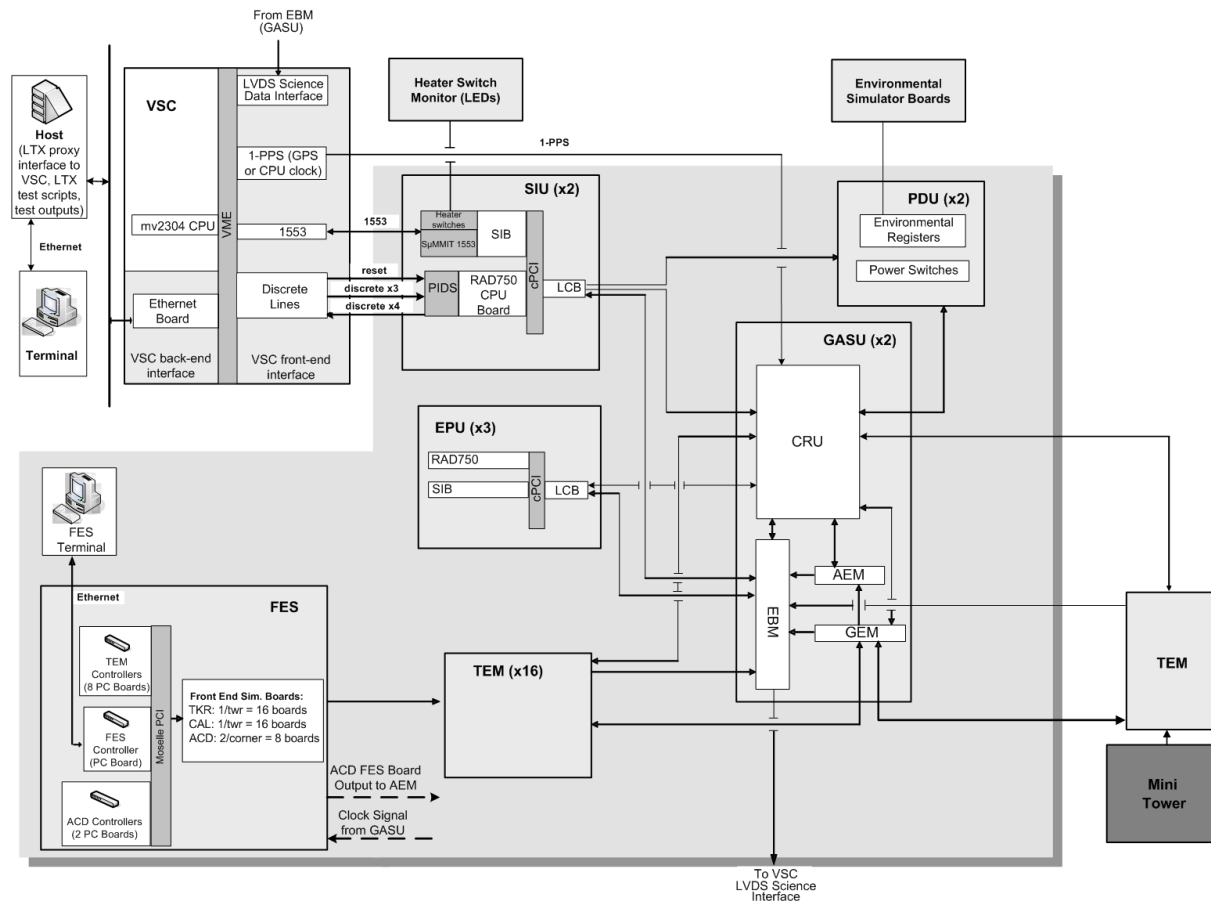


Figure 1. FSW Testbed

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		
FMX	File Management Extra		
GLEAM	GLast Event Analysis Machine		

Software	Description of Software	Software Version Number (or Specify Attachment Number)	Path to Attachment (If Applicable)
FES	Front End Simulator system software		
VSC	Virtual Spacecraft system software		
VPI	VSC Python/Proxy Interface		
(GLAST) ROOT	Data analysis toolkit		

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)
evtpmo_004.py	Main LTX qualification test execution script for EVTPMO_004		
evtpmo_004.xml	LTX test description file for EVTPMO_004		
evtpmo_004_analyze.py	Test data/results analysis script for EVTPMO_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)
EMP	TBD

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

Date

Time

Test Engineer

QAE

6. TEST PROCEDURE FOR EVTPMO_004

6.1 Test Objective

This test verifies that:

- The FSW maintains the software count of the CNO rates from the GEM CNO vector.
- The accumulation period is configurable.

The test verifies presence of the information about the GEM CNO vector software counters in the low-rate science telemetry. It runs simulated science data on the Front-End Simulator and collects the ACD/CNO software counter packets (APID TBD).

Three runs are performed: in the first two runs the CNO occupancy statistics is accumulated for the full set of L1 triggers with two different accumulation periods (configured as shown in the table in Section 6.2). In the third run the occupancy statistics is accumulated with a prescale and correspondingly increased accumulation period. In all testbed runs the event rate is set sufficiently low to ensure no missing events due to deadtime. At the end of each run, the mean CNO occupancy per accumulation period measured by the software counters is compared to the known mean CNO occupancy in the simulated data.

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

Number	Test Sub-Objective
1	Perform the three testbed runs.
2	For the first two runs (in which all L1 triggers are examined) confirm that the measured and expected occupancies match within the rounding precision of the calculations.
3	For the last run, confirm that occupancies for all 12 CNO channels are compatible with expectations within 5 standard deviations.

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)
TBD	Simulated orbit data file		
TBD	FES file simulating cosmic ray background data		
TBD	Configuration file for TBD sec accumulation period, no prescale		
TBD	Configuration file for TBD sec accumulation period, no prescale		
TBD	Configuration file for TBD sec accumulation period and prescale factor of 10		
TBD	File which contains pre-calculated occupancies for each CNO channel		

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
TBD	Telemetry file for the testbed run with TBD sec CNO rates accumulation period, no prescale		
TBD	Telemetry file for the testbed run with TBD sec CNO rates accumulation period, no prescale		
TBD	Telemetry file for the testbed run with CNO rates accumulated from the prescaled sample.		

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 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
2	Boot the Front End Simulator control nodes.	Complete/ Not Complete
3	Load simulated science data files to the FES nodes.	Complete/ Not Complete
4	Boot and initialize the Virtual Spacecraft.	Complete/ Not Complete
5	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
6	Execute Primary Boot and Secondary Boot on the SIU crate.	Complete/ Not Complete
7	Execute Primary Boot and Secondary Boot on the EPU crates.	Complete/ Not Complete
8	Confirm that FSW application modules have been loaded and that all FSW tasks have been initialized and are running. [[A script will be provided for this purpose.]]	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: [[Will be implemented using Owen Saxton's FES web server at http://lat-ent1/home.asp Support for file system browsing is not there yet.]]	Complete / Not Complete

Step No.	Description of Step	Step Outcome
2	<p>Verify that the configuration files listed in Section 6.2 are present on the SIB EEPROM and that they are included into the LPA task “working set”.</p> <p>[[A script will be provided for this purpose.]]</p>	<p>Complete / Not Complete</p>
3	<p>Launch the data acquisition script. The expected run time for this script is TBD min:</p> <p>Itx run EVTPMO_004</p> <p>The data acquisition script performs three testbed runs using the same set of Monte Carlo events and generates the three telemetry 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 simulated orbit file used for “magic seven” telecommand scheduling is the same as the orbit file used to produce the background simulation. The orbit file format is described at http://confluence.slac.stanford.edu/display/DC2/Orbit+and+Pointing+History 2) The science telemetry stream is open on the VSC (operation description TBD). 3) The Physics-Start telecommand (APID TBD) is sent to the spacecraft. This changes the LAT Instrument Manager operation mode from QUIESCENT to PHYSICS and initiates data taking by the LAT. The configuration number (an element of the LPA “working set”) is provided as the telecommand argument. 4) The LLIMSTATE telemetry (APID 0x30f) is received. The LPA task state, as identified by the lpa_state field, is required to be “Running”. The LIM operation mode, as identified by the op_mode field, is required to be PHYSICS. The timeout for LLIMSTATE telemetry reception after the Physics-Start telecommand is set to TBD seconds. 5) The FES run is started using the VSC interface FES class “start” method. FES timing is periodic. The period is set to TBD ms to avoid deadtime. 6) After a waiting period, the FES run is stopped using the VSC interface FES class “stop” method. The length of the waiting period is the FES period multiplied by the number of events in the sample. 7) The Physics-Stop telecommand (APID TBD) is sent to the spacecraft. 8) One or more LLIMSTATE telemetry packets is received, until the lpa_state field of the LLIMSTATE packet indicates that that the state of the LPA task is “Idle” and the op_mode field indicates that the instrument operation mode is QUIESCENT. The timeout for telemetry reception after the Physics-Stop telecommand is set to TBD seconds. 9) The science telemetry stream is closed on the VSC (operation description TBD). <p>In each run, the telemetry is monitored for the ACD/CNO software counter packets (APID TBD). Packet contents are saved in a telemetry file (format TBD).</p>	<p>Complete / Not Complete</p>

Step No.	Description of Step	Step Outcome
4	<p>Run the data analysis script. The expected run time for this script is TBD min:</p> <p>python \$HOME/FST/source/EVTPMO/test/EVTPMO_004/evtpmo_004_analyze.py ???</p> <p>The analysis script determines average occupancy for each CNO channel from the telemetry collected by the data acquisition script. For the runs in which all L1 triggers are monitored, the occupancy determined by the software counters must match the occupancy pre-calculated for this data sample (precision TBD). For the run with prescale, the average occupancy determined by the software counters is required to match the pre-calculated occupancy within 5 standard deviations.</p>	Complete/ Not Complete
5	<p>Confirm the outputs of the data analysis script were saved to the repository. Record the directory location of the output as indicated in Section 6.3.</p>	Complete/ Not Complete
6	<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>CNO channels with mismatching occupancy, TBD sec period : 0 : PASS CNO channels with mismatching occupancy, TBD sec period : 0 : PASS CNO channels with mismatching occupancy, prescaled smaple : 0 : PASS</p>	Pass/ Fail

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	The accumulation period for the CNO counters is modified.	

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

_____ Date _____ Time _____ Test Engineer _____ QAE

7.2Overall Outcome of EVTPMO_004

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