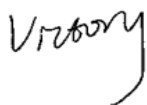


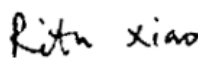
TEST REPORT

Product Name: Wireless Earphone
FCC ID: 2AORM-M8
Trademark: N/A
Model Number: M8, M3, M5, M6, M7, M9, M9X, M10, M11, M12, M13, M15, M7E, M72C, A3, A3Pro, i12, i25, i27, i3Pro, A6, A7, A8, A9, A10, A11, A13, A15, B10, X3, X5, X7, X11, X13, X15, XY-5, XY-7, TW40, TW70, TW80, TW11, TW12, SP6, SP6 Pro, SP7, SP8, SP9, SP10, SP11
Prepared For: Shenzhen Topwell Smart Electronic Co., Ltd.
Address: 4th Floor, Longxing Industrial Building, Huarong Road, Longhua District, Shenzhen, China
Manufacturer: Shenzhen Topwell Smart Electronic Co., Ltd.
Address: 4th Floor, Longxing Industrial Building, Huarong Road, Longhua District, Shenzhen, China
Prepared By: Shenzhen CTB Testing Technology Co., Ltd.
Address: Floor 1&2, Building A, No. 26 of Xinghe Road, Xinqiao Community, Xinqiao Street, Baoan District, Shenzhen, Guangdong China
Sample Received Date: May 07, 2020
Sample tested Date: May 07, 2020 to May 14, 2020
Issue Date: May 14, 2020
Report No.: CTB200513012RFX
Test Standards: FCC Part15.247
ANSI C63.10:2013
Test Results: PASS
Remark: This is Bluetooth radio test report.

Compiled by:

Victory

Reviewed by:

Rita Xiao

Approved by:

Sherwin Qian/ Director

The test report is effective only with both signature and specialized stamp. This result(s) shown in this report refer only to the sample(s) tested. Without written approval of Shenzhen CTB Testing Technology Co., Ltd. this report can't be reproduced except in full. The tested sample(s) and the sample information are provided by the client.

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(Note: N/A means not applicable)

1. VERSION

Report No.	Issue Date	Description	Approved
CTB200513012RFX	May 14, 2020	Original	Valid

2. TEST SUMMARY

The Product has been tested according to the following specifications:

Test Item	Test Requirement	Test method	Result
AC Power Line Conducted Emission	47 CFR Part 15 Subpart C Section 15.207	ANSI C63.10-2013	PASS
Radiated Spurious emissions	47 CFR Part 15 Subpart C Section 15.205/15.209	ANSI C63.10-2013	PASS
Band edge and RF Conducted Spurious Emissions	47 CFR Part 15 Subpart C Section 15.247(d)/15.205(a)	ANSI C63.10-2013	PASS
Conducted Peak Output Power	47 CFR Part 15 Subpart C Section 15.247 (b)(1)	ANSI C63.10-2013	PASS
20dB Occupied Bandwidth	47 CFR Part 15 Subpart C Section 15.247 (a)(1)	ANSI C63.10-2013	PASS
Carrier Frequencies Separation	47 CFR Part 15 Subpart C Section 15.247 (a)(1)	ANSI C63.10-2013	PASS
Hopping Channel Number	47 CFR Part 15 Subpart C Section 15.247 (b)	ANSI C63.10-2013	PASS
Dwell Time	47 CFR Part 15 Subpart C Section 15.247 (a)(1)	ANSI C63.10-2013	PASS
Pseudorandom Frequency Hopping Sequence	47 CFR Part 15 Subpart C Section 15.247(b)(4)&TCB Exclusion List (7 July 2002)	ANSI C63.10-2013	PASS
Antenna Requirement	47 CFR Part 15 Subpart C Section 15.203/15.247 (c)	ANSI C63.10-2013	PASS
RF Exposure Evaluation	47 CFR Part 15 Subpart C Section 15.247 (i)/1.1310/2.1093	KDB447498D01v06	PASS

Remark:

Test according to ANSI C63.4-2014 & ANSI C63.10-2013.

3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=2$.

Item	Uncertainty
Occupancy bandwidth	54.3kHz
Conducted output power Above 1G	0.9dB
Conducted output power below 1G	0.9dB
Power Spectral Density , Conduction	0.9dB
Conduction spurious emissions	2.0dB
Out of band emission	2.0dB
3m camber Radiated spurious emission(30MHz-1GHz)	4.6dB
3m chamber Radiated spurious emission(1GHz-18GHz)	5.1dB
3m chamber Radiated spurious emission(18GHz-40GHz)	3.4dB
humidity uncertainty	5.5%
Temperature uncertainty	0.63℃
frequency	1×10^{-7}
Conducted Emission (150KHz-30MHz)	3.2 dB
Radiated Emission(30MHz ~ 1000MHz)	4.8 dB
Radiated Emission(1GHz ~6GHz)	4.9 dB

4. PRODUCT INFORMATION AND TEST SETUP

4.1 Product Information

Model(s):	M8, M3, M5, M6, M7, M9, M9X, M10, M11, M12, M13, M15, M7E, M72C, A3, A3Pro, i12, i25, i27, i3Pro, A6, A7, A8, A9, A10, A11, A13, A15, B10, X3, X5, X7, X11, X13, X15, XY-5, XY-7, TW40, TW70, TW80, TW11, TW12, SP6, SP6 Pro, SP7, SP8, SP9, SP10, SP11
Model Description:	All model's the function, software and electric circuit are the same, only with the product model named different. Test sample model: M8
Bluetooth Version:	Bluetooth 5.0+BR+EDR+BLE
Hardware Version:	V1.1
Software Version:	V1.0
Operation Frequency:	Bluetooth: 2402-2480MHz
Max. RF output power:	Bluetooth: 6.768dBm
Type of Modulation:	Bluetooth: GFSK, $\pi/4$ DQPSK
Antenna installation:	Bluetooth: PCB antenna
Antenna Gain:	Bluetooth: -0.58dBi
Ratings:	Battery DC 3.7V 80mAh

4.2 Test Setup Configuration

See test photographs attached in EUT TEST SETUP PHOTOGRAPHS for the actual connections between Product and support equipment.

4.3 Support Equipment

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Note
1	Laptop	DELL	Inspiron5570	JR4G1A00DPC	AE
2	AC Adaptor	DELL	HA45NM140	CN-00285K-CH200-88V-OEYC-A06	AE
3	Adapter	Green cheung	LX1A	Input:100-240V, 50/60Hz, 1.5A Output: 5V 1A	AE

Notes:

1. All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.
2. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.

4.4 Channel List

CH	Frequency (MHz)	CH	Frequency (MHz)	CH	Frequency (MHz)	CH	Frequency (MHz)
0	2402	1	2403	2	2404	3	2405
4	2406	5	2407	6	2408	7	2409
8	2410	9	2411	10	2412	11	2413
12	2414	13	2415	14	2416	15	2417
16	2418	17	2419	18	2420	19	2421
20	2422	21	2423	22	2424	23	2425
24	2426	25	2427	26	2428	27	2429
28	2430	29	2431	30	2432	31	2433
32	2434	33	2435	34	2436	35	2437
36	2438	37	2439	38	2440	39	2441
40	2442	41	2443	42	2444	43	2445
44	2446	45	2447	46	2448	47	2449
48	2450	49	2451	50	2452	51	2453
52	2454	53	2455	54	2456	55	2457
56	2458	57	2459	58	2460	59	2461
60	2462	61	2463	62	2464	63	2465
64	2466	65	2467	66	2468	67	2469
68	2470	69	2471	70	2472	71	2473
72	2474	73	2475	74	2476	75	2477
76	2478	77	2479	78	2480	79	/

4.5 Test Mode

All test mode(s) and condition(s) mentioned were considered and evaluated respectively by performing full tests, the worst data were recorded and reported.

Test mode	Low channel	Middle channel	High channel
Transmitting (GFSK/π/4DQPSK)	2402MHz	2441MHz	2480MHz
Receiving (GFSK/π/4DQPSK)	2402MHz	2441MHz	2480MHz

4.6 Test Environment

Humidity(%):	55
Atmospheric Pressure(kPa):	101.1
Normal Voltage(DC):	3.7V
Normal Temperature(°C)	25
Low Temperature(°C)	0
High Temperature(°C)	40

5. TEST FACILITY AND TEST INSTRUMENT USED

5.1 Test Facility

All measurement facilities used to collect the measurement data are located at Floor 1&2, Building A, No. 26 of Xinhe Road, Xinqiao Street, Baoan District, Shenzhen China. The site and apparatus are constructed in conformance with the requirements of ANSI C63.4 and CISPR 16-1-1 other equivalent standards.

5.2 Test Instrument Used

Item	Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until
1	Spectrum Analyzer	Agilent	N9020A	MY52090073	Oct. 17, 2019	Oct. 16, 2020
2	Power Sensor	Agilent	U2021XA	MY56120032	Nov. 02, 2019	Nov. 01, 2020
3	Power Sensor	Agilent	U2021XA	MY56120034	Nov. 02, 2019	Nov. 01, 2020
4	Communication test set	R&S	CMW500	118735	Nov. 02, 2019	Nov. 01, 2020
5	Spectrum Analyzer	R&S	FSP40	100550	Nov. 02, 2019	Nov. 01, 2020
6	Signal Generator	Agilent	N5181A	MY49060920	Nov. 03, 2019	Nov. 02, 2020
7	Signal Generator	Agilent	N5182A	MY47420195	Nov. 03, 2019	Nov. 02, 2020
8	Communication test set	R&S	CMU200	119978	Nov. 02, 2019	Nov. 01, 2020
9	band rejection filter	Shenxiang	MSF2400-24 83.5MS-1154	20181015001	Nov. 02, 2019	Nov. 01, 2020
10	band rejection filter	Shenxiang	MSF5150-58 50MS-1155	20181015001	Nov. 02, 2019	Nov. 01, 2020
11	band rejection filter	Xingbo	XBLBQ-DZA 120	190821-1-1	Nov. 02, 2019	Nov. 01, 2020
12	BT&WI-FI Automatic test software	Microwave	MTS8310	Ver. 2.0.0.0	\	\
13	Rohde & Schwarz SFU Broadcast Test System	R&S	SFU	101017	Nov. 02, 2019	Nov. 01, 2020
14	Temperature humidity chamber	Hongjing	TH-80CH	DG-15174	Nov. 02, 2019	Nov. 01, 2020
15	234G Automatic test software	Microwave	MTS8200	Ver. 2.0.0.0	\	\
16	966 chamber	C.R.T.	966 Room	966	Nov. 10, 2019	Nov. 09, 2020

17	Receiver	R&S	ESPI	100362	Nov. 02, 2019	Nov. 01, 2020
18	Amplifier	HP	8447E	2945A02747	Nov. 03, 2019	Nov. 02, 2020
19	Amplifier	Agilent	8449B	3008A01838	Nov. 03, 2019	Nov. 02, 2020
20	TRILOG Broadband Antenna	Schwarzbeck	VULB 9163	869	Nov. 02, 2019	Nov. 01, 2020
21	Horn Antenna	Schwarzbeck	BBHA9120D	1911	Nov. 02, 2019	Nov. 01, 2020
22	Software	Fala	EZ-EMC	FA-03A2 RE	\	\
23	3-Loop Antenna	Daze	ZN30401	17014	Nov. 02, 2019	Nov. 01, 2020
24	loop antenna	ZHINAN	ZN30900A	/	Nov. 02, 2019	Nov. 01, 2020
25	Horn antenna	A/H/System	SAS-574	588	Nov. 02, 2019	Nov. 01, 2020
26	Amplifier	AEROFLEX	/	S/N/ 097	Nov. 02, 2019	Nov. 01, 2020

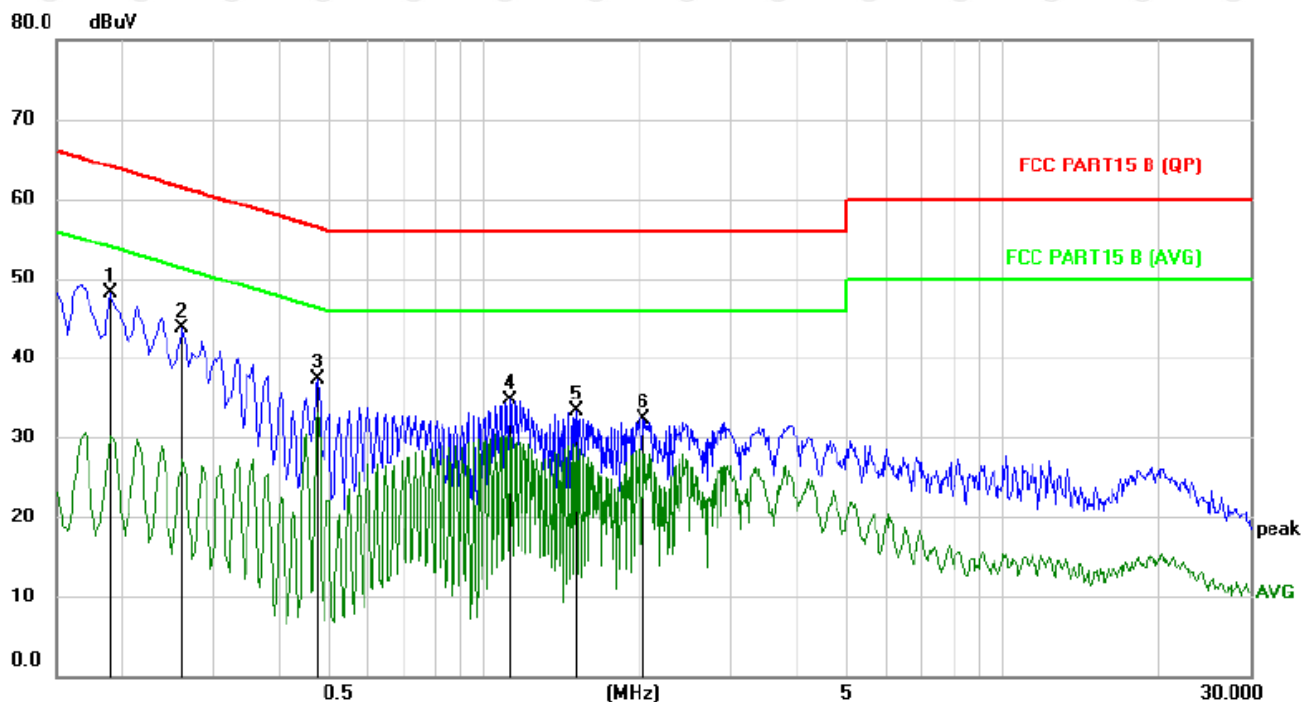
Conducted emissions Test						
27	Equipment	Manufacturer	Model#	Serial#	Last Cal.	Next Cal.
28	AMN	ROHDE&SC HWAZ	ESH3-Z5	831551852	Nov. 02, 2019	Nov. 01, 2020
29	Pulse limiter	ROHDE&SC HWAZ	ESH3Z2	357881052	Nov. 02, 2019	Nov. 01, 2020
30	EMI TEST RECEIVER	ROHDE&SC HWAZ	ESCS30	834115/006	Nov. 02, 2019	Nov. 01, 2020
31	Coaxial cable	ZDECL	Z302S	18091904	Nov. 02, 2019	Nov. 01, 2020
32	ISN	TESEQ	NTFM8158	NTFM8158# 183	Nov. 02, 2019	Nov. 01, 2020
33	EMI TEST RECEIVER	ROHDE&SC HWAZ	ESCI	10428	Nov. 02, 2019	Nov. 01, 2020
34	Software	Fala	EZ-EMC	EMC-CON 3A1.1	\	\

between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0,8 m from the LISN 2.

- 5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10 on conducted measurement.
- 6) All modes were tested at AC 120V and 240V, only the worst result of AC 120V 60Hz was reported.
- 7) If a EUT received DC power from the USB Port of Notebook PC, the PC's adapter received AC120V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.

6.4 Test Result

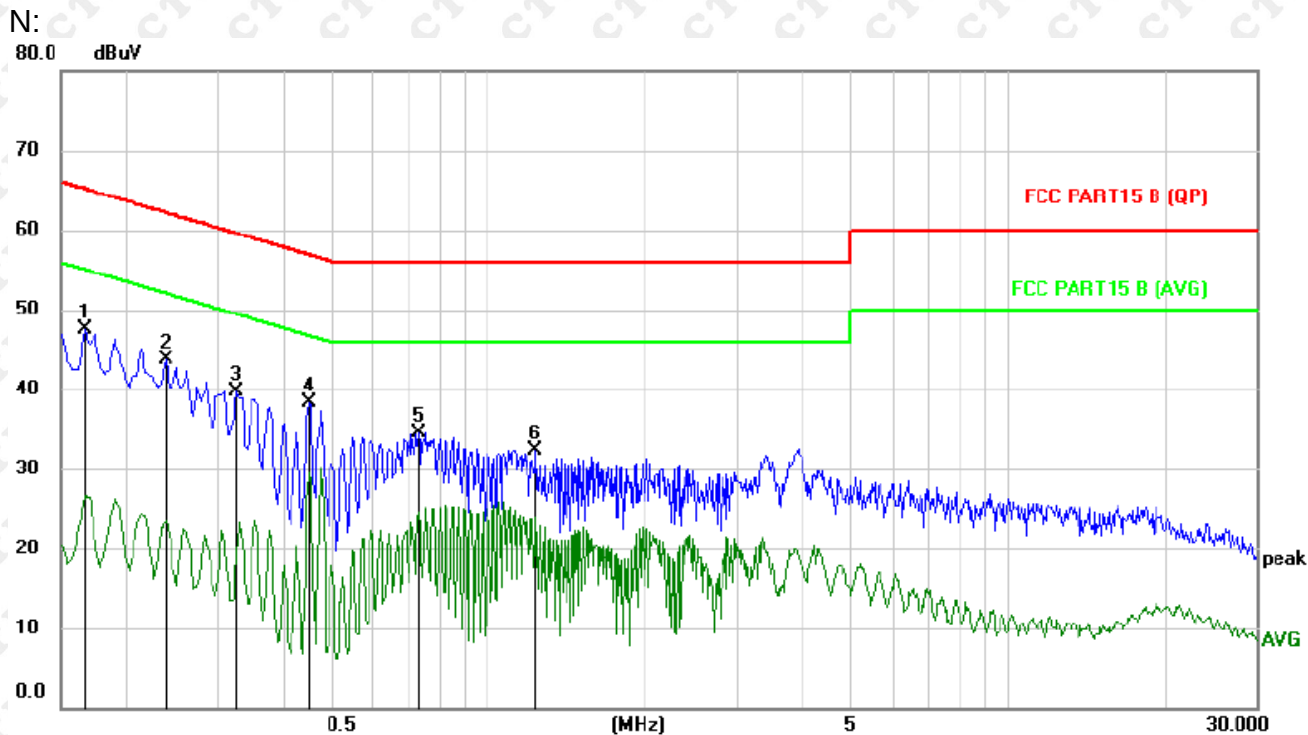
L:



No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1	*	0.1900	37.91	10.22	48.13	64.04	-15.91	peak	
2		0.2620	33.51	10.18	43.69	61.37	-17.68	peak	
3		0.4780	27.31	10.06	37.37	56.37	-19.00	peak	
4		1.1220	24.42	10.23	34.65	56.00	-21.35	peak	
5		1.5060	23.02	10.23	33.25	56.00	-22.75	peak	
6		2.0300	22.03	10.23	32.26	56.00	-23.74	peak	

Remark:

Factor = Cable loss + LISN factor, Margin = Measurement – Limit



No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Margin dB	Detector	Comment
1	*	0.1660	37.44	10.09	47.53	65.16	-17.63	peak	
2		0.2380	33.66	10.13	43.79	62.17	-18.38	peak	
3		0.3260	29.45	10.16	39.61	59.55	-19.94	peak	
4		0.4500	28.15	10.22	38.37	56.88	-18.51	peak	
5		0.7340	24.36	10.23	34.59	56.00	-21.41	peak	
6		1.2300	22.19	10.15	32.34	56.00	-23.66	peak	

Remark:

Factor = Cable loss + LISN factor, Margin = Measurement – Limit

7. RADIATED SPURIOUS EMISSION

7.1 Block Diagram Of Test Setup

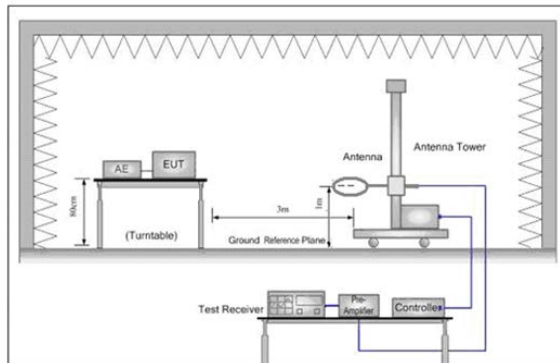


Figure 1. Below 30MHz

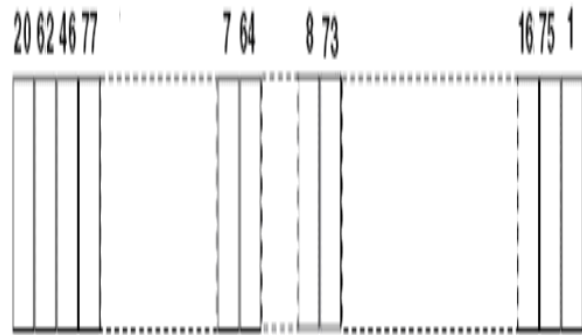


Figure 2. 30MHz to 1GHz

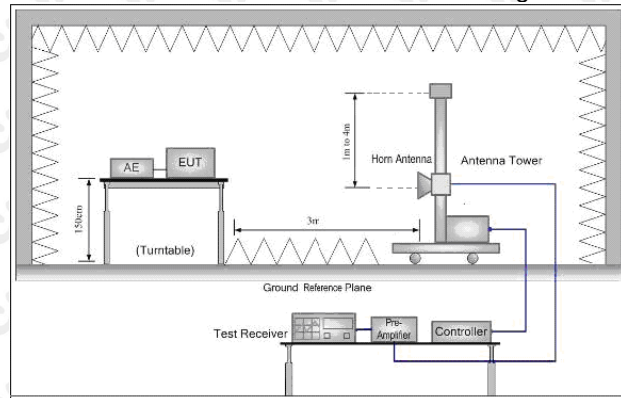


Figure 3. Above 1GHz

7.2 Limit

Spurious Emissions:

Frequency	Field strength (microvolt/meter)	Limit (dBμV/m)	Remark	Measurement distance (m)
0.009MHz-0.490MHz	2400/F (kHz)	-	-	300
0.490MHz-1.705MHz	24000/F (kHz)	-	-	30
1.705MHz-30MHz	30	-	-	30
30MHz-88MHz	100	40.0	Quasi-peak	3
88MHz-216MHz	150	43.5	Quasi-peak	3
216MHz-960MHz	200	46.0	Quasi-peak	3
960MHz-1GHz	500	54.0	Quasi-peak	3
Above 1GHz	500	54.0	Average	3

Note: 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.

7.3 Test procedure

Below 1GHz test procedure as below:

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rota table table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

Above 1GHz test procedure as below:

- g. Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber and change form table 0.8 meter to 1.5 meter(Above 18GHz the distance is 1 meter and table is 1.5 meter).
- h. Test the EUT in the lowest channel ,the middle channel ,the Highest channel
- j. Repeat above procedures until all frequencies measured was complete.
- j. Full battery is used during test

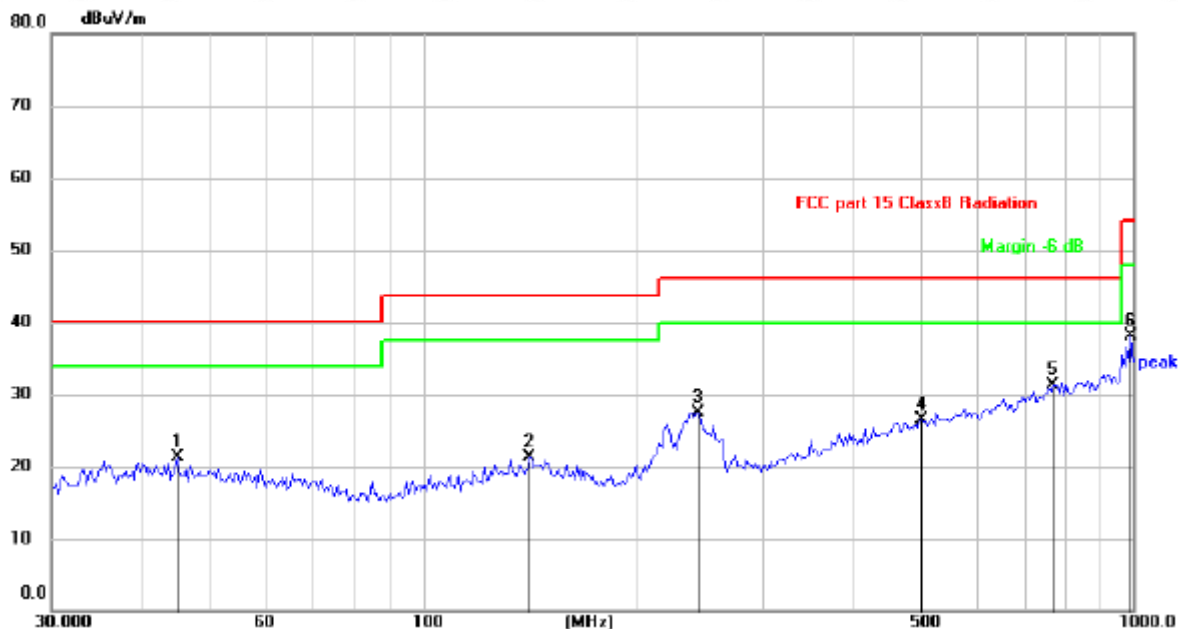
Receiver set:

Frequency	Detector	RBW	VBW	Remark
0.009MHz-0.090MHz	Peak	10kHz	30KHz	Peak
0.009MHz-0.090MHz	Average	10kHz	30KHz	Average
0.090MHz-0.110MHz	Quasi-peak	10kHz	30KHz	Quasi-peak
0.110MHz-0.490MHz	Peak	10kHz	30KHz	Peak
0.110MHz-0.490MHz	Average	10kHz	30KHz	Average
0.490MHz -30MHz	Quasi-peak	10kHz	30KHz	Quasi-peak
30MHz-1GHz	Quasi-peak	120 kHz	300KHz	Quasi-peak
Above 1GHz	Peak	1MHz	3MHz	Peak
	Peak	1MHz	10Hz	Average

7.4 Test Result

Below 1GHz Test Results:

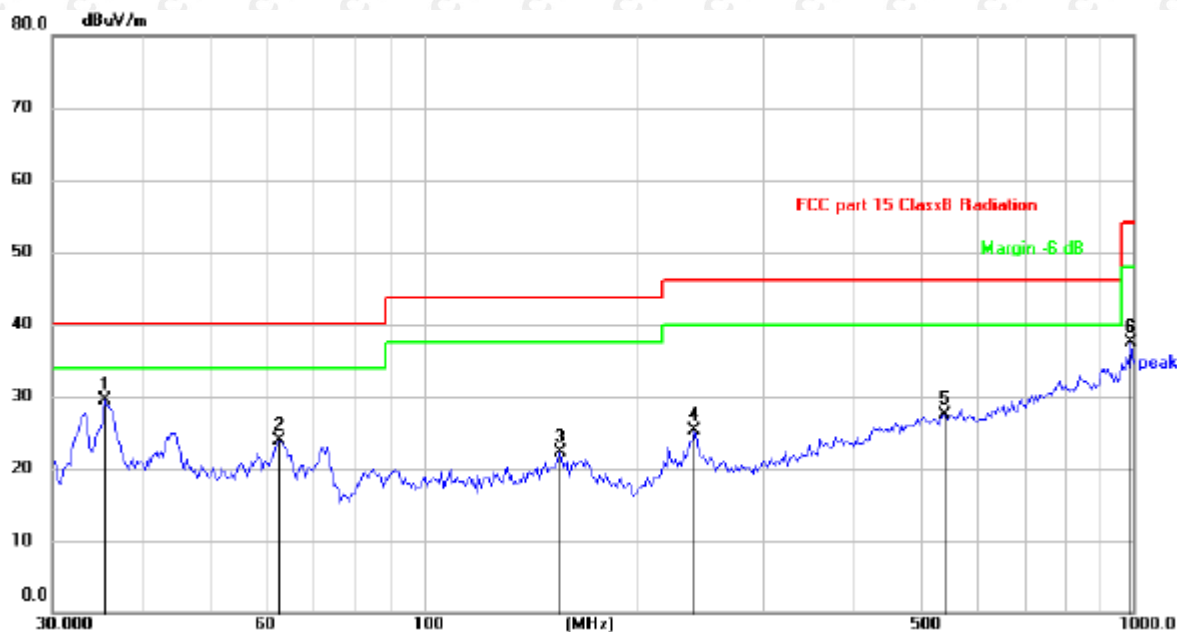
Antenna polarity: H



No.	Mk.	Freq. MHz	Reading Level dBuV/m	Correct Factor dB/m	Measure- ment dBuV/m	Limit dB/m	Margin dB	Detector	Comment
1		45.0583	27.09	-5.78	21.31	40.00	-18.69	peak	
2		141.3296	27.85	-6.47	21.38	43.50	-22.12	peak	
3		244.2321	34.22	-6.76	27.46	46.00	-18.54	peak	
4		502.9395	26.24	0.17	26.41	46.00	-19.59	peak	
5	*	771.4485	25.93	5.28	31.21	46.00	-14.79	peak	
6		993.0114	30.04	8.03	38.07	54.00	-15.93	peak	

Remark: Factor = Cable lose + Antenna factor - Pre-amplifier; Margin = Measurement - Limit

Antenna polarity: V



No.	Mk.	Freq. MHz	Reading Level dBuV/m	Correct Factor dB/m	Measure- ment dBuV/m	Limit dB/m	Margin dB	Detector	Comment
1	*	35.4992	36.04	-6.60	29.44	40.00	-10.56	peak	
2		62.6505	31.21	-7.28	23.93	40.00	-16.07	peak	
3		155.9100	28.63	-6.27	22.36	43.50	-21.14	peak	
4		240.8302	31.99	-6.69	25.30	46.00	-20.70	peak	
5		543.2741	26.65	0.83	27.48	46.00	-18.52	peak	
6		993.0113	29.50	8.03	37.53	54.00	-16.47	peak	

Remark: Factor = Cable lose + Antenna factor - Pre-amplifier; Margin = Measurement- Limit

Above 1 GHz Test Results:

CH Low (2402MHz)

Horizontal:

Frequency	Reading Result	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
4804	57.83	-3.65	54.18	74.00	-19.82	peak
4804	50.93	-3.65	47.28	54.00	-6.72	AVG
7206	58.81	-0.95	57.86	74.00	-16.14	peak
7206	40.56	-0.95	39.61	54.00	-14.39	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits						

Vertical:

Frequency	Reading Result	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
4804	58.33	-3.65	54.68	74.00	-19.32	peak
4804	49.18	-3.65	45.53	54.00	-8.47	AVG
7206	59.73	-0.95	58.78	74.00	-15.22	peak
7206	42.76	-0.95	41.81	54.00	-12.19	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits						

CH Middle (2441MHz)
Horizontal:

Frequency	Reading Result	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
4882.00	60.36	-3.54	56.82	74.00	-17.18	peak
4882.00	47.07	-3.54	43.53	54.00	-10.47	AVG
7323.00	56.61	-0.81	55.80	74.00	-18.20	peak
7323.00	41.58	-0.81	40.77	54.00	-13.23	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

Vertical:

Frequency	Reading Result	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
4882.00	58.21	-3.54	54.67	74.00	-19.33	peak
4882.00	48.81	-3.54	45.27	54.00	-8.73	AVG
7323.00	57.63	-0.81	56.82	74.00	-17.18	peak
7323.00	43.76	-0.81	42.95	54.00	-11.05	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

CH High (2480MHz)

Horizontal:

Frequency	Reading Result	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
4960	58.40	-3.43	54.97	74.00	-19.03	peak
4960	47.60	-3.44	44.16	54.00	-9.84	AVG
7440	59.06	-0.77	58.29	74.00	-15.71	peak
7440	39.83	-0.77	39.06	54.00	-14.94	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits						

Vertical:

Frequency	Reading Result	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
4960	58.64	-3.43	55.21	74.00	-18.79	peak
4960	48.69	-3.44	45.25	54.00	-8.75	AVG
7440	60.75	-0.77	59.98	74.00	-14.02	peak
7440	40.38	-0.77	39.61	54.00	-14.39	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits						

Remark:

- (1) Measuring frequencies from 1 GHz to the 25 GHz.
- (2) All modes of GFSK, $\pi/4$ DQPSK, were test at Low, Middle, and High channel, only the worst result of GFSK DH5 Low Channel was reported for below 1GHz test.
- (3) For BT above 1GHz test all modes of GFSK, $\pi/4$ DQPSK were test at Low, Middle, and High channel, only the worst result of GFSK DH5 was reported.
- (4) By preliminary testing and verifying three axis (X, Y and Z) position of EUT transmitted status, it was found that "Z axis" position was the worst, and test data recorded in this report.
- (5) Radiated emission test from 9kHz to 10th harmonic of fundamental was verified, and no emission found except system noise floor in 9kHz to 30MHz and not recorded in this report.

Restricted bands around fundamental frequency (Radiated)

hopping

Operation Mode: TX CH Low (2402MHz)

Horizontal (Worst case)

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
2310.00	57.48	-5.81	51.67	74.00	-22.33	peak
2310.00	/	-5.81	/	54.00	/	AVG
2390.00	55.43	-5.84	49.59	74.00	-24.41	peak
2390.00	/	-5.84	/	54.00	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
2310.00	56.35	-5.81	50.54	74.00	-23.46	peak
2310.00	/	-5.81	/	54.00	/	AVG
2390.00	56.63	-5.84	50.79	74.00	-23.21	peak
2390.00	/	-5.84	/	54.00	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Operation Mode: TX CH High (2480MHz)
Horizontal (Worst case)

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
2483.50	55.36	-5.81	49.55	74.00	-24.45	peak
2483.50	/	-5.81	/	54.00	/	AVG
2500.00	53.19	-6.06	47.13	74.00	-26.87	peak
2500.00	/	-6.06	/	54.00	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
2483.50	56.62	-5.81	50.81	74.00	-23.19	peak
2483.50	/	-5.81	/	54.00	/	AVG
2500.00	54.59	-6.06	48.53	74.00	-25.47	peak
2500.00	/	-6.06	/	54.00	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						
Remark: All the other emissions not reported were too low to read and deemed to comply with FCC limit.						

NO hopping

Operation Mode: TX CH Low (2402MHz)

Horizontal (Worst case)

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
2310.00	56.63	-5.81	50.82	74.00	-23.18	peak
2310.00	/	-5.81	/	54.00	/	AVG
2390.00	53.62	-5.84	47.78	74.00	-26.22	peak
2390.00	/	-5.84	/	54.00	/	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.

Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
2310.00	54.26	-5.81	48.45	74.00	-25.55	peak
2310.00	/	-5.81	/	54.00	/	AVG
2390.00	52.75	-5.84	46.91	74.00	-27.09	peak
2390.00	/	-5.84	/	54.00	/	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.

Operation Mode: TX CH High (2480MHz)
Horizontal (Worst case)

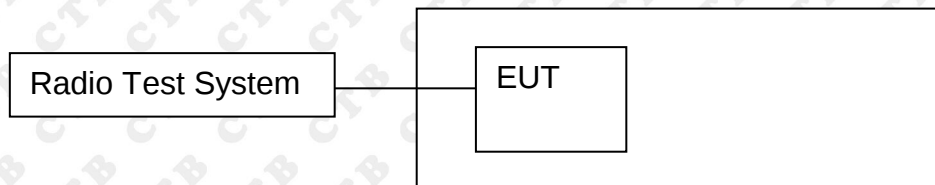
Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
2483.50	57.41	-5.81	51.60	74.00	-22.40	peak
2483.50	/	-5.81	/	54.00	/	AVG
2500.00	56.82	-6.06	50.76	74.00	-23.24	peak
2500.00	/	-6.06	/	54.00	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
2483.50	56.26	-5.81	50.45	74.00	-23.55	peak
2483.50	/	-5.81	/	54.00	/	AVG
2500.00	53.49	-6.06	47.43	74.00	-26.57	peak
2500.00	/	-6.06	/	54.00	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						
Remark: All the other emissions not reported were too low to read and deemed to comply with FCC limit.						

8. BAND EDGE AND RF CONDUCTED SPURIOUS EMISSIONS

8.1 Block Diagram Of Test Setup



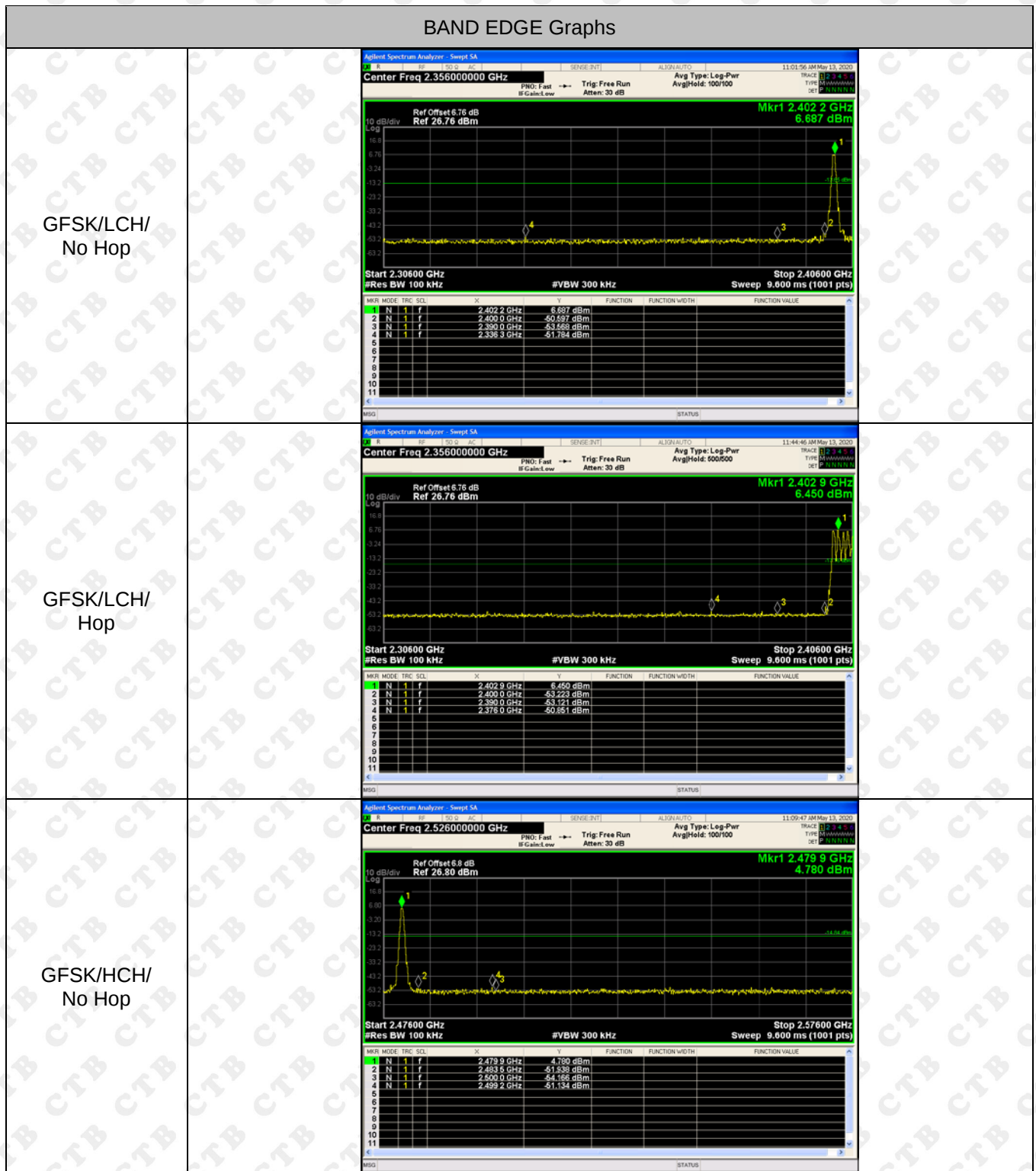
8.2 Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

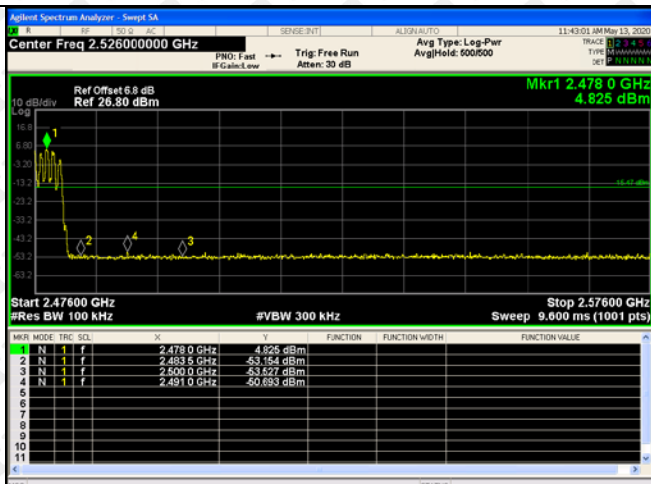
8.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer:
Below 30MHz:
RBW = 100kHz, VBW = 300kHz, Sweep = auto
Detector function = peak, Trace = max hold
Above 30MHz:
RBW = 100KHz, VBW = 300KHz, Sweep = auto
Detector function = peak, Trace = max hold

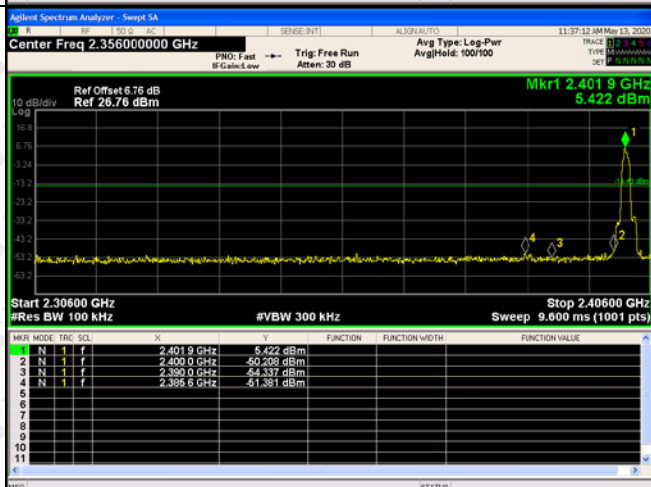
8.4 Test Result



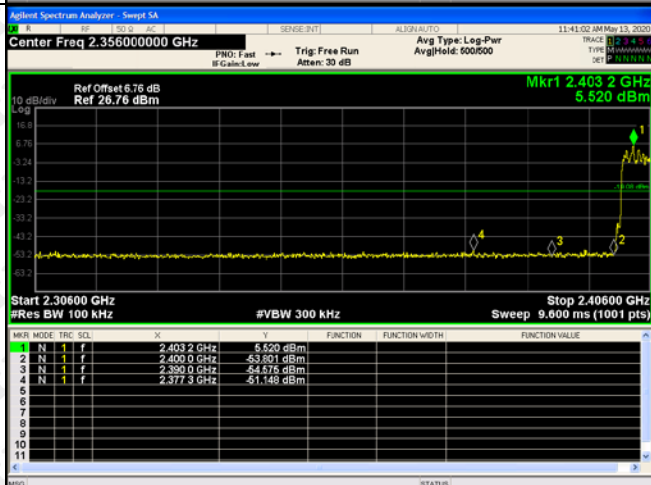
GFSK/HCH/
Hop

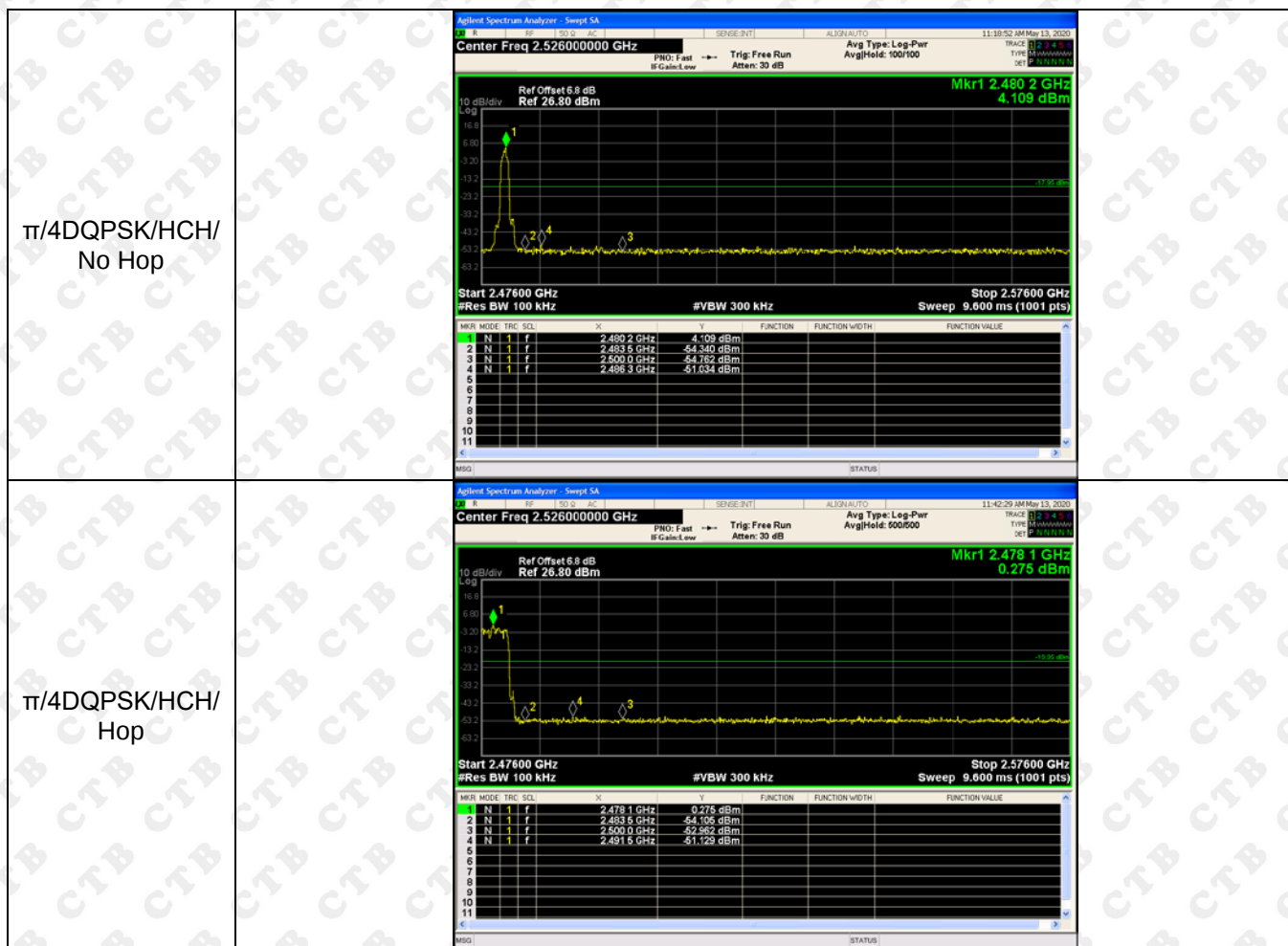


$\pi/4$ DQPSK/LCH/
No Hop



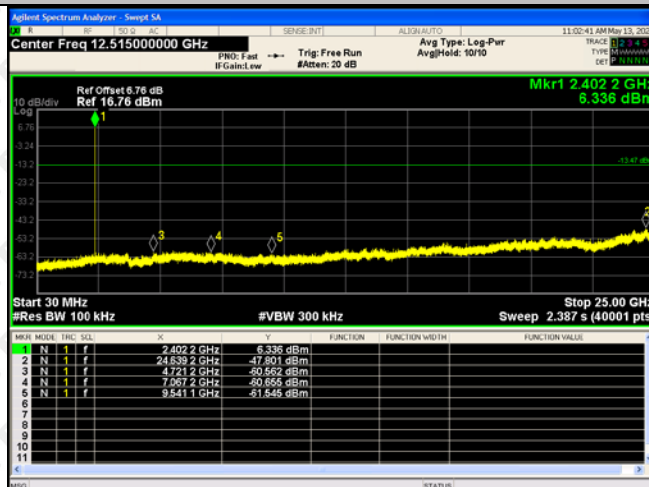
$\pi/4$ DQPSK/LCH/
Hop



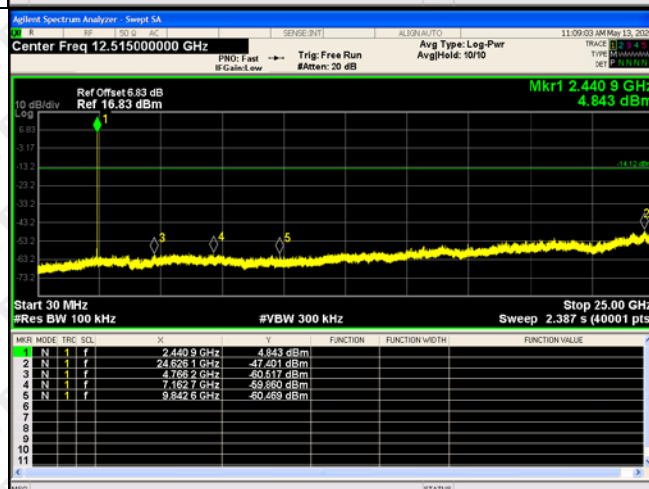


RF Conducted Spurious Emissions Graphs

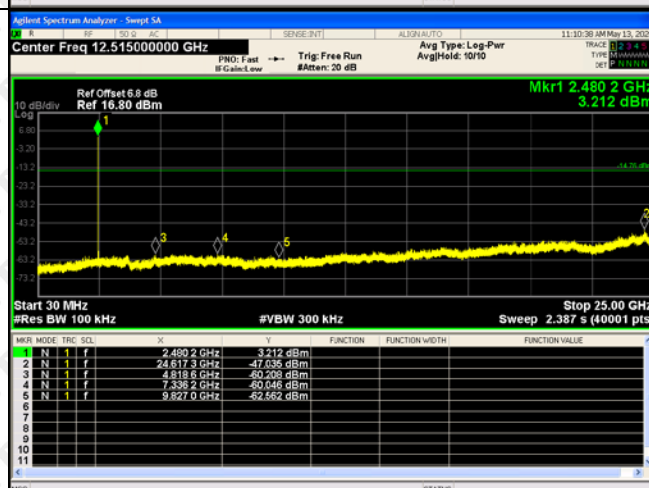
GFSK/LCH

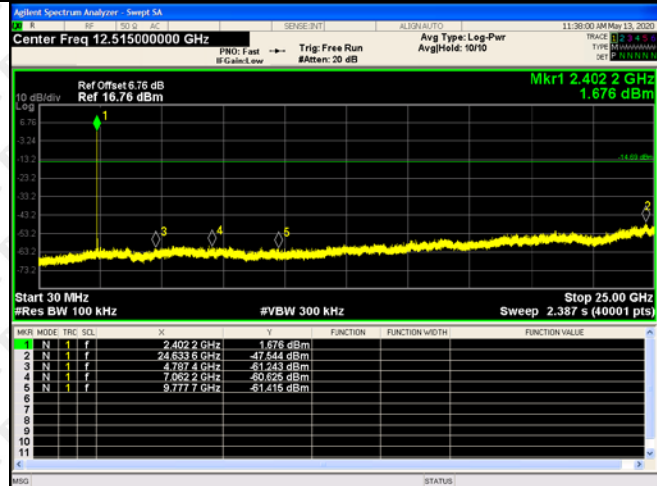
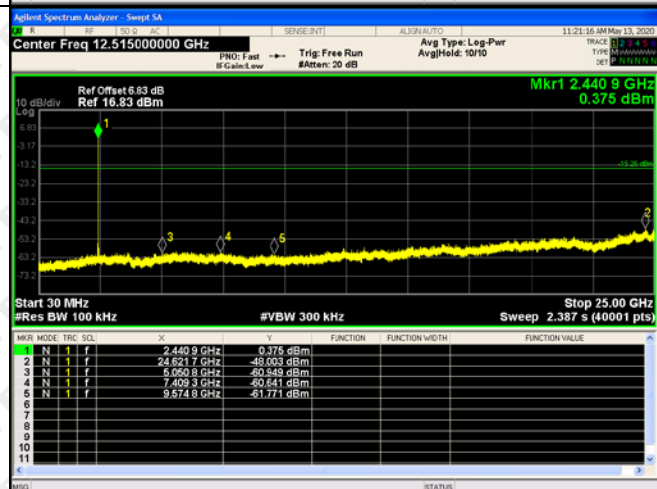
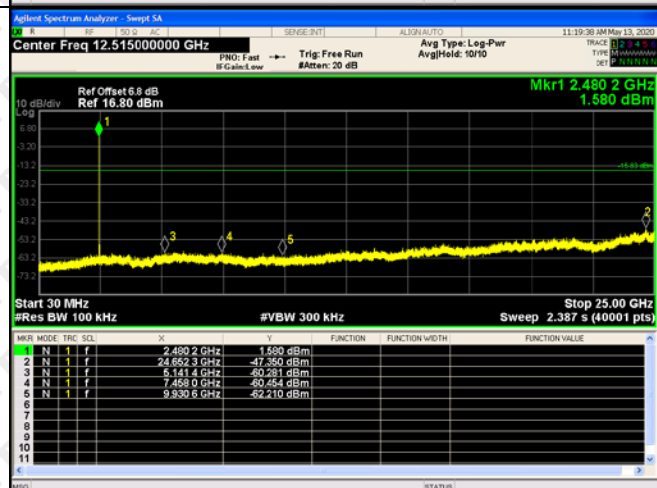


GFSK/MCH



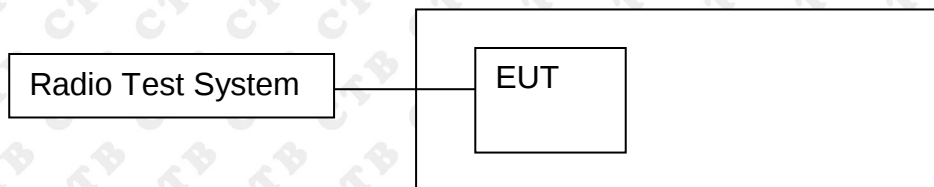
GFSK/HCH



$\pi/4$ DQPSK /LCH

 $\pi/4$ DQPSK/MCH

 $\pi/4$ DQPSK/HCH


9. COUDUCTED PEAK OUTPUT POWER

9.1 Block Diagram Of Test Setup



9.2 Limit

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

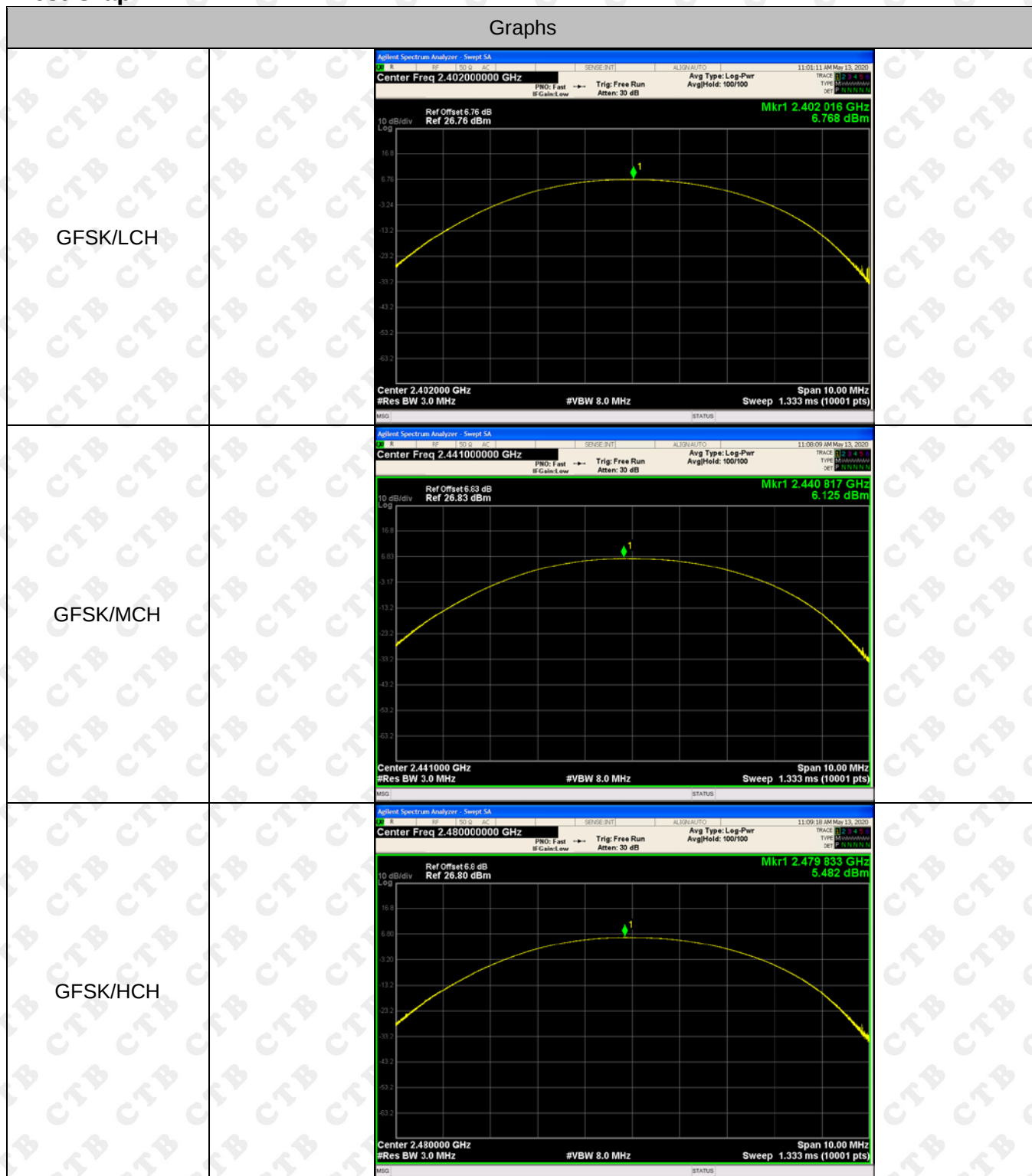
9.3 Test procedure

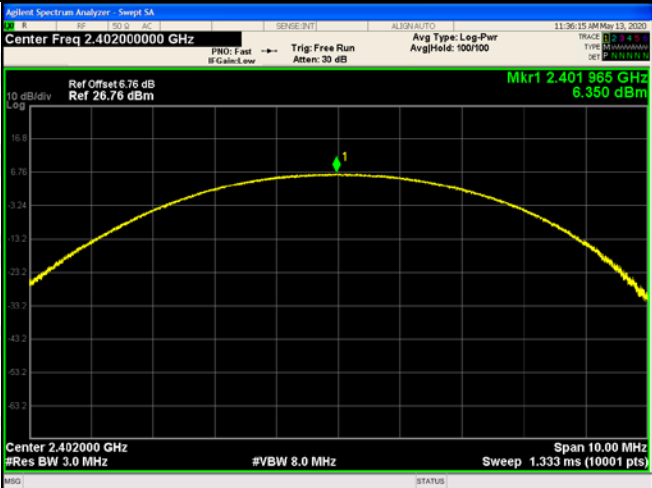
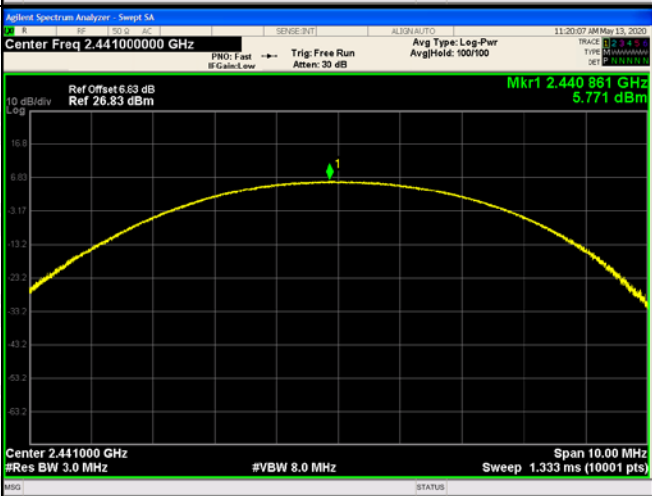
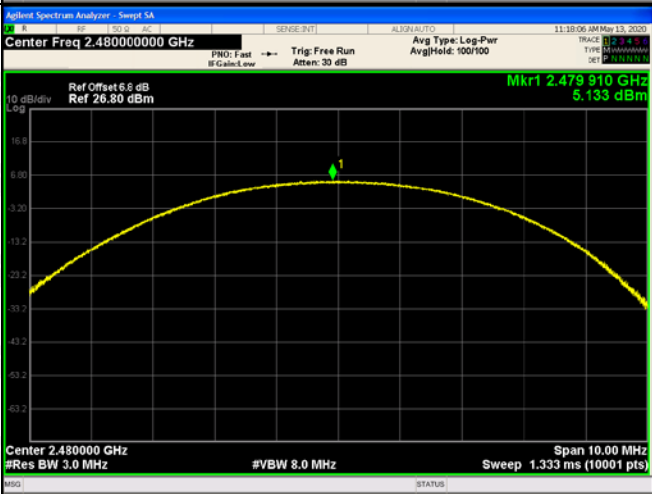
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 3MHz. VBW = 3MHz. Sweep = auto; Detector Function = Peak.
3. Keep the EUT in transmitting at lowest, middle and highest channel individually. Record the max value.

9.4 Test Result

Mode	Channel.	Maximum Peak Output Power [dBm]	Verdict
BDR mode (GFSK)	LCH	6.768	PASS
	MCH	6.125	PASS
	HCH	5.482	PASS
EDR mode ($\pi/4$ DQPSK)	LCH	6.350	PASS
	MCH	5.771	PASS
	HCH	5.133	PASS

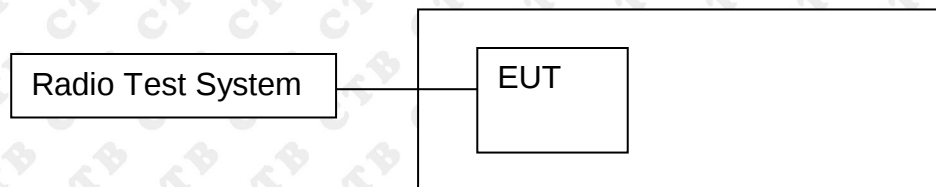
Test Graph:



$\pi/4$ DQPSK/LCH	 Agilent Spectrum Analyzer - Sweep SA Center Freq 2.40200000 GHz Ref Offset 6.76 dB Ref 26.76 dBm Mkr1 2.401 985 GHz 6.350 dBm Center 2.402000 GHz #Res BW 3.0 MHz #VBW 8.0 MHz Sweep 1.333 ms (10001 pts)
$\pi/4$ DQPSK/MCH	 Agilent Spectrum Analyzer - Sweep SA Center Freq 2.44100000 GHz Ref Offset 6.83 dB Ref 26.83 dBm Mkr1 2.440 861 GHz 5.771 dBm Center 2.441000 GHz #Res BW 3.0 MHz #VBW 8.0 MHz Sweep 1.333 ms (10001 pts)
$\pi/4$ DQPSK/HCH	 Agilent Spectrum Analyzer - Sweep SA Center Freq 2.48000000 GHz Ref Offset 6.8 dB Ref 26.80 dBm Mkr1 2.479 910 GHz 5.133 dBm Center 2.480000 GHz #Res BW 3.0 MHz #VBW 8.0 MHz Sweep 1.333 ms (10001 pts)

10. 20DB OCCUPIED BANDWIDTH

10.1 Block Diagram Of Test Setup



10.2 Limit

Alternatively, frequency hopping systems operating in the 2400-2483.5MHz band may have hopping channel carrier frequencies that are separated by 25kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125mw.

10.3 Test procedure

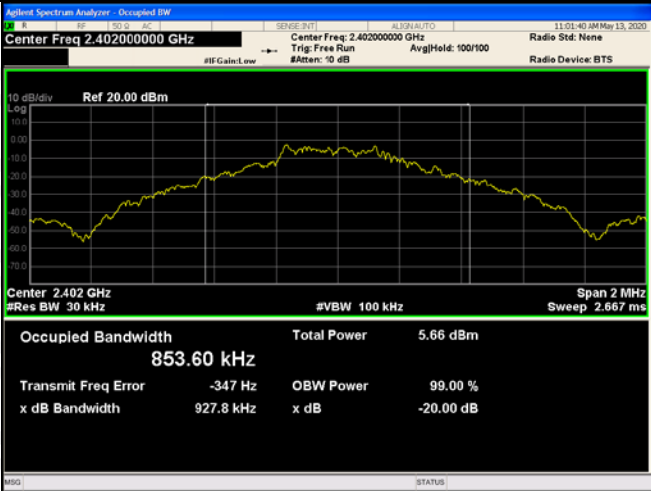
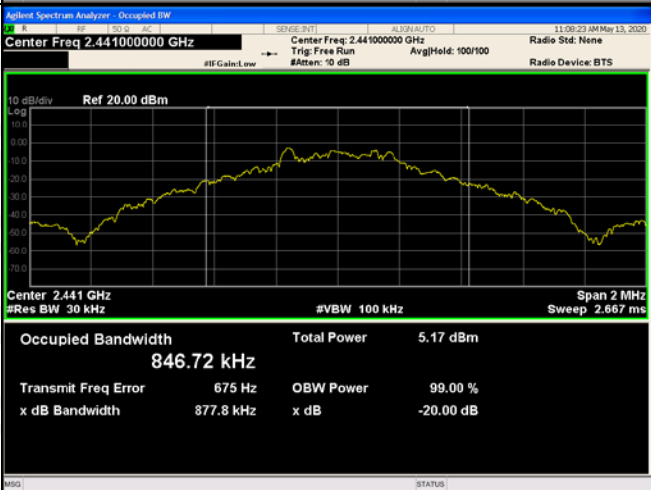
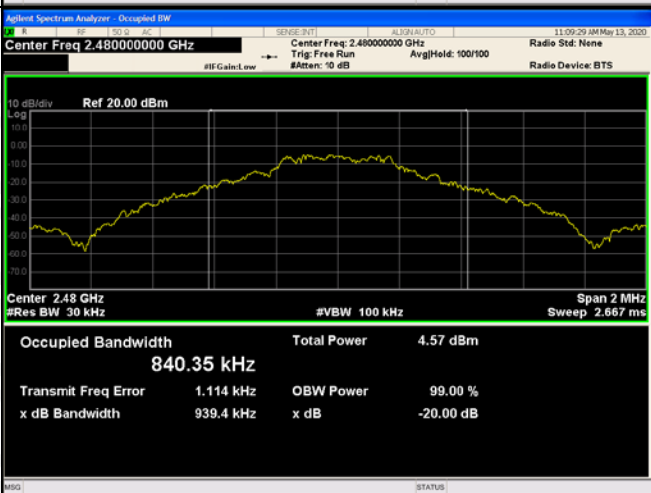
1. Rem1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

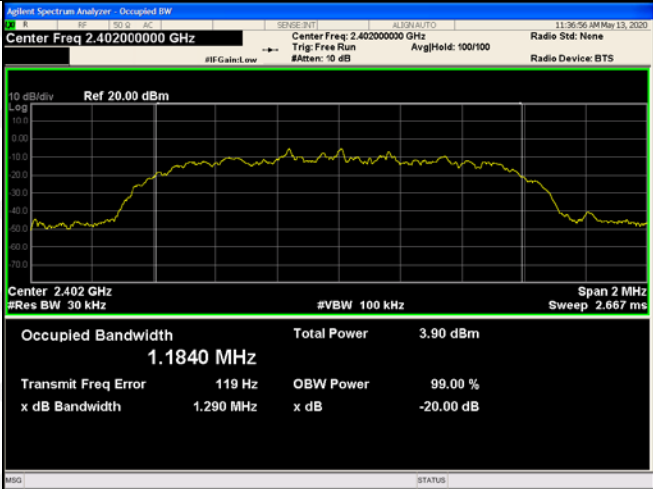
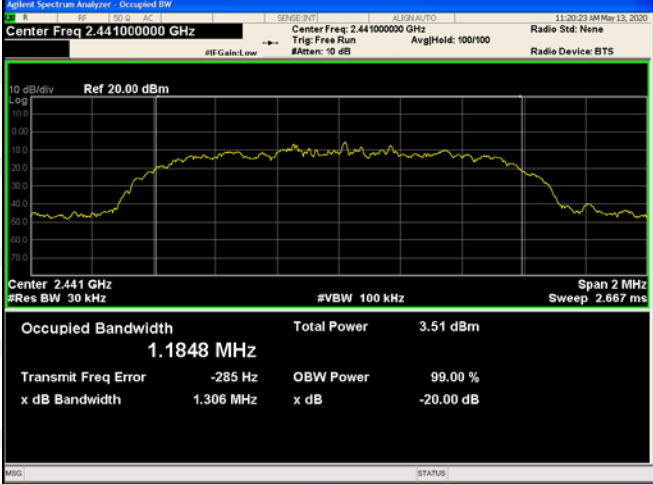
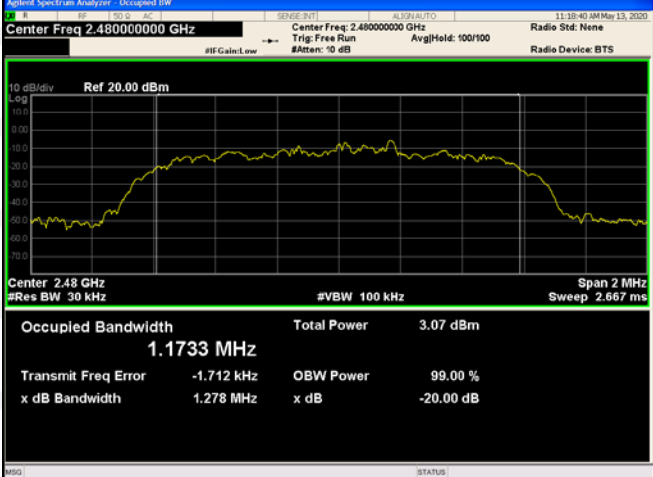
10.4 Test Result

Test Mode	Frequency	20dB Bandwidth (MHz)	Result
GFSK	Low channel	0.9278	PASS
	Mid channel	0.8778	PASS
	High channel	0.9394	PASS
$\pi/4$ DQPSK	Low channel	1.2896	PASS
	Mid channel	1.3056	PASS
	High channel	1.2779	PASS

Note: All modes of operation were Pre-scan and the worst-case emissions are reported.

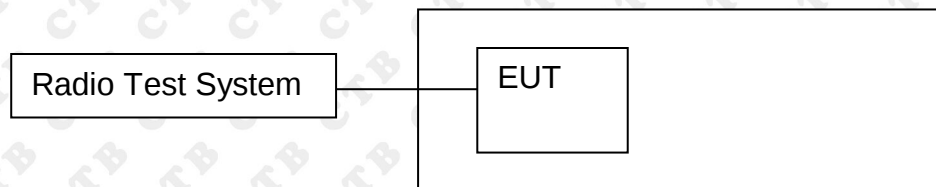
Test Graph:

GFSK Low channel	 Agilent Spectrum Analyzer - Occupied BW Center Freq 2.40200000 GHz Center Freq: 2.40200000 GHz Trig: Free Run #Att: 10 dB AvgHold: 100/100 Radio Std: Nene Radio Device: BTS 10 dB/div Ref 20.00 dBm Center 2.402 GHz #Res BW 30 kHz #VBW 100 kHz Span 2 MHz Sweep 2.667 ms Occupied Bandwidth 853.60 kHz Total Power 5.66 dBm Transmit Freq Error -347 Hz OBW Power 99.00 % x dB Bandwidth 927.8 kHz x dB -20.00 dB
GFSK Mid channel	 Agilent Spectrum Analyzer - Occupied BW Center Freq 2.44100000 GHz Center Freq: 2.44100000 GHz Trig: Free Run #Att: 10 dB AvgHold: 100/100 Radio Std: Nene Radio Device: BTS 10 dB/div Ref 20.00 dBm Center 2.441 GHz #Res BW 30 kHz #VBW 100 kHz Span 2 MHz Sweep 2.667 ms Occupied Bandwidth 846.72 kHz Total Power 5.17 dBm Transmit Freq Error 675 Hz OBW Power 99.00 % x dB Bandwidth 877.8 kHz x dB -20.00 dB
GFSK High channel	 Agilent Spectrum Analyzer - Occupied BW Center Freq 2.48000000 GHz Center Freq: 2.48000000 GHz Trig: Free Run #Att: 10 dB AvgHold: 100/100 Radio Std: Nene Radio Device: BTS 10 dB/div Ref 20.00 dBm Center 2.48 GHz #Res BW 30 kHz #VBW 100 kHz Span 2 MHz Sweep 2.667 ms Occupied Bandwidth 840.35 kHz Total Power 4.57 dBm Transmit Freq Error 1.114 kHz OBW Power 99.00 % x dB Bandwidth 939.4 kHz x dB -20.00 dB

$\pi/4$-DQPSK Low channel	 Agilent Spectrum Analyzer - Occupied BW Center Freq: 2.40200000 GHz Res BW: 30 kHz Span: 2 MHz Occupied Bandwidth: 1.1840 MHz Total Power: 3.90 dBm Transmit Freq Error: 119 Hz OBW Power: 99.00 % x dB Bandwidth: 1.290 MHz x dB: -20.00 dB	
$\pi/4$-DQPSK Mid channel	 Agilent Spectrum Analyzer - Occupied BW Center Freq: 2.44100000 GHz Res BW: 30 kHz Span: 2 MHz Occupied Bandwidth: 1.1848 MHz Total Power: 3.51 dBm Transmit Freq Error: -285 Hz OBW Power: 99.00 % x dB Bandwidth: 1.306 MHz x dB: -20.00 dB	
$\pi/4$-DQPSK High channel	 Agilent Spectrum Analyzer - Occupied BW Center Freq: 2.48000000 GHz Res BW: 30 kHz Span: 2 MHz Occupied Bandwidth: 1.1733 MHz Total Power: 3.07 dBm Transmit Freq Error: -1.712 kHz OBW Power: 99.00 % x dB Bandwidth: 1.278 MHz x dB: -20.00 dB	

11. CARRIER FREQUENCIES SEPARATION

11.1 Block Diagram Of Test Setup



11.2 Limit

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. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 0.125W.

11.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 30kHz. VBW = 100kHz , Span = 3.0MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section Submit this plot.

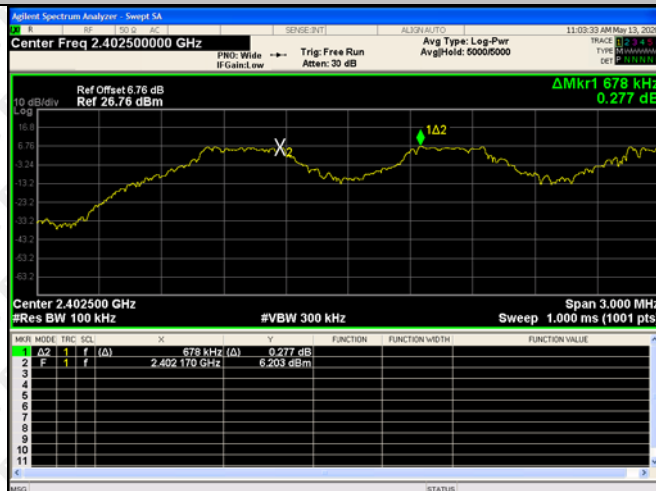
11.4 Test Result

Mode	Channel.	Carrier Frequency Separation [MHz]	Verdict
GFSK	LCH	0.678	PASS
GFSK	MCH	0.693	PASS
GFSK	HCH	1.008	PASS
$\pi/4$ DQPSK	LCH	1.044	PASS
$\pi/4$ DQPSK	MCH	0.966	PASS
$\pi/4$ DQPSK	HCH	0.879	PASS

Test Graph

Graphs

GFSK/LCH

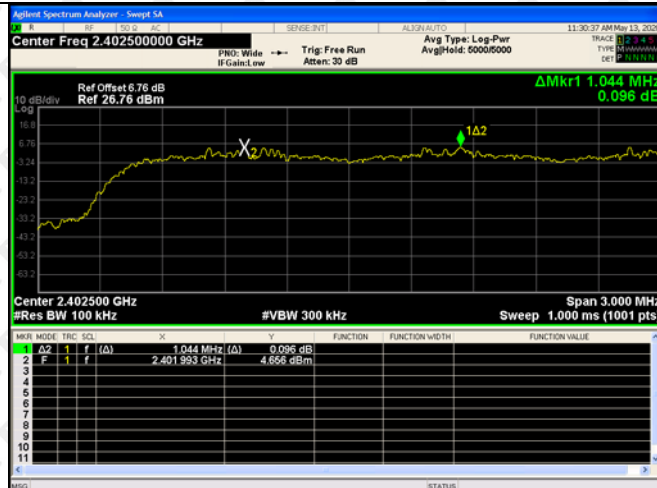


GFSK/MCH



GFSK/HCH

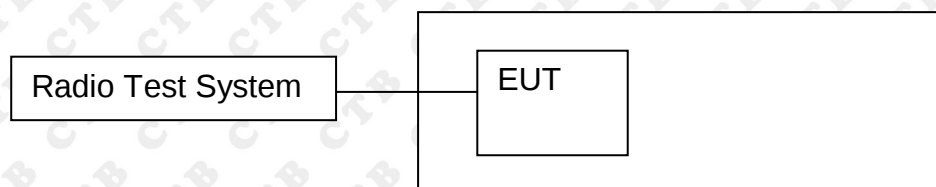


$\pi/4$ DQPSK/LCH

 $\pi/4$ DQPSK/MCH

 $\pi/4$ DQPSK/HCH


12. HOPPING CHANNEL NUMBER

12.1 Block Diagram Of Test Setup



12.2 Limit

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

12.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 100kHz. VBW = 300kHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. It may prove necessary to break the span up to sections. in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section.
4. Set the spectrum analyzer: Start Frequency = 2.4GHz, Stop Frequency = 2.4835GHz. Sweep=auto;

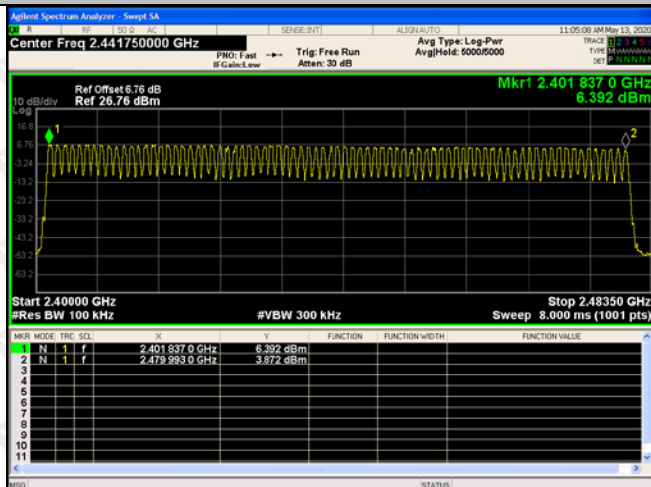
12.4 Test Result

Mode	Channel.	Number of Hopping Channel	Verdict
GFSK	Hop	79	PASS
$\pi/4$ DQPSK	Hop	79	PASS

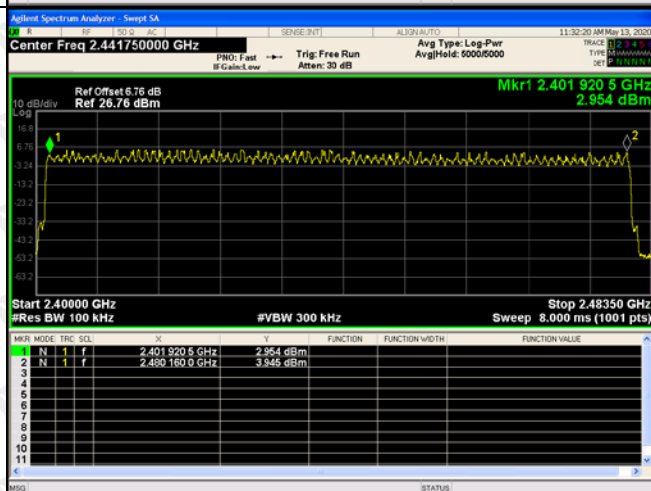
Test Graph

Graphs

GFSK/Hop

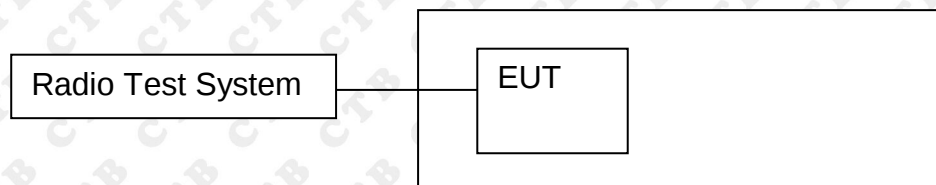


$\pi/4$ DQPSK/Hop



13. DWELL TIME

13.1 Block Diagram Of Test Setup



13.2 Limit

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

13.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set spectrum analyzer span = 0. Centred on a hopping channel;
3. Set RBW = 1MHz and VBW = 3MHz. Sweep = as necessary to capture the entire dwell time per hopping channel. Set the EUT for DH5, DH3 and DH1 packet transmitting.
4. Use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g.. data rate. modulation format. etc.). repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

13.4 Test Result

Mode	Packet	Channel	Pulse Time (ms)	Total Dwell Time (ms)	Limit (ms)	Verdict
GFSK	DH1	LCH	0.373	119.36	400	PASS
	DH1	MCH	0.373	119.36	400	PASS
	DH1	HCH	0.373	119.36	400	PASS
	DH3	LCH	1.63	260.80	400	PASS
	DH3	MCH	1.63	260.80	400	PASS
	DH3	HCH	1.63	260.80	400	PASS
	DH5	LCH	2.878	306.99	400	PASS
	DH5	MCH	2.878	306.99	400	PASS
	DH5	HCH	2.878	306.99	400	PASS

Remark: DH5 Packet permit maximum 1600 / 79 / 6 hops per second in each channel (5 time slots RX, 1 time slot TX).

DH3 Packet permit maximum 1600 / 79 / 4 hops per second in each channel (3 time slots RX, 1 time slot TX).

DH1 Packet permit maximum 1600 / 79 / 2 hops per second in each channel (1 time slot RX, 1 time slot TX). So, the Dwell Time can be calculated as follows:

DH5: $1600/79/6*0.4*79*(MkrDelta)/1000$

DH3: $1600/79/4*0.4*79*(MkrDelta)/1000$

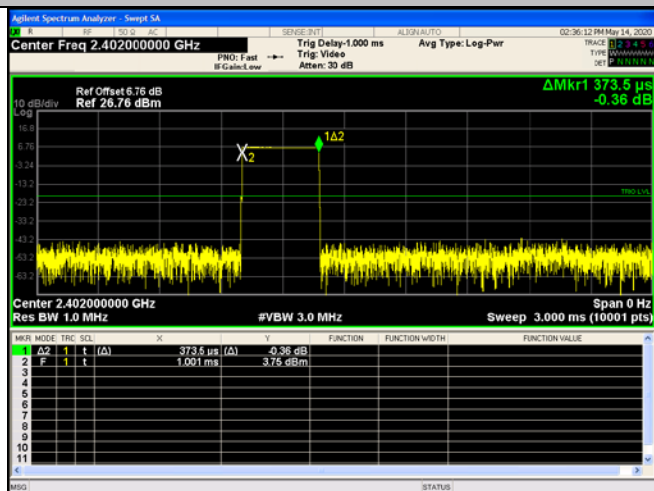
DH1: $1600/79/2*0.4*79*(MkrDelta)/1000$

Remark: Mkr Delta is once pulse time.

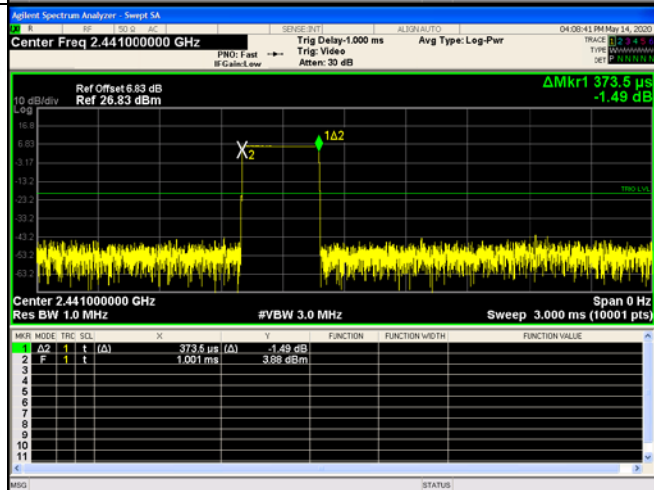
Test Graph

Graphs

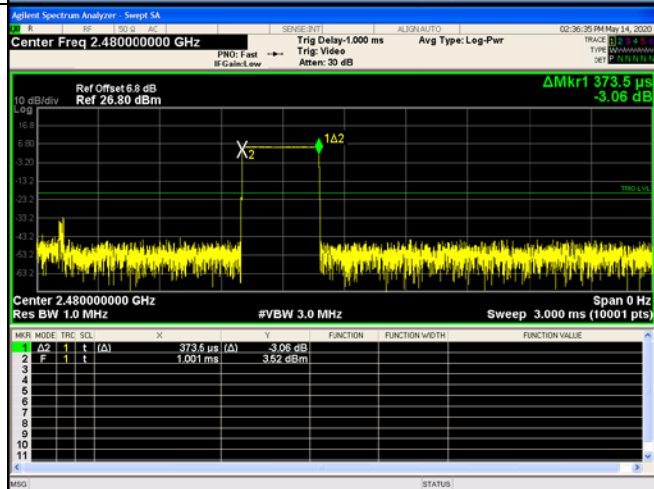
GFSK_DH1/LCH



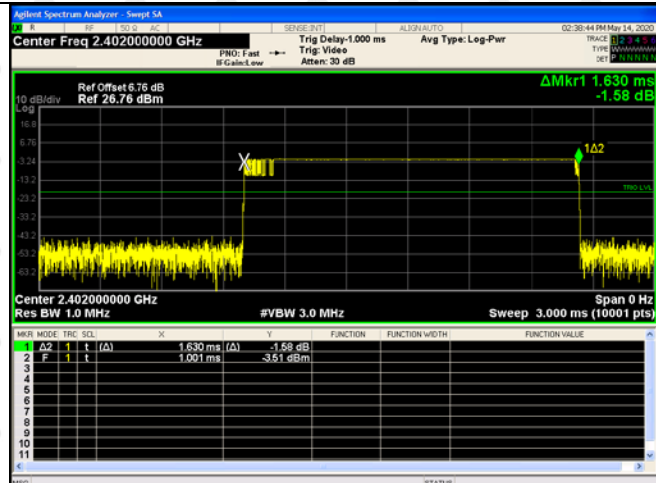
GFSK_DH1/MCH



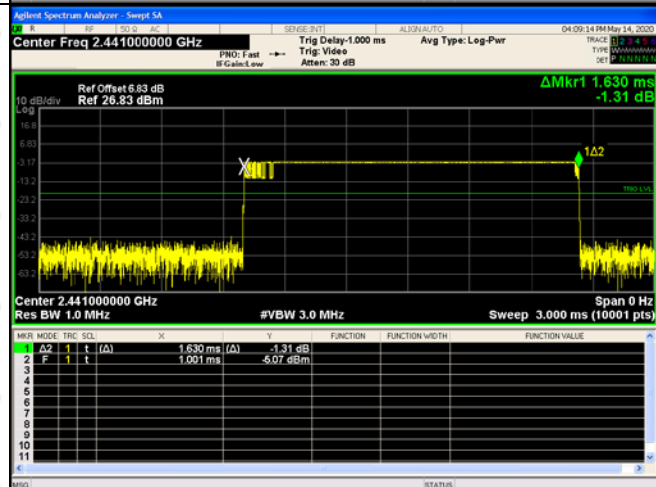
GFSK_DH1/HCH



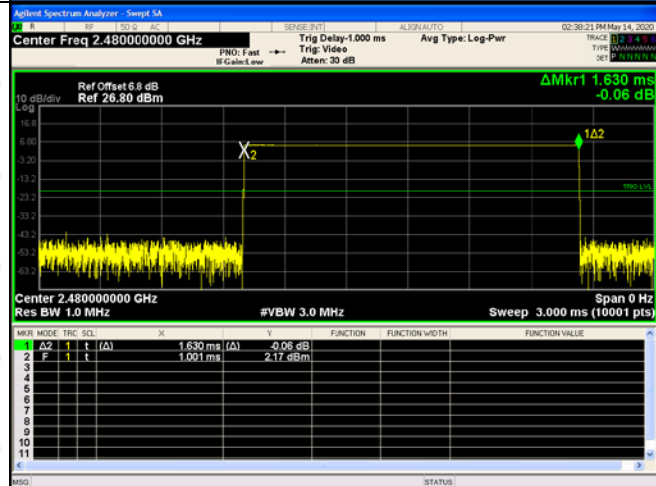
GFSK_DH3/LCH



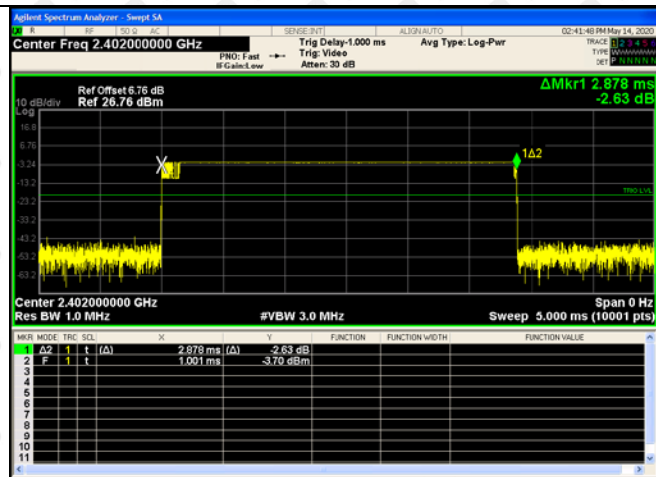
GFSK_DH3/MCH



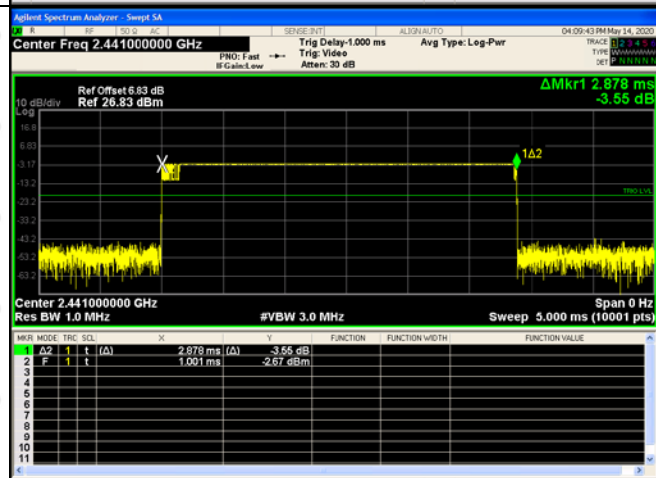
GFSK_DH3/HCH



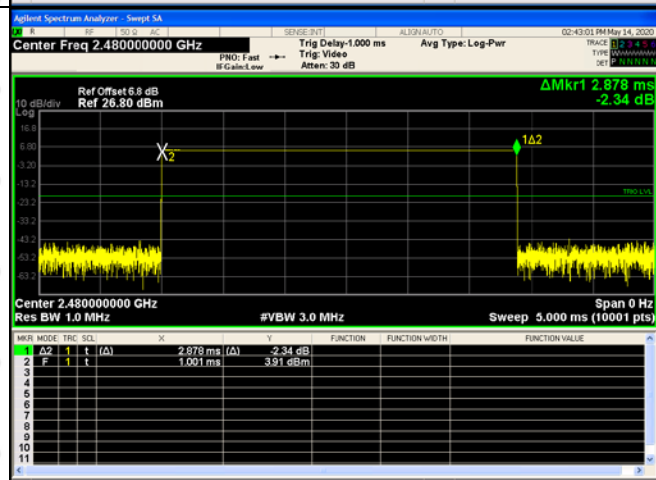
GFSK_DH5/LCH



GFSK_DH5/MCH



GFSK_DH5/HCH



14. PSEUDORANDOM FREQUENCY

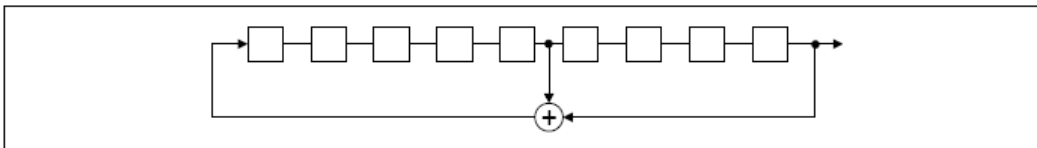
14.1 Limit

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. Alternatively. Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

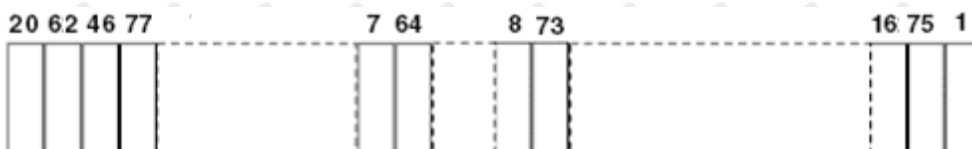
14.2 Test procedure

The pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONES; i.e. the shift register is initialized with nine ones.

- Number of shift register stages: 9
- Length of pseudo-random sequence: $2^9 - 1 = 511$ bits
- Longest sequence of zeros: 8 (non-inverted signal)



An example of Pseudorandom Frequency Hopping Sequence as follow:



Each frequency used equally on the average by each transmitter. The system receivers have input bandwidths that match the hopping channel bandwidths of their Corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

14.3 Test Result

The device does not have the ability to be coordinated with other FHSS systems in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

15. ANTENNA REQUIREMENT

15.203 requirement:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

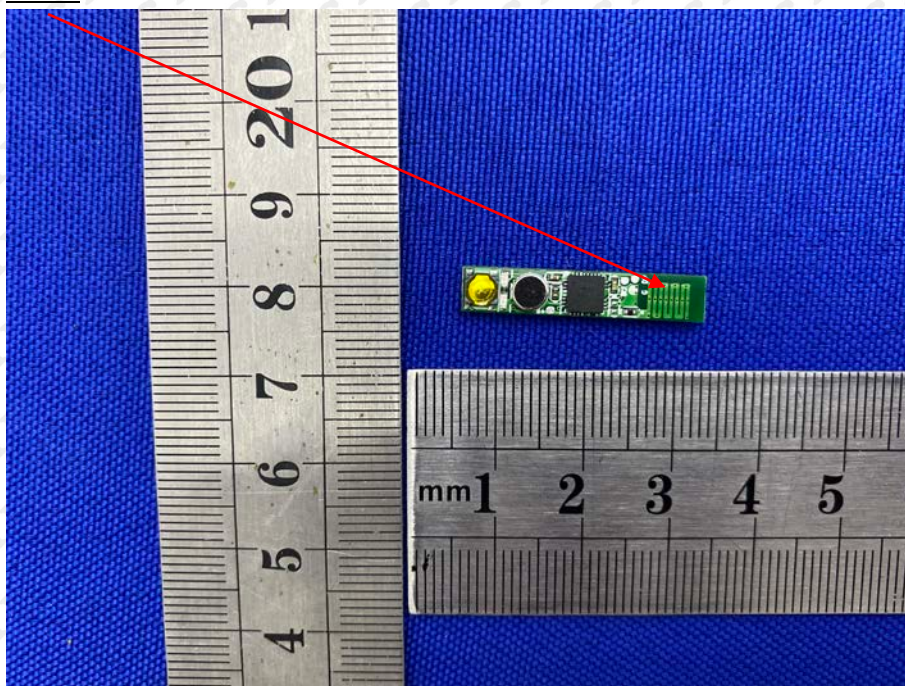
15.247(b) (4) requirement:

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

EUT Antenna:

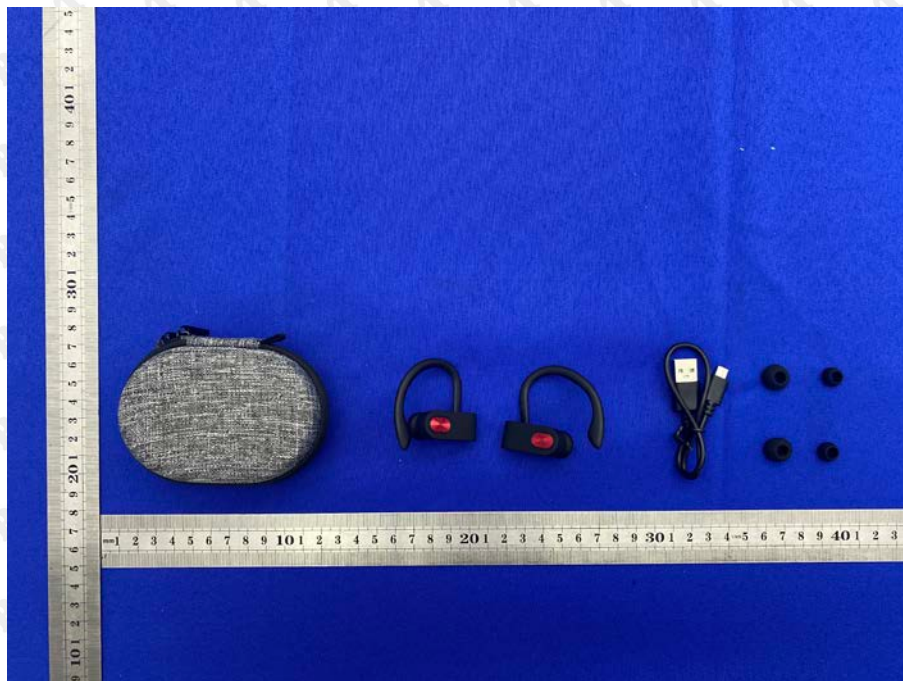
The antenna is PCB antenna. The best case gain of the antenna is -0.58dBi.

ANT.



16. EUT PHOTOGRAPHS

EUT Photo 1



EUT Photo 2



EUT Photo 3



EUT Photo 4



EUT Photo 5



EUT Photo 6



EUT Photo 7



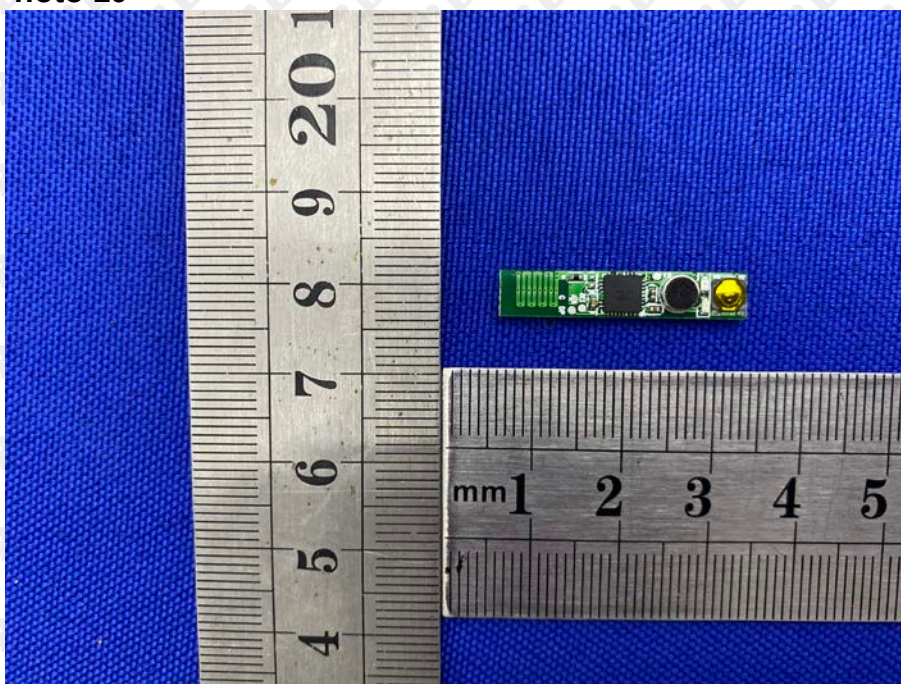
**EUT Photo 8
Left**



EUT Photo 9



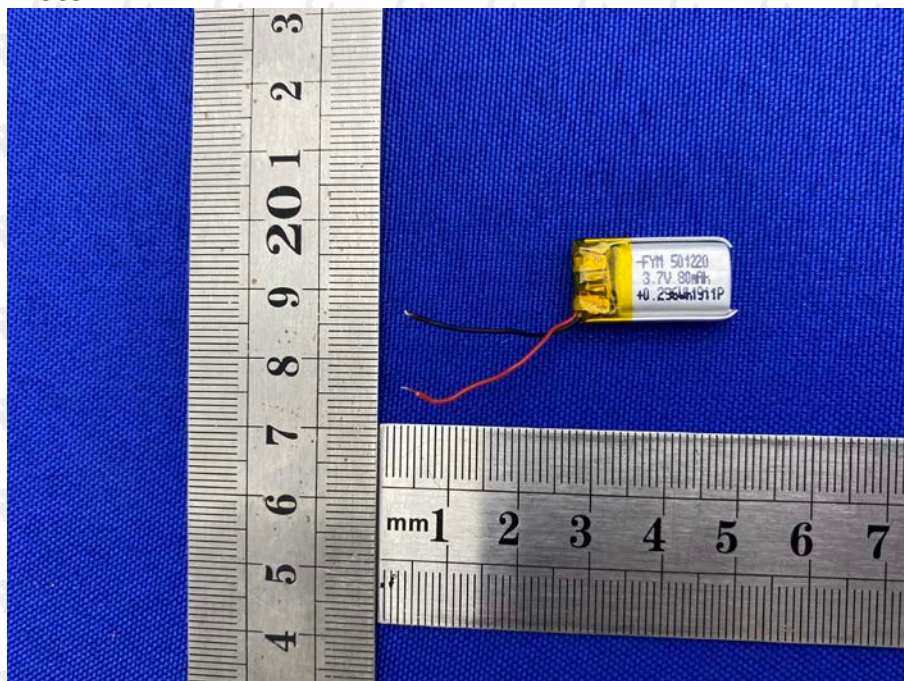
EUT Photo 10



EUT Photo 11



EUT Photo 12



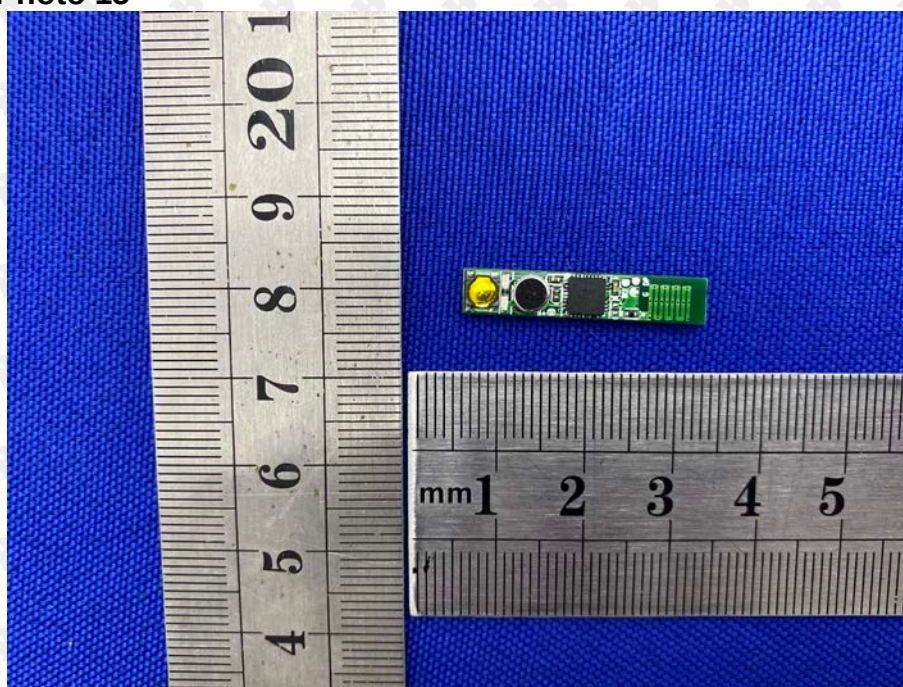
EUT Photo 13
Right



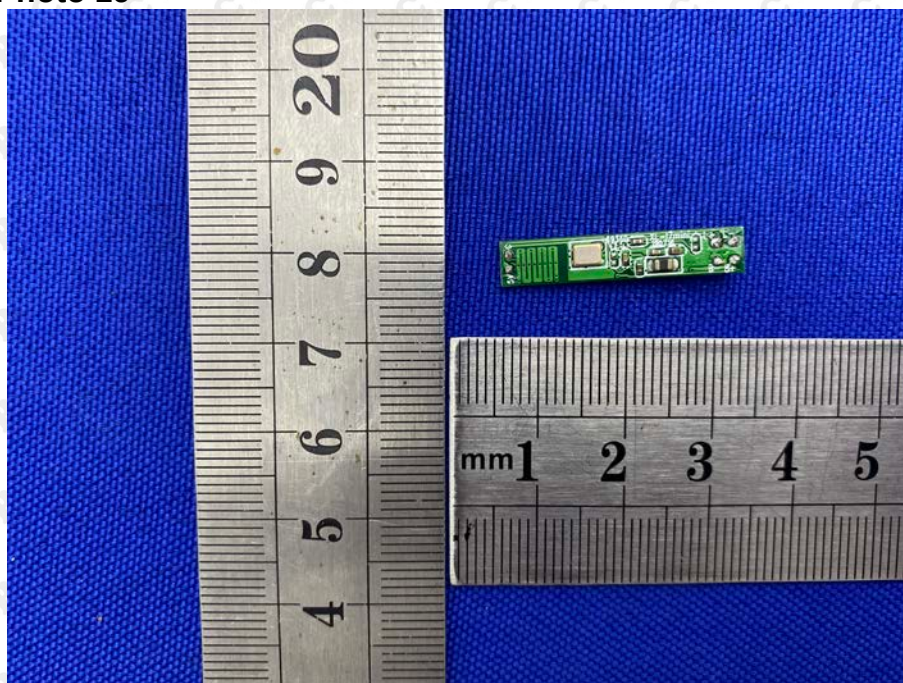
EUT Photo 14



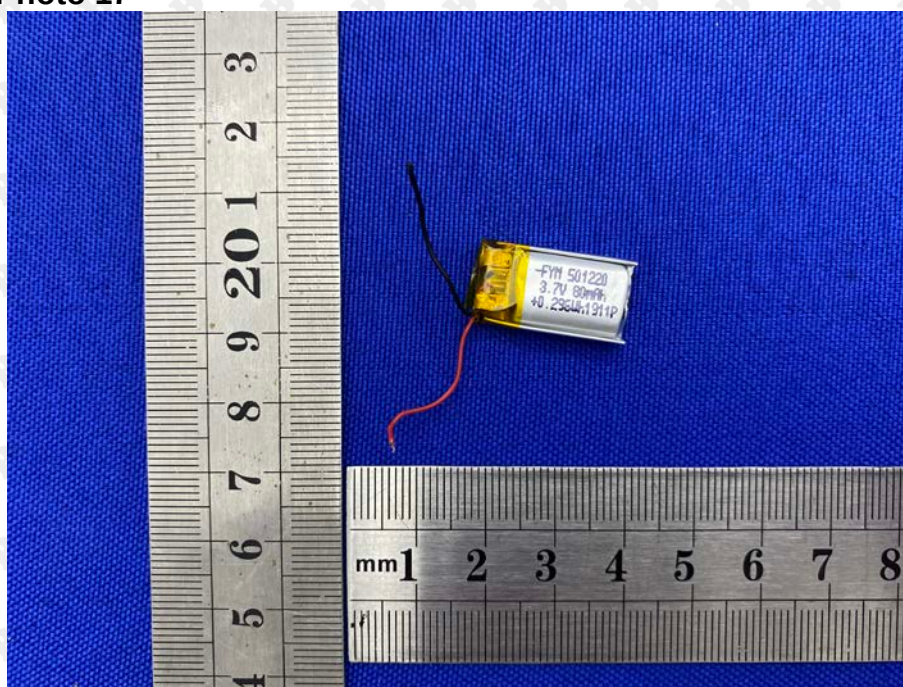
EUT Photo 15



EUT Photo 16



EUT Photo 17



17. EUT TEST SETUP PHOTOGRAPHS

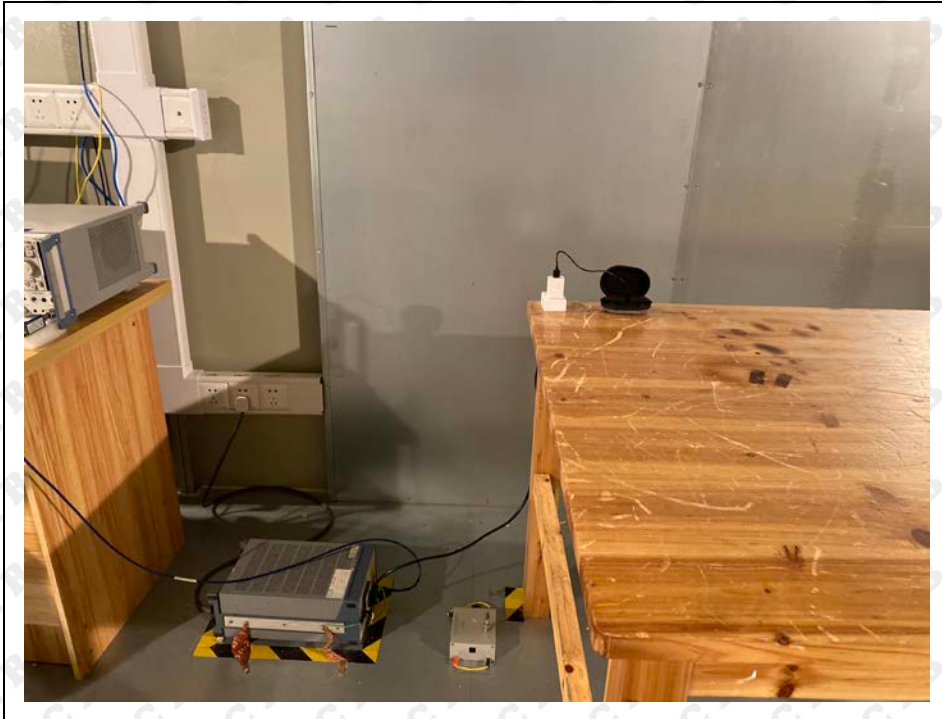
Radiated Emission

Below 1G



Above 1G



Conducted Emission

***** END OF REPORT *****