ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART C REQUIREMENT

OF

Applicant:	unitech electronics co., ltd. 5F, No. 136, Lane 235, Pao-Chiao Rd., Hsin-Tien Dist., New Taipei City, Taiwan
Product Name:	Wearable 2D Ring Scanner
Brand Name:	unitech
Model No.:	MS652 Plus
Model Difference:	N/A
Report Number:	T190313W05-RP2
FCC ID:	HLEMS652PBT
FCC Rule Part:	§15.247, Cat: DSS
Issue Date:	Jun. 10, 2019
Date of Test:	Mar. 11, 2019 ~ May 31, 2019
Date of EUT Received:	Mar. 11, 2019
Issued by:	Compliance Certification Services Inc.Wugu Lab. No.11, Wugong 6th Rd., Wugu Dist., New Taipei City 24891, Taiwan. (R.O.C.) service@ccsrf.com

The test Result was tested by Compliance Certification Services Inc. The test data, data evaluation, test procedures, and equipment configurations shown in this report were given in ANSI C63.10: 2013 and compliance standards.
The test results of this report relate only to the tested sample (EUT) identified in this re- port.
The test Report of full or partial shall not copy. Without written approval of Compliance Certification Services Inc. (Wugu Laboratory).

Tested By: Gary Lee
Gary / Engineer

Approved By: Kevin Tsai
Kevin Tsai / Deputy Manager

Revision History

Report Number	Revision	Description	Effected Page	Issue Date	Revised By
T190313W05-RP2	Rev.00	Initial creation of document	All	Jun. 10, 2019	Elle Chang

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1 GENERAL INFORMATION

1.1 Product Description

Product Name:	Wearable 2D Ring Scanner	
Brand Name:	unitech	
Model No.:	MS652 Plus	
Model Difference:	N/A	
Hardware Version:	N/A	
Software Version:	V1.1	
Power Supply:	3.7Vdc from Rechargeable Li-ion Battery or 5Vdc from Micro USB port	
	Battery:	Model No.: 1400-900050G, Supplier: HELIX CO., LTD.

Radio Technology:	Bluetooth BR+EDR
Channel number:	79 channels
Modulation type:	GFSK + π/4DQPSK + 8DPSK
Transmit Power:	7.27dBm
Frequency Range:	2.402GHz – 2.480GHz
Dwell Time:	≦ 0.4s
Antenna Designation:	Chip Antenna, Peak Gain: 2.9dBi

1.2 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247

FCC KDB 558074 D01 15.247 Meas. Guidance v05r02

ANSI C63.10:2013

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

1.3 Test Facility

Compliance Certification Services Inc. Wugu Lab. No.11, Wugong 6th Rd., Wugu Dist., New Taipei City 24891, Taiwan. (R.O.C.) (TAF code 1309)

FCC Designation number: TW1309

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.

2 SYSTEM TEST CONFIGURATION

2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

2.2 EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme.

2.3 Test Procedure

2.3.1 Conducted Emissions

The EUT is a placed on 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 according to §15.207. 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.

2.3.2 Conducted 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.

2.3.3 Radiated 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 Conducted (Antenna Port) & Radiated Emission Configuration

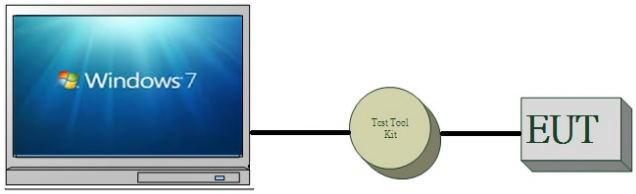


Fig 2-3 Conduction (AC Power Line) Emission

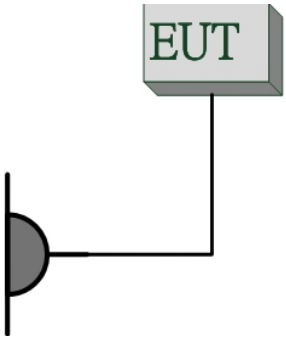


Table 2-1 Equipment Used in Tested System

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-X11BG	Shielded	Unshielded

3 SUMMARY OF TEST RESULTS

FCC Rules	Description Of Test	Result
§15.207(a)	AC Power Line Conducted Emission	Compliant
§15.247(b)(1)	Peak Output Power	Compliant
§15.247(a)(1)	20dB Bandwidth	Compliant
§15.205 §15.209 §15.247(d)	Conducted Band Edge and Spurious Emission	Compliant
§15.205 §15.209 §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

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.

AC POWER LINE CONDUCTED EMISSION TEST:

Test Condition	AC Power line conducted emission for line and neutral
Worst Case	Operation in normal mode

RADIATED EMISSION TEST:

RADIATED EMISSION TEST (BELOW 1 GHz)				
MODE	AVAILABLE FREQUENCY (MHz)	TESTED FREQUENCY (MHz)	MODULATION	PACKET TYPE
Bluetooth	2402 to 2480	2441	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 E1 position was reported.

ANTENNA PORT CONDUCTED MEASUREMENT:

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

5 MEASUREMENT UNCERTAINTY

PARAMETER	UNCERTAINTY
AC Powerline Conducted Emission	+/- 1.2575 dB
Peak Output Power	+/- 2.128 dB
20dB Bandwidth	+/- 147.256 Hz
100 kHz Bandwidth of Frequency Band Edges	+/- 2.128 dB
Frequency Separation	+/- 147.256 Hz
Number of hopping frequency	+/- 147.256 Hz
Time of Occupancy	+/- 147.256 Hz
3M Semi Anechoic Chamber / 30M~200M	+/- 4.12 dB
3M Semi Anechoic Chamber / 200M~1000M	+/- 4.68 dB
3M Semi Anechoic Chamber / 1G~8G	+/- 5.18 dB
3M Semi Anechoic Chamber / 8G~18G	+/- 5.47 dB
3M Semi Anechoic Chamber / 18G~26G	+/- 3.81 dB
3M Semi Anechoic Chamber / 26G~40G	+/- 3.87 dB

Note:

1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.
2. ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report.
3. 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.		

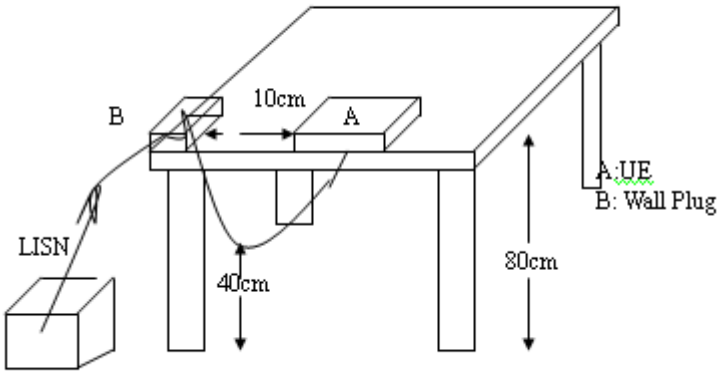
6.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	**MFR**	**MODEL NUMBER**	**SERIAL NUMBER**	**LAST CAL.**	**CAL DUE.**
CABLE	EMCI	CFD300-NL	CERF	06/29/2018	06/28/2019
EMI Test Receiver	R&S	ESCI	100064	07/24/2018	07/23/2019
LISN	SCHWARZ-BECK	NSLK 8127	8127-541	01/31/2019	01/30/2020
Software	EZ-EMC(CCS-3A1-CE)				
Adapter	SAMSUNG	ETA-U90JWS	RT4D402 KS/B	N/A	N/A

6.3 EUT Setup

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

6.4 Test SET-UP (Block Diagram of Configuration)



6.5 Measurement Procedure

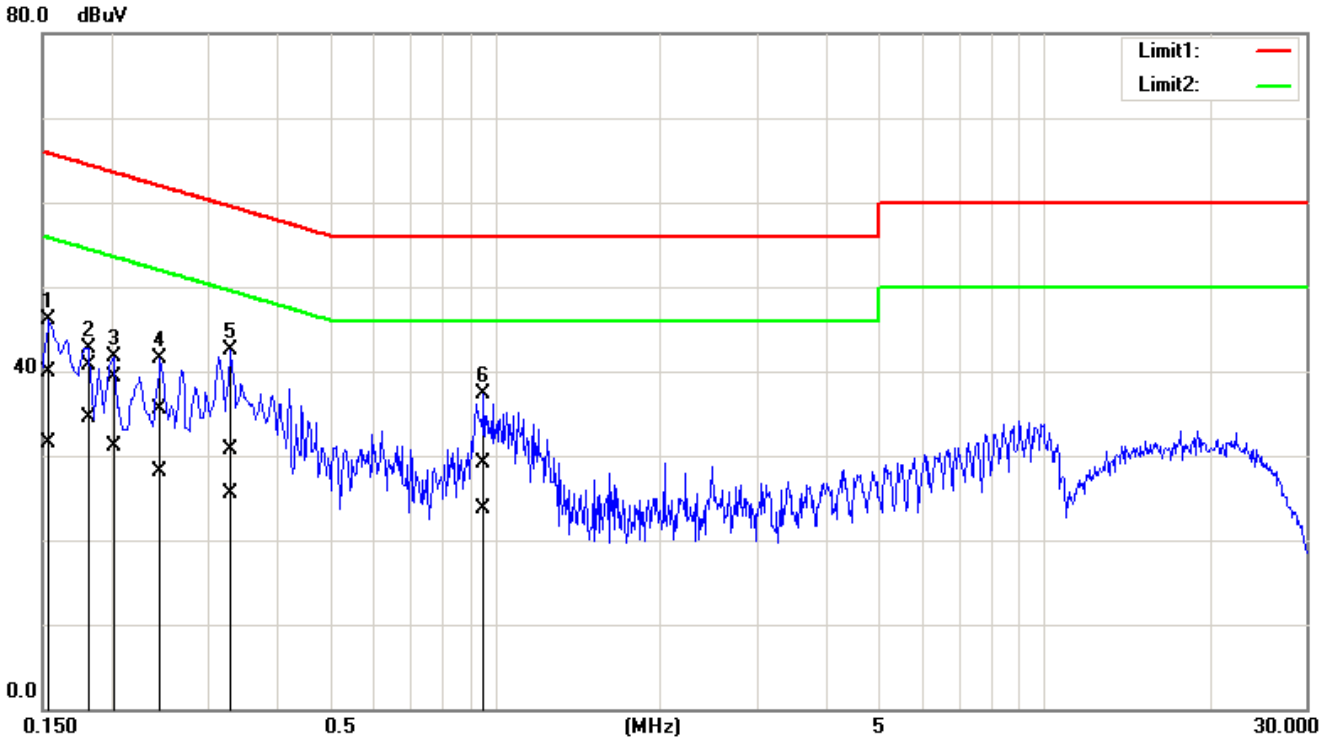
1. The EUT was placed on a table which is 0.8m above ground plan.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured were complete.

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.

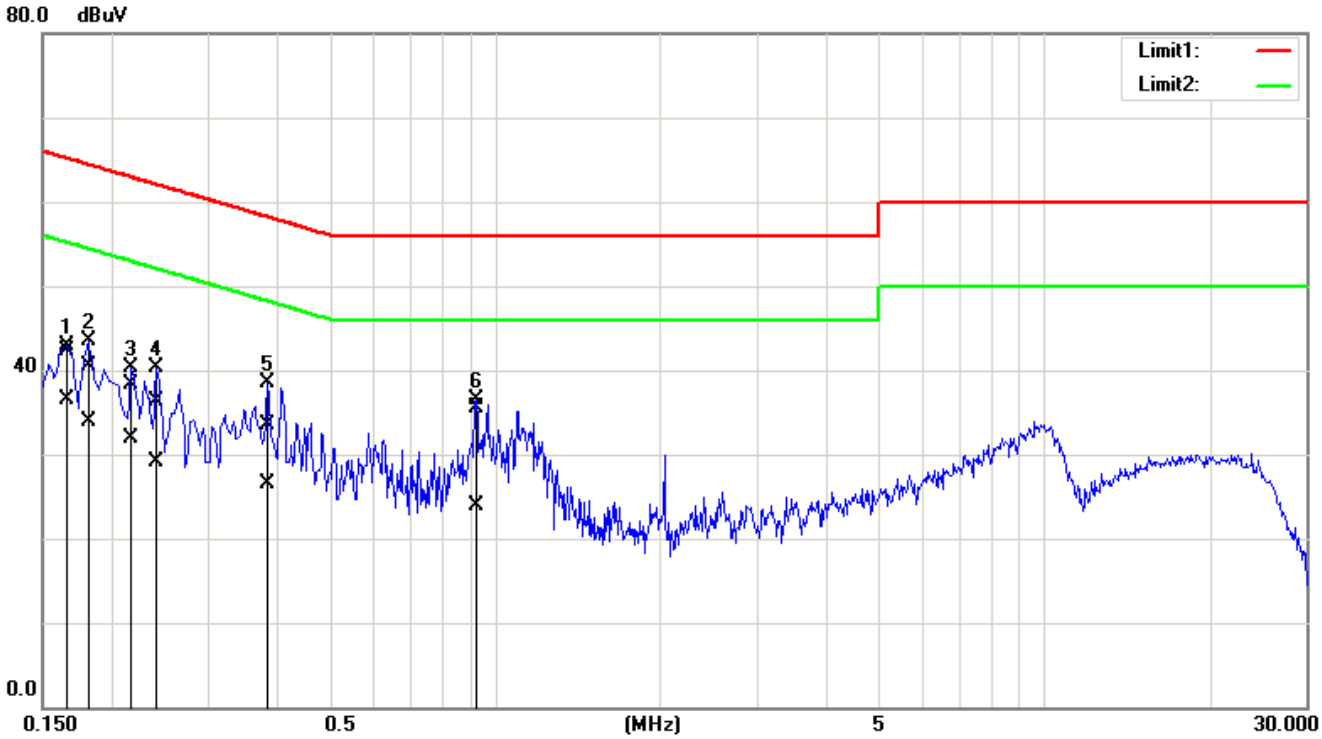
AC POWER LINE CONDUCTED EMISSION TEST DATA

Description:	**Operation**	**Date:**	**2019/5/28**
Line:	**L1**	**Temp.(℃)/Hum.(%):**	**25.1(℃)/61%**
Test Voltage:	**AC 120V/60Hz**	**Test By:**	**Peter**



No.	Frequency	QuasiPeak reading	Average reading	Correction factor	QuasiPeak result	Average result	QuasiPeak limit	Average limit	QuasiPeak margin	Average margin	Remark
	(MHz)	(dBuV)	(dBuV)	(dB)	(dBuV)	(dBuV)	(dBuV)	(dBuV)	(dB)	(dB)	
1	0.1539	29.80	21.30	10.14	39.94	31.44	65.78	55.79	-25.84	-24.35	Pass
2*	0.1819	30.64	24.33	10.13	40.77	34.46	64.39	54.40	-23.62	-19.94	Pass
3	0.2020	29.27	20.97	10.13	39.40	31.10	63.52	53.53	-24.12	-22.43	Pass
4	0.2460	25.37	18.05	10.13	35.50	28.18	61.89	51.89	-26.39	-23.71	Pass
5	0.3300	20.61	15.38	10.14	30.75	25.52	59.45	49.45	-28.70	-23.93	Pass
6	0.9580	18.96	13.49	10.17	29.13	23.66	56.00	46.00	-26.87	-22.34	Pass

Description:	**Operation**	**Date:**	**2019/5/28**
Line:	**N**	**Temp.(℃)/Hum.(%):**	**25.1(℃)/61%**
Test Voltage	**AC 120V/60Hz**	**Test By:**	**Peter**



No.	Frequency	QuasiPeak reading	Average reading	Correction factor	QuasiPeak result	Average result	QuasiPeak limit	Average limit	QuasiPeak margin	Average margin	Remark
	(MHz)	(dBuV)	(dBuV)	(dB)	(dBuV)	(dBuV)	(dBuV)	(dBuV)	(dB)	(dB)	
1*	0.1660	32.23	26.46	10.02	42.25	36.48	65.15	55.16	-22.90	-18.68	Pass
2	0.1819	30.48	23.85	10.02	40.50	33.87	64.39	54.40	-23.89	-20.53	Pass
3	0.2180	28.20	21.79	10.02	38.22	31.81	62.89	52.89	-24.67	-21.08	Pass
4	0.2420	26.28	19.03	10.02	36.30	29.05	62.02	52.03	-25.72	-22.98	Pass
5	0.3860	23.43	16.46	10.03	33.46	26.49	58.15	48.15	-24.69	-21.66	Pass
6	0.9260	25.47	13.89	10.04	35.51	23.93	56.00	46.00	-20.49	-22.07	Pass

7 PEAK OUTPUT POWER MEASUREMENT

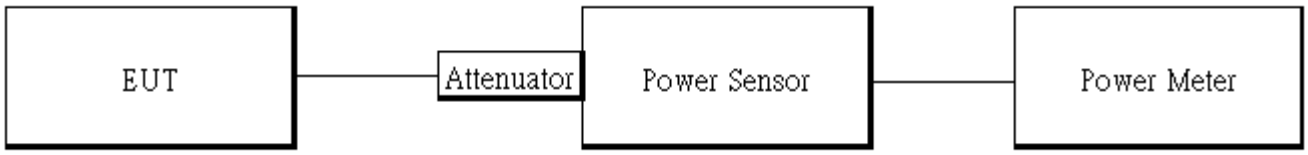
7.1 Standard Applicable

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels, The Limit: 1Watt. For all other frequency hopping systems in the 2400 – 2483.5MHz band: The Limit: 0.125 Watts. The power limit for 1Mbps is 1watt, and 2Mbps, 3Mbps and AFH mode are 0.125 watts.

7.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Power Meter	Anritsu	ML2496A	1242004	10/23/2018	10/22/2019
Power Sensor	Anritsu	MA2411B	1207365	10/23/2018	10/22/2019
Power Sensor	Anritsu	MA2411B	1207368	10/24/2018	10/23/2019

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 Measurement Result

1M BR mode (Peak):

CH	Freq. (MHz)	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	5.95	3.936	1000
Mid	2441	6.03	4.009	1000
High	2480	**6.44**	4.406	1000

1M BR mode (Average):

CH	Freq. (MHz)	Max. Output include tune up tolerance Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	5.93	3.917	1000
Mid	2441	6.01	3.990	1000
High	2480	6.41	4.375	1000

2M EDR mode (Peak):

CH	Freq. (MHz)	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	6.35	4.315	125
Mid	2441	6.35	4.315	125
High	2480	**6.72**	4.699	125

2M EDR mode (Average):

CH	Freq. (MHz)	Max. Avg.Output include tune up tolerance Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	2.98	1.986	125
Mid	2441	3.17	2.075	125
High	2480	3.87	2.438	125

3M EDR mode (Peak):

CH	Freq. (MHz)	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	7.07	5.093	125
Mid	2441	7.01	5.023	125
High	2480	**7.27**	5.333	125

3M EDR mode (Average):

CH	Freq. (MHz)	Max. Avg.Output include tune up tolerance Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	2.97	1.982	125
Mid	2441	3.17	2.075	125
High	2480	3.87	2.438	125

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

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

8 20DB BANDWIDTH MEASUREMENT

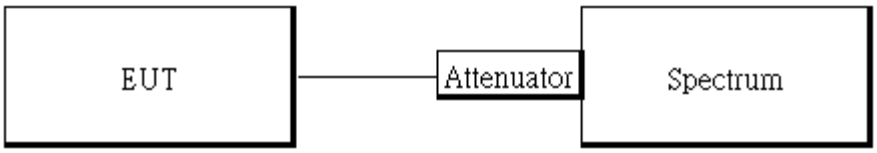
8.1 Standard Applicable

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

8.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	N9010A	MY53400256	11/21/2018	11/20/2019
DC Block	Mini-Circuits	BLK-18-S+	31129(1)	02/26/2019	02/25/2020

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

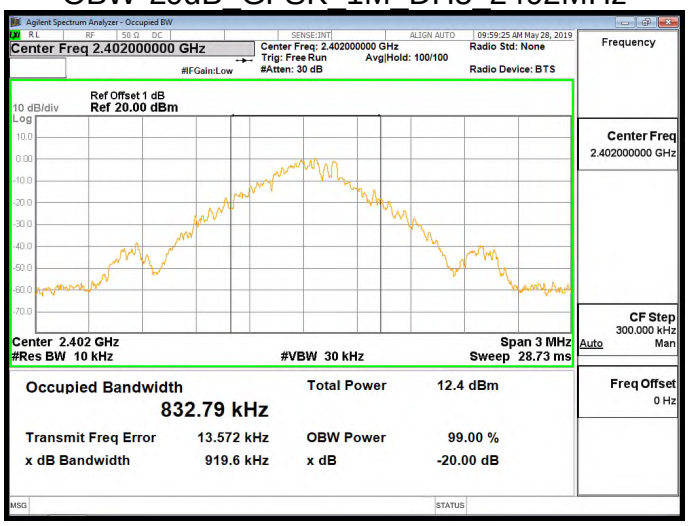
NOTE:

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

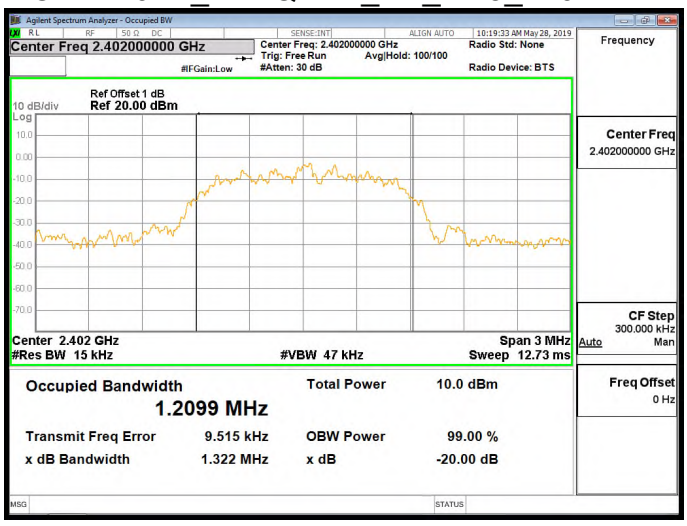
8.5 Measurement Result

GFSK			π/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	0.9196	0.61	Low	1.322	0.88	Low	1.275	0.85
Mid	0.9206	0.61	Mid	1.322	0.88	Mid	1.272	0.85
High	0.9205	0.61	High	1.323	0.88	High	1.274	0.85

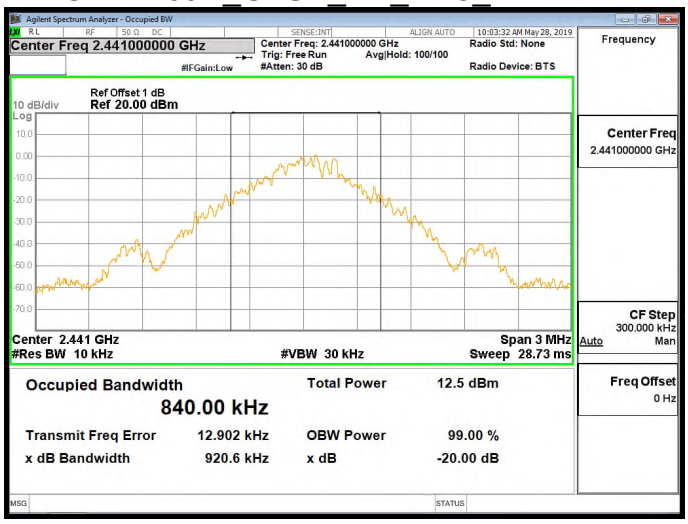
OBW 20dB_GFSK_1M_DH5_2402MHz



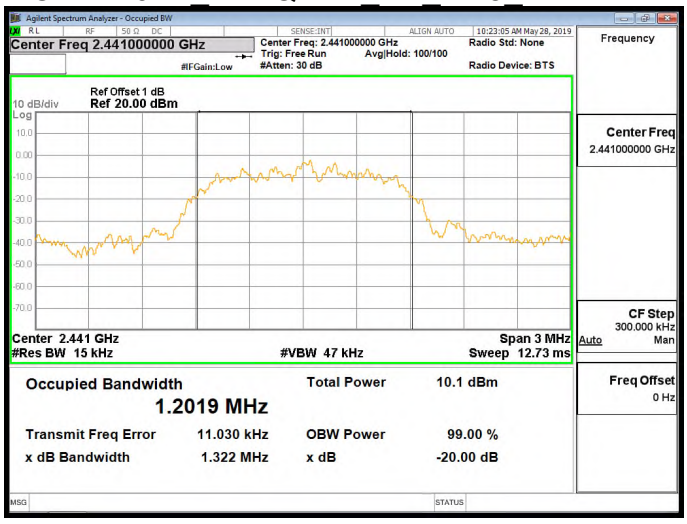
OBW 20dB_π4DQPSK_2M_DH5_2402MHz



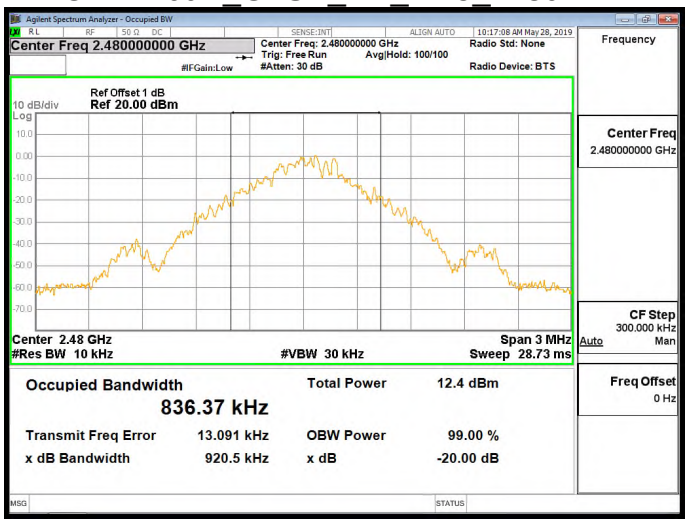
OBW 20dB_GFSK_1M_DH5_2441MHz



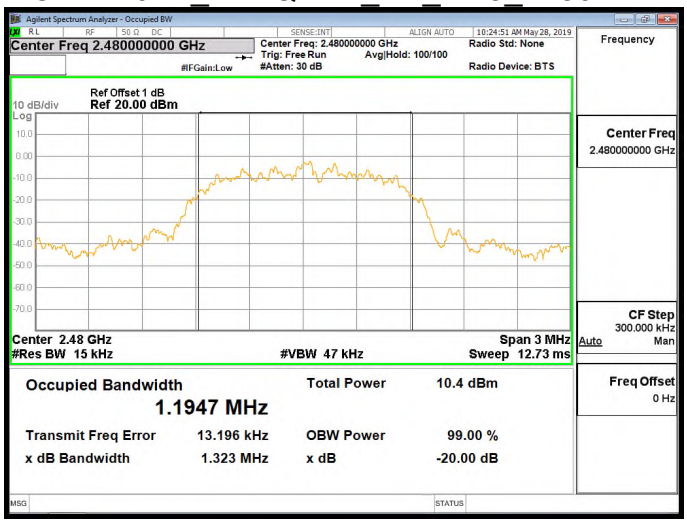
OBW 20dB_π4DQPSK_2M_DH5_2441MHz



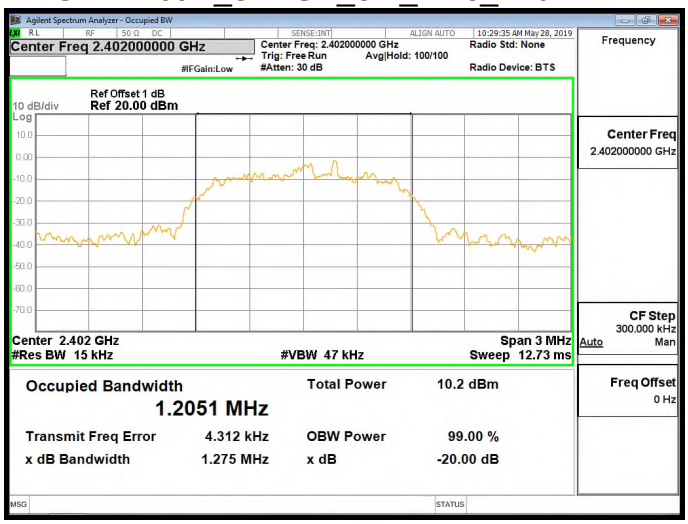
OBW 20dB_GFSK_1M_DH5_2480MHz



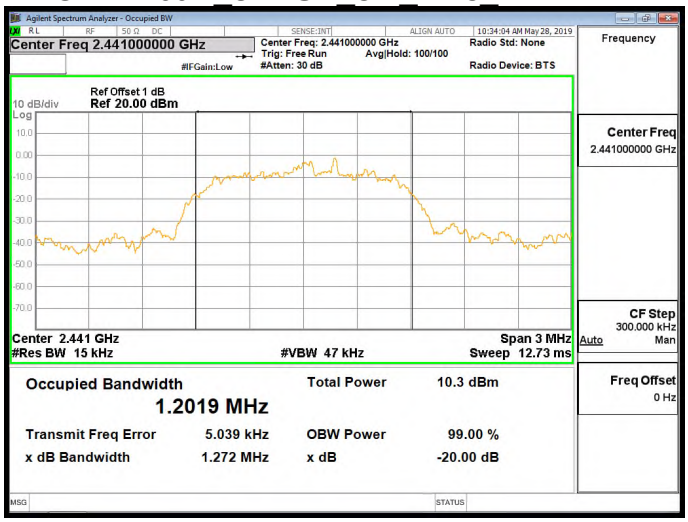
OBW 20dB_π4DQPSK_2M_DH5_2480MHz



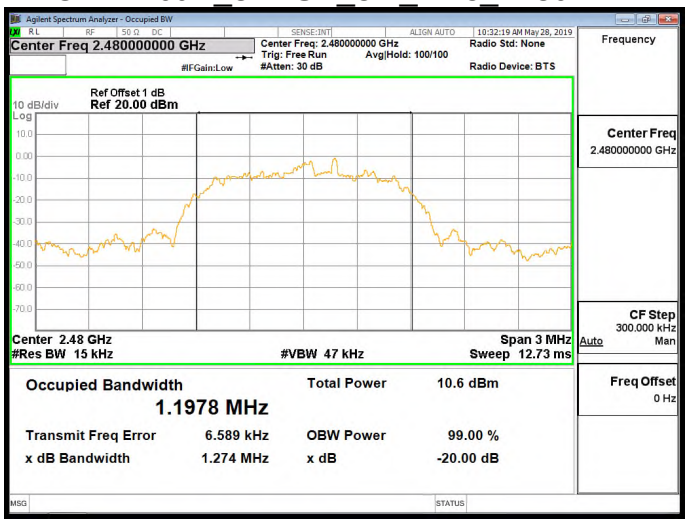
OBW 20dB_8DPSK_3M_DH5_2402MHz



OBW 20dB_8DPSK_3M_DH5_2441MHz



OBW 20dB_8DPSK_3M_DH5_2480MHz



9 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

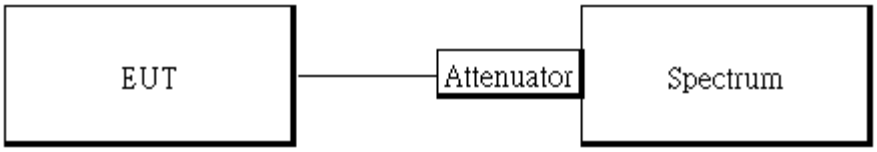
9.1 Standard Applicable

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), must also comply with the radiated emission limits specified in §15.209(a).

9.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	N9010A	MY53400256	11/21/2018	11/20/2019
DC Block	Mini-Circuits	BLK-18-S+	31129(1)	02/26/2019	02/25/2020

9.3 Test SET-UP



9.4 Measurement Procedure

Conducted Band Edge:

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

Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows ANSI C63.10:2013.
3. Set RBW = 100 kHz & VBW = 300 kHz, Detector =Peak, Sweep = Auto
4. Allow trace to fully stabilize.
5. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
6. Repeat above procedures until all default test channel measured were complete.

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

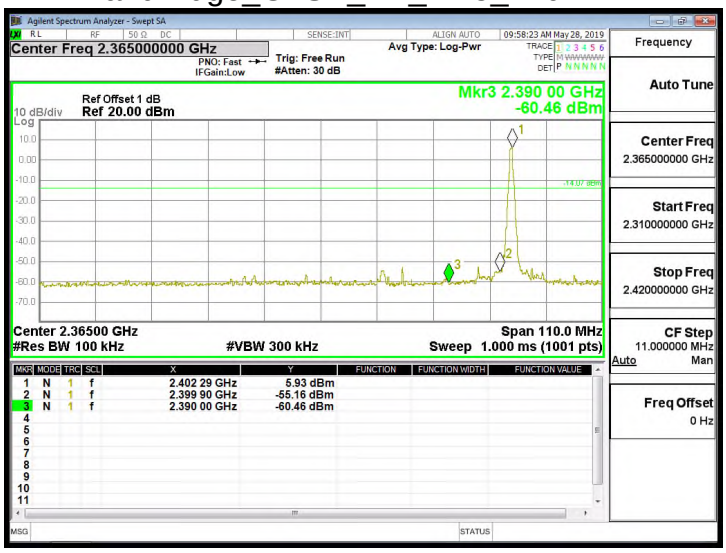
FS = RA + AF + CL - AG

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

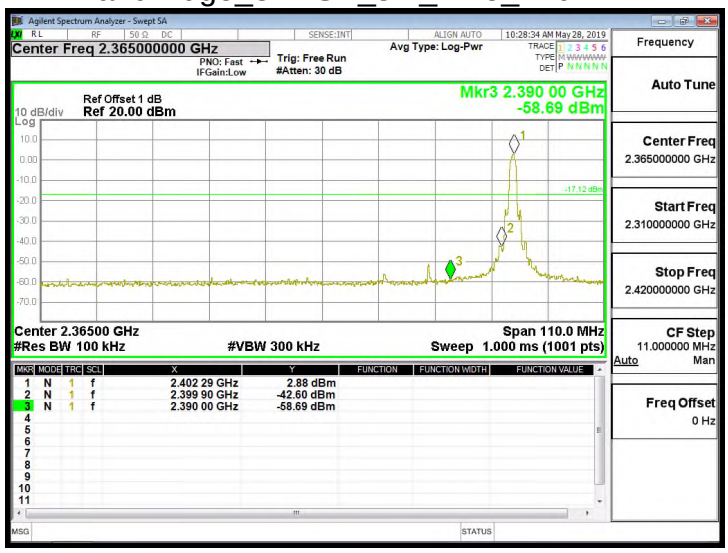
9.5 Measurement Result

See next page for test plots.

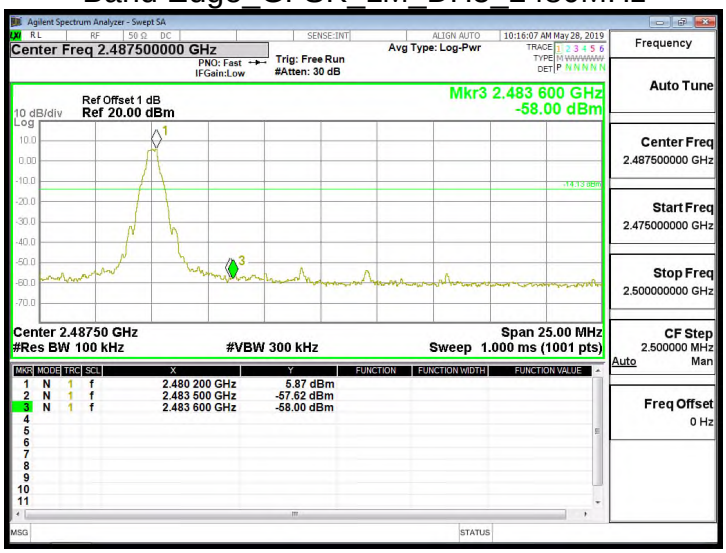
Band Edge_GFSK_1M_DH5_2402MHz



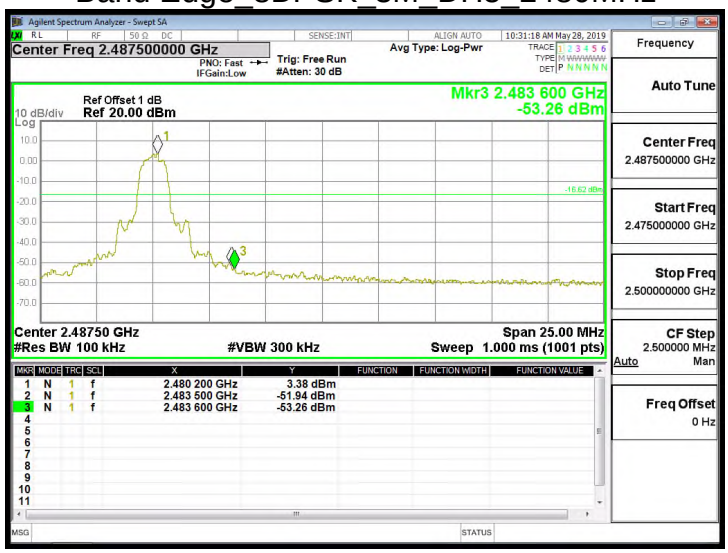
Band Edge_8DPSK_3M_DH5_2402MHz



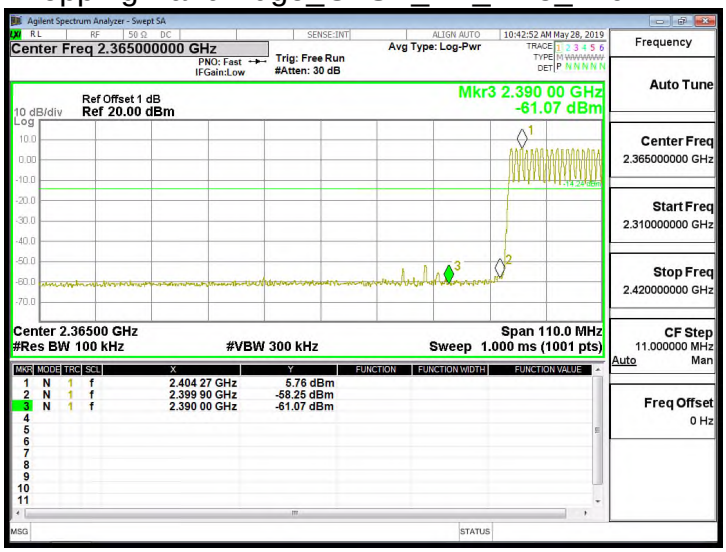
Band Edge_GFSK_1M_DH5_2480MHz



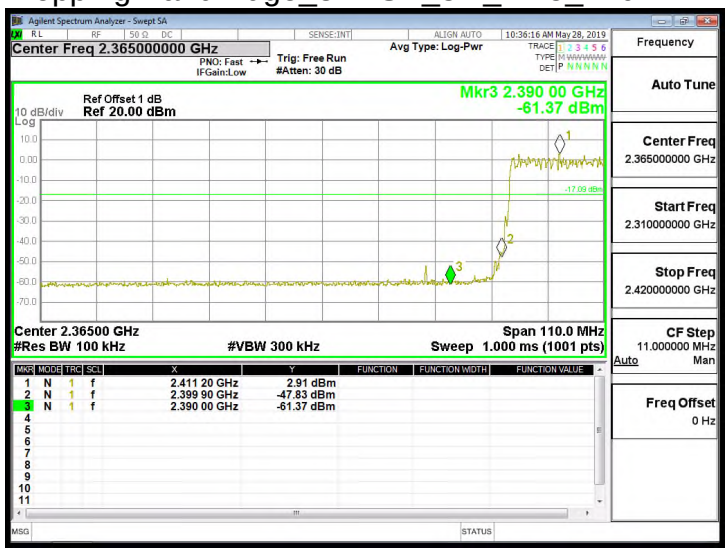
Band Edge_8DPSK_3M_DH5_2480MHz



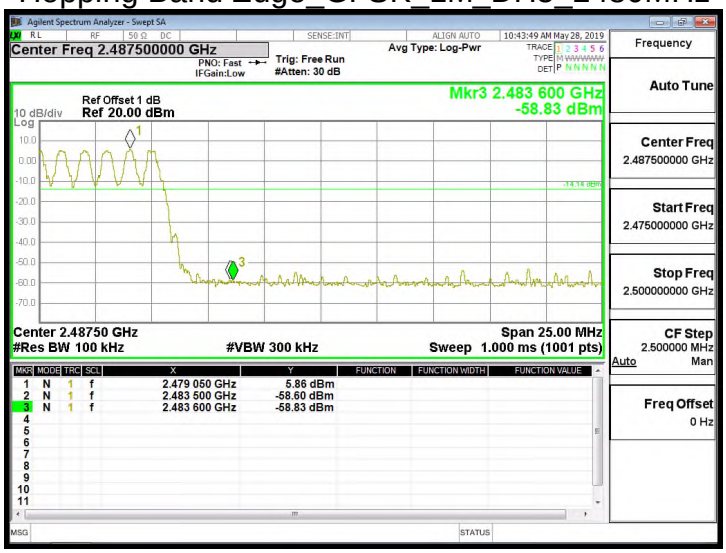
Hopping Band Edge_GFSK_1M_DH5_2402MHz



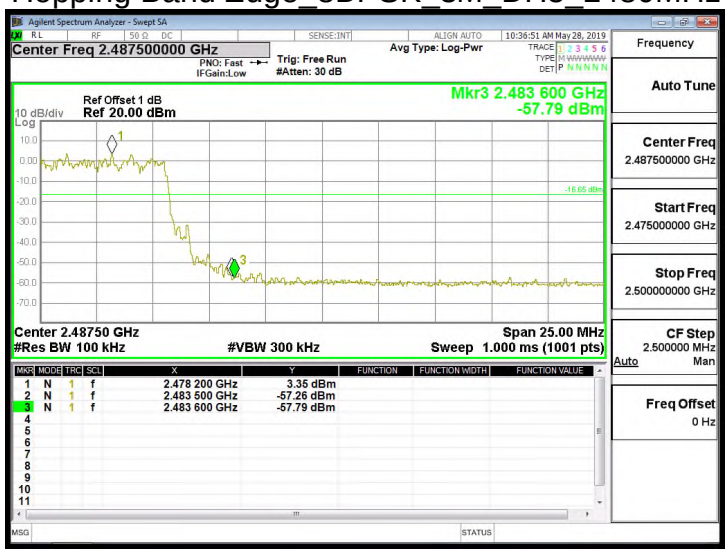
Hopping Band Edge_8DPSK_3M_DH5_2402MHz



Hopping Band Edge_GFSK_1M_DH5_2480MHz

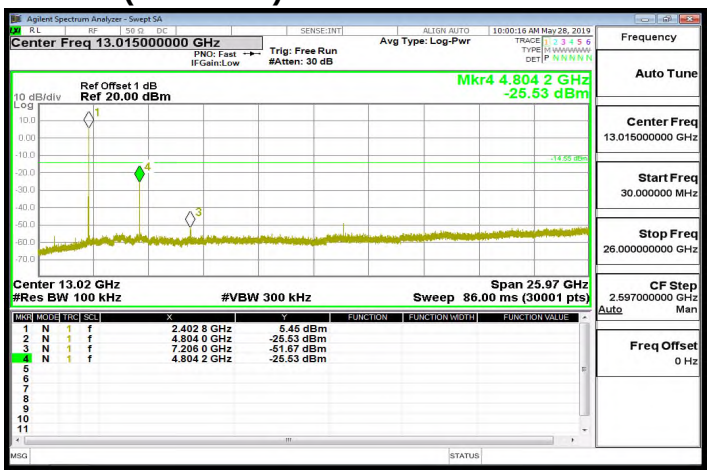


Hopping Band Edge_8DPSK_3M_DH5_2480MHz

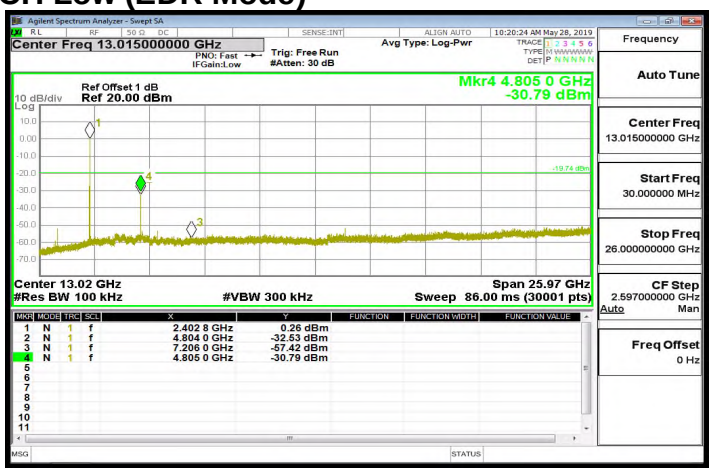


Conducted Spurious Emission Measurement Result

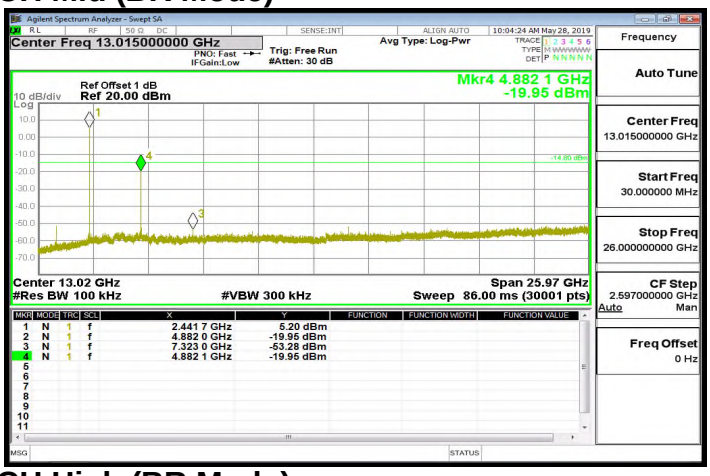
CH Low (BR Mode)



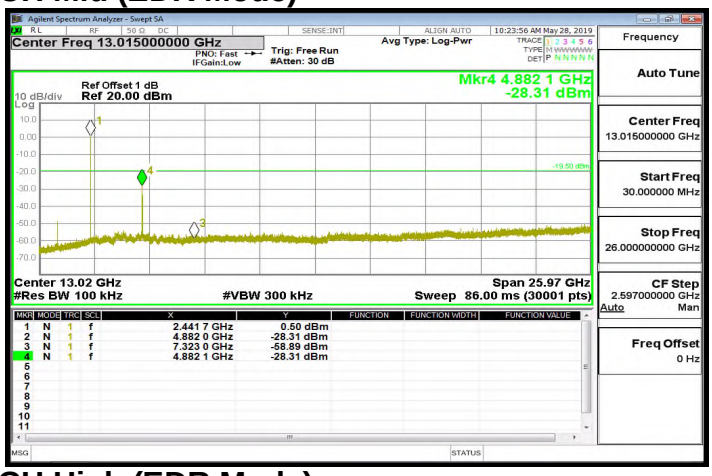
CH Low (EDR Mode)



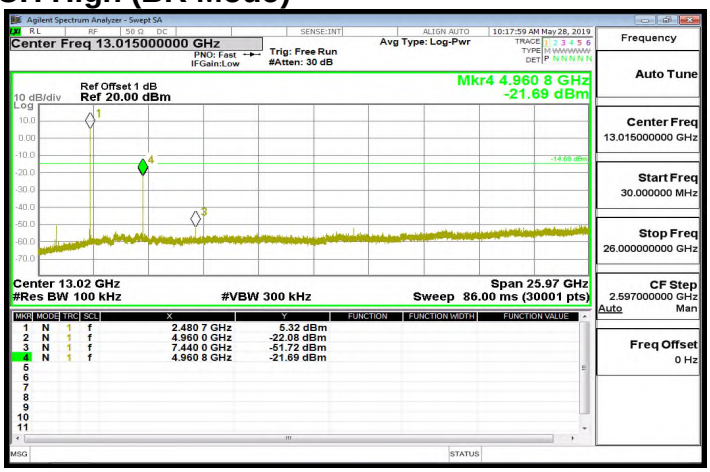
CH Mid (BR Mode)



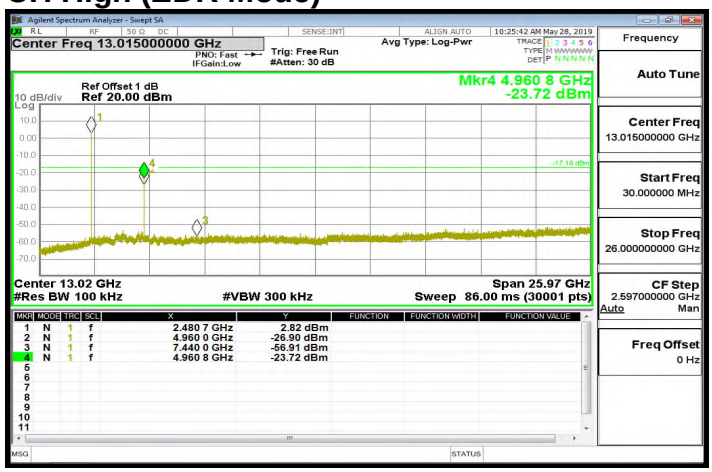
CH Mid (EDR Mode)



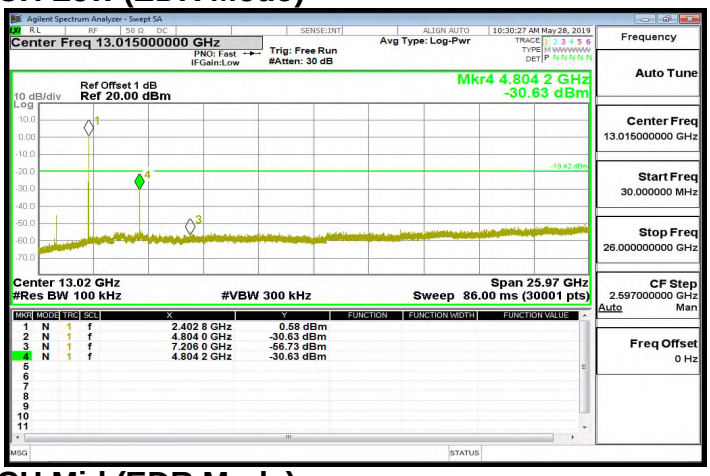
CH High (BR Mode)



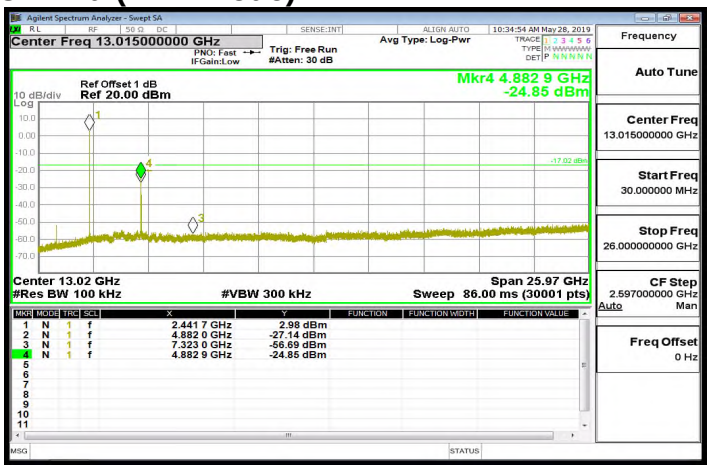
CH High (EDR Mode)



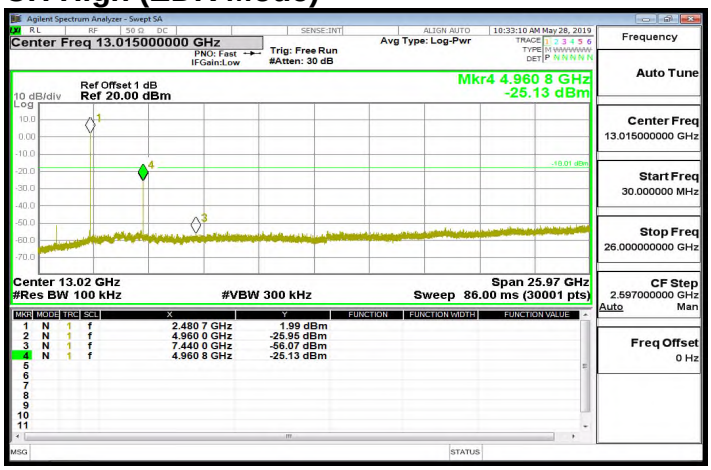
CH Low (EDR Mode)



CH Mid (EDR Mode)



CH High (EDR Mode)



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)

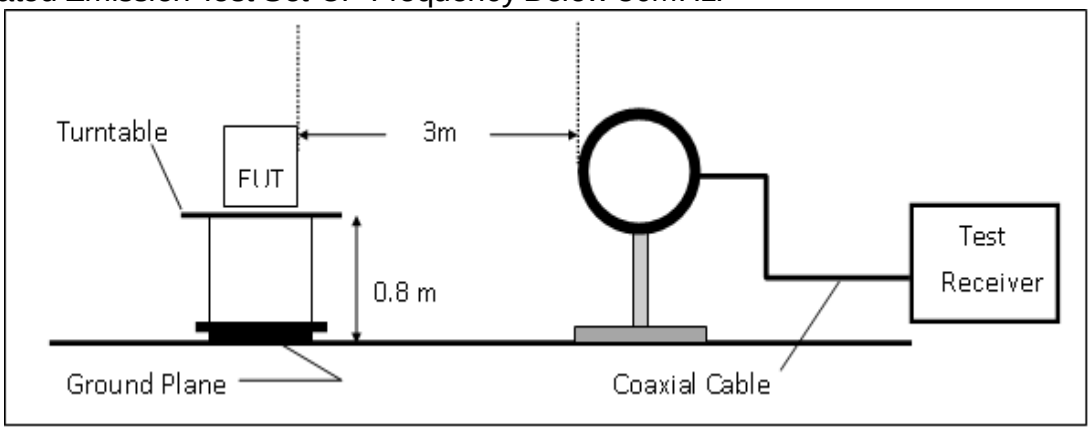
10.2 Measurement Equipment Used

966A Chamber					
EQUIPMENT TYPE	**MFR**	**MODEL NUMBER**	**SERIAL NUMBER**	**LAST CAL.**	**CAL DUE.**
Band Reject Filters	MICRO TRON-ICS	BRM 50702	120	02/26/2019	02/25/2020
Bilog Antenna	Sunol Sciences	JB3	A030105	07/13/2018	07/12/2019
Cable	HUBER SU-HNER	SUCOFLEX 104PEA	25157	02/26/2019	02/25/2020
Cable	HUBER SU-HNER	SUCOFLEX 104PEA	20995	02/26/2019	02/25/2020
Digital Thermo-Hy-gro Meter	WISEWIND	1206	D07	01/30/2019	01/29/2020
double Ridged Guide Horn An-tenna	ETC	MCTD 1209	DRH13M02003	08/20/2018	08/19/2019
Loop Antenna	COM-POWER	AL-130	121051	03/22/2019	03/21/2020
Pre-Amplifier	EMEC	EM330	060609	02/26/2019	02/25/2020
Pre-Amplifier	HP	8449B	3008A00965	02/26/2019	02/25/2020
PSA Series Spec-trum Analyzer	Agilent	E4446A	MY46180323	05/31/2018	05/30/2019
Antenna Tower	CCS	CC-A-1F	N/A	N.C.R	N.C.R
Controller	CCS	CC-C-1F	N/A	N.C.R	N.C.R
Turn Table	CCS	CC-T-1F	N/A	N.C.R	N.C.R
Software	e3 V6.11-20180413				

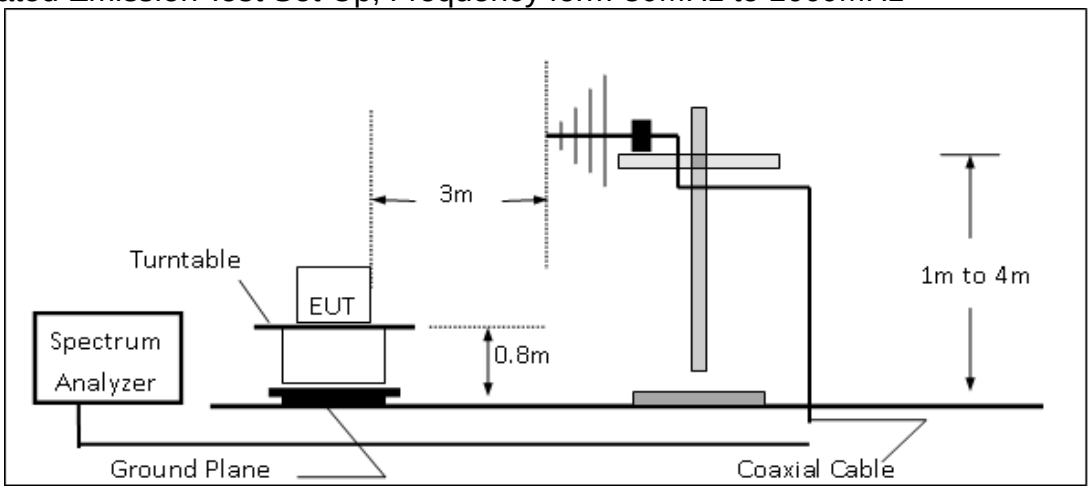
NOTE: N.C.R refers to Not Calibrated Required.

10.3 Test SET-UP

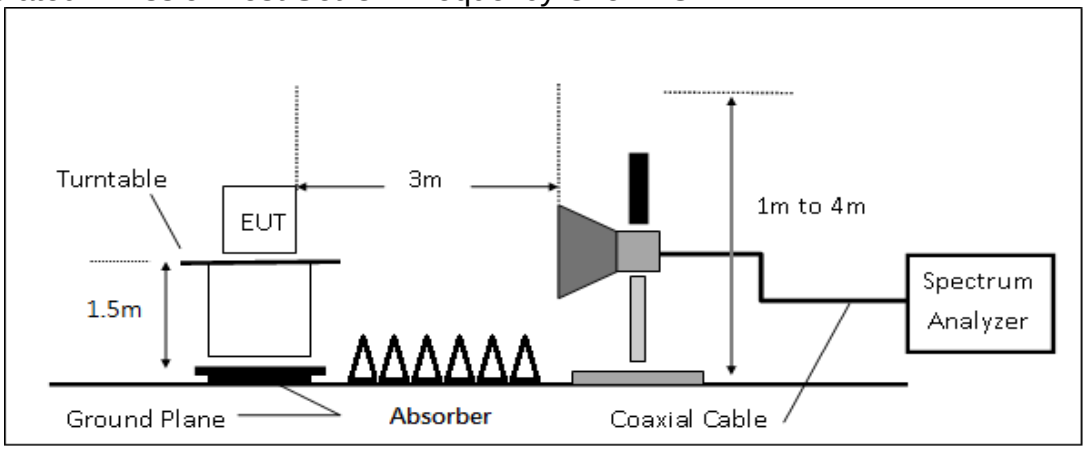
(A) Radiated Emission Test Set-UP Frequency Below 30MHz.



(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

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)

on_Time(ms)	number of 100 ms	corretion factor(dB)
2.892	2	-24.75543431

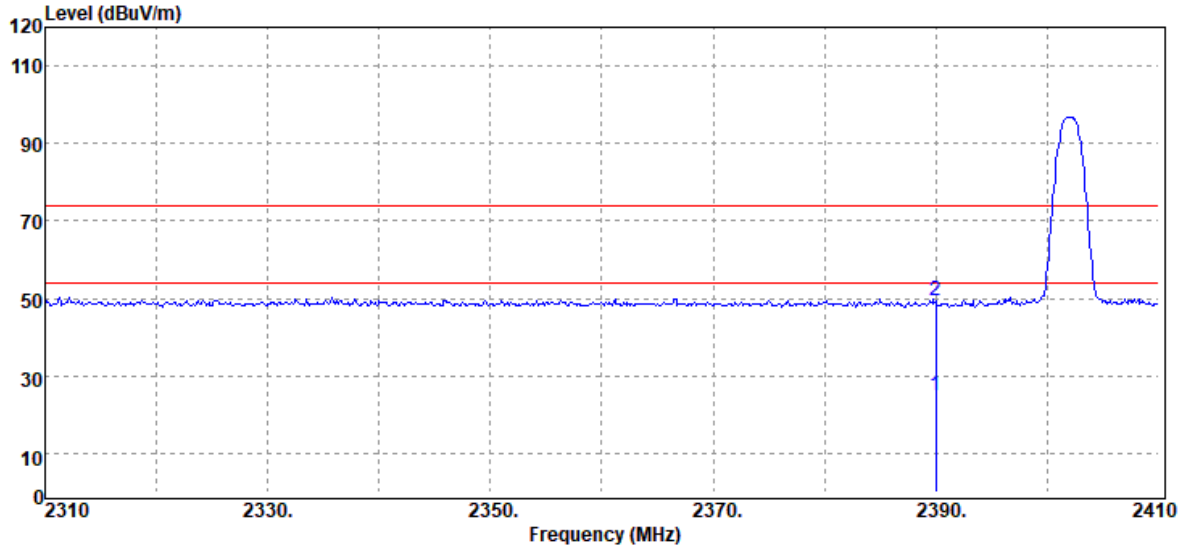
10.6 Test Results of Radiated Spurious Emissions form 9 kHz to 30 MHz

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

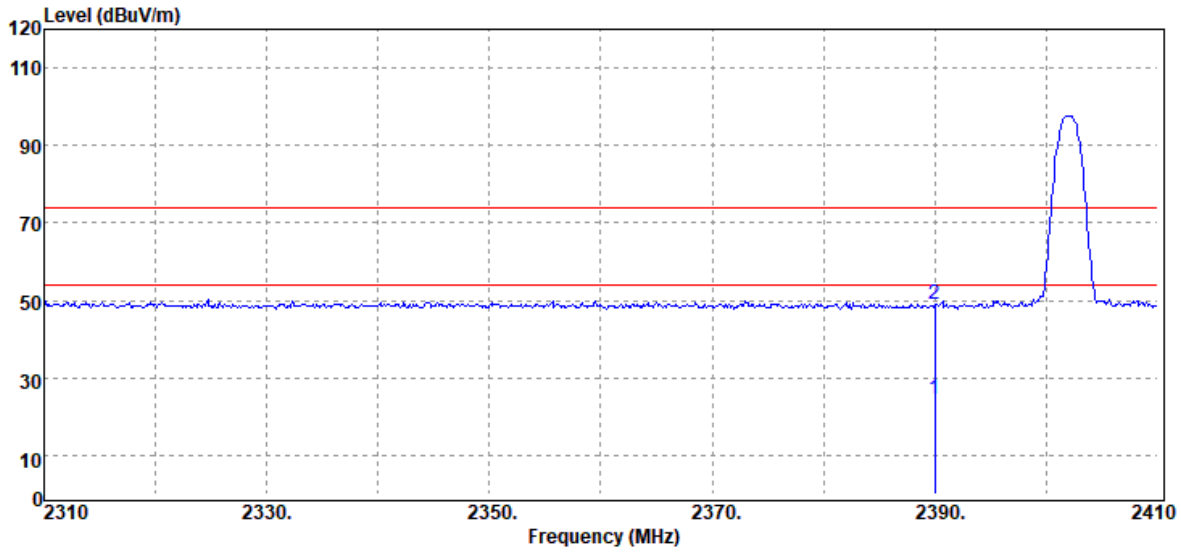
Radiated Band Edge Measurement Result:

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT BR	Temp./Humi.	:20/51
Fundamental Frequency	:2402 MHz	Engineer	:Jerry
Operation Mode	:BE CH Low	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E1 Plan		



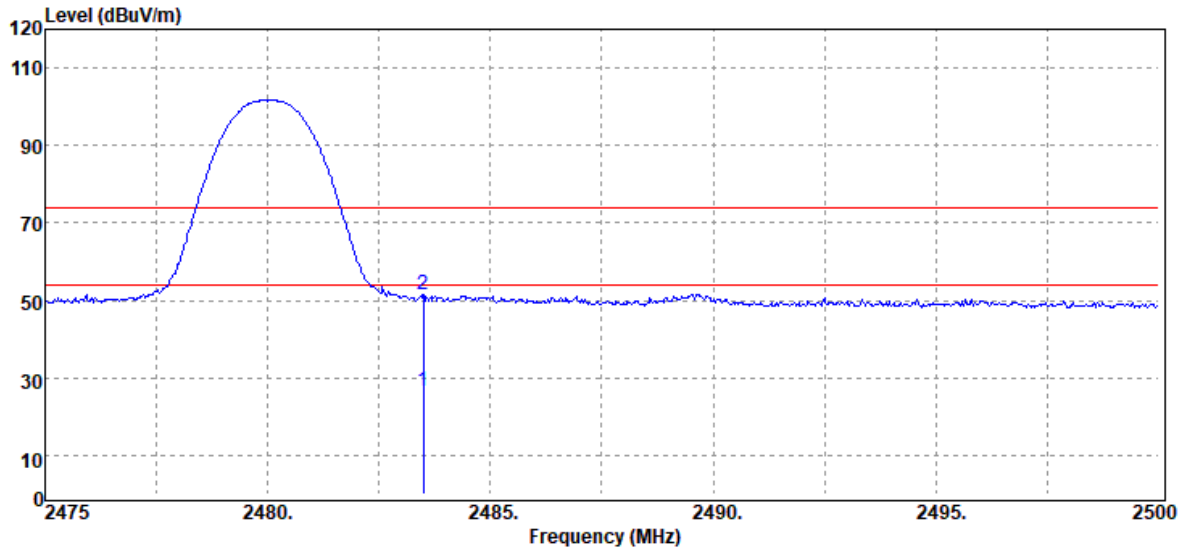
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	-	-24.75	24.83	54.00	-29.17
2390.00	Peak	52.96	-3.38	49.58	74.00	-24.42

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT BR	Temp./Humi.	:20/51
Fundamental Frequency	:2402 MHz	Engineer	:Jerry
Operation Mode	:BE CH Low	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E1 Plan		



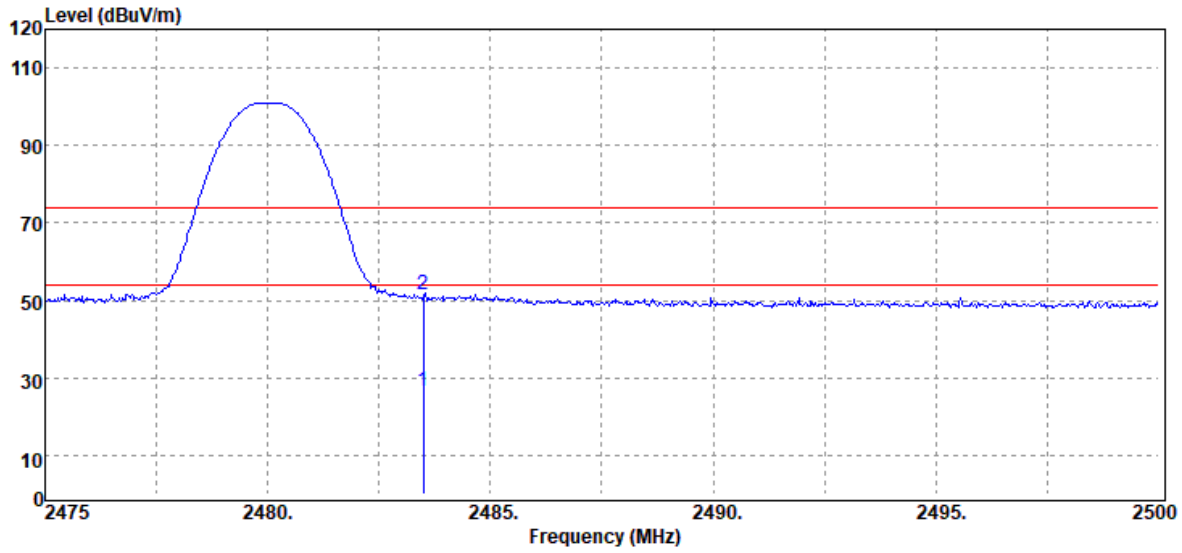
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	-	-24.75	24.37	54.00	-29.63
2390.00	Peak	52.50	-3.38	49.12	74.00	-24.88

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT BR	Temp./Humi.	:20/51
Fundamental Frequency	:2480 MHz	Engineer	:Jerry
Operation Mode	:BE CH High	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E1 Plan		



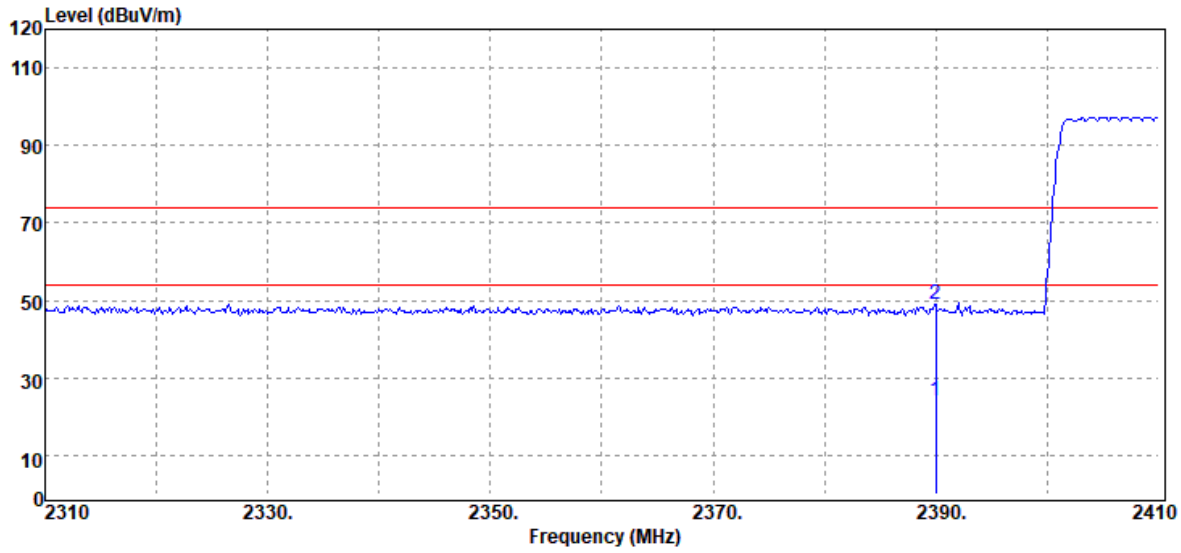
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.50	Average	-	-24.75	26.76	54.00	-27.24
2483.50	Peak	54.34	-2.83	51.51	74.00	-22.49

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT BR	Temp./Humi.	:20/51
Fundamental Frequency	:2480 MHz	Engineer	:Jerry
Operation Mode	:BE CH High	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E1 Plan		



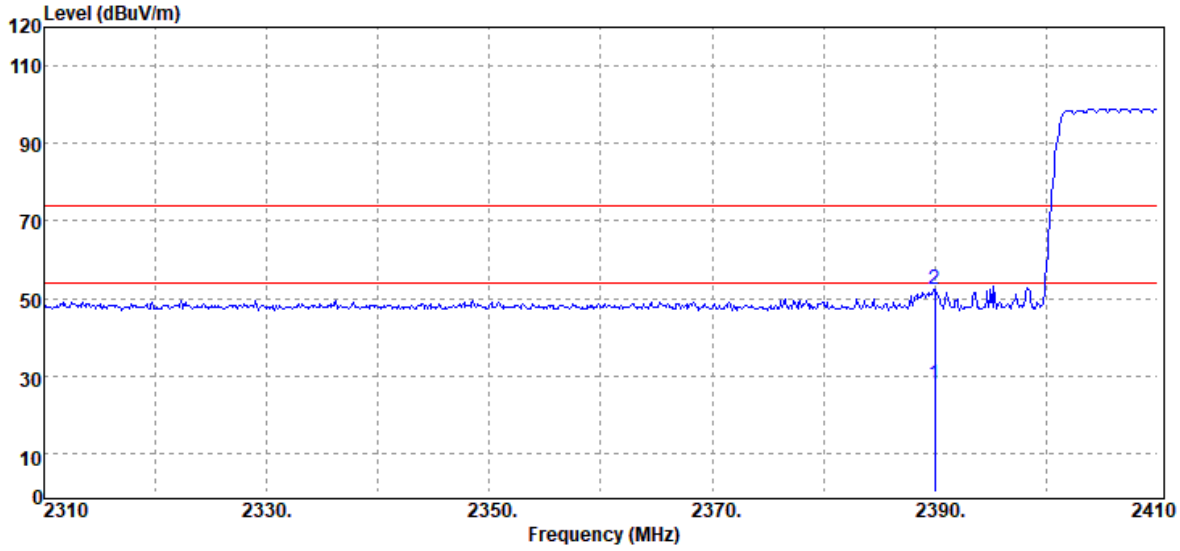
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.50	Average	-	-24.75	26.76	54.00	-27.24
2483.50	Peak	54.25	-2.83	51.42	74.00	-22.58

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT BR Hopping	Temp./Humi.	:20/51
Fundamental Frequency	:2402 MHz	Engineer	:Jerry
Operation Mode	:BE CH Low	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E1 Plan		



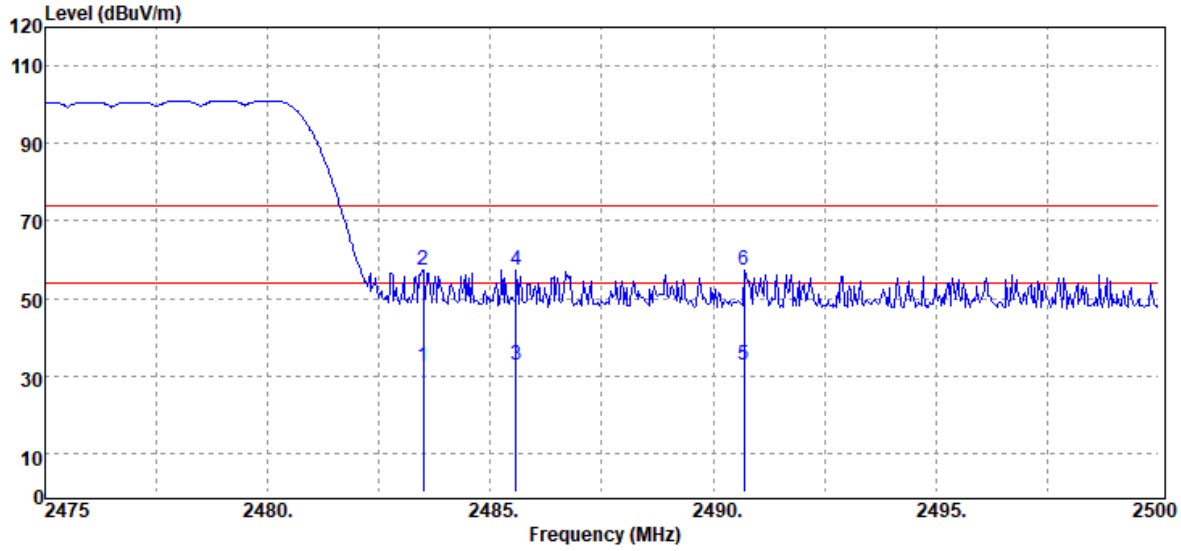
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	-	-24.75	24.07	54.00	-29.93
2390.00	Peak	52.20	-3.38	48.82	74.00	-25.18

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT BR Hopping	Temp./Humi.	:20/51
Fundamental Frequency	:2402 MHz	Engineer	:Jerry
Operation Mode	:BE CH Low	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E1 Plan		



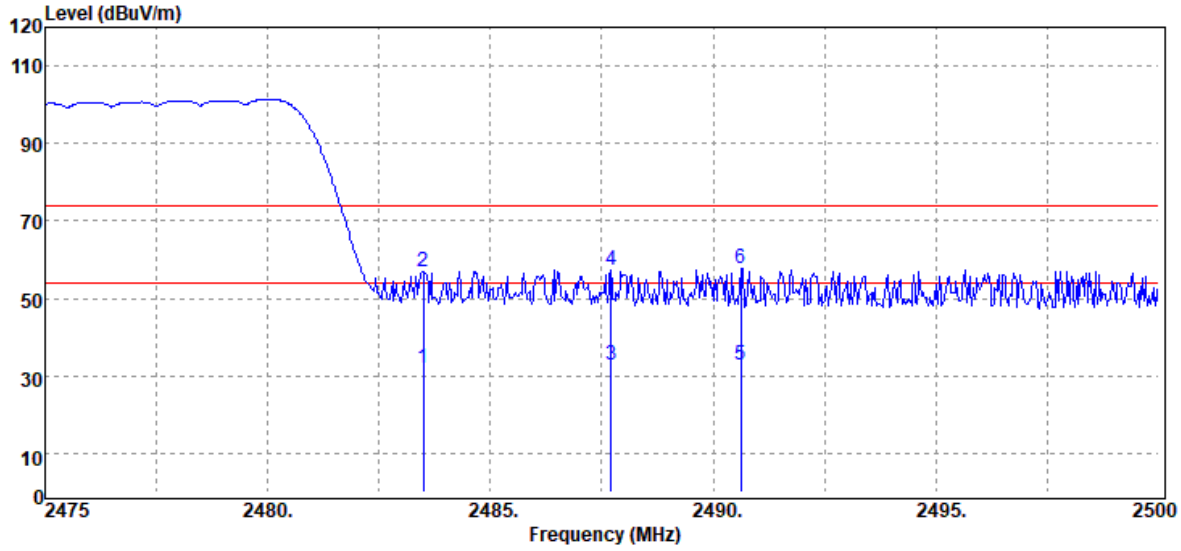
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	-	-24.75	27.68	54.00	-26.32
2390.00	Peak	55.81	-3.38	52.43	74.00	-21.57

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT BR Hopping	Temp./Humi.	:20/51
Fundamental Frequency	:2480 MHz	Engineer	:Jerry
Operation Mode	:BE CH High	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E1 Plan		



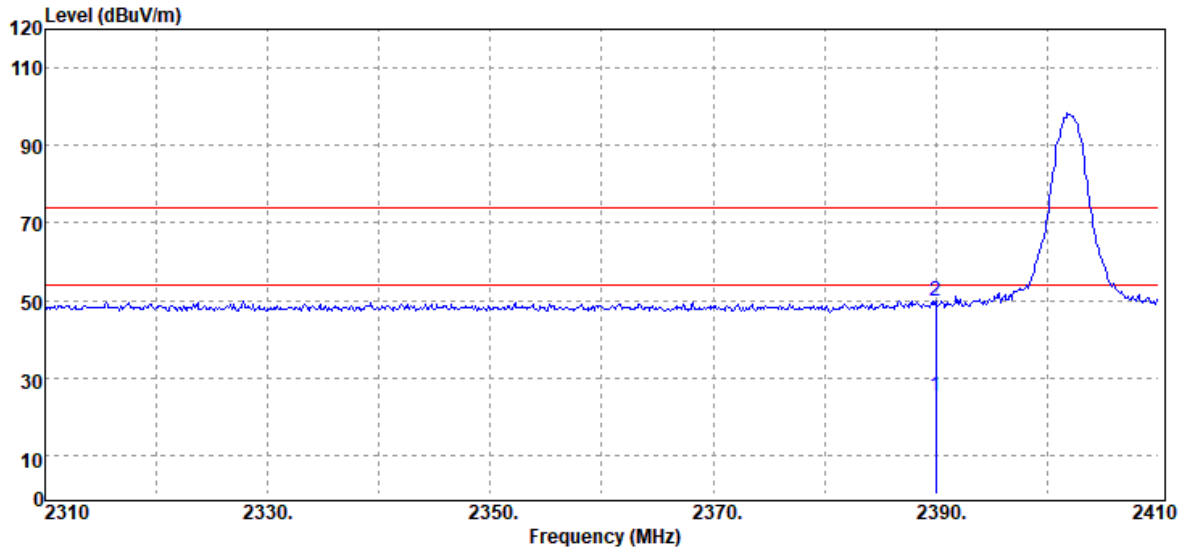
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2483.50	Average	-	-24.75	32.43	54.00	-21.57
2483.50	Peak	60.06	-2.83	57.23	74.00	-16.77
2485.58	Average	-	-24.75	32.75	54.00	-21.25
2485.58	Peak	60.32	-2.82	57.50	74.00	-16.50
2490.70	Average	-	-24.75	32.74	54.00	-21.26
2490.70	Peak	60.27	-2.78	57.49	74.00	-16.51

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT BR Hopping	Temp./Humi.	:20/51
Fundamental Frequency	:2480 MHz	Engineer	:Jerry
Operation Mode	:BE CH High	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E1 Plan		



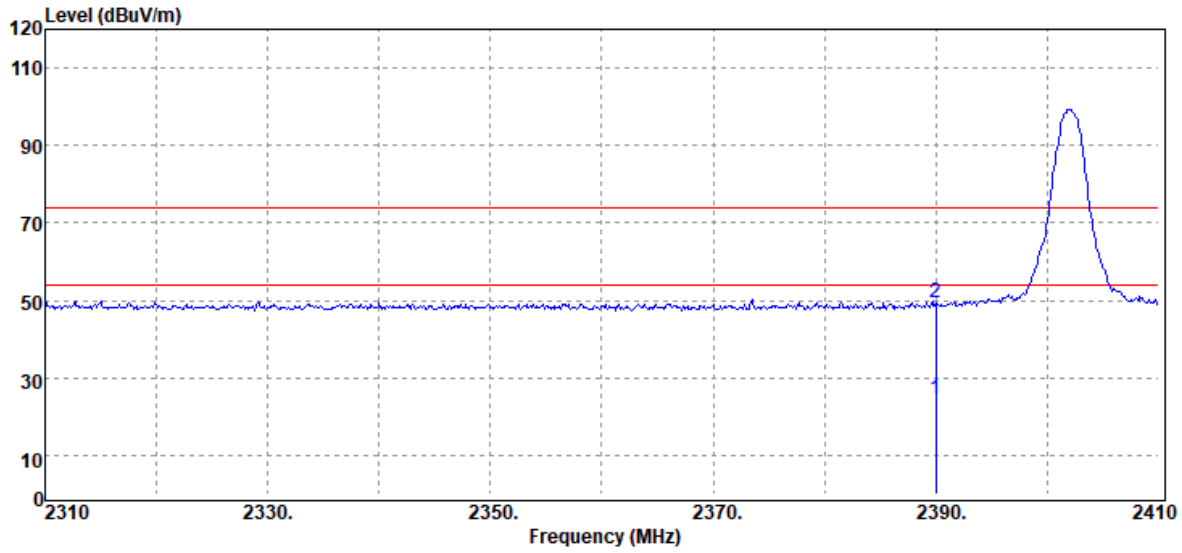
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2483.50	Average	-	-24.75	31.96	54.00	-22.04
2483.50	Peak	59.54	-2.83	56.71	74.00	-17.29
2487.70	Average	-	-24.75	32.98	54.00	-21.02
2487.70	Peak	60.13	-2.80	57.33	74.00	-16.67
2490.63	Average	-	-24.75	32.97	54.00	-21.03
2490.63	Peak	60.50	-2.78	57.72	74.00	-16.28

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT EDR	Temp./Humi.	:20/51
Fundamental Frequency	:2402 MHz	Engineer	:Jerry
Operation Mode	:BE CH Low	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E1 Plan		



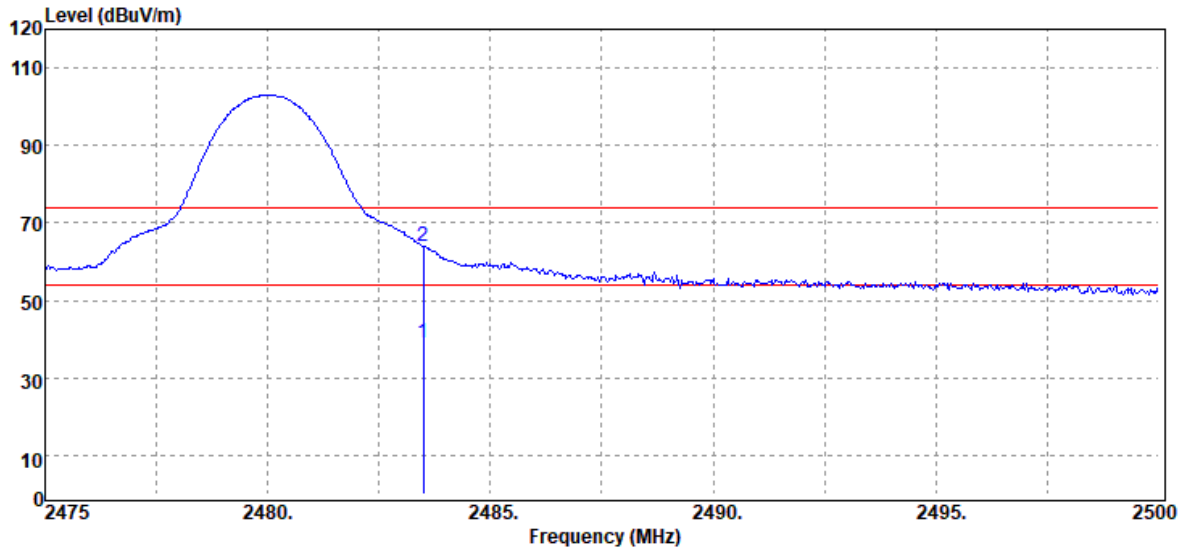
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	-	-24.75	25.17	54.00	-28.83
2390.00	Peak	53.30	-3.38	49.92	74.00	-24.08

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT EDR	Temp./Humi.	:20/51
Fundamental Frequency	:2402 MHz	Engineer	:Jerry
Operation Mode	:BE CH Low	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E1 Plan		



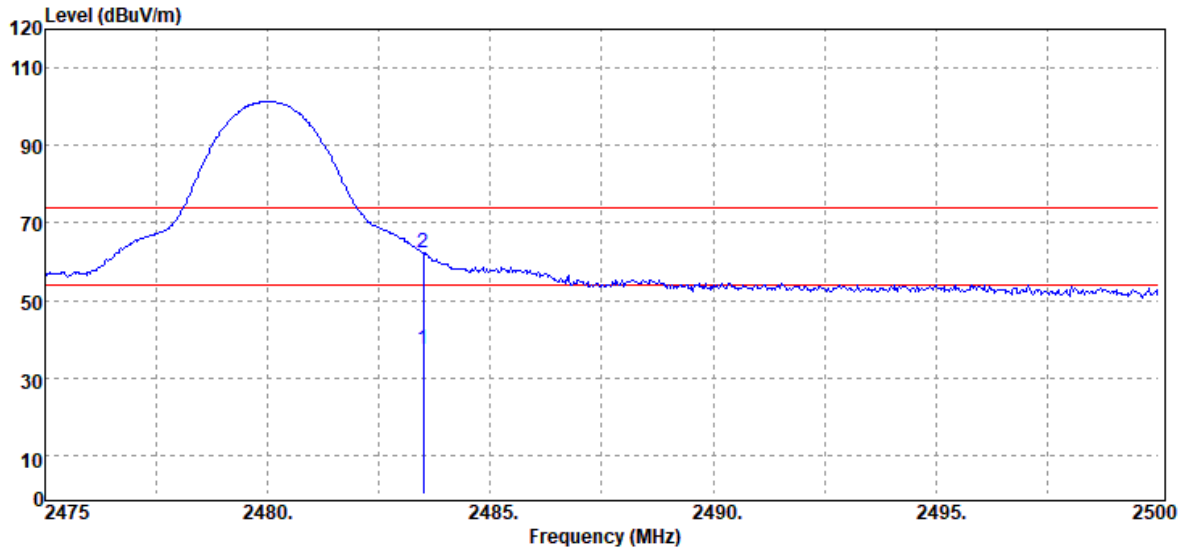
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	-	-24.75	24.51	54.00	-29.49
2390.00	Peak	52.64	-3.38	49.26	74.00	-24.74

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT EDR	Temp./Humi.	:20/51
Fundamental Frequency	:2480 MHz	Engineer	:Jerry
Operation Mode	:BE CH High	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E1 Plan		



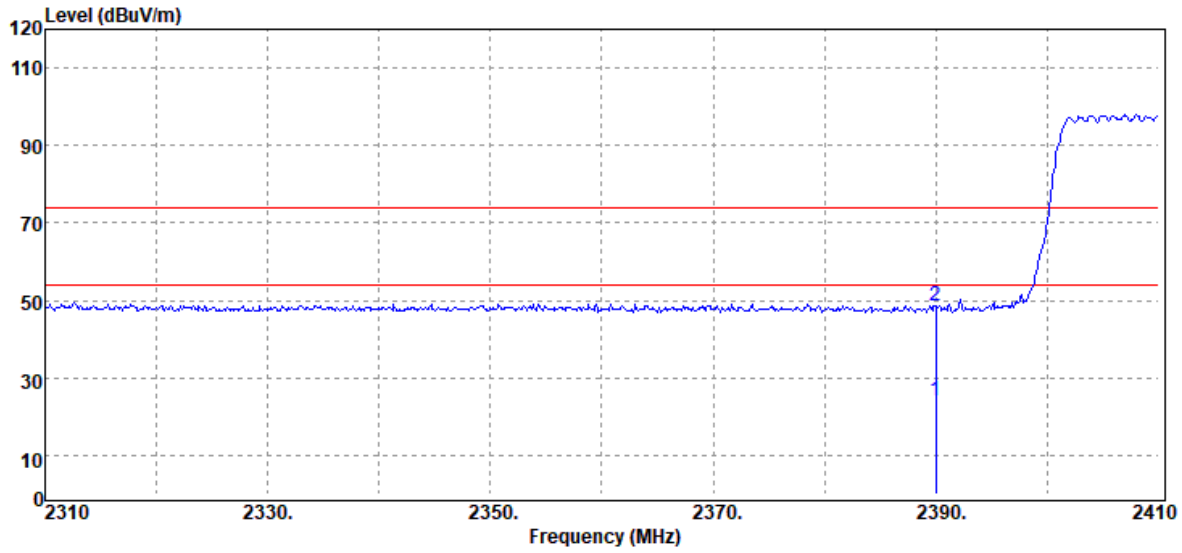
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.50	Average	-	-24.75	39.13	54.00	-14.87
2483.50	Peak	66.71	-2.83	63.88	74.00	-10.12

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT EDR	Temp./Humi.	:20/51
Fundamental Frequency	:2480 MHz	Engineer	:Jerry
Operation Mode	:BE CH High	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E1 Plan		



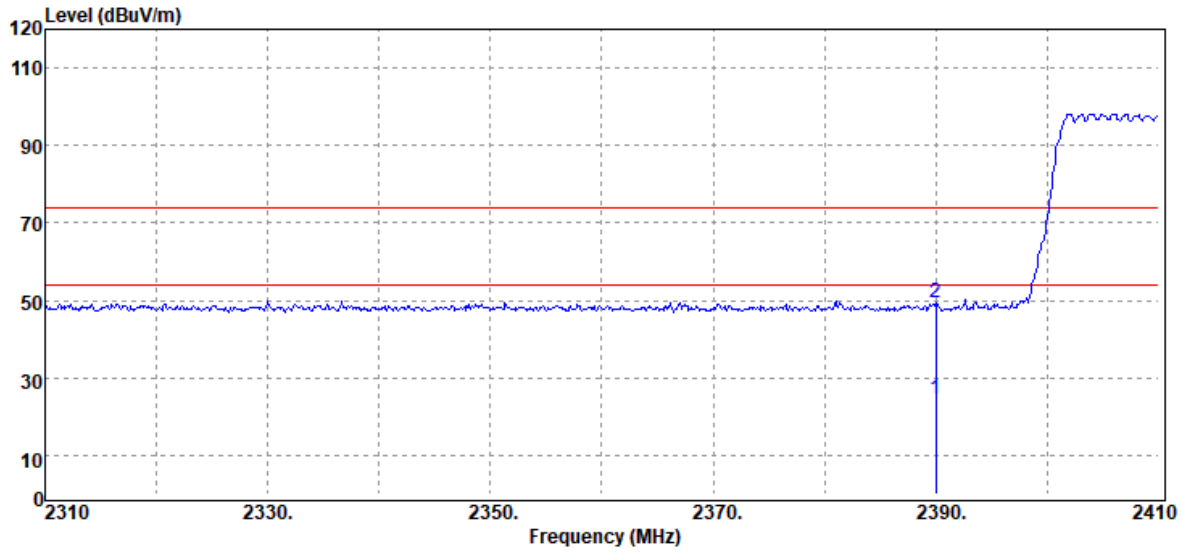
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.50	Average	-	-24.75	37.40	54.00	-16.60
2483.50	Peak	64.98	-2.83	62.15	74.00	-11.85

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT EDR Hopping	Temp./Humi.	:20/51
Fundamental Frequency	:2402 MHz	Engineer	:Jerry
Operation Mode	:BE CH Low	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E1 Plan		



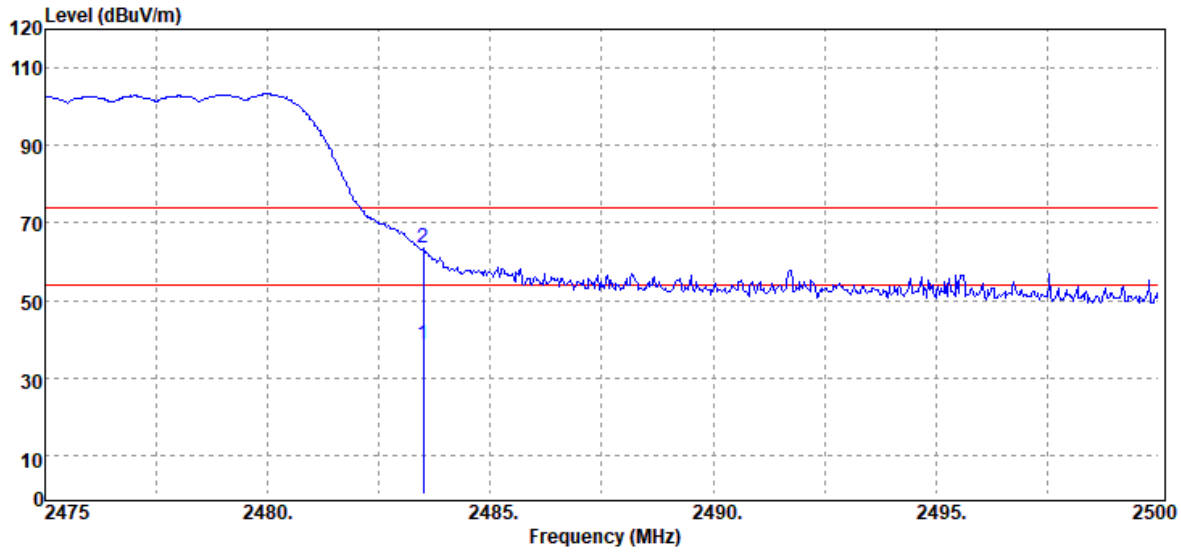
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	-	-24.75	23.92	54.00	-30.08
2390.00	Peak	52.05	-3.38	48.67	74.00	-25.33

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT EDR Hopping	Temp./Humi.	:20/51
Fundamental Frequency	:2402 MHz	Engineer	:Jerry
Operation Mode	:BE CH Low	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E1 Plan		



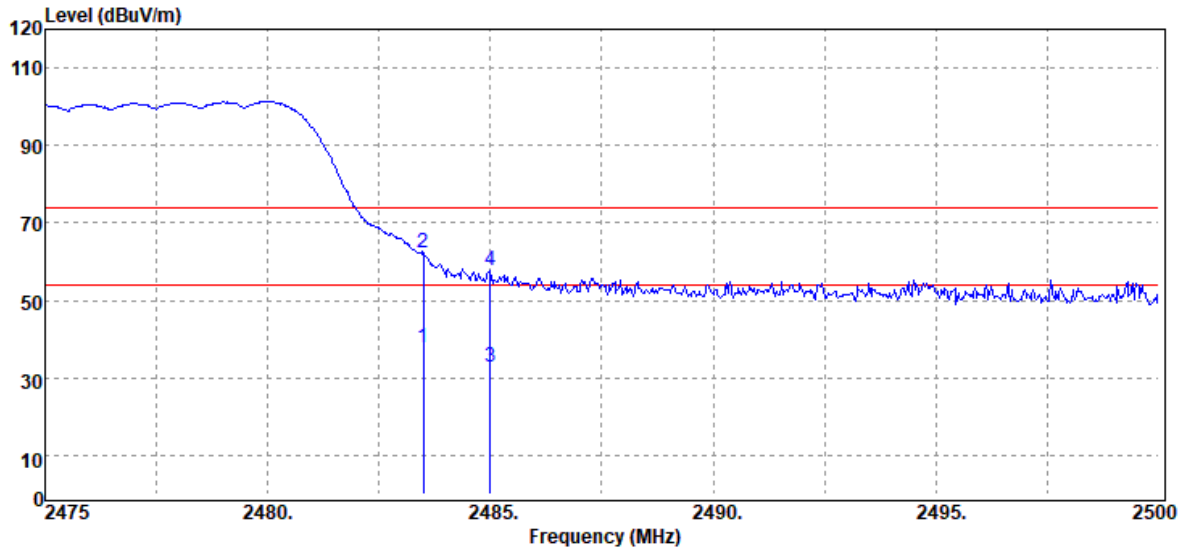
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	-	-24.75	24.57	54.00	-29.43
2390.00	Peak	52.70	-3.38	49.32	74.00	-24.68

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT EDR Hopping	Temp./Humi.	:20/51
Fundamental Frequency	:2480 MHz	Engineer	:Jerry
Operation Mode	:BE CH High	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E1 Plan		



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	-	-24.75	38.69	54.00	-15.31
2483.50	Peak	66.27	-2.83	63.44	74.00	-10.56

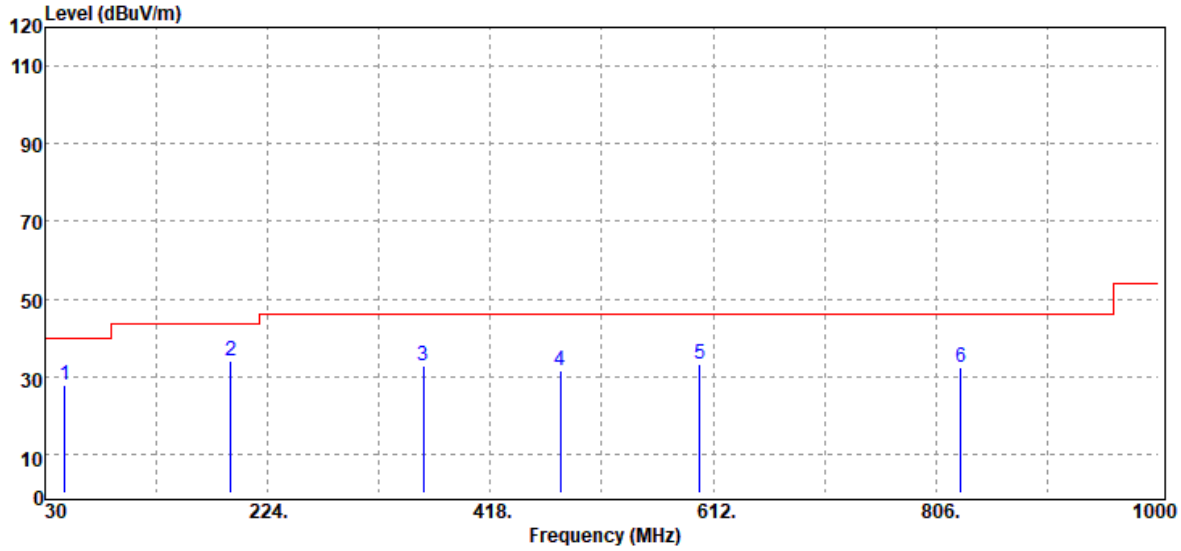
Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT EDR Hopping	Temp./Humi.	:20/51
Fundamental Frequency	:2480 MHz	Engineer	:Jerry
Operation Mode	:BE CH High	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E1 Plan		



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2483.50	Average	-	-24.75	37.62	54.00	-16.38
2483.50	Peak	65.20	-2.83	62.37	74.00	-11.63
2485.00	Average	-	-24.75	32.82	54.00	-21.18
2485.00	Peak	60.39	-2.82	57.57	74.00	-16.43

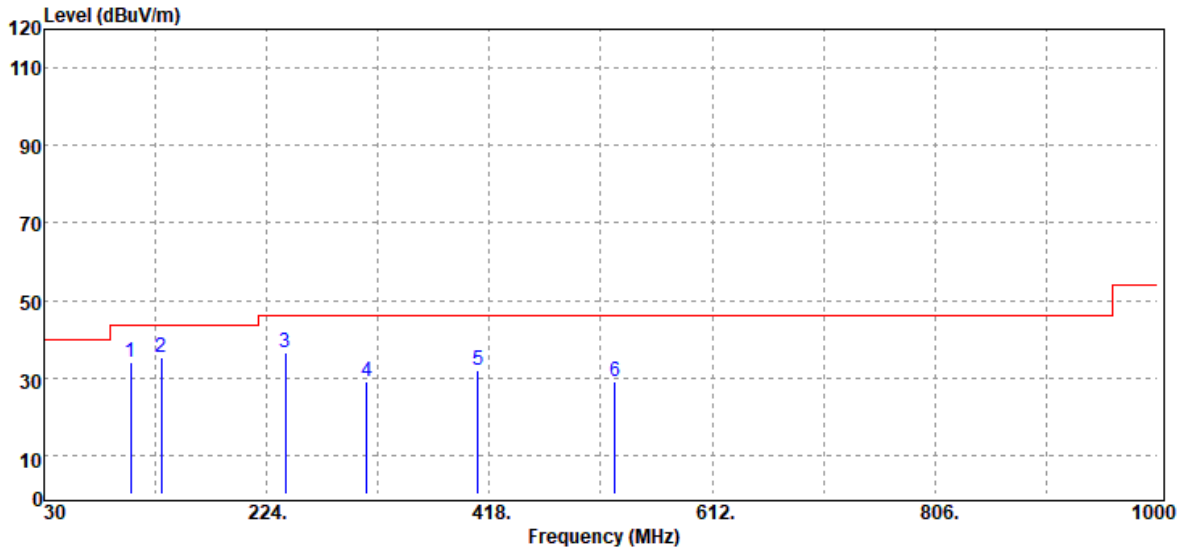
Radiated Spurious Emission Measurement Result:
Frequency from 30MHz to 1000MHz

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT EDR	Temp./Humi.	:20/51
Fundamental Frequency	:2441 MHz	Engineer	:Jerry
Operation Mode	:Tx CH Mid	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E1 Plan		



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
47.46	Peak	42.28	-14.26	28.02	40.00	-11.98
191.99	Peak	44.50	-10.55	33.95	43.50	-9.55
359.80	Peak	39.59	-6.59	33.00	46.00	-13.00
479.11	Peak	34.42	-2.98	31.44	46.00	-14.56
600.36	Peak	34.95	-1.65	33.30	46.00	-12.70
827.34	Peak	29.17	3.25	32.42	46.00	-13.58

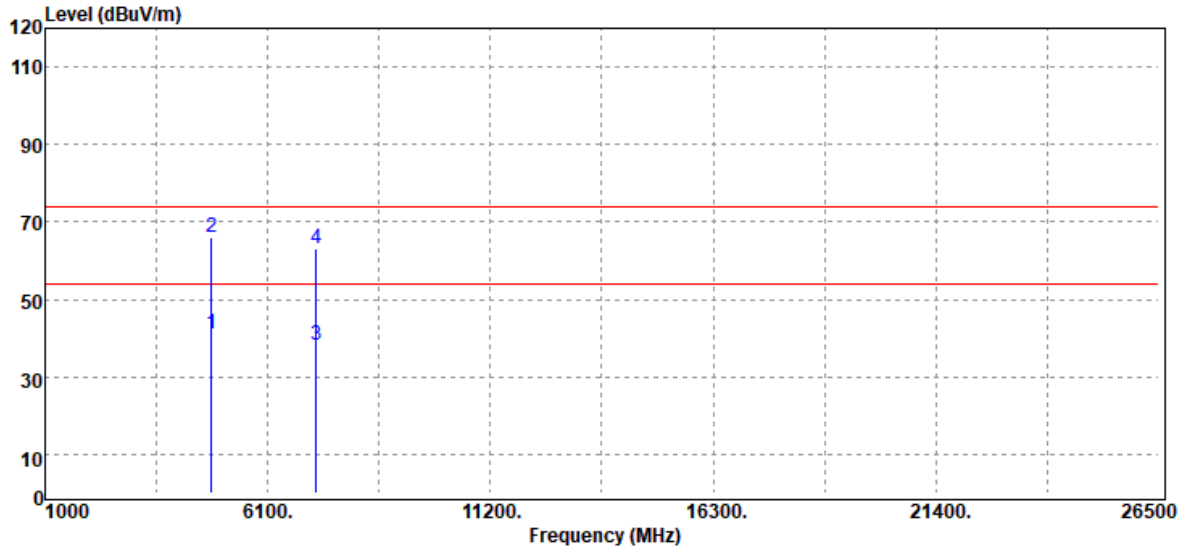
Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT EDR	Temp./Humi.	:20/51
Fundamental Frequency	:2441 MHz	Engineer	:Jerry
Operation Mode	:Tx CH Mid	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E1 Plan		



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
105.66	Peak	45.01	-11.02	33.99	43.50	-9.51
131.85	Peak	44.45	-9.12	35.33	43.50	-8.17
240.49	Peak	46.96	-10.25	36.71	46.00	-9.29
311.30	Peak	37.08	-7.86	29.22	46.00	-16.78
408.30	Peak	37.32	-5.28	32.04	46.00	-13.96
527.61	Peak	31.57	-2.38	29.19	46.00	-16.81

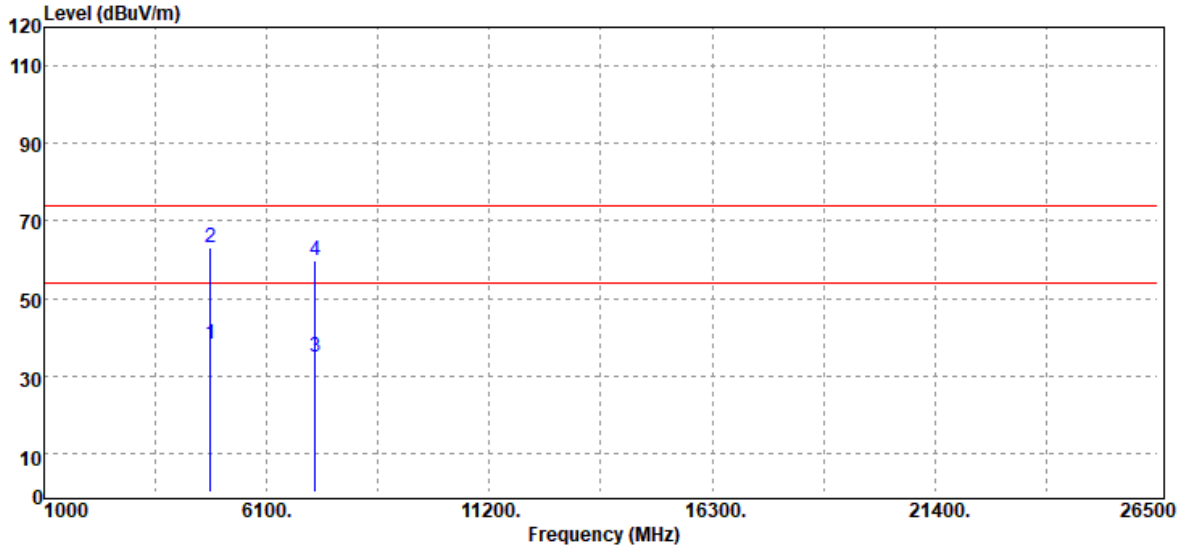
Frequency above 1000MHz

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT EDR	Temp./Humi.	:20/51
Fundamental Frequency	:2402 MHz	Engineer	:Jerry
Operation Mode	:Tx CH Low	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E1 Plan		



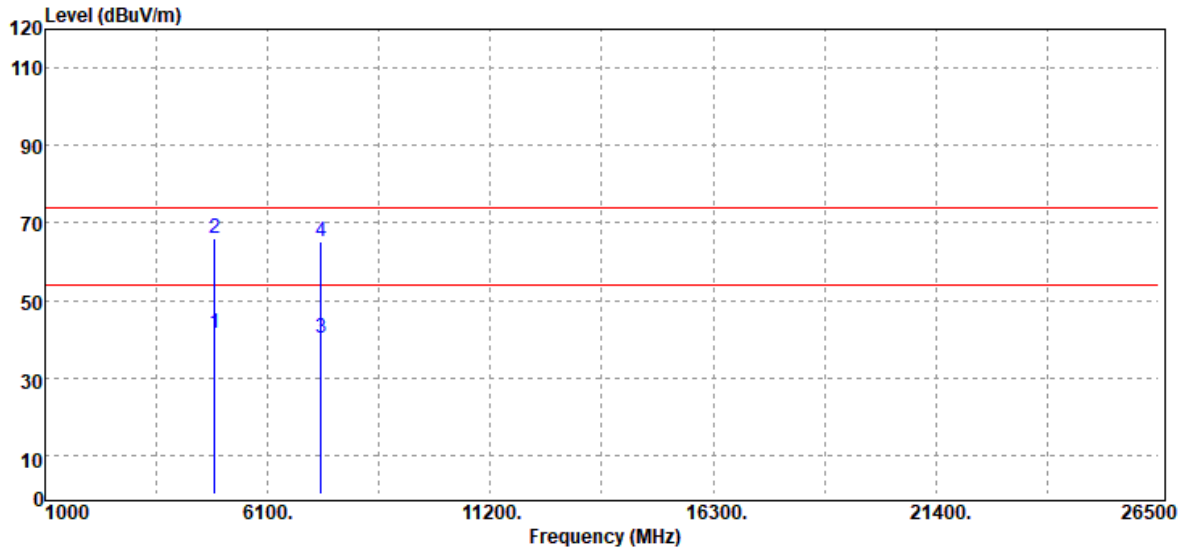
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4804.00	Average	-	-24.75	41.22	54.00	-12.78
4804.00	Peak	62.92	3.05	65.97	74.00	-8.03
7206.00	Average	-	-24.75	38.17	54.00	-15.83
7206.00	Peak	52.28	10.64	62.92	74.00	-11.08

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT EDR	Temp./Humi.	:20/51
Fundamental Frequency	:2402 MHz	Engineer	:Jerry
Operation Mode	:Tx CH Low	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E1 Plan		



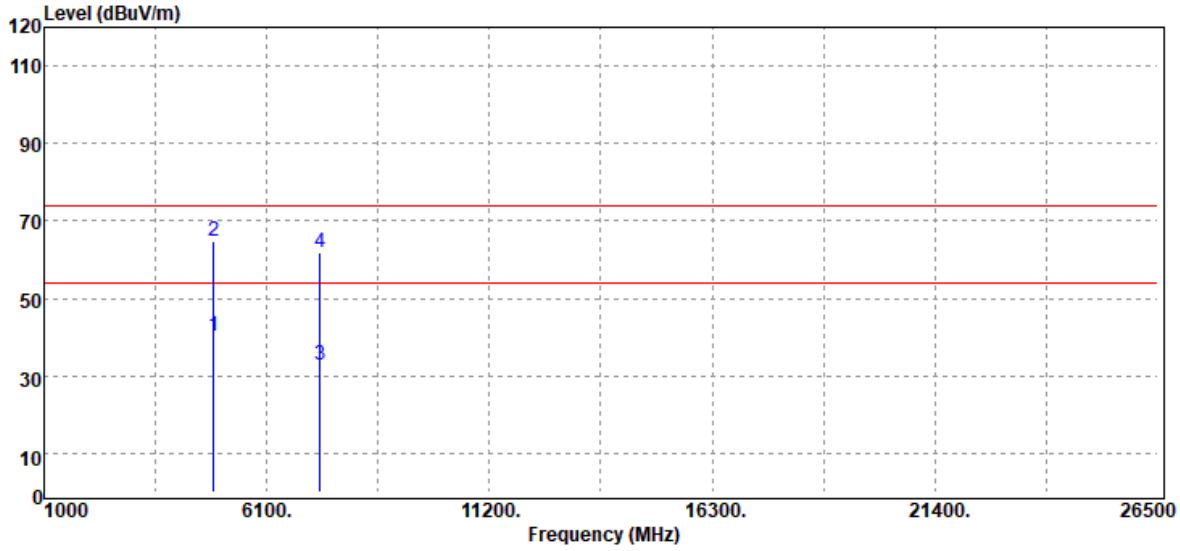
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4804.00	Average	-	-24.75	38.30	54.00	-15.70
4804.00	Peak	60.00	3.05	63.05	74.00	-10.95
7206.00	Average	-	-24.75	35.04	54.00	-18.96
7206.00	Peak	49.15	10.64	59.79	74.00	-14.21

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT EDR	Temp./Humi.	:20/51
Fundamental Frequency	:2441 MHz	Engineer	:Jerry
Operation Mode	:Tx CH Mid	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E1 Plan		



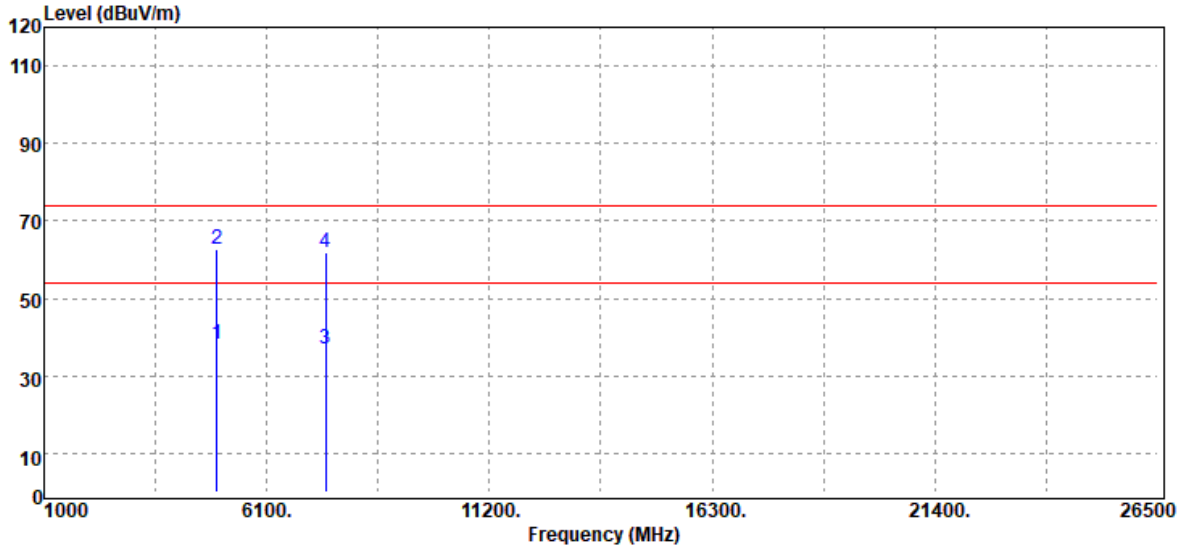
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4882.00	Average	-	-24.75	41.41	54.00	-12.59
4882.00	Peak	62.78	3.38	66.16	74.00	-7.84
7323.00	Average	-	-24.75	40.35	54.00	-13.65
7323.00	Peak	54.04	11.06	65.10	74.00	-8.90

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT EDR	Temp./Humi.	:20/51
Fundamental Frequency	:2441 MHz	Engineer	:Jerry
Operation Mode	:Tx CH Mid	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E1 Plan		



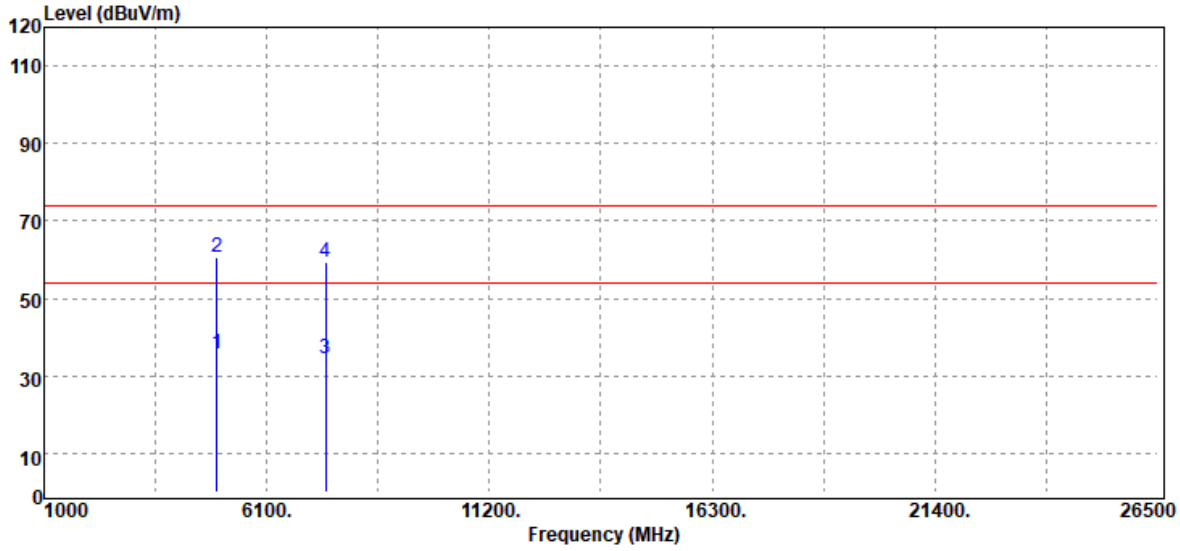
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4882.00	Average	-	-24.75	40.18	54.00	-13.82
4882.00	Peak	61.55	3.38	64.93	74.00	-9.07
7323.00	Average	-	-24.75	32.78	54.00	-21.22
7323.00	Peak	50.97	11.06	62.03	74.00	-11.97

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT EDR	Temp./Humi.	:20/51
Fundamental Frequency	:2480 MHz	Engineer	:Jerry
Operation Mode	:Tx CH High	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E1 Plan		



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4960.00	Average	-	-24.75	38.09	54.00	-15.91
4960.00	Peak	58.78	4.06	62.84	74.00	-11.16
7440.00	Average	-	-24.75	36.97	54.00	-17.03
7440.00	Peak	51.05	10.67	61.72	74.00	-12.28

Project Number	:T190313W05	Test Date	:2019-05-24
Operation Band	:BT EDR	Temp./Humi.	:20/51
Fundamental Frequency	:2480 MHz	Engineer	:Jerry
Operation Mode	:Tx CH High	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E1 Plan		



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4960.00	Average	-	-24.75	35.82	54.00	-18.18
4960.00	Peak	56.51	4.06	60.57	74.00	-13.43
7440.00	Average	-	-24.75	34.45	54.00	-19.55
7440.00	Peak	48.53	10.67	59.20	74.00	-14.80

11 FREQUENCY SEPARATION

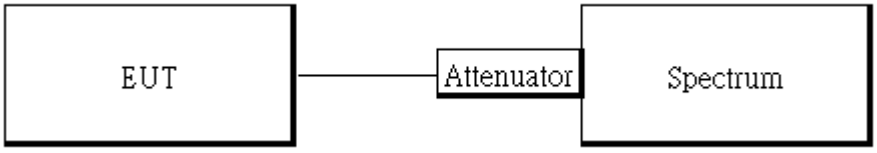
11.1 Standard Applicable

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

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	N9010A	MY53400256	11/21/2018	11/20/2019
DC Block	Mini-Circuits	BLK-18-S+	31129(1)	02/26/2019	02/25/2020

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

Frequency Separation Test Data

12 NUMBER OF HOPPING FREQUENCY

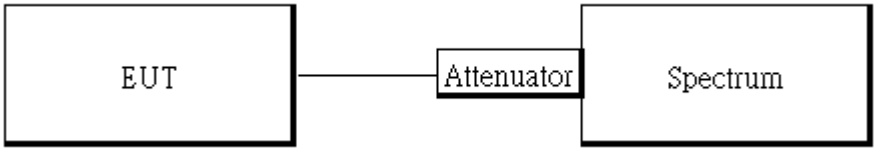
12.1 Standard Applicable

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

12.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	N9010A	MY53400256	11/21/2018	11/20/2019
DC Block	Mini-Circuits	BLK-18-S+	31129(1)	02/26/2019	02/25/2020

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.

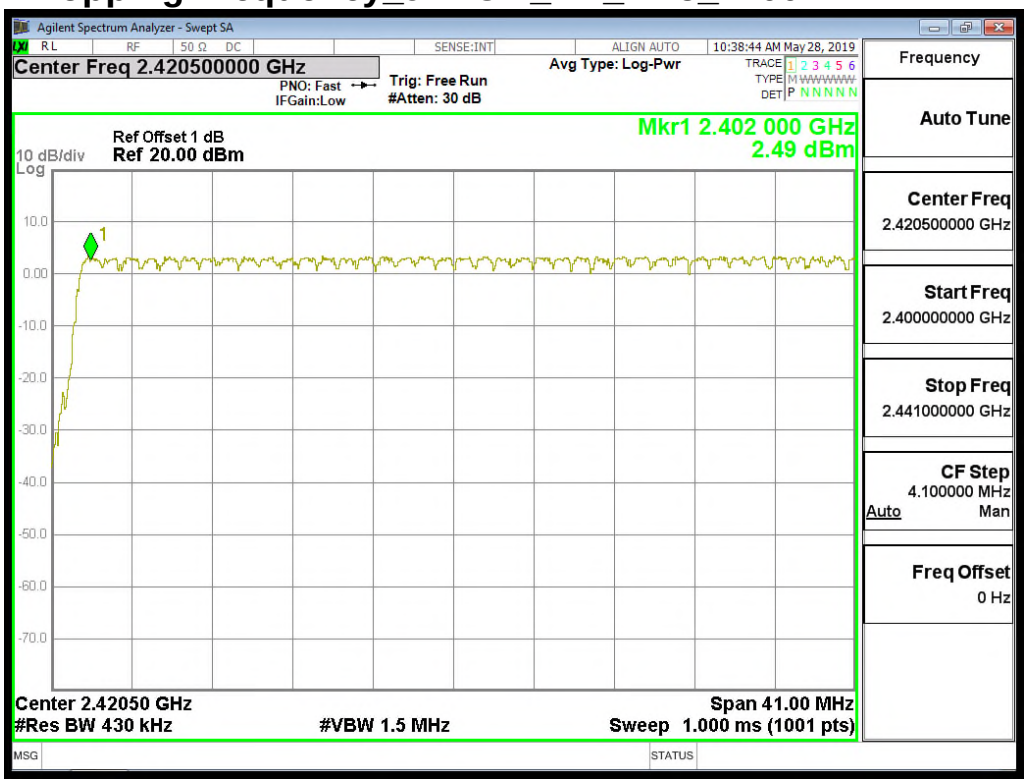
12.5 Measurement Result

Tabular Data of Total Channel Number

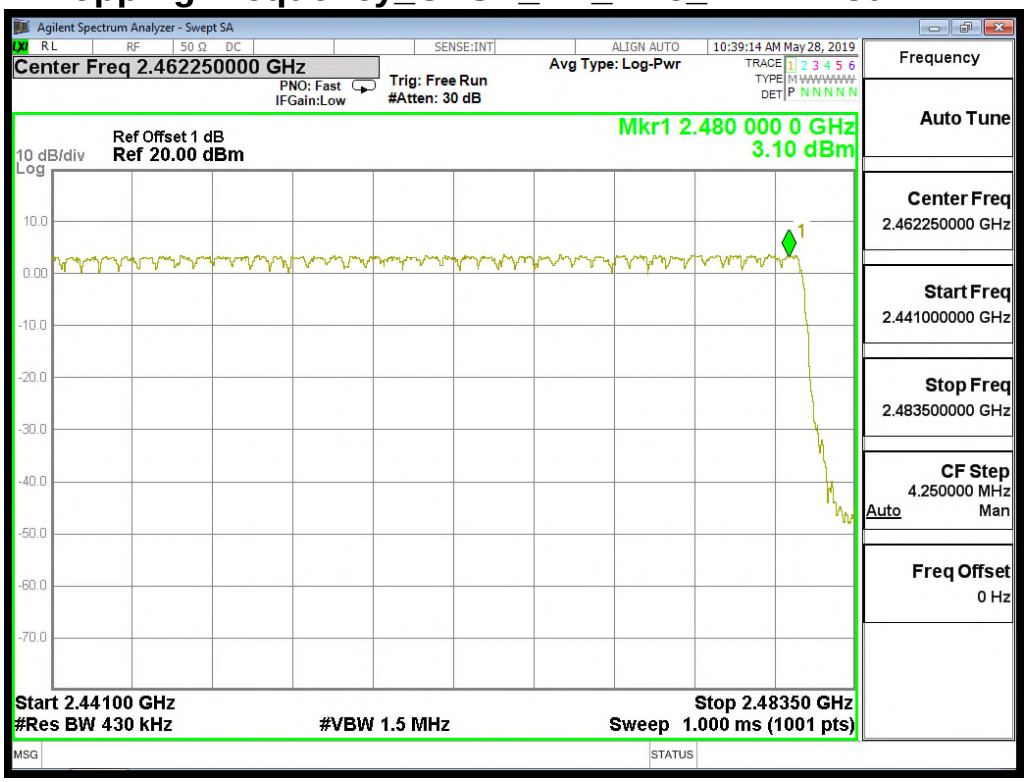
	Channel Number	Limit
2.4 GHz – 2.441 GHz	**40**	**>15**
2.441 GHz – 2.4835 GHz	**39**	
2.4 GHz ~2.4835 GHz	**(40+39) = 79**	

Channel Number

Hopping Frequency_8-DPSK _1M_DH5_2400-2441 MHz



Hopping Frequency_GFSK_1M_DH5_2441-2480 MHz



13 TIME OF OCCUPANCY (DWELL TIME)

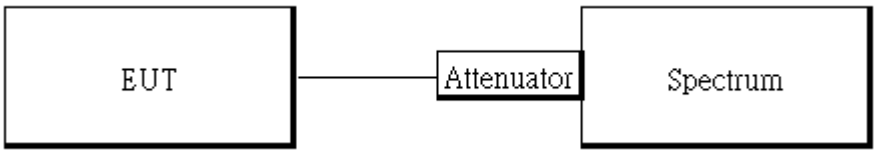
13.1 Standard Applicable

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

13.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	N9010A	MY53400256	11/21/2018	11/20/2019
DC Block	Mini-Circuits	BLK-18-S+	31129(1)	02/26/2019	02/25/2020

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	264.00	400ms	0.61	1.00
	DH5	308.80	400ms	0.35	1.00
High	DH1	123.20	400ms	2.60	3.00
	DH3	264.00	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	264.00	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	=	1.650 *	(1600/4/79)	*	31.6	=	264.00 (ms)
	DH5 time slot	=	2.895 *	(1600/6/79)	*	31.6	=	308.80 (ms)
CH High	DH1 time slot	=	0.385 *	(1600/2/79)	*	31.6	=	123.20 (ms)
	DH3 time slot	=	1.650 *	(1600/4/79)	*	31.6	=	264.00 (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	=	1.650 *	(1600/4/79)	*	31.6	=	264.00 (ms)
	2DH5 time slot	=	2.895 *	(1600/6/79)	*	31.6	=	308.80 (ms)

8-DPSK (3Mbps):

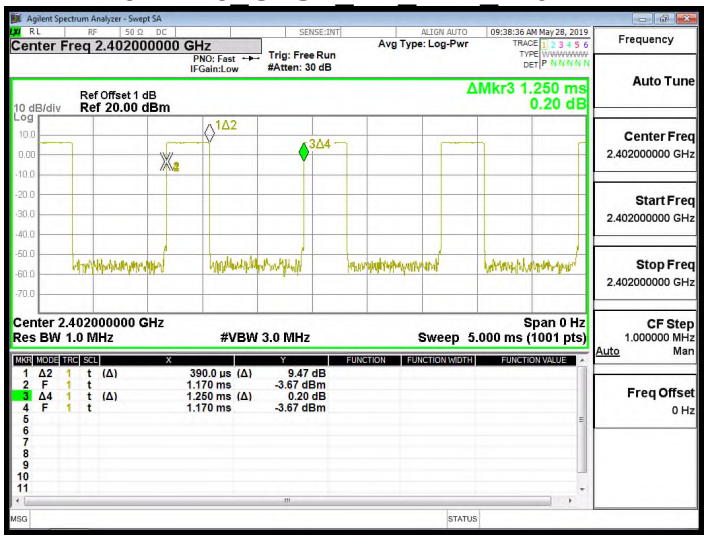
CH Mid	3DH1 time slot	=	0.395 *	(1600/2/79)	*	31.6	=	126.40 (ms)
	3DH3 time slot	=	1.650 *	(1600/4/79)	*	31.6	=	264.00 (ms)
	3DH5 time slot	=	2.895 *	(1600/6/79)	*	31.6	=	308.80 (ms)

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

13.6 Measurement Result

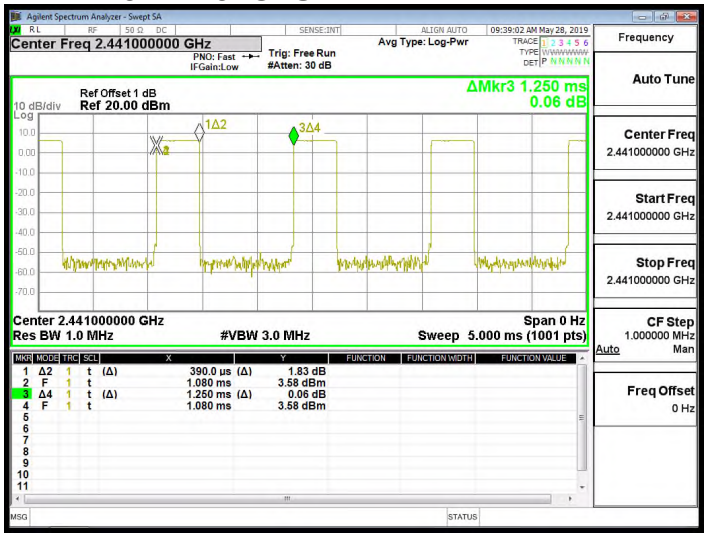
Note: Refer to next page for plots.

Dwell Time_GFSK_1M_DH1_2402MHz

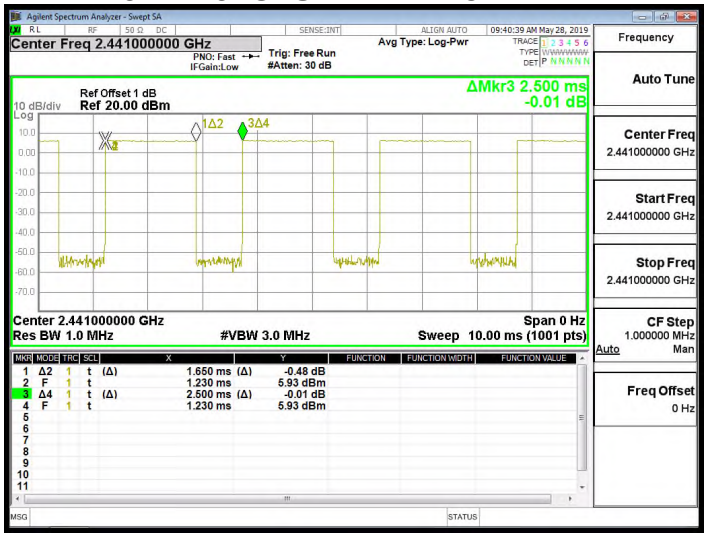


Dwell Time_GFSK_1M_DH3_2402MHz

Dwell Time_GFSK_1M_DH1_2441MHz

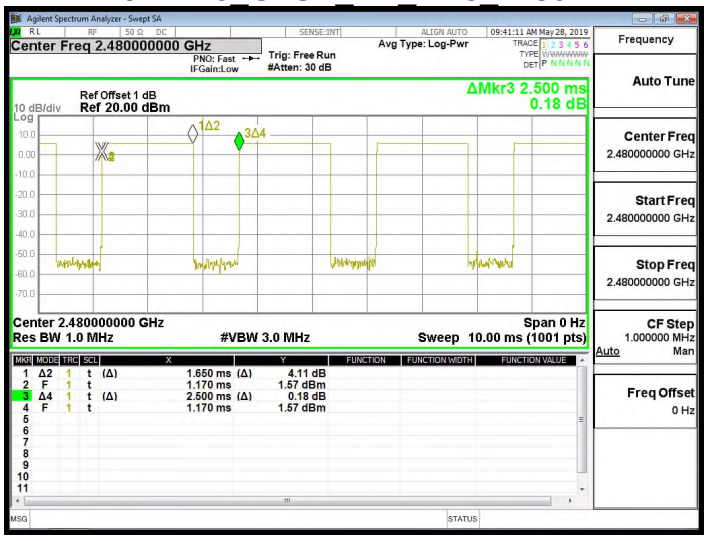


Dwell Time_GFSK_1M_DH3_2441MHz

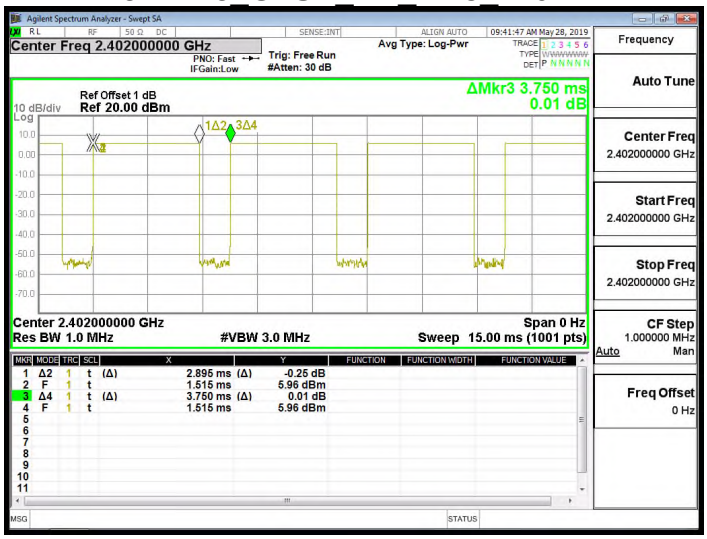


Dwell Time_GFSK_1M_DH1_2480MHz

Dwell Time_GFSK_1M_DH3_2480MHz



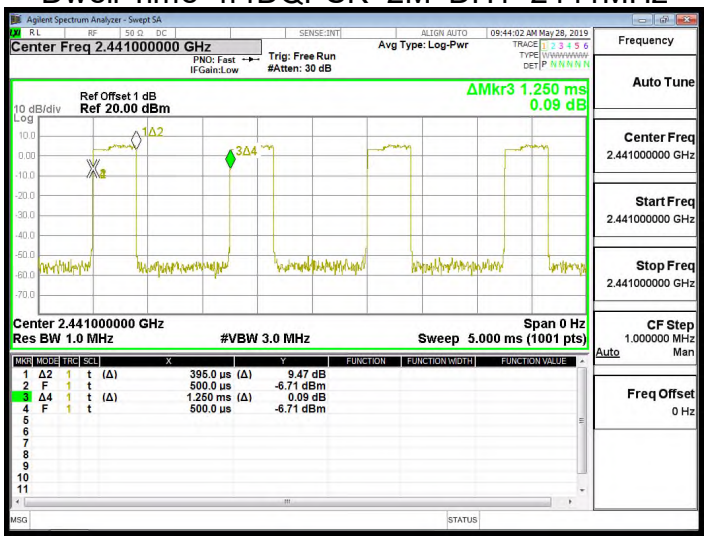
Dwell Time_GFSK_1M_DH5_2402MHz



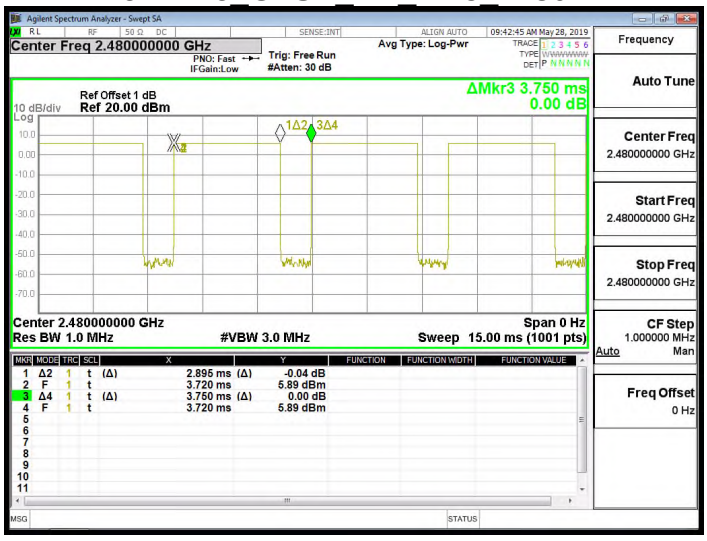
Dwell Time_π4DQPSK_2M_DH1_2402MHz

Dwell Time_GFSK_1M_DH5_2441MHz

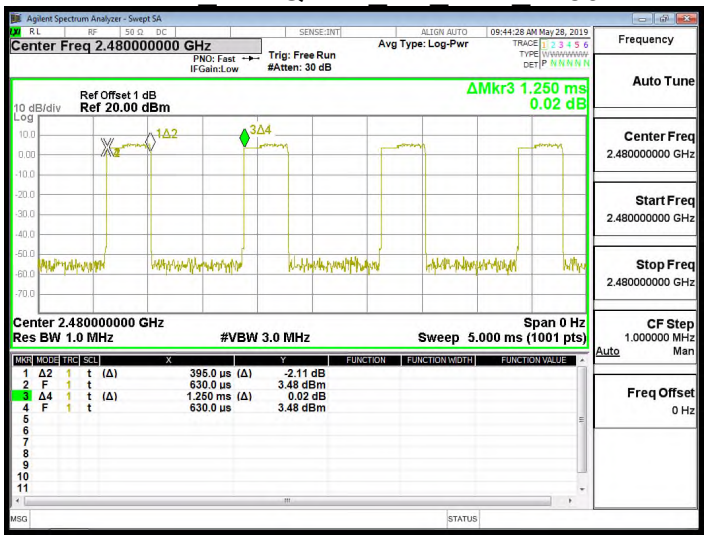
Dwell Time_π4DQPSK_2M_DH1_2441MHz



Dwell Time_GFSK_1M_DH5_2480MHz



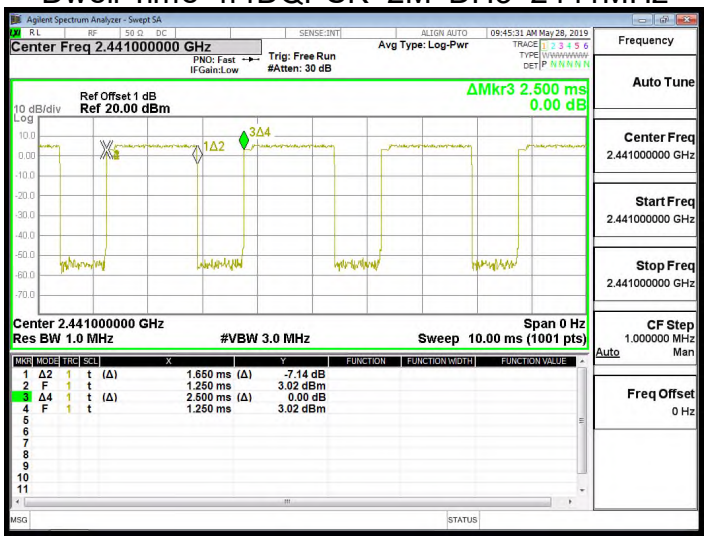
Dwell Time_π4DQPSK_2M_DH1_2480MHz



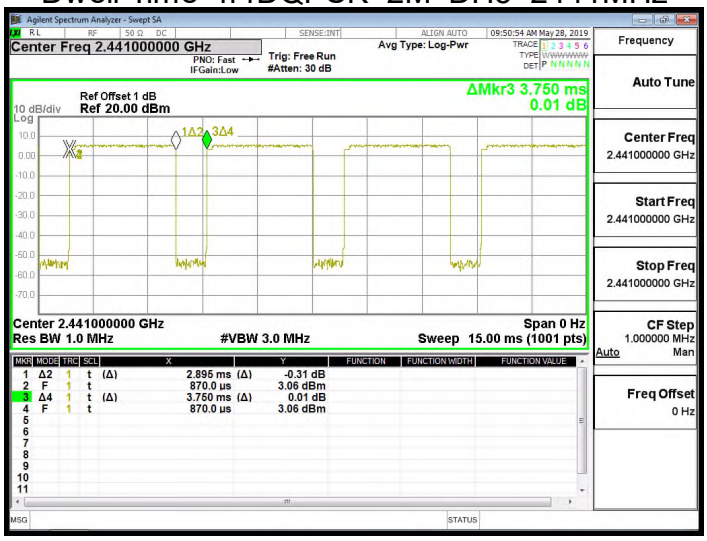
Dwell Time_π4DQPSK_2M_DH3_2402MHz

Dwell Time_π4DQPSK_2M_DH5_2402MHz

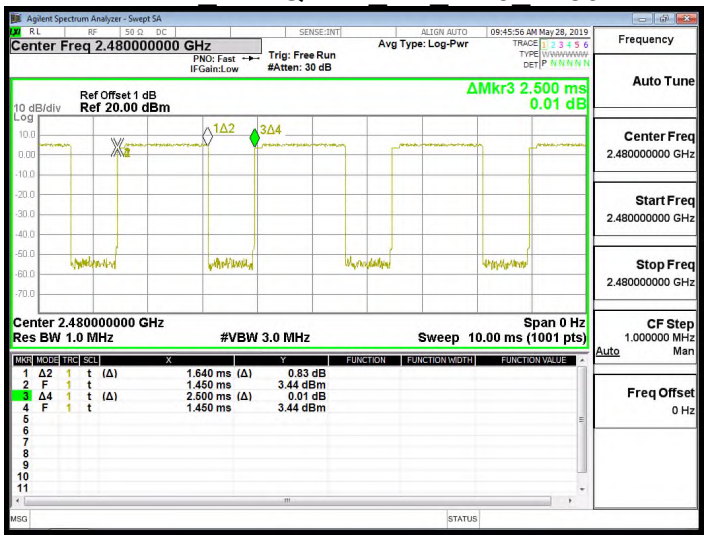
Dwell Time_π4DQPSK_2M_DH3_2441MHz



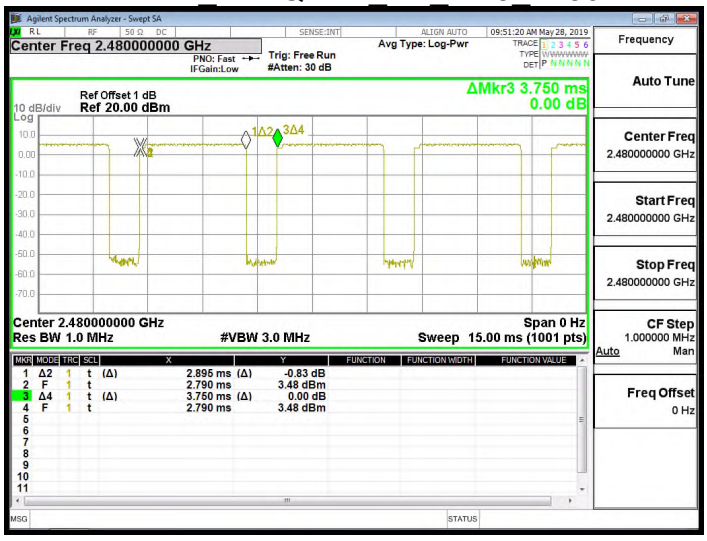
Dwell Time_π4DQPSK_2M_DH5_2441MHz



Dwell Time_π4DQPSK_2M_DH3_2480MHz



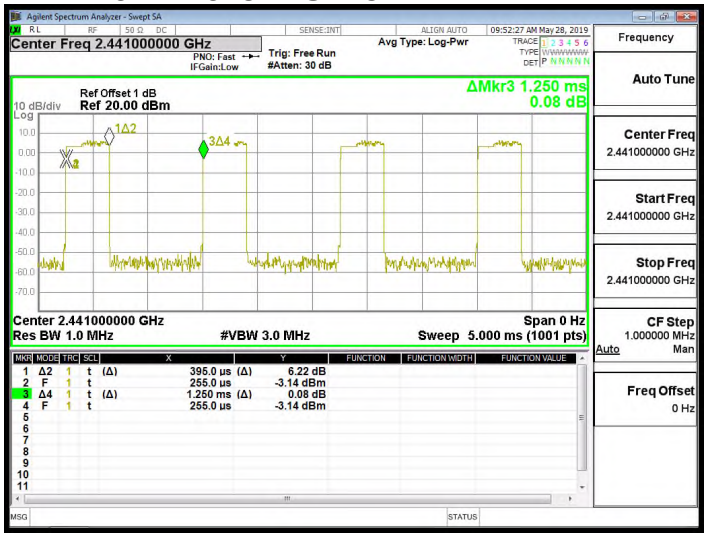
Dwell Time_π4DQPSK_2M_DH5_2480MHz



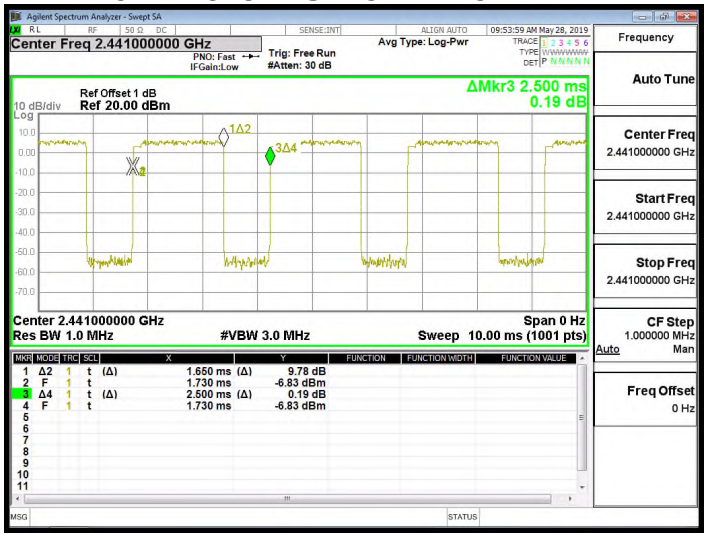
Dwell Time_8DPSK_3M_DH1_2402MHz

Dwell Time_8DPSK_3M_DH3_2402MHz

Dwell Time_8DPSK_3M_DH1_2441MHz

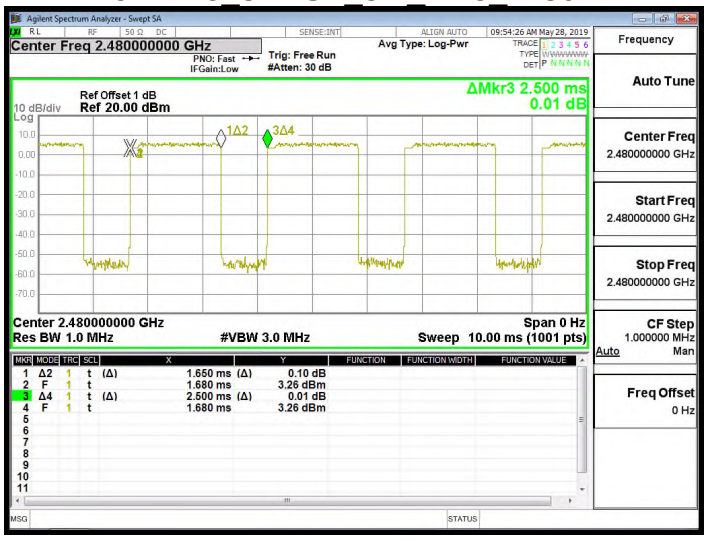


Dwell Time_8DPSK_3M_DH3_2441MHz

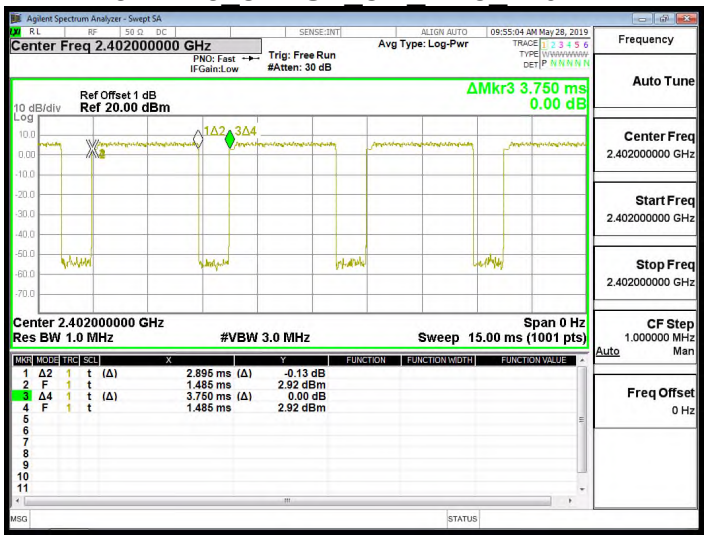


Dwell Time_8DPSK_3M_DH1_2480MHz

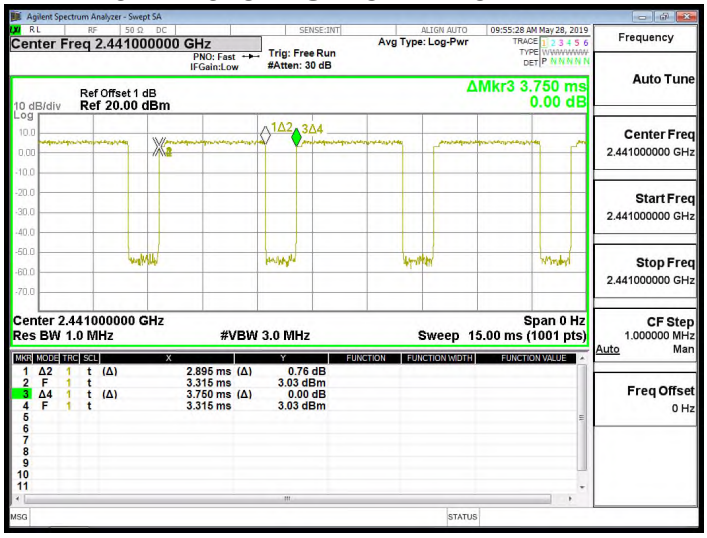
Dwell Time_8DPSK_3M_DH3_2480MHz



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 ~