

# FCC Part 15C

## Measurement and Test Report

For

**Lm technologies Ltd.**

66-68 Hagley Road, Birmingham B16 8PF, West Midlands, United Kingdom

**FCC ID: VVXLM400**

<b>Report Concerns:</b> Original Report	<b>Equipment Type:</b> Bluetooth Module with UART Connection
<b>Model:</b>	<u>LM400</u>
<b>Report No.:</b>	<u>STR08048110I</u>
<b>Test/Witness Engineer:</b>	<i>Susan Su</i>
<b>Test Date:</b>	<u>2007-04-18 to 2007-04-22</u>
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<b>Approved &amp; Authorized By:</b>	 _____ Jandy So / PSQ Manager

Note: This test report is limited to the above client company and the product model only. It may not be duplicated without prior permitted by SEM.Test Compliance Service Co., Ltd.

**TABLE OF CONTENTS**

<b>1. GENERAL INFORMATION.....</b>	<b>3</b>
1.1 PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT).....	3
1.2 TEST STANDARDS.....	3
1.3 RELATED SUBMITTAL(S)/GRANT(S).....	3
1.4 TEST METHODOLOGY.....	4
1.5 TEST FACILITY.....	4
1.6 EUT EXERCISE SOFTWARE.....	4
1.7 ACCESSORIES EQUIPMENT LIST AND DETAILS.....	4
1.8 EUT CABLE LIST AND DETAILS.....	4
<b>2. SUMMARY OF TEST RESULTS.....</b>	<b>5</b>
<b>3. §15.203 - ANTENNA REQUIREMENT.....</b>	<b>6</b>
3.1 STANDARD APPLICABLE.....	6
3.2 TEST RESULT.....	6
<b>4. NUMBER OF HOPPING CHANNELS AND CHANNEL SPACING.....</b>	<b>7</b>
4.1 STANDARD APPLICABLE.....	7
4.2 TEST EQUIPMENT LIST AND DETAILS.....	7
4.3 TEST PROCEDURE.....	7
4.4 ENVIRONMENTAL CONDITIONS.....	7
4.5 SUMMARY OF TEST RESULTS/PLOTS.....	8
<b>5. DWELL TIME OF A HOPPING CHANNEL.....</b>	<b>10</b>
5.1 STANDARD APPLICABLE.....	10
5.2 TEST EQUIPMENT LIST AND DETAILS.....	10
5.3 TEST PROCEDURE.....	10
5.4 ENVIRONMENTAL CONDITIONS.....	10
5.5 SUMMARY OF TEST RESULTS/PLOTS.....	11
<b>6. 20-DB BANDWIDTH.....</b>	<b>13</b>
6.1 STANDARD APPLICABLE.....	13
6.2 TEST EQUIPMENT LIST AND DETAILS.....	13
6.3 TEST PROCEDURE.....	13
6.4 ENVIRONMENTAL CONDITIONS.....	13
6.5 SUMMARY OF TEST RESULTS/PLOTS.....	13
<b>7. POWER OUTPUT.....</b>	<b>16</b>
7.1 STANDARD APPLICABLE.....	16
7.2 TEST EQUIPMENT LIST AND DETAILS.....	16
7.3 TEST PROCEDURE.....	16
7.4 ENVIRONMENTAL CONDITIONS.....	16
7.5 SUMMARY OF TEST RESULTS/PLOTS.....	16
<b>8. FIELD STRENGTH OF SPURIOUS EMISSIONS.....</b>	<b>17</b>
8.1 MEASUREMENT UNCERTAINTY.....	17
8.2 STANDARD APPLICABLE.....	17
8.3 TEST EQUIPMENT LIST AND DETAILS.....	18
8.4 TEST PROCEDURE.....	18
8.5 CORRECTED AMPLITUDE & MARGIN CALCULATION.....	19
8.6 ENVIRONMENTAL CONDITIONS.....	19
8.7 SUMMARY OF TEST RESULTS/PLOTS.....	19
<b>9. OUT OF BAND EMISSIONS.....</b>	<b>24</b>
9.1 STANDARD APPLICABLE.....	24
9.2 TEST EQUIPMENT LIST AND DETAILS.....	24
9.3 TEST PROCEDURE.....	24
9.4 ENVIRONMENTAL CONDITIONS.....	24
9.5 SUMMARY OF TEST RESULTS/PLOTS.....	25

## 1. GENERAL INFORMATION

### 1.1 Product Description for Equipment Under Test (EUT)

#### Client Information

Applicant: Lm technologies Ltd.  
 Address of applicant: 66-68 Hagley Road, Birmingham B16 8PF, West Midlands, United Kingdom

Manufacturer: Lm technologies Ltd.  
 Address of manufacturer: 26D Guosheng Tai, Guozhan Block, Buji Town, Shenzhen, China

#### General Description of E.U.T

Items	Description
EUT Description:	Bluetooth Module with UART Connection
Trade Name:	LM TECH
Model No.:	LM400
Rated Voltage:	DC 3.3V
Max. Output Power	-6~4 dBm
Frequency range:	2402-2480MHz
Number of channels:	79
Channel Separation:	1MHz
Type of Antenna:	Integral Antenna
Size:	3.10x2.70x0.02cm

*Note: The test data is gathered from a production sample, provided by the manufacturer.*

### 1.2 Test Standards

The following report is prepared on behalf of Lm technologies Ltd. in accordance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 of the Federal Communication Commissions rules.

The objective is to determine compliance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 of the Federal Communication Commissions rules.

**Maintenance of compliance** is the responsibility of the manufacturer. Any modification of the product, which result in lowering the emission, should be checked to ensure compliance has been maintained.

### 1.3 Related Submittal(s)/Grant(s)

No Related Submittal(s).

## 1.4 Test Methodology

All measurements contained in this report were conducted with ANSI C63.4-2003, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz.

The equipment under test (EUT) was configured to measure its highest possible emission level. The test modes were adapted with Low Channel, Middle Channel and High Channel, accordingly in reference to the Operating Instructions.

## 1.5 Test Facility

The Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in files which the Registration No.: **994117**. Measurement required was performed at laboratory of SEM. Test Compliance Service Co., Ltd. at 3/F, Jinbao Commerce Building, Xin'an Fanshen Road, Bao'an District, Shenzhen, P.R.C.

## 1.6 EUT Exercise Software

The EUT exercise program used during the testing was designed to exercise the system components.

## 1.7 Accessories Equipment List and Details

Manufacturer	Description	Model	Serial Number
IBM	Notebook	R51e	LV14893

## 1.8 EUT Cable List and Details

Cable Description	Length (M)	Shielded/Unshielded	With Core/Without Core
/	/	/	/

## 2. SUMMARY OF TEST RESULTS

FCC RULES	DESCRIPTION OF TEST	RESULT
§ 15.203; § 15.247(b)(4)(i)	Antenna Requirement	Compliant
§ 15.247(a)(1)(iii)	Quantity of Hopping Channel	Compliant
§ 15.247(a)(1)	Channel Separation	Compliant
§ 15.247(a)(1)(iii)	Time of Occupancy (Dwell time)	Compliant
§ 15.247(a)	20dB Bandwidth	Compliant
§ 15.247(b)(1)	Power Output	Compliant
§ 15.209(a)(f)	Radiated Emission	Compliant
§ 15.247(c)	Band edge	Compliant

### **3. §15.203 - ANTENNA REQUIREMENT**

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#### **3.1 Standard Applicable**

According to FCC 15.203, 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.

#### **3.2 Test Result**

This product has a permanent antenna, fulfill the requirement of this section.

## 4. NUMBER OF HOPPING CHANNELS AND CHANNEL SPACING

### 4.1 Standard Applicable

According to FCC 15.247(a)(1), the number of hops is 79 hops at a separation of 1 MHz, the requirement in the 2400 – 2483.5 MHz band is a minimum of 75 hops.

### 4.2 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Cal. Date	Due. Date
ROHDE&SCHWARZ	Spectrum Analyzer	FSEA20	DE25181	2008-01-25	2009-01-24
SCHWARZBECK	Trilog Broadband Antenna	VULB9163	9163-333	2008-01-25	2009-01-24

**Statement of Traceability:** All calibrations have been performed per the NVLAP requirements traceable to the NIST.

### 4.3 Test Procedure

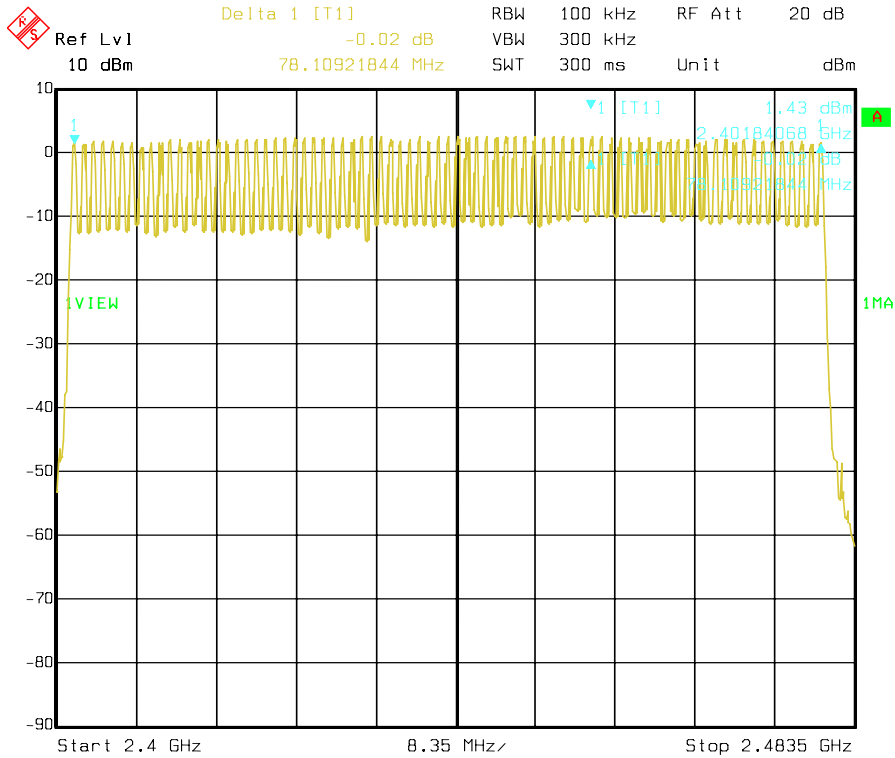
Set the Lowest channel to the Highest Channel, observed the band of 2400MHz to 2438.5MHz, than count it out the number of channels for comparing with the FCC rules. Adjust channel spacing can be read by adjusting the Analyzer SPAN.

### 4.4 Environmental Conditions

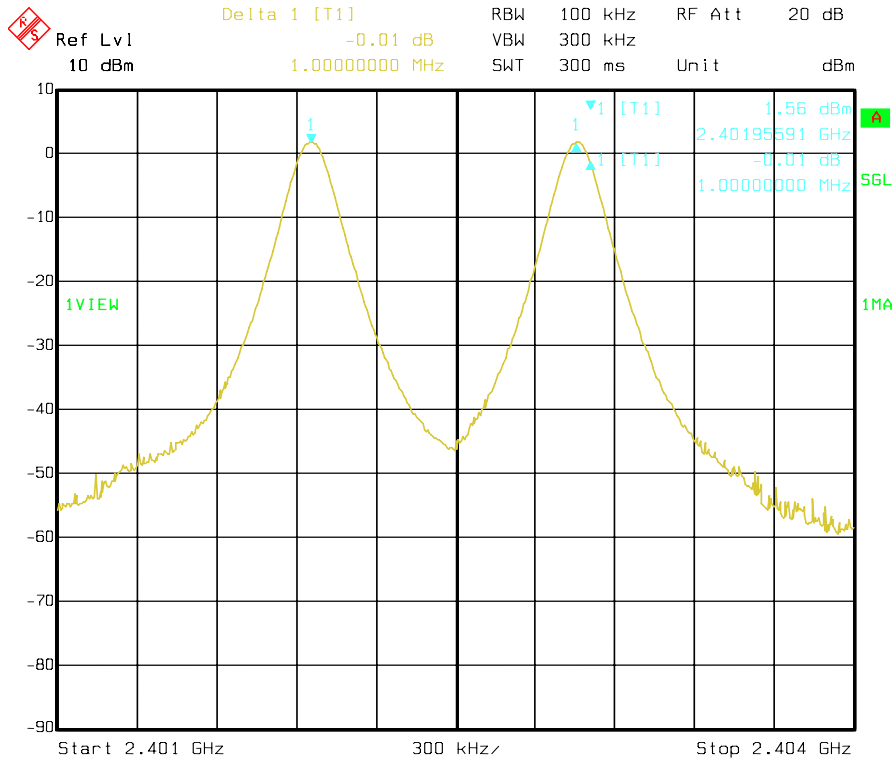
Temperature:	25 °C
Relative Humidity:	54%
ATM Pressure:	1011 mbar

### 4.5 Summary of Test Results/Plots

No. of Channel=79

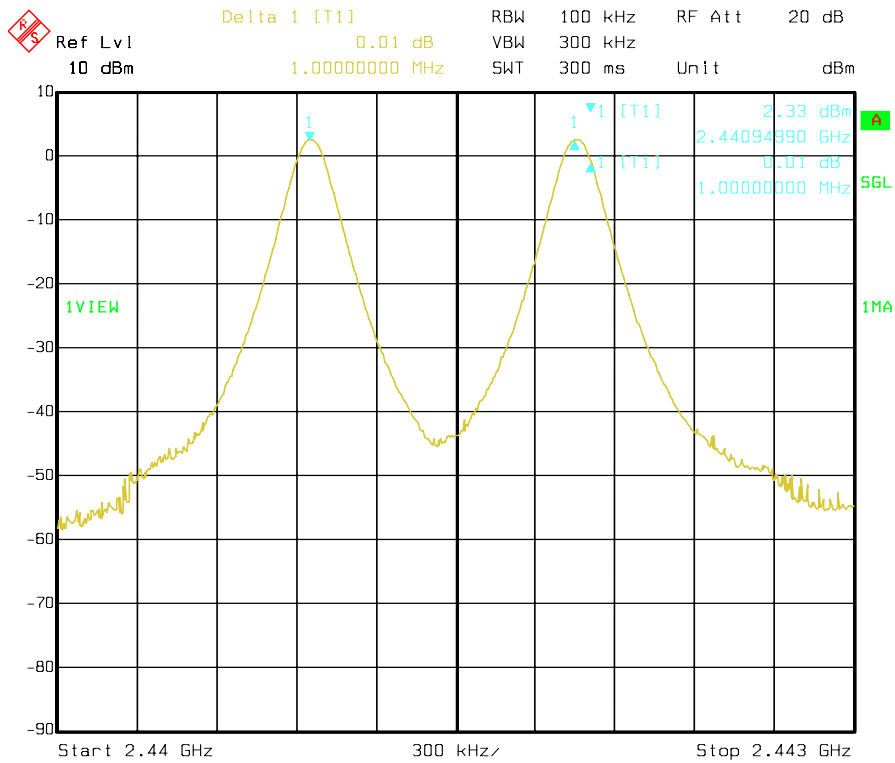


Channel Spacing (Low CH=1MHz)

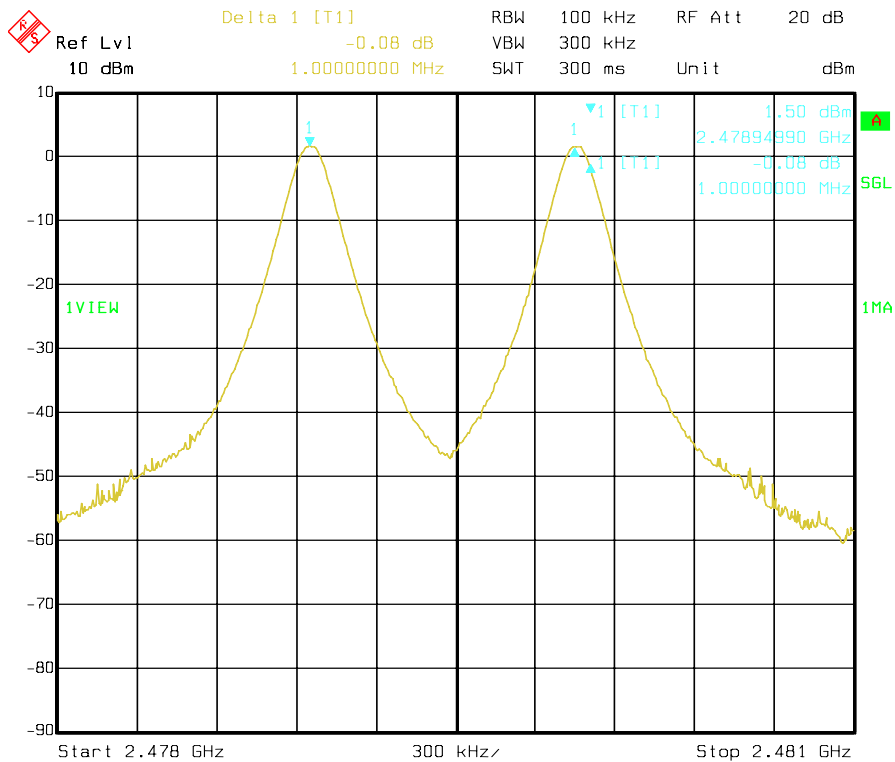




Channel Spacing (Middle CH=1MHz)



Channel Spacing (High CH=1MHz)



## 5. DWELL TIME OF A HOPPING CHANNEL

### 5.1 Standard Applicable

According to 15.247(a)(1)(iii), Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

### 5.2 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Cal. Date	Due. Date
ROHDE&SCHWARZ	Spectrum Analyzer	FSEA20	DE25181	2008-01-25	2009-01-24
SCHWARZBECK	Trilog Broadband Antenna	VULB9163	9163-333	2008-01-25	2009-01-24

**Statement of Traceability:** All calibrations have been performed per the NVLAP requirements traceable to the NIST.

### 5.3 Test Procedure

1. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
2. Set center frequency of spectrum analyzer = operating frequency.
3. Set the spectrum analyzer as RBW, VBW=100KHz, Span = 0Hz.
4. Repeat above procedures until all frequency measured was complete.

### 5.4 Environmental Conditions

Temperature:	20° C
Relative Humidity:	54%
ATM Pressure:	1011 mbar

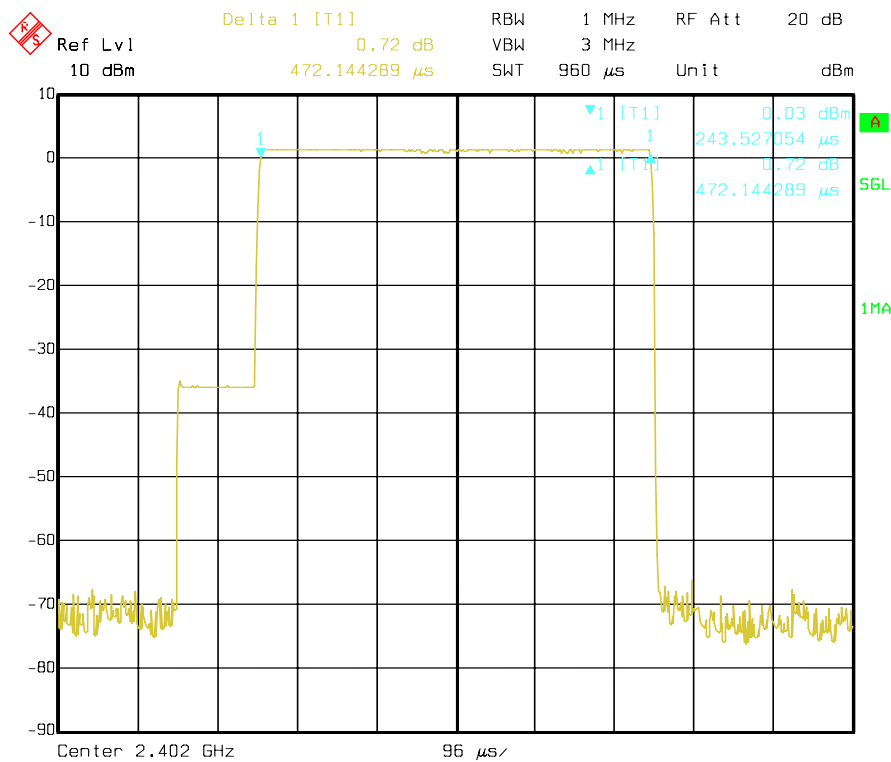
### 5.5 Summary of Test Results/Plots

The dwell time within a 31.6 second period in data mode is independent from the packet type (packet length). The calculation for a 31.6 second period is as follows:

$$\text{Dwell time} = \text{time slot length} * \text{hop rate} / \text{number of hopping channels} * 31.6\text{s}$$

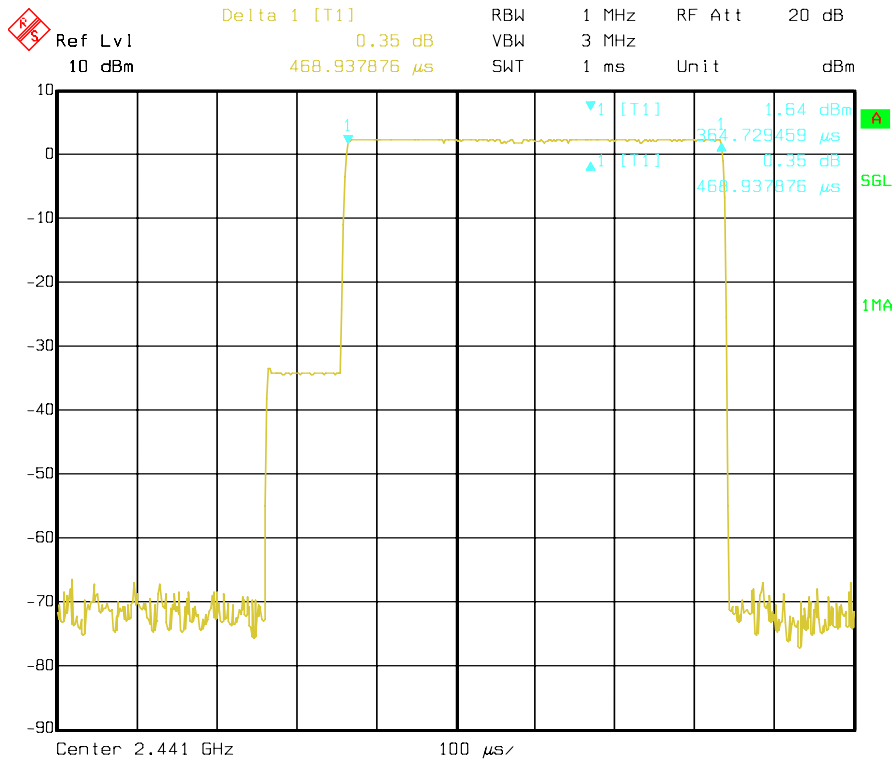
Test data is corrected with the worse case, which the packet length is DH1.

CH Low:



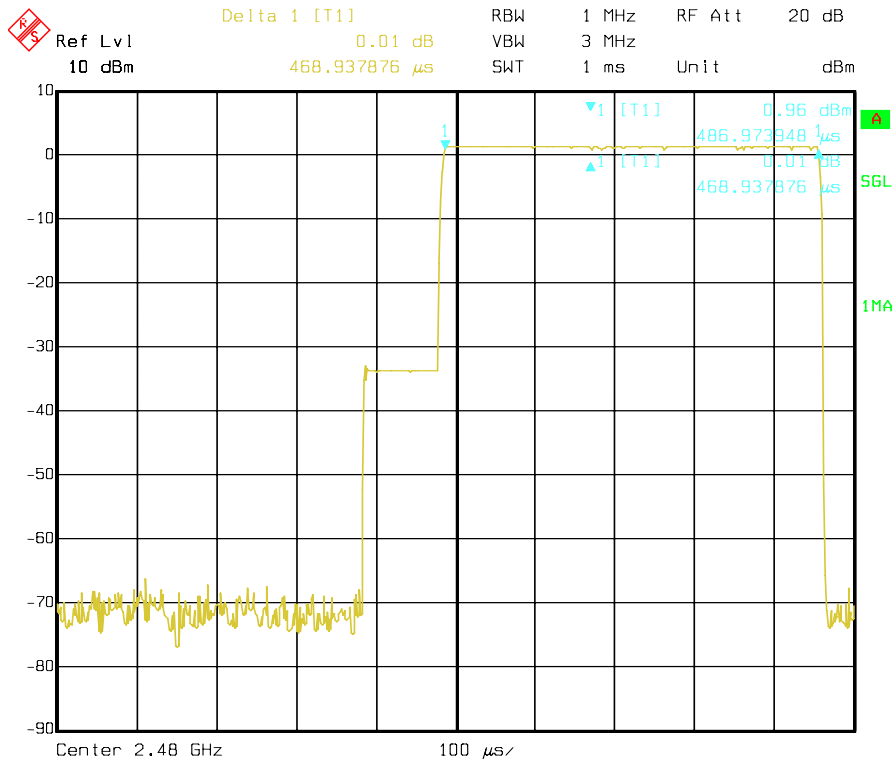
$$\text{DH1 time slot} = 0.472 \text{ (ms)} * (1600/(79)) * 31.6 = 302.08 \text{ (ms)} < 400 \text{ (ms)}$$

CH Mid:



DH1 time slot = 0.469 (ms) \* (1600/(79)) \* 31.6 = 300.16 (ms) < 400 (ms)

CH High:



DH1 time slot = 0.469 (ms) \* (1600/(79)) \* 31.6 = 300.16 (ms) < 400 (ms)

## 6. 20-dB BANDWIDTH

### 6.1 Standard Applicable

According to 15.247(a)(1)(iii). For frequency hopping systems operating in the 2400MHz-2483.5 MHz no limit for 20dB bandwidth.

### 6.2 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Cal. Date	Due. Date
ROHDE&SCHWARZ	Spectrum Analyzer	FSEA20	DE25181	2008-01-25	2009-01-24
SCHWARZBECK	Trilog Broadband Antenna	VULB9163	9163-333	2008-01-25	2009-01-24

**Statement of Traceability:** All calibrations have been performed per the NVLAP requirements traceable to the NIST.

### 6.3 Test Procedure

1. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
2. Set center frequency of spectrum analyzer = operating frequency.
3. The spectrum analyzer as RBW=10KHz (1 % of Bandwidth.), Sweep=auto
4. Mark the peak frequency and -20dB (upper and lower) frequency.

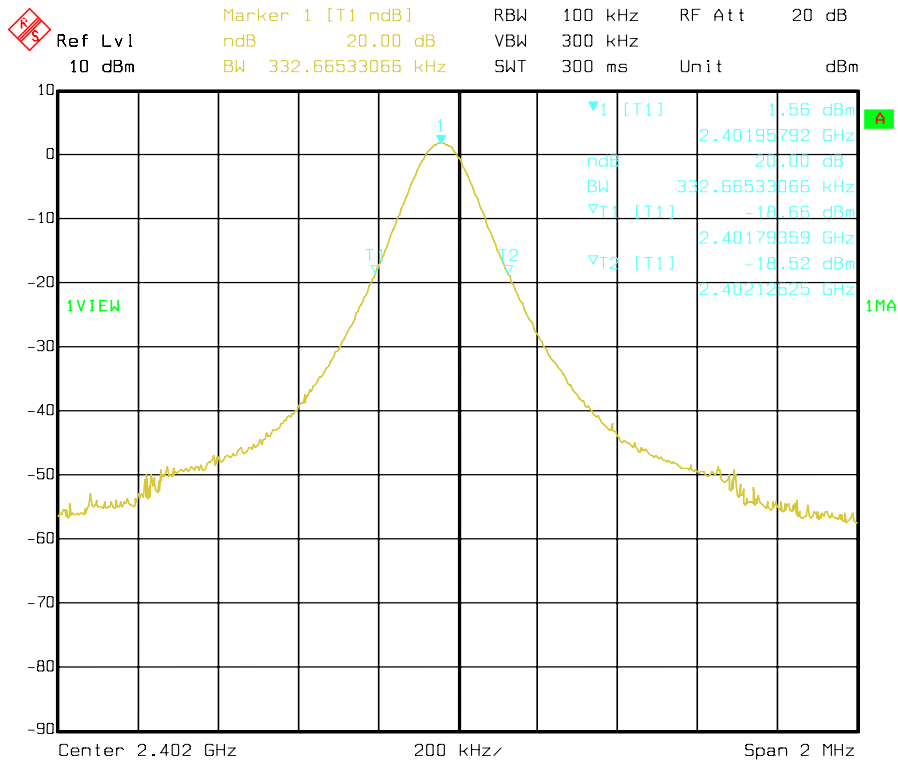
### 6.4 Environmental Conditions

Temperature:	24° C
Relative Humidity:	53%
ATM Pressure:	1018 mbar

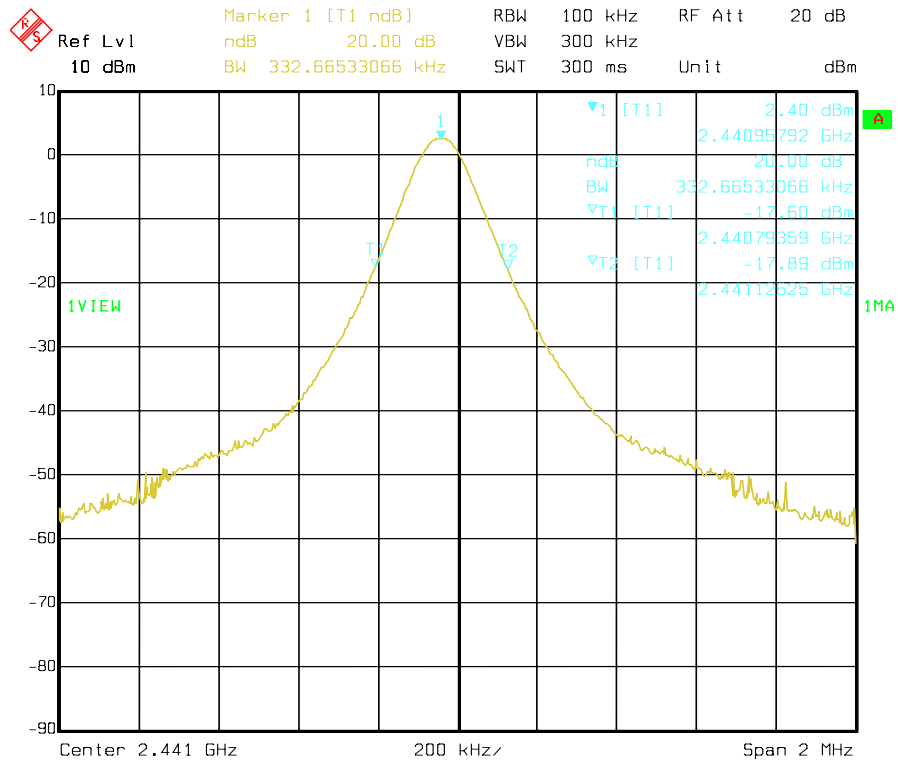
### 6.5 Summary of Test Results/Plots

Frequency MHz	20 dB Bandwidth kHz	Limit dB
2402	332.665	/
2441	332.665	/
2480	328.657	/

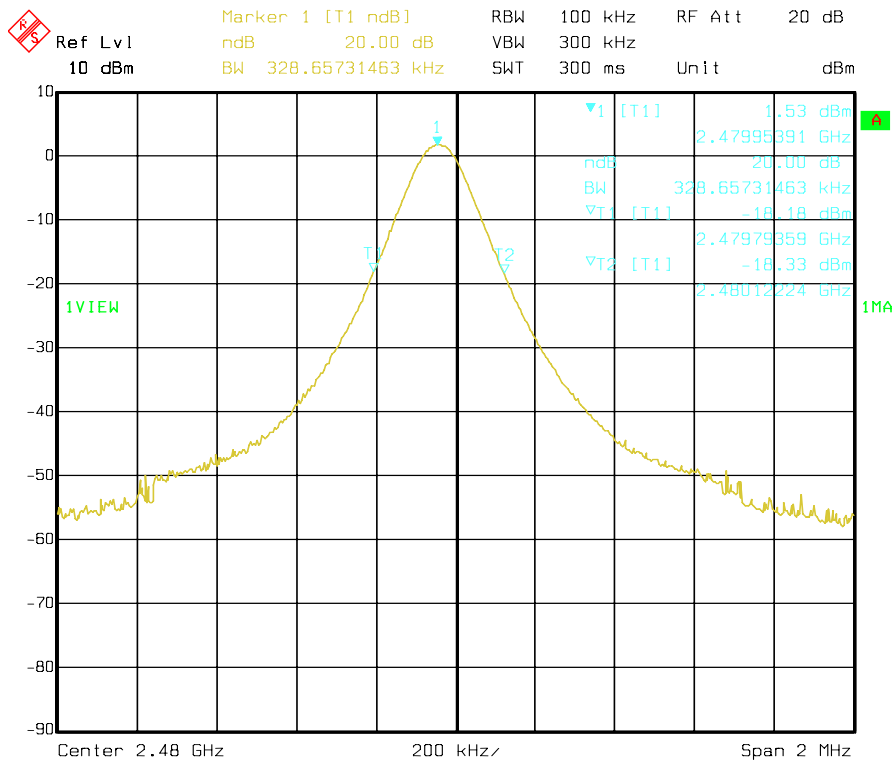
CH Low:



CH Mid:



CH High:



## 7. POWER OUTPUT

### 7.1 Standard Applicable

According to 15.247(b)(1). For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

### 7.2 Test Equipment List and Details

Description	Manufacturer	Model	Serial Number	Cal. Date	Due. Date
Spectrum Analyzer	ROHDE&SCHWARZ	FSEA20	DE25181	2008-01-25	2009-01-24
Positioning Controller	C&C	CC-C-1F	N/A	2008-01-25	2009-01-24
Trilog Broadband Antenna	SCHWARZBECK	VULB9163	9163-333	2008-01-25	2009-01-24
Horn Antenna	SCHWARZBECK	BBHX 9120	9120-426	2008-01-25	2009-01-24
RF Switch	EM	EMSW18	SW060023	2008-01-25	2009-01-24
Amplifier	Agilent	8447F	3113A06717	2008-01-25	2009-01-24
Coaxial Cable	SCHWARZBECK	AK9513	9513-10	2008-01-25	2009-01-24
EMI Test Receiver	ROHDE&SCHWARZ	ESPI	25498514	2008-01-25	2009-01-24

**Statement of Traceability:** All calibrations have been performed per the NVLAP requirements traceable to the NIST.

### 7.3 Test Procedure

The device under test has an integral antenna and the power was measured on a radiated basis.

### 7.4 Environmental Conditions

Temperature:	24 °C
Relative Humidity:	55%
ATM Pressure:	1011 mbar

### 7.5 Summary of Test Results/Plots

2402 MHz 1.3032 mW EIRP

2441 MHz 1.5885 mW EIRP

2480 MHz 1.3032 mW EIRP

Note: The Antenna Gain is under considering.



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## 8. FIELD STRENGTH OF SPURIOUS EMISSIONS

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### 8.1 Measurement Uncertainty

Based on NIS 81, The Treatment of Uncertainty in EMC Measurements, the best estimate of the uncertainty of a radiation emissions measurement is  $\pm 3.0$  dB.

### 8.2 Standard Applicable

According to §15.247(c), 15.205 15.209(b) & 15.35 (b), the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Section 15.209:

30 - 88 MHz 40 dBuV/m @3M

88 -216 MHz 43.5 dBuV/m @3M

216 -960 MHz 46 dBuV/m @3M

Above 960 MHz 54dBuV/m @3M

The emission limit in this paragraph is based on measurement instrumentation employing an average detector. The provisions in §15.35 for limiting peak emissions apply.

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 RADIATED EMISSION LIMITS IN 15.209,WHICHEVER IS THE LESSER ATTENUATION.

Emissions that fall in the restricted bands (15.205) must be less than 54dBuV/m otherwise the spurious and harmonics must be attenuated by at least 20dB.

### 8.3 Test Equipment List and Details

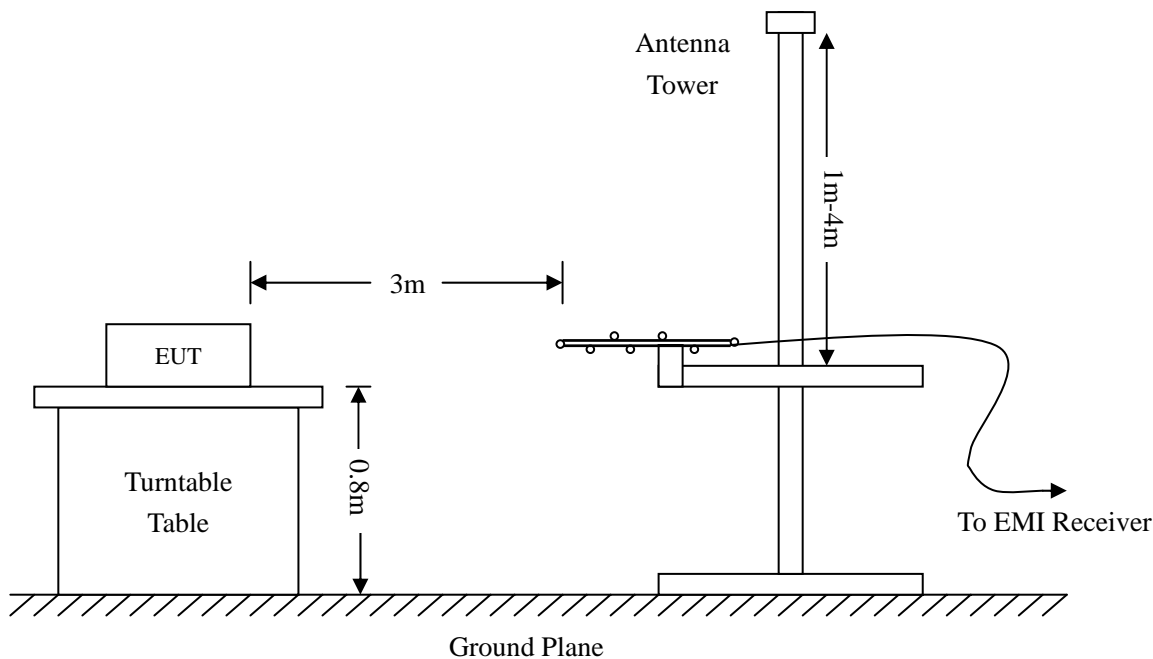
Description	Manufacturer	Model	Serial Number	Cal. Date	Due. Date
Spectrum Analyzer	ROHDE&SCHWARZ	FSEA20	DE25181	2008-01-25	2009-01-24
Positioning Controller	C&C	CC-C-1F	N/A	2008-01-25	2009-01-24
Trilog Broadband Antenna	SCHWARZBECK	VULB9163	9163-333	2008-01-25	2009-01-24
Horn Antenna	SCHWARZBECK	BBHX 9120	9120-426	2008-01-25	2009-01-24
RF Switch	EM	EMSW18	SW060023	2008-01-25	2009-01-24
Amplifier	Agilent	8447F	3113A06717	2008-01-25	2009-01-24
Coaxial Cable	SCHWARZBECK	AK9513	9513-10	2008-01-25	2009-01-24
EMI Test Receiver	ROHDE&SCHWARZ	ESPI	25498514	2008-01-25	2009-01-24

**Statement of Traceability:** All calibrations have been performed per the NVLAP requirements traceable to the NIST.

### 8.4 Test Procedure

The setup of EUT is according with per ANSI C63.4-2003 measurement procedure. The specification used was with the FCC Part 15.205 15.247(a) and FCC Part 15.209 Limit.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle. The spacing between the peripherals was 10 cm.



## 8.5 Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and the Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

$$\text{Corr. Ampl.} = \text{Indicated Reading} + \text{Ant. Factor} + \text{Cable Loss} - \text{Ampl. Gain}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of  $-6\text{dB}\mu\text{V}$  means the emission is  $6\text{dB}\mu\text{V}$  below the maximum limit for Class B. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Corr. Ampl.} - \text{FCC Part 15 Limit}$$

## 8.6 Environmental Conditions

Temperature:	25 °C
Relative Humidity:	52%
ATM Pressure:	1012 mbar

## 8.7 Summary of Test Results/Plots

According to the data below, the FCC Part 15.205, 15.209 and 15.247 standards, and had the worst margin of:

**$-5.48\text{ dB}\mu\text{V}$  at  $48.0392\text{ MHz}$  in the **Vertical** polarization for **Middle Channel, 30 MHz to 25 GHz, 3Meters****

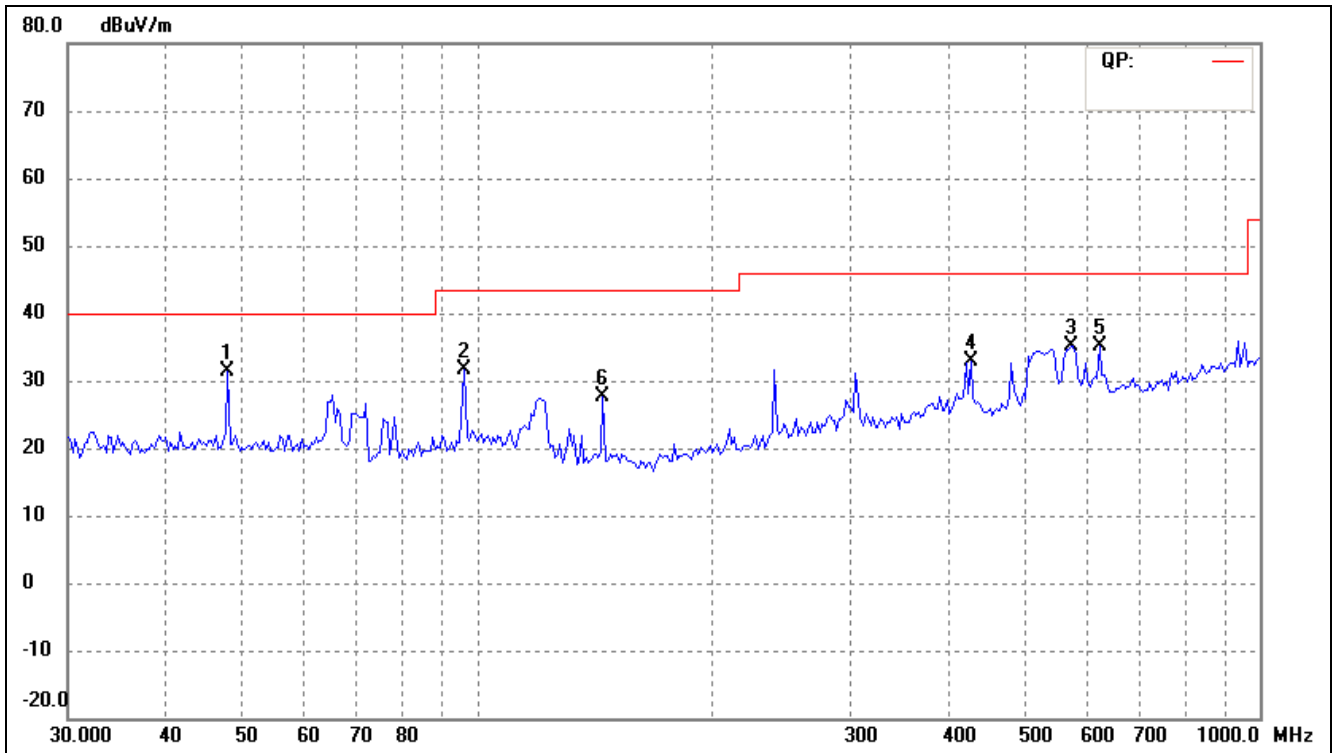
Frequency MHz	Detector	Meter Reading dBuV	Direction Degree	Polar H / V	Antenna Loss dB	Cable loss dB	Amplifier dB	Correction Amplitude dBuV/m	Limit dBuV/m	Margin dB
Low Channel (1G to 25GHz)										
4804.0	AV	45.5	66	H	34.1	5.2	33.0	41.5	54	-12.5
4804.0	AV	42.7	135	V	34.1	5.2	33.0	38.7	54	-15.3
7206.0	AV	40.7	45	H	37.4	6.1	33.5	37.1	54	-16.9
7206.0	AV	38.4	60	V	37.4	6.1	33.5	34.8	54	-19.2
2402.0	AV	89.0	45	H	29.1	3.7	34.0	82.5		(Fund.)
2402.0	AV	86.3	98	V	29.1	3.7	34.0	79.8		(Fund.)
4804.0	PK	29.0	56	H	37.4	6.1	33.5	48.3	74	-25.7
4804.0	PK	31.5	60	V	34.1	5.2	33.0	46.6	74	-27.4
7206.0	PK	24.8	266	H	34.1	5.2	33.0	39.9	74	-34.1
7206.0	PK	19.2	185	V	37.4	6.1	33.5	38.5	74	-35.5
2402.0	PK	77.6	90	H	29.1	3.7	34.0	86.2		(Fund.)
2402.0	PK	73.8	43	V	29.1	3.7	34.0	82.4		(Fund.)
Middle Channel (1G to 25GHz)										
4882.0	AV	46.3	39	H	34.1	5.2	33.0	42.3	54	-11.7
4882.0	AV	44.7	139	V	34.1	5.2	33.0	40.7	54	-13.3
7323.0	AV	42.0	42	H	37.4	6.1	33.5	38.4	54	-15.6
7323.0	AV	39.4	60	V	37.4	6.1	33.5	35.8	54	-18.2
2441.0	AV	90.0	64	H	29.1	3.7	34.0	83.5		(Fund.)
2441.0	AV	86.4	84	V	29.1	3.7	34.0	79.9		(Fund.)
4882.0	PK	25.9	237	H	37.4	6.1	33.5	45.2	74	-28.8
4882.0	PK	29.0	352	V	37.4	6.1	33.5	44.1	74	-29.9
7323.0	PK	30.7	264	H	34.1	5.2	33.0	45.8	74	-28.2
7323.0	PK	26.7	188	V	34.1	5.2	33.0	46.0	74	-28.0
2441.0	PK	75.6	50	H	29.1	3.7	34.0	84.2		(Fund.)
2441.0	PK	71.9	49	V	29.1	3.7	34.0	80.5		(Fund.)

High Channel (1G to 25GHz)										
4960.0	AV	42.2	26	H	37.4	6.1	33.5	38.2	54	-15.8
4960.0	AV	40.1	139	V	37.4	6.1	33.5	36.1	54	-17.9
7440.0	AV	44.7	35	H	34.1	5.2	33.0	41.1	54	-12.9
7440.0	AV	42.6	67	V	34.1	5.2	33.0	39.0	54	-15.0
2480.0	AV	88.9	42	H	29.1	3.7	34.0	82.4		(Fund.)
2480.0	AV	85.8	48	V	29.1	3.7	34.0	79.3		(Fund.)
4960.0	PK	24.2	50	H	34.1	5.2	33.0	43.5	74	-30.5
4960.0	PK	26.7	20	V	34.1	5.2	33.0	41.8	74	-32.2
7440.0	PK	25.2	269	H	37.4	6.1	33.5	44.3	74	-29.7
7440.0	PK	20.0	185	V	37.4	6.1	33.5	42.3	74	-31.7
2480.0	PK	76.4	93	H	29.1	3.7	34.0	85.0		(Fund.)
2480.0	PK	72.7	43	V	29.1	3.7	34.0	81.3		(Fund.)

Note: Testing is carried out with frequency rang 30MHz to the tenth harmonics, which above 5<sup>th</sup> Harmonics is close to the noise base even antenna close up to 1meter distance according the measurement of ANSI C63.4.

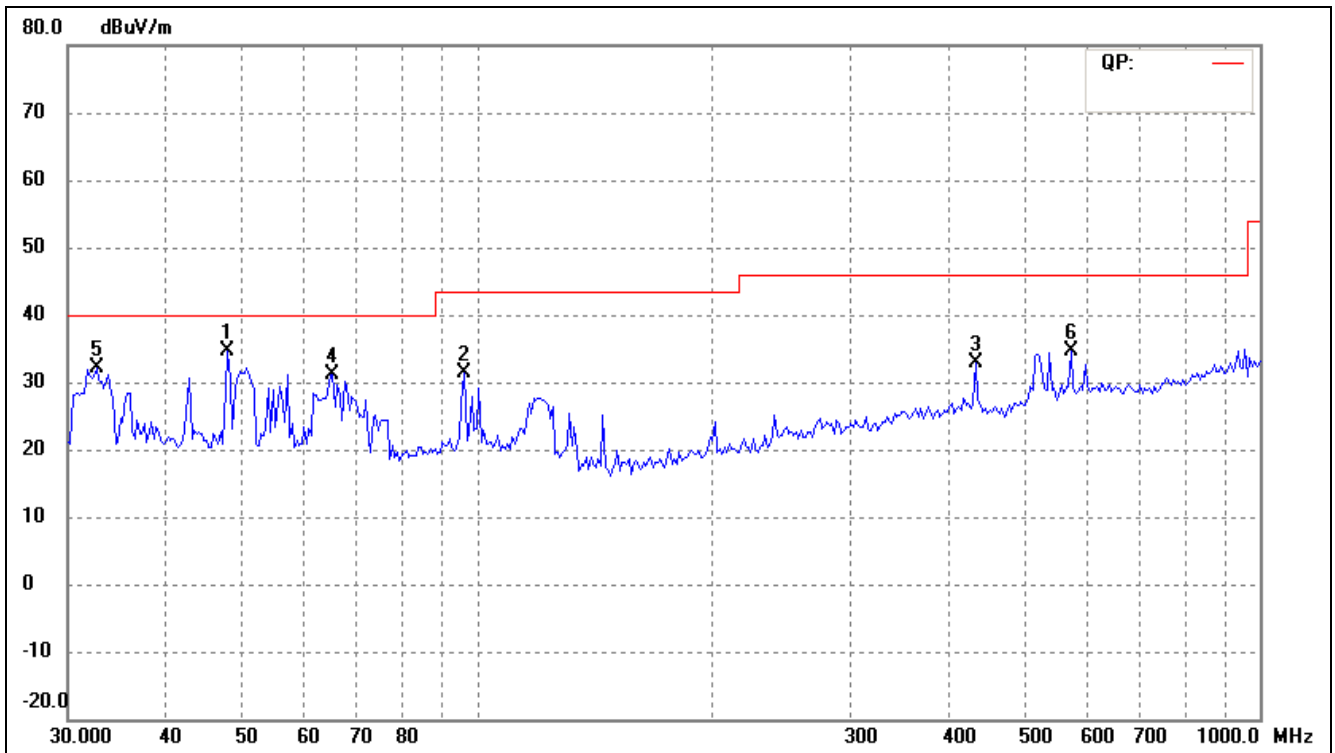
From 30 MHz to 1 GHz

Horizontal



No.	Frequency (MHz)	Reading (dBuV/m)	Correct Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Degree ( ° )	Height (m)	Remark
1	48.0392	23.25	8.07	31.32	40.00	-8.68	32	1.0	peak
2	96.3230	23.35	8.16	31.51	43.50	-11.99	60	2.0	peak
3	573.9882	21.48	13.72	35.20	46.00	-10.80	26	2.0	peak
4	427.2920	21.22	11.66	32.88	46.00	-13.12	358	1.0	peak
5	624.4897	20.95	14.25	35.20	46.00	-10.80	0	1.0	peak
6	144.7899	23.52	4.01	27.53	43.50	-15.97	30	1.0	peak

Vertical



No.	Frequency (MHz)	Reading (dBuV/m)	Correct Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Degree ( ° )	Height (m)	Remark
1	48.0392	26.45	8.07	34.52	40.00	-5.48	348	2.0	peak
2	96.3230	23.30	8.16	31.46	43.50	-12.04	27	2.0	peak
3	433.3397	20.89	11.91	32.80	46.00	-13.20	90	1.5	peak
4	65.4452	25.83	5.40	31.23	40.00	-8.77	5	1.0	peak
5	32.6395	25.41	6.77	32.18	40.00	-7.82	0	1.0	peak
6	573.9882	20.84	13.72	34.56	46.00	-11.44	37	1.0	peak

## 9. OUT OF BAND EMISSIONS

### 9.1 Standard Applicable

According to §15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, 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, provided the transmitter demonstrates compliance with the peak conducted power limits.

### 9.2 Test Equipment List and Details

Description	Manufacturer	Model	Serial Number	Cal. Date	Due. Date
Spectrum Analyzer	ROHDE&SCHWARZ	FSEA20	DE25181	2008-01-25	2009-01-24
Positioning Controller	C&C	CC-C-1F	N/A	2008-01-25	2009-01-24
Trilog Broadband Antenna	SCHWARZBECK	VULB9163	9163-333	2008-01-25	2009-01-24
Horn Antenna	SCHWARZBECK	BBHX 9120	9120-426	2008-01-25	2009-01-24
RF Switch	EM	EMSW18	SW060023	2008-01-25	2009-01-24
Amplifier	Agilent	8447F	3113A06717	2008-01-25	2009-01-24
Coaxial Cable	SCHWARZBECK	AK9513	9513-10	2008-01-25	2009-01-24
EMI Test Receiver	ROHDE&SCHWARZ	ESPI	25498514	2008-01-25	2009-01-24

**Statement of Traceability:** All calibrations have been performed per the NVLAP requirements traceable to the NIST.

### 9.3 Test Procedure

1. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
2. Set the spectrum analyzer as RBW, VBW=100KHz, Span=25MHz, Sweep = auto
3. Set the Lowest and Highest Transmitting Channel, observed the outside band of 2400MHz to 2438.5MHz, then mark the higher-level emission for comparing with the FCC rules.

### 9.4 Environmental Conditions

Temperature:	21° C
Relative Humidity:	54%
ATM Pressure:	1011 mbar

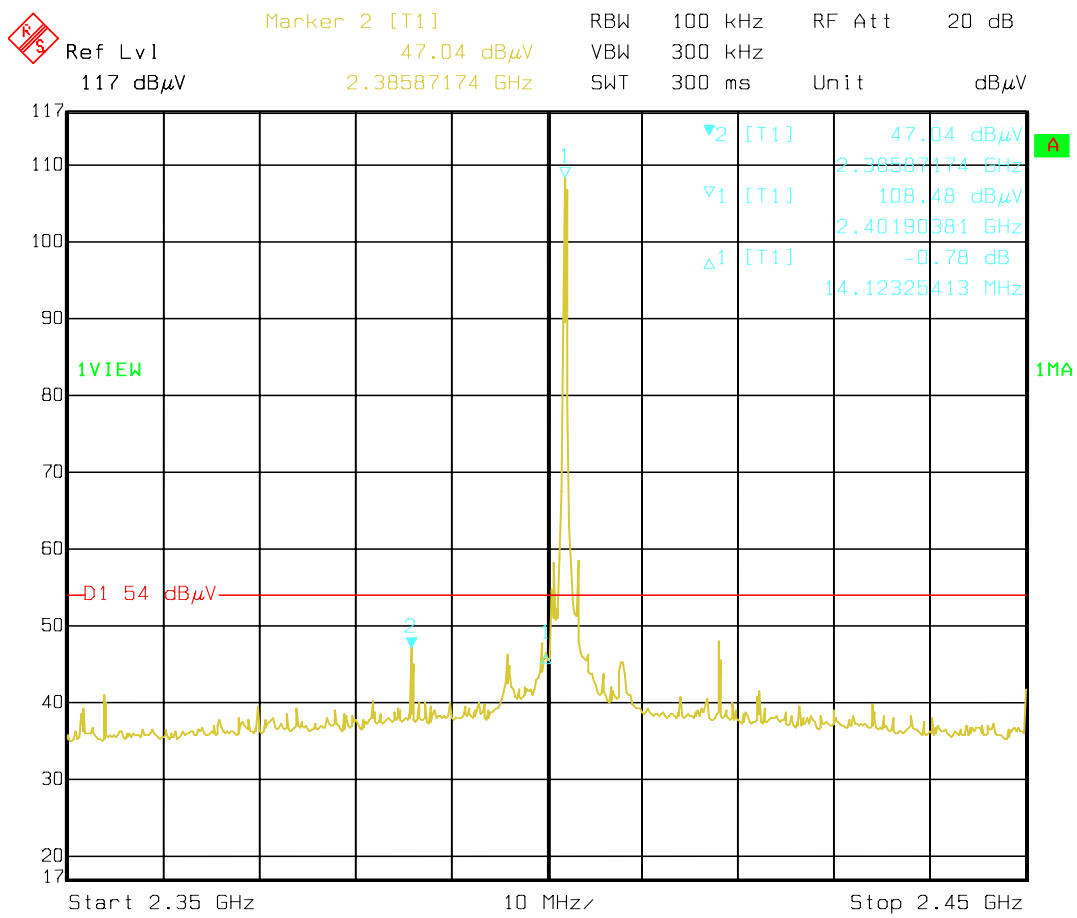


### 9.5 Summary of Test Results/Plots

Frequency MHz	Limit dB	Result
Low Edge	<54dBuv	Pass
High Edge	<54dBuv	Pass

The edge emissions are below the FCC 15.209 Limits. Please refer to the test plots below.

#### Lowest Bandedge



Highest Bandedge

