

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART C REQUIREMENT

OF

Applicant: Sharp Corporation, Mobile Communication B.U.
2-13-1, Hachihonmatsu-lida, Higashi-hiroshima-shi,
Hiroshima, 739-0192, Japan

Manufacturer: Sharp Corporation
1 Takumi-cho, Sakai-ku, Sakai City, Osaka 590-8522, Japan

Product Name: Smart Phone

Report Number: ER/2018/A0086

FCC ID: APYHRO00264

FCC Rule Part: §15.247, Cat: DSS

Issue Date: Nov. 08, 2018

Date of Test: Oct. 03, 2018 ~ Oct. 23, 2018

Date of EUT Received: Oct. 03, 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:

Marcus Tseng

Marcus Tseng / Sr. Engineer

Approved By:

Jay Lin

Jay Lin / Asst. Supervisor



Testing Laboratory
0513

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Revision History

Report Number	Revision	Description	Effected Page	Issue Date	Revised By
ER/2018/A0086	Rev.00	Initial creation of document	All	Nov. 08, 2018	Tiffany Kao

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1 GENERAL INFORMATION

1.1 Product description

General:

Product Name:	Smart Phone
Hardware Version:	DVT
Software Version:	N/A
Power Supply:	3.85V from Rechargeable Li-ion Battery

Bluetooth BR+EDR:

Frequency Range:	2.402GHz – 2.480GHz
Bluetooth Version	BT V5.0 (dual mode)
Channel number:	79 channels
Modulation type:	GFSK + $\pi/4$ DQPSK + 8DPSK
Transmit Power:	13.33dBm
Antenna Designation:	Inverted-F Antenna, Gain: -5.8dBi

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1.2 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247

KDB 558074 D01 v05 DSS Meas. Guidance

ANSI C63.10:2013

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

1.3 Test Facility

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

(TAF code 0513)

FCC Registration Numbers are: 509634 / TW0001

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 placed on a turn table which is 0.8 m above ground plane. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30 MHz. 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 placed on a turn table. For emissions testing at or below 1 GHz, the table height shall be 0.8 m above the reference ground plan. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." is still within the 3dB illumination BW of the measurement antenna.

2.4 Measurement Results Explanation Example

For all conducted test items:

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

Note:

The spectrum analyzer offset is derived from RF cable loss 0.4dB.

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2.5 Configuration of Tested System

Fig. 2-1 Radiated Emission

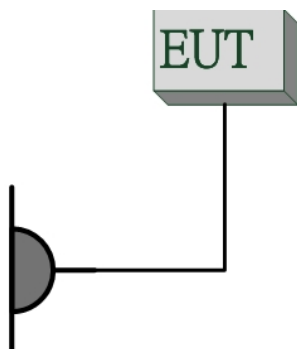


Fig. 2-3 Conducted (Antenna Port) Emission

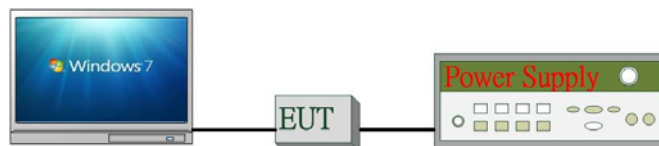


Fig. 2-2 AC Power Line Conducted Emission



Table 2-1 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Cable	Power Cord
1	Bluetooth Test Software	N/A	N/A	N/A	N/A	N/A
2.	DC Power Supply	Anritsu	E3640A	MY52410006	N/A	Unshielded
3.	Notebook	Lenovo	T440P	P0000564	Shielded	Unshielded

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3 SUMMARY OF TEST RESULTS

FCC Rules	Description Of Test	Result
§15.207(a)	AC Power Line Conducted Emission	Compliant
§15.247(b)(1)	Peak Output Power	Compliant
§15.247(a)(1)	20dB 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

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.

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

CONDUCTED TEST				
Peak Output Power, 20dB Band Width, Dwell Time				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	PACKET TYPE
Bluetooth	0 to 78	0,39,78	GFSK	DH5
	0 to 78	0,39,78	$\pi/4$ -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	GFSK	DH5
Number of hopping frequency				
Bluetooth	0 to 78	0 to 78	GFSK	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

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EMI Test Receiver	R&S	ESCI7	100335	02/02/2018	02/01/2019
LISN	SCHWARZBECK	NSLK 8127	8127-649	05/18/2018	05/17/2019

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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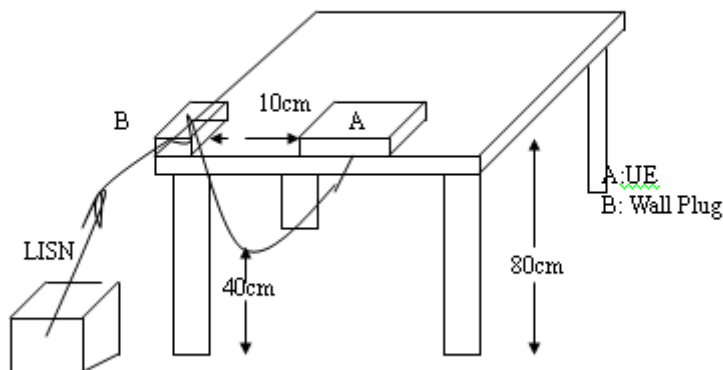
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6.4 Test SET-UP (Block Diagram of Configuration)



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

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

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

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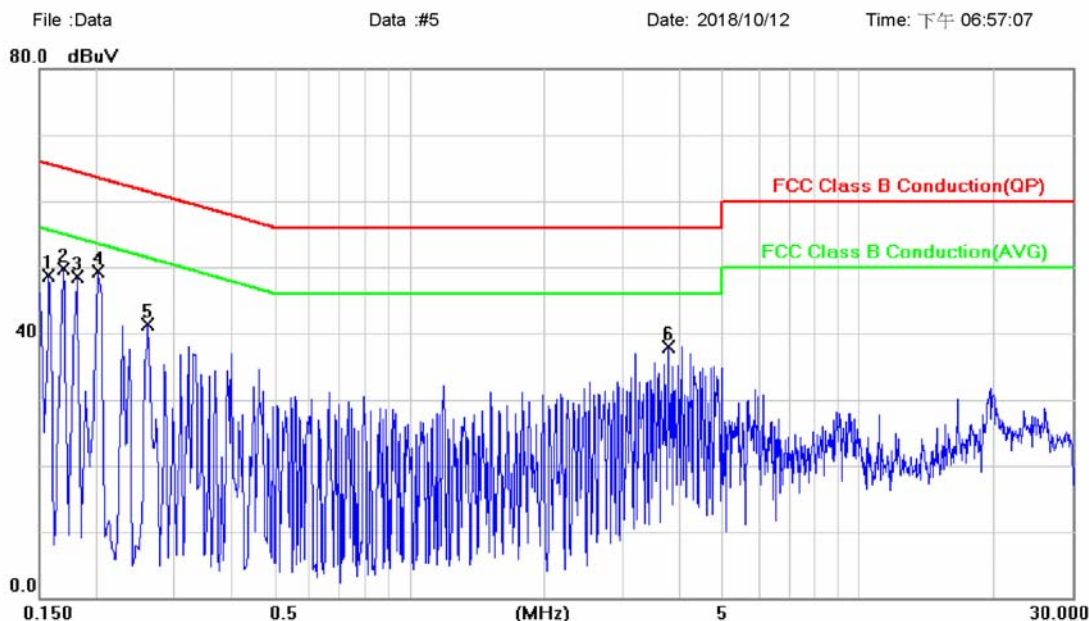
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AC POWER LINE CONDUCTED EMISSION TEST DATA

Site: Conduction Room Phase: **L1** Temperature: 25 °C
Limit: FCC Class B Conduction(QP) Power: AC 120V/60Hz Humidity: 85 %
Mode: Operation
Note:

Conducted Emission



No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over	Detector	Comment
		MHz	dBuV	dB	dBuV	dBuV	dB		
1		0.1580	48.63	0.04	48.67	65.57	-16.90	peak	
2		0.1700	49.76	0.04	49.80	64.96	-15.16	peak	
3		0.1820	48.55	0.04	48.59	64.39	-15.80	peak	
4 *		0.2020	49.29	0.04	49.33	63.53	-14.20	peak	
5		0.2620	41.18	0.04	41.22	61.37	-20.15	peak	
6		3.7820	37.83	0.15	37.98	56.00	-18.02	peak	

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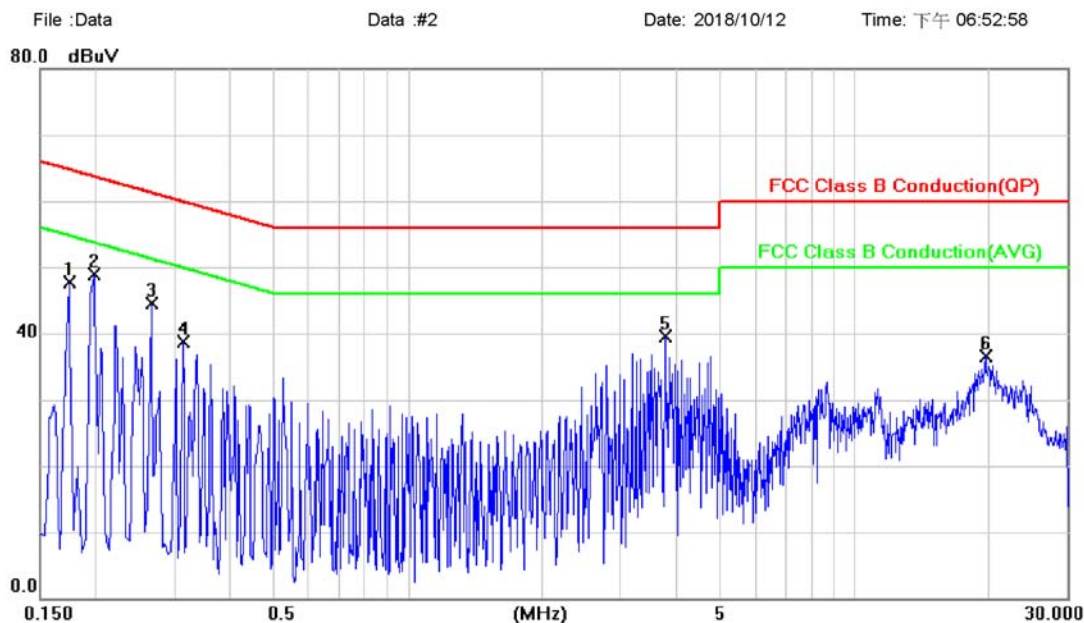
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Site Conduction Room
Limit: FCC Class B Conduction(QP)
Mode: Operation
Note:

Phase: **N**
Power: AC 120V/60Hz

Temperature: 25 °C
Humidity: 85 %

Conducted Emission



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	Detector	Comment
		MHz	dBuV	dB	dBuV	dBuV	dB		
1		0.1740	47.72	0.04	47.76	64.77	-17.01	peak	
2	*	0.1980	48.80	0.04	48.84	63.69	-14.85	peak	
3		0.2660	44.40	0.04	44.44	61.24	-16.80	peak	
4		0.3140	38.67	0.04	38.71	59.86	-21.15	peak	
5		3.7780	39.30	0.15	39.45	56.00	-16.55	peak	
6		19.6940	36.18	0.42	36.60	60.00	-23.40	peak	

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7 PEAK OUTPUT POWER MEASUREMENT

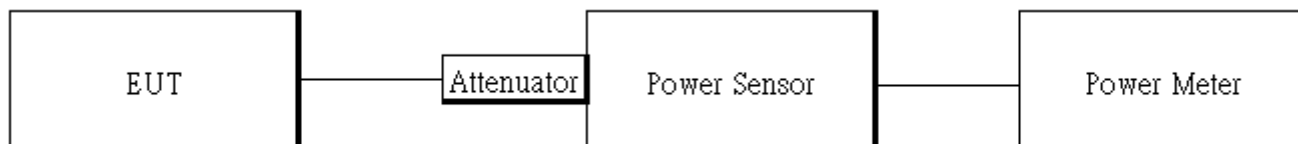
7.1 Standard Applicable

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.

7.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Power Meter	Anritsu	ML2496A	1804001	02/01/2018	01/31/2019
Power Sensor	Anritsu	MA2411B	1726104	02/01/2018	01/31/2019
Power Sensor	Anritsu	MA2411B	1726107	02/01/2018	01/31/2019
DC Power Supply	Anritsu	E3640A	MY52410006	11/28/2017	11/27/2018
Attenuator	Mini-Circuit	BW-S10W2+	2	01/02/2018	01/01/2019
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2018	01/01/2019
Coaxial Cables	N/A	WK CE Cable	N/A	01/02/2018	01/01/2019
Notebook	Lenovo	T440P	P0000564	N/A	N/A

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	13.30	21.380	1000
39	2441	13.33	21.528	1000
78	2480	13.17	20.749	1000

1M BR mode (Average):

CH	Freq. (MHz)	Max. Output include tune up tolerance Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	12.27	16.866	1000
39	2441	12.32	17.061	1000
78	2480	12.20	16.596	1000

2M EDR mode (Peak):

CH	Freq. (MHz)	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	12.95	19.724	125
39	2441	12.97	19.815	125
78	2480	10.94	12.417	125

2M EDR mode (Average):

CH	Freq. (MHz)	Max. Avg. Output include tune up tolerance	Output Power (mW)	Limit (mW)
0	2402	10.10	10.233	125
39	2441	10.02	10.046	125
78	2480	9.68	9.290	125

3M EDR mode (Peak):

CH	Freq. (MHz)	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	13.12	20.512	125
39	2441	13.09	20.370	125
78	2480	10.99	12.560	125

3M EDR mode (Average):

CH	Freq. (MHz)	Max. Avg. Output include tune up tolerance	Output Power (mW)	Limit (mW)
0	2402	10.11	10.257	125
39	2441	10.03	10.069	125
78	2480	9.70	9.333	125

NOTE: cable loss as 0.4dB that offsets in the spectrum

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

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8 20DB BANDWIDTH MEASUREMENT

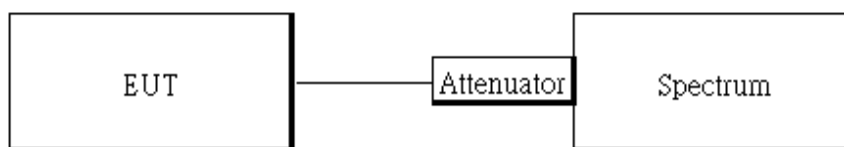
8.1 Standard Applicable

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

8.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EXA Spectrum Analyzer	Agilent	N9010A	MY57120290	02/14/2018	02/13/2019
DC Power Supply	Anritsu	E3640A	MY52410006	11/28/2017	11/27/2018
Attenuator	Mini-Circuit	BW-S10W2+	2	01/02/2018	01/01/2019
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2018	01/01/2019
Coaxial Cables	N/A	WK CE Cable	N/A	01/02/2018	01/01/2019
Notebook	Lenovo	T440P	P0000564	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:

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

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8.5 Measurement Result

GFSK			$\pi/4$ -DQPSK			8-DPSK		
CH	20 dB BW (MHz)	2/3 BW (MHz)	CH	20 dB BW (MHz)	2/3 BW (MHz)	CH	20 dB BW (MHz)	2/3 BW (MHz)
Low	0.878	0.59	Low	1.254	0.84	Low	1.245	0.83
Mid	0.879	0.59	Mid	1.278	0.85	Mid	1.245	0.83
High	0.878	0.59	High	1.314	0.88	High	1.248	0.83

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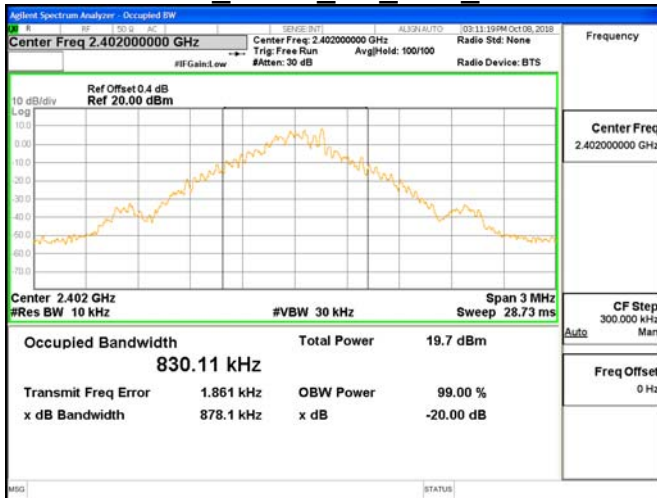
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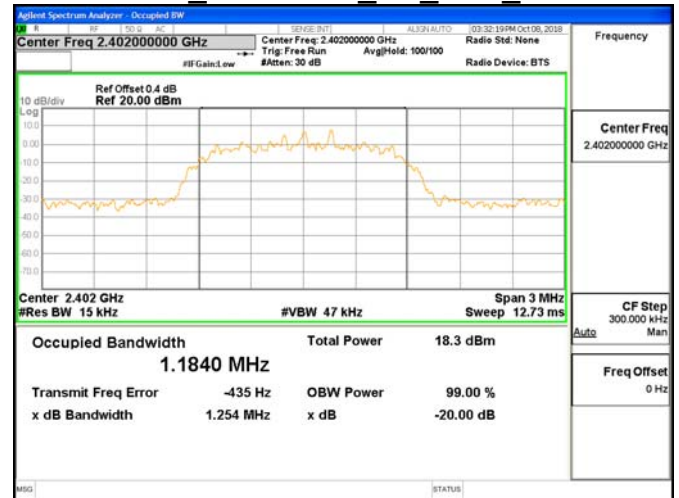
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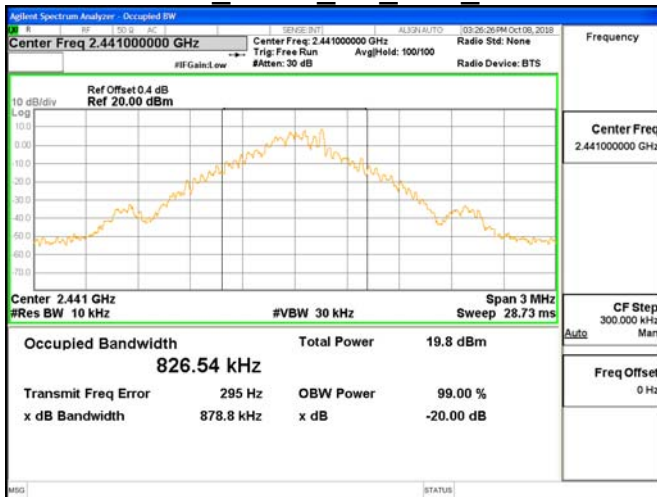
OBW 20dB GFSK 1M DH5 2402MHz



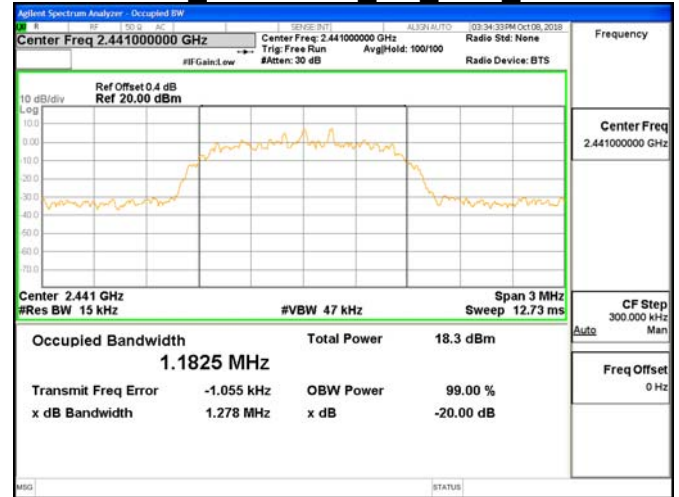
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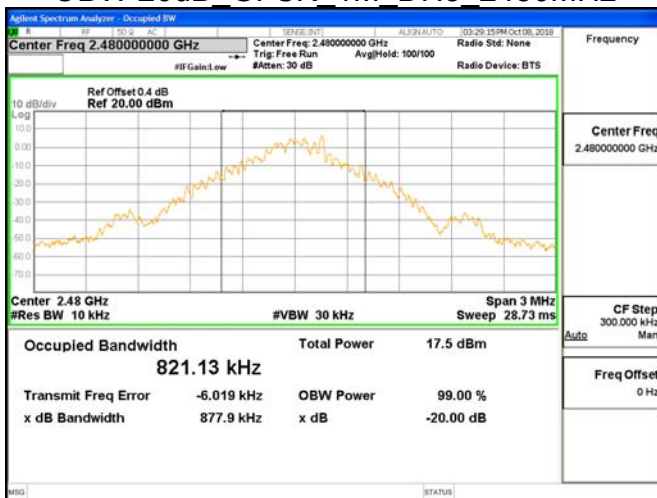
OBW 20dB GFSK 1M DH5 2441MHz



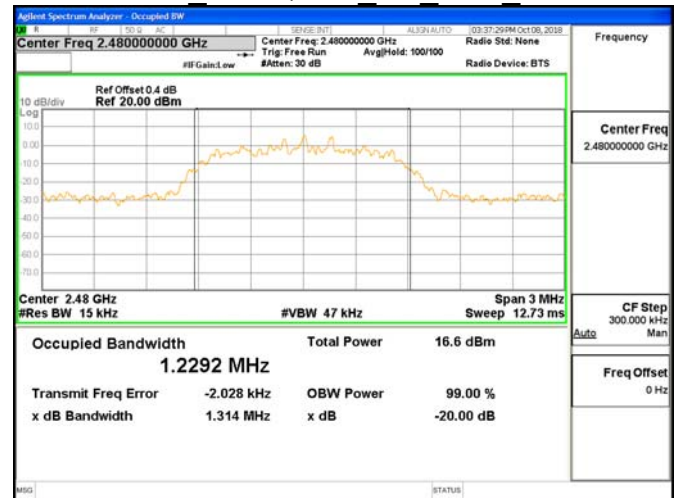
OBW 20dB π 4DQPSK 2M DH5 2441MHz



OBW 20dB GFSK 1M DH5 2480MHz



OBW 20dB π 4DQPSK 2M DH5 2480MHz

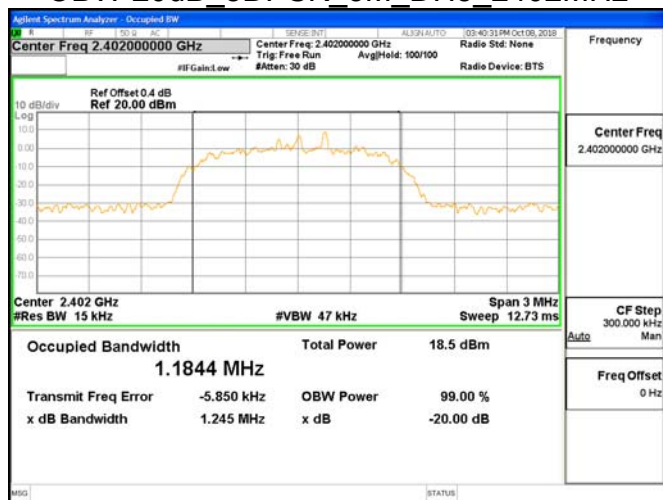


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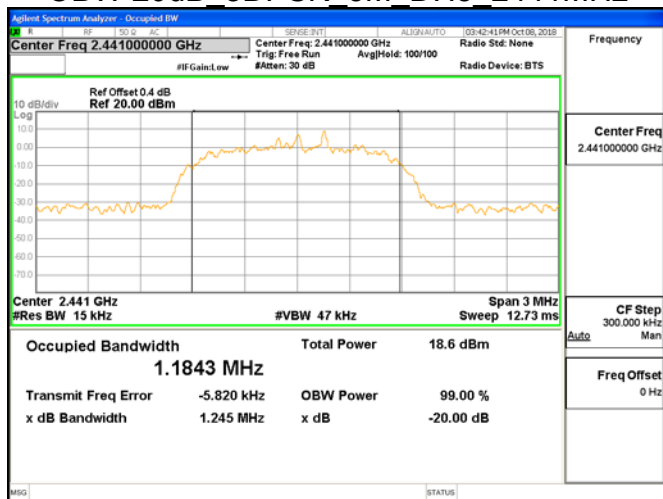
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OBW 20dB 8DPSK 3M DH5 2402MHz



OBW 20dB 8DPSK 3M DH5 2441MHz



OBW 20dB_8DPSK_3M_DH5_2480MHz



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9 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

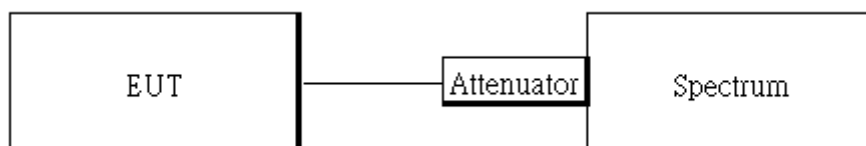
9.1 Standard Applicable

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

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EXA Spectrum Analyzer	Agilent	N9010A	MY57120290	02/14/2018	02/13/2019
DC Power Supply	Anritsu	E3640A	MY52410006	11/28/2017	11/27/2018
Attenuator	Mini-Circuit	BW-S10W2+	2	01/02/2018	01/01/2019
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2018	01/01/2019
Coaxial Cables	N/A	WK CE Cable	N/A	01/02/2018	01/01/2019
Notebook	Lenovo	T440P	P0000564	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	

9.5 Measurement Result

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

1. The occurrence of the spike on the conducted emission is the signal of the fundamental emission.

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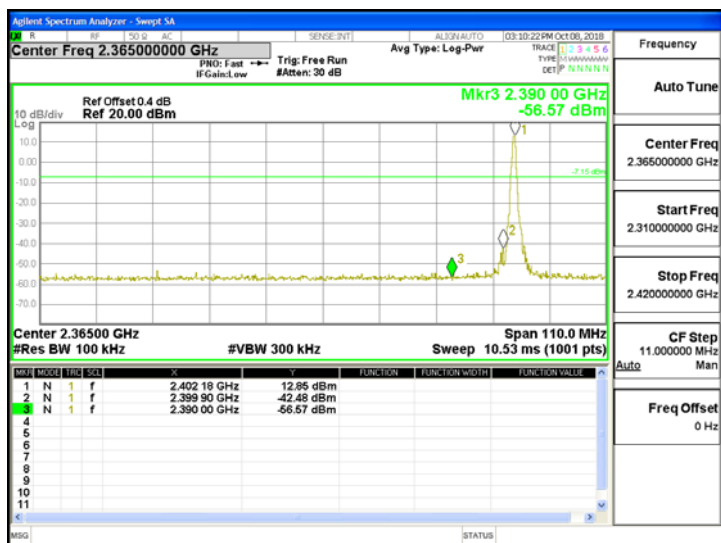
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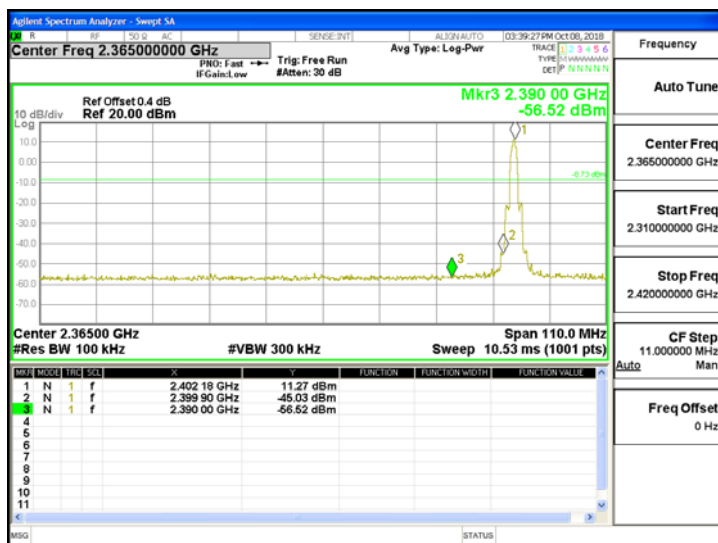
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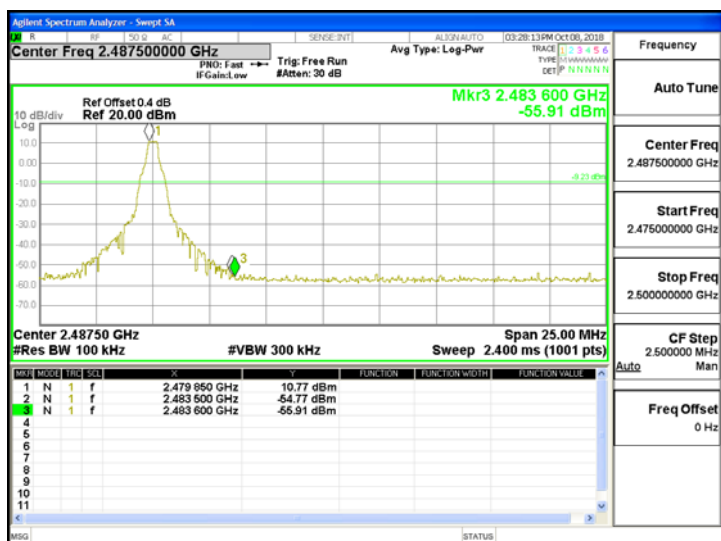
Band Edge_GFSK_1M_DH5_2402MHz



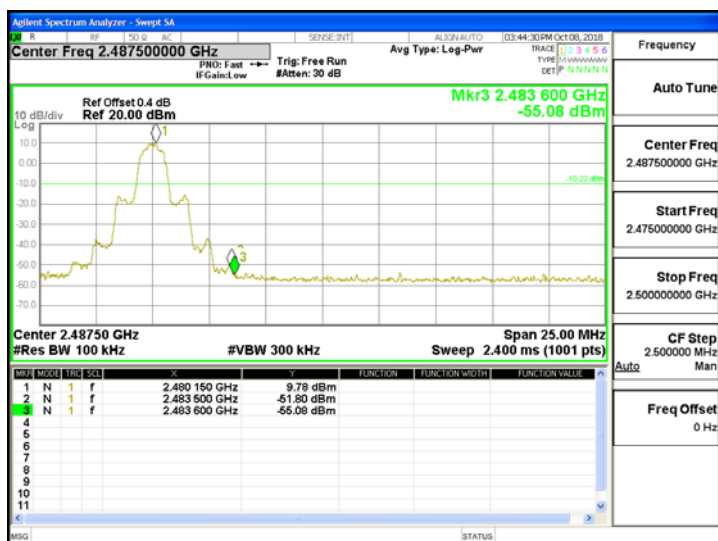
Band Edge_8DPSK_3M_DH5_2402MHz



Band Edge_GFSK_1M_DH5_2480MHz



Band Edge_8DPSK_3M_DH5_2480MHz

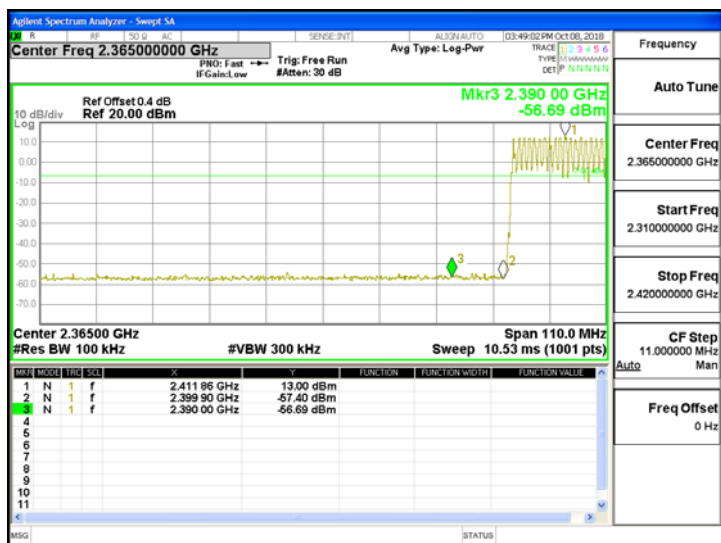


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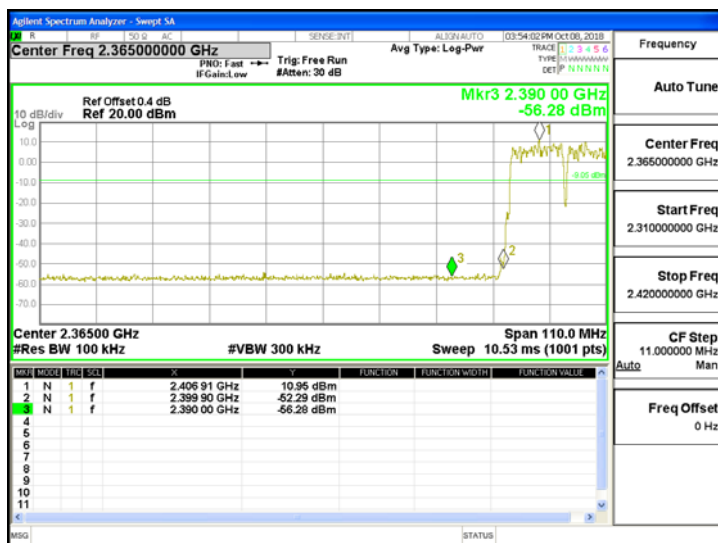
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Hopping Band Edge_GFSK_1M_DH5_2402MHz



Hopping Band Edge_8DPSK_3M_DH5_2402MHz



Hopping Band Edge_GFSK_1M_DH5_2480MHz



Hopping Band Edge_8DPSK_3M_DH5_2480MHz

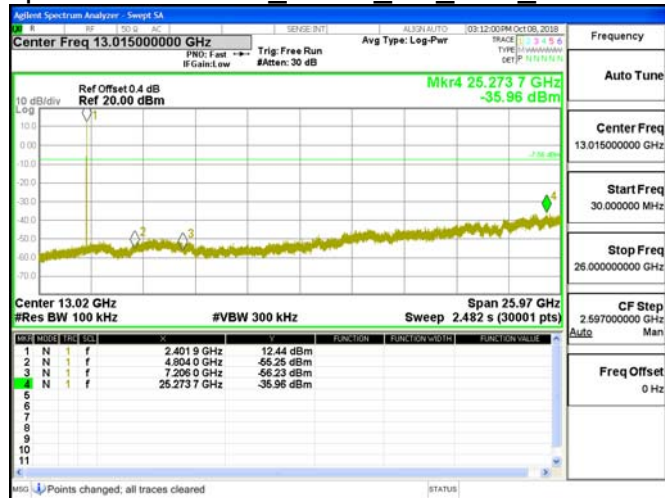


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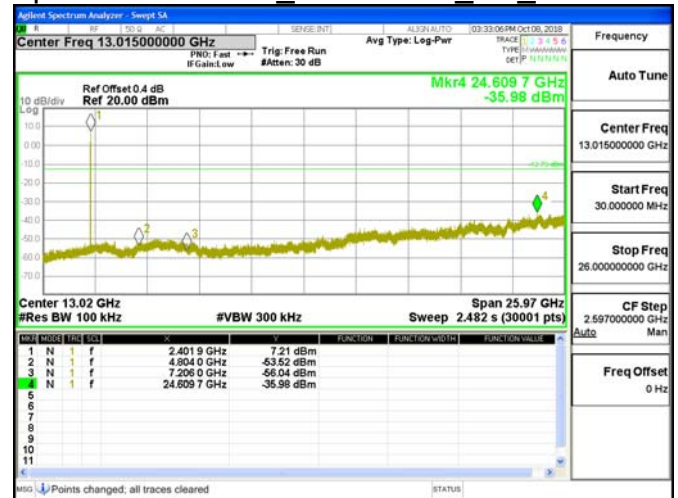
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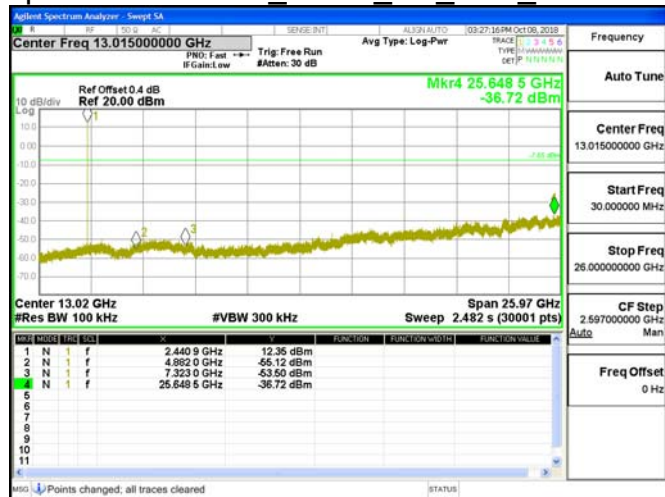
Spurious Emission_GFSK_1M_DH5_2402MHz



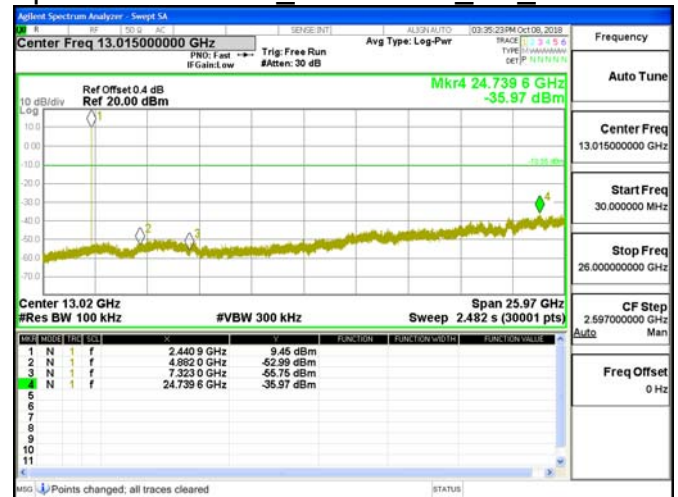
Spurious Emission_π/4DQPSK_2M_2402MHz



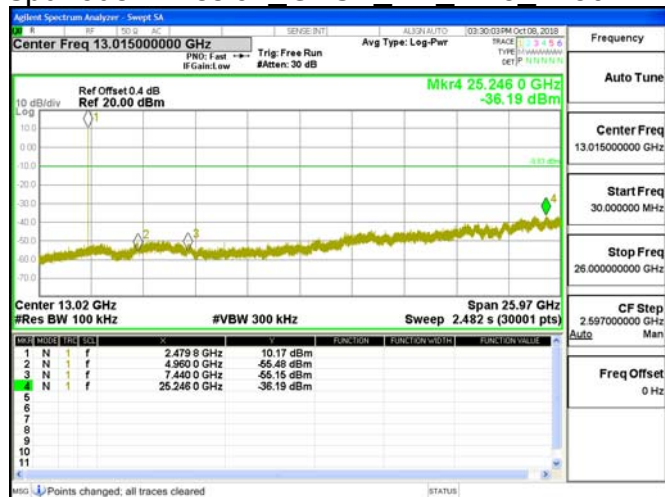
Spurious Emission_GFSK_1M_DH5_2441MHz



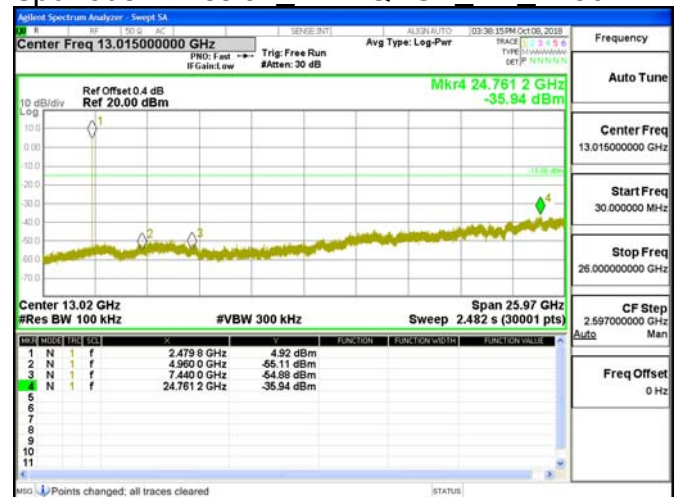
Spurious Emission_π/4DQPSK_2M_2441MHz



Spurious Emission_GFSK_1M_DH5_2480MHz



Spurious Emission_π/4DQPSK_2M_2480MHz

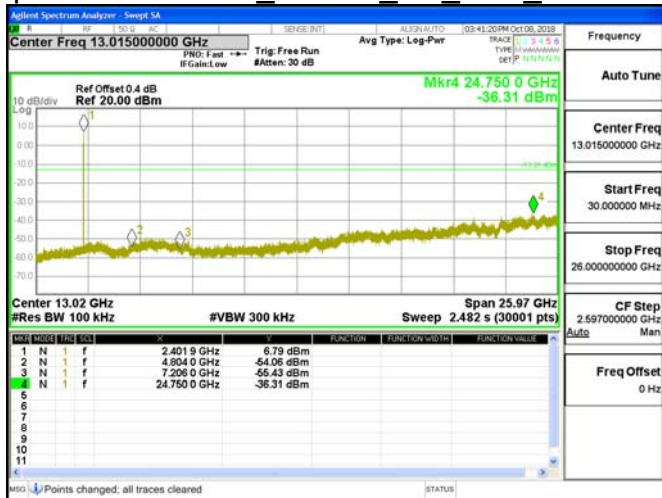


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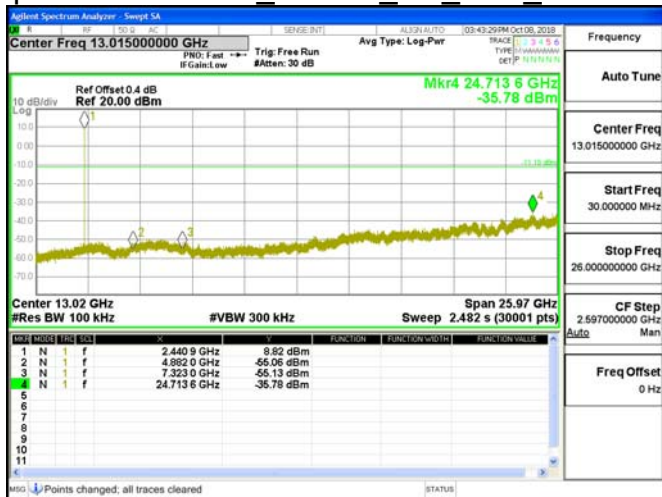
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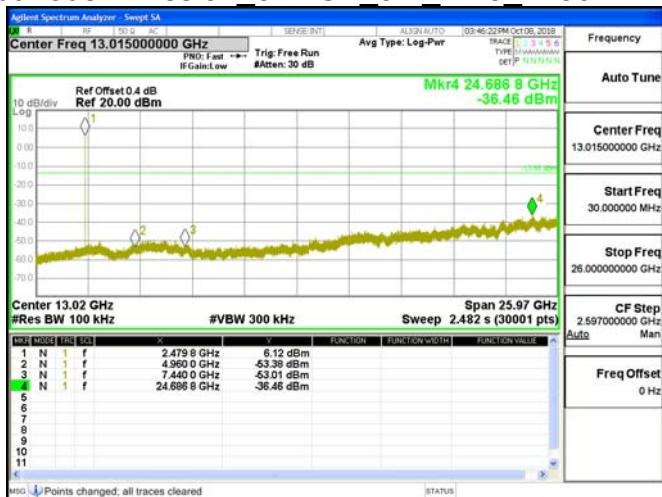
Spurious Emission_8DPSK_3M_DH5_2402MHz



Spurious Emission_8DPSK_3M_DH5_2441MHz



Spurious Emission_8DPSK_3M_DH5_2480MHz



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10 RADIATED BANDEGE 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

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Bi-log Antenna	SCHWAZBECK	VULB9168	378	12/29/2017	12/28/2018
Horn Antenna	Schwarzbeck	BBHA9120D	1441	08/16/2018	08/15/2019
Horn Antenna	Schwarzbeck	BBHA9170	184	12/12/2017	12/11/2018
Loop Antenna	ETS.LINDGREN	6502	148045	10/03/2018	10/02/2019
3m Site NSA	SGS	966 chamber	N/A	01/02/2018	01/01/2019
Spectrum Analyzer	Agilent	E4446A	MY51100003	05/15/2018	05/14/2019
EMI Test Receiver	R&S	ESCI7	100335	02/02/2018	02/01/2019
Pre-Amplifier	HP	8449B	3008A00578	01/02/2018	01/01/2019
Pre-Amplifier	HP	8447D	2944A07676	01/02/2018	01/01/2019
Pre-Amplifier	EMC Instru- ments	EMC184045B	980135	10/02/2018	10/01/2019
Attenuator	Mini-Circuit	BW-S10W2+	2	01/02/2018	01/01/2019
Filter 5150-5350 MHz	Micro-Tronics	BRM50703	1	01/02/2018	01/01/2019
Filter 5470-5725 MHz	Micro-Tronics	BRM50704	1	01/02/2018	01/01/2019
Low Loss Cable	Huber Suhner	966_RX	9	01/02/2018	01/01/2019
Notebook	Lenovo	L420	LR-7HXZA	N/A	N/A

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

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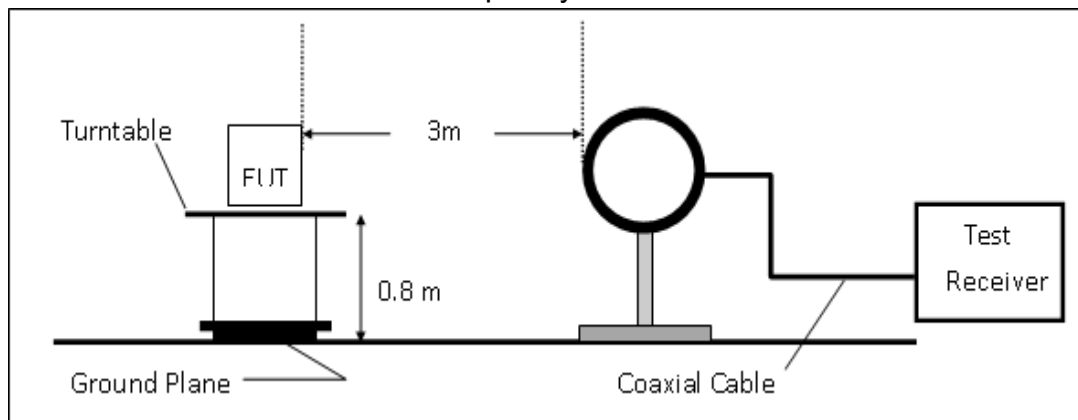
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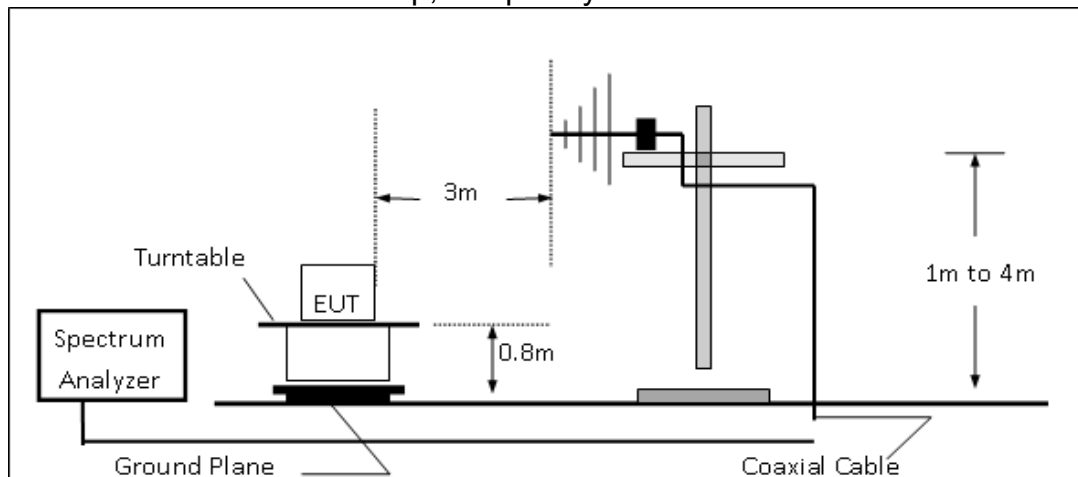
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10.3 Test SET-UP

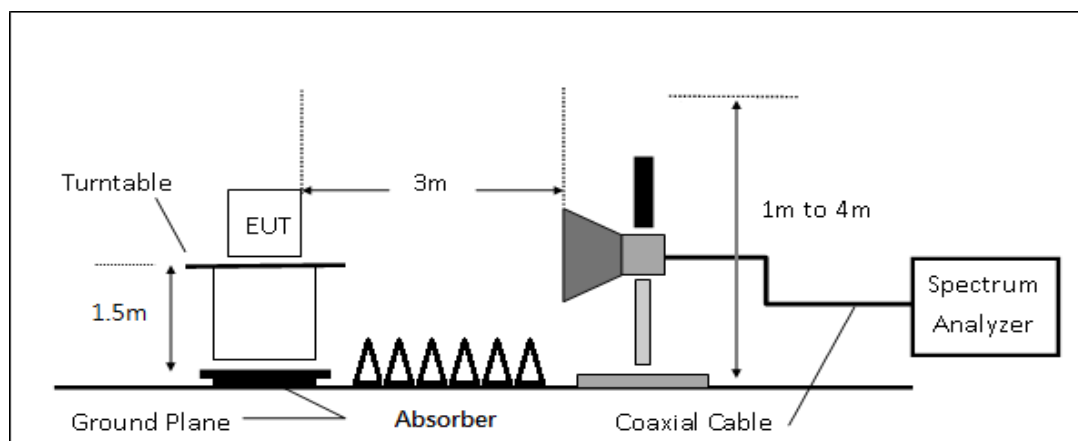
(A) Radiated Emission Test Set-UP Frequency Below 30MHz.



(B) Radiated Emission Test Set-UP, Frequency 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 was placed on a turn table with 0.8m for frequency < 1GHz and 0.8m for frequency > 1GHz above ground plan.
3. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
4. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
5. Use the follow spectrum analyzer setting:
 - (1) Span = wide enough to fully capture the emission being measured
 - (2) RBW = 1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz, VBW $\geq$ 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 = $N1 \cdot L1 + N2 \cdot L2 + \dots + N(n-1) \cdot LN(n-1) + N(n) \cdot L(n)$
 Where N1 is number of type 1 pulses, L1 is length of type 1 pulses, etc.
 Average Emission Level = Peak Emission Level + $20 \cdot \log(\text{duty Cycle})$
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 $20 \cdot \log(\mu\text{V/m})$

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

Factor(dB) = Antenna Factor(dBuV/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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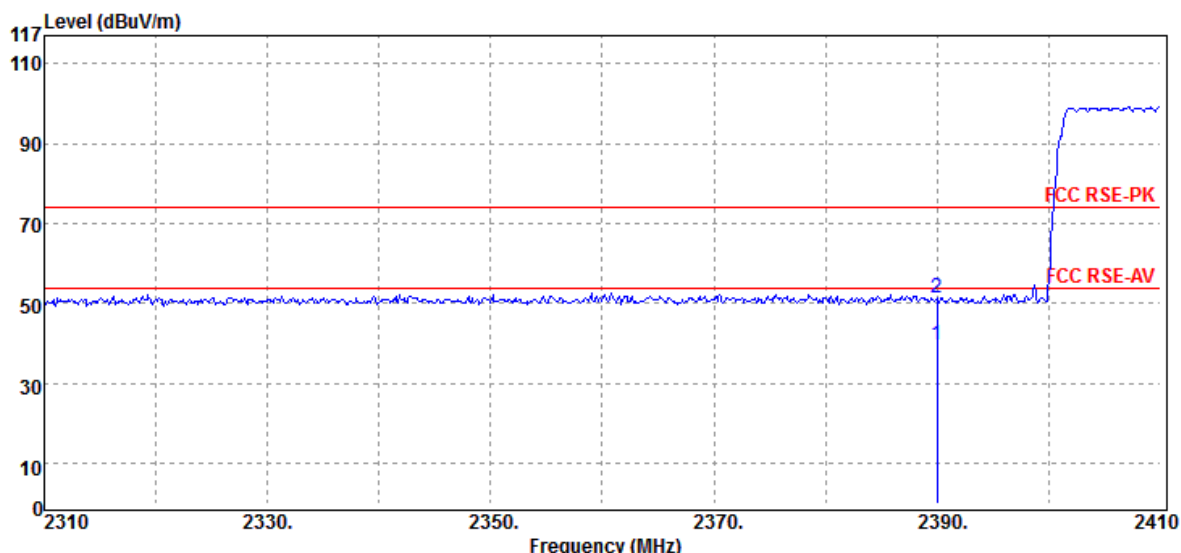
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Radiated Band Edge Measurement Result: (Hopping Mode)

Operation Band	:BR Hopping	Test Date	:2018-10-19
Fundamental Frequency	:2402 MHz	Temp./Humi.	:24.1 deg_C / 65 RH
Operation Mode	:Bandedge CH LOW	Engineer	:Tin
EUT Pol.	:H Plane	Measurement Antenna Pol.	:VERTICAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode	Reading Level			FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2390.00	Average	39.40	0.20	39.60	54.00	-14.40
2390.00	Peak	51.13	0.20	51.33	74.00	-22.67

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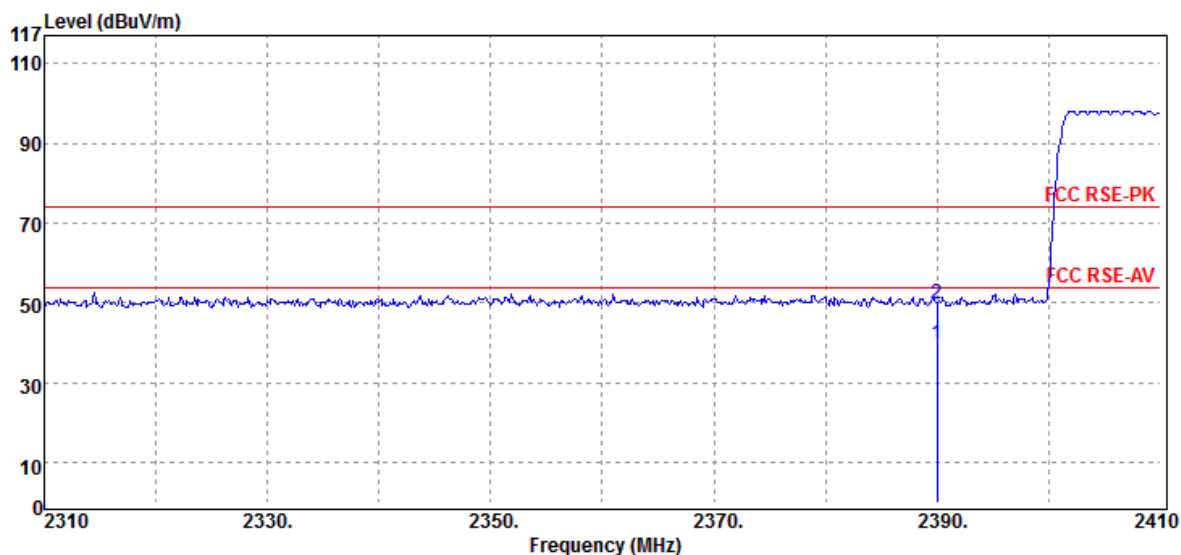
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Operation Band :BR Hopping
Fundamental Frequency :2402 MHz
Operation Mode :Bandedge CH LOW
EUT Pol. :H Plane

Test Date :2018-10-19
Temp./Humi. :24.1 deg_C / 65 RH
Engineer :Tin
Measurement Antenna Pol. :HORIZONTAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2390.00	Average	39.32	0.20	39.52	54.00	-14.48
2390.00	Peak	49.48	0.20	49.68	74.00	-24.32

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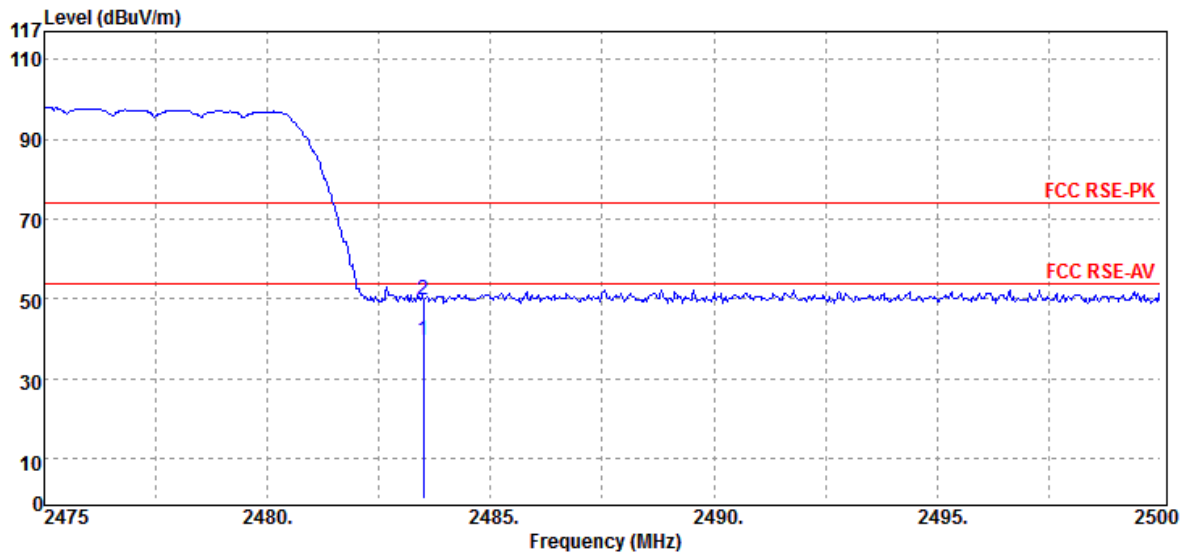
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Operation Band	:BR Hopping	Test Date	:2018-10-19
Fundamental Frequency	:2480 MHz	Temp./Humi.	:24.1 deg_C / 65 RH
Operation Mode	:Bandedge CH HIGH	Engineer	:Tin
EUT Pol.	:H Plane	Measurement Antenna Pol.	:VERTICAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2483.50	Average	39.12	0.53	39.65	54.00	-14.35
2483.50	Peak	49.35	0.53	49.88	74.00	-24.12

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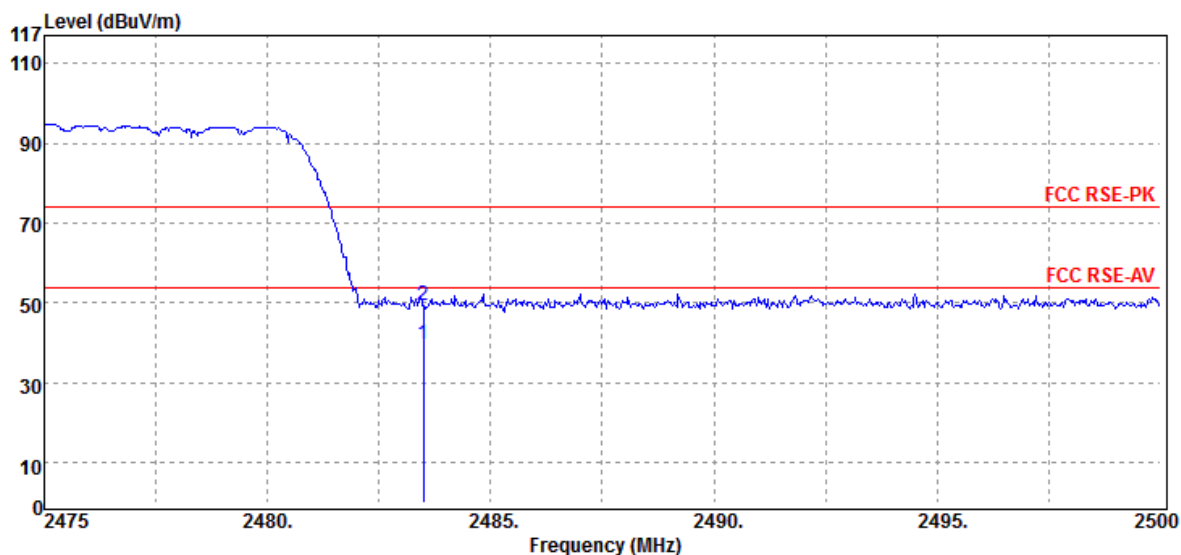
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Operation Band	:BR Hopping	Test Date	:2018-10-19
Fundamental Frequency	:2480 MHz	Temp./Humi.	:24.1 deg_C / 65 RH
Operation Mode	:Bandedge CH HIGH	Engineer	:Tin
EUT Pol.	:H Plane	Measurement Antenna Pol.	:HORIZONTAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2483.50	Average	39.30	0.53	39.83	54.00	-14.17
2483.50	Peak	48.74	0.53	49.27	74.00	-24.73

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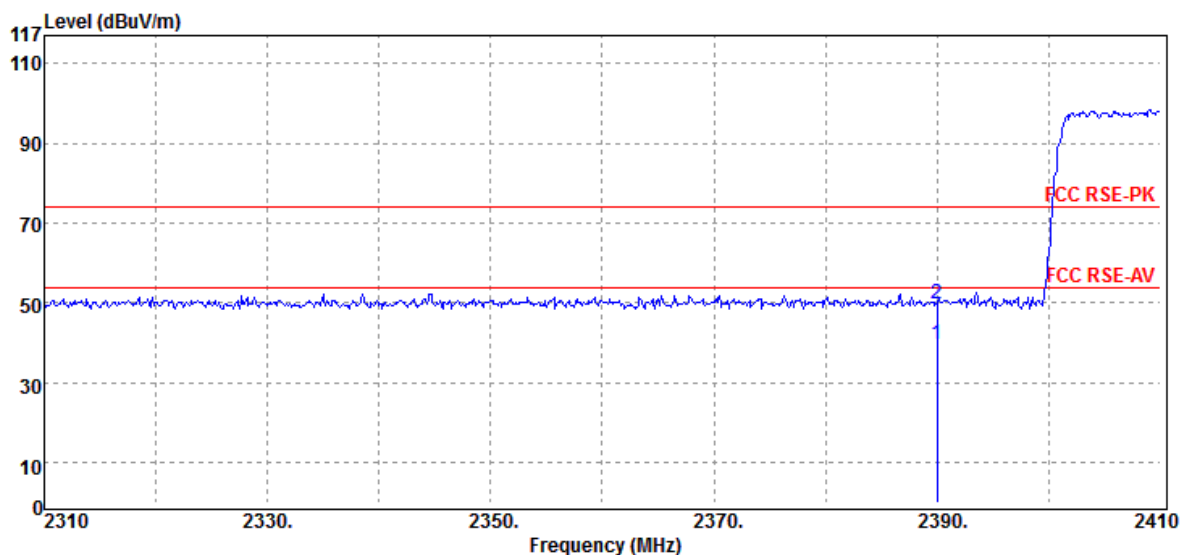
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Operation Band	:EDR Hopping	Test Date	:2018-10-19
Fundamental Frequency	:2402 MHz	Temp./Humi.	:24.1 deg_C / 65 RH
Operation Mode	:Bandedge CH LOW	Engineer	:Tin
EUT Pol.	:H Plane	Measurement Antenna Pol.	:VERTICAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2390.00	Average	39.44	0.20	39.64	54.00	-14.36
2390.00	Peak	49.71	0.20	49.91	74.00	-24.09

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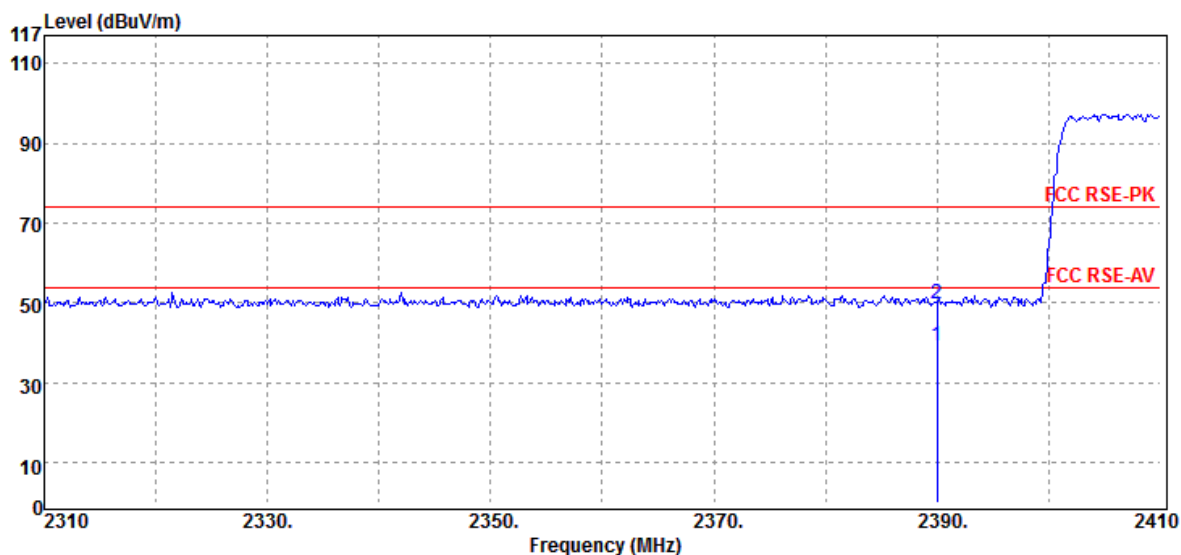
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Operation Band	:EDR Hopping	Test Date	:2018-10-19
Fundamental Frequency	:2402 MHz	Temp./Humi.	:24.1 deg_C / 65 RH
Operation Mode	:Bandedge CH LOW	Engineer	:Tin
EUT Pol.	:H Plane	Measurement Antenna Pol.	:HORIZONTAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2390.00	Average	39.20	0.20	39.40	54.00	-14.60
2390.00	Peak	49.52	0.20	49.72	74.00	-24.28

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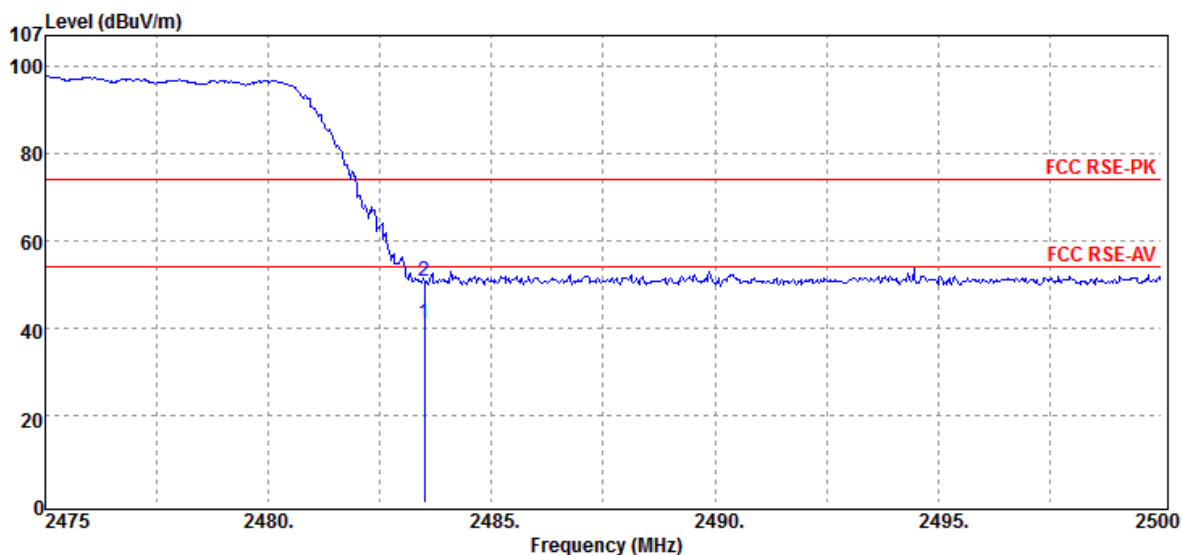
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Operation Band	:EDR Hopping	Test Date	:2018-10-19
Fundamental Frequency	:2480 MHz	Temp./Humi.	:24.1 deg_C / 65 RH
Operation Mode	:Bandedge CH HIGH	Engineer	:Tin
EUT Pol.	:H Plane	Measurement Antenna Pol.	:VERTICAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2483.50	Average	40.65	0.53	41.18	54.00	-12.82
2483.50	Peak	50.30	0.53	50.83	74.00	-23.17

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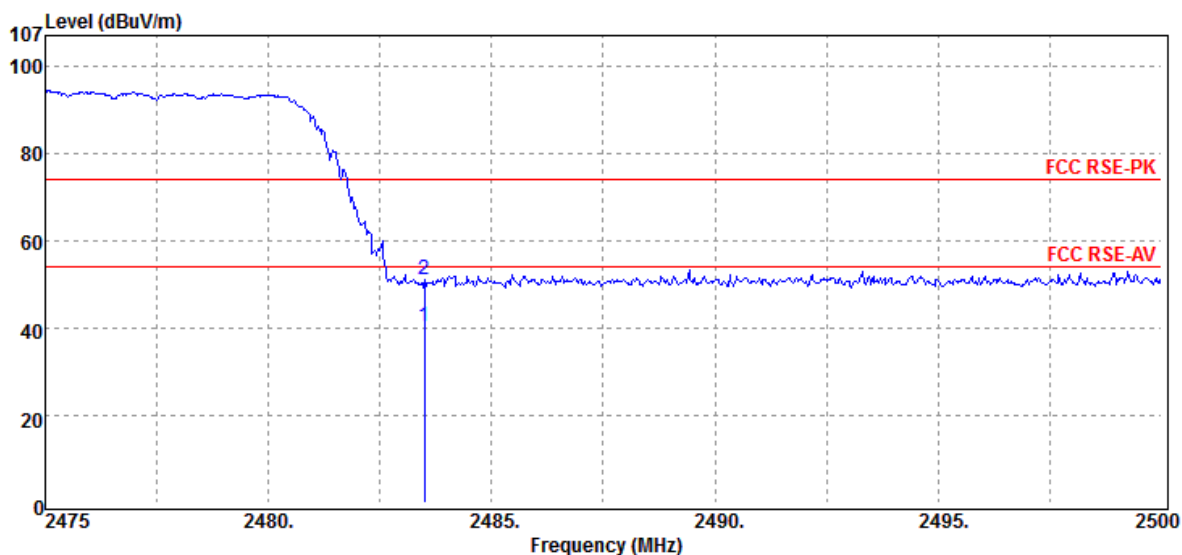
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Operation Band	:EDR Hopping	Test Date	:2018-10-19
Fundamental Frequency	:2480 MHz	Temp./Humi.	:24.1 deg_C / 65 RH
Operation Mode	:Bandedge CH HIGH	Engineer	:Tin
EUT Pol.	:H Plane	Measurement Antenna Pol.	:HORIZONTAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2483.50	Average	39.84	0.53	40.37	54.00	-13.63
2483.50	Peak	50.42	0.53	50.95	74.00	-23.05

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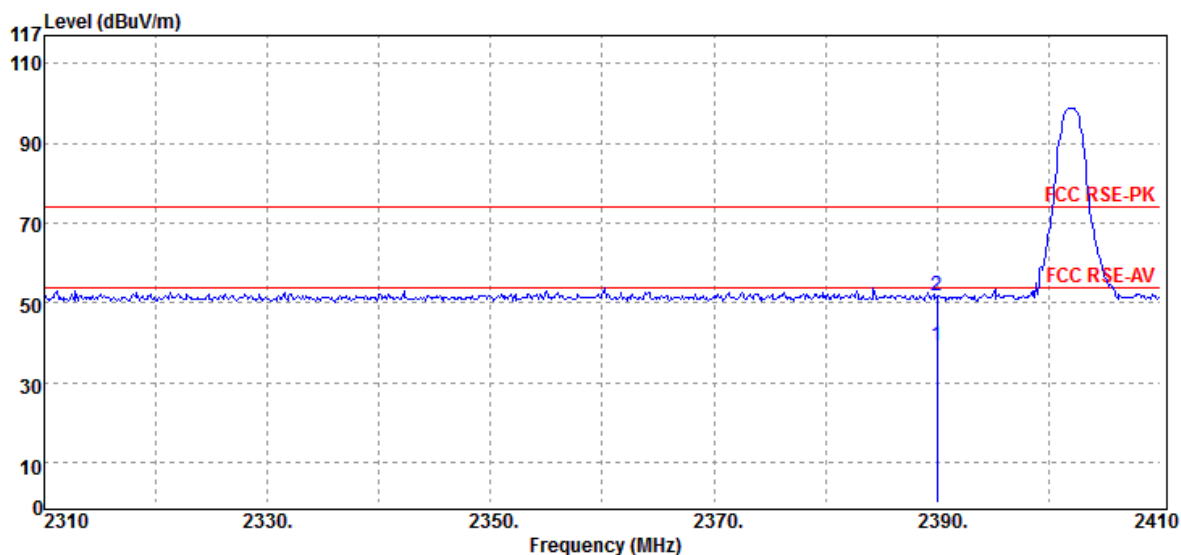
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Radiated Band Edge Measurement Result: (Non-Hopping Mode)

Operation Band	:BR(1M)	Test Date	:2018-10-19
Fundamental Frequency	:2402 MHz	Temp./Humi.	:24.1 deg_C / 65 RH
Operation Mode	:Bandedge CH LOW	Engineer	:Tin
EUT Pol.	:H Plane	Measurement Antenna Pol.	:VERTICAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	Mode	Reading Level		FS	@3m	
MHz	PK/QP/AV	dBuV	dB	dBuV/m	dBuV/m	dB
2390.00	Average	39.12	0.20	39.32	54.00	-14.68
2390.00	Peak	51.70	0.20	51.90	74.00	-22.10

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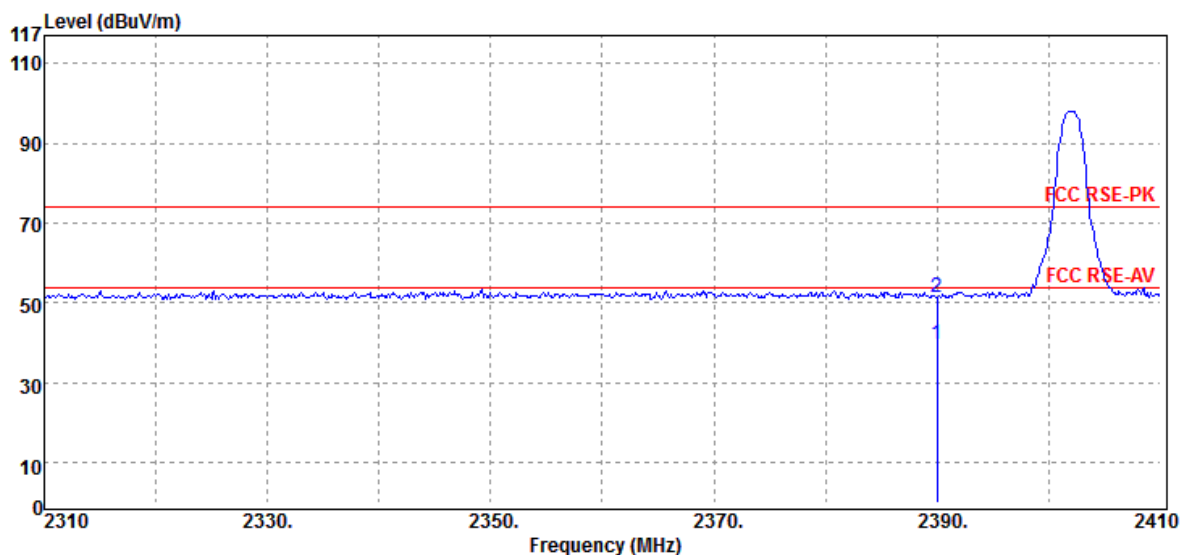
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www.tw.sgs.com

Member of SGS Group

Operation Band :BR(1M)
Fundamental Frequency :2402 MHz
Operation Mode :Bandedge CH LOW
EUT Pol. :H Plane

Test Date :2018-10-19
Temp./Humi. :24.1 deg_C / 65 RH
Engineer :Tin
Measurement Antenna Pol. :HORIZONTAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2390.00	Average	39.30	0.20	39.50	54.00	-14.50
2390.00	Peak	51.14	0.20	51.34	74.00	-22.66

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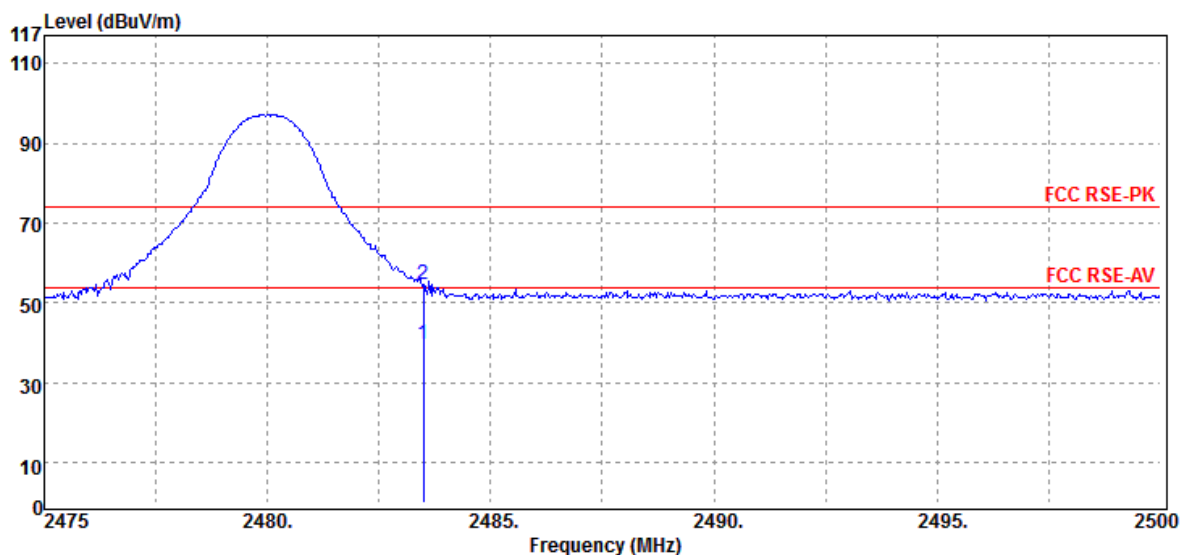
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Member of SGS Group

Operation Band :BR(1M)
Fundamental Frequency :2480 MHz
Operation Mode :Bandedge CH HIGH
EUT Pol. :H Plane

Test Date :2018-10-19
Temp./Humi. :24.1 deg_C / 65 RH
Engineer :Tin
Measurement Antenna Pol. :VERTICAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	Mode	Reading Level		FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2483.50	Average	39.23	0.53	39.76	54.00	-14.24
2483.50	Peak	54.15	0.53	54.68	74.00	-19.32

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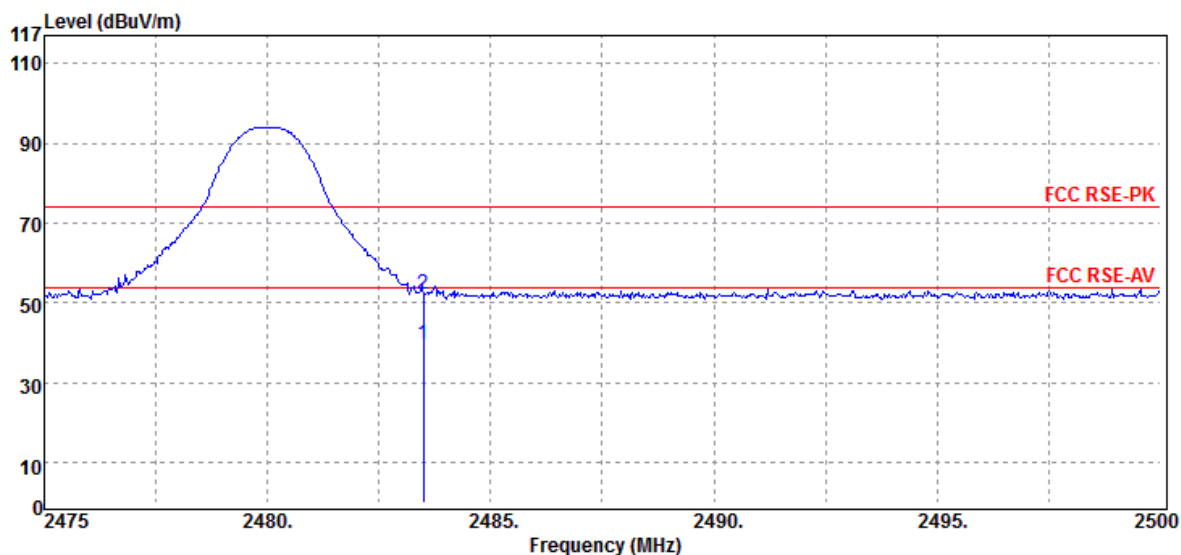
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Member of SGS Group

Operation Band :BR(1M)
Fundamental Frequency :2480 MHz
Operation Mode :Bandedge CH HIGH
EUT Pol. :H Plane

Test Date :2018-10-19
Temp./Humi. :24.1 deg_C / 65 RH
Engineer :Tin
Measurement Antenna Pol. :HORIZONTAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	Mode	Reading Level		FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2483.50	Average	39.04	0.53	39.57	54.00	-14.43
2483.50	Peak	51.86	0.53	52.39	74.00	-21.61

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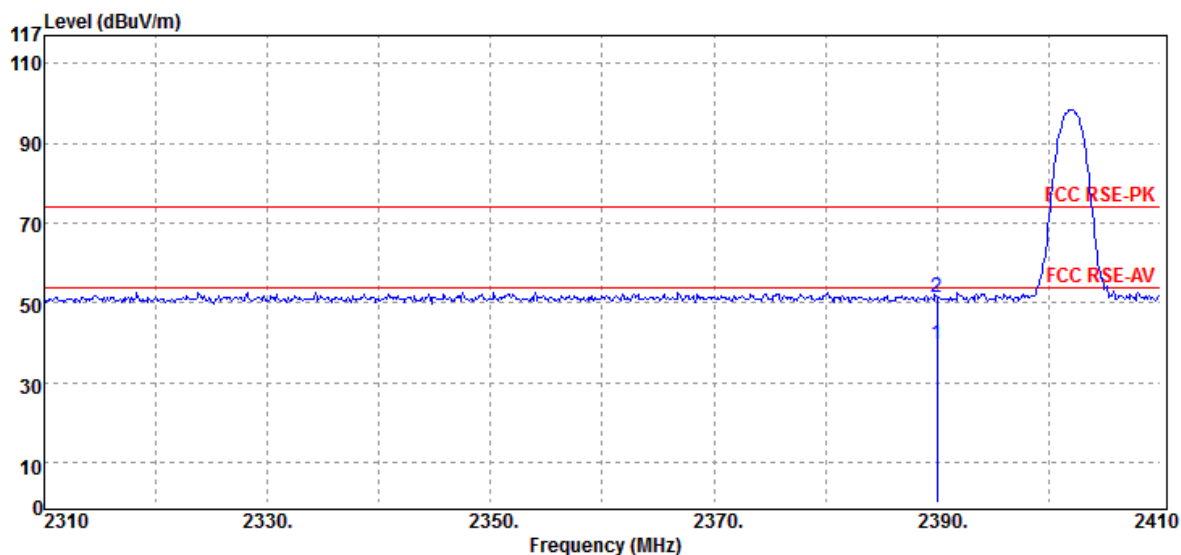
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Member of SGS Group

Operation Band :EDR(3M)
Fundamental Frequency :2402 MHz
Operation Mode :Bandedge CH LOW
EUT Pol. :H Plane

Test Date :2018-10-19
Temp./Humi. :24.1 deg_C / 65 RH
Engineer :Tin
Measurement Antenna Pol. :VERTICAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2390.00	Average	39.41	0.20	39.61	54.00	-14.39
2390.00	Peak	51.28	0.20	51.48	74.00	-22.52

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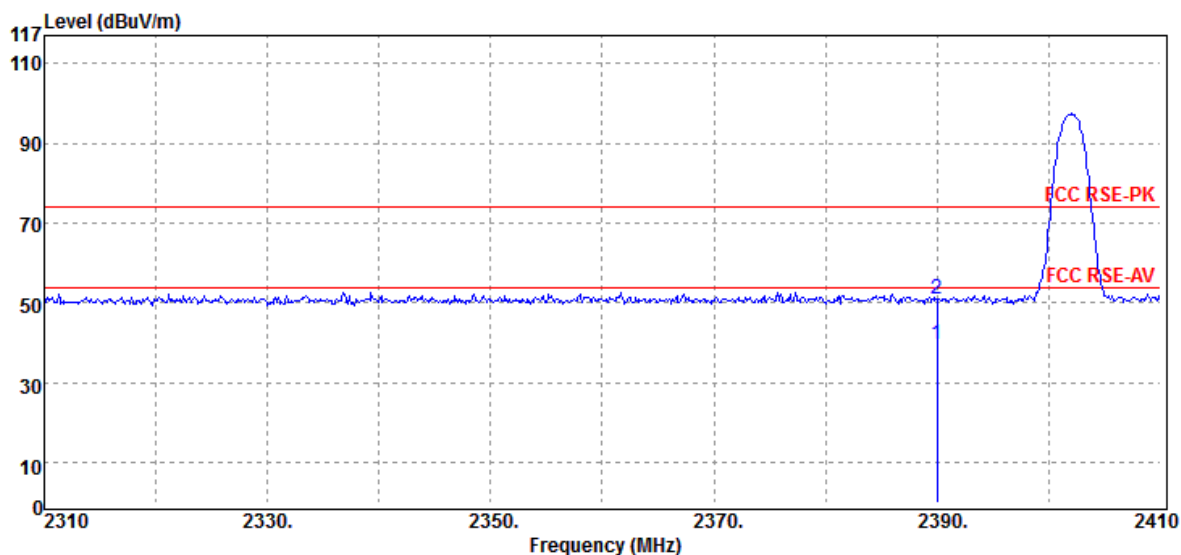
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Member of SGS Group

Operation Band :EDR(3M)
Fundamental Frequency :2402 MHz
Operation Mode :Bandedge CH LOW
EUT Pol. :H Plane

Test Date :2018-10-19
Temp./Humi. :24.1 deg_C / 65 RH
Engineer :Tin
Measurement Antenna Pol. :HORIZONTAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2390.00	Average	39.38	0.20	39.58	54.00	-14.42
2390.00	Peak	50.78	0.20	50.98	74.00	-23.02

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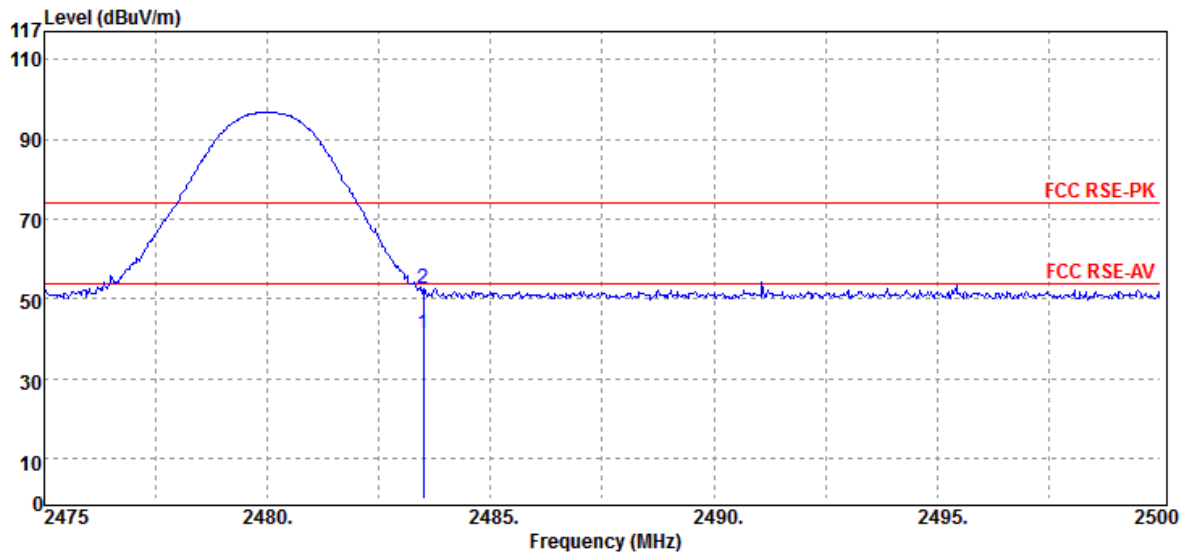
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Member of SGS Group

Operation Band :EDR(3M)
Fundamental Frequency :2480 MHz
Operation Mode :Bandedge CH HIGH
EUT Pol. :H Plane

Test Date :2018-10-19
Temp./Humi. :24.1 deg_C / 65 RH
Engineer :Tin
Measurement Antenna Pol. :VERTICAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2483.50	Average	40.92	0.53	41.45	54.00	-12.55
2483.50	Peak	52.28	0.53	52.81	74.00	-21.19

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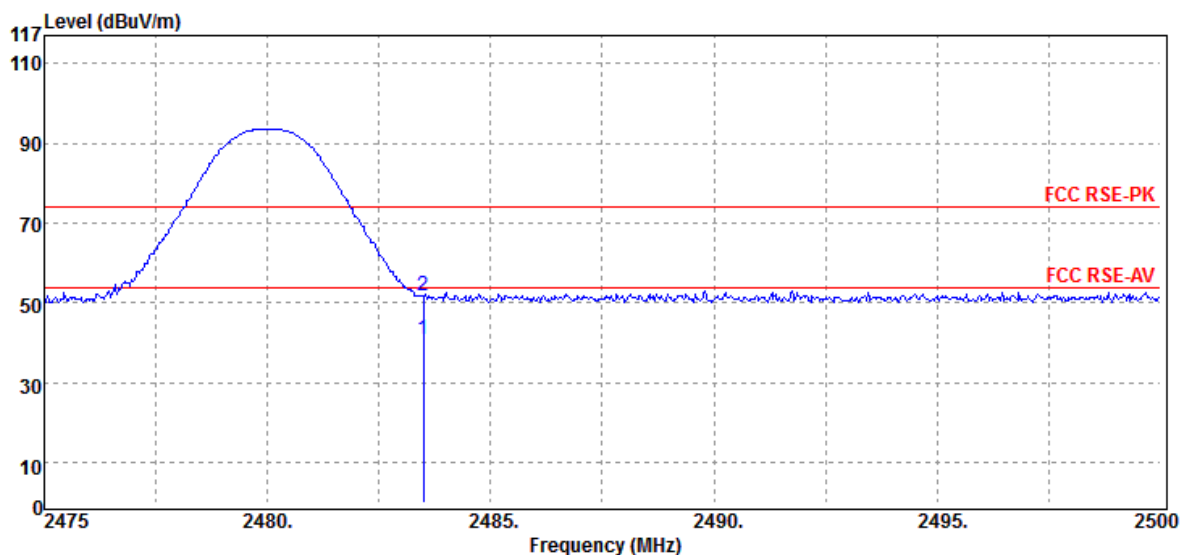
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Member of SGS Group

Operation Band :EDR(3M)
Fundamental Frequency :2480 MHz
Operation Mode :Bandedge CH HIGH
EUT Pol. :H Plane

Test Date :2018-10-19
Temp./Humi. :24.1 deg_C / 65 RH
Engineer :Tin
Measurement Antenna Pol. :HORIZONTAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2483.50	Average	40.23	0.53	40.76	54.00	-13.24
2483.50	Peak	51.33	0.53	51.86	74.00	-22.14

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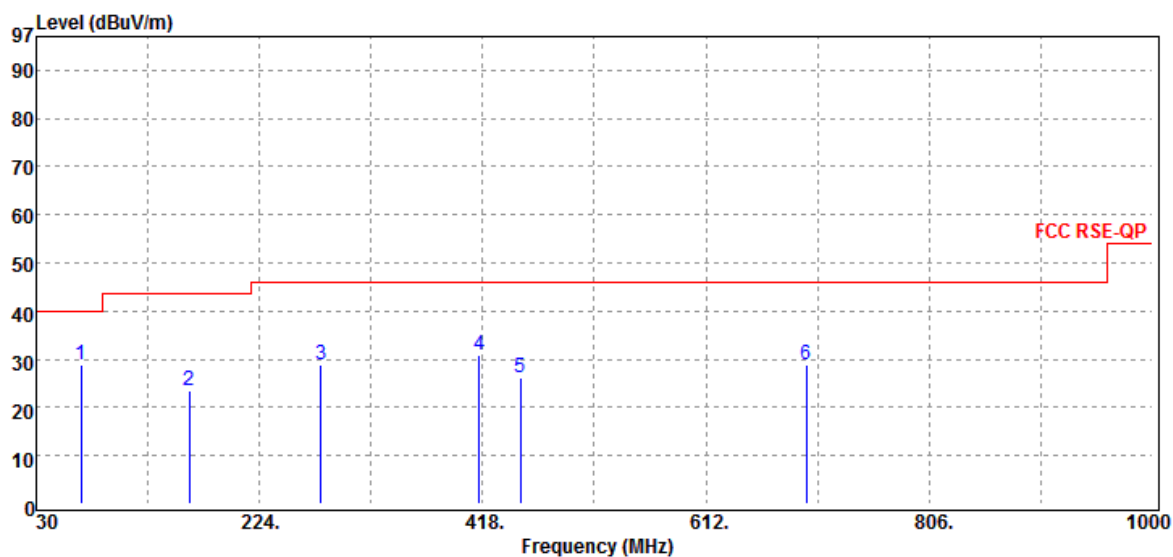
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Radiated Spurious Emission Measurement Result: (Worst Case)

For Frequency from 30MHz to 1000MHz

Operation Band	:BR(1M)	Test Date	:2018-10-15
Fundamental Frequency	:2441 MHz	Temp./Humi.	:24.1 deg_C / 65 RH
Operation Mode	:Tx CH MID	Engineer	:Tin
EUT Pol.	:H Plane	Measurement Antenna Pol.	:VERTICAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS	@3m	
MHz	PK/QP/AV	dB μ V	dB	dB μ V/m	dB μ V/m	dB
68.80	Peak	38.74	-9.83	28.91	40.00	-11.09
162.89	Peak	30.84	-7.23	23.61	43.50	-19.89
277.35	Peak	35.08	-6.27	28.81	46.00	-17.19
415.09	Peak	33.94	-2.95	30.99	46.00	-15.01
450.98	Peak	28.72	-2.61	26.11	46.00	-19.89
699.30	Peak	27.20	1.74	28.94	46.00	-17.06

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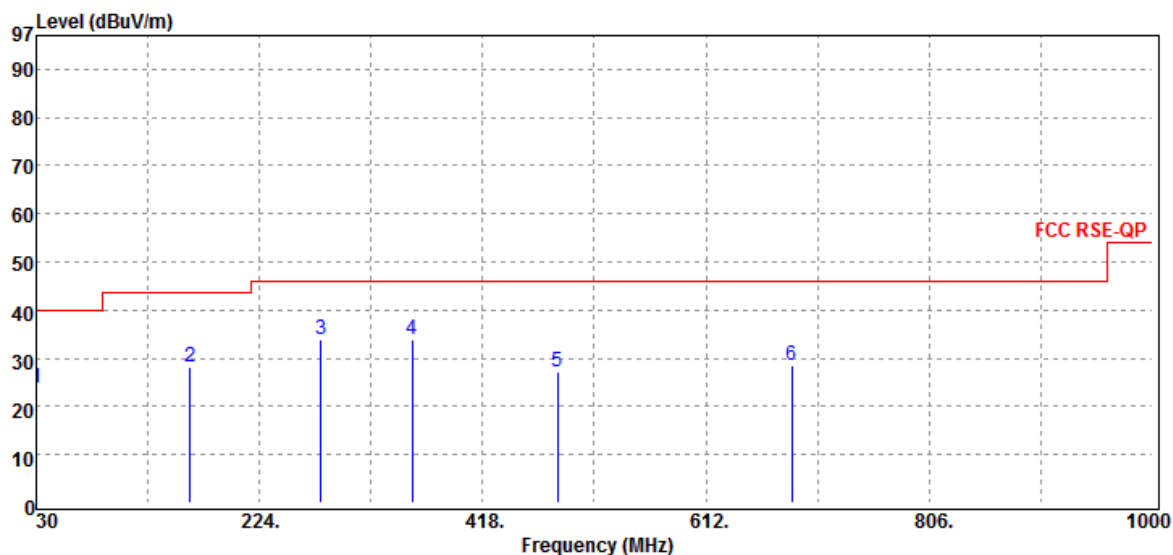
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Operation Band :BR(1M)
Fundamental Frequency :2441 MHz
Operation Mode :Tx CH MID
EUT Pol. :H Plane

Test Date :2018-10-15
Temp./Humi. :24.1 deg_C / 65 RH
Engineer :Tin
Measurement Antenna Pol. :HORIZONTAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS	@3m	
MHz	PK/QP/AV	dBuV	dB	dBuV/m	dBuV/m	dB
30.00	Peak	32.78	-8.96	23.82	40.00	-16.18
163.86	Peak	35.48	-7.27	28.21	43.50	-15.29
277.35	Peak	40.04	-6.27	33.77	46.00	-12.23
356.89	Peak	38.03	-4.21	33.82	46.00	-12.18
482.99	Peak	29.78	-2.54	27.24	46.00	-18.76
686.69	Peak	26.77	1.70	28.47	46.00	-17.53

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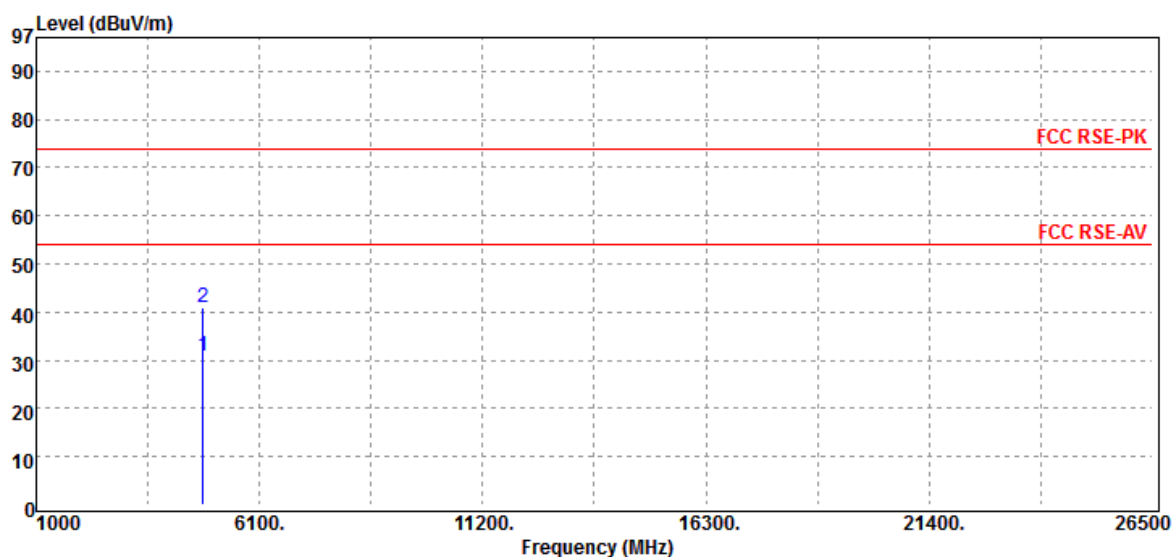
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Radiated Spurious Emission Measurement Result: (Worst Case) For Frequency above 1 GHz

Operation Band	:BR(1M)	Test Date	:2018-10-19
Fundamental Frequency	:2402 MHz	Temp./Humi.	:24.1 deg_C / 65 RH
Operation Mode	:Tx CH LOW	Engineer	:Tin
EUT Pol.	:H Plane	Measurement Antenna Pol.	:VERTICAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode	Reading Level			FS	@3m	
MHz	PK/QP/AV	dBuV	dB	dBuV/m	dBuV/m	dB
4804.00	Average	25.11	5.65	30.76	54.00	-23.24
4804.00	Peak	35.33	5.65	40.98	74.00	-33.02

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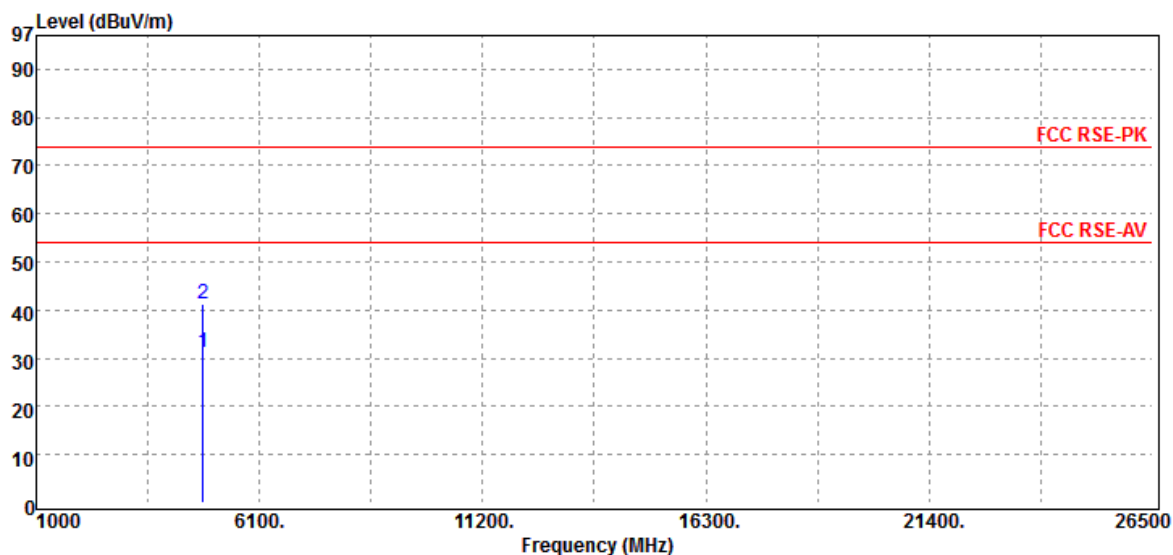
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Member of SGS Group

Operation Band :BR(1M)
Fundamental Frequency :2402 MHz
Operation Mode :Tx CH LOW
EUT Pol. :H Plane

Test Date :2018-10-19
Temp./Humi. :24.1 deg_C / 65 RH
Engineer :Tin
Measurement Antenna Pol. :HORIZONTAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
4804.00	Average	25.64	5.65	31.29	54.00	-22.71
4804.00	Peak	35.51	5.65	41.16	74.00	-32.84

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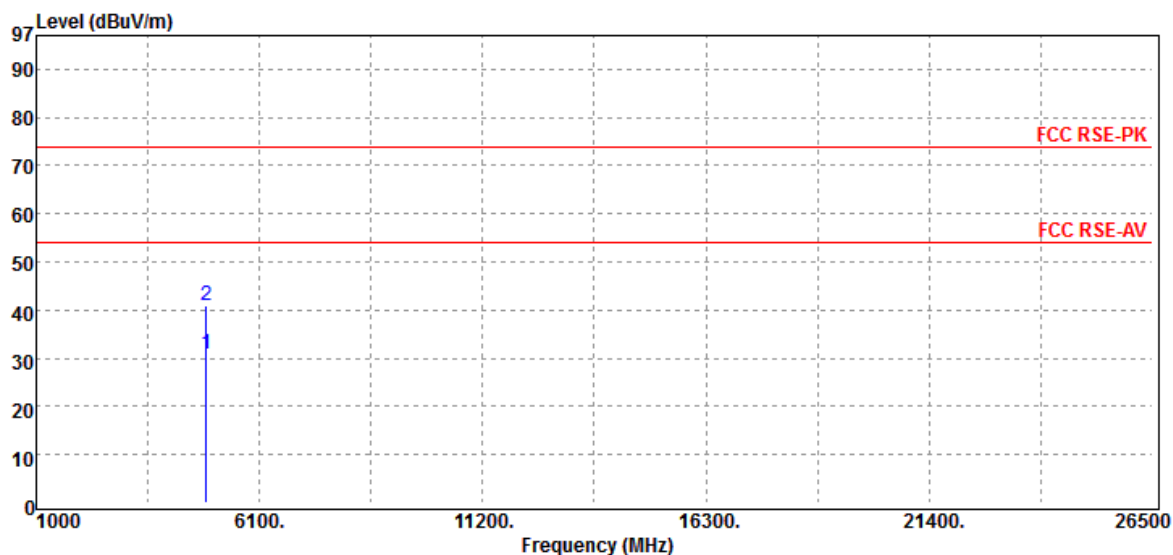
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www.tw.sgs.com

Member of SGS Group

Operation Band :BR(1M)
Fundamental Frequency :2441 MHz
Operation Mode :Tx CH MID
EUT Pol. :H Plane

Test Date :2018-10-19
Temp./Humi. :24.1 deg_C / 65 RH
Engineer :Tin
Measurement Antenna Pol. :VERTICAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
4882.00	Average	24.89	5.90	30.79	54.00	-23.21
4882.00	Peak	35.07	5.90	40.97	74.00	-33.03

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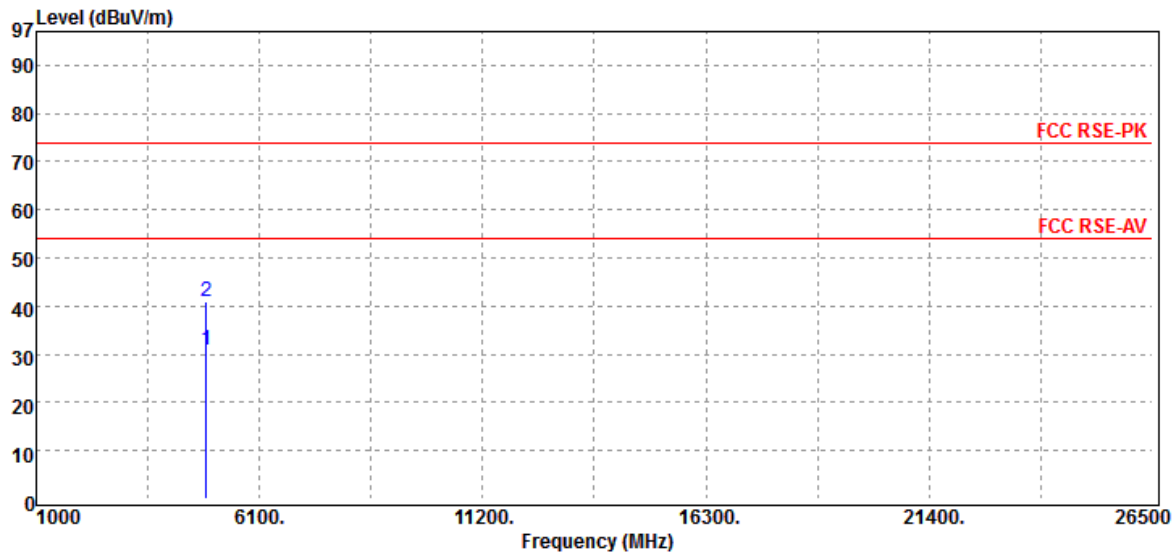
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Operation Band :BR(1M)
Fundamental Frequency :2441 MHz
Operation Mode :Tx CH MID
EUT Pol. :H Plane

Test Date :2018-10-19
Temp./Humi. :24.1 deg_C / 65 RH
Engineer :Tin
Measurement Antenna Pol. :HORIZONTAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
4882.00	Average	25.03	5.90	30.93	54.00	-23.07
4882.00	Peak	34.94	5.90	40.84	74.00	-33.16

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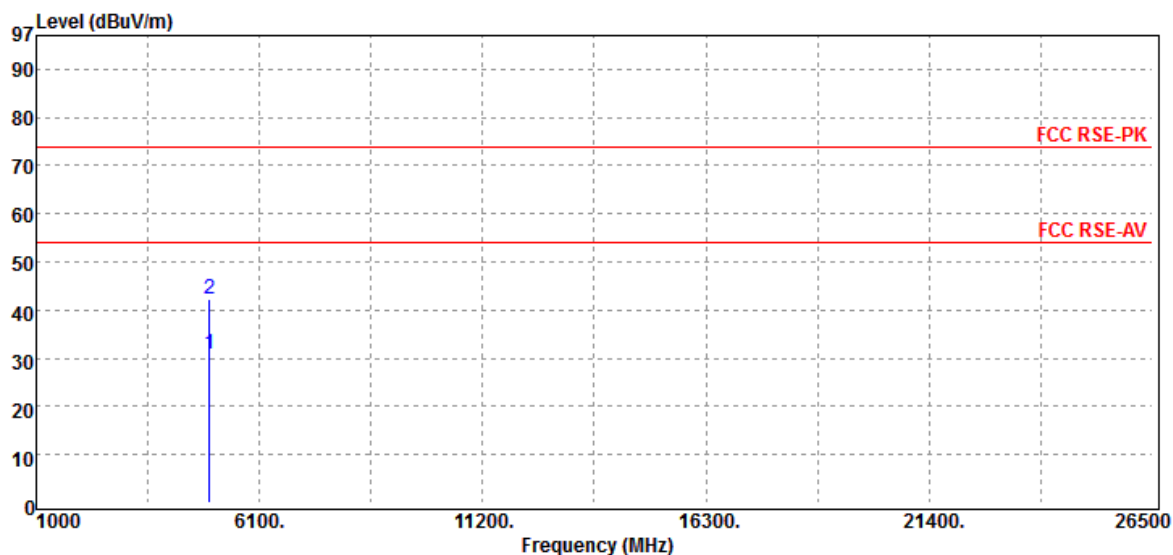
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Operation Band	:BR(1M)	Test Date	:2018-10-19
Fundamental Frequency	:2480 MHz	Temp./Humi.	:24.1 deg_C / 65 RH
Operation Mode	:Tx CH HIGH	Engineer	:Tin
EUT Pol.	:H Plane	Measurement Antenna Pol.	:VERTICAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
4960.00	Average	24.93	6.05	30.98	54.00	-23.02
4960.00	Peak	36.22	6.05	42.27	74.00	-31.73

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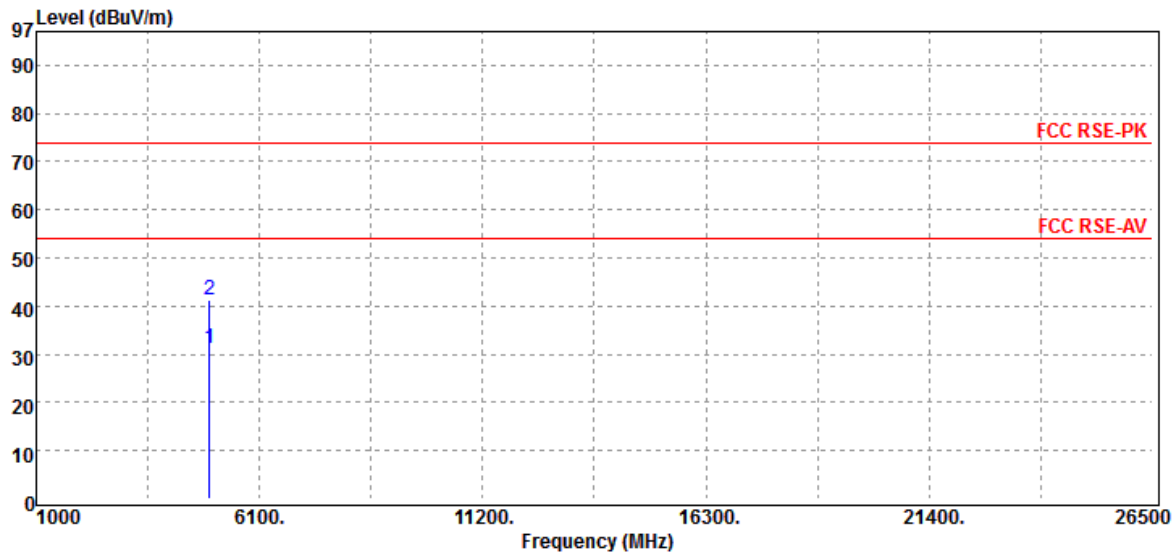
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Operation Band :BR(1M)
Fundamental Frequency :2480 MHz
Operation Mode :Tx CH HIGH
EUT Pol. :H Plane

Test Date :2018-10-19
Temp./Humi. :24.1 deg_C / 65 RH
Engineer :Tin
Measurement Antenna Pol. :HORIZONTAL



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS	@3m	
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
4960.00	Average	25.17	6.05	31.22	54.00	-22.78
4960.00	Peak	35.22	6.05	41.27	74.00	-32.73

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11 FREQUENCY SEPARATION

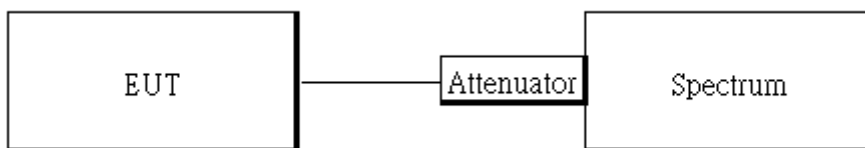
11.1 Standard Applicable

Frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25 kHz or the $2/3 \times 20\text{dB}$ bandwidth of the hopping channel, whichever is greater.

11.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EXA Spectrum Analyzer	Agilent	N9010A	MY57120290	02/14/2018	02/13/2019
DC Power Supply	Anritsu	E3640A	MY52410006	11/28/2017	11/27/2018
Attenuator	Mini-Circuit	BW-S10W2+	2	01/02/2018	01/01/2019
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2018	01/01/2019
Coaxial Cables	N/A	WK CE Cable	N/A	01/02/2018	01/01/2019
Notebook	Lenovo	T440P	P0000564	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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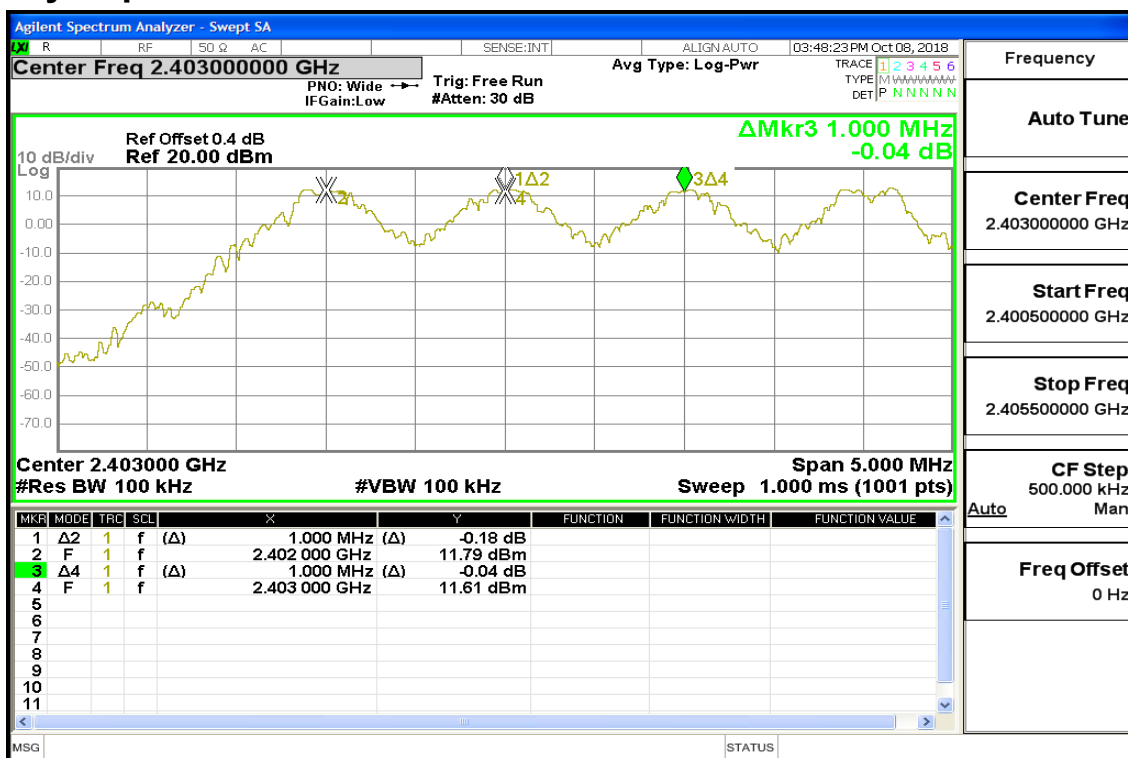
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11.5 Measurement Result

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

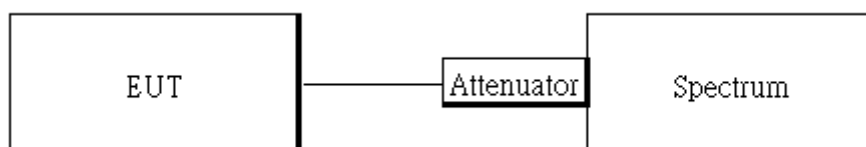
12.1 Standard Applicable

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

12.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EXA Spectrum Analyzer	Agilent	N9010A	MY57120290	02/14/2018	02/13/2019
DC Power Supply	Anritsu	E3640A	MY52410006	11/28/2017	11/27/2018
Attenuator	Mini-Circuit	BW-S10W2+	2	01/02/2018	01/01/2019
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2018	01/01/2019
Coaxial Cables	N/A	WK CE Cable	N/A	01/02/2018	01/01/2019
Notebook	Lenovo	T440P	P0000564	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.

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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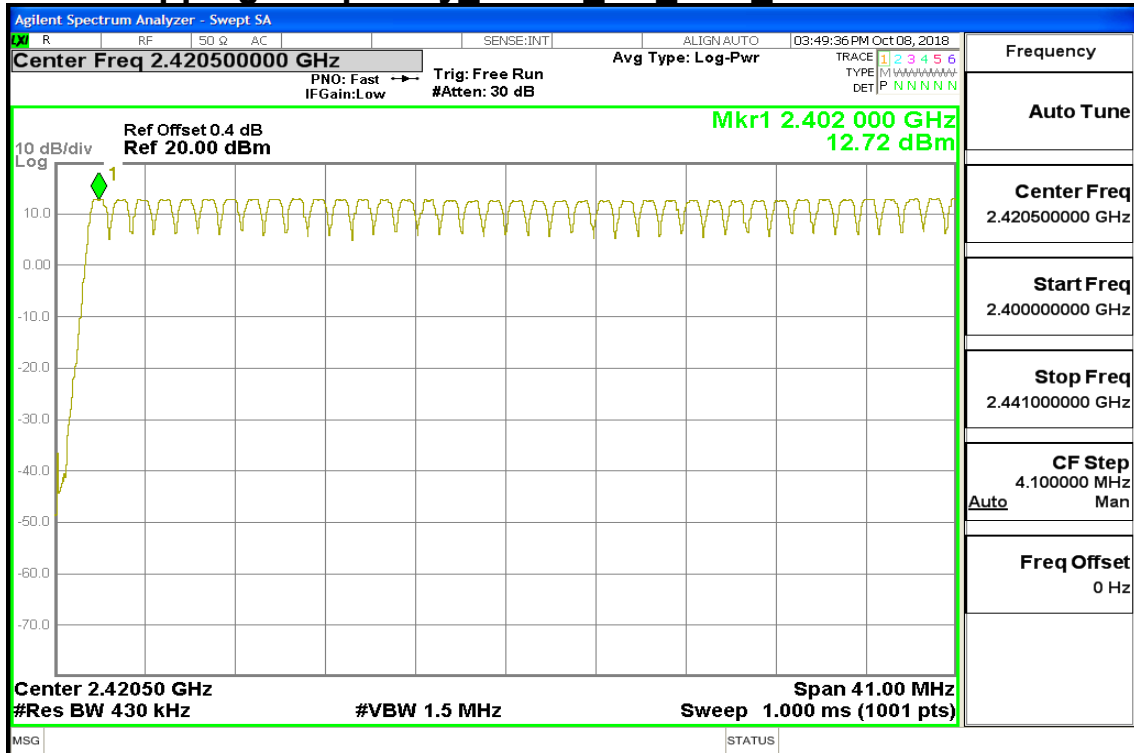
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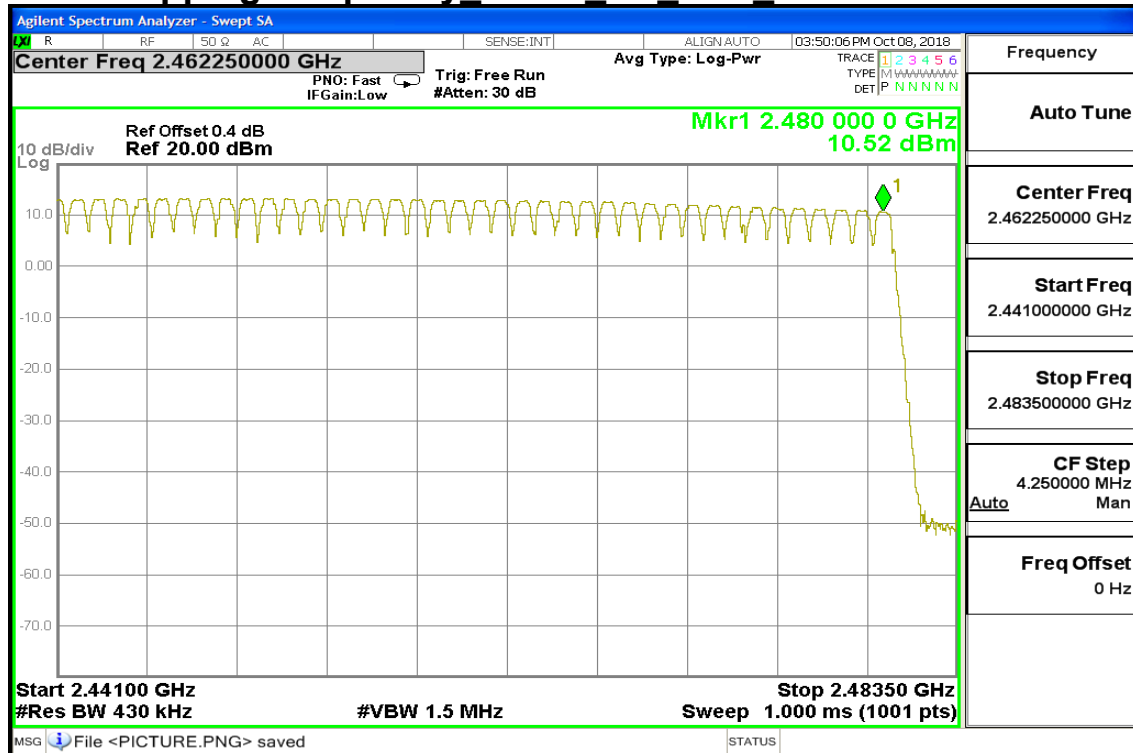
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Channel Number

Hopping Frequency GFSK 1M DH5 2400-2441 MHz



Hopping Frequency GFSK 1M DH5 2441-2480 MHz



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13 TIME OF OCCUPANCY (DWELL TIME)

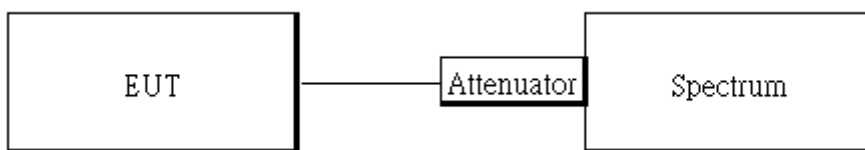
13.1 Standard Applicable

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

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EXA Spectrum Analyzer	Agilent	N9010A	MY57120290	02/14/2018	02/13/2019
DC Power Supply	Anritsu	E3640A	MY52410006	11/28/2017	11/27/2018
Attenuator	Mini-Circuit	BW-S10W2+	2	01/02/2018	01/01/2019
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2018	01/01/2019
Coaxial Cables	N/A	WK CE Cable	N/A	01/02/2018	01/01/2019
Notebook	Lenovo	T440P	P0000564	N/A	N/A

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.

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

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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)	1/T (kHz)	VBW setting (kHz)
0	DH1	123.20	400ms	2.60	3.00
	DH3	262.40	400ms	0.61	1.00
	DH5	308.80	400ms	0.35	1.00
39	DH1	123.20	400ms	2.60	3.00
	DH3	262.40	400ms	0.61	1.00
	DH5	307.20	400ms	0.35	1.00
78	DH1	121.60	400ms	2.63	3.00
	DH3	260.80	400ms	0.61	1.00
	DH5	307.20	400ms	0.00	1.00

$\pi/4$ DQPSK (2Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)	1/T (kHz)	VBW setting (kHz)
39	2DH1	124.80	400ms	2.56	3.00
	2DH3	262.40	400ms	0.61	1.00
	2DH5	308.80	400ms	0.35	1.00

8-DPSK (3Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)	1/T (kHz)	VBW setting (kHz)
39	3DH1	124.80	400ms	2.56	3.00
	3DH3	260.80	400ms	0.61	1.00
	3DH5	308.80	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 =	0.385	*	(1600/2/79)	*	31.6	=	123.20	(ms)
	DH3 time slot =	1.640	*	(1600/4/79)	*	31.6	=	262.40	(ms)
	DH5 time slot =	2.895	*	(1600/6/79)	*	31.6	=	308.80	(ms)
CH Mid	DH1 time slot =	0.385	*	(1600/2/79)	*	31.6	=	123.20	(ms)
	DH3 time slot =	1.640	*	(1600/4/79)	*	31.6	=	262.40	(ms)
	DH5 time slot =	2.880	*	(1600/6/79)	*	31.6	=	307.20	(ms)
CH High	DH1 time slot =	0.380	*	(1600/2/79)	*	31.6	=	121.60	(ms)
	DH3 time slot =	1.630	*	(1600/4/79)	*	31.6	=	260.80	(ms)
	DH5 time slot =	2.880	*	(1600/6/79)	*	31.6	=	307.20	(ms)

$\pi/4$ -DQPSK (2Mbps):

CH Mid	2DH1 time slo =	0.390	*	(1600/2/79)	*	31.6	=	124.80	(ms)
	2DH3 time slo =	1.640	*	(1600/4/79)	*	31.6	=	262.40	(ms)
	2DH5 time slo =	2.895	*	(1600/6/79)	*	31.6	=	308.80	(ms)

8-DPSK (3Mbps):

CH Mid	3DH1 time slo =	0.390	*	(1600/2/79)	*	31.6	=	124.80	(ms)
	3DH3 time slo =	1.630	*	(1600/4/79)	*	31.6	=	260.80	(ms)
	3DH5 time slo =	2.895	*	(1600/6/79)	*	31.6	=	308.80	(ms)

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GFSK (1Mbps) for AFH Mode			
Hopping Channel Number	PACKET TYPE	Measurement Result (ms)	Limit (ms)
20	DH5	153.60	400ms
$\pi/4$ DQPSK (2Mbps) for AFH Mode			
Hopping Channel Number	PACKET TYPE	Measurement Result (ms)	Limit (ms)
20	2DH5	154.40	400ms
8-DPSK (3Mbps) for AFH Mode			
Hopping Channel Number	PACKET TYPE	Measurement Result (ms)	Limit (ms)
20	3DH5	154.40	400ms

GFSK (1Mbps):

DH5 time $s_l = 2.880 \text{ (ms)} * (800/6/20 * 8 = 153.60 \text{ (ms)}$

$\pi/4$ -DQPSK (2Mbps):

2DH5 time $= 2.895 \text{ (ms)} * (800/6/20 * 8 = 154.40 \text{ (ms)}$

8-DPSK (3Mbps):

3DH5 time $= 2.895 \text{ (ms)} * (800/6/20 * 8 = 154.40 \text{ (ms)}$

13.6 Measurement Result

Note: Refer to next page for plots.

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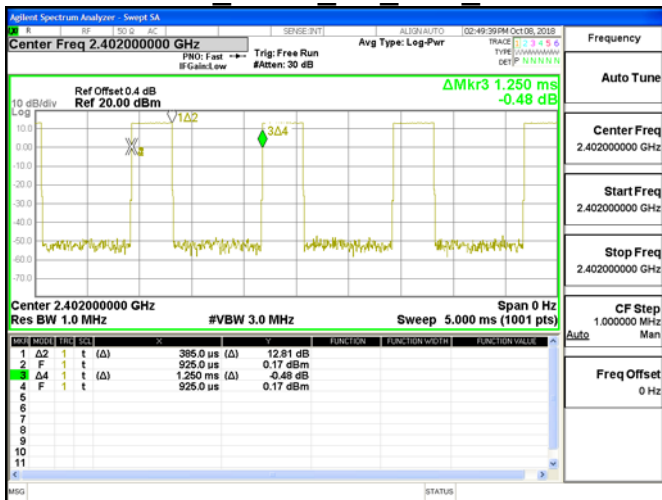
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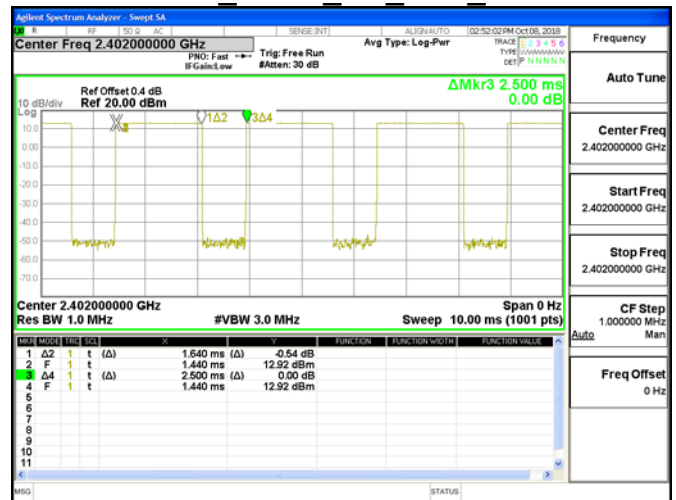
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Dwell Time_GFSK_1M_DH1_2402MHz



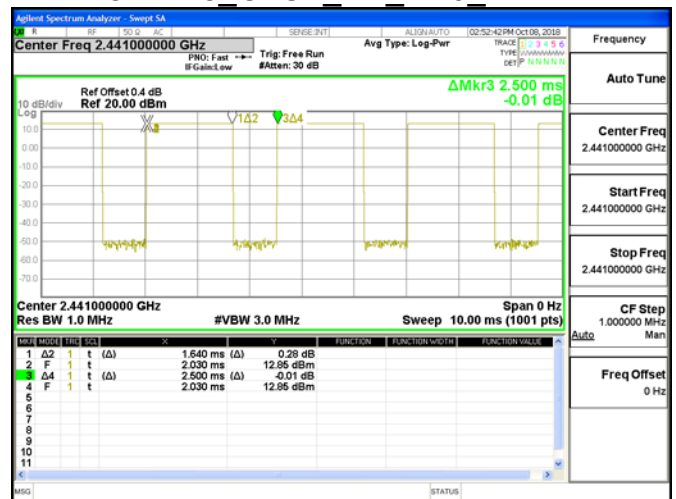
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Dwell Time_GFSK_1M_DH1_2441MHz



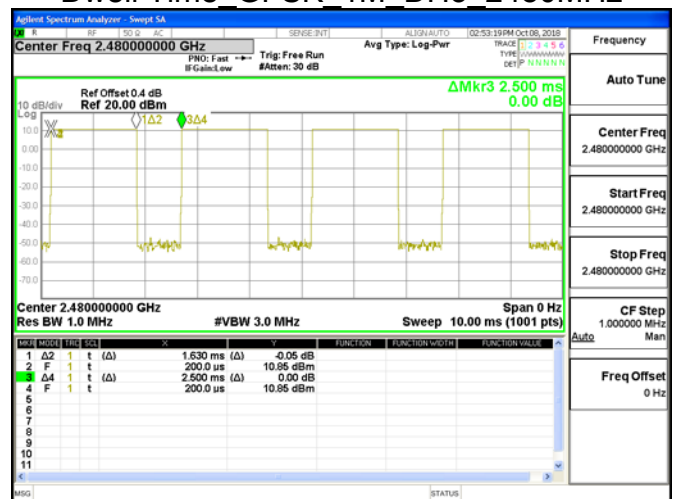
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Dwell Time_GFSK_1M_DH1_2480MHz



Dwell Time_GFSK_1M_DH3_2480MHz

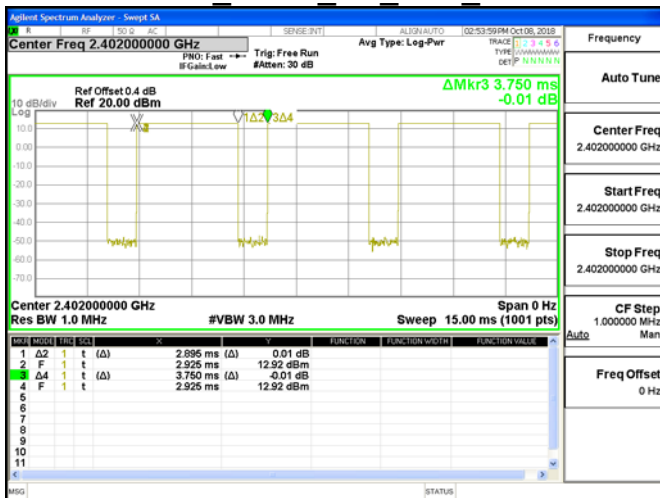


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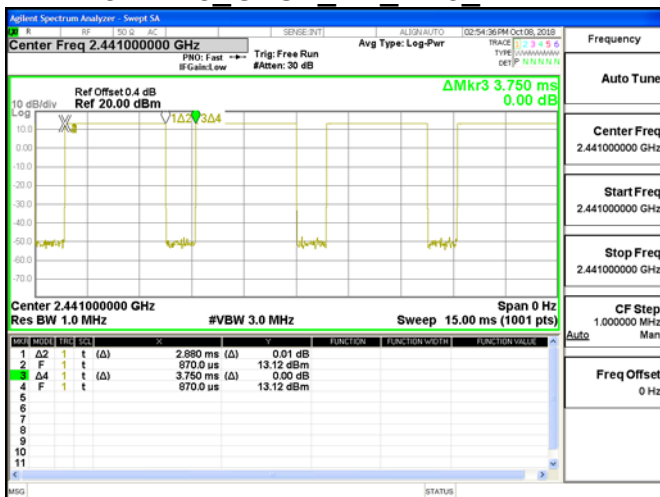
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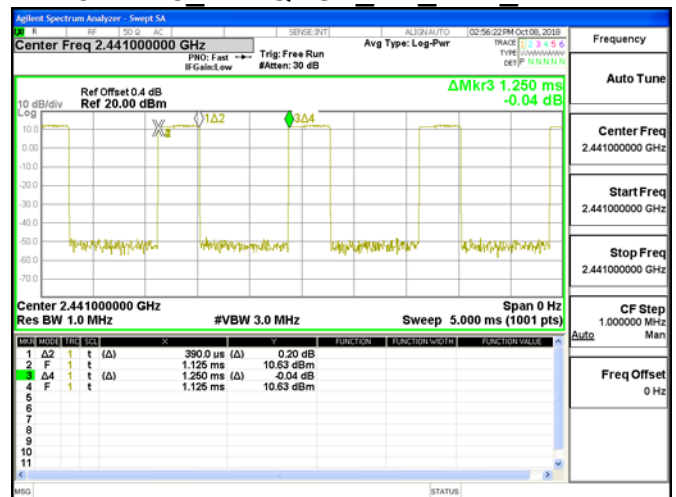
Dwell Time π4DQPSK 2M DH1 2402MHz



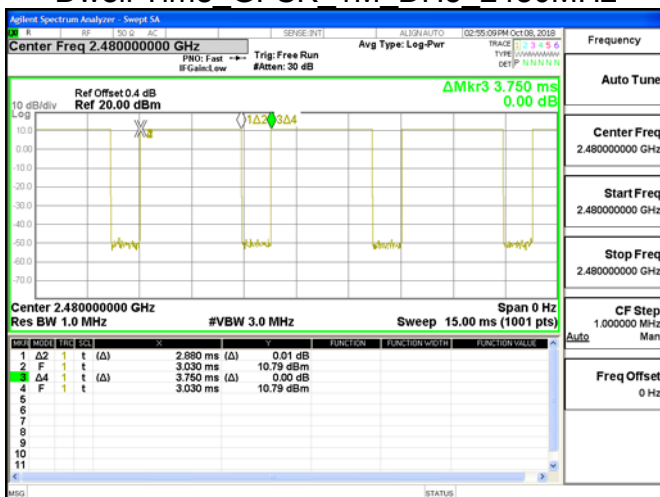
Dwell Time GFSK 1M DH5 2441MHz



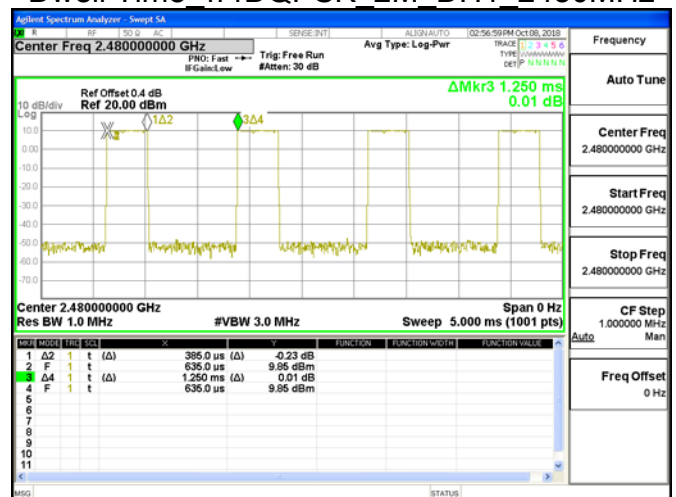
Dwell Time π4DQPSK 2M DH1 2441MHz



Dwell Time GFSK 1M DH5 2480MHz



Dwell Time π4DQPSK 2M DH1 2480MHz

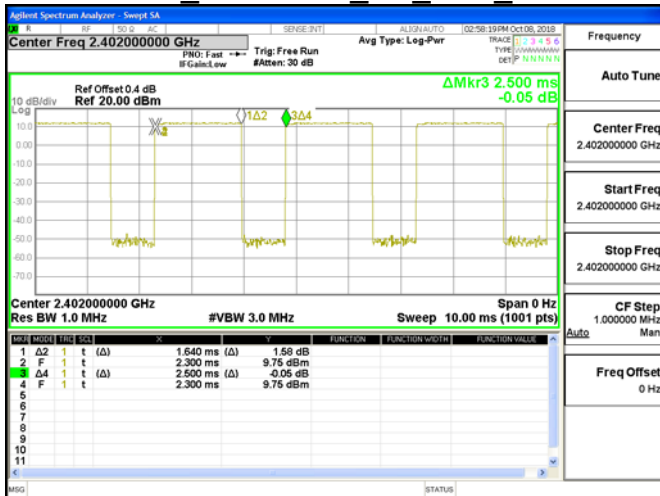


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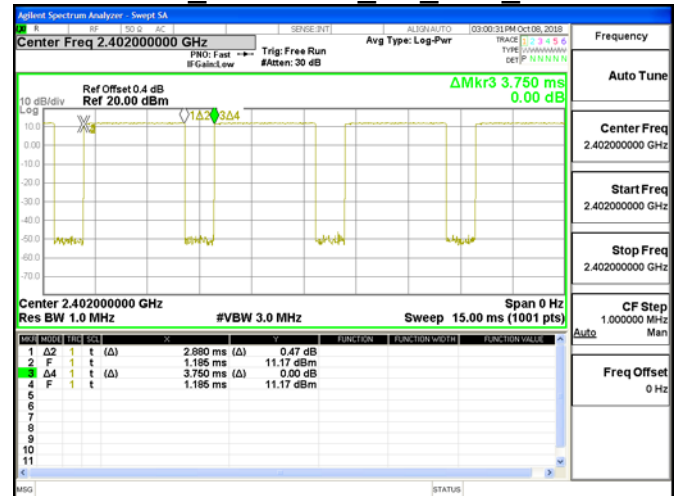
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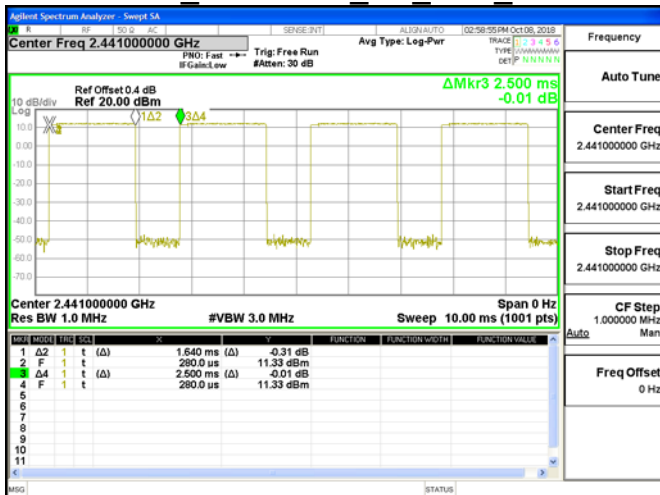
Dwell Time π 4DQPSK 2M DH3 2402MHz



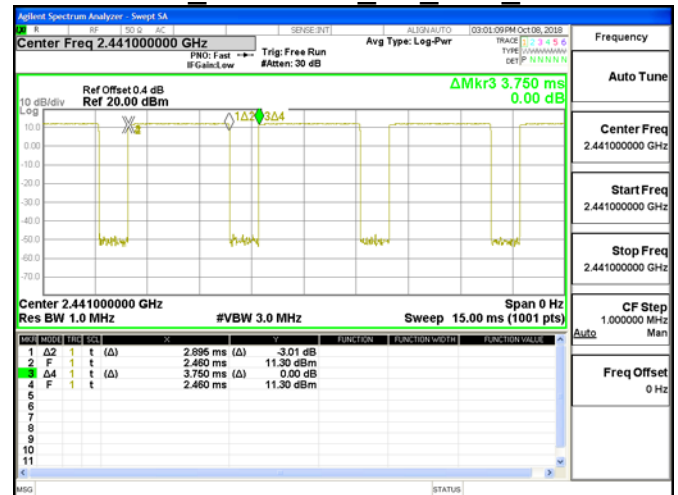
Dwell Time π 4DQPSK 2M DH5 2402MHz



Dwell Time π 4DQPSK 2M DH3 2441MHz



Dwell Time π 4DQPSK 2M DH5 2441MHz



Dwell Time π 4DQPSK 2M DH3 2480MHz



Dwell Time π 4DQPSK 2M DH5 2480MHz

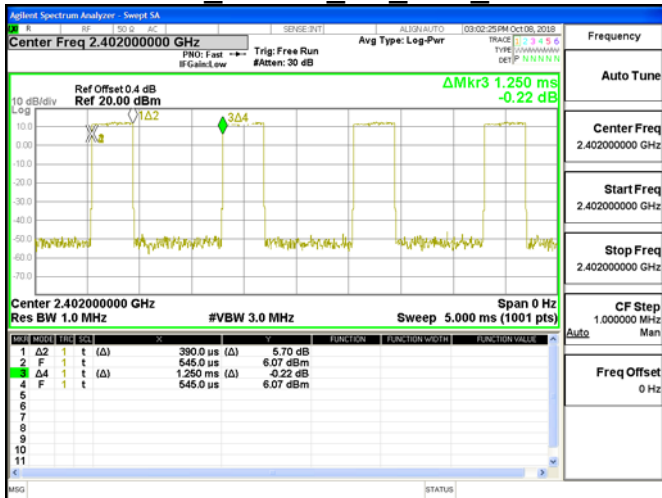


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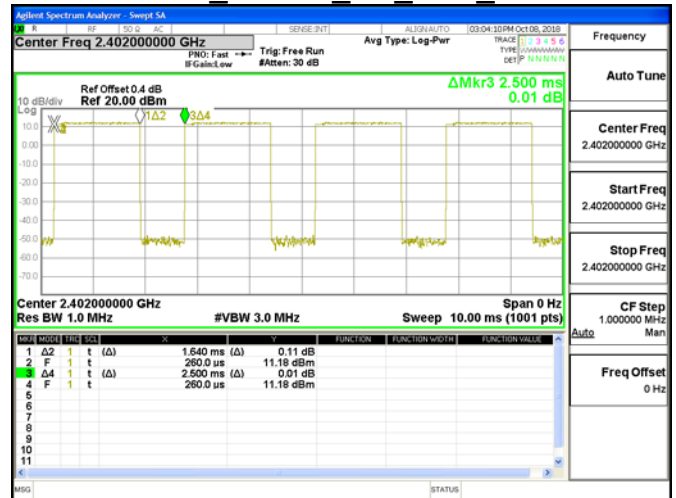
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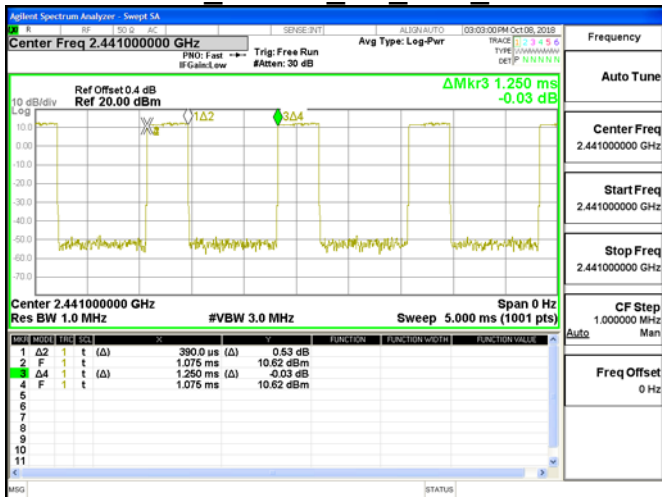
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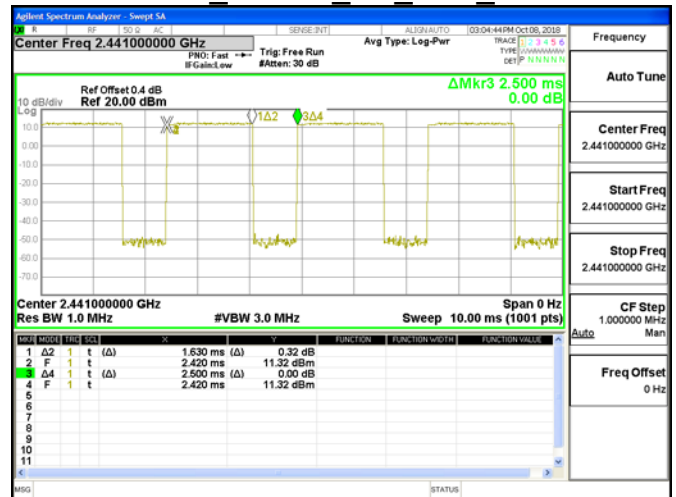
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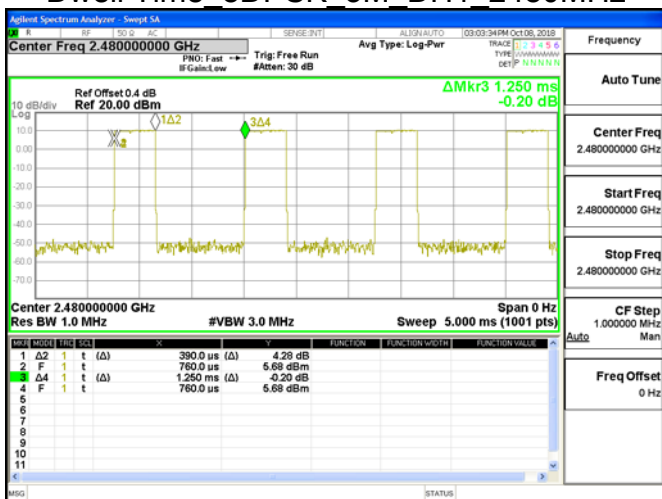
Dwell Time 8DPSK 3M DH1 2441MHz



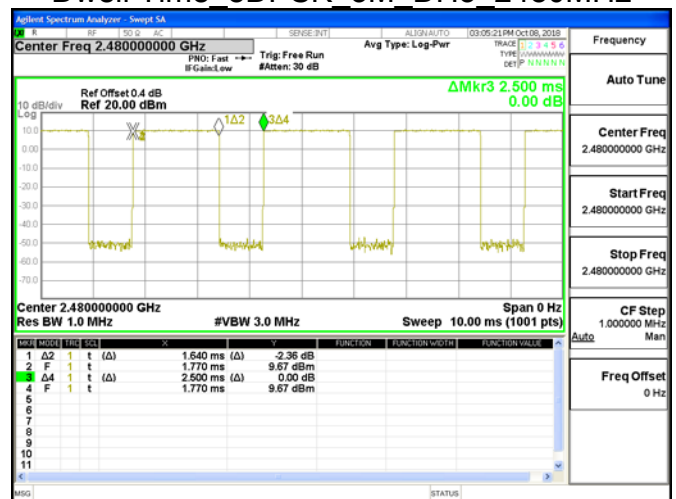
Dwell Time 8DPSK 3M DH3 2441MHz



Dwell Time 8DPSK 3M DH1 2480MHz



Dwell Time 8DPSK 3M DH3 2480MHz

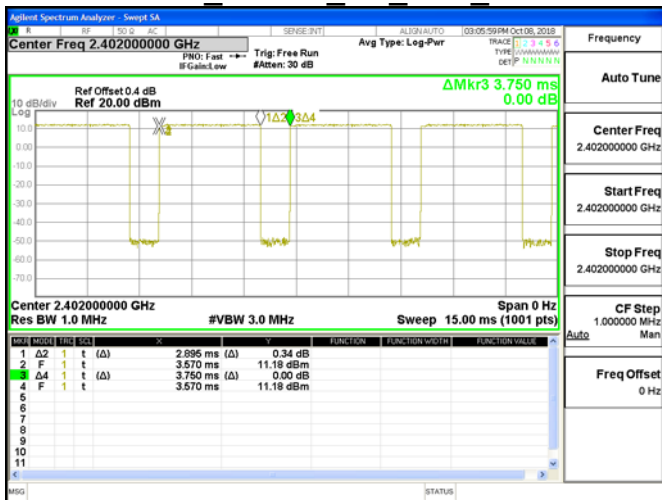


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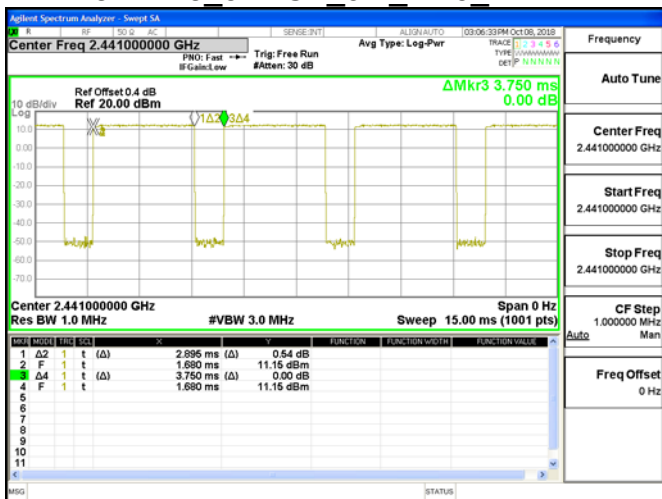
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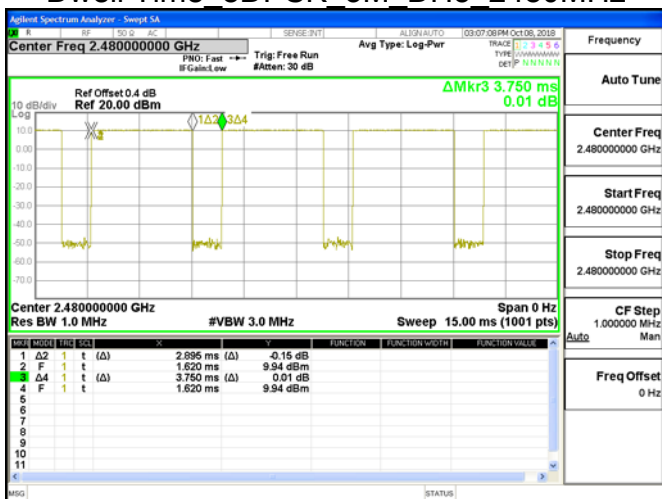
Dwell Time 8DPSK 3M DH5 2402MHz



Dwell Time 8DPSK 3M DH5 2441MHz



Dwell Time 8DPSK 3M DH5 2480MHz



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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 as permanently attached and no consideration of replacement. Please see EUT photo for details.

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