

# ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

## INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART C REQUIREMENT

OF

**Applicant:** Hon Hai Precision Industry Co., Ltd.  
No.151, Sec. 1, Nankan Rd., Lujhu, Taoyuan County, Taiwan, 33859

**Product Name:** BT4.2 Wireless Module

**Brand Name:** SHARP

**Model No.:** BTUC49-SP, BTUC49-TX

**Model Difference:** Market segmentation

**FCC ID:** RX3-BTUC49

**Report Number:** ER/2018/B0091

**FCC Rule Part:** §15.247, Cat: DSS

**Issue Date:** Dec. 05, 2018

**Date of Test:** Nov. 14, 2018 ~ Nov. 26, 2018

**Date of EUT Received:** Nov. 14, 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



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## Revision History

Report Number	Revision	Description	Effected Page	Issue Date	Revised By
ER/2018/B0091	Rev.00	Initial creation of document	All	Dec. 05, 2018	Tiffany Kao

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# 1 GENERAL INFORMATION

## 1.1 Product description

General:

Product Name:	BT4.2 Wireless Module
Brand Name:	SHARP
Model No.:	BTUC49-SP, BTUC49-TX
Model Difference:	Market segmentation
Hardware Version:	DVT
Software Version:	N/A
Power Supply:	5Vdc from USB Port

Bluetooth\_BR+EDR:

Bluetooth Version:	Bluetooth V4.2 Dual Mode
Channel number:	79 channels
Modulation type:	GFSK + $\pi/4$ DQPSK + 8DPSK
Transmit Power:	-0.08 dBm
Frequency Range:	2.402GHz – 2.480GHz
Dwell Time:	$\leq 0.4s$
Antenna Designation:	PIFA Antenna, Gain: 2.49dBi

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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

Canada Registration Number: 4620A-5

## 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 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  $\mu$ H/50 ohm 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 plane. 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

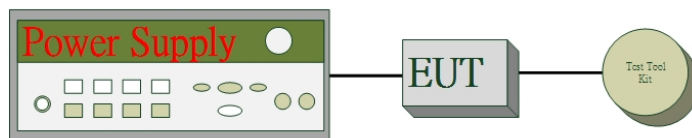


Fig. 2-2 AC Power Line Conducted Emission

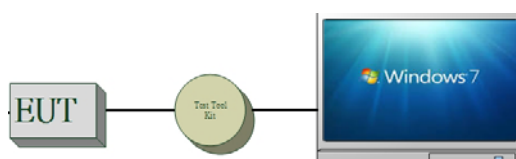


Fig. 2-3 Conducted (Antenna Port) Emission

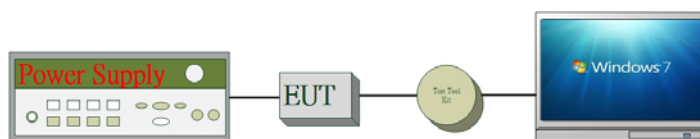


Table 2-1 Equipment Used in Tested System

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
4.	Test Kit	N/A	N/A	N/A	N/A	N/A

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### 3 SUMMARY OF TEST RESULTS

FCC Rules	Description Of Test	Result
§15.207(a)	AC Power Line Conducted Emission	Compliant
§15.247(b)(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, $\pi/4$ -DQPSK, 8-DQPK	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, $\pi/4$ -DQPSK, 8-DQPK	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 : <b>Vertical</b> )	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 : <b>Horizontal</b> )	9kHz – 30MHz: +/- 2.87 dB
	30MHz - 167MHz: +/- 4.22dB
	167MHz -500MHz: +/- 3.44dB
	0.5GHz-1GHz: +/- 3.39dB
	1GHz - 18GHz: +/- 4.08dB
	18GHz - 40GHz: +/- 4.08dB

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

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## 6 CONDUCTED EMISSION TEST

### 6.1 Standard Applicable

Frequency within 150 kHz to 30MHz shall not exceed the limit table as below.

Frequency range MHz	Limits dB(uV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50
Note		
1.The lower limit shall apply at the transition frequencies		
2.The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.		

### 6.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EMI Test Receiver	R&S	ESCI7	100335	02/02/2018	02/01/2019
LISN	SCHWARZ- BECK	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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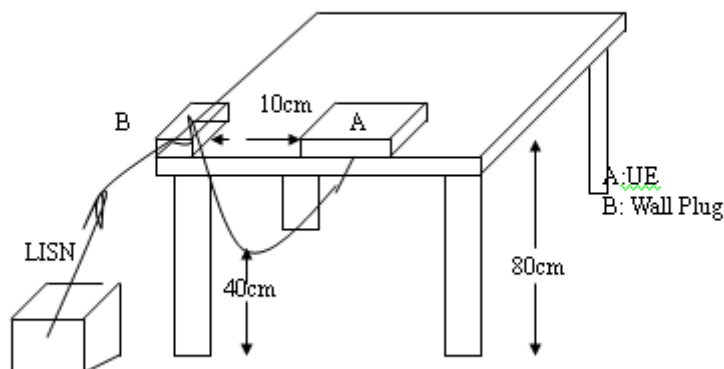
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#### 6.4 Test SET-UP (Block Diagram of Configuration)



#### 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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## 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 mode

Note:

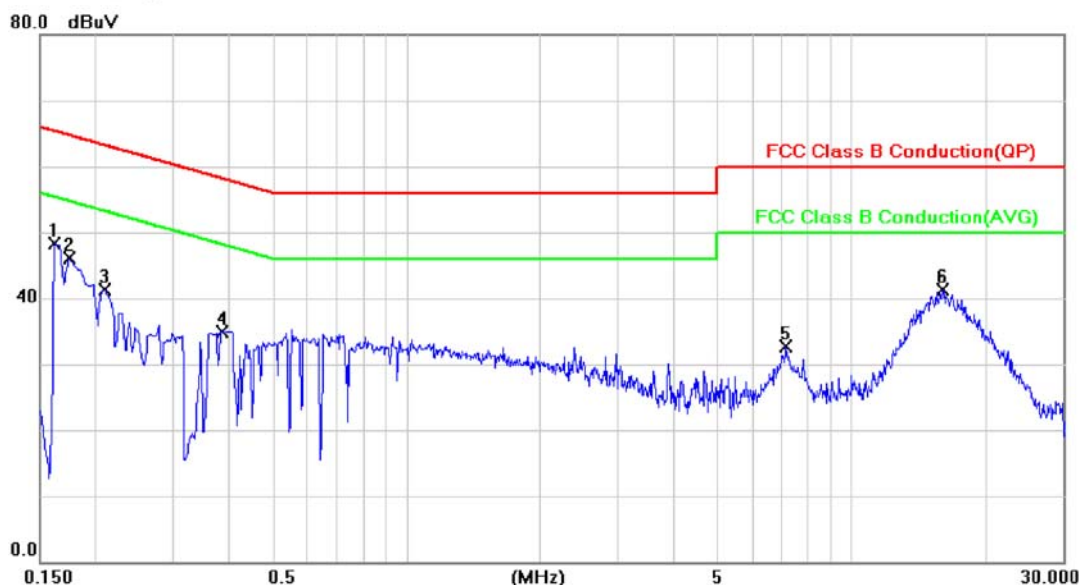
## Conducted Emission

File :鴻海精密\_BT4

Data :#4

Date: 2018/11/23

Time: 上午 07:56:35



No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over	Detector	Comment
		MHz	dBuV	dB	dBuV	dBuV	dB		
1	*	0.1620	48.19	0.07	48.26	65.36	-17.10	peak	
2		0.1740	46.08	0.06	46.14	64.77	-18.63	peak	
3		0.2100	41.24	0.05	41.29	63.21	-21.92	peak	
4		0.3860	34.92	0.04	34.96	58.15	-23.19	peak	
5		7.1660	32.62	0.16	32.78	60.00	-27.22	peak	
6		16.0700	41.08	0.20	41.28	60.00	-18.72	peak	

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

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

Temperature: 25 °C  
Humidity: 85 %

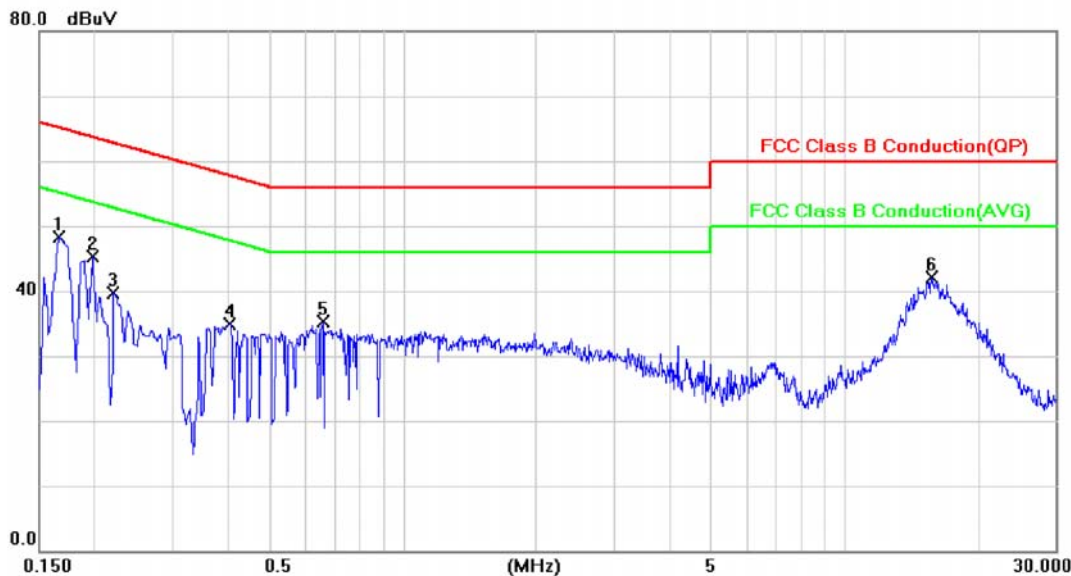
## Conducted Emission

File :鴻海精密\_BT4

Data :#3

Date: 2018/11/23

Time: 上午 07:55:08



No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1	*	0.1660	48.25	0.11	48.36	65.16	-16.80	peak	
2		0.1980	45.16	0.10	45.26	63.69	-18.43	peak	
3		0.2220	39.57	0.10	39.67	62.74	-23.07	peak	
4		0.4060	34.84	0.09	34.93	57.73	-22.80	peak	
5		0.6580	35.24	0.09	35.33	56.00	-20.67	peak	
6		15.7180	41.77	0.24	42.01	60.00	-17.99	peak	

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## 7 PEAK OUTPUT POWER MEASUREMENT

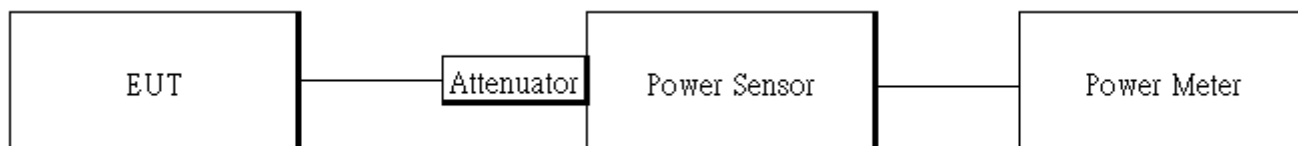
### 7.1 Standard Applicable

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

Conducted Emission Test Site					
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
EXA Spectrum Analyzer	Agilent	N9010A	MY50420195	05/03/2018	05/02/2019
DC Power Supply	Agilent	E3640A	KR93300208	08/15/2018	08/14/2019
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2018	01/01/2019
Notebook	Lenovo	L430	R9-X11BG	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. Measurement Guidelines.
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	-2.10	0.617	1000
39	2441	-0.51	0.889	1000
78	2480	-0.08	0.982	1000

1M BR mode (Average):

CH	Freq. (MHz)	Max. Output include tune up tolerance Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	-2.33	0.585	1000
39	2441	-0.70	0.851	1000
78	2480	-0.30	0.934	1000

2M EDR mode (Peak):

CH	Freq. (MHz)	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	-2.83	0.521	125
39	2441	-1.04	0.787	125
78	2480	-0.68	0.855	125

2M EDR mode (Average):

CH	Freq. (MHz)	Max. Avg. Output include tune up tolerance	Output Power (mW)	Limit (mW)
0	2402	-5.75	0.266	125
39	2441	-4.34	0.368	125
78	2480	-4.31	0.371	125

3M EDR mode (Peak):

CH	Freq. (MHz)	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	-2.41	0.574	125
39	2441	-0.66	0.859	125
78	2480	-0.28	0.938	125

3M EDR mode (Average):

CH	Freq. (MHz)	Max. Avg. Output include tune up tolerance	Output Power (mW)	Limit (mW)
0	2402	-5.73	0.267	125
39	2441	-4.37	0.366	125
78	2480	-3.95	0.403	125

NOTE: cable loss as 0.8dB that offsets in the spectru

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

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## 8 20dB BANDWIDTH MEASUREMENT

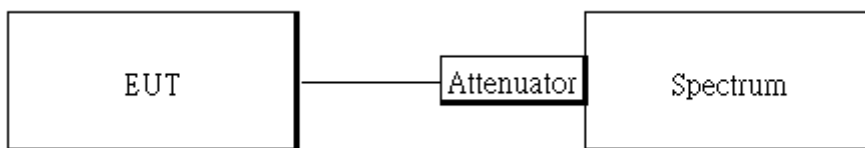
### 8.1 Standard Applicable

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.
Power Meter	Anritsu	ML2496A	1804001	02/01/2018	01/31/2019
Power Sensor	Anritsu	MA2411B	1726104	02/01/2018	01/31/2019
DC Power Supply	Agilent	E3640A	KR93300208	08/15/2018	08/14/2019
Notebook	Lenovo	L430	R9-X11BG	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. Measurement Guidelines.
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

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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	0.924	0.62	Low	1.254	0.84	Low	1.259	0.84
Mid	0.924	0.62	Mid	1.239	0.83	Mid	1.252	0.83
High	0.923	0.62	High	1.239	0.83	High	1.250	0.83

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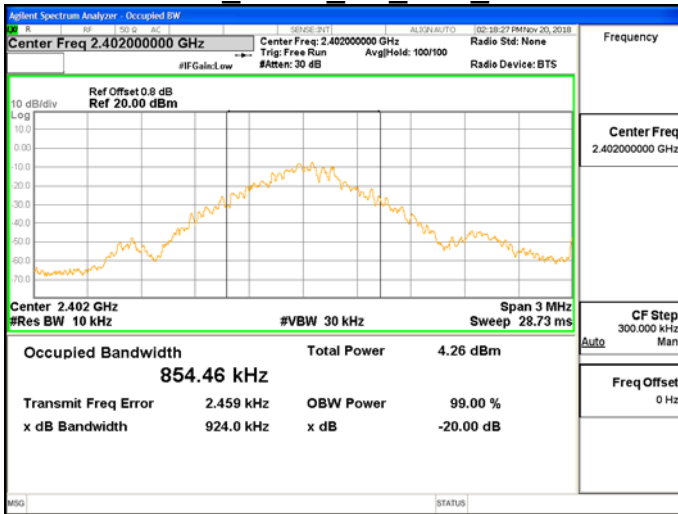
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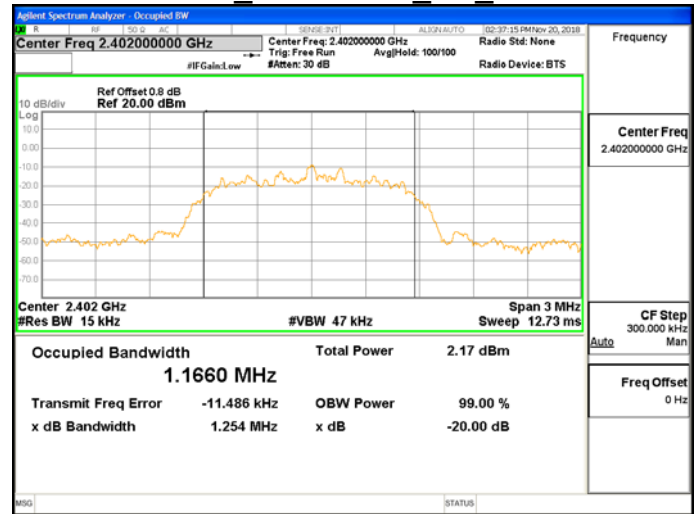
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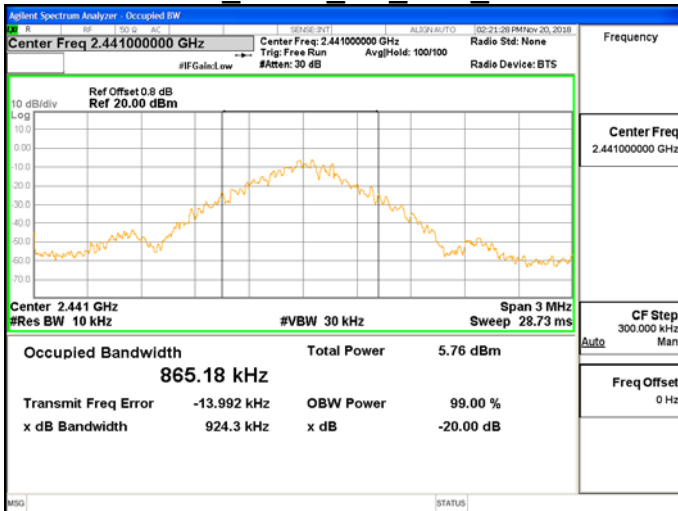
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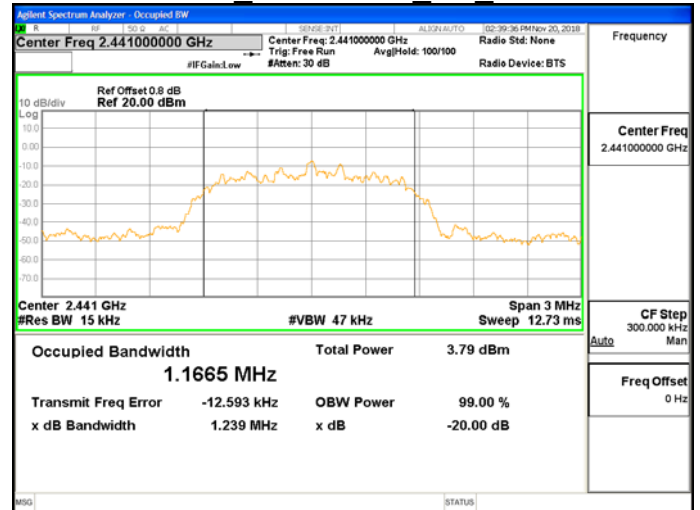
OBW 20dB\_π/4DQPSK\_2M\_2402MHz



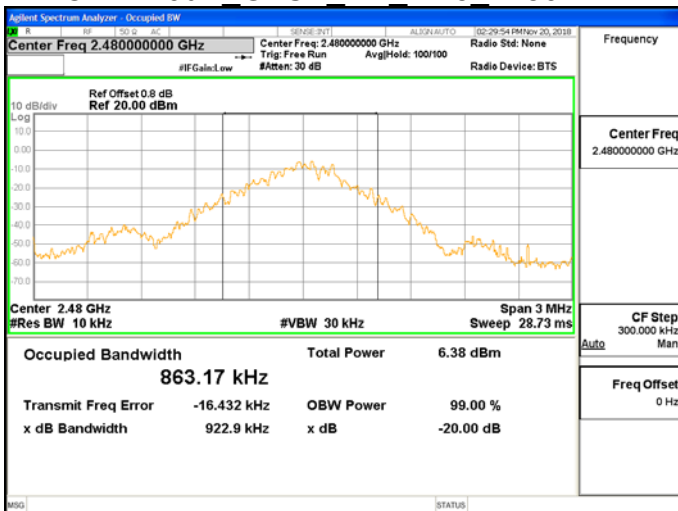
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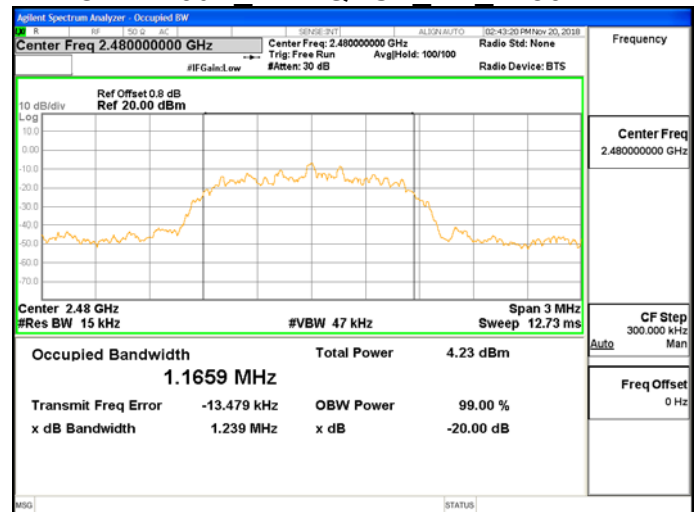
OBW 20dB\_π/4DQPSK\_2M\_2441MHz



OBW 20dB\_GFSK\_1M\_DH5\_2480MHz



OBW 20dB\_π/4DQPSK\_2M\_2480MHz



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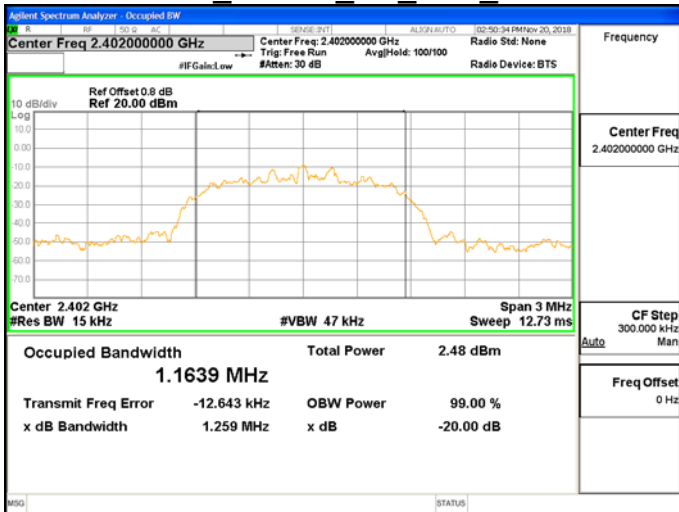
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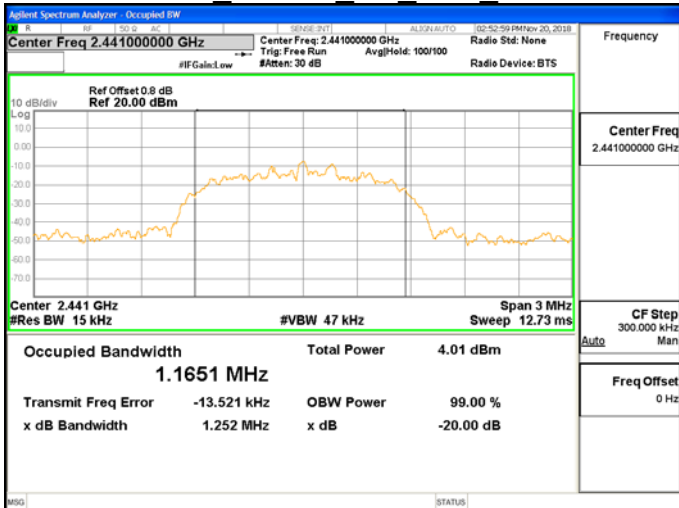
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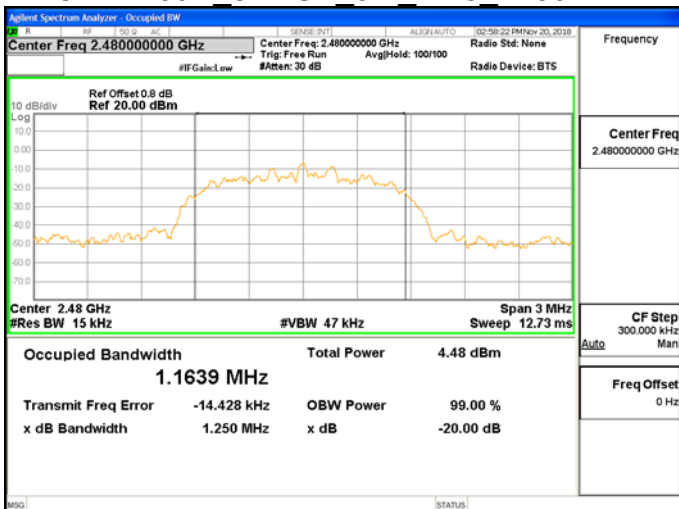
### OBW 20dB 8DPSK 3M DH5 2402MHz



### OBW 20dB 8DPSK 3M DH5 2441MHz



### OBW 20dB 8DPSK 3M DH5 2480MHz



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## 9 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

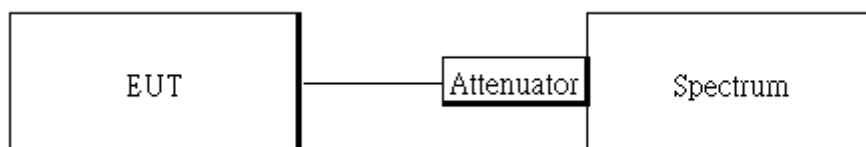
### 9.1 Standard Applicable

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

Conducted Emission Test Site					
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
DC Power Supply	Agilent	E3640A	KR93300208	08/15/2018	08/14/2019
Notebook	Lenovo	L430	R9-X11BG	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. Measurement Guidelines.
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. Measurement Guidelines.
3. Set RBW = 100 kHz & VBW = 300 kHz, Detector =Peak, Sweep = Auto
4. Allow trace to fully stabilize.
5. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
6. Repeat above procedures until all default test channel measured were complete.

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

$$FS = RA + AF + CL - AG$$

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

## 9.5 Measurement Result

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

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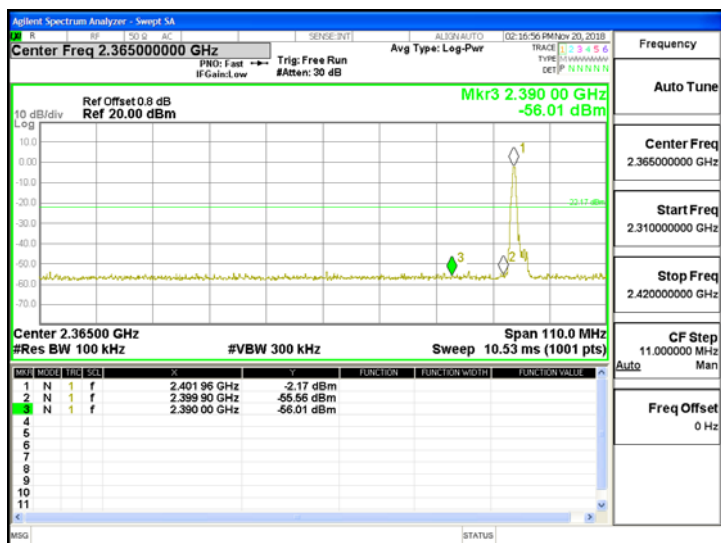
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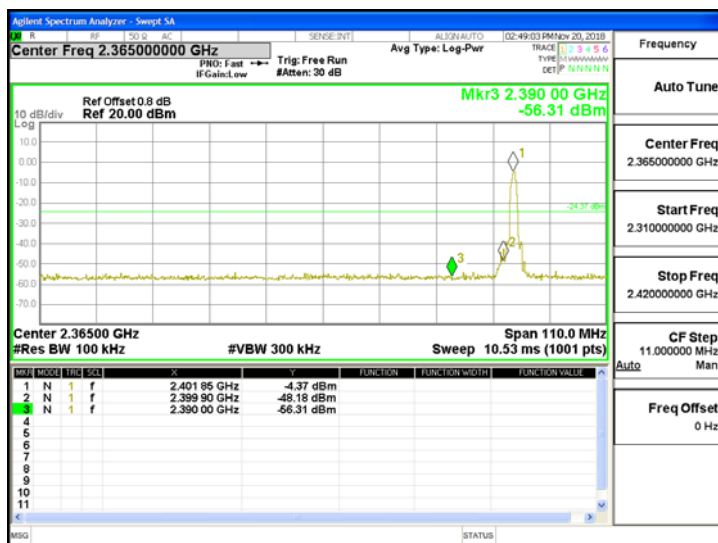
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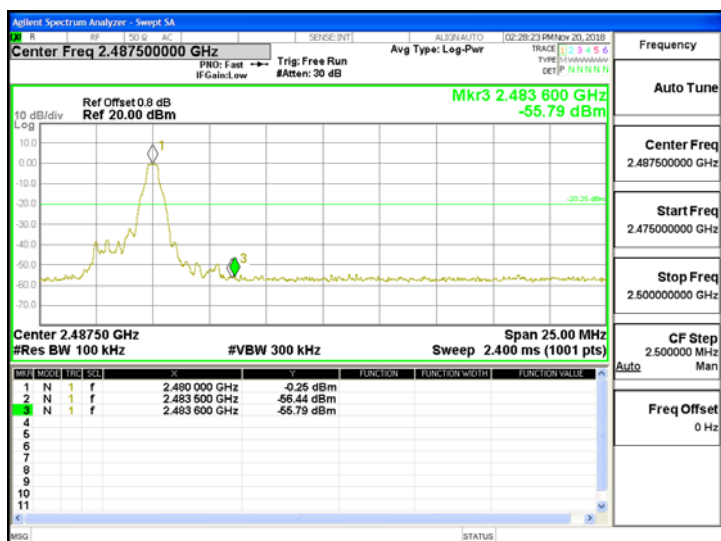
Band Edge\_GFSK\_1M\_DH5\_2402MHz



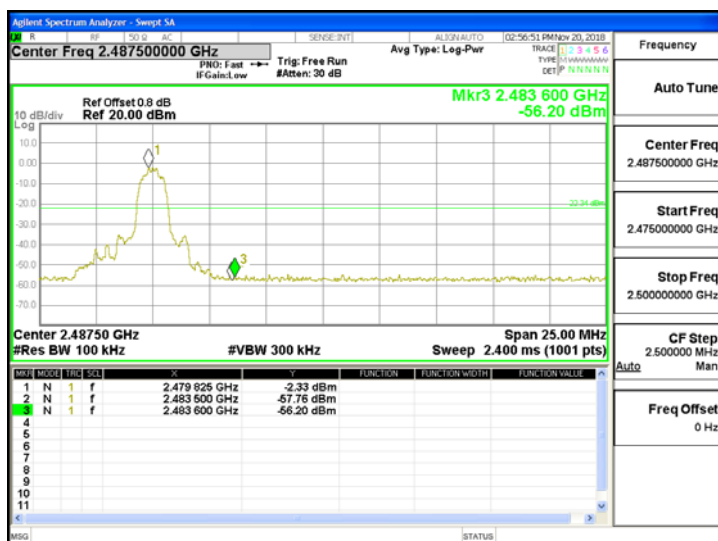
Band Edge\_8DPSK\_3M\_DH5\_2402MHz



Band Edge\_GFSK\_1M\_DH5\_2480MHz



Band Edge\_8DPSK\_3M\_DH5\_2480MHz



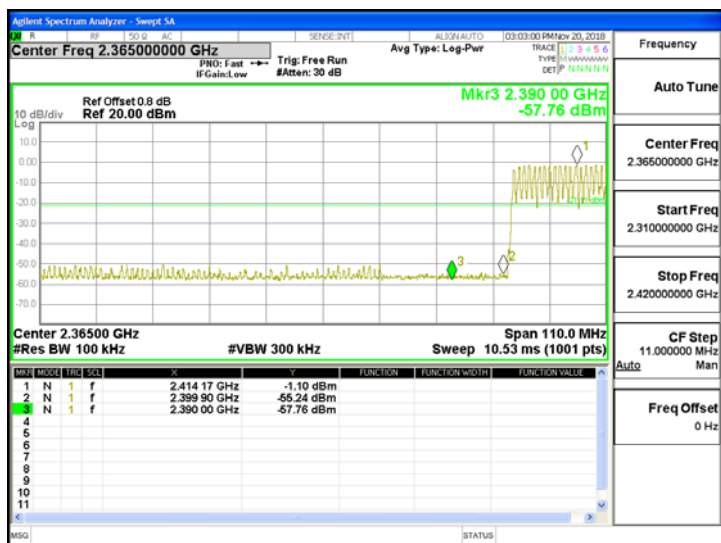
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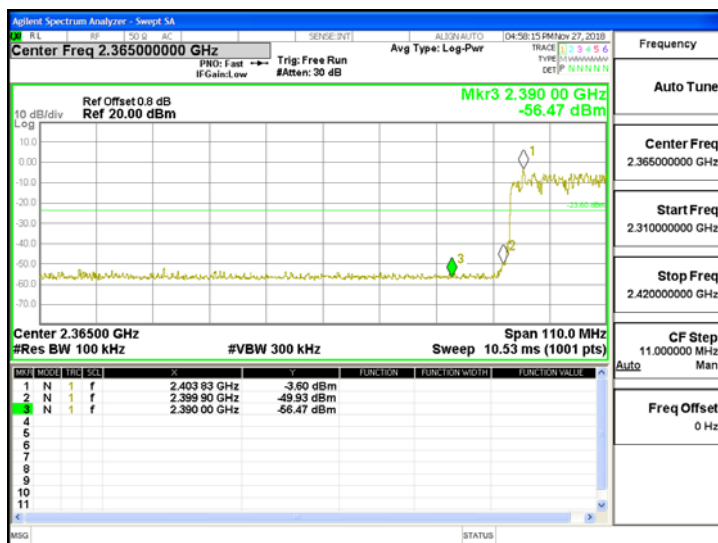
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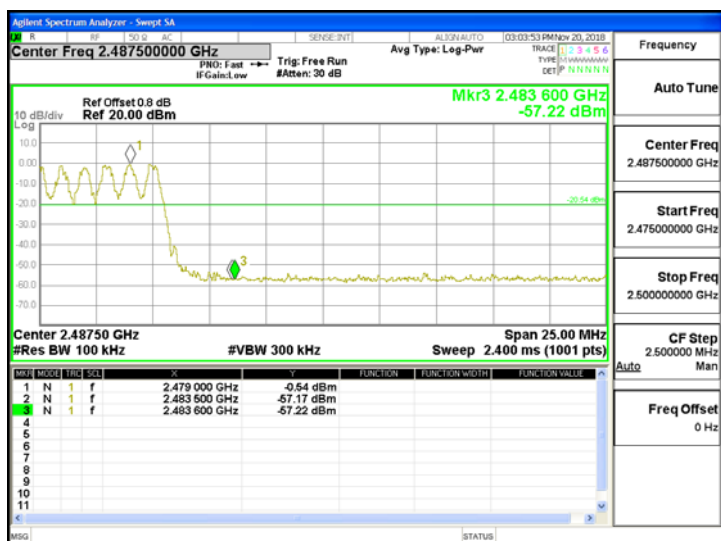
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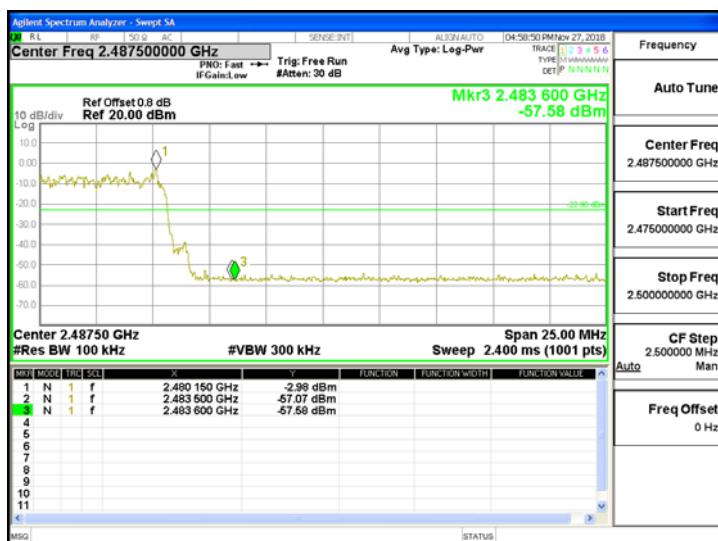
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## Hopping Band Edge\_GFSK\_1M\_DH5\_2480MHz



## Hopping Band Edge\_8DPSK\_3M\_DH5\_2480MHz



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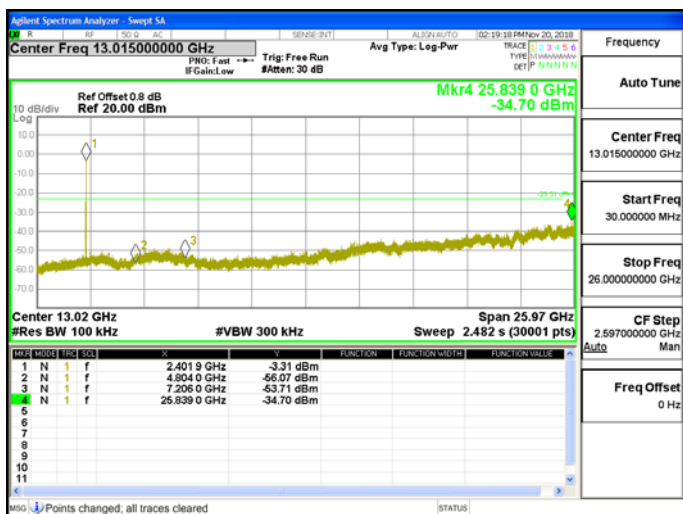
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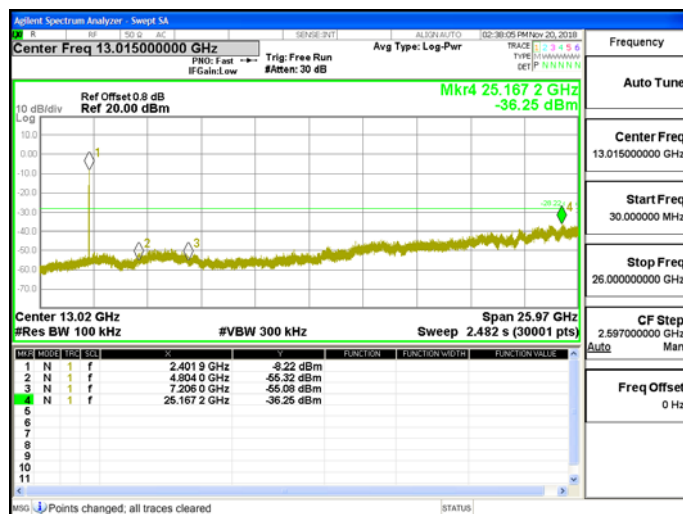
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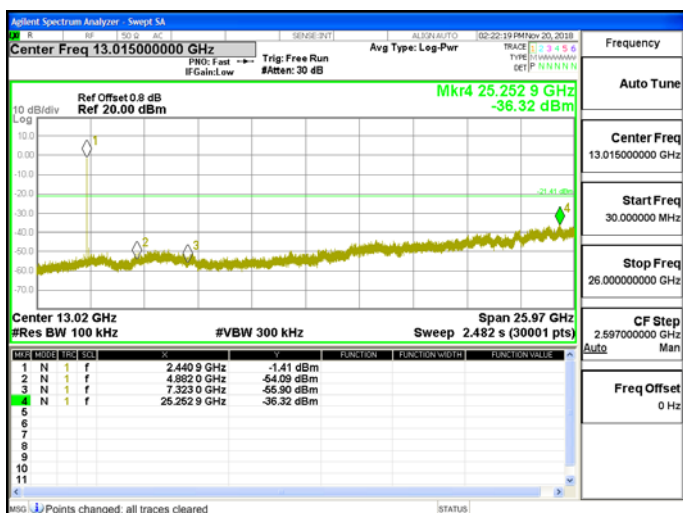
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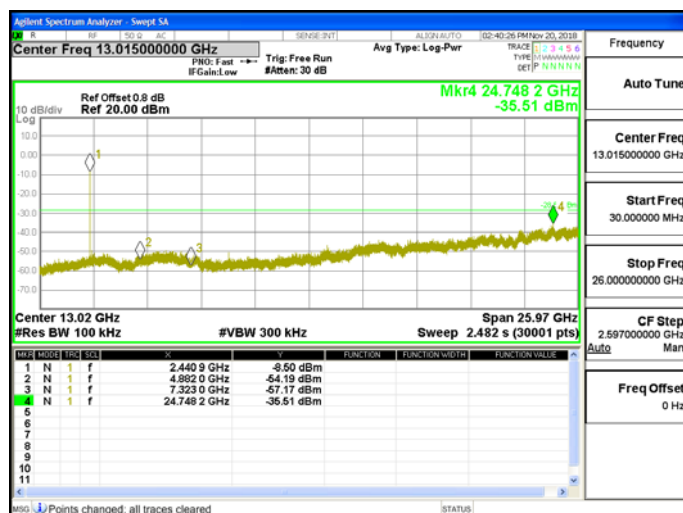
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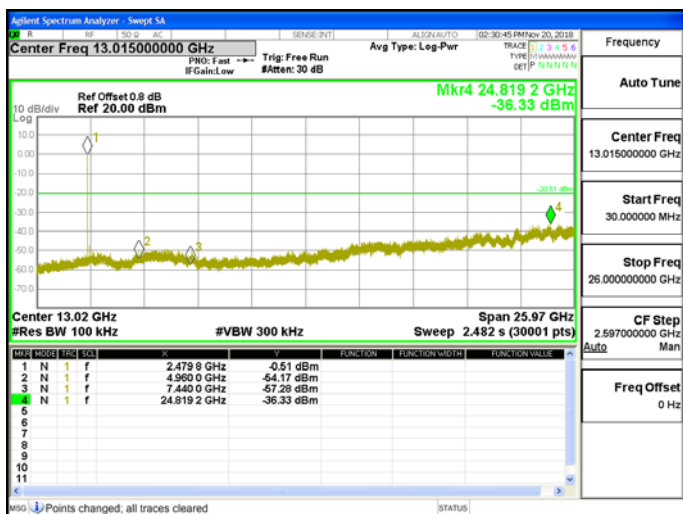
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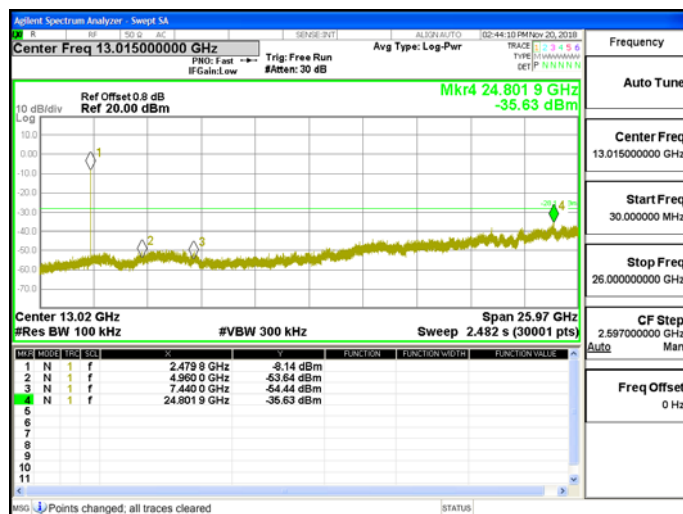
## Spurious Emission\_π/4DQPSK\_2M\_2441MHz



## Spurious Emission\_GFSK\_1M\_DH5\_2480MHz



## Spurious Emission\_π/4DQPSK\_2M\_2480MHz



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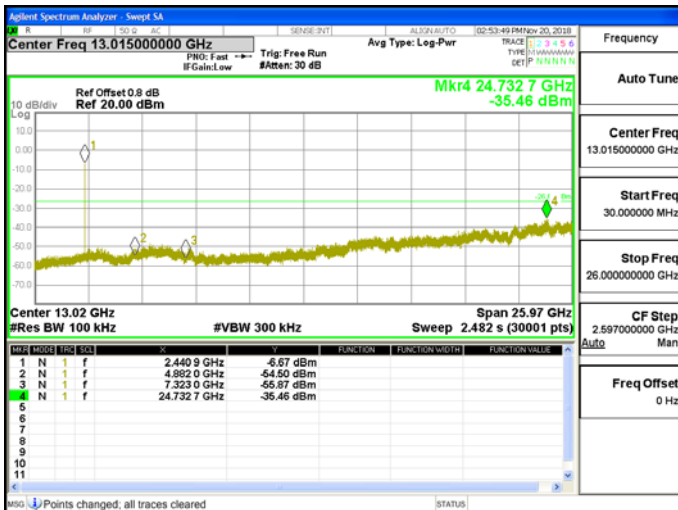
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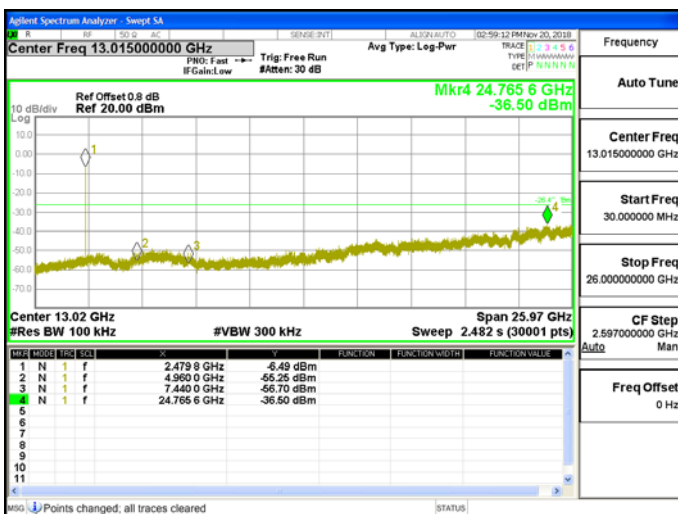
### Spurious Emission\_8DPSK\_3M\_DH5\_2402MHz



### Spurious Emission\_8DPSK\_3M\_DH5\_2441MHz



### Spurious Emission\_8DPSK\_3M\_DH5\_2480MHz



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## 10 RADIATED 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.
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	10/08/2018	10/07/2019
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 Instruments	EMC184045B	980135	10/02/2018	10/01/2019
Attenuator	Mini-Circuit	BW-S10W2+	2	01/02/2018	01/01/2019
Filter 2400-2483.5 MHz	EWT	EWT-14-0166	M1	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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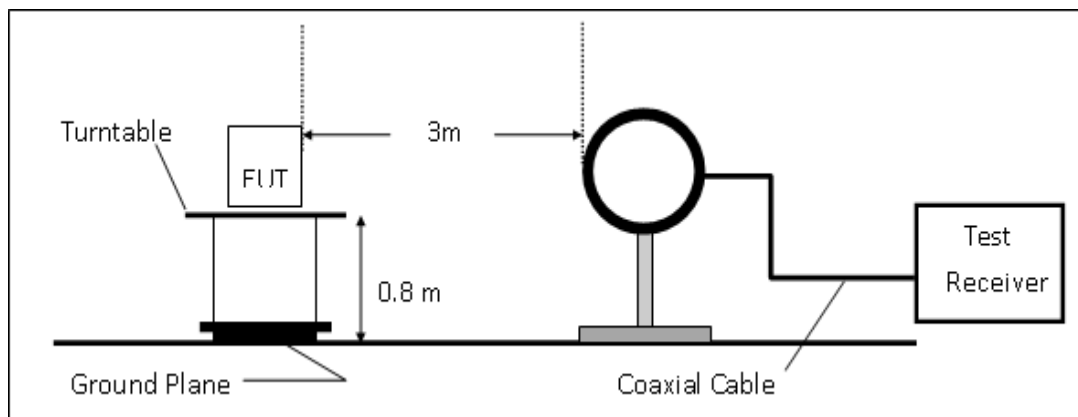
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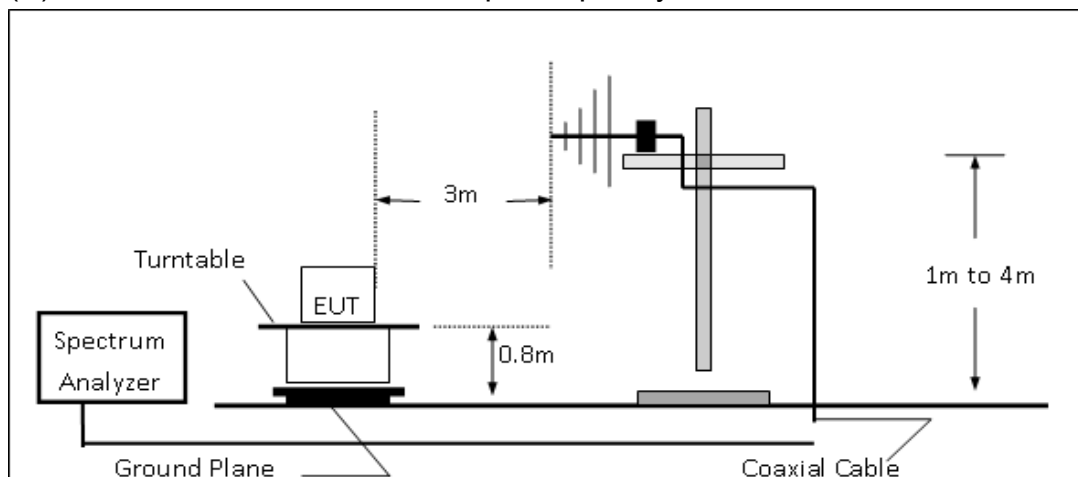
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### 10.3 Test SET-UP

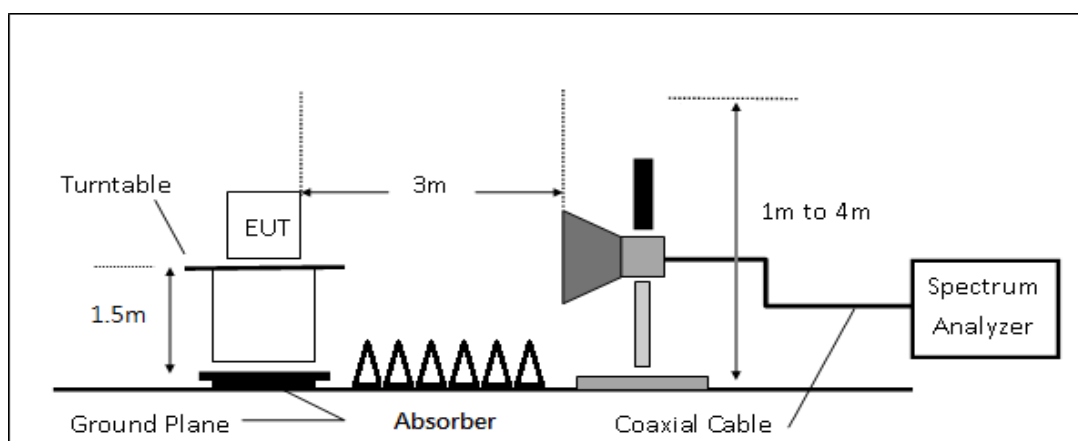
#### (A) Radiated Emission Test Set-UP Frequency Below 30MHz.



#### (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  

$$\text{On time} = N1 \cdot L1 = N2 \cdot L2 + \dots + N(n-1) \cdot L(n-1) + N(n) \cdot L(n)$$
 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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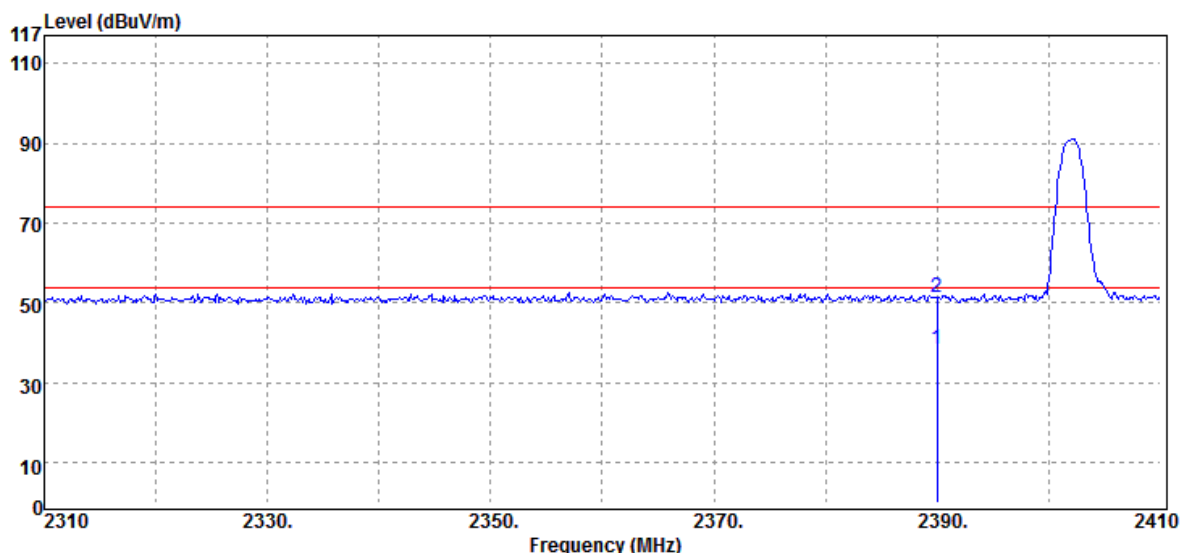
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## Radiated Band Edge Measurement Result:

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

Test Date :2018-11-23  
Temp./Humi. :23 deg\_C / 62 RH  
Engineer :Wei  
Measurement Antenna Pol. :VERTICAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2390.00	Average	38.35	0.20	38.55	54.00	-15.45
2390.00	Peak	51.33	0.20	51.53	74.00	-22.47

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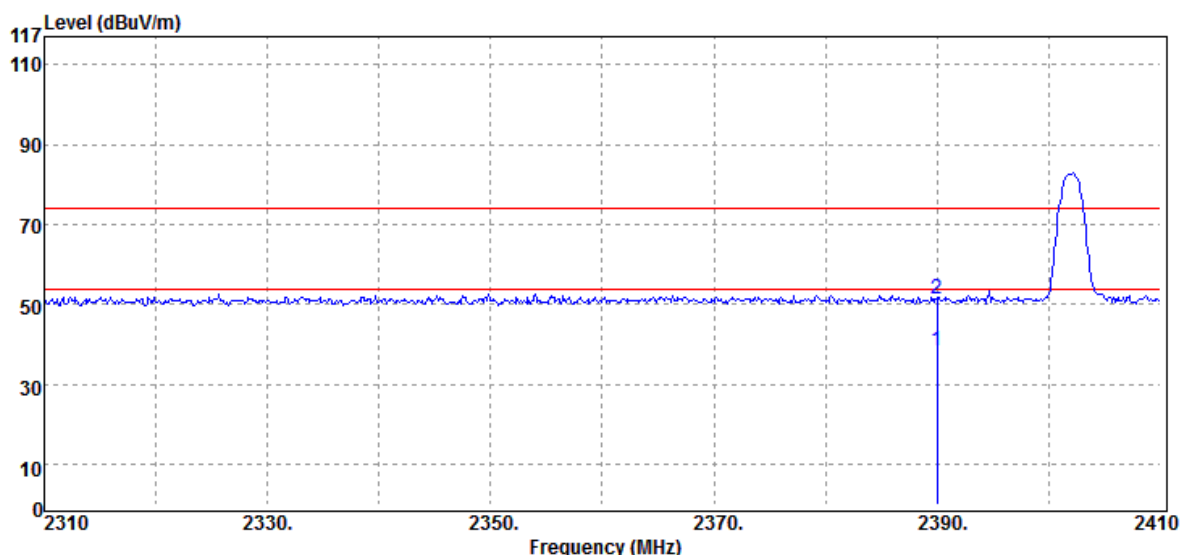
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Operation Band :BR(1M)  
Fundamental Frequency :2402 MHz  
Operation Mode :Bandedge CH LOW  
EUT Pol. :H Plane

Test Date :2018-11-23  
Temp./Humi. :23 deg\_C / 62 RH  
Engineer :Wei  
Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2390.00	Average	38.34	0.20	38.54	54.00	-15.46
2390.00	Peak	51.19	0.20	51.39	74.00	-22.61

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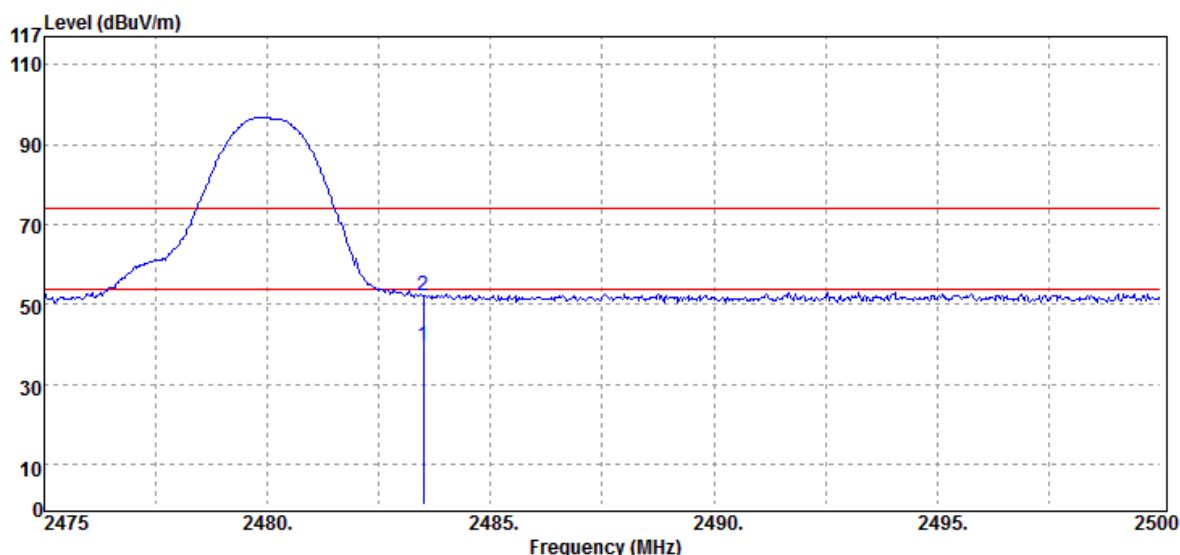
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Operation Band :BR(1M)  
 Fundamental Frequency :2480 MHz  
 Operation Mode :Bandedge CH HIGH  
 EUT Pol. :H Plane

Test Date :2018-11-23  
 Temp./Humi. :23 deg\_C / 62 RH  
 Engineer :Wei  
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2483.50	Average	39.22	0.53	39.75	54.00	-14.25
2483.50	Peak	51.53	0.53	52.06	74.00	-21.94

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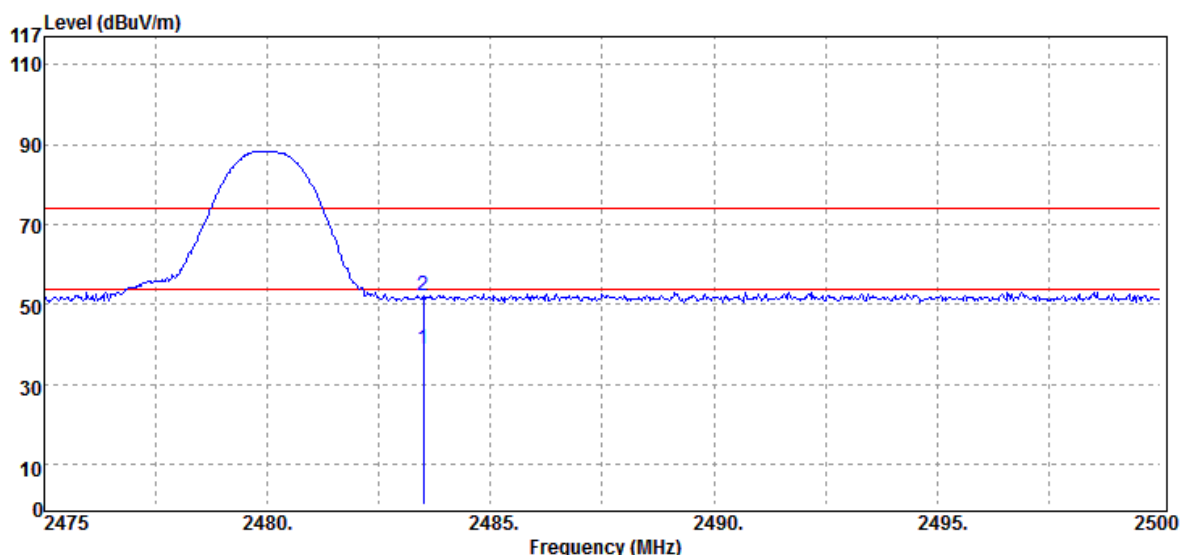
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Operation Band :BR(1M)  
Fundamental Frequency :2480 MHz  
Operation Mode :Bandedge CH HIGH  
EUT Pol. :H Plane

Test Date :2018-11-23  
Temp./Humi. :23 deg\_C / 62 RH  
Engineer :Wei  
Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2483.50	Average	38.44	0.53	38.97	54.00	-15.03
2483.50	Peak	51.76	0.53	52.29	74.00	-21.71

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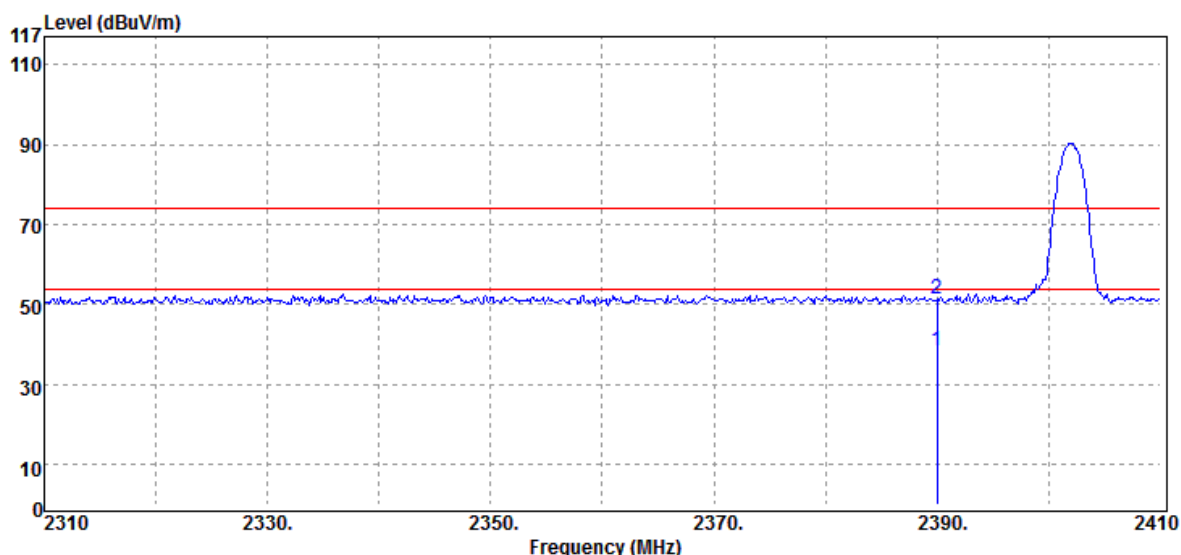
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Operation Band :EDR(3M)  
Fundamental Frequency :2402 MHz  
Operation Mode :Bandedge CH LOW  
EUT Pol. :H Plane

Test Date :2018-11-23  
Temp./Humi. :23 deg\_C / 62 RH  
Engineer :Wei  
Measurement Antenna Pol. :VERTICAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2390.00	Average	38.43	0.20	38.63	54.00	-15.37
2390.00	Peak	51.14	0.20	51.34	74.00	-22.66

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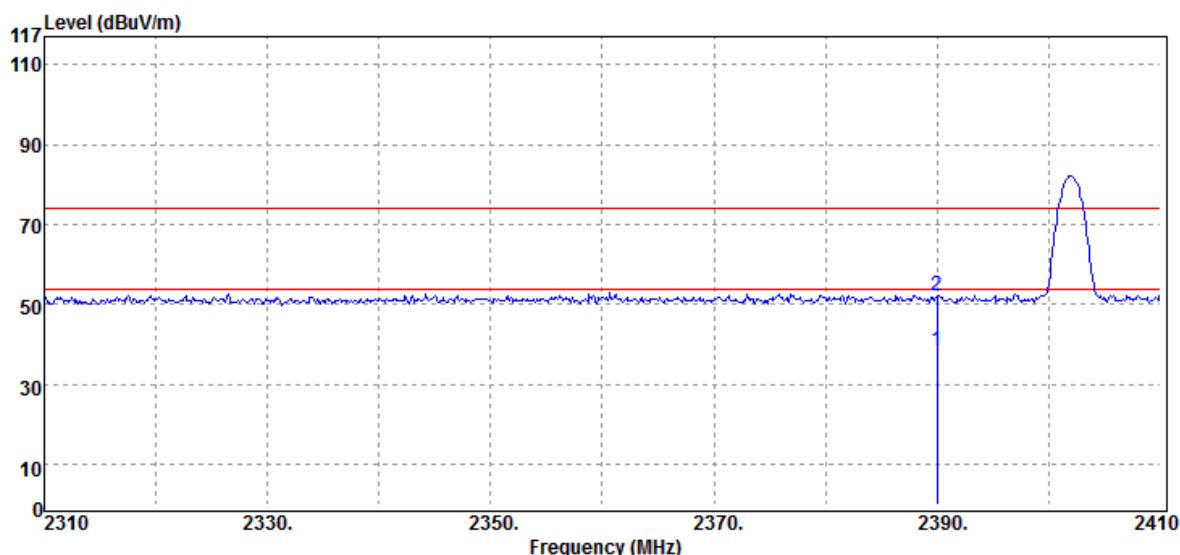
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Operation Band :EDR(3M)  
Fundamental Frequency :2402 MHz  
Operation Mode :Bandedge CH LOW  
EUT Pol. :H Plane

Test Date :2018-11-23  
Temp./Humi. :23 deg\_C / 62 RH  
Engineer :Wei  
Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2390.00	Average	38.37	0.20	38.57	54.00	-15.43
2390.00	Peak	52.10	0.20	52.30	74.00	-21.70

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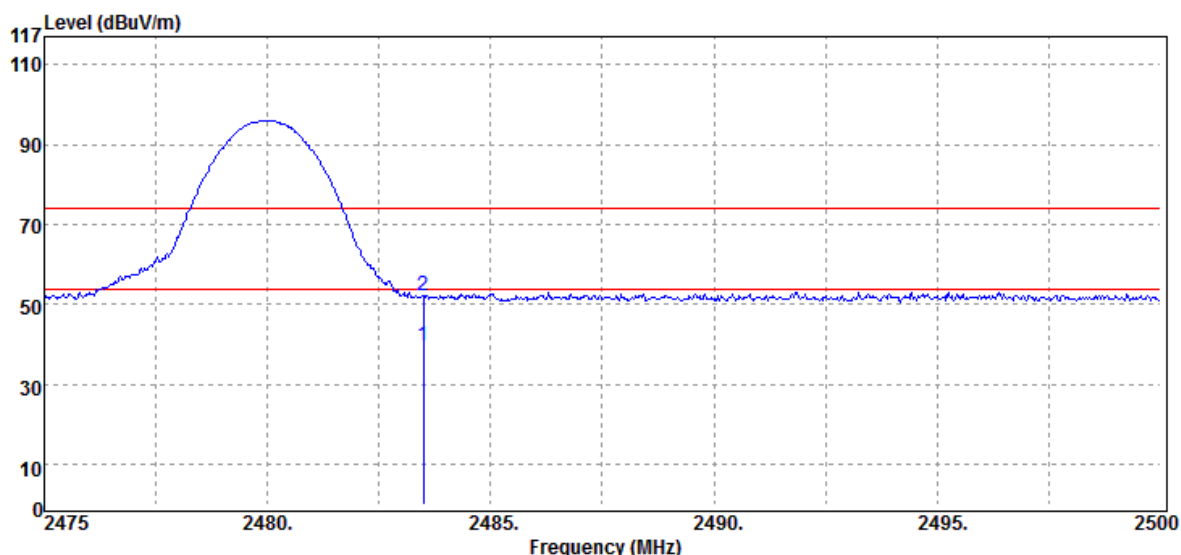
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Member of SGS Group

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

Test Date :2018-11-23  
Temp./Humi. :23 deg\_C / 62 RH  
Engineer :Wei  
Measurement Antenna Pol. :VERTICAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2483.50	Average	38.96	0.53	39.49	54.00	-14.51
2483.50	Peak	51.85	0.53	52.38	74.00	-21.62

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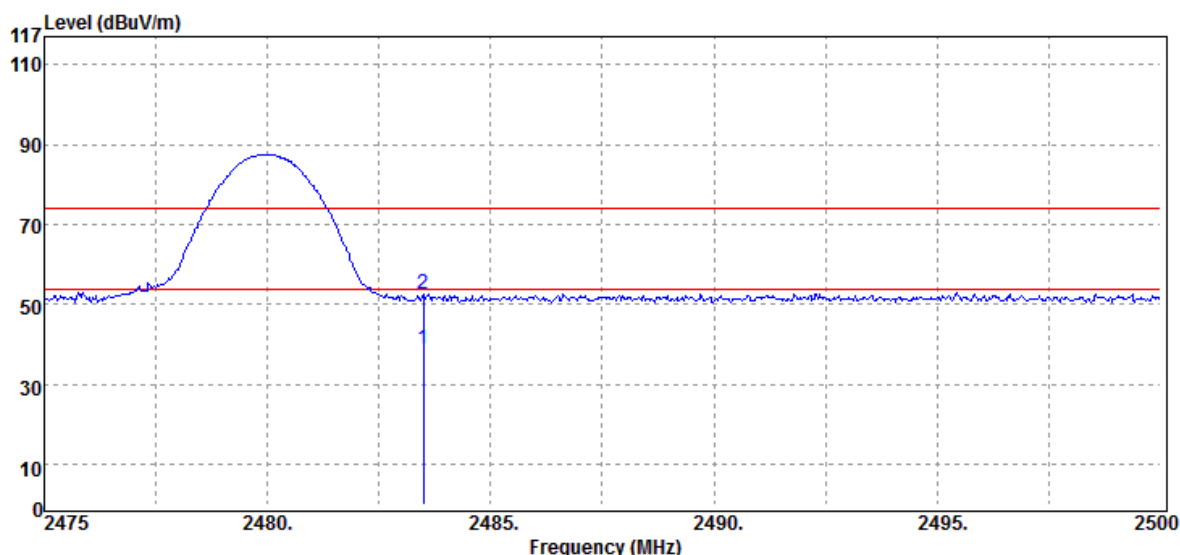
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Operation Band :EDR(3M)  
 Fundamental Frequency :2480 MHz  
 Operation Mode :Bandedge CH HIGH  
 EUT Pol. :H Plane

Test Date :2018-11-23  
 Temp./Humi. :23 deg\_C / 62 RH  
 Engineer :Wei  
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2483.50	Average	38.36	0.53	38.89	54.00	-15.11
2483.50	Peak	52.05	0.53	52.58	74.00	-21.42

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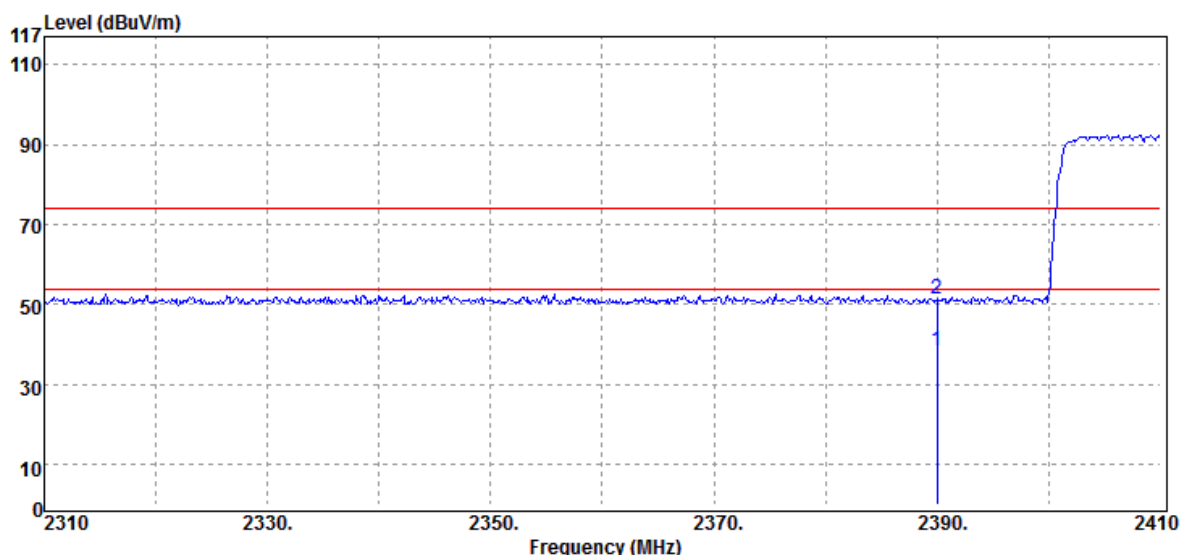
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Operation Band :BR Hopping  
Fundamental Frequency :2402 MHz  
Operation Mode :Bandedge CH LOW  
EUT Pol. :H Plane

Test Date :2018-11-23  
Temp./Humi. :23 deg\_C / 62 RH  
Engineer :Wei  
Measurement Antenna Pol. :VERTICAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2390.00	Average	38.34	0.20	38.54	54.00	-15.46
2390.00	Peak	51.27	0.20	51.47	74.00	-22.53

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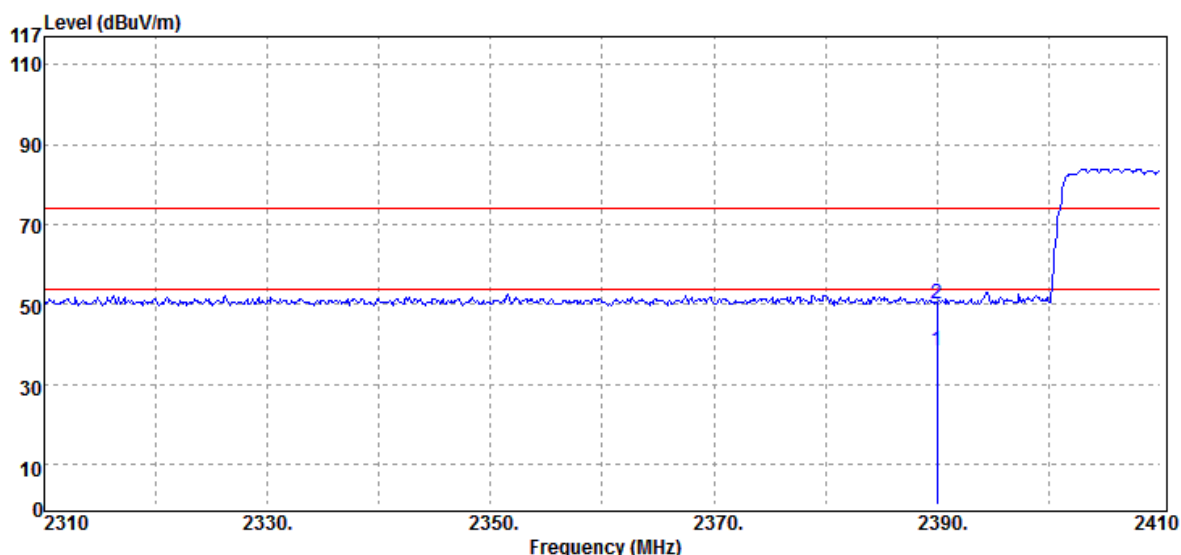
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Operation Band :BR Hopping  
Fundamental Frequency :2402 MHz  
Operation Mode :Bandedge CH LOW  
EUT Pol. :H Plane

Test Date :2018-11-23  
Temp./Humi. :23 deg\_C / 62 RH  
Engineer :Wei  
Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2390.00	Average	38.39	0.20	38.59	54.00	-15.41
2390.00	Peak	50.20	0.20	50.40	74.00	-23.60

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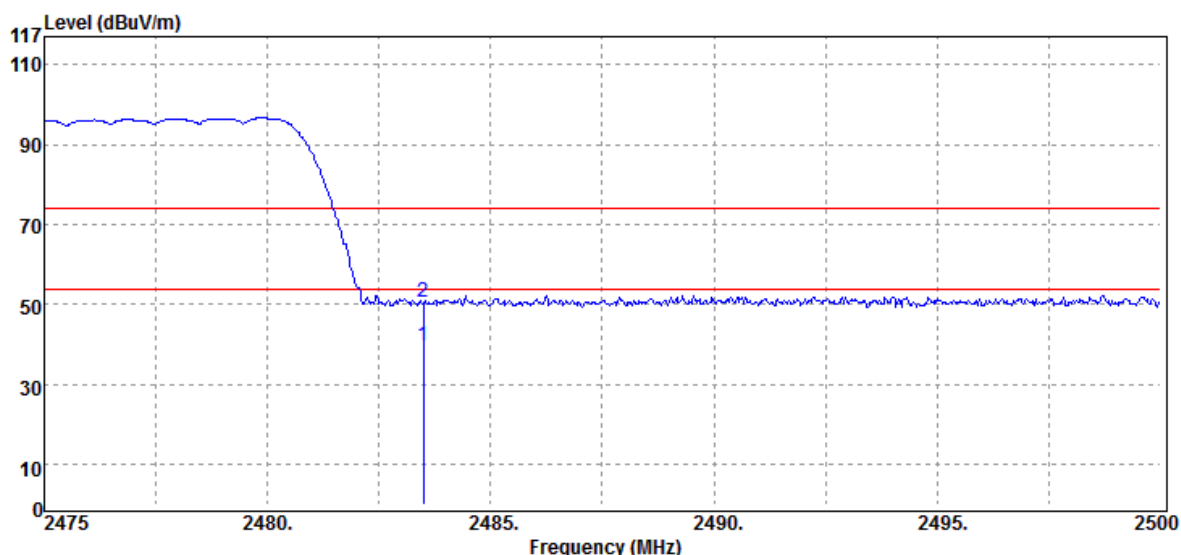
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Operation Band :BR Hopping  
Fundamental Frequency :2480 MHz  
Operation Mode :Bandedge CH HIGH  
EUT Pol. :H Plane

Test Date :2018-11-23  
Temp./Humi. :23 deg\_C / 62 RH  
Engineer :Wei  
Measurement Antenna Pol. :VERTICAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2483.50	Average	39.24	0.53	39.77	54.00	-14.23
2483.50	Peak	50.05	0.53	50.58	74.00	-23.42

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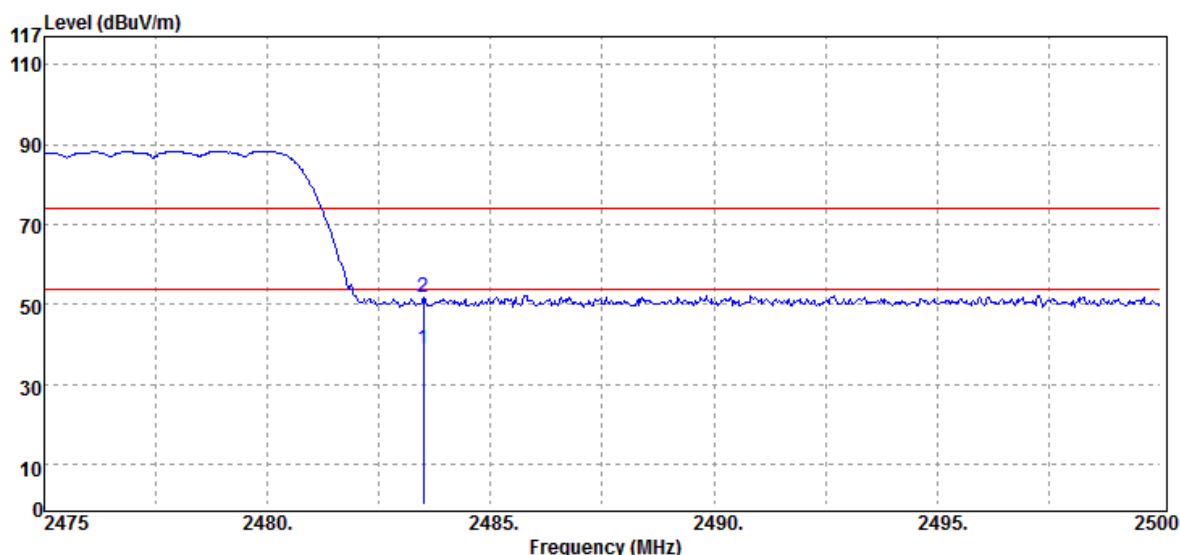
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Operation Band :BR Hopping  
Fundamental Frequency :2480 MHz  
Operation Mode :Bandedge CH HIGH  
EUT Pol. :H Plane

Test Date :2018-11-23  
Temp./Humi. :23 deg\_C / 62 RH  
Engineer :Wei  
Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2483.50	Average	38.35	0.53	38.88	54.00	-15.12
2483.50	Peak	51.11	0.53	51.64	74.00	-22.36

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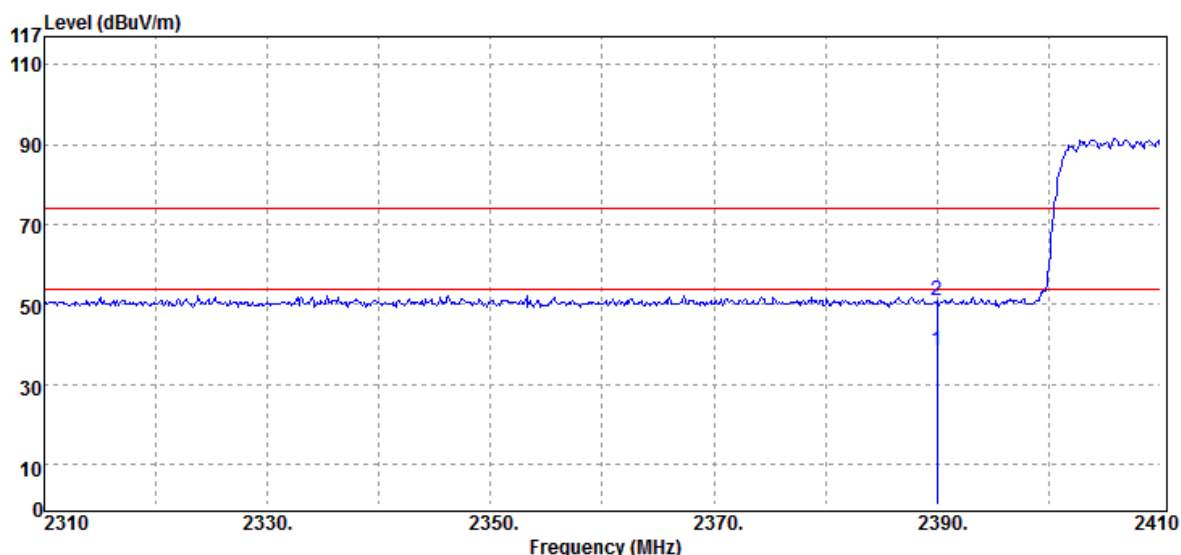
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Operation Band :EDR Hopping  
Fundamental Frequency :2402 MHz  
Operation Mode :Bandedge CH LOW  
EUT Pol. :H Plane

Test Date :2018-11-23  
Temp./Humi. :23 deg\_C / 62 RH  
Engineer :Wei  
Measurement Antenna Pol. :VERTICAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2390.00	Average	38.44	0.20	38.64	54.00	-15.36
2390.00	Peak	50.68	0.20	50.88	74.00	-23.12

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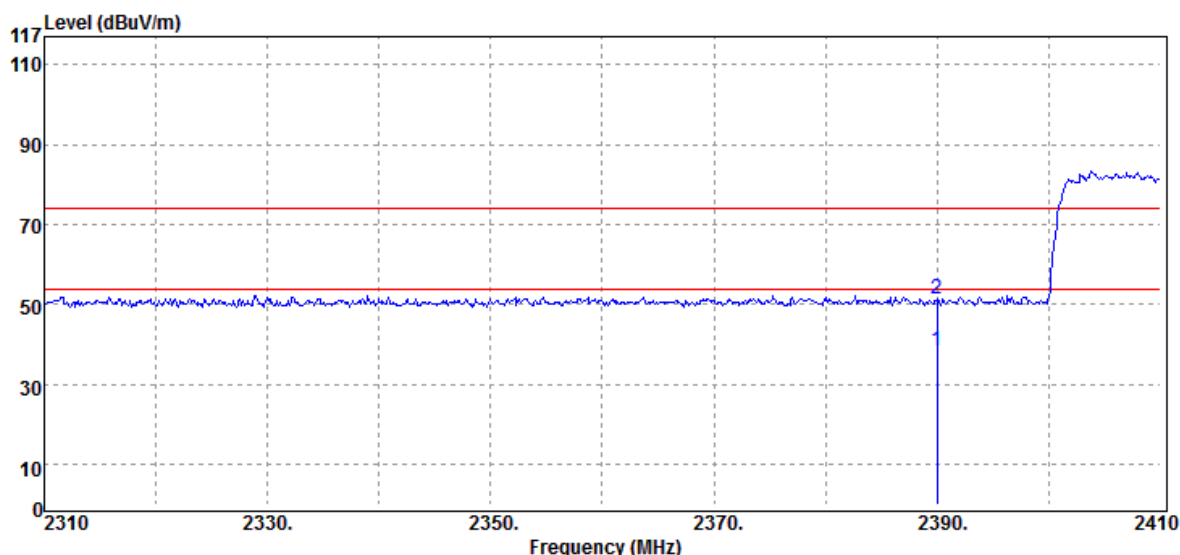
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Operation Band :EDR Hopping  
Fundamental Frequency :2402 MHz  
Operation Mode :Bandedge CH LOW  
EUT Pol. :H Plane

Test Date :2018-11-23  
Temp./Humi. :23 deg\_C / 62 RH  
Engineer :Wei  
Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2390.00	Average	38.35	0.20	38.55	54.00	-15.45
2390.00	Peak	51.02	0.20	51.22	74.00	-22.78

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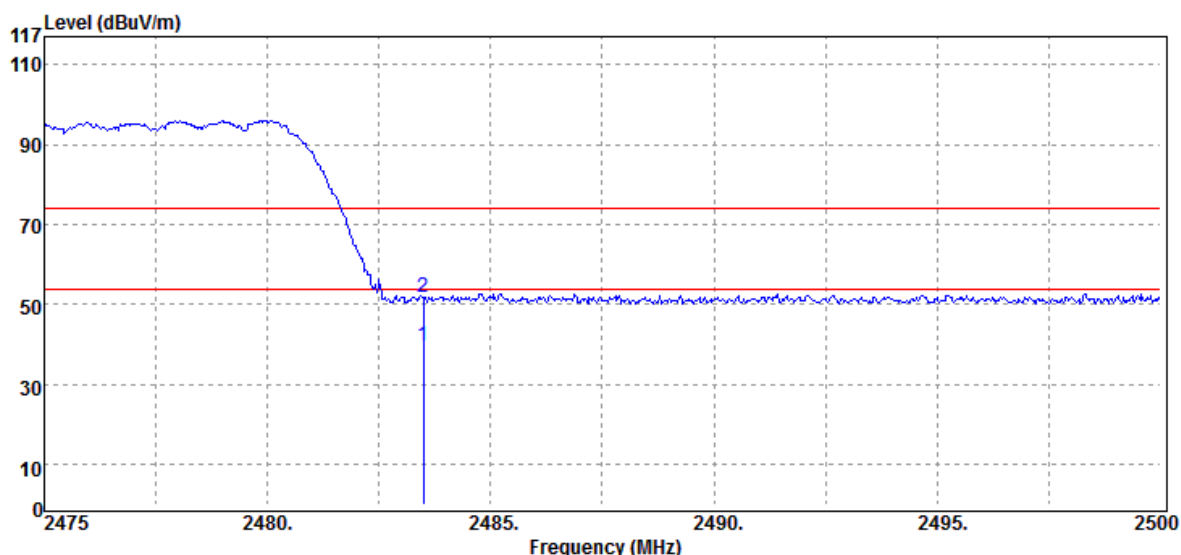
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Operation Band :EDR Hopping  
Fundamental Frequency :2480 MHz  
Operation Mode :Bandedge CH HIGH  
EUT Pol. :H Plane

Test Date :2018-11-23  
Temp./Humi. :23 deg\_C / 62 RH  
Engineer :Wei  
Measurement Antenna Pol. :VERTICAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2483.50	Average	38.99	0.53	39.52	54.00	-14.48
2483.50	Peak	51.29	0.53	51.82	74.00	-22.18

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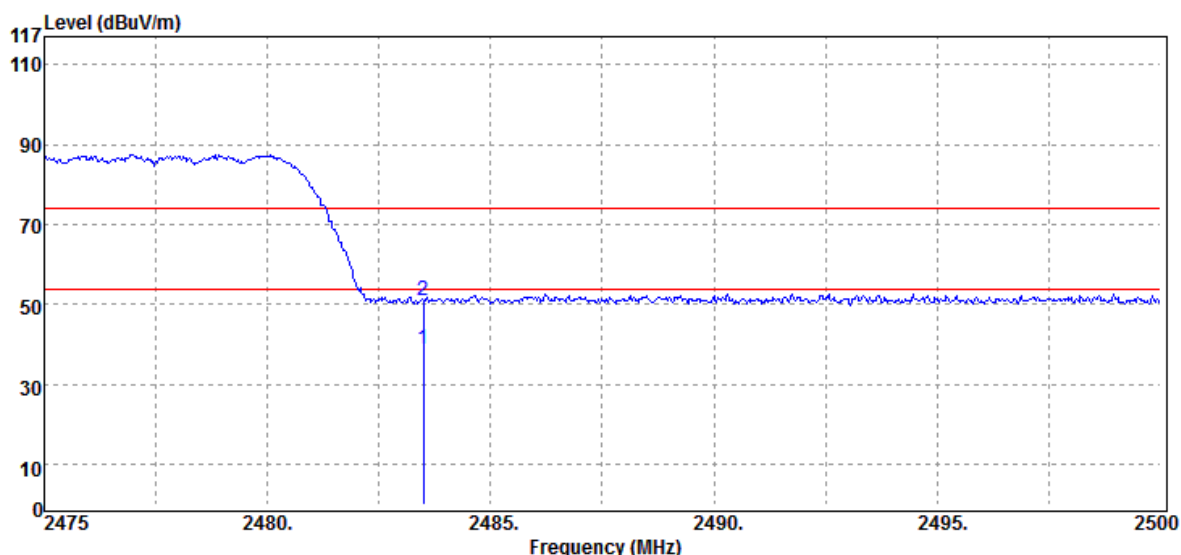
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EUT Pol. :H Plane

Test Date :2018-11-23  
Temp./Humi. :23 deg\_C / 62 RH  
Engineer :Wei  
Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2483.50	Average	38.39	0.53	38.92	54.00	-15.08
2483.50	Peak	50.59	0.53	51.12	74.00	-22.88

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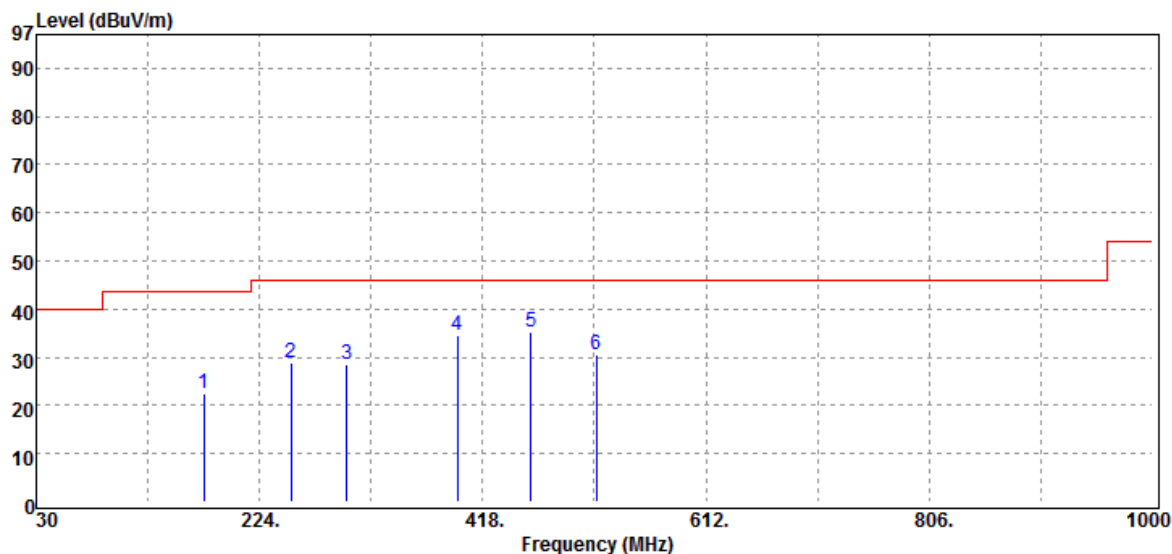


## Radiated Spurious Emission Measurement Result: (Worst Case)

### For Frequency from 30MHz to 1000MHz

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

Test Date :2018-11-23  
Temp./Humi. :23 deg\_C / 62 RH  
Engineer :Wei  
Measurement Antenna Pol. :VERTICAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
175.50	Peak	30.25	-7.89	22.36	43.50	-21.14
251.16	Peak	36.16	-7.34	28.82	46.00	-17.18
299.66	Peak	34.00	-5.52	28.48	46.00	-17.52
395.69	Peak	37.87	-3.34	34.53	46.00	-11.47
459.71	Peak	37.80	-2.46	35.34	46.00	-10.66
516.94	Peak	32.06	-1.45	30.61	46.00	-15.39

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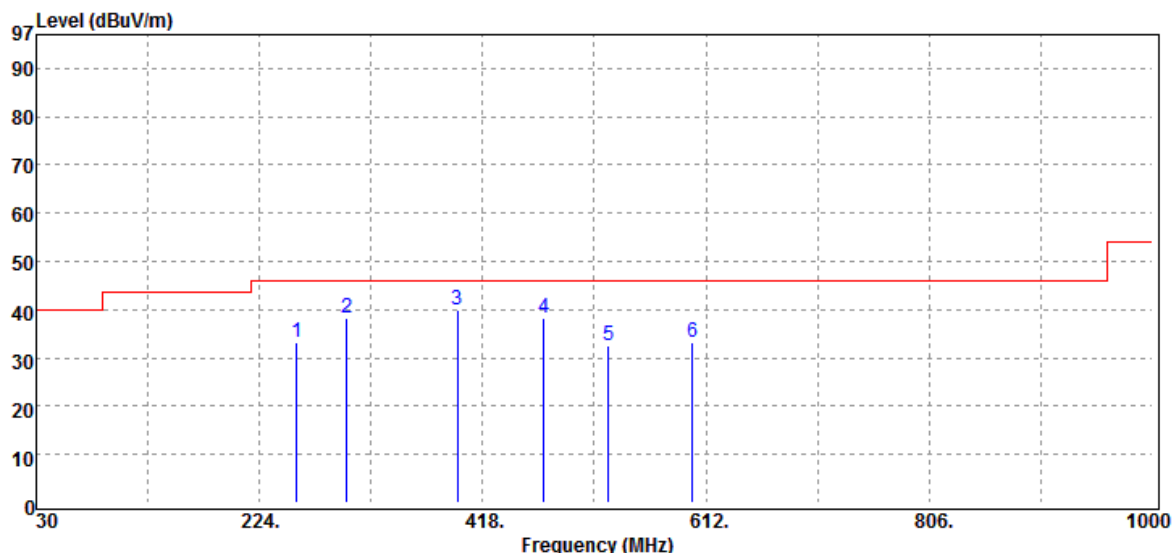
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Operation Band :BR(1M)  
 Fundamental Frequency :2441 MHz  
 Operation Mode :Tx CH MID  
 EUT Pol. :H Plane

Test Date :2018-11-23  
 Temp./Humi. :23 deg\_C / 62 RH  
 Engineer :Wei  
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
256.01	Peak	40.52	-7.13	33.39	46.00	-12.61
299.66	Peak	43.63	-5.52	38.11	46.00	-7.89
395.69	Peak	43.14	-3.34	39.80	46.00	-6.20
471.35	Peak	40.62	-2.22	38.40	46.00	-7.60
527.61	Peak	33.93	-1.34	32.59	46.00	-13.41
600.36	Peak	33.10	0.12	33.22	46.00	-12.78

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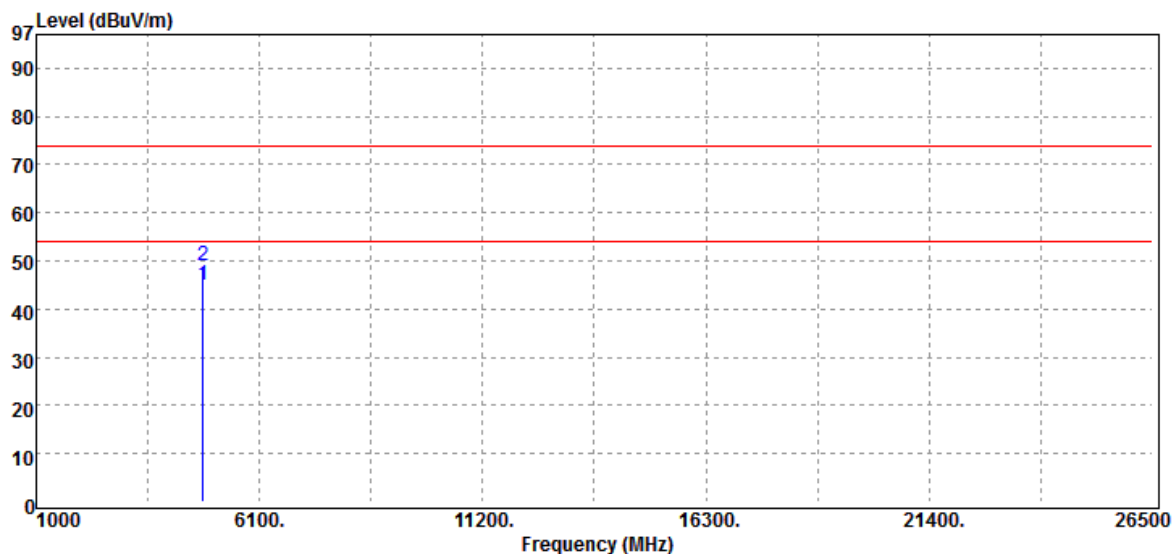
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## Radiated Spurious Emission Measurement Result: (Worst Case)

### For Frequency above 1 GHz

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

Test Date :2018-11-23  
Temp./Humi. :23 deg\_C / 62 RH  
Engineer :Wei  
Measurement Antenna Pol. :VERTICAL



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	39.32	5.65	44.97	54.00	-9.03
4804.00	Peak	43.32	5.65	48.97	74.00	-25.03

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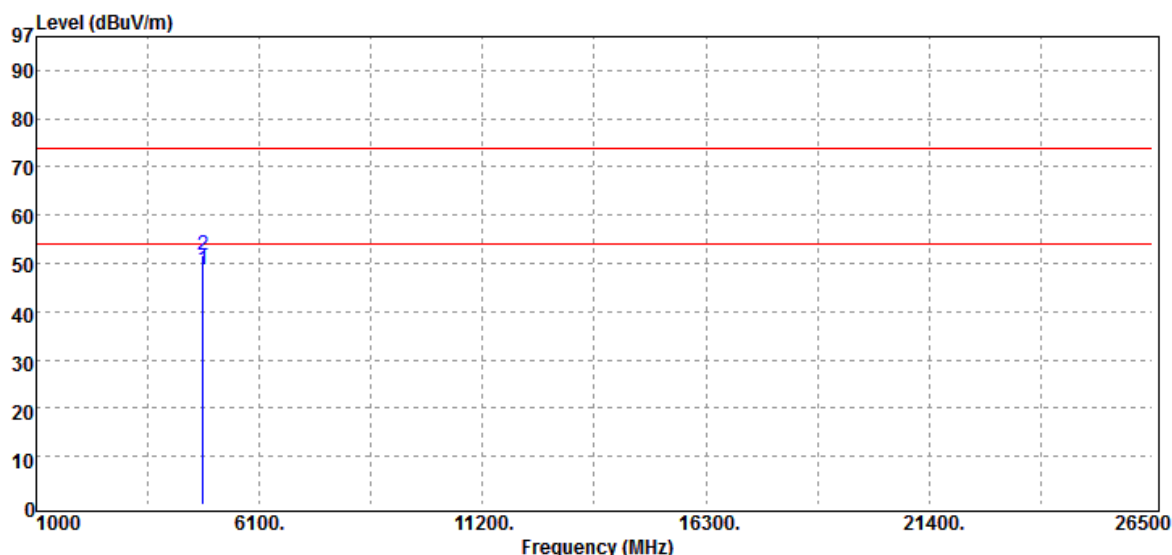
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Operation Band :BR(1M)  
 Fundamental Frequency :2402 MHz  
 Operation Mode :Tx CH LOW  
 EUT Pol. :H Plane

Test Date :2018-11-23  
 Temp./Humi. :23 deg\_C / 62 RH  
 Engineer :Wei  
 Measurement Antenna Pol. :HORIZONTAL



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	43.16	5.65	48.81	54.00	-5.19
4804.00	Peak	46.04	5.65	51.69	74.00	-22.31

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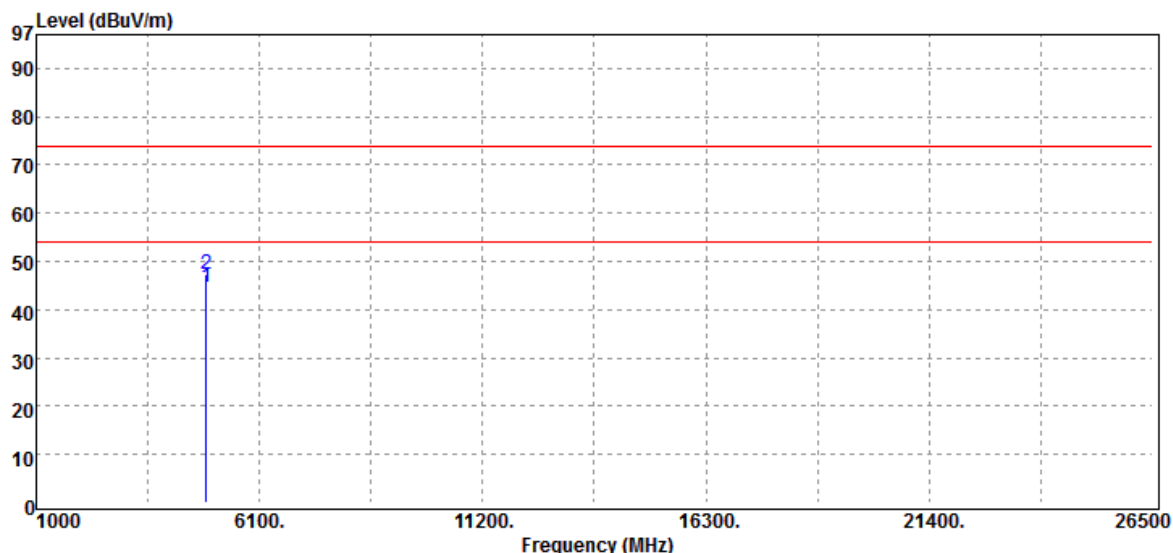
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Operation Band :BR(1M)  
 Fundamental Frequency :2441 MHz  
 Operation Mode :Tx CH MID  
 EUT Pol. :H Plane

Test Date :2018-11-23  
 Temp./Humi. :23 deg\_C / 62 RH  
 Engineer :Wei  
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
4882.00	Average	38.83	5.90	44.73	54.00	-9.27
4882.00	Peak	41.30	5.90	47.20	74.00	-26.80

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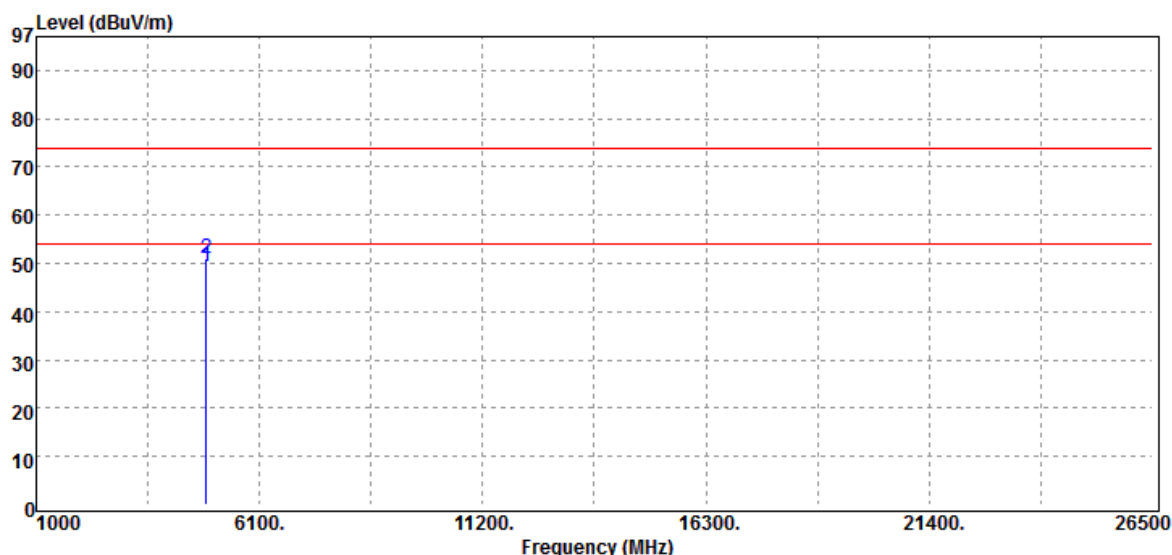
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Operation Band :BR(1M)  
Fundamental Frequency :2441 MHz  
Operation Mode :Tx CH MID  
EUT Pol. :H Plane

Test Date :2018-11-23  
Temp./Humi. :23 deg\_C / 62 RH  
Engineer :Wei  
Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
4882.00	Average	43.34	5.90	49.24	54.00	-4.76
4882.00	Peak	45.23	5.90	51.13	74.00	-22.87

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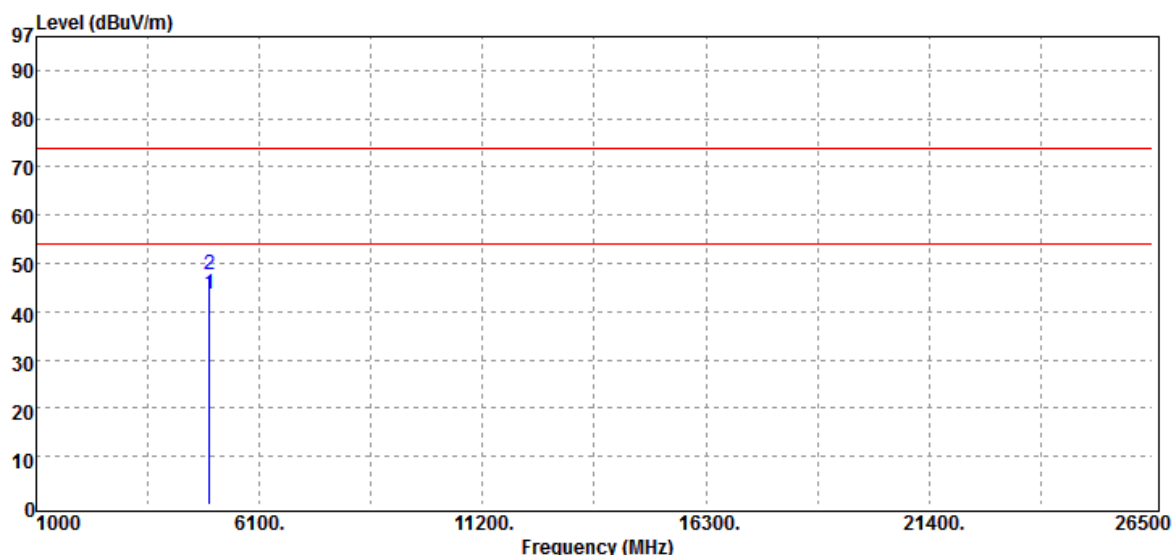
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Operation Band :BR(1M)  
 Fundamental Frequency :2480 MHz  
 Operation Mode :Tx CH HIGH  
 EUT Pol. :H Plane

Test Date :2018-11-23  
 Temp./Humi. :23 deg\_C / 62 RH  
 Engineer :Wei  
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
4960.00	Average	37.68	6.05	43.73	54.00	-10.27
4960.00	Peak	41.61	6.05	47.66	74.00	-26.34

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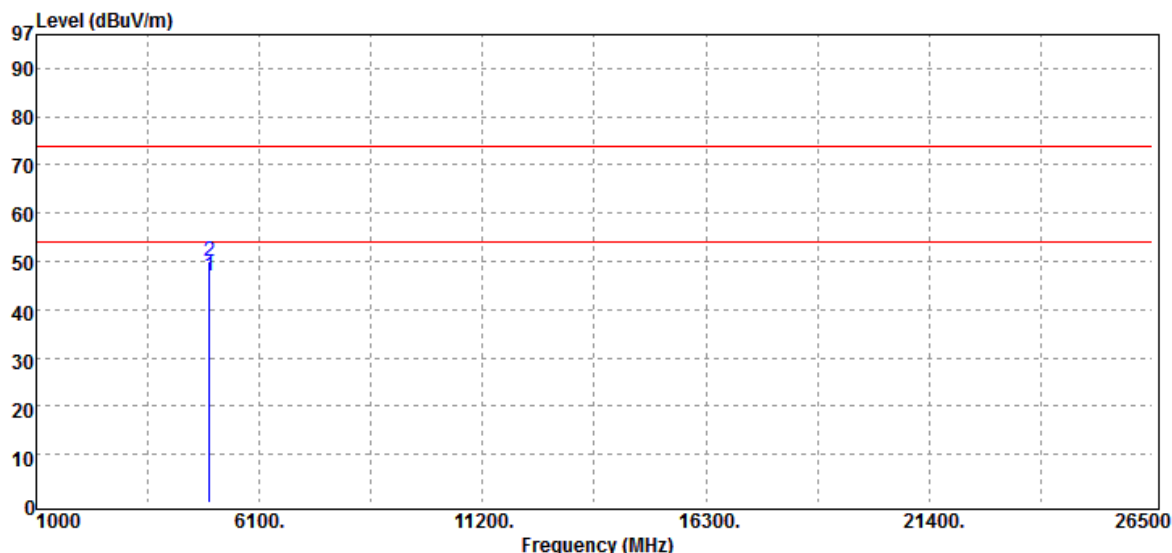
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Operation Band :BR(1M)  
 Fundamental Frequency :2480 MHz  
 Operation Mode :Tx CH HIGH  
 EUT Pol. :H Plane

Test Date :2018-11-23  
 Temp./Humi. :23 deg\_C / 62 RH  
 Engineer :Wei  
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
4960.00	Average	41.04	6.05	47.09	54.00	-6.91
4960.00	Peak	43.82	6.05	49.87	74.00	-24.13

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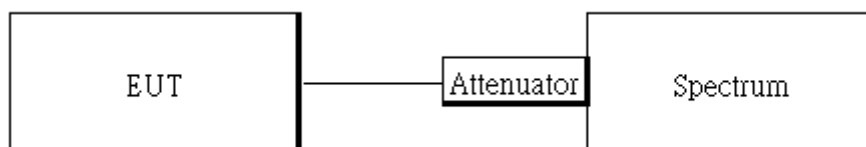
### 11.1 Standard Applicable

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

Conducted Emission Test Site					
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
DC Power Supply	Agilent	E3640A	KR93300208	08/15/2018	08/14/2019
Notebook	Lenovo	L430	R9-X11BG	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. Measurement Guidelines.
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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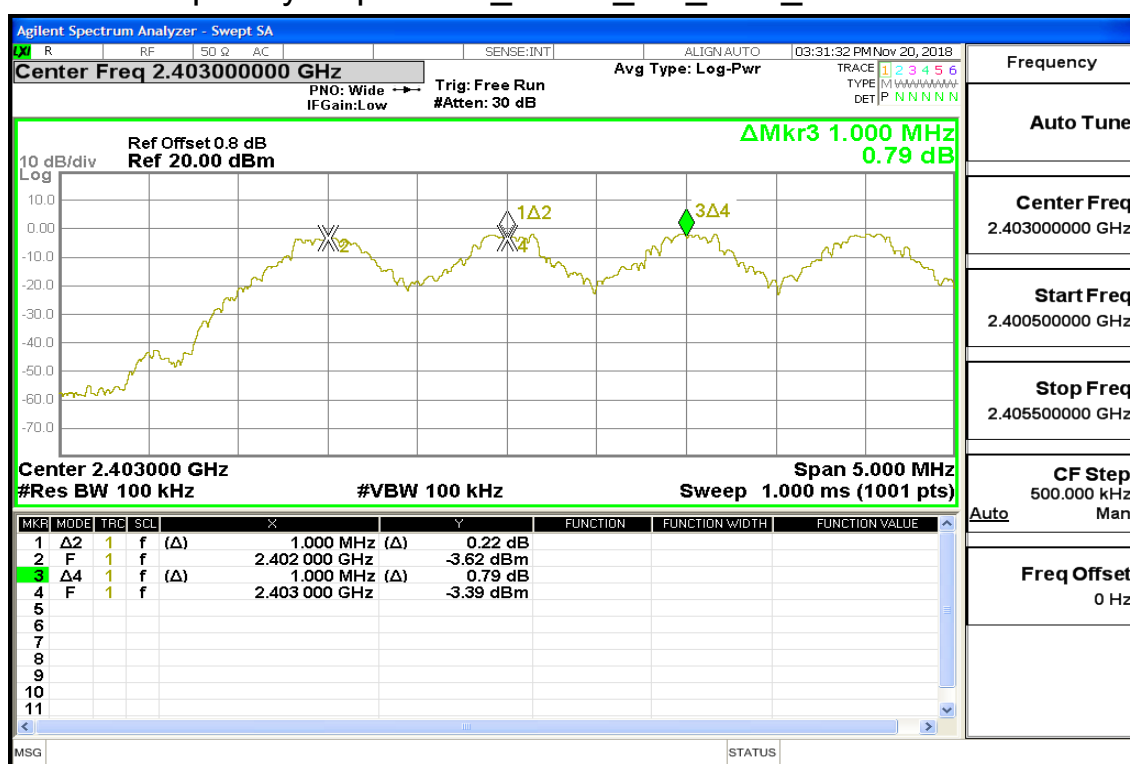
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## 11.5 Measurement Result

Channel separation (MHz)	Limit	Result
1	$\geq 25$ kHz or 2/3 times 20dB bandwidth	PASS

## Frequency Separation Test Data

### Frequency Separation\_GFSK\_1M\_DH5\_CH0CH1CH2



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## 12 NUMBER OF HOPPING FREQUENCY

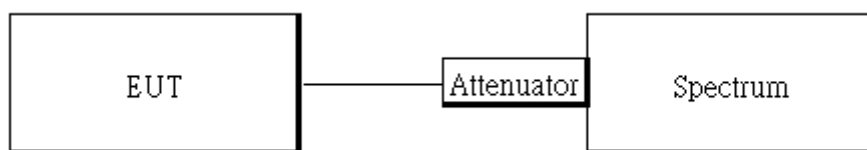
### 12.1 Standard Applicable

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.
Power Meter	Anritsu	ML2496A	1804001	02/01/2018	01/31/2019
Power Sensor	Anritsu	MA2411B	1726104	02/01/2018	01/31/2019
DC Power Supply	Agilent	E3640A	KR93300208	08/15/2018	08/14/2019
Notebook	Lenovo	L430	R9-X11BG	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. Measurement Guidelines.
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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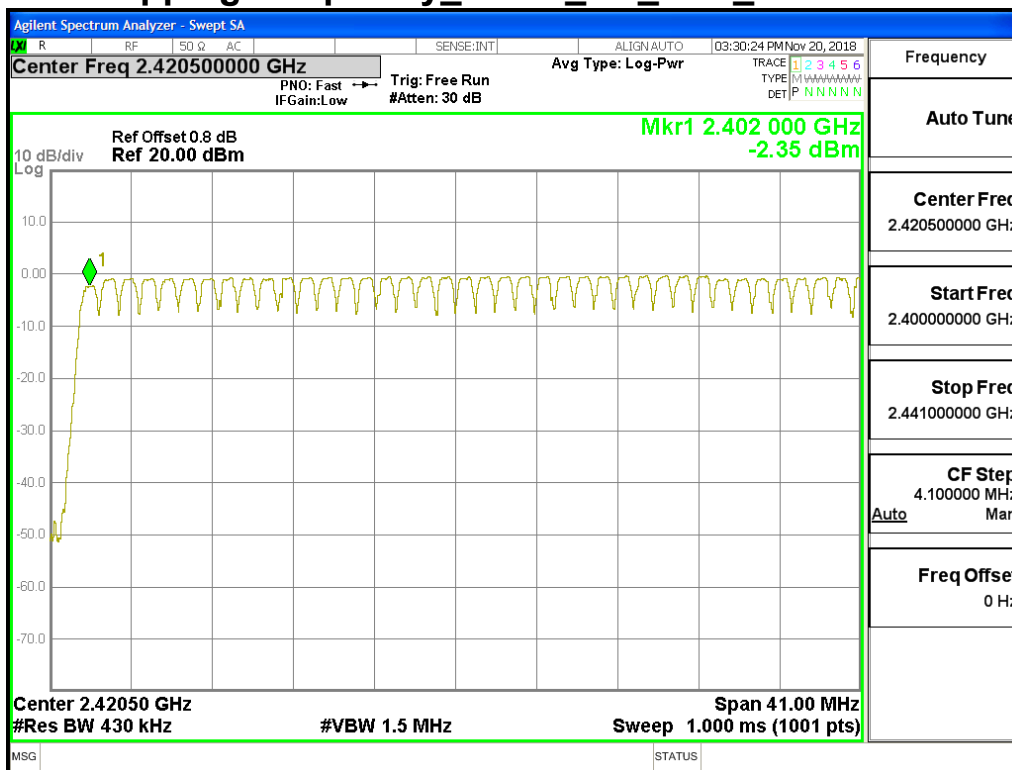
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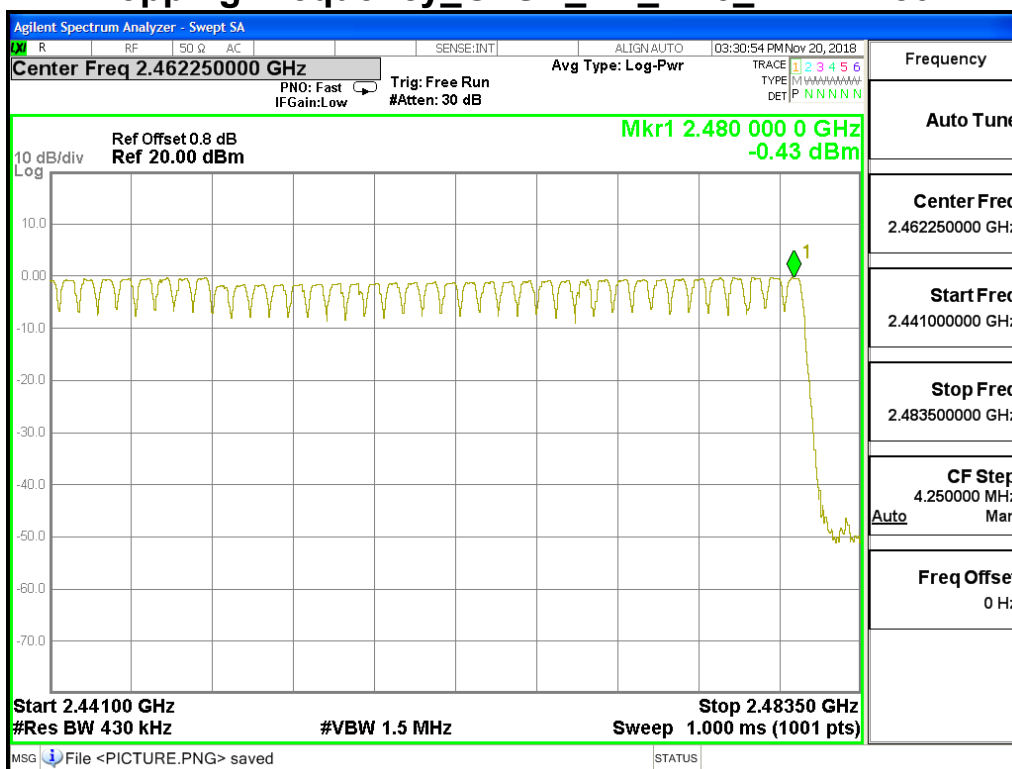
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## Channel Number

### Hopping Frequency\_GFSK\_1M\_DH5\_2400-2441



### Hopping Frequency\_GFSK\_1M\_DH5\_2441-2480



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### 13 TIME OF OCCUPANCY (DWELL TIME)

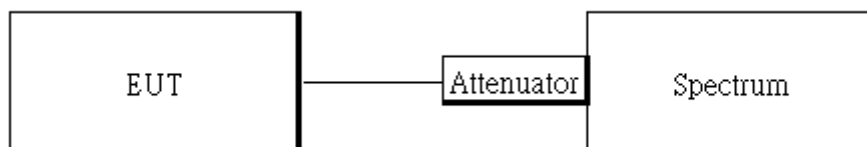
#### 13.1 Standard Applicable

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.
Power Meter	Anritsu	ML2496A	1804001	02/01/2018	01/31/2019
Power Sensor	Anritsu	MA2411B	1726104	02/01/2018	01/31/2019
DC Power Supply	Agilent	E3640A	KR93300208	08/15/2018	08/14/2019
Notebook	Lenovo	L430	R9-X11BG	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. Measurement Guidelines.
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

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DH5 consists of five time slot of the uplink, and one slot of the downlink. Total Slot: 6

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

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

### 13.5 Tabular Result of the Measurement

#### GFSK (1Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)	1/T (kHz)	VBW setting (kHz)
0	DH1	128.00	400ms	2.50	3.00
	DH3	265.60	400ms	0.60	1.00
	DH5	310.40	400ms	0.34	1.00
39	DH1	128.00	400ms	2.50	3.00
	DH3	265.60	400ms	0.60	1.00
	DH5	310.40	400ms	0.34	1.00
78	DH1	128.00	400ms	2.50	3.00
	DH3	264.00	400ms	0.61	1.00
	DH5	310.40	400ms	0.34	1.00

#### $\pi/4$ DQPSK (2Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)	1/T (kHz)	VBW setting (kHz)
39	2DH1	132.80	400ms	2.41	3.00
	2DH3	265.60	400ms	0.60	1.00
	2DH5	310.40	400ms	0.34	1.00

#### 8-DPSK (3Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)	1/T (kHz)	VBW setting (kHz)
39	3DH1	132.80	400ms	2.41	3.00
	3DH3	267.20	400ms	0.60	1.00
	3DH5	312.00	400ms	0.34	1.00

A period time =  $0.4 \text{ (s)} * 79 = 31.6 \text{ (s)}$

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### GFSK (1Mbps):

CH Low	DH1 time slot =	0.400 *	(1600/2/79) *	31.6 =	128.00 (ms)
	DH3 time slot =	1.660 *	(1600/4/79) *	31.6 =	265.60 (ms)
	DH5 time slot =	2.910 *	(1600/6/79) *	31.6 =	310.40 (ms)
CH Mid	DH1 time slot =	0.400 *	(1600/2/79) *	31.6 =	128.00 (ms)
	DH3 time slot =	1.660 *	(1600/4/79) *	31.6 =	265.60 (ms)
	DH5 time slot =	2.910 *	(1600/6/79) *	31.6 =	310.40 (ms)
CH High	DH1 time slot =	0.400 *	(1600/2/79) *	31.6 =	128.00 (ms)
	DH3 time slot =	1.650 *	(1600/4/79) *	31.6 =	264.00 (ms)
	DH5 time slot =	2.910 *	(1600/6/79) *	31.6 =	310.40 (ms)

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

CH Mid	2DH1 time slo =	0.415 *	(1600/2/79) *	31.6 =	132.80 (ms)
	2DH3 time slo =	1.660 *	(1600/4/79) *	31.6 =	265.60 (ms)
	2DH5 time slo =	2.910 *	(1600/6/79) *	31.6 =	310.40 (ms)

### 8-DPSK (3Mbps):

CH Mid	3DH1 time slo =	0.415 *	(1600/2/79) *	31.6 =	132.80 (ms)
	3DH3 time slo =	1.670 *	(1600/4/79) *	31.6 =	267.20 (ms)
	3DH5 time slo =	2.925 *	(1600/6/79) *	31.6 =	312.00 (ms)

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GFSK (1Mbps) for AFH Mode			
Hopping Channel Number	PACKET TYPE	Measurement Result (ms)	Limit (ms)
20	DH5	155.20	400ms
$\pi/4$ DQPSK (2Mbps) for AFH Mode			
Hopping Channel Number	PACKET TYPE	Measurement Result (ms)	Limit (ms)
20	2DH5	155.20	400ms
8-DPSK (3Mbps) for AFH Mode			
Hopping Channel Number	PACKET TYPE	Measurement Result (ms)	Limit (ms)
20	3DH5	156.00	400ms

### GFSK (1Mbps):

DH5 time  $s_l = 2.910 \text{ (ms)} * (800/6/20 * 8 = 155.20 \text{ (ms)}$

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

2DH5 time  $= 2.910 \text{ (ms)} * (800/6/20 * 8 = 155.20 \text{ (ms)}$

### 8-DPSK (3Mbps):

3DH5 time  $= 2.925 \text{ (ms)} * (800/6/20 * 8 = 156.00 \text{ (ms)}$

## 13.6 Measurement Result

Note: Refer to next page for plots.

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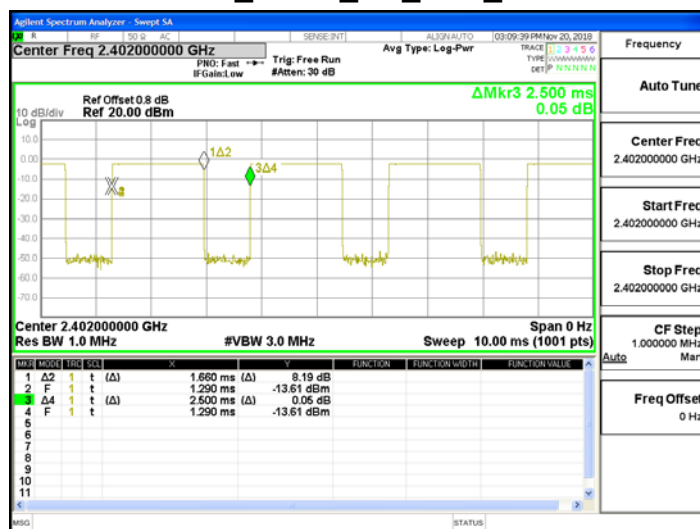
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## Dwell Time\_GFSK\_1M\_DH1\_2402MHz



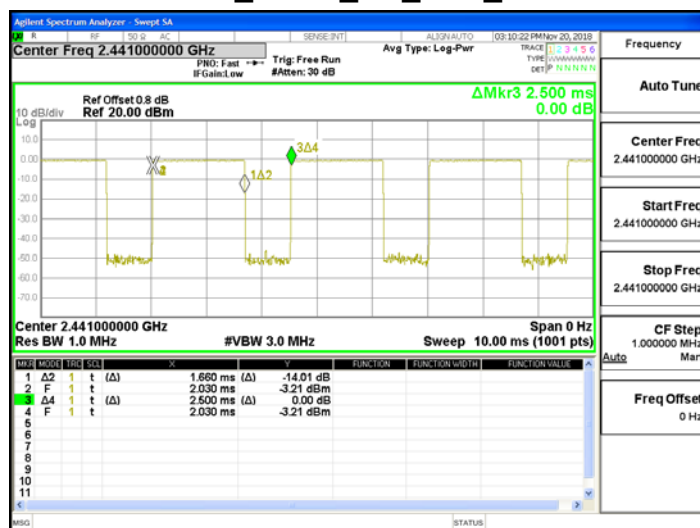
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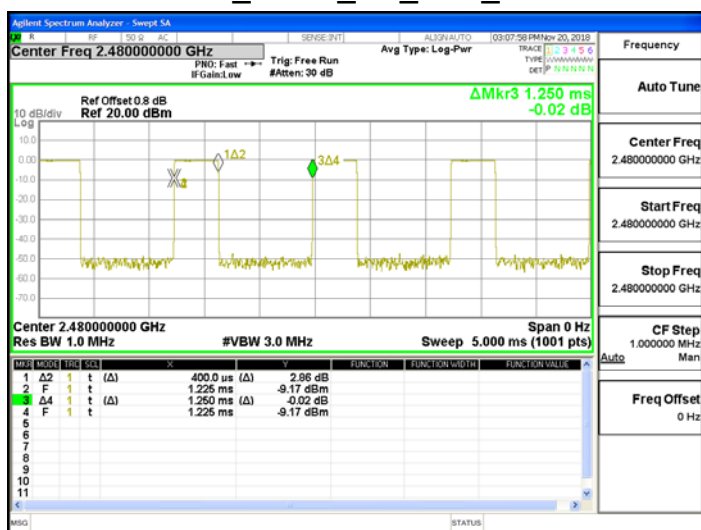
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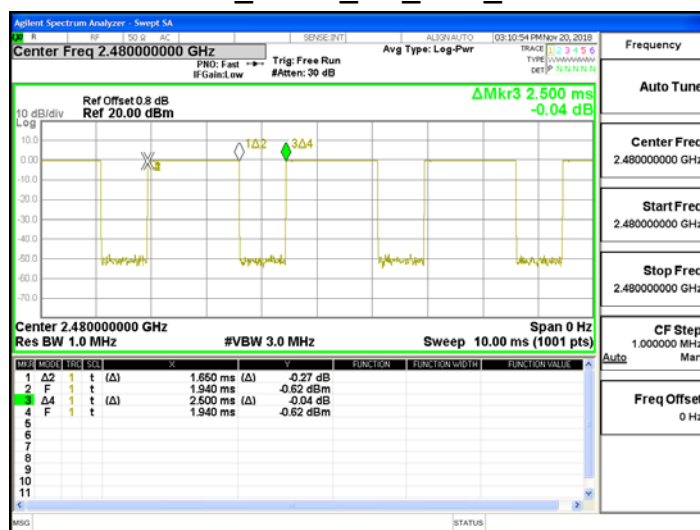
## Dwell Time\_GFSK\_1M\_DH3\_2441MHz



## Dwell Time\_GFSK\_1M\_DH1\_2480MHz



## Dwell Time\_GFSK\_1M\_DH3\_2480MHz



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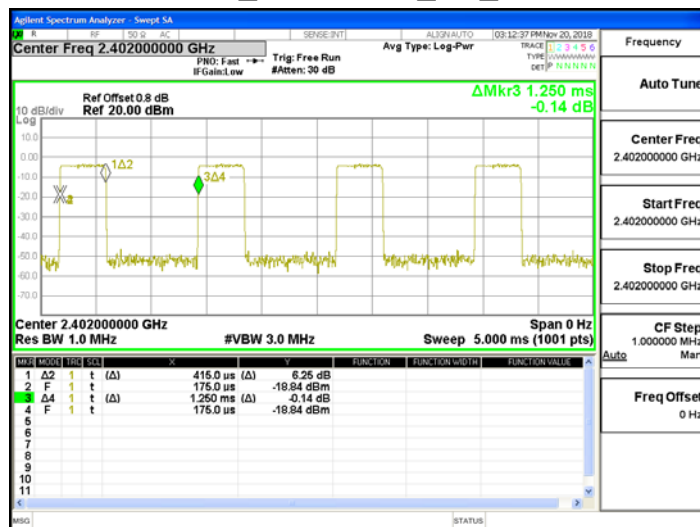
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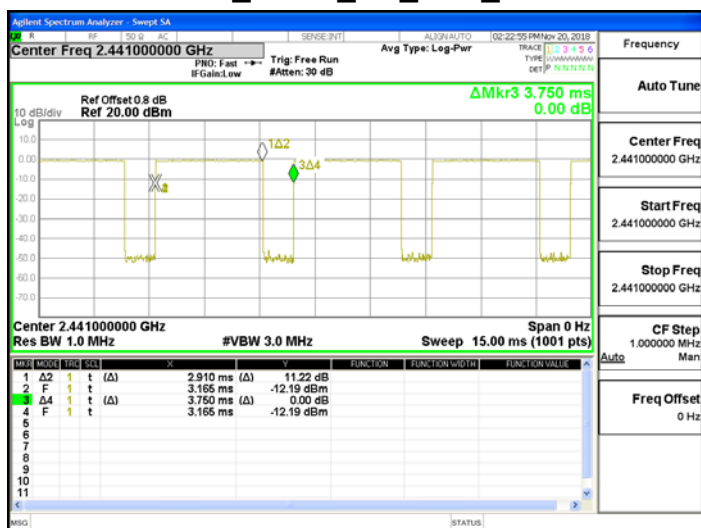
Dwell Time\_GFSK\_1M\_DH5\_2402MHz



Dwell Time\_π/4DQPSK\_2M\_2402MHz



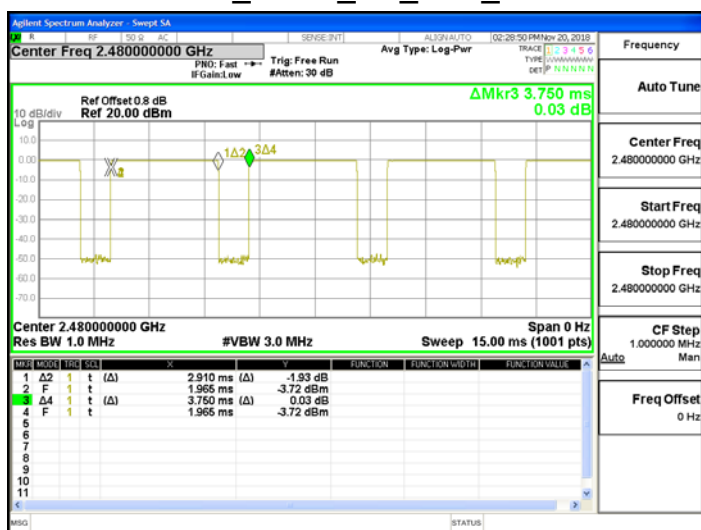
Dwell Time\_GFSK\_1M\_DH5\_2441MHz



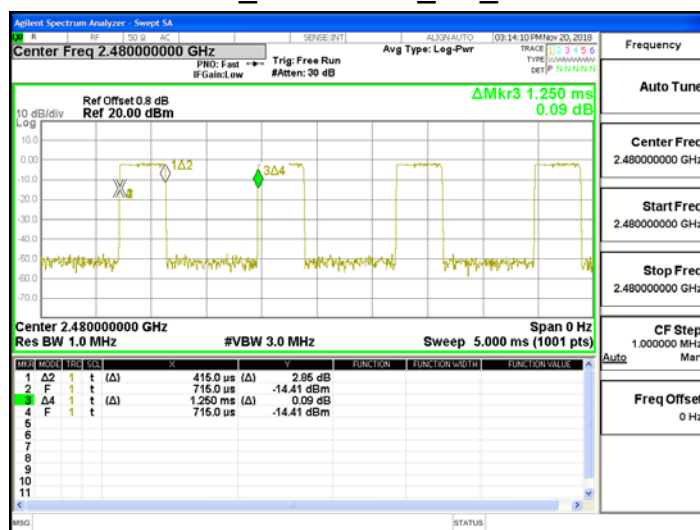
Dwell Time\_π/4DQPSK\_2M\_2441MHz



Dwell Time\_GFSK\_1M\_DH5\_2480MHz



Dwell Time\_π/4DQPSK\_2M\_2480MHz

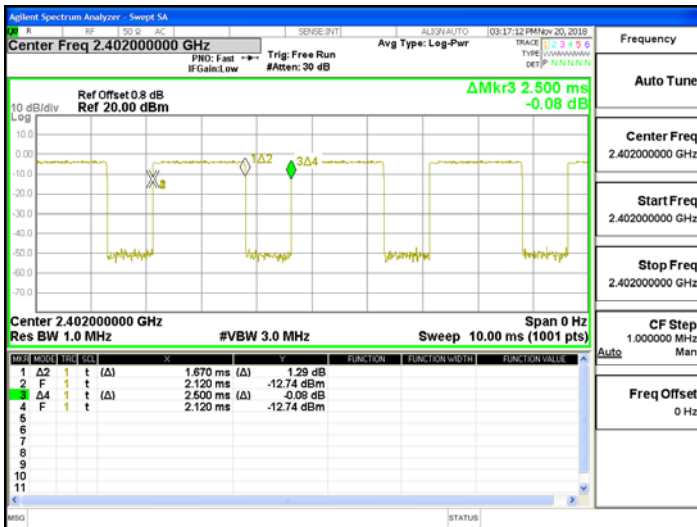


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## Dwell Time $\pi/4$ DQPSK\_2M\_2402MHz



## Dwell Time $\pi/4$ DQPSK\_2M\_2402MHz



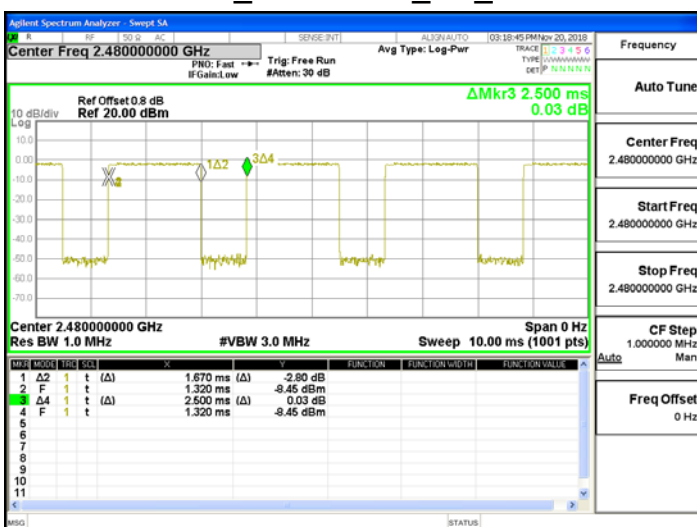
## Dwell Time $\pi/4$ DQPSK\_2M\_2441MHz



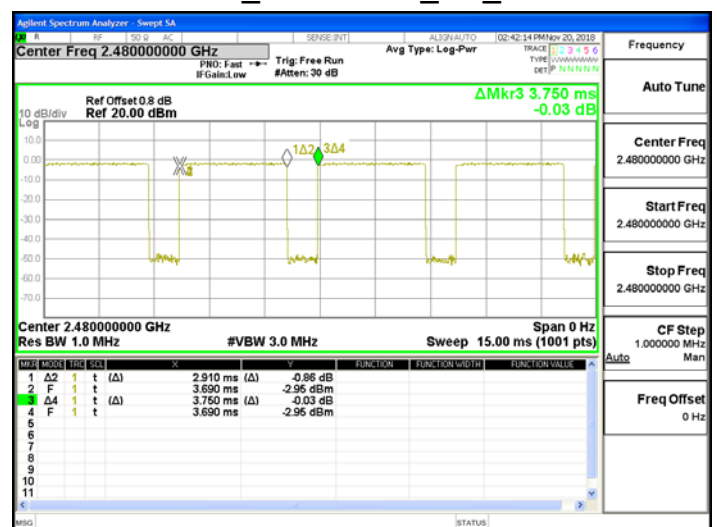
## Dwell Time $\pi/4$ DQPSK\_2M\_2441MHz



## Dwell Time $\pi/4$ DQPSK\_2M\_2480MHz



## Dwell Time $\pi/4$ DQPSK\_2M\_2480MHz



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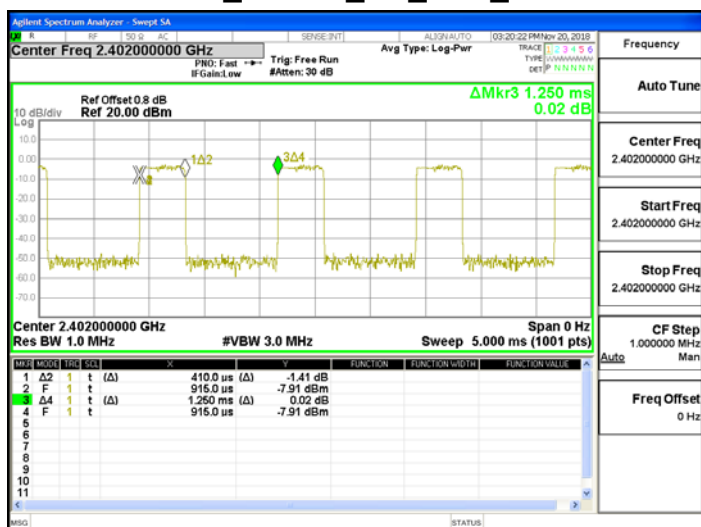
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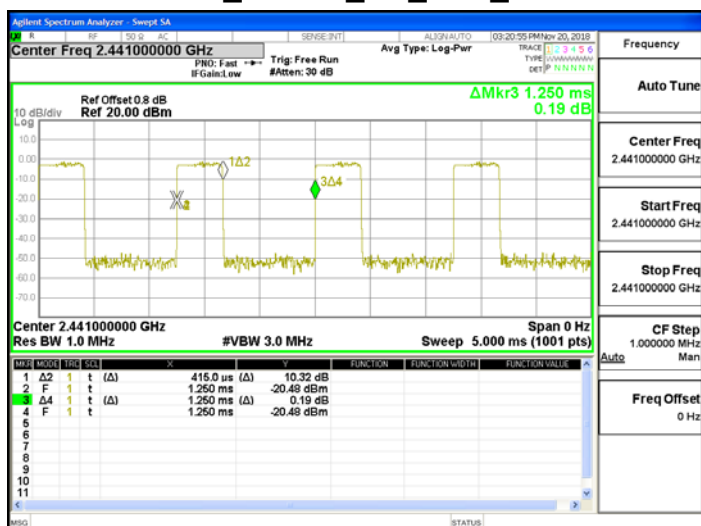
Dwell Time\_8DPSK\_3M\_DH1\_2402MHz



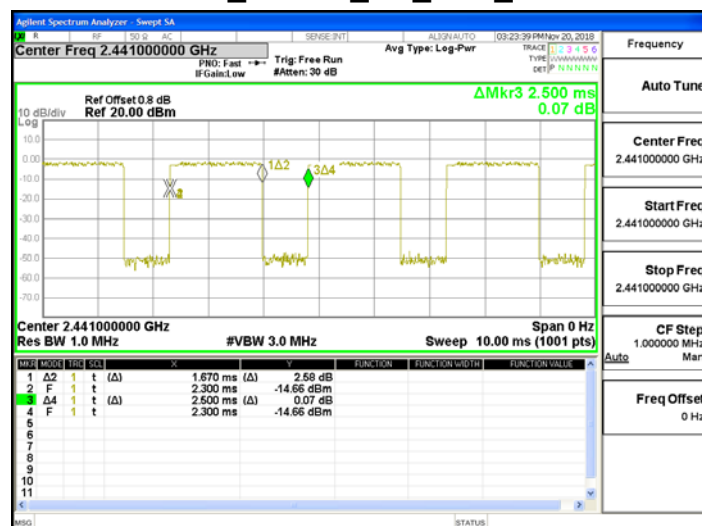
Dwell Time\_8DPSK\_3M\_DH3\_2402MHz



Dwell Time\_8DPSK\_3M\_DH1\_2441MHz



Dwell Time\_8DPSK\_3M\_DH3\_2441MHz



Dwell Time\_8DPSK\_3M\_DH1\_2480MHz



Dwell Time\_8DPSK\_3M\_DH3\_2480MHz

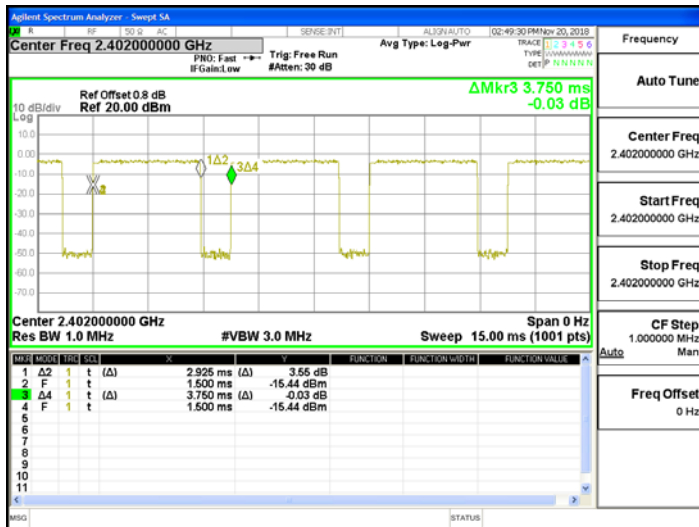


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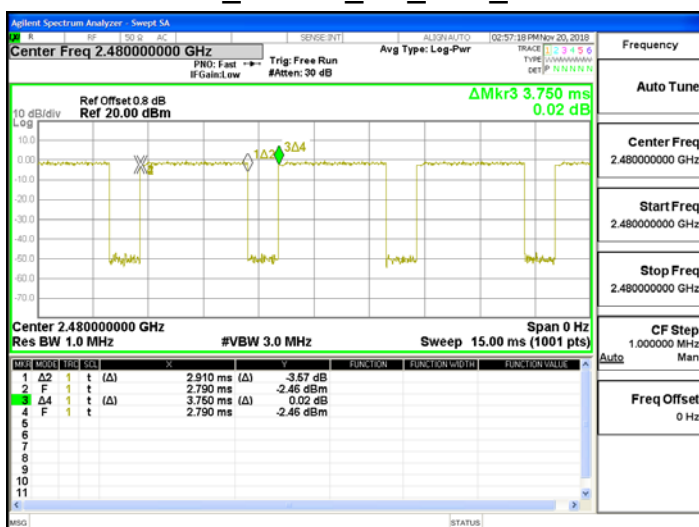
## Dwell Time\_8DPSK\_3M\_DH5\_2402MHz



## 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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## 15 MAXIMUM PERMISSIBLE EXPOSURE (MPE)

### 15.1 Standard Applicable

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

This is a Mobile device, the MPE is required.

According to §1.1310 and §2.1091 RF exposure is calculated.

Limits for Maximum Permissive Exposure (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm <sup>2</sup> )	Averaging Time (minute)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f <sup>2</sup> )	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-15000	/	/	1.0	30

f = frequency in MHz

\* = Plane-wave equipment power density

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## 15.2 Maximum Permissible Exposure (MPE) Evaluation

Prediction of MPE limit at a given distance

$$S = PG / 4\pi R^2$$

Where: S = Power density

P = Power input to antenna

G = Power gain of the antenna in the direction of interest relative to an isotropic radiator

R = Distance to the center of radiation of the antenna

Operation Mode	Evaluation Frequency (MHz)	Operation Distance (cm)	Max. output Power (dBm)	Antenna Gain (dBi)	Max. output Power EIRP (mW)	Power Density (mW/cm <sup>2</sup> )	Limit (mW/cm <sup>2</sup> )	Pass / Fail
BT	2480.00	20	-0.3	2.42	1.63	0.000	1.000	Pass

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