

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART C REQUIREMENT AND INDUSTRY CANADA RSS 247

OF

Product Name: Atlas
Brand Name: Under Armour
Model No.: UAFP8
Model Difference: N/A
FCC ID: SHI-UAFP8
IC: 10833A-UAFP8
Report No.: ER/2015/B0049
Issue Date: Dec. 18, 2015
FCC Rule Part: §15.247, Cat: DTS
IC Rule Part: RSS-247 issue 1 :2015
Prepared for: Under Armour Inc.
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Prepared by:



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VERIFICATION OF COMPLIANCE

Applicant: Under Armour Inc.
Tide Point,1020 Hull Street,Baltimore,MD 21230,USA

Product Name: Atlas

Brand Name: Under Armour

Model No.: UAfp8

Model Difference: N/A

FCC ID: SHI-UAfp8

IC: 10833A-UAfp8

Report Number: ER/2015/B0049

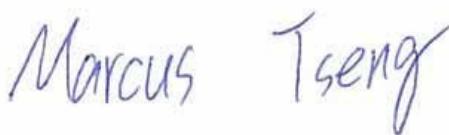
Date of test: Nov. 12, 2015 ~ Dec. 16, 2015

Date of EUT Received: Nov. 12, 2015

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.

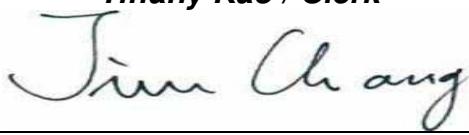
The test results of this report relate only to the tested sample identified in this report.

Test By:**Date**

Dec. 18, 2015

Marcus Tseng / Sr. Engineer**Prepared By:****Date**

Dec. 18, 2015

Tiffany Kao / Clerk**Approved By:****Date**

Dec. 18, 2015

Jim Chang / Asst. Manager

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Revision History

Report Number	Revision	Description	Issue Date
ER/2015/B0049	Rev.00	Initial creation of document	Dec. 18, 2015

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1 GENERAL INFORMATION

1.1 Product Description

General:

Product Name:	Atlas
Brand Name:	Under Armour
Model No.:	UAFP8
Model Difference:	N/A
Product SW/HW version:	N/A/ V1.3
Radio SW/HW version:	N/A / V1.3
Test SW Version:	N/A
RF power setting in TEST SW:	N/A
Power Supply:	3.0Vdc form mercury battery
	Battery: Model No.: N/A, Supplier: N/A

Bluetooth Low Energy:

Frequency Range:	2402 – 2480MHz
Bluetooth Version:	V4.0 single mode
Channel number:	40 channels
Modulation type:	GFSK
Transmit Power:	0.29 dBm
Antenna Designation:	Metal Sheet Antenna, Gain: -5.8dBi

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1.2 Product Feature of Equipment Under Test

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

Product Feature	
Product Name:	Atlas
Brand Name:	Under Armour
Model No.:	UAFP8
Model Difference:	N/A
FCC ID:	SHI-UAFP8
IC :	10833A-UAFP8
Bluetooth Version	V4.1 single mode
Modulation Type:	GFSK

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 V03r03

ANSI C63.10:2013

Canada RSS-247 issue 1: 2015

Canada RSS-Gen issue 4: 2014

Note:

1. All test items have been performed and record as per the above standards.
2. The EUT was placed 1.5m height for frequency above 1GHz in accordance with ANSI C63. 10 :2013

1.4 Test Facility

SGS Taiwan Ltd. Electronics & Communication Laboratory No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan 24803

(TAF code 0513)

FCC Registration Numbers are: 990257

Canada Registration Number: 4620A-5.

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 4.2dB.

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2.5 Configuration of Tested System

Fig. 2-1 Radiated Emission



Fig. 2-2 Conducted Emission

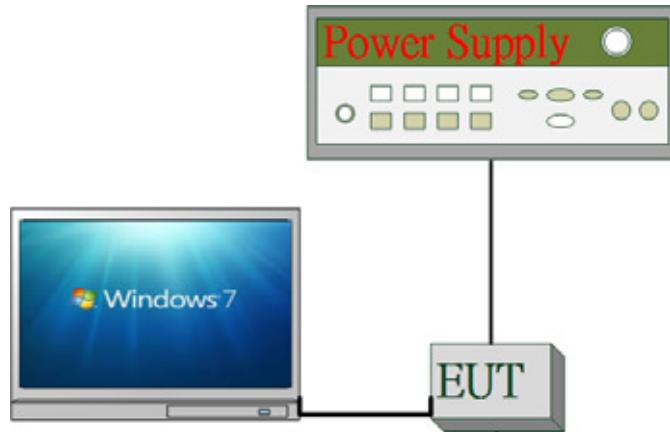


Table 2-1 Equipment Used in Tested System

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	L412	LR-957X7	Shielded	Un-shielded
3.	DC Power Supply	HP	E3640A	KR9330208	N/A	N/A

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3 SUMMARY OF TEST RESULTS

FCC Rules / IC Rules	Description Of Test	Result
§15.207(a) RSS-Gen §8.8	AC Power Line Conducted Emission	N/A
§15.247(b) (3) RSS-247 §5.4(4)	Peak Output Power	Compliant
§15.247(a)(2) RSS-247 §5.2 (1) RSS-Gen §6.6	6dB Bandwidth and 99% Power Emission Bandwidth	Compliant
§15.247(d) RSS-247 §5.5	Conducted Band Edge and Spurious Emission	Compliant
§15.247(d) RSS-247 §5.5	Radiated Band Edge and Spurious Emission	Compliant
§15.247(e) RSS-247 §5.2(2)	Peak Power Density	Compliant
§15.203 §15.247(b) RSS- Gen §6.7 RSS- Gen §8.3	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		

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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	1.0	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	1.0	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 E2 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	1.0	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)	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)	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	ESCI7	100760	05/04/2015	05/03/2016
LISN	SCHWARZBECK	NSLK 8127	8127-649	05/15/2015	05/14/2016
LISN	FCC	FCC-LISN-50/250 -25-2-01	04034	03/13/2015	03/12/2016
Coaxial Cables	N/A	WK CE Cable	N/A	11/26/2015	11/25/2016

6.3 EUT Setup:

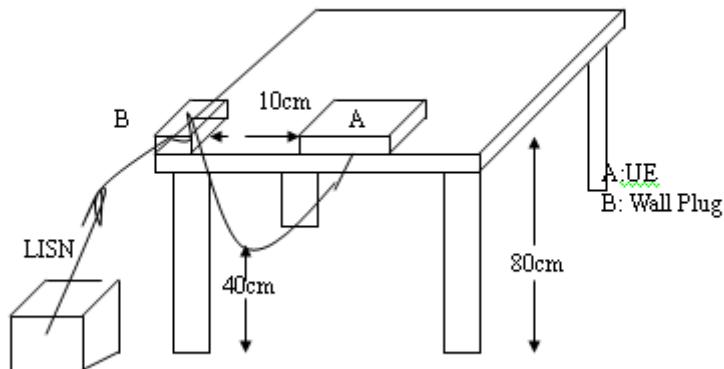
1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI C63.10:2013.
2. The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
3. The LISN was connected with 120Vac/60Hz power source.

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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:

N/A, EUT powered by mercury battery.

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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.

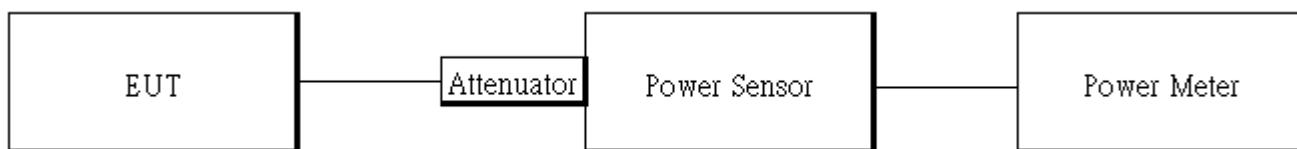
If the transmitting antenna of directional gain greater than 6dBi are used the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the Antenna exceeds 6dBi.

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	ML2495A	1005007	12/20/2014	12/19/2015
Power Sensor	Anritsu	MA2411B	917032	12/20/2014	12/19/2015
Spectrum Analyzer	Agilent	E4446A	MY51100003	01/29/2015	01/28/2016
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016
Splitter	Agilent	11636B	N/A	01/02/2015	01/01/2016

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. Guidance V03r03.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.

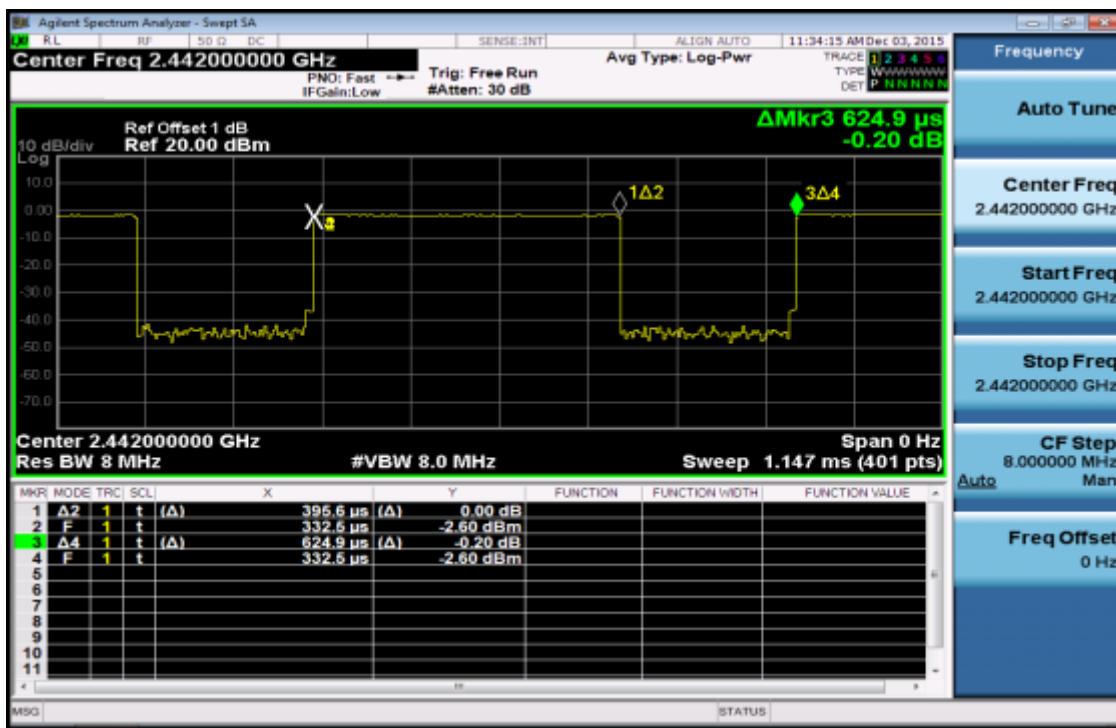
Power Meter:

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)
BLE	63.30	1.99



$$\text{Duty Cycle Factor: } 10 * \log (1/0.633) = 1.99$$

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7.5 Measurement Result:

BT4.0 mode:

CH	Frequency (MHz)	Peak Power Output(dBm)	Required Limit
0	2402	0.29	1 Watt = 30 dBm
20	2442	-0.35	1 Watt = 30 dBm
39	2480	-1.22	1 Watt = 30 dBm

CH	Frequency (MHz)	Average Power Output(dBm)	Required Limit
0	2402	-1.15	1 Watt = 30 dBm
20	2442	-2.06	1 Watt = 30 dBm
39	2480	-2.94	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 & 99% BANDWIDTH MEASUREMENT

8.1 Standard Applicable

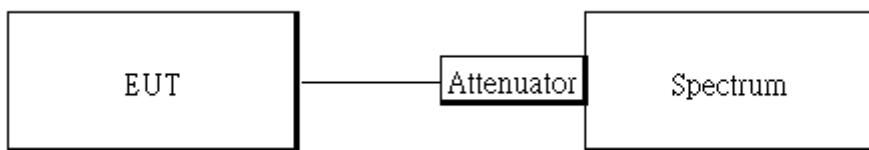
The minimum 6 dB bandwidth shall be at least 500 kHz .

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	Agilent	E4446A	MY51100003	01/29/2015	01/28/2016
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016
Splitter	Agilent	11636B	N/A	01/02/2015	01/01/2016

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. Guidance V03r03.
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%, 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:

BT4.0 mode

Frequency (MHz)	Bandwidth (MHz)	Bandwidth (MHz)	Result
2402	0.6158	> 0.5	PASS
2442	0.6132	> 0.5	PASS
2480	0.5893	> 0.5	PASS

BT4.0 mode

Frequency (MHz)	99%Bandwidth (MHz)
2402	1.052
2442	1.045
2480	1.044

Note: Refer to next page for plots.

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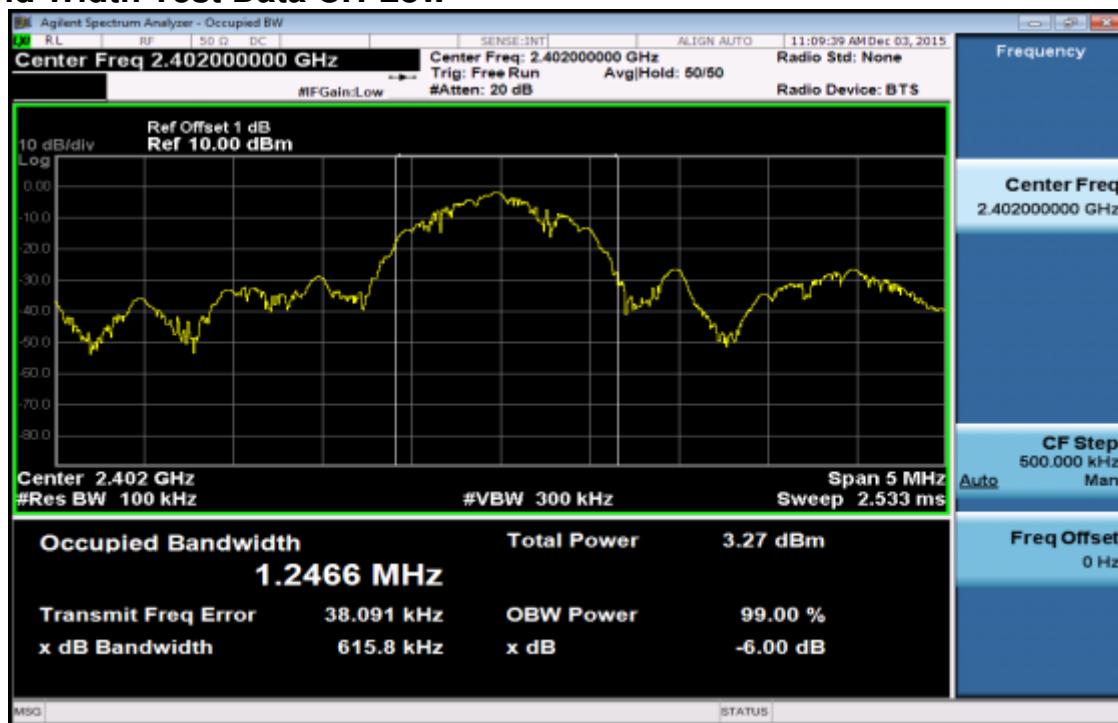
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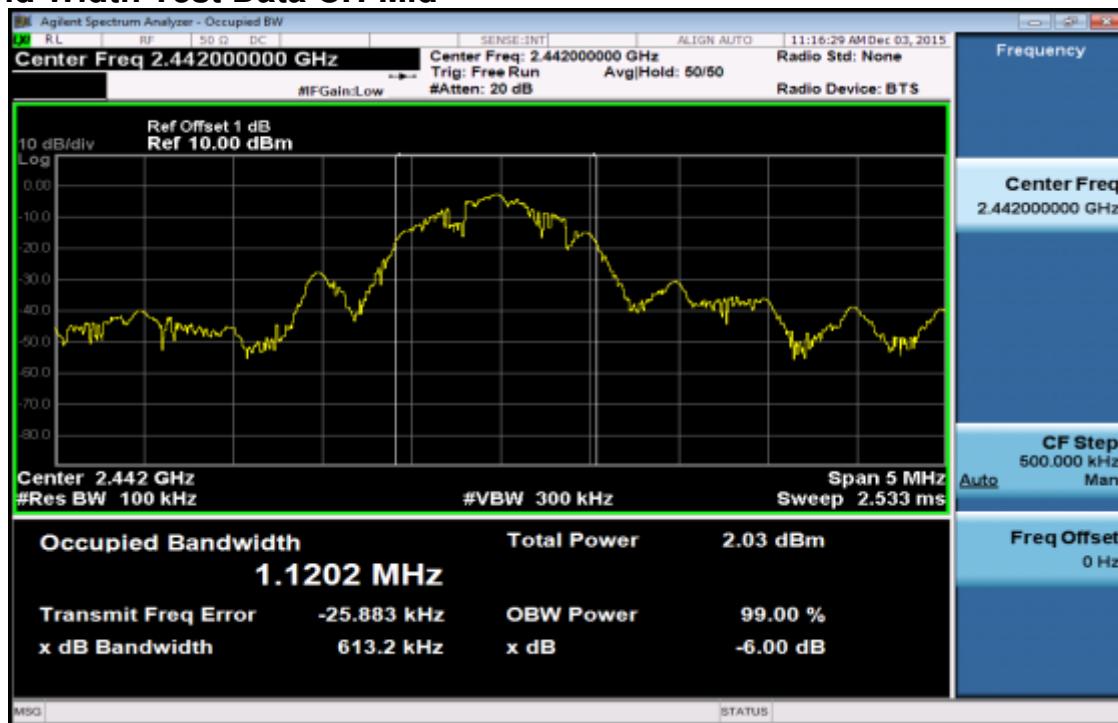
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BT4.0 mode

6dB Band Width Test Data CH-Low



6dB Band Width Test Data CH-Mid

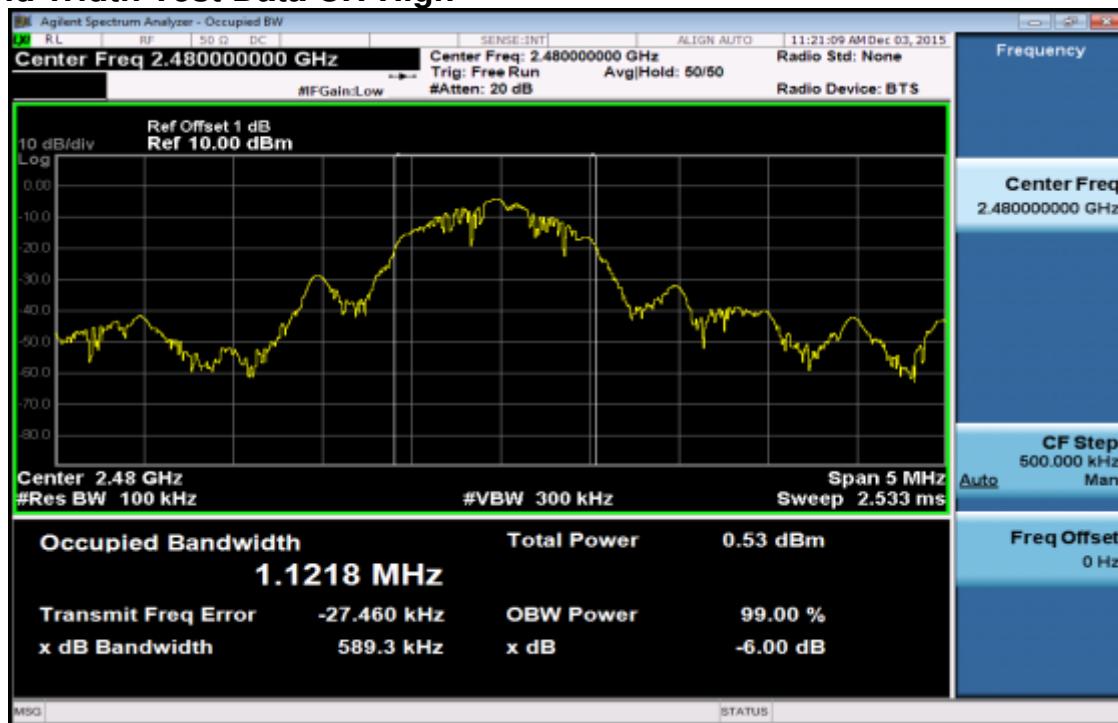


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6dB Band Width Test Data CH-High

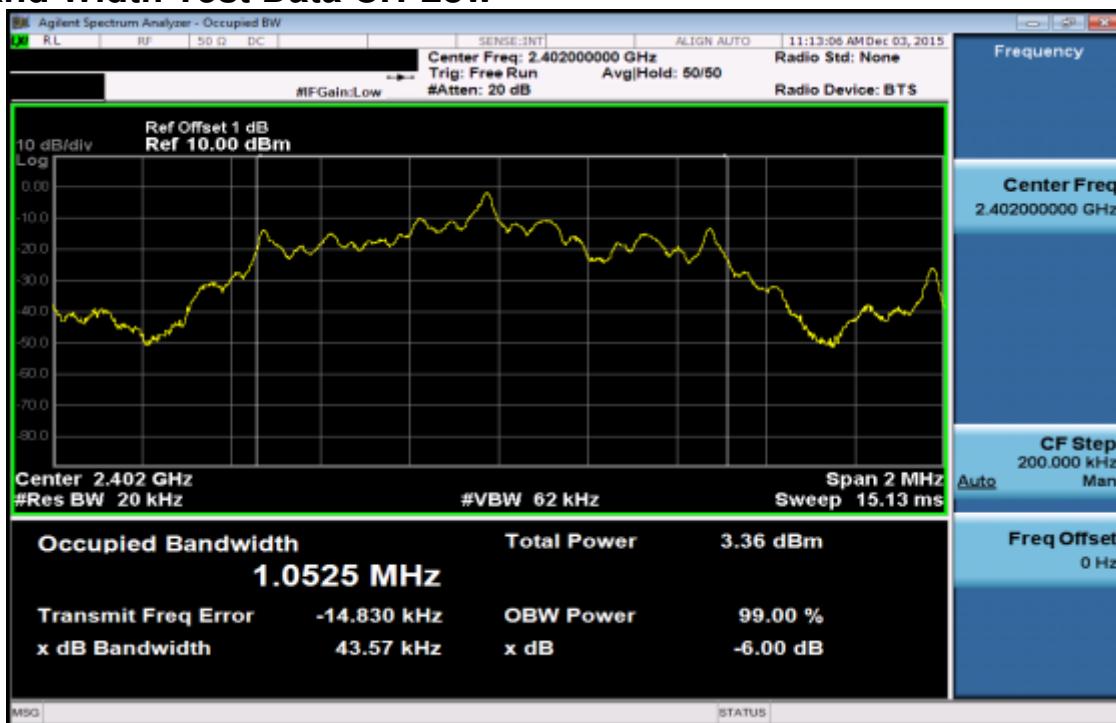


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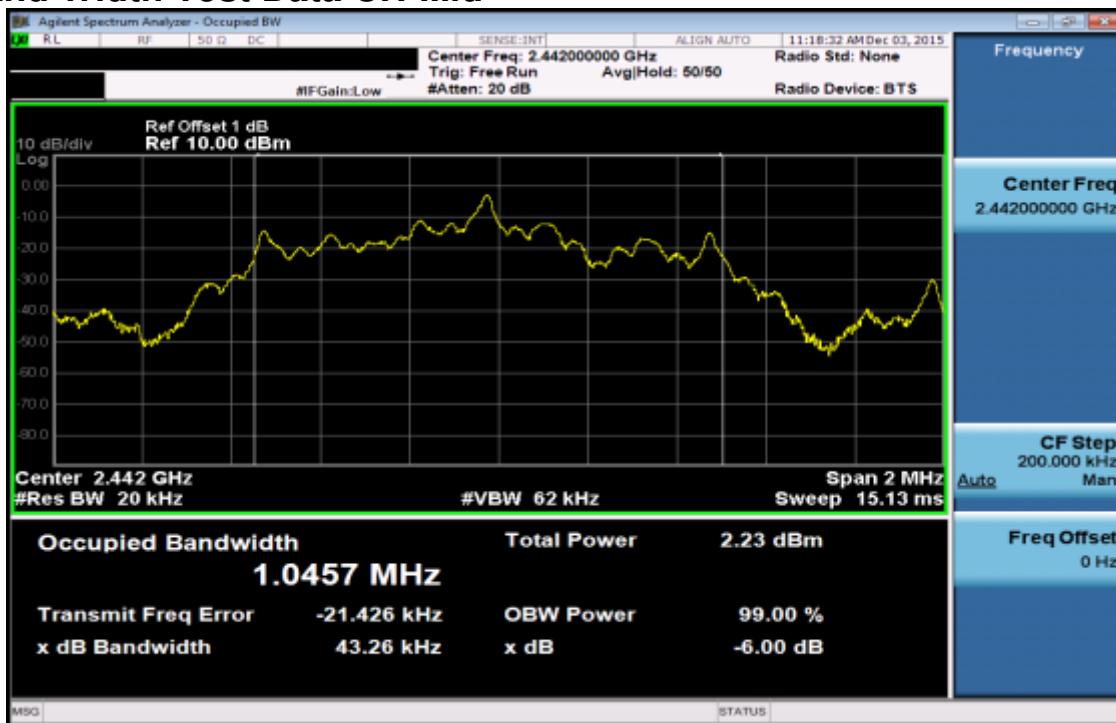
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99% Band Width Test Data CH-Low



99% Band Width Test Data CH-Mid

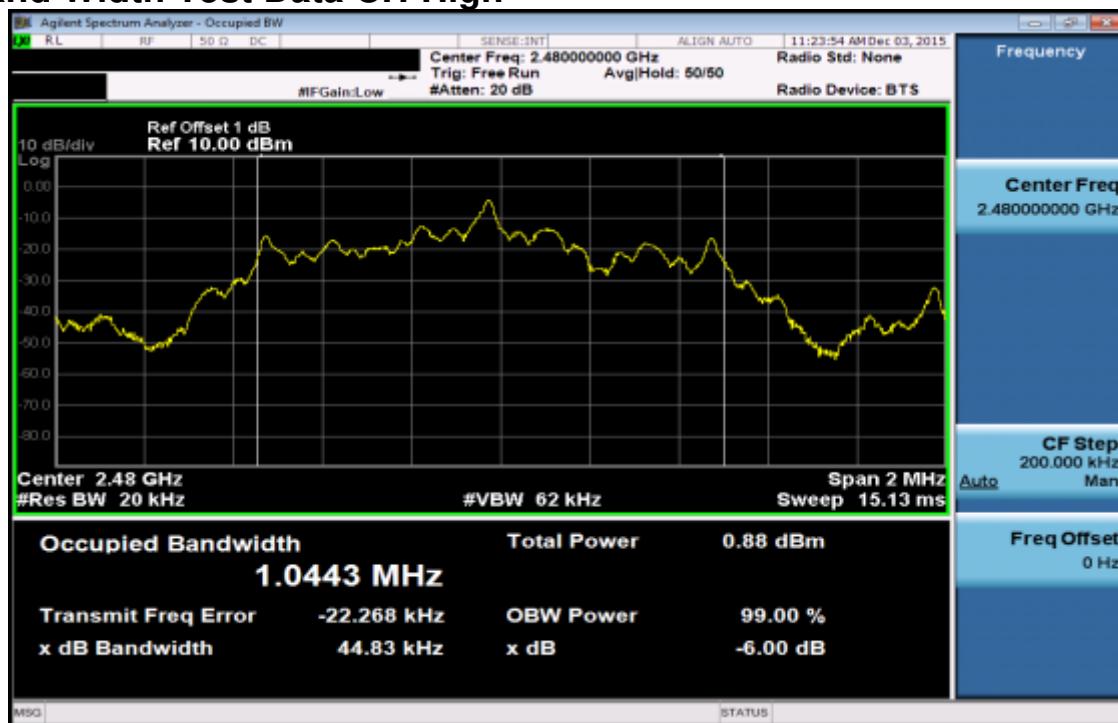


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99% Band Width Test Data CH-High



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9 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

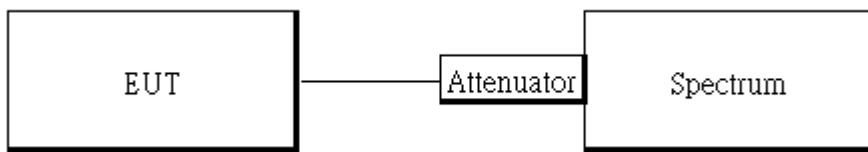
9.1 Standard Applicable

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	Agilent	E4446A	MY51100003	01/29/2015	01/28/2016
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016
Splitter	Agilent	11636B	N/A	01/02/2015	01/01/2016

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. Guidance V03r03.
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. Guidance V03r03.
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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BT4.0 mode

Band Edges Test Data CH-Low



Band Edges Test Data CH-High



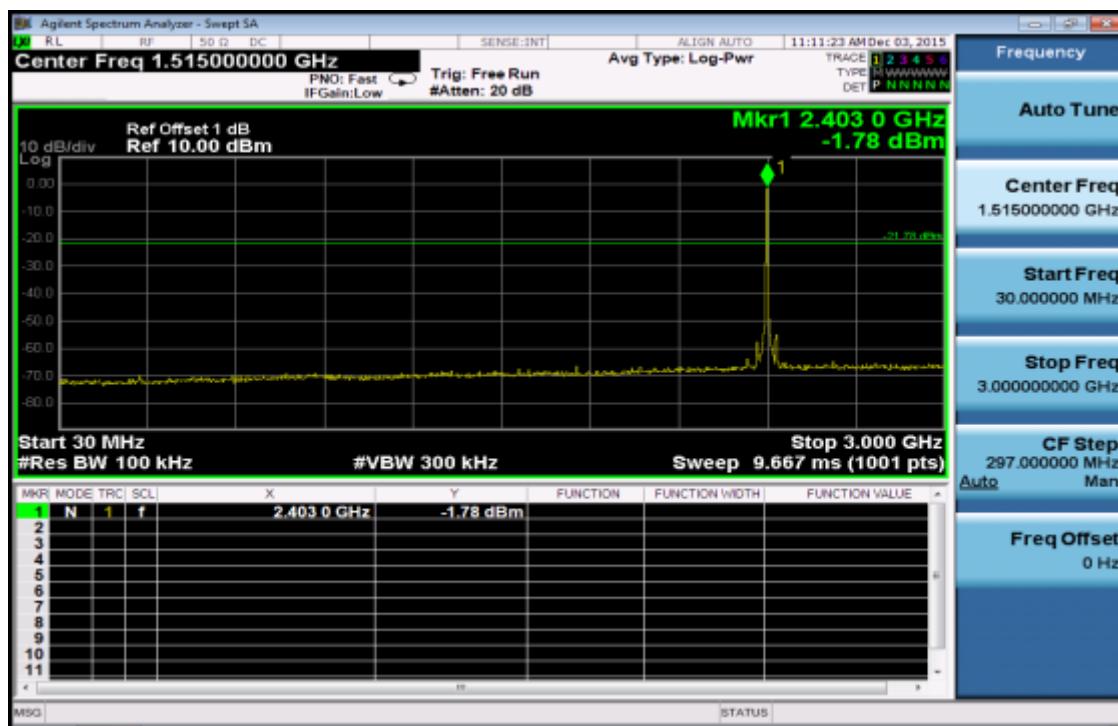
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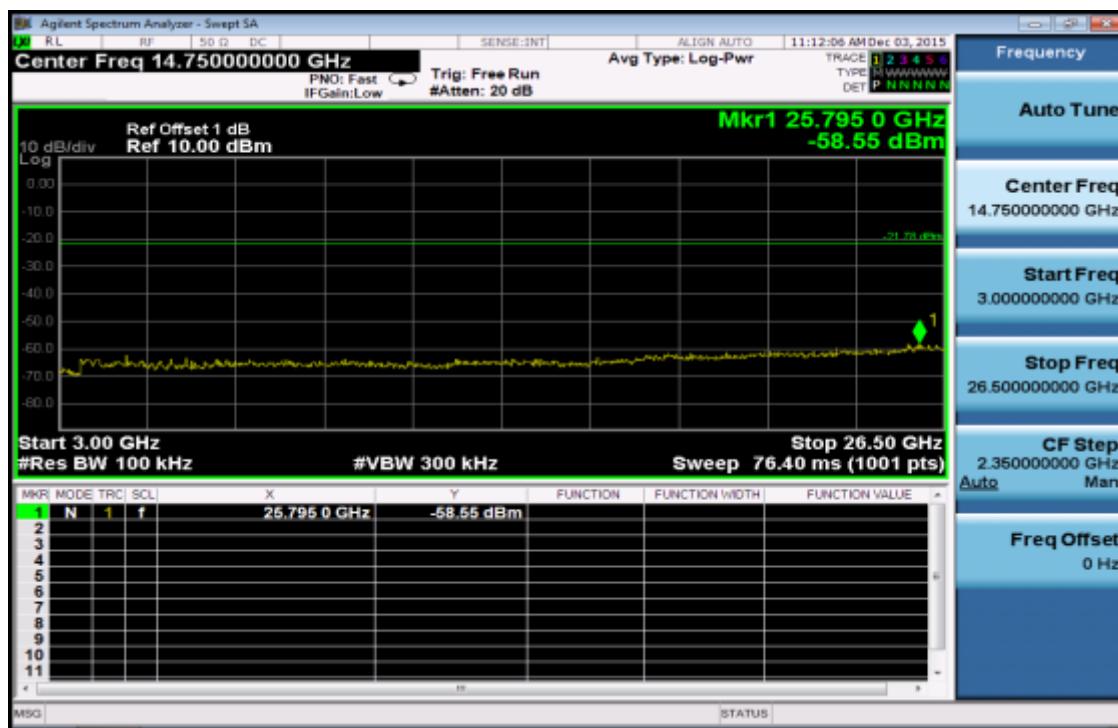
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Conducted Spurious Emission Measurement Result

CH-Low 30MHz – 3GHz



CH-Low 3GHz – 26.5GHz

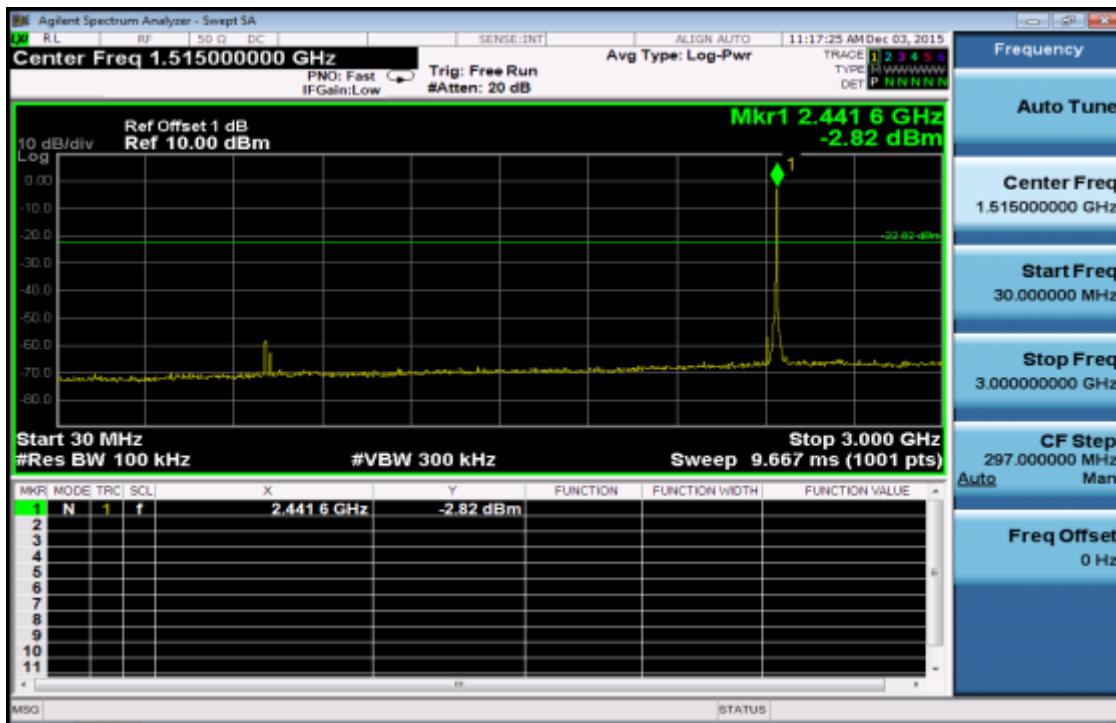


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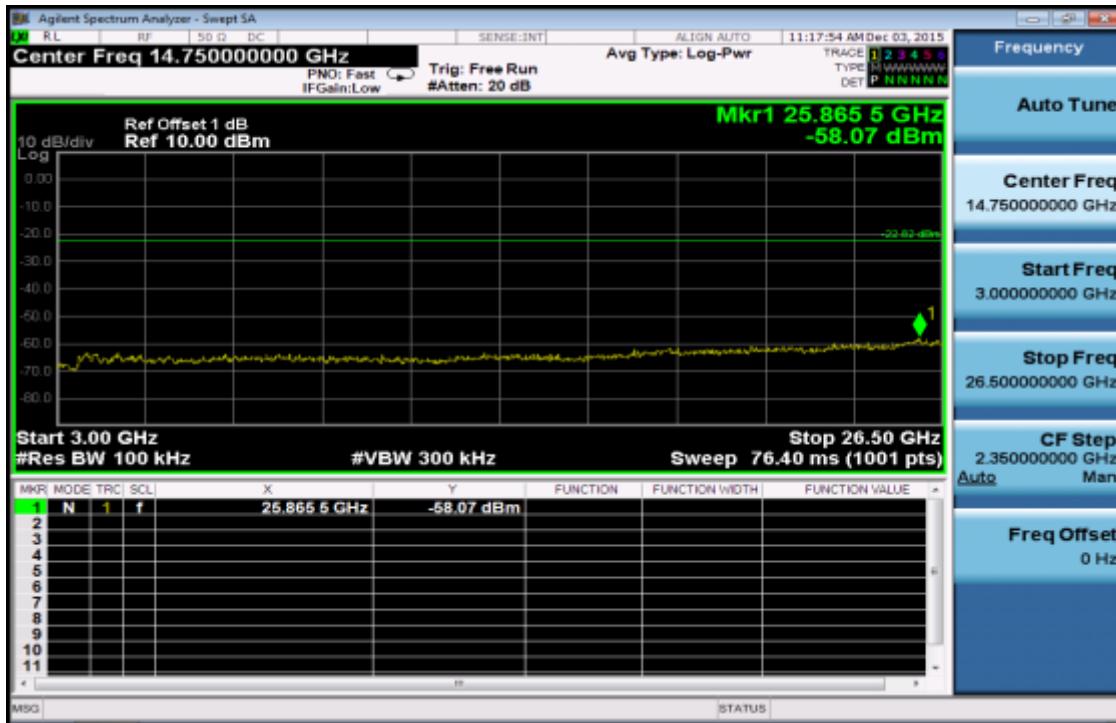
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CH-Mid 30MHz – 3GHz



CH-Mid 3GHz – 26.5GHz

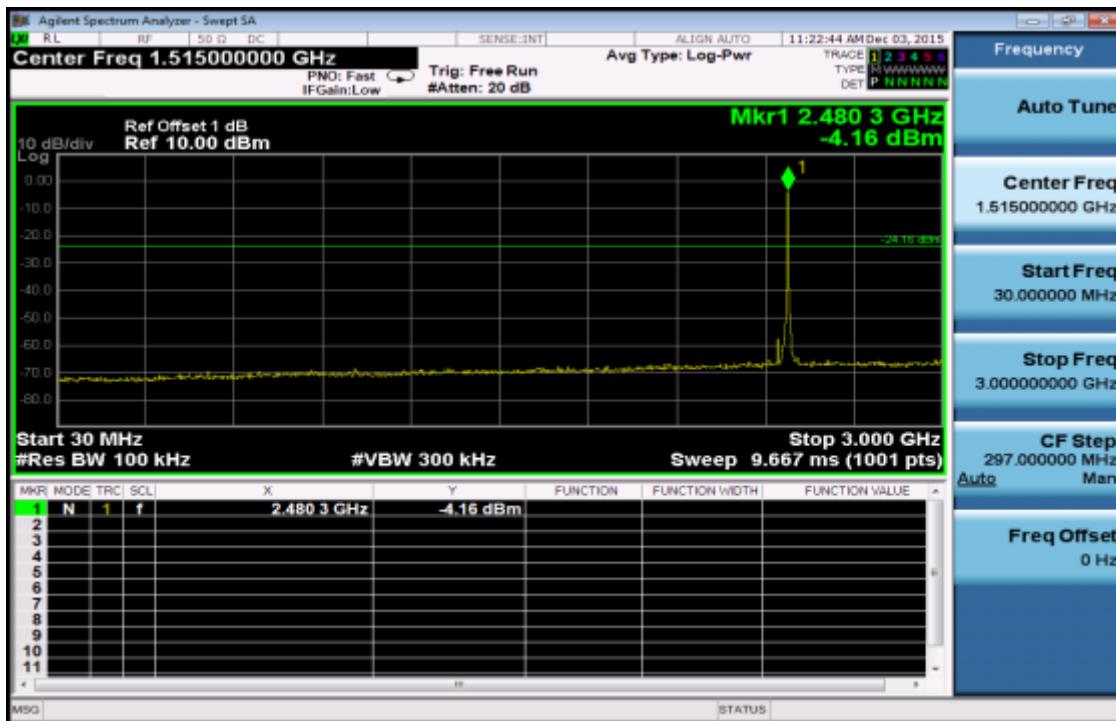


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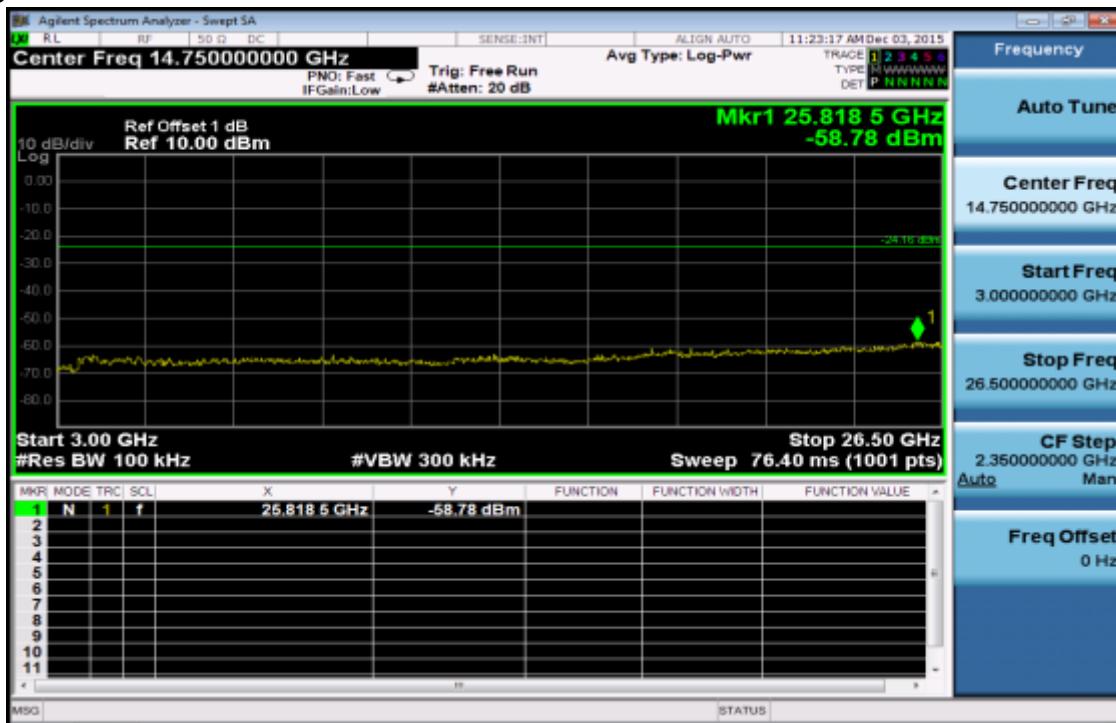
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CH-High 30MHz – 3GHz



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 §15.209 limit as below.

And according to §15.33(a) (1), 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	ESCI7	100760	05/04/2015	05/03/2016
Spectrum Analyzer	Agilent	E4446A	MY51100003	01/29/2015	01/28/2016
EXA Spectrum Analyzer	Agilent	N9010A	MY50420195	12/22/2014	12/21/2015
Spectrum Analyzer	R&S	FSV-30	101398	09/23/2015	09/22/2016
Loop Antenna	ETS.LINDGREN	6502	00143303	12/09/2015	12/08/2016
Bilog Antenna	SCHWAZBECK	VULB9168	378	12/23/2014	12/22/2015
Horn antenna	ETS.LINDGREN	3117	123995	05/05/2015	05/04/2016
Horn Antenna	Schwarzbeck	BBHA9170	184	12/25/2014	12/24/2015
Pre-Amplifier	Agilent	8447D	2944A07676	01/02/2015	01/01/2016
Pre-Amplifier	Agilent	8449B	3008A00578	01/02/2015	01/01/2016
Pre-Amplifier	EMC Instruments Corp.	EMC184045	980135	01/02/2015	01/01/2016
Filter 2400-2483.5 MHz	EWT	EWT-14-016 6	M2	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	004	01/02/2015	01/01/2016
Turn Table	HD	DT420	N/A	N.C.R	N.C.R
Antenna Tower	ChamPro	AM-BS-4500 -B	060776-ABS	N.C.R	N.C.R
Controller	ChamPro	EM1000	060776	N.C.R	N.C.R
Low Loss Cable	Huber Suhner	966_Rx	9	01/02/2015	01/01/2016
3m Site NSA	SGS	966 chamber	N/A	07/01/2015	06/30/2016

NOTE: N.C.R refers to Not Calibrated Required.

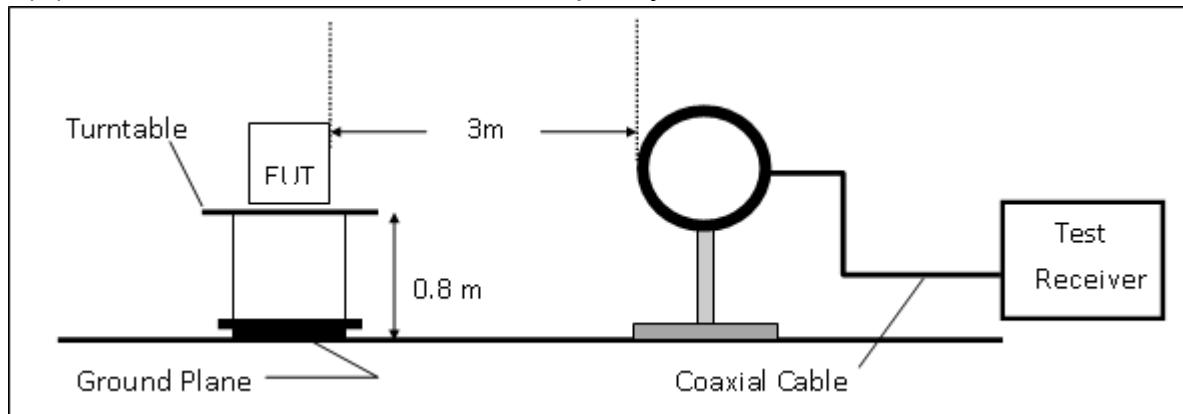
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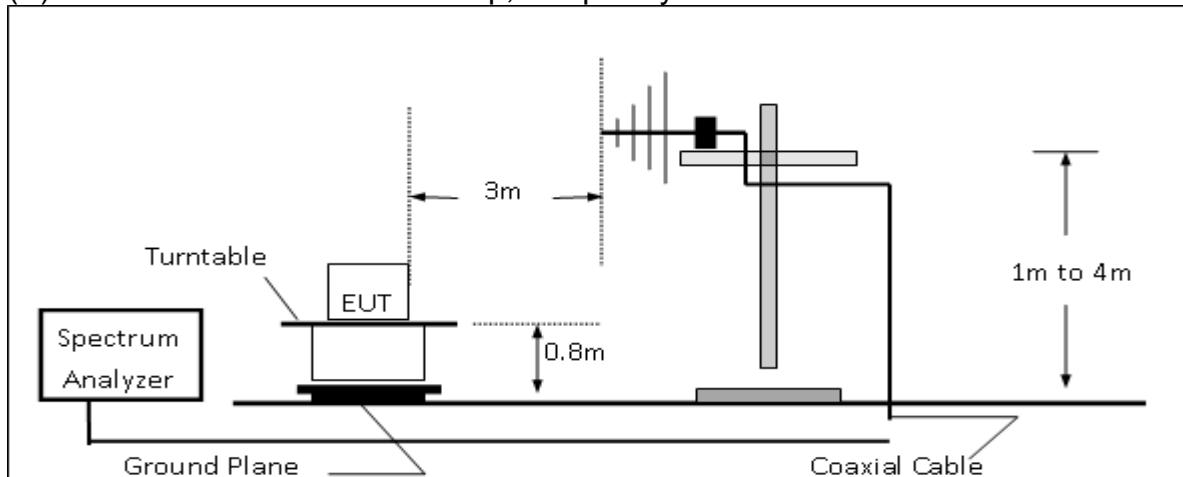
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10.3 Test SET-UP

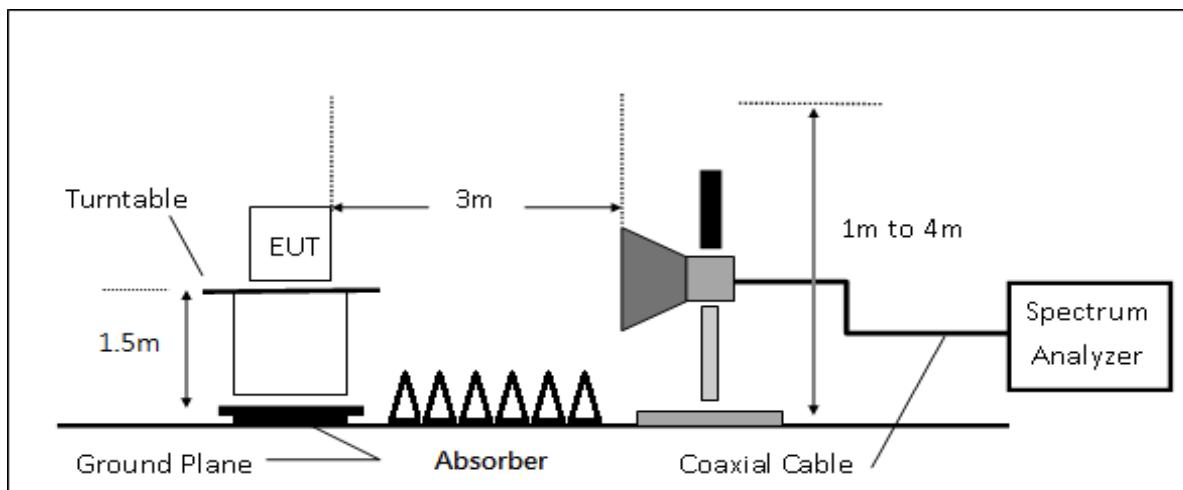
(A) Radiated Emission Test Set-UP Frequency Below 30MHz.



(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. Guidance V03r03.
2. The EUT was placed on a turn table with 0.8m for frequency < 1GHz and 1.5m 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 (BT4.0 mode)

Operation Band	:BT 4.0	Test Date	:2015-12-01
Fundamental Frequency	:2402 MHz	Temp./Humi.	:24 deg_C /59 RH
Operation Mode	:Band Edge LOW	Engineer	:Tin
EUT Pol.	:E2 Plane	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
			Mode	Reading Level				
2390.00	E	Average	29.24	5.16	34.40	54.00	-19.60	
2390.00	E	Peak	42.32	5.16	47.48	74.00	-26.52	

Operation Band	:BT 4.0	Test Date	:2015-12-01
Fundamental Frequency	:2402 MHz	Temp./Humi.	:24 deg_C /59 RH
Operation Mode	:Band Edge LOW	Engineer	:Tin
EUT Pol.	:E2 Plane	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
			Mode	Reading Level				
2390.00	E	Average	30.41	5.16	35.57	54.00	-18.43	
2390.00	E	Peak	42.44	5.16	47.60	74.00	-26.40	

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Operation Band :BT 4.0
 Fundamental Frequency :2480 MHz
 Operation Mode :Band Edge HIGH
 EUT Pol. :E2 Plane

Test Date :2015-12-01
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Tin
 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					
2483.50	E	Average	29.29	6.01	35.30	54.00	-18.70	
2483.50	E	Peak	40.67	6.01	46.68	74.00	-27.32	

Operation Band :BT 4.0
 Fundamental Frequency :2480 MHz
 Operation Mode :Band Edge HIGH
 EUT Pol. :E2 Plane

Test Date :2015-12-01
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Tin
 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					
2483.50	E	Average	30.08	6.01	36.09	54.00	-17.91	
2483.50	E	Peak	41.89	6.01	47.90	74.00	-26.10	

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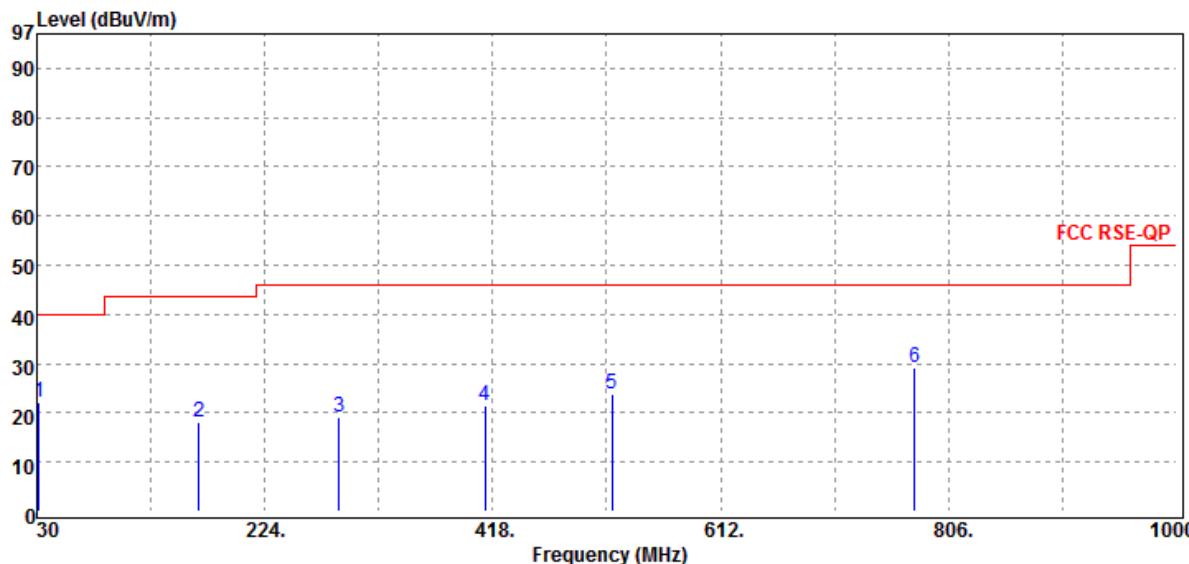
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Radiated Spurious Emission Measurement Result (BT4.0 mode)

For Frequency form 30MHz to 1000MHz

Operation Band :BT 4.0
 Fundamental Frequency :2402 MHz
 Operation Mode :TX LOW
 EUT Pol. :E2 Plane

Test Date :2015-12-01
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Tin
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum Reading Level		Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			PK/QP/AV	dB μ V				
31.94	S	Peak	32.45	32.45	-10.22	22.23	40.00	-17.77
167.74	S	Peak	27.35	27.35	-9.09	18.26	43.50	-25.24
287.05	S	Peak	27.53	27.53	-8.25	19.28	46.00	-26.72
411.21	S	Peak	27.20	27.20	-5.83	21.37	46.00	-24.63
519.85	S	Peak	28.20	28.20	-4.42	23.78	46.00	-22.22
776.90	S	Peak	28.65	28.65	0.58	29.23	46.00	-16.77

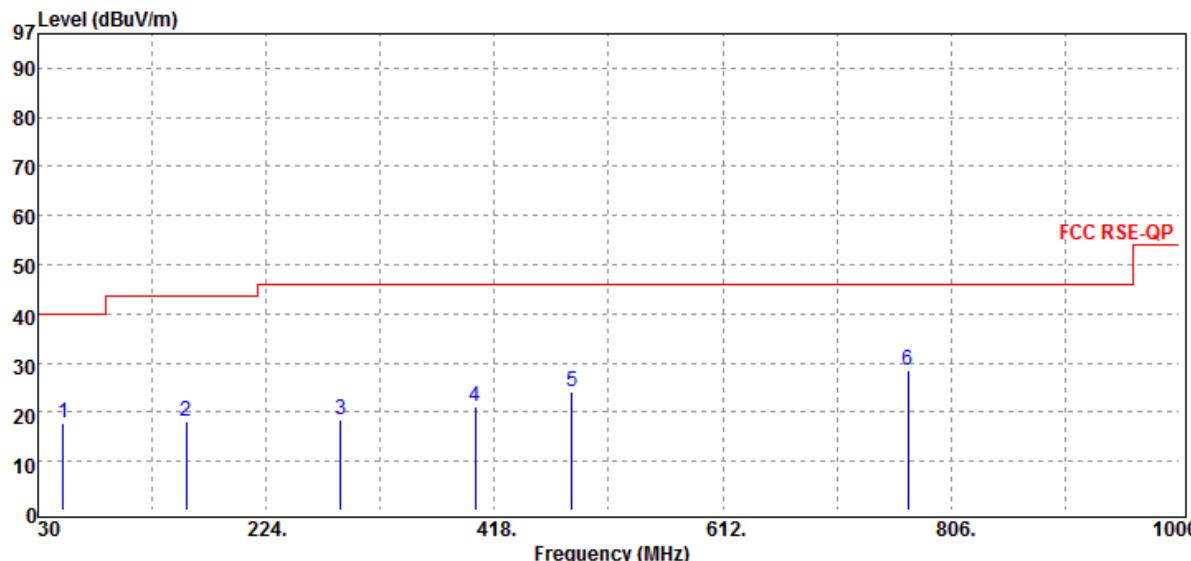
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Operation Band :BT 4.0
 Fundamental Frequency :2402 MHz
 Operation Mode :TX LOW
 EUT Pol. :E2 Plane

Test Date :2015-12-01
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Tin
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum		Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			PK/QP/AV	Reading Level dB μ V				
51.34	S	Peak	27.44	-9.49	17.95	40.00	-22.05	
156.10	S	Peak	27.11	-8.98	18.13	43.50	-25.37	
287.05	S	Peak	26.65	-8.25	18.40	46.00	-27.60	
401.51	S	Peak	27.06	-5.98	21.08	46.00	-24.92	
483.96	S	Peak	28.48	-4.43	24.05	46.00	-21.95	
769.14	S	Peak	27.42	0.99	28.41	46.00	-17.59	

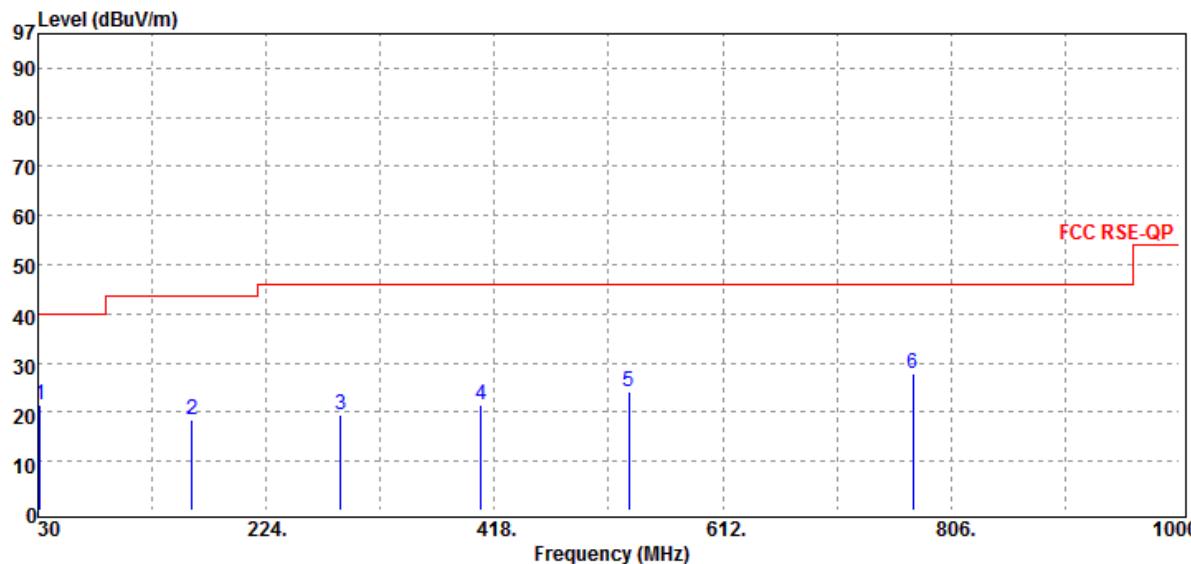
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Operation Band :BT 4.0
 Fundamental Frequency :2442 MHz
 Operation Mode :TX MID
 EUT Pol. :E2 Plane

Test Date :2015-12-01
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Tin
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum		Factor	Actual FS	Limit @3m	Margin
			PK/QP/AV	Reading Level dB μ V				
31.94	S	Peak	31.85	31.85	-10.22	21.63	40.00	-18.37
160.95	S	Peak	27.18	27.18	-8.83	18.35	43.50	-25.15
287.05	S	Peak	27.88	27.88	-8.25	19.63	46.00	-26.37
406.36	S	Peak	27.43	27.43	-5.93	21.50	46.00	-24.50
532.46	S	Peak	28.20	28.20	-4.03	24.17	46.00	-21.83
773.99	S	Peak	27.12	27.12	0.78	27.90	46.00	-18.10

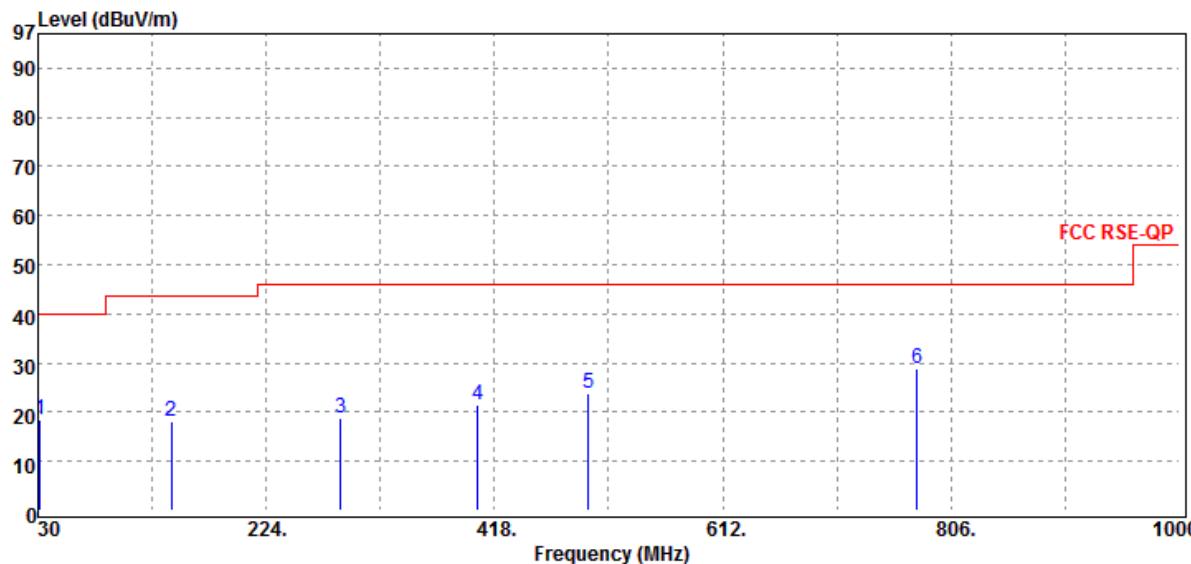
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Operation Band :BT 4.0
 Fundamental Frequency :2442 MHz
 Operation Mode :TX MID
 EUT Pol. :E2 Plane

Test Date :2015-12-01
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Tin
 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					
31.94	S	Peak	28.53	-10.22	18.31	40.00	-21.69	
143.49	S	Peak	27.88	-9.74	18.14	43.50	-25.36	
287.05	S	Peak	27.04	-8.25	18.79	46.00	-27.21	
403.45	S	Peak	27.40	-5.96	21.44	46.00	-24.56	
497.54	S	Peak	28.28	-4.35	23.93	46.00	-22.07	
776.90	S	Peak	28.12	0.58	28.70	46.00	-17.30	

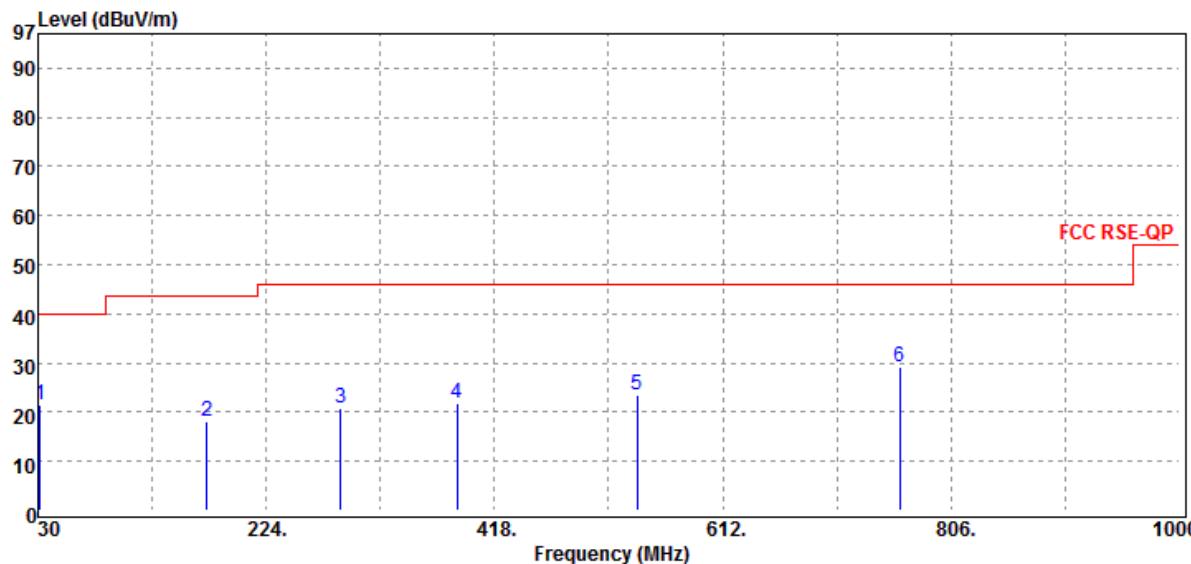
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Operation Band :BT 4.0
 Fundamental Frequency :2480 MHz
 Operation Mode :TX HIGH
 EUT Pol. :E2 Plane

Test Date :2015-12-01
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Tin
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum		Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			PK/QP/AV	Reading Level dB μ V				
31.94	S	Peak	31.79	-10.22	21.57	40.00	-18.43	
173.56	S	Peak	27.92	-9.69	18.23	43.50	-25.27	
287.05	S	Peak	29.08	-8.25	20.83	46.00	-25.17	
385.99	S	Peak	27.98	-6.22	21.76	46.00	-24.24	
539.25	S	Peak	27.60	-4.00	23.60	46.00	-22.40	
762.35	S	Peak	28.05	1.14	29.19	46.00	-16.81	

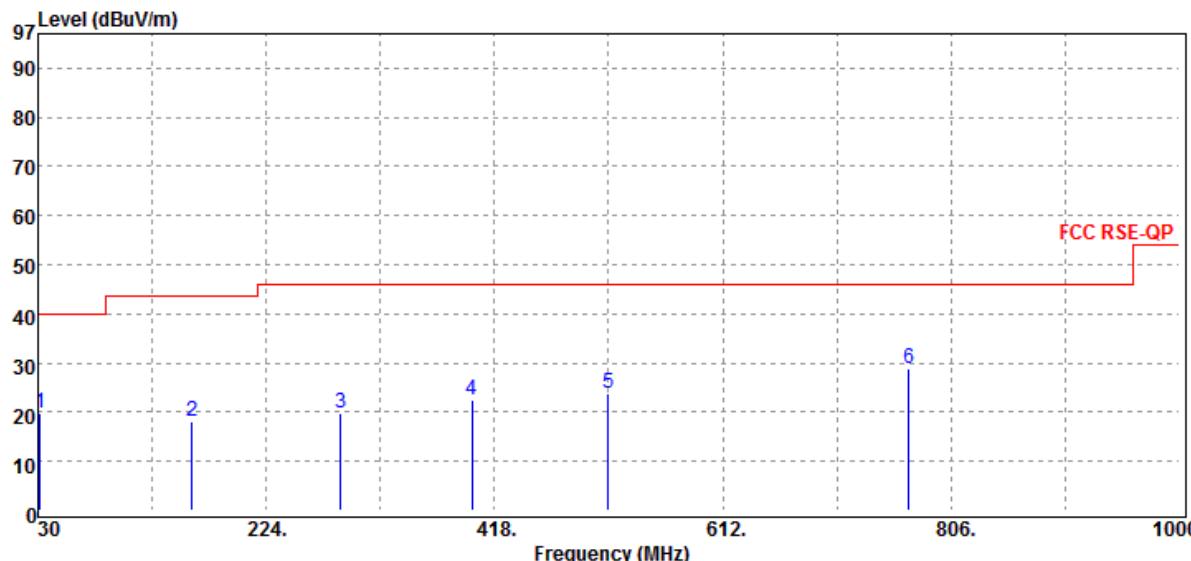
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Operation Band :BT 4.0
 Fundamental Frequency :2480 MHz
 Operation Mode :TX HIGH
 EUT Pol. :E2 Plane

Test Date :2015-12-01
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Tin
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum		Factor	Actual FS	Limit @3m	Margin
			PK/QP/AV	Reading Level dB μ V				
31.94	S	Peak	29.88	-10.22	19.66	40.00	-20.34	
160.95	S	Peak	27.04	-8.83	18.21	43.50	-25.29	
287.05	S	Peak	27.90	-8.25	19.65	46.00	-26.35	
398.60	S	Peak	28.38	-6.03	22.35	46.00	-23.65	
515.00	S	Peak	28.28	-4.51	23.77	46.00	-22.23	
770.11	S	Peak	27.90	0.94	28.84	46.00	-17.16	

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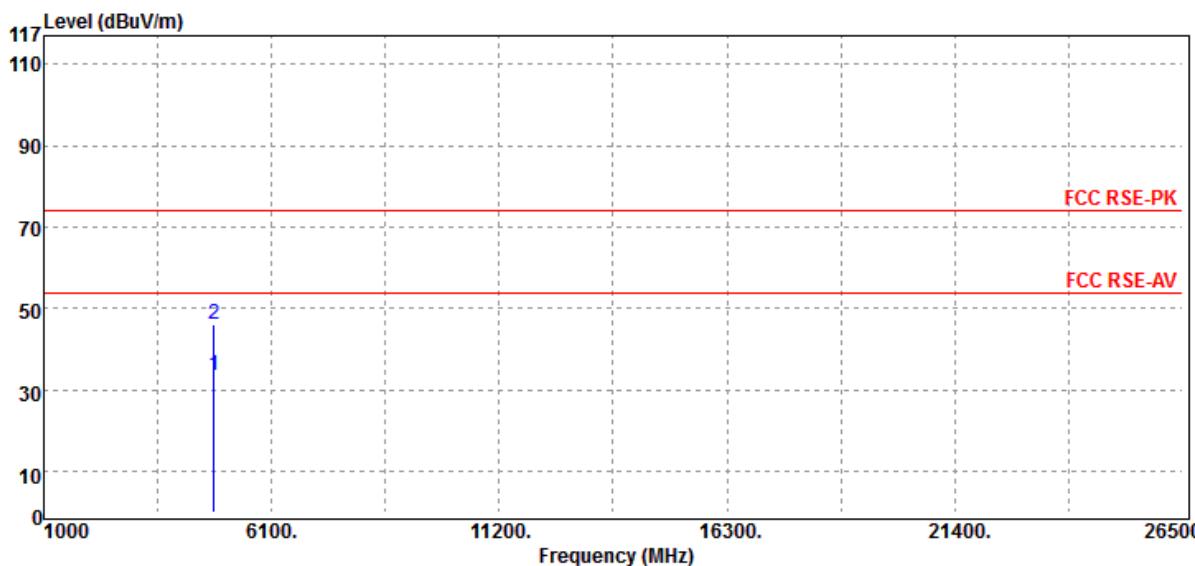
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Radiated Spurious Emission Measurement Result (BT4.1 mode)

For Frequency above 1GHz

Operation Band :BT 4.0
 Fundamental Frequency :2402 MHz
 Operation Mode :TX LOW
 EUT Pol. :E2 Plane

Test Date :2015-12-01
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Tin
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum Reading Level	Factor	Actual FS dB	Limit @3m	Margin
						dB μ V/m	dB μ V/m
4804.00	H	Average	24.03	9.56	33.59	54.00	-20.41
4804.00	H	Peak	36.58	9.56	46.14	74.00	-27.86

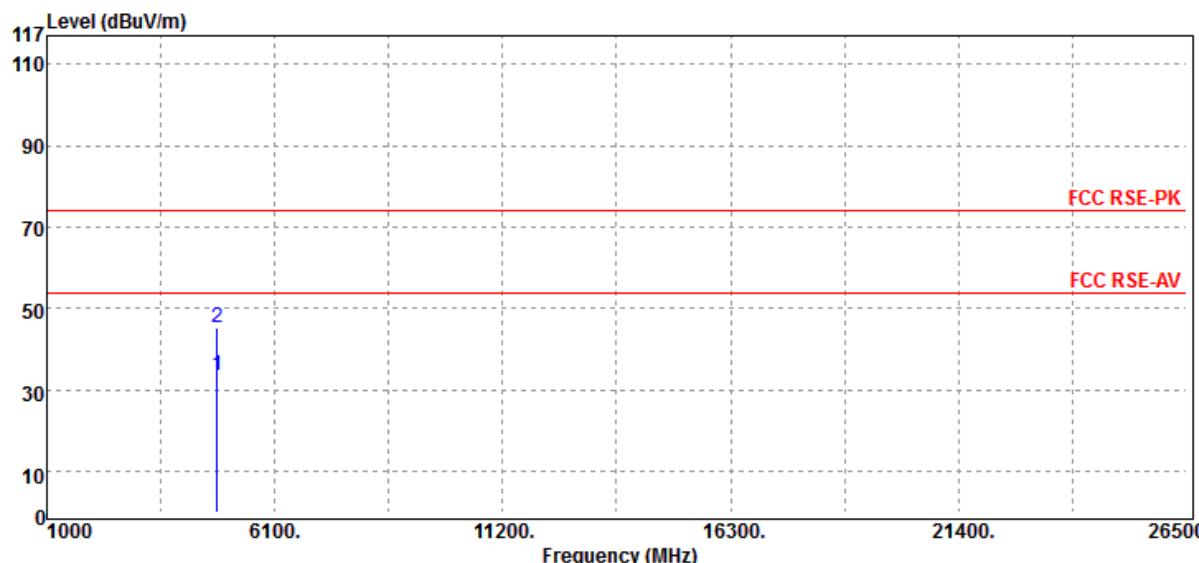
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Operation Band :BT 4.0
 Fundamental Frequency :2402 MHz
 Operation Mode :TX LOW
 EUT Pol. :E2 Plane

Test Date :2015-12-01
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Tin
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum Reading Level		Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			PK/QP/AV	dB μ V				
4804.00	H	Average		24.19	9.56	33.75	54.00	-20.25
4804.00	H	Peak		35.83	9.56	45.39	74.00	-28.61

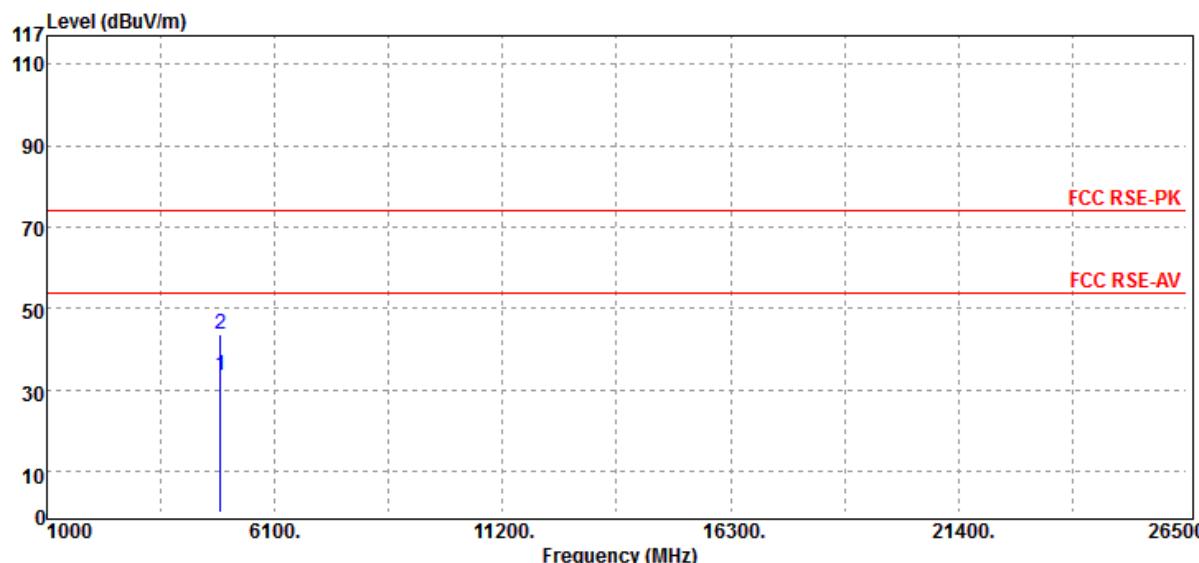
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Operation Band :BT 4.0
 Fundamental Frequency :2442 MHz
 Operation Mode :TX MID
 EUT Pol. :E2 Plane

Test Date :2015-12-01
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Tin
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum	Factor	Actual FS	Limit	Margin
			PK/QP/AV			@3m dB μ V/m	dB
4884.00	H	Average	23.88	9.85	33.73	54.00	-20.27
4884.00	H	Peak	33.77	9.85	43.62	74.00	-30.38

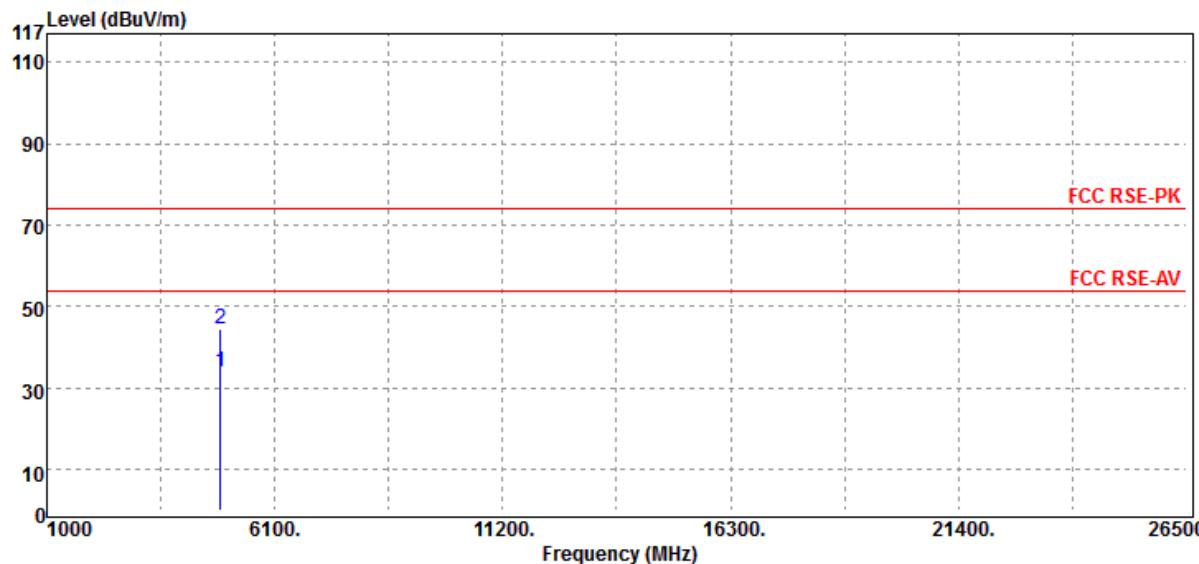
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Operation Band :BT 4.0
 Fundamental Frequency :2442 MHz
 Operation Mode :TX MID
 EUT Pol. :E2 Plane

Test Date :2015-12-01
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Tin
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum	Factor	Actual FS	Limit	Margin
			PK/QP/AV			@3m dB μ V/m	dB
4884.00	H	Average	24.17	9.85	34.02	54.00	-19.98
4884.00	H	Peak	34.66	9.85	44.51	74.00	-29.49

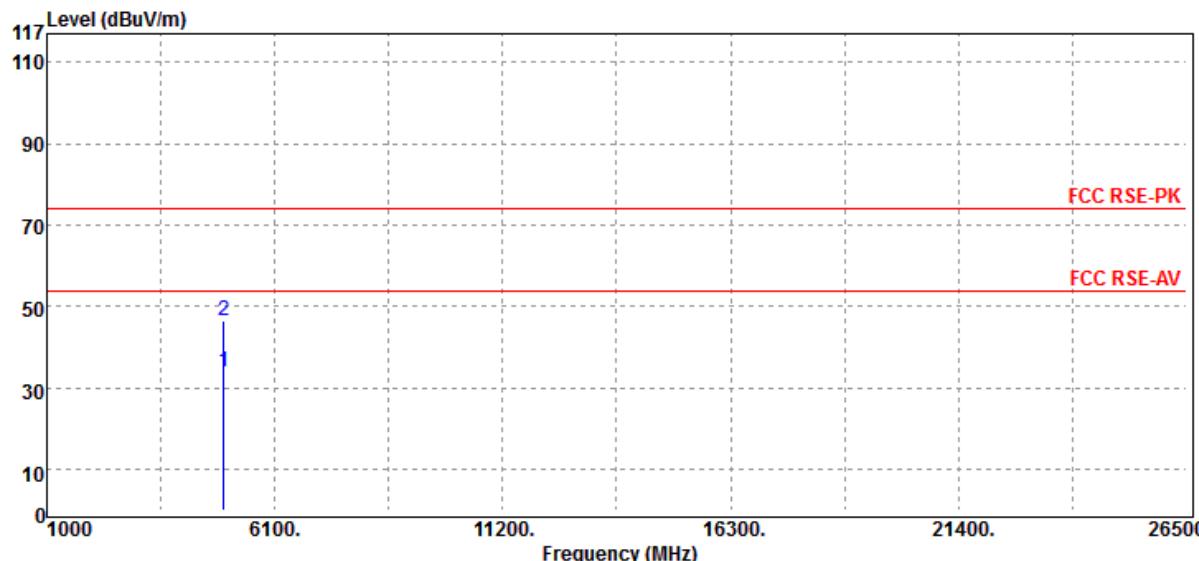
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Operation Band :BT 4.0
 Fundamental Frequency :2480 MHz
 Operation Mode :TX HIGH
 EUT Pol. :E2 Plane

Test Date :2015-12-01
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Tin
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum Reading Level		Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			PK/QP/AV	dB μ V				
4960.00	H	Average		24.12	9.86	33.98	54.00	-20.02
4960.00	H	Peak		36.76	9.86	46.62	74.00	-27.38

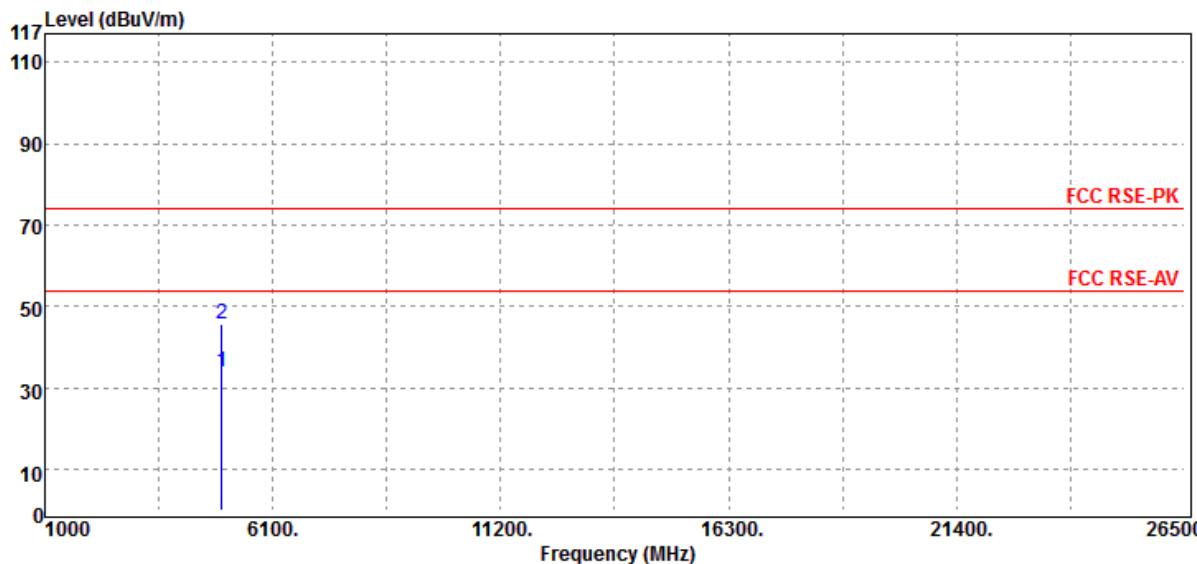
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Operation Band :BT 4.0
 Fundamental Frequency :2480 MHz
 Operation Mode :TX HIGH
 EUT Pol. :E2 Plane

Test Date :2015-12-01
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Tin
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit	Margin
						dB μ V/m	dB μ V/m
4960.00	H	Average	24.24	9.86	34.10	54.00	-19.90
4960.00	H	Peak	35.83	9.86	45.69	74.00	-28.31

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11 PEAK POWER SPECTRAL DENSITY

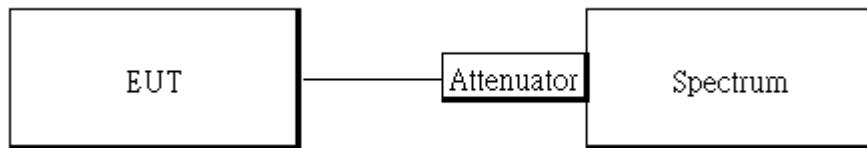
11.1 Standard Applicable:

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	Agilent	E4446A	MY51100003	01/29/2015	01/28/2016
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016
Splitter	Agilent	11636B	N/A	01/02/2015	01/01/2016

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. Guidance V03r03.
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:

BT4.0 mode

Frequency (MHz)	RF Power Density (dBm)	Maximum Limit (dBm)	Result
2402	-2.63	8	PASS
2442	-3.66	8	PASS
2480	-5.03	8	PASS

Note: Refer to next page for plots.

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BT4.0 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.

In case of point-to-point operation, the power shall be reduced by the one dB for every 3 dB that the directional gain of antenna exceeds 6dBi.

According to RSS-GEN 8.3

The applicant for equipment certification, as per RSP-100, must provide a list of all antenna types that may be used with the licence-exempt transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna.

Licence-exempt transmitters that have received equipment certification may operate with different types of antennas. However, it is not permissible to exceed the maximum equivalent isotropically radiated power (e.i.r.p.) limits specified in the applicable standard (RSS) for the licence-exempt apparatus.

Testing shall be performed using the highest gain antenna of each combination of licence-exempt transmitter and antenna type, with the transmitter output power set at the maximum level.⁹ When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer.

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.

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13 RF EXPOSURE (FCC)

13.1 Standard Applicable:

According to §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

This is a Portable device with its physical nature to be used nearby, the distance between radiating structure and human is less than 20cm.

As per KDB 447498 D01 \$4.3.1, The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0 \text{ for 1-g Head \& Body SAR and } \leq 7.5 \text{ for 10-g extremity Hand SAR, where}$

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The table of quick reference in terms of power threshold

SAR Test Exclusion Thresholds for 100 MHz – 6 GHz and ≤ 50 mm

Approximate SAR Test Exclusion Power Thresholds at Selected Frequencies and Test Separation Distances are illustrated in the following Table.

MHz	5	10	15	20	25	mm
150	39	77	116	155	194	SAR Test Exclusion Threshold (mW)
300	27	55	82	110	137	
450	22	45	67	89	112	
835	16	33	49	66	82	
900	16	32	47	63	79	
1500	12	24	37	49	61	
1900	11	22	33	44	54	
2450	10	19	29	38	48	
3600	8	16	24	32	40	
5200	7	13	20	26	33	
5400	6	13	19	26	32	
5800	6	12	19	25	31	

Note that the table present above is the table of quick reference, indexing the level of power threshold with respect to the corresponding frequency. The value of the index may be deviated, and therefore, the derivation of exemption based on KDB447498 D01 is used in this test report, relevantly.

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14 RF EXPOSURE (IC)

14.1 Standard Applicable

As per RSS-102 Issue 5 March 19, 2015, any transmitter shall be compliant with applicable RF exposure prior to being market. In §2.5.1, SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1 (see next page for quick reference).

Output power level shall be the higher of the maximum conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time-averaged output power.

14.2 Measurement Result

Power	Gain	Radiated Power (mW)	Limit (mW)
-1.15	-5.8	0.202	4

So that RF exposure generating from Bluetooth transmitter can be excluded based on RSS-102 Issue 5 March 19, 2015

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Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance^{4,5}

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

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