ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

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

OF

Applicant:	Microsoft Corporation One Microsoft Way, Redmond, WA 98052-6399 USA
Product Name:	Portable Computing Device
Brand Name:	Microsoft
Model No.:	1824
Model Difference:	N/A
FCC ID:	C3K1824
IC:	3048A-1824
Report Number:	E2/2018/10169
FCC Rule Part:	§15.247, Cat: DSS
IC Rule Part:	RSS-247 issue 2 Feb 2017
Issue Date:	Jun. 08, 2018
Date of Test:	Jan. 17, 2018 ~ Jun. 08, 2018
Date of EUT Received:	Jan. 17, 2018

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.

Tested By: Vito Pei

Vito Pei / Sr. Engineer

Approved By: Jim Chang

Jim Chang / Asst. Manager

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Revision History

Report Number	Revision	Description	Effected Page	Issue Date	Revised By
E2/2018/10169	Rev.00	Initial creation of document	All	Jun. 08, 2018	Tiffany Kao

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1 GENERAL INFORMATION

1.1 Product description

General:

Product Name:	Portable Computing Device	
Brand Name:	Microsoft	
Model No.:	1824	
Model Difference:	N/A	
Product SW/HW version:	Windows 10 Pro / EV1824	
Radio SW/HW version:	12.0.0.461 / V3.2	
Test SW Version:	N/A	
RF power setting in TEST SW:	N/A	
Power Supply:	7.66Vdc from Rechargeable Li-ion Battery or 15V from AC/DC Adapter	
	Battery:	Model No.: G16QA043H, Supplier: SMP
	Adapter:	Model No.: 1735, Supplier: LITEON

Bluetooth_BR+EDR:

Bluetooth Version:	Bluetooth V4.2 Dual Mode
Channel number:	79 channels
Modulation type:	GFSK + π/4DQPSK + 8DPSK
Transmit Power:	7.36 dBm
Frequency Range:	2.402GHz – 2.480GHz
Dwell Time:	<= 0.4s
Antenna Designation:	Loop Antenna, Antenna Gain: 2.70dBi

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1.2 Test Methodology of Applied Standards

Canada RSS-247 issue 2 Feb. 2017

RSS-Gen. issue 5 Apr. 2018

FCC Part 15, Subpart C §15.247

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.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333 (TAF code 0513)

FCC Registration Numbers are: 735305 / TW0002

Canada Registration Number: 4620A-5

1.4 Special Accessories

AC Adapter is used while the test is conducted and there is no other accessory attached. This is the worst case condition.

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 is configured to operate in a continuous transmission mode. EUT placement and various angles were checked to find worst mode where the emission characteristics are maximized.

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 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 & Conducted Emission Configuration

Fig.2-2 AC power line Configuration

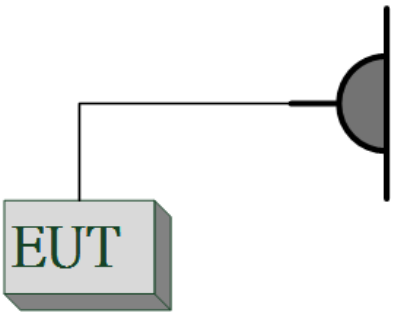

Table 2-1 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Cable	Power Cord
1.	Bluetooth Test Software	QRCT	N/A	Version 3.0.246.0	N/A	N/A
2.	Notebook	Lenovo	L430	R9-YYG88	Shielded	Unshielded

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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	Compliant
§15.247(b)(1)	RSS-247 §5.4 (2)	Peak Output Power	Compliant
§15.247(a)(1)	RSS-247 §5.1 (1) RSS-Gen §6.7	20dB & 99% 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(a)(1)	RSS-247 §5.1 (2)	Frequency Separation	Compliant
§15.247(a)(1)(iii)	RSS-247 §5.1 (4)	Number of hopping frequency	Compliant
§15.247(a)(1)(iii)	RSS-247 §5.1 (4)	Time of Occupancy	Compliant
§15.203	RSS- Gen §6.8	Antenna Requirement	Compliant

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4 DESCRIPTION OF TEST MODES

4.1 Operated in 2400 ~ 2483.5MHz Band

79 channels are provided for Bluetooth

CH	FREQUENCY	CH	FREQUENCY	CH	FREQUENCY	CH	FREQUENCY
0	2402 MHz	20	2422 MHz	40	2442 MHz	70	2462 MHz
1	2403 MHz	21	2423 MHz	41	2443 MHz	71	2463 MHz
2	2404 MHz	22	2424 MHz	42	2444 MHz	72	2464 MHz
3	2405 MHz	23	2425 MHz	43	2445 MHz	73	2465 MHz
4	2406 MHz	24	2426 MHz	44	2446 MHz	74	2466 MHz
5	2407 MHz	25	2427 MHz	45	2447 MHz	75	2467 MHz
6	2408 MHz	26	2428 MHz	46	2448 MHz	76	2468 MHz
7	2409 MHz	27	2429 MHz	47	2449 MHz	77	2469 MHz
8	2410 MHz	28	2430 MHz	48	2450 MHz	78	2470 MHz
9	2411 MHz	29	2431 MHz	49	2451 MHz	79	2471 MHz
10	2412 MHz	30	2432 MHz	50	2452 MHz	70	2472 MHz
11	2413 MHz	31	2433 MHz	51	2453 MHz	71	2473 MHz
12	2414 MHz	32	2434 MHz	52	2454 MHz	72	2474 MHz
13	2415 MHz	33	2435 MHz	53	2455 MHz	73	2475 MHz
14	2416 MHz	34	2436 MHz	54	2456 MHz	74	2476 MHz
15	2417 MHz	35	2437 MHz	55	2457 MHz	75	2477 MHz
16	2418 MHz	36	2438 MHz	56	2458 MHz	76	2478 MHz
17	2419 MHz	37	2439 MHz	57	2459 MHz	77	2479 MHz
18	2420 MHz	38	2440 MHz	58	2460 MHz	78	2480 MHz
19	2421 MHz	39	2441 MHz	59	2461 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.
3 Investigation has been done on all the possible configurations for searching the worst case.

AC POWER LINE CONDUCTION EMISSION

MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	PACKET TYPE
Bluetooth	Operation in normal mode			

RADIATED EMISSION TEST:

RADIATED EMISSION TEST (BELOW 1 GHz)				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	PACKET TYPE
Bluetooth	0 to 78	0,39,78	GFSK	DH5
RADIATED EMISSION TEST (ABOVE 1 GHz)				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	PACKET TYPE
Bluetooth	0 to 78	0,39,78	GFSK	DH5

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

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ANTENNA PORT CONDUCTED MEASUREMENT:

CONDUCTED TEST				
Peak Output Power, 20dB Band Width				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	PACKET TYPE
Bluetooth	0 to 78	0,39,78	GFSK	DH5
	0 to 78	0,39,78	π/4-DQPSK	2DH5
	0 to 78	0,39,78	8-DPSK	3DH5
Band Edge				
Bluetooth	0 to 78	0,78	GFSK / 8-DPSK	DH5/3DH5
Frequency Separation				
Bluetooth	0 to 78	0,1,2	8-DPSK	3DH5
Number of hopping frequency				
Bluetooth	0 to 78	0 to 78	8-DPSK	3DH5
Time of Occupancy (Dwell time)				
Bluetooth	0 to 78	0,39,78	GFSK	DH1/DH3/DH5
Bluetooth	0 to 78	39	π/4-DQPSK	2DH1/2DH3/2DH5
Bluetooth	0 to 78	39	8-DPSK	3DH1/3DH3/3DH5

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5 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 2.586 dB
Peak Output Power	+/- 0.84 dB
20dB Bandwidth	+/- 51.33 Hz
100 KHz Bandwidth Of Frequency Band Edges	+/- 0.84 dB
Frequency Separation	+/- 51.33 Hz
Number of hopping frequency	+/- 51.33 Hz
Time of Occupancy	+/- 51.33 Hz
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 within 150 kHz to 30MHz shall not exceed the limit table as below.

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

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

6.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	**MFR**	**MODEL NUMBER**	**SERIAL NUMBER**	**LAST CAL.**	**CAL DUE.**
EMI Test Receiver	R&S	ESCI 7	100950	12/24/2017	12/23/2018
Coaxial Cables	N/A	N30N30-1042-150cm	N/A	08/30/2017	08/29/2018
LISN	Schwarzbeck	NSLK 8127	8127-648	06/18/2017	06/17/2018
Test Software	Farad	EZ-EMC	Ver. SGS-03A2	N.C.R.	N.C.R.

6.3 EUT Setup

1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI 63.10:2013.
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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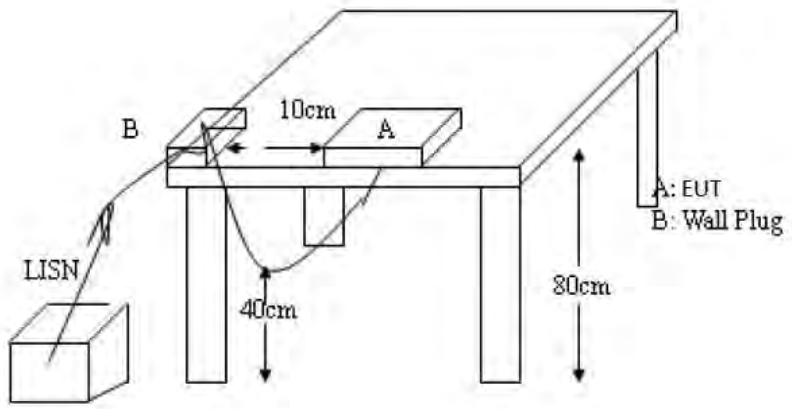
Member of SGS Group

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 frequency measured were complete.

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 By:	Jerry

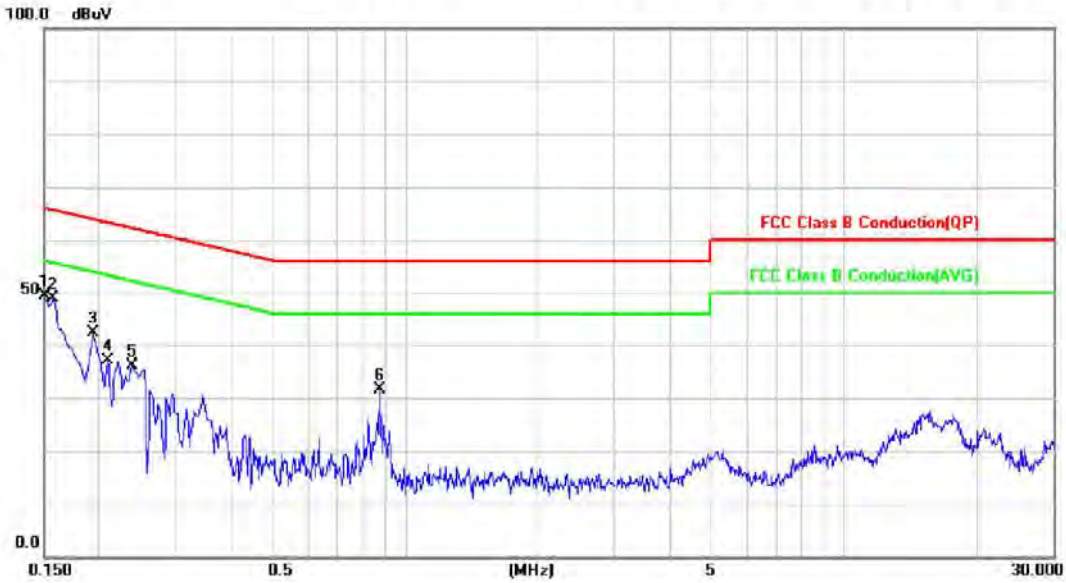
Site : Conduction Room
Limit: FCC Class B Conduction(QP)
Mode:
Note:

Phase: L1
Power: AC 120V/60Hz

Temperature: 25 ℃
Humidity: 85 %

Conducted Emission

File :Condution Data :#958 Date: 2018/5/29 Time: 下午 05:33:37



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1	*	0.1500	39.68	9.70	49.38	66.00	-16.62	peak	
2		0.1580	39.16	9.70	48.86	65.57	-16.71	peak	
3		0.1940	32.60	9.70	42.30	63.86	-21.56	peak	
4		0.2100	27.37	9.72	37.09	63.21	-26.12	peak	
5		0.2380	26.36	9.79	36.15	62.17	-26.02	peak	
6		0.8740	21.66	9.96	31.62	56.00	-24.38	peak	

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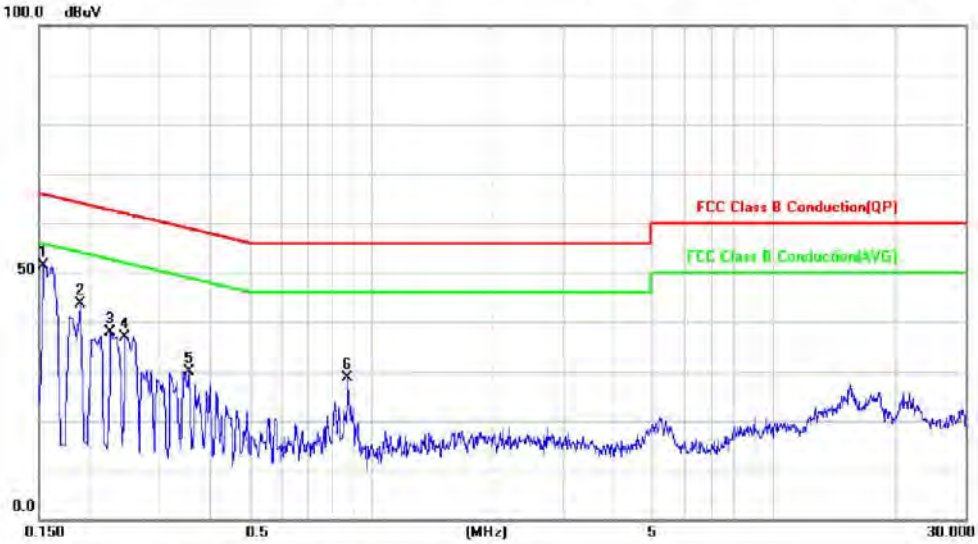
Site :	Conduction Room	Phase:	N	Temperature:	25 ℃
Limit:	FCC Class B Conduction(QP)	Power:	AC 120V/60Hz	Humidity:	85 %
Mode:					
Note:					

Conducted Emission

File :Condution Data :#955 Date: 2018/5/29 Time: 下午 05:28:50



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1	*	0.1548	41.69	9.70	51.39	65.74	-14.35	peak	
2		0.1900	33.98	9.70	43.68	64.04	-20.36	peak	
3		0.2260	28.14	9.76	37.90	62.60	-24.70	peak	
4		0.2460	27.14	9.81	36.95	61.89	-24.94	peak	
5		0.3540	19.92	10.08	30.00	58.87	-28.87	peak	
6		0.8780	18.79	9.96	28.75	56.00	-27.25	peak	

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7 PEAK OUTPUT POWER MEASUREMENT

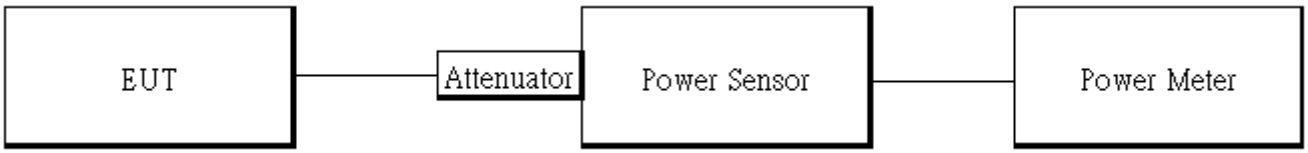
7.1 Standard Applicable

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels, The Limit: 1Watt. For all other frequency hopping systems in the 2400 – 2483.5MHz band: The Limit: 0.125 Watts. The power limit for 1Mbps is 1watt, and 2Mbps, 3Mbps and AFH mode are 0.125 watts and the e.i.r.p. shall not exceed 0.5 W if the hopset uses less than 75 hopping channels.

7.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	KEYSIGHT	N9010A	MY51440113	06/20/2017	06/19/2018
Power Meter	Anritsu	ML2496A	1326001	06/23/2017	06/22/2018
Power Sensor	Anritsu	MA2411B	1315048	06/23/2017	06/22/2018
Power Sensor	Anritsu	MA2411B	1315049	06/23/2017	06/22/2018
Coaxial Cable 30cm	WOKEN	00100A1F1A195C	RF01	12/24/2017	12/23/2018
DC Block	PASTERNACK	PE8210	RF29	12/24/2017	12/23/2018
Splitter	RF-LAMBAD	RFLT2W1G18G	RF35	12/24/2017	12/23/2018
Attenuator	WOKEN	218FS-10	RF23	12/24/2017	12/23/2018
DC Power Supply	Agilent	E3640A	MY53140006	05/02/2017	05/01/2018

7.3 Test Set-up:



7.4 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter or spectrum. (Max Hold, Detector = Peak, RBW >=20dB bandwidth)
4. Record the max. reading.
5. Repeat above procedures until all default test channel is completed.

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7.5 Measurement Result

1M BR mode (Peak):

CH	Freq. (MHz)	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	7.09	5.117	1000
39	2441	**7.36**	5.445	1000
78	2480	6.91	4.909	1000

1M BR mode (Average):

CH	Freq. (MHz)	Max. Output include tune up tolerance Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	4.42	2.767	1000
39	2441	4.49	2.812	1000
78	2480	4.40	2.754	1000

2M EDR mode (Peak):

CH	Freq. (MHz)	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	7.01	5.023	125
39	2441	**7.26**	5.321	125
78	2480	6.73	4.710	125

2M EDR mode (Average):

CH	Freq. (MHz)	Max. Avg.Output include tune up tolerance	Output Power (mW)	Limit (mW)
0	2402	4.07	2.553	125
39	2441	4.42	2.767	125
78	2480	4.04	2.535	125

3M EDR mode (Peak):

CH	Freq. (MHz)	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	7.03	5.047	125
39	2441	**7.33**	5.408	125
78	2480	6.75	4.732	125

3M EDR mode (Average):

CH	Freq. (MHz)	Max. Avg.Output include tune up tolerance	Output Power (mW)	Limit (mW)
0	2402	4.11	2.576	125
39	2441	4.45	2.786	125
78	2480	4.11	2.576	125

**Note: Max. Output include tune up tolerance Power measured by using average detector.*

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1M BR mode EIRP

Channel	Frequency (MHz)	Max. Output include tune up tolerance Power (dBm)	Antenna Gain (dBi)	EIRP (mW)	Limit (mW)
0	2402	4.42	2.70	5.152	4000
39	2441	4.49	2.70	5.236	4000
78	2480	4.40	2.70	5.129	4000

2M EDR mode EIRP

Channel	Frequency (MHz)	Max. Avg.Output include tune up tolerance	Antenna Gain (dBi)	EIRP (mW)	Limit (mW)
0	2402	4.07	2.70	4.753	4000
39	2441	4.42	2.70	5.152	4000
78	2480	4.04	2.70	4.721	4000

3M EDR mode EIRP

Channel	Frequency (MHz)	Max. Avg.Output include tune up tolerance	Antenna Gain (dBi)	EIRP (mW)	Limit (mW)
0	2402	4.11	2.70	4.797	4000
39	2441	4.45	2.70	5.188	4000
78	2480	4.11	2.70	4.797	4000

**** Note:*** EIRP = Average Power + Gain

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

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8 20dB & 99% BANDWIDTH MEASUREMENT

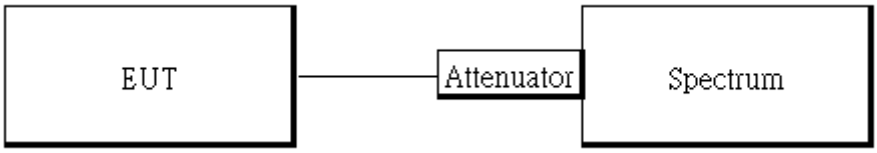
8.1 Standard Applicable

For frequency hopping systems operating in the 2400MHz-2483.5 MHz no limit for 20dB bandwidth.

8.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	KEYSIGHT	N9010A	MY51440113	06/20/2017	06/19/2018
Coaxial Cable 30cm	WOKEN	00100A1F1A195C	RF01	12/24/2017	12/23/2018
DC Block	PASTERNACK	PE8210	RF29	12/24/2017	12/23/2018
Attenuator	WOKEN	218FS-10	RF23	12/24/2017	12/23/2018
DC Power Supply	Agilent	E3640A	MY53140006	05/02/2017	05/01/2018

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 ANSI C63.10:2013.
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 the spectrum analyzer as RBW=10 kHz (1 % of 20 dB Bandwidth.), VBW = 30 kHz, Span= 3MHz, Sweep=auto, Detector = Peak, and Max hold for 20dB Bandwidth test.
5. Mark the peak frequency and –20dB (upper and lower) frequency
6. Turn on the 99% bandwidth function, max reading.
7. Repeat above procedures until all test default channel is completed

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8.5 Measurement Result

GFSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
Low	0.9236	0.62
Mid	0.92383	0.62
High	0.92358	0.62

π/4-DQPSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
Low	1.285	0.86
Mid	1.307	0.87
High	1.304	0.87

8-DPSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
Low	1.262	0.84
Mid	1.261	0.84
High	1.268	0.85

GFSK

CH	99% Bandwidth (MHz)
Low	0.88533
Mid	0.88402
High	0.88415

π/4-DQPSK

CH	99% Bandwidth (MHz)
Low	1.1797
Mid	1.1810
High	1.1808

8-DPSK

CH	99% Bandwidth (MHz)
Low	1.1831
Mid	1.1884
High	1.1865

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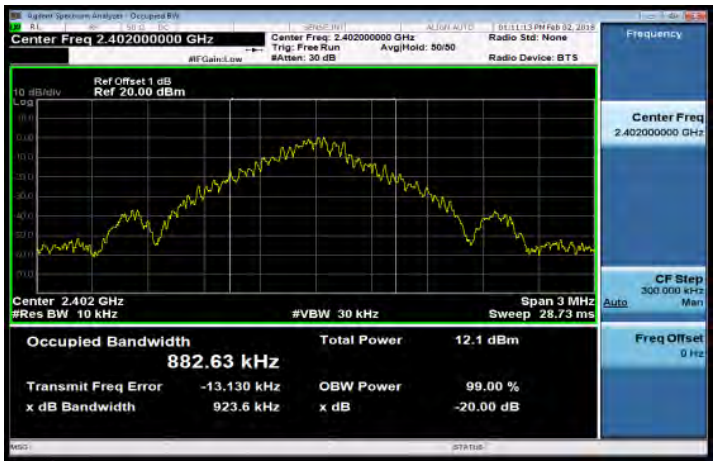
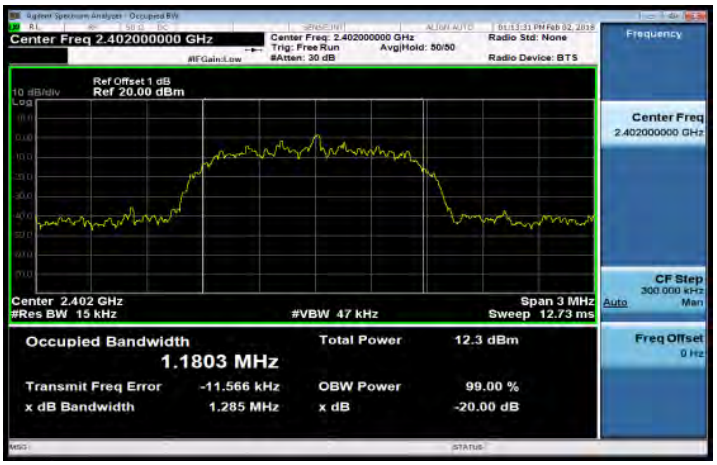
20dB Bandwidth

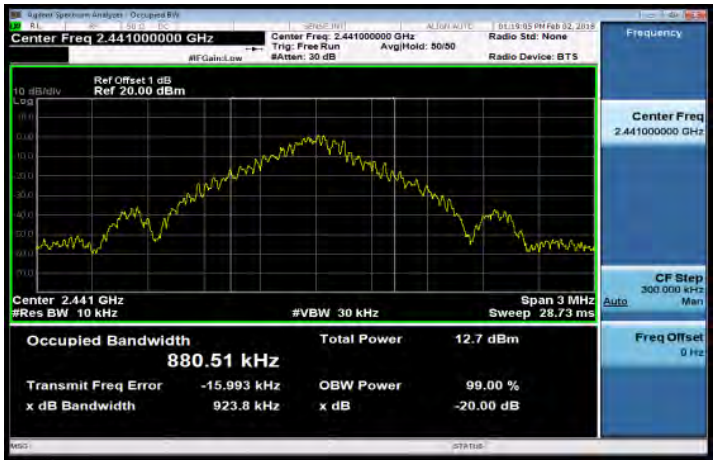
BW CH-Low (GFSK mode)



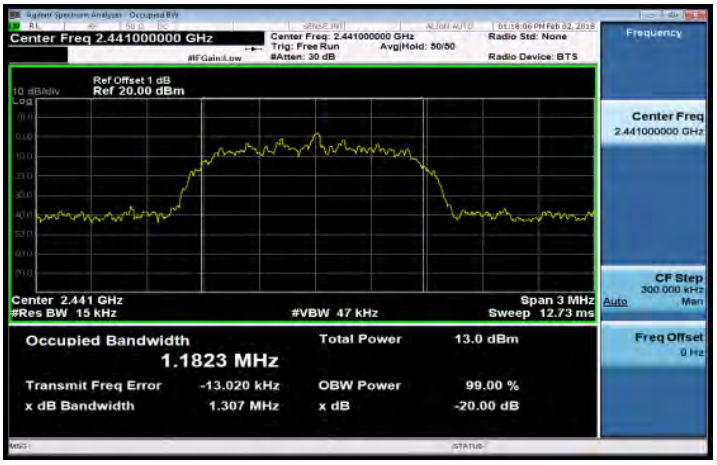
CH-Low (π/4-DQPSK mode)



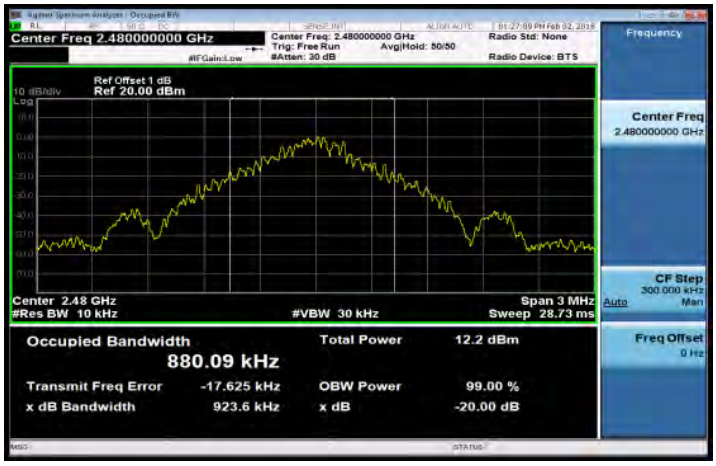
CH-Mid (GFSK mode)



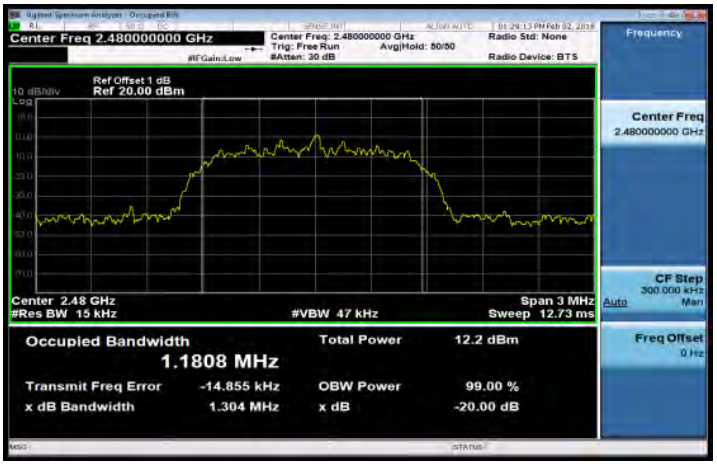
CH-Mid (π/4-DQPSK mode)



CH-High (GFSK mode)



CH-High (π/4-DQPSK mode)



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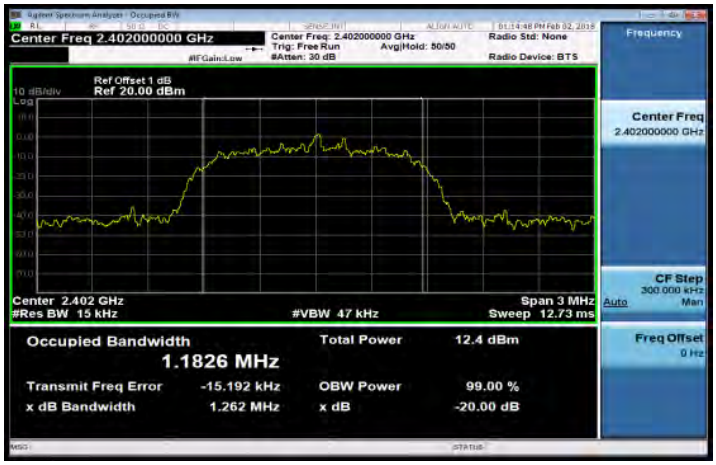
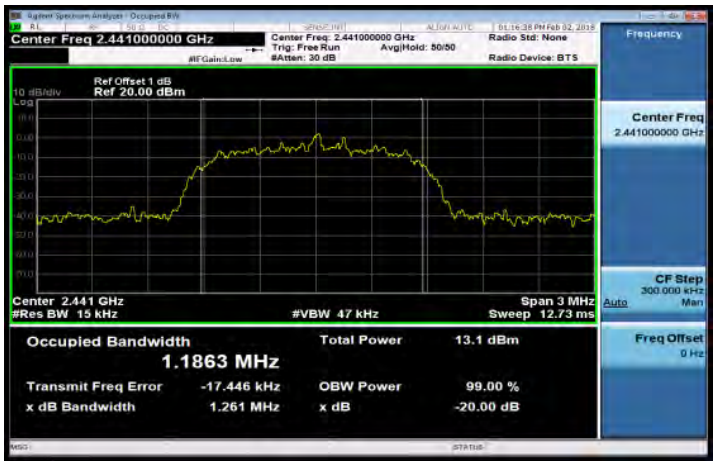
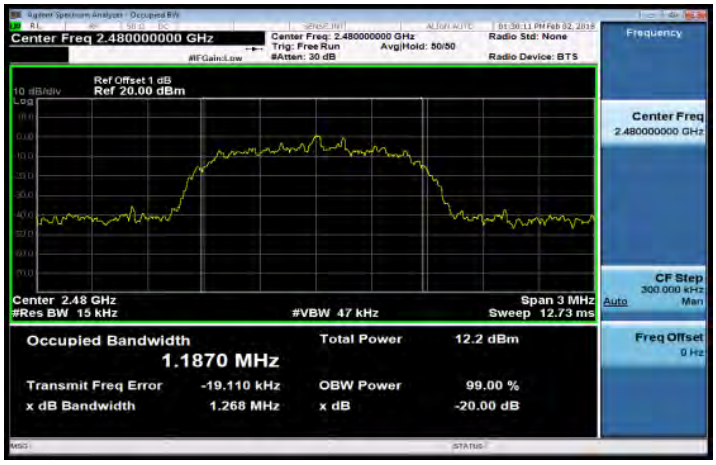
CH-Low (8-DPSK mode)



CH-Mid (8-DPSK mode)



CH-High (8-DPSK mode)



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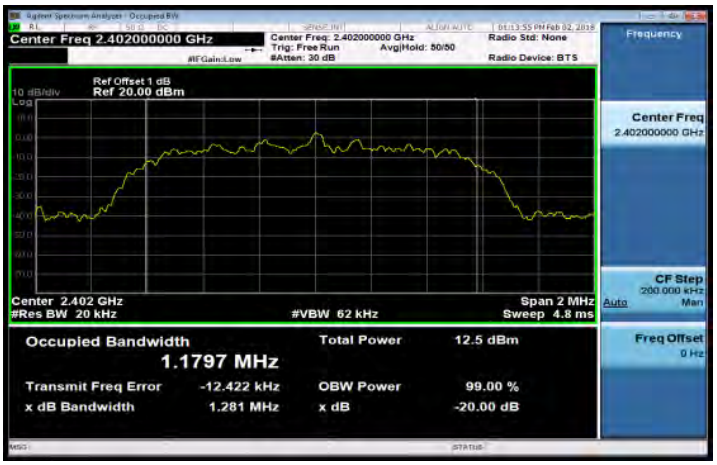
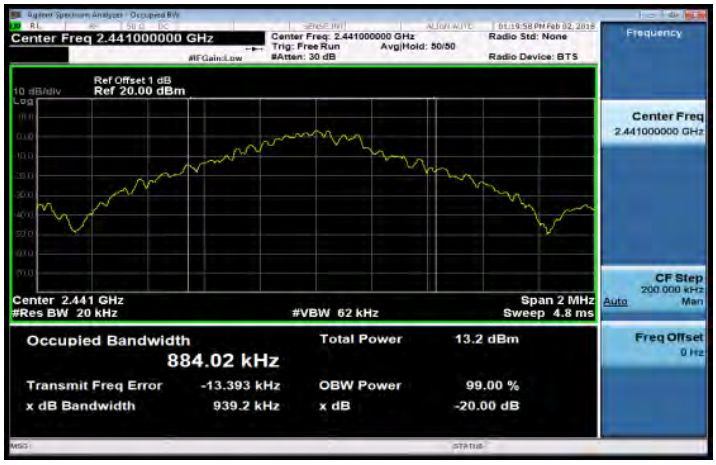
99% Bandwidth

BW CH-Low (GFSK mode)

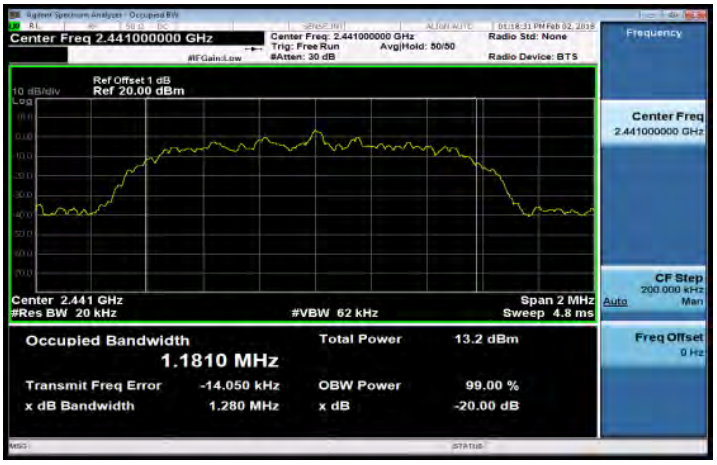
CH-Low (π/4-DQPSK mode)



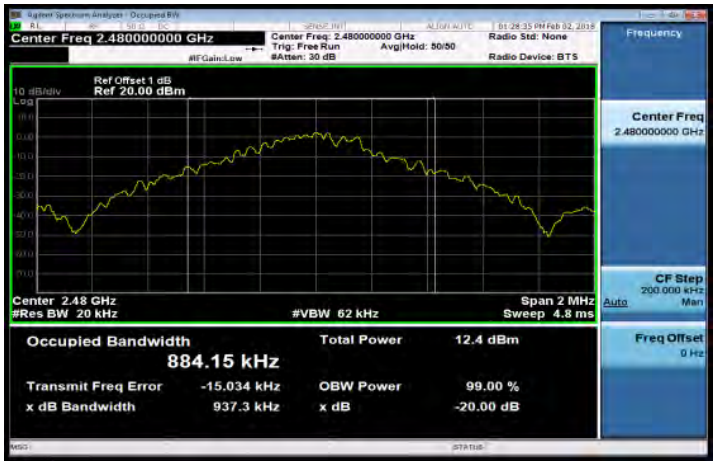
CH-Mid (GFSK mode)



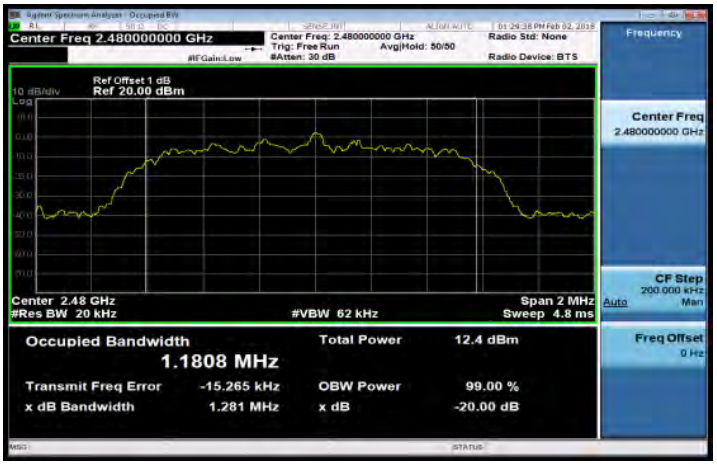
CH-Mid (π/4-DQPSK mode)



CH-High (GFSK mode)



CH-High (π/4-DQPSK mode)



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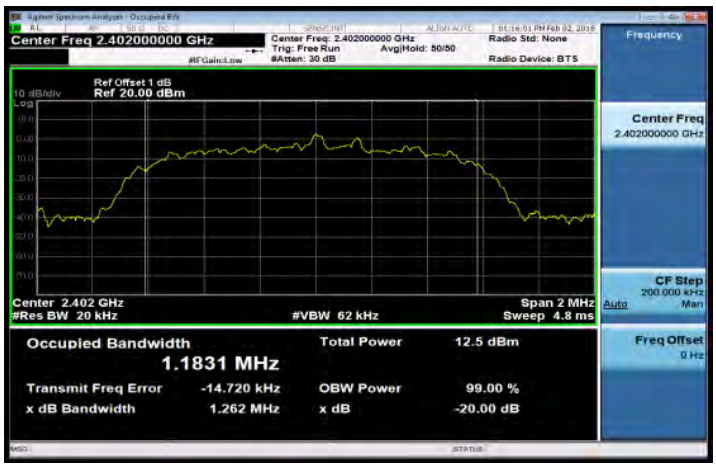
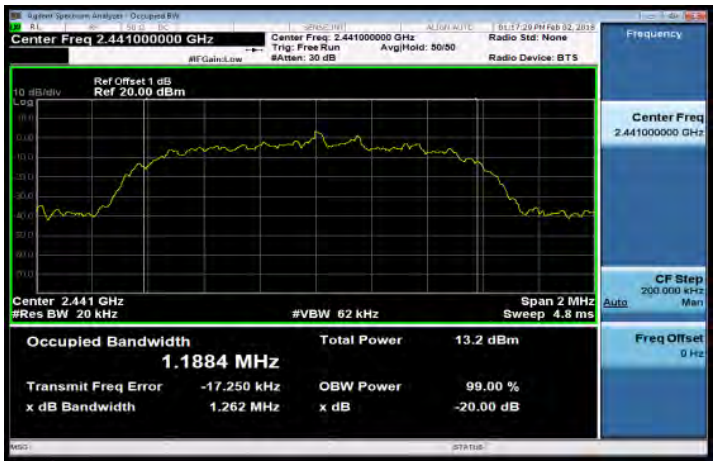
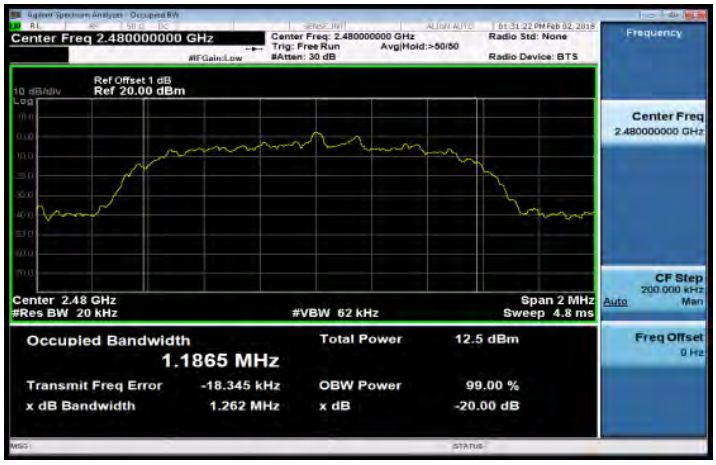
CH-Low (8-DPSK mode)



CH-Mid (8-DPSK mode)



CH-High (8-DPSK mode)



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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) & RSS-Gen §8.9 limit.

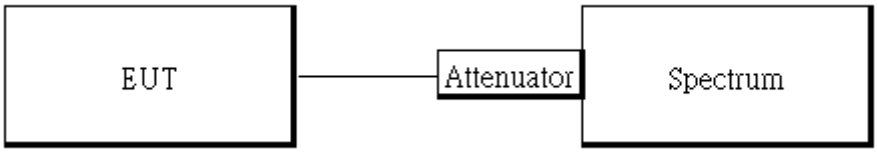
9.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	KEYSIGHT	N9010A	MY51440113	06/20/2017	06/19/2018
Coaxial Cable 30cm	WOKEN	00100A1F1A195C	RF01	12/24/2017	12/23/2018
DC Block	PASTERNACK	PE8210	RF29	12/24/2017	12/23/2018
Attenuator	WOKEN	218FS-10	RF23	12/24/2017	12/23/2018
DC Power Supply	Agilent	E3640A	MY53140006	05/02/2017	05/01/2018

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
DC Power Supply	Agilent	E3640A	MY53140006	05/01/2018	04/30/2019

Note: The measurement was taken place with the long duration of the time, and additional equipment list as shown above indicate those equipment of which has been subject to undertake the calibration in intermediate period of time of the measurement.

9.3 Test SET-UP



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9.4 Measurement Procedure

Conducted Band Edge:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013.
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 center frequency of spectrum analyzer = operating frequency.
5. Set the spectrum analyzer as RBW=100 kHz, VBW=300 kHz, Sweep = auto
6. Mark Peak, 2.3999GHz and 2.4836GHz and record the max. level.
7. Repeat above procedures until all frequency measured were complete.

Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows ANSI C63.10:2013.
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.

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	

9.5 Measurement Result

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

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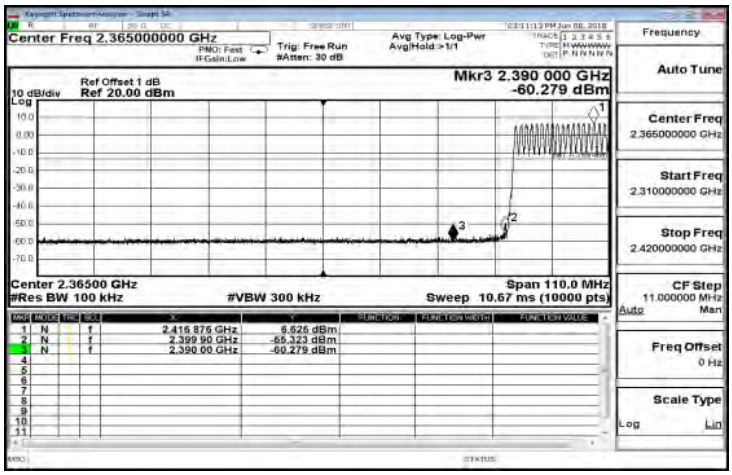
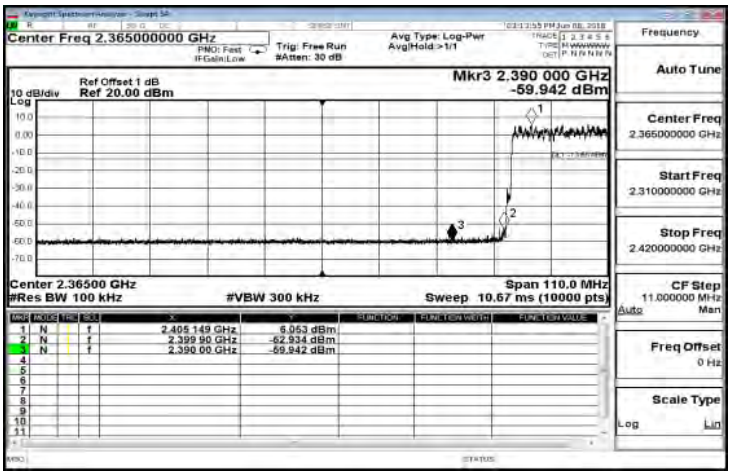
Hopping mode

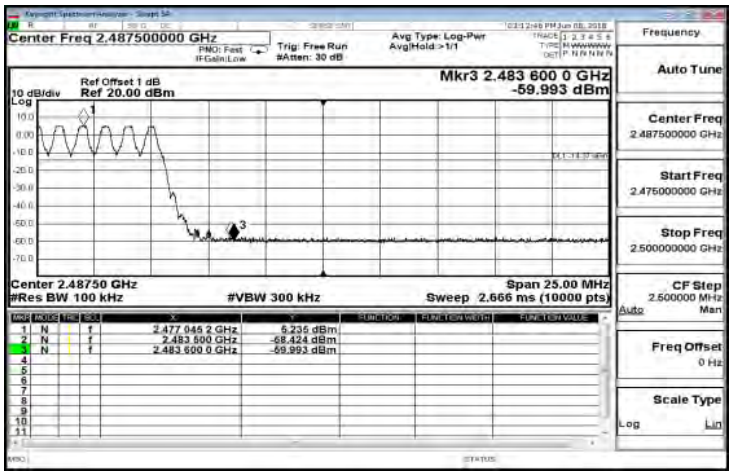
BR Band Edge CH-Low



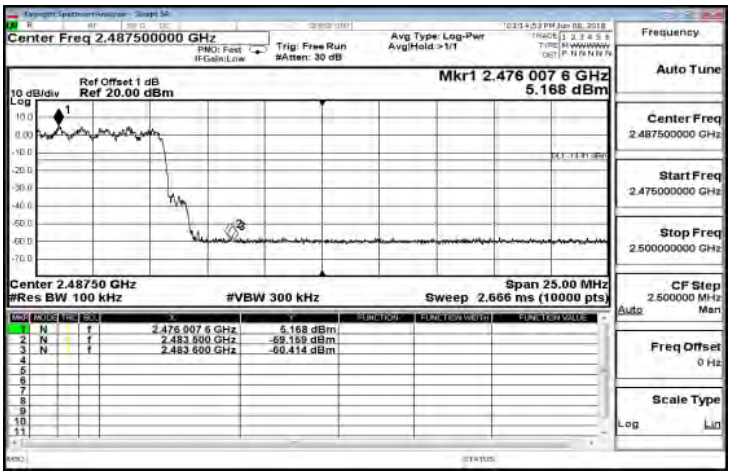
EDR Band Edge CH-Low



BR Band Edge CH-High



EDR Band Edge CH-High



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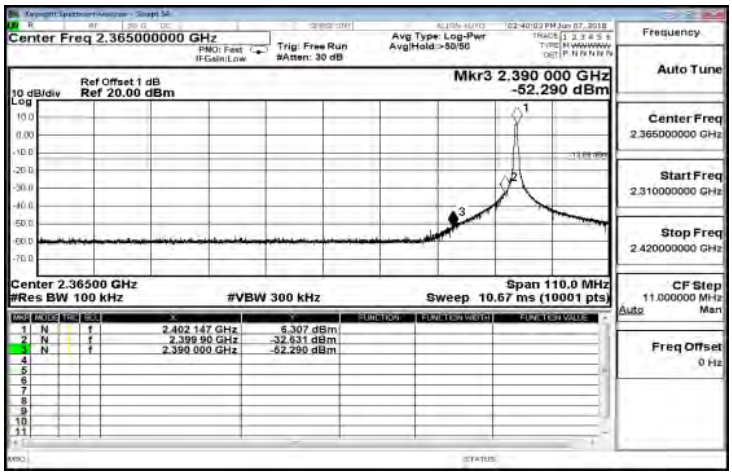
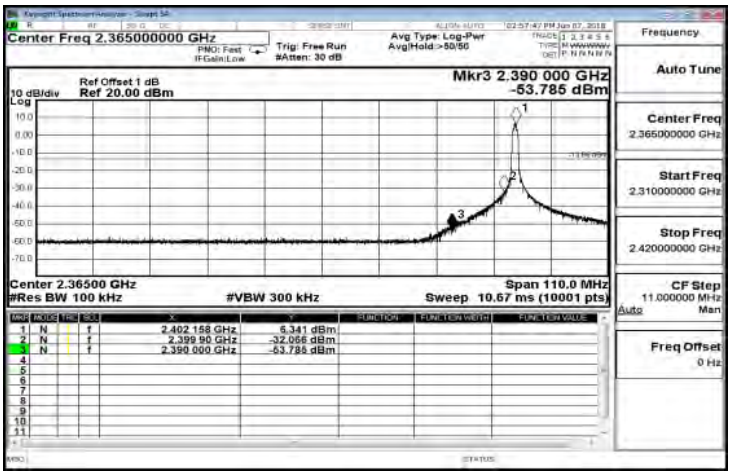
Non-Hopping

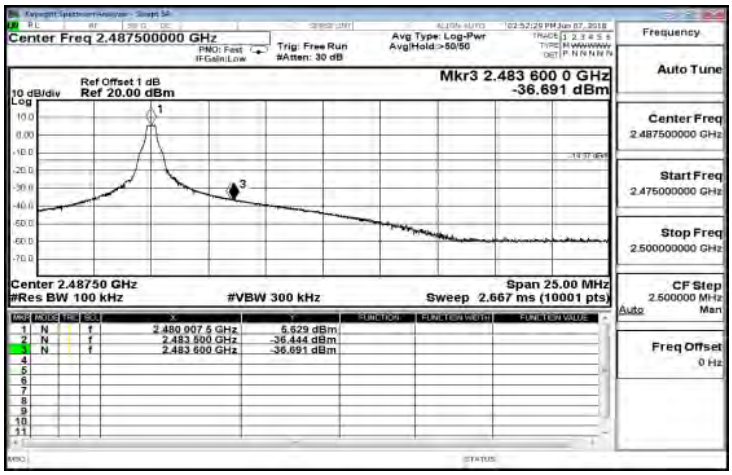
BR Band Edge CH-Low



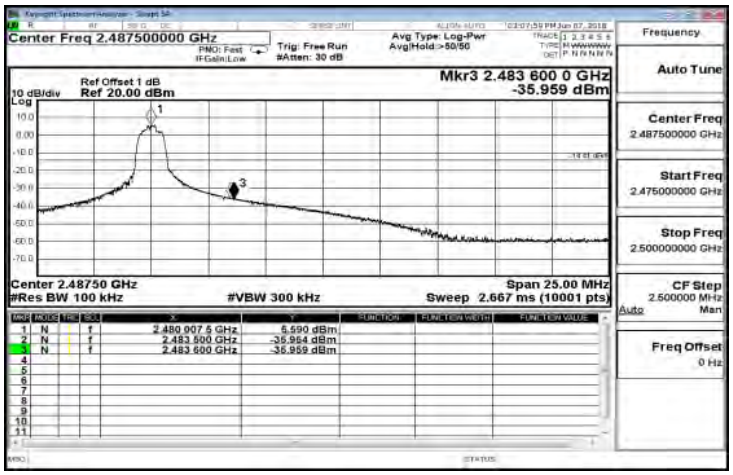
EDR Band Edge CH-Low



BR Band Edge CH-High



EDR Band Edge CH-High



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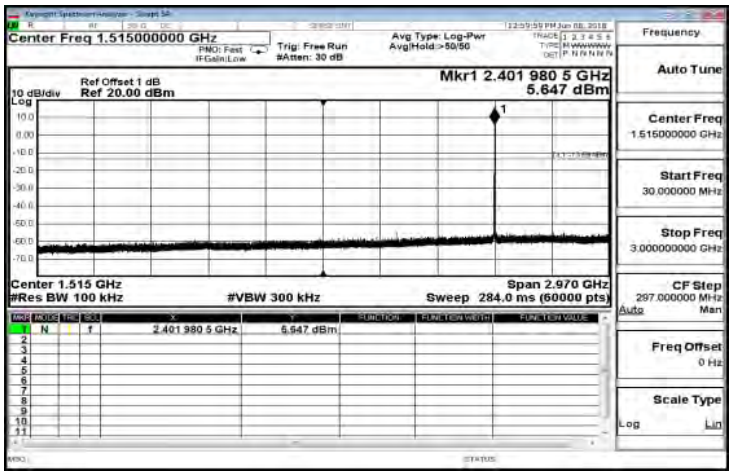
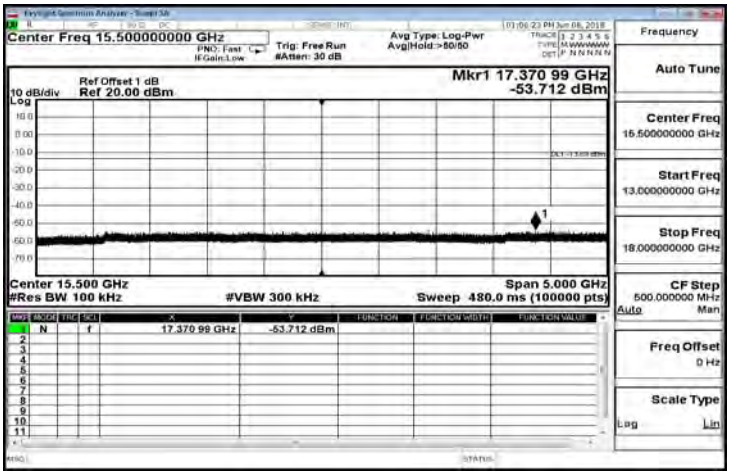
Conducted Spurious Emission Measurement Result

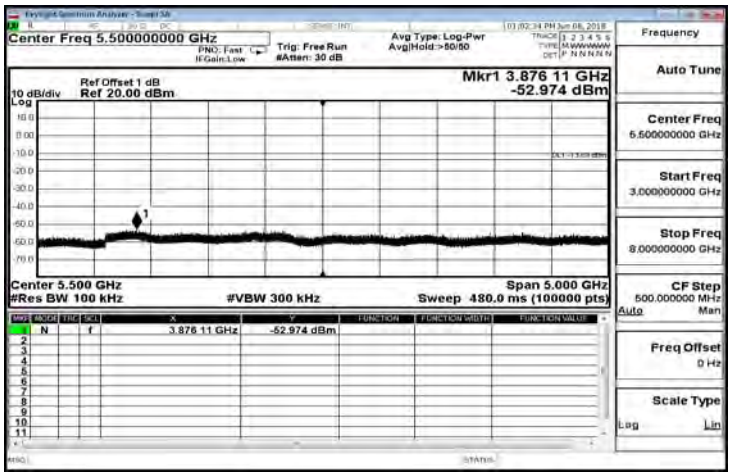
Ch Low 30MHz – 3GHz (BR Mode)



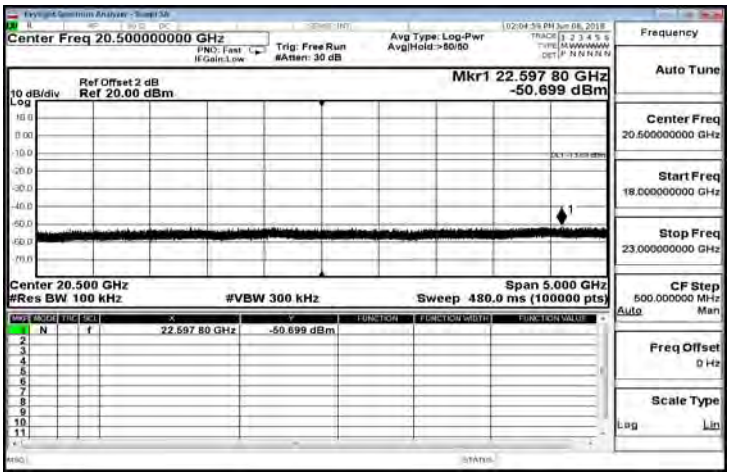
Ch Low 13GHz – 18GHz (BR Mode)



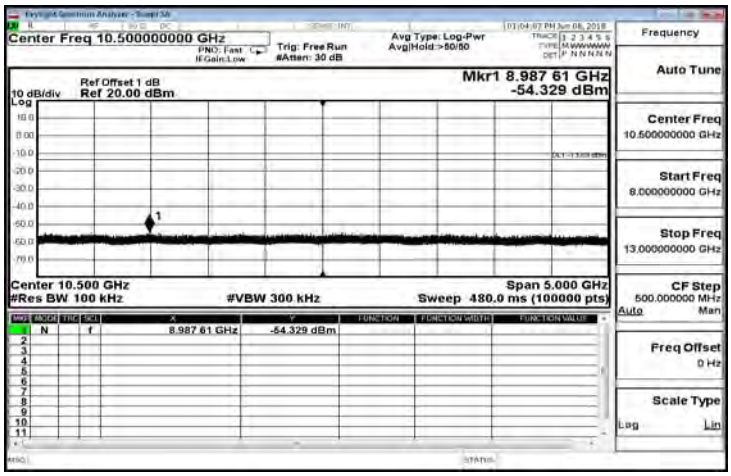
Ch Low 3GHz – 8GHz (BR Mode)



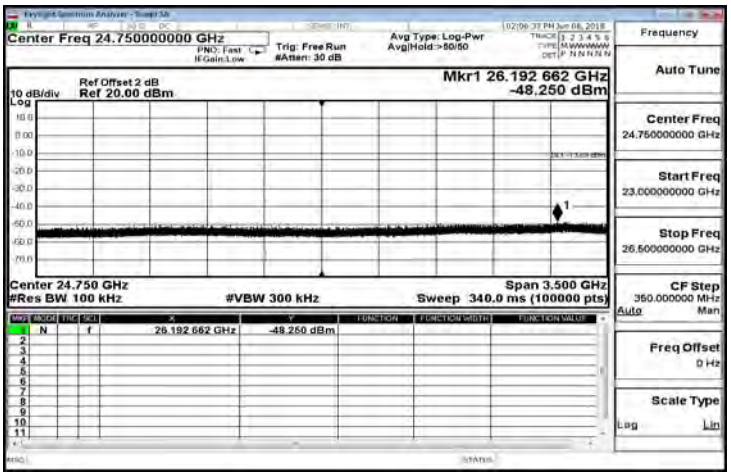
Ch Low 18GHz – 23GHz (BR Mode)



Ch Low 8GHz – 13GHz (BR Mode)



Ch Low 23GHz – 26.5GHz (BR Mode)



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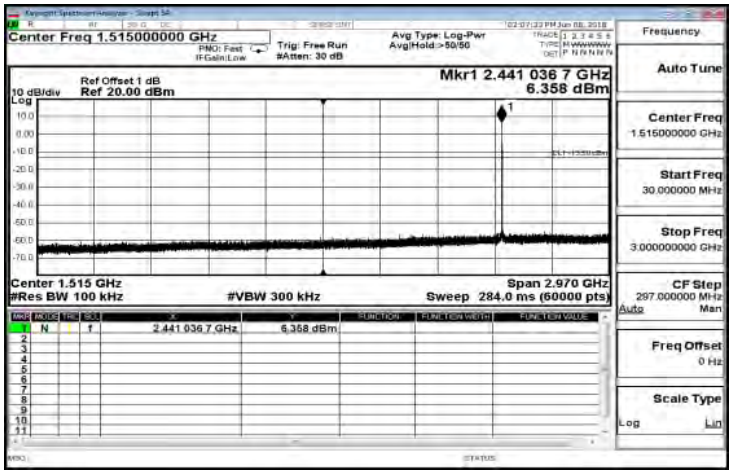
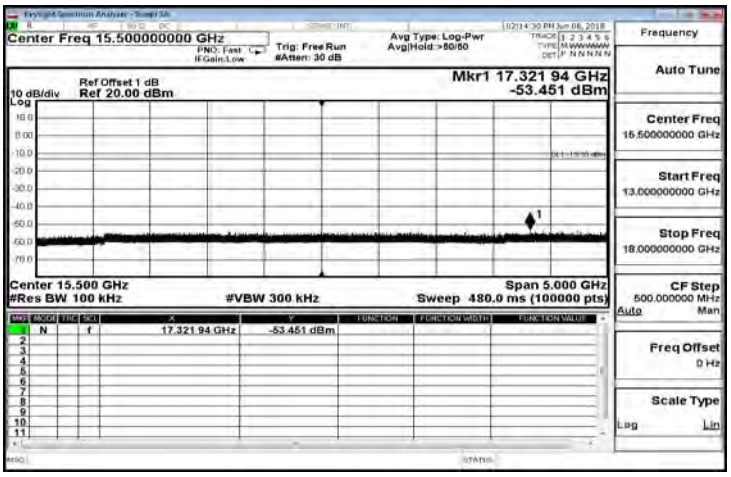
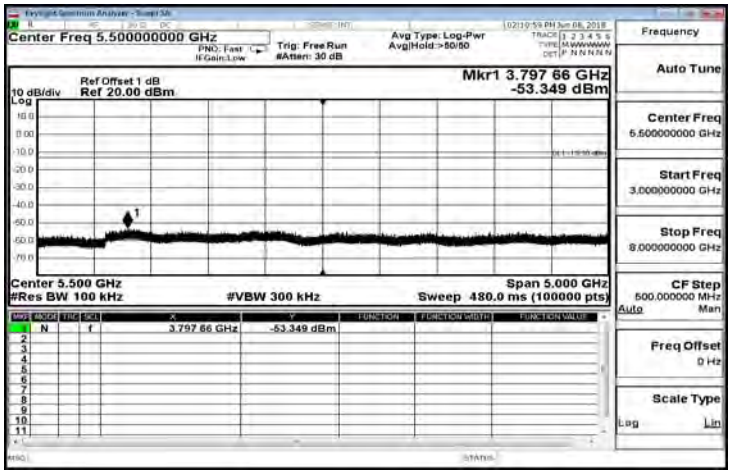
Ch Mid 30MHz – 3GHz (BR Mode)



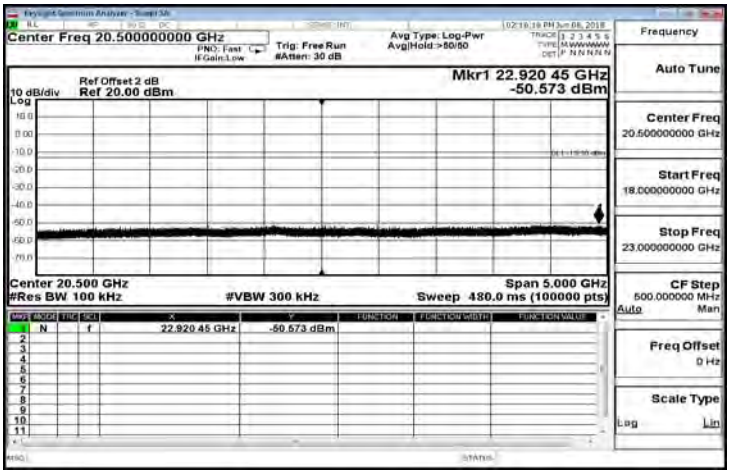
Ch Mid 13GHz – 18GHz (BR Mode)



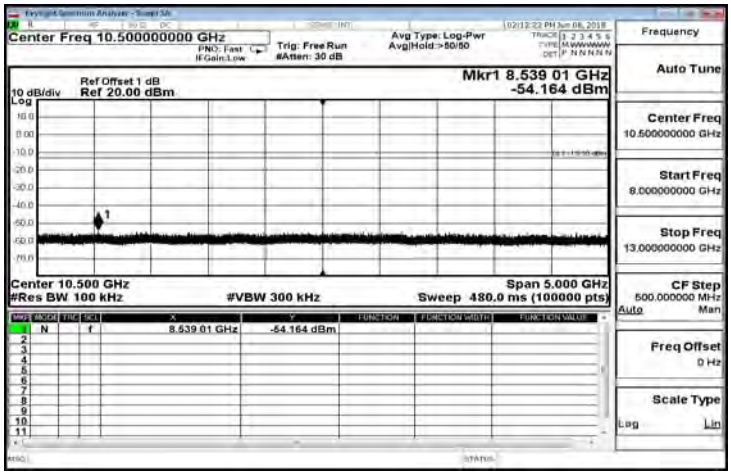
Ch Mid 3GHz – 8GHz (BR Mode)



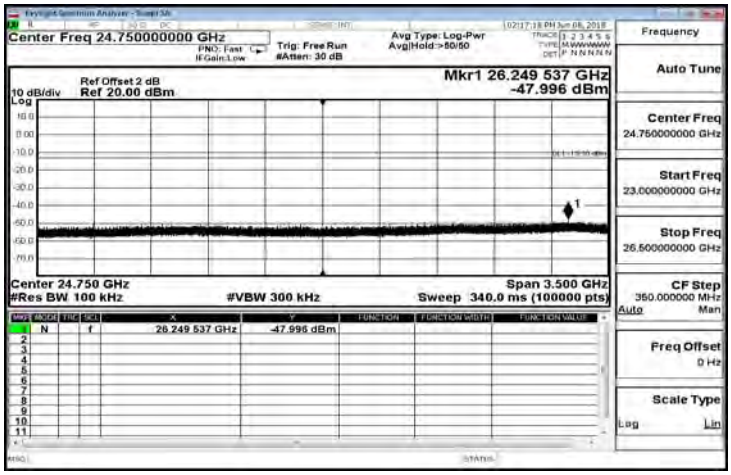
Ch Mid 18GHz – 23GHz (BR Mode)



Ch Mid 8GHz – 13GHz (BR Mode)



Ch Mid 23GHz – 26.5GHz (BR Mode)



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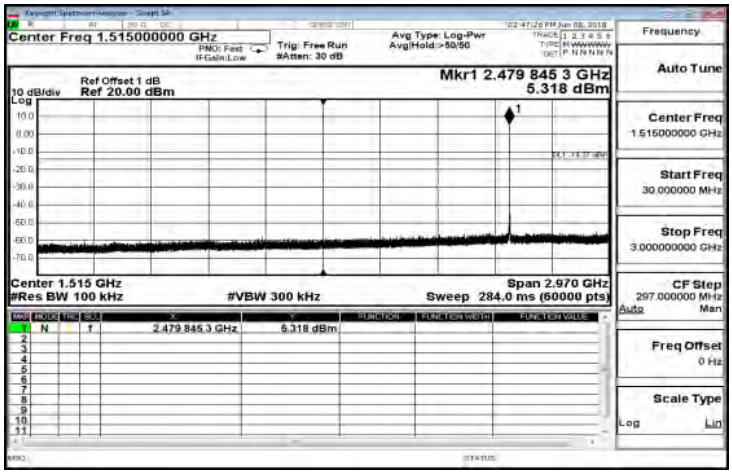
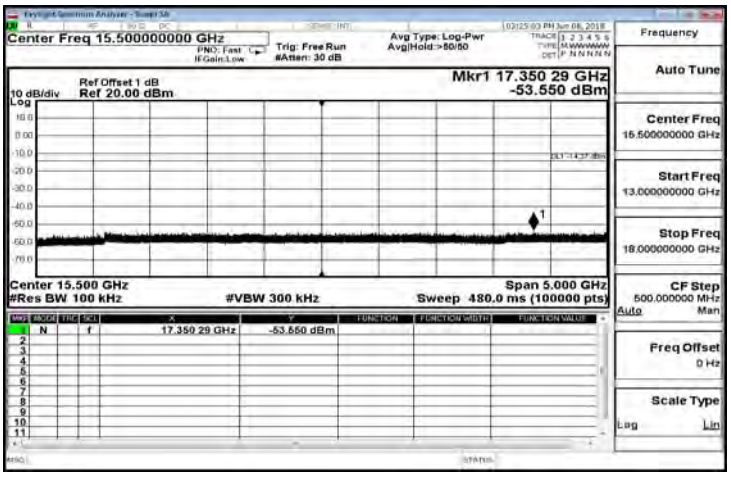
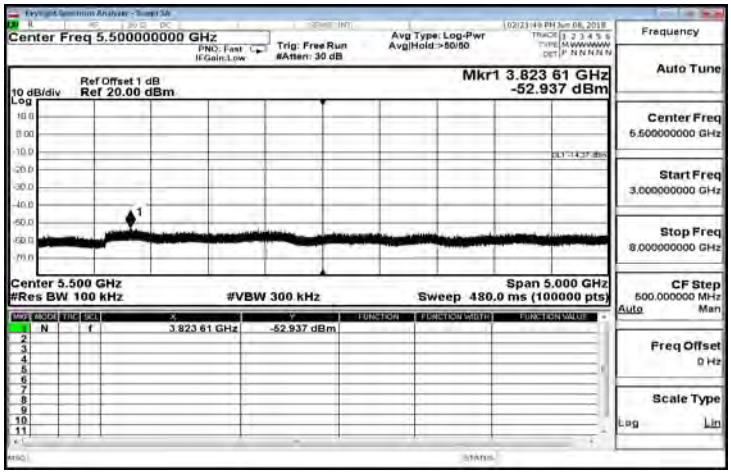
Ch High 30MHz – 3GHz (BR Mode)



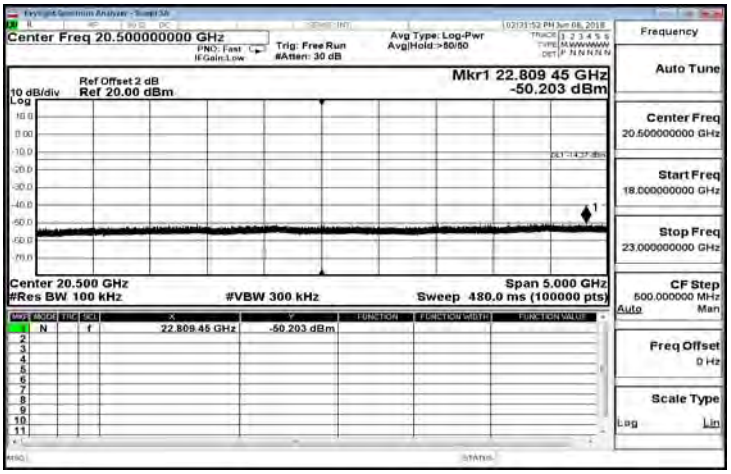
Ch High 13GHz – 18GHz (BR Mode)



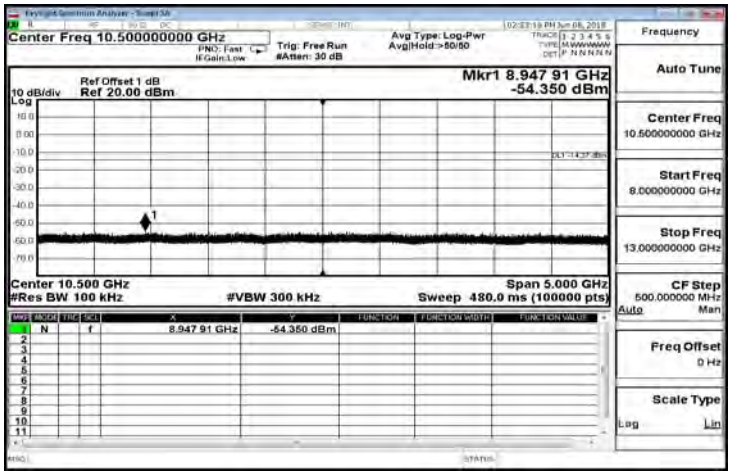
Ch High 3GHz – 8GHz (BR Mode)



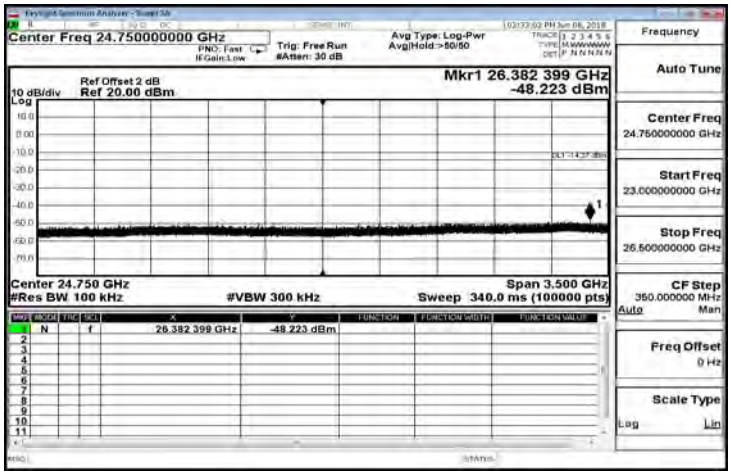
Ch High 18GHz – 23GHz (BR Mode)



Ch High 8GHz – 13GHz (BR Mode)



Ch High 23GHz – 26.5GHz (BR Mode)



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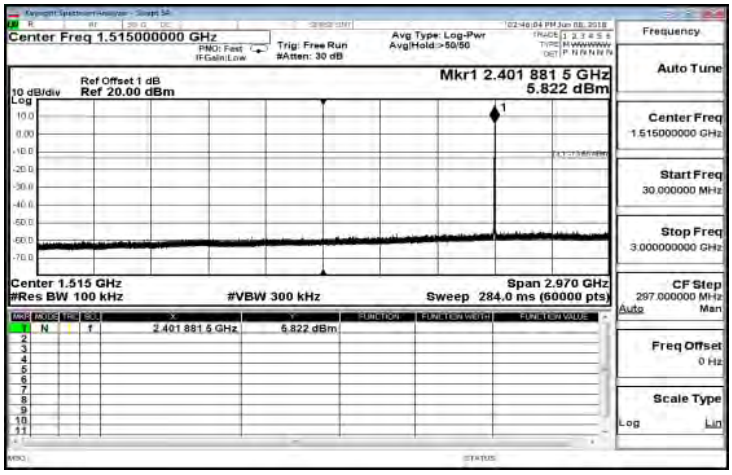
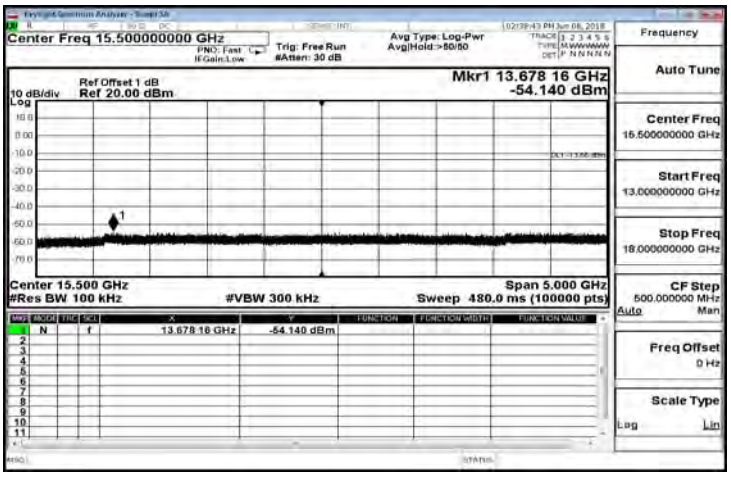
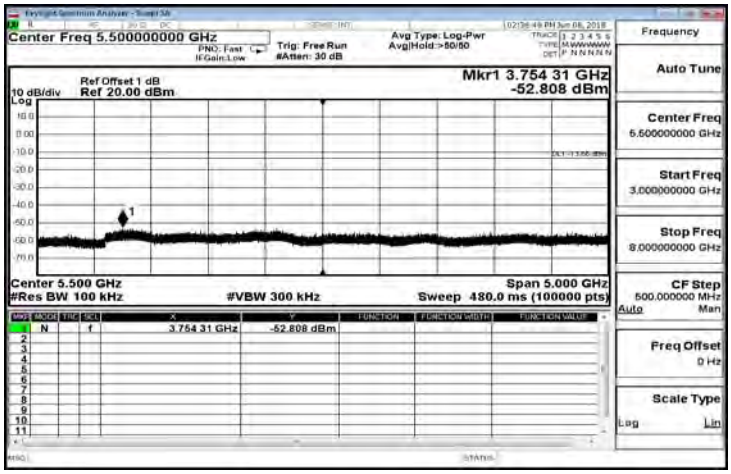
Ch Low 30MHz – 3GHz (EDR Mode)



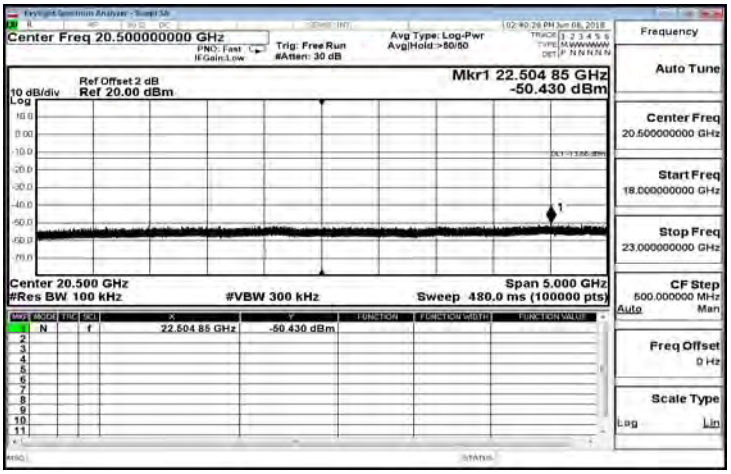
Ch Low 13GHz – 18GHz (EDR Mode)



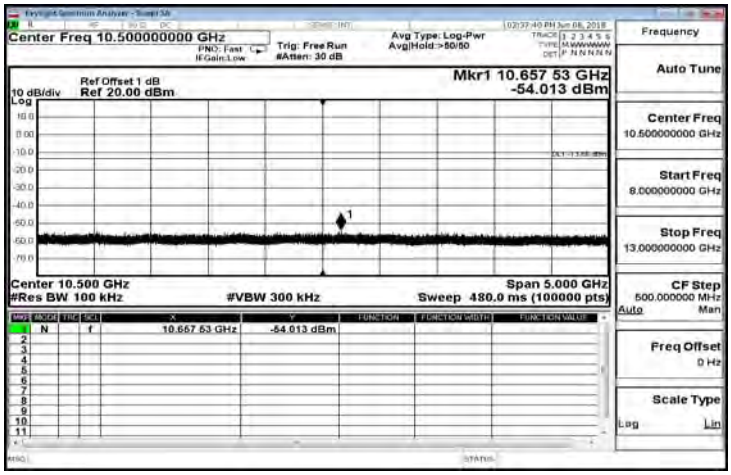
Ch Low 3GHz – 8GHz (EDR Mode)



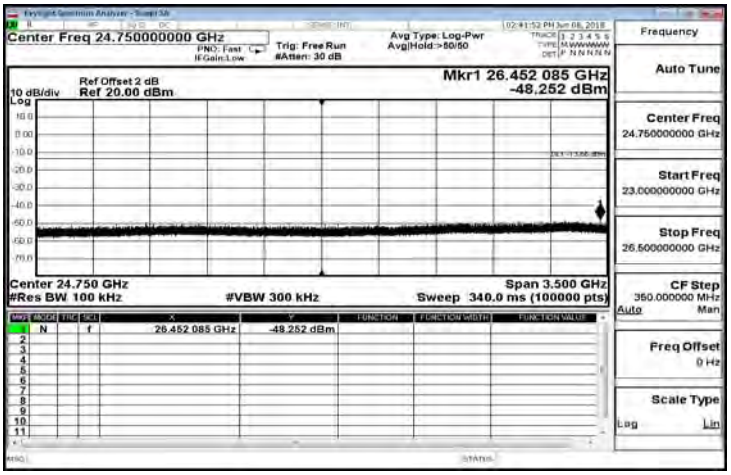
Ch Low 18GHz – 23GHz (EDR Mode)



Ch Low 8GHz – 13GHz (EDR Mode)



Ch Low 23GHz – 26.5GHz (EDR Mode)



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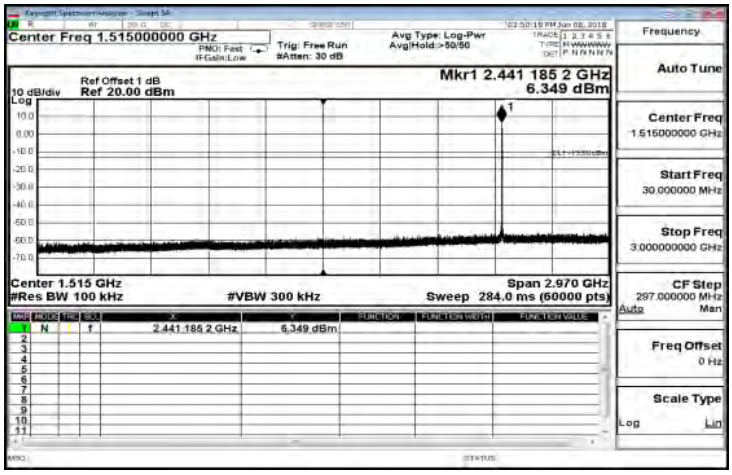
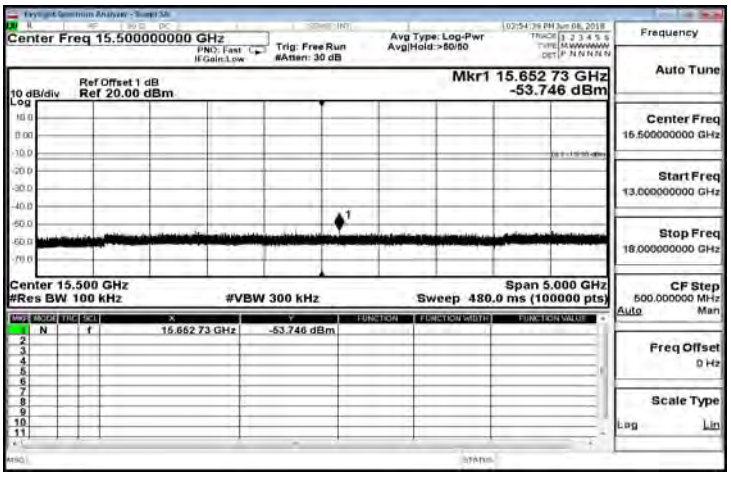
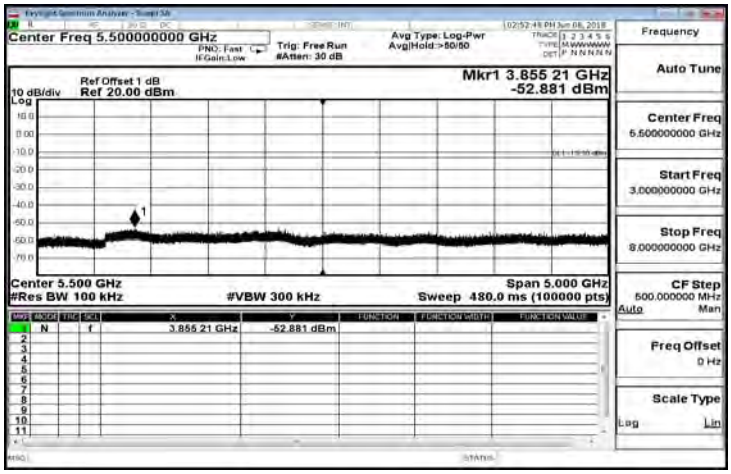
Ch Mid 30MHz – 3GHz (EDR Mode)



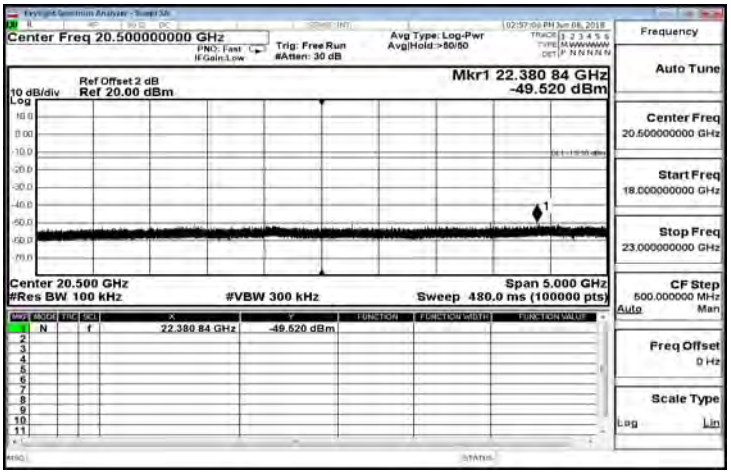
Ch Mid 13GHz – 18GHz (EDR Mode)



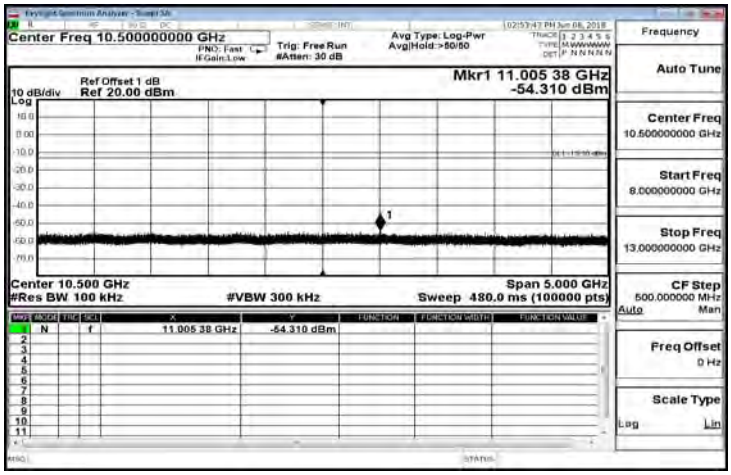
Ch Mid 3GHz – 8GHz (EDR Mode)



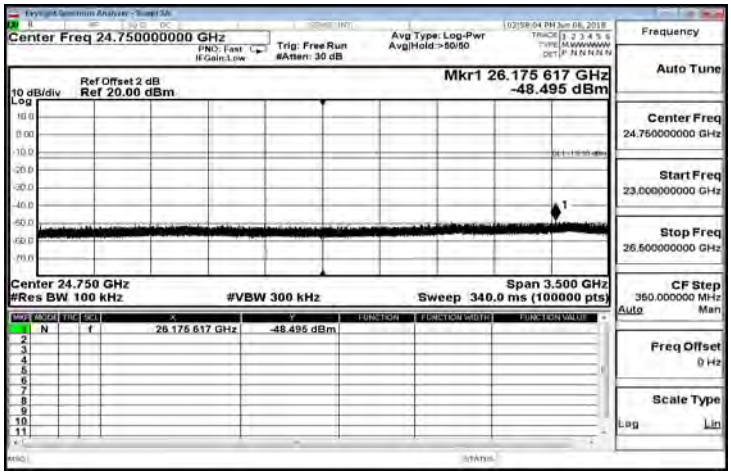
Ch Mid 18GHz – 23GHz (EDR Mode)



Ch Mid 8GHz – 13GHz (EDR Mode)



Ch Mid 23GHz – 26.5GHz (EDR Mode)



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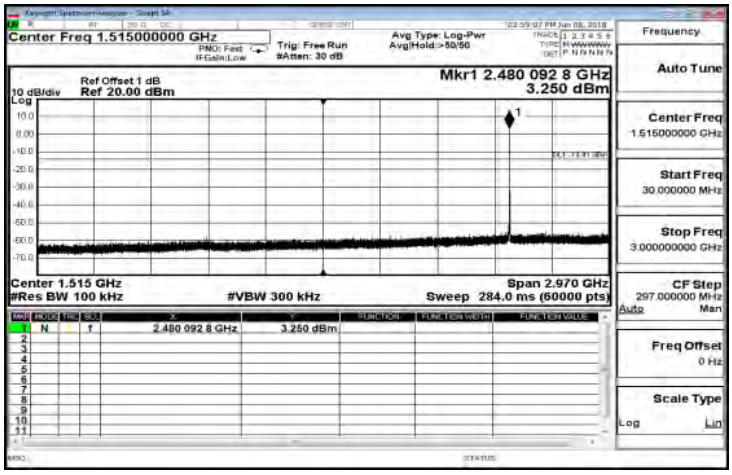
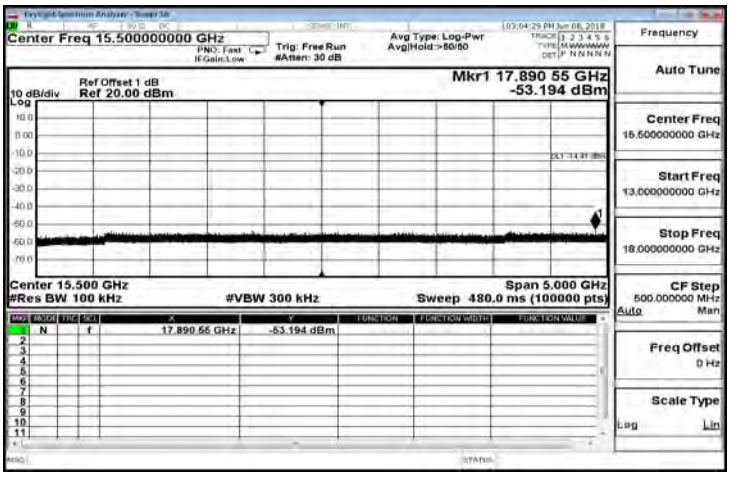
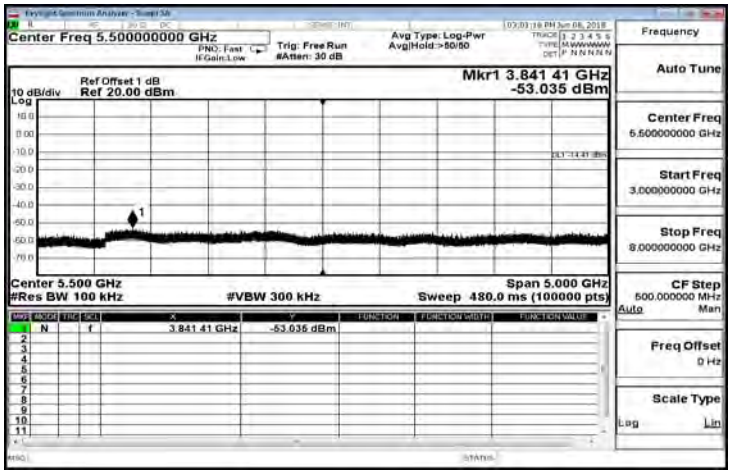
Ch High 30MHz – 3GHz (EDR Mode)



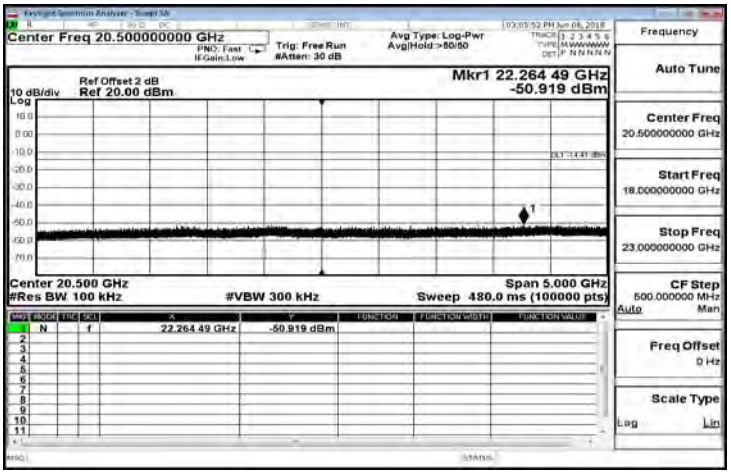
Ch High 13GHz – 18GHz (EDR Mode)



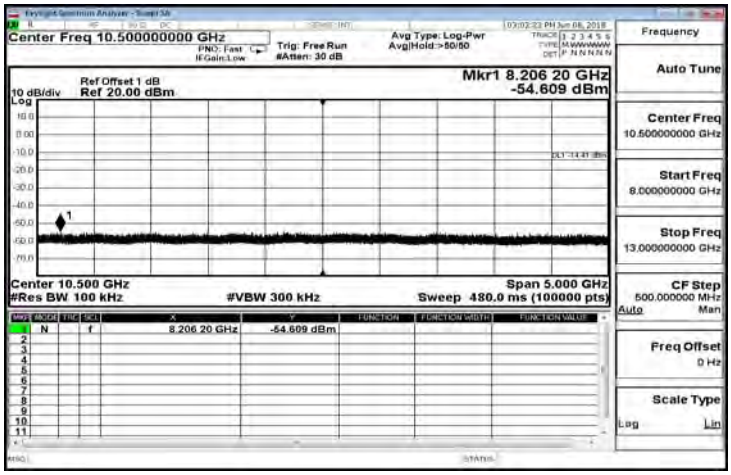
Ch High 3GHz – 8GHz (EDR Mode)



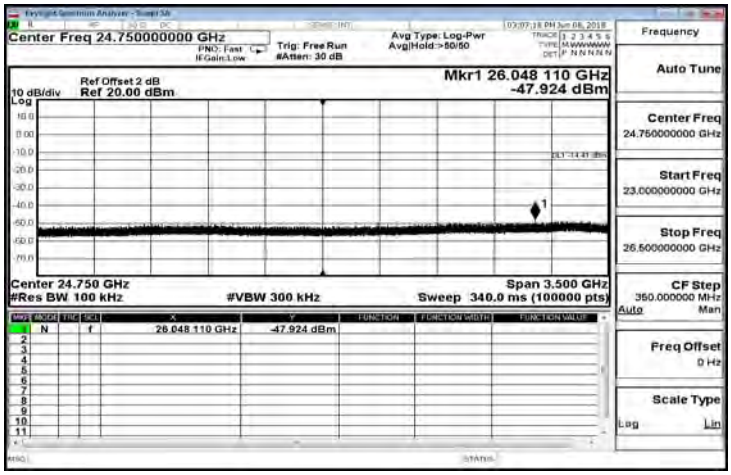
Ch High 18GHz – 23GHz (EDR Mode)



Ch High 8GHz – 13GHz (EDR Mode)



Ch High 23GHz – 26.5GHz (EDR Mode)



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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 & RSS-Gen §8.10 Table 6 limit.

And according to §15.33(a) (1) & RSS-Gen §8.9 Table 4 & 5, 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 (μV/m)

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10.2 Measurement Equipment Used

966 Chamber					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EMI Test Receiver	R&S	ESU 40	100363	04/18/2017	04/17/2018
Loop Antenna	ETS-Lindgren	6502	00143303	12/23/2017	12/22/2018
Broadband Antenna	TESEQ	CBL 6112D	35240	11/03/2017	11/02/2018
Horn Antenna	ETS-Lindgren	3117	00143272	12/15/2017	12/16/2018
Horn Antenna	Schwarzbeck	BBHA9170	185	08/01/2017	07/31/2018
Pre Amplifier	EMC Instruments	EMC330	980096	12/24/2017	12/23/2018
Pre Amplifier	EMC Instruments	EMC0011830	980199	12/24/2017	12/23/2018
Pre Amplifier	R&S	SCU-18	10204	12/24/2017	12/23/2018
Pre Amplifier	R&S	SCU-26	100780	12/24/2017	12/23/2018
Coaxial Cable	Huber+Suhner	RG 214/U	966Rx 9K-30M	12/24/2017	12/23/2018
Coaxial Cable	Huber+Suhner	RG 214/U SUCOFLEX 104	966Rx 30M-3G	12/24/2017	12/23/2018
Coaxial Cable	Huber+Suhner	SUCOFLEX 104	966Rx 1G-18G	12/24/2017	12/23/2018
Coaxial Cable	Huber+Suhner	mini 141-12 SUCOFLEX 104	966Rx 18G-40G	12/24/2017	12/23/2018
Coaxial Cable	Huber+Suhner	SUCOFLEX 104	966Tx 30M-18G	12/24/2017	12/23/2018
Coaxial Cable	Huber+Suhner	SUCOFLEX 102	966Tx 18G-40G	12/24/2017	12/23/2018
Attenuator	WOKEN	218FS-10	RF27	12/24/2017	12/23/2018
Site NSA	SGS	966 Chamber C	SAC-C	03/02/2017	03/01/2018
Site VSWR	SGS	966 Chamber C	SAC-C	03/02/2017	03/01/2018
DC Power Supply	HOLA	DP-3003	D7070035	05/04/2017	05/03/2018
Controller	MF	MF-7802	N/A	N.C.R.	N.C.R.
Antenna Master	MF	N/A	N/A	N.C.R.	N.C.R.
Turn Table	MF	N/A	N/A	N.C.R.	N.C.R.
Test Software	World-Pallas	Dr. E	V 3.0 Lite	N.C.R.	N.C.R.

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

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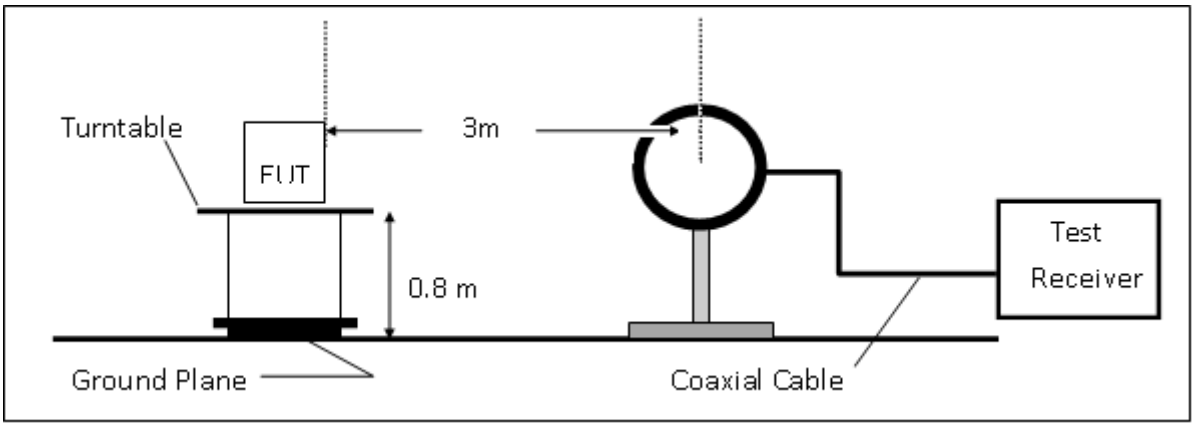
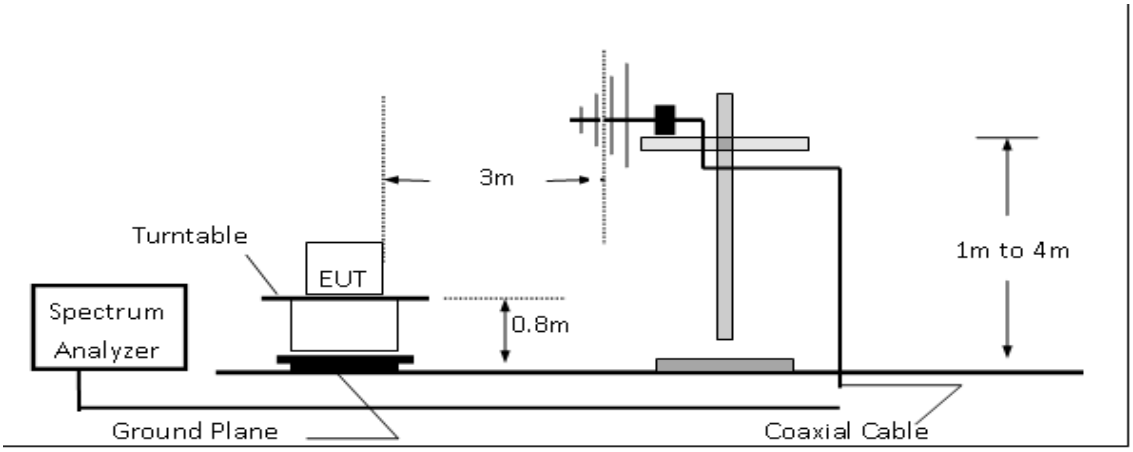
10.3 Test SET-UP

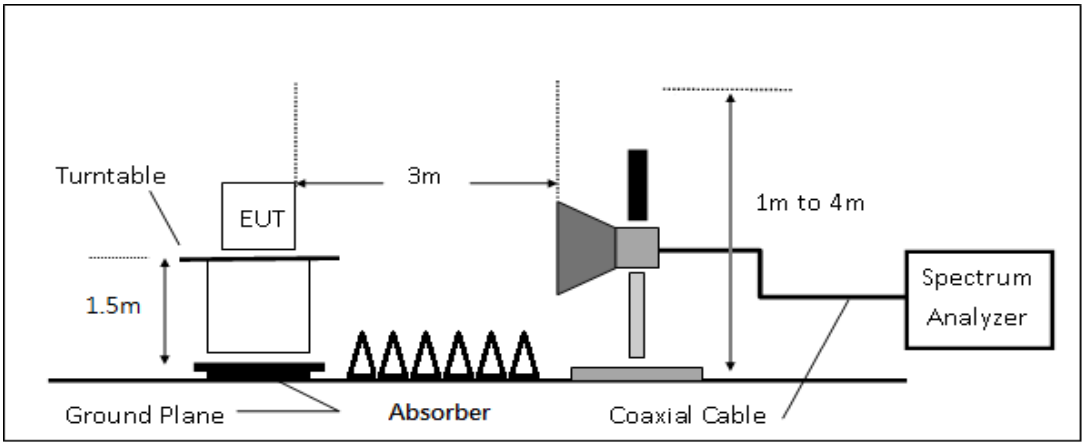
(A) Radiated Emission Test Set-UP Frequency Below 30MHz.



(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

Radiated Emission

1. The testing follows ANSI C63.10:2013.
2. The EUT is 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. Use the follow spectrum analyzer setting:
   (1) Span = wide enough to fully capture the emission being measured
   (2) RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz, VBW ≥ RBW, Sweep = auto, Detector function = peak, Trace = max hold
   (3) For average measurement: use duty cycle correction factor method per 15.35(c)
   Duty Cycle = On time/100 milliseconds
   On time = N1*L1=N2*L2+…+N(n-1)*LN(n-1)+N(n)*L(n)
   Where N1 is number of type 1 pulses, L1 is length of type 1 pulses, etc.
   Average Emission Level = Peak Emission Level + 20*log (duty Cycle)
6. 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.
7. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
8. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
9. Repeat above procedures until all frequency of the interest 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	

The limit of the emission level is expressed in dBuV/m, which converts 20*log(uV/m)

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

Factor(dB) = Antenna Factor(dB/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

Radiated emission below 30MHz is measured in a 9m*9m*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site. And there is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

After Pre-scanned 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: WLAN/BT coexistence cases were investigated and there are no new emissions to report.
Refer to next page spectrum analyzer data chart and tabular data sheets.

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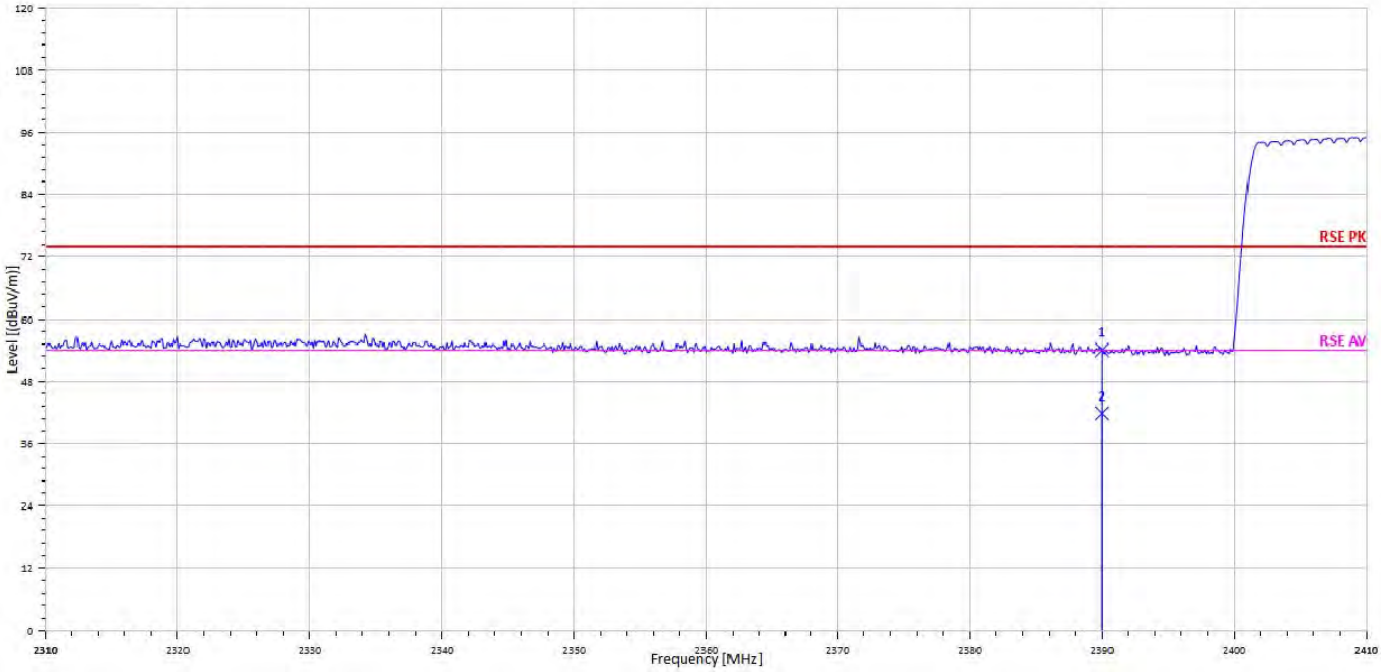
Radiated Band Edge Measurement Result: (Hopping Mode)

Operation Mode :	BT BR Hopping	Test Date :	2018/2/23
Fundamental Frequency :	2402 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	BE CH Low	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Vertical



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2390.00	E	Peak	60.87	-6.84	54.03	74	-19.97
2390.00	E	Average	48.66	-6.84	41.81	54	-12.19

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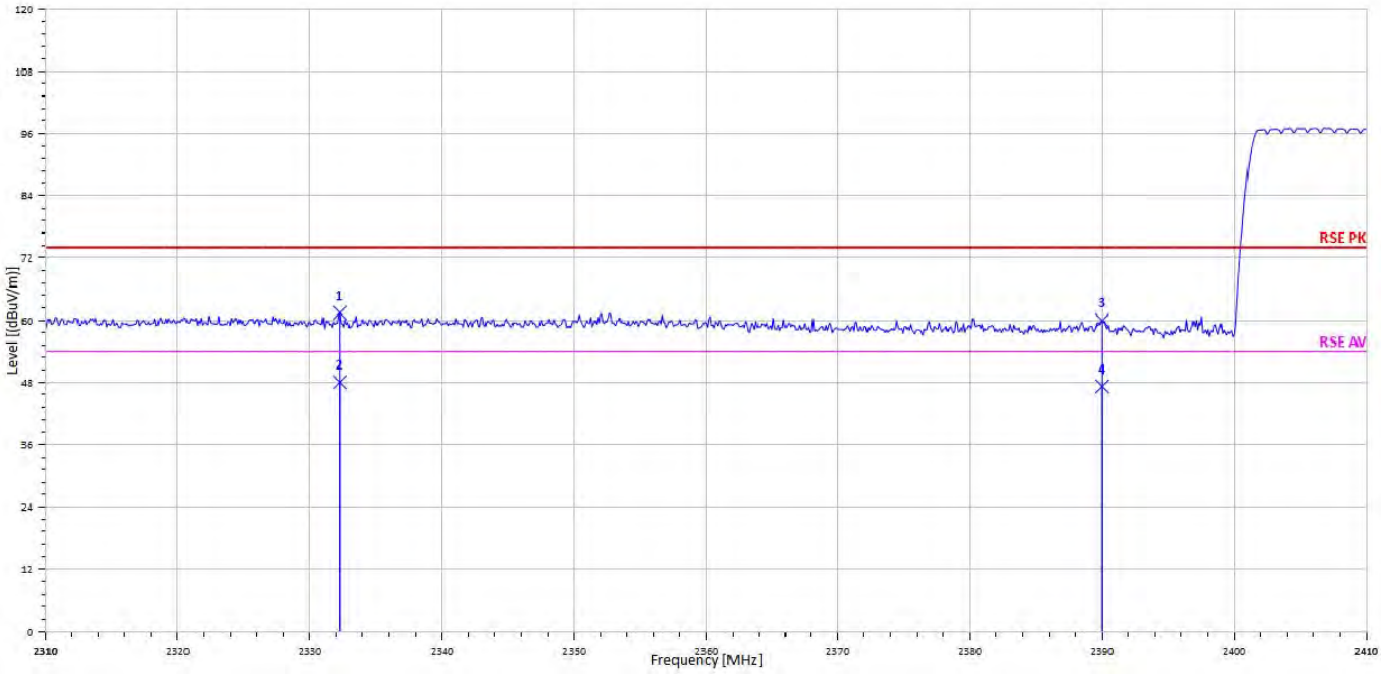
Member of SGS Group

Operation Mode :	BT BR Hopping	Test Date :	2018/2/23
Fundamental Frequency :	2402 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	BE CH Low	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Horizontal



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2332.30	S	Peak	68.47	-7.04	61.43	74	-12.57
2332.30	S	Average	55.03	-7.04	47.99	54	-6.01
2390.00	E	Peak	66.76	-6.84	59.91	74	-14.09
2390.00	E	Average	54.02	-6.84	47.17	54	-6.83

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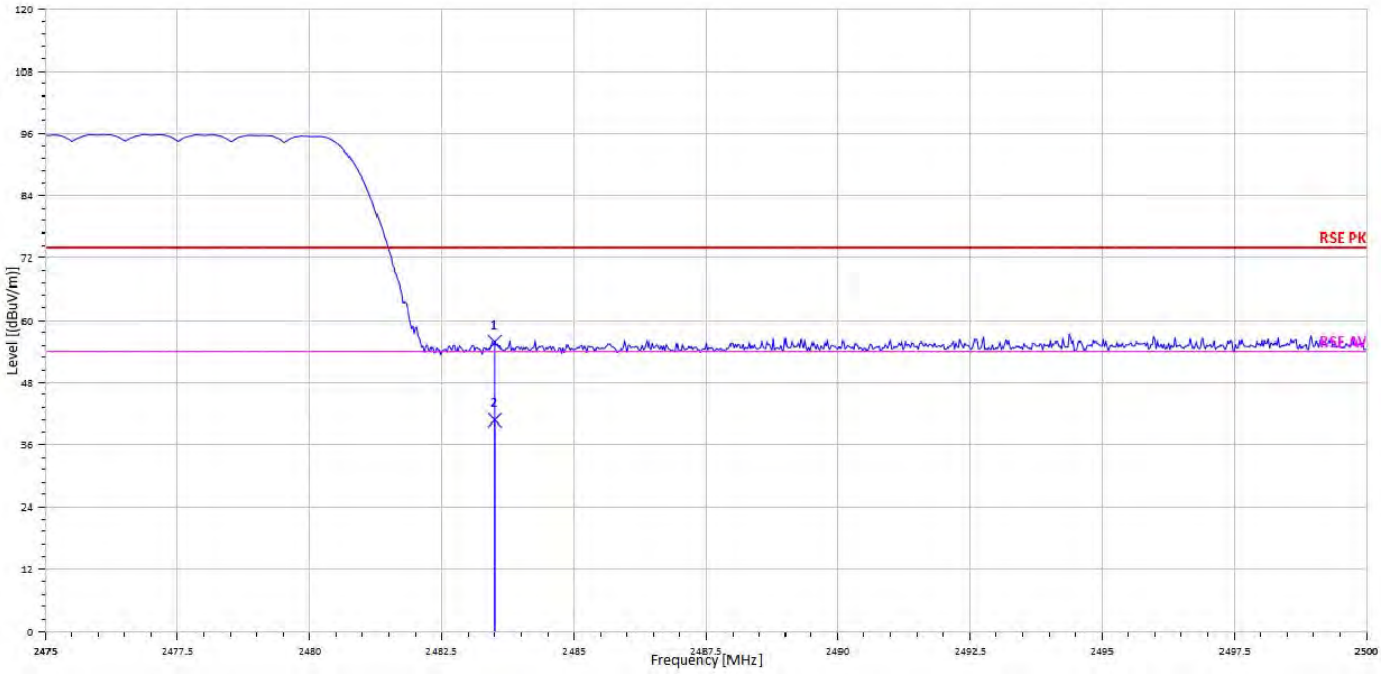
Operation Mode :	BT BR Hopping	Test Date :	2018/2/23
Fundamental Frequency :	2480 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	BE CH High	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Vertical



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2483.50	E	Peak	62.12	-6.38	55.73	74	-18.27
2483.50	E	Average	47.13	-6.38	40.74	54	-13.26

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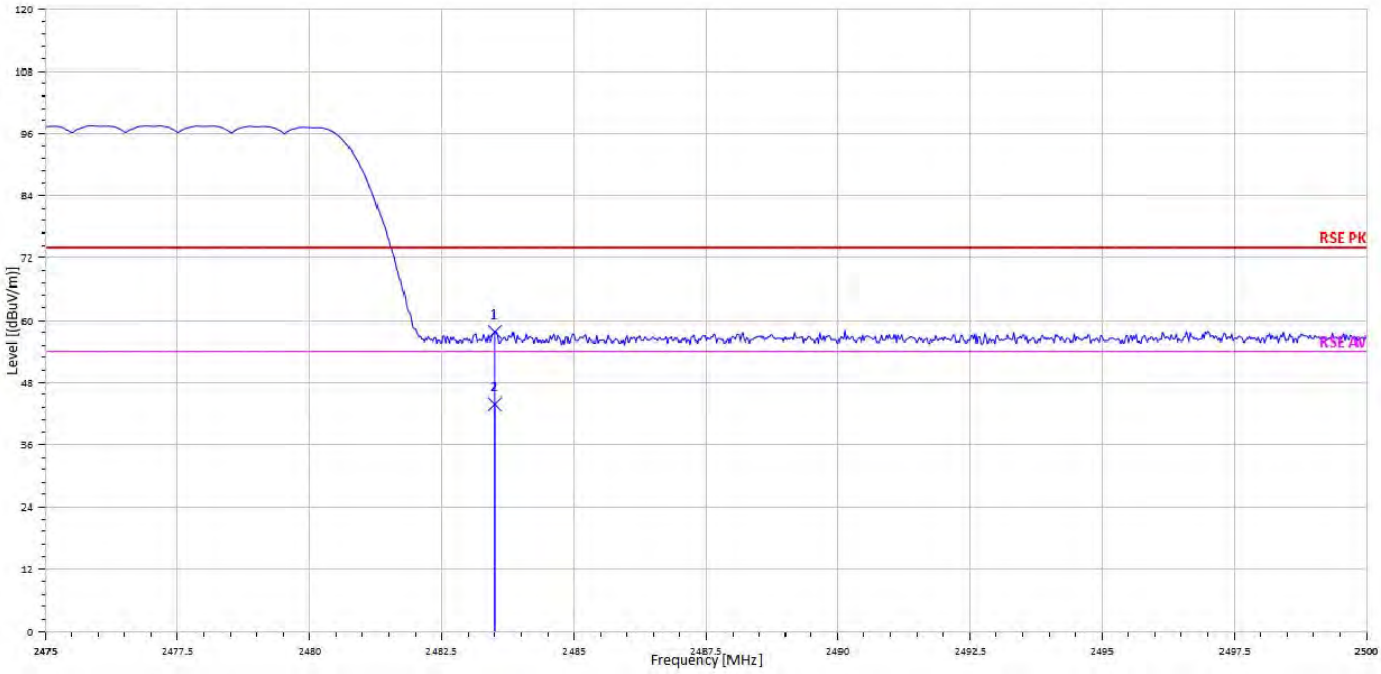
Operation Mode :	BT BR Hopping	Test Date :	2018/2/23
Fundamental Frequency :	2480 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	BE CH High	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Horizontal



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2483.50	E	Peak	64.08	-6.38	57.70	74	-16.30
2483.50	E	Average	50.22	-6.38	43.84	54	-10.16

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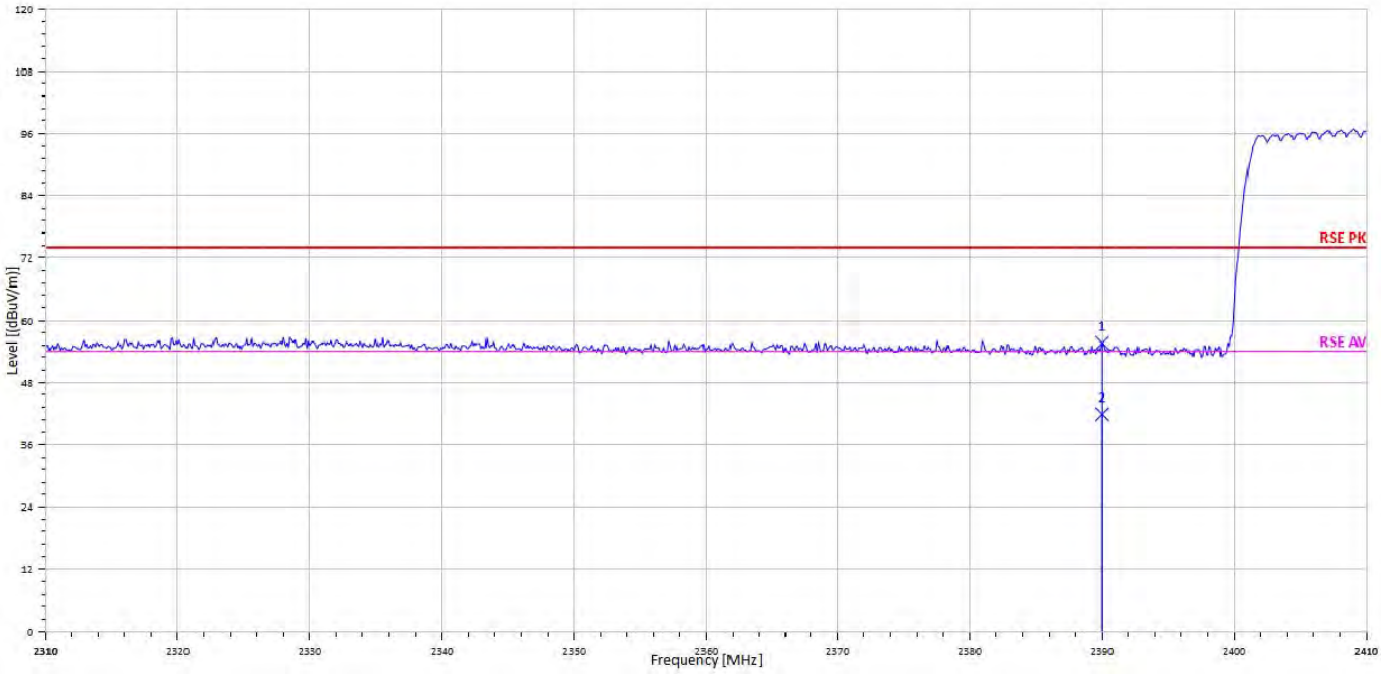
Operation Mode :	BT EDR Hopping	Test Date :	2018/2/23
Fundamental Frequency :	2402 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	BE CH Low	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Vertical



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2390.00	E	Peak	62.43	-6.84	55.58	74	-18.42
2390.00	E	Average	48.66	-6.84	41.81	54	-12.19

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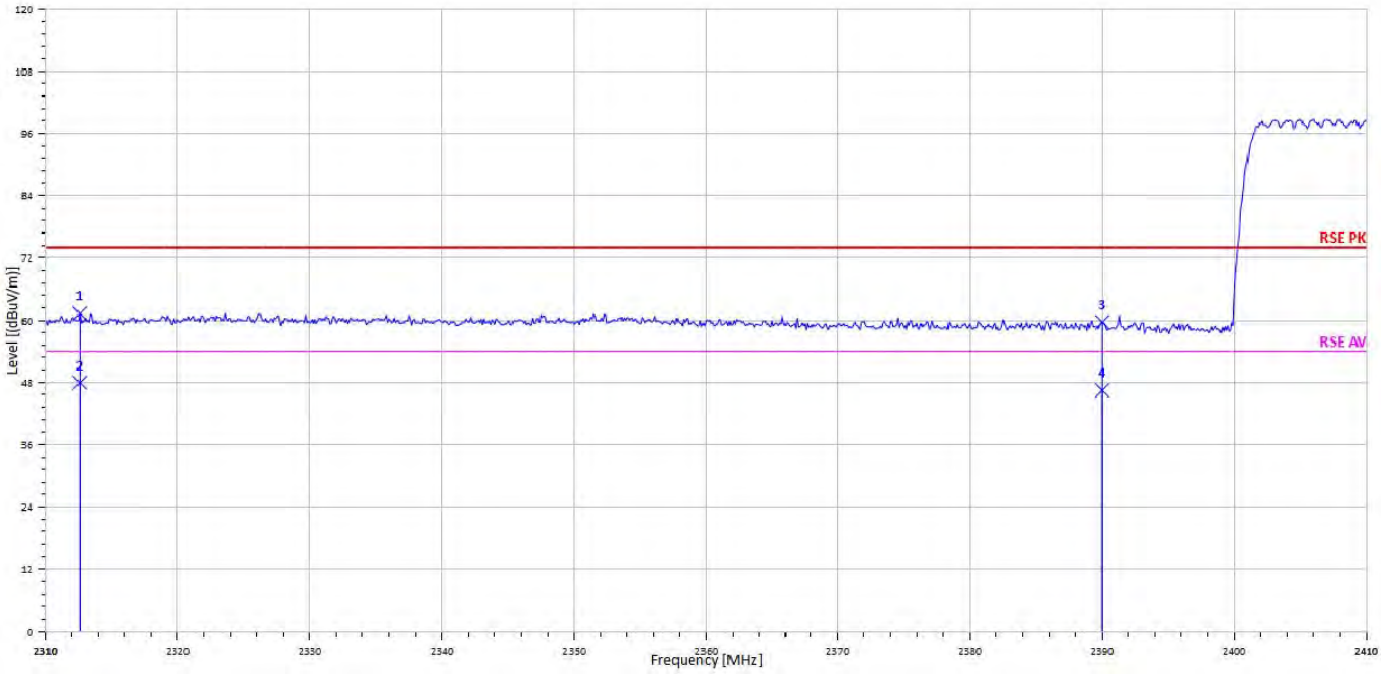
Operation Mode :	BT EDR Hopping	Test Date :	2018/2/23
Fundamental Frequency :	2402 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	BE CH Low	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Horizontal



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2312.60	S	Peak	68.40	-7.11	61.28	74	-12.72
2312.60	S	Average	55.03	-7.11	47.92	54	-6.08
2390.00	E	Peak	66.46	-6.84	59.62	74	-14.38
2390.00	E	Average	53.29	-6.84	46.44	54	-7.56

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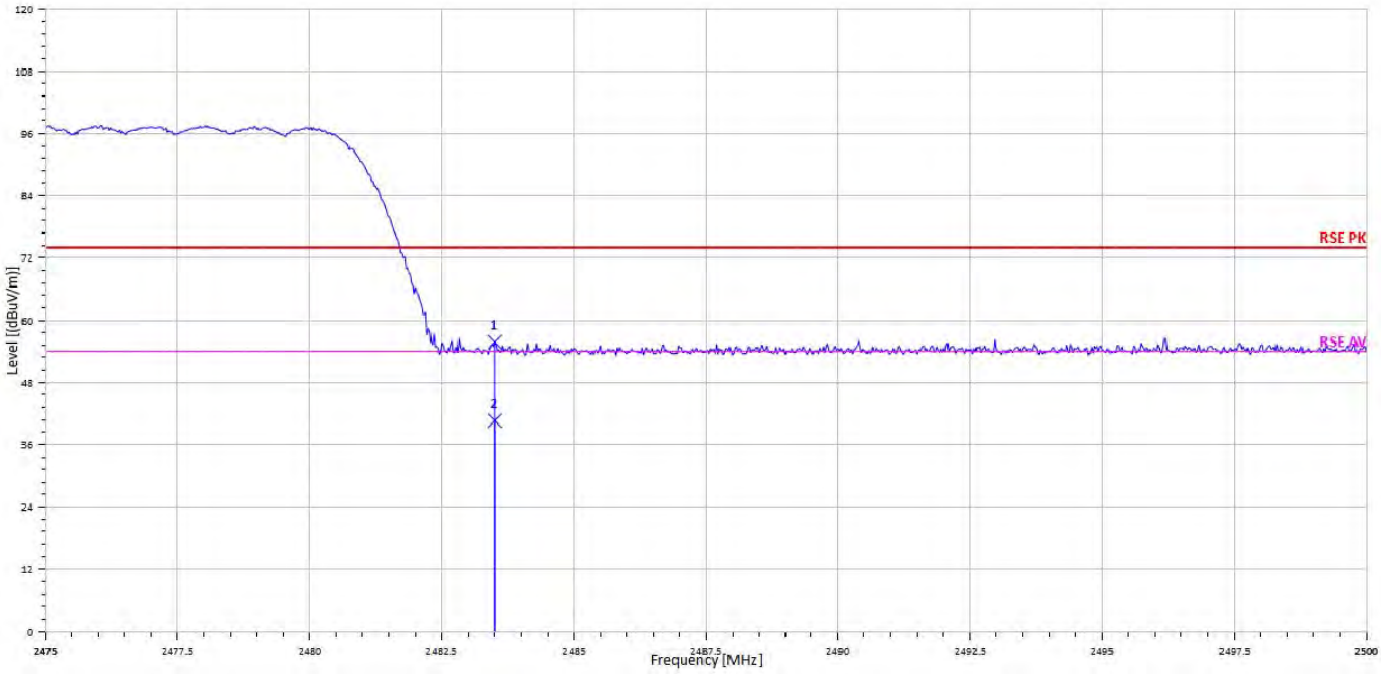
Operation Mode :	BT EDR Hopping	Test Date :	2018/2/23
Fundamental Frequency :	2480 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	BE CH High	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Vertical



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2483.50	E	Peak	62.17	-6.38	55.79	74	-18.21
2483.50	E	Average	47.02	-6.38	40.64	54	-13.36

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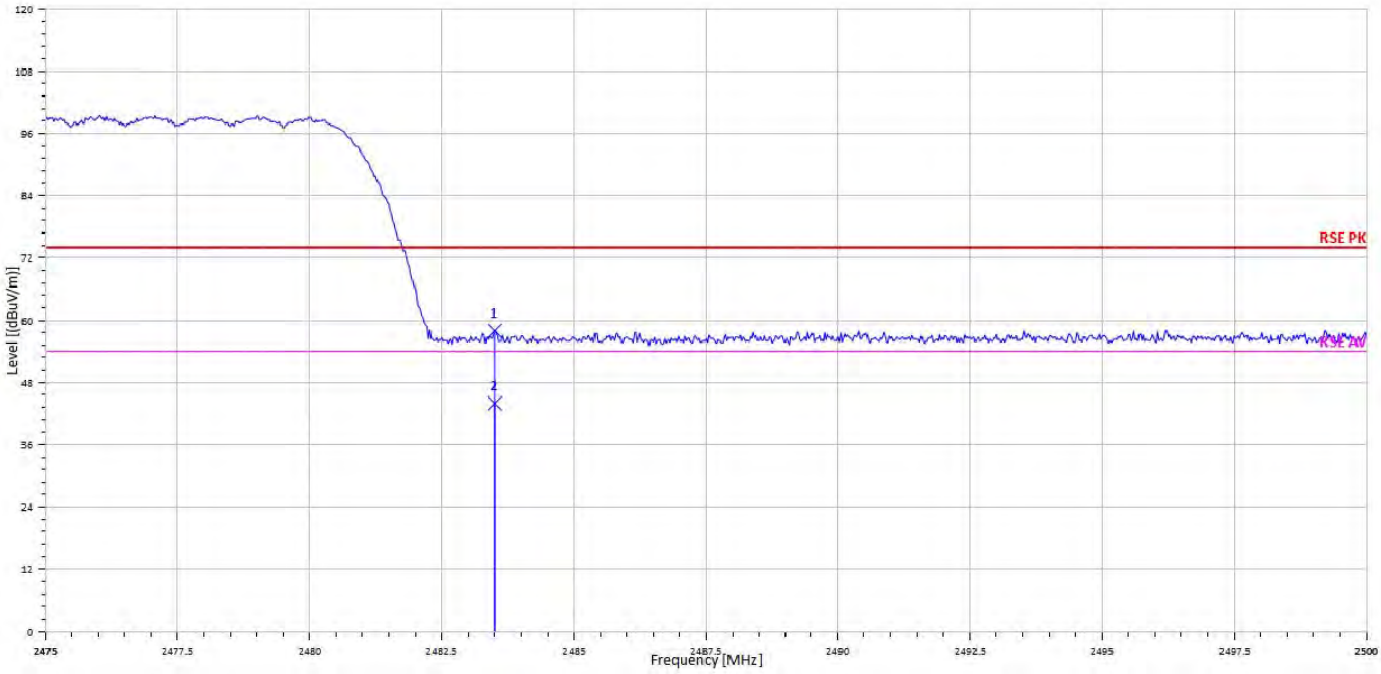
Operation Mode :	BT EDR Hopping	Test Date :	2018/2/23
Fundamental Frequency :	2480 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	BE CH High	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Horizontal



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2483.50	E	Peak	64.33	-6.38	57.95	74	-16.05
2483.50	E	Average	50.32	-6.38	43.93	54	-10.07

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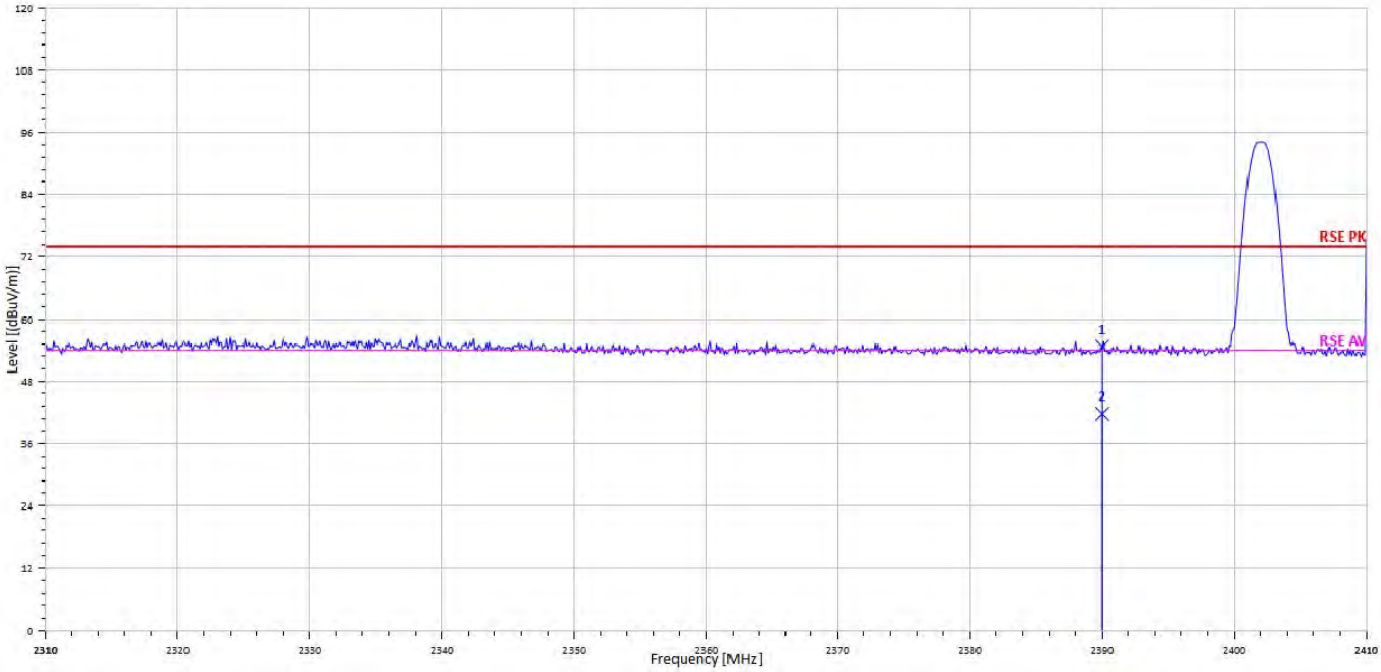
Radiated Emission – Band Edge (Non-Hopping Mode):

Operation Mode :	BT BR	Test Date :	2018/2/23
Fundamental Frequency :	2402 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	BE CH Low	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Vertical



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2390.00	E	Peak	61.50	-6.84	54.66	74	-19.34
2390.00	E	Average	48.53	-6.84	41.69	54	-12.31

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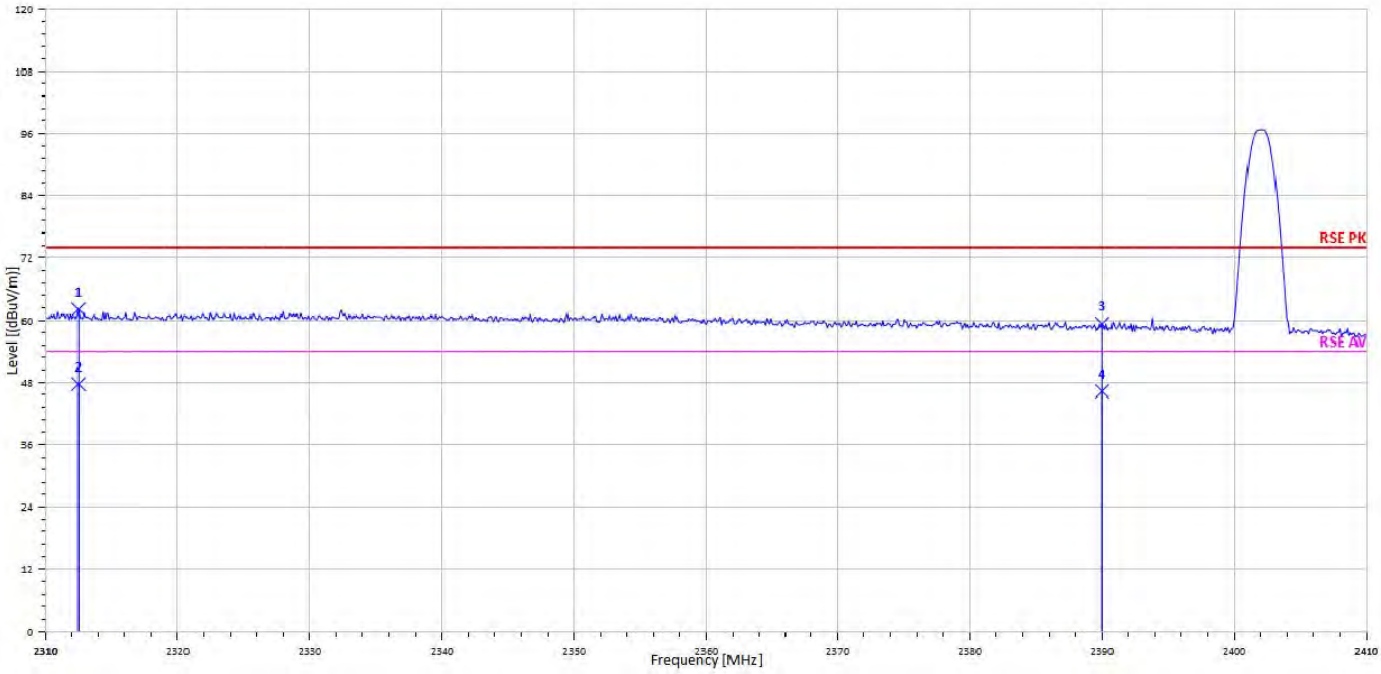
Operation Mode :	BT BR	Test Date :	2018/2/23
Fundamental Frequency :	2402 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	BE CH Low	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Horizontal



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2312.50	S	Peak	69.18	-7.11	62.07	74	-11.93
2312.50	S	Average	54.78	-7.11	47.67	54	-6.33
2390.00	E	Peak	66.14	-6.84	59.29	74	-14.71
2390.00	E	Average	53.13	-6.84	46.28	54	-7.72

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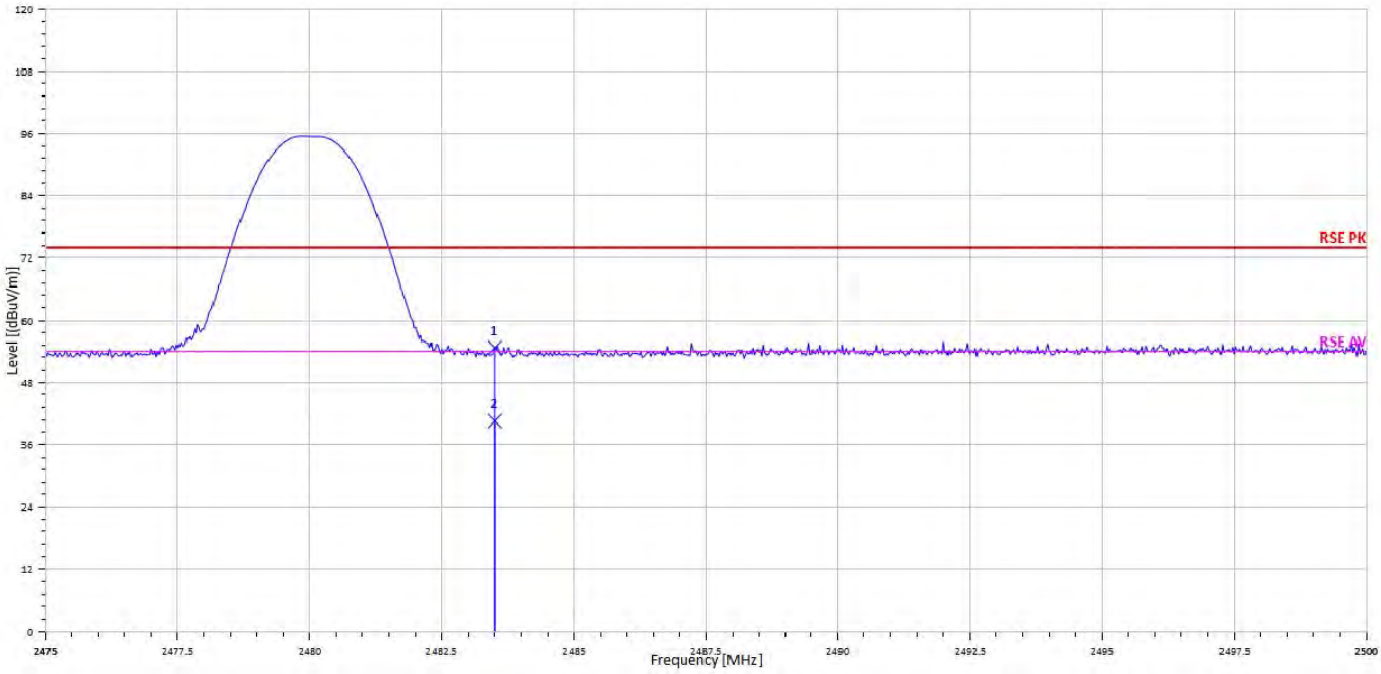
Operation Mode :	BT BR	Test Date :	2018/2/23
Fundamental Frequency :	2480 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	BE CH High	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Vertical



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2483.50	E	Peak	61.07	-6.38	54.69	74	-19.31
2483.50	E	Average	46.96	-6.38	40.57	54	-13.43

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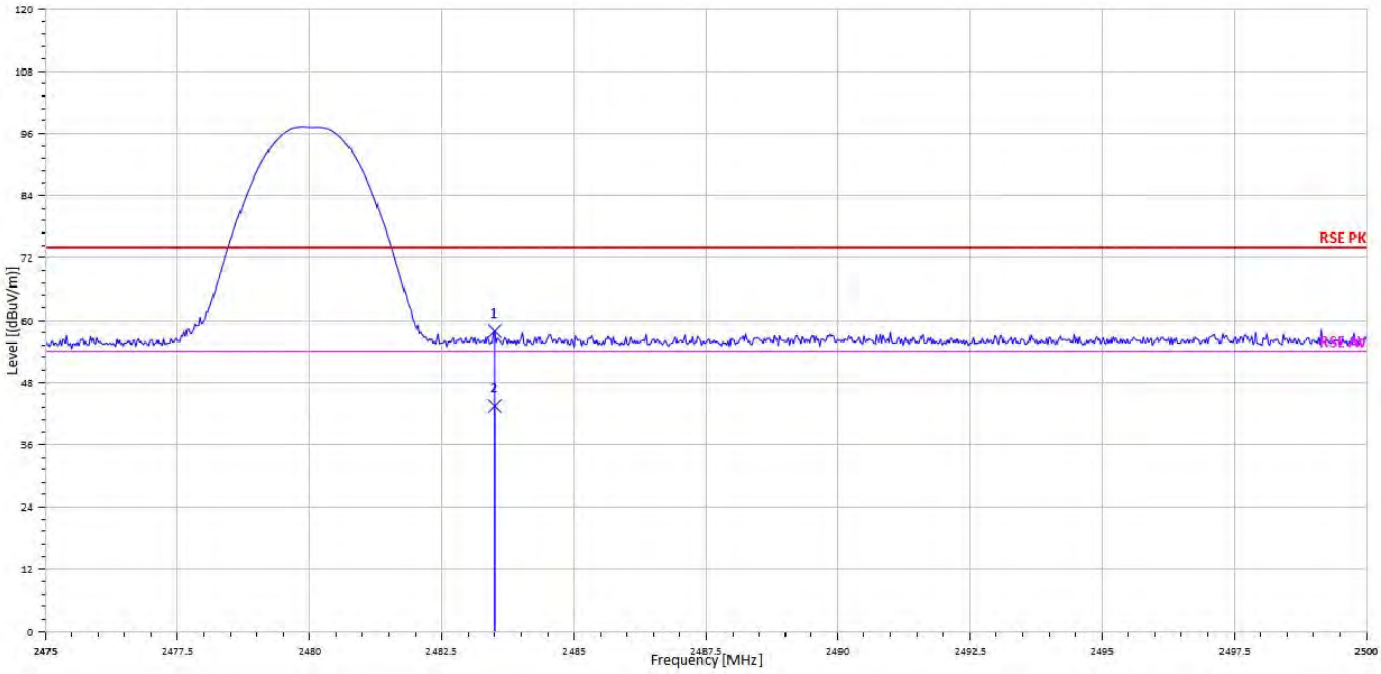
Operation Mode :	BT BR	Test Date :	2018/2/23
Fundamental Frequency :	2480 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	BE CH High	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Horizontal



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2483.50	E	Peak	64.28	-6.38	57.89	74	-16.11
2483.50	E	Average	49.86	-6.38	43.47	54	-10.53

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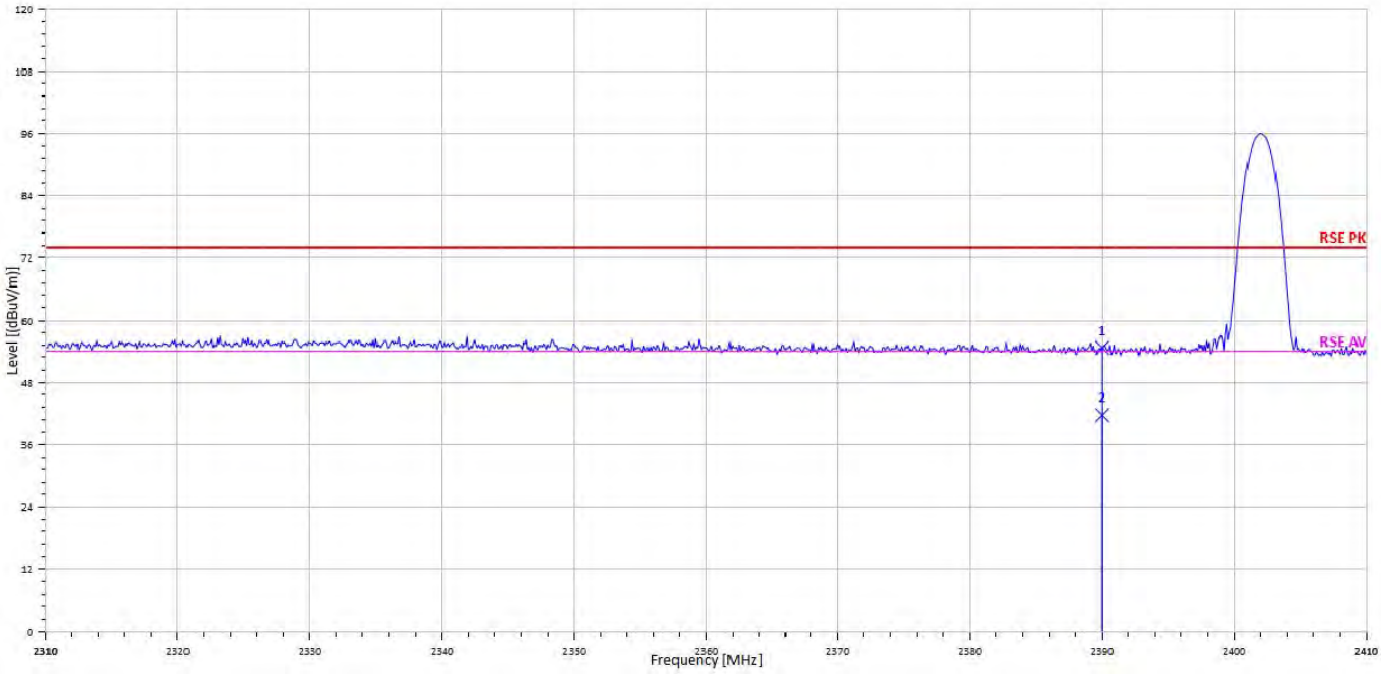
Operation Mode :	BT EDR	Test Date :	2018/2/23
Fundamental Frequency :	2402 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	BE CH Low	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Vertical



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2390.00	E	Peak	61.50	-6.84	54.66	74	-19.34
2390.00	E	Average	48.46	-6.84	41.62	54	-12.38

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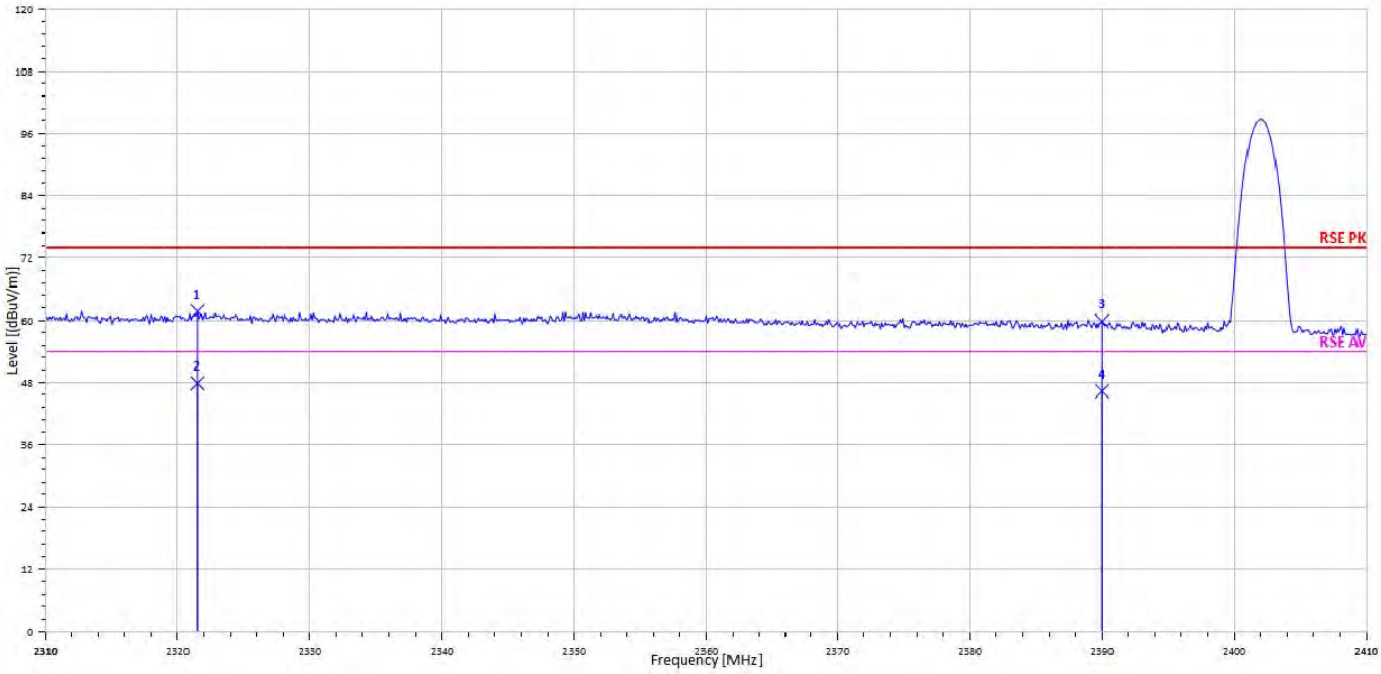
Operation Mode :	BT EDR	Test Date :	2018/2/23
Fundamental Frequency :	2402 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	BE CH Low	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Horizontal



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2321.50	S	Peak	68.77	-7.08	61.68	74	-12.32
2321.50	S	Average	54.90	-7.08	47.82	54	-6.18
2390.00	E	Peak	66.64	-6.84	59.80	74	-14.20
2390.00	E	Average	53.16	-6.84	46.32	54	-7.68

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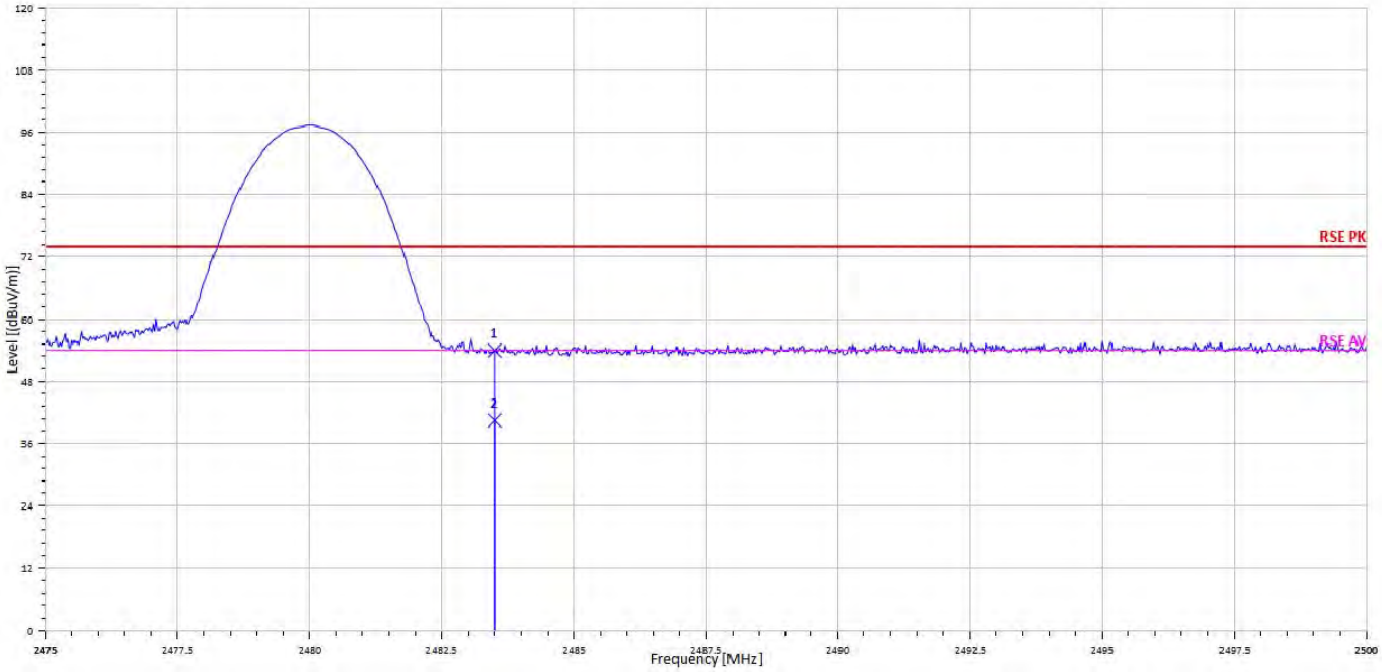
Operation Mode :	BT EDR	Test Date :	2018/2/23
Fundamental Frequency :	2480 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	BE CH High	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Vertical



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2483.50	E	Peak	60.31	-6.38	53.92	74	-20.08
2483.50	E	Average	46.84	-6.38	40.45	54	-13.55

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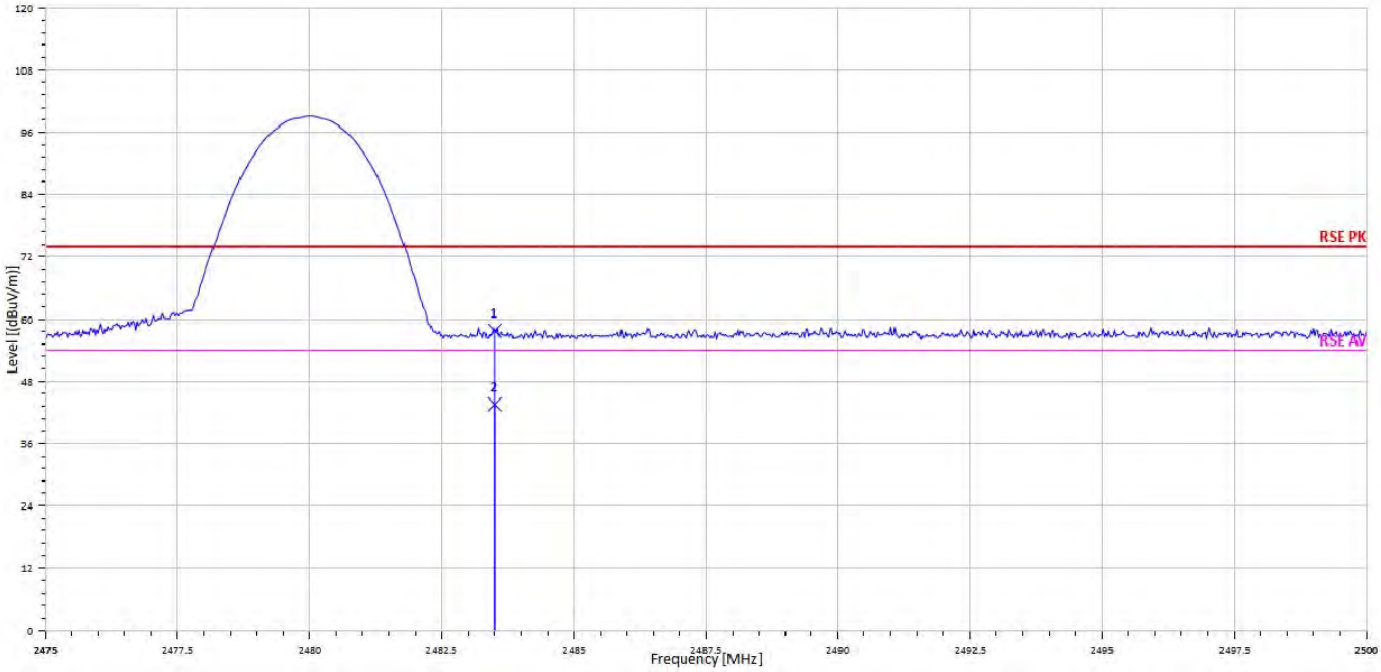
Operation Mode :	BT EDR	Test Date :	2018/2/23
Fundamental Frequency :	2480 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	BE CH High	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Horizontal



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2483.50	E	Peak	64.11	-6.38	57.73	74	-16.27
2483.50	E	Average	49.94	-6.38	43.55	54	-10.45

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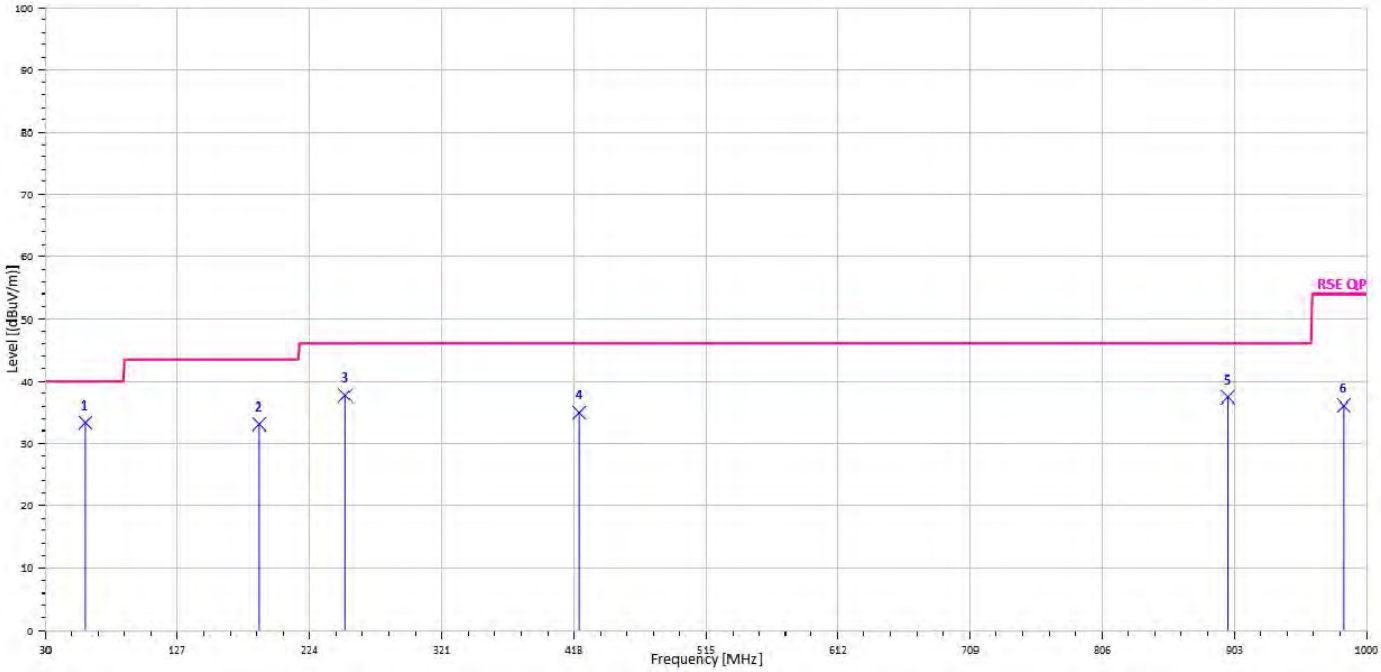
Radiated Spurious Emission Measurement Result:

For Frequency form 30MHz to 1000MHz

Operation Mode :	BT BR	Test Date :	2018/2/23
Fundamental Frequency :	2402 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	Tx CH Low	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Vertical



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
59.10	S	Peak	51.23	-17.92	33.31	40	-6.69
187.14	S	Peak	51.60	-18.53	33.06	43.5	-10.44
250.19	S	Peak	54.74	-17.05	37.69	46	-8.31
421.88	S	Peak	47.11	-12.14	34.97	46	-11.03
898.15	S	Peak	42.76	-5.31	37.45	46	-8.55
983.51	S	Peak	40.15	-4.07	36.08	54	-17.92

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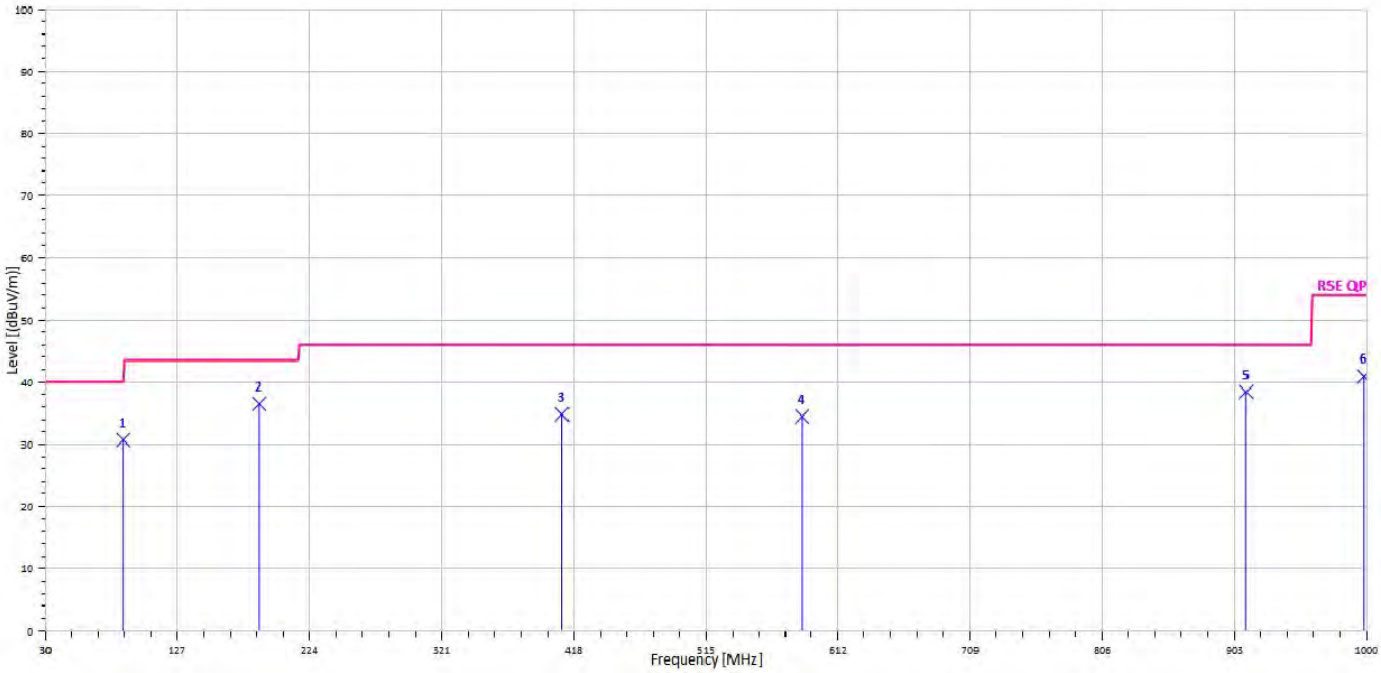
Operation Mode :	BT BR	Test Date :	2018/2/23
Fundamental Frequency :	2402 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	Tx CH Low	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Horizontal



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
87.23	S	Peak	53.02	-22.32	30.70	40	-9.30
187.14	S	Peak	55.02	-18.53	36.49	43.5	-7.01
409.27	S	Peak	46.82	-11.99	34.83	46	-11.17
585.81	S	Peak	43.27	-8.81	34.46	46	-11.54
911.73	S	Peak	43.65	-5.21	38.44	46	-7.56
998.06	S	Peak	44.69	-3.79	40.90	54	-13.10

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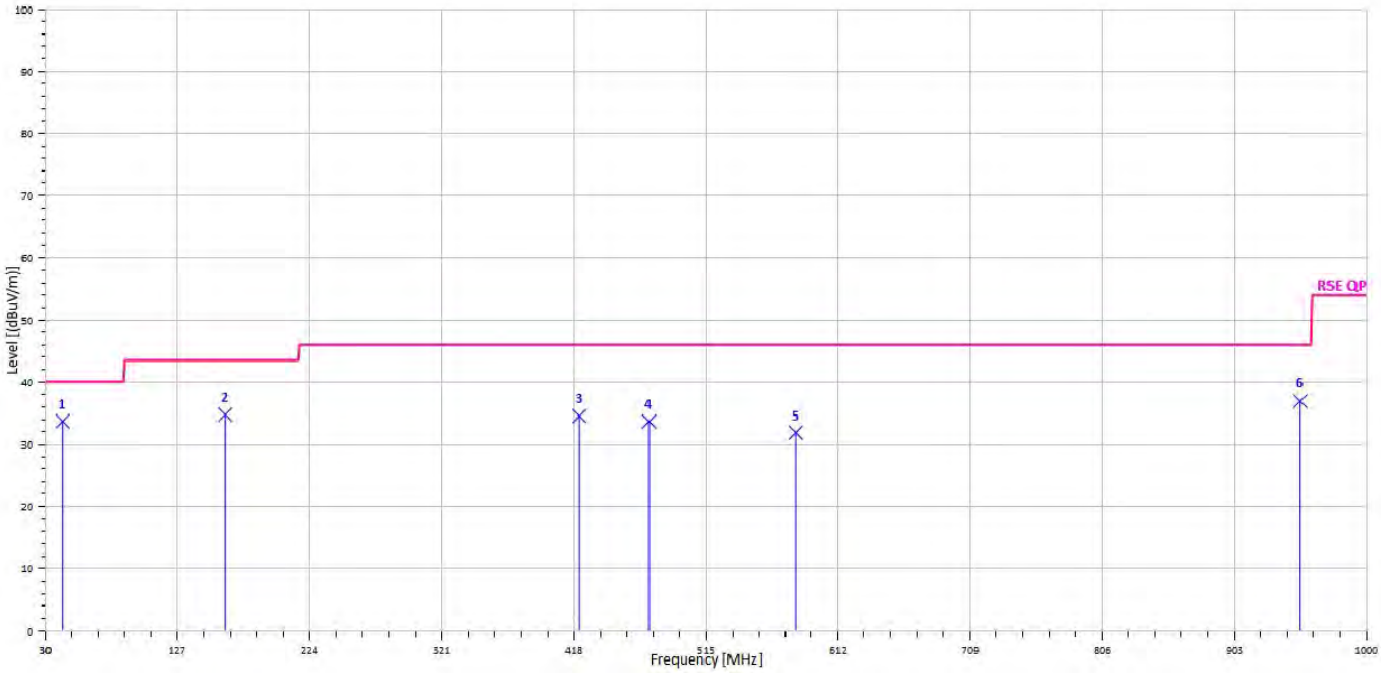
Operation Mode :	BT BR	Test Date :	2018/2/23
Fundamental Frequency :	2441 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	Tx CH Mid	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Vertical



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
42.61	S	Peak	50.87	-17.18	33.69	40	-6.31
161.92	S	Peak	50.49	-15.71	34.78	43.5	-8.72
421.88	S	Peak	46.68	-12.14	34.53	46	-11.47
473.29	S	Peak	44.77	-11.10	33.67	46	-12.33
580.96	S	Peak	40.72	-8.87	31.85	46	-14.15
951.50	S	Peak	41.56	-4.61	36.95	46	-9.05

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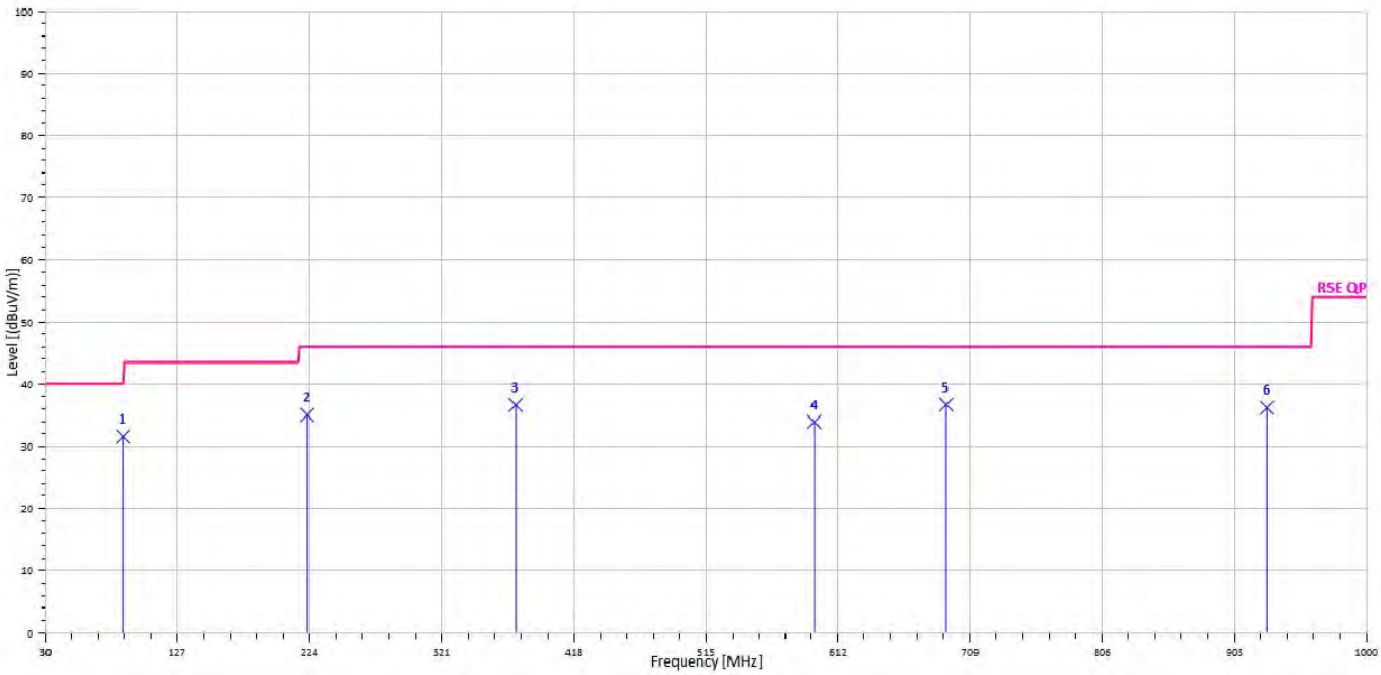
Operation Mode :	BT BR	Test Date :	2018/2/23
Fundamental Frequency :	2441 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	Tx CH Mid	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Horizontal



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
87.23	S	Peak	53.85	-22.32	31.52	40	-8.48
222.06	S	Peak	53.53	-18.47	35.06	46	-10.94
375.32	S	Peak	50.18	-13.52	36.66	46	-9.34
594.54	S	Peak	42.95	-9.04	33.91	46	-12.09
691.54	S	Peak	44.54	-7.83	36.70	46	-9.30
927.25	S	Peak	41.01	-4.81	36.20	46	-9.80

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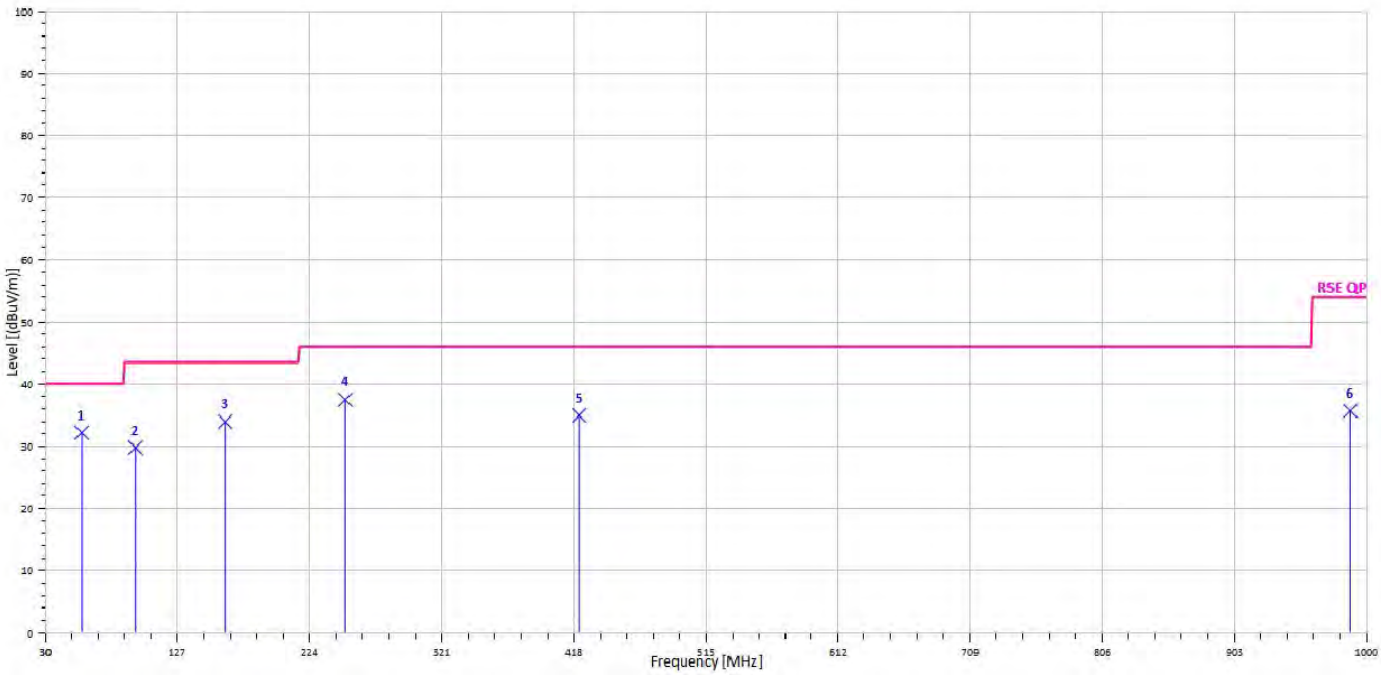
Operation Mode :	BT BR	Test Date :	2018/2/23
Fundamental Frequency :	2480 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	Tx CH High	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Vertical



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
56.56	S	Peak	49.92	-17.72	32.20	40	-7.80
95.95	S	Peak	51.82	-22.03	29.79	43.5	-13.71
161.92	S	Peak	49.68	-15.71	33.96	43.5	-9.54
250.19	S	Peak	54.55	-17.05	37.51	46	-8.49
421.88	S	Peak	47.12	-12.14	34.97	46	-11.03
988.36	S	Peak	39.78	-4.08	35.70	54	-18.30

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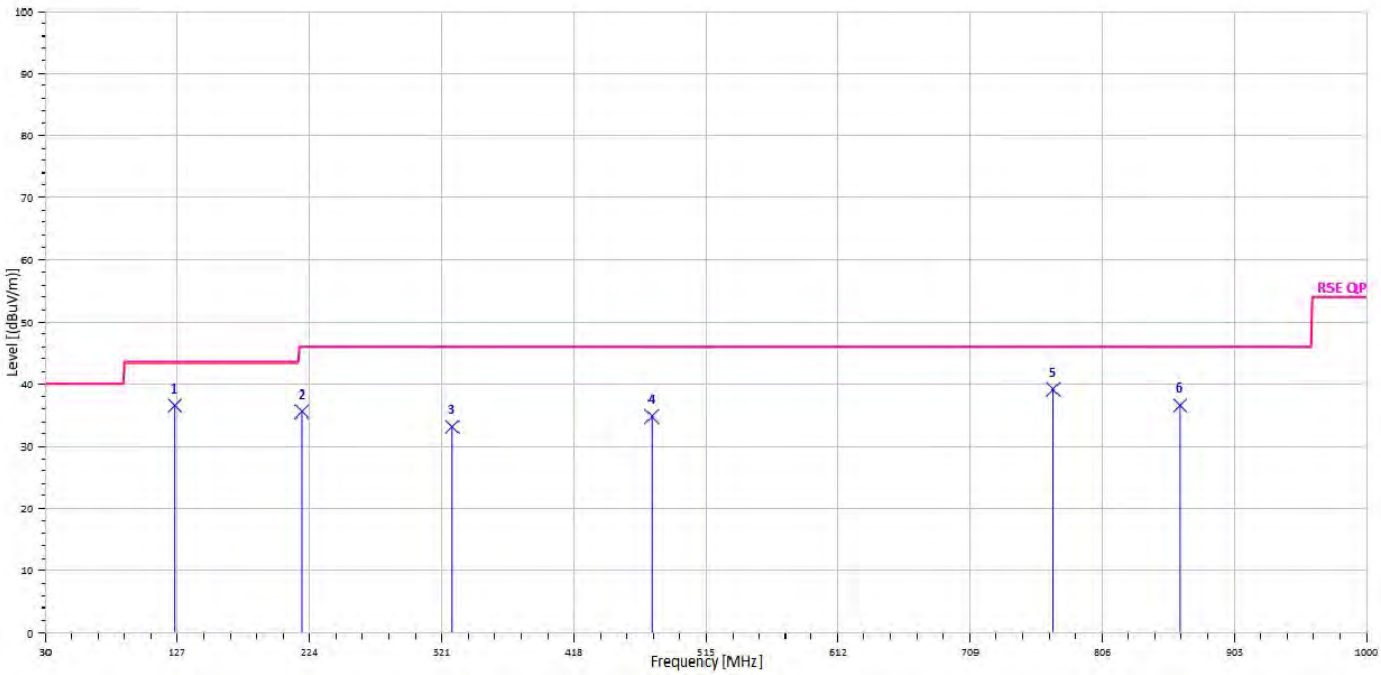
Operation Mode :	BT BR	Test Date :	2018/2/23
Fundamental Frequency :	2480 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	Tx CH High	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Horizontal



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
125.06	S	Peak	54.71	-18.16	36.55	43.5	-6.95
218.18	S	Peak	54.21	-18.64	35.57	46	-10.43
328.76	S	Peak	47.66	-14.51	33.16	46	-12.84
475.23	S	Peak	45.90	-11.09	34.80	46	-11.20
770.11	S	Peak	45.46	-6.29	39.17	46	-6.83
863.23	S	Peak	42.75	-6.19	36.56	46	-9.44

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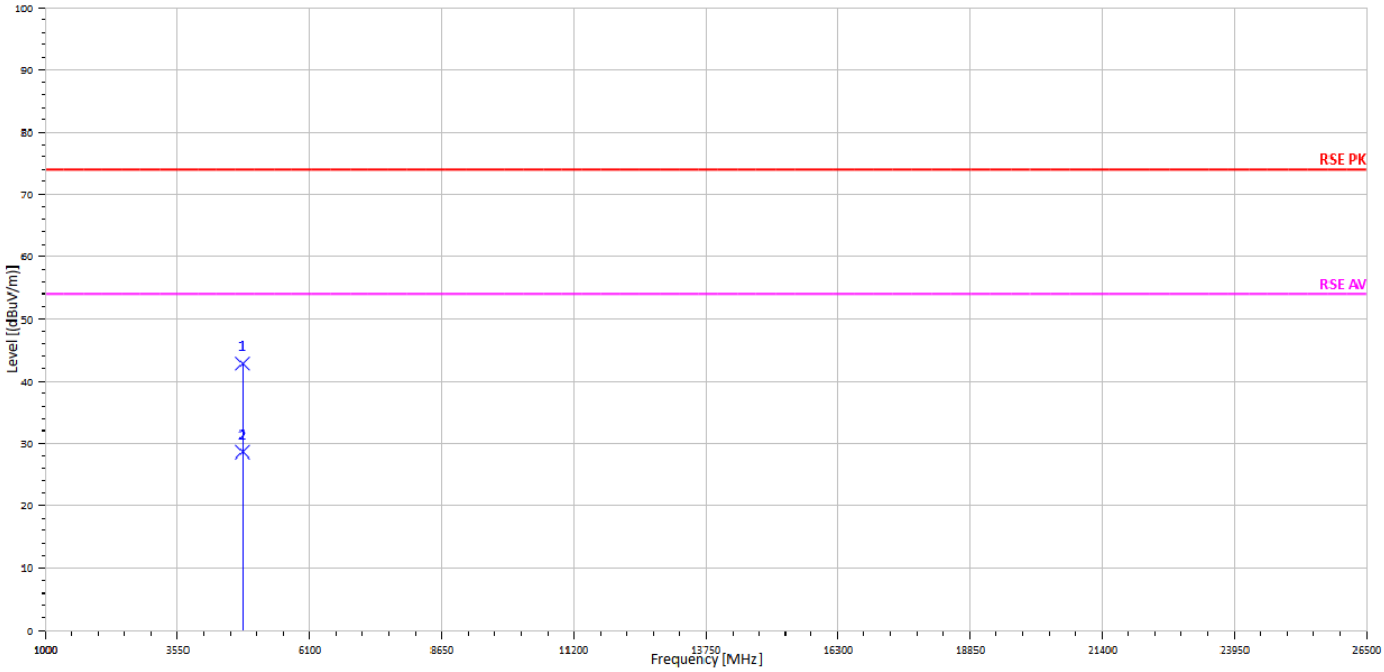
Radiated Spurious Emission Measurement Result:

For Frequency above 1 GHz

Operation Mode :	BT BR	Test Date :	2018/2/26
Fundamental Frequency :	2402 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	Tx CH Low	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Vertical



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4804.00	H	Peak	43.97	-1.16	42.81	74	-31.19
4804.00	H	Average	29.78	-1.16	28.62	54	-25.38

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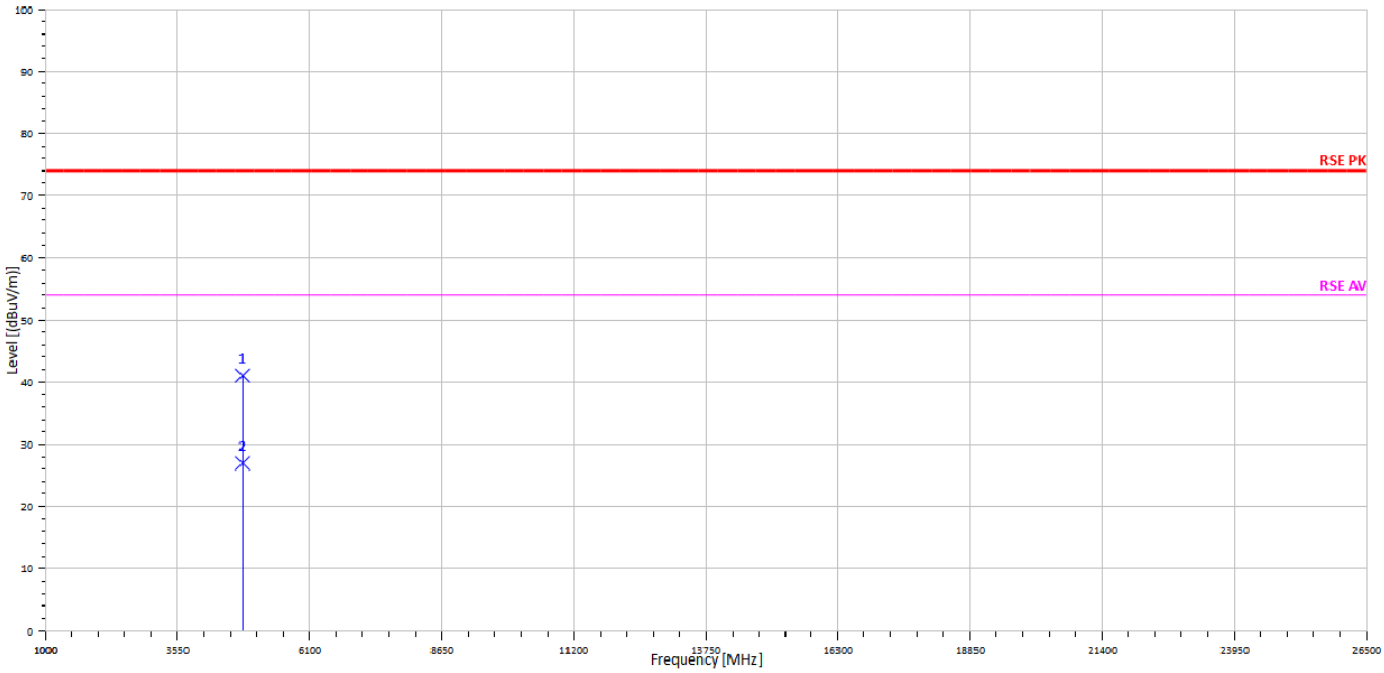
Operation Mode :	BT BR	Test Date :	2018/2/26
Fundamental Frequency :	2402 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	Tx CH Low	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Horizontal



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4804.00	H	Peak	42.19	-1.16	41.04	74	-32.96
4804.00	H	Average	28.11	-1.16	26.95	54	-27.05

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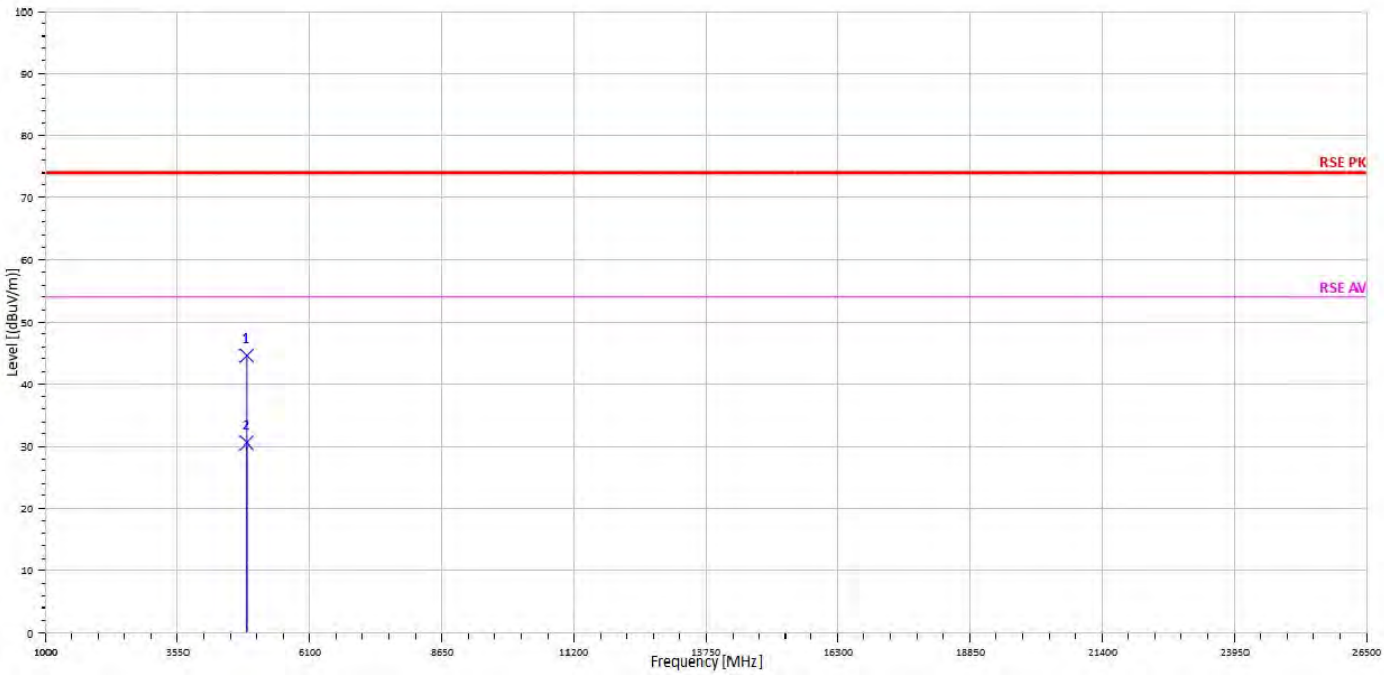
Operation Mode :	BT BR	Test Date :	2018/2/26
Fundamental Frequency :	2441 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	Tx CH Mid	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Vertical



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4882.00	H	Peak	45.24	-0.70	44.54	74	-29.46
4882.00	H	Average	31.26	-0.70	30.56	54	-23.44

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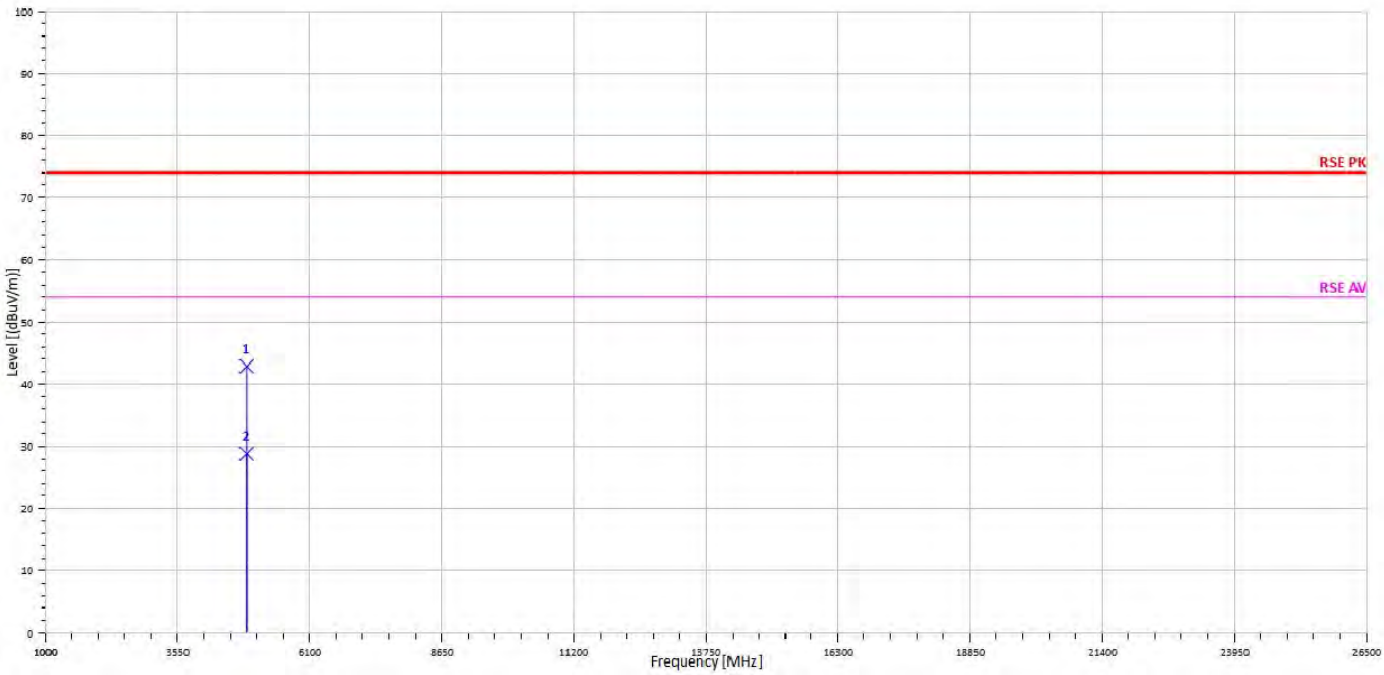
Operation Mode :	BT BR	Test Date :	2018/2/26
Fundamental Frequency :	2441 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	Tx CH Mid	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Horizontal



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4882.00	H	Peak	43.57	-0.70	42.87	74	-31.13
4882.00	H	Average	29.54	-0.70	28.84	54	-25.16

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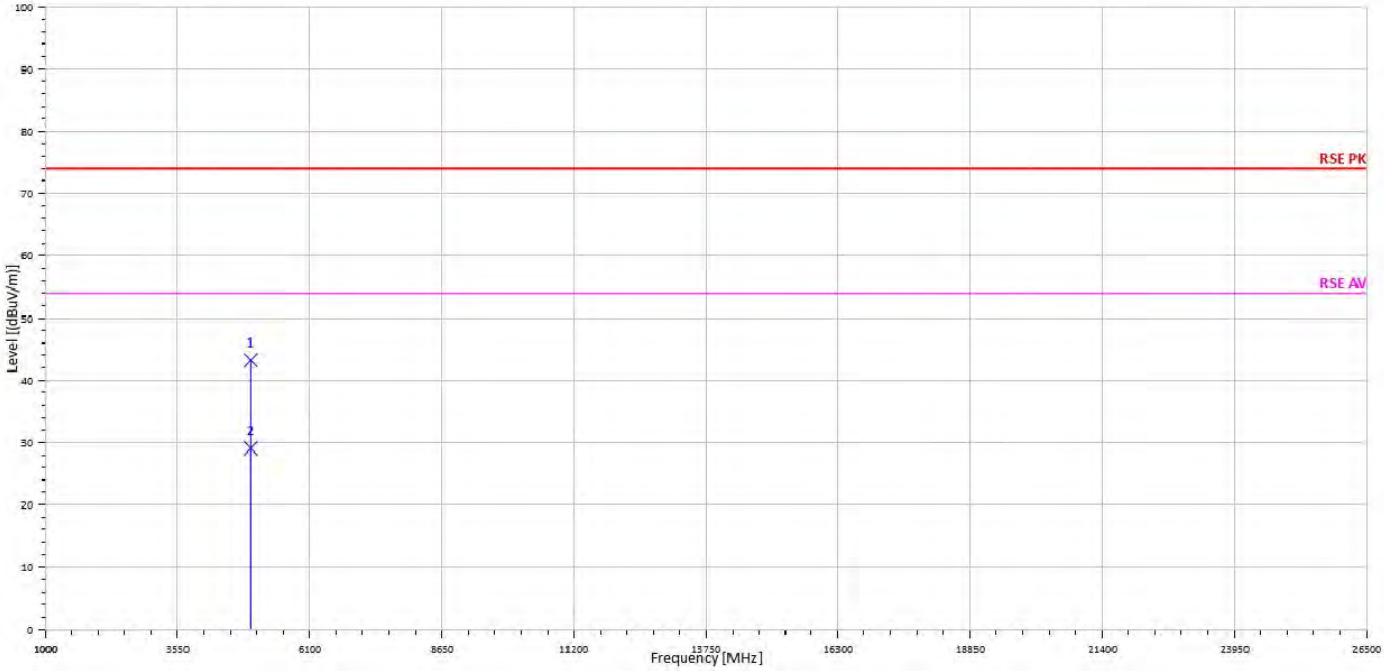
Operation Mode :	BT BR	Test Date :	2018/2/26
Fundamental Frequency :	2480 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	Tx CH High	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Vertical



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4960.00	H	Peak	44.38	-0.66	43.72	74	-30.28
4960.00	H	Average	30.51	-0.66	29.86	54	-24.15

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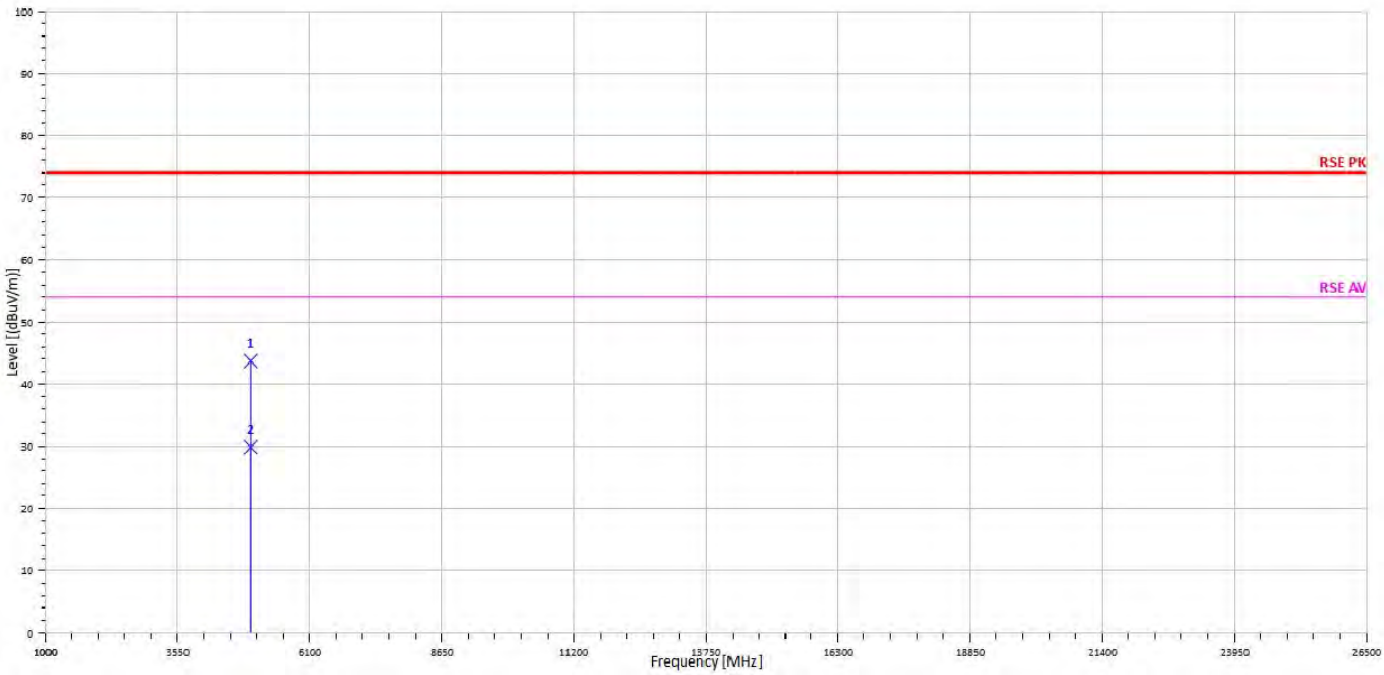
Operation Mode :	BT BR	Test Date :	2018/2/26
Fundamental Frequency :	2480 MHz	Temp. / Humi. :	25deg_C/65RH
Operation Band :	Tx CH High	Test Engineer :	Jerry
EUT Pol. :	E2	Measurement Antenna Pol. :	Horizontal



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4960.00	H	Peak	43.87	-0.66	43.21	74	-30.79
4960.00	H	Average	29.73	-0.66	29.07	54	-24.93

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11 FREQUENCY SEPARATION

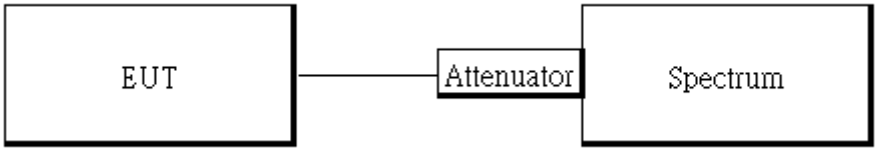
11.1 Standard Applicable

Frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25 kHz or the 2/3*20dB bandwidth of the hopping channel, whichever is greater.

11.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	KEYSIGHT	N9010A	MY51440113	06/20/2017	06/19/2018
Coaxial Cable 30cm	WOKEN	00100A1F1A195C	RF01	12/24/2017	12/23/2018
DC Block	PASTERNACK	PE8210	RF29	12/24/2017	12/23/2018
Attenuator	WOKEN	218FS-10	RF23	12/24/2017	12/23/2018
DC Power Supply	Agilent	E3640A	MY53140006	05/02/2017	05/01/2018

11.3 Test Set-up



11.4 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013.
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 center frequency of spectrum analyzer = middle of hopping channel.
5. Set the spectrum analyzer as RBW, VBW=100 kHz, Adjust Span to 5MHz, Sweep = auto.
6. Max hold. Mark 3 Peaks of hopping channel and record the 3 peaks frequency.

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11.5 Measurement Result

Channel separation (MHz)	Limit	Result
1	>=25 kHz or 2/3 times 20dB bandwidth	PASS

Frequency Separation Test Data

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12 NUMBER OF HOPPING FREQUENCY

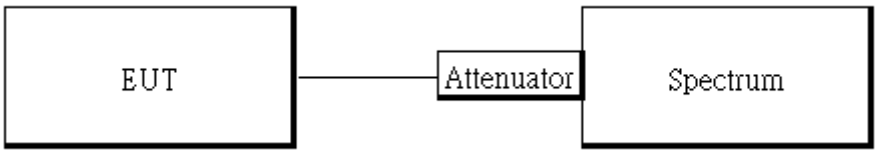
12.1 Standard Applicable

Frequency hopping systems operating in the 2400MHz-2483.5 MHz bands shall use at least 15 hopping frequencies.

12.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	KEYSIGHT	N9010A	MY51440113	06/20/2017	06/19/2018
Coaxial Cable 30cm	WOKEN	00100A1F1A195C	RF01	12/24/2017	12/23/2018
DC Block	PASTERNACK	PE8210	RF29	12/24/2017	12/23/2018
Attenuator	WOKEN	218FS-10	RF23	12/24/2017	12/23/2018
DC Power Supply	Agilent	E3640A	MY53140006	05/02/2017	05/01/2018

12.3 Test Set-up



12.4 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013
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 spectrum analyzer Start=2400MHz, Stop = 2483.5MHz, Sweep = auto.
5. Set the spectrum analyzer as RBW=430 kHz, VBW=1.5MHz., Detector = Peak
6. Max hold, view and count how many channel in the band.

12.5 Measurement Result

Tabular Data of Total Channel Number

	Channel Number	**Limit**
2.4 GHz – 2.441GHz	**40**	**>15**
2.441 GHz – 2.4835GHz	**39**	
2.4GHz ~2.4835GHz	**(40+39) = 79**	

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Channel Number

2.402GHz – 2.441GHz

2.441GHz – 2.4835GHz

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13 TIME OF OCCUPANCY (DWELL TIME)

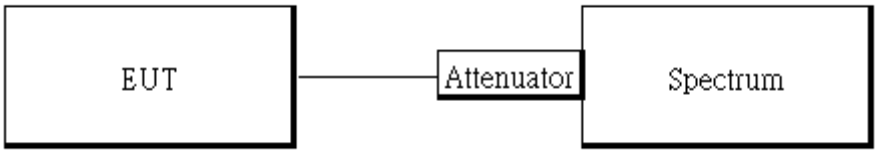
13.1 Standard Applicable

Frequency hopping systems operating in the 2400MHz-2483.5MHz. The average time of occupancy on any frequency shall not greater than 0.4 s within period of 0.4 seconds multiplied by the number of hopping channel employed.

13.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	KEYSIGHT	N9010A	MY51440113	06/20/2017	06/19/2018
Coaxial Cable 30cm	WOKEN	00100A1F1A195C	RF01	12/24/2017	12/23/2018
DC Block	PASTERNACK	PE8210	RF29	12/24/2017	12/23/2018
Attenuator	WOKEN	218FS-10	RF23	12/24/2017	12/23/2018
DC Power Supply	Agilent	E3640A	MY53140006	05/02/2017	05/01/2018

13.3 Test Set-up



13.4 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013.
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 center frequency of spectrum analyzer = operating frequency.
5. Set the spectrum analyzer as RBW, VBW=1MHz, 3MHz, Span = 0Hz , Detector = Peak, Adjust Sweep = 2~8ms.
6. Repeat above procedures until all frequency of the interest measured were complete.

Formula Deduced: time occupancy of one time slot X Hopping rate / total slot in one channel / total channel that hops X period of working channels.

Where, standard hopping rate is 1600 hops/s, slot in one channel for DH1, DH3, and DH5 is 2, 4, and 6, respectively.

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DH1 consists of single time slot of the uplink, and one slot of the downlink Total Slot: 2
DH3 consists of three time slot of the uplink, and one slot of the downlink. Total Slot: 4
DH5 consists of five time slot of the uplink, and one slot of the downlink. Total Slot: 6

In AFH mode, hopping rate is 800 hop/s with 6 slots in 20 hopping channels with channel hopping rate (800 / 6 / 20) in Occupancy Time Limit (0.4 * 20) (S), Hop Over Occupancy Time comes to (800 / 6 / 20)*(0.4 *20) =53.33

Note: the result of the complete test default channel at 1Mbps is recorded on the test report, 2Mbps, and 3Mbps only records the measurement result at middle channel that reveals no much deviation.

13.5 Tabular Result of the Measurement

GFSK (1Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)
0	DH1	115.84	400ms
	DH3	257.60	400ms
	DH5	302.61	400ms
39	DH1	116.80	400ms
	DH3	257.12	400ms
	DH5	302.61	400ms
78	DH1	116.80	400ms
	DH3	256.32	400ms
	DH5	302.61	400ms

π/4 DQPSK (2Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)
39	2DH1	119.68	400ms
	2DH3	257.60	400ms
	2DH5	302.61	400ms

8-DPSK (3Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)
39	3DH1	118.40	400ms
	3DH3	257.60	400ms
	3DH5	302.61	400ms

A period time = 0.4 (s) * 79 = 31.6 (s)

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GFSK (1Mbps):

CH Low	DH1 time slot	=	0.362	*	(1600/2/79)	*	31.6	=	115.84 (ms)
	DH3 time slot	=	1.610	*	(1600/4/79)	*	31.6	=	257.60 (ms)
	DH5 time slot	=	2.837	*	(1600/6/79)	*	31.6	=	302.61 (ms)
CH Mid	DH1 time slot	=	0.365	*	(1600/2/79)	*	31.6	=	116.80 (ms)
	DH3 time slot	=	1.607	*	(1600/4/79)	*	31.6	=	257.12 (ms)
	DH5 time slot	=	2.837	*	(1600/6/79)	*	31.6	=	302.61 (ms)
CH High	DH1 time slot	=	0.365	*	(1600/2/79)	*	31.6	=	116.80 (ms)
	DH3 time slot	=	1.602	*	(1600/4/79)	*	31.6	=	256.32 (ms)
	DH5 time slot	=	2.837	*	(1600/6/79)	*	31.6	=	302.61 (ms)

π/4 -DQPSK (2Mbps):

CH Mid	2DH1 time slo	=	0.374	*	(1600/2/79)	*	31.6	=	119.68 (ms)
	2DH3 time slo	=	1.610	*	(1600/4/79)	*	31.6	=	257.60 (ms)
	2DH5 time slo	=	2.837	*	(1600/6/79)	*	31.6	=	302.61 (ms)

8-DPSK (3Mbps):

CH Mid	3DH1 time slo	=	0.370	*	(1600/2/79)	*	31.6	=	118.40 (ms)
	3DH3 time slo	=	1.610	*	(1600/4/79)	*	31.6	=	257.60 (ms)
	3DH5 time slo	=	2.837	*	(1600/6/79)	*	31.6	=	302.61 (ms)

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GFSK (1Mbps) for AFH Mode			
Hopping Channel Number	PACKET TYPE	Measurement Result (ms)	Limit (ms)
20	DH5	151.31	400ms
π/4 DQPSK (2Mbps) for AFH Mode			
Hopping Channel Number	PACKET TYPE	Measurement Result (ms)	Limit (ms)
20	2DH5	151.31	400ms
8-DPSK (3Mbps) for AFH Mode			
Hopping Channel Number	PACKET TYPE	Measurement Result (ms)	Limit (ms)
20	3DH5	151.31	400ms

GFSK (1Mbps):

DH5 time s = 2.837 (ms) * (800/6/20 * 8 = 151.31 (ms)

π/4 -DQPSK (2Mbps

2DH5 time = 2.837 (ms) * (800/6/20 * 8 = 151.31 (ms)

8-DPSK (3Mbps):

3DH5 time = 2.837 (ms) * (800/6/20 * 8 = 151.31 (ms)

13.6 Measurement Result

Note: Refer to next page for plots.

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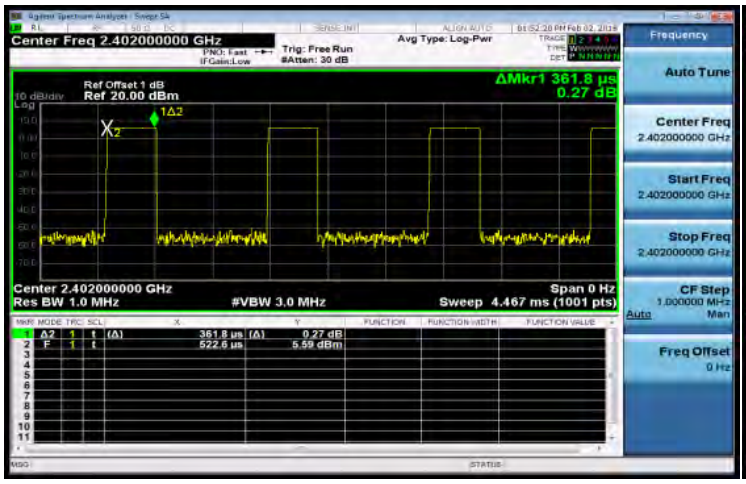
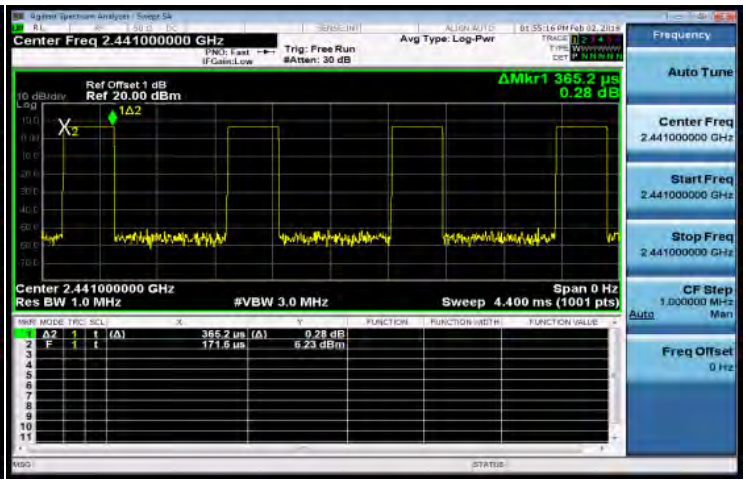
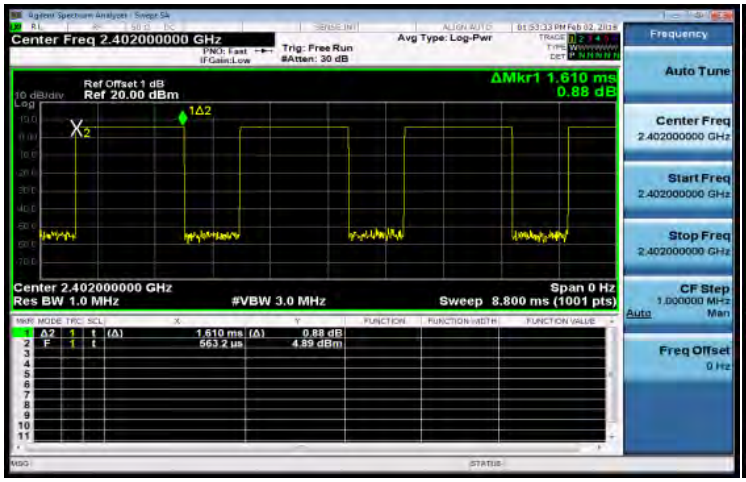
CH-Low DH1



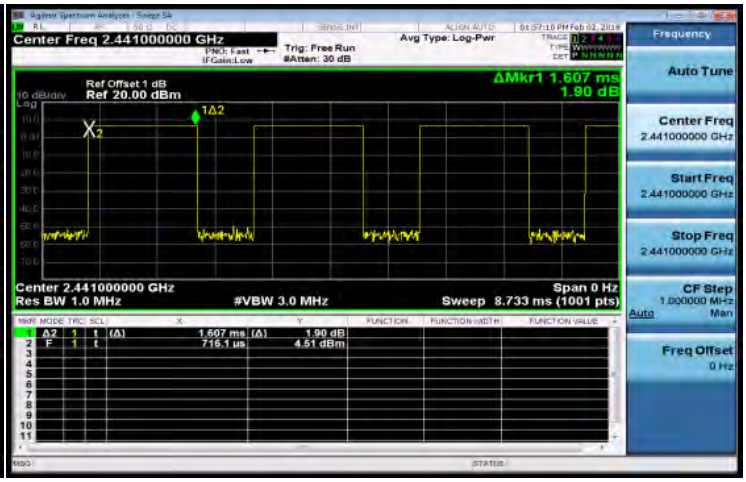
CH-Mid DH1



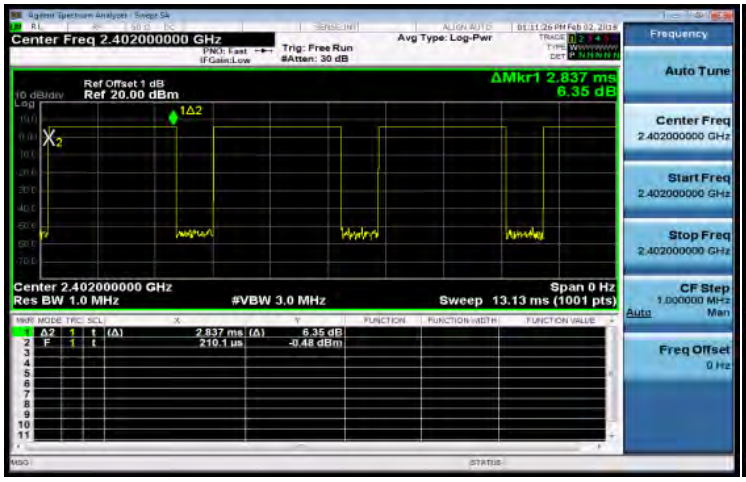
CH-Low DH3



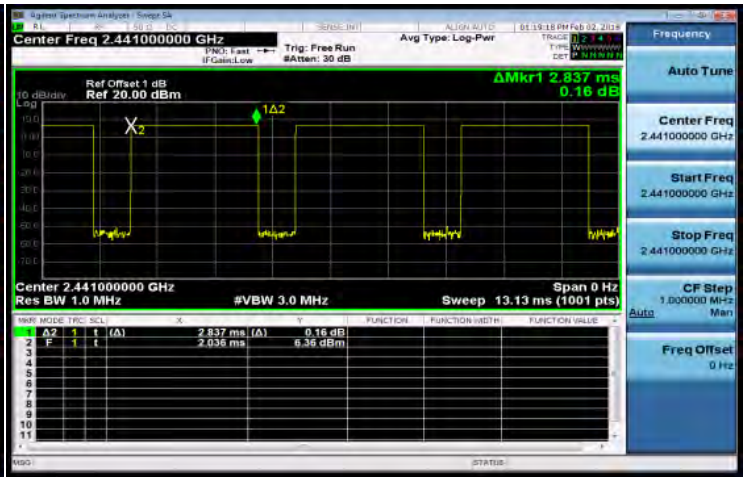
CH-Mid DH3



CH-Low DH5



CH-Mid DH5



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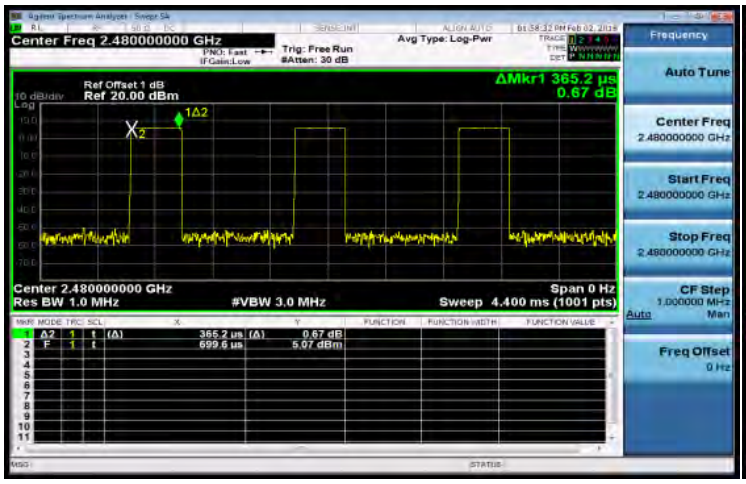
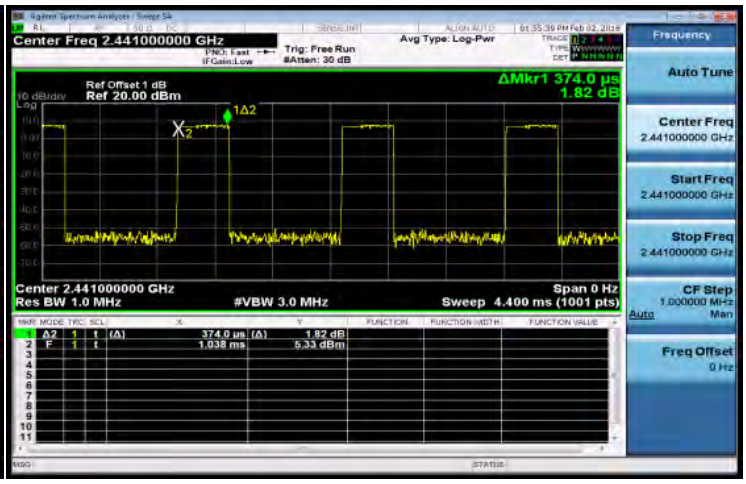
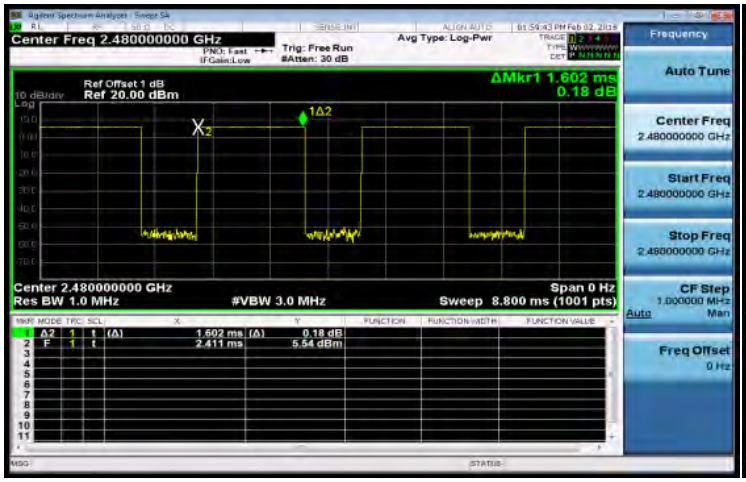
CH-High DH1



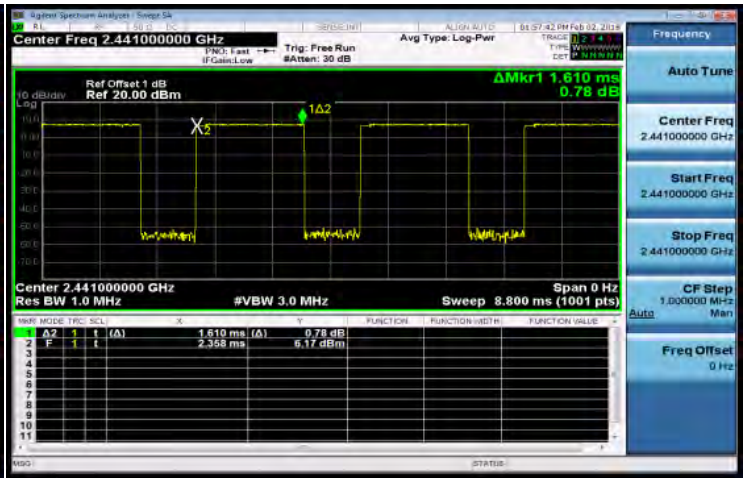
CH-Mid 2DH1



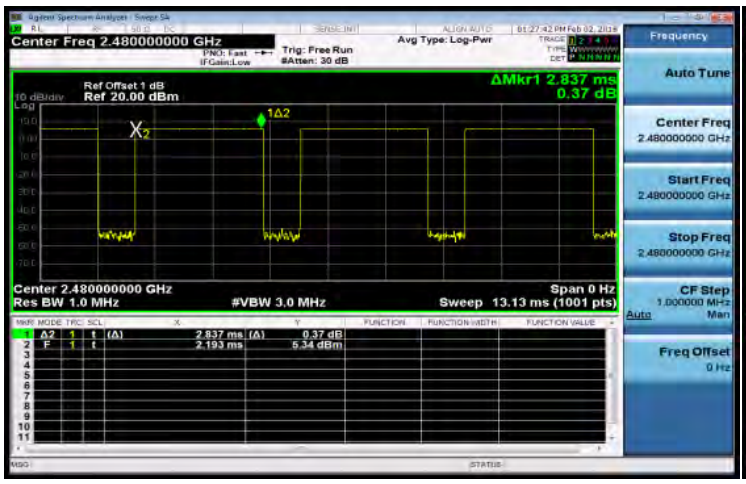
CH-High DH3



CH-Mid 2DH3



CH-High DH5



CH-Mid 2DH5

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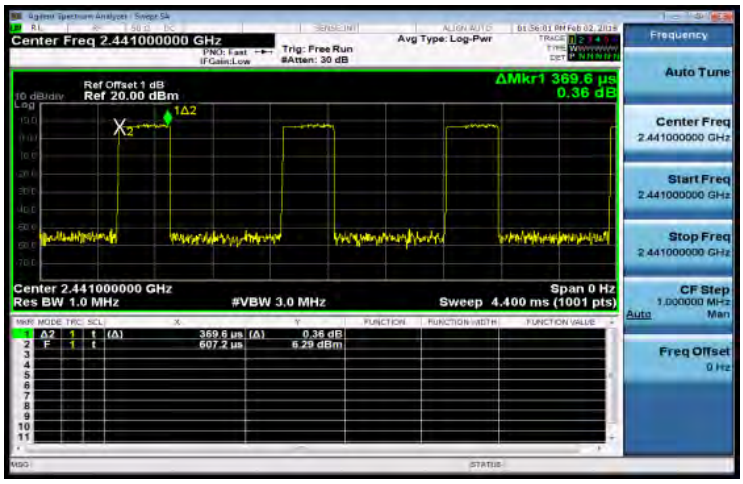
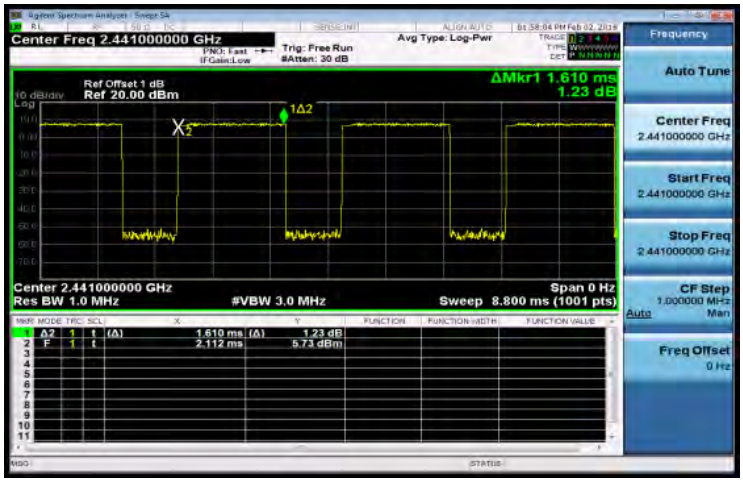
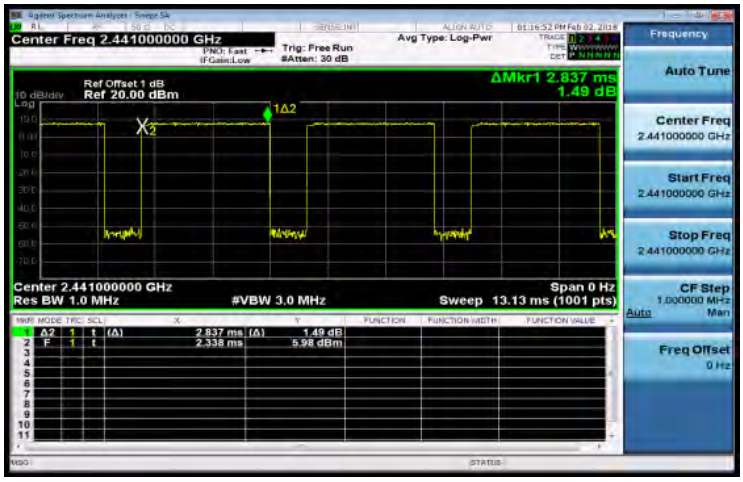
CH-Mid 3DH1



CH-Mid 3DH3



CH-Mid 3DH5



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14 ANTENNA REQUIREMENT

14.1 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.

14.2 Antenna Connected Construction

An embedded-in antenna design is used.

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

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