TUV SUD Canada

EMC & RF Test Report

As per

FCC Part 15 Subpart C

Unlicensed Intentional Radiators

on the

W2A (Zigbee)

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Testing produced for

See Appendix A for full customer & EUT details.

Industry Canada
LAB REGISTRATION #6844B-1

FCC REGISTRATION
REG#382292

Testing Laboratory
Certificate #2955.02

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Report Scope

This report addresses the EMC verification testing and test results of the W2A (Zigbee), herein referred to as EUT (Equipment Under Test) performed at TUV SUD Canada .

The EUT was tested for compliance against the following standards:

FCC Part 15 Subpart C 15

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 TUV SUD Canada

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

Client	Viconics Electronics Inc.
Product	W2A (Zigbee)
Standard(s)	FCC Part 15 Subpart C 15

Summary

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

EUT FCC Certification #, FCC ID:	V95-W2A
EUT Industry Canada Certification #, IC:	7591A-W2A
EUT Passed all tests performed.	Yes (see test results summary)
Tests conducted by	Scott Drysdale

Client	Viconics Electronics Inc.
Product	W2A (Zigbee)
Standard(s)	FCC Part 15 Subpart C 15

Test Results Summary

Standard/Method	Description	Class/Limit	Result
FCC 15.203	Antenna Requirement	Unique	Pass See Justification
FCC 15.205 RSS 247 (Table 1)	Restricted Bands for intentional operation	QuasiPeak Average	Pass See Justifications
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
Overall Result			**PASS**

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:

The EUT test data presents the modes that are representative worst case based on preliminary previous testing.

For the scope of this test report, radiated testing of the EUT was pre-scanned in three orthogonal axis to maximize emissions. Maximum emissions were found in the vertical EUT polarization. This setup is presented for all radiated emissions test data in this report.

For the Restricted Bands of operation, the EUT is designed to only operate between 2.4 GHz and 2.4835 GHz

For the Antenna requirement specified in FCC 15.203 and RSS 247 section 5.5, this device uses a chip antenna with a gain of 2.2 dBi, which is less than 6 dBi.

EUT configuration, firmware version and peripherals were as supplied and designated by the client.

The EUT was tested in both transmit and standby (receive) mode. No difference in emissions below 2 GHz were observed, and the worst case (transmit) mode is presented as representative for both modes. In standby mode, no emissions were detected above 2 GHz.

For the Restricted Bands of operation, the EUT is designed to only operate between 2.4 GHz and 2.4835 GHz

A later revision of the standard may have been substituted in place of the previous dated referenced revision. The year of the specification used are listed under applicable standards. Using the later revision accomplishes the goal of ensuring compliance to the intent of the previous specification, while allowing the laboratory to incorporate the extensions and clarifications made available by a later revision.

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
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 210:2010	- Issue 8: Spectrum Management and Telecommunications Policy. Radio Standards Specification Low Power Licence-Exempt Radiocommunication Devices
RSS 247:2016	- Issue 1: Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) 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 - Sept 8, 2016 First 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 TUV SUD Canada in Montréal, Québec, 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 measurement site used is registered with Federal Communications Commission (FCC) and Industry Canada (IC). This site is 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 semi-anechoic chamber is lined with ferrite tiles and absorption cones to minimize any undesired reflections. 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 18 Aug 10, 2016	all	SD	18-25ºC	30-45%	100 -103kPa

Detailed Test Results Section

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 for tests below 1GHz, and ANSI C63.10 for tests above 1GHz.

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 (including band edge) must also meet the requirements of -20 dBc or greater

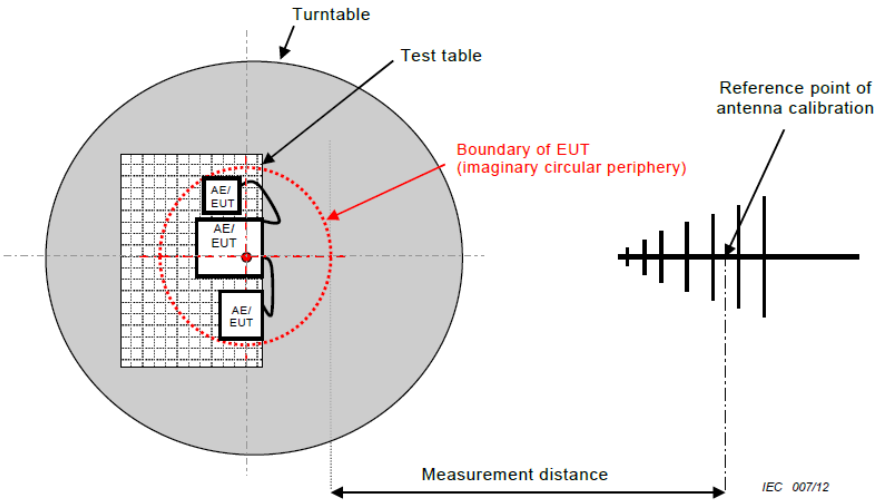
30 MHZ – 88 MHz, 100 uV/m (40.0 dBuV/m[1]) at 3 m
88 MHz – 216 MHz, 150 uV/m (43.5 dBuV/m[1]) at 3 m
216 MHz – 960 MHz, 200 uV/m (46.4 dBuV/m[1]) at 3 m
Above 960 MHz, 500 uV/m (54.0 dBuV/m[1]) at 3 m
Above 1000 MHz, 500 uV/m (54.0 dBuV/m[2]) at 3m

[1]Limit is with 120 kHz measurement bandwidth and a using a Quasi Peak detector.
[2]Limit is with 1 MHz measurement bandwidth and using an Average detector, scanned in accordance with 15.33 to above the 10th harmonic (25 GHz).

Results

The EUT passed the limits. Low, middle and high band was measured. The worst case for each mode 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.

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

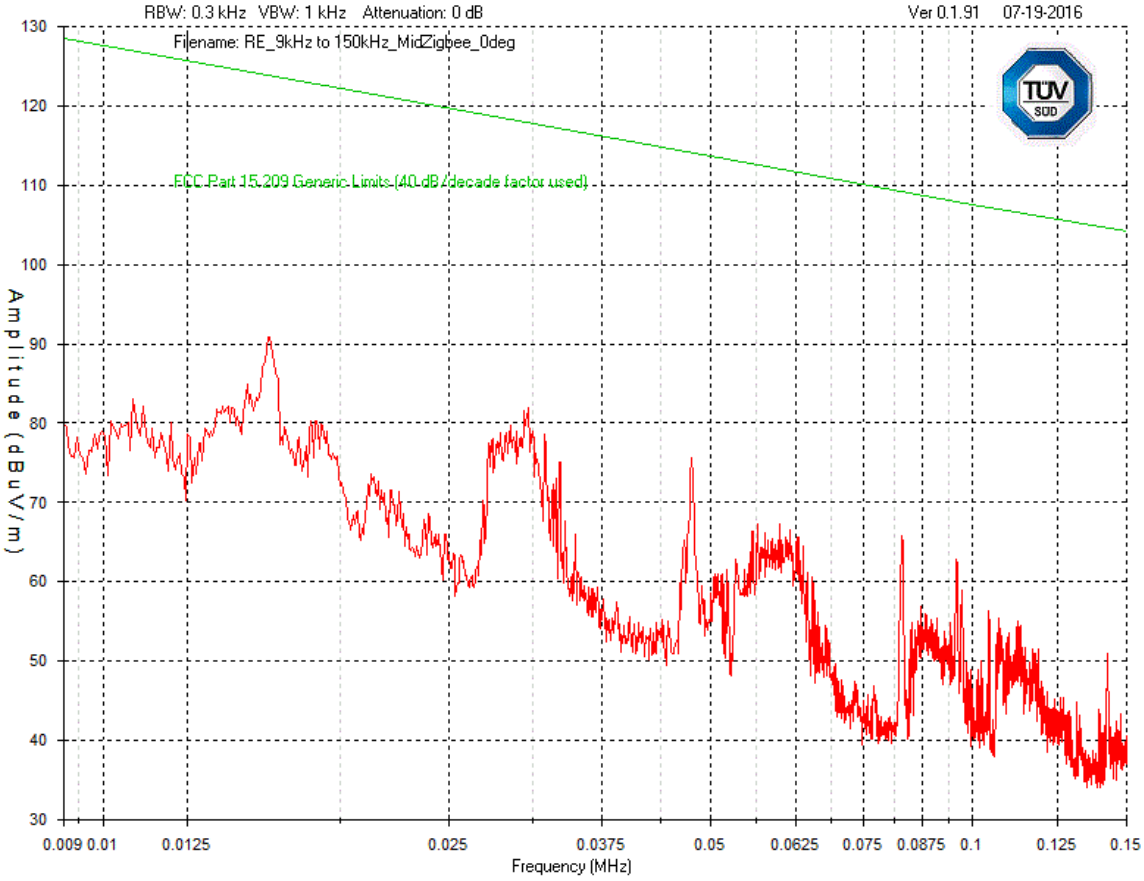
Note the graphs shown below are for graphical illustration only. For final measurements with the appropriate detector, please refer to the final measurement table where applicable. The graph shown below is a maximized peak measurement graph, measured with a resolution bandwidth greater than the final 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. Final measurements are performed over a full 0-360 degrees rotation and 1 – 4 meter height of measurement antenna.

The worst case or representative mode graphs are shown for 30 MHz to 2 GHz, however the device was scanned at low, middle, and high channel.

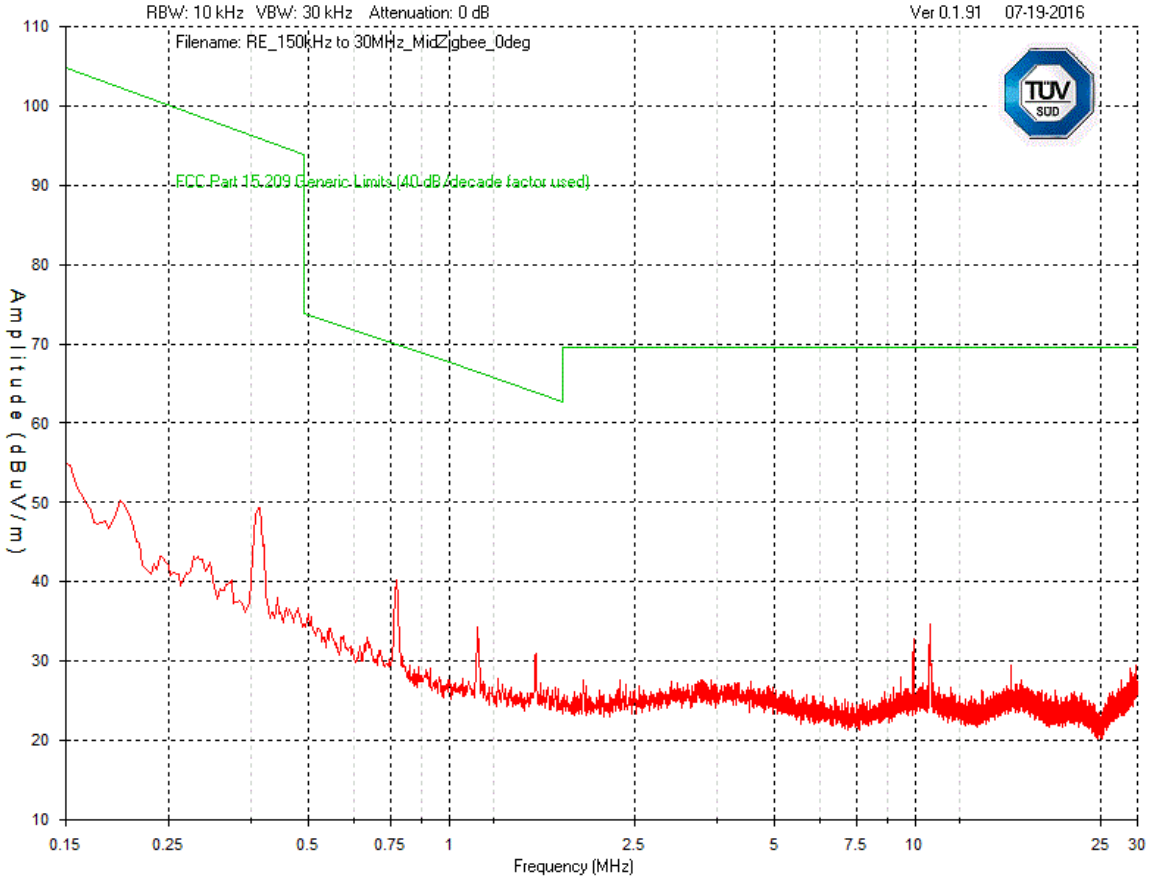
In accordance with FCC Part 15, Subpart A, Section 15.33, the device was scanned to a minimum of a 25 GHz, no emission were found above 18Ghz, while the noise floor was 6dB lower than the limit .

The graphs shown below shows the peak power output of the device during the radiated measurement at 300 kHz bandwidth during transmit operation of the EUT from 30 MHz – 1 GHz, since the RBW used is greater than the value required by the standard (100 kHz) this is a worst case reading and still complied with the limits.

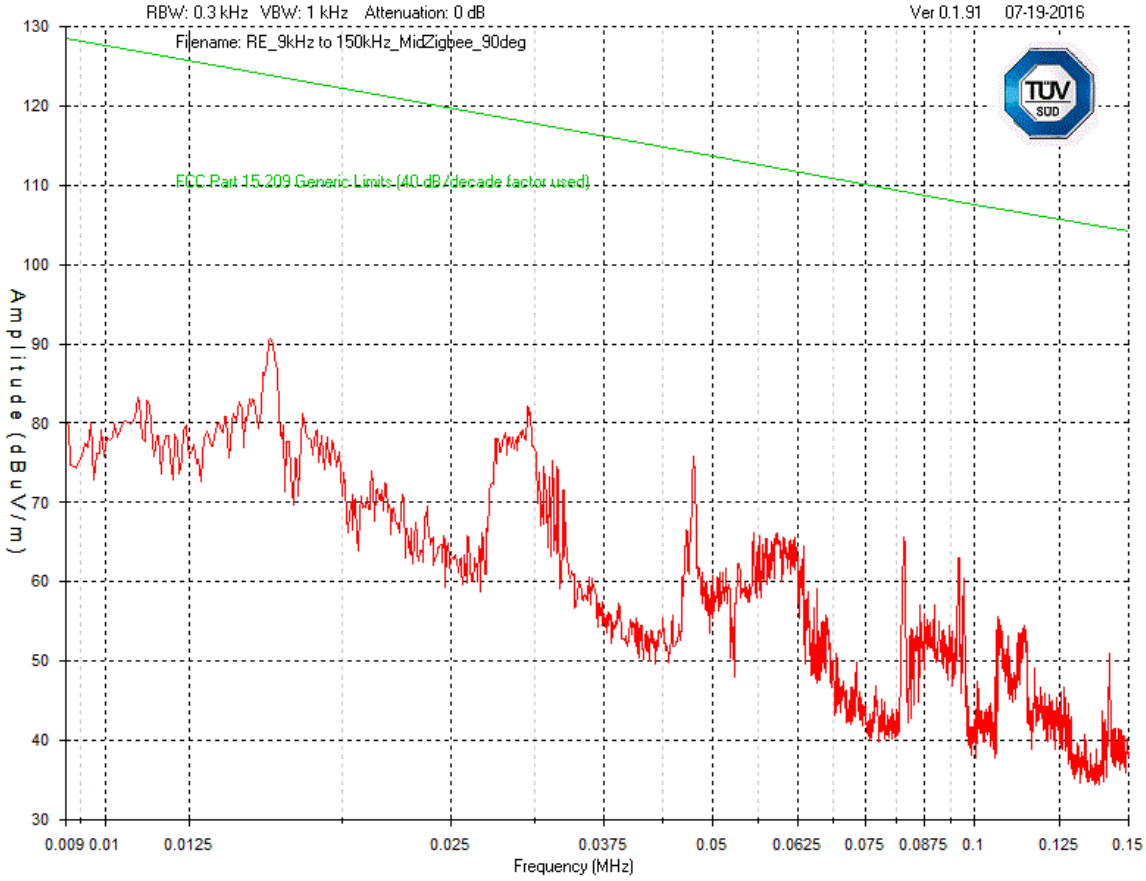
Loop @ 0 degree – Peak Emissions Graph – 9kHz to 150kHz



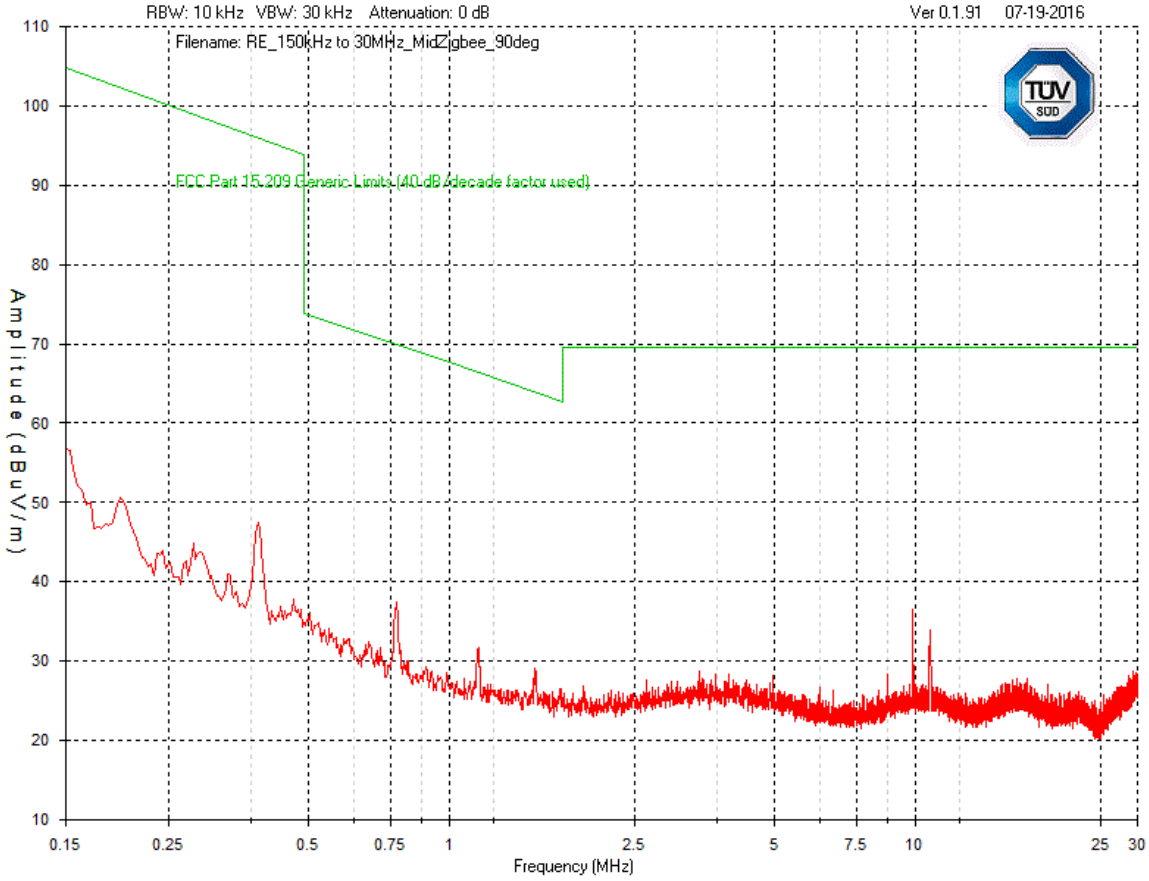
Loop @ 0 degree – Peak Emissions Graph – 150kHz to 30MHz



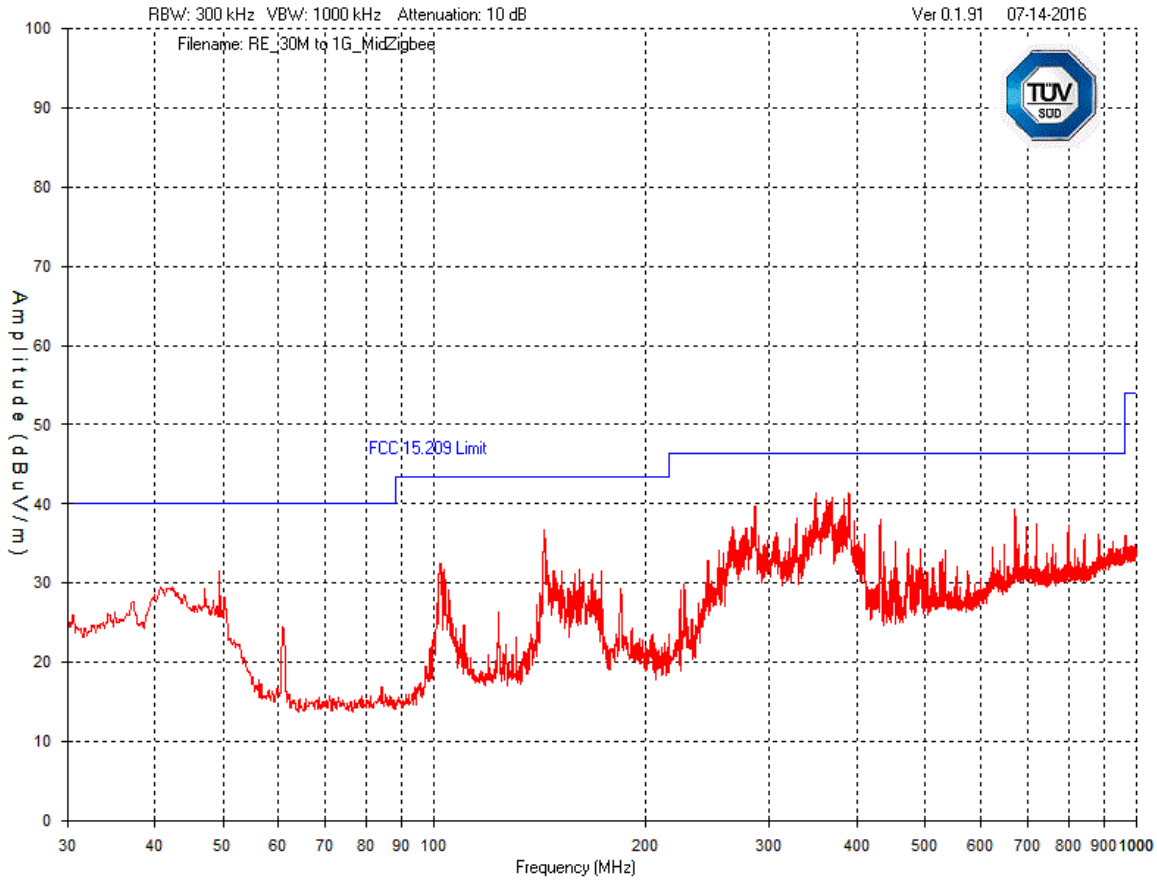
Loop @ 90 degree – Peak Emissions Graph – 9kHz to 150kHz



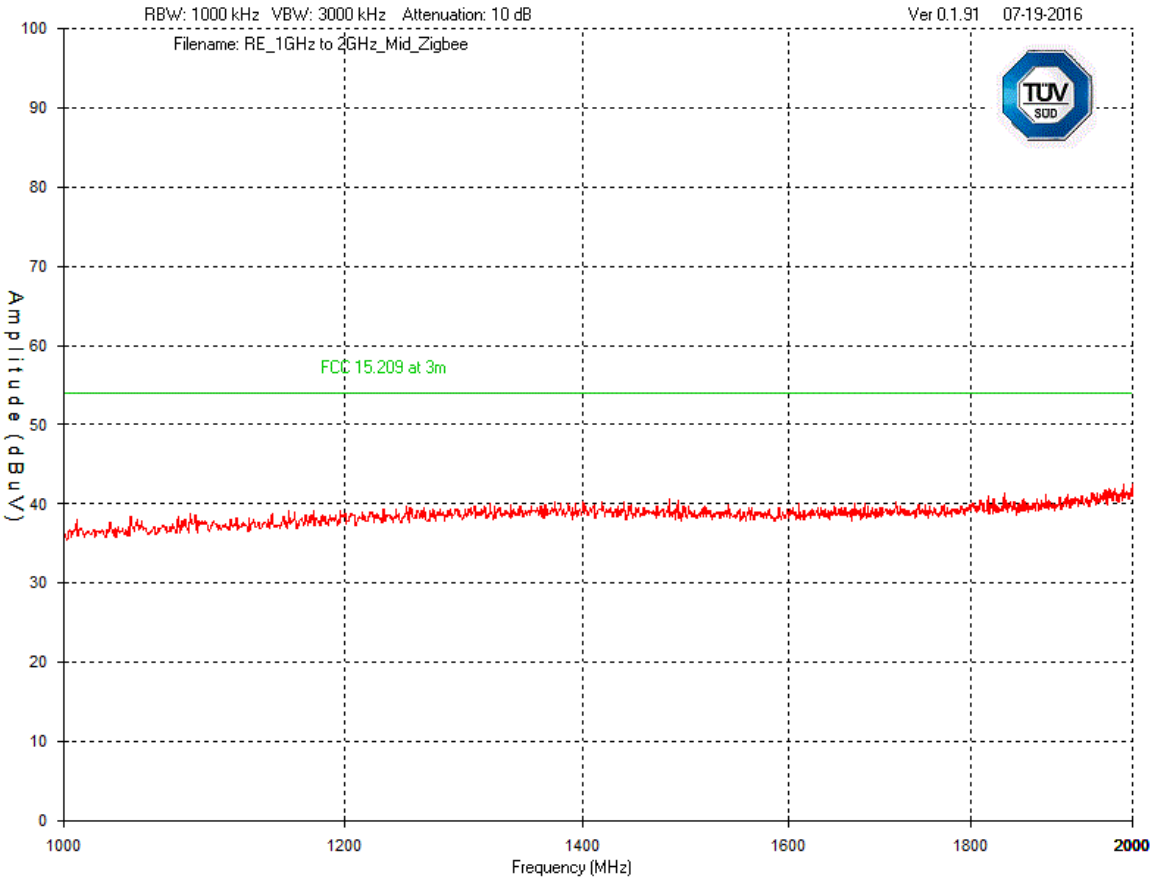
Loop @ 90 degree – Peak Emissions Graph – 150kHz to 30MHz



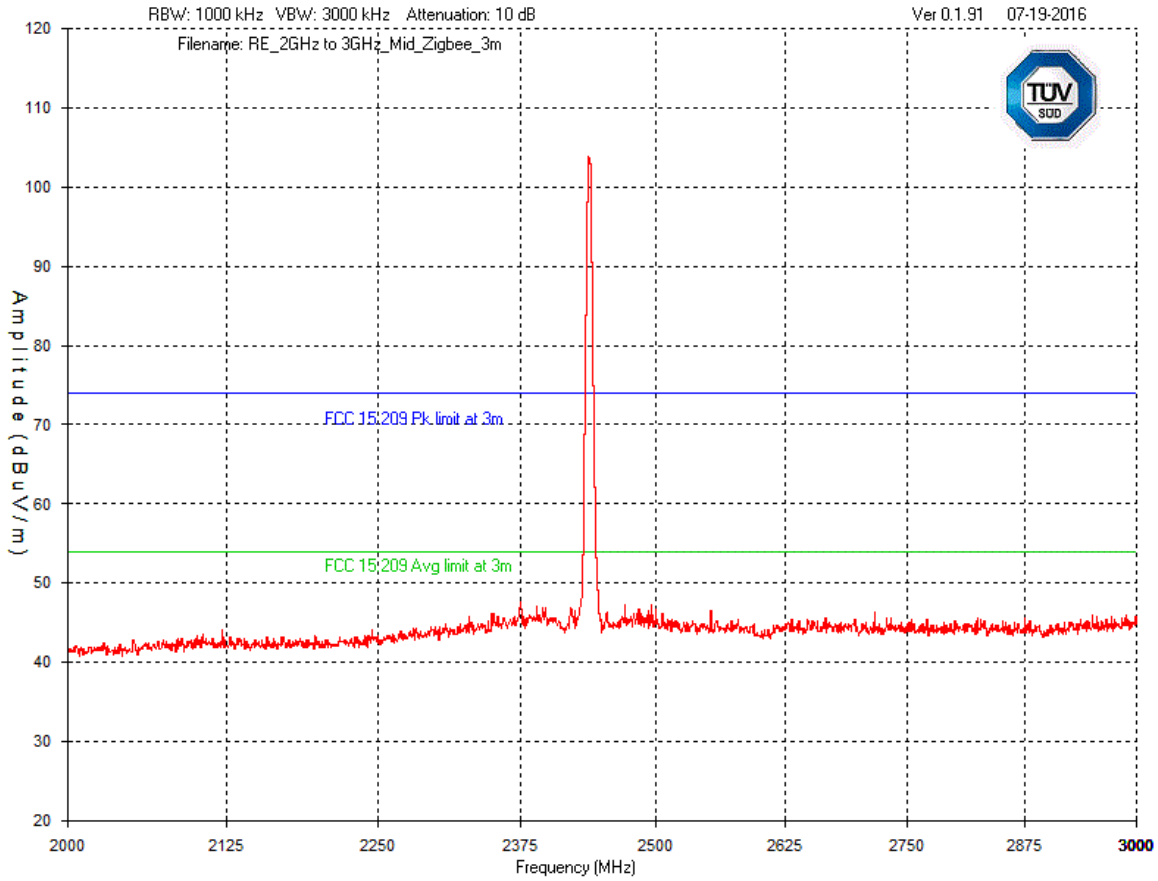
Vertical – Peak Emissions Graph – 30MHz to 1GHz (Worst case)



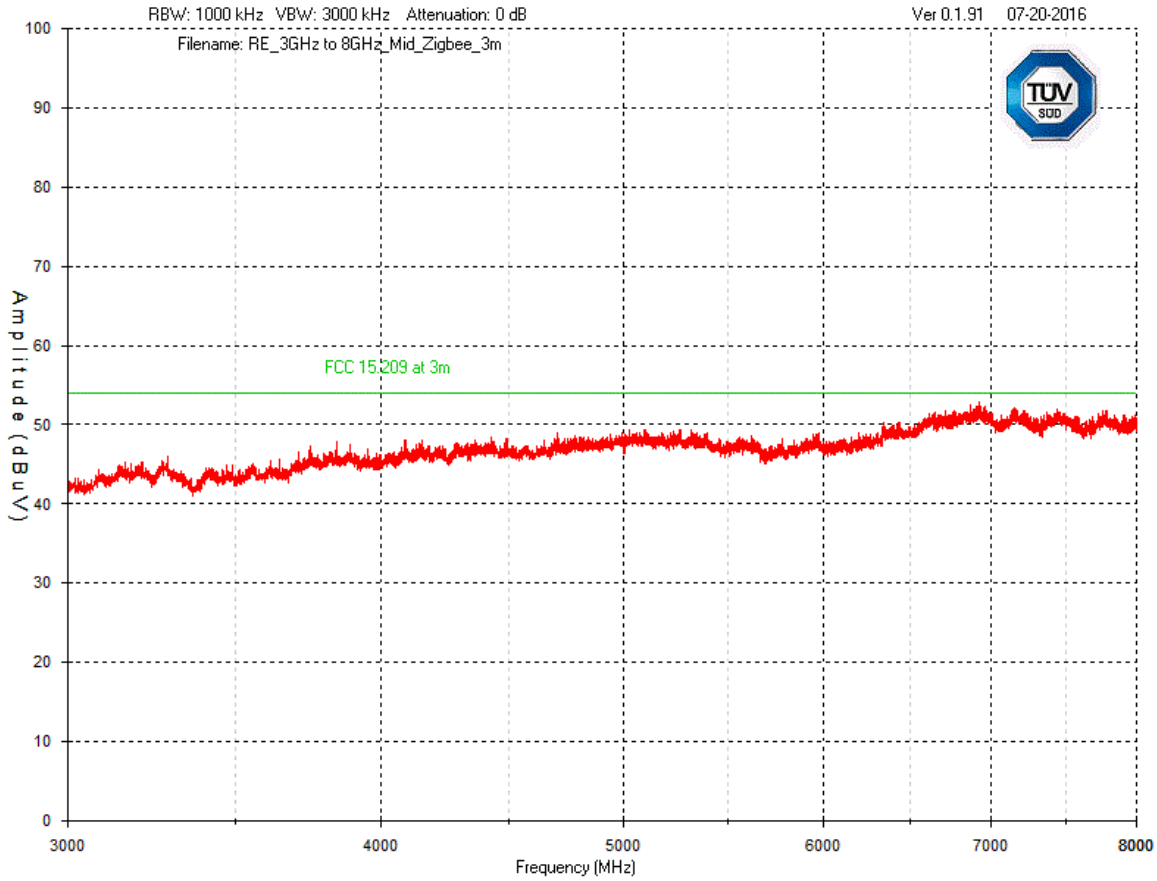
Vertical – Peak Emissions Graph – 1GHz to 2 GHz (Worst case)



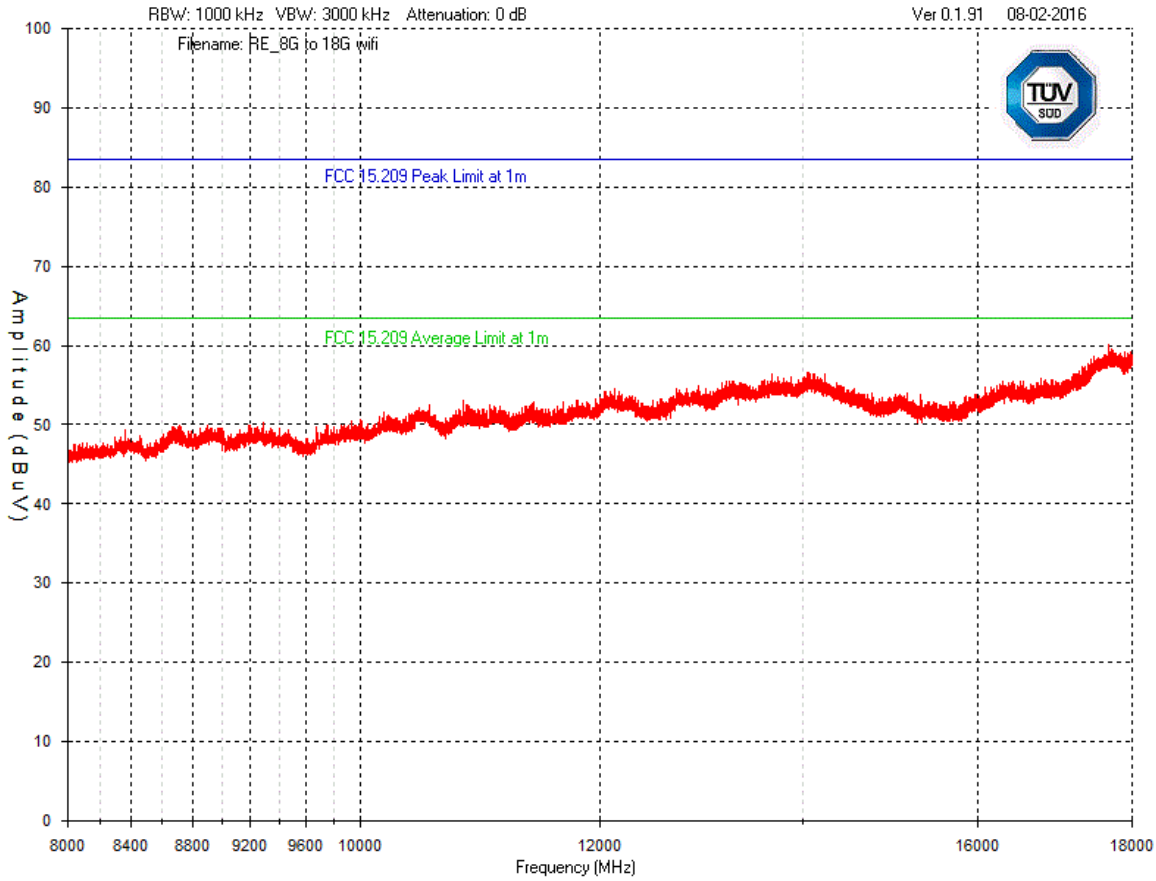
Vertical – Peak Emissions Graph –2 – 3 GHz – Low



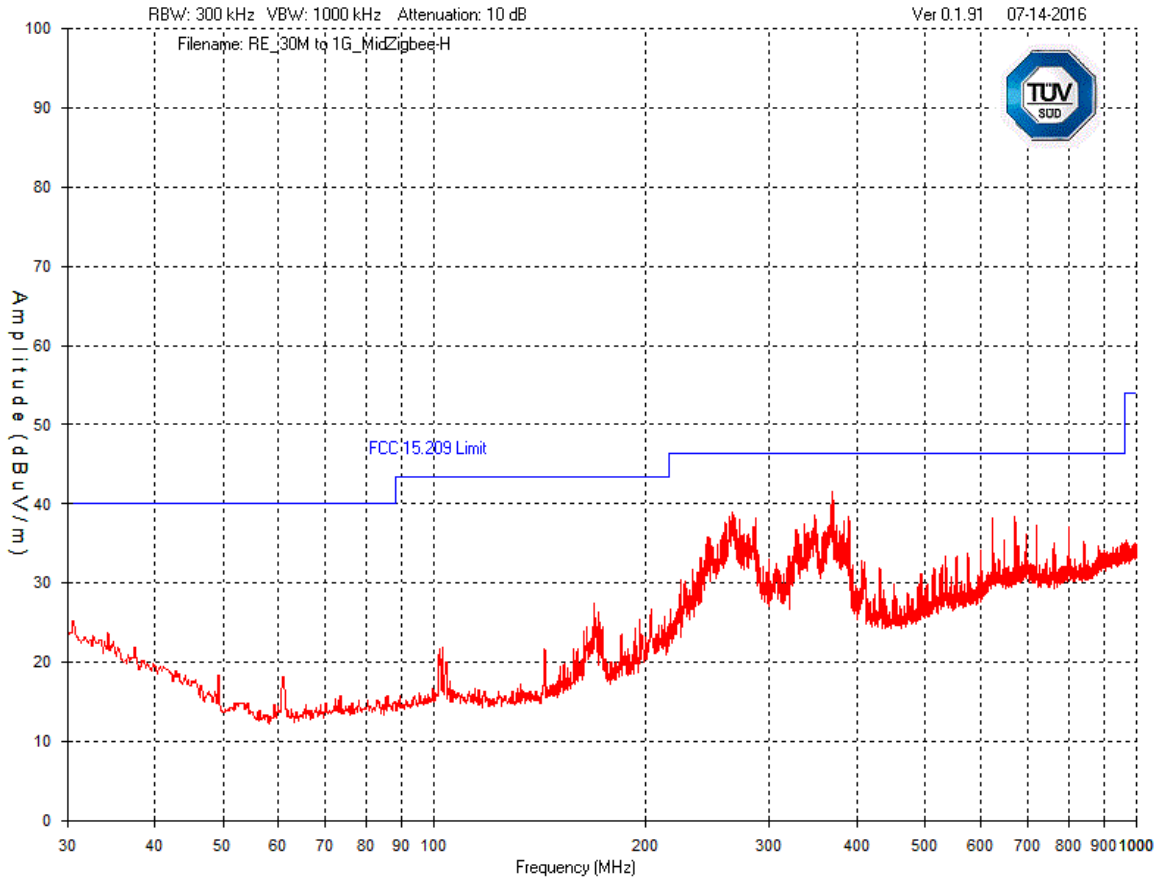
Vertical – Peak Emissions Graph –3 GHz to 8 GHz



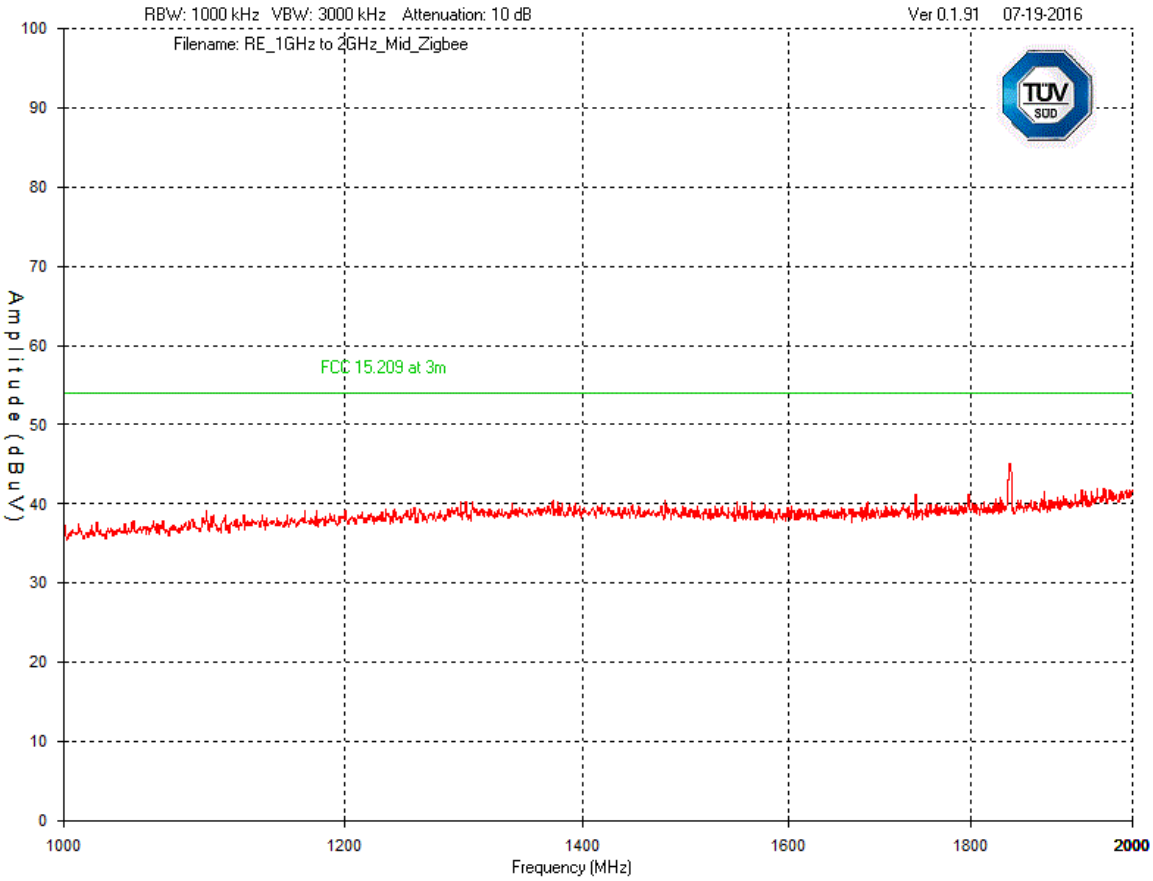
Vertical – Peak Emissions Graph –8 GHz to 18 GHz



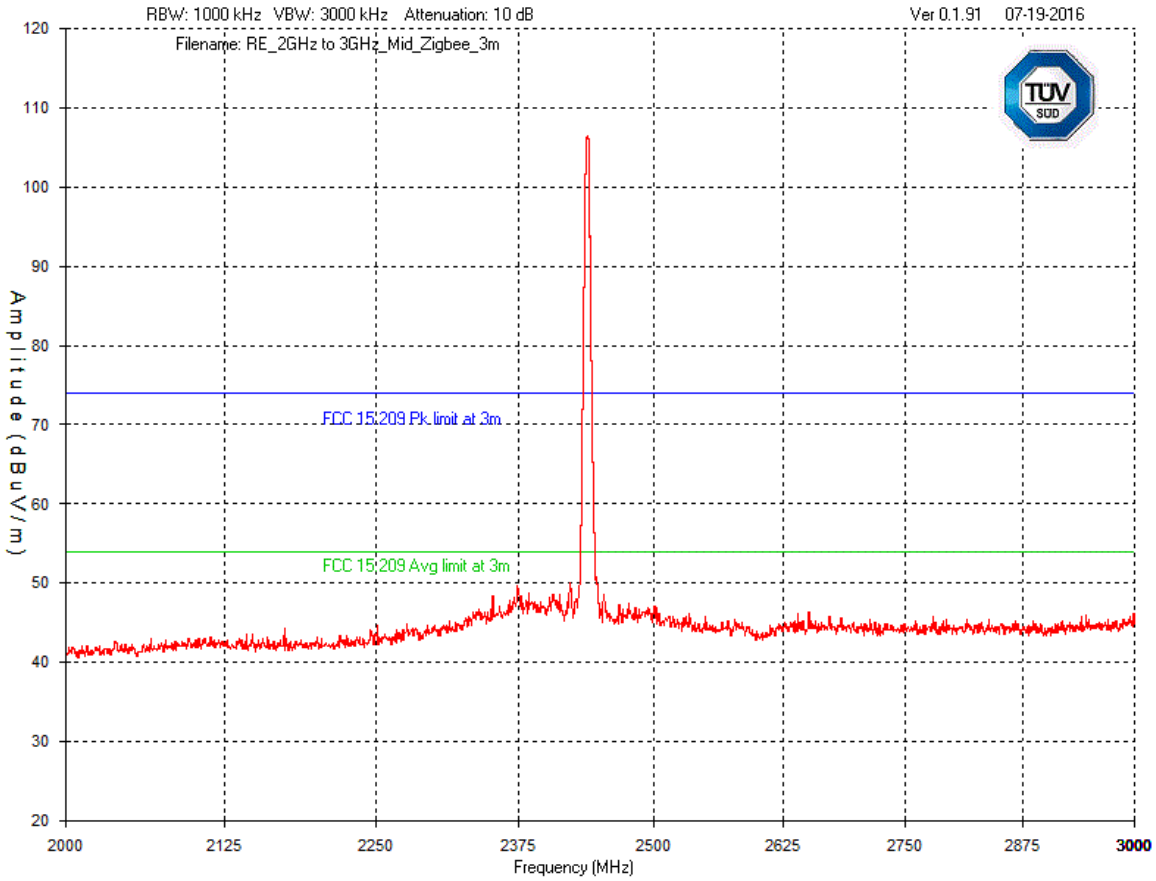
Horizontal – Peak Emissions Graph – 30MHz to 1GHz (Worst case)



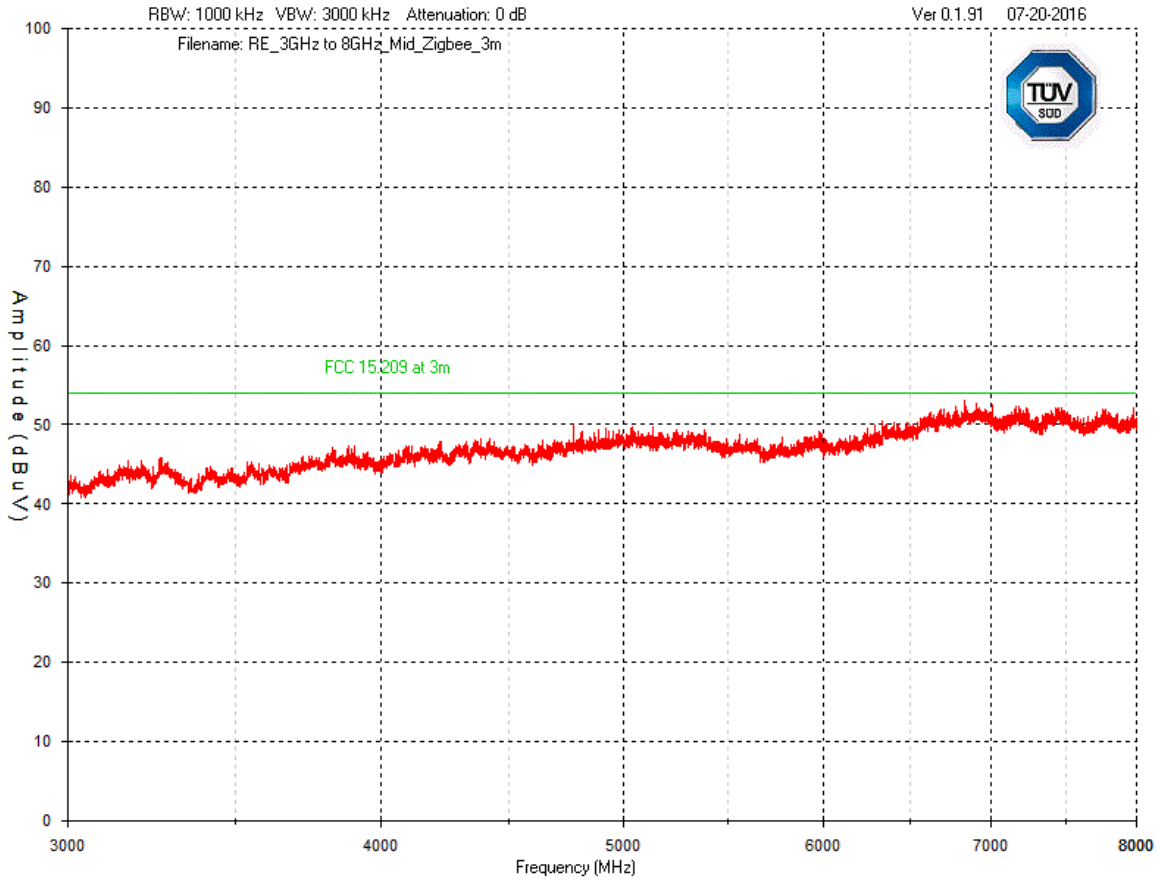
Horizontal – Peak Emissions Graph – 1GHz to 2 GHz (Worst Case)



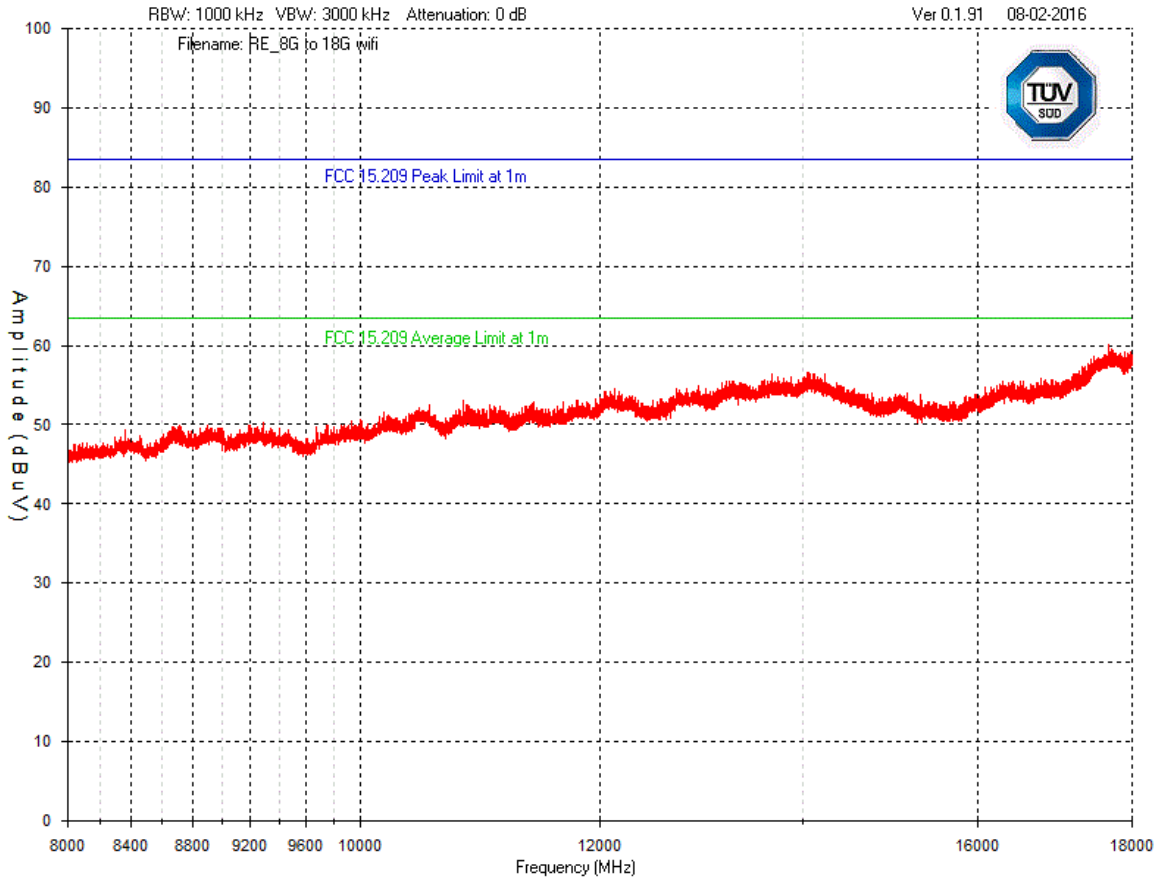
Horizontal – Peak Emissions Graph –2 – 3 GHz – Worst Case



Horizontal – Peak Emissions Graph –3 GHz to 8 GHz



Horizontal – Peak Emissions Graph –8 GHz to 18 GHz



Note: Spurious was investigated at low, middle and high channel and the worst case spurious emissions is presented

Final Measurements

Note: In accordance with 15.247(d), only radiated emissions exceeding the 15.209 limit that occur within the bands listed in 15.205, need to be verified with a quasi-peak detector or an average detector as applicable.

Radiated Emissions Measurements

Test Frequency (MHz)	Detection mode (Q-Peak)	Antenna polarity (Horz/Vert)	Raw signal dB(µV)	Antenna factor dB	Cable loss dB + Preselector	Attenuator dB	Pre-Amp Gain dB	Received signal dB(µV/m)	Emission limit dB(µV/m)	Margin dB(µV)	Result
Low Channel 11											
2405	Peak	Horz	105.9	30.6	5.2	0.0	33.0	108.7			PASS
2405	PEAK 3	Horz	106.8	30.6	5.2	0.0	33.0	109.6			PASS
2405	Peak	Vert	102.9	30.6	5.2	0.0	33.0	105.7			PASS
2405	PEAK 3	Vert	103.9	30.6	5.2	0.0	33.0	106.7			PASS
2405	Avg	Horz	104.7	30.6	5.2	0.0	33.0	107.5			PASS
2405	Avg	Vert	101.6	30.6	5.2	0.0	33.0	104.4			PASS
2390	Peak	Horz	46.1	30.6	5.2	0.0	33.0	48.9	74.0	25.1	PASS
2390	Avg	Horz	35.1	30.6	5.2	0.0	33.0	37.9	54.0	16.1	PASS
2390	Peak	Vert	45.1	30.6	5.2	0.0	33.0	47.9	74.0	26.1	PASS
2390	Avg	Vert	33.3	30.6	5.2	0.0	33.0	36.1	54.0	17.9	PASS
2400	Peak	Horz	60.9	30.6	5.2	0.0	33.0	63.7	88.7	25.0	PASS
2400	Avg	Horz	50.1	30.6	5.2	0.0	33.0	52.9	87.5	34.6	PASS
2400	Peak	Vert	58.1	30.6	5.2	0.0	33.0	60.9	85.7	24.8	PASS
2400	Avg	Vert	47.1	30.6	5.2	0.0	33.0	49.9	84.4	34.5	PASS
4810	Peak	Horz	41.3	33.7	2.9	0.0	35.7	42.2	74.0	31.8	PASS
4810	Avg	Horz	29.7	33.7	2.9	0.0	35.7	30.6	54.0	23.4	PASS
4810	Peak	Vert	41.7	33.7	2.9	0.0	35.7	42.6	74.0	31.4	PASS
4810	Avg	Vert	29.8	33.7	2.9	0.0	35.7	30.7	54.0	23.3	PASS
7215	Peak	Vert	45.3	37.9	4.3	0.0	35.9	51.6	74.0	22.4	PASS
7215	Avg	Vert	33.3	37.9	4.3	0.0	35.9	39.6	54.0	14.4	PASS
7215	Peak	Horz	44.9	37.9	4.3	0.0	35.9	51.2	74.0	22.8	PASS
7215	Avg	Horz	33.3	37.9	4.3	0.0	35.9	39.6	54.0	14.4	PASS
9620	Peak	Horz		39.2	5.8	0.0	35.9		74.0		PASS
9620	Avg	Horz		39.2	5.8	0.0	35.9		74.0		PASS
9620	Peak	Vert		39.2	5.8	0.0	35.9		74.0		PASS
9620	Avg	Vert		39.2	5.8	0.0	35.9		54.0		PASS
Mid channel 18											
2440	Peak	Horz	105.5	30.6	5.2	0.0	33.0	108.3			PASS

2440	Avg	Horz	102.1	30.6	5.2	0.0	33.0	104.9			PASS
2440	Peak	Vert	102.5	30.6	5.2	0.0	33.0	105.3			PASS
2440	Avg	Vert	99.1	30.6	5.2	0.0	33.0	101.9			PASS
4880	Peak	Horz	42.7	33.7	2.9	0.0	35.7	43.6	74.0	30.4	PASS
4880	Avg	Horz	29.9	33.7	2.9	0.0	35.7	30.8	54.0	23.2	PASS
4880	Peak	Vert	42.2	33.7	2.9	0.0	35.7	43.1	74.0	30.9	PASS
4880	Avg	Vert	30.1	33.7	2.9	0.0	35.7	31.0	54.0	23.0	PASS
7320	Peak	Vert	45.6	37.9	4.3	0.0	35.9	51.9	74.0	22.1	PASS
7320	Avg	Vert	32.9	37.9	4.3	0.0	35.9	39.2	54.0	14.8	PASS
7320	Peak	Horz	44.5	37.9	4.3	0.0	35.9	50.8	74.0	23.2	PASS
7320	Avg	Horz	32.9	37.9	4.3	0.0	35.9	39.2	54.0	14.8	PASS
High channel 25											
2475	Peak	Horz	104.5	30.6	5.2	0.0	33.0	107.3			PASS
2475	Peak3	Horz	105.4	30.6	5.2	0.0	33.0	108.2			PASS
2475	Avg	Horz	103.3	30.6	5.2	0.0	33.0	106.1			PASS
2475	Peak	Vert	102.4	30.6	5.2	0.0	33.0	105.2			PASS
2475	Peak3	Vert	103.4	30.6	5.2	0.0	33.0	106.2			PASS
2475	Avg	Vert	101.2	30.6	5.2	0.0	33.0	104.0			PASS
2483.5	Peak	Horz	47.7	30.6	5.2	0.0	33.0	50.5	74.0	23.5	PASS
2483.5	Avg	Horz	37.8	30.6	5.2	0.0	33.0	40.6	54.0	13.4	PASS
2483.5	Peak	Vert	46.3	30.6	5.2	0.0	33.0	49.1	74.0	24.9	PASS
2483.5	Avg	Vert	36.3	30.6	5.2	0.0	33.0	39.1	54.0	14.9	PASS

Spurious Emission Reading Table below – Horizontal

Frequency (MHz)	Det. mode	Raw (dBuV)	Ant. (dB/m)	Att. (dB)	Cab. (dB)	Amp (dB)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Pass/ Fail
359.8	QP	40.4	15.6	3	1.8	-28.6	32.2	46.4	14.2	Pass
379.879	QP	42.5	16	3	1.8	-28.6	34.7	46.4	11.7	Pass
317.799	QP	41.7	14.3	3	1.7	-28.6	32.1	46.4	14.3	Pass
369.403	QP	45.2	15.7	3	1.8	-28.7	37.0	46.4	9.4	Pass
389.385	QP	51.1	16.5	3	1.9	-28.7	43.8	46.4	2.6	Pass

Spurious Emission Reading Table – Vertical

Frequency (MHz)	Det. mode	Raw (dBuV)	Ant. (dB/m)	Att. (dB)	Cab. (dB)	Amp (dB)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Pass/ Fail
407.91	QP	40.3	17	3	1.9	-28.7	33.5	46.4	12.9	Pass
380.073	QP	39.2	16	3	1.8	-28.6	31.4	46.4	15.0	Pass
359.121	QP	40.5	15.6	3	1.8	-28.6	32.3	46.4	14.1	Pass
277.059	QP	30.5	13.2	3	1.7	-28.6	19.8	46.4	26.6	Pass

Note: No emissions above the 3rd harmonic were detected. In case the peak emissions exceeding the average limits, average detector emission measurements were made to ensure compliance.

Note: During the tests, EUT was operating in a continuous transmit in which it is transmitting at a 100% duty cycle.

Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration Date[1]	Next Calibration Date[1]	Asset #
Spectrum Analyzer Display	8566B	HP	1-28-15	1-28-17	4168
Spectrum Analyzer	8566B	HP	1-28-15	1-28-17	4169
Quasi Peak Adapter	85650A	HP	1-28-15	1-28-17	4170
Horn Antenna	ATH1G18G	AR	4-23-15	4-23-17	4003
Biconical Antenna	EM-6913	Electro-Metrics	4/28/15	4/28/17	4060
Log Periodic Antenna	LPA-25	Electro-Metrics	4/14/15	4/14/17	4087
Attenuator 3 dB	FP-50-3	Trilithic	1-28-15	1-28-17	4028
1-26.5GHz preamp	8449B	Agilent	9-9-14	9-9-16	6351
RF Cable 10m	LMR-400-10M-50OHM-MN-MN	LexTec	1-28-15	1-28-17	4025
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	1-28-15	1-28-17	4026
Emission software	0.1.87	TUV SUD Canada	1-28-15	1-28-17	58

1: For cables and attenuators, verification dates apply.

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 C63.4.

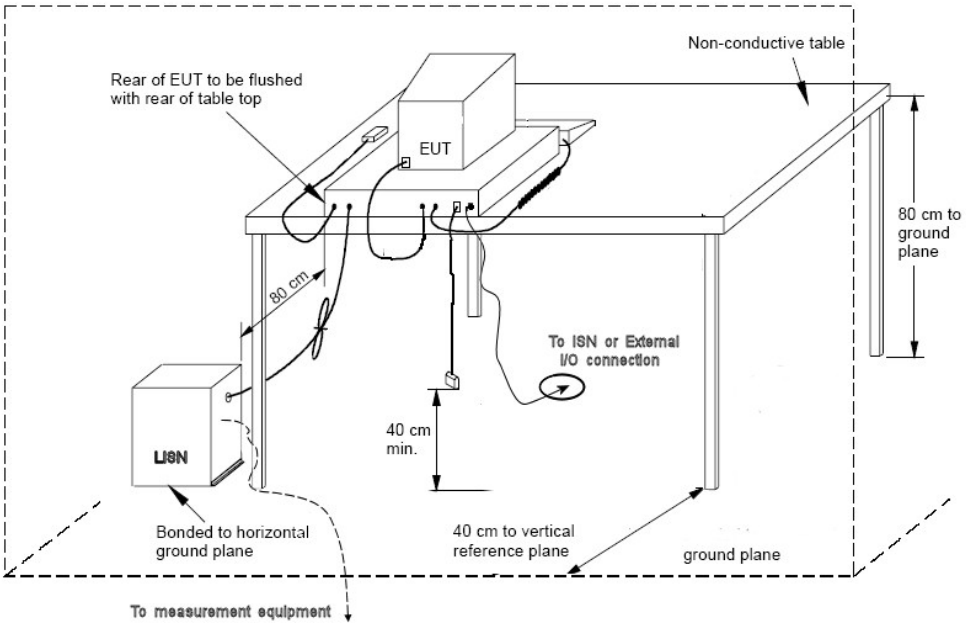
Average Limits		QuasiPeak Limits	
150 kHz – 500 kHz	56 to 46 dBuV	150 kHz – 500 kHz	66 to 56 dBuV
500 kHz – 5 MHz	46 dBuV	500 kHz – 5 MHz	56 dBuV
5 MHz – 30 MHz	50 dBuV	500 kHz – 30 MHz	60 dBuV

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



Note: The vertical reference plane is optional as per ANSI C63.4 section 5.2.2

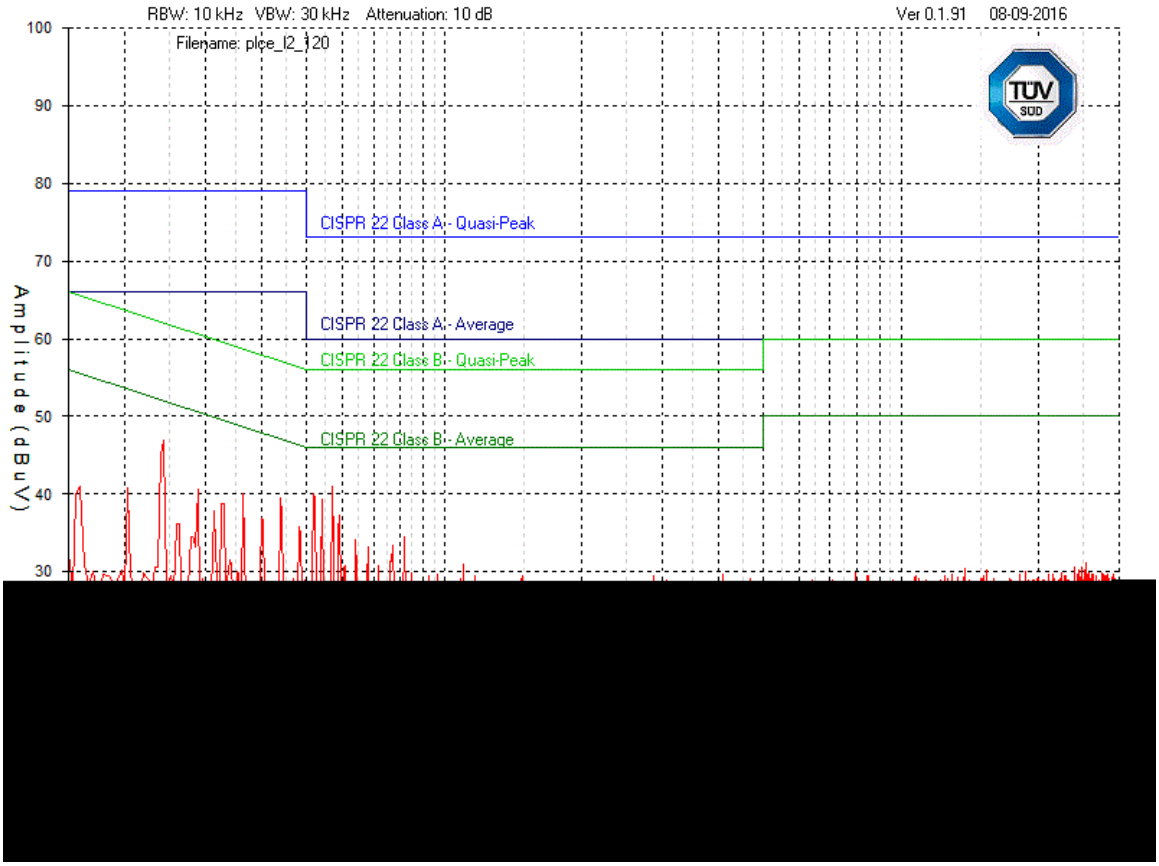
Measurement Uncertainty

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.

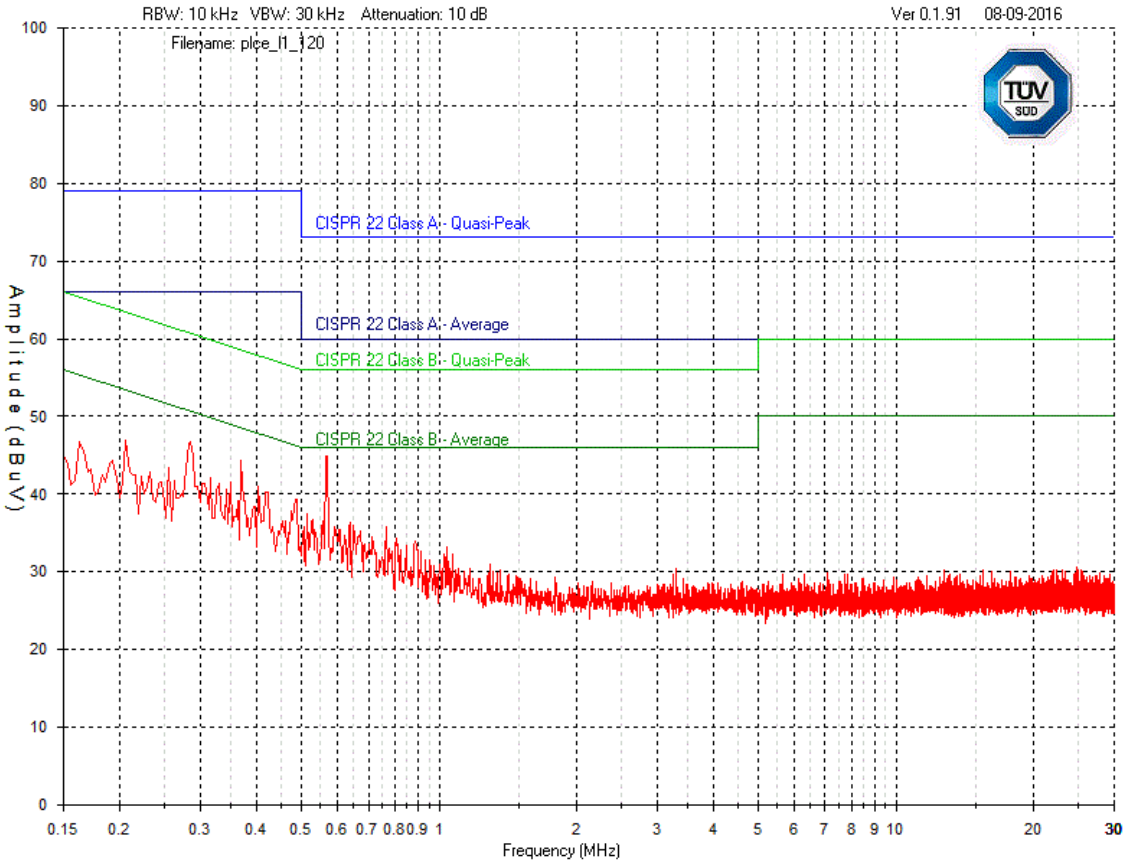
Preliminary Graphs

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.

Phase (Black/Brown)



Neutral (White/Blue)



Final Measurements

Peak readings VS. Average Emissions reading table – Line 1

Frequency (MHz)	Raw (dBuV)	Atten Factor (dB)	LISN Factor (dB)	Cable (dB)	Level (dBuV)	Limit (dB)	Margin (dB)	Pass/Fail
0.5679	30.7	10	0	0.2	40.9	46	5.1	Pass
0.2429	36.1	10	0	0.8	46.9	52	5.1	Pass
0.5182	29.8	10	0	0.2	40	46	6	Pass
0.5414	29.1	10	0	0.2	39.3	46	6.7	Pass
0.4386	29.3	10	0	0.2	39.5	47.1	7.6	Pass
0.3623	29.8	10	0	0.3	40.1	48.7	8.6	Pass

Peak readings Vs. Average Emissions reading table – Line 2

Frequency (MHz)	Raw (dBuV)	Atten Factor (dB)	LISN Factor (dB)	Cable (dB)	Level (dBuV)	Limit (dB)	Margin (dB)	Pass/Fail
0.5679	34.7	10	0	0.2	44.9	46	1.1	Pass
0.286	36.2	10	0	0.6	46.8	50.6	3.8	Pass
0.3689	34	10	0	0.3	44.3	48.5	4.2	Pass
0.2064	36	10	0	1	47	53.3	6.3	Pass
0.4883	29.2	10	0	0.2	39.4	46.2	6.8	Pass
0.4021	30.8	10	0	0.2	41	47.8	6.8	Pass

Note: See ‘Appendix B – EUT & Test Setup Photographs’ for photos showing the test set-up for the highest line conducted emission

Test Equipment List Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset#
HP Spectrum Analyzer	8566B	HP	1-28-15	1-28-17	4169
Spectrum Analyzer Display	8566B	HP	1-28-15	1-28-17	4168
Quasi Peak Adapter	85650A	HP	1-28-15	1-28-17	4170
LISN	FCC-LISN-50/250-16-2-01	FCC	3-20-15	3-20-17	4005
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	1-28-15	1-28-17	4025
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	1-28-15	1-28-17	4026
Attenuator 10 dB	FP-50-10	Trilithic	1-28-15	1-28-17	4027

1: For cables and attenuators, verification dates apply.

Spurious Conducted Emissions

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 or 30 dB if maximum power measurement is performed as a RMS average over a time interval. Spurious Conducted emissions are to be evaluated up to the 10^{th} harmonic. This -20 dBc or -30 dBc requirement also applies at the 'band edge' or 2.4 GHz and 2.4835 GHz.

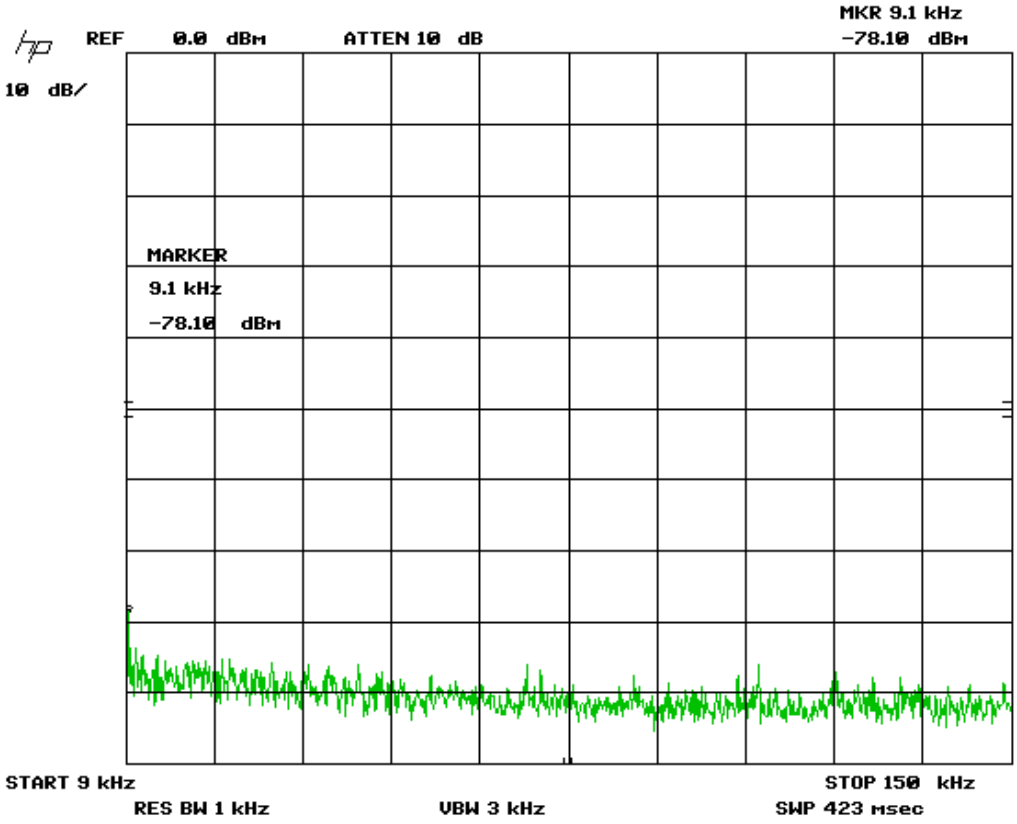
Results

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

Graph(s)

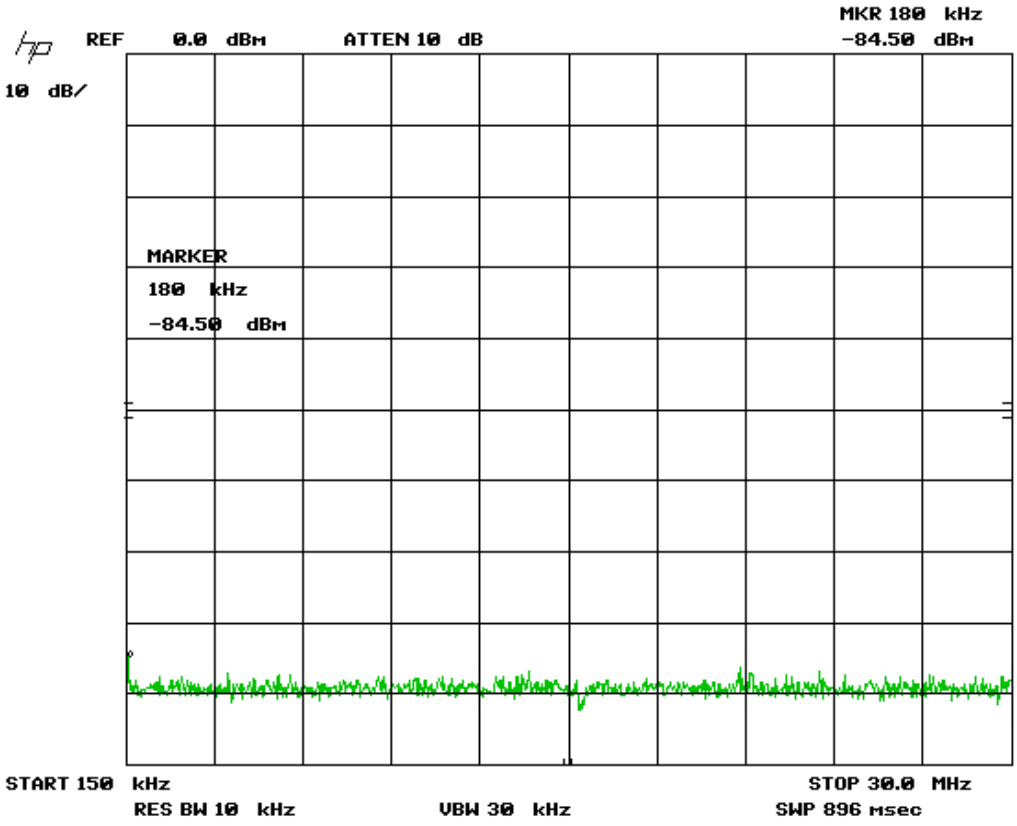
The graphs shown below shows the peak power output of the device during the antenna conducted measurement during transmit operation of the EUT. Note there was 10 dB of external attenuation and cable loss taken during this measurement.

9 kHz to 150 kHz (worst case)

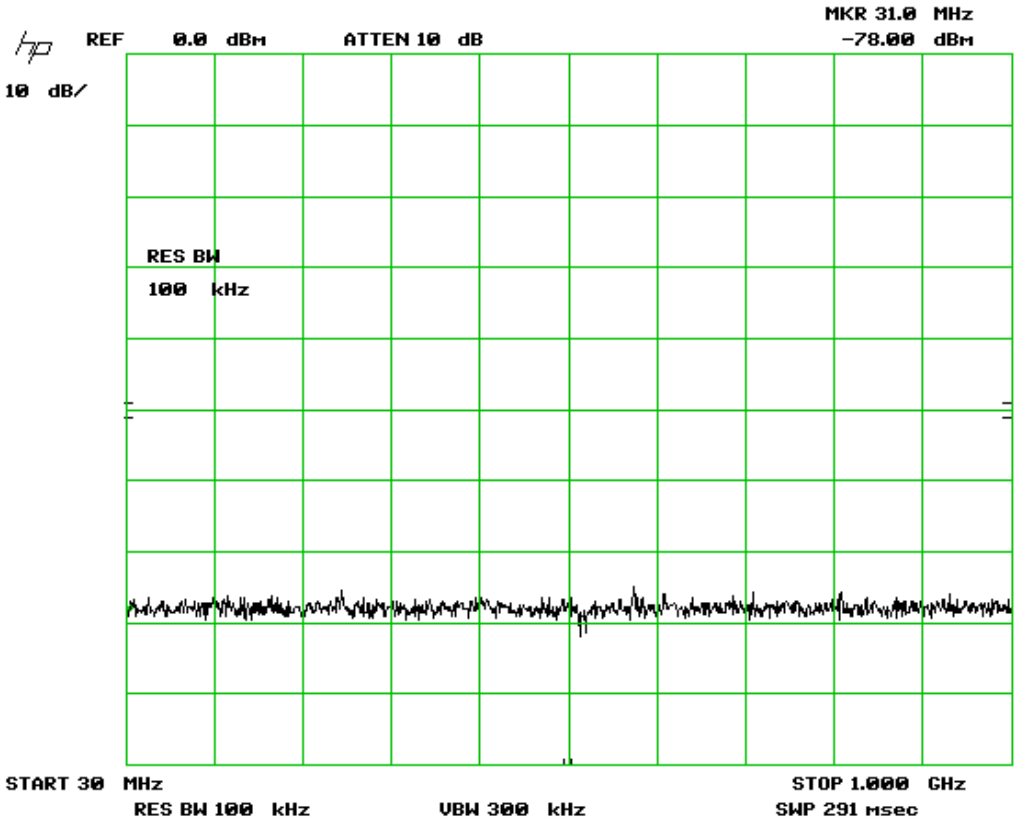


)

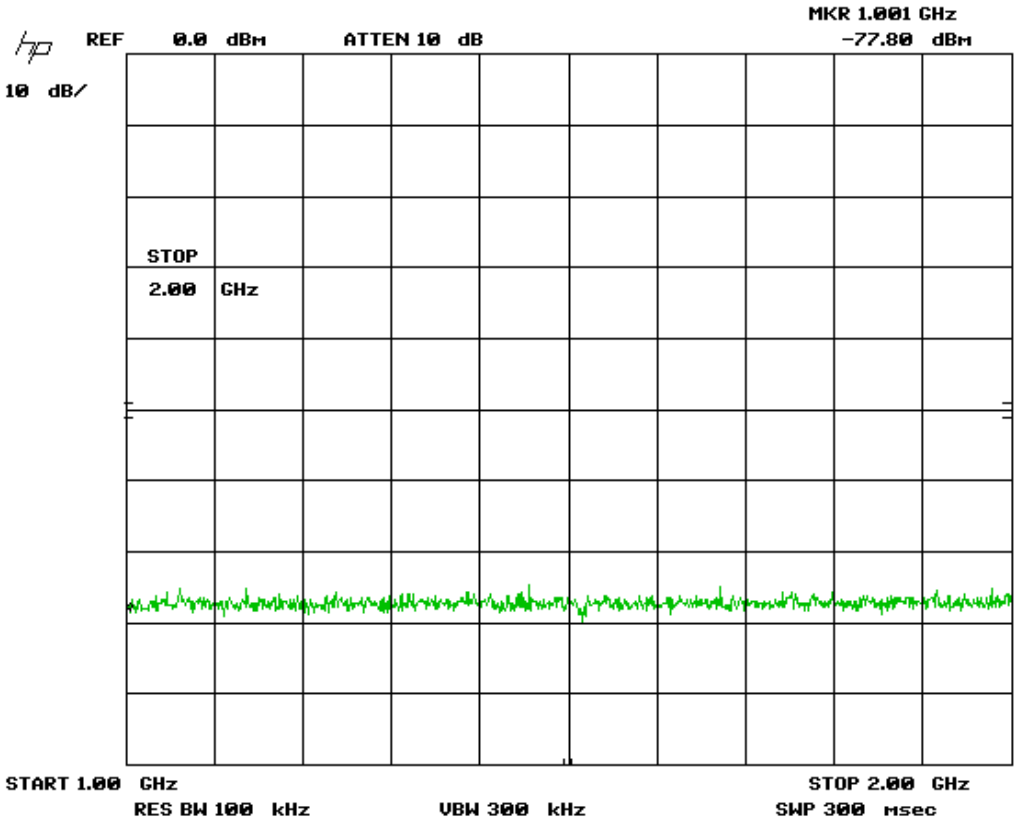
150 kHz to 30 MHz (worst case)



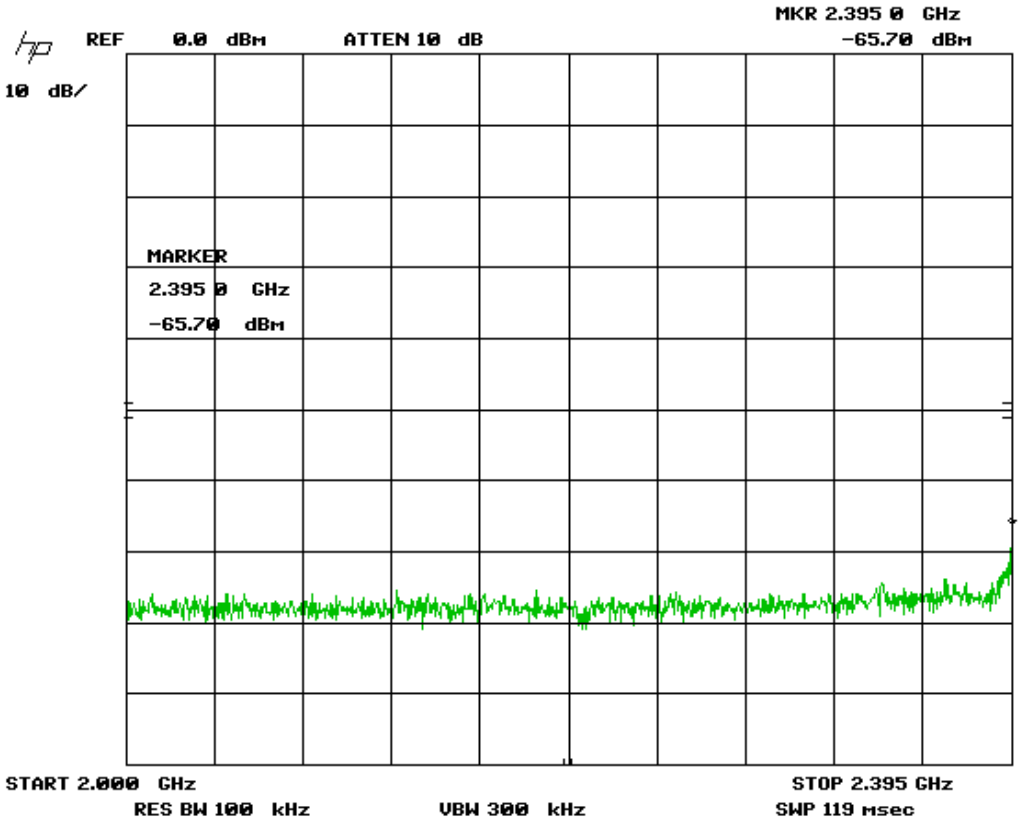
30 MHz to 1 GHz (worst case)



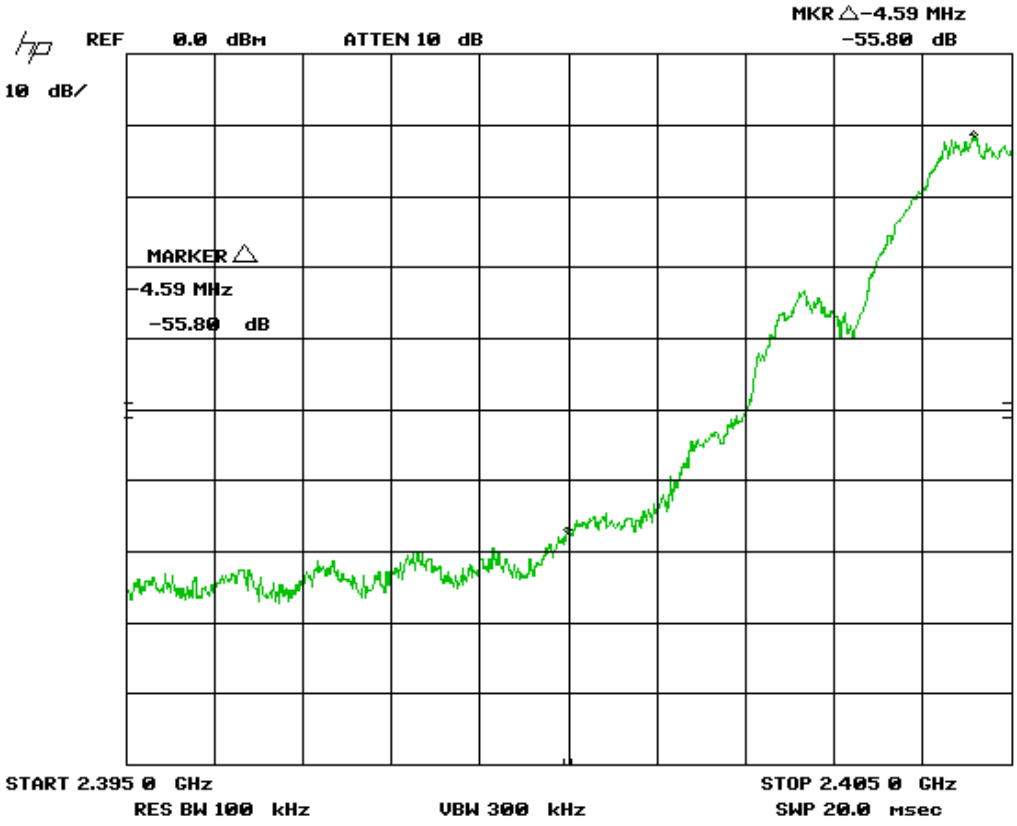
1G to 2 GHz (Worst case)



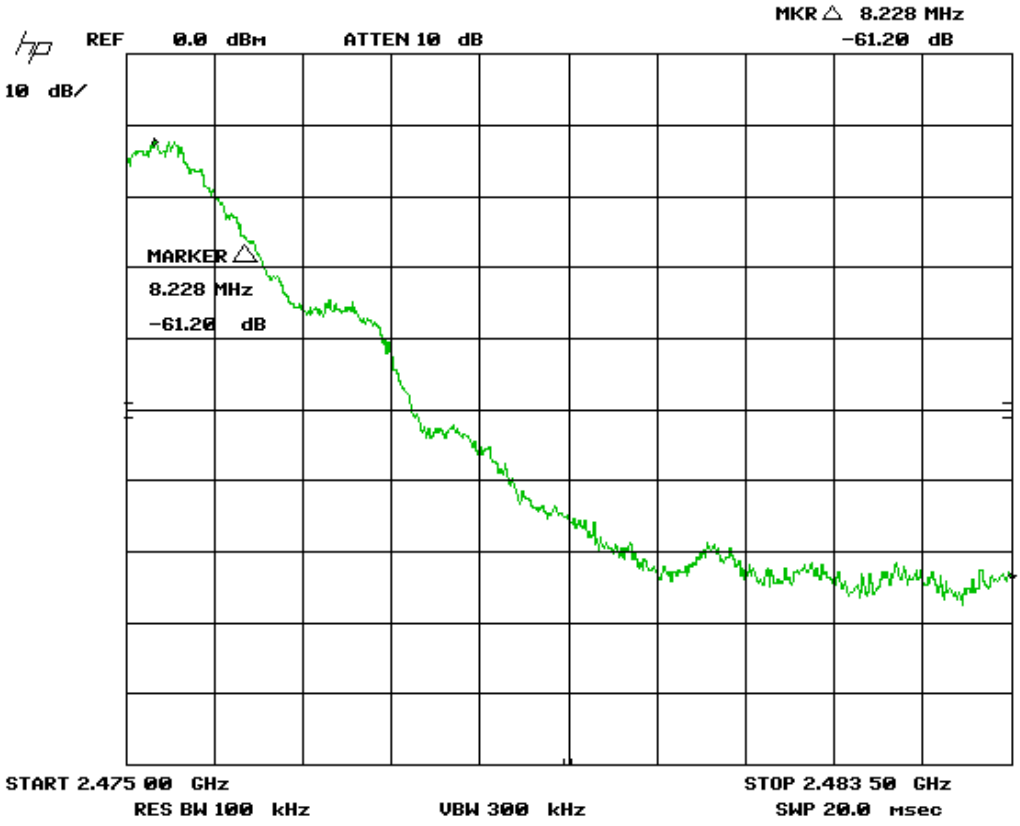
2GHz to 2.4 GHz (Worst case)



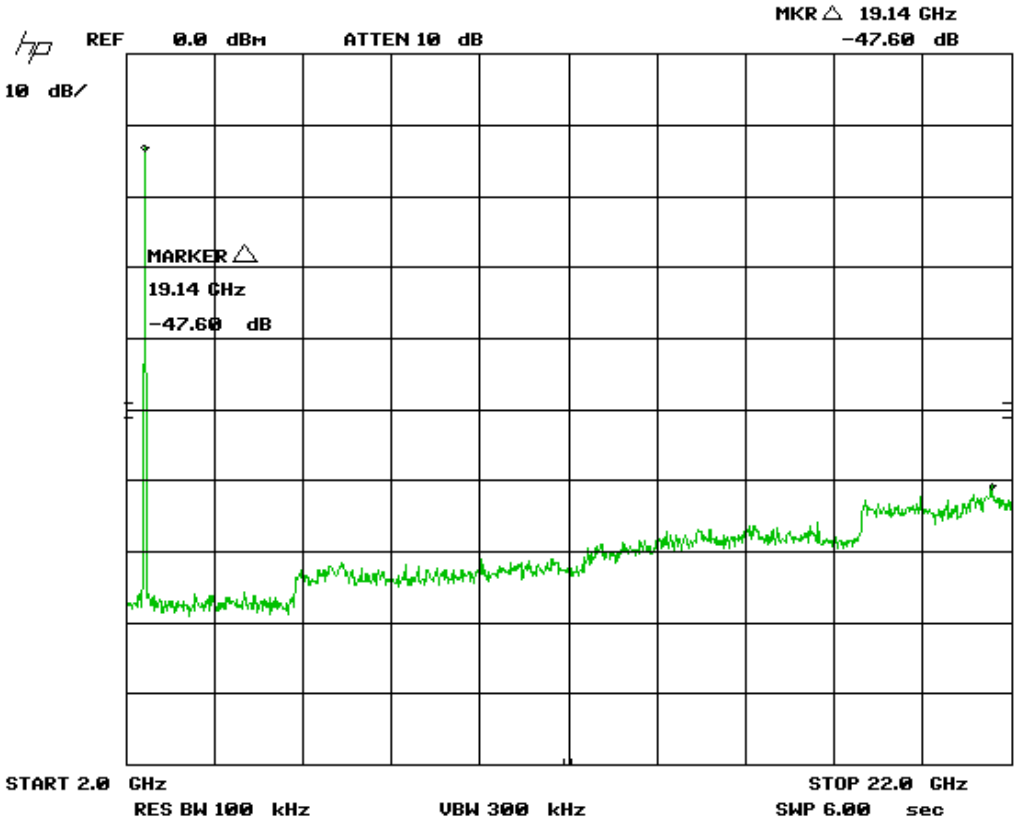
2.4GHz band edge (low)



2.4835 GHz band edge (High)



2GHz to 22 GHz



Note 1: This was additionally scanned to 25 GHz, and no emissions were observed. The noise floor was below -30 dBc.

Note 2: 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 #
Spectrum Analyzer Display	8566B	HP	1-28-15	1-28-17	4168
Spectrum Analyzer	8566B	HP	1-28-15	1-28-17	4169
Quasi Peak Adapter	85650A	HP	1-28-15	1-28-17	4170
Attenuator 10 dB	FP-50-10	Trilithic	1-28-15	1-28-17	4027

1: For cables and attenuators, verification dates apply.

Maximum Conducted (Peak) Output Power

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 excessive power level.

Limits

The limits are defined in FCC Part 15.247(b) and RSS 247.
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.

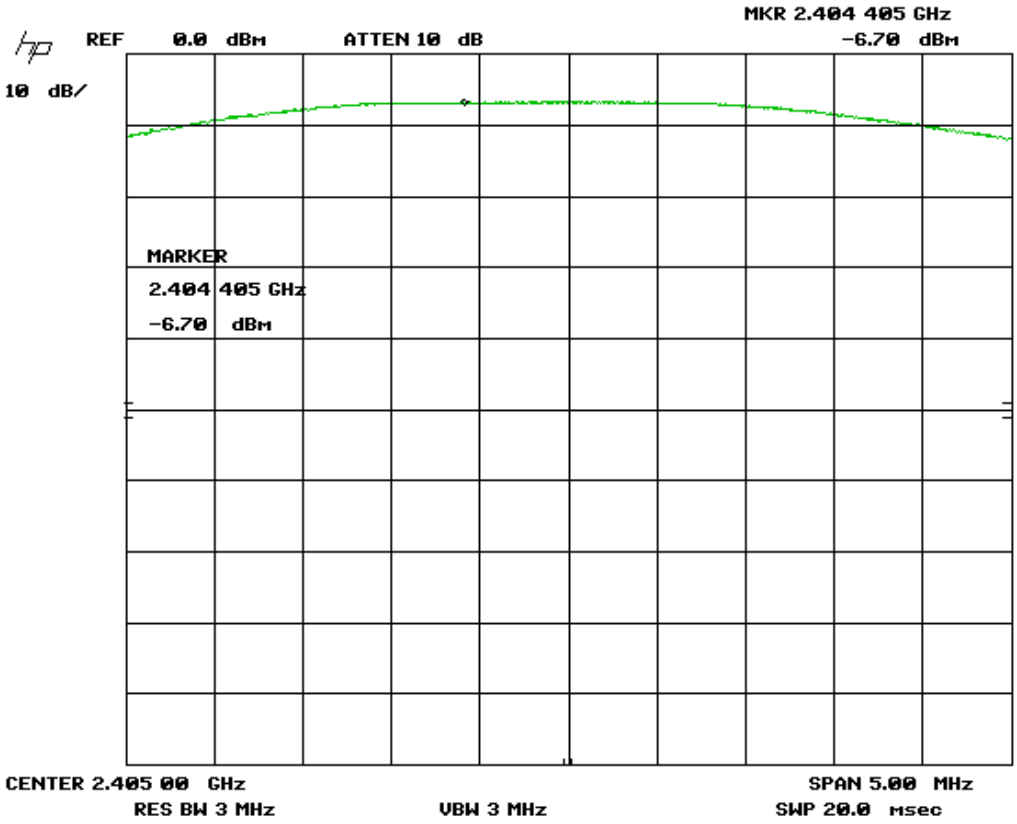
Results

The EUT passed. Method used was as per ANSI C63.10 Section 11.9.1.1. The peak power measured was 13.3 dBm.

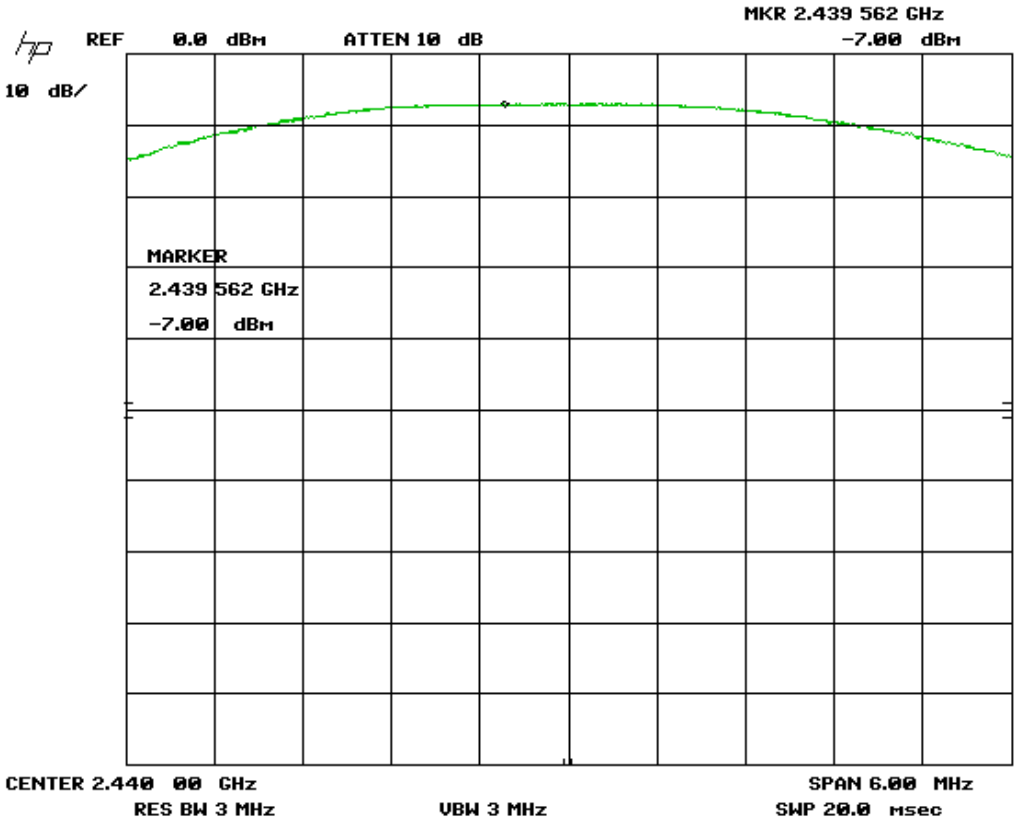
Graph(s)

The graphs shown below shows the peak power output of the device during the antenna conducted measurement during transmit operation of the EUT. Note there was 10 dB of external attenuation taken during this measurement and 1 dB of cable loss.

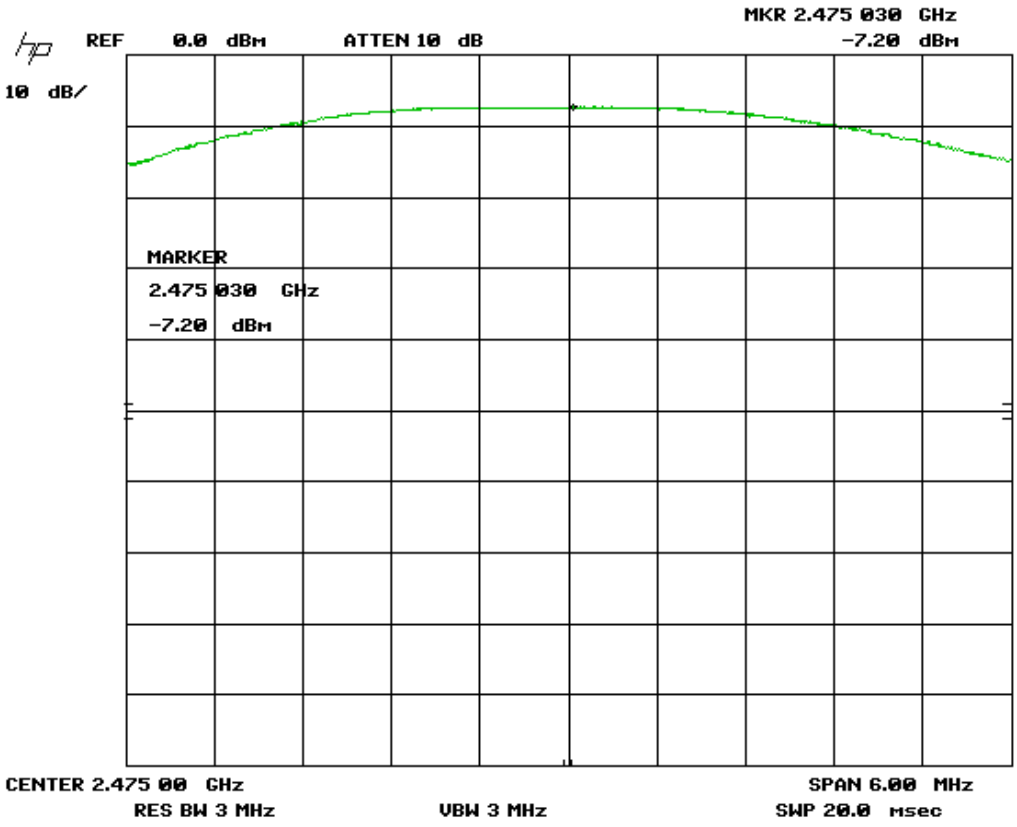
Low Channel



Mid Channel



High Channel



Table(s)

The tables shown below shows the peak power output of the device during the antenna conducted measurement during transmit operation of the EUT. Note there was 20 dB of external attenuation taken during this measurement.
Power in dBm

	Power
Low	13.3
Middle	13.0
Hi	12.8

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 #
Spectrum Analyzer Display	8566B	HP	1-28-15	1-28-17	4168
Spectrum Analyzer	8566B	HP	1-28-15	1-28-17	4169
Quasi Peak Adapter	85650A	HP	1-28-15	1-28-17	4170
Attenuator 10 dB	FP-50-10	Trilithic	1-28-15	1-28-17	4027

1: For cables and attenuators, verification dates apply.

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 247.

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 6 dB BW measured was 8.79 MHz minimal, this meets the requirement of being greater than 500 kHz. For information purposes, the 99 % OBW BW was measured to be 17.59 MHz

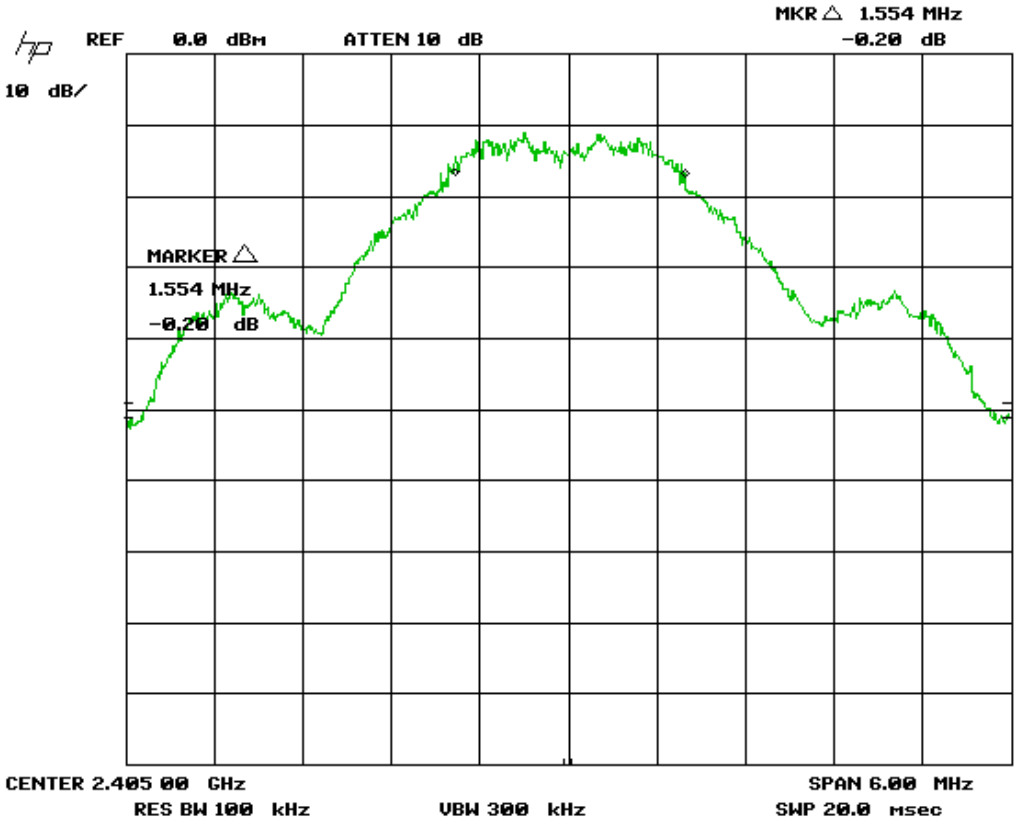
Measured Bandwidths listed MHz.

	6 MHz	OBW
Low	1.554	2.886
Middle	1.608	2.910
Hi	1.644	2.946

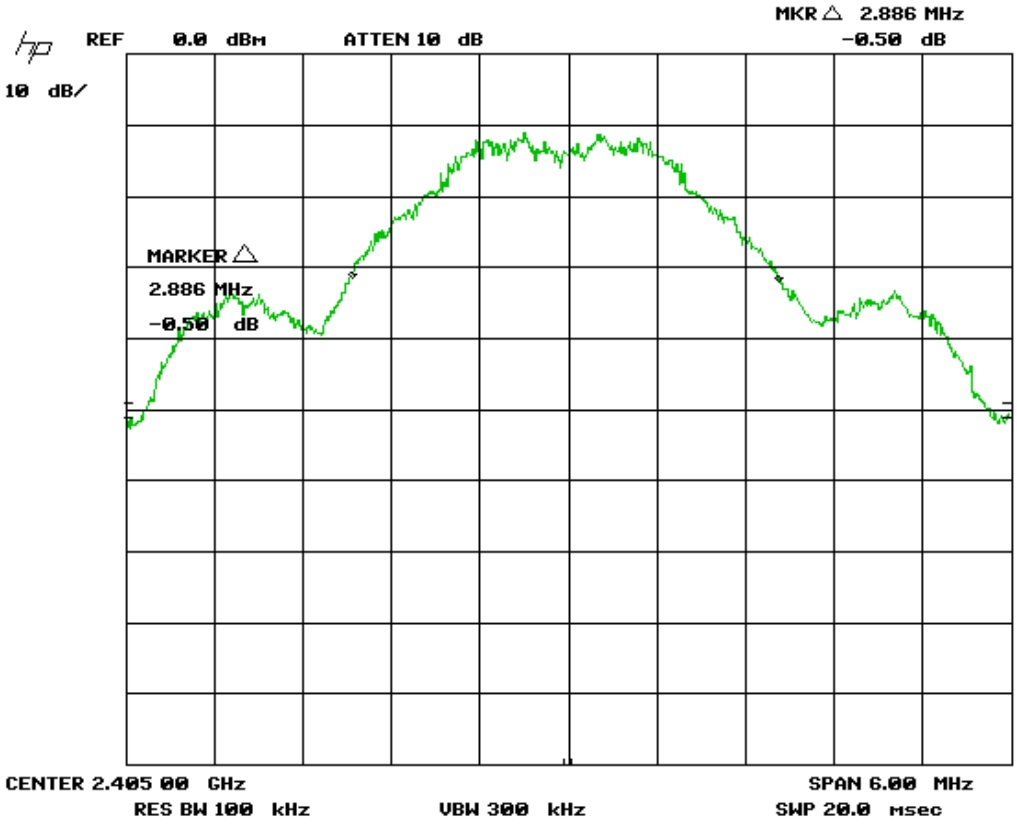
Graph(s)

The graphs shown below shows the channel spacing 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 than 1 minute.

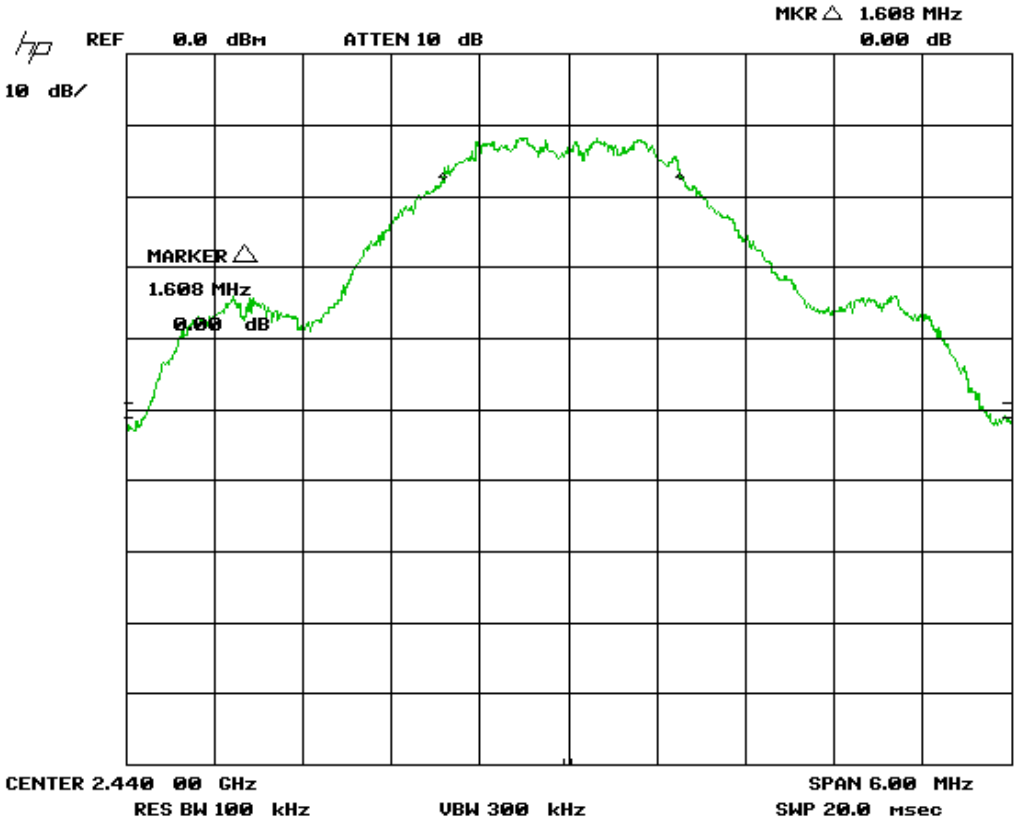
Low Channel – 6 dB bandwidth



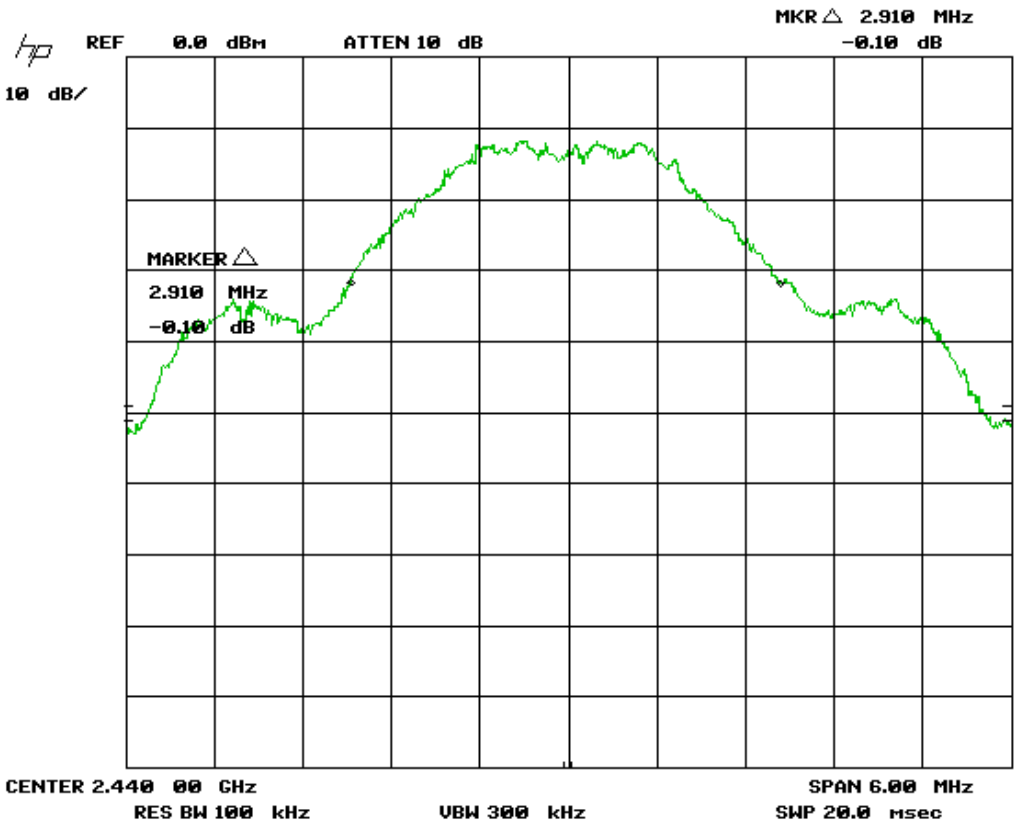
Low Channel –Occupied bandwidth



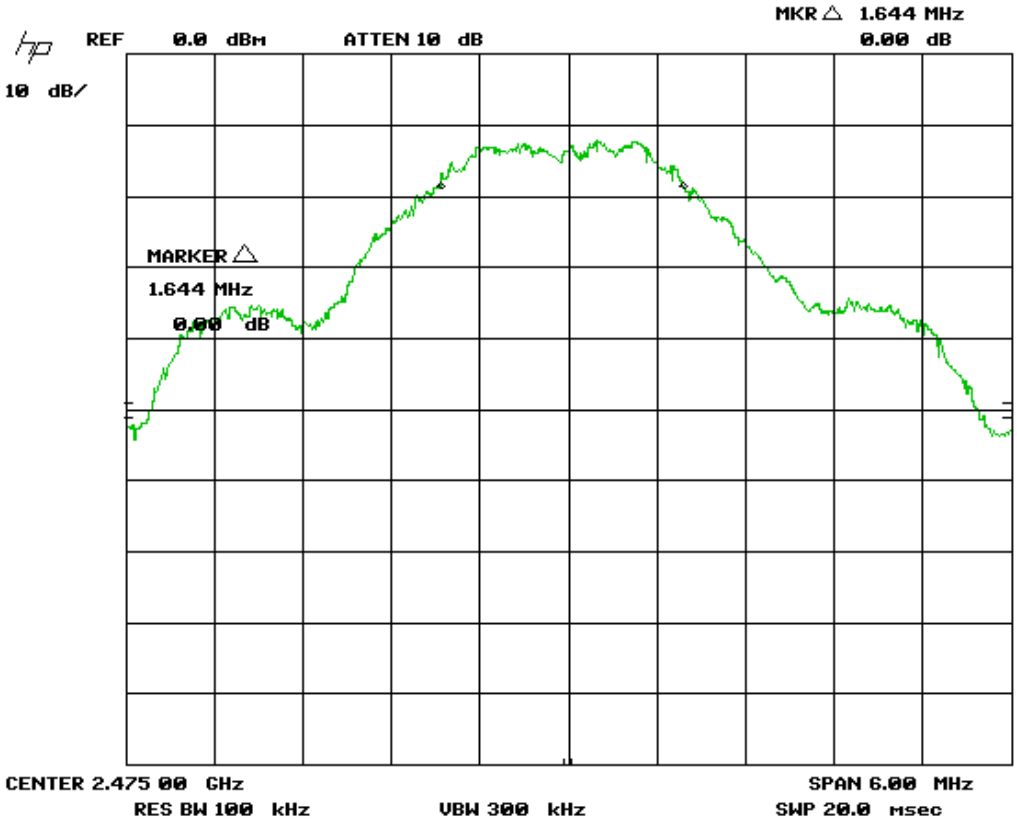
Mid Channel – 6 dB bandwidth



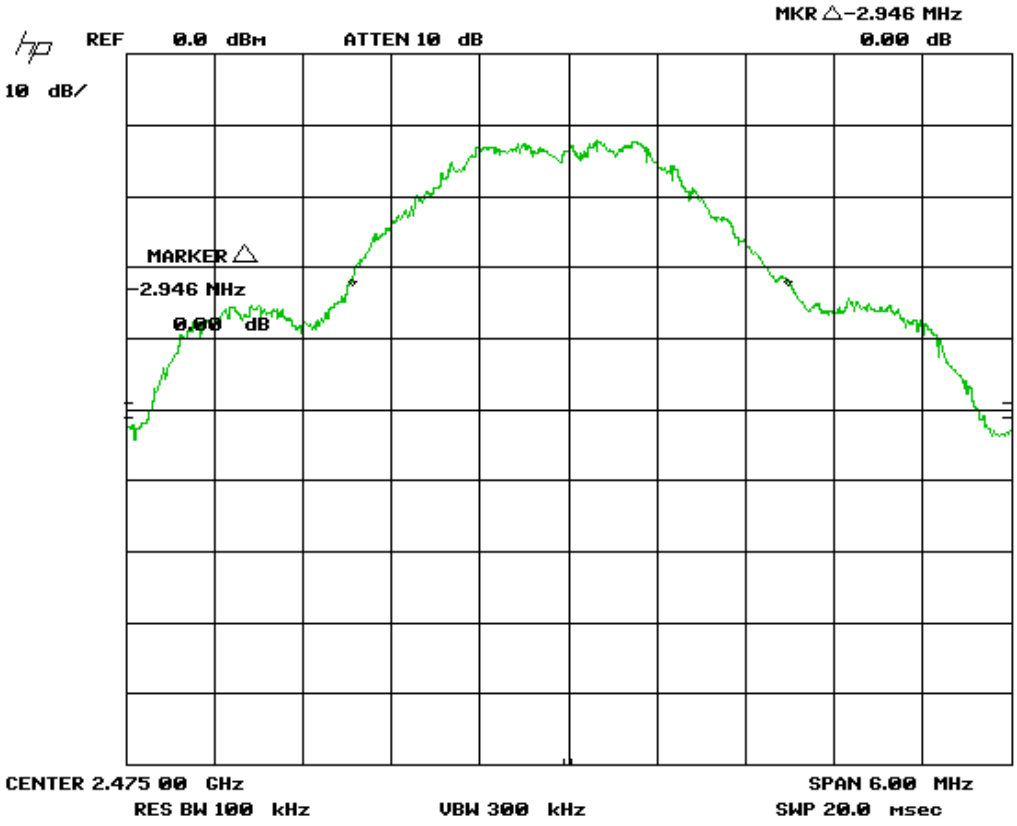
Mid Channel – Occupied Bandwidth



High Channel – 6dB



High Channel –occupied bandwidth



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 #
Spectrum Analyzer Display	8566B	HP	1-28-15	1-28-17	4168
Spectrum Analyzer	8566B	HP	1-28-15	1-28-17	4169
Quasi Peak Adapter	85650A	HP	1-28-15	1-28-17	4170
Attenuator 10 dB	FP-50-10	Trilithic	1-28-15	1-28-17	4027

1: For cables and attenuators, verification dates apply.

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. Each mode was tested at low, medium, and high band as per ANSI C 63.10 Section 11.10.2

The worst case value is as measured with a 100 kHz resolution bandwidth (RMS power).

Note there was 20 dB of external attenuation taken during this measurement.

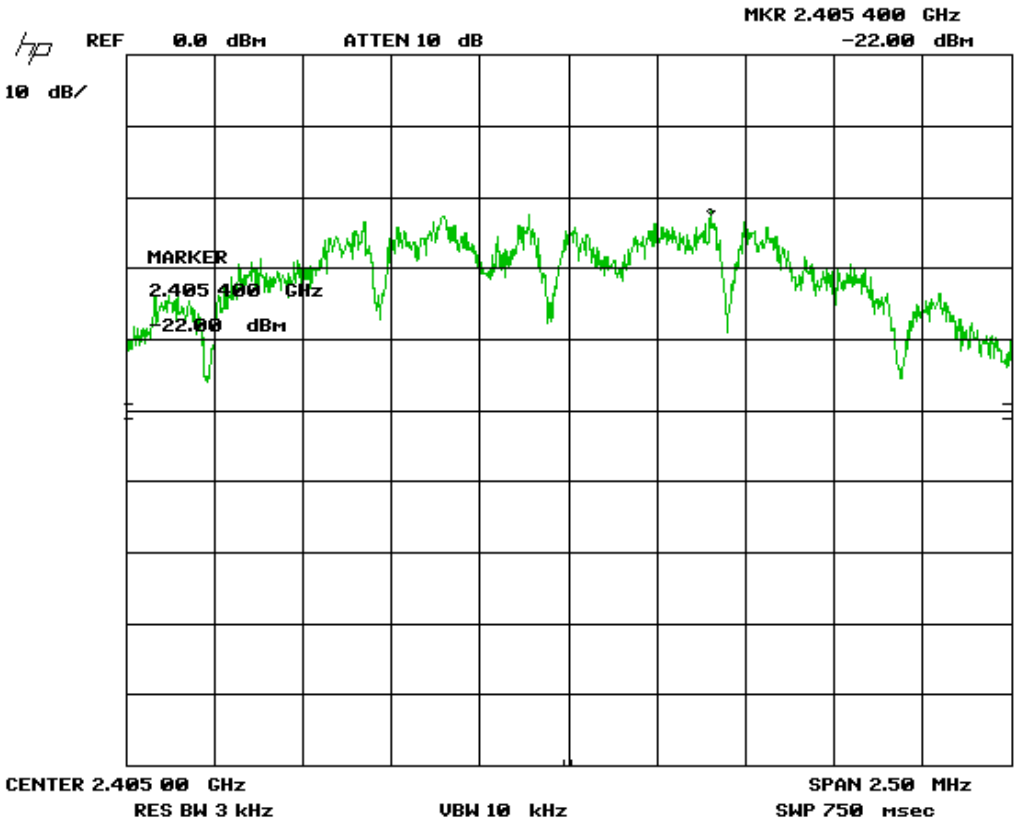
PSD in dBm

	RBW -3 kHz - dBm
Low	-2.0
Middle	-2.5
High	-2.8

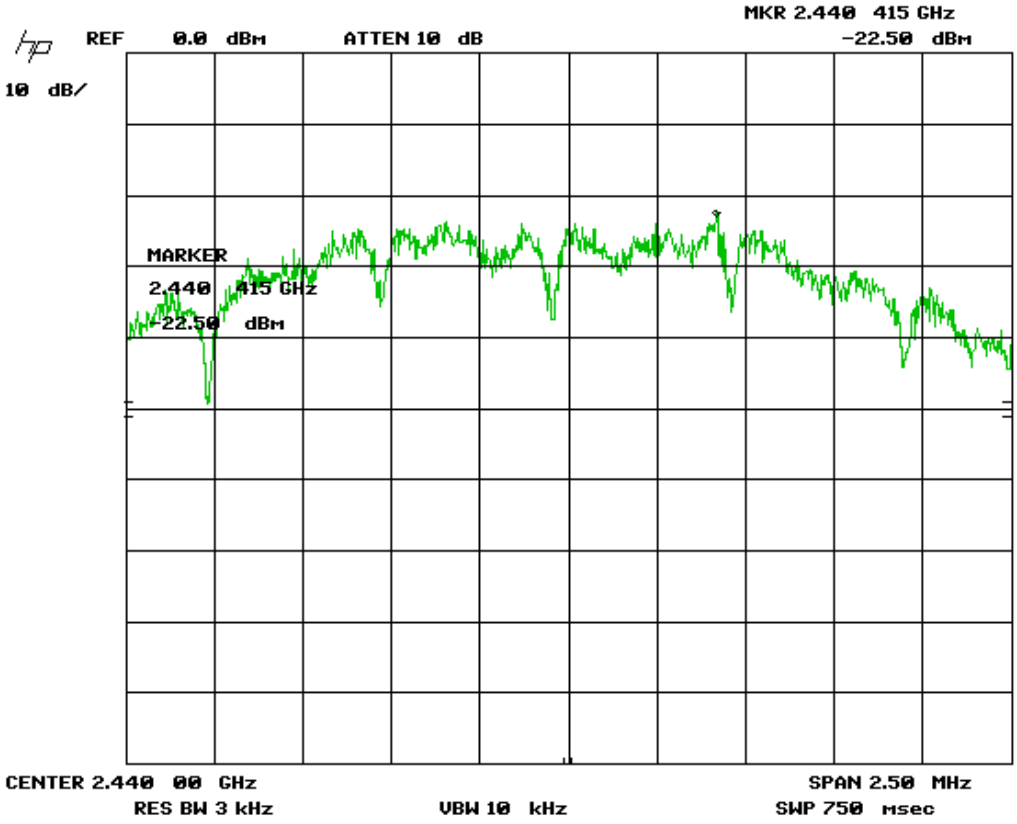
Graph(s)

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.

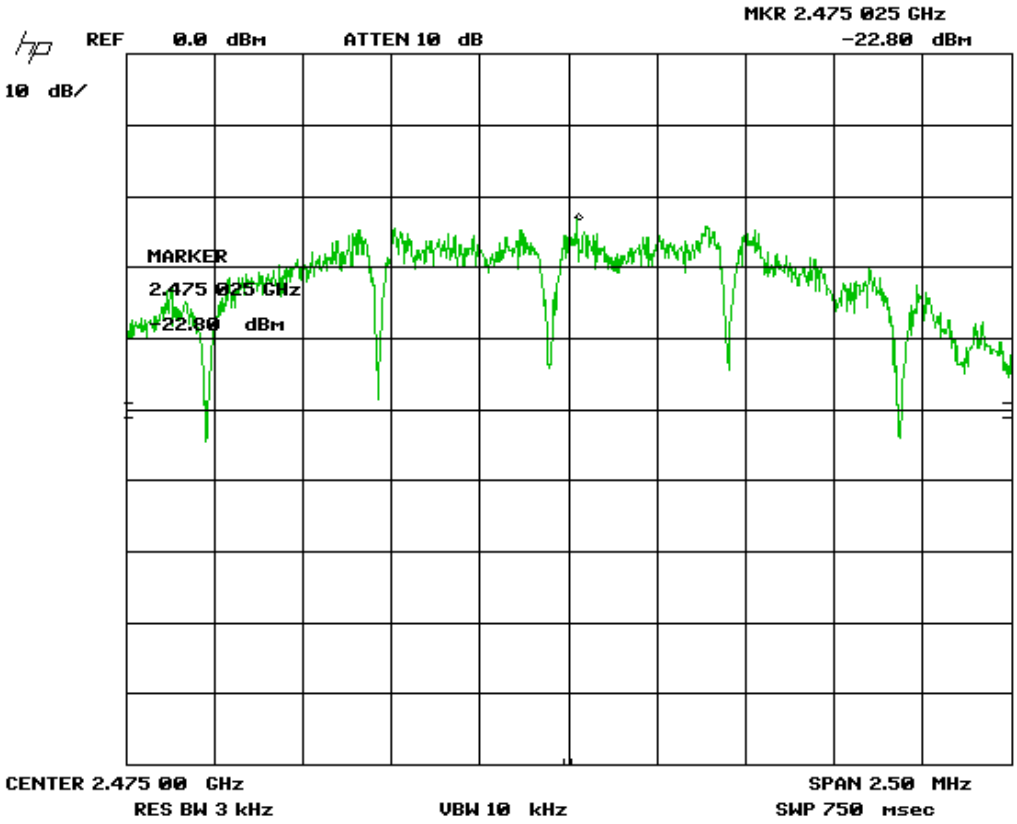
Low Channel



Mid Channel



High Channel



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 #
Spectrum Analyzer Display	8566B	HP	1-28-15	1-28-17	4168
Spectrum Analyzer	8566B	HP	1-28-15	1-28-17	4169
Quasi Peak Adapter	85650A	HP	1-28-15	1-28-17	4170
Attenuator 10 dB	FP-50-10	Trilithic	1-28-15	1-28-17	4027

1: For cables and attenuators, verification dates apply.

Appendix A – EUT Summary

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

General EUT Description

Client Details	
Organization / Address	Viconics Technologies Inc 9245 Langelier Blvd.
Contact	Emmanuel Stathopoulos
Phone	514-321-5660
Email	emmanuel.stathopoulos@schneider-electric.com

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'

EUT Functional Description

Wifi module.

EUT Configuration

Please see Appendix B for a picture of the unit running in normal conditions and labels. Configuration and firmware settings are as per client's instruction.

Operational Setup

These devices are required to be attached to the EUT for its normal operation.

- Control laptop, . The EUT was configured as client's instruction. .

Modifications for Compliance

The following modifications were made during testing for the sample to achieve compliance with the testing requirements:

None.

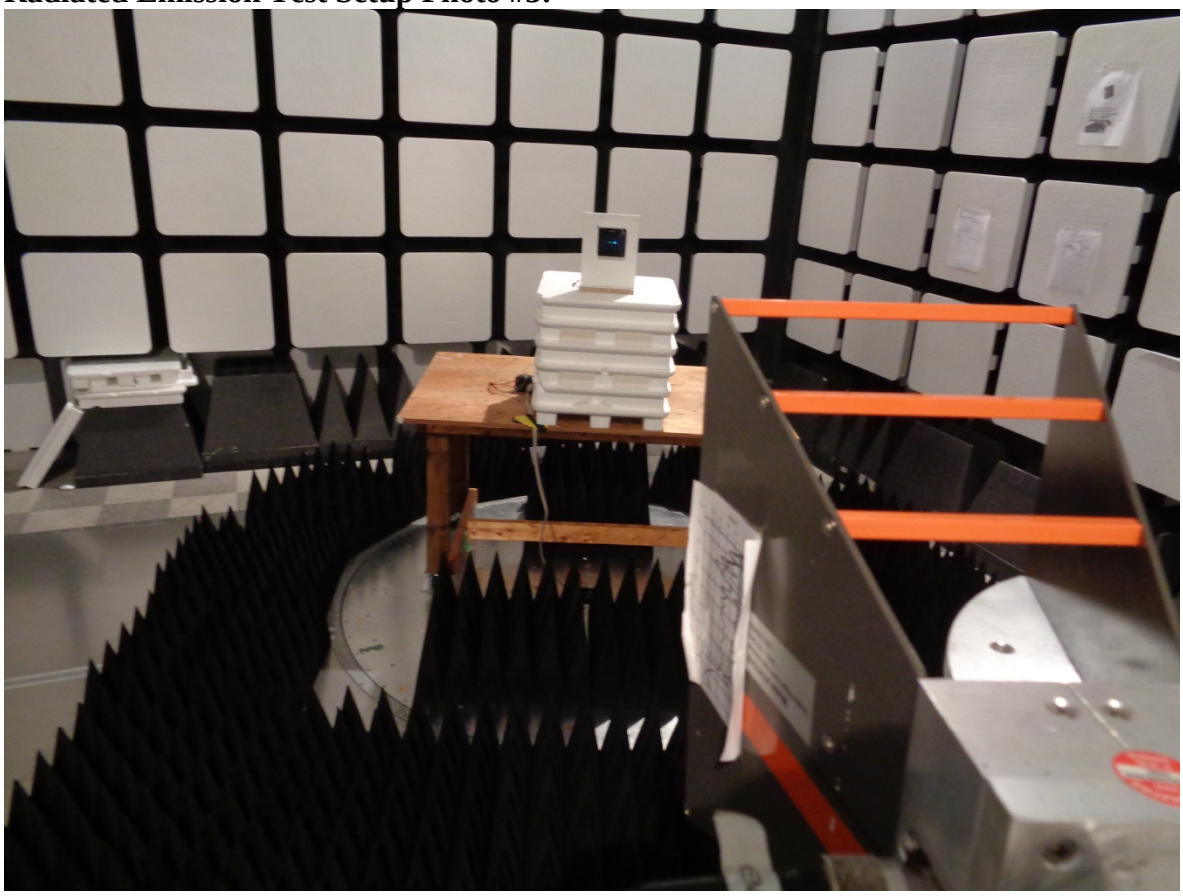
Appendix B – EUT and Test Setup Photographs

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

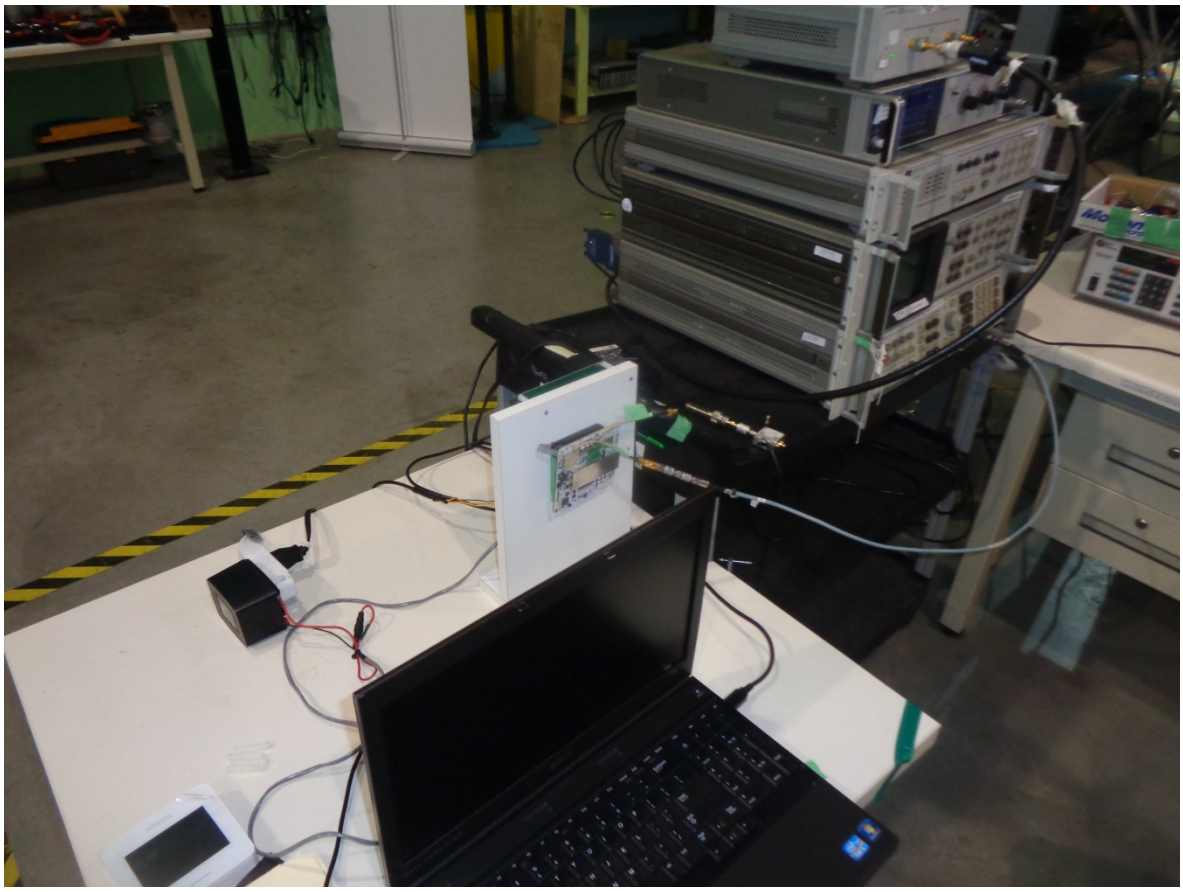
Radiated Emission Test Setup Photo #1:

Radiated Emission Test Setup Photo #2:

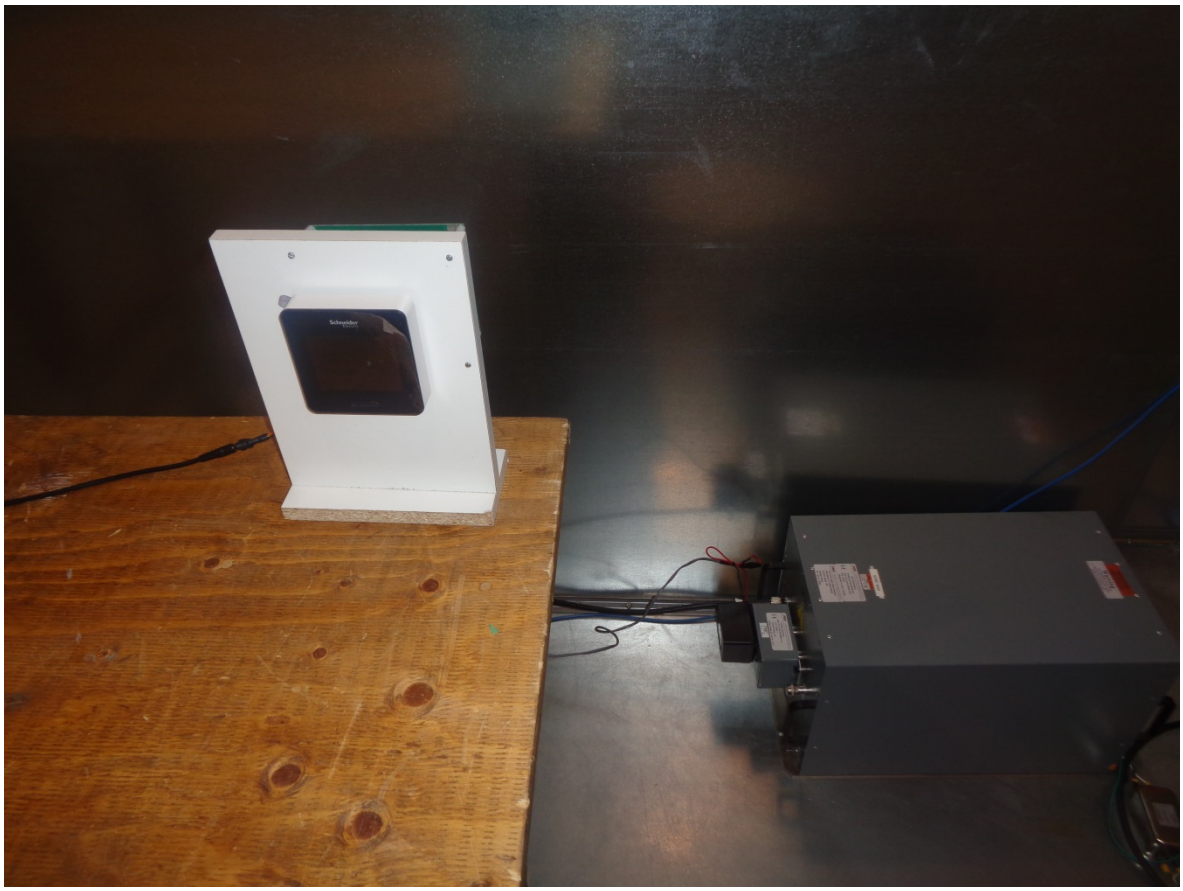
Radiated Emission Test Setup Photo #3:



Antenna conducted



Power Line Conducted Emissions 1



Power Line Conducted Emissions 2