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	Prepared by R.P. Johnson, N. Virmani, R. Williams	Supersedes None
	Subsystem/Office Tracker Subsystem	
Document Title **Tracker MCM Qualification Test Plan**		

Gamma Large Area Space Telescope (GLAST)

Large Area Telescope (LAT)

Tracker MCM Qualification Test Plan

Change History Log

Revision	Effective Date	Description of Changes
1	February 3, 2004	Initial draft

1 PURPOSE

This document describes in detail the steps to be carried out to qualify the LAT Tracker front-end electronics Multi-Chip Modules (MCMs) for space flight. This procedure is designed to qualify the ASICs as well as the overall MCM and is part of the overall Tracker electronics test plan documented in LAT-TD-00153. ASICs included on the qualification MCMs have passed screening and functional tests, as described in LAT-TD-00247 and LAT-TD-00248, but environmental qualification tests can only be carried out with the chips mounted on MCMs.

2 SCOPE

The qualification tests include electronics tests defined to ensure that the MCMs can operate over a sufficiently large region of parameters (voltage, clock frequency, temperature, etc.) as well as environmental tests designed to ensure that MCMs will not be damaged by the LAT test and operational environments. MCMs used in this qualification program shall first pass all the screening tests and inspections illustrated in Figure 1, including the electrical tests specified in LAT-PS-01971 and LAT-TD-00249, and the acceptance environmental tests and burn-in specified in LAT-TD-002367.

3 ACRONYMS AND DEFINITIONS

ASIC	Application Specific Integrated Circuit
DAQ	Data Acquisition System
DPA	Destructive Physical Analysis

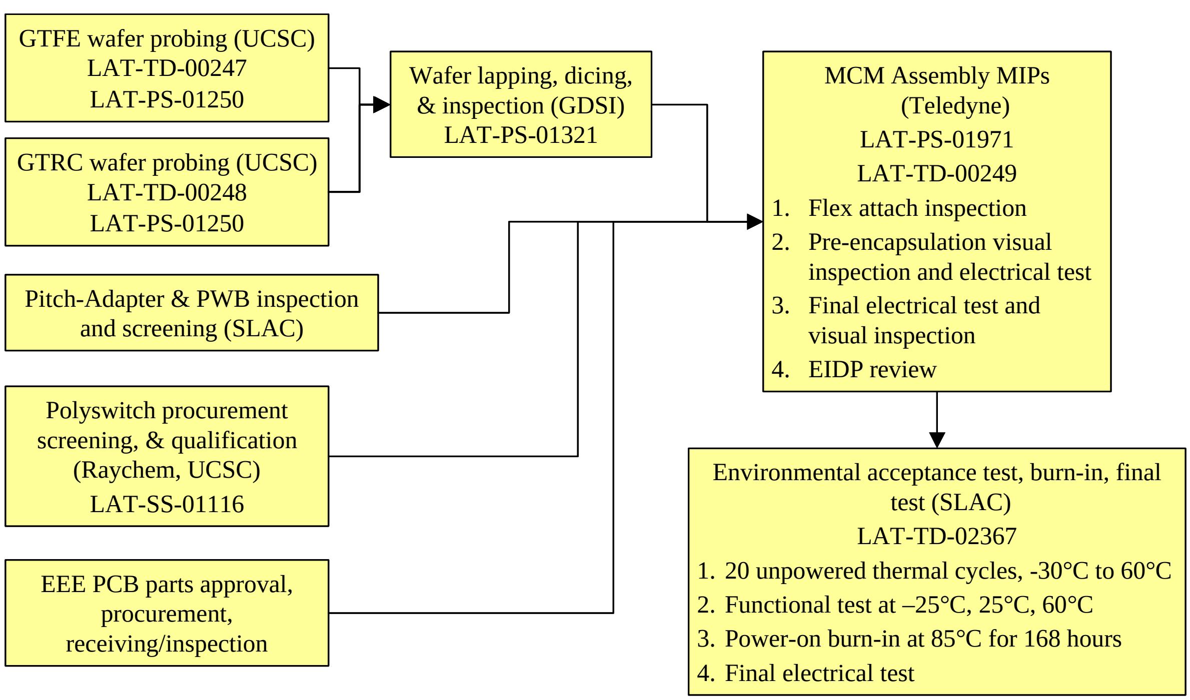

Figure 1. Tracker MCM screening flow. This flow applies to all preproduction and flight production MCMs, including those to be used for qualification testing.

EGSE	Electrical Ground Support Equipment
GLAST	Gamma-ray Large Area Space Telescope
LAT	Large Area Telescope
MCM	Multi Chip Module
MIP	Mandatory Inspection Point
PWB	Printed Wiring Board
SSD	Silicon Strip Detector
TEM	Tower Electronics Module
TKR	GLAST LAT Silicon Tracker

4 APPLICABLE DOCUMENTS

[1]	LAT-SS-00152	LAT TKR Subsystem Specification–Level IV Readout Electronics Requirements.
[2]	LAT-TD-00153	Test Plan for the GLAST Tracker Front-End Electronics.
[3]	LAT-TD-00247	LAT Tracker Front-end Readout Chip Wafer Test Procedure.
[4]	LAT-TD-00248	LAT Tracker Readout Controller Chip Wafer Test Procedure.
[5]	LAT-TD-00249	LAT Tracker MCM Test Plan
[6]	LAT-TD-00778	LAT Environmental Test Specification
[7]	LAT-TD-01004	EM Trays Vibration Test Plan
[8]	LAT-TD-01037	EM Trays Thermal Test Plan
[9]	LAT-SS-01116	Polyswitch Procurement Specification
[10]	LAT-PS-01321	Tracker ASIC Lapping, Dicing, Inspection Specification
[11]	LAT-TD-01325	Tracker ASIC Radiation Test Plan
[12]	LAT-TD-01971	LAT Tracker MCM Test Procedure
[13]	LAT-TD-02367	LAT Tracker MCM Burn-In and Acceptance Environmental Test Plan
[14]	NASA-STD-8739.7	Electrostatic Discharge Control
[15]	LAT-PR-02428	LAT Hardware Handling Procedures
[16]	SLAC-I-720-0A29Z-001	SLAC Environmental Health and Safety Manual
[17]	LAT-DS-02715	MCM Vibration Test Adapter Plate
[18]	LAT-DS-02716	MCM Thermal-Vacuum Test Adapter Plate
[19]	GEVS	General Environmental Verification Specification for STS & ELV, NASA GSFC

5 CLEAN ROOM FACILITIES AND PROCEDURES

5.1 CONTAMINATION CONTROL

The MCM qualification procedures shall conform to the requirements imposed by the LAT contamination control plan, LAT-MD-404. To the extent possible, work will be carried out in the clean room of SLAC Building 33. Outside of the cleanroom, MCMs should be kept closed inside of their black protective cases and sealed inside of ESD protective bags as much as possible (some exceptions will be needed for the 5 MCMs that undergo thermal vacuum and vibration testing). While in Building 33 all workers shall follow the posted clean-room procedures.

- MCMs normally should remain in their unopened black-plastic carrying cases throughout the electrical test and burn-in procedures. They should arrive at SLAC with connector savers already attached, so making the required electrical connections should not normally require the carrying case to be opened.
- In the event that a case is opened, all nearby workers shall wear face masks.
- Any handling of an opened MCM shall be done with non-powdered nitrile clean-room gloves.

5.2 FLIGHT HARDWARE HANDLING

Handling of the MCMs shall at all times conform to the guidelines and requirements of Ref. [15]. In particular,

- MCMs shall not be hand carried across the clean-room or into and out of the clean-room. They shall be placed on rolling carts for all transfers.
- Appropriate torque-limiting wrenches shall be used on all fasteners involved in setting up a group of MCMs for this procedure.
- An MCM that is dropped shall be set aside pending review and an NCR shall be completed.
- ESD protection shall be maintained at all times, as detailed in Section 5.3.
- It should not normally be necessary to install or remove connectors savers on the MCMs during this procedure. However, should it be necessary to replace a connector saver, a torque-limiting wrench shall be used, calibrated to the torque requirements specified on the MCM assembly drawing. All mates and demates to the flight MCMs shall be logged.

5.3 ESD PROTECTION

The facility and procedures satisfy ESD protection requirements as specified in NASA-STD-8739.7. ESD procedures posted at the clean-room entrance in Building 33 shall be strictly followed.

- The clean-room area surrounding the thermal chamber used for burn-in shall be clearly posted as an ESD controlled area during all burn-in activity. Only ESD certified personnel may enter the ESD controlled areas. All other non-certified ESD personnel must be escorted by ESD certified personnel.

- Grounded static dissipative mats shall be present on the tabletops in the work area.
- All equipment, including the probe station, computer, VME crate, auxiliary electronics, and static dissipative mats, shall be grounded to the 3rd terminal ground of the electrical outlet.
- An ESD protecting wrist strap shall be put on prior to entering the clean room and shall be verified by the wrist-strap checker prior to handling any MCMs.
- The operator shall be grounded by the wrist strap at all times when handling the MCMs. The grounding connection shall be just under the front edge of the work table. Wrist straps shall be continuously grounded when transferring MCMs to and from the thermal chamber.
- MCMs shall always be stored and transported inside of their black carrying cases enclosed in static-dissipative bags. Workers shall be properly grounded via wrist straps when removing MCMs from the bags or replacing them into the bags.
- Five MCMs must be removed from their carrying cases in order to mount them to the fixtures for thermal-vacuum testing and vibration testing. During this operation both the fixture and the operator shall be grounded, and at least one screw in each MCM shall connect the MCM ground to the fixture. The fixture shall remain grounded throughout the test.

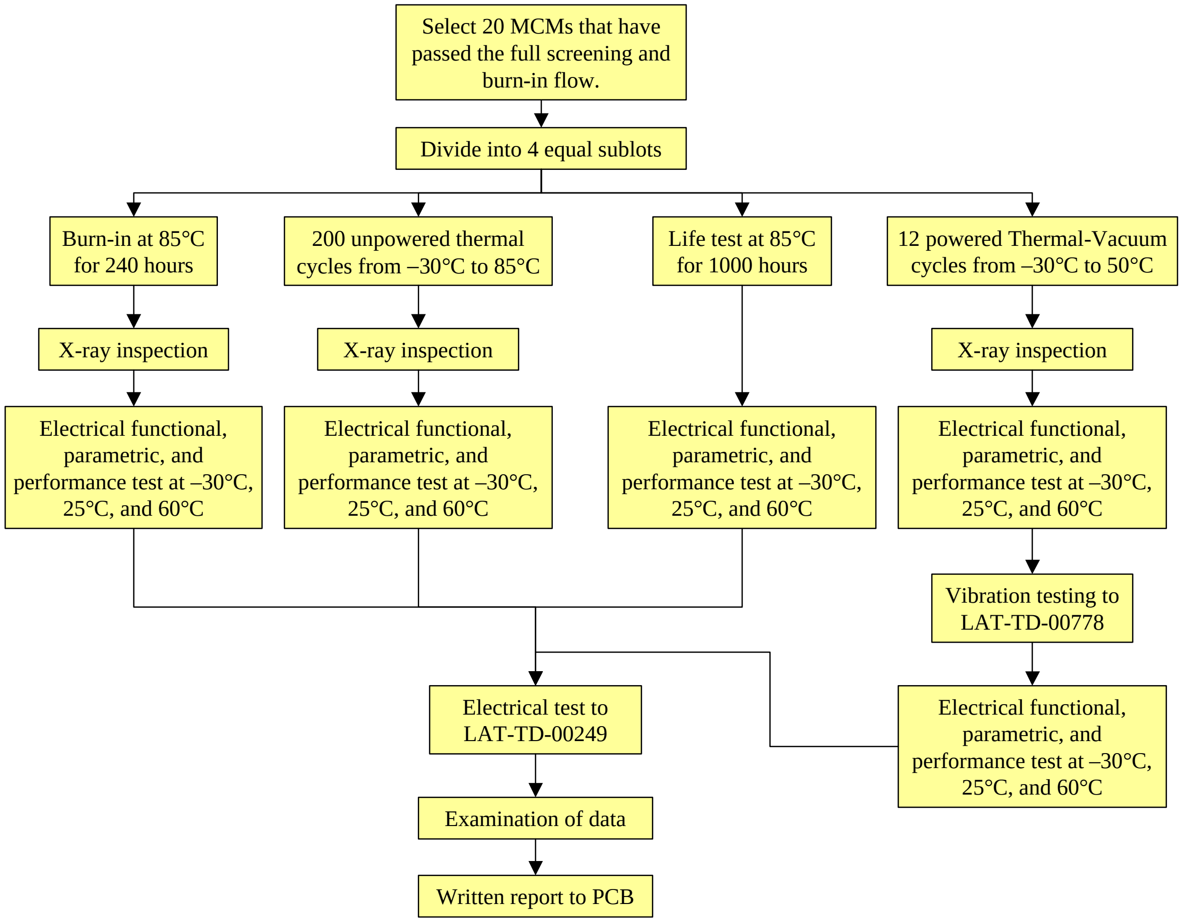

Figure 2. Tracker MCM qualification flow.

5.4 PERSONNEL TRAINING

All personnel working in the clean room during LAT Tracker MCM qualification testing shall have completed a training tutorial in clean-room procedures and in ESD protection and be ESD certified. All personnel operating the EGSE system, thermal chamber, and thermal-vacuum chamber shall be trained by the SCIPP and SLAC experts on the system and shall complete a practice session on non-flight MCMs prior to working with flight MCMs.

5.5 HEALTH AND SAFETY

All MCM qualification testing shall be conducted in compliance with the SLAC EH&S manual [16].

6 RADIATION TESTING

Radiation testing is needed only for the ASICs. It is done by mounting ASICs onto mini-MCMs without any encapsulation. The test plan can be found in LAT-PS-01325 and includes testing for single-event effects in heavy ion beams and for total radiation dose in a gamma-ray source.

7 MCM QUALIFICATION FLOW

Twenty MCMs are selected from the flight production after completion of the complete flight-MCM screening flow as illustrated in **Error! Reference source not found.**. Those MCMs are divided into 4 sets of 5. Figure 2 illustrates the flow for MCM qualification. Each group of 5 MCMs passes through a different flow. At completion of the flow, each MCM is subjected to the same standard electrical test set as is used at the end of Teledyne production. The reason for that is that this test set can test a few functional details not accessible to the EGSE system used throughout the burn-in and qualification tests. In particular, the EGSE system cannot cycle through all address bits on the GTRC chips, since the flex-circuit cable programs the address, and the EGSE system cannot measure the LVDS bias levels.

7.1 BURN-IN AND THERMAL CYCLING

As shown in Figure 2, 5 MCMs undergo a 240-hour burn-in (in addition to the 168-hour burn-in included in the screening flow shown in Figure 1), and another 5 undergo a 1000 hour life test, which is identical to the burn-in procedure. Another set of 5 MCMs undergoes 200 unpowered thermal cycles, in addition to the 20 done in the screening procedure. The 200 thermal cycles cover the temperature range from –30°C to 85°C. Aside from these specifications on time and temperature, the procedures and hardware for the burn-in and thermal cycling are identical to those specified in LAT-TD-02367 and are not repeated here.

7.2 THERMAL-VACUUM TESTING

Thermal-vacuum testing is done in the LAT T/V chamber located in the SLAC Central Lab. The MCMs are removed from their black carrying cases and mounted onto a special fixture, LAT-DS-02716, using all of the screw locations, including the grounding holes.

7.3 X-RAY INSPECTION

The MCMs are shipped to Nick Virmani of Swales Aerospace where they undergo an X-ray inspection. They are shipped in their black protective cases, which are inside of zip-lock ESD protective sleeves. They are shipped in the same manner back to SLAC after the X-ray inspection. At SLAC they continue in the test flow of Figure 2, with the next step being in call cases an electrical test.

7.4 DESTRUCTIVE PHYSICAL ANALYLSIS (DPA)

Following the full suite of qualification tests shown in Figure 2, one MCM will be submitted to Nick Virmani of Swales Aerospace to undergo destructive Physical Analysis.

7.5 VIBRATION TESTING

Vibration testing is done at Wyle labs. The MCMs are removed from their black carrying cases and mounted onto a special fixture, LAT-DS-02715, using all of the screw locations, including the grounding holes.

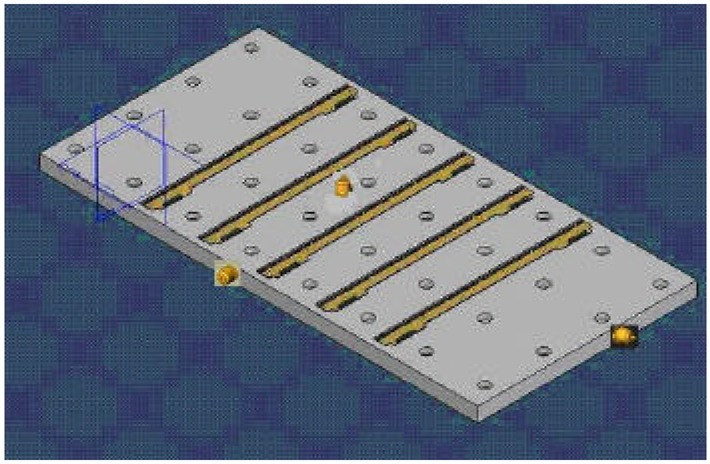

Figure 3. View of the vibration test plate with 5 MCMs mounted. The accelerometer locations are also indicated.

The MCMs are subjected to the GEVS qualification-level random vibration spectrum described in Table 1 and in Figure 4. This spectrum is applied to each of the three orthogonal axes for a duration of 2 minutes each.

In addition to the control accelerometer, we will acquire cross axis and primary axis data during each test. The primary axis response accelerometer is mounted on the Adapter Plate roughly in the center of the plate in the direction of excitation. The cross axes response accelerometers are to be mounted at the center of the plate in the remaining orthogonal axes as shown in the Figure 3.

The procedure is as follows. The adapter plate is first bolted to the vibration table and the accelerometers are connected. A test of the full-level vibration spectrum is run and the accelerometer data are checked for consistency. Then the 5 MCMs are removed from their protective cases one by one and mounted to the plate at all fastener locations, including the 3 grounding holes, with the fasteners torqued to 10 inch-oz. The full-level vibration spectrum is run, and the MCMs are removed and put back into their protective cases. The procedure is repeated for each of the 3 axes.

The objective of the test is only to verify that the MCMs survive the random vibration. There is no interest in obtaining dynamic information related to the MCMs, which are simply mounted to the stiff plate. The accelerometer data are accumulated only to verify the input spectrum.

Table 1. Vibration Test spectrum.

f	PSD
Hz	*G2/Hz*
20	0.026
50	0.160
00	0.160
2000	0.026

	Slope, N	Area	
Zone	*db/oct*	*G2*	
1	5.973	2.507	
2	0.000	120.000	
3	-5.973	77.308	
	TOTAL	**14.14**	*Grms*

7.6 Electrical Functional, Parametric, and Performance Tests

7.6.1 Standard Electrical Test

The complete test suite of LAT-TD-00249, functional and performance, is first run on the MCM using the procedure documented in LAT-PS-01971. Since all MCMs must pass this procedure before starting the qualification flow (see Figure 1), then any failure with respect to this procedure indicates a problem in the qualification. In addition, the detailed parameters are compared with those obtained prior to the qualification flow (such as currents, bad channels, etc.).

7.6.2 Frequency Sensitivity

The suite of functional tests in LAT-TD-00249 is carried out with the clock frequency varied from 1 MHz up to 30 MHz, and the functional range is noted.

7.6.3 Clock Duty Cycle Sensitivity

The GTRC configuration register is loaded and read back, as described in LAT-TD-00249, for a variation in 20 MHz clock duty cycle from 30% high to 70% high.

7.6.4 Clock-Command Phase Sensitivity

The GTRC configuration register is loaded and read back, as described in LAT-TD-00249, for the full 2π range phase difference between input clock and command lines. The range over which the commanding fails is recorded.

7.6.5 Operating Voltage Sensitivity

The suite of functional tests in LAT-TD-00249 is carried out at a range of voltages as follows, with the functional range noted:

- DVDD and AVDD varied together from 2.0 V to 3.3 V.
- DVDD held constant at 2.5 V with AVDD varied from 2.25 V to 2.75 V.

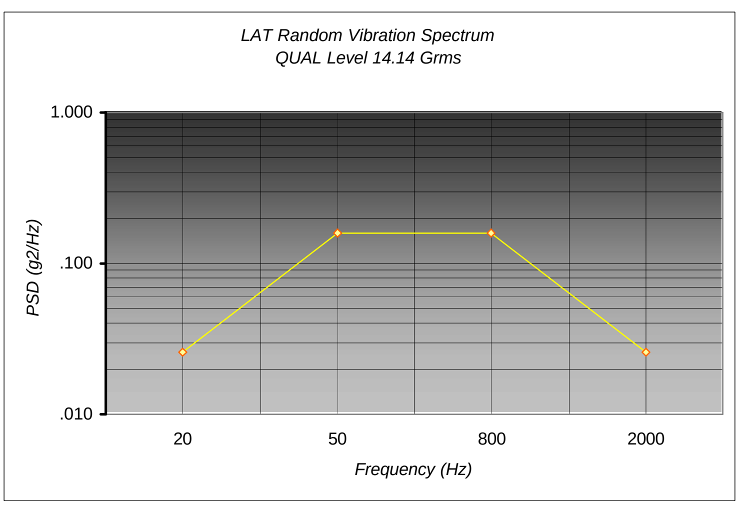

Figure 4. Vibration test spectrum.

- AVDD2 varied from 1.2 V to 2.5 V.

7.6.6 Sensitivity to LVDS Input Levels

The GTRC configuration register is loaded and read back, as described in LAT-TD-00249, for a range of common-mode voltages of the command and clock lines, 0.5 V < VCM < 2.0 V. Then the same is done for a range of values of differential voltage swing, 0.1 V < VDM < 0.4 V.

7.6.7 Temperature, Clock Frequency, and Voltage Sensitivity

The MCMs are tested at temperatures of –30°C, 25°C, and 85°C by the same procedure as specified in LAT-TD-02367, using the burn-in EGSE system. At each temperature the test is done over a range of frequencies from 10 MHz to 25 MHz. Also, at each temperature, and with a frequency of 20 MHz, the tests are repeated with the 3 voltage supplies (AVDDA, AVDDB, DVDD) varied one at a time over their full range (±10%) and with all 3 simultaneously set at their minimum and with all 3 simultaneously set at their maximum.