



Page: 1 of 17



FCC C2PC Test Report

FCC ID : SQG-LWBPLUS

Equipment : 802.11n 2.4GHz + BT5.2 M.2 Module

Model No. : Sterling LWB+

Brand Name : Laird Connectivity

Applicant : Laird Connectivity LLC

Address : W66N220 Commerce Court, Cedarburg, WI

53012 United States Of America

Standard : 47 CFR FCC Part 15.247

Received Date : Nov. 02, 2022

Tested Date : Nov. 16 ~ Nov. 21, 2022

We, International Certification Corporation, would like to declare that the tested sample has been evaluated and in compliance with the requirement of the above standards. The test results contained in this report refer exclusively to the product. It shall not be reproduced except in full without the written approval of our laboratory.

Reviewed by: Approved by:

Report No.: FR1O0407-02AD



Table of Contents

1	GENERAL DESCRIPTION	5
1.1	Information	5
1.2	Local Support Equipment List	
1.3	Test Setup Chart	
1.4	The Equipment List	g
1.5	Test Standards	
1.6	Reference Guidance	10
1.7	Deviation from Test Standard and Measurement Procedure	10
1.8	Measurement Uncertainty	10
2	TEST CONFIGURATION	11
2.1	Testing Facility	11
2.2	The Worst Test Modes and Channel Details	
3	TRANSMITTER TEST RESULTS	12
3.1	Unwanted Emissions into Restricted Frequency Bands	12
3.2	Conducted Output Power	
3.3	AC Power Line Conducted Emissions	16
4	TEST LABORATORY INFORMATION	17

Appendix A. Unwanted Emissions into Restricted Frequency Bands

Appendix B. Conducted Output Power

Appendix C. AC Power Line Conducted Emissions



Release Record

Report No.	Version	Description	Issued Date
FR1O0407-02AD	Rev. 01	Initial issue	Dec. 06, 2022

Report No.: FR100407-02AD Page: 3 of 17



Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	AC Power Line Conducted Emission	[dBuV]: 0.345MHz 32.93 (Margin -16.16dB) - AV	Pass
15.247(d)	Unwanted Emissions	[dBuV/m at 3m]: 41.96MHz	Pass
15.209	Offwartied Effissions	35.95 (Margin -4.05dB) - PK	F 455
15.247(b)(1)	Conducted Output Power	Power [dBm]: 6.75	Pass

Declaration of Conformity:

The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.

Comments and Explanations:

The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

Report No.: FR100407-02AD Page: 4 of 17



1 General Description

1.1 Information

This is a Class II Permissive Change report (C2PC).

This report is issued as a supplementary report to original report no. FR1O0407AD. The differences compared to the original design is listed as follows:

- The LWB+ SIP module (Part Number 453-00083) is mounted onto the M.2 Card for new variant (Part Number 453-00141).
- Removing Chip antenna.

1.1.1 Product Details

Brand name	Model Name	Product Name	Part Number	Description
Laird Connectivity	Sterling LWB+	802.11n 2.4GHz + BT5.2 M.2 Module	453-00141	M.2 Module

1.1.2 Specification of the Equipment under Test (EUT)

RF General Information							
Frequency Range (MHz) Bluetooth Ch. Frequency Channel Number Data R							
2400-2483.5	BR	2402-2480	0-78 [79]	1 Mbps			
2400-2483.5	EDR	2402-2480	0-78 [79]	2 Mbps			
2400-2483.5	EDR	2402-2480	0-78 [79]	3 Mbps			

Note 1: RF output power specifies that Maximum Peak Conducted Output Power.

1.1.3 Antenna Details

Ant. No.	Manufacturer	Laird Part Number	Model	Туре	Connector	Gain (dBi)
1	Laird	001-0001	2.4GHz Dipole Antenna	Dipole	RP-SMA	2
2	Laird	001-0022	FlexPIFA	PIFA	IPEX MHF4L	2
3	Laird	001-0023	FlexnNotch	PCB Dipole	IPEX MHF4L	2
4	Laird	EFA2400A3S-10MH4	mFlexPIFA	PIFA	IPEX MHF4L	2
5	Laird	001-0012	Waterproof Dipole Antenna	Dipole	RP-SMA	2
6	Laird	TRAB24003P	Phantom 800MHz - 5.8GHz	Monopole	N-female	3

Note: Antenna 6 with highest gain was chosen for final test.

Report No.: FR100407-02AD Page: 5 of 17

Note 2: Bluetooth BR uses a GFSK.

Note 3: Bluetooth EDR uses a combination of $\pi/4$ -DQPSK and 8DPSK.



1.1.4 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	3.3 Vdc from host

1.1.5 Accessories

N/A

1.1.6 Channel List

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

Report No.: FR100407-02AD Page: 6 of 17



1.1.7 Test Tool and Duty Cycle

Test Tool	Tera Term, Version: V4.74	era Term, Version: V4.74			
Modulation Mode	Duty Cycle Of Test Signal (%)	Duty Factor (dB)			
DH5	78.08%	1.07			
2DH5	78.53%	1.05			
3DH5	78.66%	1.04			

1.1.8 Power Index of Test Tool

Modulation Mode		Test Frequency (MHz)	
Wodulation Wode	2402	2441	2480
GFSK/1Mbps	default	default	default
π/4-DQPSK /2Mbps	default	default	default
8DPSK/3Mbps	default	default	default

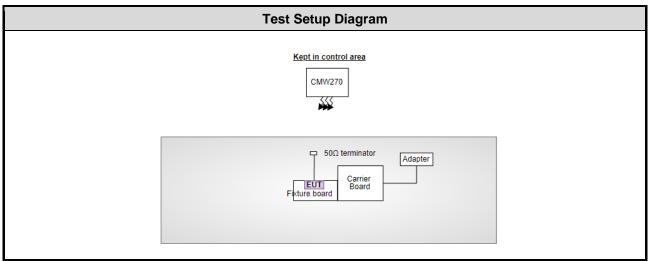
Report No.: FR100407-02AD Page: 7 of 17



1.2 Local Support Equipment List

	Support Equipment List						
No.	Equipment	Brand	Model	FCC ID	Remarks		
1	Notebook	DELL	Latitude 3400	DoC			
2	Fixture board				Provided by applicant.		
3	Carrier Board	Laird Connectivity	SU60-SOMC		Provided by applicant.		
4	Adapter	I.T.E	MU24AY12020 0-A1		Provided by applicant.		
5	Wireless connectivity tester	R&S	CMW270		Provided by applicant.		

1.3 Test Setup Chart



Note: The support notebook and USB cable were disconnected from EUT and removed from test table when EUT is set to transmit continuously.

Report No.: FR100407-02AD Page: 8 of 17



1.4 The Equipment List

Test Item	Conducted Emission	Conducted Emission							
Test Site	Conduction room 1 / (CO01-WS)								
Tested Date	Nov. 21, 2022								
Instrument	Brand	Brand Model No. Serial No. Calibration Date Calibration Until							
Receiver	R&S	R&S ESR3 101658 Feb. 16, 2022 Feb. 15, 2023							
LISN	R&S ENV216 101579 Apr. 21, 2022 Apr. 20, 2023								
LISN (Support Unit)	SCHWARZBECK	NSLK 8127	8127667	Jan .07, 2022	Jan .06, 2023				
RF Cable-CON	Woken	Woken CFD200-NL CFD200-NL-001 Oct. 17, 2022 Oct. 16, 2023							
50 ohm terminal (Support Unit)	$1 N\Delta I SO I May 10 2022 I May 09 2023 I$								
Measurement Software AUDIX e3 6.120210k NA NA									

Test Item	Radiated Emission				
Test Site	966 chamber3 / (03CH03-WS)				
Tested Date	Nov. 17, 2022				
Instrument	Brand	Model No.	Serial No.	Calibration Date	Calibration Until
Receiver	R&S	ESR3	101657	Mar. 15, 2022	Mar. 14, 2023
Spectrum Analyzer	R&S	FSV40	101499	Mar. 08, 2022	Mar. 07, 2023
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 01, 2022	Oct. 31, 2023
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-685	Jun. 28, 2022	Jun. 27, 2023
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1206	Dec. 20, 2021	Dec. 19, 2022
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170508	Jan. 11, 2022	Jan. 10, 2023
Preamplifier	EMC	EMC02325	980187	Jul. 16, 2022	Jul. 15, 2023
Preamplifier	EMC	EMC184045SE	980897	Aug. 01, 2022	Jul. 31, 2023
Preamplifier	EMC	EMC184045SE	980903	Jul. 16, 2022	Jul. 15, 2023
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Oct. 04, 2022	Oct. 03, 2023
LF cable-0.8M	EMC	EMC8D-NM-NM-800	EMC8D-NM-NM-800 -001	Sep. 23, 2022	Sep. 22, 2023
LF cable-3M	EMC	EMC8D-NM-NM-300 0	131103	Sep. 23, 2022	Sep. 22, 2023
LF cable-13M	EMC	EMC8D-NM-NM-130 00	131104	Sep. 23, 2022	Sep. 22, 2023
RF cable-3M	HUBER+SUHNER	SUCOFLEX104	MY22620/4	Sep. 23, 2022	Sep. 22, 2023
RF cable-8M	EMC	EMC104-SM-SM-80 00	181107	Sep. 23, 2022	Sep. 22, 2023
Measurement Software	AUDIX	e3	6.120210g	NA	NA
Note: Calibration Inter	Note: Calibration Interval of instruments listed above is one year.				

Report No.: FR100407-02AD Page: 9 of 17



Test Item	RF Conducted				
Test Site	(TH01-WS)				
Tested Date	Nov. 16, 2022				
Instrument	Brand	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101910	Apr. 18, 2022	Apr. 17, 2023
Power Meter	Anritsu	ML2495A	1241001	Jan. 14, 2022	Jan. 13, 2023
Power Sensor	Anritsu	MA2411B	1911228	Jan. 14, 2022	Jan. 13, 2023
Measurement Software	Sporton	SENSE-15247_DTS	V5.10.8.7.3	NA	NA
Note: Calibration Inte	rval of instruments liste	ed above is one year.		-	

1.5 Test Standards

47 CFR FCC Part 15.247 ANSI C63.10-2013

1.6 Reference Guidance

FCC KDB 558074 D01 15.247 Meas Guidance v05r02

1.7 Deviation from Test Standard and Measurement Procedure

None

1.8 Measurement Uncertainty

The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2)).

Measurement Uncertainty		
Parameters	Uncertainty	
Conducted power	±0.808 dB	
AC conducted emission	±2.92 dB	
Unwanted Emission ≤ 1GHz	±3.96 dB	
Unwanted Emission > 1GHz	±4.51 dB	

Report No.: FR100407-02AD Page: 10 of 17



2 Test Configuration

2.1 Testing Facility

Test Laboratory	International Certification Corporation
Test Site	CO01-WS, TH01-WS
Address of Test Site	No.3-1, Lane 6, Wen San 3rd St., Kwei Shan Dist., Tao Yuan City 33381, Taiwan (R.O.C.)
Test Site	03CH03-WS
Address of Test Site	No.14-1, Lane 19, Wen San 3rd St., Kwei Shan Dist., Tao Yuan City 333, Taiwan (R.O.C.)

FCC Designation No.: TW0009FCC site registration No.: 207696

➤ ISED#: 10807C

➤ CAB identifier: TW2732

2.2 The Worst Test Modes and Channel Details

 The tests reported herein were performed according to the original worst case conditions in original report no. FR100407AD.

Test item	Mode	Test Frequency (MHz)	Data Rate (Mbps)	Test Configuration
AC Power Line Conducted Emissions	8DPSK	2402	3Mbps	
Unwanted Emissions ≤ 1GHz	8DPSK	2402	3Mbps	
Unwanted Emissions > 1GHz	8DPSK	2440	3Mbps	
Conducted Output Power	GFSK л /4 DQPSK 8DPSK	2402, 2441, 2480 2402, 2441, 2480 2402, 2441, 2480	1Mbps 2Mbps 3Mbps	

NOTE:

Report No.: FR1O0407-02AD Page: 11 of 17

^{1.} The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The **Z-plane** results were found as the worst case and were shown in this report.



3 Transmitter Test Results

3.1 Unwanted Emissions into Restricted Frequency Bands

3.1.1 Limit of Unwanted Emissions into Restricted Frequency Bands

Restricted Band Emissions Limit					
Frequency Range (MHz)	Frequency Range (MHz) Field Strength (uV/m) Field Strength (dBuV/r		Measure Distance (m)		
0.009~0.490	2400/F(kHz)	48.5 - 13.8	300		
0.490~1.705	24000/F(kHz)	33.8 - 23	30		
1.705~30.0	30	29	30		
30~88	100	40	3		
88~216	150	43.5	3		
216~960	200	46	3		
Above 960	500	54	3		

Note 1:

Qusai-Peak value is measured for frequency below 1GHz except for 9–90 kHz, 110–490 kHz frequency band. Peak and average value are measured for frequency above 1GHz. The limit on average radio frequency emission is as above table. The limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit **Note 2**:

Measurements may be performed at a distance other than what is specified provided. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor as below, Frequency at or above 30 MHz: 20 dB/decade Frequency below 30 MHz: 40 dB/decade.

Report No.: FR100407-02AD Page: 12 of 17



3.1.2 Test Procedures

- Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission frequency. The EUT is placed at test table. For emissions testing at or below 1 GHz, the table height is 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height is 1.5 m
- 2. Measurement is made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna is varied in height (1m ~ 4m) above the reference ground plane to obtain the maximum signal strength. Distance between EUT and antenna is 3 m.
- 3. This investigation is performed with the EUT rotated 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.

Note:

3.

- 1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
- 2. Radiated emission above 1GHz / Peak value RBW=1MHz, VBW=3MHz and Peak detector

Radiated emission above 1GHz / Average value for harmonics
The average value is: Average = Peak value + 20log(Duty cycle) Where the duty factor is calculated from following formula for DH5 packet type which has worst duty factor:

Page: 13 of 17

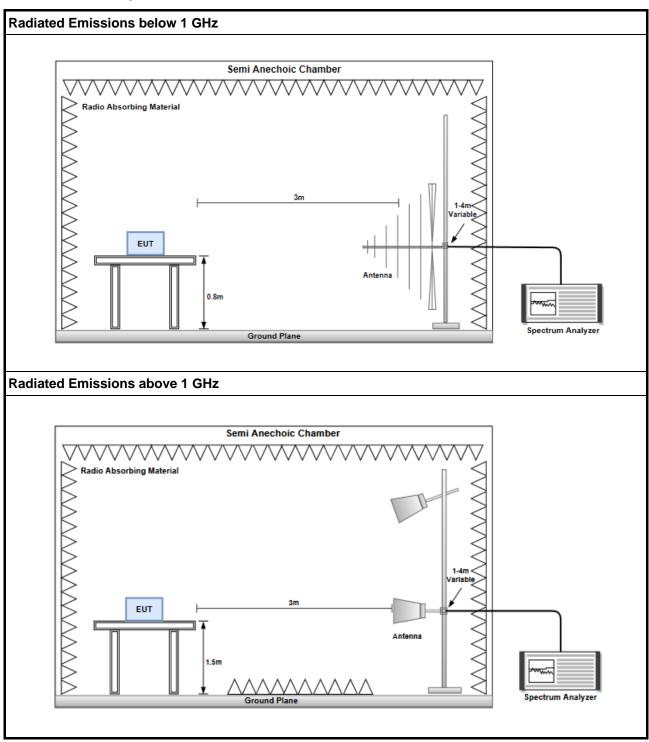
20log (Duty cycle) = 20log
$$\frac{1s / 1600 * 5}{100 \text{ ms}}$$
 = -30.1dB

4. Radiated emission above 1GHz / Average value for other emissions RBW=1MHz, VBW=1/T and Peak detector

Report Vorsion: Pay 01



3.1.3 Test Setup



3.1.4 Test Results

Refer to Appendix A.

Report No.: FR100407-02AD Page: 14 of 17



3.2 Conducted Output Power

3.2.1 Limit of Conducted Output Power

1 Watt 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.
0.125 Watt For all other frequency hopping systems in the 2400–2483.5 MHz band.
0.125 Watt For Frequency hopping systems operating in the 2400–2483.5 MHz band have hopping channel carrier frequencies that are separated by two-thirds of the 20 dB bandwidth of the hopping channel.

3.2.2 Test Procedures

- A wideband power meter is used for power measurement. Bandwidth of power senor and meter is 50MHz
- 2 If duty cycle of test signal is not 100 %, trigger and gating function of power meter will be enabled to capture transmission burst for measuring output power

3.2.3 Test Setup



3.2.4 Test Results

Ambient Condition	24°C / 66%	Tested By	Roger Lu

Refer to Appendix B.

Report No.: FR100407-02AD Page: 15 of 17



3.3 AC Power Line Conducted Emissions

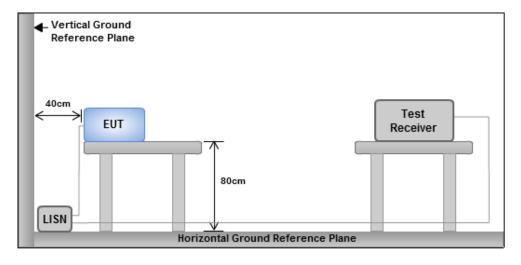
3.3.1 Limit of AC Power Line Conducted Emissions

Conducted Emissions Limit				
Frequency Emission (MHz) Quasi-Peak Average				
0.15-0.5	66 - 56 *	56 - 46 *		
0.5-5	56	46		
5-30 60 50				
5-30 60 50 Note 1: * Decreases with the logarithm of the frequency.				

3.3.2 Test Procedures

- 1. The device is placed on a test table, raised 80 cm above the reference ground plane. The vertical conducting plane is located 40 cm to the rear of the device.
- 2. The device is connected to line impedance stabilization network (LISN) and other accessories are connected to other LISN. Measured levels of AC power line conducted emission are across the 50 Ω LISN port.
- 3. AC conducted emission measurements is made over frequency range from 150 kHz to 30 MHz.
- 4. This measurement was performed with AC 120V/60Hz

3.3.3 Test Setup



Note: 1. Support units were connected to second LISN.

Both of LISNs (AMN) are 80 cm from EUT and at least 80 cm from other units and other metal planes

3.3.4 Test Results

Refer to Appendix C.

Report No.: FR100407-02AD Page: 16 of 17



4 Test laboratory information

Established in 2012, ICC provides foremost EMC & RF Testing and advisory consultation services by our skilled engineers and technicians. Our services employ a wide variety of advanced edge test equipment and one of the widest certification extents in the business.

International Certification Corporation (EMC and Wireless Communication Laboratory), it is our definitive objective is to institute long term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise and devotion to a certified value structure. Our passion is to grant our clients with best EMC / RF services by oriented knowledgeable and accommodating staff.

Our Test sites are located at Linkou District and Kwei Shan District. Location map can be found on our website http://www.icertifi.com.tw.

Linkou

Tel: 886-2-2601-1640 No.30-2, Ding Fwu Tsuen, Lin Kou District, New Taipei City, Taiwan (R.O.C.)

Kwei Shan

Tel: 886-3-271-8666
No.3-1, Lane 6, Wen San 3rd
St., Kwei Shan Dist., Tao Yuan
City 33381, Taiwan (R.O.C.)
No.2-1, Lane 6, Wen San 3rd
St., Kwei Shan Dist., Tao Yuan
City 33381, Taiwan (R.O.C.)

Kwei Shan Site II

Tel: 886-3-271-8640 No.14-1, Lane 19, Wen San 3rd St., Kwei Shan Dist., Tao Yuan City 333, Taiwan (R.O.C.)

If you have any suggestion, please feel free to contact us as below information.

Tel: 886-3-271-8666 Fax: 886-3-318-0345

Email: ICC Service@icertifi.com.tw

==END==

Report No.: FR100407-02AD Page: 17 of 17



Appendix A.1

Summary

Mode	Power	Power
	(dBm)	(W)
2.4-2.4835GHz	-	-
BT-BR(1Mbps)	6.52	0.00449
BT-EDR(2Mbps)	6.57	0.00454
BT-EDR(3Mbps)	6.75	0.00473

Result

Mode	Result	Antenna Gain (dBi)	Power (dBm)	Power Limit (dBm)
BT-BR(1Mbps)	-	-	-	-
2402MHz	Pass	3.00	6.52	21.00
2441MHz	Pass	3.00	6.42	21.00
2480MHz	Pass	3.00	6.01	21.00
BT-EDR(2Mbps)	-	-	-	-
2402MHz	Pass	3.00	6.57	21.00
2441MHz	Pass	3.00	6.56	21.00
2480MHz	Pass	3.00	6.25	21.00
BT-EDR(3Mbps)	-	-	-	-
2402MHz	Pass	3.00	6.75	21.00
2441MHz	Pass	3.00	6.71	21.00
2480MHz	Pass	3.00	6.36	21.00

DG = Directional Gain; Port X = Port X output power



Conducted Output Power(Average)

Appendix A.2

Summary

Mode	Power	Power
	(dBm)	(W)
2.4-2.4835GHz	-	-
BT-BR(1Mbps)	6.38	0.00435
BT-EDR(2Mbps)	4.19	0.00262
BT-EDR(3Mbps)	4.21	0.00264

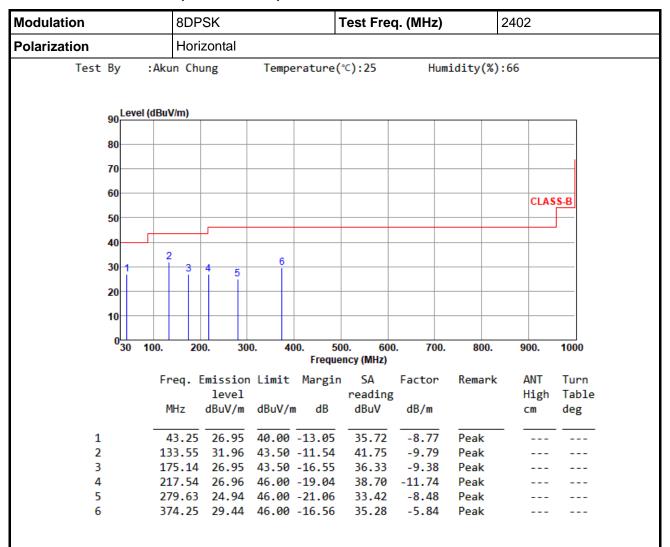
Result

Mode	Result	Antenna Gain (dBi)	Power (dBm)	Power Limit (dBm)
BT-BR(1Mbps)	-	-	-	-
2402MHz	Pass	3.00	6.38	-
2441MHz	Pass	3.00	6.25	-
2480MHz	Pass	3.00	5.83	-
BT-EDR(2Mbps)	-	-	-	-
2402MHz	Pass	3.00	4.19	-
2441MHz	Pass	3.00	4.12	-
2480MHz	Pass	3.00	3.86	-
BT-EDR(3Mbps)	-	-	-	-
2402MHz	Pass	3.00	4.21	-
2441MHz	Pass	3.00	4.13	-
2480MHz	Pass	3.00	3.87	-

Note: Average power is for reference only.



Unwanted Emissions (Below 1GHz)



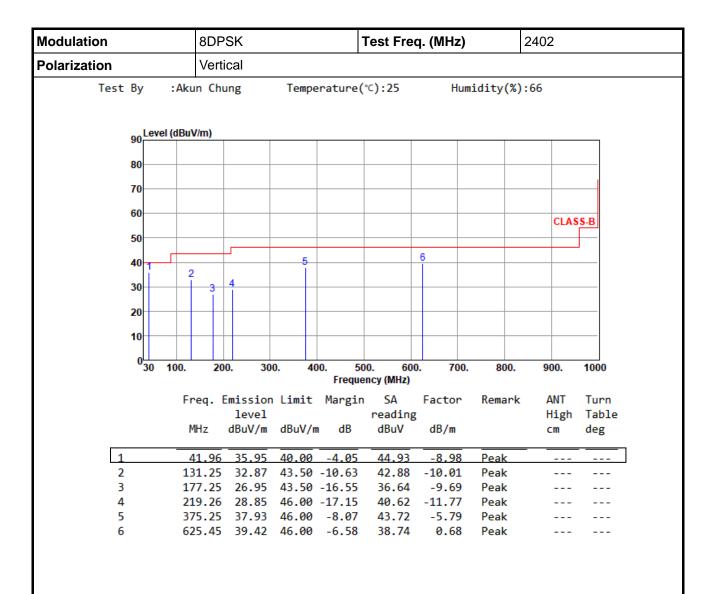
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV) + Factor* (dB/m)

*Factor includes antenna factor, cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBuV/m) - Limit (dBuV/m).

Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.





Note 1: Emission Level (dBuV/m) = SA Reading (dBuV) + Factor* (dB/m)

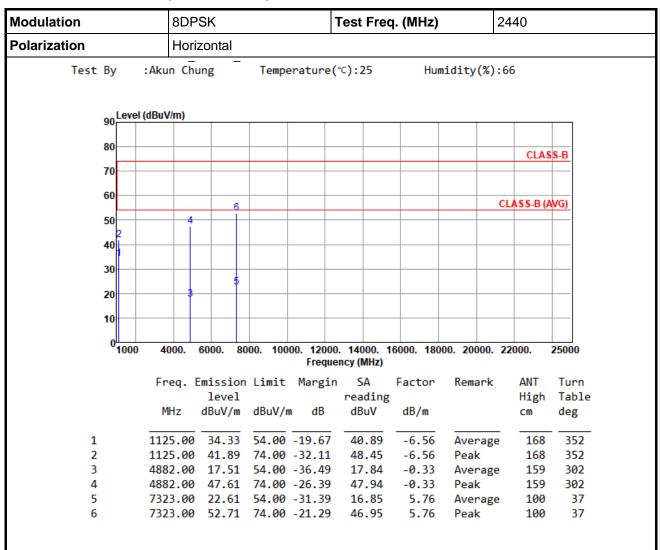
*Factor includes antenna factor, cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBuV/m) - Limit (dBuV/m).

Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.



Unwanted Emission (Above 1GHz)

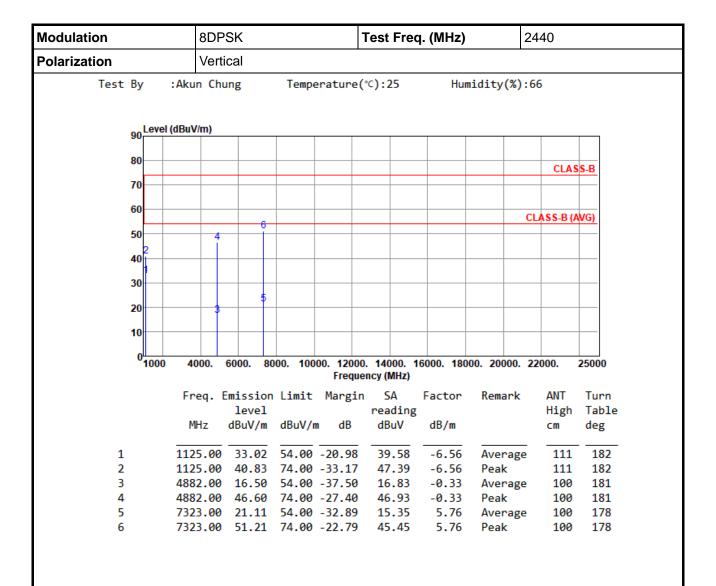


Note 1: Emission Level (dBuV/m) = SA Reading (dBuV) + Factor* (dB/m)

*Factor includes antenna factor, cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBuV/m) - Limit (dBuV/m).



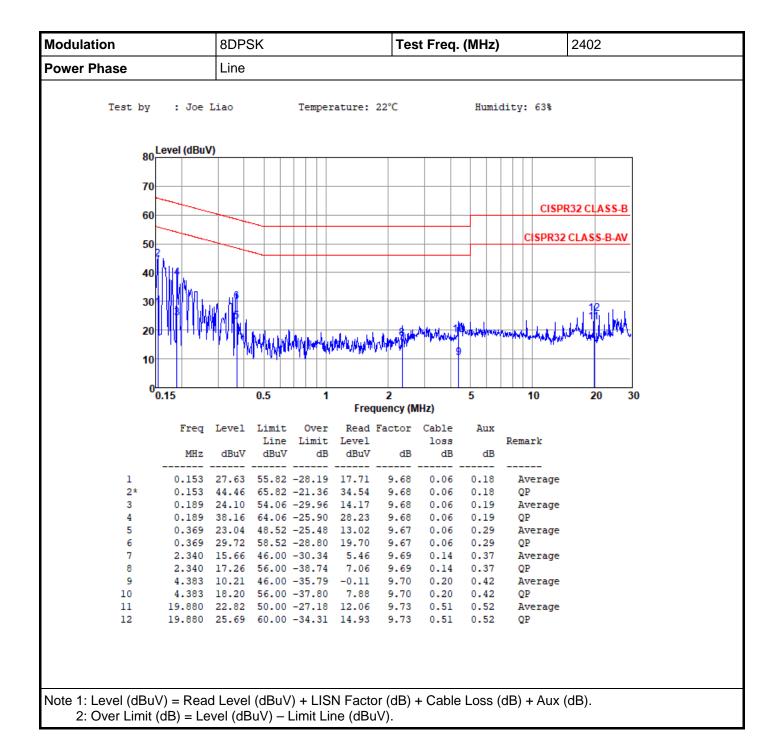


Note 1: Emission Level (dBuV/m) = SA Reading (dBuV) + Factor* (dB/m)

*Factor includes antenna factor, cable loss and amplifier gain

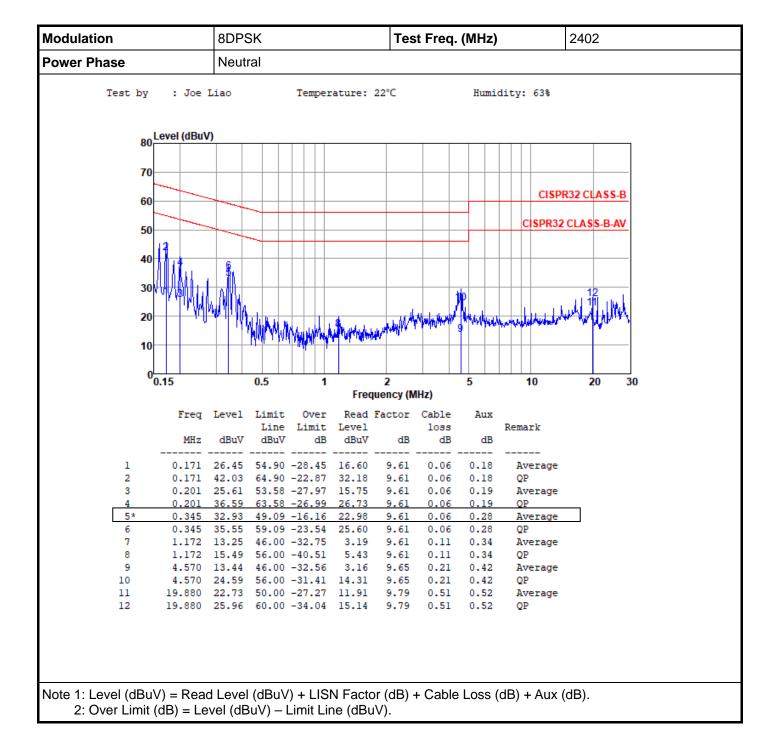
Note 2: Margin (dB) = Emission level (dBuV/m) - Limit (dBuV/m).





Page No. : 1 of





Page No. : 2 of