

Electromagnetic Compatibility Test Report

RSS-210 Issue 8 Annex8, RSS-Gen Issue 4 & FCC CFR47, PART 15/ C-15.247

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Testing Laboratory.....: Quality Auditing Institute
Address.....: 16 – 211 Schoolhouse Street, Coquitlam, BC, V3K 4X9, Canada

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Standard Council of Canada: Accredited Laboratory No. 743

International Accreditation Service Inc: Accredited Laboratory: No. TL-239

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Applicant's name: ECOFIT Networks Inc.
Address.....: 2nd Floor 2659 Douglas Street Victoria, BC, Canada V8T 5M2
Contact.....: Peter McGuire
Email.....: peter@myecofit.com
Phone.....: 250-380-0123

Test Standard..... : RSS-210 Issue 8 Annex8, RSS-Gen Issue 4 & FCC CFR47, PART 15/ C-15.247

Test item description..... : RLY101
Manufacturer.....: ECOFIT Networks Inc.
FCC ID.....: 2ADCN-RLY101
IC ID: 12408A-RLY101



The following tests demonstrate the testimony to “IC and FCC” Mark Electromagnetic compatibility testing for “RLY101” manufactured by ECOFIT Networks Inc. The testing was performed pursuant to RSS-210 Issue 8 Annex8, RSS-Gen Issue 4 & FCC CFR47, PART 15/ C-15.247

Test	Applicable Standard	Description	Result
Unintentional Radiated Emissions	ICES-003 Issue 5, RSS-Gen Issue 4, FCC Part 15 Subpart B Class B	The radiated emissions are measured in the 30MHz - 1GHz range	Complies
Intentional Radiated Emissions (Transmit Mode)	RSS-Gen Issue 4, FCC Part 15 Subpart C - 15.209	The radiated emissions are measured in the 30MHz - 18GHz range	Complies
Restricted Frequency Bands	RSS-Gen Issue 4 (8.10) FCC Part 15 Subpart C - 15.205	Fundamental frequency shall not fall within the restricted bands	Complies
Channel Bandwidth	RSS-210 Iss.8 (A8.1) FCC Part 15 Subpart C - 15.247	The channel bandwidth is measured at -20dB	Complies
Channel Separation	RSS-210 Iss.8 A8.1, FCC Part 15 Subpart C -15.247	The channel separation should be greater than the channel BW or 25kHz , whichever is greater	Complies
Number of Hopping Channels	RSS-210 Iss.8 A8.1 FCC Part 15 Subpart C -15.247	At least 15 hopping channels	Complies
Occupancy Time	RSS-210 Iss.8 A8.1 FCC Part 15 Subpart C -15.247	Less than 0.4 seconds	Complies
Output Power	RSS-210 Iss.8 A8.4 FCC Part 15 Subpart C - 15.247	Output power will not exceed 0.125W (21dBm)	Complies
EIRP Emissions	RSS-210 Iss.8 A8.4	E.I.R.P. will not exceed 4W(36dBm)	Complies
Out-of-band Emissions	RSS-210 Iss.8 A8.5 FCC Part 15 Subpart C - 15.247	At least 20 dB below the highest level of the desired power	Complies
AC Power Line Conducted Emissions	FCC Part 15 Subpart C - 15.207 RSS-Gen Issue 4 (8.8)	AC Power Line Conducted Emissions 150kHz-30MHz.	Complies
RF Exposure Evaluation Safe Distance for General Population for 1mW/cm ²	1.1307(b) 15.247 (b)(5) Safety Code 6 RSS-Gen Issue4 and RSS-102 (2.5)	Limit >20cm Measured 3.4 cm	Complies
Frequency Stability	RSS-Gen Issue4 (8.11) RSS-210 Iss.8 A8.5 FCC Part 15 Subpart C - 15.247	As specified in the applicable standards	Complies

All the tests were conducted on a sample of the equipment as requested by ECOFIT Networks Inc. for the purpose of demonstrating compliance with RSS-210 Issue 8 Annex8, RSS-Gen Issue 4 & FCC CFR47, PART 15/ C-15.247. ECOFIT Networks Inc. is responsible for the tested product configuration, continued product compliance with these standards listed, and for the appropriate auditing of subsequent products, as required. Please note that this list of tests may only comprise a partial list of the tests that are required before a FCC or IC label can be produced by the manufacturer.

This is to certify that the following report is true and correct to the best of our knowledge.

**X**

Written By Jack Qin
Technical writer/EMC Test Engineer

X

Reviewed By Aman Jathaul,
EMC Project Manager

Revision History

Date	Report Number	Rev #	Details	Authors Initials
Oct-28- 2014	E10659-1402-FCC-IC	0.0	Draft Test Report	JQ
Dec-19- 2014	E10659-1402-FCC-IC	1.0	Final Test Report	JQ
Jan 6 2015	E10659-1402-FCC-IC	2.0	Updated as per TCB response	AJ
Jan 9 2015	E10659-1402-FCC-IC	3.0	Updated as per TCB response – Low Channel Conducted Peak Power and Low channel Frequency stability data	AJ
All previous versions of this Report have been superseded by the latest dated Revision as listed in the above table. Please dispose of all previous electronic and paper printed revisions accordingly.				

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Section I: GENERAL TEST INFORMATION

PRODUCT DESCRIPTION

Applicant:	ECOFIT Networks Inc.
Equipment Under Test:	RLY101
Model Number:	RLY101



RLY101 (EUT)

EUT DESCRIPTION

EUT	RLY101
Operational Description	The ECOFIT Dallas device is targeted to stationary fitness equipment that support the CSAFE serial communication protocol. The ECOFIT Dallas device communicates with said fitness equipment utilizing the CSAFE protocol and is powered by the equipment, also utilizing the CSAFE hardware connection. The ECOFIT Dallas device extracts workout information such as distance, calories burned and power generated once per second from the fitness equipment. This information is then transmitted once per second over the ECOFIT RF communication link utilizing a 2.4GHz based frequency hopping scheme to a central base station receiver. This information is buffered at the receiver and periodically delivered to the ECOFIT servers over an HTTP connection. The RF link employs a frequency hopping technique which is pseudo-random and controlled by the base station. The base station delivers a packet once a second to the Dallas unit. This packet contains a frequency that the Dallas unit will jump to for its next transaction. The frequency in the packet is selected from a pseudo-randomly generated list by the base station with values ranging from 2404 MHz to 2482 MHz with a separation of 2MHz, making for 40 possible frequencies. Once the Dallas unit receives this package, it delivers an acknowledge with a payload packet containing the desired workout data. The Dallas unit then hops to the indicated frequency and waits to be contacted again.
FCC ID	2ADCN-RLY101
IC ID	12408A-RLY101
Serial No.	R000000001
Transmitter Type	2.4GHz ISM band operation, Nordic nRF24L01+
Transmitter(Hopping) Frequency	2404 MHz to 2482 MHz
Transmit Power	20dBm
Modulation	GFSK
Number of Channels	40
Antenna type	Chip antenna, Fractus Reach XTend FR05-S1-N-0-001
Antenna Gain	1.3dBi
EUT Input Voltage	5Vdc (USB Power)
Firmware Rev. Number	1.0.0
Received Date	Sep-15-2013
Received By	Aman
Sample Log	QAI Product Control Log (QM 1305 - Sample Inventory)

Auxiliary Equipment

Manufacturer	Acer
Product Description	Laptop computer, Aspire 1830T series
Model Number	MS2296
Serial Number	12100126020
AC Adapter	Leader Electronics Inc. Model: IU40-11190-011S Input: 100-240VAC, 1A 50-60Hz Output: 19VDC 2.15A 40W

Cables Description

Description	Connector	Length	Shielding	Ferrites
USB to Serial Port	Ethernet	1.5m	No	No

FACILITIES AND ACCREDITATION

Main Laboratory Headquarters:	Quality Auditing Institute
Headquarters Location/Address:	16 – 211 Schoolhouse Street, Coquitlam, BC, 3K 4X9, Canada
Associated Laboratory:	Quality Auditing Institute (Remote Location)
EMC Laboratory Address:	19473 Fraser Way, Pitt Meadows, BC, V3Y 2V4, Canada
FCC Test Site Registration Number: (3 m /10 m Open Area Test Site [OATS] and 3 m Semi-Anechoic Chamber [SAC]):	226383
Industry Canada Test Site Registration Number (3m SAC):	9543B-1
Standard Council of Canada: ISO/IEC 17025:2005 Accredited Laboratory No.	743
International Accreditation Service Inc.: ISO/IEC 17025:2005 Accredited Laboratory: No.	TL-239
Tested by:	Aman Jathaul
Reviewed by:	David Johanson

ENVIROMENTAL CONDITIONS: INDOORS

Temperature: 22-28°C R.H.: 39.7 - 54.4%

TESTING METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.4:2009, ANSI C63.10:2013, FCC CFR 47 Part 2, FCC CFR 47 Part 15, and RSS-Gen, Issue 3 and RSS-210, Issue 8. The FCC testing was performed according to procedures described in FCC Public notice DA 00-705.

EUT TESTING CONFIGURATION

EUT was powered using the +3Vdc power supply and tests were performed at low , middle and high channel for the purpose of compliance. The transmitter was set for continuous operation at fundamental frequencies in modulated modes of operation.

WORST TEST CASE

Worst-case orientation was determined by rotating the EUT on three orthogonal planes, during the pre-compliance test and final radiated emissions tests were performed in that worst orientation. The orientation shown in the test setup pictures in Appendix A of this report is the worst test setup scenario.

GENERAL TEST PROCEDURES

RF Conducted Emissions

The EUT is placed on a test bench connected directly to an EMI Receive and Spectrum Analyzer Conducted emissions are measured in the frequency range 10kHz to 25GHz using CISPR Peak, Quasi-Peak and Average detectors. EUT was set up to transmit modulated signal at particular channel at full power.

AC Mains Conducted Emissions

EUT was powered up using the USB port of the Laptop. AC Power line conducted emissions was performed on the AC input of the laptop used to supply power to the EUT. During this test transmitter was set up to transmit in its worst case scenario. Test was also performed when transmitter was not transmitting but the worst case data is reported in this report.

Radiated Emissions

The EUT is placed on the turntable 0.8m above a ground plane 3m away from a receiving antenna. Height of receiving antenna varied from 1m to 4m, its polarity changes from vertical to horizontal. Turntable rotates 360 degrees. Motion of turntable and receiving antenna allows determining position of maximum emission level. Quasi-peak detector applies for measurements of emissions with frequency range of 10 KHz to 1000MHz and average/peak detector above 1GHz.

Radiated emissions were investigated from 10kHz to tenth harmonics of the fundamental frequency.

Measurements were made using spectrum analyser and receiver using the appropriate attenuators and filters to optimize the reading. The settings used were:

200Hz RBW average detector for the frequency range 10kHz-150kHz
 9kHz RBW average detector for the Frequency range 150kHz to 30MHz
 120kHz RBW quasi-peak detector for the frequency range 30MHz to 1GHz
 1MHz RBW Average detector for the frequency range 1GHz to 20GHz

MEASUREMENT UNCERTAINTY

Parameter	Uncertainty
Radio Frequency	$\pm 1 \times 10^{-5}$ MHz
Total RF power, conducted	± 1 dB
RF power density, conducted	± 2.75 dB
Spurious emissions, conducted	± 3 dB
Radiated Emissions	± 3 dB
Temperature	$\pm 1^{\circ}\text{C}$
Humidity	± 5 %
DC and low frequency voltages	± 3 %

TEST EQUIPMENT LIST

Emission Testing Equipment

Manufacturer	Model	Description	Serial No.	Last Cal	Cal Due Date
Sunol Sciences	SM46C	Turntable	051204-2	N/A	N/A
Sunol Sciences	TWR95	Mast	TREML0001	N/A	N/A
Sunol Sciences	JB3	Biconilog Antenna 30MHz – 3GHz	A042004	31-Oct-2012	31-Oct-2015
ETS Lindgren	3117	Horn Antenna	00001118	29-Aug-13	29-Aug-16
EMCO	6502	Active Loop Antenna	2178	21-Aug-14	21-Aug-17
ETS Lindgren	2165	Turntable	00043677	N/A	N/A
ETS Lindgren	2125	Mast	00077487	N/A	N/A
Rohde & Schwarz	ESU40	EMI Receiver	100011	26-June-2012	26-Jun-2015
FCC	FCC-LISN- 50-25-2	LISN (150kHz-30MHz)	9927	30-Nov-2012	30-Nov-2015
ETS Lindgren	S201	5 meter Semi-Anechoic Chamber	1030	N/A	N/A

Measurement Software List

Manufacturer	Model	Version	Description
Rhode & Schwarz	EMC 32	6.20.0	Emissions Pre-scan Test Software

Part 1 - Unintentional Radiated Emissions Testing

DATE: Sep-09-2014
TEST STANDARD: ICES-003 Issue 5, RSS-Gen Issue 4, FCC Part 15 Subpart B
TEST SETUP: The EUT was operated in receive mode for these tests.
MINIMUM STANDARD: Class B Radiated Limits below 1 GHz

Frequency (MHz)	Class B Radiated Limit (dB μ V/m) at 3m	
	Quasi-peak (dB μ V/m)	
30 – 88	40	
88 – 216	43.5	
216 - 960	46	
960 – above	54	

Class B Radiated Limits above 1 GHz

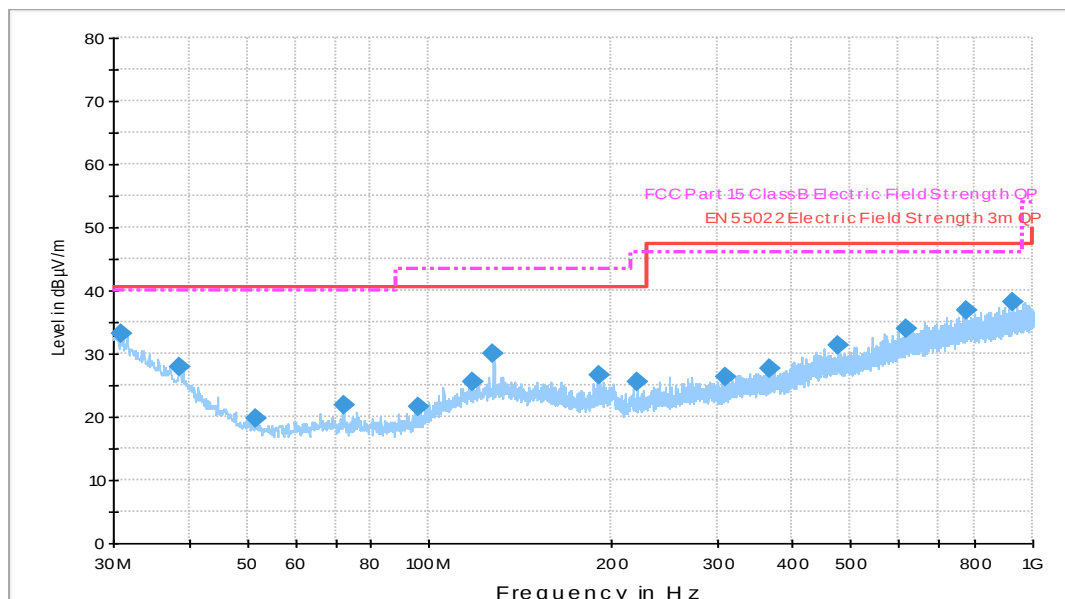
Frequency (MHz)	Class B Radiated Limit (dB μ V/m) at 3m	
	Linear Average Detector	Peak Detector
> 1000	54	74

Note: In the above emission table, the tighter limit applies at the band edges.

METHOD OF MEASUREMENT: The equipment was set up in a 3-meter Semi Anechoic Chamber for preliminary measurements and finals were completed in 3m/10m Open Air Test Site at 10meters. Emissions in both horizontal and vertical polarizations were measured while rotating the EUT on a turntable to maximize the emissions signal strength.

PERFORMANCE: Complies with standard.

MEASUREMENT DATA: * Unintentional emissions were measured from 0.009 MHz -1000MHz. All of the emissions measured were at least 20 dB below the limits. In accordance with 15.31(o) emissions that are 20dB below the permissible value have not been reported.



Plot 1: Unintentional Radiated Emissions, IC/FCC Class B, Receive Mode -3m

Part 2 - Intentional Radiated Emissions Testing (Transmit Mode)

DATE: Sep-29-2014

TEST STANDARD: RSS-Gen Issue 4, FCC Part 15 Subpart C -15.209

MINIMUM STANDARD: All emissions that fall in the restricted bands (15.205 or RSS-Gen (7.2.2)) must comply with the limits as listed in 15.209 and RSS-Gen (7.2.5). All other emissions must be at least 20dB down from the highest emission level within the authorized band as measured with a 100kHz RBW

Spurious Emission Limits below 1 GHz

Frequency (MHz)	Class B Radiated Limit (dB μ V/m) at 3m
	Quasi-peak (dB μ V/m)
30 – 88	40
88 – 216	43.5
216 - 960	46
960 – 1000	54

Spurious Emission Limits above 1 GHz

Frequency (MHz)	Class B Radiated Limit (dB μ V/m) at 3m
	Linear Average Detector
> 1000	54

Note: In the above emission table, the tighter limit applies at the band edges.

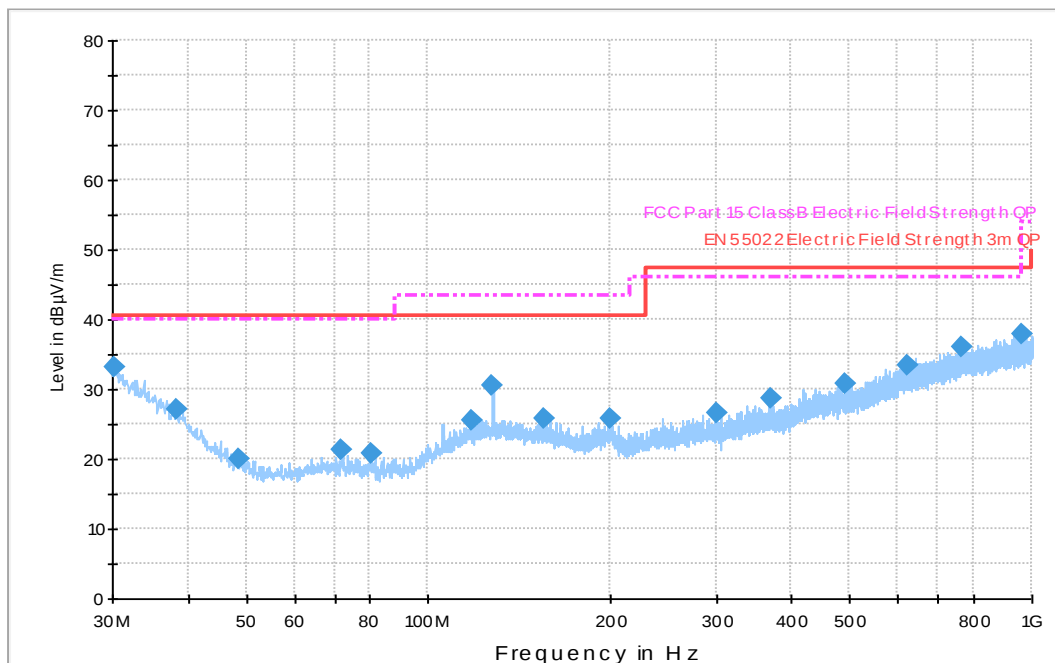
TEST SETUP: The EUT was tested in our 3 m SAC and was positioned on the center of the turntable and powered up. The Transmitter Output was connected to its standard antenna. The transmitter was set for continuous transmission. The lowest, middle and highest channels were measured for all radiated emissions 10kHz to 25 GHz. The EUT was verified in 3 orthogonal orientations and the worst orientation was used for the final measurements. The EUT was tested and placed in the Vertical orientation on the table top as indicated in the test photos.

DEVICE DESCRIPTIONS: As described in the above EUT description and setup section.

MODIFICATIONS: No modification is required to comply for this test.

PERFORMANCE: Complies with standard.

EMISSIONS DATA: No transmitter Radiated Spurious Emissions were detected from below 30MHz. Radiated emissions were investigated up to tenth harmonics of the fundamental frequency.

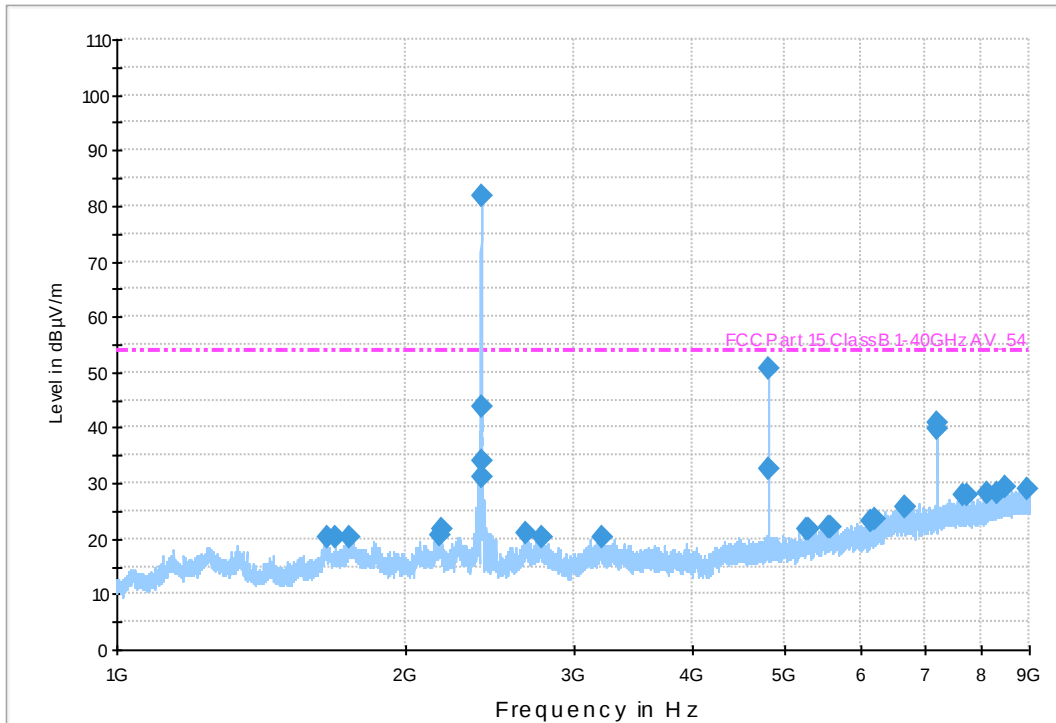


Plot 2: Intentional Radiated Emissions, 30MHz-1GHz, IC/FCC Class B, Tx Mode -3m

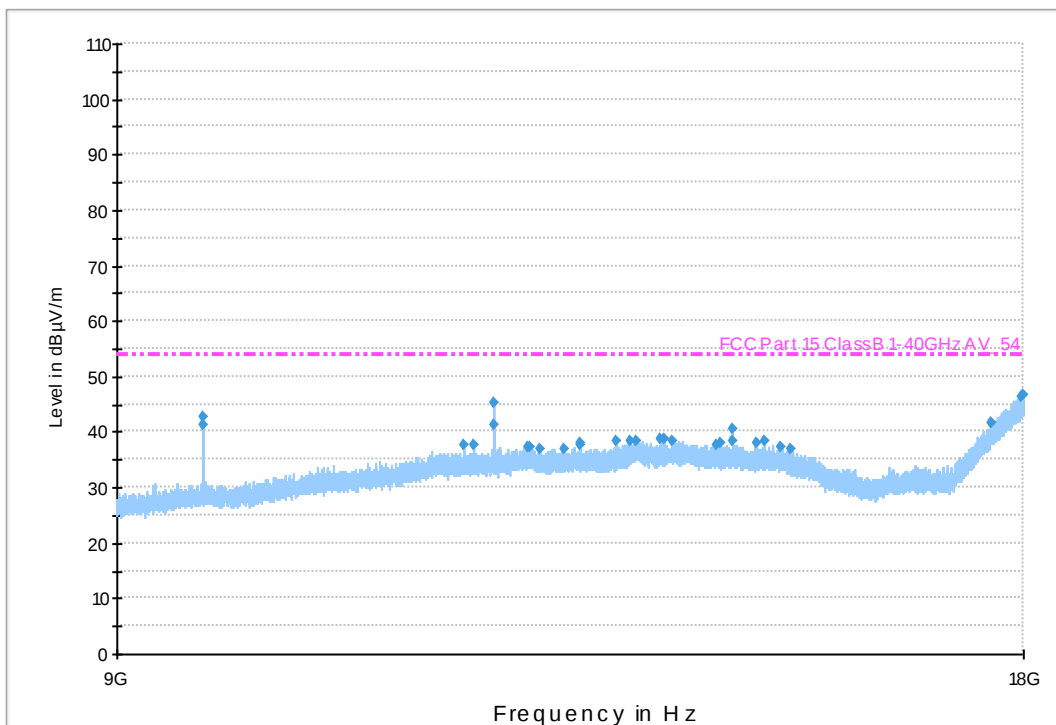
Table1: Intentional Radiated Emissions, 30MHz-1GHz, IC/FCC Class B, Tx Mode -3m

Frequency (MHz)	MaxPeak-MaxHold (dBμV/m)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
30.194000	33.2	150.0	H	270.0	28.6	6.8	40
38.342000	27.2	100.0	V	0.0	21.1	12.8	40
72.001000	21.4	150.0	V	45.0	14.3	18.6	40
117.688000	25.6	200.0	V	0.0	20.6	17.9	43.5
127.970000	30.5	100.0	H	0.0	20.9	13	43.5
155.615000	25.7	150.0	V	225.0	19.9	17.8	43.5
199.944000	25.8	150.0	V	270.0	20.0	17.7	43.5
370.276000	28.7	150.0	H	90.0	22.5	17.3	46
491.235000	30.8	100.0	H	90.0	25.0	15.2	46
622.961000	33.5	200.0	H	180.0	26.7	12.5	46
762.059000	36.0	150.0	H	0.0	28.4	10	46
960.327000	37.8	100.0	H	135.0	30.6	16.2	54

* Intentional emissions were measured from 0.009 MHz -1000MHz. In accordance with 15.31(o) emissions that are 20dB below the permissible value have not been reported.



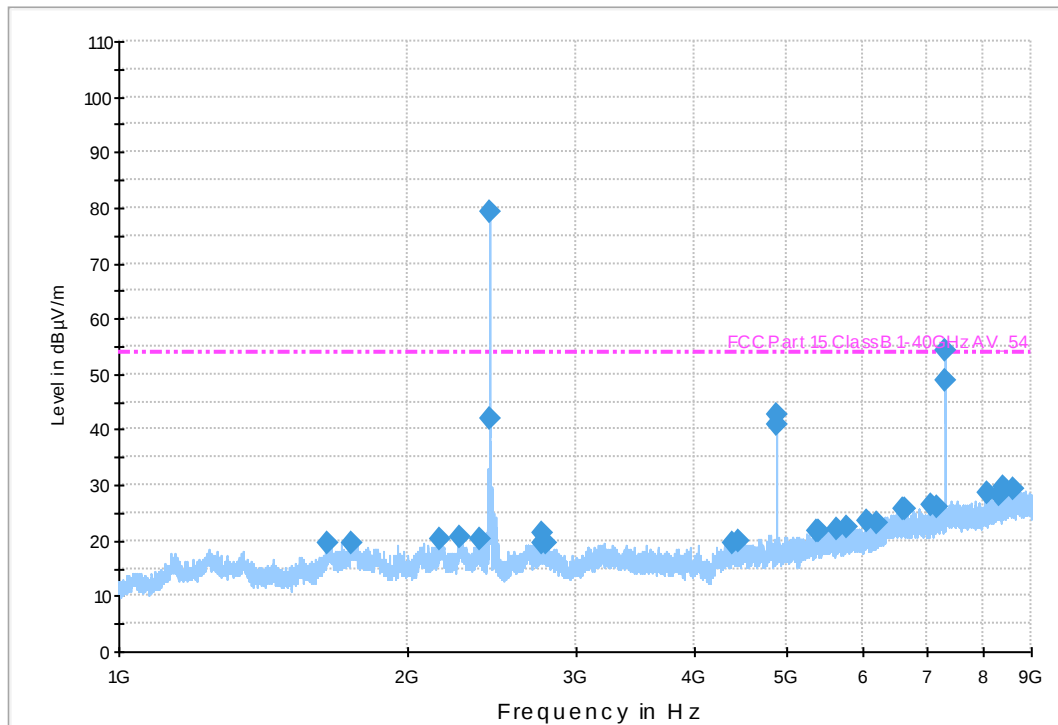
Plot 3: Intentional Radiated Emissions, 1GHz-9 GHz, TX Mode, Low Channel -3m
Note: The signal crossing the limitation line is fundamental frequency.

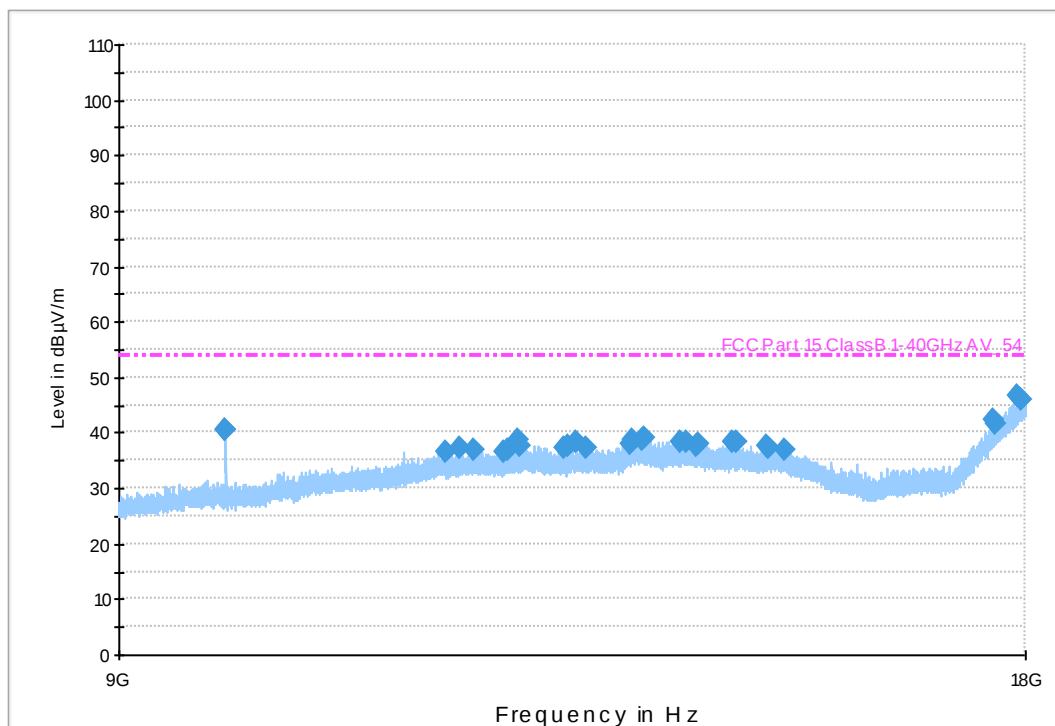


Plot 4: Intentional Radiated Emissions, 9GHz-18 GHz, TX Mode, Low Channel -3m

Table2: Intentional Radiated Emissions, Spurious/Harmonics, Low Channel

Freq.	Un-Corr Average	Un-Corr Peak	Antenna Factors	Amp Gain +Cable loss	Corr. Average	Corr. Peak	Antenna height	Pol.	Turntable position	Average Margin	Peak Margin	Average Limit	Peak Limit
MHz	dBμV/m	dBμV/m	dB	dB	dBμV/m	dBμV/m	cm		deg	dBμV/m	dBμV/m	dBμV/m	dBμV/m
4808.00	39.91	57.05	28.5	-27	41.41	58.55	100	V	31.6	12.59	15.45	54	74
4808.00	44.25	61.48	28.5	-27	45.75	62.98	106.4	H	360	8.25	11.02	54	74
7212.00	33.18	42.88	33.3	-23.3	43.18	52.88	100	V	294.8	10.82	21.12	54	74
7212.00	35.5	54.4	33.3	-23.3	45.5	64.4	147	H	299.2	8.5	9.6	54	74
9616.00	31.2	41.76	33.9	-17.5	47.6	58.16	100	V	162.4	6.4	15.84	54	74
9616.00	32.2	42.24	33.9	-17.5	48.6	58.64	100	H	317.8	5.4	15.36	54	74
12020.00	26.2	33.51	38.1	-17.4	46.9	54.21	100	V	147.2	7.1	19.79	54	74
12020.00	24	36.08	38.1	-17.4	44.7	56.78	100	H	227.3	9.3	17.22	54	74
14424.00	19	31.24	37.4	-11.5	44.9	57.14	131.5	V	336.3	9.1	16.86	54	74
14424.00	18.9	26.5	37.4	-11.5	44.8	52.4	100	H	36	9.2	21.6	54	74

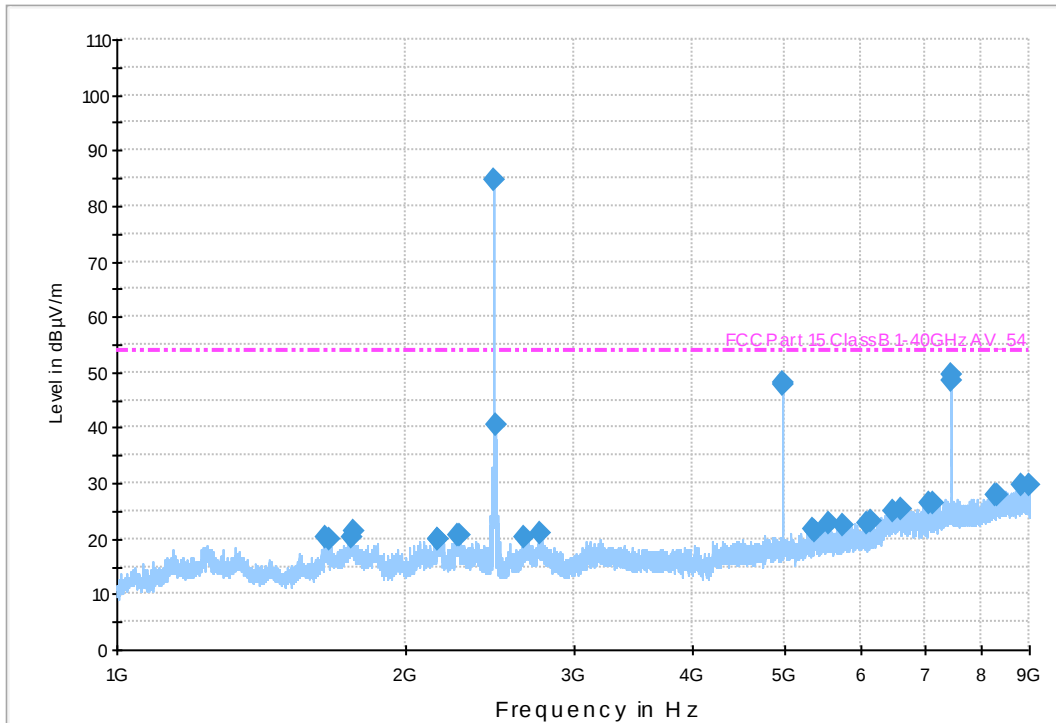




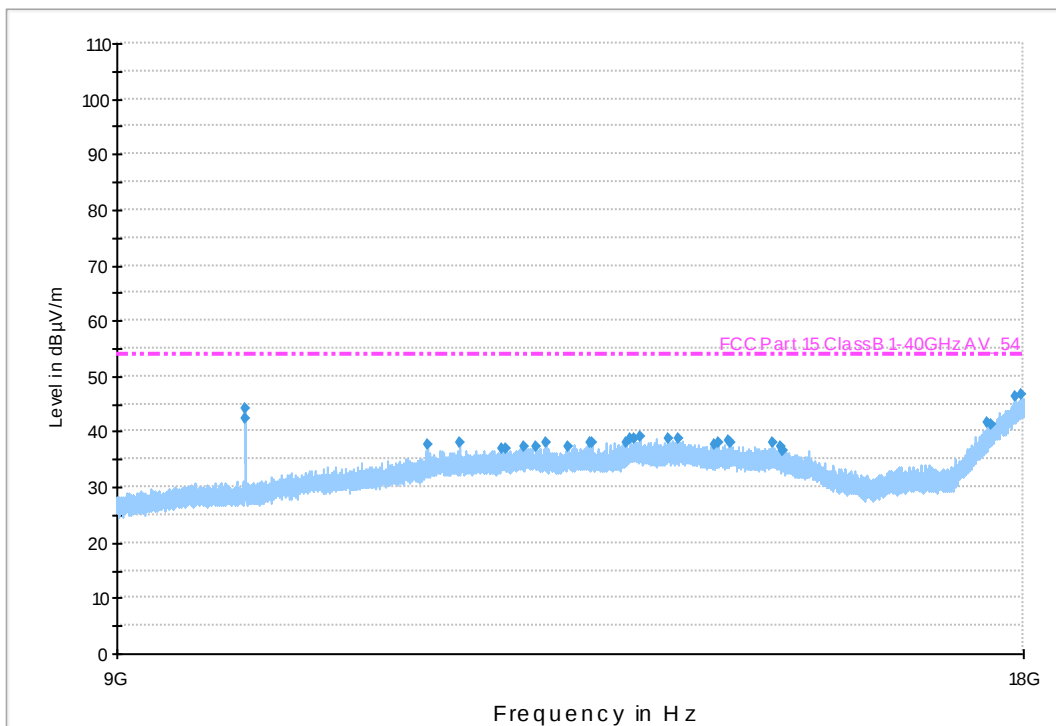
Plot 6: Intentional Radiated Emissions, 9GHz-18GHz, Tx Mode, Mid Channel -3m

Table3: Intentional Radiated Emissions, Spurious/Harmonics, Mid Channel

Freq.	Un-Corr Average	Un-Corr Peak	Antenna Factors	Amp Gain +Cable loss	Corr. Average	Corr. Peak	Antenna height	Pol.	Turntable position	Average Margin	Peak Margin	Average Limit	Peak Limit
MHz	dBμV/m	dBμV/m	dB	dB	dBμV/m	dBμV/m	cm		deg	dBμV/m	dBμV/m	dBμV/m	dBμV/m
4884.0	38.1	56.1	28.5	-27	39.6	57.6	100	V	31.6	14.4	16.4	54	74
4884.0	42.8	60.8	28.5	-27	44.3	62.3	106.4	H	360	9.7	11.7	54	74
7326.0	33.2	41.8	33.3	-23.3	43.2	51.8	100	V	294.8	10.8	22.2	54	74
7326.0	34.2	53.6	33.3	-23.3	44.2	63.6	147	H	299.2	9.8	10.4	54	74
9768.0	31.5	41	33.9	-17.5	47.9	57.4	100	V	162.4	6.1	16.6	54	74
9768.0	32	42	33.9	-17.5	48.4	58.4	100	H	317.8	5.6	15.6	54	74
12210.0	27.1	33	38.1	-17.4	47.8	53.7	100	V	147.2	6.2	20.3	54	74
12210.0	26	35.7	38.1	-17.4	46.7	56.4	100	H	227.3	7.3	17.6	54	74
14652.0	18.1	30.6	37.4	-11.5	44	56.5	131.5	V	336.3	10	17.5	54	74
14652.0	16.2	27	37.4	-11.5	42.1	52.9	100	H	36	11.9	21.1	54	74



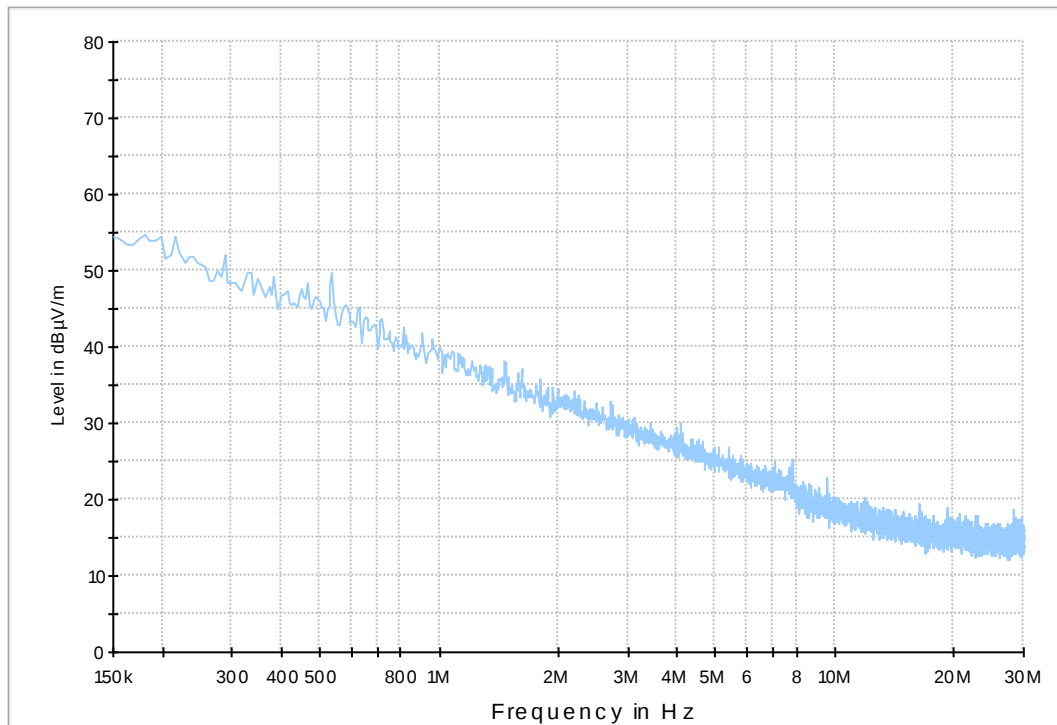
Plot 7: Intentional Radiated Emissions, 1GHz-9GHz, TX Mode, High Channel -3m
Note: The signal crossing the limitation line is fundamental frequency.



Plot 8: Intentional Radiated Emissions, 9GHz-18GHz, TX Mode, High Channel -3m

Table 4: Intentional Radiated Emissions, Spurious/Harmonics, High Channel

Freq.	Un-Corr Average	Un-Corr Peak	Antenna Factors	Amp Gain +Cable loss	Corr. Average	Corr. Peak	Antenna height	Pol.	Turntable position	Average Margin	Peak Margin	Average Limit	Peak Limit
MHz	dBμV/m	dBμV/m	dB	dB	dBμV/m	dBμV/m	cm		deg	dBμV/m	dBμV/m	dBμV/m	dBμV/m
4964.0	46.75	64.28	28.5	-27	48.25	65.78	126.6	V	28.2	5.75	8.22	54	74
4964.0	47.31	64.3	28.5	-27	48.81	65.8	103.4	H	333.1	5.19	8.2	54	74
7446.0	35.93	54.89	33.3	-23.3	45.93	64.89	183.1	V	82.1	8.07	9.11	54	74
7446.0	36.83	56.44	33.3	-23.3	46.83	66.44	143	H	308.7	7.17	7.56	54	74
9928.0	22.79	41.71	33.9	-17.5	39.19	58.11	121.1	V	169.1	14.81	15.89	54	74
9928.0	23.72	43.26	33.9	-17.5	40.12	59.66	100	H	327.8	13.88	14.34	54	74
12410.0	27.1	33	38.1	-17.4	47.8	53.7	100	V	147.2	6.2	20.3	54	74
12410.0	27	35.7	38.1	-17.4	47.7	56.4	100	H	227.3	6.3	17.6	54	74



Plot 9: Radiated Emissions 150k-30MHz

* Intentional emissions were measured below 30MHz but no emissions were found that were 20dB below the permissible limits.

Part 3 - Restricted Frequency Bands

DATE: Sep-29-2014

TEST STANDARD: RSS-Gen Issue 4(8.10), FCC Part 15 Subpart C -15.205

MINIMUM STANDARD: 1) Fundamental components not fall within the restricted bands;
2) Unwanted emissions falling into restricted bands shall comply with the limits specified in the applicable RSS-Gen and FCC Part 15 Subpart C
Restricted Bands specified in RSS-Gen Issue 3

MHz
0.090-0.110
2.1735-2.1905
3.020-3.026
4.125-4.128
4.17725-4.17775
4.20725-4.20775
5.677-5.683
6.215-6.218
6.26775-6.26825
6.31175-6.31225
8.291-8.294
8.362-8.366
8.37625-8.38675
8.41425-8.41475
12.29-12.293
12.51975-12.52025
12.57675-12.57725
13.36-13.41
16.42-16.423
16.69475-16.69525
16.80425-16.80475
25.5-25.67
37.5-38.25
73-74.6
74.8-75.2
108-138
156.52475-156.52525
156.7-156.9

MHz
240-285
322-335.4
399.9-410
608-614
960-1427
1435-1626.5
1645.5-1646.5
1660-1710
1718.8-1722.2
2200-2300
2310-2390
2655-2900
3260-3267
3332-3339
3345.8-3358
3500-4400
4500-5150
5350-5460
7250-7750
8025-8500

GHz
9.0-9.2
9.3-9.5
10.6-12.7
13.25-13.4
14.47-14.5
15.35-16.2
17.7-21.4
22.01-23.12
23.6-24.0
31.2-31.8
36.43-36.5
Above 38.6

Note: Certain frequency bands listed in Table 3 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to the devices are set out in the 200- and 300- series RSSs, such as RSS-210 and RSS-310, which contain the requirements that apply to licence-exempt radio apparatus.

22

Restricted Bands specified in FCC Part 15 Subpart C -15.205

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
10.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	(²)
13.36-13.41			

¹ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

² Above 38.6

MEASUREMENT DATA: See the Plots and the tables in Part 2

PERFORMANCE: Complies with standard.

Part 4 - Channel Bandwidth

DATE: Oct-24-2014

TEST STANDARD: RSS-210 Iss.8 A8.1, FCC Part 15 Subpart C -15.247

MINIMUM STANDARD: The bandwidth of a frequency hopping channel is the -20 dB emission bandwidth, measured with the hopping stopped. The system radio frequency (RF) bandwidth is equal to the channel bandwidth multiplied by the number of channels in the hopset. The hopset shall be such that the near-term distribution of frequencies appears random, with sequential hops randomly distributed in both direction and magnitude of change in the hopset, while the long-term distribution appears evenly distributed.

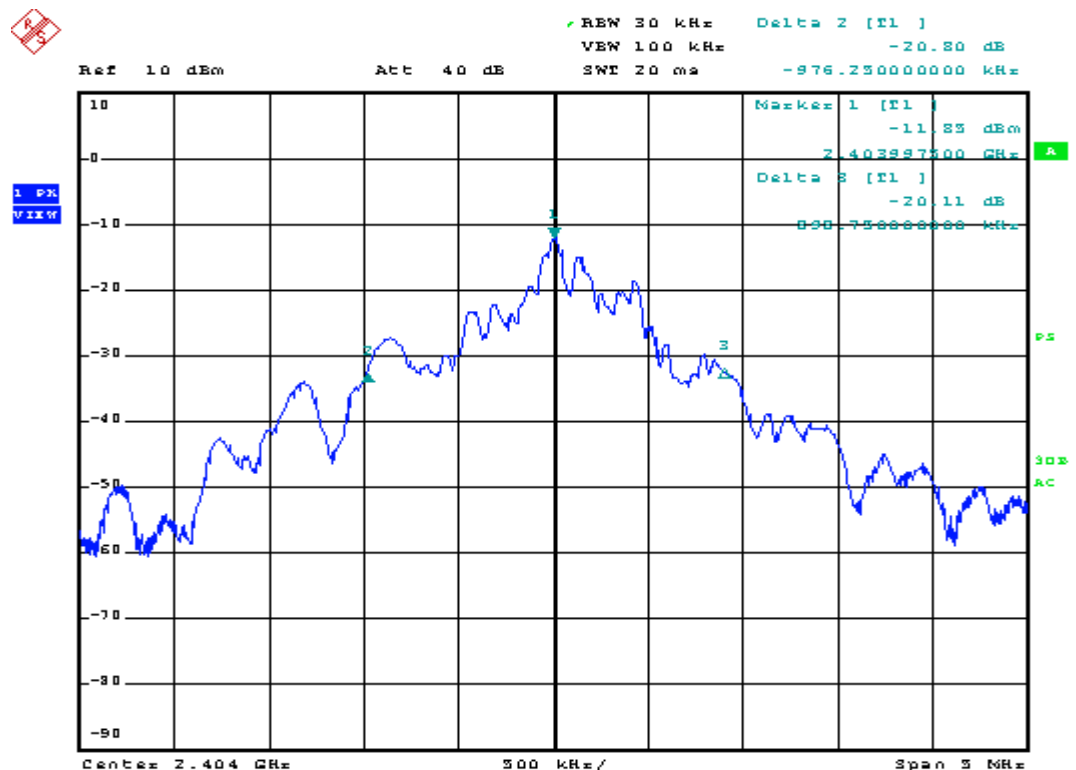
RESULT OF MEASUREMENT:

Freq (MHz)	Channel Bandwidth(MHz)
2404	1.875
2442	1.723
2482	1.587

MODIFICATIONS: No modification is required to comply for this test.

PERFORMANCE: Complies with standard.

MEASUREMENT DATA:



Plot 10: 20dB Bandwidth at LOW Frequency – 1875 kHz



Plot 11: 20dB Bandwidth at MID Frequency – 1723 kHz



Plot 12: 20dB Bandwidth at HIGH Frequency – 1587 kHz

Part 5 - Channel Separation

DATE: Oct-24-2014

TEST STANDARD: RSS-210 Iss.8 A8.1, FCC Part 15 Subpart C -15.247

MINIMUM STANDARD: Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the -20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W.

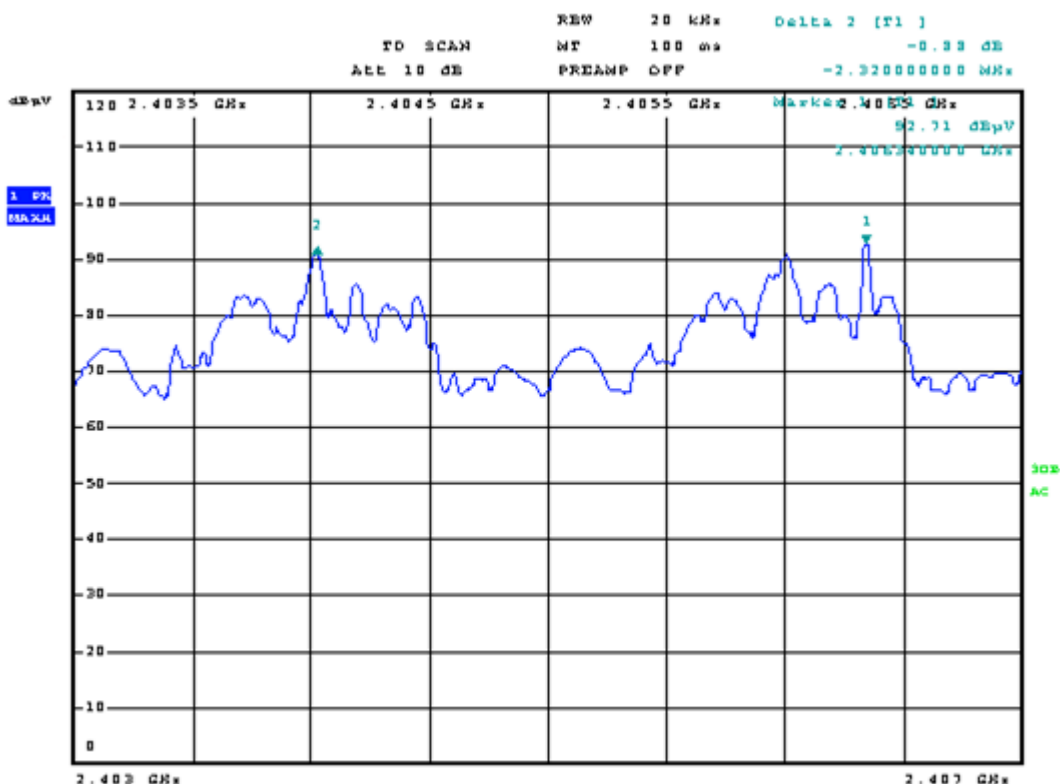
RESULT OF MEASUREMENT:

Freq (MHz)	Channel Bandwidth(MHz)	Channel Separation(MHz)	Result
2404	1.875	2.32	Pass
2442	1.723	2.32	Pass
2482	1.587	2.32	Pass

MODIFICATIONS: No modification is required to comply for this test.

PERFORMANCE: Complies with standard.

MEASUREMENT DATA:



Plot 13: Channel Separation = 2.32MHz

Part 6 - Hopping Channels

DATE: Oct-24-2014

TEST STANDARD: RSS-210 Iss.8 A8.1, FCC Part 15 Subpart C -15.247

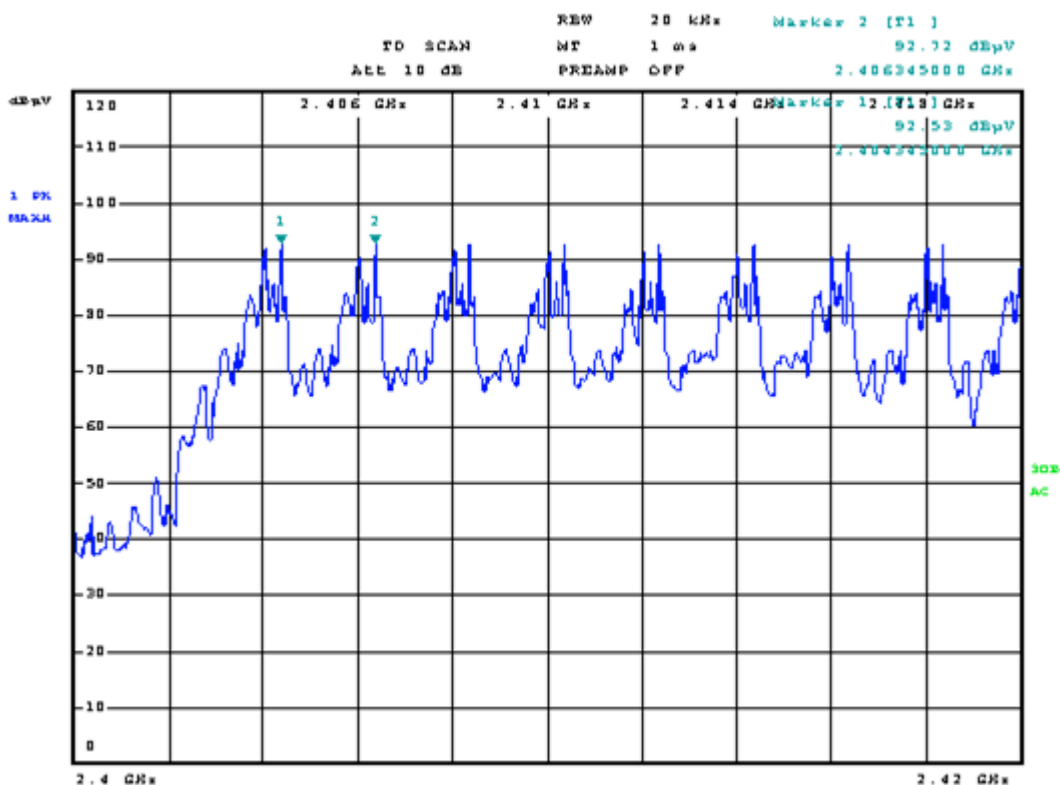
MINIMUM STANDARD: Frequency hopping systems operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels.

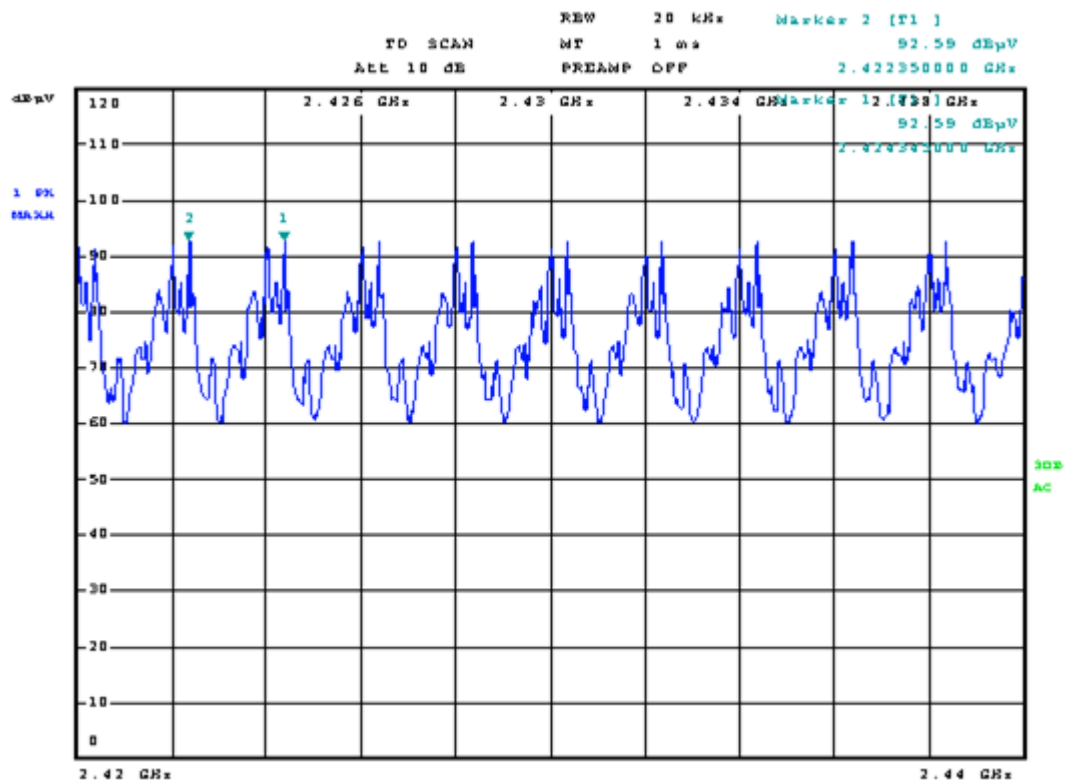
RESULT OF MEASUREMENT: Hopping channels: 40

MODIFICATIONS: No modification is required to comply for this test.

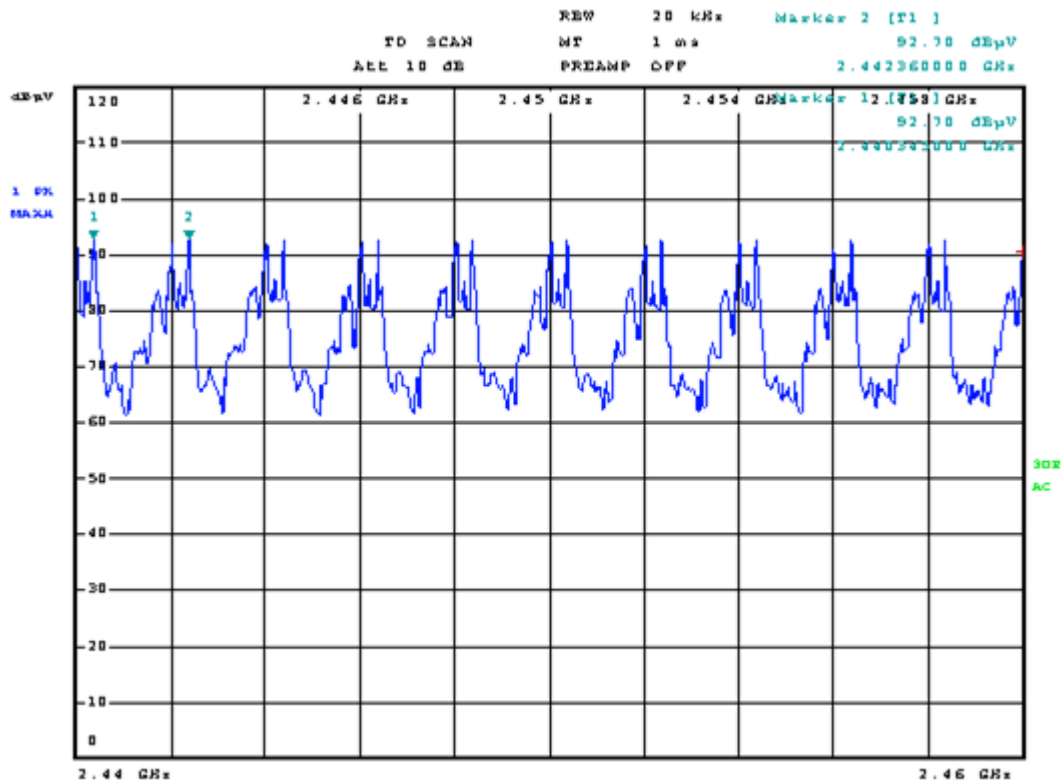
PERFORMANCE: Complies with standard

MEASUREMENT DATA:

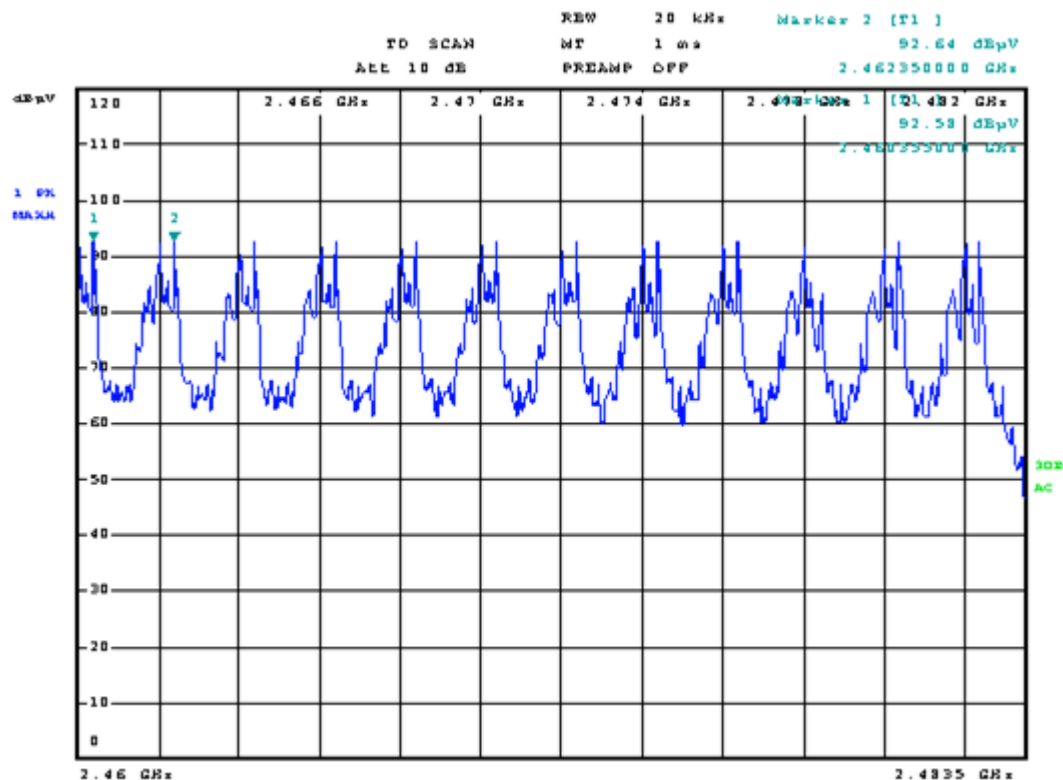




Plot 14: Number of Hopping Frequencies 2.42GHz to 2.44GHz - 9 Frequencies



Plot 15: Number of Hopping Frequencies 2.44GHz to 2.46GHz – 10 Frequencies



Plot 16: Number of Hopping Frequencies 2.46GHz to 2.4835GHz – 12 Frequencies

Part 7 - Occupancy Time

DATE: Nov-07-2014

TEST STANDARD: RSS-210 Iss.8 A8.1, FCC Part 15 Subpart C -15.247

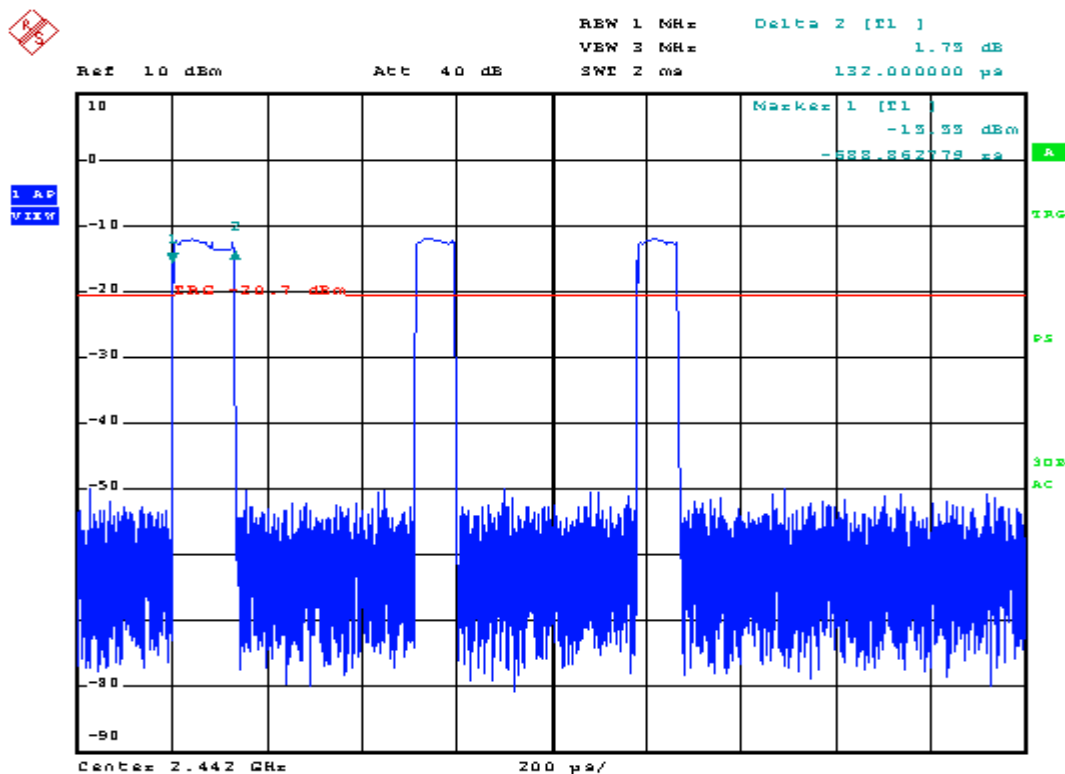
MINIMUM STANDARD: The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed.

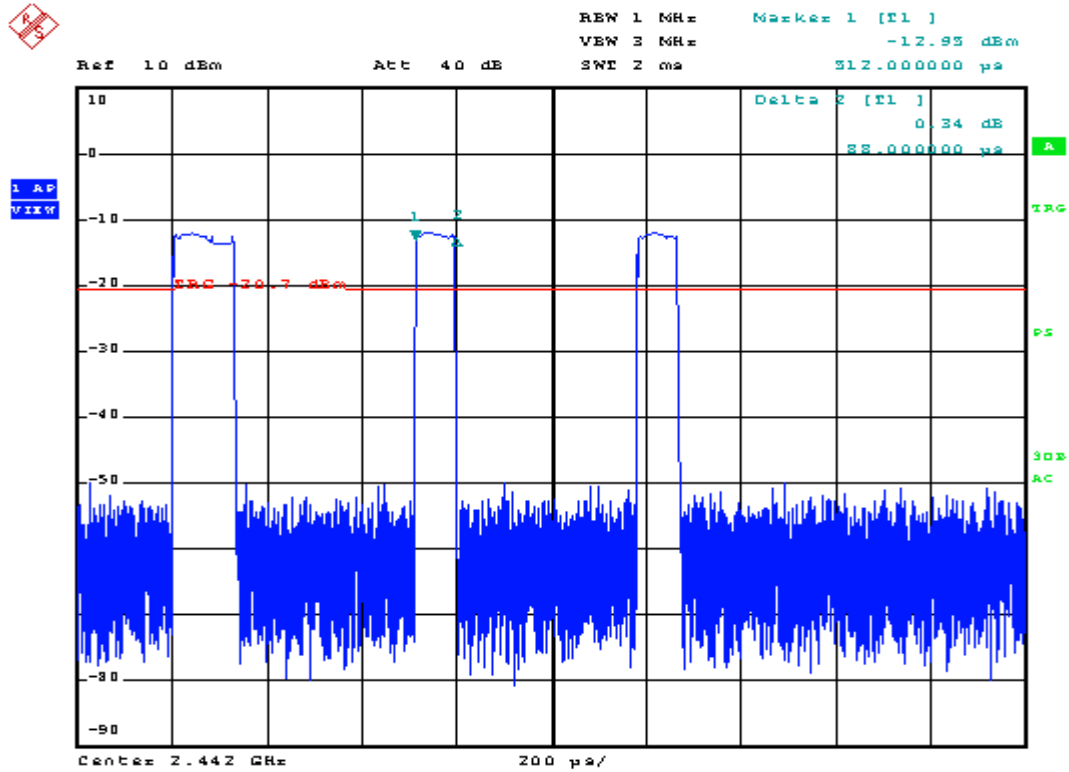
RESULT OF MEASUREMENT: Occupancy time per frequency: 0.308ms
Interval time of pulses: 48 seconds
Number of Channels=40
The average time of occupancy on any channel is less than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed (i.e. within period of 0.4sec x 40=16 secs).

MODIFICATIONS: No modification is required to comply for this test.

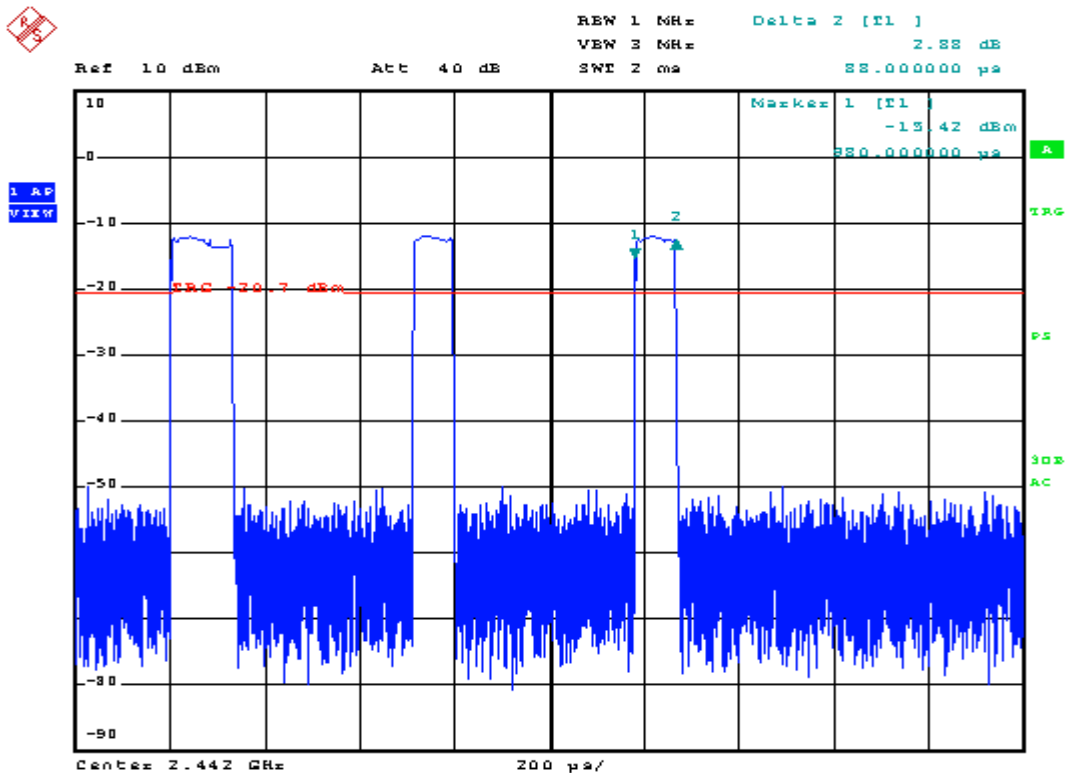
PERFORMANCE: Complies with standard,

MEASUREMENT DATA:

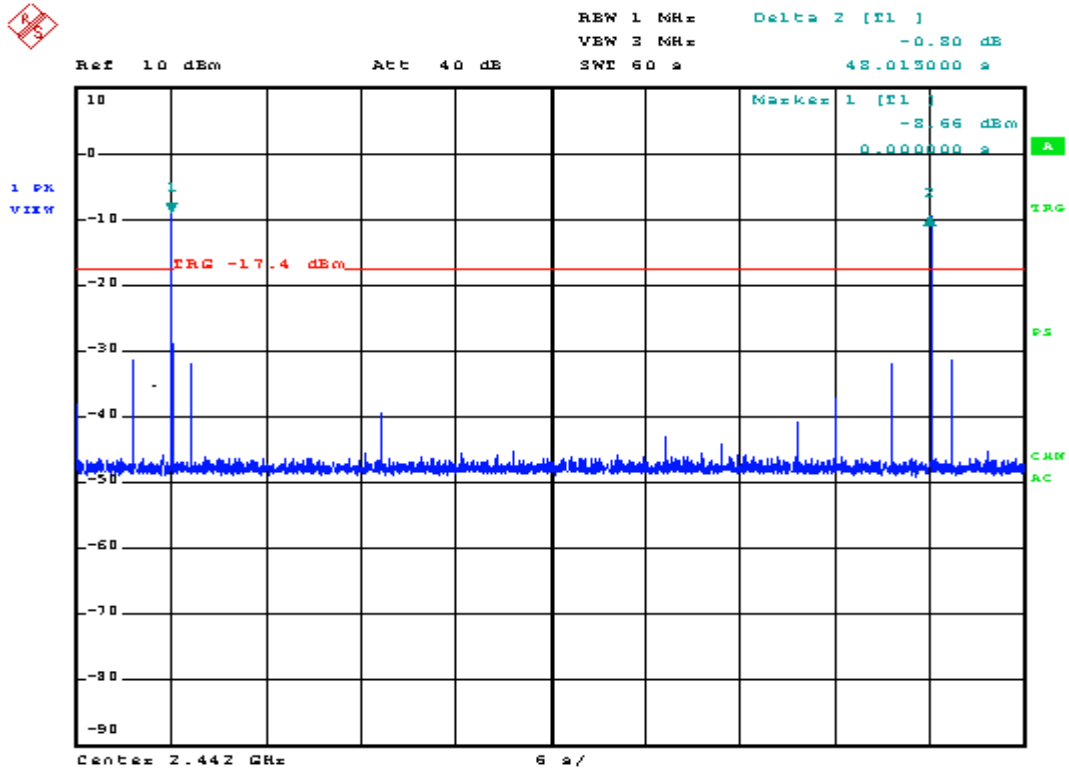




Plot 18: Occupancy time, 0.088ms @ pulse 2



Plot 19: Occupancy time, 0.088ms @ pulse 3



Plot 20: Interval time of pulses, 48 seconds

Part 8 - Conducted Output Power

DATE: Sep-30-2014

TEST STANDARD: RSS-210 Iss.8 A8.4, FCC Part 15 Subpart C -15.247

MINIMUM STANDARD: For frequency hopping systems operating in the band 2400-2483.5 MHz and employing at least 75 hopping channels, the maximum peak conducted output power shall not exceed 1 W; for all other frequency hopping systems in the band, the maximum peak conducted output power shall not exceed 0.125 W.

METHOD OF MEASUREMENT: The Antenna is connected directly to the PCB using a coaxial pigtail; the conducted output power was measured at this point. A 30dB attenuator was used to protect the instrumentation.

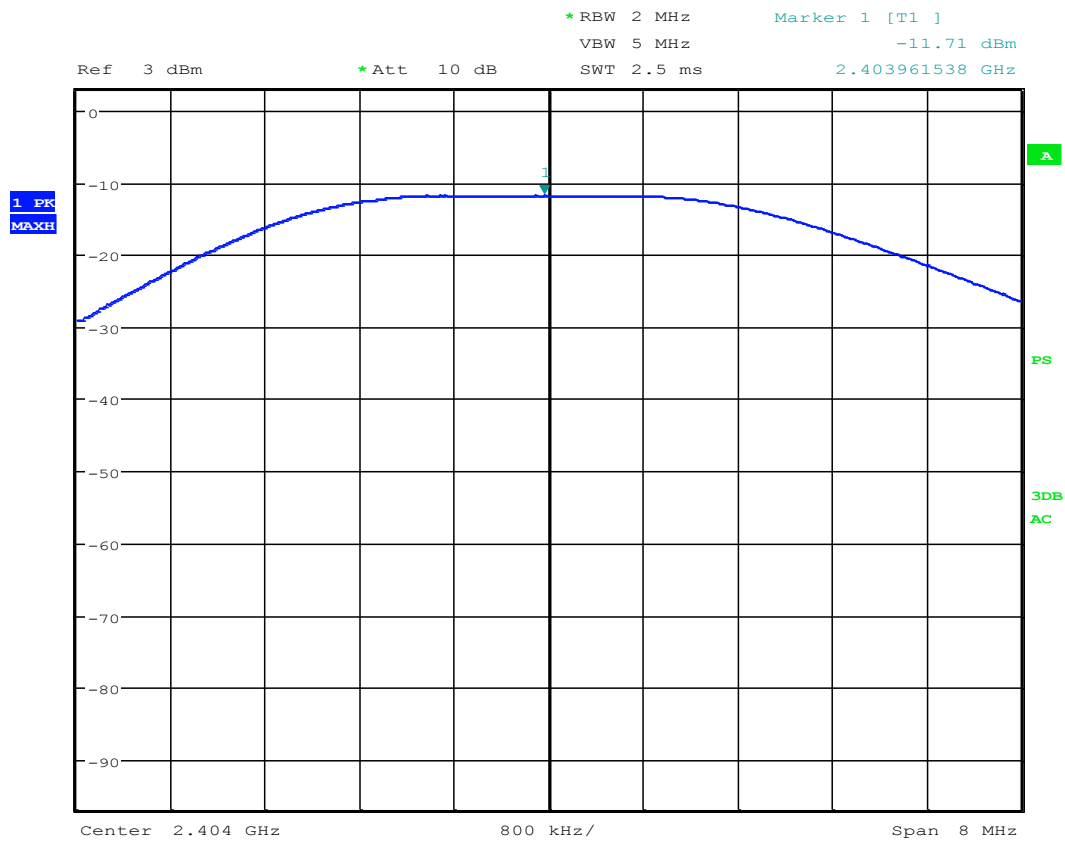
RESULT OF MEASUREMENT:

Freq (MHz)	Amplitude	Cable Loss	Output Power	Limit (dBm)
2403.96	-11.71	31	19.29	21
2441.66	-11.96	31.2	19.24	21
2481.9	-12.41	31.5	19.09	21

MODIFICATIONS: No modification is required to comply for this test.

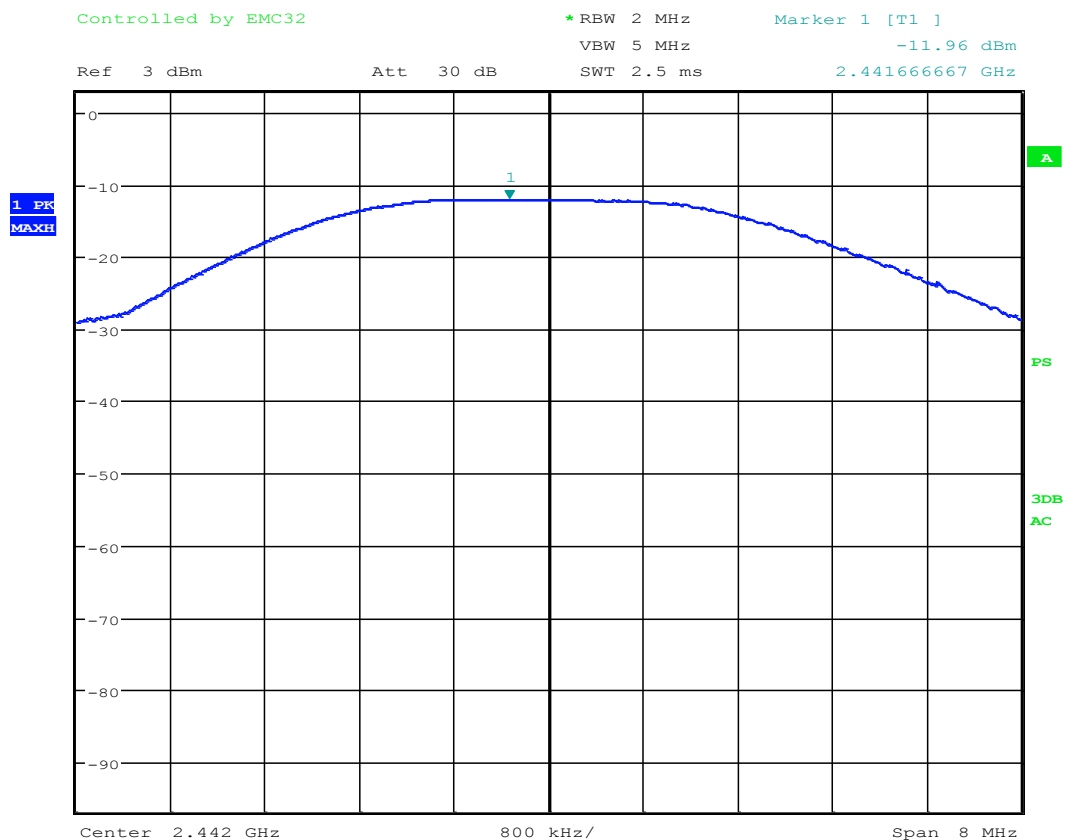
PERFORMANCE: Complies with standard.

MEASUREMENT DATA:

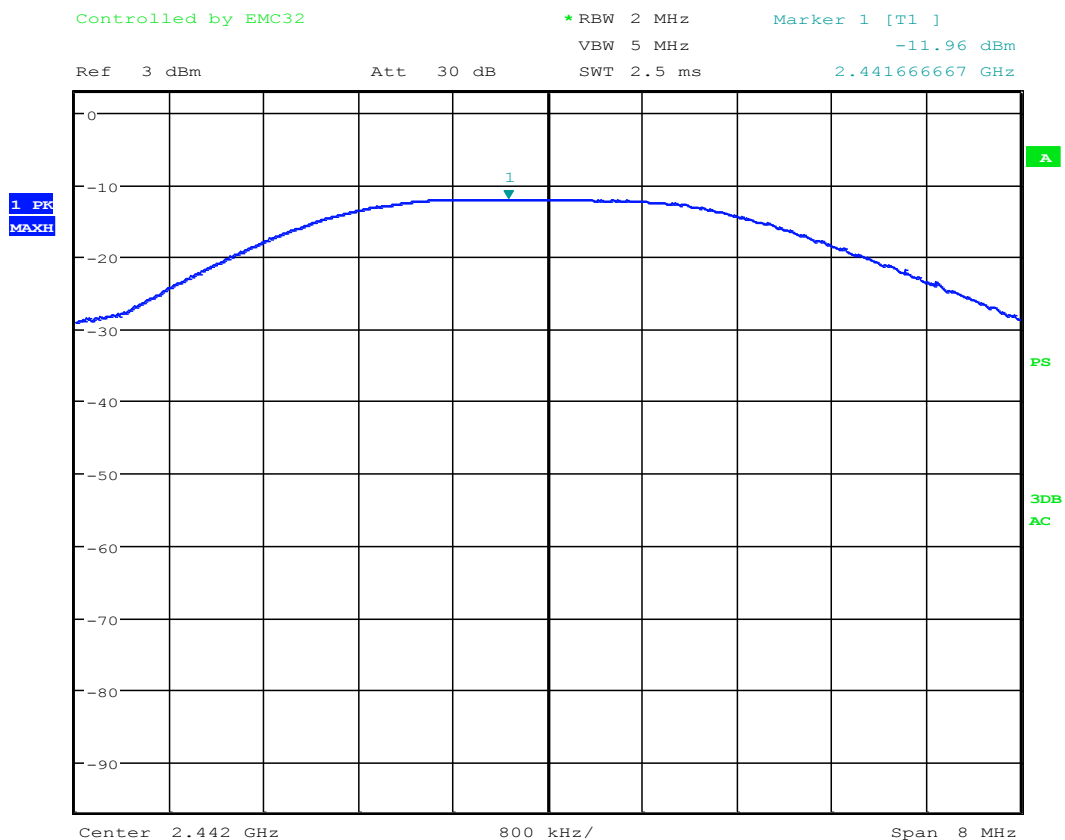


Date: 9.JAN.2015 14:20:50

Plot 21: Output Power at LOW Channel



Plot 22: Output Power at MID Channel



Plot 23: Output Power at HIGH Channel

Part 9 - EIRP Emissions

DATE: Sep-30-2014

TEST STANDARD: RSS-210 Iss.8 A8.4

MINIMUM STANDARD: EIRP shall not exceed 4 W.

METHOD OF MEASUREMENT: EIRP was measured at the 3m distance and the measurement was adjusted to account for cable loss and Antenna factor.

MODIFICATIONS: No modification is required to comply for this test.

PERFORMANCE: Complies with standard.

MEASUREMENT DATA:

Frequency	EIRP	EIRP limit
(MHz)	(dBm)	(dBm)
2403.98	19.39	36
2441.8	19.6	36
2482	18.4	36

Part 10 - Out of Band Emissions

DATE: Sep -30-2014

TEST STANDARD: RSS-210 A8.5, FCC Part 15 Subpart C -15.247

MINIMUM STANDARD: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the radio frequency power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under Section A8.4(4), the attenuation required shall be 30 dB instead of 20 dB.

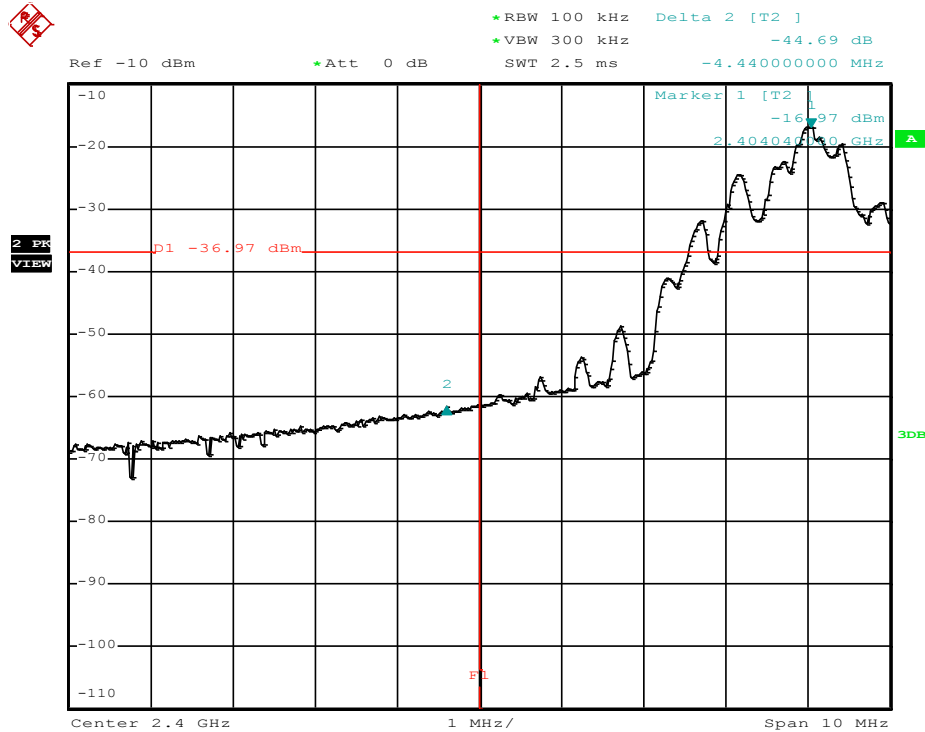
METHOD OF MEASUREMENT: Measurements were made using a horn antenna connected directly into a spectrum analyzer. The EUT was set up in a 1 meter open field test site, using the manufacturer's specified normal cabling configuration, with all cables over 1 meter in length bundled at 1 meter and retained from the floor. An application which transmitted a constant CW at the highest output power was used.

Emissions in the horizontal and vertical polarization were measured while rotating the EUT on a turntable to maximize the emissions signal strength and the results recorded on the attached plots.

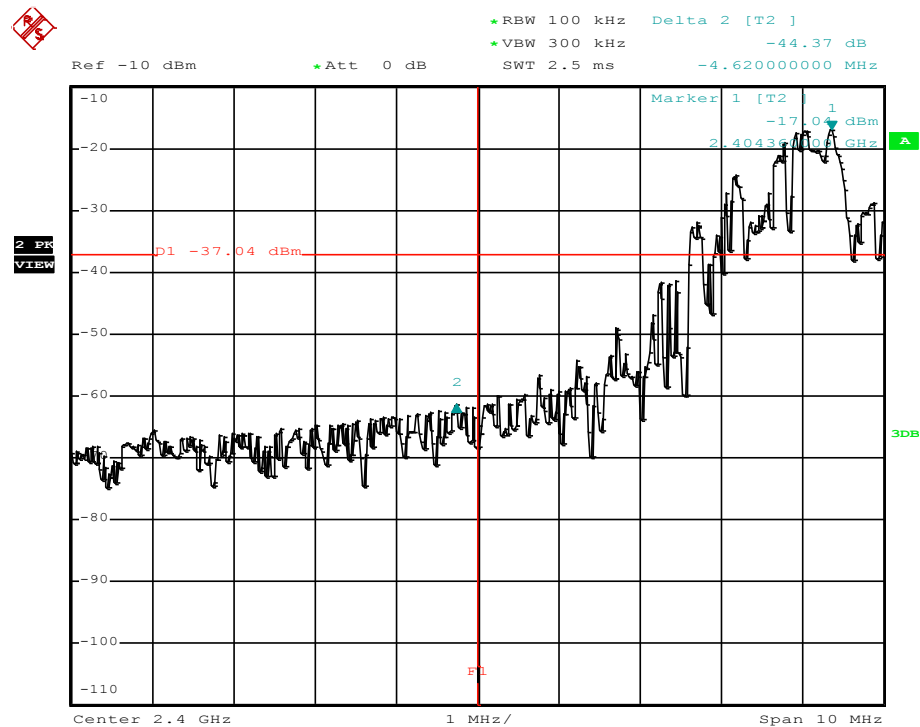
MODIFICATIONS: No modification is required to comply for this test.

PERFORMANCE: Complies with standard.

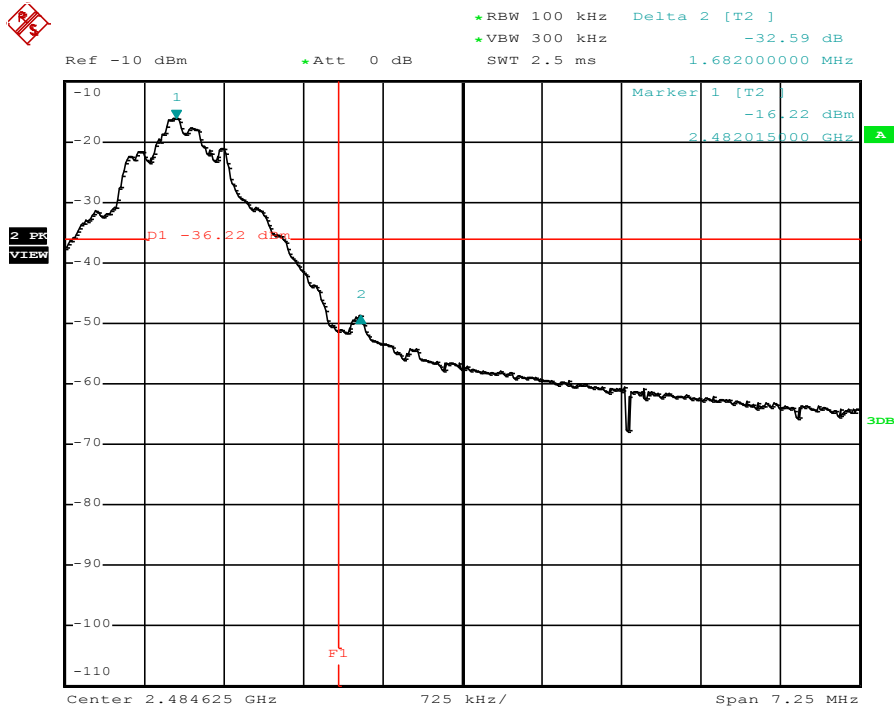
MEASUREMENT DATA:



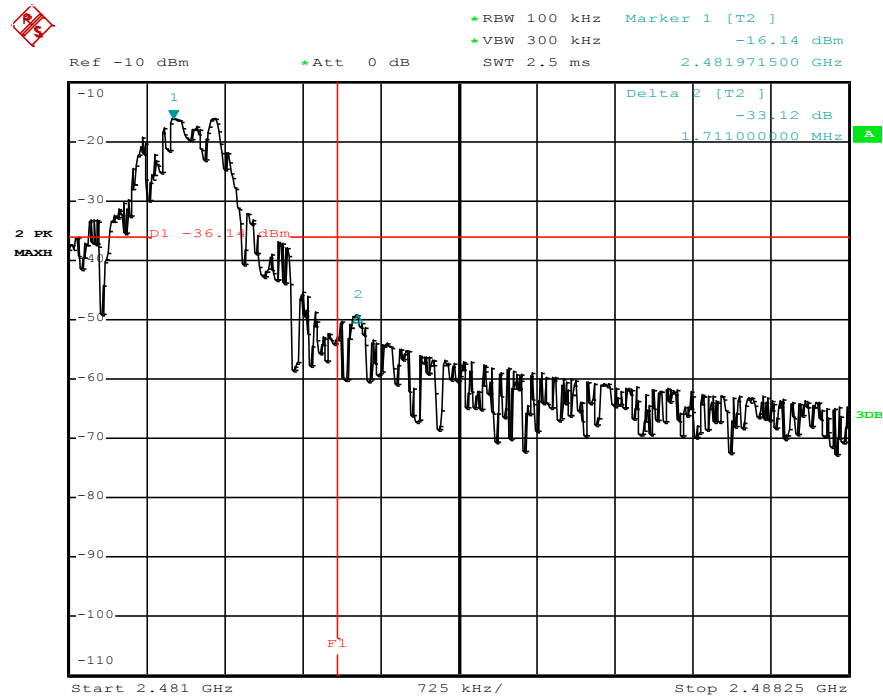
Plot 24: Low Channel Band-edge-Non hopping mode



Plot 25: Low Channel Band-edge- hopping mode



Plot 26: High Channel Band-edge Non Hopping Mode



Plot 27: High Channel Band-edge Hopping Mode

Part 11 - AC Mains Conducted Emissions

DATE: Dec 22, 2014

TEST STANDARD: FCC CFR47, Part 15, Subpart B, RSS-Gen Issue 4 (8.8)

TEST VOLTAGE: 120Vac/ 60Hz

MINIMUM STANDARD: Class B Limit:

Frequency (MHz)	Conducted Limit (dB μ V)	
	Quasi-Peak	Average
0.15 - 0.50	66 to 56	56 to 46
0.50 – 5	56	46
5-30	60	50
Note 1 The lower limit shall apply at the transition frequencies.		
Note 2 The limit decreases linearly with the logarithm of the frequency in the 0.15 to 0.50 MHz		

TEST SETUP: The laptop supplying the power to EUT was connected 120Vac/60Hz supply through the LISN. EUT was powered up using the USB port of the Laptop. AC Power line conducted emissions was performed on the AC input of the laptop used to supply power to the EUT. During this test transmitter was set up to transmit in its worst case scenario. Test was also performed when transmitter was not transmitting but the worst case data is reported in this report.

METHOD OF MEASUREMENT: Measurements were performed using a test receiver with 9 kHz bandwidth, CISPR Quasi-Peak and Average detector. AC mains conducted emissions were verified in transmitting mode and non-transmitting mode. But the data from transmitting mode was worst and reported in this report.

DEVICE DESCRIPTIONS: As described in the Equipment under Test Section, above.

CABLING DETAILS: Refer to Equipment Under Test Section for Cabling.

MODIFICATIONS: No modification is required to comply for this test.

PERFORMANCE: Complies with standard.

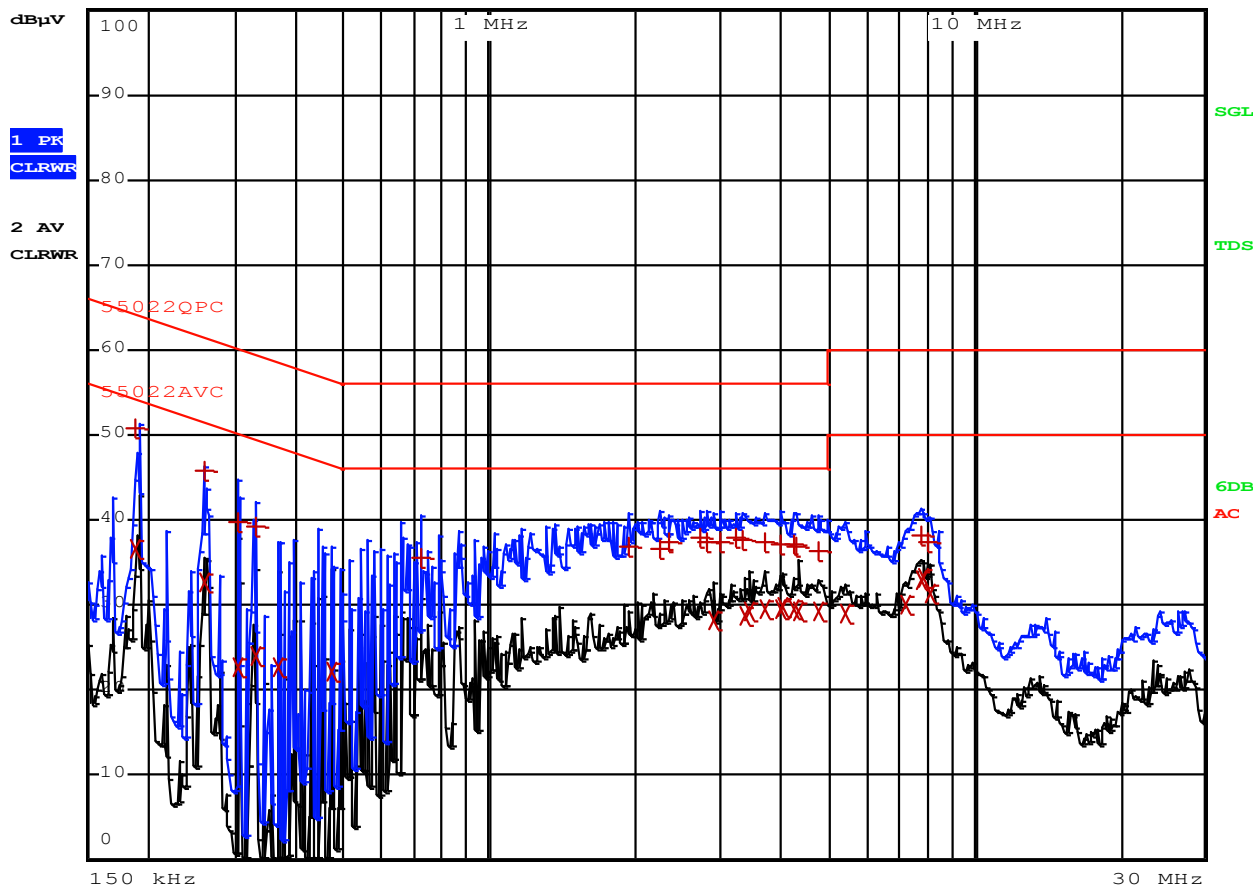
AC POWER LINE EMISSIONS DATA:

Line 1 120VAC/60Hz-Transmitting Mode



RBW 9 kHz
MT 1 s

Att 10 dB AUTO PREAMP OFF



EDIT PEAK LIST (Final Measurement Results)				
Trace1:	55022QPC			
Trace2:	55022AVC			
Trace3:	---			
TRACE	FREQUENCY	LEVEL dBµV		DELTA LIMIT dB
1 Quasi Peak	190 kHz	50.83	N gnd	-13.20
1 Quasi Peak	258 kHz	45.79	L1 gnd	-15.69
2 Average	4.034 MHz	29.73	L1 gnd	-16.26
2 Average	3.702 MHz	29.47	L1 gnd	-16.52
2 Average	4.01 MHz	29.47	L1 gnd	-16.52
2 Average	4.282 MHz	29.42	N gnd	-16.57
2 Average	4.778 MHz	29.32	N gnd	-16.67
2 Average	3.454 MHz	29.31	N gnd	-16.68
2 Average	4.378 MHz	29.17	N gnd	-16.83
2 Average	7.87 MHz	33.13	N gnd	-16.86
2 Average	7.786 MHz	33.02	N gnd	-16.98
2 Average	3.366 MHz	28.64	L1 gnd	-17.35
2 Average	190 kHz	36.68	N gnd	-17.35
2 Average	2.914 MHz	28.10	L1 gnd	-17.89
1 Quasi Peak	3.254 MHz	38.03	N gnd	-17.96
1 Quasi Peak	2.718 MHz	37.95	N gnd	-18.04
1 Quasi Peak	3.33 MHz	37.77	N gnd	-18.22
1 Quasi Peak	3.702 MHz	37.51	N gnd	-18.48
1 Quasi Peak	2.362 MHz	37.48	N gnd	-18.52
1 Quasi Peak	2.834 MHz	37.41	L1 gnd	-18.58

EDIT PEAK LIST (Final Measurement Results)				
Trace1:	55022QPC			
Trace2:	55022AVC			
Trace3:	---			
TRACE	FREQUENCY	LEVEL dBµV		DELTA LIMIT dB
1 Quasi Peak	2.99 MHz	37.34	L1 gnd	-18.65
2 Average	8.158 MHz	31.28	L1 gnd	-18.71
2 Average	258 kHz	32.78	L1 gnd	-18.71
1 Quasi Peak	4.01 MHz	37.19	L1 gnd	-18.80
1 Quasi Peak	4.278 MHz	37.09	N gnd	-18.90
1 Quasi Peak	4.302 MHz	36.88	N gnd	-19.11
1 Quasi Peak	1.942 MHz	36.85	N gnd	-19.14
1 Quasi Peak	2.246 MHz	36.70	L1 gnd	-19.29
1 Quasi Peak	4.778 MHz	36.31	L1 gnd	-19.68
2 Average	7.266 MHz	30.17	N gnd	-19.82
1 Quasi Peak	330 kHz	39.32	N gnd	-20.12
1 Quasi Peak	302 kHz	39.65	N gnd	-20.53
1 Quasi Peak	726 kHz	35.45	N gnd	-20.54
2 Average	5.446 MHz	28.90	L1 gnd	-21.09
1 Quasi Peak	7.786 MHz	38.18	N gnd	-21.81
1 Quasi Peak	8.042 MHz	37.47	N gnd	-22.53
2 Average	470 kHz	22.07	L1 gnd	-24.44
2 Average	330 kHz	23.89	N gnd	-25.55
2 Average	366 kHz	22.68	N gnd	-25.90
2 Average	302 kHz	22.76	N gnd	-27.42

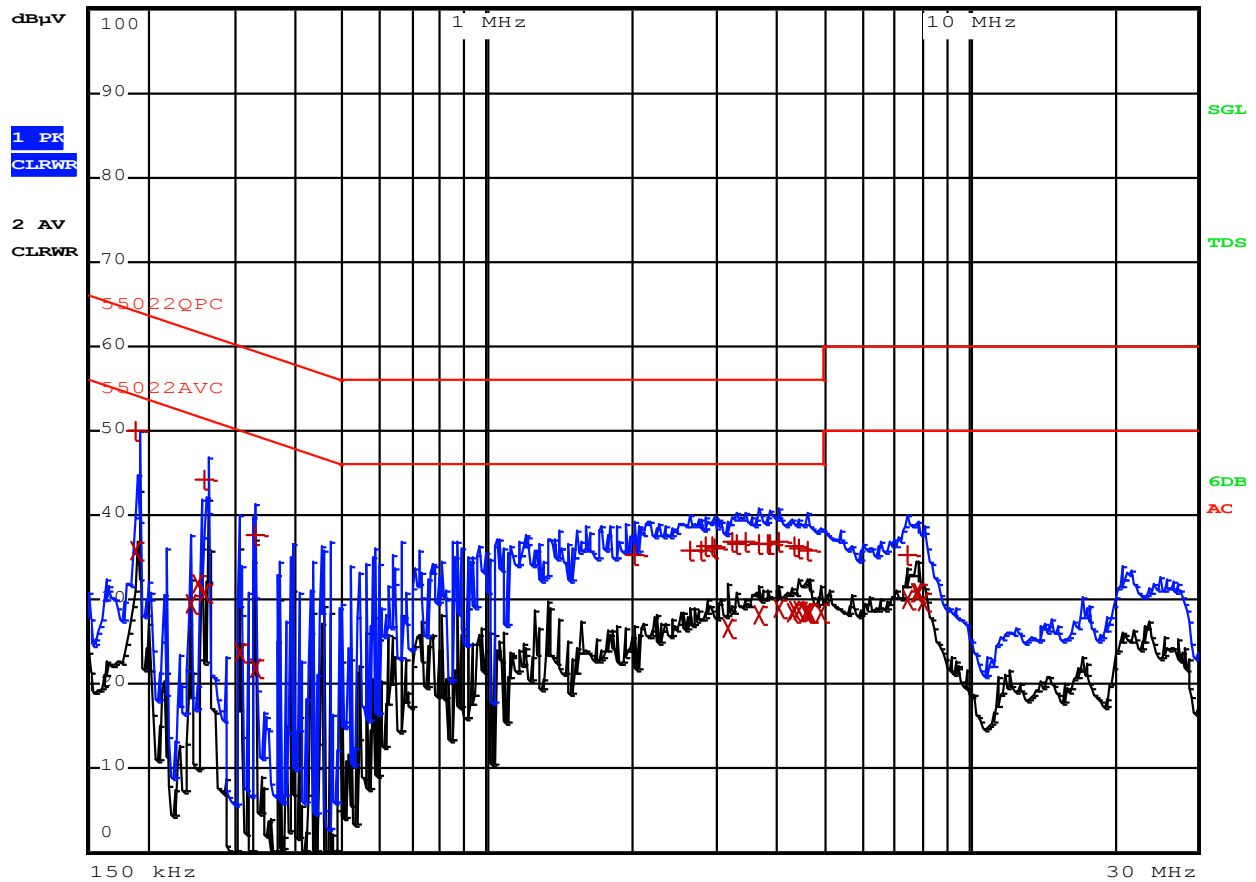
Line 2 120VAC/60Hz-Transmitting Mode



RBW 9 kHz

MT 1 s

Att 10 dB AUTO PREAMP OFF



EDIT PEAK LIST (Final Measurement Results)				
Trace1:	55022QPC			
Trace2:	55022AVC			
Trace3:	---			
TRACE	FREQUENCY	LEVEL dBµV		DELTA LIMIT dB
1 Quasi Peak	3.318 MHz	36.60	L1 gnd	-19.39
1 Quasi Peak	3.878 MHz	36.60	L1 gnd	-19.39
1 Quasi Peak	4.338 MHz	36.32	L1 gnd	-19.67
1 Quasi Peak	2.85 MHz	36.28	N gnd	-19.71
2 Average	254 kHz	31.88	N gnd	-19.74
1 Quasi Peak	2.938 MHz	36.25	N gnd	-19.74
1 Quasi Peak	2.966 MHz	36.21	L1 gnd	-19.78
1 Quasi Peak	4.458 MHz	36.11	N gnd	-19.88
2 Average	7.474 MHz	30.07	L1 gnd	-19.92
1 Quasi Peak	2.798 MHz	35.93	L1 gnd	-20.07
2 Average	8.062 MHz	29.90	N gnd	-20.09
1 Quasi Peak	2.646 MHz	35.84	L1 gnd	-20.15
1 Quasi Peak	4.646 MHz	35.75	N gnd	-20.25
2 Average	262 kHz	30.89	L1 gnd	-20.47
1 Quasi Peak	2.038 MHz	35.34	N gnd	-20.65
1 Quasi Peak	330 kHz	37.79	L1 gnd	-21.66
2 Average	242 kHz	29.56	N gnd	-22.45
1 Quasi Peak	7.506 MHz	35.27	N gnd	-24.72
2 Average	306 kHz	23.78	N gnd	-26.29
2 Average	330 kHz	21.78	N gnd	-27.66

EDIT PEAK LIST (Final Measurement Results)				
Trace1:	55022QPC			
Trace2:	55022AVC			
Trace3:	---			
TRACE	FREQUENCY	LEVEL dBµV		DELTA LIMIT dB
1 Quasi Peak	190 kHz	50.09	N gnd	-13.94
2 Average	4.05 MHz	28.87	L1 gnd	-17.12
1 Quasi Peak	262 kHz	44.23	N gnd	-17.12
2 Average	4.458 MHz	28.79	L1 gnd	-17.20
2 Average	4.358 MHz	28.62	N gnd	-17.37
2 Average	4.61 MHz	28.58	N gnd	-17.41
2 Average	4.942 MHz	28.56	L1 gnd	-17.43
2 Average	4.29 MHz	28.56	N gnd	-17.43
2 Average	4.646 MHz	28.56	L1 gnd	-17.43
2 Average	4.702 MHz	28.44	L1 gnd	-17.55
2 Average	3.686 MHz	28.22	N gnd	-17.78
2 Average	190 kHz	35.69	N gnd	-18.34
1 Quasi Peak	4.066 MHz	36.84	N gnd	-19.15
1 Quasi Peak	3.45 MHz	36.81	L1 gnd	-19.18
1 Quasi Peak	3.254 MHz	36.81	L1 gnd	-19.18
2 Average	7.794 MHz	30.79	N gnd	-19.20
2 Average	7.894 MHz	30.74	N gnd	-19.25
1 Quasi Peak	3.686 MHz	36.71	L1 gnd	-19.28
2 Average	3.166 MHz	26.69	L1 gnd	-19.30
1 Quasi Peak	3.822 MHz	36.63	N gnd	-19.36

Part 12 - Frequency Stability

DATE:	Oct 7, 2014
TEST STANDARD:	FCC Part 15.215(c) and RSS-Gen Issue 8 (8.11)
TEST VOLTAGE:	5Vdc
MINIMUM STANDARD:	Not specified. RSS-Gen (8.8) Transmitter frequency stability for licence-exempt radio apparatus shall be measured in accordance with Section 6.11. For licence-exempt radio apparatus, the frequency stability shall be measured at temperatures of -20°C (-4°F), +20°C (+68°F) and +50°C (+122°F) instead of at the temperatures specified in Section 6.11. If the frequency stability of the licence-exempt radio apparatus is not specified in the applicable standard (RSS), measurement of the frequency stability is not required provided that the occupied bandwidth of the licence-exempt radio apparatus lies entirely outside the restricted bands and the prohibited TV bands of 54-72 MHz, 76-88 MHz, 174-216 MHz, 470-608 MHz and 614-806 MHz. FCC (15.215(c)) The 20dB bandwidth must remain within the designated frequency band over the expected variations in temperature and voltage range
TEST SETUP:	The EUT was bench tested and in our temperature chamber. Due to the outdoor location and mounting method of the EUT, the EUT voltage and temperature range was specified by the manufacturer and verified at 2.6, 3 and 5Vdc; +50 to -30° Celsius. The transmitter was set for Carrier Wave (CW) mode and the lowest and highest channel Frequency was measured at each Temperature setting, after the Transmitter stabilized at the temperature.
MEASUREMENT METHOD:	Measurements were made using a Spectrum Analyzer with 120kHz RBW Average detector while directly connected to the EUT through the antenna port.
DEVICE DESCRIPTIONS:	As described in the above EUT description and setup section.

Measurement Data:

Temp	Channel	Pk Pwr Freq.	Uncorrected Peak Power	Corr.	Peak Pwr	Frequency Variance	Drift
(DegC)	(MHz)	(MHz)	(dBm)	(dB)	dBm	(KHz)	(KHz)
23.60	2404.00462700	2404.00462700	-11.71	31	19.29	0	Ref
-30.00		2404.00358200	-11.93	31	19.07	-1.045	< 100KHz
-20.00		2404.00392300	-11.81	31	19.19	-0.704	< 100KHz
-10.00		2404.00395800	-11.81	31	19.19	-0.669	< 100KHz
0.00		2404.00389400	-11.76	31	19.24	-0.733	< 100KHz
10.00		2404.00370200	-11.72	31	19.28	-0.925	< 100KHz
30.00		2404.00373400	-11.77	31	19.23	-0.893	< 100KHz
50.00		2404.00396500	-11.85	31	19.15	-0.662	< 100KHz
Mid Channel							
23.6	2442.007131	2442.007131	-11.96	31.2	19.24	0	Ref
-30		2442.006128	-11.33	31.2	19.87	-1.003	< 100KHz
-20		2442.00609	-11.45	31.2	19.75	-1.041	< 100KHz
-10		2442.006956	-11.63	31.2	19.57	-0.175	< 100KHz
0		2442.00689	-11.77	31.2	19.43	-0.241	< 100KHz
10		2442.00701	-12.01	31.2	19.19	-0.121	< 100KHz
30		2442.007019	-12.01	31.2	19.19	-0.1124	< 100KHz
50		2442.006115	-12.01	31.2	19.19	-1.0163	< 100KHz
High Channel							
23.6	2482.005356	2482.005356	-12.41	31.5	19.09	0	Ref
-30		2482.004608	-12.58	31.5	18.92	-0.748	< 100KHz
-20		2482.005512	-12.6	31.5	18.9	0.156	< 100KHz
-10		2482.00459	-12.55	31.5	18.95	-0.766	< 100KHz
0		2482.00501	-12.52	31.5	18.98	-0.346	< 100KHz
10		2482.0051	-12.47	31.5	19.03	-0.256	< 100KHz
30		2482.0049	-12.45	31.5	19.05	-0.456	< 100KHz
50		2482.0045	-12.41	31.5	19.09	-0.856	< 100KHz

Part 13 - RF Exposure Evaluation

FCC 1.1310 states the criteria listed in the table below shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Section 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Section 2.1093. Further information on evaluating compliance with these limits can be found in the FCC's OST/OET Bulletin Number 65, "Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radiofrequency Radiation".

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Average Time (s)
(A) Limits for Occupational/Control Exposures				
300-1500	-	-	F/300	6
1500-100,000	-	-	5	6
(B) Limits for General Population/Uncontrolled Exposures				
300-1500	-	-	F/1500	6
1500-100,000	-	-	1	30

1.1 EUT OPERATING CONDITION

- The antenna used for this product is a Chip antenna and is designed for a Peak antenna gain of 1.3 dBi (peak)
- Highest measured conducted output level = 19.29 dBm
- From Table 1, the Maximum Power Density safe exposure level for General Population Uncontrolled
- Exposure of 30 Seconds for the frequency range of 2.4 to 2.4835GHz is 1mW/cm²

Conducted Output Power (dBm)	Max Antenna Gain	Max EIRP (mW)	Power Density Limit Allowed (mW/cm ²)	Safe distance (cm)
19.29	1.3	114.55	1	3.01

1.2 RF EXPOSURE EVALUATION DISTANCE CALCULATION

$$d = \sqrt{\left(\frac{EIRP}{4\pi S}\right)}$$

where:

d = Distance to the center of radiation of the antenna (cm) for the allowable Power Density

S = Allowable Power density Limit (mW/cm²)

EIRP = Equivalent isotropically radiated power (mW) = 10 [TX Power (dBm) + Ant Gain (dBi)]/10

As shown above, the minimum distance where the MPE limit is reached is 3.01 cm from the EUT with the 1.3dBi antenna.

It is recommended that the unit is positioned so that the typical distance from the antenna to the end user is 20cm or greater.

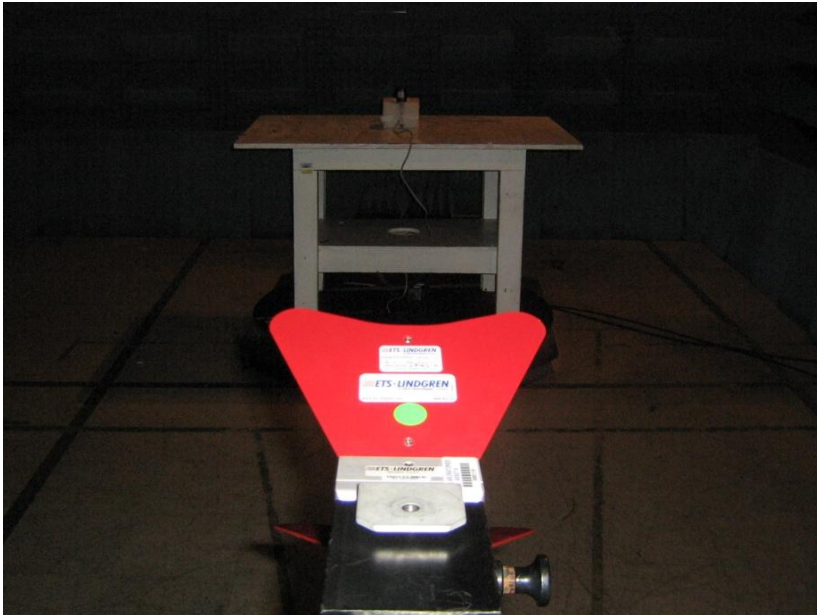
Appendix A: Test Setup Pictures



Radiated emissions test setup – EUT



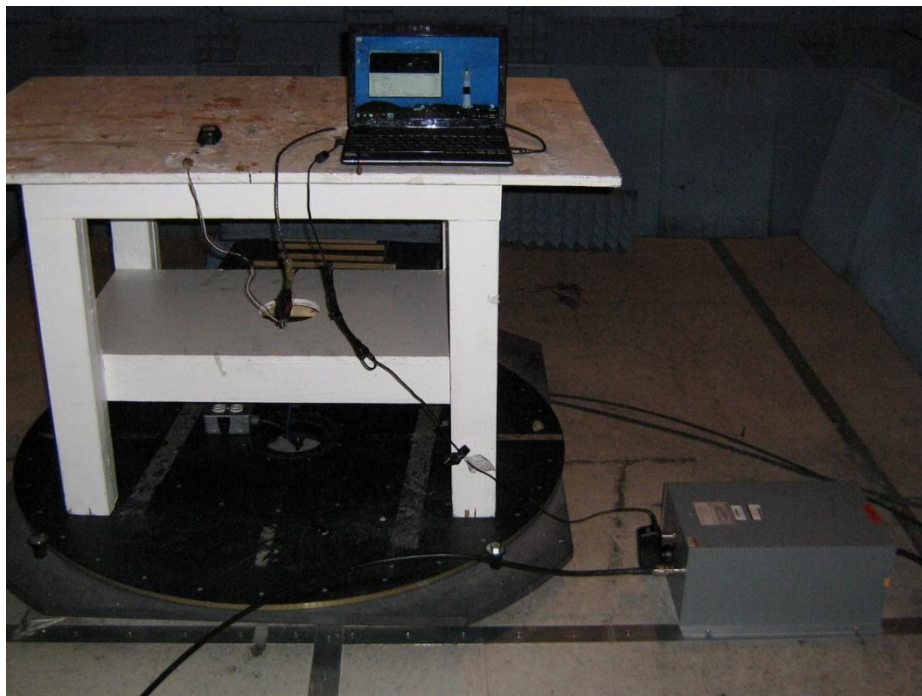
Radiated emissions test setup – 30MHz- 1GHz



Radiated emissions test setup – 1GHz- 18GHz



Radiated emissions test setup – below 30MHz



AC Power Line Conducted Emissions