NAVAL RESEARCH LABORATORY

NAVAL CENTER FOR SPACE TECHNOLOGY

GLAST LAT Calorimeter Subsystem Electromagnetic Interference (EMI) Test Procedure

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DOCUMENT APPROVAL

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CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
01	14 July, 2004	Initial Draft
02	06 Aug, 2004	Revised RE102 requirements per F. Blanchette memo.

1 Introduction

1.1 Scope

This document prescribes the procedures to be used to conduct the Electromagnetic Interference (EMI) Test of the Large Area Telescope (LAT) Calorimeter (CAL) Subsystem. The CAL subsystem consists of sixteen identical modules. This document prescribes the EMI test procedures for a single CAL module along with associated electronics components – the Tower Electronics Module (TEM) and Tower Power Supply (TPS) – provided as ground support equipment by the LAT Electronics group at the Stanford Linear Accelerator Center.

Since the TEM and TPS are electrically connected and mounted in close proximity to the CAL for these tests, the EMI/EMC effects caused by the TEM and TPS are mitigated as much as possible. Several EMI suppression methods will be used in addition to the TEM/PS compatibility. Devices that will be in use include connectors, and shielding materials (mesh, metalized tape, etc.). Shielding enclosures and/or rooms will be used to avoid emission from external sources.

The procedures prescribed herein specify the CAL 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 CAL EMI Test Procedure is applicable to an individual CAL module (one of sixteen that comprise the CAL subsystem). The article under test consists of:

- CAL Module (flight article)
- Tower Electronics Module (TEM – EM2 nonflight ground test unit)
- Tower Power Supply (TPS – EM2 nonflight ground test unit)

The TEM and TPS effects upon the CAL EMI/EMC tests are attempted to be minimized by enclosing both the TEM and TPS in a grounded enclosure. However, it is expected that all conducted emissions and susceptibility tests will be dominated by the TEM and TPS effects.

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

SSD-PS-052 NRL Component and Material Handling Procedure

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 Acceptance Test Procedures:

433-RQMT-0005 Rev A	GLAST Observatory Electromagnetic Interference (EMI) Requirements Document, NASA/GSFC, Oct 6, 2003.
LAT-MD-00408	“LAT Instrument Performance Verification Plan”, SLAC, W. Davis.
LAT-SS-00778	“LAT Environmental Specification”, SLAC, M. Nordby.
LAT-MD-00228	Calorimeter, Tracker, And Data Acquisition Contamination Control Plan, SLAC, N. Virmani.
LAT-MD-01502	GLAST LAT CAL Subsystem Test Descriptions
LAT-PS-01370	CAL Comprehensive and Limited Functional Test Definitions

Drawing List

LAT-DS-00916	CAL Module
LAT-DS-03323	EMI Test Bed, CAL
LAT-DS-03324	Base Plate, EMI Test, CAL
LAT-DS-03325	Y Mount, CAL, EMI Test
LAT-DS-03326	X Mount, CAL, EMI Test
LAT-DS-03327	Box Shield, EMI Test, CAL
LAT-DS-03328	Shield Plate, EMI Test, CAL
LAT-DS-03332	Cover, Cable, EMI Test
TBD	Leg Assembly, EMI Test

1.4 DEFINITIONS AND ACRONYMS

AFEE	Analog Front End Electronics of the Calorimeter
CAL	Calorimeter Subsystem of the LAT
DAS	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
SLAC	Stanford Linear Accelerator Center
STE	Support Test Equipment
TEM	Tower Electronics Module
TPS	TEM Power Supply
WOA	Work Order Authorization

2 EMI Test Overview

2.1 EMI Test Overview

The EMI tests prescribed for the CAL, as specified within this document, have been developed to verify the Electromagnetic Compatibility and Interference (EMI/EMC) integrity of the GLAST CAL design as set forth in LAT-MD-00408 and LAT-SS-00778. The EMI/EMC tests to be performed on the CAL subsystem will measure and document the subsystem's conducted and radiated emissions and susceptibility to other subsystem's emissions during GLAST flight operation and to assess the potential impact to other subsystems within the GLAST. A CAL module is combined with a TEM and TPS to form the testable unit. This general configuration is shown in Figure 2-1.

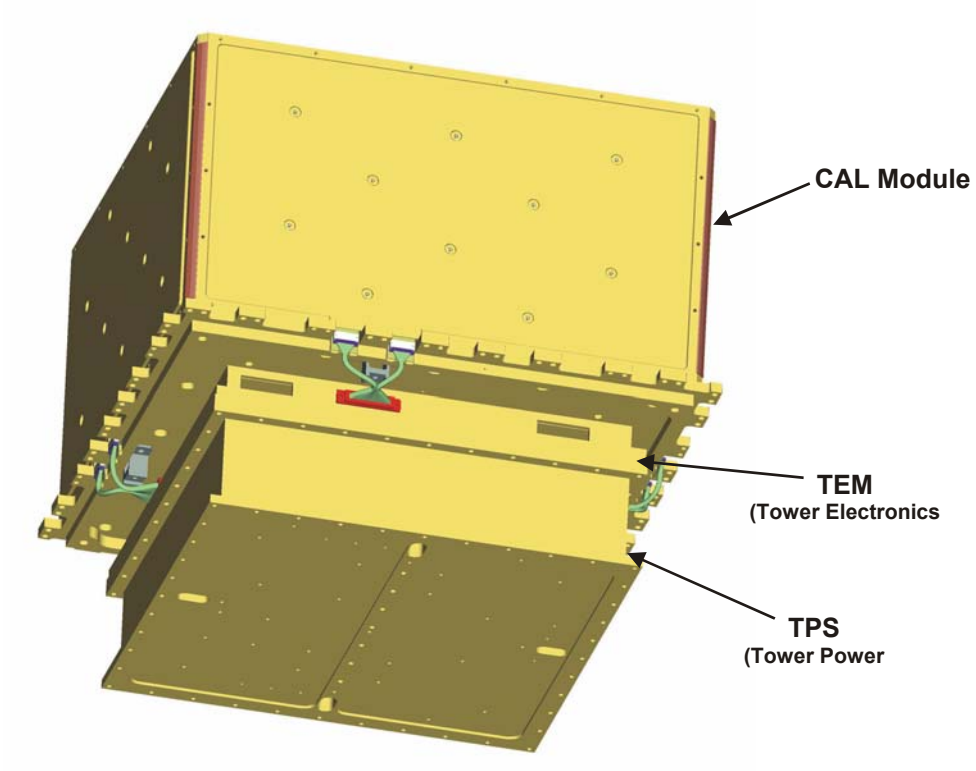

Figure 2-1: Calorimeter Module with TEM and TPS mounted on the bottom.

2.2 Design Requirements

Design requirements for the supporting test equipment, EM2 TEM/TPS, have been verified by SLAC. This includes grounding, shielding and filtering of the power converters and switching transient noise to ensure that the noise is restricted in the individual box. Wires between the TEM, the Calorimeter and the connectors will be shielded. This is done with the shortest wire connections (pigtails).

2.3 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 Calorimeter contamination procedure,
- 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 NRL CAL QA 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.

2.4 Failure Reporting and Analysis

A failure is defined as the inability of the Calorimeter 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:

a) Any departure or suspected departure from performance.

b) Failures in GSE that interface with flight Calorimeter as well as any other malfunction that could compromise mission objectives.

Testing of the Calorimeter will be tracked via the automated Work Order Authorization (WOA) system with all related information. The WOA system tracks work flow and records non-conformances from the initiation of I&T through completion.

2.5 Test Equipment Calibration

All individual test equipment and the equipment installed within the CAL Support Test Equipment (STE) used to conduct the EMI/EMC test of the CAL 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

2.6 CAL Flight Unit Handling Procedures

All personnel must be trained in the awareness of ESD hazards. Areas where the Calorimeter is handled should be limited to trained personnel to prevent inadvertent damage. Follow all of the rules and handle flight and critical GSE with care. Be wary when the CAL and any other equipment are moved to test facilities. Have a moving procedure or plan ready prior to work. Test and label all cables and connectors. Maintain temperature and humidity as specified in the Calorimeter Contamination Control Plan.

2.7 Test Data

The CAL is monitored during the EMI/EMC test by performing a series of automated tests under the control of the CAL 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 Witnessing

All test set-ups shall be verified by the EMI test engineer, the CAL system support engineer, and CAL QA prior to commencing the tests specified within that test sequence. A test readiness review shall be conducted.

2.9 Test Log Entries

A CAL EMI test log along with the WOA as described in QA requirement 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 CAL WOA, 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 NMR'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.

2.10 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.

2.11 Test Philosophy

The GLAST CAL EMI/EMC test procedure includes a series of tests specified by the LAT Environmental Specification, Document Number LAT-SS-00778. The Environmental Specification identifies the following tests to be conducted on the CAL subsystem.

2.11.1 Qualification Tests

The LAT Instrument Performance Verification Plan, LAT-MD-00408, identifies the following tests for the CAL subsystem protoflight module. A reduced set of tests are performed, as workmanship verification, on the remaining 17 CAL modules (see section 2.11.2).

CE102	Conducted Emissions, Power Leads, 10 kHz to 10 MHz	MIL-STD-462, CE03
CECM	Conducted Emissions, Time Domain, 150 MHz Bandwidth	
CS102	Conducted Susceptibility, Power Leads, 10 kHz to 10 MHz	MIL-STD-462, CS02
CSCM	Conducted Susceptibility, Common Mode, 30 Hz to 150 MHz	MIL-STD-462, CS02
CS06	Conducted Susceptibility, Spike, Power Leads	MIL-STD-462
RE101	Radiated Emissions, Magnetic Field, 20 Hz to 50 kHz	
RE102	Radiated Emissions, Electric Field, 10 kHz to 18 GHz	MIL-STD-461E
RS101	Radiated Susceptibility, Magnetic Field, 20 Hz to 50 kHz	
RS103	Radiated Susceptibility, Electric Field, 30 MHz to 18 GHz	
	Static Magnetic Field	Verification by analysis

Each of these tests require the CAL to be configured and operated in specific modes of operation to simulate a worst case operating scenario for each of the specified test configurations. The CAL EMI/EMC qualification test will be conducted at NRL EMI/EMC test facility located in Building A59.

2.11.2 Acceptance Tests

With successful completion of the protoflight EMI/EMC tests identified in section 2.11.1, the acceptance testing of the remaining 17 CAL modules will include workmanship tests as identified in the list below.

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

CS102 Conducted Susceptibility, Power Leads, 10 kHz to 10 MHz

Each of these tests require the CAL to be configured and operated in specific modes of operation to simulate a worst case operating scenario for each of the specified test configurations. This limited set of tests can be conducted in the CAL clean room facility in Bldg A59 or in the NRL EMI/EMC test facility. That decision will be made independently for each module depending on schedule constraints and facility availability.

2.12 Test Configuration

Each test defined herein require the CAL to be configured and operated in specific modes of operation to simulate a worst case operating scenario for each of the specified test configurations. The CAL EMI/EMC test will be conducted at NRL EMI/EMC test facility located in Building A59. All possible test configurations will be recorded on a WOA and photos of all configurations shall be attached to the WOA.

General requirements related to the test methods, test facilities and test equipment used during the conduct of the CAL EMI/EMC test are as specified in the following paragraphs. The general test set up for the CAL during the EMI/EMC test is as illustrated in Figure 2-2.

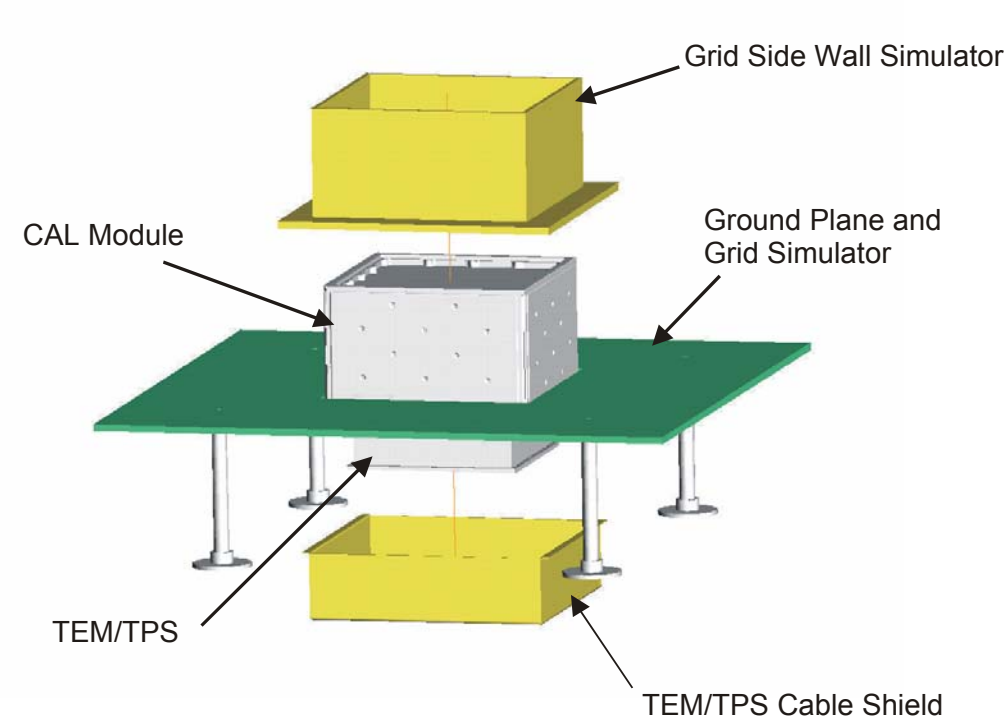

Figure 2-2: CAL/TEM/TPS test configuration

3 General EMI/EMC Test Requirements

3.1 Shielded Enclosure Test Set-Up

The CAL EMI/EMC tests will be conducted with the CAL and MIL-STD-461C/461E line conditioner as required, i.e. Large Scale Capacitor (LSC) or Line Impedance Stabilization Network (LISN), located within a shielded enclosure. All test equipment used to exercise and monitor the performance of the CAL will be located in an adjacent area that is isolated from the CAL to prevent any interaction and interference between the test system and the CAL being tested. The limited tests required for acceptance testing do not required the use of a shielded enclosure. For CAL acceptance testing, the shielded enclosure may be used, if available, but it is not required.

3.2 Ground Plane Requirements

The CAL shall be installed on a ground plane that closely approximates the actual flight system installation. The CAL shall be bonded to the ground plane using the flight unit's normal mounting interface. The DC resistance between the flight unit and the ground plane shall be less than 2.5 milli-ohms. The ground plane shall also be electrically bonded to the shielded enclosure at least once every 1-meter. This is not necessary for the EMI/EMC acceptance testing but is required for the EMI/EMC qualification testing.

3.3 Orientation of CAL

The CAL shall be mounted on the test ground plane surface approximately 14 cm from the front edge of the ground plane and shall be oriented such that surfaces, which have been determined to produce maximum radiated emissions and respond most readily to radiated signals, face the test antennas. The Flight CAL shall be secured to the test fixture as shown in LAT-DS-03323. The test fixture positions the CAL and the ground plane as illustrated in Figure 3-2. The front face of the CAL shall be positioned approximately 14 cm from the front edge of the ground plane. The test stand shall be bonded to the ground plane and the DC resistance shall be less than 2.5 milli-ohms.

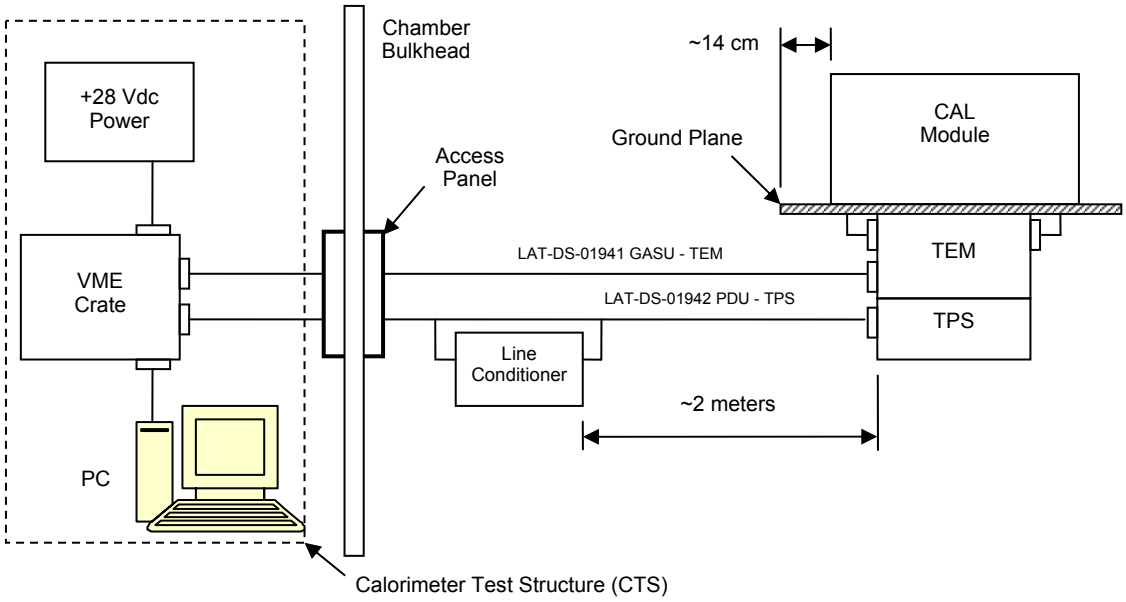

Figure 3-1: General EMI/EMC Test Configuration

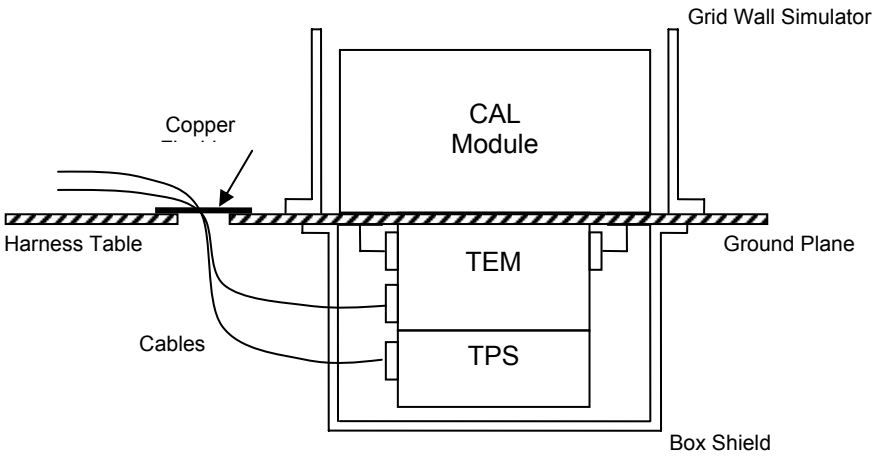

Figure 3-2: CAL Test Configuration

3.4 Interconnecting Cables

The interconnecting cables between the CAL and the STE are listed in Table 3-1.

Table 3-1. Interconnect Cable Configuration

Cable #	Description	Construction
LAT-DS-01941	GASU – TEM comm./telem	Shielded * Twisted Pairs

LAT-DS-01942	PDU – PTS power / monitors	Shielded Twisted Pairs

Each of these individual cable groups shall be separated by at least 2 cm from their outer circumference and shall all be supported 5 cm above the enclosure ground plane.

3.5 +28 Vdc Input Power Leads

During both the radiated and conducted emissions as well as the radiated and conducted susceptibility portion of the testing, the power to the CAL 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 then an adapter cable attached from the line conditioner to the CAL. The power cable to the CAL shall be routed such that two meters of input power leads shall be routed parallel to the front edge of the ground plane surface. The total length of the power cable between the line conditioner and the CAL shall be less than 2.5 meters, and shall also be supported 5 cm above the surface of the ground plane.

3.6 CAL Operation

The CAL system support engineer shall be present during all EMI testing to ensure safe start up and shut down of the Flight CAL.

3.6.1 Operating Mode for Emissions Testing

The CAL shall execute the Register Exerciser test, calf_exr_p01 as defined in LAT-MD-1502, and Charge Injection Calibration, calu_collect_ci as defined in LAT-MD-1502. To be successful, the Register Exerciser shall run to completion with no read or write errors indicated in the test report. Charge Injection shall run to completion with no block errors indicated in the Run Control status window.

3.6.2 Operating Mode for Susceptibility Testing

The CAL shall execute the Register Exerciser test, calf_exr_p01 as defined in LAT-MD-1502, and Charge Injection Calibration, calu_collect_ci as defined in LAT-MD-1502. To be successful, the Register Exerciser shall run to completion with no read or write errors indicated in the test report. Charge Injection shall run to completion with no block errors indicated in the Run Control status window.

3.7 Pass/Fail Requirements

The Pre-EMI Functional Testing will establish a nominal CAL performance baseline for operation during EMI emissions and susceptibility testing. Any abnormal performance deviations from the baseline readings observed during EMI testing is considered a failure, and must also be documented and dispositioned. The Post-EMI Functional Test performance shall be compared to the Pre-EMI Functional Test performance.

3.7.1 Telemetry Points for Flight Cal

The following telemetry shall be monitored and logged to computer disk using the LATTE test environment and display during EMI testing:

Power Supply Voltage to the TEM/TPS

Power Supply Current to the TEM/TPS

3.7.2 Pre- and Post-EMI Functional Testing of Flight CAL

Functional testing shall be performed on the Flight CAL and EM2 TEM/TPS. The Pre-EMI Functional Testing shall provide a performance baseline and establish a set of nominal system telemetry readings for pass/fail criteria during susceptibility testing. The Post-EMI Functional Testing shall be identical, i.e. no foil status, to the Pre-EMI Functional Testing and will be used to verify that the Flight CAL has not been damaged during the EMI testing. Pass/fail criteria are defined for test scripts in LAT-MD-1502. The Pre- and Post-EMI Functional Test shall be the Comprehensive Performance and Functional Test specified in LAT-PS-1370.

3.8 General Emission Testing Requirements

During emission testing, the emissions measurement equipment shall use the MIL-STD-461E bandwidths and dwell times in Table 3-2; 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 CAL test shall be measured with the specified bandwidths shown in Table 3-2 and compared against the limits required by the GLAST program. If the bandwidth or measurement time differs from Table 3-2, record the bandwidth and measurement time in the EMI log book.

Table 3-2. Emission Bandwidth and Measurement Time Limitations

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

3.9 General Susceptibility Testing Requirements

During susceptibility testing, the test signal source shall be limited to the scan rates specified in Table 3-3. Pulse modulation @ 1kHz, 50% Duty Cycle shall be used for susceptibility testing for RS03.

When the test results indicate a susceptibility condition with the CAL as defined in accordance with Section 3.7, 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 CAL 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.

Table 3-3. Susceptibility Scan Rates (MIL-STD-461E)

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

3.10 EMI/EMC Measurement System Tests

Prior to the start of each EMI test to be performed on the CAL, the measurement equipment within each set up shall be tested, calibrated, and to verified the requirements of MIL-STD-461 and as stated in Section 4.0 of this procedure.

3.11 Line Impedance Stabilization Network (LISN)

The LISN specified for use in MIL-STD-461E shall be used for all CAL EMI/EMC testing. Figure 3-3 illustrates the schematic diagram for the standard LISN.

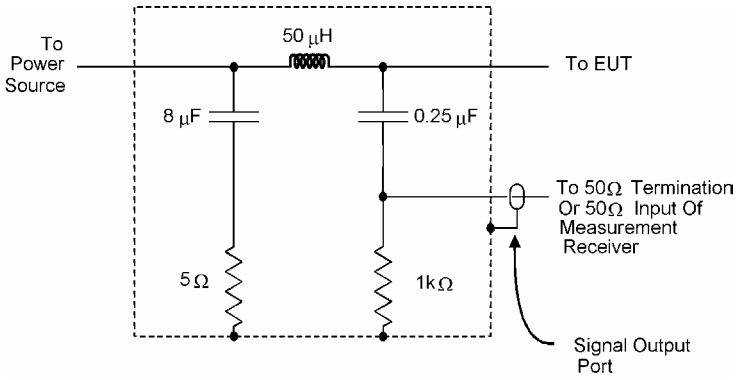

Figure 3-3: MIL-STD-461E/462D LISN Schematic

4 EMI/EMC TEST PROCEDURE

4.1 Preliminary Set-Up

The initial test set up of the CAL and the CTS shall be as illustrated in Figure 3-1 and Figure 3-2 of this procedure. Note that the CTS shall be located outside the EMI enclosure with the signal and power cables passing through the EMI enclosure access panel. Measure the resistance between the CAL and the ground plane and verify that the resistance is less than 2.5 milli-ohms. All cables shall be routed parallel to the front edge of the ground plane surface for a minimum of 2 meters. In addition, the power cable from the CAL/TEM/TPS shall be connected to the line conditioner within 2.5 meters for all EMI tests.

4.2 Pre-EMI Functional Test of Flight CAL

Conduct a Pre-EMI Functional test on the Flight CAL subsystem as specified in section 3.7.2.

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

The CE102 test is performed to verify that electromagnetic emissions from the CAL 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.

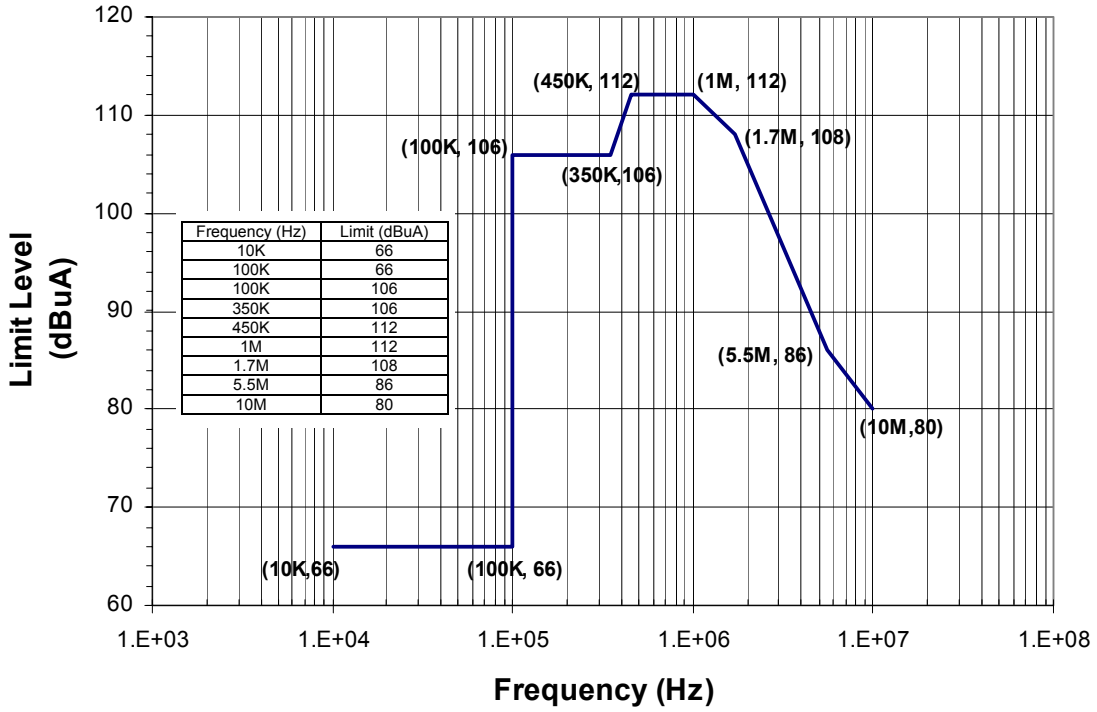

Figure 4-1: CE102 Test Limits

4.3.1 Initial Test Set-Up

Configure the test set per Figure 4-2 and conduct a pre-test calibration of the EMI test measurement system as follows:

a. Turn On power to the measurement system and allow sufficient time for equipment stabilization.

b. Apply a calibrated signal level to the terminals of dummy loads. The signal level should be 6 dB lower than the maximum allowable limits illustrated in Figure 4-1 at 10 kHz, 2 MHz and 10 MHz.

c. 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. The results of the pre-test calibration shall be recorded in the EMI test log.

4.3.2 CAL CE102 Emissions Test Procedure

a. Set up the CAL and measurement equipment per Figure 4-2. Turn On power to the CAL and configure the unit to operate in the EMI Test mode as specified in paragraph 3.6.1.

b. Connect the spectrum analyzer to the +28Vdc line. Monitor output of the current probe.

c. Set the EMI measurement equipment to scan the frequency range of 10 kHz to 10 MHz, using the bandwidths and minimum measurement times specified in Table 3-2.

d. Review the spectrum plot of the measurement equipment's scan results and verify that the resultant plot is within the limits specified in Figure 4-1. If no out-of-specification emissions are noted, record the results in the EMI test log and place a copy of the spectrum plot with the EMI test data package. If any out-of-specification emissions are observed, record the frequency and level of the out-of-specification data and initiate a Failure Report.

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

f. Repeat steps (c) and (d). If the test is successful, proceed to the next test in the EMI test sequence.

g. Turn OFF power to the CE102 measurement equipment and remove them from the test set up. If the test results show any out-of-specification emissions, initiate a Failure Report.

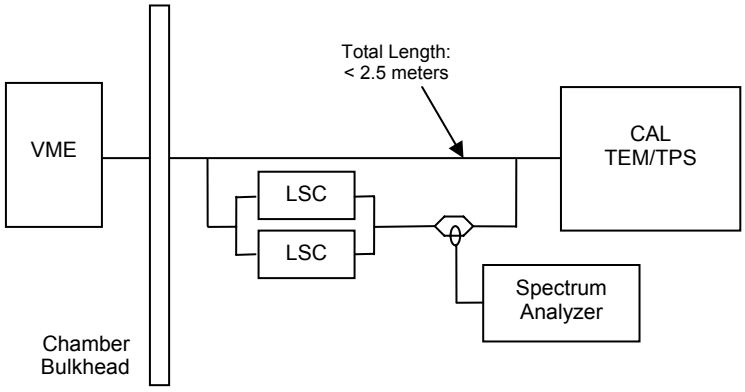

Figure 4-2: CE102 Test Set Up

4.4 Conducted Emissions, Time Domain, 150 MHz Bandwidth

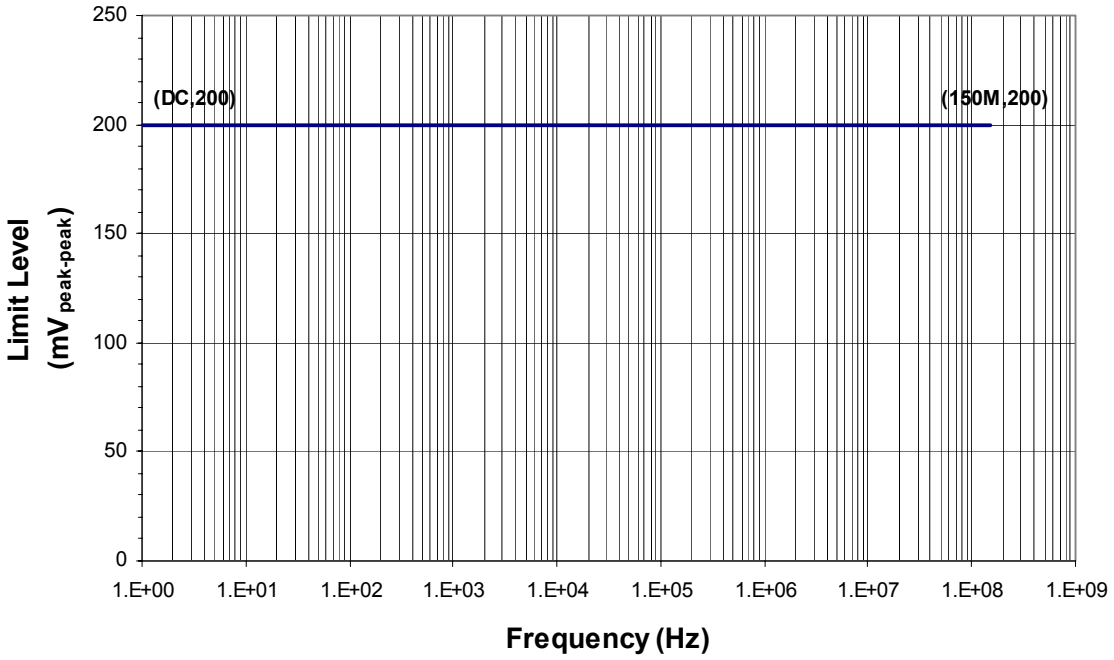

Figure 4-3: CECM Test Limits

4.4.1 CECM Conducted Emissions, Common Mode

Use dual trace oscilloscope which computes (A+B)/2, where A and B are the 28 Vdc power and return.

a. Set up the CAL and measurement equipment per Figure 4-4.

b. Turn On power to the CAL and allow sufficient warm-up time for equipment stabilization.

c. Configure the unit to operate in the EMI Test mode as specified in paragraph 3.6.1. Verify operation of the CAL and record any pertinent details.

d. Measure the time domain common mode voltage emissions from +28 Vdc line power to chassis with the oscilloscope using a 150 MHz bandwidth setting on the oscilloscope. This may take more than one time base setting. Use an oscilloscope probe that has a >150 MHz bandwidth.

e. Record the measured emissions peak-to-peak amplitude along with the limit.

f. Repeat steps (d) and (e) for all operational modes and all interfaces. If the test is successful, proceed to the next test in the EMI test sequence.

g. Turn OFF power to the CECM measurement equipment and remove them from the test set up. If the test results show any out-of-specification emissions, initiate a Failure Report.

4.4.2 CEDM Conducted Emissions, Differential Mode, 250 mV peak-to-peak

Use dual trace oscilloscope which computes (A-B), where A and B are the 28 Vdc power and return.

a. Set up the CAL and measurement equipment per Figure 4-4.

b. Turn On power to the CAL and allow sufficient warm-up time for equipment stabilization.

c. Configure the unit to operate in the EMI Test mode as specified in paragraph 3.6.1. Verify operation of the CAL and record any pertinent details.

d. Measure the time domain common mode voltage emissions from +28 Vdc line power to chassis with the oscilloscope using a 150 MHz bandwidth setting on the oscilloscope. This may take more than one time base setting. Use an oscilloscope probe that has a >150 MHz bandwidth.

e. Record the measured emissions peak-to-peak amplitude along with the limit.

f. Repeat steps (d) and (e) for all operational modes and all interfaces. If the test is successful, proceed to the next test in the EMI test sequence.

g. Turn OFF power to the CECM measurement equipment and remove them from the test set up. If the test results show any out-of-specification emissions, initiate a Failure Report.

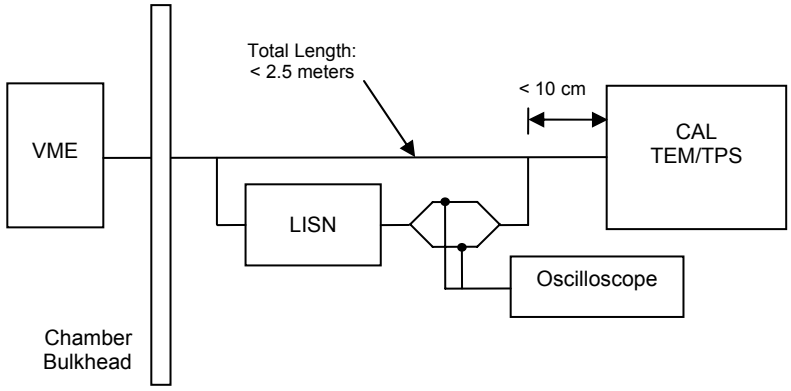

Figure 4-4: CECM, CEDM Test Set Up

4.5 CS102 Conducted Susceptibility, Power Leads, 10 kHz to 10 MHz

This test is conducted to verify the ability of the CAL to withstand signals coupled onto the unit's +28 Vdc input line. The CAL will be exercised as specified in paragraph 3.6.2 during the test. If any of the unit's operating parameters identified in paragraph 3.7 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.

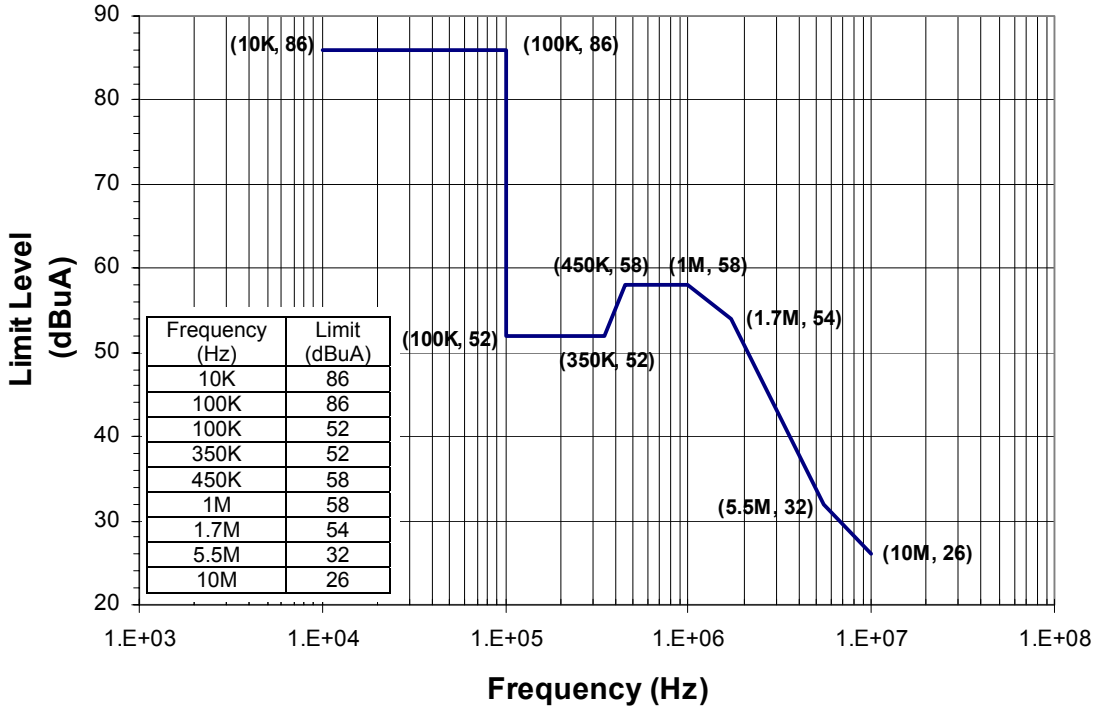

Figure 4-5: CS102 Test Limits

4.5.1 CS102, 10 kHz to 150 kHz

This test is performed per MIL-STD-461E method CS01 over the frequency range of 10 kHz to 150 kHz.

4.5.1.1 CS102 Initial Test Set Up

Set up the measurement equipment per Figure 4-6 and conduct a pre-test calibration of the test set up as follows:

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

b. Set the test signal generator to output a sine wave at 10 kHz. Increase the output level of the signal generator until the spectrum analyzer indicates the current level corresponding to the maximum required current level illustrated by the curve in Figure 4-5.

c. Record the settings of the signal source required to achieve this level.

d. Scan the entire test frequency range of 10 kHz to 150 kHz and record the signal source settings at various points in the test frequency range required to maintain the maximum levels specified in step 4.5.1.1(b).

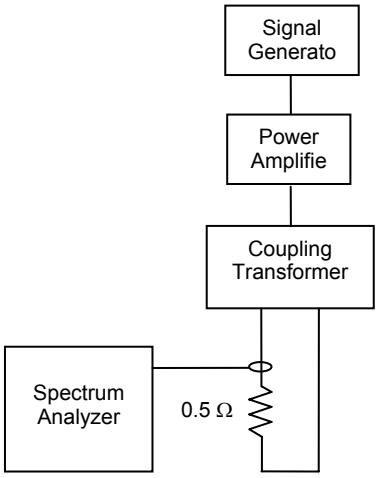

Figure 4-6: CS102 Test Equipment Calibration Set-Up for 10 kHz to 150 kHz

4.5.1.2 CAL CS102 Conducted Susceptibility Test Procedure

a. Set up the EMI test equipment and the CAL per Figure 4-7.

b. Turn On input power to the CAL and allow sufficient time for unit temperature stabilization.

c. Set up the STE to exercise the CAL as specified in paragraph 3.6.2. Verify that all data received from the CAL is within limits.

d. Set the EMI test signal generator to 10 kHz and increase its output to the setting determined in step 4.5.1.1(b). Using the spectrum analyzer connected to the unit's +28 Vdc input line, verify that the proper output level, according to the curve in Figure 4-5 has been achieved. Note: If the specified output level cannot be achieved and the signal or source settings of section 4.5.1.1 are read, the unit is considered to be not susceptible to the test signal.

e. While maintaining the proper signal levels specified by the curve in Figure 4-5, scan the test signal generator over the frequency range of 10 kHz to 150 kHz. Use the scan rates specified in Table 3-3.

f. During the test scan, monitor the data received by the STE for any out-of-specification readings. If any are noted, stop the test and determine the level and frequency at which the susceptibility occurs and record the results in the test log. If no susceptibility is noted, or the required test signal level cannot be achieved, the test is considered to be successful. Record the results in the EMI test log.

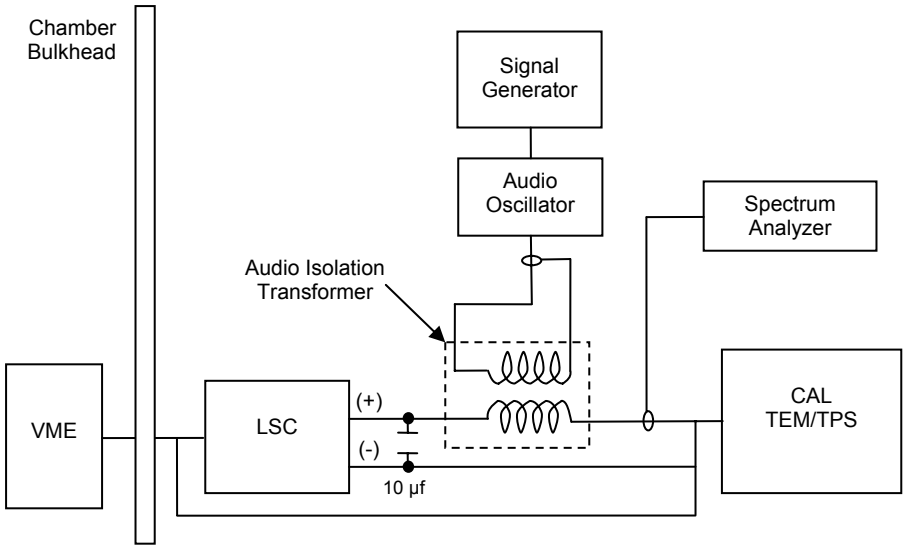

Figure 4-7: CS102 Test Set-Up for 10 kHz to 150 kHz

4.5.2 CS102, 150 kHz to 10 MHz

This test is performed per MIL-STD-462 method CS02 over the frequency range of 150 kHz to 10 MHz.

4.5.2.1 CS102 Initial Test Set Up

Set up the measurement equipment per Figure 4-8 and conduct a pre-test calibration of the test set up as follows:

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

b. Set the test signal generator to output a sine wave at 150 kHz. Increase the output level of the signal generator until the spectrum analyzer indicates the current level corresponding to the maximum required current level illustrated by the curve in Figure 4-5.

c. Record the settings of the signal source required to achieve this level.

d. Scan the entire test frequency range of 150 kHz to 10 MHz and record the signal source settings at various points in the test frequency range required to maintain the maximum levels specified in step 4.5.2.1(b).

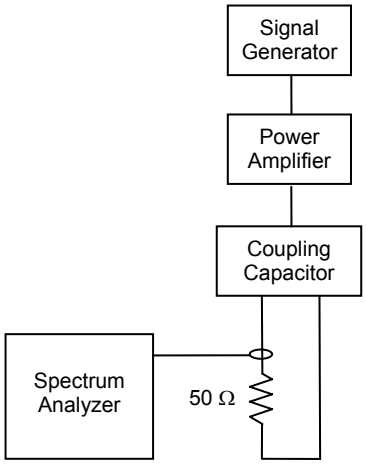

Figure 4-8: CS102 Test Equipment Calibration Set-Up for 150 kHz to 10 MHz

4.5.2.2 CAL CS102 Conducted Susceptibility Test Procedure

a. Set up the EMI test equipment and the CAL per Figure 4-9. Note: The CAL Grid Wall Simulator (Figure 3-2) may not allow the RF Generator connection to come within 5 cm of the CAL face; therefore, connect the RF Generator as close as physically possible.

b. Turn On input power to the CAL and allow sufficient time for unit temperature stabilization.

c. Set up the STE to exercise the CAL as specified in paragraph 3.6.2. Verify that all data received from the CAL is within limits.

d. Set the EMI test signal generator to 100 kHz and increase its output to the setting determined in step 4.5.2.1(b). Using the spectrum analyzer connected to the unit's +28 Vdc input line, verify that the proper output level, according to the curve in Figure 4-5 has been achieved. Note: If the specified output level cannot be achieved and the signal or source settings of section 4.5.2.1 are read, the unit is considered to be not susceptible to the test signal.

e. While maintaining the proper signal levels specified by the curve in Figure 4-5, scan the test signal generator over the frequency range of 150 kHz to 10 MHz. Use the scan rates specified in Table 3-3.

f. During the test scan, monitor the data received by the STE for any out-of-specification readings. If any are noted, stop the test and determine the level and frequency at which the susceptibility occurs and record the results in the test log. If no susceptibility is noted, or the required test signal level cannot be achieved, the test is considered to be successful. Record the results in the EMI test log.

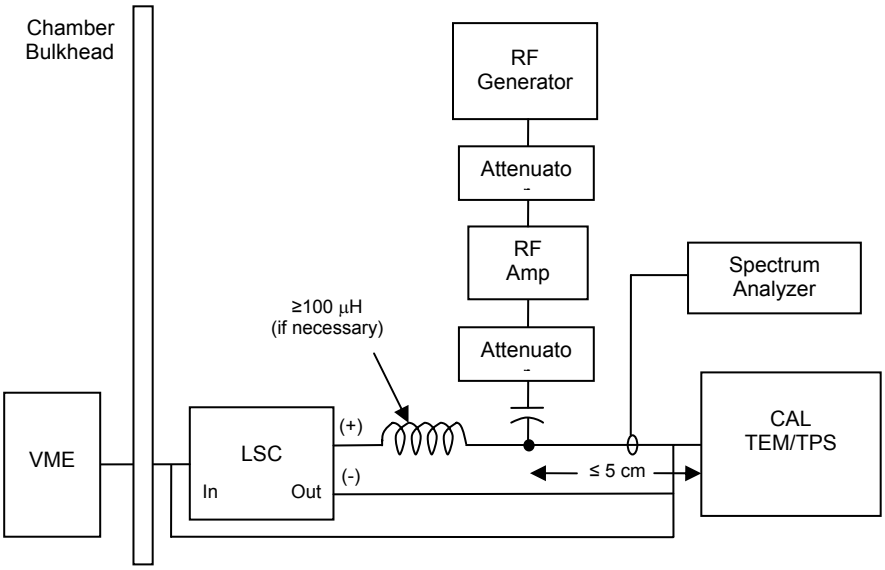

Figure 4-9: CS102 Test Set-Up for 150 kHz to 10 MHz

4.6 CSCM Conducted Susceptibility, Common Mode, 30 Hz to 150 MHz

This test is conducted to verify the ability of the CAL to withstand signals coupled onto the unit's +28 Vdc input line. The CAL will be exercised as specified in paragraph 3.6.2 during the test. If any of the unit's operating parameters identified in paragraph 3.7 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 30 Hz to 150 MHz. This test is performed per MIL-STD-462 method CS01/CS02.

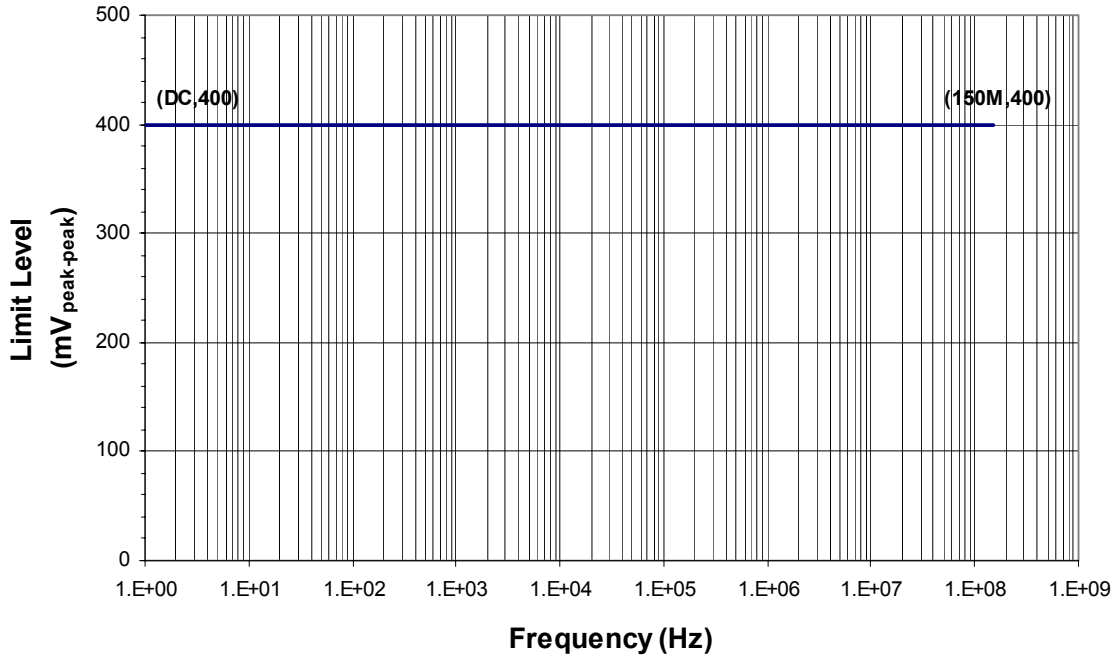

Figure 4-10: CSCM Test Limits

4.6.1 CSCM, 30 Hz to 150 kHz

This test is performed over the frequency range of 30 Hz to 150 kHz.

4.6.1.1 CSCM Initial Test Set Up

Set up the measurement equipment per Figure 4-11 and conduct a pre-test calibration of the test set up as follows:

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

b. Set the test signal generator to output a sine wave at 30 Hz. Increase the output level of the signal generator until the oscilloscope indicates the voltage level corresponding to 17.9 V peak-to-peak, a source that can dissipate 80 Watts into a 0.5-Ohm impedance. Verify that the output waveform is sinusoidal.

c. Record the settings of the signal source required to achieve this level.

d. Scan the entire test frequency range of 30 Hz to 150 kHz and record the signal source settings at various points in the test frequency range required to maintain the maximum levels specified in step 4.6.1.1(b).

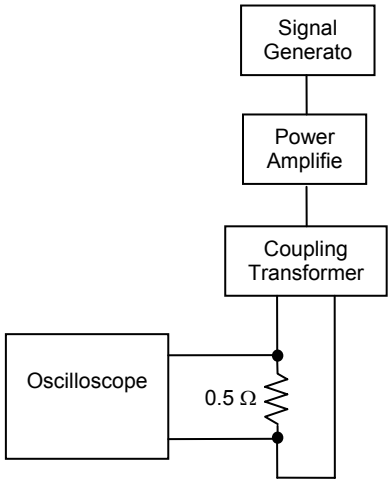

Figure 4-11: CSCM Test Equipment Calibration Set-Up for 30 Hz to 150 kHz

4.6.1.2 CAL CSCM Conducted Susceptibility Test Procedure

a. Set up the EMI test equipment and the CAL per Figure 4-12.

b. Turn On input power to the CAL and allow sufficient time for unit temperature stabilization.

c. Set up the STE to exercise the CAL as specified in paragraph 3.6.2. Verify that all data received from the CAL is within limits.

d. Using the oscilloscope connected to the unit's +28 Vdc input line to monitor the impedance voltage level, set the EMI test signal generator to 30 Hz and increase its output until the voltage level of the curve in Figure 4-10 has been achieved. Note: If the specified output level cannot be achieved and the signal source power setting (80 Watts into 0.5 Ohm) is reached, the unit is considered to be not susceptible to the test signal.

e. While maintaining the proper signal levels specified by the curve in Figure 4-10 and not exceeding the 80 Watts into 0.5 Ohm setting, scan the test signal generator over the frequency range of 30 Hz to 150 kHz. Use the scan rates specified in Table 3-3.

f. During the test scan, monitor the data received by the STE for any out-of-specification readings. If any are noted, stop the test and determine the level and frequency at which the susceptibility occurs and record the results in the test log. If no susceptibility is noted, or the required test signal level cannot be achieved, the test is considered to be successful. Record the results in the EMI test log.

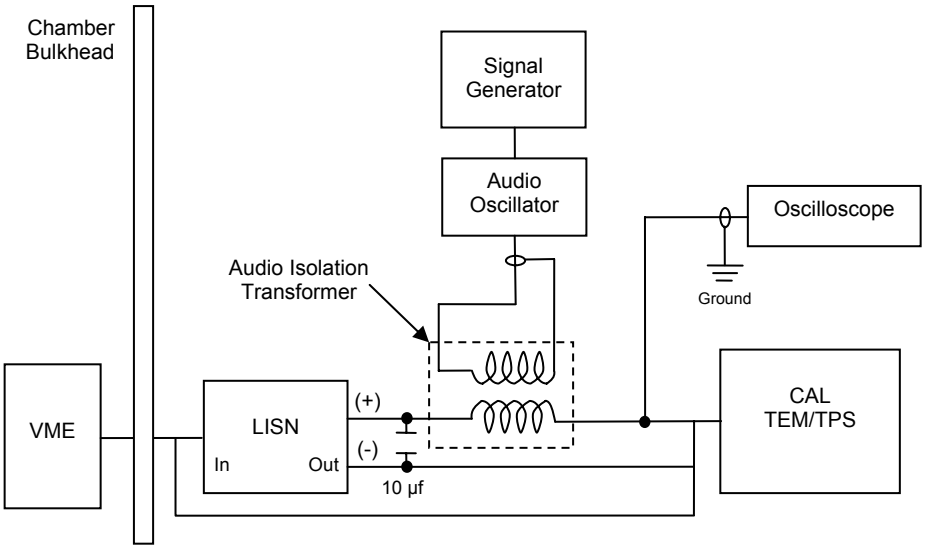

Figure 4-12: CSCM Test Set-Up – 30 Hz to 150 kHz

4.6.2 CSCM, 150 kHz to 150 MHz

This test is performed over the frequency range of 150 kHz to 150 MHz.

4.6.2.1 CSCM Initial Test Set Up

Set up the measurement equipment per Figure 4-13 and conduct a pre-test calibration of the test set up as follows:

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

b. Set the test signal generator to output a sine wave at 150 kHz. Increase the output level of the signal generator until the oscilloscope indicates the voltage level of 20 V peak-to-peak, a source that can dissipate 1 Watt into a 50-Ohm impedance. Verify that the output waveform is sinusoidal.

c. Record the settings of the signal source required to achieve this level.

d. Scan the entire test frequency range of 150 kHz to 150 MHz and record the signal source settings at various points in the test frequency range required to maintain the maximum levels specified in step 4.6.2.1(b).

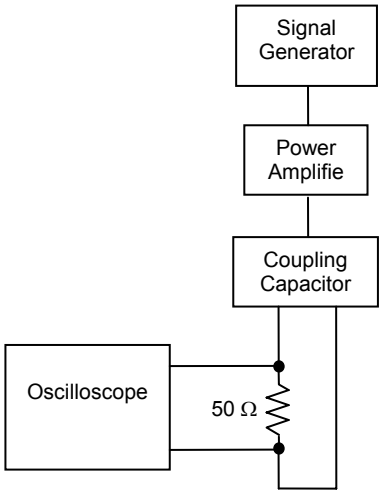

Figure 4-13: CSCM Test Equipment Calibration Set-Up – 150 kHz to 150 MHz

4.6.2.2 CAL CSCM Conducted Susceptibility Test Procedure

a. Set up the EMI test equipment and the CAL per Figure 4-14. Note: The CAL Grid Wall Simulator (Figure 3-2) may not allow the RF Generator connection to come within 5 cm of the CAL face; therefore, connect the RF Generator as close as physically possible.

b. Turn On input power to the CAL and allow sufficient time for unit temperature stabilization.

c. Set up the STE to exercise the CAL as specified in paragraph 3.6.2. Verify that all data received from the CAL is within limits.

d. Using the oscilloscope connected to the unit's +28 Vdc input line to monitor the impedance voltage level, set the EMI test signal generator to 150 Hz and increase its output until the voltage level of the curve in Figure 4-10 has been achieved. Note: If the specified output level cannot be achieved and the signal source power setting (1 Watt into 50 Ohms) is reached, the unit is considered to be not susceptible to the test signal.

e. While maintaining the proper signal levels specified by the curve in Figure 4-10 and not exceeding the 1 Watt into 50 Ohms setting, scan the test signal generator over the frequency range of 150 kHz to 150 MHz. Use the scan rates specified in Table 3-3.

f. During the test scan, monitor the data received by the STE for any out-of-specification readings. If any are noted, stop the test and determine the level and frequency at which the susceptibility occurs and record the results in the test log. If no susceptibility is noted, or the required test signal level cannot be achieved, the test is considered to be successful. Record the results in the EMI test log.

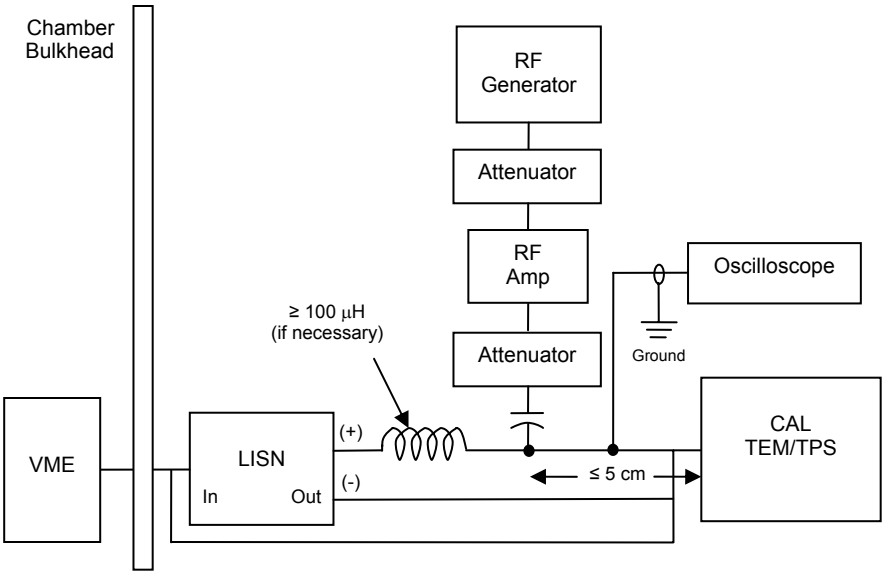

Figure 4-14: CSCM Test Set-Up – 150 kHz to 150 MHz

4.7 CS06 Conducted Susceptibility, Spike, Power Leads

This test is conducted to determine the equipment susceptibility to spike interference on power lines. This test is performed on all ungrounded DC input power leads of Class 1 equipment (see MIL-STD-461).

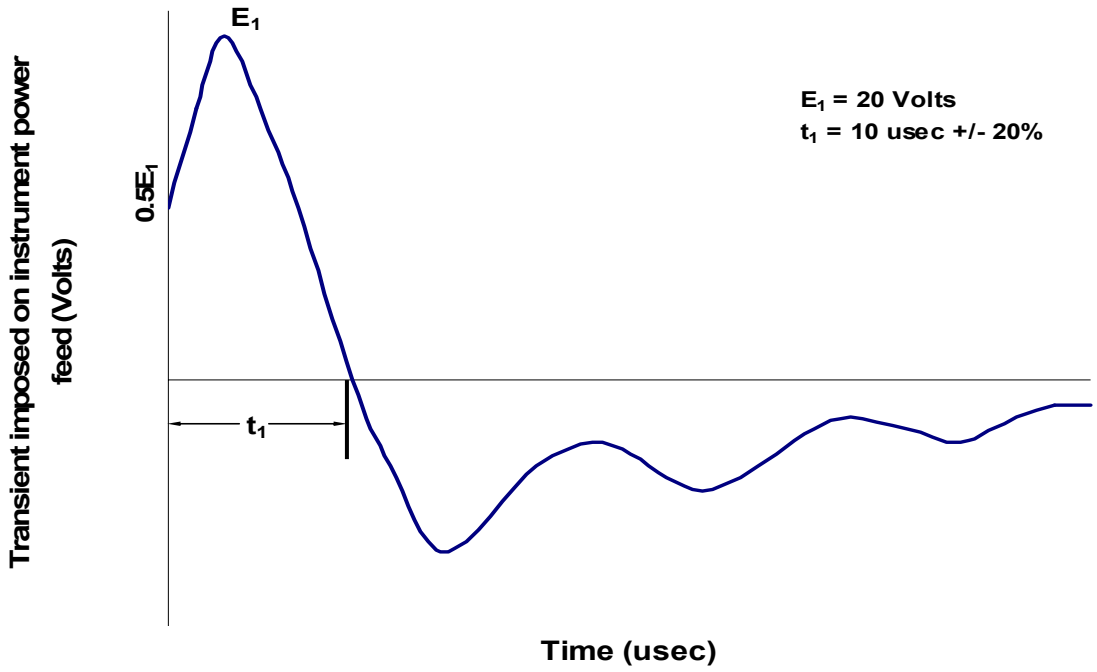

Figure 4-15: CS06 Test Limits

4.7.1 CS06 Initial Test Set-Up

Set up the measurement equipment per Figure 4-16 and conduct a pre-test calibration of the test set-up as follows:

a. Turn On the EMI measurement equipment and allow sufficient warm-up time for equipment stabilization.

b. Set up the spike generator to exercise the CAL as specified in paragraph 3.6.2. Increase the output level of the spike generator until the oscilloscope indicates 10 Volts.

c. Record the settings of the signal source required to achieve this level.

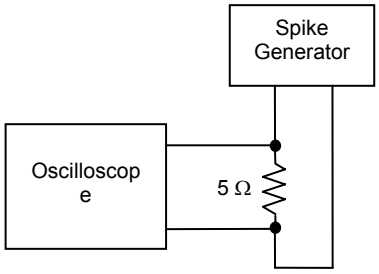

Figure 4-16: CS06 Test Equipment Calibration Set-Up

4.7.2 CAL CS06 Conducted Susceptibility Test Procedure

a. Set up the CAL, STE, and EMI test equipment per Figure 4-17. Turn On power to the CAL and allow sufficient time for the unit to warm up. Note: The CAL Grid Wall Simulator (Figure 3-2) may not allow the Spike Generator connection to come within 5 cm of the CAL face; therefore, connect the Spike Generator as close as physically possible.

b. The applied spike amplitude, rise time, and duration, as measured by the oscilloscope across the input terminals of the test sample, shall follow the curve specified in Figure 4-15.

c. Positive and negative, single and repetitive (10 p.p.s.) spikes shall be applied to the test sample's ungrounded input lines for a period of at least 5 minutes, not to exceed 30 minutes in duration.

d. If susceptibility occurs, determine and record its threshold level, repetition rate, phase position on the DC waveform, and time occurrence on digital gates.

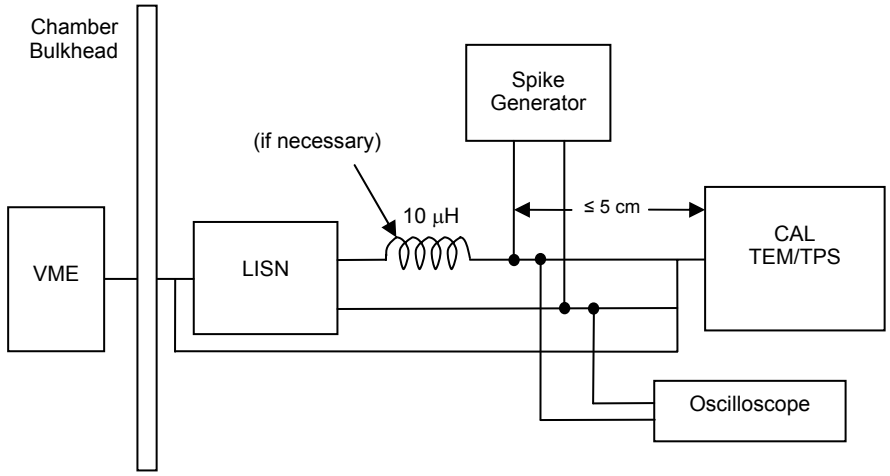

Figure 4-17: CS06 Test Set-Up

4.8 RE101 Radiated Emissions, Magnetic Field, 20 Hz to 50 kHz

This test is used to verify that magnetic field emissions from the CAL and its associated electrical interfaces do not exceed the limits illustrated in Figure 4-18 at a distance of 1 meter. This requirement is applicable for radiated emissions from equipment and subsystem enclosures, including electrical cable interfaces.

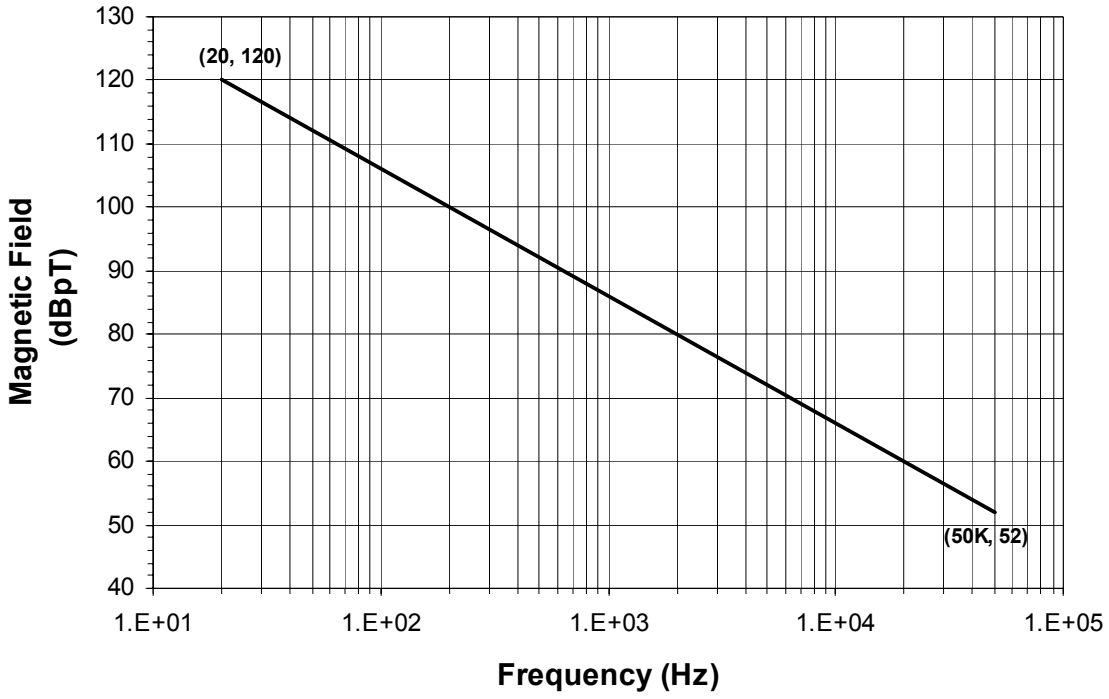

Figure 4-18: RE101 Test Limits

4.8.1 RE101 Initial Test Set-Up

a. Set up the CAL, STE, and EMI test equipment per Figure 4-19. Turn On power to the CAL and allow sufficient time for the unit to warm up.

b. Apply the calibrated signal level, at least 6 dB below the limit shown in Figure 4-18 at a frequency of 50 kHz. Tune the measurement receiver to a center frequency of 50 kHz. Record the measured level.

c. Verify that the measurement receiver indicates a level within ±3 dB of the injected signal level.

d. If readings are obtained which deviate by more than ±3 dB, locate the source of the error and correct the deficiency prior to proceeding with the testing.

e. Using an ohmmeter, verify that the resistance of the loop sensor winding is approximately 10 Ohms.

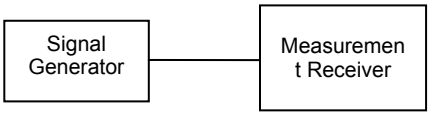

Figure 4-19: RE101 Test Equipment Calibration Set-Up

4.8.2 CAL RE101 Radiated Emissions Test Procedure

a. Set up the CAL, STE, and EMI test equipment per Figure 4-20. Turn On power to the CAL and allow sufficient time for the unit to warm up.

b. Locate the loop sensor 1 meter from the CAL face or electrical interface connector being probed. Orient the plane of the loop sensor parallel to the CAL faces.

c. Scan the measurement receiver over the frequency range of 20 Hz to 50 kHz to locate the frequencies of maximum radiation, using the bandwidths and minimum measurement times of Table 3-2.

d. Tune the measurement receiver to one of the frequencies or band of frequencies identified in 4.8.2, c.

e. Monitor the output of the measurement receiver while moving the loop sensor (maintaining the 1 meter spacing) over the face of the CAL. Note the point of maximum radiation for each frequency identified in 4.8.2, d.

f. At 1 meter from the point of maximum radiation, orient the plane of the loop sensor to give a maximum reading on the measurement receiver and record the reading.

g. Repeat steps (b) through (f) for each face of the CAL and for the electrical connectors.

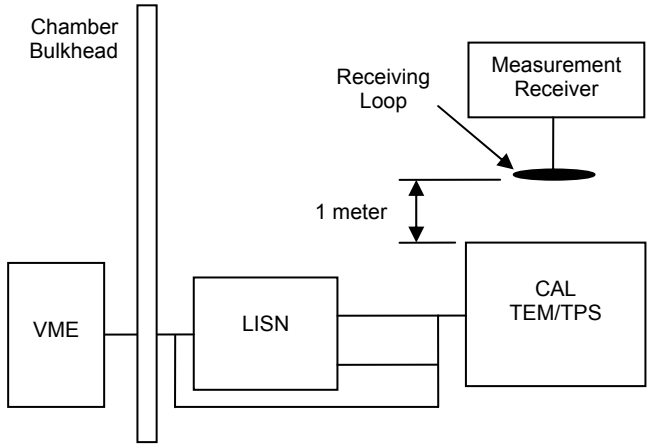

Figure 4-20: RE101 Test Set-Up

4.9 RE102 Radiated Emissions, Electric Field, 10 kHz to 18 GHz

This test is used to verify that electric field emissions from the CAL and its associated cabling do not exceed the limits illustrated in Figure 4-21.

4.9.1 RE102 General Requirements

The general requirements for positioning of antennas specified in paragraph 3, c, (2) of MIL-STD-461E shall be used to conduct the RE102 test.

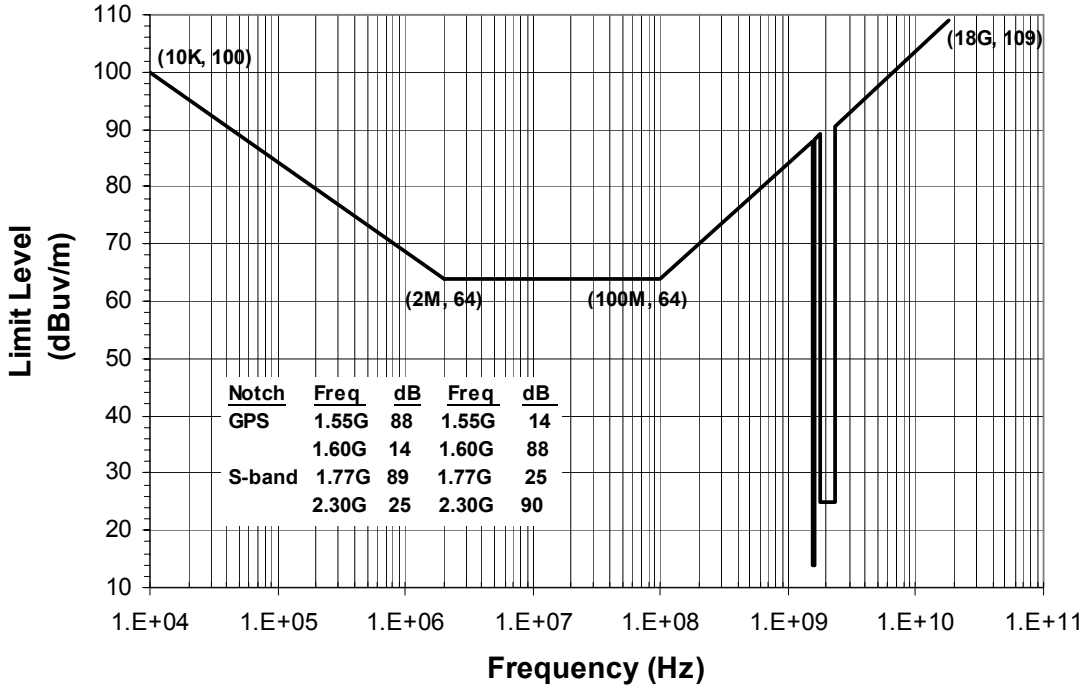

Figure 4-21: RE102 Test Limits

4.9.2 RE102 Test Set Ambient Sweep

a. Set up the CAL, STE and EMI test equipment as illustrated in Figure 4-22.

b. Turn On power to the EMI test equipment and allow sufficient time for proper equipment stabilization.

c. With the CAL powered Off, conduct an ambient sweep of the EMI chamber over the frequency range of 10 kHz to 18 GHz. Note: various antennas will be used to perform this test. A full set of antenna correction factors should be provided by the EMI test facility and maintained with the test data package. Any emissions detected during the ambient sweep should be at least 6 dB below the maximum allowable limits illustrated in Figure 4-21.

4.9.3 RE102 Initial Test Set Up

a. Turn On power to the System path check-up signal generator and allow sufficient time for proper equipment warm up.

b. Perform the following evaluation of the overall measurement system from each antenna to the signal generator output at the highest measurement frequency of the antennas.

c. Apply a calibrated signal level, which is 6 dB below the maximum allowable limits shown in Figure 4-21 (minus antenna correction factor) to the coaxial cable at the antenna connection point.

d. Scan the spectrum analyzer over the frequency range of the antenna and verify that the spectrum analyzer indicates a level within +/- 3 dB of the injected signal. If readings are obtained that show levels more than +/- 3dB, determine the source and correct the problem before proceeding with the RE102 test.

e. Record the results of the ambient sweep and the calibration test in the test log.

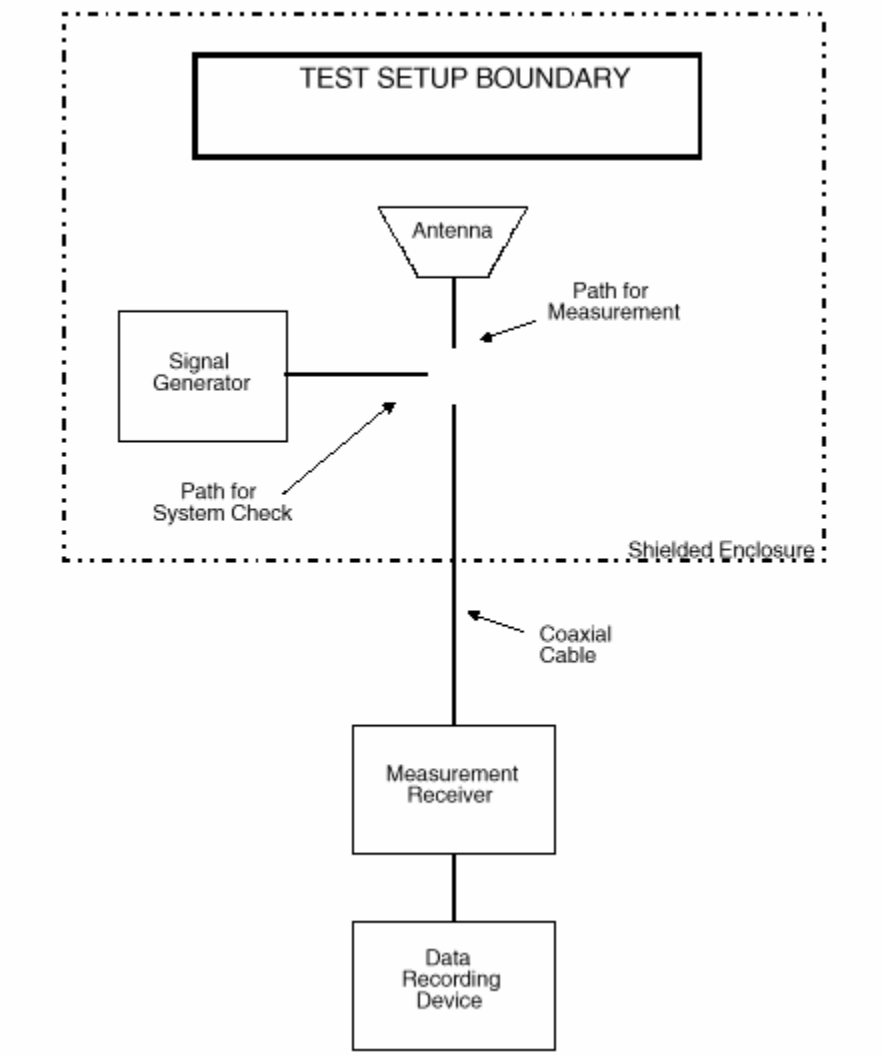

Figure 4-22: RE102 Test Set-Up

4.9.4 CAL RE102 Radiated Emissions Test Procedure

a. Turn On power to the CAL, STE and the EMI test equipment and allow sufficient time for equipment warm up and stabilization.

b. Ensure the signal generator used in step 4.9.3 is powered Off. Secure all chamber doors.

c. Set up the CAL to operate as required by paragraph 3.6.1.

d. Scan the frequency range of 10 kHz to 18 GHz using the Spectrum Analyzer. The frequency ranges and maximum allowable limits for the notches illustrated in Figure 4-21 are as shown in Table 4-1 below.

Table 4-1. RE102 Notch Frequencies

Notch	Freq (Hz)	Limit Level (dBuv/m)	Freq (Hz)	Limit Level (dBuv/m)
GPS	1.55G	32	1.55G	14
	1.60G	14	1.60G	32.2
S-band	1.77G	33.2	1.77G	25
	2.30G	25	2.30G	34.5

e. Due to the lower RE02 limit, smaller test bandwidths may be necessary to reduce the system thermal noise below the tailored RE02 limit. Indicate which bandwidths were used that did not comply with Table 3-2. NOTE: Above 30 MHz, orient the test antennas both horizontally as well as vertically polarized fields. Obtain spectrum analyzer plots for all antennas in both polarization positions over the full range of 10 kHz to 18 GHz.

f. Review the test results and verify that no measurements exceed the limits illustrated in Figure 4-21 and Table 4-1. If any measurements are out-of-specification, initiate an evaluation of the setup to determine the source of the emissions. Record the results of the RE102 test in the EMI test log. Obtain copies of test plots derived from the spectrum analyzer scans.

4.10 RS101 Radiated Susceptibility, Magnetic Field, 20 Hz to 50 kHz

This test is used to verify that the CAL and its associated subsystem enclosures, including electrical cable interfaces, are able to withstand radiated magnetic fields. The CAL shall not exhibit any malfunction, degradation or performance, or deviation from specified indications, beyond the test limits shown in Figure 4-23 when subjected to the magnetic fields. The general requirements specified in section 3 should be followed throughout this test.

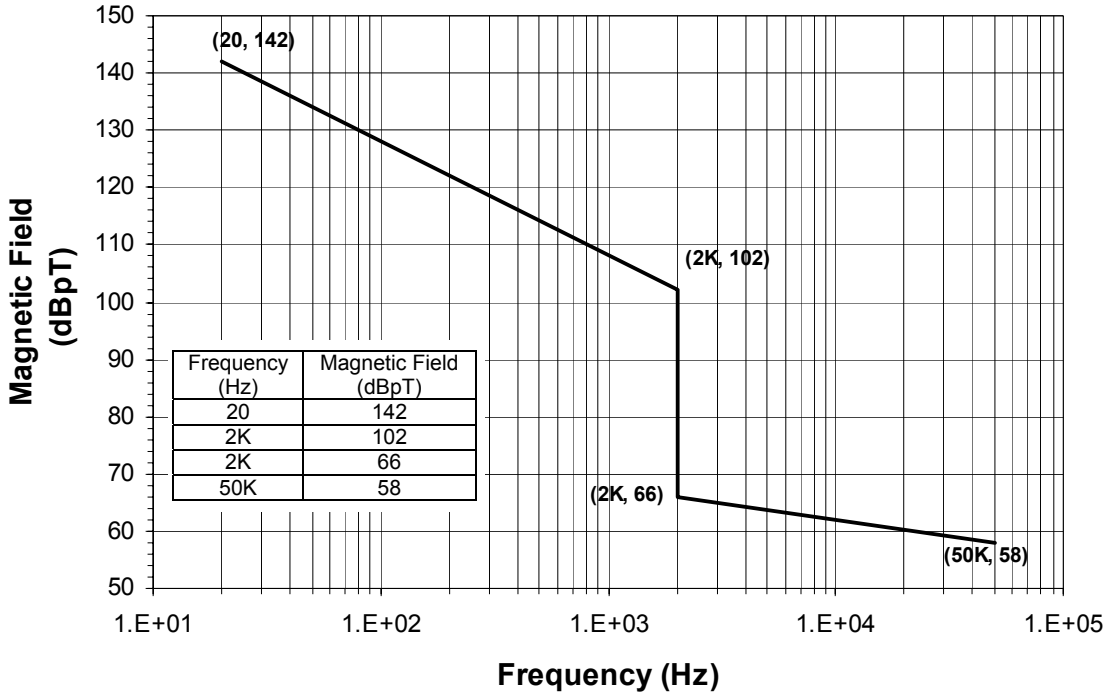

Figure 4-23: RS101 Test Limits

4.10.1 RS101 Initial Test Set Up

a. Set up the CAL, STE, and EMI test equipment per Figure 4-24. Turn On power to the CAL and allow sufficient time for the unit to warm up.

b. Set the signal source to a frequency of 1 kHz and adjust the output to provide a magnetic flux density of 110 dB above 1 picoTesla as determined by measurement receiver A and the relationship given in Figure 4-23.

c. Measure the voltage output from the loop sensor using Measurement Receiver B.

d. Verify that the output on Measurement Receiver B is within ±3 dB of the expected value based on the antenna factor and record this value.

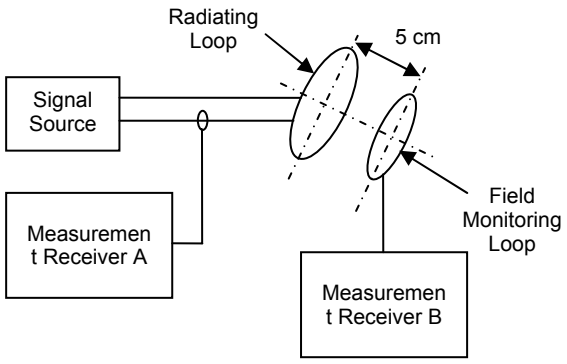

Figure 4-24: RS101 Test Equipment Calibration Set-Up

4.10.2 CAL RS101 Radiated Susceptibility Test Procedure

a. Set up the CAL, STE, and EMI test equipment per Figure 4-25. Turn On power to the EMI test equipment and allow sufficient time for equipment warm up and stabilization.

b. Locate the loop sensor 5 cm from the CAL face or electrical interface connector being probed. Orient the plane of the loop sensor parallel to the CAL faces and parallel to the axis of connectors.

c. Supply the loop with sufficient current to produce magnetic field strengths at least 10 dB greater than the limit in Figure 4-23 but not to exceed 15 amps (183 dBpT).

d. Scan the frequency range of 20 Hz to 50 kHz. Scan rates up to 3 times faster than the rates specified in Figure 4-23 are acceptable.

e. If susceptibility is noted, select no less than three test frequencies per octave at those frequencies where the maximum indications of susceptibility are present.

f. Reposition the loop successively to a location in each 10 cm by 10 cm area on each face of the CAL and at each electrical interface connector, and repeat steps (d) and (e) to determine locations and frequencies of susceptibility.

g. From the total frequency data where susceptibility was noted in steps (d) through (f), select three frequencies per octave over the frequency range of 20 Hz to 50 kHz.

h. At each frequency determined in step (g), if any, apply a current to the radiating loop that corresponds to the applicable limit. Move the loop to search for the locations determined in step (f) while maintaining the loop 5 cm from the CAL surface or connector. Verify that susceptibility is not present.

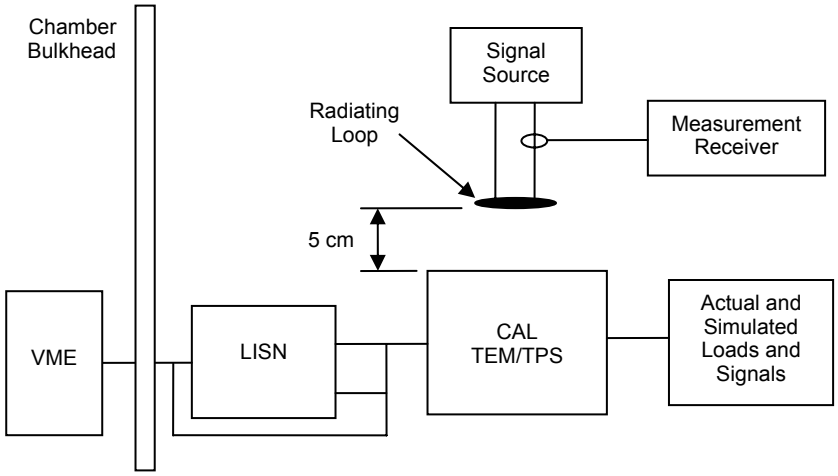

Figure 4-25: RS101 Test Set-Up

4.11 RS103 Radiated Susceptibility, Electric Field, 30 MHz to 18 GHz

This test is used to verify that the CAL and its associated cabling are able to withstand the electric fields.

4.11.1 RS103 General Requirements

The general requirements specified in section 3 should be followed throughout this test.

4.11.2 RS103 Initial Test Set Up

The test set up for the RS103 is shown in Figure 4-26.

a. Turn On power to the EMI test equipment and allow sufficient time for equipment warm up and stabilization.

b. Calibration of Electric field sensor method. Record the amplitude shown on the electric field sensor display unit due to CAL ambient. Reposition the sensor, as necessary, until this level is < 10% of the applicable field strength to be used for testing.

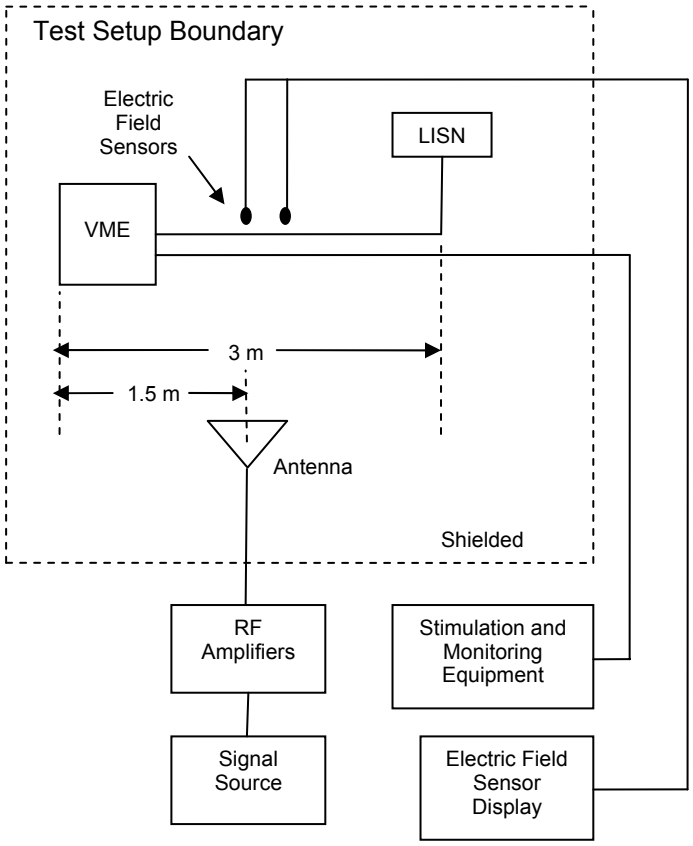

Figure 4-26: RS103 Test Set-Up

4.11.3 CAL RS103 Radiated Susceptibility Test Procedure

a. Turn ON power to CAL and set it up to operate as specified in paragraph 3.6.2. Verify that the STE readings show no out-of-tolerance measurements.

b. Set the transmit antenna signal source to 1 kHz pulse modulation, 50 % duty cycle. Using the appropriate amplifiers and antennas establish an electric field at the test start frequency of 30 MHz. Gradually increase the transmit power level until the electric field sensors indicate the required levels of Figure 4-27.

c. Scan the frequency range of 30 MHz to 18 GHz with an electric field shown in Figure 4-27 while continuously monitoring the CAL performance for any degradation or out-of-tolerance data measurements. If any susceptibility is observed, determine the level and frequency range of the susceptibility and record the results in the test log. Above 30 MHz, both vertically and horizontally polarized antennas will be used to conduct the test. Continue the test until the entire test frequency range has been scanned. Record the results of the RS103 test, including any susceptibility levels and frequency ranges in the EMI test report.

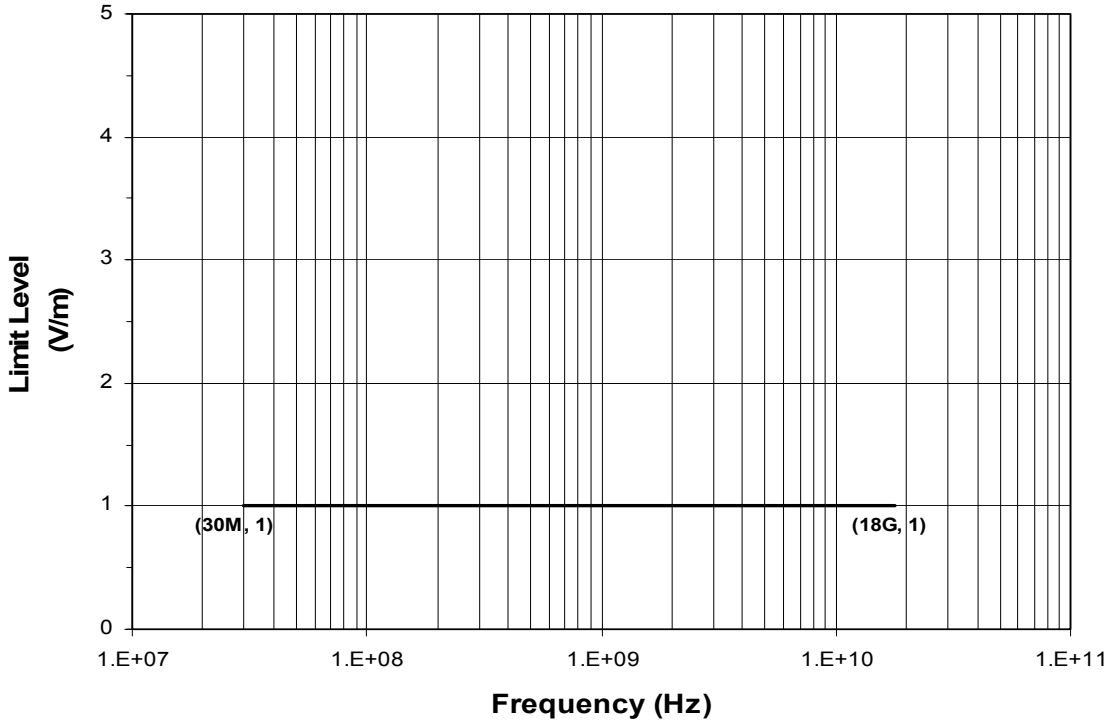

Figure 4-27: RS103 Test Limits

4.12 Static Magnetic Field

The CAL subsystem's performance in the presence of static magnetic fields of strength 2 Gauss or less is verified by the following analysis.

1. The CAL subsystem is manufactured from non-magnetic materials.

2. The CAL electronics contain no magnetic materials.

3. The CAL detectors and associated photodiodes do not use electromagnetic focusing.

Consequently, the CAL subsystem is insensitive to static magnetic fields of strength 2 Gauss or less. This has been verified in performance testing of the Engineering Model CAL module at various orientations in the earth's magnetic field.

4.13 Post EMI/EMC Performance Test

After successfully completing the EMI/EMC test, conduct a post-EMI functional test of the flight CAL subsystem as specified in section 3.7.2. Record the results in the EMI test log. When complete, turn off all power to the CAL and the STE and disconnect all test cables from the CAL subsystem.