ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART C REQUIREMENT

OF

Applicant:	Harman International Industries Incorporated 636, Ellis St, Mountain View, CA 94043, USA
Product Name:	Sprint Drive
Brand Name:	Sprint Drive
Model No.:	HSA-15US-AA
Model Difference:	N/A
FCC ID:	2AHPN-HSA-15US-AA
Report Number:	E2/2018/70102
FCC Rule Part:	§15.247, Cat: DSS
Issue Date:	Sep. 28, 2018
Date of Test:	Aug. 10, 2018 ~ Sep. 28, 2018
Date of EUT Received:	Aug. 10, 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: Aken Huang

Aken Huang / Engineer

Approved By: Jim Chang

Jim Chang / Manager

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Revision History

Report Number	Revision	Description	Effected Page	Issue Date	Revised By
E2/2018/70102	Rev.00	Initial creation of document	All	Sep. 28, 2018	Elle Chang

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1 GENERAL INFORMATION

1.1 Product description

General:

Product Name:	Sprint Drive
Brand Name:	Sprint Drive
Model No.:	HSA-15US-AA
Model Difference:	N/A
Hardware Version:	VS.0
Software Version:	HSA-15US_81_LA301_R03B
Power Supply:	3.7Vdc from Rechargeable Li-polymer Battery or 12Vdc from vehicle battery

Bluetooth_BR only:

Bluetooth Version:	Bluetooth V4.2 dual mode
Channel number:	79 channels
Modulation type:	GFSK + π/4DQPSK + 8DPSK
Transmit Power:	4.32 dBm
Frequency Range:	2.402GHz – 2.480GHz
Dwell Time:	<= 0.4s
Antenna Designation:	FPC Antenna, Gain: 2.5 dBi

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1.2 Test Methodology of Applied Standards

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 Number and Designation are: 735305 / TW0002

1.4 Special Accessories

There is no special accessory 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 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.

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2.5 Configuration of Tested System

Fig. 2-1 Radiated Emission

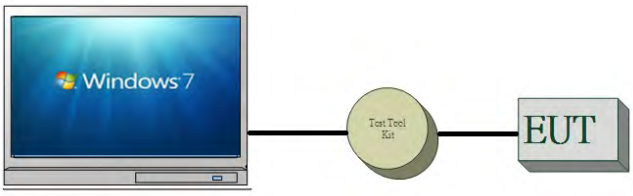

Fig. 2-2 Conducted (Antenna Port) Configuration

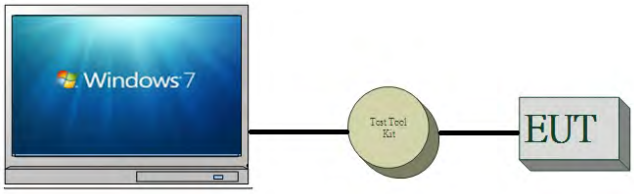

Table 2-1 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Cable	Power Cord
1.	Bluetooth Test Software	N/A	N/A	N/A	N/A	N/A
2.	Notebook	Lenovo	L412	LR-957X7	Shielded	Unshielded
3.	Test tool kit	N/A	N/A	N/A	N/A	N/A

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3 UMMARY OF TEST RESULTS

FCC Rules	Description Of Test	Result
§15.207(a)	AC Power Line Conducted Emission	N/A
§15.247(b)(1)	Peak Output Power	Compliant
§15.247(a)(1)	20dB & 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(a)(1)	Frequency Separation	Compliant
§15.247(a)(1)(iii)	Number of hopping frequency	Compliant
§15.247(a)(1)(iii)	Time of Occupancy	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

79 channels are provided for Bluetooth

Item	FREQUENCY	Item	FREQUENCY	Item	FREQUENCY	Item	FREQUENCY
1	2402 MHz	21	2422 MHz	41	2442 MHz	71	2462 MHz
2	2403 MHz	22	2423 MHz	42	2443 MHz	72	2463 MHz
3	2404 MHz	23	2424 MHz	43	2444 MHz	73	2464 MHz
4	2405 MHz	24	2425 MHz	44	2445 MHz	74	2465 MHz
5	2406 MHz	25	2426 MHz	45	2446 MHz	75	2466 MHz
6	2407 MHz	26	2427 MHz	46	2447 MHz	76	2467 MHz
7	2408 MHz	27	2428 MHz	47	2448 MHz	77	2468 MHz
8	2409 MHz	28	2429 MHz	48	2449 MHz	78	2469 MHz
9	2410 MHz	29	2430 MHz	49	2450 MHz	79	2470 MHz
10	2411 MHz	30	2431 MHz	50	2451 MHz	70	2471 MHz
11	2412 MHz	31	2432 MHz	51	2452 MHz	71	2472 MHz
12	2413 MHz	32	2433 MHz	52	2453 MHz	72	2473 MHz
13	2414 MHz	33	2434 MHz	53	2454 MHz	73	2474 MHz
14	2415 MHz	34	2435 MHz	54	2455 MHz	74	2475 MHz
15	2416 MHz	35	2436 MHz	55	2456 MHz	75	2476 MHz
16	2417 MHz	36	2437 MHz	56	2457 MHz	76	2477 MHz
17	2418 MHz	37	2438 MHz	57	2458 MHz	77	2478 MHz
18	2419 MHz	38	2439 MHz	58	2459 MHz	78	2479 MHz
19	2420 MHz	39	2440 MHz	59	2460 MHz	79	2480 MHz
20	2421 MHz	40	2441 MHz	60	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.

RADIATED EMISSION TEST:

RADIATED EMISSION TEST (BELOW 1 GHz)				
MODE	AVAILABLE FREQUENCY (MHz)	TESTED FREQUENCY (MHz)	MODULATION	PACKET TYPE
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK	DH5
RADIATED EMISSION TEST (ABOVE 1 GHz)				
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK	DH5

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 BR+EDR Transmitter for channel Low, Mid and High, the worst case H position was reported.

ANTENNA PORT CONDUCTED MEASUREMENT:

CONDUCTED TEST				
Peak Output Power, 20dB Band Width				
MODE	AVAILABLE FREQUENCY (MHz)	TESTED FREQUENCY (MHz)	MODULATION	PACKET TYPE
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK, π/4-DQPSK, 8-DPSK	DH5
Band Edge				
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK	DH5
Frequency Separation				
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK	DH5
Number of hopping frequency				
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK	DH5
Time of Occupancy (Dwell time)				
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK, π/4-DQPSK, 8-DPSK	DH1/DH3/DH5

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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

N/A

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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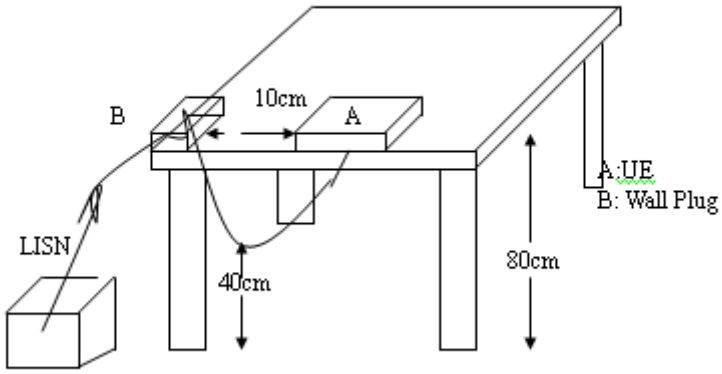
6.4 Test SET-UP (Block Diagram of Configuration)



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

N/A, the EUT powered by DC car battery.

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7 PEAK OUTPUT POWER MEASUREMENT

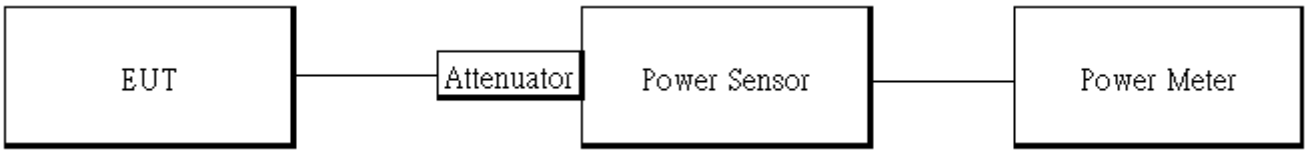
7.1 Standard Applicable

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.

7.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Power Meter	Anritsu	ML2496A	1326001	2018/08/09	2019/8/2
Power Sensor	Anritsu	MA2411B	1315048	2018/08/09	2019/8/2
Power Sensor	Anritsu	MA2411B	1315049	2018/08/09	2019/8/2
Attenuator	Marvelous	MVE2213-10	RF30	2017/12/26	2018/12/25

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 the Measurement Procedure of FCC KDB 558074 D01 V05.
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	-0.28	0.938	1000
39	2441	**3.29**	2.133	1000
78	2480	0.91	1.233	1000

1M BR mode (Average):

CH	Freq. (MHz)	Max. Output include tune up tolerance Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	-2.01	0.630	1000
39	2441	1.93	1.560	1000
78	2480	-0.55	0.881	1000

2M EDR mode (Peak):

CH	Freq. (MHz)	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	0.42	1.102	125
39	2441	**4.04**	2.535	125
78	2480	1.71	1.483	125

2M EDR mode (Average):

CH	Freq. (MHz)	Max. Avg.Output include tune up tolerance Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	-3.55	0.442	125
39	2441	0.38	1.091	125
78	2480	-1.82	0.658	125

3M EDR mode (Peak):

CH	Freq. (MHz)	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	0.72	1.180	125
39	2441	**4.32**	2.704	125
78	2480	1.98	1.578	125

NOTE: cable loss as 10.6dB that offsets in the spectrum

3M EDR mode (Average):

CH	Freq. (MHz)	Max. Avg.Output include tune up tolerance Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	-3.27	0.471	125
39	2441	0.36	1.086	125
78	2480	-1.79	0.662	125

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

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8 20DB BANDWIDTH MEASUREMENT

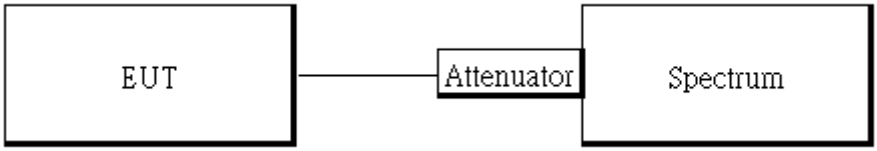
8.1 Standard Applicable

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	Agilent	N9010A	MY51440113	2018/06/20	2019/6/19
Attenuator	Marvelous	MVE2213-10	RF30	2017/12/26	2018/12/25
DC Block	PASTERNACK	PE8210	RF29	2017/12/26	2018/12/25
Notebook	Lenovo	L420	S0011721	N/A	N/A

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. Repeat above procedures until all test default channel is completed

NOTE:

For the plot of bandwidth measurement, the marker of the 20dB BW is arrow-mark

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8.5 Measurement Result

GFSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
Low	0.9232	0.62
Mid	0.9229	0.62
High	0.9232	0.62

π/4-DQPSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
Low	1.311	0.87
Mid	1.254	0.84
High	1.304	0.87

8-DPSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
Low	1.257	0.84
Mid	1.256	0.84
High	1.255	0.84

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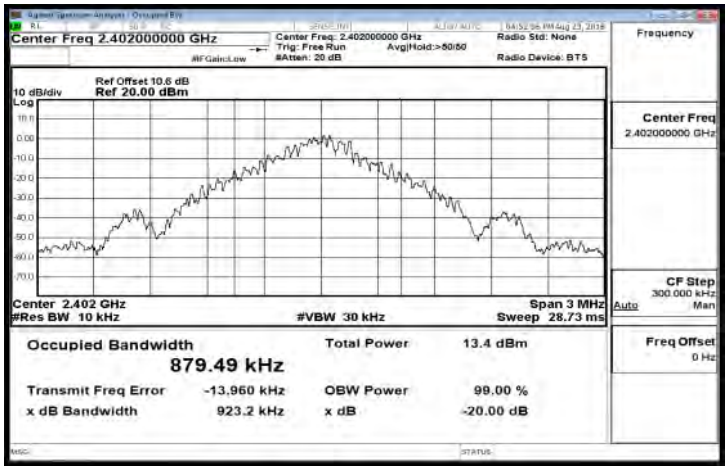
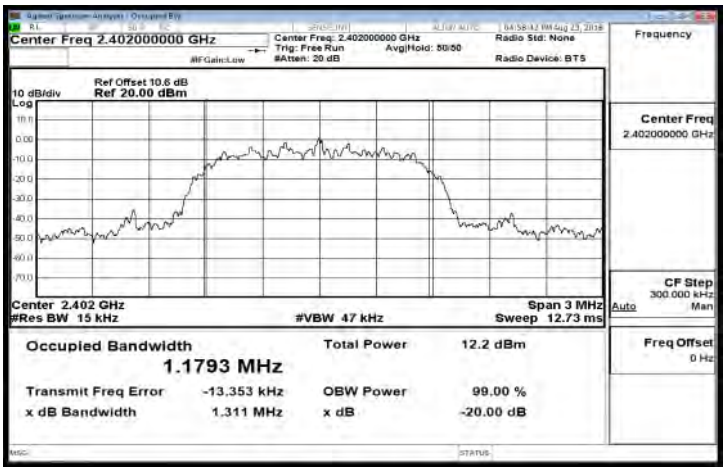
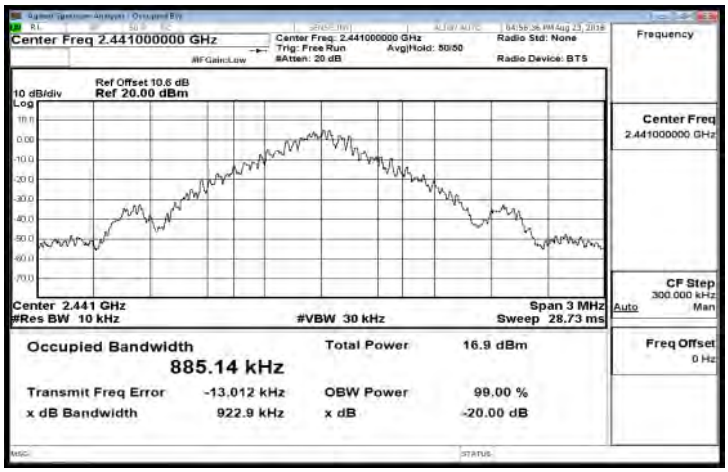
20dB Band Width Test Data CH-Low (GFSK mode)



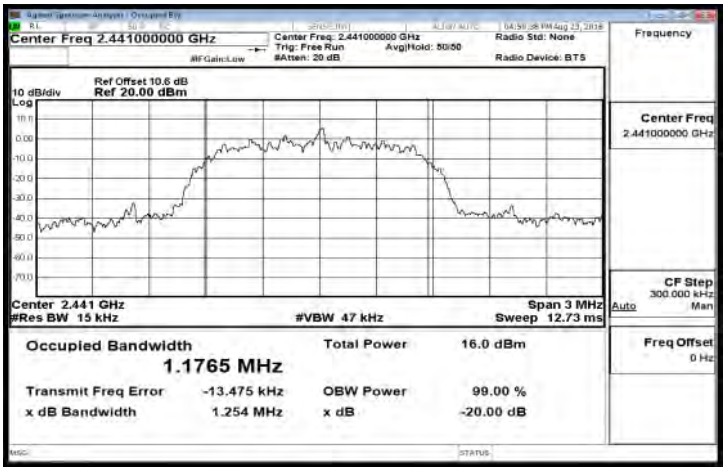
20dB Band Width Test Data CH-Low (π/4-DQPSK mode)



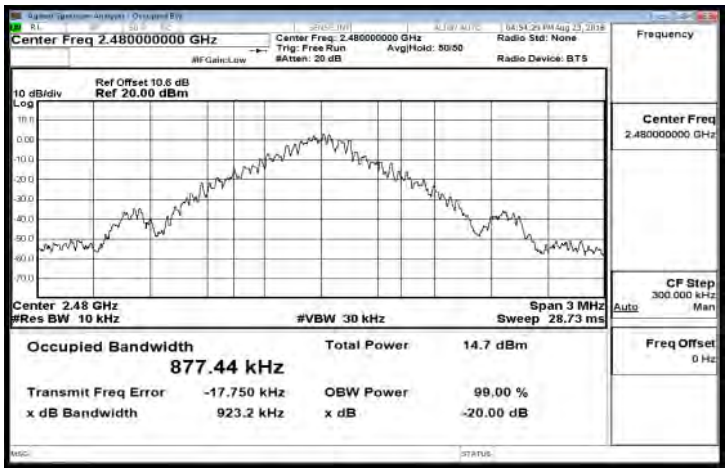
20dB Band Width Test Data CH-Mid (GFSK mode)



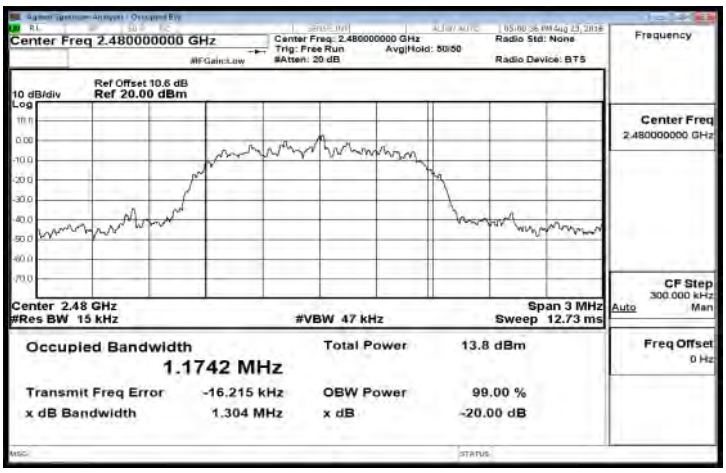
20dB Band Width Test Data CH-Mid (π/4-DQPSK mode)



20dB Band Width Test Data CH-High (GFSK mode)



20dB Band Width Test Data CH-High (π/4-DQPSK mode)



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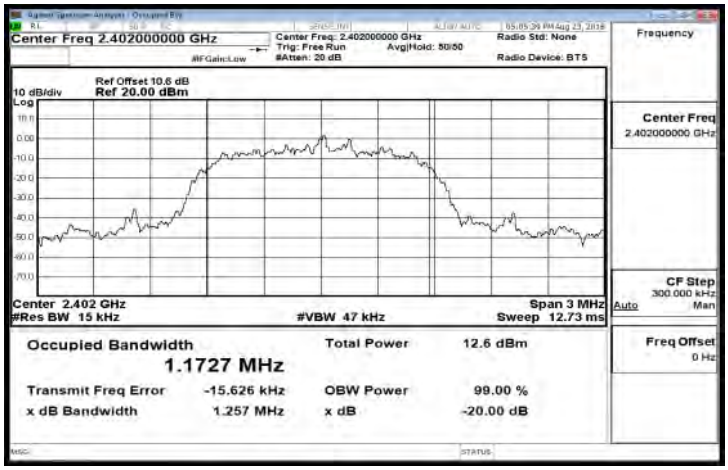
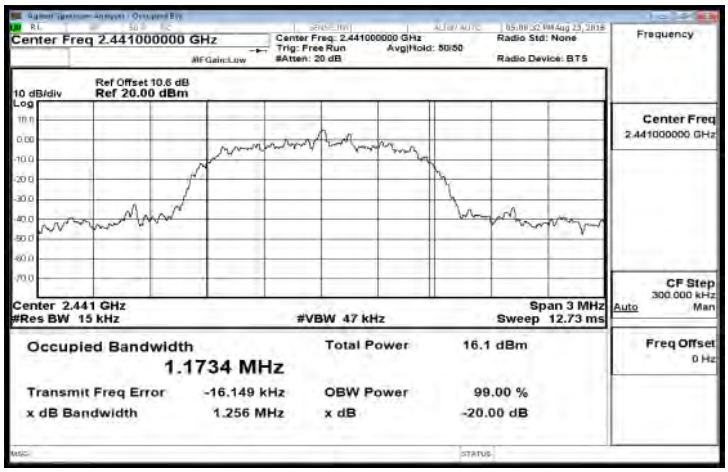
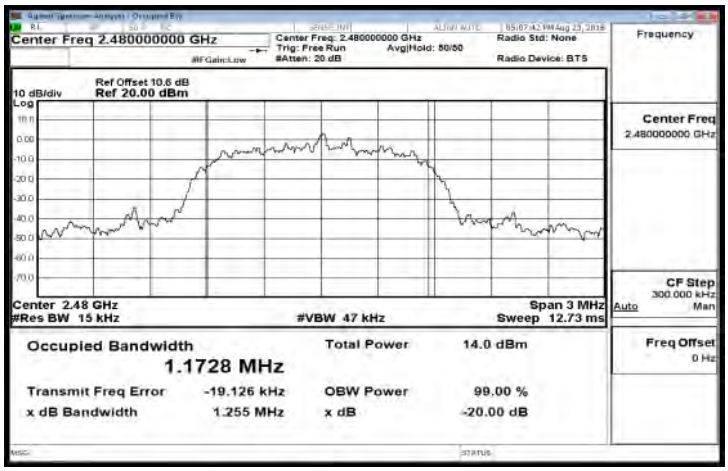
20dB Band Width Test Data CH-Low (8-DPSK mode)



20dB Band Width Test Data CH-Mid (8-DPSK mode)



20dB Width Test Data CH-High (8-DPSK mode)



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9 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

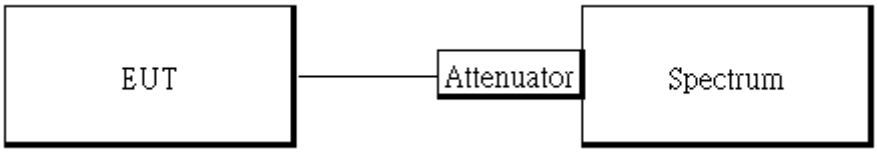
9.1 Standard Applicable

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).

9.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	N9010A	MY51440113	2018/06/20	2019/6/19
Attenuator	Marvelous	MVE2213-10	RF30	2017/12/26	2018/12/25
DC Block	PASTERNACK	PE8210	RF29	2017/12/26	2018/12/25
Notebook	Lenovo	L420	S0011721	N/A	N/A

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	

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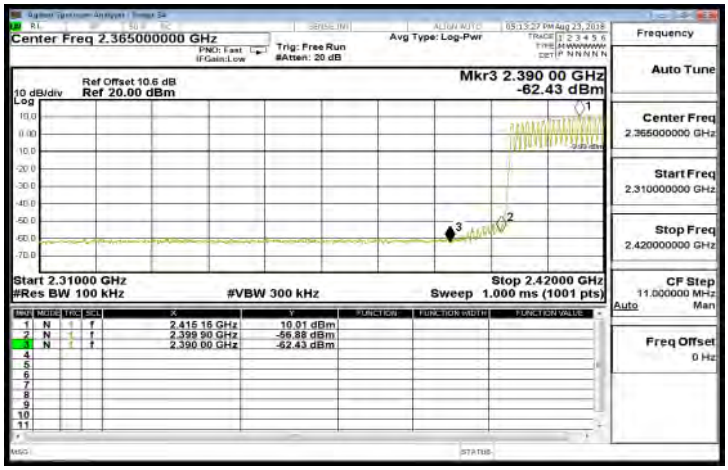
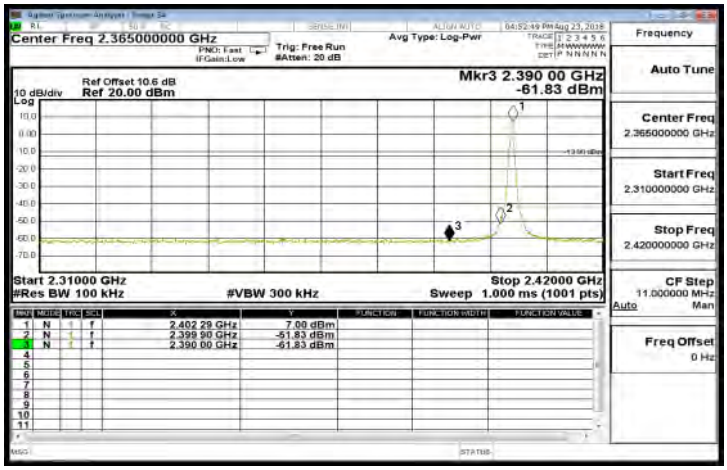
9.5 Measurement Result

GFSK

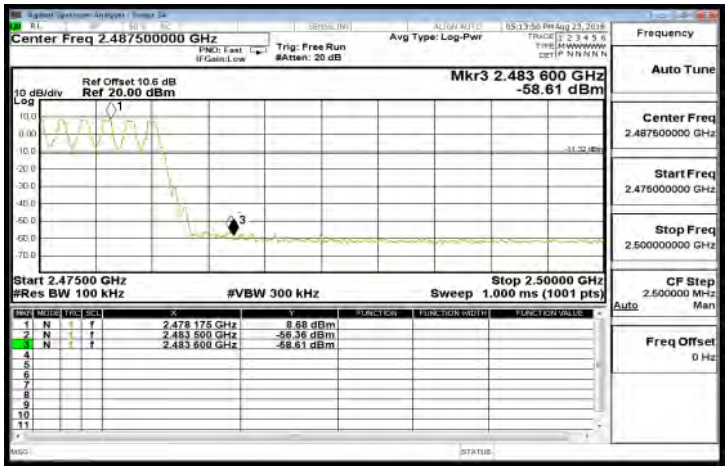
Band Edges Test Data CH-Low (Hopping mode)



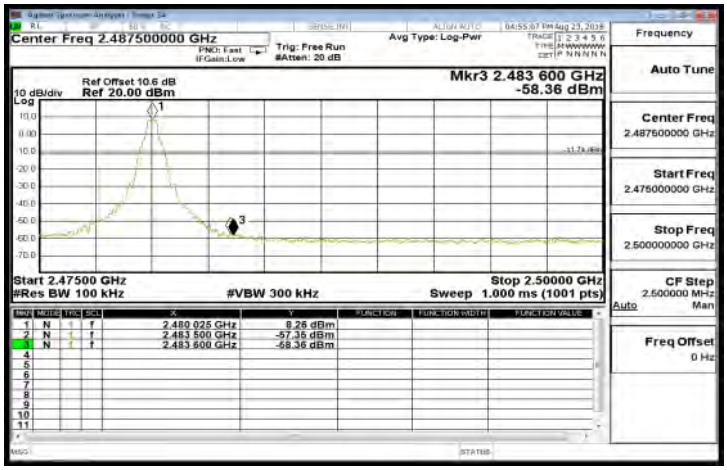
Band Edges Test Data CH-Low (Non-Hopping mode)



Band Edges Test Data CH-High



Band Edges Test Data CH-High



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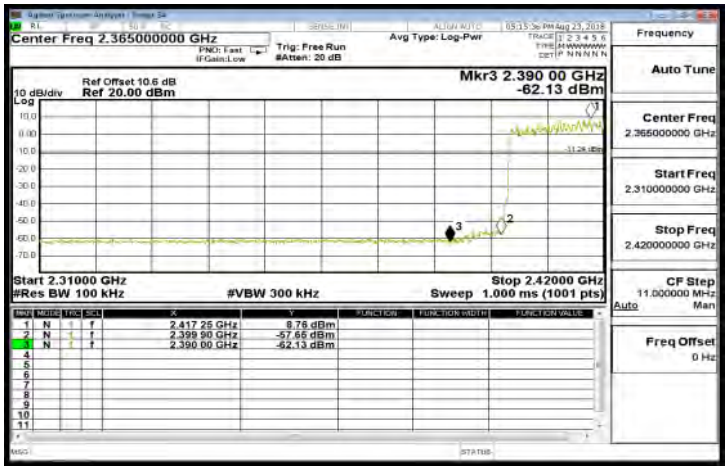
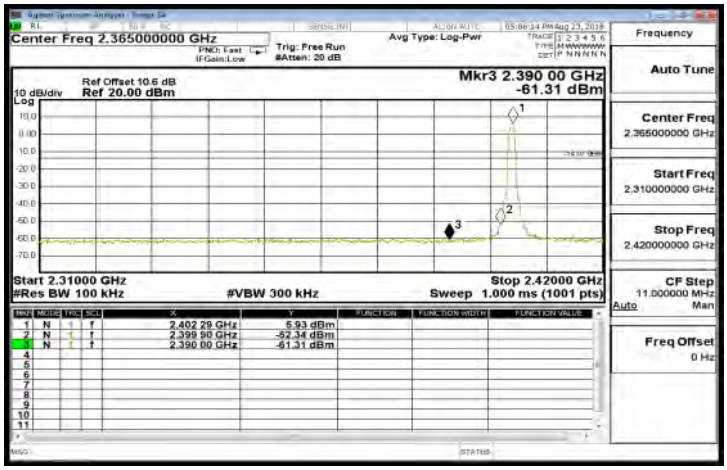
8DPSK

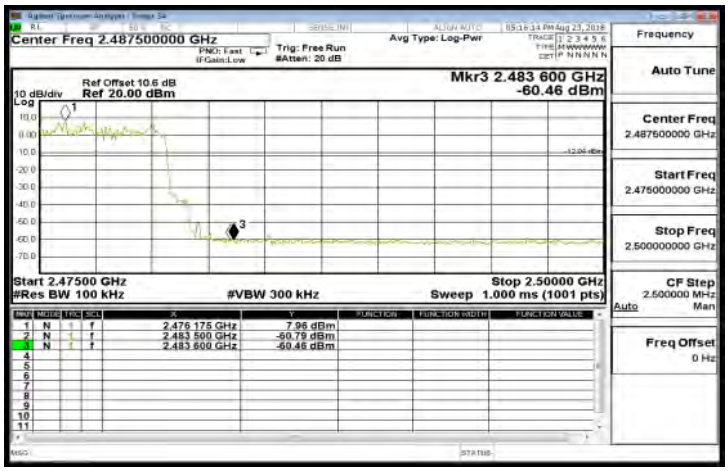
Band Edges Test Data CH-Low (Hopping mode)



Band Edges Test Data CH-Low (Non-Hopping mode)



Band Edges Test Data CH-High



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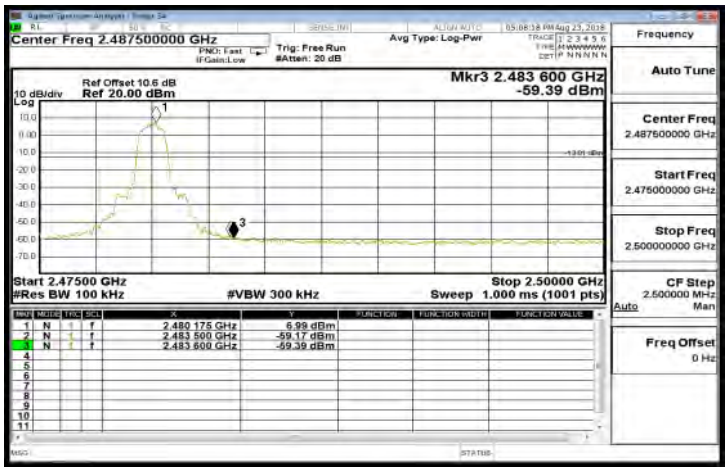

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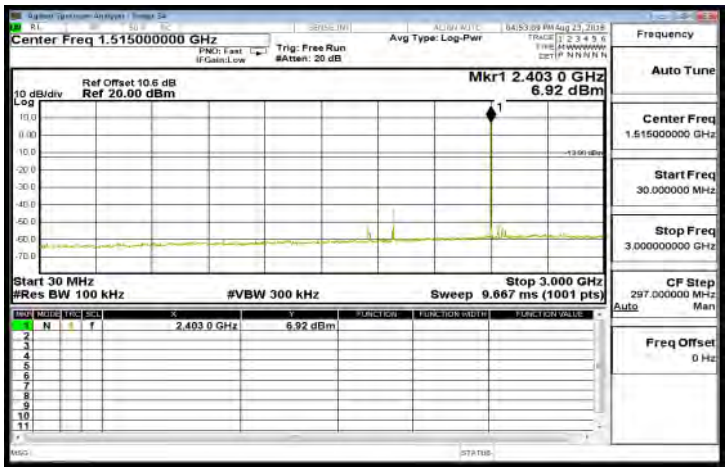
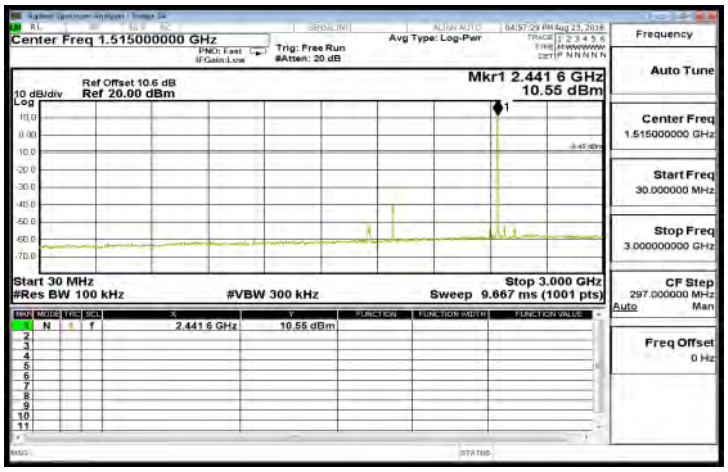
Conducted Spurious Emission Measurement Result

GFSK

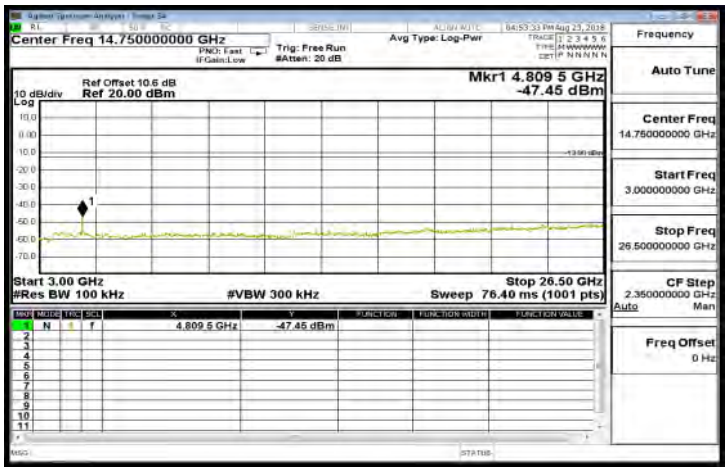
Ch Low 30MHz – 3GHz



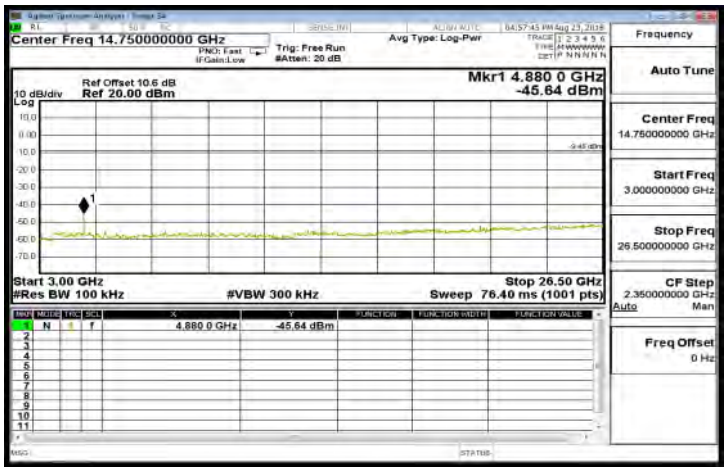
Ch Mid 30MHz – 3GHz



Ch Low 3GHz – 26.5GHz



Ch Mid 3GHz – 26.5GHz



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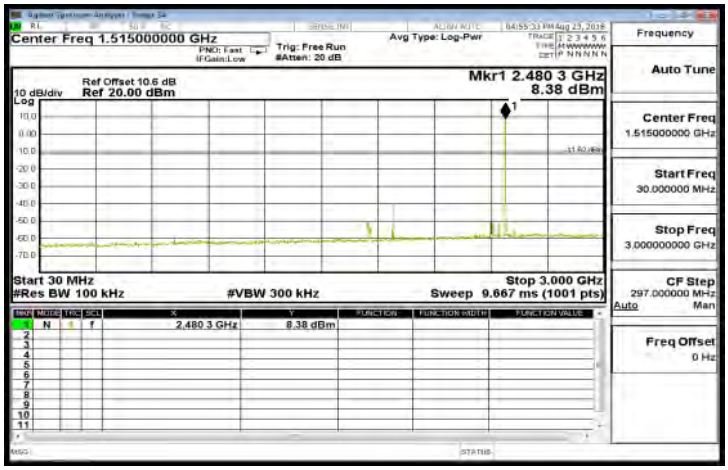
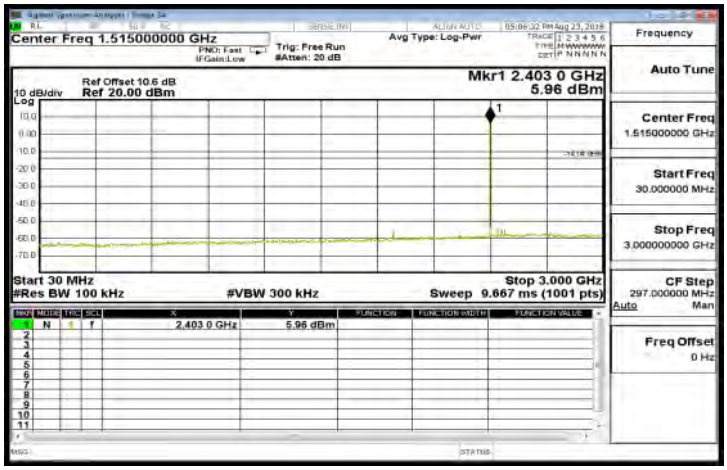
8DPSK

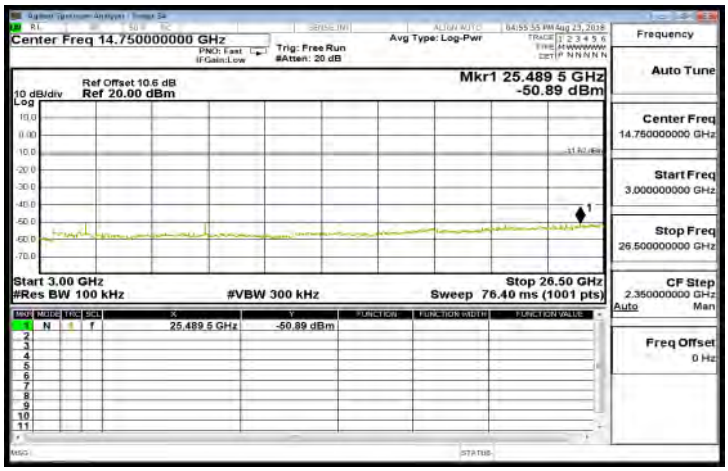
Ch High 30MHz – 3GHz



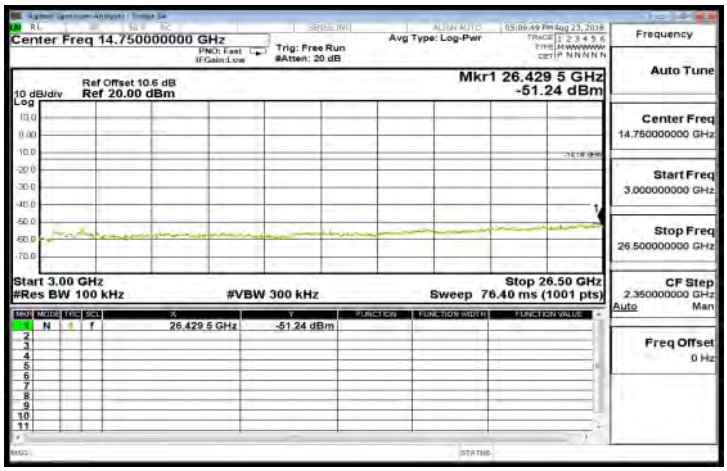
Ch Low 30MHz – 3GHz



Ch High 3GHz – 26.5GHz



Ch Low 3GHz – 26.5GHz



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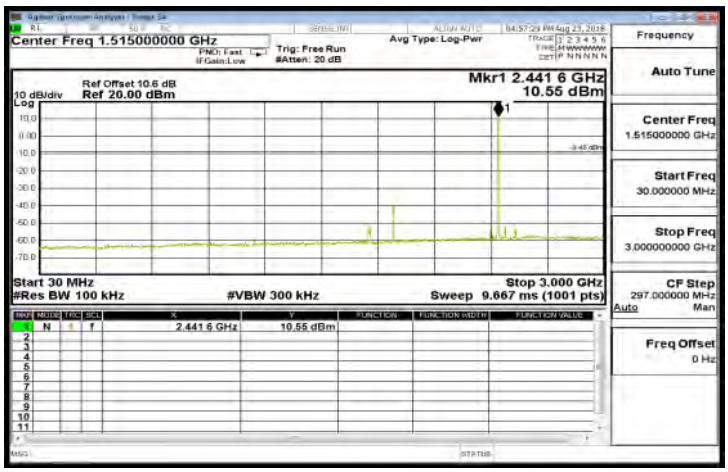
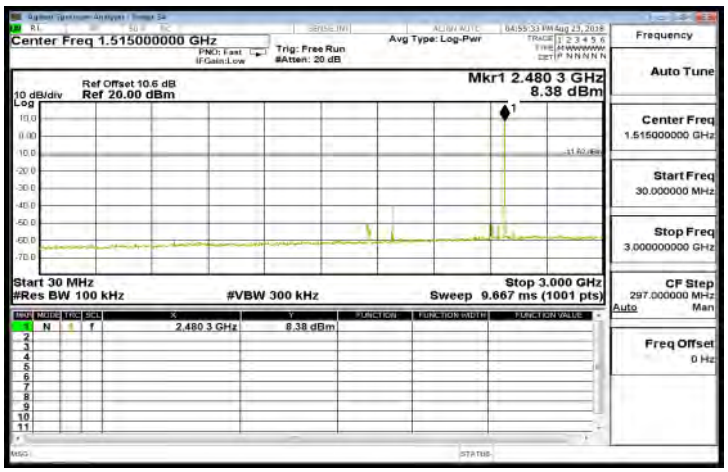
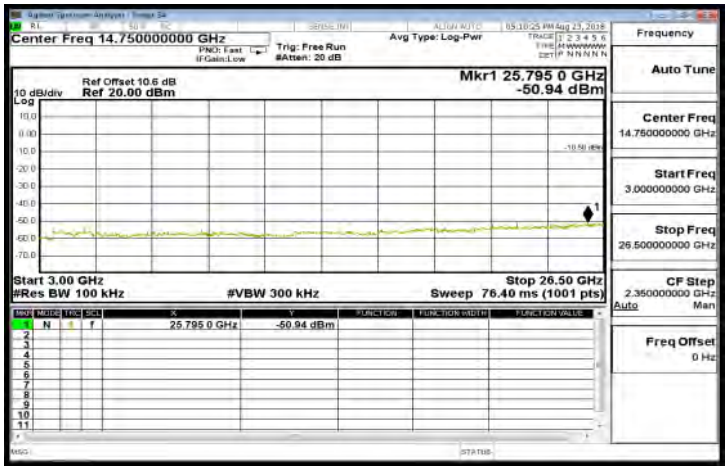
Ch Mid 30MHz – 3GHz



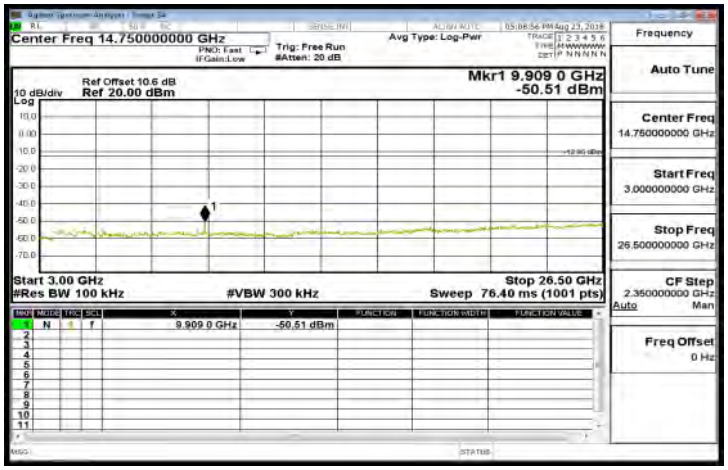
Ch High 30MHz – 3GHz



Ch Mid 3GHz – 26.5GHz



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

966 Chamber					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Broadband Antenna	SCHWAZBECK	VULB 9168	9168-617	2017/10/27	2018/10/26
Horn Antenna	Schwarzbeck	BBHA9120D	1341	2018/06/07	2019/06/06
Horn Antenna	SCHWAZBECK	BBHA9170	184	2017/12/12	2018/12/11
Loop Antenna	ETS.LINDGREN	6502	148045	2017/09/26	2018/09/25
Loop Antenna	ETS.LINDGREN	6502	148045	2018/09/26	2019/09/25
3m Site NSA	SGS	966 chamber D	N/A	2018/07/06	2019/07/05
EMI Test Receiver	R&S	ESU 40	100363	2018/04/11	2019/04/10
Pre-Amplifier	EMC Instruments	EMC184045B	980135	2017/10/27	2018/10/26
Pre-Amplifier	EMC Instruments	EMC9135	980234	2017/12/26	2018/12/25
Pre-Amplifier	EMC Instruments	EMC12630SE	980271	2017/12/26	2018/12/25
Attenuator	Marvelous	WATT-218FS-10	RF246	2017/12/26	2018/12/25
Highpass Filter	Micro Tronics	BRM50701-01	G008	2017/12/26	2018/12/25
Coaxial Cable	Huber Suhner	EMC106-SM-SM-7200	150703	2017/12/26	2018/12/25
Coaxial Cable	Huber Suhner	RG 214/U	W22.03	2017/12/26	2018/12/25
Notebook	Lenovo	L420	S0012467	N/A	N/A

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

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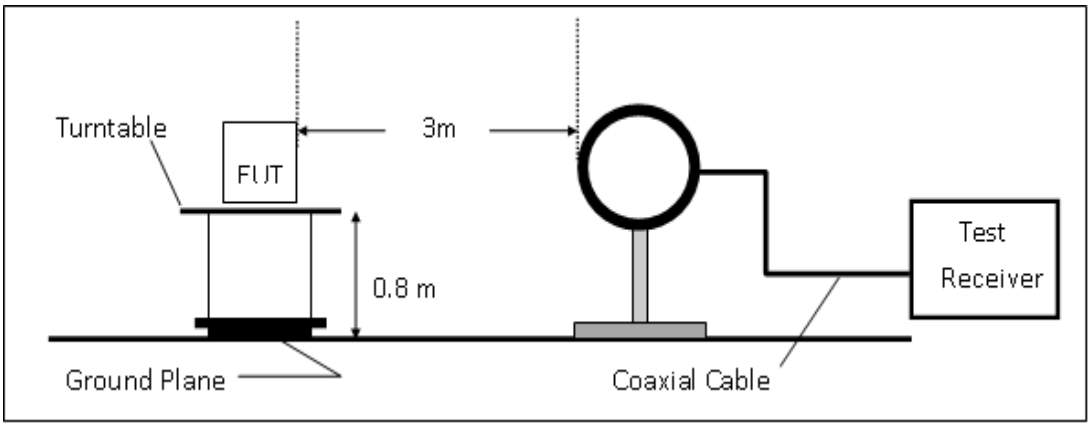
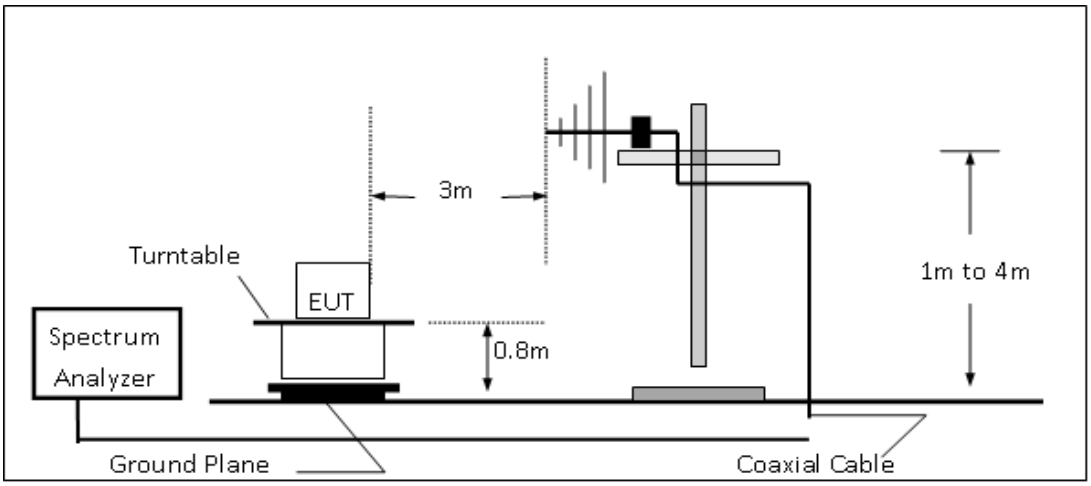
10.3 Test SET-UP

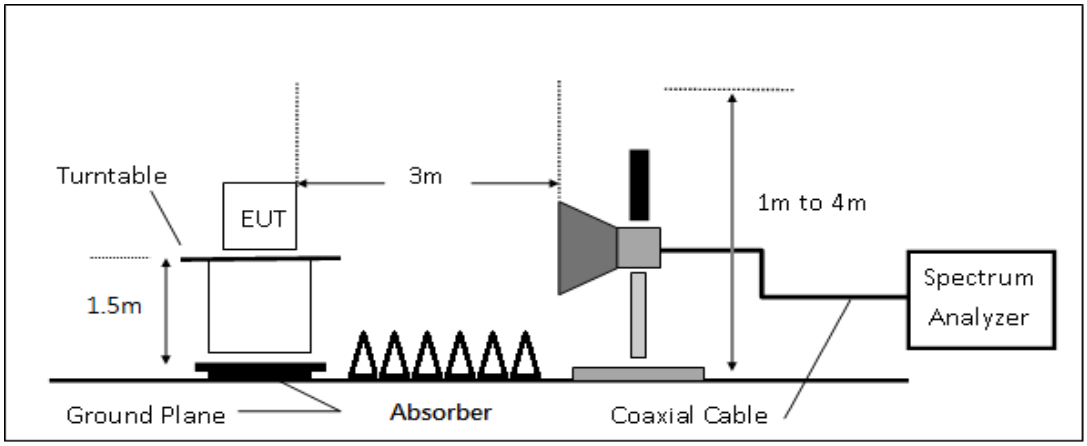
(A) Radiated Emission Test Set-UP Frequency Below 30MHz.



(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 the Measurement Procedure of ANSI C63.10:2013.
2. The EUT was placed on a turn table with 0.8m for frequency< 1GHz and 1.5m for frequency> 1GHz above ground plan.
3. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
4. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
5. Set the spectrum analyzer as RBW=120 kHz and VBW=300 kHz for Peak Detector (PK) and Quasi-peak (QP) at frequency below 1 GHz.
6. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz for Peak Detector at frequency above 1 GHz.
7. Set the spectrum analyzer as RBW=1 MHz, VBW=10 Hz (Duty cycle > 98%) or VBW ≥ 1/T (Duty cycle < 98%) for Average Detector at frequency above 1 GHz.
8. When measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” is still within the 3dB illumination BW of the measurement antenna.
9. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
10. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. On spectrum, change spectrum mode in linear display mode, and reduce VBW = 10Hz if average reading is measured.
11. Repeat above procedures until all default test channel measured were complete.

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10.5 Field Strength Calculation

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

FS = RA + AF + CL - AG

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

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(dBµV/m) + Cable Loss(dB) – Pre_Amplifier Gain(dB)

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.

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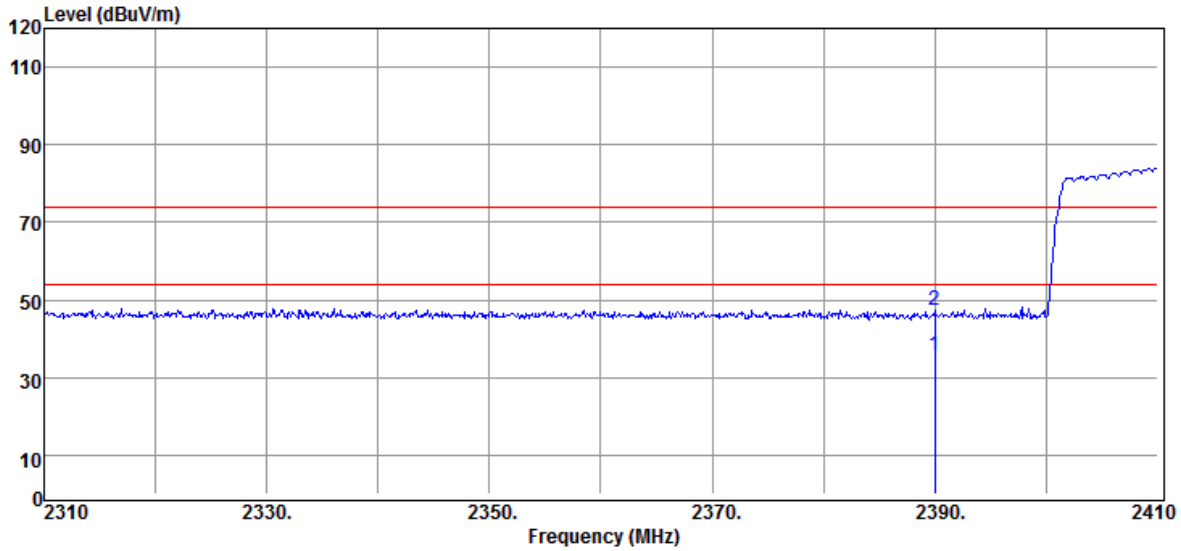
Radiated Band Edge Measurement Result: (Hopping Mode)

Operation Mode	:BT BR Hopping	Test Date	:2018-08-21
Test Mode	:BE CH Low	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2402 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2390.00	Average	41.37	-5.57	35.80	54.00	-18.20
2390.00	Peak	52.92	-5.57	47.35	74.00	-26.65

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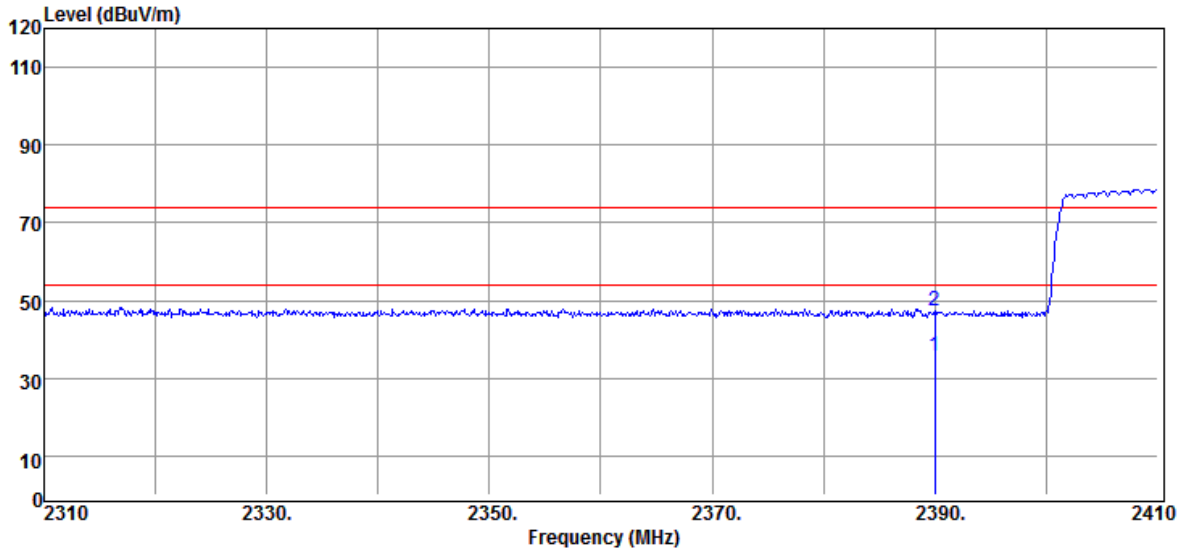
Operation Mode	:BT BR Hopping	Test Date	:2018-08-21
Test Mode	:BE CH Low	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2402 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2390.00	Average	41.28	-5.57	35.71	54.00	-18.29
2390.00	Peak	53.09	-5.57	47.52	74.00	-26.48

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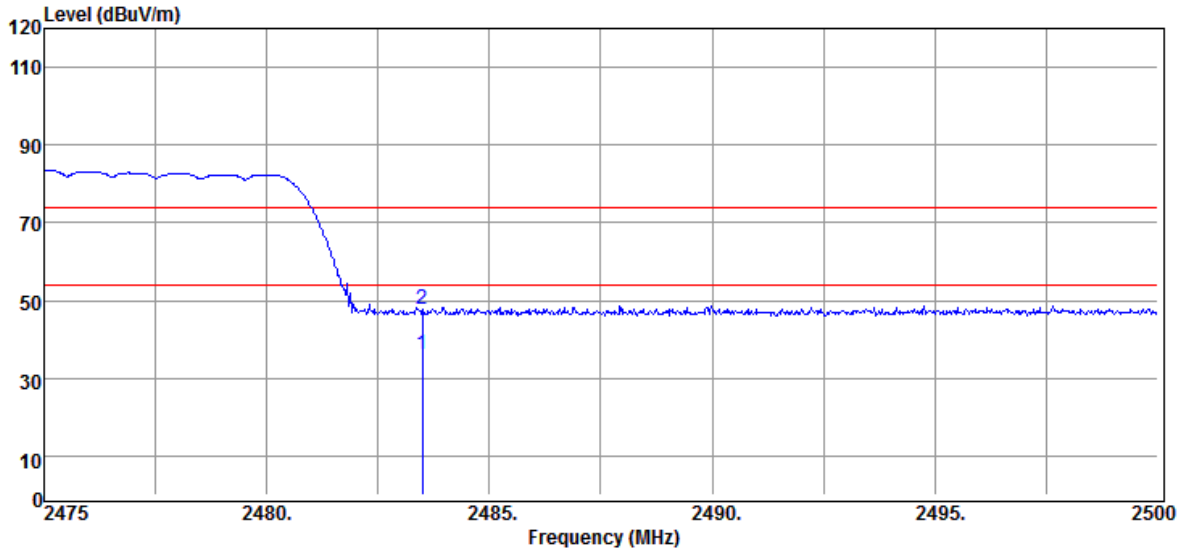
Operation Mode	:BT BR Hopping	Test Date	:2018-08-21
Test Mode	:BE CH High	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2480 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2483.50	Average	41.23	-4.90	36.33	54.00	-17.67
2483.50	Peak	52.53	-4.90	47.63	74.00	-26.37

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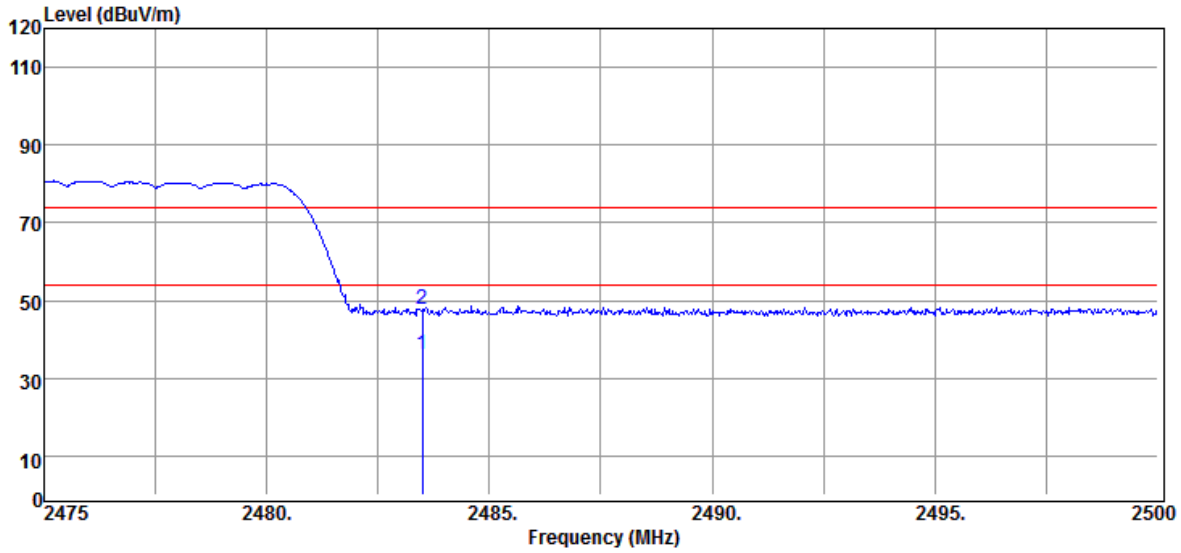
Operation Mode	:BT BR Hopping	Test Date	:2018-08-21
Test Mode	:BE CH High	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2480 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2483.50	Average	41.11	-4.90	36.21	54.00	-17.79
2483.50	Peak	52.68	-4.90	47.78	74.00	-26.22

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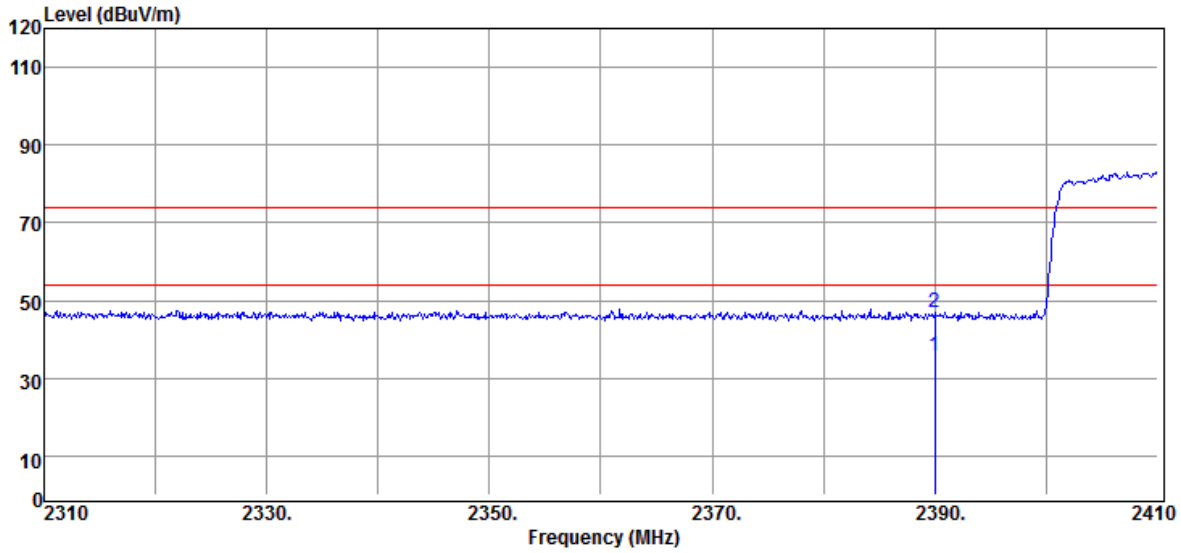
Operation Mode	:BT EDR Hopping	Test Date	:2018-08-21
Test Mode	:BE CH Low	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2402 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2390.00	Average	41.23	-5.57	35.66	54.00	-18.34
2390.00	Peak	52.30	-5.57	46.73	74.00	-27.27

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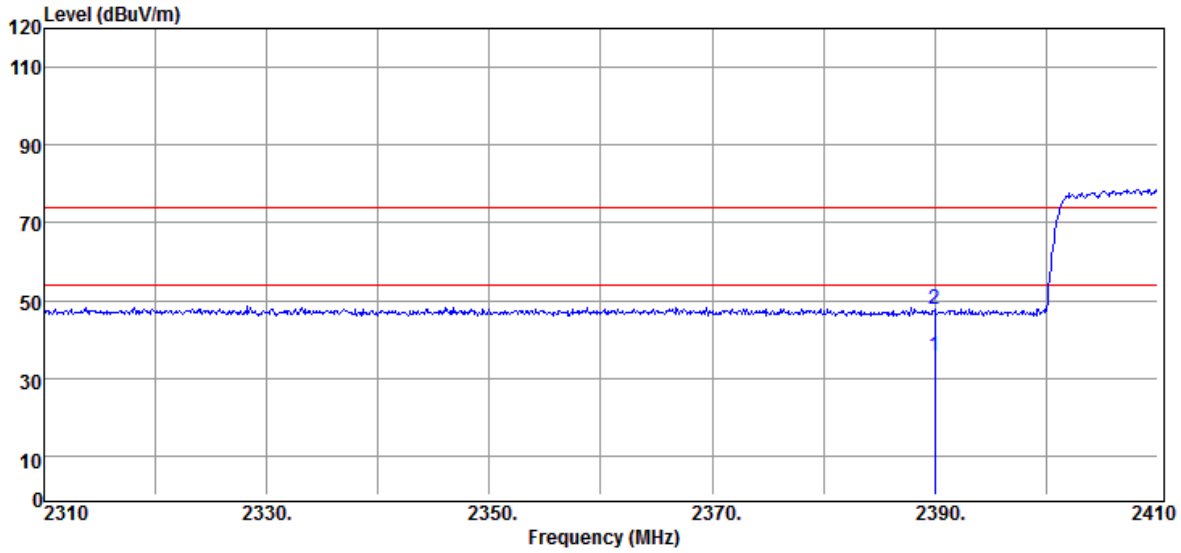
Operation Mode	:BT EDR Hopping	Test Date	:2018-08-21
Test Mode	:BE CH Low	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2402 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2390.00	Average	41.13	-5.57	35.56	54.00	-18.44
2390.00	Peak	53.47	-5.57	47.90	74.00	-26.10

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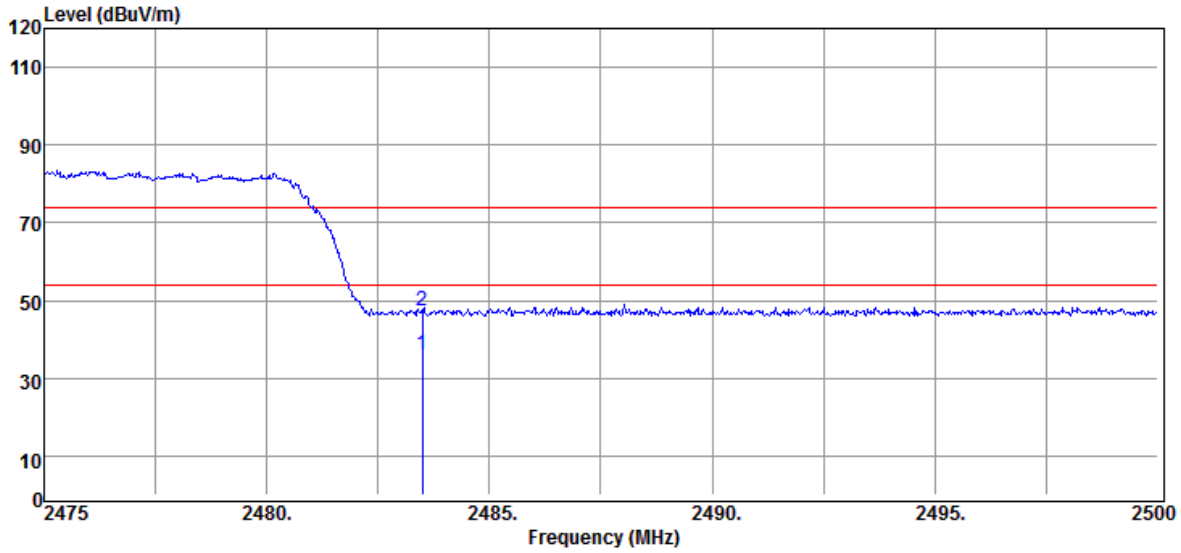
Operation Mode	:BT EDR Hopping	Test Date	:2018-08-21
Test Mode	:BE CH High	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2480 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2483.50	Average	41.11	-4.90	36.21	54.00	-17.79
2483.50	Peak	52.21	-4.90	47.31	74.00	-26.69

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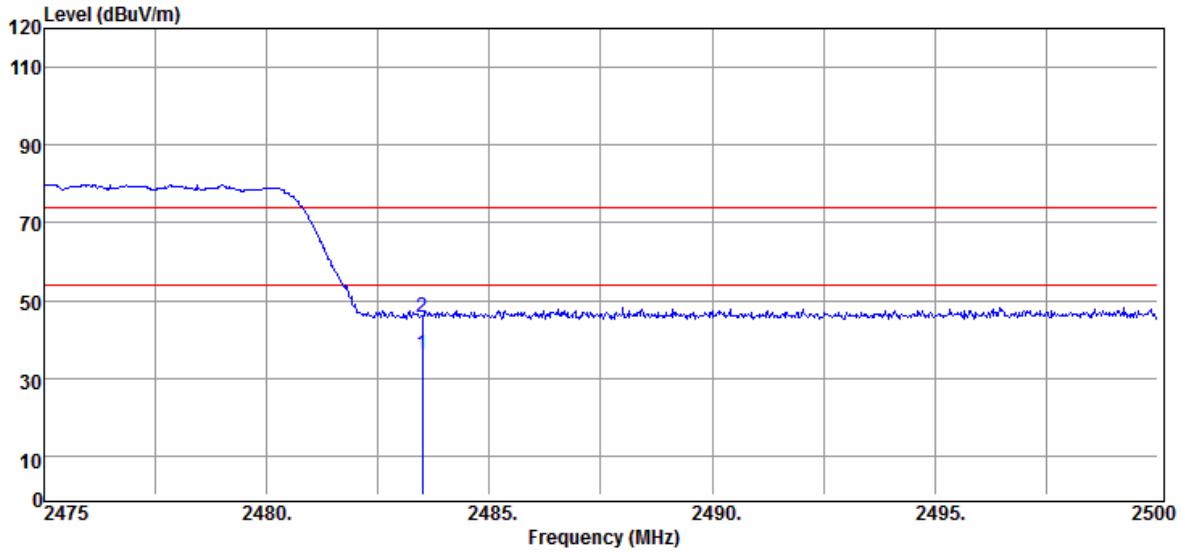
Operation Mode	:BT EDR Hopping	Test Date	:2018-08-21
Test Mode	:BE CH High	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2480 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2483.50	Average	41.20	-4.90	36.30	54.00	-17.70
2483.50	Peak	50.75	-4.90	45.85	74.00	-28.15

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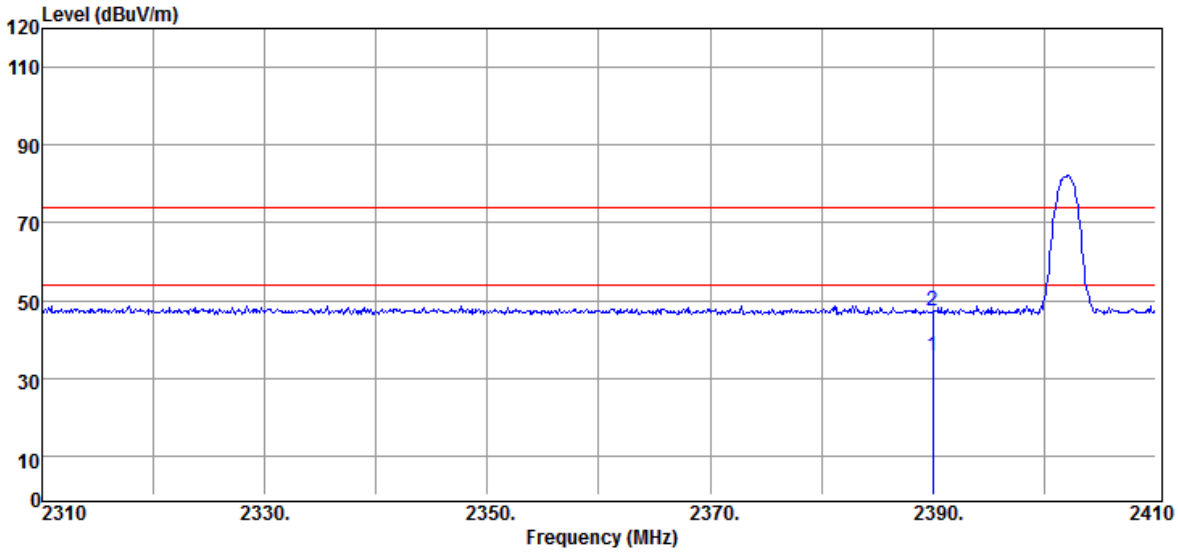
Radiated Emission – Band Edge (Non-Hopping Mode):

Operation Mode	:BT BR	Test Date	:2018-09-28
Test Mode	:BE CH Low	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2402 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2390.00	Average	41.16	-5.57	2390.00	Average	41.16
2390.00	Peak	52.89	-5.57	2390.00	Peak	52.89

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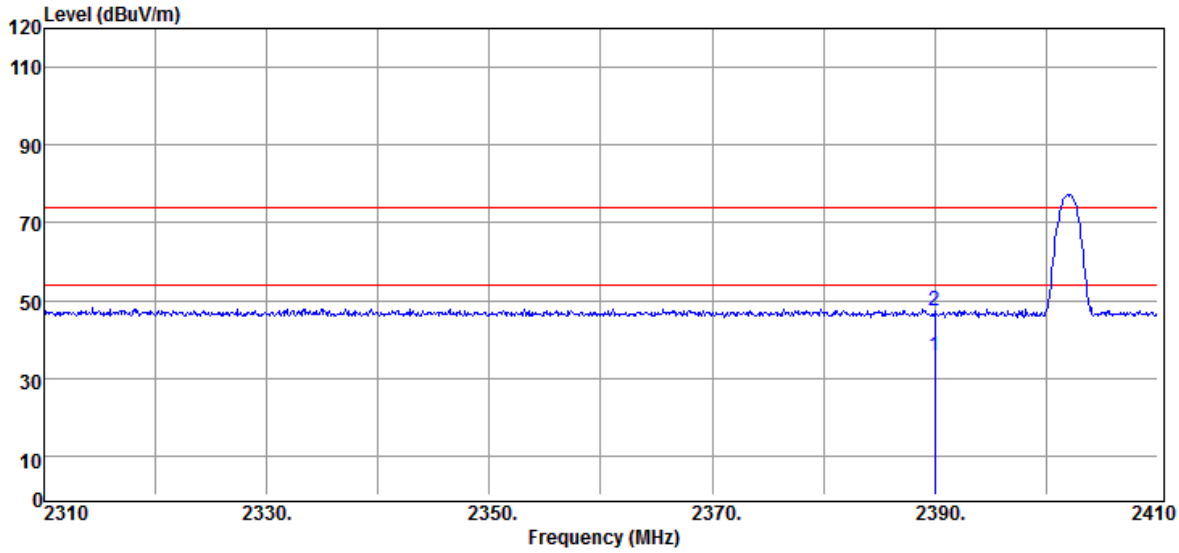
Operation Mode	:BT BR	Test Date	:2018-08-21
Test Mode	:BE CH Low	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2402 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2390.00	Average	41.37	-5.57	35.80	54.00	-18.20
2390.00	Peak	52.81	-5.57	47.24	74.00	-26.76

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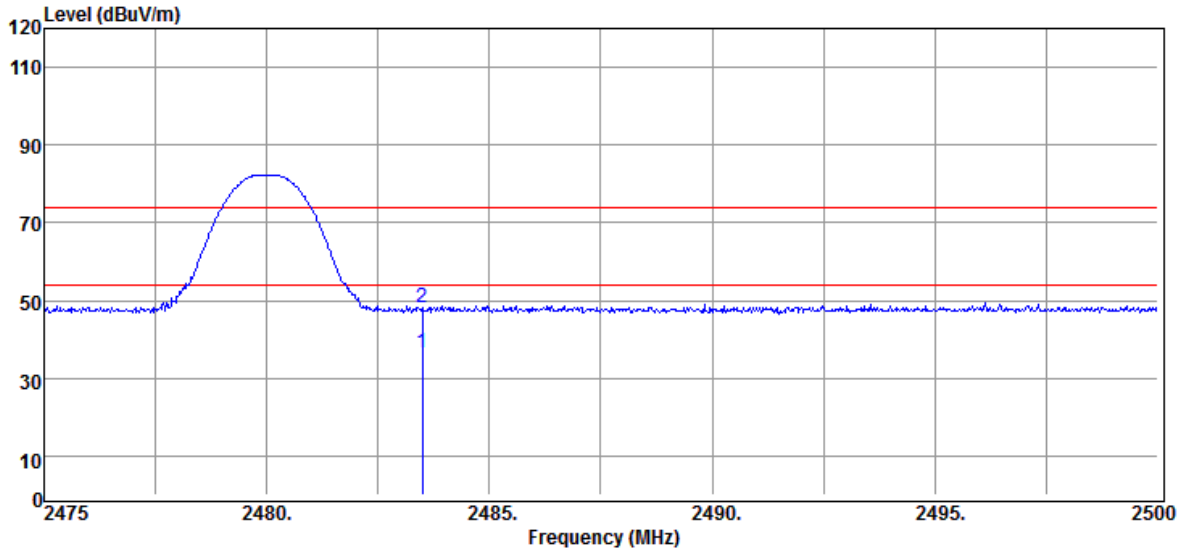
Operation Mode	:BT BR	Test Date	:2018-08-21
Test Mode	:BE CH High	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2480 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2483.50	Average	41.36	-4.90	36.46	54.00	-17.54
2483.50	Peak	52.98	-4.90	48.08	74.00	-25.92

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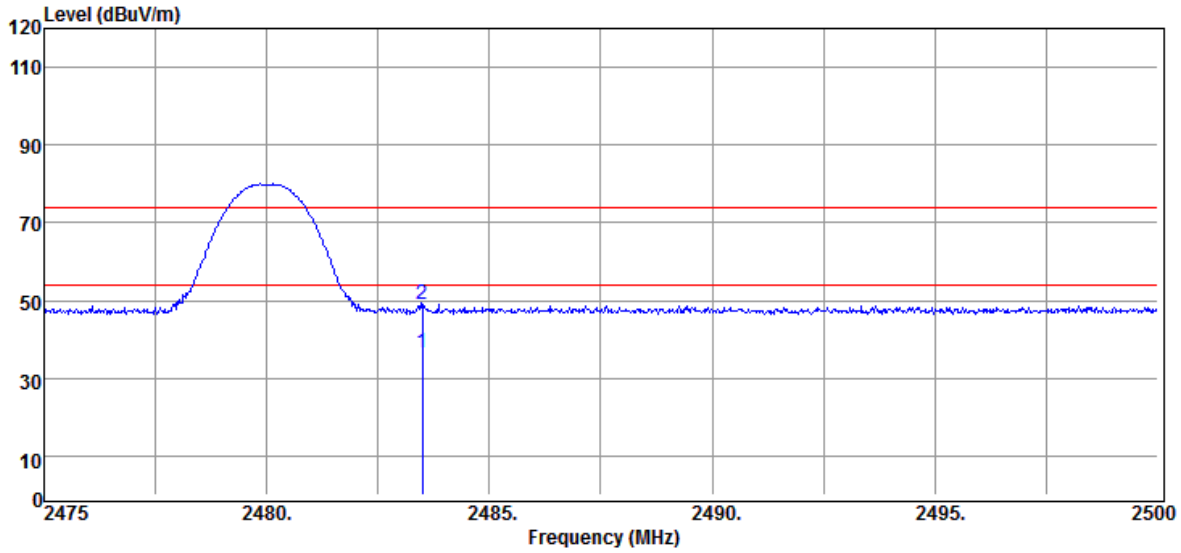
Operation Mode	:BT BR	Test Date	:2018-08-21
Test Mode	:BE CH High	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2480 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2483.50	Average	41.28	-4.90	36.38	54.00	-17.62
2483.50	Peak	53.75	-4.90	48.85	74.00	-25.15

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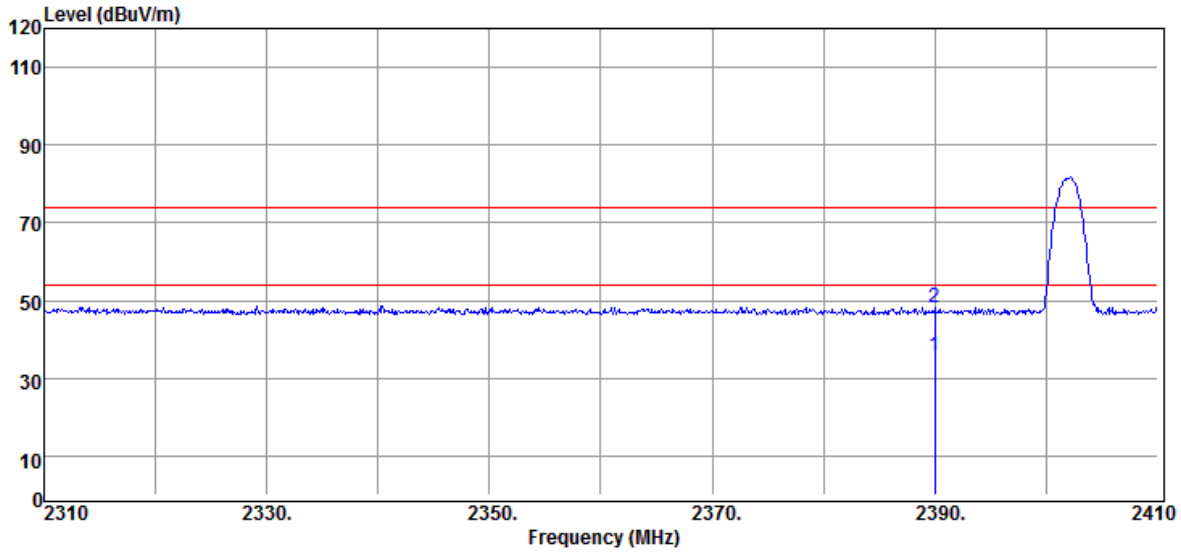
Operation Mode	:BT EDR	Test Date	:2018-08-21
Test Mode	:BE CH Low	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2402 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2390.00	Average	41.12	-5.57	35.55	54.00	-18.45
2390.00	Peak	53.77	-5.57	48.20	74.00	-25.80

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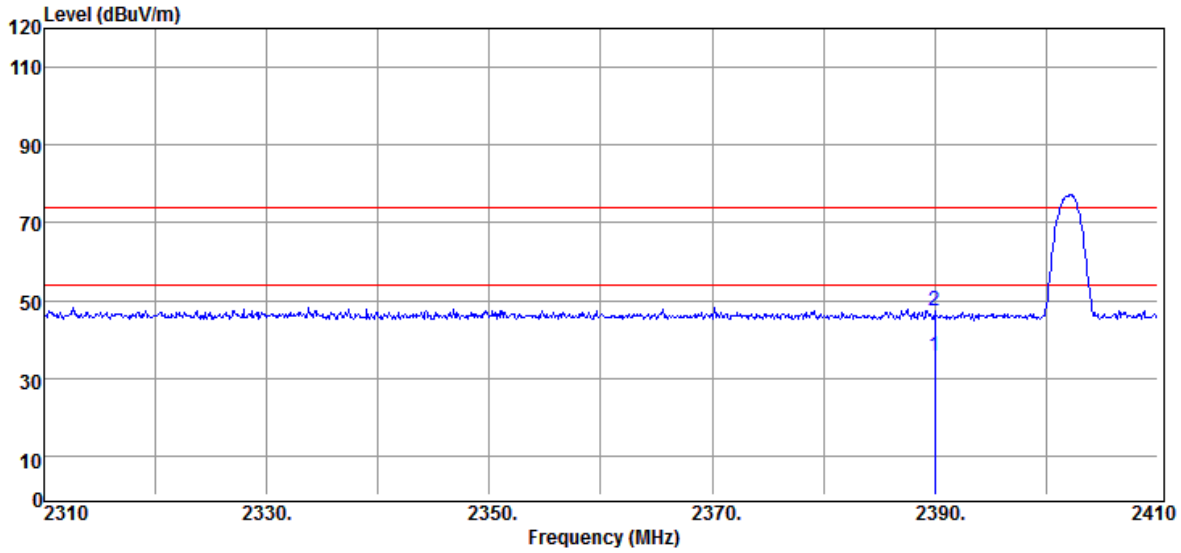
Operation Mode	:BT EDR	Test Date	:2018-08-21
Test Mode	:BE CH Low	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2402 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2390.00	Average	41.10	-5.57	35.53	54.00	-18.47
2390.00	Peak	52.82	-5.57	47.25	74.00	-26.75

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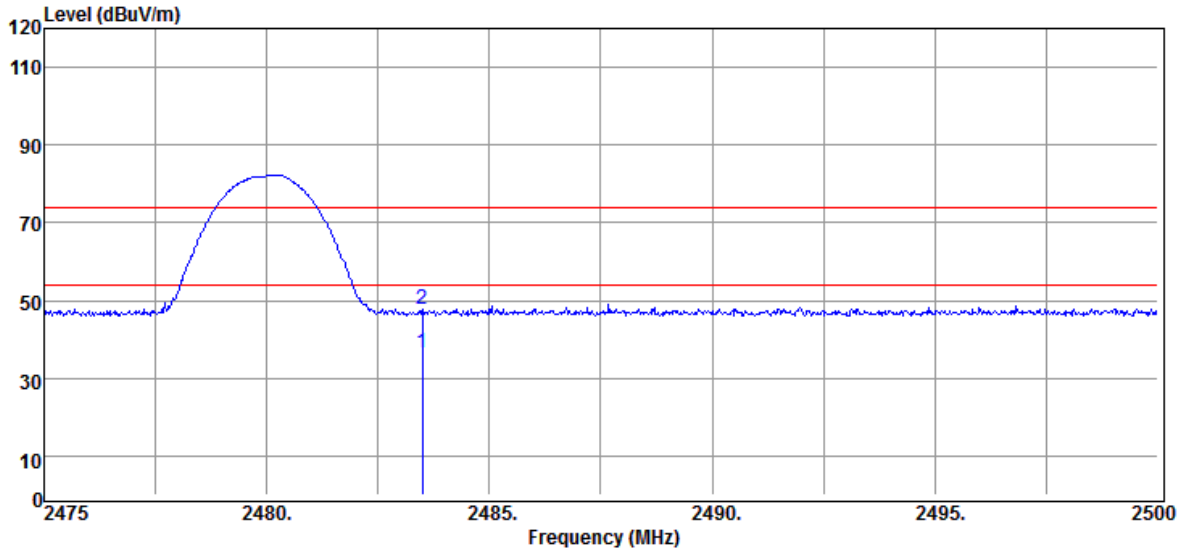
Operation Mode	:BT EDR	Test Date	:2018-08-21
Test Mode	:BE CH High	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2480 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2483.50	Average	41.35	-4.90	36.45	54.00	-17.55
2483.50	Peak	52.60	-4.90	47.70	74.00	-26.30

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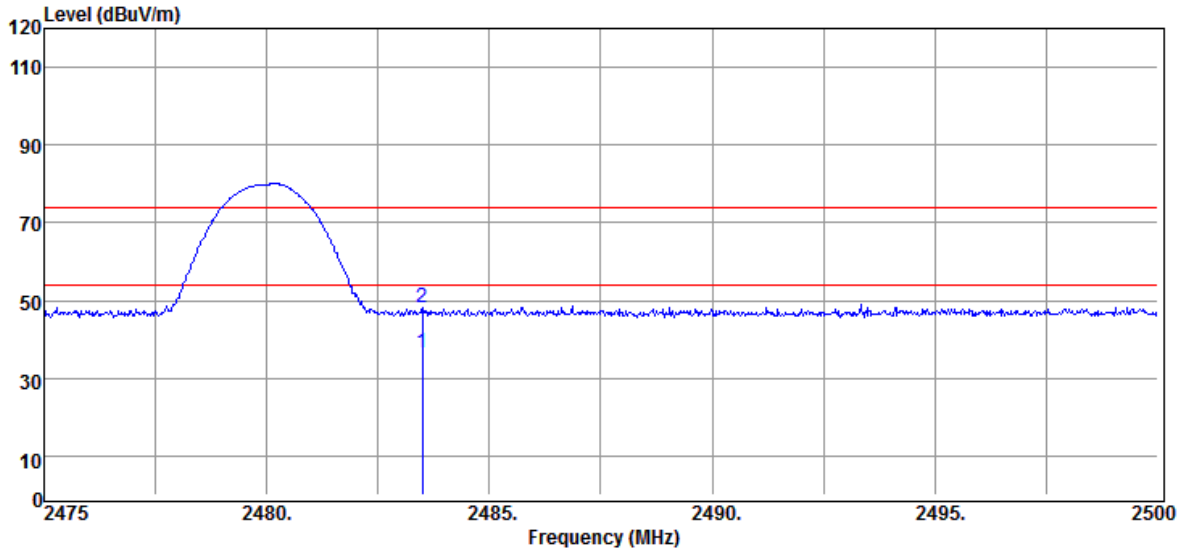
Operation Mode	:BT EDR	Test Date	:2018-08-21
Test Mode	:BE CH High	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2480 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2483.50	Average	41.36	-4.90	36.46	54.00	-17.54
2483.50	Peak	53.00	-4.90	48.10	74.00	-25.90

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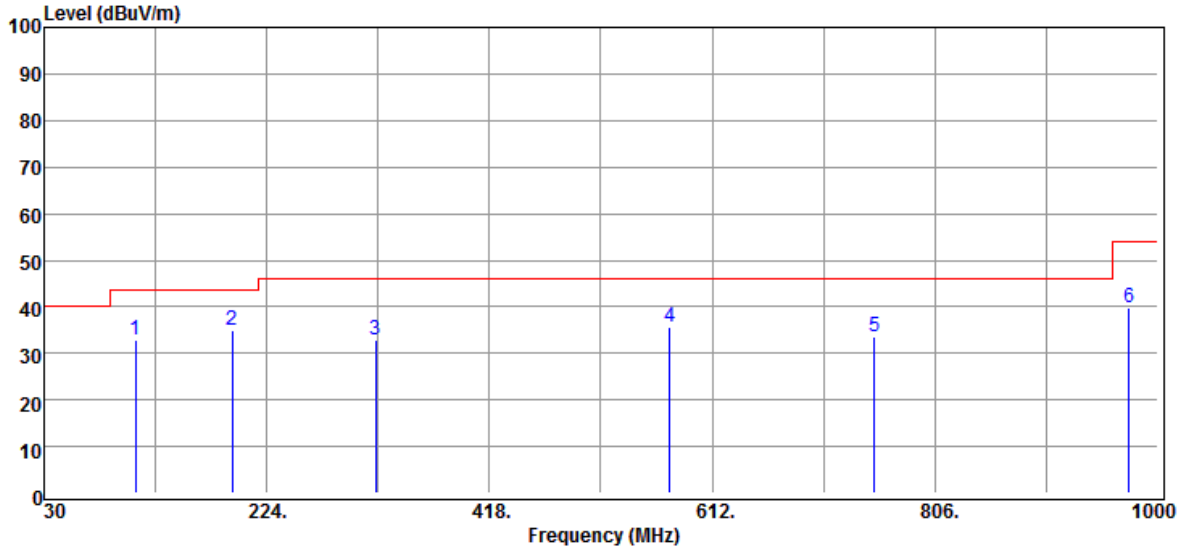
Radiated Spurious Emission Measurement Result:

For Frequency form 30MHz to 1000MHz

Operation Mode	:BT EDR	Test Date	:2018-08-21
Test Mode	:Tx CH Low	Temp./Humi.	:25/60
EUT Pol	:H Plan	Antenna Pol.	:VERTICAL
Test Channel	:2402 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
109.54	Peak	52.81	-19.88	32.93	43.50	-10.57
193.93	Peak	53.52	-18.45	35.07	43.50	-8.43
319.06	Peak	47.74	-14.80	32.94	46.00	-13.06
575.14	Peak	44.98	-9.27	35.71	46.00	-10.29
753.62	Peak	40.21	-6.78	33.43	46.00	-12.57
974.78	Peak	43.11	-3.38	39.73	54.00	-14.27

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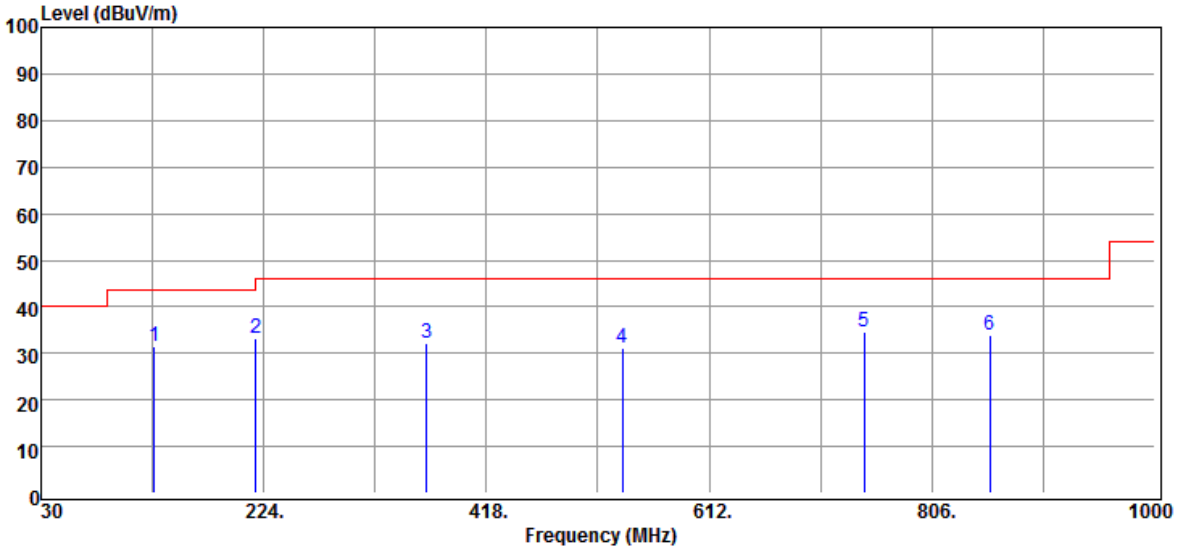
Operation Mode	:BT EDR	Test Date	:2018-08-21
Test Mode	:Tx CH Low	Temp./Humi.	:25/60
EUT Pol	:H Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2402 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
128.94	Peak	53.81	-22.16	31.65	43.50	-11.85
217.21	Peak	53.32	-20.22	33.10	46.00	-12.90
365.62	Peak	45.60	-13.59	32.01	46.00	-13.99
536.34	Peak	41.30	-10.02	31.28	46.00	-14.72
746.83	Peak	41.35	-6.84	34.51	46.00	-11.49
856.44	Peak	39.57	-5.54	34.03	46.00	-11.97

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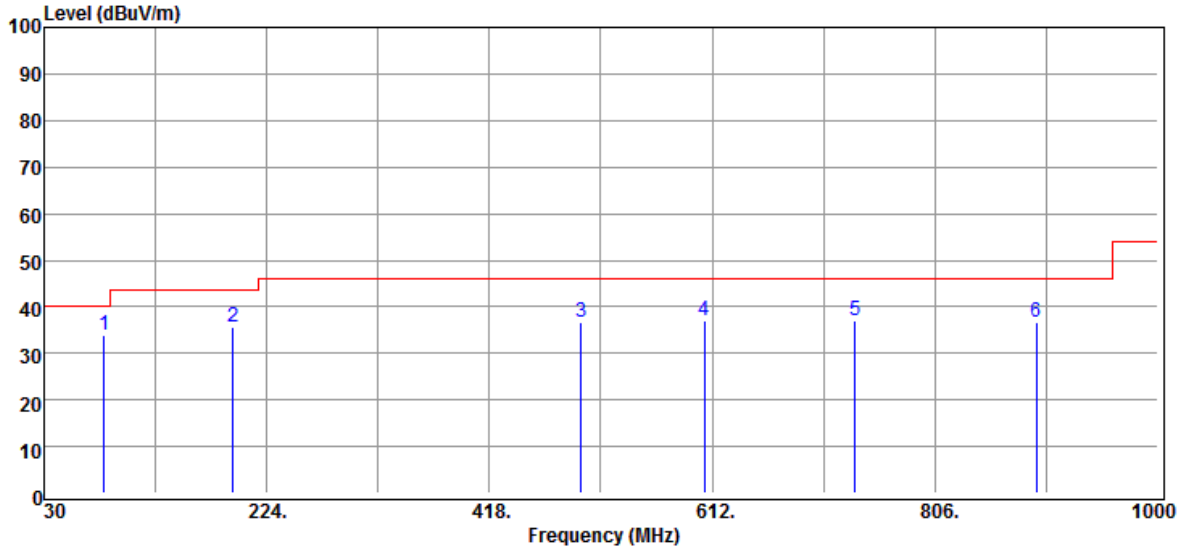
Operation Mode	:BT EDR	Test Date	:2018-08-21
Test Mode	:Tx CH Mid	Temp./Humi.	:25/60
EUT Pol	:H Plan	Antenna Pol.	:VERTICAL
Test Channel	:2441 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
82.38	Peak	55.78	-21.87	33.91	40.00	-6.09
194.90	Peak	54.09	-18.48	35.61	43.50	-7.89
497.54	Peak	47.85	-11.12	36.73	46.00	-9.27
605.21	Peak	46.56	-9.38	37.18	46.00	-8.82
736.16	Peak	43.93	-7.08	36.85	46.00	-9.15
894.27	Peak	42.73	-5.91	36.82	46.00	-9.18

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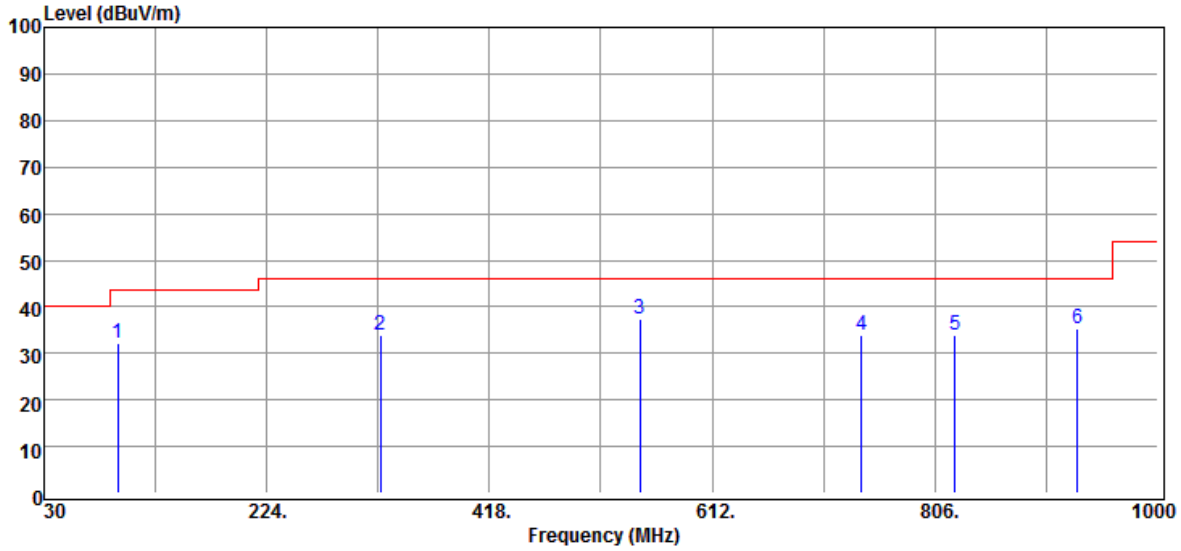
Operation Mode	:BT EDR	Test Date	:2018-08-21
Test Mode	:Tx CH Mid	Temp./Humi.	:25/60
EUT Pol	:H Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2441 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
94.02	Peak	54.58	-22.35	32.23	43.50	-11.27
322.94	Peak	51.09	-17.17	33.92	46.00	-12.08
548.95	Peak	47.74	-10.33	37.41	46.00	-8.59
741.98	Peak	40.93	-6.91	34.02	46.00	-11.98
823.46	Peak	39.98	-6.16	33.82	46.00	-12.18
930.16	Peak	39.62	-4.42	35.20	46.00	-10.80

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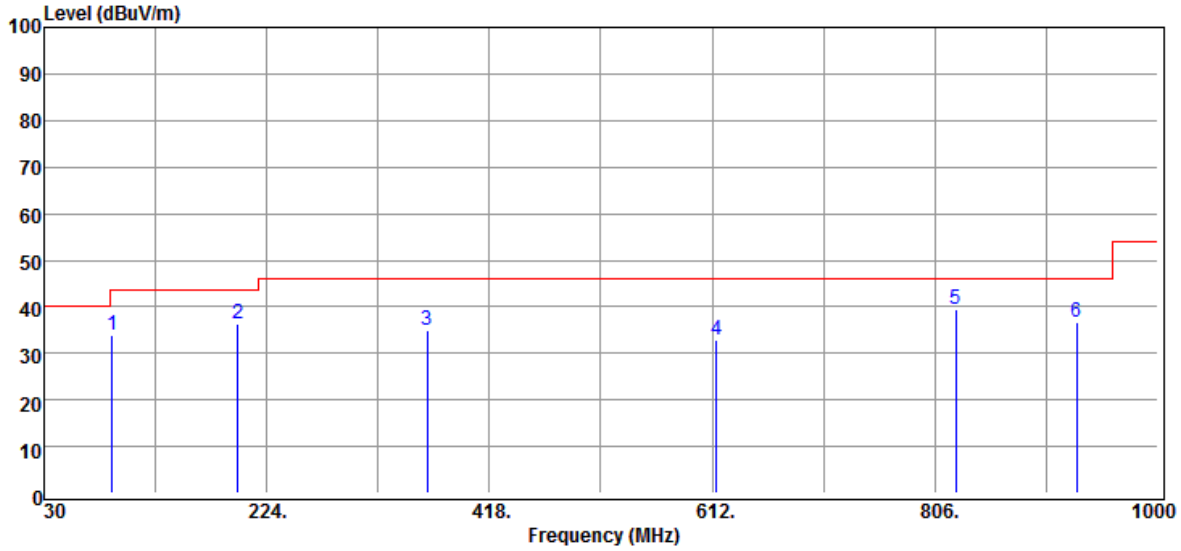
Operation Mode	:BT EDR	Test Date	:2018-08-21
Test Mode	:Tx CH High	Temp./Humi.	:25/60
EUT Pol	:H Plan	Antenna Pol.	:VERTICAL
Test Channel	:2480 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
89.17	Peak	56.82	-22.83	33.99	43.50	-9.51
198.78	Peak	54.99	-18.59	36.40	43.50	-7.10
363.68	Peak	48.58	-13.65	34.93	46.00	-11.07
615.88	Peak	42.20	-9.22	32.98	46.00	-13.02
824.43	Peak	45.71	-6.20	39.51	46.00	-6.49
929.19	Peak	41.21	-4.41	36.80	46.00	-9.20

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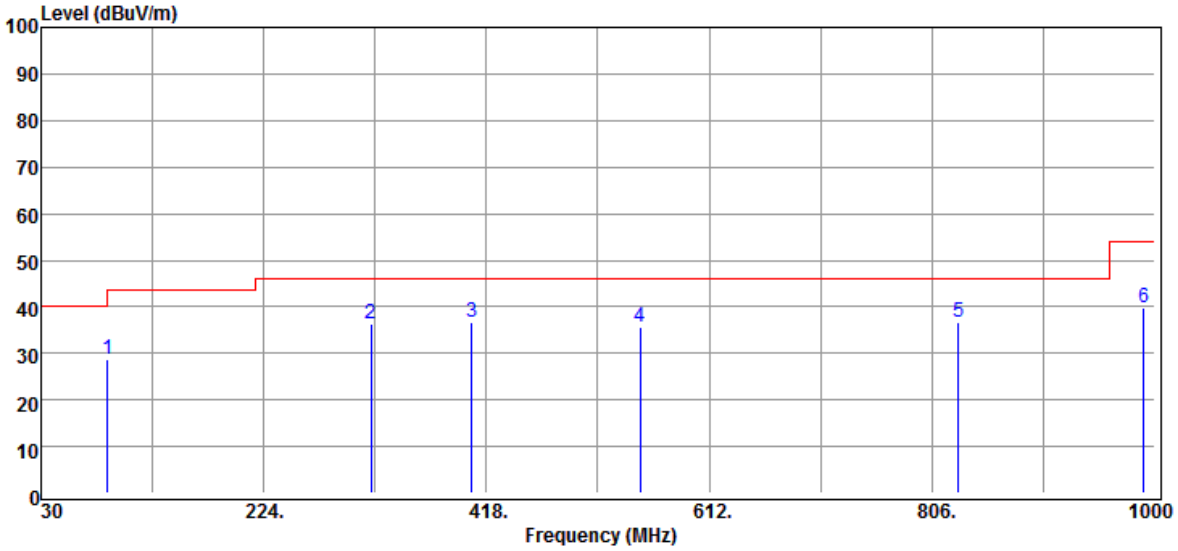
Operation Mode	:BT EDR	Test Date	:2018-08-21
Test Mode	:Tx CH High	Temp./Humi.	:25/60
EUT Pol	:H Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2480 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
88.20	Peak	54.20	-25.63	28.57	43.50	-14.93
317.12	Peak	52.86	-16.61	36.25	46.00	-9.75
405.39	Peak	49.36	-12.57	36.79	46.00	-9.21
551.86	Peak	45.92	-10.35	35.57	46.00	-10.43
829.28	Peak	43.05	-6.37	36.68	46.00	-9.32
990.30	Peak	43.57	-3.87	39.70	54.00	-14.30

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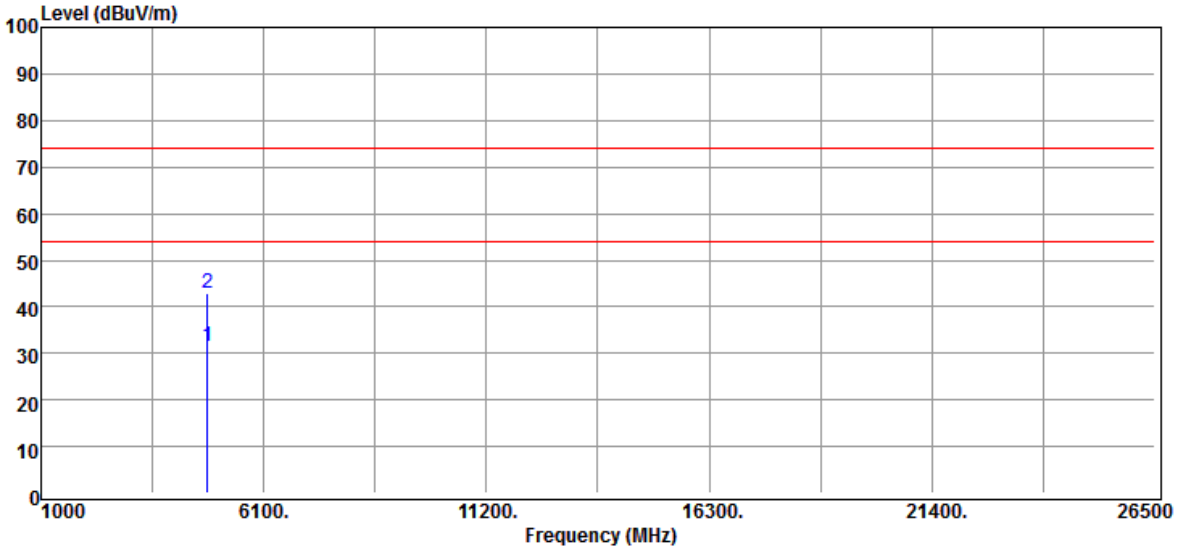
Radiated Spurious Emission Measurement Result:

For Frequency above 1 GHz

Operation Mode	:BT EDR	Test Date	:2018-08-21
Test Mode	:Tx CH Low	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2402 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4804.00	Average	31.22	0.27	31.49	54.00	-22.51
4804.00	Peak	42.53	0.27	42.80	74.00	-31.20

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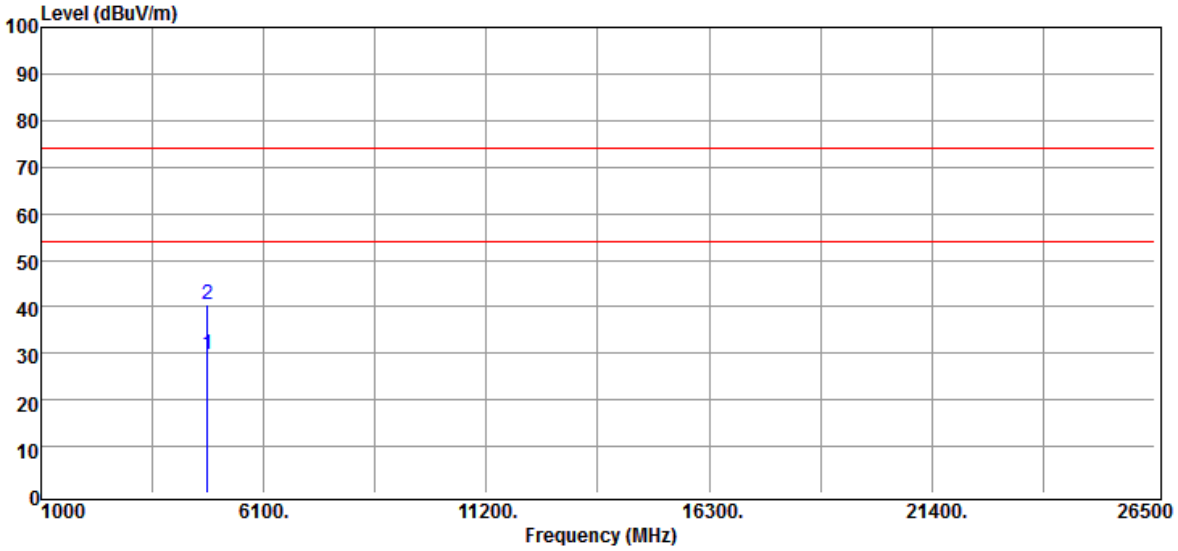
Operation Mode	:BT EDR	Test Date	:2018-08-21
Test Mode	:Tx CH Low	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2402 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4804.00	Average	29.37	0.27	29.64	54.00	-24.36
4804.00	Peak	40.23	0.27	40.50	74.00	-33.50

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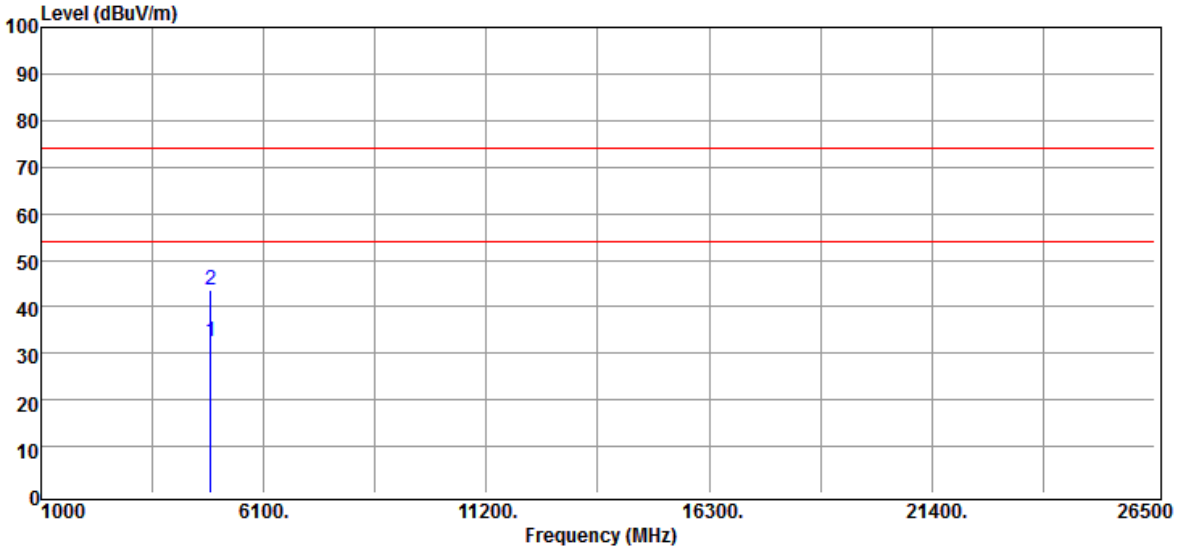
Operation Mode	:BT EDR	Test Date	:2018-08-21
Test Mode	:Tx CH Mid	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2441 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4882.00	Average	31.69	0.70	32.39	54.00	-21.61
4882.00	Peak	42.85	0.70	43.55	74.00	-30.45

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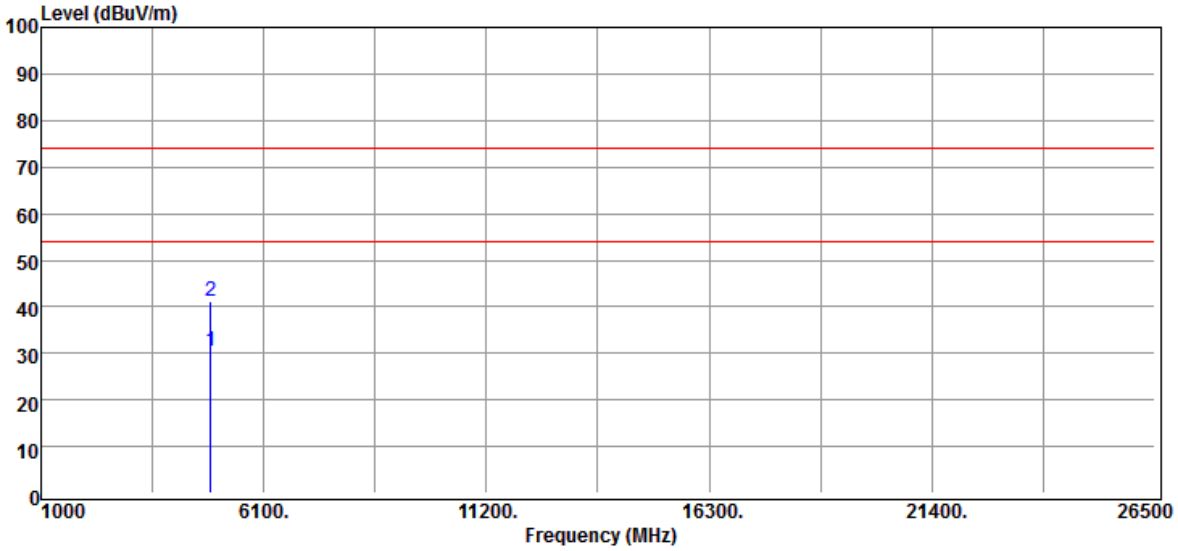
Operation Mode	:BT EDR	Test Date	:2018-08-21
Test Mode	:Tx CH Mid	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2441 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4882.00	Average	29.58	0.70	30.28	54.00	-23.72
4882.00	Peak	40.60	0.70	41.30	74.00	-32.70

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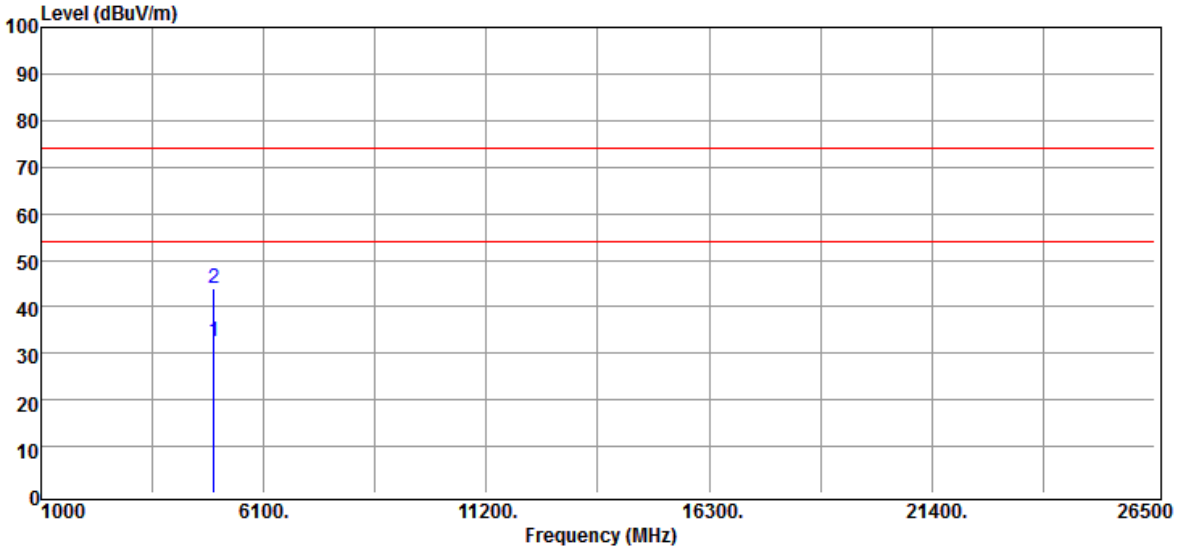
Operation Mode	:BT EDR	Test Date	:2018-08-21
Test Mode	:Tx CH High	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2480 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4962.00	Average	31.34	1.25	32.59	54.00	-21.41
4962.00	Peak	42.64	1.25	43.89	74.00	-30.11

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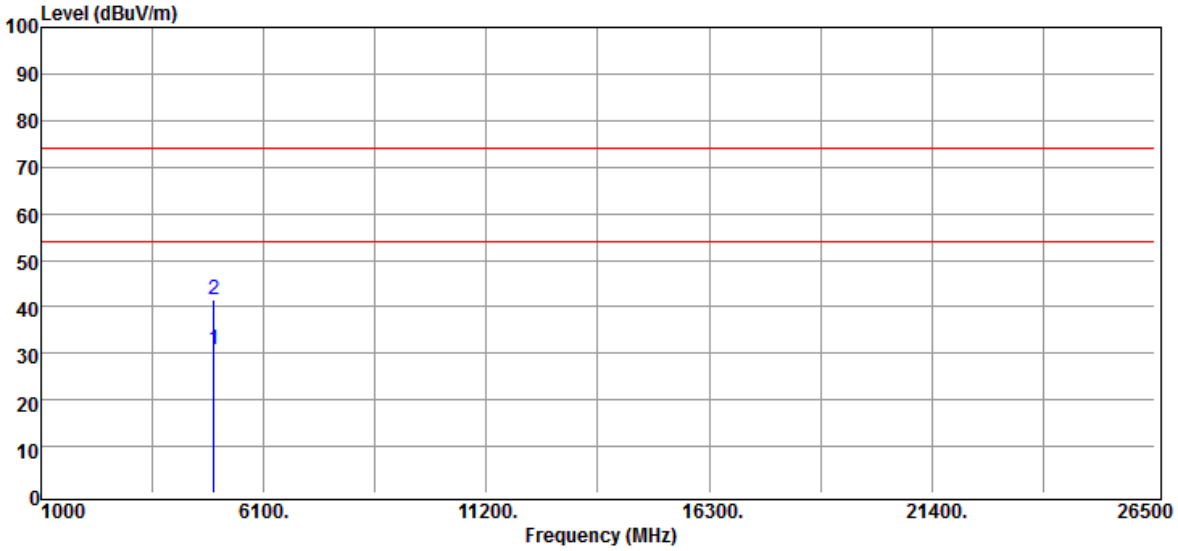
Operation Mode	:BT EDR	Test Date	:2018-08-21
Test Mode	:Tx CH High	Temp./Humi.	:25/60
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2480 MHz	Engineer	:Jerry



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4960.00	Average	29.57	1.24	30.81	54.00	-23.19
4960.00	Peak	40.38	1.24	41.62	74.00	-32.38

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11 FREQUENCY SEPARATION

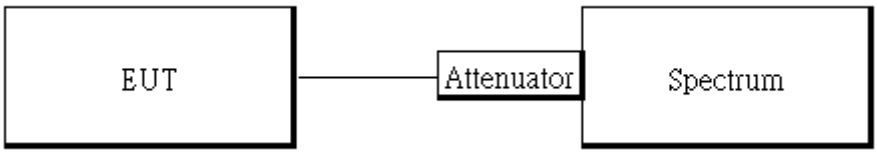
11.1 Standard Applicable

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	Agilent	N9010A	MY51440113	2018/06/20	2019/6/19
Attenuator	Marvelous	MVE2213-10	RF30	2017/12/26	2018/12/25
DC Block	PASTERNACK	PE8210	RF29	2017/12/26	2018/12/25
Notebook	Lenovo	L420	S0011721	N/A	N/A

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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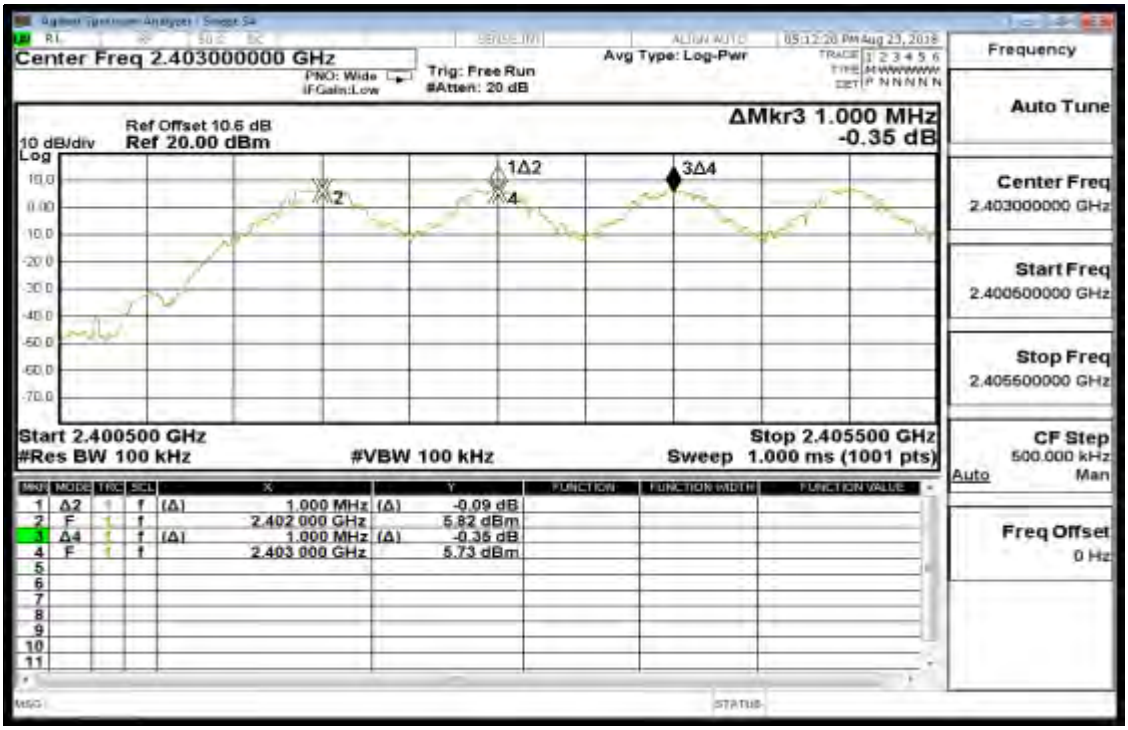
11.5 Measurement Result

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

Frequency Separation Test Data

GFSK



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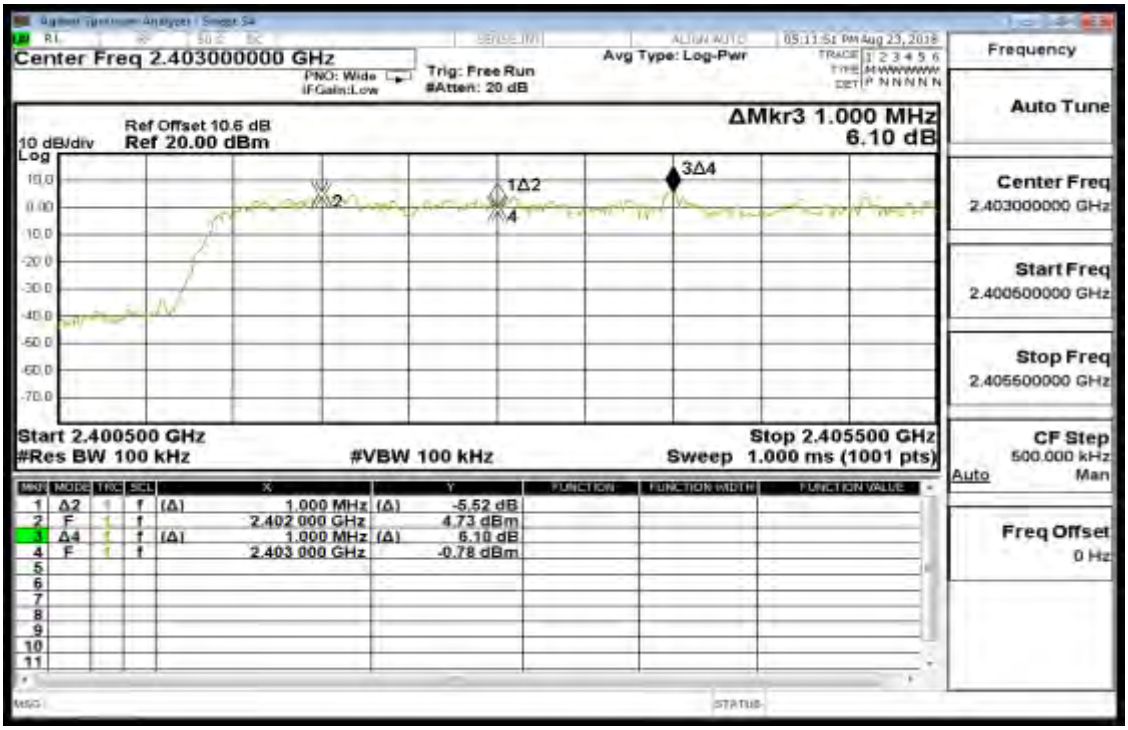
8DPSK



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12 NUMBER OF HOPPING FREQUENCY

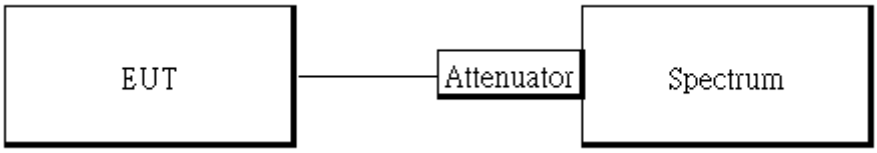
12.1 Standard Applicable

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	Agilent	N9010A	MY51440113	2018/06/20	2019/6/19
Attenuator	Marvelous	MVE2213-10	RF30	2017/12/26	2018/12/25
DC Block	PASTERNACK	PE8210	RF29	2017/12/26	2018/12/25
Notebook	Lenovo	L420	S0011721	N/A	N/A

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.

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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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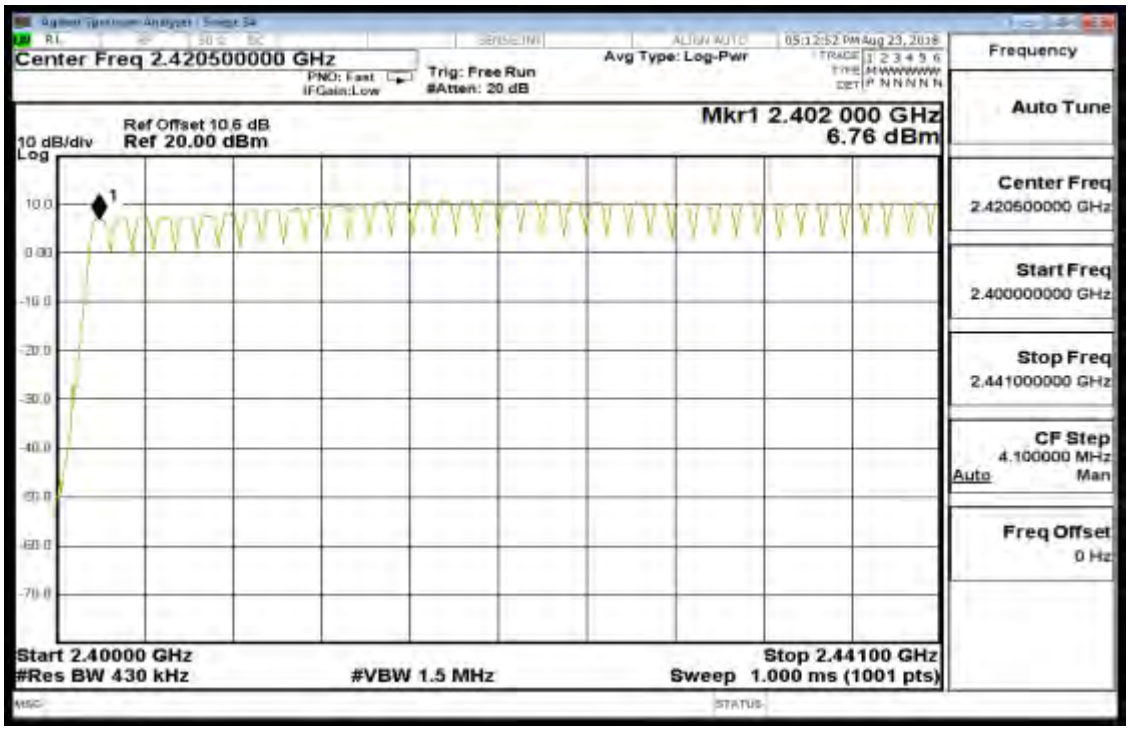
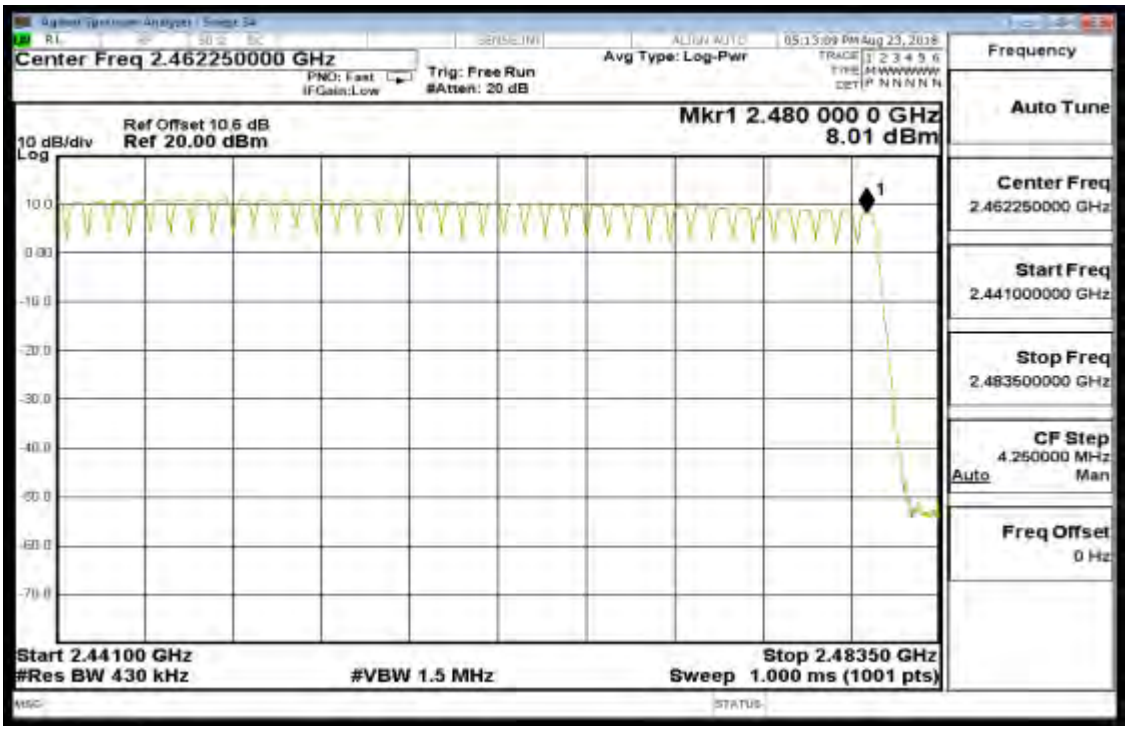
Channel Number

GFSK

2.4 – 2.441GHz



2.441 GHz – 2.4835GHz



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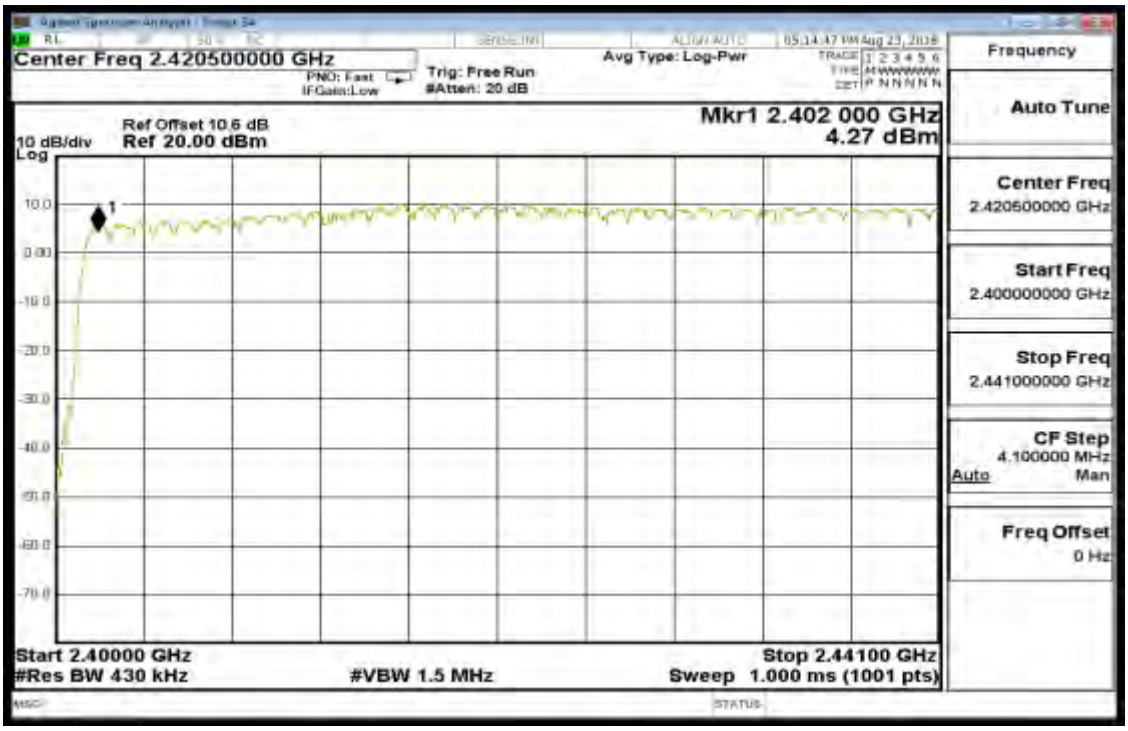
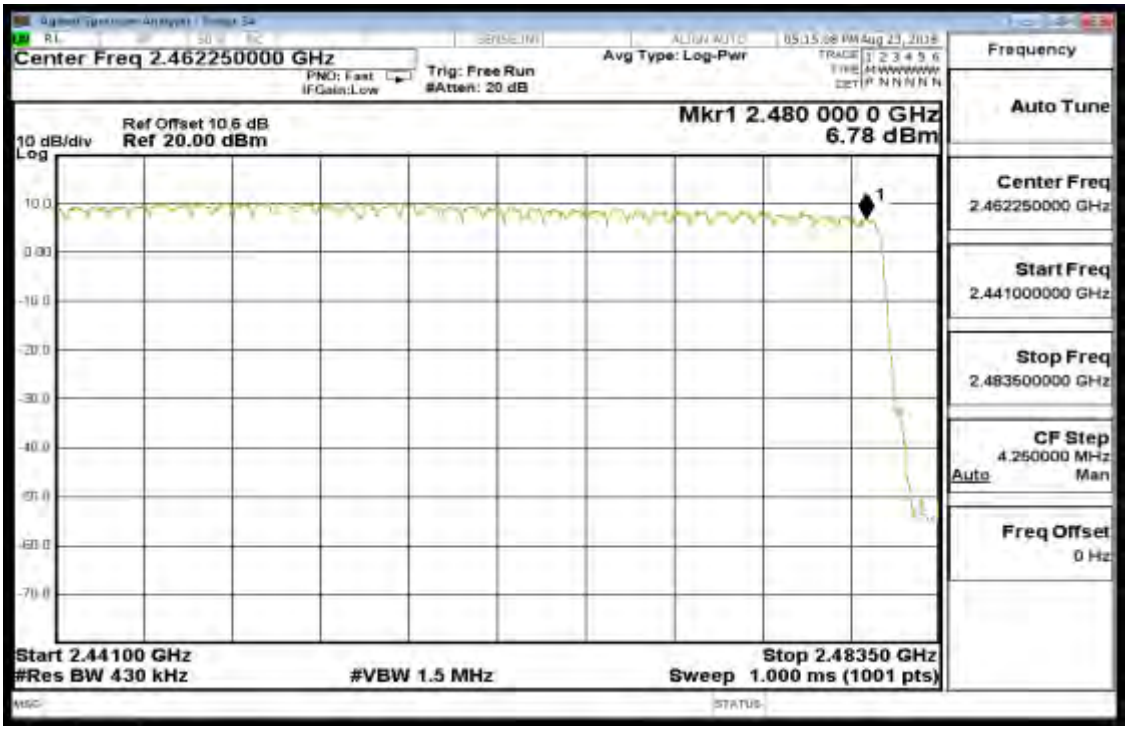
8DPSK

2.4-2.441 GHz



2.441-2.4835 GHz



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13 TIME OF OCCUPANCY (DWELL TIME)

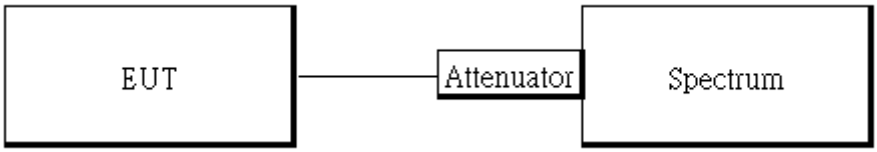
13.1 Standard Applicable

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	Agilent	N9010A	MY51440113	2018/06/20	2019/6/19
Attenuator	Marvelous	MVE2213-10	RF30	2017/12/26	2018/12/25
DC Block	PASTERNACK	PE8210	RF29	2017/12/26	2018/12/25
Notebook	Lenovo	L420	S0011721	N/A	N/A

13.3 Test Set-up



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13.4 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C6310:2015.
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.

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

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GFSK (1Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)	1/T (kHz)	VBW setting (kHz)
0	DH1	118.40	400ms	2.70	3.00
	DH3	257.12	400ms	0.62	1.00
	DH5	302.61	400ms	0.35	1.00
39	DH1	116.80	400ms	2.74	3.00
	DH3	257.60	400ms	0.62	1.00
	DH5	302.61	400ms	0.35	1.00
78	DH1	116.80	400ms	2.74	3.00
	DH3	257.60	400ms	0.62	1.00
	DH5	302.61	400ms	0.00	1.00

π/4 DQPSK (2Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)	1/T (kHz)	VBW setting (kHz)
39	2DH1	118.40	400ms	2.70	3.00
	2DH3	256.32	400ms	0.62	1.00
	2DH5	302.61	400ms	0.35	1.00

8-DPSK (3Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)	1/T (kHz)	VBW setting (kHz)
39	3DH1	119.68	400ms	2.67	3.00
	3DH3	257.12	400ms	0.62	1.00
	3DH5	302.61	400ms	0.35	1.00

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

GFSK (1Mbps):

CH Low	DH1 time slot	=	0.370 *	(1600/2/79)	*	31.6	=	118.40 (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 Mid	DH1 time slot	=	0.365 *	(1600/2/79)	*	31.6	=	116.80 (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 High	DH1 time slot	=	0.365 *	(1600/2/79)	*	31.6	=	116.80 (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)

π/4 -DQPSK (2Mbps):

CH Mid	2DH1 time slot	=	0.370 *	(1600/2/79)	*	31.6	=	118.40 (ms)
	2DH3 time slot	=	1.602 *	(1600/4/79)	*	31.6	=	256.32 (ms)
	2DH5 time slot	=	2.837 *	(1600/6/79)	*	31.6	=	302.61 (ms)

8-DPSK (3Mbps):

CH Mid	3DH1 time slot	=	0.374 *	(1600/2/79)	*	31.6	=	119.68 (ms)
	3DH3 time slot	=	1.607 *	(1600/4/79)	*	31.6	=	257.12 (ms)
	3DH5 time slot	=	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 slot = 2.837 (ms) * (800/6/20) * 8 = 151.31 (ms)

π/4 -DQPSK (2Mbps):

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

8-DPSK (3Mbps):

3DH5 time slot = 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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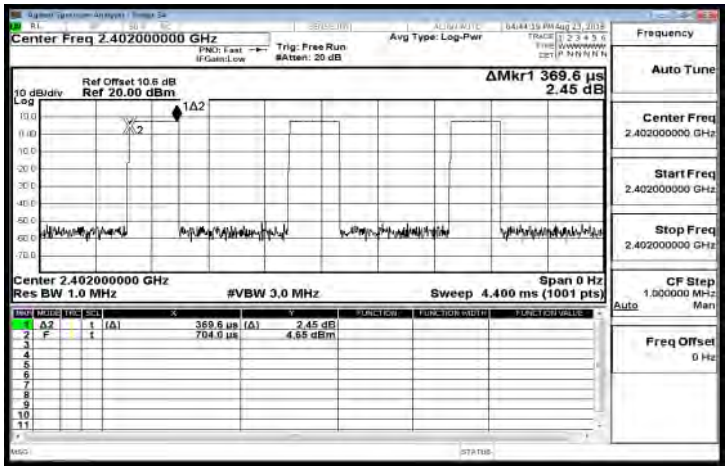
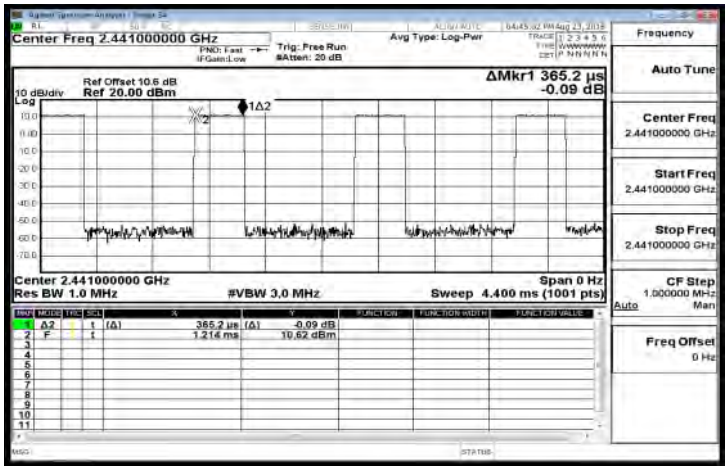
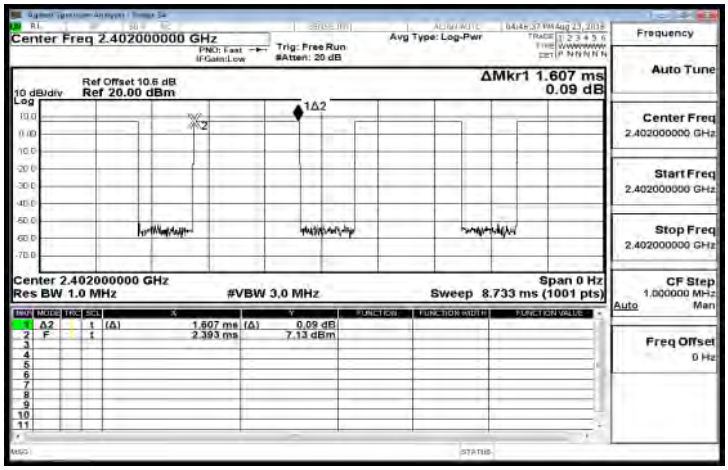
CH-Low DH1



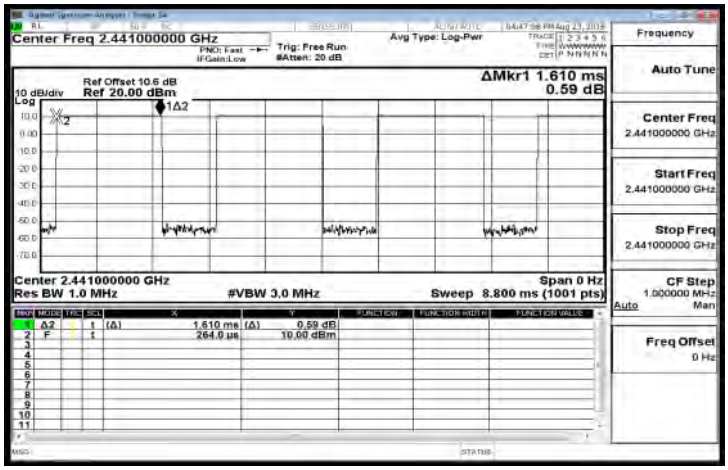
CH-Mid DH1



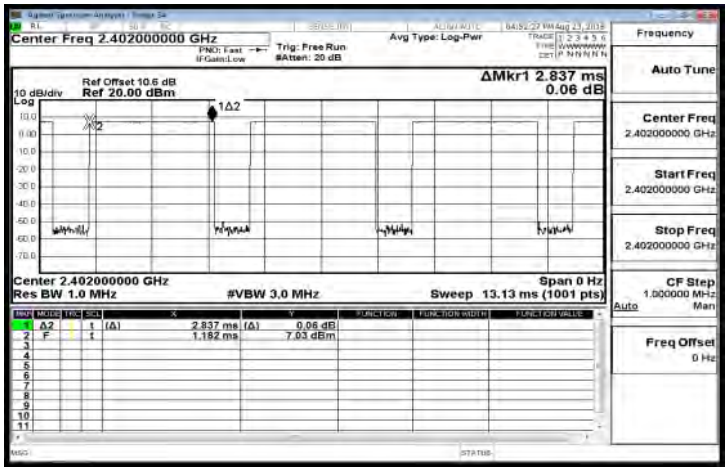
CH-Low DH3



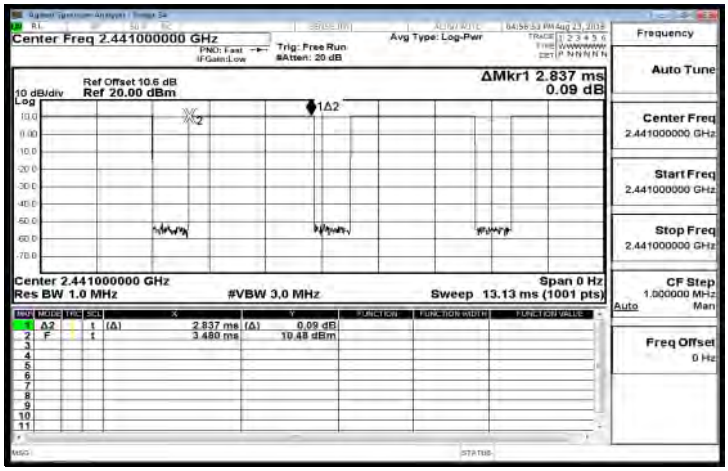
CH-Mid DH3



CH-Low DH5



CH-Mid DH5



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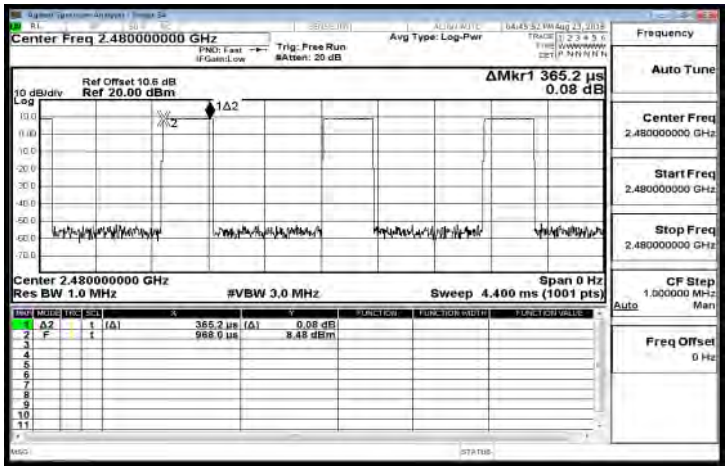
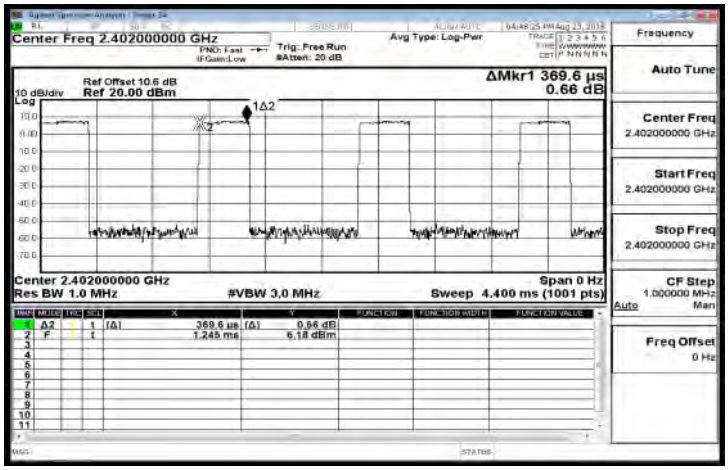
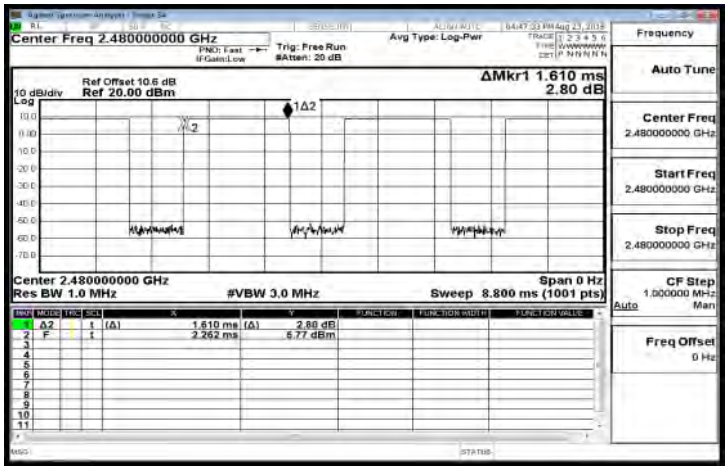
CH-High DH1



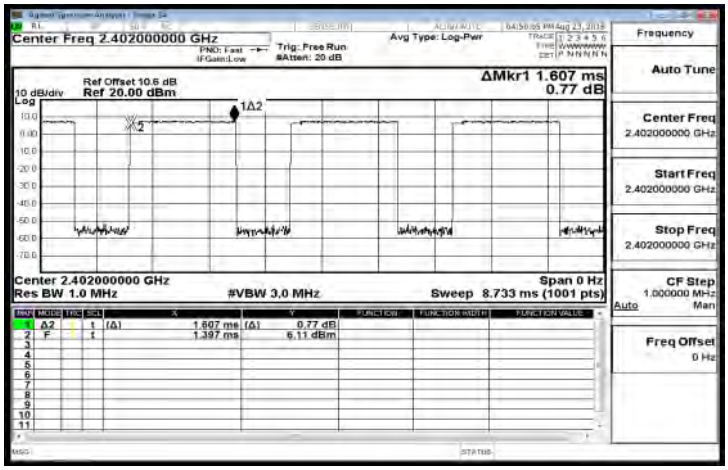
CH-Low 2DH1



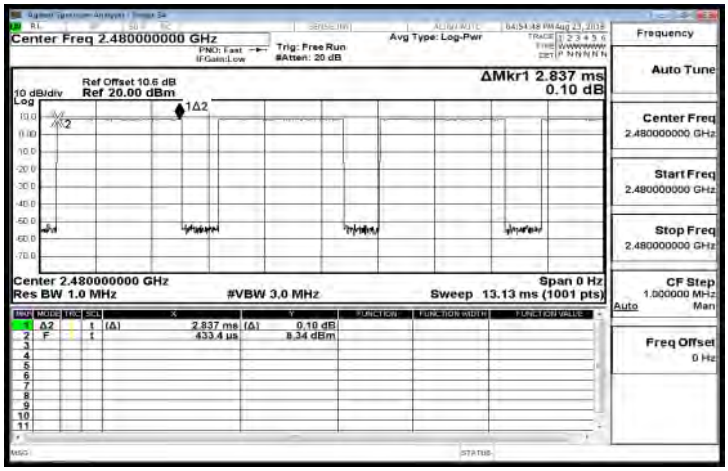
CH-High DH3



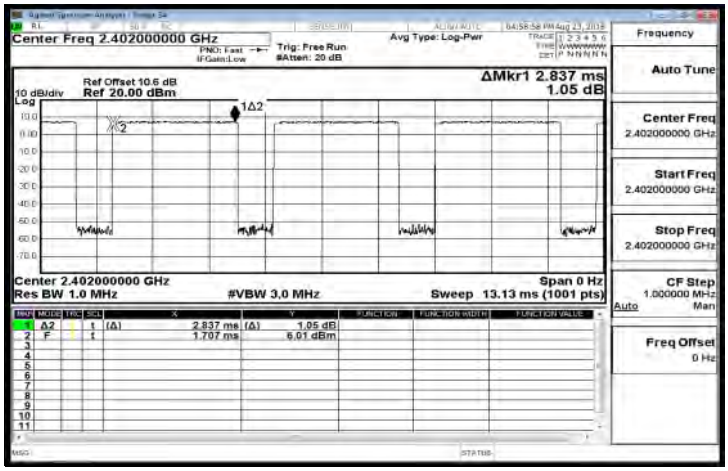
CH-Low 2DH3



CH-High DH5



CH-Low 2DH5



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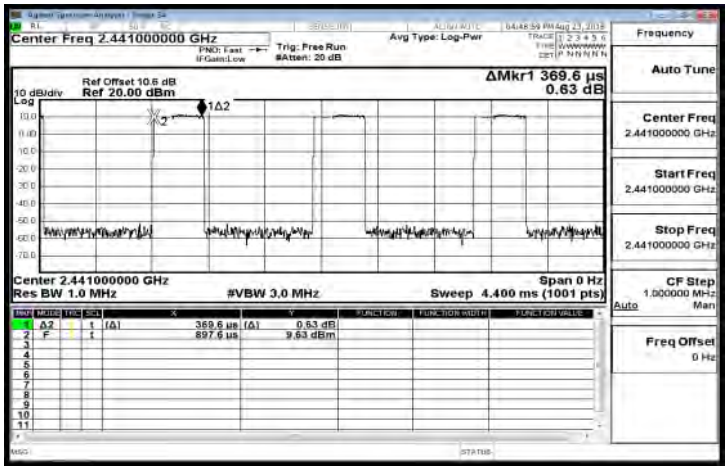
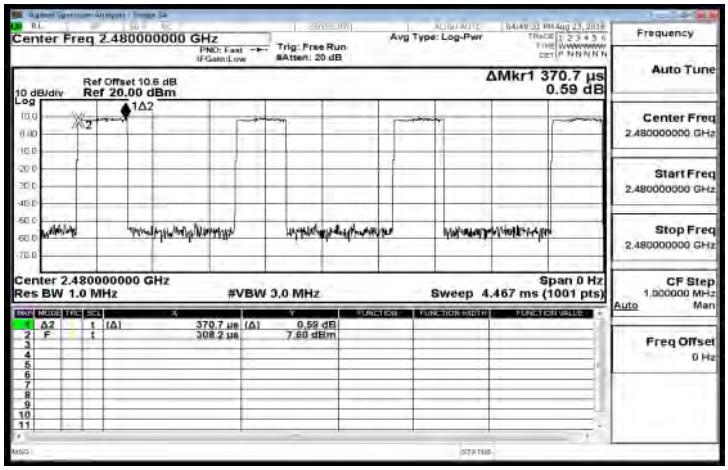
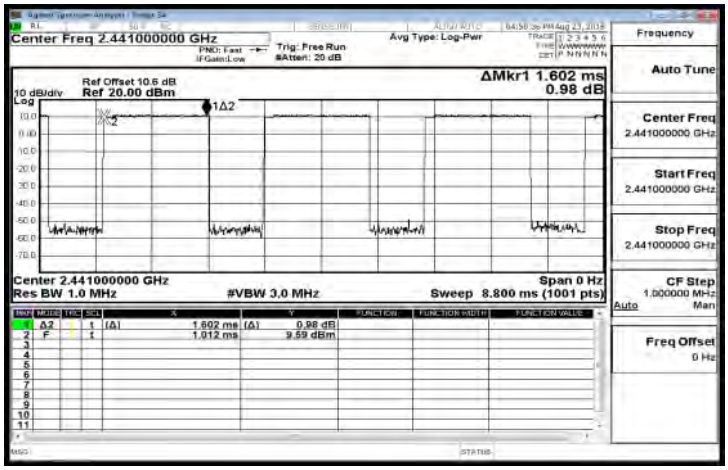
CH-Mid 2DH1



CH-High 2DH1



CH-Mid 2DH3



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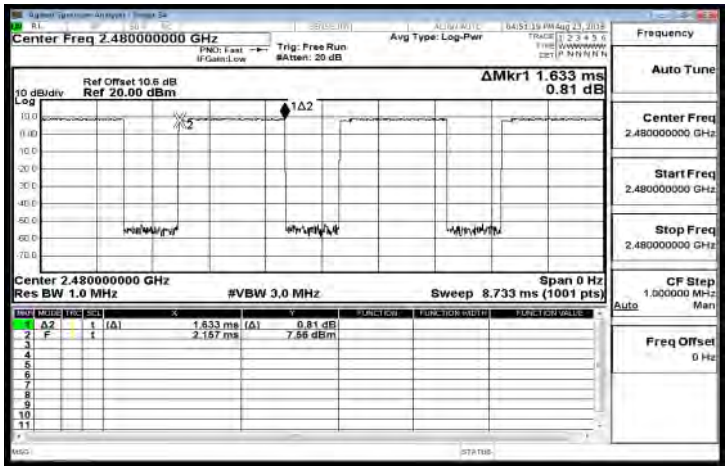

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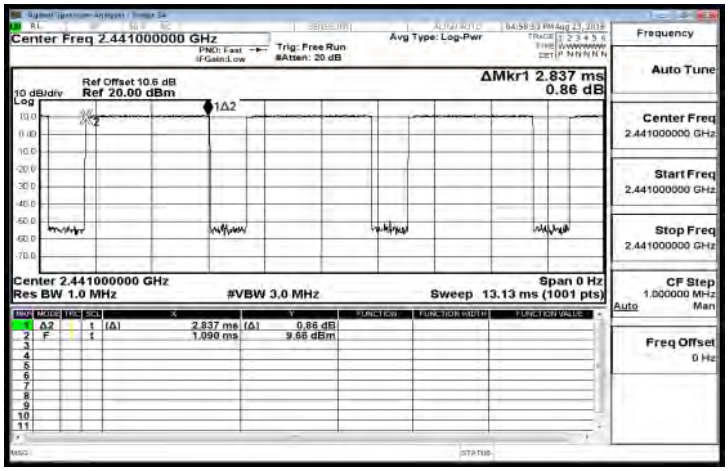

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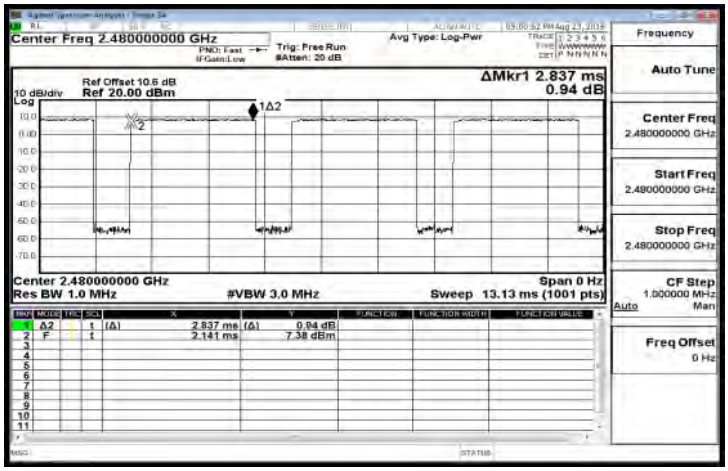

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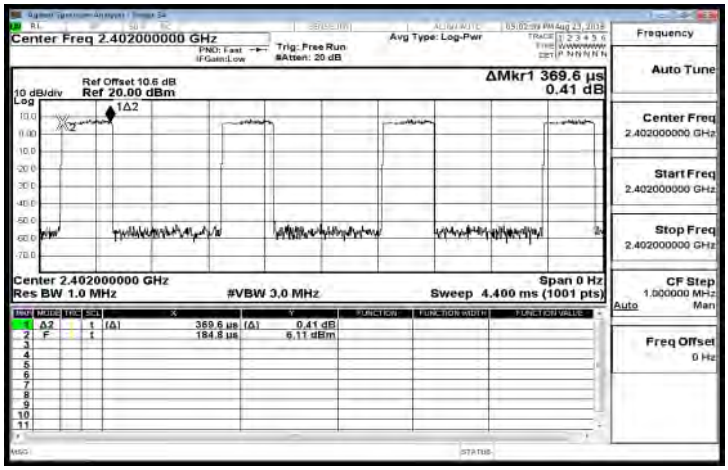
CH-Low 3DH1



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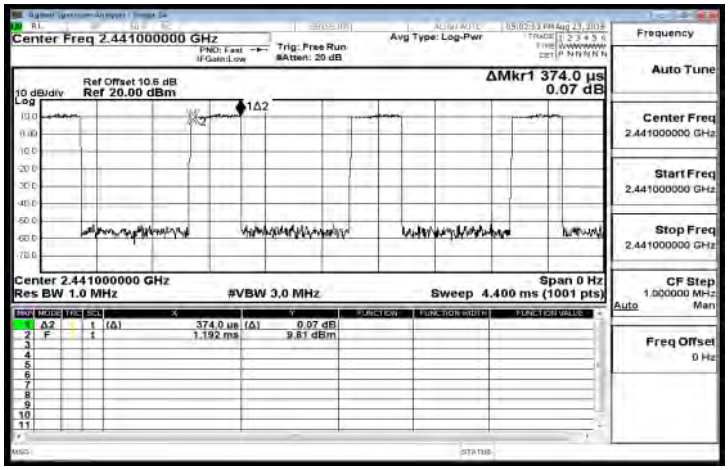

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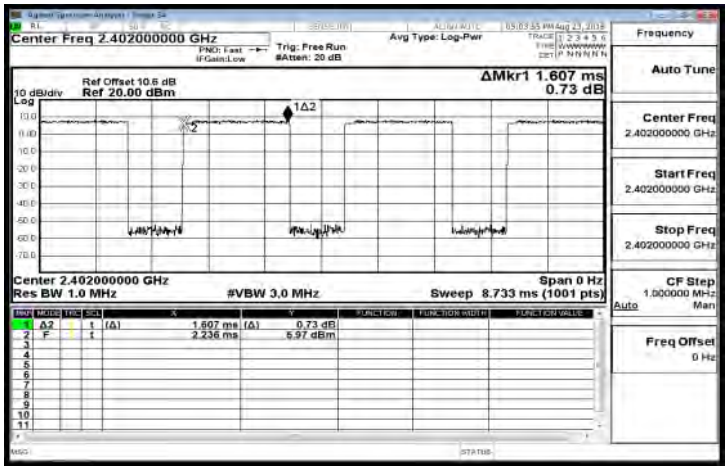

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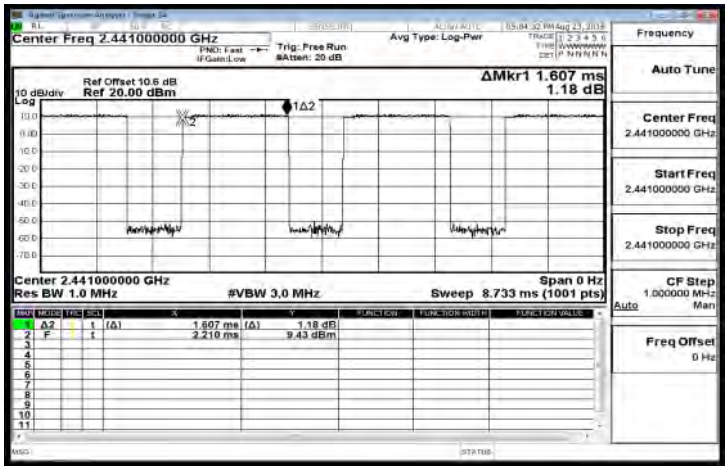

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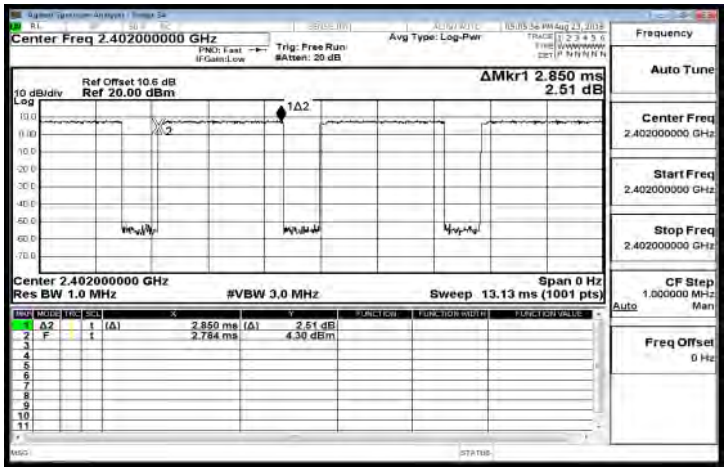

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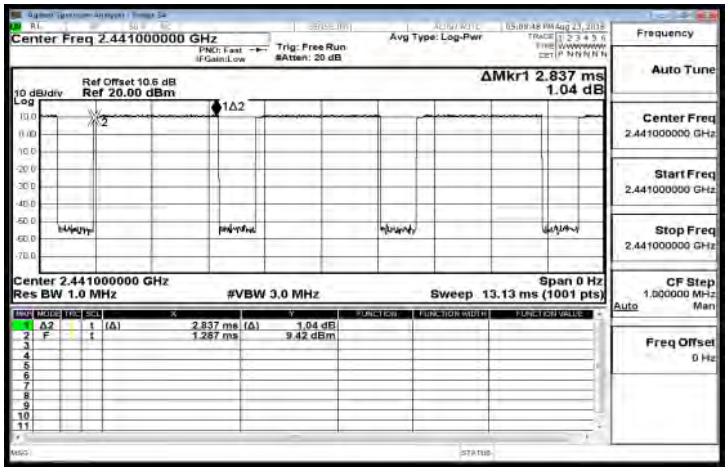

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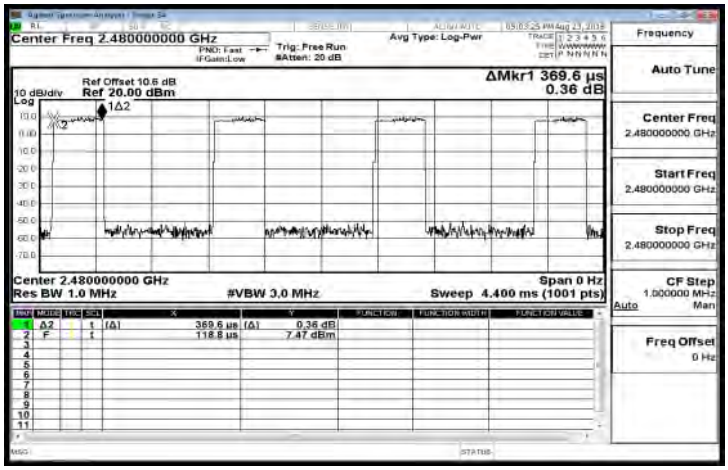
CH-High 3DH1



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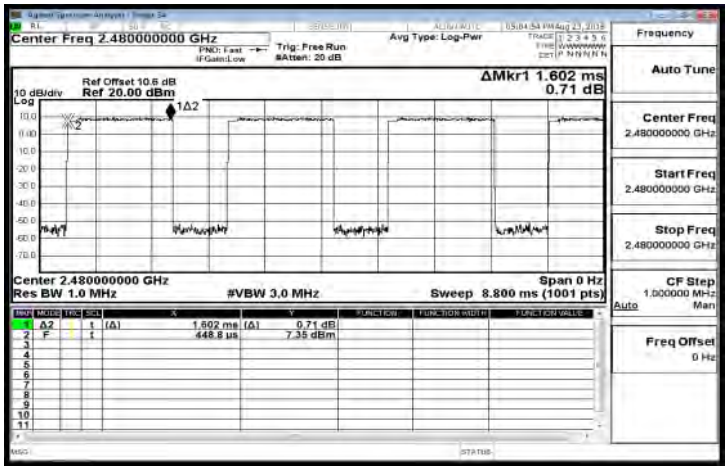

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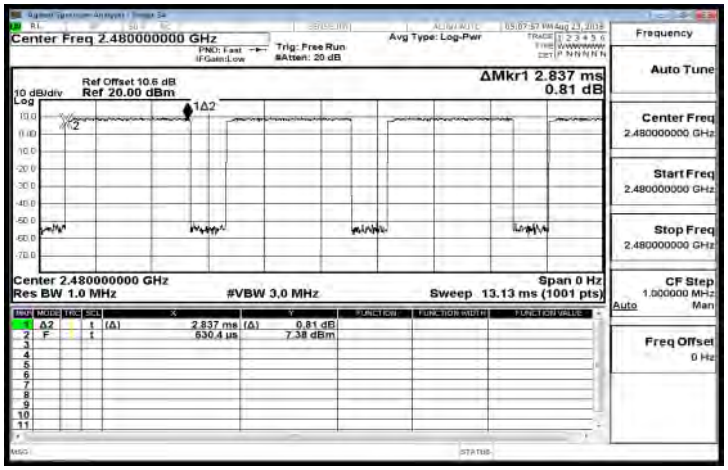

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14 ANTENNA REQUIREMENT

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.

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

14.2 Antenna Connected Construction

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

~ End of Report ~

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