

EML-0069-REF  
Rev. Basic  
May 02, 2014

**EMC TEST REPORT**

**ELECTRODYNAMIC DUST SHIELD**

**ENGINEERING SERVICE CENTER ELECTROMAGNETIC LABORATORY**  
**Kennedy Space Center, FL 32815-0233**

**JOHN F. KENNEDY SPACE CENTER, NASA**

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# **EMC TEST REPORT**

## **ELECTRODYNAMIC DUST SHIELD**

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## Revision History

<b>Revision</b>	<b>Date</b>	<b>Author(s)</b>	<b>Changes</b>
Basic	May 2, 2014	Lynne M. Carmody	Document Release

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## **Abstract**

This report documents the Electromagnetic Interference EMI evaluation performed on the Electrodynamic Dust Shield (EDS) which is part of the MISSE-X System under the Electrostatics and Surface Physics Laboratory at Kennedy Space Center.

Measurements are performed to document the emissions environment associated with the EDS units.



## 1 Introduction

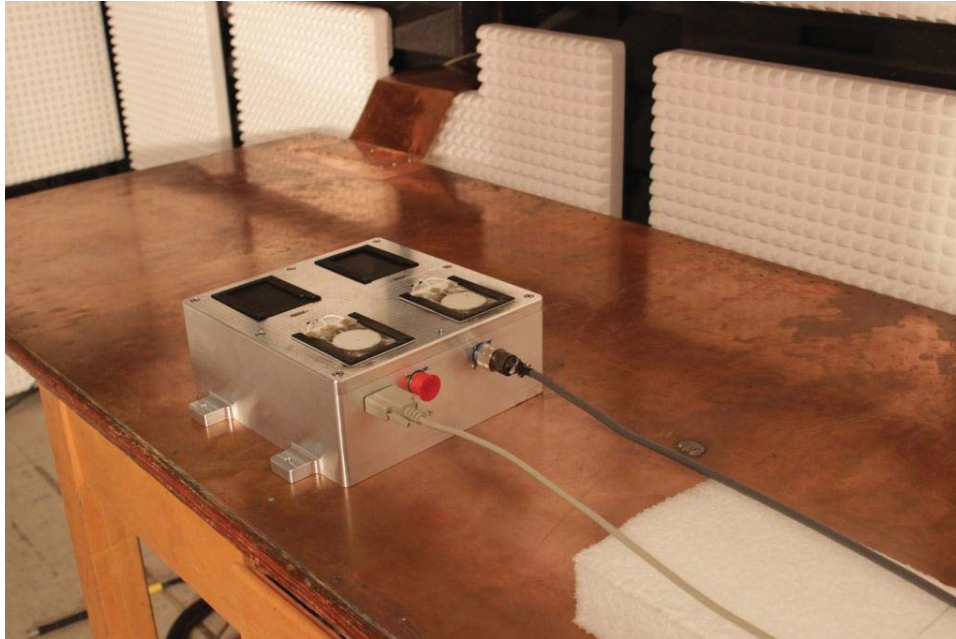
The following tests methods (See Table 1) were requested for the Electrodynamic Dust Shield Unit 1 (DC power supply). A radiated emissions evaluation was also performed on Unit 2 (AC power supply). The testing was performed using the test methods in SSP 30238.

**Table 1: Electrodynamic Dust Shield EMI Requirements**

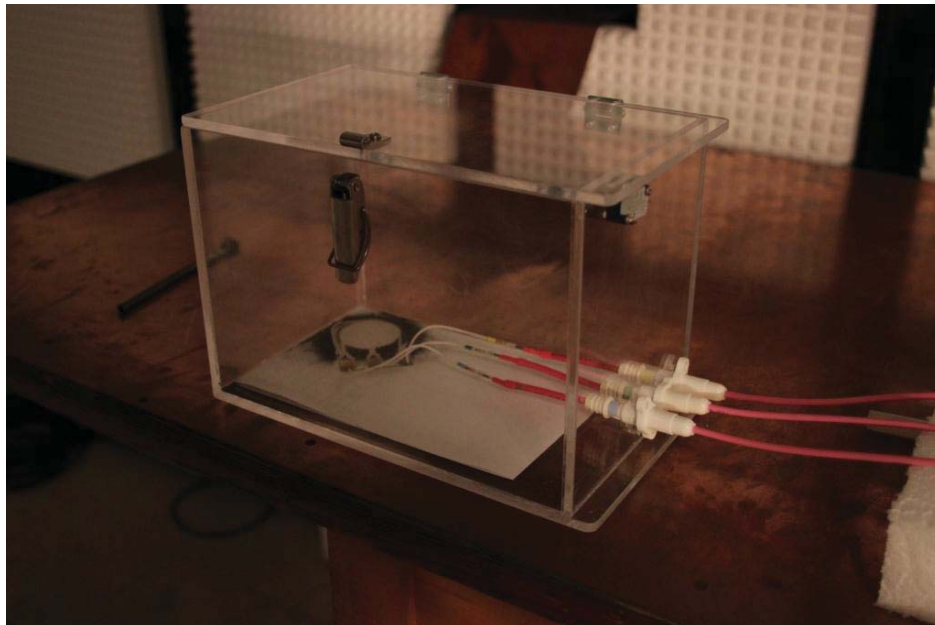
Test Method	Test Description	Frequency Range
CE01	Conducted Emissions, Power Leads	30 Hz to 15 kHz
CE03	Conducted Emissions, Power Leads	15 kHz to 50 MHz
CE07	Conducted Emissions, Spikes, DC Power Leads	N/A
RE02*	Radiated Emissions, Electric Field, Air Force Limit Specified	14 kHz to 18 GHz

\*Note: This test method was performed on both EDS units 1 and 2.

The general test setup for the Electrodynamic Dust Shield units is shown in Figures 1-1 and 1-2. The EDS units were connected to the 10  $\mu$ F capacitors using the customer supplied cables.



**Figure 1-1: Electrodynamic Dust Shield DC Unit (Unit 1) Test Setup**



**Figure 1-2: Electrodynamic Dust Shield AC Unit (Unit 2) Test Setup**

## **2 Purpose**

The purpose of this report is to collect all information needed to reproduce the testing performed on the Electrodynamic Dust Shield units, document data gathered during testing, and present the results.

## **3 Scope**

This document presents information unique to the measurements performed on the Bioculture Express Rack payload; using test methods prepared to meet SSP 30238 requirements. It includes the information necessary to satisfy the needs of the customer per work order number 1037104. The information presented herein should only be used to meet the requirements for which it was prepared.

## **4 Test Method**

Current test requirements are detailed in the SSP 30237 and test methods are specified in SSP 30238 (that meets the requirements of MIL-STD-461).

## **5 Results**

### **5.1 Testing Results**

The results of the EMI evaluation contained within this report were obtained over 21 April 2014 through 28 April 2014. Detailed results are presented in Appendix A through Appendix D.

## 6 References

- [1] *SSP 52000-IDD-ERP, International Space Station Program Expedite the Processing of Experiments to Space Station (EXPRESS) Rack Payloads Interface Definition Document, National Aeronautics and Space Administration, Johnson Space Center, TX, July 2013.*
- [2] *SSP 30237, Space Station Electromagnetic Emission and Susceptibility Requirements, National Aeronautics and Space Administration, Johnson Space Center, TX, February 2010.*
- [3] *SSP 30238, Space Station Electromagnetic Techniques, National Aeronautics and Space Administration, Johnson Space Center, TX, July 2002.*
- [4] *SSP 30243, Space Station Requirements for Electromagnetic Compatibility, National Aeronautics and Space Administration, Johnson Space Center, TX, July 2002.*
- [5] *MIL-STD-461C, Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference, Dept of Defense, Washington, DC, August 1986.*

## A CE01 Conducted Emissions, Power Leads

### A.1 CE01 Equipment

**Table A.1: CE01 Equipment List**

Nomenclature	Manufacturer	Model Number	Serial Number	Calibration Due
TDK Emissions Lab Software	TDK	VER. 6.97	NA	NA
Spectrum Analyzer	Agilent	E4446A	SG48250010	29JAN15
RF Pre-selector	Agilent	N9039A	SG46520005	05DEC14
Signal Generator (calibration only)	Agilent	N5181A	SG49060002	05DEC14
10 $\mu$ F capacitor	Solar	7314-106R	0650-30	NCR
10 $\mu$ F capacitor	Solar	7314-106R	0650-32	NCR
Oscilloscope	Tektronix	TDS5104B	B010671	14MAY14
Current Probe	Ailtech	91550-1L	119	NA
Power Supply	Lambda	LK351-FM	090921	NA
50 ohm Load	HP	909A	NA	09NOV15
Multimeter	Fluke	77	C46493	09MAY14
Clamp Meter	Fluke	337	82403235	14JUN14
RF Cable	Saxton	RG58	CE01,03	NA
20 dB Attenuator	HP	8491A	3541	NCR

Note: The equipment is also catalogued in the Maximo System.

## **A.2 Applicability**

The test method for CE01 shall be applicable for measuring narrowband conducted emissions in the frequency range between 30Hz and 15kHz on the following types of leads: dc leads which obtain power from, or provide power to other equipment, distribution panels or subsystems.

### A.3 CE01 Data

#### A.3.1 Calibration

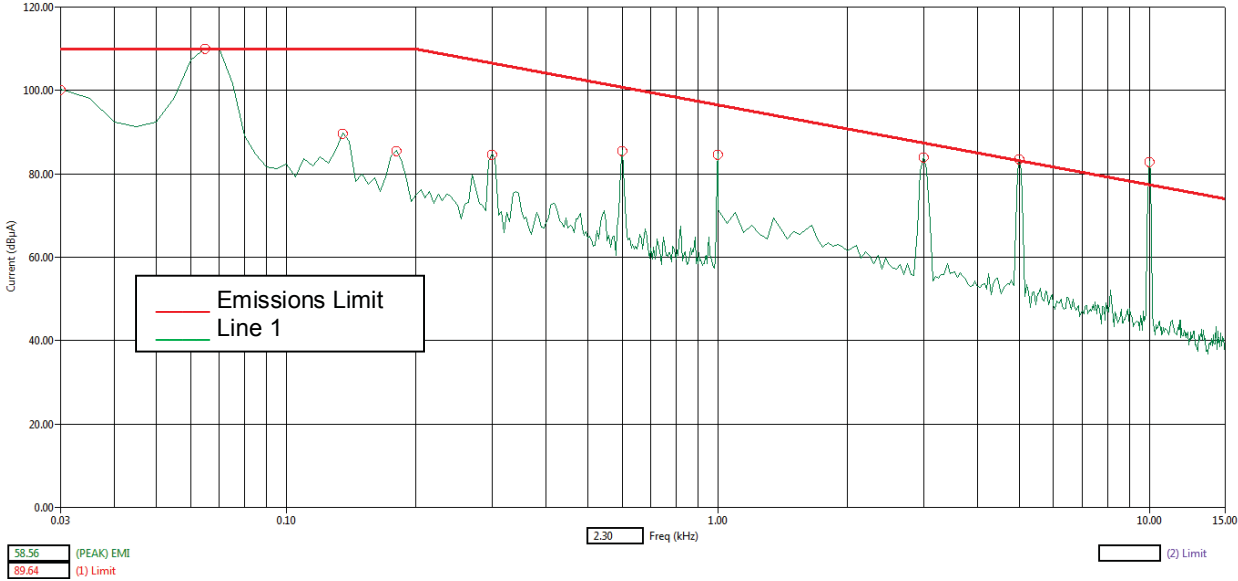


Figure A.3-1: CE01 Calibration 30 Hz to 15 kHz

Table A.3: CE01 Calibration

Measured Frequency (kHz)	Expected Current (dBµA)	Measured Current (dBµA)
0.065	110.0	110.2
3.00	87.4	84.0
5.00	83.2	83.6
10.00	77.4	82.9



A.3.2 Test Data

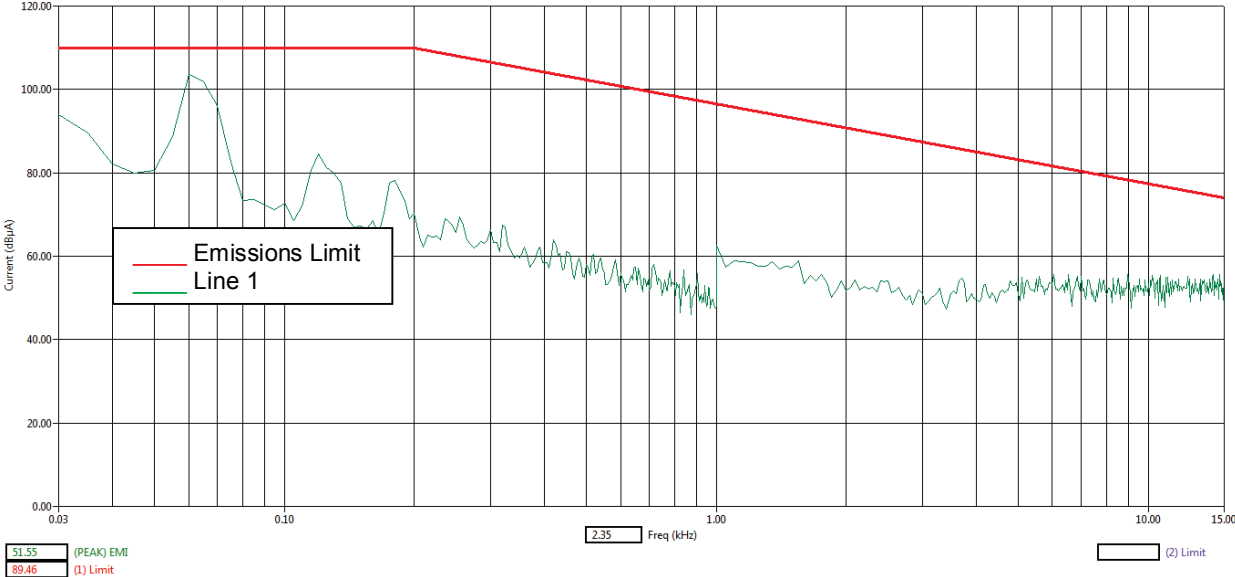


Figure A.3-2: CE01 Test Data EDS Hot Lead Standby Mode

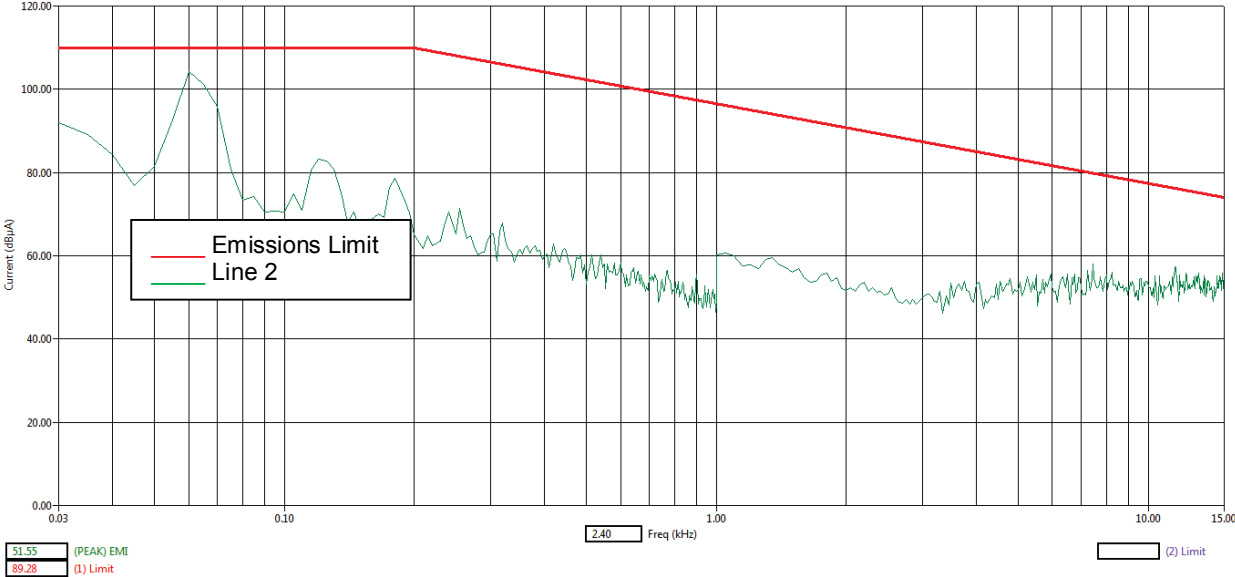


Figure A.3-3: CE01 Test Data EDS Return Lead Standby Mode

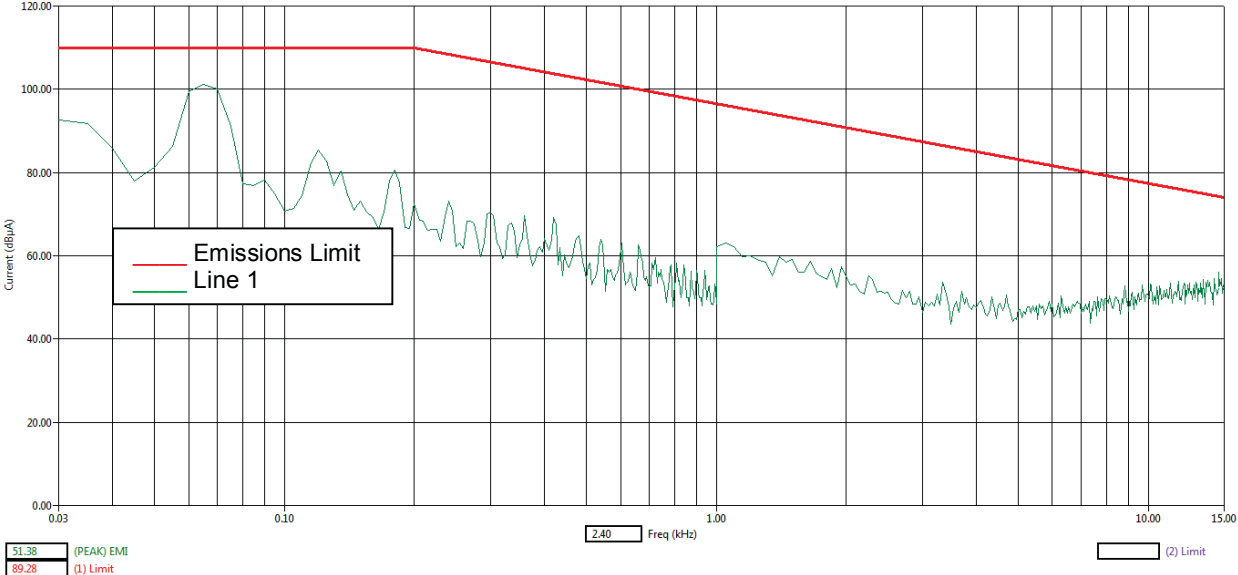


Figure A.3-2: CE01 Test Data EDS Hot Lead Active Mode

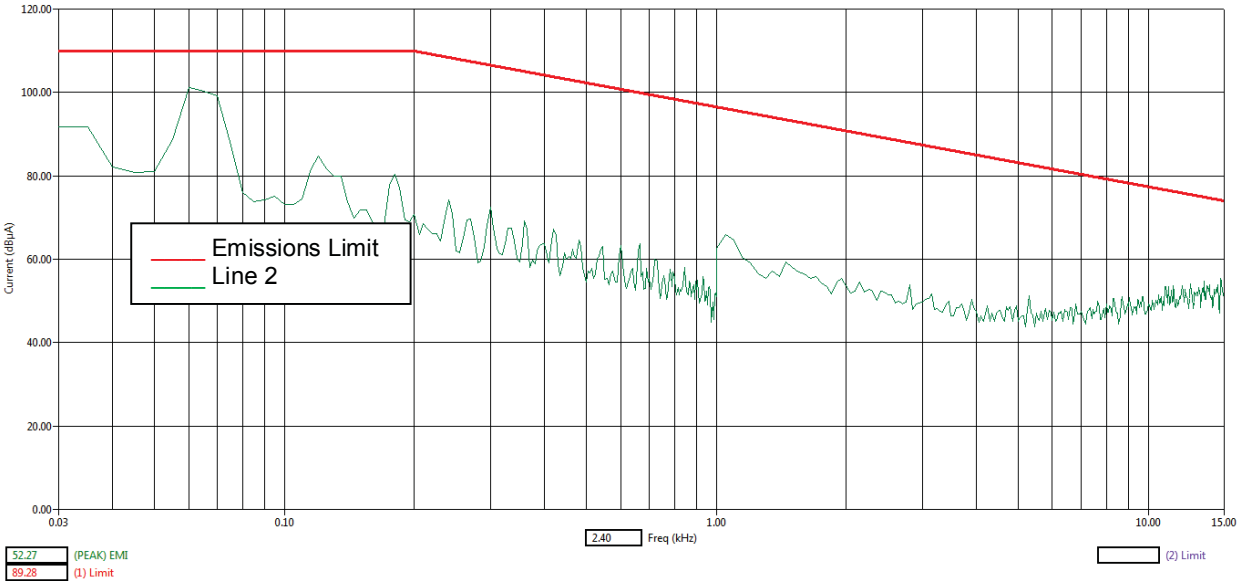


Figure A.3-3: CE01 Test Data EDS Return Lead Active Mode

A.3.3 Photos

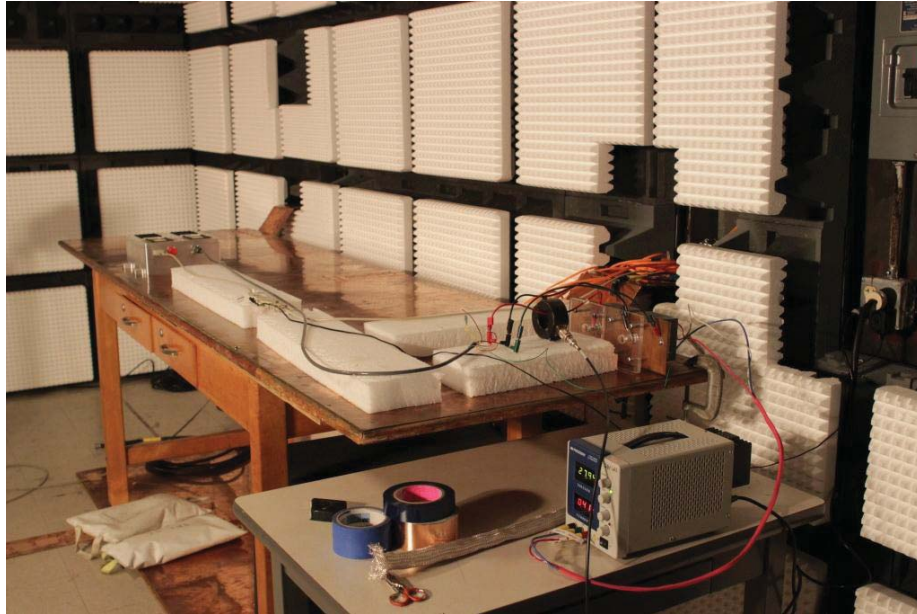


Figure A.3-4: CE01 Current Probe Setup on the VDC Hot Lead

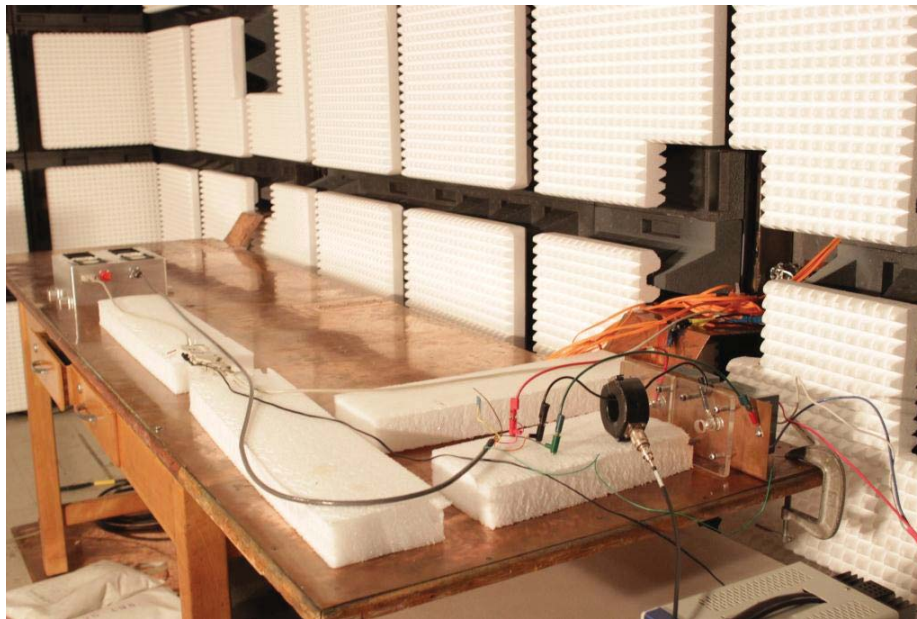


Figure A.3-5: CE01 Current Probe Setup on the VDC Return Lead

## B CE03 Conducted Emissions, Power Leads

### B.1 CE03 Equipment

**Table B.1: CE03 Equipment List**

Nomenclature	Manufacturer	Model Number	Serial Number	Calibration Due
TDK Emissions Lab Software	TDK	VER. 6.97	NA	NA
Spectrum Analyzer	Agilent	E4446A	SG48250010	29JAN15
RF Pre-selector	Agilent	N9039A	SG46520005	05DEC14
Signal Generator (calibration only)	Agilent	N5181A	SG49060002	05DEC14
10 $\mu$ F capacitor	Solar	7314-106R	0650-30	NCR
10 $\mu$ F capacitor	Solar	7314-106R	0650-32	NCR
Oscilloscope	Tektronix	TDS5104B	B010671	14MAY14
Current Probe	Ailtech	91550-1L	119	NA
Power Supply	Lambda	LK351-FM	090921	NA
50 ohm Load	HP	909A	NA	09NOV15
Multimeter	Fluke	77	C46493	09MAY14
Clamp Meter	Fluke	337	82403235	14JUN14
RF Cable	Saxton	RG58	CE01,03	NA
20 dB Attenuator	HP	8491A	3541	NCR

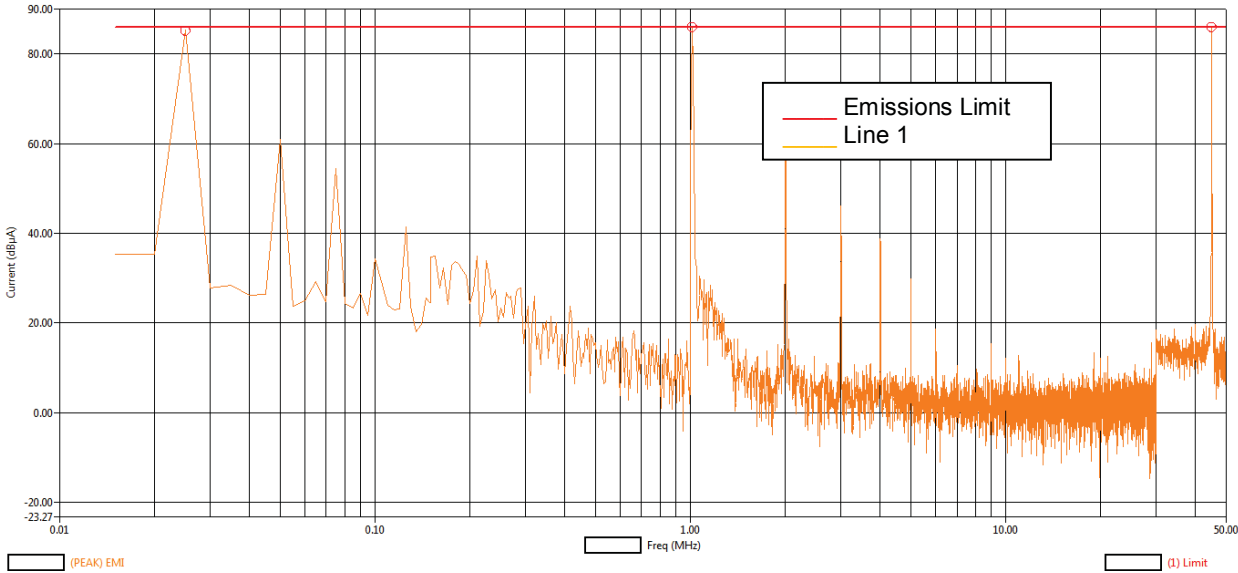
Note: The equipment is also catalogued in the Maximo System.

## **B.2 Applicability**

The test method for CE03 shall be applicable for measuring narrowband conducted emissions in the frequency range between 15 kHz and 50 MHz on the following types of leads: dc leads which obtain power from, or provide power to other equipment, distribution panels or subsystems.

**B.3 CE03 Data**

**B.3.1 Calibration**

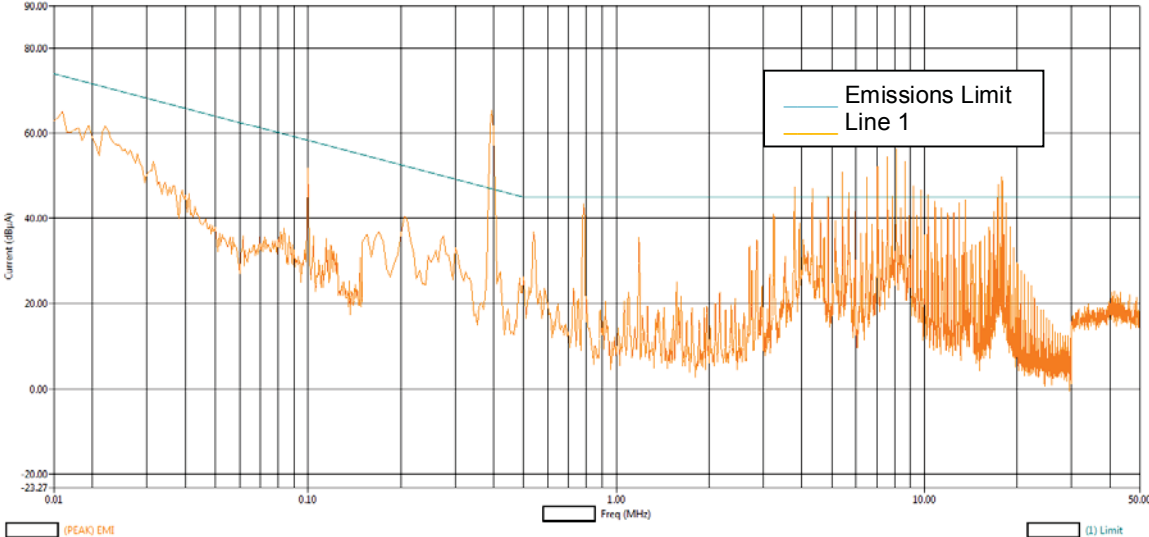


**Figure B.3-1: CE03 Calibration 15 kHz to 50 MHz**

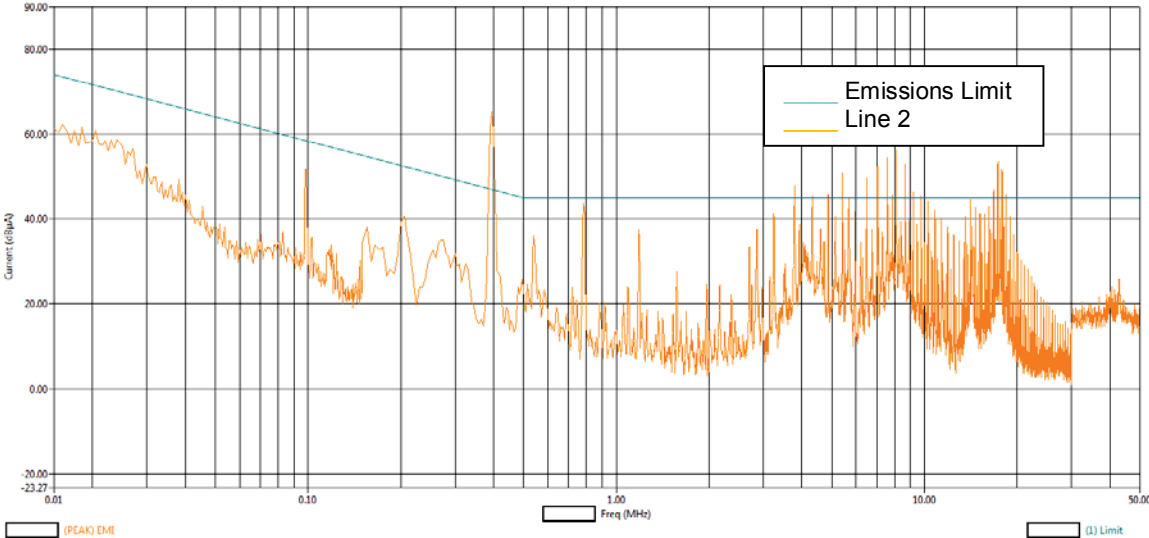
**Table B.3: CE03 Calibration**

Measured Frequency (MHz)	Expected Current (dBµA)	Measured Current (dBµA)
0.025	86.0	85.29
1.015	86.0	86.14
45.00	86.0	86.04

**B.3.2 Test Data**



**Figure B.3-2: CE03 Test Data EDS Hot Lead Standby Mode**



**Figure B.3-3: CE03 Test Data EDS Return Lead Standby Mode**

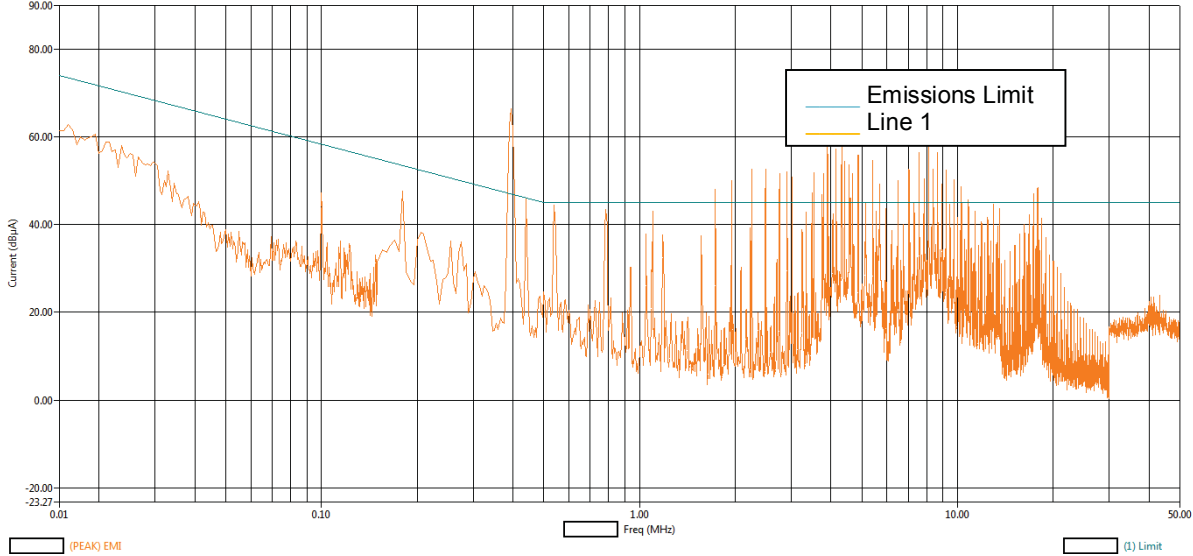


Figure B.3-2: CE03 Test Data EDS Hot Lead Active Mode

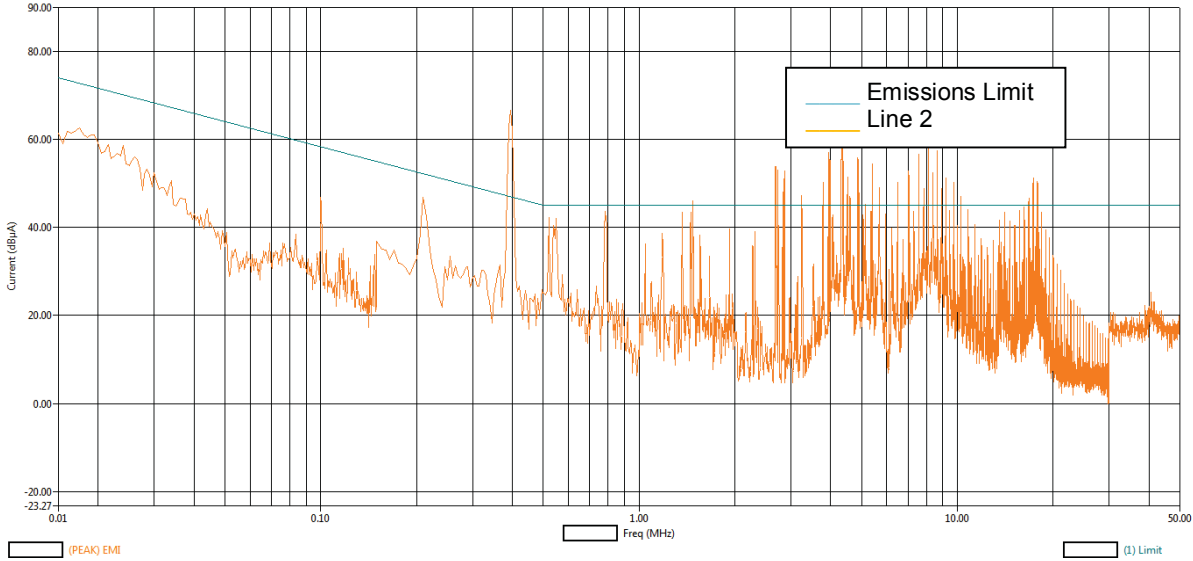


Figure B.3-3: CE03 Test Data EDS Return Lead Active Mode



### B.3.3 Photos

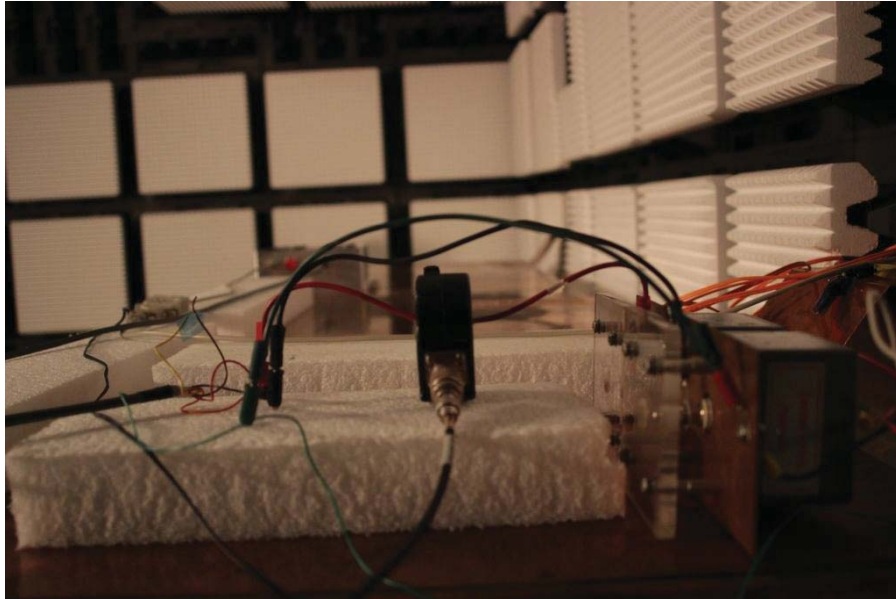


Figure B.3-4: CE03 Current Probe Setup on the VDC Hot Lead

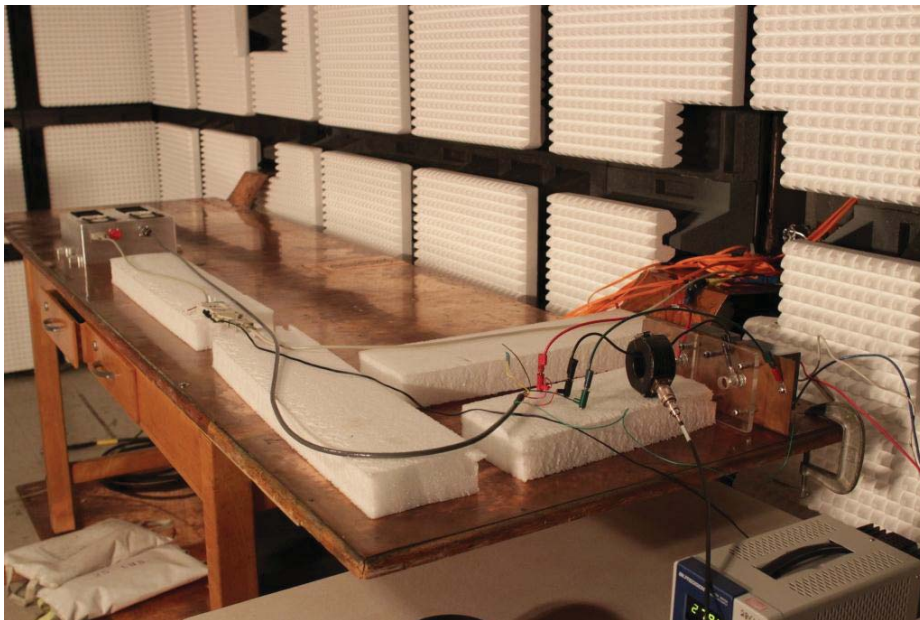


Figure B.3-5: CE03 Current Probe Setup on the VDC Return Lead

## C CE07 Conducted Emissions, Time Domain Transients, Power Leads

### C.1 CE07 Equipment

Table C.1: CE07 Equipment List

Nomenclature	Manufacturer	Model Number	Serial Number	Calibration Due
Multimeter	Fluke	8060A	4140395	14JUL14
Oscilloscope	Tektronix	TDS5104B	B064351	26SEP13
Differential Probe	Tektronix	P5205	B026990	22JUL14
LISN	EML	SSP 52000 CE07	1	206 $\mu$ F 0.1 Ohm
Capacitor	Solar	7314-106R	065032	10.23 $\mu$ F
Capacitor	Solar	7314-106R	065030	10.31 $\mu$ F

Note: The equipment is also catalogued in the Maximo System.

## **C.2 Applicability**

CE07 applies to DC input power leads, spikes, and time domain transients. CE07 is applicable for all 28V input power leads.

## **C.3 CE07 Data**

### **C.3.1 Measurements**

The Electrodynamic Dust Shield was powered on remotely. The following modes or events were tested:

1. Initial Power On.
2. Power Off.
3. Steady state.

Oscilloscope screenshots for the above CE07 events are shown in Figures C.3-1 to C.3-4.

Transients are plotted against the SSP 52000 IDD envelope. Only data values with a time greater than zero are plotted (See Figures J.4-1 to J.4.5). Pretrigger information is available in the raw tabular data file. The oscilloscope produced comma separated variable files of the transients are available to the customer or customer's designee. The file sizes prevent including the amplitude time pairs in this appendix. During testing of the initial Power On mode, transients from the power switch were captured. During testing of the steady state, no transients or spikes were observed. Photographs are shown in Figures J.4-6 and J.4-7.

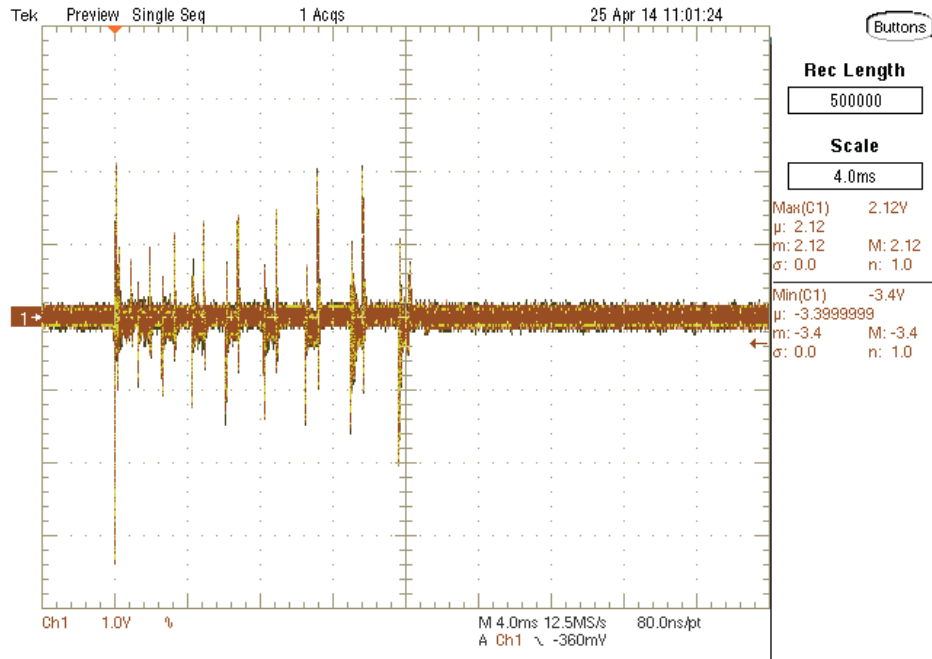


Figure C.3-1: CE07 Oscilloscope Screenshot Pulse Duration

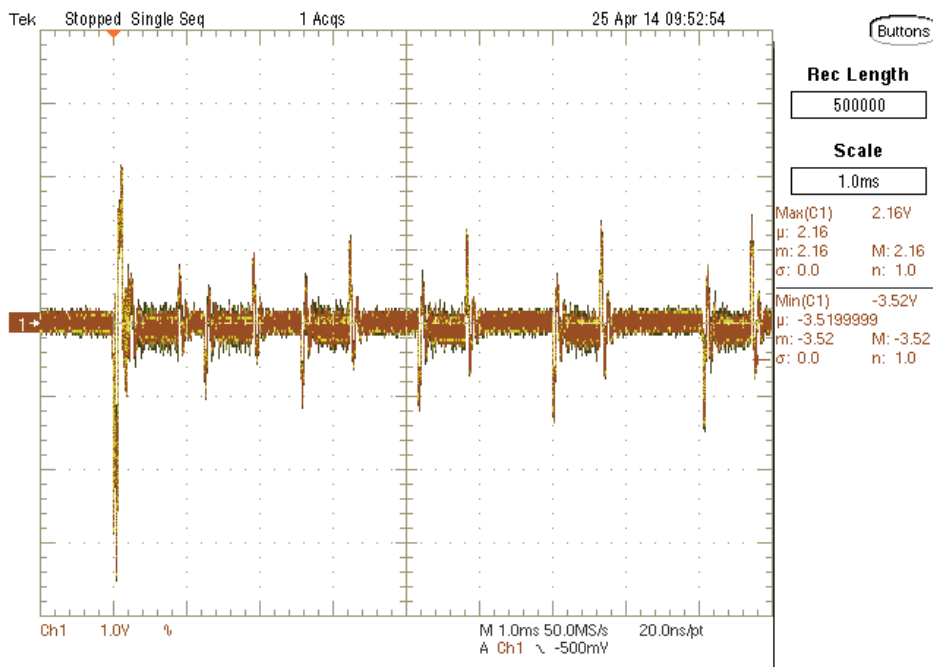


Figure C.3-2: CE07 Oscilloscope Screenshot EDS Initially Powered ON

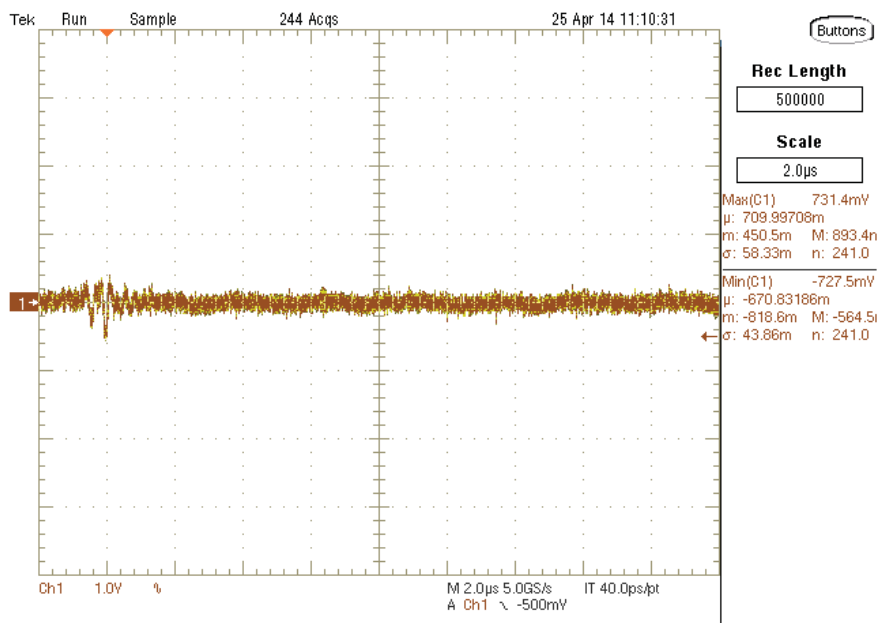


Figure C.3-3: CE07 Oscilloscope Screenshot EDS Steady State

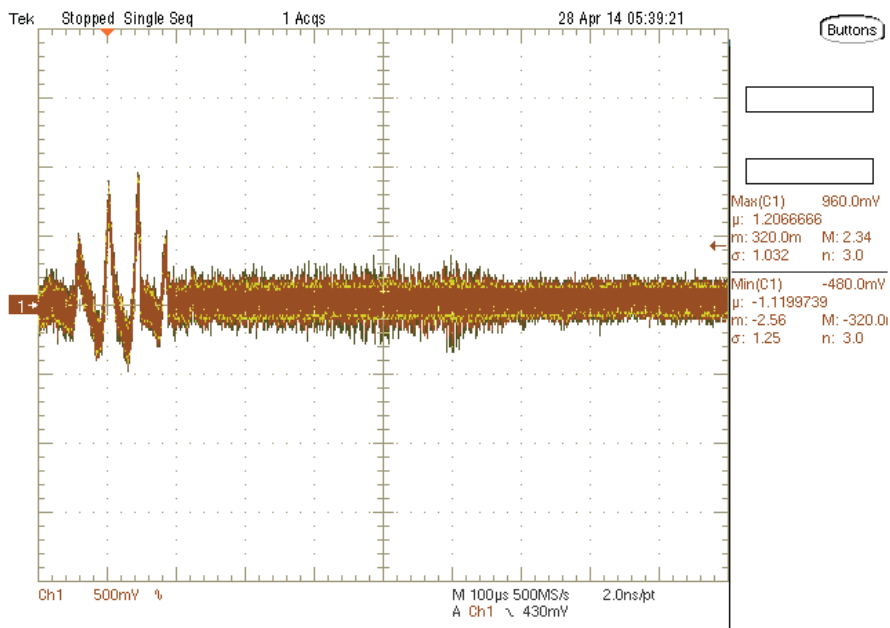
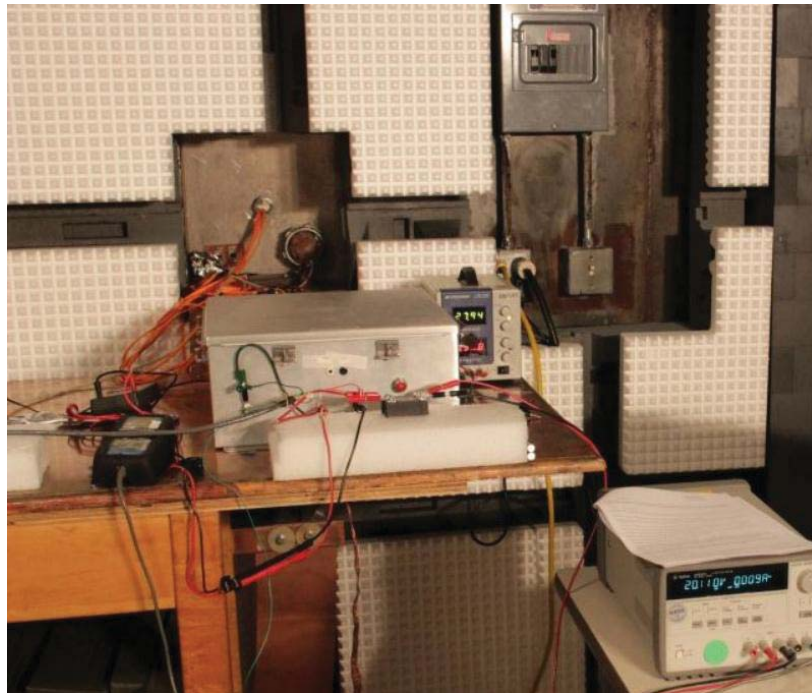
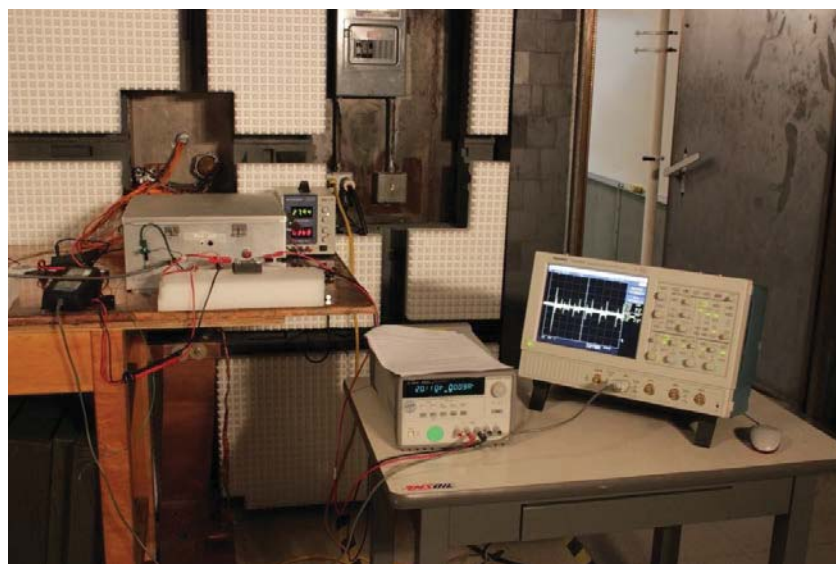


Figure C.3-4: CE07 Oscilloscope Screenshot EDS Turned OFF

### C.3.2 Photos



**Figure C.3-5: CE07 Test Setup with LISN**



**Figure C.3-6: CE07 Test Setup Equipment**

## D RE02 Radiated Emissions, Electric Field

### D.1 RE02 Equipment

**Table D.1: RE02 Equipment List**

Nomenclature	Manufacturer	Model Number	Serial Number	Calibration Due
TDK Emissions Lab Software	TDK	VER. 6.97	NA	NA
Spectrum Analyzer	Agilent	E4446A	SG48250010	29JAN15
RF Preselector	Agilent	N9039A	SG46520005	05DEC14
Analog Signal Generator	Agilent	N5181A	SG49060002	05DEC14
Signal Generator	Agilent	E8267D	MY51500109	15JUL14
Signal Generator	Agilent	N9310A	CN0116A149	30OCT14
10 $\mu$ F capacitor	Solar	7314-106R	0650-30	NCR
10 $\mu$ F capacitor	Solar	7314-106R	0650-32	NCR
Preamplifier	Agilent	8449B	3008A00475	NCR
Active Rod Antenna	EMCO	3301B	9309-3443	25JAN16
Biconical Antenna	EMCO	3104C	4656	03JAN16
Big Horn Antenna	ETS Lindgren	3106	75838	22DEC15
Small Horn Antenna	EMCO	3115	2316	08JAN16

Note: The equipment is also catalogued in the Maximo System.

## **D.2 Applicability**

RE02 is applicable for radiated emissions from equipment and subsystems, cables (including control, pulse, Interface (I/F), power and antenna transmission lines) and interconnecting wiring of the EUT; for narrowband emissions, it applies at the fundamental frequencies and all spurious emissions including harmonics, but does not apply for radiation from antennas. This requirement is applicable for narrowband emissions from 14kHz to 108GHz.



### D.3 RE02 Data

#### D.3.1 Ambient

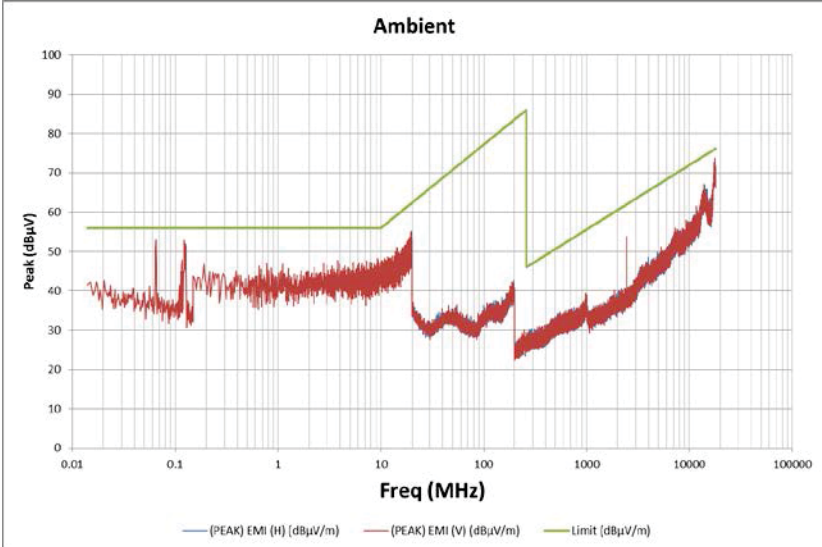


Figure D.3-1: RE02 Ambient Data AC Unit

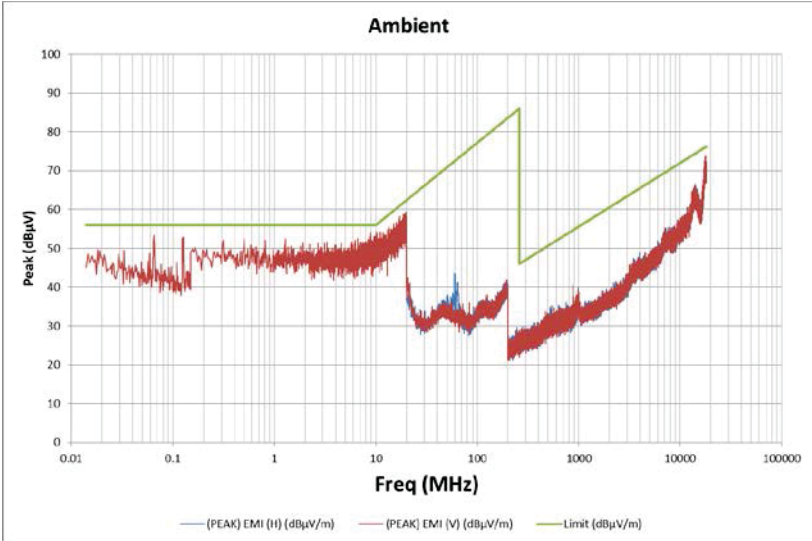


Figure D.3-2: RE02 Ambient Data DC Unit

D.3.2 Test Data

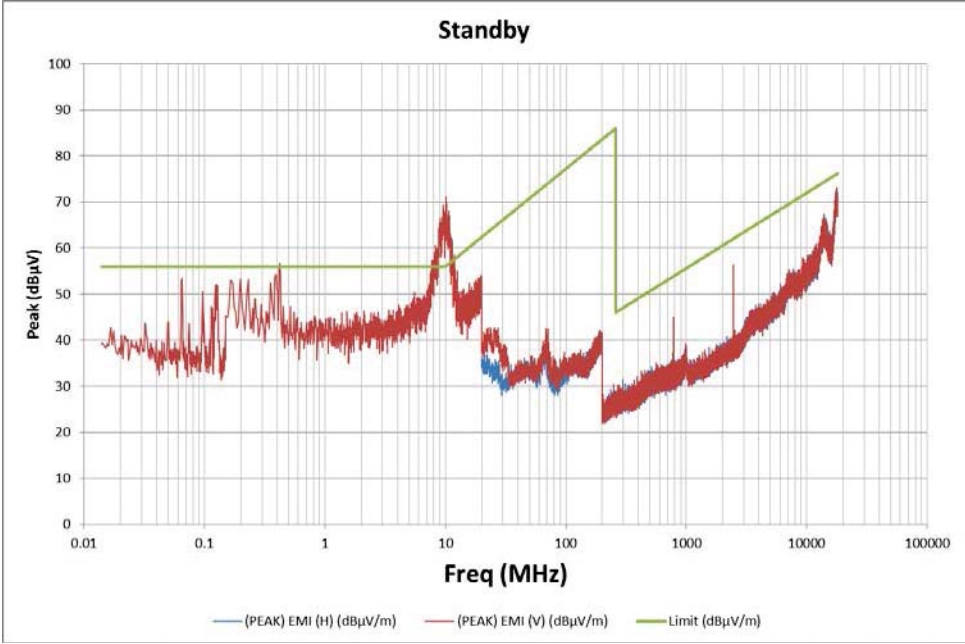


Figure D.3-3: RE02 Test Data Standby Mode AC Unit

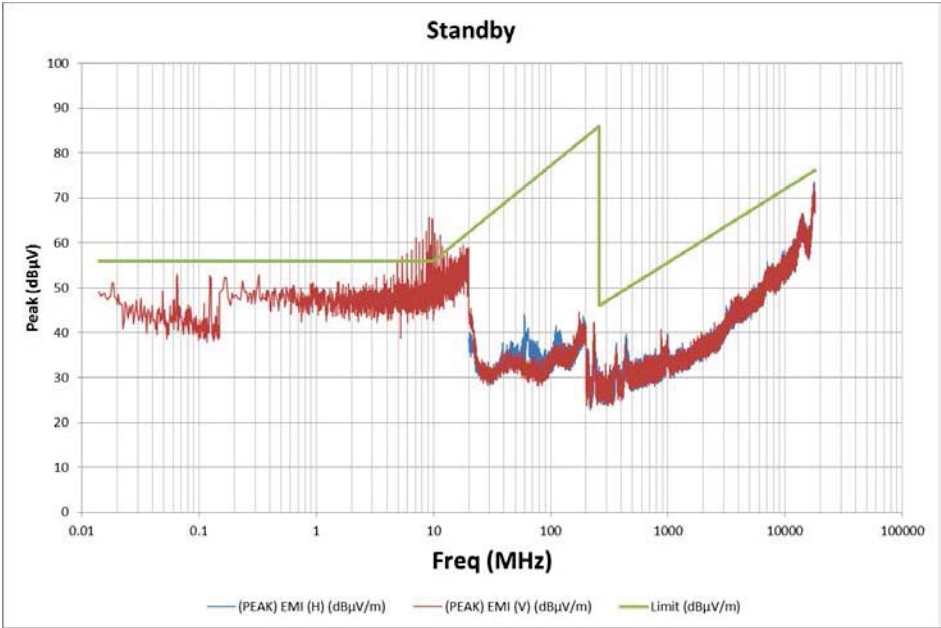


Figure D.3-4: RE02 Test Data Standby Mode DC Unit

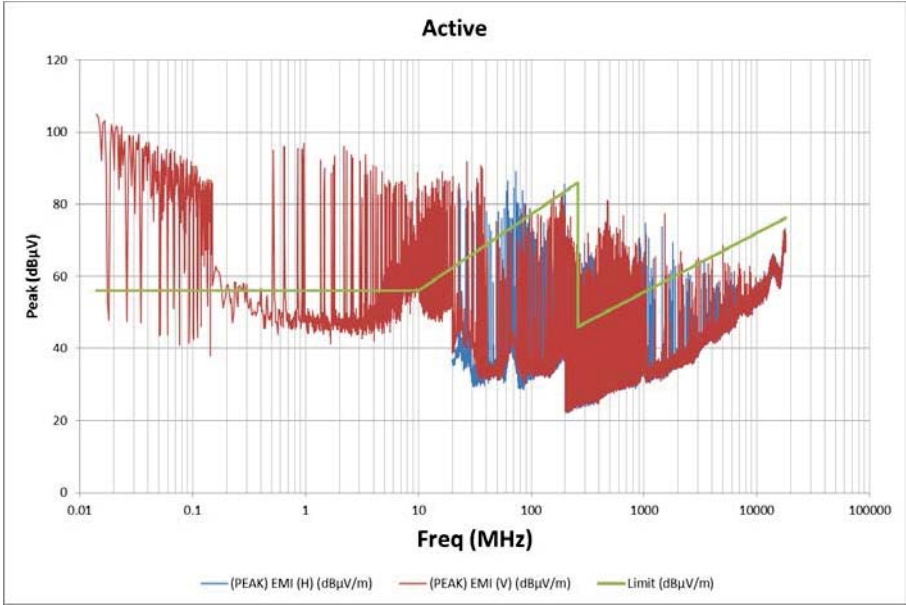


Figure D.3-5: RE02 Test Data AC Unit Active Mode

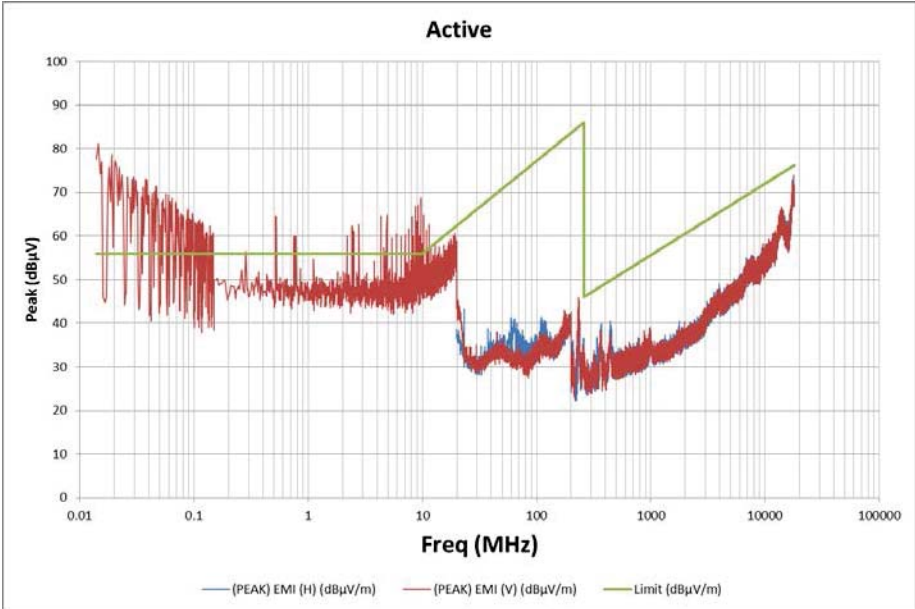


Figure D.3-6: RE02 Test Data DC Unit Active Mode

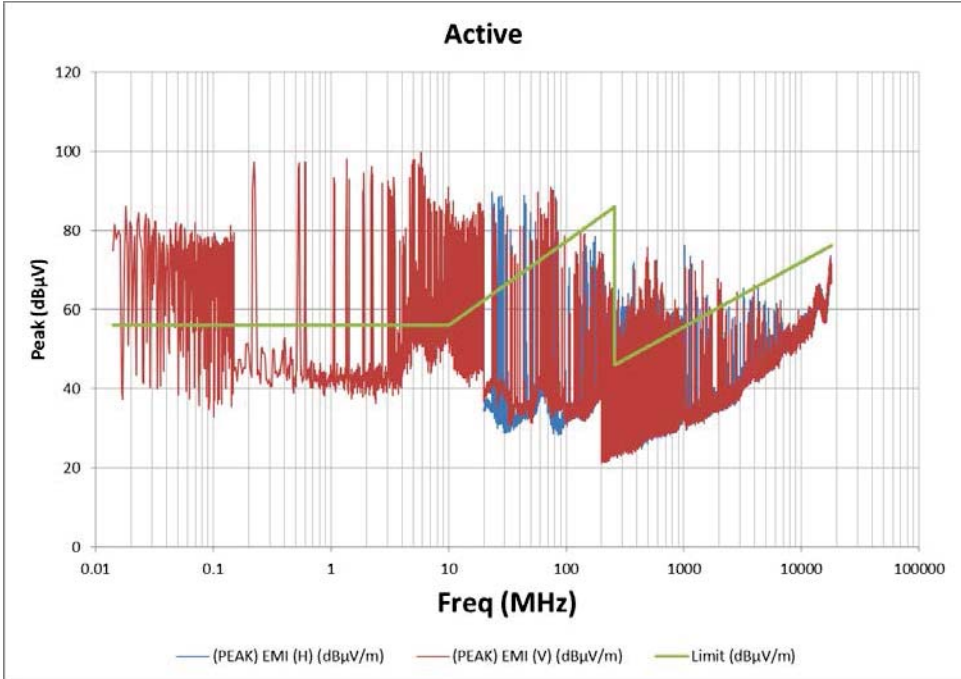
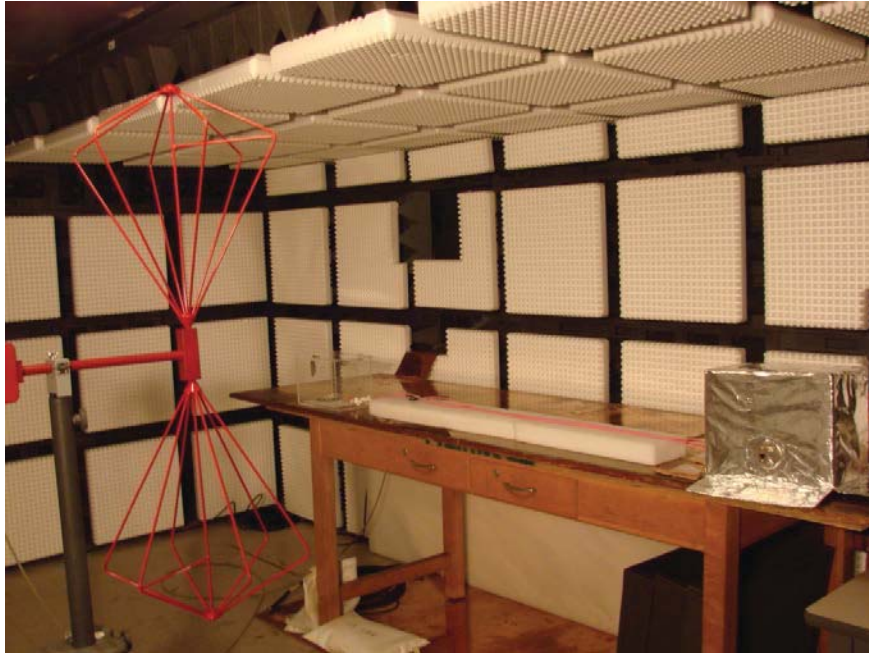


Figure D.3-7: RE02 Test Data AC Unit Active Mode with Shielding

D.3.3 Photos



Figure D.3-8: RE02 Typical Active Rod Antenna Setup



**Figure D.3-9: RE02 Typical Antenna Setup, Below 1 GHz**



**Figure D.3-10: RE02 Typical Antenna Setup, Above 1 GHz**



**Figure D.3-11: RE02 Typical Antenna Setup, with Shielding**

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