| | Document # | Date effective |
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| | Subsystem/Office<br>Electronics & DAQ Subsystem | |

Document Title

# LAT FSW Qualification Test Procedure:

# EVTFIL_002: Event Filtering – Event Filter Rates and Capacity

## CHANGE HISTORY LOG

| Revision | Effective Date | Description of Changes |
|---|---|---|
| 01 | XXXXX | Original |
| | | |
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| | | |
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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).

## 1.1Test 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_002* belongs in the Test Suite *EVTFIL* under the *FST* Project. The *EVTFIL* tests verify the functionality of the LAT onboard event filter software.

## 1.2Test ID

***EVTFIL_002***

Test *EVTFIL_002* contains one main test script, *evtfil_002.py*, which can be run when the SIU and EPUs are operating in Application Mode.

## 1.3Requirement(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 |
|---|---|---|
| 5.3.9.1 | Event Filter Rates and Capacity | The FSW shall provide the capability to filter the input stream of events accepted by the electronic trigger to an output stream commensurate with the spacecraft (SC) interface rate (see 5.2.1.3.1), and capacity of a maximum of 104 Gb in any given 24 hour period, keeping events meeting the science objectives.<br><br>Note that the 104 Gb allocation includes a total source packet overhead of 112 bits per packet (64 bits of the secondary header are for a time stamp). |

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

| 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-00010-1 | GLAST LAT Performance Specification - Level II(b) Specification |
| PROCEDURES | |
| 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 |
| DRAWINGS | |
| 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.

### 4.1Test 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.

### 4.2Quality 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.

### 4.3Safety

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.**

### 4.4Warnings, 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.

### 4.5General 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<br>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.

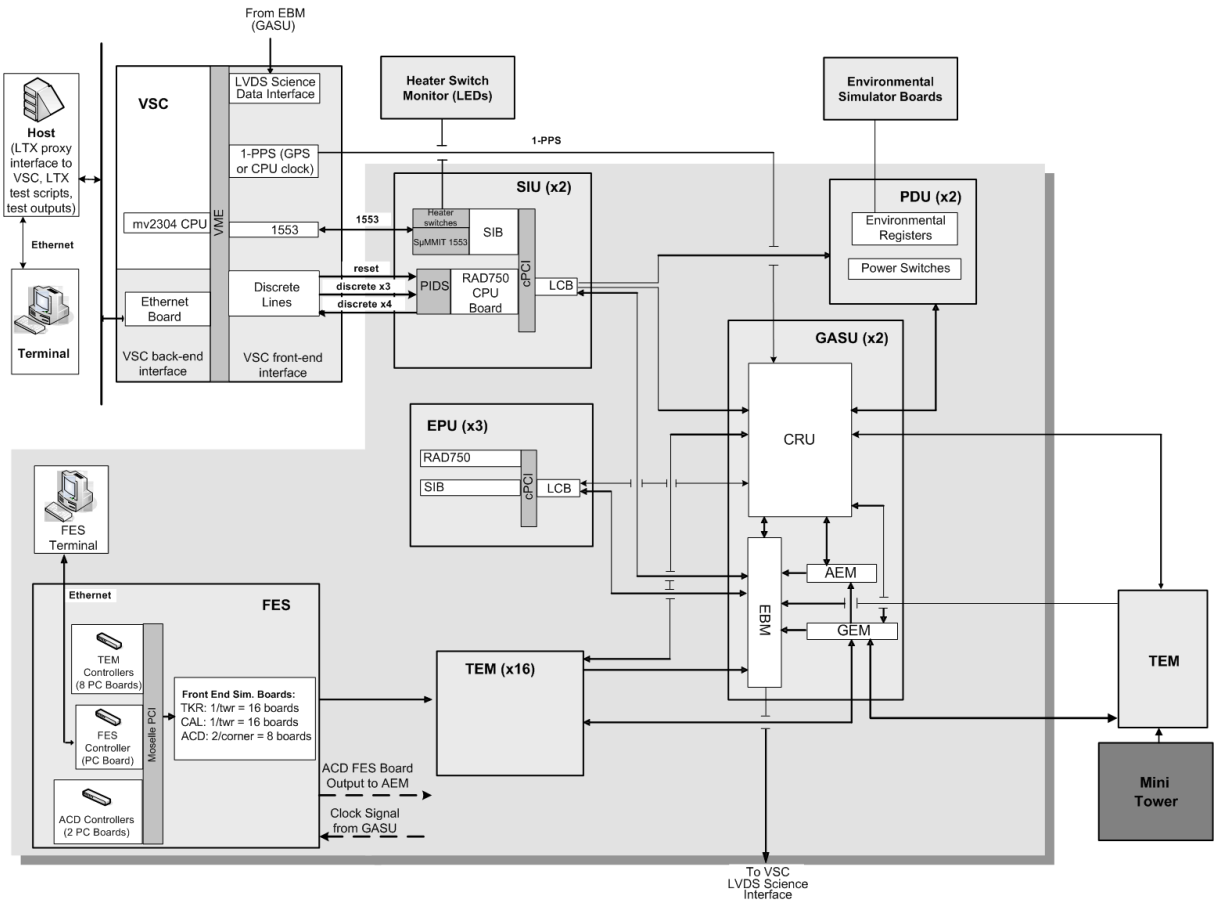


Figure 1. FSW Testbed

## 5.2Software Setup

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

### 5.2.1Test 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 | | |

### 5.2.2Test 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_002.py | Main LTX qualification test execution script for EVTFIL_002 | | |
| evtfil_002.xml | LTX test description file for EVTFIL_002 | | |
| evtfil_002_analyze.py | Test data/results analysis script for EVTFIL_002 | | |

### 5.2.3Flight 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 | 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

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 |
|---|---|---|
| | | |

## 5.3Setup Validation

### 5.3.1Hardware 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 |

### 5.3.2Software Validation

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

| Step No. | Description of Step | Step Outcome |
|---|---|---|
| 1 | Obtain version numbers of the test tools used to perform this qualification test by running the TBD script. Pick up and label the hardcopy report generated by the TBD script and attach it to this test procedure document. Record (1) the label for the attachment and (2) the directory location to which an electronic copy of the report was saved in Section 5.2.1. | Complete/ Not Complete |
| 2 | Obtain version numbers of the test scripts used to perform this qualification test by running the TBD script. Pick up and label the hardcopy report generated by the TBD script and attach it to this test procedure document. Record (1) the label for the attachment and (2) the directory location to which an electronic copy of the report was saved in Section 5.2.2. | Complete/ Not Complete |
| 3 | Obtain the versions of the FSW packages loaded on the targets by running the *version_test* script in the Application Mode. Pick up and label the hardcopy report generated by the *version_test* script and attach it to this test procedure document. Record (1) the label for the attachment and (2) the directory location to which an electronic copy of the report was saved in Section 5.2.3. | Complete/ Not Complete |

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

| _____ | _____ | _____ | _____ |
|---|---|---|---|
| Date | Time | Test Engineer | QAE |

## 6.TEST PROCEDURE FOR EVTFIL_002

### 6.1Test Objective

This test verifies that:

- The output rate of the filtered events is compatible with the spacecraft interface rate of 40 Mbps
- The filter can be configured so that the event stream does not exceed the spacecraft capacity of 104 Gb in any 24 hour period. This test assumes that the actual data volume management policy will be left to the ground operations, and only verifies that the flight software provides sufficient support for implementing such a policy.
- The trigger keeps events consistent with the LAT science objectives. These objectives are specified in the LAT Performance Specification document LAT-SS-00010-1. Objectives relevant to this test are:
    - The effective area for 20 MeV photons at normal incidence should exceed 300 $cm^2$
    - The effective area for 100 MeV photons at normal incidence should exceed 3000 $cm^2$
    - The effective area for 300 GeV photons at normal incidence should exceed 6400 $cm^2$
    - The peak effective area at optimal energy should exceed 8000 $cm^2$
    - The LAT field of view should exceed 2 steradians

The test runs several sets of simulated science data through the Front End Simulator and monitors the FSW performance while the simulations are running.

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

| Number | Test Sub-Objective |
|---|---|
| 1 | Using simulated photon data with different energies, the test confirms that the fraction of photon events passed by the filter satisfies the effective area and the field of view requirements. |
| 2 | The test uses the peak rate and size of passed background events at the orbit interval with high expected background to verify the interface rate requirement. |
| 3 | The test verifies that the filter can be reconfigured to reduce the rate of passed events in order to comply with the data volume requirement. Two alternative configuration are used: with tightened event selection criteria and with filter configured to reject all events. |

## 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 Attachmnt Number) | Path to Attachment (If Applicable) |
|---|---|---|---|
| TBD | Simulated orbit file for high background orbit | | |
| TBD | FES file simulating cosmic ray background data on high background orbit | | |
| TBD | FES file simulating 20 MeV photons | | |
| TBD | FES file simulating 100 MeV photons | | |
| TBD | FES file simulating 300 GeV photons | | |
| TBD | FES file simulating 1/E photon spectrum at normal incidence | | |
| TBD | FES file simulating 1/E photon spectrum with isotropic flux from the zenith hemisphere | | |
| TBD | Filter configuration file with tightened event selection criteria | | |
| TBD | Filter configuration for rejecting all events | | |

## 6.3Test 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 | Science data telemetry, LDF format file for the 20 MeV photon sample | | |
| TBD | Science data telemetry, LDF format file for the 100 MeV photon sample | | |

| Output File | Description of Output File | Output File Attachment Number | Path to Attachment |
|---|---|---|---|
| TBD | Science data telemetry, LDF format file for the 300 GeV photon sample | | |
| TBD | Science data telemetry, LDF format file for the 1/E normal incidence photon sample | | |
| TBD | Science data telemetry, LDF format file for the 1/E isotropic incidence photon sample | | |
| TBD | Science data telemetry, LDF format file for the background run with the standard filter configuration | | |
| TBD | Science data telemetry, LDF format file for the background run with tightened event selection criteria | | |
| TBD | Science data telemetry, LDF format file for the run in which the filter is configured to reject all events | | |

### 6.4Test 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. | 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 TEM modules and GASU are powered up. | 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. | Complete/ Not Complete |

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

| _____ | _____ | _____ | _____ |
|---|---|---|---|
| Date | Time | Test Engineer | QAE |

### 6.5Test 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 | Extract the latest version of the test script from the repository using the following sequence of commands:<br>**cmx start**<br>**cmx create project FST $HOME**<br>**cmx fetch EVTFIL –test=$HOME/FST** | Complete /<br>Not Complete |
| 2 | Verify presence of the simulated science data on the FES nodes:<br>[[Will be implemented using Owen Saxton's FES web server at http://lat-ent1/home.asp<br>Support for file system browsing is not there yet.]] | Complete /<br>Not Complete |
| 3 | Launch the data acquisition script. The expected run time for this script is ?? min:<br>**ltx run EVTFIL_002** | Complete /<br>Not Complete |
| 4 | Run the data analysis script:<br>**python $HOME/FST/source/EVTFIL/test/EVTFIL_002/evtfil_002_analyze.py ???** | Complete/<br>Not Complete |
| 5 | 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. | Complete/<br>Not Complete |

| Step No. | Description of Step | Step Outcome |
|---|---|---|
| 6 | 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:<br><br>**Effective area at 20 MeV : ?? cm^2 : PASS**<br>**Effective area at 100 MeV : ?? cm^2 : PASS**<br>**Effective area at 300 GeV : ?? cm^2 : PASS**<br>**Peak effective area : ?? cm^2 : PASS**<br>**Field of view : ?? sr : PASS**<br>**Peak SC interface rate : ?? Mbps : PASS**<br>**SC interface volume with default configuration : ?? Gb : PASS**<br>**SC interface volume with tightened event selection : ?? Gb : PASS**<br>**SC interface volume with filter configured to reject all events : 0 Gb : PASS** | Pass/<br>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 | Filter configuration 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 EVTFIL_002

Based on the analysis of the test results, the overall outcome of Test EVTFIL_002 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.

_____

_____

_____

_____

_____

_____