

EMISSIONS TEST REPORT

Report Number: 102037004BOX-001c
Project Number: G101718120

Report Issue Date: 06/16/2015

Product Designation: 2048910

Standards: CFR47 Part 15 Subpart C 15.247 (2014)
CFR47 Part 15 Subpart B (2014)
IC RSS-210 Issue 8 December 2010 Annex 8
IC RSS-Gen Issue 4 November 2014
IC ICES-003 Issue 5 August 2012
IC RSS-102 Issue 4 March 2010 updated December 2010

Tested by:
Intertek Testing Services NA, Inc.
70 Codman Hill Road
Boxborough, MA 01719 U.S.A

Client:
Opex Corporation
305 Commerce Drive
Moorestown, NJ 08057 U.S.A

Report prepared by



Kouma Sinn / Staff Engineer, EMC

Report reviewed by



Vathana Ven / Staff Engineer, EMC

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1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 3.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested.

2 Test Summary

Section	Test full name	Result
3	Client Information	--
4	Description of Equipment Under Test	--
5	System Setup and Method	--
6	Maximum Peak Output Power, Human RF Exposure, & Duty Cycle CFR47 FCC Part 15 Subpart C (2014), Section 15.247 (b)(3) IC RSS-210 Issue 8 December 2010, A8.4 (4) IC RSS-102 Issue 4 March 2010 updated December 2010	Pass
7	Transmitter Radiated Spurious Emissions CFR47 FCC Part 15 Subpart C(2014), Section 15.247 (d) IC RSS-210 Issue 8 December 2010, A8.5	Pass
8	6 dB Bandwidth & 99% Power Bandwidth CFR47 FCC Part 15 Subpart C (2014), Section 15.247 (a)(2) IC RSS-210 Issue 8 December 2010, A8.2 (a)	Pass
9	Power Spectral Density CFR47 FCC Part 15 Subpart C (2014), Section 15.247 (e) IC RSS-210 Issue 8 December 2010, A8.2 (b)	Pass
10	Band-edge Compliance CFR47 FCC Part 15 Subpart C (2014), Section 15.247 (d) IC RSS-210 Issue 8 December 2010, A8.5	Pass
11	Digital Devices Radiated Spurious Emissions CFR47 FCC Part 15:2013 Subpart B Section 15.109 IC ICES-003 Issue 5 August 2012	Pass
--	Receiver Radiated Spurious Emissions CFR47 FCC Part 15 Subpart B (2014), Section 15.109 IC RSS-Gen Issue 4 November 2014, Section 7	Exempt, above 960 MHz
12	AC Mains Conducted Emissions CFR47 FCC Part 15 Subpart B (2014), Section 15.207 IC RSS-Gen Issue 4 November 2014, 8.8 (Table 3)	Pass
13	Revision History	--

3 Client Information

This EUT was tested at the request of:

Company: Opex Corporation
305 Commerce Drive
Moorestown, NJ 08057
U.S.A

Contact: Mr. Michael Powell
Telephone: (856) 727-1100 ext. 2267
Email: mpowell@opex.com

4 Description of Equipment Under Test

Equipment Under Test			
Description	Manufacturer	Model Number	Serial Number
iBot-New Antennae V2	Opex Corporation	2048910	BOX1503021541-001

Receive Date:	07/11/2014 & 03/02/2015
Received Condition:	Good
Type:	Production

Description of Equipment Under Test (provided by client)	
The Opex iBOT is a small radio controlled robotic vehicle which runs in a track system as part of a larger automated sorting machine. It uses Zigbee, 0-QPSK Modulation operates at frequency range of 2405-2480 MHz with a detachable antenna.	

Equipment Under Test Power Configuration			
Rated Voltage	Rated Current	Rated Frequency	Number of Phases
100-240 VAC	1.3 A	50/60 Hz	1

Operating modes of the EUT:	
No.	Descriptions of EUT Exercising
1	The iBOT was connected to a power supply which was powered by 120VAC. Opex Incorporated provided test commands to enable constant transmission at the maximum duty cycle that will be used in normal operation. Tests were performed on the high, middle, and low channels at maximum output power and in receive mode.

Software used by the EUT:

No.	Descriptions of EUT Exercising
1	Hyperterminal through RS232

5 System Setup and Method

Cables					
Qty	Description	Length (m)	Shielding	Ferrites	Termination
1	AC Mains	2	None	Yes	AC Mains

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
Laptop*	Dell	P/N: PU982AW#ABA	CNU6101PBW

*Notes: The laptop was used to program the device then disconnected during testing.

5.1 Method:

Configuration as required by ANSI C 63.4:2009, FCC Part 15 Subpart C (2014) Section 15.247, RSS-210 Issue 8 December 2010, IC RSS-Gen Issue 4 November 2014 , and ANSI C63.10:2013.

5.2 EUT Block Diagram:



6 Maximum Peak Output Power, Human RF Exposure, & Duty Cycle

6.1 Method

Tests are performed in accordance with FCC Part 15 Subpart C Section 15.247, ANSI C63.10:2013, ANSI C63.4:2009, RSS-102, FCC Part 2.1093, KDB558074 V03:2013, and RSS-210 Annex 8.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	4.6	6.3
Radiated Emissions, 3m	30-1000 MHz	5.3	6.3
Radiated Emissions, 3m	1-6 GHz	4.5	5.2
Radiated Emissions, 3m	6-15 GHz	5.2	5.5
Radiated Emissions, 3m	15-18 GHz	5.0	5.5
Radiated Emissions, 3m	18-40 GHz	5.0	5.5

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where FS = Field Strength in $\text{dB}\mu\text{V}/\text{m}$

RA = Receiver Amplitude (including preamplifier) in $\text{dB}\mu\text{V}$

CF = Cable Attenuation Factor in dB

AF = Antenna Factor in dB

AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 $\text{dB}\mu\text{V}$ is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 $\text{dB}\mu\text{V}/\text{m}$. This value in $\text{dB}\mu\text{V}/\text{m}$ was converted to its corresponding level in $\mu\text{V}/\text{m}$.

$$RA = 52.0 \text{ dB}\mu\text{V}$$

$$AF = 7.4 \text{ dB}/\text{m}$$

$$CF = 1.6 \text{ dB}$$

$$AG = 29.0 \text{ dB}$$

$$FS = 32 \text{ dB}\mu\text{V}/\text{m}$$

To convert from $\text{dB}\mu\text{V}$ to μV or mV the following was used:

$$UF = 10^{(NF/20)} \text{ where } UF = \text{Net Reading in } \mu\text{V}$$

$$NF = \text{Net Reading in } \text{dB}\mu\text{V}$$

Example:

$$FS = RA + AF + CF - AG = 52.0 + 7.4 + 1.6 - 29.0 = 32.0$$

$$UF = 10^{(32 \text{ dB}\mu\text{V}/\text{m} / 20)} = 39.8 \mu\text{V}/\text{m}$$

Alternately, when C5 Software is used, the "Level" includes all losses and gains and is compared directly in the "Margin" column to the "Limit". "AF" is the Antenna Factor; "PA+CL" are Preamp and Cable Loss. These are already accounted for in the "Level" column.

6.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV004'	Weather Station	Davis Instruments	7400	PE80529A61A	09/25/2012	09/25/2014
CBL030'	High Frequency Cable 40GHz	Megaphase	TM40 K1K1 80	CBL030	04/05/2014	04/05/2015
ROS001'	Spectrum Analyzer 20Hz - 40 GHz	Rohde & Schwartz	FSEK-30	100225	05/19/2014	05/19/2015
WEI8'	Attenuator	Weinschel Corp	47-10-34	BD8309	03/26/2014	03/26/2015
MAN1'	Digital 4 Line Barometer	Mannix	0ABA116	MAN1	08/13/2012	08/13/2014
ETS001'	1-18GHz DRG Horn Antenna	ETS-Lindgren	3117	00143259	01/06/2014	01/06/2015
145-416'	Cables 145-400 145-402 145-404 145-408	Huber + Suhner	3m Track B cables	multiple	10/04/2013	10/04/2014
145128'	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/17/2014	03/17/2015

Software Utilized:

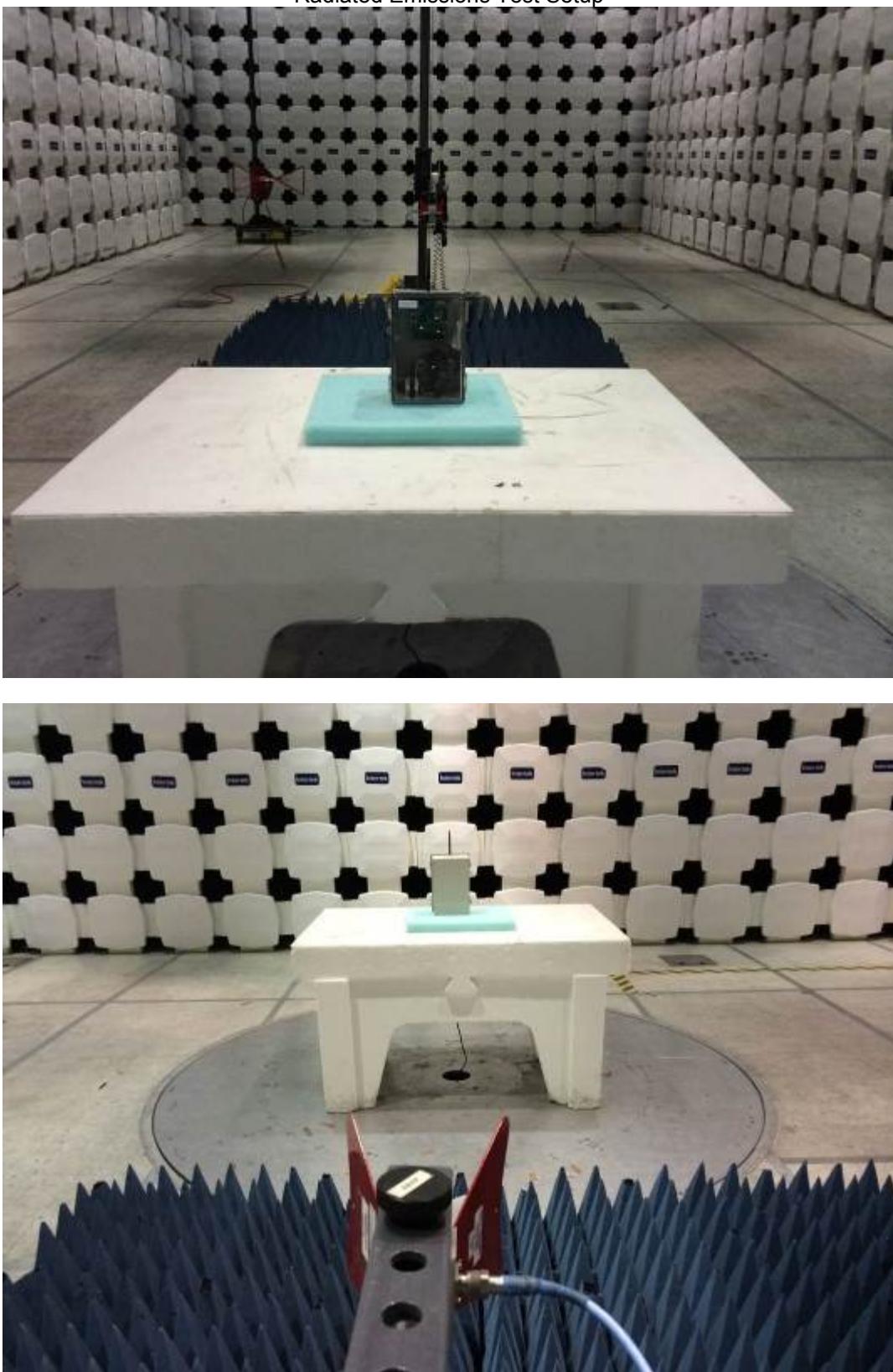
Name	Manufacturer	Version
Excel 2003	Microsoft	(11.8231.8221) SP3
EMI Boxborough.xls	Intertek	08/27/10

6.3 Results:

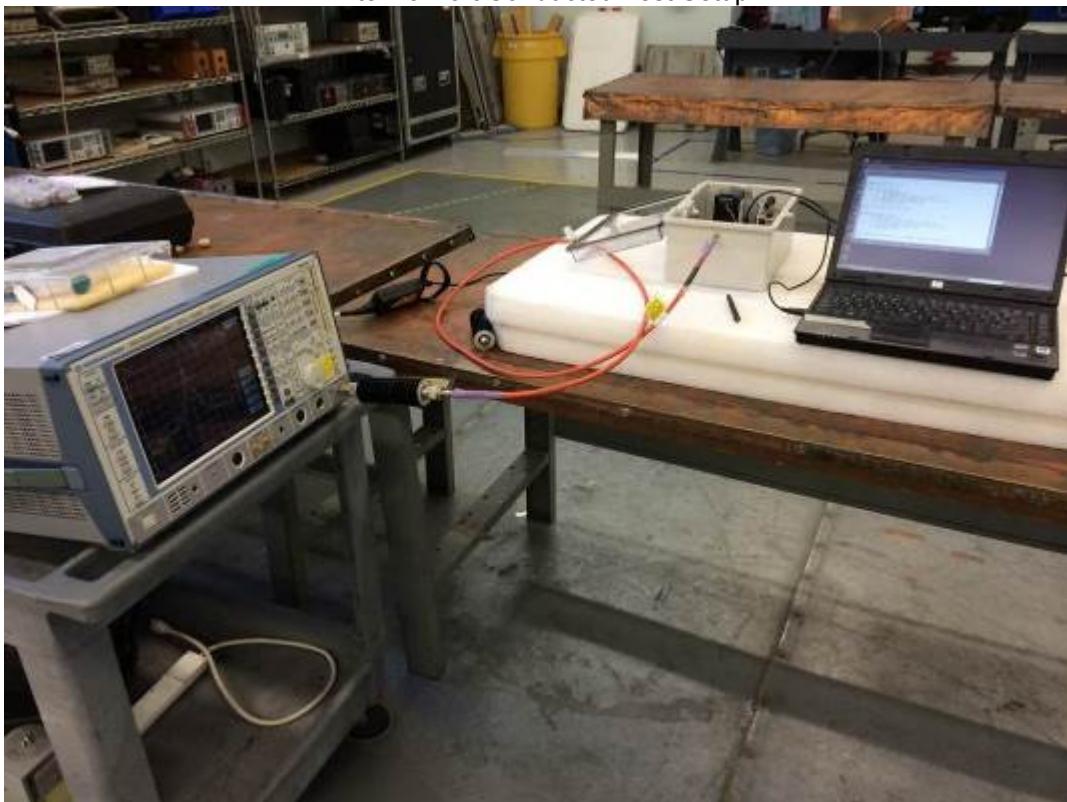
The sample tested was found to comply. The EIRP must not exceed 30 dBm. The Human RF Exposure limit is 1 mW/cm².

6.4 Setup Photographs:

Radiated Emissions Test Setup



Antenna Port Conducted Test Setup



Duty cycle Factor Setup



6.5 Test Data:**Radiated Fundamental Power**

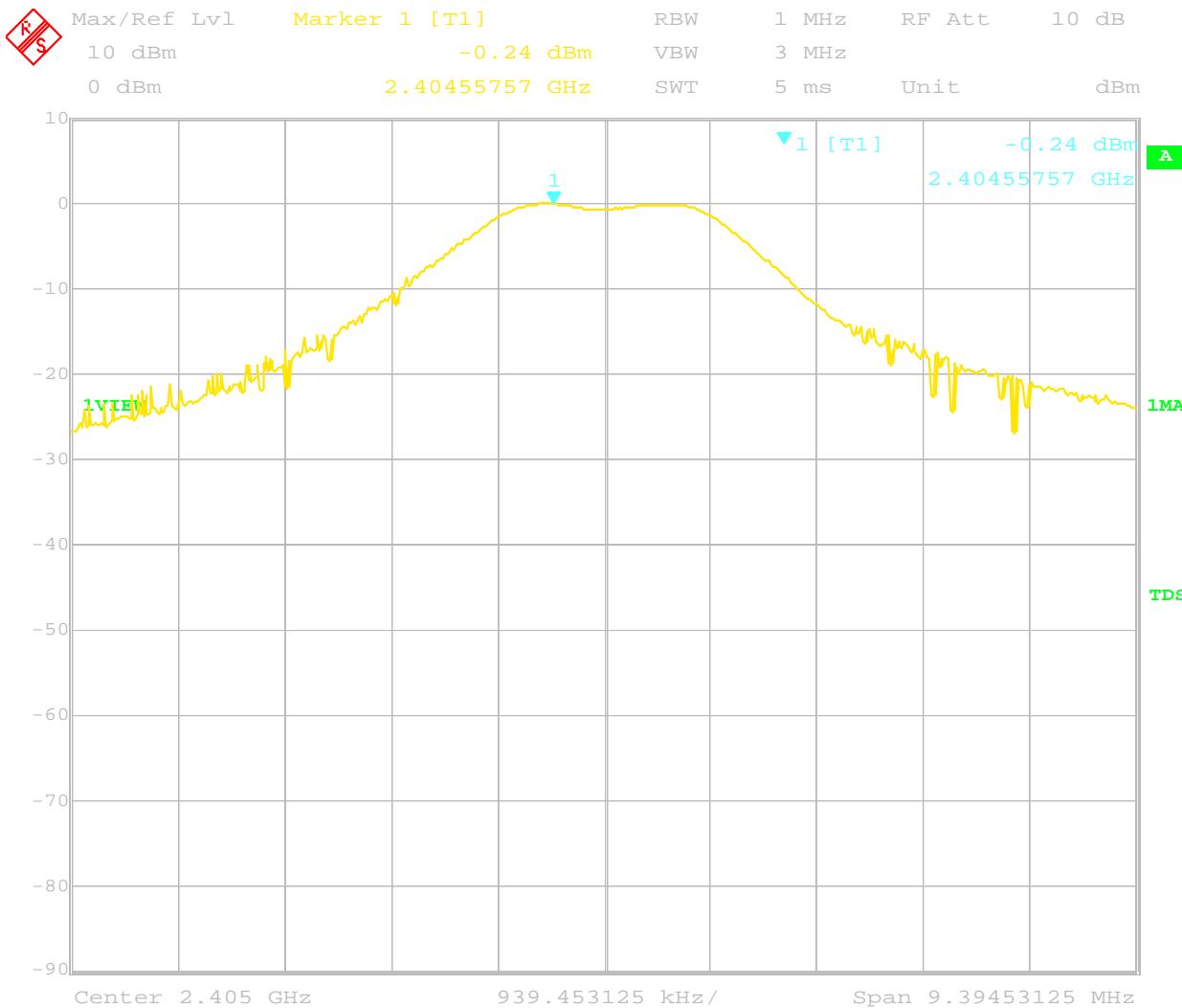
Company: Opex
 Model #: 2048910
 Serial #: BOX1503021541-001
 Engineers: Kouma Sinn
 Project #: G101718120 Date(s): 07/15/14
 Standard: FCC Part 15 Subpart C 15.247
 Receiver: 145-128 Limit Distance (m): 3
 PreAmp: NONE. Test Distance (m): 3
 PreAmp Used? (Y or N): N Voltage/Frequency: 120VAC/60Hz Frequency Range: Fundamental Frequencies
 Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)
 Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dBm	Limit dBm	Margin dB	Bandwidth
Tx: CH 2405 MHz - Fundamental Output Power = Peak Reading - 95.22. At 3 meters with no pre-amp											
PK	V	2405.000	61.42	32.11	5.92	0.00	0.00	4.23	30.00	-25.77	1/3MHz
PK	H	2405.000	56.35	32.11	5.92	0.00	0.00	-0.84	30.00	-30.84	1/3MHz
PK	V	2405.000	61.31	32.11	5.92	0.00	0.00	4.12	30.00	-25.88	5/10MHz
PK	H	2405.000	56.42	32.11	5.92	0.00	0.00	-0.77	30.00	-30.77	5/10MHz
Tx: CH 2440 MHz - Fundamental Output Power = Peak Reading - 95.22. At 3 meters with no pre-amp											
PK	V	2440.000	60.84	32.20	5.98	0.00	0.00	3.80	30.00	-26.20	1/3MHz
PK	H	2440.000	52.12	32.20	5.98	0.00	0.00	-4.92	30.00	-34.92	1/3MHz
PK	V	2440.000	60.93	32.20	5.98	0.00	0.00	3.89	30.00	-26.11	5/10MHz
PK	H	2440.000	52.45	32.20	5.98	0.00	0.00	-4.59	30.00	-34.59	5/10MHz
Tx: CH 2480 MHz - Fundamental Output Power = Peak Reading - 95.22. At 3 meters with no pre-amp											
PK	V	2480.000	58.47	32.30	6.06	0.00	0.00	1.61	30.00	-28.39	1/3MHz
PK	H	2480.000	51.29	32.30	6.06	0.00	0.00	-5.57	30.00	-35.57	1/3MHz
PK	V	2480.000	58.54	32.30	6.06	0.00	0.00	1.68	30.00	-28.32	5/10MHz
PK	H	2480.000	51.57	32.30	6.06	0.00	0.00	-5.29	30.00	-35.29	5/10MHz

FCC IC

Low Channel Antenna Port Conducted Fundamental Power, 102VAC/60Hz

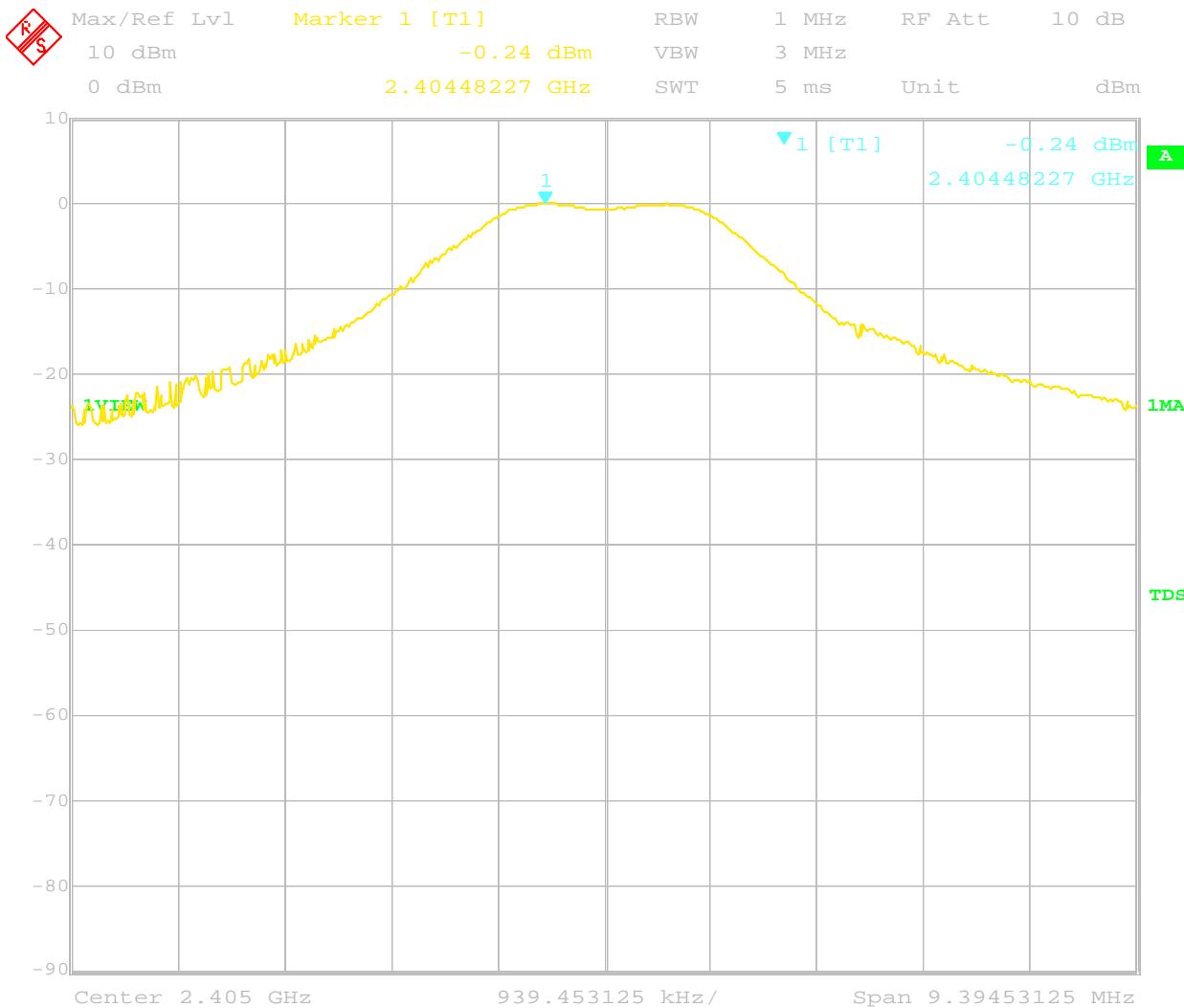
Power, -0.24 dBm



Date: 18.JUL.2014 11:54:21

Low Channel Antenna Port Conducted Fundamental Power, 120VAC/60Hz

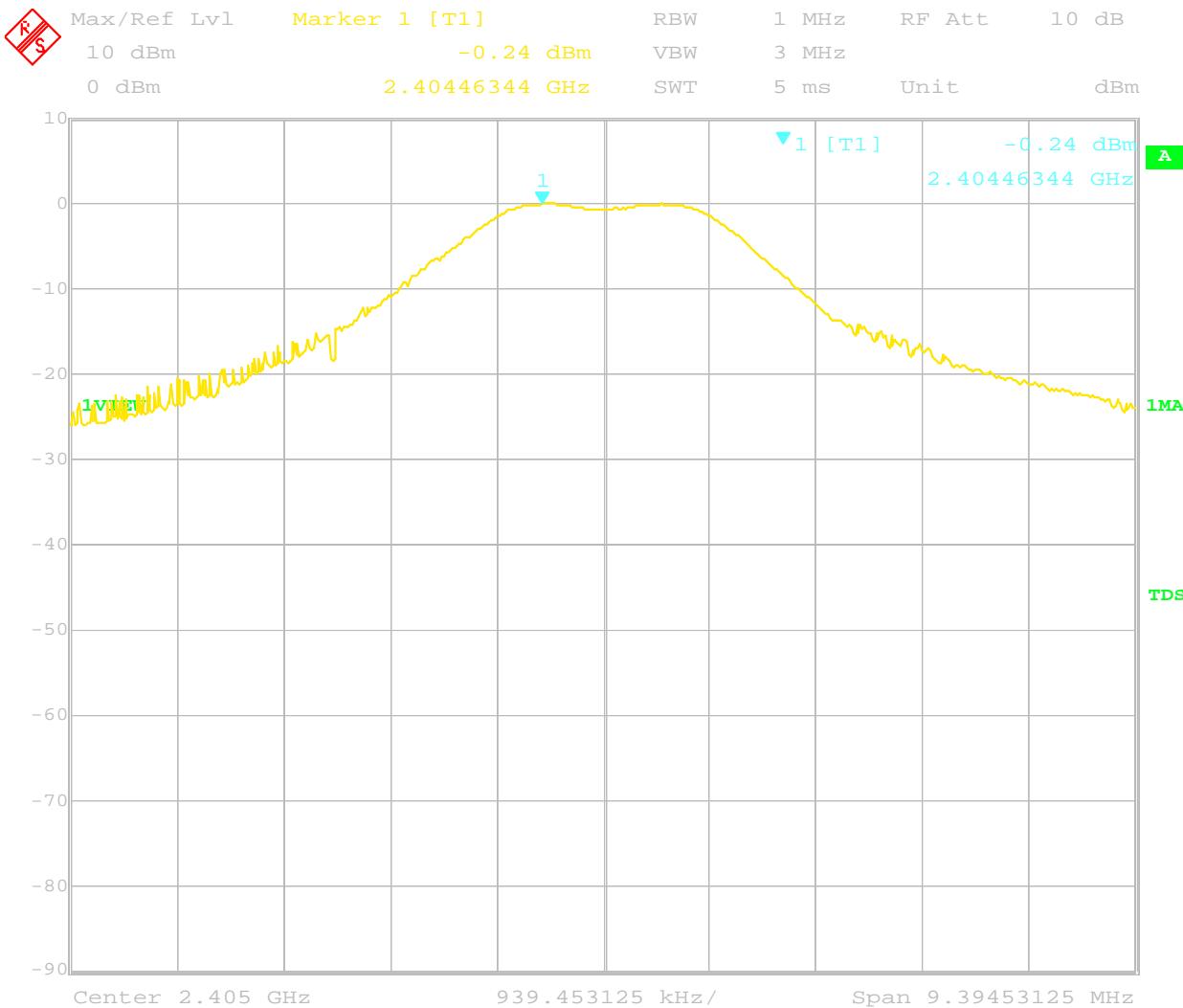
Power, -0.24 dBm



Date: 18.JUL.2014 11:50:21

Low Channel Antenna Port Conducted Fundamental Power, 138VAC/60Hz

Power, -0.24 dBm

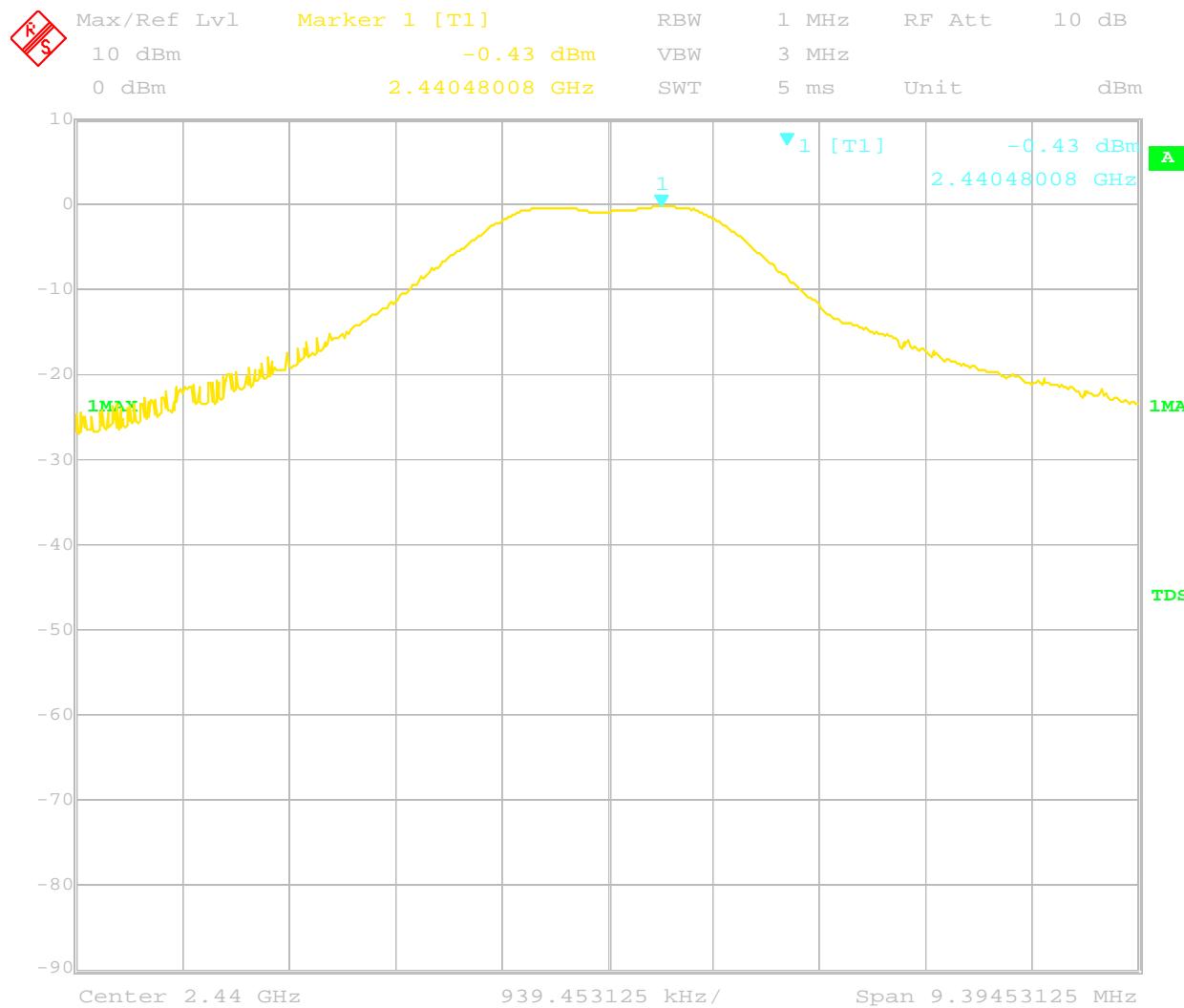


Date: 18.JUL.2014 11:57:59

Notes: There's no fundamental power variation with 85% and 115% of AC mains voltage. The rest of the channels fundamental power was measured at 120VAC/60Hz.

Mid Channel Antenna Port Conducted Fundamental Power, 120VAC/60Hz

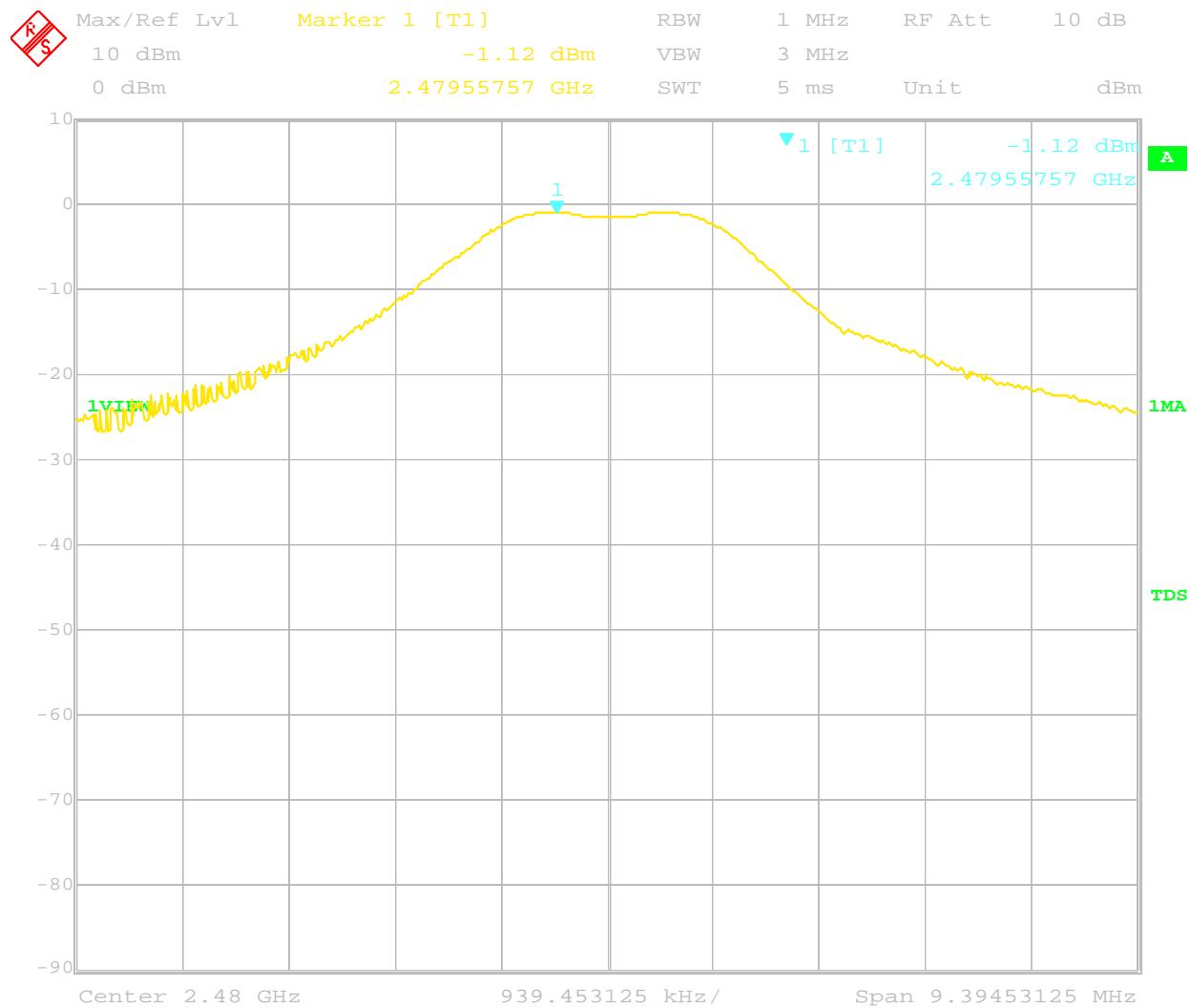
Power, -0.43 dBm



Date: 18.JUL.2014 12:10:15

High Channel Antenna Port Conducted Fundamental Power, 120VAC/60Hz

Power, -1.12 dBm



Date: 18.JUL.2014 12:22:44

Test Personnel: Kouma Sinn KPS
Supervising/Reviewing
Engineer:
(Where Applicable) N/A

Product Standard: FCC Part 15.247,
RSS-210 Annex 8
Input Voltage: 120VAC/60Hz

Pretest Verification w/
Ambient Signals or
BB Source: Ambient Signals

Test Date: 07/18/2014

Limit Applied: Emissions below the limits
specified in Section 6.3

Ambient Temperature: 21 °C

Relative Humidity: 64 %

Atmospheric Pressure: 1012mbars

Deviations, Additions, or Exclusions: None

Human RF Exposure, & Duty Cycle

The EUT was measured in a radiated fashion. The RF output power was measured using a resolution bandwidth which encompassed the entire emission bandwidth. The data obtained was adjusted for equipment losses and converted from a field strength reading to a power reading using the provisions of FCC KDB 558074 and RSS-Gen 4.6. .

§1.1310 The criteria listed in table 1 shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices shall be evaluated according to the provisions of §2.1093 of this chapter.

Part §1.1310 Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	*100	6
3.0-30	1842/f	4.89/f	*900/f ²	6
30-300	61.4	0.163	1.0	6
300-1,500			f/300	6
1,500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*100	30
1.34-30	824/f	2.19/f	*180/f ²	30
30-300	27.5	0.073	0.2	30
300-1,500			f/1500	30
1,500-100,000			1.0	30

f = frequency in MHz * = Plane-wave equivalent power density

(1) Occupational/controlled exposure limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when a person is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure. The phrase *fully aware* in the context of applying these exposure limits means that an exposed person has received written and/or verbal information fully explaining the potential for RF exposure resulting from his or her employment. With the exception of *transient* persons, this phrase also means that an exposed person has received appropriate training regarding work practices relating to controlling or mitigating his or her exposure. Such training is not required for *transient* persons, but they must receive written and/or verbal information and notification (for example, using signs) concerning their exposure potential and appropriate means available to mitigate their exposure. The phrase *exercise control* means that an exposed person is allowed to and knows how to reduce or avoid exposure by administrative or engineering controls and work practices, such as use of personal protective equipment or time averaging of exposure.

(2) General population/uncontrolled exposure limits apply in situations in which the general public may be exposed, or in which persons who are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

RSS-102 Issue 5 Exposure Limits:**Table 4: RF Field Strength Limits for Devices Used by the General Public
(Uncontrolled Environment)**

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
0.003-10 ²¹	83	90	-	Instantaneous*
0.1-10	-	0.73/ <i>f</i>	-	6**
1.1-10	87/ <i>f</i> ^{0.5}	-	-	6**
10-20	27.46	0.0728	2	6
20-48	58.07/ <i>f</i> ^{0.25}	0.1540/ <i>f</i> ^{0.25}	8.944/ <i>f</i> ^{0.5}	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 <i>f</i> ^{0.3417}	0.008335 <i>f</i> ^{0.3417}	0.02619 <i>f</i> ^{0.6834}	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ <i>f</i> ^{1.2}
150000-300000	0.158 <i>f</i> ^{0.5}	4.21 x 10 ⁻⁴ <i>f</i> ^{0.5}	6.67 x 10 ⁻⁵ <i>f</i>	616000/ <i>f</i> ^{1.2}

Note: *f* is frequency in MHz.
 *Based on nerve stimulation (NS).
 ** Based on specific absorption rate (SAR).

1.1 Test Procedure

An MPE evaluation was performed in order to show that the device was compliant with §2.1091. The maximum power density was calculated for each transmitter at a separation distance of 20 cm.

For each transmitter the maximum power RF exposure at a 20 cm distance using the formula:

$$\text{Conducted Power}_{\text{mW}} = 10^{\text{ConductedPower(dBm)/10}}$$

$$\text{Power Density} = [\text{Conducted Power}_{\text{mW}} \times \text{Ant.Gain}] / [4\pi \times (20_{\text{cm}})^2]$$

1.2 Results:

$$\text{Maximum Conducted Output Power} = 10^{(-0.24/10)} \text{ or } 0.95 \text{ mW}$$

$$\text{Maximum Antenna Gain} = 2.14 \text{ dBi}$$

$$\text{Power Density} = (-0.24 \text{ dBm} + 2.14 \text{ dBi}) / 5025.6 \text{ or } 0.00038 \text{ mW/cm}^2$$

$$\text{Limit at 2.4 GHz} = 1 \text{ mW/cm}^2$$

$$\text{RSS-102 Issue 5 Exposure Limit at 2.4 GHz} = 5.35 \text{ W/m}^2$$

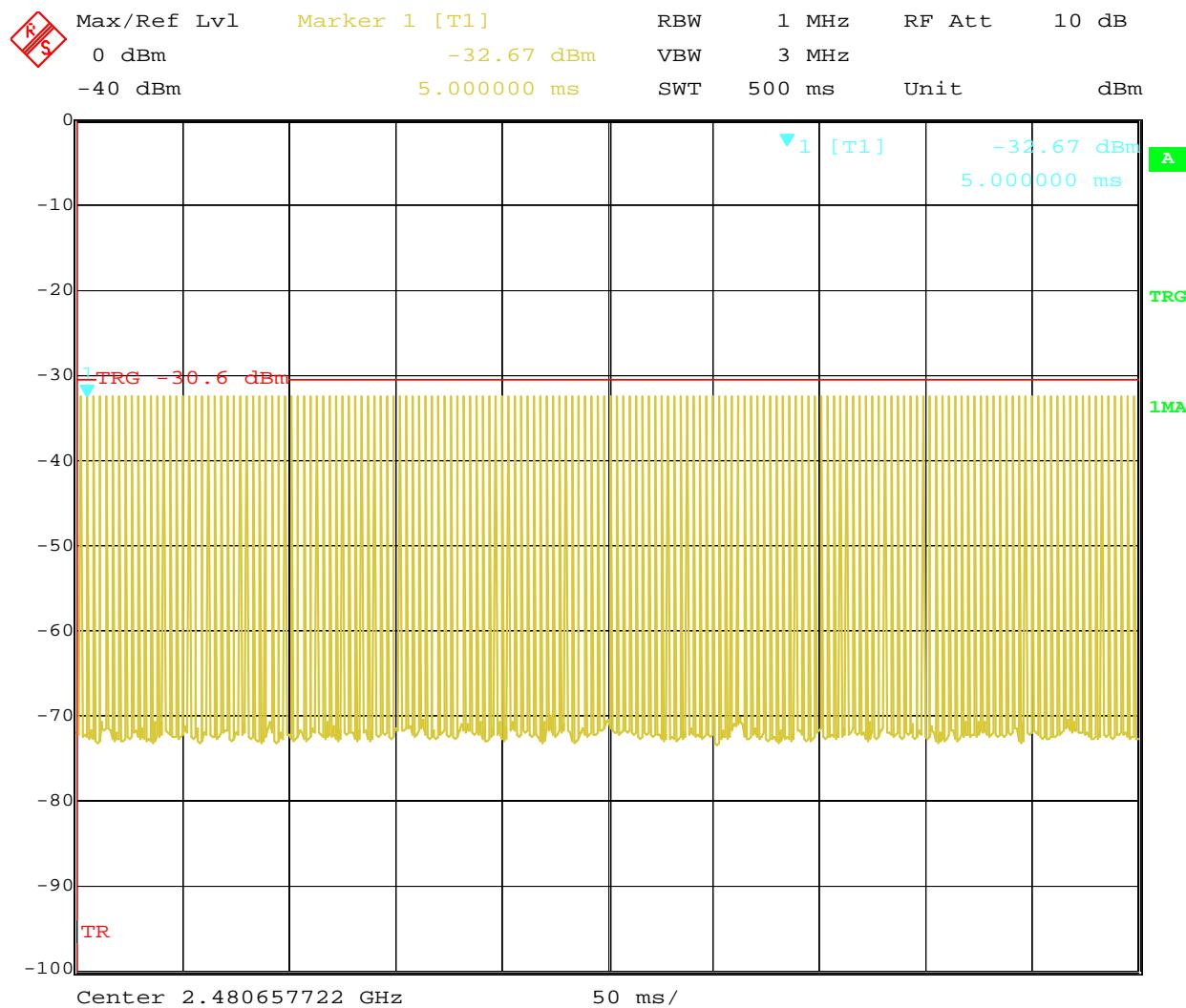
$$\text{Power Density} = 0.0038 \text{ W/m}^2$$

The calculated maximum power density at 20 cm distance is less than the limit for general population / uncontrolled exposure.

Duty Cycle:

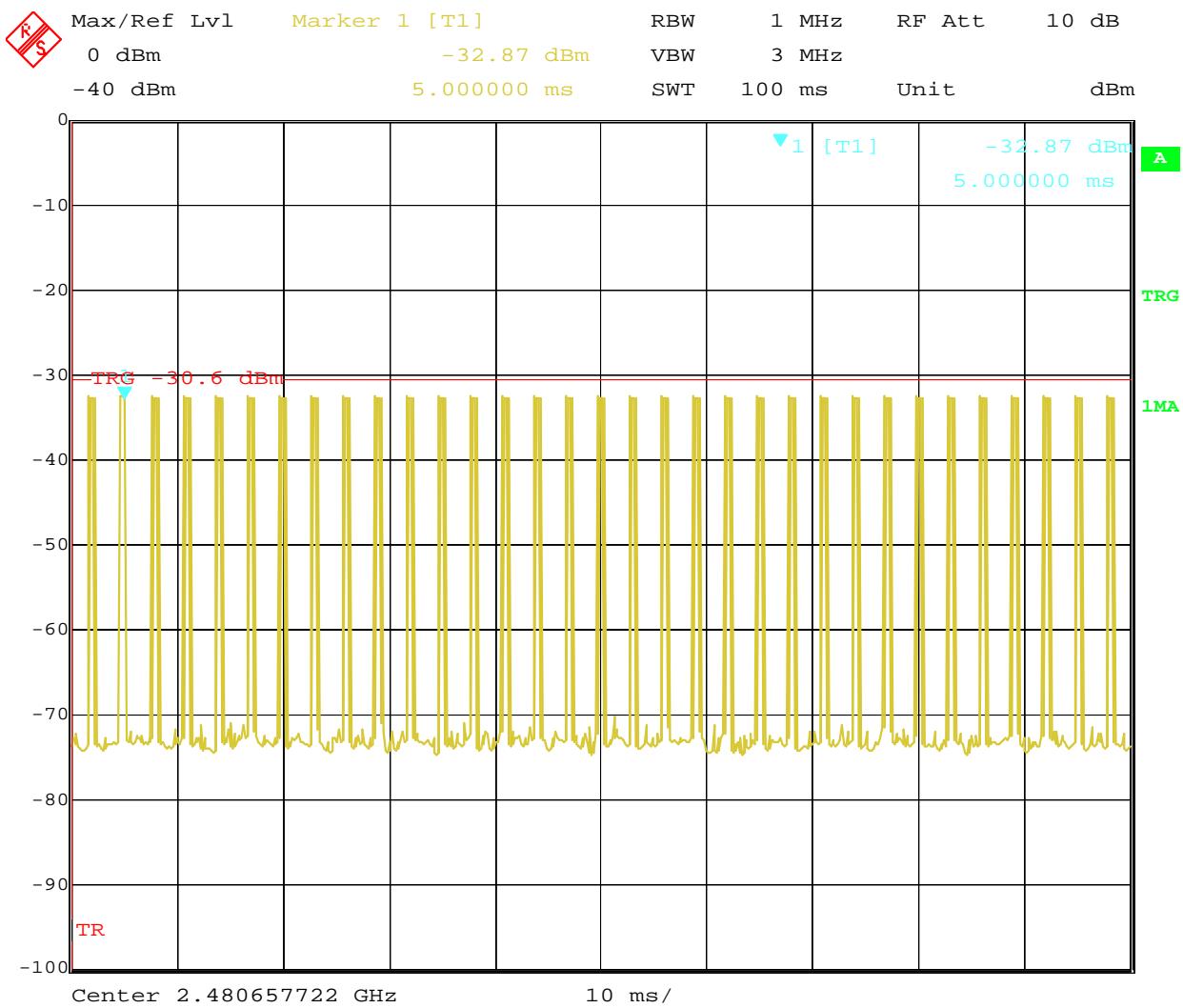
The worst-case duty cycle for typical EUT operation is shown below. The pulse train repeats over a larger than 100ms period.

Pulse train repeats longer than 100 ms



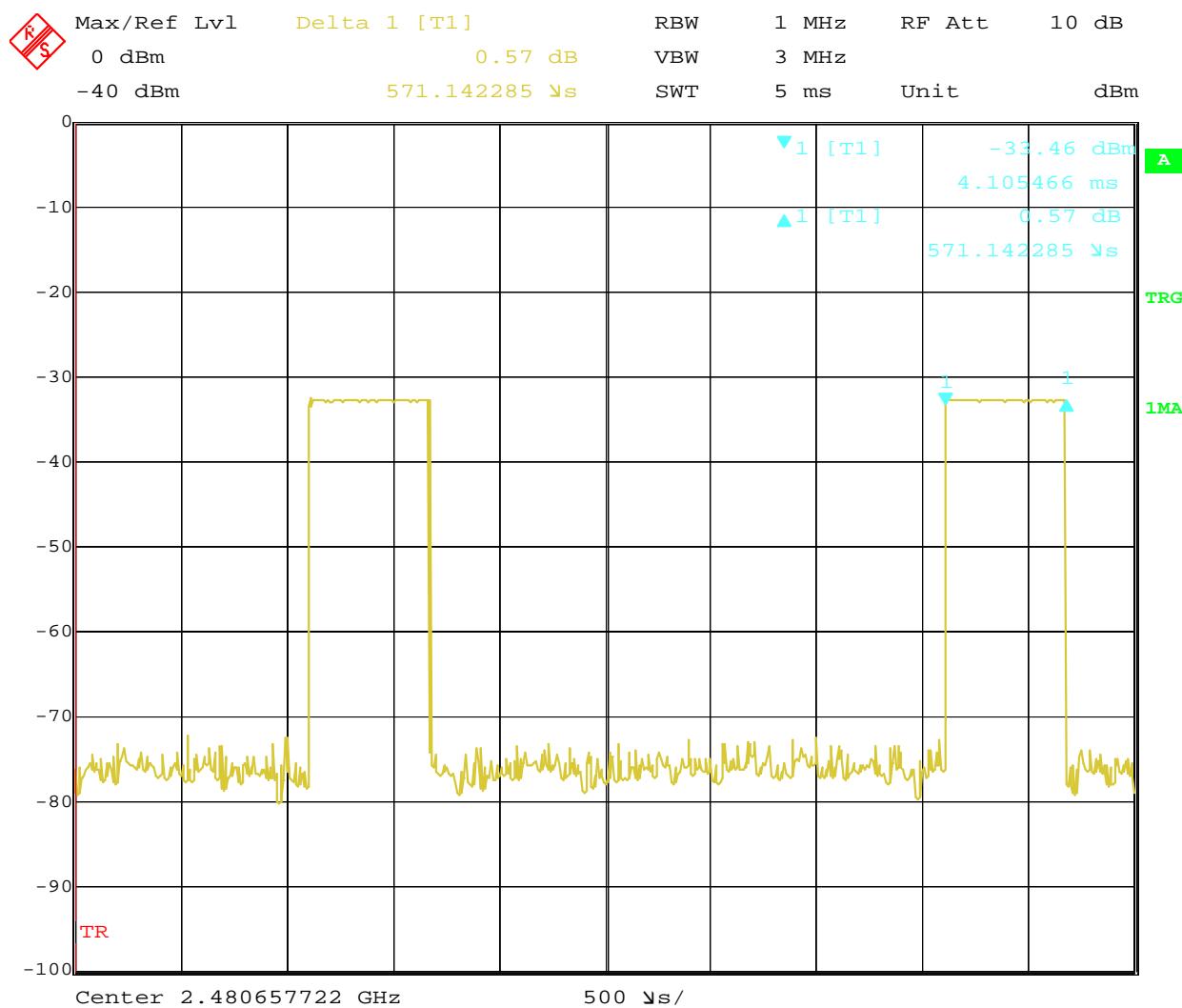
Date: 2.JAN.1997 22:53:28

Pulse train repeats within 100 ms



Date: 2.JAN.1997 22:57:45

Pulse Width



Date: 2.JAN.1997 23:01:01

Total on time = 18.8477 ms
 Duty Cycle = 18.8477/100 or 0.188477
 Average Factor = $20 \times \log (0.188477)$ or 14.5 dB

Test Personnel: Kouma Sinn KPS
 Supervising/Reviewing
 Engineer:
 (Where Applicable) N/A

Test Date: 5/13/2015

Product Standard: FCC Part 15.247,
 RSS-210 Annex 8
 Input Voltage: 120VAC/60Hz
 Pretest Verification w/
 Ambient Signals or
 BB Source: N/A

Limit Applied: Emissions below the limits
 specified in Section 6.3

Ambient Temperature: 23 °C

Relative Humidity: 26 %

Atmospheric Pressure: 1008 mbars

Deviations, Additions, or Exclusions: None

7 Transmitter Radiated Spurious Emissions

7.1 Method

Tests are performed in accordance with FCC Part 15 Subpart C Section 15.247, ANSI C63.4:2009, and RSS-210 Annex 8.

TEST SITE: EMC Lab & 10m ALSE

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	4.6	6.3
Radiated Emissions, 3m	30-1000 MHz	5.3	6.3
Radiated Emissions, 3m	1-6 GHz	4.5	5.2
Radiated Emissions, 3m	6-15 GHz	5.2	5.5
Radiated Emissions, 3m	15-18 GHz	5.0	5.5
Radiated Emissions, 3m	18-40 GHz	5.0	5.5

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where FS = Field Strength in $\text{dB}\mu\text{V}/\text{m}$

RA = Receiver Amplitude (including preamplifier) in $\text{dB}\mu\text{V}$

CF = Cable Attenuation Factor in dB

AF = Antenna Factor in dB

AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 $\text{dB}\mu\text{V}$ is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 $\text{dB}\mu\text{V}/\text{m}$. This value in $\text{dB}\mu\text{V}/\text{m}$ was converted to its corresponding level in $\mu\text{V}/\text{m}$.

$RA = 52.0 \text{ dB}\mu\text{V}$

$AF = 7.4 \text{ dB}/\text{m}$

$CF = 1.6 \text{ dB}$

$AG = 29.0 \text{ dB}$

$FS = 32 \text{ dB}\mu\text{V}/\text{m}$

To convert from $\text{dB}\mu\text{V}$ to μV or mV the following was used:

$$UF = 10^{(NF/20)} \text{ where } UF = \text{Net Reading in } \mu\text{V}$$

NF = Net Reading in $\text{dB}\mu\text{V}$

Example:

$$FS = RA + AF + CF - AG = 52.0 + 7.4 + 1.6 - 29.0 = 32.0$$

$$UF = 10^{(32 \text{ dB}\mu\text{V}/20)} = 39.8 \mu\text{V}/\text{m}$$

Alternately, when C5 Software is used, the "Level" includes all losses and gains and is compared directly in the "Margin" column to the "Limit". "AF" is the Antenna Factor; "PA+CL" are Preamp and Cable Loss. These are already accounted for in the "Level" column.

7.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
MAN1'	Digital 4 Line Barometer	Mannix	0ABA116	MAN1	08/13/2012	08/13/2014
145-410'	Cables 145-400 145-403 145-405 145-406 145-407	Huber + Suhner	10m Track A Cables	multiple	10/04/2013	10/04/2014
145128'	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/17/2014	03/17/2015
145106'	Bilog Antenna (30MHz - 5GHz)	Sunol Sciences	JB5	A111003	10/01/2013	10/01/2014
145003'	Preamplifier (150 KHz to 1.3 GHz)	Hewlett Packard	8447D	2443A04077	10/07/2013	10/07/2014
ETS001'	1-18GHz DRG Horn Antenna	ETS-Lindgren	3117	00143259	01/14/2015	01/14/2016
EMC04'	ANTENNA, RIDGED GUIDE, 18-40 GHZ	EMCO	3116	2090	04/07/2015	04/07/2016
PRE8'	PREAMPLIFIER 1- 40 GHz	MITEQ	NSP4000-NF	507145	04/15/2014	04/15/2015
145014'	Preamplifier (1 GHz to 26.5 GHz)	Hewlett Packard	8449B	3008A00232	05/05/2014	05/05/2015
CBLHF2012 -2M-1'	2m 9kHz-40GHz Coaxial Cable - SET1	Huber & Suhner	SF102	252675001	02/05/2015	02/05/2016
CBLHF2012 -5M-1'	5m 9kHz-40GHz Coaxial Cable - SET 1	Huber & Suhner	SF102	252676001	02/05/2015	02/05/2016
REA003'	1GHz High Pass Filter	Reactel, Inc	7HS-1G/10G-S11	06-1	12/30/2013	12/30/2015

Software Utilized:

Name	Manufacturer	Version
C5 Emissions	TESEQ	5.26.46.46
EMI Boxborough.xls	Intertek	08/27/2010

Equipment used for Antenna Port Conducted Measurements

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV004'	Weather Station	Davis Instruments	7400	PE80529A61A	09/25/2012	09/25/2014
REA006'	18GHz High Pass Filter	Reactel, Inc	7HS-18G/40G K11	(06)1	08/08/2012	08/08/2014
CBL030'	High Frequency Cable 40GHz	Megaphase	TM40 K1K1 80	CBL030	04/05/2014	04/05/2015
ROS001'	Spectrum Analyzer 20Hz - 40 GHz	Rohde & Schwartz	FSEK-30	100225	05/19/2014	05/19/2015
WEI8'	Attenuator	Weinschel Corp	47-10-34	BD8309	03/26/2014	03/26/2015

Software Utilized:

Name	Manufacturer	Version
None		

7.3 Results:

The sample tested was found to Comply.

FCC Part 15.247(d) & RSS-210 A8.5 – Non Restricted Band Radiated Spurious/Harmonics Limits

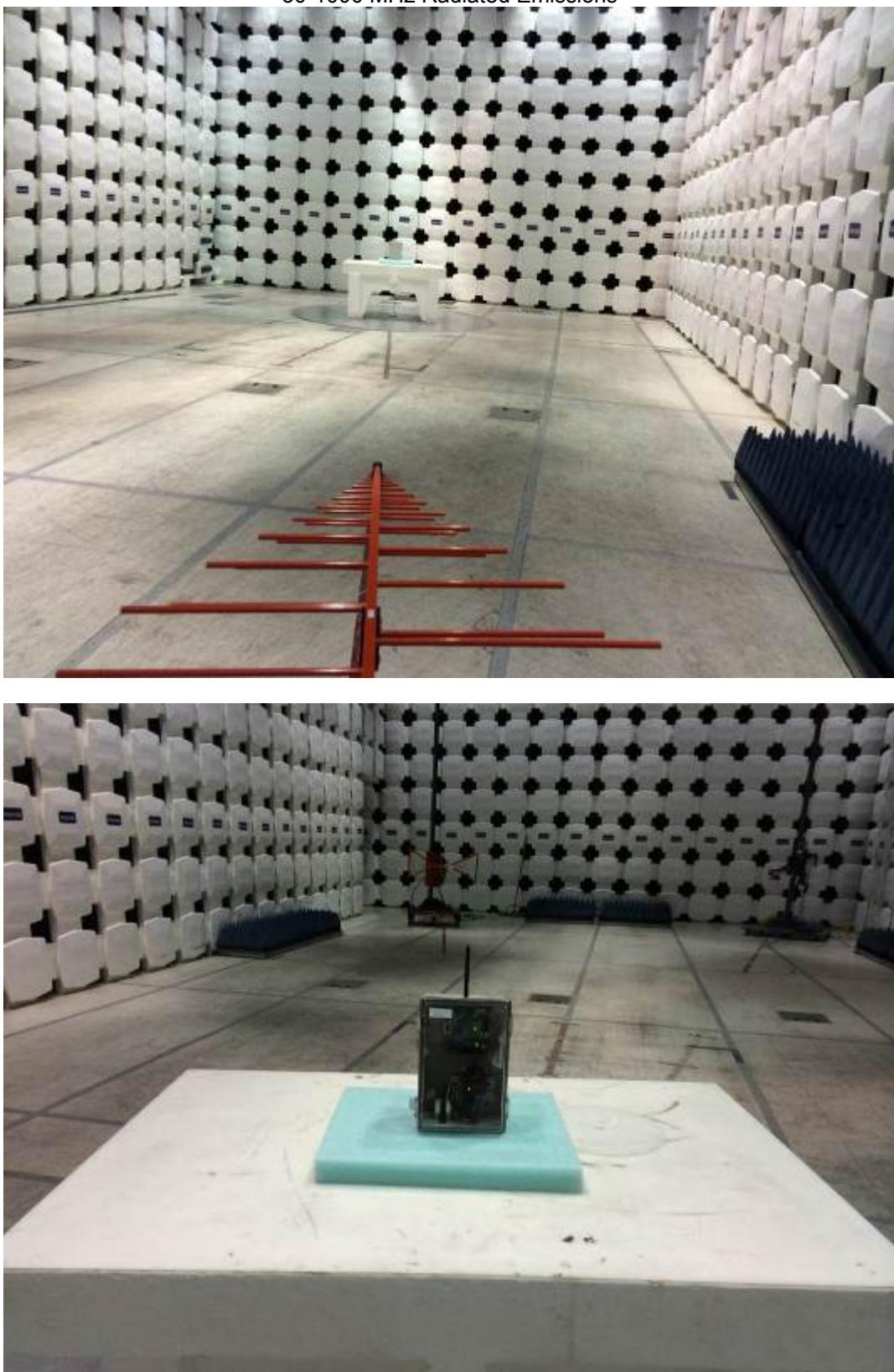
In any 100 kHz bandwidth outside the frequency band , the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in §15.209(a) and RSS-Gen Section 7.2.5 Table 5 is not required. In addition, radiated emissions which fall in the restricted bands, as defined in 15.205(a) and RSS-Gen Section 7.2.2 Table 3, must also comply with the radiated emission limits specified in 15.209(a) and IC RSS-Gen Section 7.2.5 Table 5).

FCC Part 15.209(a) & RSS-210 A8.5 & RSS-Gen Section 7.2.5 Table 5 – Restricted Band Radiated Spurious/Harmonics Limits

Frequency (MHz)	Field Strength µV/m	Field Strength dBµV/m	Test Distance (meters)
30-88	100	40.00	3
88-216	150	43.52	3
216-960	200	46.02	3
Above 960	500	53.98	3

7.4 Setup Photographs:

30-1000 MHz Radiated Emissions



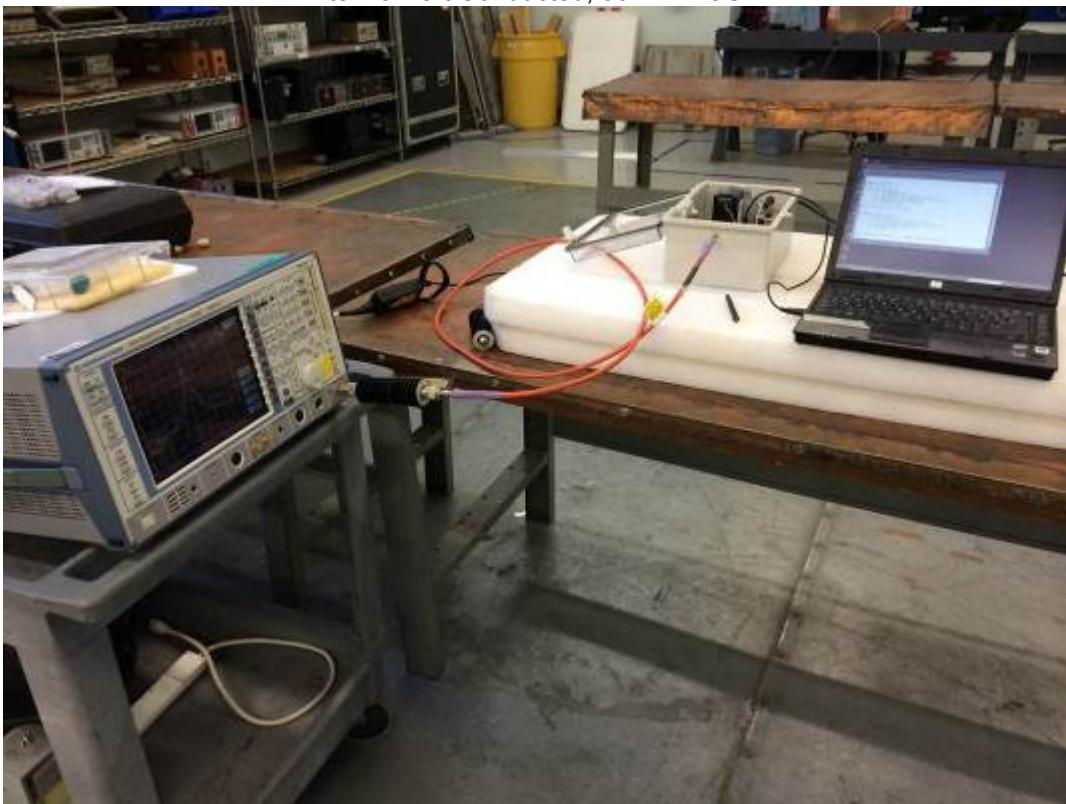
1-18 GHz



18-25 GHz



Antenna Port Conducted, 30MHz-18GHz



Antenna Port Conducted, 18-25 GHz



7.5 Plots/Data:

Low Channel Radiated Emissions

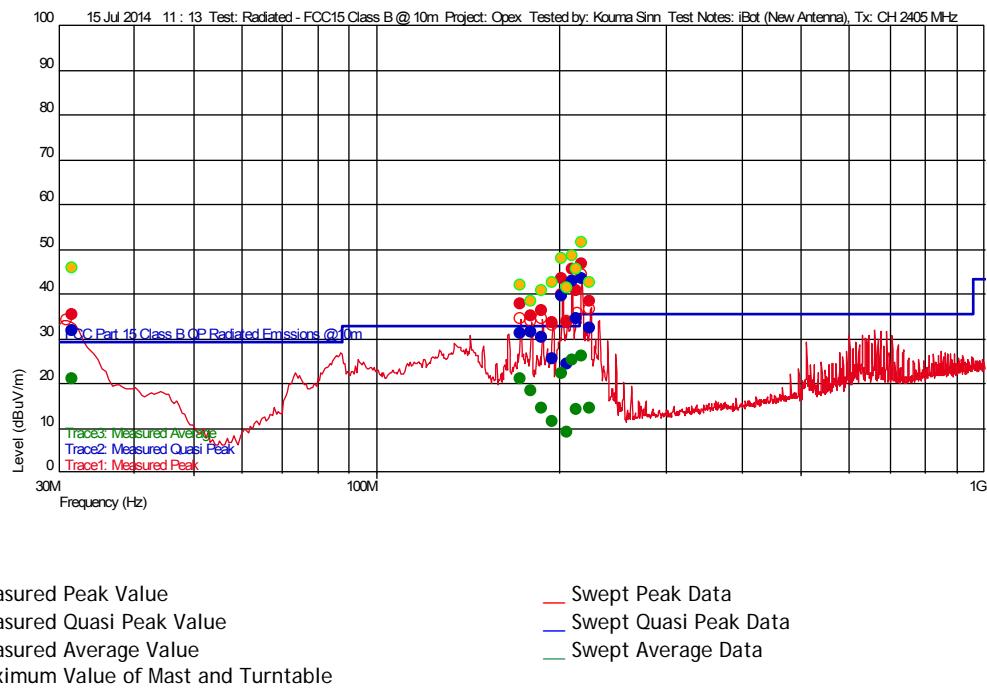
Transmit on 2405 MHz, 50 Ohm Terminator, (30-1000 MHz)

Test Information

Test Details
 Test: User Entry
 Project: Radiated - FCC15 Class B @ 10m
 Opx
 Test Notes: iBot (New Antenna), Tx: CH 2405 MHz
 Temperature: 22C
 Humidity: 44%, 1000mbar
 Tested by: Kouma Sinn
 Test Started: 15 Jul 2014 11:13

Additional Information

Prescan Emission Graph



Notes: Disregard the limit line on the plot, see the following page for final test results.

Emissions Test Data

Notes: Non-restricted band emissions limit is 20 dB below the fundamental signal using 100kHz
Resolution Bandwidth

Fundamental Peak = 94.63 dBuV/m,
Limit = 94.63-20 or 74.63 dBuV/m (20 dB below the fundamental signal)

Trace1: Measured Peak

Frequency(Hz)	Level (dBuV/m)	AF	PA+CL	Limit (dBuV/m)	Margin(dBuV/m)	Hor (-), Ver ()	Azimuth (deg)(Deg)	Mast Height(m)	RBW(Hz)	Comment
194.835070162 M	33.44	12.084	-24.030	74.63	-41.19		208	1.56	120 k	
206.241683679 M	33.73	10.850	-23.870	74.63	-40.9		191	1.04	120 k	
179.970541421 M	34.96	11.400	-24.435	74.63	-39.67		146	1.25	120 k	
224.748897297 M	38.41	11.095	-23.811	74.63	-36.22		192	1.05	120 k	
187.573547275 M	36.29	11.357	-24.228	74.63	-38.34		195	1.16	120 k	
172.432465427 M	37.88	11.757	-24.640	--	--		161	1.26	120 k	Rest. Band
31.691783679 M	35.25	20.116	-26.235	74.63	-39.38		168	1.05	120 k	
213.879559385 M	40.73	10.778	-23.846	74.63	-33.9		194	1.04	120 k	
202.527254429 M	43.46	11.790	-23.882	74.63	-31.17		192	1.05	120 k	
217.513025711 M	46.65	10.901	-23.834	74.63	-27.98		173	1.04	120 k	
209.997995754 M	45.53	10.700	-23.858	74.63	-29.1		164	1.04	120 k	

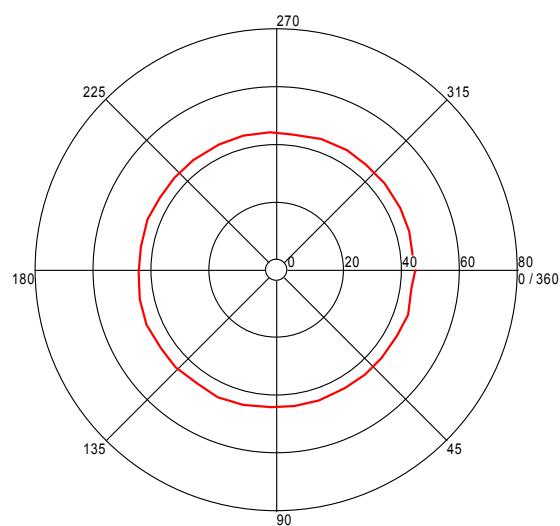
Notes: Restricted band emissions limit is per FCC Part 15.209.

Trace2: Measured Quasi Peak

Frequency(Hz)	Level (dBuV/m)	AF	PA+CL	Limit (dBuV/m)	Margin(dBuV/m)	Hor (-), Ver ()	Azimuth (deg)(Deg)	Mast Height(m)	RBW(Hz)	Comment
206.241683679 M	24.42	10.850	-23.870	--	--		191	1.04	120 k	
194.835070162 M	25.51	12.084	-24.030	--	--		208	1.56	120 k	
224.748897297 M	32.43	11.095	-23.811	--	--		192	1.05	120 k	
187.573547275 M	30.15	11.357	-24.228	--	--		195	1.16	120 k	
172.432465427 M	31.25	11.757	-24.640	33.040	-1.79		161	1.26	120 k	
179.970541421 M	31.46	11.400	-24.435	--	--		146	1.25	120 k	Rest. Band
213.879559385 M	34.47	10.778	-23.846	--	--		194	1.04	120 k	
31.691783679 M	31.81	20.116	-26.235	--	--		168	1.05	120 k	
202.527254429 M	39.60	11.790	-23.882	--	--		192	1.05	120 k	
217.513025711 M	43.44	10.901	-23.834	--	--		173	1.04	120 k	
209.997995754 M	42.93	10.700	-23.858	--	--		164	1.04	120 k	

Azimuth Plots

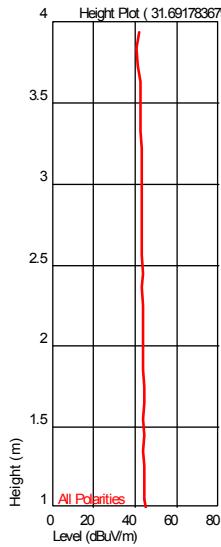
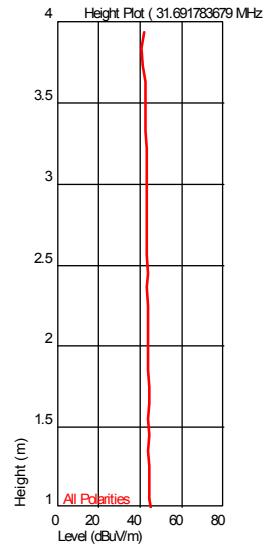
Turntable Plot (31.691783679 MHz)



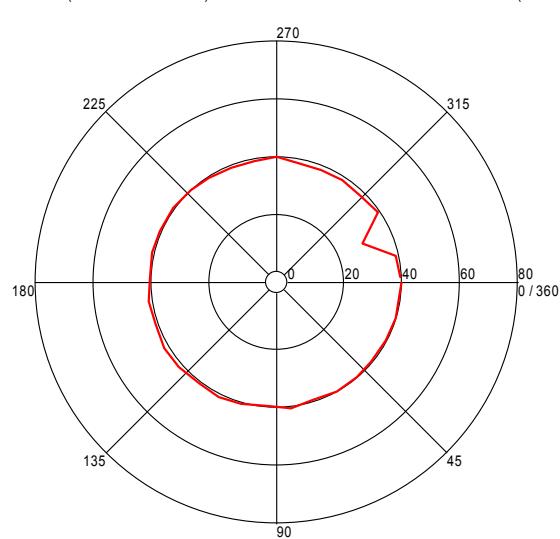
Level (dBuV/m)

Turntable Plots

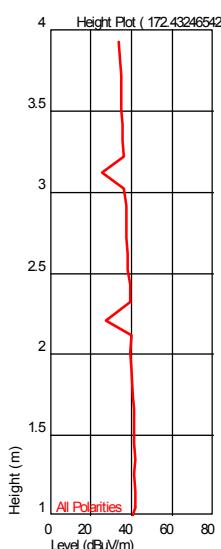
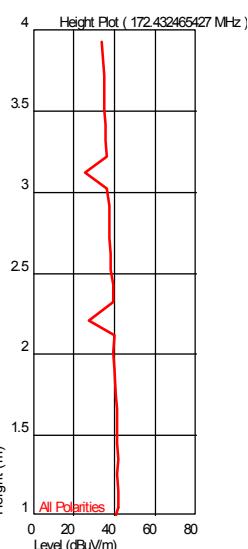
Height Plot (31.691783679 MHz)



Turntable Plot (172.432465427 MHz)



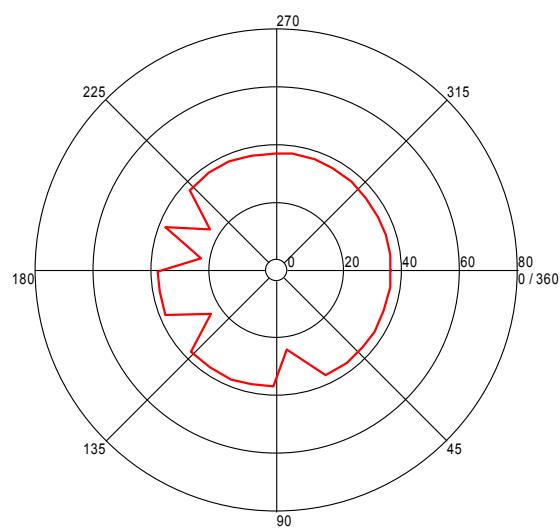
Level (dBuV/m)



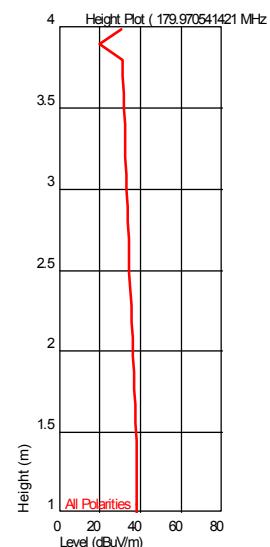
All Polarities

Azimuth (Degrees)

Turntable Plot (179.970541421 MHz)



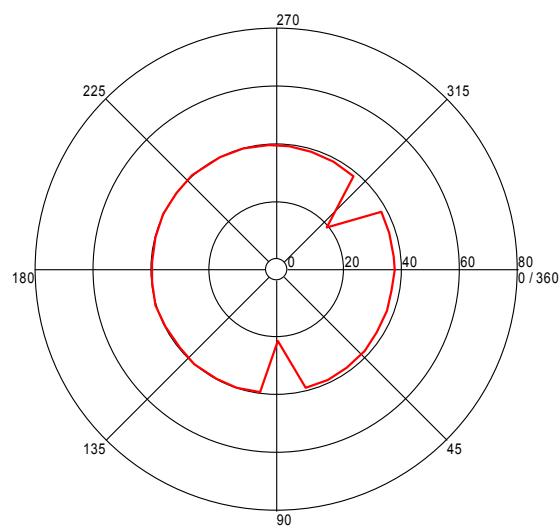
Level (dBuV/m)



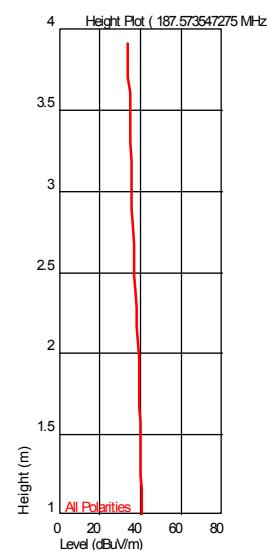
All Polarities

Azimuth (Degrees)

Turntable Plot (187.573547275 MHz)



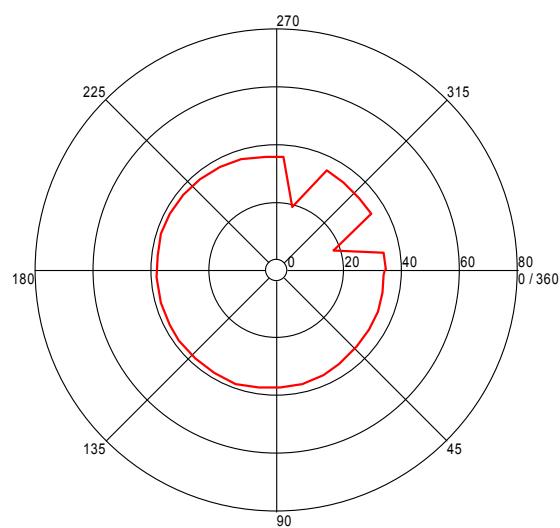
Level (dBuV/m)



All Polarities

Azimuth (Degrees)

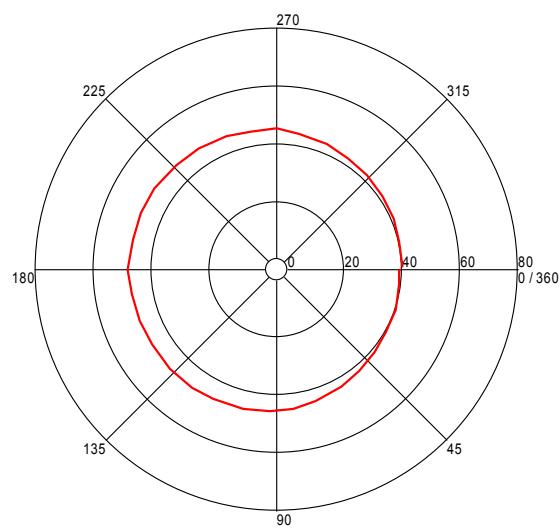
Turntable Plot (194.835070162 MHz)



Level (dBuV/m)

Azimuth (Degrees)

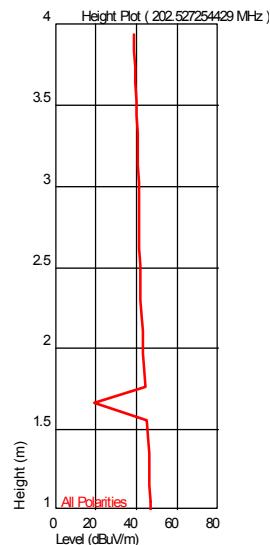
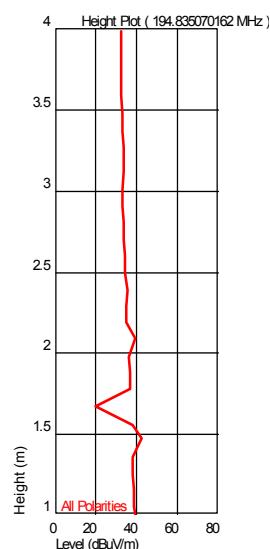
Turntable Plot (202.527254429 MHz)



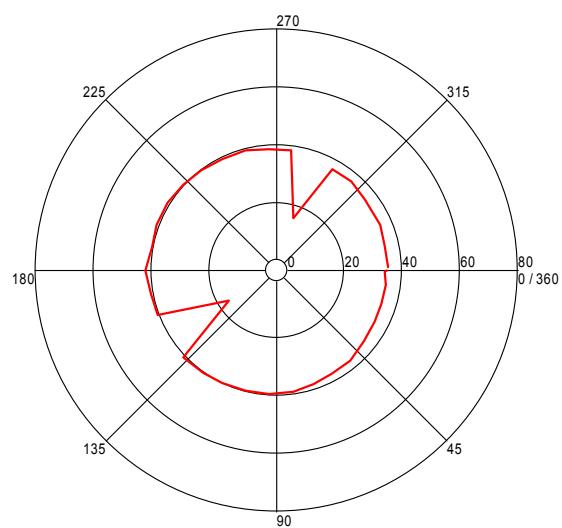
Level (dBuV/m)

Azimuth (Degrees)

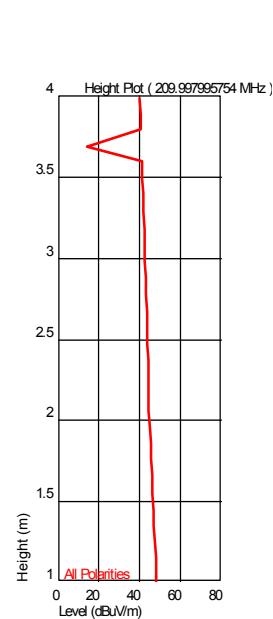
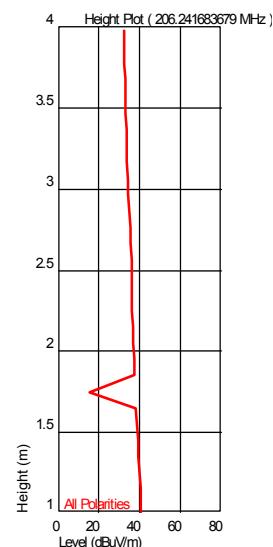
All Polarities



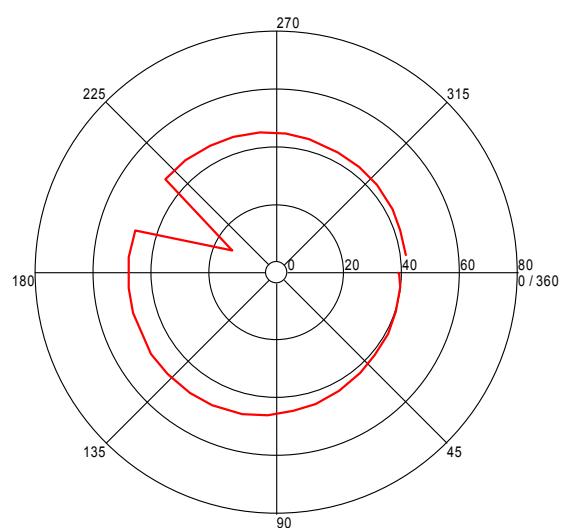
Turntable Plot (206.241683679 MHz)



Level (dBuV/m)



Turntable Plot (209.997995754 MHz)

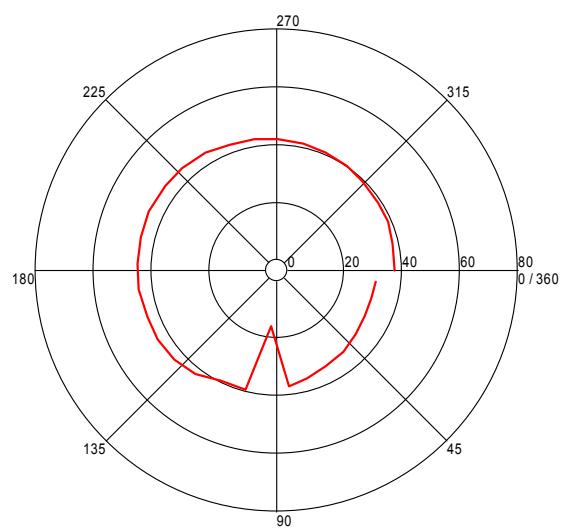


Level (dBuV/m)

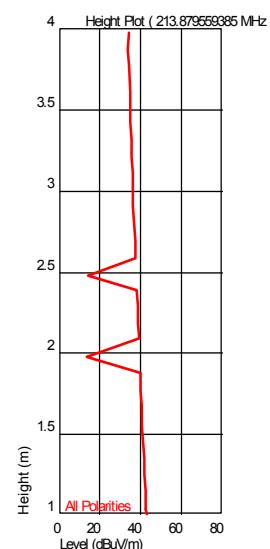
Azimuth (Degrees)

All Polarities

Turntable Plot (213.879559385 MHz)



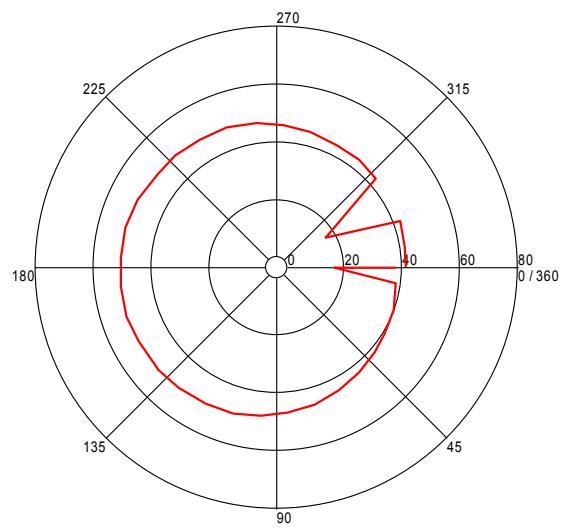
Level (dBuV/m)



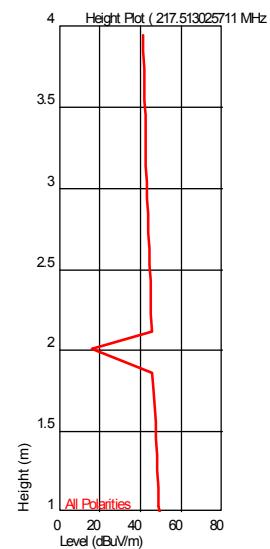
All Polarities

Azimuth (Degrees)

Turntable Plot (217.513025711 MHz)



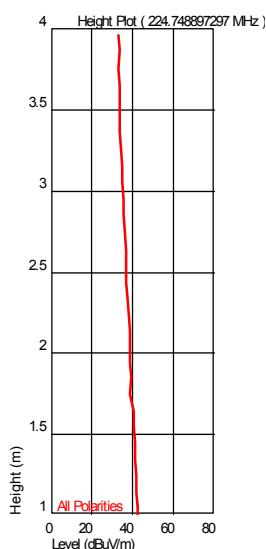
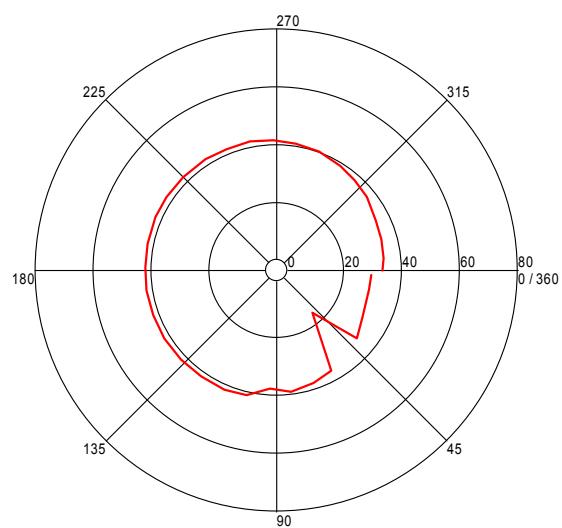
Level (dBuV/m)



All Polarities

Azimuth (Degrees)

Turntable Plot (224.748897297 MHz)



Low Radiated Emissions

Transmit on 2405 MHz, 50 Ohm Terminator, (1-25 GHz)

Company: Opex
 Model #: 2048910
 Serial #: BOX1503021541-001

Engineers: Kouma Sinn
 Project #: G101718120 Date(s): 07/15/14
 Standard: FCC Part 15 Subpart C, 15.247/RSS-210

Receiver: 145-128 Limit Distance (m): 3
 PreAmp: PRE145014 04-29-2015.txt Test Distance (m): 3
 PreAmp Used? (Y or N): Y Voltage/Frequency: 120VAC/60Hz Frequency Range: 1-25 GHz
 Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)

Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth	FCC	IC
Hand scans were done from 18-25 GHz. No emissions were detected above the measuring noise floor.													
Tx: CH 2405 MHz (The EUT sits on its side), worst-case.													
PK	H	1008.000	42.00	27.24	3.75	30.80	0.00	42.19	74.00	-31.81	1/3MHz	RB	RB
AVG	H	1008.000	28.60	27.24	3.75	30.80	0.00	28.79	54.00	-25.21	1/3MHz	RB	RB
PK	H	4810.000	34.80	34.20	8.65	31.71	0.00	45.94	74.00	-28.06	1/3MHz	RB	RB
AVG	H	4810.000	24.40	34.20	8.65	31.71	0.00	35.54	54.00	-18.46	1/3MHz	RB	RB
PK	H	7215.000	25.88	35.76	11.02	32.18	0.00	40.49	54.00	-13.51	100/300 kHz		
PK	H	9620.000	25.60	36.84	12.78	32.03	0.00	43.19	74.00	-30.81	100/300 kHz	RB	RB
PK	H	12025.000	32.96	38.82	14.93	31.46	0.00	55.25	74.00	-18.75	1/3MHz	RB	RB
AVG	H	12025.000	22.47	38.82	14.93	31.46	0.00	44.76	54.00	-9.24	1/3MHz	RB	RB
PK	H	14430.000	22.80	39.49	15.12	29.48	9.54	38.39	54.00	-15.61	100/300 kHz	1m	
PK	H	16835.000	24.40	42.01	18.22	30.49	9.54	44.60	54.00	-9.40	100/300 kHz	1m	

Mid Channel Radiated Emissions

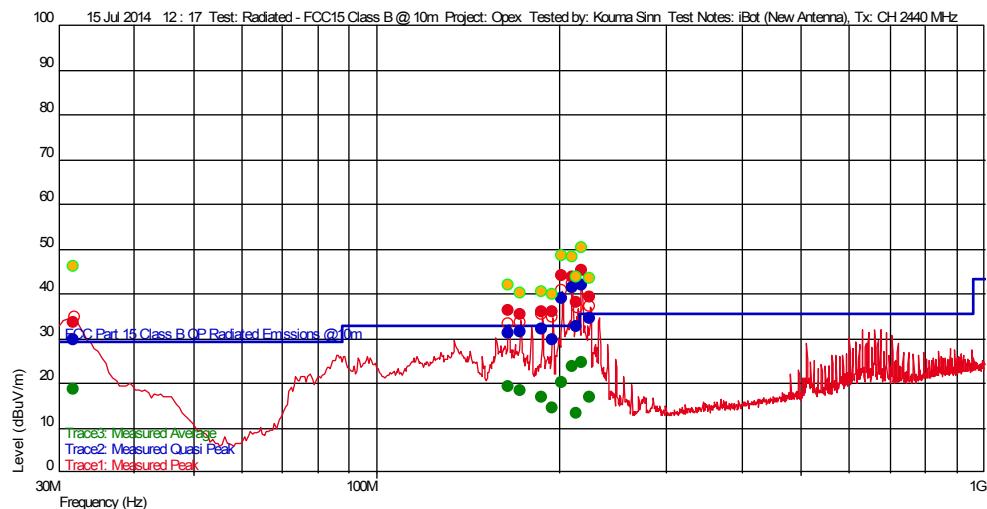
Transmit on 2440 MHz, 50 Ohm Terminator, (30-1000 MHz)

Test Information

Test Details: User Entry
 Test: Radiated - FCC15 Class B @ 10m
 Project: Opex
 Test Notes: iBot (New Antenna), Tx: CH 2440 MHz
 Temperature: 22C
 Humidity: 44%, 1000mbar
 Tested by: Kouma Sinn
 Test Started: 15 Jul 2014 12:17

Additional Information

Prescan Emission Graph



● Measured Peak Value	— Swept Peak Data
● Measured Quasi Peak Value	— Swept Quasi Peak Data
● Measured Average Value	— Swept Average Data
● Maximum Value of Mast and Turntable	

Notes: Disregard the limit line on the plot, see the following page for final test results.

Emissions Test Data

Notes: Non-restricted band emissions limit is 20dB below the fundamental signal using 100kHz Resolution Bandwidth

Fundamental Peak Reading = 103.82 dBuV/m,
Limit = 103.82-20 or 83.82 dBuV/m (20 dB below the fundamental signal)

Trace1: Measured Peak

Frequency(Hz)	Level (dBuV/m)	AF	PA+CL	Limit (dBuV/m)	Margin(dBuV/m)	Hor (-), Ver ()	Azimuth (deg)(Deg)	Mast Height(m)	RBW(Hz)	Comment
172.514028497 M	35.27	11.749	-24.638	--	--		158	1.34	120 k	Rest. Band
187.478156493 M	35.83	11.348	-24.231	83.82	-47.99		222	1.25	120 k	
194.909018114 M	35.94	12.091	-24.028	83.82	-47.88		194	1.14	120 k	
164.95270501 M	36.23	12.195	-24.843	--	--		180	1.45	120 k	Rest. Band
224.720841184 M	39.40	11.094	-23.811	83.82	-44.42		183	1.05	120 k	
31.811623471 M	33.50	20.032	-26.234	83.82	-50.32		127	3.44	120 k	
213.915631529 M	37.95	10.778	-23.845	83.82	-45.87		165	1.04	120 k	
217.481562729 M	45.18	10.899	-23.834	83.82	-38.64		166	1.04	120 k	
209.990981782 M	43.70	10.700	-23.858	83.82	-40.12		169	1.04	120 k	
202.438276473 M	44.17	11.822	-23.882	83.82	-39.65		191	1.05	120 k	

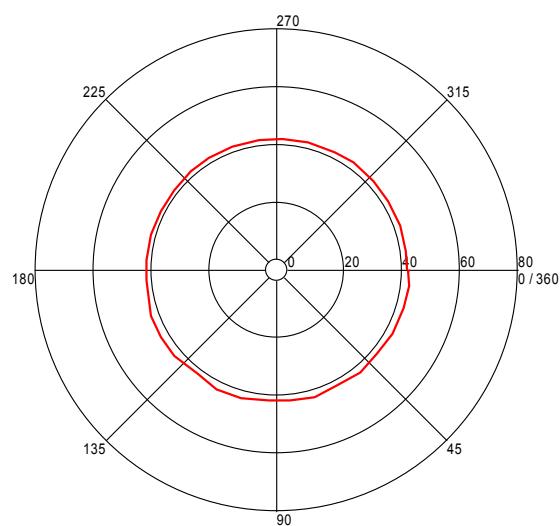
Notes: Restricted band emissions limit is per FCC Part 15.209.

Trace2: Measured Quasi Peak

Frequency(Hz)	Level (dBuV/m)	AF	PA+CL	Limit (dBuV/m)	Margin(dBuV/m)	Hor (-), Ver ()	Azimuth (deg)(Deg)	Mast Height(m)	RBW(Hz)	Comment
194.909018114 M	29.62	12.091	-24.028	--	--		194	1.14	120 k	
164.95270501 M	31.15	12.195	-24.843	33.040	-1.89		180	1.45	120 k	Rest. Band
172.514028497 M	31.35	11.749	-24.638	33.040	-1.69		158	1.34	120 k	Rest. Band
187.478156493 M	32.09	11.348	-24.231	--	--		222	1.25	120 k	
224.720841184 M	34.60	11.094	-23.811	--	--		183	1.05	120 k	
213.915631529 M	32.70	10.778	-23.845	--	--		165	1.04	120 k	
31.811623471 M	29.83	20.032	-26.234	--	--		127	3.44	120 k	
202.438276473 M	38.87	11.822	-23.882	--	--		191	1.05	120 k	
217.481562729 M	41.89	10.899	-23.834	--	--		166	1.04	120 k	
209.990981782 M	41.29	10.700	-23.858	--	--		169	1.04	120 k	

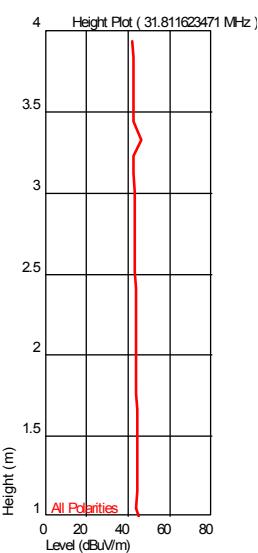
Azimuth Plots

Turntable Plot (31.811623471 MHz)

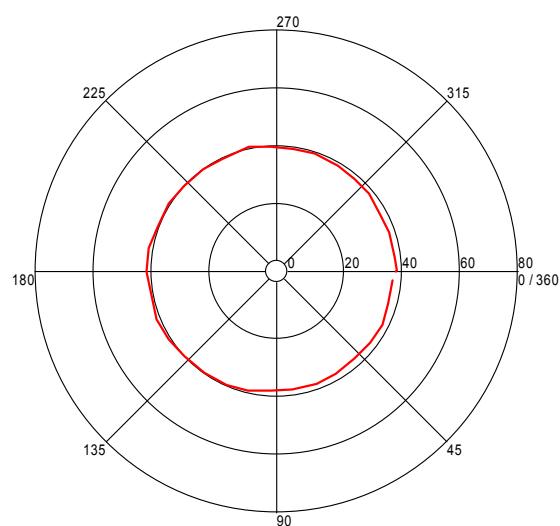


All Polarities

Level (dBuV/m)

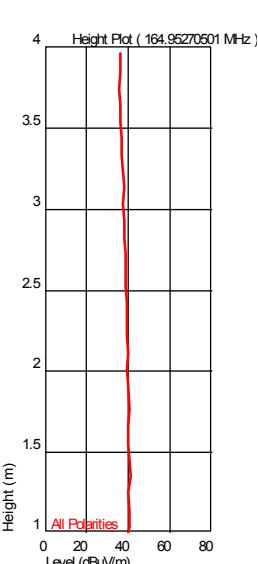
Turntable Plots

Turntable Plot (164.95270501 MHz)



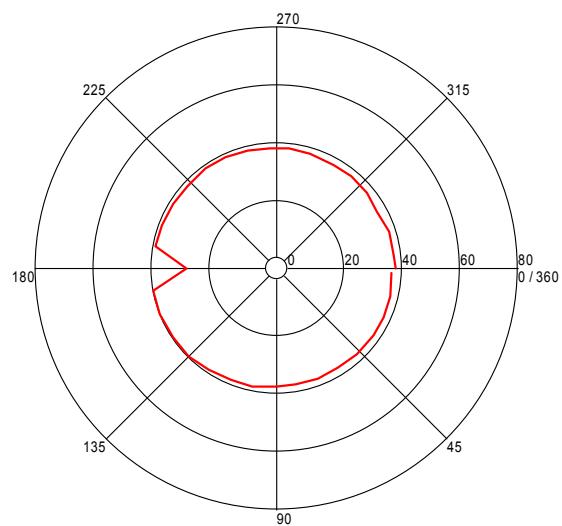
All Polarities

Level (dBuV/m)

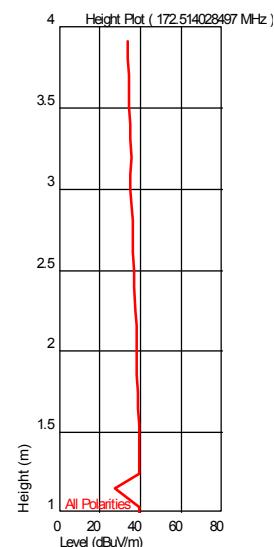


Azimuth (Degrees)

Turntable Plot (172.514028497 MHz)



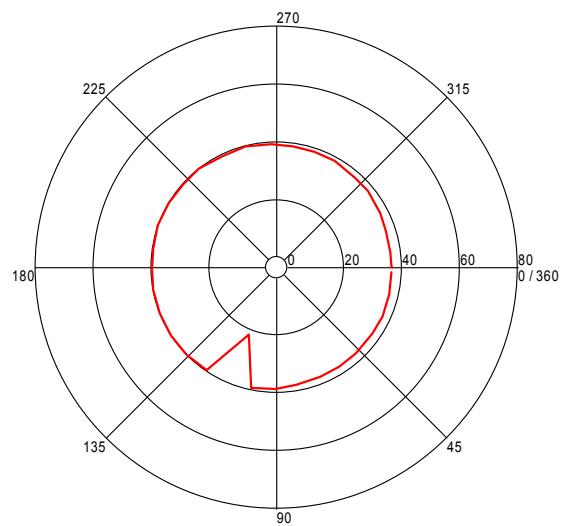
Level (dBuV/m)



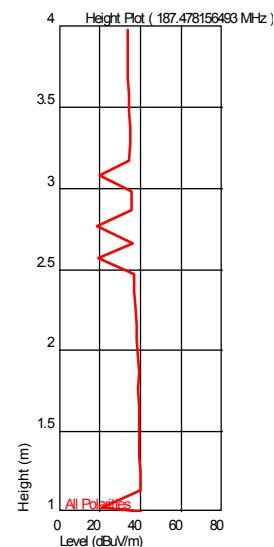
All Polarities

Azimuth (Degrees)

Turntable Plot (187.478156493 MHz)



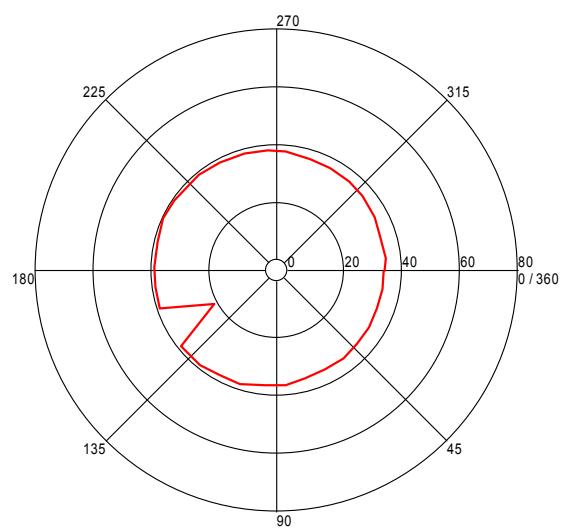
Level (dBuV/m)



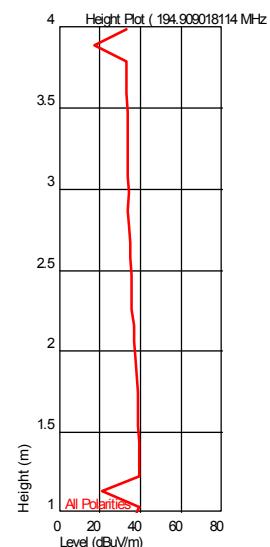
All Polarities

Azimuth (Degrees)

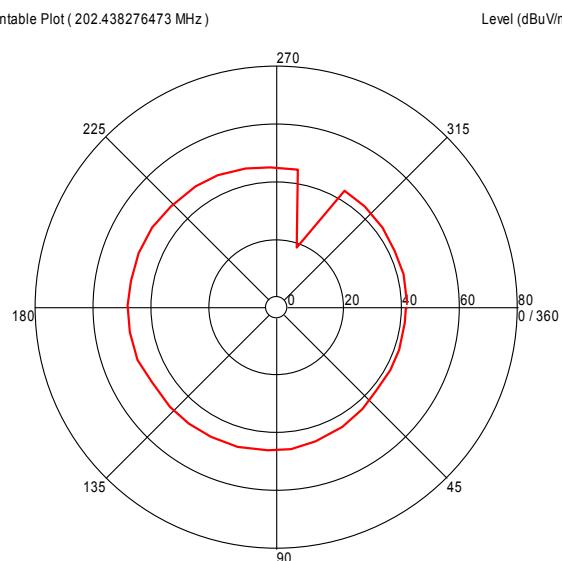
Turntable Plot (194.909018114 MHz)



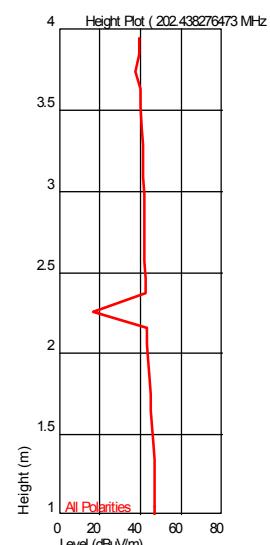
Level (dBuV/m)



Turntable Plot (202.438276473 MHz)



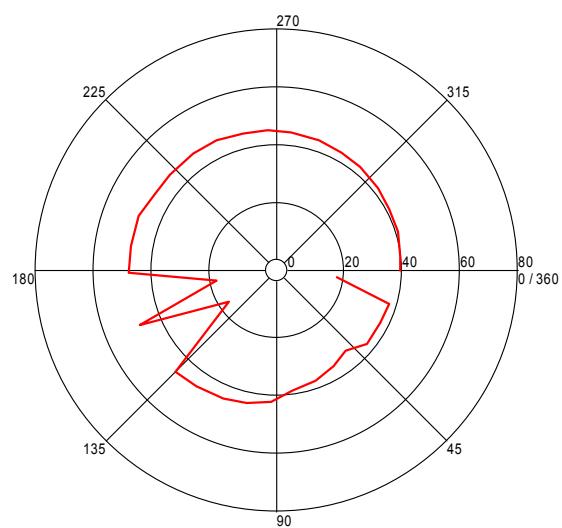
Level (dBuV/m)



All Polarities

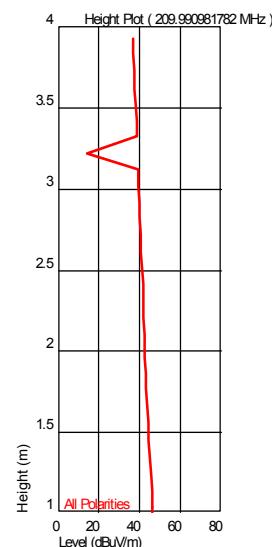
Azimuth (Degrees)

Turntable Plot (209.990981782 MHz)

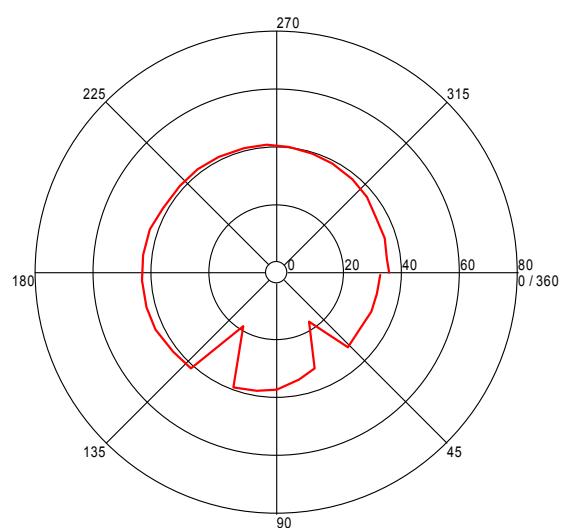


Level (dBuV/m)

Azimuth (Degrees)

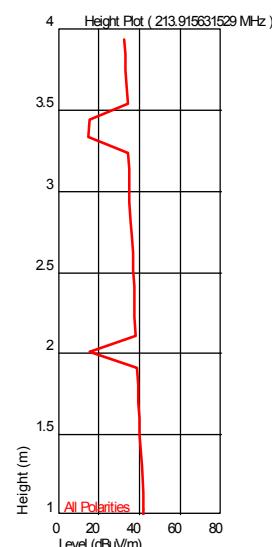


Turntable Plot (213.915631529 MHz)



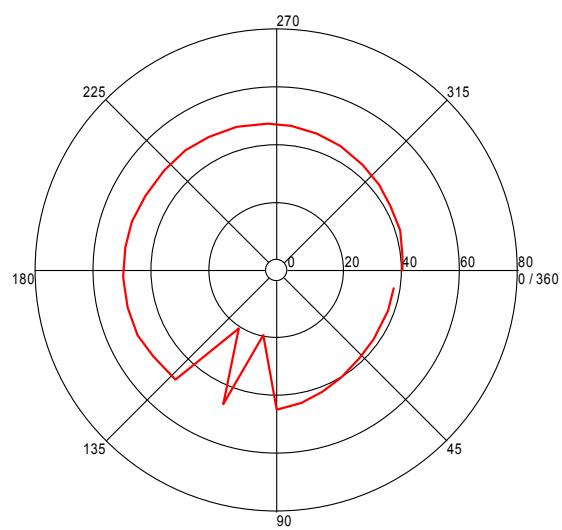
Level (dBuV/m)

Azimuth (Degrees)



All Polarities

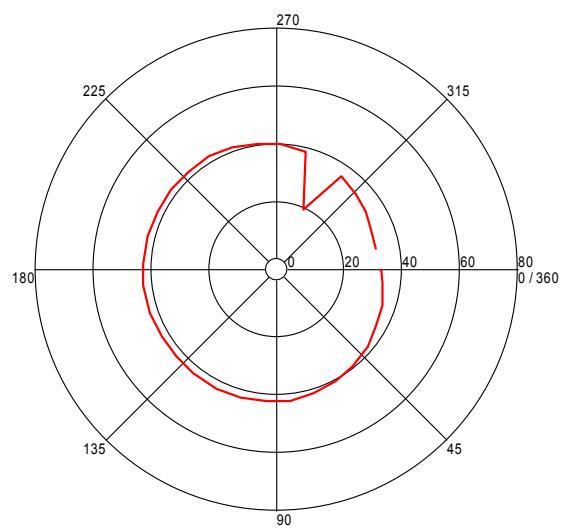
Turntable Plot (217.481562729 MHz)



Level (dBuV/m)

Azimuth (Degrees)

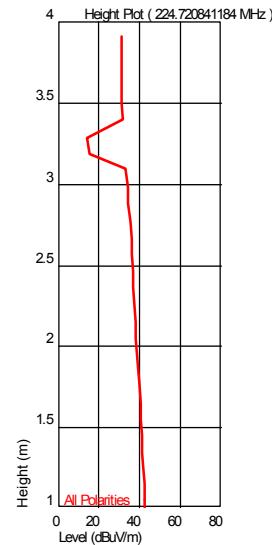
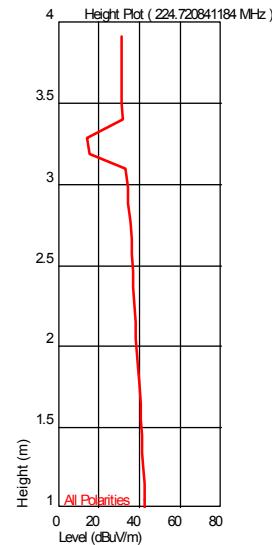
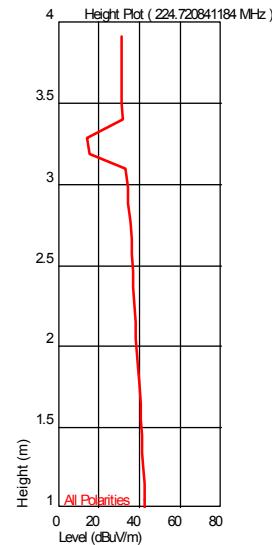
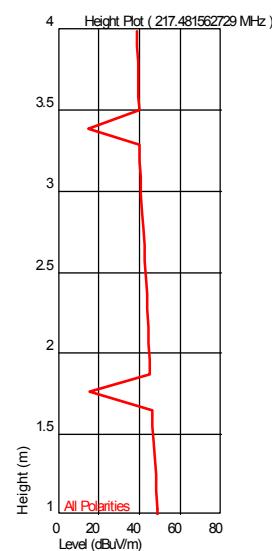
Turntable Plot (224.720841184 MHz)



Level (dBuV/m)

Azimuth (Degrees)

All Polarities



Mid Channel Radiated Emissions

Transmit on 2440 MHz, 50 Ohm Terminator, (1-25 GHz)
Radiated Emissions

Company: Opex
Model #: 2048910
Serial #: BOX1503021541-001
Engineers: Kouma Sinn
Project #: G101718120 Date(s): 07/15/14
Standard: FCC Part 15 Subpart C, 15.247/RSS-210
Receiver: 145-128 Limit Distance (m): 3
PreAmp: PRE145014 04-29-2015.txt Test Distance (m): 3
PreAmp Used? (Y or N): Y Voltage/Frequency: 120VAC/60Hz Frequency Range: 1-25 GHz
Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)
Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth	FCC	IC
Hand scans were done from 18-25 GHz. No emissions were detected above the measuring noise floor.													
Tx: CH 2405 MHz (The EUT sits on its side), worst-case.													
PK	H	1008.000	39.90	27.24	3.75	30.80	0.00	40.09	74.00	-33.91	1/3MHz	RB	RB
AVG	H	1008.000	28.40	27.24	3.75	30.80	0.00	28.59	54.00	-25.41	1/3MHz	RB	RB
PK	H	4880.000	36.15	34.25	8.75	31.70	0.00	47.45	74.00	-26.55	1/3MHz	RB	RB
AVG	H	4880.000	24.60	34.25	8.75	31.70	0.00	35.90	54.00	-18.10	1/3MHz	RB	RB
PK	H	7320.000	34.18	35.75	11.10	32.21	0.00	48.82	74.00	-25.18	1/3MHz	RB	RB
AVG	H	7320.000	24.26	35.75	11.10	32.21	0.00	38.90	54.00	-15.10	1/3MHz	RB	RB
PK	H	9760.000	24.70	36.96	13.11	32.27	0.00	42.51	54.00	-11.49	100/300 kHz		
PK	H	12200.000	33.67	39.03	14.80	31.17	0.00	56.33	74.00	-17.67	1/3MHz	RB	RB
AVG	H	12200.000	22.20	39.03	14.80	31.17	0.00	44.86	54.00	-9.14	1/3MHz	RB	RB
PK	H	14640.000	22.30	39.62	15.25	29.93	9.54	37.69	54.00	-16.31	100/300 kHz	1m	
PK	H	17080.000	22.50	42.09	19.00	30.30	9.54	43.75	54.00	-10.25	100/300 kHz	1m	

High Channel Radiated Emissions

Transmit on 2480 MHz, 50 Ohm Terminator,

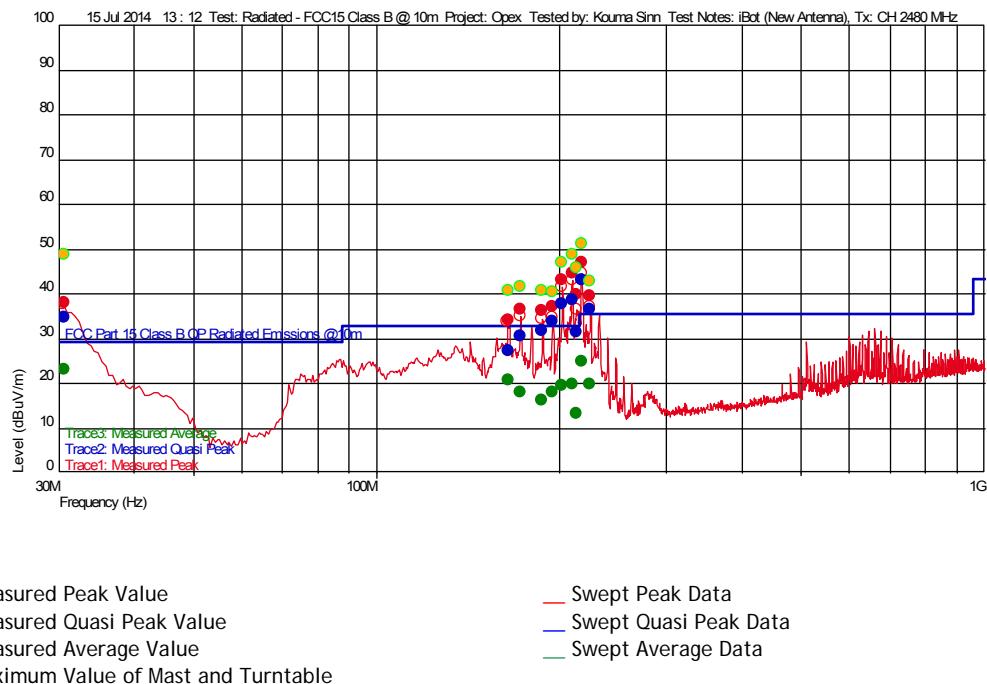
30-1000 MHz

Test Information

Test Details
 Test: Radiated - FCC15 Class B @ 10m
 Project: Opex
 Test Notes: iBot (New Antenna), Tx: CH 2480 MHz
 Temperature: 22C
 Humidity: 44%, 1000mbar
 Tested by: Kouma Sinn
 Test Started: 15 Jul 2014 13 : 12

Additional Information

Prescan Emission Graph



Notes: Disregard the limit line on the plot, see the following page for final test results.

Emissions Test Data

Notes: Non-restricted band emissions limit is 20dB below fundamental signals using 100kHz Resolution Bandwidth

Fundamental Peak Reading = 92.59 dBuV/m,
Limit = 92.59-20 or 72.59 dBuV/m (20 dB below the fundamental signal)

Trace1: Measured Peak

Frequency(Hz)	Level (dBuV/m)	AF	PA+CL	Limit (dBuV/m)	Margin (dBuV/m)	Hor (--), Ver ()	Azimuth (deg)(Deg)	Mast Height(m)	RBW(Hz)	Comment
164.857915375 M	34.15	12.186	-24.846	--	--		212	1.87	120 k	Rest. Band
187.458918016 M	36.34	11.346	-24.231	72.59	-36.25		200	1.15	120 k	
172.442685812 M	36.64	11.756	-24.640	--	--		160	1.56	120 k	Rest. Band
224.671141786 M	39.55	11.093	-23.811	72.59	-33.04		218	1.05	120 k	
195.028456992 M	37.20	12.106	-24.025	72.59	-35.39		202	1.03	120 k	
213.832665485 M	39.82	10.777	-23.846	72.59	-32.77		169	1.04	120 k	
30.646292641 M	38.03	20.848	-26.244	72.59	-34.56		141	1.05	120 k	
202.56252497 M	43.12	11.777	-23.882	72.59	-29.47		203	1.04	120 k	
217.460921503 M	47.07	10.898	-23.834	72.59	-25.52		177	1.04	120 k	
209.910019858 M	44.75	10.704	-23.858	72.59	-27.84		222	1.05	120 k	

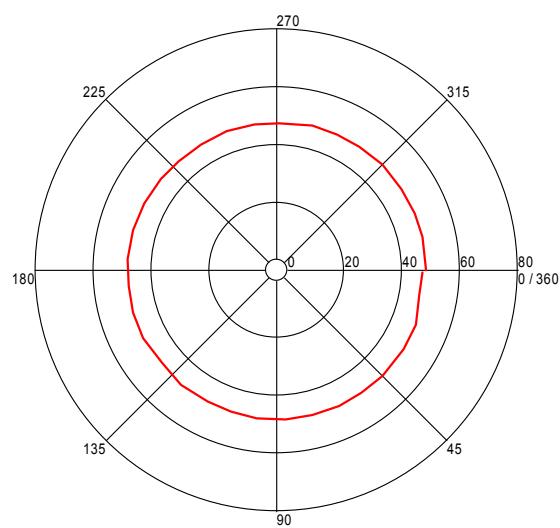
Notes: Restricted band emissions limit is per FCC Part 15.209.

Trace2: Measured Quasi Peak

Frequency(Hz)	Level (dBuV/m)	AF	PA+CL	Limit (dBuV/m)	Margin (dBuV/m)	Hor (--), Ver ()	Azimuth (deg)(Deg)	Mast Height(m)	RBW(Hz)	Comment
164.857915375 M	27.18	12.186	-24.846	33.040	-5.86		212	1.87	120 k	Rest. Band
172.442685812 M	30.64	11.756	-24.640	33.040	-2.40		160	1.56	120 k	Rest. Band
213.832665485 M	31.44	10.777	-23.846	--	--		169	1.04	120 k	
187.458918016 M	31.65	11.346	-24.231	--	--		200	1.15	120 k	
195.028456992 M	34.00	12.106	-24.025	--	--		202	1.03	120 k	
224.671141786 M	36.59	11.093	-23.811	--	--		218	1.05	120 k	
202.56252497 M	37.65	11.777	-23.882	--	--		203	1.04	120 k	
30.646292641 M	34.80	20.848	-26.244	--	--		141	1.05	120 k	
209.910019858 M	38.59	10.704	-23.858	--	--		222	1.05	120 k	
217.460921503 M	43.02	10.898	-23.834	--	--		177	1.04	120 k	

Azimuth Plots

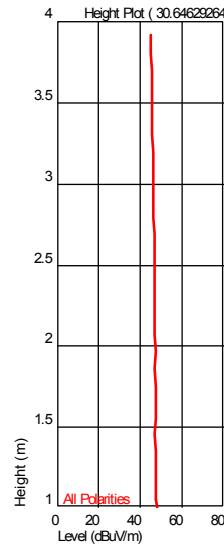
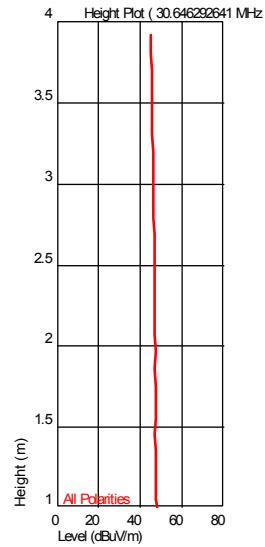
Turntable Plot (30.646292641 MHz)



Level (dBuV/m)

Turntable Plots

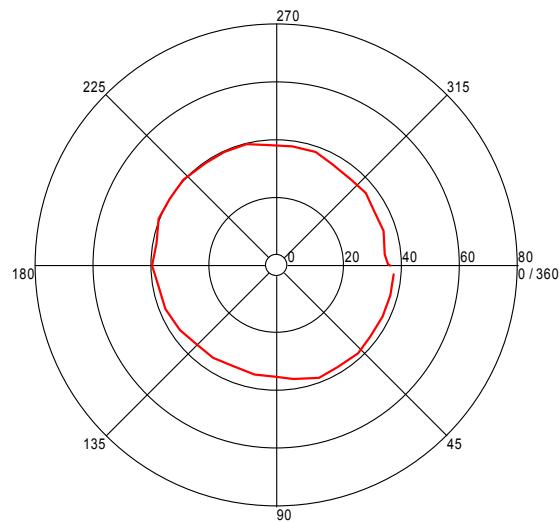
Height Plot (30.646292641 MHz)



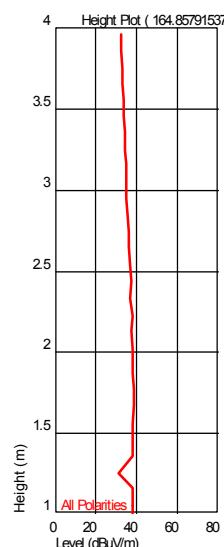
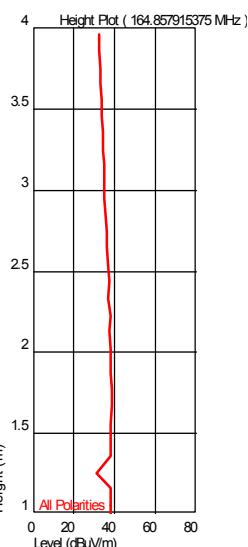
All Polarities

Azimuth (Degrees)

Turntable Plot (164.857915375 MHz)



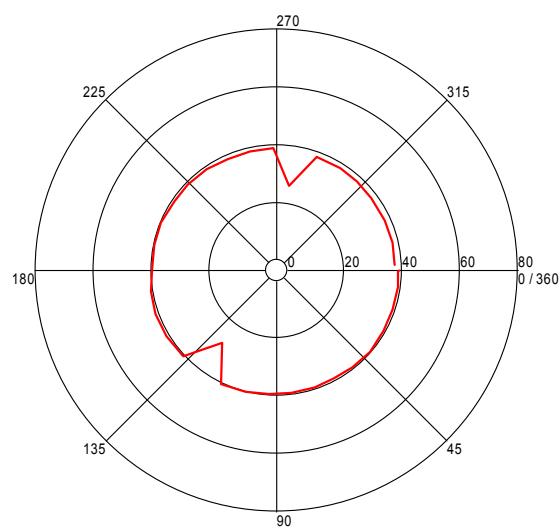
Level (dBuV/m)



All Polarities

Azimuth (Degrees)

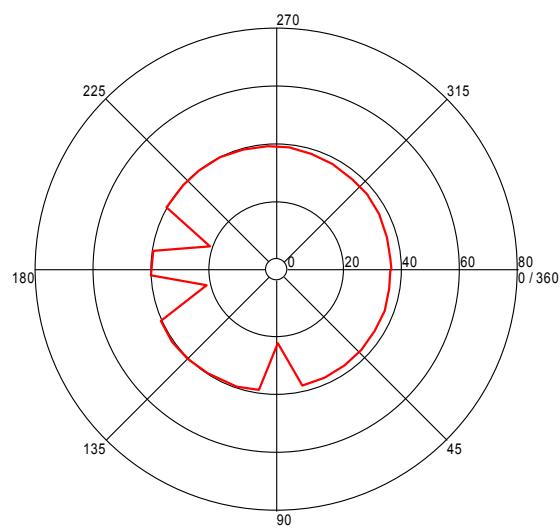
Turntable Plot (172.442685812 MHz)



Level (dBuV/m)

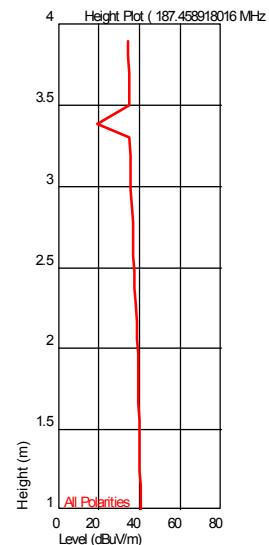
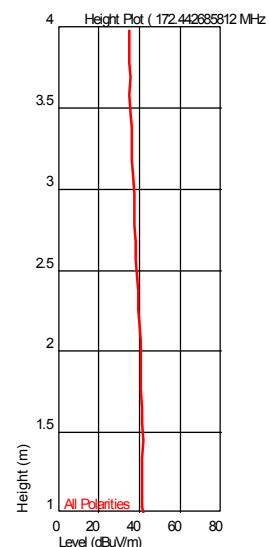
Azimuth (Degrees)

Turntable Plot (187.458918016 MHz)

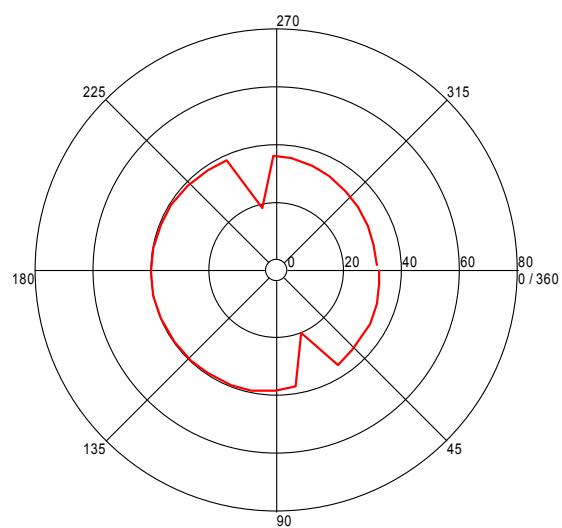


Level (dBuV/m)

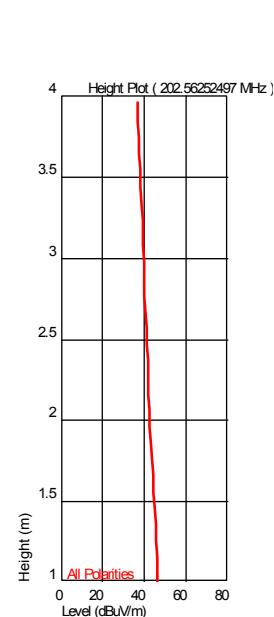
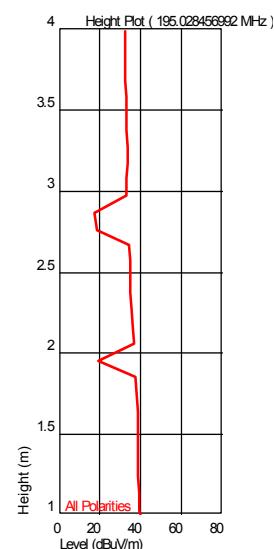
Azimuth (Degrees)



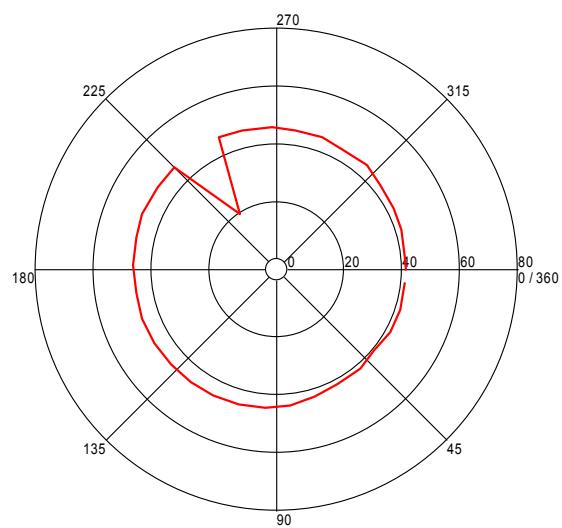
Turntable Plot (195.028456992 MHz)



Level (dBuV/m)



Turntable Plot (202.56252497 MHz)

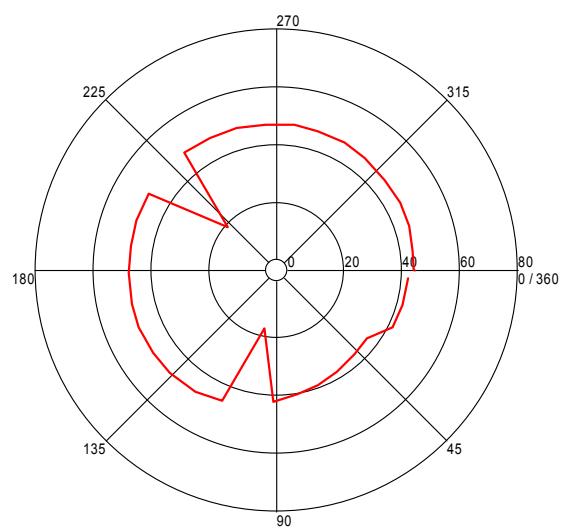


Level (dBuV/m)

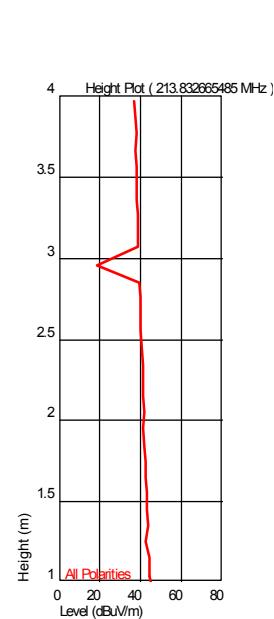
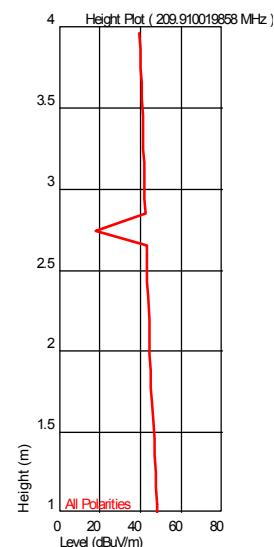
Azimuth (Degrees)

All Polarities

Turntable Plot (209.910019858 MHz)



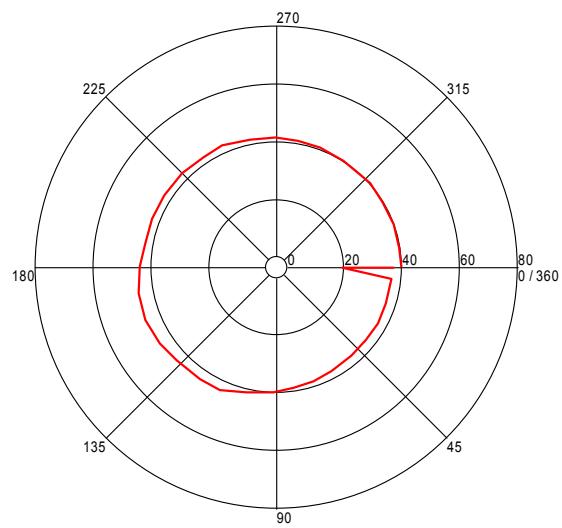
Level (dBuV/m)



All Polarities

Azimuth (Degrees)

Turntable Plot (213.832665485 MHz)

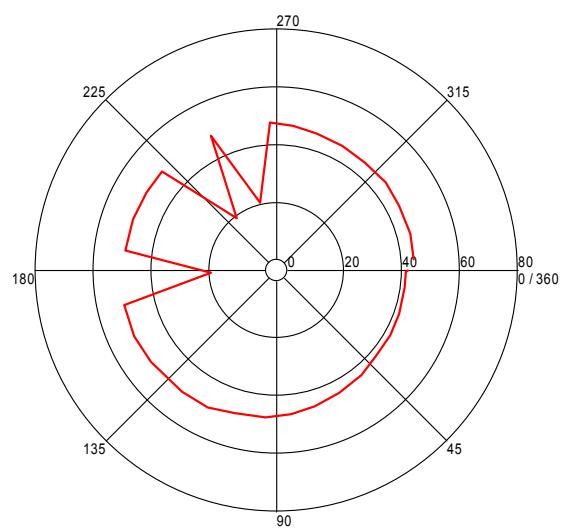


Level (dBuV/m)

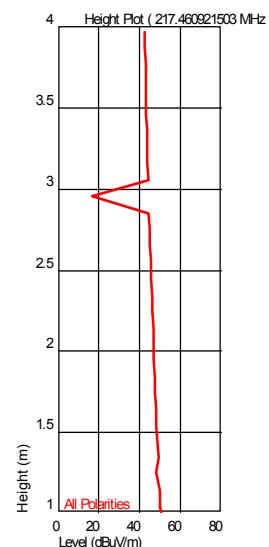
All Polarities

Azimuth (Degrees)

Turntable Plot (217.460921503 MHz)



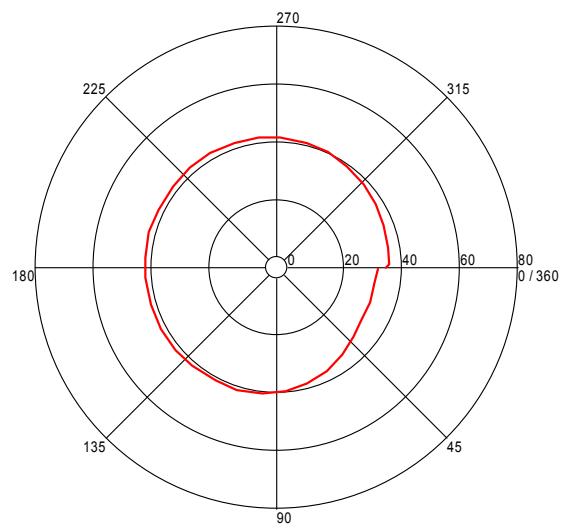
Level (dBuV/m)



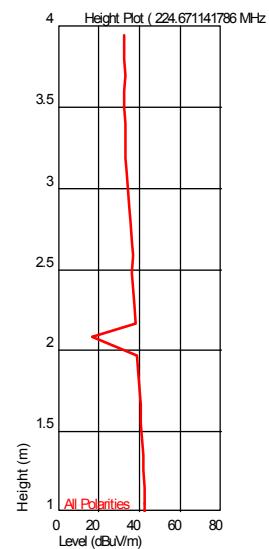
All Polarities

Azimuth (Degrees)

Turntable Plot (224.671141786 MHz)



Level (dBuV/m)



All Polarities

Azimuth (Degrees)

High Channel Radiated Emissions

Transmit on 2480MHz, 50 Ohm Terminator, 1-25 GHz
Radiated Emissions

Company: Opex
Model #: 2048910
Serial #: BOX1503021541-001
Engineers: Kouma Sinn
Project #: G101718120 Date(s): 07/15/14
Standard: FCC Part 15 Subpart C, 15.247/RSS-210
Receiver: 145-128 Limit Distance (m): 3
PreAmp: PRE145014 04-29-2015.txt Test Distance (m): 3
PreAmp Used? (Y or N): Y Voltage/Frequency: 120VAC/60Hz Frequency Range: 1-25 GHz
Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)
Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
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Hand scans were done from 18-25 GHz. No emissions were detected above the measuring noise floor.

Tx: CH 2480 MHz (The EUT sits on its side), worst-case.

PK	H	1008.000	38.90	27.24	3.75	30.80	0.00	39.09	74.00	-34.91	1/3MHz
AVG	H	1008.000	26.70	27.24	3.75	30.80	0.00	26.89	54.00	-27.11	1/3MHz
PK	H	4960.000	34.67	34.28	8.86	31.65	0.00	46.15	74.00	-27.85	1/3MHz
AVG	H	4960.000	23.92	34.28	8.86	31.65	0.00	35.40	54.00	-18.60	1/3MHz
PK	H	7440.000	36.00	35.78	11.19	32.22	0.00	50.74	74.00	-23.26	1/3MHz
AVG	H	7440.000	23.84	35.78	11.19	32.22	0.00	38.58	54.00	-15.42	1/3MHz
PK	H	9920.000	23.16	37.11	13.49	32.46	0.00	41.30	54.00	-12.70	100/300 kHz
PK	H	12400.000	34.05	39.22	14.65	30.85	0.00	57.07	74.00	-16.93	1/3MHz
AVG	H	12400.000	22.64	39.22	14.65	30.85	0.00	45.66	54.00	-8.34	1/3MHz
PK	H	14880.000	23.05	39.81	15.67	29.90	9.54	39.08	54.00	-14.92	100/300 kHz
PK	H	17360.000	25.30	42.07	20.94	30.40	9.54	48.37	54.00	-5.63	100/300 kHz

FCC

RB

RB

RB

RB

RB

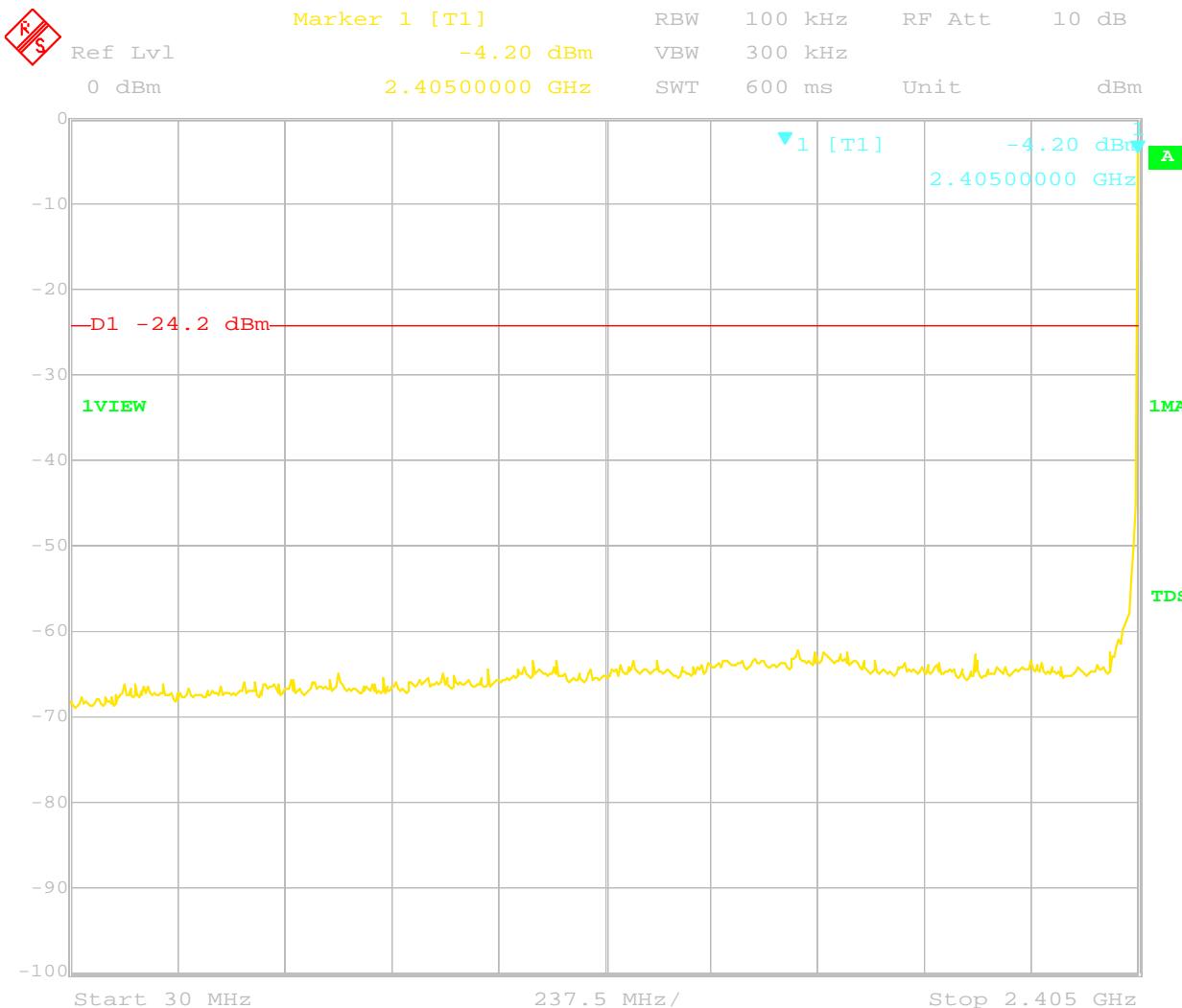
RB

1m

1m

Low Channel Antenna Port Conducted Emissions (30-2405 MHz)

No emissions were detected

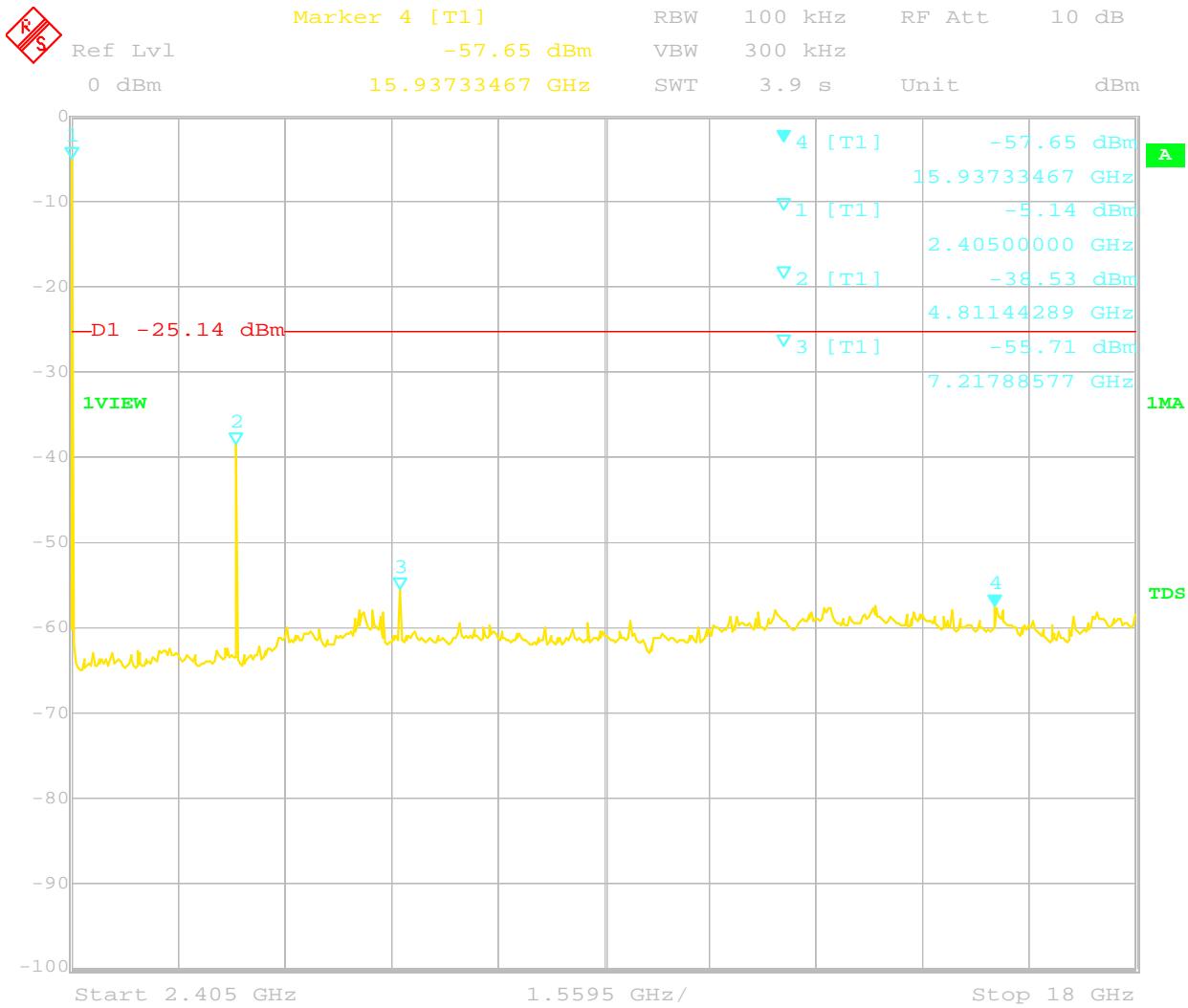


Date: 18.JUL.2014 10:50:46

Low Channel Antenna Port Conducted Emissions (2.405-18 GHz), 100 kHz ResBW

Emissions were detected as shown in plot below

Limit line = 20 dB below Fund.

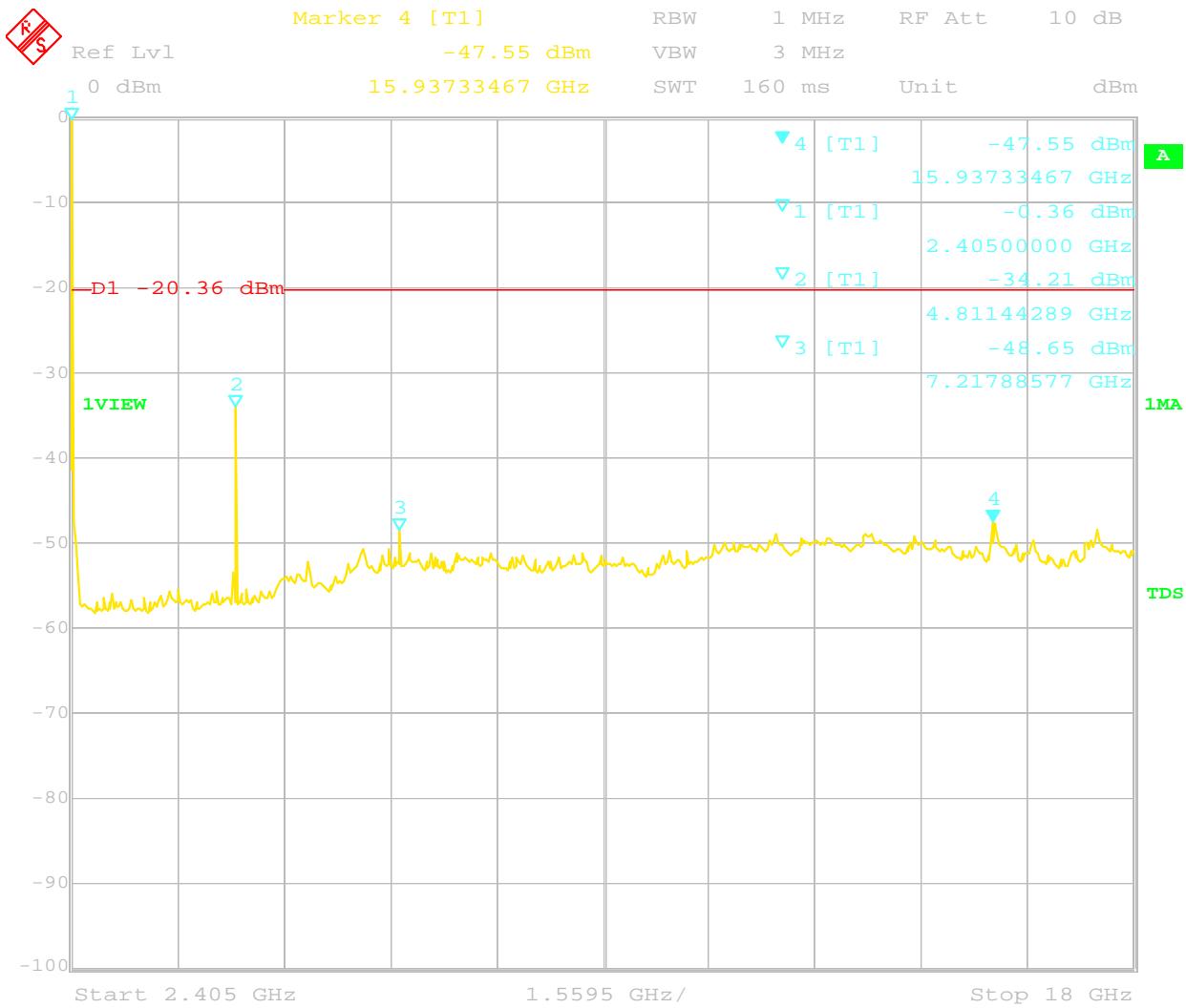


Date: 18.JUL.2014 11:30:37

Low Channel Antenna Port Conducted Emissions (2.405-18 GHz), 1MHz ResBW

Emissions were detected as shown in plot below

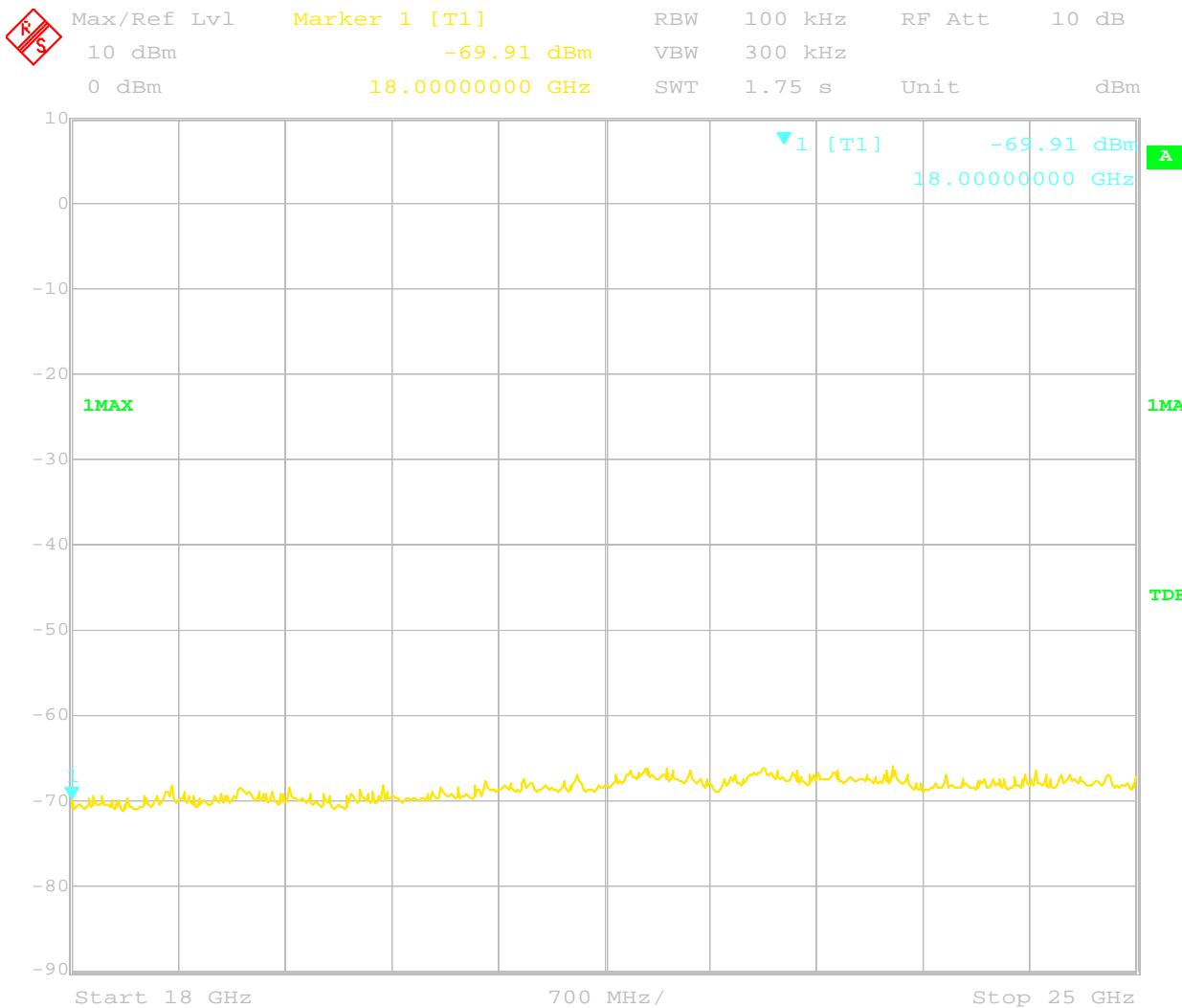
Limit line = 20 dB below Fund.



Date: 18.JUL.2014 11:38:19

Low Channel Antenna Port Conducted Emissions (18-25 GHz), 100kHz ResBW

No emissions were detected

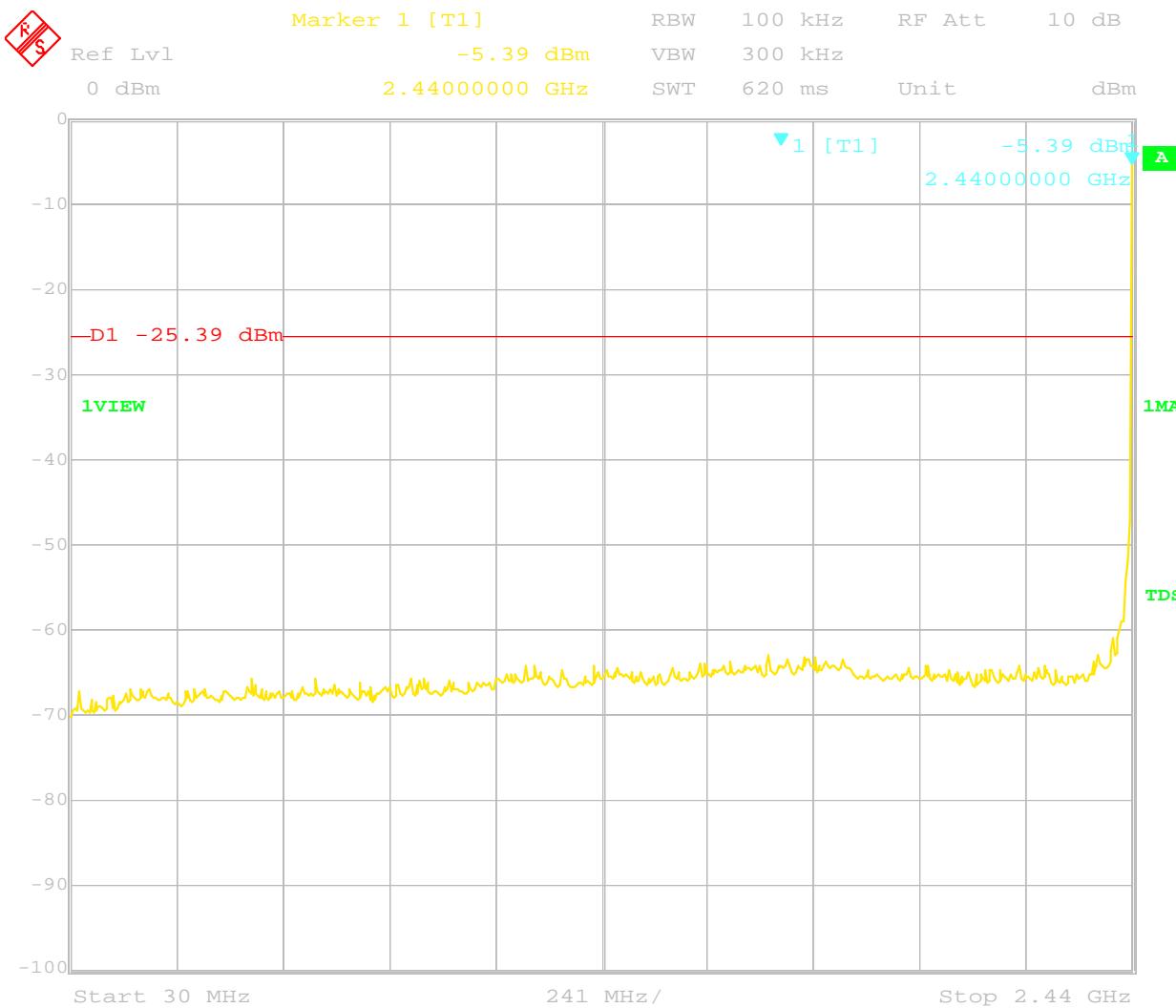


Date: 18.JUL.2014 14:45:57

Mid Antenna Port Conducted Emissions (30-2440 MHz)

No emissions were detected

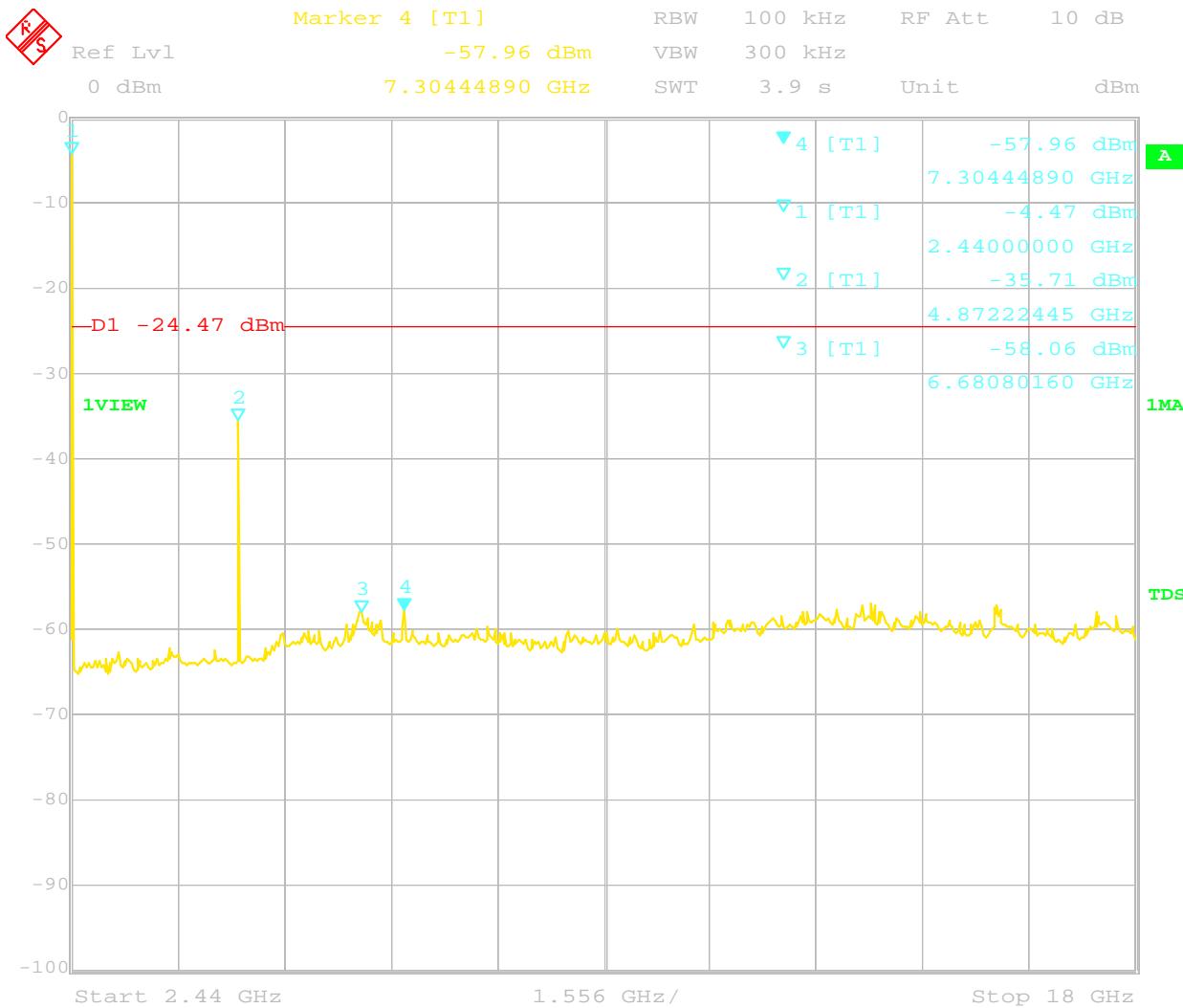
Limit line = 20 dB below Fund.



Mid Channel Antenna Port Conducted Emissions (2.440-18 GHz), 100kHz ResBW

Emissions were detected as shown in plot below

Limit line = 20 dB below Fund.

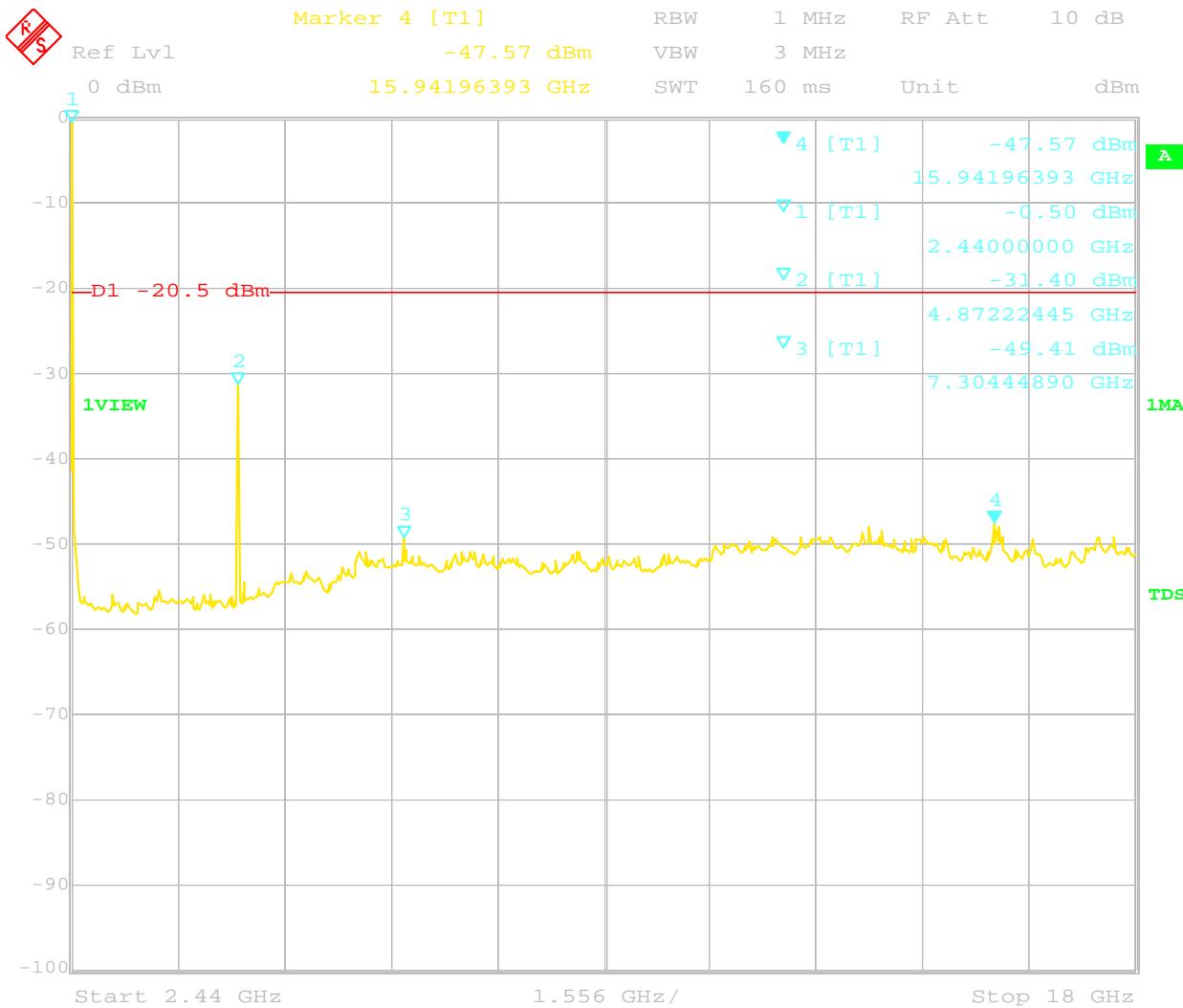


Date: 18.JUL.2014 11:27:29

Mid Channel Antenna Port Conducted Emissions (2.440-18 GHz), 1MHz ResBW

Emissions were detected as shown in plot below

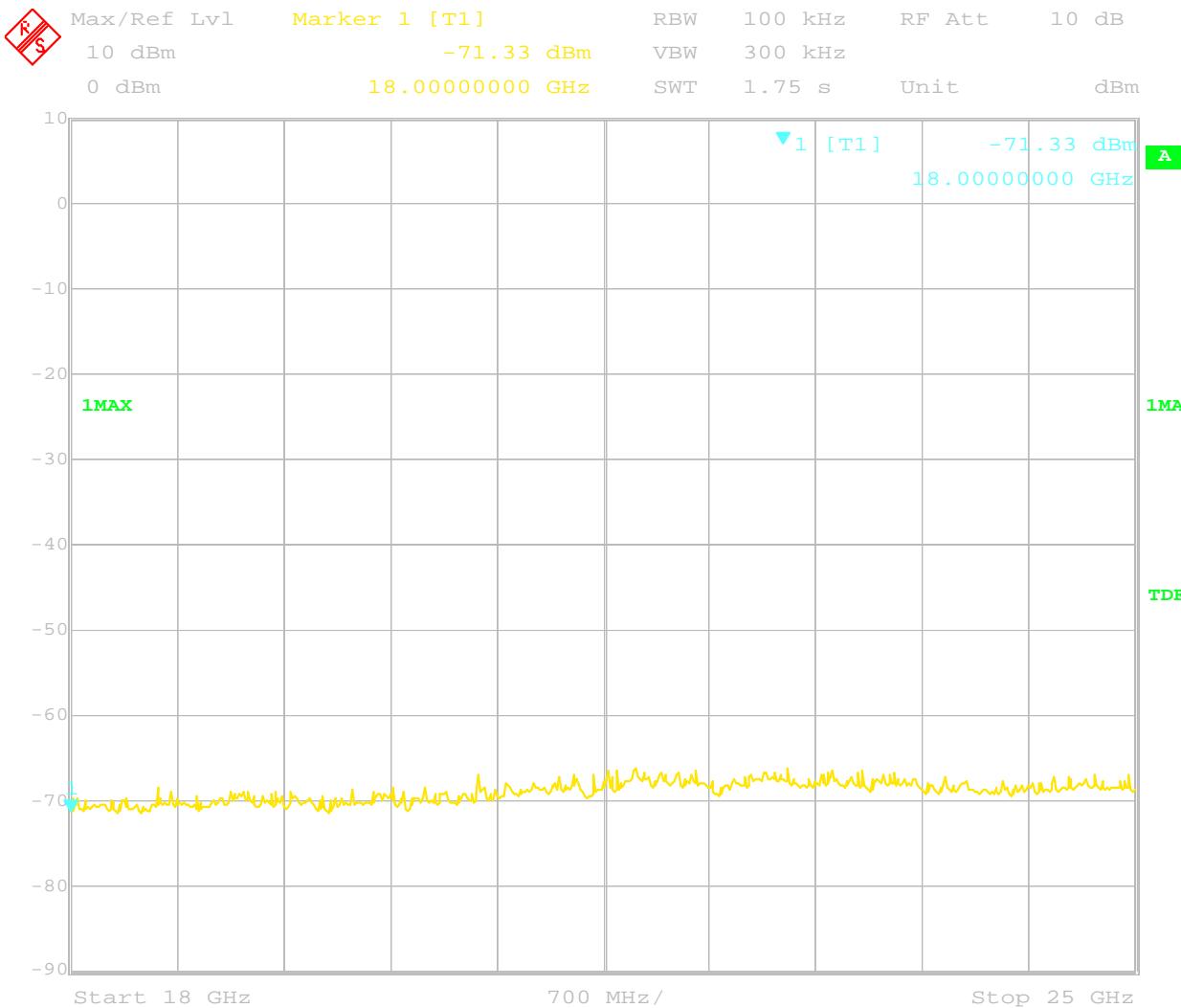
Limit line = 20 dB below Fund.



Date: 18.JUL.2014 11:23:53

Mid Channel Antenna Port Conducted Emissions (18-25 GHz), 100kHz ResBW

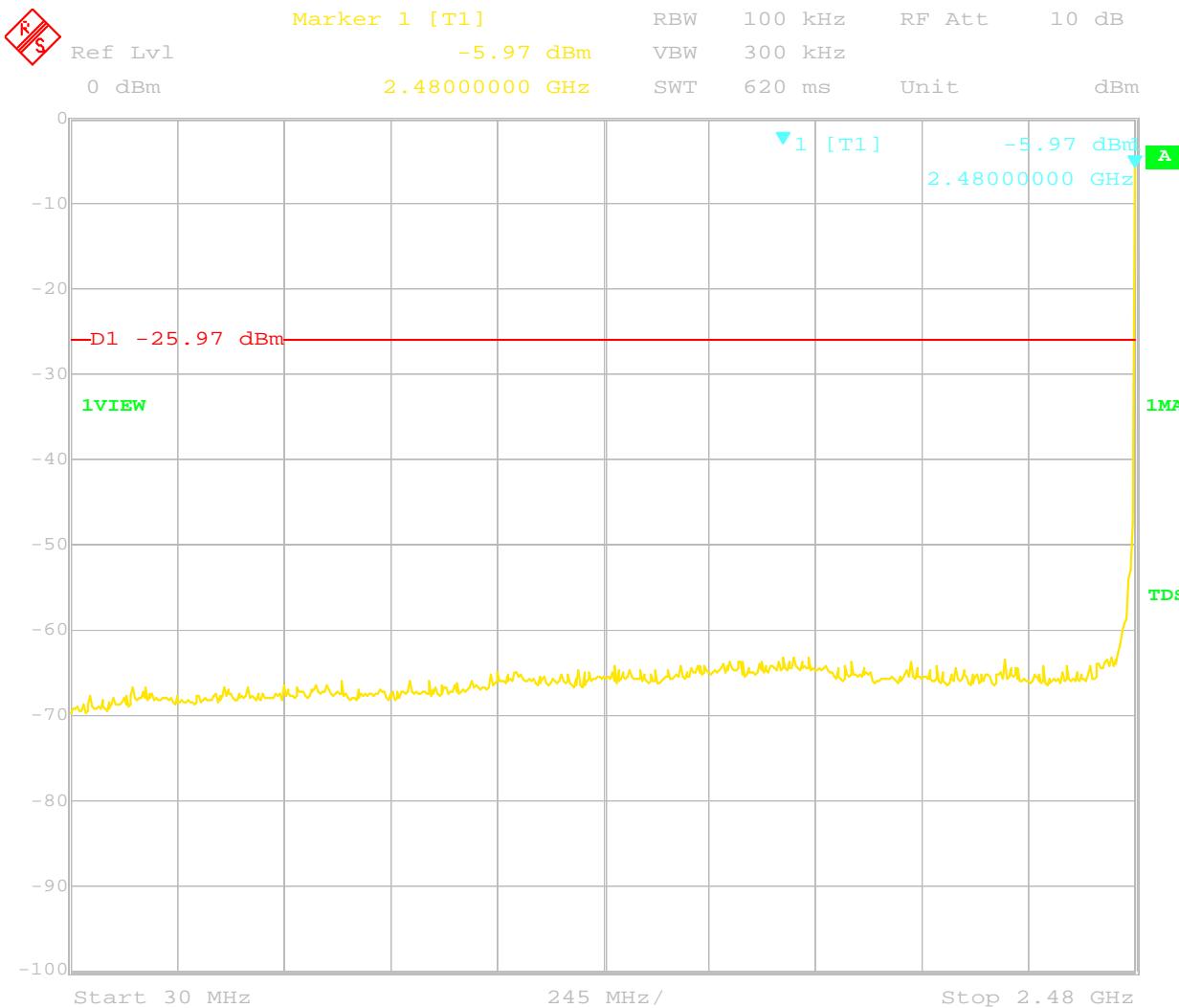
No emissions were detected



Date: 18.JUL.2014 14:50:28

High Channel Antenna Port Conducted Emissions (30-2480 MHz)

No emissions were detected

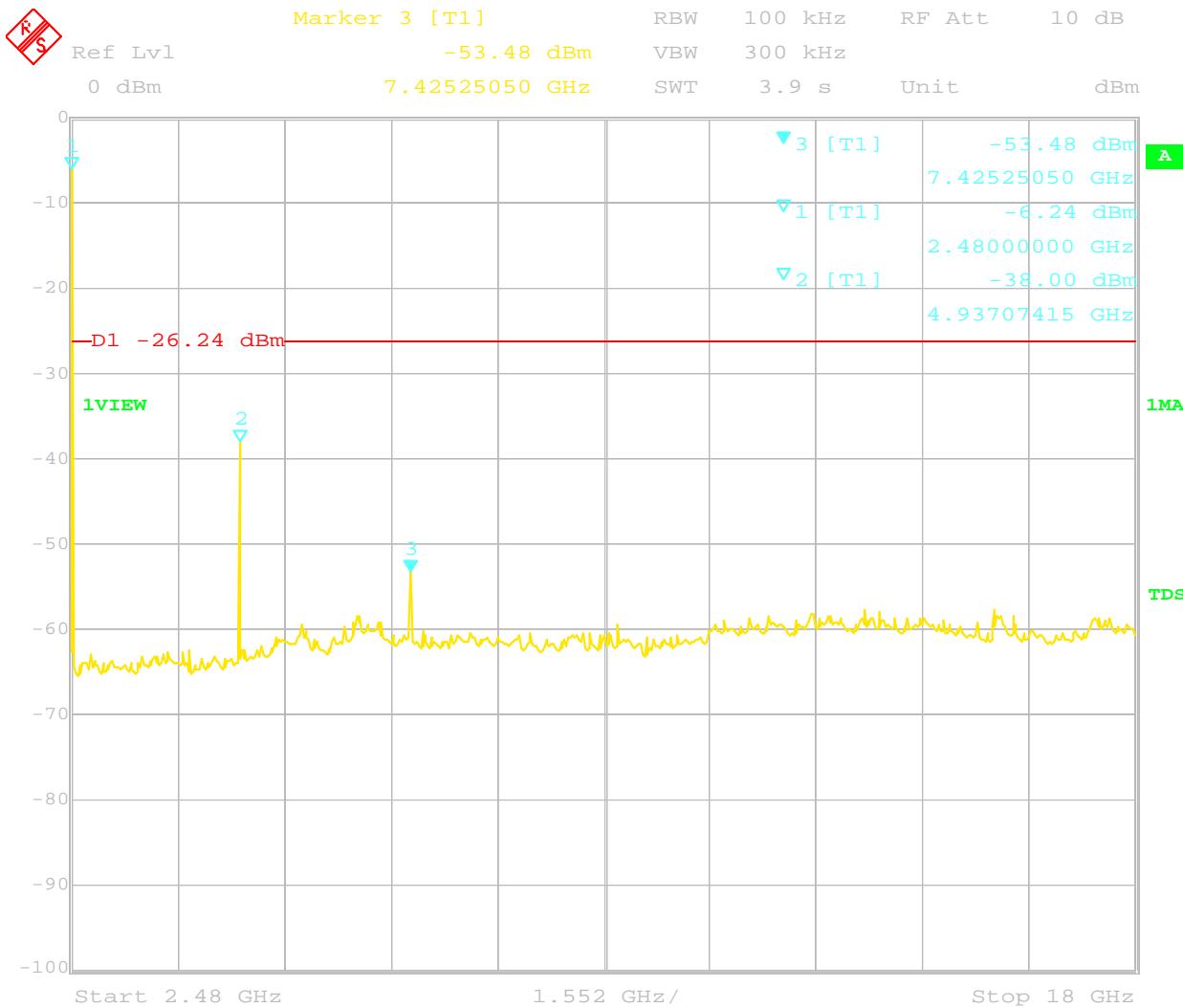


Date: 18.JUL.2014 11:03:13

High Channel Antenna Port Conducted Emissions (2.480-18 GHz), 100kHz ResBW

Emissions were detected as shown in plot below

Limit line = 20 dB below Fund.

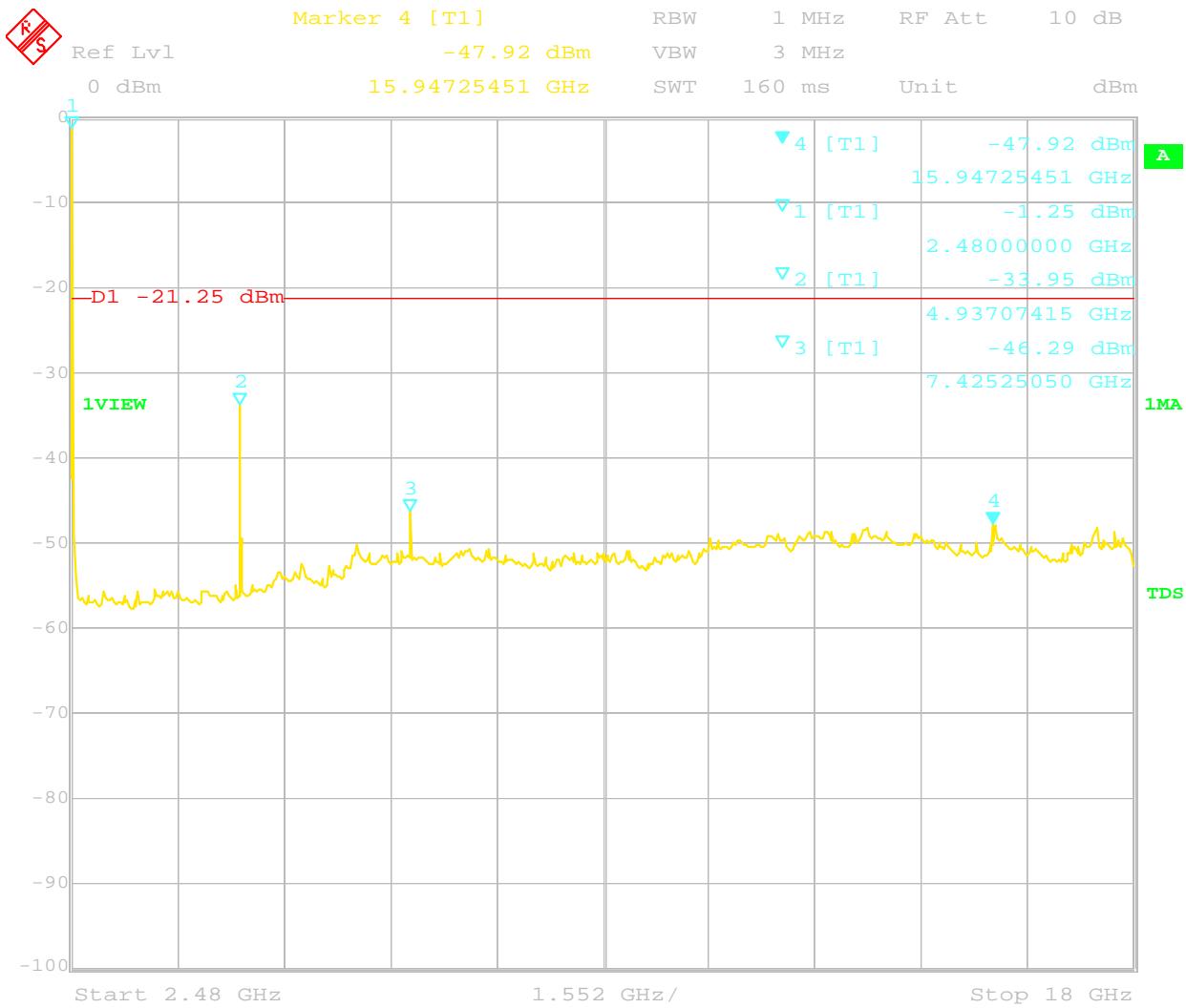


Date: 18.JUL.2014 11:13:25

High Channel Antenna Port Conducted Emissions (2.480-18 GHz), 1MHz ResBW

Emissions were detected as shown in plot below

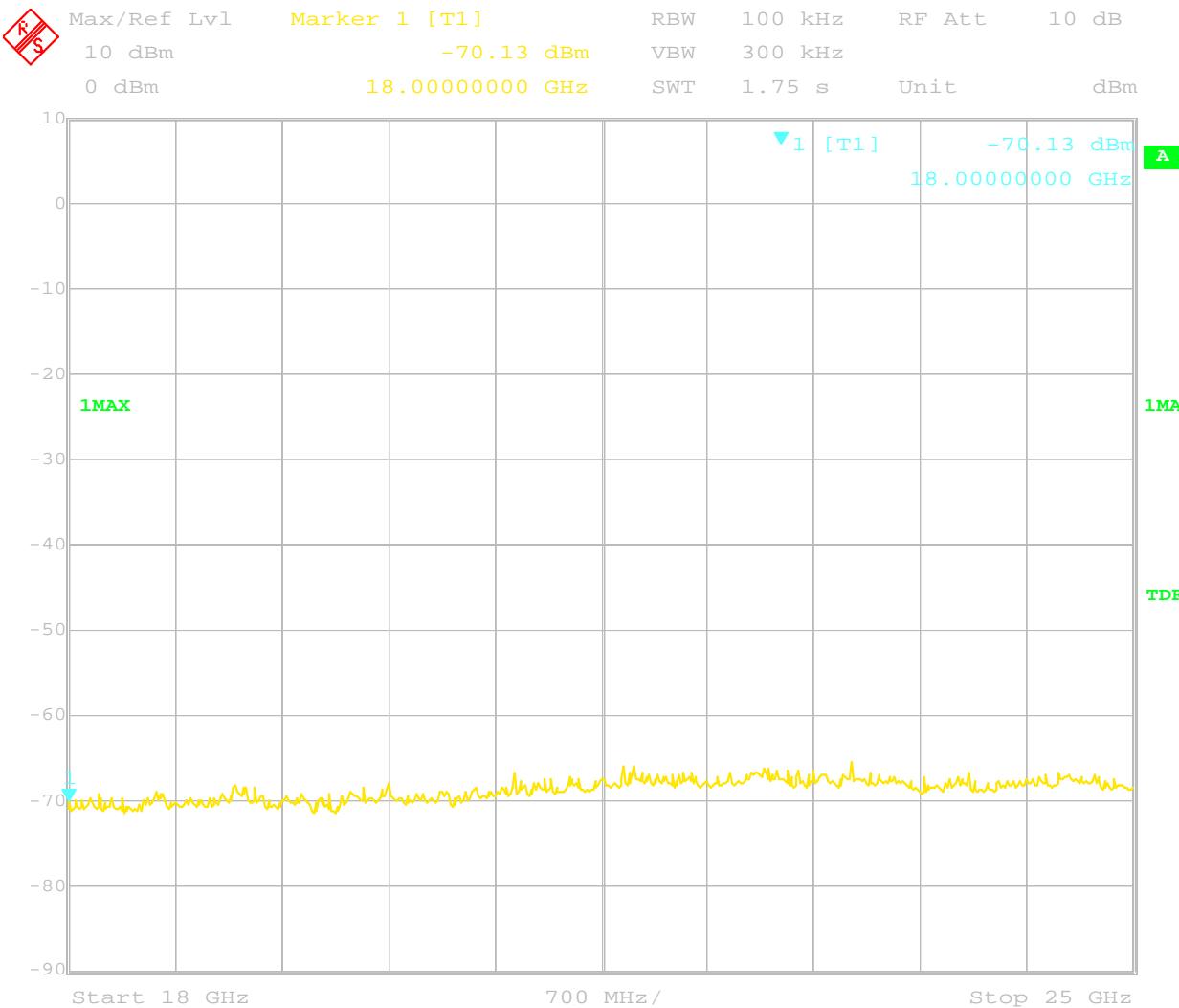
Limit line = 20 dB below Fund.



Date: 18.JUL.2014 11:19:23

High Channel Antenna Port Conducted Emissions (18-25 GHz)

No emissions were detected



Date: 18.JUL.2014 14:52:11

Test Personnel: Kouma Sinn *KPS*
Supervising/Reviewing Engineer: Vathana Ven *VJV*
(Where Applicable) _____

Product Standard: FCC Part 15.247,
RSS-210 Annex 8
Input Voltage: 120VAC/60Hz

Pretest Verification w/
Ambient Signals or
BB Source: Ambient Signals

Test Date: 07/15/2014, 7/18/2014

Limit Applied: Emissions below the limits specified in Section 7.3

Ambient Temperature: 22, 24, 21 °C

Relative Humidity: 44, 45, 64 %

Atmospheric Pressure: 1000, 999, 1012 mbars

Deviations, Additions, or Exclusions: None

8 6 dB Bandwidth & 99% Power Bandwidth

8.1 Method

Tests are performed in accordance with FCC Part 15 Subpart C Section 15.247, ANSI C63.10:2009, and RSS-210 Annex 8.

TEST SITE: EMC Lab

The EMC Lab has two Semi-anechoic Chambers and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

8.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV004'	Weather Station	Davis Instruments	7400	PE80529A61A	09/25/2012	09/25/2014
REA006'	18GHz High Pass Filter	Reactel, Inc	7HS-18G/40G K11	(06)1	08/08/2012	08/08/2014
CBL030'	High Frequency Cable 40GHz	Megaphase	TM40 K1K1 80	CBL030	04/05/2014	04/05/2015
ROS001'	Spectrum Analyzer 20Hz - 40 GHz	Rohde & Schwartz	FSEK-30	100225	05/19/2014	05/19/2015
WEI8'	Attenuator	Weinschel Corp	47-10-34	BD8309	03/26/2014	03/26/2015

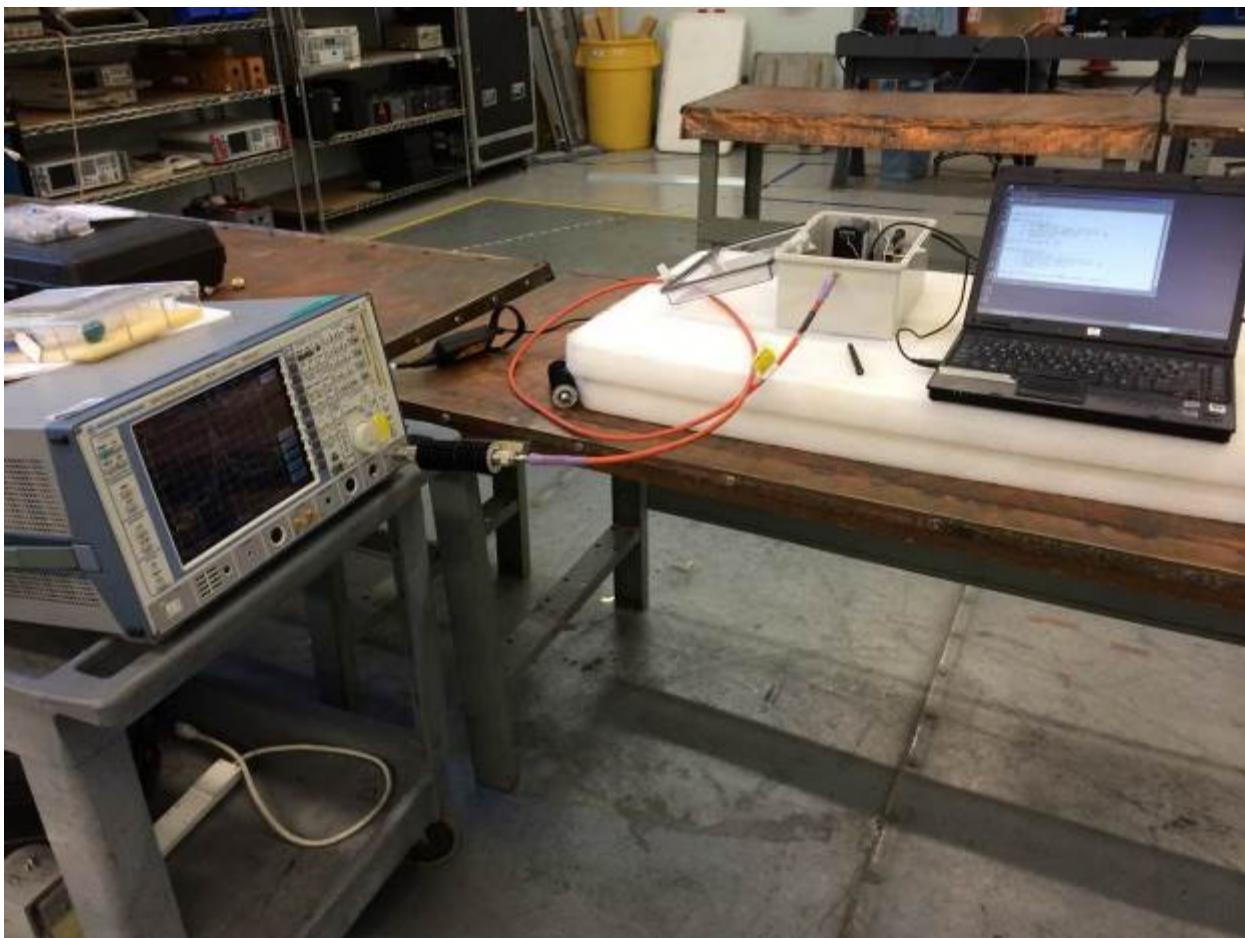
Software Utilized:

Name	Manufacturer	Version
None		

8.3 Results:

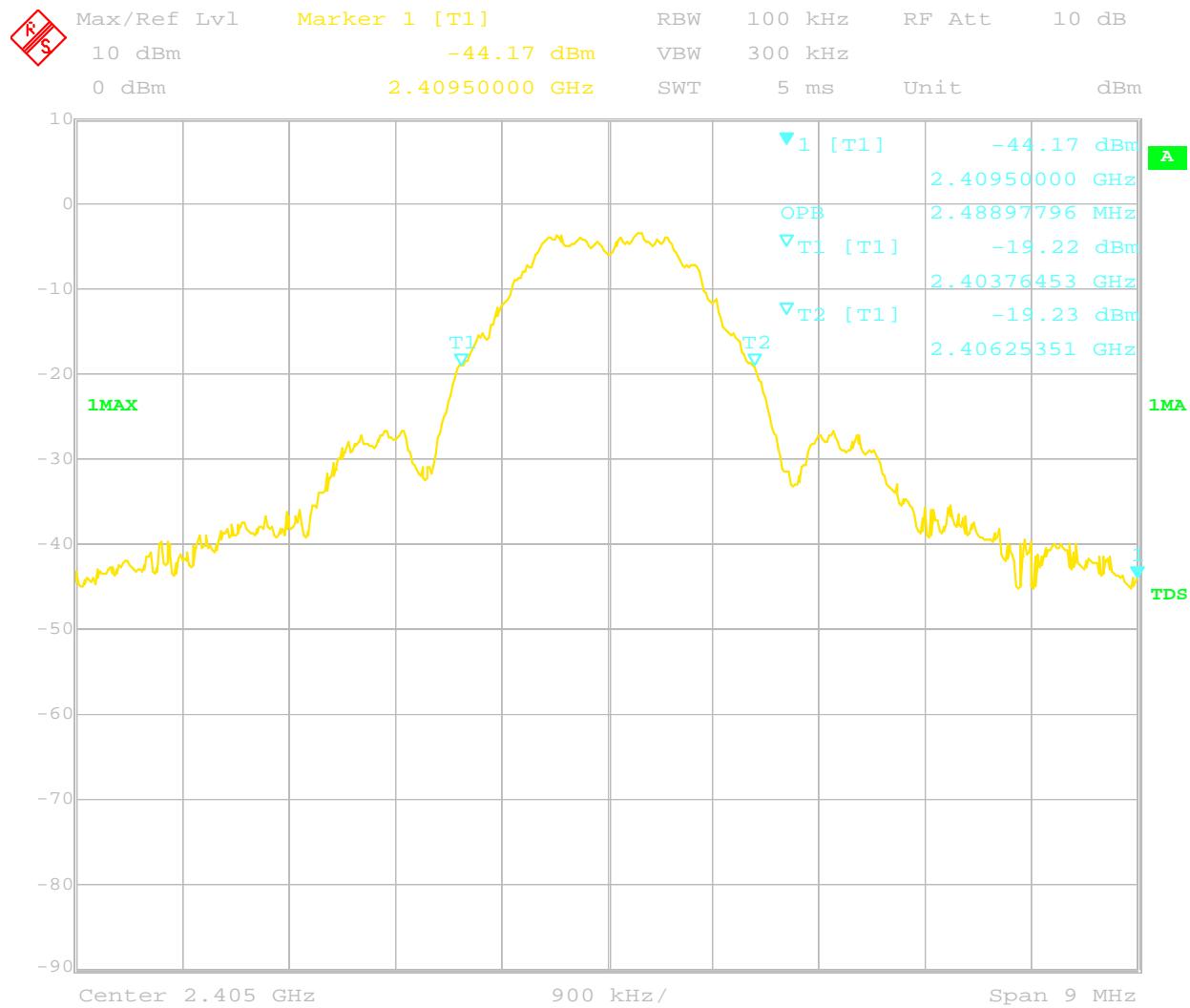
The sample tested was found to Comply. The 99% power bandwidth, or 6 dB bandwidth, must not be less than 500 kHz.

Plots were taken using a RBW of 100 kHz per KDB 558074v03 04/09/2013 and IC RSS-Gen Section 4.6.2.

8.4 Setup Photograph:

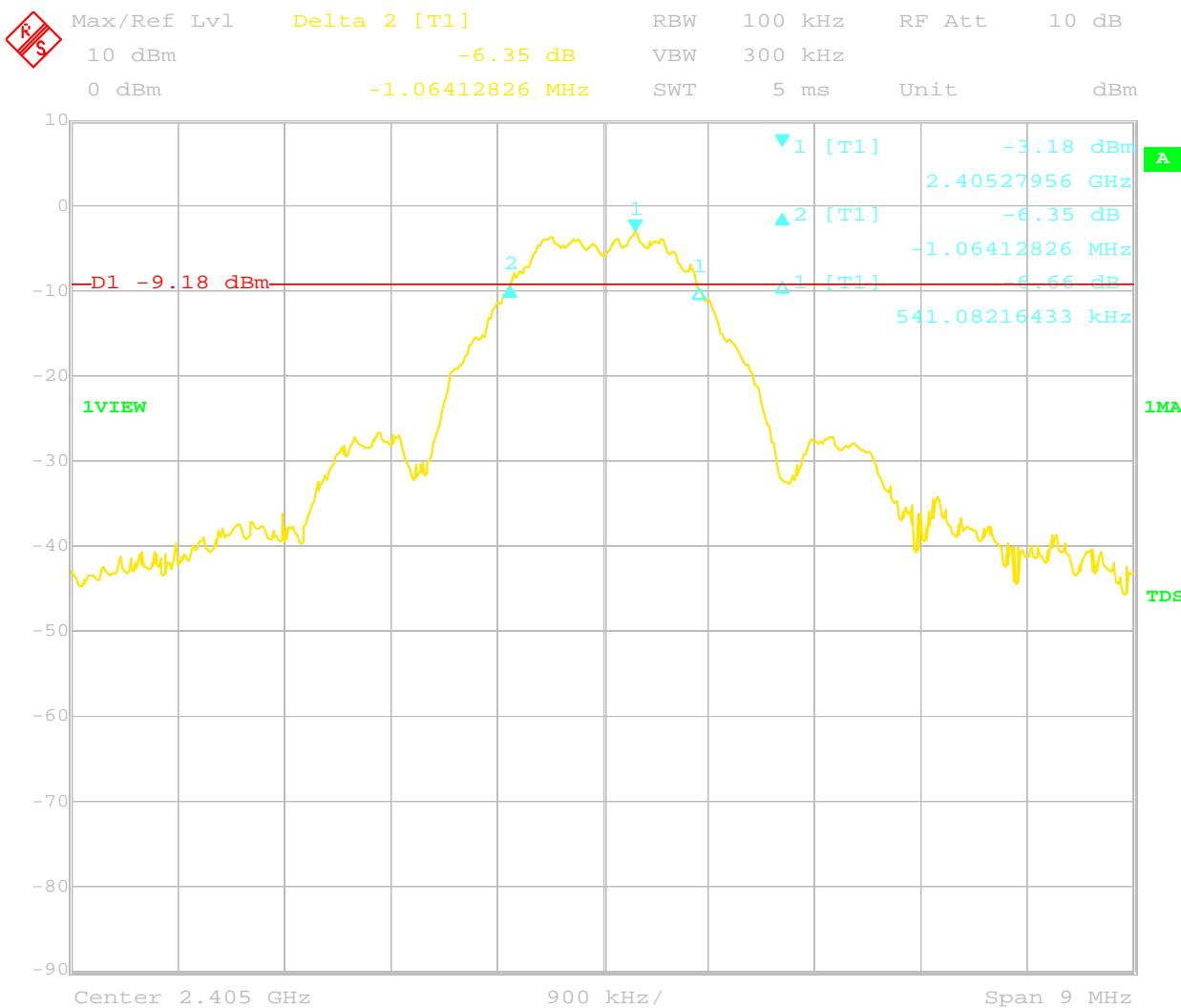
8.5 Plots/Data:

Low Channel, 99% Power BW = 2.489 MHz



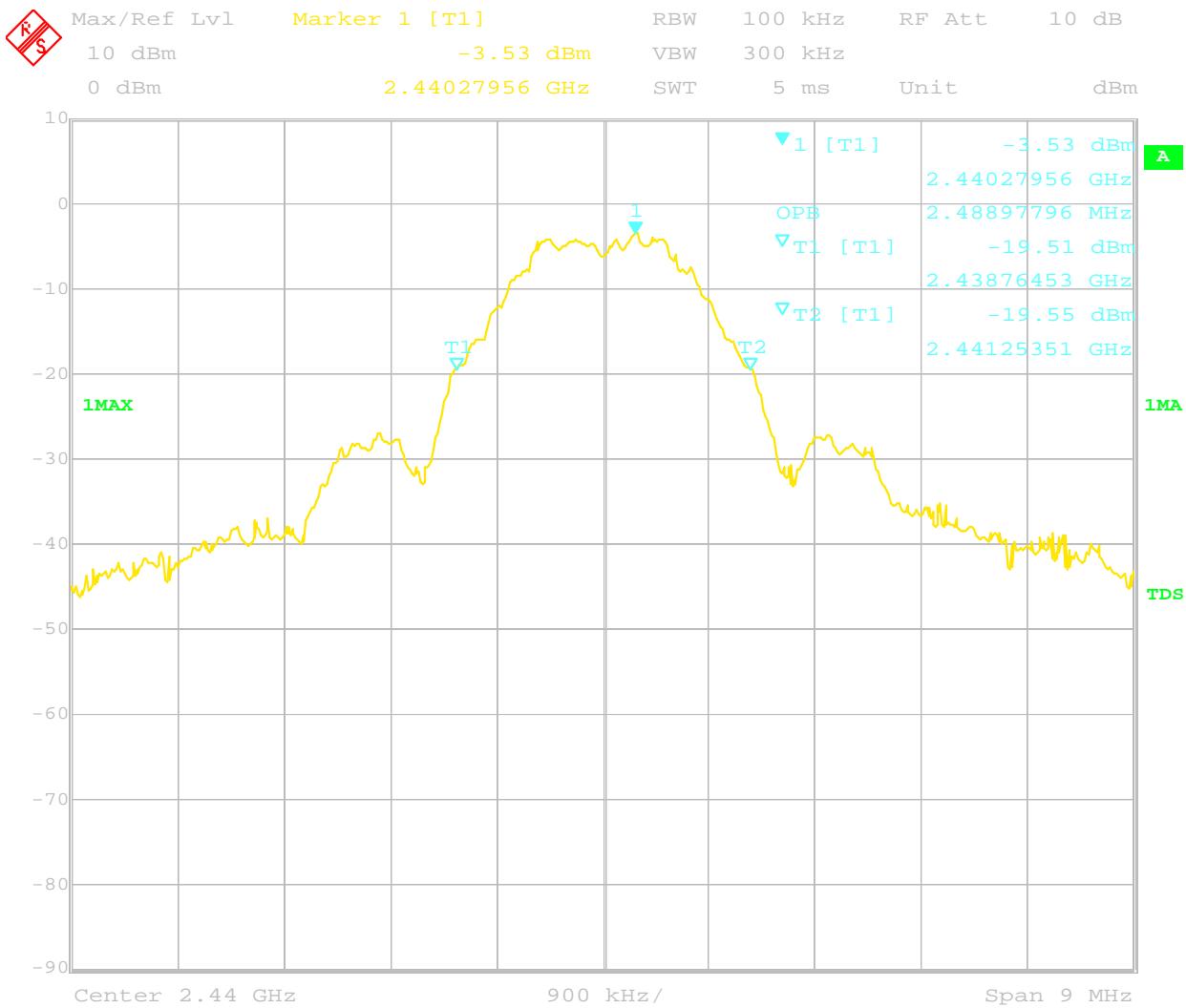
Date: 18.JUL.2014 13:00:26

Low Channel, 6dB BW = 1.605 MHz



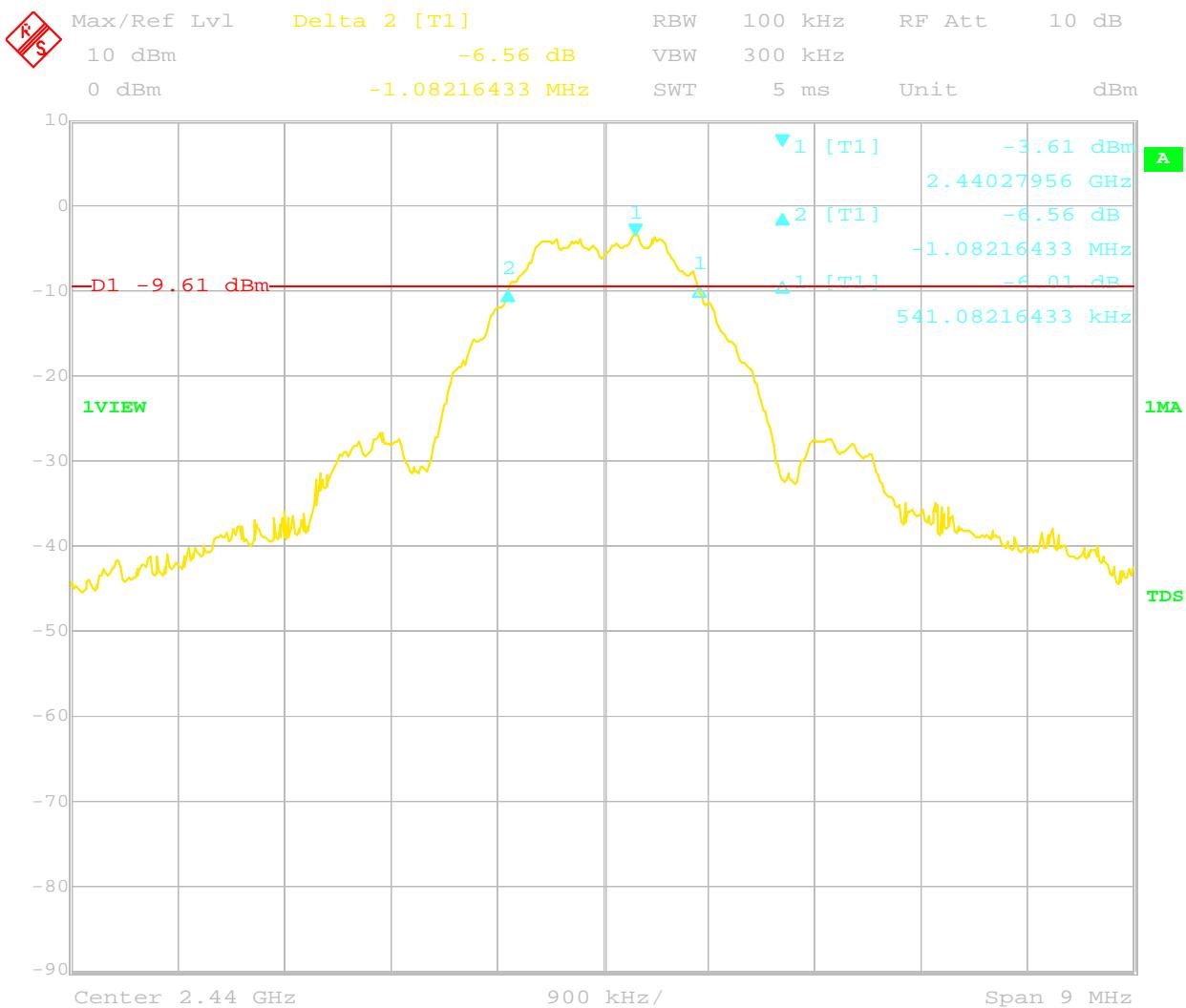
Date: 18.JUL.2014 13:04:46

Mid Channel, 99% Power BW = 2.489 MHz



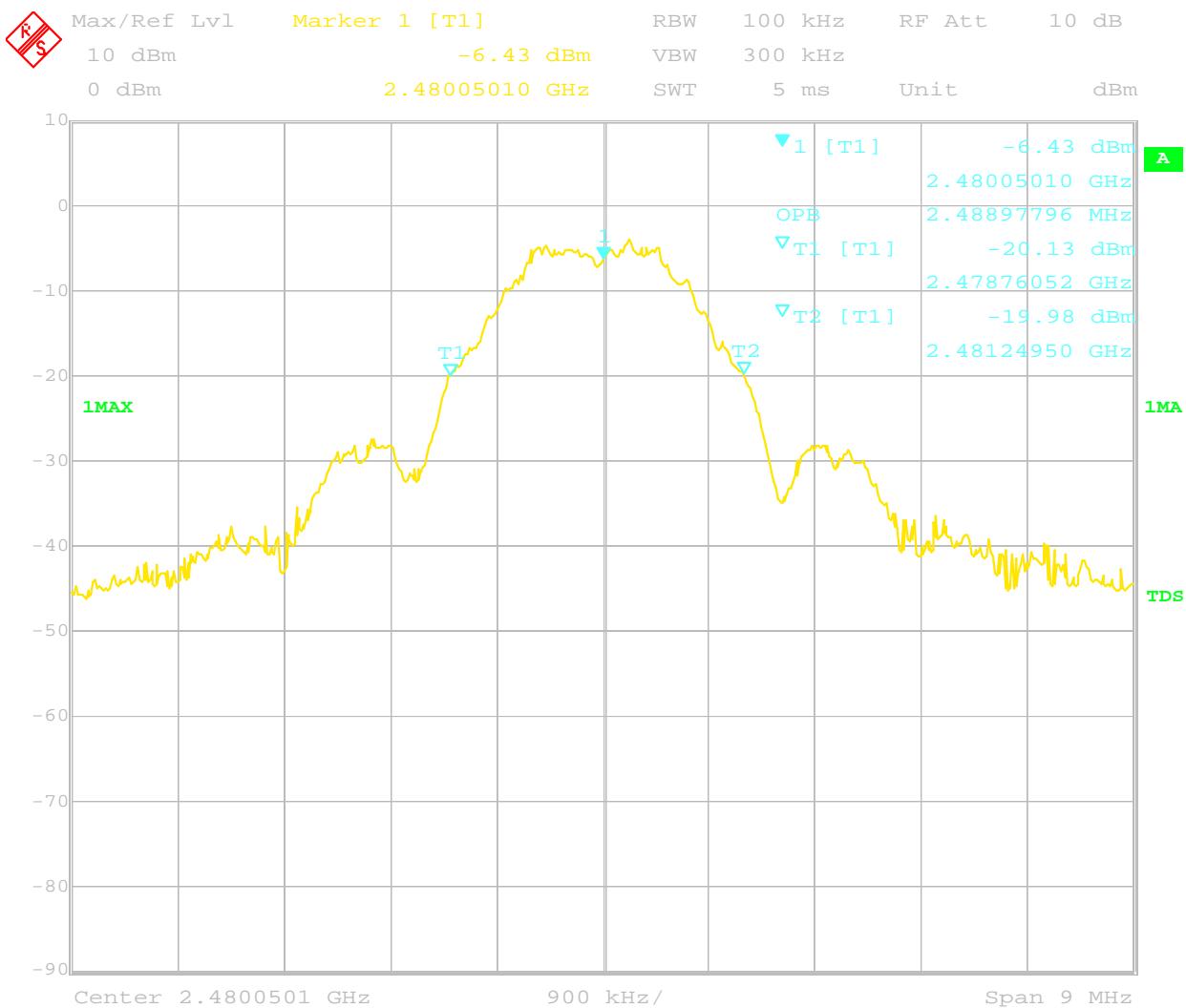
Date: 18.JUL.2014 12:57:15

Mid Channel, 6dB BW = 1.623 MHz



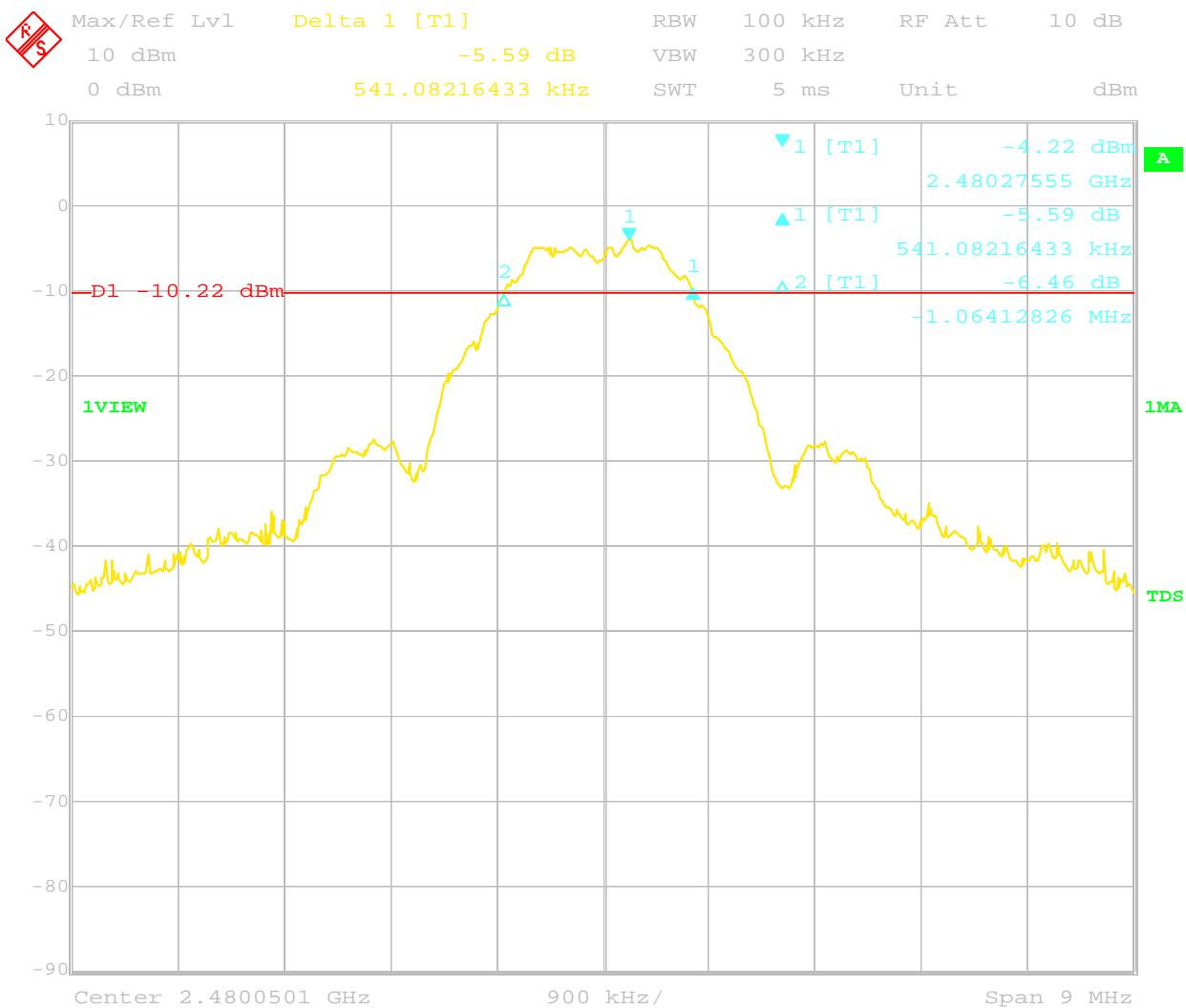
Date: 18.JUL.2014 12:54:21

High Channel, 99% Power BW = 2.489 MHz



Date: 18.JUL.2014 12:48:31

High Channel, 6dB BW = 1.605 MHz



Date: 18.JUL.2014 12:51:23

Test Personnel: Kouma Sinn *KPS*
Supervising/Reviewing
Engineer:(Where Applicable) N/ATest Date: 7/18/2014Product Standard: FCC Part 15.247,
RSS-210 Annex 8
Input Voltage: 120VAC/60HzLimit Applied: Emissions below the limits
specified in Section 8.3Pretest Verification w/
Ambient Signals or
BB Source: Ambient SignalsAmbient Temperature: 21 °CRelative Humidity: 64 %Atmospheric Pressure: 1012 mbars

Deviations, Additions, or Exclusions: None

9 Power Spectral Density

9.1 Method

Tests are performed in accordance with FCC Part 15 Subpart C Section 15.247, ANSI C63.10:2009, and RSS-210 Annex 8.

TEST SITE: EMC Lab & 10m ALSE

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	4.6	6.3
Radiated Emissions, 3m	30-1000 MHz	5.3	6.3
Radiated Emissions, 3m	1-6 GHz	4.5	5.2
Radiated Emissions, 3m	6-15 GHz	5.2	5.5
Radiated Emissions, 3m	15-18 GHz	5.0	5.5
Radiated Emissions, 3m	18-40 GHz	5.0	5.5

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where FS = Field Strength in $\text{dB}\mu\text{V}/\text{m}$

RA = Receiver Amplitude (including preamplifier) in $\text{dB}\mu\text{V}$

CF = Cable Attenuation Factor in dB

AF = Antenna Factor in dB

AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 $\text{dB}\mu\text{V}$ is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 $\text{dB}\mu\text{V}/\text{m}$. This value in $\text{dB}\mu\text{V}/\text{m}$ was converted to its corresponding level in $\mu\text{V}/\text{m}$.

$$RA = 52.0 \text{ dB}\mu\text{V}$$

$$AF = 7.4 \text{ dB}/\text{m}$$

$$CF = 1.6 \text{ dB}$$

$$AG = 29.0 \text{ dB}$$

$$FS = 32 \text{ dB}\mu\text{V}/\text{m}$$

To convert from $\text{dB}\mu\text{V}$ to μV or mV the following was used:

$$UF = 10^{(NF/20)} \text{ where } UF = \text{Net Reading in } \mu\text{V}$$

$$NF = \text{Net Reading in } \text{dB}\mu\text{V}$$

Example:

$$FS = RA + AF + CF - AG = 52.0 + 7.4 + 1.6 - 29.0 = 32.0$$

$$UF = 10^{(32 \text{ dB}\mu\text{V}/20)} = 39.8 \mu\text{V}/\text{m}$$

Alternately, when C5 Software is used, the "Level" includes all losses and gains and is compared directly in the "Margin" column to the "Limit". "AF" is the Antenna Factor; "PA+CL" are Preamp and Cable Loss. These are already accounted for in the "Level" column.

9.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV004'	Weather Station	Davis Instruments	7400	PE80529A61A	09/25/2012	09/25/2014
REA006'	18GHz High Pass Filter	Reactel, Inc	7HS-18G/40G K11 (06)1		08/08/2012	08/08/2014
CBL030'	High Frequency Cable 40GHz	Megaphase	TM40 K1K1 80	CBL030	04/05/2014	04/05/2015
ROS001'	Spectrum Analyzer 20Hz - 40 GHz	Rohde & Schwartz	FSEK-30	100225	05/19/2014	05/19/2014
WEI8'	Attenuator	Weinschel Corp	47-10-34	BD8309	03/26/2014	03/26/2015
MAN1'	Digital 4 Line Barometer	Mannix	0ABA116	MAN1	08/13/2012	08/13/2014
ETS001'	1-18GHz DRG Horn Antenna	ETS-Lindgren	3117	00143259	01/06/2014	01/06/2015
145-416'	Cables 145-400 145-402 145-404 145-408	Huber + Suhner	3m Track B cables	multiple	10/04/2013	10/04/2014
145128'	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/17/2014	03/17/2015

Software Utilized:

Name	Manufacturer	Version
None		

9.3 Results:**9.3**

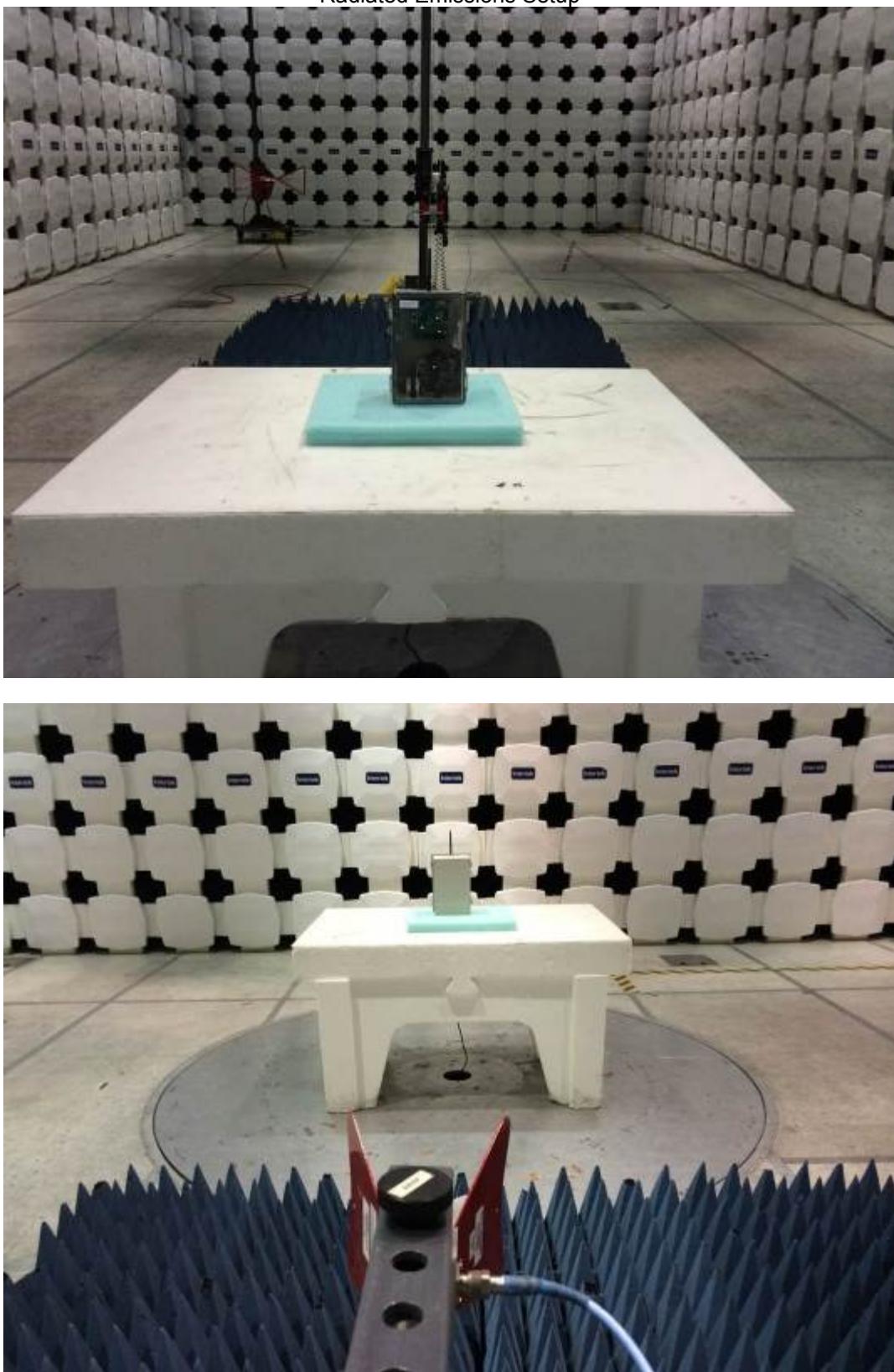
9.3 The sample tested was found to Comply. The peak power spectral density must not exceed 8 dBm in any 3 kHz bandwidth using the methods of ANSI C63.10:2009.

9.3

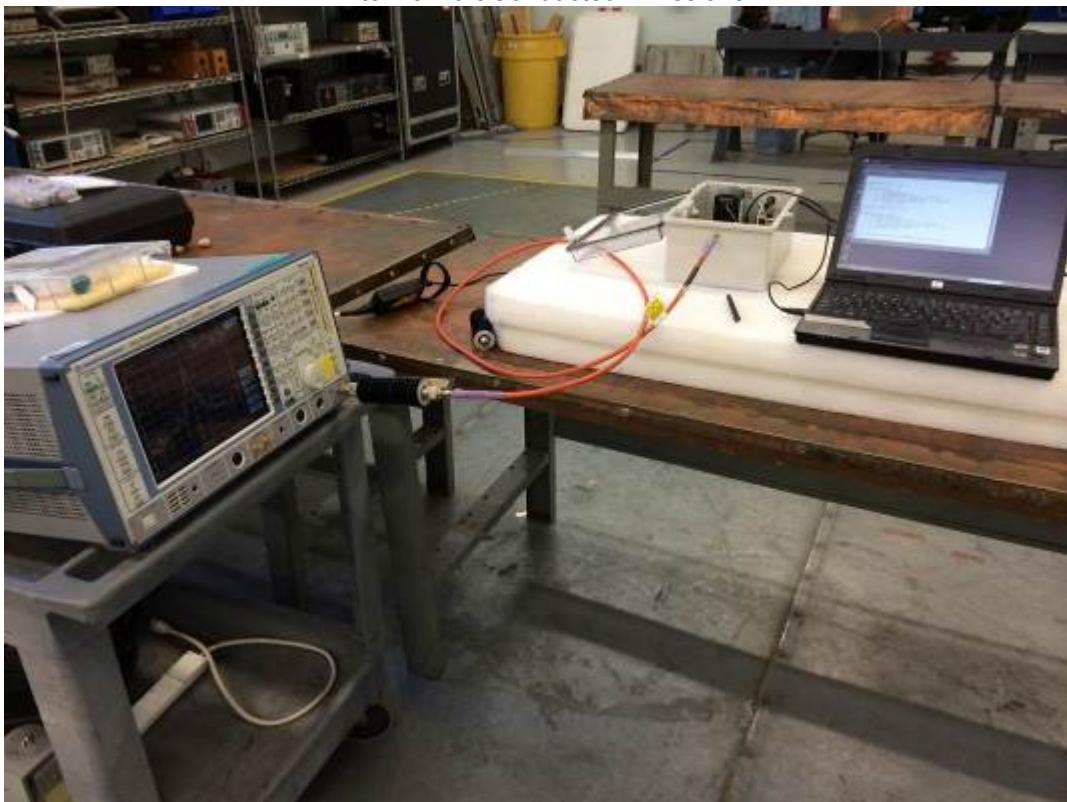
<b

9.4 Setup Photographs:

Radiated Emissions Setup



Antenna Port Conducted Emissions

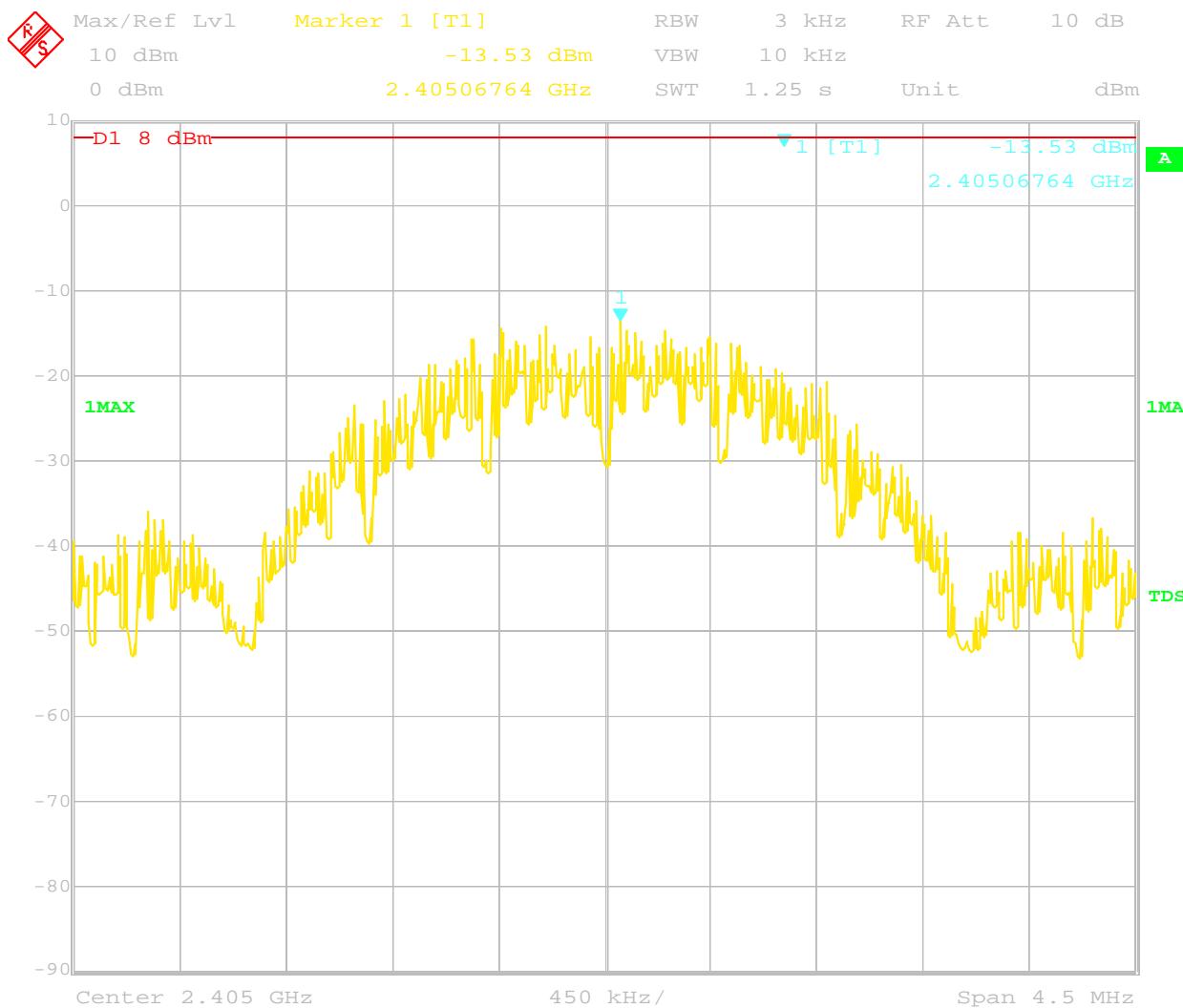


9.5 Test Data:**Low, Mid, and High Channel Radiated Spectral Density**

Company: Opex
 Model #: 2048910
 Serial #: BOX1503021541-001
 Engineers: Kouma Sinn
 Project #: G101718120
 Date(s): 07/15/14
 Standard: FCC Part 15 Subpart C 15.247
 Receiver: 145-128
 PreAmp: NONE.
 PreAmp Used? (Y or N): N
 Voltage/Frequency: 120VAC/60Hz
 Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)
 Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

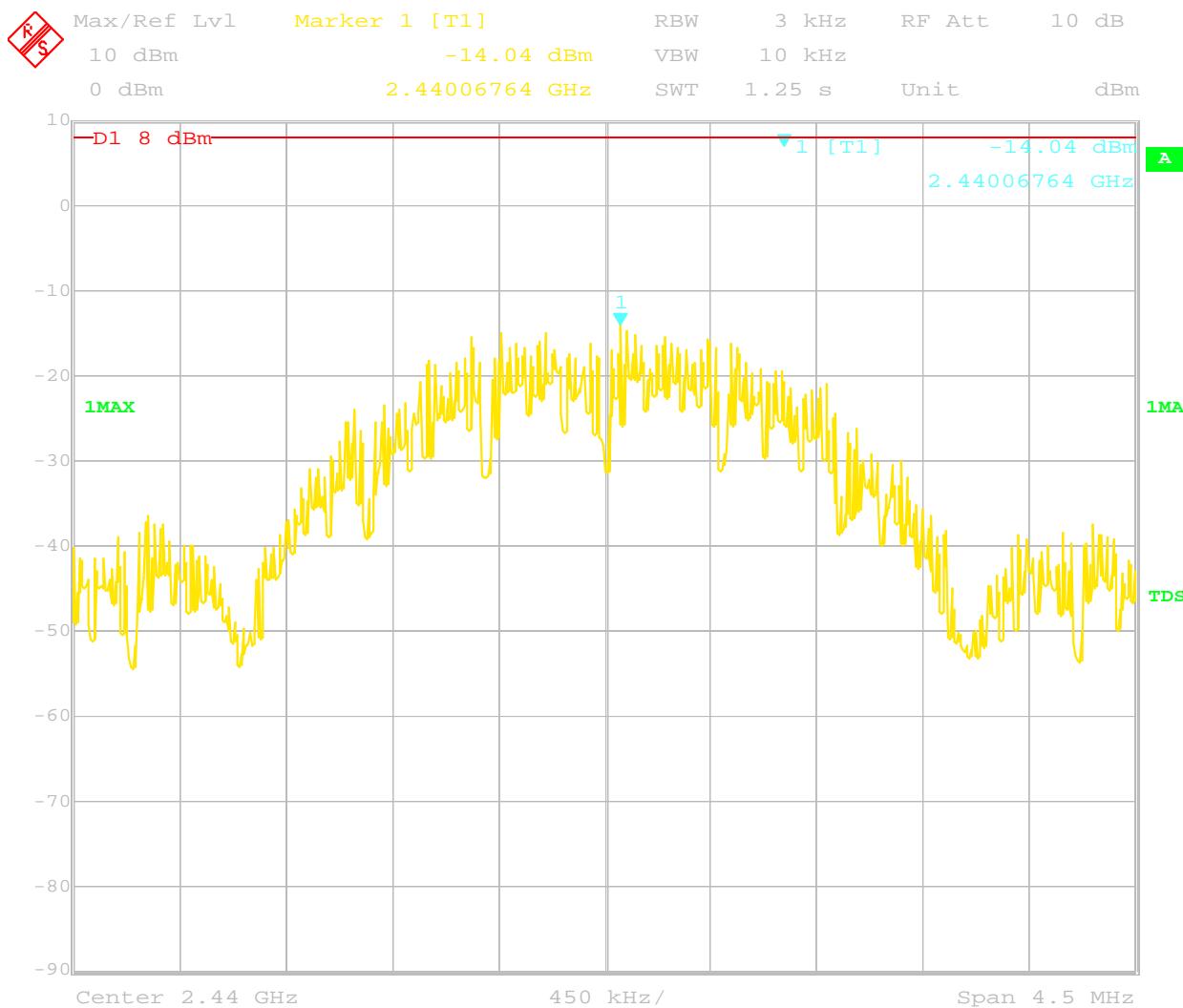
Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dBm	Limit dBm	Margin dB	Bandwidth	FCC	IC
Spectral Density = Peak Reading - 95.22. At 3 meters with no pre-amp													
PK	V	2405.000	46.29	32.11	5.92	0.00	0.00	-10.90	8.00	-18.90	3/30kHz		
PK	H	2405.000	41.13	32.11	5.92	0.00	0.00	-16.06	8.00	-24.06	3/30kHz		
Spectral Density = Peak Reading - 95.22. At 3 meters with no pre-amp													
PK	V	2440.000	45.70	32.20	5.98	0.00	0.00	-11.34	8.00	-19.34	3/30kHz		
PK	H	2440.000	36.40	32.20	5.98	0.00	0.00	-20.64	8.00	-28.64	3/30kHz		
Spectral Density = Peak Reading - 95.22. At 3 meters with no pre-amp													
PK	V	2480.000	43.12	32.30	6.06	0.00	0.00	-13.74	8.00	-21.74	3/30kHz		
PK	H	2480.000	35.77	32.30	6.06	0.00	0.00	-21.09	8.00	-29.09	3/30kHz		

Low Channel Antenna Port Conducted Spectral Density



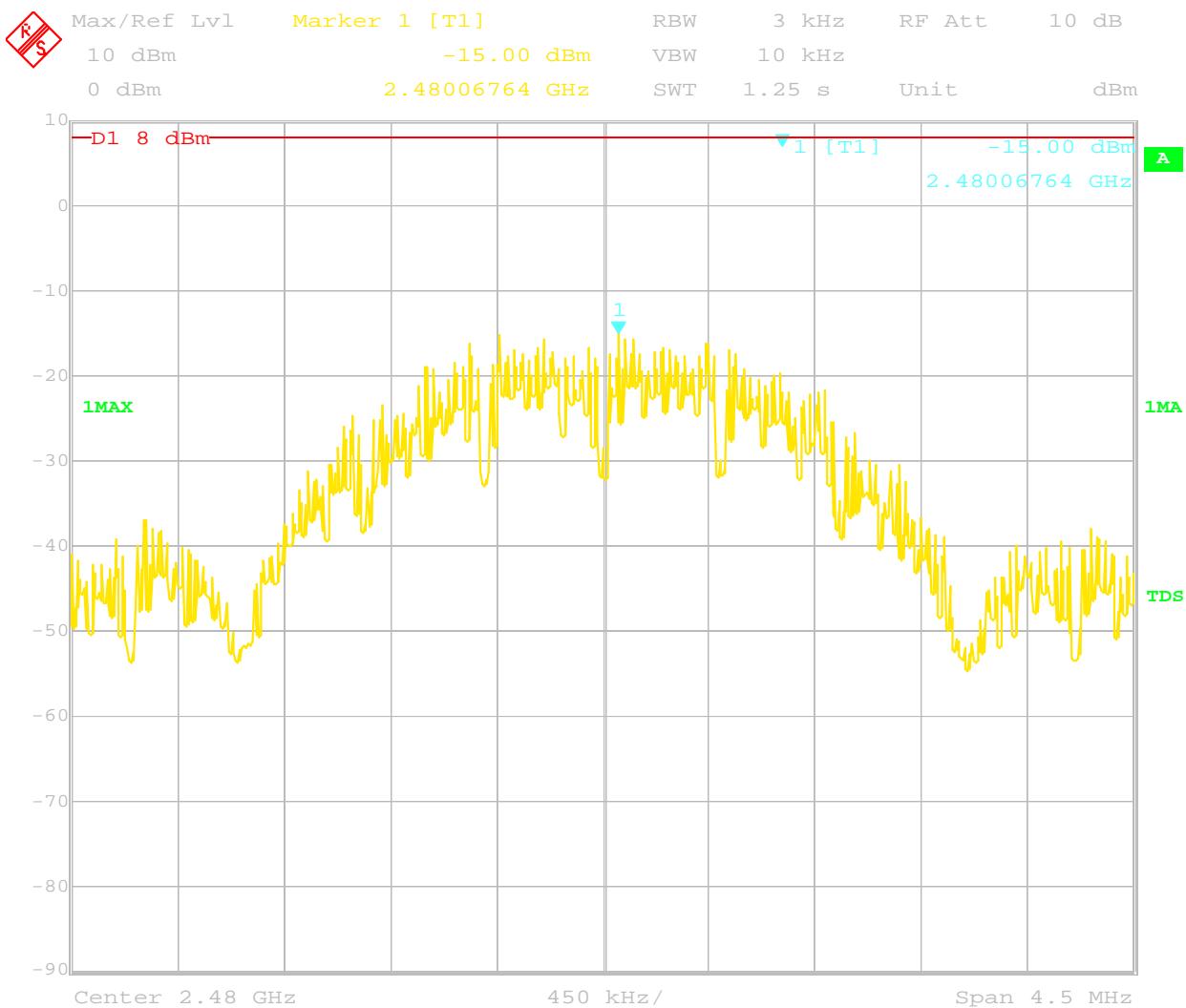
Date: 18.JUL.2014 14:01:03

Mid Channel Antenna Port Conducted Spectral Density



Date: 18.JUL.2014 14:04:35

High Channel Antenna Port Conducted Spectral Density



Date: 18.JUL.2014 14:07:18

Test Personnel: Kouma Sinn *KPS*
Supervising/Reviewing
Engineer:
(Where Applicable) N/A

Product Standard: FCC Part 15.247,
RSS-210 Annex 8
Input Voltage: 120VAC/60Hz

Pretest Verification w/
Ambient Signals or
BB Source: Ambient Signals

Test Date: 07/18/2014

Limit Applied: Emissions below the limits
specified in Section 9.3

Ambient Temperature: 21 °C

Relative Humidity: 64 %

Atmospheric Pressure: 1012 mbars

Deviations, Additions, or Exclusions: None

10 Band-edge Compliance

10.1 Method

Tests are performed in accordance with FCC Part 15 Subpart C Section 15.247, ANSI C63.4:2009, ANSI C63.10:2013, KDB558074 V03:2013, and RSS-210 Annex 8.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	4.6	6.3
Radiated Emissions, 3m	30-1000 MHz	5.3	6.3
Radiated Emissions, 3m	1-6 GHz	4.5	5.2
Radiated Emissions, 3m	6-15 GHz	5.2	5.5
Radiated Emissions, 3m	15-18 GHz	5.0	5.5
Radiated Emissions, 3m	18-40 GHz	5.0	5.5

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where FS = Field Strength in $\text{dB}\mu\text{V}/\text{m}$

RA = Receiver Amplitude (including preamplifier) in $\text{dB}\mu\text{V}$

CF = Cable Attenuation Factor in dB

AF = Antenna Factor in dB

AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 $\text{dB}\mu\text{V}$ is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 $\text{dB}\mu\text{V}/\text{m}$. This value in $\text{dB}\mu\text{V}/\text{m}$ was converted to its corresponding level in $\mu\text{V}/\text{m}$.

$$RA = 52.0 \text{ dB}\mu\text{V}$$

$$AF = 7.4 \text{ dB}/\text{m}$$

$$CF = 1.6 \text{ dB}$$

$$AG = 29.0 \text{ dB}$$

$$FS = 32 \text{ dB}\mu\text{V}/\text{m}$$

To convert from $\text{dB}\mu\text{V}$ to μV or mV the following was used:

$$UF = 10^{(NF/20)} \text{ where } UF = \text{Net Reading in } \mu\text{V}$$

$$NF = \text{Net Reading in } \text{dB}\mu\text{V}$$

Example:

$$FS = RA + AF + CF - AG = 52.0 + 7.4 + 1.6 - 29.0 = 32.0$$

$$UF = 10^{(32 \text{ dB}\mu\text{V}/20)} = 39.8 \mu\text{V}/\text{m}$$

Alternately, when C5 Software is used, the "Level" includes all losses and gains and is compared directly in the "Margin" column to the "Limit". "AF" is the Antenna Factor; "PA+CL" are Preamp and Cable Loss. These are already accounted for in the "Level" column.

10.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
ETS001'	1-18GHz DRG Horn Antenna	ETS Lindgren	3117	00143259	01/14/2015	01/14/2016
145014'	Preamplifier (1 GHz to 26.5 GHz)	Hewlett Packard	8449B	3008A00232	05/05/2014	05/05/2015
145128'	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/14/2015	03/14/2016
145-416'	Cables 145-400 145-402 145-404 145-408	Huber + Suhner	3m Track B cables	multiple	10/04/2014	10/04/2015

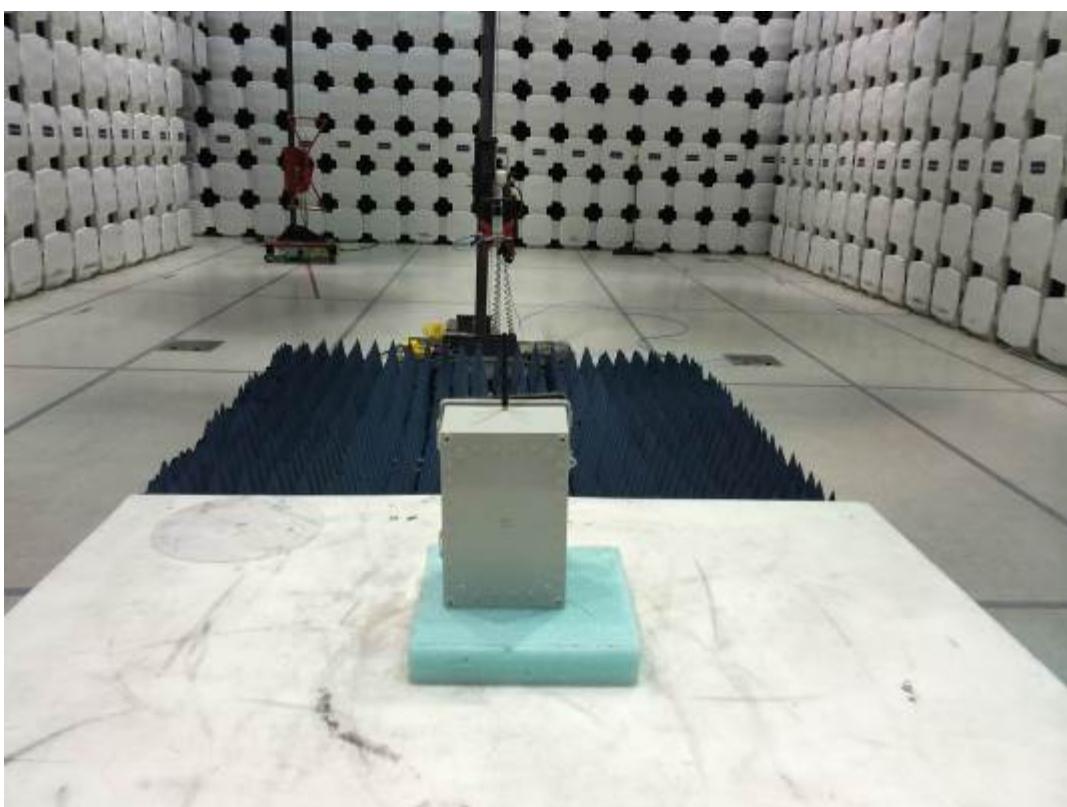
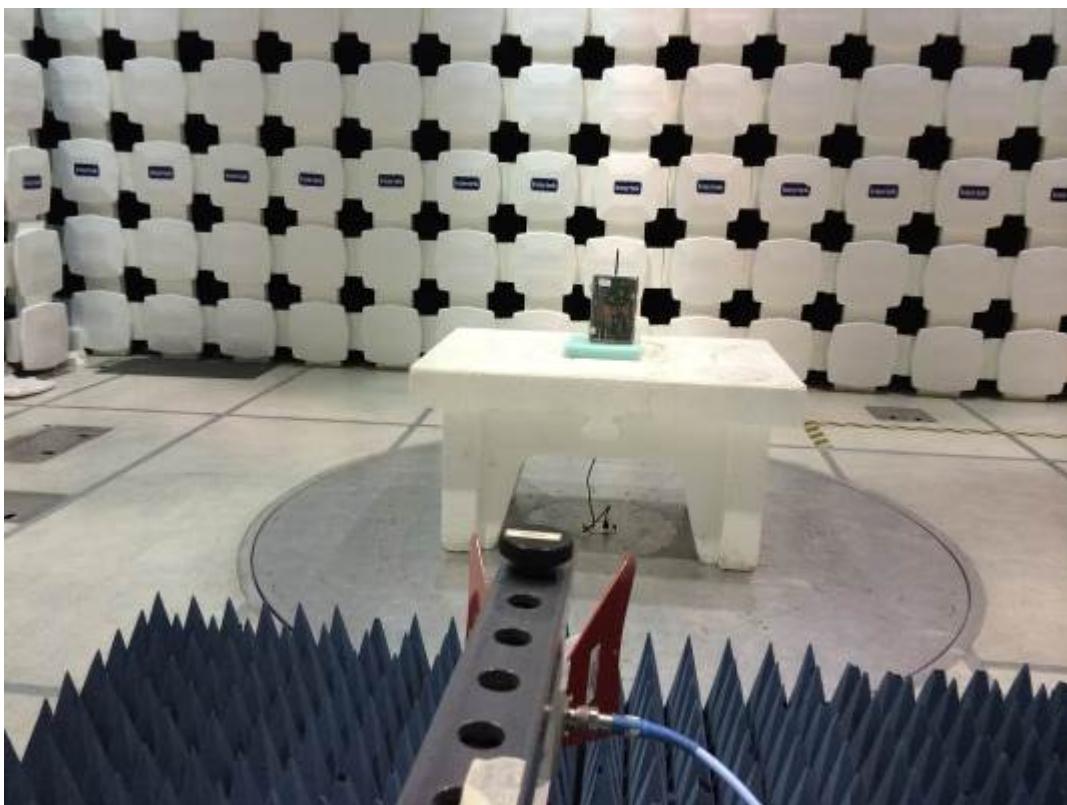
Software Utilized:

Name	Manufacturer	Version
Excel 2003	Microsoft	(11.8231.8221) SP3
EMI Boxborough.xls	Intertek	08/27/10

10.3 Results:

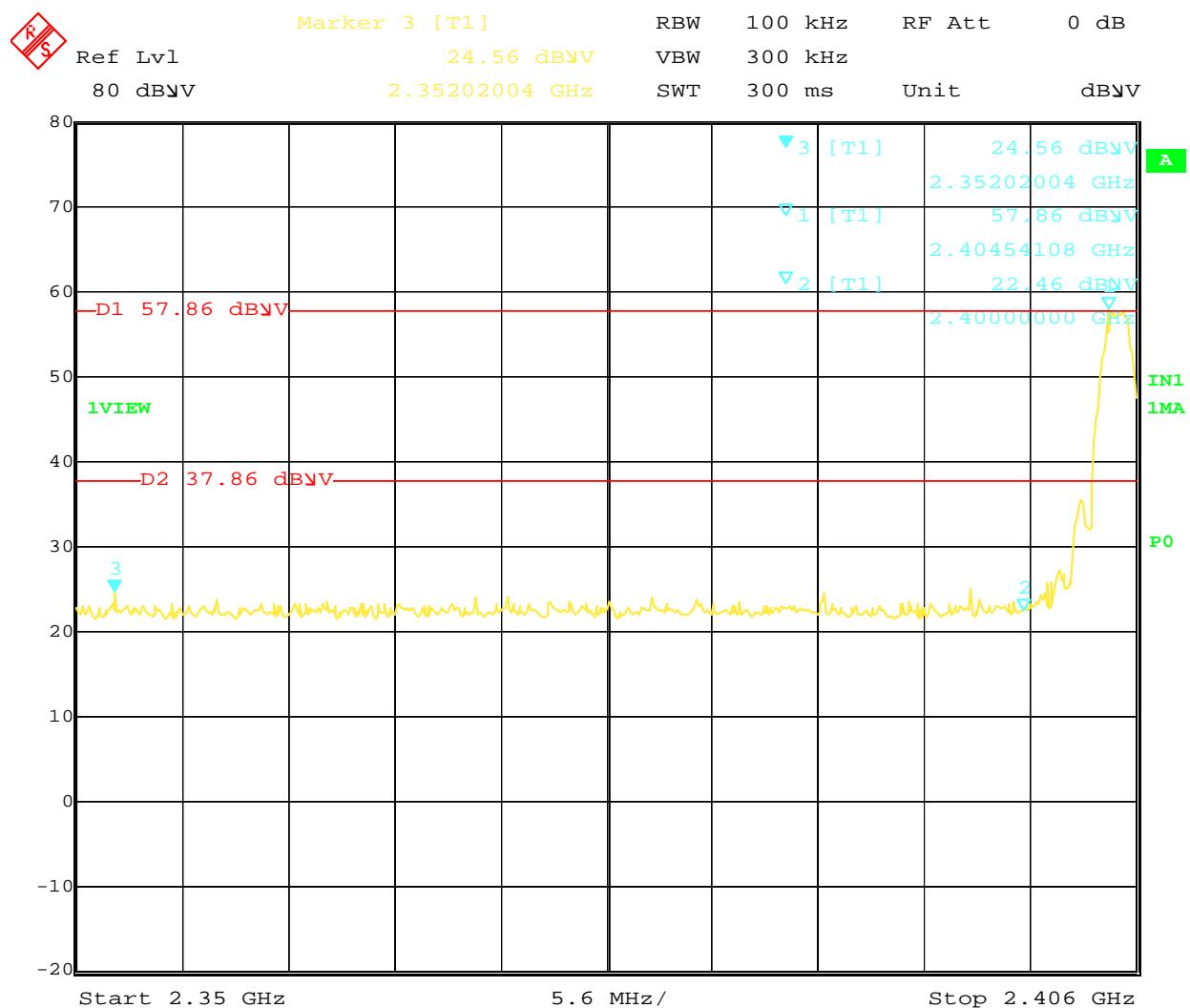
The sample tested was found to Comply.

Spurious emissions at the band edges must be at least 20 dB lower than the fundamental field strength when measured with a 100 kHz bandwidth, without the need to be below the general limits of FCC Part 15 Section 15.209 and of RSS-Gen 7.2.5 Table 5. Emissions in restricted bands must meet the general limits of FCC Part 15 Section 15.209 and of RSS-Gen 7.2.5 Table 5.

10.4 Setup Photographs:

10.5 Test Data:

Lower Bandedge Compliant



Date: 25.APR.2015 15:45:29

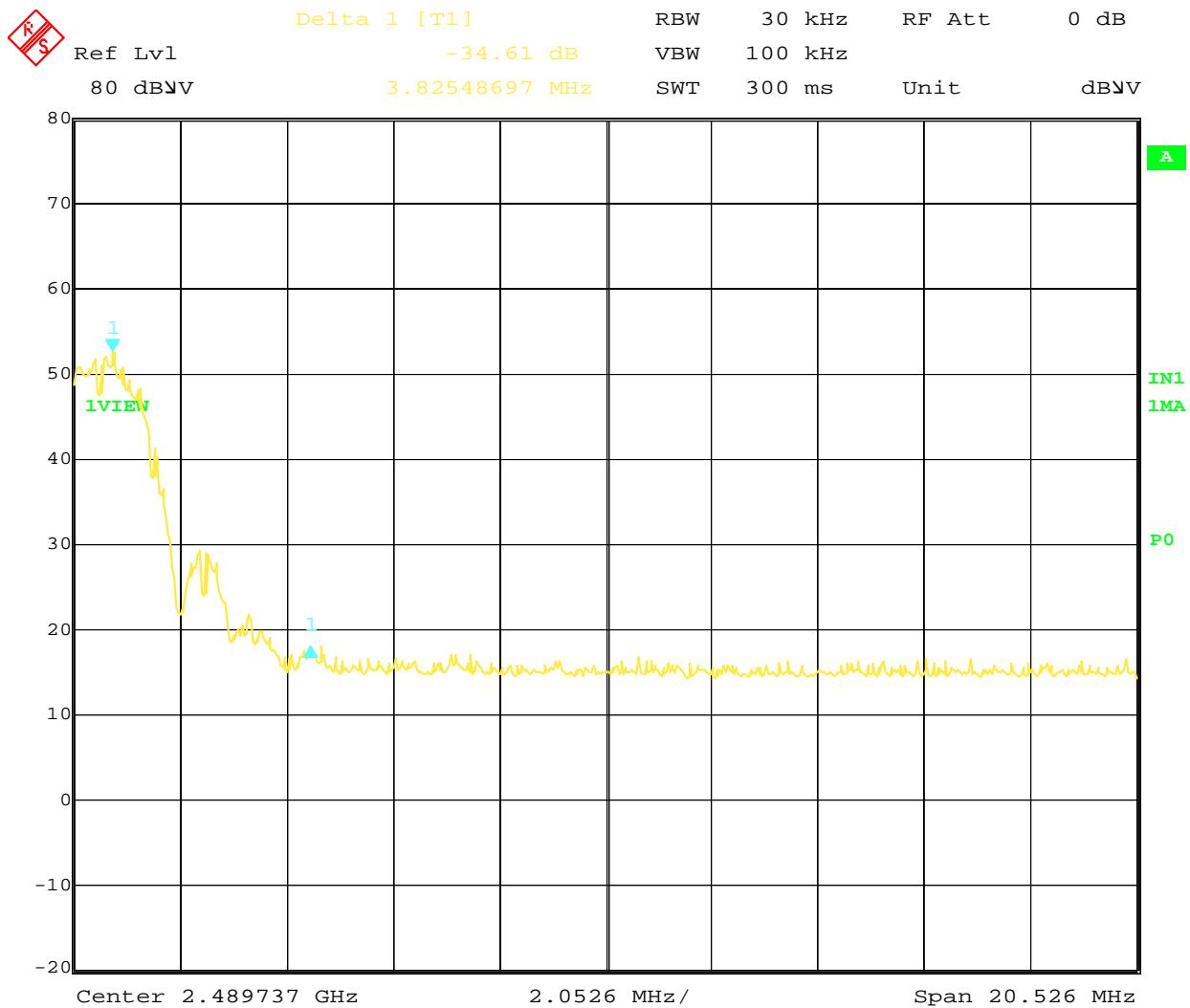
Upper Bandedge Radiated Emissions

Company: Opex Corporation Antenna & Cables: LF Bands: N, LF, HF, SHF
 Model #: 2048910 Antenna: ETS001 01-06-15.txt ETS001 01-06-15.txt
 Serial #: BOX1503021541-001 Cable(s): 145-416 3m Track B 1-15GHz Cable 10-04-15.txt NONE.
 Engineers: Kouma Sinn Location: 10m Chamber Barometer: DAV004 Filter: NONE
 Project #: G102037004 Date(s): 04/25/15
 Standard: FCC Part 15 Subpart C 15.247 Temp/Humidity/Pressure: 22C 16% 995mbar
 Receiver: 145128 Limit Distance (m): 3
 PreAmp: NONE. Test Distance (m): 3
 PreAmp Used? (Y or N): N Voltage/Frequency: 120VAC/60Hz Frequency Range: Band edge
 Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)
 Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
Upper Band edge - Delta Method Method per ANSI 63.10-2013 Section 6.10.6. Part (a). AVG-AF = PK -9.4 dB											
PK	V	2483.500	39.83	32.31	5.99	0.00	0.00	78.12	--	--	1/3MHz
AVG-AF	V	2483.500	25.33	32.31	5.99	0.00	0.00	63.62	--	--	1/3MHz
PK	V	2484.117	37.44	32.31	5.99	0.00	0.00	75.74	--	--	1/3MHz
AVG-AF	V	2484.117	22.94	32.31	5.99	0.00	0.00	61.24	--	--	1/3MHz
Set the ResBW to 1% the total span to cover the fundamental peak and the emissions in the restricted band of 2483.5-2500 MHz. Part (b)											
PK	V	2483.500	23.63	32.31	5.99	0.00	0.00	61.92	--	--	30/100kHz
PK	V	2484.117	24.61	32.31	5.99	0.00	0.00	62.91	--	--	30/100kHz
PK	V	2486.167	23.54	32.32	5.99	0.00	0.00	61.85	--	--	30/100kHz
PK	V	2500.000	23.72	32.35	6.01	0.00	0.00	62.08	--	--	30/100kHz
The delta from the fundamental peak to the highest peak in the restricted band is -34.64 dB.											
Reading below is: Reading Part a (1MHz ResBW) - Delta (34.64 dB). Part c											
PK	V	2483.500	5.19	32.31	5.99	0.00	0.00	43.48	74.00	-30.52	1/3MHz
AVG-AF	V	2483.500	-9.31	32.31	5.99	0.00	0.00	28.99	54.00	-25.01	1/3MHz
PK	V	2484.117	2.80	32.32	5.99	0.00	0.00	41.11	74.00	-32.89	1/3MHz
AVG-AF	V	2484.117	-11.70	32.35	6.01	0.00	0.00	26.66	54.00	-27.34	1/3MHz

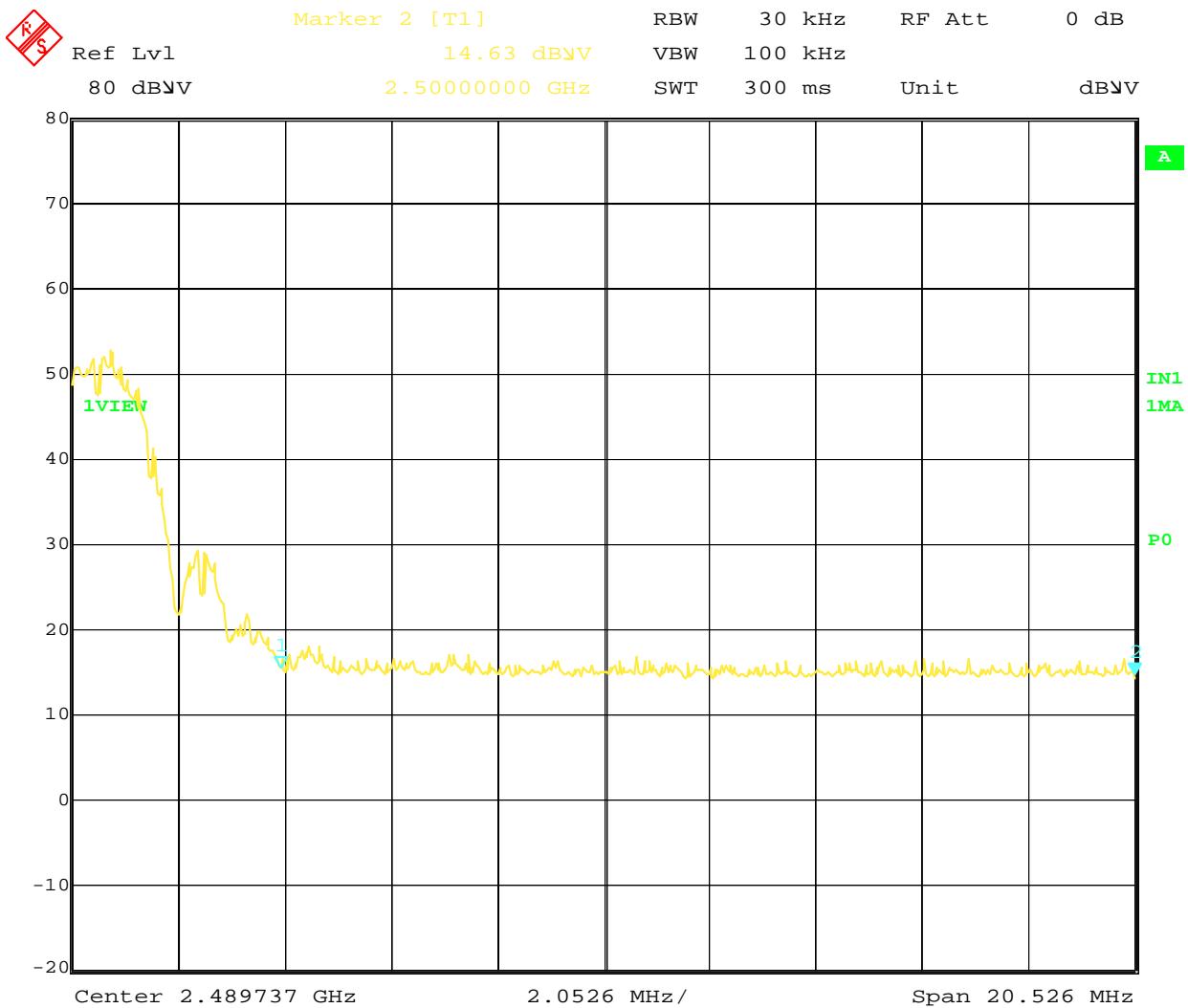
The average factor 14.5 dB was applied to the peak reading to obtain average reading

Delta from fundamental highest peak to highest spurious in the restricted band



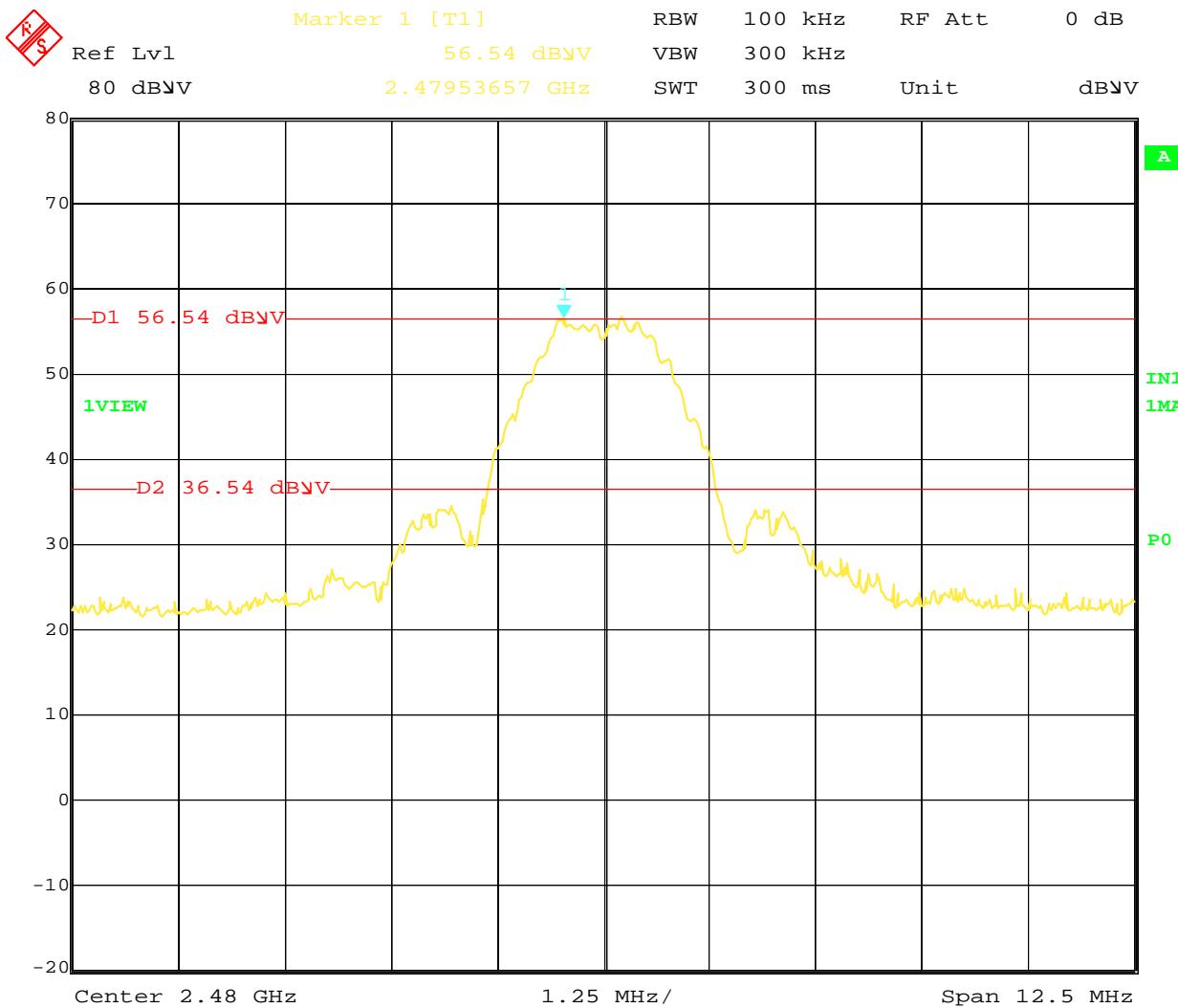
Date: 25.APR.2015 14:37:51

Spurious Emissions in the restricted band (2483.5-2500 MHz)



Date: 25.APR.2015 14:35:45

No emissions exceed the 20 dB/below carrier limit



Date: 25.APR.2015 14:19:45

Test Personnel: Kouma Sinn *kps*
 Supervising/Reviewing
 Engineer:
 (Where Applicable) N/A

Test Date: 04/26/2015

Product Standard: FCC Part 15.247,
 RSS-210 Annex 8
 Input Voltage: 120VAC/60Hz

Pretest Verification w/
 Ambient Signals or
 BB Source: Ambient Signals

Limit Applied: Emissions below the limits
 specified in Section 10.3

Ambient Temperature: 22 °C

Relative Humidity: 16 %

Atmospheric Pressure: 995 mbars

11 Digital Devices Radiated Spurious Emissions

11.1 Method

Tests are performed in accordance with FCC Part 15 Subpart B, IC ICES-003, and ANSI C63.4:2009.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	4.6	6.3
Radiated Emissions, 3m	30-1000 MHz	5.3	6.3
Radiated Emissions, 3m	1-6 GHz	4.5	5.2
Radiated Emissions, 3m	6-15 GHz	5.2	5.5
Radiated Emissions, 3m	15-18 GHz	5.0	5.5
Radiated Emissions, 3m	18-40 GHz	5.0	5.5

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where

FS = Field Strength in $\text{dB}\mu\text{V}/\text{m}$

RA = Receiver Amplitude (including preamplifier) in $\text{dB}\mu\text{V}$

CF = Cable Attenuation Factor in dB

AF = Antenna Factor in dB

AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 $\text{dB}\mu\text{V}$ is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 $\text{dB}\mu\text{V}/\text{m}$. This value in $\text{dB}\mu\text{V}/\text{m}$ was converted to its corresponding level in $\mu\text{V}/\text{m}$.

$$RA = 52.0 \text{ dB}\mu\text{V}$$

$$AF = 7.4 \text{ dB}/\text{m}$$

$$CF = 1.6 \text{ dB}$$

$$AG = 29.0 \text{ dB}$$

$$FS = 32 \text{ dB}\mu\text{V}/\text{m}$$

To convert from $\text{dB}\mu\text{V}$ to μV or mV the following was used:

$$UF = 10^{(NF/20)} \text{ where } UF = \text{Net Reading in } \mu\text{V}$$

$$NF = \text{Net Reading in } \text{dB}\mu\text{V}$$

Example:

$$FS = RA + AF + CF - AG = 52.0 + 7.4 + 1.6 - 29.0 = 32.0$$

$$UF = 10^{(32 \text{ dB}\mu\text{V}/20)} = 39.8 \mu\text{V}/\text{m}$$

Alternately, when C5 Software is used, the "Level" includes all losses and gains and is compared directly in the "Margin" column to the "Limit". "AF" is the Antenna Factor; "PA+CL" are Preamp and Cable Loss. These are already accounted for in the "Level" column.

11.2 Test Equipment Used:

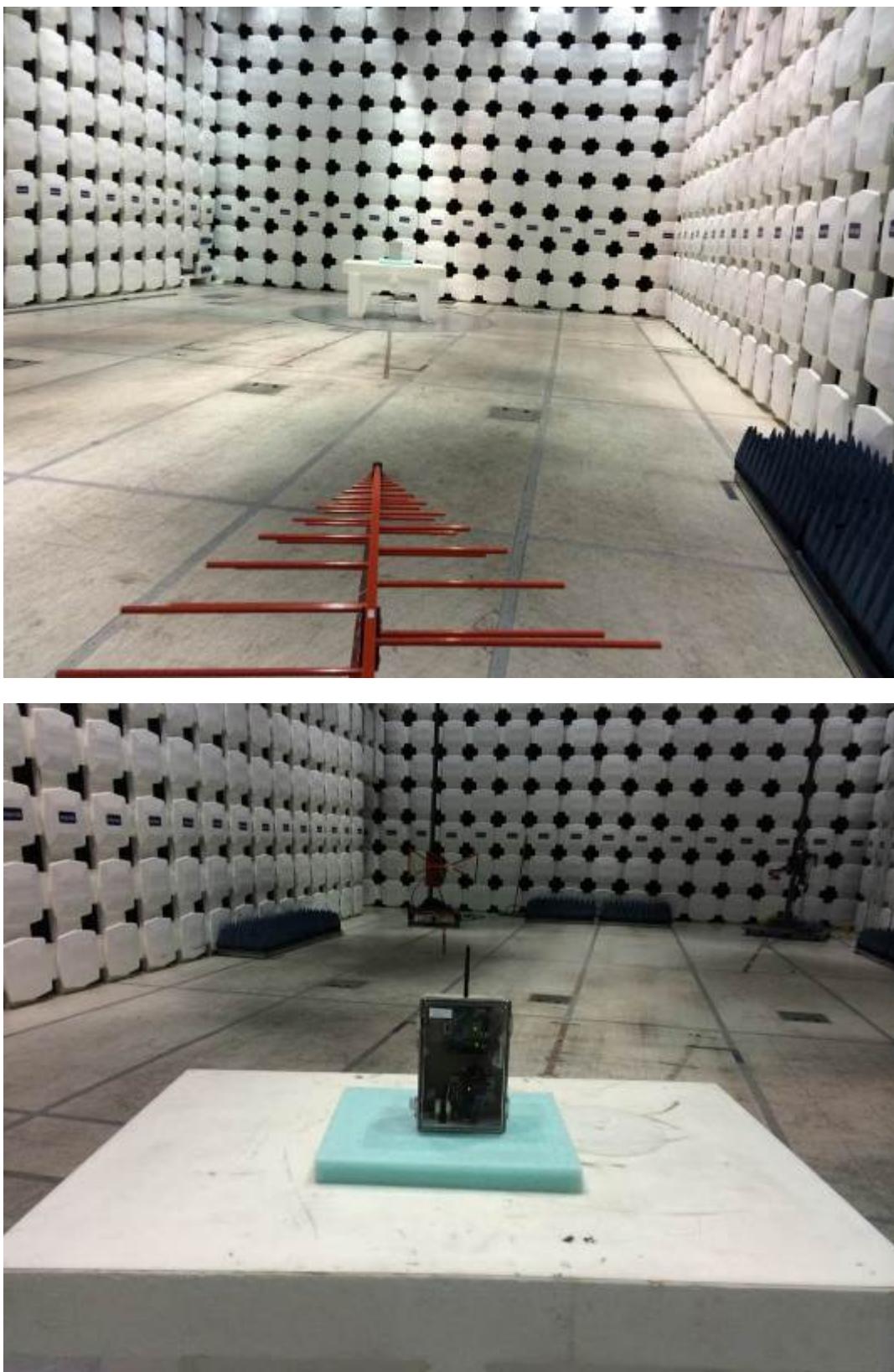
Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
MAN1'	Digital 4 Line Barometer	Mannix	0ABA116	MAN1	08/13/2012	08/13/2014
145-410'	Cables 145-400 145-403 145-405 145-406 145-407	Huber + Suhner	10m Track A Cables	multiple	10/04/2013	10/04/2014
145128'	EMI Receiver (20 Hz - 40 Gzh)	Rohde & Schwarz	ESIB 40	839283/001	03/17/2014	03/17/2015
145106'	Bilog Antenna (30MHz - 5GHz)	Sunol Sciences	JB5	A111003	10/01/2013	10/01/2014
145003'	Preamplifier (150 KHz to 1.3 GHz)	Hewlett Packard	8447D	2443A04077	10/07/2013	10/07/2014

Software Utilized:

Name	Manufacturer	Version
C5	Teseq	5.26.46.46

11.3 Results:

The sample tested was found to comply.

11.4 Setup Photographs:

Ferrite on power cable



11.5 Plots/Data:

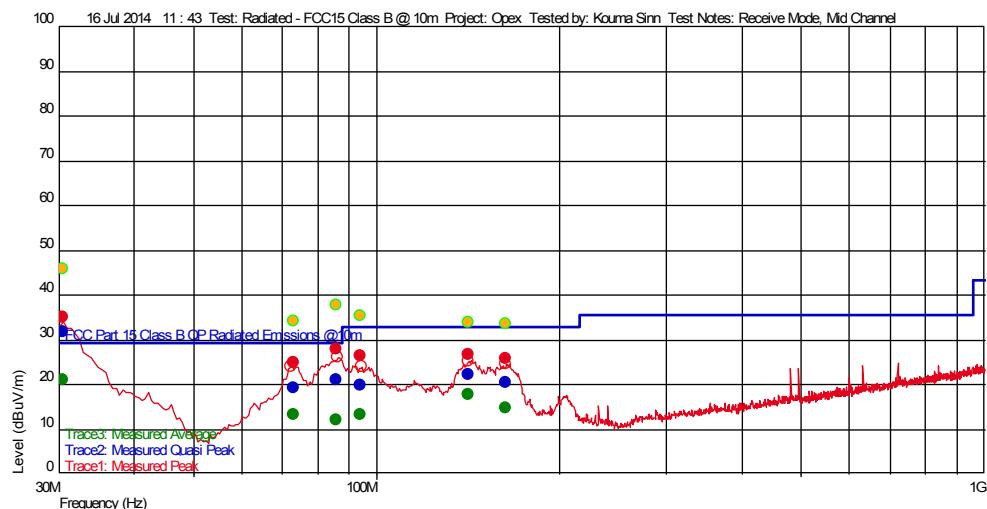
Initial Scan: Receive Mode on Mid channel

Test Information

Test Details
 Test: Radiated - FCC15 Class B @ 10m
 Project: Opex
 Test Notes: Receive Mode, Mid Channel
 Temperature: 21C
 Humidity: 46%, 1000mbar
 Tested by: Kouma Sinn
 Test Started: 16 Jul 2014 11 : 43

Additional Information

Prescan Emission Graph



- Measured Peak Value
- Measured Quasi Peak Value
- Measured Average Value
- Maximum Value of Mast and Turntable
- Swept Peak Data
- Swept Quasi Peak Data
- Swept Average Data

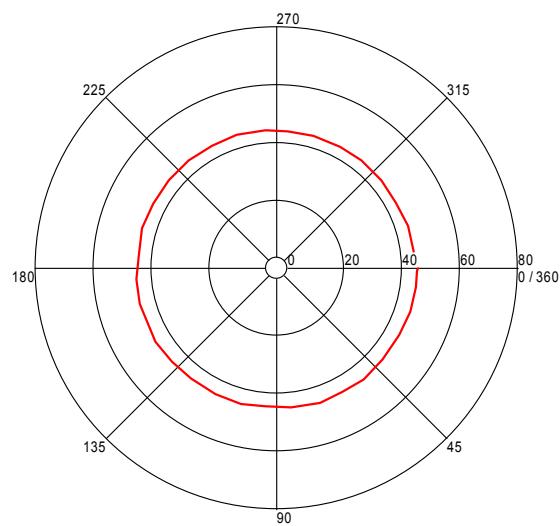
Emissions Test Data

Trace2: Measured Quasi Peak

Frequency(Hz)	Level (dBuV/m)	AF	PA+CL	Limit(dBuV/m)	Margin(dBuV/m)	Hor (--), Ver ()	Azimuth (deg)(Deg)	Mast Height(m)	RBW(Hz)	Comment
94.069138739 M	19.79	8.721	-25.518	33.040	-13.25		0	1.78	120 k	
163.07474993 M	20.33	12.193	-24.894	33.040	-12.71		210	1.26	120 k	
142.123847601 M	22.36	13.388	-25.286	33.040	-10.68		40	1.04	120 k	
73.023446776 M	19.23	7.998	-25.808	29.540	-10.31		106	1.34	120 k	
86.118636784 M	21.09	7.400	-25.626	29.540	-8.45		360	1.95	120 k	
30.569138277 M	31.78	20.902	-26.245	29.540	2.24		165	1.05	120 k	

Azimuth Plots

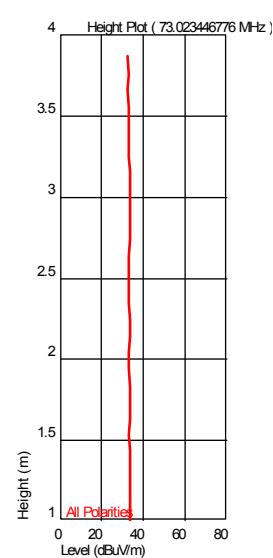
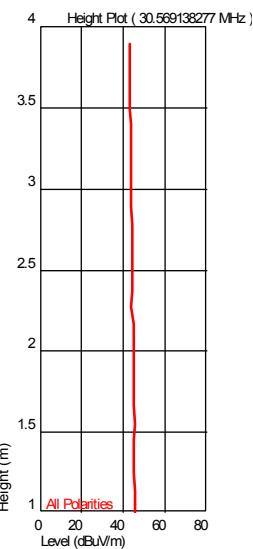
Turntable Plot (30.569138277 MHz)



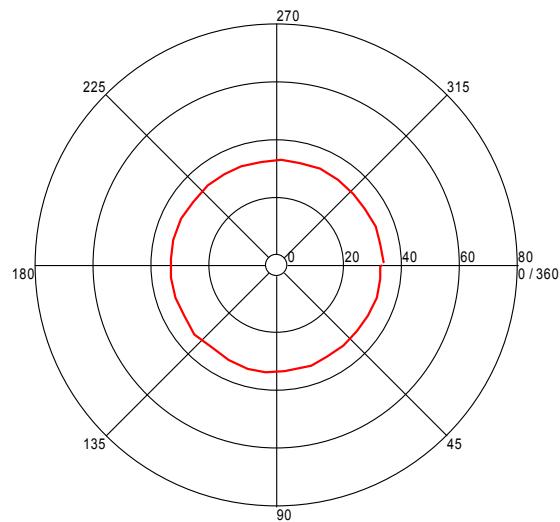
All Polarities

Azimuth (Degrees)

Level (dBuV/m)

Turntable Plots

Turntable Plot (73.023446776 MHz)

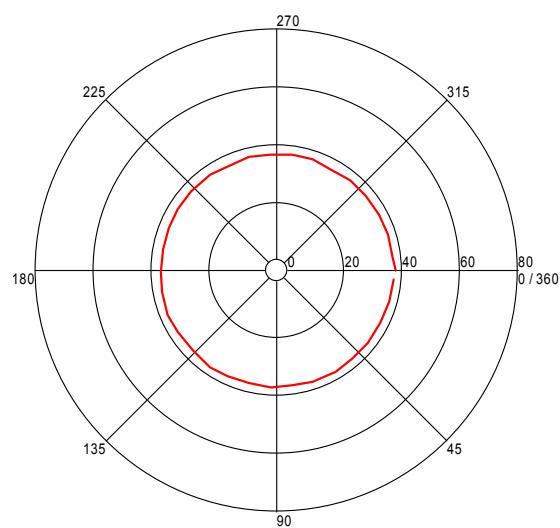


All Polarities

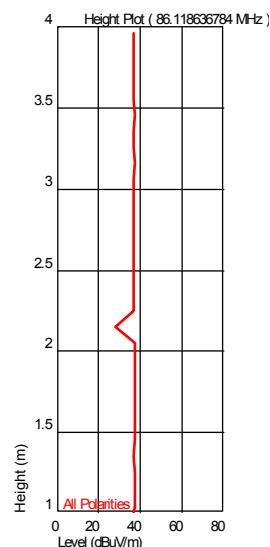
Azimuth (Degrees)

Level (dBuV/m)

Turntable Plot (86.118636784 MHz)



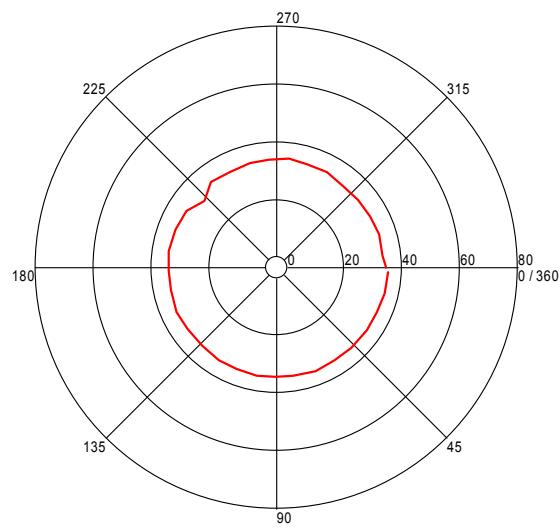
Level (dBuV/m)



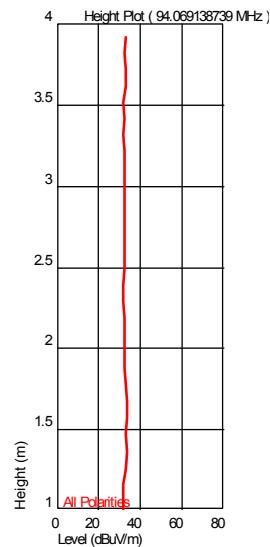
All Polarities

Azimuth (Degrees)

Turntable Plot (94.069138739 MHz)



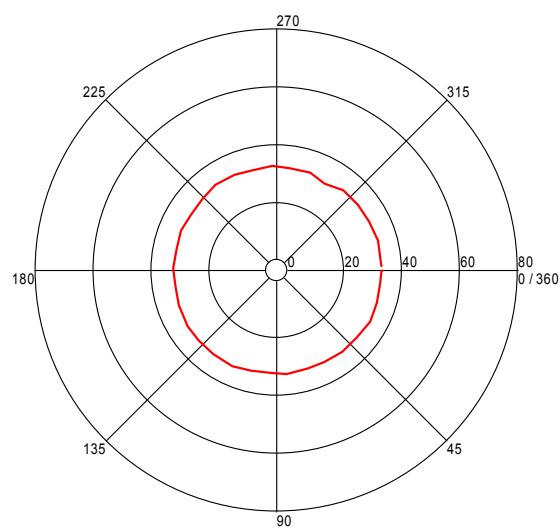
Level (dBuV/m)



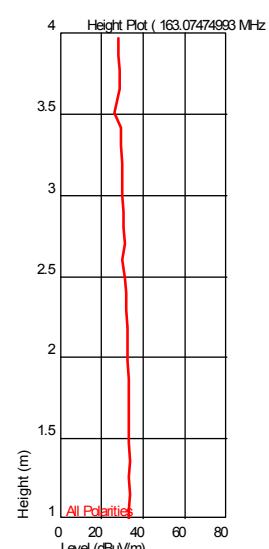
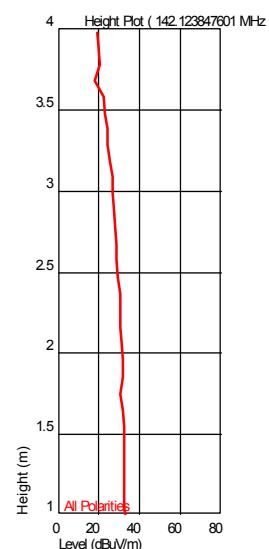
All Polarities

Azimuth (Degrees)

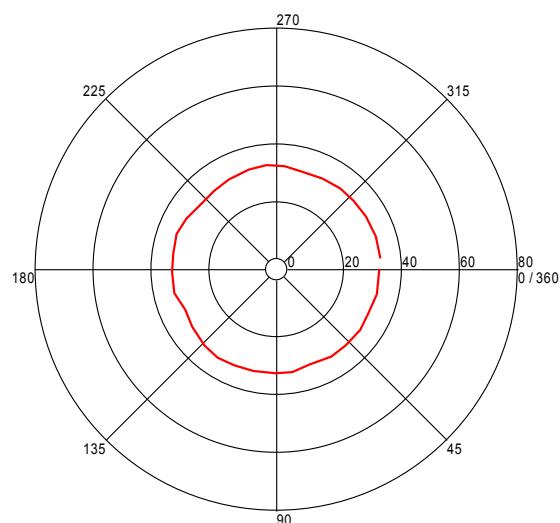
Turntable Plot (142.123847601 MHz)



Level (dBuV/m)



Turntable Plot (163.07474993 MHz)



Level (dBuV/m)

Azimuth (Degrees)

All Polarities

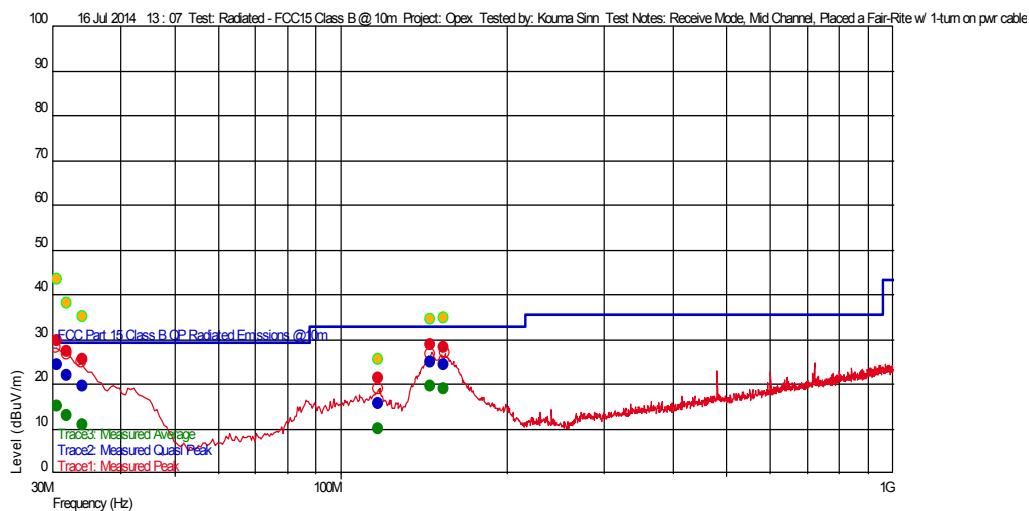
Final Scan: Receive Mode, Mid Channel, with a ferrite sleeve (Manufacturer: Fair-Rite, Part # 0446164151) w/ 1-turn on AC mains power cable as shown in photo

Test Information

Test Details
 Test: User Entry
 Radiated - FCC15 Class B @ 10m
 Project: Opex
 Test Notes: Receive Mode, Mid Channel, Placed a Fair-Rite w/ 1-turn on pwr
 Temperature: 21C
 Humidity: 46%, 1000mbar
 Tested by: Kouma Sinn
 Test Started: 16 Jul 2014 13 : 07

Additional Information

Prescan Emission Graph



●	Measured Peak Value	—	Swept Peak Data
●	Measured Quasi Peak Value	—	Swept Quasi Peak Data
●	Measured Average Value	—	Swept Average Data
●	Maximum Value of Mast and Turntable		

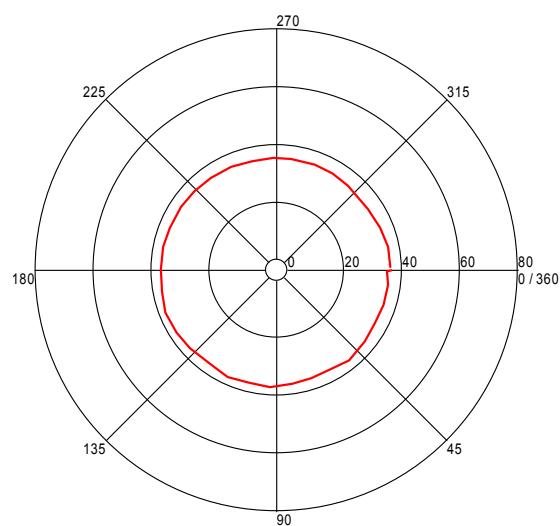
Emissions Test Data

Trace2: Measured Quasi Peak

Frequency(Hz)	Level (dBuV/m)	AF	PA+CL	Limit(dBuV/m)	Margin(dBuV/m)	Hor (-), Ver ()	Azimuth (deg)(Deg)	Mast Height(m)	RBW(Hz)	Comment
116.815030104 M	15.65	13.700	-25.403	33.040	-17.39		132	1.77	120 k	
34.198798044 M	19.69	18.361	-26.212	29.540	-9.85		118	1.25	120 k	
153.849298962 M	24.29	12.600	-25.145	33.040	-8.75		189	1.05	120 k	
145.569940234 M	24.94	13.086	-25.270	33.040	-8.10		157	1.13	120 k	
31.922244713 M	21.91	19.954	-26.233	29.540	-7.63		177	3.21	120 k	
30.650300657 M	24.43	20.845	-26.244	29.540	-5.11		169	2.59	120 k	

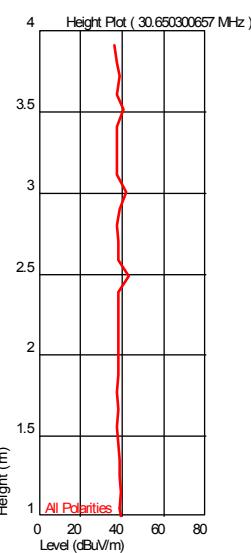
Azimuth Plots

Turntable Plot (30.650300657 MHz)

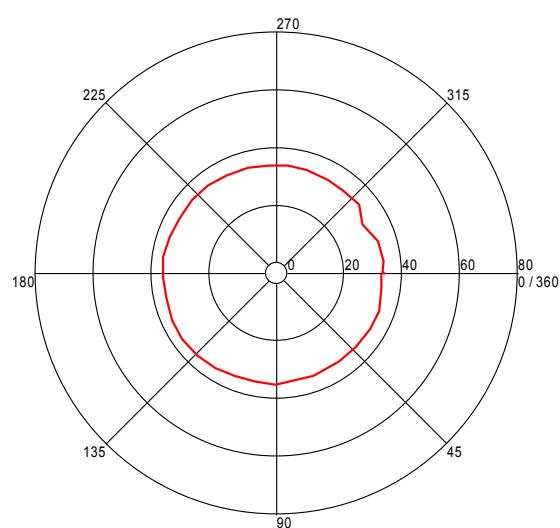


All Polarities

Azimuth (Degrees)

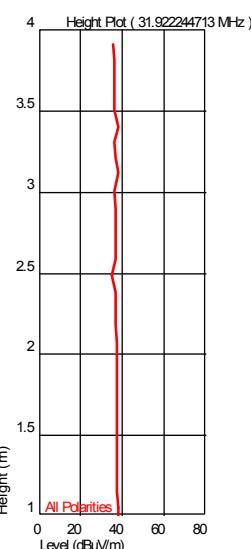
Turntable Plots

Turntable Plot (31.922244713 MHz)

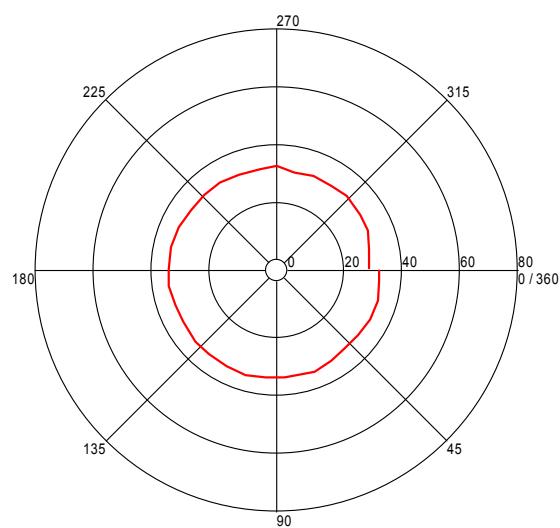


All Polarities

Azimuth (Degrees)



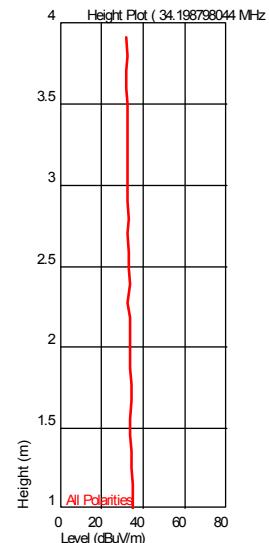
Turntable Plot (34.198798044 MHz)



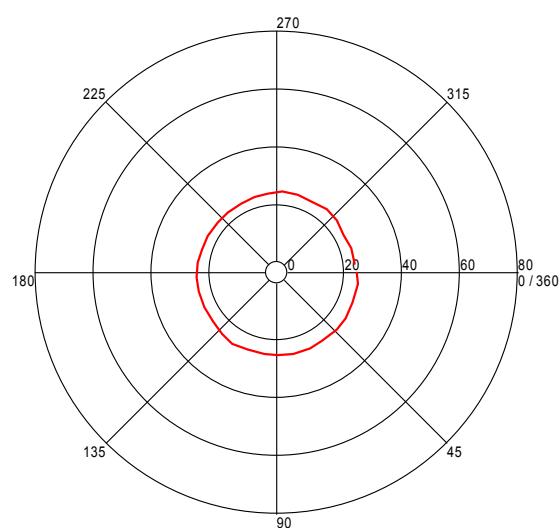
All Polarities

Azimuth (Degrees)

Level (dBuV/m)



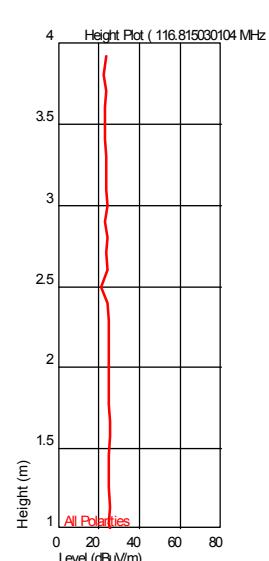
Turntable Plot (116.815030104 MHz)



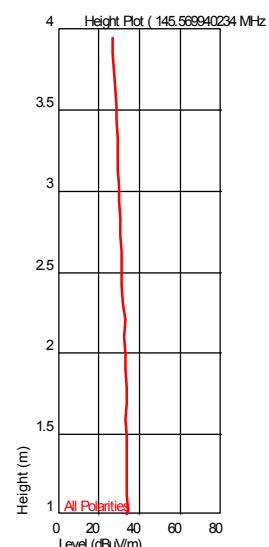
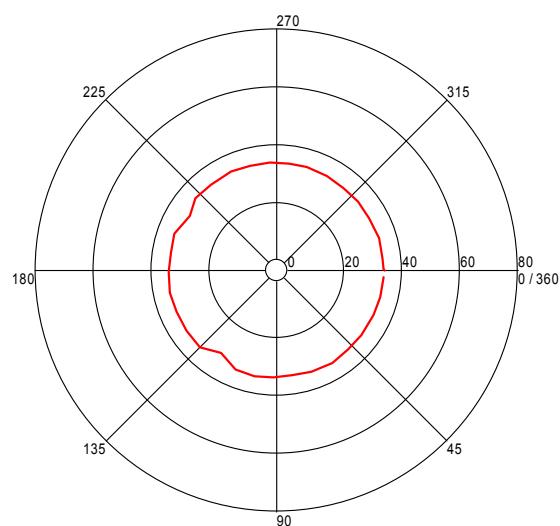
All Polarities

Azimuth (Degrees)

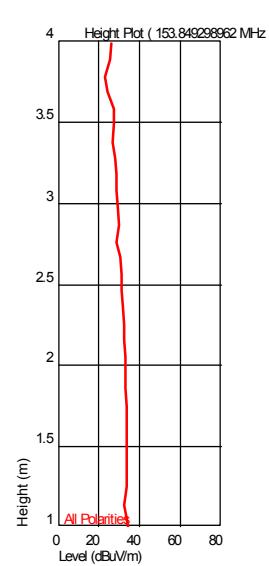
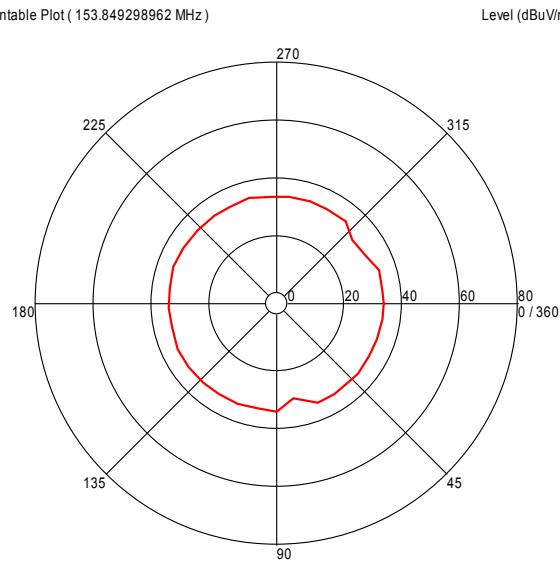
Level (dBuV/m)



Turntable Plot (145.569940234 MHz)



Turntable Plot (153.849298962 MHz)



All Polarities

All Polarities

Test Personnel: Kouma Sinn *KPS*
 Supervising/Reviewing
 Engineer:
 (Where Applicable) N/A
 Product Standard: FCC Part 15.247,
RSS-210 Annex 8
 Input Voltage: 120VAC/60Hz
 Pretest Verification w/
 Ambient Signals or
 BB Source: BB Source

Test Date: 07/16/2014

Limit Applied: Emissions below the limits
 specified in Section 11.3
 Ambient Temperature: 21 °C
 Relative Humidity: 46 %
 Atmospheric Pressure: 1000 mbars

Deviations, Additions, or Exclusions: None

12 AC Mains Conducted Emissions

12.1 Method

Tests are performed in accordance with FCC Part 15 Subpart B, IC ICES-003, and ANSI C63.4:2009.

TEST SITE: EMC Lab

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
AC Line Conducted Emissions	150 kHz - 30 MHz	2.8	3.4
Telco Port Emissions	150 kHz - 30 MHz	3.2	5

Sample Calculations

The following is how net line-conducted readings were determined:

$$NF = RF + LF + CF + AF$$

Where NF = Net Reading in $\text{dB}\mu\text{V}$

RF = Reading from receiver in $\text{dB}\mu\text{V}$

LF = LISN or ISN Correction Factor in dB

CF = Cable Correction Factor in dB

AF = Attenuator Loss Factor in dB

To convert from $\text{dB}\mu\text{V}$ to μV or mV the following was used:

$$UF = 10^{(NF/20)} \text{ where } UF = \text{Net Reading in } \mu\text{V}$$

NF = Net Reading in $\text{dB}\mu\text{V}$

Example:

$$NF = RF + LF + CF + AF = 28.5 + 0.2 + 0.4 + 20.0 = 49.1 \text{ dB}\mu\text{V}$$

$$UF = 10^{(49.1 \text{ dB}\mu\text{V}/20)} = 285.1 \mu\text{V}/\text{m}$$

Alternately, when C5 Software is used, the "Level" includes all losses and gains and is compared directly in the "Margin" column to the "Limit". "TF" is the Transducer Factor; in this case LISN or ISN loss.

12.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
ROS002'	9kHz to 3GHz EMI Test Receiver	Rohde & Schwartz	ESCI 1166.5950K03	100067	06/18/2013	07/18/2014
CBLBNC2012-1'	50 Ohm Coaxial Cable	Pomona	RG58C/U	CBLBNC2012-1	10/28/2013	10/28/2013
DS26A'	Attenuator, 20dB	Mini Circuits	20dB, 50 ohm	DS26A	10/04/2013	10/04/2014
LISN30'	CISPR 16 LISN	Com-Power	LI-215A	191961	02/26/2014	02/26/2015
DAV004'	Weather Station	Davis Instruments	7400	PE80529A61A	09/25/2012	09/25/2014

Software Utilized:

Name	Manufacturer	Version
C5 Emissions	TESEQ	5.26.46.46

12.3 Results:

The sample tested was found to Comply.

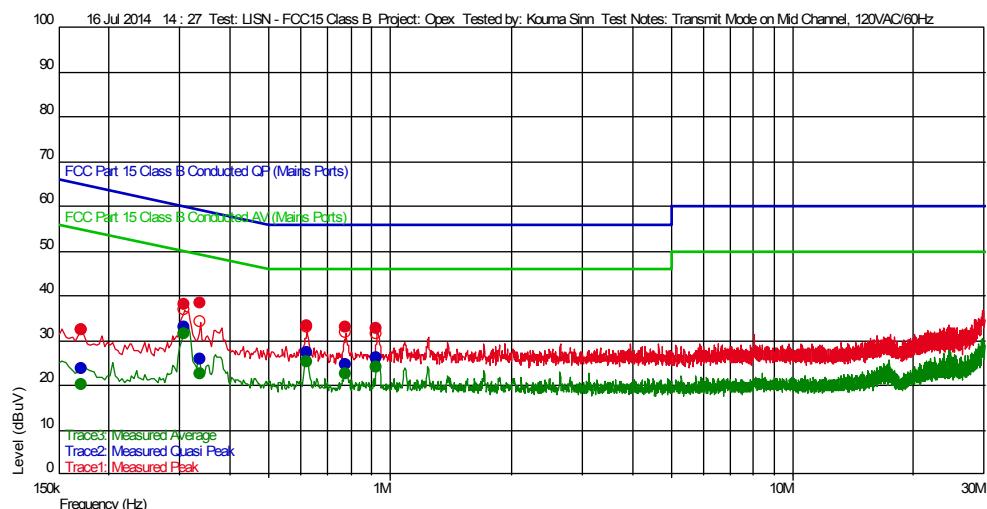
12.4 Setup Photograph:

12.5 Plots/Data:**Transmit Mode on Mid Channel, 120VAC/60Hz****Test Information**

Test Details
 Test: LISN - FCC15 Class B
 Project: Opex
 Test Notes: Transmit Mode on Mid Channel, 120VAC/60Hz
 Temperature: 20C
 Humidity: 67%, 998mbar
 Tested by: Kouma Sinn
 Test Started: 16 Jul 2014 14 : 27

User Entry
 LISN - FCC15 Class B
 Opex
 Transmit Mode on Mid Channel, 120VAC/60Hz
 20C
 67%, 998mbar
 Kouma Sinn
 16 Jul 2014 14 : 27

Additional Information

Prescan Emission Graph

● Measured Peak Value	— Swept Peak Data
● Measured Quasi Peak Value	— Swept Quasi Peak Data
● Measured Average Value	— Swept Average Data
● Maximum Value of Mast and Turntable	

Emissions Test Data**Trace2: Measured Quasi Peak**

Frequency(Hz)	Level(dBuV)	TF	PA+CL	Limit(dBuV)	Margin(dBuV)	RBW(Hz)	Comment	LINE
171.0 k	23.75	0.056	20.767	64.912	-41.16	9 k		L1
339.0 k	25.96	0.029	20.783	59.228	-33.27	9 k		N
777.0 k	24.70	0.030	20.797	56.000	-31.30	9 k		L1
927.0 k	26.10	0.030	20.807	56.000	-29.90	9 k		N
621.0 k	27.25	0.029	20.794	56.000	-28.75	9 k		N
309.0 k	32.87	0.048	20.780	59.997	-27.13	9 k		L1

Trace3: Measured Average

Frequency(Hz)	Level(dBuV)	TF	PA+CL	Limit(dBuV)	Margin(dBuV)	RBW(Hz)	Comment	LINE
171.0 k	20.28	0.056	20.767	54.912	-34.64	9 k		L1
339.0 k	22.45	0.029	20.783	49.228	-26.78	9 k		N
777.0 k	22.55	0.030	20.797	46.000	-23.45	9 k		L1
927.0 k	24.14	0.030	20.807	46.000	-21.86	9 k		N
621.0 k	25.35	0.029	20.794	46.000	-20.65	9 k		N
309.0 k	31.48	0.048	20.780	49.997	-18.51	9 k		L1

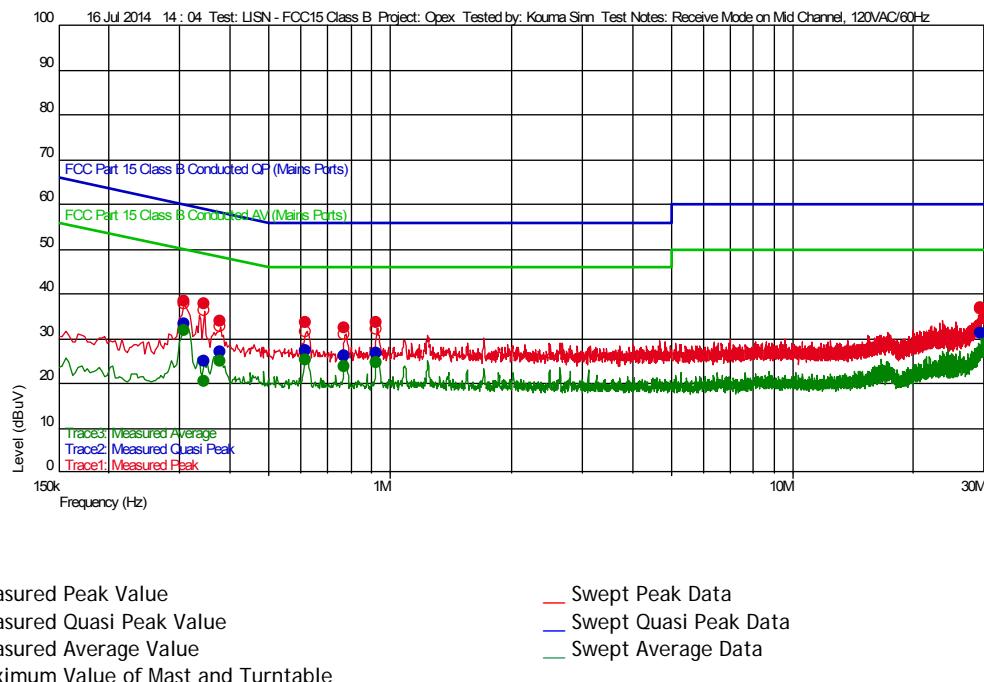
Receive Mode on Mid Channel, 120VAC/60Hz

Test Information

Test Details
 Test: LISN - FCC15 Class B
 Project: Opex
 Test Notes: Receive Mode on Mid Channel, 120VAC/60Hz
 Temperature: 20C
 Humidity: 67%, 998mbar
 Tested by: Kouma Sinn
 Test Started: 16 Jul 2014 14 : 04

Additional Information

Prescan Emission Graph



Emissions Test Data

Trace2: Measured Quasi Peak

Frequency(Hz)	Level(dBuV)	TF	PA+CL	Limit(dBuV)	Margin(dBuV)	RBW(Hz)	Comment	LINE
345.0 k	25.01	0.024	20.783	59.082	-34.08	9 k	N	
378.0 k	27.11	0.030	20.786	58.323	-31.22	9 k	N	
774.0 k	26.05	0.030	20.797	56.000	-29.95	9 k	N	
927.0 k	26.61	0.030	20.807	56.000	-29.39	9 k	N	
29.5212 M	31.16	0.098	21.050	60.000	-28.84	9 k	L1	
618.0 k	27.18	0.030	20.794	56.000	-28.82	9 k		
309.0 k	33.26	0.048	20.780	59.997	-26.73	9 k	N	

Trace3: Measured Average

Frequency(Hz)	Level(dBuV)	TF	PA+CL	Limit(dBuV)	Margin(dBuV)	RBW(Hz)	Comment	LINE
345.0 k	20.35	0.024	20.783	49.082	-28.73	9 k	N	
378.0 k	24.79	0.030	20.786	48.323	-23.53	9 k	N	
29.5212 M	26.82	0.098	21.050	50.000	-23.18	9 k	L1	
774.0 k	23.84	0.030	20.797	46.000	-22.16	9 k	N	
927.0 k	24.67	0.030	20.807	46.000	-21.33	9 k	N	
618.0 k	25.25	0.030	20.794	46.000	-20.75	9 k	N	
309.0 k	31.93	0.048	20.780	49.997	-18.06	9 k	N	

Test Personnel: Kouma Sinn
Supervising/Reviewing
Engineer:
(Where Applicable) N/A
Product Standard: FCC Part 15.247,
RSS-210 Annex 8
Input Voltage: 120VAC/60Hz
Pretest Verification w/
Ambient Signals or
BB Source: Ambient Signals

Test Date: 07/16/2014
Limit Applied: Class B
Ambient Temperature: 20 °C
Relative Humidity: 67 %
Atmospheric Pressure: 998 mbars

Deviations, Additions, or Exclusions: None

13 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	05/14/2015	102037004BOX-001	KPS <i>KPS</i>	MFM <i>MFM</i>	Original Issue
1	05/19/2015	102037004BOX-001b	KPS <i>KPS</i>	MFM <i>MFM</i>	Model # correction
2	06/16/2015	102037004BOX-001c	KPS <i>KPS</i>		Revised RF exposure calculation