LAT PROJECT DOCUMENT CHANGE NOTICE (DCN)

DCN No. LAT-XR-05815-01

SHEET 1 **OF** 1

ORIGINATOR: Dave Nelson	**PHONE:** 650-926-4652	**DATE:** 2/9/05
CHANGE TITLE: DCN for LAT TEM/TPS EMI Acceptance Test Procedure		**ORG.:**

DOCUMENT NUMBER	TITLE	NEW REV.
LAT-TD-05671	LAT TEM/TPS EMI Acceptance Test Procedure	02

CHANGE DESCRIPTION (FROM/TO):

Please see LAT-XR-05816-01 for changes made to this document

REASON FOR CHANGE:
Minor changes found during first test run

ACTION TAKEN: ☒ **Change(s) included in new release** ☐ **DCN attached to document(s), changes to be included in next revision**
☐ **Other (specify):**

DISPOSITION OF HARDWARE (IDENTIFY SERIAL NUMBERS):	**DCN DISTRIBUTION:**
☒ **No hardware affected (record change only)**	
☐ **List S/Ns which comply already:**	
☐ **List S/Ns to be reworked or scrapped:**	
☐ **List S/Ns to be built with this change:**	
☐ **List S/Ns to be retested per this change:**	
☐	

SAFETY, COST, SCHEDULE, REQUIREMENTS IMPACT? ☐ **YES** ☒ **NO**
If yes, CCB approval is required. Enter change request number:

APPROVALS	DATE	OTHER APPROVALS (specify):	DATE
ORIGINATOR: D. Nelson (signature on file)	2/9/05		
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PSA- Darren Marsh (signature on file)	2/9/05		
Manufacturing- R. Patterson (signature on file)	2/9/05		
Co-Author- L. Sapozhnikov (signature on file)	2/9/05		
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	Author(s) David Nelson Leonid Sapozhnikov	Supersedes
	Subsystem/Office Electronics & DAQ Subsystem	

Document Title

GLAST LAT TEM/TPS EMI acceptance Test Procedure

DOCUMENT APPROVAL

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
01	January 31, 2005	First Revision
02	Feb. 9, 2005	Added text to Para 3.4.1, changed 4.4.1 reference to Fig 4.6, removed 5cm from Fig 4-9, removed line cond. from data sheet 4.2, changed name of test to Basic test in data sheet, Added conn. colors to 4.4.3 data sheet.

Table of Contents

1. INTRODUCTION

1.1 Scope

This document prescribes the procedures to be used to conduct the Electromagnetic Interference (EMI) Acceptance Test of the Large Area Telescope (LAT) Tower Electronics Module/Tower Power Supply (TEM/TPS). This document prescribes the EMI test procedures for a TEM/TPS assembly along with associated electronics components – the Tower Electronics Module (TEM) Tester Board and Load Board – provided as ground support equipment.

The procedures prescribed herein specify the TEM/TPS test set-up preparations prior to the start of EMI testing, the EMI test sequence and the specific tests to be performed during the EMI test program.

1.2 Applicability

The TEM/TPS EMI Test Procedure is applicable to an individual TEM/TPS module (one of sixteen that comprise the TEM/TPS subsystem). The article under test consists of:

- Tower Electronics Module (TEM – Flight unit)
- Tower Power Supply (TPS - Flight unit)
- TEM Test Board (Non-Flight unit)

1.3 Applicable Documents

The following documents, of the exact issue shown, form a part of this document to the extent specified in section 3.0 and 4.0. In the event of a conflict between the specified documents referenced herein and the contents of the system specification, the contents of this document shall be considered a superseding requirement.

EMI Documents:

MIL-STD-45662	Calibration Systems Requirements
MIL-STD-461E	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
MIL-STD-462	Measurement of Electromagnetic Interference Characteristics

Design Specifications, Handling and Test Procedures:

433-RQMT-0005	GLAST Observatory Electromagnetic Interference (EMI) Requirements Document, NASA/GSFC
LAT-MD-00408	LAT Instrument Performance Verification Plan
LAT-SS-00778	LAT Environmental Specification
LAT-SS-00288	TEM ICD/Specification
LAT-SS-01281	TPS ICD/Specification
LAT-TD-04085	TEM/TPS Performance Procedure

Drawing List

LAT-DS-05369	Tower Test Stand Assembly
LAT-DS-01643	TEM/TPS Assembly

1.4 DEFINITIONS AND ACRONYMS

DAQ	Data Acquisition System
EM2	Engineering Model Version 2
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
GLAST	Gamma-Ray Large Area Space Telescope
GSE	Ground Support Equipment
LAT	Large Area Telescope
LISN	Line Impedance Stabilization Network
LSC	Large Scale Capacitor
QA	Quality Assurance
STE	Support Test Equipment
TEM	Tower Electronics Module
TKR	Tracker Subsystem of the LAT
TPS	TEM Power Supply
WOA	Work Order Authorization

2. EMI ACCEPTANCE TEST OVERVIEW

2.1 EMI Acceptance Test Overview

The EMI tests prescribed for the TEM/TPS, as specified within this document, have been developed to verify the Electromagnetic Compatibility and Interference (EMI/EMC) integrity of the GLAST TEM/TPS design as set forth in LAT-MD-00408 and LAT-SS-00778. Described here are the acceptance tests which are run on the Flight TEM/TPS assemblies and are a subset of the qualification tests which are run on only one module and fully verify the EMI performance. The acceptance EMI/EMC tests to be performed on the TEM/TPS assembly measure and document the assemblies conducted emissions and susceptibility to other subsystem's emissions during GLAST flight operation and to assess the potential impact to other subsystems within the GLAST. This general configuration is shown in the Figure below.

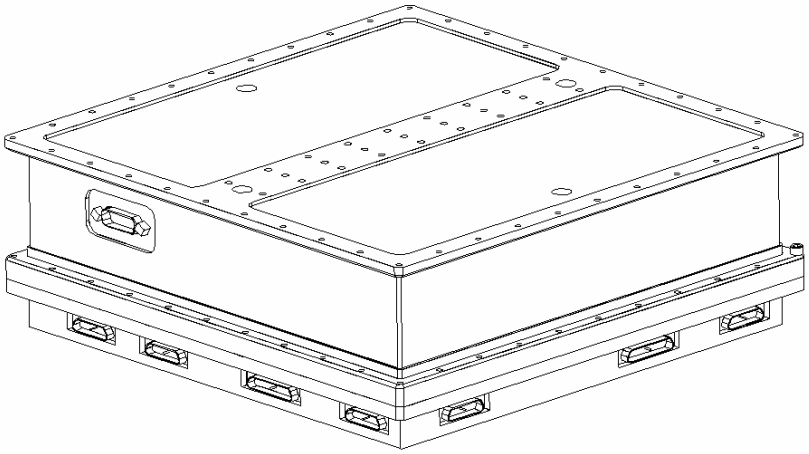


Figure 2-1: TEM/TPS Assembly, (Connector savers are installed on all connectors)

2.2 Quality Assurance Requirements

The Quality Assurance program shall consist of the following characteristics:

- Methods, procedures, and tools have been defined and are implemented in order to prove that each applicable requirement is verified;
- For this configuration there is a defined and implemented qualification approach that makes it possible to demonstrate that the item is so designed that it will perform satisfactorily in the intended environment to meet its requirement,
- Adequate controls are established for the temperature, humidity, ESD and other handling requirements as per the LAT Contamination Control Plan.
- A nonconformance control system (work order and problem report) is maintained in order to systematically track all anomalies or discrepancies,
- All quality test records are maintained and analyzed so that data can be analyzed, detected and reported in time to enable preventive / corrective actions to be taken, if required,
- Equipment and tools used for inspecting, measuring, and testing must be verified for calibration to ensure their accuracy,
- Procedures and instructions are established to provide for the identification, segregation, handling, packaging, preservation, storage, and transportation in the specification or on a work order,
- Assurance is provided that the operations including during and post EMI/EMC testing are carried out in a controlled way and in accordance with the relevant requirements.
- Personnel performing critical processes shall be trained.

The SLAC QA TEAM shall perform surveys and audits, as necessary, to evaluate the adequacy of, and conformance to requirements. The QA manager shall participate in integration test readiness reviews and will monitor tests as required.

2.3 Failure Reporting and Analysis

A failure is defined as the inability of the TEM/TPS to perform within the limits of its specified test requirement or specification. Failures during testing will be documented on Problem Reports and analyzed by the engineer with the appropriate disposition. The failure reporting system will include the following:

- Any departure or suspected departure from performance.
- Failures in GSE that interface with flight TEM/TPS as well as any other malfunction that could compromise mission objectives.

2.4 Test Equipment Calibration

All individual test equipment and the equipment installed within the TEM/TPS Support Test Equipment (STE) used to conduct the EMI/EMC test of the TEM/TPS shall be maintained under a calibration system administered in accordance with the requirements of MIL-STD-45662. As such, all test equipment model numbers, serial numbers and calibration dates shall be recorded in the Test Equipment Calibration Data Sheet

2.5 Clean Room Facilities and Procedures

All work will be carried out in the 100K clean-room at SLAC. All workers shall follow the standard clean-room procedures posted in the laboratory. No mates and demates of flight connectors will be performed as part this test.

2.6 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 shall be strictly followed.

- The clean-room area surrounding the test stand shall be clearly posted as an ESD controlled area during all testing activity. Only ESD trained personnel may enter the ESD controlled areas.
- 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 tray.
- The operator shall be grounded by the wrist strap at all times when handling the tray. The grounding connection shall be just under the front edge of the work table.

2.7 Test Data

The TEM/TPS is monitored during the EMI/EMC test by performing a series of automated tests under the control of the TEM/TPS test stand. As such, all test data is compiled and reported by the test PC and recorded on automated test data sheets. At the completion of each test sequence, the recorded test data shall be reviewed by the test engineer to ensure that all data meets the requirements specified for the test performed prior to continuing with the next test.

2.8 Test Log Entries

A TEM/TPS EMI test log shall be maintained throughout the EMI/EMC test program. This procedure shall contain a chronological record of the EMI/EMC test sequence and all information pertinent to the conduct and outcome of the test. Information to be included in the TEM/TPS EMI test log, as a minimum, the following information:

- Constraints for testing
- Support equipment details
- Test start and stop dates and times
- Flight Unit power on/off sequences
- Test results of each test performed
- Detailed description of all test anomalies/test failures with specific reference to failure investigation report numbers or NCR's
- Approval by QA and test engineer to proceed with testing following a test anomaly or test failure
- Disposition of all open problem reports and close problem reports where possible.

2.9 Test Failures/Anomalies

All flight unit test anomalies or test failures shall be processed in accordance with QA requirements as defined herein. If a test anomaly/test failure occurs, the flight unit shall be maintained in its current configuration to preserve the state of the flight unit and the test system, unless there are indications that doing so could be detrimental to the safety of the flight unit or test system. The test in progress shall be discontinued while leaving the flight unit in its present test environment until the appropriate personnel have been notified. Where deviation from the test level requirements is made based on the intended installation and location, the deviation shall be documented and approved by the test engineer.

3. GENERAL EMI/EMC TEST REQUIREMENTS

3.1 Shielded Enclosure Test Set-Up

The TEM/TPS EMI/EMC tests will be conducted with the TEM/TPS and MIL-STD-461C/461E line conditioner as required, i.e. Large Scale Capacitor (LSC) or Line Impedance Stabilization Network (LISN). As only conducted emission and conducted susceptibility tests are being done (no radiation tests), a shielded enclosure is not necessary for these tests.

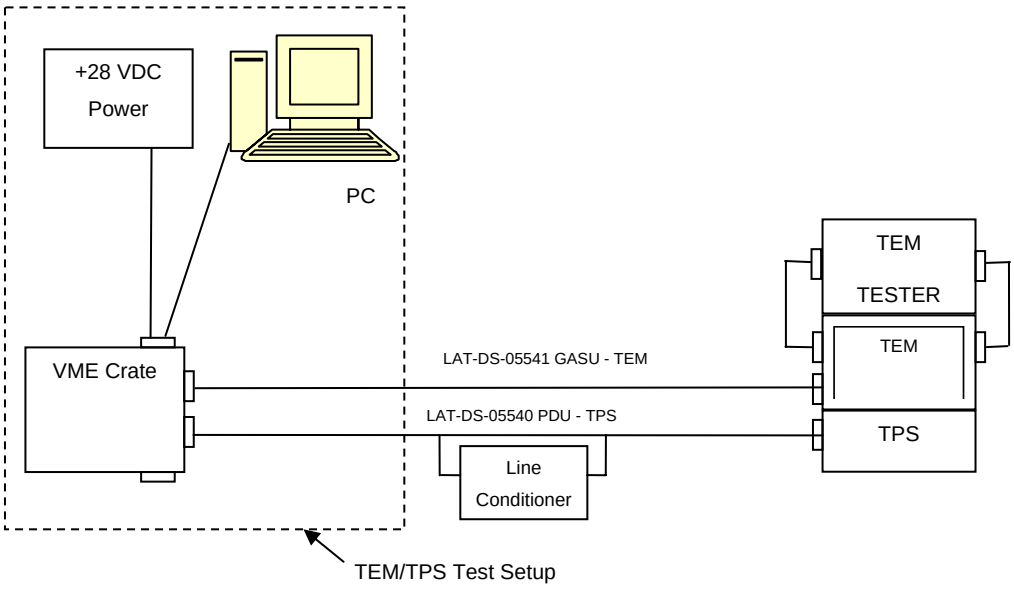


Figure 3-1: General EMI/EMC Test Configuration

3.2 Interconnecting Cables

The interconnecting cables between the TEM/TPS and the Tracker test setup are listed in the Table below.

Cable #	Description	Construction
LAT-DS-05541	GASU – TEM comm./telem	Shielded Twisted Pairs
LAT-DS-05540	PDU – TPS power /monitors	Shielded Twisted Pairs

3.3 +28 VDC Input Power Leads

During both tests, the power to the TEM/TPS will be supplied by the TPS via the VME 28V power supply. The power cable shall be routed via the applicable line conditioner. The power cable from the VME shall be attached to the line conditioner, and from there to the TEM/TPS. The cable has a split in it with banana plug connectors to make this possible.

3.4 TEM/TPS Operation

A TEM/TPS system support engineer shall be present during all EMI testing to ensure safe power-up, testing and power-down of the Flight TEM/TPS. The TEM/TPS LAT-DS-04085 procedure is used for operational testing of the TEM/TPS assembly.

3.4.1 Operating Mode for Emissions and Susceptibility Testing

Power up per LAT-TD-04085 Para 5.5.2 and execute the script "BiasTest.py". Then execute the script "BasicTest.py" in Para 5.5.4 (set to continuous mode) to test all the function registers on the TEM.

3.5 Pass/Fail Requirements

The Pre-EMI Functional Testing will establish a nominal TEM/TPS performance baseline for operation during EMI emissions and susceptibility testing. Test runs equal the number of tests for the Calorimeter and Tracker. Green light means test passed. Red light means a failure. The operator sets the number of runs to zero for infinite runs. The operator exits to stop tests. A red error light on GUI indicates a performance deviation from the baseline readings observed during EMI testing is considered a failure, and must also be documented and dispositioned.

3.6 General Emission Testing Requirements

During emission testing, the emissions measurement equipment shall use the MIL-STD-461E bandwidths and dwell times in the Table below; however, lower bandwidths shall be used if the noise floor is not at least 6 dB below the test requirements for the tailored GLAST program limits. All emissions detected during the TEM/TPS test shall be measured with the specified bandwidths shown in the Table below and compared against the limits required by the GLAST program. If the bandwidth or measurement time differs from the Table below, record the bandwidth and measurement time in the EMI log book.

Frequency Range	6 dB Bandwidth	Dwell Time	Minimum Measurement Time
30 Hz – 1 kHz	10 Hz	0.15 sec	0.015 sec/Hz
1 kHz – 10 kHz	100 Hz	0.015 sec	0.15 sec/kHz
10 kHz – 150 kHz	1 kHz	0.015 sec	0.015 sec/kHz
150 kHz – 30 MHz	10 kHz	0.015 sec	1.5 sec/MHz
30 MHz – 1 GHz	100 kHz	0.015 sec	0.15 sec/MHz
Above 1 GHz	1 MHz	0.015 sec	15 sec/GHz

3.7 General Susceptibility Testing Requirements

During susceptibility testing, the test signal source shall be limited to the scan rates specified in the Table below.

When the test results indicate a susceptibility condition with the TEM/TPS as per the pass fail requirements, the threshold level at which the susceptible condition no longer exists shall be determined and recorded. The threshold level shall be determined by reducing the test interference signal until the TEM/TPS no longer exhibits evidence of being susceptible to the signal and then gradually increasing the level of the interference signal until the susceptible condition just recurs. The level of the interference signal and the frequency range of susceptibility shall be recorded before proceeding with any further testing.

FREQUENCY RANGE	MAXIMUM ANALOG SCAN RATES	MAXIMUM STEPPED SCAN SIZE	SCAN DWELL TIME
30 Hz – 1 MHz	0.0333 f/sec	0.05 f	3 Sec
1 MHz – 30 MHz	0.00667 f/sec	0.01 f	3 Sec
30 MHz – 1 GHz	0.00333 f/sec	0.005 f	3 Sec
1 GHz – 8 GHz	0.000667 f/sec	0.001 f	3 Sec
8 GHz – 40 GHz	0.000333 f/sec	0.0005 f	3 Sec

3.8 EMI/EMC Measurement System Tests

Prior to the start of each EMI test to be performed on the TEM/TPS, the measurement equipment within each set up shall be tested, calibrated, and verified to the requirements of MIL-STD-461 and as stated in this procedure.

3.9 Large Scale Capacitor (LSC)

The LSC specified for use in MIL-STD-461E shall be used for all TEM/TPS EMI/EMC testing per the Figure below.

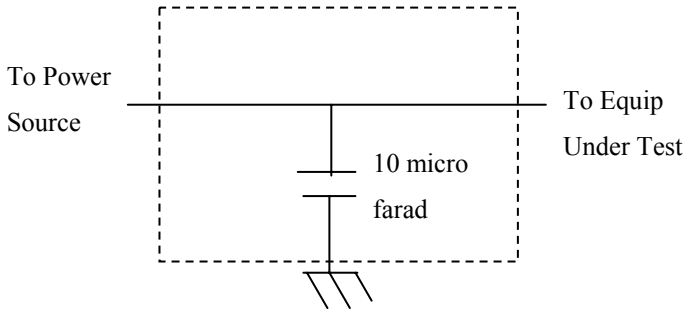


Figure 3-2: LSC Schematic

4. TEST PROCEDURE

The powered testing in this document for the TEM/TPS assembly is run from LAT-TD-04085 and an AIDS will direct the testing operation.

4.1 Setup and Pre-Verification Checks

The initial test set up of the TKR and the Tracker Test Setup shall be as illustrated in Figure 3-1 of this procedure. The power cable from the TKR/TEM/TPS shall be connected to the line conditioner within 2.5 meters for all EMI tests. Use the data sheets found in Appendix F for the setup and pre-verification checks.

4.1.1 Interconnect Diagram

The Figure below shows the interconnections for the test setup. The power cable from the TEM/TPS shall be connected to the line conditioner within 2.5 meters for all EMI tests.

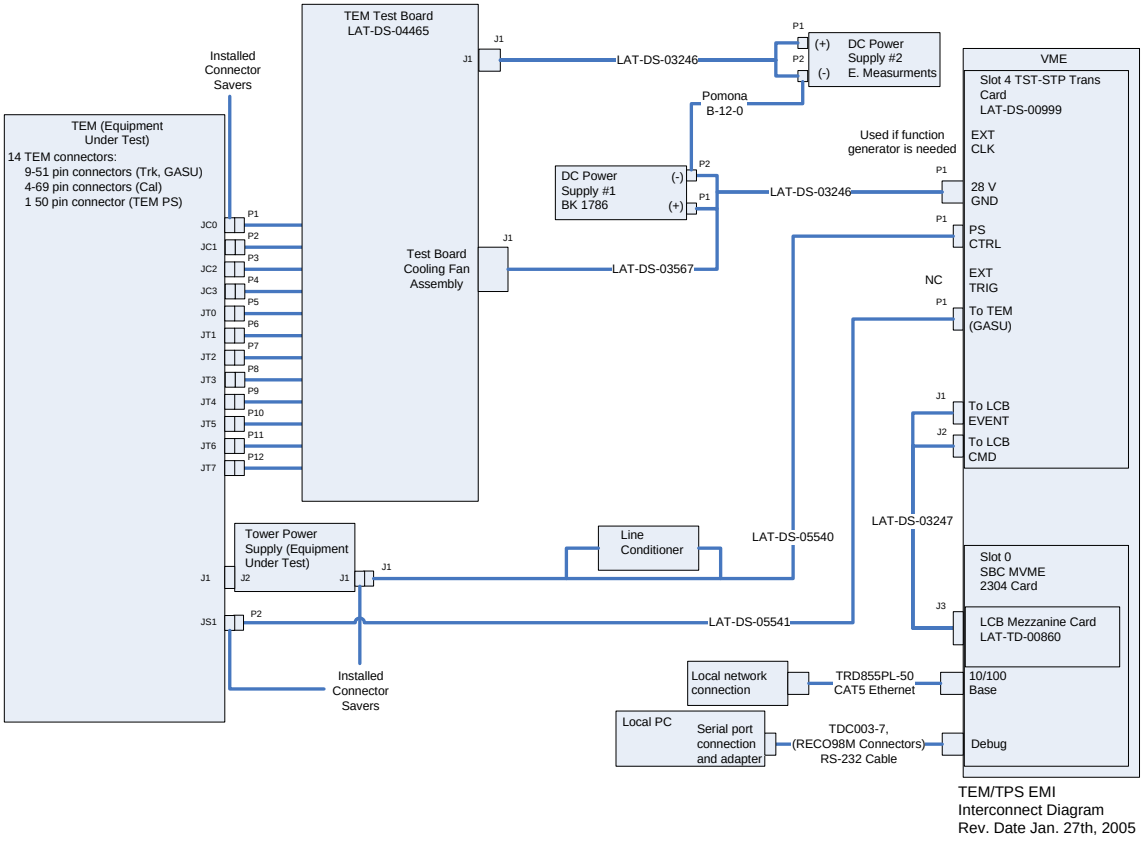


Figure 4-1: TEM/TPS Test Interconnect Diagram

4.1.2 Test Equipment

The test equipment listed below is necessary for the tests described in this procedure. If additional equipment is used, please add it to the table below with the signature of the TC and QAE, proceed with the test.

To record the test equipment, cables, connector savers and software:

1) Record the information for all equipment on the data sheet. See the list below for descriptions of the information to be recorded.

- Description and Manufacturer
- Model/LAT number (cables, etc.)
- Serial/Revision number (for equipment, files and software)
- Calibration due date (enter NA for non calibrated equipment)
- Validation completion date for all EGSE

The list below indicates the equipment that is known to be used to perform this procedure:

Test Equipment Description, Manufacturer	Model/LAT Number
Digital Multimeter, Fluke/Meterman	* 87-III/38XR
Oscilloscope	
Spectrum Analyzer	
Line Conditioner	
Audio Isolation Transformer	
Power Amplifier	
Line Stability Circuit (two needed)	
VME Crate, Dawn VME Products	11-1011777-2119
VME, TST-STP Trans card	LAT-DS-00999
VME SBC MVME2304 card, Motorola	PN MVME2304-0123
VME LCB Mezzanine card	LAT-TD-00860
Software for the local PC	LATTE P04-04-01 www-glast.slac.stanford.edu/IntegrationTest/ONLINE/updates/
Software for the local PC	TEMPROD V00-00-00
DC Power supply #1, BK Precision	BK 1786
DC Power supply #2, BK Precision	BK 1786
28 Volt supply cable (two needed)	LAT-DS-03246
PS Control cable	LAT-DS-04831
TEM to GASU cable	LAT-DS-05541
Power cable VME to TPS	LAT-DS-5540
LCB Transition board cable	LAT-DS-03247
TEM Test Board Assembly	LAT-DS-04465
TEM Test board cooling fan assembly	LAT-DS-03567
CAT5 Ethernet cable	TRD855PL-50
RS-232 Cable	TDC003-7 (RECO98M connectors)
Ground jumper, Banana, Pomona	B-12-0
PS extension cable	LAT-DS-04629
TEM/TPS Assembly	LAT-DS-01643

* Do not substitute other DMM's

CAUTION: Fluke 87-III and Fluke 87-V are not the same, Fluke 87-V is not allowed.

4.1.3 Participant List

This section provides a data sheet to record test participants.

1) Record all test participants in the data sheet.

4.1.4 Pre-Operation Verifications

This section details the pre-operation verification checks before testing the EUT.

To perform the pre-operation verification checks:

Note: Follow ESD processes during this checkout.

Note: Prior to the connection of any hardware to other electronics, it shall be verified that all power supplies, signal generators, VME racks, and any other test and measurement equipment shall be connected to the same AC ground. The simplest way to do this is to connect all AC-powered equipment to the same power strip. In cases where this is not practical (e.g. possibly a thermal-vacuum test), greater care must be taken to ensure there are no floating grounds since this would represent a hazard to the electronics.

Note: Leave all connector savers in place until the actual flight mate is to be made. The AIDS provides authorization to install and remove connector savers.

Note: All flight mates and demates must be completed and entered into the mate demate log before measurements are made or testing can start.

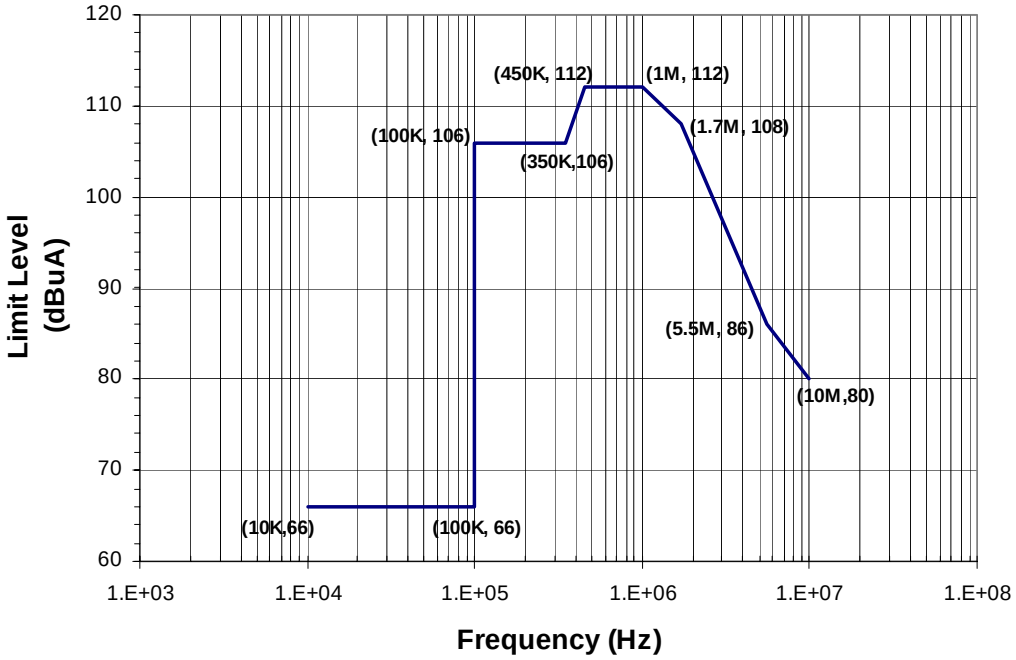
1) Notify QAE that testing is expected to start, so the QAE can arrange to be present for the setup and start of testing. Record per the data sheet.
2) Verify that the Test Readiness Review has concluded and all parties have signed the cover sheet. Record per the data sheet.
3) Record the serial numbers per the data sheet.
4) Turn off the power on the EGSE. Record in the data sheet.
5) Set the DMM to the auto-ranging resistance setting. Record in the data sheet.
6) Measure DMM lead resistance by connecting the two leads together. Record in the data sheet.
7) Measure the resistance between the EUT chassis and technical ground. Record in the data sheet.
8) Measure the resistance between the test equipment chassis and technical ground. Record in the data sheet.

9) Verify connector savers are on all flight hardware (install the connector savers per authorization from an AIDS if necessary). Record in the data sheet.

10) Verify that the test equipment and participant lists have been completed.

4.2 Procedure Figures

This section contains the figures relevant to the test procedures. The text of the procedures are in the next section.



Frequency (Hz)	Limit (dBuA)
10K	66
100K	66
100K	106
350K	106
450K	112
1M	112
1.7M	108
5.5M	86
10M	80

Figure 4-2: CE102 Test Limits

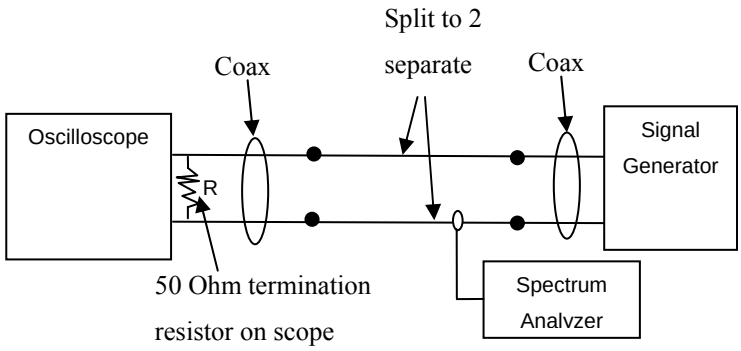


Figure 4-3: CE102 Calibration Set Up

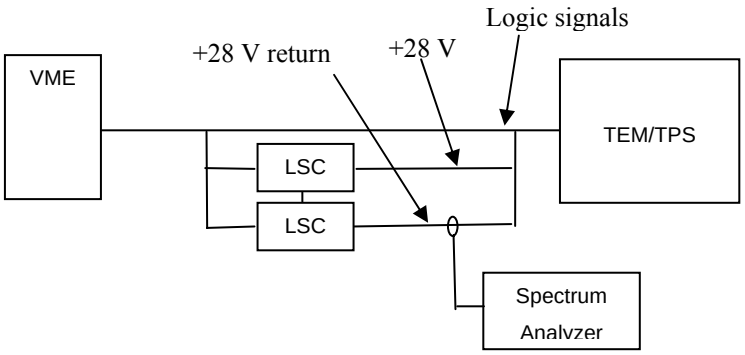
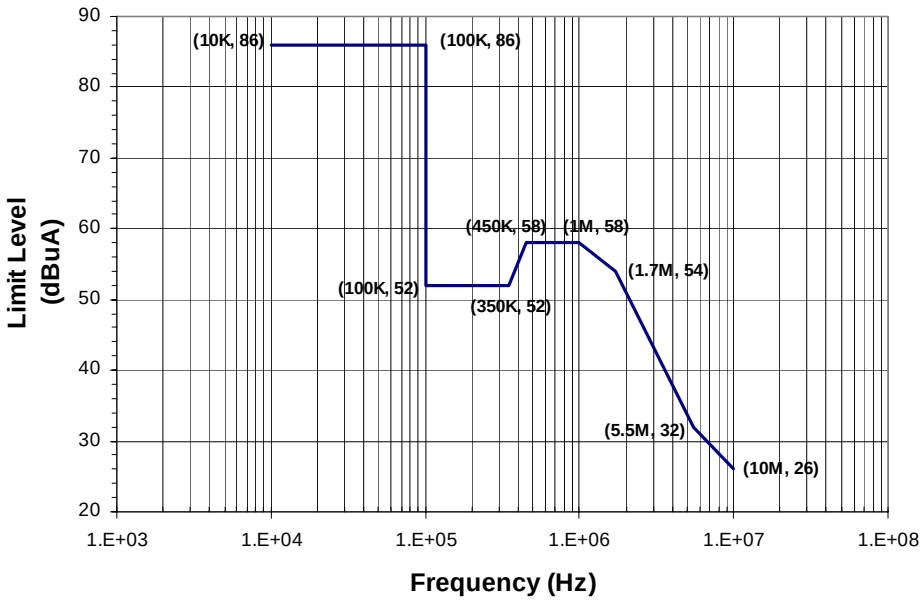


Figure 4-4: CE102 Test Set Up



Frequency (Hz)	Limit (dBuA)
10K	86
100K	86
100K	52
350K	52
450K	58
1M	58
1.7M	54
5.5M	32
10M	26

Figure 4-5: CS102 Test Limits

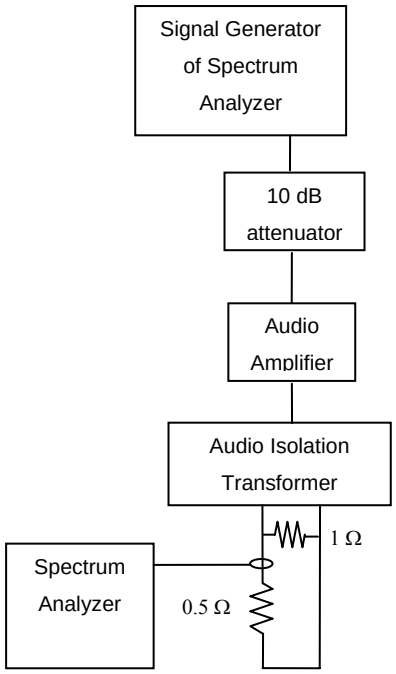


Figure 4-6: CS102 Calibration Set-Up for 10 kHz to 150 kHz

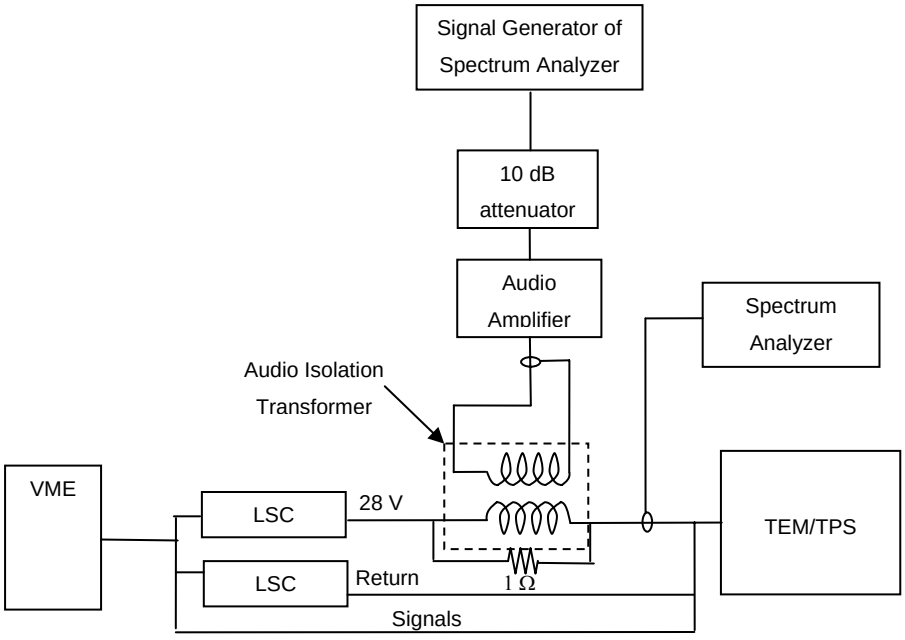


Figure 4-7: CS102 Test Set-Up for 10 kHz to 150 kHz

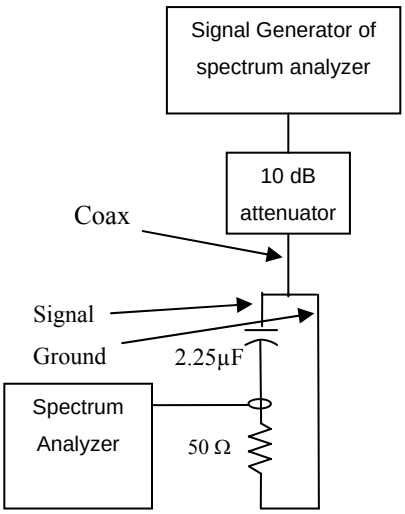


Figure 4-8: CS102 Calibration Set-Up for 150 kHz to 10 MHz

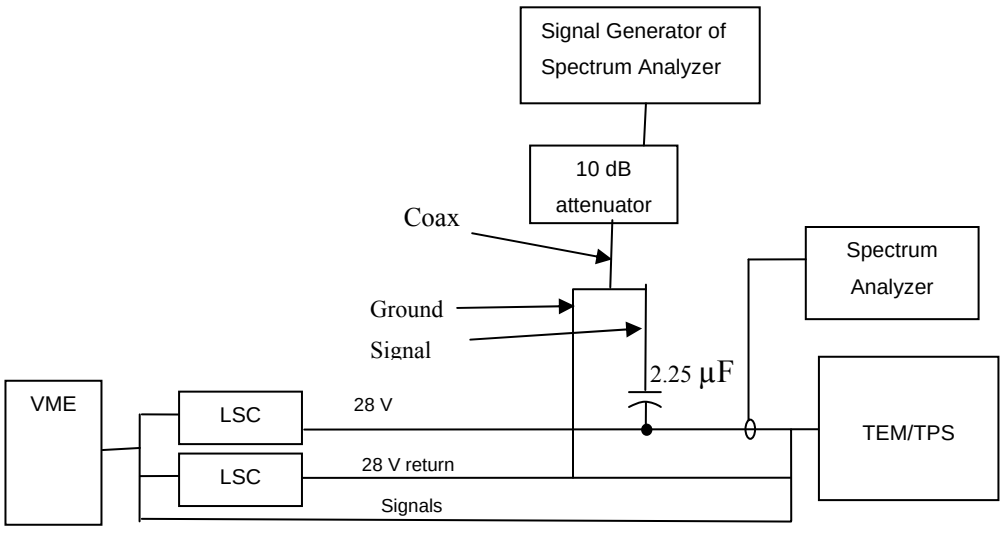


Figure 4-9: CS102 Test Set-Up for 150 kHz to 10 MHz

4.3 CE102 Conducted Emissions, Power Leads, 10 kHz to 10 MHz

The CE102 test is performed to verify that electromagnetic emissions from the TEM/TPS do not exceed the specified requirements for input power leads (including returns). The test is to be performed over the frequency range of 10 kHz to 10 MHz as specified in the following paragraphs. This test is performed per MIL-STD-462 method CE03, and does not conform to MIL-STD-461E.

4.3.1 Initial Test Set-Up and Calibration Check

Setup and conduct a pre-test calibration of the EMI test measurement system as follows:

1) Configure the test set per Figure 4-3: CE102 Calibration Set Up.

2) Verify the setup, record per the data sheet.

3) Turn ON power to the measurement system and allow sufficient time for equipment stabilization.

4) Recall Analyzer setup "CE102CAL".

5) Apply a signal with the signal generator. The signal level should be 6 dB lower than the maximum allowable limits illustrated in Figure 4-2: CE102 Test Limits at 10 kHz, 2 MHz and 10 MHz. Determine the signal level with the oscilloscope which is across the resistor.

6) Scan the Spectrum Analyzer and verify that the measured signals are within +/- 3 dB of the injected test signal levels. Correction factors shall be applied for any attenuator used. If the measured levels deviate by more than +/- 3 dB, determine the source of the error and correct the problem before proceeding. Record the results of the pre-test calibration in the EMI test log. Record in the data sheet Table.

Note: The Table in the data sheet shows the values to set the Analyzer source amplitude to (dBm out), and the expected readings on the scope and the Analyzer. The spreadsheet from which it is derived is in appendix A.

7) Verify all calibration data is good and record per the data sheet.

4.3.2 Conducted Emissions Test

1) Set up the TEM/TPS and measurement equipment per Figure 4-4: CE102 Test Set Up.

2) Verify the setup and record per the data sheet.

3) Turn ON power to the TEM/TPS and configure the unit to operate in the EMI Test mode as specified in paragraph 3.4.1.

4) Connect the spectrum analyzer's current probe to the +28VDC line. Monitor output of the current probe.

5) Recall the setups per the table below.

Frequency Range (MHz)	Current Probe ON	Setup to Recall
0.15 - 2	+28 V	CE102A
2-6	+28 V	CE102B
6-10	+28 V	CE102C
0.15 - 2	+28 V return	CE102A
2-6	+28 V return	CE102B
6-10	+28 V return	CE102C

6) Review the spectrum plot of the measurement equipment's scan results and verify that the resultant plot is within the limits specified in Figure 4-2: CE102 Test Limits. Record the results in the table per the data sheet and place a copy of the spectrum plot with the EMI test data package. Save a copy on the spectrum analyzer's floppy disk. If any out-of-specification emissions are observed, record the frequency and level of the out-of-specification data and initiate a Failure Report.

Note: The test is done in 3 frequency ranges.

7) The test limits are contained in the setups and are shown on the analyzer as the top green line. The test passes if the measured spectrum is all below the green line. The spreadsheet which calculates the green line is in Appendix B. Record pass/fail and the file name and save the analyzer data to the floppy disk. Record per the Table in the data sheet.

8) If the test is successful, reconnect the spectrum analyzer to the +28 VDC return line. Monitor output of the current probe.

9) Repeat steps 5 to 7 to recall each setup and measure the data.

10) Verify all data is good and record per the data sheet.

4.4 Conducted Susceptibility, 10 kHz to 10 MHz

This test is conducted to verify the ability of the TEM/TPS to withstand signals coupled onto the unit's +28 VDC input line. The TEM/TPS will be exercised as specified in paragraph 3.4.1 during the test. If any of the unit's operating parameters identified in paragraph 3.5 are out-of-tolerance, the test will be stopped and an evaluation of the interference frequency and signal level will be conducted. This test is performed over the frequency range of 10 kHz to 10 MHz. The signal is inductively coupled in the low frequency range and capacitively coupled in the high frequency range.

It is done in two parts:

- This test is performed per MIL-STD-461E method CS01 over the frequency range of 10 kHz to 150 kHz.
    - ♦ The functional test shall be performed per section 5.6 of LAT-TD-04085.
    - ♦ A frequency sweep and noise measurement shall be made per section 5.7 for each voltage.
- This test is performed per MIL-STD-462 method CS02 over the frequency range of 150 kHz to 10 MHz.
    - ♦ The functional test shall be performed per section 5.6 of LAT-TD-04085.
    - ♦ A frequency sweep and noise measurement shall be made per section 5.7 for each voltage.

4.4.1 Initial Test Set-Up and Calibration, 10 kHz to 150 kHz

Setup and conduct a pre-test calibration of the EMI test measurement system as follows:

1) Set up the measurement equipment per Figure 4-6: CS102 Calibration Set-Up for 10 kHz to 150 kHz.

2) Verify the setup and record per the data sheet.

3) Turn on the EMI measurement equipment and allow sufficient warm-up time for equipment stabilization.

4) Recall analyzer setup "CS102A". This setup includes a green line that shows the desired signal levels. See appendix C for the spreadsheet where these values were calculated. It also includes signal generator strengths that should result in a signal that matches or is slightly above the green line.

5) Scan the entire test frequency range of 10 kHz to 150 kHz and make sure the yellow measurement line is near or somewhat above the green limit line. Note that the setup has the trigger set to SINGLE so measurements are not continuously made as this would wear out the relay that changes the source amplitude. To make a measurement, go to the TRIGGER menu and select "MEASURE RESTART".

6) If the whole yellow line is shifted, correct it by adjusting the amplifier gain (which is not a calibrated device).

7) If you need to make frequency dependent changes to the source strength, edit the sweep list on the analyzer by going to the SWEEP menu, selecting "SWEEP TYPE MENU" and then "EDIT LIST". If the rest of what needs to be done is not obvious from the menus, see page 9-3 of the manual for details. Save the completed analyzer data to floppy.

8) Record the changes and file name per the data sheet.

4.4.2 Conducted Susceptibility Register Test, 10 kHz to 150 kHz

1) Set up the EMI test equipment and the TEM/TPS per Figure 4-7: CS102 Test Set-Up for 10 kHz to 150 kHz.

2) Verify the setup and record per the data sheet.

3) Continue to use setup CS102A which was loaded in the previous step.

4) Do a single quick measurement or two to make sure things are working. The yellow measurement line will not be exactly where it was during the setup as the impedance of the TPS is different from the simple resistor used in the setup. However, it will look similar. If it is flat at low magnitude, something isn't setup right.

5) Set the sweep time to 246 seconds (3 seconds per point as specified in the Susceptibility Requirements).

6) Initial to show the sweep time was set, record per the data sheet.

7) Set up the TEM/TPS test system to exercise the TEM/TPS as specified in paragraph 3.4.1. Verify that the test passed. Record in the data sheet.

8) Press MEASURE RESTART on the TRIGGER menu to do the scan.

9) During the test scan, monitor the red and green lights on the GUI. If only the green light is on and the red light is off, the test is considered to be successful.

10) Record TEM/TPS run number per the data sheet.

11) Record test Pass/Fail.

12) Save analyzer data to floppy and record filename

4.4.3 Conducted Susceptibility Noise Test, 10 kHz to 150 kHz

Perform noise measurements per LAT-TD-04085. One frequency scan shall be used for each supply noise measurement.

1) Press MEASURE RESTART on the TRIGGER menu to do the scan.
2) Measure and record per the data sheet the largest noise voltage on CAL bias (HV) during the frequency sweep.
3) Press MEASURE RESTART on the TRIGGER menu to do the scan.
4) Measure and record per the data sheet the largest noise voltage on CAL 3.3 analog during the frequency sweep.
5) Press MEASURE RESTART on the TRIGGER menu to do the scan.
6) Measure and record per the data sheet the largest noise voltage on CAL 3.3 digital during the frequency sweep.
7) Press MEASURE RESTART on the TRIGGER menu to do the scan.
8) Measure and record per the data sheet the largest noise voltage on TKR bias (HV) during the frequency sweep.
9) Press MEASURE RESTART on the TRIGGER menu to do the scan.
10) Measure and record per the data sheet the largest noise voltage on TKR 2.5 analog during the frequency sweep.
11) Press MEASURE RESTART on the TRIGGER menu to do the scan.
12) Measure and record per the data sheet the largest noise voltage on TKR 1.5 analog during the frequency sweep.
13) Press MEASURE RESTART on the TRIGGER menu to do the scan.
14) Measure and record per the data sheet the largest noise voltage on TKR 2.5 digital during the frequency sweep.

4.4.4 Initial Test Set Up and Calibration, 150 KHz to 10 MHz

Setup and conduct a pre-test calibration of the EMI test measurement system as follows:

1) Set up the measurement equipment per Figure 4-8: CS102 Calibration Set-Up for 150 kHz to 10 MHz:

2) Verify the setup and record per the data sheet.

3) Turn on the EMI measurement equipment and allow sufficient warm-up time for equipment stabilization.

4) Recall analyzer setup CS102B. This setup includes a green line that shows the desired signal levels. See appendix C for the spreadsheet where these values were calculated. It also includes signal generator strengths that should result in a signal that matches or is slightly above the green line.

5) Scan the entire test frequency range of 150 KHz to 10 MHz and make sure the yellow measurement line is near or somewhat above the green limit line. Note that the setup has the trigger set to SINGLE so measurements are not continuously made as this would wear out the relay that changes the source amplitude. To make a measurement, go to the TRIGGER menu and select "MEASURE RESTART".

6) If you need to make changes to the source strength, edit the sweep list on the analyzer by going to the SWEEP menu, selecting SWEEP TYPE MENU and then EDIT LIST. If the rest of what needs to be done is not obvious from the menus, see page 9-3 of the manual for details. Note the changes you made below, or initial the no changes needed line. Save the completed analyzer data to floppy. Record per the data sheet.

7) Record the changes and file name per the data sheet.

4.4.5 Conducted Susceptibility Register Test, 150 kHz to 10MHz

1) Set up the EMI test equipment and the TEM/TPS per Figure 4-9: CS102 Test Set-Up for 150 kHz to 10 MHz.

2) Verify the setup and record per the data sheet.

3) Continue to use setup CS102B which was loaded in the previous step.

4) Do a single quick measurement or two to make sure things are working. The yellow measurement line will not be exactly where it was during the setup as the impedance of the TPS is different from the simple resistor used in the setup. However, it will look similar. If it is flat at low magnitude, something isn't setup right.

5) Set the sweep time to 357 seconds (3 seconds per point as specified in the Susceptibility Requirements)

6) Initial to show the sweep time was set, record per the data sheet.

7) Set up the Tracker test system to exercise the TEM/TPS as specified in paragraph 3.4.1. Verify that all data received from the TEM/TPS is within limits.

8) Press MEASURE RESTART on the TRIGGER menu to do the scan.

9) During the test scan, monitor the red and green lights on the GUI. If only the green light is on and the red light is off, the test is considered to be successful.

10) Record TEM/TPS run number, per the data sheet.

11) Record test Pass/Fail, per the data sheet.

12) Save analyzer data to floppy and record filename, per the data sheet.

4.4.6 Conducted Susceptibility Noise Test, 150 kHz to 10 MHz

Perform noise measurements per LAT-TD-04085. One frequency scan shall be used for each supply noise measurement.

1) Press MEASURE RESTART on the TRIGGER menu to do the scan.
2) Measure and record per the data sheet the largest noise voltage on CAL bias (HV) during the frequency sweep.
3) Press MEASURE RESTART on the TRIGGER menu to do the scan.
4) Measure and record per the data sheet the largest noise voltage on CAL 3.3 analog during the frequency sweep.
5) Press MEASURE RESTART on the TRIGGER menu to do the scan.
6) Measure and record per the data sheet the largest noise voltage on CAL 3.3 digital during the frequency sweep.
7) Press MEASURE RESTART on the TRIGGER menu to do the scan.
8) Measure and record per the data sheet the largest noise voltage on TKR bias (HV) during the frequency sweep.
9) Press MEASURE RESTART on the TRIGGER menu to do the scan.
10) Measure and record per the data sheet the largest noise voltage on TKR 2.5 analog during the frequency sweep.
11) Press MEASURE RESTART on the TRIGGER menu to do the scan.
12) Measure and record per the data sheet the largest noise voltage on TKR 1.5 analog during the frequency sweep.
13) Press MEASURE RESTART on the TRIGGER menu to do the scan.
14) Measure and record per the data sheet the largest noise voltage on TKR 2.5 digital during the frequency sweep.

Appendix A (Calculation of conducted emissions calibration values)

This is the spreadsheet used to calculate the values to use for the conducted emissions calibration. Note that the whole spreadsheet is embedded in this Word document, so if you double click on the table, you will be able to see the formulas used in the spreadsheet.

Freq (MHz)	dB Ohm	dBuA Fig 4-1	dBm out	dBm in	V p-p out	V p-p in	
10	13.6	74	0.989700043	-19.38970004	0.708785783	0.067849241	
2	12.1	102	28.98970004	7.110299957	17.80389391	1.433986271	spectrum analyzer can only put out 15 dBm
2	12.1	88	14.98970004	-6.889700043	3.552343859	0.286117877	Use this lower calib value instead.
0.01	-23.3	60	-13.01029996	-70.28970004	0.141421356	0.000193439	Won't be visible on scope, but will be on spectrum analyzer

Appendix B (Calculation of conducted emissions limits)

This is the spreadsheet used to calculate the limits to use for the conducted emissions test. Note that the whole spreadsheet is embedded in this Word document, so if you double click on the table, you will be able to see the formulas used in the spreadsheet.

This is basically a conversion from the specification (with units of dBμA) to dBm, taking into account the sensitivity of the current probe. The column in bold is the value programmed into the analyzer setup limit line. The derivation of that conversion is in Appendix D.

Freq (MHz)	dB Ohm	dBuA Fig 4-1	dBm out	dBm in	V p-p out	V p-p in
0.01	-23.3	66	-7.0103	**-64.2897**	0.282173	0.000386
0.1	-3.3	66	-7.0103	**-44.2897**	0.282173	0.00386
0.101	-3.3	106	32.9897	**-4.2897**	28.21727	0.385962
0.35	5.825	106	32.9897	**4.8353**	28.21727	1.103558
0.45	7.525	112	38.9897	**12.5353**	56.30086	2.677904
1	10.8	112	38.9897	**15.8103**	56.30086	3.904316
1.7	11.71	108	34.9897	**12.7203**	35.52344	2.735552
5.5	13	86	12.9897	**-7.9897**	2.821727	0.252084
10	13.6	80	6.9897	**-13.3897**	1.414214	0.135377

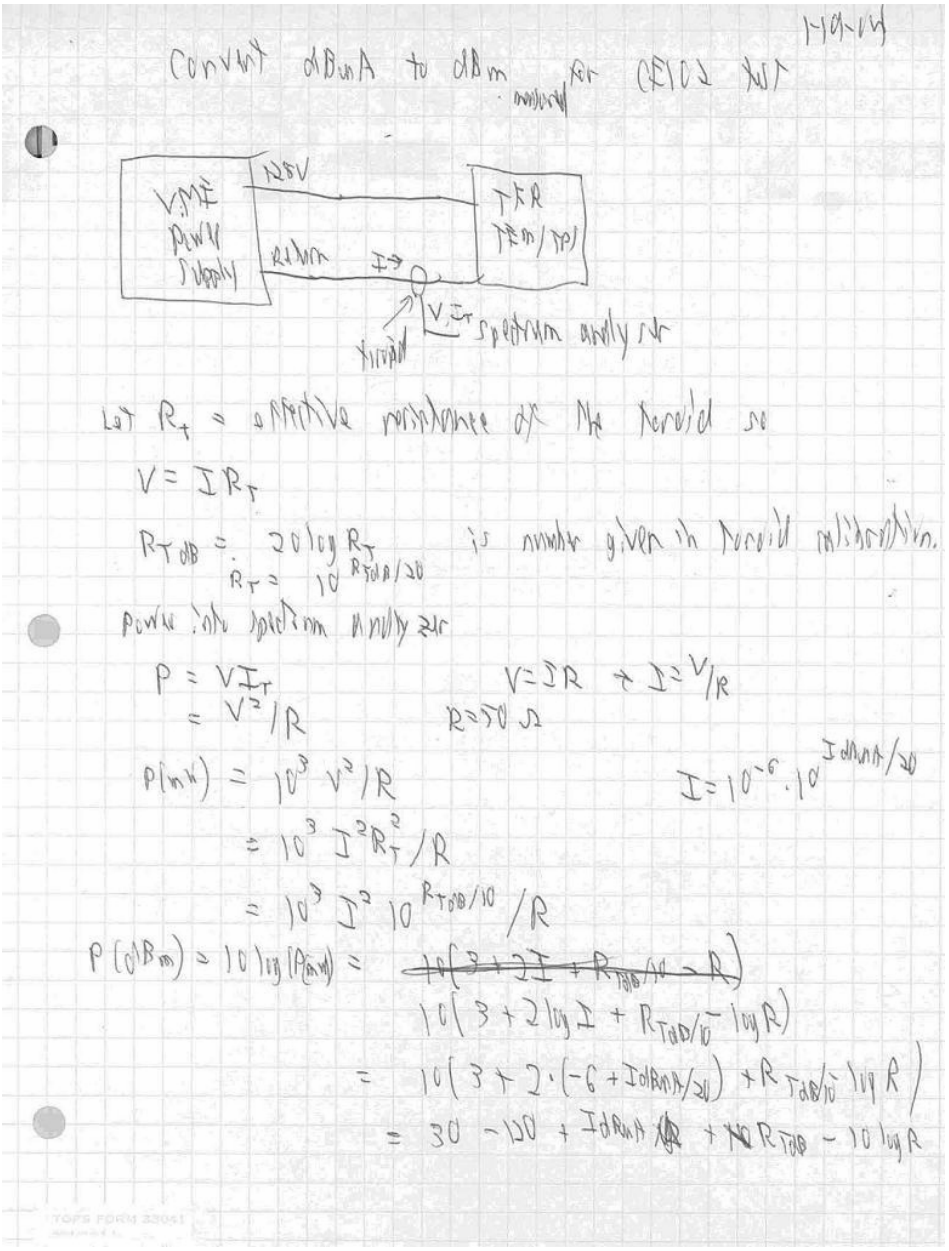
Appendix C (Calculation of conducted susceptibility source strength)

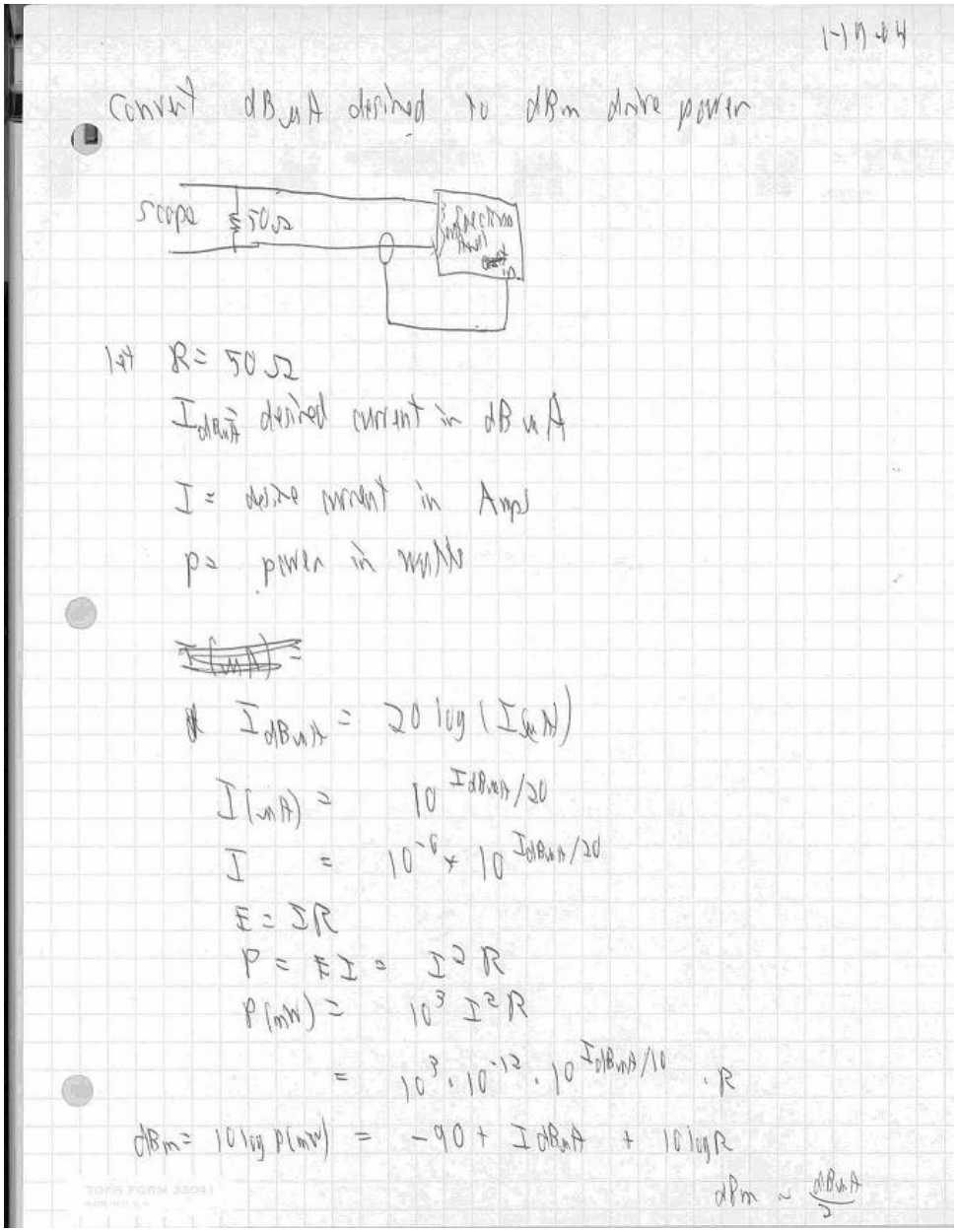
This is the spreadsheet used to calculate the source strengths to use for the conducted susceptibility test. Note that the whole spreadsheet is embedded in this Word document, so if you double click on the table, you will be able to see the formulas used in the spreadsheet.

This is basically a conversion from the specification (with units of dBμA) to dBm, taking into account the sensitivity of the current probe. The column in bold is the value programmed into the analyzer setup limit line. The derivation of that conversion is in Appendix D.

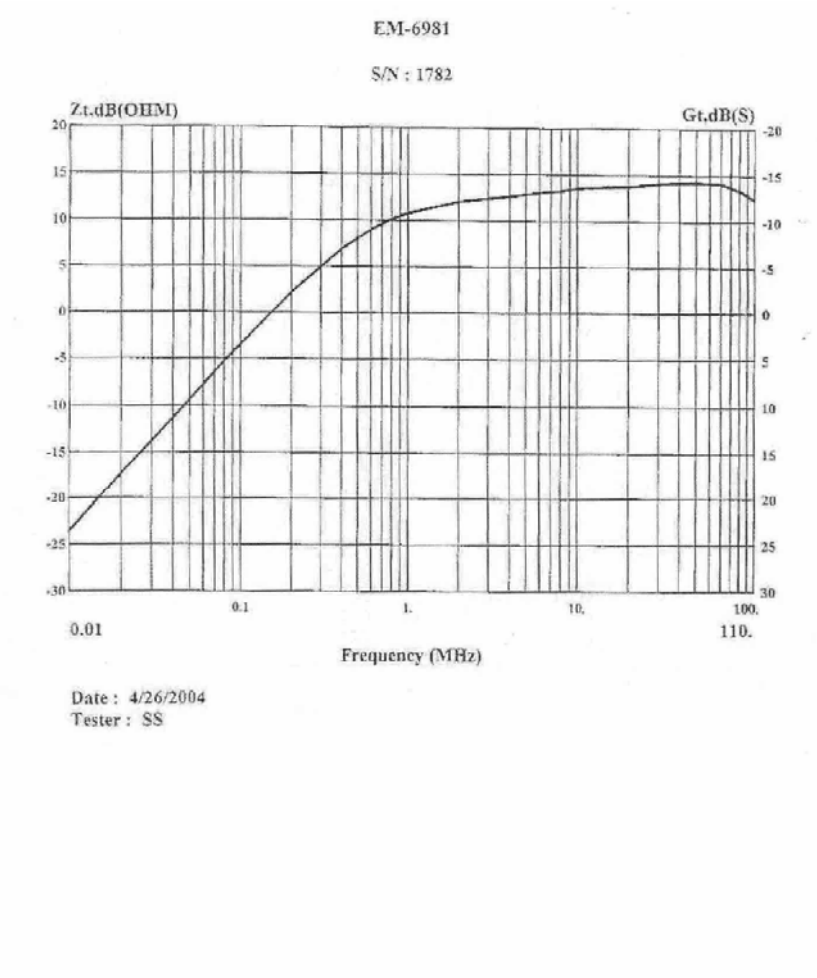
Freq (MHz)	dB Ohm	dBuA Fig 4-1	dBm out	dBm in	V p-p out	V p-p in
0.01	-23.3	86	12.9897	**-44.2897**	2.821727	0.00386
0.1	-3.3	86	12.9897	**-24.2897**	2.821727	0.038596
0.101	-3.3	52	-21.0103	**-58.2897**	0.056301	0.00077
0.35	5.825	52	-21.0103	**-49.1647**	0.056301	0.002202
0.45	7.525	58	-15.0103	**-41.4647**	0.112335	0.005343
1	10.8	58	-15.0103	**-38.1897**	0.112335	0.00779
1.7	11.71	54	-19.0103	**-41.2797**	0.070879	0.005458
5.5	13	32	-41.0103	**-61.9897**	0.00563	0.000503
10	13.6	26	-47.0103	**-67.3897**	0.002822	0.00027

Appendix D (Derivation of dBm from dbµA)




Convert dBuA desired to dBm drive power
scope
50Ω
Let R = 50Ω
I_{dBuA} desired current in dBuA
I = drive current in Amps
p = power in mW
$I_{dBuA} = 20 \log(I_{uA})$
$I(mA) = 10^{I_{dBuA}/20}$
$I = 10^{-6} \times 10^{I_{dBuA}/20}$
$E = IR$
$P = EI = I^2R$
$P(mW) = 10^3 I^2 R$
$= 10^3 \cdot 10^{-12} \cdot 10^{I_{dBuA}/10} \cdot R$
$dBm = 10 \log P(mW) = -90 + I_{dBuA} + 10 \log R$
dBm ~ dBuA

Appendix E (Calibration of the current probe, from the manufacturer)



EM-6981

SERIAL NUMBER: 1702

DATE: 4/26/2004

TESTER: SS

Frequency (MHz.)	Amp. (dBmV)
.01	-23.1
.02	-17
.04	-11.1
.06	-7.5
.08	-5.1
.1	-3.3
.2	2.3
.4	7
.6	9.1
.8	10.2
1	10.8
2	12.1
4	12.7
6	13.1
8	13.3
10	13.5
20	13.8
40	14.3
60	14.2
70	14.1
80	13.8
90	13.4
100	13
110	12.5

Page 1

Appendix F (Cover and Data Sheets)

COVER SHEET

Program: GLAST

Procedure Number: LAT-TD-05671

Procedure Title: TEM/TPS EMI Acceptance Test Proc.

Controlling Document Number: _____

Controlling Document Step Number: _____

Unit S/N: _____

Descriptive Comment: _____

TEST READINESS REVIEW COMPLETED AND APPROVED BY THE FOLLOWING:

Test Director: _____ Date: _____

Quality Assurance: _____ Date: _____

Test Conductor: _____ Date: _____

POST TEST REVIEW COMPLETED AND APPROVED BY THE FOLLOWING:

Test Director: _____ Date: _____

Quality Assurance: _____ Date: _____

Test Conductor: _____ Date: _____

TEST DATA SHEET	Unit S/N:	Date/Temperature:
Title: 4.2 Test Equipment	Operator:	QA:

Para./ Step	Test Equipment Description, Manufacturer	Model/LAT Number	Serial/Rev. Number	*Cal./Val. Date
4.2.1 - 1	**Record Model/LAT number, Serial/Revision number, Calibration due dates and Validation date for all equipment used in this procedure:**			
	** Digital Multi Meter, Fluke/Meterman	87-III/38XR		
	VME Crate, Dawn VME Products	11-1011777-2119		
	Oscilloscope			
	Spectrum Analyzer			
	Audio Isolation Transformer			
	Audio Amplifier			
	Large Scale Capacitor (#1)			
	Large Scale Capacitor (#2)			
	VME, TST-STP Trans card	LAT-DS-00999		
	VME SBC MVME2304 card, Motorola	PN MVME2304-0123		
	VME LCB Mezzanine card	LAT-TD-00860		
	Software for the local PC	TEMPROD V00-00-00		
	DC Power supply #1, BK Precision	BK 1786		
	DC Power supply #2, BK Precision	BK 1786		
	28 Volt supply cable (#1)	LAT-DS-03246		
	28 Volt supply cable (#2)	LAT-DS-03246		
	PS Control cable	LAT-DS-04831		
	TEM to GASU cable	LAT-DS-05541		
	Power cable VME to TPS	LAT-DS-05540		
	LCB Transition board cable	LAT-DS-03247		
	TEM Test Board Assembly	LAT-DS-04465		
	TEM Test board cooling fan assembly	LAT-DS-03567		
	CAT5 Ethernet cable	TRD855PL-50		
	RS-232 Cable	TDC003-7 (RECO98M conn)		
	Ground jumper, Banana, Pomona	B-12-0		
	PS extension cable	LAT-DS-04629		
	TEM/TPS Assembly	LAT-DS-01643		

* This column is for recording the calibration due date for a given piece of equipment or the date that EGSE was validated.

** Do not substitute other DMM's CAUTION: Fluke 87-III and Fluke 87-V are not the same, Fluke 87-V is not allowed.

TEST DATA SHEET	Unit S/N:	Date/Temperature:
Title: 4.2 Test Equipment	Operator:	QA:

Para./ Step	Title	Print Name	Signature
4.1.3 - 1	**Record names of all personnel that take part in the test/operation:**		

TEST DATA SHEET	Unit S/N:	Date:
Title: 4.1.4 Pre Operation Verifications	Operator:	QA:

Para./ Step	Description	Limits	Unit	Data
4.1.4	**Pre-Operation Verifications**			
-1	Notify QAE.	OK	OK/NG	
-2	Test Readiness Review is done.	OK	OK/NG	
-3	Record the EUT equipment:			
	TEM/TPS Assembly Part number	NA	NA	
	TEM/TPS Assembly Serial number	NA	NA	
-4	EGSE power is OFF.	OFF	ON/OFF	
-5	Set DMM to autoranging for resistance.	OK	OK/NG	
-6	Measure DMM lead resistance.	< 2.0	Ω	
-7	Measure EUT to ground.	< 2.0	Ω	
-8	Measure test equipment to ground.	< 2.0	Ω	
-9	All connector savers are installed on the flight connections.	OK	OK/NG	
-10	The test equipment and participant lists have been completed.	OK	OK/NG	

TEST DATA SHEET	Unit S/N:	Date:
Title: 4.3 CE102 Conducted Emissions, 10 kHz to 150 kHz	Operator:	QA:

Para./ Step	Description	Limits	Unit	Data
4.3.1	**Initial Test Set-Up and Calibration Check**			
-2	Verify that the setup is complete.	OK	OK/NG	
-6	Record data in the Table below:	OK	OK/NG	
-7	Verify calibration data is good.	OK	OK/NG	

Freq (MHz)	dBm out	Expected pk-pk voltage (V)	Measured pk-pk voltage (V)	Expected dBm on Analyzer	Actual dBm on Analyzer
10	1	0.71		-19.4	
2	15	3.55		-6.9	
.01	-13	0.141		-70.3	

4.3.2	**Conducted Emissions Test**			
-2	Verify that the setup is complete.	OK	OK/NG	
-7	Record data in the Table below:	OK	OK/NG	
-10	Verify that all data is good for all six setups.	OK	OK/NG	

Frequency Range (MHz)	Current Probe on	Setup to Recall	Pass/fail	Saved data filename
0.15 - 2	+28 V	CE102A		A
2-6	+28 V	CE102B		B
6-10	+28 V	CE102C		C
0.15 - 2	+28 V return	CE102A		A2
2-6	+28 V return	CE102B		B2
6-10	+28 V return	CE102C		C2

TEST DATA SHEET	Unit S/N:	Date/Temperature:
Title: CS 102 Conducted Susceptibility 10KHz to 150KHz	Operator:	QA:

Para./ Step	Description	Limits	Unit	Data
4.4.1	**Initial Test Set-up and Calibration Check**			
-2	Verify setup	OK	OK/NG	
-8	Verify all calibration data is good	OK	OK/NG	
	Save analyzer data to floppy and record file name			

TEST DATA SHEET	Unit S/N:	Date/Temperature:
Title: CS 102 Conducted Susceptibility 10KHz to 150KHz	Operator:	QA:

Para./ Step	Description	Limits	Unit	Data
4.4.2	**Conducted Emissions Basic Test**			
-2	Verify setup	OK	OK/NG	
-6	Initial to show the sweep time was set	OK	OK/NG	
-7	Verify that the test passed	OK	OK/NG	
-10	Record TEM/TPS run number	OK	OK/NG	
-11	Record pass fail	OK	OK/NG	
-12	Save analyzer data to floppy and record file name			

TEST DATA SHEET		Unit S/N:		Date/Temperature:
Title: CS 102 Conducted Susceptibility 10KHz to 150KHz		Operator:		QA:
Para./ Step	Description	Limits	Unit	Data
4.4.3	**Conducted Susceptibility Noise Test**			
-2	Record largest noise voltage CAL Bias (HV) (red connection)	<500µ	Volts	
-4	Record largest noise voltage CAL 3.3 analog (yellow connection)	<150µ	Volts	
-6	Record largest noise voltage CAL 3.3 digital (green connection)	<200µ	Volts	
-8	Record largest noise voltage TKR bias (HV) (blue connection)	<500µ	Volts	
-10	Record largest noise voltage TKR 2.5 analog (green connection)	<150µ	Volts	
-12	Record largest noise voltage TKR 1.5 analog (red connection)	<150µ	Volts	
-14	Record largest noise voltage TKR 2.5 digital (yellow connection)	<150µ	Volts	

TEST DATA SHEET		Unit S/N:		Date/Temperature:
Title: CS 102 Conducted Susceptibility 150KHz to 10MHz		Operator:		QA:
Para./ Step	Description	Limits	Unit	Data
4.4.4	**Initial Test Set-up and Calibration Check**			
-2	Verify setup	OK	OK/NG	
-6	Verify all calibration data is good	OK	OK/NG	
-7	Record the changes and file name			

TEST DATA SHEET	Unit S/N:	Date/Temperature:
Title: CS 102 Conducted Susceptibility 150Hz to 10MHz	Operator:	QA:

Para./ Step	Description	Limits	Unit	Data
4.4.5	**Conducted Emissions Register Test**			
-2	Verify setup	OK	OK/NG	
-6	Initial to show the sweep time was set	OK	OK/NG	
-7	Verify that the data is within limits	OK	OK/NG	
-10	Record TEM/TPS run number	OK	OK/NG	
-11	Record Pass/Fail	OK	OK/NG	
-12	Save analyzer data and record file name			

TEST DATA SHEET	Unit S/N:	Date/Temperature:
Title: CS 102 Conducted Susceptibility 150Hz to 10MHz	Operator:	QA:

Para./ Step	Description	Limits	Unit	Data
4.4.6	**Conducted Emissions Noise Test**			
-2	Record largest noise voltage CAL Bias (HV)	<500µ	Volts	
-4	Record largest noise voltage CAL 3.3 analog	<150µ	Volts	
-6	Record largest noise voltage CAL 3.3 digital	<200µ	Volts	
-8	Record largest noise voltage TKR bias (HV)	<500µ	Volts	
-10	Record largest noise voltage TKR 2.5 analog	<150µ	Volts	
-12	Record largest noise voltage TKR 1.5 analog	<150µ	Volts	
-14	Record largest noise voltage TKR 2.5 digital	<150µ	Volts	

Appendix G (Connector Mate/Demate Log)

The Excel Mate/Demate log form that is below is the actual Excel file imported into this word document. You can copy and paste it into a folder and then open it as an Excel worksheet.

CONNECTOR MATE / DEMATE

UNIT DESCRIPTION: _____

Connector(s)	**Authorized by**	**Date**	**Mate or De-mate**	**Flight** or **Test**	**Verify Power Off**	**Pre-mate Inspect**		**ESD Bleed and Connector Mate**		**Final Inspect** Fasteners Torqued, Witness Stripe applied	
Connector Reference Designator	Procedure & para or NCR	M/D/Y	M or D	F or T	Emp. ID#	*Emp. ID#	QA	* Emp ID#	QA	* Emp. ID#	QA

*Personnel that is Mate/Demate certified.

Connector /Bracket R/D: