RADIO TEST REPORT
FCC 47 CFR PART 15 SUBPART C

Test Standard	**FCC Part 15.247**
Product name	**802.11a/b/g/n/ac 1x1 with BT 5.0 SiP Module**
Brand Name	**USI**
Model No.	**WM-BAC-BM-25-UFL**
Test Result	**Pass**
Statements of Conformity	**Determination of compliance is based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.**

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 report.
The test Report of full or partial shall not copy. Without written approval of Compliance Certification Services Inc.(Wugu Laboratory)

Approved by:

Sehni Hu
Supervisor

Revision History

Rev.	Issue Date	Revisions	Revised By
00	August 28, 2024	Initial Issue	Peggy Tsai

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1. GENERAL INFORMATION

1.1 EUT INFORMATION

Applicant	Universal Global Scientific Industrial Co., Ltd. No. 141, Lane 351, Sec. 1, Taiping Road, Tsaotuen, Nantou County 542007, Taiwan
Manufacturer	Universal Global Scientific Industrial Co., Ltd. No. 141, Lane 351, Sec. 1, Taiping Road, Tsaotuen, Nantou County 542007, Taiwan
Equipment	802.11a/b/g/n/ac 1x1 with BT 5.0 SiP Module
Model No.	WM-BAC-BM-25-UFL
Model Discrepancy	N/A
Trade Name	USI
Received Date	July 12, 2024
Date of Test	July 12 ~ 30, 2024
Power Operation	Power from Power supply: DC 3.6V
HW Version	V30
FW Version	dhd-1.363.125.25

Remark:
1. For more details, please refer to the User's manual of the EUT.
2. Disclaimer: Antenna information is provided by the applicant, test results of this report are applicable to the sample EUT received.

1.2 INFORMATION ABOUT THE FHSS CHARACTERISTICS

1.2.1 Pseudorandom Frequency Hopping Sequence

The channel is represented by a pseudo-random hopping sequence hopping through the 79 RF channels. The hopping sequence is unique for the piconet and is determined by the Bluetooth device address of the master; the phase in the hopping sequence is determined by the Bluetooth clock of the master. The channel is divided into time slots where each slot corresponds to an RF hop frequency. Consecutive hops correspond to different RF hop frequencies. The nominal hop rate is 1 600 hops/s.

1.2.2 Equal Hopping Frequency Use

The channels of this system will be used equally over the long-term distribution of the hopsets.

1.2.3 Example of a 79 hopping sequence in data mode:

02, 05, 31, 24, 20, 10, 43, 36, 30, 23, 40, 06, 21, 50, 44, 09, 71, 78, 01, 13, 73, 07, 70, 72, 35, 62, 42, 11, 41, 08, 16, 29, 60, 15, 34, 61, 58, 04, 67, 12, 22, 53, 57, 18, 27, 76, 39, 32, 17, 77, 52, 33, 56, 46, 37, 47, 64, 49, 45, 38, 69, 14, 51, 26, 79, 19, 28, 65, 75, 54, 48, 03, 25, 66, 05, 16, 68, 74, 59, 63, 55

1.2.4 System Receiver Input Bandwidth

Each channel bandwidth is 1MHz.
The system receivers have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

1.2.5 Equipment Description

The Rx input bandwidths shift frequencies in synchronization with the transmitted signals.
In accordance with the Bluetooth Industry Standard, the system is designed to comply with all of the regulations in standard when the transmitter is presented with a continuous data (or information) system.
In accordance with the Bluetooth Industry Standard, the system does not coordinate it channels selection/ hopping sequence with other frequency hopping systems for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

1.3 EUT CHANNEL INFORMATION

Frequency Range	2402MHz-2480MHz
Modulation Type	1. GFSK for BDR-1Mbps 2. π/4-DQPSK for EDR-2Mbps 3. 8DPSK for EDR-3Mbps
Number of channel	79 Channels

Remark:
Refer as ANSI C63.10: 2013 clause 5.6.1 Table 4 for test channels

Number of frequencies to be tested		
Frequency range in which device operates	**Number of frequencies**	**Location in frequency range of operation**
☐ 1 MHz or less	1	Middle
☐ 1 MHz to 10 MHz	2	1 near top and 1 near bottom
☒ More than 10 MHz	3	1 near top, 1 near middle, and 1 near bottom

1.4 ANTENNA INFORMATION

Antenna Type	☐ PIFA ☐ PCB ☐ Dipole ☒ FPC Antenna
Antenna Brand / Model	Amphenol / ST0224-10-401-A
Antenna Gain	Gain: 2.10 dBi
Antenna Connector	I-PEX MHF 1

Notes:
1.The antenna(s) of the EUT are permanently attached and there are no provisions for connection to an external antenna. So the EUT complies with the requirements of §15.203.

1.5 MEASUREMENT UNCERTAINTY

PARAMETER	UNCERTAINTY
AC Powerline Conducted Emission	± 2.213 dB
Channel Bandwidth	± 2.7 %
RF output power (Power Meter + Power sensor)	± 0.243 dB
Power Spectral density	± 2.739 dB
Conducted Bandedge	± 2.739 dB
Conducted Spurious Emission	± 2.742 dB
Radiated Emission_9kHz-30MHz	± 3.761 dB
Radiated Emission_30MHz-200MHz	± 3.473 dB
Radiated Emission_200MHz-1GHz	± 3.946 dB
Radiated Emission_1GHz-6GHz	± 4.797 dB
Radiated Emission_6GHz-18GHz	± 4.803 dB
Radiated Emission_18GHz-26GHz	± 3.459 dB
Radiated Emission_26GHz-40GHz	± 3.297 dB

Remark:
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.

1.6 FACILITIES AND TEST LOCATION

All measurement facilities used to collect the measurement data are located at

☒ No.11, Wugong 6th Rd., Wugu Dist., New Taipei City, Taiwan.

CAB identifier: TW1309

Test site	Test Engineer	Remark
AC Conduction Room	Ben Yang	-
Radiation	Tony Chao、Ray Li	-
RF Conducted	Jerry Chang	-

Remark: The lab has been recognized as the FCC accredited lab. under the KDB 974614 D01 and is listed in the FCC pubic Access Link (PAL) database, FCC Registration No. :444940, the FCC Designation No.:TW1309

1.7 INSTRUMENT CALIBRATION

Conducted_FCC/IC/NCC (All)					
Name of Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Date**	**Calibration Due**
Power Supply	GWINSTEK	SPS-3610	GPE880163	2023-11-16	2024-11-15
Power Sensor	Anritsu	MA2411B	1726104	2024-04-16	2025-04-15
Power Sensor	Anritsu	MA2412B	1726107	2024-04-16	2025-04-15
Power Meter	Anritsu	ML2496A	1804001	2024-04-16	2025-04-15
EXA Signal Analyzer	Keysight	N9010B	MY55460167	2024-01-03	2025-01-02
Software	Radio Test Software Ver. 21				

966A_Radiated					
Name of Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Date**	**Calibration Due**
Signal Analyzer	KEYSIGHT	N9010A	MY52220817	2024-03-15	2025-03-14
Thermo-Hygro Meter	WISEWIND	1206	D07	2023-12-08	2024-12-07
Active Loop Antenna	SCHWARZBECK	FMZB 1513-60	1513-60-028	2023-12-13	2024-12-12
Bi-Log Antenna	Sunol Sciences	JB3	A030105	2024-07-12	2025-07-11
Preamplifier	EMEC	EM330	060609	2024-02-21	2025-02-20
Cable	Huber+Suhner	104PEA	20995+21000+182330	2024-02-21	2025-02-20
Horn Antenna	ETC	MCTD 1209	DRH13M02003	2023-12-28	2024-12-27
Preamplifier	HP	8449B	3008A00965	2023-12-22	2024-12-21
Cable	EMCI	EMC101G	221213+221011+221012	2023-10-17	2024-10-16
Attenuator	Mini-Circuits	BW-S9W5	BWS9W5-09-966A-01	2024-02-07	2025-02-06
High Pass Filters	Titan Microwave	T04H30001800070S01	22011402-4	2024-06-12	2025-06-13
Horn Antenna	SCHWARZBECK	BBHA9170	1047	2023-12-13	2024-12-12
Pre-Amplifier	EMCI	EMC184045SE	980860	2023-12-12	2024-12-11
Turn Table	CCS	CC-T-1F	N/A	N.C.R	N.C.R
Controller	CCS	CC-C-1F	N/A	N.C.R	N.C.R
Antenna Tower	CCS	CC-A-1F	N/A	N.C.R	N.C.R
Software	e3 V9-210616c				

Remark:
1. Each piece of equipment is scheduled for calibration once a year.
2. N.C.R. = No Calibration Required.

AC Mains Conduction					
Name of Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Date**	**Calibration Due**
EMI Test Receiver	R&S	ESCI	100064	2024-06-14	2025-06-13
LISN	TESEQ	LN2-16N	22012	2024-02-29	2025-02-27
Cable	Woken	SFL402	185A	2024-07-08	2025-07-07
Power Supply	GWINISTEK	SPS-3610	GPE880163	2023-10-16	2024-10-15
Software	e3 V6-110812				

Remark:
1. Each piece of equipment is scheduled for calibration once a year.
2. N.C.R. = No Calibration Required.

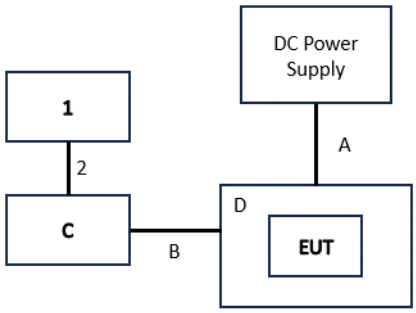
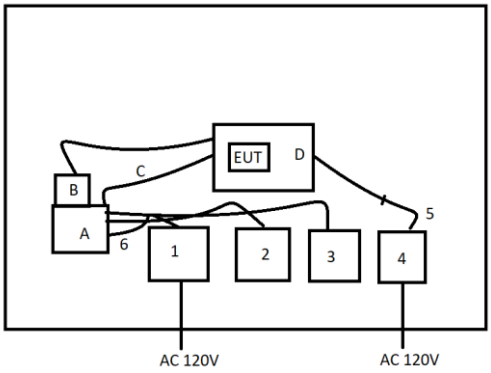
1.8 SUPPORT AND EUT ACCESSORIES EQUIPMENT

EUT Accessories Equipment						
No.	**Equipment**	**Brand**	**Model**	**Series No.**	**FCC ID**	**IC**
D	Test Kit	N/A	N/A	N/A	N/A	N/A

Support Equipment (Conducted)					
No.	**Equipment**	**Brand**	**Model**	**Series No.**	**FCC ID**
1	Monitor	Viewsonic	VS16263	N/A	N/A
2	HDMI Cable	UGREEN	HD104	N/A	N/A
A	DC Cable	N/A	N/A	N/A	N/A
B	Micro USB Cable	N/A	N/A	N/A	N/A
C	PC	ASUS	D320MT	N/A	N/A

Support Equipment (RSE & Conduction)					
No.	**Equipment**	**Brand**	**Model**	**Series No.**	**FCC ID**
1	Monitor	View sonic	VS16263	N/A	N/A
2	MOUSE	Lenovo	300 USB	N/A	N/A
3	KeyBoard	Logitech	K120	N/A	N/A
4	DC Power Source	GWINSTEK	SPS-3610	GPE880163	N/A
5	DC Cable	MISUMI	MCR3S-RE	N/A	N/A
6	HDMI Cable	UGREEN	HD104	N/A	N/A
A	PC	ASUS	D320MT	N/A	N/A
B	Test Kit	N/A	N/A	N/A	N/A
C	Micro USB Cable	N/A	N/A	N/A	N/A

1.9 TEST SET UP DIAGRAM

Conducted	RSE & Conduction
	

1.10 TEST METHODOLOGY AND APPLIED STANDARDS

The EUT connection corresponds to the surrounding fixture control board.
This EUT uses the Linux system setup command to set the frequency, modulation, and power to allow the sample to continuously transmit (including frequency hopping mode).

1.11 TEST METHODOLOGY AND APPLIED STANDARDS

The test methodology, setups and results comply with all requirements in accordance with ANSI C63.10:2013, FCC Part 2, FCC Part 15.247, KDB 558074.

2. TEST SUMMERY

FCC Standard Section	Report Section	Test Item	Result
15.203	1.3	Antenna Requirement	Pass
15.207(a)	4.1	AC Conducted Emission	Pass
15.247(a)(1)	4.2	20 dB Bandwidth	Pass
-	4.2	Occupied Bandwidth (99%)	Pass
15.247(b)(1)	4.3	Output Power Measurement	Pass
15.247(a)(1)	4.4	Frequency Separation	Pass
15.247(a)(1)(iii)	4.5	Number of Hopping	Pass
15.247(d)	4.6	Conducted Band Edge	Pass
15.247(d)	4.6	Conducted Spurious Emission	Pass
15.247(a)(1)(iii)	4.7	Time of Occupancy	Pass
15.247(d) 15.205, 15.209	4.8	Radiation Band Edge	Pass
15.247(d) 15.205, 15.209	4.8	Radiation Spurious Emission	Pass

3. DESCRIPTION OF TEST MODES

3.1 THE WORST MODE OF OPERATING CONDITION

Operation mode	GFSK for BDR-1Mbps (DH5) π/4-DQPSK for 2Mbps (2DH5) 8DPSK for EDR-3Mbps (3DH5)
Test Channel Frequencies	**GFSK for BDR-1Mbps:** 1.Lowest Channel: 2402MHz 2.Middle Channel: 2441MHz 3.Highest Channel: 2480MHz **π/4-DQPSK for 2Mbps:** 1.Lowest Channel: 2402MHz 2.Middle Channel: 2441MHz 3.Highest Channel: 2480MHz **8DPSK for EDR-3Mbps:** 1.Lowest Channel: 2402MHz 2.Middle Channel: 2441MHz 3.Highest Channel: 2480MHz

Remark:
1. EUT pre-scanned data rate of output power for each mode, the worst data rate were recorded in this report.
2.The system support GFSK ,π/4 DQPSK ,8DPSK , the π/4 DQPSK were reduced since the identical parameters with 8dpsk. In the following test items, number of hopping, conducted bandedge, radiated band edge and spurious emissions.

3.2 THE WORST MODE OF MEASUREMENT

AC Power Line Conducted Emission	
Test Condition	AC Power line conducted emission for line and neutral
Power supply Mode	Mode 1: EUT Power by DC power Supply
Worst Mode	☒ Mode 1 ☐ Mode 2 ☐ Mode 3 ☐ Mode 4

Radiated Emission Measurement Above 1G	
Test Condition	Radiated Emission Above 1G
Power supply Mode	Mode 1: EUT power by Power Supply
Worst Mode	☒ Mode 1 ☐ Mode 2 ☐ Mode 3 ☐ Mode 4
Worst Position	☐ Placed in fixed position. ☐ Placed in fixed position at X-Plane (E2-Plane) ☐ Placed in fixed position at Y-Plane (E1-Plane) ☒ Placed in fixed position at Z-Plane (H-Plane)

Radiated Emission Measurement Below 1G	
Test Condition	Radiated Emission Below 1G
Power supply Mode	Mode 1: EUT power by Power Supply
Worst Mode	☒ Mode 1 ☐ Mode 2 ☐ Mode 3 ☐ Mode 4

Radiated Emission Measurement [Co-Location]	
Test Condition	Radiated Emission [Co-Location]
Power supply Mode	Mode 1: EUT Power by Wi-Fi 2.4G+BLE_1M Mode 2: EUT Power by Wi-Fi 2.4G+BT BR Mode 3: EUT Power by Wi-Fi 5G+BLE_1M Mode 4: EUT Power by Wi-Fi 5G+BT BR
Worst Mode	☐ Mode 1 ☐ Mode 2 ☐ Mode 3 ☒ Mode 4

Remark:

1. The worst mode was record in this test report.
2. AC power line conducted emission were performed the EUT transmit at the highest output power channel as worse case.
3. EUT pre-scanned in three axis ,X,Y, Z and two polarity, for radiated measurement. The worst case(Z -Plane) were recorded in this report

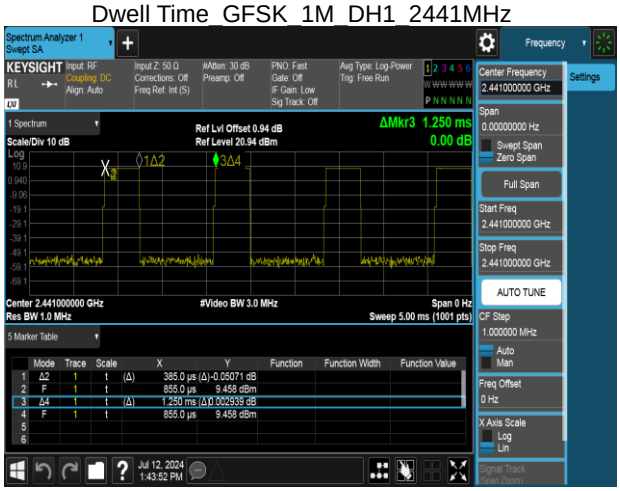
3.3 EUT DUTY CYCLE

Temperature: 23.1 ~ 25.2℃ **Test date:** July 12 ~ 30, 2024

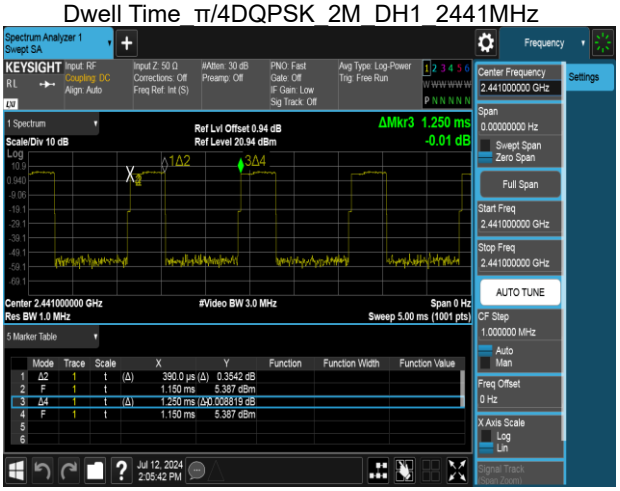
Humidity: 50 ~ 61% RH **Tested by:** Jerry Chang

	Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log (1/Duty Cycle)	1/T (kHz)	VBW setting (kHz)
DH1	30.80	5.11	2.60	3.00
DH3	65.60	1.83	0.61	1.00
DH5	77.20	1.12	0.35	1.00
2DH1	31.20	5.06	2.56	3.00
2DH3	66.00	1.80	0.61	1.00
2DH5	77.20	1.12	0.35	1.00
3DH1	31.20	5.06	2.56	3.00
3DH3	65.60	1.83	0.61	1.00
3DH5	77.20	1.12	0.35	1.00

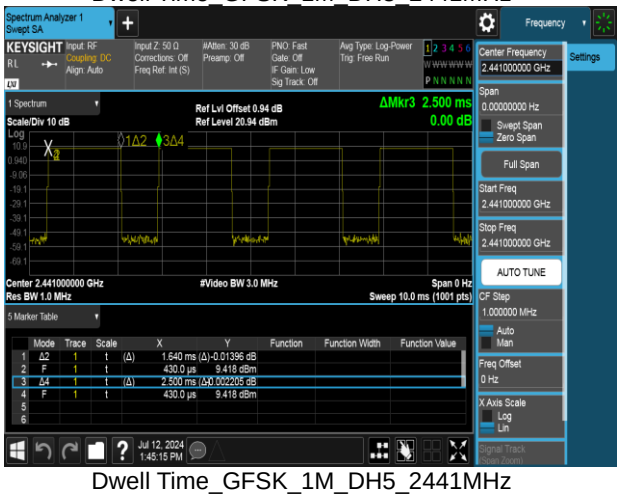
Dwell Time_GFSK_1M_DH1_2441MHz



Dwell Time_π/4DQPSK_2M_DH1_2441MHz



Dwell Time_GFSK_1M_DH3_2441MHz



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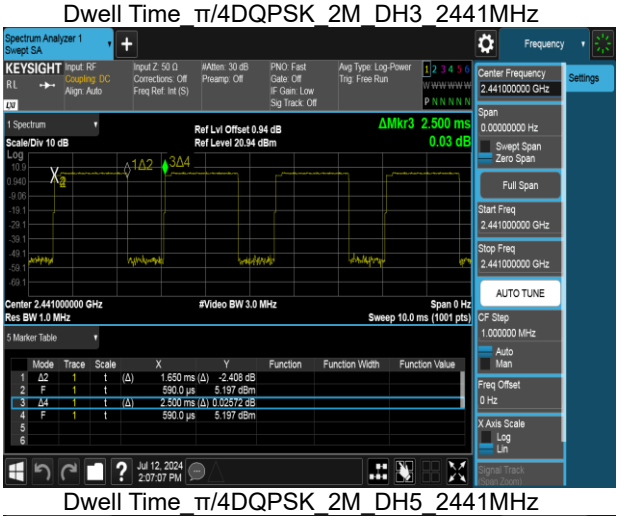

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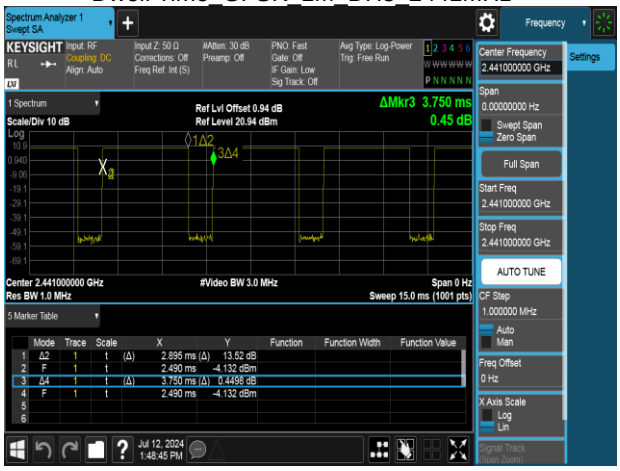

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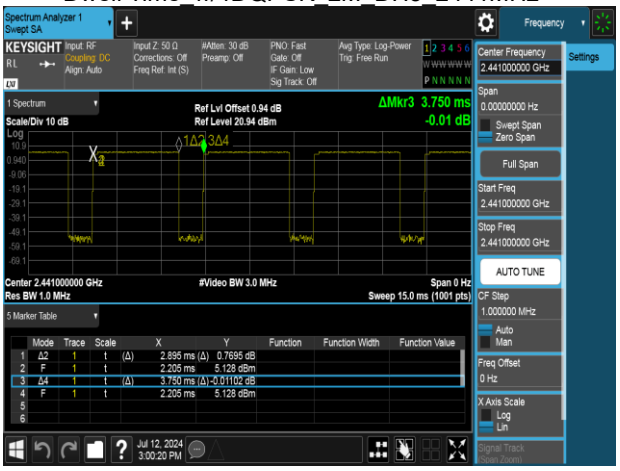
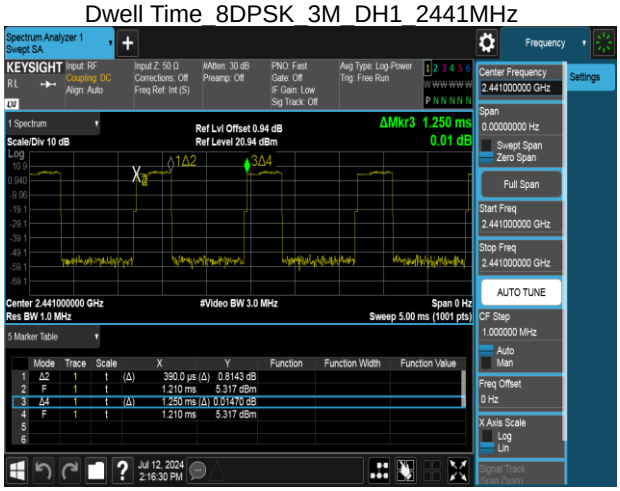
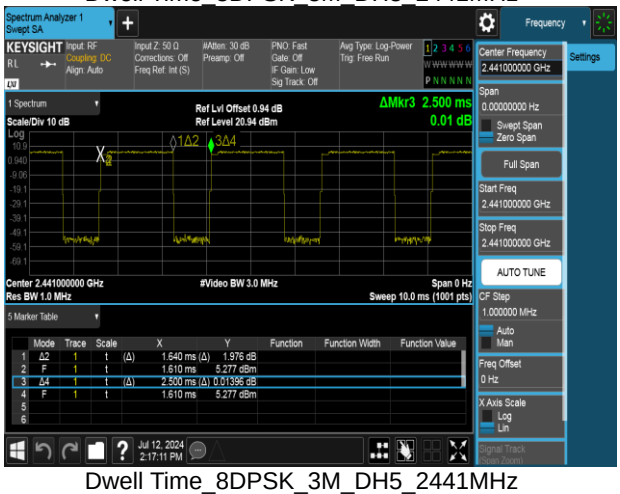


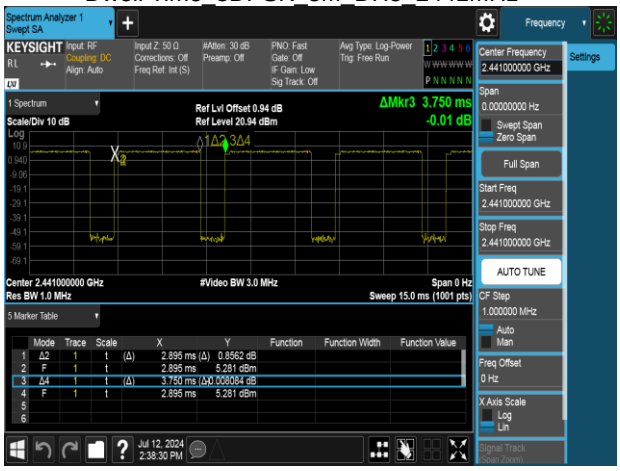
Dwell Time_8DPSK_3M_DH1_2441MHz



Dwell Time_8DPSK_3M_DH3_2441MHz



Dwell Time_8DPSK_3M_DH5_2441MHz



4. TEST RESULT

4.1 AC POWER LINE CONDUCTED EMISSION

4.1.1 Test Limit

According to §15.207(a),

Frequency Range (MHz)	Limits(dBμV)	
	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

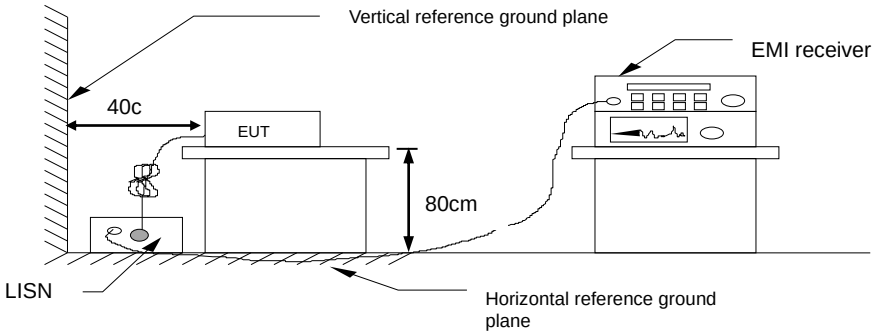
* Decreases with the logarithm of the frequency.

4.1.2 Test Procedure

Test method Refer as ANSI C63.10: 2013 clause 6.2,

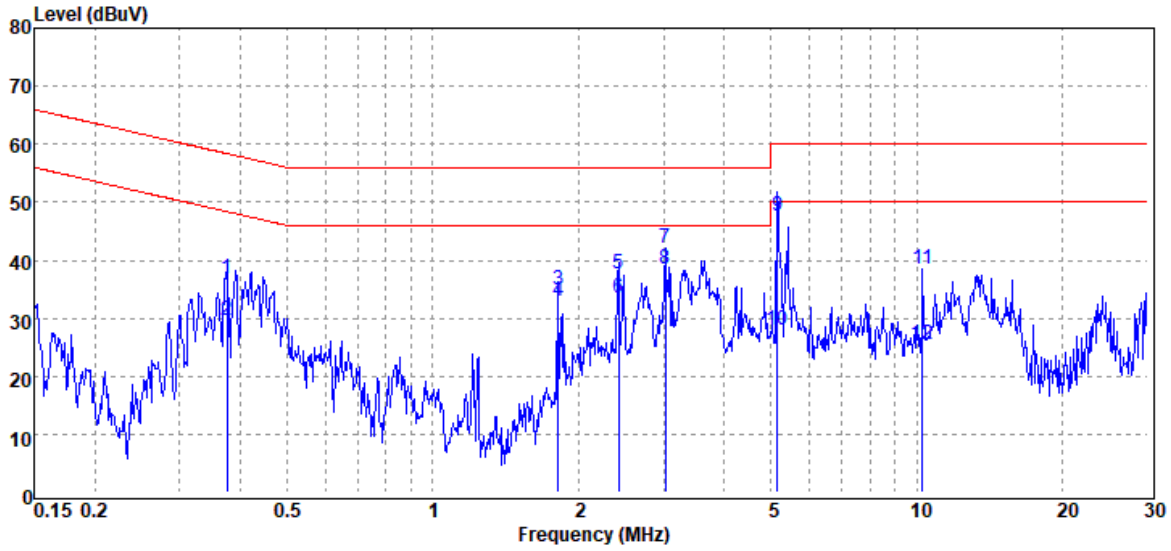
1. The EUT was placed on a non-conducted table, which is 0.8m above horizontal ground plane and 0.4m above vertical ground plane.
2. EUT connected to the line impedance stabilization network (LISN)
3. Receiver set RBW of 9kHz and Detector Peak, and note as quasi-peak and average.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. Recorded Line for Neutral and Line.

4.1.3 Test Setup



4.1.4 Test Result

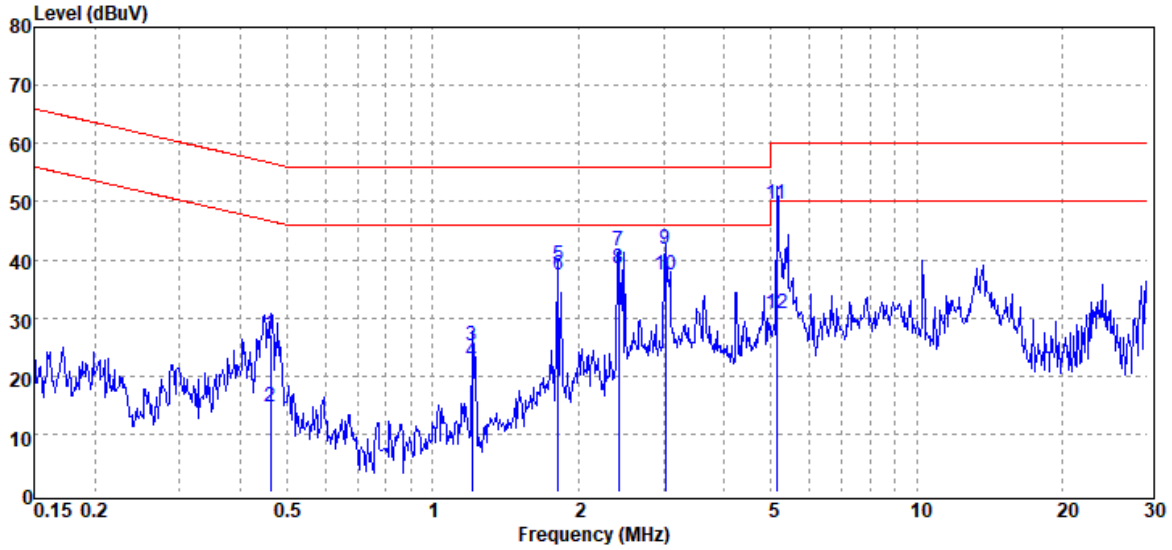
Project No	: TM-2407000112P	Test Date	: 2024-07-22
Operation Mode	: BT	Temp./Humi.	: 23.4°C / 54%
Test Chamber	: Conduction	Engineer	: Ben Yang
Probe	: LINE	Test Voltage	: AC 120V/60Hz
Note	:		



Freq.	Detector Mode	Spectrum Read Level	Factor	Actual FS	Limit	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV	dBµV	dB
0.375	QP	36.42	0.38	36.80	58.38	-21.58
0.375	Average	29.13	0.38	29.51	48.38	-18.87
1.817	QP	34.67	0.18	34.85	56.00	-21.15
1.817	Average	32.76	0.18	32.94	46.00	-13.06
2.422	QP	37.37	0.20	37.57	56.00	-18.43
2.422	Average	33.23	0.20	33.43	46.00	-12.57
3.019	QP	41.75	0.22	41.97	56.00	-14.03
3.019	Average	38.15	0.22	38.37	46.00	-7.63
5.151	QP	47.21	0.27	47.48	60.00	-12.52
5.151	Average	27.74	0.27	28.01	50.00	-21.99
10.283	QP	38.02	0.36	38.38	60.00	-21.62
10.283	Average	25.17	0.36	25.53	50.00	-24.47

Note: 1. Actual FS= Spectrum Read Level + Factor
Note: 2. Margin= Actual FS - Limit

Project No	: TM-2407000112P	Test Date	: 2024-07-22
Operation Mode	: BT	Temp./Humi.	: 23.4°C / 54%
Test Chamber	: Conduction	Engineer	: Ben Yang
Probe	: NEUTRAL	Test Voltage	: AC 120V/60Hz
Note	:		



Freq.	Detector Mode	Spectrum Read Level	Factor	Actual FS	Limit	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV	dBµV	dB
0.463	QP	26.84	0.35	27.19	56.64	-29.45
0.463	Average	14.31	0.35	14.66	46.64	-31.98
1.207	QP	24.95	0.14	25.09	56.00	-30.91
1.207	Average	22.34	0.14	22.48	46.00	-23.52
1.817	QP	38.99	0.16	39.15	56.00	-16.85
1.817	Average	37.18	0.16	37.34	46.00	-8.66
2.419	QP	41.35	0.18	41.53	56.00	-14.47
2.419	Average	38.32	0.18	38.50	46.00	-7.50
3.027	QP	41.56	0.19	41.75	56.00	-14.25
3.027	Average	37.14	0.19	37.33	46.00	-8.67
5.138	QP	49.26	0.25	49.51	60.00	-10.49
5.138	Average	30.49	0.25	30.74	50.00	-19.26

Note: 1. Actual FS= Spectrum Read Level + Factor
Note: 2. Margin= Actual FS - Limit

4.2 20dB BANDWIDTH AND OCCUPIED BANDWIDTH (99%)

4.2.1 Test Limit

According to §15.247(a) (1),

20 dB Bandwidth ：For reporting purposes only.

Occupied Bandwidth(99%) ：For reporting purposes only.

4.2.2 Test Procedure

Test method Refer as ANSI C63.10: 2013 clause 7.8.7,

1. The EUT RF output connected to the spectrum analyzer by RF cable.
2. Setting maximum power transmit of EUT
3. SA set RBW = 30kHz, VBW = 100kHz and Detector = Peak, to measurement 20 dB Bandwidth and 99% Bandwidth.
4. Measure and record the result of 20 dB Bandwidth and 99% Bandwidth. in the test report.

4.2.3 Test Setup

Refer to section 1.9.

4.2.4 Test Result

Temperature:	23.1 ~ 25.2℃	**Test date:**	July 12 ~ 30, 2024
Humidity:	50 ~ 61% RH	**Tested by:**	Jerry Chang

20dB BANDWIDTH

GFSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
Low	0.9508	0.63
Mid	0.9503	0.63
High	0.9506	0.63

π/4-DQPSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
Low	1.360	0.91
Mid	1.364	0.91
High	1.363	0.91

8-DPSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
Low	1.316	0.88
Mid	1.315	0.88
High	1.319	0.88

BANDWIDTH 99%

GFSK

CH	99% BW (MHz)
Low	0.90052
Mid	0.90147
High	0.90133

π/4-DQPSK

CH	99% BW (MHz)
Low	1.2055
Mid	1.2055
High	1.2036

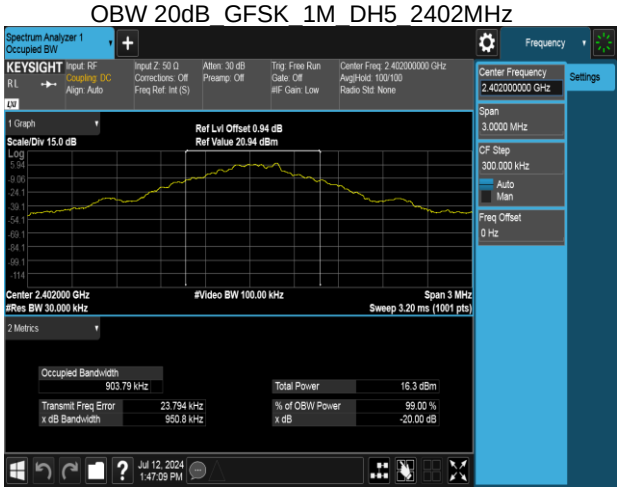
8-DPSK

CH	99% BW (MHz)
Low	1.2083
Mid	1.2085
High	1.2090

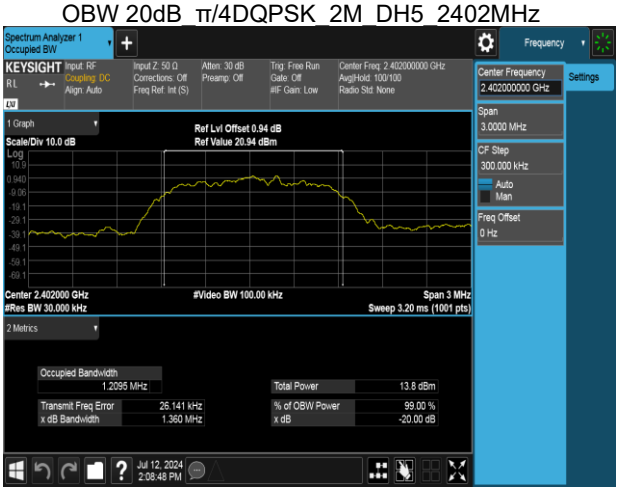
Test Data

20dB BANDWIDTH

OBW 20dB_GFSK_1M_DH5_2402MHz



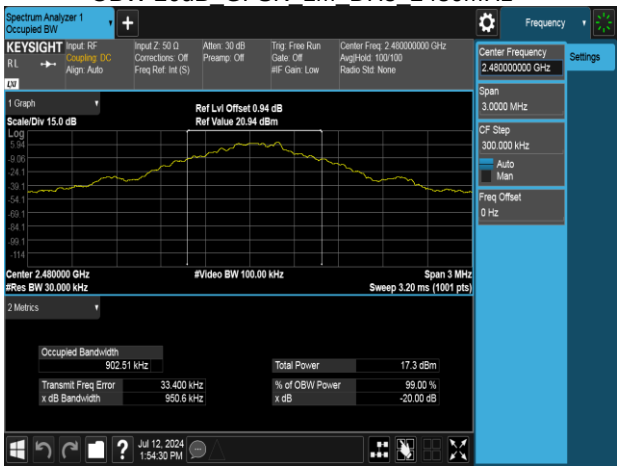
OBW 20dB_π/4DQPSK_2M_DH5_2402MHz



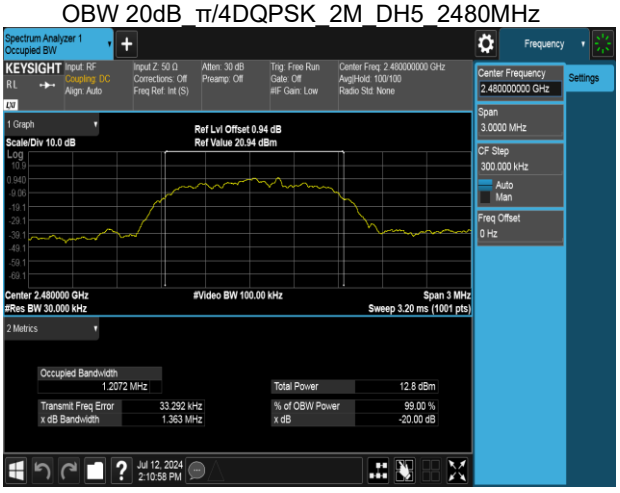
OBW 20dB_GFSK_1M_DH5_2441MHz

OBW 20dB_π/4DQPSK_2M_DH5_2441MHz

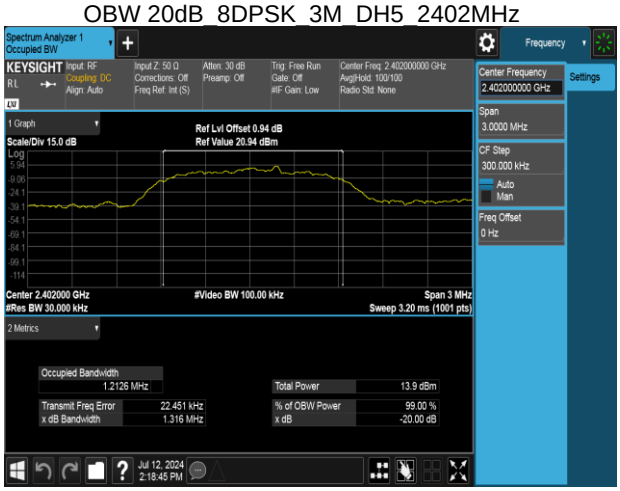
OBW 20dB_GFSK_1M_DH5_2480MHz



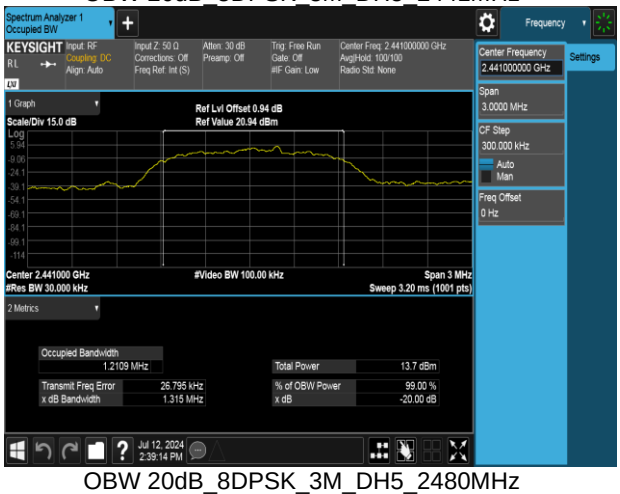
OBW 20dB_π/4DQPSK_2M_DH5_2480MHz



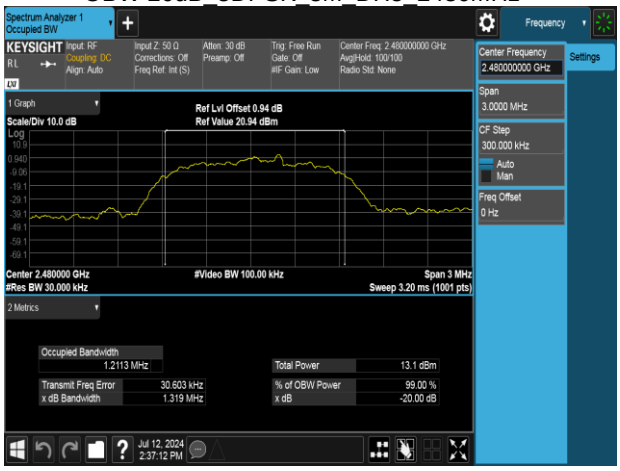
OBW 20dB_8DPSK_3M_DH5_2402MHz



OBW 20dB_8DPSK_3M_DH5_2441MHz

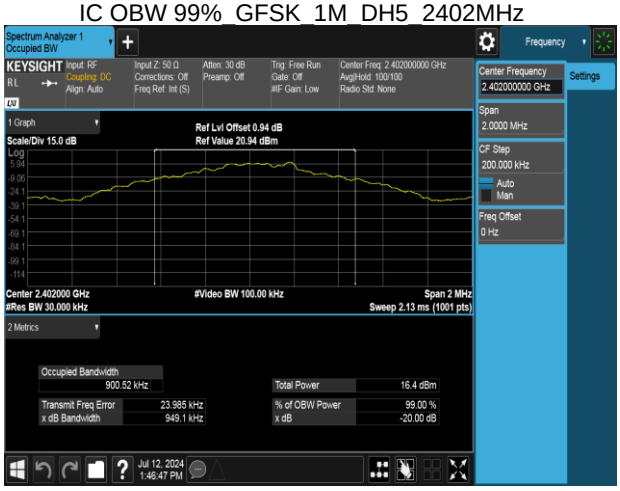


OBW 20dB_8DPSK_3M_DH5_2480MHz

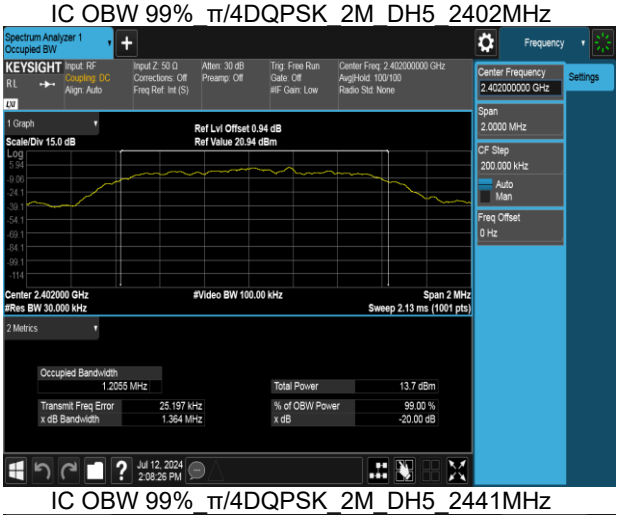


BANDWIDTH 99%

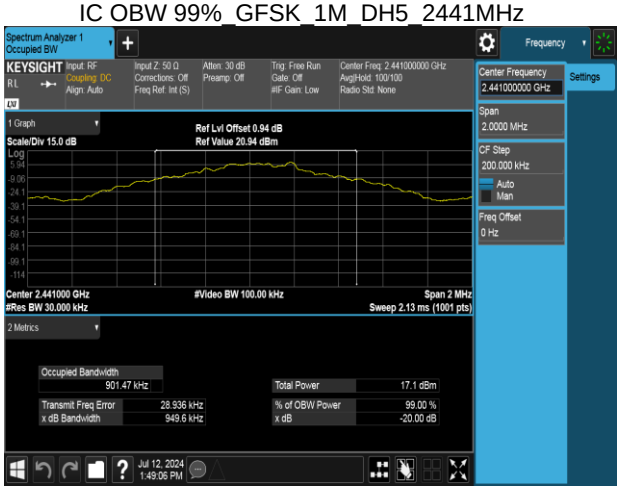
IC OBW 99% GFSK 1M DH5 2402MHz



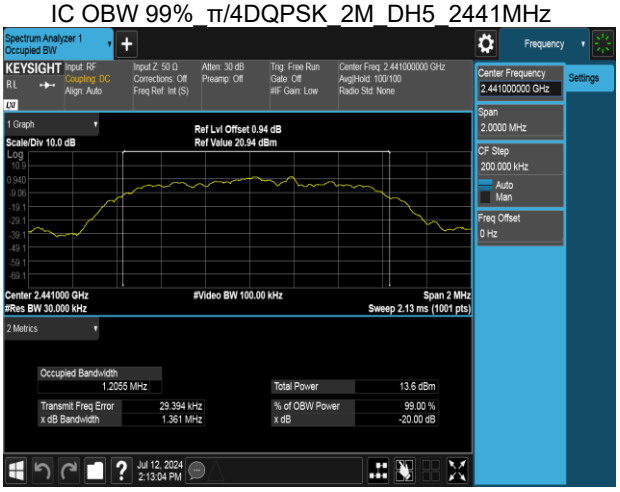
IC OBW 99% π/4DQPSK 2M DH5 2402MHz



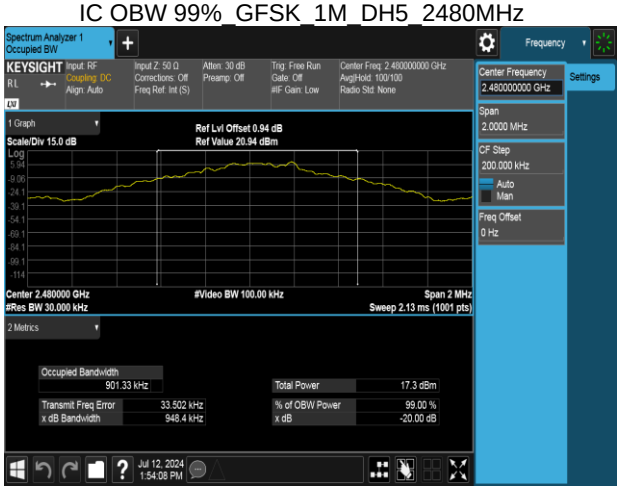
IC OBW 99% GFSK 1M DH5 2441MHz



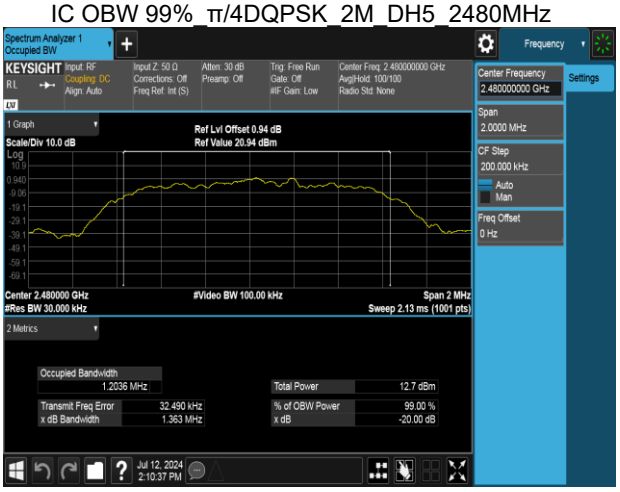
IC OBW 99% π/4DQPSK 2M DH5 2441MHz



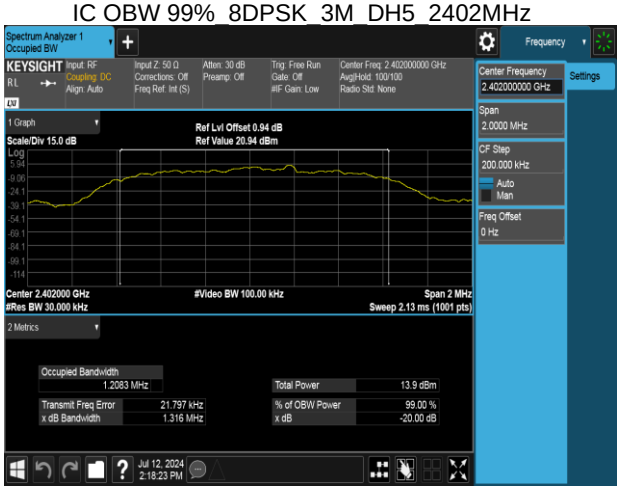
IC OBW 99% GFSK 1M DH5 2480MHz



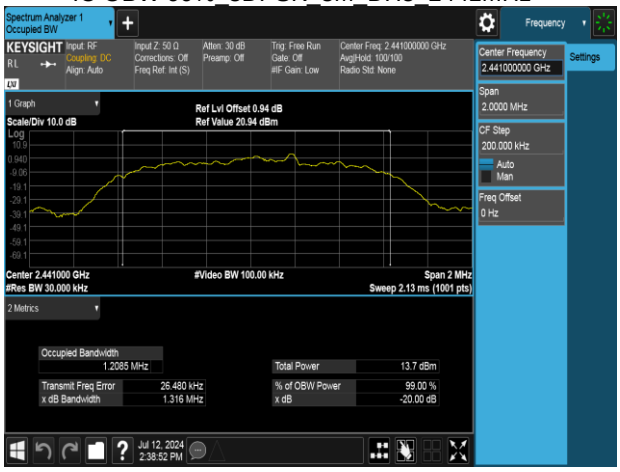
IC OBW 99% π/4DQPSK 2M DH5 2480MHz



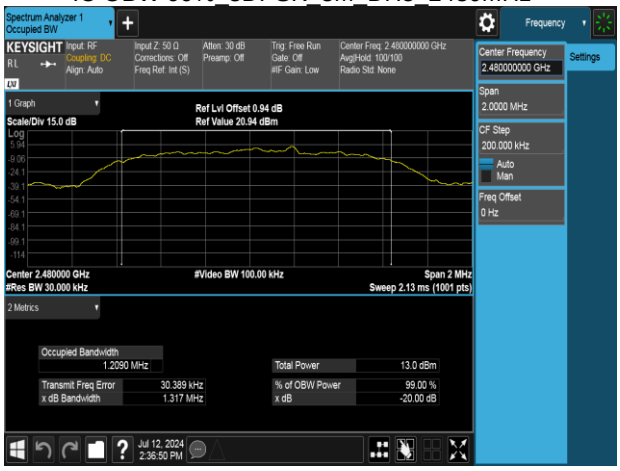
IC OBW 99%_8DPSK_3M_DH5_2402MHz



IC OBW 99%_8DPSK_3M_DH5_2441MHz



IC OBW 99%_8DPSK_3M_DH5_2480MHz



4.3 OUTPUT POWER MEASUREMENT

4.3.1 Test Limit

According to §15.247(a)(1),

Peak output power：

FCC

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

Average output power：For reporting purposes only.

4.3.2 Test Procedure

1. The EUT RF output connected to the power meter by RF cable.
2. Setting maximum power transmit of EUT.
3. The path loss was compensated to the results for each measurement.
4. Measure and record the result of Peak output power and Average output power. in the test report.

4.3.3 Test Setup

Refer to section 1.9.

4.3.4 Test Result

Temperature: 23.1 ~ 25.2℃ **Test date:** July 12 ~ 30, 2024

Humidity: 50 ~ 61% RH **Tested by:** Jerry Chang

Peak & Average output power：

1M BR mode (Peak):

CH	Freq. (MHz)	Power Setting	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	0	8.85	7.674	125
Mid	2441	0	9.79	9.528	125
High	2480	0	**9.93**	9.840	125

1M BR mode (Average):

CH	Freq. (MHz)	Power Setting	Avg. Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	0	8.79	7.575	125
Mid	2441	0	9.75	9.449	125
High	2480	0	9.86	9.691	125

2M EDR mode (Peak):

CH	Freq. (MHz)	Power Setting	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	0	7.77	5.984	125
Mid	2441	0	**7.98**	6.281	125
High	2480	0	7.25	5.309	125

2M EDR mode (Average):

CH	Freq. (MHz)	Power Setting	Avg. Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	0	5.49	3.543	125
Mid	2441	0	5.60	3.634	125
High	2480	0	4.81	3.030	125

3M EDR mode (Peak):

CH	Freq. (MHz)	Power Setting	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	0	7.93	6.209	125
Mid	2441	0	**8.16**	6.546	125
High	2480	0	7.51	5.636	125

3M EDR mode (Average):

CH	Freq. (MHz)	Power Setting	Avg. Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	0	5.50	3.551	125
Mid	2441	0	5.61	3.642	125
High	2480	0	4.88	3.079	125

Note: Measured by power meter, cable loss + Duty cycle factor has been offseted to the power meter for Avg. power and cable loss has been offseted for Peak power measurement.

4.4 FREQUENCY SEPARATION

4.4.1 Test Limit

According to §15.247(a)(1) ,

Alternatively, 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.

Limit	> two-thirds of the 20 dB bandwidth

4.4.2 Test Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. EUT RF output port connected to the SA by RF cable.
3. Set the spectrum analyzer as RBW = 300kHz, VBW = 910kHz, Sweep = auto. Max hold, mark 3 peaks of hopping channel and record the 3 peaks frequency

4.4.3 Test Setup

Refer to section 1.9.

4.4.4 Test Result

Temperature: 23.1 ~ 25.2℃ **Test date:** July 12 ~ 30, 2024

Humidity: 50 ~ 61% RH **Tested by:** Jerry Chang

Test mode: GFSK_BDR-1Mbps mode / 2402-2480 MHz				
Channel	**Frequency (MHz)**	**Channel Separation (MHz)**	**Channel Separation Limits (MHz)**	**Result**
Low	2402	1.000	0.63	PASS
Mid	2441	1.000	0.63	PASS
High	2480	1.000	0.63	PASS

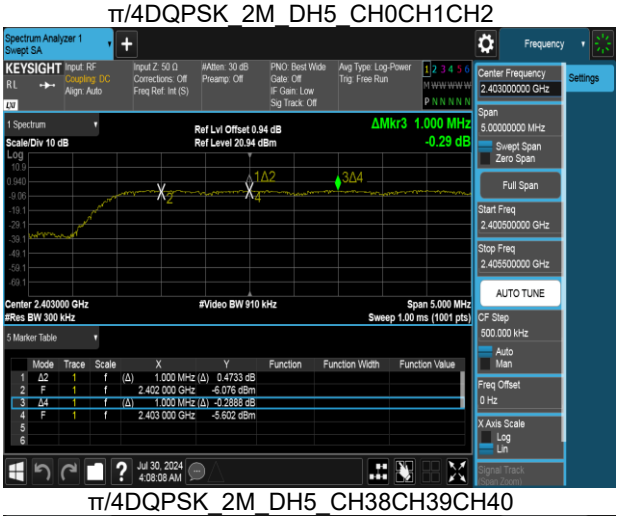
Test mode: π/4-DQPSK_2Mbps mode / 2402-2480 MHz				
Channel	**Frequency (MHz)**	**Channel Separation (MHz)**	**Channel Separation Limits (MHz)**	**Result**
Low	2402	1.000	0.91	PASS
Mid	2441	1.000	0.91	PASS
High	2480	1.000	0.91	PASS

Test mode: 8DPSK_EDR-3Mbps mode / 2402-2480 MHz				
Channel	**Frequency (MHz)**	**Channel Separation (MHz)**	**Channel Separation Limits (MHz)**	**Result**
Low	2402	1.000	0.88	PASS
Mid	2441	1.000	0.88	PASS
High	2480	1.000	0.88	PASS

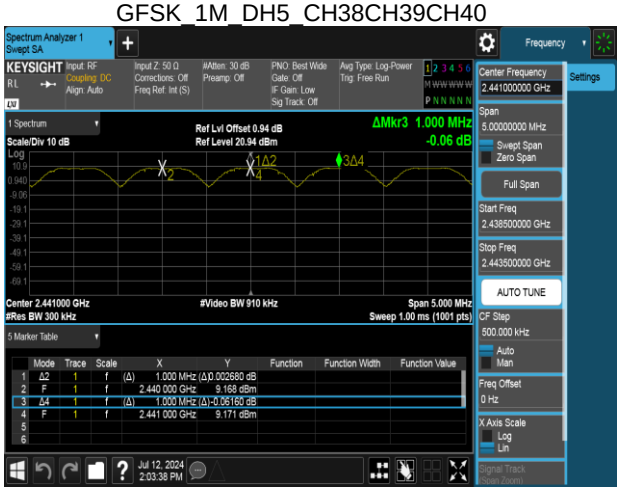
Test Data

GFSK_1M_DH5_CH0CH1CH2

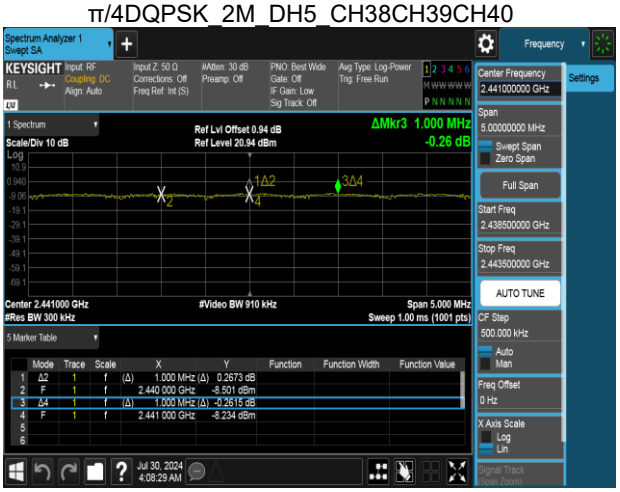
π/4DQPSK_2M_DH5_CH0CH1CH2



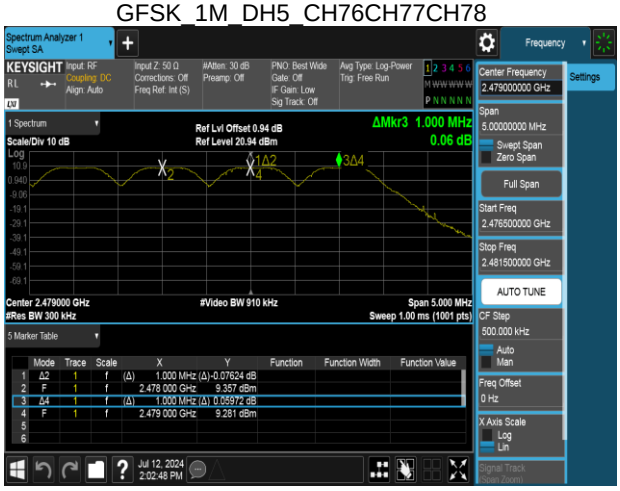
GFSK_1M_DH5_CH38CH39CH40



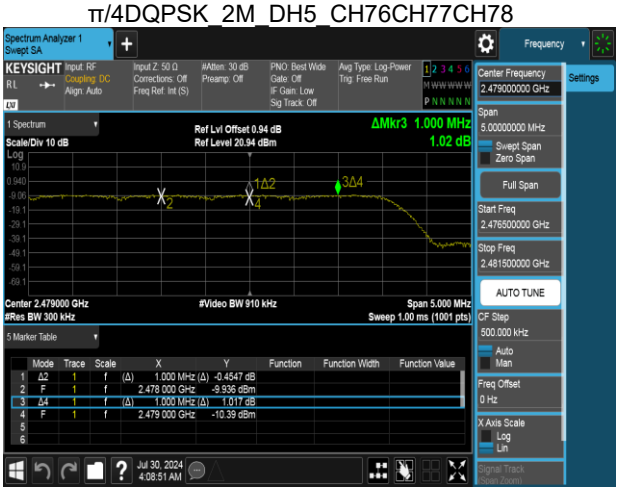
π/4DQPSK_2M_DH5_CH38CH39CH40



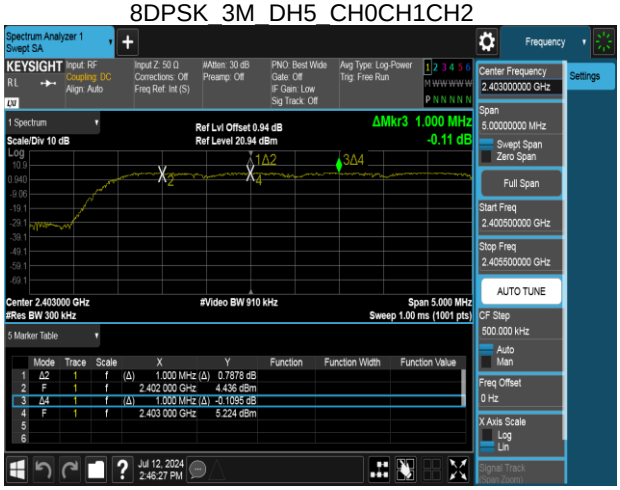
GFSK_1M_DH5_CH76CH77CH78



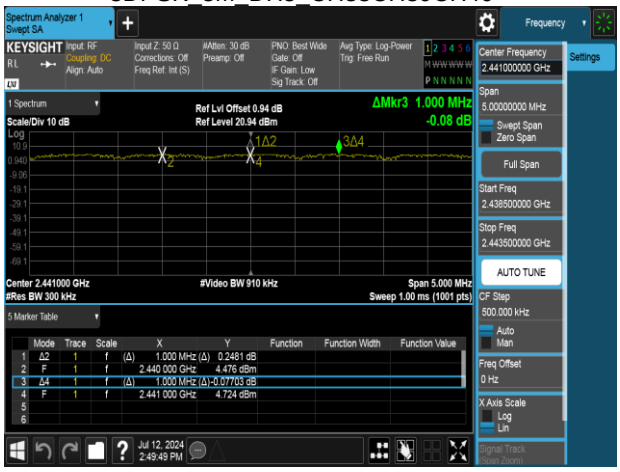
π/4DQPSK_2M_DH5_CH76CH77CH78



8DPSK_3M_DH5_CH0CH1CH2



8DPSK_3M_DH5_CH38CH39CH40



8DPSK_3M_DH5_CH76CH77CH78

4.5 NUMBER OF HOPPING

4.5.1 Test Limit

According to §15.247(a)(1)(iii),

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

4.5.2 Test Procedure

Test method Refer as ANSI C63.10: 2013 clause 7.8.3
1. Place the EUT on the table and set it in transmitting mode.
2. EUT RF output port connected to the SA by RF cable.
3. Set spectrum analyzer Start Freq. = 2400 MHz, Stop Freq. = 2441 MHz, RBW=300KHz, VBW =910kHz for left half.
4. Set spectrum analyzer Start Freq. = 2441 MHz, Stop Freq. = 2483.5 MHz, RBW=300KHz, VBW =910kHz for right half.
5. Max hold, view and count how many channel in the band.

4.5.3 Test Setup

Refer to section 1.9.

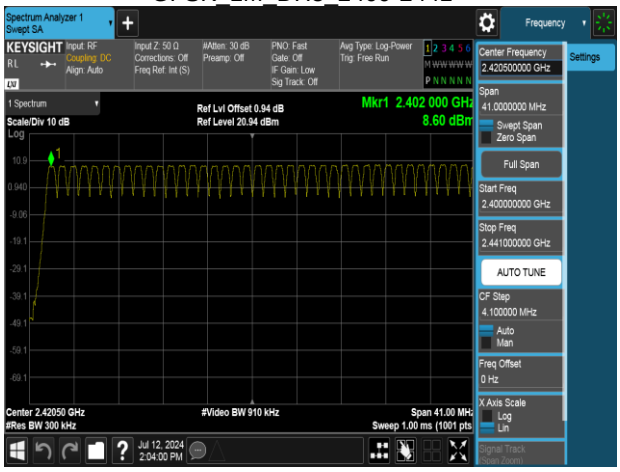
4.5.4 Test Result

Temperature:	23.1 ~ 25.2℃	**Test date:**	July 12 ~ 30, 2024
Humidity:	50 ~ 61% RH	**Tested by:**	Jerry Chang

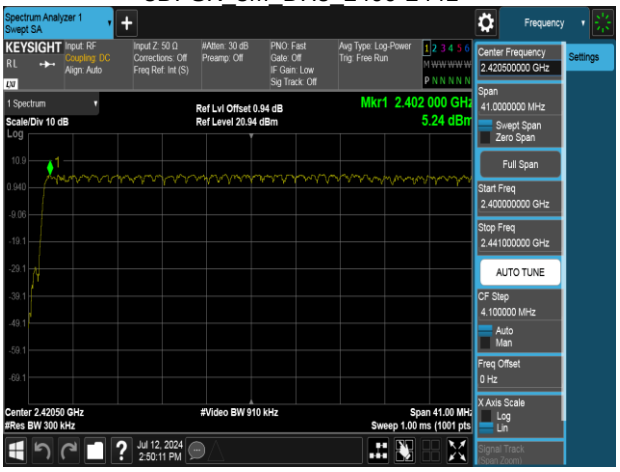
Number of Hopping				
Mode	**Frequency (MHz)**	**Hopping Channel Number**	**Hopping Channel Number Limits**	**Result**
BDR-1Mbps	2402-2480	79	15	Pass
EDR-3Mbps	2402-2480	79	15	

Test Data

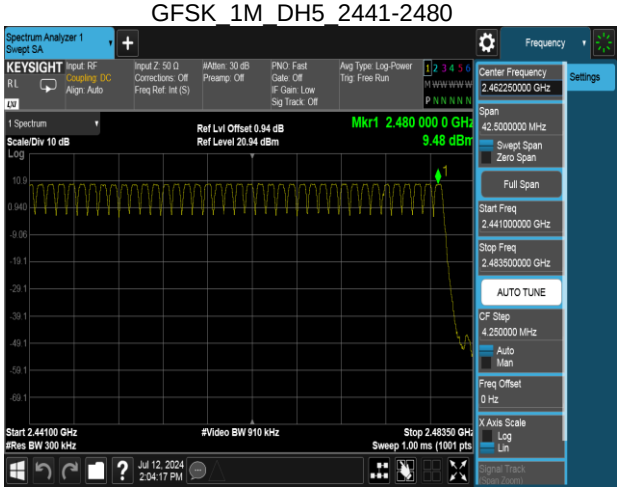
GFSK_1M_DH5_2400-2441



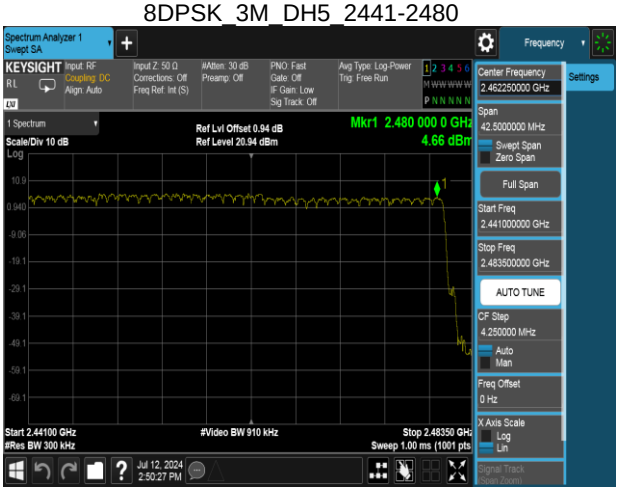
8DPSK_3M_DH5_2400-2441



GFSK_1M_DH5_2441-2480



8DPSK_3M_DH5_2441-2480



4.6 CONDUCTED BANDEDGE AND SPURIOUS EMISSION

4.6.1 Test Limit

According to §15.247(d),

Limit	-20 dBc

.

4.6.2 Test Procedure

1. EUT RF output port connected to the SA by RF cable, and the path loss was compensated to result.

2. SA setting, RBW=100kHz, VBW=300kHz, Detector=Peak, Trace mode = max hold, SWT = Auto.

3. The Band Edge at 2.4GHz and 2.4835GHz are investigated with both hopping “ON” and “OFF” modes “.

4.6.3 Test Setup

Refer to section 1.9.

4.6.4 Test Result

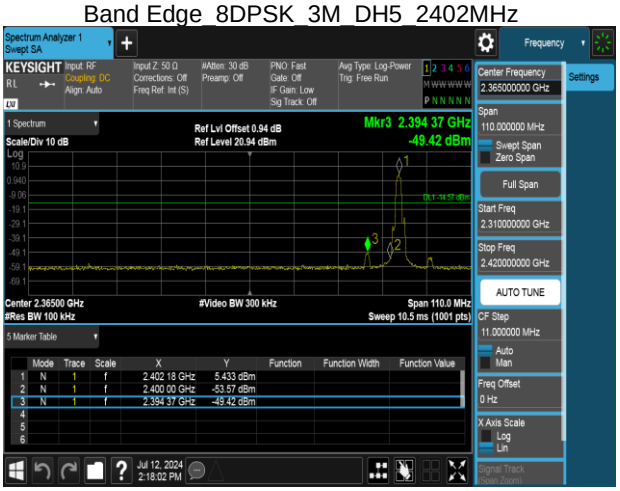
Temperature:	23.1 ~ 25.2℃	**Test date:**	July 12 ~ 30, 2024
Humidity:	50 ~ 61% RH	**Tested by:**	Jerry Chang

Test Data

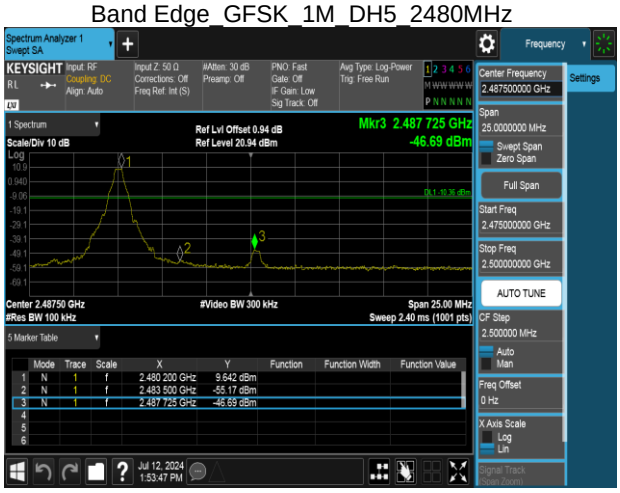
Band Edge

Band Edge_GFSK_1M_DH5_2402MHz

Band Edge_8DPSK_3M_DH5_2402MHz



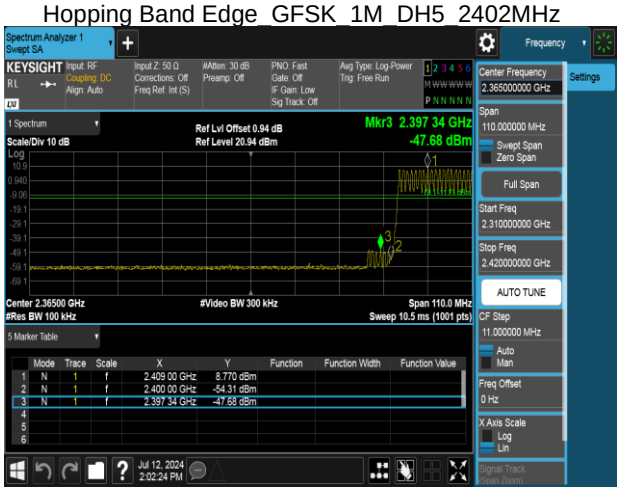
Band Edge_GFSK_1M_DH5_2480MHz



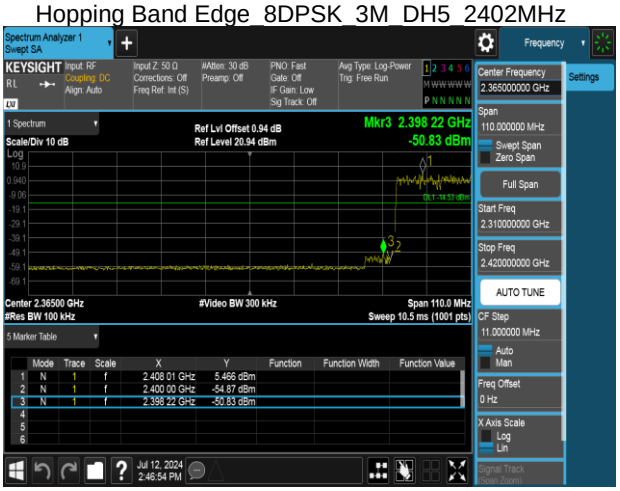
Band Edge_8DPSK_3M_DH5_2480MHz

Hopping mode

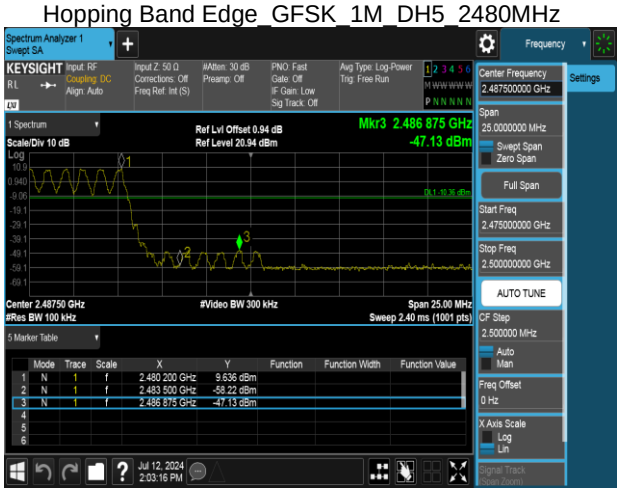
Hopping Band Edge_GFSK_1M_DH5_2402MHz



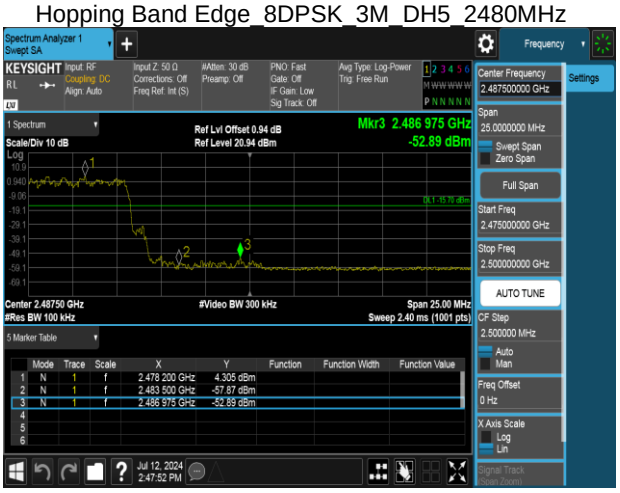
Hopping Band Edge_8DPSK_3M_DH5_2402MHz



Hopping Band Edge_GFSK_1M_DH5_2480MHz

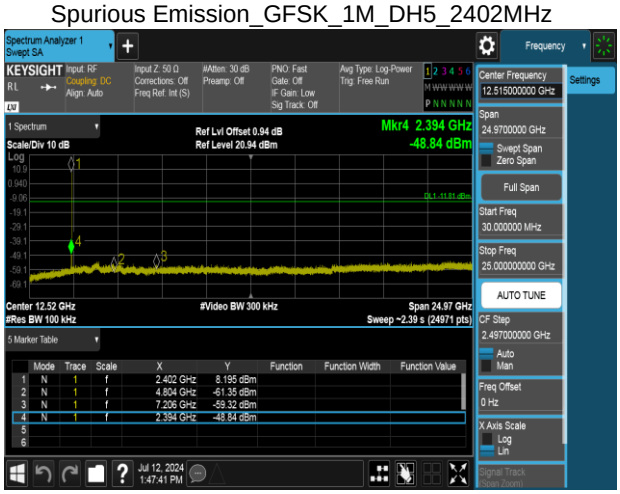


Hopping Band Edge_8DPSK_3M_DH5_2480MHz

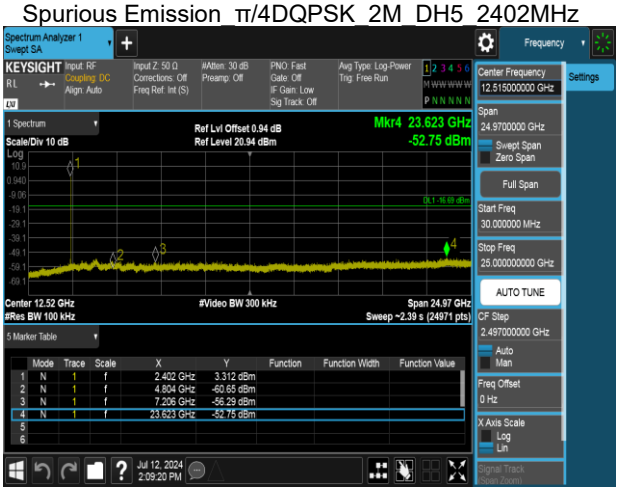


Spurious Emission

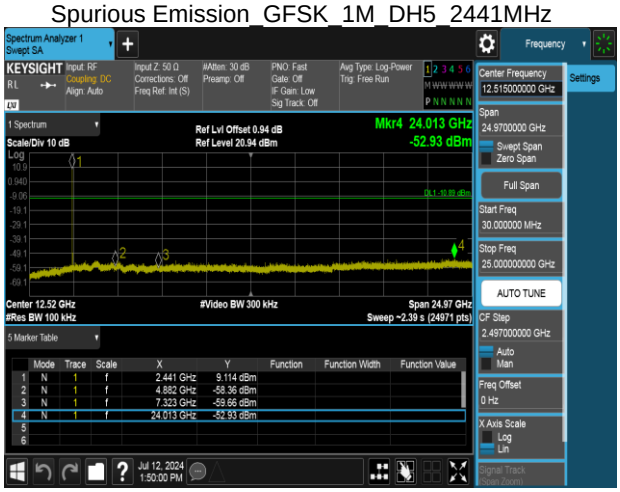
Spurious Emission_GFSK_1M_DH5_2402MHz



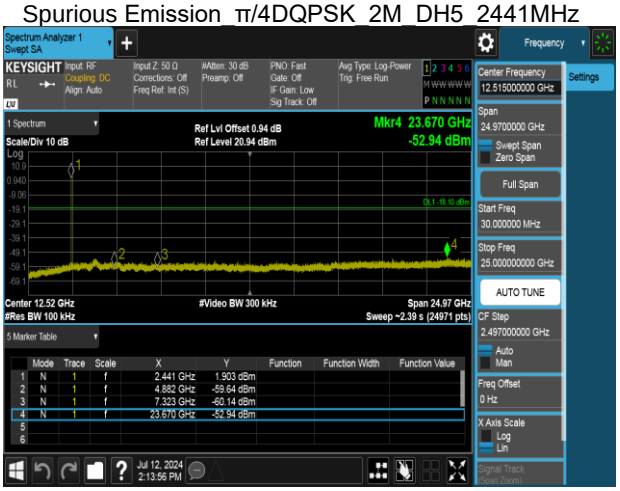
Spurious Emission_π/4DQPSK_2M_DH5_2402MHz



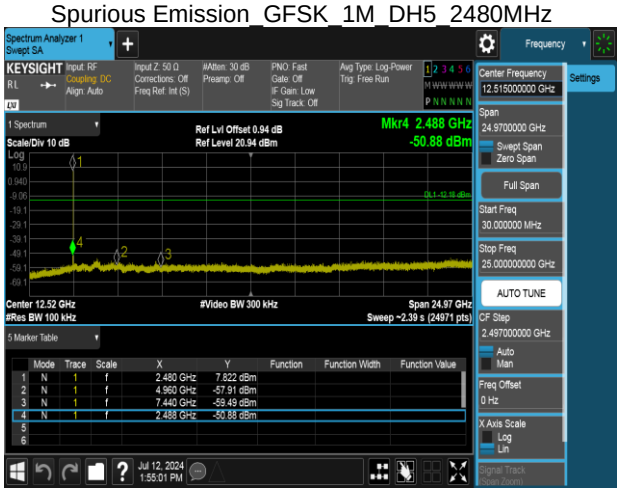
Spurious Emission_GFSK_1M_DH5_2441MHz



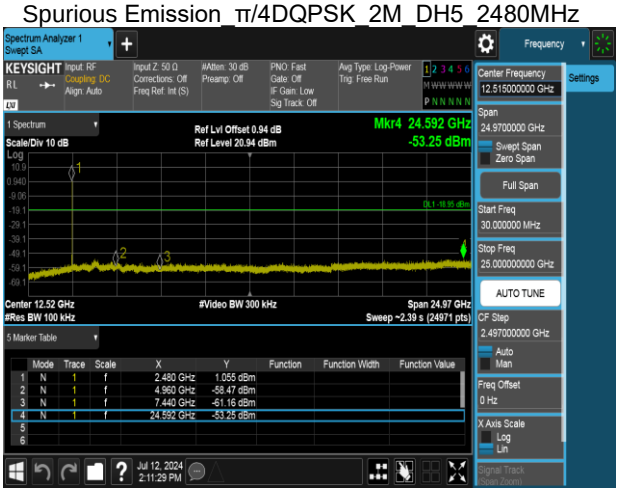
Spurious Emission_π/4DQPSK_2M_DH5_2441MHz



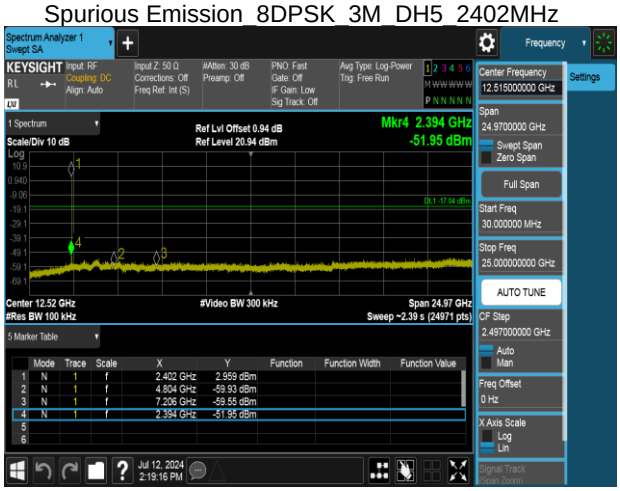
Spurious Emission_GFSK_1M_DH5_2480MHz



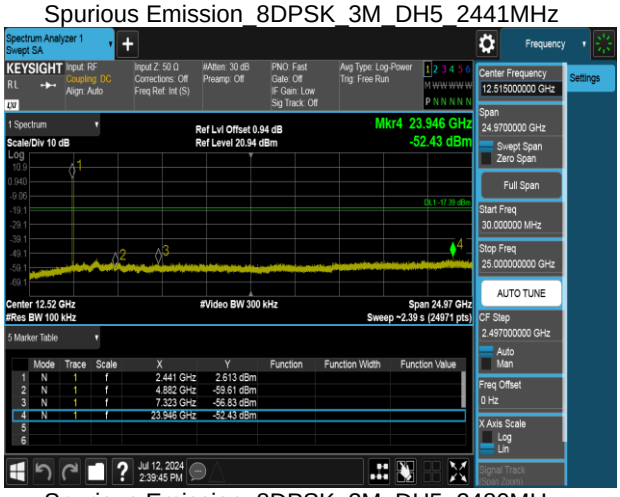
Spurious Emission_π/4DQPSK_2M_DH5_2480MHz



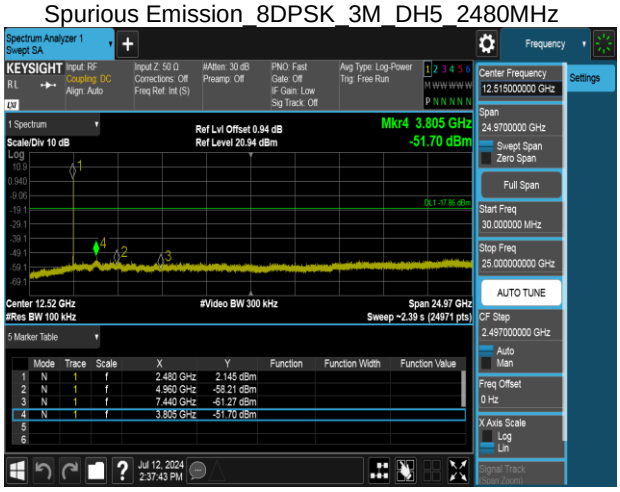
Spurious Emission_8DPSK_3M_DH5_2402MHz



Spurious Emission_8DPSK_3M_DH5_2441MHz



Spurious Emission_8DPSK_3M_DH5_2480MHz



4.7 TIME OF OCCUPANCY (DWELL TIME)

4.7.1 Test Limit

According to §15.247(a)(1)(iii),

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

4.7.2 Test Procedure

1. EUT RF output port connected to the SA by RF cable.

2. Set center frequency of spectrum analyzer = operating frequency.

3. Set the spectrum analyzer as RBW=1MHz, VBW=3MHz, Sweep = 5 ms ~15ms(Depends on signal characteristics)

4.7.3 Test Setup

Refer to section 1.9.

4.7.4 Test Result

Temperature: 23.1 ~ 25.2℃ **Test date:** July 12 ~ 30, 2024

Humidity: 50 ~ 61% RH **Tested by:** Jerry Chang

GFSK (1Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)
Mid	DH1	123.20	400
	DH3	262.40	400
	DH5	308.80	400

π/4 DQPSK (2Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)
Mid	2DH1	124.80	400
	2DH3	264.00	400
	2DH5	308.80	400

8-DPSK (3Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)
Mid	3DH1	124.80	400
	3DH3	262.40	400
	3DH5	308.80	400

GFSK (1Mbps):

CH Mid	DH1 time slot	=	0.385	*	(1600/2/79)	*	31.6	=	123.20 (ms)
	DH3 time slot	=	1.640	*	(1600/4/79)	*	31.6	=	262.40 (ms)
	DH5 time slot	=	2.895	*	(1600/6/79)	*	31.6	=	308.80 (ms)

π/4 -DQPSK (2Mbps):

CH Mid	2DH1 time slot	=	0.390	*	(1600/2/79)	*	31.6	=	124.80 (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	=	0.390	*	(1600/2/79)	*	31.6	=	124.80 (ms)
	3DH3 time slot	=	1.640	*	(1600/4/79)	*	31.6	=	262.40 (ms)
	3DH5 time slot	=	2.895	*	(1600/6/79)	*	31.6	=	308.80 (ms)

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

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

GFSK (1Mbps):

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

π/4 -DQPSK (2Mbps):

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

8-DPSK (3Mbps):

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

A period time=0.4 (s) * 20= 8 (s)

Note: Based on normal hopping, the DH5 type has worse results than DH1, so only DH5 is recorded.