GLAST Large Area Telescope:

Tracker Subsystem
MCM Production Readiness Review

MCM Design Overview

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Tracker Readout Architecture

The Tracker readout includes a left-right redundancy:
- Power is supplied from both left and right cables.
- Every GTFE chip can be controlled from the left or the right.
- Every GTFE chip can send its data either to the left or the right.
Fail-Safe Features

- Power short-circuit in an MCM: the polyswitches limit the current flow, allowing all MCMs on the other 3 sides and MCMs lower on the same side to function.
- Bias short in a detector ladder: separate series resistors for each ladder limit the current flow, maintaining bias in all other ladders.
- Open failure of a cable or connector:
  - Power can flow through the other cable.
  - All GTFE chips can be reprogrammed for control and readout through the other cable.
- Failure of a single GTFE chip: all chips to the left get reprogrammed for control and readout to the left, and all chips to the right get reprogrammed for control and readout to the right. Only 64 channels are lost.
- Failure of connections between two GTFE chips: the control and readout can be split around the fault, resulting in no loss of channels.
- Failure of a single GTRC chip: all GTFE chips can be reprogrammed for control and readout through the opposite cable.
MCM Functionality Requirements

• The Tracker system is required on delivery to have >98% hit efficiency in each SSD layer within the fiducial area.
  – Missing a hit in a given layer generally does not result in missing the track, since 36 layers are present.
  – However, it can result in reduced angular resolution.
• We allocate a maximum of 0.5% of this inefficiency to bad channels on the MCM. This is equivalent to 8 channels out of 1536. A bad channel can be
  – A broken amplifier (bad gain or noisy).
    • Verified by electronic testing.
  – A broken connection (bad wire bond or broken pitch-adapter trace).
    • Verified by visual inspection on 100% of MCMs.
    • Checked on a small number of MCMs by probing.
MCM Functionality Requirements

- Since we want to maintain the high tracking efficiency into orbit, we require all of the designed-in redundancy to be functional:
  - For an MCM to pass, we must be able to control and read out every GTFE chip from both left and right.
    - Verified by electronics testing.
    - Faults are corrected before encapsulation of the integrated circuits and wire bonds.
      - This requirement is maintained after thermal cycling and burn-in, up to the point of delivery of the MCM to Italy.
      - High reliability parts and mil-spec processes.
  - A 100% functional MCM is useful only if it can be integrated into the system
    - Dimensional requirements verified by gauges.
    - Wire bonding surfaces verified by visual inspection.
    - Cleaning and contamination control.
**Design Changes Since CDR**

- **GTRC ASIC**
  - Fixed bug in the time-over-threshold algorithm.
  - Changed the clock edge for data output, to improve the timing margin.
  - **Status:**
    - V7 chips pass all testing in the wafer probing and MCM test systems.
    - The TOT bug fix has been verified.
    - The communication between MCMs works to >25 MHz at VDD=2.5V.

- Added a resistor to ground on the tri-state GTFE configuration register readout bus to keep it properly biased when no drivers are active.
- Kapton cover layer on the back side to protect against shorts.
- Back side metal moved well away from screw holes and edges.
- Increased the right-angle-interconnect radius to 1.0 mm.
- Encapsulation stay-clear on the pitch adapter to provide a clear region for clamping the MCM while mounting to the tray.
**Design Status**

- There are no outstanding design issues.
- The MCM/SSD design has been demonstrated in the mini-tower to conform to the design requirements, particularly
  - Power consumption
  - Noise occupancy
  - Tracking efficiency
  - Timing and readout rates
- MCMs have been shown to survive thermal cycling tests and are robust with respect to parametric variations (clock frequency, voltage, etc.) and radiation (total dose and SEE).
- The design drawing package is complete and in release.
  - MCM assembly drawings, LAT-DS-00898 and 899.
  - PWB and flex drawings and design files.
  - ASIC drawings and design files.
MCM Integration onto Trays

MCMs on all 4 sides of the tower
MCM Integration onto Trays

- SSD’s
- Bias-Circuit
- Structural Tray Panel
- Converter Foils
- Bias-Circuit
- SSD’s
- TMCM
Four parts have to be reasonably well aligned:

1. Pitch adapter.
2. Bias circuit
3. Two SSD ladders

or the wire bonds will be angled and crossed.
MCM Integration onto Trays

One of 5 functional trays built using the first prototype MCMs and preproduction ASICs.
Italian Concern

• MCM flatness on the wire-bonding edge
  – Flatness and straightness along the length of the board appear to be okay, within ±100 microns.
  – Perpendicularity: most, but not all, traces fall within an error of 4 degrees. The Teledyne gluing fixture cannot control or tweak this, so with that tooling we are probably stuck with what we get.
• G&A started development of a new gluing fixture that is able to hold the flatness tolerances desired.
G&A Gluing Fixture

- The fixture defines the outer surface of the finished part, and this worked well on some test pieces.
- This fixture, however, uses holes drilled through the circuit to align the board, so a new alignment scheme must be developed.
- Also, the pressure required to force the fixture against the board and squeeze out the glue is high, so some sort of mechanical or pneumatic aid will be needed.

We have requested a quote from G&A to purchase this fixture.
Flex-Attach Plans

- Proceed with flight MCM production using the existing process.
- G&A is preparing to test MCM mounting and wire bonding to preproduction MCMs. They will evaluate the bond strength versus slope of the surface.
- They are confident that they can achieve good wire bonding on the parts, but the surface variation may slow them down significantly.
- We will move forward with development of the new fixture as a backup solution that we can introduce if it becomes apparent that the MCM/Tray integration at G&A is too slow and expensive.
- This is a separate issue from the process under review today.