

FCC Test Report

FCC ID : DMOSEBT2

Equipment : Bluetooth in-ear headphones

Model No. : SEBT2

Brand Name : SENNHEISER

Applicant : Sennheiser Electronic Corp

Address : 1 Enterprise Drive Old Lyme, CT 06371, U.S.A

Standard : 47 CFR FCC Part 15.247

Received Date : Sep. 02, 2019

Tested Date : Sep.16 ~ Sep. 23, 2019

We, International Certification Corp., 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: Approved by:

Along Chen Assistant Manager Gary Chang / Manager

A THE

Testing Laboratory 2732

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Release Record

Report No.	Version	Description	Issued Date
FR982602AD	Rev. 01	Initial issue	Oct. 18, 2019

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Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	Conducted Emissions	[dBuV]: 0.153MHz 50.24 (Margin -15.58dB) - QP	Pass
15.247(d)	Radiated Emissions	[dBuV/m at 3m]: 2483.50MHz	Pass
15.209	Radiated Effissions	39.46 (Margin -14.54dB) - AV	F d 5 5
15.247(d)	Band Edge	Meet the requirement of limit	Pass
15.247(b)(1)	Conducted Output Power	Power [dBm]: 10.93	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.

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1 General Description

1.1 Information

1.1.1 Specification of the Equipment under Test (EUT)

RF General Information							
Frequency Range (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.

1.1.2 Antenna Details

Ant. No.	Туре	Connector	Gain (dBi)	Remarks
1	Chip Antenna	N/A	0	

1.1.3 Power Supply Type of Equipment under Test (EUT)

1.1.4 Accessories

	Accessories					
No.	Equipment	Description				
1	Battery	Brand Name: Synergy Model Name: AHB480832PLT Power Rating: 3.7Vdc, 100 mAh				
2	Type C-Charging Cable	Brand Name: SENNHEISER Model Name: 501-30303L4342-0 Power line: 0.15m shielded cable w/o core				

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Note 2: Bluetooth BR uses a GFSK.

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



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			

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1.1.6 Test Tool and Duty Cycle

Test Tool	Bluetooth Tester					
	Modulation Mode	Duty Cycle (%)	Duty Factor (dB)			
Duty Cycle and Duty Factor	DH5	78.08	1.07			
	3DH5	78.32	1.06			

1.1.7 Power Index of Test Tool

Modulation Mode	Test Frequency (MHz)		
Wiodulation Wiode	2402	2441	2480
GFSK/1Mbps	Default	Default	Default
π/4-DQPSK /2Mbps	Default	Default	Default
8DPSK/3Mbps	Default	Default	Default

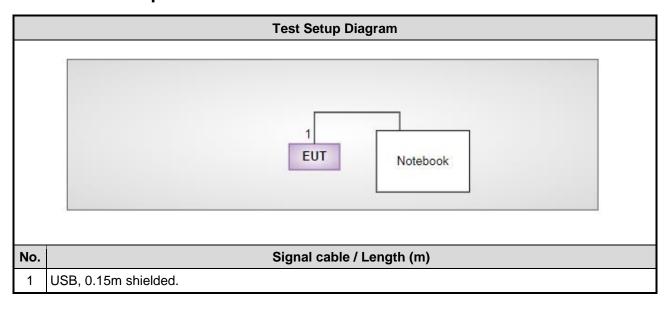
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1.2 Local Support Equipment List

	Support Equipment List							
No.	No. Equipment Brand Model FCC ID Remarks							
1	Notebook	DELL	Latitude E5470	DoC				

1.3 Test Setup Chart



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1.4 The Equipment List

Test Item	Conducted Emission							
Test Site	Conduction room 1 / (Conduction room 1 / (CO01-WS)						
Instrument	Manufacturer Model No. Serial No. Calibration Date Calibration Until							
Receiver	R&S	ESR3	101657	Jan. 08, 2019	Jan. 07, 2020			
LISN	R&S	ENV216	101579	Mar. 08, 2019	Mar. 07, 2020			
RF Cable-CON	Woken	CFD200-NL	CFD200-NL-001	Oct. 23, 2018	Oct. 22, 2019			
Measurement Software AUDIX e3 6.120210k NA NA								
Note: Calibration Int	terval of instruments list	ed above is one year.	ı	1	1			

Test Item	Radiated Emission								
Test Site	966 chamber1 / (03Cl	H01-WS)							
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until				
Spectrum Analyzer	R&S	FSV40	101498	Dec. 27, 2018	Dec. 26, 2019				
Receiver	R&S	ESR3	101658	Dec. 11, 2018	Dec. 10, 2019				
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-522	Jul. 12, 2019	Jul. 11, 2020				
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1096	Dec. 18, 2018	Dec. 17, 2019				
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170517	Nov. 15, 2018	Nov. 14, 2019				
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 09, 2018	Nov. 08, 2019				
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Oct. 08, 2018	Oct. 07, 2019				
Preamplifier	EMC	EMC02325	980225	Jul. 09, 2019	Jul. 08, 2020				
Preamplifier	Agilent	83017A	MY39501308	Oct. 04, 2018	Oct. 03, 2019				
Preamplifier	EMC	EMC184045B	980192	Aug. 01, 2019	Jul. 31, 2020				
RF Cable	EMC	EMC104-SM-SM-80 00	181106	Oct. 08, 2018	Oct. 07, 2019				
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16019/4	Oct. 08, 2018	Oct. 07, 2019				
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16014/4	Oct. 08, 2018	Oct. 07, 2019				
LF cable 1M	EMC	EMCCFD400-NM-N M-1000	160502	Oct. 08, 2018	Oct. 07, 2019				
LF cable 3M	Woken	CFD400NL-LW	CFD400NL-001	Oct. 08, 2018	Oct. 07, 2019				
LF cable 10M	Woken	CFD400NL-LW	CFD400NL-002	Oct. 08, 2018	Oct. 07, 2019				
Measurement Software AUDIX e3 6.120210g NA NA					NA				
Note: Calibration Inter	val of instruments liste	d above is one year.							

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Test Item	RF Conducted								
Test Site	(TH01-WS)								
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until				
Bluetooth Tester	R&S	CBT	100959	Sep. 24, 2018	Sep. 23, 2019				
Spectrum Analyzer	R&S	FSV40	101063	Apr. 17, 2019	Apr. 16, 2020				
Power Meter	Anritsu	ML2495A	1241002	Oct. 09, 2018	Oct. 08, 2019				
Power Sensor	Anritsu	MA2411B	1207366	Oct. 09, 2018	Oct. 08, 2019				
DC POWER SOURCE	GW INSTEK	GPC-6030D	EM892433	Oct. 25, 2018	Oct. 24, 2019				
Measurement Software	Sporton	Sporton_1	1.3.30	NA	NA				
Note: Calibration Interval of instruments listed above is one year.									

1.5 Test Standards

According to the specification of EUT, the EUT must comply with following standards and KDB documents.

47 CFR FCC Part 15.247

ANSI C63.10-2013

FCC KDB 558074 D01 15.247 Meas Guidance v05r02

1.6 Deviation from Test Standard and Measurement Procedure

None

1.7 Measurement Uncertainty

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. 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	±3.41 dB					
Radiated emission > 1GHz	±4.59 dB					

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2 Test Configuration

2.1 Testing Condition

Test Item	Test Site	Ambient Condition	Tested By
AC Conduction	CO01-WS	24°C / 62%	Alex Tasi
Radiated Emissions	03CH01-WS	24-26°C / 64-65%	Akun Chung Aska Huang
RF Conducted	TH01-WS	22°C / 63%	Brad Wu

FCC Designation No.: TW2732FCC site registration No.: 181692

➤ 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	GFSK	2441	1Mbps	
Radiated Emissions ≤ 1GHz	GFSK	2441	1Mbps	
Radiated Emissions > 1GHz	GFSK 8DPSK	2402, 2441, 2480 2402, 2441, 2480	1Mbps 3Mbps	
Conducted Output Power	GFSK л/4 DQPSK 8DPSK	2402, 2441, 2480 2402, 2441, 2480 2402, 2441, 2480	1Mbps 2Mbps 3Mbps	
Number of Hopping Channels	GFSK л/4 DQPSK 8DPSK	2402~2480 2402~2480 2402~2480	1Mbps 2Mbps 3Mbps	
Hopping Channel Separation 20dB and Occupied bandwidth	GFSK л/4 DQPSK 8DPSK	2402, 2441, 2480 2402, 2441, 2480 2402, 2441, 2480	1Mbps 2Mbps 3Mbps	
Dwell Time	GFSK л/4 DQPSK 8DPSK	2441 2441 2441	1Mbps 2Mbps 3Mbps	

NOTE:

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

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3 Transmitter Test Results

3.1 Conducted Emissions

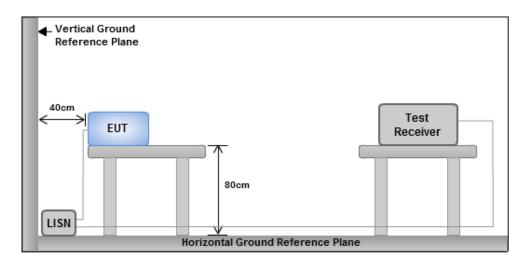
3.1.1 Limit of Conducted Emissions

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



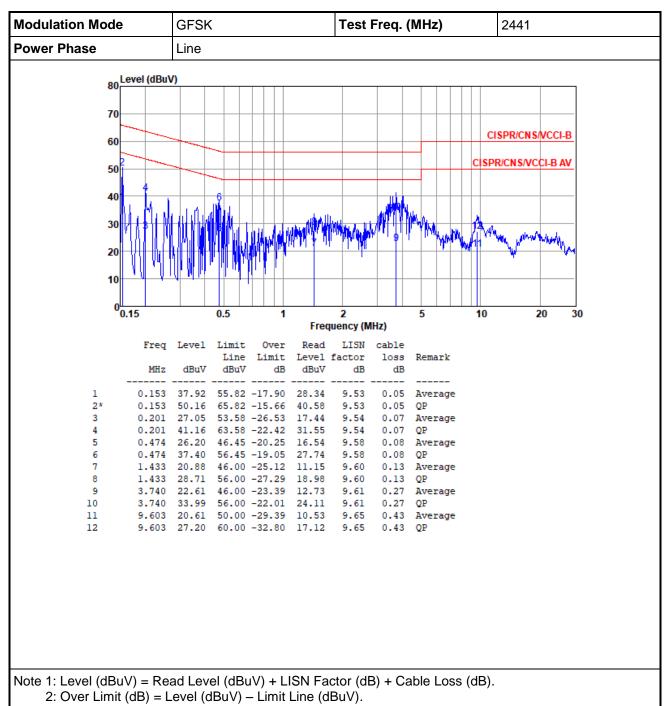
Note: 1. Support units were connected to second LISN.

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

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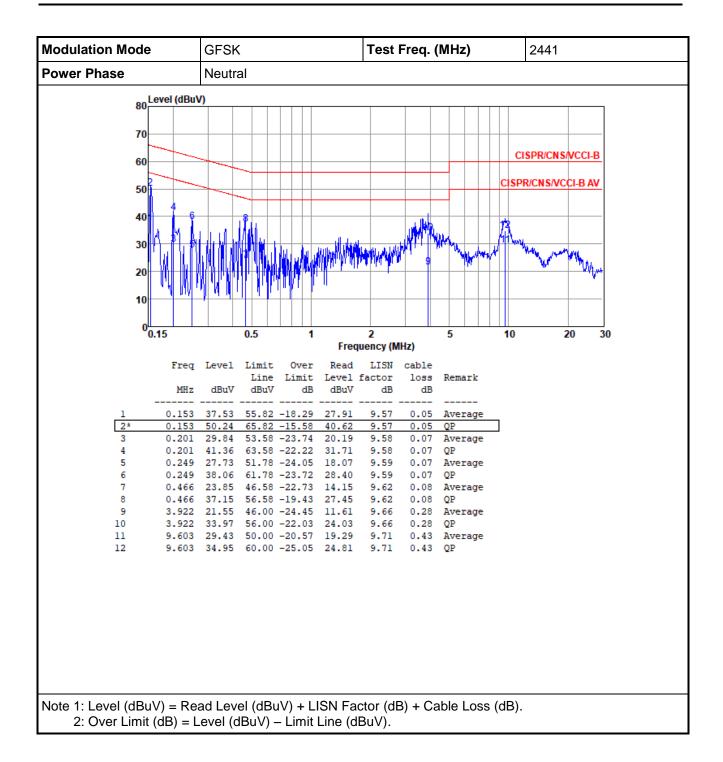


3.1.4 Test Result of Conducted Emissions



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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.

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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:

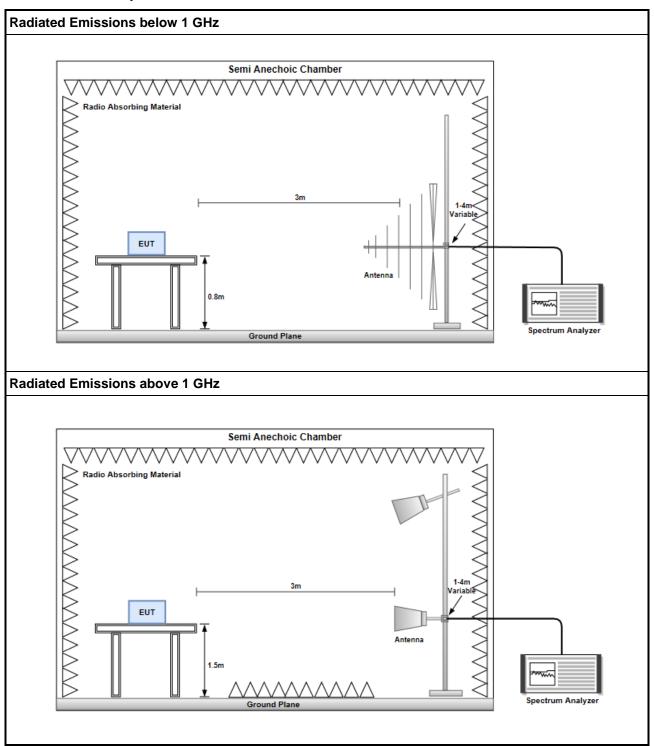
3. $\frac{1s / 1600 * 5}{100 \text{ ms}} = -30.1 \text{dB}$

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

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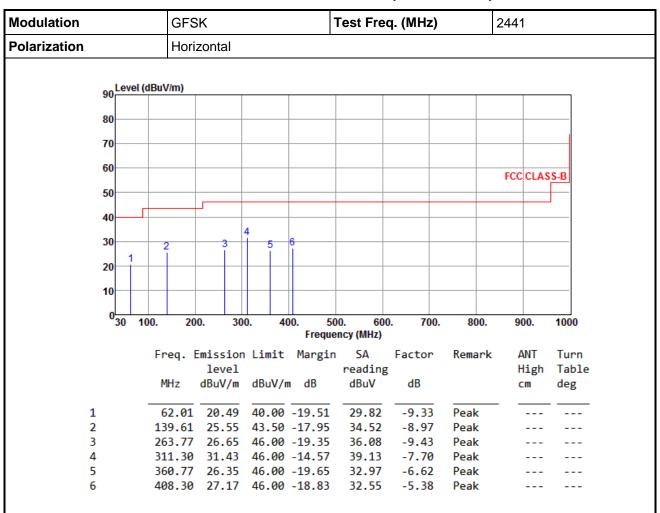
3.2.3 Test Setup



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3.2.4 Transmitter Radiated Unwanted Emissions (Below 1GHz)



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

*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.

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Modulation		GFSK			٦	Test Freq. (MHz)			2441		
Polarization V			al								
90 <mark>Le</mark>	evel (dBuV/	/m)									
80											
70											
60											
00									FCC	CLAS	S-B
50											
40											
30											
20	12 3	5	6								
10											
030	100.	200	. 300). 40	0. 50	0. 600	0. 700.	800.	90	0	1000
		200				ncy (MHz)					
	Fre	eq. Er	mission	Limit	Margin	SA	Factor	Remark	Al	NT	Turn
			level			reading			H:	igh	Table
	MH	dz o	dBuV/m	dBuV/m	ı dB	dBuV	dB		CI	m	deg
1	46	5.49	20.60	40.00	-19.40	29.06	-8.46	Peak			
2			19.35			28.21	-8.86	Peak			
3	136	88.6	18.65	43.50	-24.85	28.31	-9.66	Peak			
4				43.50		30.62	-8.78	Peak			
5		3.04	20.45		-23.05	28.98	-8.53	Peak			
6	261	1.83	21.33	46.00	-24.6/	30.88	-9.55	Peak			

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

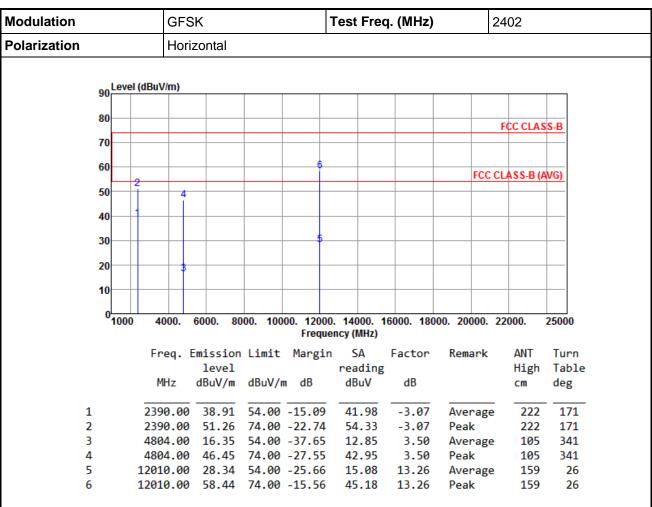
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

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

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



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

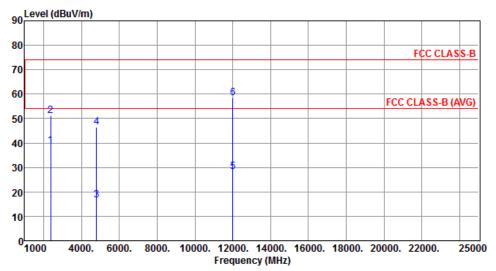
*Factor includes antenna factor, cable loss and amplifier gain

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

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Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Vertical		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m		SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	38.86	54.00	-15.14	41.93	-3.07	Average	351	61
2	2390.00	51.12	74.00	-22.88	54.19	-3.07	Peak	351	61
3	4804.00	16.51	54.00	-37.49	13.01	3.50	Average	312	96
4	4804.00	46.61	74.00	-27.39	43.11	3.50	Peak	312	96
5	12010.00	28.19	54.00	-25.81	14.93	13.26	Average	361	245
6	12010.00	58.29	74.00	-15.71	45.03	13.26	Peak	361	245

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

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

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2

3

4

5

6

7

8

2390.00

2483.50

2483.50

4882.00

4882.00

7323.00 22.42

50.26 74.00 -23.74

54.00 -15.69

74.00 -24.32

54.00 -37.90

74.00 -27.80

54.00 -31.58

38.31

49.68

16.10

46.20

7323.00 52.52 74.00 -21.48

Modulation	GFSK	Test Freq. (MHz)	2441	
Polarization	Horizontal			
90 Level (dB	uV/m)			
80				
70			FCC CLASS-B	
60	8	FCC	C CLASS-B (AVG)	
50 24	6			
40				
30	7			
10	5			
01000		0. 14000. 16000. 18000. 20000.	. 22000. 25000	
		ency (MHz)	ANT Torre	
	Freq. Emission Limit Margi level MHz dBuV/m dBuV/m dB	n SA Factor Remark reading dBuV dB	: ANT Turn High Table cm deg	
1 2	390.00 38.69 54.00 -15.31			

53.33

41.53

52.90

12.49

42.59

13.63

43.73

-3.07

-3.22

-3.22

3.61

3.61

8.79

8.79

Peak

Peak

Peak

Peak

Average

Average

Average

212

212

212

100

100

378

378

169

169

169

345

345

1

1

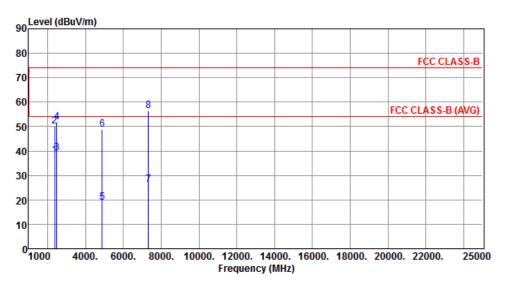
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB) *Factor includes antenna factor , cable loss and amplifier gain

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

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Modulation	GFSK	Test Freq. (MHz)	2441
Polarization	Vertical		



	Freq.	Emission level	Limit	Margin	SA reading	Factor	Remark	ANT High	Turn Table
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB		cm	deg
1	2390.00	38.25	54.00	-15.75	41.32	-3.07	Average	359	57
2	2390.00	50.01	74.00	-23.99	53.08	-3.07	Peak	359	57
3	2483.50	39.05	54.00	-14.95	42.27	-3.22	Average	359	57
4	2483.50	51.89	74.00	-22.11	55.11	-3.22	Peak	359	57
5	4882.00	18.82	54.00	-35.18	15.21	3.61	Average	329	101
6	4882.00	48.92	74.00	-25.08	45.31	3.61	Peak	329	101
7	7323.00	26.23	54.00	-27.77	17.44	8.79	Average	385	285
8	7323.00	56.33	74.00	-17.67	47.54	8.79	Peak	385	285

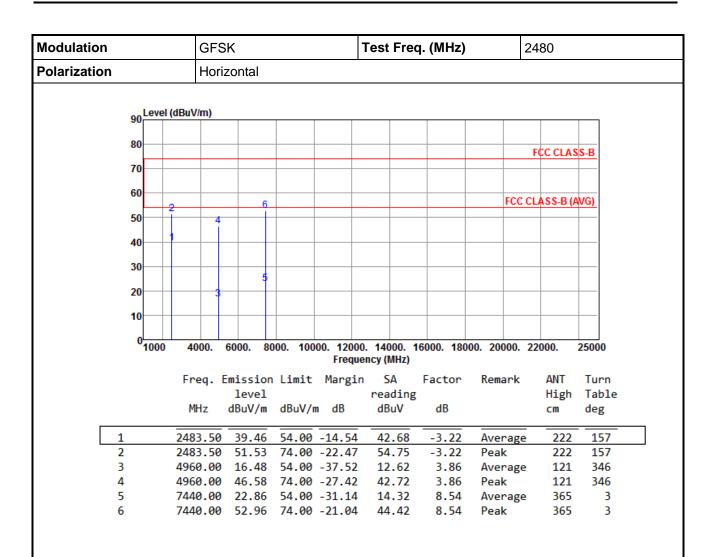
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)

*Factor includes antenna factor, cable loss and amplifier gain

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

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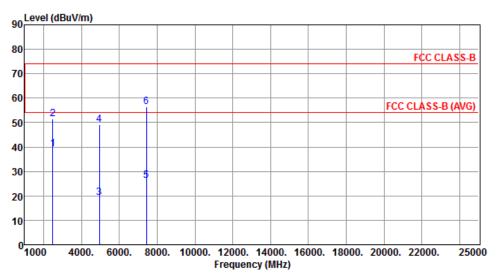
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB) *Factor includes antenna factor, cable loss and amplifier gain

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

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Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Vertical		



	Freq.	Emission level dBuV/m	Limit dBuV/m	Ū	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
	PHIZ	ubuv/III	ubuv/III	ub	ubuv	ub		CIII	ueg
1	2483.50	39.21	54.00	-14.79	42.43	-3.22	Average	351	62
2	2483.50	51.44	74.00	-22.56	54.66	-3.22	Peak	351	62
3	4960.00	19.14	54.00	-34.86	15.28	3.86	Average	318	114
4	4960.00	49.24	74.00	-24.76	45.38	3.86	Peak	318	114
5	7440.00	26.39	54.00	-27.61	17.85	8.54	Average	324	265
6	7440.00	56.49	74.00	-17.51	47.95	8.54	Peak	324	265

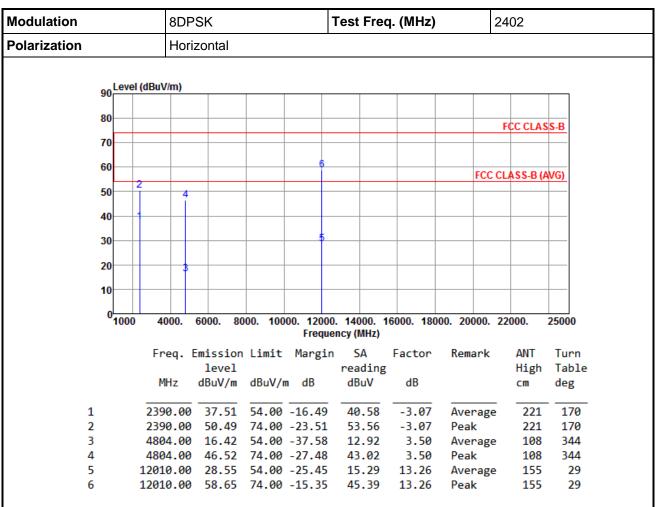
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB) *Factor includes antenna factor , cable loss and amplifier gain

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

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



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

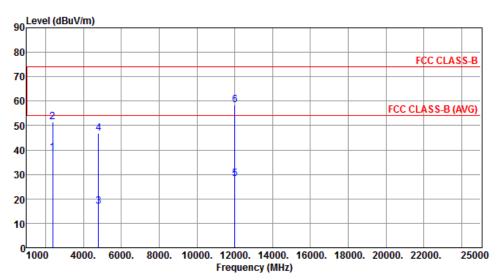
*Factor includes antenna factor, cable loss and amplifier gain

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

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



	Freq.	Emission level	Limit	Margin	SA reading	Factor	Remark	ANT High	Turn Table
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB		cm	deg
1	2390.00	38.98	54.00	-15.02	42.05	-3.07	Average	345	62
2	2390.00	51.35	74.00	-22.65	54.42	-3.07	Peak	345	62
3	4804.00	16.85	54.00	-37.15	13.35	3.50	Average	301	88
4	4804.00	46.95	74.00	-27.05	43.45	3.50	Peak	301	88
5	12010.00	28.34	54.00	-25.66	15.08	13.26	Average	329	245
6	12010.00	58.44	74.00	-15.56	45.18	13.26	Peak	329	245

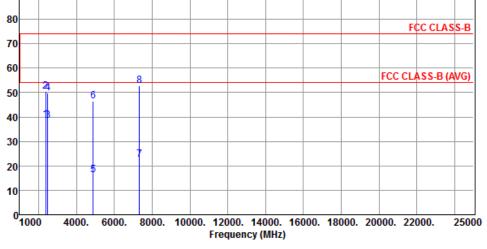
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB) *Factor includes antenna factor , cable loss and amplifier gain

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

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Modulation		8DPS	K			Test	Freq.	(MHz)	24	41	
Polarization		Horizo	Horizontal									
90 <mark>.</mark>	evel (dBu	V/m)				I	ı	ī	I	I		
80-										F	CC CLAS	SS-B
70												



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Ū	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	38.82	54.00	-15.18	41.89	-3.07	Average	214	168
2	2390.00	50.44	74.00	-23.56	53.51	-3.07	Peak	214	168
3	2483.50	38.41	54.00	-15.59	41.63	-3.22	Average	214	168
4	2483.50	49.82	74.00	-24.18	53.04	-3.22	Peak	214	168
5	4882.00	16.29	54.00	-37.71	12.68	3.61	Average	100	341
6	4882.00	46.39	74.00	-27.61	42.78	3.61	Peak	100	341
7	7323.00	22.74	54.00	-31.26	13.95	8.79	Average	356	4
8	7323.00	52.84	74.00	-21.16	44.05	8.79	Peak	356	4

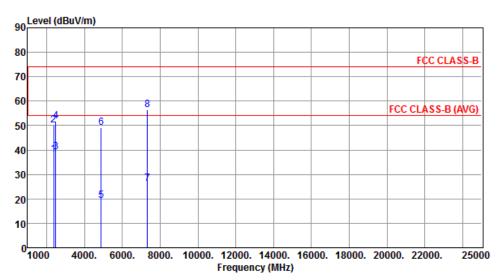
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB) *Factor includes antenna factor , cable loss and amplifier gain

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

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



	Freq.	Emission level	Limit	Margin	SA reading	Factor	Remark	ANT High	Turn Table
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB		cm	deg
1	2390.00	38.29	54.00	-15.71	41.36	-3.07	Average	358	59
2	2390.00	50.24	74.00	-23.76	53.31	-3.07	Peak	358	59
3	2483.50	39.22	54.00	-14.78	42.44	-3.22	Average	358	59
4	2483.50	51.94	74.00	-22.06	55.16	-3.22	Peak	358	59
5	4882.00	19.15	54.00	-34.85	15.54	3.61	Average	329	114
6	4882.00	49.25	74.00	-24.75	45.64	3.61	Peak	329	114
7	7323.00	26.33	54.00	-27.67	17.54	8.79	Average	361	292
8	7323.00	56.43	74.00	-17.57	47.64	8.79	Peak	361	292

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

*Factor includes antenna factor, cable loss and amplifier gain

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

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Modulation		8DF	PSK		,	Test Fred	q. (MHz)		2480	
Polarization		Hor	izontal		•			•		
9	00 Leve	l (dBuV/m)		1						
	80									
•	30								FCC CLAS	S-B
7	70									
	50									
		2	6					FCC	CLASS-B (A	(VG)
!	50	4								
4	40	1								
;	30		5							
	20	- 3								
	10									
	10									
	1000	4000.	6000. 8	000. 100	000. 12000	0. 14000. 1	6000. 180	00. 20000.	22000.	25000
						ency (MHz)				
		Freq.	Emission	n Limit	Margin	n SA	Factor	Remark	ANT	Turn
			level			reading			High	Table
		MHz	dBuV/m	dBuV/	m dB	dBuV	dB		CM	deg
1		2/83 50	39.20	5/ 00	-14.80	42.42	-3.22	Average	210	169
2			52.88		-21.12	56.10	-3.22	Peak	210	169
3			16.55				3.86	Average		344
4		4960.00	46.65	74.00	-27.35	42.79	3.86	Peak	122	344
5		7440.00	23.12	54.00	-30.88	14.58	8.54	Average	365	5
_									200	_

7440.00 53.22 74.00 -20.78 44.68

8.54

Peak

365

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

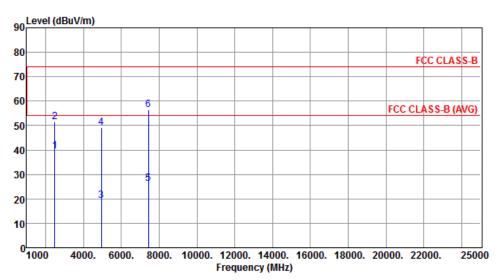
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

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



	Freq.	Emission level	Limit	Margin	SA reading	Factor	Remark	ANT High	Turn Table
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB		cm	deg
1	2483.50	39.36	54.00	-14.64	42.58	-3.22	Average	349	65
2	2483.50	51.59	74.00	-22.41	54.81	-3.22	Peak	349	65
3	4960.00	19.14	54.00	-34.86	15.28	3.86	Average	318	114
4	4960.00	49.24	74.00	-24.76	45.38	3.86	Peak	318	114
5	7440.00	26.39	54.00	-27.61	17.85	8.54	Average	324	265
6	7440.00	56.49	74.00	-17.51	47.95	8.54	Peak	324	265

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

*Factor includes antenna factor, cable loss and amplifier gain

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

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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

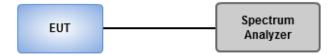
Reference level measurement

- 1. Set RBW=100kHz, VBW = 300kHz, Detector = Peak, Sweep time = Auto
- 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

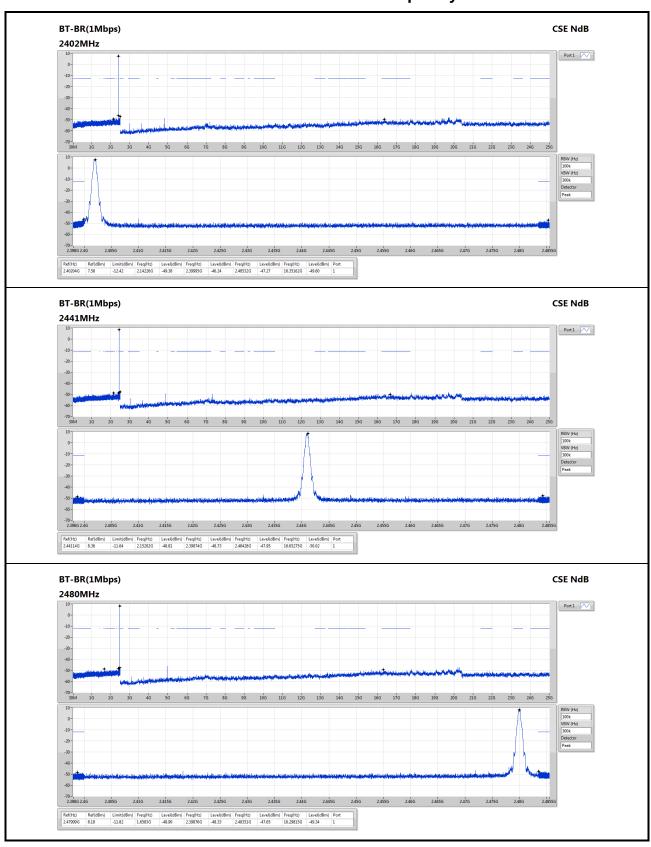
3.3.3 Test Setup



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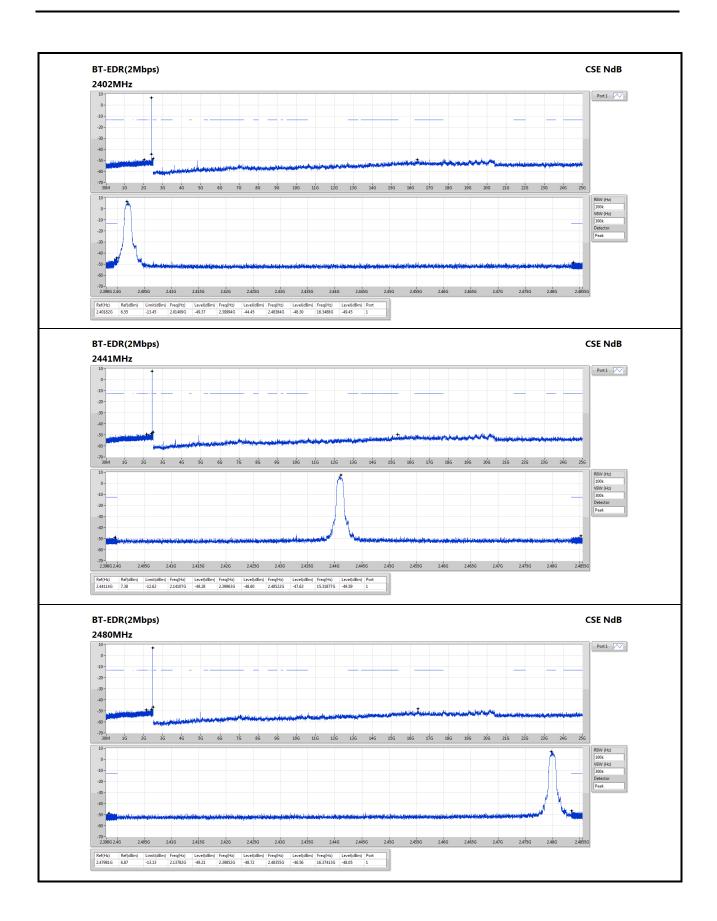


3.3.4 Unwanted Emissions into Non-Restricted Frequency Bands



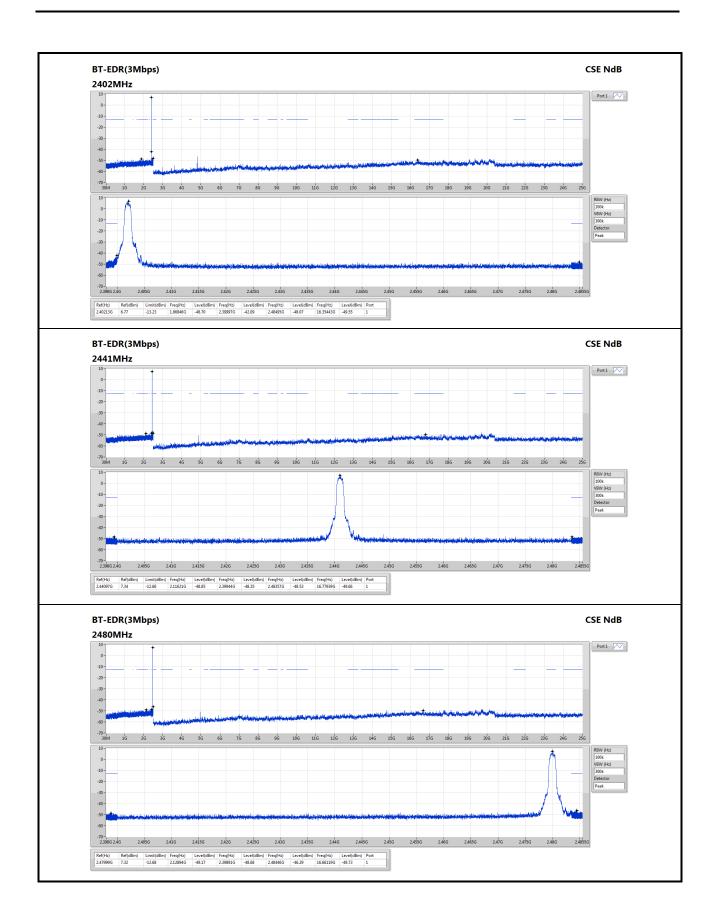
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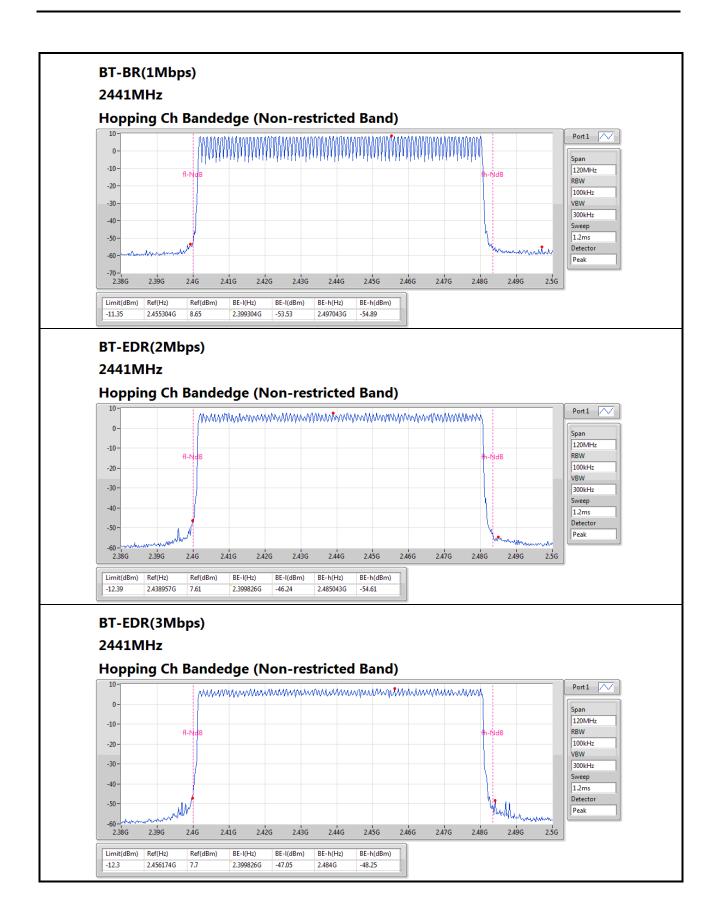
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3.4 Conducted Output Power

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

- 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

3.4.3 Test Setup



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3.4.4 Test Result of Conducted Output Power

Peak Output Power

Summary

Mode	Power	Power
	(dBm)	(W)
2.4-2.4835GHz	-	-
BT-BR(1Mbps)	8.95	0.00785
BT-EDR(2Mbps)	10.42	0.01102
BT-EDR(3Mbps)	10.93	0.01239

Result

Mode	Result	Gain	Power	Power Limit
		(dBi)	(dBm)	(dBm)
BT-BR(1Mbps)	-	-	-	-
2402MHz	Pass	0.00	8.64	21.00
2441MHz	Pass	0.00	8.95	21.00
2480MHz	Pass	0.00	8.85	21.00
BT-EDR(2Mbps)	-	-	-	-
2402MHz	Pass	0.00	10.15	21.00
2441MHz	Pass	0.00	10.42	21.00
2480MHz	Pass	0.00	10.33	21.00
BT-EDR(3Mbps)	-	-	-	-
2402MHz	Pass	0.00	10.65	21.00
2441MHz	Pass	0.00	10.93	21.00
2480MHz	Pass	0.00	10.84	21.00

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Average Output Power

Summary

Mode	Power	Power
	(dBm)	(W)
2.4-2.4835GHz	-	-
BT-BR(1Mbps)	8.88	0.00773
BT-EDR(2Mbps)	7.91	0.00618
BT-EDR(3Mbps)	7.91	0.00618

Result

Mode	Result	Gain	Power	Power Limit
		(dBi)	(dBm)	(dBm)
BT-BR(1Mbps)	-	-	-	-
2402MHz	Pass	0.00	8.58	-
2441MHz	Pass	0.00	8.88	-
2480MHz	Pass	0.00	8.77	-
BT-EDR(2Mbps)	-	-	-	-
2402MHz	Pass	0.00	7.61	-
2441MHz	Pass	0.00	7.91	-
2480MHz	Pass	0.00	7.81	-
BT-EDR(3Mbps)	-	-	-	-
2402MHz	Pass	0.00	7.61	-
2441MHz	Pass	0.00	7.91	-
2480MHz	Pass	0.00	7.79	-

Note: Average power is for reference only.

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3.5 Number of Hopping Frequency

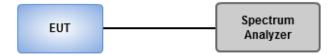
3.5.1 Limit of Number of Hopping Frequency

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



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3.5.4 Test Result of Number of Hopping Frequency

Summary

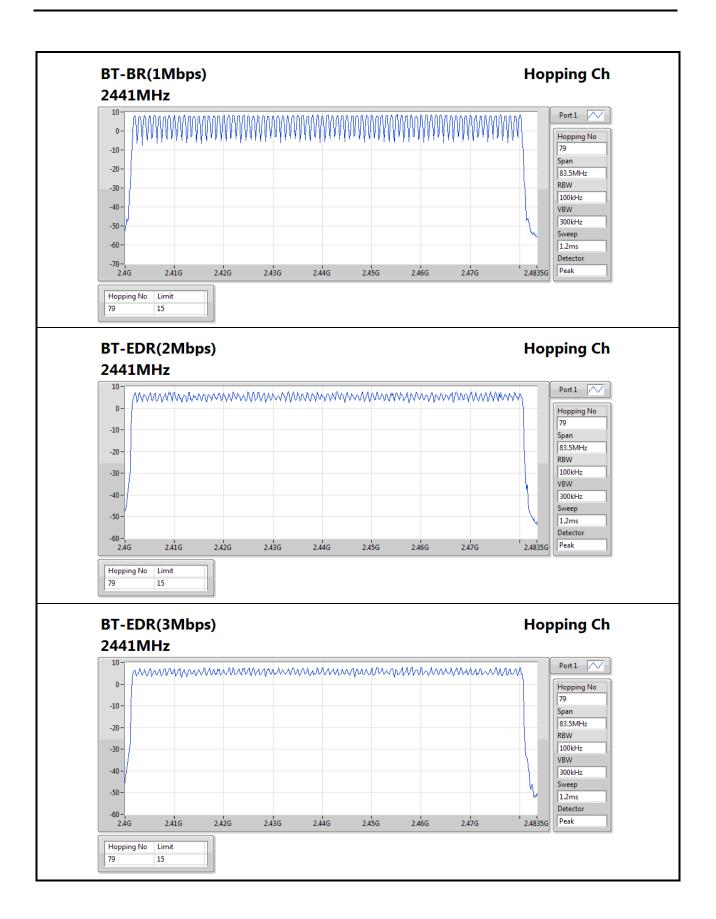
Mode	Max-Hop No
2.4-2.4835GHz	-
BT-BR(1Mbps)	79
BT-EDR(2Mbps)	79
BT-EDR(3Mbps)	79

Result

Nesuit				
Mode	Result	Hopping No	Limit	
BT-BR(1Mbps)	-	-	-	
2441MHz	Pass	79	15	
BT-EDR(2Mbps)	-	-	-	
2441MHz	Pass	79	15	
BT-EDR(3Mbps)	-	-	-	
2441MHz	Pass	79	15	

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3.6 20dB and Occupied Bandwidth

3.6.1 Test Procedures

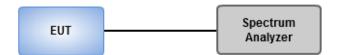
20dB Bandwidth

- Set RBW=10kHz VBW= 30kHz for BT BR mode, RBW=20kHz, VBW=100kHz for other modes, Sweep time = Auto, Detector=Peak, Trace max hold
- 2 Allow trace to stabilize
- 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

- Set RBW=10kHz VBW= 30kHz for BT BR mode, RBW=20kHz, VBW=100kHz for other modes, 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



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3.6.3 Test result of 20dB and Occupied Bandwidth

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)	920.29k	875.543k	876KF1D	920.29k	871.925k
BT-EDR(2Mbps)	1.341M	1.212M	1M21G1D	1.326M	1.194M
BT-EDR(3Mbps)	1.337M	1.205M	1M21G1D	1.312M	1.205M

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;

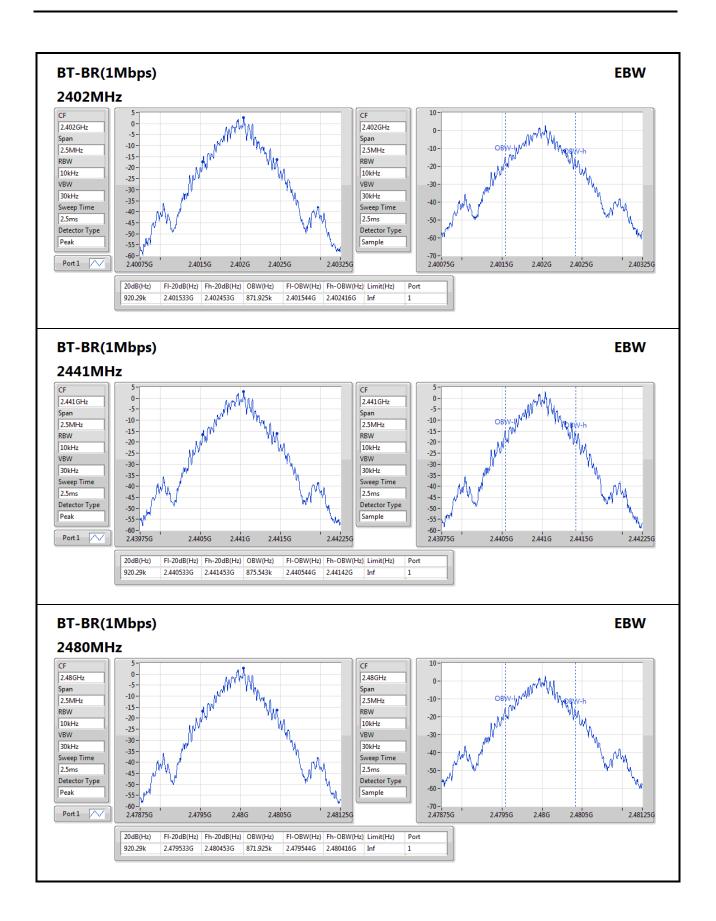
Result

Mode	Result	Limit	Limit Port 1-N dB	
		(Hz)	(Hz)	(Hz)
BT-BR(1Mbps)	-	-	-	-
2402MHz	Pass	Inf	920.29k	871.925k
2441MHz	Pass	Inf	920.29k	875.543k
2480MHz	Pass	Inf	920.29k	871.925k
BT-EDR(2Mbps)	-	-	-	-
2402MHz	Pass	Inf	1.326M	1.201M
2441MHz	Pass	Inf	1.341M	1.212M
2480MHz	Pass	Inf	1.326M	1.194M
BT-EDR(3Mbps)	-	-	-	-
2402MHz	Pass	Inf	1.315M	1.205M
2441MHz	Pass	Inf	1.312M	1.205M
2480MHz	Pass	Inf	1.337M	1.205M

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

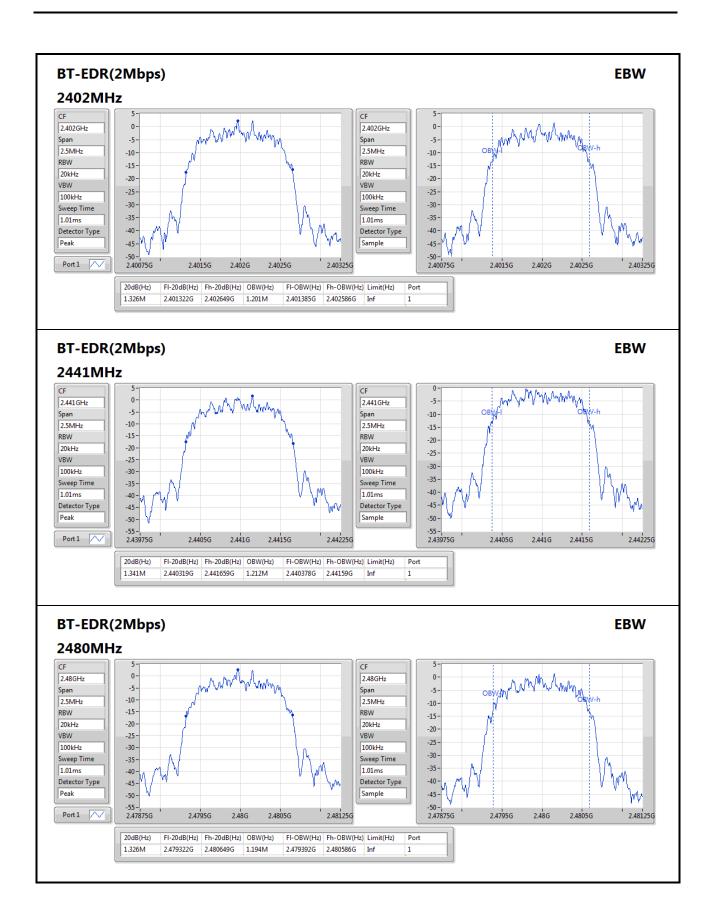
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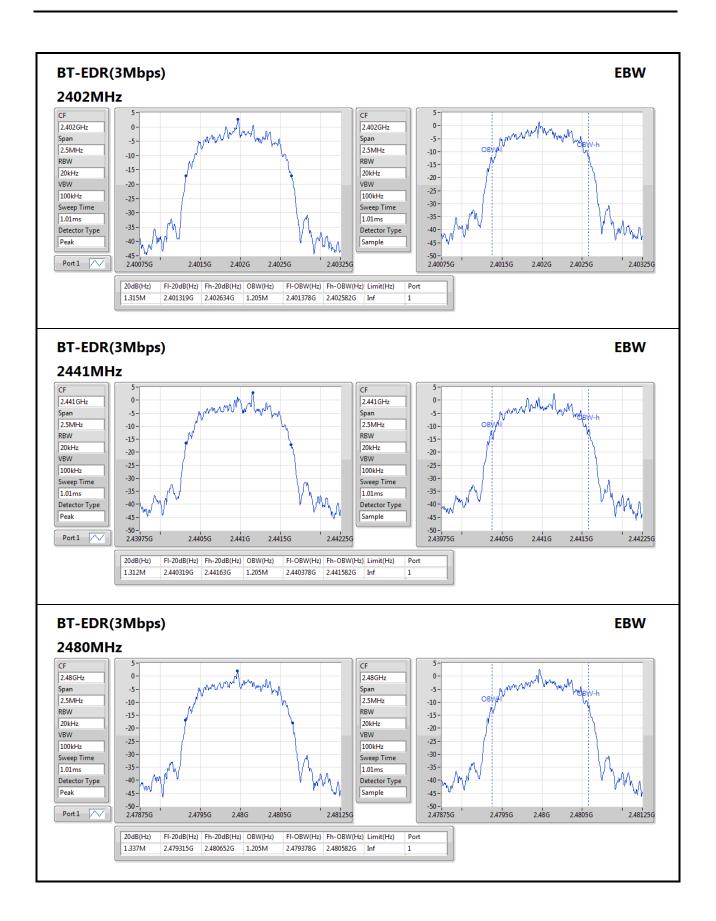
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3.7 Channel Separation

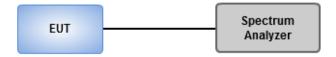
3.7.1 Limit of Channel Separation

- 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



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3.7.4 Test result of Channel Separation

Summary

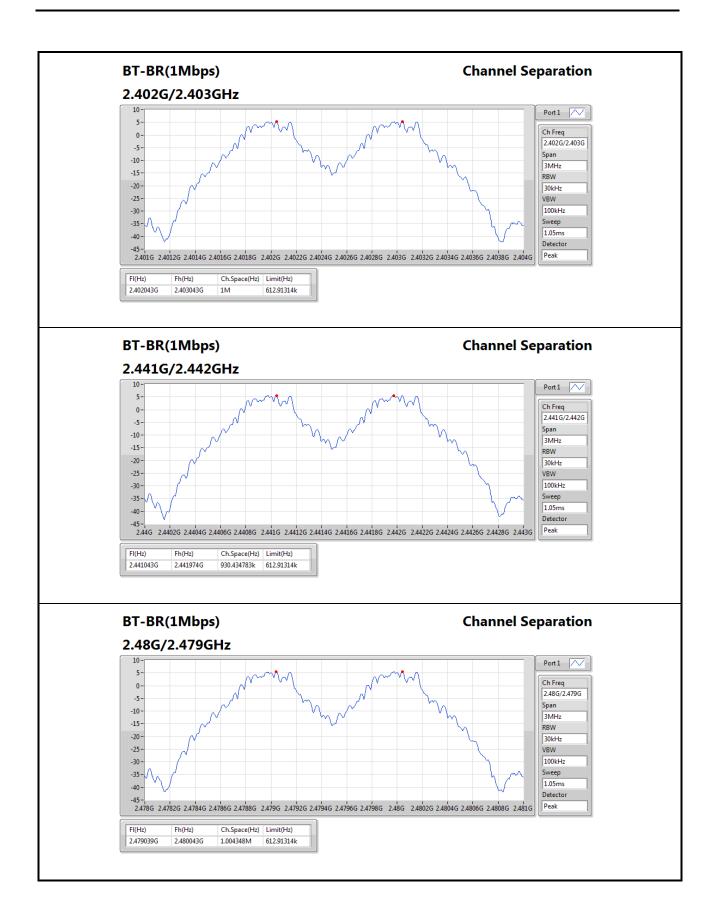
Mode	Max-Space	Min-Space
	(Hz)	(Hz)
2.4-2.4835GHz	-	-
BT-BR(1Mbps)	1.004348M	930.434783k
BT-EDR(2Mbps)	1.004348M	1M
BT-EDR(3Mbps)	1.013043M	1M

Result

Mode	Result	FI	Fh	Ch.Space	Limit
		(Hz)	(Hz)	(Hz)	(Hz)
BT-BR(1Mbps)	-	-	-	-	-
2402MHz	Pass	2.402043G	2.403043G	1M	612.91314k
2441MHz	Pass	2.441043G	2.441974G	930.434783k	612.91314k
2480MHz	Pass	2.479039G	2.480043G	1.004348M	612.91314k
BT-EDR(2Mbps)	-	-	-	-	-
2402MHz	Pass	2.401974G	2.402974G	1M	883.116k
2441MHz	Pass	2.440974G	2.441978G	1.004348M	893.106k
2480MHz	Pass	2.47897G	2.479974G	1.004348M	883.116k
BT-EDR(3Mbps)	-	-	-	-	-
2402MHz	Pass	2.40197G	2.402983G	1.013043M	875.79k
2441MHz	Pass	2.44097G	2.441974G	1.004348M	873.792k
2480MHz	Pass	2.478974G	2.479974G	1M	890.442k

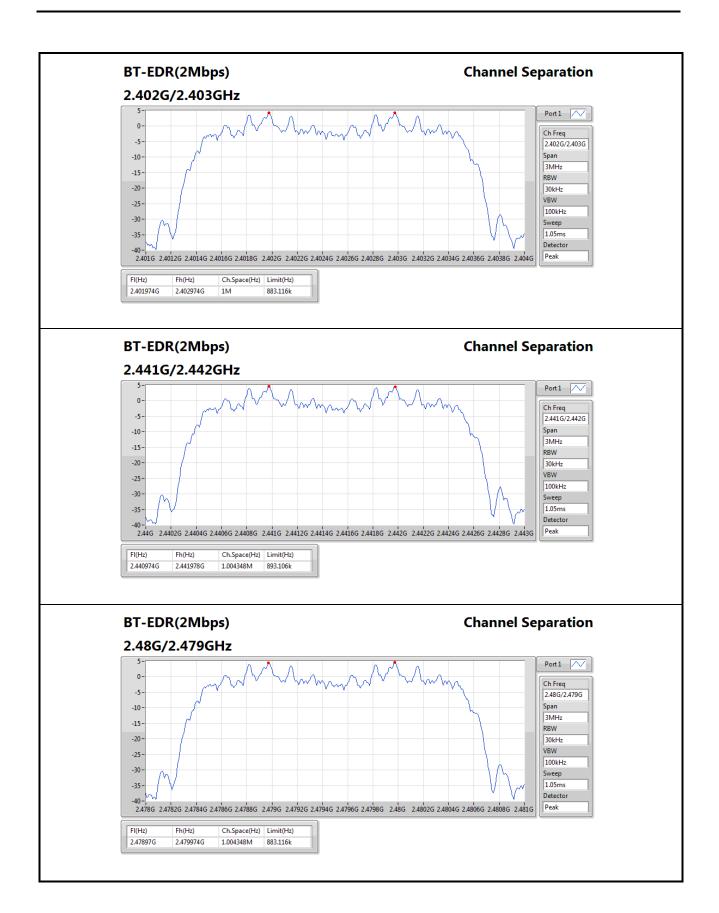
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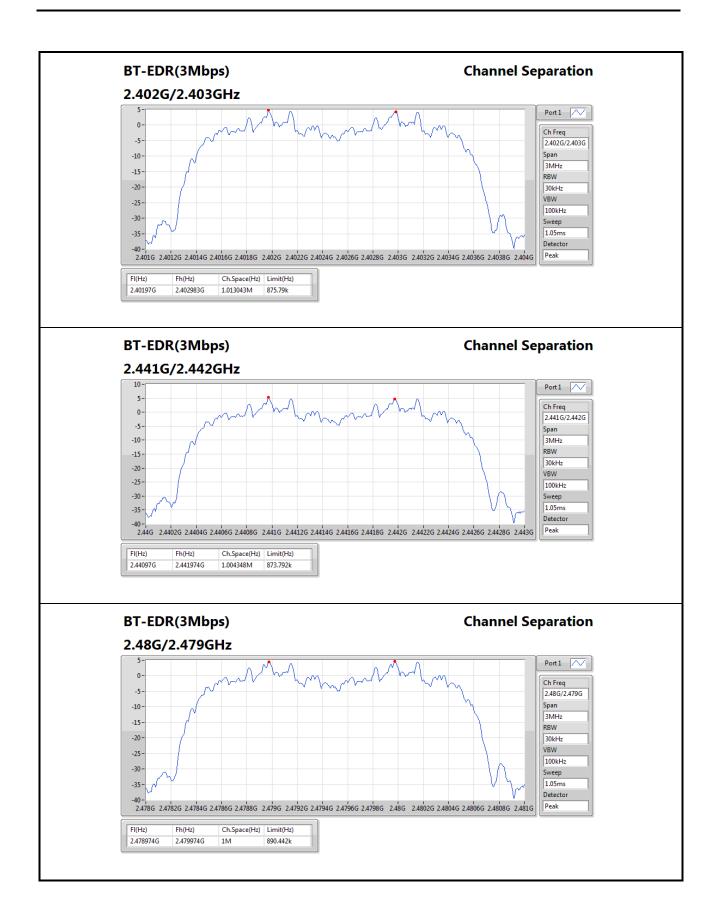
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3.8 Number of Dwell Time

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

- Set RBW=300kHz,VBW=1MHz,Sweep time = 10 ms, Detector=Peak, Span=0Hz,Trace max hold
- 2 Enable gating and trigger function of spectrum analyzer to measure burst on time.
- The DH1 packet can cover a single time slot. A maximum length packet has duration of 1 time slots. Non AFH mode

The hopping rate is 1600 hops/second so the maximum dwell time is 1/1600 seconds. DH1 Packet permit maximum 1600 / 79 / 2 = 10.12 hops per second in each channel (1 time slot TX, 1 time slot RX). So, the dwell time is the time duration of the pulse times $10.12 \times 31.6 = 320$ within 31.6 seconds. AFH mode

The hopping rate is 800 hops/second so the maximum dwell time is 1/800 seconds. DH1 Packet permit maximum 800/20/2 = 20 hops per second in each channel (1 time slot TX, 1 time slot RX). So, the dwell time is the time duration of the pulse times $20 \times 8 = 160$ within 8 seconds.

4. The DH3 packet can cover up to 3 time slots. A maximum length packet has duration of 3 time slots. Non AFH mode

The hopping rate is 1600 hops/second so the maximum dwell time is 3/1600 seconds. DH3 Packet permit maximum 1600 / 79 / 4 = 5.06 hops per second in each channel (3 time slots TX, 1 time slot RX). So, the dwell time is the time duration of the pulse times $5.06 \times 31.6 = 160 \text{ within } 31.6 \text{ seconds}$. AFH mode

The hopping rate is 800hops/second so the maximum dwell time is 3/800 seconds. DH3 Packet permit maximum 800 / 20 / 4 = 10 hops per second in each channel (3 time slots TX, 1 time slot RX). So, the dwell time is the time duration of the pulse times $10 \times 8 = 80$ within 8 seconds.

The DH5 packet can cover up to 5 time slots. Operate DH5 at maximum dwell time and maximum duty cycle. A maximum length packet has duration of 5 time slots.

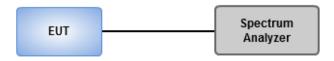
Non AFH mode

The hopping rate is 1600 hops/second so the maximum dwell time is 5/1600 seconds, or 3.125ms. DH5 Packet permit maximum 1600/79/6 = 3.37 hops per second in each channel (5 time slots TX, 1 time slot RX). So, the dwell time is the time duration of the pulse times $3.37 \times 31.6 = 106.6$ within 31.6 seconds

AFH mode

The hopping rate is 800 hops/second so the maximum dwell time is 5/800 seconds. DH5 Packet permit maximum 800/20 / 6 = 6.667 hops per second in each channel (5 time slots TX, 1 time slot RX). So, the dwell time is the time duration of the pulse times $6.667 \times 8 = 53.33$ within 8 seconds

3.8.3 Test Setup



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3.8.4 Test Result of Dwell Time

Summary

Mode	Max-Dwell	
	(s)	
2.4-2.4835GHz	-	
BT-BR(1Mbps)	310.530435m_DH5	
BT-EDR(2Mbps)	310.530435m_DH5	
BT-EDR(3Mbps)	310.530435m_DH5	

Result/ Non AFH mode

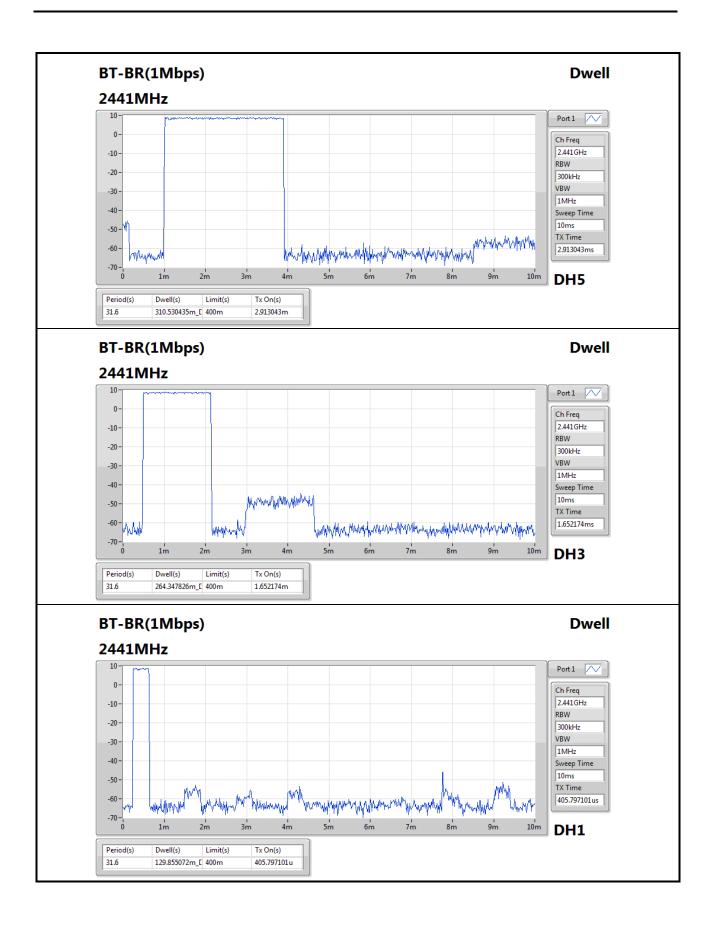
Mode	Result	Period	Dwell	Limit	Tx On
		(s)	(s)	(s)	(s)
BT-BR(1Mbps)	-	-	-	-	-
2441MHz	Pass	31.6	310.530435m_DH5	400m	2.913043m
2441MHz	Pass	31.6	264.347826m_DH3	400m	1.652174m
2441MHz	Pass	31.6	129.855072m_DH1	400m	405.797101u
BT-EDR(2Mbps)	-	-	-	-	-
2441MHz	Pass	31.6	310.530435m_DH5	400m	2.913043m
2441MHz	Pass	31.6	266.666667m_DH3	400m	1.666667m
2441MHz	Pass	31.6	134.492754m_DH1	400m	420.289855u
BT-EDR(3Mbps)	-	-	-	-	-
2441MHz	Pass	31.6	310.530435m_DH5	400m	2.913043m
2441MHz	Pass	31.6	266.666667m_DH3	400m	1.666667m
2441MHz	Pass	31.6	134.492754m_DH1	400m	420.289855u

Result/ AFH mode

Mode	Result	Period	Dwell	Limit	Tx On
		(s)	(s)	(s)	(s)
BT-BR(1Mbps)	-	-	-	-	-
2441MHz	Pass	8	155.3526m_DH5	400m	2.913043m
2441MHz	Pass	8	132.1739m_DH3	400m	1.652174m
2441MHz	Pass	8	64.92754m_DH1	400m	405.797101u
BT-EDR(2Mbps)	-	-	-	-	-
2441MHz	Pass	8	155.3526m_DH5	400m	2.913043m
2441MHz	Pass	8	133.3334m_DH3	400m	1.666667m
2441MHz	Pass	8	67.24638m_DH1	400m	420.289855u
BT-EDR(3Mbps)	-	-	-	•	-
2441MHz	Pass	8	155.3526m_DH5	400m	2.913043m
2441MHz	Pass	8	133.3334m_DH3	400m	1.666667m
2441MHz	Pass	8	67.24638m_DH1	400m	420.289855u

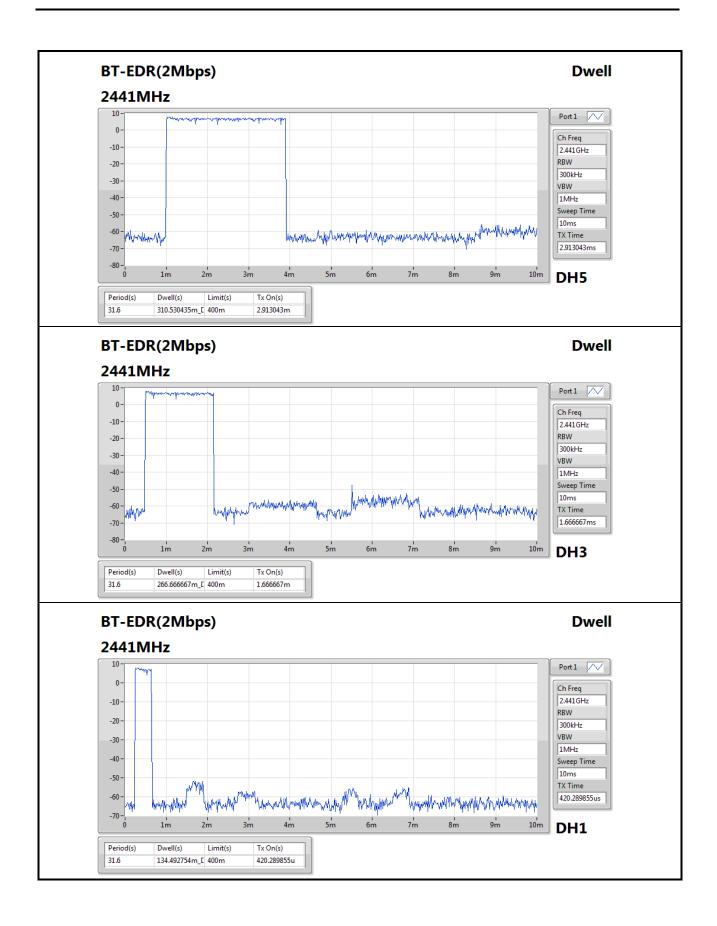
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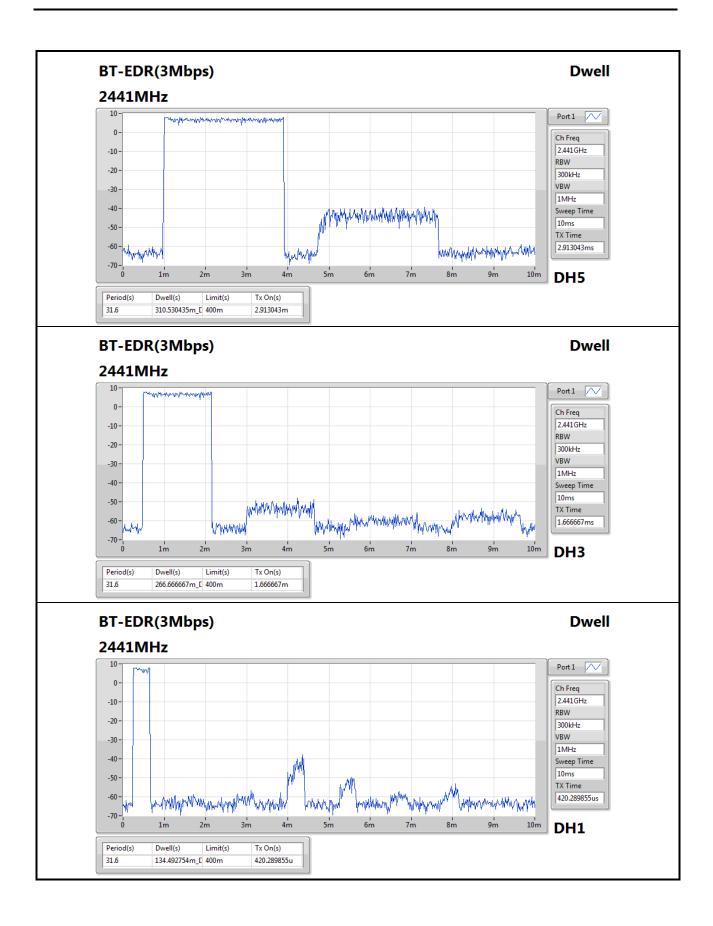
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4 Test laboratory information

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 Corp (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 District, Tao Yuan City 333, Taiwan, R.O.C.

Kwei Shan Site II

Tel: 886-3-271-8640 No. 14-1, Lane 19, Wen San 3rd St., Kwei Shan District, 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: 886-3-318-0155

Email: ICC_Service@icertifi.com.tw

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