



Project No: TM-2412000356P
Report No.: TMWK2503001161KR

FCC ID: QPKMBJWCAM5A

Page: 1 / 76
Rev.: 00

RADIO TEST REPORT

FCC 47 CFR PART 15 SUBPART C

Test Standard	FCC Part 15.247
Product name	SAPPHIRE PULSE(mother board)
Brand Name	Sapphire
Model No.	B650M
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:

Dally Hong
Sr. Engineer

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 90 days only.
除非另有說明，此報告結果僅對測試之樣品負責，同時此樣品僅保留90天。本報告未經本公司書面許可，不可部份複製。

This document is issued by the Company subject to its General Conditions of Service printed overleaf, available on request or accessible at <http://www.sgs.com.tw/Terms-and-Conditions> and, for electronic format documents, subject to Terms and Conditions for Electronic Documents at <http://www.sgs.com.tw/Terms-and-Conditions>. Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of client's instruction, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents. This document cannot be reproduced, except in full, without prior written approval of the Company. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law.

Revision History

Rev.	Issue Date	Revisions	Effect Page	Revised By
00	April 17, 2025	Initial Issue	ALL	Peggy Tsai

Table of contents

1. GENERAL INFORMATION	4
1.1 EUT INFORMATION	4
1.2 INFORMATION ABOUT THE FHSS CHARACTERISTICS.....	5
1.3 EUT CHANNEL INFORMATION	6
1.4 ANTENNA INFORMATION	6
1.5 MEASUREMENT UNCERTAINTY	7
1.6 FACILITIES AND TEST LOCATION	7
1.7 INSTRUMENT CALIBRATION.....	8
1.8 SUPPORT AND EUT ACCESSORIES EQUIPMENT.....	10
1.9 TEST SET UP DIAGRAM	11
1.10 TEST METHODOLOGY AND APPLIED STANDARDS	11
1.11 TEST METHODOLOGY AND APPLIED STANDARDS	11
2. TEST SUMMERY	12
3. DESCRIPTION OF TEST MODES	13
3.1 THE WORST MODE OF OPERATING CONDITION.....	13
3.2 THE WORST MODE OF MEASUREMENT	14
3.3 EUT DUTY CYCLE	15
4. TEST RESULT	18
4.1 AC POWER LINE CONDUCTED EMISSION	18
4.2 20DB BANDWIDTH AND OCCUPIED BANDWIDTH (99%)	21
4.3 OUTPUT POWER MEASUREMENT.....	28
4.4 FREQUENCY SEPARATION.....	30
4.5 NUMBER OF HOPPING	34
4.6 CONDUCTED BANDEDGE AND SPURIOUS EMISSION	36
4.7 TIME OF OCCUPANCY (DWELL TIME).....	41
4.8 RADIATION BANDEDGE AND SPURIOUS EMISSION	47
APPENDIX 1 - PHOTOGRAPHS OF EUT	

1. GENERAL INFORMATION

1.1 EUT INFORMATION

Applicant	Sapphire Technology Limited Unit 1910-1919, 19/F., Tower 2, Grand Central Plaza, 138 Shatin Rural Committee Road, Shatin, N.T., HK.
Manufacturer	Sapphire Technology Limited Unit 1910-1919, 19/F., Tower 2, Grand Central Plaza, 138 Shatin Rural Committee Road, Shatin, N.T., HK.
Equipment	SAPPHIRE PULSE(mother board)
Model No.	B650M
Model Discrepancy	N/A
Trade Name	Sapphire
Received Date	December 27, 2024
Date of Test	February 12 ~ 18, 2025
Power Operation	Powered from AC 120V
HW Version	JAM5MC05 V1.0
FW Version	BIOS AM50D101R3

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 its 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. $\pi/4$ -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 ☐ Coils
Antenna Brand / Model Name	South star / 301800008709
Antenna Gain	Gain: 3.83
Antenna Connector	SMA

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	+/- 2.21 dB
Channel Bandwidth	+/- 2.79 dB
RF output power (Power Meter + Power sensor)	+/- 0.24 dB
Channel Separation	+/- 2.76 dB
Conducted Bandedge	+/- 2.74 dB
Conducted Spurious Emission	+/- 2.74 dB
Radiated Emission_9kHz-30MHz	+/- 3.492 dB
Radiated Emission_30MHz-200MHz	+/- 3.62 dB
Radiated Emission_200MHz-1GHz	+/- 3.899 dB
Radiated Emission_1GHz-6GHz	+/- 5.063 dB
Radiated Emission_6GHz-18GHz	+/- 5.122 dB
Radiated Emission_18GHz-26GHz	+/- 3.032 dB
Radiated Emission_26GHz-40GHz	+/- 3.271 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	-
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
Cable	Woken	WC12	CC003	2024-06-26	2025-06-25
Cable	Woken	WC12	CC001	2024-06-26	2025-06-25
PXA Signal Analyzer	Keysight	N9030B	MY62291089	2024-10-04	2025-10-03
Power Sensor	Anritsu	MA2411B	1911387	2024-08-30	2025-08-29
Power Sensor	Anritsu	MA2411B	1911386	2024-07-19	2025-07-18
Power Meter	Anritsu	ML2496A	2136002	2024-07-19	2025-07-18
DC Blocks	Marvelous Microwave	MVE6411	MVE-001	2024-08-08	2025-08-07
Software	Radio Test Software Ver. 21				

Remark:

- Each piece of equipment is scheduled for calibration once a year.
- N.C.R. = No Calibration Required.

966A_Radiated					
Name of Equipment	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due
Signal Analyzer	KEYSIGHT	N9010A	MY52220817	2024-03-15	2025-03-14
Active Loop Antenna	SCHWARZBECK	FMZB 1513-60	1513-60-028	2024-12-11	2025-12-10
Thermo-Hygro Meter	WISEWIND	1206	D07	2024-11-26	2025-11-25
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	2024-08-07	2025-08-06
Horn Antenna	ETC	MCTD 1209	DRH13M02003	2024-12-20	2025-12-19
Preamplifier	HP	8449B	3008A00965	2024-12-18	2025-12-17
Cable	EMCI	EMC101G	221011+221012+221213	2024-10-11	2025-10-10
Attenuator	Mini-Circuits	BW-S9W5	BWS9W5-09-966A-01	2024-02-07 2025-02-06	2025-02-06 2026-02-05
Site Validation	CCS	966A	N/A	2024-08-03	2025-08-02
High Pass Filters	Titan Microwave	T04H30001800070S01	22011402-4	2024-06-12	2025-06-11
Pre-Amplifier	EMCI	EMC184045SE	980860	2024-12-02	2025-12-01
Horn Antenna	SCHWARZBECK	BBHA9170	1047	2024-12-06	2025-12-05
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				

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
Software	e3 V6-110812				

Remark:

- Each piece of equipment is scheduled for calibration once a year.
- N.C.R. = No Calibration Required.

1.8 SUPPORT AND EUT ACCESSORIES EQUIPMENT

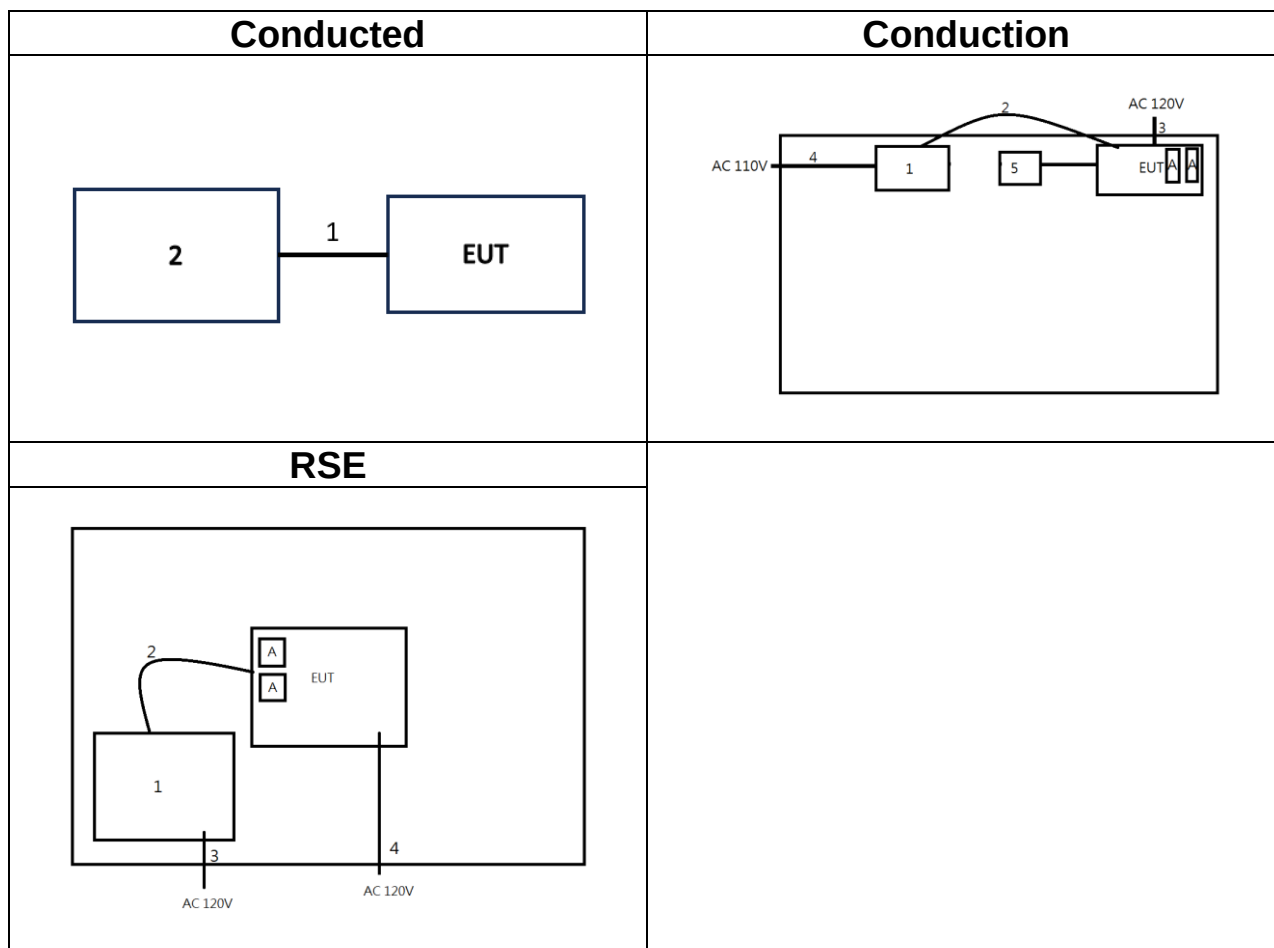
EUT Accessories Equipment						
No.	Equipment	Brand	Model	Series No.	FCC ID	IC
	N/A					

Support Equipment (Conducted)						
No.	Equipment	Brand	Model	Series No.	FCC ID	
1	HDMI Cable	High Speed	E342987	N/A	N/A	
2	LCD Monitor	Lenovo	A20238FT0	N/A	N/A	

Support Equipment (Conduction)						
No.	Equipment	Brand	Model	Series No.	FCC ID	
1	Monitor	Lenovo	A20238FT0	VKPN2606	N/A	
2	HDMI Cable	High Speed	E342987	N/A	N/A	
3	Power Cable	N/A	N/A	N/A	N/A	
4	Power Cable	N/A	N/A	N/A	N/A	
5	Mouse	Lenovo	MO32BOA	4460028	N/A	
A	Dipole Antenna	South star	301800008709	N/A	N/A	

Support Equipment (RSE)						
No.	Equipment	Brand	Model	Series No.	FCC ID	
1	Monitor	Lenovo	A20238FT0	VKPN2606	N/A	
2	HDMI Cable	High Speed	E342987	N/A	N/A	
3	Power Cable	StarTech	5214-PXT101_3-ND	PXT101_3	N/A	
4	Power Cable	StarTech	5214-PXT101_3-ND	PXT101_3	N/A	
A	Dipole Antenna	South star	301800008709	N/A	N/A	

1.9 TEST SET UP DIAGRAM



1.10 TEST METHODOLOGY AND APPLIED STANDARDS

The EUT connection corresponds to the surrounding fixture control board.
This EUT uses MP tool & RtlBluetoothMP tool 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) $\pi/4$ -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 $\pi/4$-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 , $\pi/4$ DQPSK ,8DPSK , the $\pi/4$ 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 Conduction Emission	
Test Condition	AC Power line conduction emission for line and neutral
Power supply Mode	Mode 1: EUT Power by AC 120V
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 AC(120V)
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 AC(120V)
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

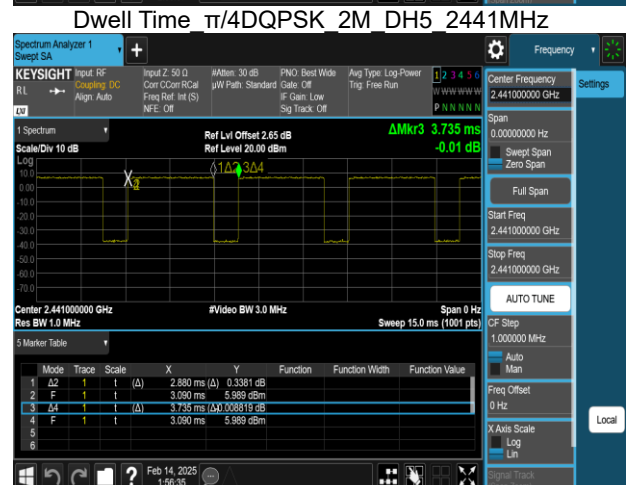
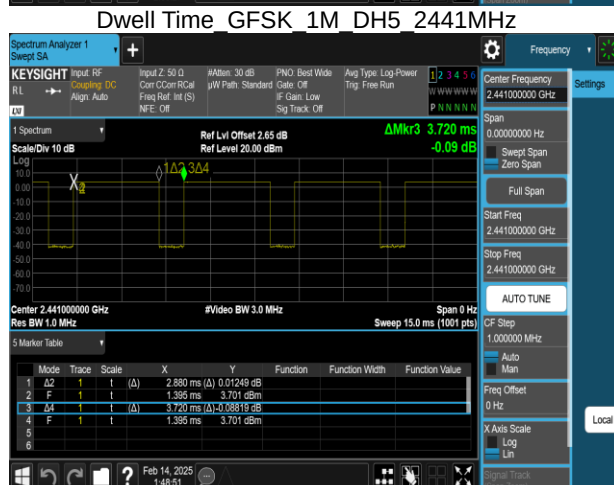
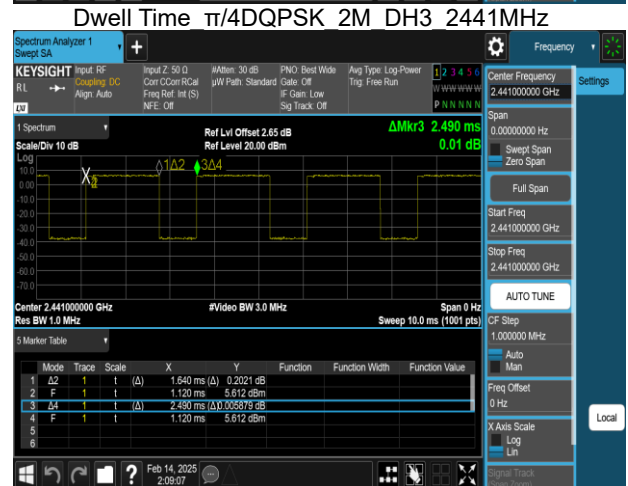
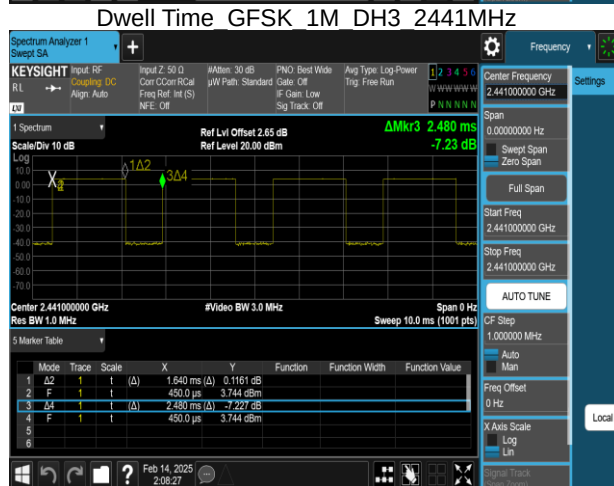
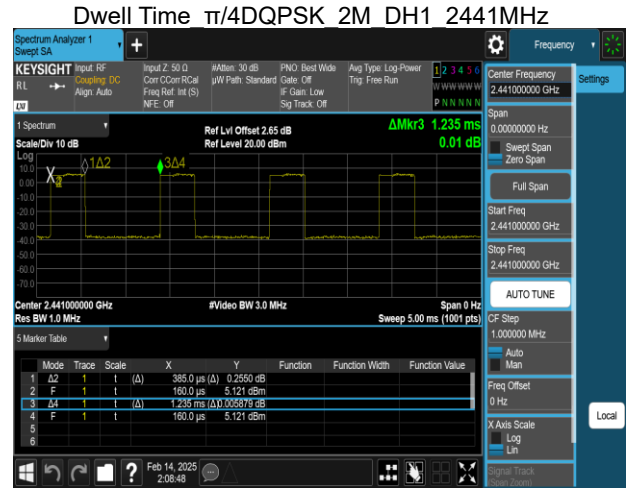
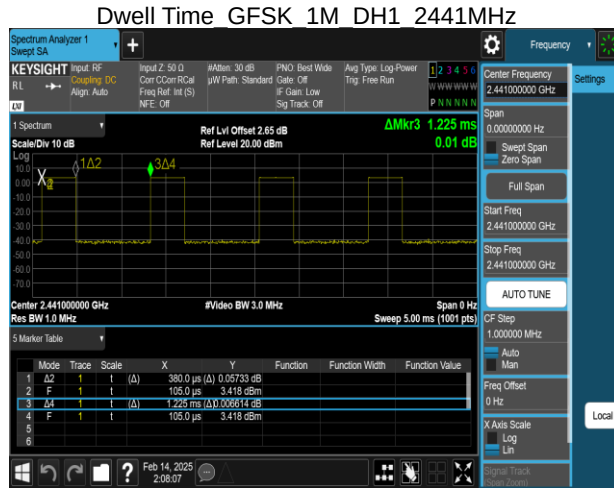
Temperature: 22.6°C

Test date: February 14, 2025

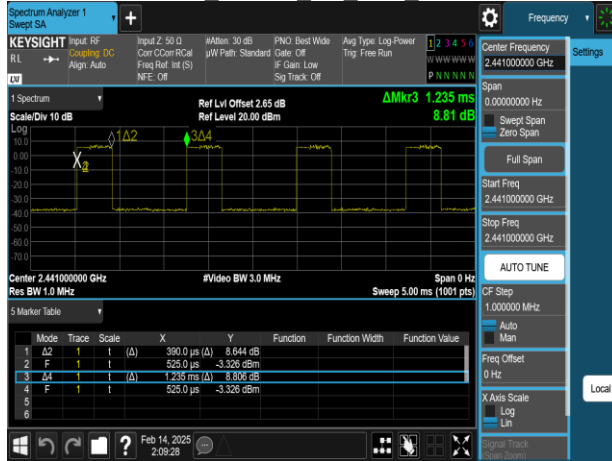
Humidity: 56% RH

Tested by: Jerry Chang

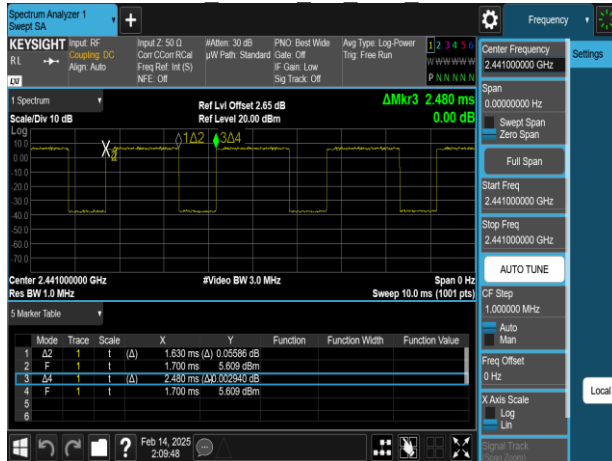
Mode	Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log (1/Duty Cycle)	1/T (kHz)	VBW setting (kHz)
DH1	31.02	5.08	2.63	3.00
DH3	66.13	1.80	0.61	1.00
DH5	77.42	1.11	0.35	1.00
2DH1	31.17	5.06	2.60	3.00
2DH3	65.86	1.81	0.61	1.00
2DH5	77.11	1.13	0.35	1.00
3DH1	31.58	5.01	2.56	3.00
3DH3	65.73	1.82	0.61	1.00
3DH5	77.11	1.13	0.35	1.00



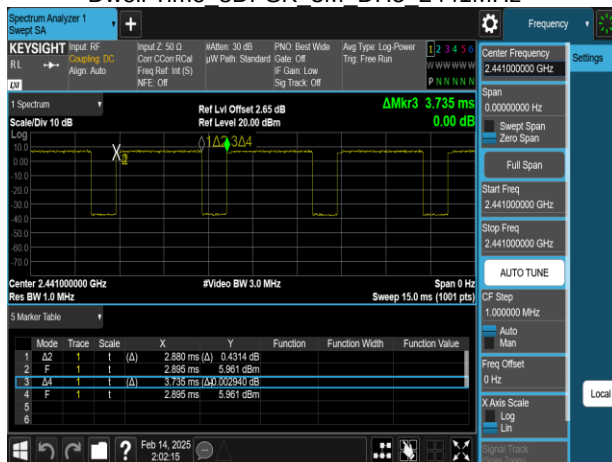
Dwell Time 8DPSK 3M DH1 2441MHz



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(dB μ V)	
	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

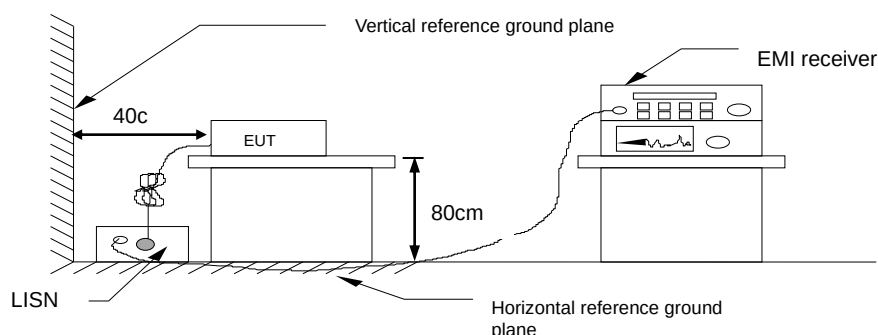
* Decreases with the logarithm of the frequency.

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.

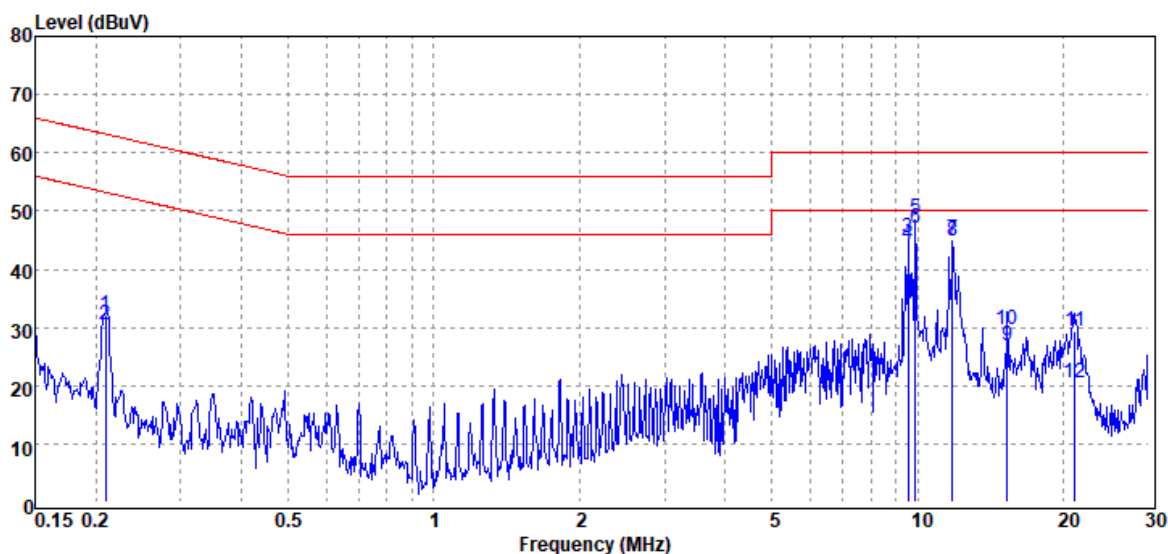
4.1.3 Test Setup



4.1.4 Test Result

Project No : TM-2412000356P
Operation Mode : BT
Test Chamber : Conduction
Probe : LINE
Note :

Test Date : 2025-02-12
Temp./Humi. : 23.4°C / 54%
Engineer : Ben.Yang
Test Voltage : AC 120V/60Hz



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Read Level dBμV	Factor dB	Actual FS dBμV	Limit dBμV	Margin dB
0.210	QP	31.83	0.39	32.22	63.21	-30.99
0.210	Average	30.16	0.39	30.55	53.21	-22.66
9.555	QP	45.17	0.36	45.53	60.00	-14.47
9.555	Average	44.02	0.36	44.38	50.00	-5.62
9.884	QP	48.35	0.36	48.71	60.00	-11.29
9.884	Average	46.83	0.36	47.19	50.00	-2.81
11.816	QP	44.68	0.38	45.06	60.00	-14.94
11.816	Average	44.37	0.38	44.75	50.00	-5.25
15.294	QP	29.19	0.43	29.62	60.00	-30.38
15.294	Average	26.28	0.43	26.71	50.00	-23.29
21.124	QP	28.74	0.49	29.23	60.00	-30.77
21.124	Average	19.97	0.49	20.46	50.00	-29.54

Note: 1. Actual FS= Spectrum Read Level + Factor

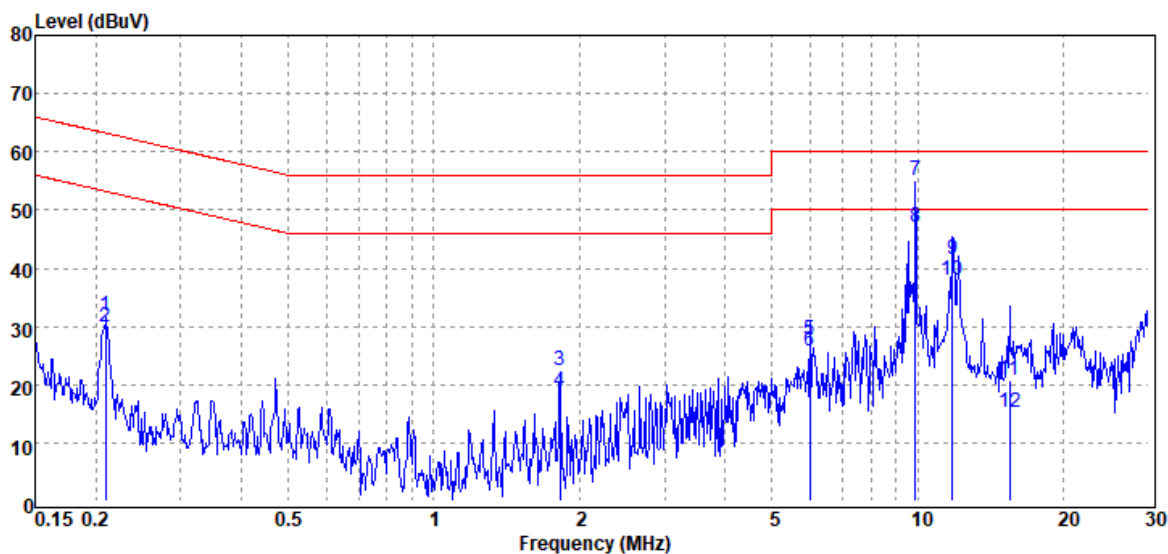
Note: 2. Margin= Actual FS - Limit

Project No: TM-2412000356P
Report No.: TMWK2503001161KR

Page: 20 / 76
Rev.: 00

Project No : TM-2412000356P
Operation Mode : BT
Test Chamber : Conduction
Probe : NEUTRAL
Note :

Test Date : 2025-02-12
Temp./Humi. : 23.4°C / 54%
Engineer : Ben.Yang
Test Voltage : AC 120V/60Hz



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Read Level dBμV	Factor dB	Actual FS dBμV	Limit dBμV	Margin dB
0.210	QP	31.41	0.36	31.77	63.21	-31.44
0.210	Average	29.55	0.36	29.91	53.21	-23.30
1.822	QP	22.28	0.16	22.44	56.00	-33.56
1.822	Average	18.71	0.16	18.87	46.00	-27.13
5.984	QP	27.51	0.27	27.78	60.00	-32.22
5.984	Average	25.41	0.27	25.68	50.00	-24.32
9.884	QP	54.83	0.34	55.17	60.00	-4.83
9.884	Average	46.60	0.34	46.94	50.00	-3.06
11.816	QP	41.04	0.36	41.40	60.00	-18.60
11.816	Average	37.59	0.36	37.95	50.00	-12.05
15.470	QP	20.32	0.40	20.72	60.00	-39.28
15.470	Average	14.87	0.40	15.27	50.00	-34.73

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: 22.6°C
Humidity: 56% RH

Test date: February 14, 2025
Tested by: Jerry Chang

20dB BANDWIDTH

GFSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
0	0.955	0.64
39	0.9552	0.64
78	0.9552	0.64

$\pi/4$ -DQPSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
0	1.282	0.85
39	1.282	0.85
78	1.283	0.86

8-DPSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
0	1.290	0.86
39	1.290	0.86
78	1.291	0.86

BANDWIDTH 99%

GFSK

CH	99% BW (MHz)
0	0.88398
39	0.8827
78	0.87765

$\pi/4$ -DQPSK

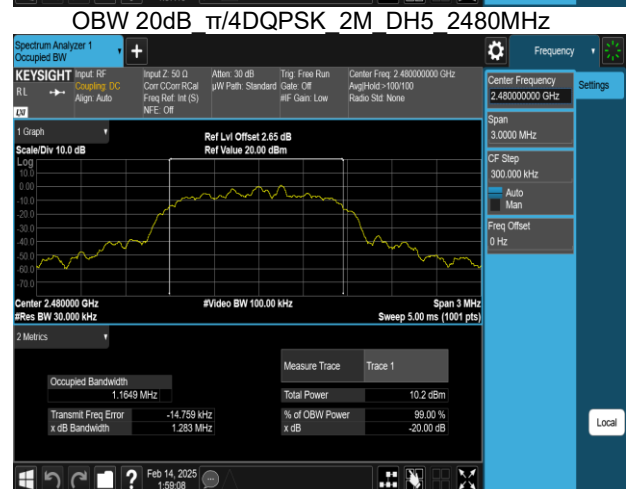
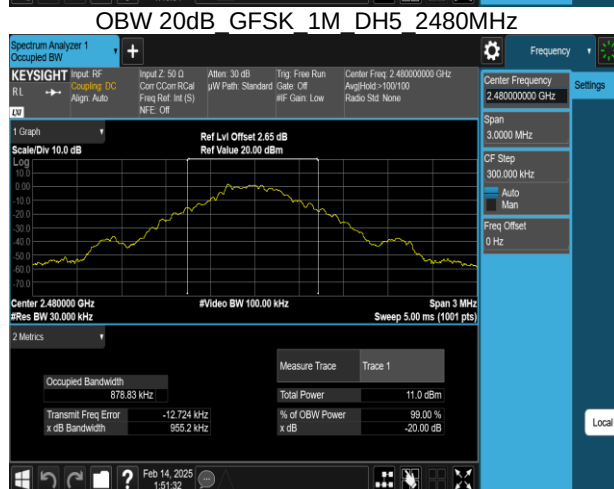
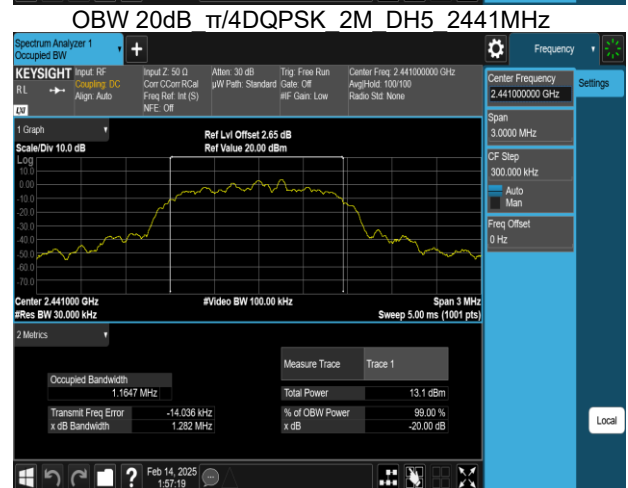
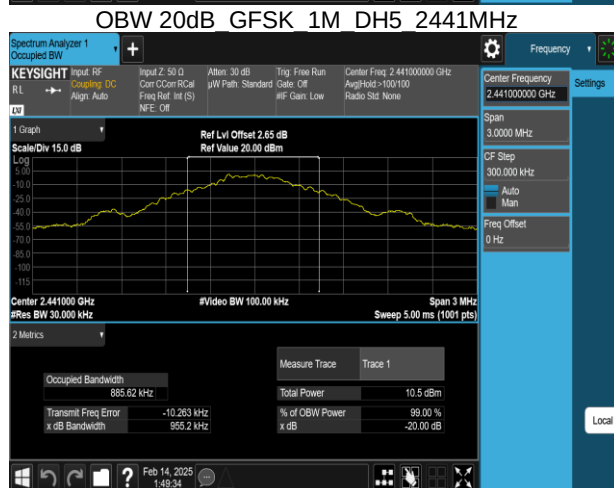
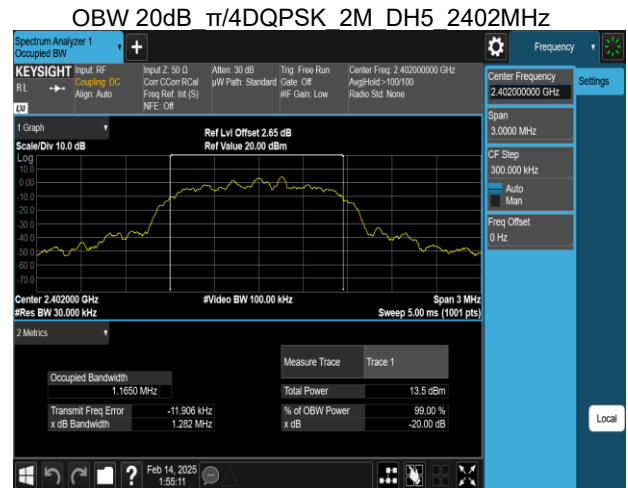
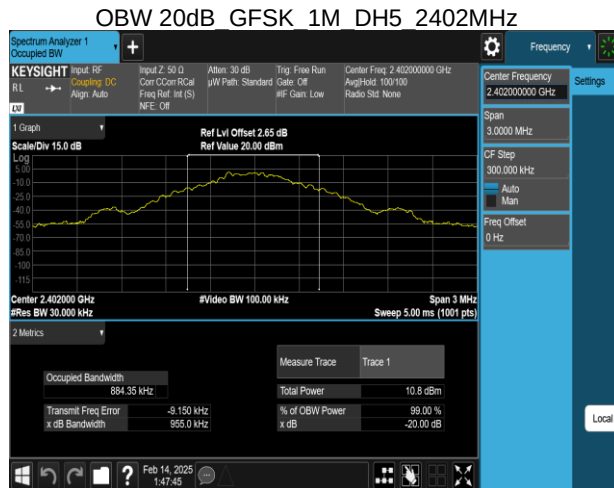
CH	99% BW (MHz)
0	1.1645
39	1.1643
78	1.1639

8-DPSK

CH	99% BW (MHz)
0	1.1674
39	1.1675
78	1.1680

Test Data

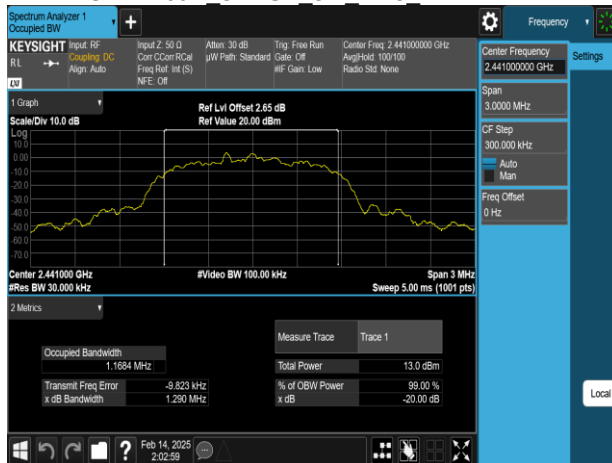
20dB BANDWIDTH



OBW 20dB 8DPSK 3M DH5 2402MHz



OBW 20dB 8DPSK 3M DH5 2441MHz

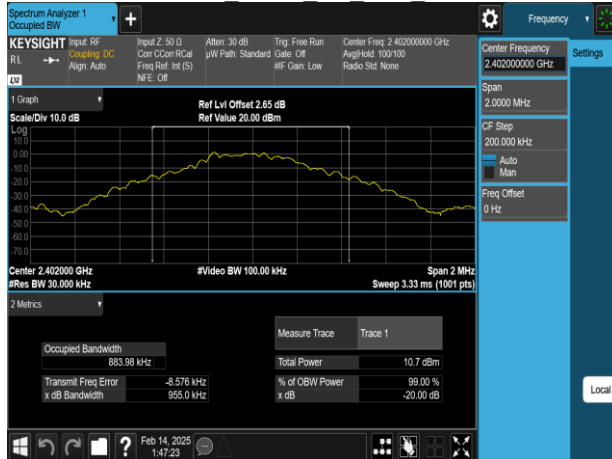


OBW 20dB 8DPSK 3M DH5 2480MHz

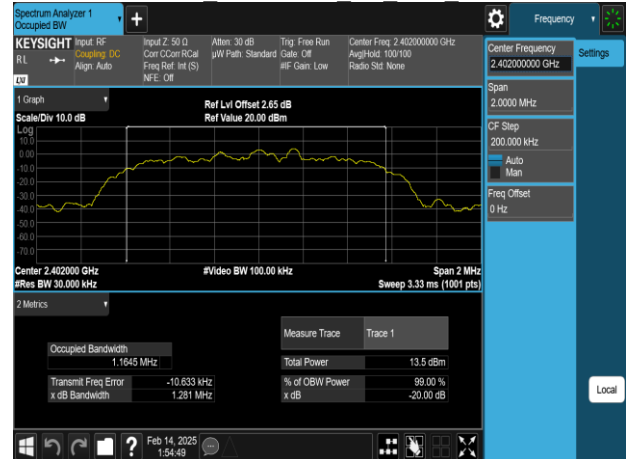


BANDWIDTH 99

IC OBW 99% GFSK 1M DH5 2402MHz



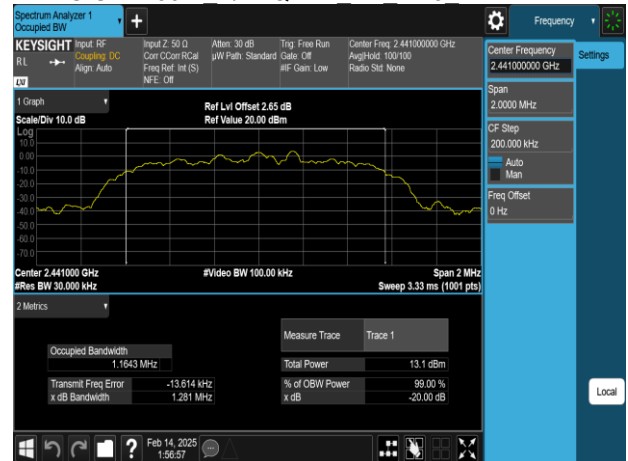
IC OBW 99% π /4DQPSK 2M DH5 2402MHz



IC OBW 99% GFSK 1M DH5 2441MHz



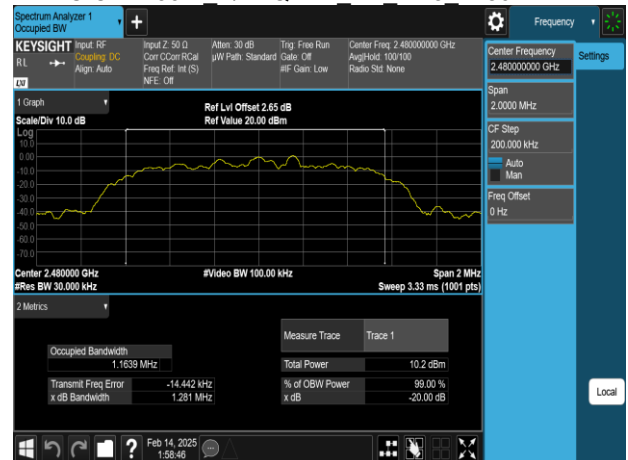
IC OBW 99% π /4DQPSK 2M DH5 2441MHz



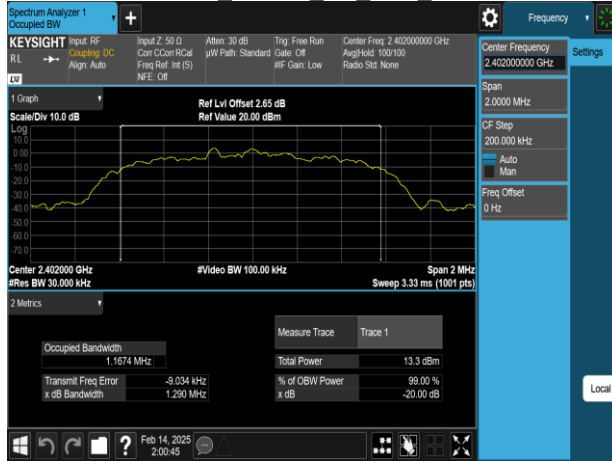
IC OBW 99% GFSK 1M DH5 2480MHz



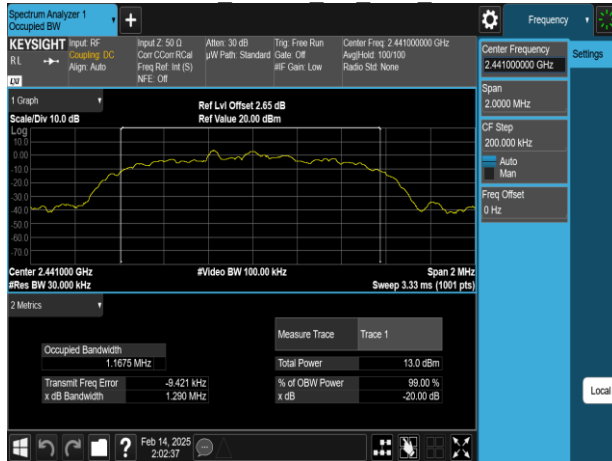
IC OBW 99% π /4DQPSK 2M DH5 2480MHz



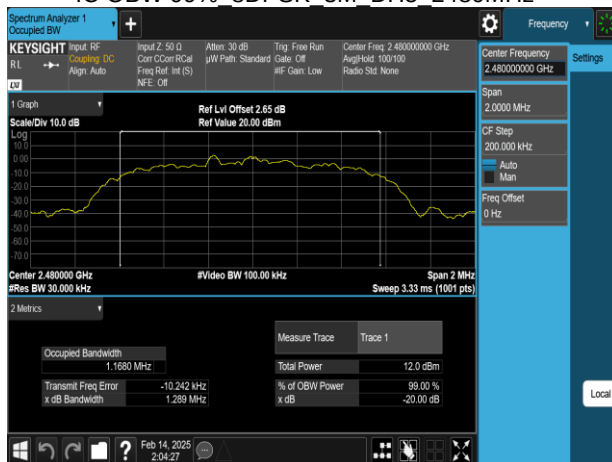
IC OBW 99% 8DPSK 3M DH5 2402MHz



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) and RSS-247 section 5.4(b),

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: 22.6°C

Test date: February 14, 2025

Humidity: 56% 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)
0	2402	default	3.69	2.339	1000
39	2441	default	3.95	2.483	1000
78	2480	default	3.94	2.477	1000

1M BR mode (Average):

CH	Freq. (MHz)	Power Setting	Avg. Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	default	3.48	2.229	1000
39	2441	default	3.78	2.389	1000
78	2480	default	3.82	2.411	1000

2M EDR mode (Peak):

CH	Freq. (MHz)	Power Setting	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	default	6.06	4.036	125
39	2441	default	6.25	4.217	125
78	2480	default	5.92	3.908	125

2M EDR mode (Average):

CH	Freq. (MHz)	Power Setting	Avg. Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	default	3.54	2.259	125
39	2441	default	3.74	2.365	125
78	2480	default	3.42	2.197	125

3M EDR mode (Peak):

CH	Freq. (MHz)	Power Setting	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	default	6.70	4.677	125
39	2441	default	6.72	4.699	125
78	2480	default	6.54	4.508	125

3M EDR mode (Average):

CH	Freq. (MHz)	Power Setting	Avg. Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	default	3.59	2.285	125
39	2441	default	3.77	2.382	125
78	2480	default	3.43	2.202	125

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

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: 22.6°C

Test date: February 14, 2025

Humidity: 56% 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	0.64	PASS
Mid	2441	1.000	0.64	PASS
High	2480	1.000	0.64	PASS

Test mode: $\pi/4$ -DQPSK_2Mbps mode / 2402-2480 MHz				
Channel	Frequency (MHz)	Channel Separation (MHz)	Channel Separation Limits (MHz)	Result
Low	2402	1.000	0.85	PASS
Mid	2441	1.000	0.85	PASS
High	2480	1.000	0.86	PASS

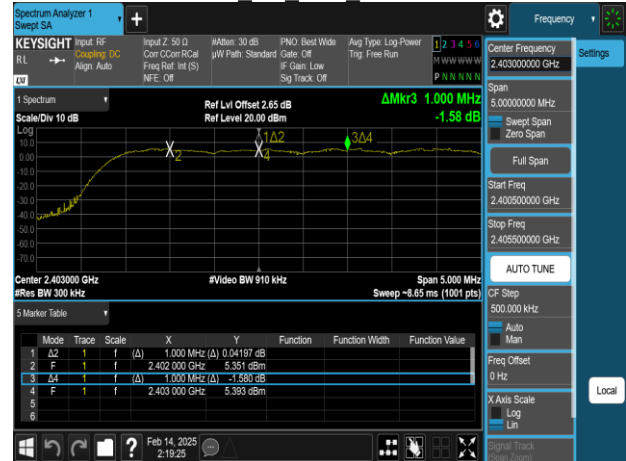
Test mode: 8DPSK_EDR-3Mbps mode / 2402-2480 MHz				
Channel	Frequency (MHz)	Channel Separation (MHz)	Channel Separation Limits (MHz)	Result
Low	2402	1.000	0.86	PASS
Mid	2441	1.000	0.86	PASS
High	2480	1.000	0.86	PASS

Test Data

GFSK 1M DH5 CH0CH1CH2



$\pi/4$ DQPSK 2M DH5 CH0CH1CH2



GFSK 1M DH5 CH38CH39CH40



$\pi/4$ DQPSK 2M DH5 CH38CH39CH40



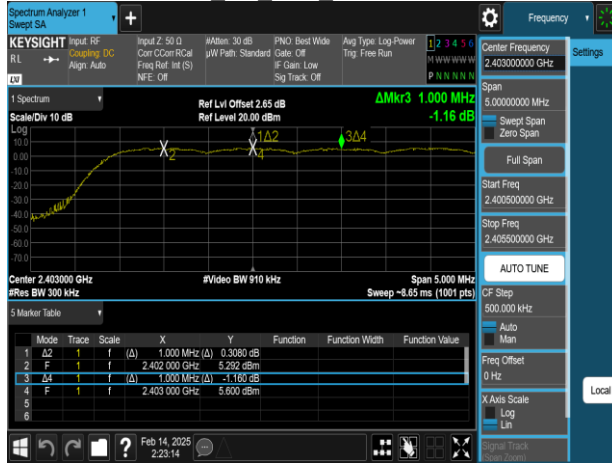
GFSK 1M DH5 CH76CH77CH78



$\pi/4$ DQPSK 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.

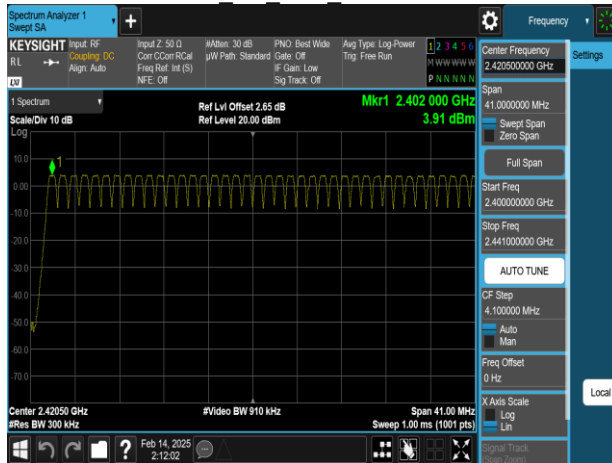
4.5.4 Test Result

Temperature: 22.6°C **Test date:** February 14, 2025
Humidity: 56% RH **Tested by:** Jerry Chang

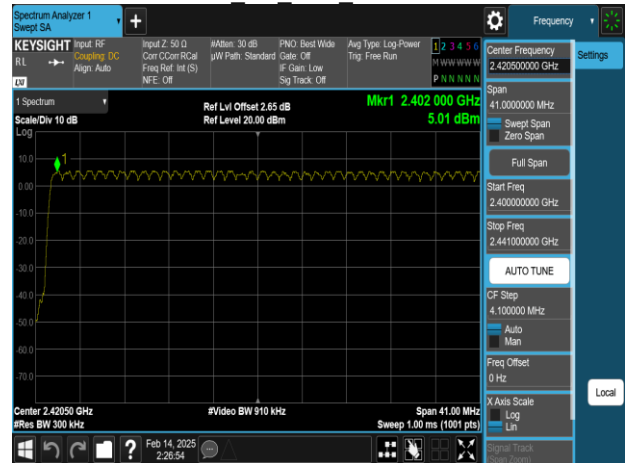
Number of Hopping				
Mode	Frequency (MHz)	Hopping Channel Number	Hopping Channel Number Limits	Result
BDR-1Mbps	2402-2480	79	15	Pass
EDR-3Mbps	2402-2480	79	15	

Test Data

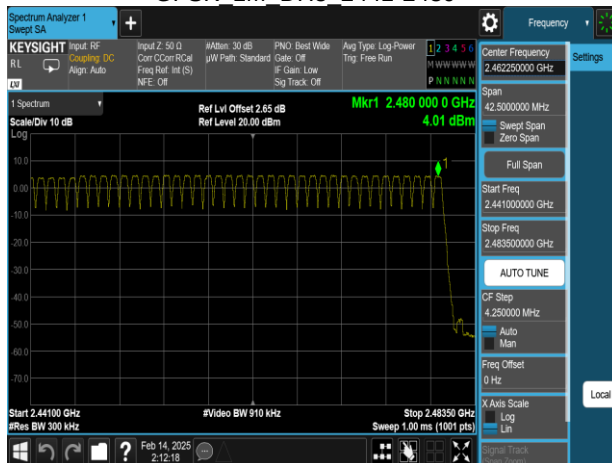
GFSK 1M DH5 2400-2441



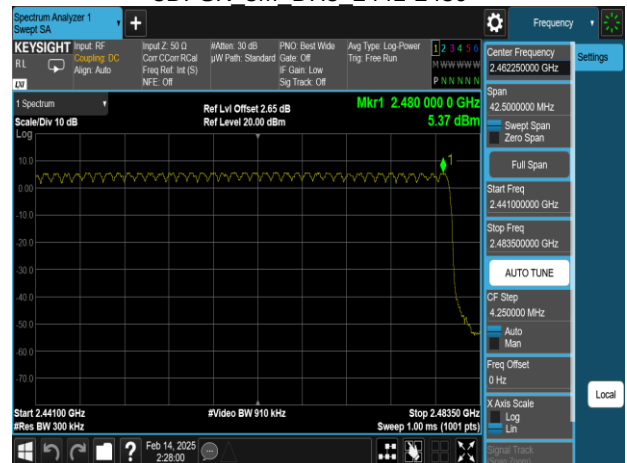
8DPSK 3M DH5 2400-2441



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.

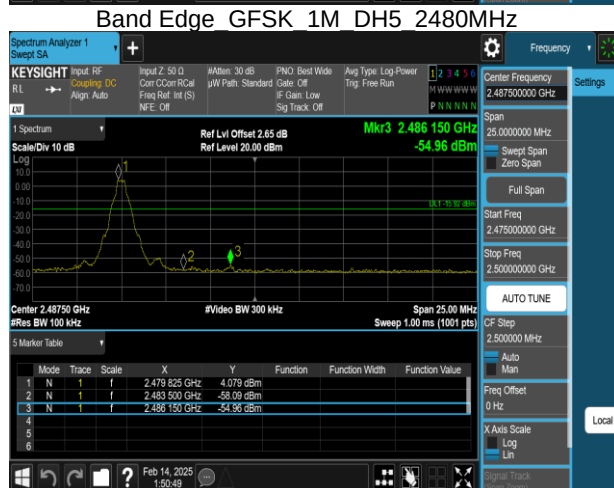
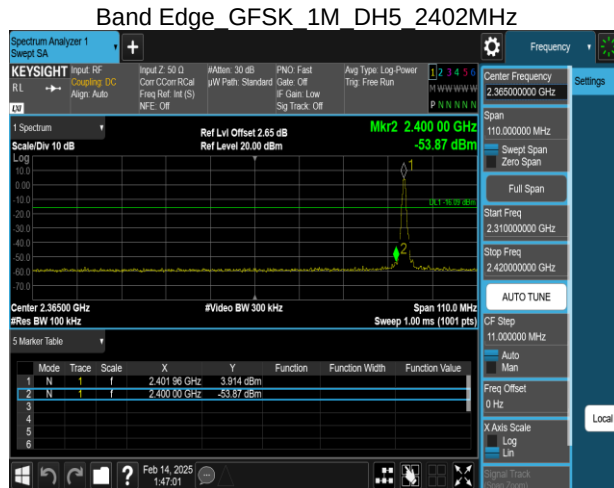
4.6.4 Test Result

Temperature: 22.6°C
Humidity: 56% RH

Test date: February 14, 2025
Tested by: Jerry Chang

Test Data

Band Edge



Hopping Band Edge

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 $\pi/4$ DQPSK 2M DH5 2402MHz



Spurious Emission GFSK 1M DH5 2441MHz



Spurious Emission $\pi/4$ DQPSK 2M DH5 2441MHz



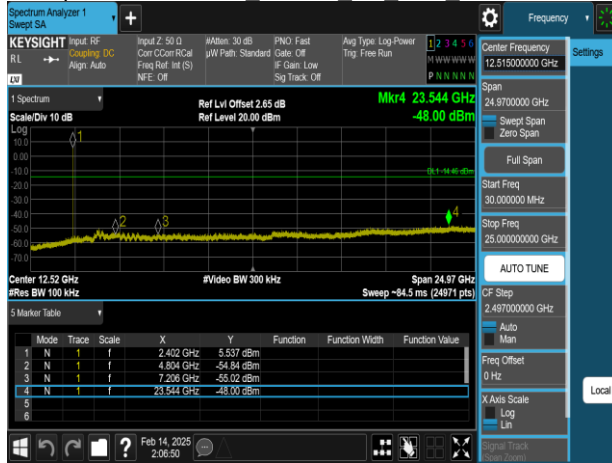
Spurious Emission GFSK 1M DH5 2480MHz



Spurious Emission $\pi/4$ DQPSK 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: 22.6°C

Test date: February 14, 2025

Humidity: 56% RH

Tested by: Jerry Chang

GFSK (1Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)
39	DH1	121.60	400
	DH3	262.40	400
	DH5	307.20	400

$\pi/4$ DQPSK (2Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)
39	2DH1	123.20	400
	2DH3	262.40	400
	2DH5	307.20	400

8-DPSK (3Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)
39	3DH1	124.80	400
	3DH3	260.80	400
	3DH5	307.20	400

GFSK (1Mbps):

CH Mid	DH1 time slot	=	0.380	*	(1600/2/79)	*	31.6	=	121.60 (ms)
	DH3 time slot	=	1.640	*	(1600/4/79)	*	31.6	=	262.40 (ms)
	DH5 time slot	=	2.880	*	(1600/6/79)	*	31.6	=	307.20 (ms)

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

CH Mid	2DH1 time slot	=	0.385	*	(1600/2/79)	*	31.6	=	123.20 (ms)
	2DH3 time slot	=	1.640	*	(1600/4/79)	*	31.6	=	262.40 (ms)
	2DH5 time slot	=	2.880	*	(1600/6/79)	*	31.6	=	307.20 (ms)

8-DPSK (3Mbps):

CH Mid	3DH1 time slot	=	0.390	*	(1600/2/79)	*	31.6	=	124.80 (ms)
	3DH3 time slot	=	1.630	*	(1600/4/79)	*	31.6	=	260.80 (ms)
	3DH5 time slot	=	2.880	*	(1600/6/79)	*	31.6	=	307.20 (ms)

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