

## ELECTROMAGNETIC COMPATIBILITY TEST REPORT

### TO FCC 47 CFR Part 15 SUBPART C SECTION 15.247 & INDUSTRY CANADA RSS-210

**Report Number:** E10633-1402  
**Issue:** Release version 2.0  
**Date of Issue:** April 29, 2014  
**Number of Pages:** 55

**Testing laboratory:** Quality Auditing Institute

**Address:** 16 – 211 Schoolhouse Street, Coquitlam, BC, V3K 4X9, Canada

**Accreditations (ISO 17025):**



**Standard Council of Canada: Accredited Laboratory No. 743**  
**International Accreditation Service Inc.: Accredited Laboratory: No. TL-239**

This report has been completed in accordance with the requirements of ISO/IEC 17025. Test results contained in this report are within QAI Laboratories ISO/IEC 17025 accreditation. QAI Laboratories authorizes the applicant to reproduce this report provided it is reproduced in its entirety and for the use by the company's employees only.

**Applicant's name:** Kineteks Corporation  
**Address:** #126 – 1020 Mainland Street Vancouver, BC, Canada V6B 2T4  
**Contact:** Jeff Franchini  
**Email:**  
**Phone:** 604.732.6628      **Fax:** 604.568.6621

**Test Standard:** RSS-Gen, Issue 3; RSS-210, Issue 8; FCC Part 15.247

**Test Item Description:** Motion Tracking sensor to analyze human movement.



**Trade Mark:**  
**Manufacturer:** Kineteks Corporation  
**Model Number:** BT Smart Sensor  
**IC Certificate number:** 9751A-TSEN002  
**FCC Registration:** ZP2-TSEN002



**BT Smart Sensor**

## Revision History

Date	Report Number	Rev #	Details	Authors Initials
Apr 16, 2014	E10633-1402	0.0	Draft Test Report	AJ
Apr 23, 2014	E10633-1402	1.0	Final Test Report- with some minor corrections	AJ
Apr 29, 2014	E10633-1402	2.0	Final Test Report- added plots at page 44 and 45 in response to TCB findings	AJ

*All previous versions of this report have been superseded by the latest dated revision as listed in the above table. Please dispose of all previous electronic and paper printed revisions accordingly.*

## Table of Contents

Section I.	GENERAL TEST INFORMATION .....	5
	EMC TEST SUMMARY.....	5
	PRODUCT DESCRIPTION.....	6
	EUT DESCRIPTION .....	6
	ANTENNA DESCRIPTION .....	6
	FACILITIES AND ACCREDITATION.....	7
	ENVIROMENTAL CONDITIONS: INDOORS .....	7
	TESTING METHODOLOGY .....	7
	EUT TESTING CONFIGURATION .....	7
	MEASUREMENT UNCERTAINTY .....	9
Section II:	Requirements as FCC and Industry Canada.....	10
	Part 1 - Antenna Requirements .....	11
	Part 2 - RF Peak Power Output .....	12
	Part 3 - Occupied Bandwidth 6dB Bandwidth.....	16
	Part 4 - Power Spectral Density .....	20
	Part 5 - Out of Band Emissions (Band Edge) .....	24
	Part 6 - Conducted Spurious Emissions .....	27
	TEST PLOTS – RF CONDUCTED SPURIOUS EMISSIONS .....	28
	Part 7 - Radiated Spurious Emissions-Transmit Mode .....	37
	Part 8 - Radiated Spurious Emissions-Receive Mode.....	46
	Part 9 - DUTY CYCLE CORRECTION FACTOR FOR RADIATED EMISSIONS .....	51
Appendix A:	EUT photos during the testing .....	53

## Section I. GENERAL TEST INFORMATION

### EMC TEST SUMMARY

The following tests demonstrate testimony for the FCC & IC Marks for Transceivers / electromagnetic compatibility testing for this EUT.

Test / Requirement Description	Applicable FCC Rule Parts	Applicable Industry Canada Rule Parts	Results
Antenna requirement	FCC 47 CFR Part 15.203	RSS-Gen (7.1.2)	Complies
RF Peak Power Output	FCC Part 15.247 (b)(3)	RSS 210 Issue 8 A8.4(4)	Complies
Occupied Bandwidth 6dB Bandwidth	FCC Part 15.247 (b)(3)	RSS 210 Issue 8 A8.2(a)	Complies
Power Spectral Density	FCC Part 15.247 (e)	RSS 210 Issue 8 A8.2(b)	Complies
Out-of-band Emissions (Band edge)	FCC Part 15.247 (d) RSS 210 Issue 8 A8.2(a)	RSS 210 Issue 8 A8.5	Complies
Conducted Spurious Emissions	FCC Part 15.247 (d)	RSS 210 Issue 8 A8.5	Complies
Radiated Spurious Emissions- Transmit Mode	FCC Part 15.247 (d), FCC Part 15.209 (a), FCC Part 15.205	RSS 210 Issue 8 A2.5,A8.5, RSS-Gen Issue3	Complies
Radiated Spurious Emissions - Receive Mode	FCC Part 15.247 (d), FCC Part 15.209 (a), FCC Part 15.205	RSS-210, ICES-003 Issue 5	Complies

Tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with FCC 15.247 & Industry Canada RSS-210. The manufacturer is responsible for the tested product configuration, continued product compliance with these standards listed, and for the appropriate auditing of subsequent products as required. BT Smart Sensor (EUT) has Bluetooth low energy transmitter. Bluetooth LE devices do not fulfill the requirements of FHSS and Bluetooth LE devices are classified as system using digital modulation techniques. Hence EUT was tested to comply for FCC 15.247 and RSS-210 as systems using digital modulation techniques operating in 2400 - 2483.5MHz band.

X

Tested By  
 Aman Jathaul, EMC Project Manager

X

Reviewed By  
 David Johanson RF/EMC Test Engineer

## PRODUCT DESCRIPTION

Applicant: Kineteks Corporation  
 #126 – 1020 Mainland Street Vancouver, BC, Canada V6B 2T4  
 Equipment Under Test: Motion tracking sensor to analyze human movement.  
 Trade Name: BT Smart Sensor  
 Model: BT Smart Sensor  
 Date of Test: March 24 –April 2 2014

## EUT DESCRIPTION

EUT	BT Smart Sensor
Functional Description	A health awareness solution that discretely tracks your activity --- the distance you walk or run, the calories you burn, the amount of time that you are active --- all for the purpose of helping you to develop a healthier lifestyle.
Operational Description	BT Smart Sensor tracks motion for the purpose of assisting people to live more active and healthier lives. Bluetooth Low energy module communicates with iPad using application to track, transfer and analyze the stored data.
FRN	0020989547
FCC ID	ZP2-TSEN002
IC	9751A-TSEN002
Manufacturer	Kineteks Corporation
Model/Type	BT Smart Sensor
Serial No.	#1
Transmitter Type	Bluetooth Low Energy
Frequency Range	2402-2480MHz
Transmit Power	0.00089W
Modulation	GFSK
Number of Channels	40
Antenna	Integrated, maximum gain is 0.8 dBi
Ratings	3Vdc (coin cell battery)
Software and Firmware	Version 19473
Received Date	March-24-2014
Received By	Aman
Sample Log	QAI Product Control Log (QM 1305 - Sample Inventory)

## ANTENNA DESCRIPTION

Polarization	Linear
Compact Size	5.4mm x 14.4
RoHS	Compatible
Frequency Range	2400 – 2480 MHz
Linear Max Gain	0.8 dBi
Impedance	50 Ω

## FACILITIES AND ACCREDITATION

<b>Main Laboratory Headquarters:</b>	Quality Auditing Institute
Headquarters Location/Address:	16 – 211 Schoolhouse Street, Coquitlam, BC, V3K 4X9, Canada
<b>Associated Laboratory:</b>	Quality Auditing Institute (Remote Location)
EMC Laboratory Address:	19473 Fraser Way, Pitt Meadows, BC, V3Y 2V4, Canada
FCC Test Site Registration Number: (3 m /10 m Open Area Test Site [OATS] and 3 m Semi-Anechoic Chamber [SAC]):	226383
Industry Canada Test Site Registration Number (3m SAC):	9543B-1
Standard Council of Canada:	ISO/IEC 17025:2005 Accredited Laboratory No. 743
International Accreditation Service Inc.:	ISO/IEC 17025:2005 Accredited Laboratory: No. TL-239
Tested by:	Aman Jathaul
Reviewed by:	David Johanson

## ENVIRONMENTAL CONDITIONS: INDOORS

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

## TESTING METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.4, ANSI C63.10, FCC CFR 47 Part 2, FCC CFR 47 Part 15, and RSS-Gen, Issue 3 and RSS-210, Issue 8. The FCC testing was also done using the FCC KDB 558074 D01 DTS Measurement Guidance v03r01 for the BLE transmitters

## EUT TESTING CONFIGURATION

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

BT Smart Sensor (EUT) has Bluetooth low energy transmitter. As per FCC Bluetooth LE devices do not fulfill the requirements of FHSS and Bluetooth LE devices are classified as system using digital modulation techniques. Hence EUT was tested to comply for FCC 15.247 and RSS-210 as systems using digital modulation techniques operating in 2400 - 2483.5MHz band.

## WORST TEST CASE

Worst-case orientation was determined by rotating the EUT on three axis, during the pre-compliance test and final radiated emissions tests were performed in that orientation. The highest measured output power was at 2402MHz.

## GENERAL TEST PROCEDURES

### RF Conducted Emissions

The EUT is placed on a test bench connected directly to an EMI Receive and Spectrum Analyzer. Conducted emissions are measured in the frequency range 9kHz to 25GHz using CISPR Peak, Quasi-Peak and Average detectors. EUT was set up to transmit modulated signal at particular channel at full power.

### AC Mains Conducted Emissions

This test was not applicable to this device. EUT operates only with 3Vdc Coin cell battery.

### Radiated Emissions

The EUT is placed on the turntable 0.8m above a ground plane 3m away from a receiving antenna. Height of receiving antenna varied from 1m to 4m, its polarity changes from vertical to horizontal. Turntable rotates 360 degrees. Motion of turntable and receiving antenna allows determining position of maximum emission level. Quasi-peak detector applies for measurements of emissions with frequency range of 30 to 1000MHz. and average/peak detector otherwise.

## MEASUREMENT UNCERTAINTY

Radio Frequency .....	: $\pm 1.5 \times 10^{-5}$
Total RF power, conducted.....	: $\pm 1$ dB
RF power density, conducted.....	: $\pm 2.75$ dB
Spurious emissions, conducted.....	: $\pm 3$ dB
All emissions, radiated.....	: $\pm 3.5$ dB
Temperature.....	: $\pm 1^{\circ}\text{C}$
Humidity.....	: $\pm 5$ %
DC and low frequency voltages.....	: $\pm 3$ %

## Test Equipment List

Semi-Anechoic Chamber Equipment List					
Manufacturer	Model	Description	Serial No.	Last Cal	Cal Due Date
ETS Lindgren	2165	Turntable	00043677	N/A	N/A
ETS Lindgren	2125	Mast	00077487	N/A	N/A
Sunol Sciences	JB3	Biconilog Antenna 30MHz-3GHz (Prescan use only)	A120106	28-Oct-2013	28-Oct-2015
Rohde & Schwarz	ESU40	EMI Receiver	100011	26-June-2012	26-Jun-2015
COM-POWER	AHA-118	Dual Ridge Horn Antenna	711040	11-Mar-2011	11-Apr-2014
ETS Lindgren	S201	5 meter Semi-Anechoic Chamber	1030	Conditional Use	Conditional Use
AH Systems	PAM118	Amplifier 10KHz-18GHz	189	Conditional Use	Conditional Use
AH Systems	PAM-1840H	Amplifier 18-40GHz	152	14-Jun-2013	14-Jun-2016

## Measurement Software List

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

## Section II: Requirements as FCC and Industry Canada

### Test Summary:

	<b>Test</b>	<b>Standard</b>	<b>Description</b>	<b>Result</b>
<b>Part 1</b>	Antenna requirement	FCC 47 CFR Part 15.203 RSS-Gen (7.1.2)	Soldered, non-replaceable antenna	Complies
<b>Part 2</b>	RF Peak Power Output	FCC Part 15.247 (b)(3) RSS 210 Issue 8 A8.4(4)	Maximum peak conducted output power shall not exceed 1 W. Except as provided in Section RSS 210 A8.4 (5), the e.i.r.p. shall not exceed 4 W.	Complies
<b>Part 3</b>	Occupied Bandwidth 6dB Bandwidth	FCC Part 15.247 (a)(2) RSS 210 Issue 8 A8.2(a)	The minimum -6 dB bandwidth shall be at least 500 kHz.	Complies
<b>Part 4</b>	Power Spectral Density	FCC Part 15.247 (e) RSS 210 Issue 8 A8.2(b)	The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission	Complies
<b>Part 5</b>	Out-of-band Emissions (Bandedge)	FCC Part 15.247 (d) RSS 210 Issue 8 A8.5	In any 100 kHz bandwidth outside the frequency band in which the digitally modulated device is operating, the RF power that is produced shall be at least 20dB.	Complies
<b>Part 6</b>	Conducted Spurious Emissions	FCC Part 15.247 (d) RSS 210 Issue 8 A8.5	In any 100 kHz bandwidth outside the frequency band in which the digitally modulated device is operating, the RF power that is produced shall be at least 20dB.	Complies
<b>Part 7</b>	Radiated Spurious Emissions-Transmit Mode	FCC Part 15.247 (d) FCC Part 15.209 (a) RSS 210 Issue 8 A2.5,A8.5 RSS Gen Issue 3	Radiated emissions requirements as stated in the Standards.	Complies
<b>Part 8</b>	Radiated Spurious Emissions – Receive Mode	FCC Part 15.247 (d) FCC Part 15.209 (a) ICES-003 Issue 5	Radiated emissions requirements as stated in the Standards	Complies
<b>Part 9</b>	Duty Cycle Correction	FCC Part 15.35(C) RSS-GEN,RSS-210	Measurement and Calculation for duty cycle correction as stated in the standards.	Complies

## **Part 1 - Antenna Requirements**

DATE: March 24 2014

TEST STANDARD: FCC 47 CFR Part 15.203 and IC RSS-Gen Section 7.1.2

APPLICABLE REGULATIONS: - "An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited."... "the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded."

RESULT: This unit meets antenna requirement. Bluetooth antenna was soldered to the circuit board and was not accessible to the end-user.

## Part 2 - RF Peak Power Output

DATE: Mar-24-2014

TEST STANDARD: FCC Part 15.247 (b)(3) RSS 210 Issue 8 A8.4(4)

TEST REQUIREMENT: For systems employing digital modulation techniques operating in the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz, the maximum peak conducted output power shall not exceed 1 W. Except as provided in RSS 210 Section A8.4 (5), the e.i.r.p. shall not exceed 4 W.

TEST SETUP: The antenna port of EUT was directly connected to a spectrum analyser.

MEASUREMENT METHOD: As called by the standards above.

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

EMISSIONS DATA:

### Conducted Output Power Measurements

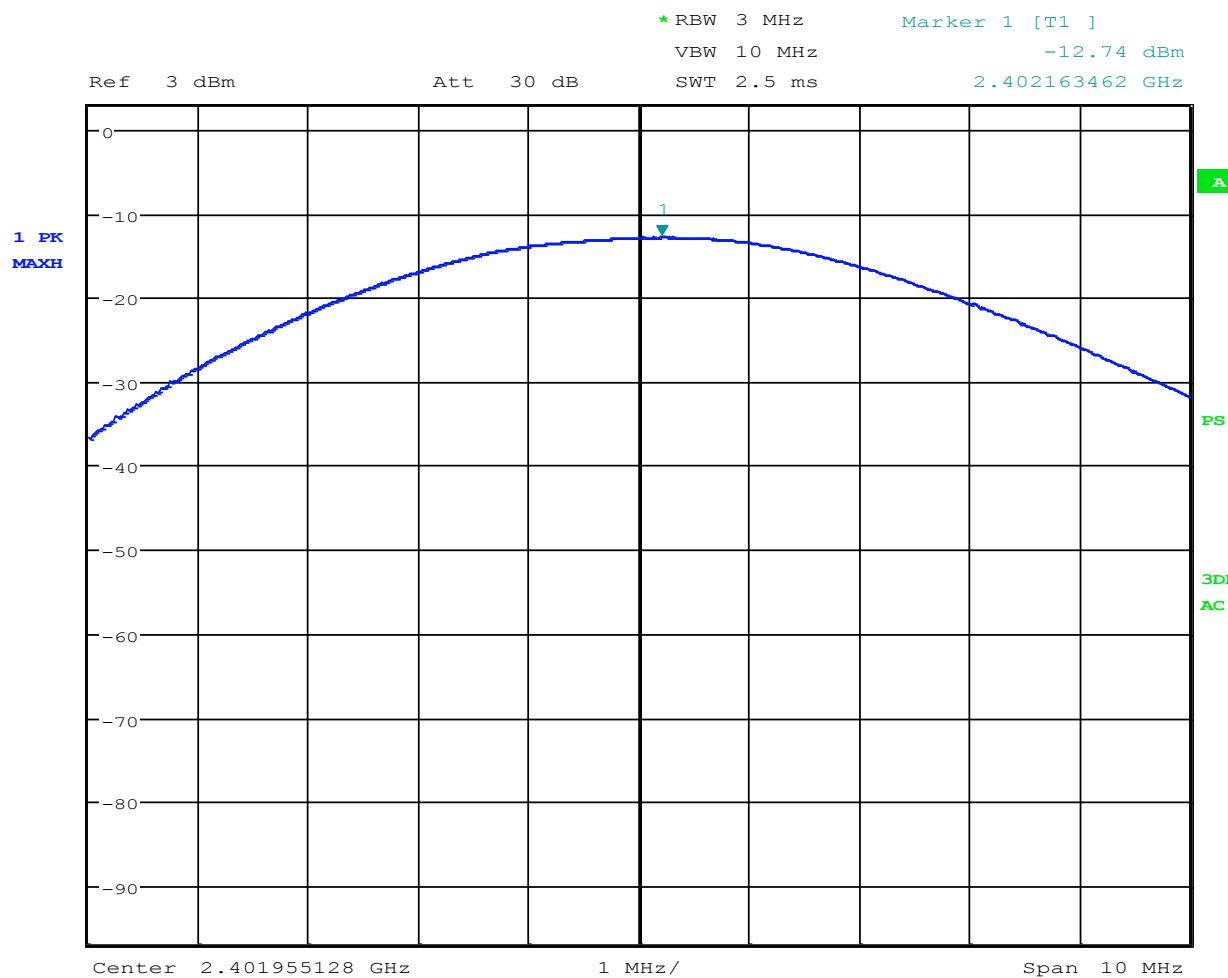
Channel	Frequency (GHz)	Peak Power (dBm)	CF (dB)	Corrected Power (dBm)	Limit (dBm)
Low	2.402	-12.74	12.23	-0.51	30
Mid	2.440	-14.21	12.65	-1.56	30
High	2.480	-15.44	12.83	-2.61	30

### EIRP Measurements

Channel	Frequency (GHz)	Corrected Peak at 3m (dBuV/m)	3m EIRP (dBm)
Low	2.402	95.8	0.64
Mid	2.44	95.51	0.35
High	2.48	94.7	-0.45

RESULTS: Pass: Complies.

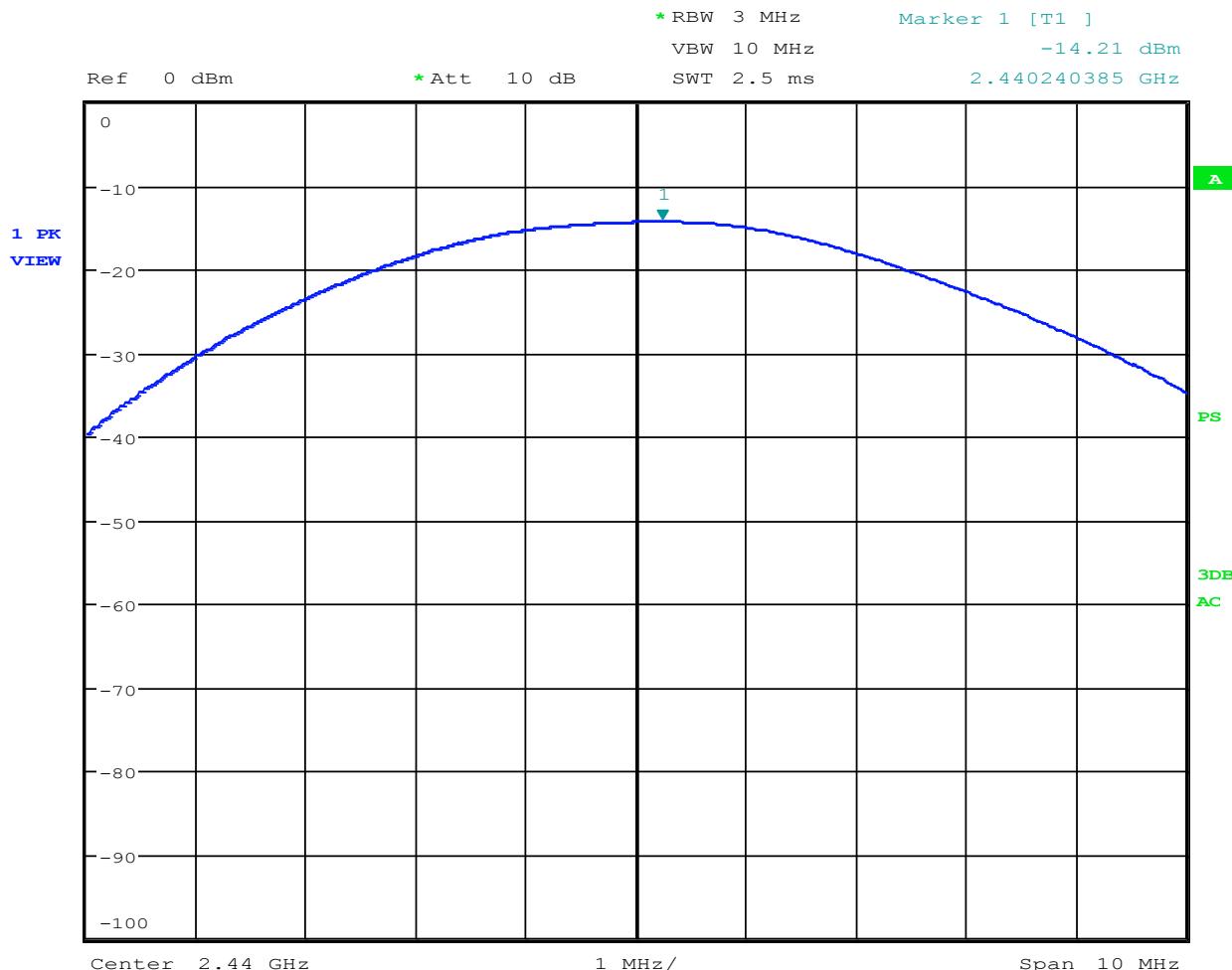
### **TEST PLOTS - RF PEAK POWER**



TTTTTT

Date: 24.MAR.2014 18:45:22

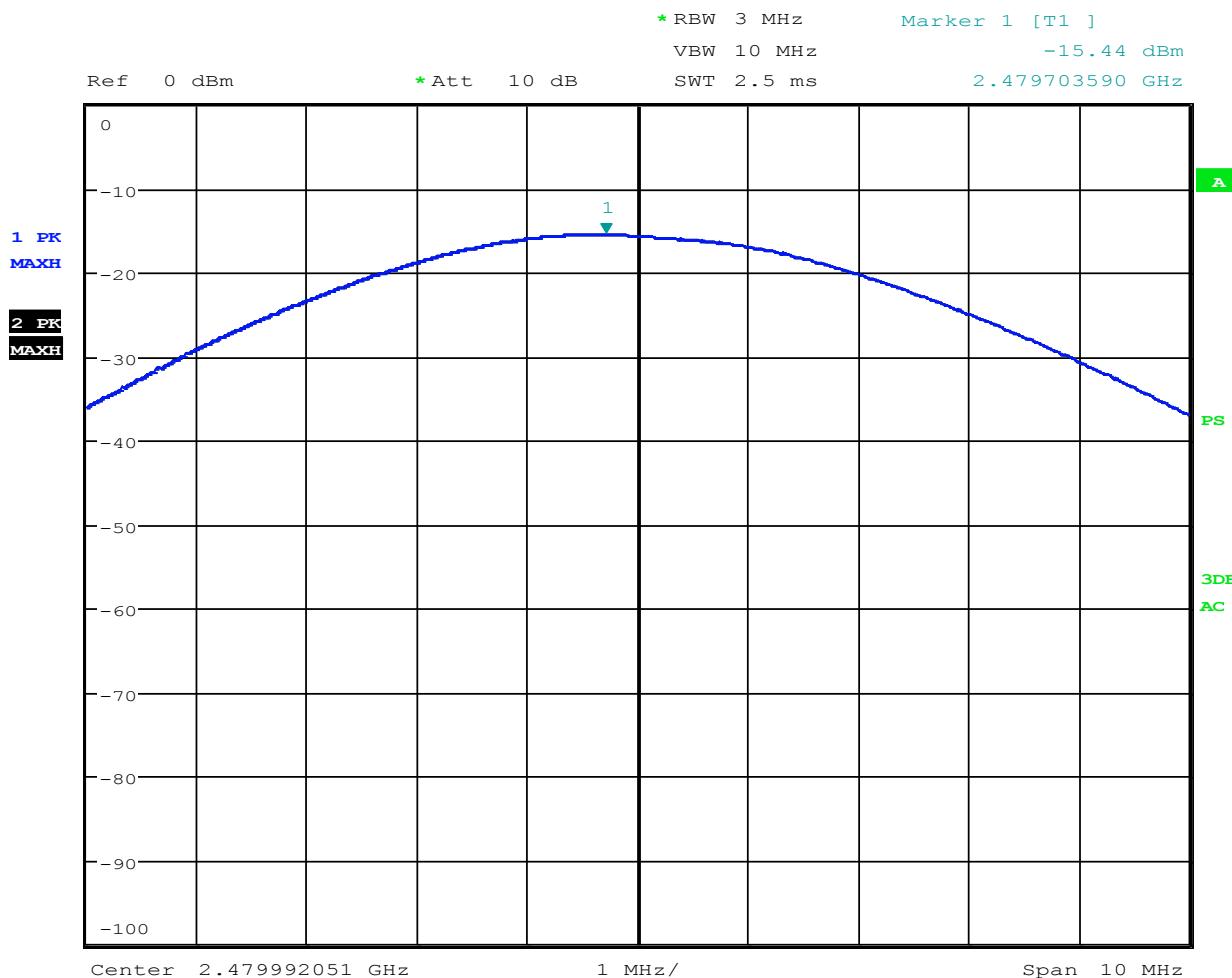
### **PLOT 1 - PEAK OUTPUT POWER, LOW CHANNEL**



TTTTTT

Date: 24.MAR.2014 19:43:18

### PLOT 2 - PEAK POWER, MID CHANNEL



TTTTTT

Date: 24.MAR.2014 20:28:25

**PLOT 3 - PEAK POWER, HIGH CHANNEL**

**Part 3 - Occupied Bandwidth 6dB Bandwidth**

DATE: March 24 2014

TEST STANDARD: FCC Part 15.247 (a) (2) and RSS 210 Issue 8 A8.2

TEST REQUIREMENT: The minimum -6 dB bandwidth shall be at least 500 kHz.

TEST SETUP: The antenna port of EUT was directly connected to a spectrum analyzer.

MEASUREMENT METHOD: As called by the standards above.

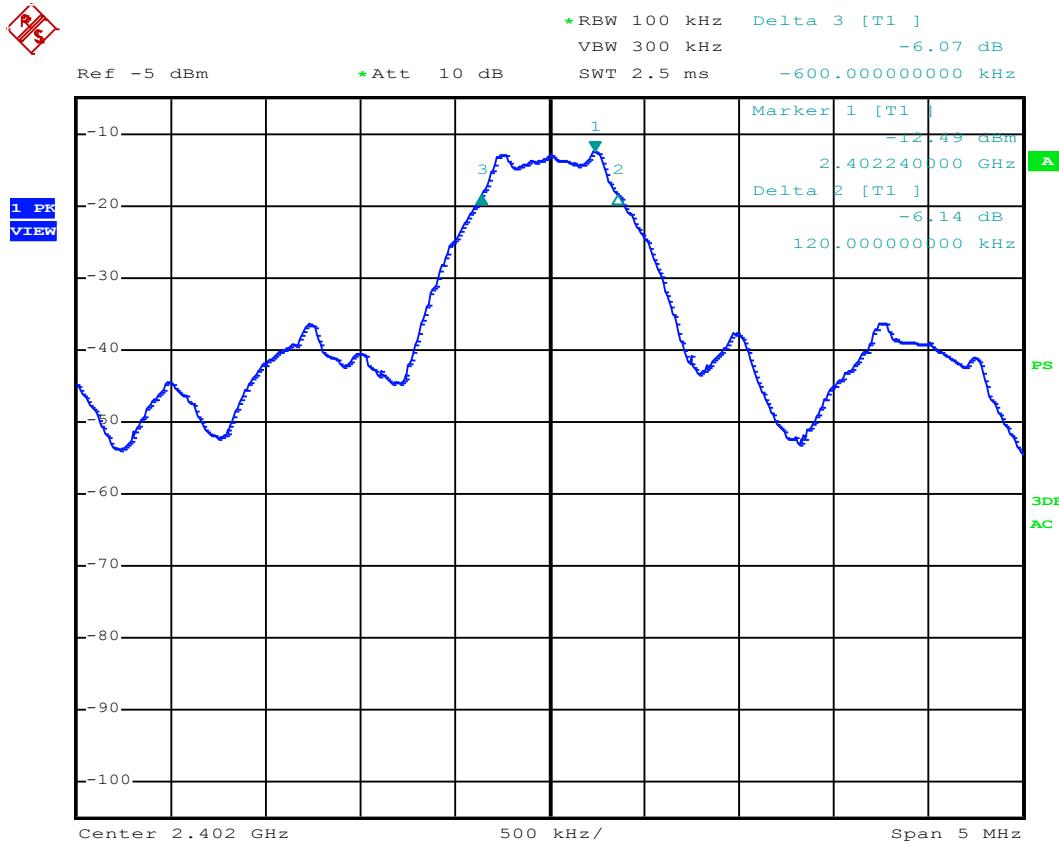
DEVICE DESCRIPTIONS: As described in the above EUT description and set up section.

EMISSIONS DATA:

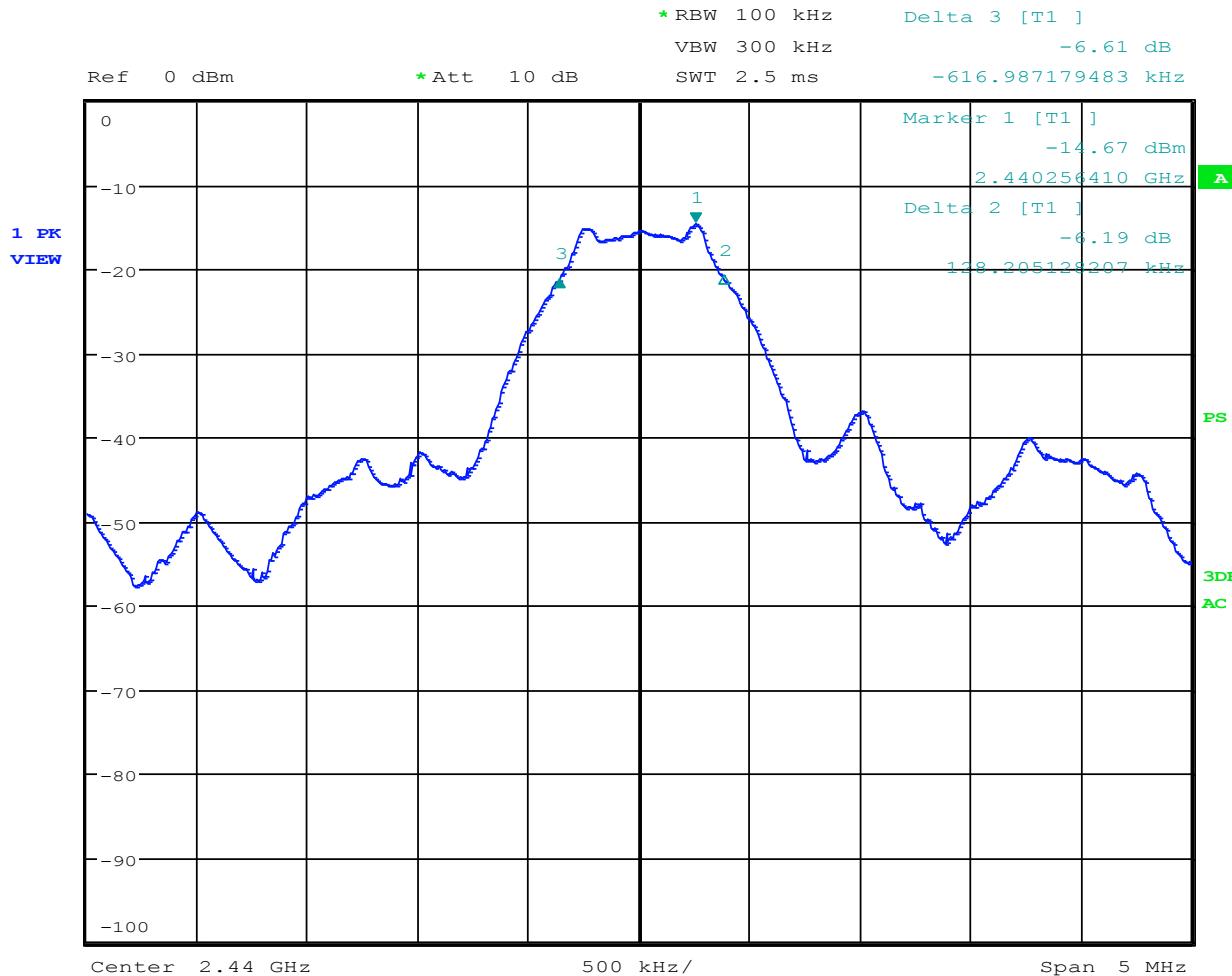
Channel	Frequency (GHz)	6dB Bandwidth (kHz)
Low	2.402	720
Mid	2.440	745.18
High	2.480	743.99

RESULTS: Pass: Complies.

### **TEST PLOTS – 6dB OCCUPIED BANDWIDTH**



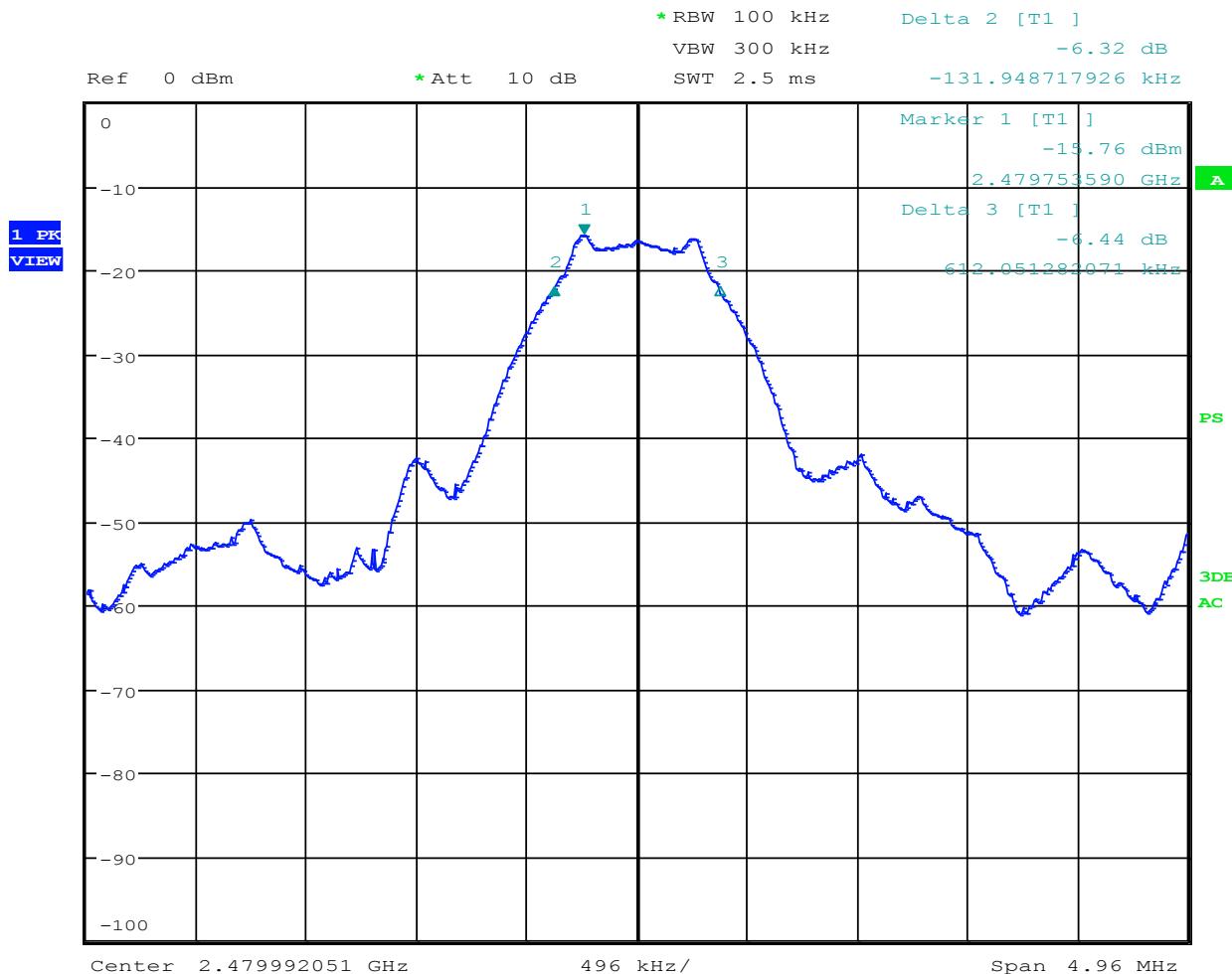
**PLOT 4 - LOW CHANNEL – 6dB OCCUPIED BANDWIDTH**



TTTTTT

Date: 24.MAR.2014 19:56:35

#### PLOT 5 – MID CHANNEL – 6dB OCCUPIED BANDWIDTH



TTTTTT

Date: 24.MAR.2014 20:26:02

**PLOT 6 - HIGH CHANNEL – 6dB OCCUPIED BANDWIDTH**

## **Part 4 - Power Spectral Density**

DATE: March 24 2014

TEST STANDARD: FCC Part 15.247 (e) and RSS 210 Issue 8 A 8.2(b)

TEST REQUIREMENT: The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission. The power spectral density was determined using the same method as is used to determine the conducted output power).

TEST SETUP: The antenna port of EUT was directly connected to a spectrum analyzer.

MEASUREMENT METHOD: As called by the standards above.

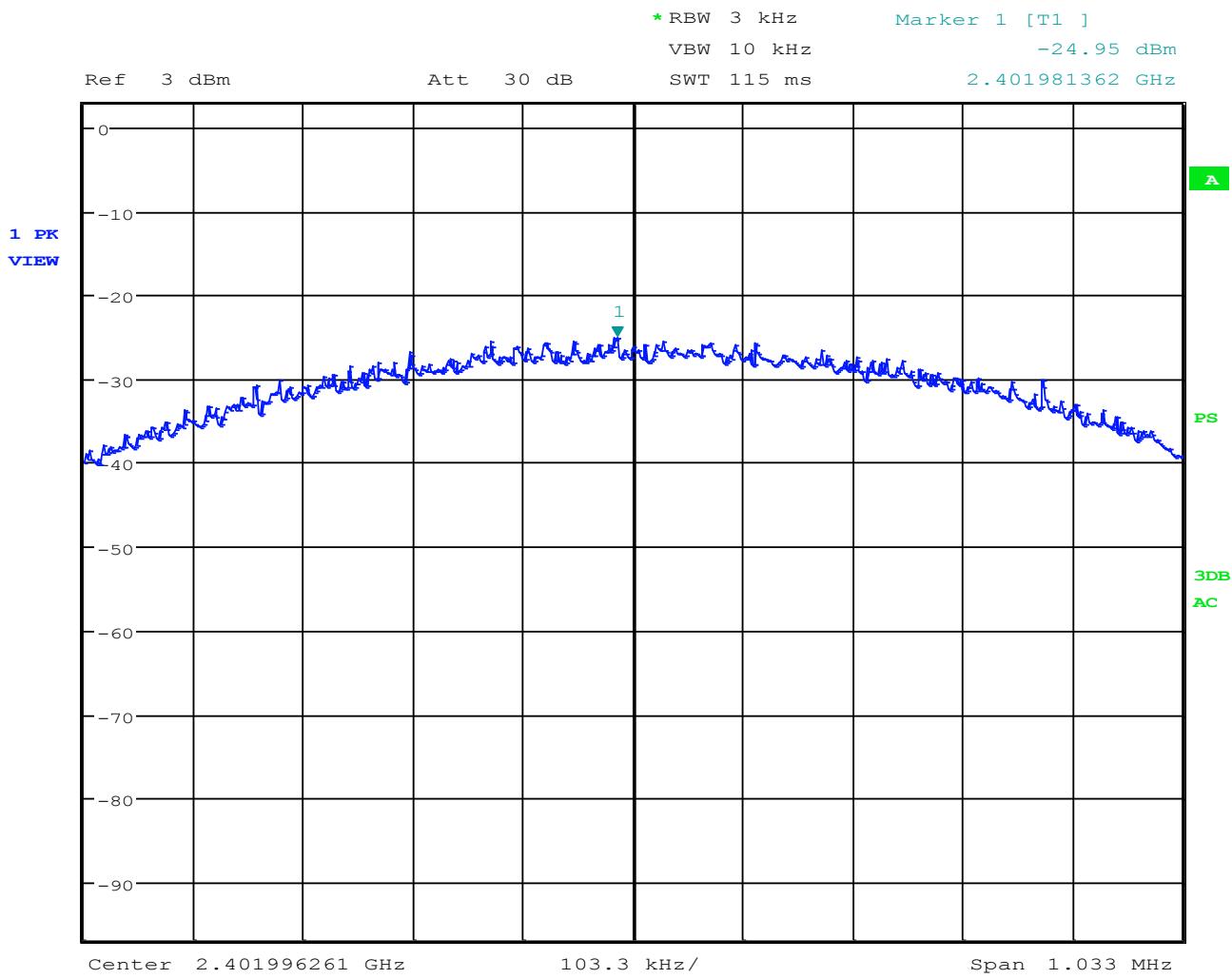
DEVICE DESCRIPTIONS: As described in the above EUT description and set up section.

EMISSIONS DATA:

Channel	Frequency	Un-Corrected PSD	Correction Factor	Corrected PSD	Limit	Margin	Results
	(GHz)	(dBm)	(dB)	(dBm)	(dBm)	(dB)	Pass/Fail
Low	2.402	-24.95	12.23	-12.72	8	20.72	Pass
Mid	2.44	-25.82	12.65	-13.17	8	21.17	Pass
High	2.48	-27.65	12.83	-14.82	8	22.82	Pass

RESULTS: PASS: Complies.

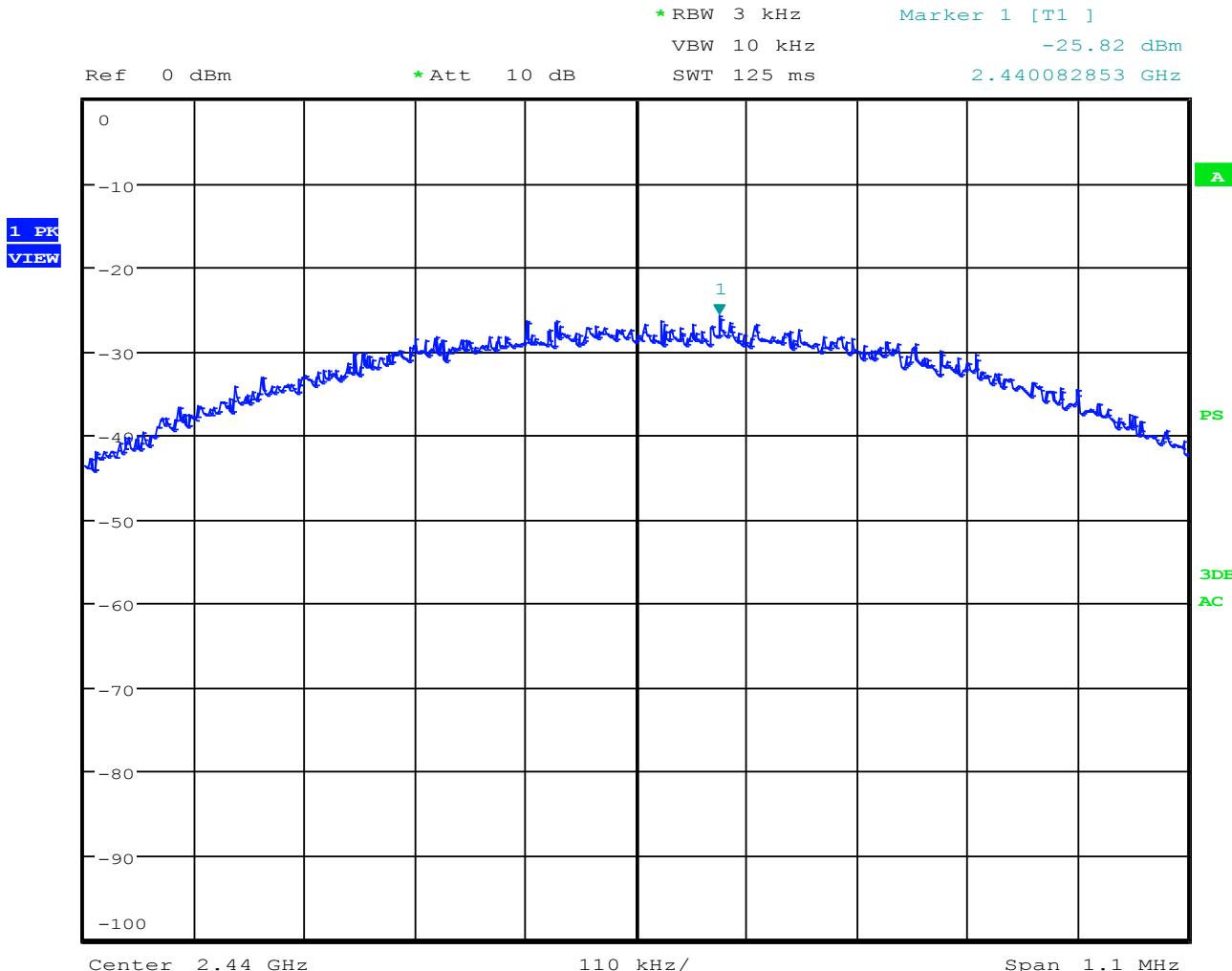
**TEST PLOTS - POWER SPRCTRAL DENSITY**



TTTTTT

Date: 24.MAR.2014 18:50:21

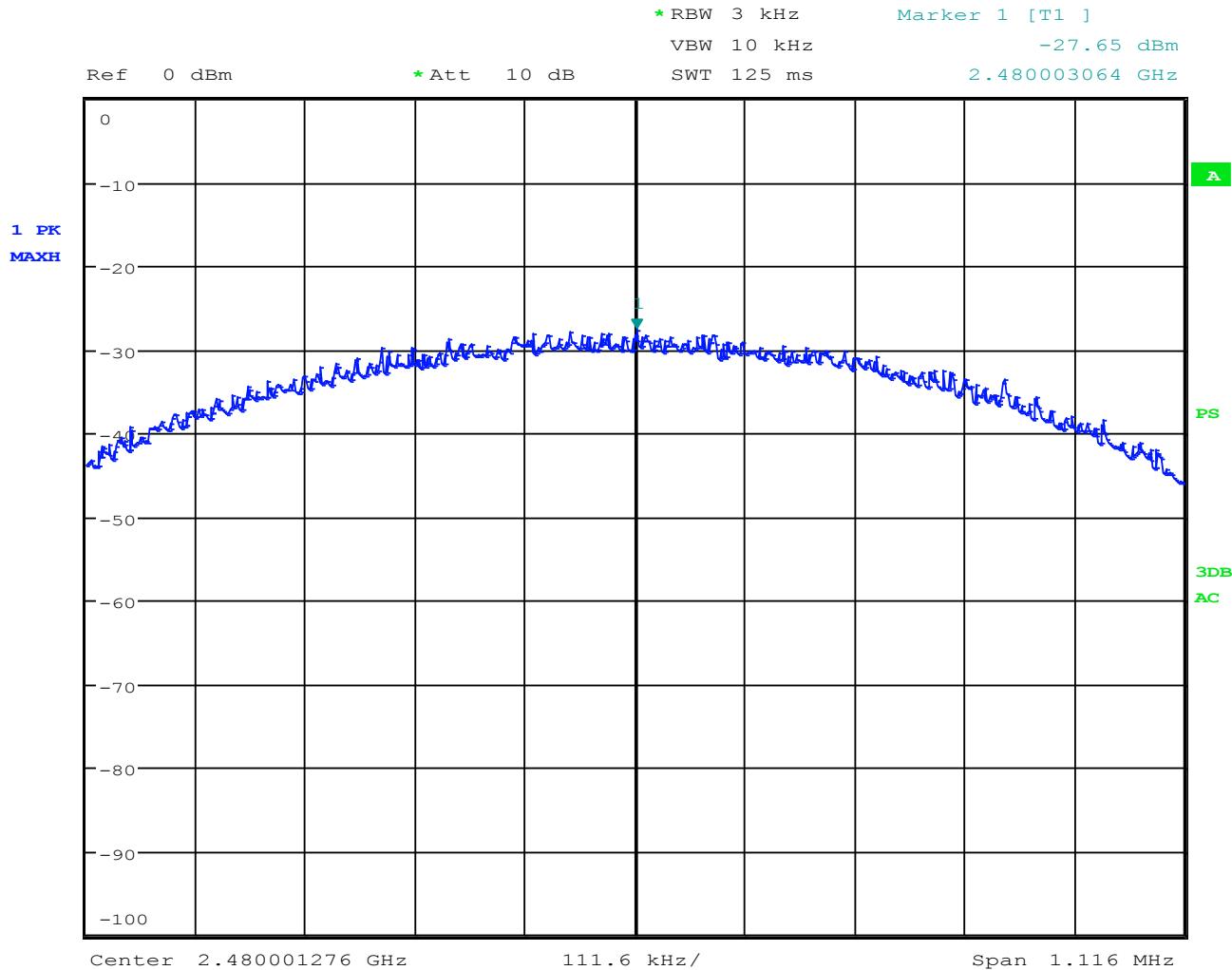
**PLOT 7 – LOW CHANNEL - POWER SPECTRAL DENSITY**



TTTTTT

Date: 24.MAR.2014 20:00:56

**PLOT 8 – MID CHANNEL - POWER SPECTRAL DENSITY**



TTTTTT

Date: 24.MAR.2014 20:31:33

#### PLOT 9 – HIGH CHANNEL - POWER SPECTRAL DENSITY

## **Part 5 - Out of Band Emissions (Band Edge)**

DATE: March 24 2014

TEST STANDARD: FCC Part 15.247 (d) and RSS 210 Issue 8 A8.5

TEST REQUIREMENTS:

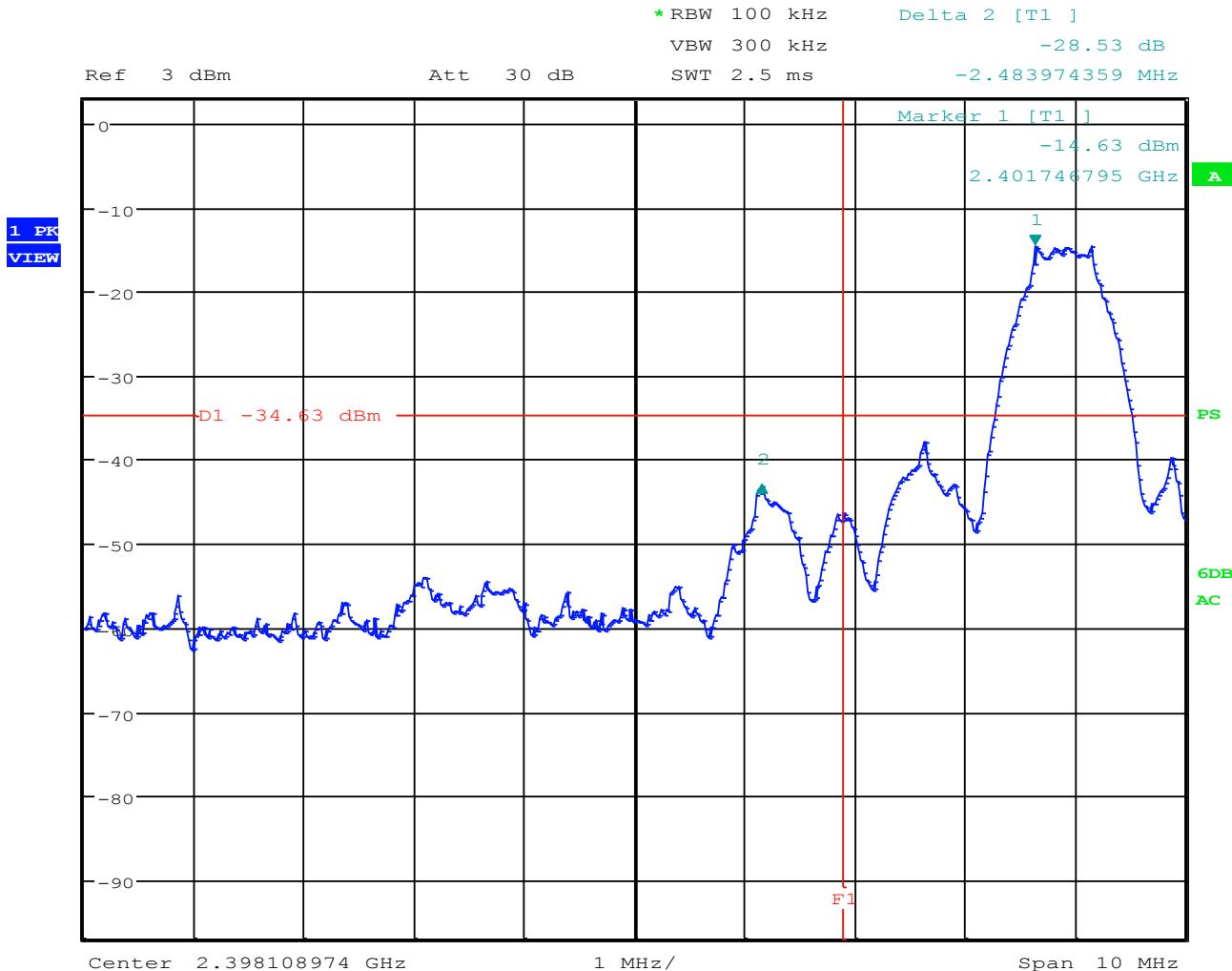
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section A8.4 (4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

MEASUREMENT METHOD: As called by the standards above.

EMISSIONS DATA:

Frequency (MHz)	Out of band Emissions Level (dBc)	Limit	Results
2399.26	-28.53	>20dBc	Pass
2483.53	-38.28	>20dBc	Pass

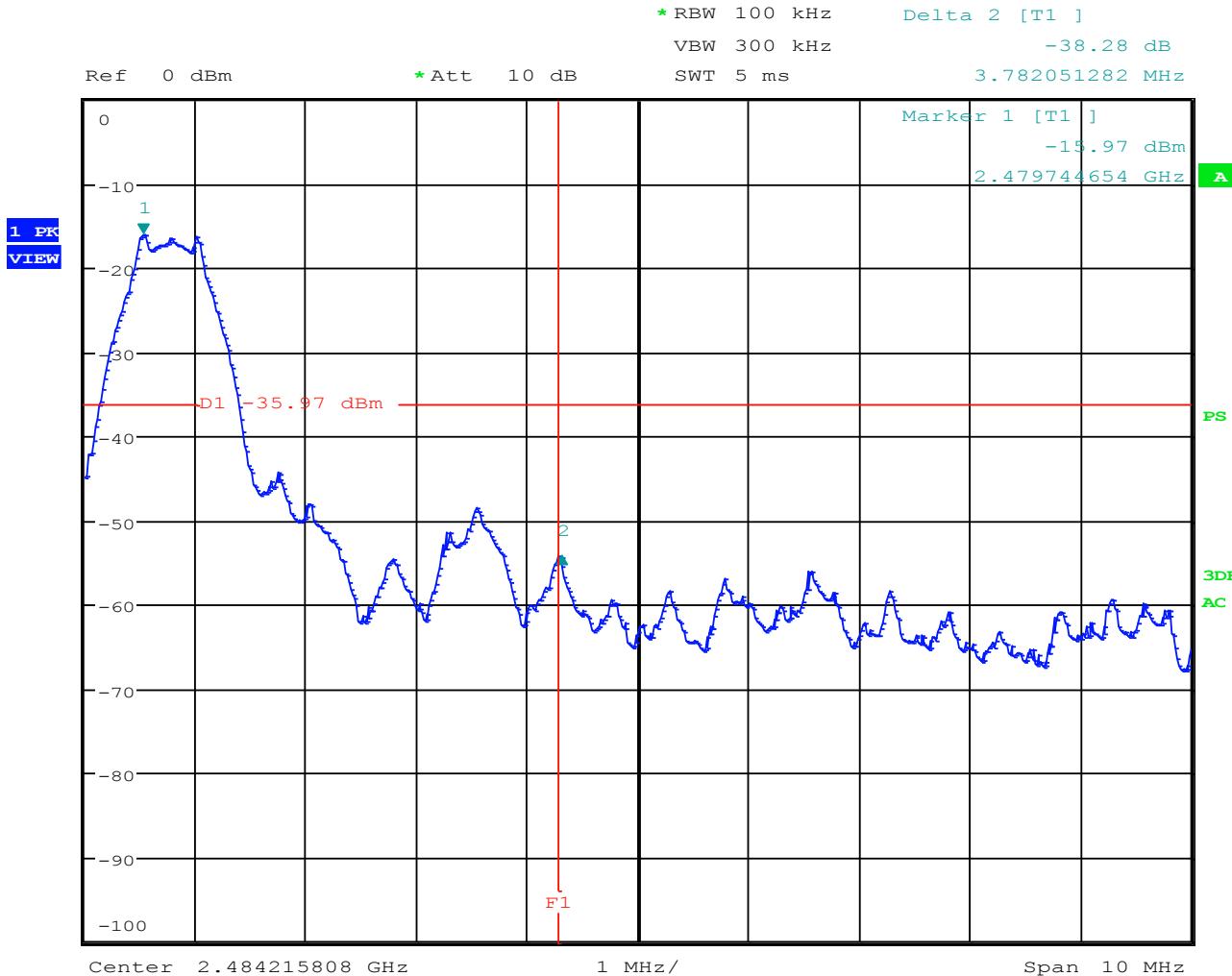
RESULTS: Pass: Complies



TTTTTT

Date: 24.MAR.2014 18:39:01

**PLOT 10: OUT OF BAND EMISSIONS LOW CHANNEL**



TTTTTT

Date: 24.MAR.2014 20:43:28

## PLOT 11: OUT OF BAND EMISSIONS HIGH CHANNEL

## **Part 6 - Conducted Spurious Emissions**

DATE: March 24 2014

TEST STANDARD: FCC Part 15.247 (d), FCC Part 15.209 (a) and RSS 210 Issue 8 A8.5

TEST REQUIREMENTS:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits.

MEASUREMENT METHOD: As called by the standards above. Conducted spurious emissions were measured up to 25GHz

EMISSIONS DATA:

**Low Channel Conducted Spurious Emissions**

Frequency (MHz)	Conducted Spurious Level (dBc)	Limit dBc	Results (Pass/Fail)
32.02	-56.45	>20	Pass
63.98	-59.05	>20	Pass
4807.74	-41.26	>20	Pass

**Middle Channel Conducted Spurious Emissions**

Frequency (MHz)	Conducted Emissions Level (dBc)	Limit dBc	Results (Pass/Fail)
32.02	-53.81	>20	Pass
63.98	-55.98	>20	Pass
4879.8	-43.4	>20	Pass

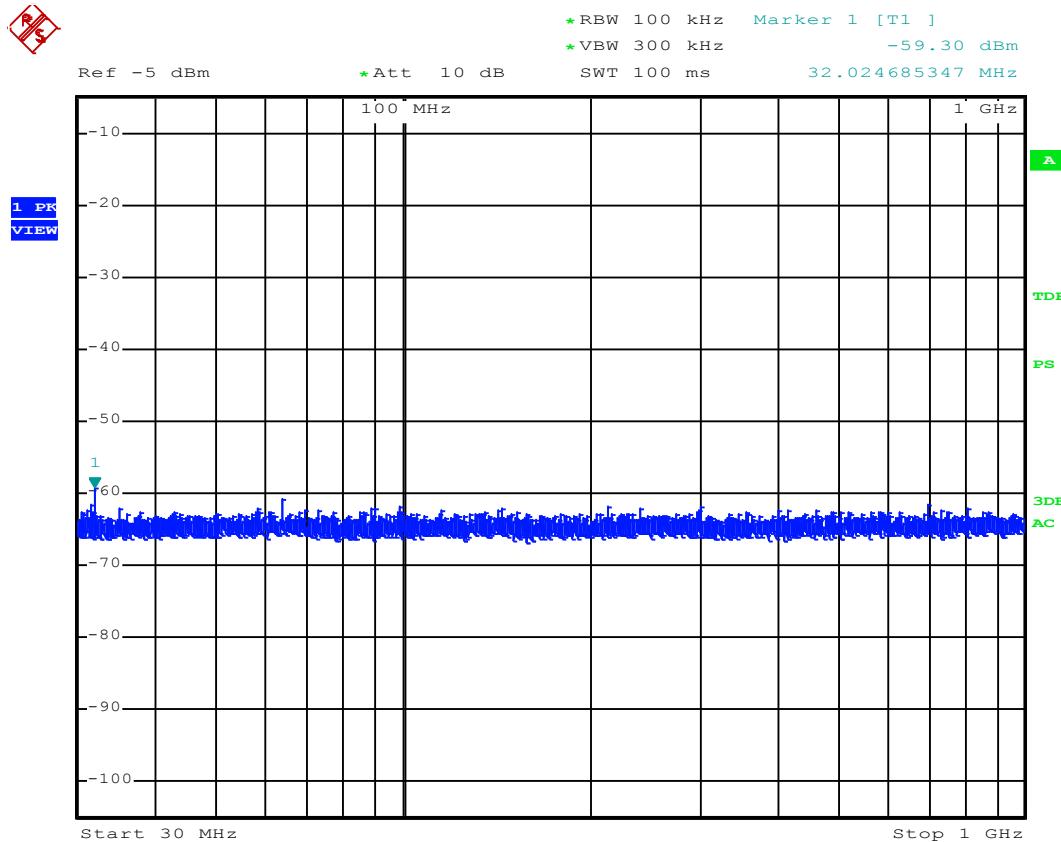
**High Channel Conducted Spurious Emissions**

Frequency (MHz)	Conducted Spurious Emissions Level (dBc)	Limit dBc	Results (Pass/Fail)
32.01	-54.83	>20	Pass
63.98	-55.29	>20	Pass
4966.34	-49.59	>20	Pass

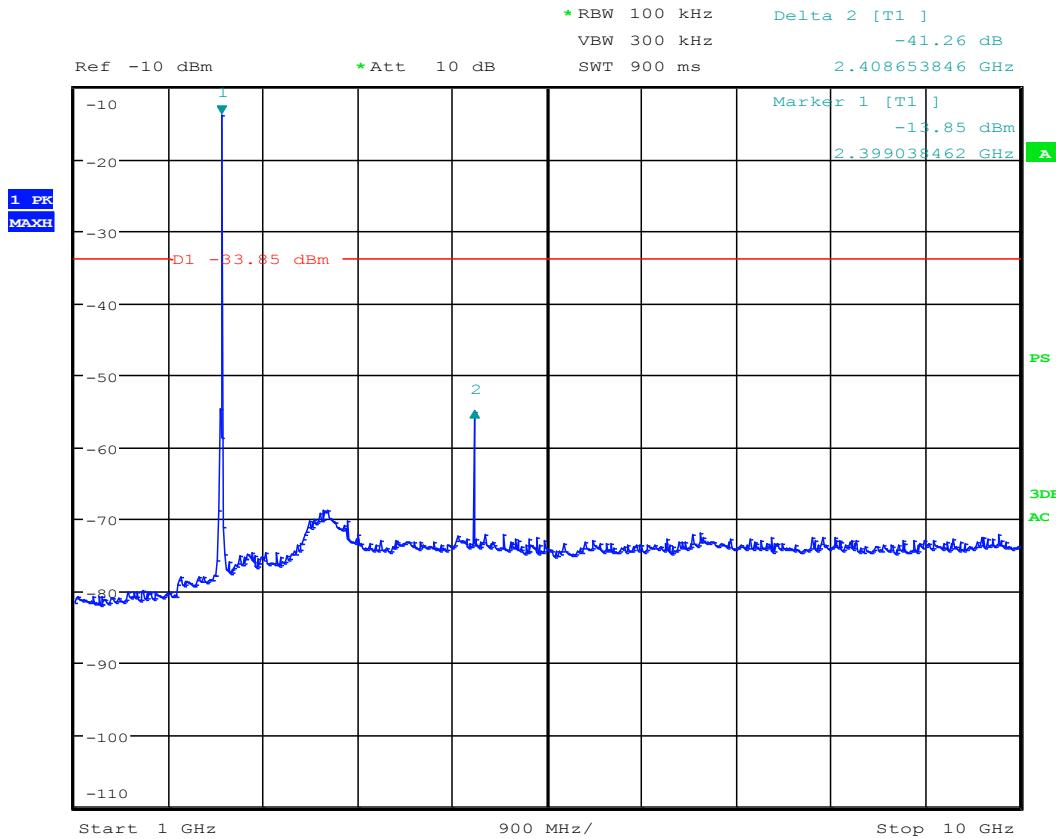
RESULTS: Pass: Complies

## TEST PLOTS – RF CONDUCTED SPURIOUS EMISSIONS

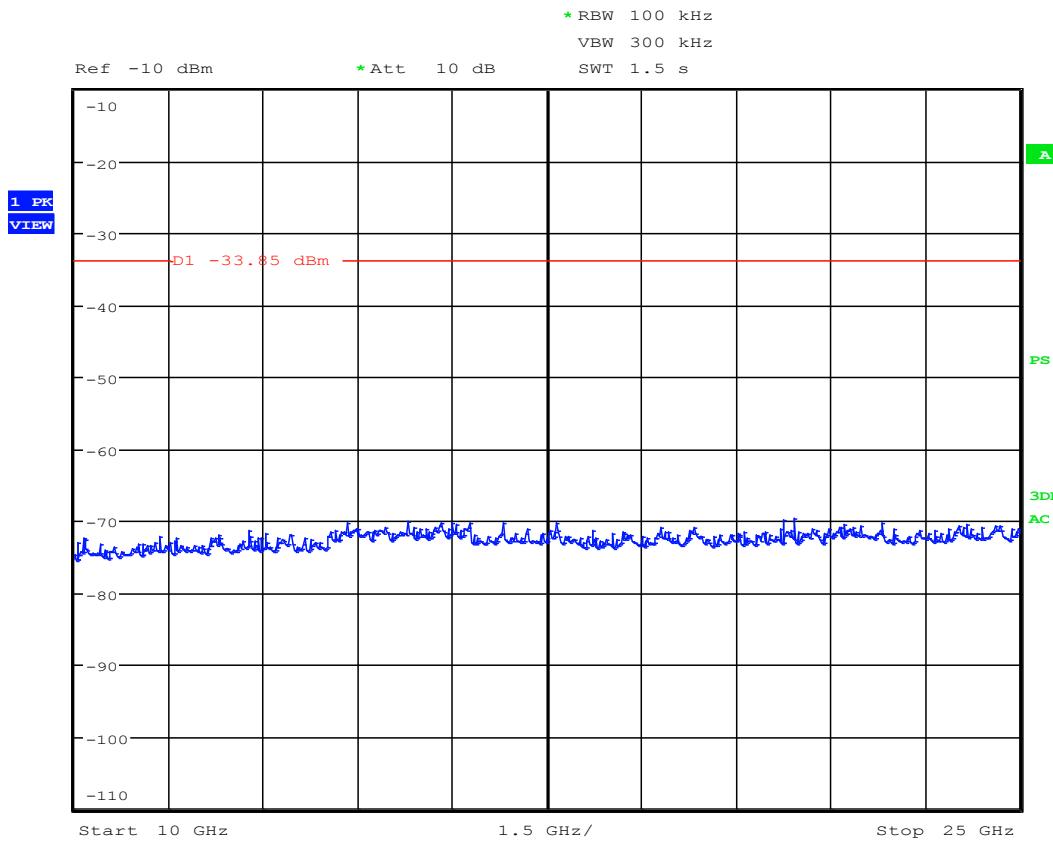
### RF CONDUCTED SPURIOUS EMISSIONS – LOW CHANNEL



PLOT 12: Low Channel - Conducted Spurious Emissions 30MHz-1GHz

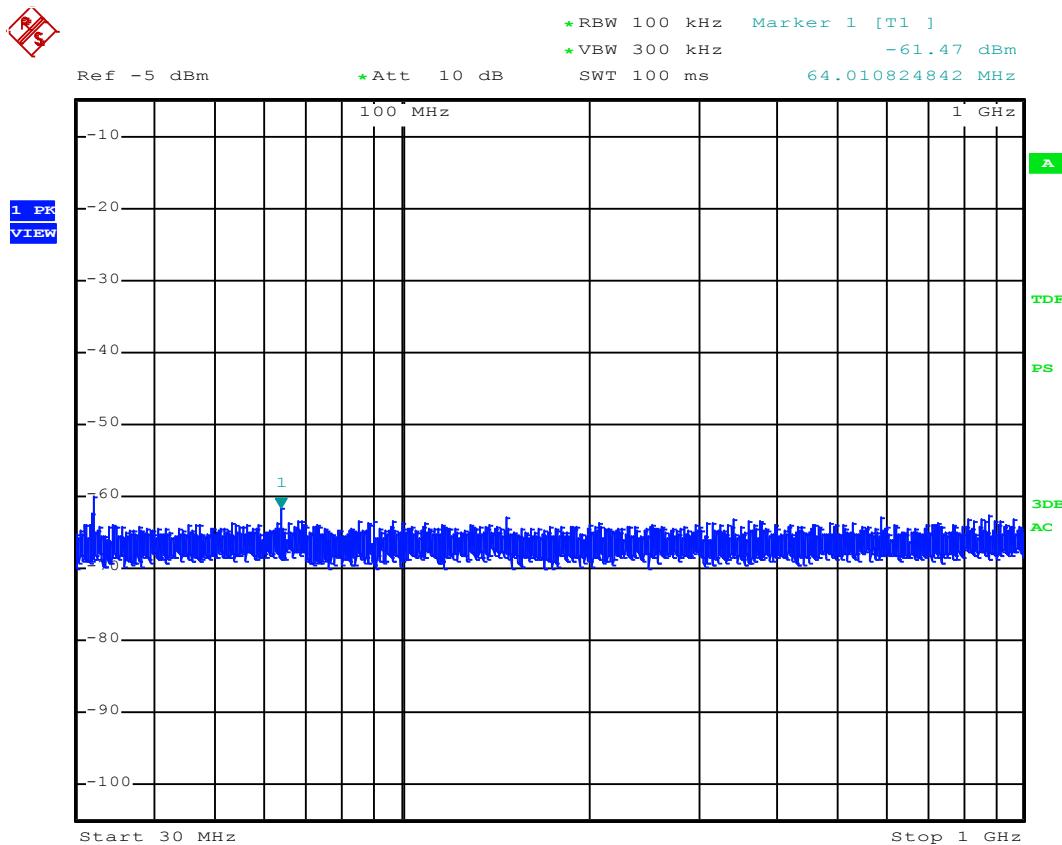


**PLOT 13: Low Channel - Conducted Spurious Emissions 1 - 10GHz**

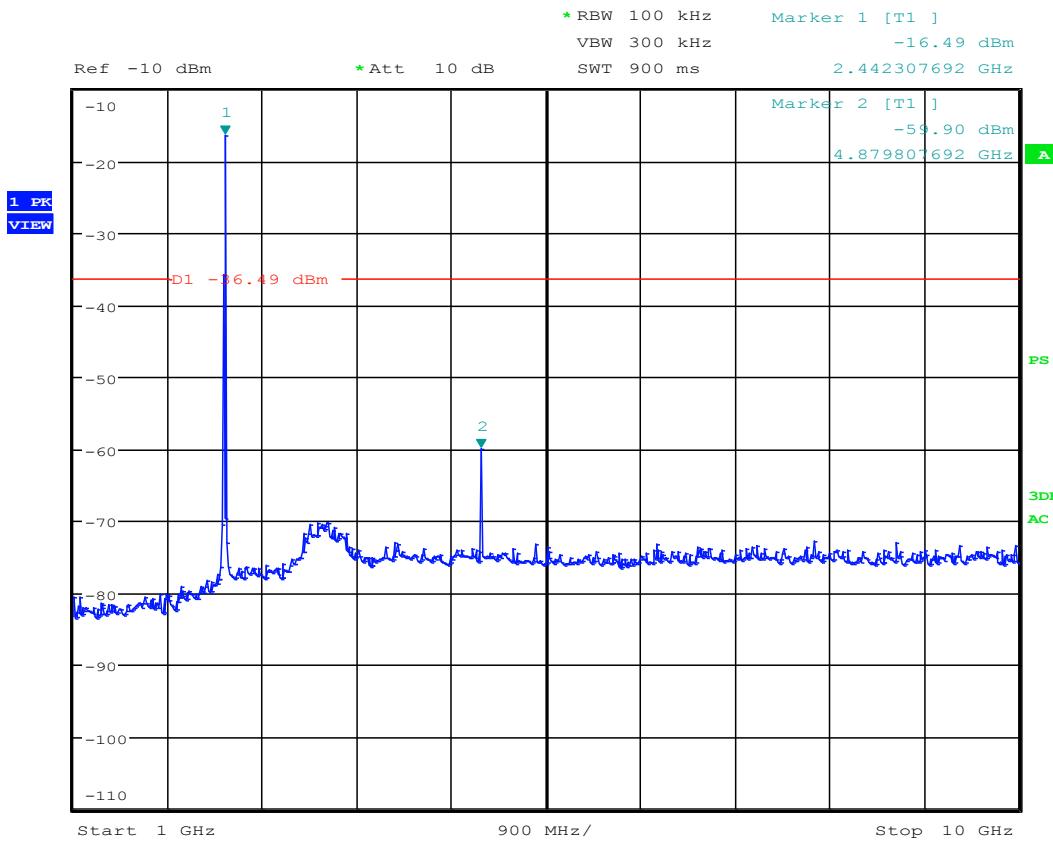


**PLOT 14: Low Channel - Conducted Spurious Emissions 10 - 25GHz**

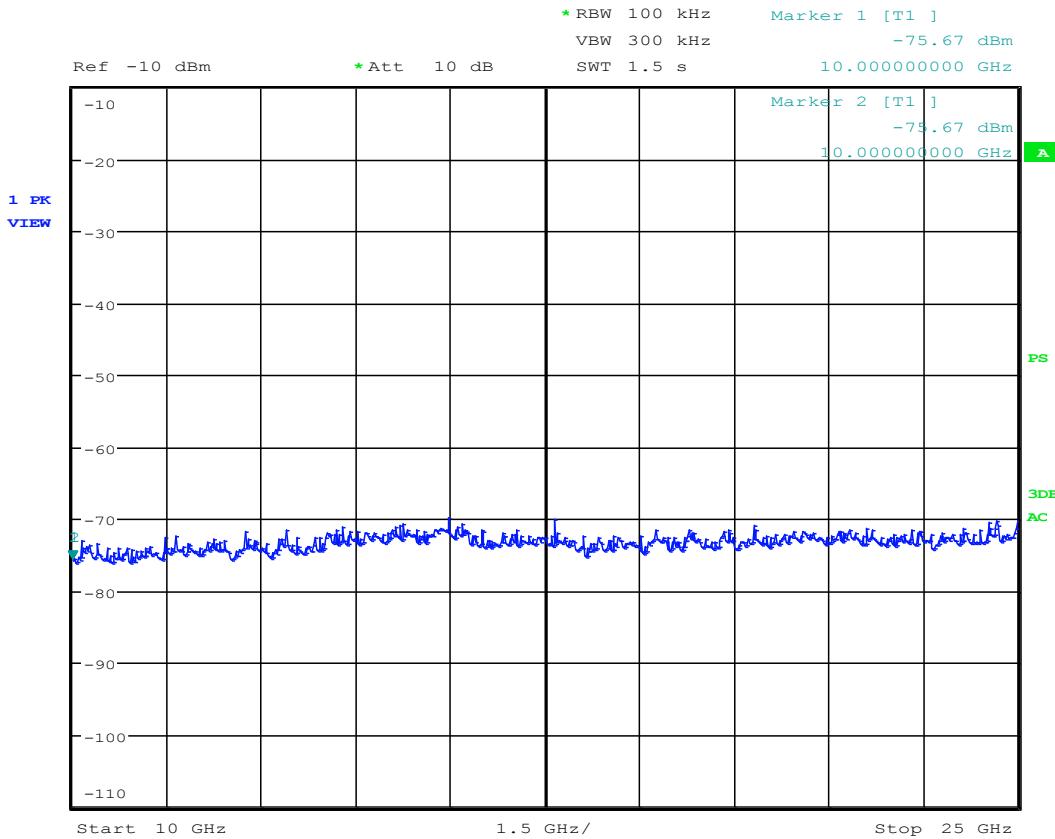
## RF CONDUCTED SPURIOUS EMISSIONS – MIDDLE CHANNEL



**PLOT 15: Middle Channel - Conducted Spurious Emissions 30MHz-1GHz**

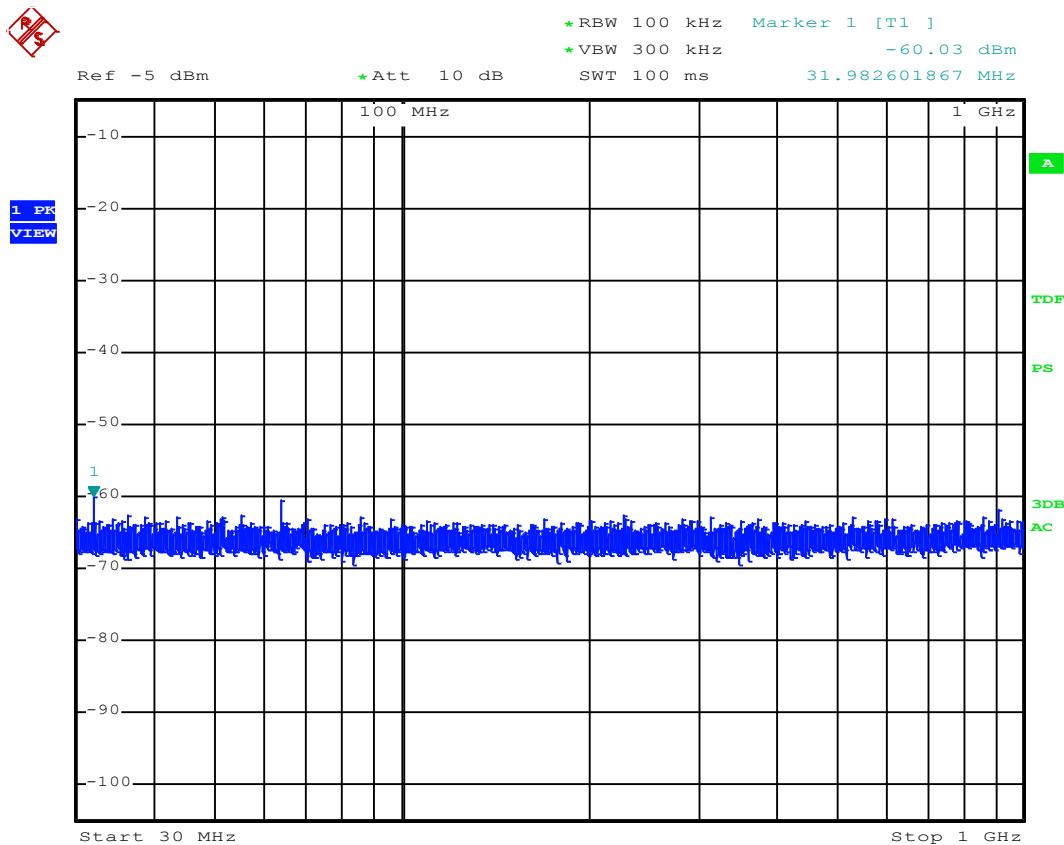


**PLOT 16: Middle Channel - Conducted Spurious Emissions 1 - 10GHz**

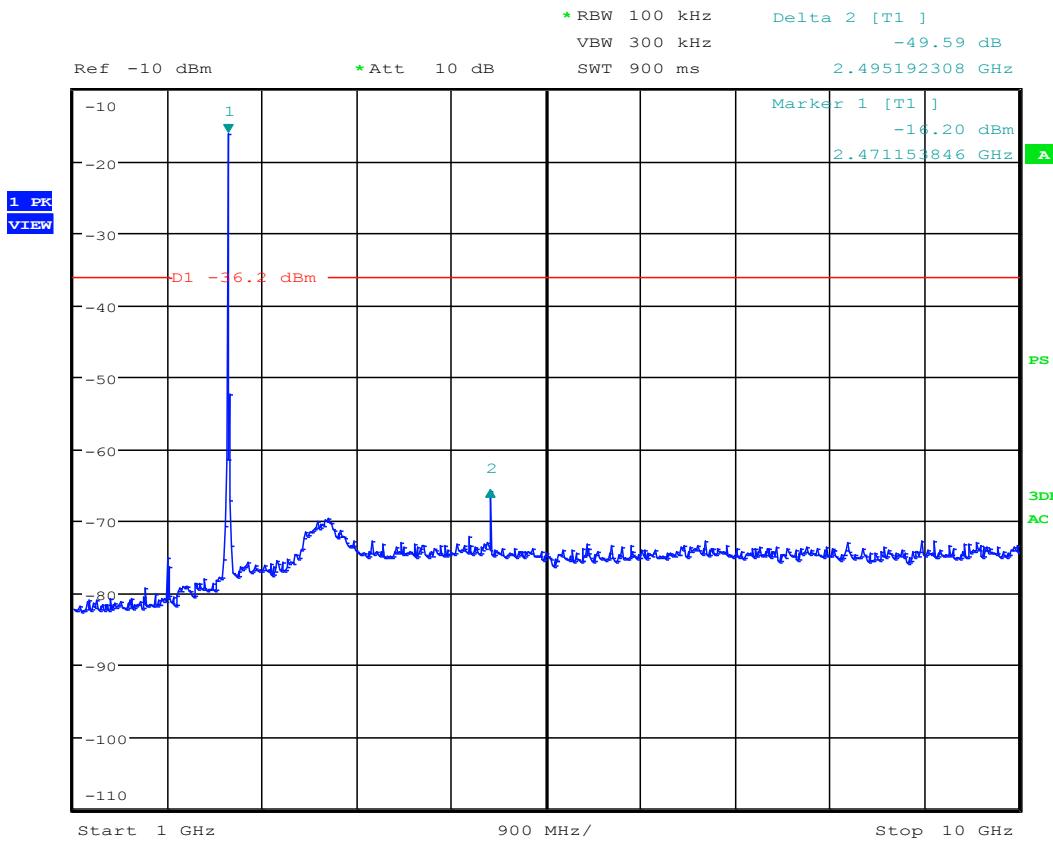


**PLOT 17: Middle Channel - Conducted Spurious Emissions 10 – 25GHz**

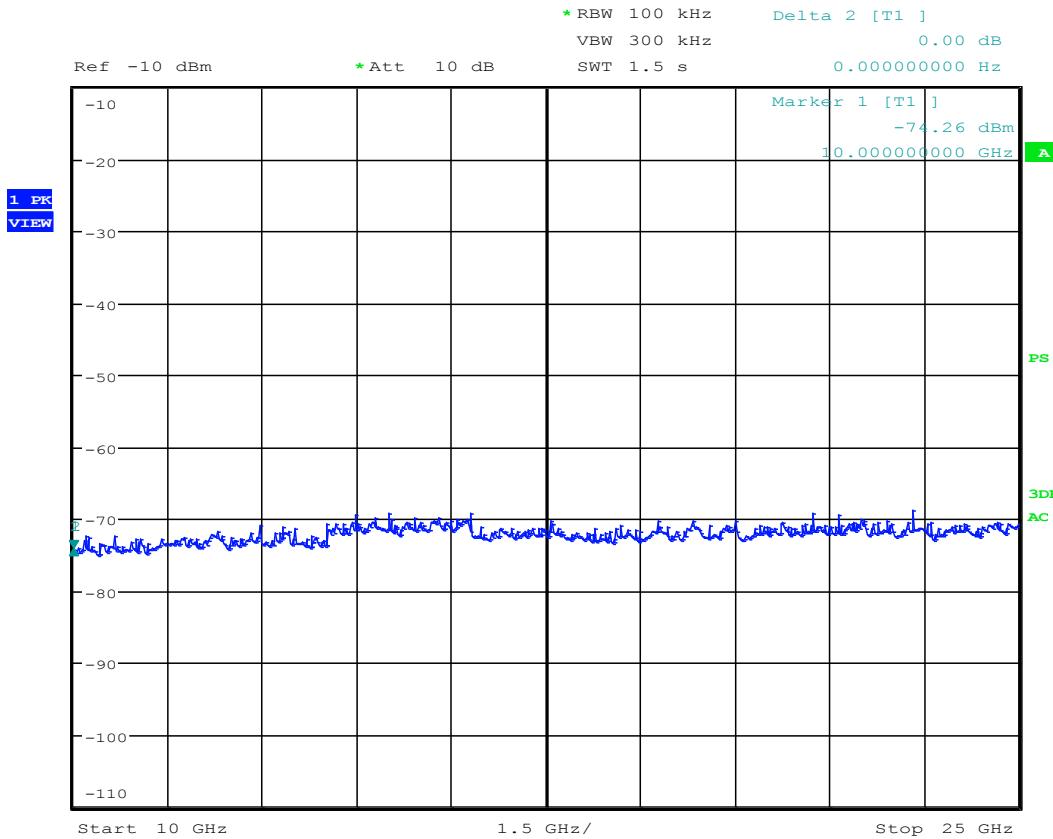
**RF CONDUCTED SPURIOUS EMISSIONS – HIGH CHANNEL**



**PLOT 18: High Channel - Conducted Spurious Emissions 30MHz-1GHz**



**PLOT 19: High Channel - Conducted Spurious Emissions 1 - 10GHz**



**PLOT 20: High Channel - Conducted Spurious Emissions 10 - 25GHz**

## **Part 7 - Radiated Spurious Emissions-Transmit Mode**

DATE: March 28 2014

TEST STANDARD: FCC Part 15.247 (d), FCC Part 15.209 (a), FCC Part 15.205, IC RSS-210 Annex 2 Section (A2.2)(b), RSS-Gen Section (7.2.5)

TEST VOLTAGE: 3Vdc

TEST CONDITIONS: Indoor

MINIMUM STANDARD: Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 20 dB below the level of the fundamental or to the general field strength limits listed in RSS-Gen, whichever is less stringent.  
 In measuring unwanted emissions, the spectrum shall be investigated from 30 MHz or the lowest radio frequency signal generated in the equipment, whichever is lower, without going below 9 kHz, up to at least the frequency ... if the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

**Unwanted emissions falling into restricted bands of shall comply with the limits specified below**

Frequency (MHz)	Field Strength	
	uV/m @ 3-m	Calculated dB $\mu$ V/m at 3m
30 – 88	100	40.0
88 - 216	150	43.5
216 - 960	200	46.0
960 - 1000	500	54.0

**FCC PART 15.205-RESTRICTED BANDS OF OPERATION**

**(a)** Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

<b>MHz</b>	<b>MHz</b>	<b>MHz</b>	<b>GHz</b>
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
1 0.495-0.505*	16.69475-	608-614	5.35-5.46
2.1735-2.1905	16.80425-	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	(2)
13.36-13.41			

\* - note FCC-specific .

Canada-specific frequency ranges - 3.020-3.026, 5.677-5.683, 121.94-123.0, 149.9-150.05, 162.0125-167.17, 167.72-173.2, 1300-1427, 2483.5-2500, 3500-3600,

(2) Above 38.6 GHz

**(b)** Except as provided in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in § 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in § 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in § 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in § 15.35 apply to these measurements.

### RESTRICTED FREQUENCY BANDS (RSS-GEN)

<b>MHz</b>	<b>MHz</b>	<b>GHz</b>
0.090-0.110	240-285	9.0-9.2
2.1735-2.1905	322-335.4	9.3-9.5
3.020-3.026	399.9-410	10.6-12.7
4.125-4.128	608-614	13.25-13.4
4.17725-4.17775	960-1427	14.47-14.5
4.20725-4.20775	1435-1626.5	15.35-16.2
5.677-5.683	1645.5-1646.5	17.7-21.4
6.215-6.218	1660-1710	22.01-23.12
6.26775-6.26825	1718.8-1722.2	23.6-24.0
6.31175-6.31225	2200-2300	31.2-31.8
8.291-8.294	2310-2390	36.43-36.5
8.362-8.366	2655-2900	Above 38.6
8.37625-8.38675	3260-3267	
8.41425-8.41475	3332-3339	
12.29-12.293	3345.8-3358	
12.51975-12.52025	3500-4400	
12.57675-12.57725	4500-5150	
13.36-13.41	5350-5460	
16.42-16.423	7250-7750	
16.69475-16.69525	8025-8500	
16.80425-16.80475		
25.5-25.67		
37.5-38.25		
73-74.6		
74.8-75.2		
108-138		
156.52475-156.52525		
156.7-156.9		

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

#### TEST SETUP:

The EUT was tested in our 3 m SAC and was positioned on the center of the turntable and connected to a 3Vdc battery. The transmitter was set for continuous transmission. The lowest, middle and highest channels in the 2400-2483.5 MHz band were measured for all radiated emissions 10kHz to 18 GHz. The EUT was pre-scanned in 3 different orthogonal orientations and was found to radiate highest when placed flat on the table top as indicated in the test photos.

#### MEASUREMENT METHOD:

Measurements were made using spectrum analyser and receiver, 200Hz RBW average detector for the frequency range 9-150kHz; 9kHz RBW average detector for the Frequency range 150kHz to 30MHz; 120kHz RBW quasi-peak detector using the appropriate antennas, amplifiers and filters.

The measurement results are obtained as described below:

**E [dB $\mu$ V/m] = Un-Corrected Value + ATOT**

Where ATOT is total correction factor including cable loss, antenna factor and preamplifier gain (ATOT = LCABLES + AF - AMP).

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

**EMISSIONS DATA:**

**Radiated Spurious Emissions – Low Channel**

Freq	Un-corr Pk	Un-corr Avg	Height	Pol	Table position	Ant. Factor	Corr. Factors	Corr. Avg	Corr Peak	Margin Avg	Limit Avg	Margin Peak	Limit Peak
MHz	dB $\mu$ V/m	dB $\mu$ V/m	cm		deg	dB	dB	dB $\mu$ V/m	dB $\mu$ V/m	dB	dB $\mu$ V/m	dB	dB $\mu$ V/m
4807.8578	45.9	39.5	133	V	212	28.5	-26.4	41.6	48	12.4	54	26	74
4809.4656	49.9	44.06	158	H	272	28.5	-26.2	46.36	52.2	7.64	54	21.8	74
7213.212	40.3	28.7	100	V	60	33.4	-26.6	35.5	47.1	18.5	54	26.9	74
7213.3582	43.2	31.4	156	H	165	33.4	-26.6	38.2	50	15.8	54	24	74
9608	35.3	24.1	144	H	180	37.1	-20.7	40.5	51.7	13.5	54	22.3	74

**Radiated Spurious Emissions – Middle Channel**

Freq	Un-corr Pk	Un-corr Avg	Height	Pol	Table position	Ant. Factor	Corr. Factors	Corr. Avg	Corr PK	Margin Avg	Limit Avg	Margin Peak	Limit Peak
MHz	dB $\mu$ V/m	dB $\mu$ V/m	cm		deg	dB	dB	dB $\mu$ V/m	dB $\mu$ V/m	dB	dB $\mu$ V/m	dB	dB $\mu$ V/m
4880	44.62	36.51	172	V	184	28.6	-27.7	37.41	45.52	16.59	54	28.48	74
4880	48.86	41.85	152	H	300	28.6	-27.7	42.75	49.76	11.25	54	24.24	74
7320	40.5	27.6	100	V	30	33.5	-25.68	35.42	48.32	18.58	54	25.68	74
7320	41.8	30.1	145	H	350	33.5	-25.68	37.92	49.62	16.08	54	24.38	74

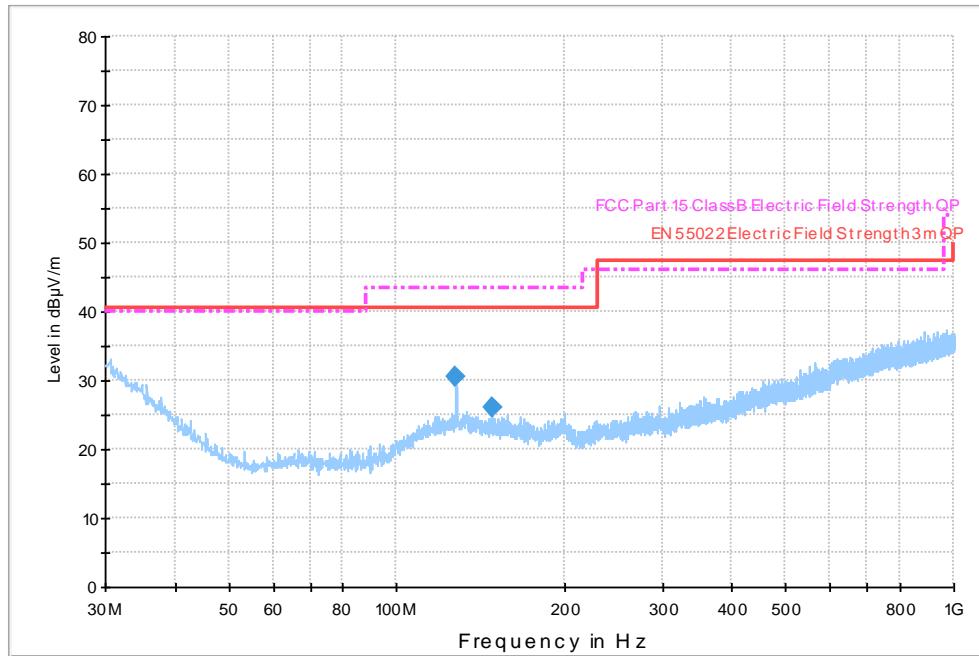
**Radiated Spurious Emissions – High Channel**

Freq	Un-corr Pk	Un-corr Avg	Height	Pol	Table position	Ant. Factors	Corr. Factors	Corr. Avg	Corr PK	Margin Avg	Limit Avg	Margin Peak	Limit Peak
MHz	dB $\mu$ V/m	dB $\mu$ V/m	cm		deg	dB	dB	dB $\mu$ V/m	dB $\mu$ V/m	dB	dB $\mu$ V/m	dB	dB $\mu$ V/m
4960	44	34.76	184	V	213	28.85	-25.89	37.72	46.96	16.28	54	27.04	74
4960	47.5	39.4	155	H	293	28.85	-25.89	42.36	50.46	11.64	54	23.54	74
7438.5632	39.8	30	100	V	360	33.5	-26.38	37.12	46.92	16.88	54	27.08	74
7438.6957	41.78	31.29	100	H	335	33.5	-26.38	38.41	48.9	15.59	54	25.1	74

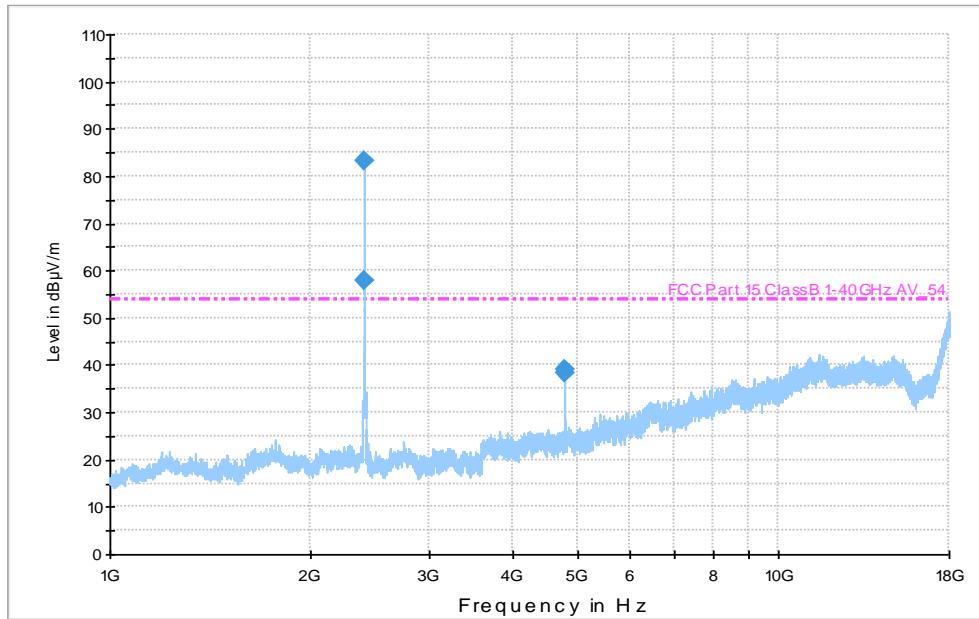
**RESULTS:**

Pass: Complies

**TEST PLOTS: RADIATED SPURIOUS EMISSIONS TRANSMIT MODE**



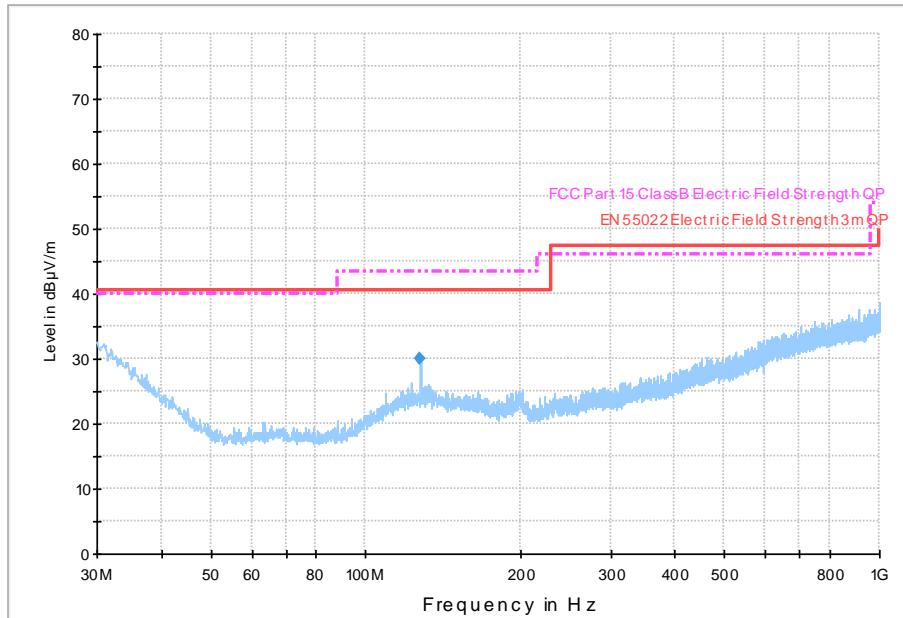
**PLOT 21: Low Channel Radiated Spurious Emissions 30MHz – 1GHz**



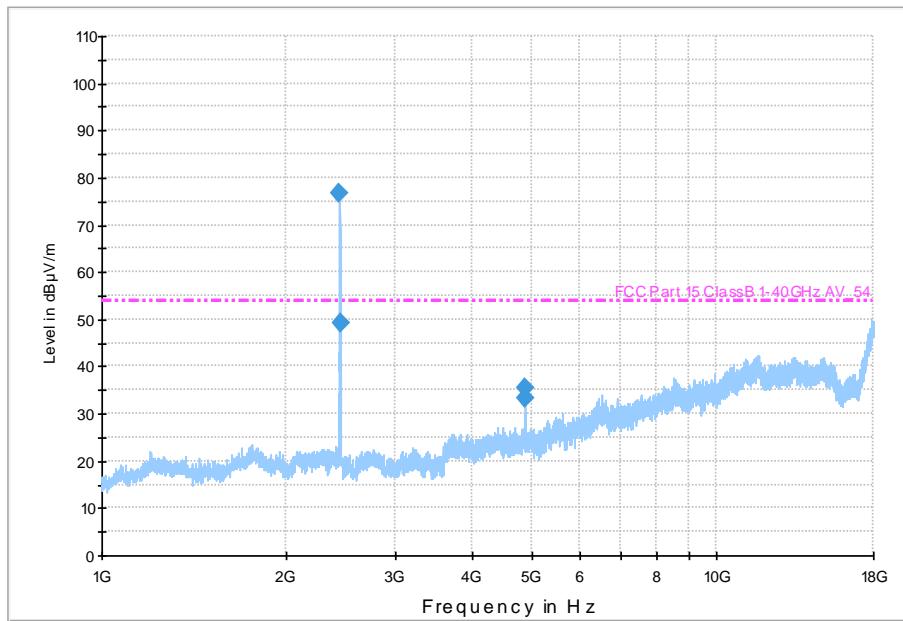
**PLOT 22: Low Channel Radiated Spurious Emissions 1 – 18GHz**

**Note:**

1. Emissions marked in Plot 21 were ambient signals. All other emissions below 1GHz were more than 20dB lower than the limit line.
2. Radiated Emissions test was performed from 9 kHz-25GHz. Except the emissions reported above, all other signals were more than 20dB lower than the limit.



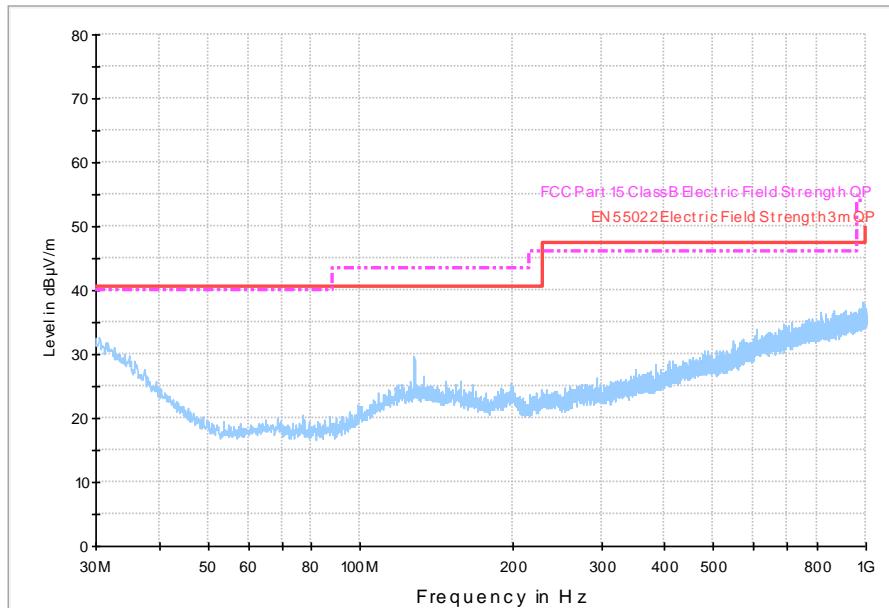
**PLOT 23: Middle Channel - Radiated Spurious Emissions 30MHz – 1GHz**



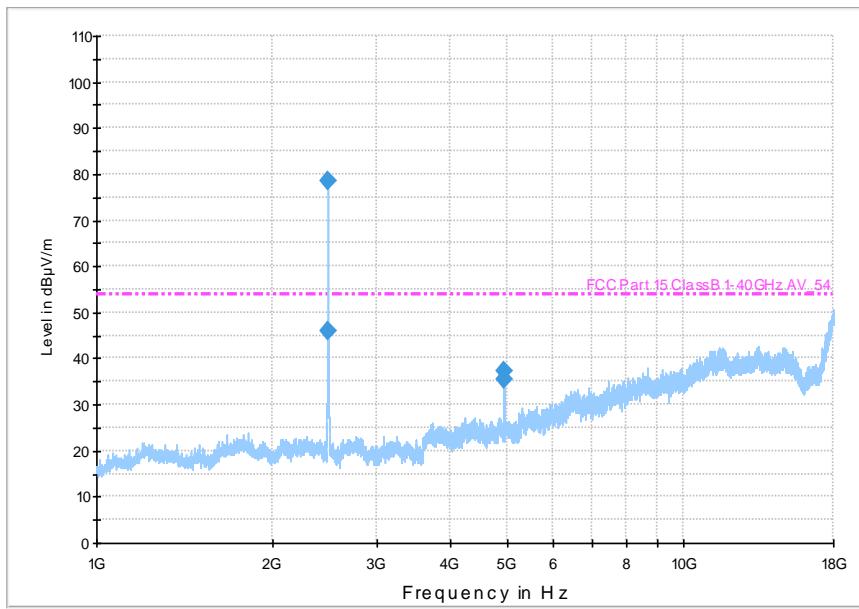
**PLOT 24: Middle Channel - Radiated Spurious Emissions 1-18GHz**

**Note:**

1. Emissions marked in Plot 23 were ambient signals. All other emissions below 1GHz were more than 20dB lower than the limit line.
2. Radiated Emissions test was performed from 9 kHz-25GHz. Except the emissions reported above, all other signals were more than 20dB lower than the limit.



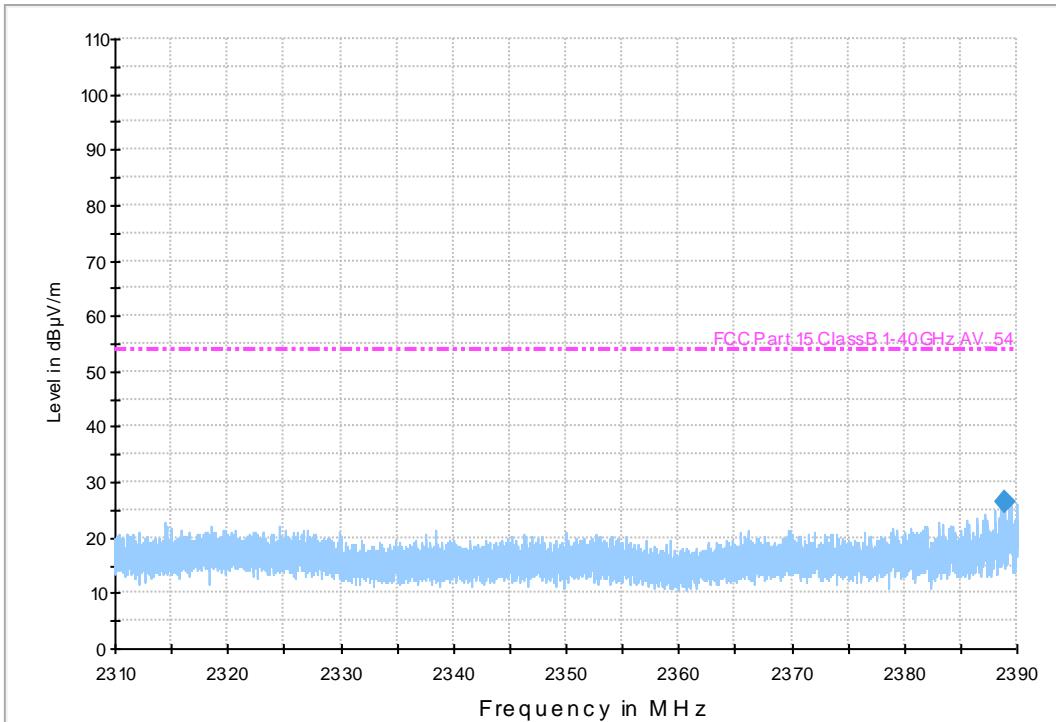
**PLOT 25: High Channel - Radiated Spurious Emissions 30MHz – 1000GHz**



**PLOT 26: High Channel - Radiated Spurious Emissions 1 – 18GHz**

**Note:**

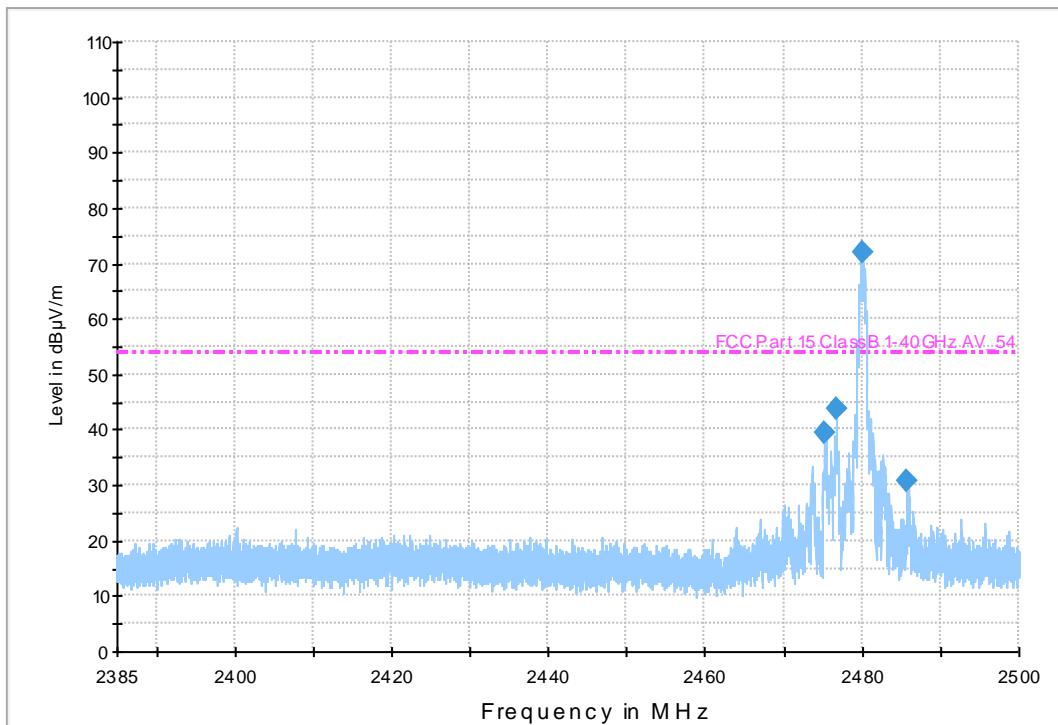
1. Emissions marked in Plot 25 were ambient signals. All other emissions below 1GHz were more than 20dB lower than the limit line.
2. Radiated Emissions test was performed from 9 kHz-25GHz. Except the emissions reported above, all other signals were more than 20dB lower than the limit.



**PLOT 27: Radiated Spurious Emissions 2.31 - 2.39 GHz**

**Radiated Spurious Emissions**

Freq	Un-corr Pk	Un-corr Avg	Height	Pol	Table position	Corr. Factors	Corr. Avg	Corr PK	Margin Avg	Limit Avg	Margin Peak	Limit Peak
MHz	dBμV/m	dBμV/m	cm		deg	dB	dBμV/m	dBμV/m	dB	dBμV/m	dB	dBμV/m
2389.01	36.58	28.26	145	H	178	-9.6	18.66	26.98	35.34	54	47.02	74



**PLOT 28: Radiated Spurious Emissions 2.385 - 2.5 GHz**

**Radiated Spurious Emissions**

Freq	Un-corr	Un-corr	Height	Pol	Table position	Corr. Factors	Corr. Avg	Corr	Margin	Limit	Margin	Limit
	Pk	Avg							PK	Avg	Avg	Peak
MHz	dBμV/m	dBμV/m	cm		deg	dB	dBμV/m	dB	dBμV/m	dB	dBμV/m	Peak
2475.206	47.6	41.4	127	H	279	-10.1	31.3	37.5	22.7	54	36.5	74
2485.786	44.5	38.3	115	H	210	-10.1	28.2	34.4	25.8	54	39.6	74
2476.71633	40.4	31.84	100	H	289	-10.1	21.7	30.3	32.3	54	43.7	74

Note: Emissions over the limit line in the above plot was the fundamental transmitting frequency.

## **Part 8 - Radiated Spurious Emissions-Receive Mode**

DATE:	March 28 2014
TEST STANDARD:	FCC Part 15.247 (d), FCC Part 15.209 (a) and ICES-003 Issue 5
TEST VOLTAGE:	3Vdc
TEST CONDITIONS:	Indoor
MINIMUM STANDARD:	<p>Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 20 dB below the level of the fundamental or to the general field strength limits listed in RSS-Gen, whichever is less stringent.</p> <p>In measuring unwanted emissions, the spectrum shall be investigated from 30 MHz or the lowest radio frequency signal generated in the equipment, whichever is lower, without going below 9 kHz, up to at least the frequency ... if the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.</p> <p>Unwanted emissions falling into restricted bands of shall comply with the limits specified below</p>

Frequency (MHz)	Field Strength	
	uV/m @ 3-m	Calculated dB $\mu$ V/m at 3m
30 – 88	100	40.0
88 - 216	150	43.5
216 - 960	200	46.0
960 - 1000	500	54.0

TEST SETUP:	The EUT was tested in our 3 m SAC and was positioned on the center of the turntable and connected to a 3Vdc battery. The transmitter was set for continuous transmission. The lowest, middle and highest channels in the 2400-2483.5 MHz band were measured for all radiated emissions 10kHz to 18 GHz. The EUT was pre-scanned in 3 different orthogonal orientations and was found to radiate highest when placed flat on the table top as indicated in the test photos.
MEASUREMENT METHOD:	Measurements were made using spectrum analyser and receiver, 200Hz RBW average detector for the frequency range 9-150kHz; 9kHz RBW average detector for the Frequency range 150kHz to 30MHz; 120kHz RBW quasi-peak detector using the appropriate antennas, amplifiers and filters.
	<p>The measurement results are obtained as described below:</p> <p><b>E [dB<math>\mu</math>V/m] = Un-Corrected Value + ATOT</b></p> <p>Where ATOT is total correction factor including cable loss, antenna factor and preamplifier gain (ATOT = LCABLES + AF - AMP).</p>
DEVICE DESCRIPTIONS:	As described in the above EUT description and setup section.

EMISSIONS DATA:

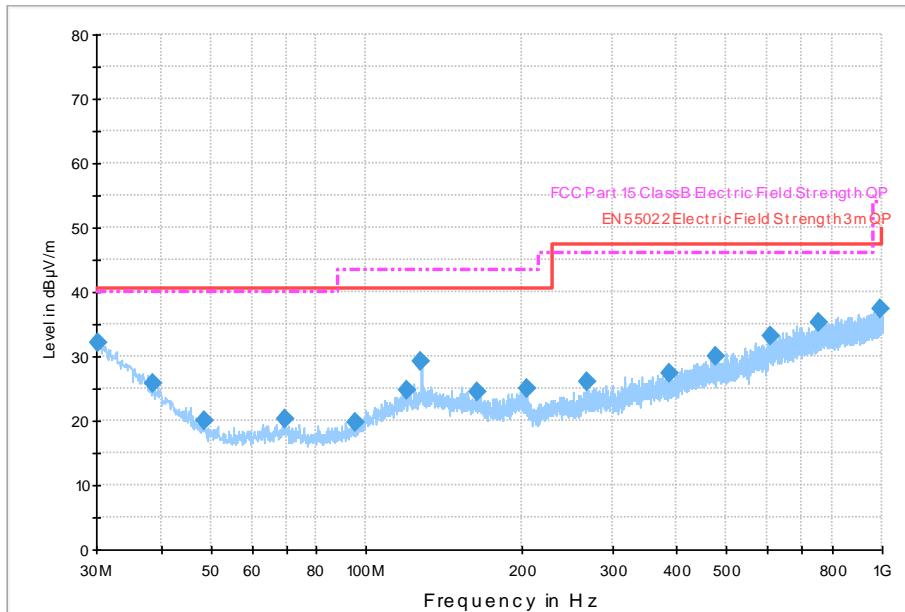
Radiated Emissions Receive Mode for Low, Middle and High Channel

Frequency (MHz)	Uncorr-Avg (dB $\mu$ V/m)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Antenna Factors (dB)	Correction Factors (dB)	Corr. Avg (dB $\mu$ V/m)	Margin (dB)	Limit (dB $\mu$ V/m)
4805.4656	40.6	1000	100	H	89	28.5	-26.2	42.9	11.1	54
4881.1	39.23	1000	100	H	109	28.6	-27.7	40.13	13.87	54
4960	39.08	1000	155	H	293	28.85	-25.89	42.04	11.96	54

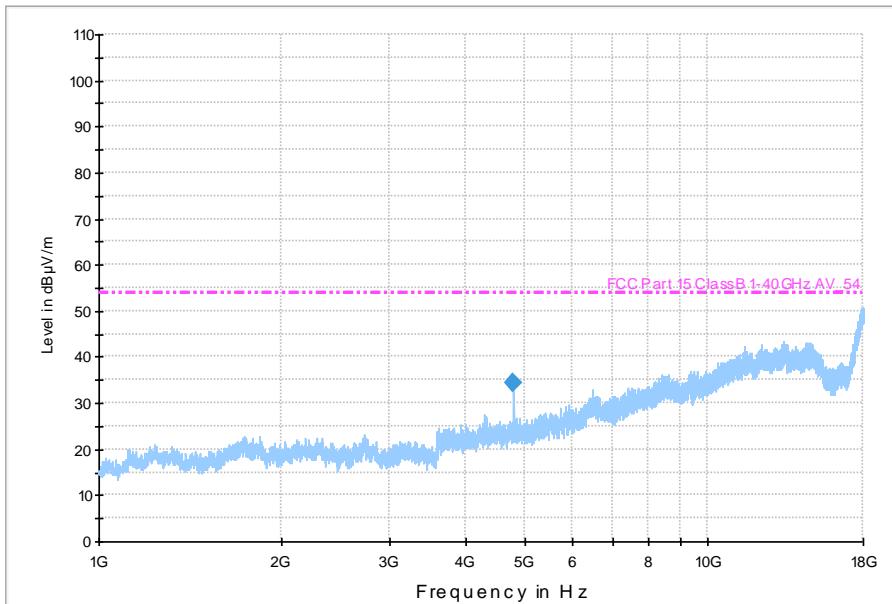
Note: All other emissions from 9KHz – 25GHz were more than 20dB lower than the limit line.

RESULTS: Pass: Complies.

**TEST PLOTS – RADIATED EMISSIONS RECEIVE MODE**



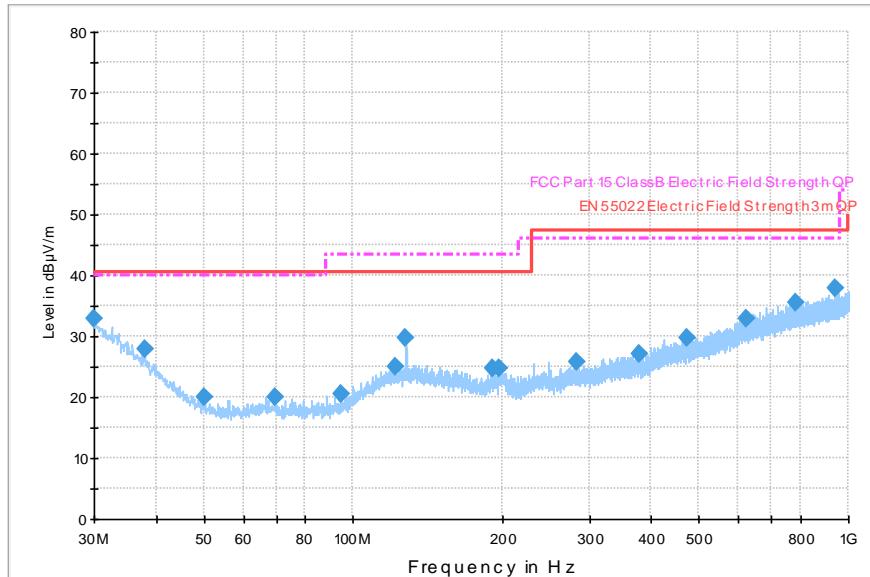
**PLOT 29: Low Channel - Radiated Spurious Emissions (Receive Mode) - 30MHz – 1GHz**



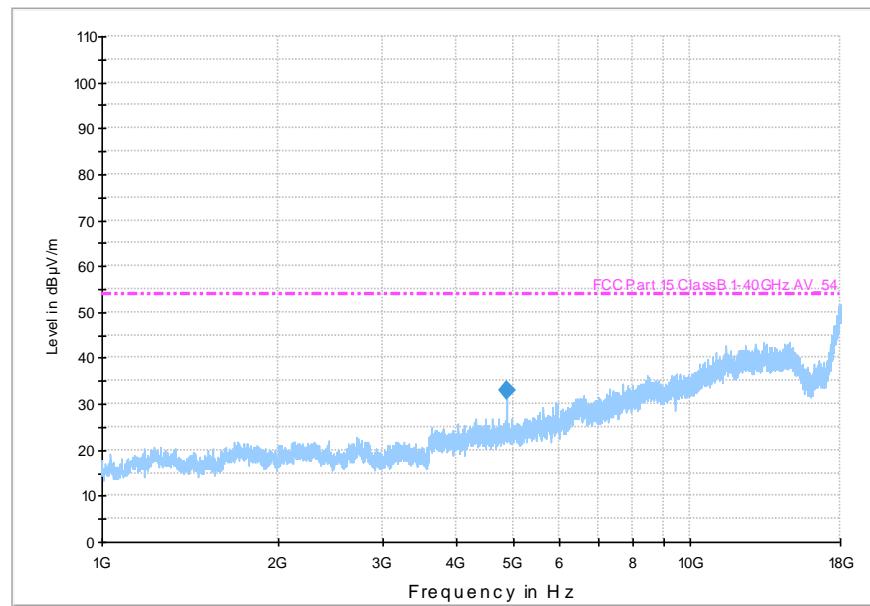
**PLOT 30: Low Channel - Radiated Spurious Emissions (Receive Mode) – 1 - 18GHz**

Note:

1. Emissions marked in Plot 27 were ambient signals. All other emissions below 1GHz were more than 20dB lower than the limit line.
2. Radiated Emissions test was performed from 9 kHz-25GHz. Except the emissions reported above, all other signals were more than 20dB lower than the limit.



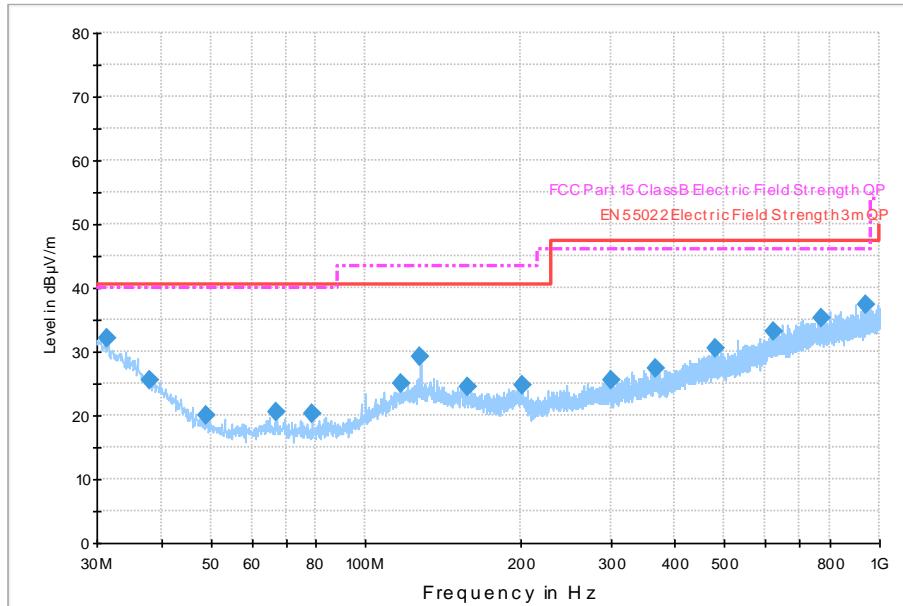
**PLOT 31: Middle Channel - Radiated Spurious Emissions (Receive Mode) - 30MHz – 1GHz**



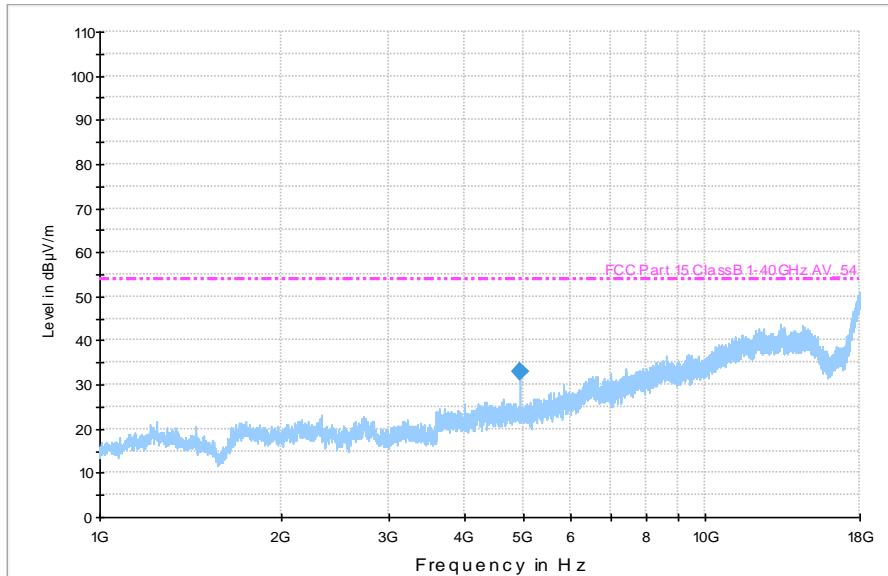
**PLOT 32: Middle Channel - Radiated Spurious Emissions (Receive Mode) – 1-18GHz**

**Note:**

1. Emissions marked in Plot 29 were ambient signals. All other emissions below 1GHz were more than 20dB lower than the limit line.
2. Radiated Emissions test was performed from 9 kHz-25GHz. Except the emissions reported above, all other signals were more than 20dB lower than the limit.



**PLOT 33: High Channel - Radiated Spurious Emissions (Receive Mode) - 30MHz – 1GHz**



**PLOT 34: High Channel - Radiated Spurious Emissions (Receive Mode) – 1 – 18GHz**

Note:

1. Emissions marked in Plot 31 were ambient signals. All other emissions below 1GHz were more than 20dB lower than the limit line.
2. Radiated Emissions test was performed from 9 kHz-25GHz. Except the emissions reported above, all other signals were more than 20dB lower than the limit.

## Part 9 - DUTY CYCLE CORRECTION FACTOR FOR RADIATED EMISSIONS

DATE: March 28 2014

TEST STANDARD: FCC Part 15.35 (d), FCC Part 15.209 (a) and ICES-003 Issue 5

TEST VOLTAGE: 3Vdc

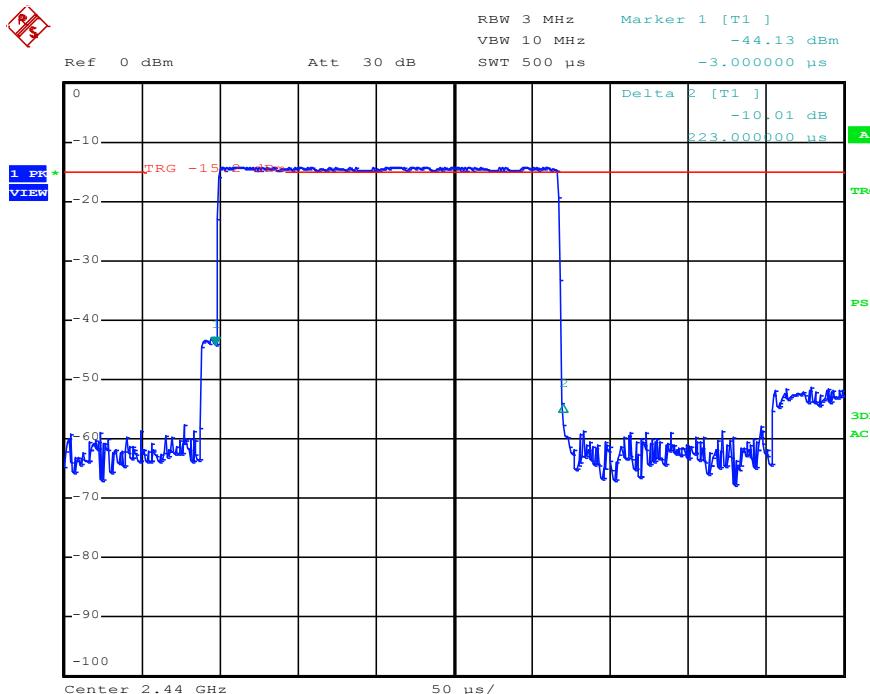
TEST CONDITIONS: Indoor

MEASUREMENT METHOD: The FCC regulations provide an allowance for correcting pulsed transmissions when the limits are expressed in terms of an average, and the average measurement may be derived from the peak pulse amplitude corrected for the duty cycle.

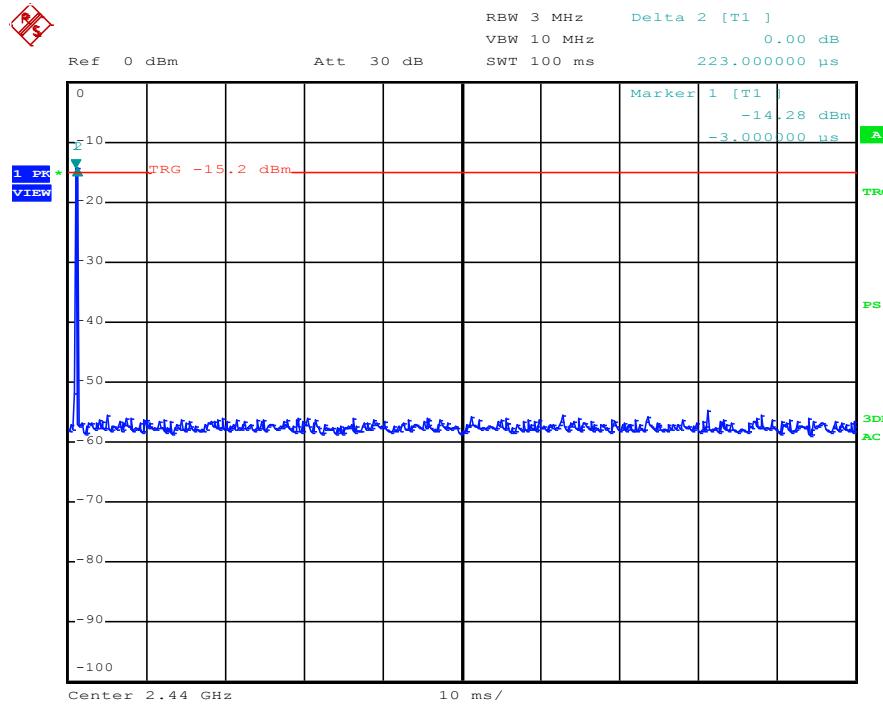
As detailed in 47 CFR Part 15.35(c), the correction factor of a transmission is a 100 ms capture of a characteristic pulse train of "on time". In the event that the pulse train is greater than 100 ms, the 100 ms pulse train captured must include a representation of worst-case "on time" pulses.

TEST SETUP: EUT was set up to operate in its normal mode of operation and communicating with iPad.

MEASUREMENT DATA:



**Plot 35: DWELL TIME: 223μsec**



**PLOT 36: DWELL TIME OVER 100msec**

**RESULTS:** Duty cycle correction factor =  $20 * \log (\text{Dwell Time}/100) = -53.03 \text{ dB}$

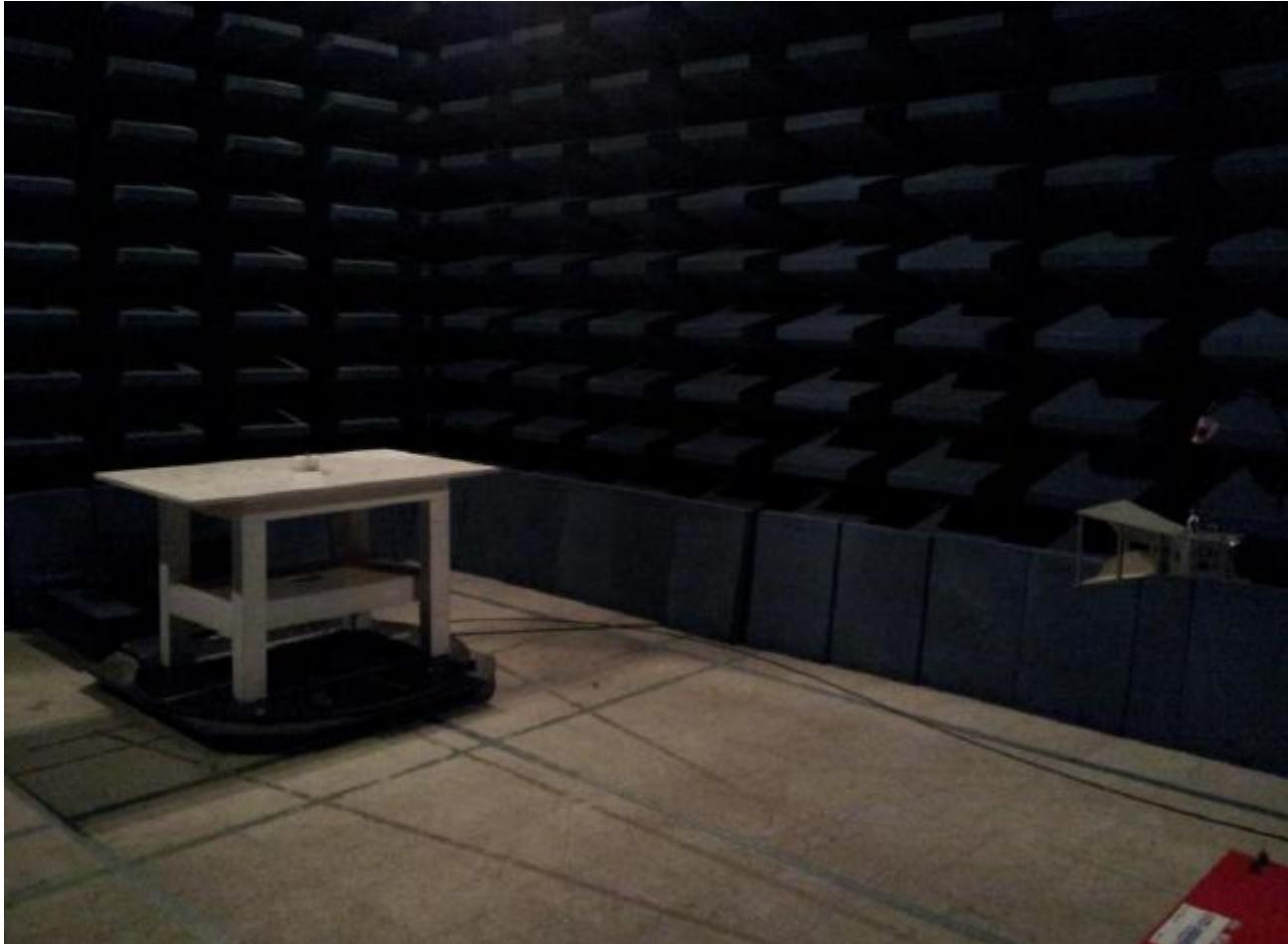
## **Appendix A: EUT photos during the testing**



Radiated Emissions Setup in Semi-Anechoic Chamber



Radiated Emissions Test-Setup 30MHz-1GHz



Radiated Emissions Test-Setup above 1GHz