

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART C REQUIREMENT OF

Product Name: BLE/ Wi-Fi Intelligent Sensor Gateway
Brand Name: Advantech
Model No.: WISE-2400, WISE-2400XXXXXXXXXXXXXX (where "X" may be any alphanumeric character, “-“ or blank)
Model Difference: For market different
FCC ID: M82-WISE-2400
Report No.: E2/2016/50019
Issue Date: Jun. 03, 2016
FCC Rule Part: §15.247, Cat: DTS
Advantech Co., Ltd
Prepared for: No. 1, Alley 20, Lane 26, Rueiguang Road, Neihu District, Taipei 11491, Taiwan, R.O.C.
SGS Taiwan Ltd.
Prepared by: Electronics & Communication Laboratory
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VERIFICATION OF COMPLIANCE

Applicant: Advantech Co., Ltd
No. 1, Alley 20, Lane 26, Rueiguang Road, Neihu District, Taipei
11491, Taiwan, R.O.C.

Product Name: BLE/ Wi-Fi Intelligent Sensor Gateway

Brand Name: Advantech

Model No.: WISE-2400, WISE-2400XXXXXXXXXXXXXX
(where "X" may be any alphanumeric character, “-“ or blank)

Model Difference: For market different

FCC ID: M82-WISE-2400

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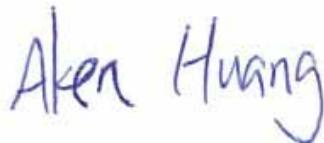
Date of test: May. 11, 2016 ~ Jun. 03, 2016

Date of EUT Received: May. 11, 2016

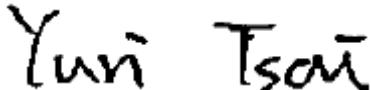
We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Electronics & Communication Laboratory. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT tested as described in this report is in compliance with conducted and radiated emission limits.

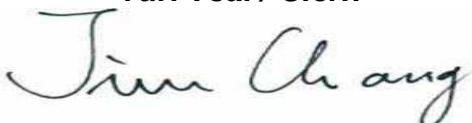
The test results of this report relate only to the tested sample identified in this report.

Test By:**Date**

Jun. 03, 2016

Aken Huang/ Engineer**Prepared By:****Date**

Jun. 03, 2016

Yuri Tsai / Clerk**Approved By:****Date**

Jun. 03, 2016

Jim Chang / Asst. Manager

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Revision History

Report Number	Revision	Description	Issue Date
E2/2016/50019	Rev.00	Initial creation of document	Jun. 03, 2016

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Contents

1 GENERAL INFORMATION.....	6
1.1 Product Description.....	6
1.2 Product Feature of Equipment Under Test.....	7
1.3 Test Methodology of Applied Standards.....	8
1.4 Test Facility	8
1.5 Special Accessories	8
1.6 Equipment Modifications.....	8
2 SYSTEM TEST CONFIGURATION	9
2.1 EUT Configuration	9
2.2 EUT Exercise	9
2.3 Test Procedure.....	9
2.4 Measurement Results Explanation Example	9
2.5 Configuration of Tested System	10
3 SUMMARY OF TEST RESULTS	11
4 DESCRIPTION OF TEST MODES.....	11
4.1 Operated in 2400 ~ 2483.5MHz Band	11
4.2 The Worst Test Modes and Channel Details.....	12
5 MEASUREMENT UNCERTAINTY.....	13
6 CONDUCTED EMISSION TEST.....	14
6.1 Standard Applicable:	14
6.2 Measurement Equipment Used:.....	14
6.3 EUT Setup:	14
6.4 Test SET-UP (Block Diagram of Configuration)	15
6.5 Measurement Procedure:	15
6.6 Measurement Result:.....	15
7 PEAK OUTPUT POWER MEASUREMENT	18
7.1 Standard Applicable:	18
7.2 Measurement Equipment Used:.....	18
7.3 Test Set-up:.....	18
7.4 Measurement Procedure:	19
7.5 Measurement Result:.....	20

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8 6dB BANDWIDTH MEASUREMENT	21
8.1 Standard Applicable	21
8.2 Measurement Equipment Used	21
8.3 Test Set-up:.....	21
8.4 Measurement Procedure:	22
8.5 Measurement Result:.....	22
9 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT	25
9.1 Standard Applicable	25
9.2 Measurement Equipment Used:.....	25
9.3 Test SET-UP:	25
9.4 Measurement Procedure	26
9.5 Measurement Result.....	26
10 RADIATED BANDEDGE AND SPURIOUS EMISSION MEASUREMENT.....	31
10.1 Standard Applicable	31
10.2 Measurement Equipment Used	32
10.3 Test SET-UP	33
10.4 Measurement Procedure	34
10.5 Field Strength Calculation	35
10.6 Test Results of Radiated Spurious Emissions form 9 kHz to 30 MHz	35
10.7 Measurement Result:.....	35
11 PEAK POWER SPECTRAL DENSITY	50
11.1 Standard Applicable:	50
11.2 Measurement Equipment Used:.....	50
11.3 Test Set-up:.....	50
11.4 Measurement Procedure:	50
11.5 Measurement Result:.....	51
12 ANTENNA REQUIREMENT	54
12.1 Standard Applicable:	54
12.2 Antenna Connected Construction:	54

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1 GENERAL INFORMATION

1.1 Product Description

General:

Product Name:	BLE/ Wi-Fi Intelligent Sensor Gateway
Brand Name:	Advantech
Model No.:	WISE-2400, WISE-2400XXXXXXXXXXXXXX (where "X" may be any alphanumeric character, “-“ or blank)
Model Difference:	For market differenet
Product SW/HW version:	V12 / V12
Radio SW/HW version:	V12 / V12
Test SW Version:	N/A
RF power setting in TEST SW:	N/A
Power Supply:	5Vdc from AC/DC Adapter Model:TC-E100, Supplier: TOPCOM

Bluetooth Low Energy:

Frequency Range:	2402 – 2480MHz
Bluetooth Version:	V4.1
Channel number:	40 channels
Modulation type:	GFSK
Transmit Power:	8.00 dBm
Antenna Designation:	Material Antenna, Supplier: ARISTOTLE, Gain:1.5dBi

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1.2 Product Feature of Equipment Under Test

The equipment under Test (Hereafter Called: EUT) is supporting Bluetooth, WIFI features, and below is details of information:

Product Feature	
Product Name:	BLE/ Wi-Fi Intelligent Sensor Gateway
Brand Name:	Advantech
Model No.:	WISE-2400, WISE-2400XXXXXXXXXXXXXX (where "X" may be any alphanumeric character, "-" or blank)
Model Difference:	For market different
FCC ID:	M82-WISE-2400
Wi-Fi Specification	802.11b/g/n
Bluetooth Version	V4.1

Note: The above EUT information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

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1.3 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247

FCC KDB 558074 D01 DTS Meas. Guidance

ANSI C63.10:2013

Note:

1. All test items have been performed and record as per the above standards.
2. The composite system is compliance with FCC Subpart B is authorized under a DoC procedure.

1.4 Test Facility

SGS Taiwan Ltd. Electronics & Communication Laboratory No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan. (TAF code 0513)

FCC Registration Numbers are: 628985

1.5 Special Accessories

There are no special accessories used while test was conducted.

1.6 Equipment Modifications

There was no modification incorporated into the EUT.

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2 SYSTEM TEST CONFIGURATION

2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

2.2 EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme.

2.3 Test Procedure

2.3.1 Conducted Emissions

The EUT is a placed on as turn table which is 0.8 m above ground plan. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz,. The CISPR Quasi-Peak and Average detector mode is employed according to §15.207. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

2.3.2 Radiated Emissions

The EUT is a placed on as turn table. For emissions testing at or below 1 GHz, the table height shall be 0.8 m above the reference ground plan. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” is still within the 3dB illumination BW of the measurement antenna.

2.4 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

Note:

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Following shows an offset computation example with cable loss and splitter.

Offset = RF cable loss (dB)+ splitter(dB) = 4.2 + 0 = 4.2(dB)

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2.5 Configuration of Tested System

Fig. 2-1 Radiated & Conducted Emission

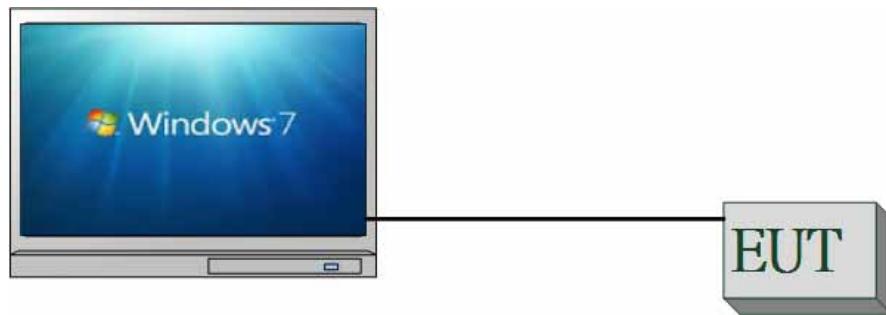


Fig. 2-2 Conduction

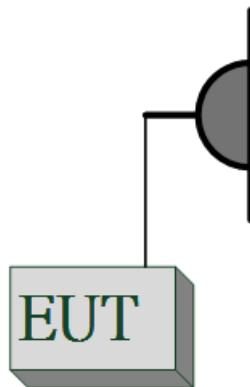


Table 2-1 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Cable	Power Cord
1.	Bluetooth Test Software	N/A	N/A	N/A	N/A	N/A
2.	Notebook	Lenovo	L430	R9-YYG88	Shielded	Un-shielded

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3 SUMMARY OF TEST RESULTS

FCC Rules	Description Of Test	Result
§15.207(a)	AC Power Line Conducted Emission	Compliant
§15.247(b) (3)	Peak Output Power	Compliant
§15.247(a)(2)	6dB Bandwidth Power Emission Bandwidth	Compliant
§15.247(d)	Conducted Band Edge and Spurious Emission	Compliant
§15.247(d)	Radiated Band Edge and Spurious Emission	Compliant
§15.247(e)	Peak Power Density	Compliant
§15.203 §15.247(b)	Antenna Requirement	Compliant

4 DESCRIPTION OF TEST MODES

4.1 Operated in 2400 ~ 2483.5MHz Band

40 channels are provided for Bluetooth LE

CHANNEL	FREQUENCY	CHANNEL	FREQUENCY	CHANNEL	FREQUENCY
0	2402 MHz	14	2430 MHz	28	2458 MHz
1	2404 MHz	15	2432 MHz	29	2460 MHz
2	2406 MHz	16	2434 MHz	30	2462 MHz
3	2408 MHz	17	2436 MHz	31	2464 MHz
4	2410 MHz	18	2438 MHz	32	2466 MHz
5	2412 MHz	19	2440 MHz	33	2468 MHz
6	2414 MHz	20	2442 MHz	34	2470 MHz
7	2416MHz	21	2444 MHz	35	2472 MHz
8	2418 MHz	22	2446 MHz	36	2474 MHz
9	2420 MHz	23	2448 MHz	37	2476 MHz
10	2422 MHz	24	2450 MHz	38	2478 MHz
11	2424 MHz	25	2452 MHz	39	2480 MHz
12	2426 MHz	26	2454 MHz		
13	2428 MHz	27	2456 MHz		

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4.2 The Worst Test Modes and Channel Details

1. The EUT has been tested under operating condition.
2. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

RADIATED EMISSION TEST:

RADIATED EMISSION TEST (BELOW 1 GHz)					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
Bluetooth LE	0 to 39	0,20,39	GFSK	1	MAIN

RADIATED EMISSION TEST (ABOVE 1 GHz)					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
Bluetooth LE	0 to 39	0,20,39	GFSK	1	MAIN

Note:

The field strength of radiation emission was measured as EUT stand-up position (H mode) and lie down position (E1, E2 mode) for Bluetooth LE Transmitter for channel Low, Mid and High, the worst case H position was reported.

ANTENNA PORT CONDUCTED MEASUREMENT:

CONDUCTED TEST					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
Bluetooth LE	0 to 39	0,20,39	GFSK	1	MAIN

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5 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 2.586 dB
Peak Output Power	+/- 0.84 dB
6dB Bandwidth	+/- 51.33 Hz
100 KHz Bandwidth Of Frequency Band Edges	+/- 0.84 dB
Peak Power Density	+/- 1.3 dB
Temperature	+/- 0.65 °C
Humidity	+/- 4.6 %
DC / AC Power Source	DC= +/- 0.13%, AC= +/- 0.2%

Radiated Spurious Emission:

Measurement uncertainty (Polarization : Vertical)	9kHz-30MHz: +/- 2.87dB
	30MHz - 180MHz: +/- 3.37dB
	180MHz -417MHz: +/- 3.19dB
	0.417GHz-1GHz: +/- 3.19dB
	1GHz - 18GHz: +/- 4.04dB
	18GHz - 40GHz: +/- 4.04dB

Measurement uncertainty (Polarization : Horizontal)	9kHz-30MHz: +/- 2.87dB
	30MHz - 167MHz: +/- 4.22dB
	167MHz -500MHz: +/- 3.44dB
	0.5GHz-1GHz: +/- 3.39dB
	1GHz - 18GHz: +/- 4.08dB
	18GHz - 40GHz: +/- 4.08dB

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

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6 CONDUCTED EMISSION TEST

6.1 Standard Applicable:

Frequency range within 150kHz to 30MHz shall not exceed the Limit table as below.

Frequency range MHz	Limits dB(uV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

Note

- 1.The lower limit shall apply at the transition frequencies
- 2.The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

6.2 Measurement Equipment Used:

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EMI Test Receiver	R&S	ESCI 7	100950	12/12/2015	12/11/2016
Coaxial Cables	N/A	N30N30-1042-150 cm	N/A	02/07/2016	02/06/2017
LISN	Schwarzbeck	NSLK 8127	8127-648	06/09/2015	06/08/2016
Test Software	Farad	EZ-EMC	Ver. SGS-03A2	N.C.R.	N.C.R.

6.3 EUT Setup:

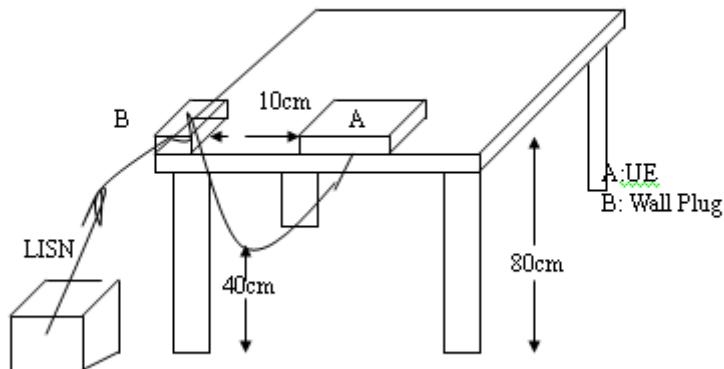
1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI C63.10:2013.
2. The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
3. The LISN was connected with 120Vac/60Hz power source.

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6.4 Test SET-UP (Block Diagram of Configuration)



6.5 Measurement Procedure:

1. The EUT was placed on a table which is 0.8m above ground plan.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all phases of power being supplied by given UE are completed

6.6 Measurement Result:

Note: Refer to next page for measurement data and plots.

Note2: The * reveals the worst-case results that closet to the limit

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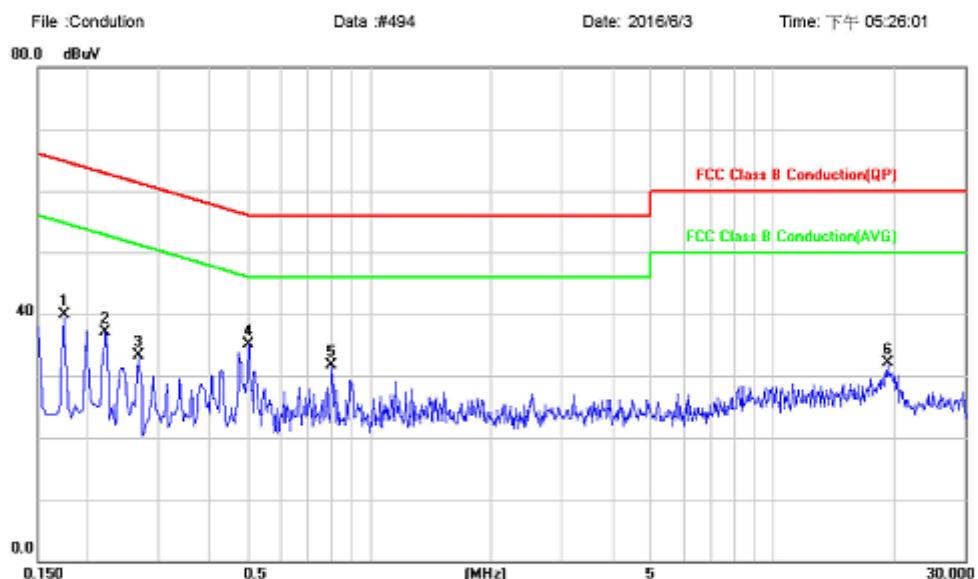
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AC POWER LINE CONDUCTED EMISSION TEST DATA

Operation Mode:	Operation mode			Test Date:	Jun. 03, 2016
Temperature:	26	Humidity:	54 %	Test By:	Aken
				Phase:	L1

Site : Conduction Room Phase: **L1** Temperature: 21 °C
 Limit: FCC Class B Conduction(QP) Power: AC 120V/60Hz Humidity: 69 %
 Mode:
 Note: Adapter:TC-E100

Conducted Emission



No.	Mk.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
	MHz	dBuV	dB	dBuV	dB	Detector	Comment
1	0.1740	20.32	19.64	39.96	64.77	-24.81	peak
2	0.2220	17.44	19.62	37.06	62.74	-25.68	peak
3	0.2660	13.72	19.64	33.36	61.24	-27.88	peak
4 *	0.5020	15.38	19.73	35.11	56.00	-20.89	peak
5	0.8020	12.07	19.59	31.66	56.00	-24.34	peak
6	19.2940	12.15	19.86	32.01	60.00	-27.99	peak

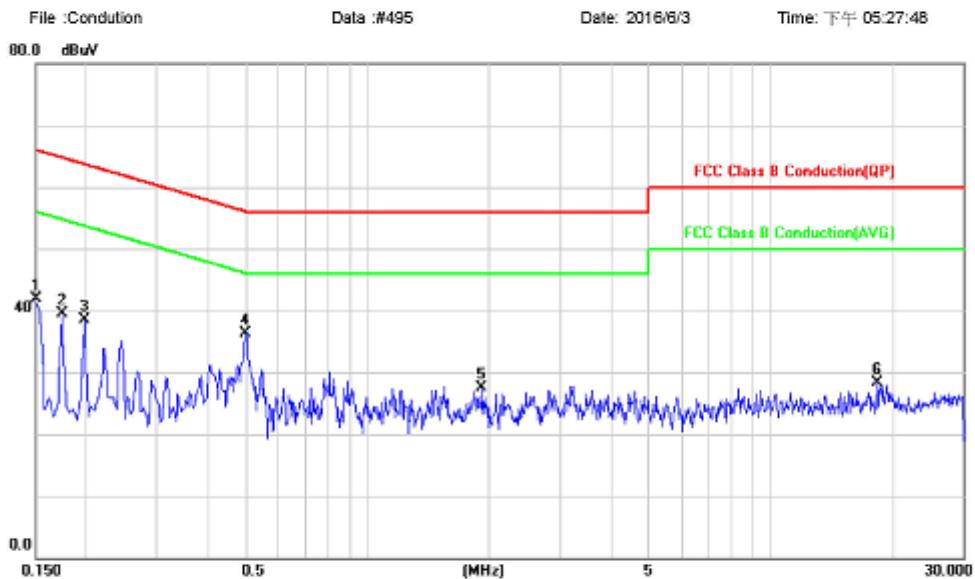
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Site : Conduction Room Phase: **N** Temperature: 21 °C
 Limit: FCC Class B Conduction(QP) Power: AC 120V/60Hz Humidity: 69 %
 Mode:
 Note: Adapter:TC-E100

Conducted Emission



No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Over	Comment
			Level	Factor	ment			
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector
1		0.1500	22.18	19.66	41.84	66.00	-24.16	peak
2		0.1740	19.76	19.65	39.41	64.77	-25.36	peak
3		0.1980	18.86	19.62	38.48	63.69	-25.21	peak
4 *		0.4980	16.64	19.74	36.38	56.03	-19.65	peak
5		1.9220	7.96	19.59	27.55	56.00	-28.45	peak
6		18.3300	8.37	19.91	28.28	60.00	-31.72	peak

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7 PEAK OUTPUT POWER MEASUREMENT

7.1 Standard Applicable:

For systems using digital modulation in the 2400-2483.5 MHz bands, the limit for peak output power is 1Watt.

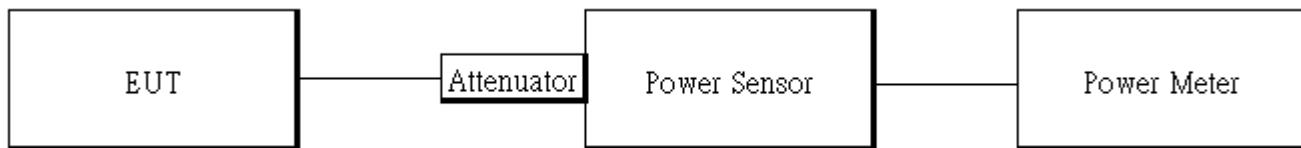
If the transmitting antenna of directional gain greater than 6dBi are used the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the Antenna exceeds 6dBi.

In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of Antenna exceeds 6dBi.

7.2 Measurement Equipment Used:

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Power Meter	Anritsu	ML2496A	1326001	06/23/2015	06/22/2016
Power Sensor	Anritsu	MA2411B	1315048	06/23/2015	06/22/2016
Spectrum Analyzer	KEYSIGHT	N9010A	MY54510568	04/14/2015	04/13/2016
DC Block	PASTERNACK	PE8210	RF29	12/12/2015	12/11/2016
Splitter	RF-LAMBAD	RFLT2W1G1 8G	RF35	12/12/2015	12/11/2016
Attenuator	WOKEN	218FS-10	RF23	12/12/2015	12/11/2016

7.3 Test Set-up:



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7.4 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.

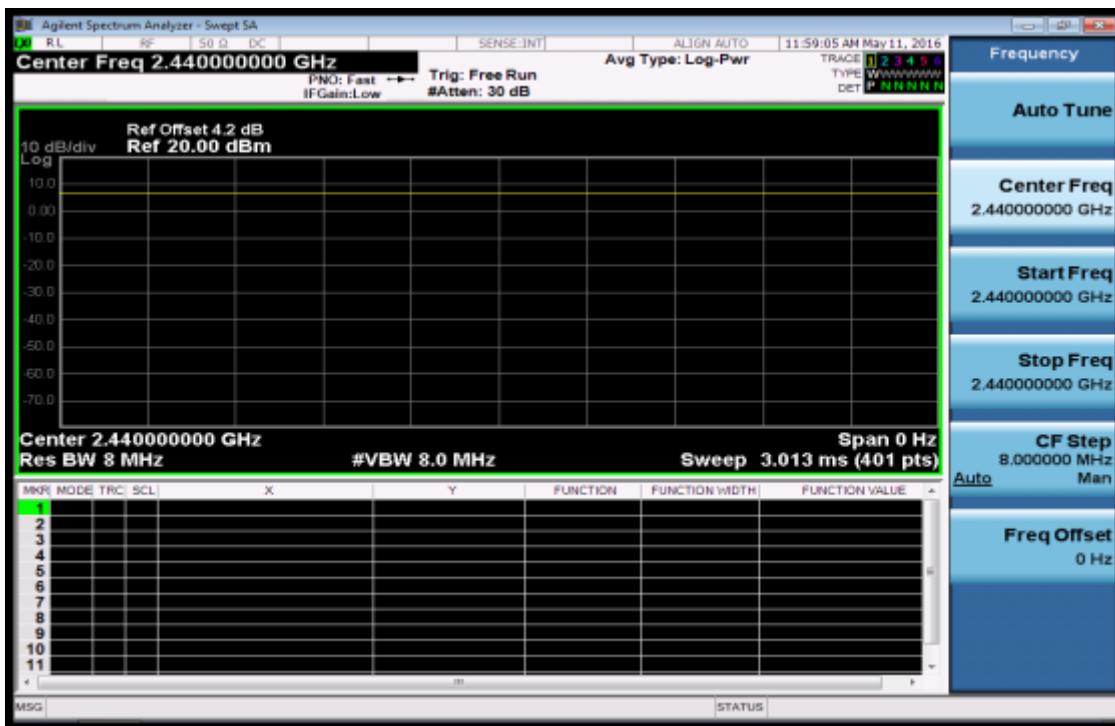
Power Meter:

It is used as the auxiliary test equipment to conduct the output power measurement.

4. Record the max. Reading as observed from Power Meter.
5. Repeat above procedures until all test default channel measured was complete.

Duty Factor:

	Duty Cycle	Duty Factor (dB)
Bluetooth LE	100%	0



Duty Cycle Factor: $10 * \log (1/100/100) = 0$

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7.5 Measurement Result:

BT4.1 mode:

CH	Frequency (MHz)	Peak Power Output(dBm)	Required Limit
0	2402	8.00	1 Watt = 30 dBm
19	2440	6.63	1 Watt = 30 dBm
39	2480	5.28	1 Watt = 30 dBm

CH	Frequency (MHz)	Average Power Output(dBm)	Required Limit
0	2402	7.79	1 Watt = 30 dBm
19	2440	6.41	1 Watt = 30 dBm
39	2480	5.07	1 Watt = 30 dBm

**Note: Measured by power meter, as cable loss+ Duty cycle factor that offsets on the power meter*

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8 6dB BANDWIDTH MEASUREMENT

8.1 Standard Applicable

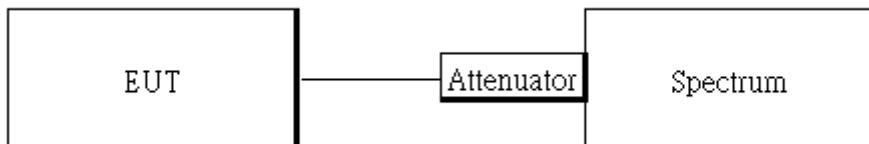
The minimum 6 dB bandwidth shall be at least 500 kHz .

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth.

8.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	KEYSIGHT	N9010A	MY54510568	04/14/2016	04/13/2017
DC Block	PASTERNACK	PE8210	RF29	12/12/2015	12/11/2016
Splitter	RF-LAMBAD	RFLT2W1G18 G	RF35	12/12/2015	12/11/2016
Attenuator	WOKEN	218FS-10	RF23	12/12/2015	12/11/2016

8.3 Test Set-up:



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8.4 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. For 6dB Bandwidth:
Set the spectrum analyzer as RBW=100 kHz, VBW= 3*RBW, Span = 5MHz, Detector=Peak, Sweep=auto.
5. Mark the peak frequency and –6dB (upper and lower) frequency.
6. For 99% Bandwidth:
Set the spectrum analyzer as RBW=1%~5%, VBW=3*RBW, Span = 2MHz, Detector=Sample, Sweep=auto.
7. Turn on the 99% bandwidth function, max reading.
8. Repeat above procedures until all test default channel is completed

8.5 Measurement Result:

BLE mode

Frequency (MHz)	6dB Bandwidth (MHz)	Bandwidth (MHz)	Result
2402	0.6869	> 0.5	PASS
2440	0.7005	> 0.5	PASS
2480	0.7204	> 0.5	PASS

Note: Refer to next page for plots.

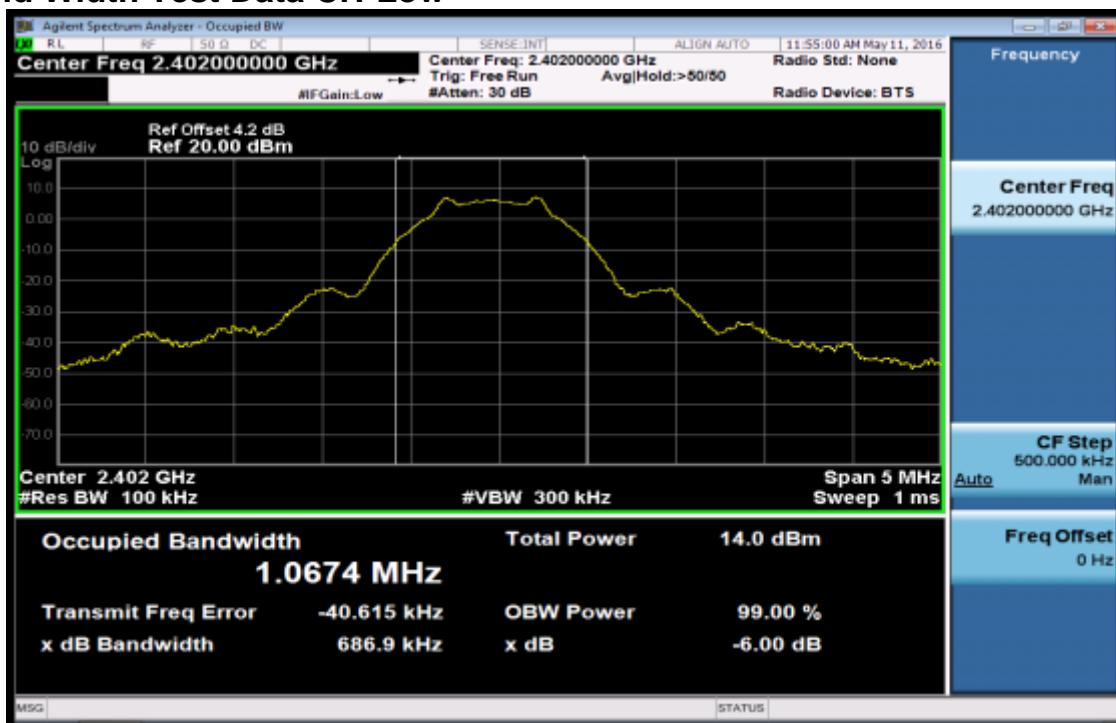
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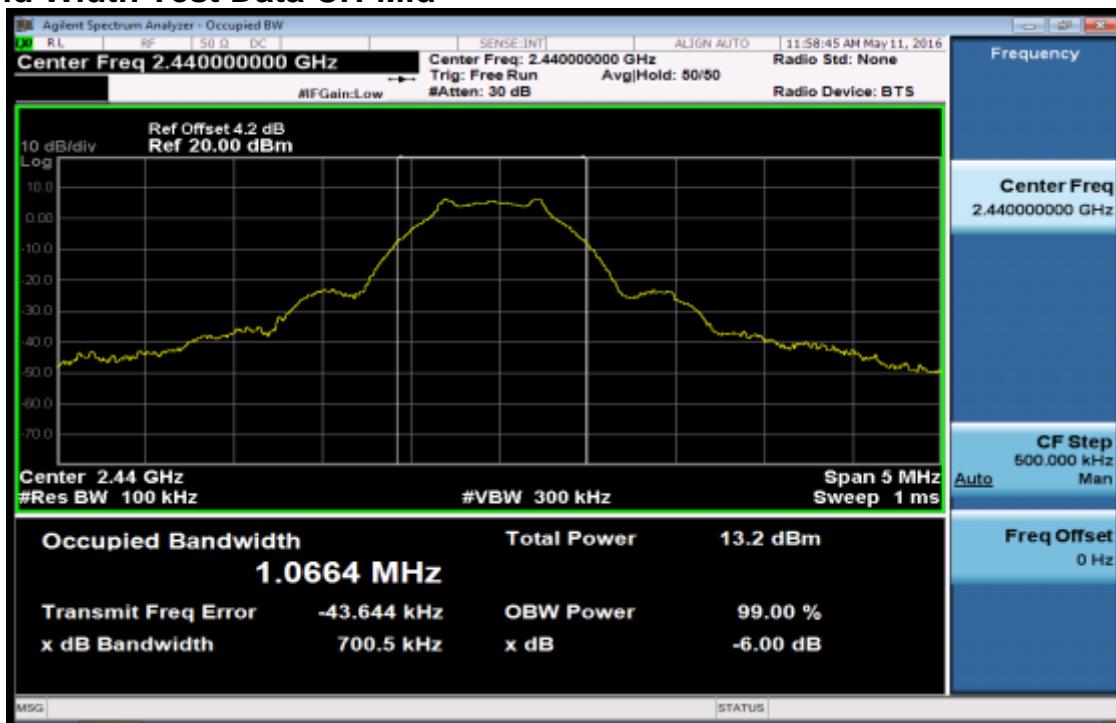
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BT4.1 mode

6dB Band Width Test Data CH-Low



6dB Band Width Test Data CH-Mid

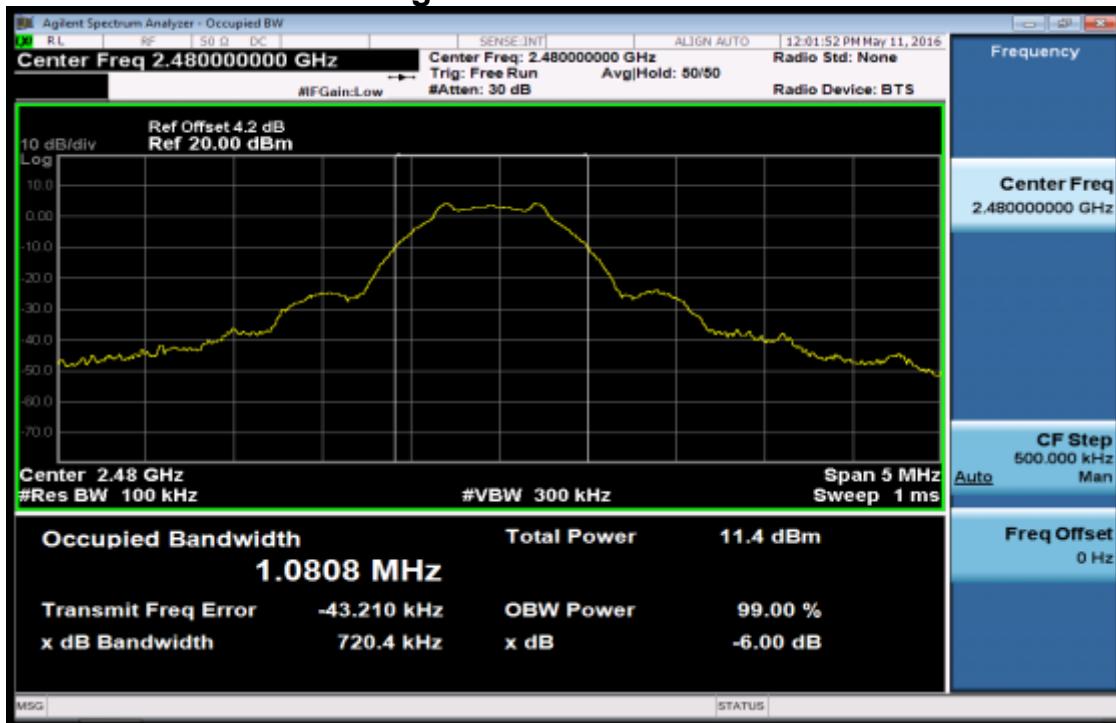


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6dB Band Width Test Data CH-High



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9 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

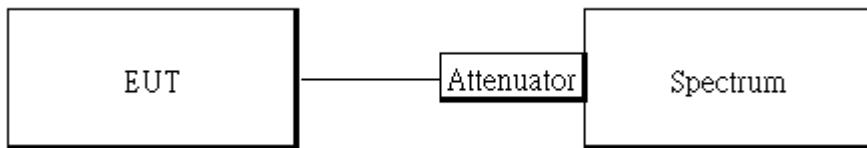
9.1 Standard Applicable

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. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

9.2 Measurement Equipment Used:

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	KEYSIGHT	N9010A	MY54510568	04/14/2016	04/13/2017
DC Block	PASTERNAK	PE8210	RF29	12/12/2015	12/11/2016
Splitter	RF-LAMBAD	RFLT2W1G18 G	RF35	12/12/2015	12/11/2016
Attenuator	WOKEN	218FS-10	RF23	12/12/2015	12/11/2016

9.3 Test SET-UP:



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9.4 Measurement Procedure

Conducted Band Edge:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set start to edge frequency, and stop frequency of spectrum analyzer so as to encompass the spectrum to be examined.
5. Set the spectrum analyzer as RBW=100 kHz, VBW=300 kHz, Detector = Peak, Sweep = auto
6. Mark the highest reading of the emission as the reference level measurement.
7. Set DL as the limit = reading on marker 1 – 20dBm
8. Marker on frequency, 2.3999GHz and 2.4836GHz, and examine shall 100 kHz immediately outside the authorized (2400~2483.5) be attenuated by 20dB at least relative to the maximum emission of power.
9. Repeat above procedures until all default test channel (low, middle, and high) was complete.

Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas.
3. Set RBW = 100 kHz & VBW=300 kHz, Detector =Peak, Sweep = Auto
4. Allow trace to fully stabilize.
5. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
6. Repeat above procedures until all default test channel measured were complete.

9.5 Measurement Result

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

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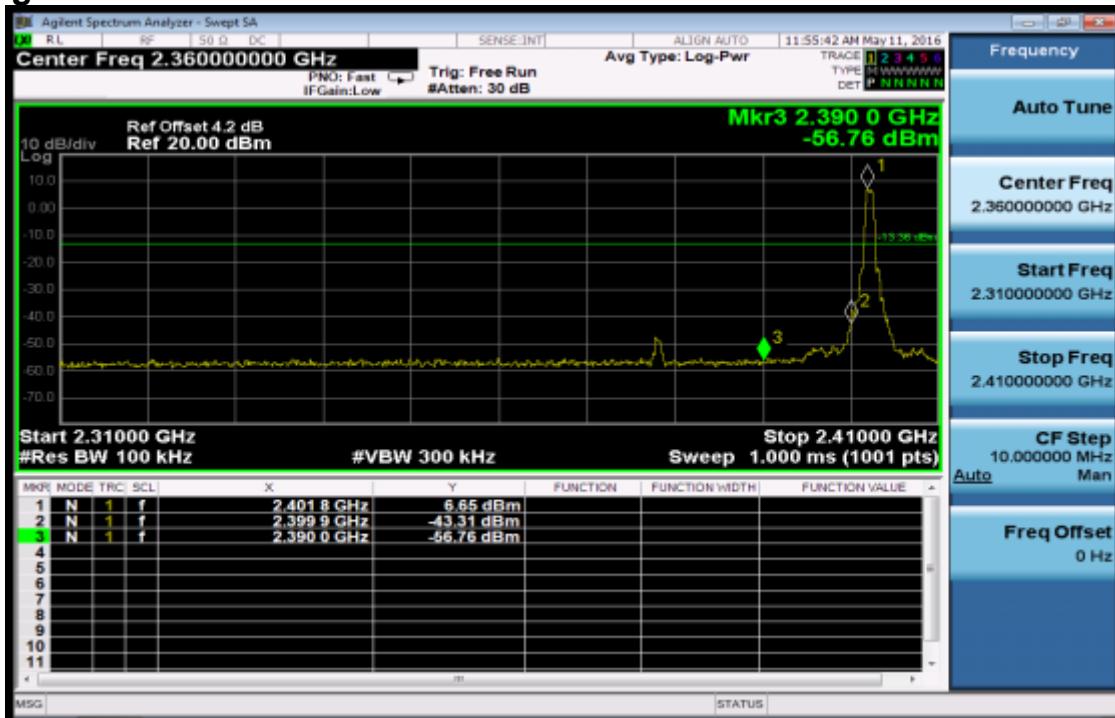
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BT4.1 mode

Band Edges Test Data CH-Low



Band Edges Test Data CH-High



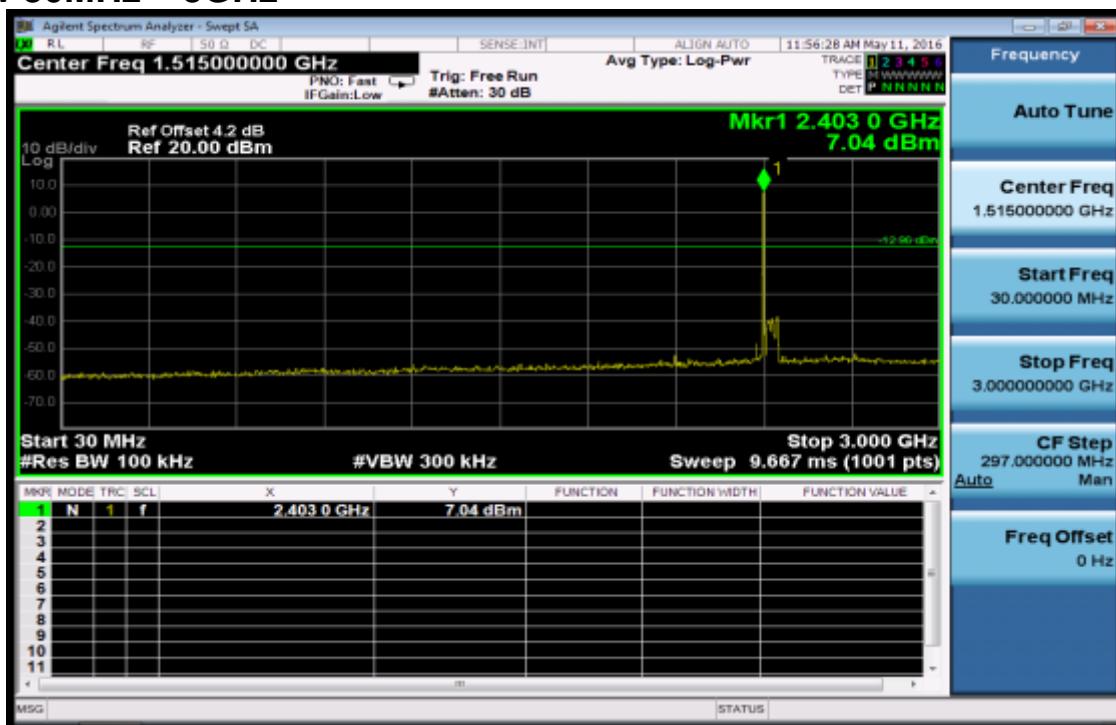
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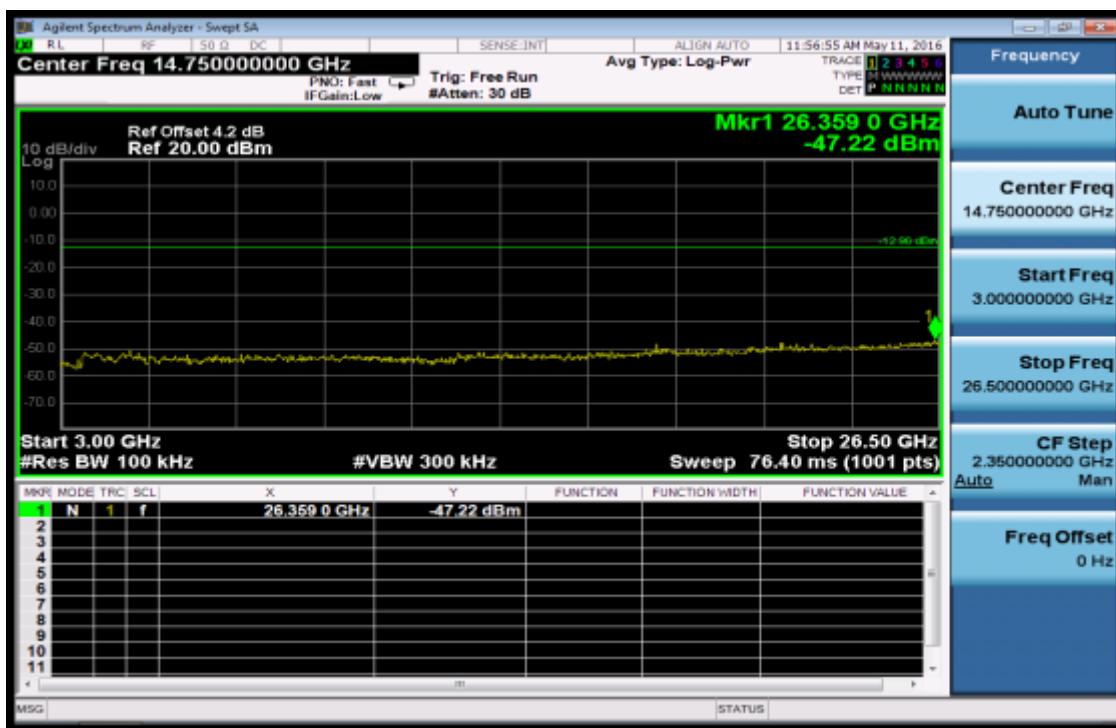
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Conducted Spurious Emission Measurement Result

CH-Low 30MHz – 3GHz



CH-Low 3GHz – 26.5GHz



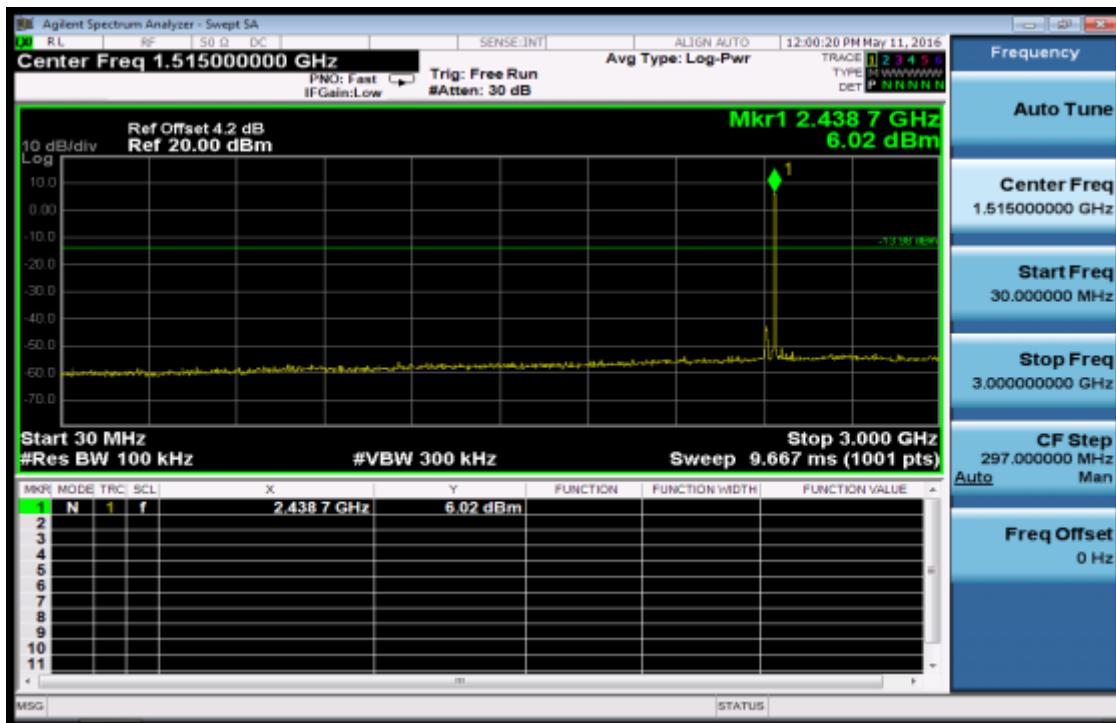
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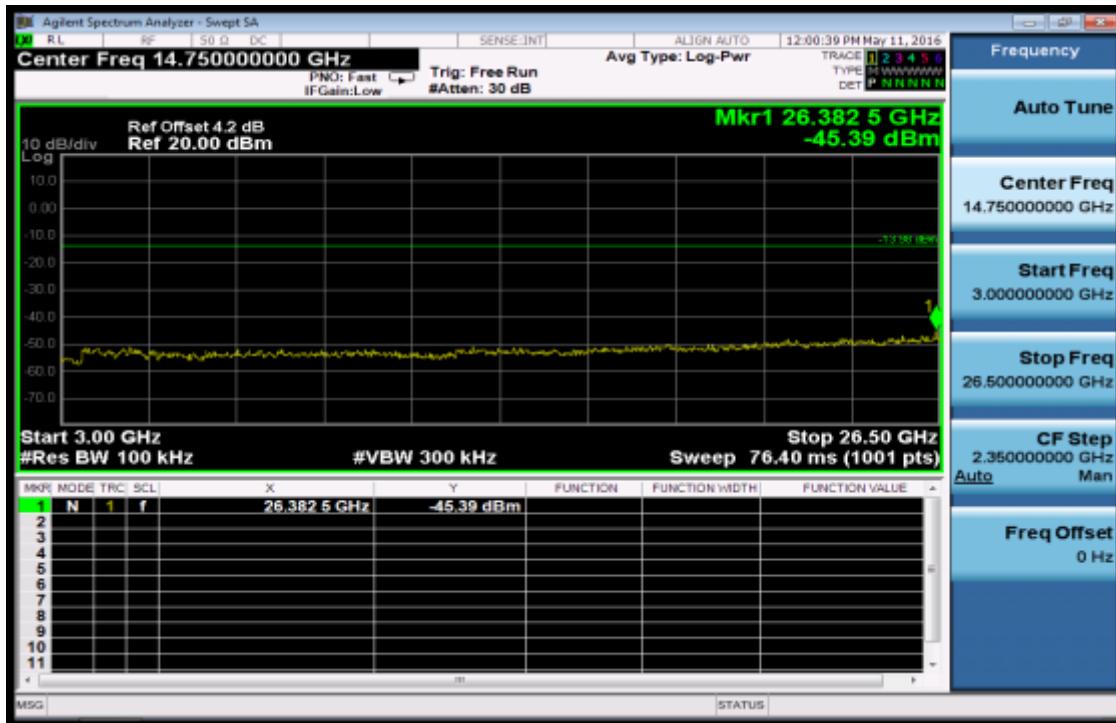
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CH-Mid 30MHz – 3GHz



CH-Mid 3GHz – 26.5GHz



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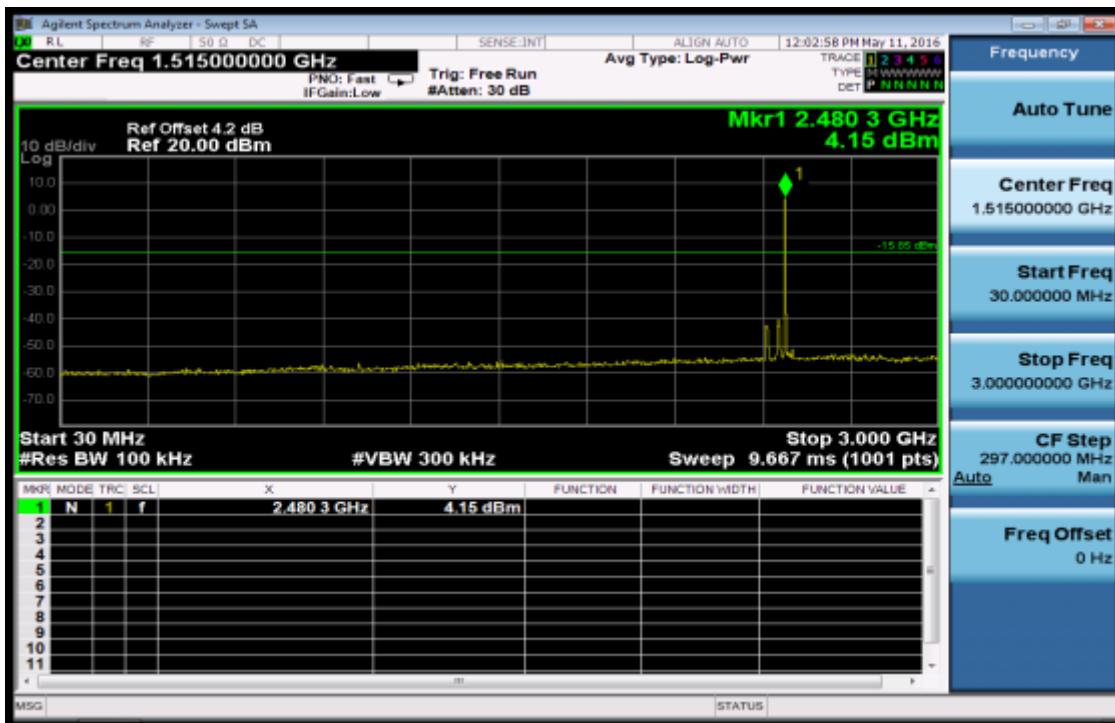
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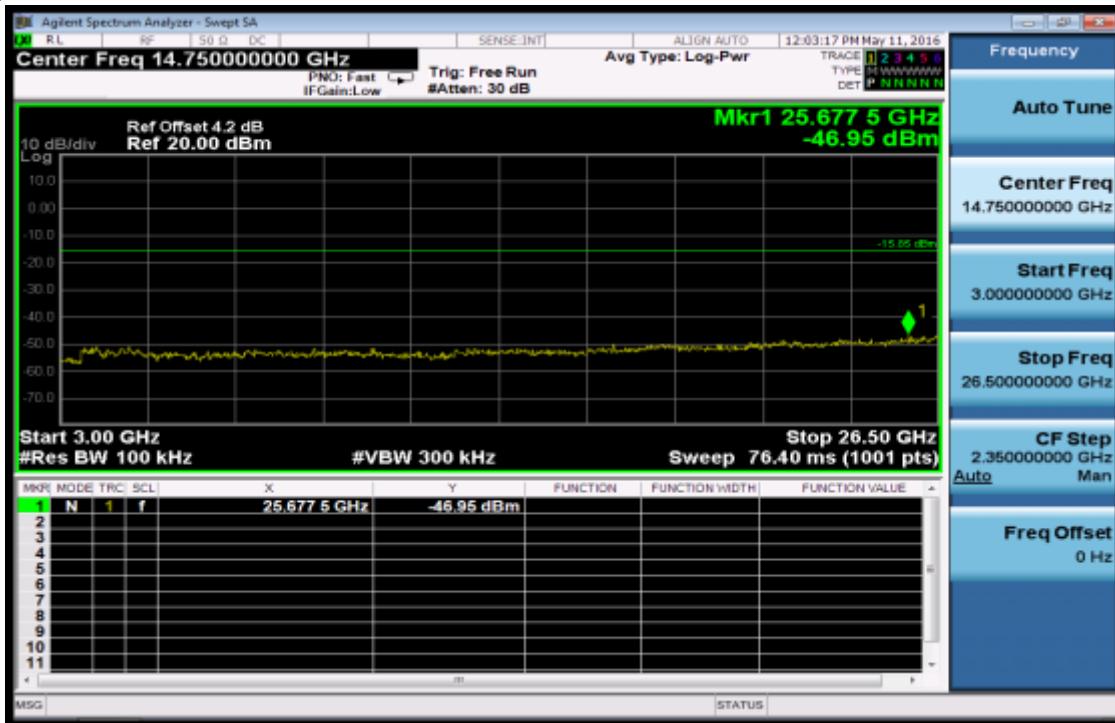
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CH-High 30MHz – 3GHz



CH- High 3GHz – 26.5GHz



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10 RADIATED BANDEDGE AND SPURIOUS EMISSION MEASUREMENT

10.1 Standard Applicable

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. In addition, radiated emissions which fall in the restricted bands must also comply with the limit as below.

For an intentional radiator operates below 10GHz, the frequency range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower.

Frequency (MHz)	Field strength (microvolts/meter)	Distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dB μ V/m) = 20 log Emission level (dB μ V/m)

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10.2 Measurement Equipment Used

966 Chamber					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EMI Test Receiver	R&S	ESU 40	100363	04/12/2016	04/11/2017
Loop Antenna	ETS-Lindgren	6502	00143303	12/23/2015	12/22/2016
Broadband Antenna	TESEQ	CBL 6112D	35240	10/28/2015	10/27/2016
Horn Antenna	ETS-Lindgren	3117	00143272	12/16/2015	12/15/2016
Horn Antenna	Schwarzbeck	BBHA9170	185	07/24/2015	07/23/2016
Pre Amplifier	EMC Instruments	EMC330	980096	12/12/2015	12/11/2016
Pre Amplifier	EMC Instruments	EMC0011830	980199	12/12/2015	12/11/2016
Pre Amplifier	R&S	SCU-18	10204	12/12/2015	12/11/2016
Pre Amplifier	R&S	SCU-26	100780	12/12/2015	12/11/2016
Coaxial Cable	Huber+Suhner	RG 214/U	966Rx 9K-30M	12/12/2015	12/11/2016
Coaxial Cable	Huber+Suhner	RG 214/U SUCOFLEX 104	966Rx 30M-3G	12/12/2015	12/11/2016
Coaxial Cable	Huber+Suhner	SUCOFLEX 104	966Rx 1G-18G	12/12/2015	12/11/2016
Coaxial Cable	Huber+Suhner	mini 141-12 SUCOFLEX 104	966Rx 18G-40G	12/12/2015	12/11/2016
Coaxial Cable	Huber+Suhner	SUCOFLEX 104	966Tx 30M-18G	12/12/2015	12/11/2016
Coaxial Cable	Huber+Suhner	SUCOFLEX 102	966Tx 18G-40G	12/12/2015	12/11/2016
Attenuator	WOKEN	218FS-10	RF27	12/12/2015	12/11/2016
Site NSA	SGS	966 Cham- ber C	SAC-C	03/04/2016	03/03/2017
Site VSWR	SGS	966 Cham- ber C	SAC-C	03/04/2016	03/03/2017
DC Power Supply	HOLA	DP-3003	D7070035	05/04/2016	05/03/2017
Controller	MF	MF-7802	N/A	N.C.R.	N.C.R.
Antenna Master	MF	N/A	N/A	N.C.R.	N.C.R.
Turn Table	MF	N/A	N/A	N.C.R.	N.C.R.
Test Software	World-Pallas	Dr. E	V 3.0 Lite	N.C.R.	N.C.R.

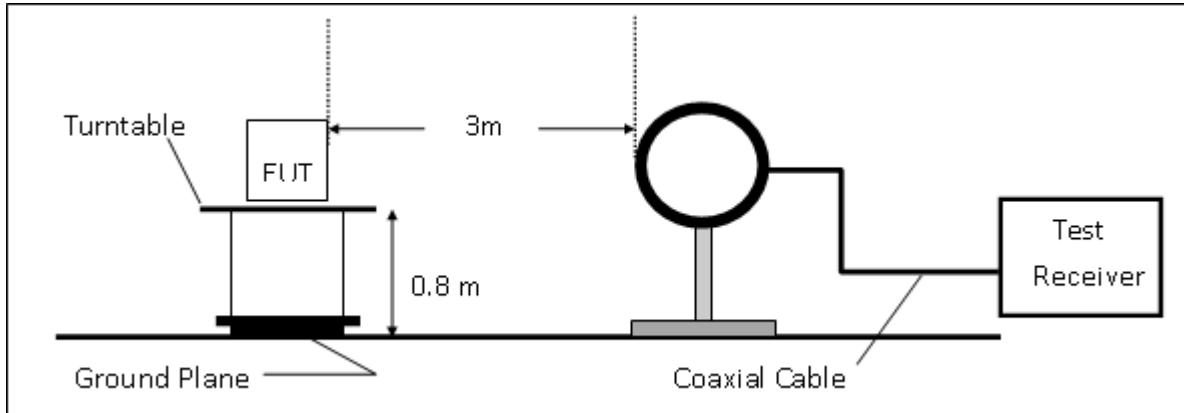
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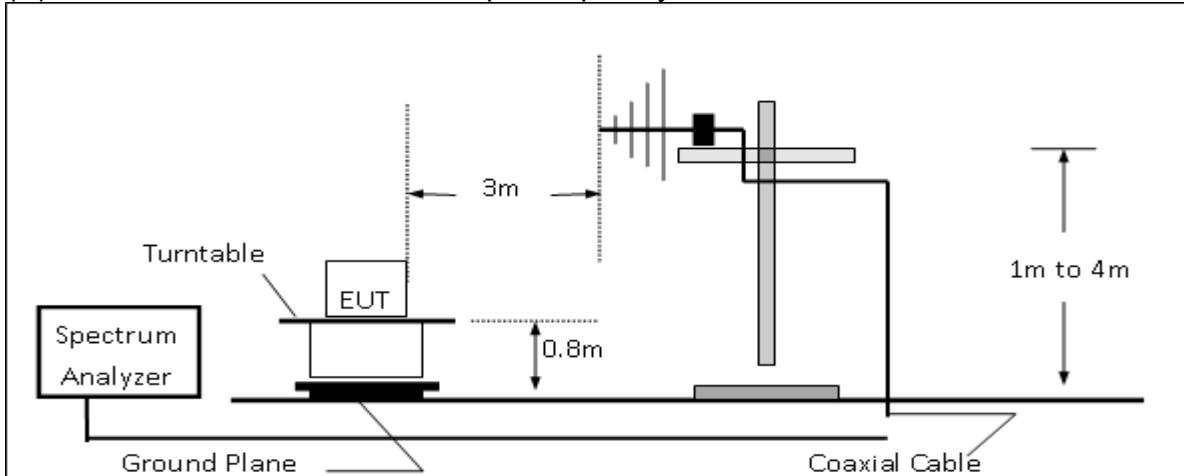
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10.3 Test SET-UP

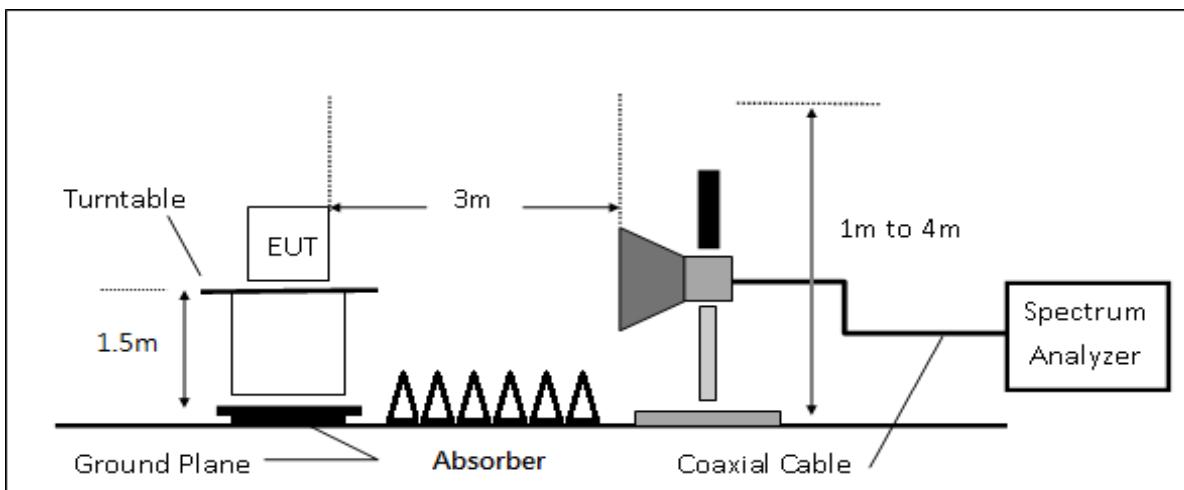
(A) Radiated Emission Test Set-UP Frequency Below 30MHz.



(B) Radiated Emission Test Set-UP, Frequency from 30MHz to 1000MHz



(C) Radiated Emission Test Set-UP Frequency Over 1 GHz



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10.4 Measurement Procedure

1. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas.
2. The EUT was placed on a turn table with 0.8m for frequency < 1GHz and 0.8m for frequency > 1GHz above ground plan.
3. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
4. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
5. Set the spectrum analyzer as RBW=120 kHz and VBW=300 kHz for Peak Detector (PK) and Quasi-peak (QP) at frequency below 1 GHz.
6. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz for Peak Detector at frequency above 1 GHz.
7. Set the spectrum analyzer as RBW=1 MHz, VBW=10 Hz (Duty cycle > 98%) or VBW \geq 1/T (Duty cycle < 98%) for Average Detector at frequency above 1 GHz.
8. When measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." is still within the 3dB illumination BW of the measurement antenna.
9. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
10. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. On spectrum, change spectrum mode in linear display mode, and reduce VBW = 10Hz if average reading is measured.
11. Repeat above procedures until all default test channel measured were complete.

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10.5 Field Strength Calculation

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

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

Where	FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
RA	Reading Amplitude	AG = Amplifier Gain
AF	Antenna Factor	

Actual FS(dB μ V/m) = SPA. Reading level(dB μ V) + Factor(dB)

Factor(dB) = Antenna Factor(dB μ V/m) + Cable Loss(dB) – Pre_Amplifier Gain(dB)

Note :

“F” : denotes Fundamental Frequency. ; “H” : denotes Harmonic Frequency.

“E” : denotes Band Edge Frequency. ; “S” : denotes Spurious Frequency.

10.6 Test Results of Radiated Spurious Emissions from 9 kHz to 30 MHz

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit per 15.31(o) was not reported.

10.7 Measurement Result:

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

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Radiated Band Edge Measurement Result (BT4.1 mode)

Operation Mode : 4.1 Test Date : 2016/5/24
 Fundamental Frequency : 2402 MHz Temp. / Humi. : 22.7deg_C/57RH
 Operation Band : BE CH Low Test Engineer : Penny
 EUT Pol. : E2 Measurement Antenna Pol. : Vertical

Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level		Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			dB μ V	dB				
2378.00	S	Peak	56.30	-6.89	49.42	74	-24.58	
2378.00	S	Average	46.12	-6.89	39.23	54	-14.77	
2390.00	E	Peak	53.60	-6.84	46.75	74	-27.25	
2390.00	E	Average	46.08	-6.84	39.24	54	-14.76	

Operation Mode : 4.1 Test Date : 2016/5/24
 Fundamental Frequency : 2402 MHz Temp. / Humi. : 22.7deg_C/57RH
 Operation Band : BE CH Low Test Engineer : Penny
 EUT Pol. : E2 Measurement Antenna Pol. : Horizontal

Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level		Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			dB μ V	dB				
2390.00	E	Peak	53.05	-6.84	46.21	74	-27.79	
2390.00	E	Average	40.36	-6.84	33.52	54	-20.48	

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Operation Mode : 4.1 Test Date : 2016/5/24
Fundamental Frequency : 2480 MHz Temp. / Humi. : 22.7deg_C/57RH
Operation Band : BE CH High Test Engineer : Penny
EUT Pol. : E2 Measurement Antenna Pol. : Vertical

Freq.	Note	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	F/H/E/S	PK/QP/AV	dB μ V	dB	dB μ V/m	dB μ V/m	dB
2483.50	E	Peak	55.35	-6.38	48.97	74	-25.03
2483.50	E	Average	43.67	-6.38	37.29	54	-16.71

Operation Mode : 4.1 Test Date : 2016/5/24
Fundamental Frequency : 2480 MHz Temp. / Humi. : 22.7deg_C/57RH
Operation Band : BE CH High Test Engineer : Penny
EUT Pol. : E2 Measurement Antenna Pol. : Horizontal

Freq.	Note	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	F/H/E/S	PK/QP/AV	dB μ V	dB	dB μ V/m	dB μ V/m	dB
2483.50	E	Peak	55.63	-6.38	49.25	74	-24.75
2483.50	E	Average	43.46	-6.38	37.08	54	-16.92

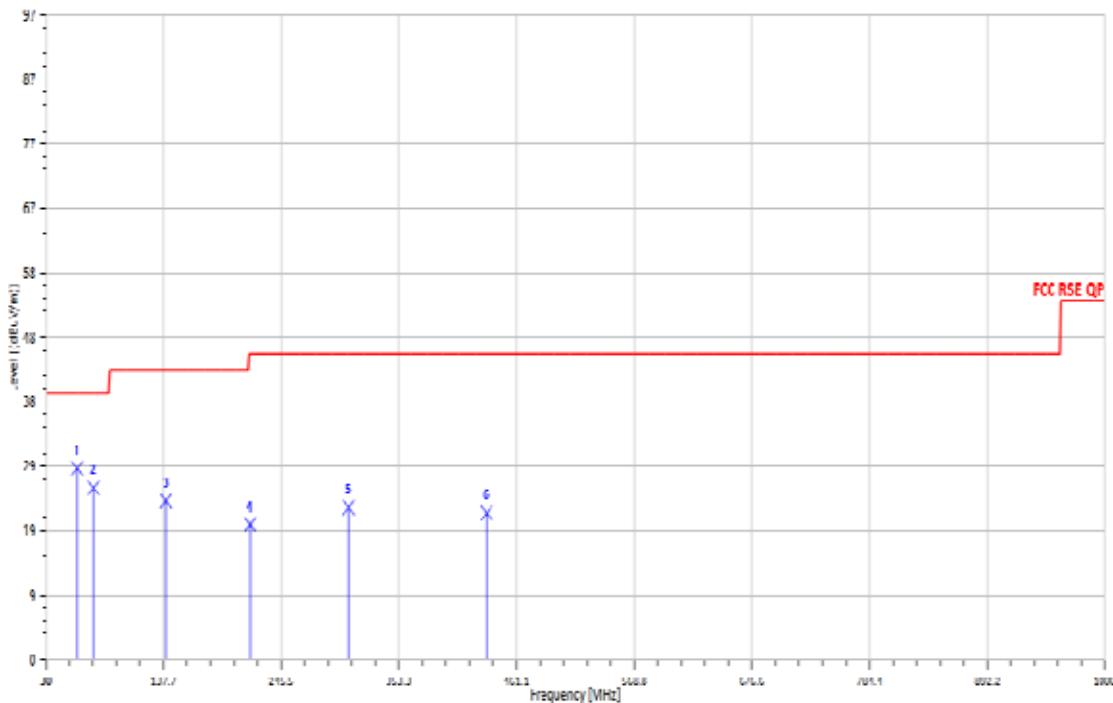
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Radiated Spurious Emission Measurement Result (BT4.1 mode) For Frequency form 30MHz to 1000MHz

Operation Mode : 4.1 Test Date : 2016/5/24
 Fundamental Frequency : 2402 MHz Temp. / Humi. : 22.7deg_C/57RH
 Operation Band : Tx CH Low Test Engineer : Penny
 EUT Pol. : E2 Measurement Antenna Pol. : Vertical



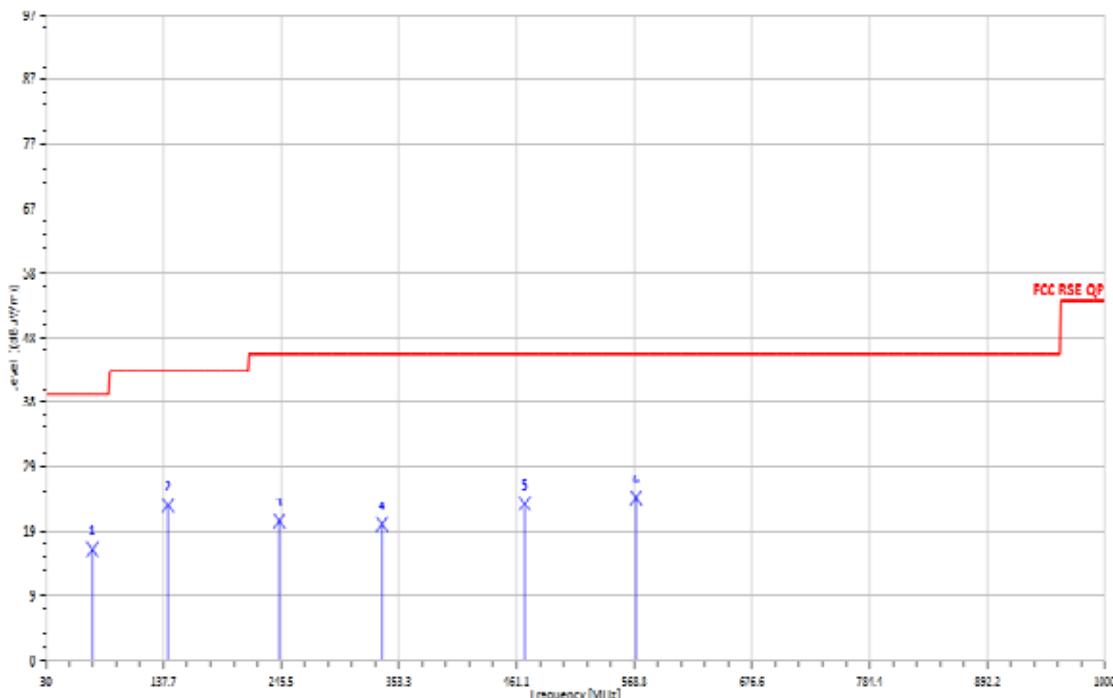
Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
58.13	S	Peak	46.59	-17.84	28.74	40	-11.26
73.65	S	Peak	45.79	-19.96	25.83	40	-14.17
139.61	S	Peak	40.37	-16.50	23.86	43.5	-19.64
217.21	S	Peak	38.89	-18.63	20.27	46	-25.73
307.42	S	Peak	38.04	-15.16	22.88	46	-23.12
433.52	S	Peak	34.66	-12.60	22.06	46	-23.94

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Operation Mode : 4.1 Test Date : 2016/5/24
 Fundamental Frequency : 2402 MHz Temp. / Humi. : 22.7deg_C/57RH
 Operation Band : Tx CH Low Test Engineer : Penny
 EUT Pol. : E2 Measurement Antenna Pol. : Horizontal



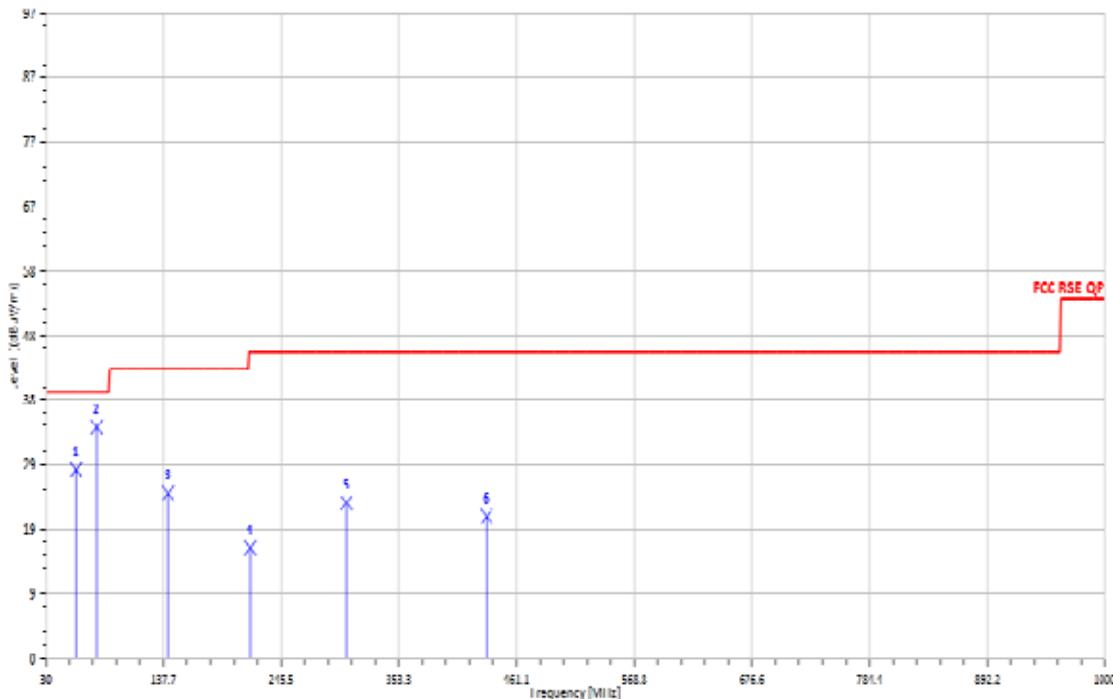
Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
72.68	S	Peak	36.42	-19.79	16.63	40	-23.37
141.55	S	Peak	39.62	-16.36	23.26	43.5	-20.24
243.40	S	Peak	37.92	-16.99	20.93	46	-25.07
337.49	S	Peak	34.82	-14.37	20.45	46	-25.55
468.44	S	Peak	34.62	-11.13	23.49	46	-22.51
570.29	S	Peak	34.04	-9.62	24.42	46	-21.58

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Operation Mode : 4.1 Test Date : 2016/5/24
 Fundamental Frequency : 2442 MHz Temp. / Humi. : 22.7deg_C/57RH
 Operation Band : Tx CH Mid Test Engineer : Penny
 EUT Pol. : E2 Measurement Antenna Pol. : Vertical



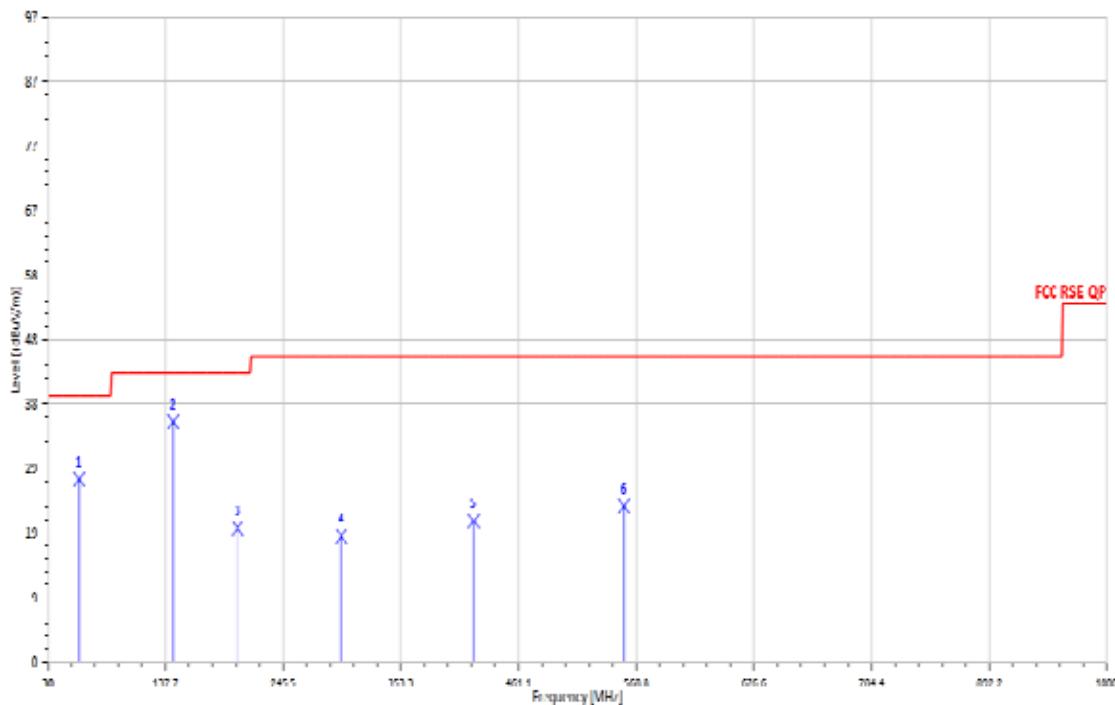
Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
57.16	S	Peak	46.11	-17.77	28.34	40	-11.66
76.56	S	Peak	55.15	-20.47	34.68	40	-5.32
141.55	S	Peak	41.14	-16.36	24.78	43.5	-18.72
217.21	S	Peak	35.21	-18.63	16.58	46	-29.42
305.48	S	Peak	38.53	-15.21	23.32	46	-22.68
433.52	S	Peak	33.88	-12.60	21.28	46	-24.72

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Operation Mode : 4.1 Test Date : 2016/5/24
 Fundamental Frequency : 2442 MHz Temp. / Humi. : 22.7deg_C/57RH
 Operation Band : Tx CH Mid Test Engineer : Penny
 EUT Pol. : E2 Measurement Antenna Pol. : Horizontal



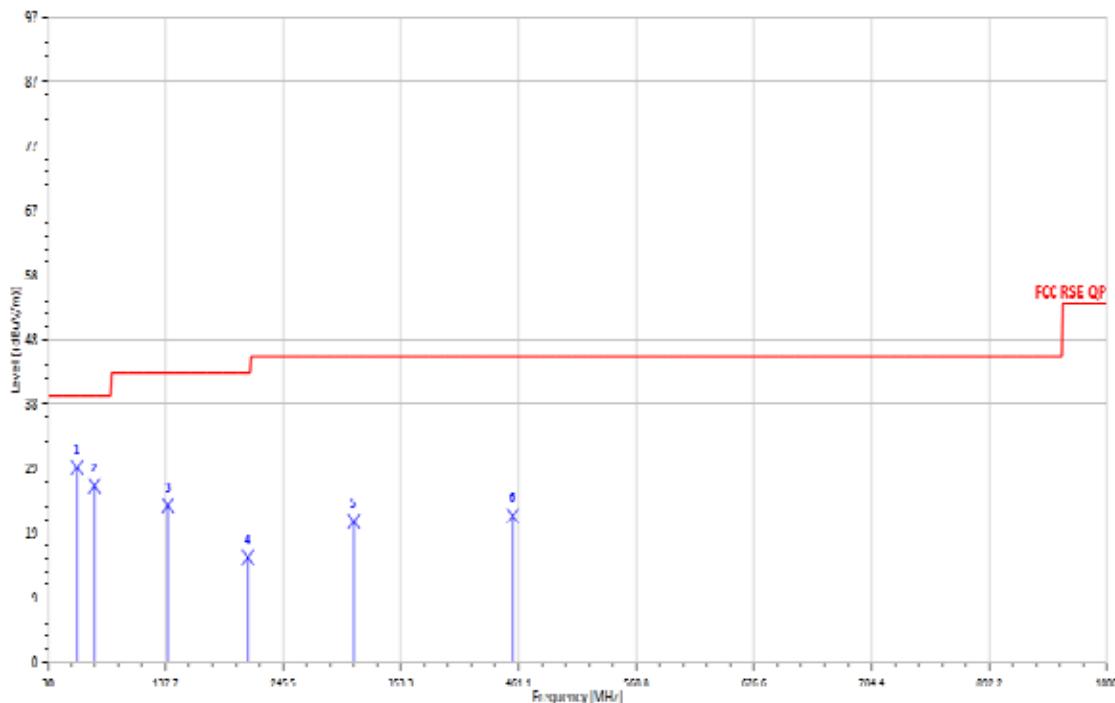
Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
58.13	S	Peak	45.30	-17.84	27.45	40	-12.55
144.46	S	Peak	52.25	-16.17	36.07	43.5	-7.43
203.63	S	Peak	38.68	-18.60	20.08	43.5	-23.42
298.69	S	Peak	34.29	-15.38	18.91	46	-27.09
419.94	S	Peak	33.22	-12.04	21.19	46	-24.81
557.68	S	Peak	33.71	-10.30	23.41	46	-22.59

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Operation Mode : 4.1 Test Date : 2016/5/24
 Fundamental Frequency : 2480 MHz Temp. / Humi. : 22.7deg_C/57RH
 Operation Band : Tx CH High Test Engineer : Penny
 EUT Pol. : E2 Measurement Antenna Pol. : Vertical



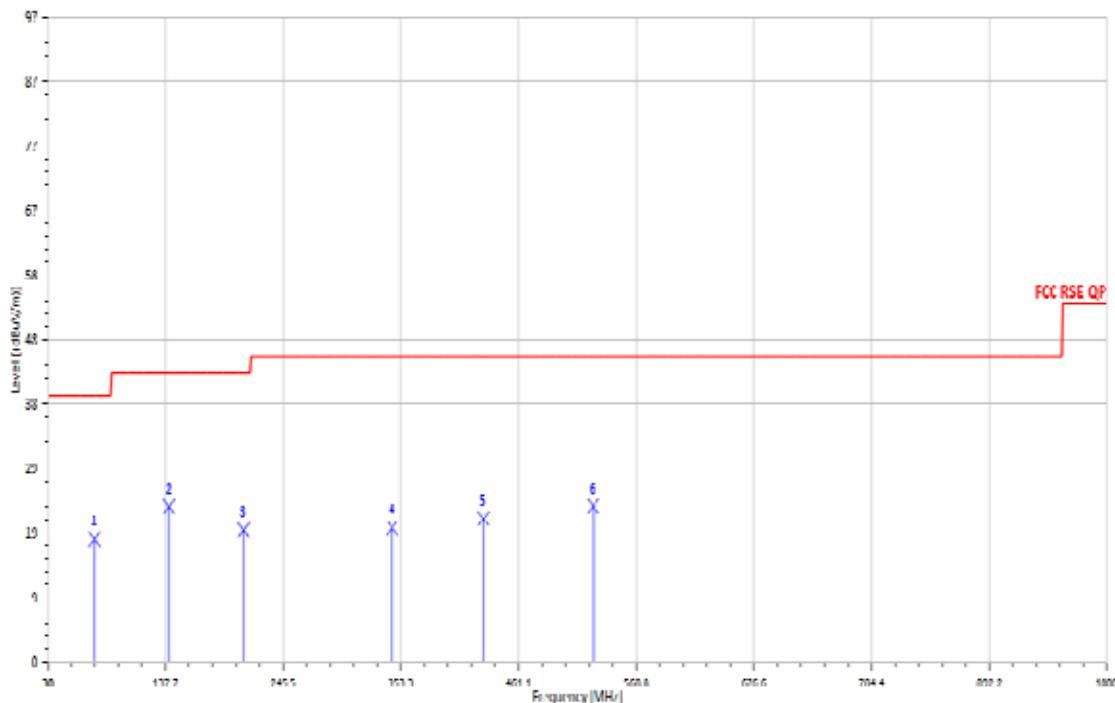
Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
56.19	S	Peak	46.91	-17.69	29.21	40	-10.79
72.68	S	Peak	46.29	-19.79	26.50	40	-13.50
139.61	S	Peak	40.01	-16.50	23.50	43.5	-20.00
213.33	S	Peak	34.25	-18.57	15.67	43.5	-27.83
310.33	S	Peak	36.17	-15.07	21.10	46	-24.90
455.83	S	Peak	33.49	-11.53	21.96	46	-24.04

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Operation Mode : 4.1 Test Date : 2016/5/24
 Fundamental Frequency : 2480 MHz Temp. / Humi. : 22.7deg_C/57RH
 Operation Band : Tx CH High Test Engineer : Penny
 EUT Pol. : E2 Measurement Antenna Pol. : Horizontal



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dB _μ V	Factor dB	Actual FS dB _μ V/m	Limit @3m dB _μ V/m	Margin dB
72.68	S	Peak	38.26	-19.79	18.47	40	-21.53
140.58	S	Peak	39.76	-16.42	23.34	43.5	-20.16
209.45	S	Peak	38.33	-18.53	19.79	43.5	-23.71
345.25	S	Peak	34.45	-14.29	20.16	46	-25.84
428.67	S	Peak	34.06	-12.54	21.52	46	-24.48
529.55	S	Peak	33.79	-10.39	23.41	46	-22.59

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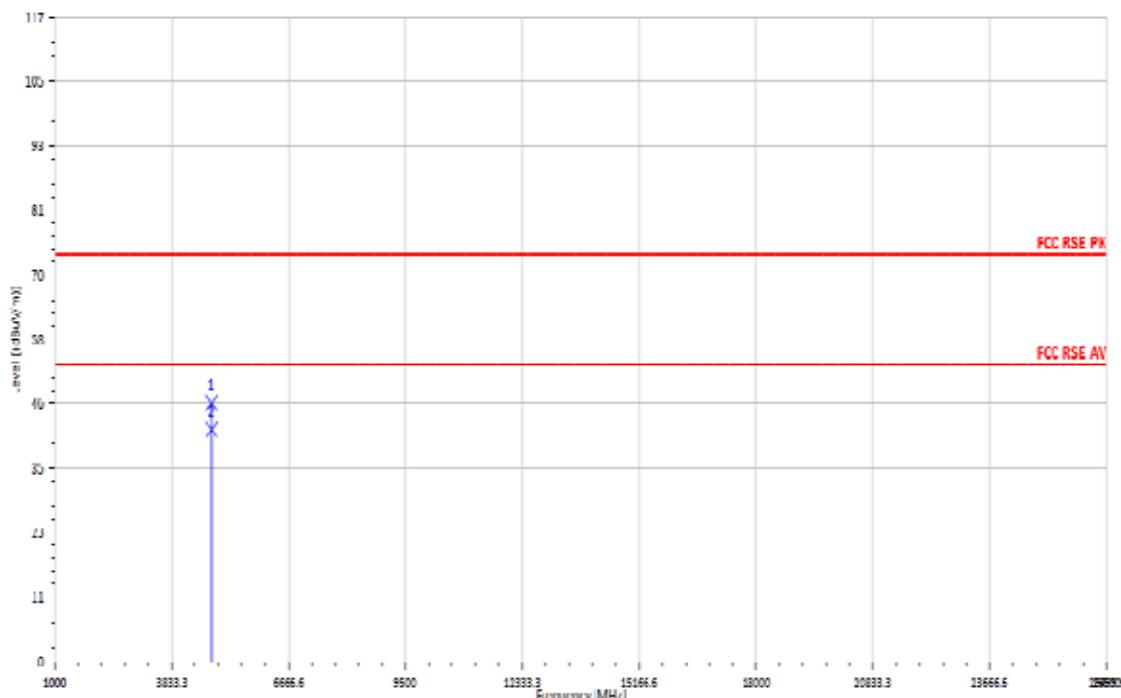
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Radiated Spurious Emission Measurement Result (BT4.1 mode)

For Frequency above 1GHz

Operation Mode : 4.1 Test Date : 2016/5/24
 Fundamental Frequency : 2402 MHz Temp. / Humi. : 22.7deg_C/57RH
 Operation Band : Tx CH Low Test Engineer : Pennny
 EUT Pol. : E2 Measurement Antenna Pol. : Vertical



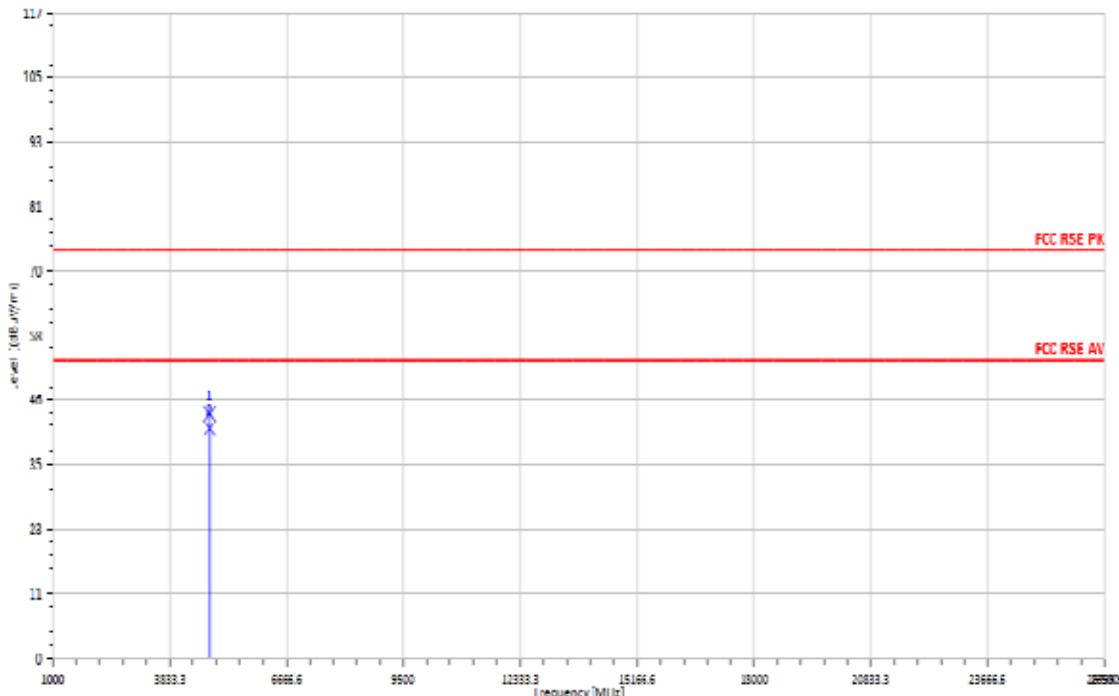
Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4804.00	H	Peak	48.05	-1.16	46.89	74	-27.11
4804.00	H	Average	43.21	-1.16	42.05	54	-11.95

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Operation Mode : 4.1 Test Date : 2016/5/24
 Fundamental Frequency : 2402 MHz Temp. / Humi. : 22.7deg_C/57RH
 Operation Band : Tx CH Low Test Engineer : Penny
 EUT Pol. : E2 Measurement Antenna Pol. : Horizontal



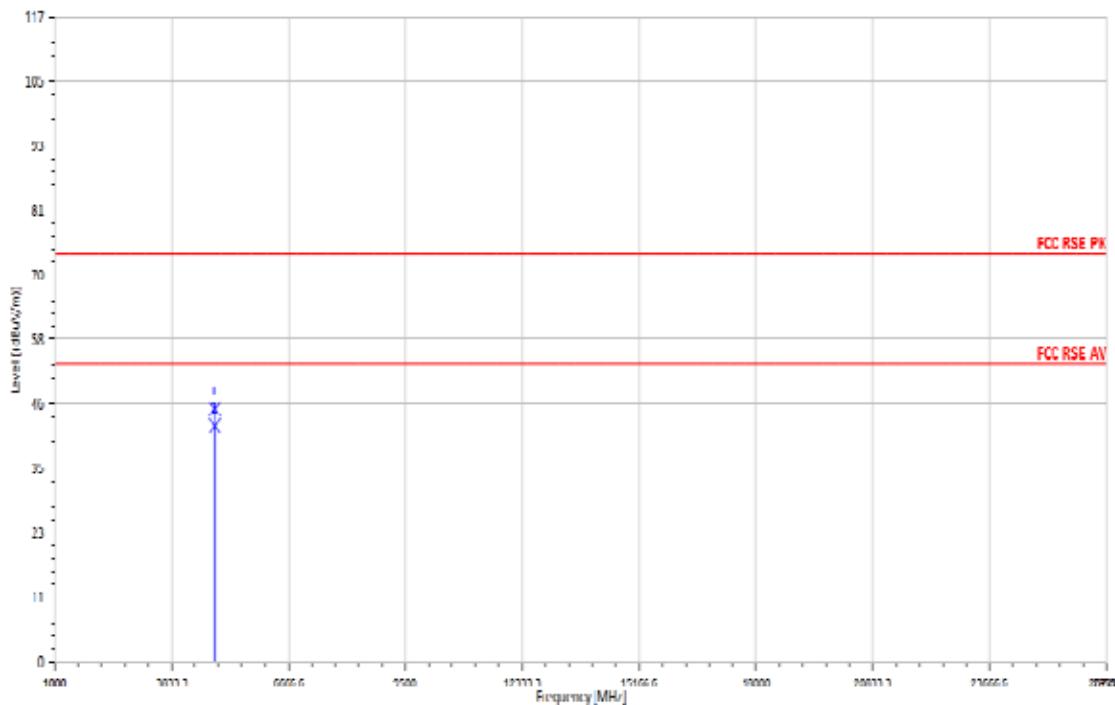
Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
4804.00	H	Peak	45.48	-1.16	44.32	74	-29.68
4804.00	H	Average	42.78	-1.16	41.62	54	-12.38

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Operation Mode : 4.1 Test Date : 2016/5/24
 Fundamental Frequency : 2440 MHz Temp. / Humi. : 22.7deg_C/57RH
 Operation Band : Tx CH Mid Test Engineer : Penny
 EUT Pol. : E2 Measurement Antenna Pol. : Vertical



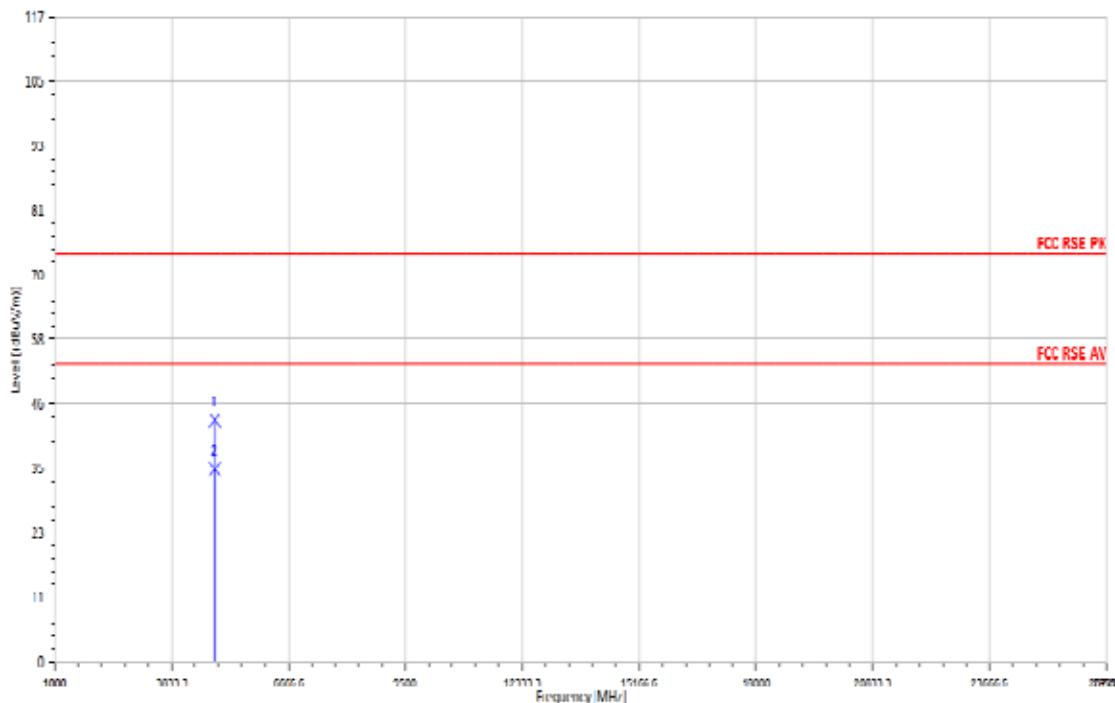
Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4880.00	H	Peak	46.60	-0.71	45.88	74	-28.12
4880.00	H	Average	43.53	-0.71	42.82	54	-11.18

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 90 days only.

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Operation Mode : 4.1 Test Date : 2016/5/24
 Fundamental Frequency : 2440 MHz Temp. / Humi. : 22.7deg_C/57RH
 Operation Band : Tx CH Mid Test Engineer : Penny
 EUT Pol. : E2 Measurement Antenna Pol. : Horizontal



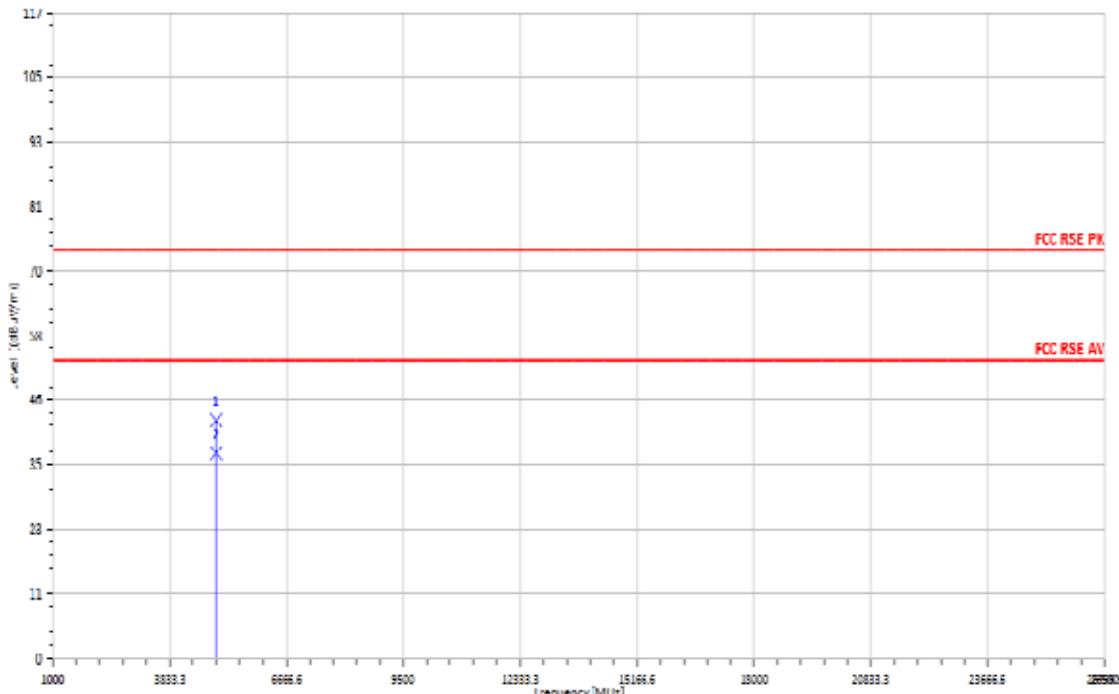
Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4880.00	H	Peak	44.54	-0.71	43.83	74	-30.17
4880.00	H	Average	35.05	-0.71	34.98	54	-19.02

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Operation Mode : 4.1 Test Date : 2016/5/24
 Fundamental Frequency : 2480 MHz Temp. / Humi. : 22.7deg_C/57RH
 Operation Band : Tx CH High Test Engineer : Penny
 EUT Pol. : E2 Measurement Antenna Pol. : Vertical



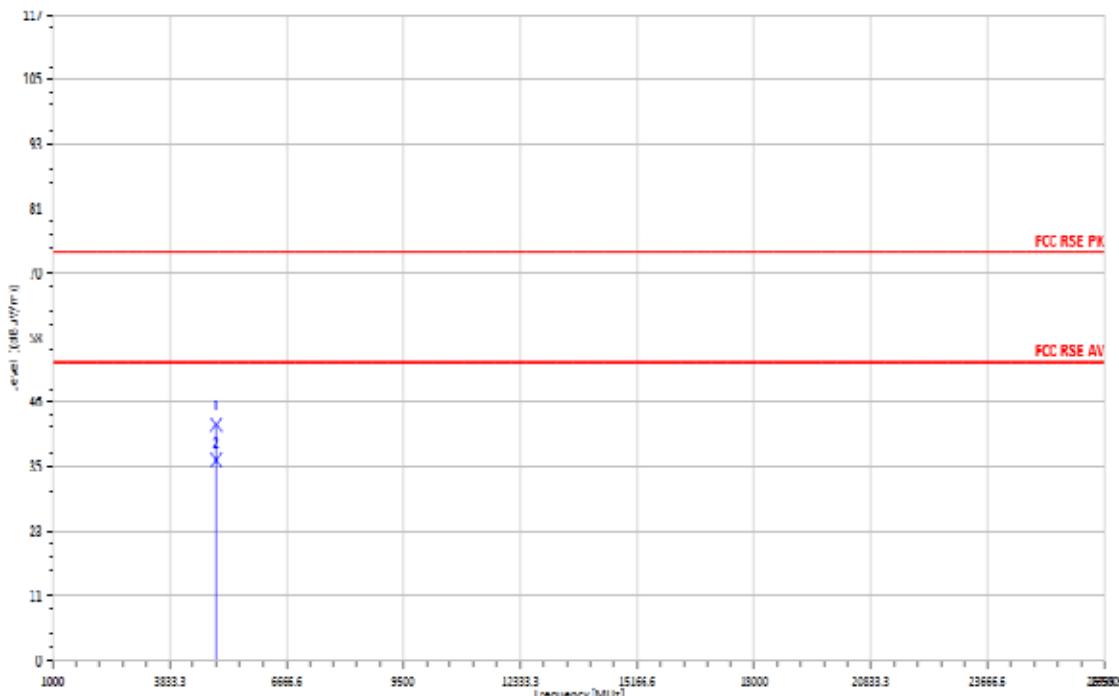
Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4960.00	H	Peak	43.77	-0.66	43.11	74	-30.89
4960.00	H	Average	37.81	-0.66	37.15	54	-16.85

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Operation Mode : 4.1 Test Date : 2016/5/24
 Fundamental Frequency : 2480 MHz Temp. / Humi. : 22.7deg_C/57RH
 Operation Band : Tx CH High Test Engineer : Penny
 EUT Pol. : E2 Measurement Antenna Pol. : Horizontal



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4960.00	H	Peak	43.35	-0.66	42.69	74	-31.31
4960.00	H	Average	36.88	-0.66	36.22	54	-17.78

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11 PEAK POWER SPECTRAL DENSITY

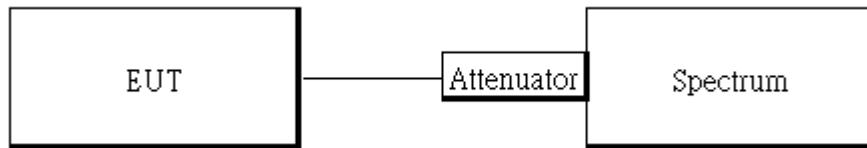
11.1 Standard Applicable:

The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

11.2 Measurement Equipment Used:

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	KEYSIGHT	N9010A	MY54510568	04/14/2016	04/13/2017
DC Block	PASTERNAK	PE8210	RF29	12/12/2015	12/11/2016
Splitter	RF-LAMBAD	RFLT2W1G18 G	RF35	12/12/2015	12/11/2016
Attenuator	WOKEN	218FS-10	RF23	12/12/2015	12/11/2016

11.3 Test Set-up:



11.4 Measurement Procedure:

1. Set analyzer center frequency to DTS channel center frequency.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas.
3. Set the span to 1.5 times the DTS channel bandwidth.
4. Set the RBW = 3 kHz.
5. Set the VBW = 10 kHz.
6. Detector = peak.
7. Sweep time = auto couple.
8. Trace mode = max hold.
9. Allow trace to fully stabilize.
10. Use the peak marker function to determine the maximum amplitude level.

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11.5 Measurement Result:

BT4.1 mode

Frequency (MHz)	RF Power Density (dBm)	Maximum Limit (dBm)	Result
2402	-2.89	8	PASS
2440	-3.34	8	PASS
2480	-5.45	8	PASS

Note: Refer to next page for plots.

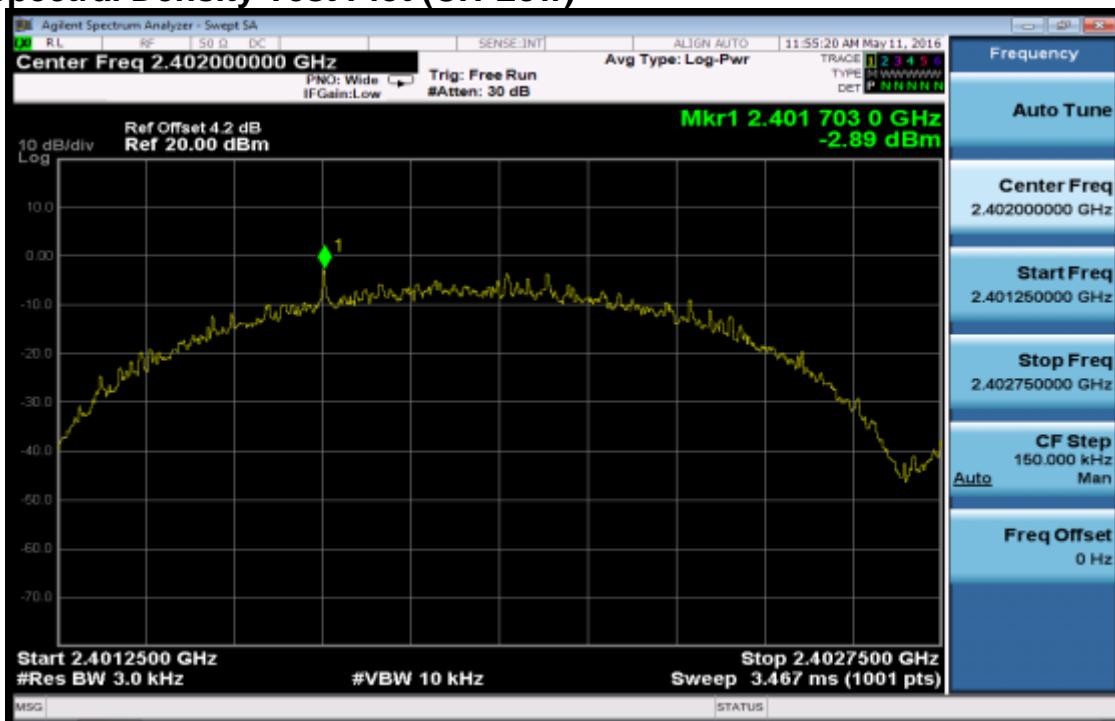
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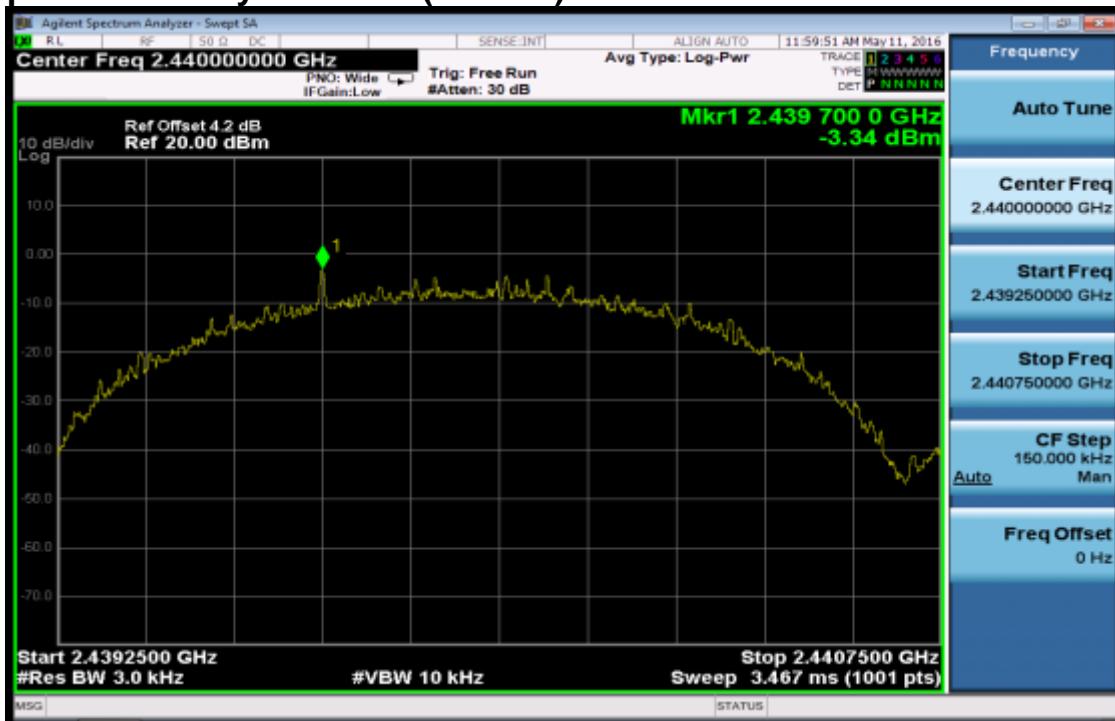
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BT4.1 mode

Power Spectral Density Test Plot (CH-Low)



Power Spectral Density Test Plot (CH-Mid)



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Power Spectral Density Test Plot (CH-High)



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12 ANTENNA REQUIREMENT

12.1 Standard Applicable:

For intentional device, according to §15.203, an intentional radiator shall be designed to ensure that no antenna other than furnished by the responsible party shall be used with the device.

If the transmitting antenna is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi.

12.2 Antenna Connected Construction:

An embedded-in antenna design is used.

The antenna connector is designed with unique type RF connector and no consideration of replacement. Please see EUT photo and antenna spec. for details.

The antenna gain is less than 6dBi. Therefore, it is not necessary to reduce maximum output power limit.

~ End of Report ~

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