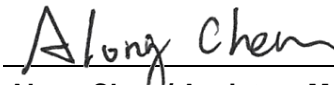


FCC Test Report

FCC ID : SQG-LWBPLUS
Equipment : 802.11n 2.4GHz + BT5.2 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 : Oct. 04, 2021
Tested Date : Oct. 27 ~ Nov. 02, 2021

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 may be duplicated completely for legal use with the approval of the applicant. It shall not be reproduced except in full without the written approval of our laboratory.

Reviewed by:


Along Chen / Assistant Manager

Approved by:


Gary Chang / Manager



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Release Record

Report No.	Version	Description	Issued Date
FR1O0407AD	Rev. 01	Initial issue	Dec. 10, 2021

Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	Conducted Emissions	[dBuV]: 0.402MHz 30.22 (Margin -17.59dB) - AV	Pass
15.247(d) 15.209	Radiated Emissions	[dBuV/m at 3m]: 483.96MHz 44.42 (Margin -1.58dB) - QP	Pass
15.247(d)	Band Edge	Meet the requirement of limit	Pass
15.247(b)(1)	Conducted Output Power	Power [dBm]: 7.23	Pass
15.247(a)(1)(iii)	Number of Hopping Channels	Meet the requirement of limit	Pass
15.247(a)(1)	Hopping Channel Separation	Meet the requirement of limit	Pass
15.247(a)(1)(iii)	Dwell Time	Meet the requirement of limit	Pass
15.203	Antenna Requirement	Meet the requirement of limit	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.

1 General Description

1.1 Information

The device has 3 configurations as below:

Brand name	Model Name	Product Name	Part Number	Description
Laird Connectivity	Sterling LWB+	802.11n 2.4GHz + BT5.2 Module	453-00085	Chip Antenna
Laird Connectivity	Sterling LWB+	802.11n 2.4GHz + BT5.2 Module	453-00084	MHF4 Connector
Laird Connectivity	Sterling LWB+	802.11n 2.4GHz + BT5.2 Module	453-00083	SIP Module

Note: Part Number: 453-00084 was selected as a representative one for the final test

1.1.1 Specification of the Equipment under Test (EUT)

RF General Information				
Frequency Range (MHz)	Bluetooth Mode	Ch. Frequency (MHz)	Channel Number	Data Rate
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.
 Note 2: Bluetooth BR uses a GFSK.
 Note 3: Bluetooth EDR uses a combination of $\pi/4$ -DQPSK and 8DPSK.

1.1.2 Antenna Details

Ant. No.	Manufacturer	Laird Part Number	Model	Type	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
7	ACX	AT3216-A2R4PAAT/LF	Chip Antenna	Chip Antenna	-	1.5

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

1.1.3 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	3.3 Vdc from host
--------------------------	-------------------

1.1.4 Accessories

N/A

1.1.5 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	---	---

1.1.6 Test Tool and Duty Cycle

Test Tool	Tera Term, Version: V4.74	
Modulation Mode	Duty Cycle Of Test Signal (%)	Duty Factor (dB)
DH5	78.76%	1.04
2DH5	78.76%	1.04
3DH5	78.76%	1.04

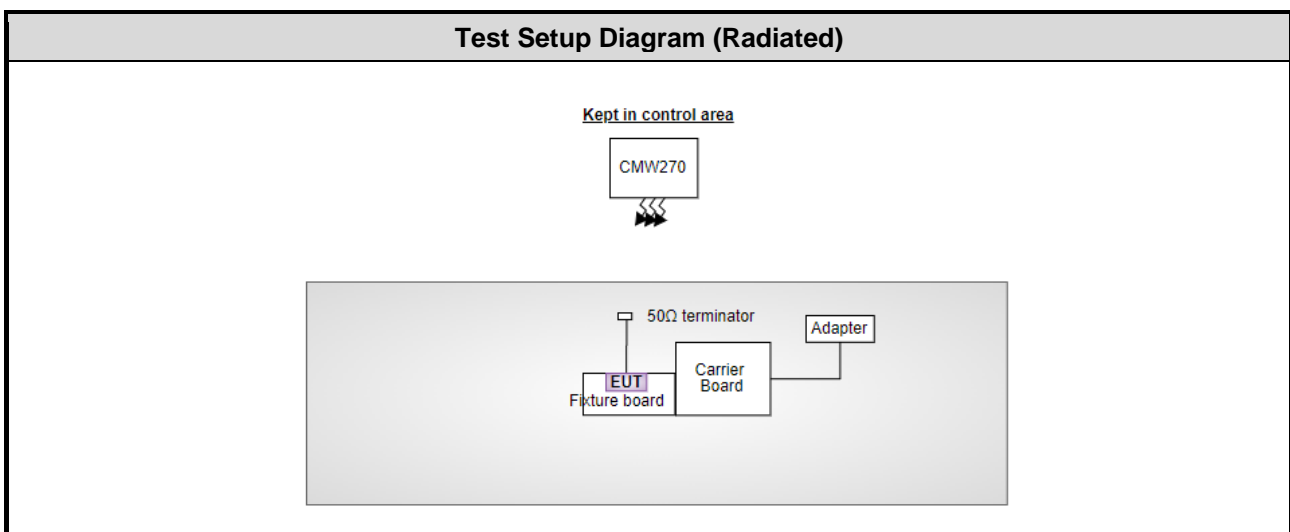
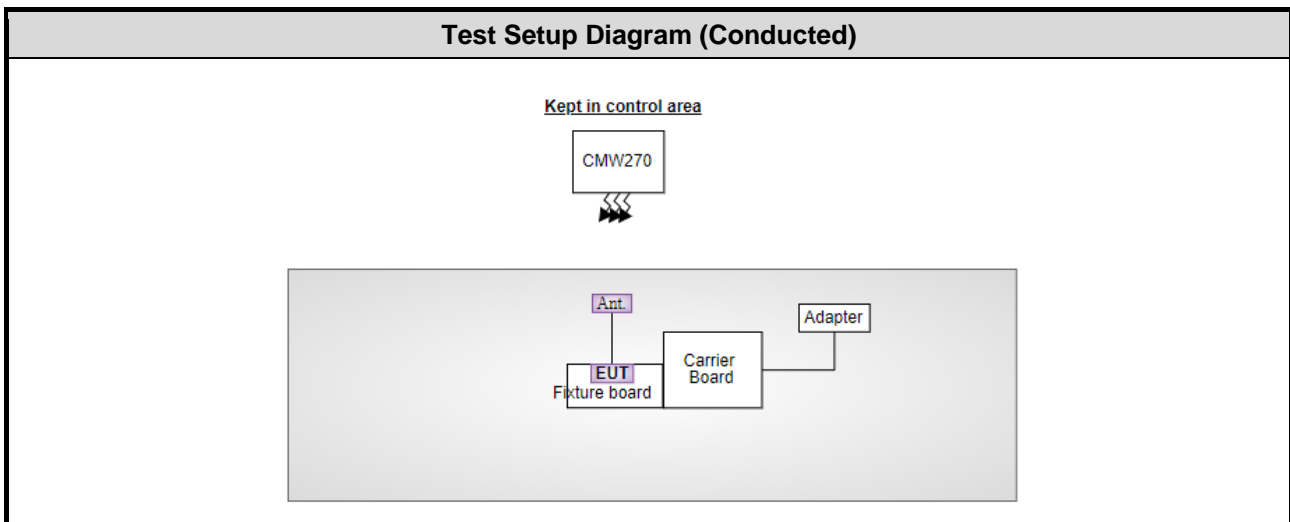
1.1.7 Power Index of Test Tool

Modulation Mode	Test Frequency (MHz)		
	2402	2441	2480
GFSK/1Mbps	default	default	default
$\pi/4$ -DQPSK /2Mbps	default	default	default
8DPSK/3Mbps	default	default	default

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	MU24AY120200-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.

1.4 The Equipment List

Test Item	Conducted Emission				
Test Site	Conduction room 1 / (CO01-WS)				
Tested Date	Nov. 02, 2021				
Instrument	Brand	Model No.	Serial No.	Calibration Date	Calibration Until
Receiver	R&S	ESR3	101658	Feb. 08, 2021	Feb. 07, 2022
LISN	R&S	ENV216	101579	Mar. 17, 2021	Mar. 16, 2022
LISN (Support Unit)	SCHWARZBECK	Schwarzbeck 8127	8127-666	Dec. 29, 2020	Dec. 28, 2021
RF Cable-CON	Woken	CFD200-NL	CFD200-NL-001	Oct. 19, 2021	Oct. 18, 2022
50 ohm terminal (Support Unit)	NA	50	04	May 25, 2021	May 24, 2022
Measurement Software	AUDIX	e3	6.120210k	NA	NA

Note: Calibration Interval of instruments listed above is one year.

Test Item	Radiated Emission				
Test Site	966 chamber3 / (03CH03-WS)				
Tested Date	Oct. 28, 2021				
Instrument	Brand	Model No.	Serial No.	Calibration Date	Calibration Until
Receiver	R&S	ESR3	101657	Mar. 12, 2021	Mar. 11, 2022
Spectrum Analyzer	R&S	FSV40	101499	Mar. 02, 2021	Mar. 01, 2022
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 17, 2020	Nov. 16, 2021
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-685	May 06, 2021	May 05, 2022
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1206	Dec. 22, 2020	Dec. 21, 2021
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170517	Nov. 06, 2020	Nov. 05, 2021
Preamplifier	EMC	EMC02325	980187	Jul. 26, 2021	Jul. 25, 2022
Preamplifier	Agilent	83017A	MY39501309	Sep. 06, 2021	Sep. 05, 2022
Preamplifier	EMC	EMC184045B	980192	Jul. 14, 2021	Jul. 13, 2022
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Oct. 05, 2021	Oct. 04, 2022
LF cable-0.8M	EMC	EMC8D-NM-NM-800	EMC8D-NM-NM-800-001	Sep. 24, 2021	Sep. 23, 2022
LF cable-3M	EMC	EMC8D-NM-NM-3000	131103	Sep. 24, 2021	Sep. 23, 2022
LF cable-13M	EMC	EMC8D-NM-NM-13000	131104	Sep. 24, 2021	Sep. 23, 2022
RF cable-3M	HUBER+SUHNER	SUCOFLEX104	MY22620/4	Sep. 24, 2021	Sep. 23, 2022
RF cable-8M	EMC	EMC104-SM-SM-8000	181107	Sep. 24, 2021	Sep. 23, 2022
Measurement Software	AUDIX	e3	6.120210g	NA	NA
Wireless connectivity tester	R&S	CMW270	100856	Nov. 02, 2020	Nov. 01, 2021

Note: Calibration Interval of instruments listed above is one year.

Test Item	RF Conducted				
Test Site	(TH01-WS)				
Tested Date	Oct. 27 ~ Oct. 29, 2021				
Instrument	Brand	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101498	Dec. 04, 2020	Dec. 03, 2021
Power Meter	Anritsu	ML2495A	1218007	Jan. 26, 2021	Jan. 25, 2022
Power Sensor	Anritsu	MA2411B	1207367	Jan. 26, 2021	Jan. 25, 2022
Measurement Software	Sporton	SENSE-15247_FS	V5.10.7.11	NA	NA
Wireless connectivity tester	R&S	CMW270	100856	Nov. 02, 2020	Nov. 01, 2021
Note: Calibration Interval of instruments listed 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
Bandwidth	±34.130 Hz
Conducted power	±0.808 dB
Power density	±0.583 dB
Conducted emission	±2.715 dB
AC conducted emission	±2.92 dB
Radiated emission ≤ 1GHz	±3.96 dB
Radiated emission > 1GHz	±4.51 dB
Time	±0.1%

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.: TW0009
- FCC site registration No.: 207696
- ISED#: 10807A
- CAB identifier: TW2732

2.2 The Worst Test Modes and Channel Details

Test item	Mode	Test Frequency (MHz)	Data Rate (Mbps)	Test Configuration
Conducted Emissions Radiated Emissions ≤ 1GHz	8DPSK	2402	3Mbps	---
Radiated Emissions > 1GHz	GFSK 8DPSK	2402, 2441, 2480 2402, 2441, 2480	1Mbps 3Mbps	---
Conducted Output Power	GFSK π/4 DQPSK 8DPSK	2402, 2441, 2480 2402, 2441, 2480 2402, 2441, 2480	1Mbps 2Mbps 3Mbps	---
Number of Hopping Channels	GFSK π/4 DQPSK 8DPSK	2402~2480 2402~2480 2402~2480	1Mbps 2Mbps 3Mbps	---
Hopping Channel Separation 20dB and Occupied bandwidth	GFSK π/4 DQPSK 8DPSK	2402, 2441, 2480 2402, 2441, 2480 2402, 2441, 2480	1Mbps 2Mbps 3Mbps	---
Dwell Time	GFSK π/4 DQPSK 8DPSK	2402 2402 2402	1Mbps 2Mbps 3Mbps	---

NOTE:

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.
2. The 50Ω terminators are connected to antenna port of EUT for radiated emission measurement.

3 Transmitter Test Results

3.1 Conducted Emissions

3.1.1 Limit of Conducted Emissions

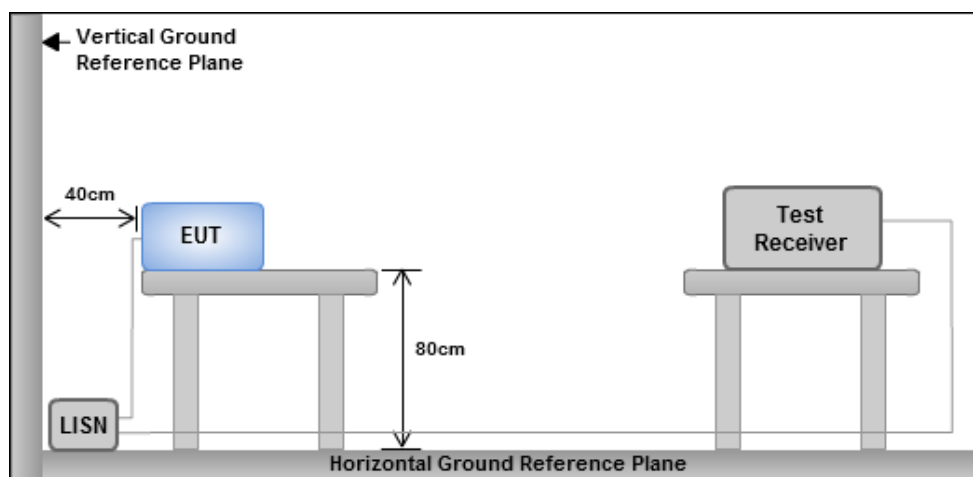
Conducted Emissions Limit		
Frequency Emission (MHz)	Quasi-Peak	Average
0.15-0.5	66 - 56 *	56 - 46 *
0.5-5	56	46
5-30	60	50

Note 1: * Decreases with the logarithm of the frequency.

3.1.2 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

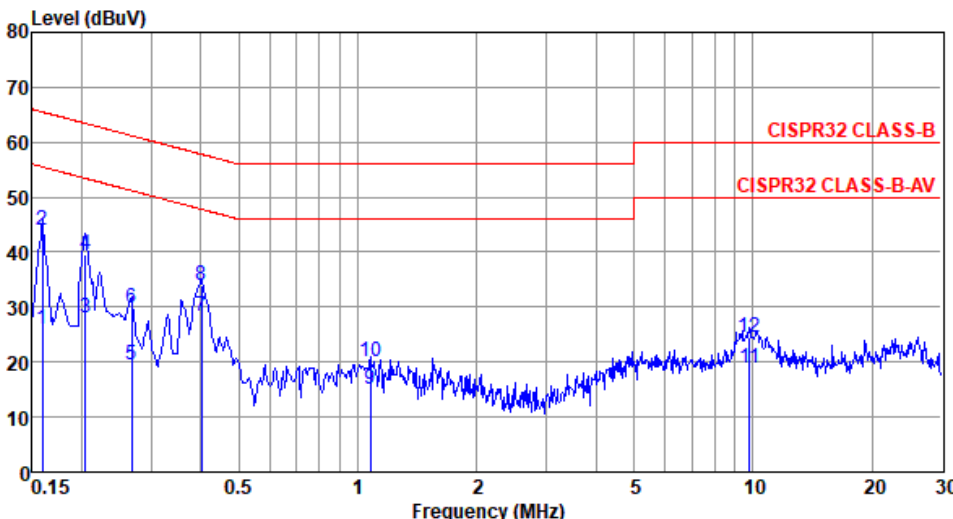
3.1.3 Test Setup



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

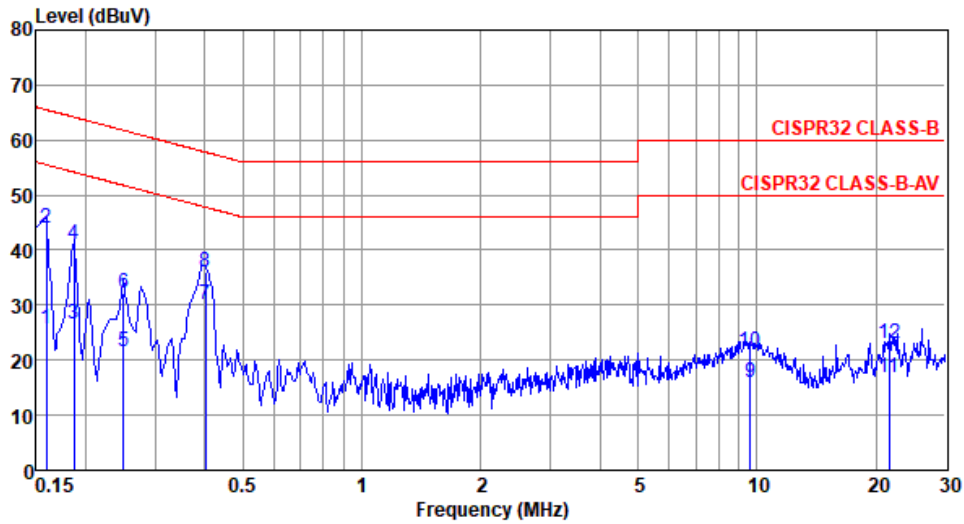
2. Both of LISNs (AMN) are 80 cm from EUT and at least 80 cm from other units and other metal planes

3.1.4 Test Result of Conducted Emissions

Modulation Mode	8DPSK	Test Freq. (MHz)	2402																																																																																																																																		
Power Phase	Line																																																																																																																																				
<p>Test by : Joe Liao Temperature: 22°C Humidity: 63%</p>																																																																																																																																					
																																																																																																																																					
<table border="1"> <thead> <tr> <th></th> <th>Freq MHz</th> <th>Level dBuV</th> <th>Limit Line dBuV</th> <th>Over Limit dB</th> <th>Read Level dBuV</th> <th>Factor dB</th> <th>Cable loss dB</th> <th>Aux dB</th> <th>Remark</th> </tr> </thead> <tbody> <tr><td>1</td><td>0.159</td><td>26.12</td><td>55.52</td><td>-29.40</td><td>16.18</td><td>9.66</td><td>0.08</td><td>0.20</td><td>Average</td></tr> <tr><td>2</td><td>0.159</td><td>43.88</td><td>65.52</td><td>-21.64</td><td>33.94</td><td>9.66</td><td>0.08</td><td>0.20</td><td>QP</td></tr> <tr><td>3</td><td>0.204</td><td>28.09</td><td>53.45</td><td>-25.36</td><td>18.14</td><td>9.65</td><td>0.08</td><td>0.22</td><td>Average</td></tr> <tr><td>4</td><td>0.204</td><td>39.69</td><td>63.45</td><td>-23.76</td><td>29.74</td><td>9.65</td><td>0.08</td><td>0.22</td><td>QP</td></tr> <tr><td>5</td><td>0.267</td><td>19.61</td><td>51.20</td><td>-31.59</td><td>9.60</td><td>9.65</td><td>0.08</td><td>0.28</td><td>Average</td></tr> <tr><td>6</td><td>0.267</td><td>29.86</td><td>61.20</td><td>-31.34</td><td>19.85</td><td>9.65</td><td>0.08</td><td>0.28</td><td>QP</td></tr> <tr><td>7*</td><td>0.402</td><td>28.32</td><td>47.81</td><td>-19.49</td><td>18.24</td><td>9.64</td><td>0.08</td><td>0.36</td><td>Average</td></tr> <tr><td>8</td><td>0.402</td><td>33.88</td><td>57.81</td><td>-23.93</td><td>23.80</td><td>9.64</td><td>0.08</td><td>0.36</td><td>QP</td></tr> <tr><td>9</td><td>1.077</td><td>15.20</td><td>46.00</td><td>-30.80</td><td>5.02</td><td>9.65</td><td>0.16</td><td>0.37</td><td>Average</td></tr> <tr><td>10</td><td>1.077</td><td>20.09</td><td>56.00</td><td>-35.91</td><td>9.91</td><td>9.65</td><td>0.16</td><td>0.37</td><td>QP</td></tr> <tr><td>11</td><td>9.809</td><td>19.02</td><td>50.00</td><td>-30.98</td><td>8.43</td><td>9.71</td><td>0.44</td><td>0.44</td><td>Average</td></tr> <tr><td>12</td><td>9.809</td><td>24.58</td><td>60.00</td><td>-35.42</td><td>13.99</td><td>9.71</td><td>0.44</td><td>0.44</td><td>QP</td></tr> </tbody> </table>					Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	Factor dB	Cable loss dB	Aux dB	Remark	1	0.159	26.12	55.52	-29.40	16.18	9.66	0.08	0.20	Average	2	0.159	43.88	65.52	-21.64	33.94	9.66	0.08	0.20	QP	3	0.204	28.09	53.45	-25.36	18.14	9.65	0.08	0.22	Average	4	0.204	39.69	63.45	-23.76	29.74	9.65	0.08	0.22	QP	5	0.267	19.61	51.20	-31.59	9.60	9.65	0.08	0.28	Average	6	0.267	29.86	61.20	-31.34	19.85	9.65	0.08	0.28	QP	7*	0.402	28.32	47.81	-19.49	18.24	9.64	0.08	0.36	Average	8	0.402	33.88	57.81	-23.93	23.80	9.64	0.08	0.36	QP	9	1.077	15.20	46.00	-30.80	5.02	9.65	0.16	0.37	Average	10	1.077	20.09	56.00	-35.91	9.91	9.65	0.16	0.37	QP	11	9.809	19.02	50.00	-30.98	8.43	9.71	0.44	0.44	Average	12	9.809	24.58	60.00	-35.42	13.99	9.71	0.44	0.44	QP
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12	9.809	24.58	60.00	-35.42	13.99	9.71	0.44	0.44	QP																																																																																																																												
<p>Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB). 2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).</p>																																																																																																																																					

Modulation Mode	8DPSK	Test Freq. (MHz)	2402
Power Phase	Neutral		

Test by : Joe Liao Temperature: 22°C Humidity: 63%



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	Factor dB	Cable loss dB	Aux dB	Remark
1	0.159	25.79	55.52	-29.73	15.86	9.69	0.08	0.16	Average
2	0.159	44.05	65.52	-21.47	34.12	9.69	0.08	0.16	QP
3	0.186	26.63	54.20	-27.57	16.70	9.68	0.08	0.17	Average
4	0.186	41.00	64.20	-23.20	31.07	9.68	0.08	0.17	QP
5	0.249	21.68	51.78	-30.10	11.74	9.68	0.08	0.18	Average
6	0.249	32.15	61.78	-29.63	22.21	9.68	0.08	0.18	QP
7*	0.402	30.22	47.81	-17.59	20.28	9.67	0.08	0.19	Average
8	0.402	35.99	57.81	-21.82	26.05	9.67	0.08	0.19	QP
9	9.603	15.80	50.00	-34.20	5.23	9.76	0.44	0.37	Average
10	9.603	21.43	60.00	-38.57	10.86	9.76	0.44	0.37	QP
11	21.600	16.93	50.00	-33.07	5.95	9.84	0.67	0.47	Average
12	21.600	23.06	60.00	-36.94	12.08	9.84	0.67	0.47	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
 2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

3.2 Unwanted Emissions into Restricted Frequency Bands

3.2.1 Limit of Unwanted Emissions into Restricted Frequency Bands

Restricted Band Emissions Limit			
Frequency Range (MHz)	Field Strength (uV/m)	Field Strength (dBuV/m)	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.

3.2.2 Test Procedures

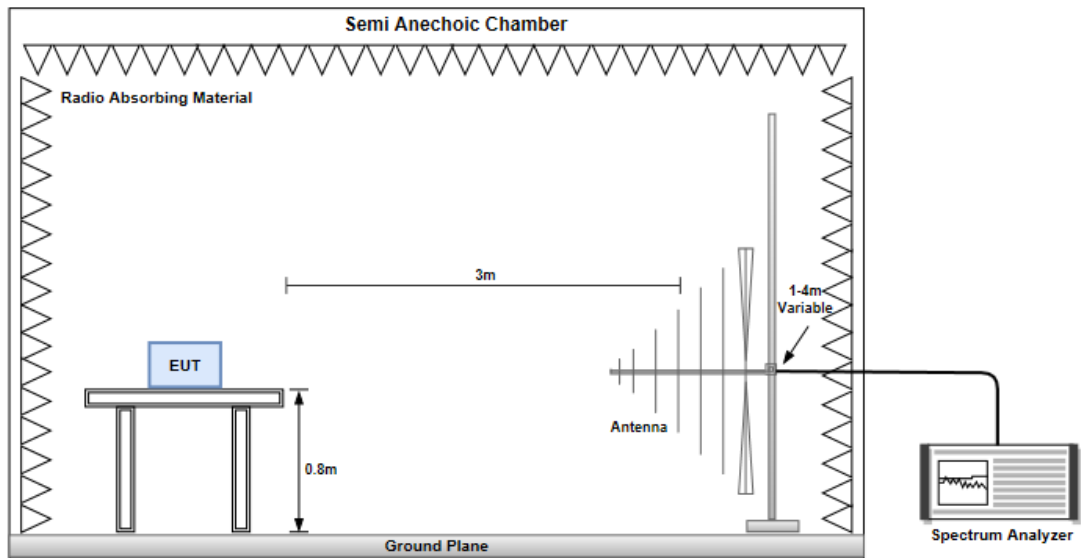
1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission 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:

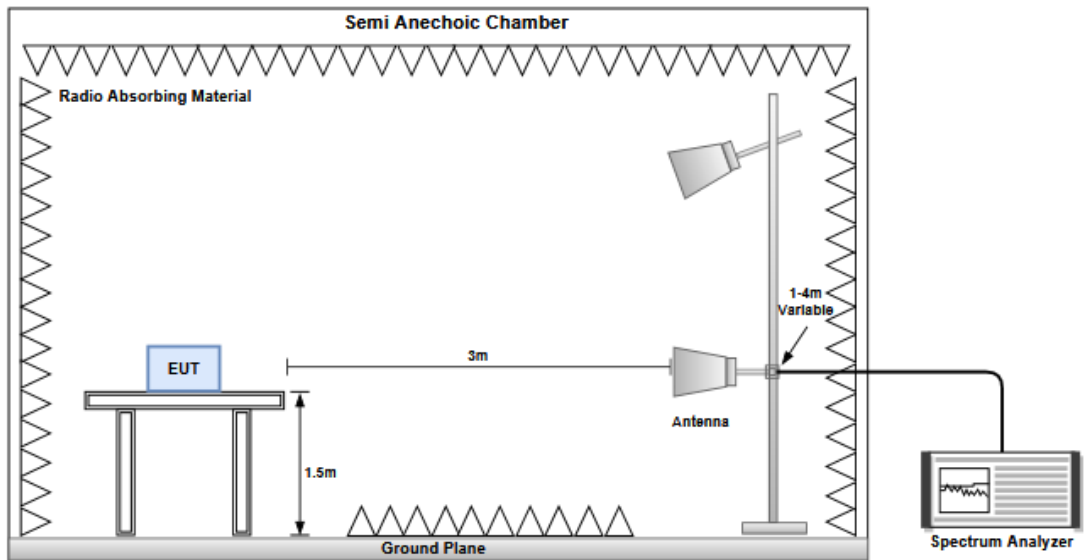
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. Radiated emission above 1GHz / Peak value
RBW=1MHz, VBW=3MHz and Peak detector
Radiated emission above 1GHz / Average value for harmonics
The average value is: Average = Peak value + 20log(Duty cycle) Where the duty factor is calculated from following formula for DH5 packet type which has worst duty factor:
3.
$$20\log(\text{Duty cycle}) = 20\log \frac{1\text{s} / 1600 * 5}{100\text{ ms}} = -30.1\text{dB}$$
4. Radiated emission above 1GHz / Average value for other emissions
RBW=1MHz, VBW=1/T and Peak detector

3.2.3 Test Setup

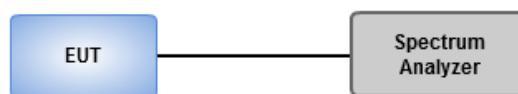
Radiated Emissions below 1 GHz



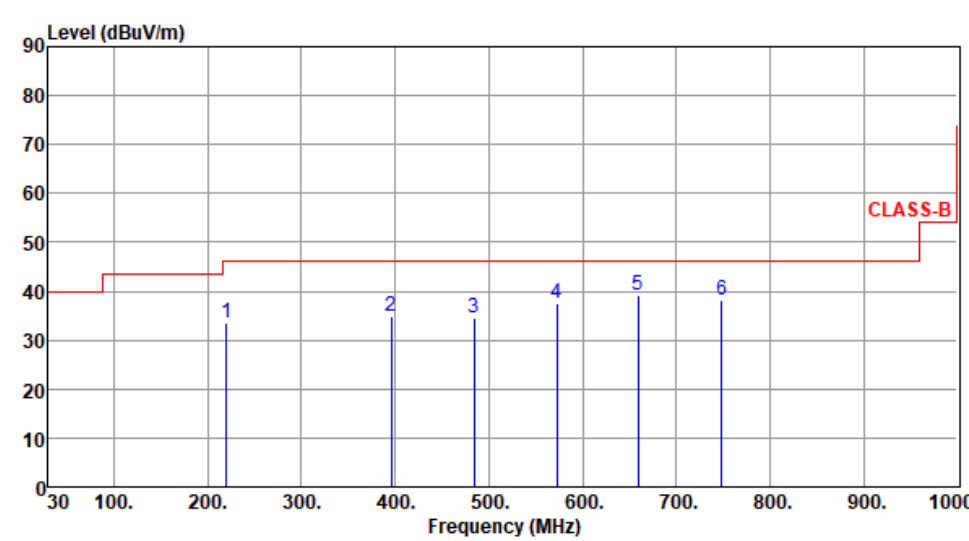
Radiated Emissions above 1 GHz



Transmitter Conducted Unwanted Emissions (30MHz~25GHz)



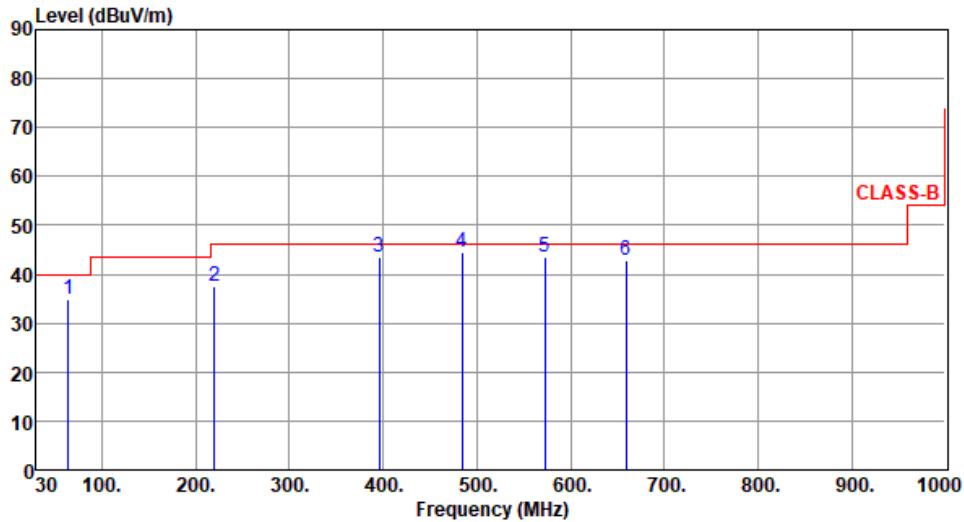
3.2.4 Transmitter Radiated Unwanted Emissions (Below 1GHz)

Modulation	8DPSK	Test Freq. (MHz)	2402						
Polarization	Horizontal								
Test By :Brad Wu Temperature(°C):23 Humidity(%):64									
									
	Freq.	Emission level	Limit	Margin	SA reading	Factor	Remark	ANT High	Turn Table
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m		cm	deg
1	220.12	33.63	46.00	-12.37	45.48	-11.85	Peak	---	---
2	395.69	34.91	46.00	-11.09	40.51	-5.60	Peak	---	---
3	483.96	34.67	46.00	-11.33	37.75	-3.08	Peak	---	---
4	572.23	37.64	46.00	-8.36	38.79	-1.15	Peak	---	---
5	659.53	39.12	46.00	-6.88	38.43	0.69	Peak	---	---
6	748.77	38.12	46.00	-7.88	35.25	2.87	Peak	---	---

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.

Modulation	8DPSK	Test Freq. (MHz)	2402
Polarization	Vertical		

Test By :Brad Wu Temperature(°C):23 Humidity(%):64



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB/m	Remark	ANT High cm	Turn Table deg
1	63.95	34.83	40.00	-5.17	44.69	-9.86	Peak	---	---
2	220.12	37.38	46.00	-8.62	49.23	-11.85	Peak	---	---
3	395.69	43.56	46.00	-2.44	49.16	-5.60	QP	135	96
4	483.96	44.42	46.00	-1.58	47.50	-3.08	QP	100	205
5	572.23	43.59	46.00	-2.41	44.74	-1.15	QP	100	62
6	659.53	42.73	46.00	-3.27	42.04	0.69	Peak	---	---

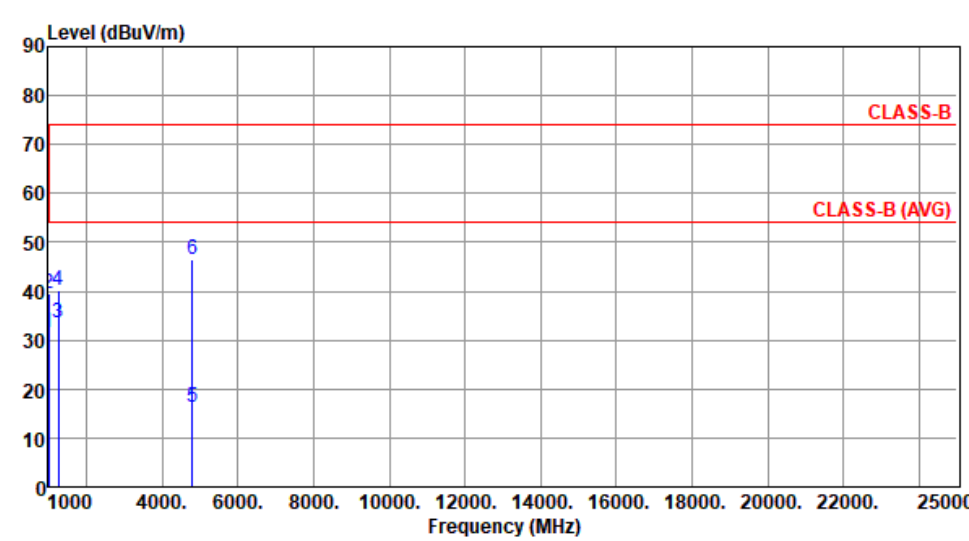
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV) + Factor* (dB/m)

*Factor includes antenna factor , cable loss and amplifier gain

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

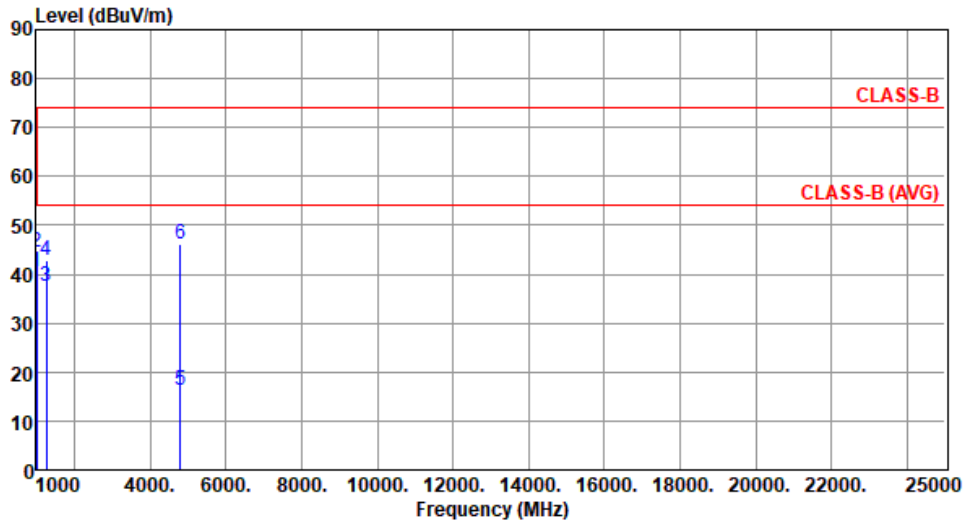
Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

3.2.5 Transmitter Radiated Unwanted Emissions (Above 1GHz) for GFSK

Modulation	GFSK	Test Freq. (MHz)	2402						
Polarization	Horizontal								
Test By :Brad Wu Temperature(°C):23 Humidity(%):64									
									
	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB/m	Remark	ANT High cm	Turn Table deg
1	1012.00	31.54	54.00	-22.46	40.94	-9.40	Average	165	31
2	1012.00	39.41	74.00	-34.59	48.81	-9.40	Peak	165	31
3	1276.00	33.51	54.00	-20.49	40.23	-6.72	Average	100	274
4	1276.00	40.25	74.00	-33.75	46.97	-6.72	Peak	100	274
5	4804.00	16.25	54.00	-37.75	11.06	5.19	Average	100	6
6	4804.00	46.35	74.00	-27.65	41.16	5.19	Peak	100	6
<p>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).</p>									

Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Vertical		

Test By :Brad Wu Temperature(°C):23 Humidity(%):64



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB/m	Remark	ANT High cm	Turn Table deg
1	1012.00	40.45	54.00	-13.55	49.85	-9.40	Average	112	14
2	1012.00	44.36	74.00	-29.64	53.76	-9.40	Peak	112	14
3	1276.00	37.59	54.00	-16.41	44.31	-6.72	Average	168	344
4	1276.00	42.75	74.00	-31.25	49.47	-6.72	Peak	168	344
5	4804.00	16.15	54.00	-37.85	10.96	5.19	Average	100	268
6	4804.00	46.25	74.00	-27.75	41.06	5.19	Peak	100	268

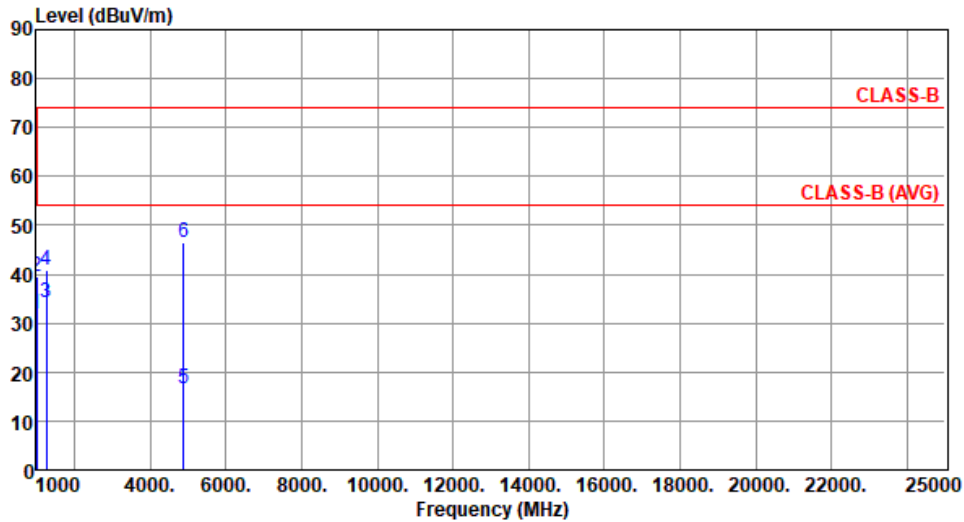
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV) + Factor* (dB/m)

*Factor includes antenna factor , cable loss and amplifier gain

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

Modulation	GFSK	Test Freq. (MHz)	2441
Polarization	Horizontal		

Test By :Brad Wu Temperature(°C):23 Humidity(%):64



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB/m	Remark	ANT High cm	Turn Table deg
1	1012.00	31.77	54.00	-22.23	41.17	-9.40	Average	155	39
2	1012.00	39.65	74.00	-34.35	49.05	-9.40	Peak	155	39
3	1276.00	34.14	54.00	-19.86	40.86	-6.72	Average	100	296
4	1276.00	40.92	74.00	-33.08	47.64	-6.72	Peak	100	296
5	4882.00	16.45	54.00	-37.55	11.17	5.28	Average	100	19
6	4882.00	46.55	74.00	-27.45	41.27	5.28	Peak	100	19

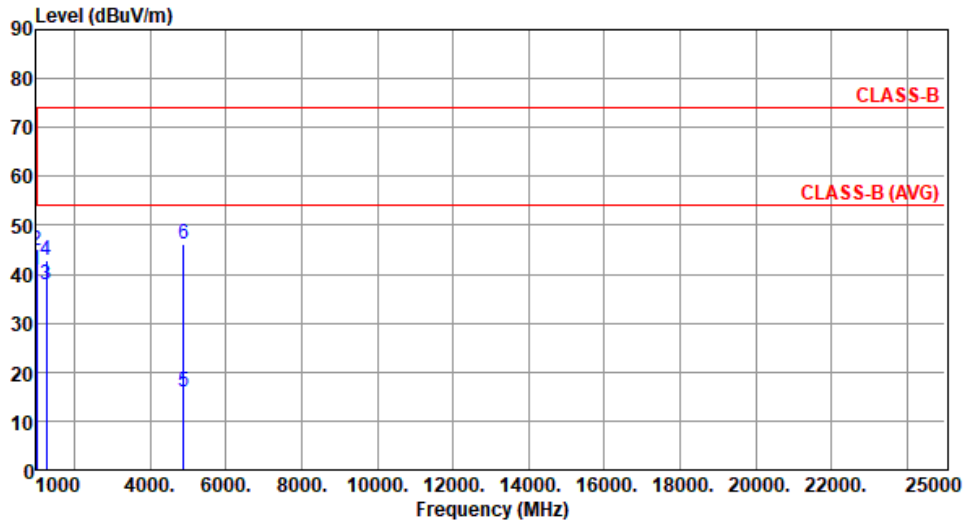
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV) + Factor* (dB/m)

*Factor includes antenna factor , cable loss and amplifier gain

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

Modulation	GFSK	Test Freq. (MHz)	2441
Polarization	Vertical		

Test By :Brad Wu Temperature(°C):23 Humidity(%):64



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB/m	Remark	ANT High cm	Turn Table deg
1	1012.00	40.85	54.00	-13.15	50.25	-9.40	Average	115	19
2	1012.00	44.68	74.00	-29.32	54.08	-9.40	Peak	115	19
3	1276.00	37.81	54.00	-16.19	44.53	-6.72	Average	174	346
4	1276.00	42.88	74.00	-31.12	49.60	-6.72	Peak	174	346
5	4882.00	16.09	54.00	-37.91	10.81	5.28	Average	100	261
6	4882.00	46.19	74.00	-27.81	40.91	5.28	Peak	100	261

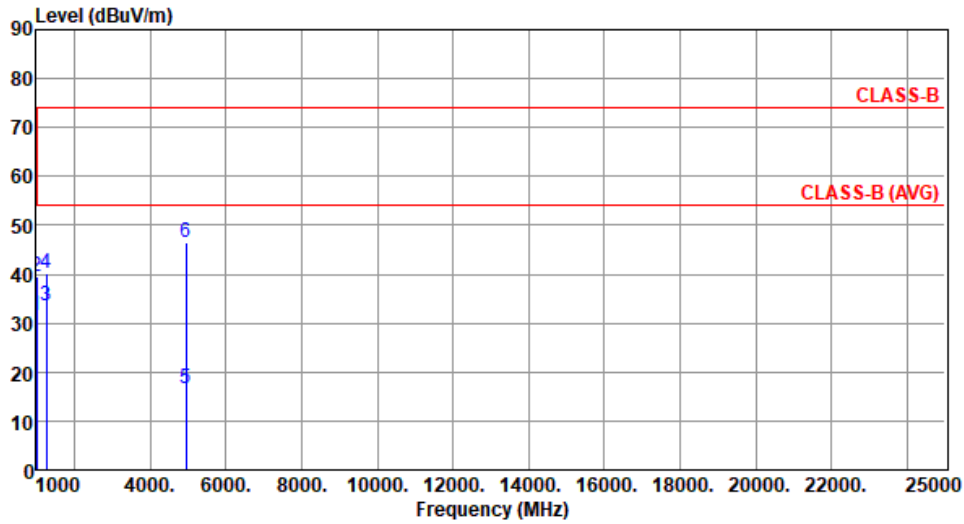
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV) + Factor* (dB/m)

*Factor includes antenna factor , cable loss and amplifier gain

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

Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Horizontal		

Test By :Brad Wu Temperature(°C):23 Humidity(%):64



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB/m	Remark	ANT High cm	Turn Table deg
1	1012.00	31.66	54.00	-22.34	41.06	-9.40	Average	164	45
2	1012.00	39.58	74.00	-34.42	48.98	-9.40	Peak	164	45
3	1276.00	33.38	54.00	-20.62	40.10	-6.72	Average	100	251
4	1276.00	40.24	74.00	-33.76	46.96	-6.72	Peak	100	251
5	4960.00	16.44	54.00	-37.56	10.93	5.51	Average	100	13
6	4960.00	46.54	74.00	-27.46	41.03	5.51	Peak	100	13

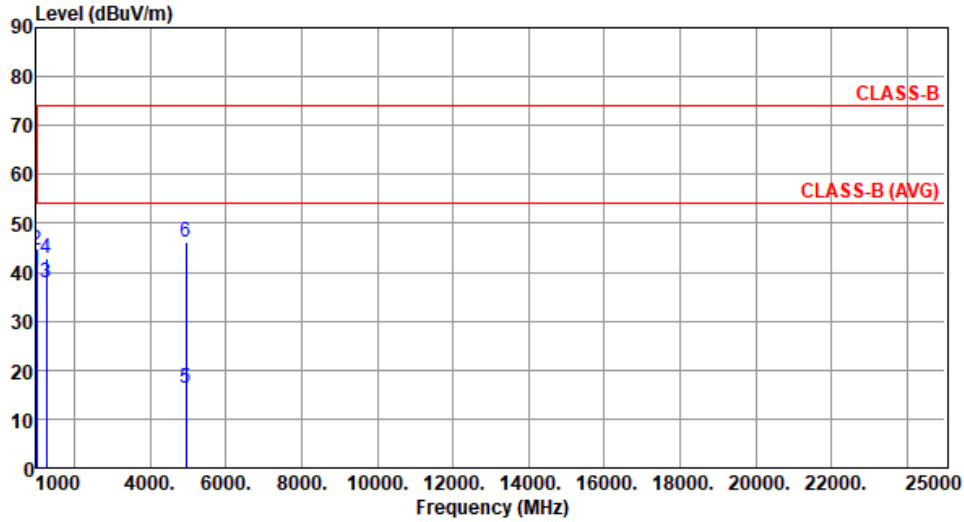
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV) + Factor* (dB/m)

*Factor includes antenna factor , cable loss and amplifier gain

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

Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Vertical		

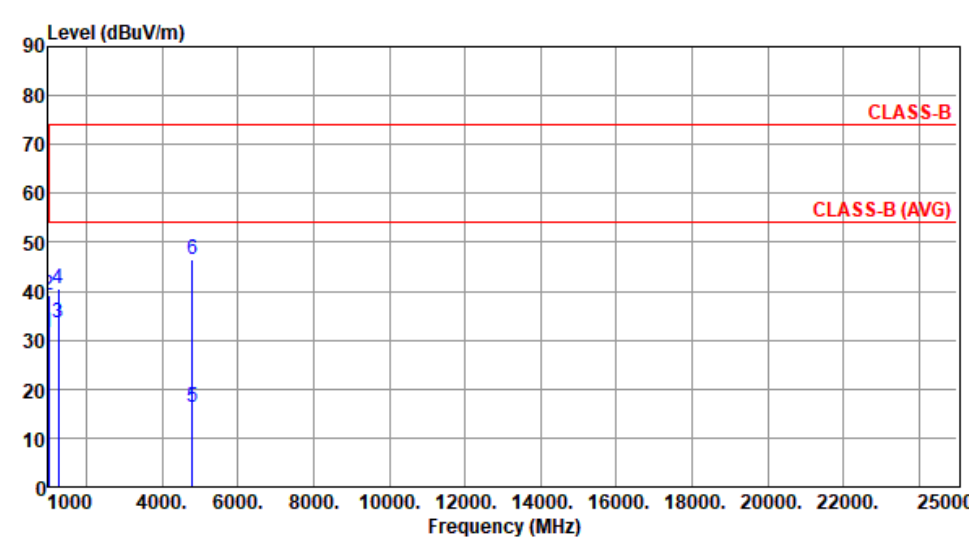
Test By :Brad Wu Temperature(°C):23 Humidity(%):64



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB/m	Remark	ANT High cm	Turn Table deg
1	1012.00	40.64	54.00	-13.36	50.04	-9.40	Average	105	16
2	1012.00	44.52	74.00	-29.48	53.92	-9.40	Peak	105	16
3	1276.00	37.88	54.00	-16.12	44.60	-6.72	Average	177	348
4	1276.00	42.93	74.00	-31.07	49.65	-6.72	Peak	177	348
5	4960.00	16.15	54.00	-37.85	10.64	5.51	Average	100	276
6	4960.00	46.25	74.00	-27.75	40.74	5.51	Peak	100	276

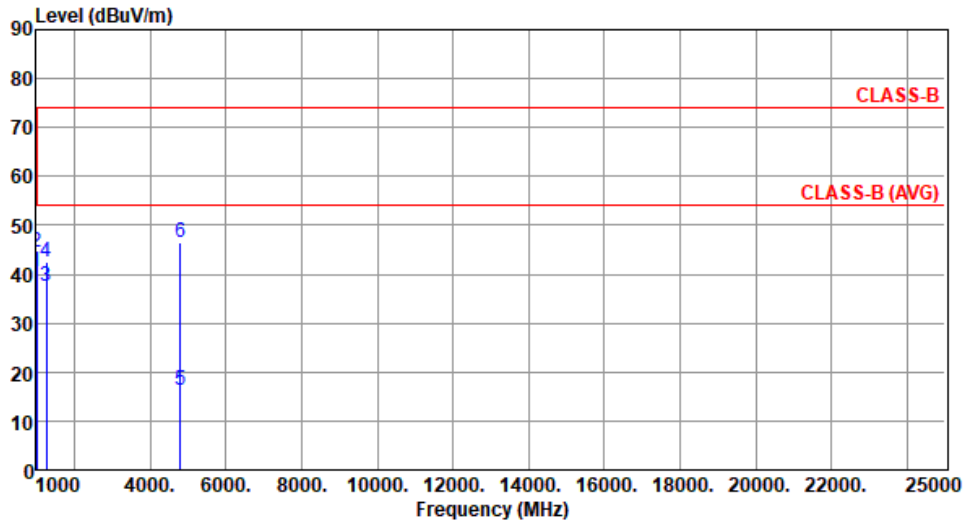
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV) + Factor* (dB/m)
 *Factor includes antenna factor , cable loss and amplifier gain
 Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

3.2.6 Transmitter Radiated Unwanted Emissions (Above 1GHz) for 8DPSK

Modulation	8DPSK	Test Freq. (MHz)	2402						
Polarization	Horizontal								
Test By :Brad Wu Temperature(°C):23 Humidity(%):64									
									
	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB/m	Remark	ANT High cm	Turn Table deg
1	1012.00	31.42	54.00	-22.58	40.82	-9.40	Average	161	35
2	1012.00	39.25	74.00	-34.75	48.65	-9.40	Peak	161	35
3	1276.00	33.69	54.00	-20.31	40.41	-6.72	Average	100	281
4	1276.00	40.46	74.00	-33.54	47.18	-6.72	Peak	100	281
5	4804.00	16.34	54.00	-37.66	11.15	5.19	Average	100	12
6	4804.00	46.44	74.00	-27.56	41.25	5.19	Peak	100	12
<p>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).</p>									

Modulation	8DPSK	Test Freq. (MHz)	2402
Polarization	Vertical		

Test By :Brad Wu Temperature(°C):23 Humidity(%):64

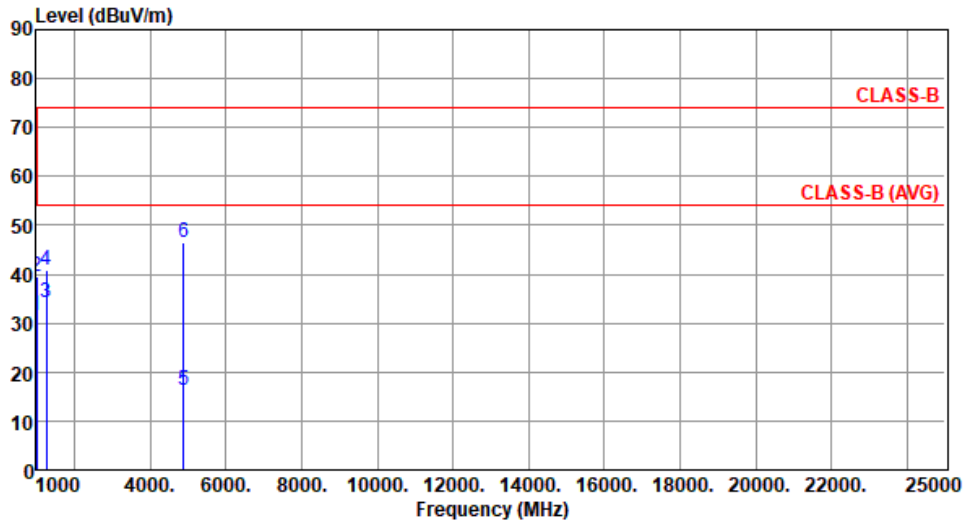


	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB/m	Remark	ANT High cm	Turn Table deg
1	1012.00	40.59	54.00	-13.41	49.99	-9.40	Average	108	16
2	1012.00	44.48	74.00	-29.52	53.88	-9.40	Peak	108	16
3	1276.00	37.44	54.00	-16.56	44.16	-6.72	Average	166	348
4	1276.00	42.65	74.00	-31.35	49.37	-6.72	Peak	166	348
5	4804.00	16.36	54.00	-37.64	11.17	5.19	Average	100	259
6	4804.00	46.46	74.00	-27.54	41.27	5.19	Peak	100	259

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).

Modulation	8DPSK	Test Freq. (MHz)	2441
Polarization	Horizontal		

Test By :Brad Wu Temperature(°C):23 Humidity(%):64



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB/m	Remark	ANT High cm	Turn Table deg
1	1012.00	31.64	54.00	-22.36	41.04	-9.40	Average	151	42
2	1012.00	39.48	74.00	-34.52	48.88	-9.40	Peak	151	42
3	1276.00	34.06	54.00	-19.94	40.78	-6.72	Average	100	285
4	1276.00	40.78	74.00	-33.22	47.50	-6.72	Peak	100	285
5	4882.00	16.24	54.00	-37.76	10.96	5.28	Average	100	21
6	4882.00	46.34	74.00	-27.66	41.06	5.28	Peak	100	21

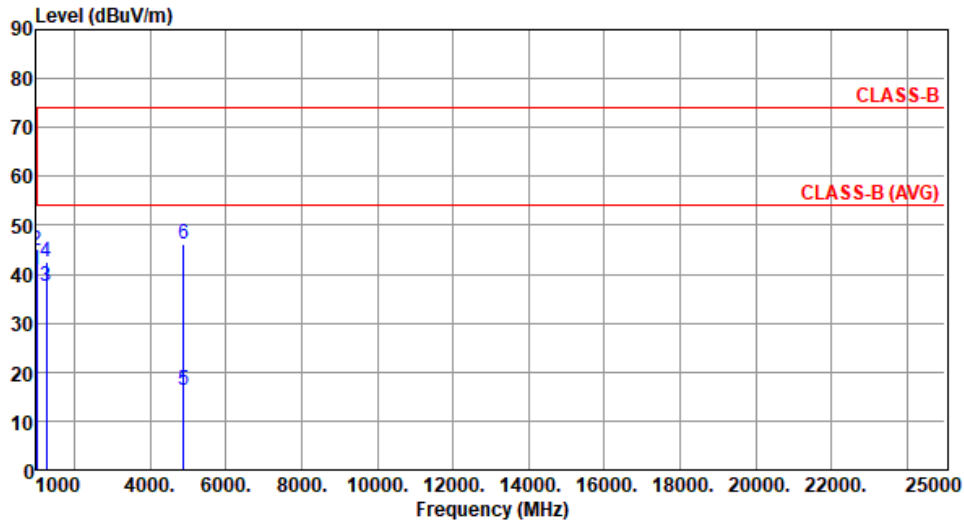
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV) + Factor* (dB/m)

*Factor includes antenna factor , cable loss and amplifier gain

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

Modulation	8DPSK	Test Freq. (MHz)	2441
Polarization	Vertical		

Test By :Brad Wu Temperature(°C):23 Humidity(%):64



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB/m	Remark	ANT High cm	Turn Table deg
1	1012.00	40.98	54.00	-13.02	50.38	-9.40	Average	114	25
2	1012.00	44.82	74.00	-29.18	54.22	-9.40	Peak	114	25
3	1276.00	37.59	54.00	-16.41	44.31	-6.72	Average	166	342
4	1276.00	42.65	74.00	-31.35	49.37	-6.72	Peak	166	342
5	4882.00	16.18	54.00	-37.82	10.90	5.28	Average	100	265
6	4882.00	46.28	74.00	-27.72	41.00	5.28	Peak	100	265

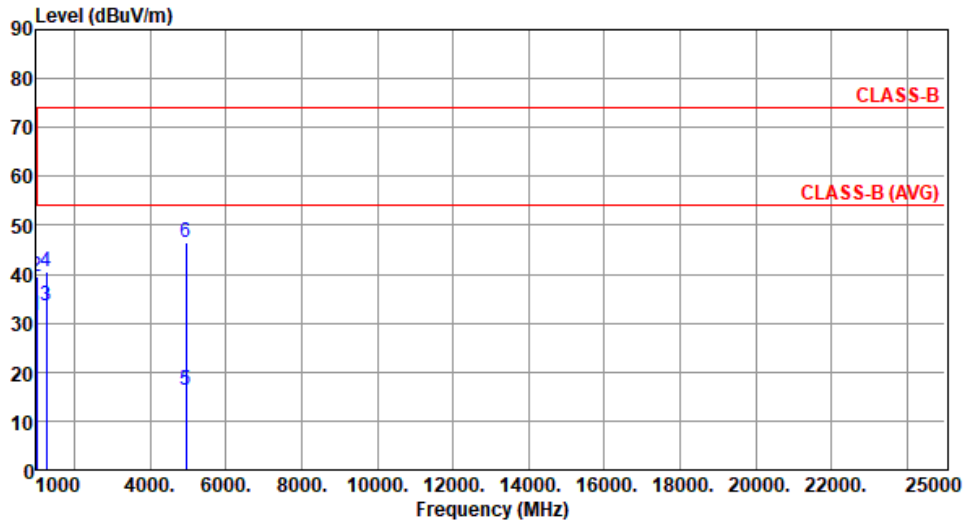
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV) + Factor* (dB/m)

*Factor includes antenna factor , cable loss and amplifier gain

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

Modulation	8DPSK	Test Freq. (MHz)	2480
Polarization	Horizontal		

Test By :Brad Wu Temperature(°C):23 Humidity(%):64



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB/m	Remark	ANT High cm	Turn Table deg
1	1012.00	31.52	54.00	-22.48	40.92	-9.40	Average	158	39
2	1012.00	39.41	74.00	-34.59	48.81	-9.40	Peak	158	39
3	1276.00	33.48	54.00	-20.52	40.20	-6.72	Average	100	248
4	1276.00	40.39	74.00	-33.61	47.11	-6.72	Peak	100	248
5	4960.00	16.25	54.00	-37.75	10.74	5.51	Average	100	19
6	4960.00	46.35	74.00	-27.65	40.84	5.51	Peak	100	19

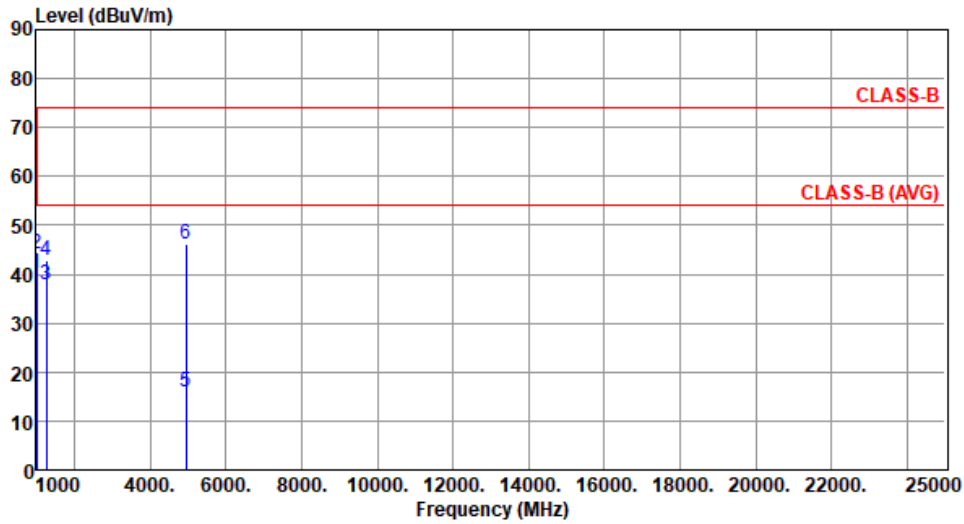
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV) + Factor* (dB/m)

*Factor includes antenna factor , cable loss and amplifier gain

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

Modulation	8DPSK	Test Freq. (MHz)	2480
Polarization	Vertical		

Test By :Brad Wu Temperature(°C):23 Humidity(%):64



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB/m	Remark	ANT High cm	Turn Table deg
1	1012.00	40.32	54.00	-13.68	49.72	-9.40	Average	101	14
2	1012.00	44.29	74.00	-29.71	53.69	-9.40	Peak	101	14
3	1276.00	37.75	54.00	-16.25	44.47	-6.72	Average	174	342
4	1276.00	42.81	74.00	-31.19	49.53	-6.72	Peak	174	342
5	4960.00	16.08	54.00	-37.92	10.57	5.51	Average	100	265
6	4960.00	46.18	74.00	-27.82	40.67	5.51	Peak	100	265

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).

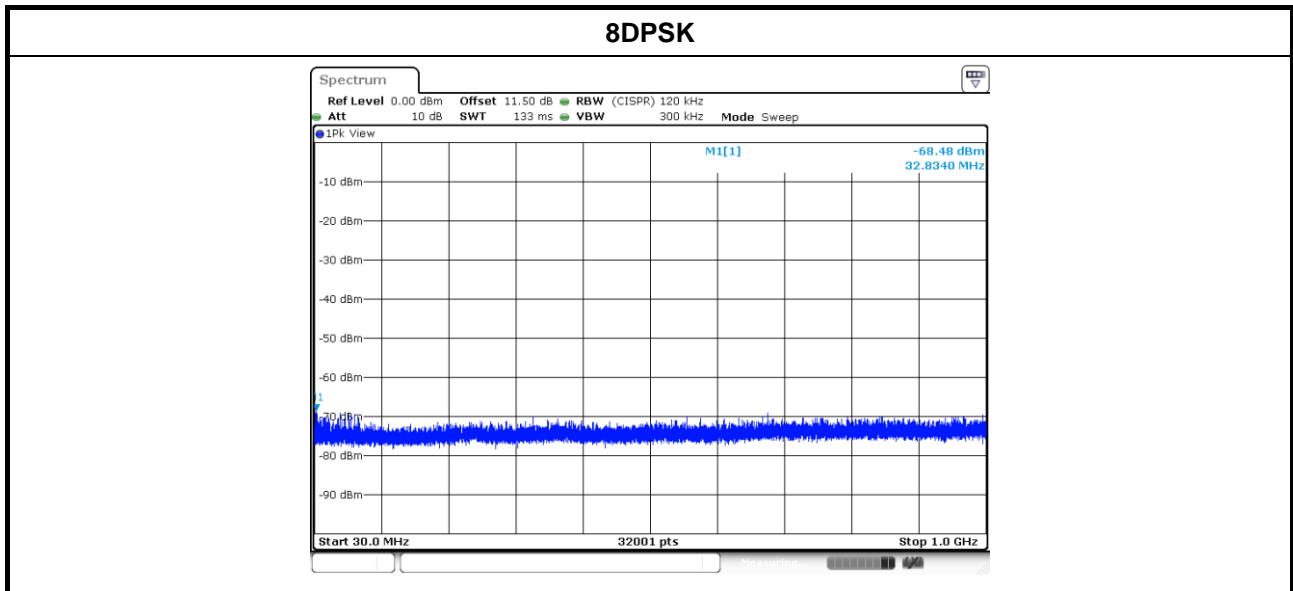
Ambient Condition	23°C / 66%	Tested By	Aska Huang
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3.2.7 Transmitter Conducted Unwanted Emissions (Below 1 GHz)

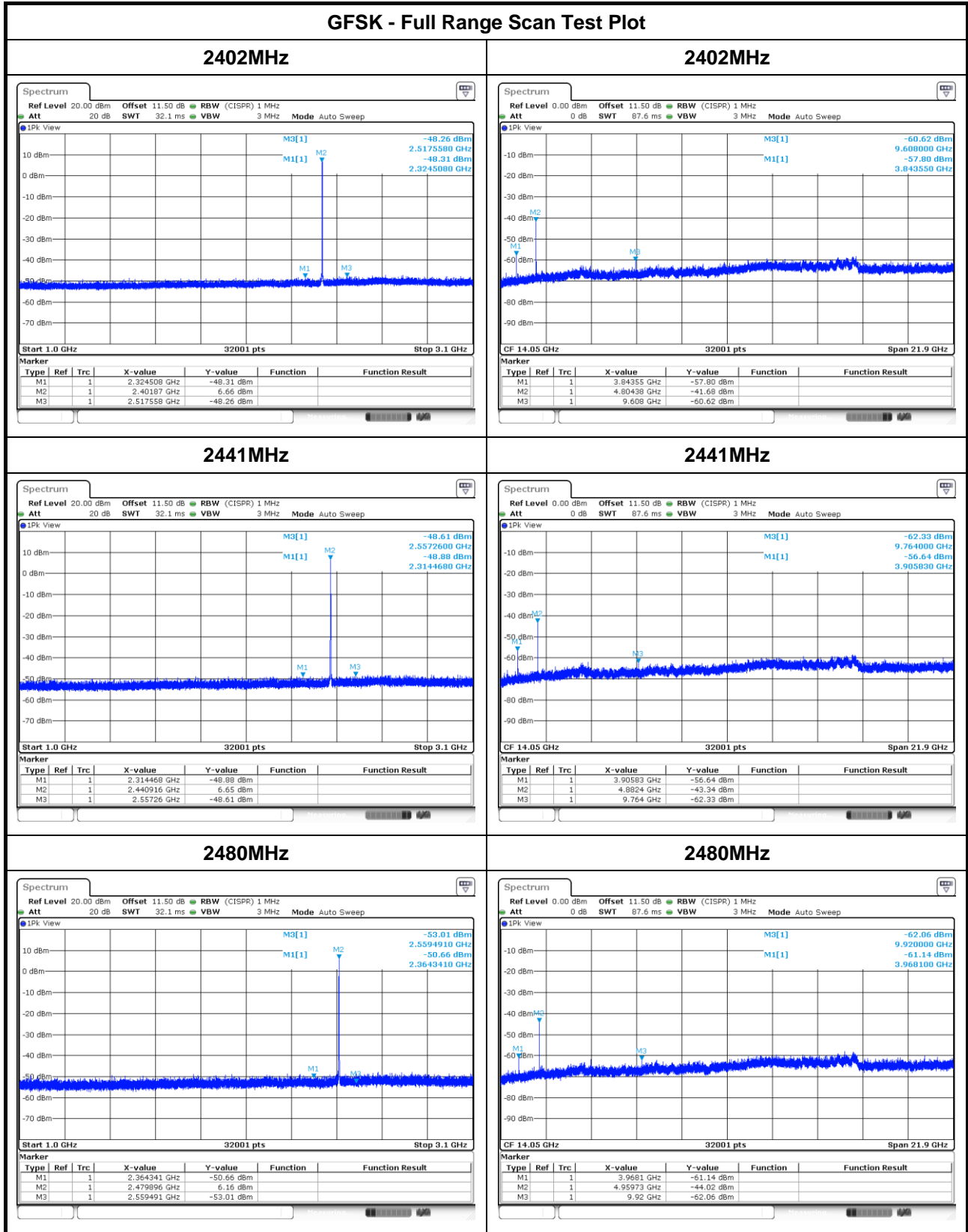
Modulation Mode		8DPSK		Frequency		2402MHz	
Range (MHz)	Max Value (dBm)	DG (dBi)	GRF (dB)	EIRP (dBm)	E-Field (dBuV/m)	Min E-Field Limit (dBuV/m)	E-Field Margin (dB)
30~1000	-68.48	3.00	4.70	-60.78	34.48	40.00	-5.52

Note:

1. GRF = Ground Reflection Factor.
2. DG = Directional Gain.
3. Worst case of emission limit below 1GHz is selected to be limit.

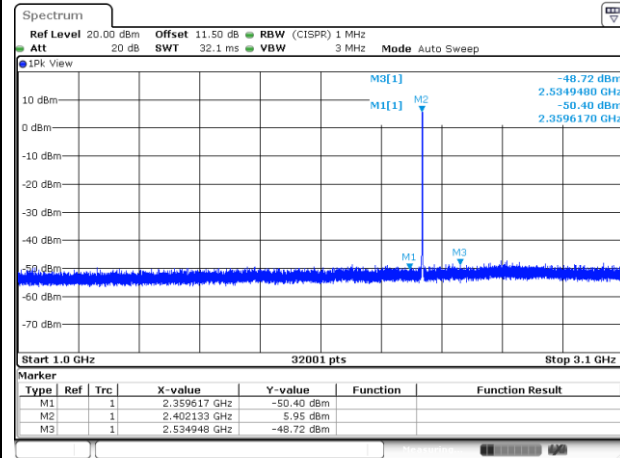


3.2.8 Transmitter Conducted Unwanted Emissions (Above 1GHz)

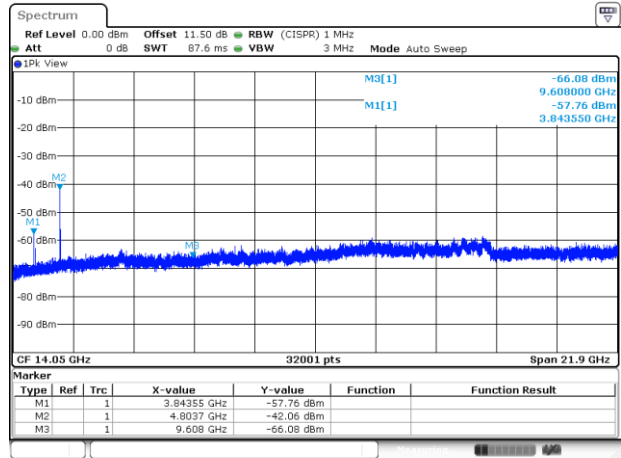


8DPSK - Full Range Scan Test Plot

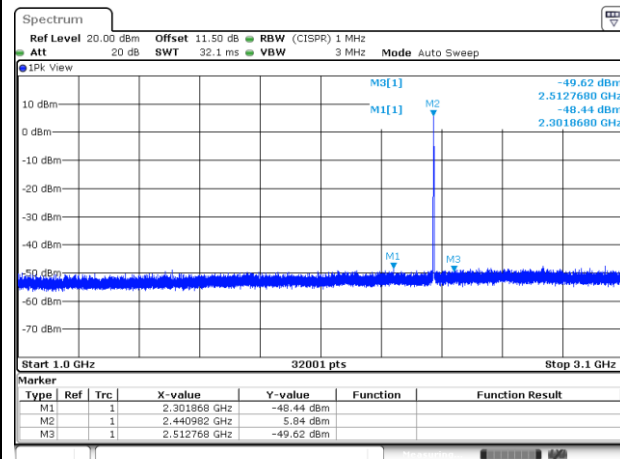
2402MHz



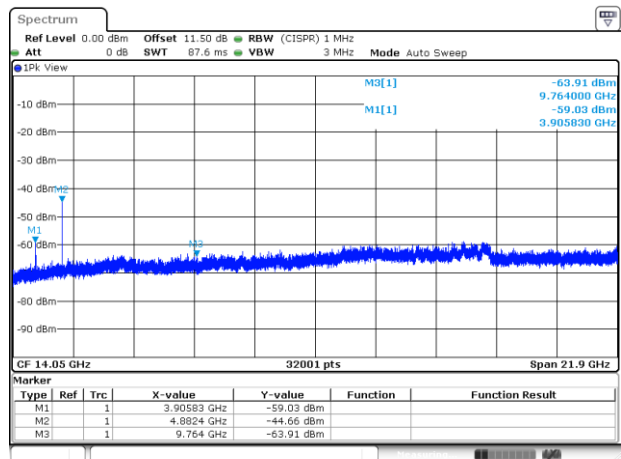
2402MHz



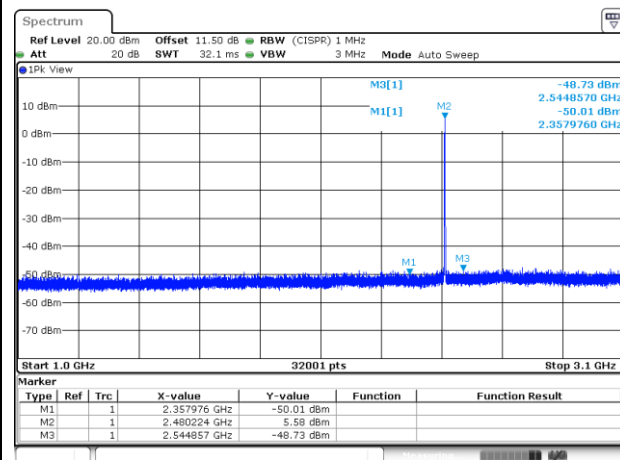
2441MHz



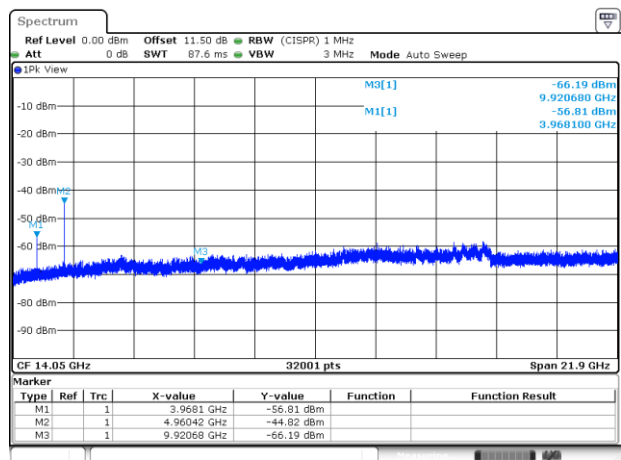
2441MHz



2480MHz



2480MHz



Transmitter Conducted Unwanted Emissions Results in Band Edge								
Modulation Mode		GFSK						
Test ch. Freq. (MHz)	Range (MHz)	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)	Remark
2402	2310~2390	-48.23	3.00	-45.23	50.03	74.00	-23.97	PK
	2310~2390	-62.06	3.00	-59.06	36.20	54.00	-17.80	AV
	2483.5~2500	-48.79	3.00	-45.79	49.47	74.00	-24.53	PK
	2483.5~2500	-60.36	3.00	-57.36	37.90	54.00	-16.10	AV
2441	2310~2390	-50.16	3.00	-47.16	48.10	74.00	-25.90	PK
	2310~2390	-62.66	3.00	-59.66	35.60	54.00	-18.40	AV
	2483.5~2500	-49.44	3.00	-46.44	48.82	74.00	-25.18	PK
	2483.5~2500	-60.91	3.00	-57.91	37.35	54.00	-16.65	AV
2480	2310~2390	-50.13	3.00	-47.13	48.13	74.00	-25.87	PK
	2310~2390	-62.46	3.00	-59.46	35.80	54.00	-18.20	AV
	2483.5~2500	-48.01	3.00	-45.01	50.25	74.00	-23.75	PK
	2483.5~2500	-59.64	3.00	-56.64	38.62	54.00	-15.38	AV

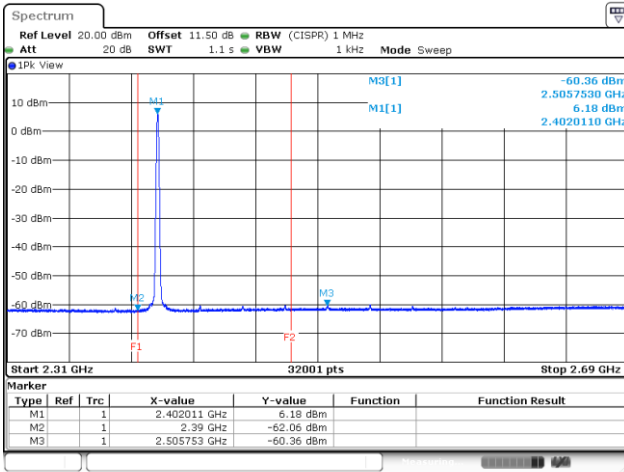
Note: DG = Directional Gain.

Transmitter Conducted Unwanted Emissions Results in Band Edge								
Modulation Mode		8DPSK						
Test ch. Freq. (MHz)	Range (MHz)	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)	Remark
2402	2310~2390	-49.07	3.00	-46.07	49.19	74.00	-24.81	PK
	2310~2390	-62.60	3.00	-59.60	35.66	54.00	-18.34	AV
	2483.5~2500	-47.67	3.00	-44.67	50.59	74.00	-23.41	PK
	2483.5~2500	-60.76	3.00	-57.76	37.50	54.00	-16.50	AV
2441	2310~2390	-48.12	3.00	-45.12	50.14	74.00	-23.86	PK
	2310~2390	-62.15	3.00	-59.15	36.11	54.00	-17.89	AV
	2483.5~2500	-47.36	3.00	-44.36	50.90	74.00	-23.10	PK
	2483.5~2500	-61.05	3.00	-58.05	37.21	54.00	-16.79	AV
2480	2310~2390	-48.20	3.00	-45.20	50.06	74.00	-23.94	PK
	2310~2390	-61.96	3.00	-58.96	36.30	54.00	-17.70	AV
	2483.5~2500	-48.40	3.00	-45.40	49.86	74.00	-24.14	PK
	2483.5~2500	-59.73	3.00	-56.73	38.53	54.00	-15.47	AV

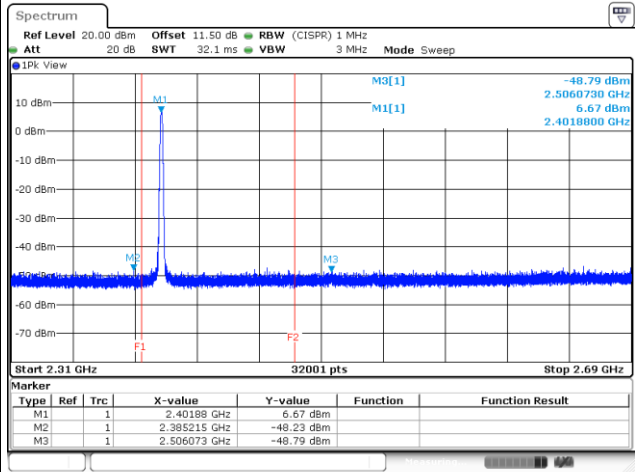
Note: DG = Directional Gain.

Band Edge Test Plot - GFSK

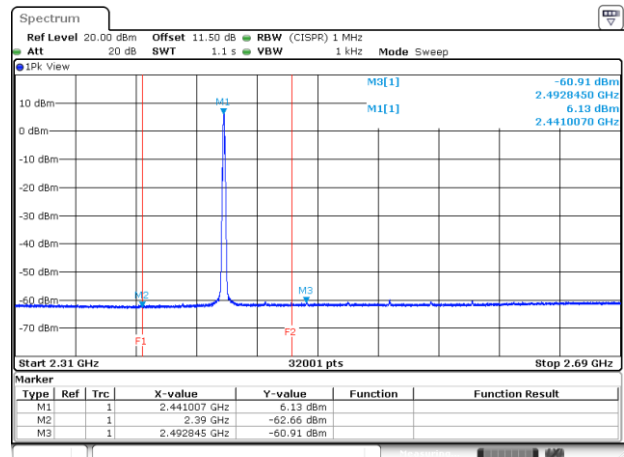
2402MHz - AV



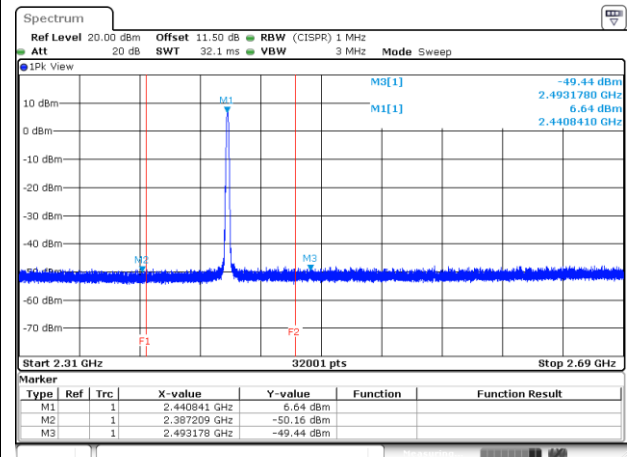
2402MHz - PK



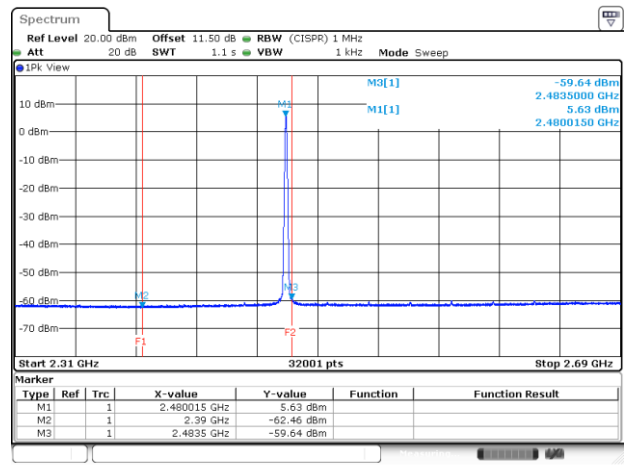
2441MHz - AV



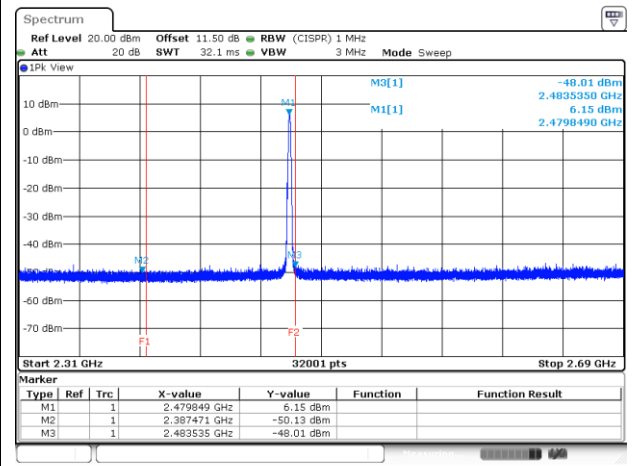
2441MHz - PK



2480MHz - AV

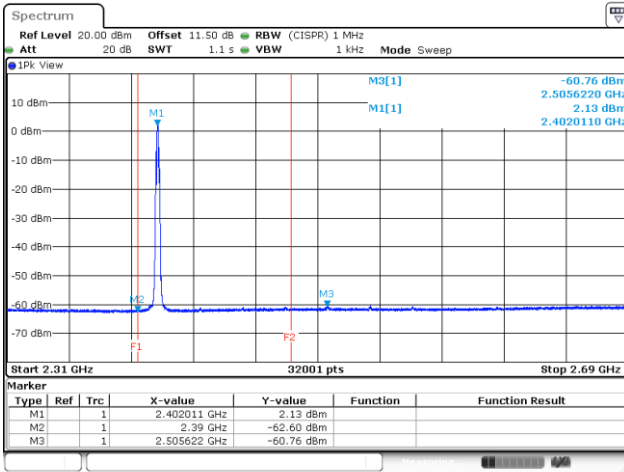


2480MHz - PK

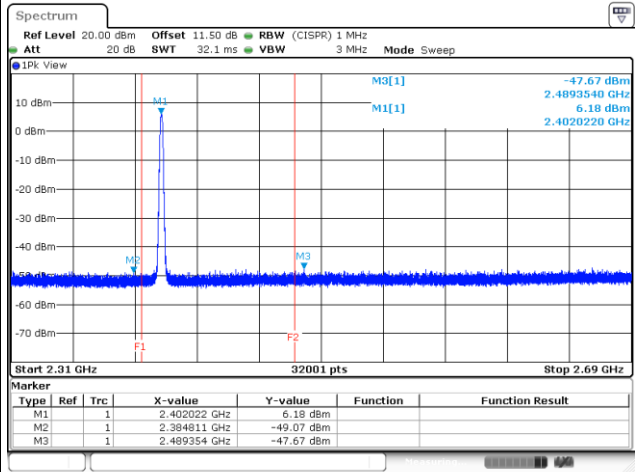


Band Edge Test Plot - 8DPSK

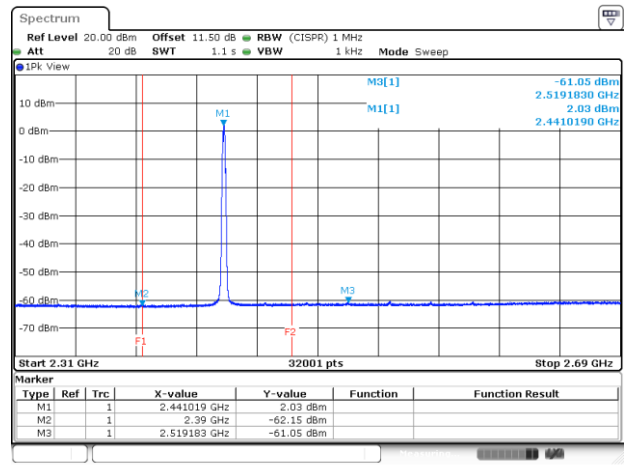
2402MHz - AV



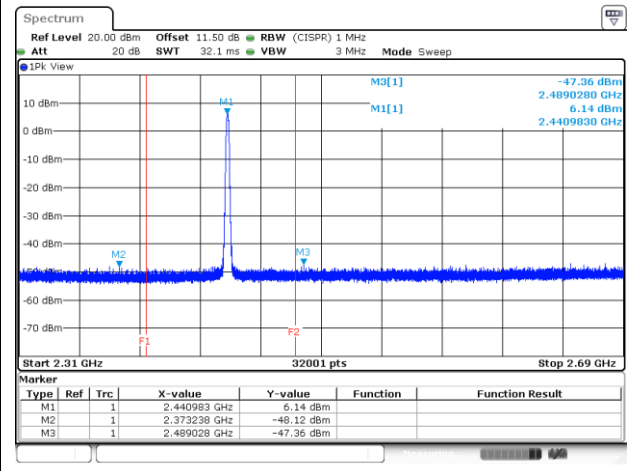
2402MHz - PK



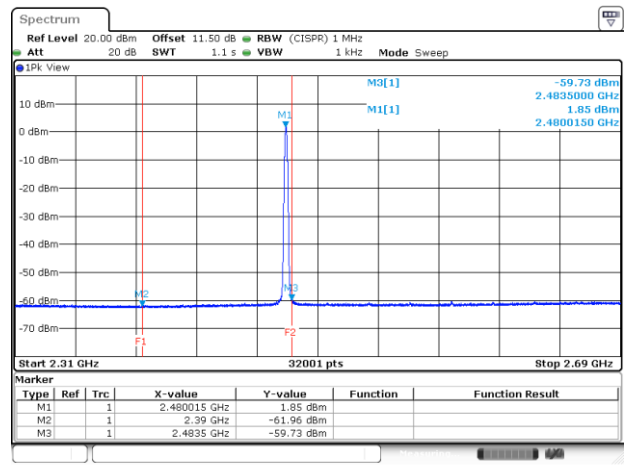
2441MHz - AV



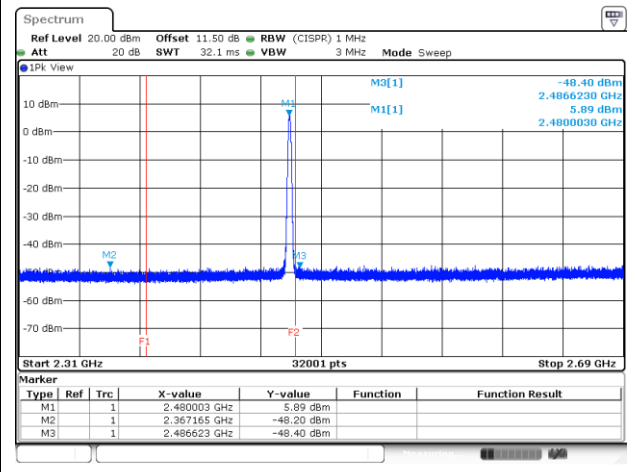
2441MHz - PK



2480MHz - AV



2480MHz - PK



Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		GFSK		Frequency		2402MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
3843.20	PK	-56.34	3.00	-53.34	41.92	74.00	-32.08
3843.20	AV ^{note1}	-	3.00	-	-	54.00	-
4804.00	PK	-41.50	3.00	-38.50	56.76	74.00	-17.24
4804.00	AV ^{note2}	-71.60	3.00	-68.60	26.66	54.00	-27.34

Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		GFSK		Frequency		2441MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
3905.60	PK	-55.78	3.00	-52.78	42.48	74.00	-31.52
3905.60	AV ^{note1}	-	3.00	-	-	54.00	-
4882.00	PK	-43.04	3.00	-40.04	55.22	74.00	-18.78
4882.00	AV ^{note2}	-73.14	3.00	-70.14	25.12	54.00	-28.88

Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		GFSK		Frequency		2480MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
3968.00	PK	-55.36	3.00	-52.36	42.90	74.00	-31.10
3968.00	AV ^{note1}	-	3.00	-	-	54.00	-
4960.00	PK	-43.91	3.00	-40.91	54.35	74.00	-19.65
4960.00	AV ^{note2}	-74.01	3.00	-71.01	24.25	54.00	-29.75

Note:

1. If the PK margin greater than 20 dB, there is no need to get AVG reading.
2. 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

Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		8DPSK		Frequency		2402MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
3843.20	PK	-55.37	3.00	-52.37	42.89	74.00	-31.11
3843.20	AV ^{note1}	-	3.00	-	-	54.00	-
4804.00	PK	-41.35	3.00	-38.35	56.91	74.00	-17.09
4804.00	AV ^{note2}	-71.45	3.00	-68.45	26.81	54.00	-27.19

Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		8DPSK		Frequency		2441MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
3905.60	PK	-55.94	3.00	-52.94	42.32	74.00	-31.68
3905.60	AV ^{note1}	-	3.00	-	-	54.00	-
4882.00	PK	-42.96	3.00	-39.96	55.30	74.00	-18.70
4882.00	AV ^{note2}	-73.06	3.00	-70.06	25.20	54.00	-28.80

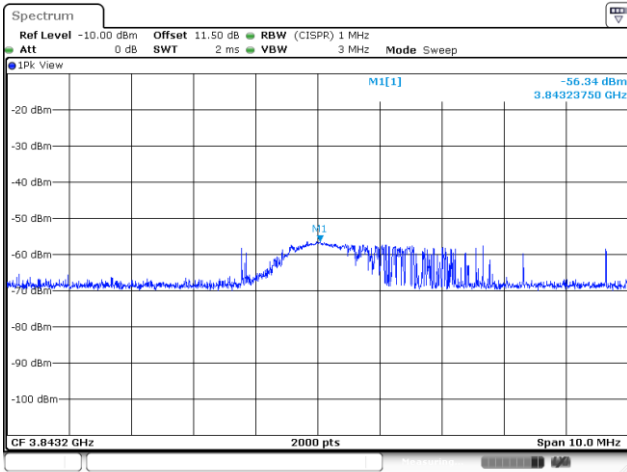
Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		8DPSK		Frequency		2480MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
3968.00	PK	-55.47	3.00	-52.47	42.79	74.00	-31.21
3968.00	AV ^{note1}	-	3.00	-	-	54.00	-
4960.00	PK	-43.69	3.00	-40.69	54.57	74.00	-19.43
4960.00	AV ^{note2}	-73.79	3.00	-70.79	24.47	54.00	-29.53

Note:

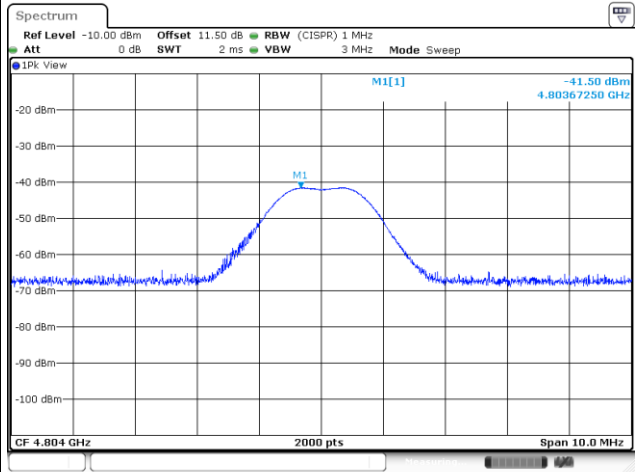
1. If the PK margin greater than 20 dB, there is no need to get AVG reading.
2. Emission above 1GHz / Average value for harmonics The average value is: Average = Peak value + 20log(Duty cycle)
Where the duty factor is calculated from following formula for DH5 packet type which has worst duty factor

Test Plots- GFSK

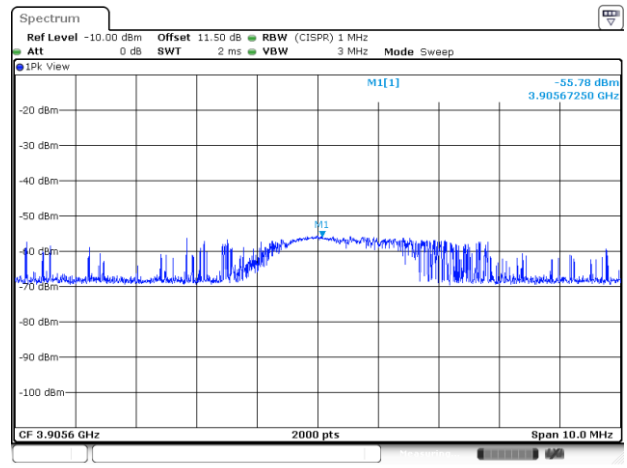
2402MHz - PK



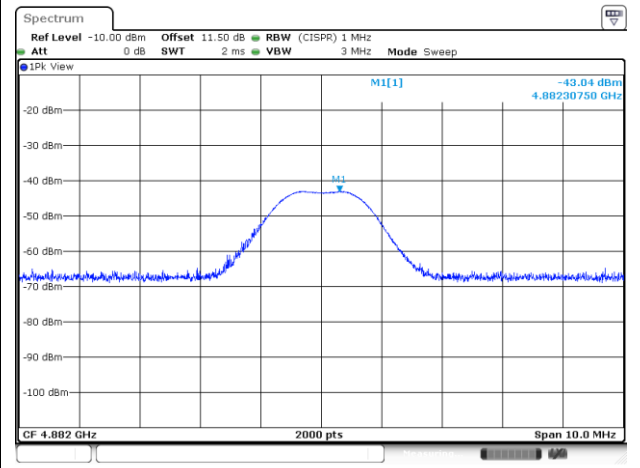
2402MHz - PK



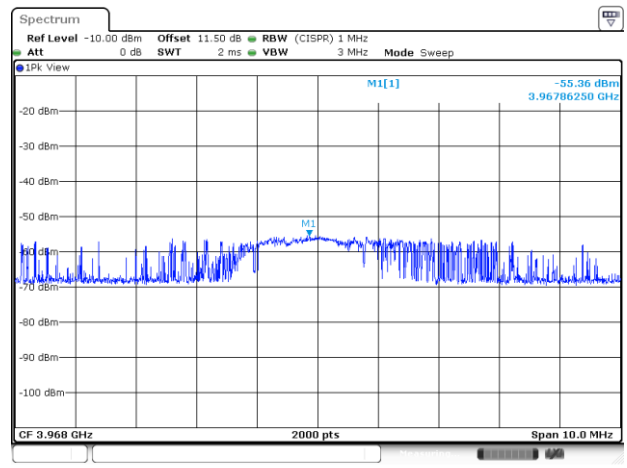
2441MHz - PK



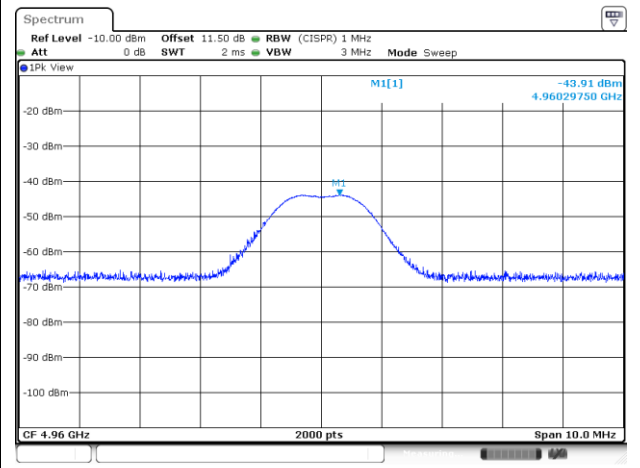
2441MHz - PK



2480MHz - PK

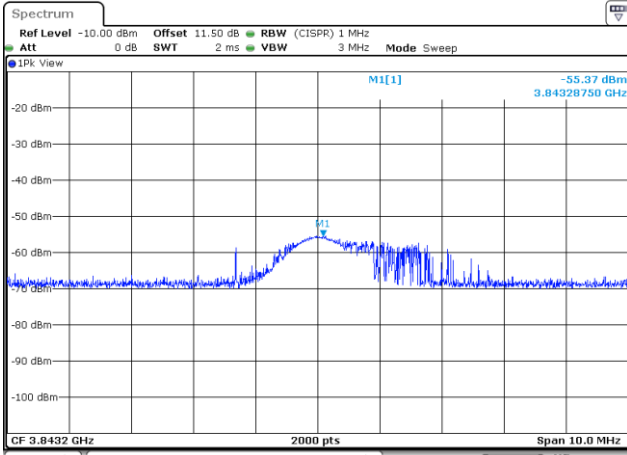


2480MHz - PK

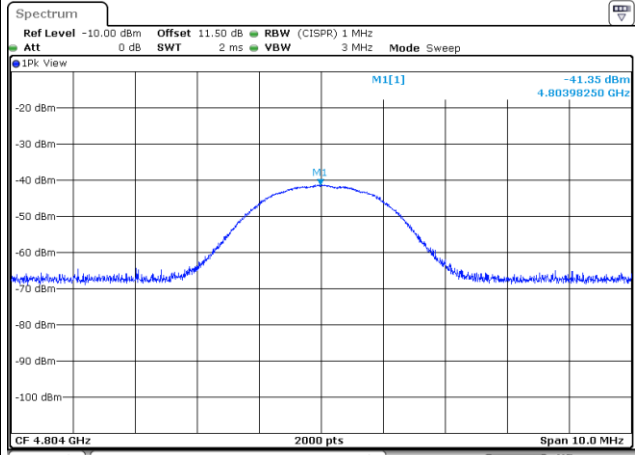


Test Plots- 8DPSK

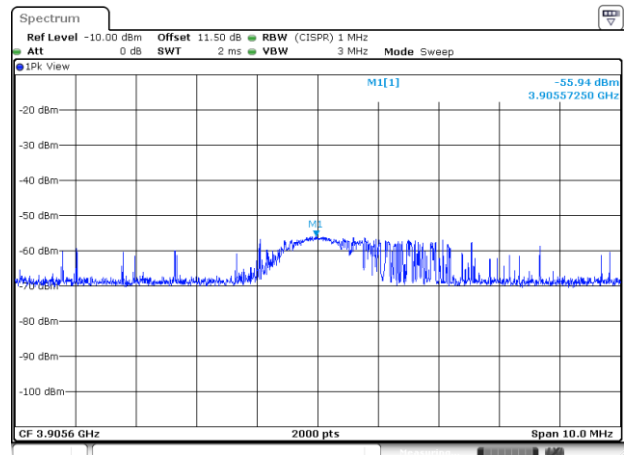
2402MHz - PK



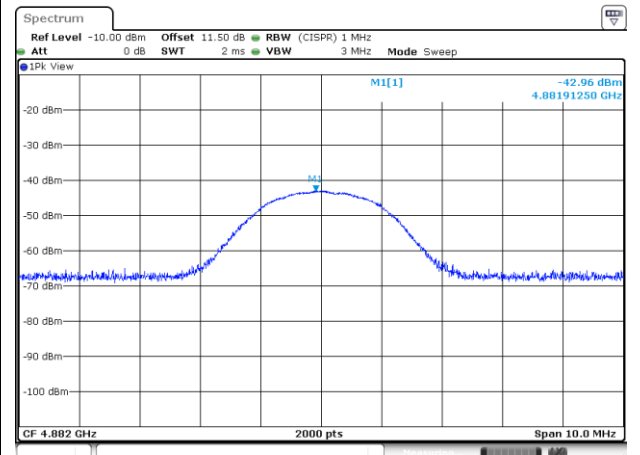
2402MHz - PK



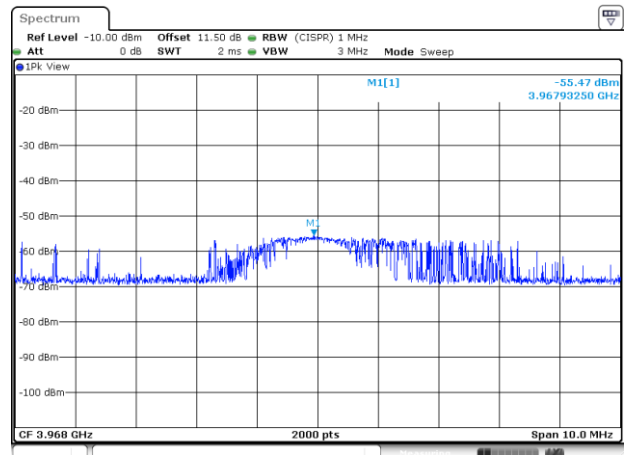
2441MHz - PK



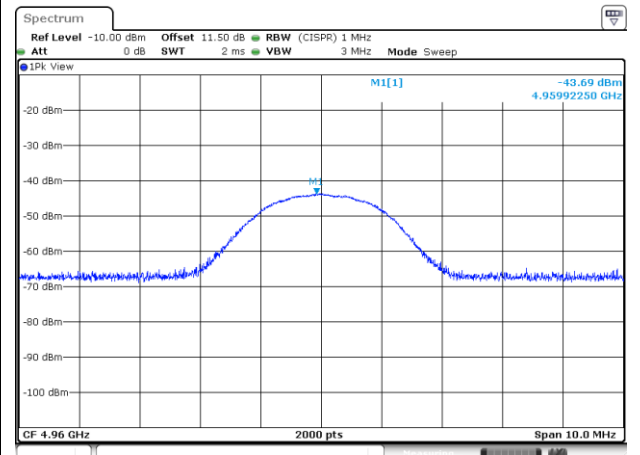
2441MHz - PK



2480MHz - PK



2480MHz - PK



3.3 Unwanted Emissions into Non-Restricted Frequency Bands

3.3.1 Limit of Unwanted Emissions into Non-Restricted Frequency Bands

Peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz.

3.3.2 Test Procedures

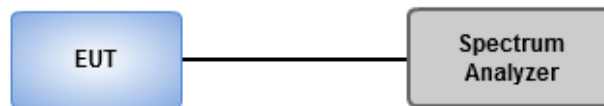
Reference level measurement

1. Set RBW=100kHz, VBW = 300kHz , Detector = Peak, Sweep time = Auto
2. Trace = max hold , Allow Trace to fully stabilize
3. Use the peak marker function to determine the maximum PSD level

Emission level measurement

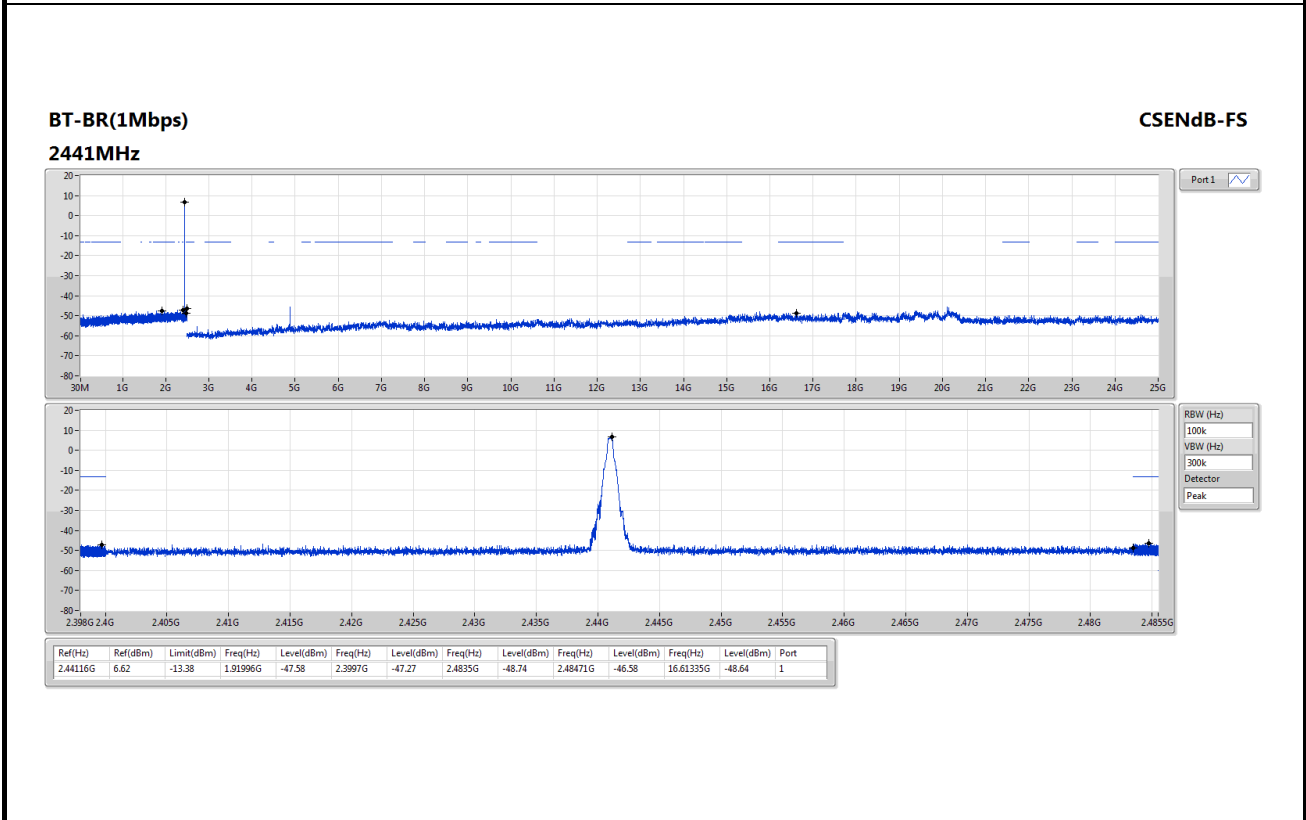
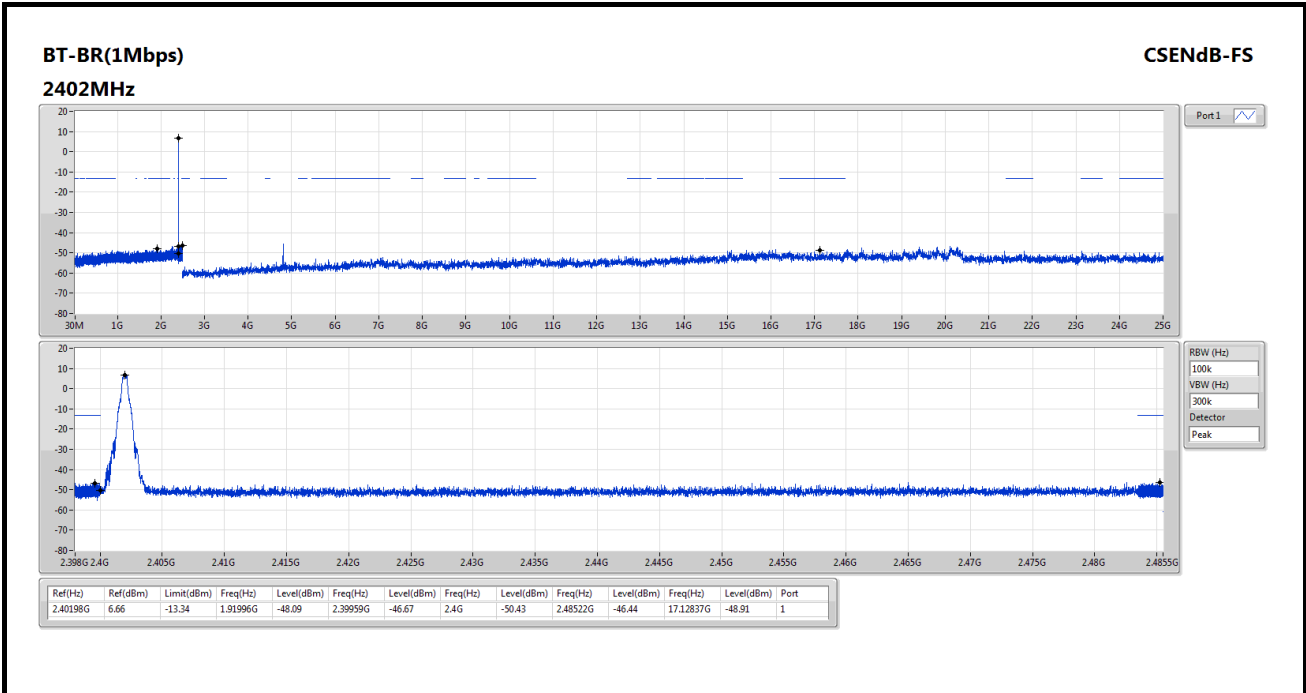
1. Set RBW=100kHz, VBW = 300kHz , Detector = Peak, Sweep time = Auto
2. Trace = max hold , Allow Trace to fully stabilize
3. Scan Frequency range is up to 25GHz
4. Use the peak marker function to determine the maximum amplitude level

3.3.3 Test Setup



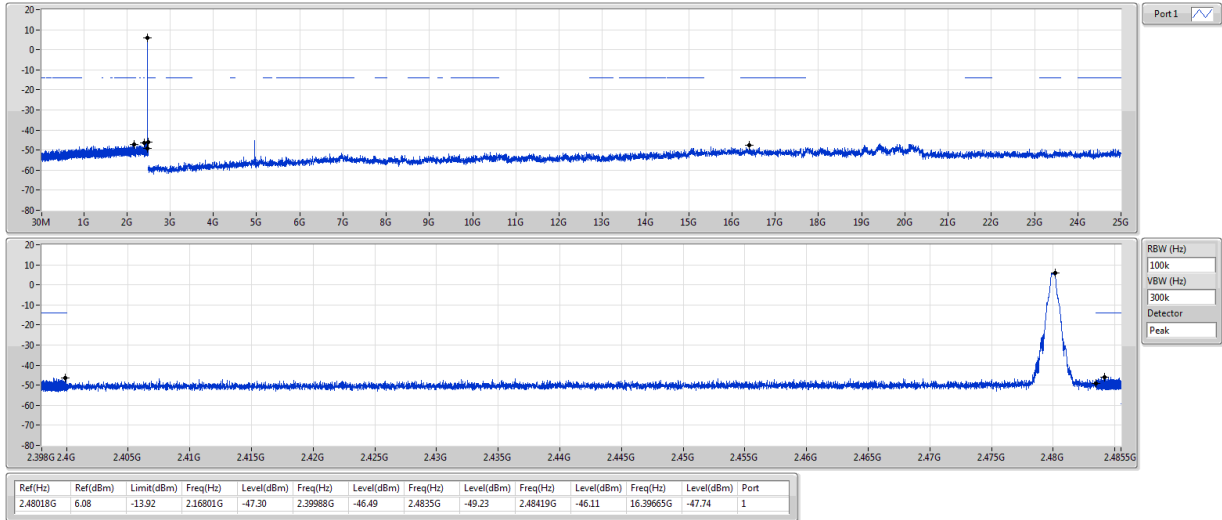
3.3.4 Unwanted Emissions into Non-Restricted Frequency Bands

Ambient Condition	22~23°C / 64~65%	Tested By	Aska Huang
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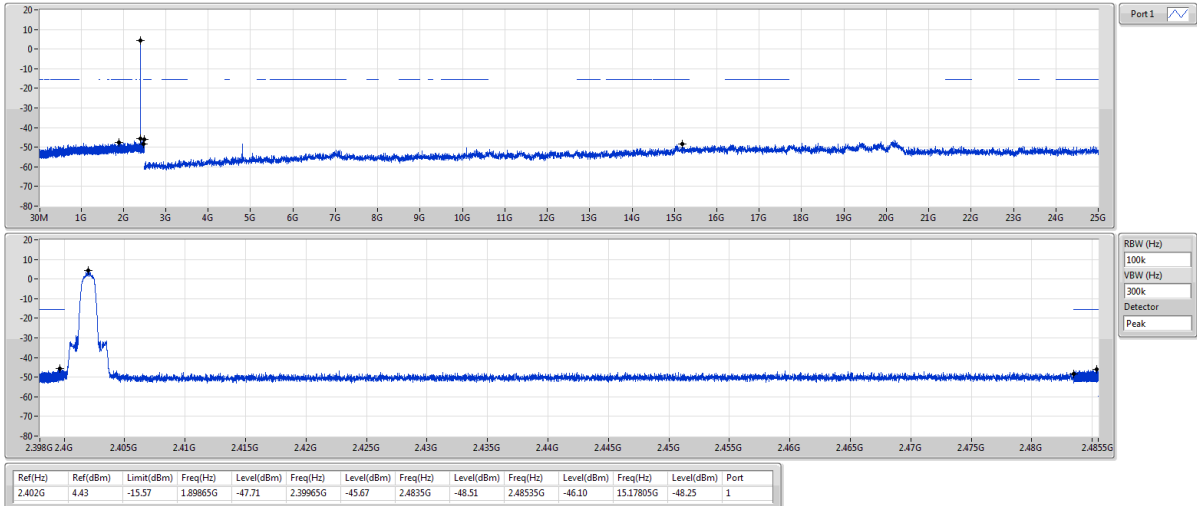
BT-BR(1Mbps)
2480MHz

CSEndB-FS



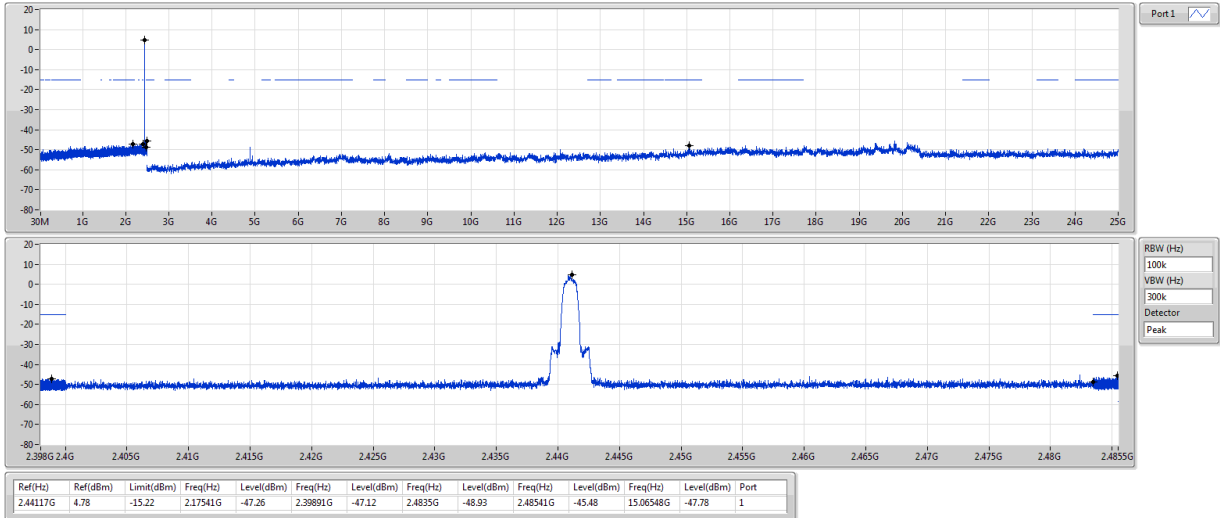
BT-EDR(2Mbps)
2402MHz

CSEndB-FS



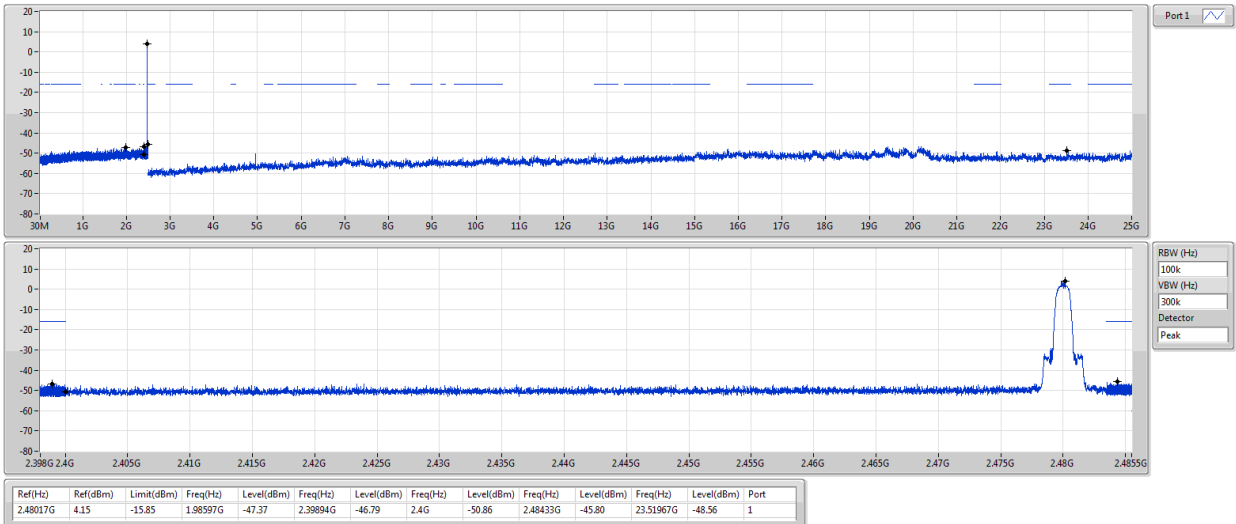
BT-EDR(2Mbps)
2441MHz

CSEndB-FS



BT-EDR(2Mbps)
2480MHz

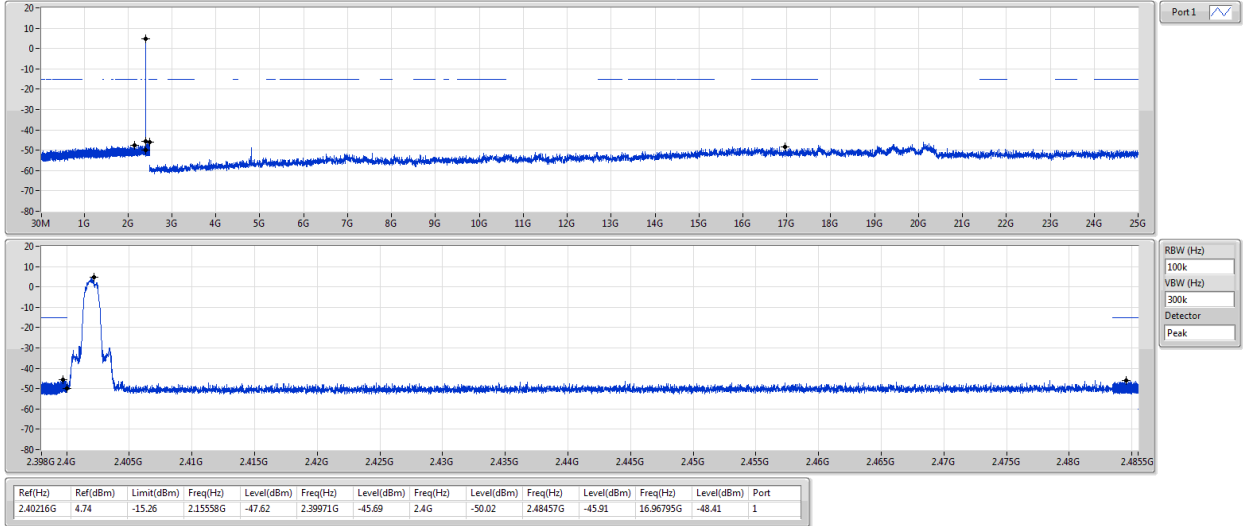
CSEndB-FS



BT-EDR(3Mbps)

CSENdB-FS

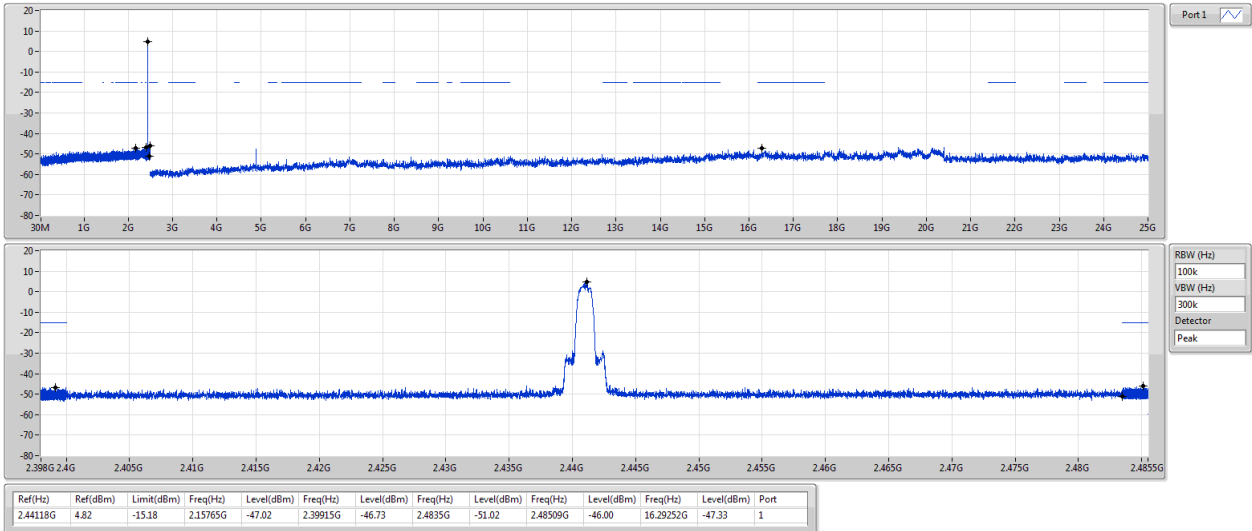
2402MHz

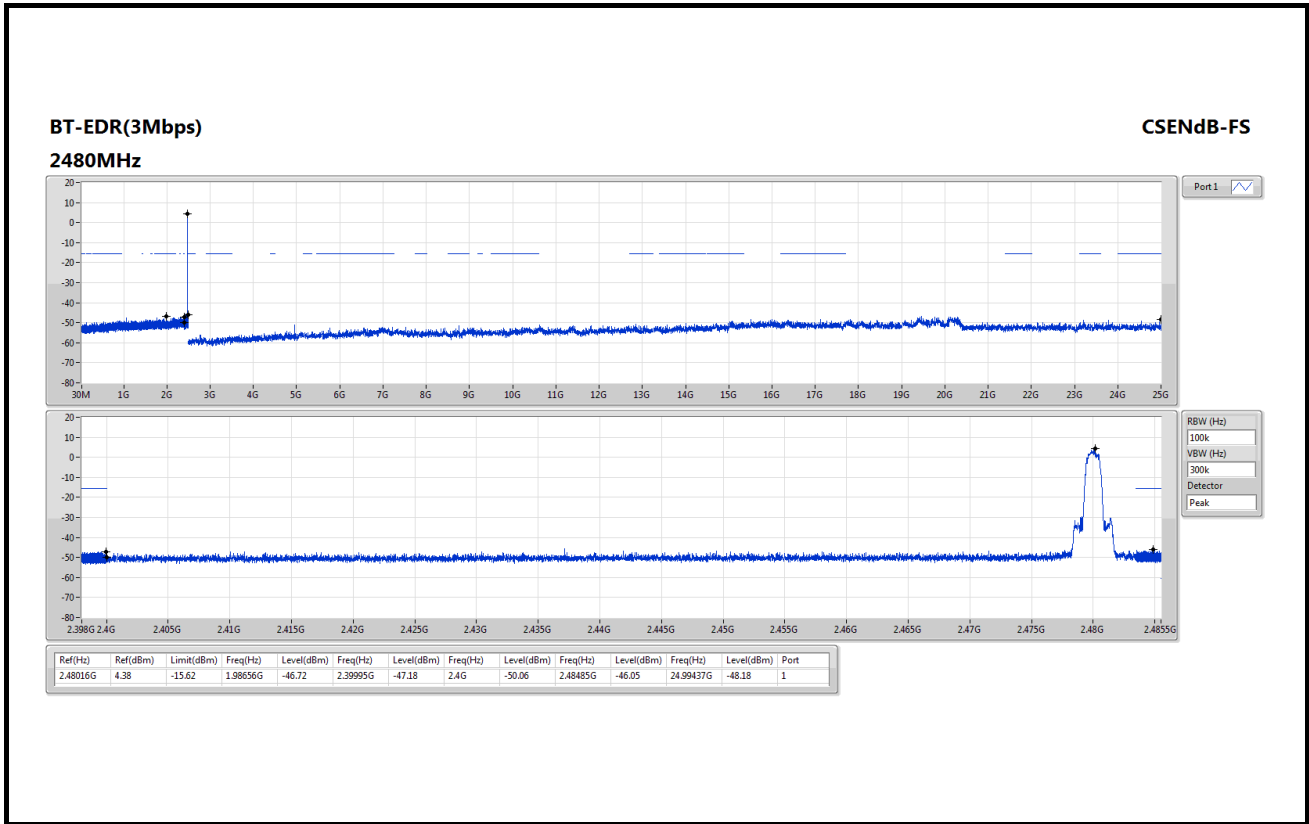


BT-EDR(3Mbps)

CSENdB-FS

2441MHz

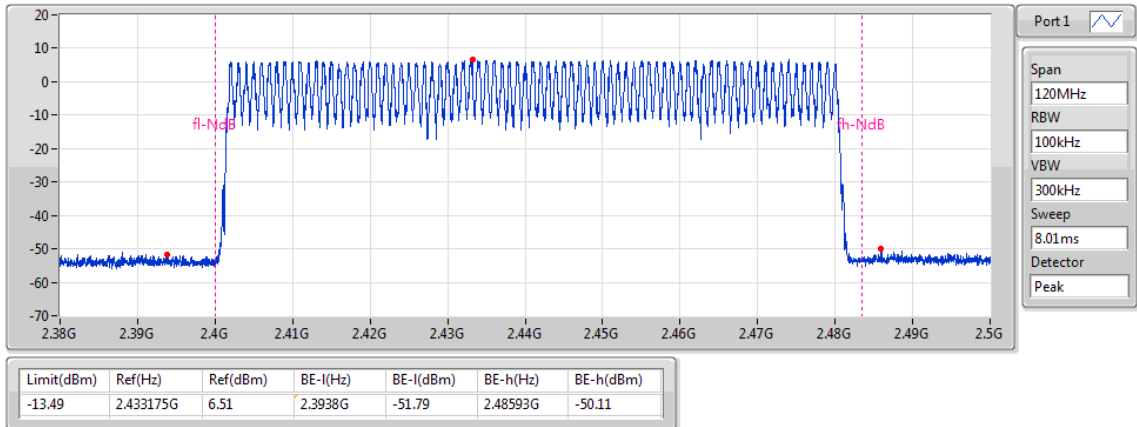




BT-BR(1Mbps)

2402MHz

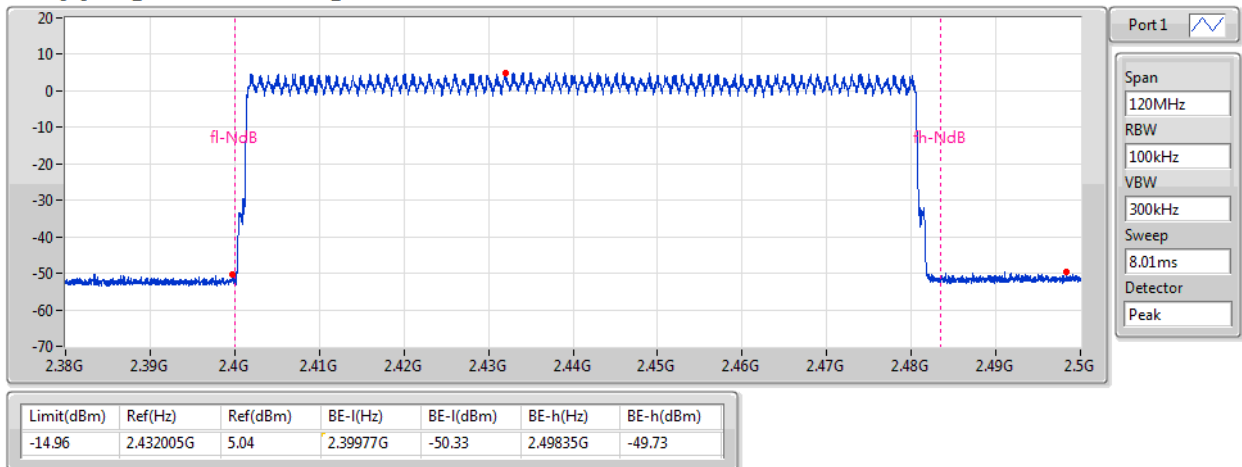
Hopping Ch Bandedge (Non-restricted Band)



BT-EDR(2Mbps)

2402MHz

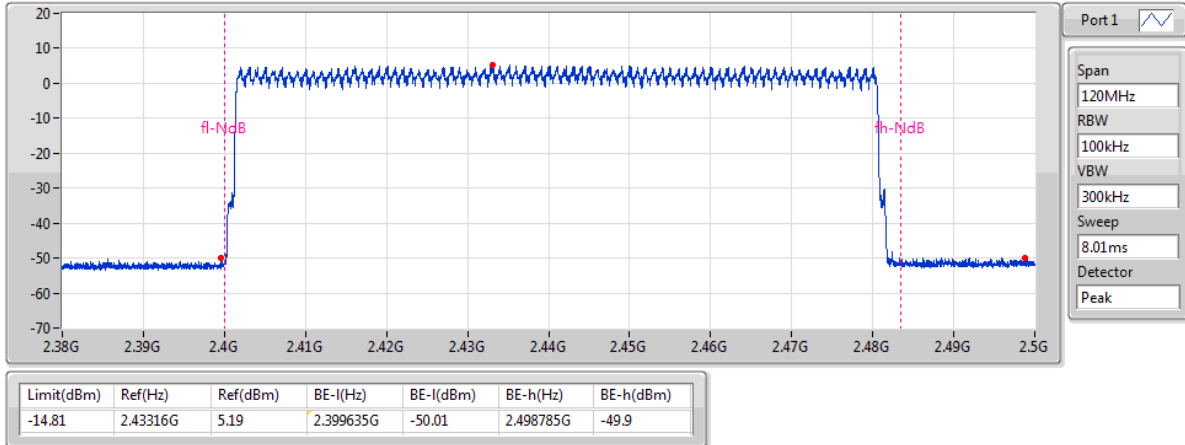
Hopping Ch Bandedge (Non-restricted Band)



BT-EDR(3Mbps)

2402MHz

Hopping Ch Bandedge (Non-restricted Band)



3.4 Conducted Output Power

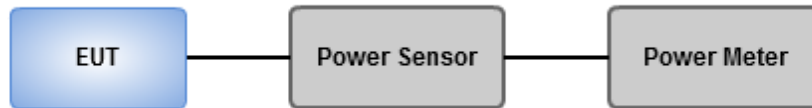
3.4.1 Limit of Conducted Output Power

- 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.

3.4.2 Test Procedures

1. A wideband power meter is used for power measurement. Bandwidth of power sensor 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

3.4.3 Test Setup



3.4.4 Test Result of Conducted Output Power

Ambient Condition	22~23°C / 64~65%	Tested By	Aska Huang
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Summary of Peak Conducted Output Power

Mode	Power (dBm)	Power (W)
2.4-2.4835GHz	-	-
BT-BR(1Mbps)	6.78	0.00476
BT-EDR(2Mbps)	7.07	0.00509
BT-EDR(3Mbps)	7.23	0.00528

Result

Mode	Result	Gain (dBi)	Power (dBm)	Power Limit (dBm)
BT-BR(1Mbps)	-	-	-	-
2402MHz	Pass	3.00	6.78	21.00
2441MHz	Pass	3.00	6.71	21.00
2480MHz	Pass	3.00	6.22	21.00
BT-EDR(2Mbps)	-	-	-	-
2402MHz	Pass	3.00	7.07	21.00
2441MHz	Pass	3.00	6.98	21.00
2480MHz	Pass	3.00	6.68	21.00
BT-EDR(3Mbps)	-	-	-	-
2402MHz	Pass	3.00	7.23	21.00
2441MHz	Pass	3.00	7.15	21.00
2480MHz	Pass	3.00	6.85	21.00

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

Summary of Conducted (Average) Output Power

Mode	Power (dBm)	Power (W)
2.4-2.4835GHz	-	-
BT-BR(1Mbps)	6.61	0.00458
BT-EDR(2Mbps)	4.62	0.00290
BT-EDR(3Mbps)	4.63	0.00290

Result

Mode	Result	Gain (dBi)	Power (dBm)	Power Limit (dBm)
BT-BR(1Mbps)	-	-	-	-
2402MHz	Pass	3.00	6.61	21.00
2441MHz	Pass	3.00	6.53	21.00
2480MHz	Pass	3.00	6.05	21.00
BT-EDR(2Mbps)	-	-	-	-
2402MHz	Pass	3.00	4.62	21.00
2441MHz	Pass	3.00	4.53	21.00
2480MHz	Pass	3.00	4.23	21.00
BT-EDR(3Mbps)	-	-	-	-
2402MHz	Pass	3.00	4.63	21.00
2441MHz	Pass	3.00	4.54	21.00
2480MHz	Pass	3.00	4.24	21.00

Note: Average power is for reference only.

3.5 Number of Hopping Frequency

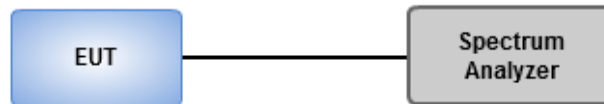
3.5.1 Limit of Number of Hopping Frequency

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

3.5.2 Test Procedures

1. Set RBW = 100kHz, VBW = 300kHz, Sweep time = Auto, Detector = Peak Trace max hold.
2. Allow trace to stabilize.

3.5.3 Test Setup



3.5.4 Test Result of Number of Hopping Frequency

Ambient Condition	22~23°C / 64~65%	Tested By	Aska Huang
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Summary

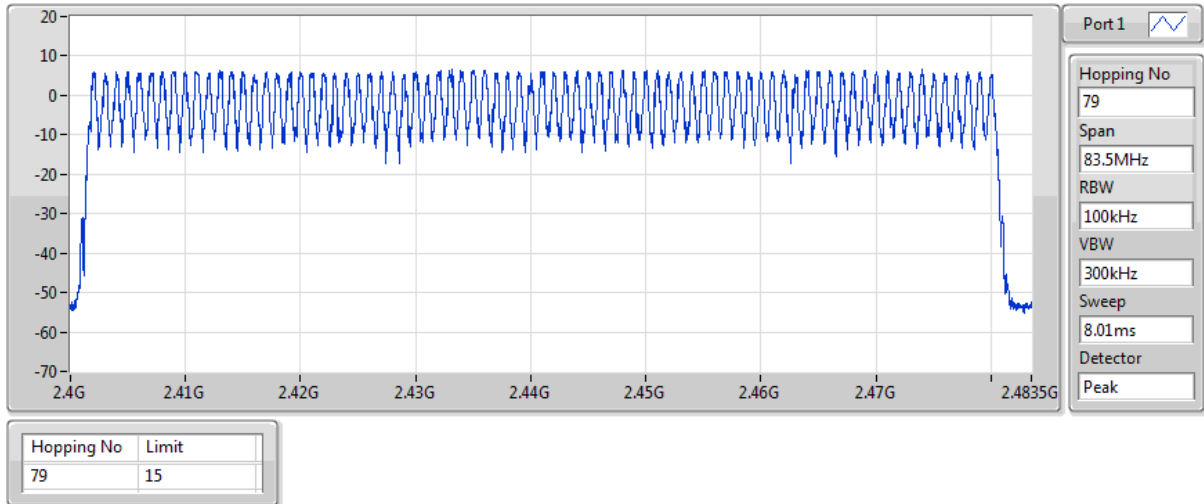
Mode	Max-Hop No
2.4-2.4835GHz	-
BT-BR(1Mbps)	79
BT-EDR(2Mbps)	79
BT-EDR(3Mbps)	79

Result

Mode	Result	Hopping No	Limit
BT-BR(1Mbps)	-	-	-
2402MHz	Pass	79	15
BT-EDR(2Mbps)	-	-	-
2402MHz	Pass	79	15
BT-EDR(3Mbps)	-	-	-
2402MHz	Pass	79	15

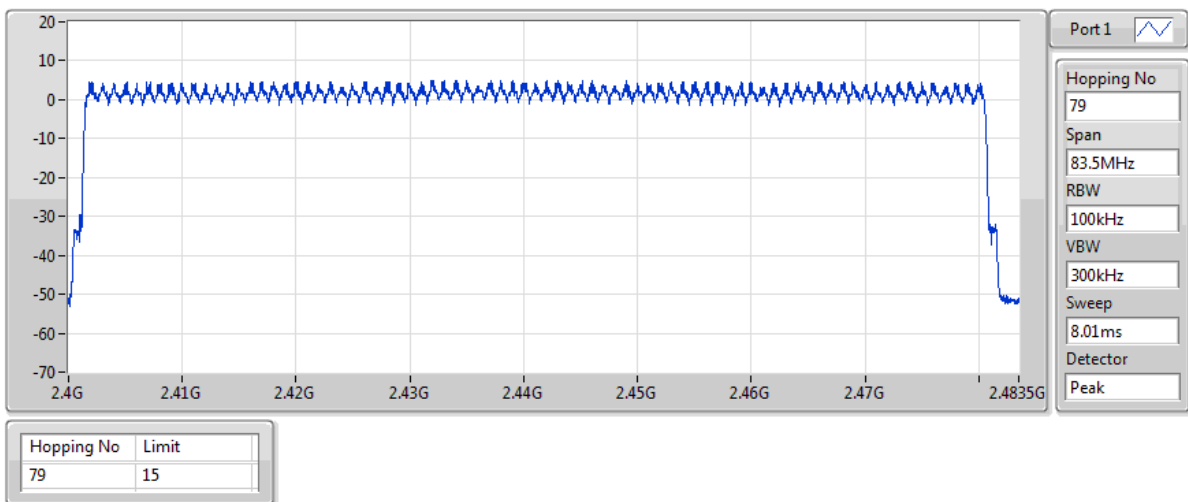
BT-BR(1Mbps)
2402MHz

Hopping-FS



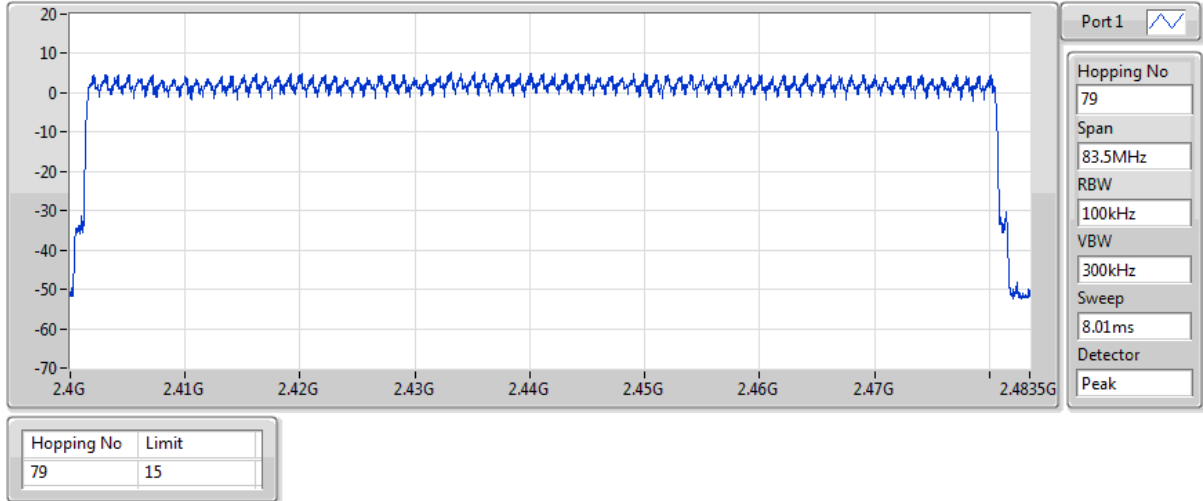
BT-EDR(2Mbps)
2402MHz

Hopping-FS



**BT-EDR(3Mbps)
2402MHz**

Hopping-FS



3.6 20dB and Occupied Bandwidth

3.6.1 Test Procedures

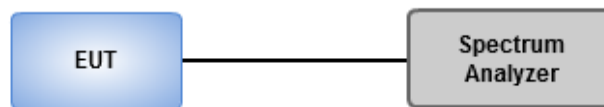
20dB Bandwidth

1. Set RBW=20kHz, VBW=100kHz, Sweep time = Auto, Detector=Peak , Trace max hold
2. Allow trace to stabilize
3. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 20 dB relative to the maximum level measured in the fundamental emission.

Occupied Bandwidth

1. Set RBW=20kHz, VBW=100kHz, Sweep time = Auto, Detector=Sample , Trace max hold
2. Allow trace to stabilize
3. Use Occupied bandwidth function of spectrum analyzer to measuring 99% occupied bandwidth

3.6.2 Test Setup



3.6.3 Test result of 20dB and Occupied Bandwidth

Ambient Condition	22~23°C / 64~65%	Tested By	Aska Huang
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Summary

Mode	Max-N dB (Hz)	Max-OBW (Hz)	ITU-Code	Min-N dB (Hz)	Min-OBW (Hz)
2.4-2.4835GHz	-	-	-	-	-
BT-BR(1Mbps)	1.004M	918.958k	919KF1D	967.391k	908.104k
BT-EDR(2Mbps)	1.348M	1.226M	1M23G1D	1.344M	1.223M
BT-EDR(3Mbps)	1.344M	1.226M	1M23G1D	1.337M	1.219M

Max-N dB = Maximum 20dB down bandwidth; Max-OBW = Maximum 99% occupied bandwidth;
Min-N dB = Minimum 20dB down bandwidth; Min-OBW = Minimum 99% occupied bandwidth

Result

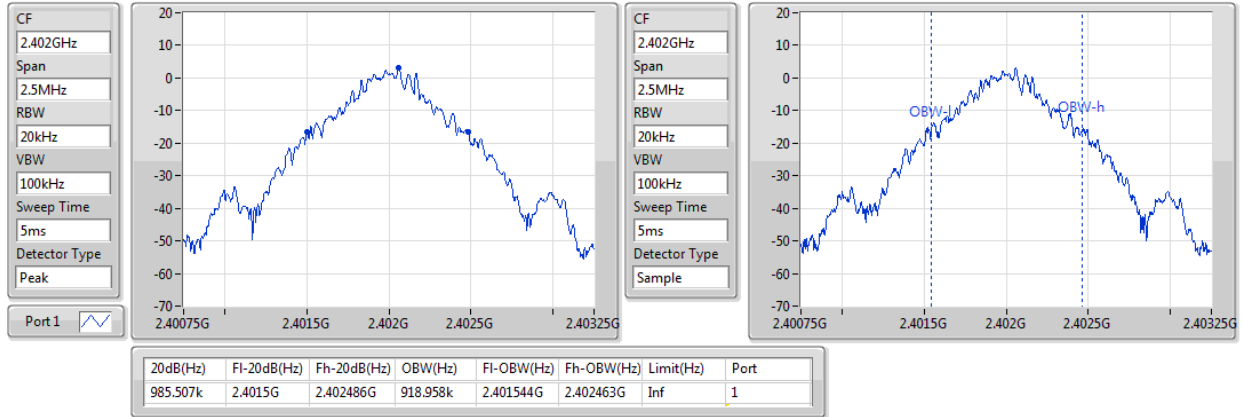
Mode	Result	Limit (Hz)	Port 1-N dB (Hz)	Port 1-OBW (Hz)
BT-BR(1Mbps)	-	-	-	-
2402MHz	Pass	Inf	985.507k	918.958k
2441MHz	Pass	Inf	967.391k	908.104k
2480MHz	Pass	Inf	1.004M	908.104k
BT-EDR(2Mbps)	-	-	-	-
2402MHz	Pass	Inf	1.344M	1.223M
2441MHz	Pass	Inf	1.348M	1.223M
2480MHz	Pass	Inf	1.348M	1.226M
BT-EDR(3Mbps)	-	-	-	-
2402MHz	Pass	Inf	1.341M	1.219M
2441MHz	Pass	Inf	1.337M	1.223M
2480MHz	Pass	Inf	1.344M	1.226M

Port X-N dB = Port X 20dB down bandwidth;
Port X-OBW = Port X 99% occupied bandwidth

BT-BR(1Mbps)

EBW-FS

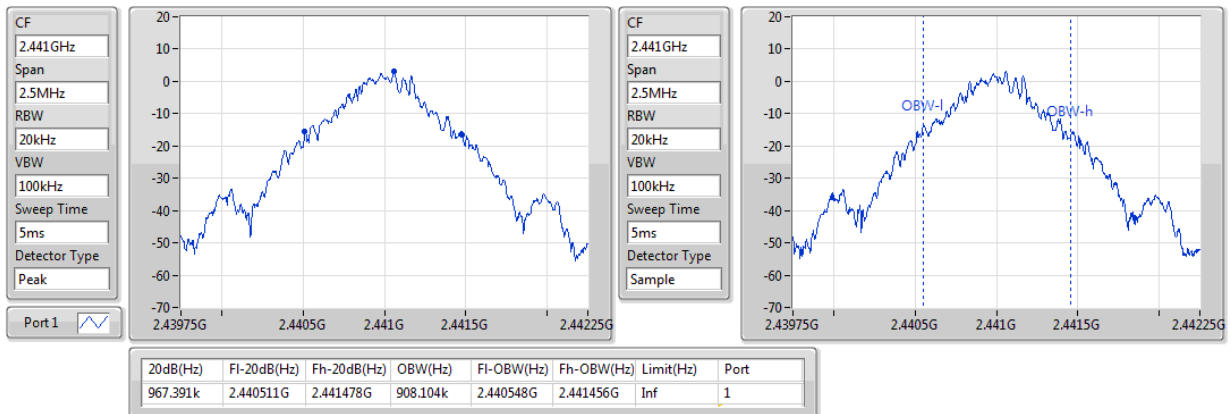
2402MHz



BT-BR(1Mbps)

EBW-FS

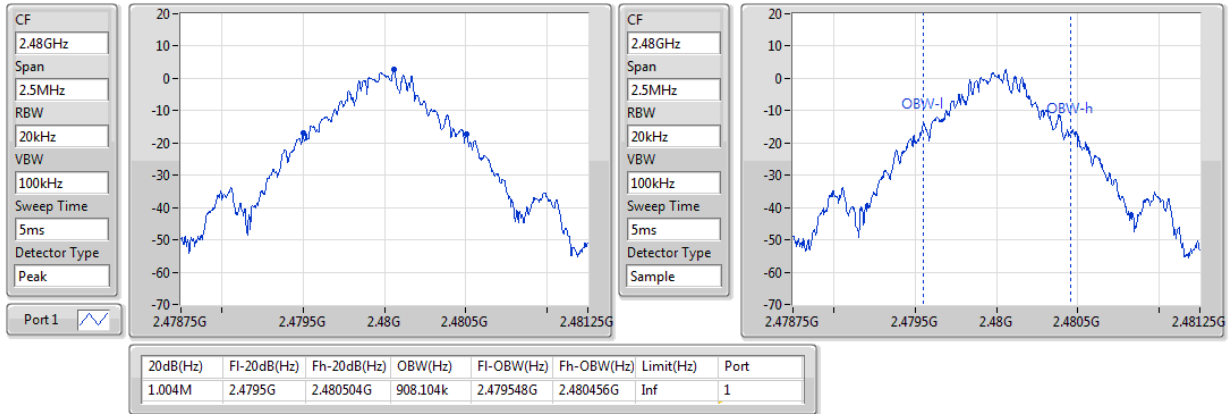
2441MHz



BT-BR(1Mbps)

EBW-FS

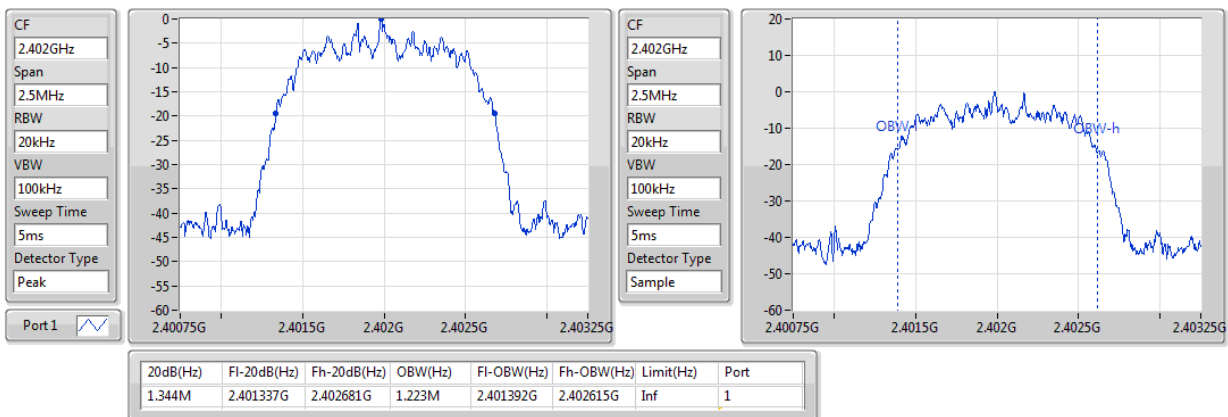
2480MHz



BT-EDR(2Mbps)

EBW-FS

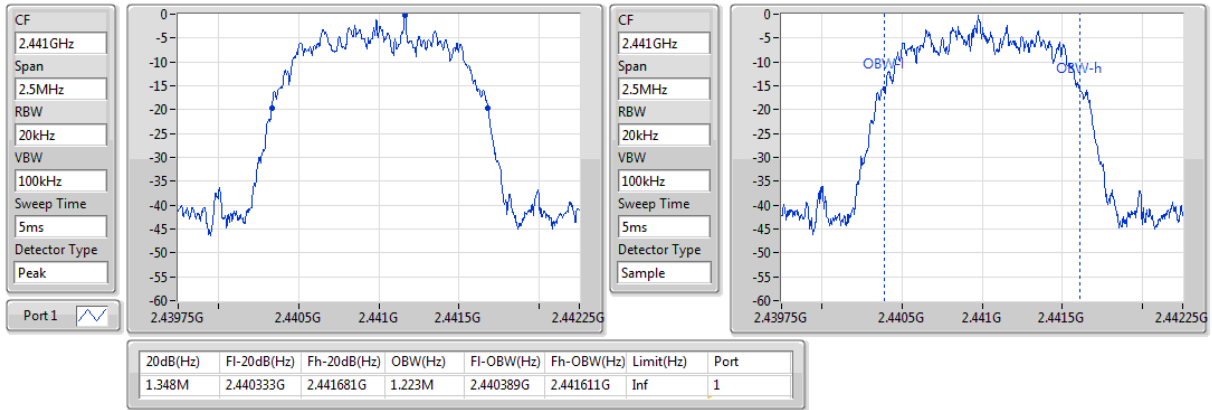
2402MHz



BT-EDR(2Mbps)

EBW-FS

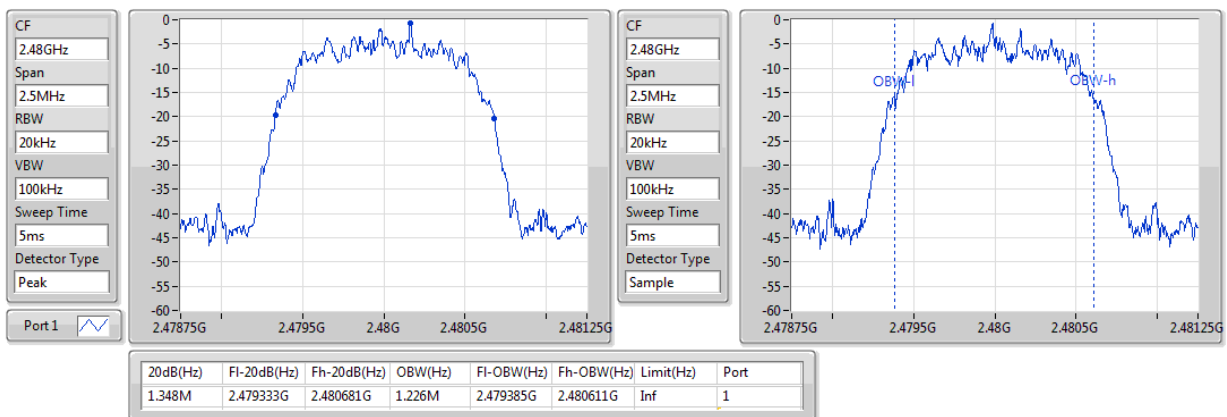
2441MHz



BT-EDR(2Mbps)

EBW-FS

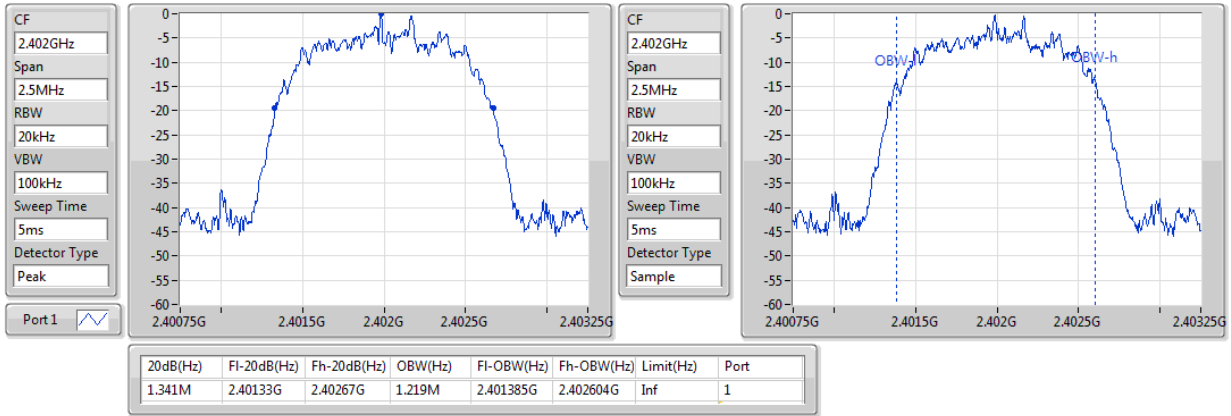
2480MHz



BT-EDR(3Mbps)

EBW-FS

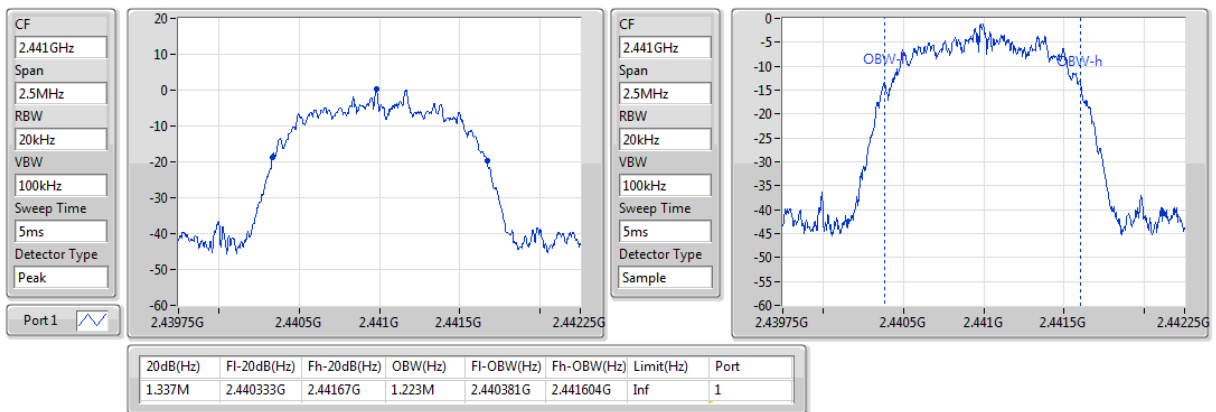
2402MHz



BT-EDR(3Mbps)

EBW-FS

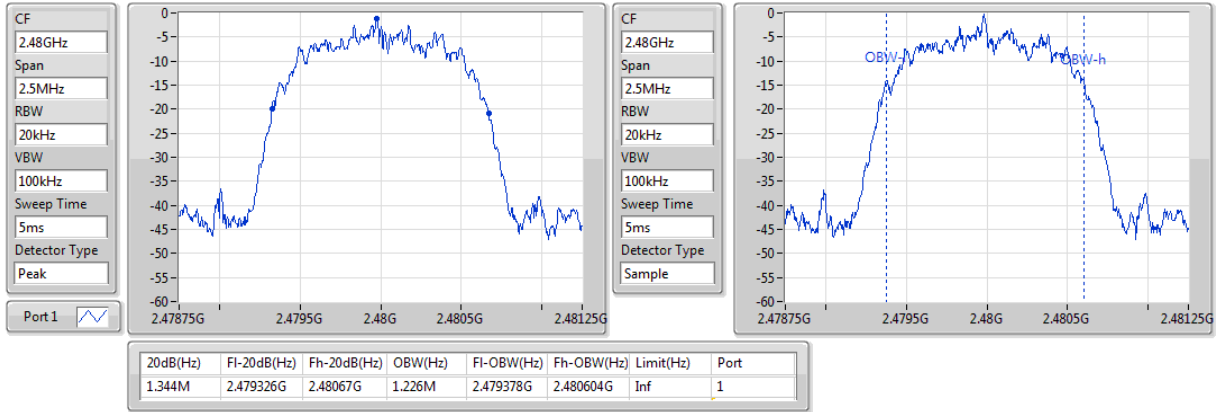
2441MHz



BT-EDR(3Mbps)

EBW-FS

2480MHz



3.7 Channel Separation

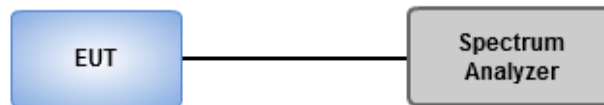
3.7.1 Limit of Channel Separation

- Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.
- 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.

3.7.2 Test Procedures

1. Set RBW=30kHz, VBW=100kHz, Sweep time = Auto, Detector=Peak Trace max hold
2. Allow trace to stabilize
3. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The EUT shall show compliance with the appropriate regulatory limit

3.7.3 Test Setup



3.7.4 Test result of Channel Separation

Ambient Condition	22~23°C / 64~65%	Tested By	Aska Huang
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Summary

Mode	Max-Space (Hz)	Min-Space (Hz)
2.4-2.4835GHz	-	-
BT-BR(1Mbps)	1.004348M	1M
BT-EDR(2Mbps)	1M	1M
BT-EDR(3Mbps)	1.004348M	1M

Result

Mode	Result	Fl (Hz)	Fh (Hz)	Ch.Space (Hz)	Limit (Hz)
BT-BR(1Mbps)	-	-	-	-	-
2402MHz	Pass	2.402061G	2.403061G	1M	656.347662k
2441MHz	Pass	2.441061G	2.442061G	1M	644.282406k
2480MHz	Pass	2.479057G	2.480061G	1.004348M	668.664k
BT-EDR(2Mbps)	-	-	-	-	-
2402MHz	Pass	2.401991G	2.402991G	1M	895.104k
2441MHz	Pass	2.440991G	2.441991G	1M	897.768k
2480MHz	Pass	2.478987G	2.479987G	1M	897.768k
BT-EDR(3Mbps)	-	-	-	-	-
2402MHz	Pass	2.401991G	2.402996G	1.004348M	893.106k
2441MHz	Pass	2.440991G	2.441991G	1M	890.442k
2480MHz	Pass	2.478987G	2.479991G	1.004348M	895.104k

BT-BR(1Mbps)

Channel Separation-FS

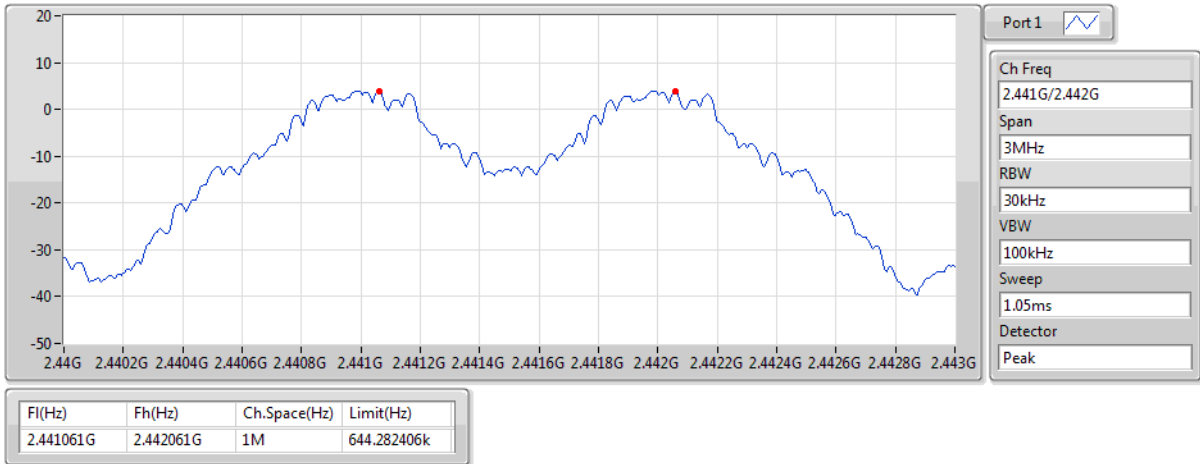
2.402G/2.403GHz



BT-BR(1Mbps)

Channel Separation-FS

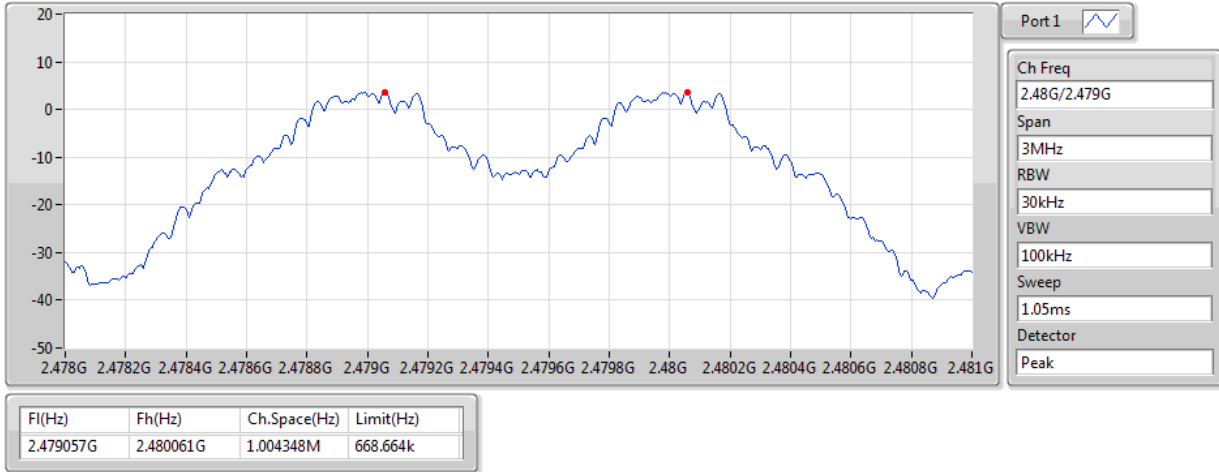
2.441G/2.442GHz



BT-BR(1Mbps)

Channel Separation-FS

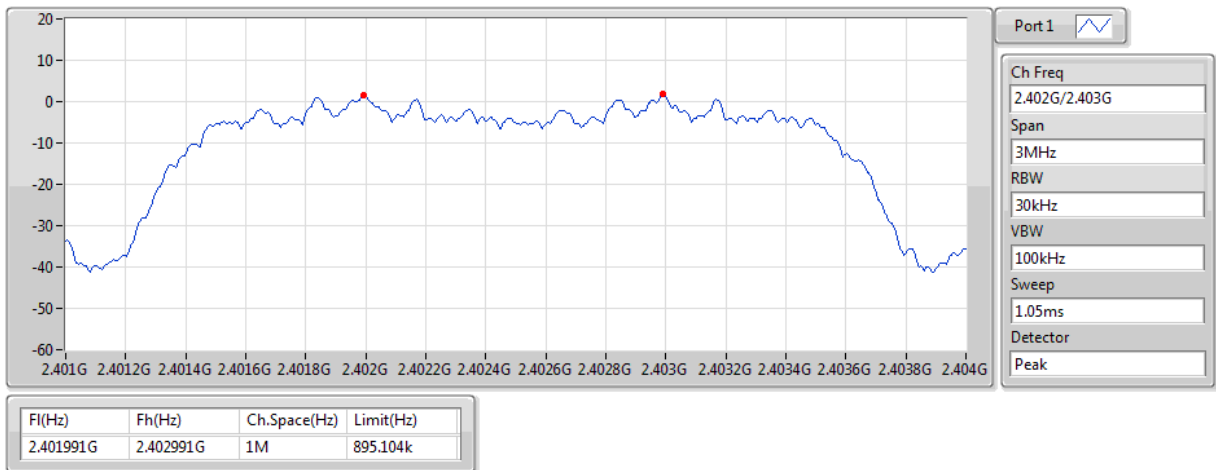
2.48G/2.479GHz



BT-EDR(2Mbps)

Channel Separation-FS

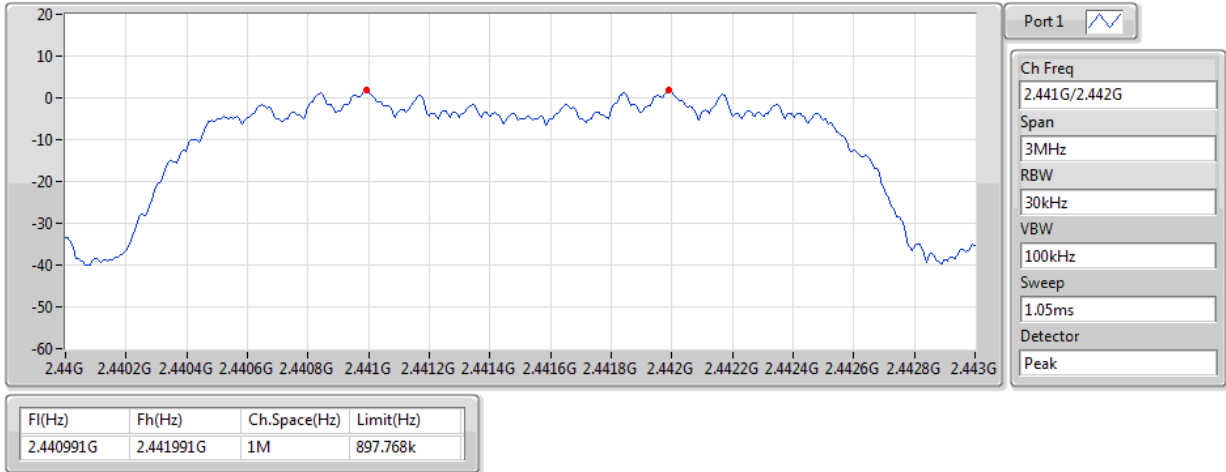
2.402G/2.403GHz



BT-EDR(2Mbps)

Channel Separation-FS

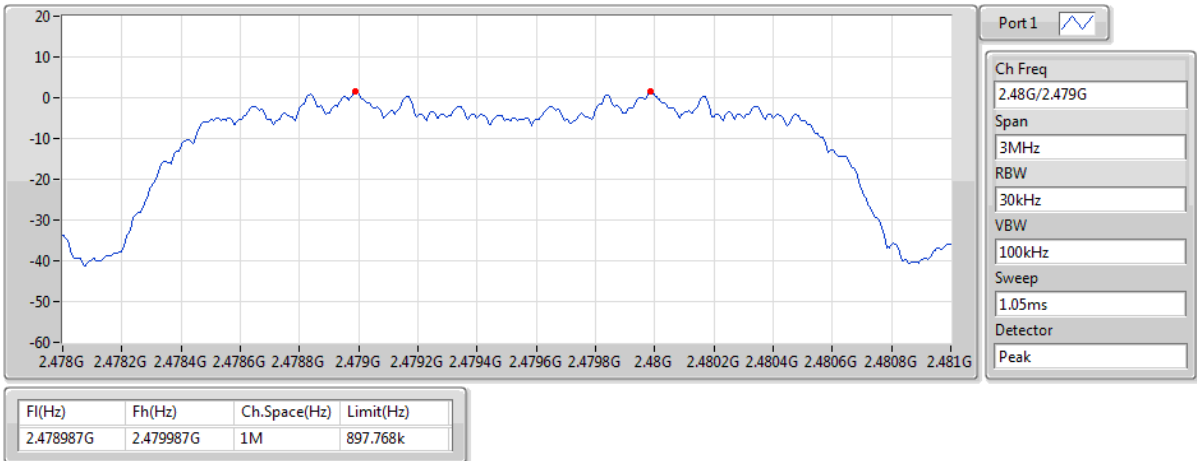
2.441G/2.442GHz



BT-EDR(2Mbps)

Channel Separation-FS

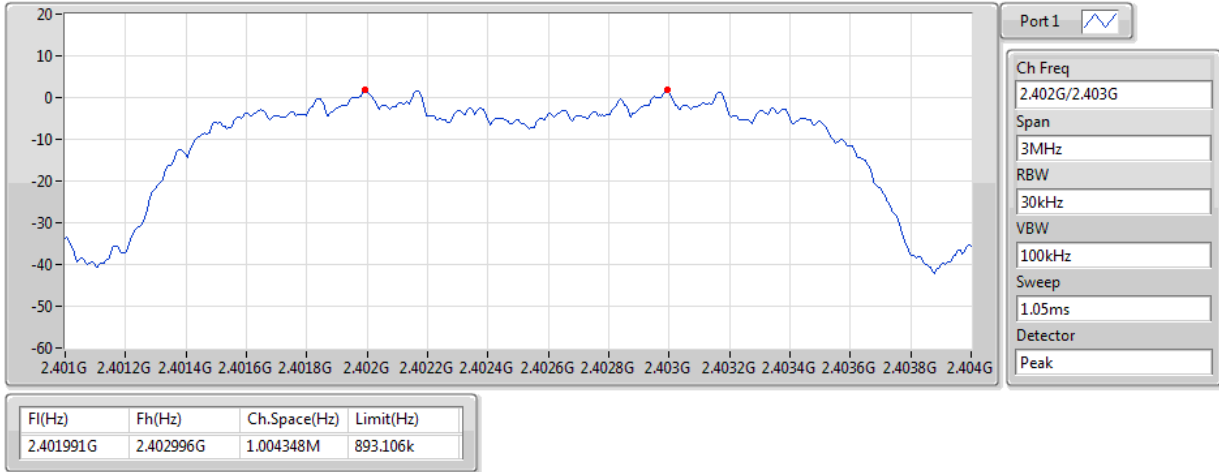
2.48G/2.479GHz



BT-EDR(3Mbps)

Channel Separation-FS

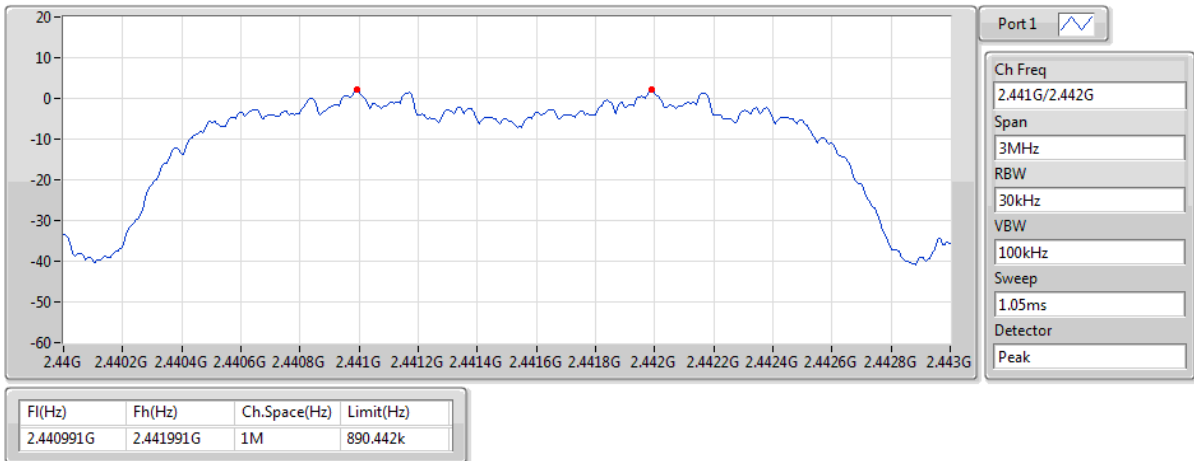
2.402G/2.403GHz



BT-EDR(3Mbps)

Channel Separation-FS

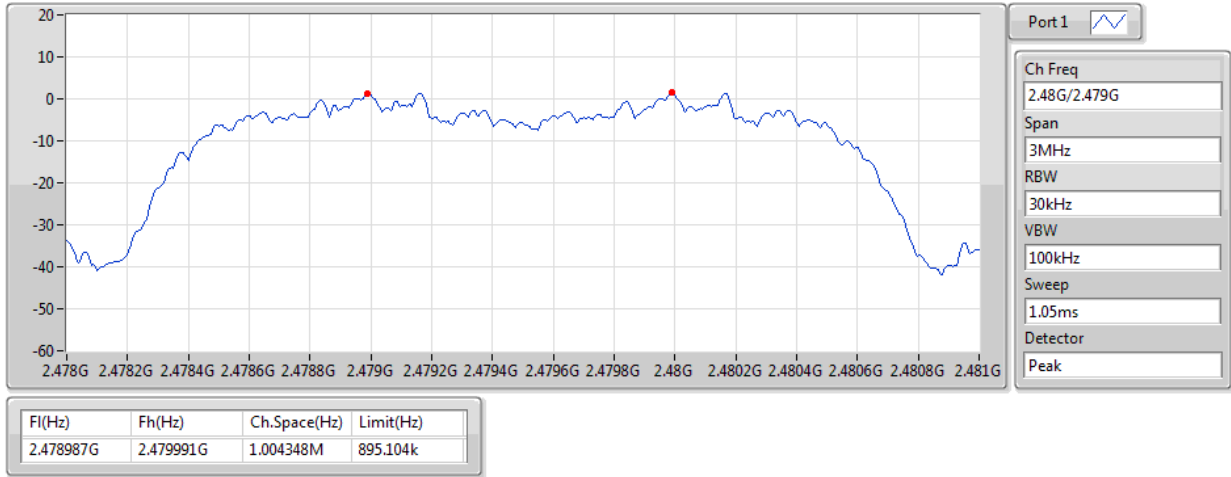
2.441G/2.442GHz



BT-EDR(3Mbps)

Channel Separation-FS

2.48G/2.479GHz



3.8 Number of Dwell Time

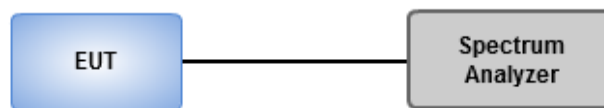
3.8.1 Limit of Dwell time

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.

3.8.2 Test Procedures

1. Set RBW=300 kHz, VBW=1 MHz, Sweep time=8 ms, Detector=Peak, Span=0 Hz, Trace max hold.
2. Enable gating and trigger function of spectrum analyzer to measure burst on time.
3. Set RBW=300 kHz, VBW=1 MHz, Sweep time=5 s / 2 s, Detector=Peak, Span=0 Hz, Trace max hold.
4. Enable gating and trigger function of spectrum analyzer to measure burst on number of transmission.
5. Set RBW=300 kHz, VBW=1 MHz, Sweep time=31.6 s / 8 s, Detector=Peak, Span=0 Hz, Trace max hold.
6. Enable gating and trigger function of spectrum analyzer to measure burst on number of transmission of entire time cycle.

3.8.3 Test Setup



3.8.4 Test Result of Dwell Time

Ambient Condition	22~23°C / 64~65%	Tested By	Aska Huang
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Summary

Mode	Max-Dwell (s)
2.4-2.4835GHz	-
BT-BR(1Mbps)	310.74334m_DH5
BT-EDR(2Mbps)	314.04712m_DH5
BT-EDR(3Mbps)	332.77644m_DH5
BT-BR-AFH(1Mbps)	312.309m_DH5-AFH
BT-EDR-AFH(2Mbps)	316.17m_DH5-AFH
BT-EDR-AFH(3Mbps)	292.475m_DH5-AFH

Result/ Non AFH mode

Mode	Result	Period (s)	Dwell (s)	Limit (s)	Tx On (ms)	Number of transmission in a 5 s
BT-BR(1Mbps)	-	-	-	-	-	-
2402MHz_DH5	PASS	31.6	0.31074	0.4	2.89225	17
BT-EDR(2Mbps)	-	-	-	-	-	-
2402MHz_DH5	PASS	31.6	0.31405	0.4	2.92300	17
BT-EDR(3Mbps)	-	-	-	-	-	-
2402MHz_DH5	PASS	31.6	0.33278	0.4	2.92525	18

Note 1: Dwell time =Number of transmission in a 5 second x Tx On Time x 6.32

Note 2: DH5 was the worst mode.

Result/ AFH mode

Mode	Result	Period (s)	Dwell (s)	Limit (s)	Tx On (ms)	Number of transmission in a 2 s
BT-BR-AFH(1Mbps)	-	-	-	-	-	-
2402MHz_DH5	PASS	8	0.31231	0.4	2.89175	27
BT-EDR-AFH(2Mbps)	-	-	-	-	-	-
2402MHz_DH5	PASS	8	0.31617	0.4	2.92750	27
BT-EDR-AFH(3Mbps)	-	-	-	-	-	-
2402MHz_DH5	PASS	8	0.29248	0.4	2.92475	25

Note 1: Dwell time =Number of transmission in a 2 second x Tx On Time x 4

Note 2: DH5 was the worst mode.

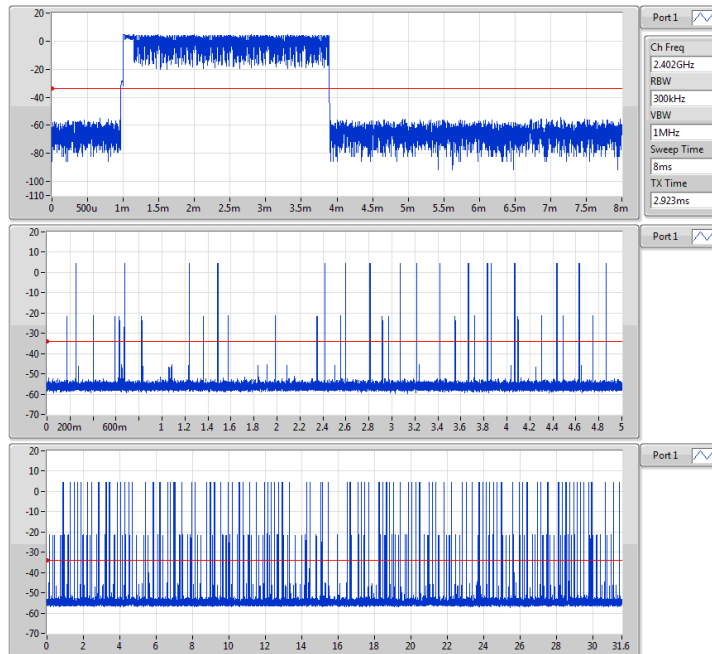
BT-BR(1Mbps)
2402MHz

Dwell-FS



BT-EDR(2Mbps)
2402MHz

Dwell-FS



BT-EDR(3Mbps)

Dwell-FS

2402MHz



BT-BR-AFH(1Mbps)

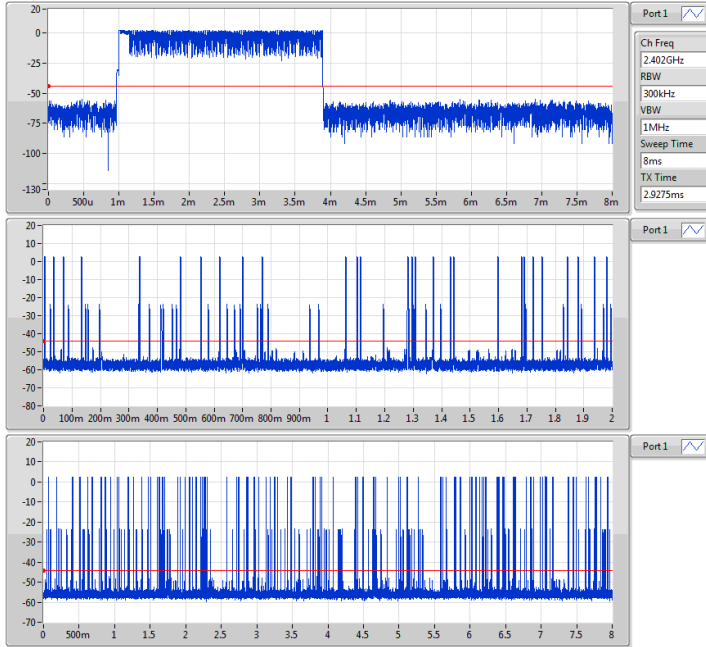
Dwell-FS

2402MHz



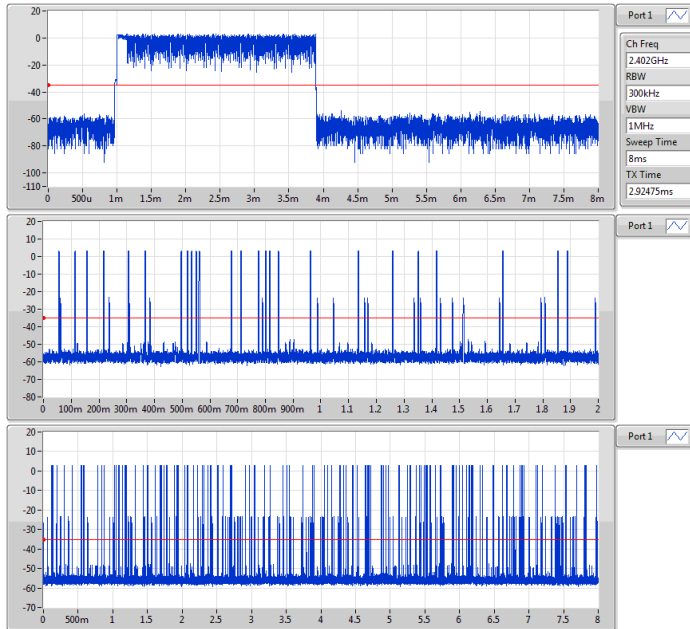
BT-EDR-AFH(2Mbps)
2402MHz

Dwell-FS



BT-EDR-AFH(3Mbps)
2402MHz

Dwell-FS



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

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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==