CAL EMI/EMC Testing
History and Plans
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Johnson, Ampe, Dizon, Raynor, Lovellette
Naval Research Lab
Oscar Ferreira
LLR Ecole Polytechnique
Attempted LAT qualification program for EMI/EMC specifications.

Configuration:
- EM1 TEM and TEM Power Supply.
- EM CAL Module.
- No shielding from GRID or other LAT components.

Results:
- TEM Power Supply was not of sufficient quality to support EMI/EMC testing.
- CAL had significant Radiated Emissions and modest Susceptibility – closing CAL joints w/ copper tape improved both.
- Grounding arrangement of TEM/TPS is very important – copper sheet from TPS to ground improved performance significantly.

Actions: Plug the holes
- Modify CAL closeouts and side panels for better EMI/EMC containment.
Engineering Model
Test Configurations

TEM + PS on Test Table

CAL + TEM/TPS on CAL Stand on Test Table

Tests performed on TEM + PS alone and then repeated with CAL + TEM + PS.

Significant grounding issues. Note copper sheet between TEM/PS and table
TEM/TPS Emissions dominate CAL
Adding CAL adds many clock harmonics
EM CAL + TEM/TPS

Adding extra grounding including large Cu sheet from TEM/PS to table reduces broad band noise – NOT FLIGHT CONFIG.
Clock harmonics are above specification.
Register Testing

Muon event digitization and readout

CAL ADC readout adds broad band noise.
Appears to be DC-DC converter power supply harmonics.
Several Areas of Susceptibility – changes somewhat from day-to-day

- **Vertical polarization**
  - Date: 7/9/03
    - 1.000 – 1.090 GHz: many extra triggers
    - 1.090 – 1.107 GHz: OK
    - 1.107 – 1.176 GHz: many extra triggers
  - Date: 7/10/03
    - 1.000 – 1.179 GHz: extra triggers without ok region in middle

- **Trigger discriminator level setting**
  - For ground test discriminator levels (~ 3 MeV)
    - 900 MHz horizontal, problems at 11 V/m
    - 448 MHz vertical, 1 V/m
  - For flight discriminator levels (~ 100 MeV) the situation is much better but there may still be some issues.

- **Do not see any communications errors.**
Radiated Emissions / Susceptibility

Modifications being incorporated in design

- **Metal part surface treatment**
  - All aluminum parts – electroless nickel.

- **Side Panel attachment**
  - Double number of fasteners
  - Create lip on top frame
  - Use EMI gasket

- **Closeout plate joint in vertical corners**
  - Use EMI O-strip and groove.

Outstanding Issues – no easy solution

- **Structure EMI shield at base plate tabs**
  - Open area for AFEE cable
  - Open area (the same) for venting

- **AFEE – TEM cable – no connector shells, incomplete shielding**
- Added ceramic bypass caps on GCFE digital supply
- Larger ceramic cap on GCRCs
- Split AFEE row group of 12 ADCs into two groups of 6, each group with larger ceramic bypass cap
Side Panel

**Fasteners x2**

**EMI Gasket**
Chomerics Elastomer
0.5 mm thick

**Conductive elastomeric seal**

**Side panel**
Closeout Plates

New Groove
2nd Groove seals to top frame

Dovetail Groove

Cho-seal O-strip

Cho-seal type conductive elastomer O-strip (compressed on picture)
Corner Details

Add lip to top frame
AFEE-TEM Cable Issues

- AFEE Card Exposed. No Seal of Side Panel around cable area.
- Incomplete shielding of cable. No connector shields.
- No bulkhead seal of TEM connectors. No shield on TEM connector.
Flight EMI/EMC Test Configuration

GLAST Calorimeter

Flight EMI/EMC Test Configuration

Ground Plane and Grid Simulator

Grid Side Wall Simulator

CAL Module

TEM/TPS
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Copper Sheet ground available from Ground Plane to TPS.

TEM/TPS

TEM/TPS/Cable Shield
Outstanding Issues

- Shielding of CAL – TEM cable and box attach points.
- Test specification – difficulty in separating CAL and TEM/PS performance issues.
- Test configuration – identification of subsystem configuration which represents LAT environment, shielding, etc.