



FCC RADIO TEST REPORT

Applicant : Willo 32, Inc
Address : 12 E 33rd Street, 10th Floor, New York NY, 10016
Equipment : Powered Toothbrush
Model No. : Willo W
Trade Name : Willo
FCC ID. : 2AVNVWILLO-W-3201

I HEREBY CERTIFY THAT :

The sample was received on Jun. 19, 2019 and the testing was completed on Jan. 14, 2020 at CerpPASS Technology Corp. The test result refers exclusively to the test presented test model / sample. Without written approval of CerpPASS Technology Corp., the test report shall not be reproduced except in full.

Approved by:

Mark Liao / Supervisor

Laboratory Accreditation:

CerpPASS Technology Corporation Test Laboratory





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History of this test report

Report No.	Issue Date	Description
TEFB1906034	Jan. 16, 2020	Original



1. Summary of Test Procedure and Test Results

1.1 Applicable Standards

ANSI C63.4:2014

ANSI C63.10:2013

FCC Rules and Regulations Part 15 Subpart C §15.247

FCC Rule	Description of Test	Result
15.203	. Antenna Requirement	PASS
15.207	. AC Power Line Conducted Emission	PASS
15.209 15.205	. Radiated Spurious Emission	PASS
15.247(d)	. Conducted Spurious Emission	PASS
15.247(a)(1)	. Channel Carrier Frequencies Separation	PASS
15.247(a)(1)	. 20dB Bandwidth	PASS
15.247(a)(1)	. Dwell Time	PASS
15.247(b)	. Number of Hopping Channels	PASS
15.247(b)	. Peak Output Power Measurement Data	PASS

*The principle of judgment is made according to the laboratory's reporting control and measurement uncertainty standard procedures.

*This EUT has been also tested and compiled with the requirement of FCC Part 15, Subpart B, recorded in a separate test report(TEFD1906034).



2. Test Configuration of Equipment under Test

2.1 Feature of Equipment under Test

AC Adapter	Model No.: W18-036N1A Input: 100-240V~ 50/60Hz, 1A Output: 12V, 3A
Frequency Range	BT / BLE: 2402MHz~2480MHz 802.11b/g/n: 2412MHz~2462MHz
NFC Frequency Range	13.553MHz~13.567MHz
Modulation Mode	BT: GFSK, $\pi/4$ -DQPSK, 8DPSK BLE: GFSK NFC:ASK WLAN: 802.11b: CCK, DQPSK, DBPSK 802.11g/n: BPSK, QPSK, 16QAM, 64QAM
Data Rate	BT: GFSK: 1Mbps, $\pi/4$ -DQPSK: 2Mbps, 8DPSK: 3Mbps BLE: GFSK: 1Mbps WLAN: 802.11b: 1, 2, 5.5, 11Mbps 802.11g: 6, 9, 12, 18, 24, 36, 48, 54Mbps 802.11n: MCS0 – MCS7, HT20/40
Antenna Type	PCB Antenna
Antenna Gain	2400-2483.5MHz: 10dBi BLE: 10dBi Bluetooth: 10dBi NFC: 0dBi

Note:

1. For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual.



2.2 Carrier Frequency of Channes

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
*00	2402	20	2422	40	2442	60	2462
01	2403	21	2423	41	2443	61	2463
02	2404	22	2424	42	2444	62	2464
03	2405	23	2425	43	2445	63	2465
04	2406	24	2426	44	2446	64	2466
05	2407	25	2427	45	2447	65	2467
06	2408	26	2428	46	2448	66	2468
07	2409	27	2429	47	2449	67	2469
08	2410	28	2430	48	2450	68	2470
09	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	---	---

Note: Channels remarked * are selected to perform test.



2.3 Test Mode & Test Software

- During testing, the interface cables and equipment positions were varied according to ANSI C63.10
- The complete test system included Notebook and EUT for RF test.
- An executive program," EspRFtest Tool: V1.1.0 " under WIN 7 was executed to transmit and receive data via Bluetooth.
- The following test modes were performed for the test:

Conducted Emissions from the AC mains power ports	
Test Mode	Operating Description
1	BT 3M 8DPSK
caused "Test Mode 1" generated the worst case, it was reported as the final data.	
Radiation Emissions (30MHz ~ 1GHz)	
Test Mode	Operating Description
1	BT 3M 8DPSK
caused "Test Mode 1" generated the worst case, they were reported as the final data.	
Radiation Emissions (1GHz ~ 25GHz)	
Test Mode	Operating Description
1	BT 1M GFSK
2	BT 3M 8DPSK
caused "Test Mode 1,2" generated the worst case, they were reported as the final data.	

2.4 Description of Test System

N/A



2.5 General Information of Test

Test Site	Cerpass Technology Corporation Test Laboratory Address: No.10, Ln. 2, Lianfu St., Luzhu Dist., Taoyuan City 33848, Taiwan (R.O.C.) Tel:+886-3-3226-888 Fax:+886-3-3226-881	
	FCC	TW1439, TW1079
	IC	4934E-1, 4934E-2
	VCCI	T-2205 for Telecommunication test C-4663 for Conducted emission test R-4218 for Radiated emission test G-10812, G-10813 for radiated disturbance above 1GHz
Frequency Range Investigated:	Conducted: from 150kHz to 30 MHz Radiation: from 30 MHz to 40,000MHz	
Test Distance:	The test distance of radiated emission from antenna to EUT is 3 M.	

Test Item	Test Site	Finish Date	Environmental Conditions	Tested By
RF Conducted	RFCON01-NK	2019/07/24	24°C / 60%	Vic Yeh
Radiated Emissions	3M02-NK	2020/01/14	23°C / 52%	Leon Huang
AC Power Line Conducted Emission	CON02-NK	2020/01/13	27°C / 49%	Leon Huang

2.6 Measurement Uncertainty

Measurement Item	Uncertainty
AC Power Line Conduction(150K~30MHz)	±1.60dB
Radiated Spurious Emission(9KHz~30MHz)	±3.405dB
Radiated Spurious Emission(30MHz~1GHz)	±5.326dB
Radiated Spurious Emission(1GHz~25GHz)	±5.918dB
Conducted Spurious Emission	±2.156dB
6dB Bandwidth	±4.401%
20dB Bandwidth	±4.40%
Occupied Bandwidth	±4.41%
Peak Output Power(Conducted Power Meter)	±1.31dB
Dwell Time	±0.11%
Duty Cycle	±0.17%



3. Test Equipment and Ancillaries Used for Tests

Test Item	Radiated Emissions				
Test Site	Semi Anechoic Room(3M02-NK)				
Instrument	Manufacturer	Model No	Serial No	Calibration Date	Valid Date
Bilog Antenna	Schwarzbeck	VULB9168	275	2019/09/24	2020/09/23
Bilog Antenna	Schwarzbeck	VULB9168	369	2019/03/29	2020/03/28
Active Loop Antenna	EMCO	6507	40855	2019/05/24	2020/05/23
Horn Antenna	EMCO	3115	31589	2019/04/01	2020/03/31
Horn Antenna	EMCO	3116	31974	2019/09/17	2020/09/16
EMI Receiver	ROHDE & SCHWARZ	ESCI	101423	2019/05/14	2020/05/13
Spectrum Analyzer	ROHDE & SCHWARZ	FSP 40	100047	2019/03/28	2020/03/27
Spectrum Analyzer	ROHDE & SCHWARZ	FSV 40-N	102151	2019/08/02	2020/08/01
Preamplifier	EM Electronics corp.	EM330	60660	2019/03/11	2020/03/10
Preamplifier	EMC INSTRUMENTS	EMC051845SE	980333	2019/09/20	2020/09/19
Preamplifier	Agilent	8449B	3008A01954	2019/03/11	2020/03/10
Preamplifier	EMC INSTRUMENTS	EMC184045	980065	2019/11/07	2020/11/06
Bluetooth Tester	ROHDE & SCHWARZ	CBT	101133	2019/04/07	2020/04/06
Cable-3in1(30M-1G)	HARBOUR INDUSTRIES	LL142	CCE1315	2019/04/09	2020/04/08
Cable-3in1(30M-1G)	HARBOUR INDUSTRIES	LL142	CCE1316	2019/09/20	2020/09/19
Cable-0.5m(1G-40G)	HUBER SUHNER	SUCOFLEX 100	805443/4	2019/05/20	2020/05/19
Cable-3m(1G-40G)	HUBER SUHNER	SUCOFLEX 100	805796/4	2019/05/20	2020/05/19
Cable-8m(1G-40G)	HUBER SUHNER	SUCOFLEX 100	805795/4	2019/05/20	2020/05/19
E3	AUDIX	v8.2014-8-6	RK-000529	NA	NA

Test Item	RF Conducted				
Test Site	RFCON01-NK				
Instrument	Manufacturer	Model No	Serial No	Calibration Date	Valid Date
CAX Signal Analyzer	KEYSIGHT	N9000B	MY57100291	2018/11/01	2019/10/31
Spectrum Analyzer	ROHDE & SCHWARZ	FSP 40	100047	2019/03/28	2020/03/27
Bluetooth Tester	ROHDE & SCHWARZ	CBT	101133	2019/04/07	2020/04/06
Attenuator	KEYSIGHT	8491B	MY39250705	2018/09/04	2019/09/03
TEMP & HUMIDITY CHAMBER	T-MACHINE	TMJ-9712	T-12-040111	2018/08/30	2019/08/29
Power Sensor	Anritsu	MA2411B	1207295	2019/04/09	2020/04/08



Test Item	AC Power Line Conducted Emission				
Test Site	CON02-NK				
Instrument	Manufacturer	Model No	Serial No	Calibration Date	Valid Date
EMI Receiver	ROHDE & SCHWARZ	ESCI	100821	2019/09/16	2020/09/15
Line Impedance Stabilization Network	Schwarzbeck	NSLK 8127	8127-516	2019/09/19	2020/09/18
TWO-LINE V-NETWORK	ROHDE & SCHWARZ	ENV216	102185	2019/07/05	2020/07/04
Cable-6m(9k~300M)	NA	EMC5D-BM-BM-6	130606	2019/03/14	2020/03/13
E3	AUDIX	v8.2014-8-6	RK-000536	NA	NA



4. Antenna Requirements

4.1 Standard Applicable

For intentional device, according to FCC 47 CFR Section 15.203, 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.

And according to FCC 47 CFR Section 15.247 (b), if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

4.2 Antenna Construction and Directional Gain

Antenna Type	PCB Antenna
Antenna Gain	10 dBi



5. Test of AC Power Line Conducted Emission

5.1 Test Limit

Conducted Emissions were measured from 150 kHz to 30 MHz with a bandwidth of 9 KHz, according to the methods defined in ANSI C63.4-2014. The EUT was placed on a nonmetallic stand in a shielded room 0.8 meters above the ground plane. The interface cables and equipment positioning were varied within limits of reasonable applications to determine the position produced maximum conducted emissions.

Frequency (MHz)	Quasi Peak (dB μ V)	Average (dB μ V)
0.15 – 0.5	66-56*	56-46*
0.5 – 5.0	56	46
5.0 – 30.0	60	50

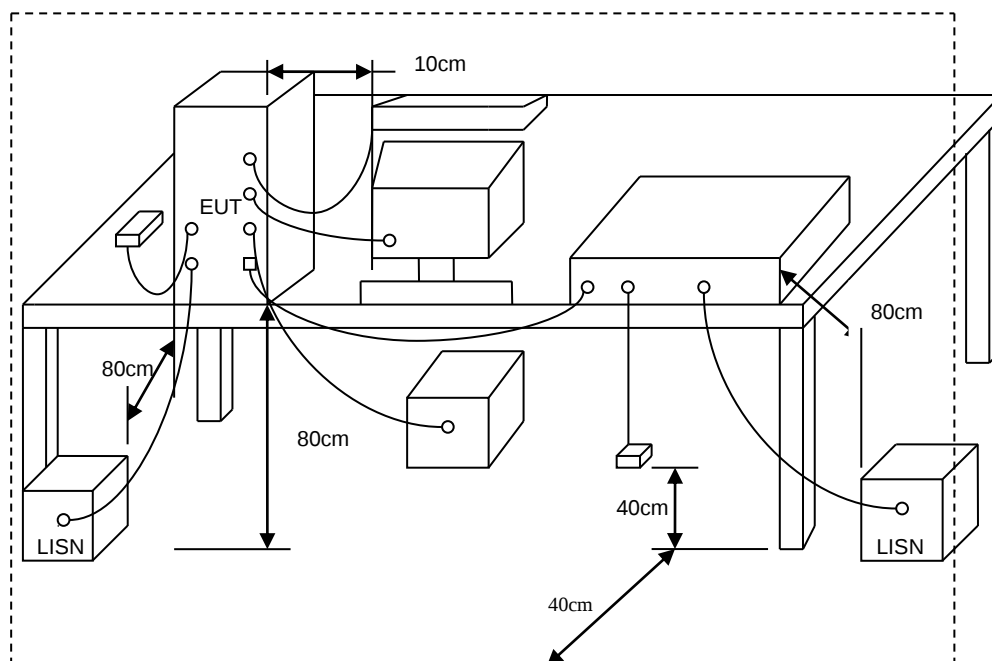
*Decreases with the logarithm of the frequency.

5.2 Test Procedures

- The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
- Connect EUT to the power mains through a line impedance stabilization network (LISN).
- All the support units are connecting to the other LISN.
- The LISN provides 50 ohm coupling impedance for the measuring instrument.
- The FCC states that a 50 ohm, 50 micro-Henry LISN should be used.
- Both sides of AC line were checked for maximum conducted interference.
- The frequency range from 150 kHz to 30 MHz was searched.
- Set the test-receiver system to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.



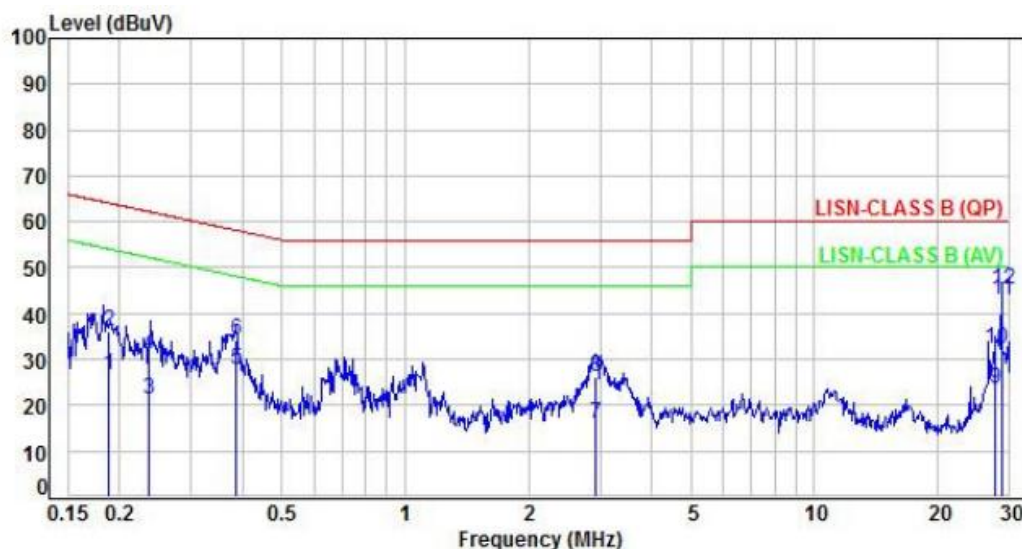
5.3 Typical Test Setup





5.4 Test Result and Data

Power	: AC 120V / 60Hz	Pol/Phase	: LINE
Test Mode	: Mode 1		:



No.	Frequency (MHz)	Factor (dB)	Reading (dBUV)	Level (dBUV)	Limit (dBUV)	Margin (dB)	Detector	P/F
1	0.19	9.64	17.07	26.71	54.13	-27.42	Average	P
2	0.19	9.64	26.66	36.30	64.13	-27.83	QP	P
3	0.24	9.64	11.64	21.28	52.24	-30.96	Average	P
4	0.24	9.64	21.54	31.18	62.24	-31.06	QP	P
5	0.39	9.64	17.93	27.57	48.16	-20.59	Average	P
6	0.39	9.64	24.57	34.21	58.16	-23.95	QP	P
7	2.92	9.76	6.08	15.84	46.00	-30.16	Average	P
8	2.92	9.76	16.45	26.21	56.00	-29.79	QP	P
9	27.63	9.98	13.77	23.75	50.00	-26.25	Average	P
10	27.63	9.98	22.29	32.27	60.00	-27.73	QP	P
11	28.67	9.99	33.06	43.05	50.00	-6.95	Average	P
12	28.67	9.99	35.38	45.37	60.00	-14.63	QP	P

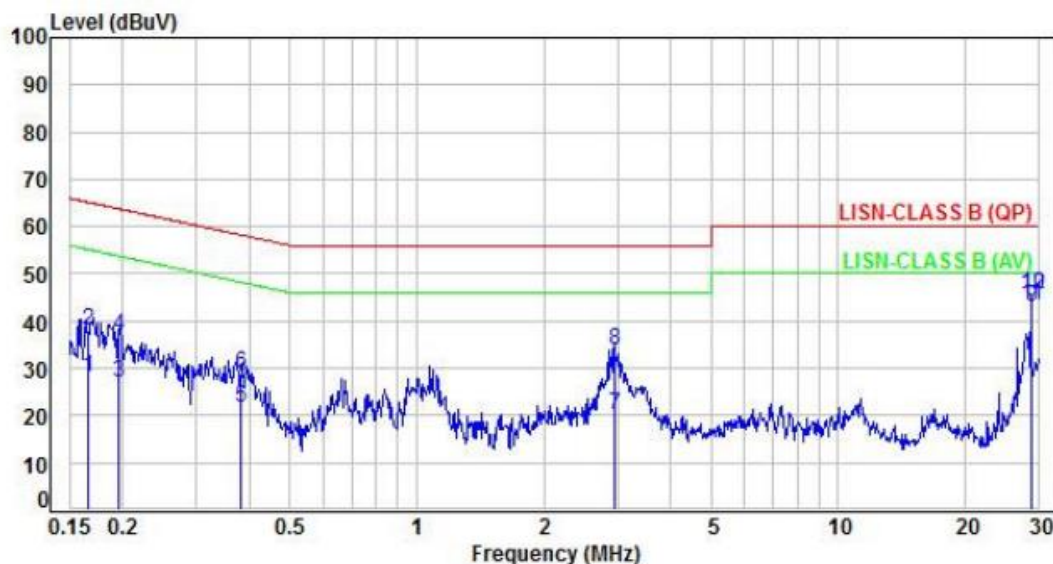
Note: Level=Reading+Factor

Margin=Level-Limit

Factor=(LISN or ISN or Current Probe)Factor + Cable Loss



Power	: AC 120V / 60Hz	Pol/Phase	: NEUTRAL
Test Mode	: Mode 1		:



No.	Frequency (MHz)	Factor (dB)	Reading (dBUV)	Level (dBUV)	Limit (dBUV)	Margin (dB)	Detector	P/F
1	0.17	9.64	18.62	28.26	55.14	-26.88	Average	P
2	0.17	9.64	28.31	37.95	65.14	-27.19	QP	P
3	0.20	9.63	17.55	27.18	53.76	-26.58	Average	P
4	0.20	9.63	27.18	36.81	63.76	-26.95	QP	P
5	0.38	9.64	12.08	21.72	48.25	-26.53	Average	P
6	0.38	9.64	19.10	28.74	58.25	-29.51	QP	P
7	2.96	9.75	10.50	20.25	46.00	-25.75	Average	P
8	2.96	9.75	23.97	33.72	56.00	-22.28	QP	P
9	28.67	10.07	33.00	43.07	50.00	-6.93	Average	P
10	28.67	10.07	35.38	45.45	60.00	-14.55	QP	P
11	28.67	10.07	33.13	43.20	50.00	-6.80	Average	P
12	28.67	10.07	35.39	45.46	60.00	-14.54	QP	P

Note: Level=Reading+Factor

Margin=Level-Limit

Factor=(LISN or ISN or Current Probe)Factor + Cable Loss



6. Test of Radiated Spurious Emission

6.1 Test Limit

In any 100kHz 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 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. If the transmitter measurement is based on the maximum conducted output power, the attenuation required under this paragraph shall be 30dB instead of 20dB. In addition, radiated emissions which fall in section 15.205(a) the restricted bands must also comply with the radiated emission limit specified in section 15.209(a).

Frequency (MHz)	Field Strength (microvolt/meter)	Measurement Distance (meters)
0.009 ~ 0.490	2400/F(kHz)	300
0.490 ~ 1.705	24000/F(kHz)	30
1.705 ~ 30.0	30	30
30 ~ 88	100	3
88 ~ 216	150	3
216 ~ 960	200	3
Above 960	500	3

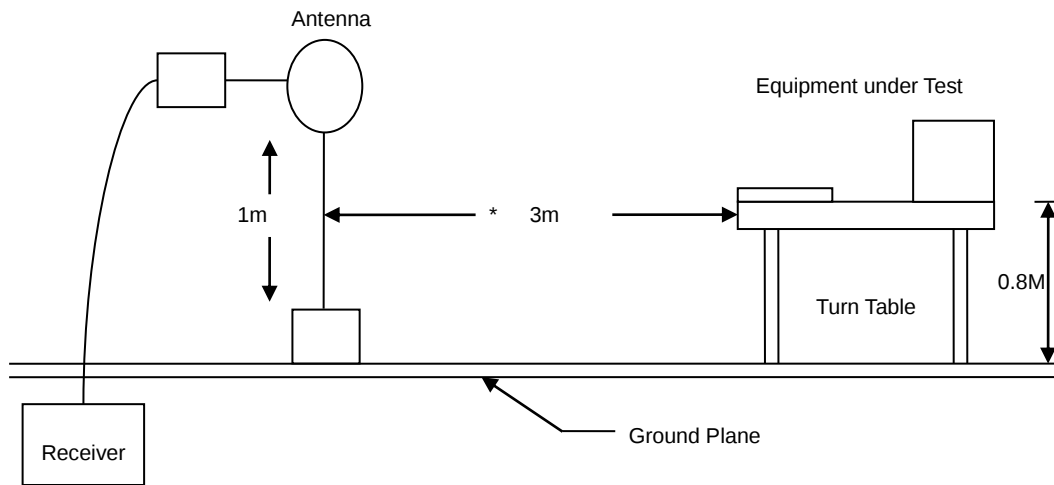
6.2 Test Procedures

- The EUT was placed on a rotatable table top 0.8 meter above ground.
- The EUT was set 3 meters from the interference receiving antenna which was mounted on the top of a variable height antenna tower.
- The table was rotated 360 degrees to determine the position of the highest radiation.
- The antenna is a broadband antenna and its height is varied between one meter and four meters above ground to find the maximum value of the field strength both horizontal polarization and vertical polarization of the antenna are set to make the measurement.
- For each suspected emission the EUT was arranged to its worst case and then tune the antenna tower (from 1 M to 4 M) and turn table (from 0 degree to 360 degrees) to find the maximum reading.
- Set the test-receiver system to Peak or CISPR quasi-peak Detect Function and specified bandwidth with Maximum Hold Mode.
- If the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions which do not have 3 dB margin will be repeated one by one using the quasi-peak method and reported.
- For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in peak mode also complies with the limit in average mode), then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.

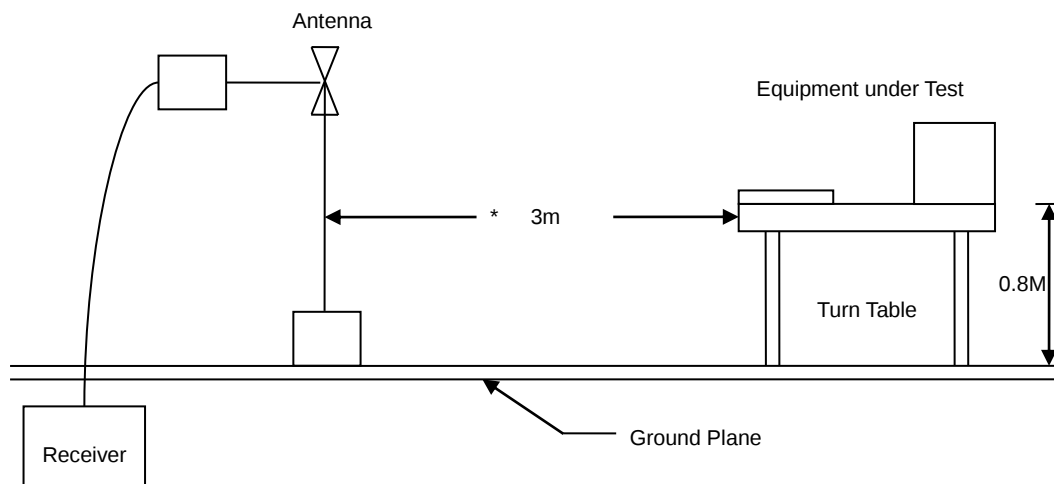


6.3 Typical Test Setup

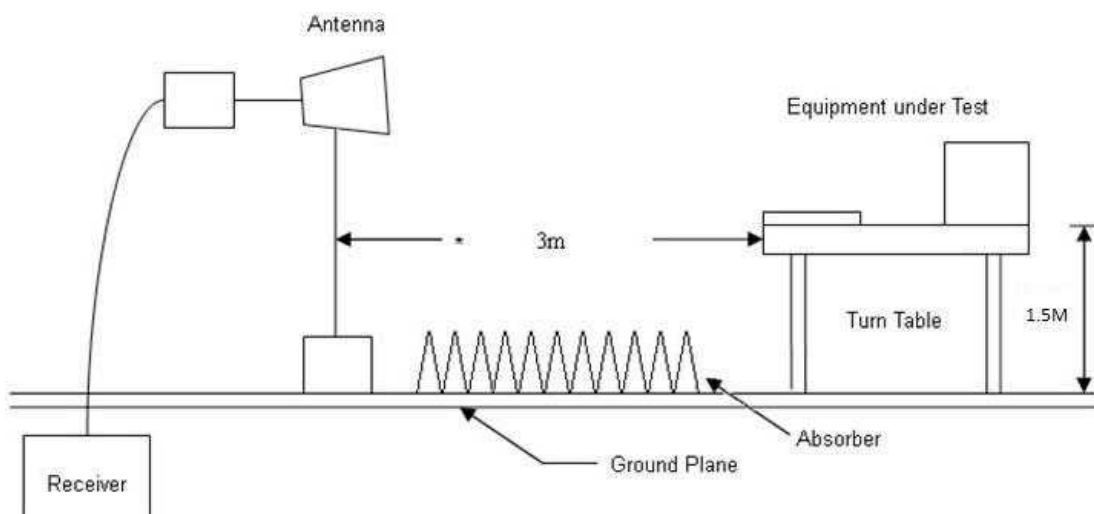
Below 30MHz test setup



30MHz- 1GHz Test Setup



Above 1GHz Test Setup



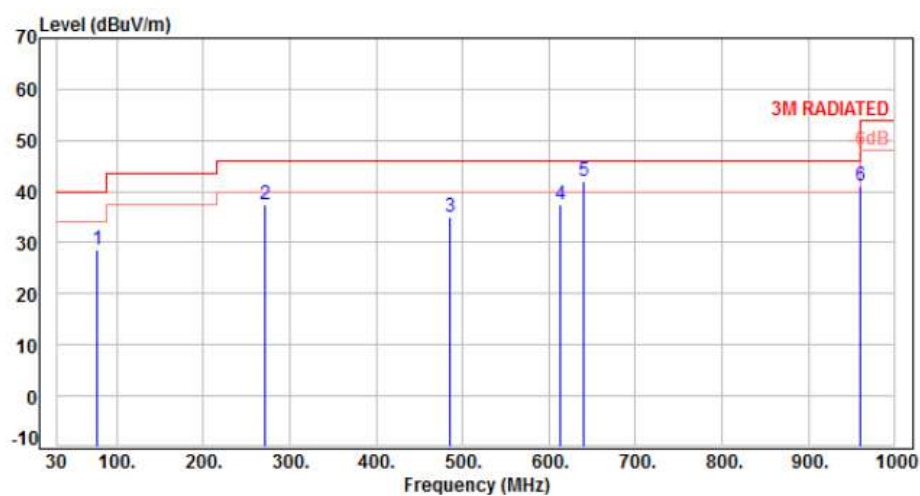


6.4 Test Result and Data (9kHz ~ 30MHz)

The 9kHz-30MHz spurious emission is under limit 20dB more.

6.5 Test Result and Data (30MHz ~ 1GHz)

Power	: AC 120V /60Hz	Pol/Phase	: VERTICAL
Test Mode	: Mode 1		:



No.	Frequency (MHz)	Factor (dB)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg)	P/F
1	77.00	-13.68	42.17	28.49	40.00	-11.51	Peak	400	0	P
2	270.88	-9.39	46.84	37.45	46.00	-8.55	Peak	400	0	P
3	485.13	-3.85	38.73	34.88	46.00	-11.12	Peak	400	0	P
4	613.33	-0.87	38.26	37.39	46.00	-8.61	Peak	400	0	P
5	640.29	-0.76	42.73	41.97	46.00	-4.03	Peak	400	0	P
6	960.88	4.13	37.11	41.24	54.00	-12.76	Peak	400	0	P

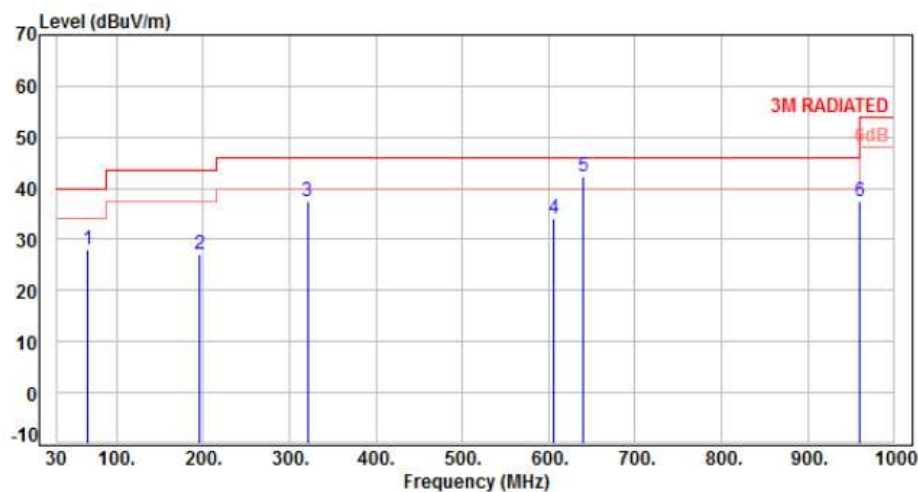
Note: Level=Reading+Factor

Margin=Level-Limit

Factor=Antenna Factor + cable loss - Amplifier Factor



Power	: AC 120V /60Hz	Pol/Phase	: HORIZONTAL
Test Mode	: Mode 1		:



No.	Frequency (MHz)	Factor (dB)	Reading (dBUV)	Level (dBUV/m)	Limit (dBUV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg)	P/F
1	66.84	-11.09	39.07	27.98	40.00	-12.02	Peak	100	0	P
2	195.82	-12.03	39.17	27.14	43.50	-16.36	Peak	100	0	P
3	320.85	-7.81	45.16	37.35	46.00	-8.65	Peak	100	0	P
4	605.45	-0.98	35.22	34.24	46.00	-11.76	Peak	100	0	P
5	640.55	-0.76	43.12	42.36	46.00	-3.64	Peak	100	0	P
6	960.56	4.14	33.19	37.33	54.00	-16.67	Peak	100	0	P

Note: Level=Reading+Factor

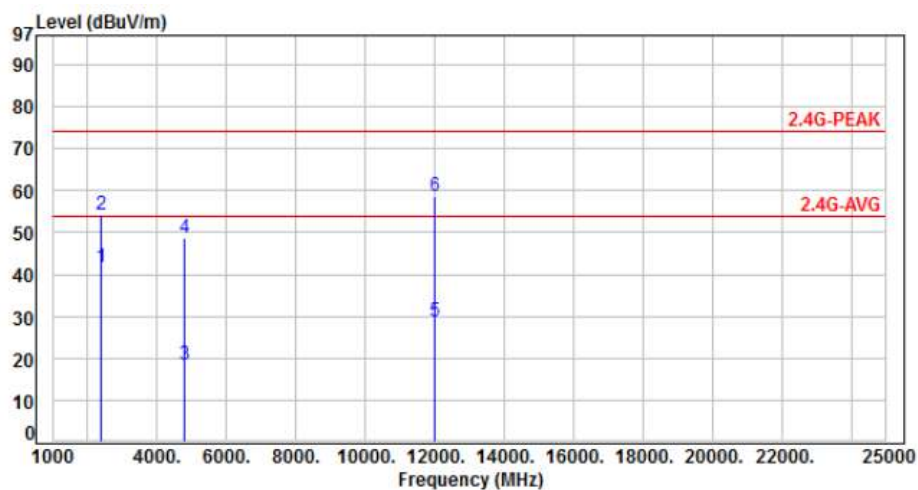
Margin=Level-Limit

Factor=Antenna Factor + cable loss - Amplifier Factor



6.6 Test Result and Data (1GHz ~ 25GHz)

Power	:	AC 120V / 60Hz	Pol/Phase	:	VERTICAL
Test Mode	:	Mode 1, CH00		:	



No.	Frequency (MHz)	Factor (dB)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg)	P/F
1	2390.00	-3.64	45.16	41.52	54.00	-12.48	Average	215	80	P
2	2390.00	-3.64	57.81	54.17	74.00	-19.83	Peak	215	80	P
3	4804.00	3.65	14.92	18.57	54.00	-35.43	Average	100	138	P
4	4804.00	3.65	45.02	48.67	74.00	-25.33	Peak	100	138	P
5	12010.00	13.50	15.22	28.72	54.00	-25.28	Average	100	360	P
6	12010.00	13.50	45.32	58.82	74.00	-15.18	Peak	100	360	P

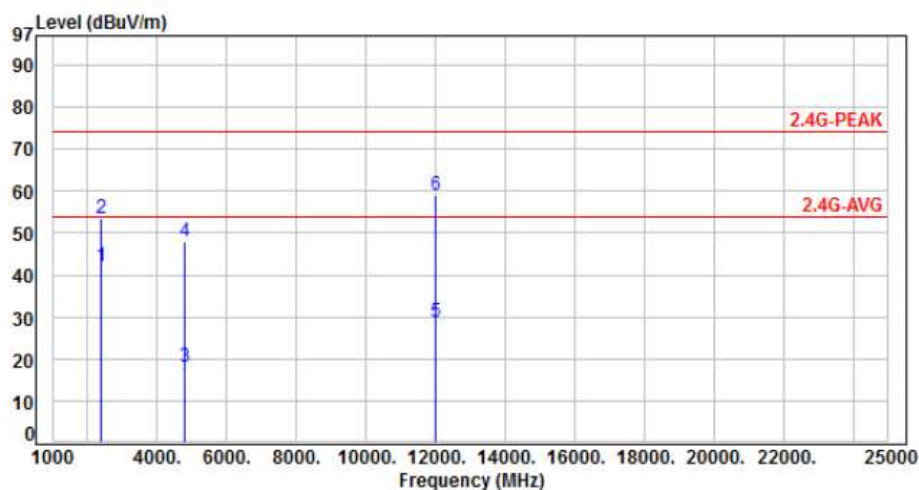
Note: Level=Reading+Factor

Margin=Level-Limit

Factor=Antenna Factor + cable loss - Amplifier Factor



Power	: AC 120V / 60Hz	Pol/Phase	: HORIZONTAL
Test Mode	: Mode 1, CH00		:



No.	Frequency (MHz)	Factor (dB)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg)	P/F
1	2390.00	-3.64	45.83	42.19	54.00	-11.81	Average	115	39	P
2	2390.00	-3.64	57.15	53.51	74.00	-20.49	Peak	115	39	P
3	4804.00	3.65	14.33	17.98	54.00	-36.02	Average	100	230	P
4	4804.00	3.65	44.43	48.08	74.00	-25.92	Peak	100	230	P
5	12010.00	13.50	15.36	28.86	54.00	-25.14	Average	100	335	P
6	12010.00	13.50	45.46	58.96	74.00	-15.04	Peak	100	335	P

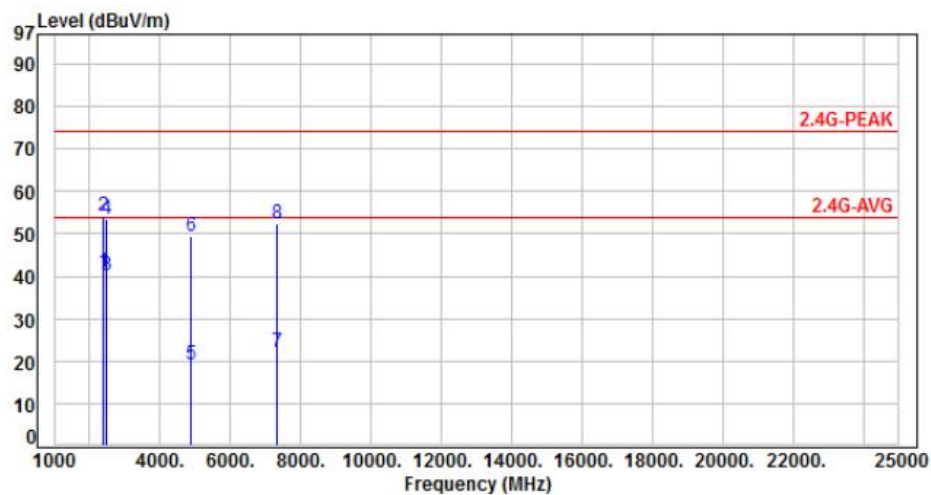
Note: Level=Reading+Factor

Margin=Level-Limit

Factor=Antenna Factor + cable loss - Amplifier Factor



Power	: AC 120V / 60Hz	Pol/Phase	: VERTICAL
Test Mode	: Mode 1, CH39		:



No.	Frequency (MHz)	Factor (dB)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg)	P/F
1	2390.00	-3.64	44.58	40.94	54.00	-13.06	Average	122	35	P
2	2390.00	-3.64	57.80	54.16	74.00	-19.84	Peak	122	35	P
3	2483.50	-3.30	43.54	40.24	54.00	-13.76	Average	122	35	P
4	2483.50	-3.30	56.72	53.42	74.00	-20.58	Peak	122	35	P
5	4882.00	3.97	15.32	19.29	54.00	-34.71	Average	100	137	P
6	4882.00	3.97	45.42	49.39	74.00	-24.61	Peak	100	137	P
7	7323.00	8.84	13.45	22.29	54.00	-31.71	Average	100	76	P
8	7323.00	8.84	43.55	52.39	74.00	-21.61	Peak	100	76	P

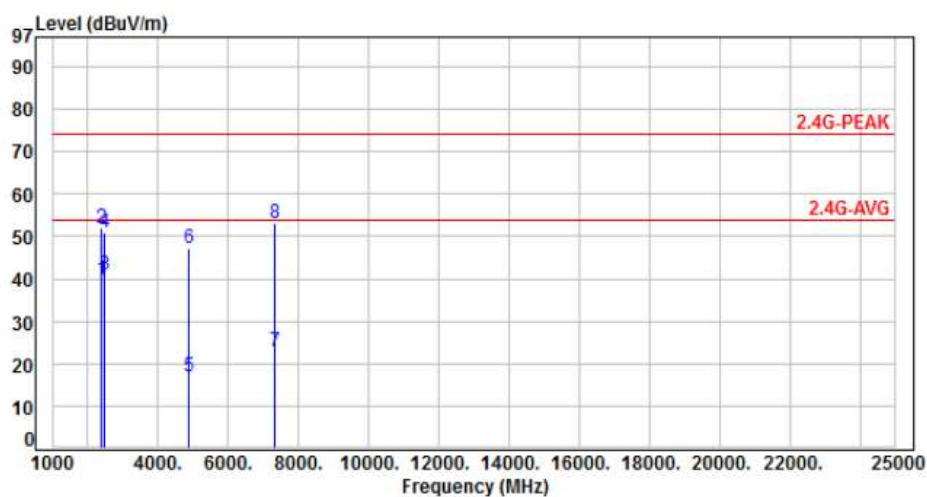
Note: Level=Reading+Factor

Margin=Level-Limit

Factor=Antenna Factor + cable loss - Amplifier Factor



Power	: AC 120V / 60Hz	Pol/Phase	: HORIZONTAL
Test Mode	: Mode 1, CH39		:



No.	Frequency (MHz)	Factor (dB)	Reading (dBUV)	Level (dBUV/m)	Limit (dBUV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg)	P/F
1	2390.00	-3.64	43.50	39.86	54.00	-14.14	Average	220	150	P
2	2390.00	-3.64	55.60	51.96	74.00	-22.04	Peak	220	150	P
3	2483.50	-3.30	44.11	40.81	54.00	-13.19	Average	220	150	P
4	2483.50	-3.30	54.35	51.05	74.00	-22.95	Peak	220	150	P
5	4882.00	3.97	13.01	16.98	54.00	-37.02	Average	100	268	P
6	4882.00	3.97	43.11	47.08	74.00	-26.92	Peak	100	268	P
7	7323.00	8.84	14.05	22.89	54.00	-31.11	Average	100	312	P
8	7323.00	8.84	44.15	52.99	74.00	-21.01	Peak	100	312	P

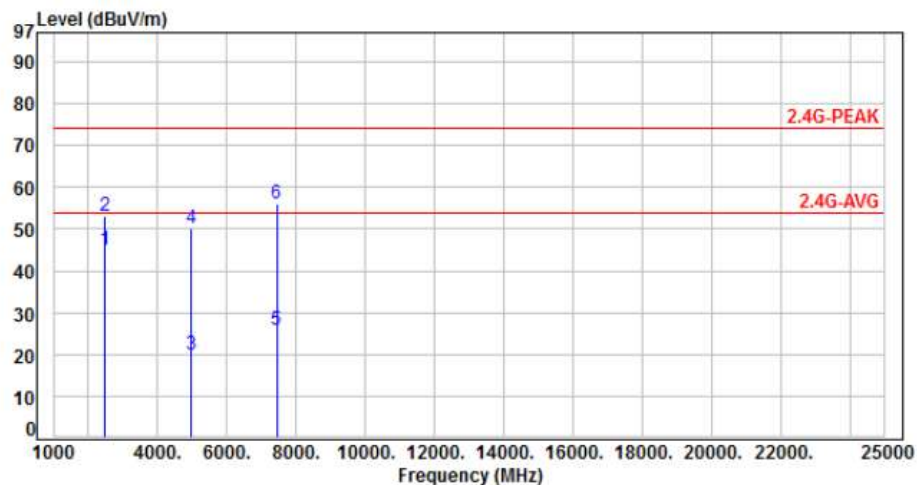
Note: Level=Reading+Factor

Margin=Level-Limit

Factor=Antenna Factor + cable loss - Amplifier Factor



Power	: AC 120V / 60Hz	Pol/Phase	: VERTICAL
Test Mode	: Mode 1, CH78		:



No.	Frequency (MHz)	Factor (dB)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg)	P/F
1	2483.50	-3.30	48.11	44.81	54.00	-9.19	Average	264	118	P
2	2483.50	-3.30	56.29	52.99	74.00	-21.01	Peak	264	118	P
3	4960.00	4.21	15.88	20.09	54.00	-33.91	Average	135	100	P
4	4960.00	4.21	45.98	50.19	74.00	-23.81	Peak	135	100	P
5	7440.00	8.98	16.87	25.85	54.00	-28.15	Average	100	110	P
6	7440.00	8.98	46.97	55.95	74.00	-18.05	Peak	100	110	P

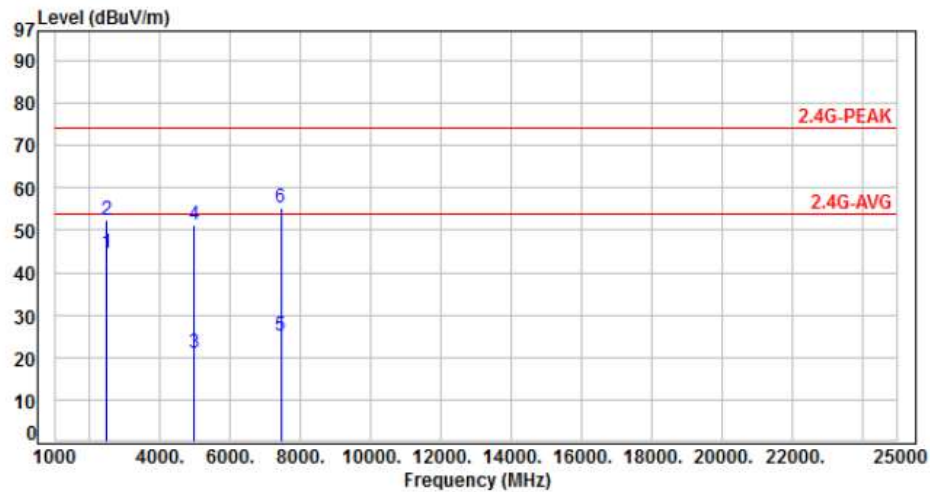
Note: Level=Reading+Factor

Margin=Level-Limit

Factor=Antenna Factor + cable loss - Amplifier Factor



Power	: AC 120V / 60Hz	Pol/Phase	: HORIZONTAL
Test Mode	: Mode 1, CH78		:



No.	Frequency (MHz)	Factor (dB)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg)	P/F
1	2483.50	-3.30	47.86	44.56	54.00	-9.44	Average	215	275	P
2	2483.50	-3.30	55.73	52.43	74.00	-21.57	Peak	215	275	P
3	4960.00	4.21	16.99	21.20	54.00	-32.80	Average	145	275	P
4	4960.00	4.21	47.09	51.30	74.00	-22.70	Peak	145	275	P
5	7440.00	8.98	16.17	25.15	54.00	-28.85	Average	100	360	P
6	7440.00	8.98	46.27	55.25	74.00	-18.75	Peak	100	360	P

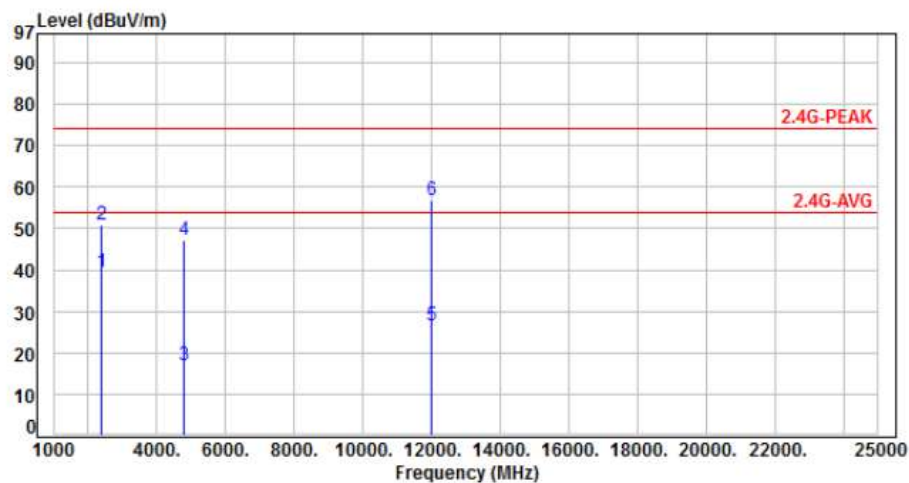
Note: Level=Reading+Factor

Margin=Level-Limit

Factor=Antenna Factor + cable loss - Amplifier Factor



Power	: AC 120V / 60Hz	Pol/Phase	: VERTICAL
Test Mode	: Mode 2, CH00		:



No.	Frequency (MHz)	Factor (dB)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg)	P/F
1	2390.00	-3.64	43.11	39.47	54.00	-14.53	Average	150	44	P
2	2390.00	-3.64	54.36	50.72	74.00	-23.28	Peak	150	44	P
3	4804.00	3.65	13.40	17.05	54.00	-36.95	Average	240	159	P
4	4804.00	3.65	43.50	47.15	74.00	-26.85	Peak	240	159	P
5	12010.00	13.50	13.16	26.66	54.00	-27.34	Average	100	88	P
6	12010.00	13.50	43.26	56.76	74.00	-17.24	Peak	100	88	P

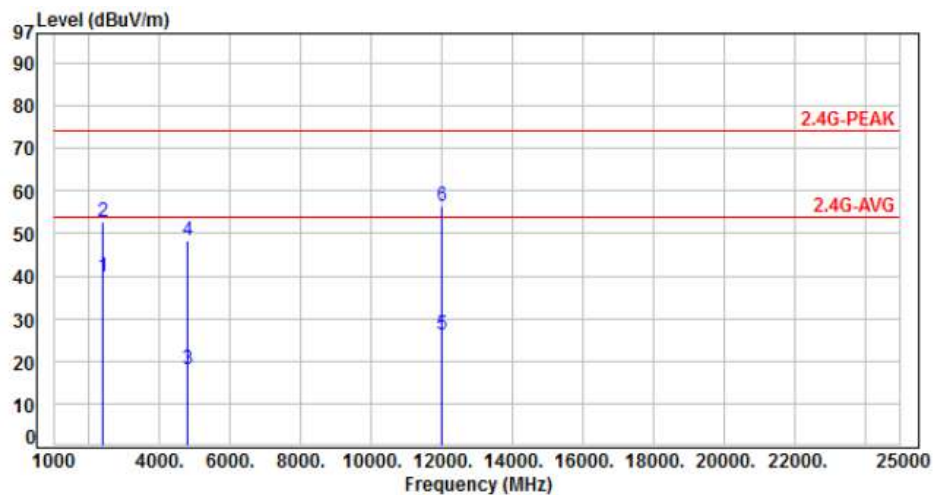
Note: Level=Reading+Factor

Margin=Level-Limit

Factor=Antenna Factor + cable loss - Amplifier Factor



Power	: AC 120V / 60Hz	Pol/Phase	: HORIZONTAL
Test Mode	: Mode 2, CH00		:



No.	Frequency (MHz)	Factor (dB)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg)	P/F
1	2390.00	-3.64	43.51	39.87	54.00	-14.13	Average	123	47	P
2	2390.00	-3.64	56.20	52.56	74.00	-21.44	Peak	123	47	P
3	4804.00	3.65	14.50	18.15	54.00	-35.85	Average	292	127	P
4	4804.00	3.65	44.60	48.25	74.00	-25.75	Peak	292	127	P
5	12010.00	13.50	12.86	26.36	54.00	-27.64	Average	100	325	P
6	12010.00	13.50	42.96	56.46	74.00	-17.54	Peak	100	325	P

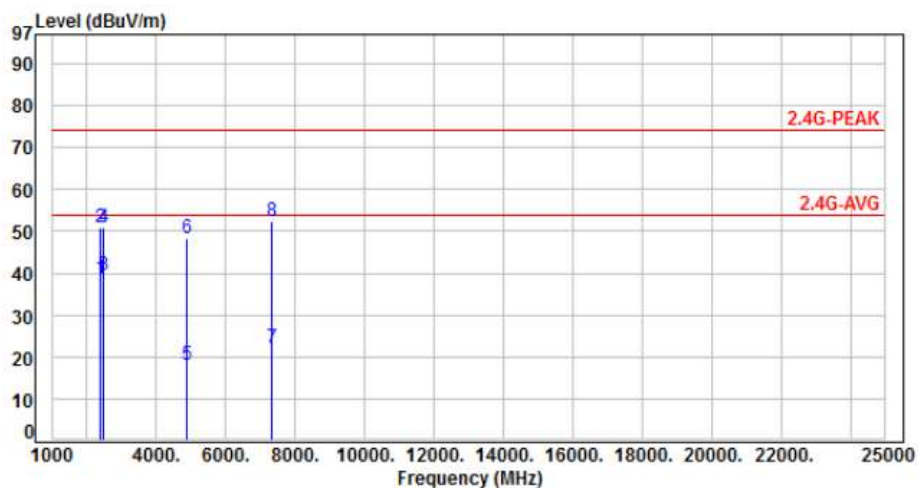
Note: Level=Reading+Factor

Margin=Level-Limit

Factor=Antenna Factor + cable loss - Amplifier Factor



Power	:	AC 120V / 60Hz	Pol/Phase	:	VERTICAL
Test Mode	:	Mode 2, CH39		:	



No.	Frequency (MHz)	Factor (dB)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg)	P/F
1	2390.00	-3.64	42.33	38.69	54.00	-15.31	Average	136	60	P
2	2390.00	-3.64	54.40	50.76	74.00	-23.24	Peak	136	60	P
3	2483.50	-3.30	42.62	39.32	54.00	-14.68	Average	136	60	P
4	2483.50	-3.30	54.25	50.95	74.00	-23.05	Peak	136	60	P
5	4882.00	3.97	14.19	18.16	54.00	-35.84	Average	106	141	P
6	4882.00	3.97	44.29	48.26	74.00	-25.74	Peak	106	141	P
7	7323.00	8.84	13.42	22.26	54.00	-31.74	Average	100	97	P
8	7323.00	8.84	43.52	52.36	74.00	-21.64	Peak	100	97	P

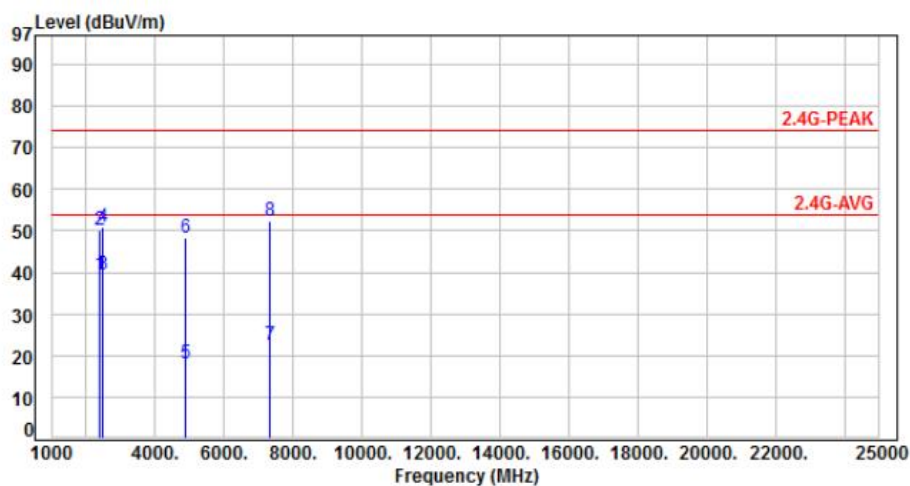
Note: Level=Reading+Factor

Margin=Level-Limit

Factor=Antenna Factor + cable loss - Amplifier Factor



Power	: AC 120V / 60Hz	Pol/Phase	: HORIZONTAL
Test Mode	: Mode 2, CH39		:



No.	Frequency (MHz)	Factor (dB)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg)	P/F
1	2390.00	-3.64	43.25	39.61	54.00	-14.39	Average	200	163	P
2	2390.00	-3.64	53.88	50.24	74.00	-23.76	Peak	200	163	P
3	2483.50	-3.30	42.62	39.32	54.00	-14.68	Average	200	163	P
4	2483.50	-3.30	54.15	50.85	74.00	-23.15	Peak	200	163	P
5	4882.00	3.97	14.26	18.23	54.00	-35.77	Average	100	144	P
6	4882.00	3.97	44.36	48.33	74.00	-25.67	Peak	100	144	P
7	7323.00	8.84	13.55	22.39	54.00	-31.61	Average	100	322	P
8	7323.00	8.84	43.65	52.49	74.00	-21.51	Peak	100	322	P

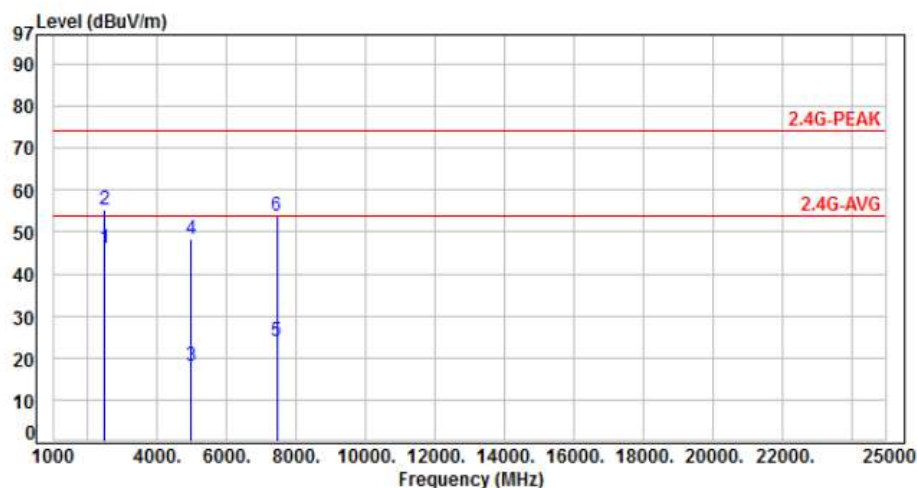
Note: Level=Reading+Factor

Margin=Level-Limit

Factor=Antenna Factor + cable loss - Amplifier Factor



Power	: AC 120V / 60Hz	Pol/Phase	: VERTICAL
Test Mode	: Mode 2, CH78		:



No.	Frequency (MHz)	Factor (dB)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg)	P/F
1	2483.50	-3.30	49.55	46.25	54.00	-7.75	Average	400	101	P
2	2483.50	-3.30	58.62	55.32	74.00	-18.68	Peak	400	101	P
3	4960.00	4.21	14.00	18.21	54.00	-35.79	Average	123	101	P
4	4960.00	4.21	44.10	48.31	74.00	-25.69	Peak	123	101	P
5	7440.00	8.98	14.84	23.82	54.00	-30.18	Average	100	79	P
6	7440.00	8.98	44.94	53.92	74.00	-20.08	Peak	100	79	P

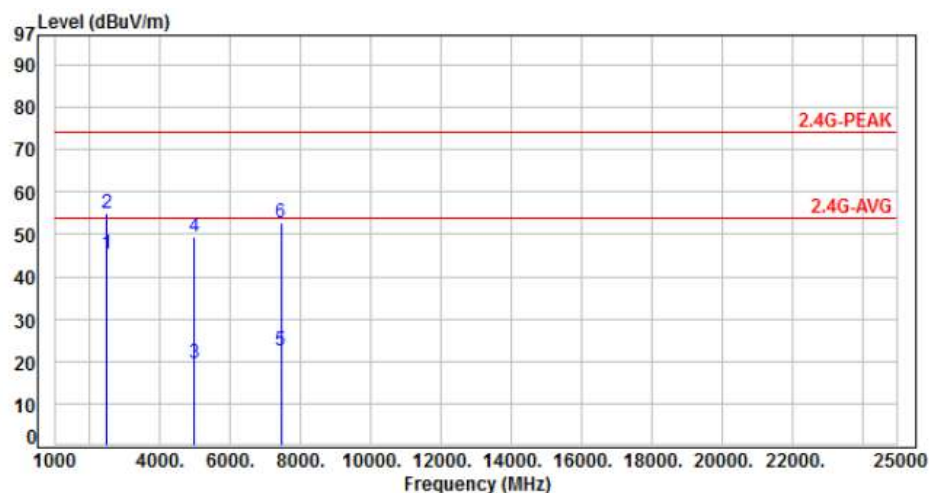
Note: Level=Reading+Factor

Margin=Level-Limit

Factor=Antenna Factor + cable loss - Amplifier Factor



Power	: AC 120V / 60Hz	Pol/Phase	: HORIZONTAL
Test Mode	: Mode 2, CH78		:



No.	Frequency (MHz)	Factor (dB)	Reading (dBUV)	Level (dBUV/m)	Limit (dBUV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg)	P/F
1	2483.50	-3.30	48.59	45.29	54.00	-8.71	Average	387	36	P
2	2483.50	-3.30	58.29	54.99	74.00	-19.01	Peak	387	36	P
3	4960.00	4.21	15.16	19.37	54.00	-34.63	Average	152	260	P
4	4960.00	4.21	45.26	49.47	74.00	-24.53	Peak	152	260	P
5	7440.00	8.98	13.54	22.52	54.00	-31.48	Average	100	314	P
6	7440.00	8.98	43.64	52.62	74.00	-21.38	Peak	100	314	P

Note: Level=Reading+Factor

Margin=Level-Limit

Factor=Antenna Factor + cable loss - Amplifier Factor



6.7 Restricted Bands of Operation

Only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.09000 – 0.11000	16.42000 – 16.42300	399.9 – 410.0	4.500 – 5.250
0.49500 – 0.505**	16.69475 – 16.69525	608.0 – 614.0	5.350 – 5.460
2.17350 – 2.19050	16.80425 – 16.80475	960.0 – 1240.0	7.250 – 7.750
4.12500 – 4.12800	25.50000 – 25.67000	1300.0 – 1427.0	8.025 – 8.500
4.17725 – 4.17775	37.50000 – 38.25000	1435.0 – 1626.5	9.000 – 9.200
4.20725 – 4.20775	73.00000 – 74.60000	1645.5 – 1646.5	9.300 – 9.500
6.21500 – 6.21800	74.80000 – 75.20000	1660.0 – 1710.0	10.600 – 12.700
6.26775 – 6.26825	108.00000 – 121.94000	1718.8 – 1722.2	13.250 – 13.400
6.31175 – 6.31225	123.00000 – 138.00000	2200.0 – 2300.0	14.470 – 14.500
8.29100 – 8.29400	149.90000 – 150.05000	2310.0 – 2390.0	15.350 – 16.200
8.36200 – 8.36600	156.52475 – 156.52525	2483.5 – 2500.0	17.700 – 21.400
8.37625 – 8.38675	156.70000 – 156.90000	2655.0 – 2900.0	22.010 – 23.120
8.41425 – 8.41475	162.01250 – 167.17000	3260.0 – 3267.0	23.600 – 24.000
12.29000 – 12.29300	167.72000 – 173.20000	3332.0 – 3339.0	31.200 – 31.800
12.51975 – 12.52025	240.00000 – 285.00000	3345.8 – 3358.0	36.430 – 36.500
12.57675 – 12.57725	322.00000 – 335.40000	3600.0 – 4400.0	Above 38.6
13.36000 – 13.41000			

** : Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz



7. Test of Conducted Spurious Emission

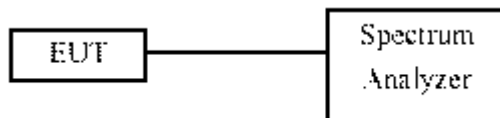
7.1 Test Limit

Below -20dB of the highest emission level of operating band (in 100kHz Resolution Bandwidth).

7.2 Test Procedure

- The transmitter output was connected to the spectrum analyzer via a low loss cable.
- Set both RBW and VBW of spectrum analyzer to 100 KHz with convenient frequency span including 100 KHz bandwidth from band edge.
- The band edges was measured and recorded.

7.3 Test Setup Layout

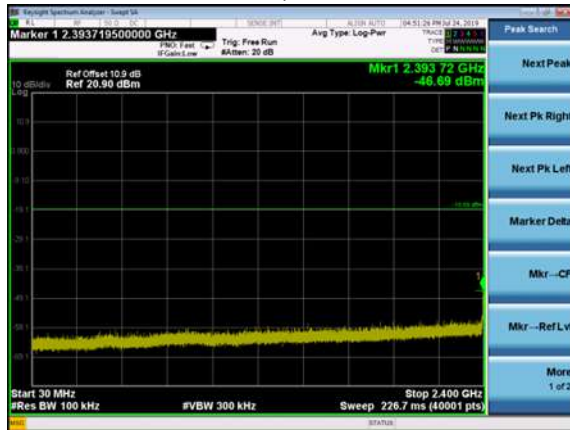


7.4 Test Result and Data

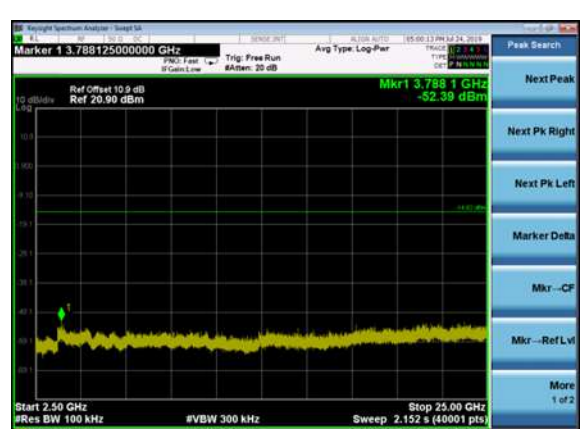
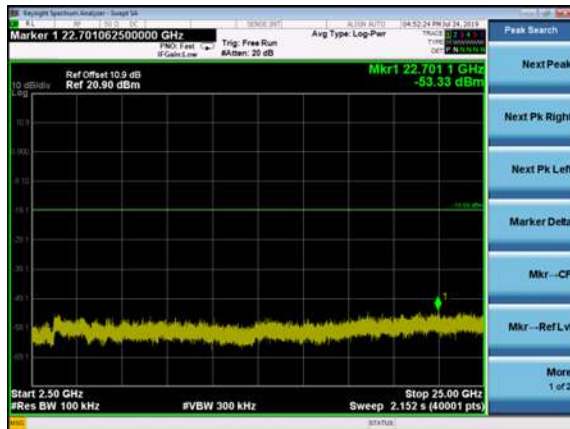
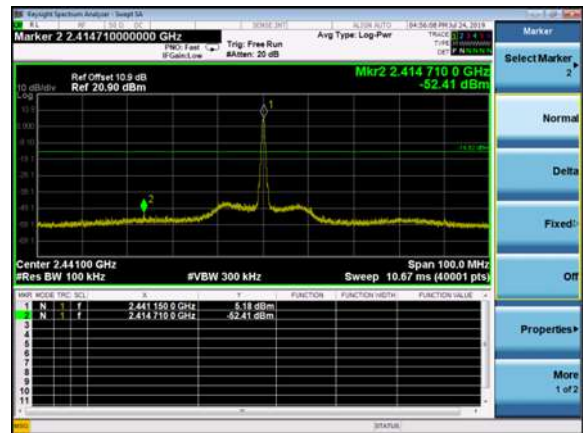
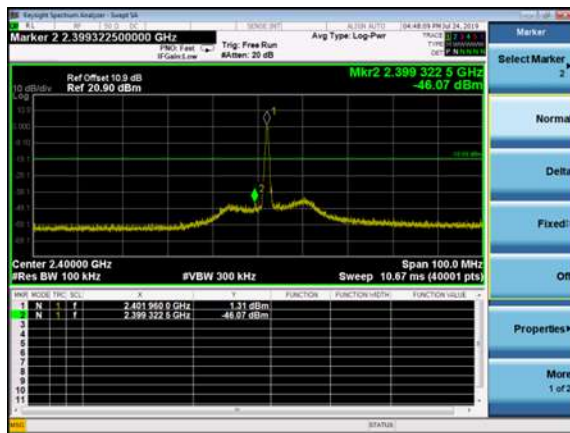
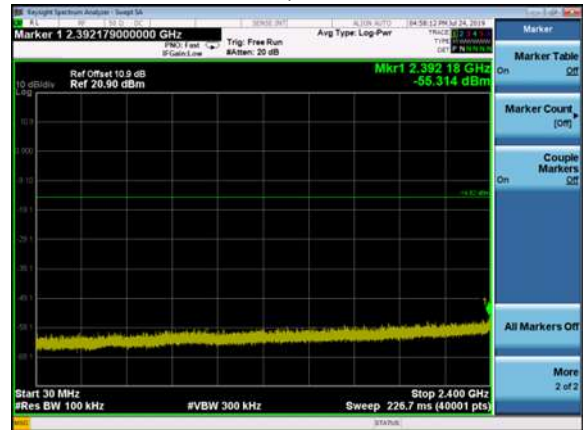
Note: Test plots refer to the following pages.



Modulation Mode: GFSK, CH00

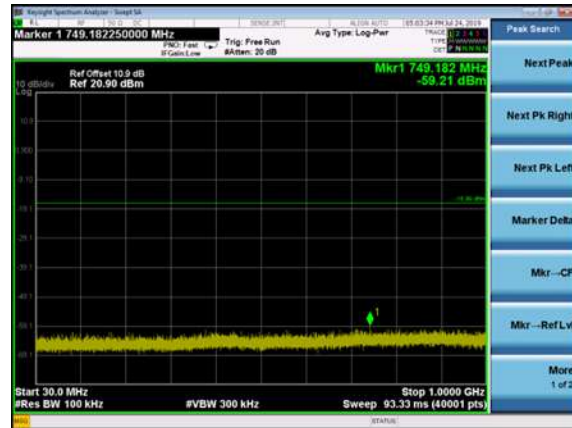
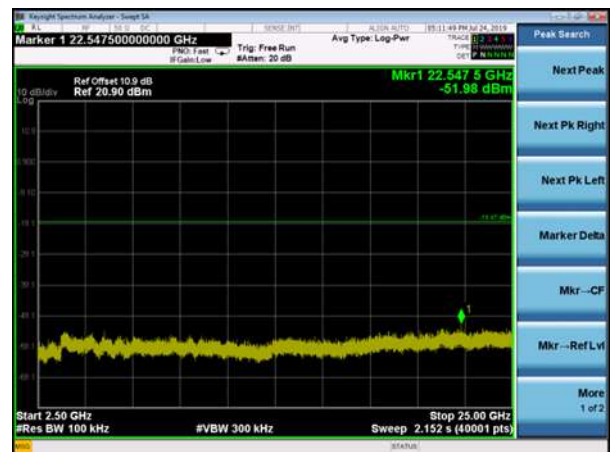
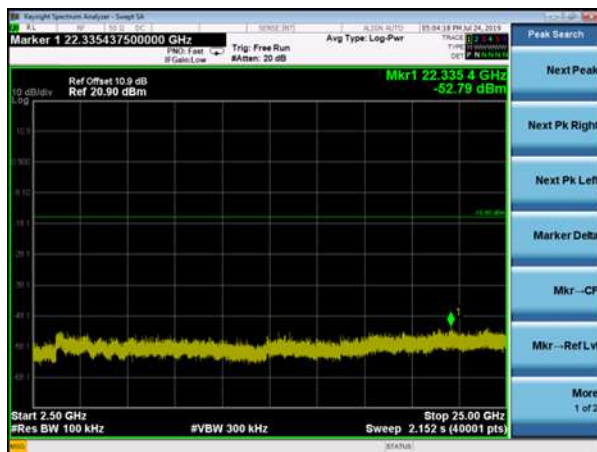
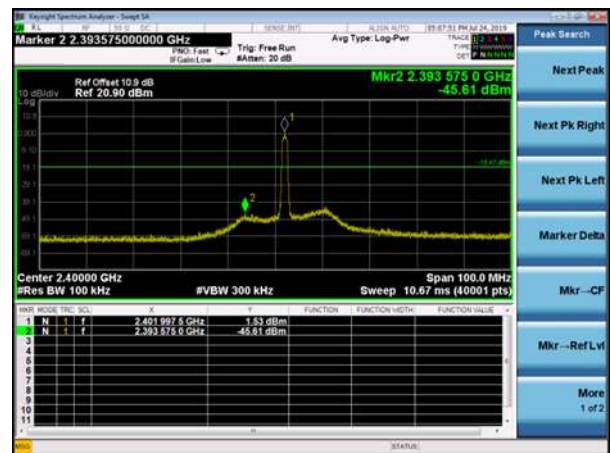
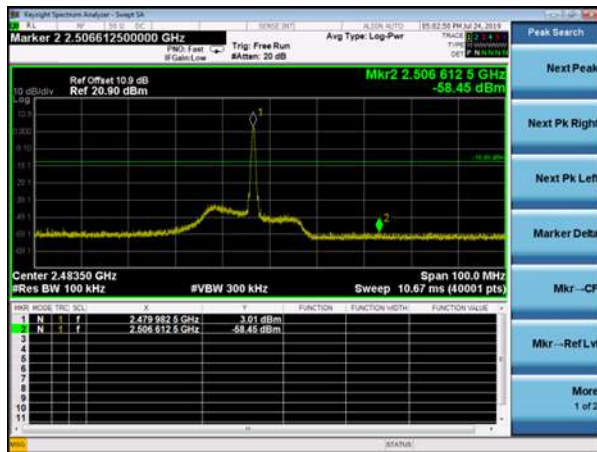
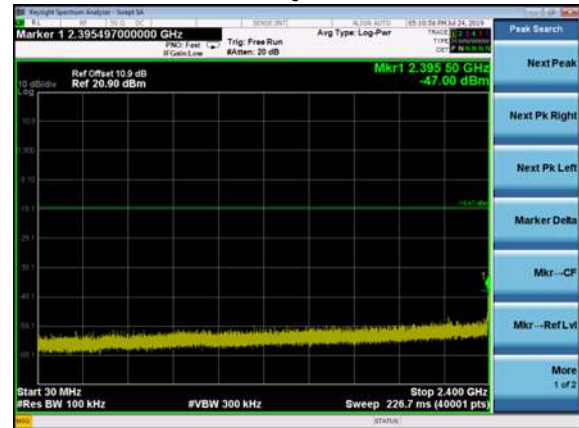


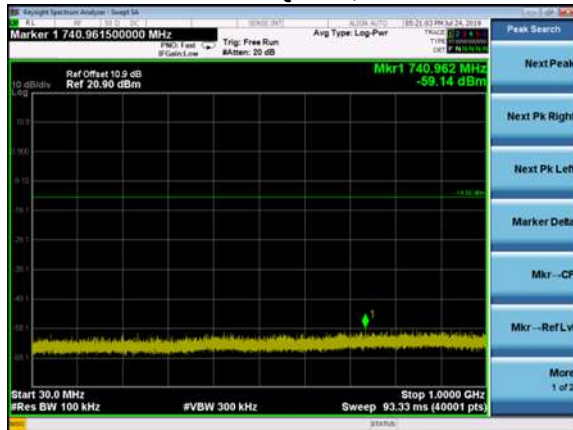
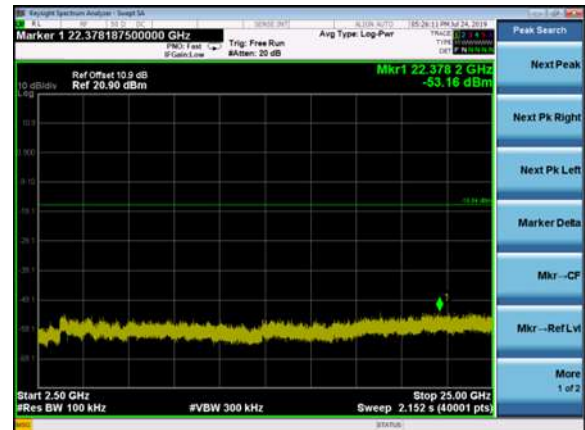
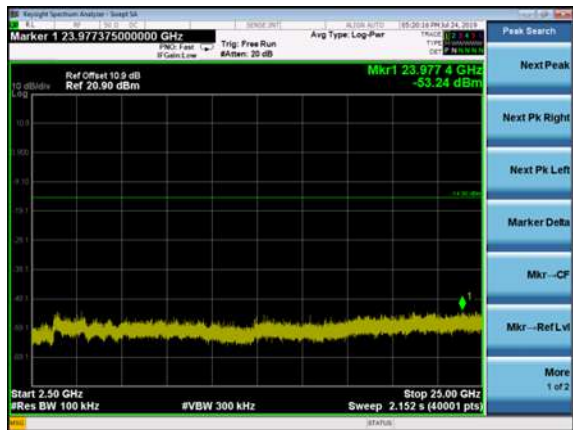
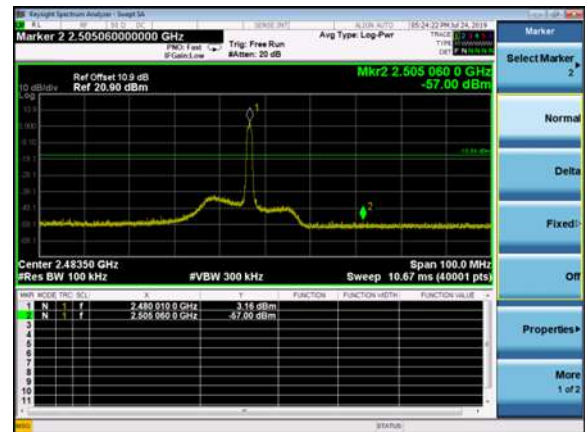
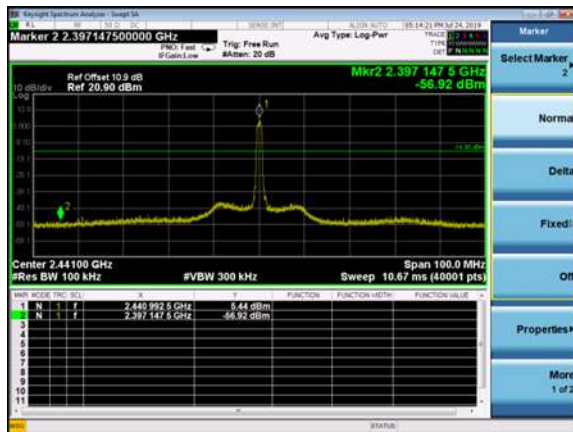
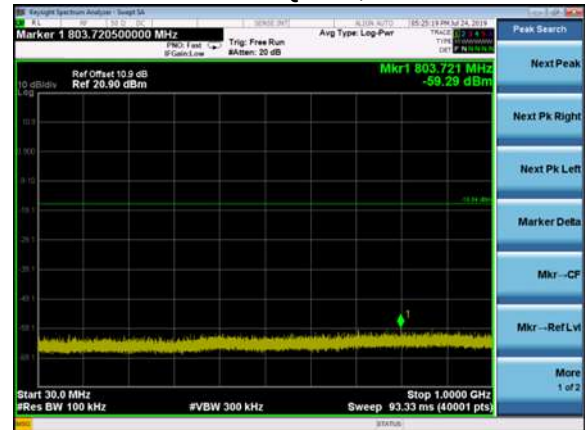
Modulation Mode: GFSK, CH39





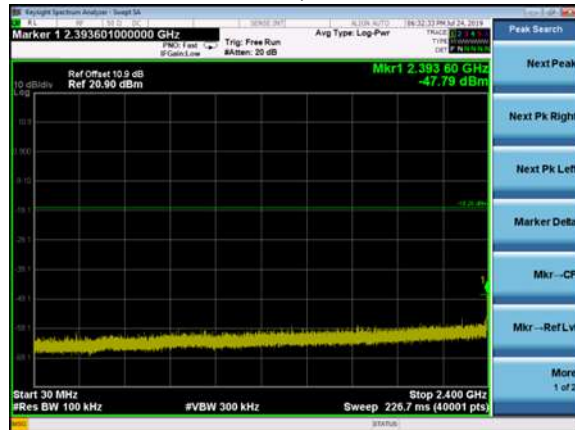
Modulation Mode: GFSK, CH78

Modulation Mode: $\pi/4$ -DQPSK, CH00

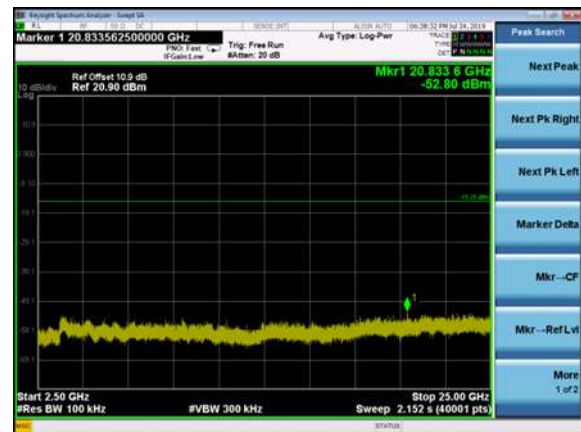
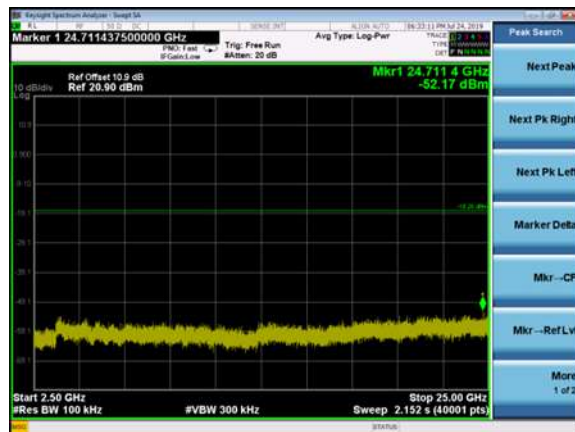
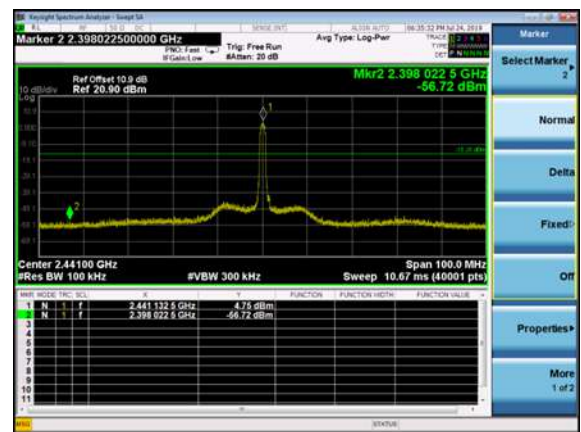
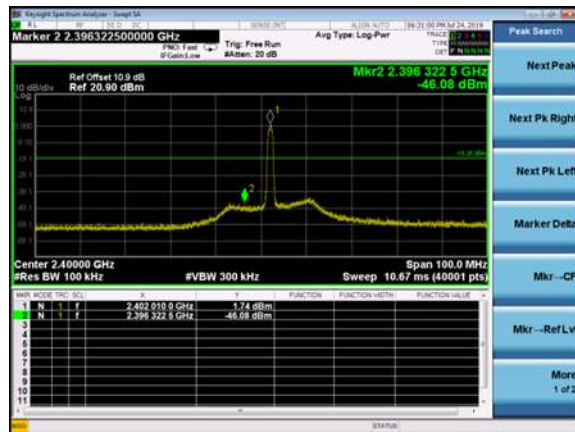
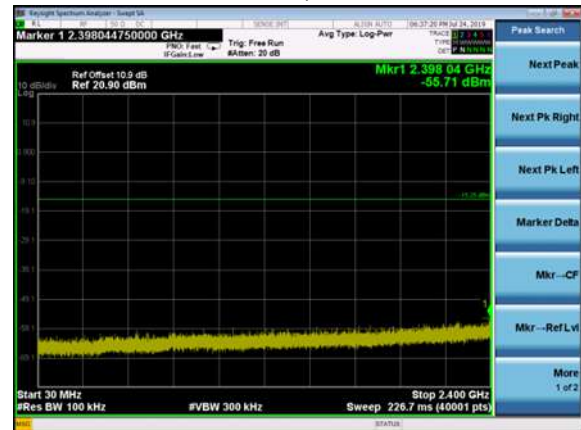
Modulation Mode: $\pi/4$ -DQPSK, CH39Modulation Mode: $\pi/4$ -DQPSK, CH78



Modulation Mode: 8DPSK, CH00

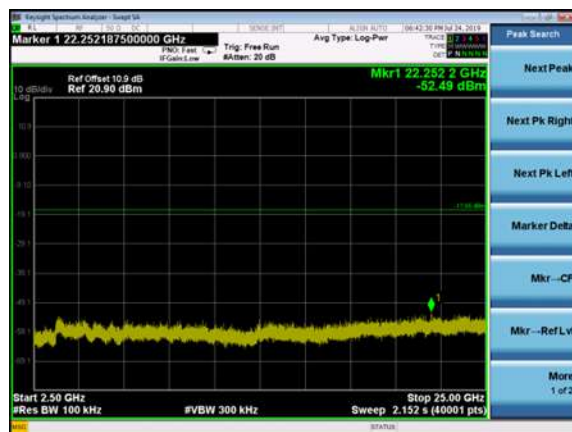
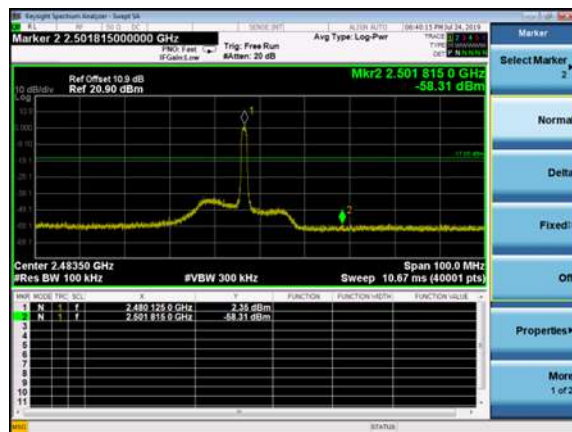
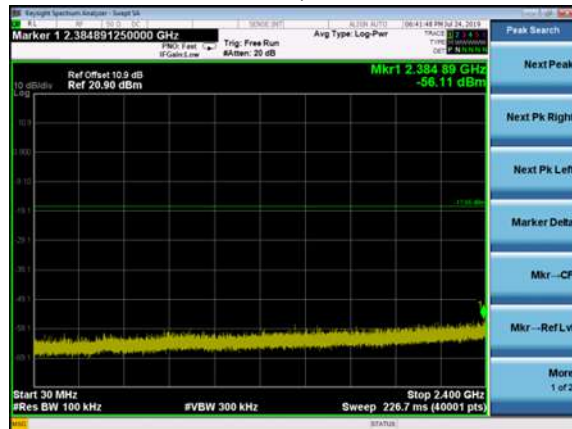


Modulation Mode: 8DPSK, CH39



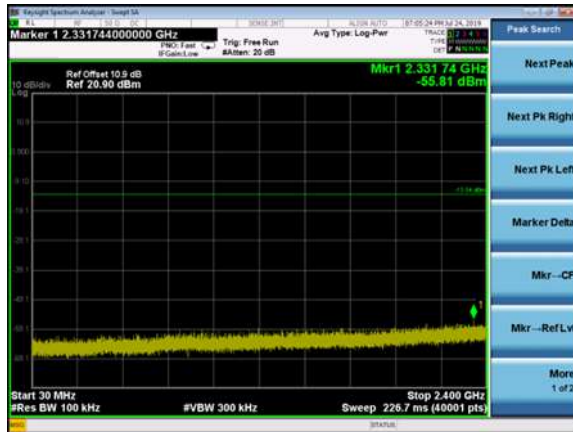


Modulation Mode: 8DPSK, CH78

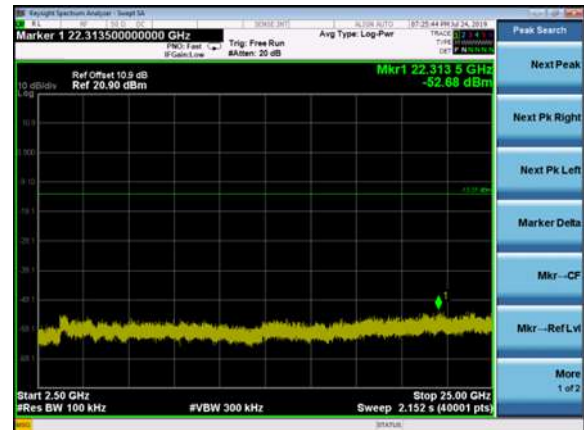
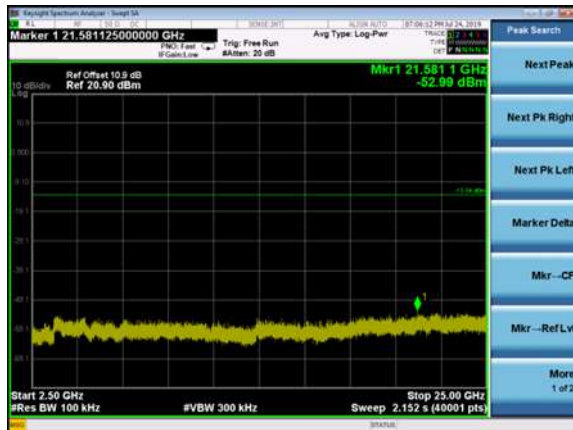
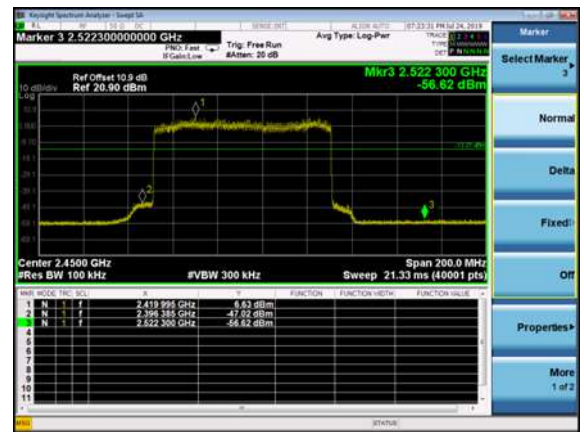
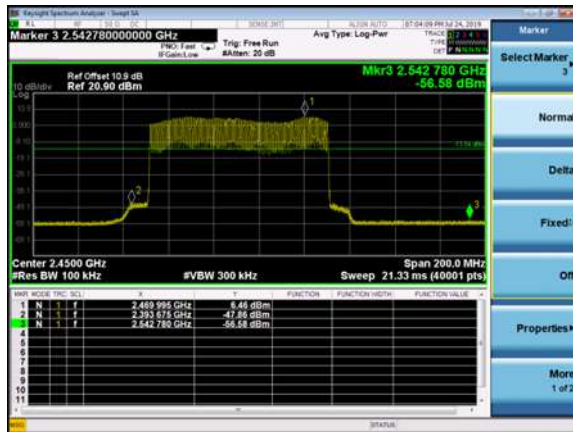
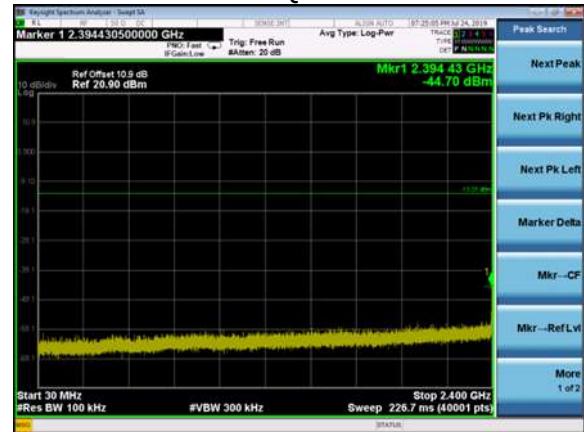




Hopping Mode:
Modulation Mode: GFSK

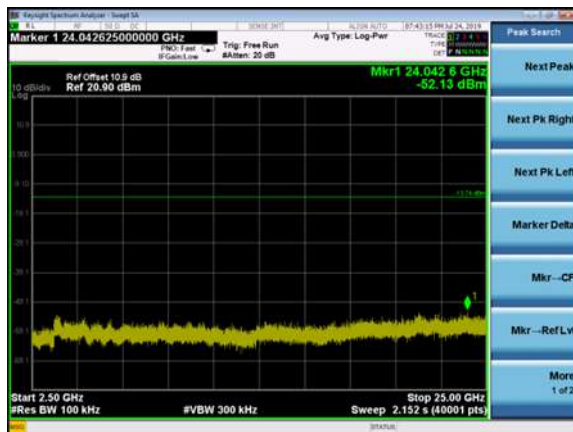
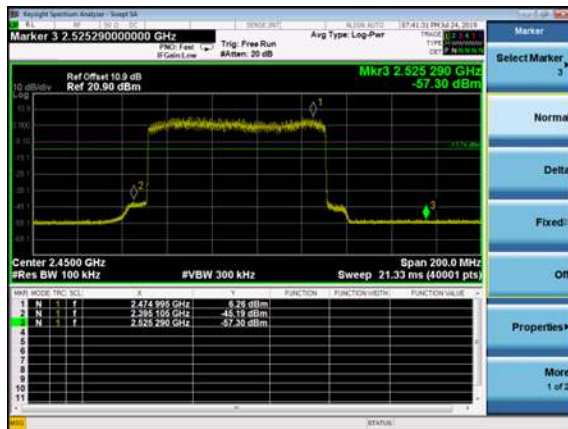
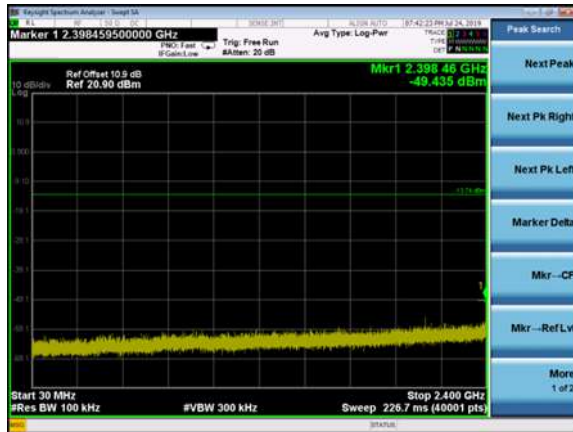


Modulation Mode: $\pi/4$ -DQPSK





Modulation Mode: 8DPSK





8. 20dB Bandwidth Measurement Data

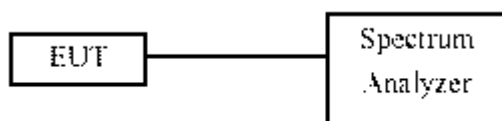
8.1 Test Limit

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.

8.2 Test Procedures

- The transmitter output was connected to the spectrum analyzer.
- Set RBW of spectrum analyzer to 30 KHz and VBW to 100 KHz.
- The 20 dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20 dB.

8.3 Test Setup Layout

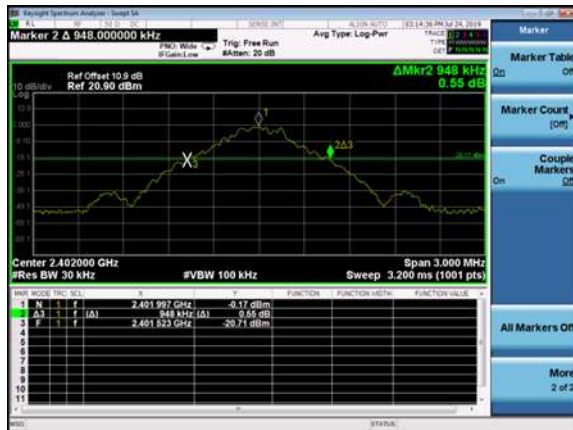


8.4 Test Result and Data

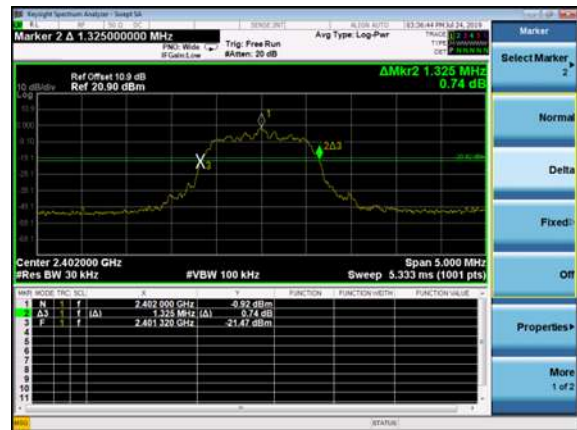
Modulation Mode	Channel	Frequency (MHz)	20dB Bandwidth (MHz)	2/3 20dB Bandwidth (MHz)
GFSK	0	2402	0.948	0.632
	39	2441	0.963	0.642
	78	2480	0.966	0.644
$\pi/4$ -DQPSK	0	2402	1.325	0.883
	39	2441	1.325	0.883
	78	2480	1.330	0.887
8DPSK	0	2402	1.320	0.880
	39	2441	1.325	0.883
	78	2480	1.325	0.883



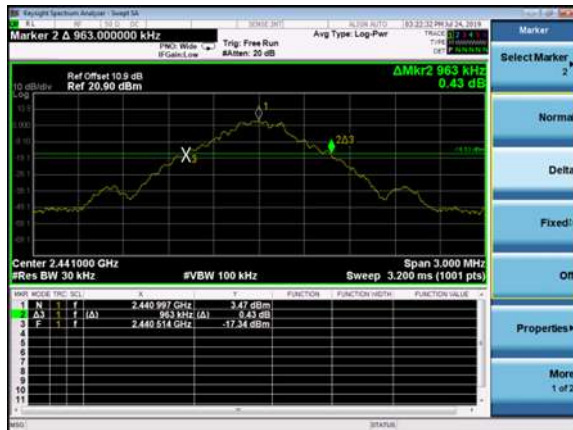
Modulation Mode: GFSK
CH00



Modulation Mode: $\pi/4$ -DQPSK
CH00



CH39



CH39



CH78

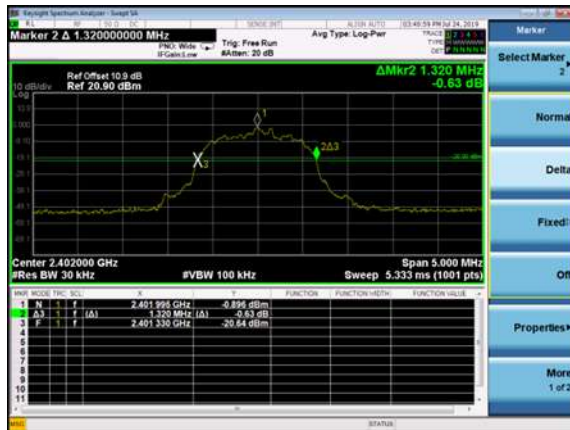


CH78

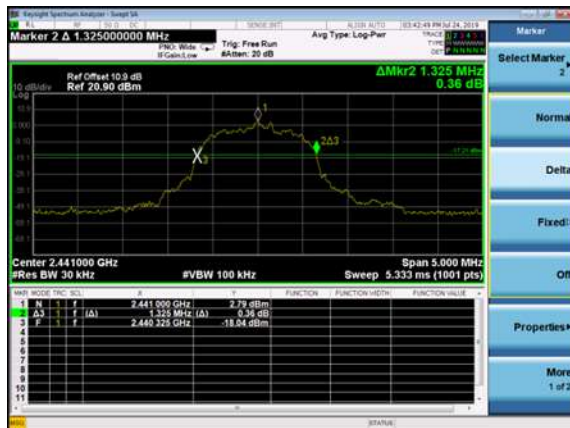




Modulation Mode: 8DSPK
CH00



CH39



CH78





9. Frequencies Separation

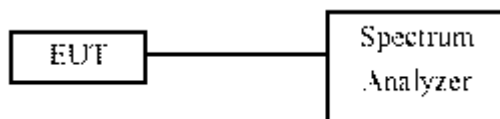
9.1 Test Limit

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

9.2 Test Procedures

- The transmitter output was connected to the spectrum analyzer.
- Set RBW of spectrum analyzer to 100 KHz and VBW to 300 KHz.
- By using the MaxHold function record the separation of two adjacent channels.
- Measure the frequency difference of these two adjacent channels.

9.3 Test Setup Layout

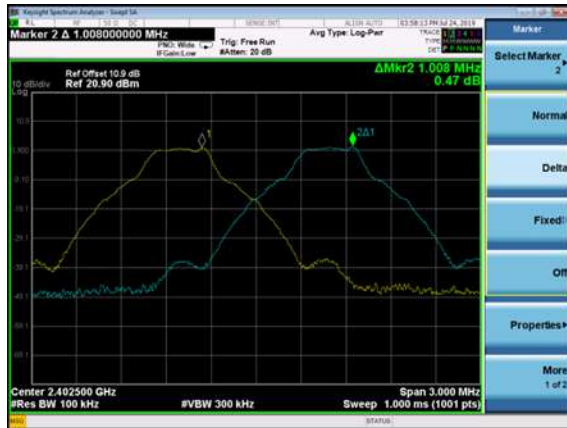


9.4 Test Result and Data

Modulation Mode	Channel	Frequency (MHz)	Channel Separation (MHz)	Limit (MHz)
GFSK	0	2402	1.008	0.632
	39	2441	1.005	0.642
	78	2480	1.002	0.644
$\pi/4$ -DQPSK	0	2402	1.020	0.883
	39	2441	1.008	0.883
	78	2480	1.008	0.887
8DPSK	0	2402	1.002	0.880
	39	2441	1.002	0.883
	78	2480	1.002	0.883



Modulation Mode: GFSK
CH00



Modulation Mode: $\pi/4$ -DQPSK
CH00



CH39



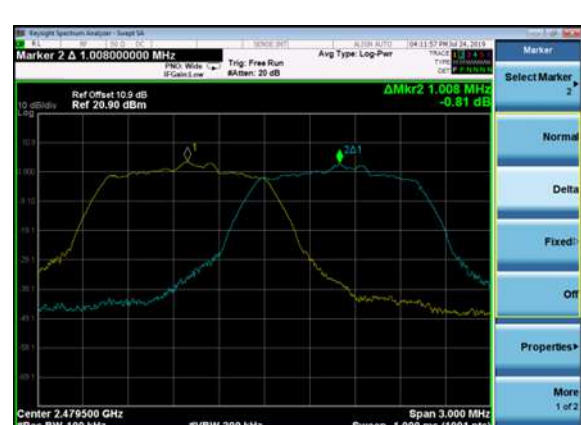
CH39



CH78

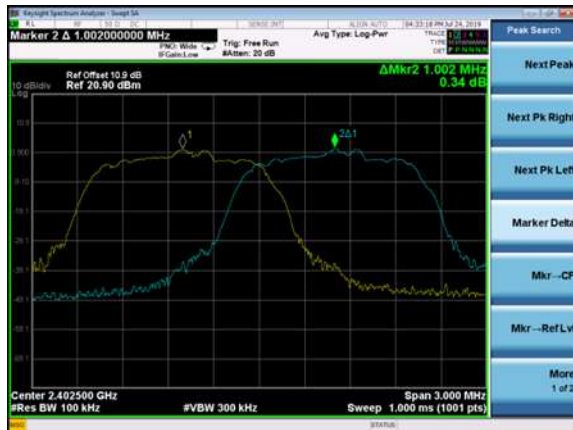


CH78





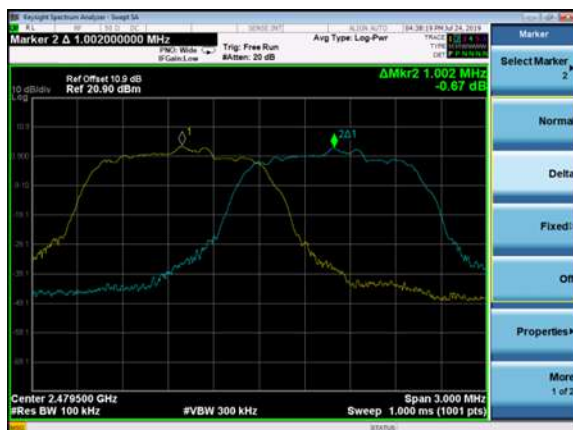
Modulation Mode: 8DSPK
CH00



CH39



CH78





10. Dwell Time on each channel

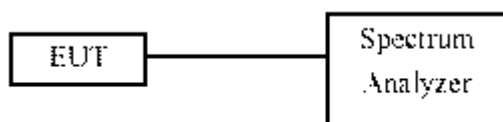
10.1 Test Limit

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.

10.2 Test Procedures

1. The transmitter output was connected to the spectrum analyzer.
2. Adjust the center frequency to measure frequency, then set zero span mode.
2. Set RBW of spectrum analyzer to 1 MHz and VBW to 1 MHz.
4. Measure the time duration of one transmission on the measured frequency.

10.3 Test Setup Layout



10.4 Test Result and Data

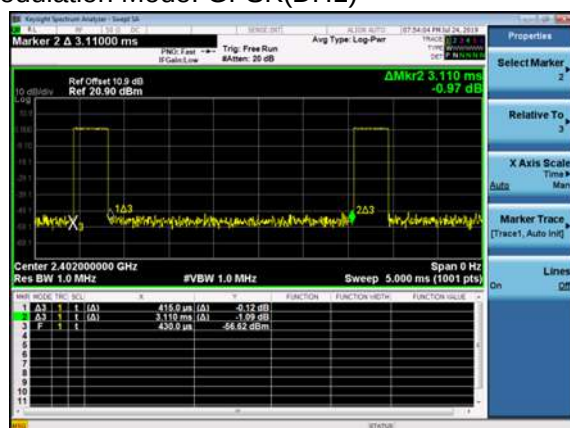
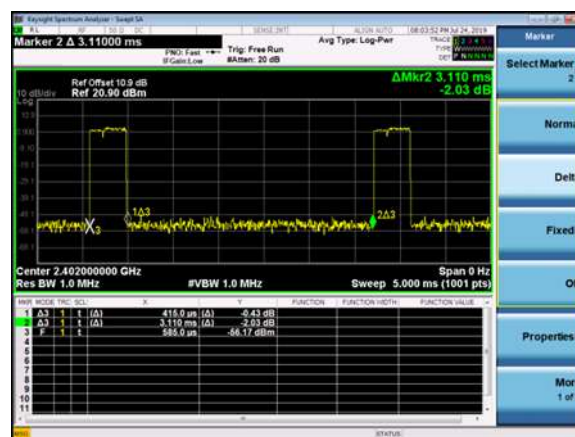
Modulation Mode	Frequency (MHz)	Length of transmission time (ms)	Number of transmission in a 31.6 (79 Hopping*0.4)	Dwell Time (ms)	Limit (ms)
GFSK-DH1	2402	0.415	320.10	132.84	400
GFSK-DH3	2402	1.665	159.90	266.23	400
GFSK-DH5	2402	2.910	106.81	310.82	400
$\pi/4$ -DQPSK-DH1	2402	0.415	320.10	132.84	400
$\pi/4$ -DQPSK-DH3	2402	1.680	159.90	268.63	400
$\pi/4$ -DQPSK-DH5	2402	2.940	106.81	314.02	400
8DPSK-DH1	2402	0.405	320.10	129.64	400
8DPSK-DH3	2402	1.670	159.90	267.03	400
8DPSK-DH5	2402	2.940	106.81	314.02	400

Test Period = 0.4 (second/ channel) x 20 Channel = 8 sec

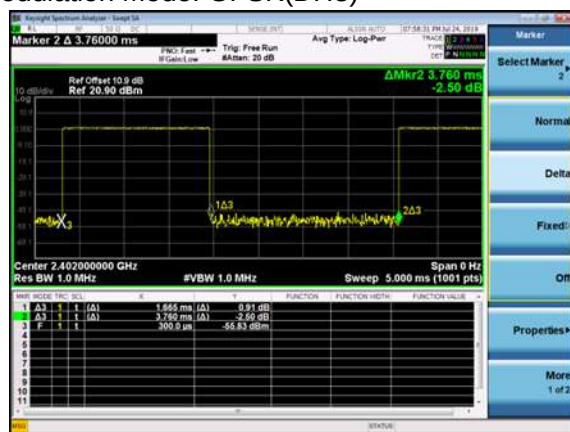
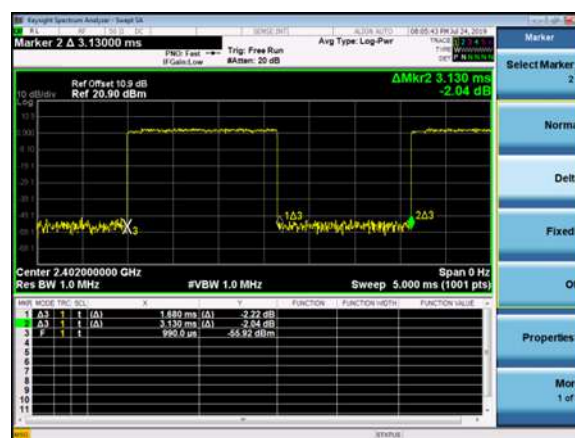
Modulation Mode	Frequency (MHz)	Length of transmission time (ms)	Number of transmission in a 8 (20 Hopping*0.4)	Dwell Time (ms)	Limit (ms)
AFH-DH1	2402-2421	0.415	160.00	66.40	400
AFH-DH3	2402-2421	1.665	80.00	133.20	400
AFH-DH5	2402-2421	2.910	53.33	155.19	400



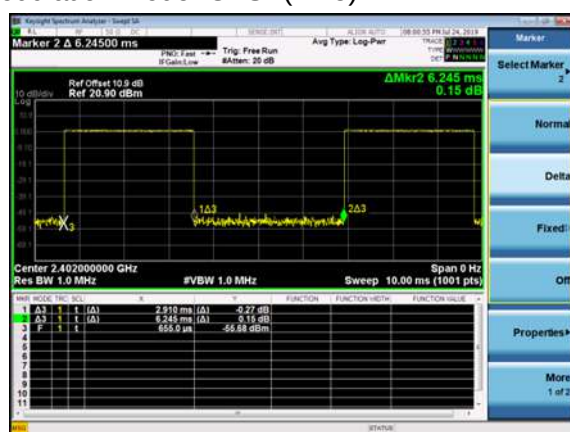
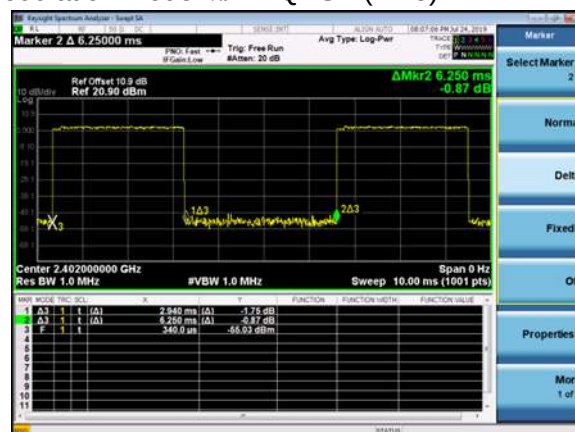
Modulation Mode: GFSK(DH1)

Modulation Mode: $\pi/4$ -DQPSK (DH1)

Modulation Mode: GFSK(DH3)

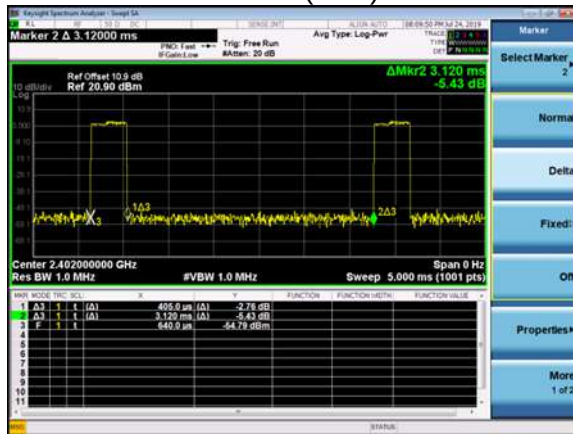
Modulation Mode: $\pi/4$ -DQPSK (DH3)

Modulation Mode: GFSK(DH5)

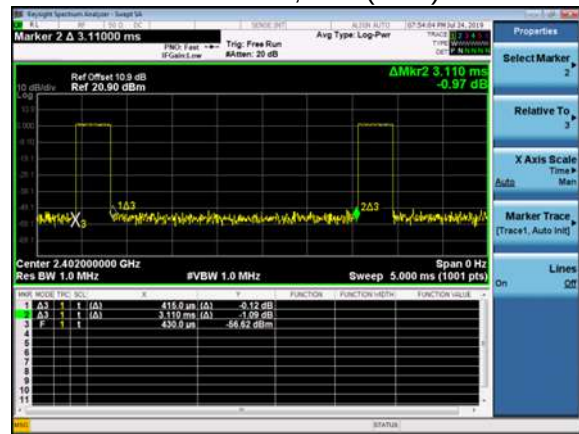
Modulation Mode: $\pi/4$ -DQPSK (DH5)



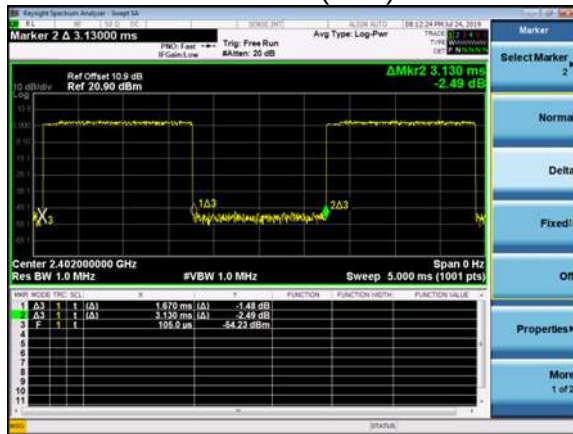
Modulation Mode: 8DSPK (DH1)



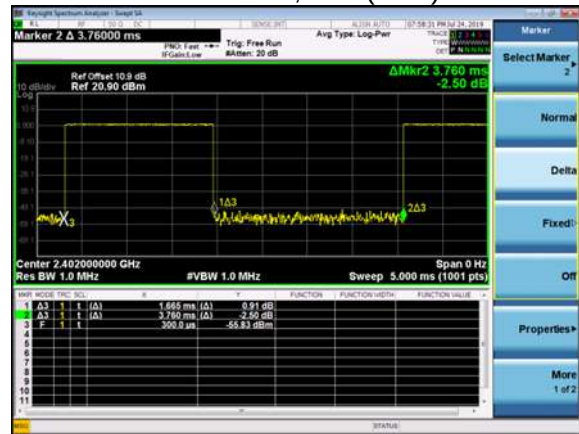
Modulation Mode: GFSK ,AFH (DH1)



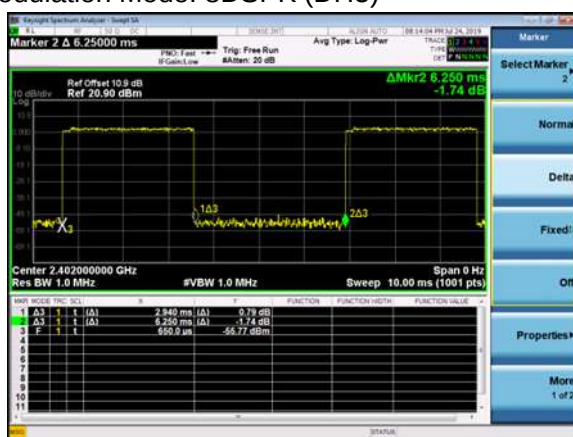
Modulation Mode: 8DSPK (DH3)



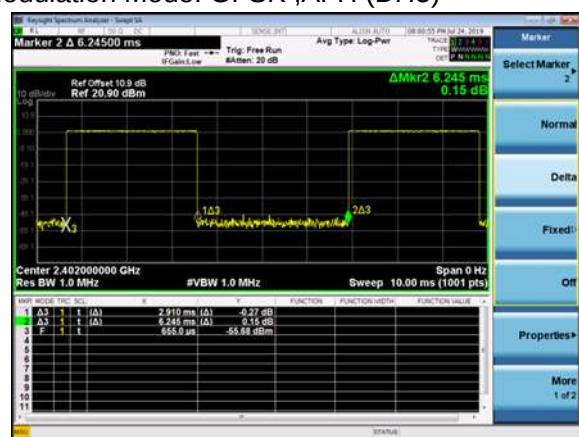
Modulation Mode: GFSK ,AFH (DH3)



Modulation Mode: 8DSPK (DH5)



Modulation Mode: GFSK ,AFH (DH5)





11. Number of Hopping Channels

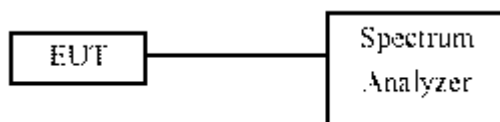
11.1 Test Limit

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

11.2 Test Procedures

- a. The transmitter output was connected to the spectrum analyzer.
- b. 2. Set RBW of spectrum analyzer to 100 KHz and VBW to 100 KHz.
- c. 3. Set the MaxHold function, and then keep the EUT in hopping mode. Record all the signals from each channel until each one has been record.

11.3 Test Setup Layout

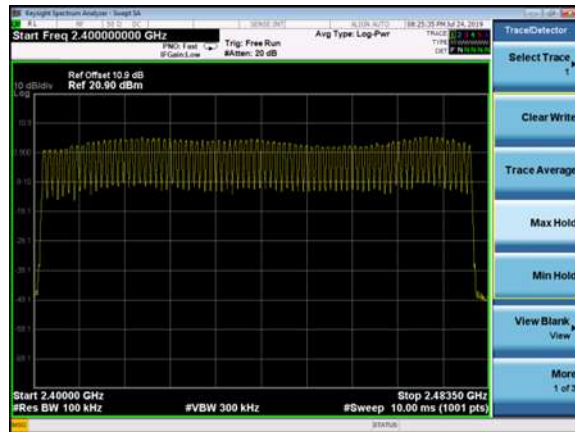


11.4 Test Result and Data

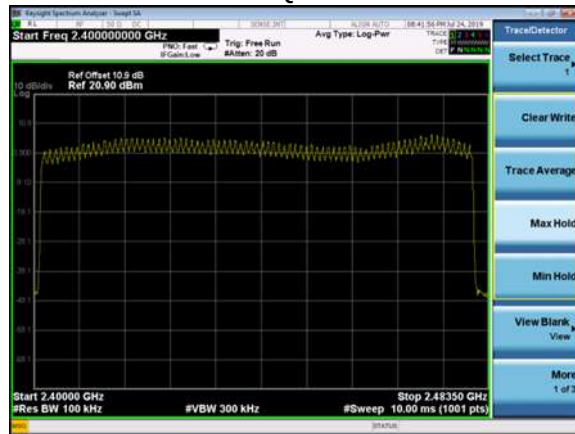
Modulation Mode	Hopping Channels
GFSK	79
$\pi/4$ -DQPSK	79
8DPSK	79



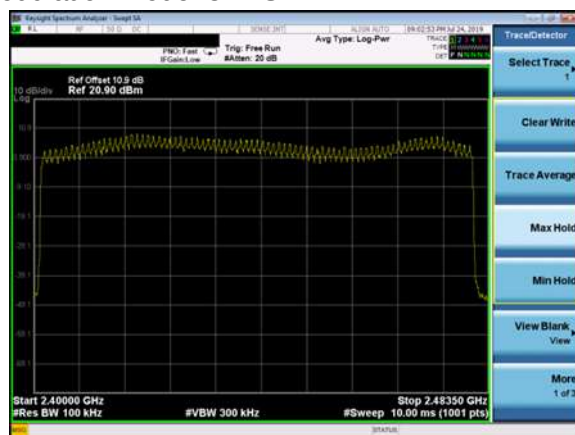
Modulation Mode: GFSK



Modulation Mode: $\pi/4$ -DQPSK



Modulation Mode: 8DPSK





12. Maximum Peak Output Power

12.1 Test Limit

The Maximum Peak Output Power Measurement is 30dBm.

12.2 Test Procedures

The antenna port(RF output)of the EUT was connected to the input(RF input)of a power meter. Power was read directly from the meter and cable loss connection was added to the reading to obtain power at the EUT antenna terminal. The EUT Output Power was set to maximum to produce the worse case test result.

12.3 Test Setup Layout





12.4 Test Result and Data

Modulation Mode	Channel	Frequency(MHz)	PK Output Power (dBm)	PK Output Power (mW)
GFSK	0	2402	-2.12	0.614
	39	2441	5.39	3.459
	78	2480	0.73	1.183
$\pi/4$ -DQPSK	0	2402	-0.97	0.800
	39	2441	6.78	4.764
	78	2480	2.02	1.592
8DPSK	0	2402	-0.83	0.826
	39	2441	6.95	4.955
	78	2480	2.13	1.633

Modulation Mode	Channel	Frequency(MHz)	AV Output Power (dBm)	AV Output Power (mW)
GFSK	0	2402	-3.17	0.482
	39	2441	5.02	3.177
	78	2480	-0.04	0.991
$\pi/4$ -DQPSK	0	2402	-3.23	0.475
	39	2441	4.96	3.133
	78	2480	-0.03	0.993
8DPSK	0	2402	-3.19	0.480
	39	2441	4.93	3.112
	78	2480	-0.07	0.984

Note: Average power is for reference only.

AFH Mode

Modulation Mode	Channel	Frequency(MHz)	PK Output Power (dBm)	PK Output Power (mW)
GFSK	0-19	2402-2421	2.49	1.774
$\pi/4$ -DQPSK	0-19	2402-2421	3.48	2.228
8DPSK	0-19	2402-2421	3.64	2.312

Modulation Mode	Channel	Frequency(MHz)	AV Output Power (dBm)	AV Output Power (mW)
GFSK	0-19	2402-2421	1.68	1.472
$\pi/4$ -DQPSK	0-19	2402-2421	1.43	1.390
8DPSK	0-19	2402-2421	1.38	1.374

Note: Average power is for reference only.