ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART C REQUIREMENT

OF

Applicant:	**Sirqul, Inc.** **81 Vine St Suite 101c, Seattle, WA 98121**
Product Name:	**Edysen Smart Mesh Socket**
Brand Name:	**Sirqul, Inc.**
Model No.:	**FBDA EDYSEN01**
Model Difference:	**N/A**
FCC ID:	**2AOHD-CBX70**
Report No.:	**ER/2017/B0207**
FCC Rule Part:	**§15.247, Cat: DTS**
Issue Date:	**Dec. 04, 2017**
Date of Test:	**Nov. 15, 2017 ~ Nov. 30, 2017**
Date of EUT Received:	**Nov. 15, 2017**

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.

Prepared By: Tiffany Kao

Tiffany Kao / Clerk

Approved By: Jim Chang

Jim Chang / Asst. Manager

Testing Laboratory
0513

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Revision History

Report Number	Revision	Description	Issue Date
ER/2017/B0207	Rev.00	Initial creation of document	Dec. 04, 2017

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1. GENERAL INFORMATION

1.1 Product Description

General:

Product Name:	Edysen Smart Mesh Socket
Brand Name:	Sirqul, Inc.
Model No.:	FBDA EDYSEN01
Model Difference:	N/A
Product SW/HW version:	N/A / N/A
Radio SW/HW version:	N/A / N/A
Test SW Version:	N/A
RF power setting in TEST SW:	N/A
Power Supply:	100V~230V

Bluetooth Low Energy:

Bluetooth Version	BT V4.0 (dual mode)
Channel number:	40 channels
Modulation type:	GFSK
Transmit Power:	8.37dBm
Frequency Range:	2402 – 2480MHz
Antenna Designation:	PCB Antenna, Gain: -0.1dBi

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1.2 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247

FCC KDB 558074 D01 DTS Meas. Guidance

ANSI C63.10:2013

Note: All test items have been performed and record as per the above standards.

1.3 Test Facility

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

(TAF code 0513)

FCC Registration Numbers are: 509634

1.4 Special Accessories

There are no special accessories used while test was conducted.

1.5 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 1dB.

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2.5 Configuration of Tested System

Fig. 2-1 Radiated Emission

Fig. 2-3 Conducted (Antenna Port) Emission

Fig. 2-2 AC Power Line Conducted Emission

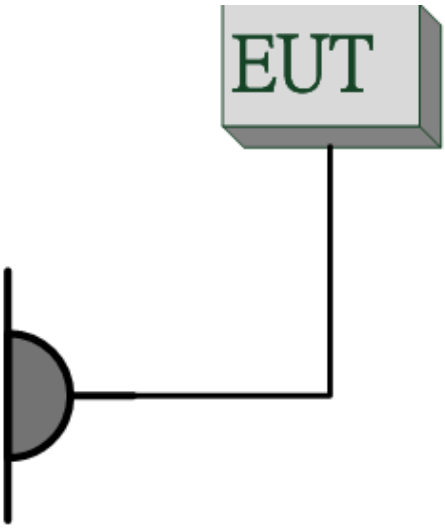

Table 2-1 Equipment Used in Tested System

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	L430	PK-OCGFF	N/A	N/A

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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 and 99% 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

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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)
Bluetooth LE	0 to 39	0,19,39	GFSK	1
RADIATED EMISSION TEST (ABOVE 1 GHz)				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)
Bluetooth LE	0 to 39	0,19,39	GFSK	1

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)
Bluetooth LE	0 to 39	0,19,39	GFSK	1

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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: +/- 2.87 dB
	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: +/- 2.87 dB
	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	05/11/2017	05/10/2018
LISN	SCHWARZ-BECK	NSLK 8127	8127-649	05/22/2017	05/21/2018
LISN	MESS TEC	FCC-LISN-50/250-25-2-01	4034	03/19/2017	03/18/2018
Coaxial Cables	N/A	WK CE Cable	N/A	11/26/2017	11/25/2018

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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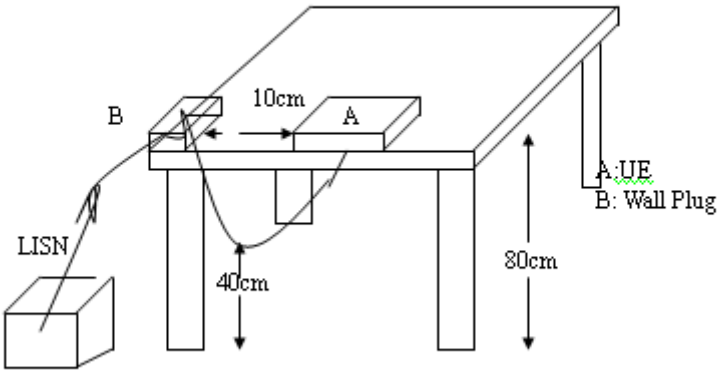
6.4 Test SET-UP (Block Diagram of Configuration)



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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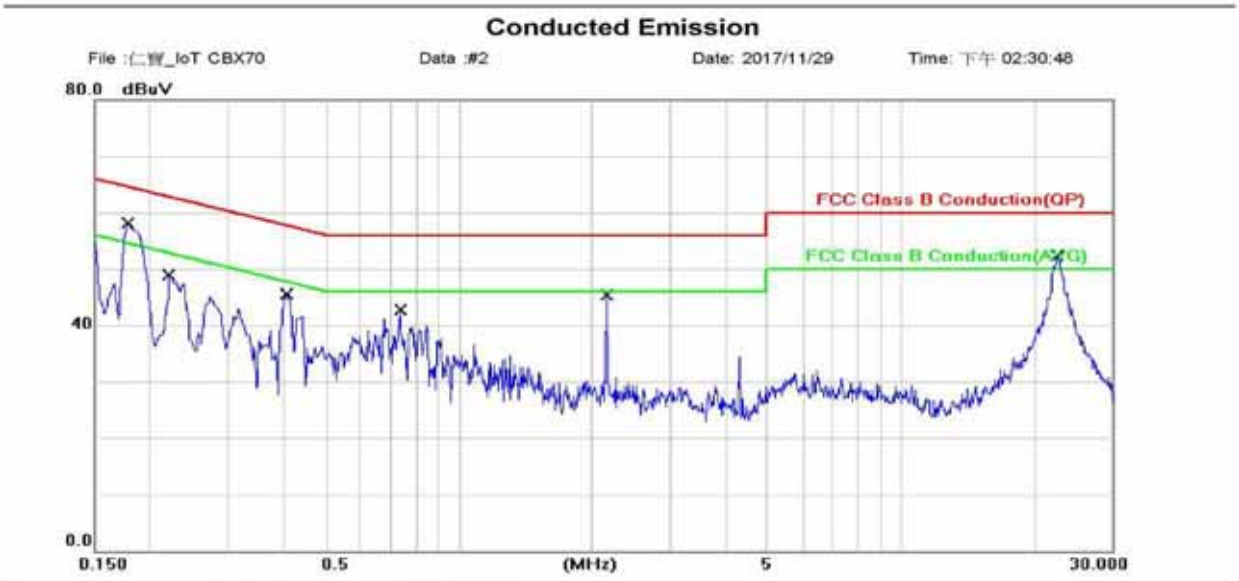
AC POWER LINE CONDUCTED EMISSION TEST DATA

Operation Mode:	Operation mode			Test Date:	Nov. 29, 2017
Temperature:	23 ℃	Humidity:	71 %	Test By:	Tin
				Phase:	L1

Site Conduction Room
Limit: FCC Class B Conduction(QP)
Mode: Operation mode
Note:

Phase: L1
Power: AC 120V/60Hz

Temperature: 20 ℃
Humidity: 58 %



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1806	56.50	0.12	56.62	64.46	-7.84	QP	
2		0.1806	45.10	0.12	45.22	54.46	-9.24	AVG	
3		0.2220	46.60	0.12	46.72	62.74	-16.02	QP	
4		0.2220	35.40	0.12	35.52	52.74	-17.22	AVG	
5		0.4100	45.30	0.11	45.41	57.65	-12.24	QP	
6		0.4100	43.40	0.11	43.51	47.65	-4.14	AVG	
7		0.7380	40.00	0.12	40.12	56.00	-15.88	QP	
8		0.7380	31.60	0.12	31.72	46.00	-14.28	AVG	
9		2.1620	44.02	0.15	44.17	56.00	-11.83	QP	
10	*	2.1620	44.00	0.15	44.15	46.00	-1.85	AVG	
11		22.6020	46.70	0.69	47.39	60.00	-12.61	QP	
12		22.6020	37.80	0.69	38.49	50.00	-11.51	AVG	

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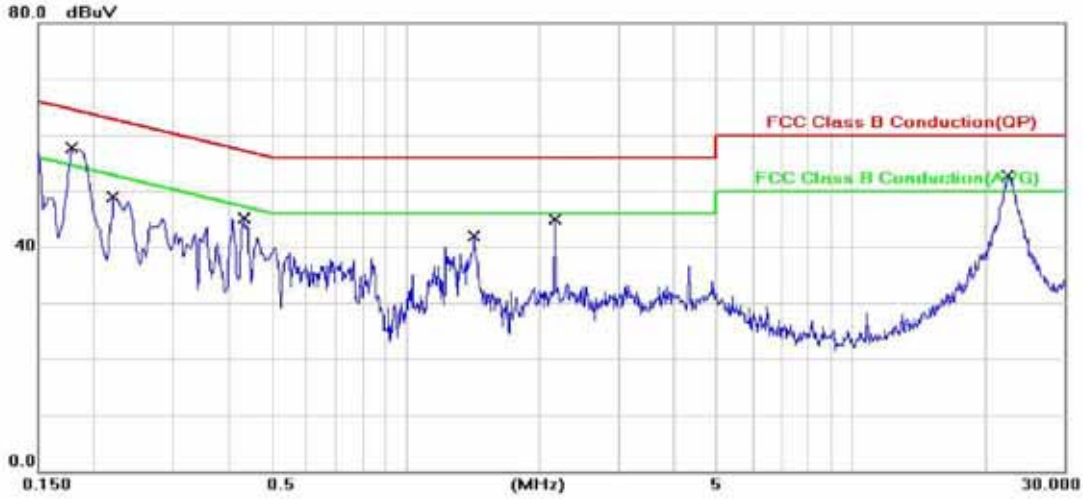
Site: Conduction Room		Phase:	N	Temperature:	20 ℃
Limit: FCC Class B Conduction(QP)		Power:	AC 120V/60Hz	Humidity:	58 %
Mode: Operation mode					
Note:					

Conducted Emission

File :仁寶_IoT CBX70 Data :#3 Date: 2017/11/29 Time: 下午 02:38:22



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1780	55.70	0.07	55.77	64.58	-8.81	QP	
2		0.1780	48.30	0.07	48.37	54.58	-6.21	AVG	
3		0.2220	45.90	0.07	45.97	62.74	-16.77	QP	
4		0.2220	37.60	0.07	37.67	52.74	-15.07	AVG	
5		0.4340	43.10	0.08	43.18	57.18	-14.00	QP	
6		0.4340	35.80	0.08	35.88	47.18	-11.30	AVG	
7		1.4300	39.80	0.10	39.90	56.00	-16.10	QP	
8		1.4300	28.80	0.10	28.90	46.00	-17.10	AVG	
9		2.1620	44.20	0.12	44.32	56.00	-11.68	QP	
10	*	2.1620	44.00	0.12	44.12	46.00	-1.88	AVG	
11		22.3820	46.60	0.54	47.14	60.00	-12.86	QP	
12		22.3820	37.40	0.54	37.94	50.00	-12.06	AVG	

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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.

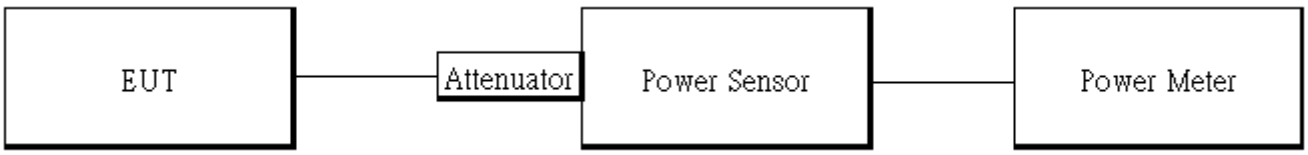
If the transmitting antenna of directional gain greater than 6dBi are used the peak output power form the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the Antenna exceeds 6dBi.

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	12/15/2016	12/14/2017
Power Sensor	Anritsu	MA2411B	917032	12/15/2016	12/14/2017
EXA Spectrum Analyzer	Agilent	N9030A	MY53120760	03/21/2017	03/20/2018
DC Block	Mini-Circuits	BLK-18-S+	1	01/05/2017	01/04/2018

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

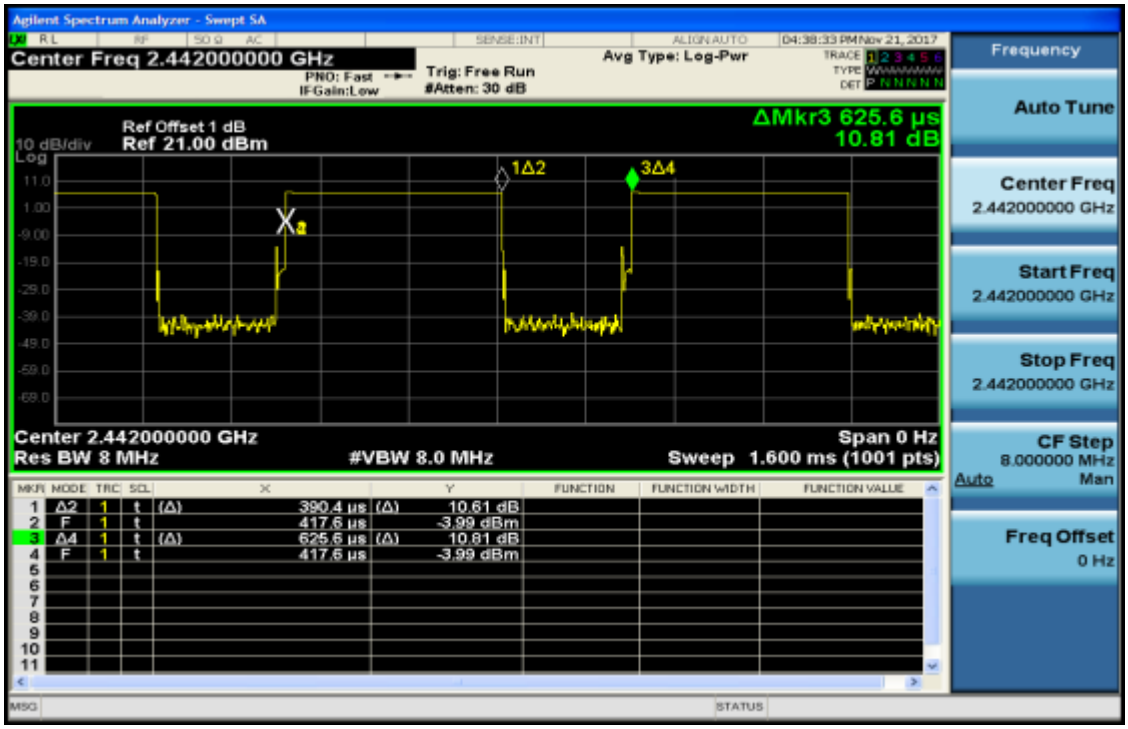
Power Meter:

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	62.40	2.05



Duty Cycle Factor:10*log(1/(62.4/100))=2.05

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7.5 Measurement Result:

BLE mode:

CH	Frequency (MHz)	Peak Power Output (dBm)	Required Limit
0	2402	**8.37**	1 Watt = 30 dBm
20	2442	7.99	1 Watt = 30 dBm
39	2480	7.79	1 Watt = 30 dBm

BLE mode:

CH	Frequency (MHz)	Avg. Output Power (dBm)	Required Limit
0	2402	8.30	1 Watt = 30 dBm
20	2442	7.81	1 Watt = 30 dBm
39	2480	7.59	1 Watt = 30 dBm

**Note: Measured by power meter, cable loss as 1 dB that offsets on the power meter in Peak*
Note: Measured by power meter,* ***as cable loss+ Duty cycle factor that offsets on the power meter*
**Note: Max. Output include tune up tolerance Power is average power*

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8. 6DB BANDWIDTH MEASUREMENT

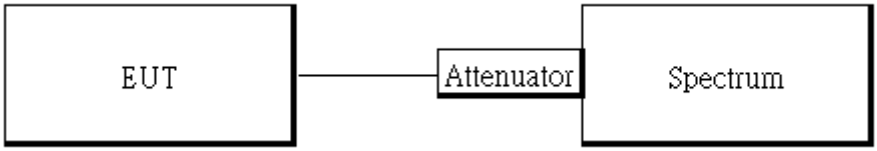
8.1 Standard Applicable

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

8.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EXA Spectrum Analyzer	Agilent	N9030A	MY53120760	03/21/2017	03/20/2018
DC Block	Mini-Circuits	BLK-18-S+	1	01/05/2017	01/04/2018
Attenuator	Mini-Circuit	BW-S10W2+	2	01/05/2017	01/04/2018

8.3 Test Set-up:



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.
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. Repeat above procedures until all test default channel is completed

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8.5 Measurement Result:

BLE mode

Frequency (MHz)	6dB BW (MHz)	BW (MHz)	Result
2402	0.70632	> 0.5	PASS
2442	0.72237	> 0.5	PASS
2480	0.71377	> 0.5	PASS

Note: Refer to next page for plots.

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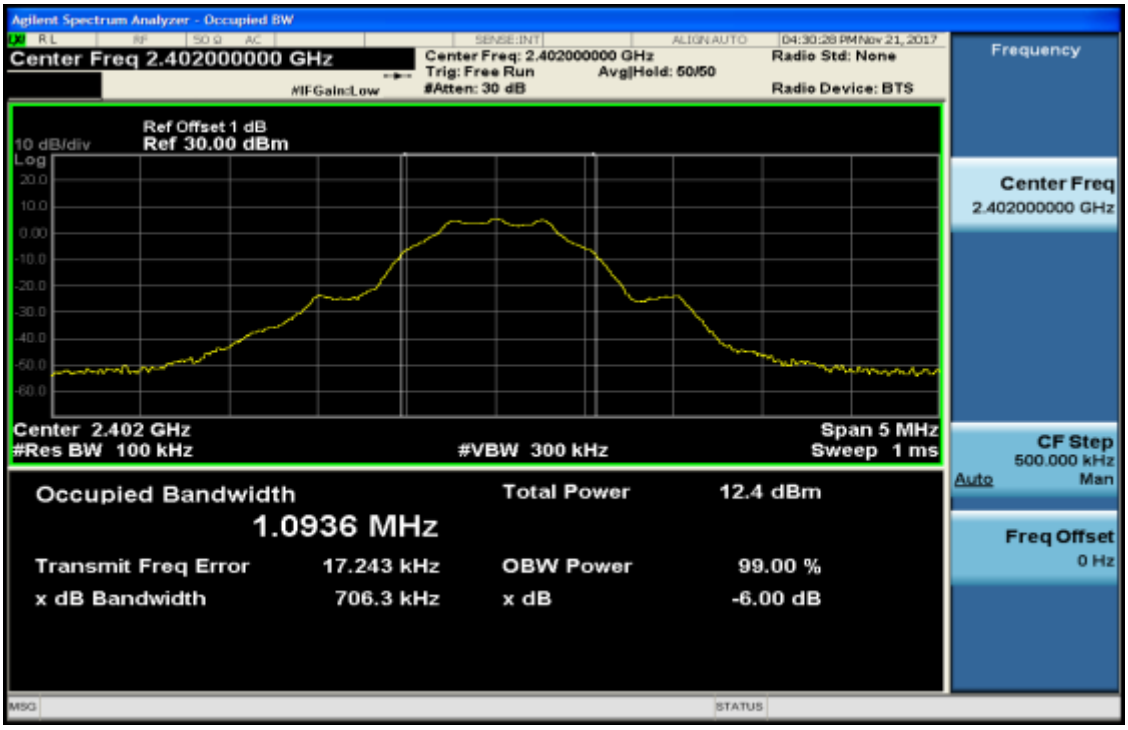
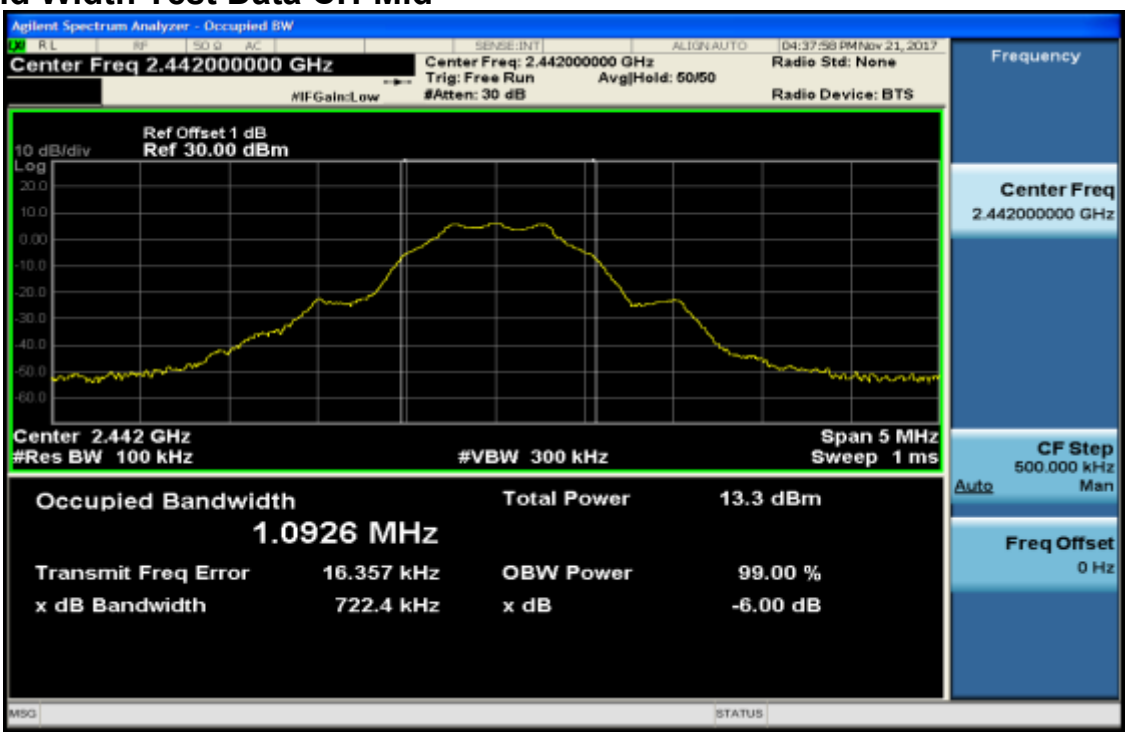
BLE mode
6dB Band Width Test Data CH-Low



6dB Band Width Test Data CH-Mid



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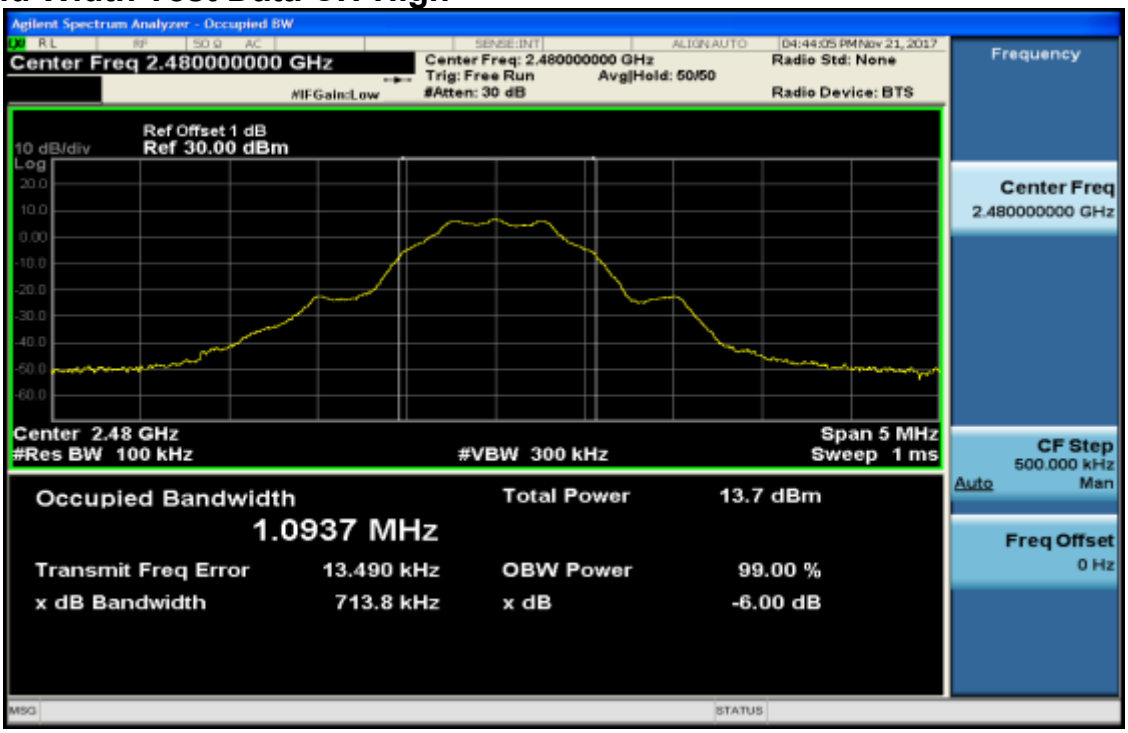
6dB Band Width Test Data CH-High



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9. CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

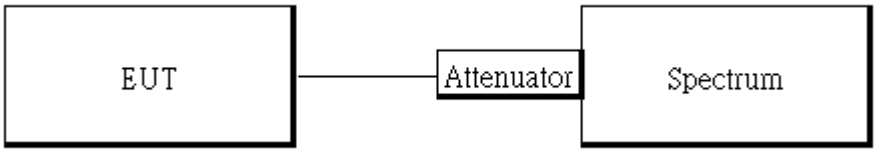
9.1 Standard Applicable

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.
EXA Spectrum Analyzer	Agilent	N9030A	MY53120760	03/21/2017	03/20/2018
DC Block	Mini-Circuits	BLK-18-S+	1	01/05/2017	01/04/2018
Attenuator	Mini-Circuit	BW-S10W2+	2	01/05/2017	01/04/2018

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.
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.
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

1. *Refer to next page spectrum analyzer data chart and tabular data sheets.*
2. *For restricted Band Edge Limit, please refer to section 12.5 of this report for measurement result.*

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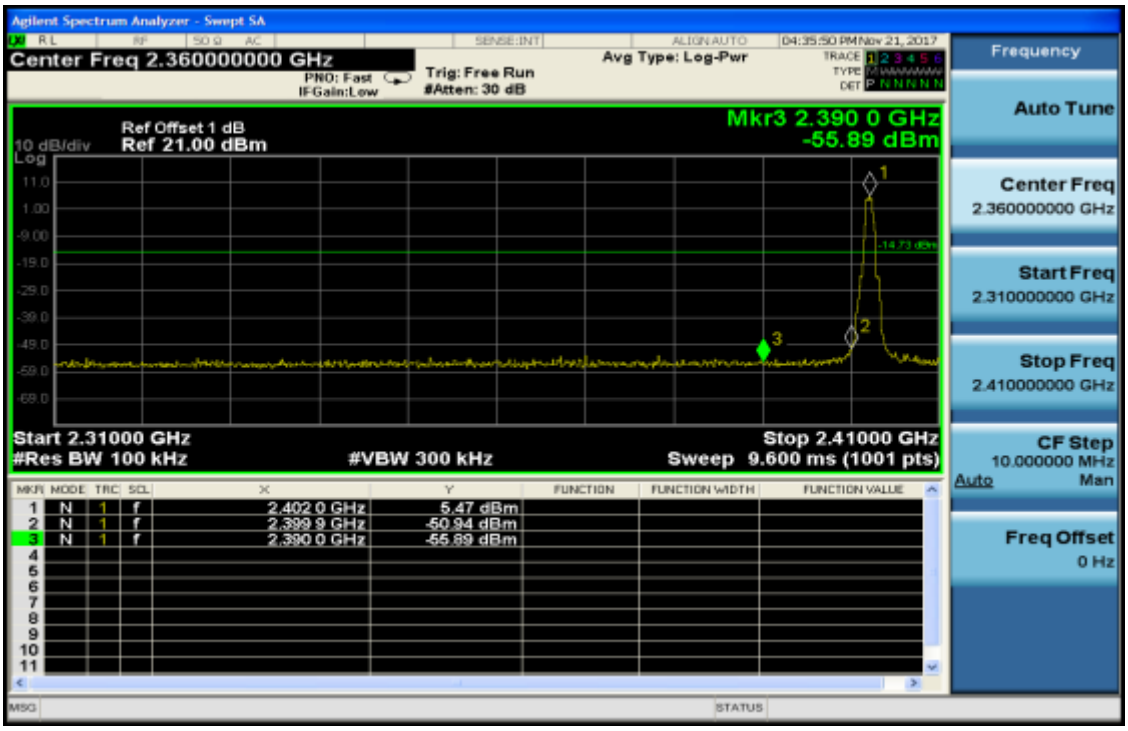
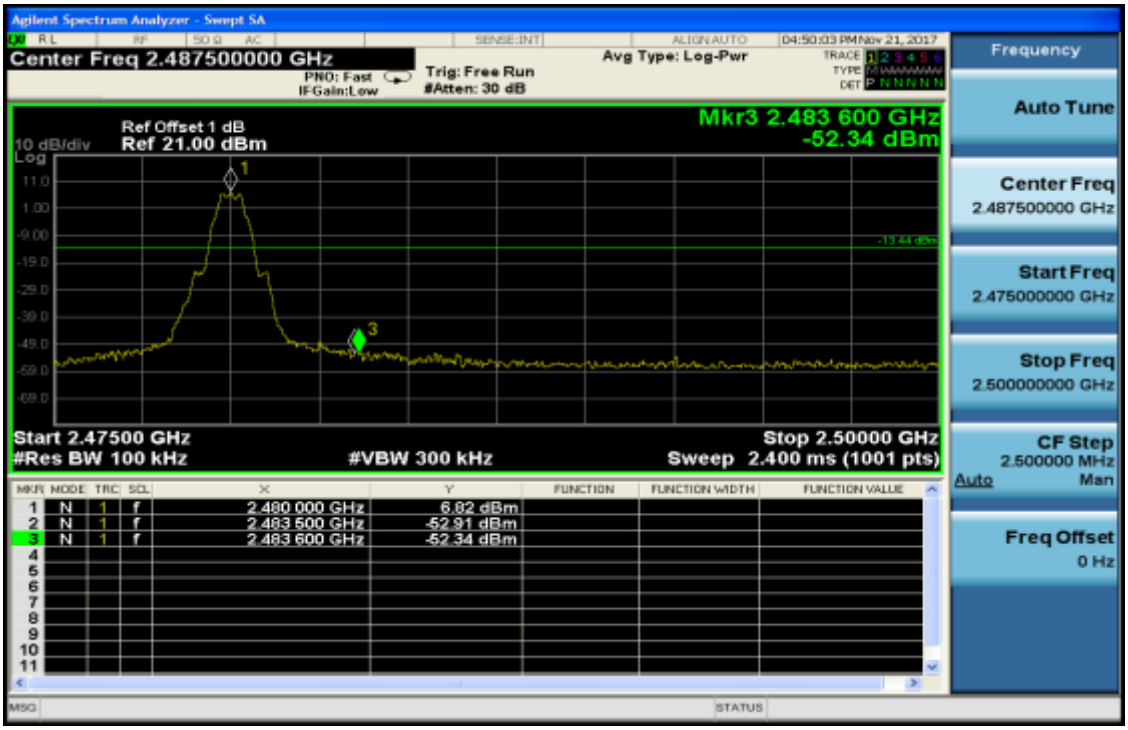
BLE mode
Band Edges Test Data CH-Low



Band Edges Test Data CH-High



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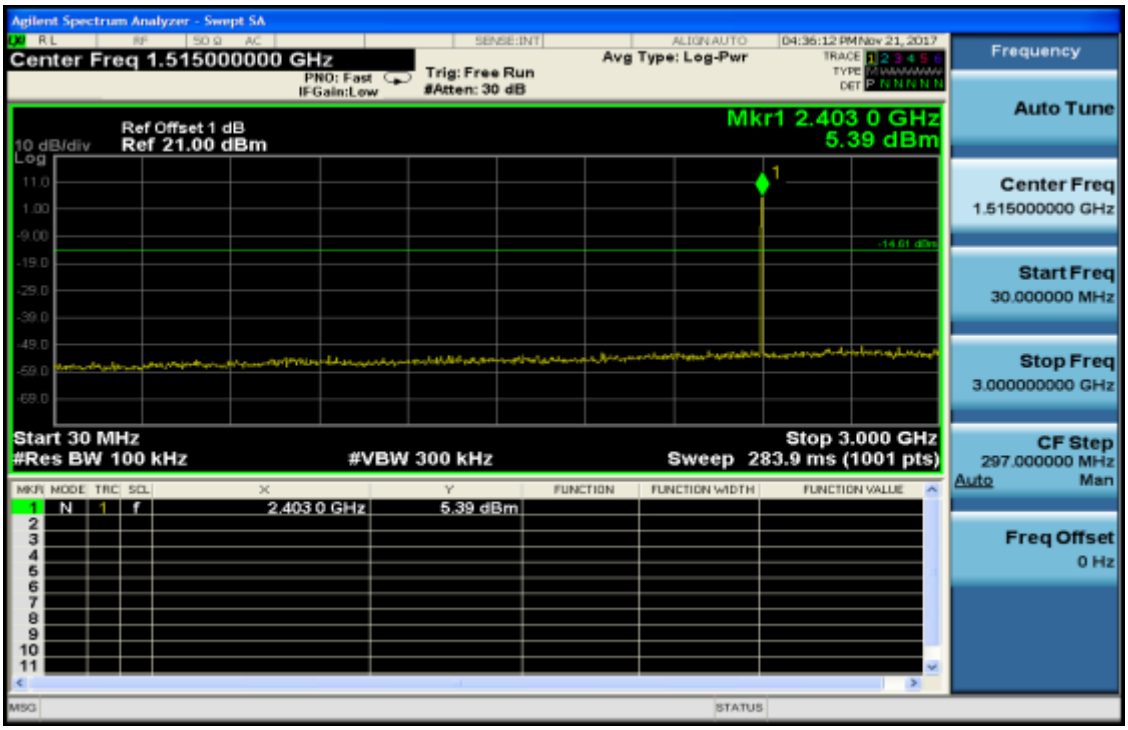
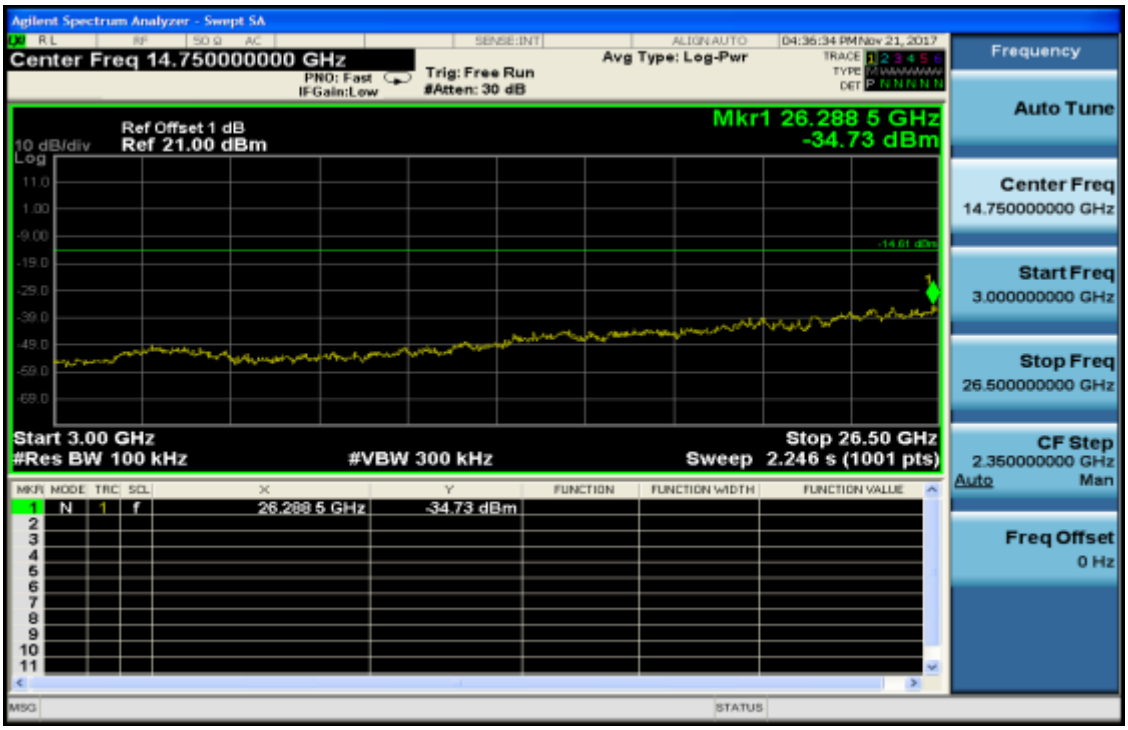
Conducted Spurious Emission Measurement Result

CH-Low 30MHz – 3GHz



CH-Low 3GHz – 26.5GHz



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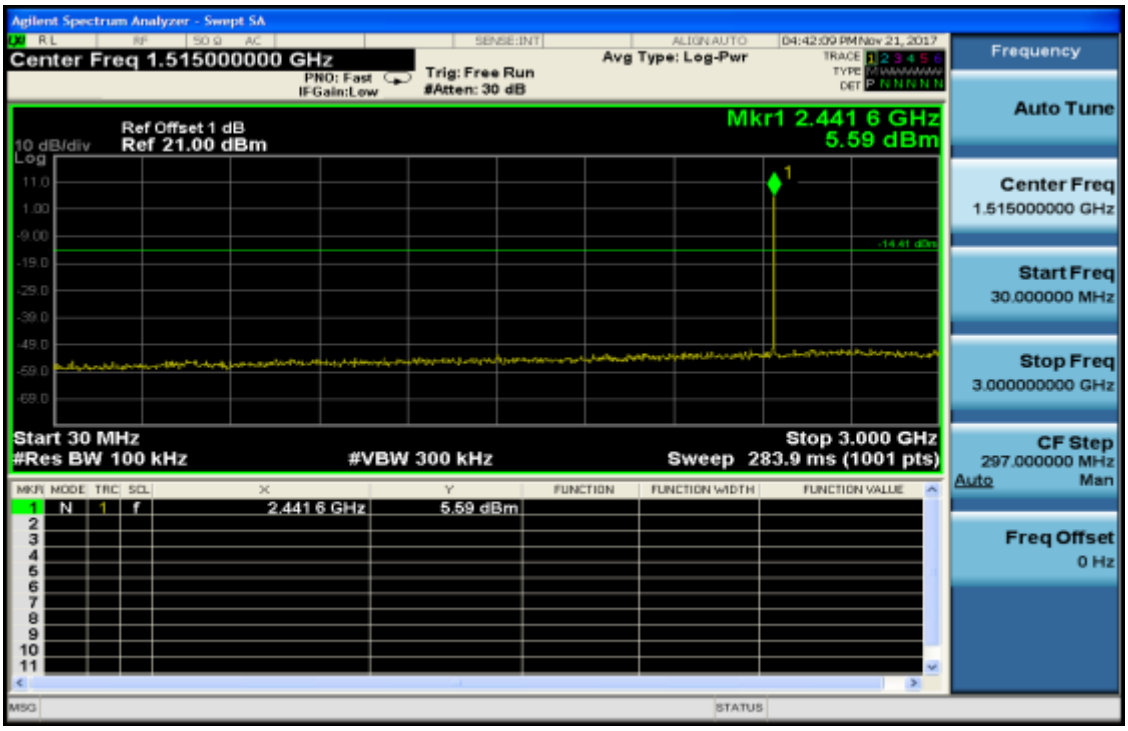
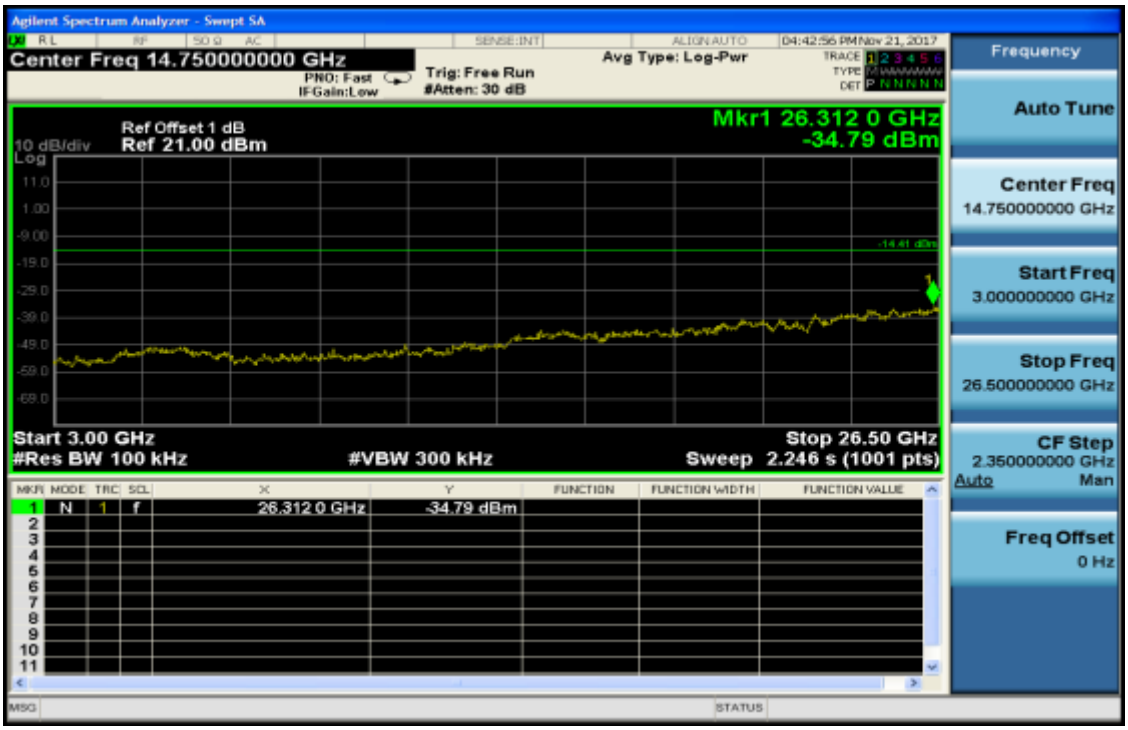
CH-Mid 30MHz – 3GHz



CH-Mid 3GHz – 26.5GHz



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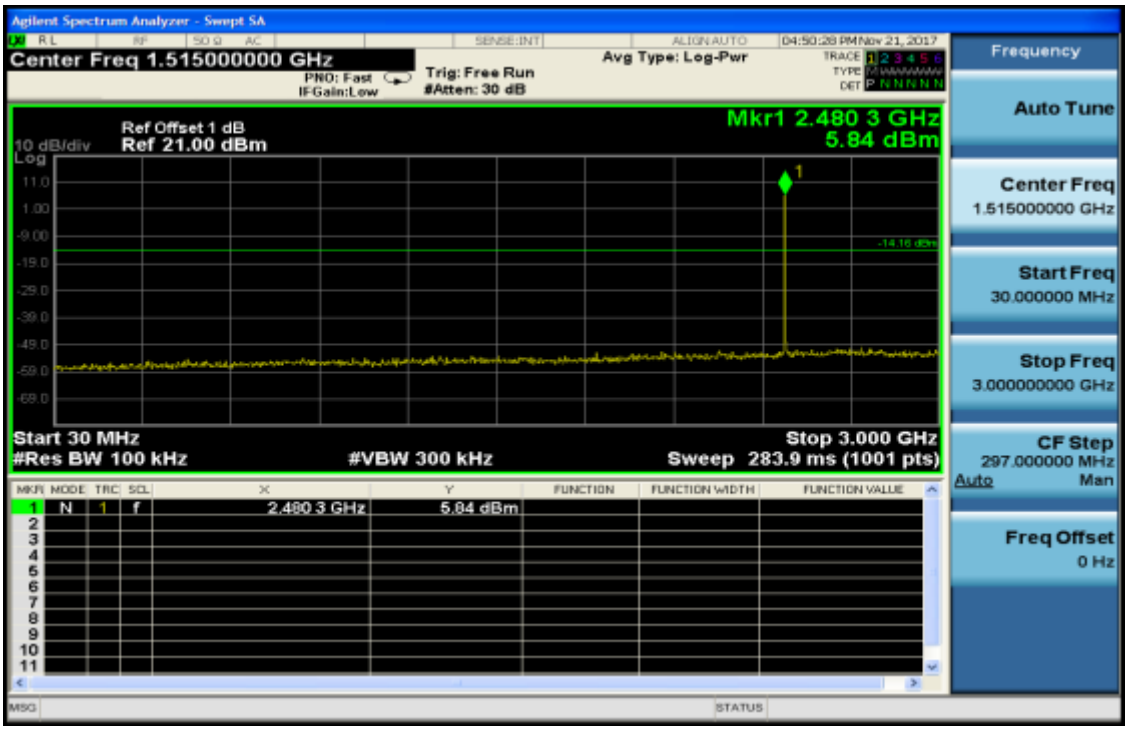
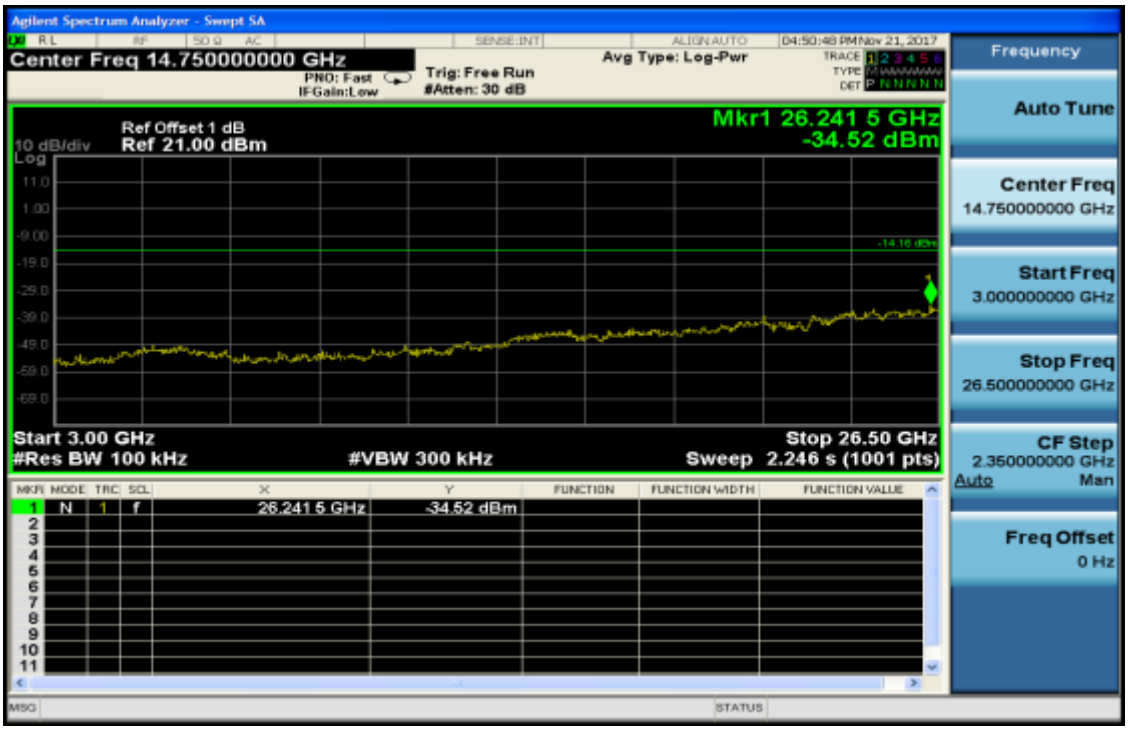
CH-High 30MHz – 3GHz



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 (dBμV/m) = 20 log Emission level (dBμV/m)

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10.2 Measurement Equipment Used

SGS 966 Chamber No.C					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EMI Test Receiver	R&S	ESCI7	100760	05/11/2017	05/10/2018
Spectrum Analyzer	Agilent	E4446A	MY51100003	04/25/2017	04/24/2018
Loop Antenna	ETS-Lindgren	6502	148045	09/20/2017	09/19/2018
Bilog Antenna	SCHWAZBECK	VULB9168	378	12/19/2016	12/18/2017
Horn Antenna	Schwarzbeck	BBHA9120D	1441	08/04/2017	08/03/2018
Pre-Amplifier	Agilent	8447D	2944A07676	01/03/2017	01/02/2018
Pre-Amplifier	EMC Instruments Corp.	EMC0126530	980038	01/03/2017	01/02/2018
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	60776	N.C.R	N.C.R
Low Loss Cable	Huber Suhner	966_RX	9	01/05/2017	01/04/2018
3m Site NSA	SGS	966 chamber	N/A	07/01/2017	06/30/2018
Low Loss Cable	Huber Suhner	966 TX	1	01/05/2017	01/04/2018
Horn Antenna	Schwarzbeck	BBHA9170	184	12/12/2016	12/11/2017
Pre-Amplifier	EMC Instruments Corp.	EMC184045	980135	01/05/2017	01/04/2018

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

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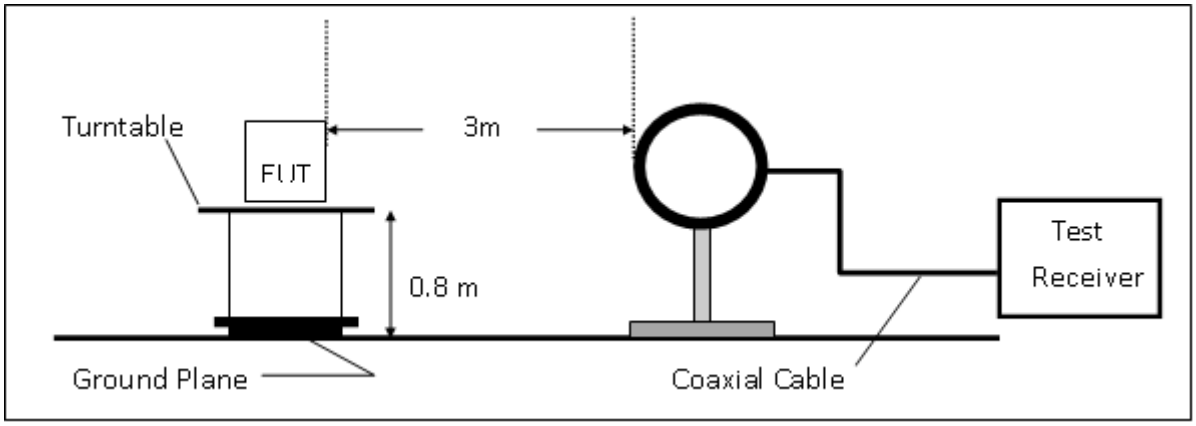
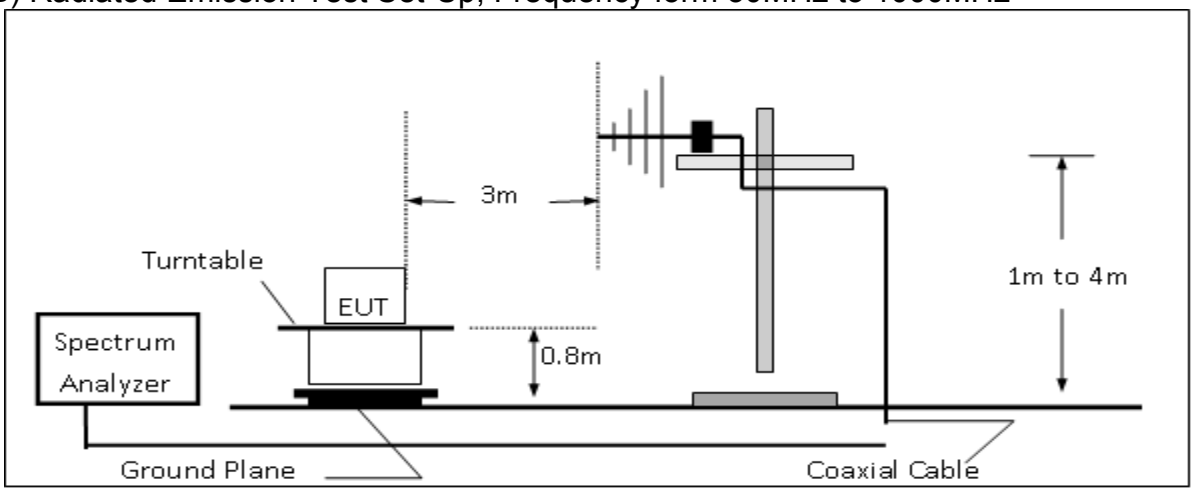
10.3 Test SET-UP

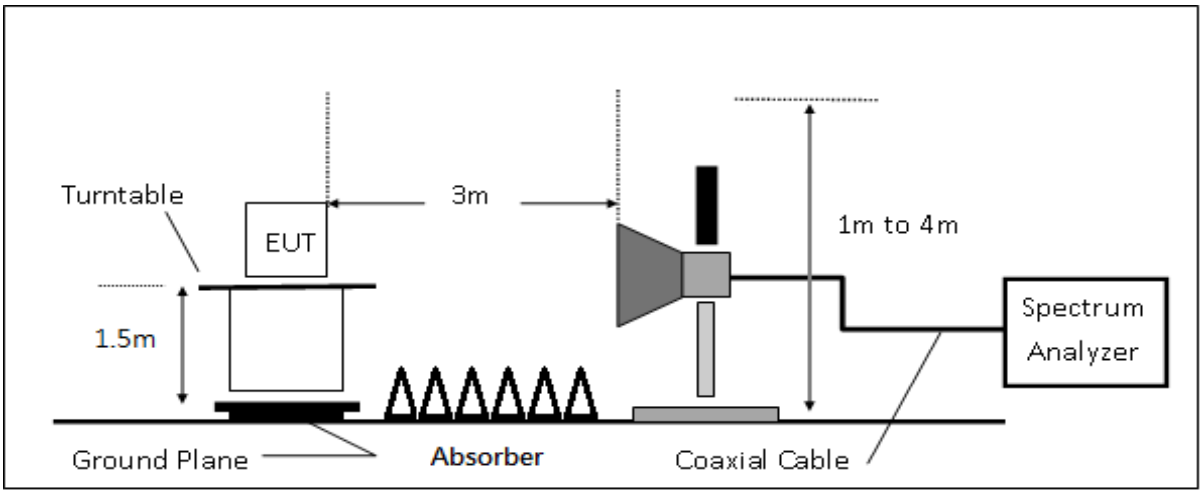
(A) Radiated Emission Test Set-UP Frequency Below 30MHz.



(B) Radiated Emission Test Set-Up, Frequency form 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.
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 ≥ 1/T (Duty cycle < 98%) for Average Detector at frequency above 1 GHz.

Band	Duty Cycle(%)	T(μs)	1/T(kHz)	VBW Setting
BLE	62.4	390.4	2.56	3kHz

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(dBμV/m) = SPA. Reading level(dBμV) + Factor(dB)

Factor(dB) = Antenna Factor(dBμV/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 form 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.

There is a comparison data of both open-field test site and semi-Anechoic, and test result came out very similar.

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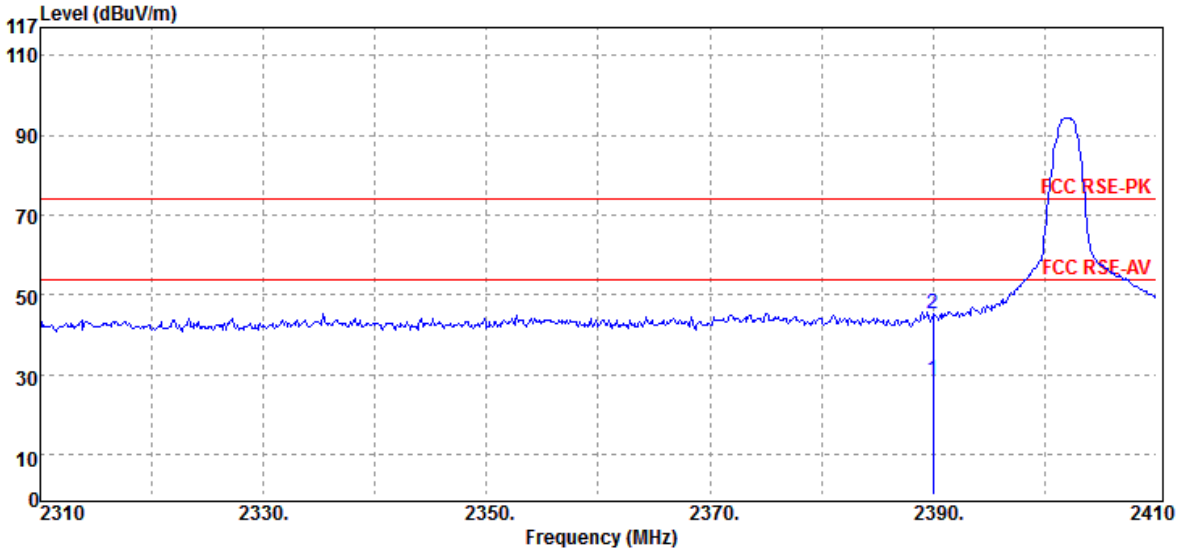
Member of SGS Group

Radiated Band Edge Measurement Result (BLE mode)

Operation Band	:BLE	Test Date	:2017-11-23
Fundamental Frequency	:2402 MHz	Temp./Humi.	:21 deg_C / 61 RH
Operation Mode	:Bandedge CH LOW	Engineer	:Tin
EUT Pol.	:E2 Plane	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	dBμV	dB	dBμV/m	dBμV/m	dB
2390.00	E	Average	30.41	-1.74	28.67	54.00	-25.33
2390.00	E	Peak	47.07	-1.74	45.33	74.00	-28.67

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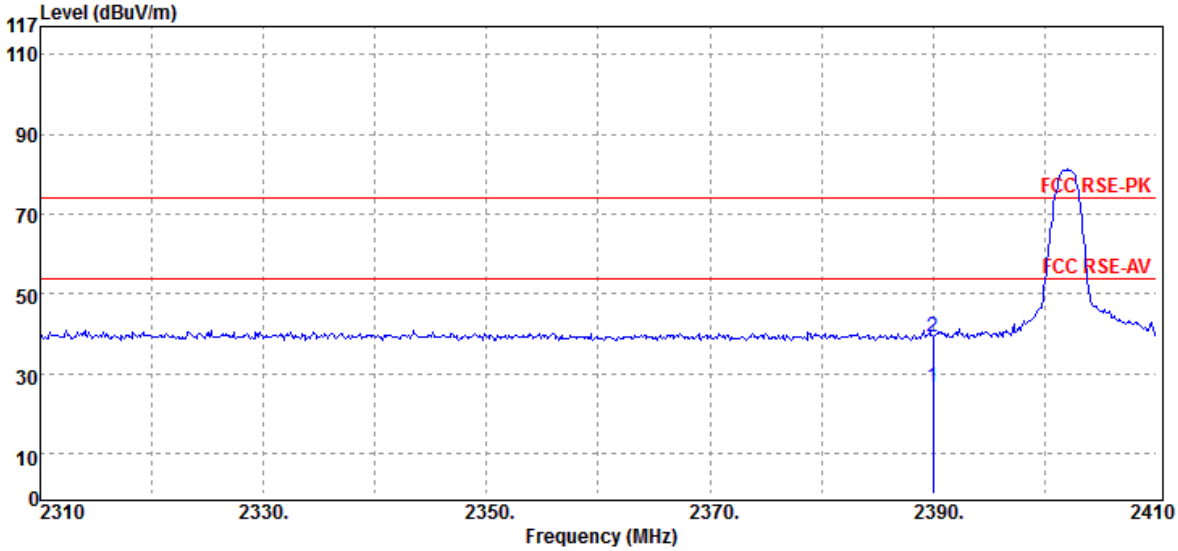
Operation Band	:BLE	Test Date	:2017-11-23
Fundamental Frequency	:2402 MHz	Temp./Humi.	:21 deg_C / 61 RH
Operation Mode	:Bandedge CH LOW	Engineer	:Tin
EUT Pol.	:E2 Plane	Measurement Antenna Pol.	:HORIZONTAL



Freq.	Note	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2390.00	E	Average	28.50	-1.74	26.76	54.00	-27.24
2390.00	E	Peak	40.97	-1.74	39.23	74.00	-34.77

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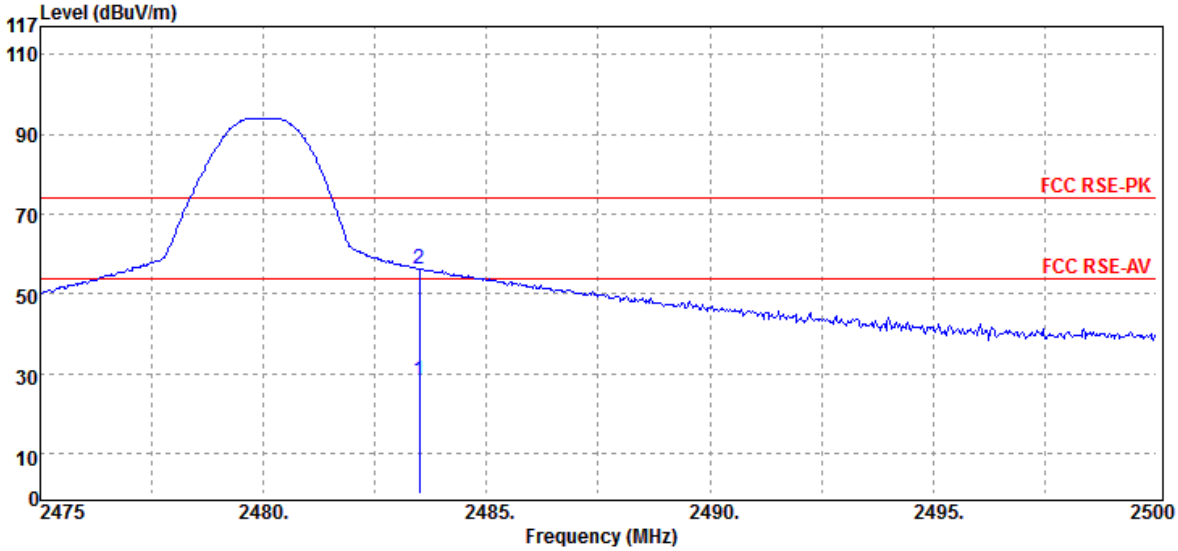
Operation Band	:BLE	Test Date	:2017-11-23
Fundamental Frequency	:2480 MHz	Temp./Humi.	:21 deg_C / 61 RH
Operation Mode	:Bandedge CH HIGH	Engineer	:Tin
EUT Pol.	:E2 Plane	Measurement Antenna Pol.	:VERTICAL



Freq.	Note	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2483.50	E	Average	29.98	-1.62	28.36	54.00	-25.64
2483.50	E	Peak	57.86	-1.62	56.24	74.00	-17.76

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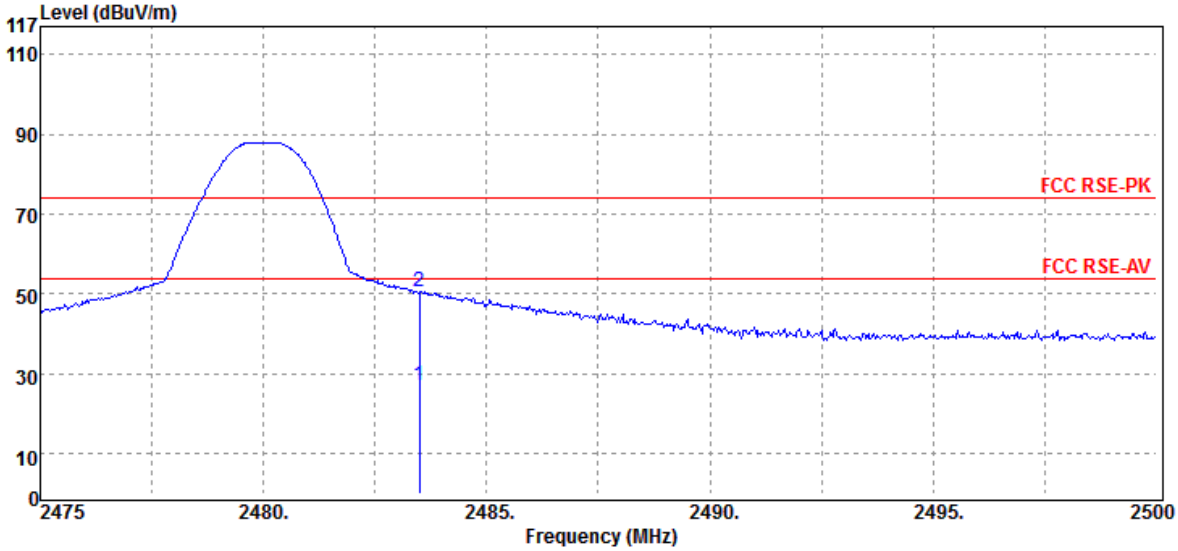
Operation Band	:BLE	Test Date	:2017-11-23
Fundamental Frequency	:2480 MHz	Temp./Humi.	:21 deg_C / 61 RH
Operation Mode	:Bandedge CH HIGH	Engineer	:Tin
EUT Pol.	:E2 Plane	Measurement Antenna Pol.	:HORIZONTAL



Freq.	Note	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2483.50	E	Average	28.54	-1.62	26.92	54.00	-27.08
2483.50	E	Peak	52.15	-1.62	50.53	74.00	-23.47

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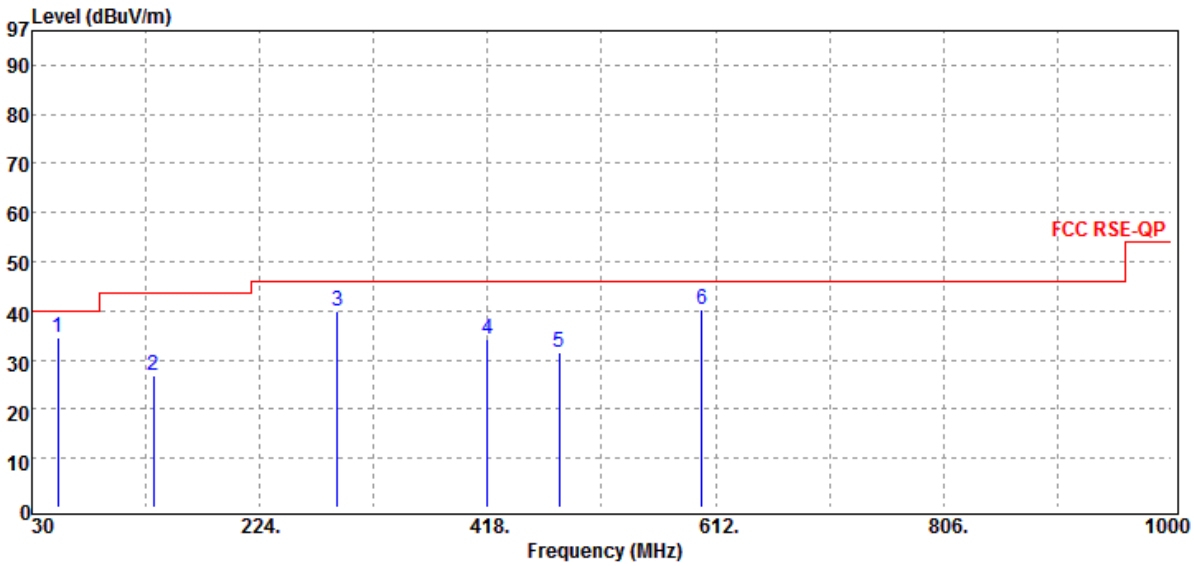
Radiated Spurious Emission Measurement Result (BLE mode)
For Frequency form 30MHz to 1000MHz

Operation Band	:BLE	Test Date	:2017-11-23
Fundamental Frequency	:2442 MHz	Temp./Humi.	:21 deg_C / 61 RH
Operation Mode	:Tx CH MID	Engineer	:Tin
EUT Pol.	:E2 Plane	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	dBμV	dB	dBμV/m	dBμV/m	dB
52.31	S	Peak	42.38	-7.76	34.62	40.00	-5.38
133.79	S	Peak	35.81	-8.99	26.82	43.50	-16.68
289.96	S	Peak	46.04	-6.07	39.97	46.00	-6.03
418.00	S	Peak	37.57	-3.37	34.20	46.00	-11.80
479.11	S	Peak	33.87	-2.39	31.48	46.00	-14.52
600.36	S	Peak	40.35	-0.14	40.21	46.00	-5.79

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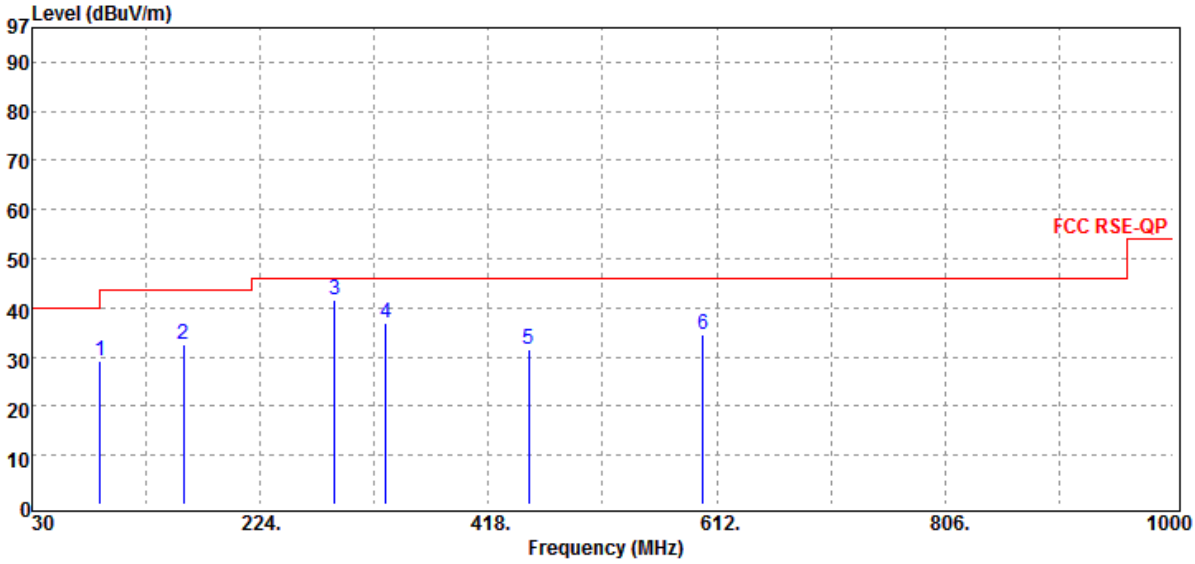
Operation Band	:BLE	Test Date	:2017-11-23
Fundamental Frequency	:2442 MHz	Temp./Humi.	:21 deg_C / 61 RH
Operation Mode	:Tx CH MID	Engineer	:Tin
EUT Pol.	:E2 Plane	Measurement Antenna Pol.	:HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
88.20	S	Peak	42.67	-13.50	29.17	43.50	-14.33
159.01	S	Peak	40.06	-7.38	32.68	43.50	-10.82
287.05	S	Peak	47.80	-6.19	41.61	46.00	-4.39
330.70	S	Peak	42.50	-5.42	37.08	46.00	-8.92
451.95	S	Peak	34.32	-2.84	31.48	46.00	-14.52
600.36	S	Peak	34.81	-0.14	34.67	46.00	-11.33

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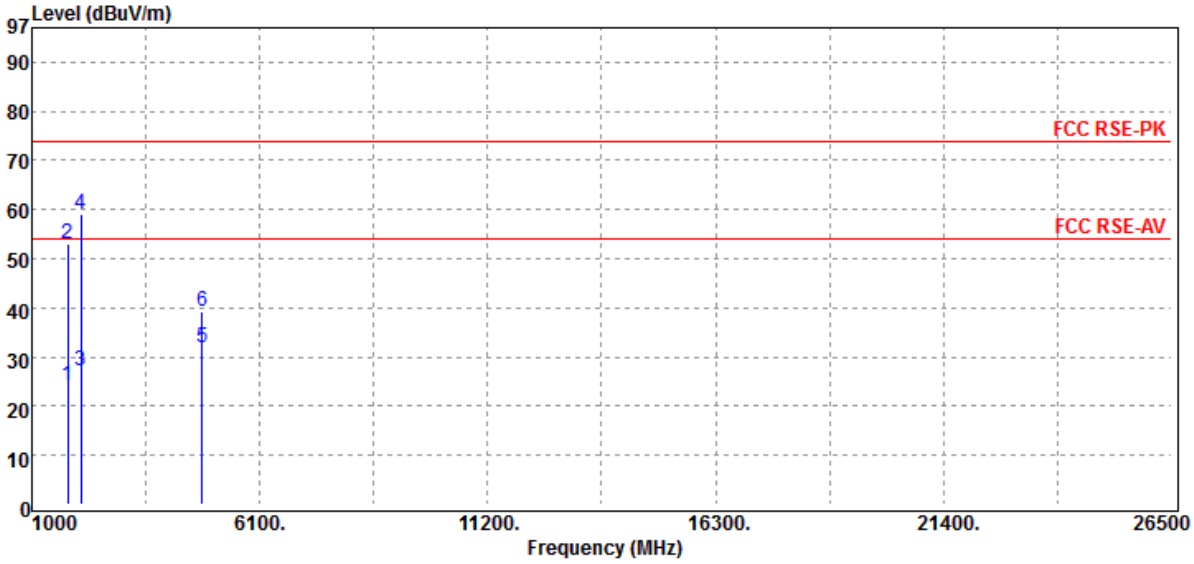
Radiated Spurious Emission Measurement Result:

For Frequency above 1 GHz

Operation Band	:BLE	Test Date	:2017-11-28
Fundamental Frequency	:2402 MHz	Temp./Humi.	:21 deg_C / 61 RH
Operation Mode	:Tx CH 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 dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
1805.00	S	Average	28.78	-4.67	24.11	54.00	-29.89
1805.00	S	Peak	57.64	-4.67	52.97	74.00	-21.03
2099.00	S	Average	29.84	-2.62	27.22	54.00	-26.78
2099.00	S	Peak	61.86	-2.62	59.24	74.00	-14.76
4804.00	H	Average	26.88	4.92	31.80	54.00	-22.20
4804.00	H	Peak	34.21	4.92	39.13	74.00	-34.87

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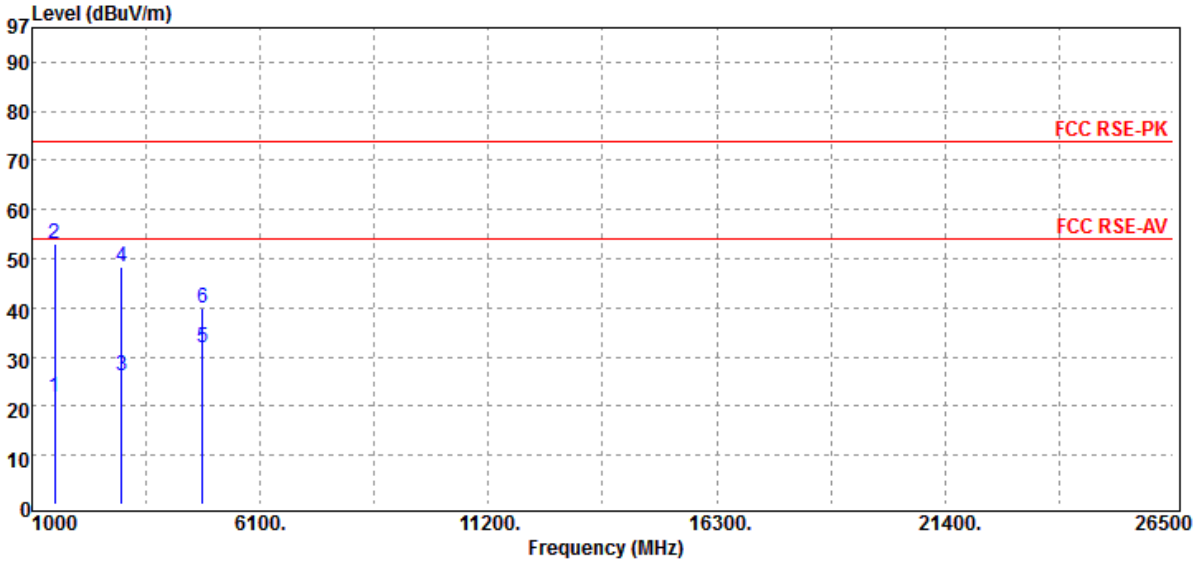
Operation Band	:BLE	Test Date	:2017-11-28
Fundamental Frequency	:2402 MHz	Temp./Humi.	:21 deg_C / 61 RH
Operation Mode	:Tx CH LOW	Engineer	:Tin
EUT Pol.	:E2 Plane	Measurement Antenna Pol.	:HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
1504.00	S	Average	27.15	-5.40	21.75	54.00	-32.25
1504.00	S	Peak	58.28	-5.40	52.88	74.00	-21.12
2995.00	S	Average	26.81	-0.51	26.30	54.00	-27.70
2995.00	S	Peak	48.76	-0.51	48.25	74.00	-25.75
4804.00	H	Average	27.12	4.92	32.04	54.00	-21.96
4804.00	H	Peak	35.06	4.92	39.98	74.00	-34.02

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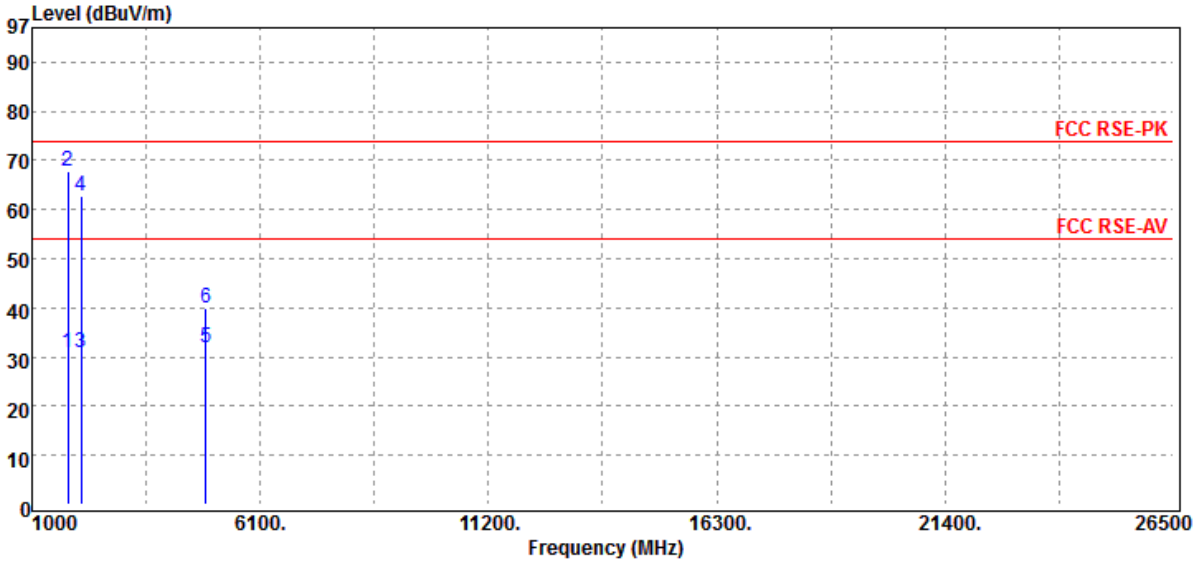
Operation Band	:BLE	Test Date	:2017-11-28
Fundamental Frequency	:2442 MHz	Temp./Humi.	:21 deg_C / 61 RH
Operation Mode	:Tx CH MID	Engineer	:Tin
EUT Pol.	:E2 Plane	Measurement Antenna Pol.	:VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
1805.00	S	Average	35.56	-4.67	30.89	54.00	-23.11
1805.00	S	Peak	72.60	-4.67	67.93	74.00	-6.07
2099.00	S	Average	33.56	-2.62	30.94	54.00	-23.06
2099.00	S	Peak	65.30	-2.62	62.68	74.00	-11.32
4884.00	H	Average	26.53	5.20	31.73	54.00	-22.27
4884.00	H	Peak	34.66	5.20	39.86	74.00	-34.14

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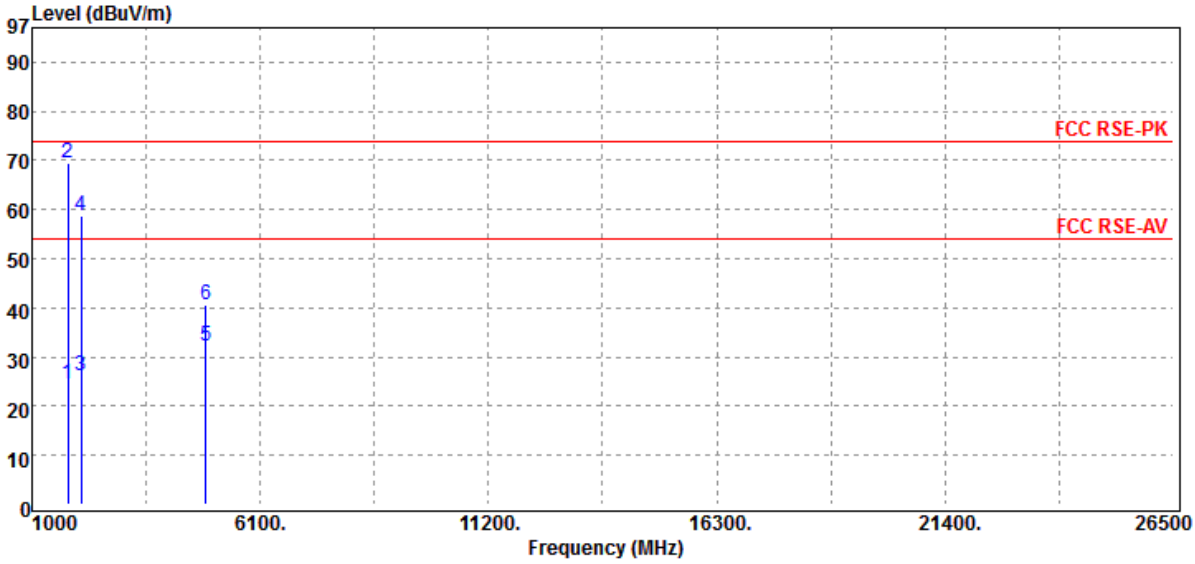
Operation Band	:BLE	Test Date	:2017-11-28
Fundamental Frequency	:2442 MHz	Temp./Humi.	:21 deg_C / 61 RH
Operation Mode	:Tx CH MID	Engineer	:Tin
EUT Pol.	:E2 Plane	Measurement Antenna Pol.	:HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
1805.00	S	Average	29.24	-4.67	24.57	54.00	-29.43
1805.00	S	Peak	74.16	-4.67	69.49	74.00	-4.51
2099.00	S	Average	28.74	-2.62	26.12	54.00	-27.88
2099.00	S	Peak	61.43	-2.62	58.81	74.00	-15.19
4884.00	H	Average	26.94	5.20	32.14	54.00	-21.86
4884.00	H	Peak	35.43	5.20	40.63	74.00	-33.37

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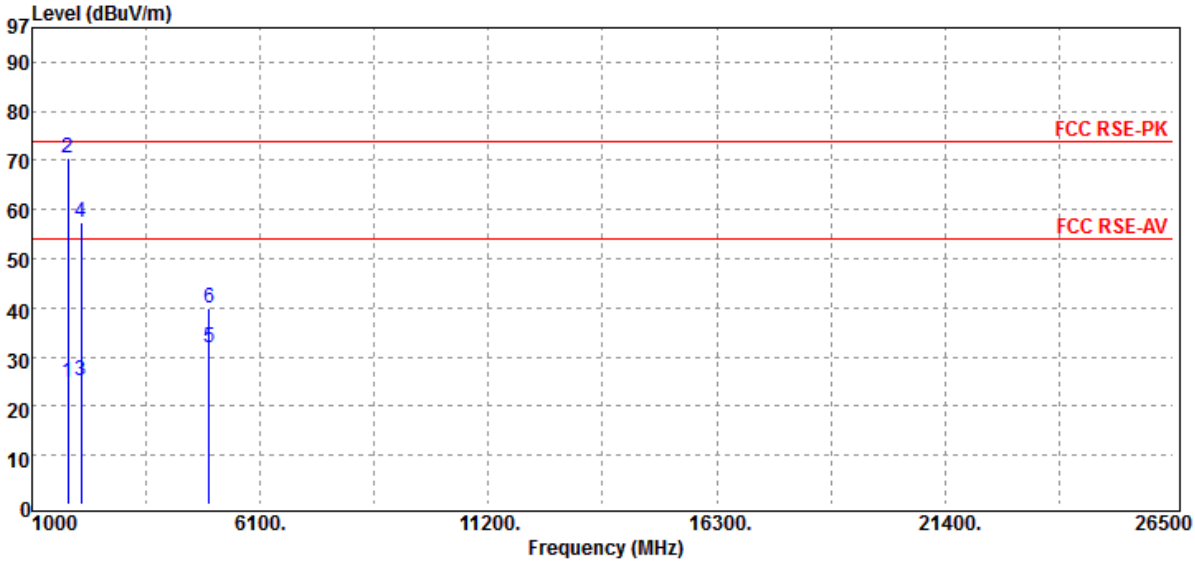
Operation Band	:BLE	Test Date	:2017-11-28
Fundamental Frequency	:2480 MHz	Temp./Humi.	:21 deg_C / 61 RH
Operation Mode	:Tx CH HIGH	Engineer	:Tin
EUT Pol.	:E2 Plane	Measurement Antenna Pol.	:VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
1805.00	S	Average	29.48	-4.67	24.81	54.00	-29.19
1805.00	S	Peak	75.28	-4.67	70.61	74.00	-3.39
2099.00	S	Average	27.63	-2.62	25.01	54.00	-28.99
2099.00	S	Peak	59.87	-2.62	57.25	74.00	-16.75
4960.00	H	Average	26.74	5.29	32.03	54.00	-21.97
4960.00	H	Peak	34.79	5.29	40.08	74.00	-33.92

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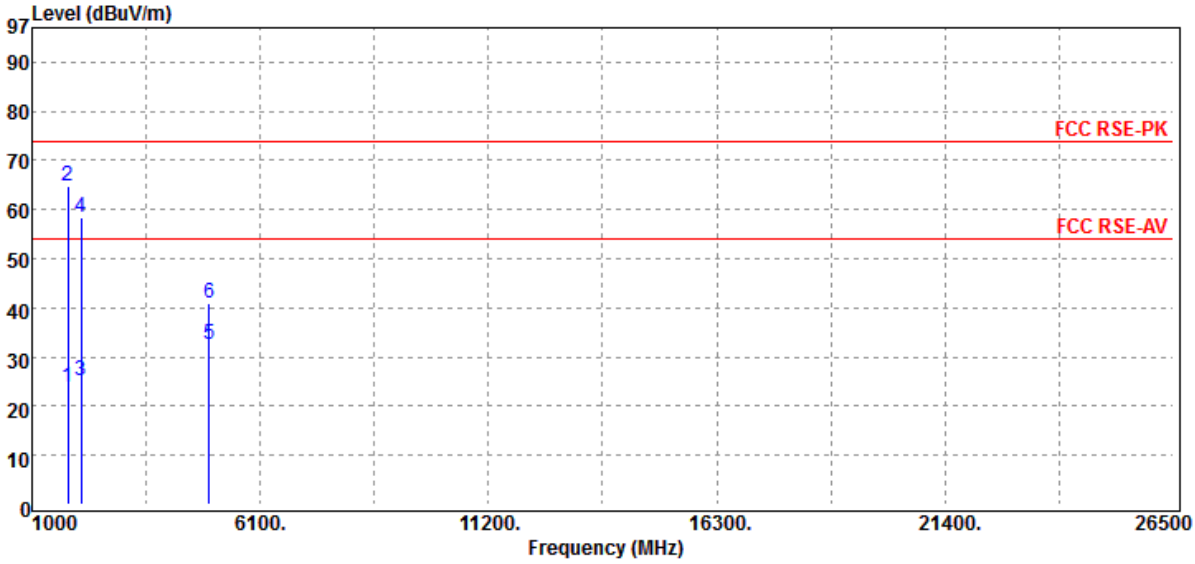
Operation Band	:BLE	Test Date	:2017-11-28
Fundamental Frequency	:2480 MHz	Temp./Humi.	:21 deg_C / 61 RH
Operation Mode	:Tx CH HIGH	Engineer	:Tin
EUT Pol.	:E2 Plane	Measurement Antenna Pol.	:HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
1805.00	S	Average	28.45	-4.67	23.78	54.00	-30.22
1805.00	S	Peak	69.45	-4.67	64.78	74.00	-9.22
2099.00	S	Average	27.81	-2.62	25.19	54.00	-28.81
2099.00	S	Peak	61.16	-2.62	58.54	74.00	-15.46
4960.00	H	Average	27.11	5.29	32.40	54.00	-21.60
4960.00	H	Peak	35.66	5.29	40.95	74.00	-33.05

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11. PEAK POWER SPECTRAL DENSITY

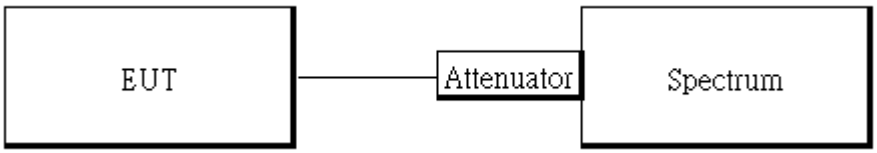
11.1 Standard Applicable:

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.
EXA Spectrum Analyzer	Agilent	N9030A	MY53120760	03/21/2017	03/20/2018
DC Block	Mini-Circuits	BLK-18-S+	1	01/05/2017	01/04/2018
Attenuator	Mini-Circuit	BW-S10W2+	2	01/05/2017	01/04/2018

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 .
3. Set the span to 1.5 times the DTS channel bandwidth.
4. Set the RBW = 3 kHz & VBW = 10 kHz.
5. For defining Restricted Band Edge Limit:
   Set the RBW = 100kHz & VBW = 300 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:

BLE mode

Frequency (MHz)	RF Power Density (dBm)	Maximum Limit (dBm)	Result
2402	-7.96	8	PASS
2442	-6.98	8	PASS
2480	-6.71	8	PASS

NOTE: cable loss as 1dB that offsets in the spectrum

Band Edge Limit

Frequency (MHz)	RF Power Density (dBm)	Bandedge Limit = PSD - 20dB (dBm)
2402	5.27	-14.73
2480	6.56	-13.44

NOTE: cable loss as dB that offsets in the spectrum

NOTE: Refer to next page for plots.

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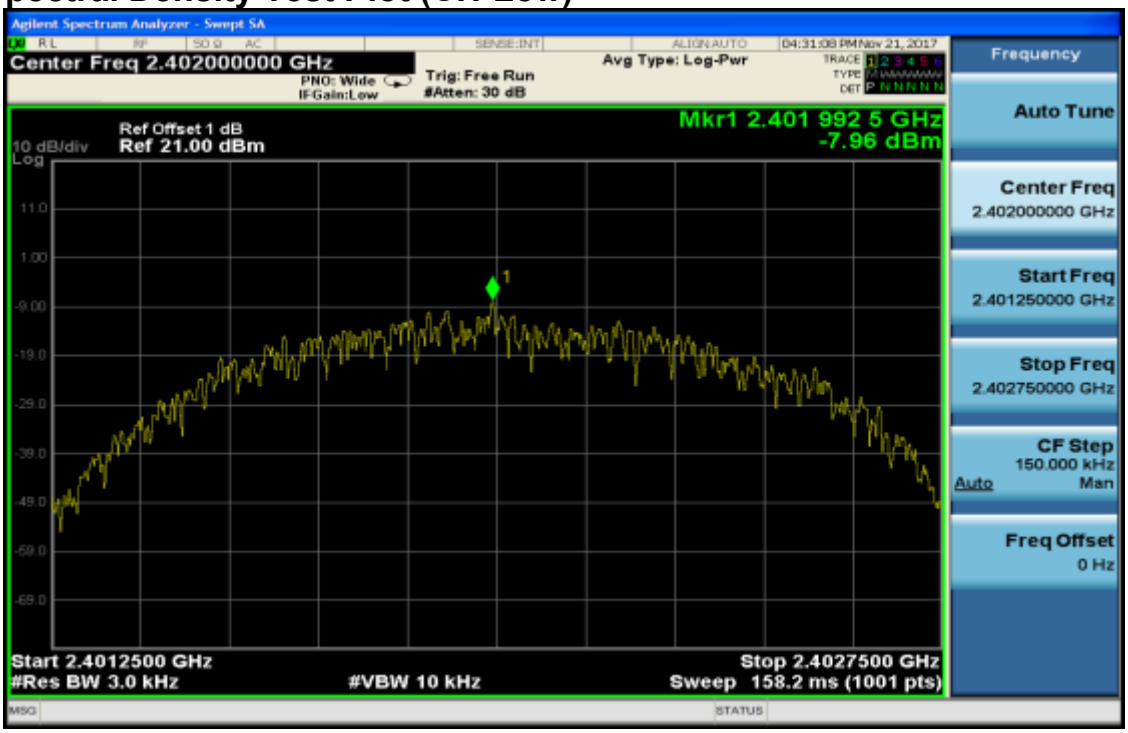
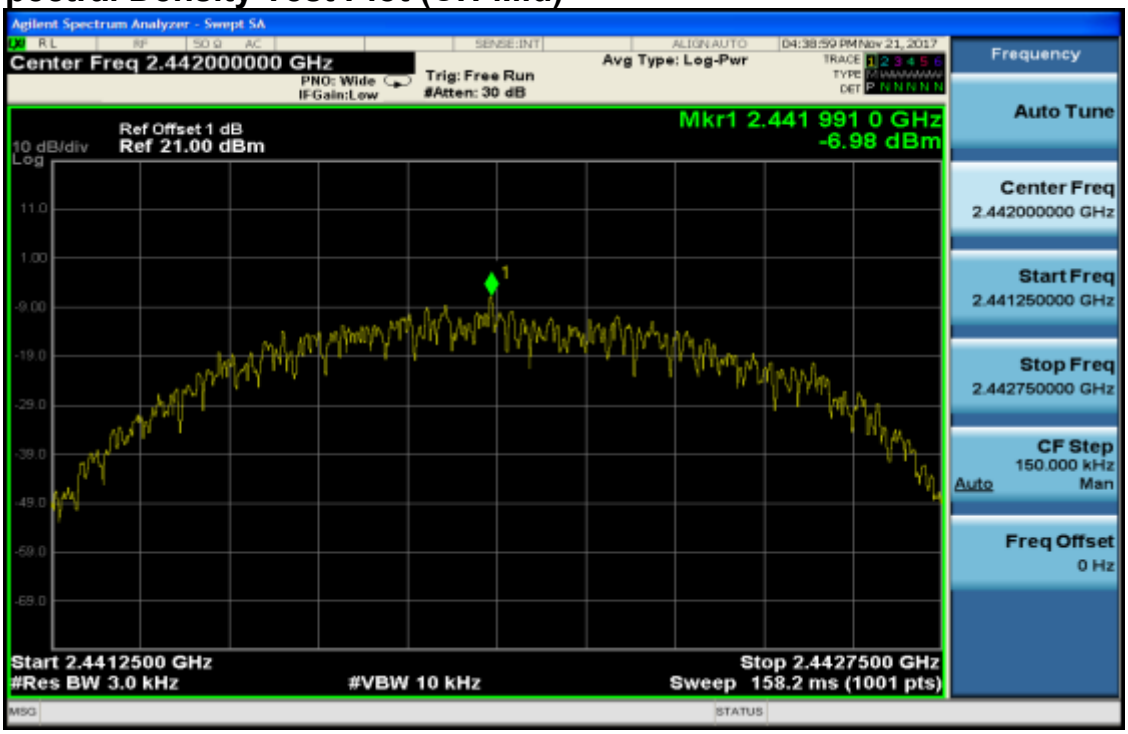
Power Spectral Density Test Plot (CH-Low)



Power Spectral Density Test Plot (CH-Mid)



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Power Spectral Density Test Plot (CH-High)

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Power Spectral Density for Bandedge Limit (CH-Low)

Power Spectral Density for Bandedge Limit (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.

12.2 Antenna Connected Construction:

An embedded-in antenna design is used.

The antenna is designed as permanently attached 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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