RADIO TEST REPORT

FCC 47 CFR PART 15 SUBPART C
INDUSTRY CANADA RSS-247

Test Standard	**FCC Part 15.247** **IC RSS-247 issue 2 and IC RSS-GEN issue 5**
Product name	**Play-Fi Wireless Module**
Brand Name	**XPERI**
Model No.	**Caprica5UXL-2**
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

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.
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Revision History

Rev.	Issue Date	Revisions	Effect Page	Revised By
00	September 14, 2023	Initial Issue	ALL	Doris Chu
01	October 6, 2023	See the following Note Rev. (01)	P.4, P.10, P.13, P.5, P.11, P.62-85	Doris Chu
02	October 20, 2023	See the following Note Rev. (02)	P.4	Doris Chu
03	November 20, 2023	See the following Note Rev. (03)	P.6	Doris Chu
04	November 28, 2023	See the following Note Rev. (04)	P.6	Doris Chu
05	December 8, 2023	See the following Note Rev. (05)	P.35, P.40, P.53, P.9, P.49	Doris Chu

Rev. (01)
1. Add serial number in section 1.1.
2. Add test methodology in section 1.8.
3. Modify remark 1 in section 3.2.
4. Modify Antenna connector to IPEX Connecter in section 1.3.
5. Add 15.205 in FCC Standard in section 2.
6. Modify Bandedge in section 4.8.4.

Rev. (02)
1. Modify serial number in section 1.1.

Rev. (03)
1. Modify Antenna connector in section 1.4.

Rev. (04)
1. Modify Antenna connector in section 1.4.

Rev. (05)
1. Modify Test Procedure in section 4.4.2, 4.5.2 and 4.7.2.
2. Modify Conducted equipment list in section 1.7.
3. Add π/4-DQPSK_2Mbps Hopping test data in section 4.6.4.

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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 8
1.7 INSTRUMENT CALIBRATION 9
1.8 SUPPORT AND EUT ACCESSORIES EQUIPMENT 10
1.9 TEST METHODOLOGY AND APPLIED STANDARDS 10
2. TEST SUMMARY 11
3. DESCRIPTION OF TEST MODES 12
3.1 THE WORST MODE OF OPERATING CONDITION 12
3.2 THE WORST MODE OF MEASUREMENT 13
3.3 EUT DUTY CYCLE 14
4. TEST RESULT 18
4.1 AC POWER LINE CONDUCTED EMISSION 18
4.2 20DB BANDWIDTH AND OCCUPIED BANDWIDTH (99%) 23
4.3 OUTPUT POWER MEASUREMENT 31
4.4 FREQUENCY SEPARATION 35
4.5 NUMBER OF HOPPING 40
4.6 CONDUCTED BANDEDGE AND SPURIOUS EMISSION 43
4.7 TIME OF OCCUPANCY (DWELL TIME) 53
4.8 RADIATION BANDEDGE AND SPURIOUS EMISSION 58
APPENDIX 1 - PHOTOGRAPHS OF EUT

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1. GENERAL INFORMATION

1.1 EUT INFORMATION

Applicant	Phorus, Inc. 5220 Las Virgenes Road, Calabasas, California 91302, United States
Manufacturer	Phorus, Inc. 5220 Las Virgenes Road, Calabasas, California 91302, United States
Equipment	Play-Fi Wireless Module
Model Name	Caprica5UXL-2
Model Discrepancy	N/A
Brand Name	XPERI
Received Date	May 17, 2023
Date of Test	June 1 ~ December 8, 2023
Power Supply	Power from host device. (DC 3.3V)
HW Version	PVT-V03
SW Version	508.4.0.007
Serial number	C14-0000-0001

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.

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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

15.247(a)(1) that the Rx input bandwidths shift frequencies in synchronization with the transmitted signals.
15.247(g): In accordance with the Bluetooth Industry Standard, the system is designed to comply with all of the regulations in Section 15.247 when the transmitter is presented with a continuous data (or information) system.
15.247(h): 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.
RSS-247, 5.1 (a): The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

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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 and RSS-GEN Table 1 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 Specification	Dipole Antenna / Gain: 5 dBi (*Worst) PIFA Antenna / Gain: 4.80 dBi
Antenna connector	Dipole Antenna: SMA Female PIFA Antenna: IPEX Compatible

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 and RSS-GEN 6.8.

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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	± 2.738 kHz
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.

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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.

☐ No. 12, Ln. 116, Wugong 3rd Rd., Wugu Dist., New Taipei City, Taiwan 24803

CAB identifier: TW1309

Test site	Test Engineer	Remark
AC Conduction Room	Tony Chao	-
Radiation	Tony Chao, Ray Li	-
RF Conducted	Marco Chan	-

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

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1.7 INSTRUMENT CALIBRATION

RF Conducted Test Site					
Name of Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Date**	**Calibration Due**
Power Sensor	Anritsu	MA2411B	1911386	2022-08-08	2023-08-07
				2023-07-25	2024-07-24
Power Sensor	Anritsu	MA2411B	1911387	2022-08-08	2023-08-07
				2023-07-25	2024-07-24
EXA Signal Analyzer	Keysight	N9010B	MY60242460	2023-02-20	2024-02-01
Power Meter	Anritsu	ML2496A	2136002	2022-11-24	2023-11-23
				2023-11-16	2024-11-15
Attenuator	Mini-Circuits	BW-S10W2+	2	2022-12-13	2023-12-12
Software	Radio Test Software Ver. 21				

3M 966 Chamber Test Site					
Name of Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Date**	**Calibration Due**
Horn Antenna	ETS LINDGREN	3116	00026370	2022-12-22	2023-12-21
Loop Antenna	COM-POWER	AL-130	121051	2023-05-23	2024-05-22
Preamplifier	EMEC	EM330	060609	2023-02-22	2024-02-21
Thermo-Hygro Meter	WISEWIND	1206	D07	2022-12-19	2023-12-18
PXA Signal Analyzer	Keysight Technologies	N9030B	MY62291089	2022-10-14	2023-10-13
Preamplifier	HP	8449B	3008A00965	2022-12-23	2023-12-22
Bi-Log Antenna	Sunol Sciences	JB3	A030105	2022-08-03	2023-08-02
Cable	Huber+Suhner	104PEA	20995+21000+182330	2023-02-22	2024-02-21
Horn Antenna	ETC	MCTD 1209	DRH13M02003	2023-01-12	2024-01-11
High Pass Filters	Titan Microwave	T04H30001800070S01	22011402-4	2022-06-29	2023-06-28
				2023-06-17	2024-06-16
Horn Antenna	SCHWARZBECK	BBHA9170	1047	2022-12-30	2023-12-29
Pre-Amplifier	EMCI	EMC184045SE	980860	2022-12-27	2023-12-26
Cable	EMCI	EMC101G	211010+211011+211012	2022-12-12	2023-12-11
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				

AC Conducted Emissions Test Site					
Equipment	**Manufacturer**	**Model**	**S/N**	**Cal Date**	**Cal Due**
EMI Test Receiver	R&S	ESCI	100064	2023-06-07	2024-06-06
LISN	TESEQ	LN2-16N	22012	2023-03-08	2024-03-07
Cable	EMCI	CFD300-NL	CERF	2023-06-26	2024-06-25
Software	EZ-EMC(CCS-3A1-CE-WUGU)				

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

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1.8 SUPPORT AND EUT ACCESSORIES EQUIPMENT

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

Support Equipment						
No.	**Equipment**	**Brand**	**Model**	**Series No.**	**FCC ID**	**IC**
1	NB(E)	Lenovo	T460	N/A	N/A	N/A

1.9 TEST METHODOLOGY AND APPLIED STANDARDS

Test Mode
The EUT is connected to the laptop, and the test software (MP Tool) is used to set according to the test requirements (Modulation, Freueqnecy, Power Setting...), so that the RF signal is continuously transmitted to perform the test.

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 662911, KDB 558074, RSS-247 Issue 2 and RSS-GEN Issue 5.

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2. TEST SUMMARY

IC Standard Section	FCC Standard Section	Report Section	Test Item	Result
-	15.203	1.3	Antenna Requirement	Pass
RSS-GEN 8.8	15.207(a)	4.1	AC Conducted Emission	Pass
RSS-247(5.1)(a)	15.247(a)(1)	4.2	20 dB Bandwidth	Pass
RSS-GEN 6.7	-	4.2	Occupied Bandwidth (99%)	Pass
RSS-247(5.4)(b)	15.247(b)(1)	4.3	Output Power Measurement	Pass
RSS-247(5.1)(b)	15.247(a)(1)	4.4	Frequency Separation	Pass
RSS-247(5.1)(d)	15.247(a)(1)(iii)	4.5	Number of Hopping	Pass
RSS-247(5.5)	15.247(d)	4.6	Conducted Band Edge	Pass
RSS-247(5.5)	15.247(d)	4.6	Conducted Spurious Emission	Pass
RSS-247(5.1)(d)	15.247(a)(1)(iii)	4.7	Time of Occupancy	Pass
RSS-GEN 8.9, 8.10	15.247(d) 15.205	4.8	Radiation Band Edge	Pass
RSS-GEN 8.9, 8.10	15.247(d) 15.205	4.8	Radiation Spurious Emission	Pass

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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, frequency hopping, Conducted band edge, radiated band edge and spurious emissions.

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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 Adapter (Dipole) Mode 2: EUT power by Adapter (PIFA)
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 Adapter (Dipole) Mode 2: EUT power by Adapter (PIFA)
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 Adapter (Dipole) Mode 2: EUT power by Adapter (PIFA)
Worst Mode	☒ Mode 1 ☒ Mode 2 ☐ Mode 3 ☐ Mode 4

Remark:
1. There are three types of EUT memory (ESMT, NANYA, MICRON), the worst of which is ESMT memory, and is recorded in the test report.
2. 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. AC power line conducted emission and for below 1G radiation emission were performed the EUT transmit at the highest output power channel as worse case.

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3.3 EUT DUTY CYCLE

Temperature: 21.1 ~ 26.3℃ **Test date:** June 1 ~ July 10, 2023

Humidity: 50 ~ 61% RH **Tested by:** Marco Chan

For GFSK (1Mbps)

Duty Cycle				
Configuration	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

For π/4-DQPSK (2Mbps)

Duty Cycle				
Configuration	Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log (1/Duty Cycle)	1/T (kHz)	VBW setting (kHz)
2DH1	31.17	5.06	2.60	3.00
2DH3	65.86	1.81	0.61	1.00
2DH5	77.42	1.11	0.35	1.00

For 8-DPSK (3Mbps)

Duty Cycle				
Configuration	Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log (1/Duty Cycle)	1/T (kHz)	VBW setting (kHz)
3DH1	31.58	5.01	2.56	3.00
3DH3	65.86	1.81	0.61	1.00
3DH5	77.51	1.11	0.35	1.00

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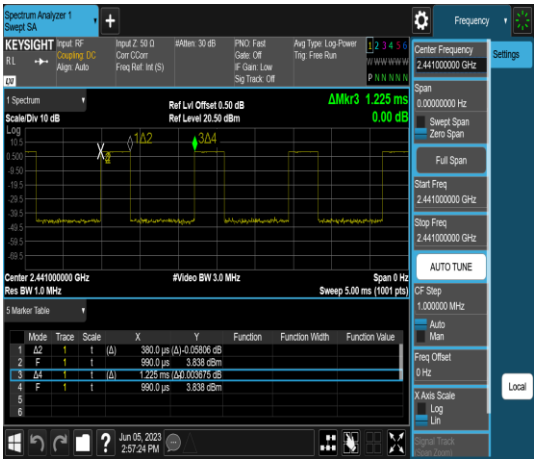
For GFSK (1Mbps)	
DH1	DH3
	
DH5	

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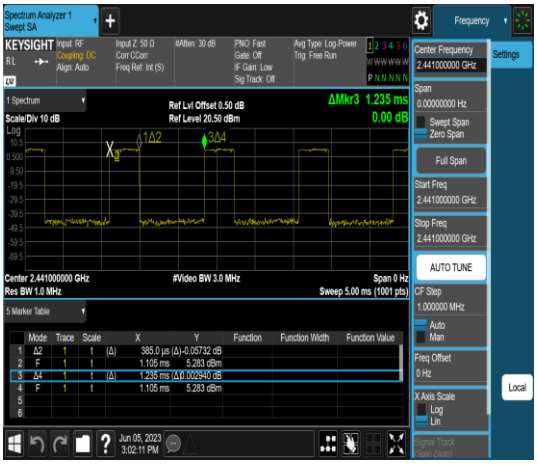
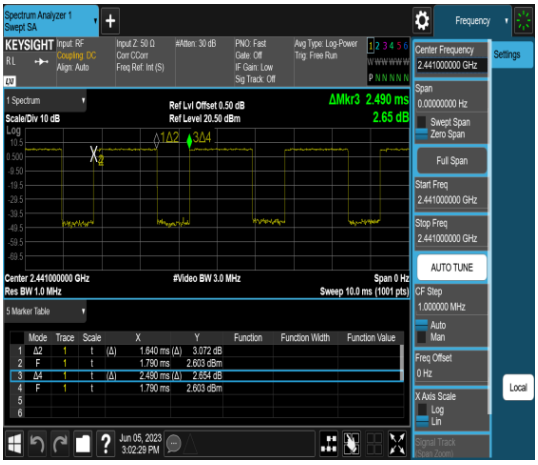
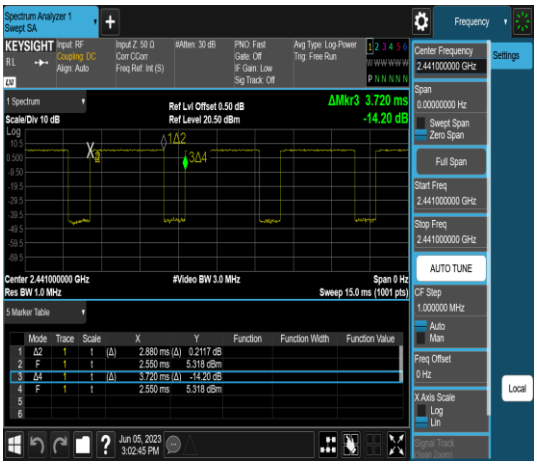
For π/4-DQPSK (2Mbps)	
2DH1	2DH3
	
2DH5	
	

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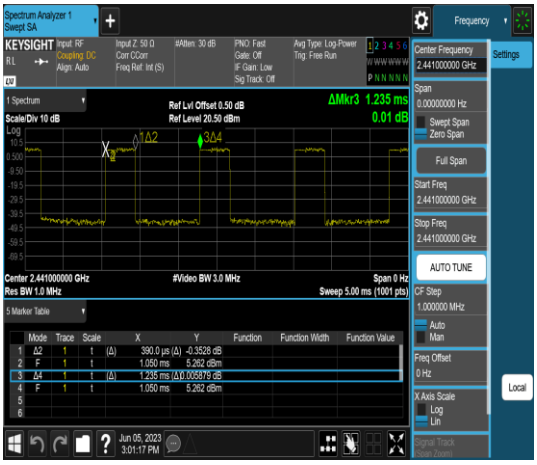
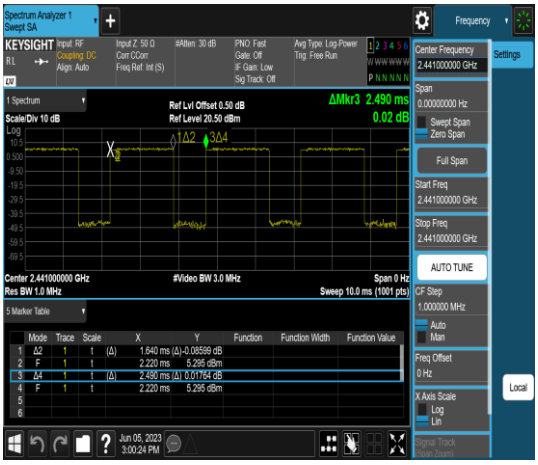
For 8-DPSK (3Mbps)	
3DH1	3DH3
	
3DH5	

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4. TEST RESULT

4.1 AC POWER LINE CONDUCTED EMISSION

4.1.1 Test Limit

According to §15.207(a) and RSS-GEN section 8.8,

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

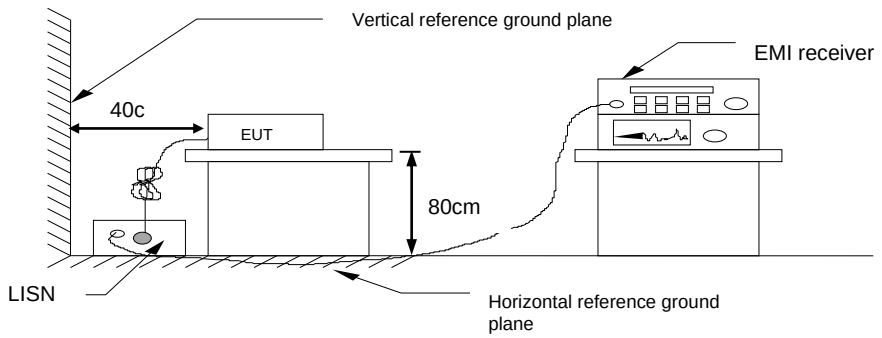
* Decreases with the logarithm of the frequency.

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

Pass.

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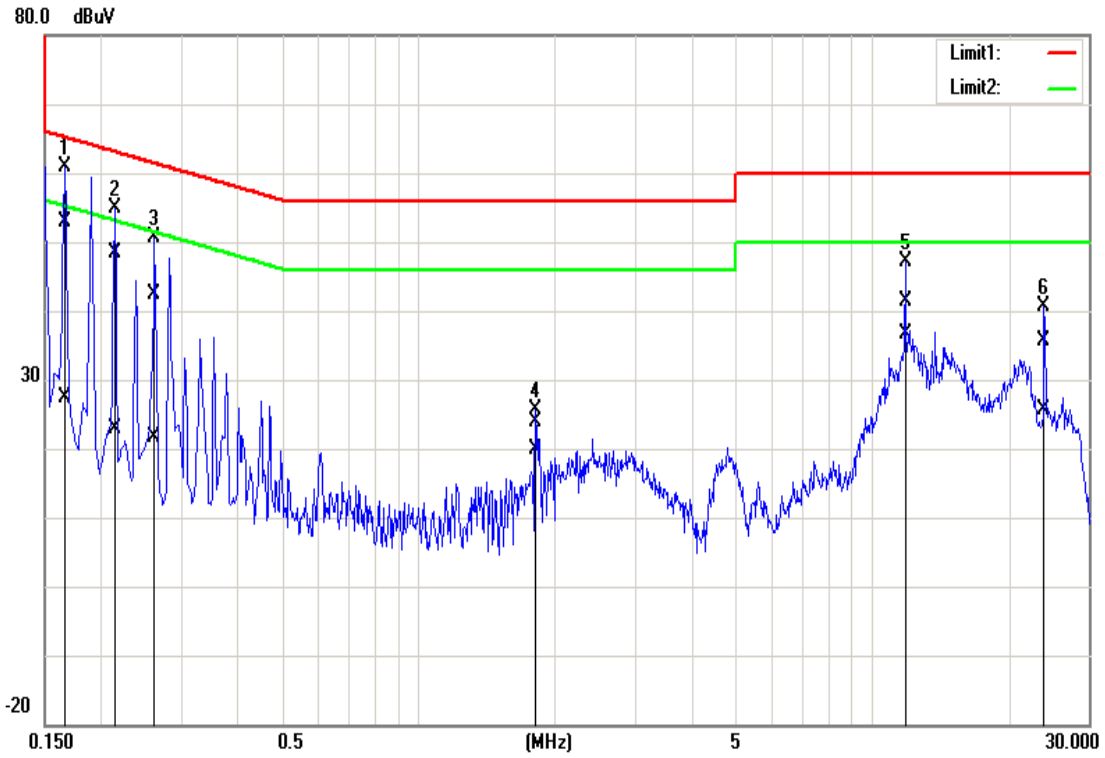
Test Data

Test Mode:	Mode 1	Temp/Hum	24.3(℃)/ 52%RH
Phase:	Line	Test Date	July 5, 2023
Test Voltage:	120Vac, 60Hz	Test Engineer	Tony Chao



Frequency (MHz)	Quasi Peak reading (dBuV)	Average reading (dBuV)	Correction factor (dB)	Quasi Peak result (dBuV)	Average result (dBuV)	Quasi Peak limit (dBuV)	Average limit (dBuV)	Quasi Peak margin (dB)	Average margin (dB)	Remark
0.1660	52.77	27.23	0.15	52.92	27.38	65.16	55.16	-12.24	-27.78	Pass
0.2140	48.26	22.74	0.15	48.41	22.89	63.05	53.05	-14.64	-30.16	Pass
0.2620	42.26	21.53	0.15	42.41	21.68	61.37	51.37	-18.96	-29.69	Pass
1.8180	23.58	19.58	0.21	23.79	19.79	56.00	46.00	-32.21	-26.21	Pass
11.8140	41.11	36.22	0.38	41.49	36.60	60.00	50.00	-18.51	-13.40	Pass
23.9580	35.15	25.07	0.56	35.71	25.63	60.00	50.00	-24.29	-24.37	Pass

Note: 1. Correction factor = LISN loss + Cable loss.

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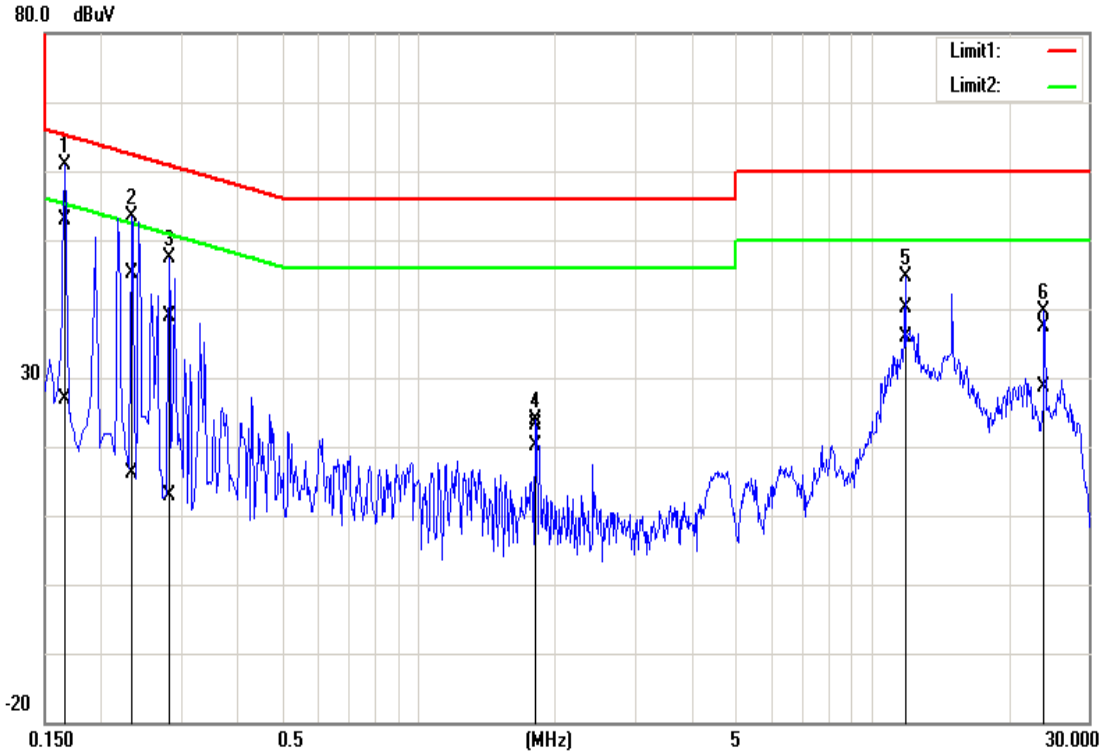
Test Mode:	Mode 1	Temp/Hum	24.3(℃)/ 52%RH
Phase:	Neutral	Test Date	July 5, 2023
Test Voltage:	120Vac, 60Hz	Test Engineer	Tony Chao



Frequency (MHz)	Quasi Peak reading (dBuV)	Average reading (dBuV)	Correction factor (dB)	Quasi Peak result (dBuV)	Average result (dBuV)	Quasi Peak limit (dBuV)	Average limit (dBuV)	Quasi Peak margin (dB)	Average margin (dB)	Remark
0.1660	52.67	26.67	0.19	52.86	26.86	65.16	55.16	-12.30	-28.30	Pass
0.2340	44.88	15.83	0.19	45.07	16.02	62.31	52.31	-17.24	-36.29	Pass
0.2820	38.67	12.59	0.19	38.86	12.78	60.76	50.76	-21.90	-37.98	Pass
1.8180	22.89	19.82	0.25	23.14	20.07	56.00	46.00	-32.86	-25.93	Pass
11.8140	39.78	35.49	0.41	40.19	35.90	60.00	50.00	-19.81	-14.10	Pass
24.0100	36.79	27.97	0.55	37.34	28.52	60.00	50.00	-22.66	-21.48	Pass

Note: 1. Correction factor = LISN loss + Cable loss.

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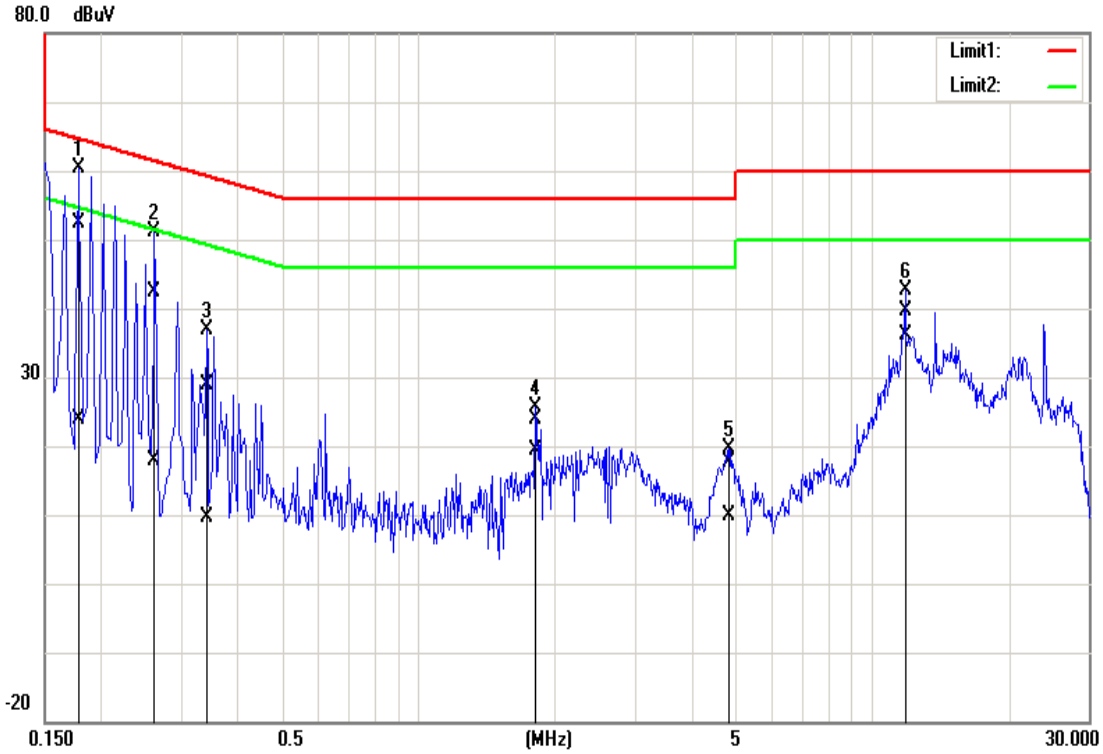
Test Mode:	Mode 2	Temp/Hum	24.3(℃)/ 52%RH
Phase:	Line	Test Date	July 5, 2023
Test Voltage:	120Vac, 60Hz	Test Engineer	Tony Chao



Frequency (MHz)	Quasi Peak reading (dBuV)	Average reading (dBuV)	Correction factor (dB)	Quasi Peak result (dBuV)	Average result (dBuV)	Quasi Peak limit (dBuV)	Average limit (dBuV)	Quasi Peak margin (dB)	Average margin (dB)	Remark
0.1780	52.33	23.80	0.15	52.48	23.95	64.58	54.58	-12.10	-30.63	Pass
0.2620	42.25	17.68	0.15	42.40	17.83	61.37	51.37	-18.97	-33.54	Pass
0.3420	28.66	9.42	0.15	28.81	9.57	59.15	49.15	-30.34	-39.58	Pass
1.8180	23.74	19.16	0.21	23.95	19.37	56.00	46.00	-32.05	-26.63	Pass
4.8420	17.24	9.65	0.27	17.51	9.92	56.00	46.00	-38.49	-36.08	Pass
11.8260	39.34	35.76	0.38	39.72	36.14	60.00	50.00	-20.28	-13.86	Pass

Note: 1. Correction factor = LISN loss + Cable loss.

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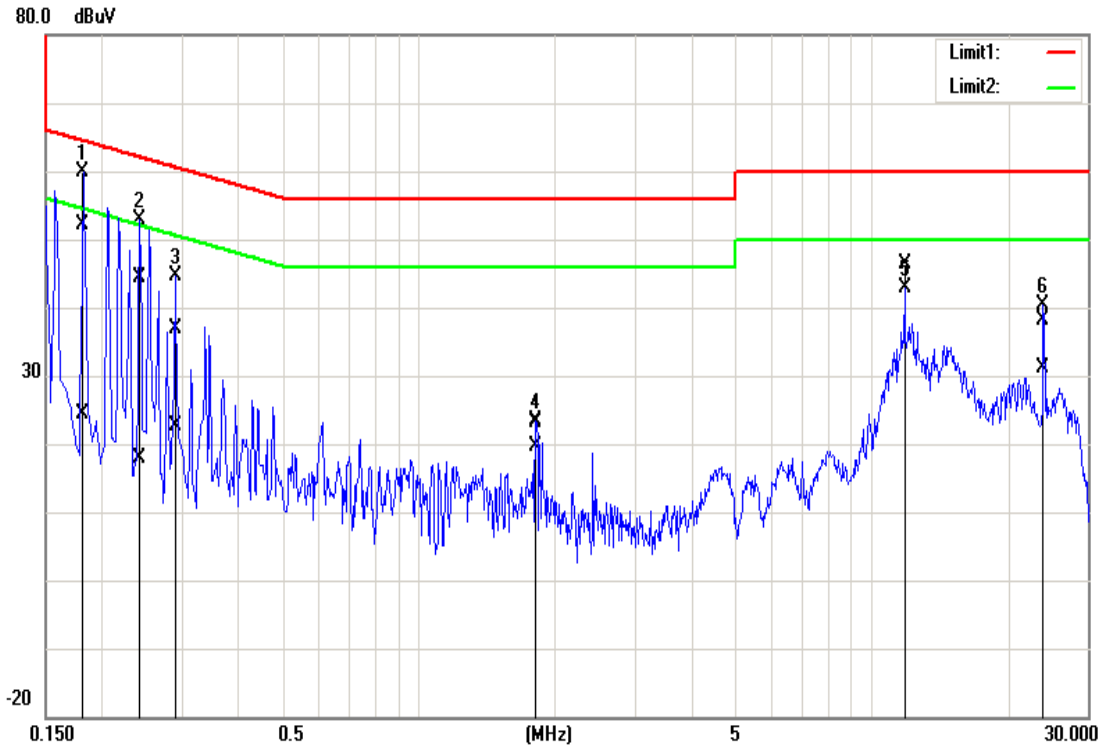
Test Mode:	Mode 2	Temp/Hum	24.3(℃)/ 52%RH
Phase:	Neutral	Test Date	July 5, 2023
Test Voltage:	120Vac, 60Hz	Test Engineer	Tony Chao



Frequency (MHz)	Quasi Peak reading (dBuV)	Average reading (dBuV)	Correction factor (dB)	Quasi Peak result (dBuV)	Average result (dBuV)	Quasi Peak limit (dBuV)	Average limit (dBuV)	Quasi Peak margin (dB)	Average margin (dB)	Remark
0.1820	51.84	24.23	0.20	52.04	24.43	64.39	54.39	-12.35	-29.96	Pass
0.2420	44.19	17.75	0.19	44.38	17.94	62.03	52.03	-17.65	-34.09	Pass
0.2900	36.79	22.50	0.19	36.98	22.69	60.52	50.52	-23.54	-27.83	Pass
1.8180	22.78	19.33	0.25	23.03	19.58	56.00	46.00	-32.97	-26.42	Pass
11.8140	45.95	42.54	0.41	46.36	42.95	60.00	50.00	-13.64	-7.05	Pass
24.0060	37.55	30.57	0.55	38.10	31.12	60.00	50.00	-21.90	-18.88	Pass

Note: 1. Correction factor = LISN loss + Cable loss.

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4.2 20dB BANDWIDTH AND OCCUPIED BANDWIDTH (99%)

4.2.1 Test Limit

According to §15.247(a) (1), RSS-247 section 5.1(a) and RSS-GEN 6.7

20 dB Bandwidth ：For reporting purposes only.

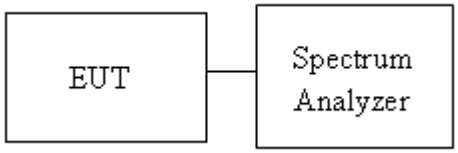
Occupied Bandwidth(99%) ：For reporting purposes only.

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 = 1% ~ 5% OBW, VBW ≥3*RBW and Detector = Peak, to measurement 20 dB Bandwidth.
4. SA set RBW = 1% ~ 5% OBW, VBW ≥ three times the RBW and Detector = Peak, to measurement 99% Bandwidth
5. Measure and record the result of 20 dB Bandwidth and 99% Bandwidth. in the test report.

4.2.3 Test Setup



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4.2.4 Test Result

Temperature:	21.1 ~ 26.3℃	**Test date:**	June 1 ~ July 10, 2023
Humidity:	50 ~ 61% RH	**Tested by:**	Marco Chan

Test mode: GFSK_BDR-1Mbps mode / 2402-2480 MHz			
Channel	**Frequency (MHz)**	**OBW(99%) (MHz)**	**20dB BW (MHz)**
Low	2402	0.85280	0.9545
Mid	2441	0.85238	0.9546
High	2480	0.85300	0.9536

Test mode: π/4-DQPSK_2Mbps mode / 2402-2480 MHz			
Channel	**Frequency (MHz)**	**OBW(99%) (MHz)**	**20dB BW (MHz)**
Low	2402	1.1559	1.276
Mid	2441	1.1557	1.276
High	2480	1.1563	1.277

Test mode: 8DPSK_EDR-3Mbps mode / 2402-2480 MHz			
Channel	**Frequency (MHz)**	**OBW(99%) (MHz)**	**20dB BW (MHz)**
Low	2402	1.1620	1.288
Mid	2441	1.1617	1.290
High	2480	1.1631	1.288

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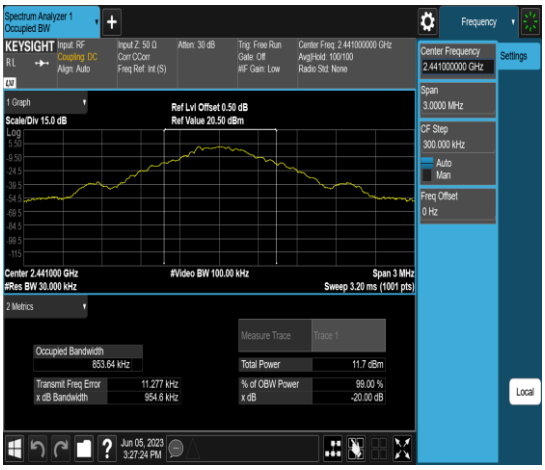
Test Data

20dB BANDWIDTH

GFSK_BDR-1Mbps mode	
Low CH	**Mid CH**
	
High CH	

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π/4-DQPSK_2Mbps mode	
Low CH	**Mid CH**
High CH	

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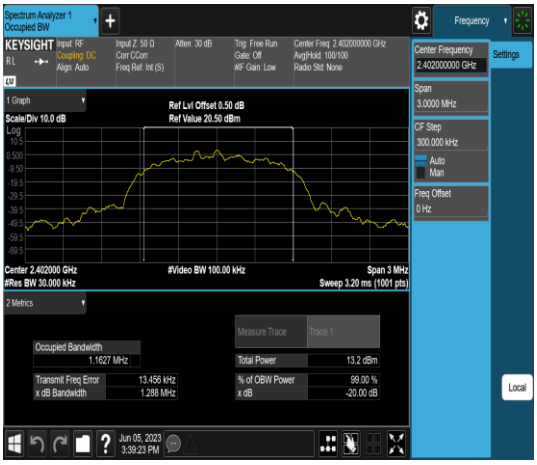
8DPSK_EDR-3Mbps mode	
Low CH	**Mid CH**
	
High CH	

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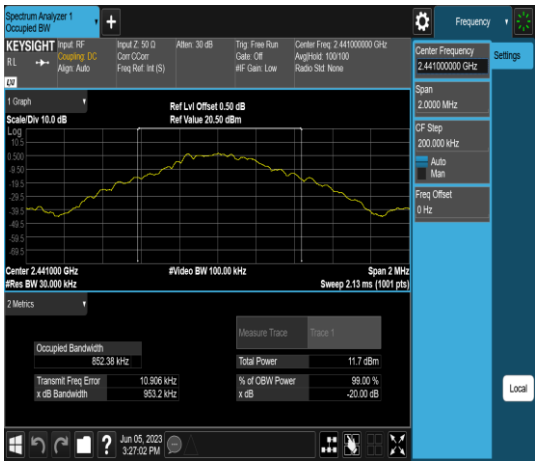
Test Data

BANDWIDTH 99%

GFSK_BDR-1Mbps mode	
Low CH	**Mid CH**
	
High CH	

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π/4-DQPSK_2Mbps mode	
Low CH	**Mid CH**
High CH	

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8DPSK_EDR-3Mbps mode	
Low CH	**Mid CH**
High CH	

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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

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.

IC

According to RSS-247 section 5.4(b), For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channels. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

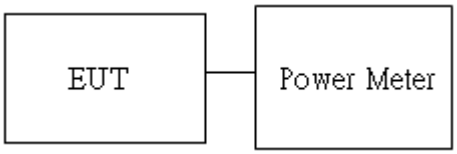
Limit	☒ Antenna not exceed 6 dBi：21dBm ☐ Antenna with DG greater than 6 dBi：21dBm [Limit = 30 – (DG – 6)]

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



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4.3.4 Test Result

Temperature:	21.1 ~ 26.3℃	**Test date:**	June 1 ~ July 10, 2023
Humidity:	50 ~ 61% RH	**Tested by:**	Marco Chan

Peak output power：

1M BR mode (Peak):

CH	Freq. (MHz)	Power set	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	default	4.28	2.679	125
Mid	2441	default	3.77	2.382	125
High	2480	default	**4.51**	2.825	125

2M EDR mode (Peak):

CH	Freq. (MHz)	Power set	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	default	6.43	4.395	125
Mid	2441	default	**7.24**	5.297	125
High	2480	default	6.33	4.295	125

3M EDR mode (Peak):

CH	Freq. (MHz)	Power set	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	default	6.12	4.093	125
Mid	2441	default	**7.82**	6.053	125
High	2480	default	6.10	4.074	125

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Average output power：

1M BR mode (Average):

CH	Freq. (MHz)	Power set	Max. Avg. Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	default	4.24	2.656	125
Mid	2441	default	3.71	2.350	125
High	2480	default	4.46	2.794	125

2M EDR mode (Average):

CH	Freq. (MHz)	Power set	Max. Avg. Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	default	4.16	2.607	125
Mid	2441	default	4.84	3.049	125
High	2480	default	4.07	2.554	125

3M EDR mode (Average):

CH	Freq. (MHz)	Power set	Max. Avg. Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	default	4.23	2.646	125
Mid	2441	default	4.88	3.074	125
High	2480	default	4.20	2.628	125

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EIRP Power:

1M BR mode EIRP

Channel	Frequency (MHz)	Power set	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (mW)	Limit (mW)
Low	2402	default	4.24	5.00	8.398	4000
Mid	2441	default	3.71	5.00	7.433	4000
High	2480	default	4.46	5.00	8.834	4000

2M EDR mode EIRP

Channel	Frequency (MHz)	Power set	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (mW)	Limit (mW)
Low	2402	default	4.16	5.00	8.244	4000
Mid	2441	default	4.84	5.00	9.642	4000
High	2480	default	4.07	5.00	8.075	4000

3M EDR mode EIRP

Channel	Frequency (MHz)	Power set	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (mW)	Limit (mW)
Low	2402	default	4.23	5.00	8.368	4000
Mid	2441	default	4.88	5.00	9.719	4000
High	2480	default	4.20	5.00	8.311	4000

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4.4 FREQUENCY SEPARATION

4.4.1 Test Limit

According to §15.247(a)(1) and RSS-247 section 5.1(b)

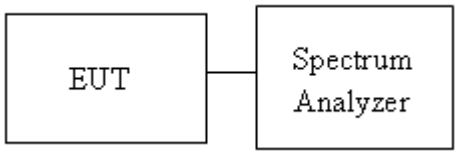
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 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 ≥ 3*RBW, Sweep = auto.
   Max hold, mark 3 peaks of hopping channel and record the 3 peaks frequency

4.4.3 Test Setup



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4.4.4 Test Result

Temperature:	21.1 ~ 26.3℃	**Test date:**	June 1 ~ July 10, 2023
Humidity:	50 ~ 61% RH	**Tested by:**	Marco Chan

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: π/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	0.85	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

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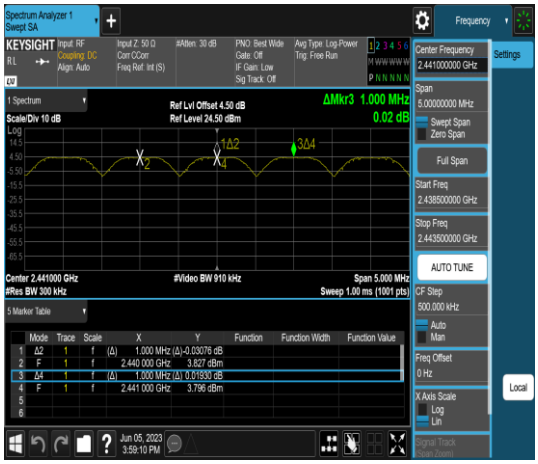
Test Data

GFSK_BDR-1Mbps mode	
Low CH	**Mid CH**
	
High CH	

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π/4-DQPSK_2Mbps mode	
Low CH	**Mid CH**
High CH	

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8DPSK_EDR-3Mbps mode	
Low CH	**Mid CH**
High CH	

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4.5 NUMBER OF HOPPING

4.5.1 Test Limit

According to §15.247(a)(1)(iii) and RSS-247 section 5.1(d)

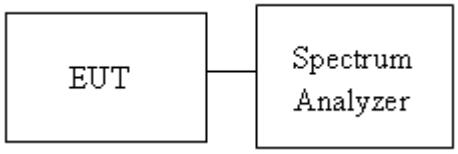
Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

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 for Low range, Start Freq. = 2441 MHz, Stop Freq. = 2483.5 MHz for High range.
4. RBW: Set spectrum analyzer Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
5. Set spectrum analyzer VBW ≥ RBW.
6. Max hold, view and count how many channel in the band.

4.5.3 Test Setup



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4.5.4 Test Result

Temperature:	21.1 ~ 26.3℃	**Test date:**	June 1 ~ July 10, 2023
Humidity:	50 ~ 61% RH	**Tested by:**	Marco Chan

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	

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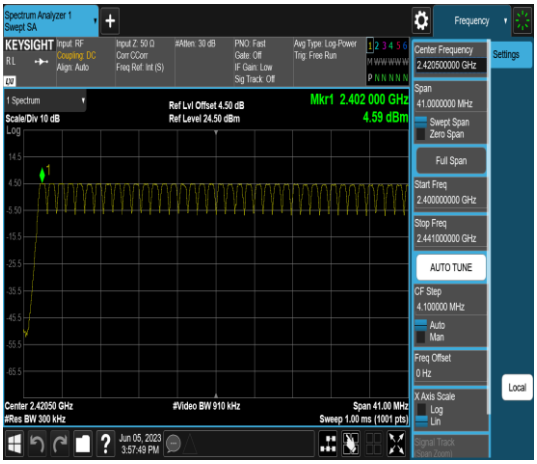
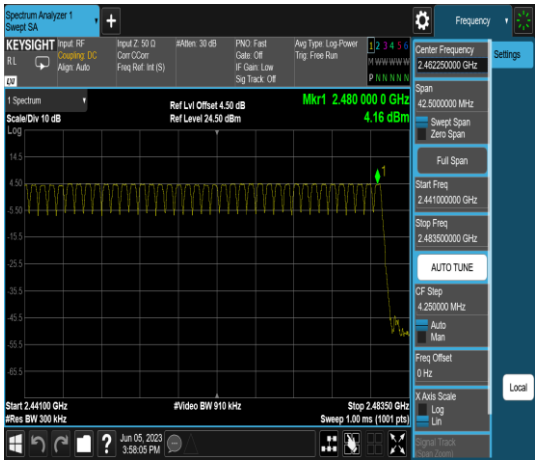
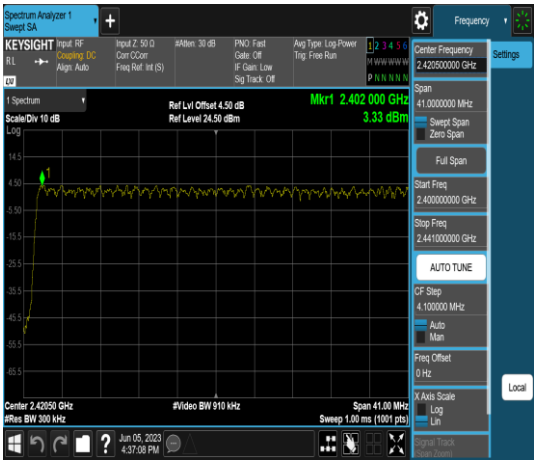
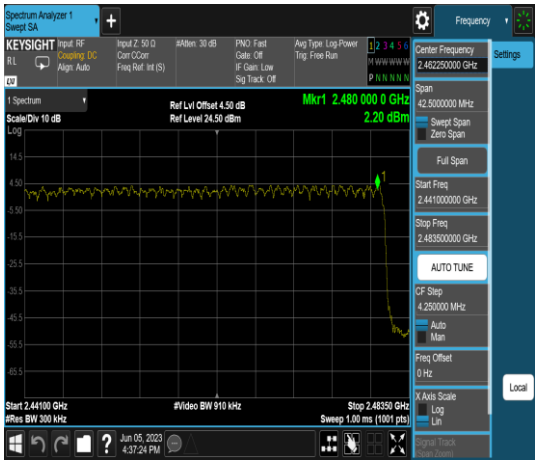
Test Data

Number of Hopping	
GFSK_BDR-1Mbps mode	
Low	High
	
8DPSK_EDR-3Mbps mode	
Low	High
	

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4.6 CONDUCTED BANDEDGE AND SPURIOUS EMISSION

4.6.1 Test Limit

According to §15.247(d) and RSS-247 section 5.5

Limit	-20 dBc

.

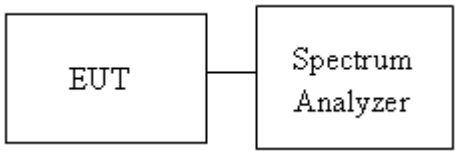
4.6.2 Test Procedure

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



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4.6.4 Test Result

Temperature:	21.1 ~ 26.8℃	**Test date:**	June 1 ~ December 8, 2023
Humidity:	50 ~ 61% RH	**Tested by:**	Marco Chan

Test Data

GFSK_BDR-1Mbps mode Band Edge	
Low CH	**High CH**

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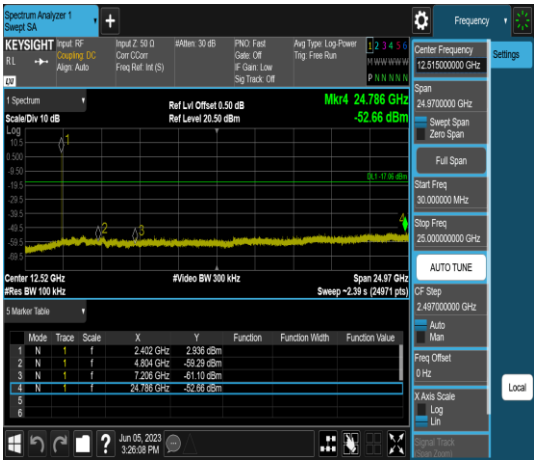
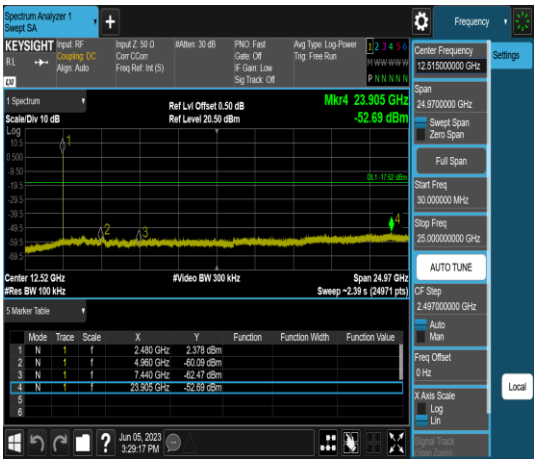
GFSK_BDR-1Mbps mode Spurious Emission 30MHz-25GHz	
Low CH	**Mid CH**
	
High CH	
	

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GFSK_BDR-1Mbps Hopping mode	
Low Band Edge	**High Band Edge**

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π/4-DQPSK_2Mbps mode Band Edge	
Low CH	**High CH**

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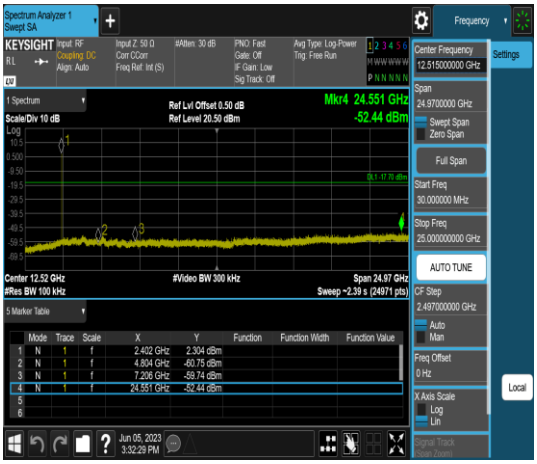
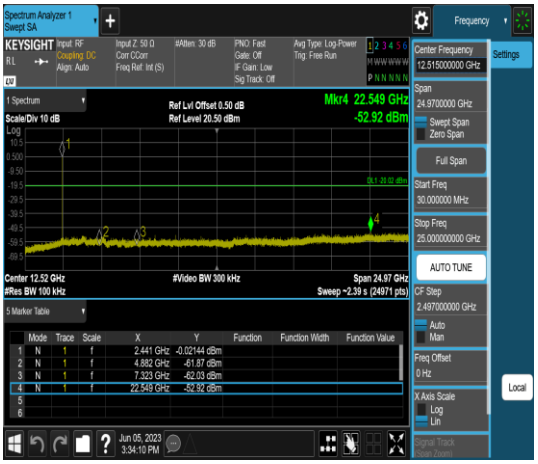
π/4-DQPSK_2Mbps mode Spurious Emission 30MHz-25GHz	
Low CH	**Mid CH**
	
High CH	

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π/4-DQPSK_2Mbps mode Hopping mode	
Low Band Edge	**High Band Edge**

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8DPSK_EDR-3Mbps mode Band Edge	
Low CH	**High CH**

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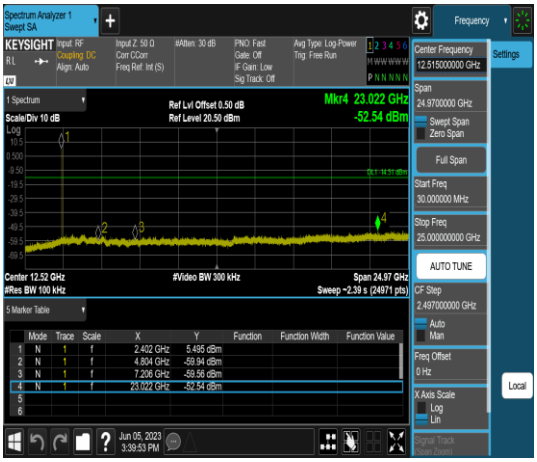
8DPSK_EDR-3Mbps mode Spurious Emission 30MHz-25GHz	
Low CH	**Mid CH**
	
High CH	

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8DPSK_EDR-3Mbps mode Hopping mode	
Low Band Edge	**High Band Edge**

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4.7 TIME OF OCCUPANCY (DWELL TIME)

4.7.1 Test Limit

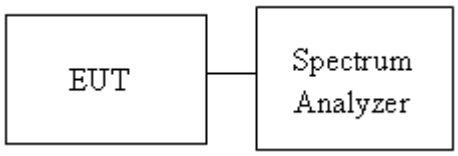
According to §15.247(a)(1)(iii) and RSS-247 section 5.1(d)

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 > one cycle.

4.7.3 Test Setup



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4.7.4 Test Result

Temperature:	21.1 ~ 26.3℃	**Test date:**	June 1 ~ July 10, 2023
Humidity:	50 ~ 61% RH	**Tested by:**	Marco Chan

For GFSK (1Mbps)

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

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)

For π/4 -DQPSK (2Mbps):

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

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)

For 8-DPSK (3Mbps)

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

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)

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