ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

Applicant:	Murata Manufacturing Co., Ltd. 10-1, Higashikotari 1-chome, Nagaokakyo-shi, Kyoto 617-8555 Japan
Product Name:	Communication Module
Brand Name:	muRata
Model No.:	LBEQ6ZZ1BN
Model Difference:	N/A
Report Number:	ER/2019/A0012
FCC ID:	VPYLB1BN
IC:	772C-LB1BN
FCC Rule Part:	§15.247, Cat: DSS
IC RSS:	RSS-247 issue 2 Feb 2017
Issue Date:	Oct. 24, 2019
Date of Test:	Oct. 02, 2019 ~ Oct. 23, 2019
Date of EUT Received:	Oct. 02, 2019

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.

Approved By: CHUN-CHIEH, CHEN

CHUN CHIEH CHEN /
Asst. Supervisor

Testing Laboratory
0513

Revision History

Revision	Description	Issue Date	Remark
Rev.00	Original.	Oct. 24, 2019	Revised By: Yuri Tsai

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1 GENERAL INFORMATION

1.1 Product description

Product Name:	Communication Module
Brand Name:	muRata
Model No.:	LBEQ6ZZ1BN
Model Difference:	N/A
Hardware Version:	1.0
Software Version:	1.0
Power Supply:	Typ. 3.3V, Min 3.0V, Max 3.6V from DC power supply

Radio Technology:	Bluetooth BR+EDR
Channel number:	79 channels
Modulation type:	GFSK + π/4DQPSK + 8DPSK
Transmit Power:	10.25 dBm
Frequency Range:	2.402GHz – 2.480GHz
Dwell Time:	≦ 0.4s
Antenna Designation:	Dipole Antenna, Gain: 2.37dBi Model No: GW.59.3153; Supplier: Taoglas

1.2 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247
KDB 558074 D01 v05 DSS Meas. Guidance
RSS-247 issue 2 Feb. 2017
RSS-Gen. issue 5 Mar. 2019
ANSI C63.10:2013

1.3 Test Facility

SGS Taiwan Ltd. Electronics & Communication Laboratory (TAF code 0513)
No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan 24803

FCC Designation number: TW0001

Canada Registration Number: 4620A-4

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.

1.6 Radiated Emission Test Sites For Measurements From 9 kHz To 30 MHz

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

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

2.3.1Conducted Emissions

The EUT is a 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 30MHz. The CISPR Quasi-Peak and Average detector mode is employed. The two LISNs provide 50uH/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.

2.3.2Conducted Test (RF)

The active antenna port of the unlicensed wireless device is connected to the spectrum analyzer with attenuator to protect the instrumentation. If a second antenna port is available, it is tested at one operating frequency, with other port(s) appropriately terminated, to verify it has similar output characteristics as the fully tested port.

2.3.3Radiated Emissions

The EUT is a 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.

2.5 Configuration of Tested System

Fig. 2-1 Radiated Emission

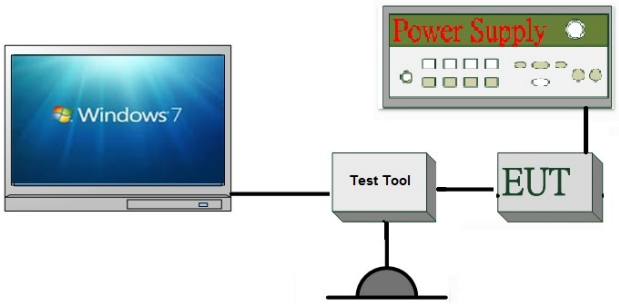


Fig. 2-3 Conducted (Antenna Port) Configuration

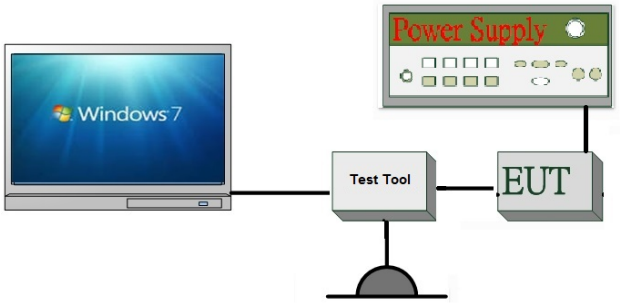


Fig 2-2 Conduction (AC Power Line) Radiated Emission

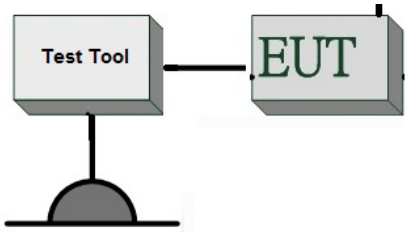


Table 2-1 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Cable	Power Cord
1	Bluetooth Test Software	N/A	N/A	N/A	N/A	N/A
2	Notebook	Lenovo	L430	R9-XFG0X	Shielded	Unshielded
3	DC power supply	Agilent	E3640A	MY52410006	N/A	Unshielded
4	Test tool kit	N/A	N/A	N/A	N/A	N/A

3 SUMMARY OF TEST RESULTS

FCC Rules	IC Rules	Description Of Test	Result
§15.207(a)	RSS-Gen §8.8	AC Power Line Conducted Emission	Compliant
§15.247(b)(1)	RSS-247 §5.4 b	Peak Output Power	Compliant
§15.247(a)(1)	RSS-247 §5.1 b RSS-Gen §6.7	20dB & 99% Bandwidth	Compliant
§15.205 §15.209 §15.247(d)	RSS-247 §5.5 RSS-Gen §8.9 RSS-Gen §8.10	Conducted & Radiated Band Edge and Spurious Emission	Compliant
§15.247(a)(1)	RSS-247 §5.1 b	Frequency Separation	Compliant
§15.247(a)(1)(iii)	RSS-247 §5.1 d	Number of hopping frequency Time of Occupancy	Compliant
§15.203	N/A	Antenna Requirement	Compliant

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		

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.

MODE	AVAILABLE FREQUENCY (MHz)	TESTED FREQUENCY (MHz)	MODULATION	PACKET TYPE
RADIATED EMISSION TEST (BELOW 1 GHz)				
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 TEST				
MODE	AVAILABLE FREQUENCY (MHz)	TESTED FREQUENCY (MHz)	MODULATION	PACKET TYPE
Peak Output Power, 20dB Band Width				
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK, π/4-DQPSK, 8-DQPK	DH1/DH3/DH5
Band Edge				
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK	DH5
Frequency Separation				
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK	DH5
Number of hopping frequency				
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK	DH5
Time of Occupancy (Dwell time)				
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK, π/4-DQPSK, 8-DQPK	DH1/DH3/DH5

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: +-2.3dB
	30MHz - 180MHz: +/- 3.37dB
	180MHz -417MHz: +/- 3.19dB
	0.417GHz-1GHz: +/- 3.19dB
	1GHz - 18GHz: +/- 4.04dB
	18GHz - 40GHz: +/- 4.04dB
Polarization: Horizontal	9kHz~30MHz: +-2.3dB
	30MHz - 167MHz: +/- 4.22dB
	167MHz -500MHz: +/- 3.44dB
	0.5GHz-1GHz: +/- 3.39dB
	1GHz - 18GHz: +/- 4.08dB
	18GHz - 40GHz: +/- 4.08dB

Note:

1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.
2. The conformity assessment statement in this report is based solely on the test results, measurement uncertainty is excluded.

6 CONDUCTED EMISSION TEST

6.1 Standard Applicable

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

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

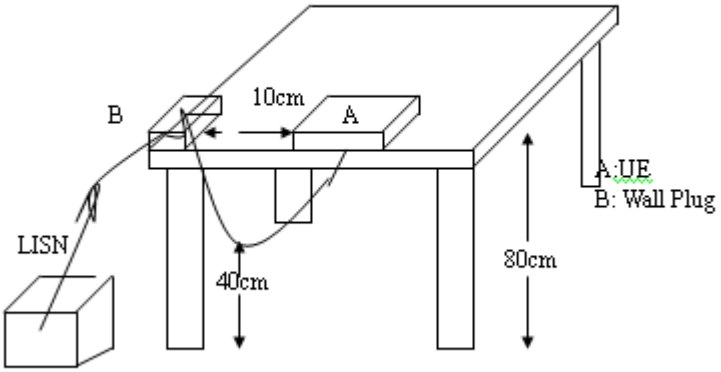
6.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	**MFR**	**MODEL NUMBER**	**SERIAL NUMBER**	**LAST CAL.**	**CAL DUE.**
EMI Test Receiver	R&S	ESCI 3	100335	02/12/2019	02/11/2020
Coaxial Cables	N/A	WK CE Cable	N/A	11/26/2018	11/25/2019
LISN	SCHWARZBECK	NSLK 8127	8127-649	04/02/2019	04/01/2020
LISN	FCC	FCC-LISN-50/250-25-2-01	4034	04/09/2019	04/08/2020
Test Software	Farad	EZ-EMC	Ver. SGS-03A2	N.C.R	N.C.R

6.3 EUT Setup

1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI 63.10:2013.
2. The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
3. The LISN was connected with 120Vac/60Hz power source.

6.4 Test SET-UP (Block Diagram of Configuration)



6.5 Measurement Procedure

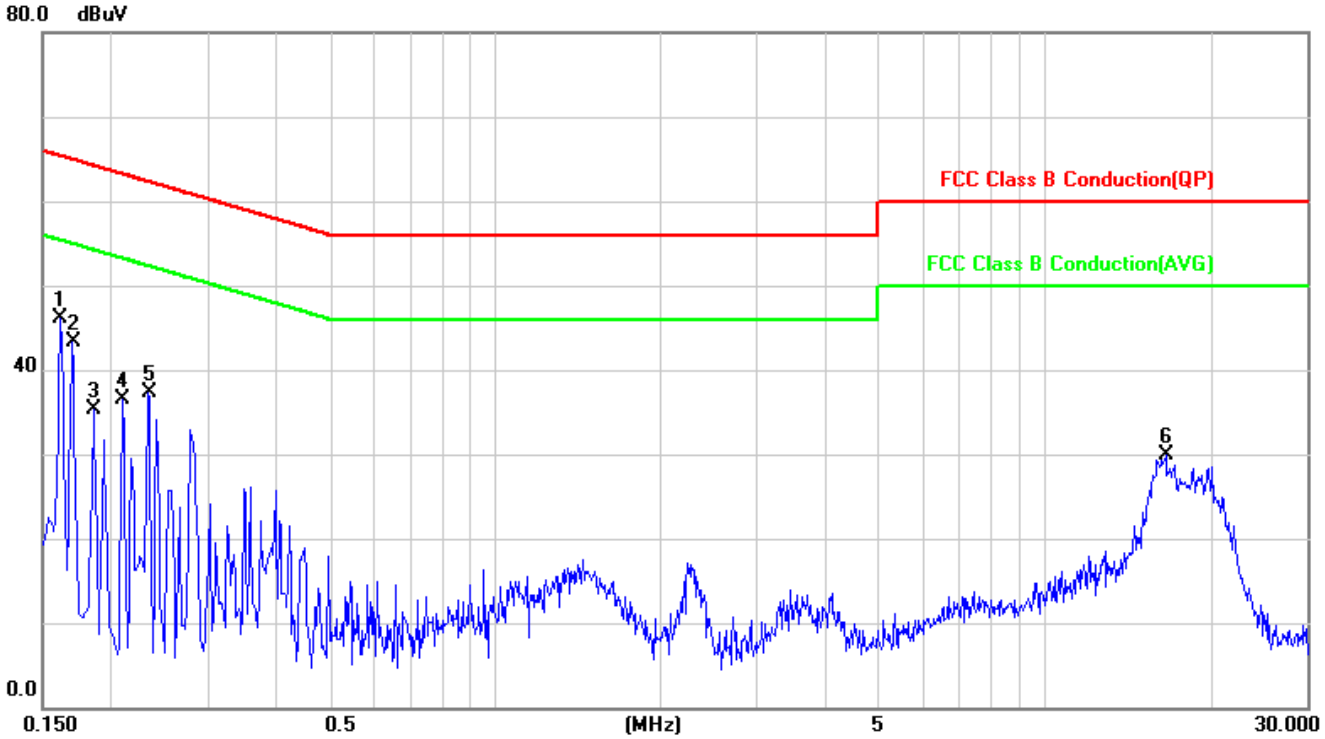
1. The EUT was placed on a table which is 0.8m above ground plan.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured were complete.

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.

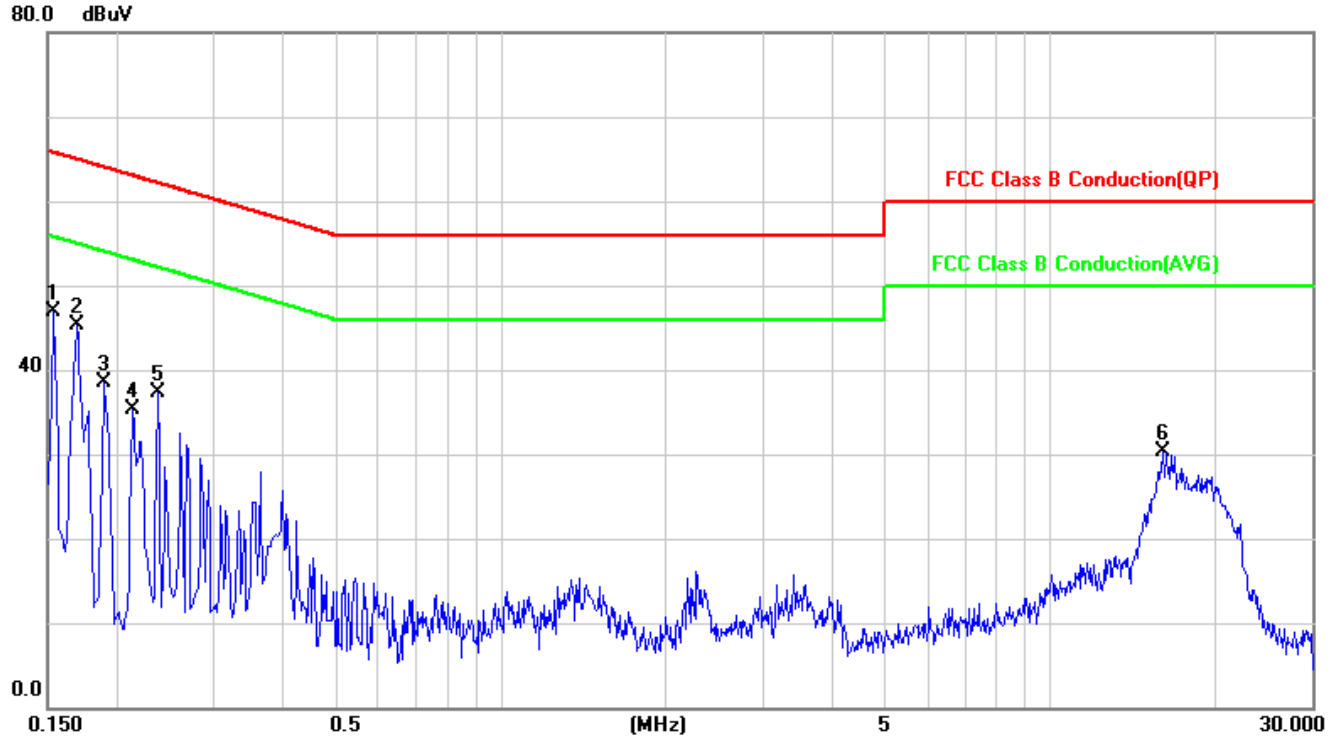
AC POWER LINE CONDUCTED EMISSION TEST DATA

Description:	**Operation**	**Date:**	**2019/10/23**
Line:	**L1**	**Temp.(℃)/Hum.(%):**	**24(℃)/71%**
Test Voltage:	**AC 120V/60Hz**	**Test By:**	**Nick**



No.	Mk.	Freq.	Reading	Factor	Measurement	Limit	Over	Detector
		(MHz)	dBuV	(dB)	(dBuV)	(dBuV)	(dB)	
1	*	0.1620	46.15	0.00	46.15	65.36	-19.21	peak
2		0.1700	43.25	0.00	43.25	64.96	-21.71	peak
3		0.1860	35.28	0.01	35.29	64.21	-28.92	peak
4		0.2100	36.53	0.01	36.54	63.21	-26.67	peak
5		0.2340	37.29	0.01	37.30	62.31	-25.01	peak
6		16.5900	29.52	0.35	29.87	60.00	-30.13	peak

Description:	**Operation**	**Date:**	**2019/10/23**
Line:	**N**	**Temp.(℃)/Hum.(%):**	**24(℃)/71%**
Test Voltage:	**AC 120V/60Hz**	**Test By:**	**Nick**



No.	Mk.	Freq.	Reading	Factor	Measurement	Limit	Over	Detector
		(MHz)	dBuV	(dB)	(dBuV)	(dBuV)	(dB)	
1	*	0.1540	46.91	0.03	46.94	65.78	-18.84	peak
2		0.1700	45.23	0.03	45.26	64.96	-19.70	peak
3		0.1900	38.54	0.03	38.57	64.04	-25.47	peak
4		0.2140	35.19	0.03	35.22	63.05	-27.83	peak
5		0.2380	37.26	0.03	37.29	62.17	-24.88	peak
6		16.0580	29.90	0.37	30.27	60.00	-29.73	peak

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.
The e.i.r.p. shall not exceed 4 W.

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	02/13/2019	02/12/2020
Power Sensor	Anritsu	MA2411B	1726104	02/13/2019	02/12/2020
Power Sensor	Anritsu	MA2411B	1726107	02/13/2019	02/12/2020
DC Power Supply	Agilent	E3640A	MY52410006	12/04/2018	12/03/2019

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 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.

7.5 Peak & Average Power Measurement Result

1M BR mode (Peak):

CH	Freq. (MHz)	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	**10.25**	10.593	125
Mid	2441	10.01	10.023	125
High	2480	9.93	9.840	125

1M BR mode (Average):

CH	Freq. (MHz)	Max. Output include tune up tolerance Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	9.83	9.625	125
Mid	2441	9.61	9.149	125
High	2480	9.67	9.276	125

2M EDR mode (Peak):

CH	Freq. (MHz)	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	**9.64**	9.204	125
Mid	2441	9.33	8.570	125
High	2480	9.21	8.337	125

2M EDR mode (Average):

CH	Freq. (MHz)	Max. Avg.Output include tune up tolerance Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	8.15	6.537	125
Mid	2441	7.54	5.680	125
High	2480	7.77	5.989	125

3M EDR mode (Peak):

CH	Freq. (MHz)	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	**9.93**	9.840	125
Mid	2441	9.65	9.226	125
High	2480	9.52	8.954	125

NOTE: cable loss as 0.5dB that offsets in the sp

3M EDR mode (Average):

CH	Freq. (MHz)	Max. Avg.Output include tune up tolerance Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	7.71	5.907	125
Mid	2441	7.50	5.628	125
High	2480	7.55	5.694	125

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

7.6 EIRP Measurement Result

1M BR mode EIRP

Channel	Frequency (MHz)	Max. Output include tune up tolerance Power (dBm)	Antenna Gain (dBi)	EIRP (mW)	Limit (mW)
Low	2402	9.83	1.87	14.804	4000
Mid	2441	9.61	1.87	14.073	4000
High	2480	9.67	1.87	14.269	4000

2M EDR mode EIRP

Channel	Frequency (MHz)	Max. Avg.Output include tune up tolerance	Antenna Gain (dBi)	EIRP (mW)	Limit (mW)
Low	2402	8.15	1.87	10.055	4000
Mid	2441	7.54	1.87	8.737	4000
High	2480	7.77	1.87	9.213	4000

3M EDR mode EIRP

Channel	Frequency (MHz)	Max. Avg.Output include tune up tolerance	Antenna Gain (dBi)	EIRP (mW)	Limit (mW)
Low	2402	7.71	1.87	9.086	4000
Mid	2441	7.50	1.87	8.657	4000
High	2480	7.55	1.87	8.758	4000

Note: EIRP = Average Power + Gain

8 20dB & 99% BANDWIDTH MEASUREMENT

8.1 Standard Applicable

For frequency hopping systems operating in the 2400 MHz-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.
EXA Spectrum Analyzer	Agilent	N9010A	MY50420195	05/02/2019	05/01/2020
DC Power Supply	Agilent	E3640A	MY52410006	12/04/2018	12/03/2019
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2019	01/01/2020

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

8.5 20dB Bandwidth

GFSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
Low	0.9247	0.62
Mid	0.9254	0.62
High	0.9247	0.62

π/4-DQPSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
Low	1.317	0.88
Mid	1.316	0.88
High	1.316	0.88

8-DPSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
Low	1.292	0.86
Mid	1.293	0.86
High	1.291	0.86

8.6 99% Bandwidth

GFSK

CH	99% Bandwidth (MHz)
Low	0.85768
Mid	0.86247
High	0.85589

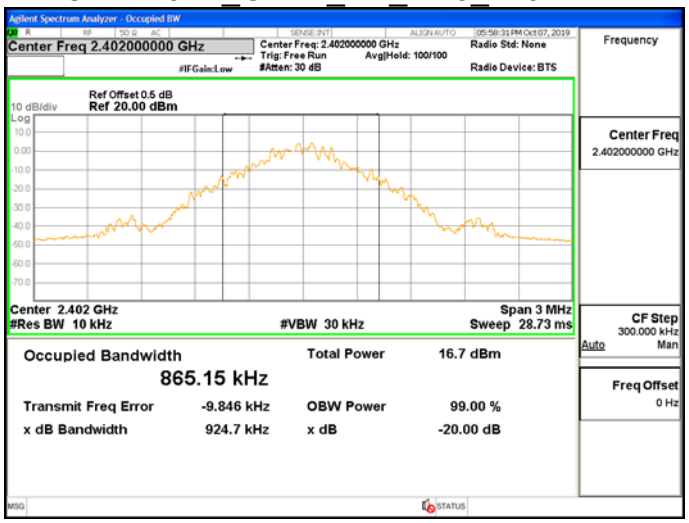
π/4-DQPSK

CH	99% Bandwidth (MHz)
Low	1.1668
Mid	1.1665
High	1.1663

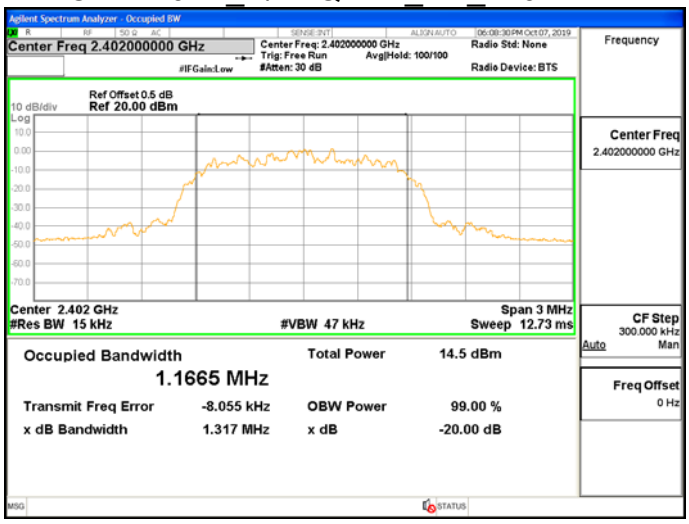
8-DPSK

CH	99% Bandwidth (MHz)
Low	1.1662
Mid	1.1656
High	1.1655

OBW 20dB_GFSK_1M_DH5_2402MHz



OBW 20dB_π/4DQPSK_2M_2402MHz



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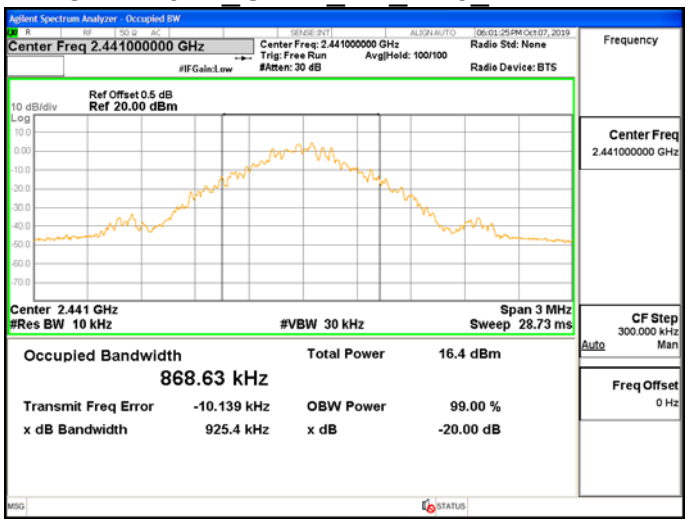

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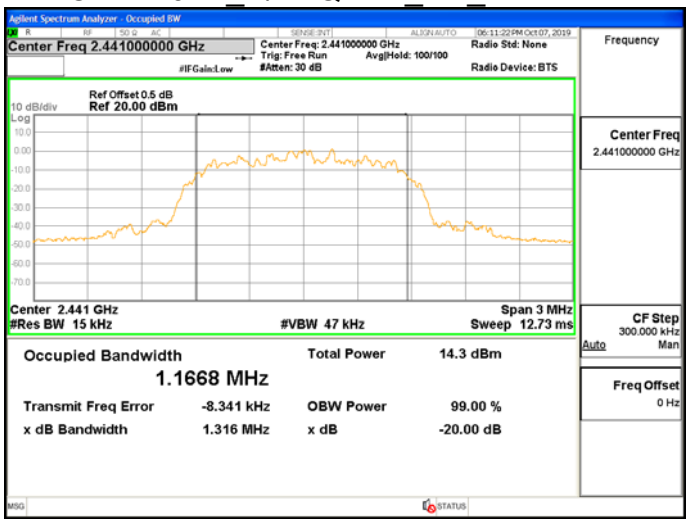
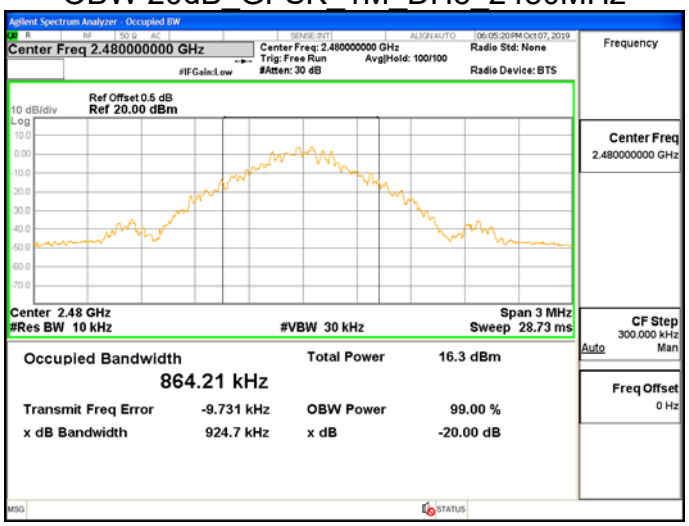
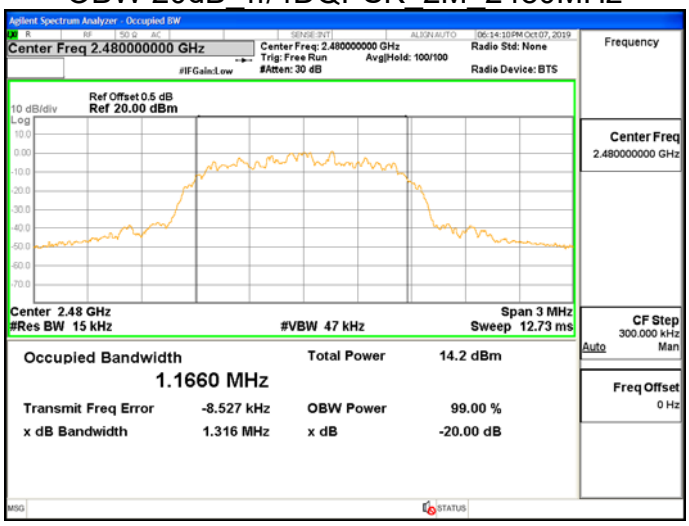


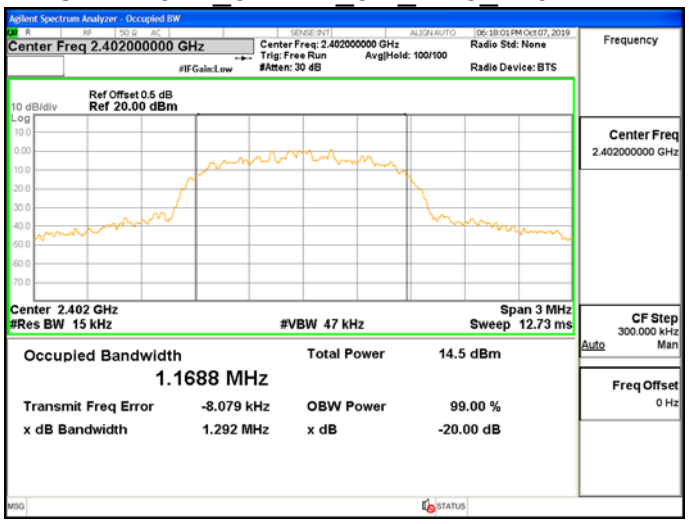
OBW 20dB_GFSK_1M_DH5_2480MHz



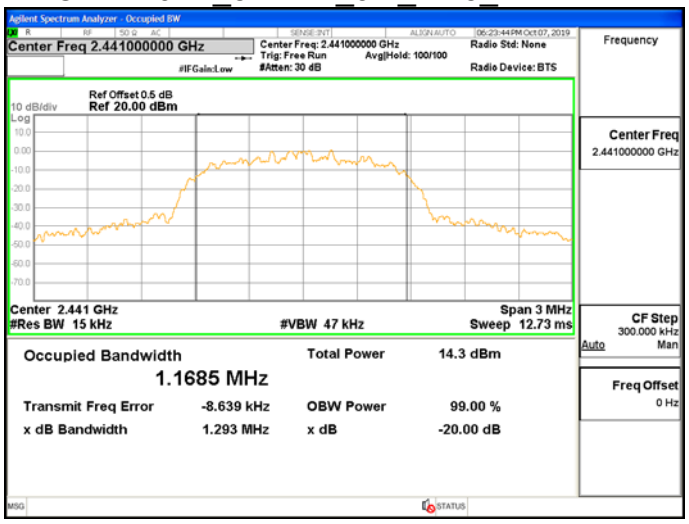
OBW 20dB_π/4DQPSK_2M_2480MHz



OBW 20dB_8DPSK_3M_DH5_2402MHz



OBW 20dB_8DPSK_3M_DH5_2441MHz



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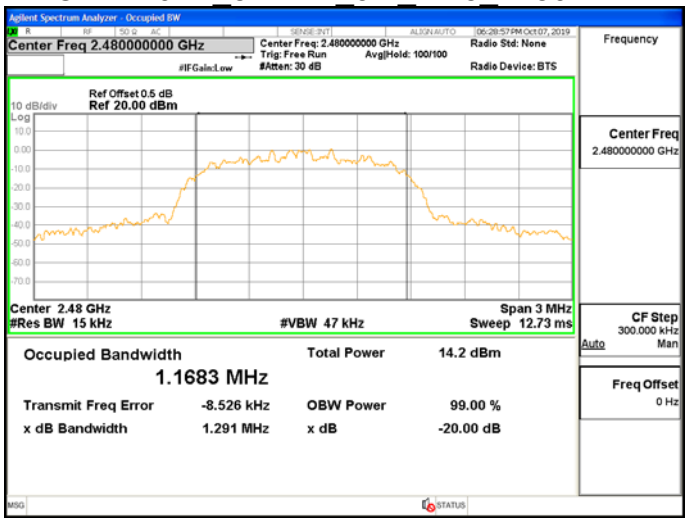
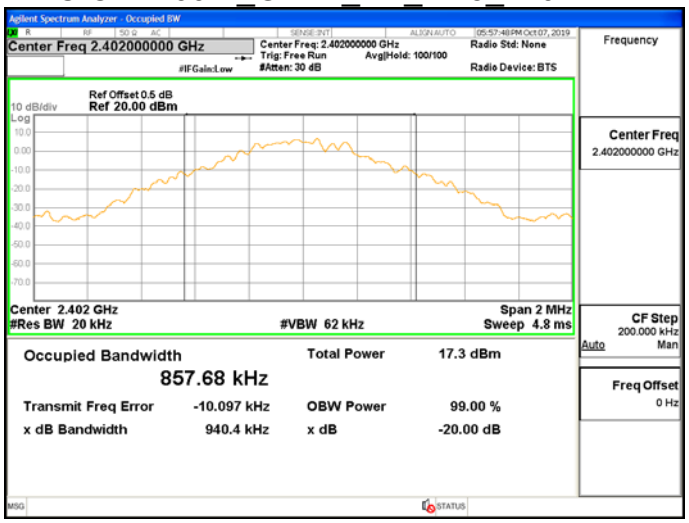
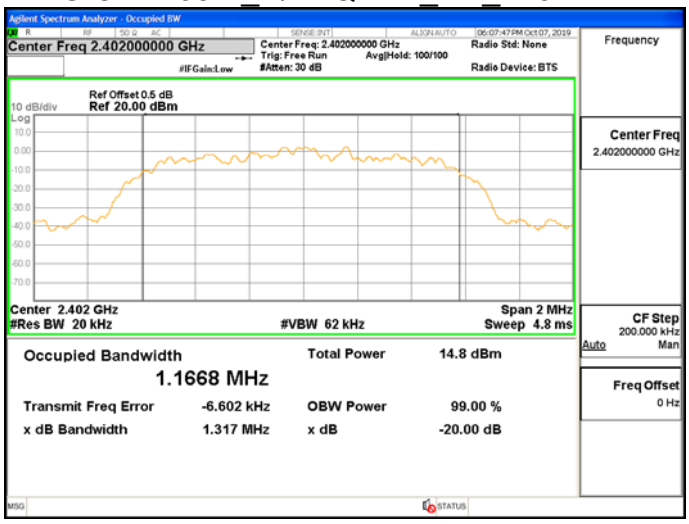


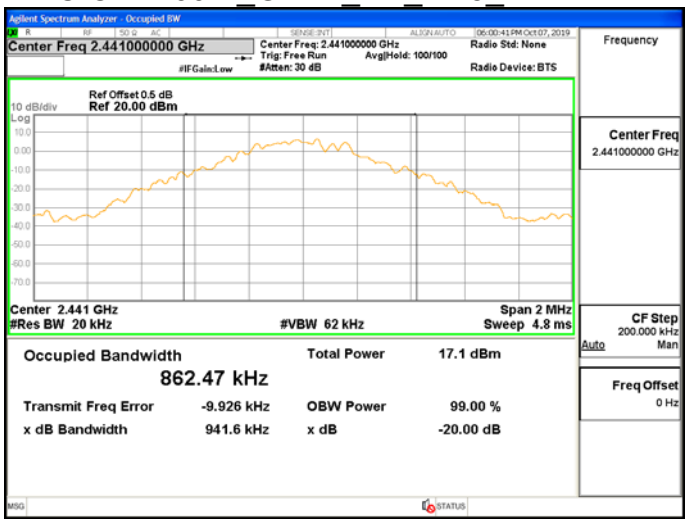
IC OBW 99%_GFSK_1M_DH5_2402MHz



IC OBW 99%_π/4DQPSK_2M_2402MHz



IC OBW 99%_GFSK_1M_DH5_2441MHz



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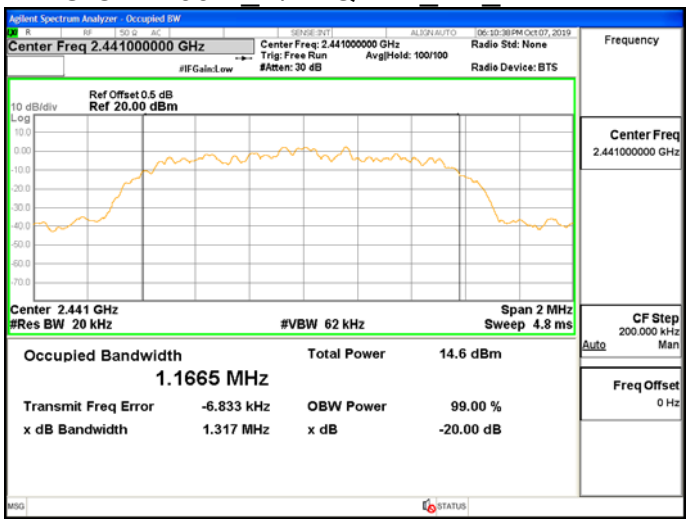
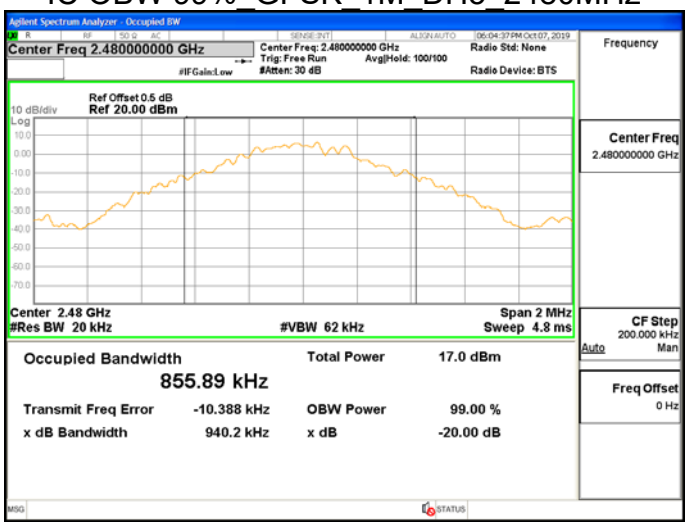
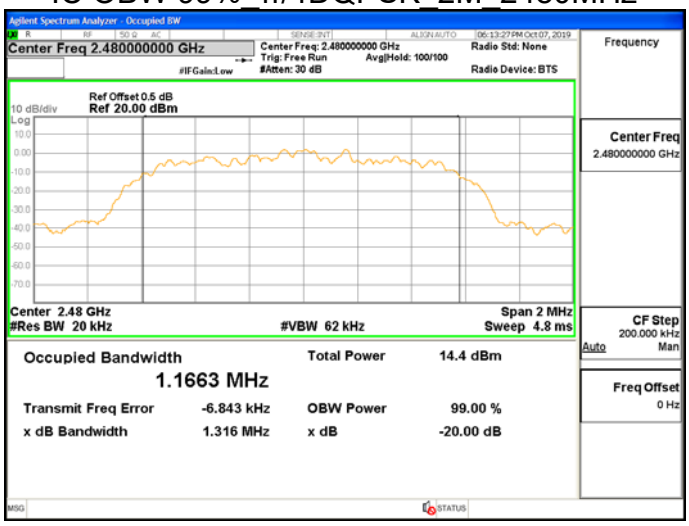


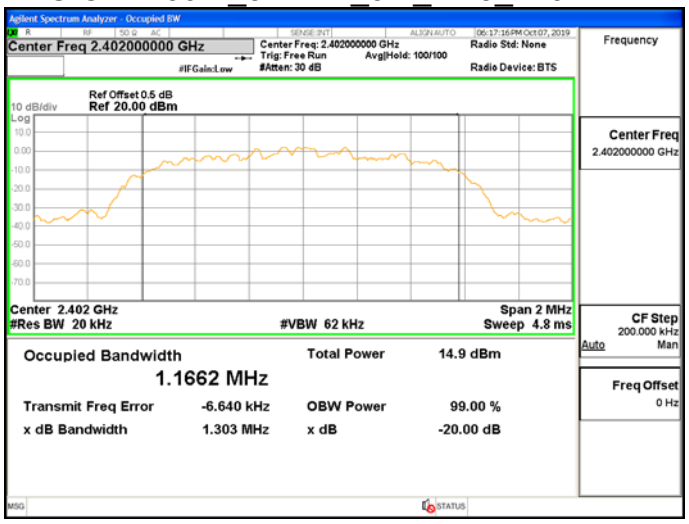
IC OBW 99%_GFSK_1M_DH5_2480MHz



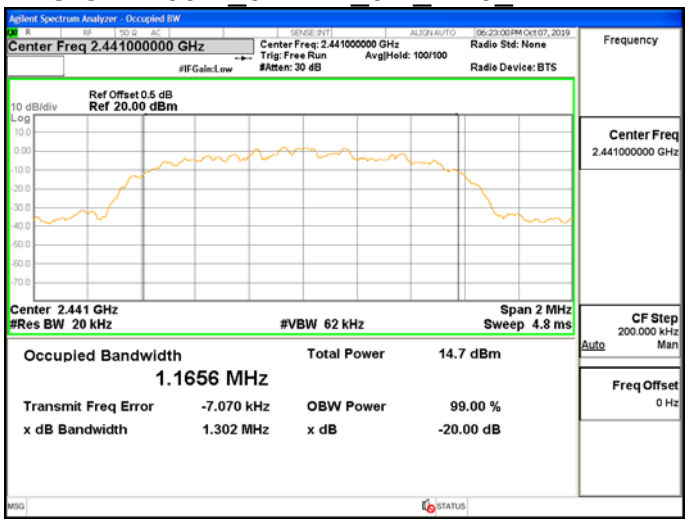
IC OBW 99%_π/4DQPSK_2M_2480MHz



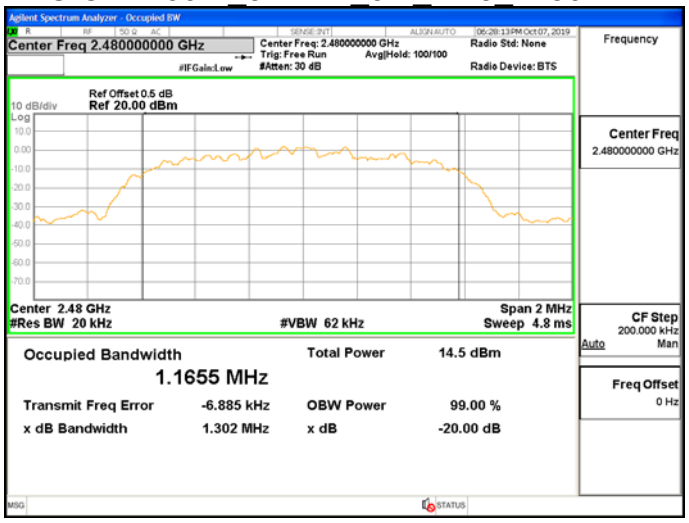
IC OBW 99%_8DPSK_3M_DH5_2402MHz



IC OBW 99%_8DPSK_3M_DH5_2441MHz



IC OBW 99%_8DPSK_3M_DH5_2480MHz



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) & RSS-Gen §8.10, must also comply with the radiated emission limits specified in §15.209(a) & RSS-Gen §8.9.

9.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	**MFR**	**MODEL NUMBER**	**SERIAL NUMBER**	**LAST CAL.**	**CAL DUE.**
EXA Spectrum Analyzer	Agilent	N9010A	MY50420195	05/02/2019	05/01/2020
DC Power Supply	Agilent	E3640A	MY52410006	12/04/2018	12/03/2019
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2019	01/01/2020

9.3 Test SET-UP

9.4 Measurement Procedure

9.4.1Conducted 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.

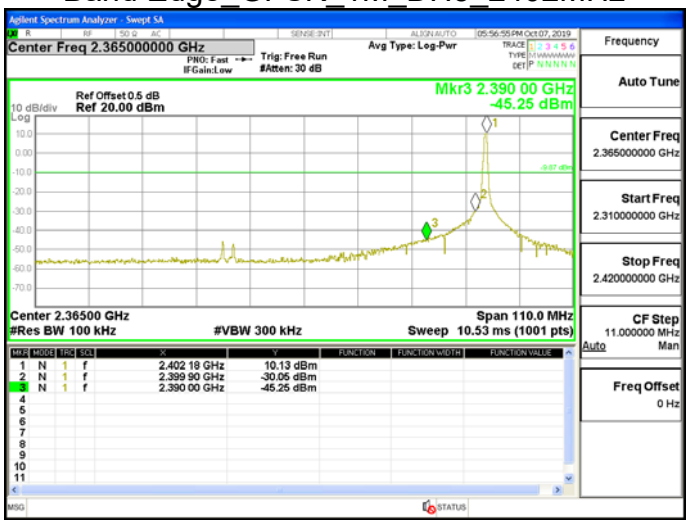
9.4.2Conducted Spurious Emission:

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.

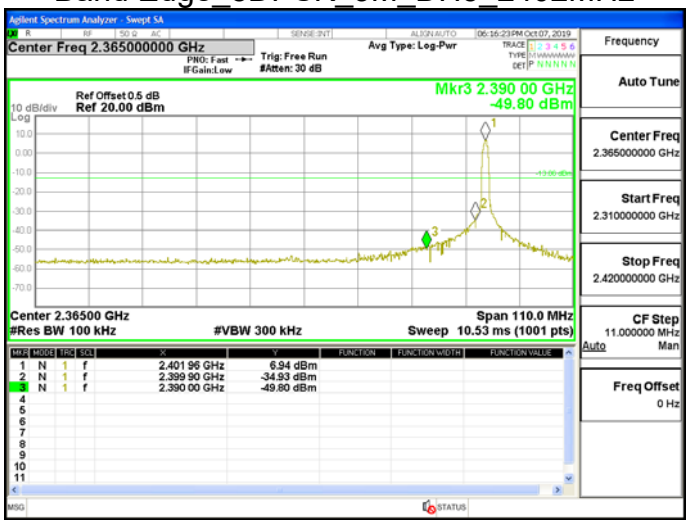
9.5 Measurement Result

See next page for test plots.

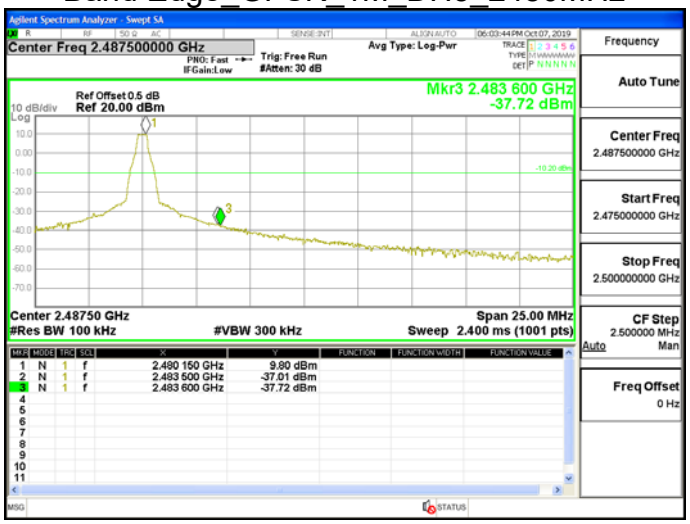
Band Edge_GFSK_1M_DH5_2402MHz



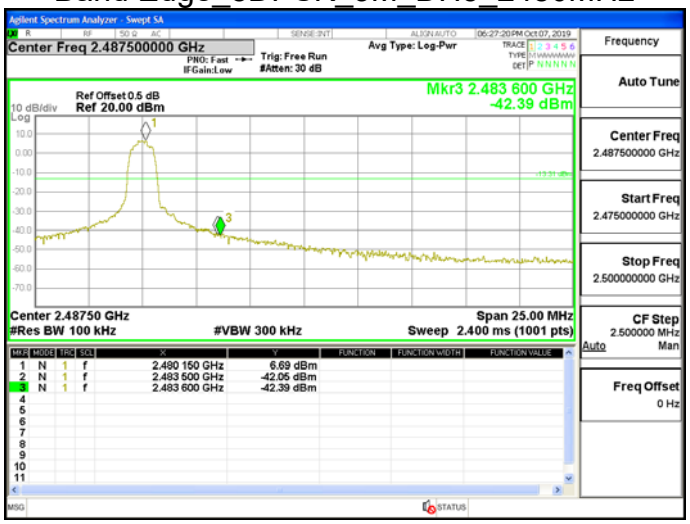
Band Edge_8DPSK_3M_DH5_2402MHz



Band Edge_GFSK_1M_DH5_2480MHz

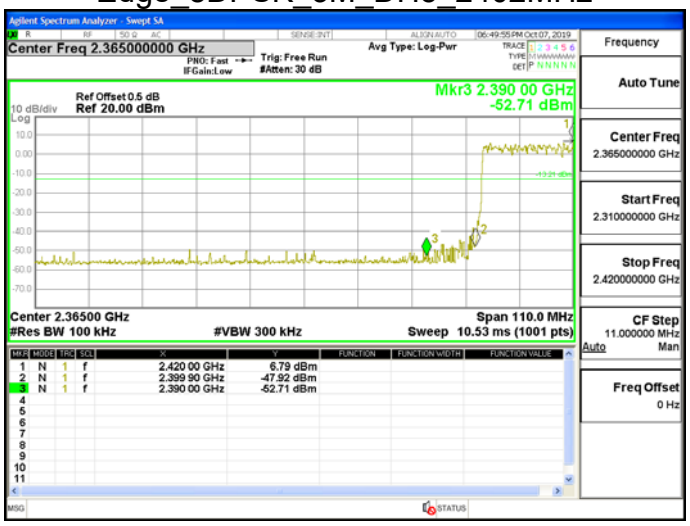


Band Edge_8DPSK_3M_DH5_2480MHz

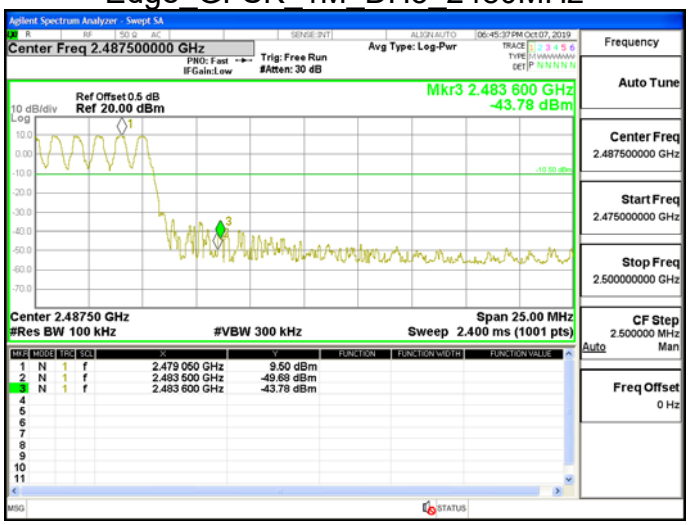


Hopping Band
Edge_GFSK_1M_DH5_2402MHz

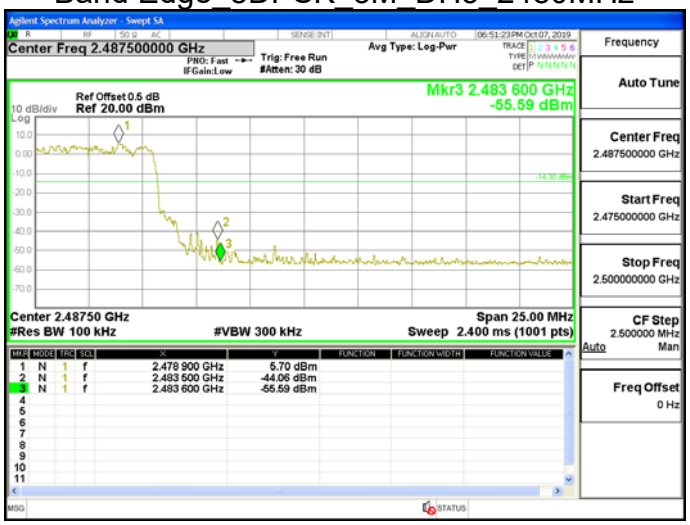
Hopping Band
Edge_8DPSK_3M_DH5_2402MHz



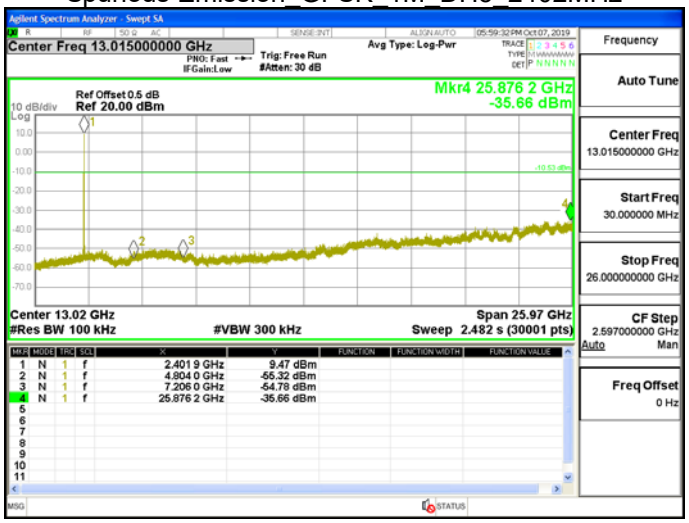
Hopping Band
Edge_GFSK_1M_DH5_2480MHz



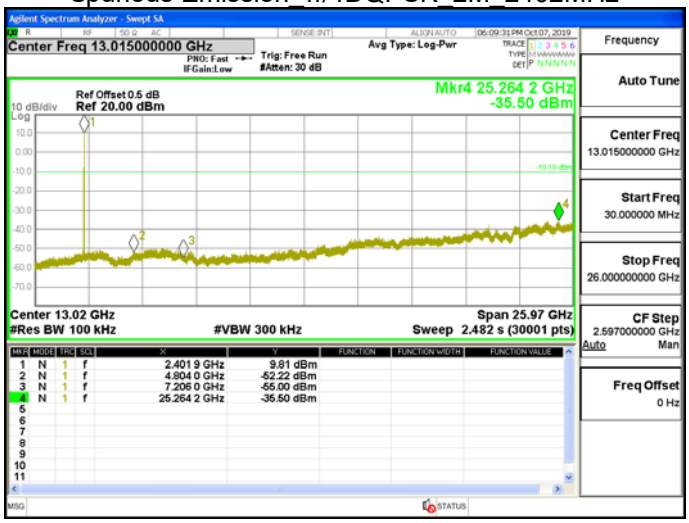
Hopping Band
Band Edge_8DPSK_3M_DH5_2480MHz



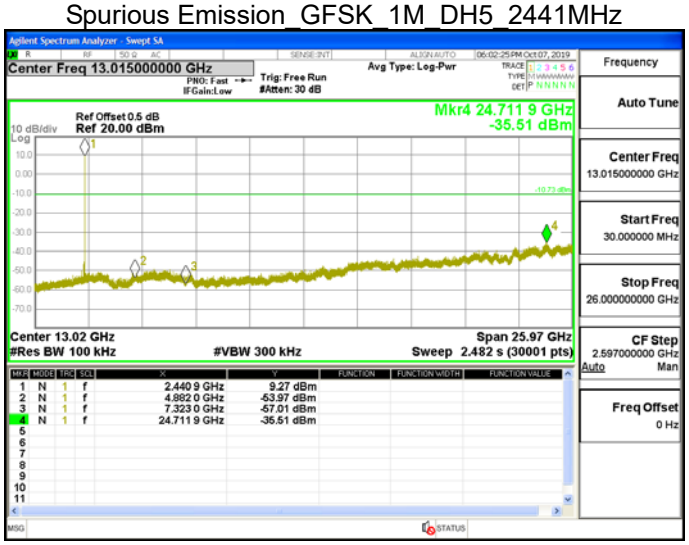
Spurious Emission_GFSK_1M_DH5_2402MHz



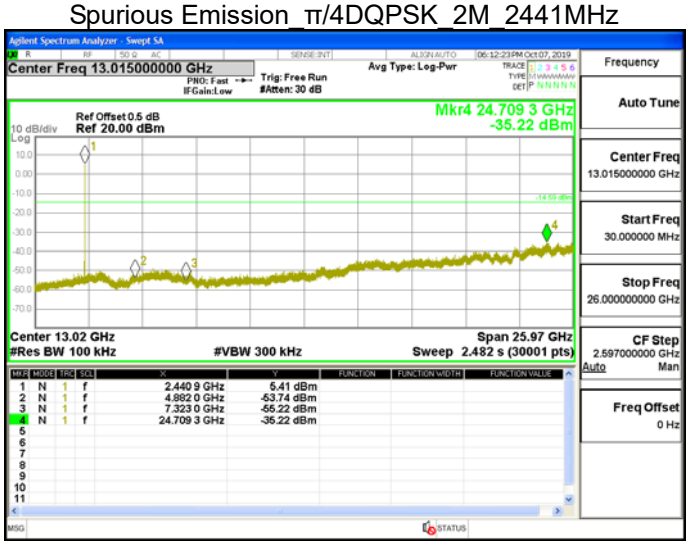
Spurious Emission_π/4DQPSK_2M_2402MHz



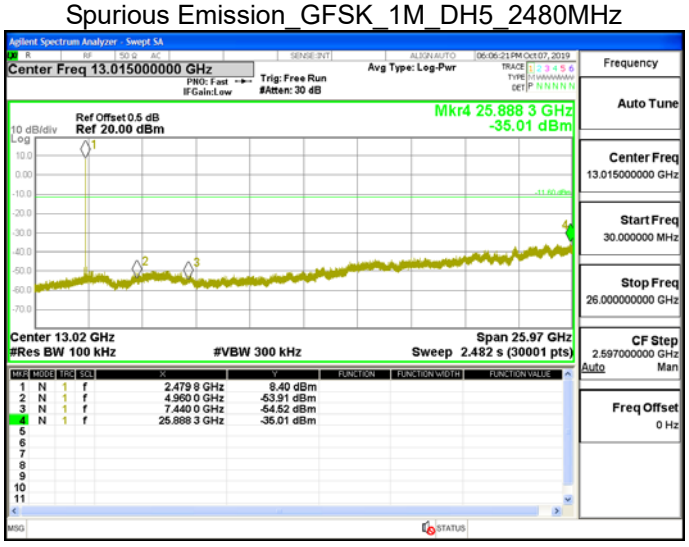
Spurious Emission_GFSK_1M_DH5_2441MHz



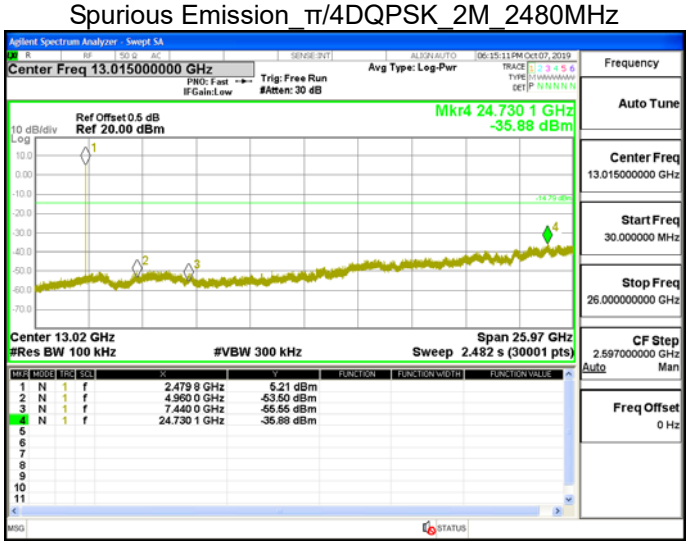
Spurious Emission_π/4DQPSK_2M_2441MHz



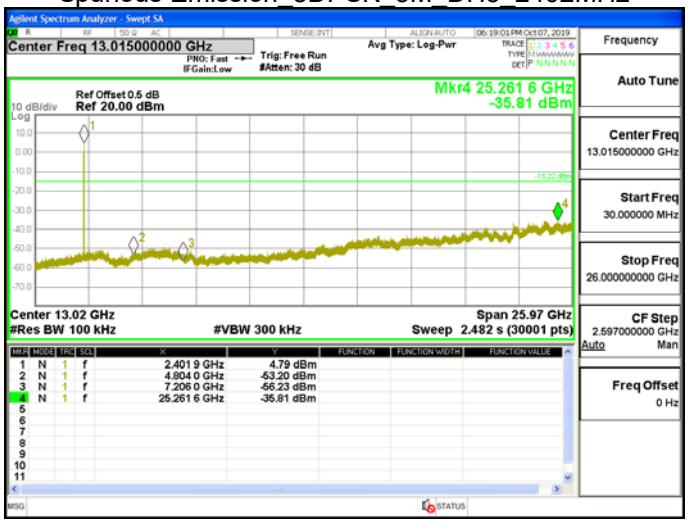
Spurious Emission_GFSK_1M_DH5_2480MHz



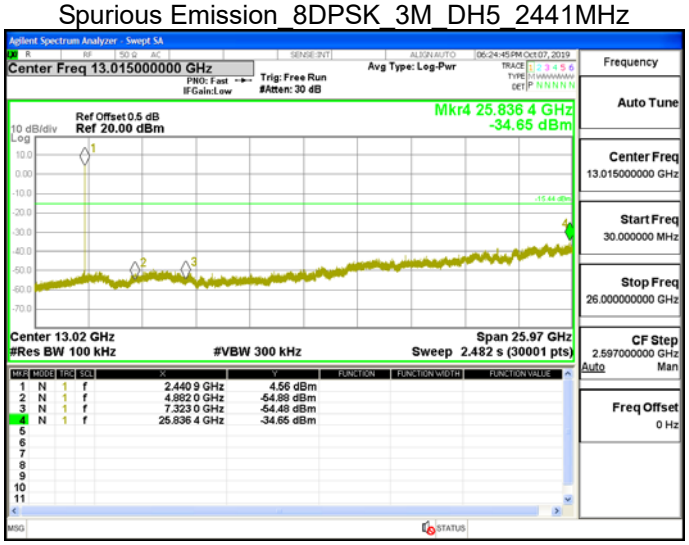
Spurious Emission_π/4DQPSK_2M_2480MHz



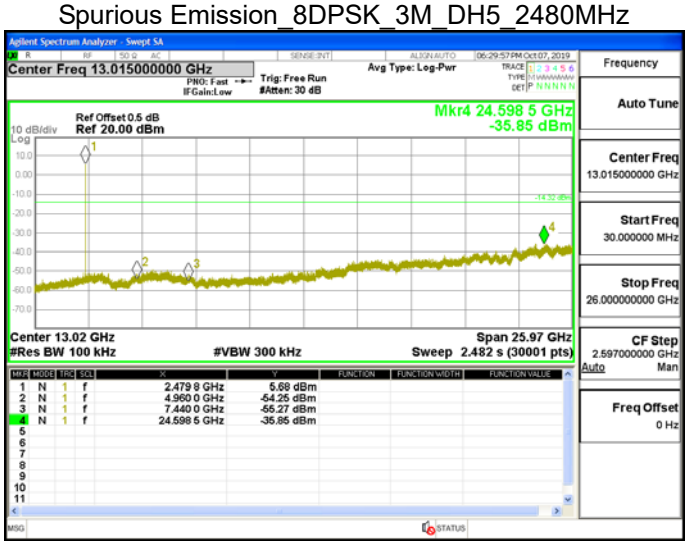
Spurious Emission_8DPSK_3M_DH5_2402MHz



Spurious Emission_8DPSK_3M_DH5_2441MHz



Spurious Emission_8DPSK_3M_DH5_2480MHz



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)*

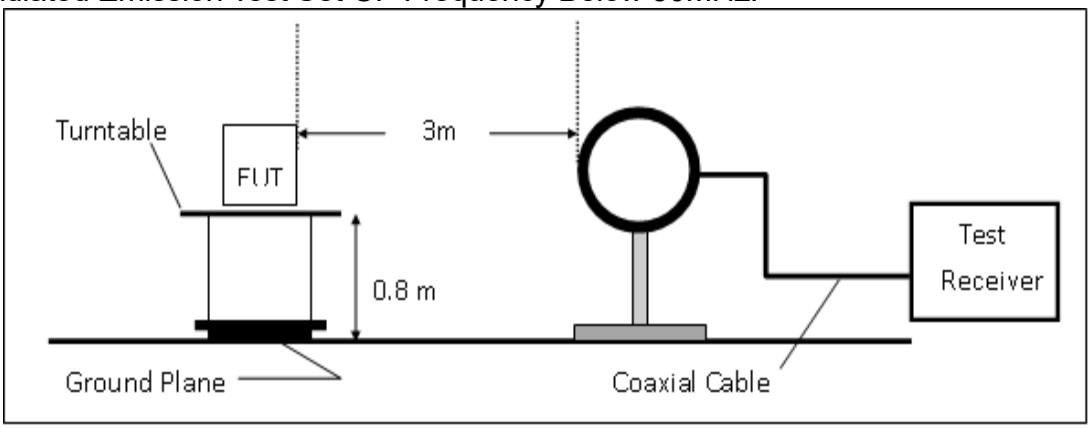
10.2 Measurement Equipment Used

966 Chamber					
EQUIPMENT TYPE	**MFR**	**MODEL NUMBER**	**SERIAL NUMBER**	**LAST CAL.**	**CAL DUE.**
Bi-log Antenna	TESEO	CBL 6112D	35242 & AT-N0555	01/10/2019	01/09/2020
Horn Antenna	Schwarzbeck	BBHA9170	07/02/1900	12/27/2018	12/26/2019
Horn Antenna	Schwarzbeck	BBHA9120D	D803	12/24/2018	12/23/2019
Loop Antenna	ETS.LINDGREN	6502	148045	10/08/2018	10/07/2019
PXA Spectrum Analyzer	Agilent	N9030A	MY53120760	04/22/2019	04/21/2020
EMI Test Receiver	R&S	ESCI 3	100335	02/12/2019	02/11/2020
Pre-Amplifier	EMC Instru-ments	EMC184045B	980135	01/02/2019	01/01/2020
Pre-Amplifier	EMC Instru-ments	EMC051825	980152	01/02/2019	01/01/2020
Pre-Amplifier	HP	8447D	2944A09469	01/02/2019	01/01/2020
Filter 2400-2483.5 MHz	EWT	EWT-14-0166	M1	01/02/2019	01/01/2020
High Pass Filter	WI	WHKX4.0/18G-10SS	22	01/02/2019	01/01/2020
Coaxial Cable	Huber Suhner	succoflex 102	MY2622/2	01/02/2019	01/01/2020
Coaxial Cable	Huber Suhner	succoflex 104A	800086/4a	01/02/2019	01/01/2020
Coaxial Cable	Huber Suhner	EMC 104-SM-SM-2000	160123	01/02/2019	01/01/2020
Software	e3 V6.11-20180413				

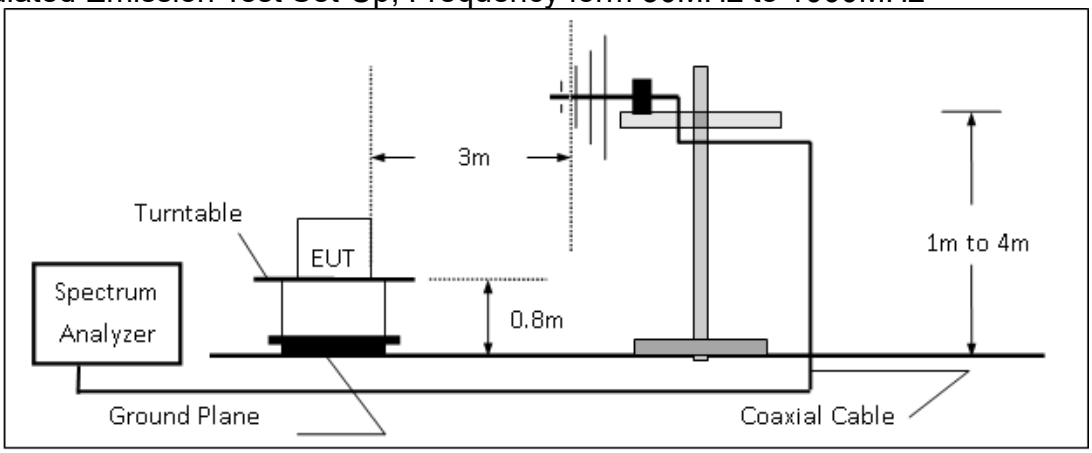
NOTE: *N.C.R refers to Not Calibrated Required.*

10.3 Test SET-UP

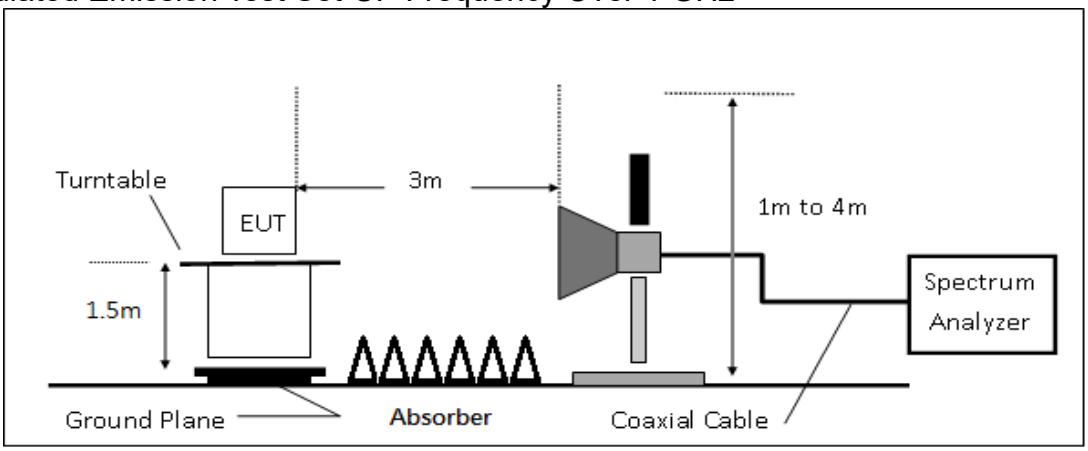
(A) Radiated Emission Test Set-UP Frequency Below 30MHz.



(B) Radiated Emission Test Set-Up, Frequency form 30MHz to 1000MHz



(C) Radiated Emission Test Set-UP Frequency Over 1 GHz



10.4 Measurement Procedure

10.4.1 Radiated Emission

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

10.5 Field Strength Calculation

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

$$FS = RA + AF + CL – AG$$

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

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

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

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

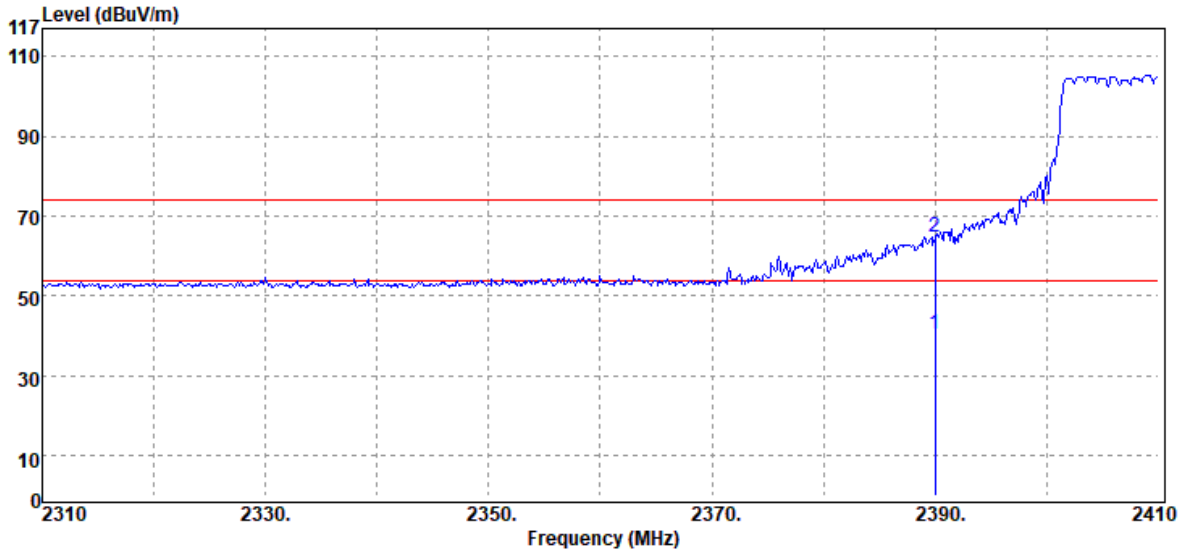
10.6 Test Results of Radiated Spurious Emissions form 9 kHz to 30 MHz

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit per 15.31(o) & RSS-GEN §6.13.2 was not reported.

10.7 Measurement Result:

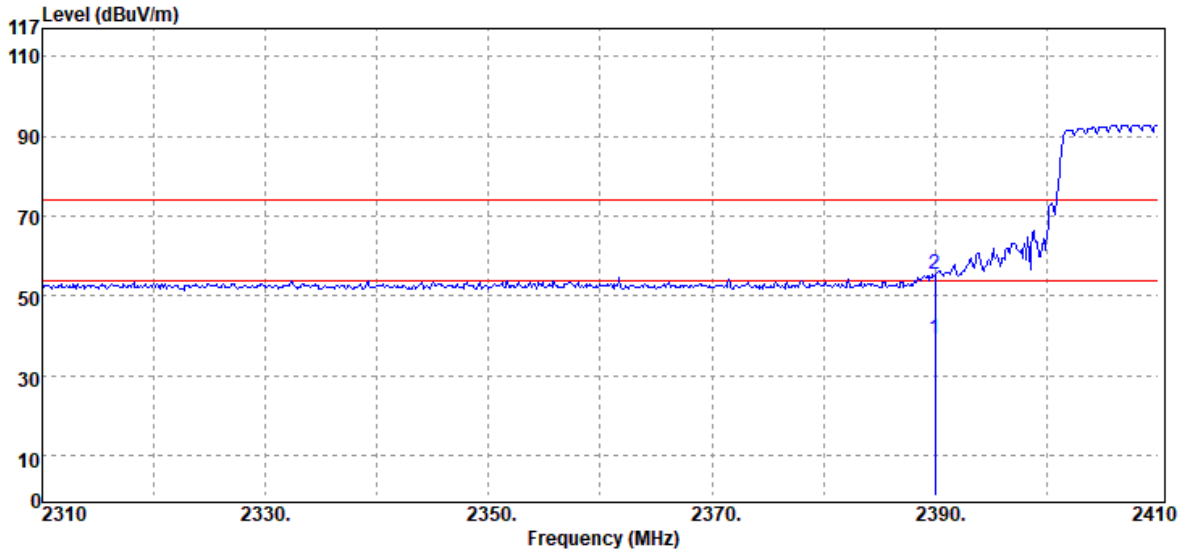
10.7.1 Radiated Bandedge Result (Hopping Mode)

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT BR Hopping	Temp./Humi.	:23.1/66
Test Channel	:2402 MHz	Antenna Pol.	:VERTICAL
Test Mode	:Bandedge CH Low	Engineer	:Nick
EUT Pol	:H Plane		



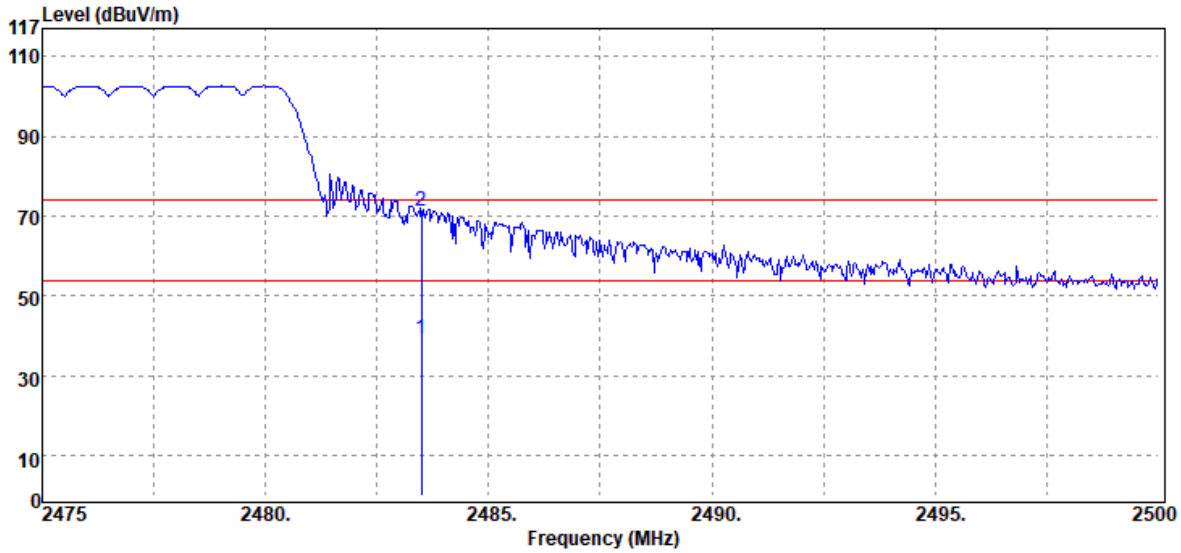
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	33.11	7.57	40.68	54.00	-13.32
2390.00	Peak	57.03	7.57	64.60	74.00	-9.40

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT BR Hopping	Temp./Humi.	:23.1/66
Test Channel	:2402 MHz	Antenna Pol.	:HORIZONTAL
Test Mode	:Bandedge CH Low	Engineer	:Nick
EUT Pol	:H Plane		



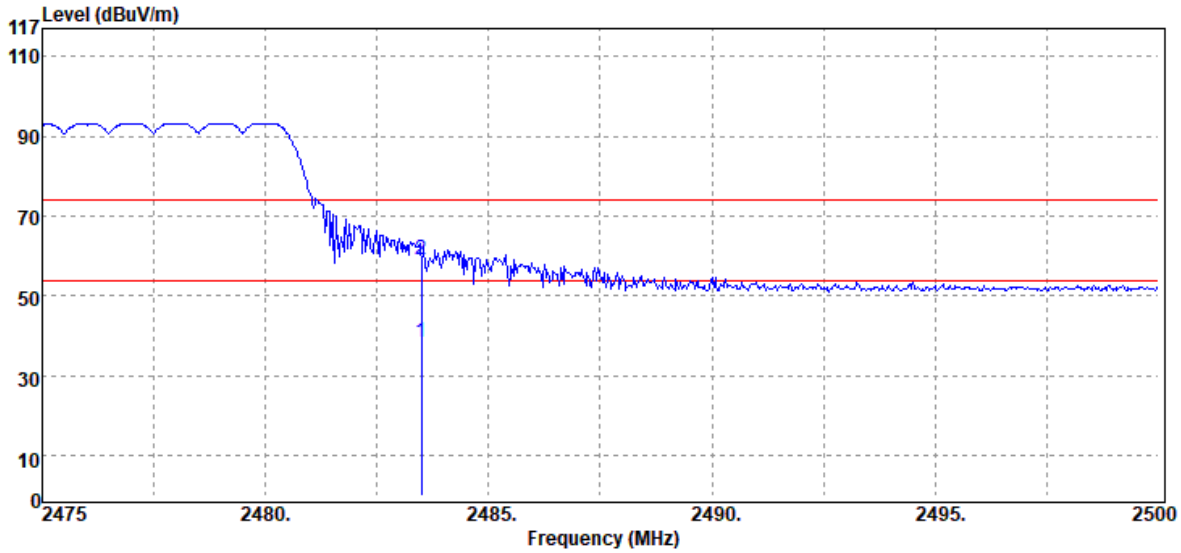
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	31.88	7.57	39.45	54.00	-14.55
2390.00	Peak	47.94	7.57	55.51	74.00	-18.49

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT BR Hopping	Temp./Humi.	:23.1/66
Test Channel	:2480 MHz	Antenna Pol.	:VERTICAL
Test Mode	:Bandedge CH High	Engineer	:Nick
EUT Pol	:H Plane		



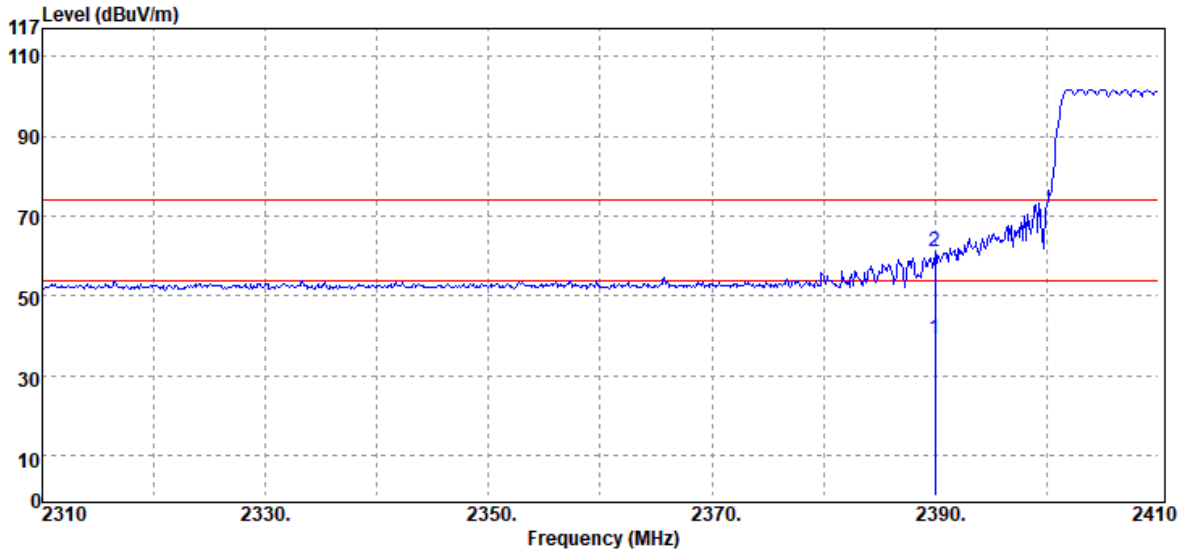
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.50	Average	32.17	6.94	39.11	54.00	-14.89
2483.50	Peak	64.34	6.94	71.28	74.00	-2.72

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT BR Hopping	Temp./Humi.	:23.1/66
Test Channel	:2480 MHz	Antenna Pol.	:HORIZONTAL
Test Mode	:Bandedge CH High	Engineer	:Nick
EUT Pol	:H Plane		



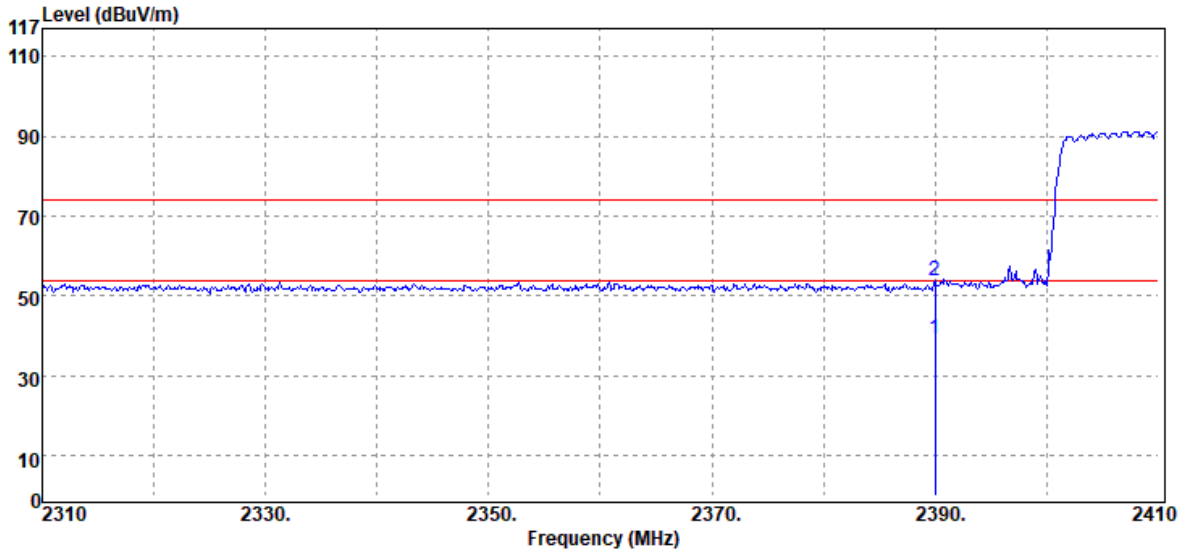
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.50	Average	31.56	6.94	38.50	54.00	-15.50
2483.50	Peak	52.25	6.94	59.19	74.00	-14.81

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT EDR Hopping	Temp./Humi.	:23.1/66
Test Channel	:2402 MHz	Antenna Pol.	:VERTICAL
Test Mode	:Bandedge CH Low	Engineer	:Nick
EUT Pol	:H Plane		



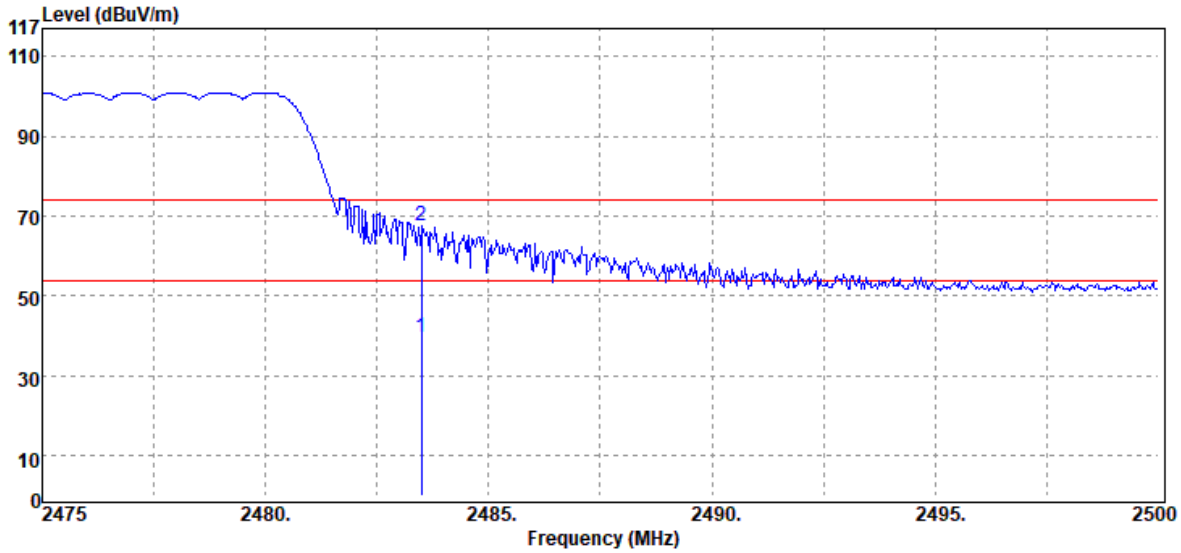
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	31.77	7.57	39.34	54.00	-14.66
2390.00	Peak	53.39	7.57	60.96	74.00	-13.04

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT EDR Hopping	Temp./Humi.	:23.1/66
Test Channel	:2402 MHz	Antenna Pol.	:HORIZONTAL
Test Mode	:Bandedge CH Low	Engineer	:Nick
EUT Pol	:H Plane		



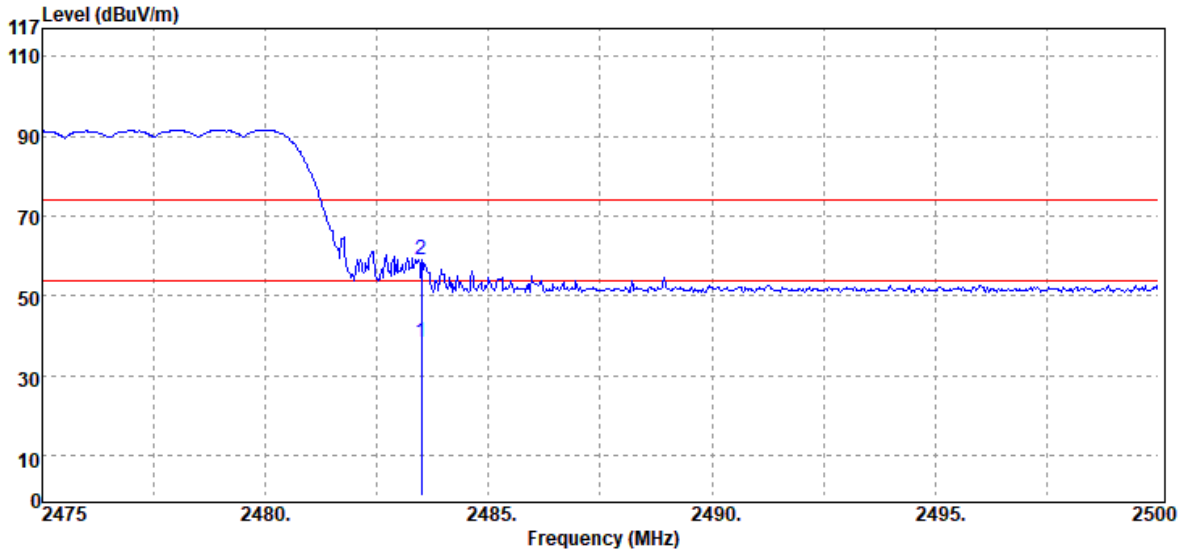
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	31.53	7.57	39.10	54.00	-14.90
2390.00	Peak	46.10	7.57	53.67	74.00	-20.33

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT EDR Hopping	Temp./Humi.	:23.1/66
Test Channel	:2480 MHz	Antenna Pol.	:VERTICAL
Test Mode	:Bandedge CH High	Engineer	:Nick
EUT Pol	:H Plane		



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.50	Average	32.86	6.94	39.80	54.00	-14.20
2483.50	Peak	60.74	6.94	67.68	74.00	-6.32

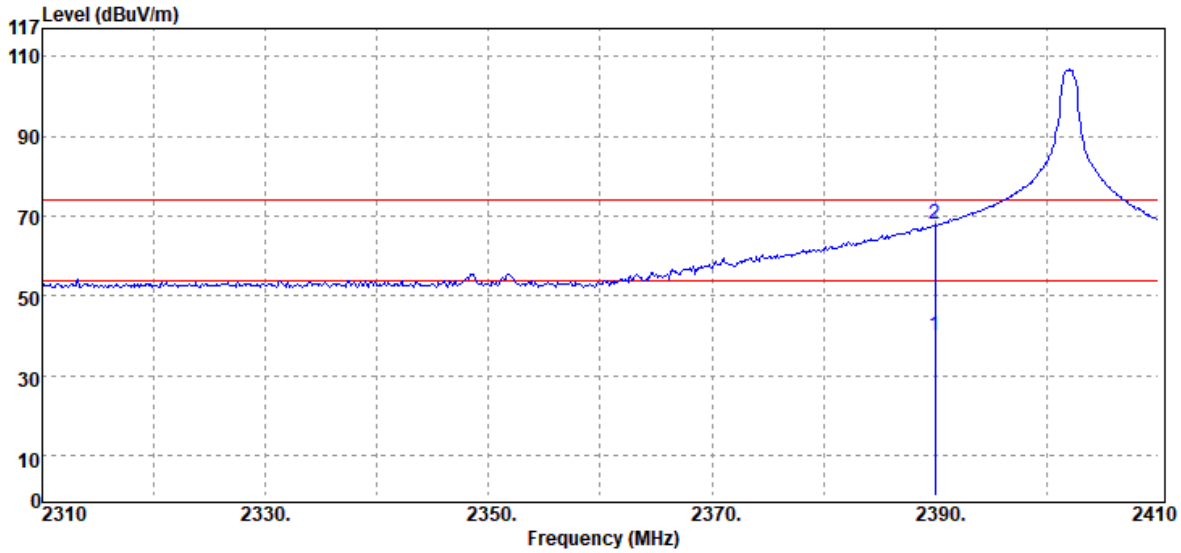
Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT EDR Hopping	Temp./Humi.	:23.1/66
Test Channel	:2480 MHz	Antenna Pol.	:HORIZONTAL
Test Mode	:Bandedge CH High	Engineer	:Nick
EUT Pol	:H Plane		



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.50	Average	31.54	6.94	38.48	54.00	-15.52
2483.50	Peak	52.32	6.94	59.26	74.00	-14.74

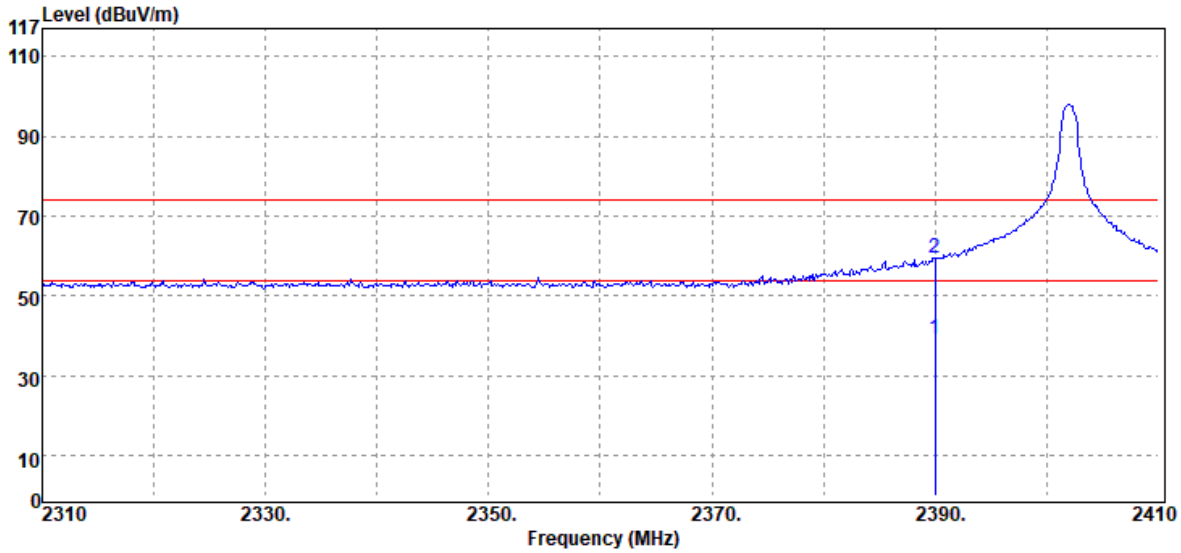
10.7.2 Radiated Bandedge Result (Non-Hopping Mode)

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT BR	Temp./Humi.	:23.1/66
Test Channel	:2402 MHz	Antenna Pol.	:VERTICAL
Test Mode	:Bandedge CH Low	Engineer	:Nick
EUT Pol	:H Plane		



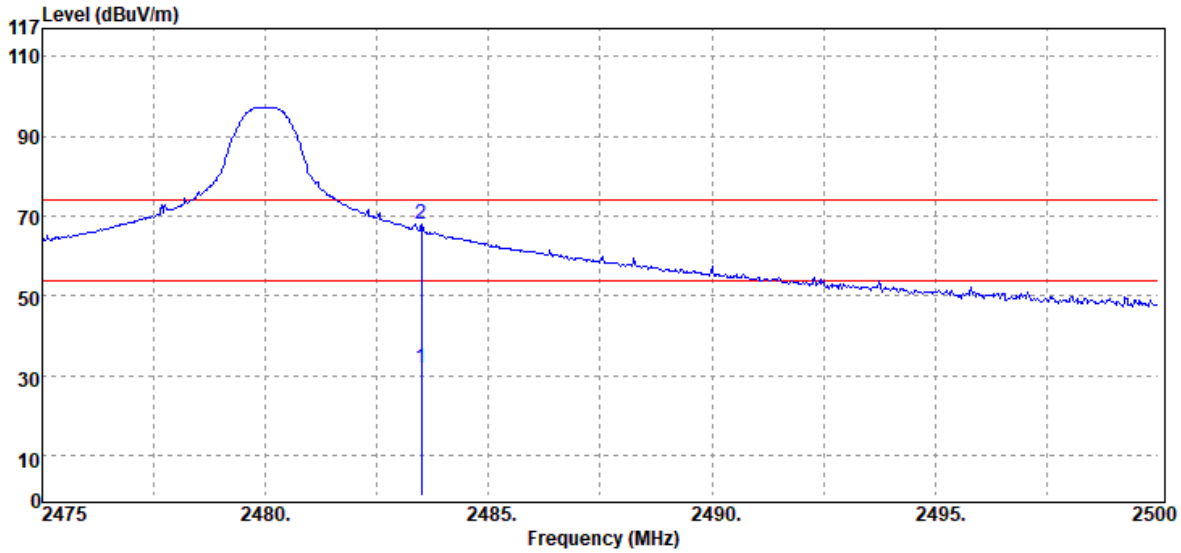
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	32.53	7.57	40.10	54.00	-13.90
2390.00	Peak	60.37	7.57	67.94	74.00	-6.06

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT BR	Temp./Humi.	:23.1/66
Test Channel	:2402 MHz	Antenna Pol.	:HORIZONTAL
Test Mode	:Bandedge CH Low	Engineer	:Nick
EUT Pol	:H Plane		



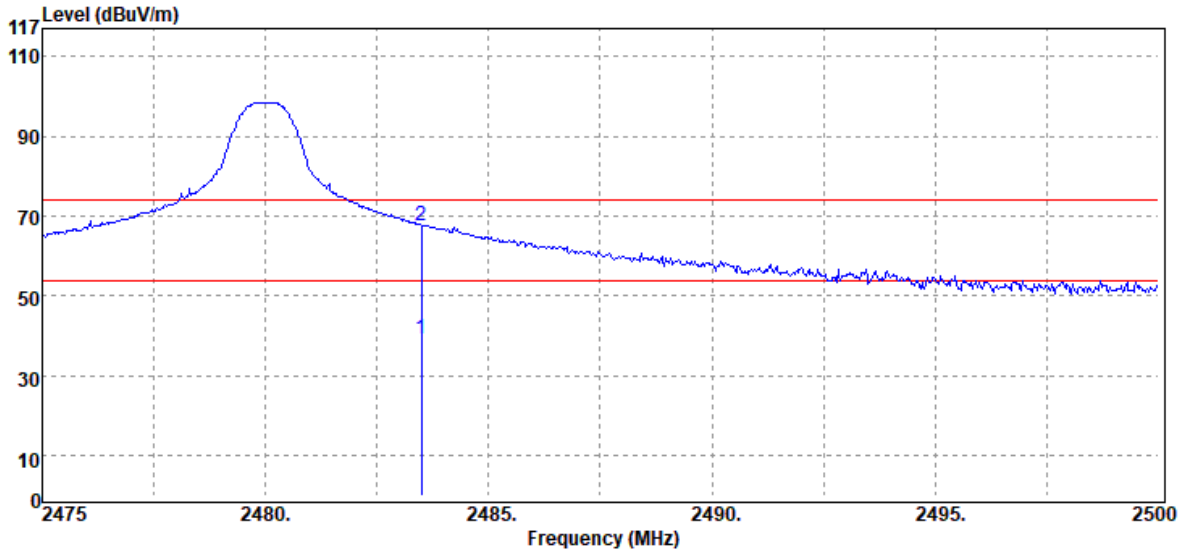
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	31.89	7.57	39.46	54.00	-14.54
2390.00	Peak	51.84	7.57	59.41	74.00	-14.59

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT BR	Temp./Humi.	:23.1/66
Test Channel	:2480 MHz	Antenna Pol.	:VERTICAL
Test Mode	:Bandedge CH High	Engineer	:Nick
EUT Pol	:H Plane		



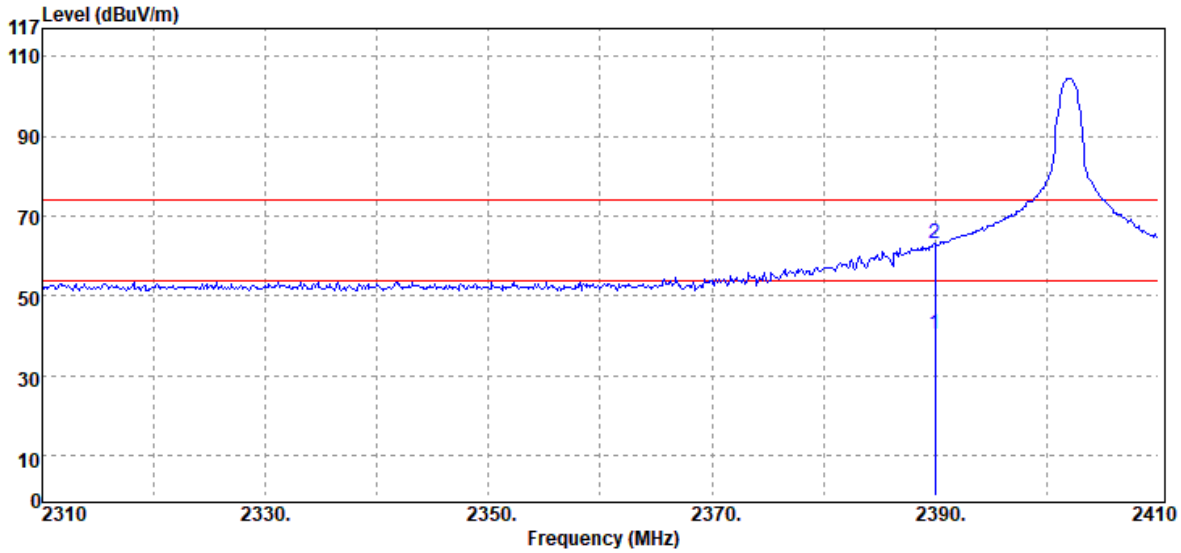
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.50	Average	25.22	6.94	32.16	54.00	-21.84
2483.50	Peak	60.99	6.94	67.93	74.00	-6.07

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT BR	Temp./Humi.	:23.1/66
Test Channel	:2480 MHz	Antenna Pol.	:HORIZONTAL
Test Mode	:Bandedge CH High	Engineer	:Nick
EUT Pol	:H Plane		



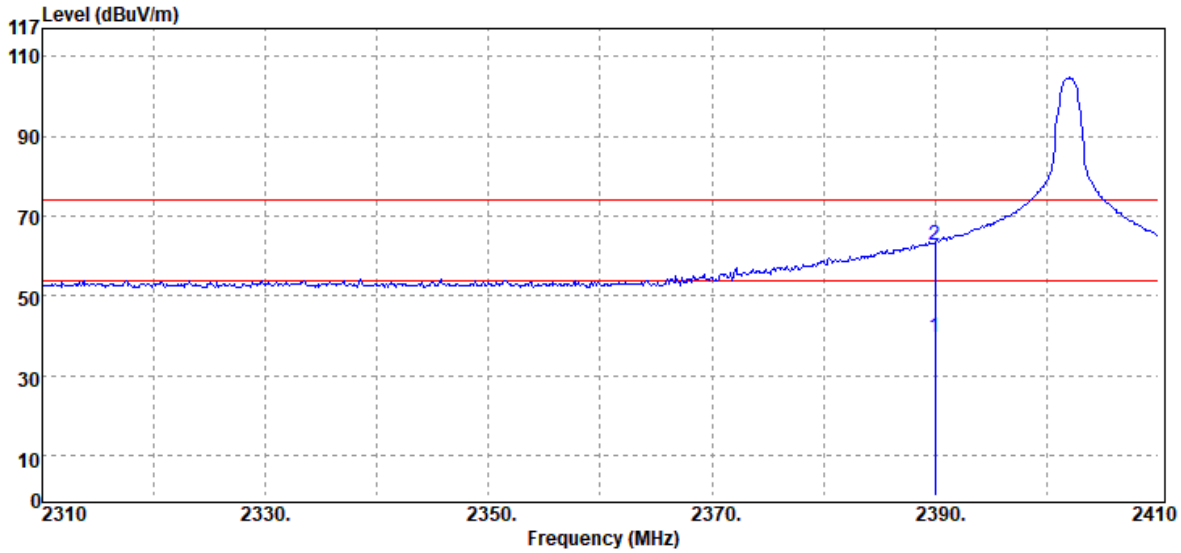
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.50	Average	32.24	6.94	39.18	54.00	-14.82
2483.50	Peak	60.84	6.94	67.78	74.00	-6.22

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT EDR	Temp./Humi.	:23.1/66
Test Channel	:2402 MHz	Antenna Pol.	:VERTICAL
Test Mode	:Bandedge CH Low	Engineer	:Nick
EUT Pol	:H Plane		



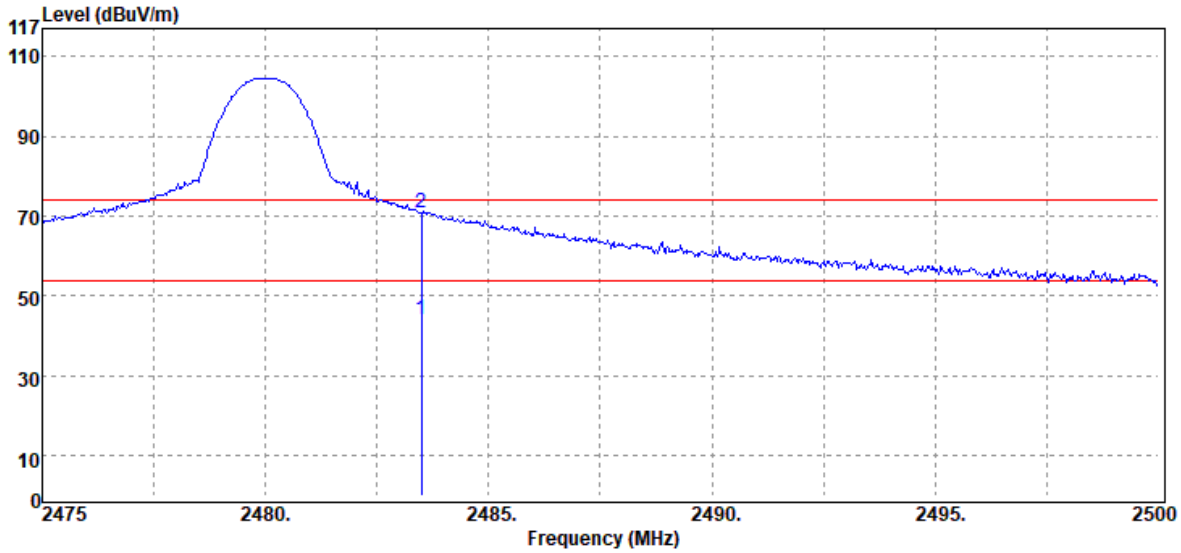
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	32.93	7.57	40.50	54.00	-13.50
2390.00	Peak	55.47	7.57	63.04	74.00	-10.96

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT EDR	Temp./Humi.	:23.1/66
Test Channel	:2402 MHz	Antenna Pol.	:HORIZONTAL
Test Mode	:Bandedge CH Low	Engineer	:Nick
EUT Pol	:H Plane		



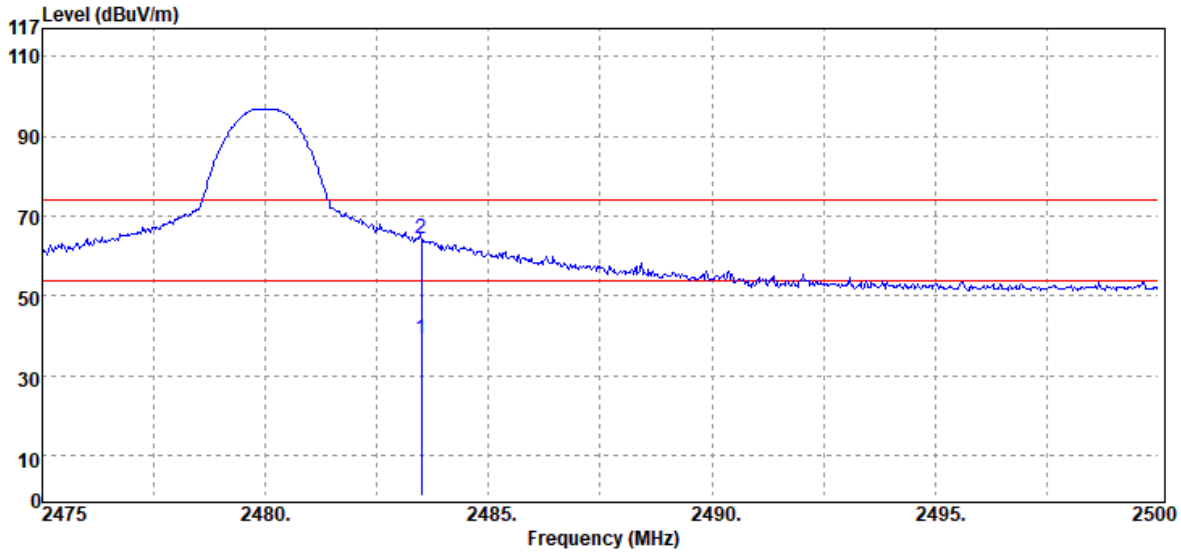
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	31.91	7.57	39.48	54.00	-14.52
2390.00	Peak	55.30	7.57	62.87	74.00	-11.13

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT EDR	Temp./Humi.	:23.1/66
Test Channel	:2480 MHz	Antenna Pol.	:VERTICAL
Test Mode	:Bandedge CH High	Engineer	:Nick
EUT Pol	:H Plane		



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.50	Average	37.00	6.94	43.94	54.00	-10.06
2483.50	Peak	63.82	6.94	70.76	74.00	-3.24

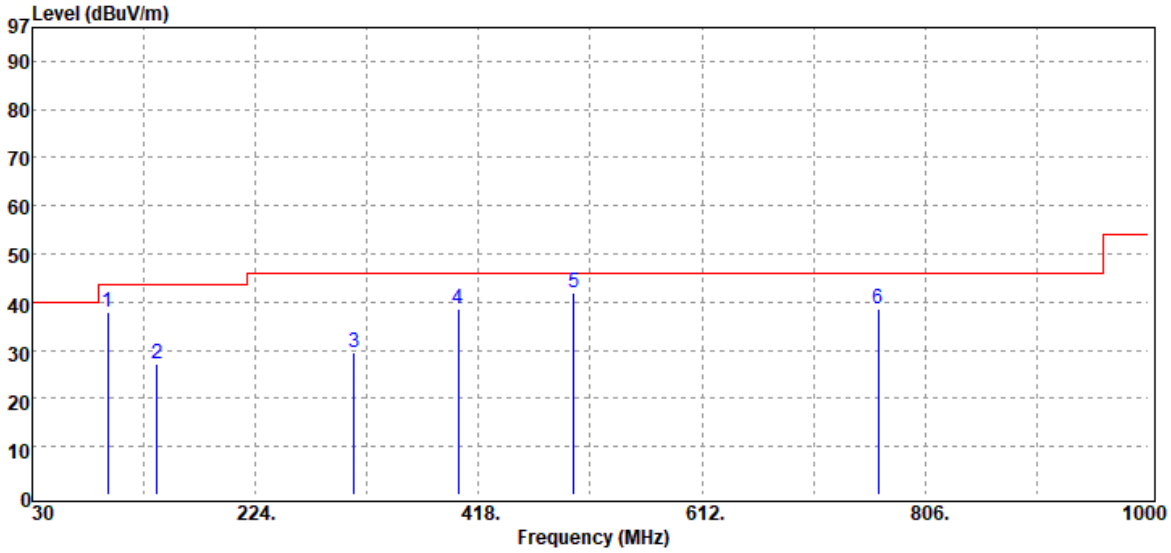
Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT EDR	Temp./Humi.	:23.1/66
Test Channel	:2480 MHz	Antenna Pol.	:HORIZONTAL
Test Mode	:Bandedge CH High	Engineer	:Nick
EUT Pol	:H Plane		



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.50	Average	32.17	6.94	39.11	54.00	-14.89
2483.50	Peak	57.62	6.94	64.56	74.00	-9.44

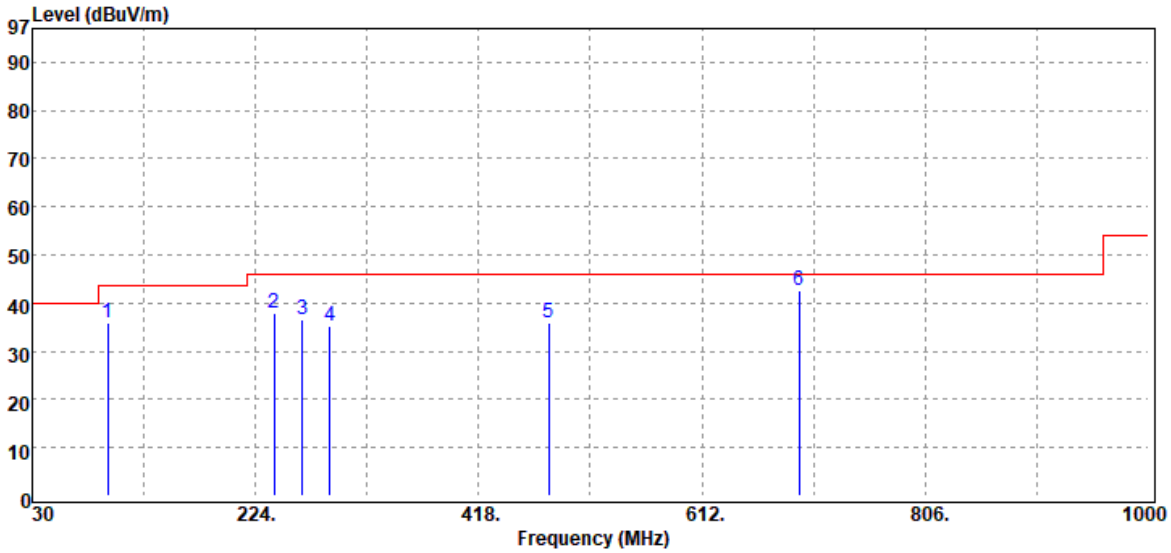
10.7.3 Radiated Spurious Emission form 30MHz to 1000MHz:

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT BR	Temp./Humi.	:23.1/66
Test Channel	:2441 MHz	Antenna Pol.	:VERTICAL
Test Mode	:Tx CH Mid	Engineer	:Nick
EUT Pol	:H Plane		



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
95.96	Peak	51.05	-13.12	37.93	43.50	-5.57
138.64	Peak	39.19	-11.86	27.33	43.50	-16.17
309.36	Peak	37.79	-8.22	29.57	46.00	-16.43
400.54	Peak	44.57	-6.07	38.50	46.00	-7.50
500.45	Peak	46.41	-4.31	42.10	46.00	-3.90
765.26	Peak	39.86	-1.36	38.50	46.00	-7.50

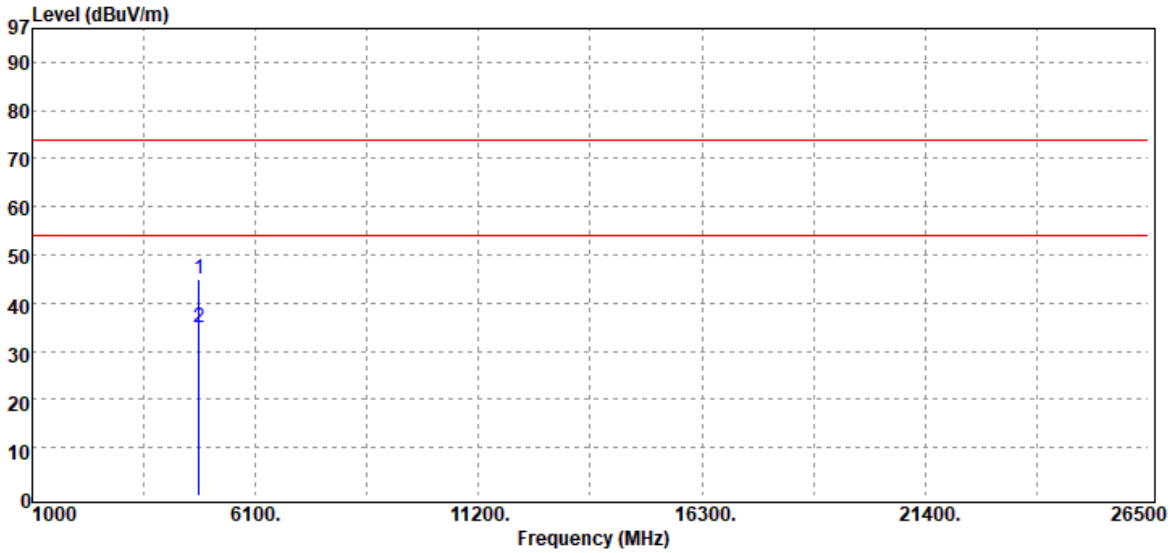
Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT BR	Temp./Humi.	:23.1/66
Test Channel	:2441 MHz	Antenna Pol.	:HORIZONTAL
Test Mode	:Tx CH Mid	Engineer	:Nick
EUT Pol	:H Plane		



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
95.96	Peak	49.15	-13.12	36.03	43.50	-7.47
240.49	Peak	48.18	-10.24	37.94	46.00	-8.06
264.74	Peak	44.95	-8.47	36.48	46.00	-9.52
288.99	Peak	43.96	-8.70	35.26	46.00	-10.74
479.11	Peak	41.29	-5.51	35.78	46.00	-10.22
696.39	Peak	44.81	-2.29	42.52	46.00	-3.48

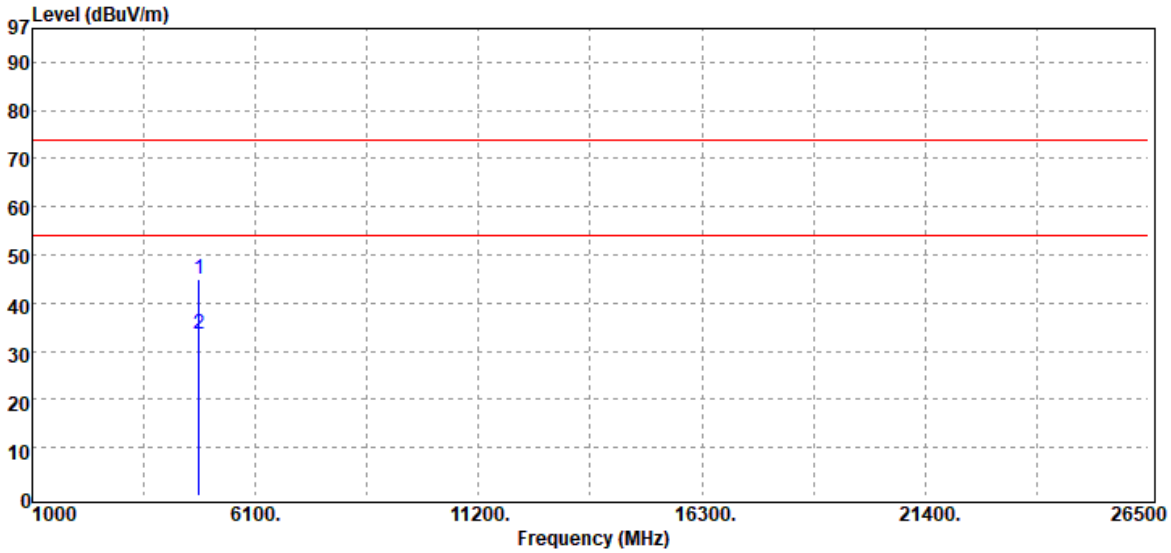
10.7.4 Radiated Spurious Emission above 1 GHz:

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT BR	Temp./Humi.	:23.1/66
Test Channel	:2402 MHz	Antenna Pol.	:VERTICAL
Test Mode	:Tx CH Low	Engineer	:Nick
EUT Pol	:H Plane		



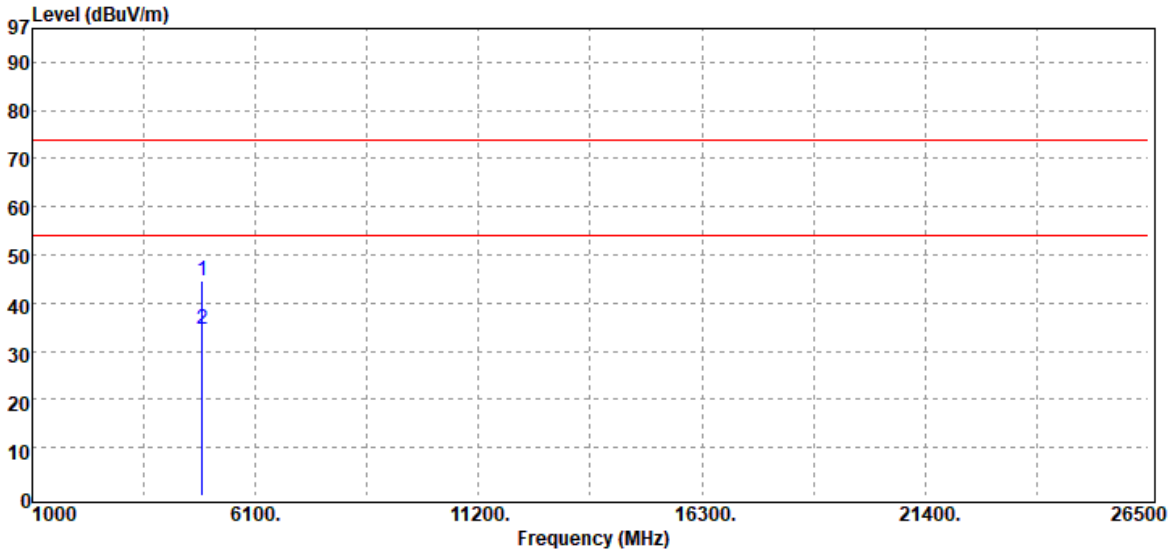
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4804.00	Peak	30.41	14.57	44.98	74.00	-29.02
4804.00	Average	20.46	14.57	35.03	54.00	-18.97

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT BR	Temp./Humi.	:23.1/66
Test Channel	:2402 MHz	Antenna Pol.	:HORIZONTAL
Test Mode	:Tx CH Low	Engineer	:Nick
EUT Pol	:H Plane		



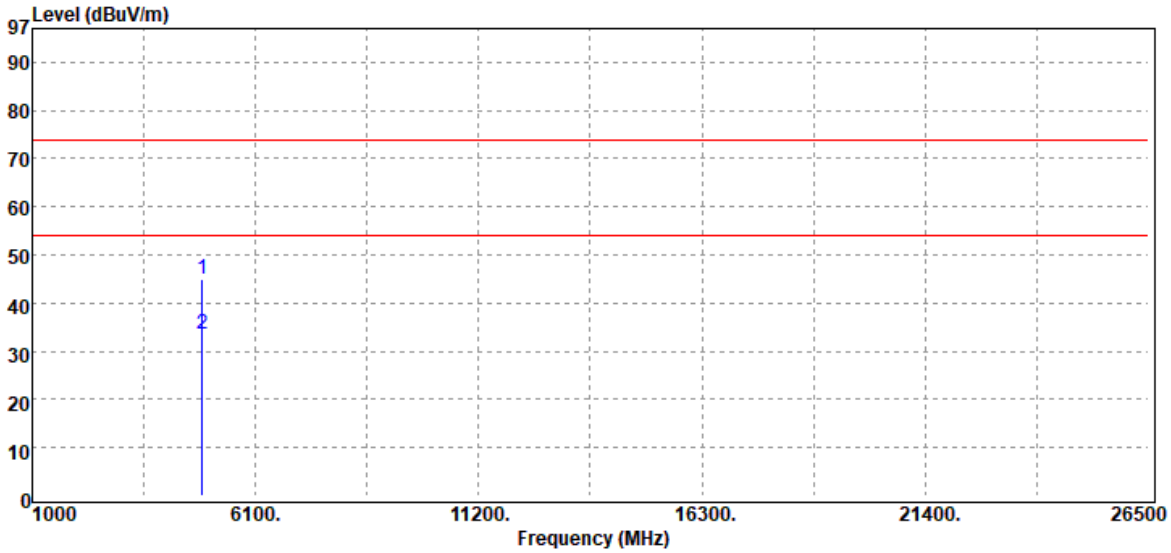
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4804.00	Peak	30.42	14.57	44.99	74.00	-29.01
4804.00	Average	18.95	14.57	33.52	54.00	-20.48

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT BR	Temp./Humi.	:23.1/66
Test Channel	:2441 MHz	Antenna Pol.	:VERTICAL
Test Mode	:Tx CH Mid	Engineer	:Nick
EUT Pol	:H Plane		



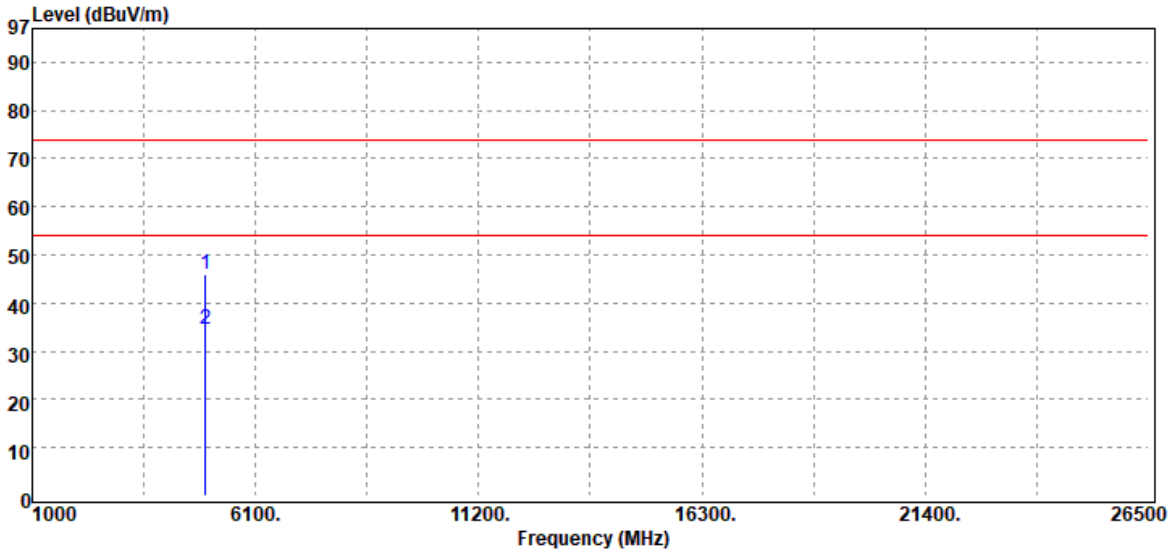
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4882.00	Peak	29.46	15.08	44.54	74.00	-29.46
4882.00	Average	19.65	15.08	34.73	54.00	-19.27

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT BR	Temp./Humi.	:23.1/66
Test Channel	:2441 MHz	Antenna Pol.	:HORIZONTAL
Test Mode	:Tx CH Mid	Engineer	:Nick
EUT Pol	:H Plane		



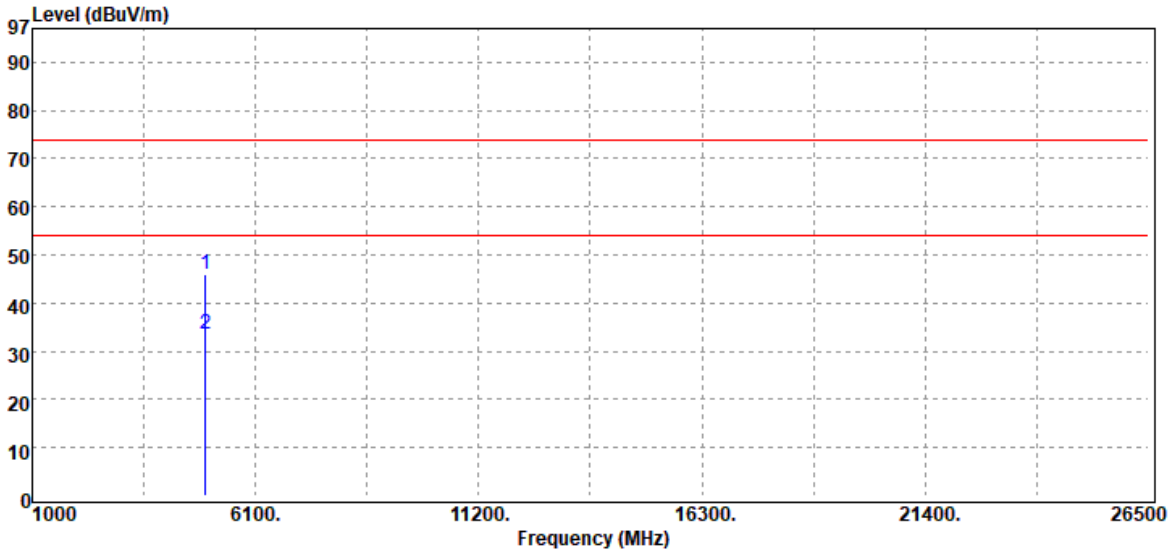
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4882.00	Peak	30.02	15.08	45.10	74.00	-28.90
4882.00	Average	18.55	15.08	33.63	54.00	-20.37

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT BR	Temp./Humi.	:23.1/66
Test Channel	:2480 MHz	Antenna Pol.	:VERTICAL
Test Mode	:Tx CH High	Engineer	:Nick
EUT Pol	:H Plane		



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4960.00	Peak	30.72	15.13	45.85	74.00	-28.15
4960.00	Average	19.37	15.13	34.50	54.00	-19.50

Report Number	:ER-2019-A0012	Test Date	:2019-10-05
Operation Mode	:BT BR	Temp./Humi.	:23.1/66
Test Channel	:2480 MHz	Antenna Pol.	:HORIZONTAL
Test Mode	:Tx CH High	Engineer	:Nick
EUT Pol	:H Plane		



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4960.00	Peak	30.95	15.13	46.08	74.00	-27.92
4960.00	Average	18.49	15.13	33.62	54.00	-20.38

11 FREQUENCY SEPARATION

11.1 Standard Applicable

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

11.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	**MFR**	**MODEL NUMBER**	**SERIAL NUMBER**	**LAST CAL.**	**CAL DUE.**
EXA Spectrum Analyzer	Agilent	N9010A	MY50420195	05/02/2019	05/01/2020
DC Power Supply	Agilent	E3640A	MY52410006	12/04/2018	12/03/2019
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2019	01/01/2020

11.3 Test Set-up

11.4 Measurement Procedure

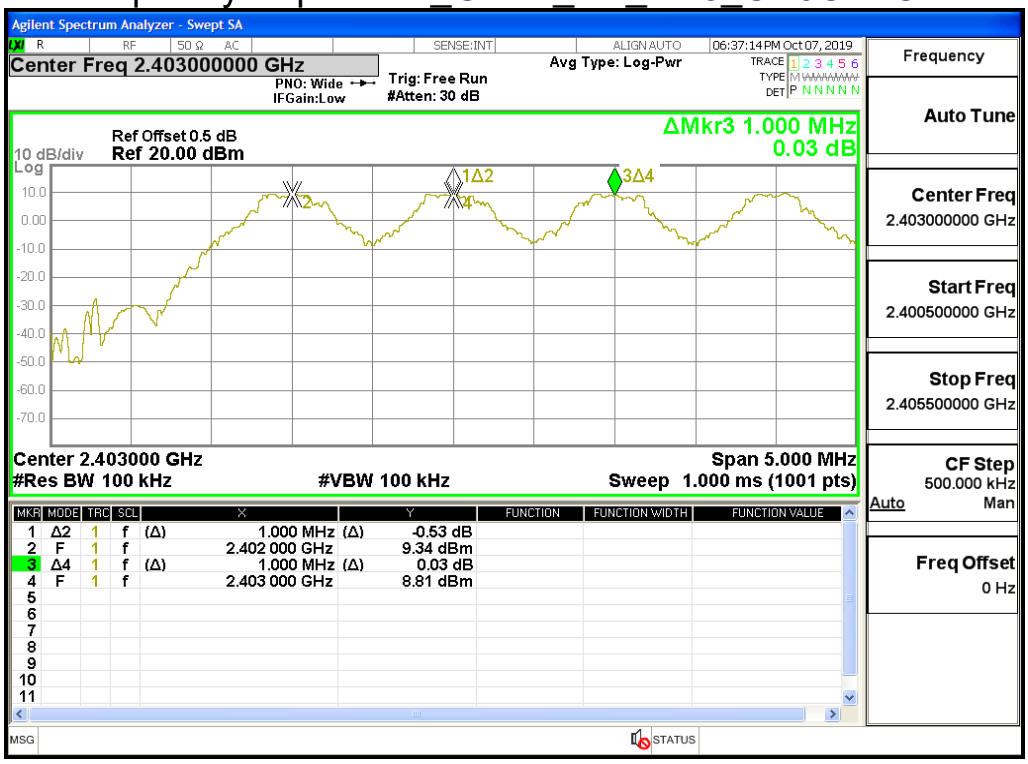
1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set center frequency of spectrum analyzer = middle of hopping channel.
5. 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.

11.5 Measurement Result

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

11.6 Frequency Separation Test Plots

Frequency Separation_GFSK_1M_DH5_CH0CH1CH2



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.**
EXA Spectrum Analyzer	Agilent	N9010A	MY50420195	05/02/2019	05/01/2020
DC Power Supply	Agilent	E3640A	MY52410006	12/04/2018	12/03/2019
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2019	01/01/2020

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=430kHz, VBW=1.5MHz., Detector = Peak
6. Max hold, view and count how many channel in the band.

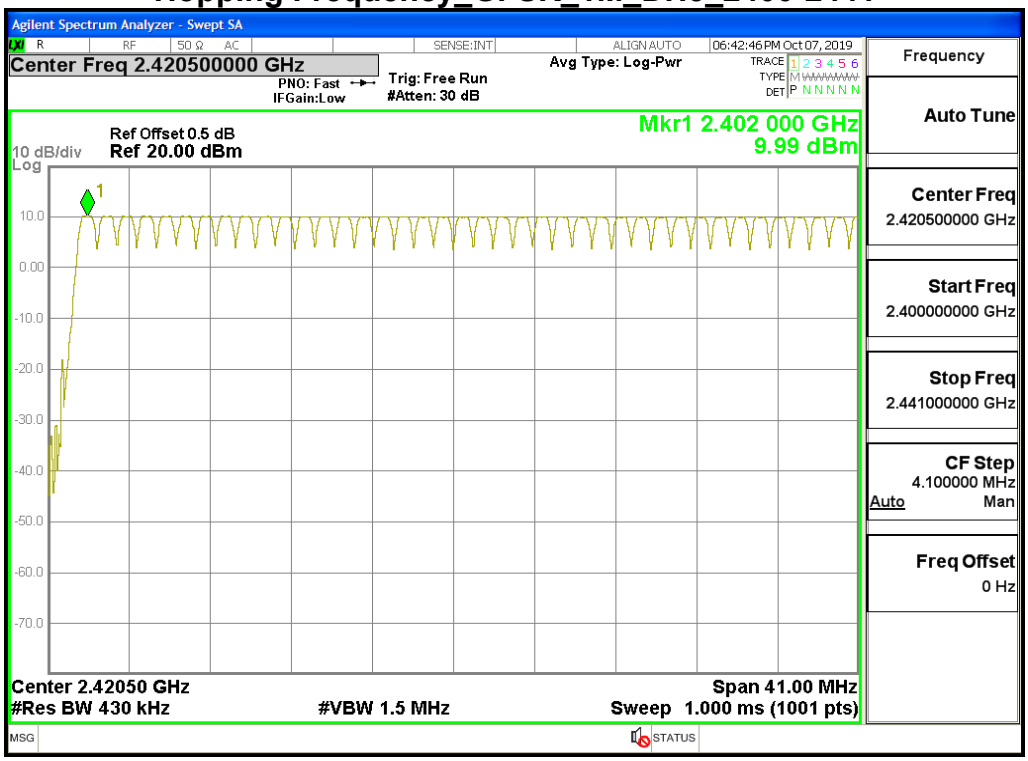
12.5 Measurement Result

Tabular Data of Total Channel Number

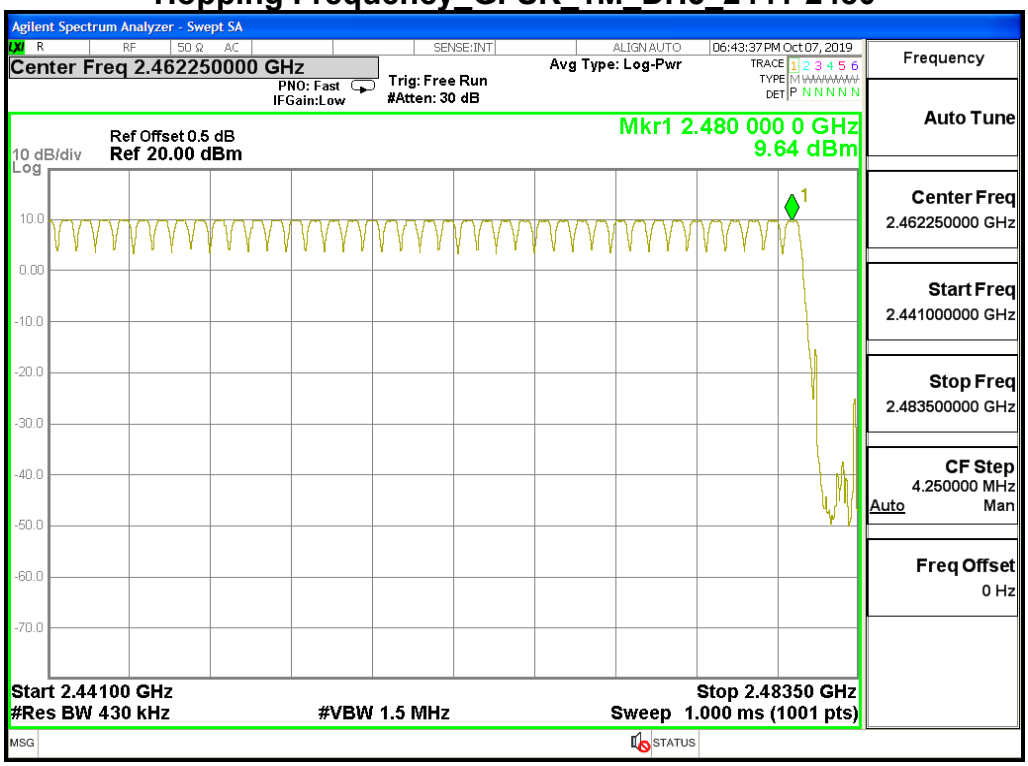
	Channel Number	**Limit**
2.4 GHz – 2.441 GHz	**40**	**>15**
2.441 GHz – 2.4835 GHz	**39**	
2.4 GHz ~2.4835 GHz	**(40+39) = 79**	

12.6 Channel Number Test Plots

Hopping Frequency_GFSK_1M_DH5_2400-2441



Hopping Frequency_GFSK_1M_DH5_2441-2480



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.**
EXA Spectrum Analyzer	Agilent	N9010A	MY50420195	05/02/2019	05/01/2020
DC Power Supply	Agilent	E3640A	MY52410006	12/04/2018	12/03/2019
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2019	01/01/2020

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 C6310:2015.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set center frequency of spectrum analyzer = operating frequency.
5. Set the spectrum analyzer as RBW, VBW=1MHz, 3MHz, Span = 0Hz , Detector = Peak, Adjust Sweep = 2~8ms.
6. Repeat above procedures until all frequency of the interest measured were complete.

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

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

DH1 consists of single time slot of the uplink, and one slot of the downlink Total Slot: 2

DH3 consists of three time slot of the uplink, and one slot of the downlink. Total Slot: 4

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

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

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

13.5 Tabular Result of the Measurement

GFSK (1Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)	1/T (kHz)	VBW setting (kHz)
Low	DH1	124.80	400ms	2.56	3.00
	DH3	262.40	400ms	0.61	1.00
	DH5	308.80	400ms	0.35	1.00
Mid	DH1	124.80	400ms	2.56	3.00
	DH3	262.40	400ms	0.61	1.00
	DH5	308.80	400ms	0.35	1.00
High	DH1	126.40	400ms	2.53	3.00
	DH3	262.40	400ms	0.61	1.00
	DH5	308.80	400ms	0.00	1.00

π/4 DQPSK (2Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)	1/T (kHz)	VBW setting (kHz)
Mid	2DH1	126.40	400ms	2.53	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)
Mid	3DH1	126.40	400ms	2.53	3.00
	3DH3	264.00	400ms	0.61	1.00
	3DH5	308.80	400ms	0.35	1.00

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

GFSK (1Mbps):

CH Low	DH1 time slot	=	0.390	*	(1600/2/79)	*	31.6	=	124.80 (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	=	0.390	*	(1600/2/79)	*	31.6	=	124.80 (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 High	DH1 time slot	=	0.395	*	(1600/2/79)	*	31.6	=	126.40 (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)

π/4 -DQPSK (2Mbps):

CH Mid	2DH1 time slot	=	0.395	*	(1600/2/79)	*	31.6	=	126.40 (ms)
	2DH3 time slot	=	1.640	*	(1600/4/79)	*	31.6	=	262.40 (ms)
	2DH5 time slot	=	2.895	*	(1600/6/79)	*	31.6	=	308.80 (ms)

8-DPSK (3Mbps):

CH Mid	3DH1 time slot	=	0.395	*	(1600/2/79)	*	31.6	=	126.40 (ms)
	3DH3 time slot	=	1.650	*	(1600/4/79)	*	31.6	=	264.00 (ms)
	3DH5 time slot	=	2.895	*	(1600/6/79)	*	31.6	=	308.80 (ms)

GFSK (1Mbps) for AFH Mode			
Hopping Channel Number	**PACKET TYPE**	**Measurement Result (ms)**	**Limit (ms)**
20	DH5	154.40	400ms
π/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 sl = 2.895 (ms) * (800/6/20) * 8 = 154.40 (ms)

π/4 -DQPSK (2Mbps

2DH5 time sl = 2.895 (ms) * (800/6/20) * 8 = 154.40 (ms)

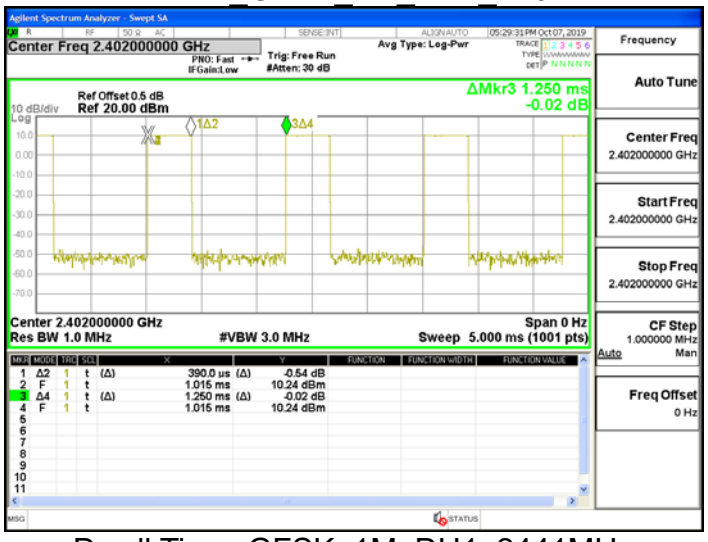
8-DPSK (3Mbps):

3DH5 time sl = 2.895 (ms) * (800/6/20) * 8 = 154.40 (ms)

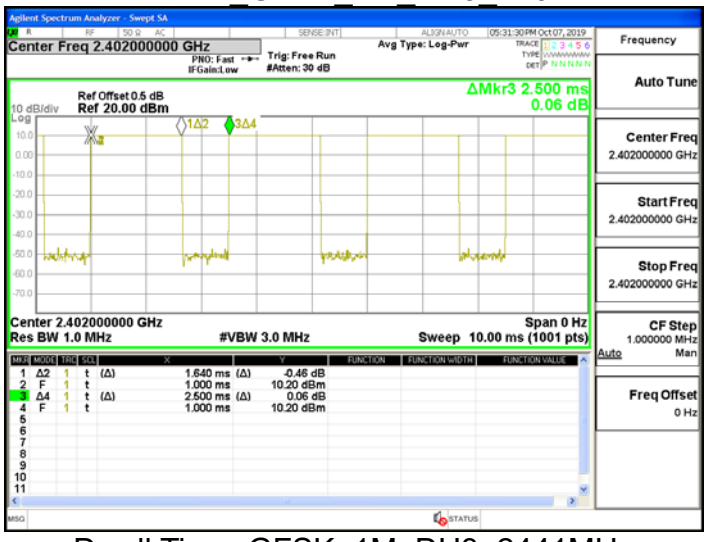
13.6 Measurement Result

Note: Refer to next page for plots.

Dwell Time_GFSK_1M_DH1_2402MHz

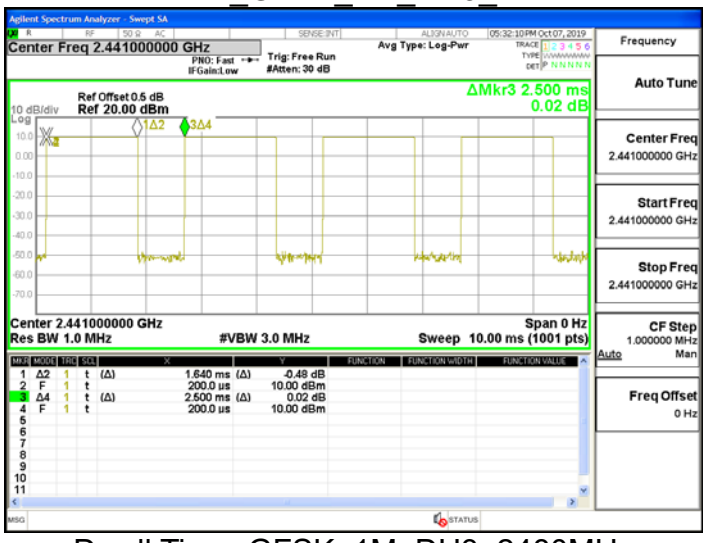


Dwell Time_GFSK_1M_DH3_2402MHz

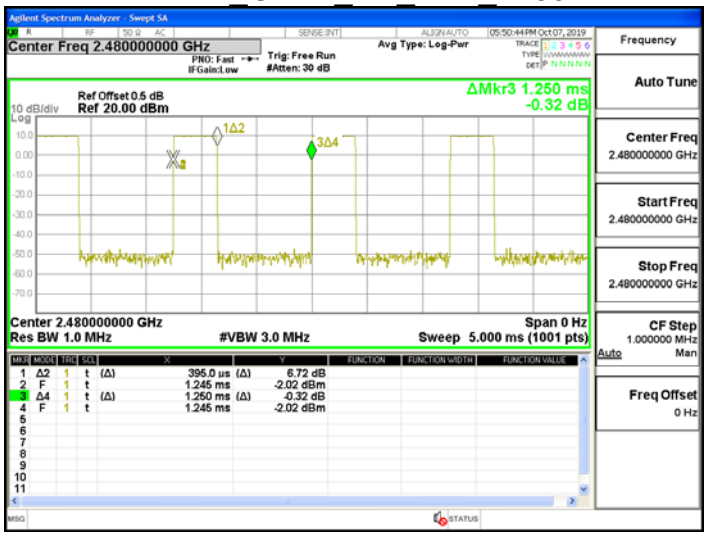


Dwell Time_GFSK_1M_DH1_2441MHz

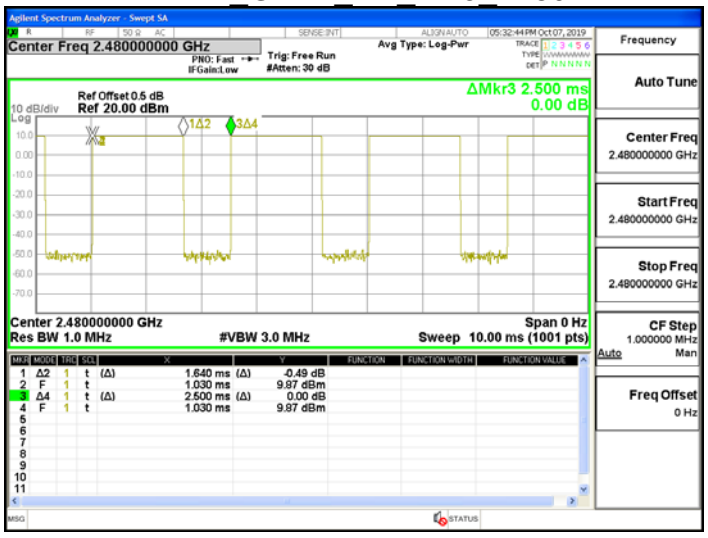
Dwell Time_GFSK_1M_DH3_2441MHz



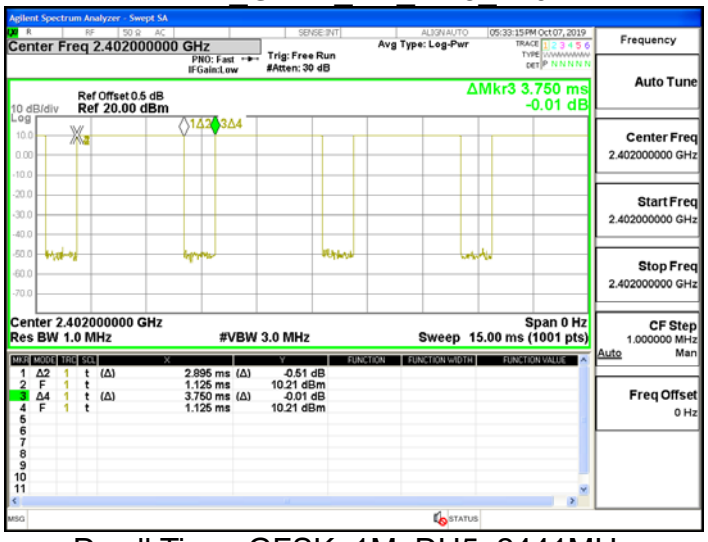
Dwell Time_GFSK_1M_DH1_2480MHz



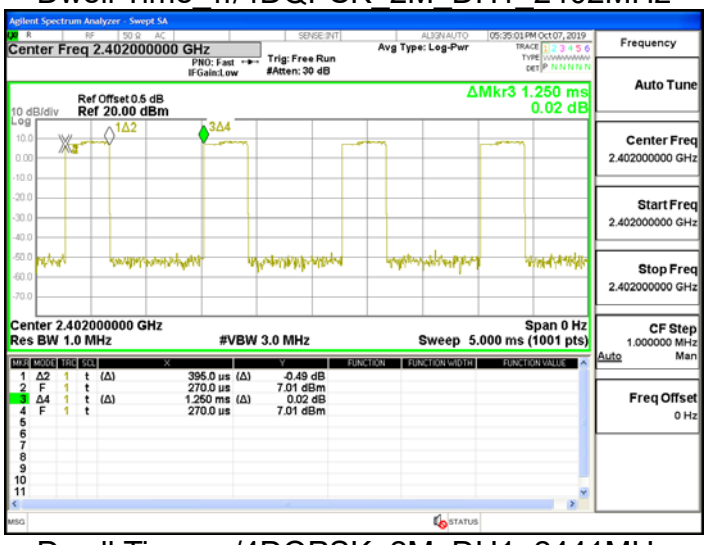
Dwell Time_GFSK_1M_DH3_2480MHz



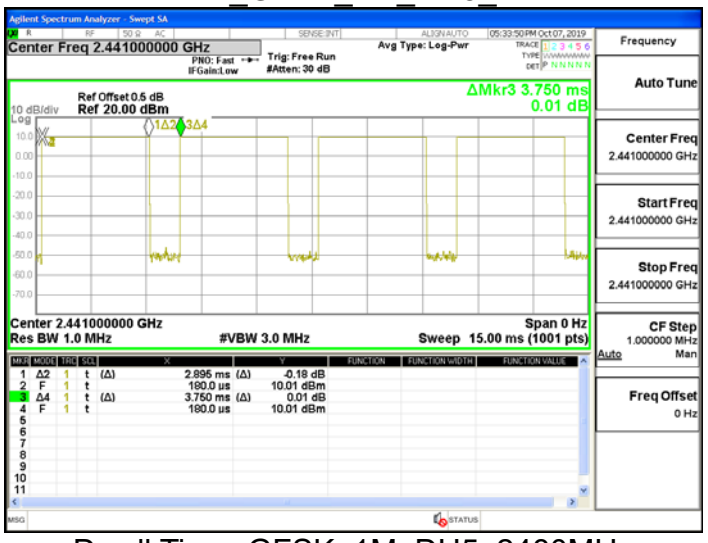
Dwell Time_GFSK_1M_DH5_2402MHz



Dwell Time_π/4DQPSK_2M_DH1_2402MHz

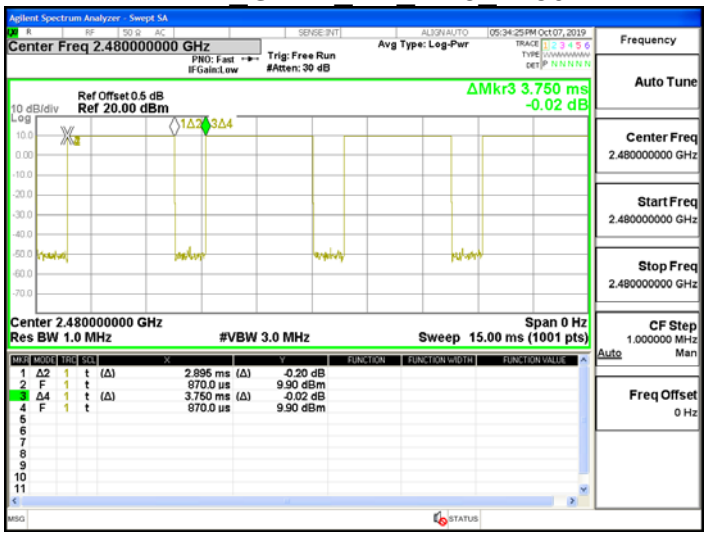


Dwell Time_GFSK_1M_DH5_2441MHz



Dwell Time_π/4DQPSK_2M_DH1_2441MHz

Dwell Time_GFSK_1M_DH5_2480MHz

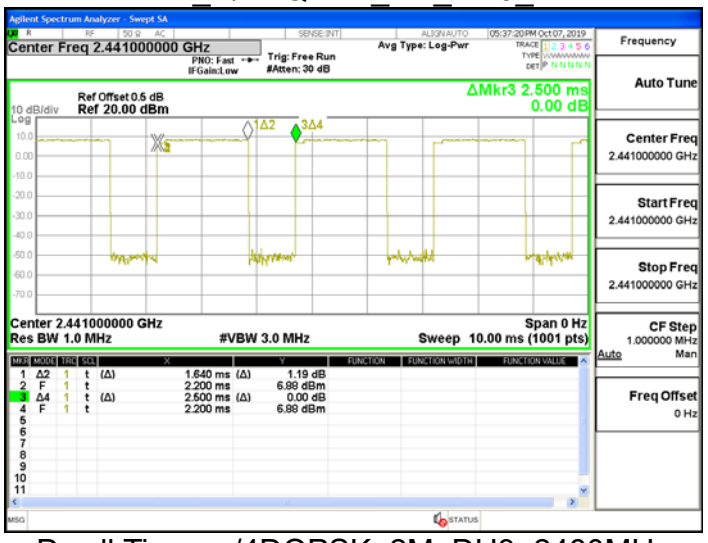


Dwell Time_π/4DQPSK_2M_DH1_2480MHz

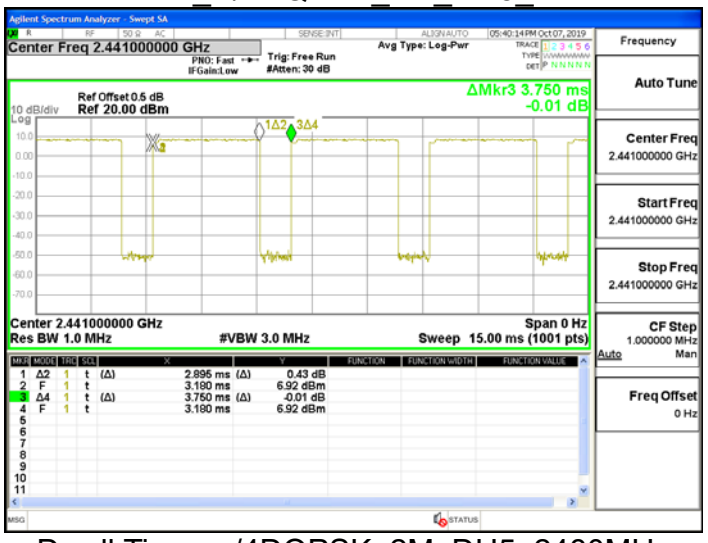
Dwell Time_π/4DQPSK_2M_DH3_2402MHz

Dwell Time_π/4DQPSK_2M_DH5_2402MHz

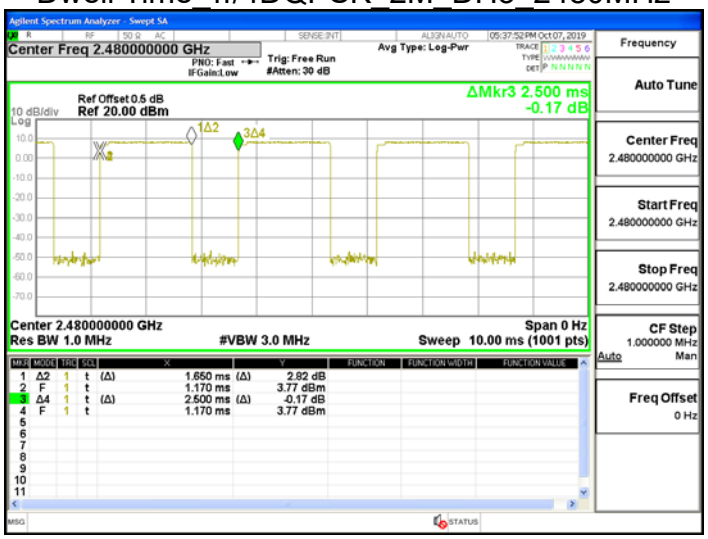
Dwell Time_π/4DQPSK_2M_DH3_2441MHz



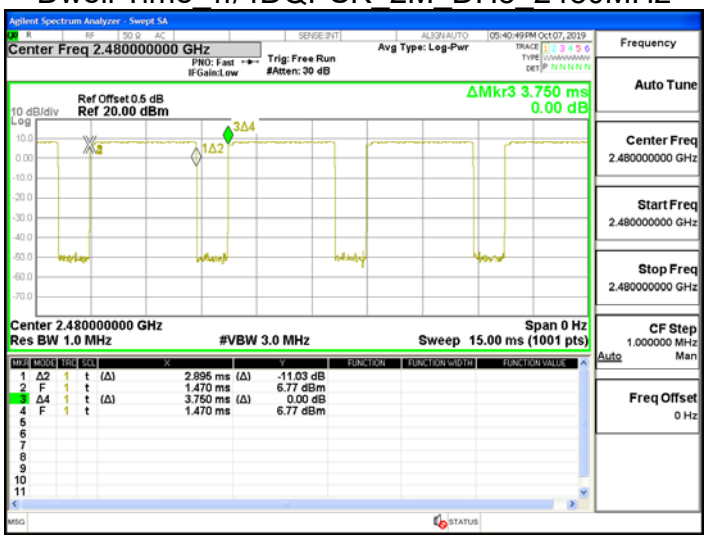
Dwell Time_π/4DQPSK_2M_DH5_2441MHz



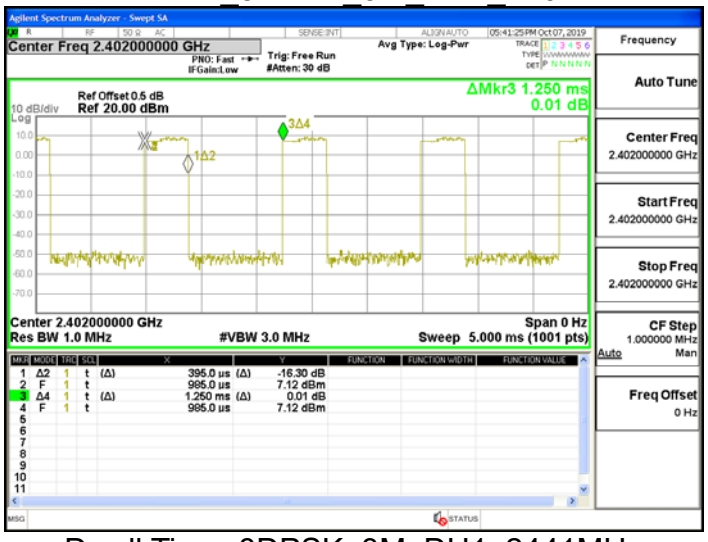
Dwell Time_π/4DQPSK_2M_DH3_2480MHz



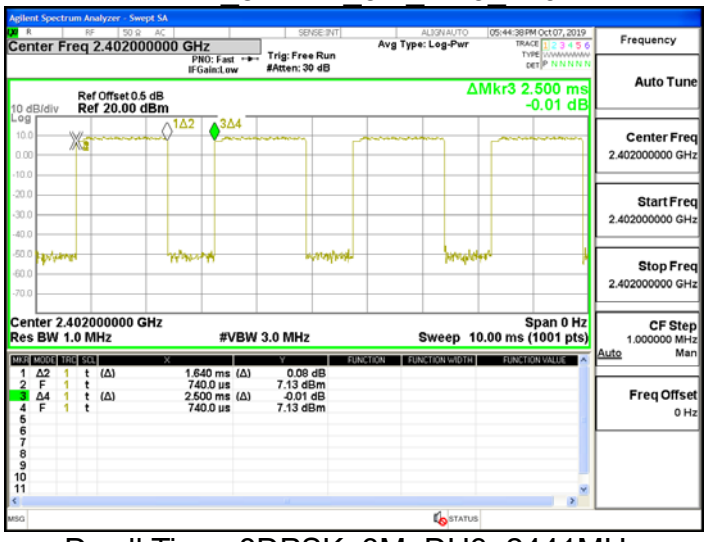
Dwell Time_π/4DQPSK_2M_DH5_2480MHz



Dwell Time_8DPSK_3M_DH1_2402MHz

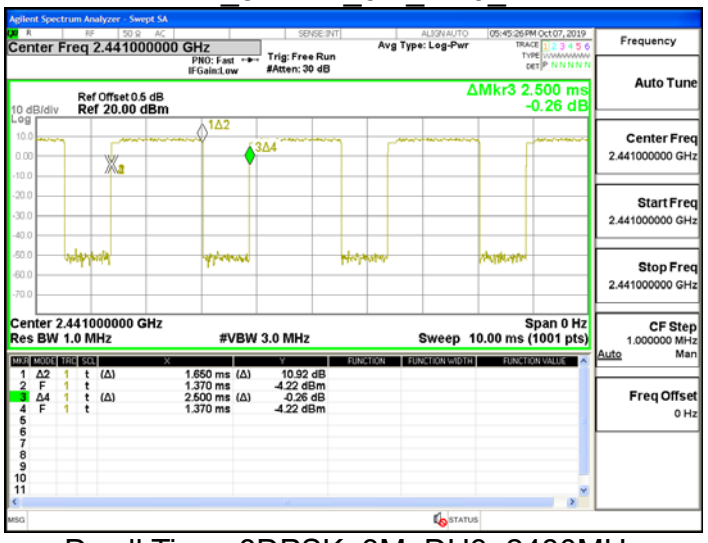


Dwell Time_8DPSK_3M_DH3_2402MHz

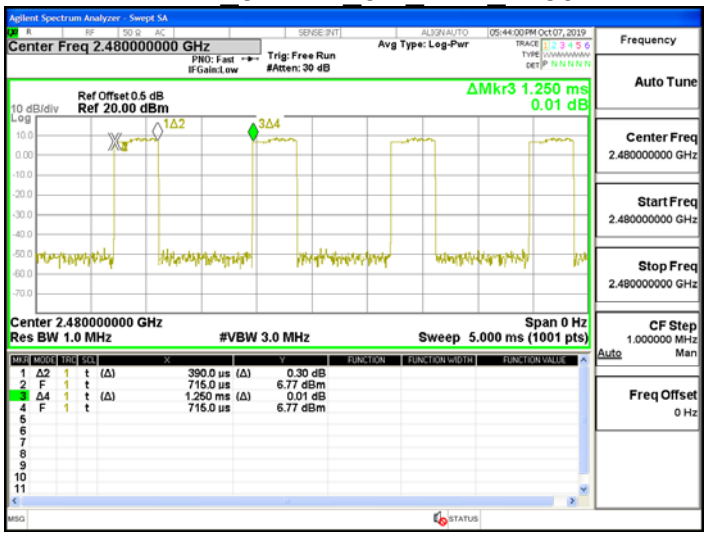


Dwell Time_8DPSK_3M_DH1_2441MHz

Dwell Time_8DPSK_3M_DH3_2441MHz

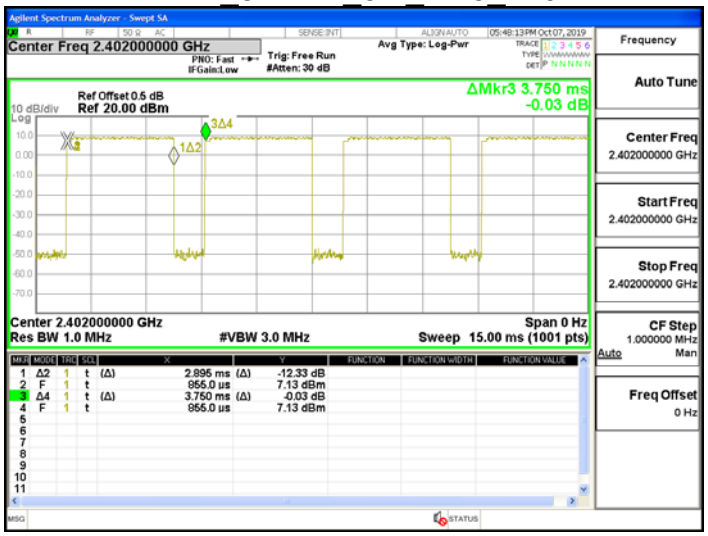


Dwell Time_8DPSK_3M_DH1_2480MHz



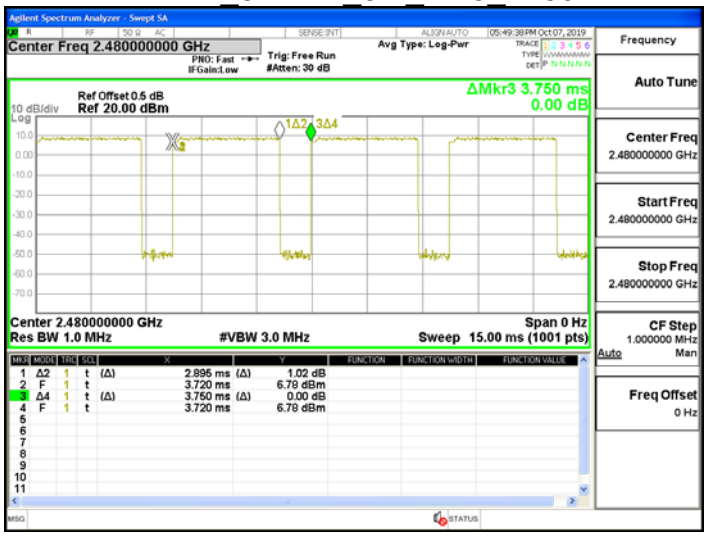
Dwell Time_8DPSK_3M_DH3_2480MHz

Dwell Time_8DPSK_3M_DH5_2402MHz



Dwell Time_8DPSK_3M_DH5_2441MHz

Dwell Time_8DPSK_3M_DH5_2480MHz



14 ANTENNA REQUIREMENT

14.1 Standard Applicable

For intentional device, according to §15.203, an intentional radiator shall be designed to ensure that no antenna other than furnished by the responsible party shall be used with the device.

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

14.2 Antenna Connected Construction

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

~ End of Report ~