Global EMC Inc. Labs

EMC & RF Test Report

As per

RSS 210 Issue 8:2010

&

FCC Part 15 Subpart C:2013

Unlicensed Intentional Radiators

on the

Hornet/Z357PA20

Min Xie
Project Engineer
11 Gordon Collins Dr,
Gormley, ON, L0H 1G0 Canada
Ph: (905) 883-8189

Testing produced for

MMB Research

See Appendix A for full customer & EUT details.

Industry Canada
LAB REGISTRATION #6844A-3

FCC REGISTRATION #377448

R-4023 C-4498

Testing Laboratory Certificate #2555.01

Table of Contents

Report Scope

This report addresses the EMC verification testing and test results of the MMB Research Hornet /Z357PA20, herein referred to as EUT (Equipment Under Test) performed at Global EMC Labs.

The EUT was tested for compliance against the following standards:

RSS 210 Issue 8:2010
FCC Part 15 Subpart C 15:2013

Test procedures, results, justifications, and engineering considerations, if any, follow later in this report.

The results contained in this report relate only to the item(s) tested.

This report does not imply product endorsement by A2LA or any other accreditation agency, any government, or Global EMC Inc.

Opinions/interpretations expressed in this report, if any, are outside the scope of Global EMC Inc accreditation. Any opinions expressed do not necessarily reflect the opinions of Global EMC Inc, unless otherwise stated.

Client	**MMB Research Inc**
Product	Hornet /Z357PA20
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2013

Summary

The results contained in this report relate only to the item(s) tested.

EUT FCC Certification #, FCC ID:	XFFZ357PA20
EUT Industry Canada Certification #, IC:	8365A- Z357PA20
EUT Passed all tests performed.	Yes (see test results summary)
Tests conducted by	Min Xie

Client	**MMB Research Inc**
Product	Hornet /Z357PA20
Standard(s)	RSS 210 Issue 8:2010 / FCC Part 15 Subpart C 15:2013

Test Results Summary

Standard/Method	Description	Class/Limit	Result
FCC 15.203	Antenna Requirement	Unique	Pass See Justification
FCC 15.205 RSS 210 (Table 1)	Restricted Bands for intentional operation	QuasiPeak Average	Pass
FCC 15.207	Power line conducted emissions	QuasiPeak Average	Pass
FCC 15.209 RSS-210 (Table 2)	Spurious Radiated emissions	QuasiPeak Average	Pass
FCC 15.247(a)2 RSS-210 A8.2(a)	6 dB Bandwidth	> 500 kHz	Pass
FCC 15.247(b)2 RSS-210 A8.4(4)	Max output power	< 1 Watt	Pass
FCC 15.247(b)(4) RSS-210 A8.4(5)	Antenna Gain	< 6 dBi	Pass See Justifications
FCC 15.247(d) RSS-210 A8.5	Antenna conducted spurious	< 20 dBc	Pass
FCC 15.247(e) RSS-210 A8.2(b)	Spectral Density	< 8 dBm (3 kHz BW)	Pass
FCC 15.247(i) IC Safety code 6	Maximum Permissible Exposure	> 20 cm separation.	Pass See justification and calculations
Overall Result			**PASS**

All tests were performed by Min Xie.

If the product as tested or otherwise complies with the specification, the EUT is deemed to comply with the requirement and is deemed a ‘PASS’ grade. If not ‘FAIL’ grade will be issued. Note that ‘PASS’ / ‘FAIL’ grade is independent of any measurement uncertainties. A ‘PASS’ / ‘FAIL’ grade within measurement uncertainty is marked with a ‘*’.

Justifications, Descriptions, or Deviations

The following justifications for tests not performed or deviations from the above listed specifications apply:

For the Antenna requirement specified in FCC 15.203 (RSS 210 section 5.5), the unit uses a ceramic chip antenna (0.5 dbi gain - Johanson 2450AT43A100) or a External antenna (5.0 dBi gain – Mag Layers EDA-1713-2G4C1-A2) with less than 6 dBi gain for both. The antennas are mutually exclusive. Spurious emissions and band edges were measured for both of them. Worst case emissions are shown in the report below.

For the Restricted Bands of operation, the EUT is designed to only operate between 2400 – 2483.5 MHz.

For maximum permissible exposure, this device operates at less than 1 Watt at 2400 – 2483.5 MHz and is designed to operate greater than 20 cm from personnel during normal operation. No testing is required, however worst case calculated exposure compliance follows later in this report.

The EUT is not a hybrid system and FCC 15.247 (f) does not apply to it. However the 15.247 (d) requirement of power density were met and are detailed later in this test report.

For the scope of this test report the EUT was mounted in three orthogonal axes to maximize emissions. Worst case results are presented.

Applicable Standards, Specifications and Methods

ANSI C63.4:2009	- Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10:2009	- American national standard for testing unlicensed wireless devices
CFR 47 FCC 15	- Code of Federal Regulations – Radio Frequency Devices
CISPR 22:2008	- Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement
FCC KDB 558074	- FCC KDB 558074 Digital Transmission Systems, measurements and procedures
ICES-003:2012	- Digital Apparatus - Spectrum Management and Telecommunications Policy Interference-Causing Equipment Standard
ISO 17025:2005	- General Requirements for the competence of testing and calibration laboratories
RSS-GEN	General Requirements and Information for the Certification of Radio Apparatus
RSS 210:2010	- Issue 8: Spectrum Management and Telecommunications Policy. Radio Standards Specification Low Power License-Exempt Radiocommunication Devices

Sample calculation(s)

Margin = limit – (received signal + antenna factor + cable loss – pre-amp gain)
Margin = 50.5dBuV/m – (50dBuV + 10dB + 2.5dB – 20dB)
Margin = 8.5 dB

Document Revision Status

Revision 1 - July 11, 2013
Initial release

Definitions and Acronyms

The following definitions and acronyms are applicable in this report.
See also ANSI C63.14.

AE – Auxiallary Equipment.

BW – Bandwidth. Unless otherwise stated, this is refers to the 6 dB bandwidth.

EMC – Electro-Magnetic Compatibility

EMI – Electro-Magnetic Immunity

EUT – Equipment Under Test

ITE – Information Technology Equipment with a primary function(s) of entry, storage, display, retrieval, transmission, processing, switching, or control, of data.

LISN – Line impedance stabilization network

NCR – No Calibration Required

RF – Radio Frequency

Testing Facility

Testing for EMC on the EUT was carried out at Global EMC labs in Toronto, Ontario, Canada. The testing lab consists of a 3m semi-anechoic chamber calibrated to be able to allow measurements on an EUT with a maximum width or length of up to 2m and height up to 3m. The chamber is equipped with a turn table that is capable of testing devices up to 3300lb in weight. This facility is capable of testing products that are rated for 120 Vac and 240Vac single phase, or 208 Vac 3 phase input. DC capability is also available. The chamber is equipped with an antenna mast that controls polarization and height from the control room adjoining the shielded chamber. Radiated emissions measurements are performed using a Bilog, and Horn antenna where applicable. Conducted emissions, unless otherwise stated, are performed using a LISN.

Calibrations and Accreditations

The 3m semi-anechoic chamber is registered with Federal Communications Commission (FCC, 377448), Industry Canada (IC, 6844A-3) and VCCI (R-4023 and C-4498). This semi-anechoic chamber complies with the requirements of EN55016-2-3:2006, section 7.5 and the site attenuation requirements of EN55016-1-4. This chamber was additionally calibrated for Normalized Site Attenuation (NSA) using test procedures outlined in ANSI C63.4 “Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz”. The chamber is lined with ferrite tiles and absorption cones to minimize any undesired reflections. The NSA data is kept on file at Global EMC. For radiated susceptibility testing, a 16 point field calibration has been performed on the chamber. The field uniformity data is kept on file at Global EMC. Global EMC Inc is accredited to ISO 17025 by A2LA with Testing Certificate #2555.01. The laboratories current scope of accreditation listing can be found as listed on the A2LA website. All measuring equipment is calibrated on an annual or bi-annual basis as listed for each respective test.

Testing Environmental Conditions and Dates

Following were the environmental conditions in the facility during time of testing –

Date	Test	Init.	Temperature (ºC)	Humidity (%)	Pressure (kPa)
July 2- 5, 2013	All	MX	21-25ºC	35 - 41%	98 -103kPa

Detailed Test Results Section

6dB Bandwidth of Digitally Modulated Systems

Purpose

The purpose of this test is to ensure that the bandwidth occupied exceeds a stated minimum. This helps ensure the utilization of the frequency allocation is sufficiently wide. This also helps prevent corruption of data by ensuring adequate data separation to distinguish the reception of the intended information.

Limits

The Limit is as specified in FCC Part 15 and RSS 210.

Systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz. This should be measured with a 100 kHz RBW and a 300 kHz VBW.

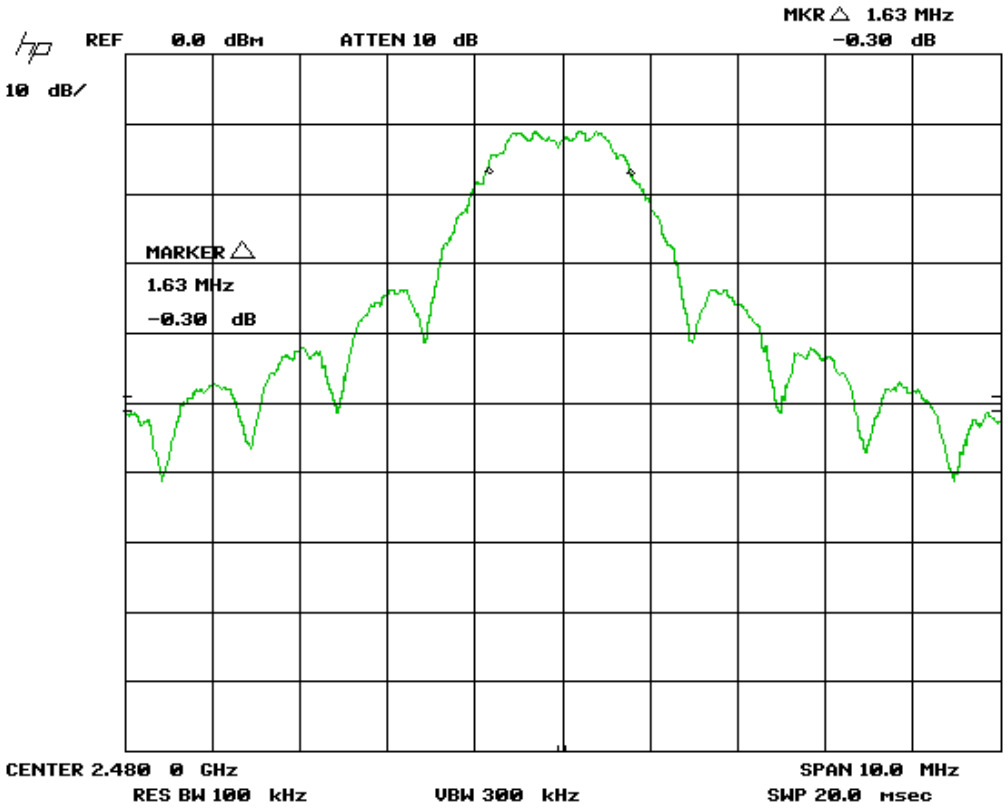
Results

The EUT passed. The minimum 6 dB BW measured was 1.60 MHz and the 20 dB BW is 2.68 MHz.

Graph(s)

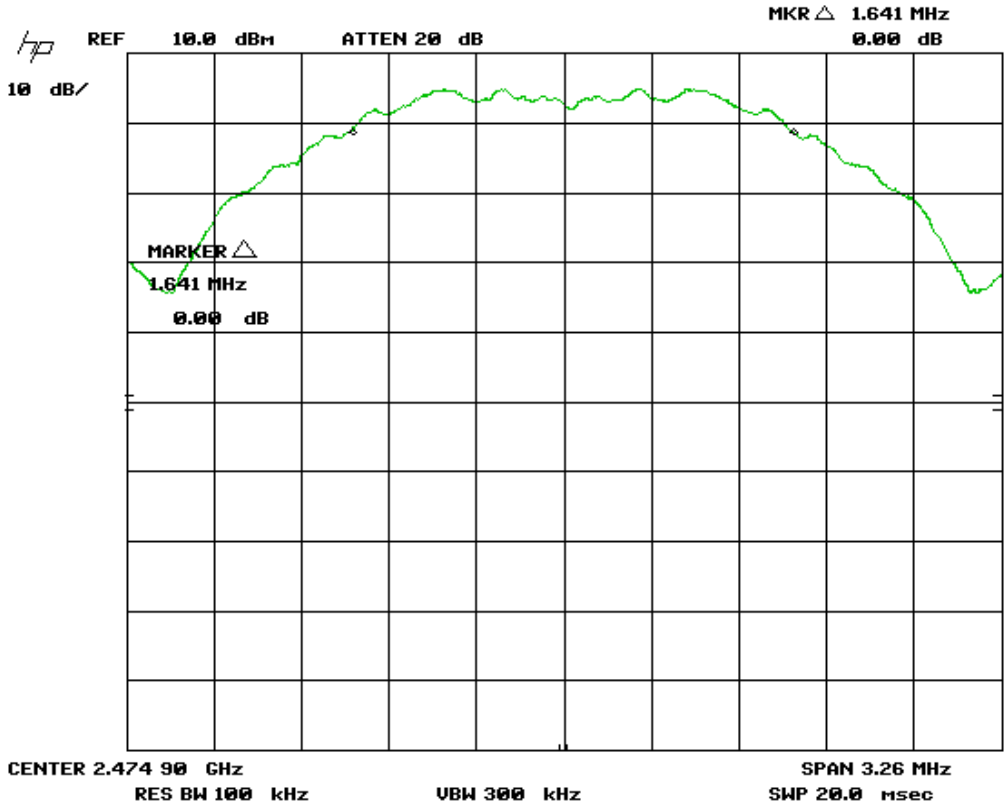
The graphs showed below shows the OBW during the operation of the device. This is measured by a max hold on the spectrum analyzer and the highest resolution bandwidth that is sufficiently low to exhibit the 6 dB bandwidth of a channel during operation of the EUT. This measurement is a peak measurement. Max hold is performed for a duration of not less then 1 minute.

Hi Channel



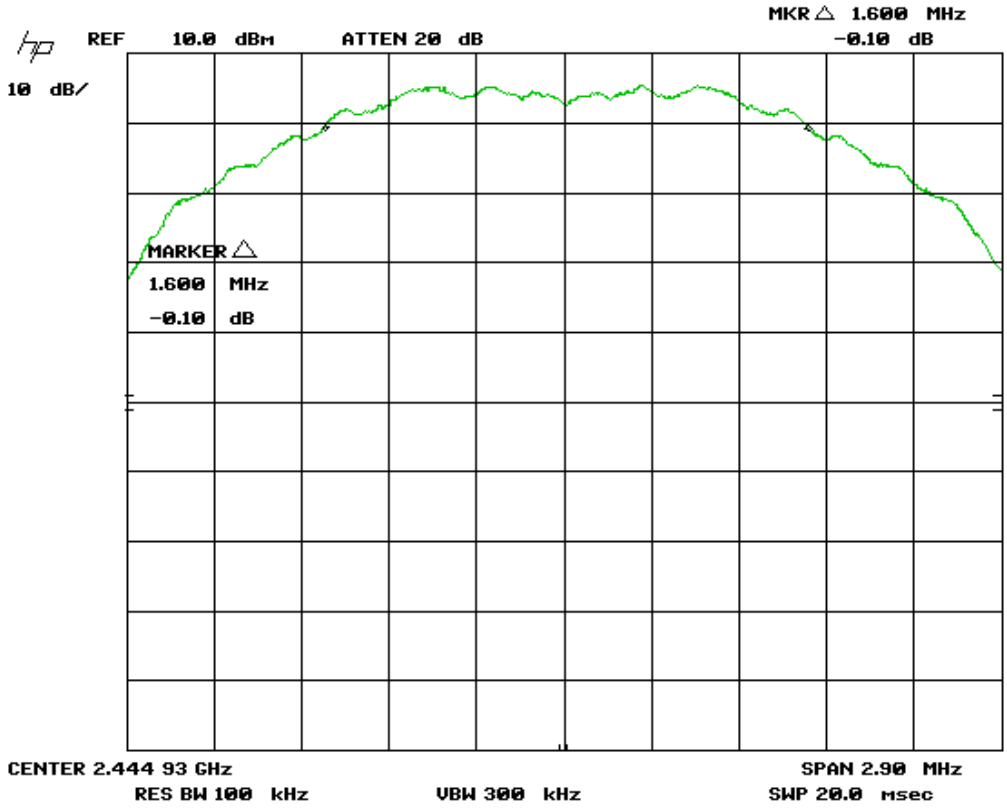
6 dB BW = 1.63 MHz
20 dB BW = 2.76 MHz

Channel 25



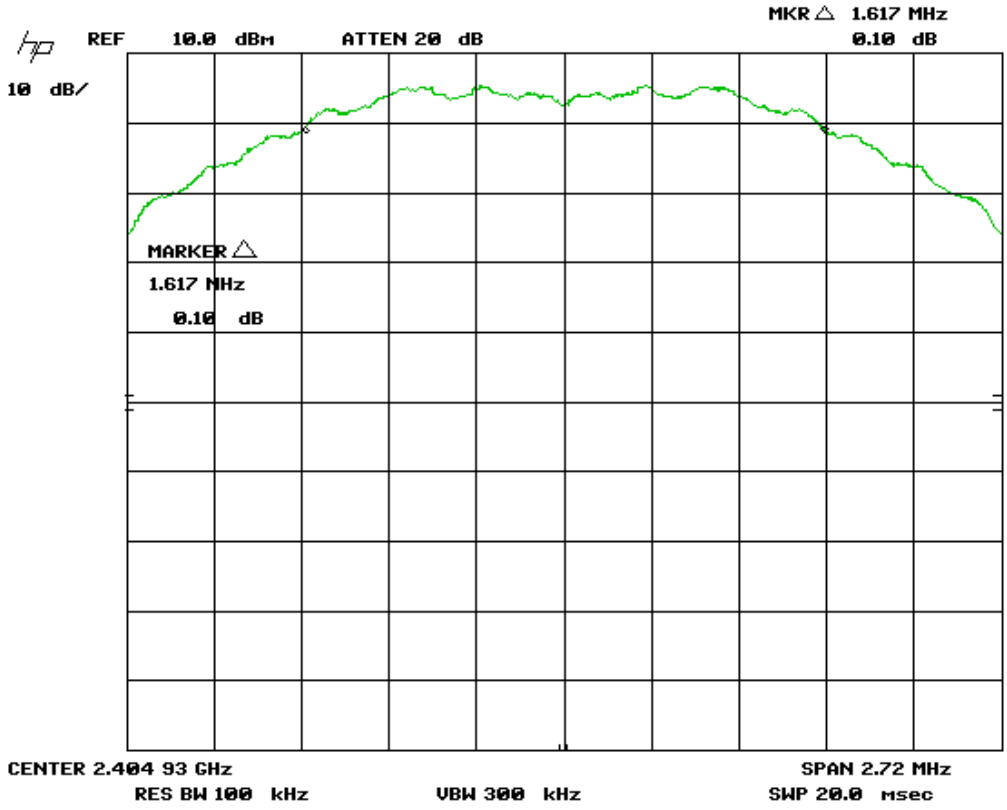
6 dB BW = 1.64 MHz
20 dB BW = 2.69 MHz

Mid Channel



6 dB BW = 1.60 MHz
20 dB BW = 2.68 MHz

Low Channel



6 dB BW = 1.62 MHz
20 dB BW = 2.69 MHz

Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Quasi Peak Adapter	85650A	HP	12/21/ 2011	12/21/2013	GEMC 7
Spectrum Analyzer	8566B	HP	12/21/ 2011	12/21/2013	GEMC 141
Attenuator 10 dB	8493B	Agilent	NCR	NCR	GEMC 133
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Maximum Peak Envelope Conducted Power - DM

Purpose

The purpose of this test is to ensure that the maximum power conducted to the radiating element does not exceed the limits specified. This ensures that if the end-user replaces the antenna, that the maximum power does not exceed an amount which may create an an excessive power level.

Limits

The limits are defined in FCC Part 15.247(b) and RSS 210.
For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands, the peak limit is 1 watt.

Results

The EUT passed. The power of the EUT was set to (-2 dBm for channels 0xB to 0x19 and to -20 dBm for channel 0x1A) for the internal antenna and for the external antenna it was set to (-11 dBm for channels 0xB to 0x19 and -26 dBm for channel 0x1A). Three Channels 0xB, 0x13, and 0x19 were measured for each channel range. The following table show the peak powers measured

Internal Antenna			
Channel	Frequency (MHz)	Power (dBm)	Power (mW)
Lo Channel (0xB)	2404.94	18.9	77.6
Mid Channel (0x13)	2444.97	19.1	81.3
Hi Channel (0x19)	2474.93	19.2	83.2
Hi Channel (0x1A)	2479.44	2.5	1.8

Internal Antenna			
Channel	Frequency (MHz)	Power (dBm)	Power (mW)
Lo Channel (0xB)	2404.94	11.1	12.9
Mid Channel (0x13)	2444.97	12.0	15.8
Hi Channel (0x19)	2474.93	12.5	17.9
Hi Channel (0x1A)	2479.44	-4.1	0.4

Table(s)

The photos shown below shows the peak power output of the device during the antenna conducted measurement during transmit operation of the EUT.

Tests were conducted using a power meter.

Figure 1: Maximum power of Lo, Mid, and Channel-25 channels using -2 dBm (actual power) setting in SW

Figure 2: Hi (Channel-26) channel using -20 dBm (actual power) setting in SW

Figure 3: Maximum power of Lo, Mid, and Channel 25 using -11 dBm (actual power) setting in SW

Figure 4: Hi (Channel-26) channel using -26 dBm (actual power) setting in SW

Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Power Head	PH 2000	AR	2013-02-07	2015-02-07	GEMC 15
Power meter	PM 2002	AR	2013-02-07	2015-02-07	GEMC 16
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Antenna Spurious Conducted Emissions (-20 dBc Requirement)

Purpose

The purpose of this test is to ensure that the maximum power conducted to the radiating element at frequencies outside of the authorized spectrum does not exceed the limits specified. This ensures that the only the intended signal is delivered to the radiating element.

Limits

The limits are defined in 15.247(d). In any 100 kHz band, the peak spurious harmonics emissions must be at least 20 dB below the fundamental. Spurious Conducted emissions are to be evaluated up to the 10^{th} harmonic. This -20 dBc requirement also applies at the 'band edge' or 2.4 GHz and 2.4835 GHz.

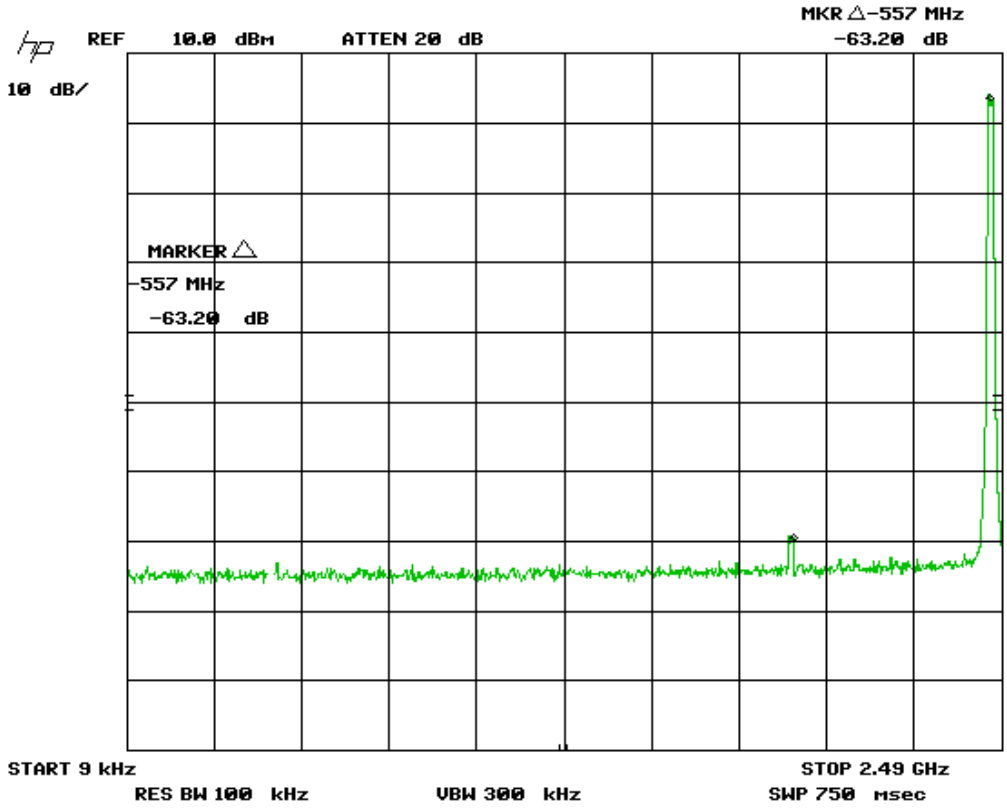
Results

The EUT passed the limits. Low, middle and high band was measured. The worst case is presented as a graph for the spectrum. The -20 dBc requirement is shown for the lower band edge at 2.4 GHz in the low band. The -20 dBc requirement is also shown for the higher band edge at 2.4835 GHz in the high band.

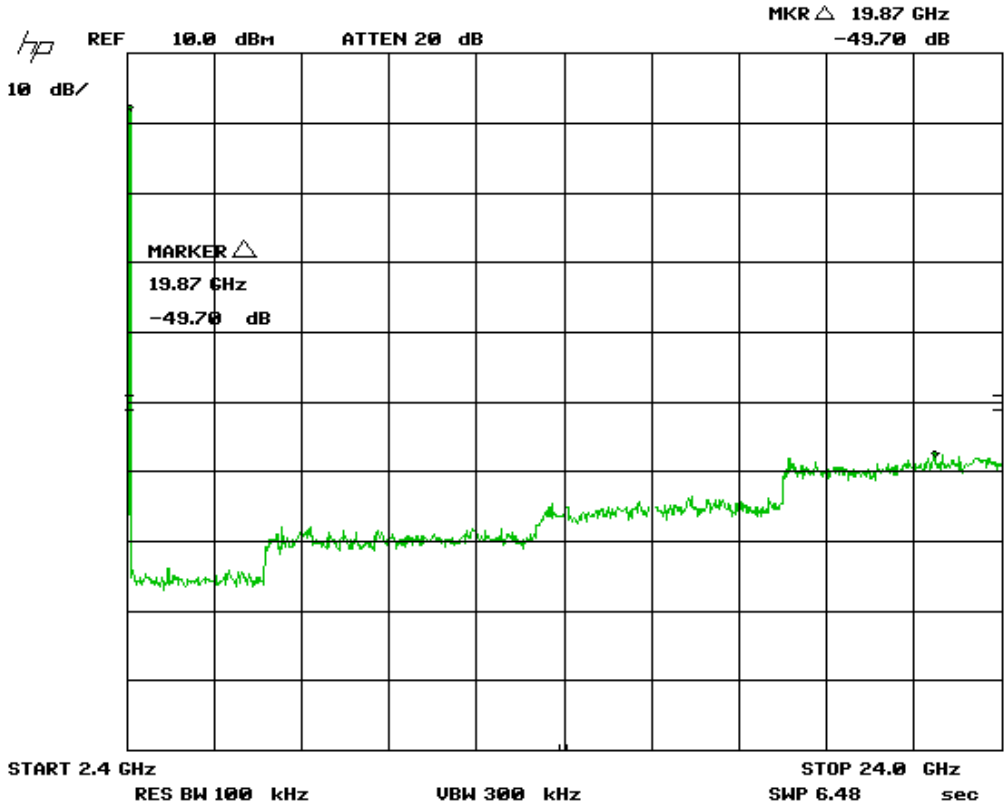
Graph(s)

The graphs shown below shows the peak power output of the device during the antenna conducted measurement during transmit operation of the EUT.

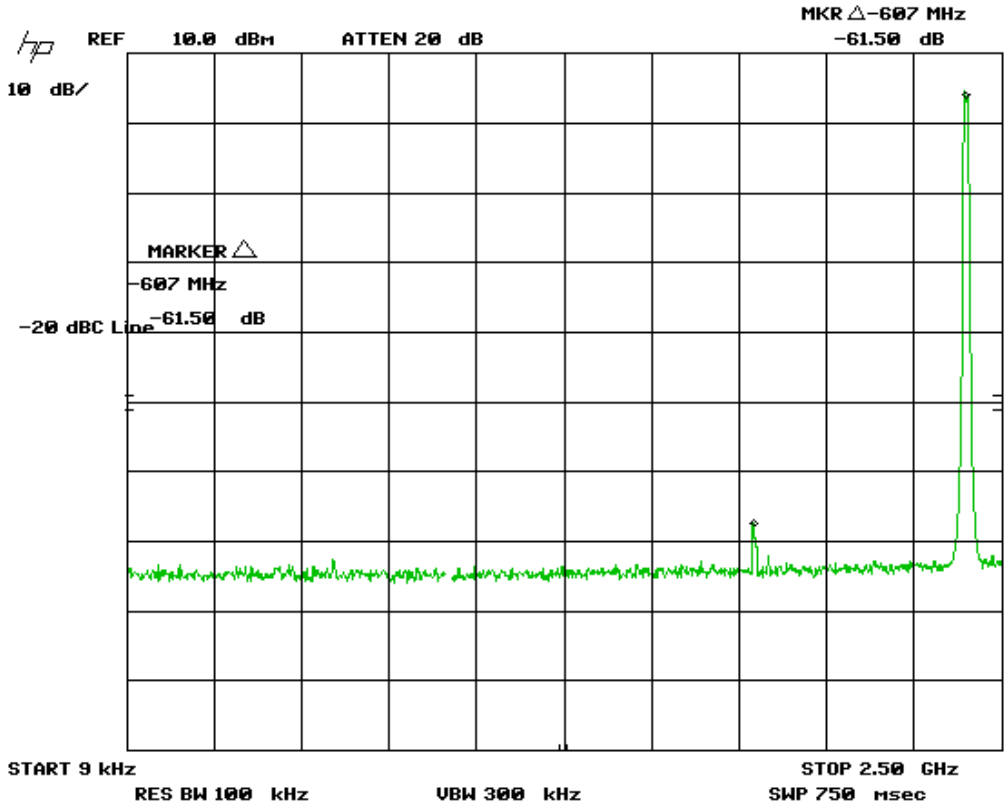
Hi Channel 9 kHz – 2.5 GHz



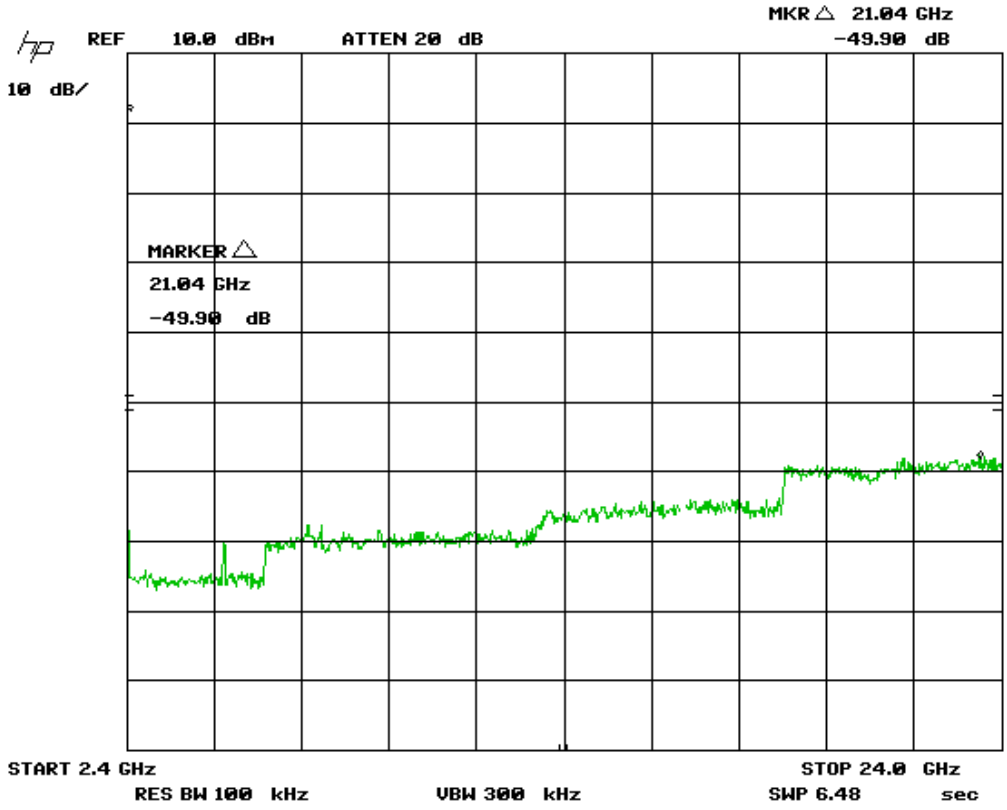
Hi Channel 2.4 GHz – 24 GHz



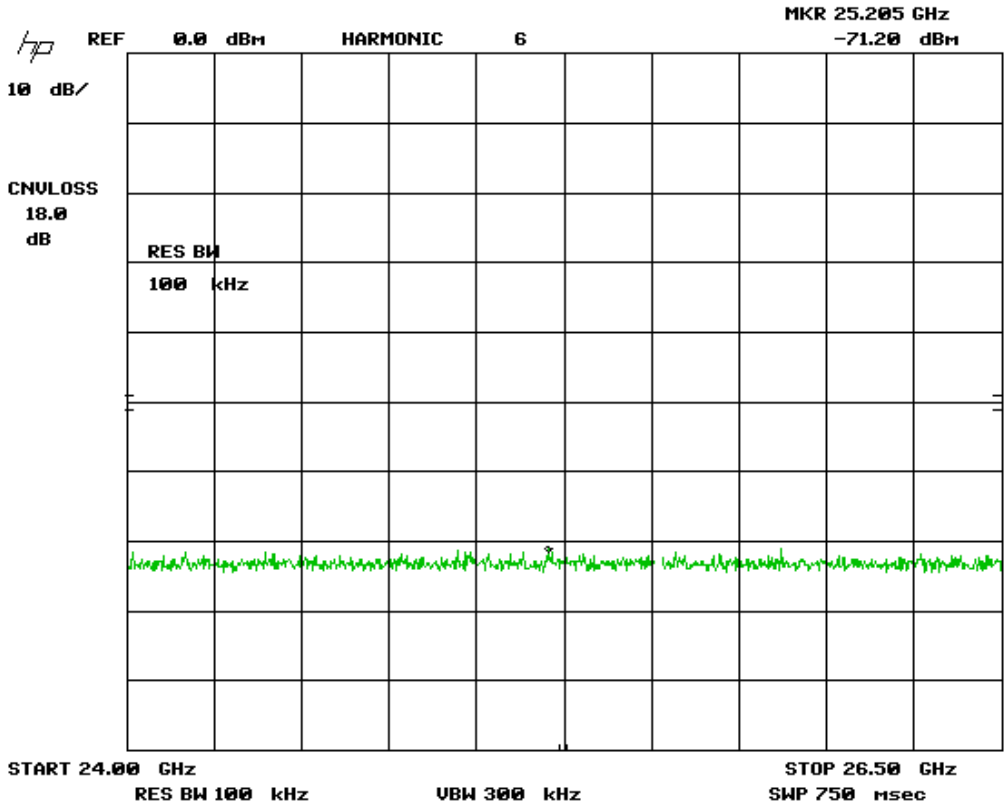
Low Channel 9 kHz – 2.5 GHz



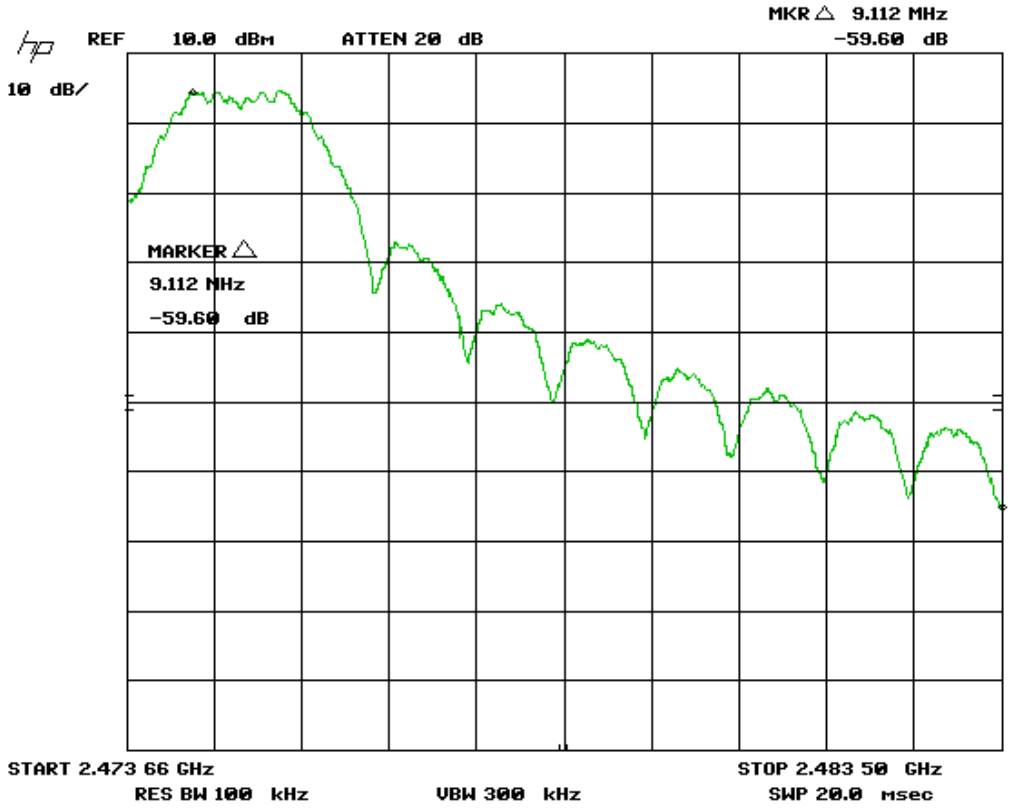
Low Channel 2.4 GHz – 24 GHz



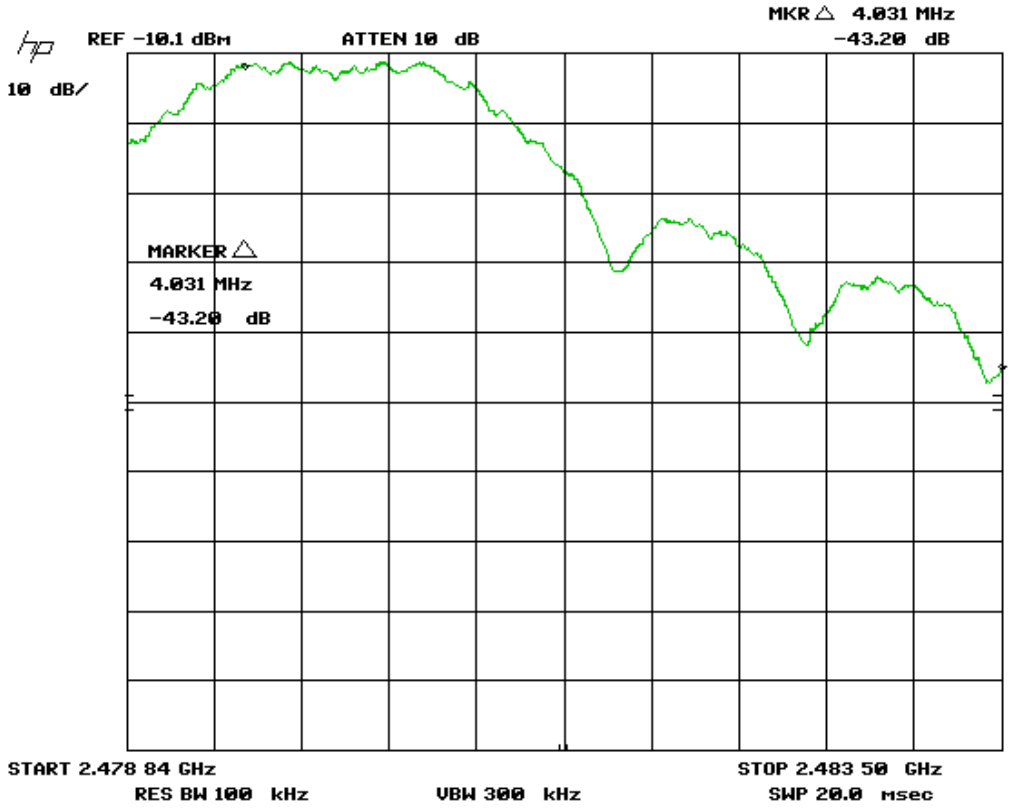
Low Channel 24 GHz – 26 GHz



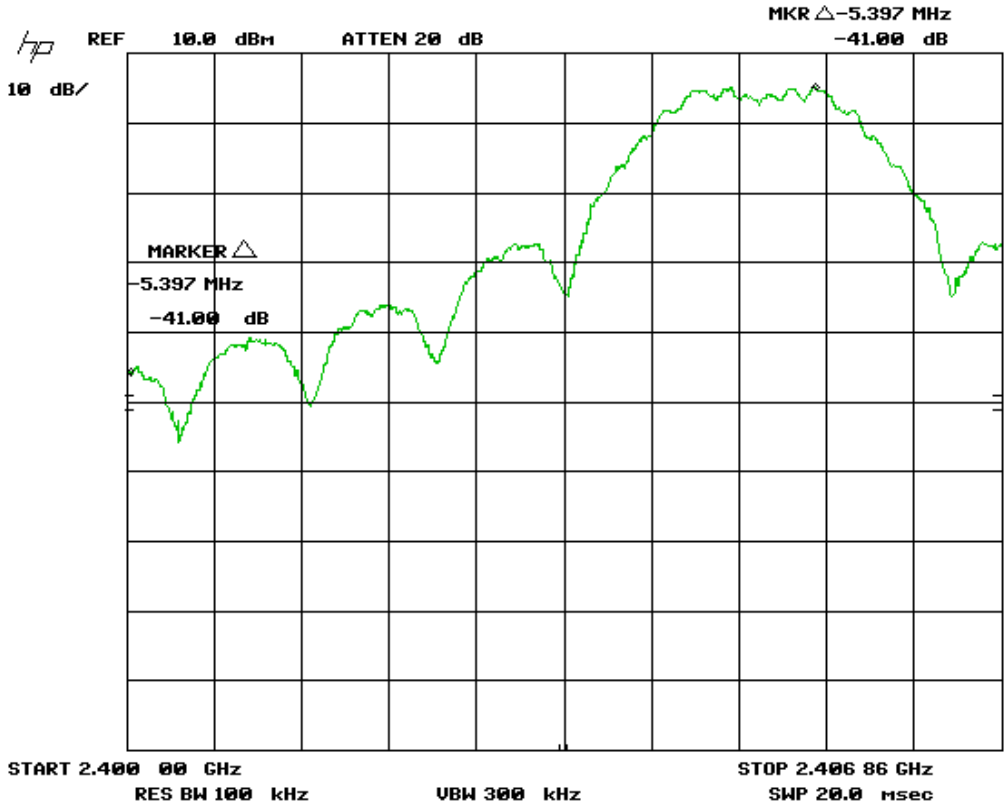
Channel – 25 - 2483.5 Band Edge



Hi Channel – 2483.5 Band Edge



Low Channel – 2400 MHz



Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Attenuator 10 dB	8493B	Agilent	NCR	NCR	GEMC 133
Spectrum Analyzer	8566B	HP	12/21/ 2011	12/21/2013	GEMC 141
Quasi Peak Adapter	85650A	HP	12/21/ 2011	12/21/2013	GEMC 7
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Transmitter Spurious Radiated Emissions

Purpose

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT does not exceed the limits listed below as defined in the applicable test standard, as measured from a receiving antenna. This helps protect broadcast radio services such as television, FM radio, pagers, cellular telephones, emergency services, and so on, from unwanted interference.

Limit(s) and Method

The method is as defined in ANSI C63.4:2003.
The limits are as defined in FCC Part 15, Section 15.209:

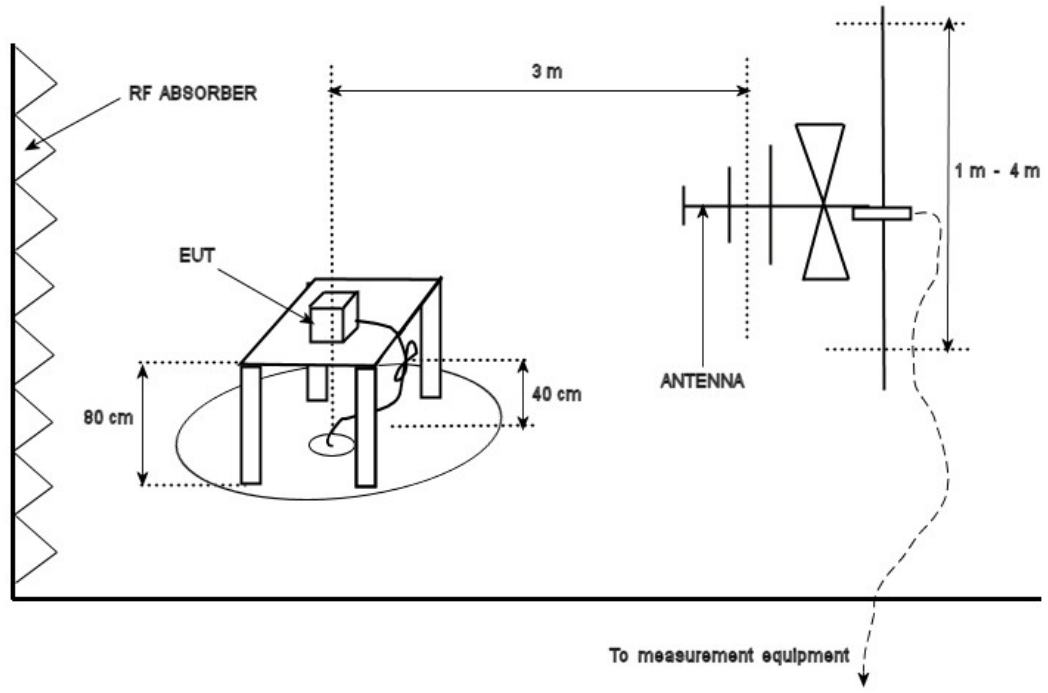
The limits, as defined in 15.247(d) for unintentional radiated emissions apply for those emissions that fall in the restricted bands, as defined in Section 15.205(a). These emissions must comply with the radiated emission limits specified in Section 15.209(a).

All unintentional emissions must also meet the 'Spurious Conducted Emissions' requirements of -20 dBc or greater. See also 'Spurious Conducted Emissions' for further details.

0.009 MHz – 0.490 MHz, 2400/F(kHz) uV/m at 300 m[1]
0.490 MHz – 1.705 MHz, 24000/F(kHz) uV/m at 30 m[1]
1.705 MHz – 30 MHz, 30 uV/m at 30 m[1]
30 MHz – 88 MHz, 100 uV/m (40.0 dBuV/m[1]) at 3 m
88 MHz – 216 MHz, 150 uV/m (43.5 dBuV/m[1]) at 3 m
216 MHz – 960 MHz, 200 uV/m (46.0 dBuV/m[1]) at 3 m
Above 960 MHz, 500 uV/m (54.0 dBuV/m[1]) at 3 m
Above 1000 MHz, 500 uV/m (54 dBuV/m[2]) at 3m
Above 1000 MHz, 500 uV/m (74 dBuV/m[3]) at 3m

[1]Limit is with Quasi Peak detector with bandwidths as defined in CISPR-16-1-1
[2]Limit is with 1 MHz measurement bandwidth and using an Average detector
[3]Limit is with 1 MHz measurement bandwidth and using a Peak detector

Typical Radiated Emissions Setup



Measurement Uncertainty

The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is +/-4.4 dB with a 'k=2' coverage factor and a 95% confidence level.

Preliminary Graphs

Note the graphs shown below are for graphical illustration only. For final measurements with the appropriate detector, please refer to the final measurement table where applicable. The graph shown below is a maximized peak measurement graph, measured with a resolution bandwidth greater then the final required detector and over a full 0-360 rotation. This peaking process is done as a worst case measurement. This process enables the detection of frequencies of concern for final measurement, and provides considerable time savings.

In accordance with FCC Part 15, Subpart A, Section 15.33, the device was scanned to the 10^{th} harmonic (a minimum of a 24.835 GHz).

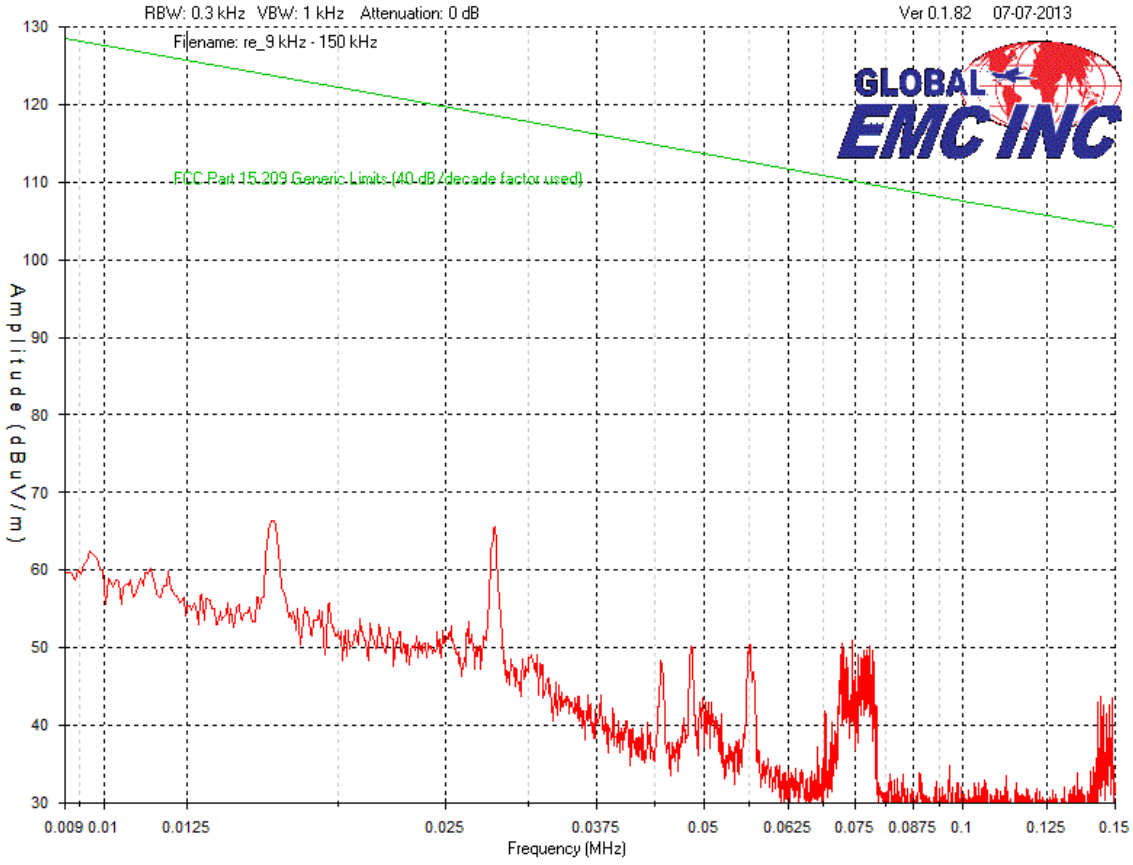
Devices scanned may be scanned at alternate test distances, and in accordance with FCC Part 15, Subpart A, Section 15.31, an extrapolation factor of 20 dB/decade was used above

30 MHz and 40 dB/decade below 30 MHz. For example for 1 meter measurements, an extrapolation factor 9.5 dB from 20 Log (1m / 3m) is applied.

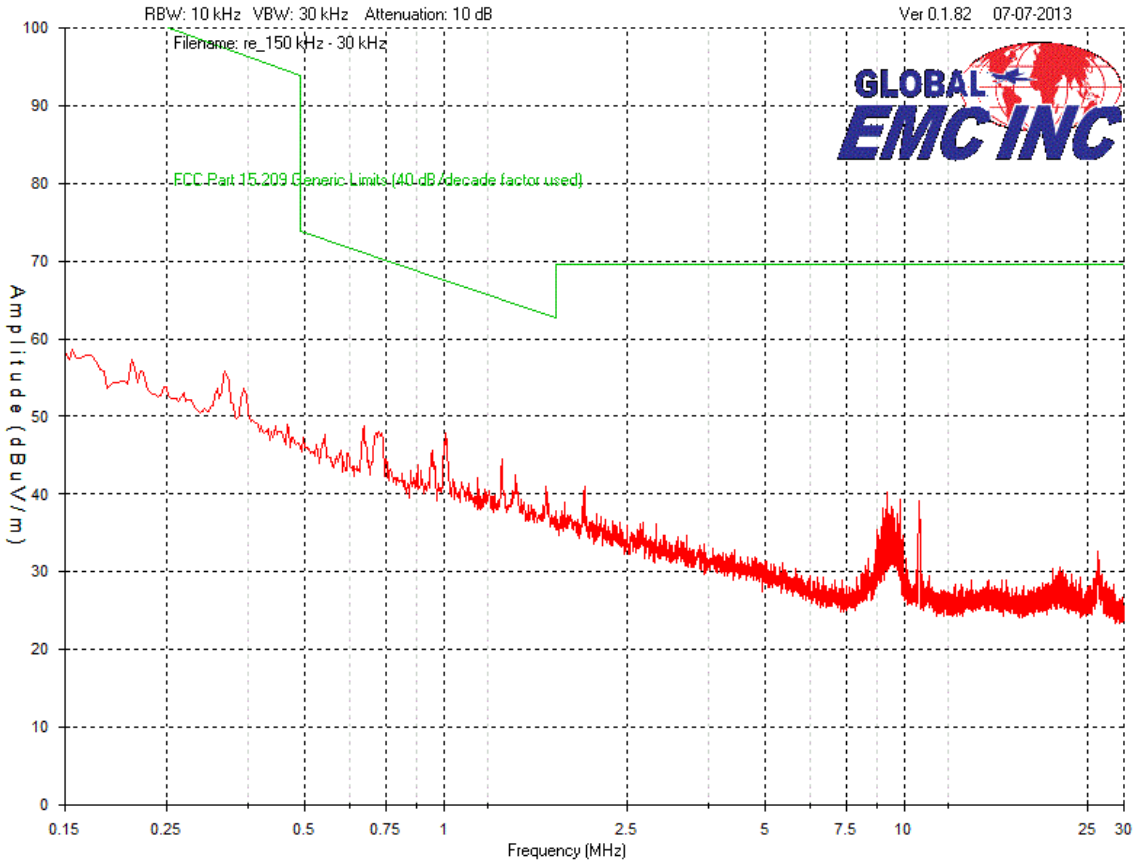
Low, middle and high channels, each in three orthogonal axes were checked; however the worst case graphs are presented.

Band edge measure graphs were shown for illustrations purpose. See final measurement section for all measurements.

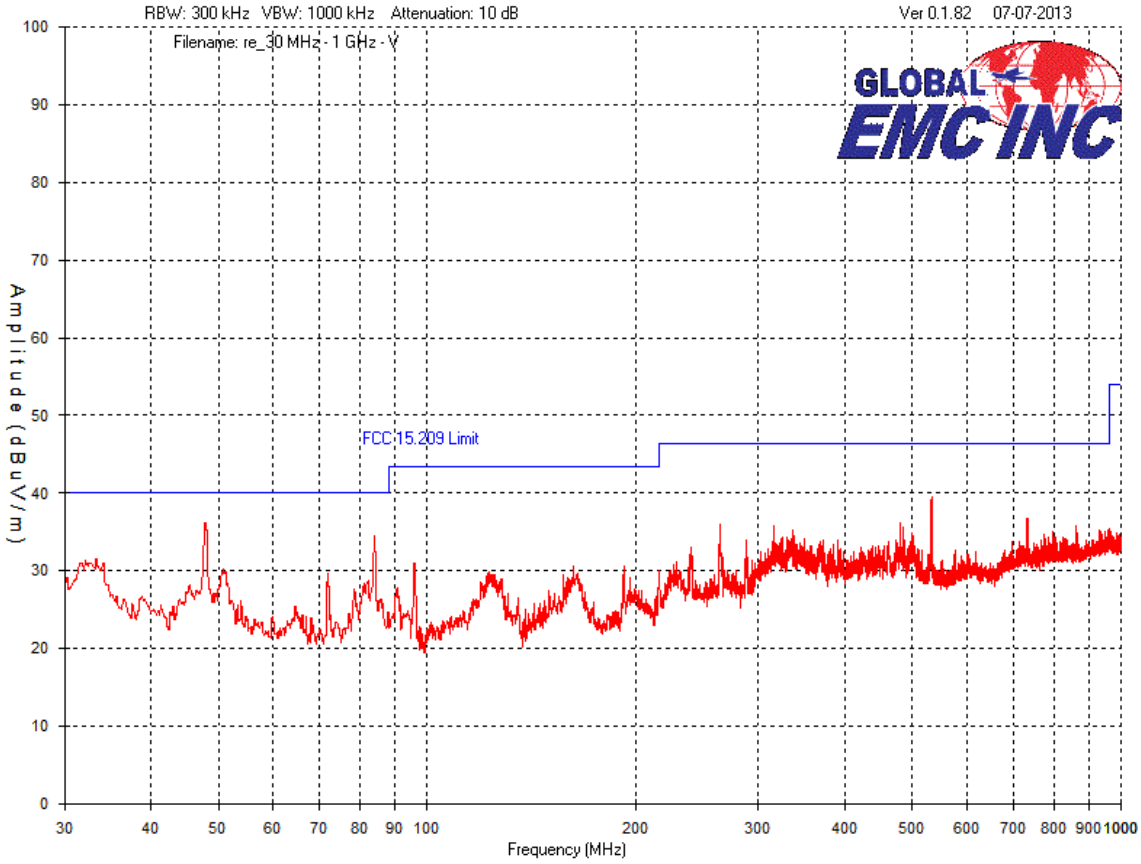
9 kHz – 150 kHz



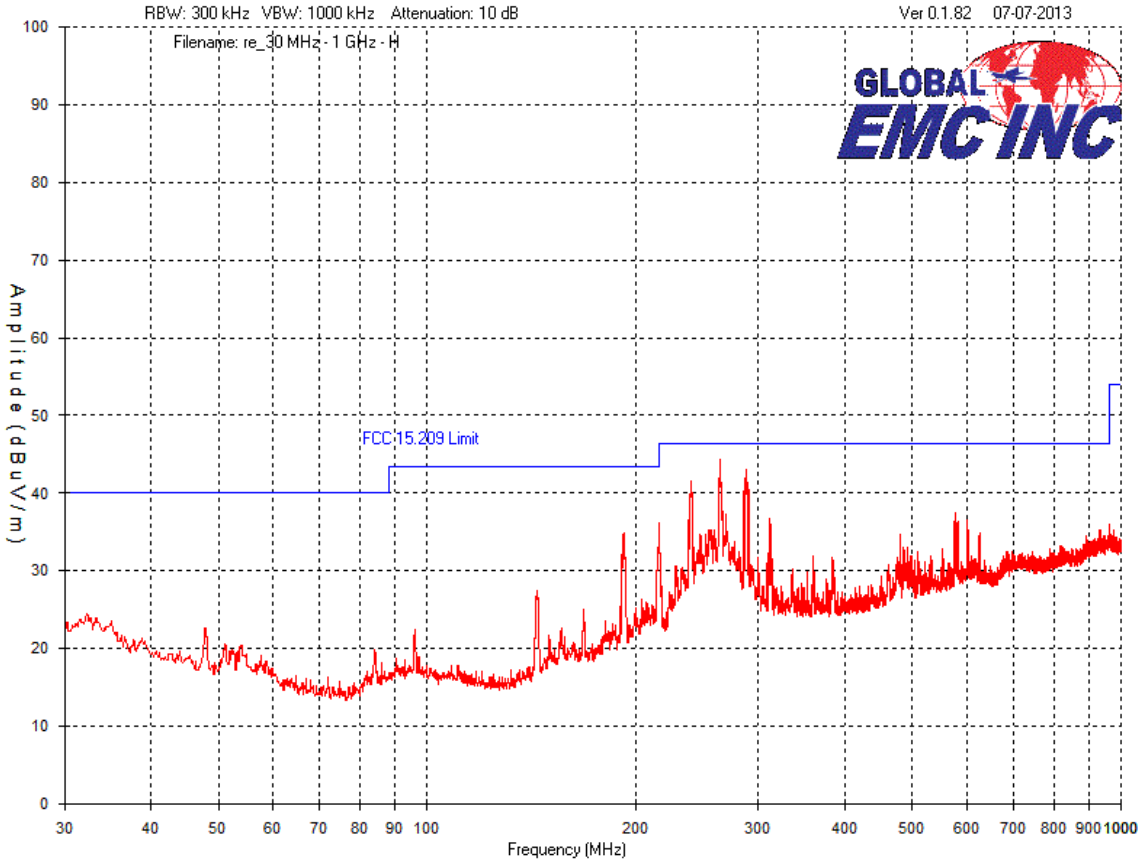
150 kHz – 30 MHz



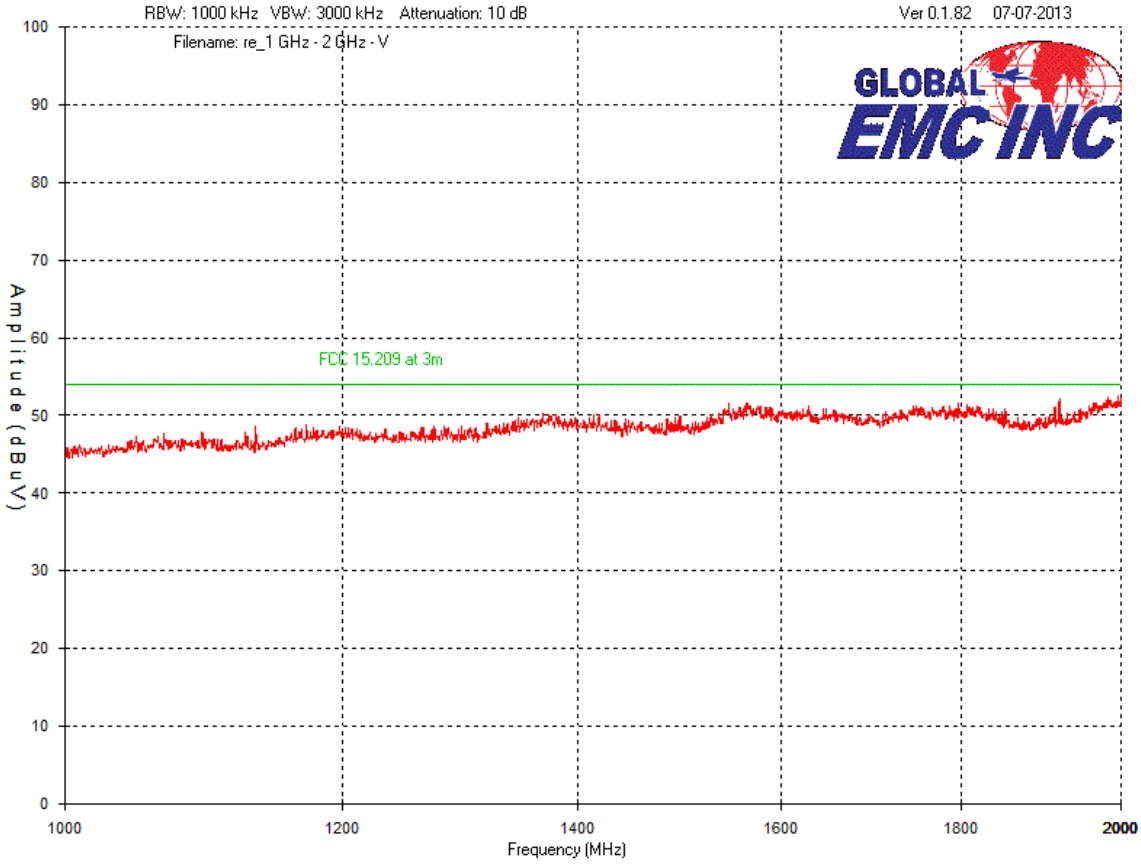
Mid Channel - 30 MHz – 1 GHz
Vertical – Peak Emission Graph



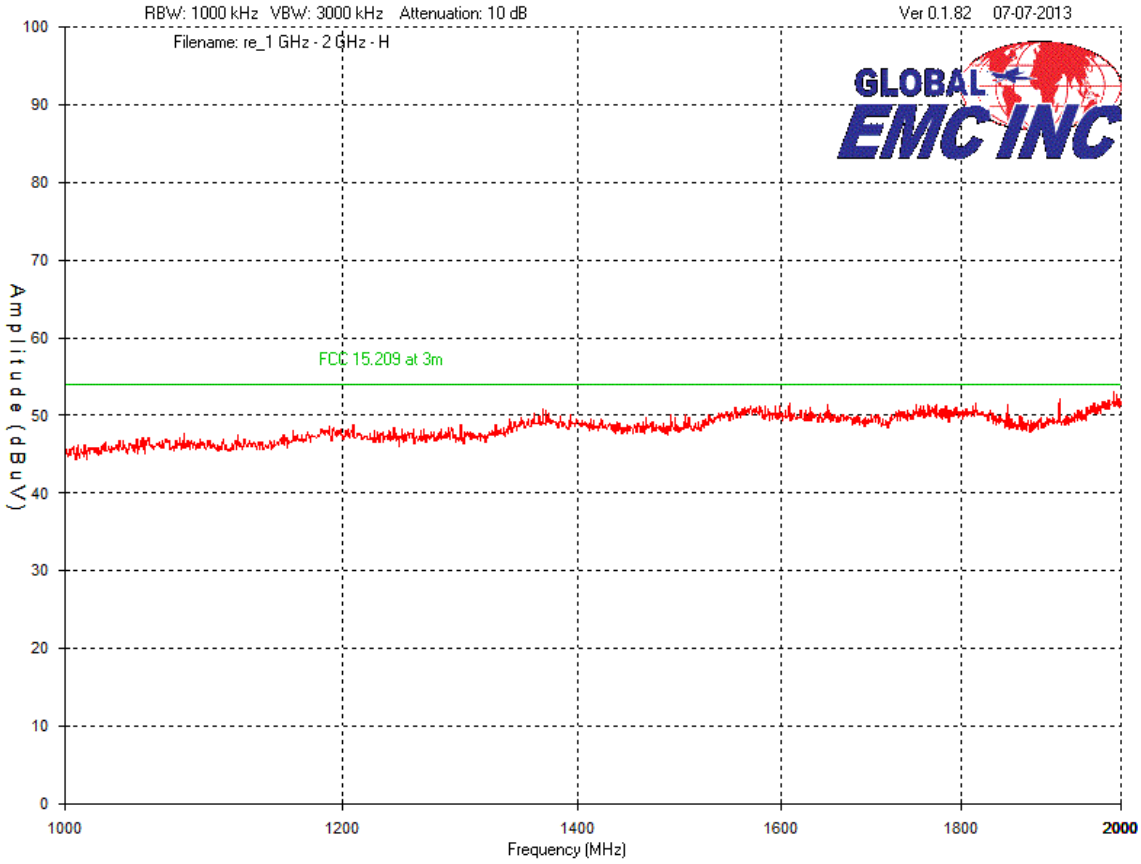
Mid Channel – 30 MHz – 1 GHz
Horizontal - Peak Emission Graph



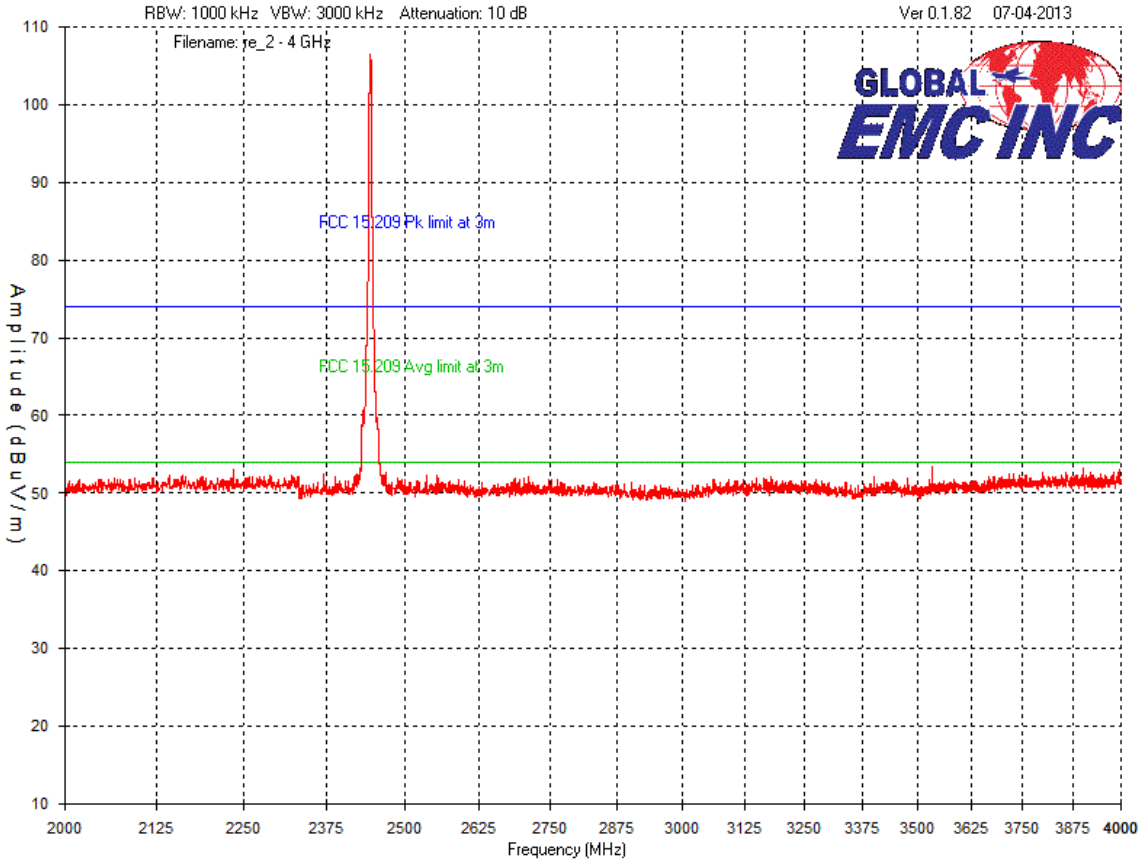
Mid Channel – 1 GHz – 2 GHz
Vertical - Peak Emission Graph



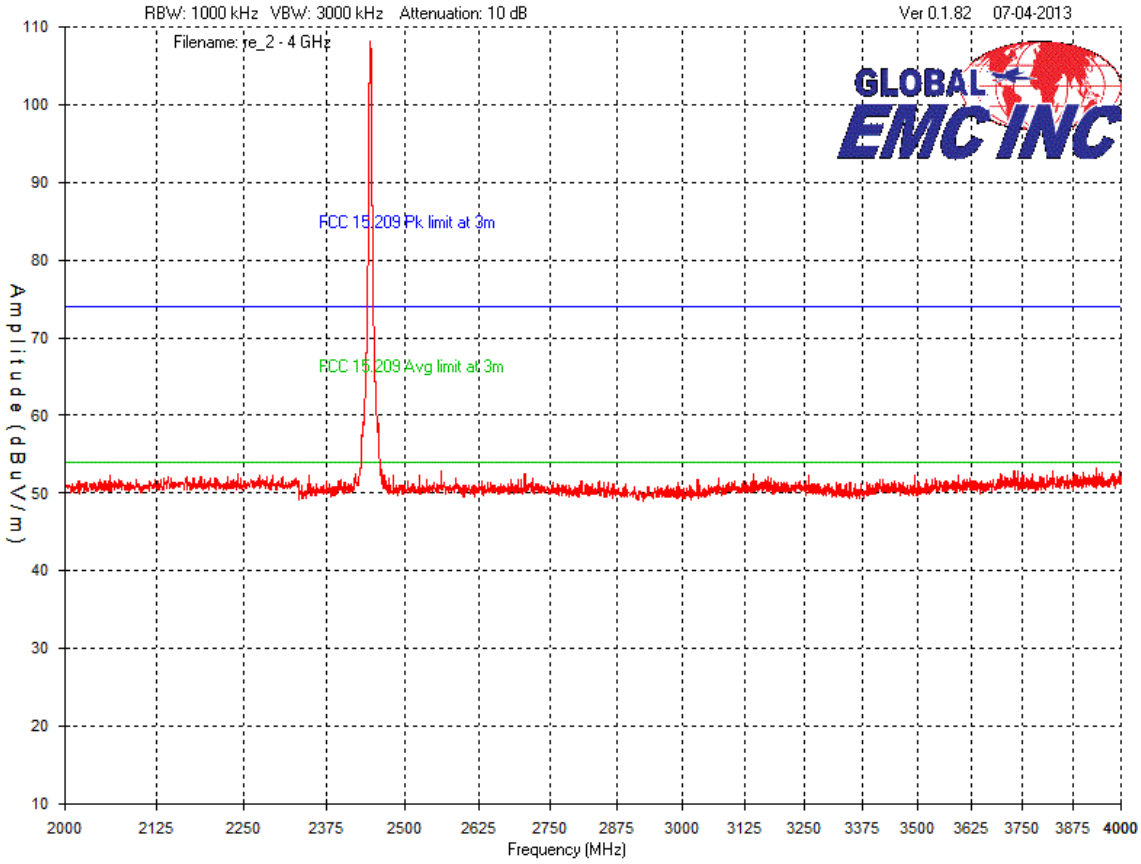
Mid Channel – 1 GHz – 2 GHz
Horizontal - Peak Emission Graph



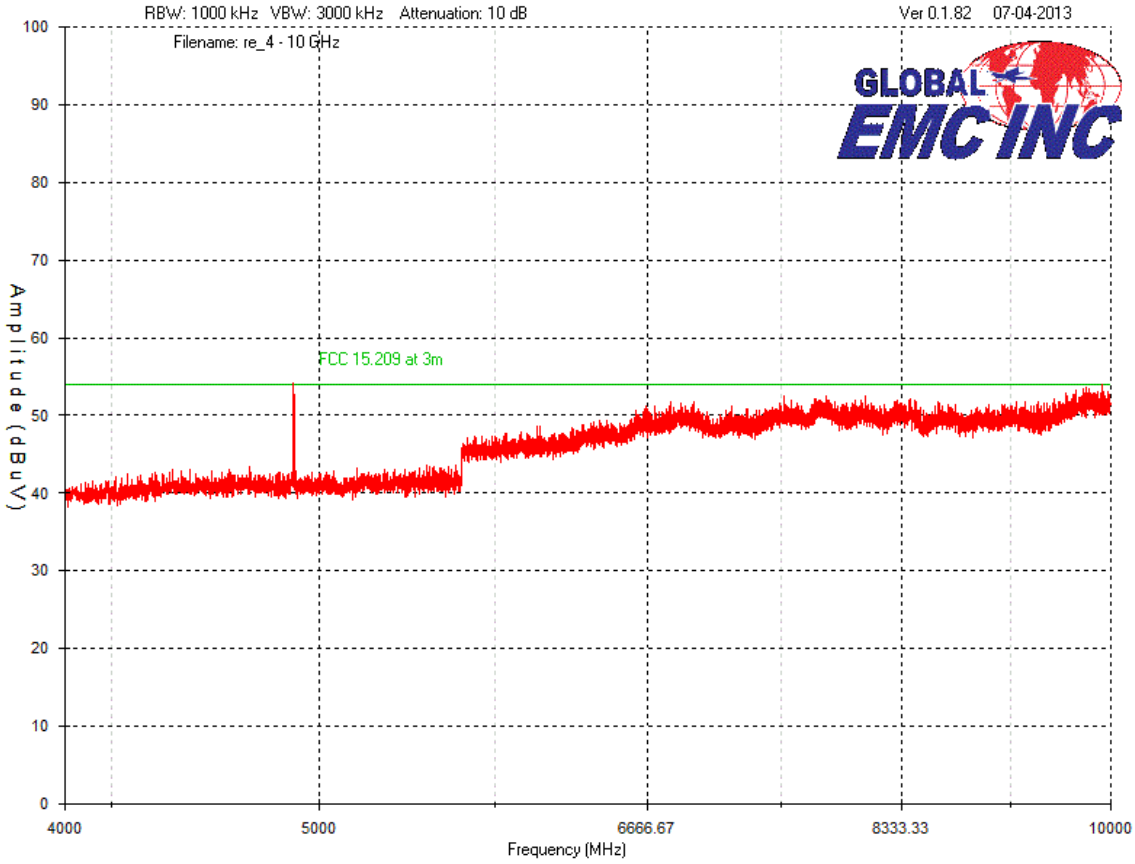
Mid Channel – 2 GHz – 4 GHz
Horizontal - Peak Emission Graph



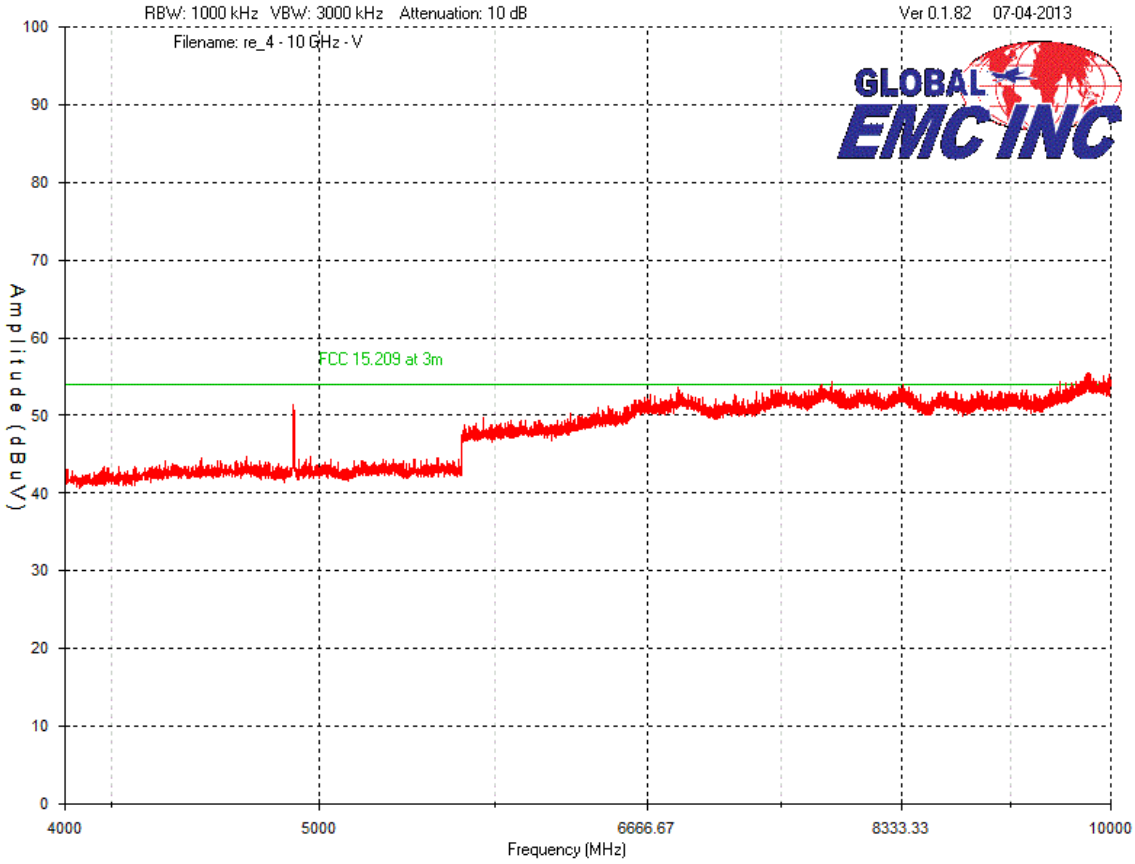
Mid Channel – 2 GHz – 4 GHz
Vertical - Peak Emission Graph



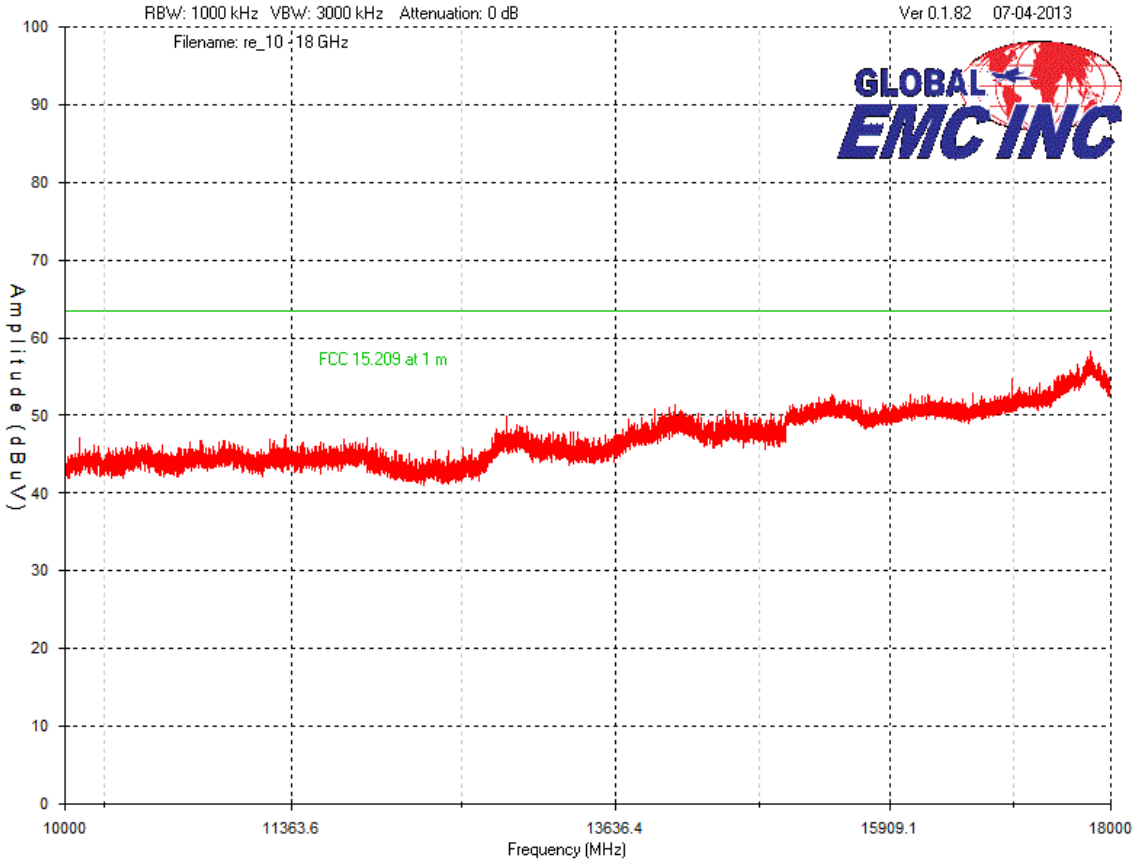
Mid Channel – 4 GHz – 10 GHz
Horizontal - Peak Emission Graph



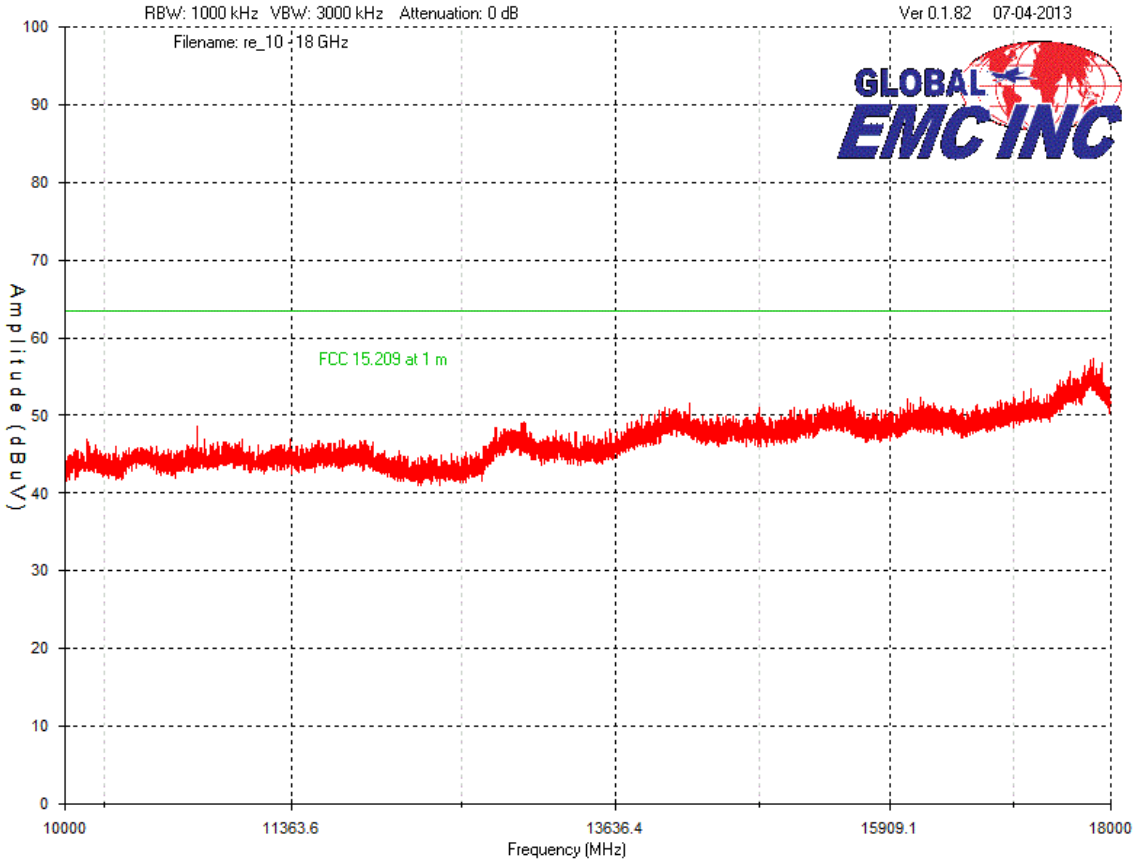
Mid Channel – 4 GHz – 10 GHz
Vertical - Peak Emission Graph



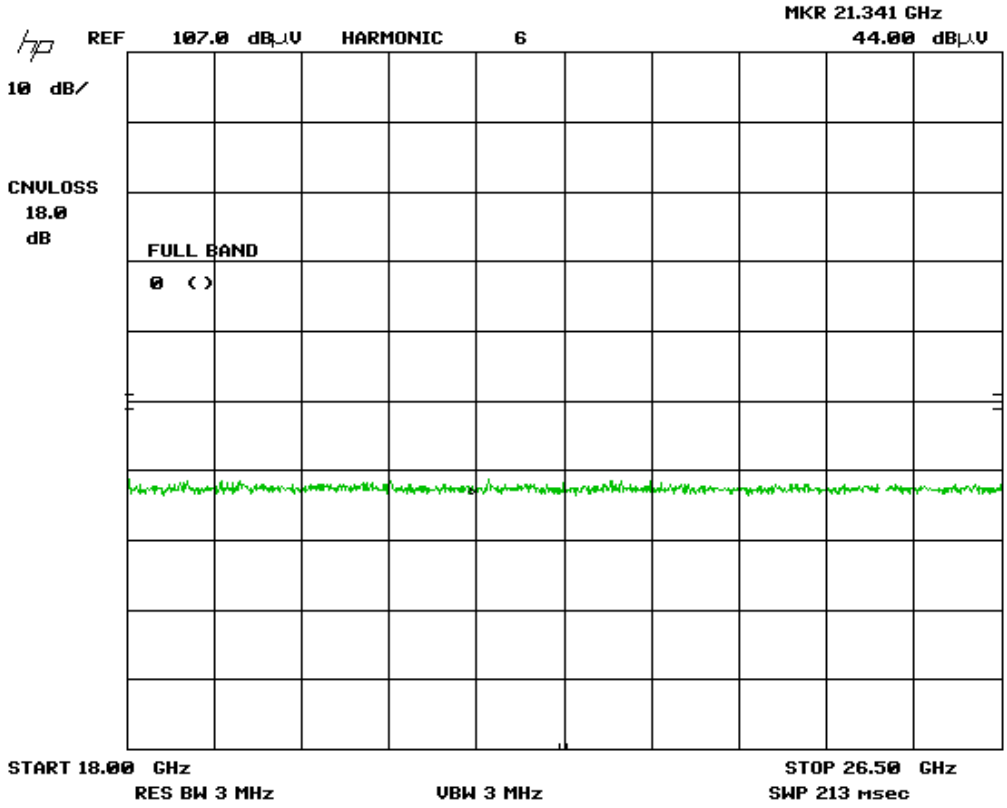
Mid Channel – 10 GHz – 18 GHz
Horizontal - Peak Emission Graph



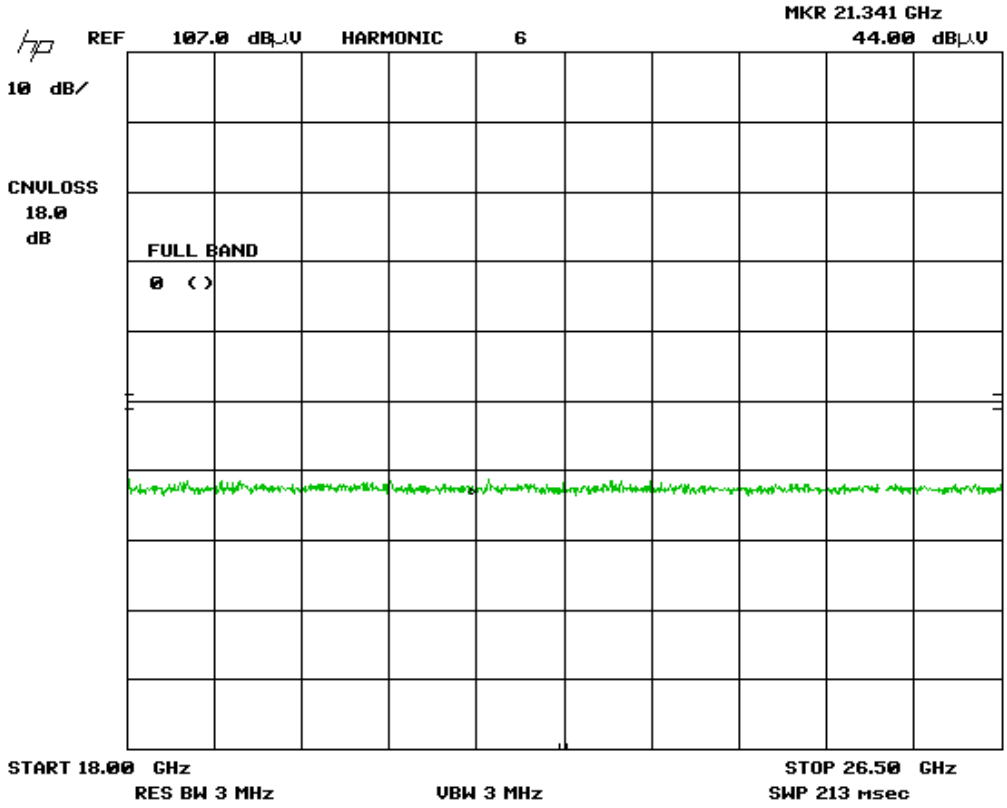
Mid Channel – 10 GHz – 18 GHz
Vertical - Peak Emission Graph



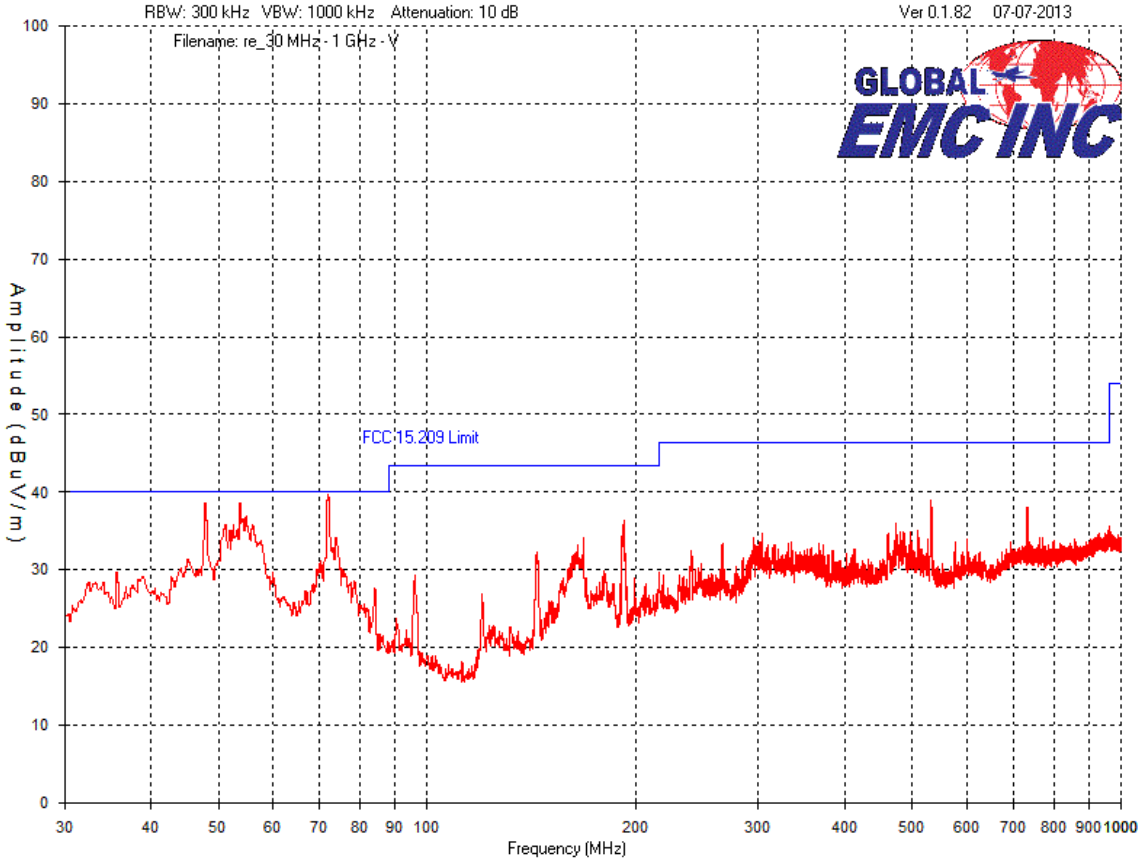
Mid Channel – 18 GHz – 26 GHz
Horizontal - Peak Emission Graph



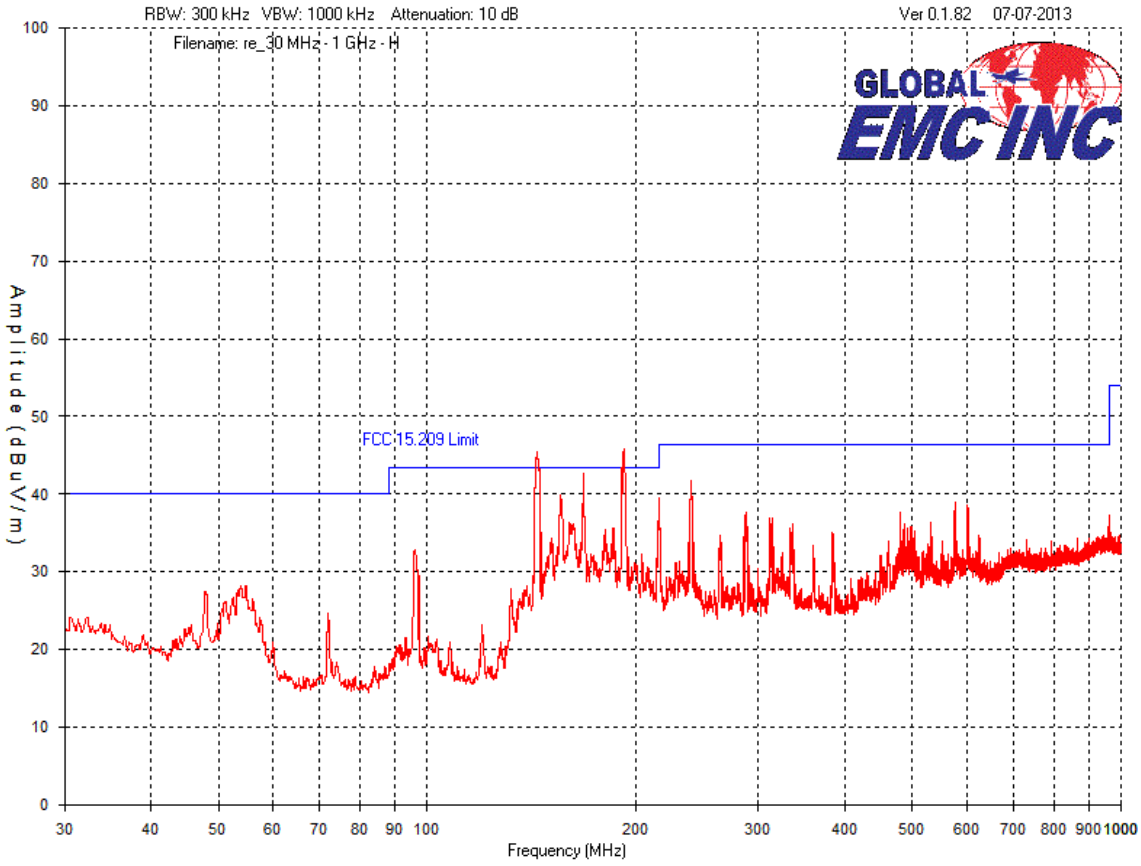
Mid Channel – 18 GHz – 26 GHz
Vertical - Peak Emission Graph



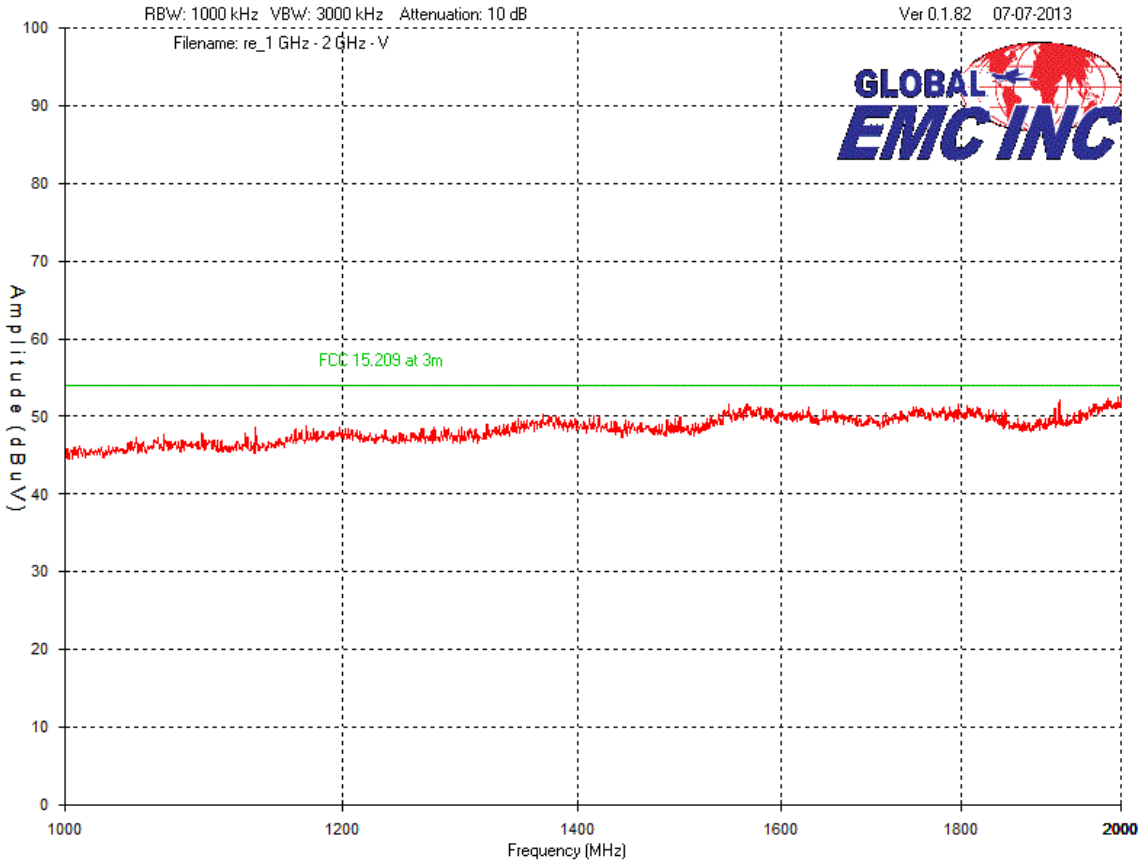
Mid Channel – 30 MHz – 1 GHz
Vertical - Peak Emission Graph
With External Antenna



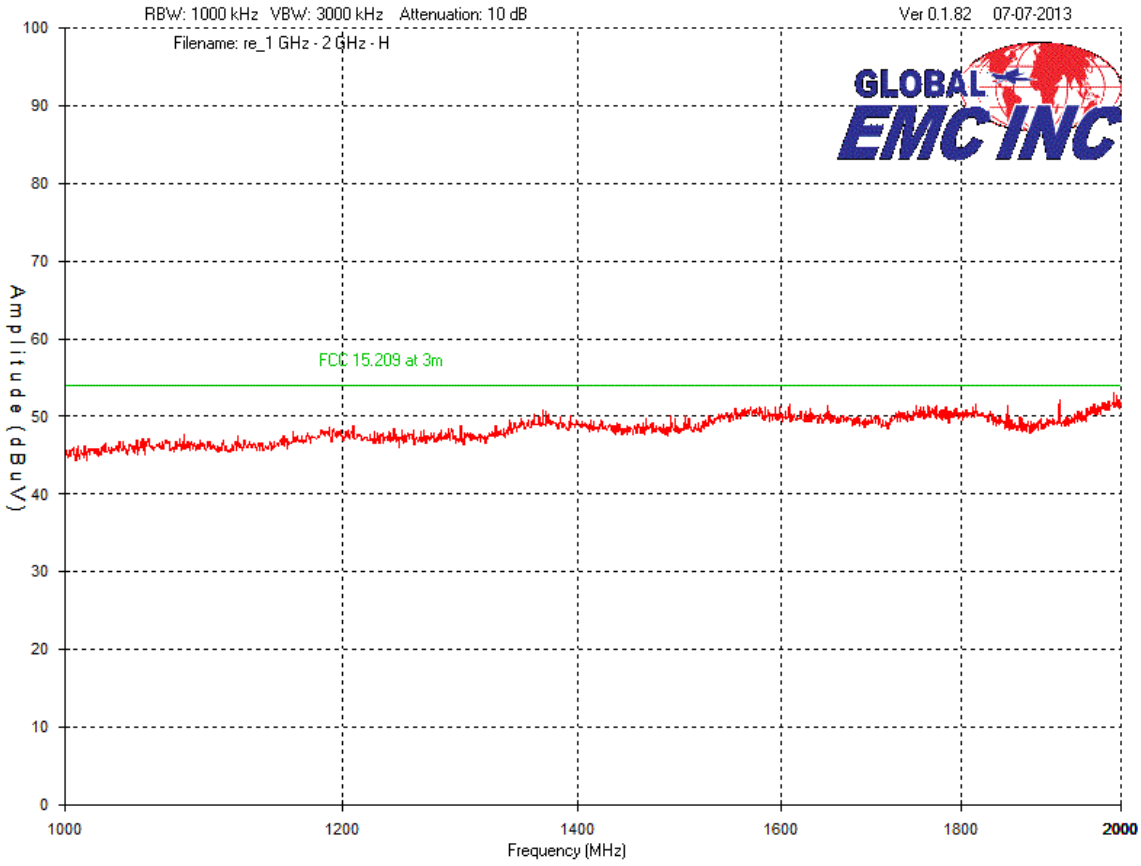
Mid Channel – 30 MHz – 1 GHz
Horizontal - Peak Emission Graph
With External Antenna



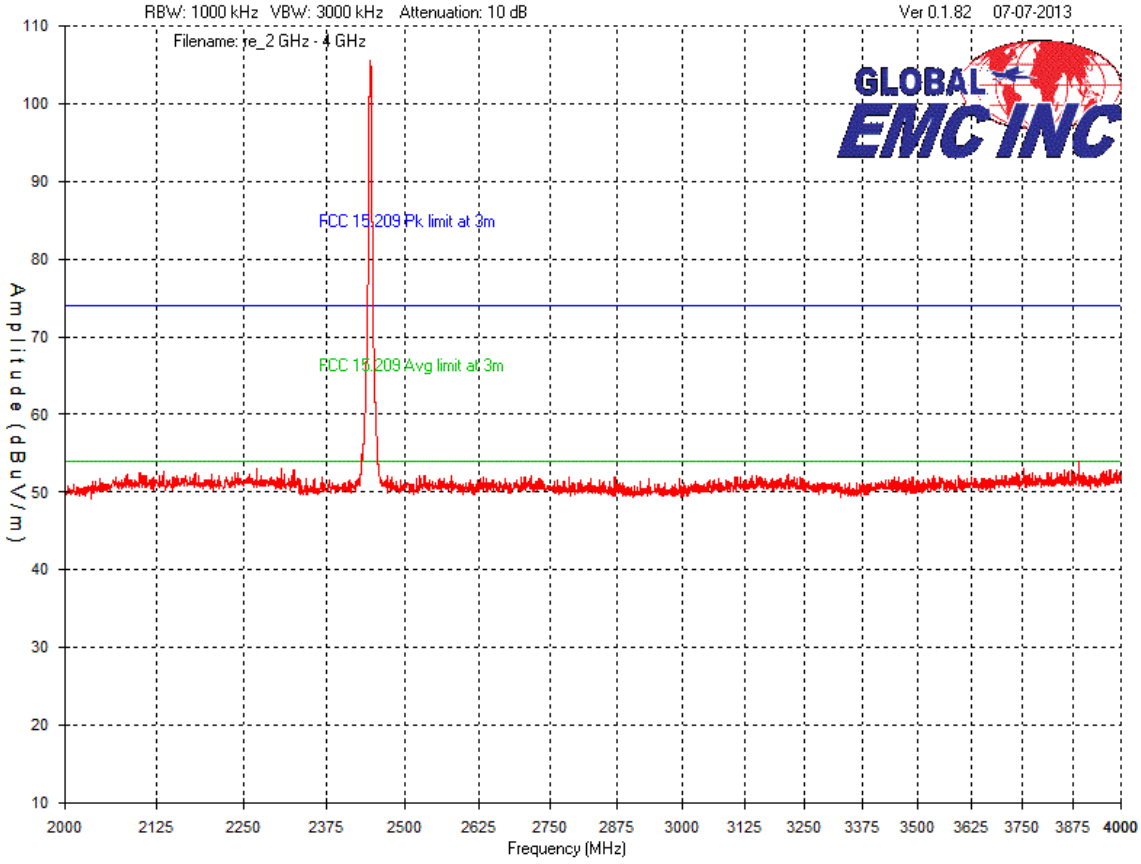
Mid Channel – 1 GHz – 2 GHz
Vertical - Peak Emission Graph
With External Antenna



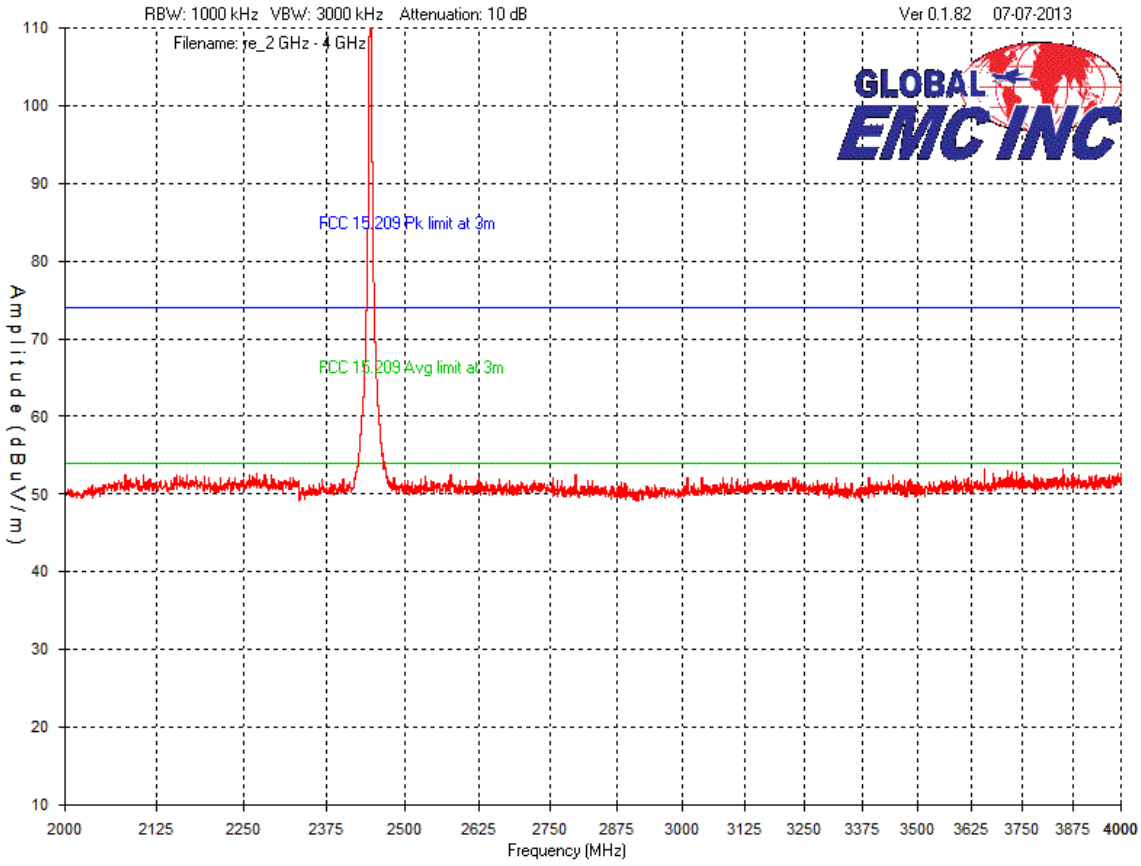
Mid Channel – 1 GHz – 2 GHz
Horizontal - Peak Emission Graph
With External Antenna



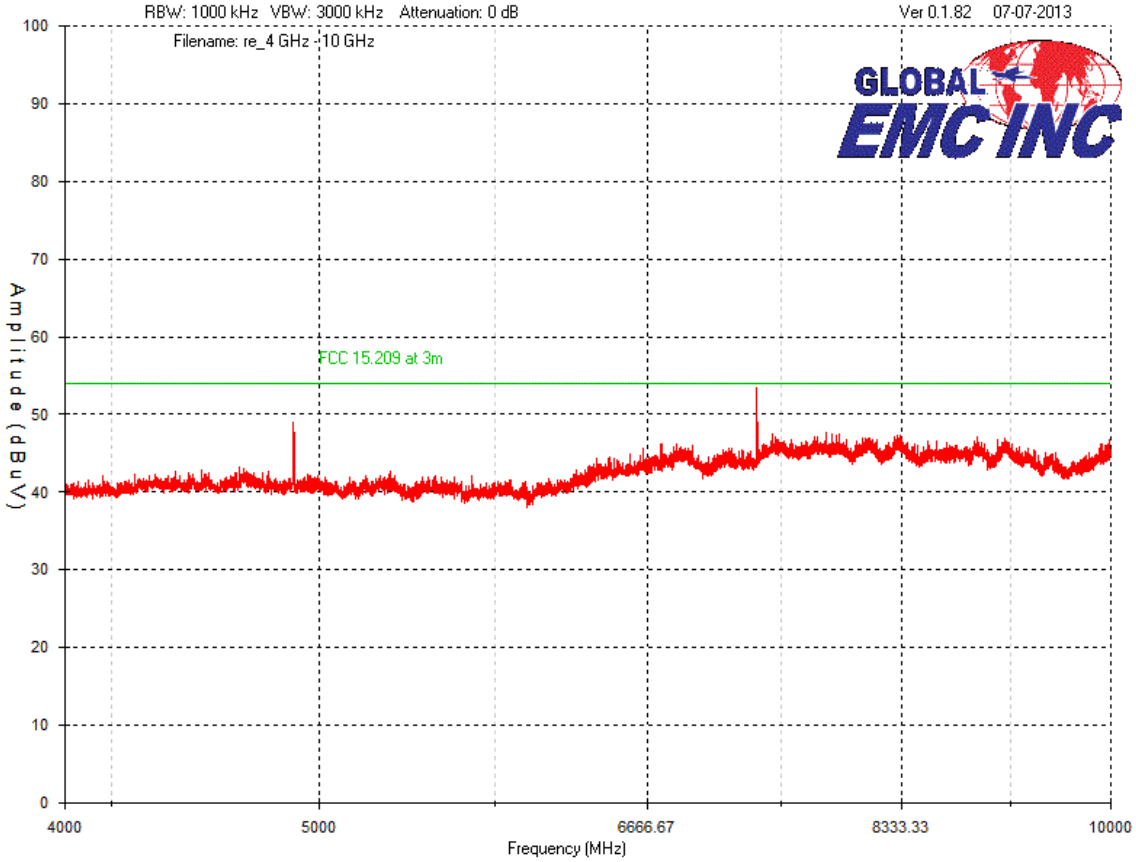
Mid Channel – 2 GHz – 4 GHz
Vertical - Peak Emission Graph
With External Antenna



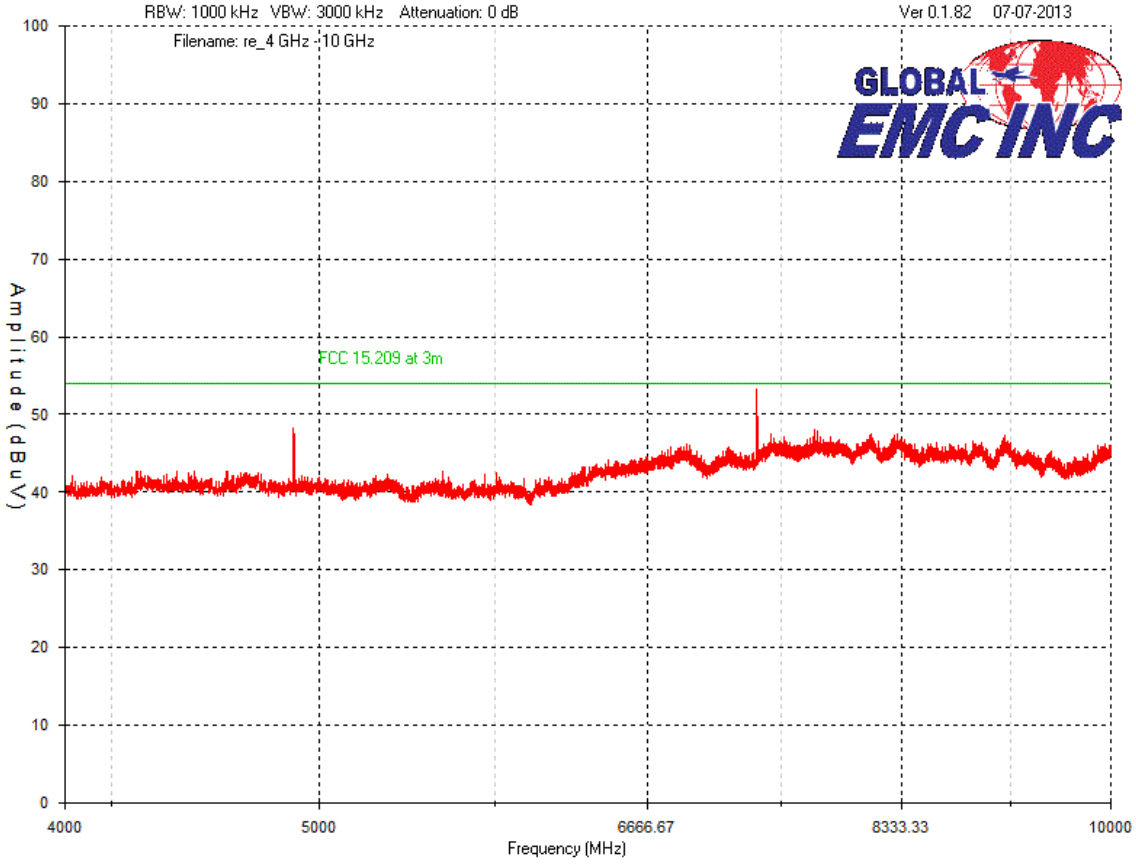
Mid Channel – 2 GHz – 4 GHz
Horizontal - Peak Emission Graph
With External Antenna



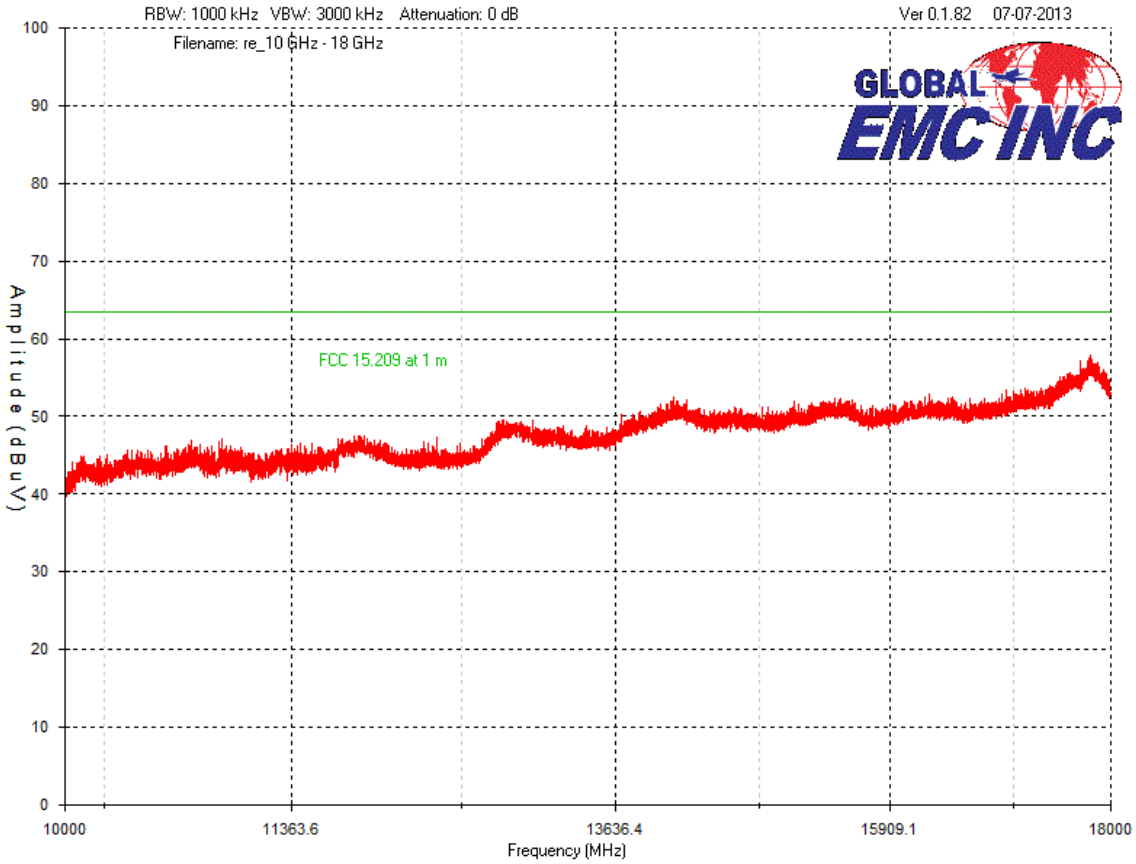
Mid Channel – 4 GHz – 10 GHz
Vertical - Peak Emission Graph
With External Antenna



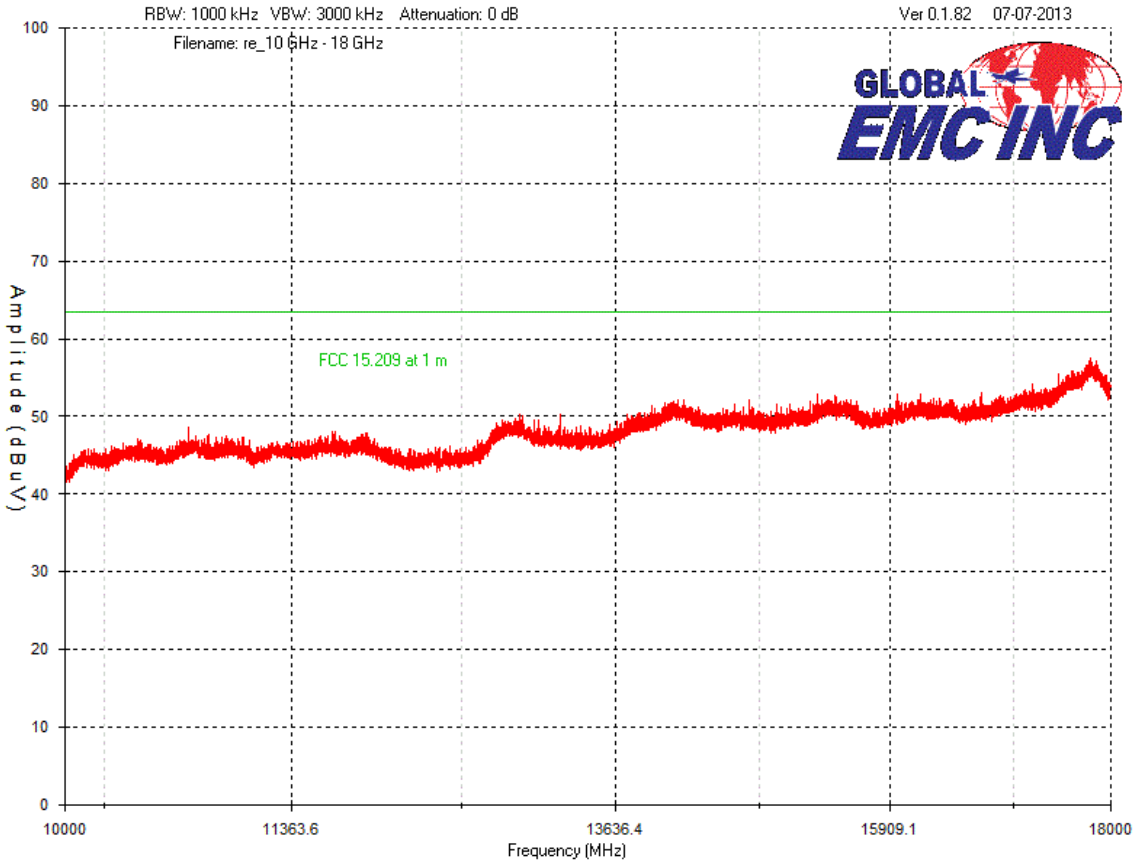
Mid Channel – 4 GHz – 10 GHz
Horizontal - Peak Emission Graph
With External Antenna



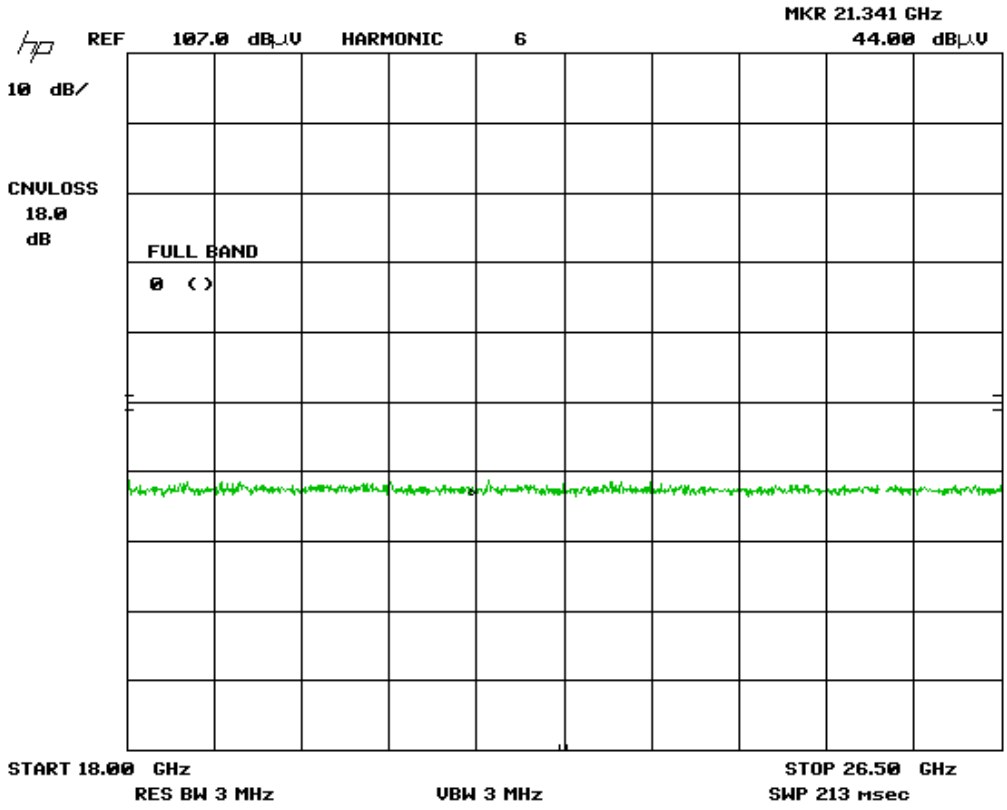
Mid Channel – 10 GHz – 18 GHz
Vertical - Peak Emission Graph
With External Antenna



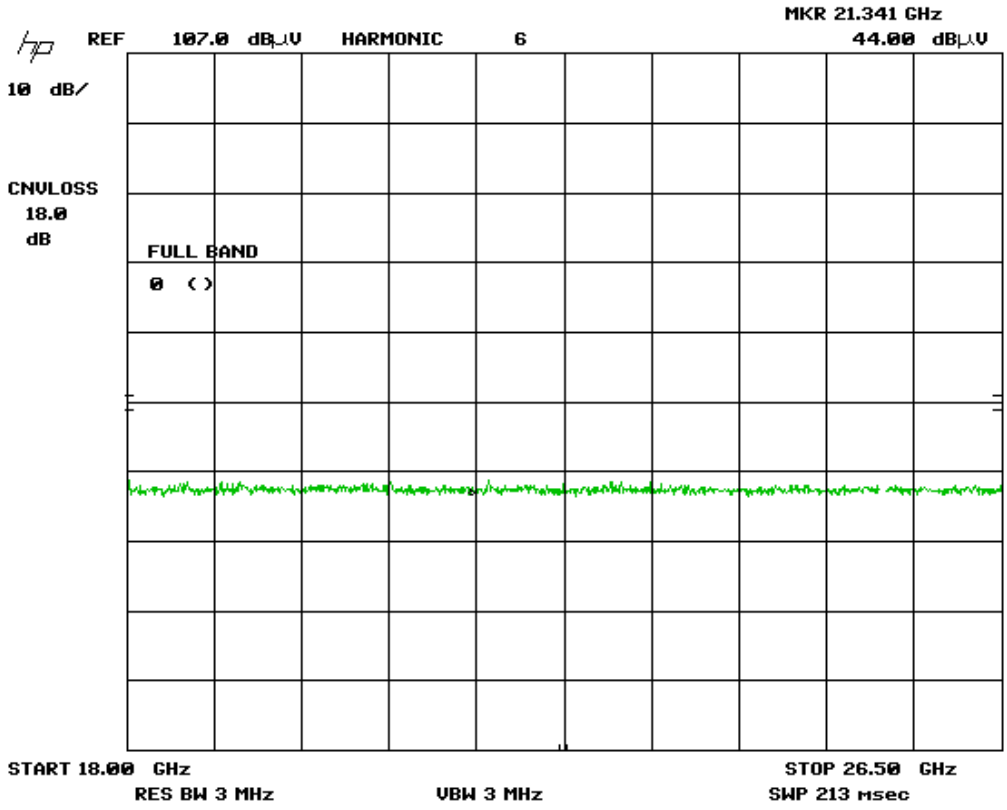
Mid Channel – 10 GHz – 18 GHz
Horizontal - Peak Emission Graph
With External Antenna



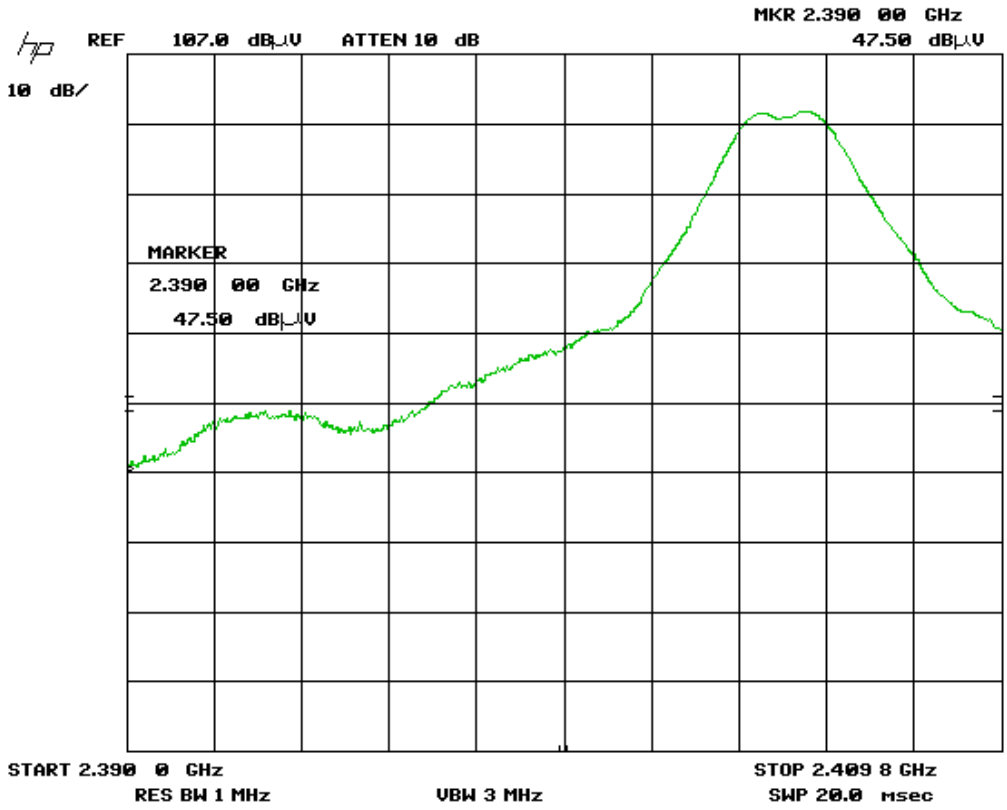
Mid Channel – 18 GHz – 26 GHz
Horizontal - Peak Emission Graph
With External Antenna



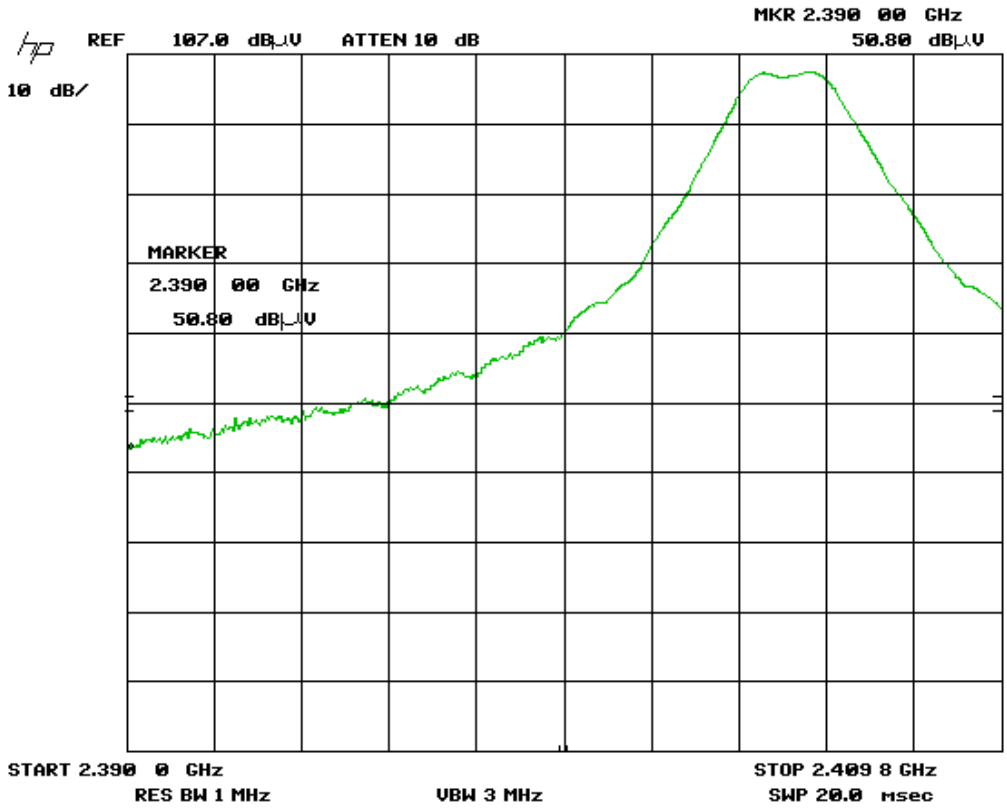
Mid Channel – 18 GHz – 26 GHz
Vertical - Peak Emission Graph
With External Antenna



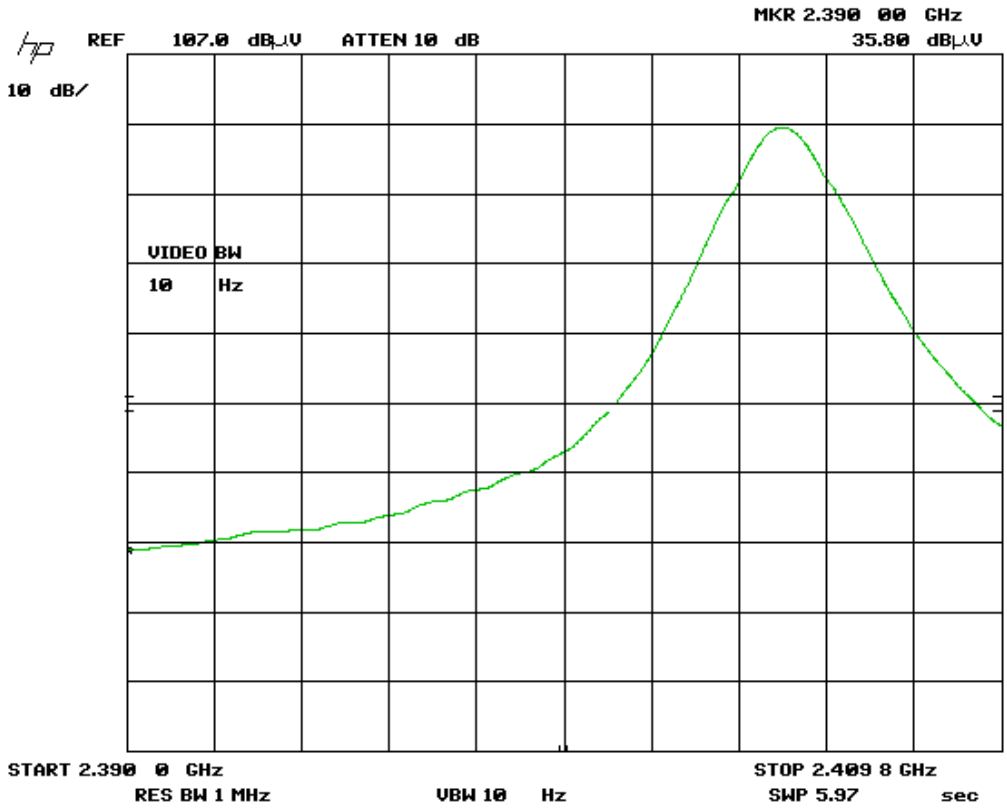
Band Edge – Low Channel
Vertical - Peak Emission



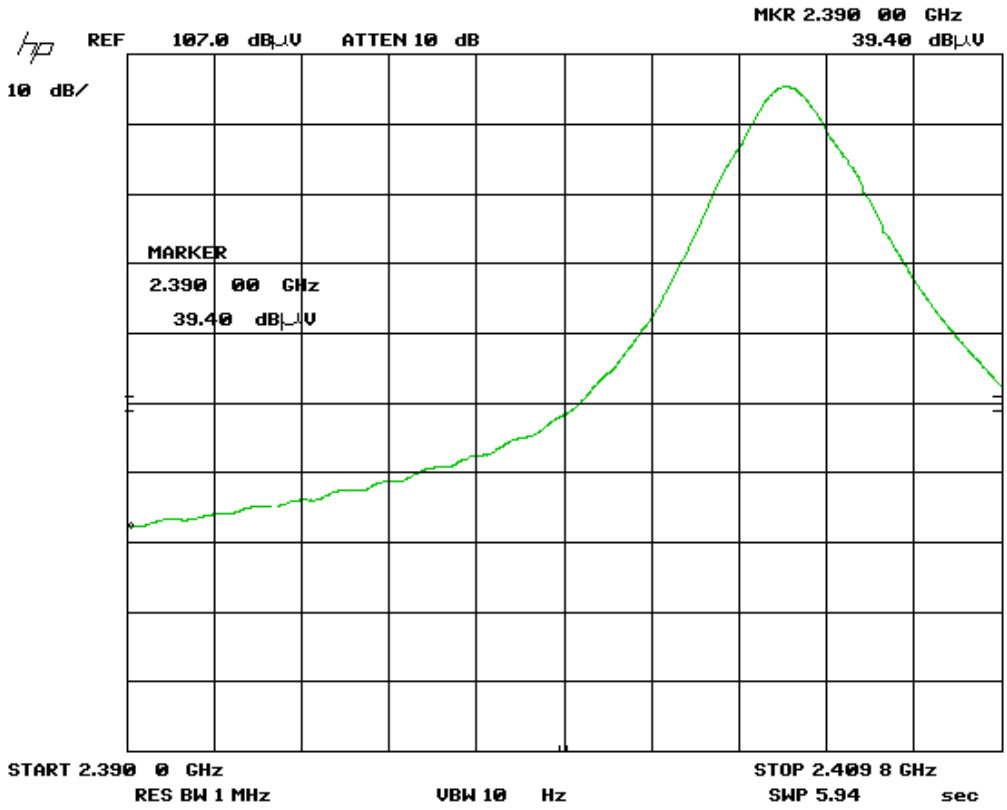
Band Edge – Low Channel
Horizontal - Peak Emission



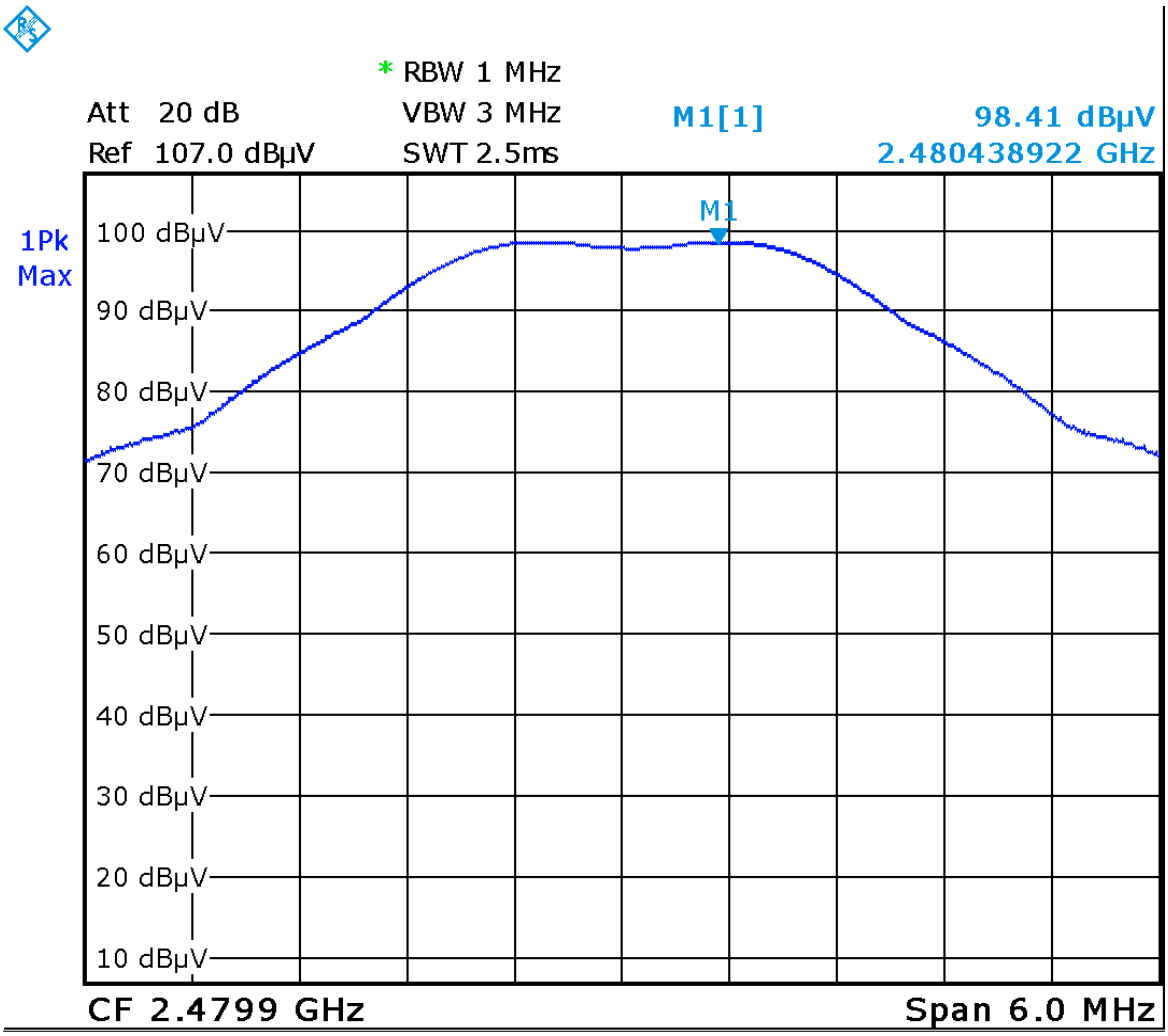
Band Edge – Low Channel
Vertical – Average Emission



Band Edge – Low Channel
Horizontal - Average Emission

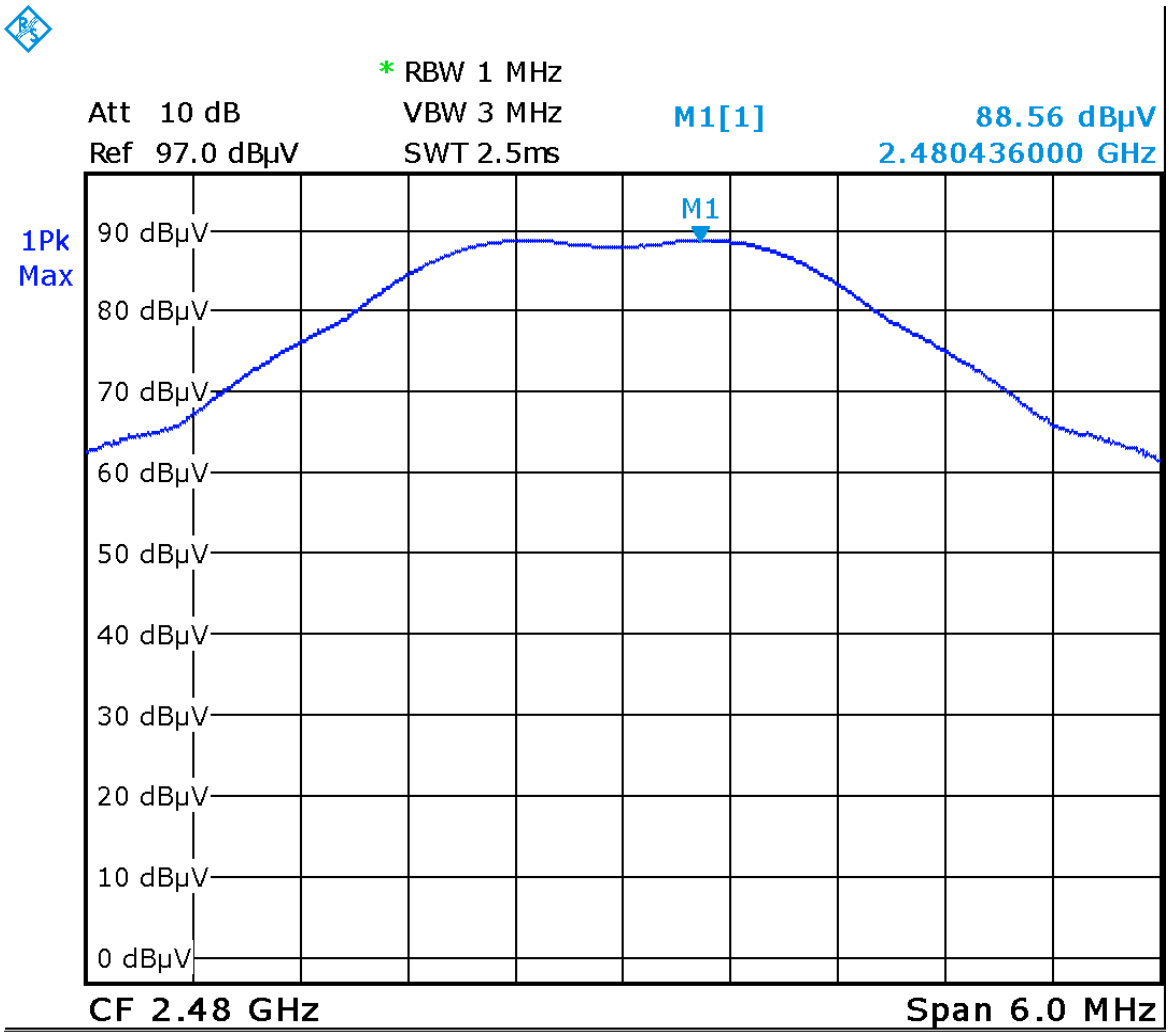


Band Edge – Hi Channel
Vertical - Peak Emission



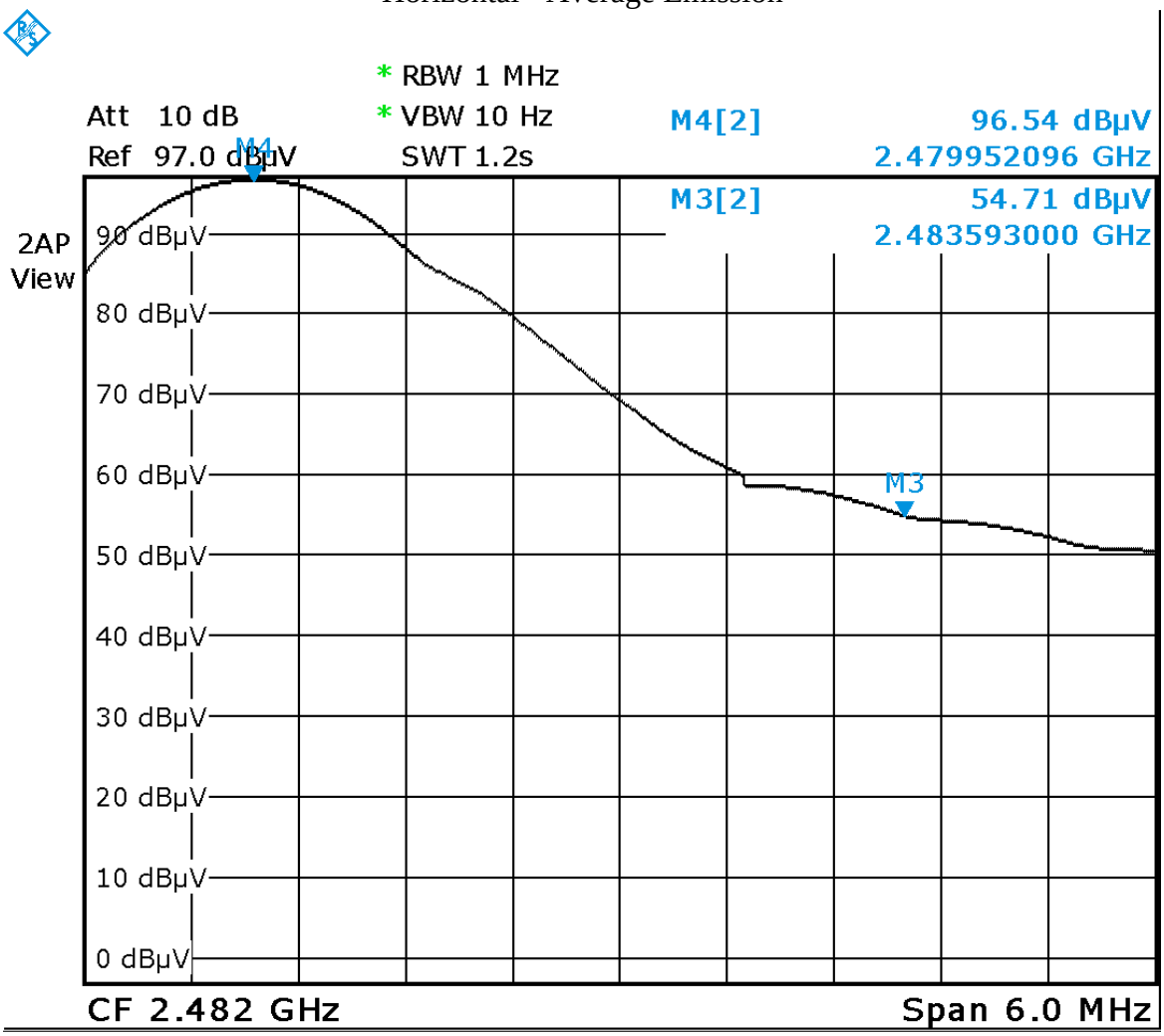
Date: 3.JUL.2013 16:13:03

Band Edge – Hi Channel
Horizontal - Peak Emission



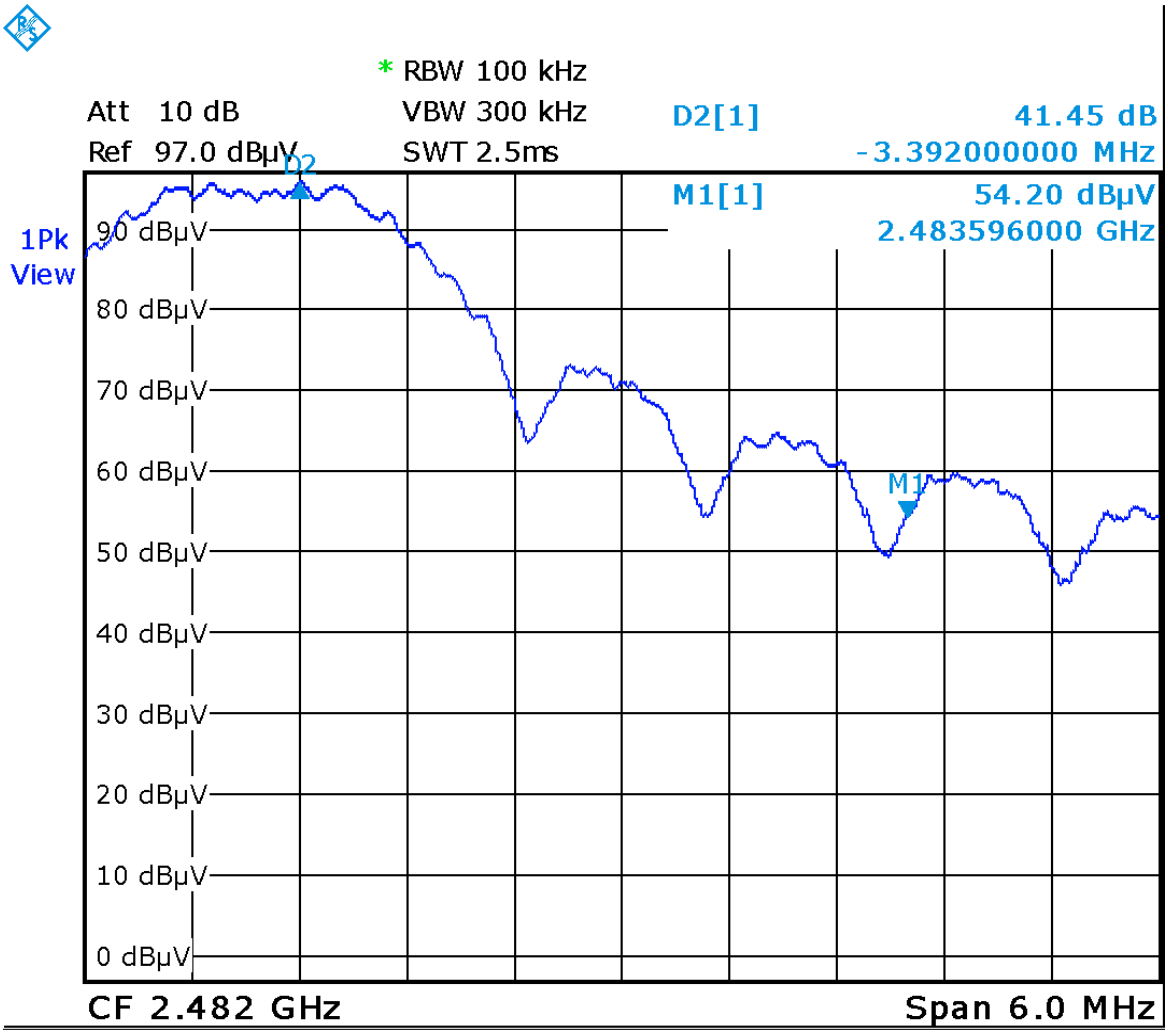
Date: 3.JUL.2013 16:32:10

Band Edge – Hi Channel
Horizontal - Average Emission



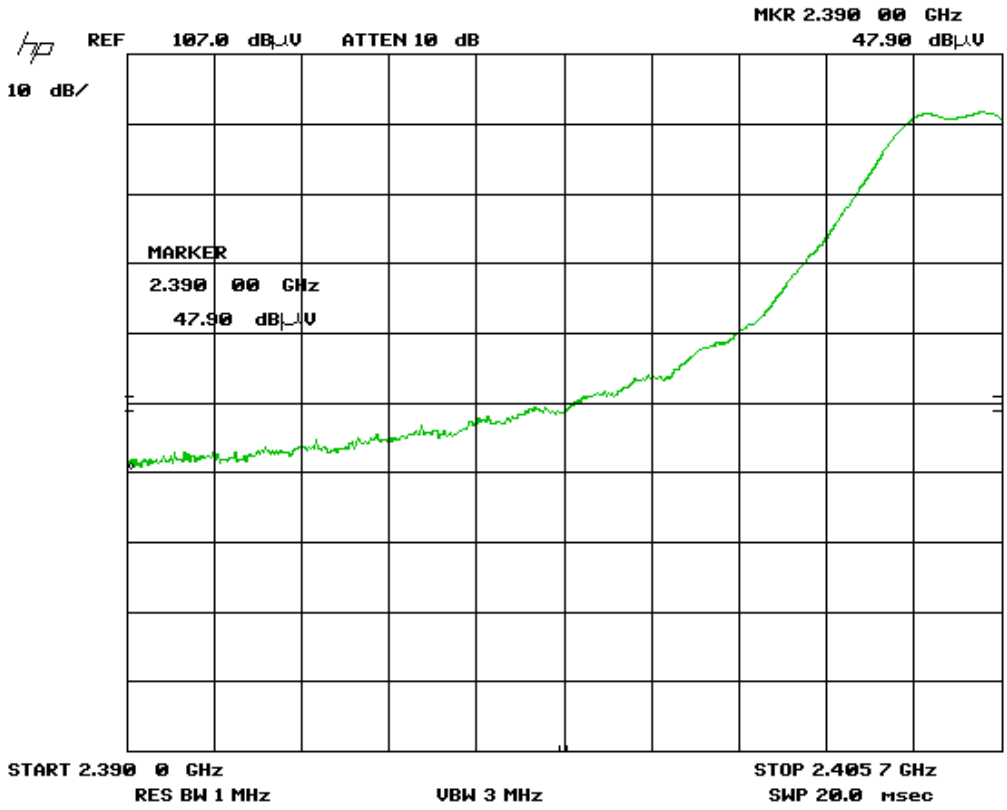
Date: 3.JUL.2013 16:06:00

Band Edge – High channel (EUT in horizontal position)
Horizontal – Marker-Delta measurement

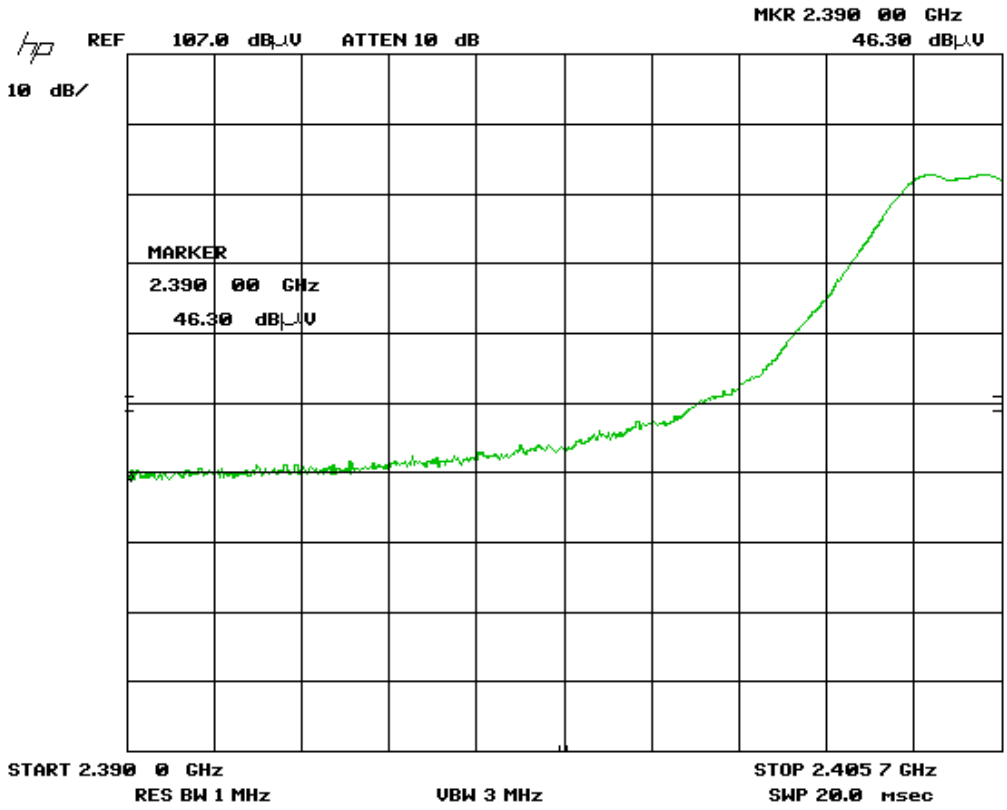


Date: 3.JUL.2013 16:09:14

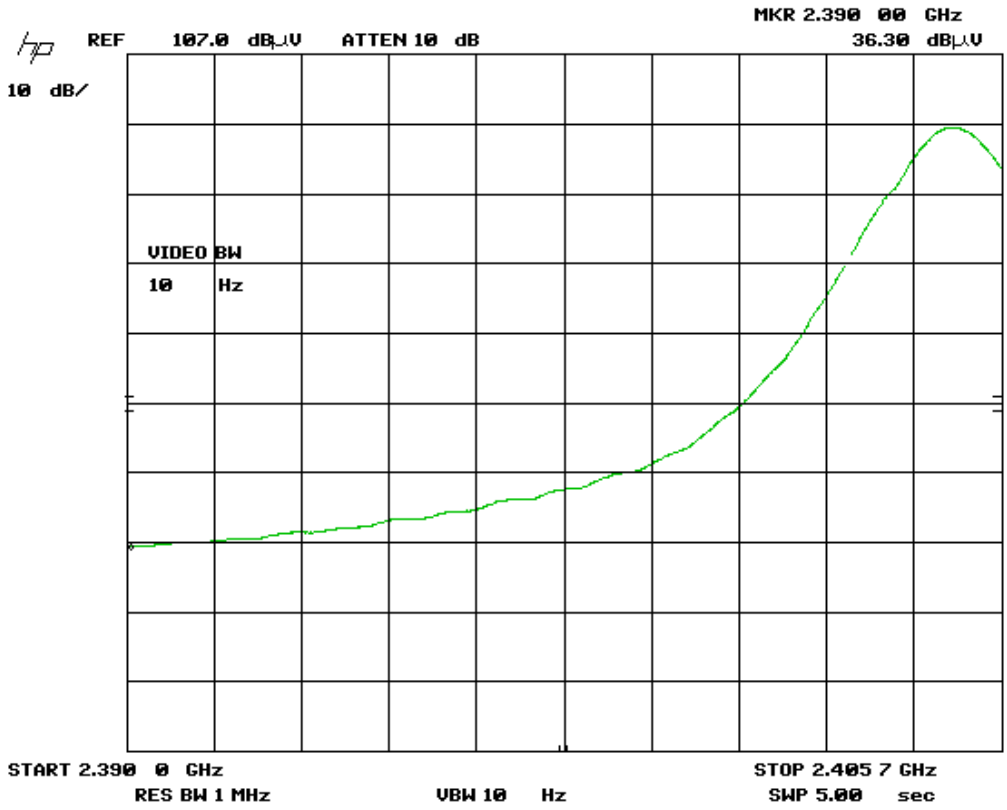
Band Edge – Low Channel (External Antenna)
Vertical - Peak Emission



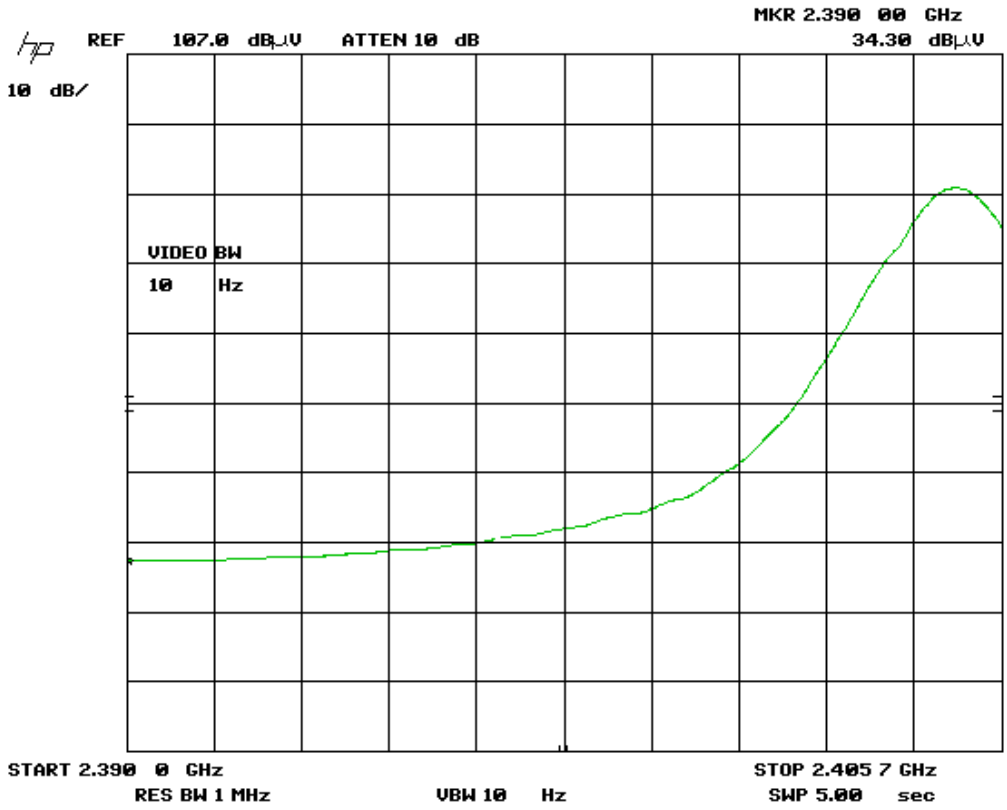
Band Edge – Low Channel (External Antenna)
Horizontal - Peak Emission



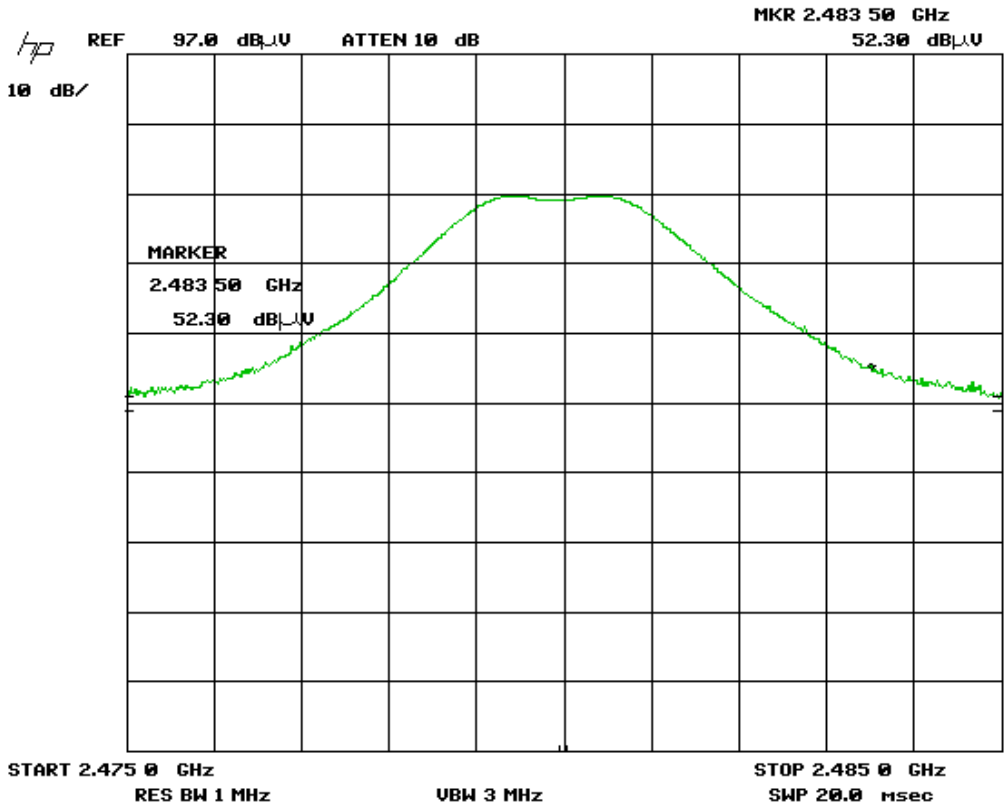
Band Edge – Low Channel (External Antenna)
Vertical – Average Emission



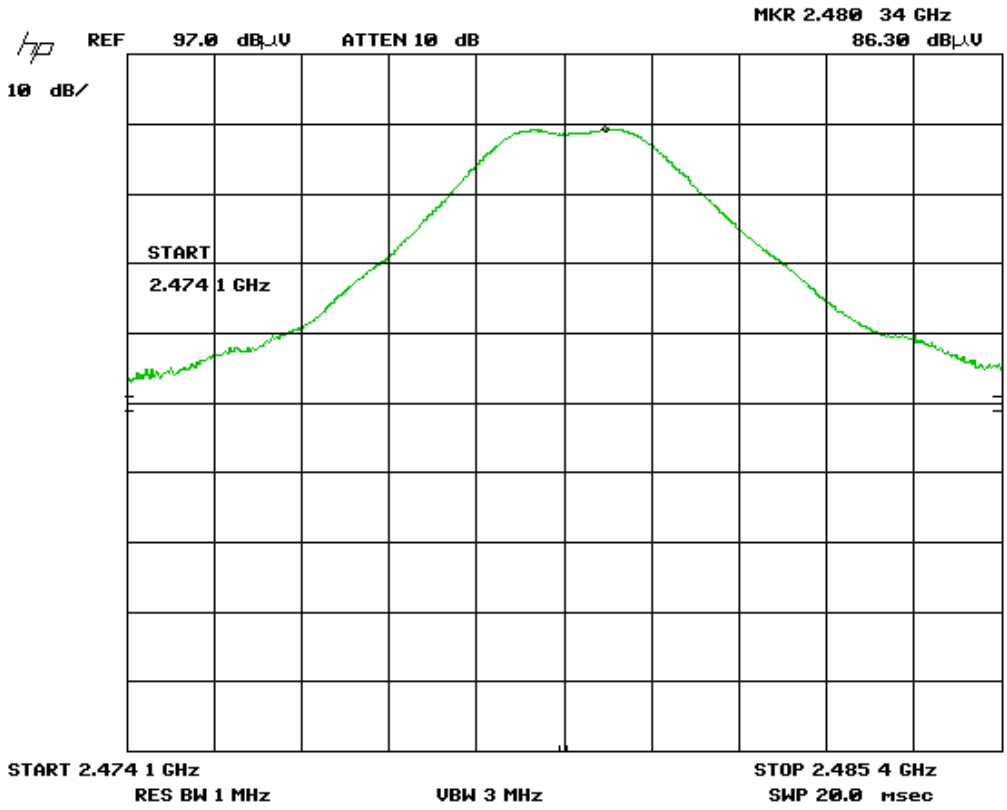
Band Edge – Low Channel (External Antenna)
Horizontal - Average Emission



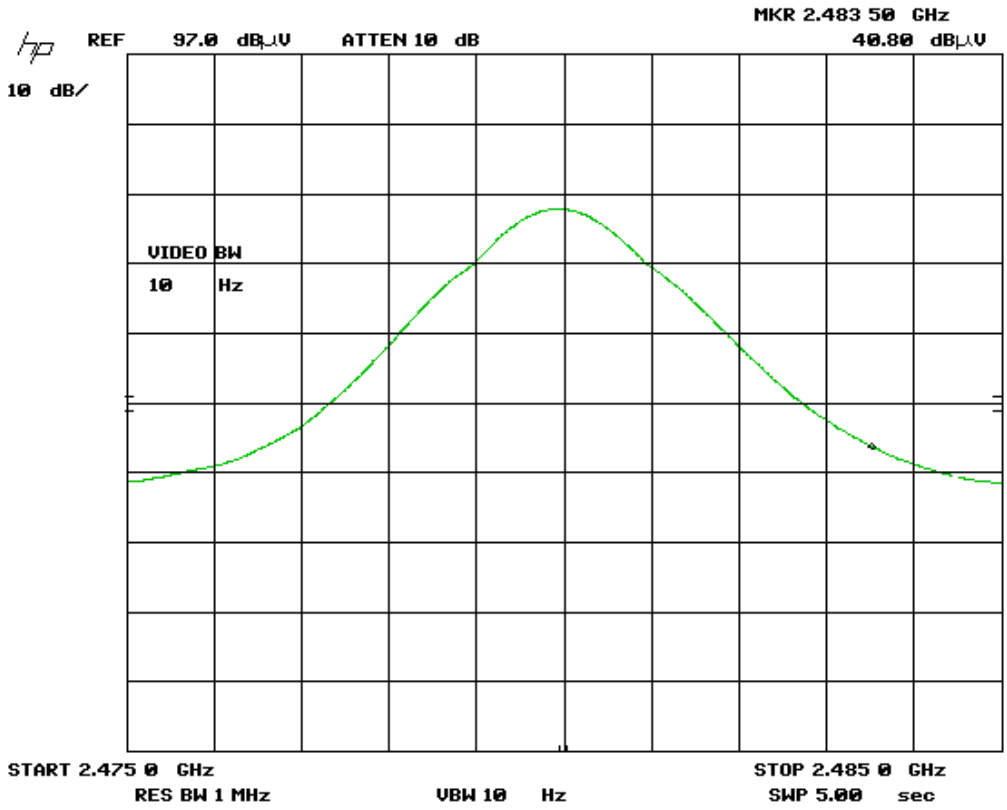
Band Edge – Hi Channel (External Antenna)
Vertical - Peak Emission



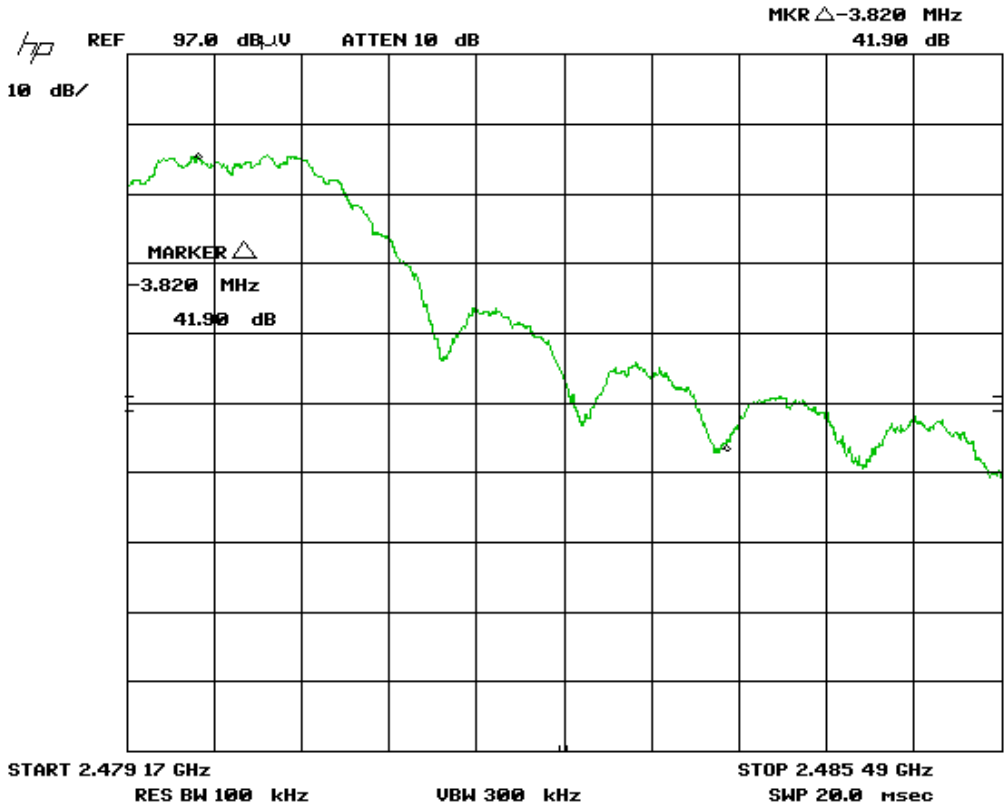
Band Edge – Hi Channel (External Antenna)
Horizontal - Peak Emission



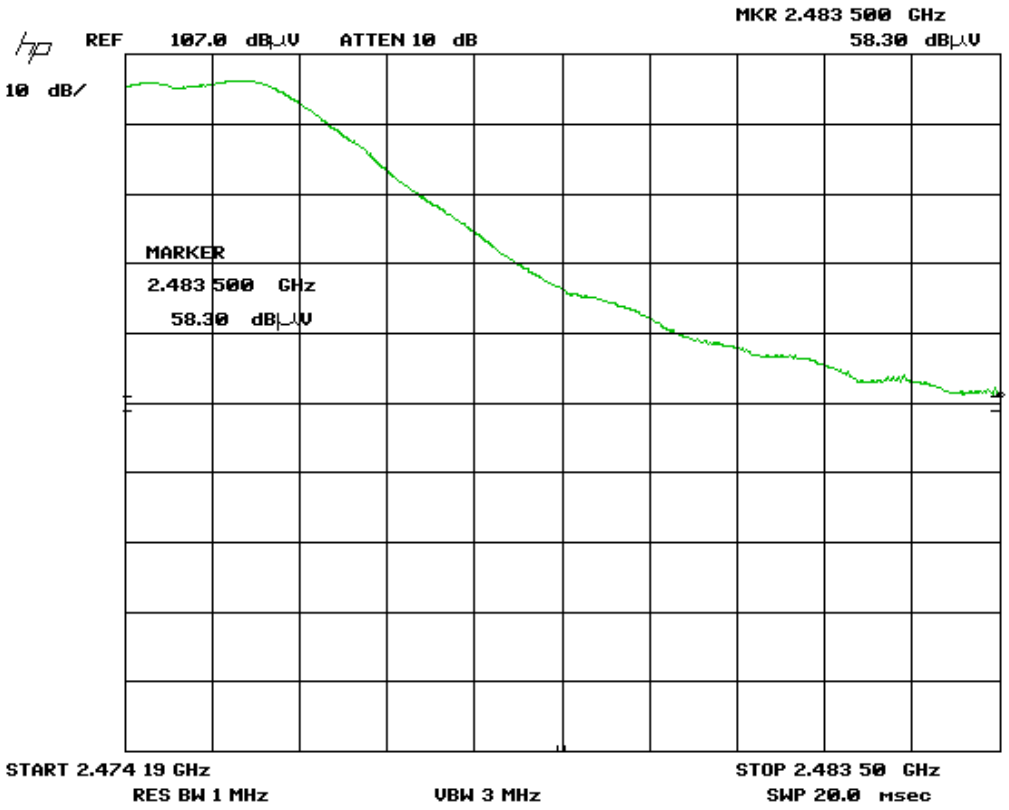
Band Edge – Hi Channel (External Antenna)
Vertical – Average Emission



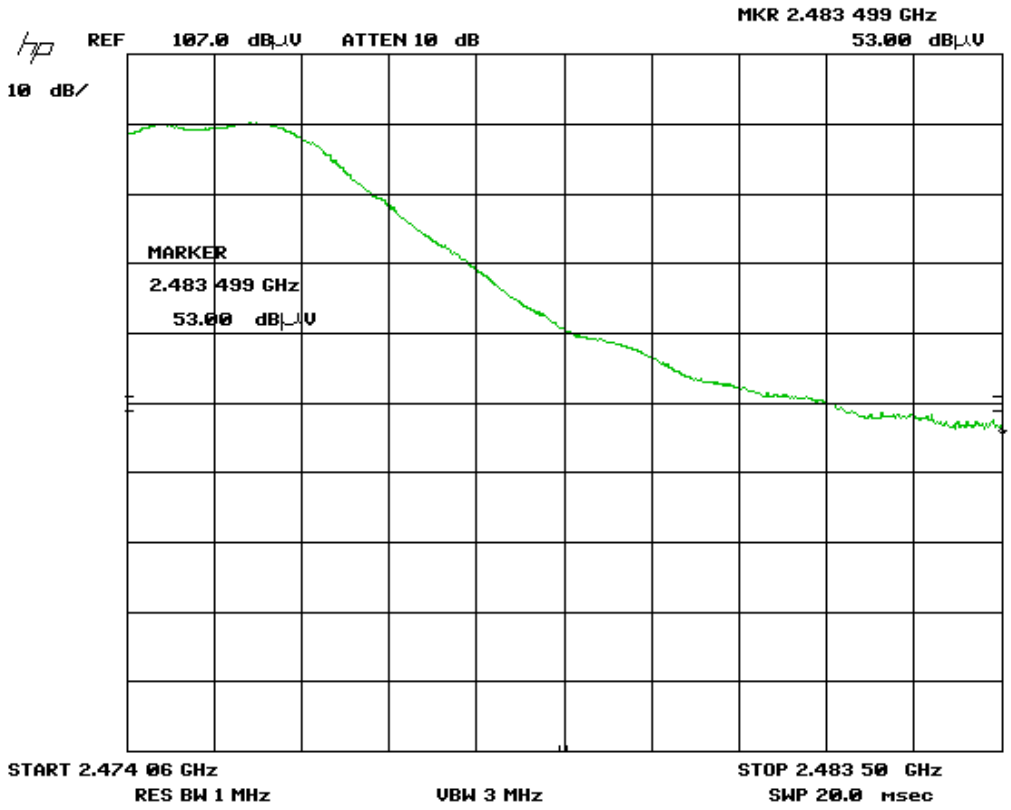
Band Edge – Hi Channel (External Antenna)
Horizontal – Marker Delta



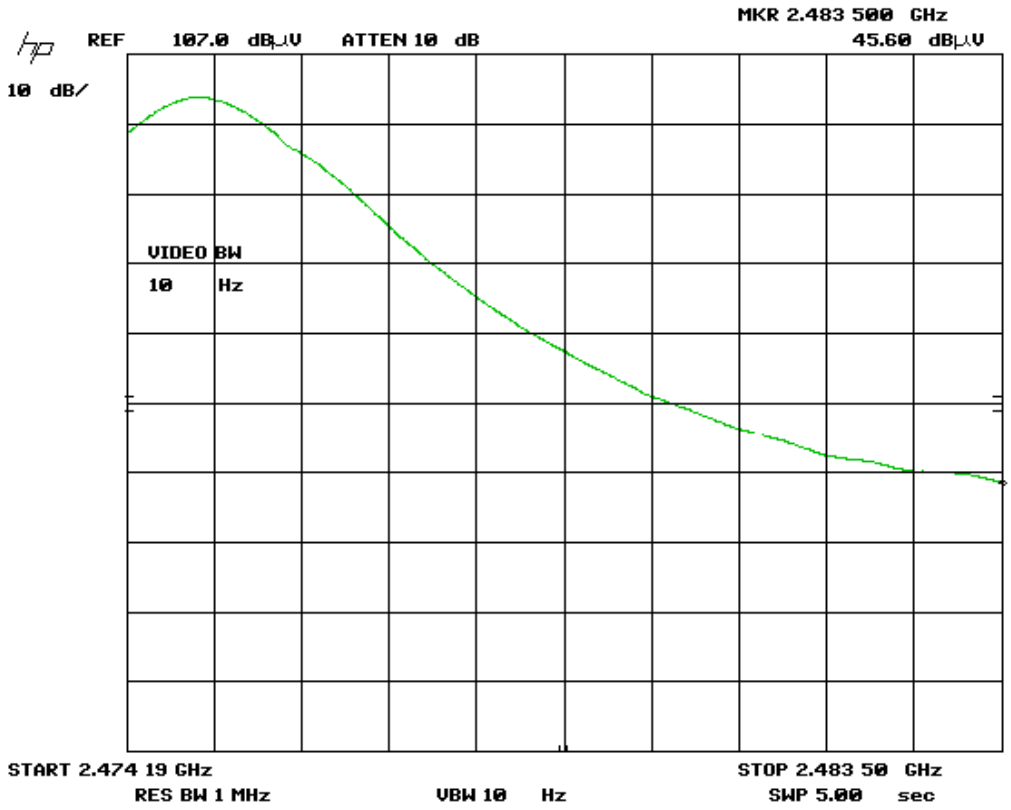
Band Edge – Channel 25 (External Antenna)
Vertical - Peak Emission



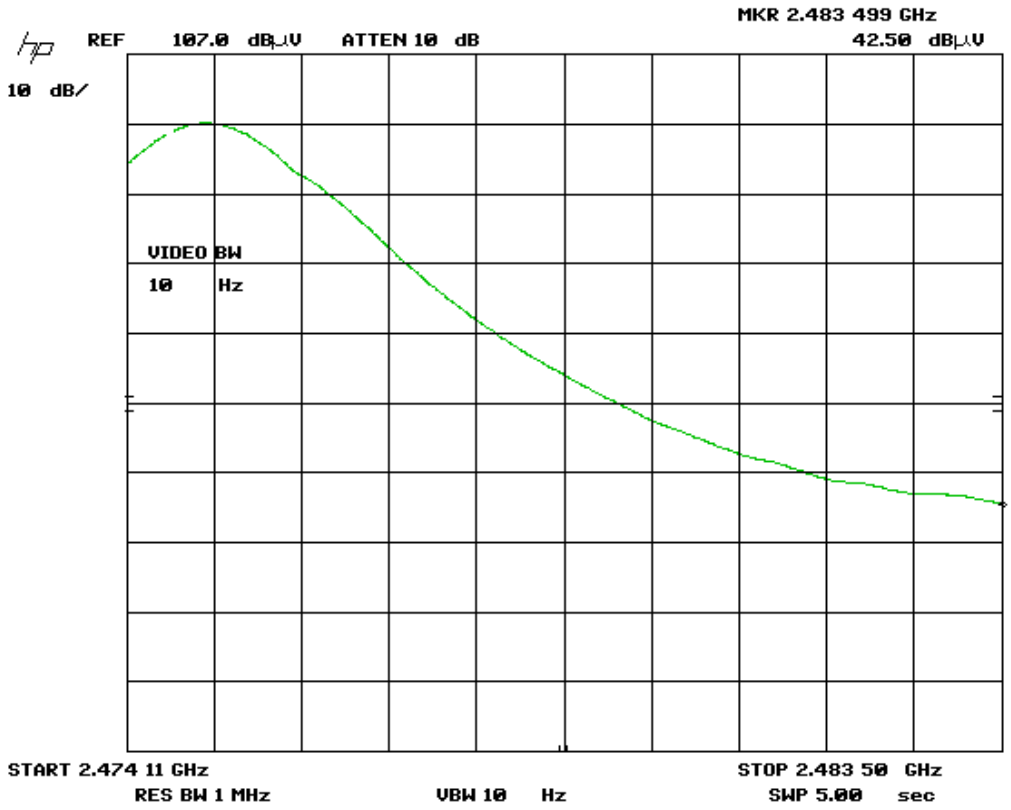
Band Edge – Channel 25 (External Antenna)
Horizontal - Peak Emission



Band Edge – Channel 25 (External Antenna)
Vertical – Average Emission



Band Edge – Channel 25 (External Antenna)
Horizontal - Average Emission



Final Measurements

Note: In accordance with 15.247(d), only frequencies exceeding the 15.209 limit that occur within the bands listed in 15.205, need to be verified with a final detector.

See 'Spurious Conducted' measurements for further details and for peak emissions above 1 GHz.

Internal Antenna								
Quasi-Peak Emissions Table - Vertical								
Frequency (MHz)	Raw (dBuV)	Antenna Factor (dB/m)	Cable RE Factor (dB)	Pre-Amp (dB)	Level (dBuV/m)	Limit (dB)	Margin (dB)	Pass/Fail
47.848	48.48	8.5	0.6	-28.7	28.88	40	11.12	Pass
Quasi Peak Emissions Table - Horizontal								
264.061	56.44	12.9	1.2	-28.8	41.74	46.4	4.66	Pass
287.826	55.1	12.9	1.3	-28.8	40.5	46.4	5.9	Pass
240.005	54.2	12.4	1.2	-28.7	39.1	46.4	7.3	Pass

Test Frequency (MHz)	Detection mode (Q-Peak)	Antenna polarity (Horz/Vert)	Raw signal dB(µV)	Antenna factor dB	Cable loss dB + Preselecor	Attenuator dB	Pre-Amp Gain dB	Received signal dB(µV/m)	Emission limit dB(µV/m)	Margin dB(µV)	Result
Low Channel Internal Antenna - Board Horizontal (SW = -2 dBm)											
2404.8	Peak	Horz	104.6	30.6	2.2	10.0	36.2	111.2			PASS
2404.8	Avg	Horz	102.4	30.6	2.2	10.0	36.2	109.0			PASS
2404.8	Peak	Vert	98.8	30.6	2.2	10.0	36.2	105.4			PASS
2404.8	Avg	Vert	96.6	30.6	2.2	10.0	36.2	103.2			PASS
2390	Peak	Horz	49.9	30.6	2.2	10.0	36.2	56.5	74.0	17.5	PASS
2390	Avg	Horz	39.3	30.6	2.2	10.0	36.2	45.9	54.0	8.1	PASS
2390	Peak	Vert	47.4	30.6	2.2	10.0	36.2	54.0	74.0	20.0	PASS
2390	Avg	Vert	35.8	30.6	2.2	10.0	36.2	42.4	54.0	11.6	PASS
4809.6	Peak	Horz	48.3	33.7	4.3	10.0	35.7	60.6	74.0	13.4	PASS
4809.6	Avg	Horz	36.2	33.7	4.3	10.0	35.7	48.5	54.0	5.5	PASS
4809.6	Peak	Vert	48.2	33.7	4.3	10.0	35.7	60.5	74.0	13.5	PASS
4809.6	Avg	Vert	36.9	33.7	4.3	10.0	35.7	49.2	54.0	4.8	PASS
Low Channel Internal Antenna - Board Vertical (SW = -2 dBm)											
2404.8	Peak	Horz	102.4	30.6	2.2	10.0	36.2	109.0			PASS
2404.8	Avg	Horz	99.8	30.6	2.2	10.0	36.2	106.4			PASS
2404.8	Peak	Vert	99.3	30.6	2.2	10.0	36.2	105.9			PASS
2404.8	Avg	Vert	96.6	30.6	2.2	10.0	36.2	103.2			PASS
2390	Peak	Horz	49.3	30.6	2.2	10.0	36.2	55.9	74.0	18.1	PASS
2390	Avg	Horz	37.1	30.6	2.2	10.0	36.2	43.7	54.0	10.3	PASS
2390	Peak	Vert	47.3	30.6	2.2	10.0	36.2	53.9	74.0	20.1	PASS
2390	Avg	Vert	36.3	30.6	2.2	10.0	36.2	42.9	54.0	11.1	PASS
4809.6	Peak	Horz	50.1	33.7	4.3	10.0	35.7	62.4	74.0	11.6	PASS
4809.6	Avg	Horz	38.8	33.7	4.3	10.0	35.7	51.1	54.0	2.9	PASS
4809.6	Peak	Vert	50.3	33.7	4.3	10.0	35.7	62.6	74.0	11.4	PASS
4809.6	Avg	Vert	38.4	33.7	4.3	10.0	35.7	50.7	54.0	3.3	PASS

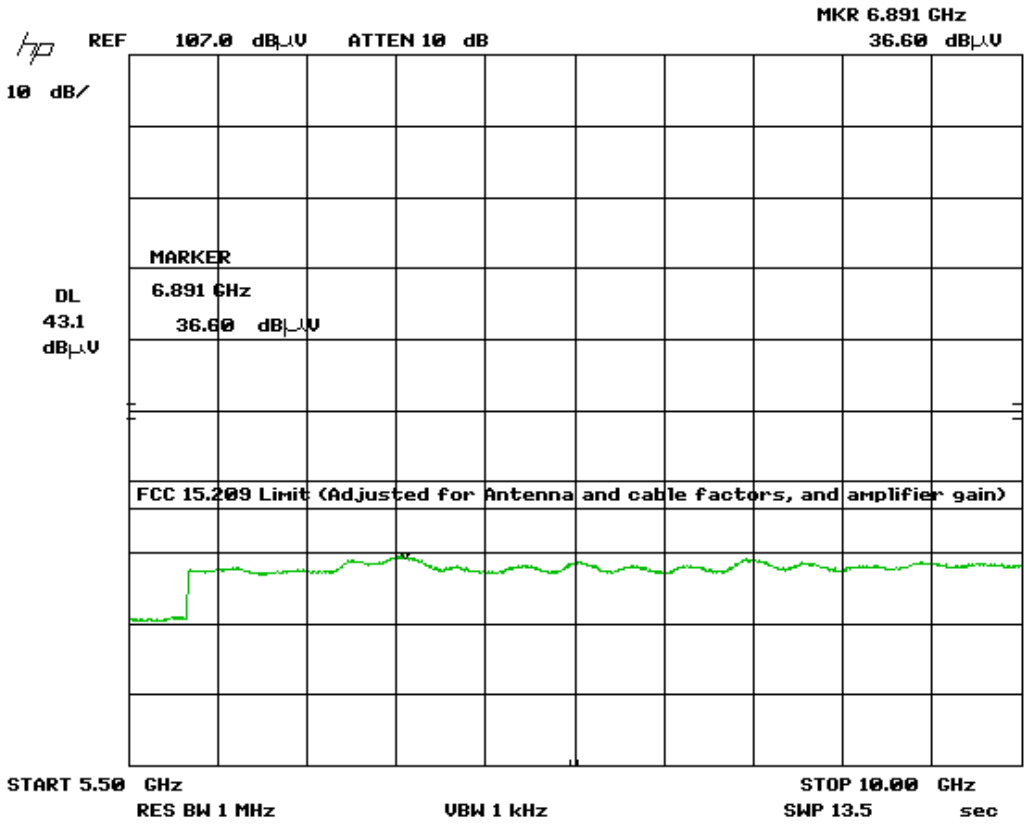
Test Frequency (MHz)	Detection mode (Q-Peak)	Antenna polarity (Horz/Vert)	Raw signal dB(µV)	Antenna factor dB	Cable loss dB + Preselecor	Attenuator dB	Pre-Amp Gain dB	Received signal dB(µV/m)	Emission limit dB(µV/m)	Margin dB(µV)	Result
Mid channel Internal Antenna - Horizontal (SW = -2 dBm)											
2444.8	Peak	Horz	103.3	30.6	2.2	10.0	36.2	109.9			PASS
2444.8	Avg	Horz	101.1	30.6	2.2	10.0	36.2	107.7			PASS
2444.8	Peak	Vert	96.1	30.6	2.2	10.0	36.2	102.7			PASS
2444.8	Avg	Vert	93.6	30.6	2.2	10.0	36.2	100.2			PASS
4889.6	Peak	Horz	47.9	33.7	4.3	10.0	35.7	60.2	74.0	13.8	PASS
4889.6	Avg	Horz	35.8	33.7	4.3	10.0	35.7	48.1	54.0	5.9	PASS
4889.6	Peak	Vert	46.6	33.7	4.3	10.0	35.7	58.9	74.0	15.1	PASS
4889.6	Avg	Vert	33.1	33.7	4.3	10.0	35.7	45.4	54.0	8.6	PASS
7334.4	Peak	Vert	48.3	37.9	7.1	0.0	35.9	57.4	74.0	16.6	PASS
7334.4	Avg	Vert	34.5	37.9	7.1	0.0	35.9	43.6	54.0	10.4	PASS
7334.4	Peak	Horz	47.9	37.9	7.1	0.0	35.9	57.0	74.0	17.0	PASS
7334.4	Avg	Horz	35.1	37.9	7.1	0.0	35.9	44.2	54.0	9.8	PASS
Mid channel Internal Antenna - Vertical (SW = -2 dBm)											
2444.8	Peak	Horz	103.6	30.6	2.2	10.0	36.2	110.2			PASS
2444.8	Avg	Horz	101.3	30.6	2.2	10.0	36.2	107.9			PASS
2444.8	Peak	Vert	100.4	30.6	2.2	10.0	36.2	107.0			PASS
2444.8	Avg	Vert	98.0	30.6	2.2	10.0	36.2	104.6			PASS
4889.6	Peak	Horz	48.6	33.7	4.3	10.0	35.7	60.9	74.0	13.1	PASS
4889.6	Avg	Horz	36.6	33.7	4.3	10.0	35.7	48.9	54.0	5.1	PASS
4889.6	Peak	Vert	47.3	33.7	4.3	10.0	35.7	59.6	74.0	14.4	PASS
4889.6	Avg	Vert	34.4	33.7	4.3	10.0	35.7	46.7	54.0	7.3	PASS
7334.4	Peak	Vert	48.1	37.9	7.1	0.0	35.9	57.2	74.0	16.8	PASS
7334.4	Avg	Vert	34.8	37.9	7.1	0.0	35.9	43.9	54.0	10.1	PASS
7334.4	Peak	Horz	47.9	37.9	7.1	0.0	35.9	57.0	74.0	17.0	PASS
7334.4	Avg	Horz	35.0	37.9	7.1	0.0	35.9	44.1	54.0	9.9	PASS

Test Frequency (MHz)	Detection mode (Q-Peak)	Antenna polarity (Horz/Vert)	Raw signal dB(µV)	Antenna factor dB	Cable loss dB + Preselecor	Attenuator dB	Pre-Amp Gain dB	Received signal dB(µV/m)	Emission limit dB(µV/m)	Margin dB(µV)	Result
High channel 26 Internal Antenna - Board Horizontal (SW = -20 dBm)											
2480	Peak	Horz	98.4	30.6	2.2	0.0	36.2	95.0			PASS
2480	Avg	Horz	96.5	30.6	2.2	0.0	36.2	93.1			PASS
2480	Peak	Vert	88.5	30.6	2.2	0.0	36.2	85.1			PASS
2480	Avg	Vert	86.6	30.6	2.2	0.0	36.2	83.2			PASS
2483.5	Peak	Horz	57.0	30.6	2.2	0.0	36.2	53.6	74.0	20.5	PASS
2483.5	Avg	Horz	55.0	30.6	2.2	0.0	36.2	51.6	54.0	2.4	PASS
2483.5	Peak	Vert	58.6	30.6	2.2	0.0	36.2	55.2	74.0	18.8	PASS
2483.5	Avg	Vert	47.2	30.6	2.2	0.0	36.2	43.8	54.0	10.2	PASS
2483.593	Peak	Horz	69.0	30.6	2.2	0.0	36.2	65.6	74.0	8.4	PASS
2483.593	Avg	Horz	54.7	30.6	2.2	0.0	36.2	51.3	54.0	2.7	PASS
2483.593	Peak	Vert	59.3	30.6	2.2	0.0	36.2	55.9	74.0	18.1	PASS
2483.593	Avg	Vert	46.6	30.6	2.2	0.0	36.2	43.2	54.0	10.8	PASS
4960	Peak	Horz	52.3	33.7	4.3	0.0	35.7	54.6	74.0	19.5	PASS
4960	Avg	Horz	41.5	33.7	4.3	0.0	35.7	43.8	54.0	10.2	PASS
4960	Peak	Vert	44.9	33.7	4.3	0.0	35.7	47.2	74.0	26.8	PASS
4960	Avg	Vert	30.5	33.7	4.3	0.0	35.7	32.8	54.0	21.3	PASS
7440	Peak	Vert	48.2	37.9	7.1	0.0	35.9	57.3	74.0	16.7	PASS
7440	Avg	Vert	32.1	37.9	7.1	0.0	35.9	41.2	54.0	12.8	PASS
7440	Peak	Horz	47.9	37.9	7.1	0.0	35.9	57.0	74.0	17.0	PASS
7440	Avg	Horz	33.0	37.9	7.1	0.0	35.9	42.1	54.0	11.9	PASS

Note: The marker-delta method was used at 2483.5 MHz with the measuring antenna at horizontal polarity. The RBW = 100 kHz is used to obtain the marker-delta value. The marker-delta value is 41.5 dB.

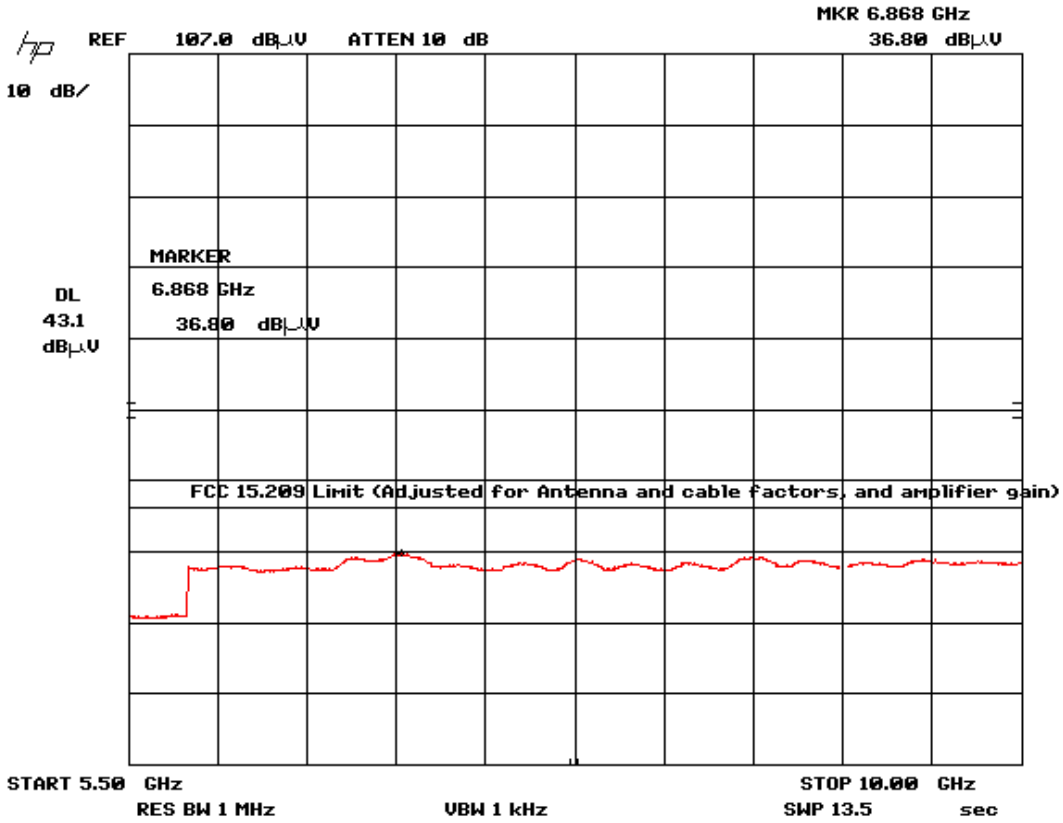
Test Frequency (MHz)	Detection mode (Q-Peak)	Antenna polarity (Horz/Vert)	Raw signal dB(µV)	Antenna factor dB	Cable loss dB + Preselecor	Attenuator dB	Pre-Amp Gain dB	Received signal dB(µV/m)	Emission limit dB(µV/m)	Margin dB(µV)	Result
High channel 25 Internal Antenna - Horizontal (SW = -2dBm)											
2474.9	Peak	Horz	104.3	30.6	2.2	10.0	36.2	110.9			PASS
2474.9	Avg	Horz	102.2	30.6	2.2	10.0	36.2	108.8			PASS
2474.9	Peak	Vert	97.4	30.6	2.2	10.0	36.2	104.0			PASS
2474.9	Avg	Vert	94.4	30.6	2.2	10.0	36.2	101.0			PASS
2483.5	Peak	Horz	58.6	30.6	2.2	10.0	36.2	65.2	74.0	8.8	PASS
2483.5	Avg	Horz	46.1	30.6	2.2	10.0	36.2	52.7	54.0	1.3	PASS
2483.5	Peak	Vert	50.8	30.6	2.2	10.0	36.2	57.4	74.0	16.6	PASS
2483.5	Avg	Vert	39.6	30.6	2.2	10.0	36.2	46.2	54.0	7.8	PASS
4949.8	Peak	Horz	46.3	33.7	4.3	10.0	35.7	58.6	74.0	15.4	PASS
4949.8	Avg	Horz	32.5	33.7	4.3	10.0	35.7	44.8	54.0	9.2	PASS
4949.8	Peak	Vert	48.5	33.7	4.3	10.0	35.7	60.8	74.0	13.2	PASS
4949.8	Avg	Vert	35.8	33.7	4.3	10.0	35.7	48.1	54.0	5.9	PASS
7424.7	Peak	Vert	48.1	37.9	7.1	0.0	35.9	57.2	74.0	16.8	PASS
7424.7	Avg	Vert	35.1	37.9	7.1	0.0	35.9	44.2	54.0	9.8	PASS
7424.7	Peak	Horz	48.5	37.9	7.1	0.0	35.9	57.6	74.0	16.4	PASS
7424.7	Avg	Horz	34.9	37.9	7.1	0.0	35.9	44.0	54.0	10.0	PASS
High channel 25 - Vertical (Power = -2dBm)											
2474.9	Peak	Horz	104.3	30.6	2.2	10.0	36.2	110.9			PASS
2474.9	Avg	Horz	102.2	30.6	2.2	10.0	36.2	108.8			PASS
2474.9	Peak	Vert	100.3	30.6	2.2	10.0	36.2	106.9			PASS
2474.9	Avg	Vert	97.6	30.6	2.2	10.0	36.2	104.2			PASS
2483.5	Peak	Horz	57.8	30.6	2.2	10.0	36.2	64.4	74.0	9.6	PASS
2483.5	Avg	Horz	45.5	30.6	2.2	10.0	36.2	52.1	54.0	1.9	PASS
2483.5	Peak	Vert	55.3	30.6	2.2	10.0	36.2	61.9	74.0	12.1	PASS
2483.5	Avg	Vert	42.9	30.6	2.2	10.0	36.2	49.5	54.0	4.5	PASS
4949.8	Peak	Horz	49.9	33.7	4.3	10.0	35.7	62.2	74.0	11.8	PASS
4949.8	Avg	Horz	32.1	33.7	4.3	10.0	35.7	44.4	54.0	9.6	PASS
4949.8	Peak	Vert	46.5	33.7	4.3	10.0	35.7	58.8	74.0	15.2	PASS
4949.8	Avg	Vert	33.0	33.7	4.3	10.0	35.7	45.3	54.0	8.7	PASS
7424.7	Peak	Vert	48.5	37.9	7.1	0.0	35.9	57.6	74.0	16.4	PASS
7424.7	Avg	Vert	35.7	37.9	7.1	0.0	35.9	44.8	54.0	9.2	PASS
7424.7	Peak	Horz	47.9	37.9	7.1	0.0	35.9	57.0	74.0	17.0	PASS
7424.7	Avg	Horz	34.1	37.9	7.1	0.0	35.9	43.2	54.0	10.8	PASS

Mid Channel – 5.5 GHz – 10 GHz
Horizontal - Average Emission Graph



Note: Display Line at 43.1 dBuV is the FCC 15.209 limit adjusted for antenna gain, cable loss, and amplifier gain.

Mid Channel – 5.5 GHz – 10 GHz
Vertical - Average Emission Graph



Note: Display Line at 43.1 dBuV is the FCC 15.209 limit adjusted for antenna gain, cable loss, and amplifier gain.

External Antenna								
Quasi-Peak Emissions Table - Vertical								
Frequency (MHz)	Raw (dBuV)	Antenna Factor (dB/m)	Cable RE Factor (dB)	Pre-Amp (dB)	Level (dBuV/m)	Limit (dB)	Margin (dB)	Pass/Fail
71.904	56.02	5.7	0.7	-28.7	33.72	40	6.28	Pass
53.765	53.9	8	0.6	-28.7	33.8	40	6.2	Pass
47.848	53.2	8.5	0.6	-28.7	33.6	40	6.4	Pass
Quasi Peak Emissions Table - Horizontal								
191.893	59.3	10.4	1.1	-28.7	42.1	43.5	1.4	Pass
143.975	59.5	8.4	0.9	-28.7	40.1	43.5	3.4	Pass
190.147	37	10.3	1.1	-28.7	19.7	43.5	23.8	Pass
167.837	54.5	10	1	-28.7	36.8	43.5	6.7	Pass
155.809	52.3	9.8	1	-28.7	34.4	43.5	9.1	Pass

Test Frequency (MHz)	Detection mode (Q-Peak)	External Antenna polarity (Horz/Vert)	Raw signal dB(µV)	External Antenna factor dB	Cable loss dB + Prese lecor	Atten uator dB	Pre-Amp Gain dB	Receive d signal dB(µV/m)	Emission limit dB(µV/m)	Margin dB(µV)	Result
Low Channel - External Antenna Horizontal (power = -11 dBm)											
2404.8	Peak	Horz	98.5	30.6	2.2	10.0	36.2	105.1			PASS
2404.8	Avg	Horz	96.0	30.6	2.2	10.0	36.2	102.6			PASS
2404.8	Peak	Vert	89.5	30.6	2.2	10.0	36.2	96.1			PASS
2404.8	Avg	Vert	87.5	30.6	2.2	10.0	36.2	94.1			PASS
2390	Peak	Horz	47.9	30.6	2.2	10.0	36.2	54.5	74.0	19.5	PASS
2390	Avg	Horz	35.8	30.6	2.2	10.0	36.2	42.4	54.0	11.6	PASS
2390	Peak	Vert	46.0	30.6	2.2	10.0	36.2	52.6	74.0	21.4	PASS
2390	Avg	Vert	34.1	30.6	2.2	10.0	36.2	40.7	54.0	13.3	PASS
4809.6	Peak	Horz	48.1	33.7	4.3	0.0	35.7	50.4	74.0	23.6	PASS
4809.6	Avg	Horz	34.2	33.7	4.3	0.0	35.7	36.5	54.0	17.5	PASS
4809.6	Peak	Vert	50.1	33.7	4.3	0.0	35.7	52.4	74.0	21.6	PASS
4809.6	Avg	Vert	39.2	33.7	4.3	0.0	35.7	41.5	54.0	12.5	PASS
Low Channel - External Antenna Vertical (power = -11dBm)											
2404.8	Peak	Horz	90.1	30.6	2.2	10.0	36.2	96.7			PASS
2404.8	Avg	Horz	87.9	30.6	2.2	10.0	36.2	94.5			PASS
2404.8	Peak	Vert	99.2	30.6	2.2	10.0	36.2	105.8			PASS
2404.8	Avg	Vert	96.6	30.6	2.2	10.0	36.2	103.2			PASS
2390	Peak	Horz	46.3	30.6	2.2	10.0	36.2	52.9	74.0	21.1	PASS
2390	Avg	Horz	34.3	30.6	2.2	10.0	36.2	40.9	54.0	13.1	PASS
2390	Peak	Vert	47.9	30.6	2.2	10.0	36.2	54.5	74.0	19.5	PASS
2390	Avg	Vert	36.3	30.6	2.2	10.0	36.2	42.9	54.0	11.1	PASS
4809.6	Peak	Horz	47.5	33.7	4.3	0.0	35.7	49.8	74.0	24.2	PASS
4809.6	Avg	Horz	33.9	33.7	4.3	0.0	35.7	36.2	54.0	17.8	PASS
4809.6	Peak	Vert	52.4	33.7	4.3	0.0	35.7	54.7	74.0	19.4	PASS
4809.6	Avg	Vert	41.1	33.7	4.3	0.0	35.7	43.4	54.0	10.7	PASS

Test Frequency (MHz)	Detection mode (Q-Peak)	External Antenna polarity (Horz/Vert)	Raw signal dB(µV)	External Antenna factor dB	Cable loss dB + Preselecor	Attenuator dB	Pre-Amp Gain dB	Received signal dB(µV/m)	Emission limit dB(µV/m)	Margin dB(µV)	Result
Mid channel - External Antenna Horizontal (Power = -11 dBm)											
2444.8	Peak	Horz	101.4	30.6	2.2	10.0	36.2	108.0			PASS
2444.8	Avg	Horz	98.9	30.6	2.2	10.0	36.2	105.5			PASS
2444.8	Peak	Vert	92.7	30.6	2.2	10.0	36.2	99.3			PASS
2444.8	Avg	Vert	90.3	30.6	2.2	10.0	36.2	96.9			PASS
4889.6	Peak	Horz	47.9	33.7	4.3	0.0	35.7	50.2	74.0	23.8	PASS
4889.6	Avg	Horz	36.0	33.7	4.3	0.0	35.7	38.3	54.0	15.7	PASS
4889.6	Peak	Vert	51.0	33.7	4.3	0.0	35.7	53.3	74.0	20.7	PASS
4889.6	Avg	Vert	33.1	33.7	4.3	0.0	35.7	35.4	54.0	18.6	PASS
7334.4	Peak	Vert	48.3	37.9	7.1	0.0	35.9	57.4	74.0	16.6	PASS
7334.4	Avg	Vert	34.5	37.9	7.1	0.0	35.9	43.6	54.0	10.4	PASS
7334.4	Peak	Horz	47.9	37.9	7.1	0.0	35.9	57.0	74.0	17.0	PASS
7334.4	Avg	Horz	35.1	37.9	7.1	0.0	35.9	44.2	54.0	9.8	PASS
Mid channel - External Antenna Vertical (Power = -11 dBm)											
2444.8	Peak	Horz	95.0	30.6	2.2	10.0	36.2	101.6			PASS
2444.8	Avg	Horz	93.0	30.6	2.2	10.0	36.2	99.6			PASS
2444.8	Peak	Vert	100.7	30.6	2.2	10.0	36.2	107.3			PASS
2444.8	Avg	Vert	98.5	30.6	2.2	10.0	36.2	105.1			PASS
4889.6	Peak	Horz	47.1	33.7	4.3	0.0	35.7	49.4	74.0	24.6	PASS
4889.6	Avg	Horz	34.2	33.7	4.3	0.0	35.7	36.5	54.0	17.5	PASS
4889.6	Peak	Vert	50.8	33.7	4.3	0.0	35.7	53.1	74.0	20.9	PASS
4889.6	Avg	Vert	39.8	33.7	4.3	0.0	35.7	42.1	54.0	11.9	PASS
7334.4	Peak	Vert	48.6	37.9	7.1	0.0	35.9	57.7	74.0	16.3	PASS
7334.4	Avg	Vert	34.3	37.9	7.1	0.0	35.9	43.4	54.0	10.6	PASS
7334.4	Peak	Horz	49.0	37.9	7.1	0.0	35.9	58.1	74.0	15.9	PASS
7334.4	Avg	Horz	34.4	37.9	7.1	0.0	35.9	43.5	54.0	10.5	PASS

Test Frequency (MHz)	Detection mode (Q-Peak)	External Antenna polarity (Horz/Vert)	Raw signal dB(µV)	External Antenna factor dB	Cable loss dB + Preselecor	Attenuator dB	Pre-Amp Gain dB	Received signal dB(µV/m)	Emission limit dB(µV/m)	Margin dB(µV)	Result
High channel 26 - External Antenna Vertical (Power = -26dBm)											
2480	Peak	Horz	78.1	30.6	2.2	10.0	36.2	84.7			PASS
2480	Avg	Horz	76.2	30.6	2.2	10.0	36.2	82.8			PASS
2480	Peak	Vert	86.2	30.6	2.2	10.0	36.2	92.8			PASS
2480	Avg	Vert	84.3	30.6	2.2	10.0	36.2	90.9			PASS
2483.5	Peak	Horz	52.5	30.6	2.2	10.0	36.2	59.1	74.0	14.9	PASS
2483.5	Avg	Horz	42.3	30.6	2.2	10.0	36.2	48.9	54.0	5.1	PASS
2483.5	Peak	Vert	44.3	30.6	2.2	10.0	36.2	50.9	74.0	23.1	PASS
2483.5	Avg	Vert	42.4	30.6	2.2	10.0	36.2	49.0	54.0	5.0	PASS
2483.563	Peak	Vert	58.2	30.6	2.2	10.0	36.2	64.8	74.0	9.2	PASS
2483.563	Avg	Vert	44.3	30.6	2.2	10.0	36.2	50.9	54.0	3.1	PASS
High channel 26 - External Antenna Horizontal (Power = -26 dBm)											
2480	Peak	Horz	86.7	30.6	2.2	10.0	36.2	93.3			PASS
2480	Avg	Horz	84.3	30.6	2.2	10.0	36.2	90.9			PASS
2480	Peak	Vert	77.3	30.6	2.2	10.0	36.2	83.9			PASS
2480	Avg	Vert	74.9	30.6	2.2	10.0	36.2	81.5			PASS
2483.5	Peak	Horz	44.8	30.6	2.2	10.0	36.2	51.4	74.0	22.6	PASS
2483.5	Avg	Horz	42.4	30.6	2.2	10.0	36.2	49.0	54.0	5.0	PASS
2483.5	Peak	Vert	51.5	30.6	2.2	10.0	36.2	58.1	74.0	15.9	PASS
2483.5	Avg	Vert	40.8	30.6	2.2	10.0	36.2	47.4	54.0	6.6	PASS
2483.563	Peak	Horz	59.7	30.6	2.2	10.0	36.2	66.3	74.0	7.7	PASS
2483.563	Avg	Horz	47.1	30.6	2.2	10.0	36.2	53.7	54.0	0.3	PASS
4960	Peak	Horz	44.4	33.7	4.3	0.0	35.7	46.7	74.0	27.3	PASS
4960	Avg	Horz	30.9	33.7	4.3	0.0	35.7	33.2	54.0	20.8	PASS
4960	Peak	Vert	44.1	33.7	4.3	0.0	35.7	46.4	74.0	27.6	PASS
4960	Avg	Vert	30.9	33.7	4.3	0.0	35.7	33.2	54.0	20.8	PASS
7440	Peak	Vert	48.9	37.9	7.1	0.0	35.9	58.0	74.0	16.0	PASS
7440	Avg	Vert	34.8	37.9	7.1	0.0	35.9	43.9	54.0	10.1	PASS
7440	Peak	Horz	48.6	37.9	7.1	0.0	35.9	57.7	74.0	16.3	PASS
7440	Avg	Horz	34.6	37.9	7.1	0.0	35.9	43.7	54.0	10.3	PASS

Note: The marker-delta method was used at 2483.5 MHz with the measuring antenna at horizontal polarity and external antenna in horizontal position and with the measuring antenna at vertical polarity and external antenna in vertical position. The RBW = 100 kHz is used to obtain the marker-delta value. The marker-delta value is 41.9 dB.

Test Frequency (MHz)	Detection mode (Q-Peak)	External Antenna polarity (Horz/Vert)	Raw signal dB(µV)	External Antenna factor dB	Cable loss dB + Preselecor	Attenuator dB	Pre-Amp Gain dB	Received signal dB(µV/m)	Emission limit dB(µV/m)	Margin dB(µV)	Result
High channel 25 - Horizontal (Power = -11dBm)											
2474.9	Peak	Horz	105.6	30.6	2.2	10.0	36.2	112.2			PASS
2474.9	Avg	Horz	103.3	30.6	2.2	10.0	36.2	109.9			PASS
2474.9	Peak	Vert	97.0	30.6	2.2	10.0	36.2	103.6			PASS
2474.9	Avg	Vert	94.7	30.6	2.2	10.0	36.2	101.3			PASS
2483.5	Peak	Horz	60.1	30.6	2.2	10.0	36.2	66.7	74.0	7.3	PASS
2483.5	Avg	Horz	47.3	30.6	2.2	10.0	36.2	53.9	54.0	0.1	PASS
2483.5	Peak	Vert	52.7	30.6	2.2	10.0	36.2	59.3	74.0	14.7	PASS
2483.5	Avg	Vert	40.4	30.6	2.2	10.0	36.2	47.0	54.0	7.0	PASS
4949.8	Peak	Horz	48.8	33.7	4.3	0.0	35.7	51.1	74.0	22.9	PASS
4949.8	Avg	Horz	36.9	33.7	4.3	0.0	35.7	39.2	54.0	14.8	PASS
4949.8	Peak	Vert	52.0	33.7	4.3	0.0	35.7	54.3	74.0	19.7	PASS
4949.8	Avg	Vert	41.4	33.7	4.3	0.0	35.7	43.7	54.0	10.3	PASS
7424.7	Peak	Vert	49.2	37.9	7.1	0.0	35.9	58.3	74.0	15.7	PASS
7424.7	Avg	Vert	35.2	37.9	7.1	0.0	35.9	44.3	54.0	9.7	PASS
7424.7	Peak	Horz	49.8	37.9	7.1	0.0	35.9	58.9	74.0	15.1	PASS
7424.7	Avg	Horz	37.3	37.9	7.1	0.0	35.9	46.4	54.0	7.6	PASS
High channel 25 - External Antenna Vertical (Power = -11dBm)											
2474.9	Peak	Horz	97.2	30.6	2.2	10.0	36.2	103.8			PASS
2474.9	Avg	Horz	94.9	30.6	2.2	10.0	36.2	101.5			PASS
2474.9	Peak	Vert	104.0	30.6	2.2	10.0	36.2	110.6			PASS
2474.9	Avg	Vert	100.9	30.6	2.2	10.0	36.2	107.5			PASS
2483.5	Peak	Horz	53.0	30.6	2.2	10.0	36.2	59.6	74.0	14.4	PASS
2483.5	Avg	Horz	40.9	30.6	2.2	10.0	36.2	47.5	54.0	6.5	PASS
2483.5	Peak	Vert	58.3	30.6	2.2	10.0	36.2	64.9	74.0	9.1	PASS
2483.5	Avg	Vert	45.6	30.6	2.2	10.0	36.2	52.2	54.0	1.8	PASS
4949.8	Peak	Horz	49.4	33.7	4.3	0.0	35.7	51.7	74.0	22.3	PASS
4949.8	Avg	Horz	38.7	33.7	4.3	0.0	35.7	41.0	54.0	13.0	PASS
4949.8	Peak	Vert	52.8	33.7	4.3	0.0	35.7	55.1	74.0	18.9	PASS
4949.8	Avg	Vert	42.1	33.7	4.3	0.0	35.7	44.4	54.0	9.6	PASS
7424.7	Peak	Vert	48.2	37.9	7.1	0.0	35.9	57.3	74.0	16.7	PASS
7424.7	Avg	Vert	35.3	37.9	7.1	0.0	35.9	44.4	54.0	9.6	PASS
7424.7	Peak	Horz	49.4	37.9	7.1	0.0	35.9	58.5	74.0	15.5	PASS
7424.7	Avg	Horz	35.1	37.9	7.1	0.0	35.9	44.2	54.0	9.8	PASS

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	12/21/ 2011	12/21/2013	GEMC 141
Spectrum Analyzer	ESL 6	Rohde & Schwarz	Oct-06, 2011	Oct-06, 2013	GEMC 160
Quasi Peak Adapter	85650A	HP	12/21/ 2011	12/21/2013	GEMC 7
Loop Antenna	EM 6871	Electro-Metrics	Feb 5, 2013	Feb 5, 2015	GEMC 70
Loop Antenna	EM 6872	Electro-Metrics	Feb 5, 2013	Feb 5, 2015	GEMC 71
BiLog Antenna	3142-C	ETS	Feb 4, 2013	Feb 4, 2015	GEMC 137
Attenuator 10 dB	8493B	Agilent	NCR	NCR	GEMC 133
4GHZ-12GHz High Pass filter	11SH10-4000/T12000-0/0	K & L Microwave	NCR	NCR	GEMC 119
Chase Preamp 9kHz - 2 GHz	CPA9231A	Chase	8/29/2012	8/29/2014	GEMC 6403
Q-Par 1.5-18 GHz Horn	6878/24	Q-par	8/23/2012	8/23/2014	GEMC 6365
Horn Antenna 18 GHz - 26.5 GHz	SAS-572	A.H. Systems	8/27/2012	8/27/2014	GEMC 6371
18.0-26.5 GHz Harmonic Mixer	11970K	HP	21-Dec-11	21-Dec-13	GEMC 158
1-26G pre-amp	HP 8449B	HP	8/22/2012	8/22/2014	GEMC 6351
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
RF Cable 0.5M	LMR-400-0.5M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 31

This report module is based on GEMC template "FCC - 15.209 - Radiated Emissions_Rev1.doc"

Receiver Spurious Radiated Emissions

Purpose

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT does not exceed the limits listed below as defined in the applicable test standard, as measured from a receiving antenna. This helps protect broadcast radio services such as television, FM radio, pagers, cellular telephones, emergency services, and so on, from unwanted interference.

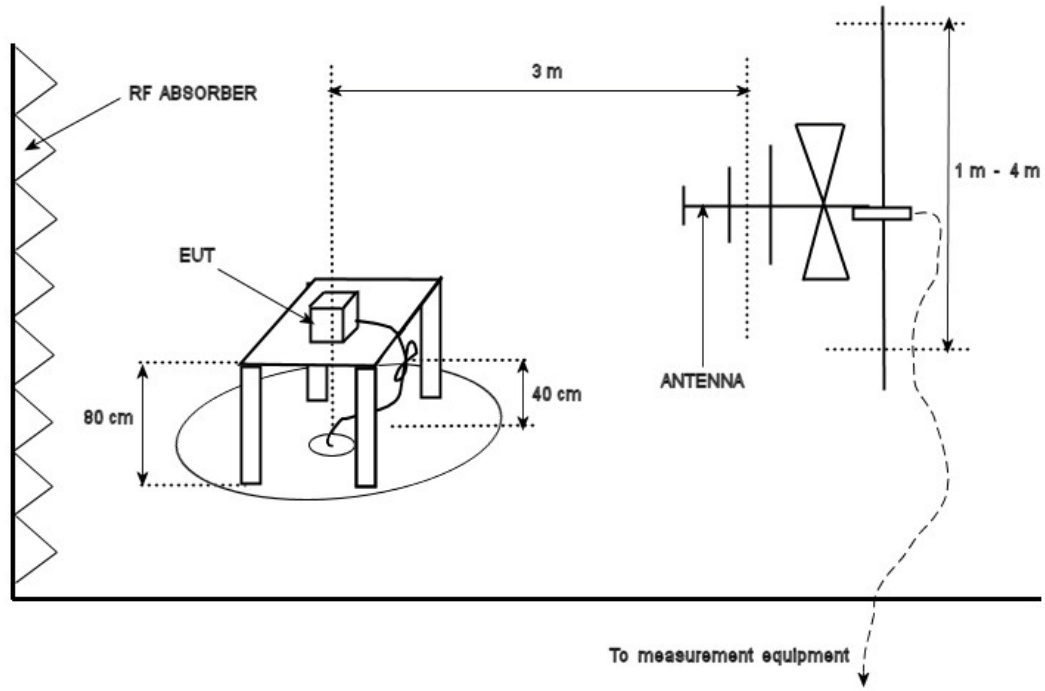
Limit(s) and Method

The method is as defined in ANSI C63.4:2003.
The limits are as defined in FCC Part 15, Section 15.209:

0.009 MHz – 0.490 MHz, 2400/F(kHz) uV/m at 300 m[1]
0.490 MHz – 1.705 MHz, 24000/F(kHz) uV/m at 30 m[1]
1.705 MHz – 30 MHz, 30 uV/m at 30 m[1]
30 MHz – 88 MHz, 100 uV/m (40.0 dBuV/m[1]) at 3 m
88 MHz – 216 MHz, 150 uV/m (43.5 dBuV/m[1]) at 3 m
216 MHz – 960 MHz, 200 uV/m (46.0 dBuV/m[1]) at 3 m
Above 960 MHz, 500 uV/m (54.0 dBuV/m[1]) at 3 m
Above 1000 MHz, 500 uV/m (54 dBuV/m[2]) at 3m
Above 1000 MHz, 500 uV/m (74 dBuV/m[3]) at 3m

[1]Limit is with Quasi Peak detector with bandwidths as defined in CISPR-16-1-1
[2]Limit is with 1 MHz measurement bandwidth and using an Average detector
[3]Limit is with 1 MHz measurement bandwidth and using a Peak detector

Typical Radiated Emissions Setup



Measurement Uncertainty

The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is +/-4.4 dB with a 'k=2' coverage factor and a 95% confidence level.

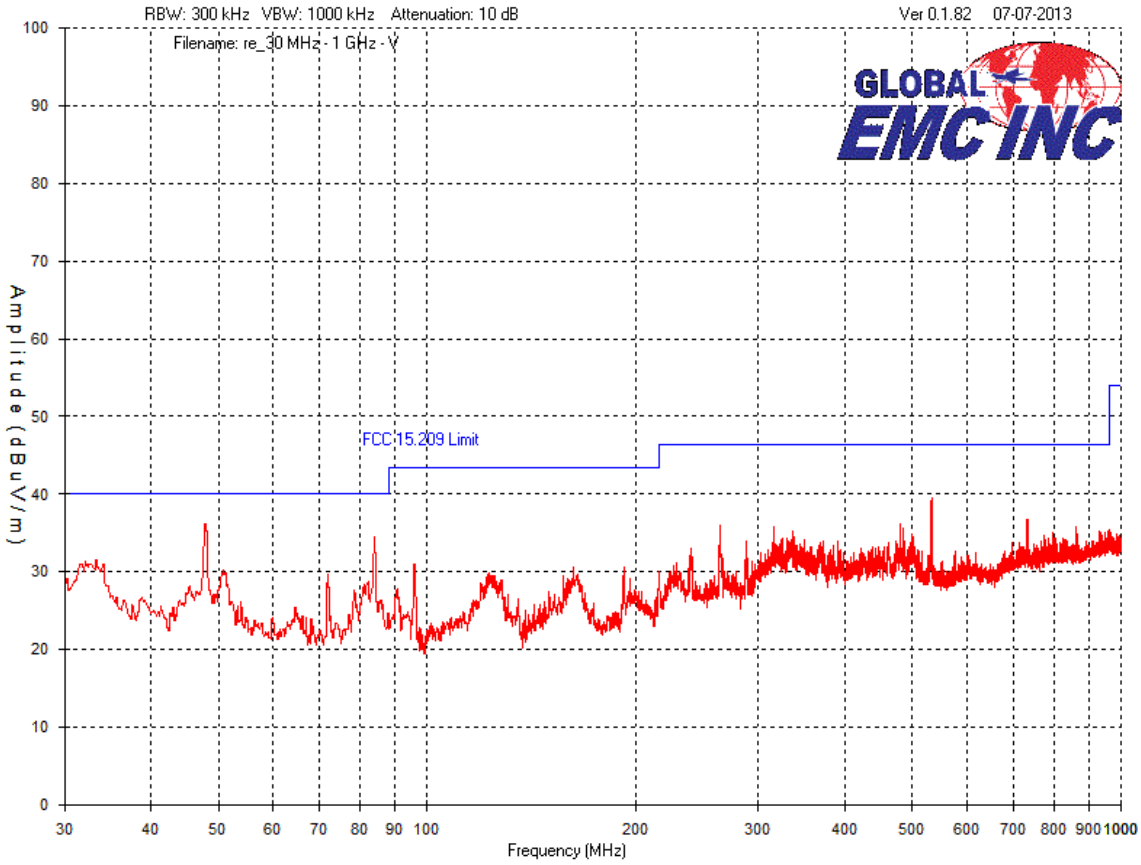
Preliminary Graphs

Note the graphs shown below are for graphical illustration only. For final measurements with the appropriate detector, please refer to the final measurement table where applicable. The graph shown below is a maximized peak measurement graph, measured with a resolution bandwidth greater then the final required detector and over a full 0-360 rotation. This peaking process is done as a worst case measurement. This process enables the detection of frequencies of concern for final measurement, and provides considerable time savings.

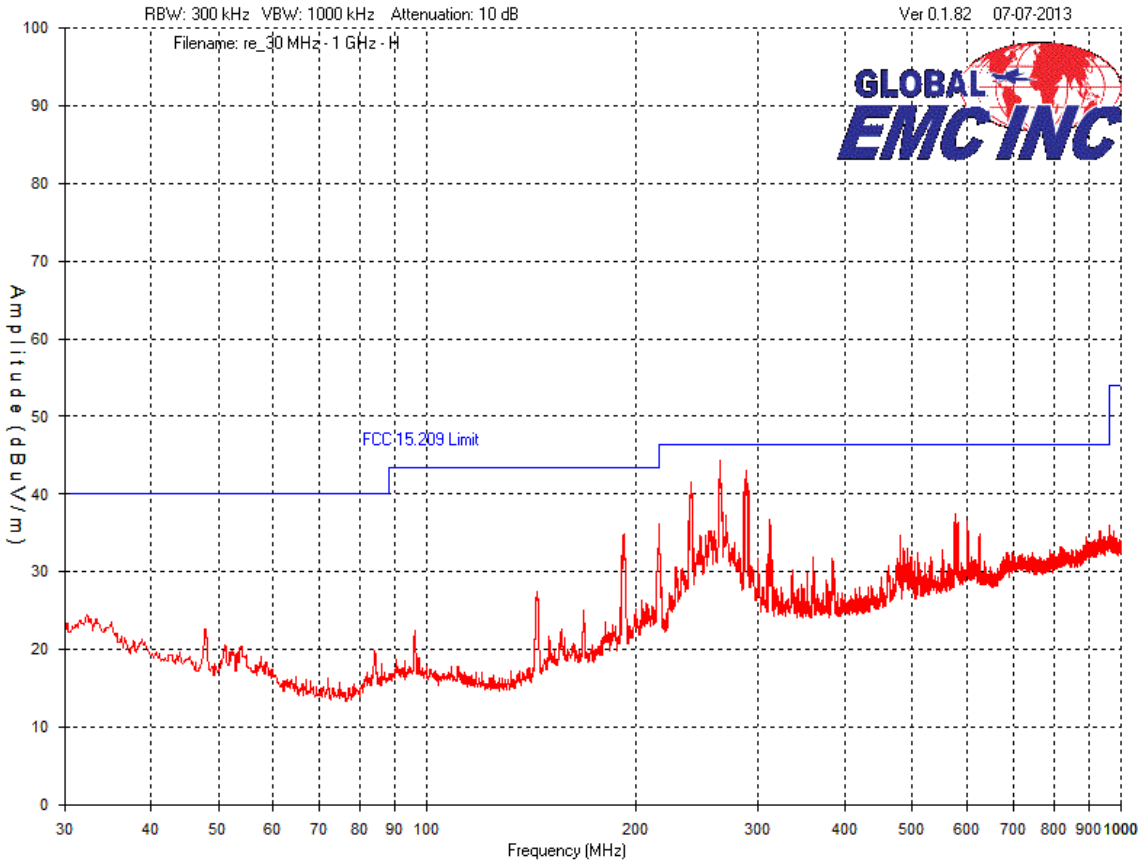
In accordance with FCC Part 15, Subpart A, Section 15.33, the device was scanned to the 10^{th} harmonic (a minimum of a 25 GHz). however no emissions were detected above 6 GHz.

Devices scanned may be scanned at alternate test distances, and in accordance with FCC Part 15, Subpart A, Section 15.31, an extrapolation factor of 20 dB/decade was used above 30 MHz and 40 dB/decade below 30 MHz. For example for 1 meter measurements, an extrapolation factor 9.5 dB from 20 Log (1m / 3m) is applied.

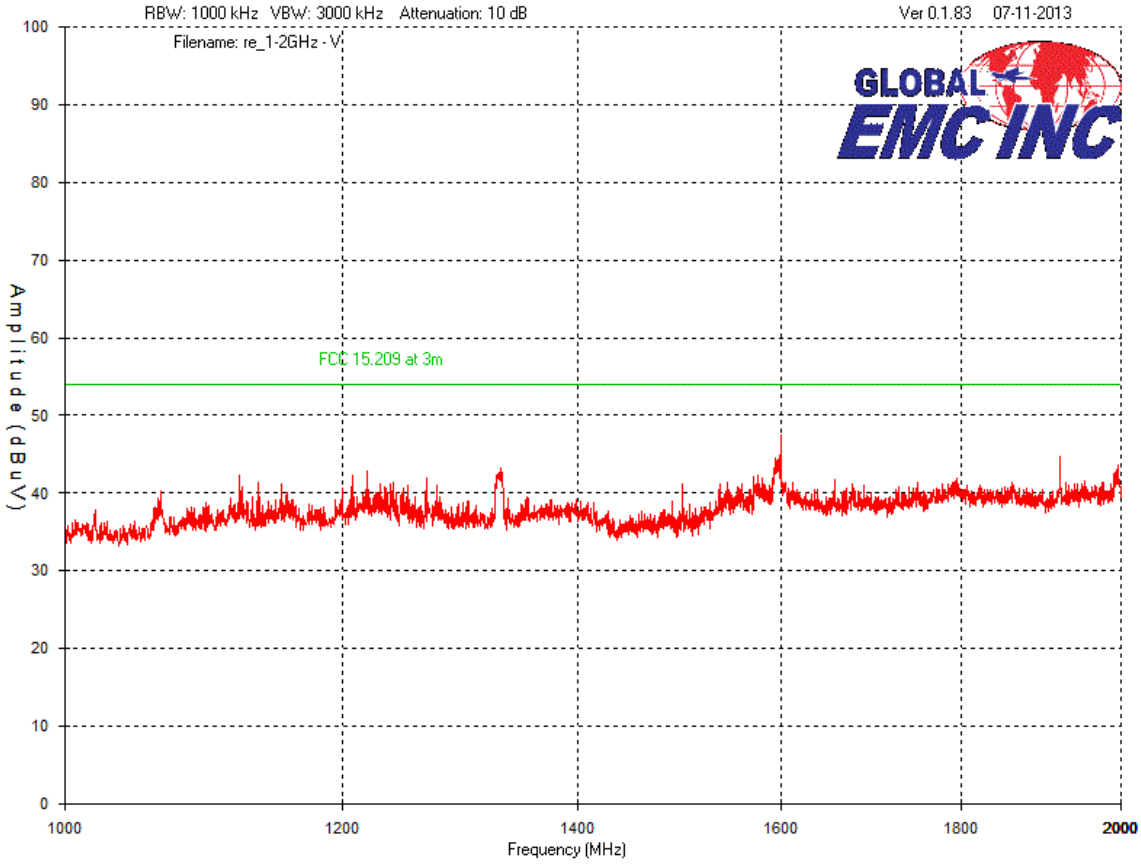
Vertical – Peak Emissions Graph
30 MHz – 1 GHz



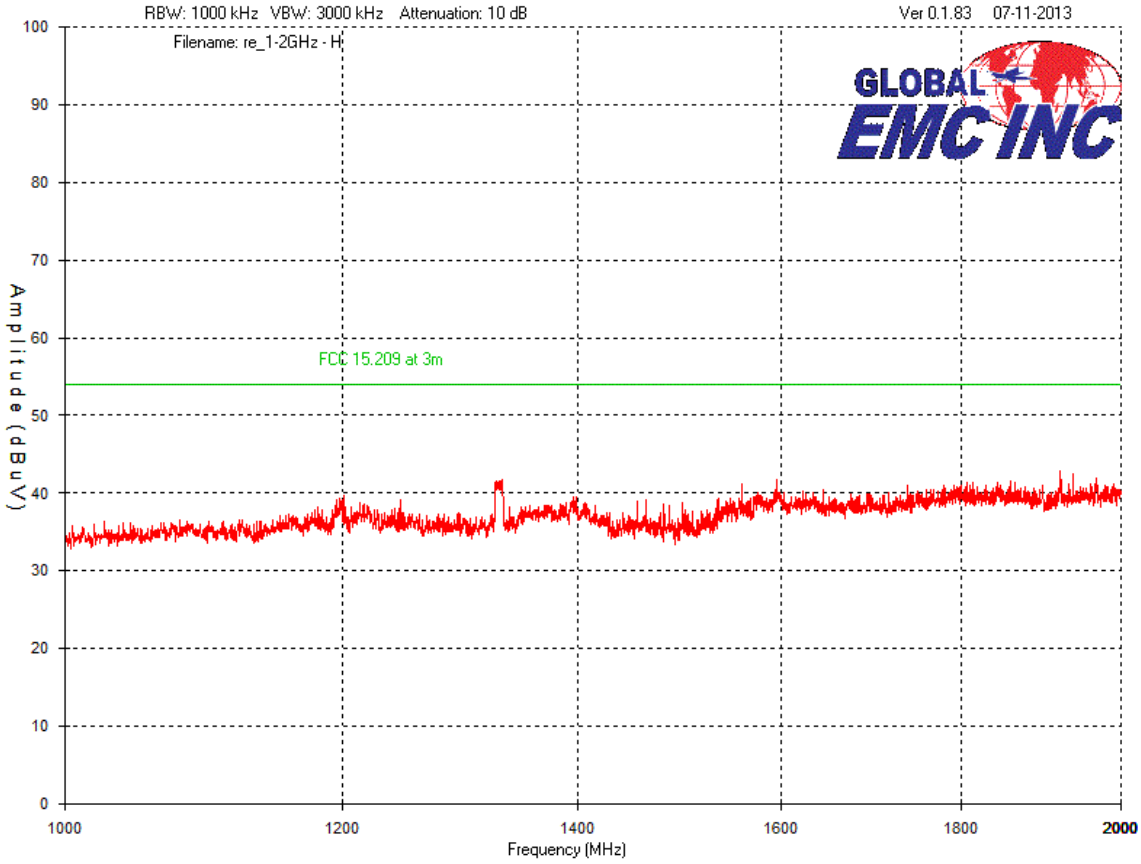
Horizontal – Peak Emissions Graph



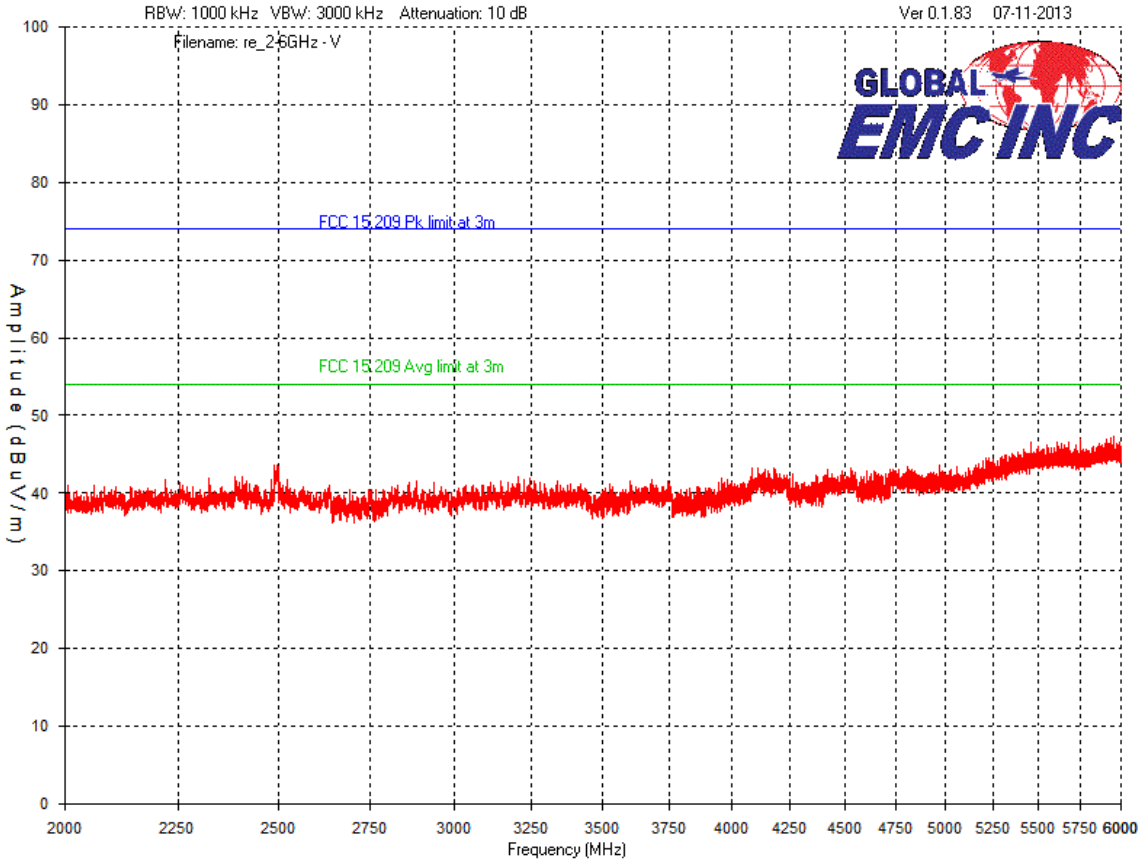
Vertical – Peak Emission Graph
1 GHz – 2 GHz



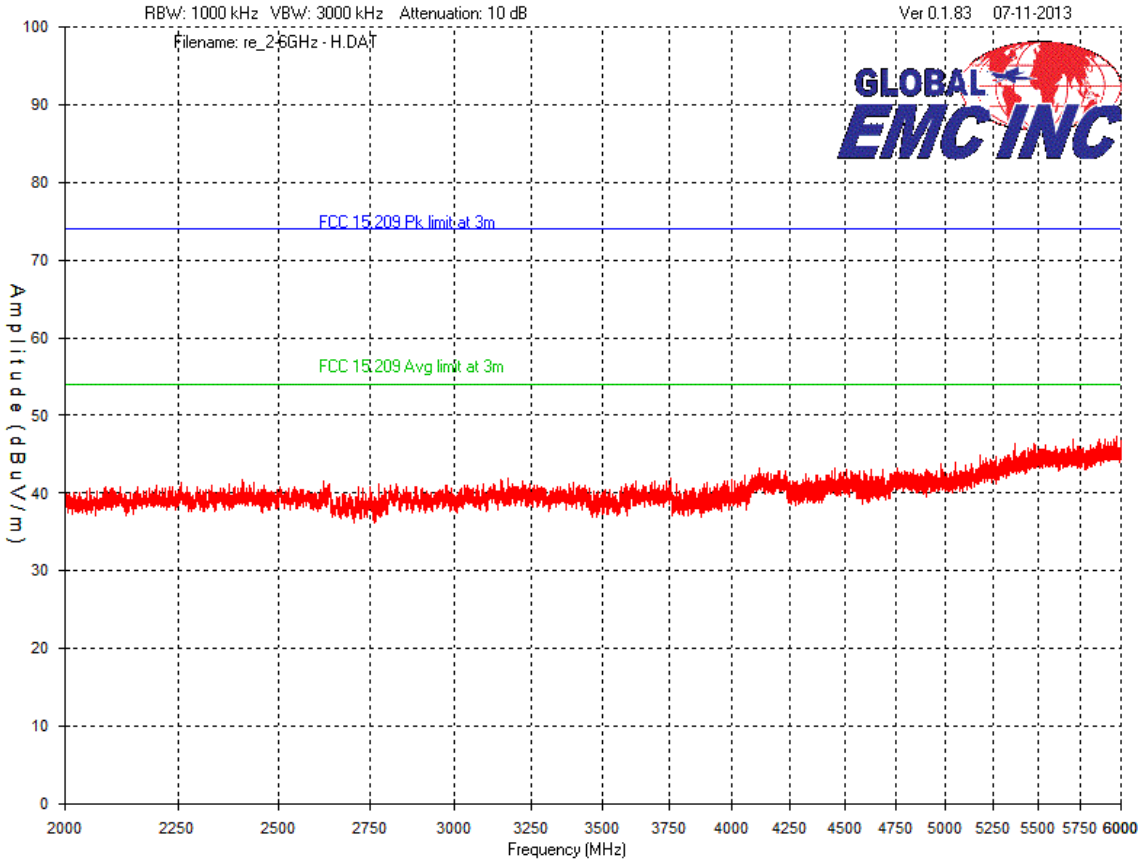
Horizontal – Peak Emission Graphs
1 GHz – 2 GHz



Vertical – Peak Emission Graph
2 GHz – 6 GHz



Horizontal – Peak Emission Graphs
2 GHz – 6 GHz



Final Measurements

Note: In accordance with 15.247(d), only frequencies exceeding the 15.209 limit that occur within the bands listed in 15.205, need to be verified with a final detector.

For frequency shown on the peak graphs and not listed in 15.205, measurements were taken for reference.

Internal Antenna								
Quasi-Peak Emissions Table - Vertical								
Frequency (MHz)	Raw (dBuV)	Antenna Factor (dB/m)	Cable RE Factor (dB)	Pre-Amp (dB)	Level (dBuV/m)	Limit (dB)	Margin (dB)	Pass/Fail
47.848	48.48	8.5	0.6	-28.7	28.88	40	11.12	Pass
Quasi Peak Emissions Table - Horizontal								
264.061	56.44	12.9	1.2	-28.8	41.74	46.4	4.66	Pass
287.826	55.1	12.9	1.3	-28.8	40.5	46.4	5.9	Pass
240.005	54.2	12.4	1.2	-28.7	39.1	46.4	7.3	Pass

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	12/21/ 2011	12/21/2013	GEMC 141
Spectrum Analyzer	ESL 6	Rohde & Schwarz	Oct-06, 2011	Oct-06, 2013	GEMC 160
Quasi Peak Adapter	85650A	HP	12/21/ 2011	12/21/2013	GEMC 7
Loop Antenna	EM 6871	Electro-Metrics	Feb 5, 2013	Feb 5, 2015	GEMC 70
Loop Antenna	EM 6872	Electro-Metrics	Feb 5, 2013	Feb 5, 2015	GEMC 71
BiLog Antenna	3142-C	ETS	Feb 4, 2013	Feb 4, 2015	GEMC 137
Chase Preamp 9kHz - 2 GHz	CPA9231A	Chase	8/29/2012	8/29/2014	GEMC 6403
Q-Par 1.5-18 GHz Horn	6878/24	Q-par	8/23/2012	8/23/2014	GEMC 6365
Horn Antenna 18 GHz - 26.5 GHz	SAS-572	A.H. Systems	8/27/2012	8/27/2014	GEMC 6371
18.0-26.5 GHz Harmonic Mixer	11970K	HP	21-Dec-11	21-Dec-13	GEMC 158
1-26G pre-amp	HP 8449B	HP	8/22/2012	8/22/2014	GEMC 6351
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
RF Cable 0.5M	LMR-400-0.5M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 31

This report module is based on GEMC template "FCC - 15.209 - Radiated Emissions_Rev1.doc"

Power Spectral Density - DM

Purpose

The purpose of this test is to ensure that the maximum power spectral density to the radiating element does not exceed the limits specified. This ensures that the modulation is significantly wide enough, or low enough in power that it will allow for co-operation of other wireless devices operating within this frequency allocation.

Limits

The limits are defined in 15.247(e).

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

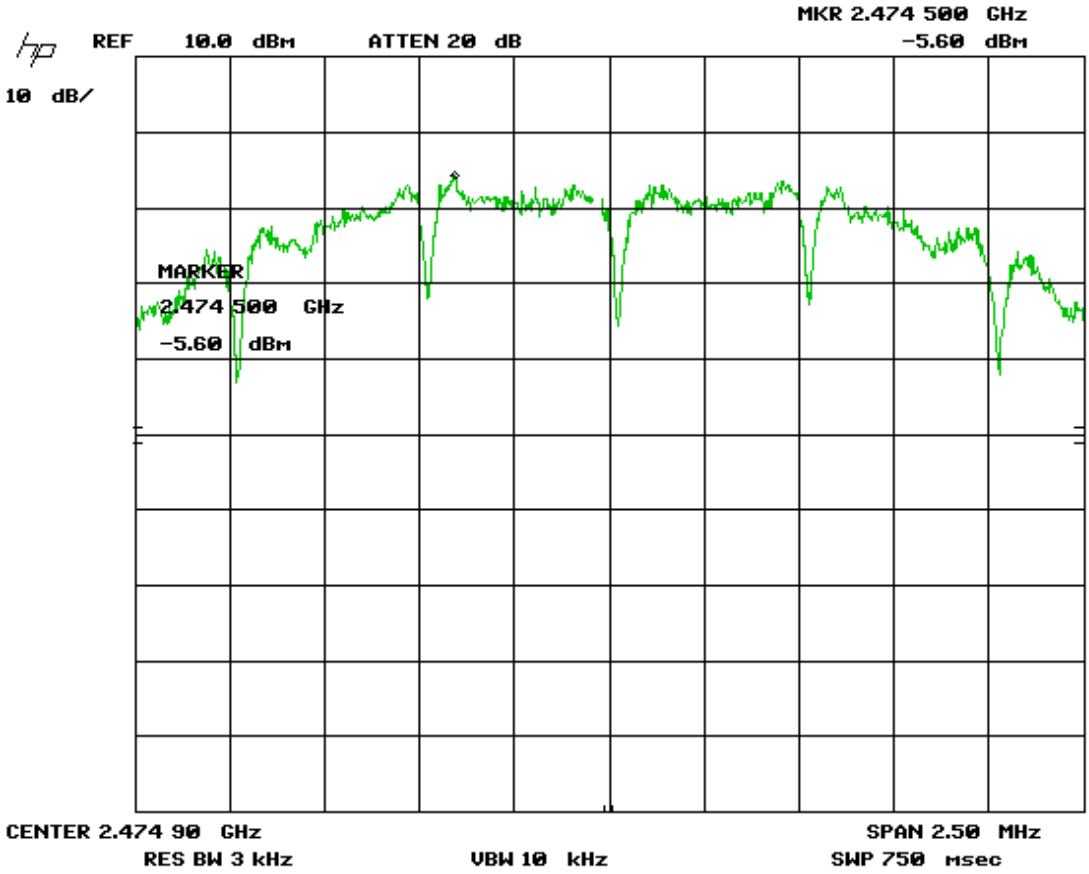
Results

The EUT passed. Low, medium, and high band was tested. The worst case value is 4.9 dBm as measured with a 3 kHz resolution bandwidth (peak power).

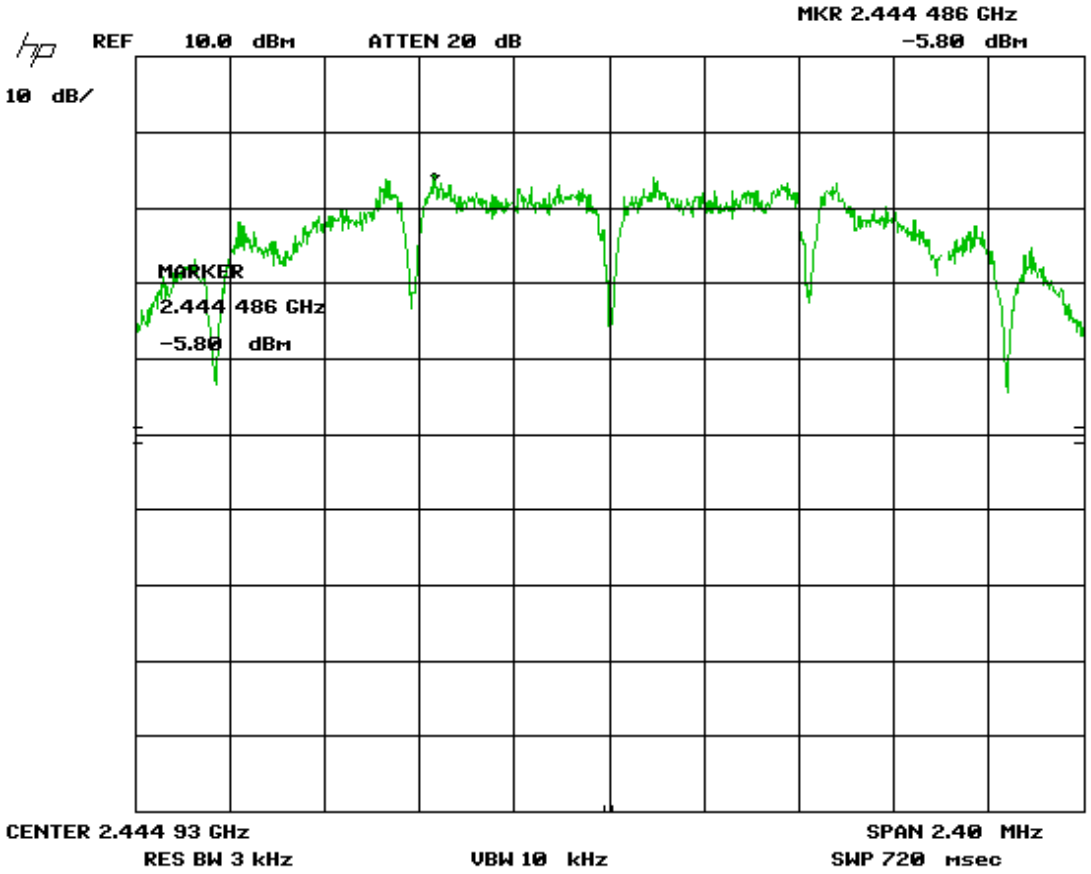
Graph(s)

The graphs shown below show the power spectral density of the device during the conducted measurement operation of the EUT. Low, middle, and high channel was investigated in each mode, with the worst case being presented.

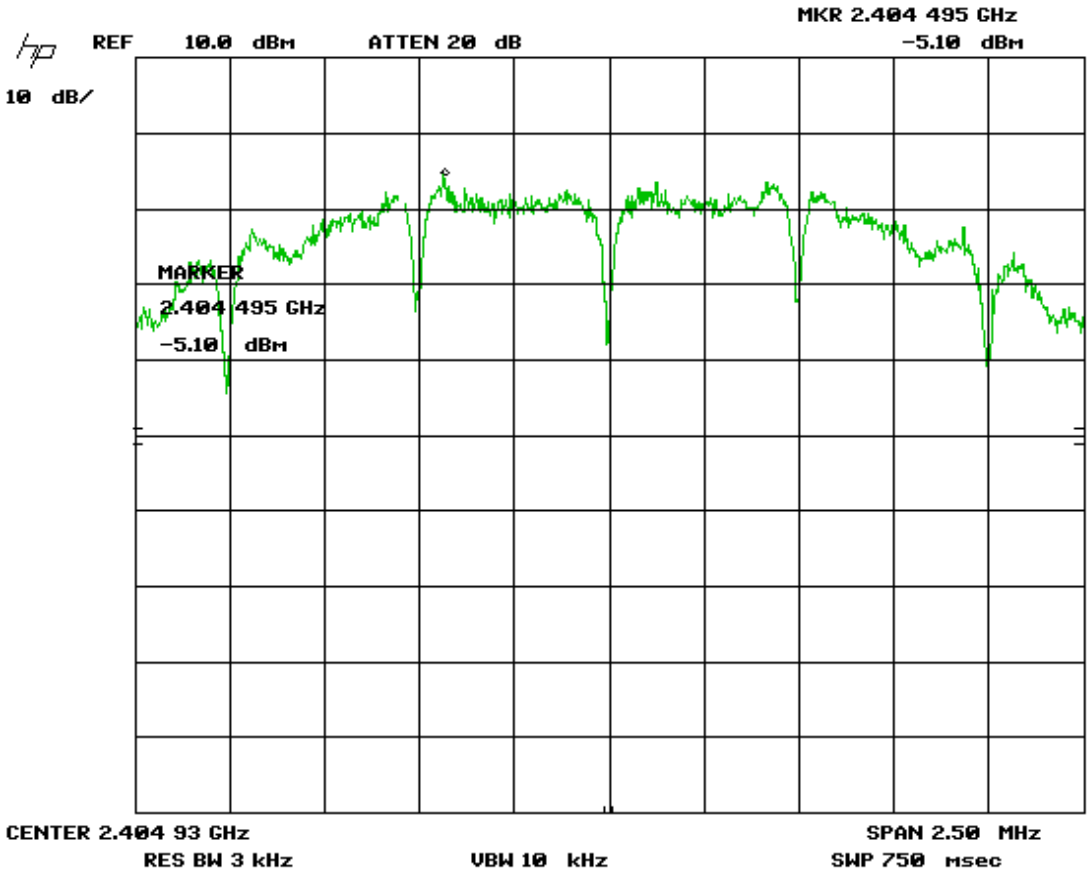
Channel 25 (10 dB external attenuator)



Mid Channel (10 dB external attenuator)



Low Channel (10 dB external attenuator)



Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Attenuator 10 dB	8493B	Agilent	NCR	NCR	GEMC 133
Spectrum Analyzer	8566B	HP	12/21/ 2011	12/21/2013	GEMC 141
Quasi Peak Adapter	85650A	HP	12/21/ 2011	12/21/2013	GEMC 7
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Maximum Permissible Exposure

Purpose

The purpose of this test is to ensure that the RF energy intentionally transmitted, in terms of power density emitted from the EUT at a stated operating distance does not exceed the limits listed below as defined in the applicable test standard, as calculated based upon readings obtained during testing. This helps protect human exposure to excessive RF fields.

Limit(s) and Method

The limits, as defined in FCC 15.247(i) and FCC 1.1310 Table 1 (B) limits for general public exposure was applied. The limit for the frequency range of 1.5 GHz to 100 GHz was applied. This is a limit of 1.0 mW/ cm^2. The distance used for calculations was 20cm, as this is the minimum distance an operator will be from the EUT during normal operation, as stated by the manufacturer.

Results

The EUT passed the requirements. The worst case calculated power density was 0.02 mW/cm^2, this is significantly under the 1.0 mW/cm^2 requirement.

Calculations

Method 1 (conducted power)
Internal antenna

$P_d = (P_t*G) / (4*pi*R^2)$
Where Pt = 19.2 dBm or 83.2 mW as per Peak power conducted output
Where G = 0.5 dBi, or numerically 1.12
Where R = 20 cm

$P_d = (83.2\ mW * 1.12) / (4 * pi * 20cm^2)$
$P_d = 93.2\ mW / 5026\ cm^2$
$P_d = 0.018\ mW/cm^2$

External antenna

$P_d = (P_t*G) / (4*pi*R^2)$
Where Pt = 12.5 dBm or 17.78 mW as per Peak power conducted output
Where G = 5 dBi, or numerically 3.16
Where R = 20 cm

$P_d = (17.78\ mW * 3.16) / (4 * pi * 20cm^2)$
$P_d = 56.18\ mW / 5026\ cm^2$
$P_d = 0.011\ mW/cm^2$

Power Line Conducted Emissions

Purpose

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT's power line does not exceed the limits listed below as defined in the applicable test standard, as measured from a LISN. This helps protect lower frequency radio services such as AM radio, shortwave radio, amateur radio operators, maritime radio, CB radio, and so on, from unwanted interference.

Limits & Method

The limits are as defined in 47 CFR FCC Part 15 Section 15.207
Method is as defined in ANSI C64:2003

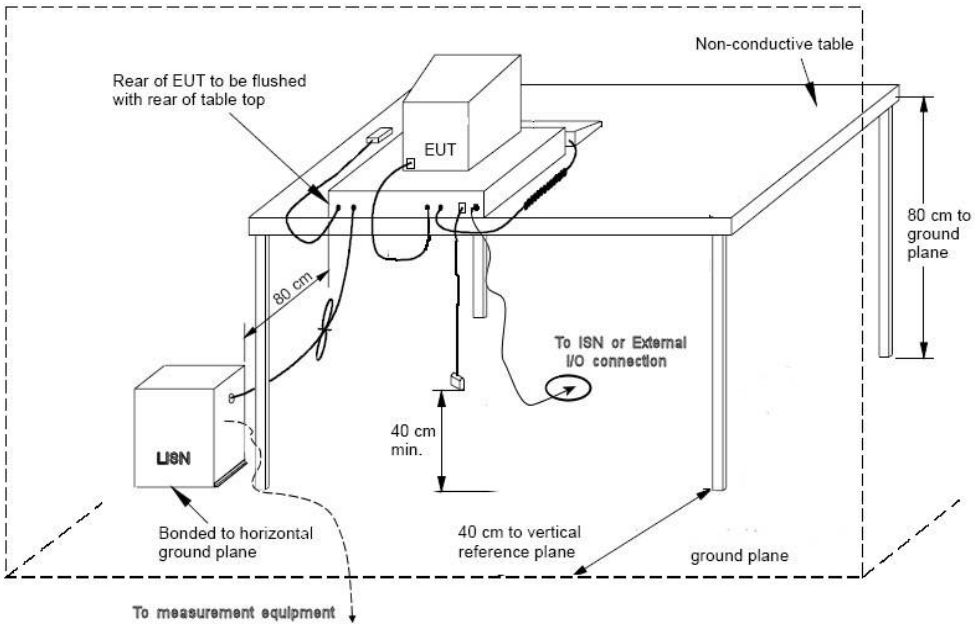
Average Limits		QuasiPeak Limits	
150 kHz – 500 kHz	56 to 46 dBuV	150 kHz – 500 kHz	66 to 56 dBuV
500 kHz – 5 MHz	46 dBuV	500 kHz – 5 MHz	56 dBuV
5 MHz – 30 MHz	50 dBuV	500 kHz – 30 MHz	60 dBuV

The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

Note: If the Peak or Quasi Peak detector measurements do not exceed the Average limits, then the EUT is deemed to have passed the requirements.

Both limits are applicable, and each is specified as being measured with a 9 kHz measurement bandwidth.

Typical Setup Diagram



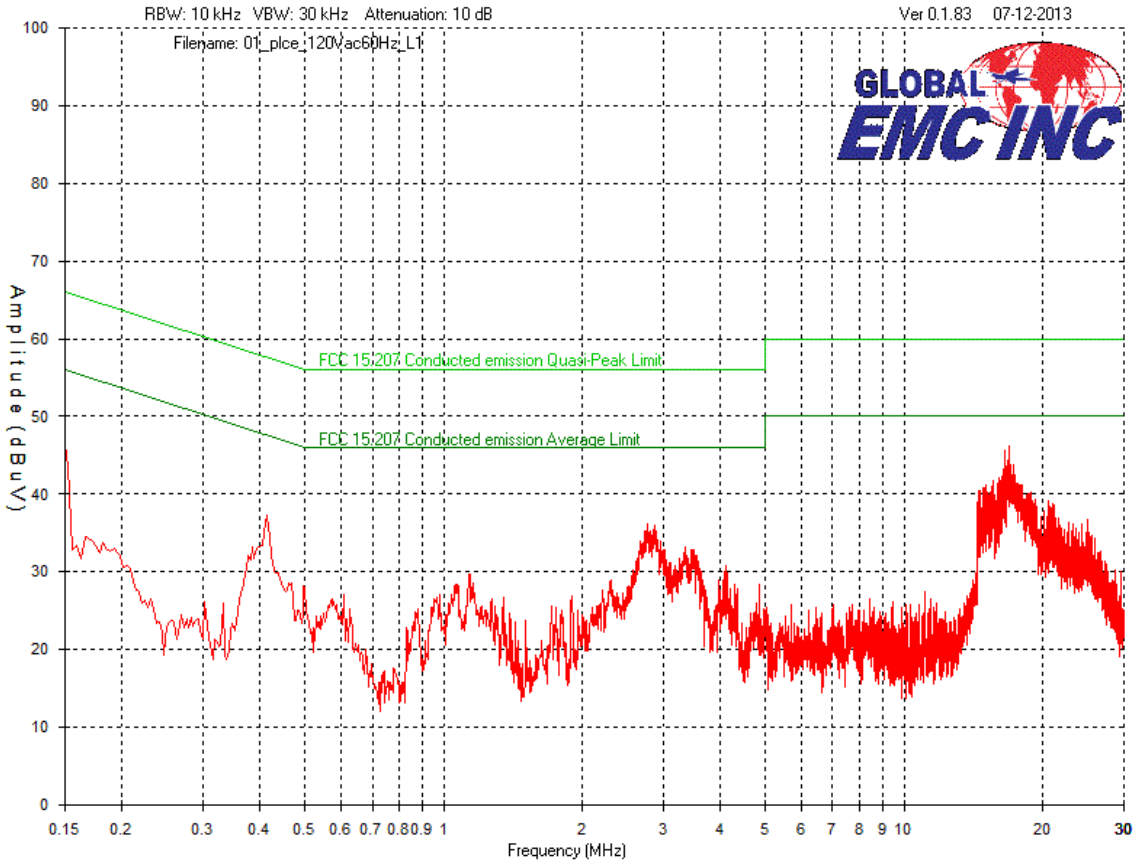
Measurement Uncertainty

The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is +/-3.6 dB with a 'k=2' coverage factor and a 95% confidence level.

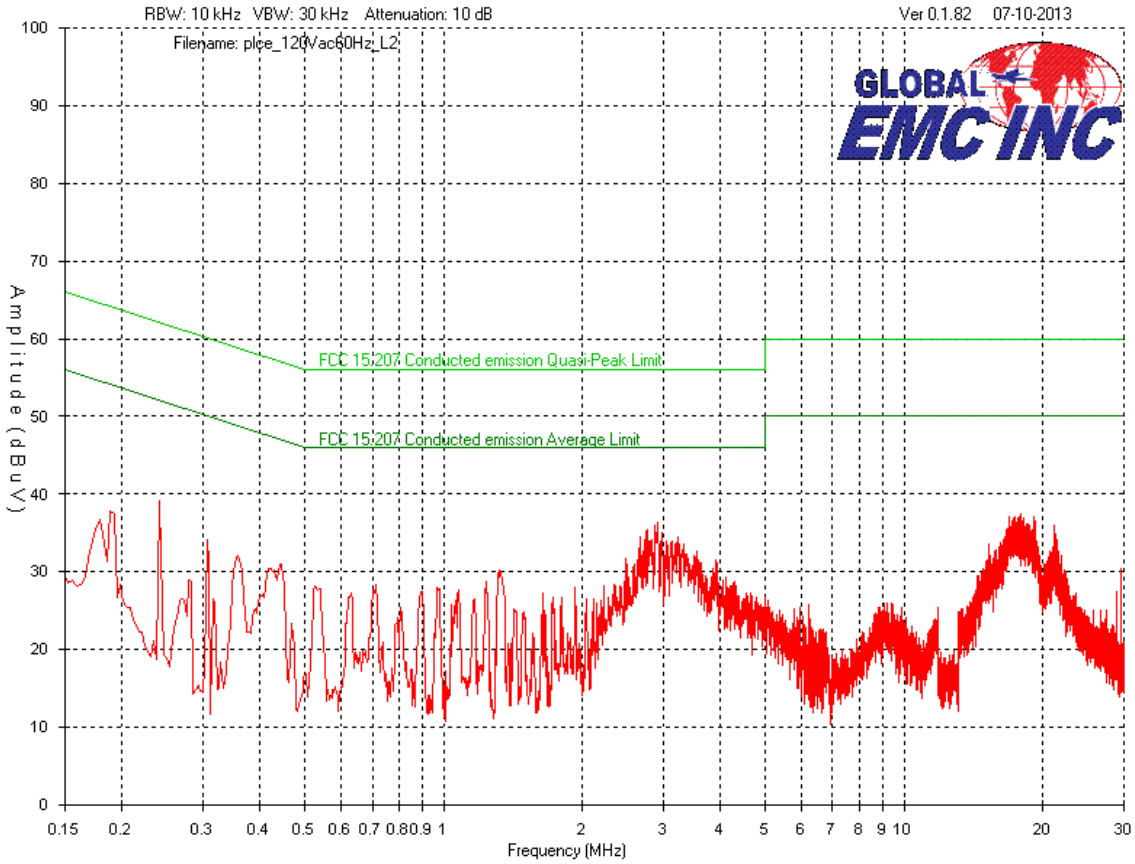
Preliminary Graphs

Note the graphs shown below are for graphical illustration only. For final measurements with the appropriate detector where applicable, please refer to the table. The graph shown below is a peak measurement graph, measured with a resolution bandwidth greater then or equal to the final required detector. These graphs are performed as a worst case measurement to enable the detection of frequencies of concern and for considerable time savings.

L1(Line) – 120Vac 60Hz



L2 (Neutral) – 120Vac 60Hz



Final Measurements

Product Category	Class B						
Product	Hornet/Z357PA20						
Supply	120 VAC 60 Hz						
L1 (Line) – Peak emission with respect to Average limit							
Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	LISN Factor (dB)	Level (dBuV)	Limit (dB)	Margin (dB)	Pass/Fail
16.9147	45.9	0.2	0.1	46.2	50	3.8	Pass
16.5123	45.4	0.2	0.1	45.7	50	4.3	Pass
16.9698	45	0.2	0.1	45.3	50	4.7	Pass
16.6421	42.7	0.2	0.1	43	50	7	Pass
16.6129	42.7	0.2	0.1	43	50	7	Pass
16.2755	42	0.2	0.1	42.3	50	7.7	Pass
L2 (Neutral) - Peak emission with respect to Average limit							
2.9144	36.1	0.1	0.1	36.3	46	9.7	Pass
2.7684	35.2	0.1	0.1	35.4	46	10.6	Pass
2.9793	34.9	0.1	0.1	35.1	46	10.9	Pass
3.2421	34.4	0.1	0.1	34.6	46	11.4	Pass
2.6743	34.3	0.1	0.1	34.5	46	11.5	Pass
3.0442	33.7	0.1	0.1	33.9	46	12.1	Pass

Notes:

1. No peak emissions exceeded power line conducted emission average limits; therefore, the unit was deemed to meet power line conducted emission requirements base on peak emissions. The above table represents the peak emission reading with respect to the average limit.

2. The EUT was connected to a Lenovo T410i laptop computer with AC Adaptor model 42T4438. Power line conducted emissions was performed on the AC Adaptor.

3. See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up for the highest line conducted emission

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	ESL 6	Rohde & Schwarz	Oct-06, 2011	Oct-06, 2013	GEMC 160
LISN	FCC-LISN-50/250-16-2-01	FCC	Feb 03, 2011	Feb 03, 2013	GEMC 65
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Appendix A – EUT Summary

For further details for filing purposes, refer to filing package.

General EUT Description

Client	
Organization	MMB Research Inc.
Contact	Mark Borins
Phone	416.636.3145
Email	mark.borins@mmbresearch.com
EUT Details	
EUT Model number	ZGB357PA20
Equipment Category	Wireless module
Basic EUT Functionality	The Z357PA20 module (XFFZ357PA20) is a ZigBee radio transceiver with integrated microcontroller operating in the 2.4GHz ISM band. The radio operates according to the IEEE 802.15.4 standard and employs DSSS and O-QPSK modulation. The EUT employs onboard shielding and internal ground plane. The antenna is a 50 ohm ceramic chip tuned to match the RF circuit of the radio transceiver. The module is typically used in automation applications where it will transmit small packets of command and control information. For example turning a light switch on or off, adjusting a thermostat, reading energy consumption data, etc.
Input Voltage and Frequency	5 Vdc
Connectors available on EUT	None.
Peripherals Required for Test	None.
Release type	Final
Intentional Radiator	2400 – 2475.0 MHz for Zigbee applications as described

Frequency	above.

Note the EUT is considered to have been received the date of the commencement of the first test, unless otherwise stated. For a close-up picture of the EUT, see 'Appendix B – EUT & Test Setup Photographs'.

Appendix B – EUT and Test Setup Photographs

Note: These photos are for information purposes only. Also refer to PDF files that are separate from this test report.

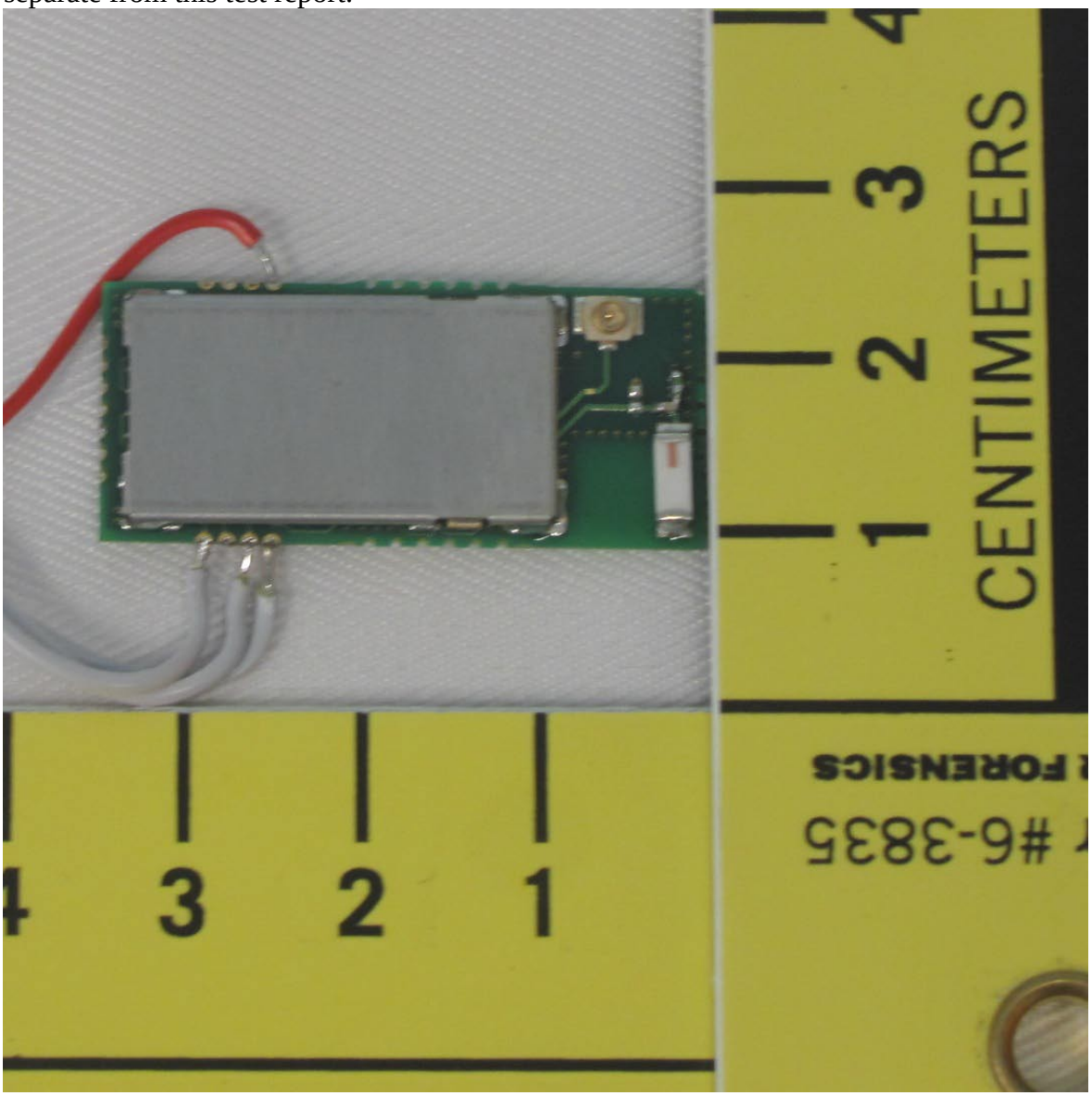


Illustration 1: EUT front view

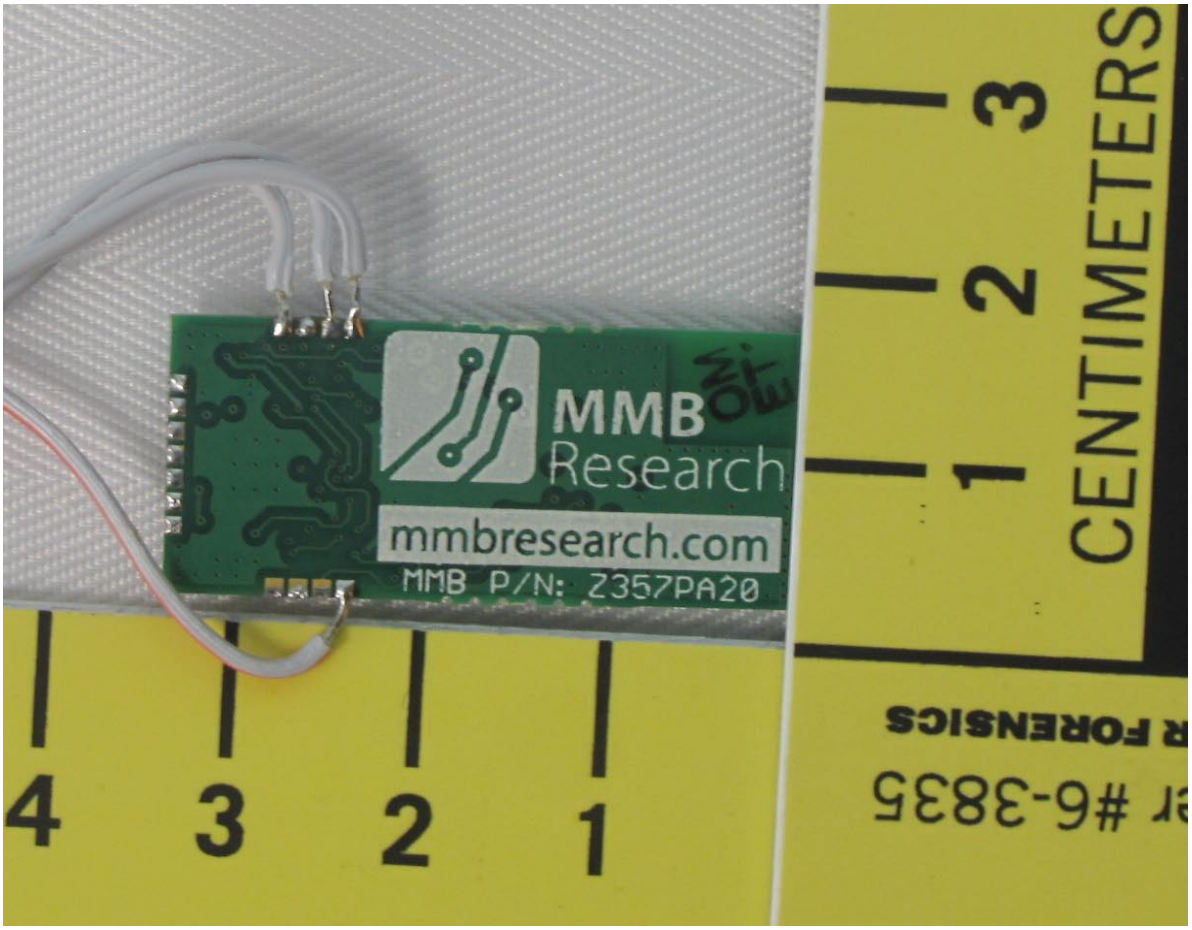


Illustration 2: EUT rear view

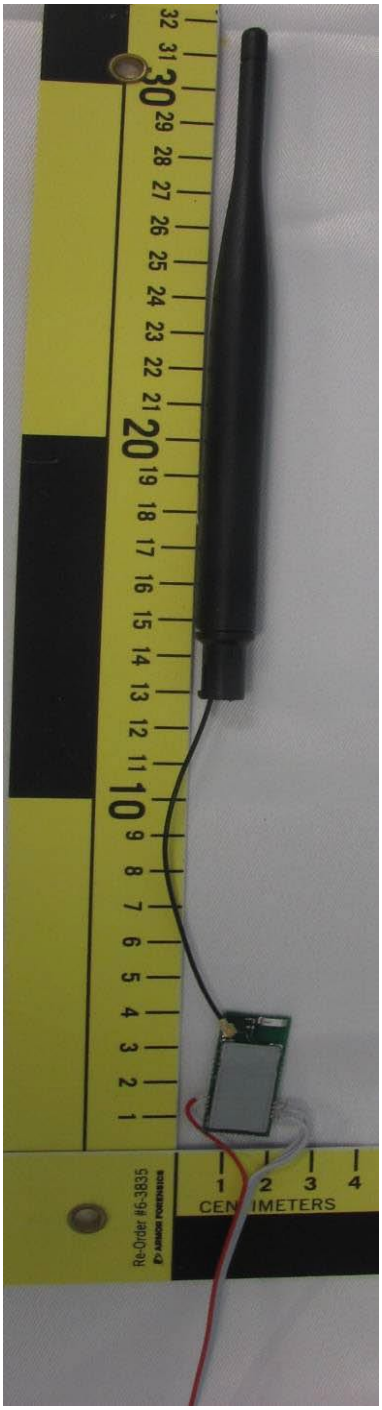


Illustration 3: EUT with external whip antenna

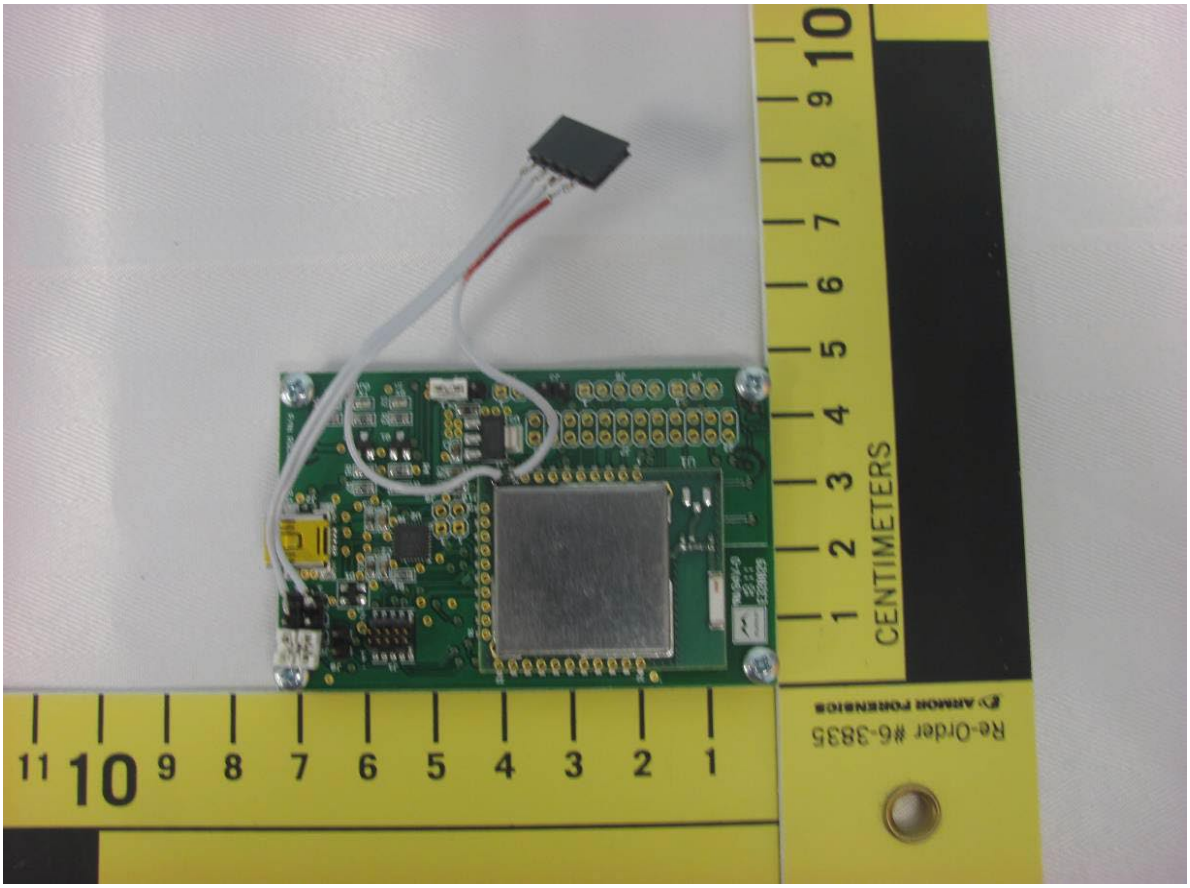


Illustration 4: EUT test support

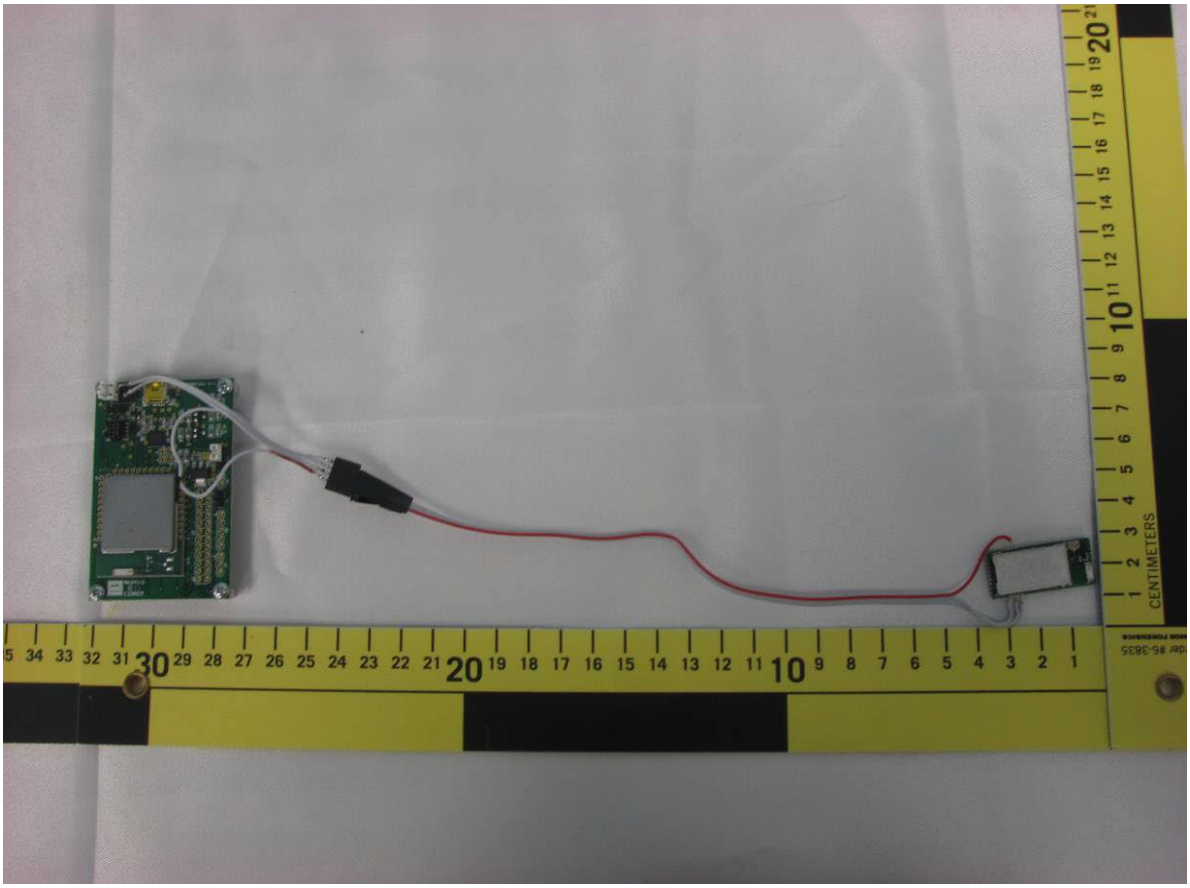


Illustration 5: EUT test setup

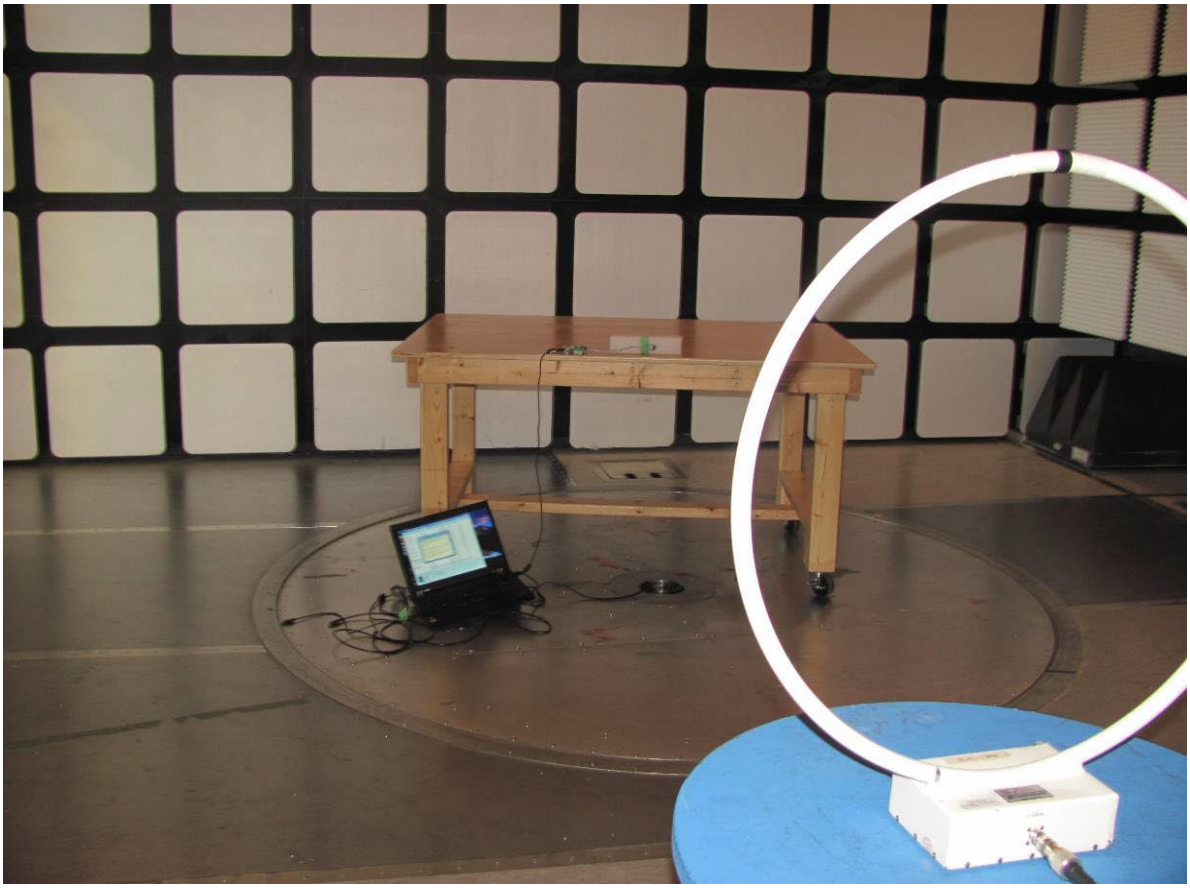


Illustration 6: Radiated emission setup – photo 1

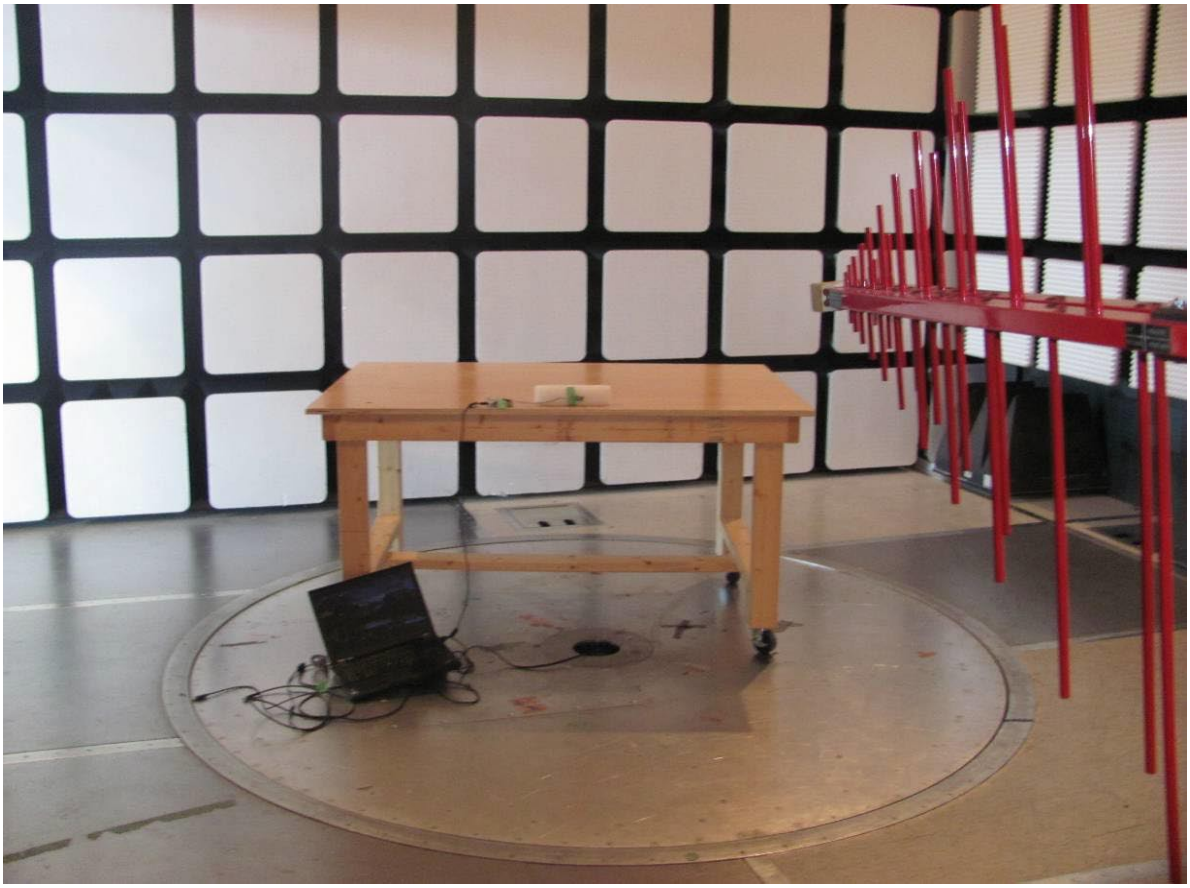


Illustration 7: Radiated emission setup - photo 2

Illustration 8: Radiated setup - photo 3

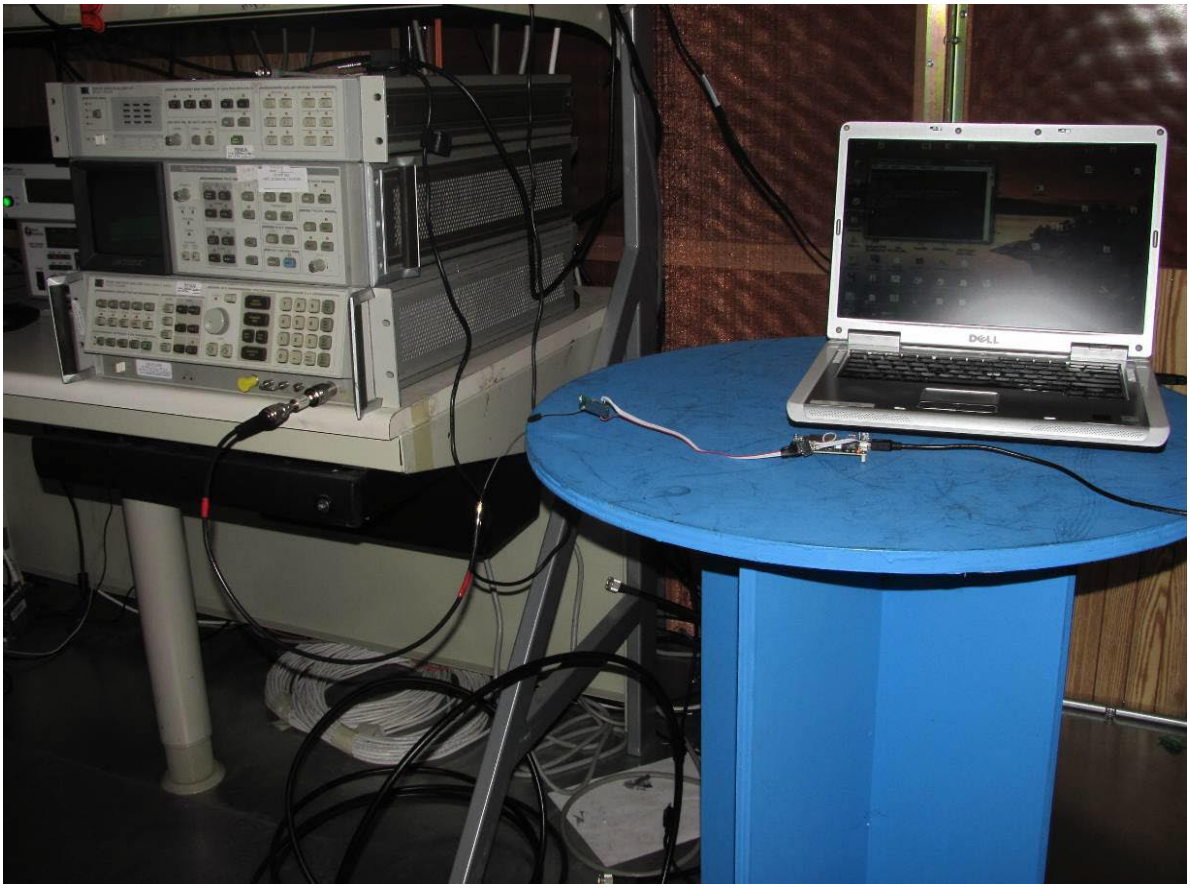


Illustration 9: Antenna conducted emission setup

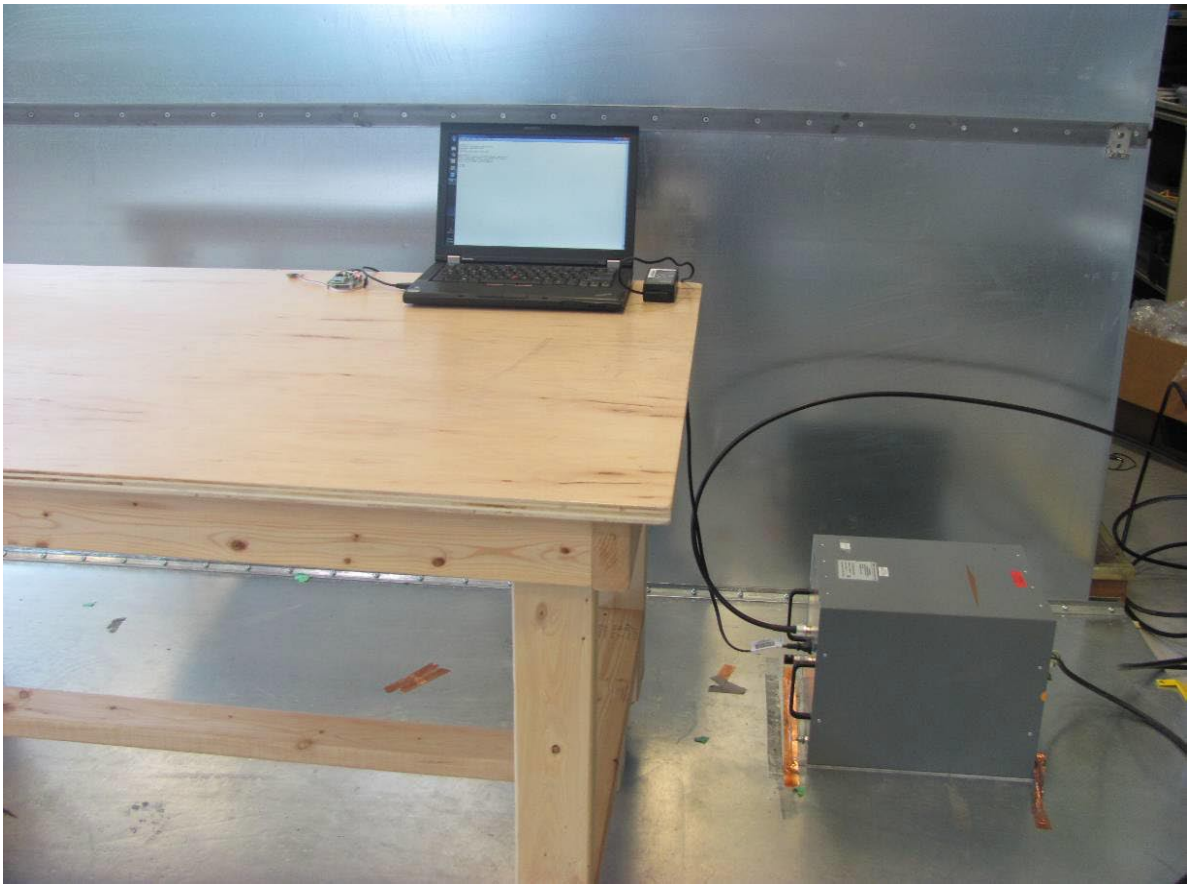


Illustration 10: Power line conducted emission setup – photo 1

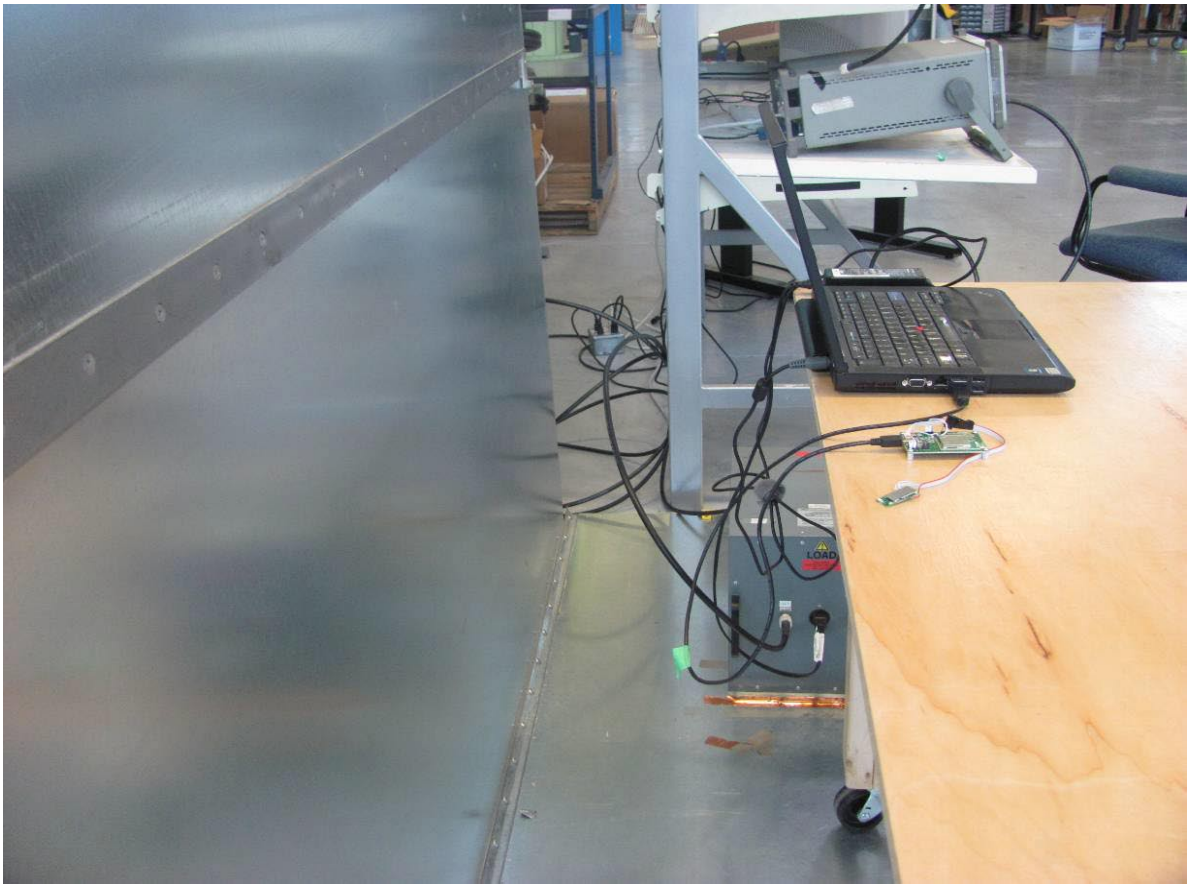


Illustration 11: Power line conducted emission – photo 2