

Global EMC Inc. Labs

EMC & RF Test Report

As per
RSS 247 Issue 1: 2015
&
FCC Part 15 Subpart C:2016
Unlicensed Intentional Radiators
on the
Hornet MiO/Z357PA40



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Testing produced for



See Appendix A for full customer & EUT details.



Client	MMB Research Inc	
Product	Hornet MiO /Z357PA40	
Standard(s)	RSS 247 Issue 1:2015 / FCC Part 15 Subpart C 15.247:2016	

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Client	MMB Research Inc	
Product	Hornet MiO /Z357PA40	
Standard(s)	RSS 247 Issue 1:2015 / FCC Part 15 Subpart C 15.247:2016	

Report Scope

This report addresses the EMC verification testing and test results of the MMB Research Hornet MiO/Z357PA40, herein referred to as EUT (Equipment Under Test) performed at Global EMC Labs.

The EUT was tested for compliance against the following standards:

RSS 247 Issue 1: 2015

FCC Part 15 Subpart C 15.247: 2016

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 MiO /Z357PA40	
Standard(s)	RSS 247 Issue 1:2015 / FCC Part 15 Subpart C 15.247:2016	

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

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Product	Hornet MiO /Z357PA40	
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Test Results Summary

Standard/Method	Description	Class/Limit	Result
FCC 15.203	Antenna Requirement	Unique	Pass See Justification
FCC 15.205 RSS-GEN (Table 3)	Restricted Bands for intentional operation	QuasiPeak Average	Pass
FCC 15.207	Power line conducted emissions	QuasiPeak Average	Pass See Justification
FCC 15.209 RSS-GEN (Table 2)	Spurious Radiated emissions	QuasiPeak Average	Pass
FCC 15.247(a)2 RSS-247	6 dB Bandwidth	> 500 kHz	Pass See Justification
FCC 15.247(b)2 RSS-247	Max output power	< 1 Watt	Pass See Justification
FCC 15.247(b)(4) RSS-247	Antenna Gain	< 6 dBi	Pass See Justifications
FCC 15.247(d) RSS-247	Antenna conducted spurious	< 20 dBc	Pass See Justification
FCC 15.247(e) RSS-247	Spectral Density	< 8 dBm (3 kHz BW)	Pass See Justification
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 '*'.

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Justifications, Descriptions, or Deviations

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

This is a Class II Permissive Change report. More I/Os are utilized in EM357 Zigbee chip compared to the original certified equipment. Radiated band edges and spurious emissions in the restricted bands were verified to compliances to the rules.

The product uses the same circuitry and performs the same transmitter and receiver function as the existing model. With respect to the power supply, RF frequency generation, transmitter and receiver operation, there are no differences between the models. The only changes relate to employing more I/O on the original RF Chip. As evidenced in the attached schematics and parts lists. The model is electrically identical from a RF perspective.

The other characteristics are not affected by the change and therefore does not require testing: 6 dB bandwidth, RF output power, power spectral density, -20 dBc.

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Applicable Standards, Specifications and Methods

ANSI C63.4:2014	- Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10:2013	- 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
FCC KDB 178919	Permissive Change Policy
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 247 Issue 1:2015	Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Devices

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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 0 - February 29, 2016
Initial release

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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

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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.

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Testing Environmental Conditions and Dates

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

Date	Test	Init.	Temperature (°C)	Humidity (%)	Pressure (kPa)
2016/1/27	All	MX	21-25°C	35 - 41%	98 -103kPa

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Detailed Test Results Section

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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 C63.10:2013.

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 m¹
0.490 MHz – 1.705 MHz, 24000/F(kHz) uV/m at 30 m¹
1.705 MHz – 30 MHz, 30 uV/m at 30 m¹
30 MHz – 88 MHz, 100 uV/m (40.0 dBuV/m¹) at 3 m
88 MHz – 216 MHz, 150 uV/m (43.5 dBuV/m¹) at 3 m
216 MHz – 960 MHz, 200 uV/m (46.0 dBuV/m¹) at 3 m
Above 960 MHz, 500 uV/m (54.0 dBuV/m¹) at 3 m
Above 1000 MHz, 500 uV/m (54 dBuV/m²) at 3m
Above 1000 MHz, 500 uV/m (74 dBuV/m³) at 3m

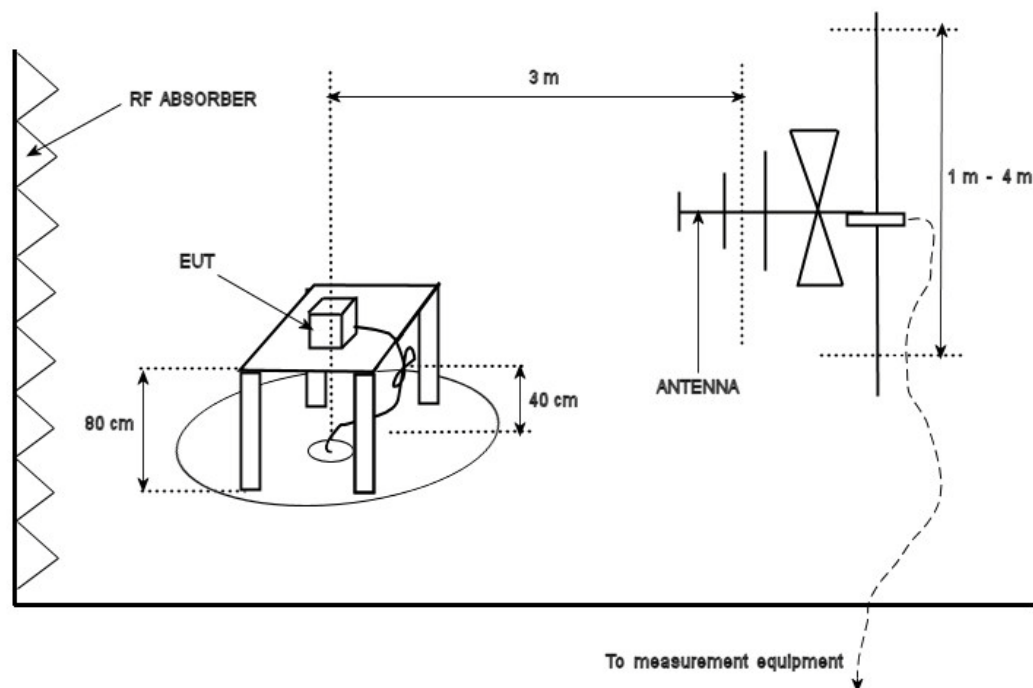
¹Limit is with Quasi Peak detector with bandwidths as defined in CISPR-16-1-1

²Limit is with 1 MHz measurement bandwidth and using an Average detector

³Limit is with 1 MHz measurement bandwidth and using a Peak detector

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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 than 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 10th harmonic (a minimum of a 24.835 GHz).

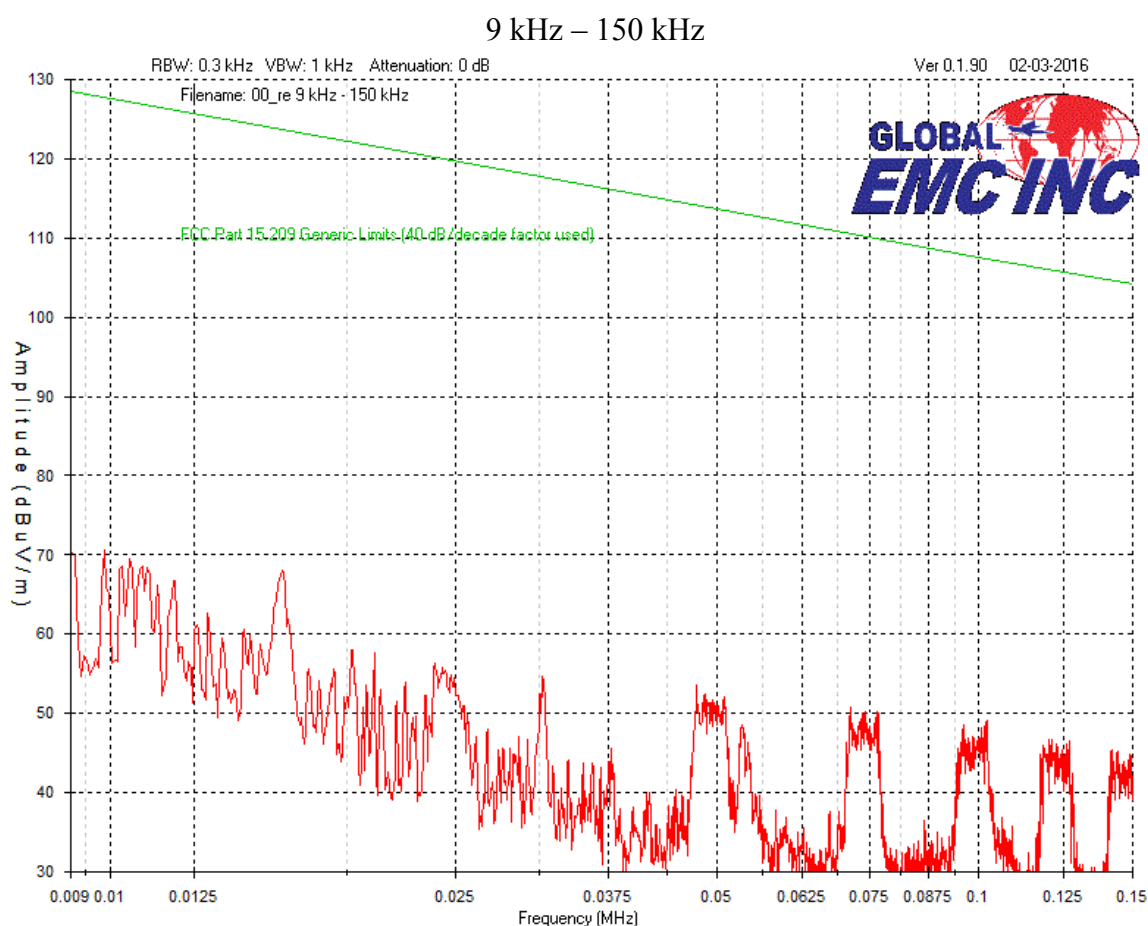
Devices scanned may be scanned at alternate test distances, and in accordance with FCC Part 15, Subpart A, Section 15.31, an extrapolation factor of 20 dB/decade was used above

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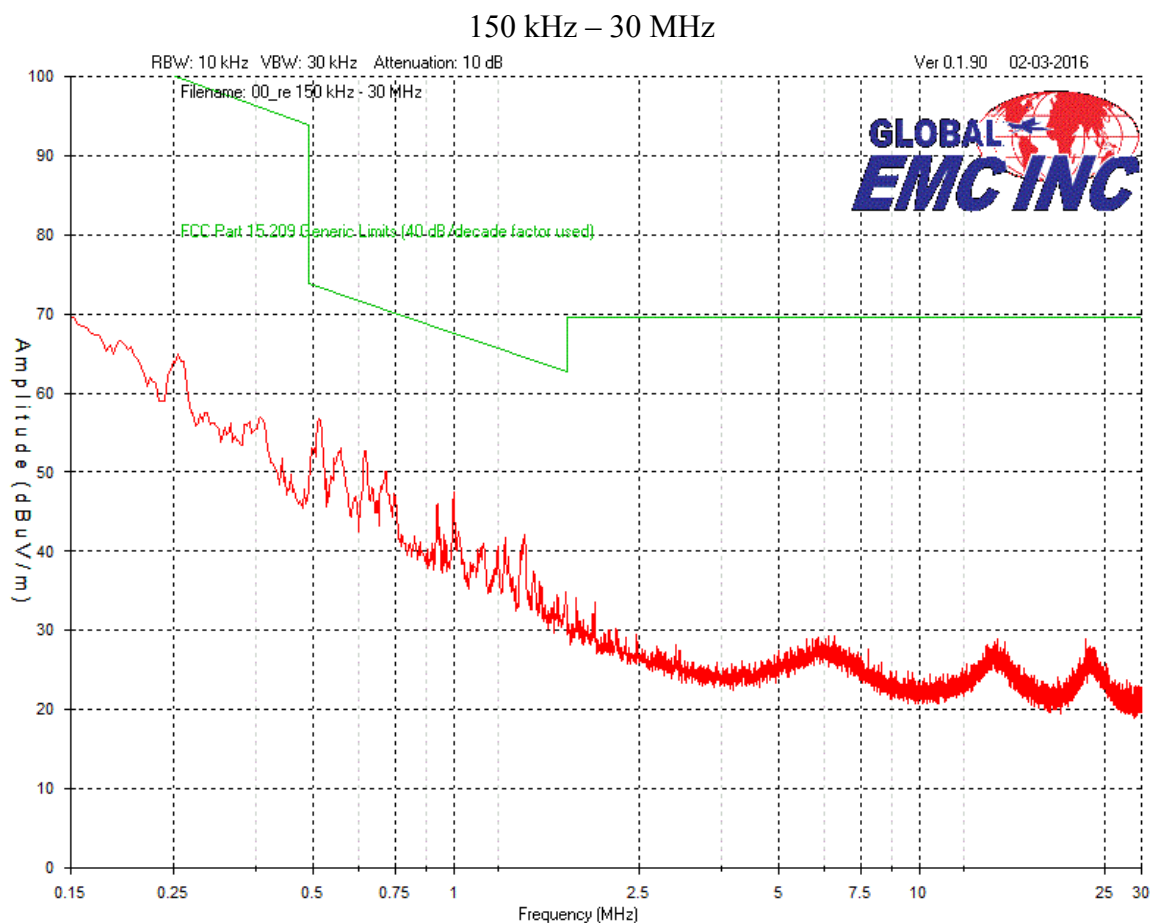
30 MHz and 40 dB/decade below 30 MHz. For example for 1 meter measurements, an extrapolation factor 9.5 dB from 20 Log (1m / 3m) is applied.

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.

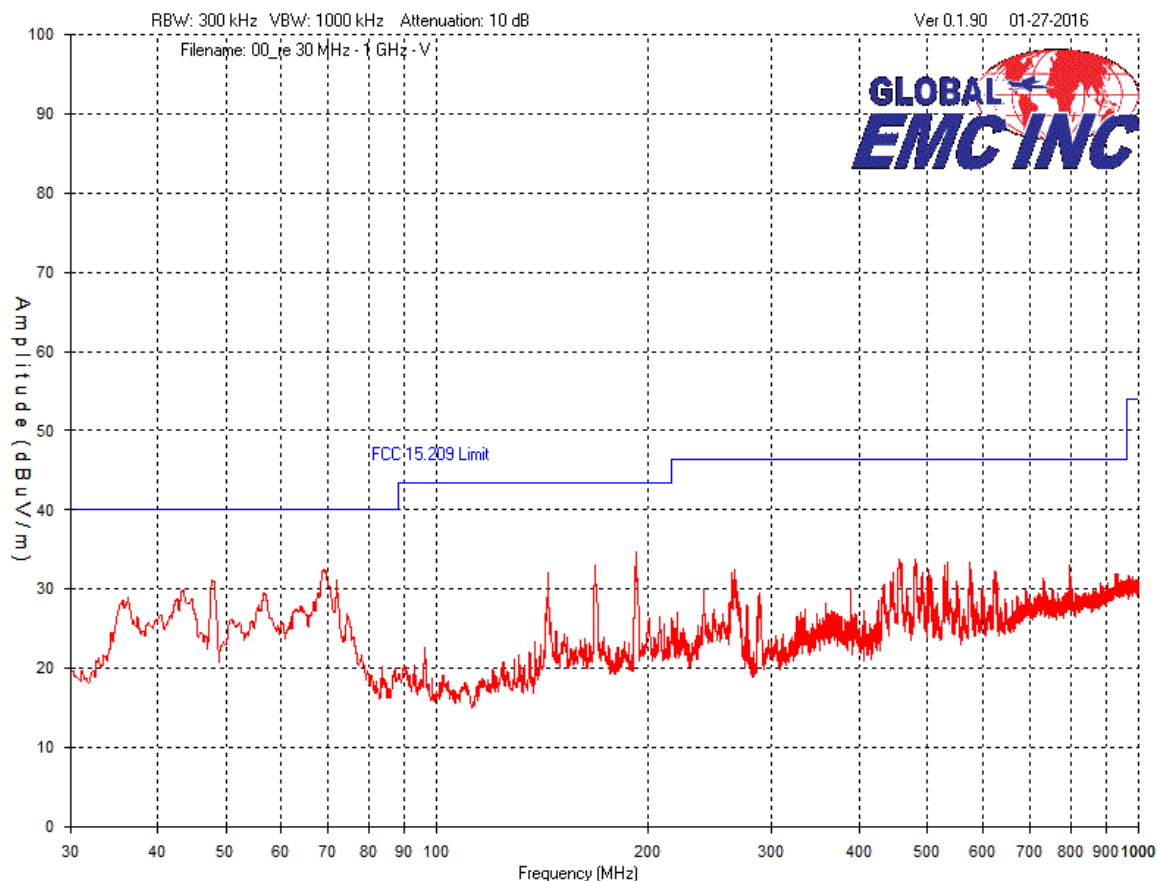


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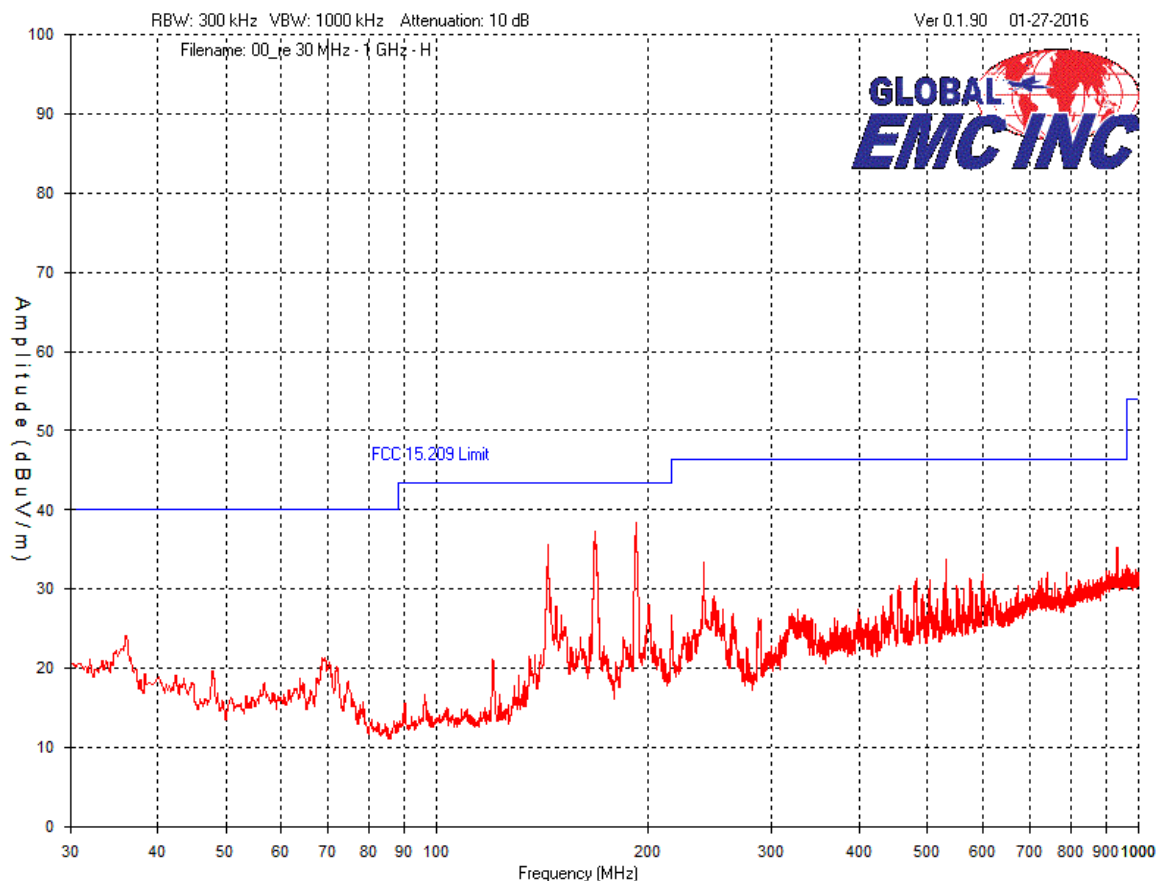
Client	MMB Research Inc	
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Mid Channel – 30 MHz – 1 GHz
Vertical - Peak Emission Graph
With External Antenna



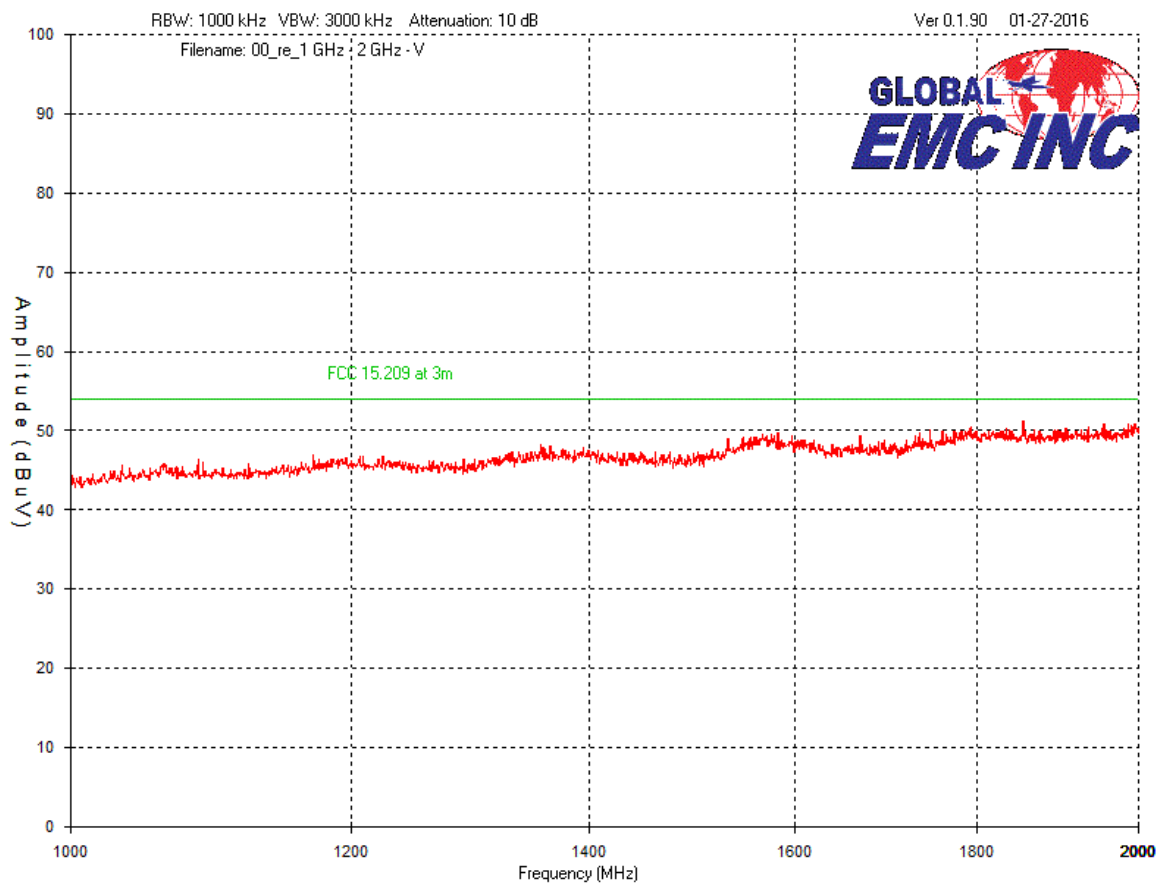
Client	MMB Research Inc	
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Mid Channel – 30 MHz – 1 GHz
Horizontal - Peak Emission Graph
With External Antenna



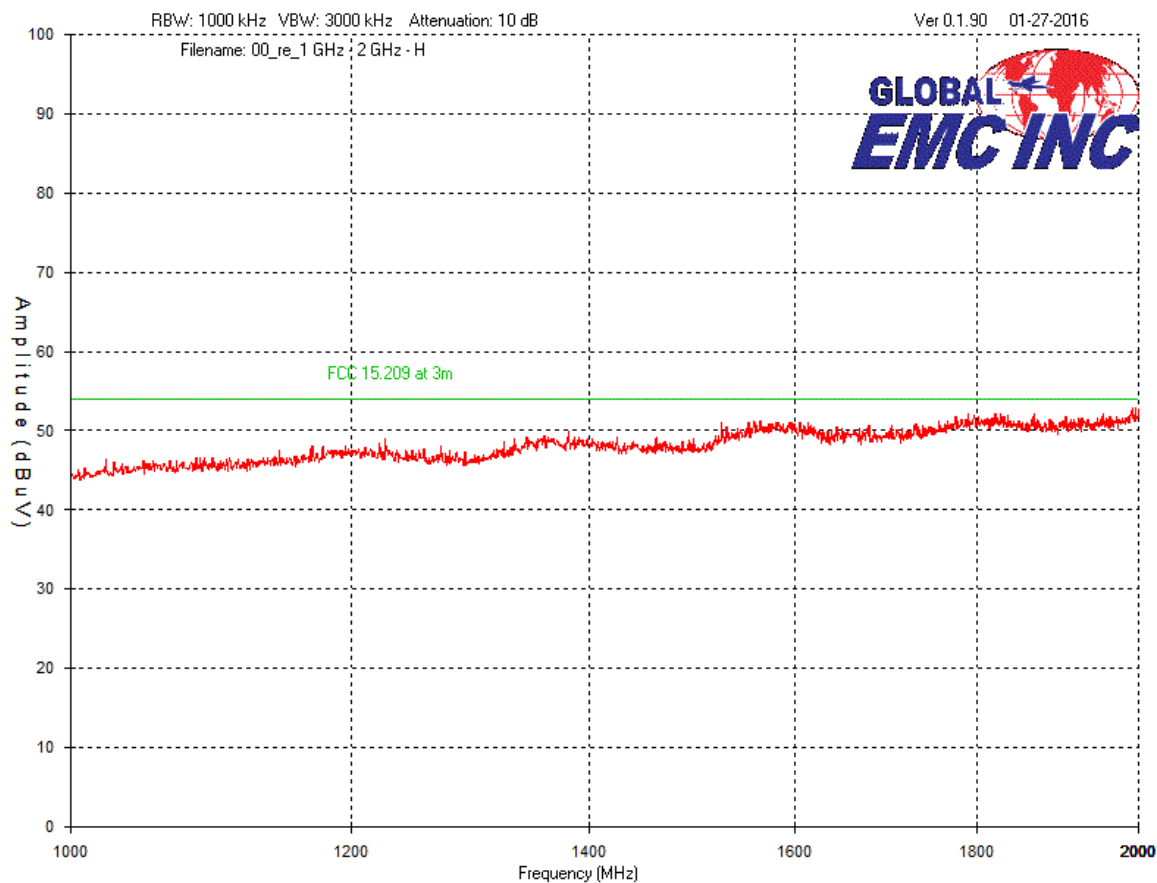
Client	MMB Research Inc	
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Mid Channel – 1 GHz – 2 GHz
Vertical - Peak Emission Graph
With External Antenna



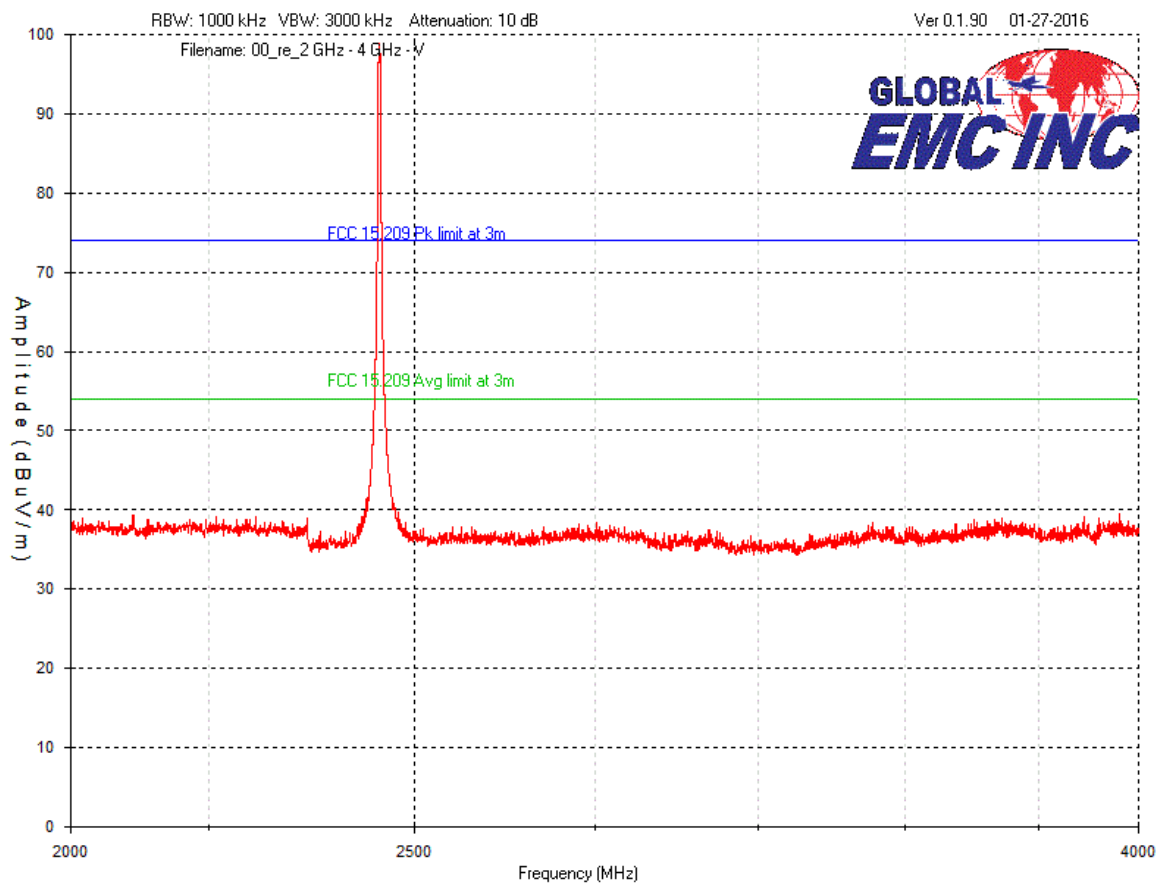
Client	MMB Research Inc	
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Mid Channel – 1 GHz – 2 GHz
Horizontal - Peak Emission Graph
With External Antenna



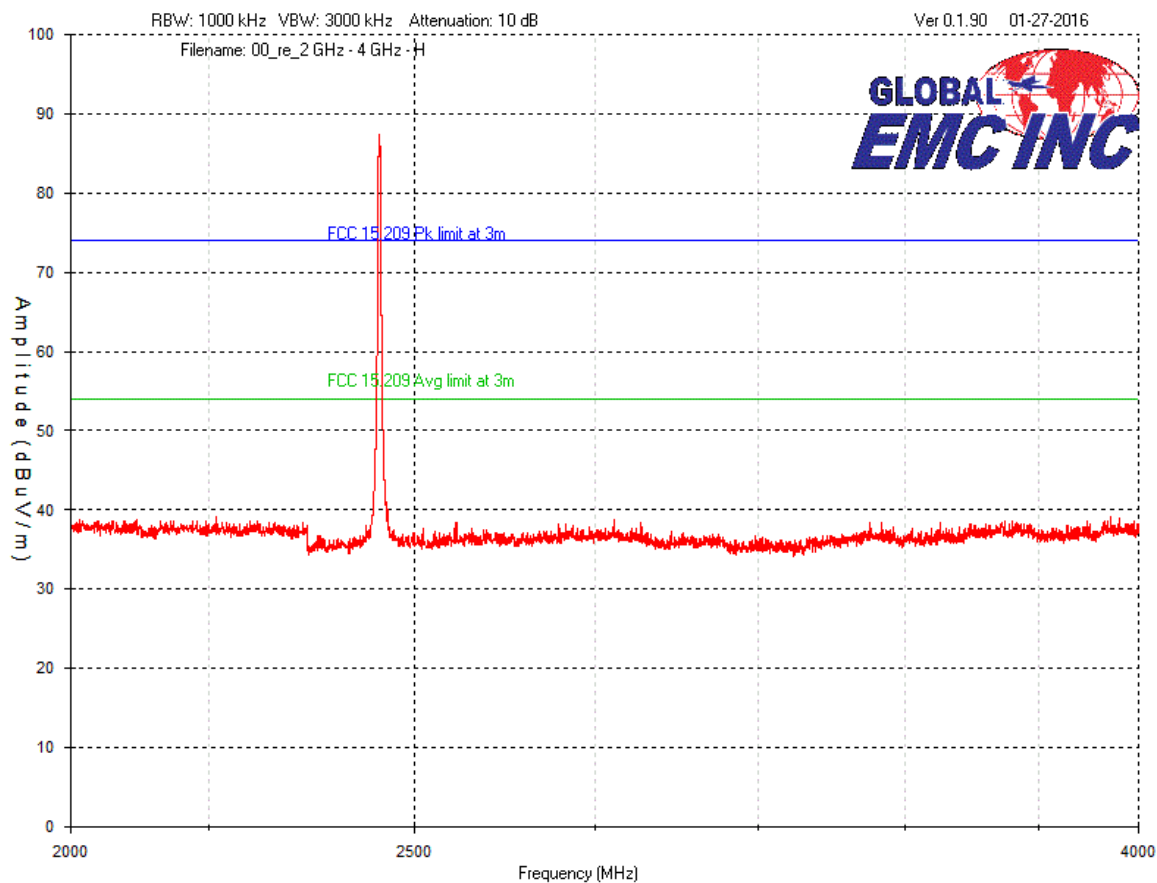
Client	MMB Research Inc	
Product	Hornet MiO /Z357PA40	
Standard(s)	RSS 247 Issue 1:2015 / FCC Part 15 Subpart C 15.247:2016	

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



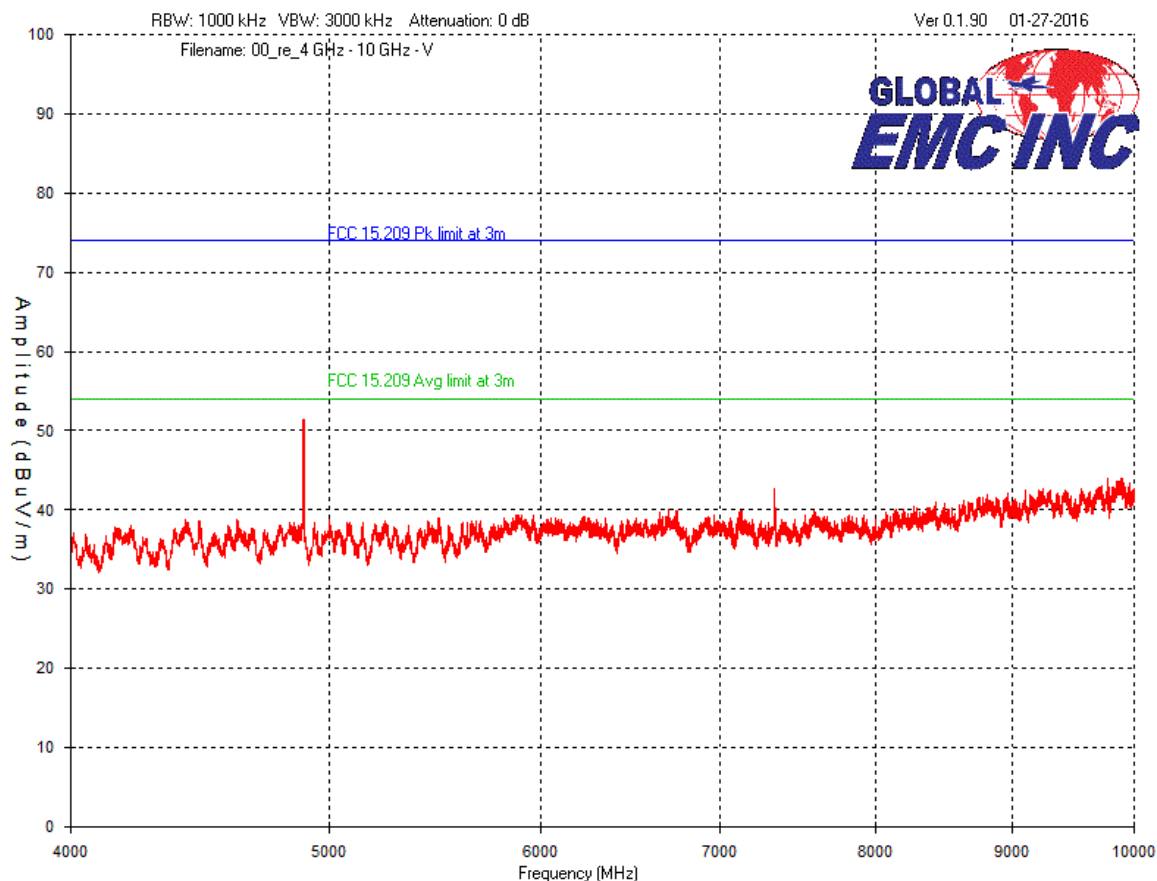
Client	MMB Research Inc	
Product	Hornet MiO /Z357PA40	
Standard(s)	RSS 247 Issue 1:2015 / FCC Part 15 Subpart C 15.247:2016	

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



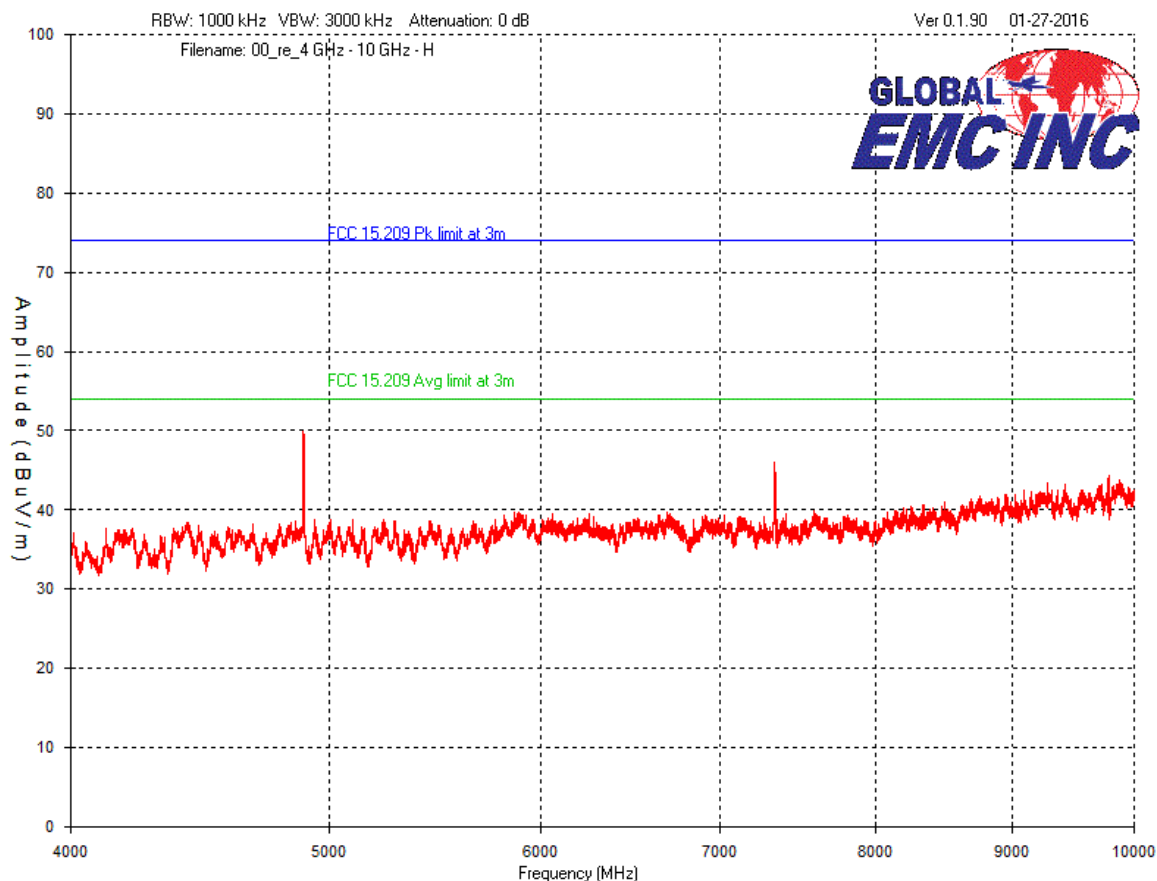
Client	MMB Research Inc	
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Standard(s)	RSS 247 Issue 1:2015 / FCC Part 15 Subpart C 15.247:2016	

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



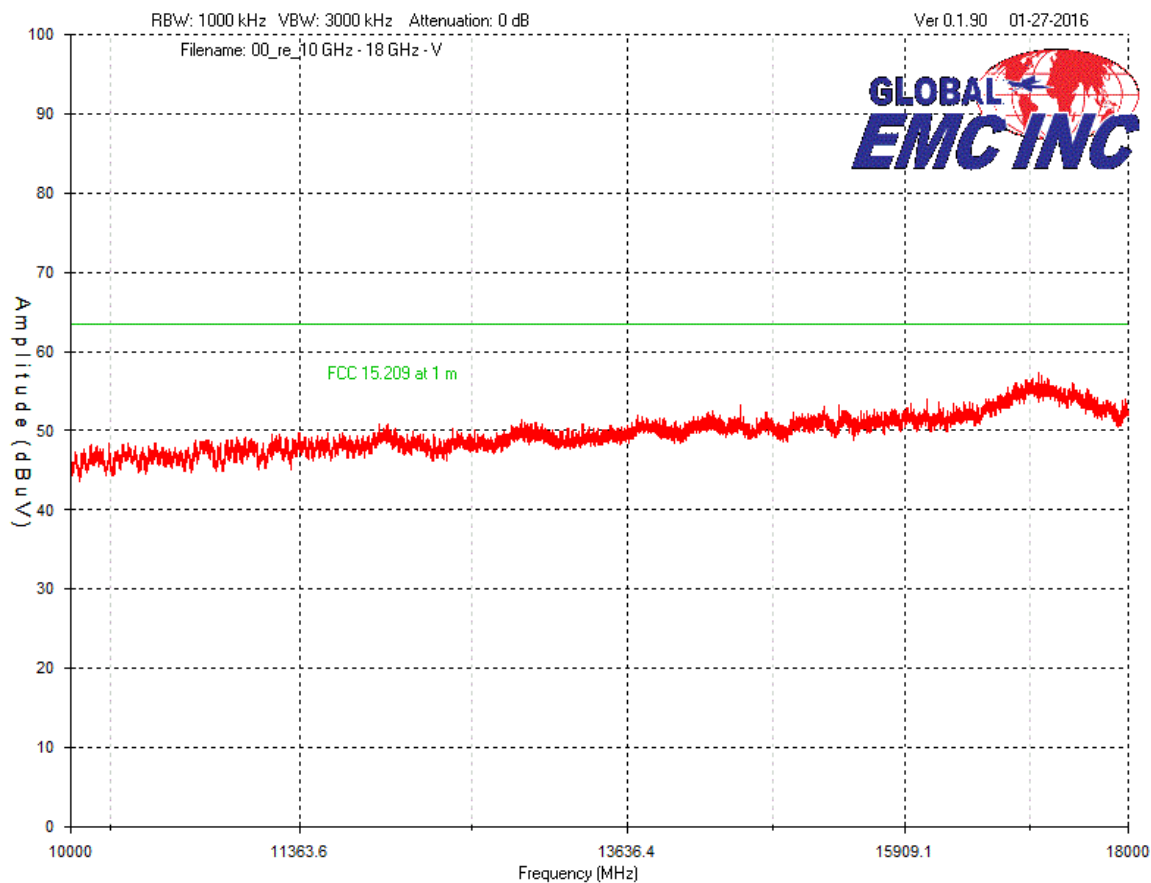
Client	MMB Research Inc	
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Standard(s)	RSS 247 Issue 1:2015 / FCC Part 15 Subpart C 15.247:2016	

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



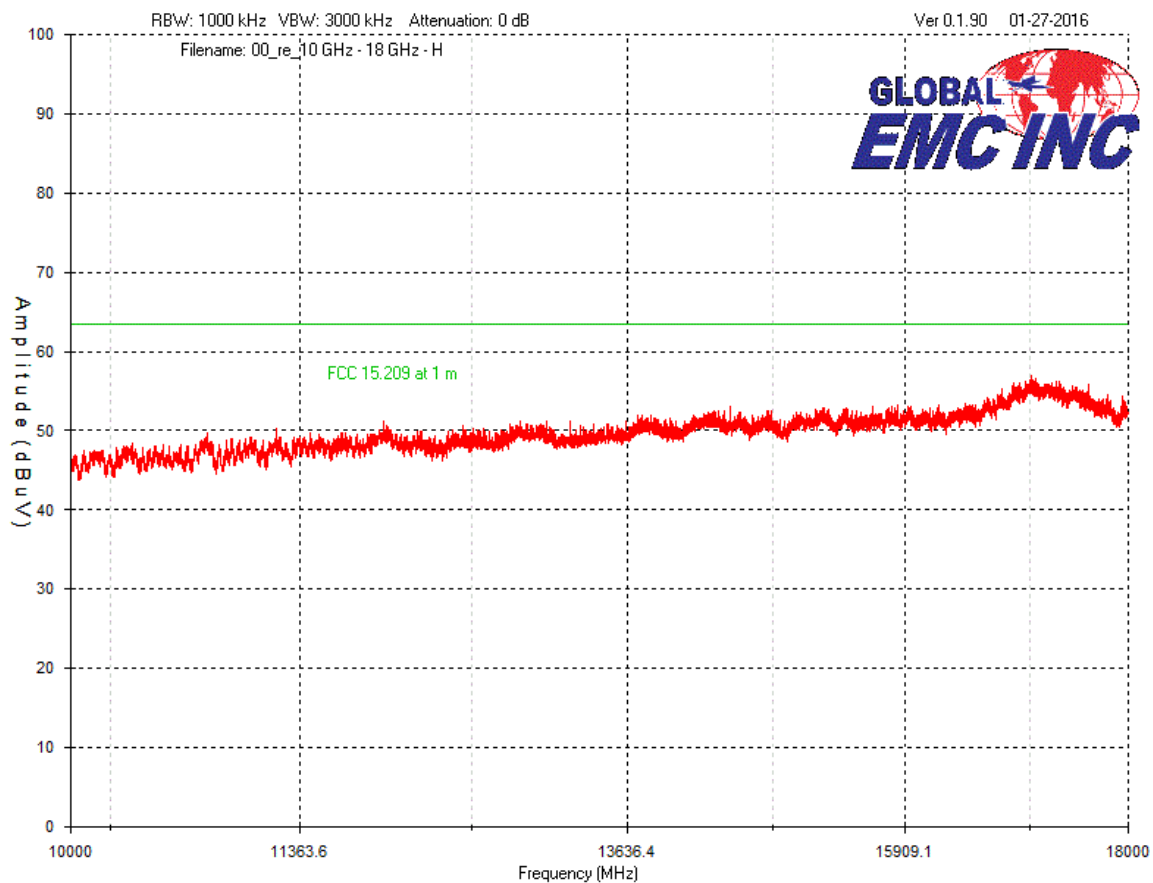
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Standard(s)	RSS 247 Issue 1:2015 / FCC Part 15 Subpart C 15.247:2016	

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



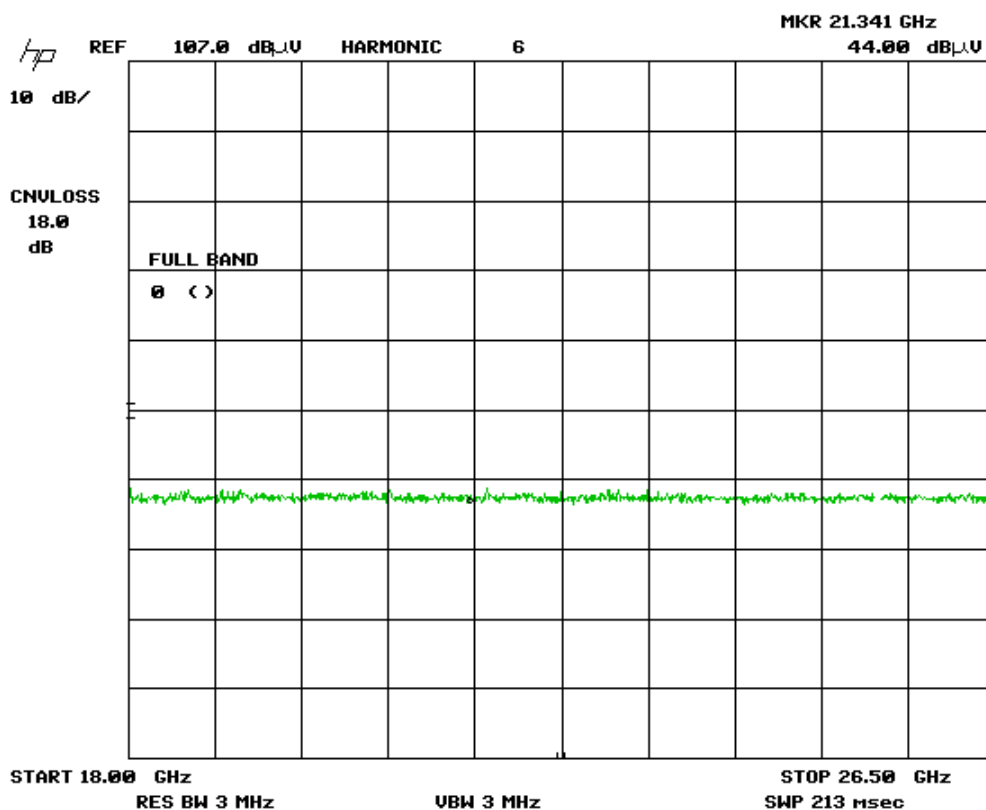
Client	MMB Research Inc	
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Standard(s)	RSS 247 Issue 1:2015 / FCC Part 15 Subpart C 15.247:2016	

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



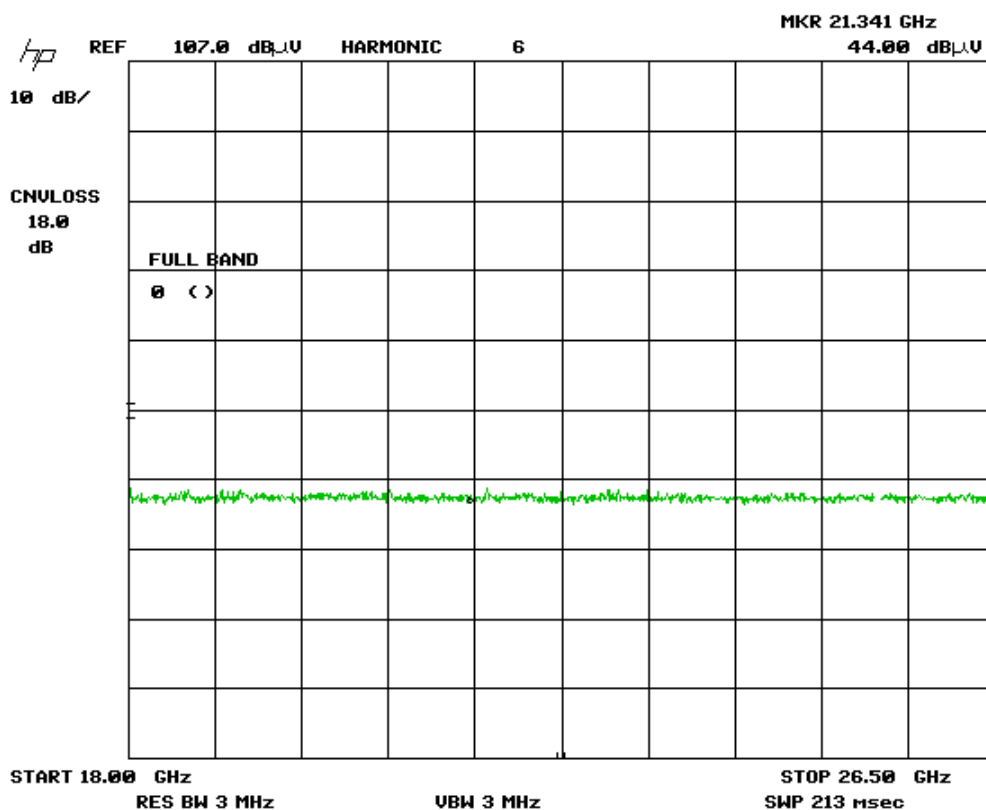
Client	MMB Research Inc	
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Standard(s)	RSS 247 Issue 1:2015 / FCC Part 15 Subpart C 15.247:2016	

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



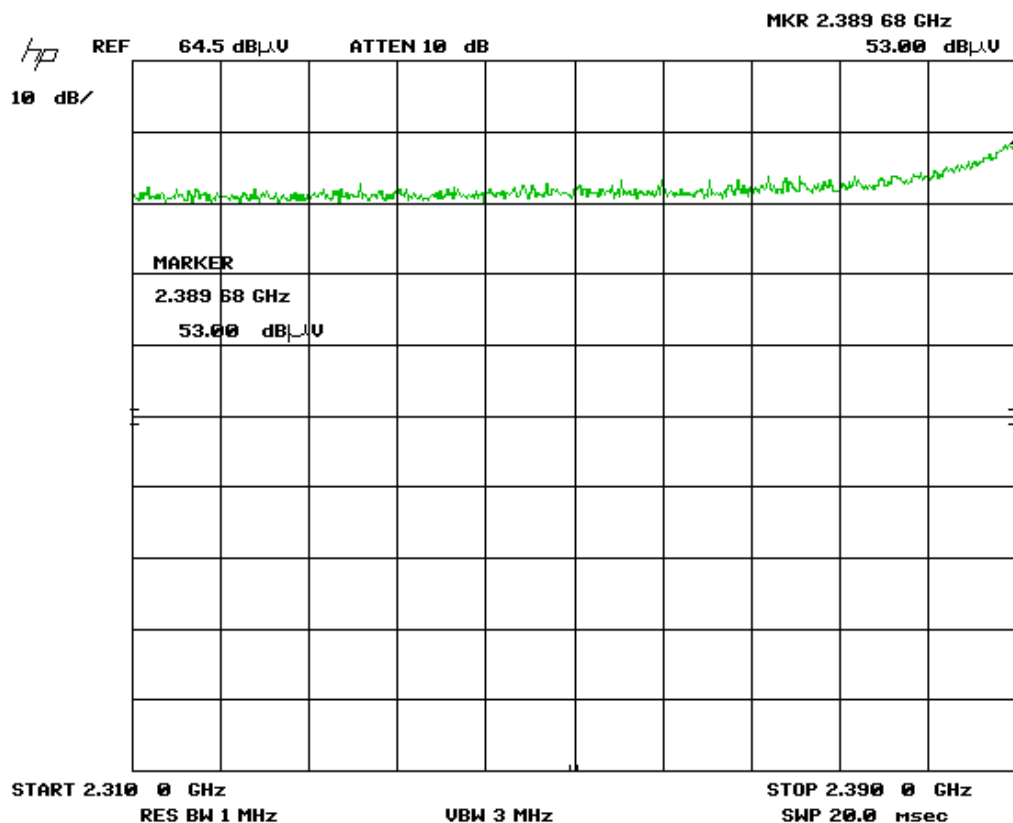
Client	MMB Research Inc	
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Standard(s)	RSS 247 Issue 1:2015 / FCC Part 15 Subpart C 15.247:2016	

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



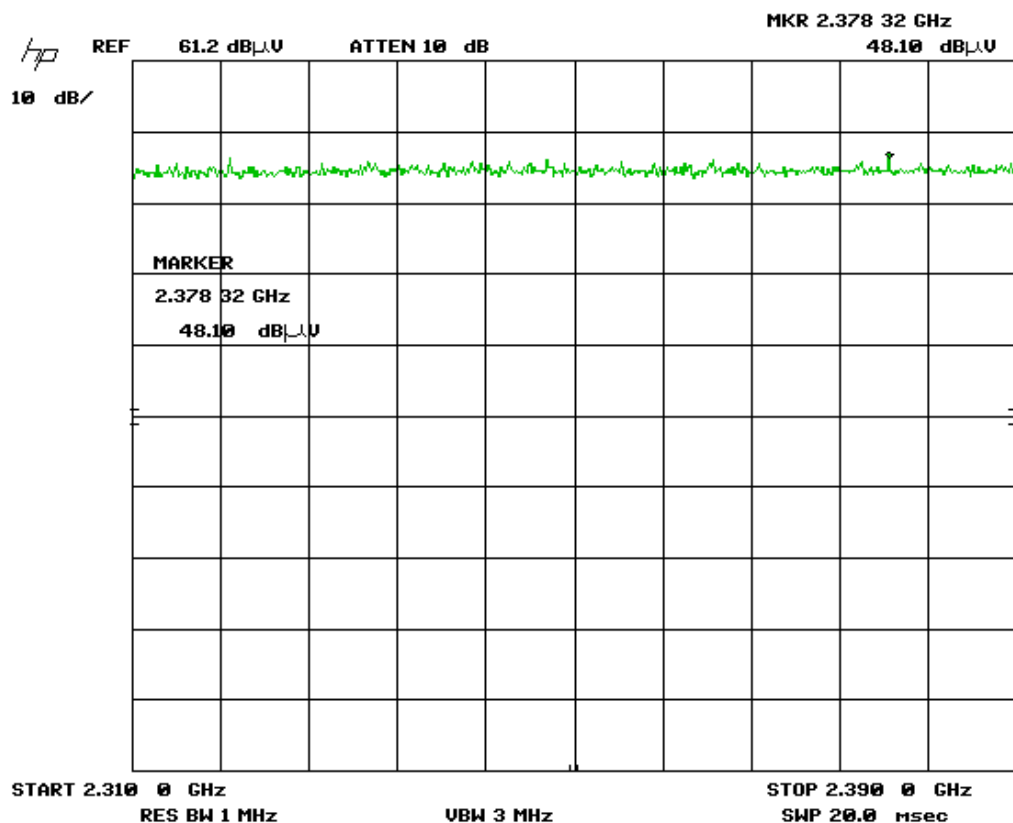
Client	MMB Research Inc	
Product	Hornet MiO /Z357PA40	
Standard(s)	RSS 247 Issue 1:2015 / FCC Part 15 Subpart C 15.247:2016	

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



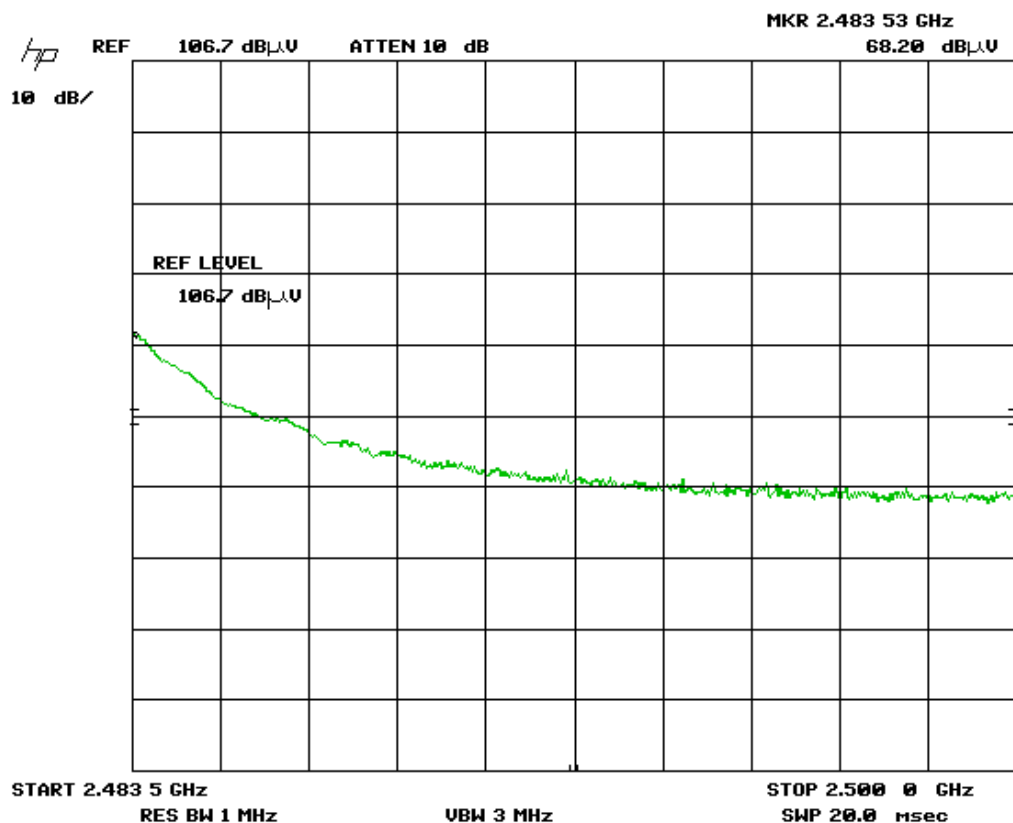
Client	MMB Research Inc	
Product	Hornet MiO /Z357PA40	
Standard(s)	RSS 247 Issue 1:2015 / FCC Part 15 Subpart C 15.247:2016	

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



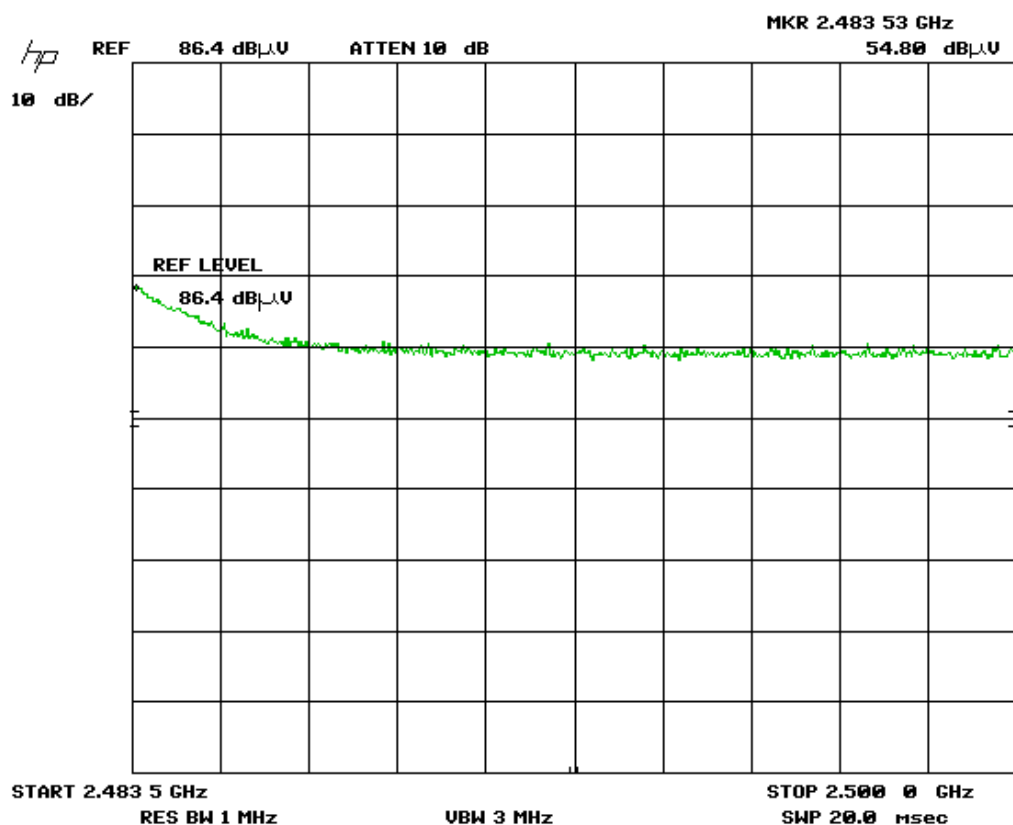
Client	MMB Research Inc	
Product	Hornet MiO /Z357PA40	
Standard(s)	RSS 247 Issue 1:2015 / FCC Part 15 Subpart C 15.247:2016	

Band Edge – High Channel (Channel 26) (External Antenna)
Vertical - Peak Emission



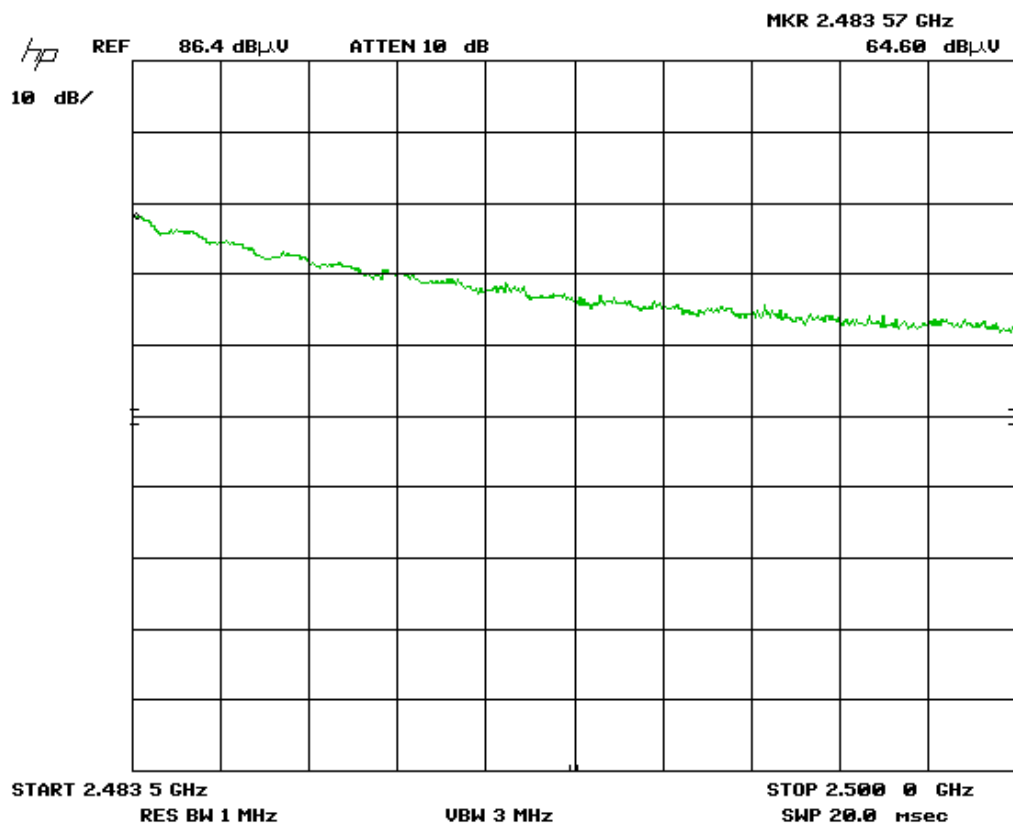
Client	MMB Research Inc	
Product	Hornet MiO /Z357PA40	
Standard(s)	RSS 247 Issue 1:2015 / FCC Part 15 Subpart C 15.247:2016	

Band Edge – High Channel (Channel 26) (External Antenna)
Horizontal - Peak Emission



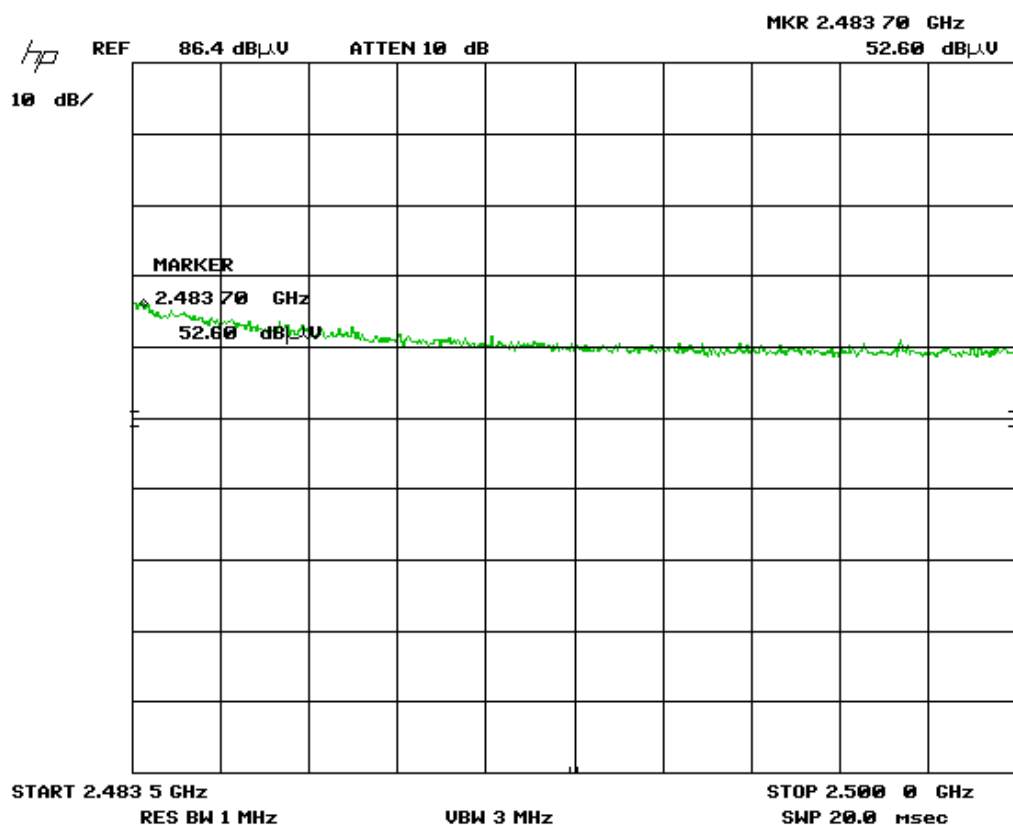
Client	MMB Research Inc	
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Band Edge – Channel 25 (External Antenna)
Vertical - Peak Emission



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



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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. Emissions outside the restricted bands were measured for information purpose only, if applicable.

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

The EUT have a source base duty cycle of 11.58%; a duty cycle correction factor of -18.7 dB was used to derived Average emissions from peak emissions for restricted band emissions.

Test Frequency (MHz)	Detection mode	Antenna polarity (Horz/Vert)	Raw signal dB(μV)	Antenna factor dB	Cable loss dB	Attenuator dB	Pre-Amp Gain dB	Received signal dB(μV/m)	Emission limit dB(μV/m)	Margin dB	Result
Low Channel (11) - Z axis (Flat) Setpower -0xB (Actual Power = -11 dBm)											
2390	Peak	Horz	48.1	26.1	4.2	10.0	35.8	52.6	74.0	21.4	PASS
2390	Avg	Horz	33.1	26.1	4.2	10.0	35.8	37.6	54.0	16.4	PASS
2390	Peak	Vert	53.0	26.1	4.2	10.0	35.8	57.5	74.0	16.5	PASS
2390	Avg	Vert	40.5	26.1	4.2	10.0	35.8	45.0	54.0	9.0	PASS
Mid Channel (0x13) - Z axis (Flat)											
4890	Peak	Horz	55.4	27.6	5.9	0.0	35.3	53.6	74.0	20.4	PASS
4890	Avg	Horz	46.9	27.6	5.9	0.0	35.3	45.1	54.0	8.9	PASS
4890	Peak	Vert	57.1	27.6	5.9	0.0	35.3	55.3	74.0	18.7	PASS
4890	Avg	Vert	49.0	27.6	5.9	0.0	35.3	47.2	54.0	6.8	PASS
7335	Peak	Vert	51.1	28.9	7.3	0.0	35.6	51.7	74.0	22.3	PASS
7335	Avg	Vert	40.2	28.9	7.3	0.0	35.6	40.8	54.0	13.2	PASS
7335	Peak	Horz	50.7	28.9	7.3	0.0	35.6	51.3	74.0	22.7	PASS
7335	Avg	Horz	39.4	28.9	7.3	0.0	35.6	40.0	54.0	14.0	PASS
High Channel (0x19) - Z axis (Flat) - set power -0xB (Actual Power = -11 dBm)											
2483.5	Peak	Horz	52.6	26.1	4.2	10.0	35.8	57.1	74.0	16.9	PASS
2483.5	Avg	Horz	39.3	26.1	4.2	10.0	35.8	43.8	54.0	10.2	PASS
2483.5	Peak	Vert	64.6	26.1	4.2	10.0	35.8	69.1	74.0	4.9	PASS
2483.5	Avg	Vert	45.9	26.1	4.2	10.0	35.8	50.4	54.0	3.6	PASS
High Channel (0x1A) -Z Axis (Flat) Set Power -0x1A (Actual Power = -26 dBm)											
2483.5	Peak	Horz	54.8	26.1	4.2	10.0	35.8	59.3	74.0	14.7	PASS
2483.5	Avg	Horz	44.7	26.1	4.2	10.0	35.8	49.2	54.0	4.8	PASS
2483.5	Peak	Vert	68.0	26.1	4.2	10.0	35.8	72.5	74.0	1.5	PASS
2483.5	Avg	Vert	49.3	26.1	4.2	10.0	35.8	53.8	54.0	0.2	PASS

Client	MMB Research Inc	
Product	Hornet MiO /Z357PA40	
Standard(s)	RSS 247 Issue 1:2015 / FCC Part 15 Subpart C 15.247:2016	

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration /Verification date	Next calibration /Verification due date	Asset #
Spectrum Analyzer	8566B	HP	Oct 2, 2013	Oct 2, 2015	GEMC 190
Quasi Peak Adapter	85650A	HP	Oct 1, 2013	Oct 1, 2015	GEMC 191
Loop Antenna	EM 6871	Electro-Metrics	Feb 3, 2015	Feb 5, 2017	GEMC 70
Loop Antenna	EM 6872	Electro-Metrics	Feb 3, 2015	Feb 5, 2017	GEMC 71
BiLog Antenna	3142-C	ETS	Sept 8, 2014	Sept 8, 2016	GEMC 8
Attenuator 10 dB	8493B	Agilent	Feb-11, 2015	Feb-11, 2016	GEMC 133
4GHZ-12GHz High Pass filter	11SH10-4000/T12000-0/0	K & L Microwave	Apr 9, 2015	Apr 9, 2016	GEMC 119
Chase Preamp 9kHz - 2 GHz	CPA9231A	Chase	Sept 9, 2014	Sept 9, 2016	GEMC 6403
Q-Par 1.5-18 GHz Horn	6878/24	Q-par	Sept 10, 2014	Sept 10, 2016	GEMC 6365
Horn Antenna 18 GHz - 26.5 GHz	SAS-572	A.H. Systems	Sept 9, 2014	Sept 9, 2016	GEMC 6371
18.0-26.5 GHz Harmonic Mixer	11970K	HP	Jan 28, 2014	Jan 28, 2016	GEMC 158
1-26G pre-amp	HP 8449B	HP	Sept 9, 2014	Sept 9, 2016	GEMC 6351
2.0-8.0 GHz Amplifier	11975A	HP	Jan 28, 2014	Jan 28, 2016	GEMC157
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	Feb 10, 2015	Feb 15, 2016	GEMC 28
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	Feb 10, 2015	Feb 15, 2016	GEMC 29
RF Cable 0.5M	LMR-400-0.5M-50OHM-MN-MN	LexTec	Feb 10, 2015	Feb 15, 2016	GEMC 31

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

Client	MMB Research Inc	
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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	Z357PA40
Equipment Category	Wireless module
Basic EUT Functionality	The Z357PA40 module 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	3.3 Vdc
Connectors available on EUT	None.
Peripherals Required for Test	None.
Release type	Final
Intentional Radiator Frequency	2405 – 2480.0 MHz for Zigbee applications as described above.

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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’.

Client	MMB Research Inc	
Product	Hornet MiO /Z357PA40	
Standard(s)	RSS 247 Issue 1:2015 / FCC Part 15 Subpart C 15.247:2016	

Appendix B – EUT and Test Setup Photographs

Client	MMB Research Inc	
Product	Hornet MiO /Z357PA40	
Standard(s)	RSS 247 Issue 1:2015 / FCC Part 15 Subpart C 15.247:2016	

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

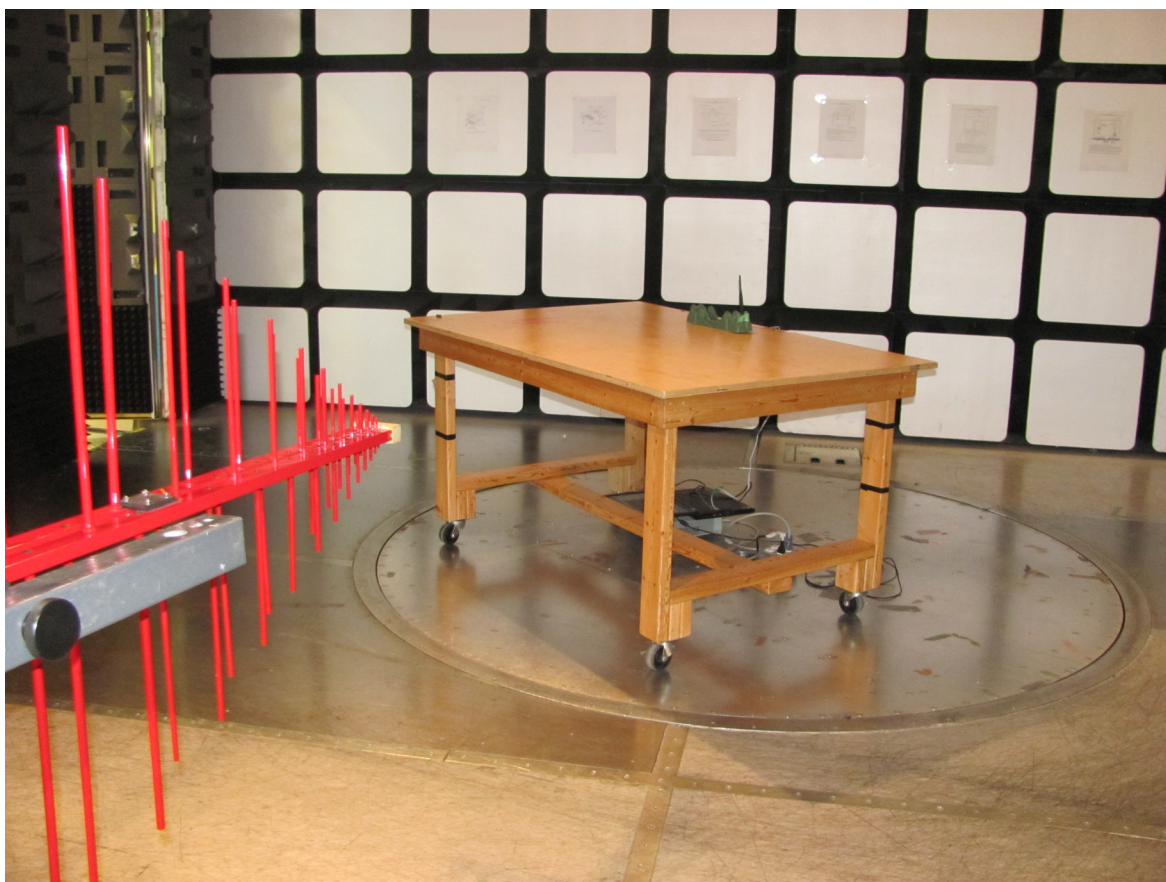


Illustration 1: Radiated emission setup – photo 1

Client	MMB Research Inc	
Product	Hornet MiO /Z357PA40	
Standard(s)	RSS 247 Issue 1:2015 / FCC Part 15 Subpart C 15.247:2016	

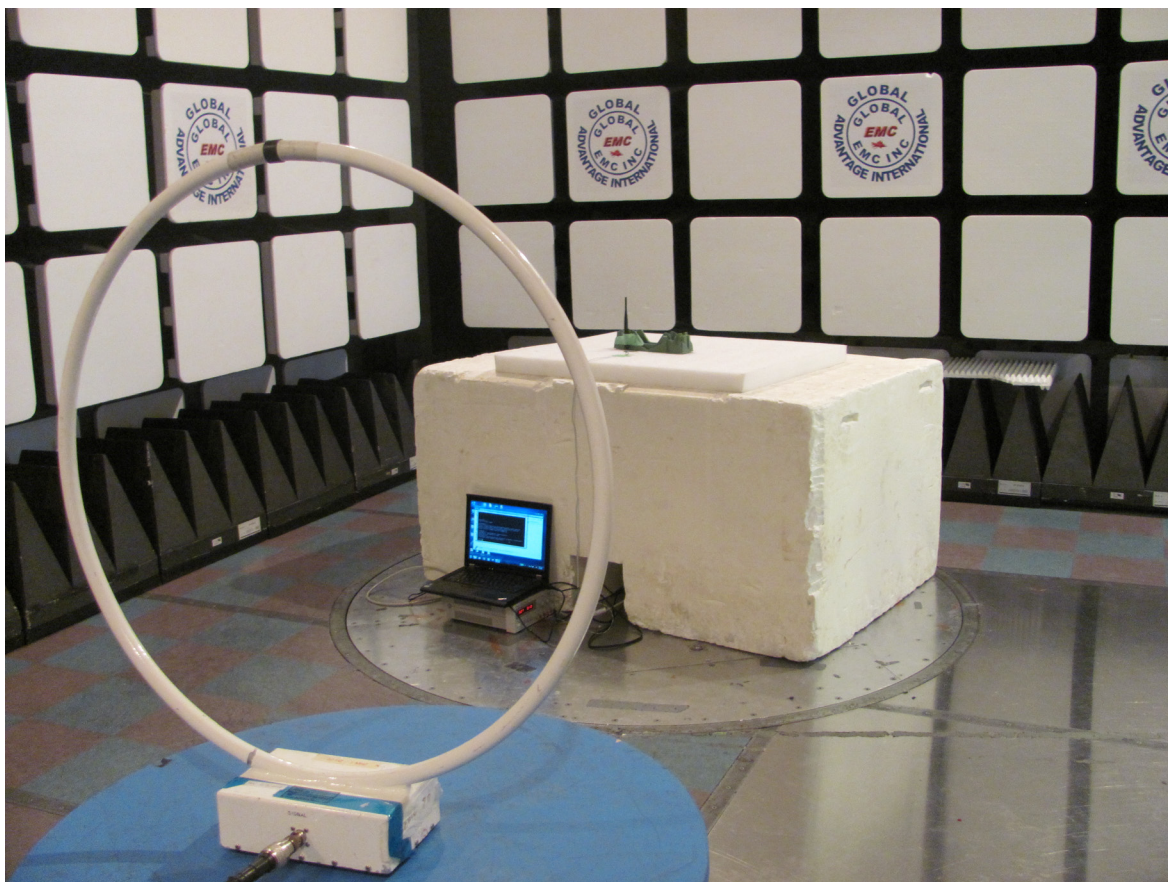


Illustration 2: Radiated emission setup - photo 2

Client	MMB Research Inc	
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Illustration 3: Radiated setup - photo 3