



**MET Laboratories, Inc.** *Safety Certification - EMI - Telecom Environmental Simulation*  
914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230-3432 • PHONE (410) 354-3300 • FAX (410) 354-3313

August 21, 2008

Multispectral Solutions, Inc.  
20300 Century Boulevard, Suite 250  
Germantown, MD 20874-1132

Dear Lester Foster,

Enclosed is the EMC test report for compliance testing of the Multispectral Solutions, Inc., Echo Distance Measuring Radio ED652-M as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-03 ed.), Part 15 Subpart C, §15.250 for WB Devices.

Thank you for using the services of MET Laboratories, Inc. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,  
MET LABORATORIES, INC.

Jennifer Warnell  
Documentation Department

Reference: (\Multispectral Solutions, Inc.\ Echo Distance Measuring Radio ED652-M \ EMC23617-FCC250)

DOC-EMC702 2/26/2004



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## **Electromagnetic Compatibility Criteria Test Report**

For the

**Multispectral Solutions, Inc.  
Echo Distance Measuring Radio ED652-M**

Tested under

**FCC Certification Rules  
Title 47 of the CFR, Part 15, Subpart C for WB Devices**

**MET Report: EMC23617-FCC250**

August 21, 2008

**Prepared For:**

**Multispectral Solutions, Inc.  
20300 Century Boulevard, Suite 250  
Germantown, MD 20874-1132**

**Prepared By:**  
**MET Laboratories, Inc.**  
914 W. Patapsco Ave.  
Baltimore, MD 21230



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Dusmantha Tennakoon  
Electromagnetic Compatibility Lab

Jennifer Warnell  
Documentation Department

**Engineering Statement:** The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Part 15, §15.250 of the FCC Rules under normal use and maintenance.

Shawn McMillen  
Wireless Manager, Electromagnetic Compatibility Lab



## Report Status Sheet

Revision	Report Date	Reason for Revision
Ø	August 21, 2008	Initial Issue.



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## List of Terms and Abbreviations

<b>AC</b>	<b>A</b> lternating <b>C</b> urrent
<b>ACF</b>	<b>A</b> ntenna <b>C</b> orrection <b>F</b> actor
<b>Cal</b>	<b>C</b> alibration
<b>d</b>	<b>M</b> easurement <b>D</b> istance
<b>dB</b>	<b>D</b> eci <b>B</b> els
<b>dB<math>\mu</math>V</b>	<b>D</b> eci- <b>B</b> els above one <b>m</b> icro <b>V</b> olt
<b>dB<math>\mu</math>V/m</b>	<b>D</b> eci- <b>B</b> els above one <b>m</b> icro <b>V</b> olt <b>p</b> er <b>m</b> eter
<b>DC</b>	<b>D</b> irect <b>C</b> urrent
<b>DCF</b>	<b>D</b> istance <b>C</b> orrection <b>F</b> actor
<b>E</b>	<b>E</b> lectric <b>F</b> ield
<b>DSL</b>	<b>D</b> igital <b>S</b> ubscriber <b>L</b> ine
<b>ESD</b>	<b>E</b> lectrostatic <b>D</b> ischarge
<b>EUT</b>	<b>E</b> quipment <b>U</b> nder <b>T</b> est
<b>f</b>	<b>F</b> requency
<b>FCC</b>	<b>F</b> ederal <b>C</b> ommunications <b>C</b> ommission
<b>H</b>	<b>M</b> agnetic <b>F</b> ield
<b>GHz</b>	<b>G</b> iga <b>H</b> ertz
<b>Hz</b>	<b>H</b> ertz
<b>ICES</b>	<b>I</b> nterference- <b>C</b> ausing <b>E</b> quipment <b>S</b> tandard
<b>kHz</b>	<b>k</b> ilo <b>h</b> ertz
<b>kPa</b>	<b>k</b> ilo <b>p</b> ascal
<b>kV</b>	<b>k</b> ilo <b>V</b> olt
<b>LISN</b>	<b>L</b> ine <b>I</b> mpedance <b>S</b> tabilization <b>N</b> etwork
<b>MHz</b>	<b>M</b> ega <b>H</b> ertz
<b><math>\mu</math>H</b>	<b>m</b> icro <b>H</b> enry
<b><math>\mu</math>F</b>	<b>m</b> icro <b>F</b> arad
<b><math>\mu</math>s</b>	<b>m</b> icro <b>s</b> econds
<b>RF</b>	<b>R</b> adio <b>F</b> requency
<b>RMS</b>	<b>R</b> oot- <b>M</b> ean- <b>S</b> quare
<b>V/m</b>	<b>V</b> olts per <b>m</b> eter
<b>WB</b>	<b>U</b> ltra- <b>W</b> ideband



## 1. Requirements Summary

The following tests were performed on a sample of the equipment for the purpose of demonstrating compliance with Part 15, Subpart C, §15.250, in accordance with Multispectral Solutions, Inc. Purchase Order Number 07746.

Reference	Description	Compliance
Title 47 of the CFR, Part 15, Subpart C, §15.207(a)	Electromagnetic Compatibility - Conducted Emissions for Intentional Radiators	Compliant
Title 47 of the CFR, Part 15, Subpart C, §15.209(a)	Antenna Requirements	Compliant
Title 47 of the CFR, Part 15, Subpart C, §15.250(a)(b)	-10 dB Bandwidth	Compliant
Title 47 of the CFR, Part 15, Subpart C, §15.250(c)	Operational Restrictions	Applicant has been advised of these requirements.
Title 47 of the CFR, Part 15, Subpart C, §15.250(d)(1)	Radiated emissions above 960 MHz (RMS Avg)	Compliant
Title 47 of the CFR, Part 15, Subpart C, §15.250(d)(2)	GPS emissions	Compliant
Title 47 of the CFR, Part 15, Subpart C, §15.250(d)(3)	Peak emissions	Compliant
Title 47 of the CFR, Part 15, Subpart C, §15.250(d)(4)	Radiated emissions below 960 MHz	Compliant

**Table 1. Requirements Summary of EMC Part 15.250 Compliance Testing**





## 2. Equipment Configuration

### 2.1 Overview

An EMC evaluation to determine compliance of the Multispectral Solutions, Inc., Echo Distance Measuring Radio ED652-M with the requirements of Part 15, Subpart C, §15.250 was performed. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the Multispectral Solutions, Inc. Echo Distance Measuring Radio ED652-M. Multispectral Solutions, Inc. should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Echo Distance Measuring Radio ED652-M has been **permanently** discontinued.

<b>Type of Submission/Rule:</b>	Part 15.250 for WB Devices	
<b>Model(s) Tested:</b>	Echo Distance Measuring Radio ED652-M	
<b>EUT Specifications:</b>	<b>FCC ID:</b>	QCJECHO108
	<b>Equipment Code:</b>	WB
	<b>WB Bandwidth:</b>	1.2495 GHz
<b>Analysis:</b>	The results obtained relate only to the item(s) tested.	
<b>Evaluated by:</b>	Dusmantha Tennakoon	
<b>Date(s):</b>	08/08/08 – 08/11/08	

### 2.2 Test Site

All testing was performed at MET Laboratories, Inc., 914 W. Patapsco Avenue, Baltimore, Maryland 21230. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed inside of a semi-anechoic chamber. In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories.



### 2.3 Description of Test Sample

The Echo Distance Measuring Radio ED652-M, Equipment Under Test (EUT), is a propagation time measurement networking radio module that also supports a low data rate communication capability to enhance radio location and tracking applications. The product is utilized for applications of radio frequency identification, radio navigation, location and tracking. The module was designed as a component for integration with other electronic sensors, processors and communication systems. It complies with all requirements under Part 15.212 for modular transmitters. Since it is a modular device, the power of the unit will be provided by the system integrator's host processor.

The device is commanded and controlled by an external processor through its electrical wired interface using either Universal Serial Bus (USB) or serial communications via RS232. It is also commanded and controlled by other Echo DMR units over its wireless interface. The Echo DMR units have four functions they can perform. They (1) measure distance or time of transmission between two radio pairs, (2) discover radios in the subnetwork, (3) communicate small data messages between two units, and (4) instruct other radios to perform communications, range measurement and discovery with limited source based network routing. The networking capability permits one microprocessor to control a network of Echo DMR modules.



Figure 1. Picture of EUT, Front View



Figure 2. Picture of EUT, Rear View

## 2.4 Equipment Configuration

The EUT was set up as outlined in Figure 3. All equipment incorporated as part of the EUT is included in the following list.

Name / Description	Model Number	Serial Number
ECHO DMR MODULE	ED652-M	01001
REVERSE SMA SUPER-OMNI ANTENNA	135-905-003-03	N/A

Table 2. Equipment Configuration



## 2.5 Support Equipment

Support equipment necessary for the operation and testing of the EUT is included in the following list.

Ref. ID	Name / Description	Manufacturer	Model Number	Serial Number
1	LAPTOP COMPUTER	SONY	PCG-384L	28201032 3004460
2	BENCH POWER SUPPLY	N/A	N/A	N/A
3	USB CABLE	L-COM	CSMUAMB5-2M	N/A
4	RS232 SERIAL D9 CONNECTOR	MSSI	N/A	N/A
5	USB TO SERIAL D9 ADAPTER	FTDI	US232B	N/A
6	LAPTOP COMPUTER AC ADAPTER 19.5V	SONY	VGP-AC19V19	0713 0739133

Table 3. Support Equipment

## 2.6 Ports and Cabling Information

Ref. ID	Port Name on EUT	Cable Description	Qty.	Length (m)	Shielded (Y/N)	Termination Point
1	USB	DATA INTERFACE AND POWER	1	2	Y	LAPTOP COMPUTER PORT ID 2
3	RS232	DATA INTERFACE	1	0.27	N	D9 SERIAL CONNECTOR TO USB ADAPTER CONNECTED TO LAPTOP COMPUTER PORT ID 2
4	POWER	POWER CONNECTOR	1	0.29	N	BENCH POWER SUPPLY

Table 4. Ports and Cabling Information



## 2.7 Mode of Operation

To test the emissions, the radio is set up to perform a command that will instruct another radio through network hopping to perform a discover command. If the addressed radio was within reception range, it would receive the command and perform the discovery function to determine the ID numbers of all radios within its radio communication range. The routed discovery function was selected since it provides for a emission mode of operation that causes the most RF power to be emitted from the unit under test. The radio ID in which the discovery command is directed is not present in the test chamber so the command will go unheeded. The EUT will be commanded by a computer application to repeat the discover command continuously until the computer application is stopped.

The test will utilize two modes of operation utilizing the two different methods of electrical and data connection to the EUT. The first mode will interface power and data communication to the unit over USB. The data communication from the computer will instruct the radio to perform the commanded action. The second mode will utilize two connections to the EUT. The first connection will power the unit with a regulated voltage. The second connection provides data communication to and from the unit following the serial RS232 standard to command the radio to operate.

## 2.8 Method of Monitoring EUT Operation

The first Pass/Fail criterion that indicates the unit is operating properly is when the device communicates successfully over RS 232 or USB interface to the controlling microprocessor (laptop computer). The ranging radio test application will provide information letting the user know if the unit is not communicating over this interface upon the "routed\_discovery" application command selection (2) to perform the discover command.

The second Pass/Fail criterion is that if the unit is working then its emissions are detected on the spectrum analyzer which indicates the unit is responding to commands to communicate over the radio physical layer to determine who is on the ranging network.

## 2.9 Frequency Determining Parameters

The highest frequency employed in §15.33 to determine the frequency range over which radiated emissions are made was based on the center frequency,  $f_c$ , unless a higher frequency was generated within the WB device. For measuring emission levels, the spectrum was investigated from the lowest frequency generated in the WB, without going below 9 kHz, up to the frequency range shown in Section 15.33(a) of the CFR 47 or up to  $f_c + 3/(\text{pulse width in seconds})$ , whichever was higher. There is no requirement to measure emissions beyond 40 GHz provided  $f_c$  was less than 10 GHz; beyond 100 GHz if  $f_c$  was at or above 10 GHz and below 30 GHz; or beyond 200 GHz if  $f_c$  was at or above 30 GHz.

The center frequency  $f_c$  was found to be 6.566 GHz.

The frequency at which the highest radiated emission occurs is  $f_M$  (6.1394 GHz)

The pulse width of the EUT was 2 ns.

Therefore, the highest frequency to be measured was 40 GHz.



## **2.10 Modifications**

### **2.10.1 Modifications to EUT**

No modifications were made to the EUT.

### **2.10.2 Modifications to Test Standard**

No modifications were made to the test standard.

## **2.11 Disposition of EUT**

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Multispectral Solutions, Inc. upon completion of testing.

### 3. Electromagnetic Compatibility Criteria for WB Devices

#### 3.1. Antenna Requirement

**Requirement:** § 15.203: The structure and application of the EUT were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

- a.) Antenna must be permanently attached to the unit.
- b.) Antenna must use a unique type of connector to attach to the EUT.
- c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

**Results:** The EUT complied with the requirement(s) of this section. The module has a reverse sma antenna connector, and is, therefore, an unique connector. The module will be used with a 5 dBi Omni antenna.



**Photograph 1. Picture of Reverse SMA Connector**



### 3.2. AC Line Conducted Emissions

**Test Requirement(s):** 15.207(a), Except as shown in paragraphs (b) and (c) of this section\*, charging, AC adapters or battery eliminators the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the Table 5, as measured using a 50  $\mu$ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

Note: \*Testing is applicable except to carrier current systems operating as intentional radiators on frequencies below 30 MHz, containing their fundamental emission within the frequency band 535–1705 kHz and intended to be received using a standard AM broadcast receiver, or devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines 15.207 (b), or for an intentional radiator that is designed to be connected to the public utility (AC) power line 15.207 (c).

Frequency range (MHz)	Class A Conducted Limits (dB $\mu$ V)		*Class B Conducted Limits (dB $\mu$ V)	
	Quasi-Peak	Average	Quasi-Peak	Average
* 0.15- 0.45	79	66	66 - 56	56 - 46
0.45 - 0.5	79	66	56	46
0.5 - 30	73	60	60	50

Note 1 — The lower limit shall apply at the transition frequencies.

Note 2 — The limit decreases linearly with the logarithm if the frequency in the range 0.15 MHz to 0.5 MHz.

\* -- Limits per Subsection 15.207(a).

**Table 5. Conducted Limits for Radio Frequency Devices calculated from FCC Part 15 Section 15.207(a)**

**Test Procedure:**

The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50  $\Omega$ /50  $\mu$ H Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with ANSI C63.4-1992 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz". The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50  $\Omega$ /50  $\mu$ H LISN as the input transducer to an EMC/field intensity meter. The tests were conducted in a RF-shielded enclosure.

The EUT was in a continuous transmit mode.

**Results:**

The EUT is compliant with this requirement.

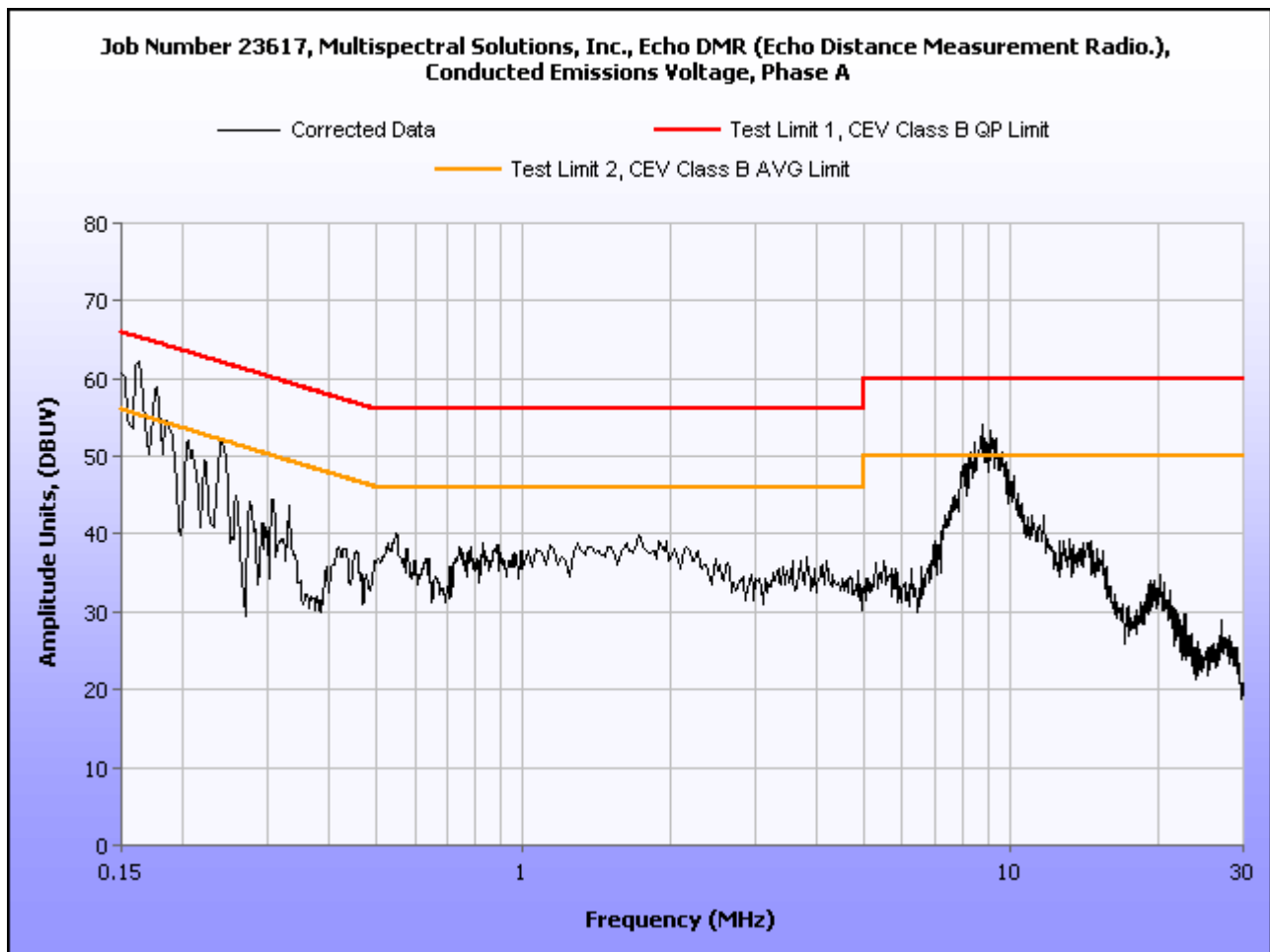




### Conducted Emission Limits

Frequency (MHz)	Quasi-Peak Amplitude (dBμV)	Quasi-Peak Limit (dBμV)	Quasi-Peak Margin (dBμV)	Average Amplitude (dBμV)	Average Limit (dBμV)	Average Margin (dBμV)
0.165	35.2605	65.21	-29.9495	20.2405	55.21	-34.9695
0.5012	25.55	56	-30.45	16.87	46	-29.13
0.6362	25.27	56	-30.73	16.87	46	-29.13
8.985	37.395867	60	-22.6041	27.655867	50	-22.3441
14.9	23.36	60	-36.64	16.46	50	-33.54
20.32	19.51488	60	-40.4851	13.10488	50	-36.8951

Table 6. Conducted Emissions - Voltage, Worst Case Emissions, AC Power, Phase Line



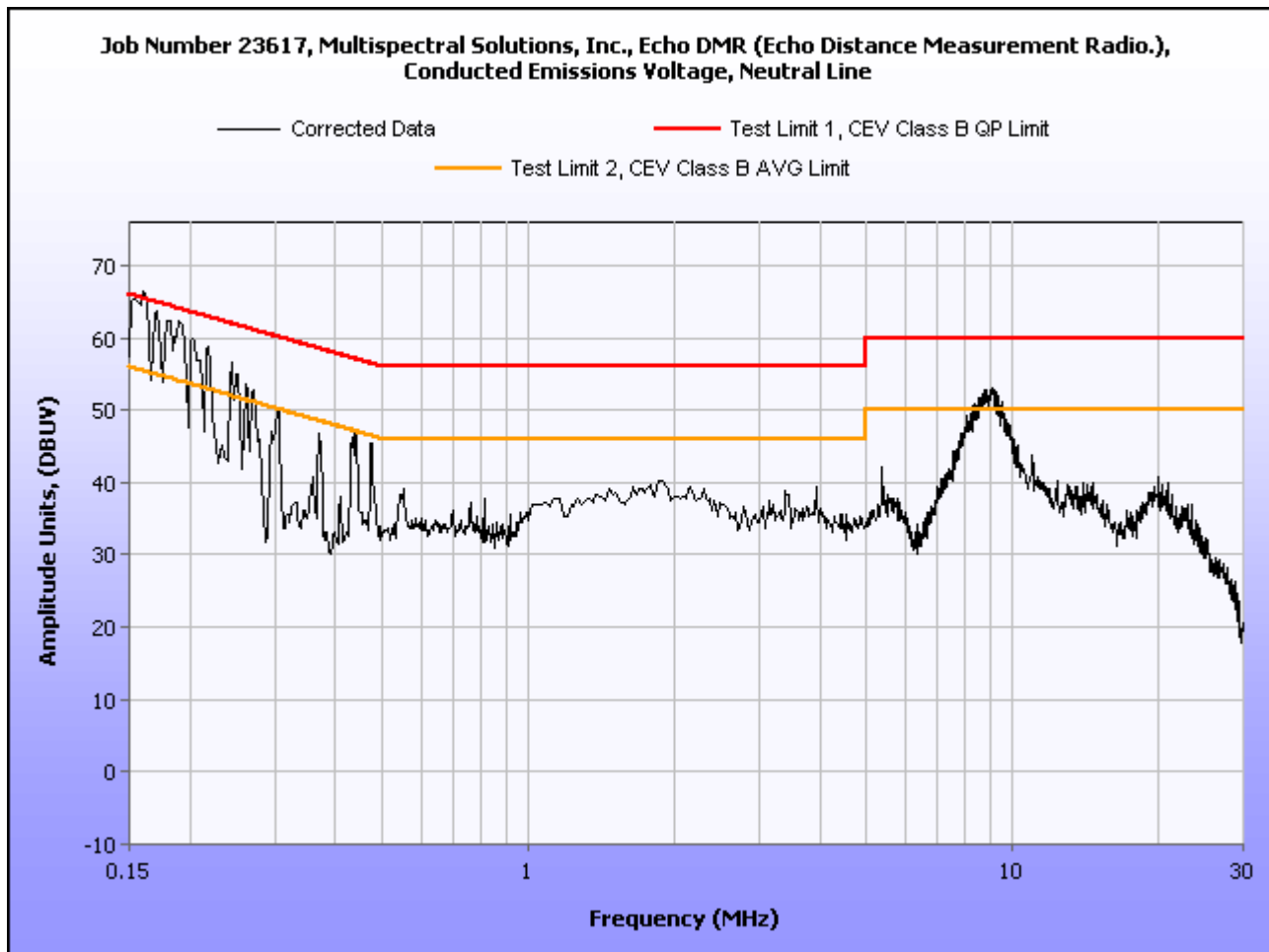
Plot 1. Conducted Emission Limits, Phase Line Plot



### Conducted Emission Limits

Frequency (MHz)	Quasi-Peak Amplitude (dBμV)	Quasi-Peak Limit (dBμV)	Quasi-Peak Margin (dBμV)	Average Amplitude (dBμV)	Average Limit (dBμV)	Average Margin (dBμV)
0.1562	45.32554	65.66	-20.3345	39.74554	55.66	-15.9145
0.2107	34.98	63.18	-28.2	28.32	53.18	-24.86
0.6175	25.81	56	-30.19	17.82	46	-28.18
0.845	23.52	56	-32.48	16.74	46	-29.26
8.918	40.552293	60	-19.4477	32.542293	50	-17.4577
14.68	26.73	60	-33.27	20.94	50	-29.06

Table 7. Conducted Emissions - Voltage, Worst Case Emissions, AC Power, Neutral Line



Plot 2. Conducted Emission Limits, Neutral Line Plot



## Conducted Emission Limits Test Setup



**Photograph 2. Conducted Emissions Test Setup**



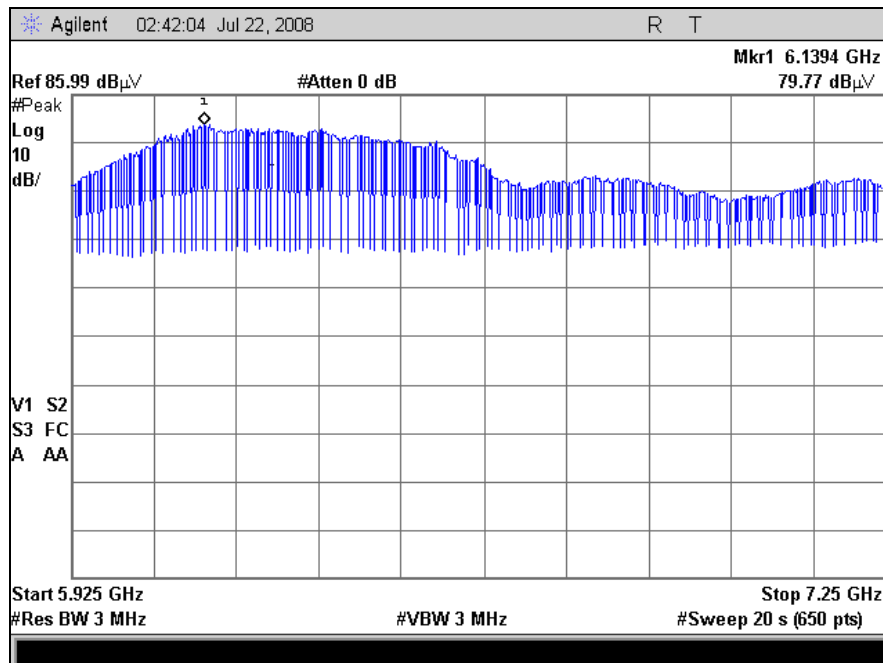
### 3.3. -10 dB Bandwidth Requirements

**Test Requirements:** § 15.250(a)(b): The -10 dB bandwidth of a device operating under the provisions of this section must be contained within the 5925 and 7250 MHz band under all conditions of operation including the effects from stepped frequency, frequency hopping or other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. The -10 dB bandwidth of the fundamental emission shall be at least 50 MHz.

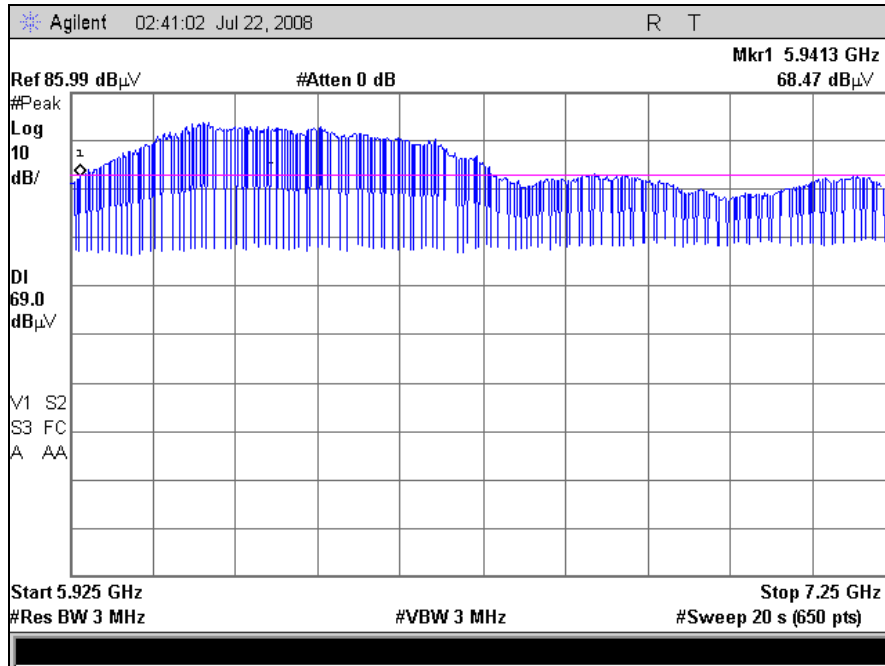
**Test Procedure:** Emissions were measured using a horn antenna placed very close to the EUT. Due to the extremely wide nature of WB emissions, special considerations were taken to make the bandwidth measurements. The RBW was set to 3 MHz and the VBW to 3 MHz. Cable loss, pre-amp, and antenna correction factors have been programmed into spectrum analyzer.

**Test Results** The EUT complied with the requirement(s) of this section.

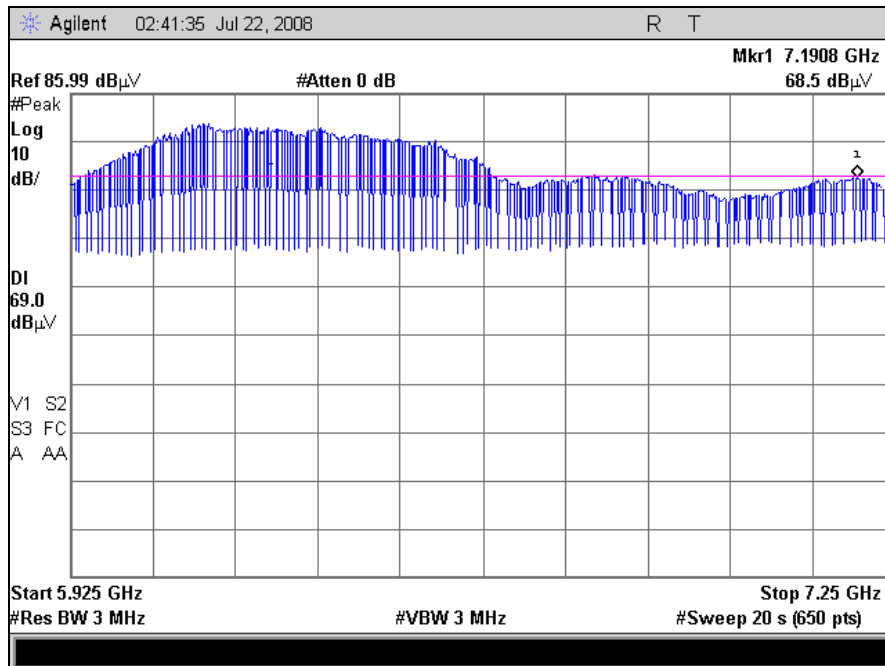
$$f_M = 6.1394 \text{ GHz}, f_L = 5.9413 \text{ GHz}, f_H = 7.1908 \text{ GHz}$$
$$\text{Therefore, -10 dB bandwidth} = f_H - f_L = 1.2495 \text{ GHz}$$



Plot 3. -10 dB Bandwidth, fM



Plot 4. -10 dB Bandwidth, fL



Plot 5. -10 dB Bandwidth, fH



**Photograph 3. -10 dB Bandwidth Requirements, Test Setup**



### 3.4. Operational Restrictions

**Transmitter Requirements:** §15.250(c): Technical Requirements for WB systems.

Operation under the provisions of this section is limited to WB transmitters employed in the following limitations;

- (1) Operation on board an aircraft or a satellite is prohibited.
- (2) Devices operating under this section may not be employed for the operation of toys.
- (3) Except for operation onboard a ship or a terrestrial transportation vehicle, the use of a fixed outdoor infrastructure is prohibited. A fixed infrastructure includes antennas mounted on outdoor structures, e.g., antennas mounted on the outside of a building or on a telephone pole.

**Results:** The client was notified of these requirements.

**Test Engineer:** Dusmantha Tennakoon

**Test Dates:** 08/11/08



### 3.5. Radiated Emissions Above 960 MHz RMS Average

**Test Requirements:** § 15.250 (d)(1): Emissions from a transmitter operating under this section shall not exceed the following equivalent isotropically radiated power (EIRP) density levels:

Radiated Emissions above 960 MHz from a device operating under this section shall not exceed the average limits of Table 8 when measured using a RBW of 1 MHz.

Frequency in MHz	EIRP in dBm
960 - 1610	-75.3
1610 - 1990	-63.3
1990 - 3100	-61.3
3100 - 5925	-51.3
5925-7250	-41.3
7250-10600	-51.3
Above 10600	-61.3

**Table 8. Limits for Radiated Emissions (RBW = 1MHz)**

**Test Procedure:** The EUT was placed on a pedestal inside a semi-anechoic chamber. The pedestal is made from acrylic and Rohacell<sup>®</sup>. A horn antenna was placed 1 m away from the EUT and measurements made. Measurements were performed with the EUT oriented in 3 orthogonal axis and rotated 360 degrees to determine worst case orientation for maximum emissions. Measurements were made at 1m.

The emissions were investigated up to 40 GHz. Cable loss, pre-amp, and antenna correction factors have been programmed into the spectrum analyzer.





**Frequency determining parameters:** The highest frequency employed in §15.33 to determine the frequency range over which radiated emissions are made were based on the center frequency,  $f_c$ , unless a higher frequency was generated within the WB device. For measuring emission levels, the spectrum were investigated from the lowest frequency generated in the WB, without going below 9 kHz, up to the frequency range shown in Section 15.33(a) of the CFR 47 or up to  $f_c + 3/(\text{pulse width in seconds})$ , whichever was higher. There is no requirement to measure emissions beyond 40 GHz provided  $f_c$  was less than 10 GHz; beyond 100 GHz if  $f_c$  was at or above 10 GHz and below 30 GHz; or beyond 200 GHz if  $f_c$  was at or above 30 GHz.

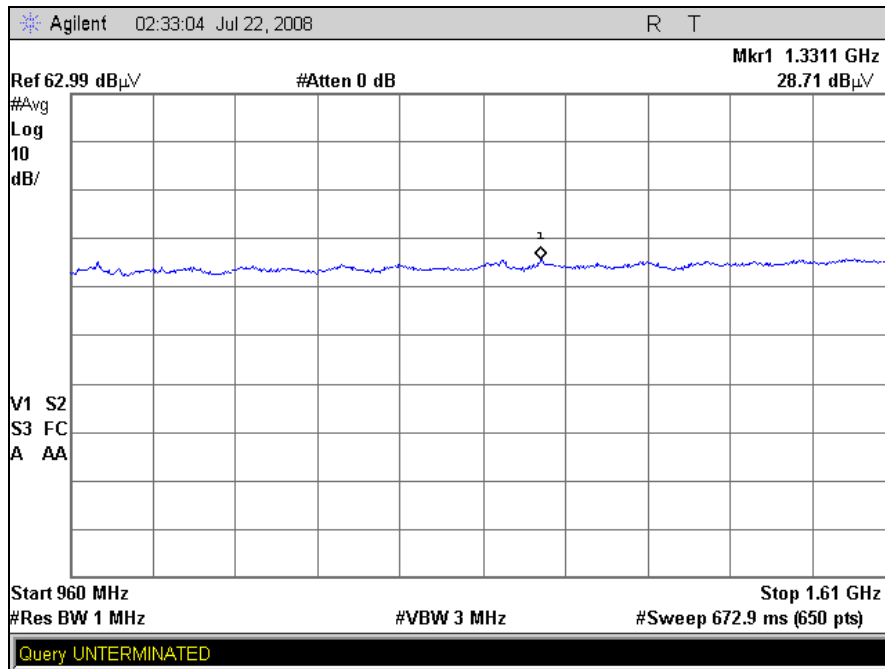
**Calculation of Limit:** The EIRP limit is mathematically converted to the equivalent 3 m field strength using the following equation from §15.521(g):  $E(\text{dBuV/m}) = P(\text{dBm EIRP}) + 95.2$

**Test Results:** The EUT complied with the requirement(s) of this section. There are no detectable emissions from 30 MHz to 40 GHz, except for the fundamental. Emissions were investigated from 18 GHz to 40 GHz and only noise floor was measured.

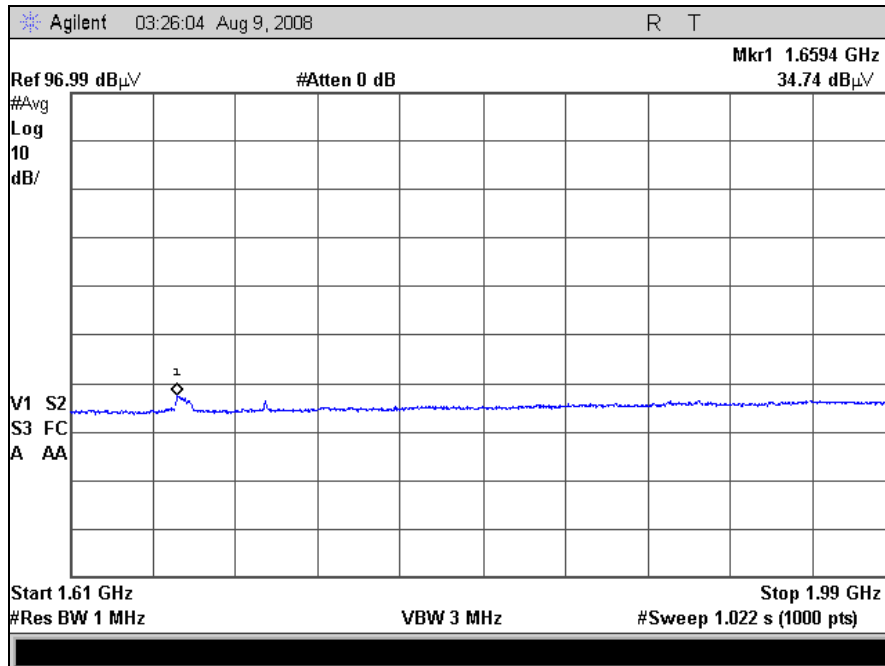
Frequency (GHz)	Antenna Polarity	Measured amplitude (dBuV/m)	Distance correction factor (dB) (-)	Corrected amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
*1.3311	V	28.71	9.54	19.17	19.9	-0.73
1.6594	V	34.74	9.54	25.2	31.9	-6.7
2.9689	V	35.95	9.54	26.41	33.9	-7.49
5.9109	V	48.49	9.54	38.95	43.9	-4.95
6.1662	V	62.4	9.54	52.86	53.9	-1.04

**Table 9. Radiated Emissions Test Results, Above 960 MHz**

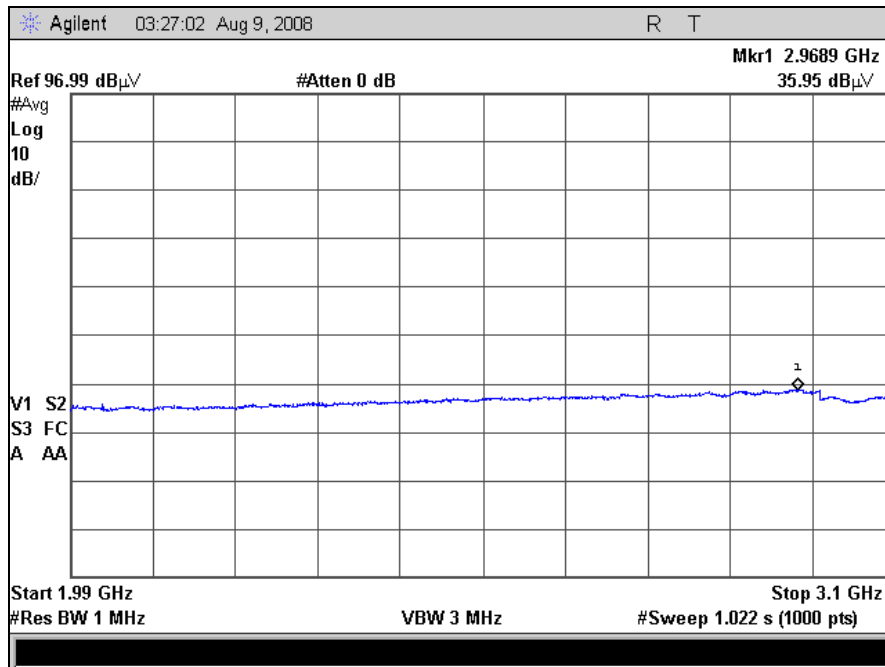
- Notes:
- \* This emission was not from the EUT. Once the EUT was removed from the chamber the emission was still present.
  - The pre-amp, cable loss, and antenna corrections factors have been programmed into spectrum analyzer.



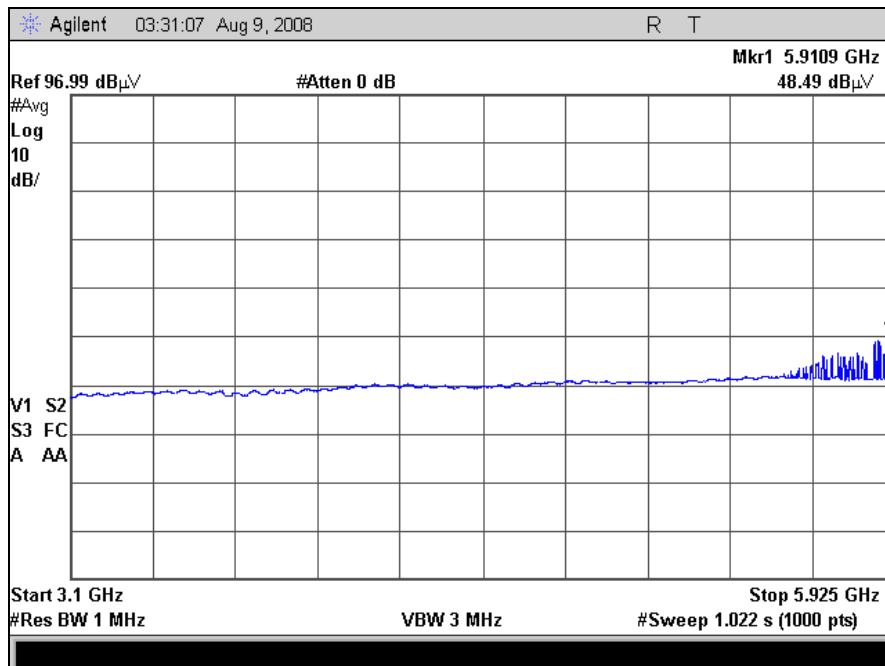
Plot 6. Average, 960 MHz – 1.61 GHz



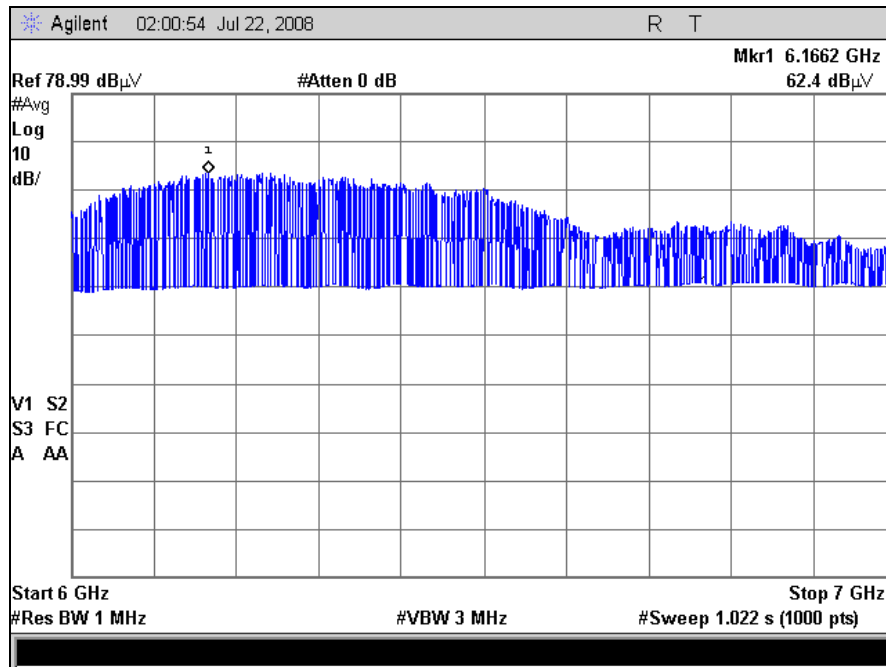
Plot 7. Average, 1.61 – 1.99 GHz



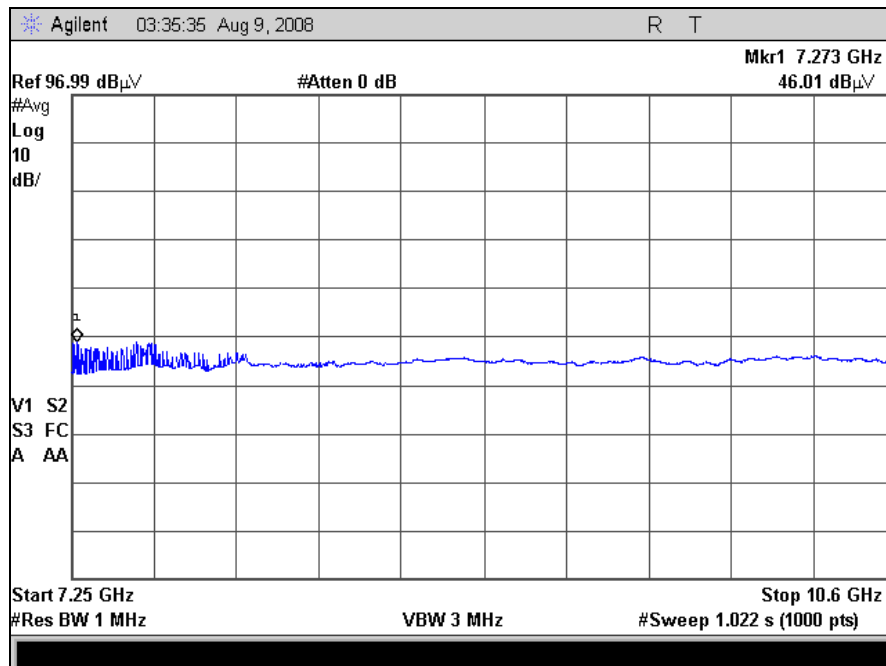
Plot 8. Average, 1.99 – 3.1 GHz



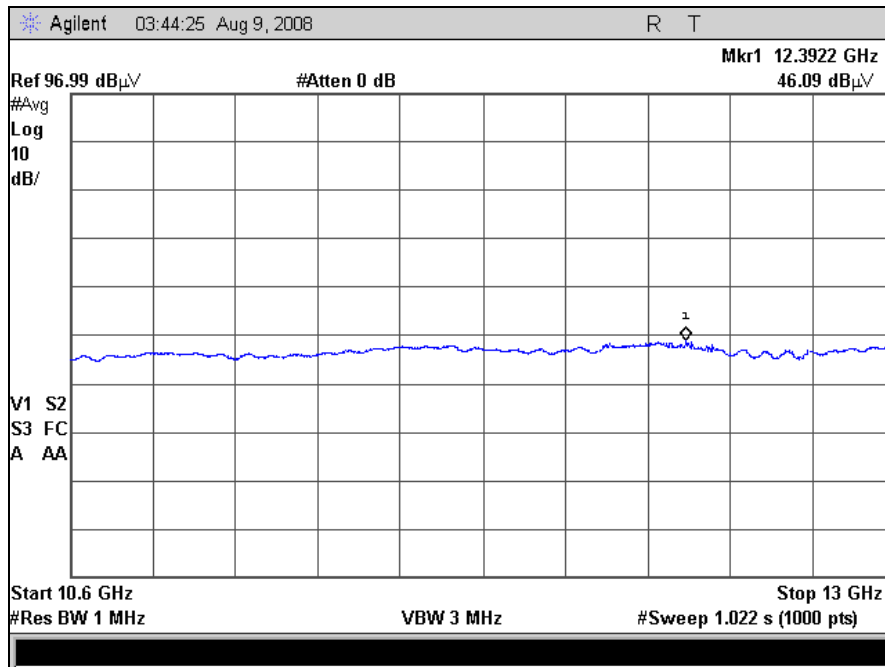
Plot 9. Average, 3.1 – 5.925 GHz



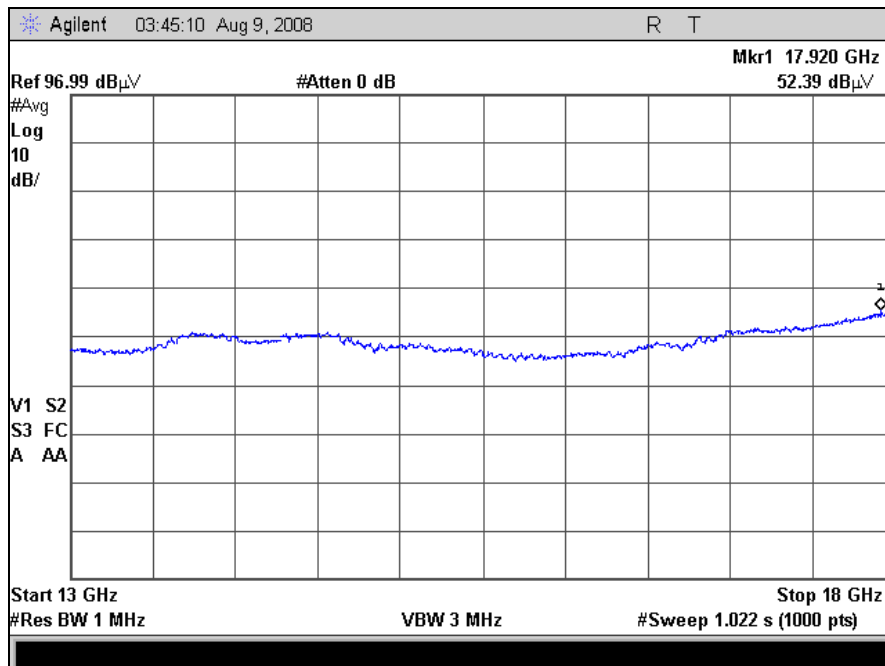
Plot 10. Average, 6 – 7 GHz



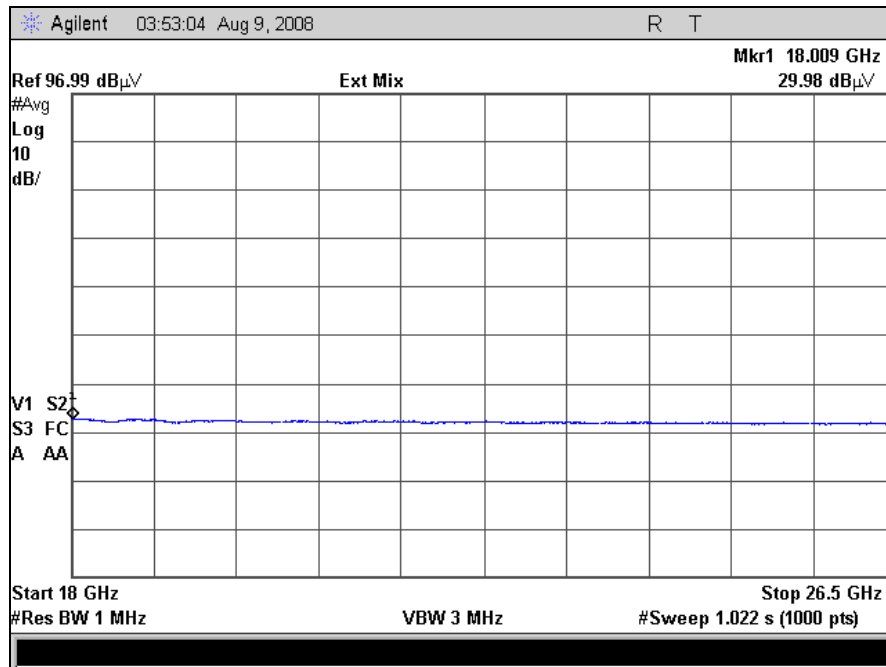
Plot 11. Average, 7.25 – 10.6 GHz



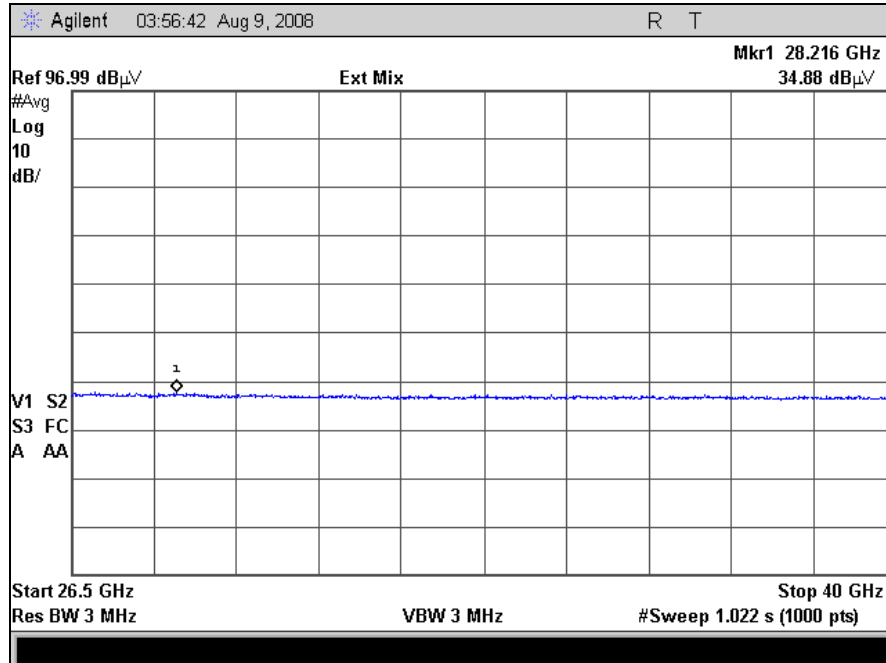
Plot 12. Average, 10.6 – 13 GHz



Plot 13. Average, 13 – 18 GHz



Plot 14. Average, 18GHz – 26.5GHz



Plot 15. Average, 26.5 – 40 GHz

Test Engineer: Dusmantha Tennakoon

Test Date: 08/11/2008



**Photograph 4. 15.250(d)(1) Radiated Emissions Above 960 MHz (RMS Average), Test Setup**



### 3.6. GPS emissions

**Test Requirements:** §15.250(d)(2): In addition to the radiated emission limits specified in the table in paragraph (d)(1) of this section, transmitters operating under the provisions of this section shall not exceed the following RMS average limits when measured using a resolution bandwidth of no less than 1 kHz:

Frequency in MHz	EIRP in dBm
1164 - 1240	-85.3 (9.9 dBuV)
1559 - 1610	-85.3 (9.9 dBuV)

**Table 10. Limits for Radiated Emissions (RBW >= 1kHz)**

**Calculation of Limit:** The EIRP limit is mathematically converted to the equivalent 3 m field strength using the following equation from §15.521(g):  
 $E(\text{dBuV/m}) = P(\text{dBm EIRP}) + 95.2$

**Test Results:** The EUT was compliant with the requirement(s) of this section. Measurements were made at 1 m.

**Test Engineer:** Dusmantha Tennakoon

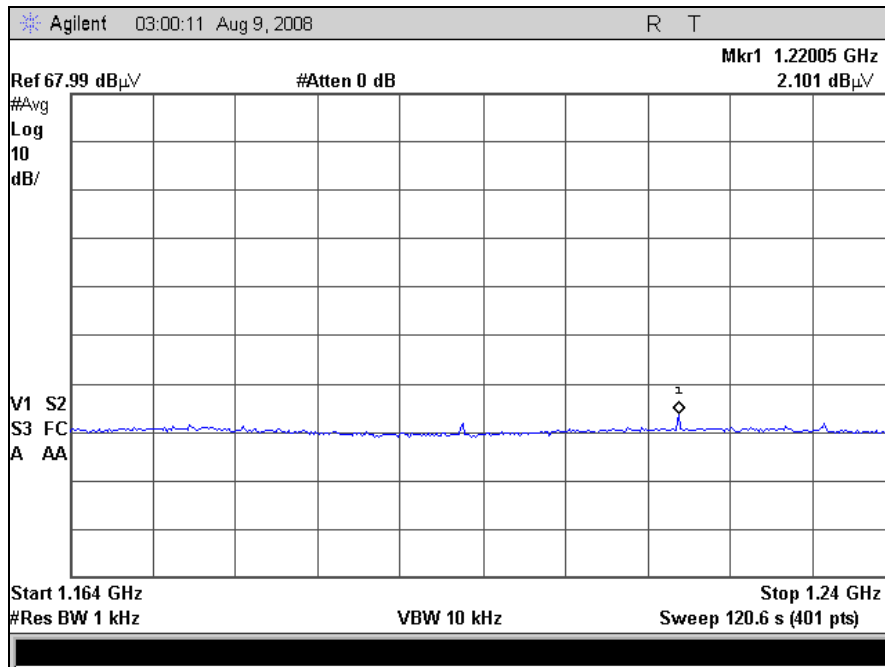
**Test Date:** 08/11/2008

Frequency (GHz)	Antenna Polarity	Measured amplitude (dBuV/m)	Distance correction factor (dB) (-)	Corrected amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
1.22005	V	2.1	9.54	-7.44	9.9	-17.34
1.59993	V	1.35	9.54	-8.19	9.9	-18.09

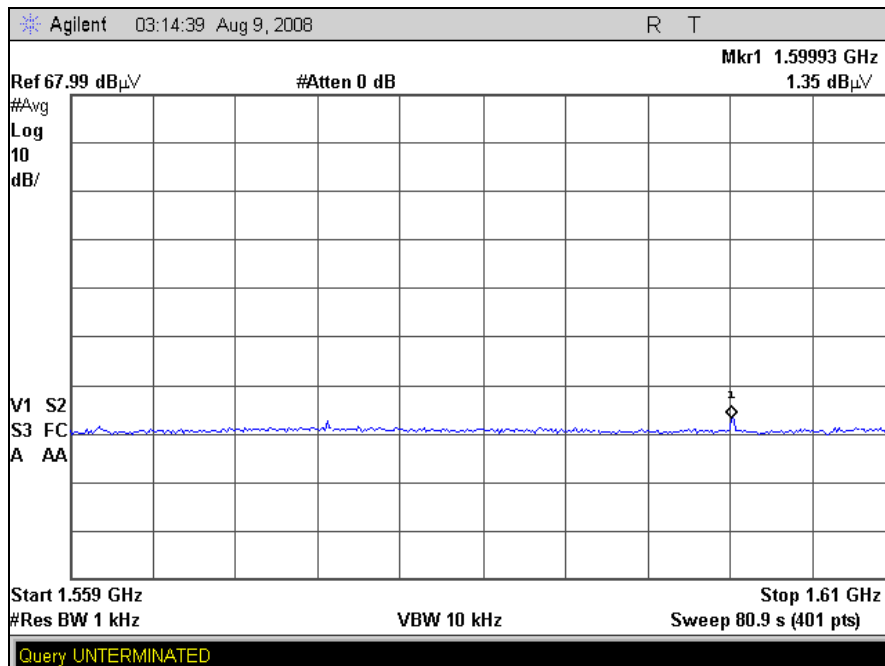
**Table 11. GPS emissions, Test Results**

Note: The pre-amp, cable loss and antenna correction factors have been programmed into spectrum analyzer.





Plot 16. GPS, Band 1



Plot 17. GPS, Band 2



**Photograph 5. GPS Emissions, Test Setup**



### 3.7. Peak Radiated Emissions Requirements

**Test Requirements:** §15.250(d)(3): There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs and this 50 MHz bandwidth must be contained within the 5925–7250 MHz band. The peak EIRP limit is  $20 \log (RBW/50)$  dBm where RBW is the resolution bandwidth in megahertz that is employed by the measurement instrument. RBW shall not be lower than 1 MHz or greater than 50 MHz. The video bandwidth of the measurement instrument shall not be less than RBW. If RBW is greater than 3 MHz, the application for certification filed with the Commission shall contain a detailed description of the test procedure, calibration of the test setup, and the instrumentation employed in the testing.

**Calculation of Limit:** Pursuant to §15.250(d)(3), the peak EIRP limit =  $20 \log (3\text{MHz}/50) = -24.4\text{dBm}$ . The equivalent field strength at 3m =  $(-24.4) + 95.2 = 70.76 \text{ dBuV/m}$ .

**Test Results:** The EUT was found to comply with the requirements of §15.250(d)(3). All cable loss and pre-amp factors have been programmed into spectrum analyzer. Measurements were made at 1 m.

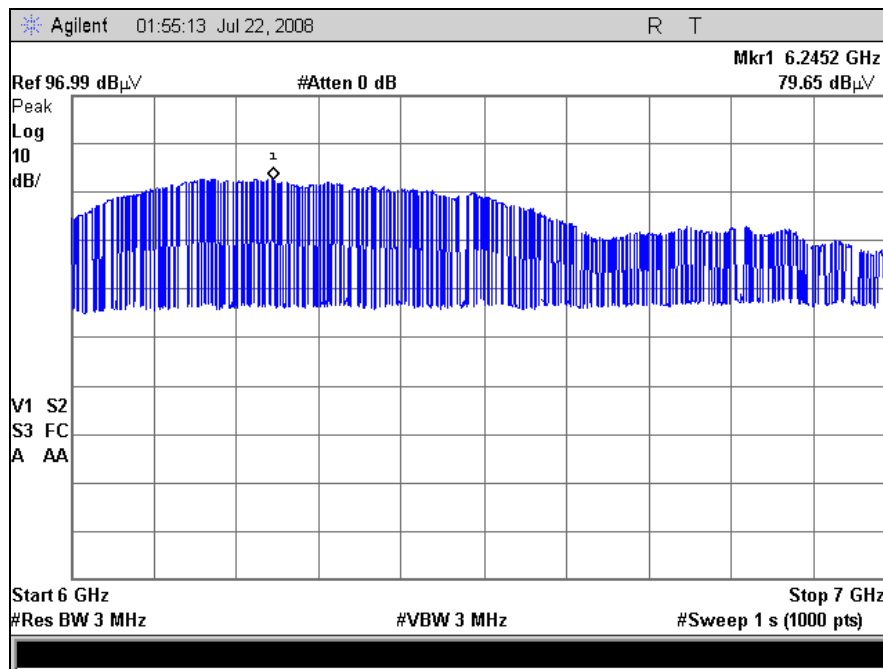
Frequency (GHz)	Antenna Polarity	Measured amplitude @ 1m (dBuV/m)	Distance correction factor (dB) (-)	Corrected amplitude @ 3m (dBuV/m)	Limit (dBuV/m)	Margin (dB)
6.2452	V	79.65	9.54	70.11	70.76	-0.65

**Table 12. Peak Radiated Emissions, Test Results**

- Notes: 1. The pre-amp, cable loss and antenna correction factors have been programmed into spectrum analyzer.  
2. A VBW=3 MHz was used.

**Test Engineer:** Dusmantha Tennakoon

**Test Date:** 08/11/2008



Plot 18. Peak Emissions, 6 – 6.5 GHz



**Photograph 6. Peak Radiated Emissions, Test Setup**



### 3.8. 15.250(d)(4) Radiated emissions below 960 MHz

**Test Requirements:** § 15.250 (d)(4): Radiated emissions at or below 960 MHz shall not exceed the emission levels in § 15.209.

§ 15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in Table 13.

Frequency (MHz)	§15.209(a), Radiated Emission Limits (dBµV) @ 3m
30 - 88	40.00*
88 - 216	43.50*
216 - 960	46.00*
Above 960	54.00

\* -- Except perimeter protection systems operating under paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Subpart.

**Table 13. Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)**

**Test Procedure:** The EUT was placed on a 0.8 m high wooden pedestal inside a semi-anechoic chamber. An antenna was placed near the EUT and measurements of frequencies and amplitudes of field strengths were recorded for reference during final measurements. For final radiated testing, measurements were performed in a semi-anechoic chamber. Measurements were performed with the EUT oriented in 3 orthogonal axis and rotated 360 degrees to determine worst case orientation for maximum emissions.

Measurements of the radiated field were made with the measurement antenna located at a distance of 3 meter from the EUT unless specified otherwise in the measurement results. The antenna was adjusted between 1 m and 4 m in height above the ground plane for maximum meter reading at each test frequency. The antenna-to-EUT azimuth was varied from zero to 360 degrees during the measurement to find the maximum field strength readings. The antenna polarization was varied (horizontal to vertical) during the measurements to find the maximum field strength readings.

For frequencies from 30 MHz to 960 MHz, measurements were made using a quasi-peak detector with a 120 kHz bandwidth.

**Test Results:** The EUT complied with the requirement(s) of this section.

**Test Engineer:** Dusmantha Tennakoon

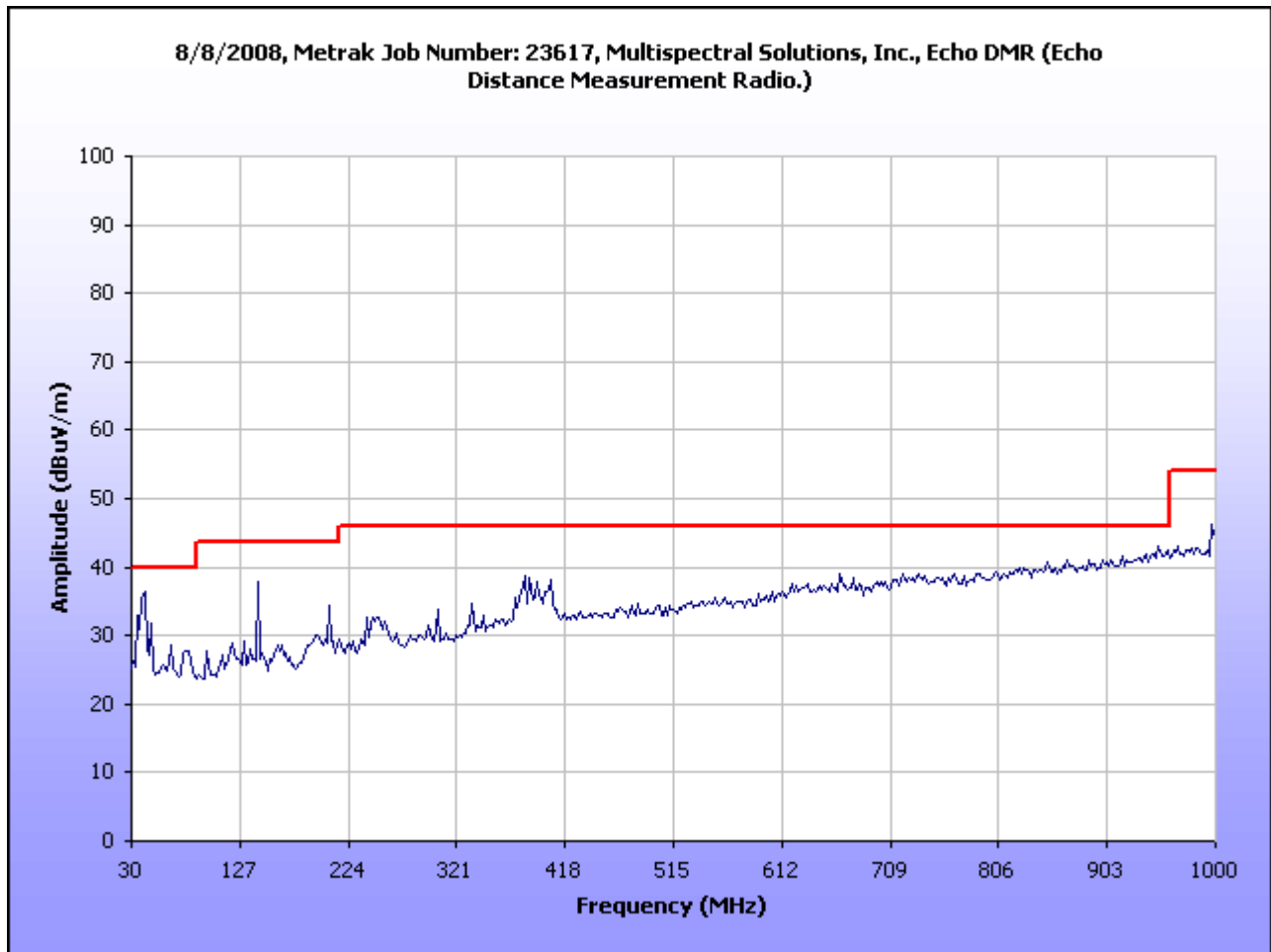
**Test Date:** 08/11/2008



Frequency (MHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna Height (m)	Uncorrected Amplitude (dBu)	Antenna Correction Factor (dB/m) (+)	Cable Loss (dB) (+)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
35.985972	143	H	1	6.3	8.16	0.89	0	15.35	40	-24.65
35.985972	281	V	1	21.03	6.84	0.89	0	28.75	40	-11.25
143.98522	227	H	2.16	23.59	7.96	1.31	0	32.86	43.5	-10.64
143.98522	296	V	1	27.77	7.86	1.31	0	36.94	43.5	-6.56
399.83768	192	H	2.54	6.16	15.40	1.79	0	23.34	46	-22.66
399.83768	302	V	1	10.1	15.31	1.79	0	27.19	46	-18.81
207.13978	284	H	1	21.54	10.49	1.45	0	33.48	43.5	-10.02
207.13978	309	V	2.3	17.22	10.30	1.45	0	28.97	43.5	-14.53
899.98998	284	H	1.64	9.68	22.50	2.67	0	34.85	46	-11.15
899.98998	0	V	1	8.41	22.10	2.67	0	33.18	46	-12.82
335.99198	20	H	1	16.94	13.94	1.74	0	32.62	46	-13.38
335.99198	293	V	1.57	13.5	14.54	1.74	0	29.78	46	-16.22

**Table 14. Radiated Emissions Test Results, Below 960 MHz, USB**

Note : The EUT was tested at 3 m.



Plot 19. Radiated Emissions, Pre-Scan, USB

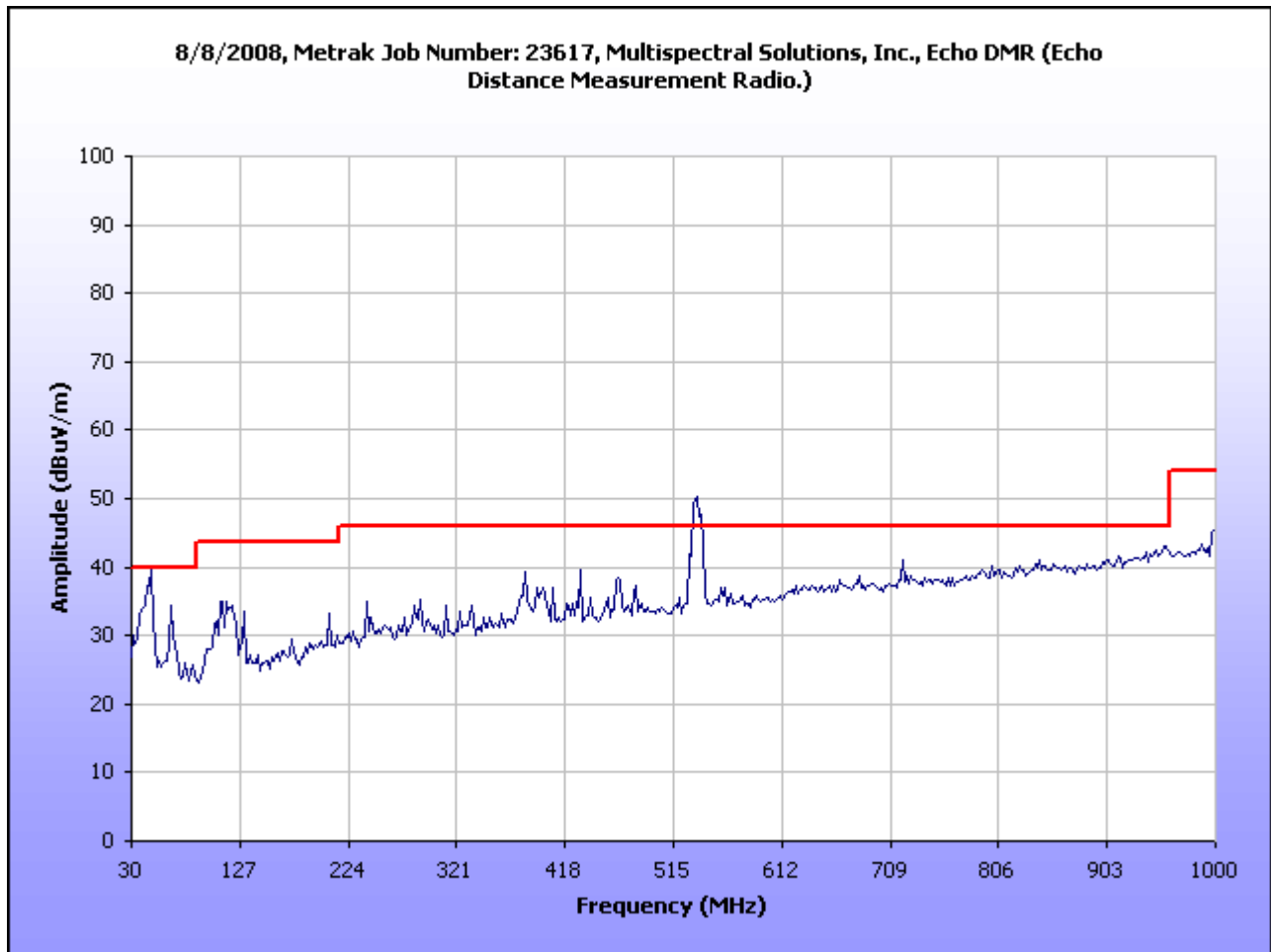




Frequency (MHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna Height (m)	Uncorrected Amplitude (dBuV)	Antenna Correction Factor (dB/m) (+)	Cable Loss (dB) (+)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
535.34068	139	H	1.73	16.05	18.01	2.00	0	36.07	46	-9.93
535.34068	226	V	1	21	18.21	2.00	0	41.21	46	-4.79
48.039579	138	H	3.58	11.12	9.68	1.00	0	21.80	40	-18.20
48.039579	0	V	1	24.58	9.43	1.00	0	35.01	40	-4.99
65.786573	360	H	2.64	14.51	10.36	1.07	0	25.94	40	-14.06
65.786573*	0	V	1	27.85	9.86	1.07	0	38.78	40	-1.22
119.99649	360	H	2.63	21.21	7.30	1.29	0	29.80	43.5	-13.70
119.99649	0	V	1	23.37	7.70	1.29	0	32.36	43.5	-11.14
432.16232	116	H	2.23	20.96	16.21	1.87	0	39.05	46	-6.95
432.16232	106	V	1	18.69	16.53	1.87	0	37.09	46	-8.91
719.98622	138	H	1	11.16	20.70	2.43	0	34.29	46	-11.71
719.98622	116	V	1	16.8	20.80	2.43	0	40.03	46	-5.97

**Table 15. Radiated Emissions Test Results, Below 960 MHz, RS232**

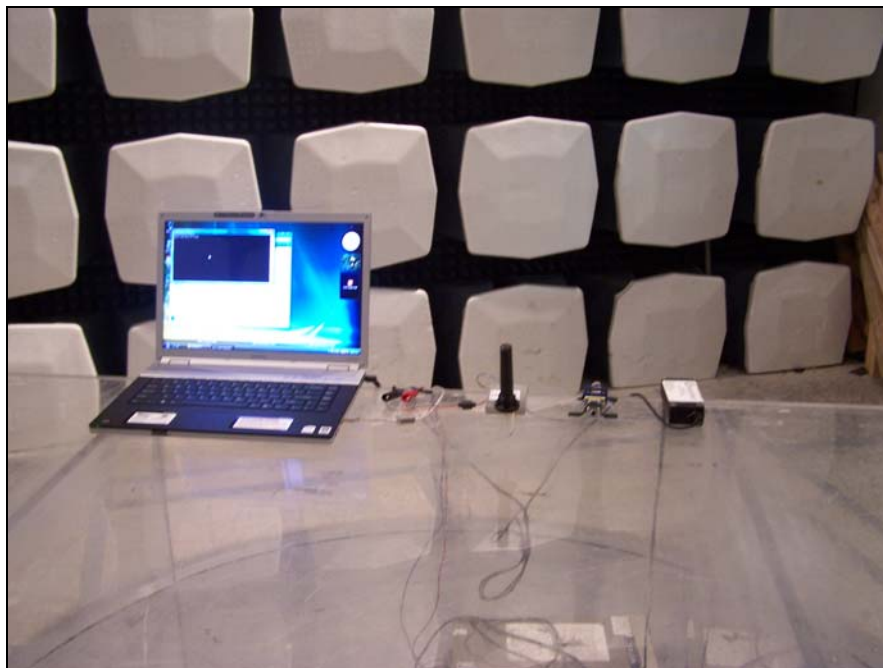
Note : The EUT was tested at 3 m.



Plot 20. Radiated Emissions, Pre-Scan, RS232



**Photograph 7. Radiated Emissions Below 960 MHz, Test Setup, USB**



**Photograph 8. Radiated Emissions Below 960 MHz, Test Setup, RS232**



#### 4. Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ANSI/NCSL Z540-1-1994 and ANSI/ISO/IEC 17025:2000.

Test Name: -10 dB Bandwidth, Radiated Emissions Above 960 MHz				Test Date(s): 8/11/2008	
MET Asset #	Nomenclature	Manufacturer	Model	Last Cal Date	Cal Due Date
1T4352	MOBILE COMMUNICATION DC SOURCE	AGILENT	66311B	SEE NOTE	
1T4442	PRE-AMPLIFIER, MICROWAVE	MITEQ	AFS42-01001800-30-10P	SEE NOTE	
1T2511	ANTENNA; HORN	EMCO	3115	07/29/2008	07/29/2009
1T4300	SEMI-ANECHOIC CHAMBER # 1	EMC TEST SYSTEMS	NONE	02/17/2006	01/17/2009
1T4612	ESA-E SERIES SPECTRUM ANALYZER	AGILENT	E4407B	01/04/2008	01/04/2009
Test Name: Radiated Emissions, Radiated Emissions Below 960 MHz				Test Date(s): 8/11/2008	
MET Asset #	Nomenclature	Manufacturer	Model	Last Cal Date	Cal Due Date
1T4568	RADIATING NOISE SOURCE	MET LABORATORIES	N/A	N/A	N/A
1T4632	THERMO/HYGROMETER	CONTROL COMPANY	S6-627-9	09/25/2007	09/25/2009
1T4303	ANTENNA; BILOG	SCHAFNER - CHASE EMC	CBL6140A	07/07/2008	07/07/2009
1T4300	SEMI-ANECHOIC CHAMBER # 1	EMC TEST SYSTEMS	NONE	02/17/2006	01/17/2009
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	04/18/2008	04/18/2009

Note: Functionally verified test equipment is verified using calibrated instrumentation at the time of testing.



## 5. Compliance Information

### 5.1. Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

#### § 2.801 Radio-frequency device defined.

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

- (a) The various types of radio communication transmitting devices described throughout this chapter.
- (b) *The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.*
- (c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.
- (d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

#### § 2.803 Marketing of radio frequency devices prior to equipment authorization.

- (a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:
  - (1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or
  - (2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.
- (d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.



- (e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:
- (i) *Compliance testing;*
  - (ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;
  - (iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;
  - (iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or
  - (v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.
- (e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.
- (f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.



**The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, and Subpart J— Equipment Authorization Procedures:**

**§ 2.901 Basis and Purpose**

- (a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.<sup>1</sup> *In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer*, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.
- (b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, and the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant.

**§ 2.907 Certification**

- (a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.
- (b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

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<sup>1</sup> In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart B (of Part 15), which deals with unintentional radiators.



**§ 2.948 Description of measurement facilities.**

- (a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.
  - (1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.
    - (i) *If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.*
    - (ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.
  - (2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.