ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

Applicant:	Qualcomm Technologies, Inc. 5775 Morehouse Drive, San Diego, CA 92121-1714, United States
Manufacturer:	Qualcomm Technologies, Inc. 5775 Morehouse Drive, San Diego, CA 92121-1714, United States
Product Name:	Tri-Radio LGA Module for IoT applications
Brand Name:	Qualcomm
Model No.:	QCC743M-0
Report Number:	TERF2411003329ER
FCC ID	J9C-QCC743M0
Date of EUT Received:	November 6, 2024
Date of Test:	November 6, 2024~November 29, 2024
Issue Date:	December 13, 2024

Approved By Paul Chiang

Paul Chiang

We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Central RF Lab The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2020 and the energy emitted by the sample EUT comply with FCC rule part §15.247.

The results of this report relate only to the sample identified in this report.

Revision History

Report Number	Revision	Description	Issue Date	Revised By	Remark
TERF2411003329ER	00	Original	December 5, 2024	Karen Huang	
TERF2411003329ER	01	Update Applicant's address	December 13, 2024	Karen Huang	*

Note:

1、 The remark "*" indicates modification of the report upon requests from certification body.

2、 Variant information of HW SKU is provided by the applicant, test results of this report are applicable to the sample EUT(s) received.
And are assessed as electrically identical in RF characteristics, therefore, no further assessment required for the variant(s).

Contents

1 GENERAL INFORMATION

1.1 Product Description

Product Name:	Tri-Radio LGA Module for IoT applications
Brand Name:	Qualcomm
Model No.:	QCC743M-0
HW SKU:	QCC743M-0U, QCC743M-0B
Hardware Version:	N/A
Firmware Version:	N/A
EUT Series No.:	02B221846S00C8
Power Supply:	3.3Vdc
Test Software (Name/Version)	QConn_RCT 1.8.9

1.2 RF Specification

Radio Technology:	BT BR+EDR
Channel number:	79 channels
Modulation type:	GFSK + π/4DQPSK + 8DPSK
Transmit Power:	12.62dBm
Frequency Range:	2.402GHz – 2.480GHz
Dwell Time:	≦ 0.4s

1.3 HW SKU Difference Table:

HW SKU	Antenna Type	Impedance
QCC743M-0U	3 types: PIFA, Monopole, Dipole	C21=1.86pF, C20=1.89pF
QCC743M-0B	1 type: PCB	C21=1.52pF, C20=2.05pF

1.4 Antenna Designation

Antenna Type	Antenna Part No.	Freq.	Peak Antenna Gain (dBi)
PCB Antenna	RFIQM0743010NB001	2.4GHz	1.89
PIFA Antenna	RFPCA441010EMABY01		3.19
Dipole Antenna	RFPCA521010EMABY01		3.37
Monopole Antenna	RFPCA501010EMABY01		3.12

Note:

1. Pre-scanned was done on the above antennas, measurements were demonstrated by using the antenna with the highest gain as the worst case scenarios.
2. Antenna information is provided by the applicant.

1.5 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247
FCC KDB 558074 D01 15.247 Meas. Guidance v05r02
ANSI C63.10:2020

1.6 Test Facility

Laboratory	Test Site Address	Test Site Name	FCC Designation number	IC CAB identifier
SGS Taiwan Ltd. Central RF Lab. (TAF code 3702)	No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan.	SAC 1	TW0027	TW3702
		SAC 2		
		SAC 3		
		Conduction 1		
		Conducted 1		
		Conducted 2		
		Conducted 3		
		Conducted 4		
		Conducted 5		
		Conducted 6		
	No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333	Conduction C	TW0028	
		SAC C		
		SAC D		
		SAC G		
		Conducted A		
		Conducted B		
		Conducted C		
		Conducted D		
		Conducted E		
		Conducted F		
		Conducted G		

Note: Test site name is remarked on the equipment list in each section of this report as an indication where measurements occurred in specific test site and address.

1.7 Special Accessories

There is no special accessory used while test was conducted.

1.8 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. 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

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

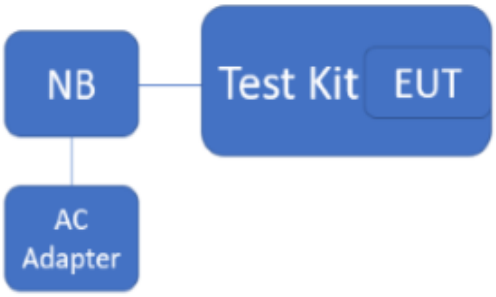
Radiated emission below 30MHz is measured in a 9m*6m*6m semi-ane choic chamber, the measurements correspond to those obtained at an open-field test site.
There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

2.4.2 For all conducted test items:

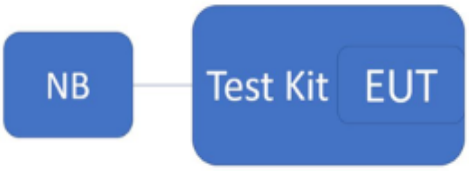
The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

2.5 Test Configuration

Conduction Setup



Conducted Setup



Radiated Setup

2.6 Control Unit(s)

AC Power-Line Conducted Emission Test Site: Conduction 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
AC Adapter	HP	TPN-LA16	N/A	N/A	N/A
Notebook	HP	HSN-Q35C-4	5CD238GDV5	N/A	N/A
Type-C to USB Cable	Xiaomi	SJX10ZM	N/A	N/A	N/A
QCC74X Module Development Kit Board	Walsin	QCC743-DVK	N/A	N/A	N/A

Conducted Emission Test Site: Conducted 2					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
Notebook	HP	HSN-Q35C-4	5CD238GDV5	N/A	N/A
Type-C to USB Cable	Xiaomi	SJX10ZM	N/A	N/A	N/A
QCC74X Module Development Kit Board	Walsin	QCC743-DVK	N/A	N/A	N/A

Radiated Emission Test Site: SAC 3					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Notebook	HP	HSN-Q35C-4	5CD238GDV5	N/A	N/A
Type-C to USB Cable	Xiaomi	SJX10ZM	N/A	N/A	N/A
QCC74X Module Development Kit Board	Walsin	QCC743-DVK	N/A	N/A	N/A

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)	Emission Bandwidth	Compliant
§15.247(d) §15.209	Conducted Band Edge and Spurious Emission	Compliant
§15.247(d) §15.209	Radiated Spurious Emission	Compliant
§15.205	Restricted Bands	Compliant
§15.247(a)(1)	Frequency Separation	Compliant
§15.247(a)(1)(iii)	Number of hopping frequency Time of Occupancy	Compliant
§15.203	Antenna Requirement	Compliant

4 DESCRIPTION OF TEST MODES

4.1 Operated in 2400 ~ 2483.5MHz Band

2400~2483.5 MHz							
CH	Freq. (MHz)	CH	Freq. (MHz)	CH	Freq. (MHz)	CH	Freq. (MHz)
0	2402	20	2422	40	2442	60	2462
1	2403	21	2423	41	2443	61	2463
2	2404	22	2424	42	2444	62	2464
3	2405	23	2425	43	2445	63	2465
4	2406	24	2426	44	2446	64	2466
5	2407	25	2427	45	2447	65	2467
6	2408	26	2428	46	2448	66	2468
7	2409	27	2429	47	2449	67	2469
8	2410	28	2430	48	2450	68	2470
9	2411	29	2431	49	2451	69	2471
10	2412	30	2432	50	2452	70	2472
11	2413	31	2433	51	2453	71	2473
12	2414	32	2434	52	2454	72	2474
13	2415	33	2435	53	2455	73	2475
14	2416	34	2436	54	2456	74	2476
15	2417	35	2437	55	2457	75	2477
16	2418	36	2438	56	2458	76	2478
17	2419	37	2439	57	2459	77	2479
18	2420	38	2440	58	2460	78	2480
19	2421	39	2441	59	2461		

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.

ANTNNA PORT CONDUCTED TEST				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	PACKET TYPE
Peak Output Power, 20dB Band Width, Spurious Emission				
Bluetooth	0 to 78	0,39,78	GFSK	DH5
	0 to 78	0,39,78	π/4-DQPSK	2DH5
	0 to 78	0,39,78	8-DPSK	3DH5
Band Edge				
Bluetooth	0 to 78	0,78	GFSK/8-DPSK	DH5/3DH5
Frequency Separation				
Bluetooth	0 to 78	0,1,2, 38,39,40, 76,77,78	GFSK	DH5
			π/4-DQPSK	2DH5
			8-DPSK	3DH5
Number of Hopping Frequency, Hopping Band edge				
Bluetooth	0 to 78	0 to 78	GFSK/8-DPSK	DH5/3DH5
Time of Occupancy(Dwell time)				
Bluetooth	0 to 78	39	GFSK	DH1/DH3/DH5
			π/4-DQPSK	2DH1/2DH3/2DH5
			8-DPSK	3DH1/3DH3/3DH5
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	PACKET TYPE
TRANSMIT EMISSION TEST (BELOW 1 GHz)				
Bluetooth	0 to 78	39	8-DPSK	3DH5
TRANSMIT EMISSION TEST (ABOVE 1 GHz)				
Bluetooth	0 to 78	0,39,78	GFSK/8-DPSK	DH5/3DH5

Note:
1. The field strength of radiation emission was measured as EUT stand-up position (H mode) and lie down position (E1, E2 mode) for channel Low, Mid and High, the worst case position was reported.
2. Radiated test was done with 50ohm terminator on antenna port.

5 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty		
AC Power Line Conducted Emission	+/-	1.54	dB
Output Power measurement	+/-	0.97	dB
Emission Bandwidth	+/-	1.38	Hz
Conducted emission measurement	+/-	0.77	dB
Frequency Separation	+/-	1.48	Hz
Number of hopping frequency	+/-	1.48	Hz
Time of Occupancy	+/-	1.48	Hz
Temperature	+/-	0.6	°C
Humidity	+/-	3	%
DC / AC Power Source	+/-	1	%

Radiated Spurious Emission Measurement Uncertainty				
Polarization: Vertical	**+/-**	**1.89**	**dB**	9kHz~30MHz
	+/-	**4.15**	**dB**	30MHz - 1000MHz
	+/-	**3.43**	**dB**	1GHz - 18GHz
	+/-	**3.86**	**dB**	18GHz - 40GHz
Polarization: Horizontal	**+/-**	**1.89**	**dB**	9kHz~30MHz
	+/-	**4.02**	**dB**	30MHz - 1000MHz
	+/-	**3.43**	**dB**	1GHz - 18GHz
	+/-	**3.86**	**dB**	18GHz - 40GHz
Radiated Spurious Emission	**+/-**	**2**	**dB**	33GHz-50GHz
	+/-	**1.59**	**dB**	50GHz-60GHz
	+/-	**1.7**	**dB**	60GHz-90GHz
	+/-	**1.64**	**dB**	90GHz-140GHz
	+/-	**3.83**	**dB**	140GHz-220GHz

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 MEASUREMENT EQUIPMENT USED

6.1 Emission from AC power line

AC Power-Line Conducted Emission Test Site: Conduction 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Coaxial Cables	EMC Instruments Corp.	EMCCFD300-BM-BM-3000	161207	06/22/2024	06/21/2025
EMI Test Receiver	R&S	ESCI 7	100759	08/28/2024	08/27/2025
LISN	SCHWARZBECK	NSLK 8127	1040	09/07/2024	09/06/2025
Pulse Limiter	SCHWARZBECK	VTSD 9561F-N	793	06/22/2024	06/21/2025
Test Software	Audix	e3	Ver. 9.210616	N.C.R	N.C.R

6.2 Conducted Measurement

Conducted Emission Test Site: Conducted 2					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
Attenuator	Mini-Circuits	BW-S10W2+	6	12/12/2023	12/11/2024
DC Block	Mini-Circuits	BLK-18-S+	31129	12/12/2023	12/11/2024
EXA Spectrum Analyzer	KEYSIGHT	N9010B	MY59071541	07/08/2024	07/07/2025
Power Meter	Anritsu	ML2496A	2132007	09/23/2024	09/22/2025
Power Sensor	Anritsu	MA2411B	1911391	09/23/2024	09/22/2025
Power Sensor	Anritsu	MA2411B	1911392	09/23/2024	09/22/2025
Test Software	SGS	Radio Test Software	Ver. 21	N.C.R	N.C.R

6.3 Radiated Measurement

Radiated Emission Test Site: SAC 3					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
4G High Pass Filter	WI	WHKX4.0	22	12/12/2023	12/11/2024
Attenuator	Mini-Circuits	BW-S10W2+	16	12/12/2023	12/11/2024
Band Reject Filter 2400-2483.5	EWT	EWT-54-0038	M2	12/12/2023	12/11/2024
Bi-log Antenna	SCHWARZBECK	VULB9168	378	08/09/2024	08/08/2025
Coaxial Cables	EMCI+Huber Suhner	EMC107-SM-SM-1000 +SUCOFLEX 104PEA +EMC107-SM-SM-1500 +SUCOFLEX 106	RX Cable 9K-18G (221110+MY4251/4 PEA+221106+76096 /6)	08/30/2024	08/29/2025
Coaxial Cables	Huber Suhner	SUCOFLEX 102	RX Cable 18G-40G MY2630/2+805062/ 2	08/30/2024	08/29/2025
EMI Test Receiver	R&S	ESCI 7	100759	08/28/2024	08/27/2025
EXA Spectrum Analyzer	KEYSIGHT	N9010B	MY63440386	02/06/2024	02/05/2025
Horn Antenna	RF SPIN	DRH0844	LE2D05A0844	07/10/2024	07/09/2025
Horn Antenna	SCHWARZBECK	BBHA9120D	1441	09/23/2024	09/22/2025
Loop Antenna	COM-POWER	AL-130R	10160104	12/04/2023	12/03/2024
Pre-Amplifier	EMCI	EMC118A45SEE	980868	08/30/2024	08/29/2025
Pre-Amplifier	EMCI	EMC184045SEE	9080939	08/30/2024	08/29/2025
Pre-Amplifier	HP	8447D	2944A07676	08/30/2024	08/29/2025
Site Cal	SGS	SAC 3	N/A	08/30/2024	08/29/2025
SMA Termination	RF Microwave WOKEN	WTER-18S2	N/A	N/A	N/A
Test Software	Audix	e3	Ver. 9.210616	N.C.R	N.C.R

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

7 CONDUCTED EMISSION TEST

7.1 Standard Applicable

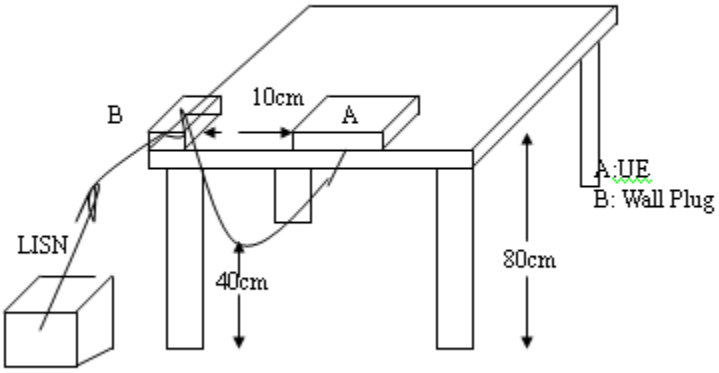
Frequency within 150 kHz to 30MHz shall not exceed the limit table as below.

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.		

7.2 EUT Setup:

1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI C63.10:2020.
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.

7.3 Test Setup



7.4 Measurement Procedure

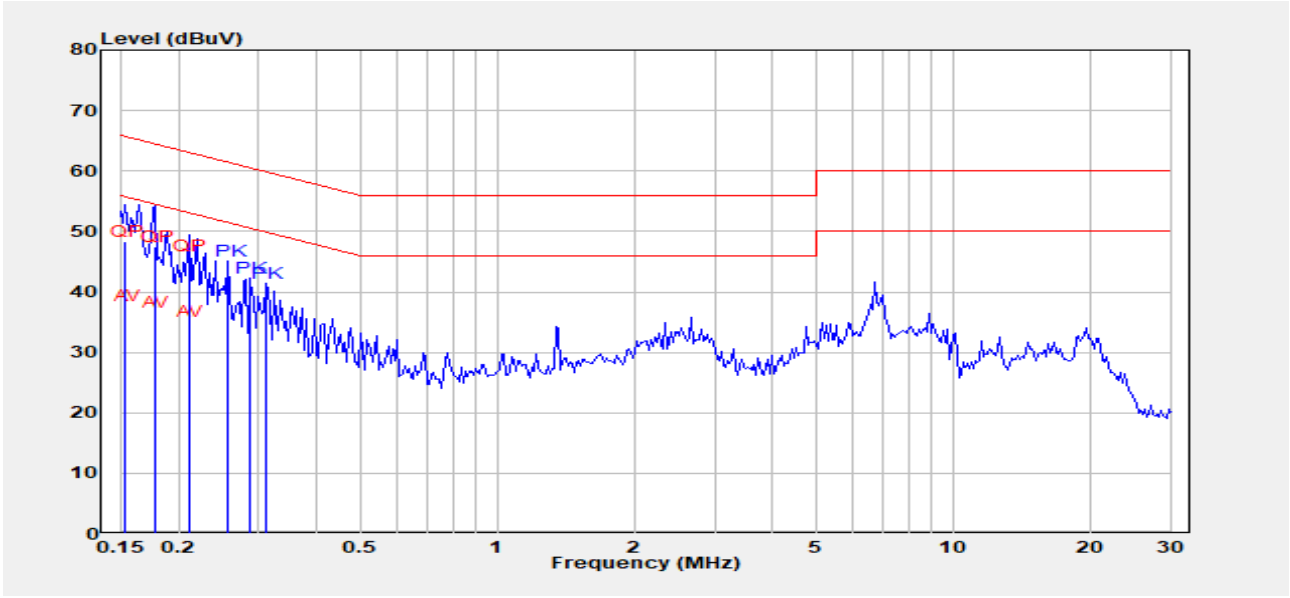
1. The EUT was placed on a table which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured were complete.

7.5 Measurement Result

Note: Refer to next page for measurement data and plots.
Note2: The * reveals the worst-case results that closest to the limit.

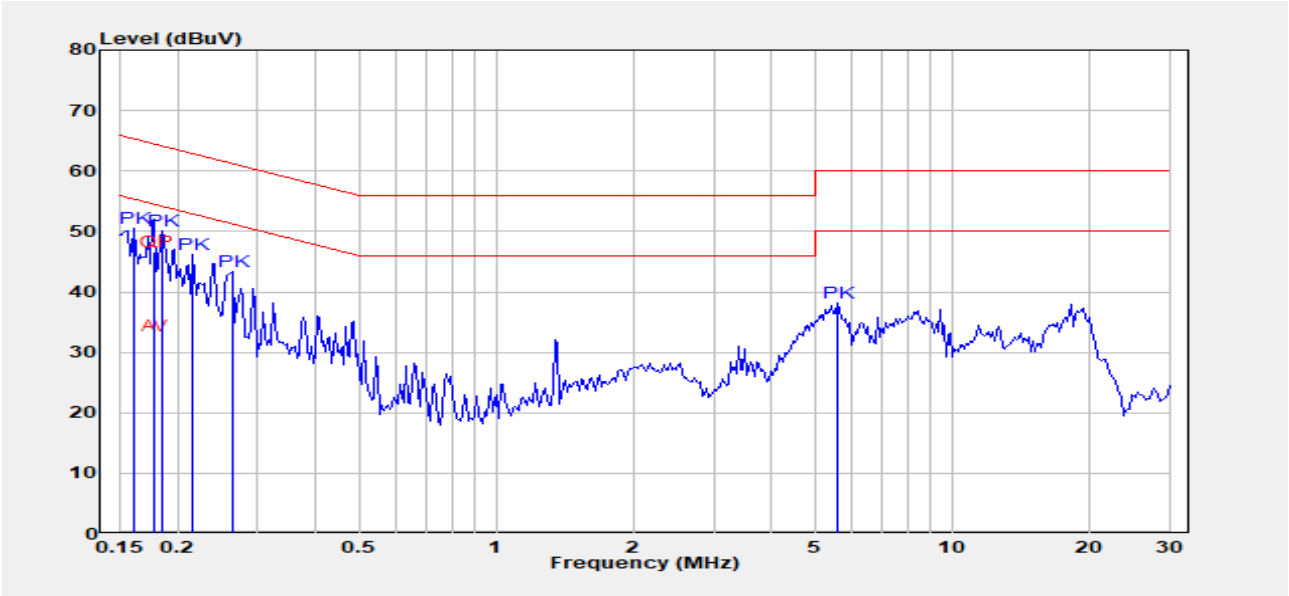
AC POWER LINE CONDUCTED EMISSION TEST DATA

Report Number	:TERF2411003329ER	Test Site	:Conduction 1
Operation Mode	:BT	Test Date	:2024-11-18
Power	:120V/60Hz	Temp./Humi.	:25.5℃/62%
Probe	:L	Engineer	:Nick Lin
Note:	:		



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV	dBµV	dB
0.153	Average	27.58	10.13	37.71	55.82	-18.11
0.153	QP	38.27	10.13	48.40	65.82	-17.42
0.178	Average	26.47	10.13	36.60	54.59	-17.99
0.178	QP	37.42	10.13	47.55	64.59	-17.04
0.211	Average	25.02	10.13	35.15	53.18	-18.03
0.211	QP	35.89	10.13	46.02	63.18	-17.16
0.258	Peak	35.00	10.14	45.14	61.51	-16.37
0.286	Peak	32.21	10.14	42.35	60.63	-18.28
0.312	Peak	31.27	10.14	41.42	59.93	-18.51

Report Number	:TERF2411003329ER	Test Site	:Conduction 1
Operation Mode	:BT	Test Date	:2024-11-18
Power	:120V/60Hz	Temp./Humi.	:25.5℃/62%
Probe	:N	Engineer	:Nick Lin
Note:	:		



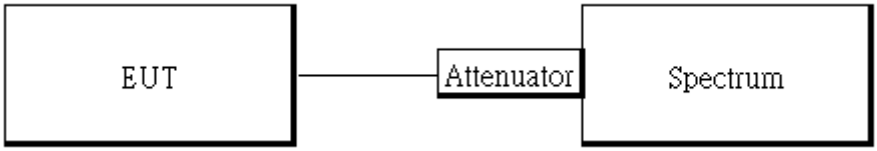
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV	dBµV	dB
0.160	Peak	40.50	10.12	50.62	65.47	-14.85
0.178	Average	22.58	10.12	32.70	54.59	-21.89
0.178	QP	36.58	10.12	46.70	64.59	-17.89
0.185	Peak	39.96	10.12	50.08	64.24	-14.16
0.215	Peak	35.97	10.12	46.10	63.01	-16.91
0.263	Peak	33.25	10.13	43.39	61.34	-17.95
5.623	Peak	27.74	10.36	38.11	60.00	-21.89

8 FREQUENCY SEPARATION

8.1 Standard Applicable

Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

8.2 Test Setup



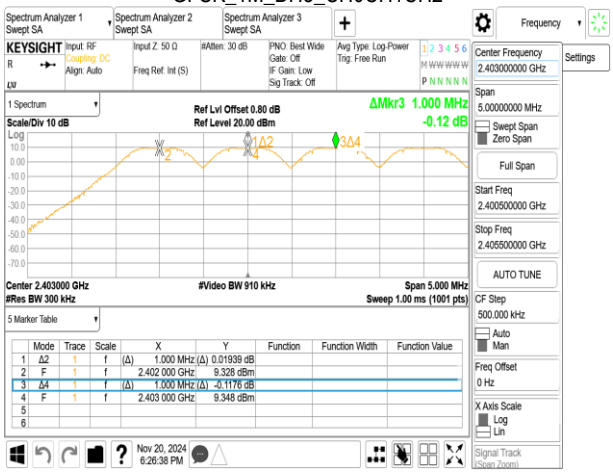
8.3 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2020.
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 RBW approximately 30% of the channel spacing, VBW ≥ RBW.
6. Adjust Span to Wide enough to capture the peaks of two adjacent channels.
7. Sweep = auto.
8. Max hold. Mark 3 Peaks of hopping channel and record the 3 peaks frequency.

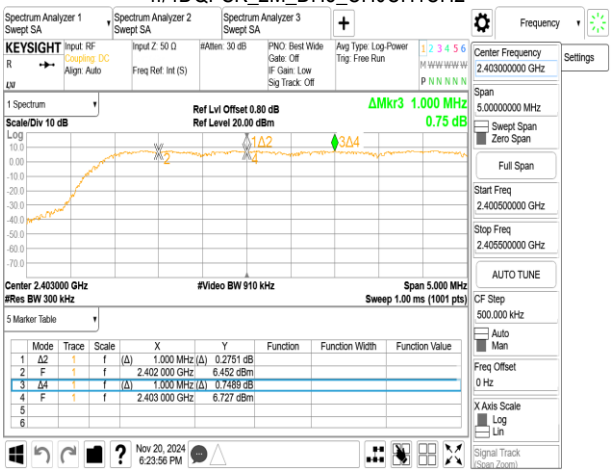
8.4 Measurement Result

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

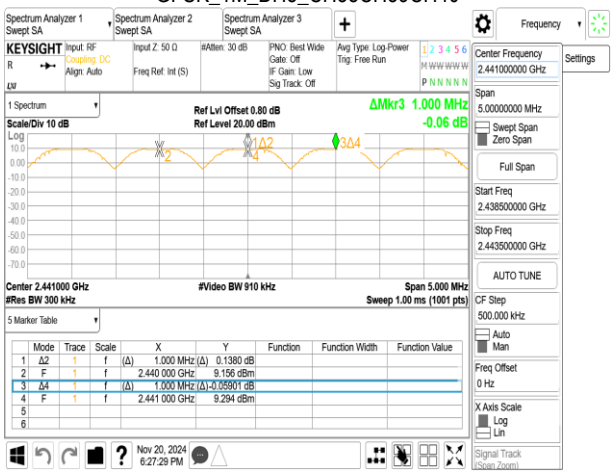
GFSK_1M_DH5_CH0CH1CH2



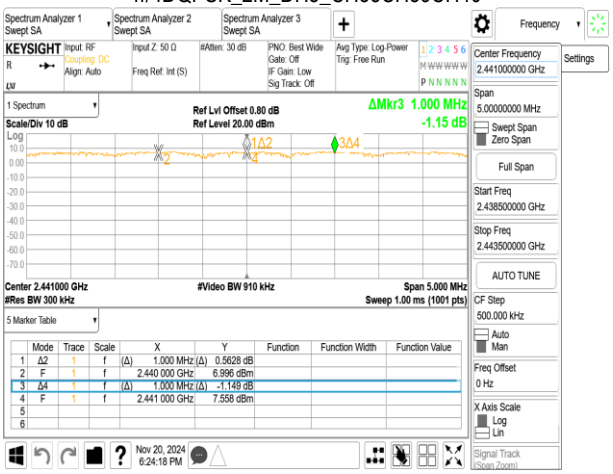
π/4DQPSK_2M_DH5_CH0CH1CH2



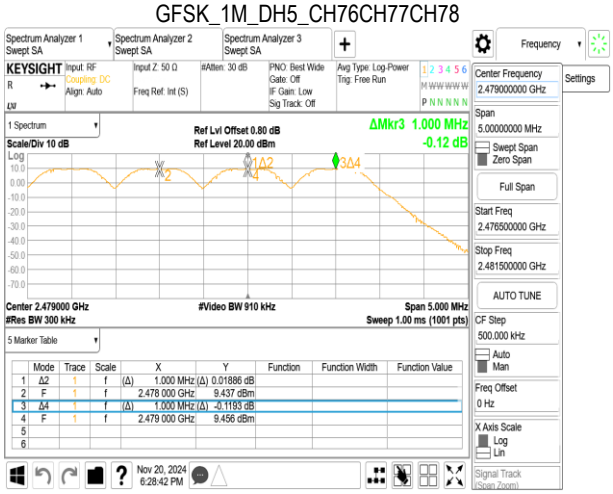
GFSK_1M_DH5_CH38CH39CH40



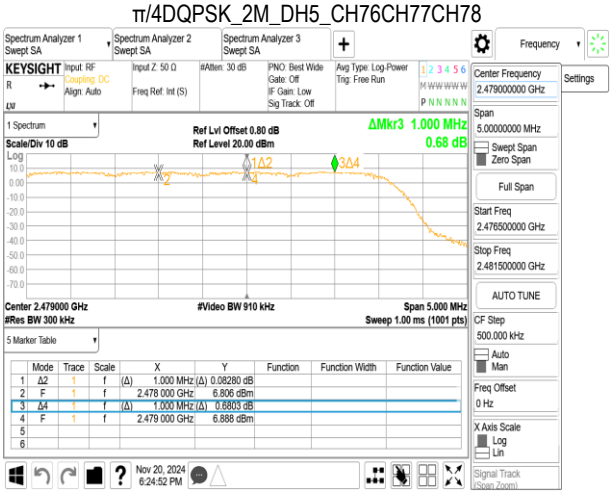
π/4DQPSK_2M_DH5_CH38CH39CH40



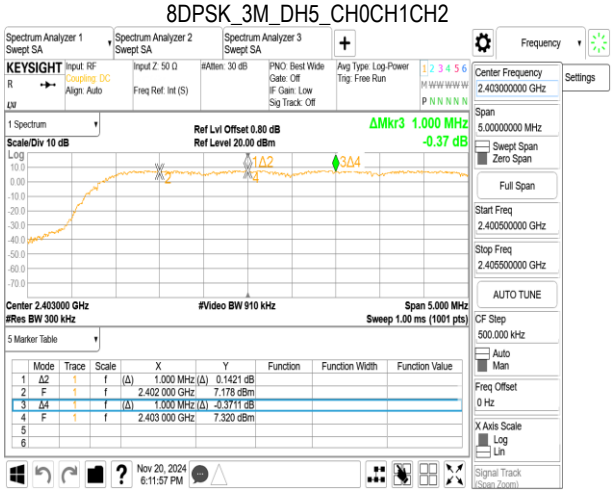
GFSK_1M_DH5_CH76CH77CH78



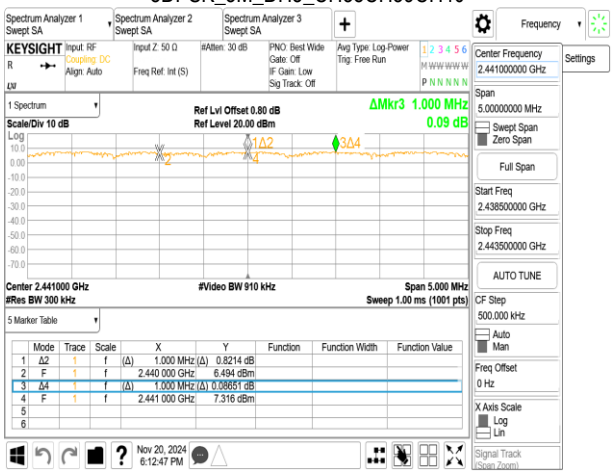
π/4DQPSK_2M_DH5_CH76CH77CH78



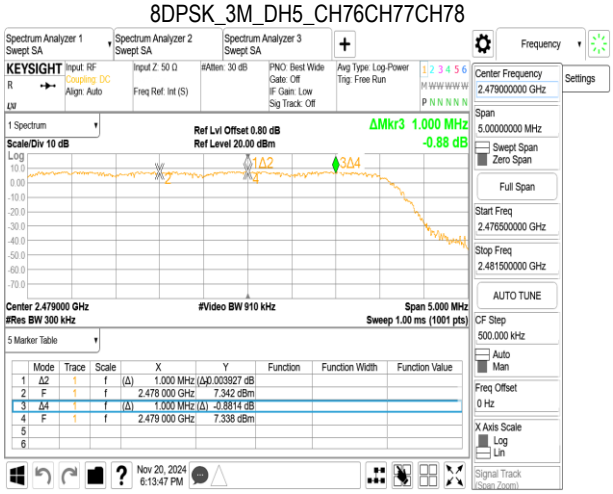
8DPSK_3M_DH5_CH0CH1CH2



8DPSK_3M_DH5_CH38CH39CH40



8DPSK_3M_DH5_CH76CH77CH78

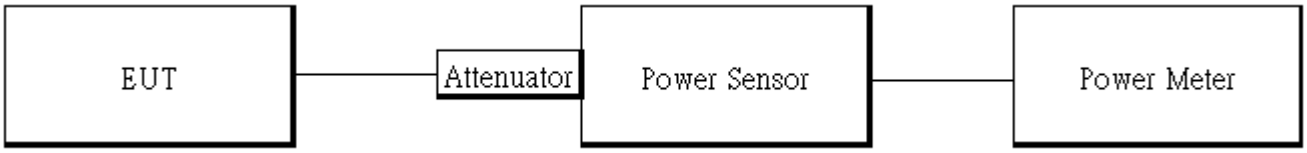


9 PEAK OUTPUT POWER MEASUREMENT

9.1 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.

9.2 Test Setup



9.3 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. Duty cycle of test signal is < 98 %, duty factor shall be considered.
4. 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 band-width)
5. Record the max. reading.
6. Repeat above procedures until all default test channel is completed.

9.4 Peak & Average Power Measurement Result

	Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log (1/Duty Cycle)
DH5	76.80	1.15
2DH5	76.80	1.15
3DH5	76.80	1.15

1M BR mode (Peak):

CH	Freq. (MHz)	Power Setting	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	10	**9.68**	9.290	1000
39	2441	10	9.67	9.268	1000
78	2480	10	9.21	8.337	1000

1M BR mode (Average):

CH	Freq. (MHz)	Power Setting	Avg. Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	10	9.65	9.218	1000
39	2441	10	9.64	9.197	1000
78	2480	10	9.19	8.292	1000

2M EDR mode (Peak):

CH	Freq. (MHz)	Power Setting	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	10	**12.21**	16.634	125
39	2441	10	12.17	16.482	125
78	2480	10	11.69	14.757	125

2M EDR mode (Average):

CH	Freq. (MHz)	Power Setting	Avg. Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	10	9.86	9.675	125
39	2441	10	9.84	9.630	125
78	2480	10	9.38	8.662	125

3M EDR mode (Peak):

CH	Freq. (MHz)	Power Setting	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	10	**12.62**	18.281	125
39	2441	10	**12.62**	18.281	125
78	2480	10	12.19	16.558	125

3M EDR mode (Average):

CH	Freq. (MHz)	Power Setting	Avg. Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	10	9.88	9.719	125
39	2441	10	9.87	9.697	125
78	2480	10	9.40	8.702	125

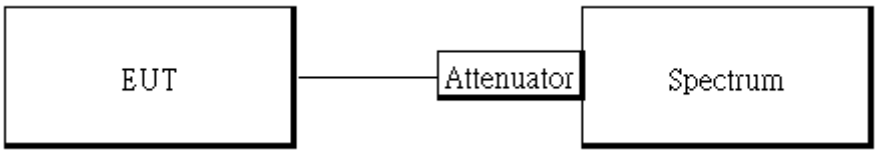
***Note:** Avg. output power has been calculated with duty factor.*

10 EMISSION BANDWIDTH MEASUREMENT

10.1 Standard Applicable

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

10.2 Test Setup



10.3 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2020.
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= 1 % to 5% of OBW ,
   VBW = 3 X RBW,
   Span= 2 to 5 times of the OBW,
   Sweep=auto,
   Detector = Peak, and Max hold for 20dB Bandwidth test.
5. Mark the peak frequency and –20dB (upper and lower) frequency
6. Set the spectrum analyzer as
   RBW= 1 % to 5% of 99% Bandwidth ,
   VBW ≥ 3 X RBW,
   Span= large enough to capture all products of the modulation process,
   Sweep=auto,
   Detector = Peak, and Max hold for 99% Bandwidth test.
7. Mark the peak frequency and 99%dB (upper and lower) frequency
8. Repeat above procedures until all test default channel is completed

10.4 20dB Bandwidth

GFSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
0	0.9324	0.62
39	0.9320	0.62
78	0.9322	0.62

π/4-DQPSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
0	1.286	0.86
39	1.285	0.86
78	1.286	0.86

8-DPSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
0	1.303	0.87
39	1.302	0.87
78	1.302	0.87

10.5 99% Bandwidth

GFSK

CH	99% BW (MHz)
0	0.82598
39	0.82687
78	0.82539

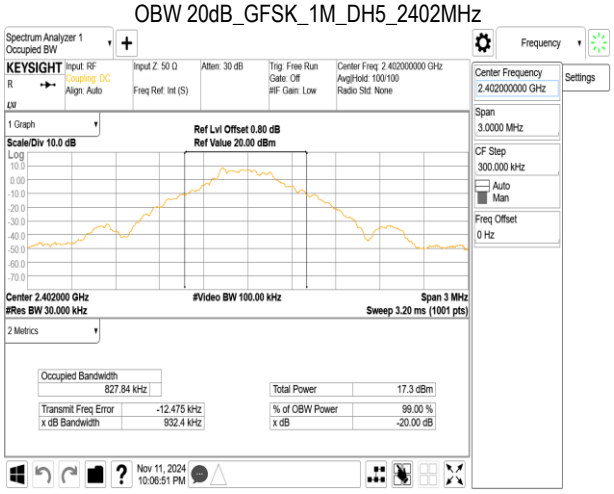
π/4-DQPSK

CH	99% BW (MHz)
0	1.1796
39	1.1787
78	1.1785

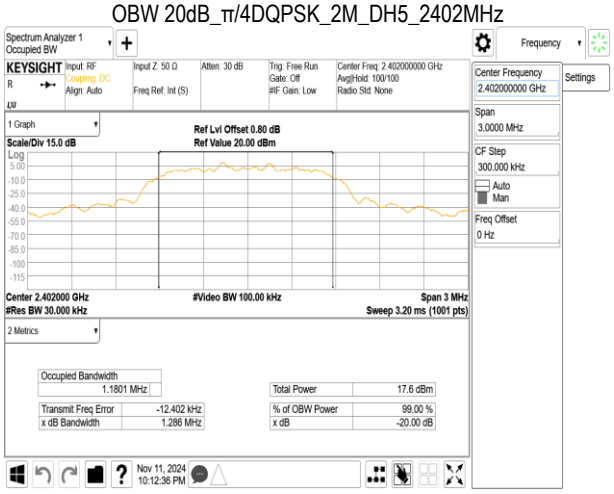
8-DPSK

CH	99% BW (MHz)
0	1.1866
39	1.1864
78	1.1868

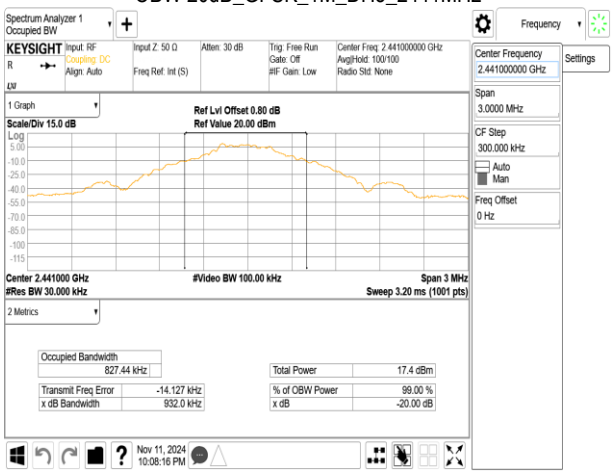
OBW 20dB_GFSK_1M_DH5_2402MHz



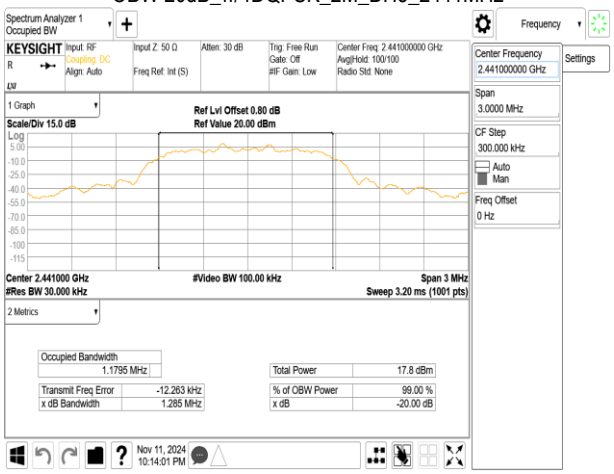
OBW 20dB_π/4DQPSK_2M_DH5_2402MHz



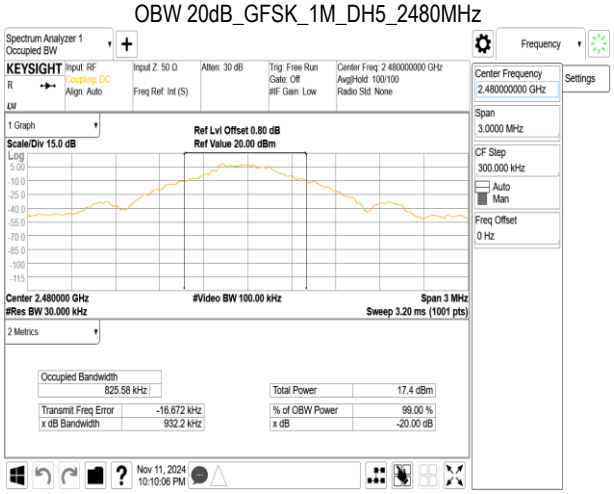
OBW 20dB_GFSK_1M_DH5_2441MHz



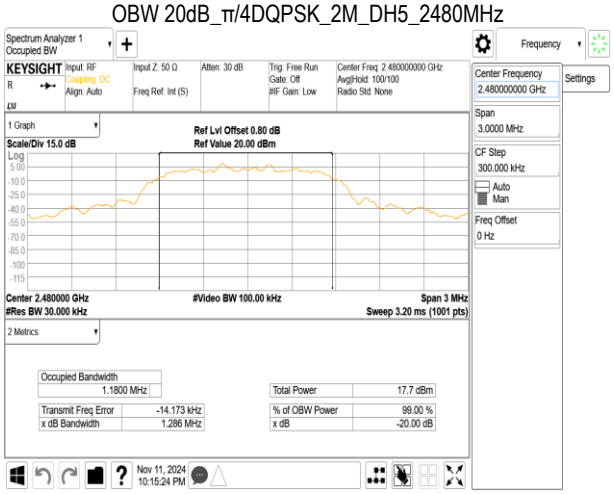
OBW 20dB_π/4DQPSK_2M_DH5_2441MHz



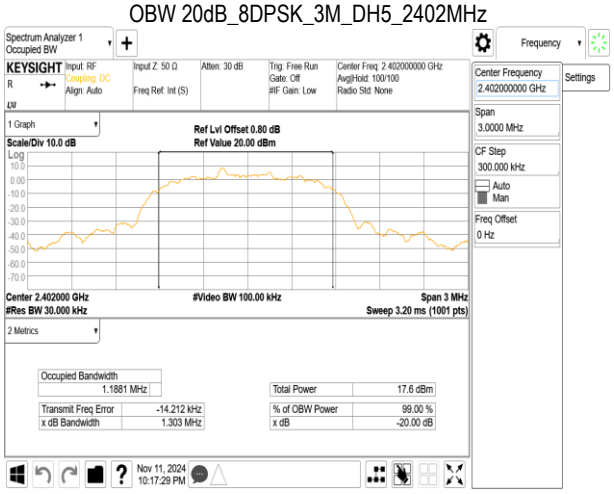
OBW 20dB_GFSK_1M_DH5_2480MHz



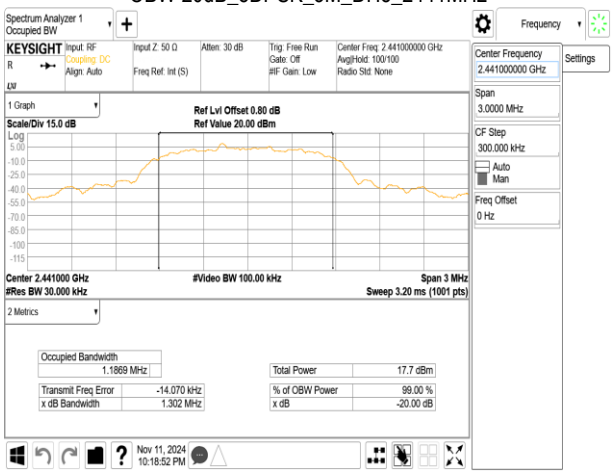
OBW 20dB_π/4DQPSK_2M_DH5_2480MHz



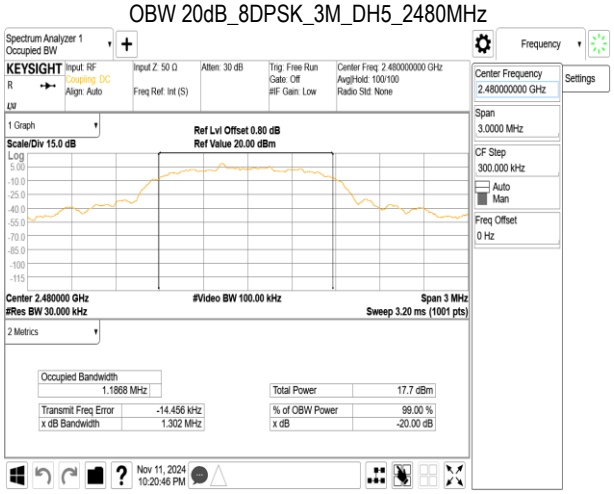
OBW 20dB_8DPSK_3M_DH5_2402MHz



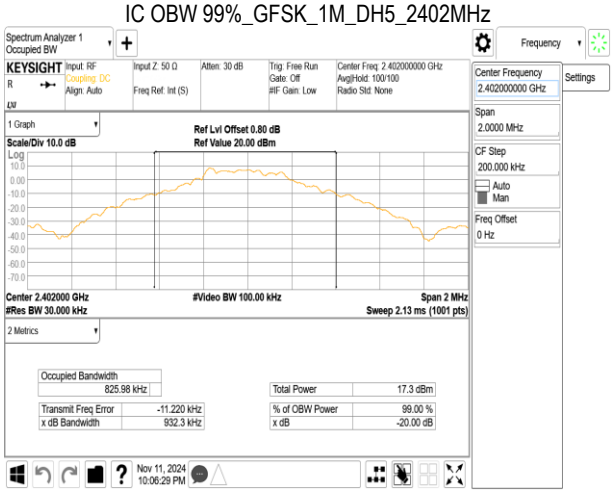
OBW 20dB_8DPSK_3M_DH5_2441MHz



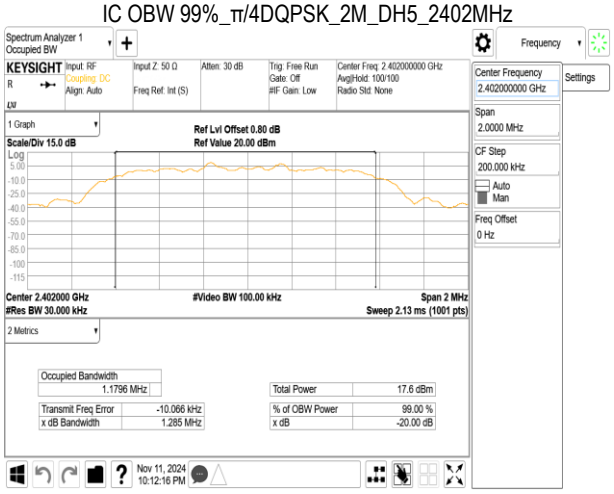
OBW 20dB_8DPSK_3M_DH5_2480MHz



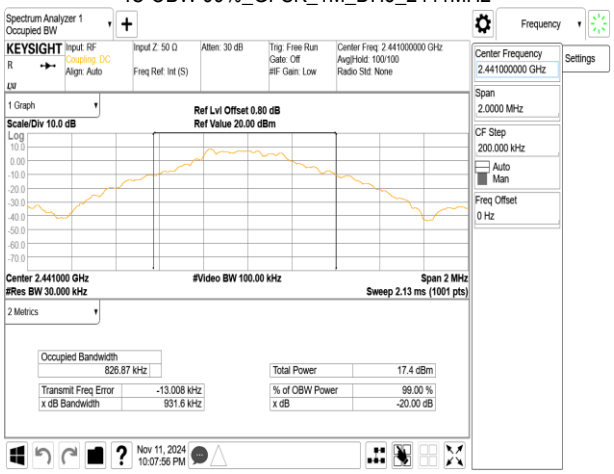
IC OBW 99%_GFSK_1M_DH5_2402MHz



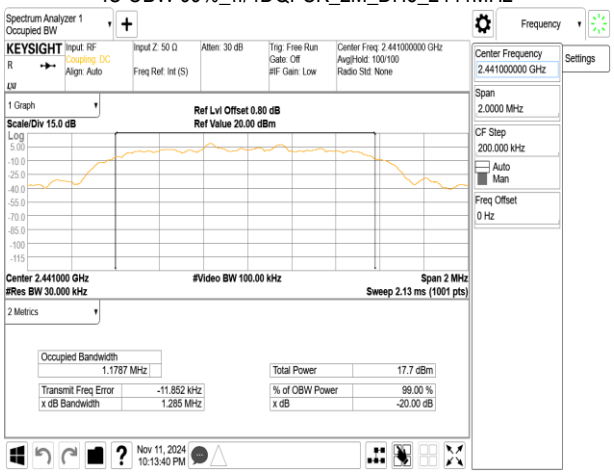
IC OBW 99%_π/4DQPSK_2M_DH5_2402MHz



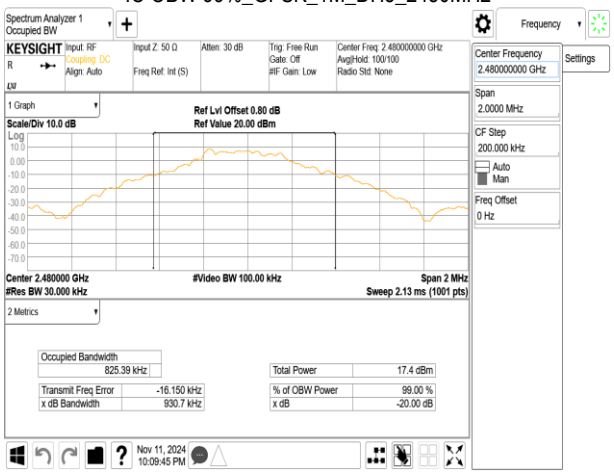
IC OBW 99%_GFSK_1M_DH5_2441MHz



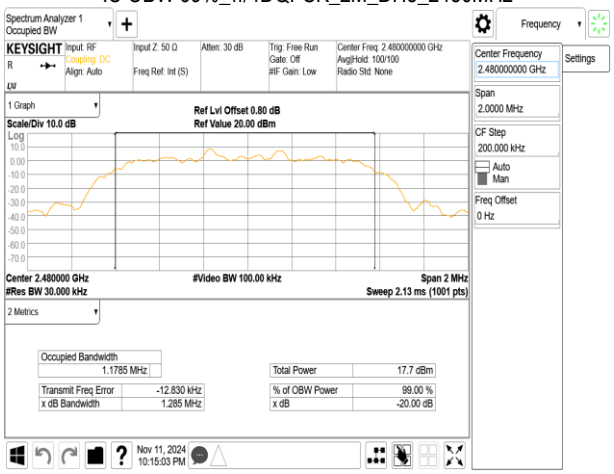
IC OBW 99%_π/4DQPSK_2M_DH5_2441MHz



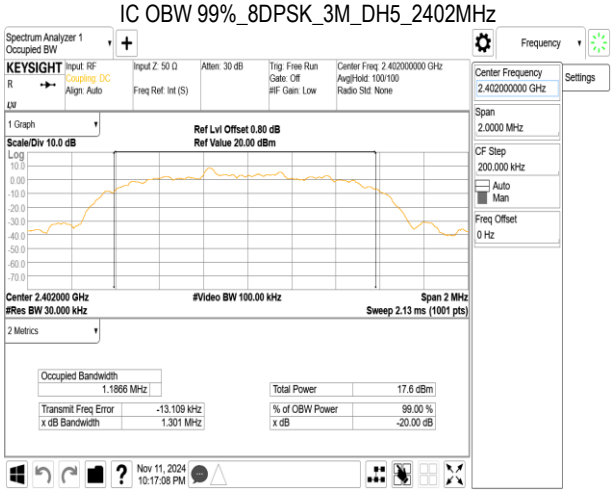
IC OBW 99%_GFSK_1M_DH5_2480MHz



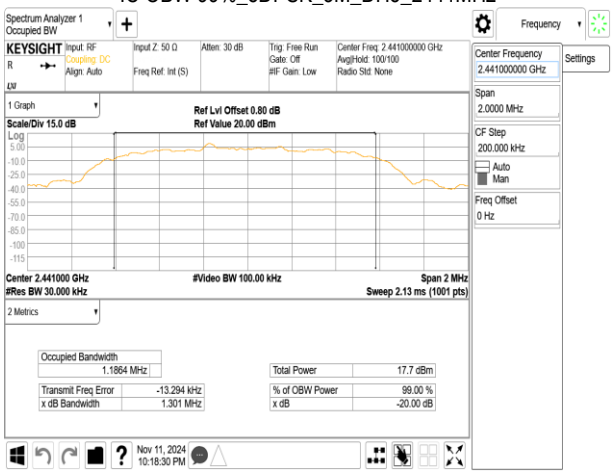
IC OBW 99%_π/4DQPSK_2M_DH5_2480MHz



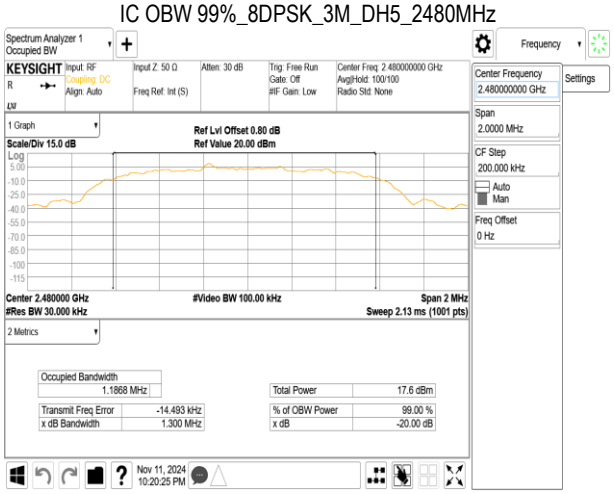
IC OBW 99%_8DPSK_3M_DH5_2402MHz



IC OBW 99%_8DPSK_3M_DH5_2441MHz



IC OBW 99%_8DPSK_3M_DH5_2480MHz

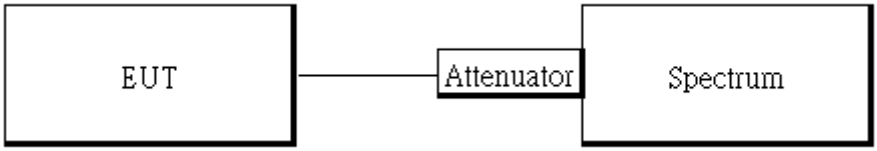


11 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

11.1 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).

11.2 Test Setup



11.3 Measurement Procedure

11.3.1 Conducted Band Edge:

In any 100 kHz bandwidth outside the frequency band

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, below 2.4GHz and above 2.4835GHz and record the max. level.
7. Repeat above procedures until all frequency measured were complete.

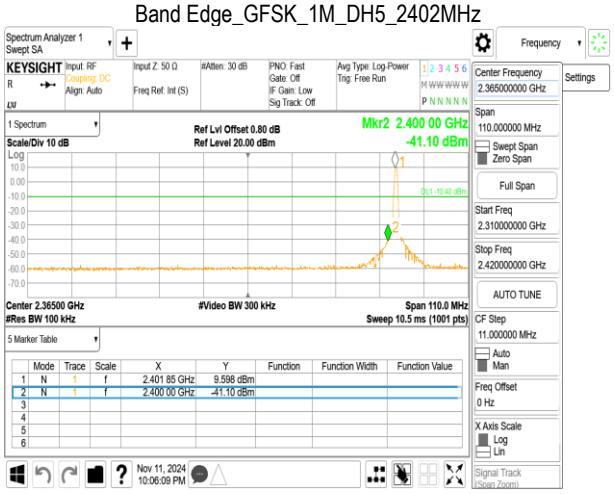
11.3.2 Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows ANSI C63.10:2020.
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.

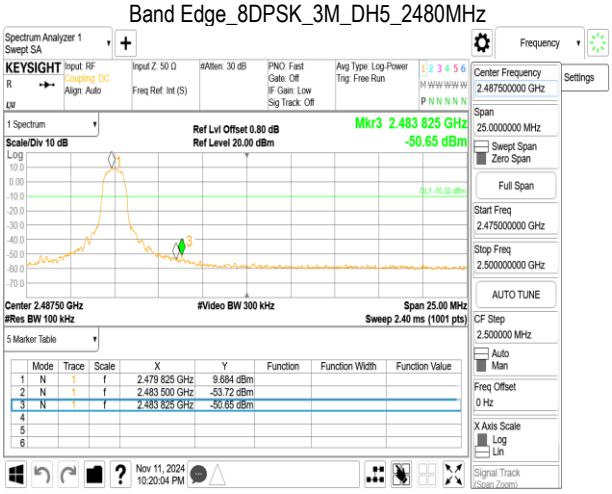
11.4 Measurement Result

See next page for test plots.

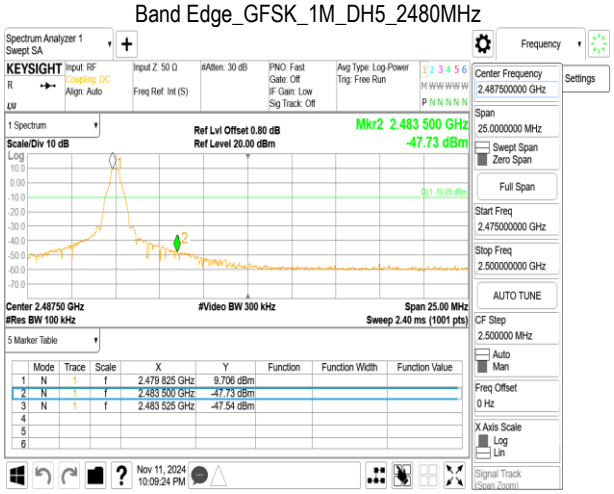
Band Edge_GFSK_1M_DH5_2402MHz



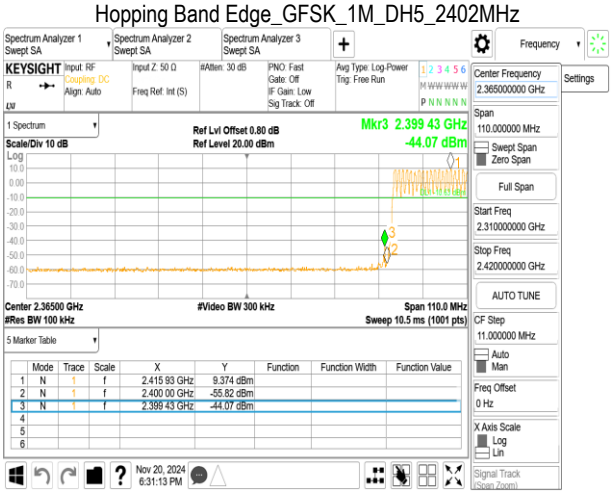
Band Edge_8DPSK_3M_DH5_2480MHz



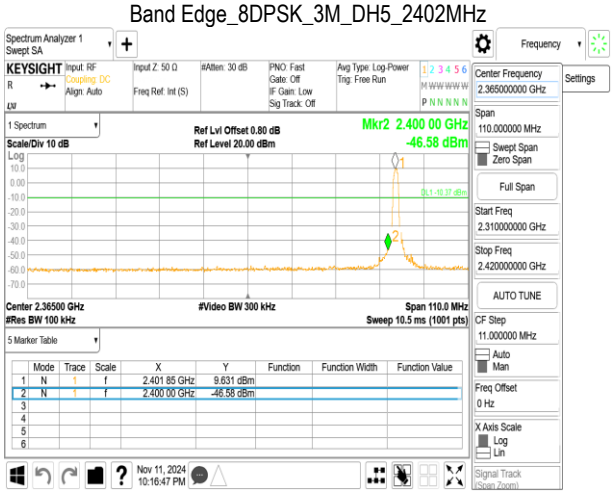
Band Edge_GFSK_1M_DH5_2480MHz



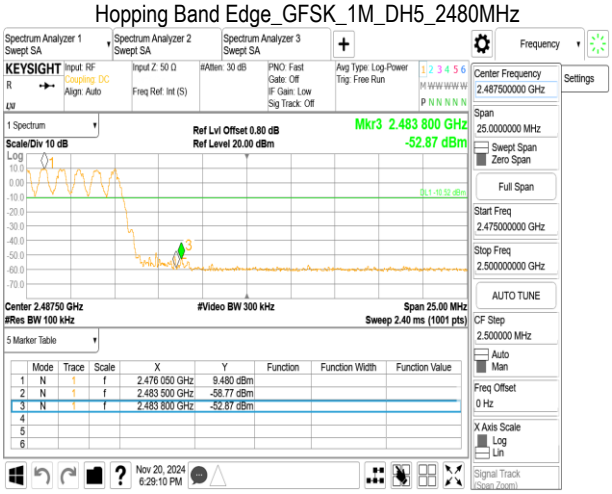
Hopping Band Edge_GFSK_1M_DH5_2402MHz



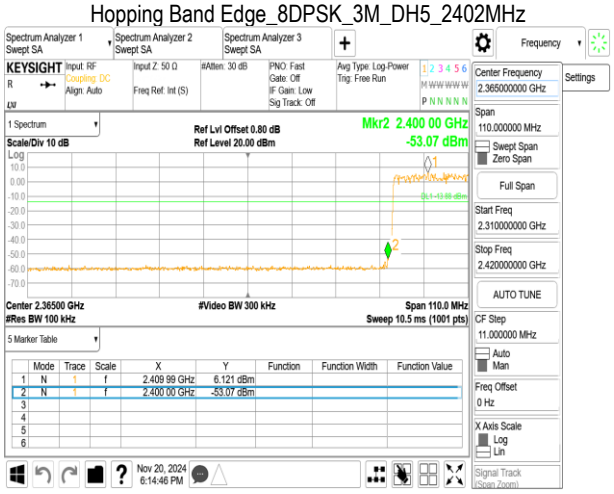
Band Edge_8DPSK_3M_DH5_2402MHz



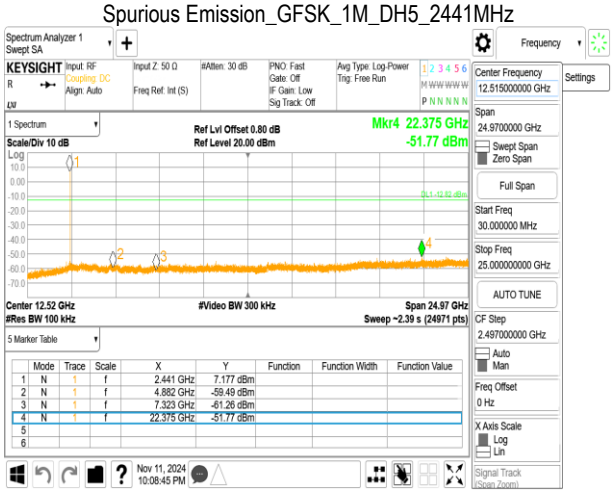
Hopping Band Edge_GFSK_1M_DH5_2480MHz



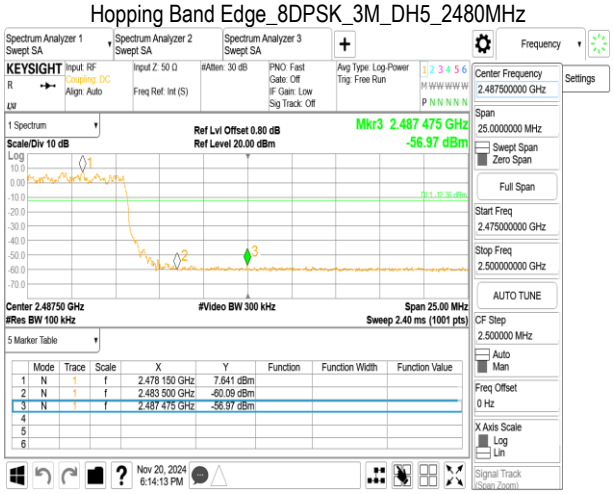
Hopping Band Edge_8DPSK_3M_DH5_2402MHz



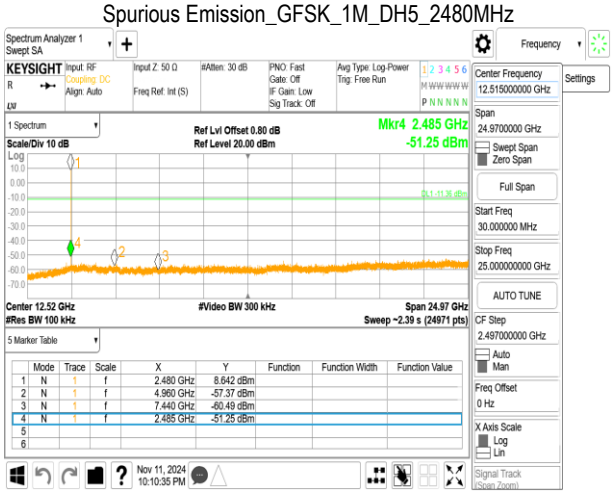
Spurious Emission_GFSK_1M_DH5_2441MHz



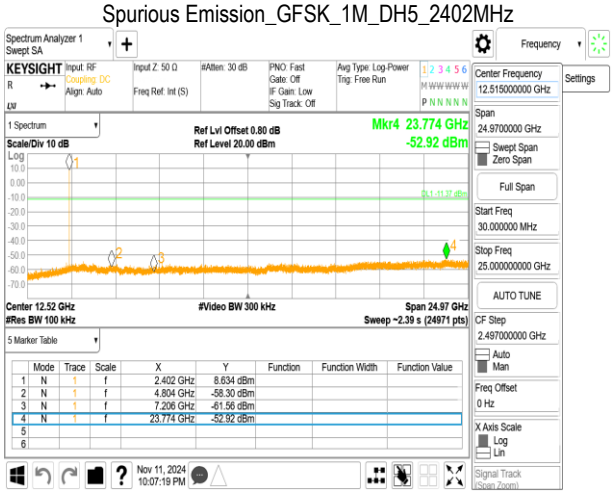
Hopping Band Edge_8DPSK_3M_DH5_2480MHz



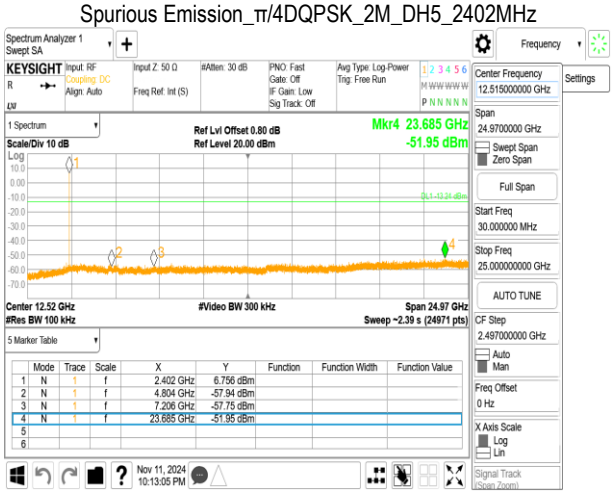
Spurious Emission_GFSK_1M_DH5_2480MHz



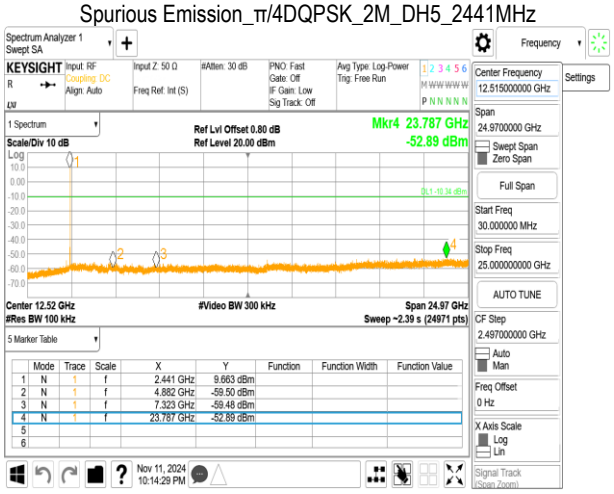
Spurious Emission_GFSK_1M_DH5_2402MHz



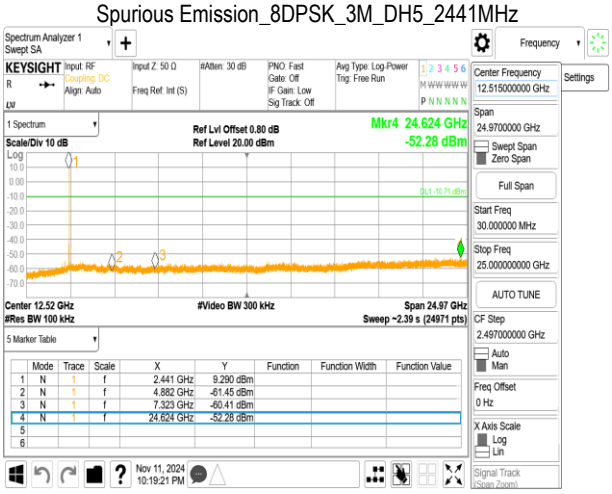
Spurious Emission_π/4DQPSK_2M_DH5_2402MHz



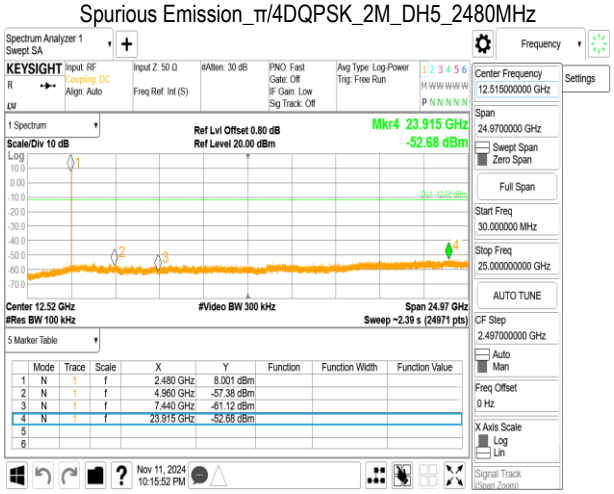
Spurious Emission_π/4DQPSK_2M_DH5_2441MHz



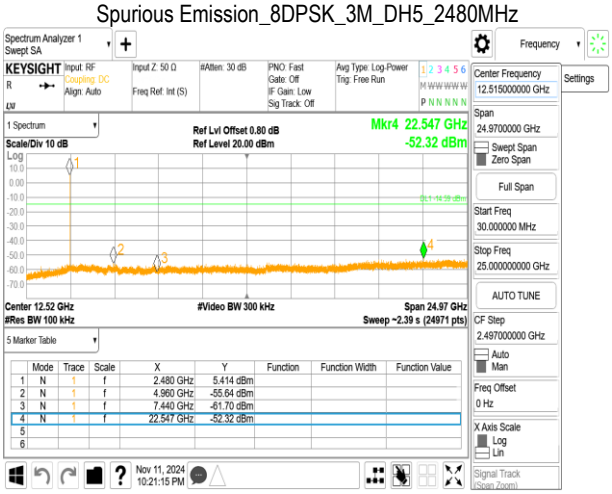
Spurious Emission_8DPSK_3M_DH5_2441MHz



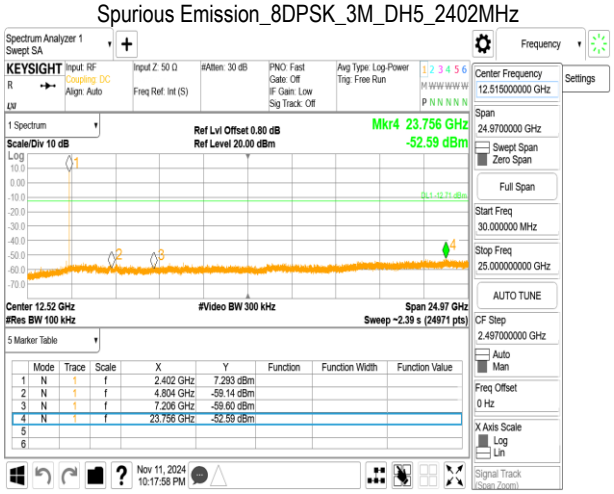
Spurious Emission_π/4DQPSK_2M_DH5_2480MHz



Spurious Emission_8DPSK_3M_DH5_2480MHz



Spurious Emission_8DPSK_3M_DH5_2402MHz



12 BANDEDGE AND SPURIOUS EMISSION MEASUREMENT

12.1 Standard Applicable

12.1.1 Duty Cycle Correction Factor

According to 15. 35(c), the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification.

12.1.2 Spurious Emission

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.

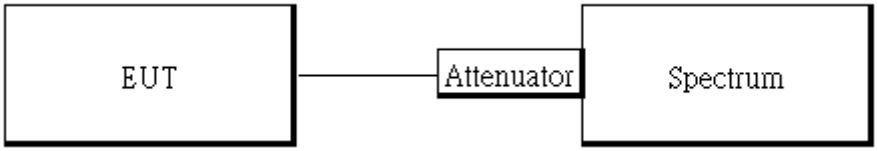
Frequency (MHz)	Field strength (microvolts/meter)	Distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note:

1. *The lower limit shall apply at the transition frequencies.*

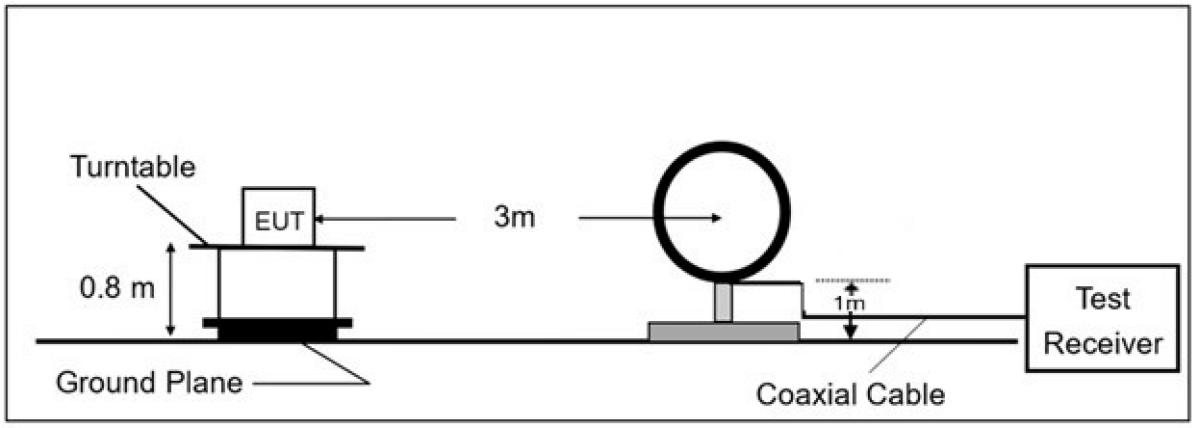
12.2 Test Setup

12.2.1 Bandedge & Emission

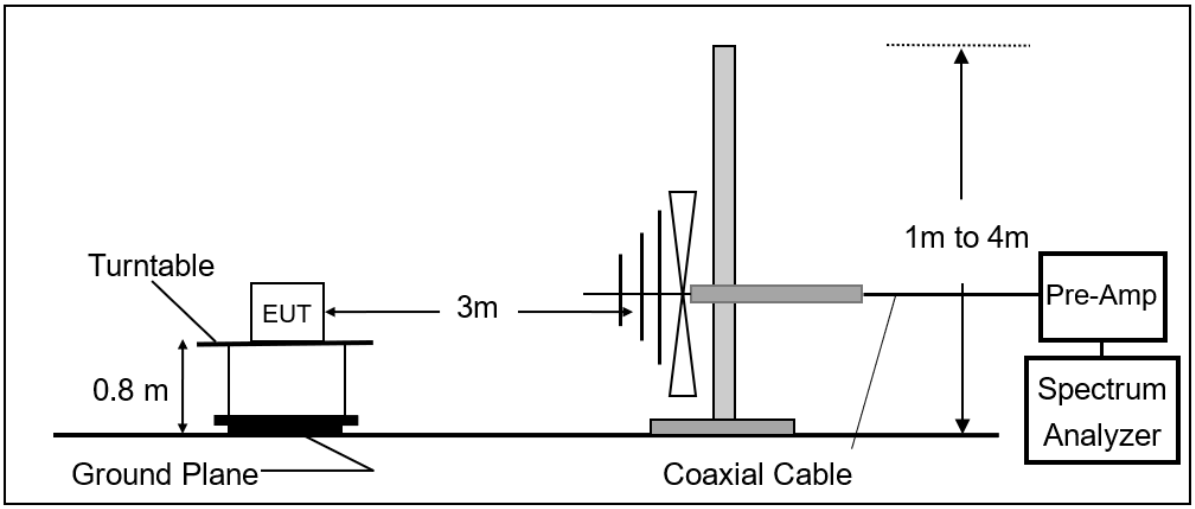


12.2.2 Radiated Emission

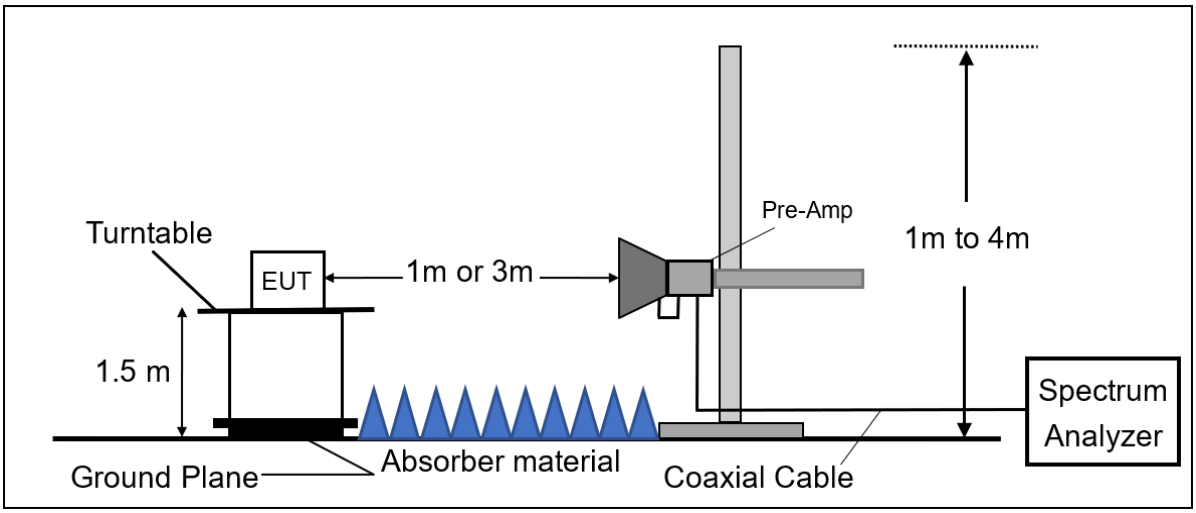
(A) Radiated Emission Test Set-Up, Frequency Below 30MHz.



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



(C) Radiated Emission Test Set-Up, Frequency Above 1 GHz.



12.3 Measurement Procedure

12.3.1 Duty Cycle Correction Factor

1. Adjust and configure any EUT switches, controls, or input data streams to ensure that the EUT is transmitting or encoded to obtain the “worst-case” pulse ON time.
2. The testing follows ANSI C63.10:2020.
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=100ms.
6. Repeat above procedures until all frequency of the interest measured were complete.

12.3.2 Band edge and Spurious Emission

1. Set the spectrum analyzer as RBW=100 kHz and VBW=300 kHz for Peak Detector (PK) at frequency between 30MHz and 1 GHz.
2. Use receiver mode as RBW=120 kHz for Quasi-peak (QP) at frequency between 30MHz and 1 GHz.
3. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz, Detector = Peak for Maximum Emission Measurements at frequency above 1 GHz.
4. According to C63.10:2013 Section 7.5 Procedure for determining the average value of pulsed emissions with duty cycle correction factor 20 log (T_{on}/100ms)

12.3.3 Spurious Emission measurements

1. The testing follows the Measurement Procedure of ANSI C63.10:2020.
2. The EUT was placed on a turn table with 0.8m for frequency< 1GHz and 1.5m for frequency> 1GHz above ground plane.
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. 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.
6. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
7. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
8. Repeat above procedures until all default test channel measured were complete.

12.4 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)

Average value(dBμV/m)=Peak Actual FS(dBμV/m)+ Duty Cycle Correction Factor(dB)
Duty Cycle Correction Factor(dB) = 20 log (T_{on}/100 ms)

12.5 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.

12.6 Measurement Result:

12.6.1 Duty Cycle Correction Factor

Bluetooth 1M_BR

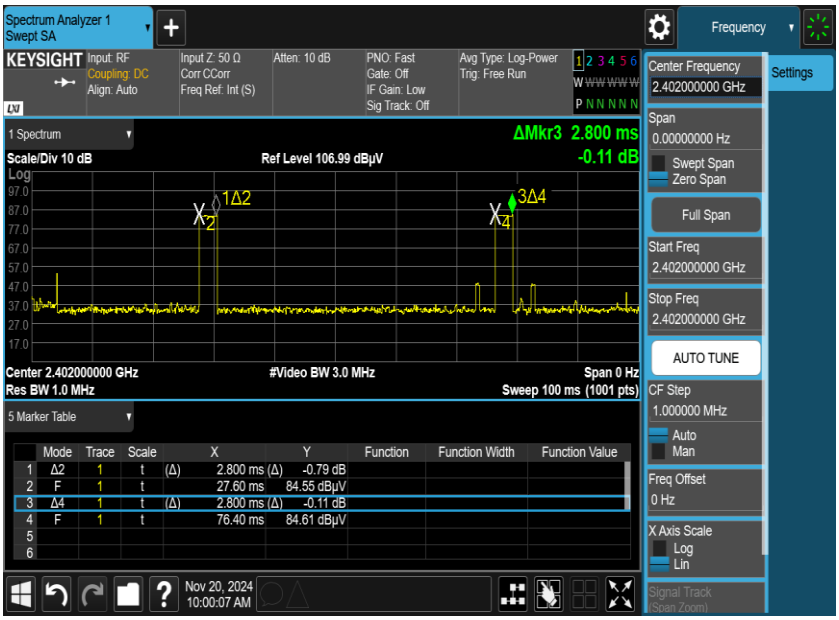
Time ON of 100ms: 5.600 ms
Duty Cycle=5.6ms / 100ms= 0.056
Duty Cycle correction factor=20 LOG 0.056 = -25.03 dB

Bluetooth 3M_EDR

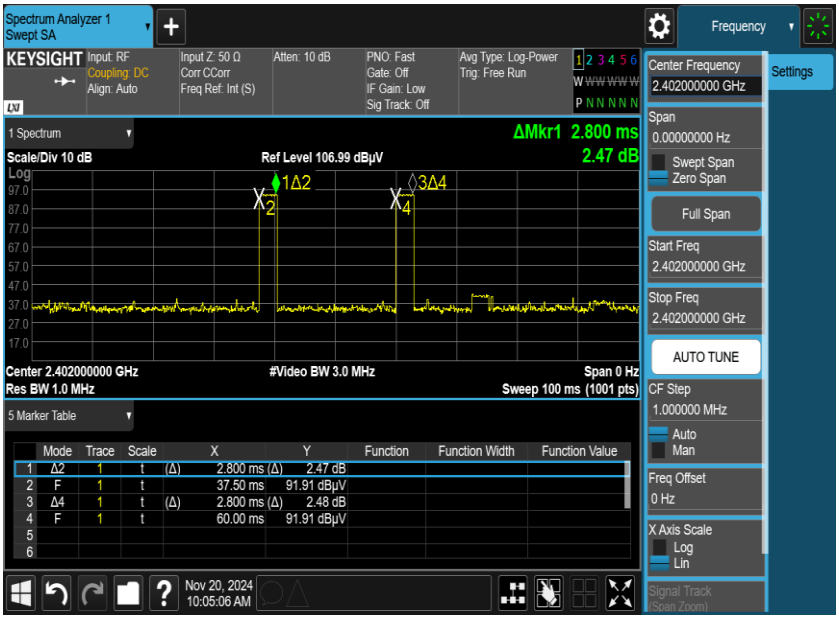
Time ON of 100ms: 5.600 ms
Duty Cycle=5.6ms / 100ms= 0.056
Duty Cycle correction factor=20 LOG 0.056 = -25.03 dB

12.6.2 Duty Cycle test plot

BR



EDR



12.6.3 CBE

BT_1M_BR

Channel	Frequency (MHz)	Raw Value(dBm) Chain 0	Duty factor (dB)	Antenna Peak Gain (dBi) Chain 0	EIRP (dBm)	Emission Level (dBuV/m)	Margin (dB)	Limit (dBuV/m)	
0	2402	-47.660	-	3.37	-44.29	50.91	-23.09	74	PK
		-	-25.03	3.37	-69.32	25.88	-28.12	54	AV
78	2480	-31.720	-	3.37	-28.35	66.85	-7.15	74	PK
		-	-25.03	3.37	-53.38	41.82	-12.18	54	AV

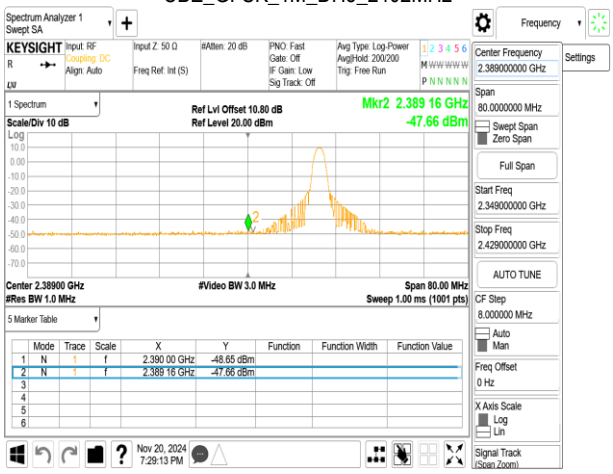
Average Duty Factor= -25.03(dB)
Average Level=Peak Level+Duty Factor

BT_3M_EDR

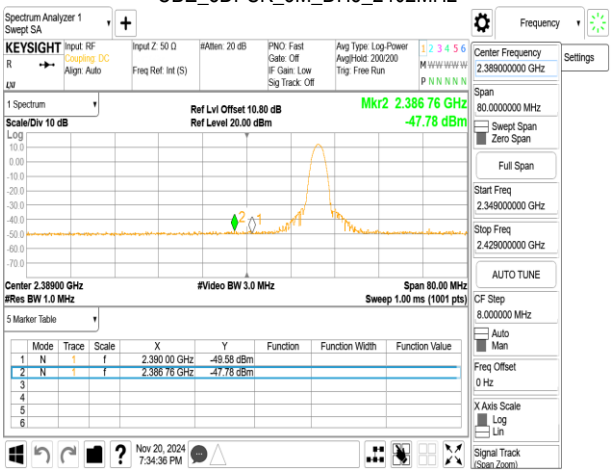
Channel	Frequency (MHz)	Raw Value(dBm) Chain 0	Duty factor (dB)	Antenna Peak Gain (dBi) Chain 0	EIRP (dBm)	Emission Level (dBuV/m)	Margin (dB)	Limit (dBuV/m)	
0	2402	-47.780	-	3.37	-44.41	50.79	-23.21	74	PK
		-	-25.03	3.37	-69.44	25.76	-28.24	54	AV
78	2480	-36.950	-	3.37	-33.58	61.62	-12.38	74	PK
		-	-25.03	3.37	-58.61	36.59	-17.41	54	AV

Average Duty Factor= -25.03(dB)
Average Level=Peak Level+Duty Factor

CBE_GFSK_1M_DH5_2402MHz

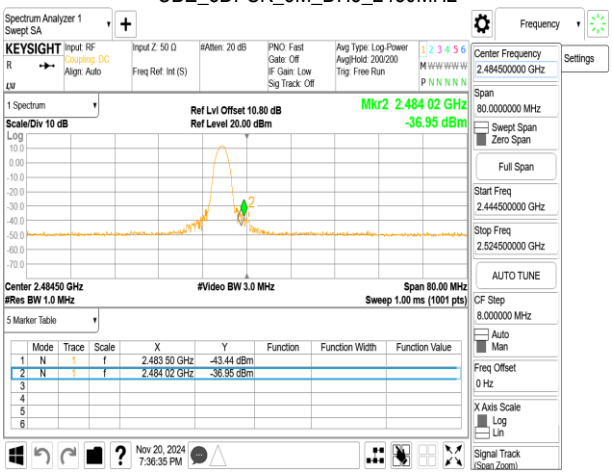


CBE_8DPSK_3M_DH5_2402MHz



CBE_GFSK_1M_DH5_2480MHz

CBE_8DPSK_3M_DH5_2480MHz



12.6.4 Conducted Emission

(30MHz~1GHz)

BT_3DH5_EDR

Channel	Frequency (MHz)	Raw Value(dBm)	Correction Factor(dB)	EIRP (dBm)	Emission Level (dBuV/m)	Margin (dB)	Limit (dBuV/m)	
		Chain 0	Chain 0					
39	2441	-79.470	8.07	-71.40	23.80	-16.20	40	PK
		-81.700	8.07	-73.63	21.57	-21.93	43.5	PK
		-80.770	8.07	-72.70	22.50	-23.50	46	PK
		-63.360	8.07	-55.29	39.91	-6.09	46	PK
		-80.570	8.07	-72.50	22.70	-23.30	46	PK
		-81.800	8.07	-73.73	21.47	-32.53	54	PK

Note:
Correction Factor=maximum ground reflection factor+Antenna Gain

(1~26.5GHz)

BT_DH5_BR

Channel	Frequency (MHz)	Raw Value(dBm)	Duty factor (dB)	Antenna Peak Gain (dBi)	EIRP (dBm)	Emission Level (dBuV/m)	Margin (dB)	Limit (dBuV/m)	
		Chain 0		Chain 0					
0	2402	-42.200	-	3.37	-38.83	56.37	-17.63	74	PK
		-	-25.03	3.37	-63.86	31.34	-22.66	54	AV
39	2441	-41.250	-	3.37	-37.88	57.32	-16.68	74	PK
		-	-25.03	3.37	-62.91	32.29	-21.71	54	AV
78	2480	-42.020	-	3.37	-38.65	56.55	-17.45	74	PK
		-	-25.03	3.37	-63.68	31.52	-22.48	54	AV

Average Duty Factor=-25.03(dB)
Average Level=Peak Level+Duty Factor

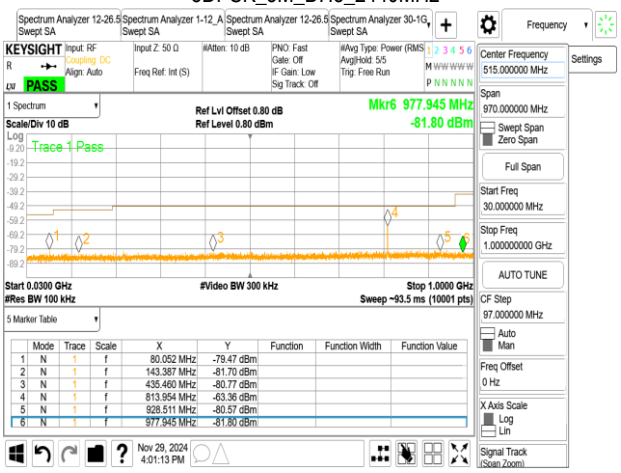
BT_3DH5_EDR

Channel	Frequency (MHz)	Raw Value(dBm)	Duty factor (dB)	Antenna Peak Gain (dBi)	EIRP (dBm)	Emission Level (dBuV/m)	Margin (dB)	Limit (dBuV/m)	
		Chain 0		Chain 0					
0	2402	-40.780	-	3.37	-37.41	57.79	-16.21	74	PK
		-	-25.03	3.37	-62.44	32.76	-21.24	54	AV
39	2441	-41.750	-	3.37	-38.38	56.82	-17.18	74	PK
		-	-25.03	3.37	-63.41	31.79	-22.21	54	AV
78	2480	-42.580	-	3.37	-39.21	55.99	-18.01	74	PK
		-	-25.03	3.37	-64.24	30.96	-23.04	54	AV

Average Duty Factor=-25.03(dB)
Average Level=Peak Level+Duty Factor

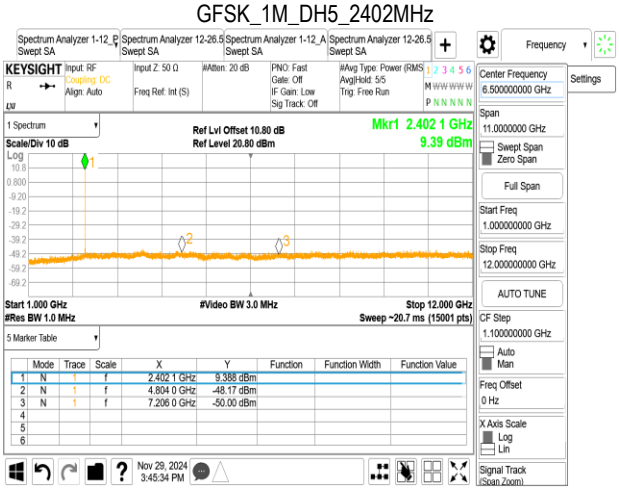
Peak (30MHz~1GHz)

8DPSK_3M_DH5_2440MHz

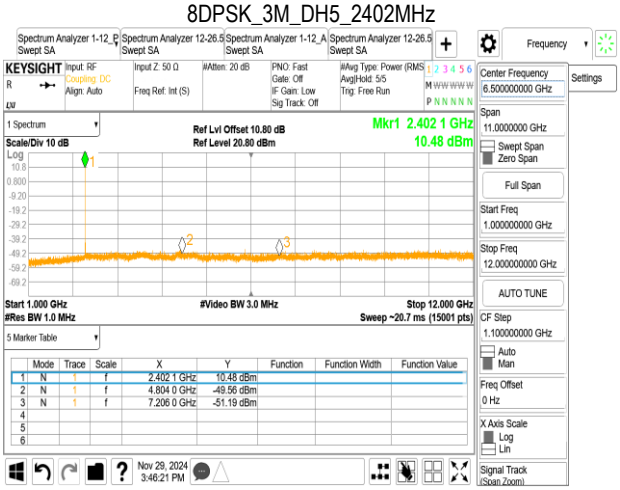


Peak (1~12GHz)

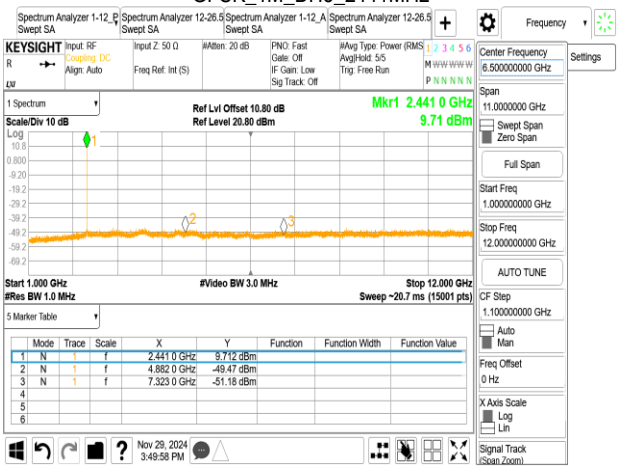
GFSK_1M_DH5_2402MHz



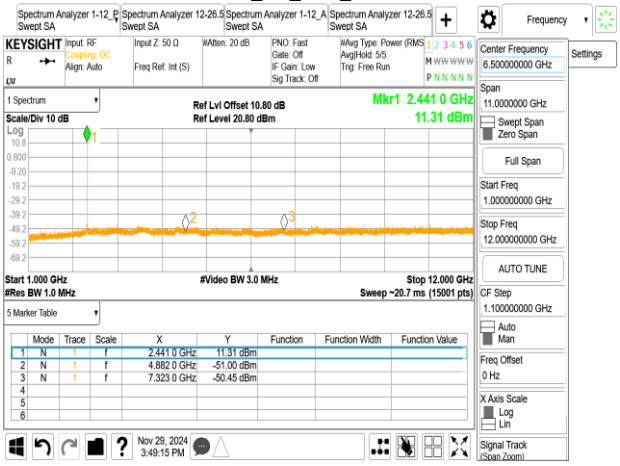
8DPSK_3M_DH5_2402MHz



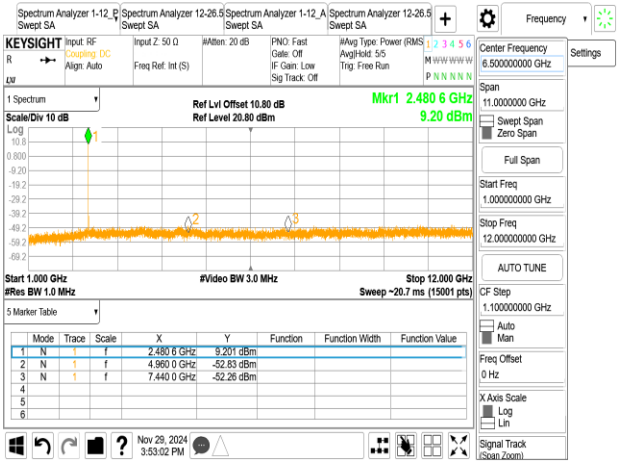
GFSK_1M_DH5_2441MHz



8DPSK_3M_DH5_2441MHz



GFSK_1M_DH5_2480MHz



8DPSK_3M_DH5_2480MHz