FCC TEST REPORT

Product	:	Mobile Phone
Trade mark	:	MI
Model/Type reference	:	2016117
Report Number	:	1608310293RFC-3
Date of Issue	:	Oct.16, 2016
FCC ID	:	2AFZZ-RM6117
Test Standards	:	47 CFR Part 15 Subpart C (2015)
Test result	:	PASS

Prepared for:

Xiaomi Communications Co., Ltd.
The Rainbow City of China Resources, NO.68, Qinghe Middle Street, Haidian District, Beijing, China

Prepared by:

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Reviewed by: Jim Long — Jim Long, RF Senior Supervisor

Approved by: Billy Li — Billy Li, Technical Director

Date: Oct.16, 2016

Version

Version No.	Date	Description
V1.0	Oct.16, 2016	Original

Content

1 General Information

1.1 Client Information

Applicant:	Xiaomi Communications Co., Ltd.
Address of Applicant:	The Rainbow City of China Resources, NO.68, Qinghe Middle Street, Haidian District, Beijing, China
Manufacturer:	Xiaomi Communications Co., Ltd.
Address of Manufacturer:	The Rainbow City of China Resources, NO.68, Qinghe Middle Street, Haidian District, Beijing, China

1.2 General Description of EUT

Product Name:	Mobile Phone	
Model No.(EUT):	2016117	
Add Mode No.:	N/A	
Trade Mark:	MI	
EUT Supports Radios application:	GSM850/900/1800/1900 WCDMA Band I/Band II/Band V/Band VIII LTE FDD Band 1/Band 3/ Band 4/ Band 5/Band 7/Band 8/Band 20 LTE TDD Band 40/Band 41 Wlan 2.4GHz 802.11b/g/n(HT20) Bluetooth V3.0+EDR&Bluetooth V4.0 BLE GPS, Glonass	
Power Supply:	AC adapter	Model:MDY-08-EF Input:100-240V~50/60Hz, 0.35A; Output: 5V⎓2A
	Battery1	Model: BN30 Brand: Sunwoda Rated voltage: 3.84Vdc Battery capacity: 3030mAh(Li-on Rechargeable)
	Battery2	Model: BN30 Brand: SCUD Rated voltage: 3.84Vdc Battery capacity: 3030mAh(Li-on Rechargeable)
USB Micro-B Plug cable:	117cm(Shielded)	
Sample Received Date:	Sep. 09, 2016	
Sample tested Date:	Sep. 11, 2016 to Sep. 29, 2016	

1.3 Product Specification subjective to this standard

Operation Frequency:	2402MHz~2480MHz
Bluetooth Version:	2.0+EDR
Modulation Technique:	Frequency Hopping Spread Spectrum(FHSS)
Modulation Type:	GFSK, π/4DQPSK, 8DPSK
Number of Channel:	79
Hopping Channel Type:	Adaptive Frequency Hopping systems
Sample Type:	Portable production
Antenna Type:	LDS Antenna
Antenna Gain:	-3 dBi
Normal Test voltage:	3.84Vdc
Extreme Test voltage:	3.6~4.35Vdc (declared by the manufacturer)

Operating Temperature:	0℃ to +40℃ (declared by the manufacturer)
Software Version:	MIUI8
Hardware Version:	P3

Operation Frequency each of channel

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

Modulation Configure

Modulation	Packet	Packet Type	Packet Size
GFSK	DH1	4	27
	DH3	11	183
	DH5	15	339
Pi/4 DQPSK	2DH1	20	54
	2DH3	26	367
	2DH5	30	679

8DPSK	3DH1	24	83
	3DH3	27	552
	3DH5	31	1021

1.4 Description of Support Units

The EUT has been tested with associated equipment below.

1) Support equipment

Description	Manufacturer	Model No.	Serial Number	Supplied by
Notebook	Lenovo	E450	SL10G10780	UnionTrust

2) Cable

Cable No.	Description	Connector Type	Cable Type/Length	Supplied by
N/A	N/A	N/A	N/A	N/A

1.5 Test Location

All tests were performed at:

Shenzhen Huatongwei International Inspection Co., Ltd.

Address: 1/F, Bldg 3,Hongfa Hi-tech Industrial Park, Genyu Road, Tianliao, Gongming, Shenzhen, China

Telephone: +86 (0) 755 26748019 Fax:+86 (0) 755 26748089

1.6 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

FCC-Registration No.: 317478

Shenzhen Huatongwei International Inspection Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the FCC (Federal Communications Commission). The acceptance letter from the FCC is maintained in our files. Registration 317478, Renewal date Jul.18, 2014, valid time is until Jul.18, 2017.

1.7 Deviation from Standards

None.

1.8 Abnormalities from Standard Conditions

None.

1.9 Other Information Requested by the Customer

None.

1.10 Measurement Uncertainty (95% confidence levels, k=1.96)

No.	Item	Measurement Uncertainty
1	Transmitter power conducted	0.57 dB
2	Transmitter power Radiated	2.20 dB
3	Conducted spurious emission 9KHz-40GHz	1.60 dB
	Radiated spurious emission 9KHz-40GHz	2.20 dB
4	Conducted emission 9KHz-30MHz	3.39 dB
	Radiated emission 30MHz-1000MHz	4.24 dB
5	Radiated emission 1GHz-18GHz	5.16 dB
6	Radiated emission 18GHz-40GHz	5.54 dB

2 Test Summary

Tests for radiated and conducted emissions were performed. All measurements were performed according to the 2013 version of ANSI C63.10

Test Item	Test Requirement	Test method	Result
Antenna Requirement	47 CFR Part 15 Subpart C Section 15.203/15.247 (c)	ANSI C63.10-2013	PASS
AC Power Line Conducted Emission	47 CFR Part 15 Subpart C Section 15.207	ANSI C63.10-2013	PASS
Conducted Peak Output Power	47 CFR Part 15 Subpart C Section 15.247 (b)(1)	DA 00-705	PASS
20 dB Bandwidth	47 CFR Part 15Subpart C Section 15.247 (a)(1)	DA 00-705	PASS
Carrier Frequencies Separation	47 CFR Part 15 Subpart C Section 15.247 (a)(1)	DA 00-705	PASS
Number of Hopping Channel	47 CFR Part 15 Subpart C Section 15.247 (b)(1)	DA 00-705	PASS
Dwell Time	47 CFR Part 15 Subpart C Section 15.247 (a)(1)	DA 00-705	PASS
Pseudorandom Frequency Hopping Sequence	47 CFR Part 15 Subpart C Section 15.247(a)(1)(g)(h)	DA 00-705	PASS
Conducted Out of Band Emission	47 CFR Part 15 Subpart C Section 15.247(d)	DA 00-705	PASS
Radiated Emissions	47 CFR Part 15 Subpart C Section 15.205/15.209	DA 00-705	PASS
Band Edge Measurement	47 CFR Part 15 Subpart C Section 15.205/15.209	DA 00-705	PASS

Remark:

Tx: In this whole report Tx (or tx) means Transmitter.

Rx: In this whole report Rx (or rx) means Receiver.

RF: In this whole report RF means Radiated Frequency.

CH: In this whole report CH means channel.

3 Equipment List

Conducted Emission Test					
Equipment	**Manufacturer**	**Mode No.**	**Serial Number**	**Cal date (mm-dd-yyyy)**	**Due date (mm-dd-yyyy)**
EMI Test Receiver	R&S	ESCI	101247	11/1/2015	10/31/2016
Artificial Mains	SCHWARZBECK	NNLK 8121	573	11/1/2015	10/31/2016
Pulse Limiter	R&S	ESH3-Z2	101488	11/1/2015	10/31/2016
EMI Test Receiver	R&S	ESCI	101247	11/1/2015	10/31/2016

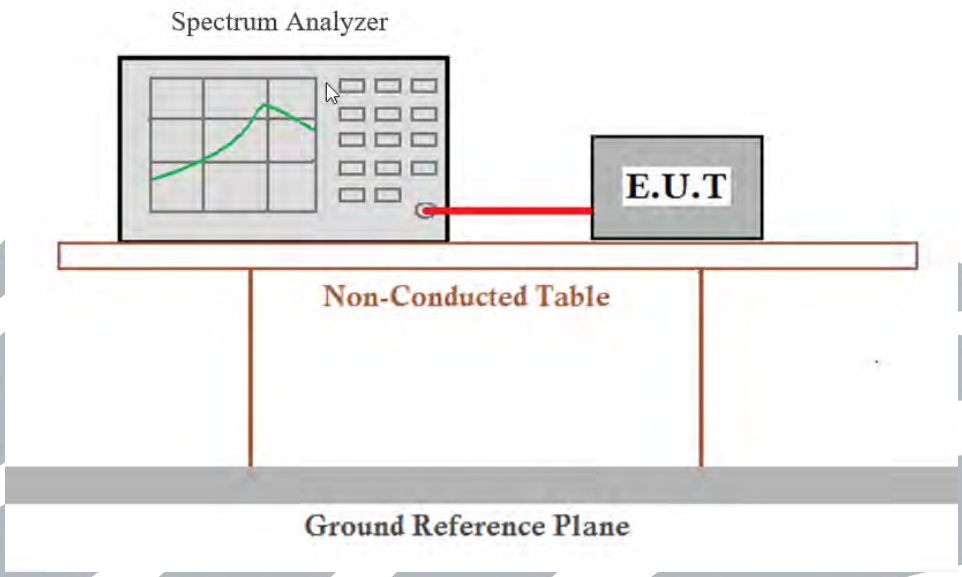
3m (Semi-Anechoic Chamber)					
Equipment	**Manufacturer**	**Mode No.**	**Serial Number**	**Cal date (mm-dd-yyyy)**	**Due date (mm-dd-yyyy)**
Ultra-Broadband Antenna	SCHWARZBECK	VULB9163	538	11/8/2015	11/7/2017
Double-Ridged-Waveguide Horn Antenna	SCHWARZBECK	9120D	1011	11/8/2015	11/7/2017
Emi Test Receiver	R&S	ESCI	101247	11/1/2015	10/31/2016
Spectrum Analyzer	R&S	FSP40	100597	11/1/2015	10/31/2016
Pre-amplifer	SCHWARZBECK	BBV 9743	9743-0022	11/1/2015	10/31/2016
Broadband Preamplifer	SCHWARZBECK	BBV 9718	9718-248	11/1/2015	10/31/2016
Turntable	Maturo Germany	TT2.0-1T	\	N/A	N/A
Antenna Mast	Maturo Germany	CAM-4.0-P-12	\	N/A	N/A
Test Software	R&S	ES-K1	/	N/A	N/A

	Conducted RF test				
Equipment	**Manufacturer**	**Mode No.**	**Serial Number**	**Cal date (mm-dd-yyyy)**	**Due date (mm-dd-yyyy)**
Spectrum Analyzer	Keysight	N9030A	ATO-67098	07/19/2016	07/18/2017
Power Sensor	KEYSIGHT	U2021XA	MY55430035	01-09-2016	01-08-2017

4 Test Requirement

4.1 Test setup

4.1.1 For Conducted test setup



4.1.2 For Radiated Emissions test setup

Radiated Emissions setup:

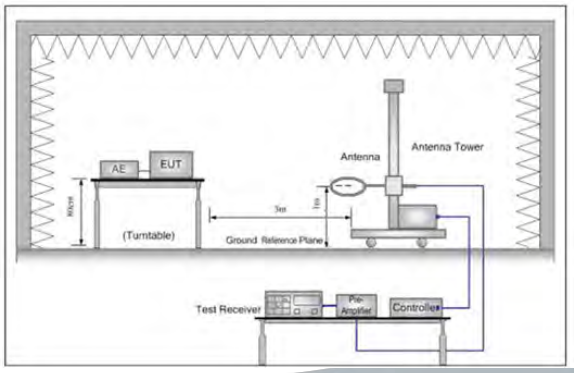


Figure 1. Below 30MHz

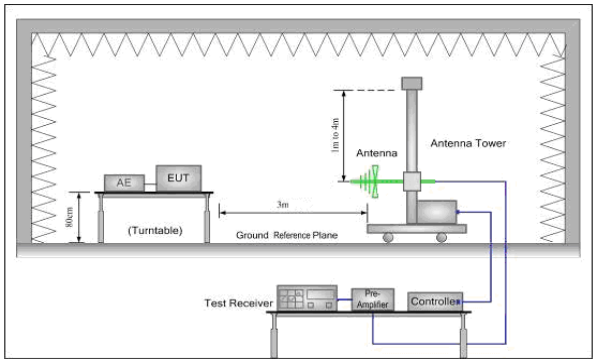


Figure 2. 30MHz to 1GHz

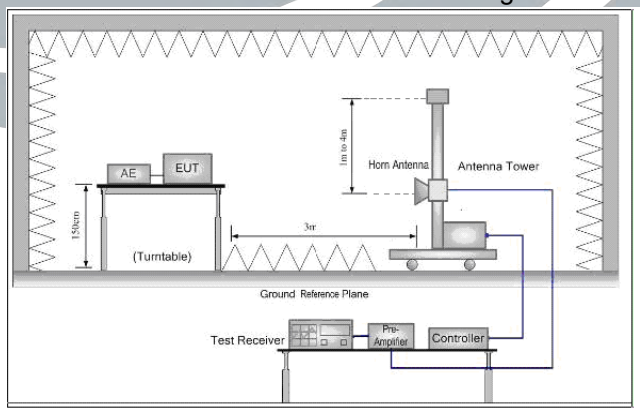
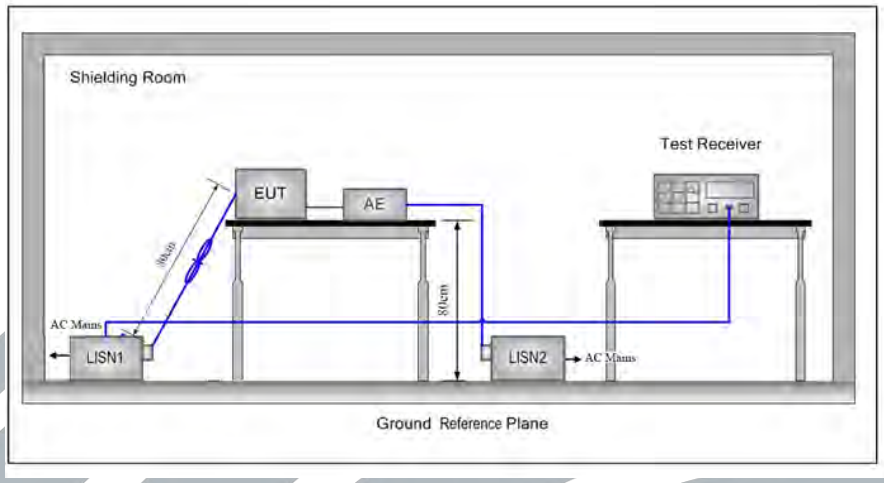


Figure 3. Above 1GHz

4.1.3 For Conducted Emissions test setup

Conducted Emissions setup



4.2 Test Environment

Operating Environment:	
Temperature:	25.4 °C
Humidity:	55.6 % RH
Atmospheric Pressure:	99.80 Kpa

4.3 System Test Configuration

For emissions testing, the equipment under test (EUT) setup to transmit continuously to simplify the measurement methodology. Care was taken to ensure proper power supply voltages during testing. During testing, radiated emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario. It was powered by a 3.84Vdc rechargeable Li-on battery. Only the worst case data were recorded in this test report.

The signal is maximized through rotation and placement in the three orthogonal axes. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters. Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. Therefore, all final radiated testing was performed with the EUT in (see table below) orientation.

Frequency Band(GHz)	Mode	Antenna Port	Worst-case Orientation
Below 1GHz	1TX	Chain 0	Z-Portrait
Above 1GHz	1TX	Chain 0	Y-Portrait

All readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance. Analyzer resolution is 100 kHz or greater for frequencies below 1000MHz. The resolution is 1 MHz or greater for frequencies above 1000MHz. The spurious emissions more than 20 dB below the permissible value are not reported.

Radiated emission measurement were performed from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

4.4 Test Condition

4.4.1 Test channel

Modulation Type	Tx/Rx	RF Channel		
		Low(L)	Middle(M)	High(H)
GFSK/π/4DQPSK/ 8DPSK (DH1,DH3,DH5)	2402MHz ~2480 MHz	Channel 1	Channel 40	Channel 79
		2402MHz	2441MHz	2480MHz

4.4.2 Test mode

Pre-scan under all packets at lowest channel

Modulation Type	GFSK			π/4DQPSK			8DPSK		
Packets	1-DH1	1-DH3	1-DH5	2-DH1	2-DH3	2-DH5	3-DH1	3-DH3	3-DH5
AVg Power	10.34	10.67	**11.15**	9.67	9.83	**10.24**	9.12	9.65	**10.25**

Through Pre-scan, 1-DH5 packet the power is the worst case of GFSK, 2-DH5 packet the power is the worst case of π/4DQPSK, 3-DH5 packet the power is the worst case of 8DPSK.

So, the worst-case packets see table below:

Modulation Type	Worst-case packets
GFSK	1-DH5
π/4DQPSK	2-DH5
8DPSK	3-DH5

5 Radio Technical Requirements Specification

Reference documents for testing:

No.	Identity	Document Title
1	FCC Part15C (2015)	Subpart C-Intentional Radiators
2	ANSI C63.10-2013	American National Standard for Testing Unlicesed Wireless Devices
3	FCC Public Notice DA 00-705	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems

5.1 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:	
Both antenna in the interior of the equipment and no consideration of replacement. The gain of the antenna is -3dBi.	

5.2 Pseudorandom Frequency Hopping Sequence

Technical Requirement: 47 CFR Part 15 Subpart C Section 15.247(b)(g)(h)
Test Method: DA 00-705

Frequency Hopping System:

This transmitter device is frequency hopping device, and complies with FCC part 15.247 rule.

This device uses Bluetooth radio which operates in 2400-2483.5 MHz band. Bluetooth uses a radio technology called frequency-hopping spread spectrum, which chops up the data being sent and transmits chunks of it on up to 79 bands (1 MHz each; centred from 2402 to 2480 MHz) in the range 2,400-2,483.5 MHz. The transmitter switches hop frequencies 1,600 times per second to assure a high degree of data security. All Bluetooth devices participating in a given piconet are synchronized to the frequency-hopping channel for the piconet. The frequency hopping sequence is determined by the master's device address and the phase of the hopping sequence (the frequency to hop at a specific time) is determined by the master's internal clock. Therefore, all slaves in a piconet must know the master's device address and must synchronize their clocks with the master's clock.

Adaptive Frequency Hopping (AFH) was introduced in the Bluetooth specification to provide an effective way for a Bluetooth radio to counteract normal interference. AFH identifies "bad" channels, where either other wireless devices are interfering with the Bluetooth signal or the Bluetooth signal is interfering with another device. The AFH-enabled Bluetooth device will then communicate with other devices within its piconet to share details of any identified bad channels. The devices will then switch to alternative available "good" channels, away from the areas of interference, thus having no impact on the bandwidth used.

EUT Pseudorandom Frequency Hopping Sequence:

Pseudorandom Frequency Hopping Sequence Table as below:
Channel: 08, 24, 40, 56, 40, 56, 72, 09, 01, 09, 33, 41, 33, 41, 65, 73, 53, 69, 06, 22, 04, 20, 36, 52, 38, 46, 70, 78, 68, 76, 21, 29, 10, 26, 42, 58, 44, 60, 76, 13, 03, 11, 35, 43, 37, 45, 69, 77, 55, 71, 08, 24, 08, 24, 40, 56, 40, 48, 72, 01, 72, 01, 25, 33, 12, 28, 44, 60, 42, 58, 74, 11, 05, 13, 37, 45 etc.

The system receiver have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

5.3 Conducted Peak Output Power

Test Requirement: 47 CFR Part 15 Subpart C Section15.247 (b)(1)

Test Method: DA 00-705

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.

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Use the following spectrum analyzer settings:

a) Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
b) RBW > the 20 dB bandwidth of the emission being measured
c) VBW ≥ RBW
d) Sweep = auto
e) Detector function = peak
f) Trace = max hold
g) All the trace to stabilize, use the marker-to-peak function to set the marker to the peak of the emission, the indicated level is the peak output power (the external attenuation and cable loss shall be considered).

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.1.1 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Transmitter mode

Test Results: Pass

Test Data:

Maximum Conducted Peak Output Power:

Modulation Type	Peak Output Power (dBm)			Peak Output Power (mW)			Limit (mW)	Results
	Channel 1	Channel 40	Channel 79	Channel 1	Channel 40	Channel 79		
GFSK	10.283	11.276	8.524	10.673	13.415	7.119	1000	Pass
π/4 DQPSK	10.915	11.977	9.236	12.345	15.542	8.387	1000	Pass
8DPSK	11.118	12.194	9.451	12.936	16.573	8.997	1000	Pass

Note: the antenna gain of -3 dBi less than 6dBi maximum permission antenna gain value based on 0.125 watt peak output power limit.

5.4 20 dB Bandwidth

Test Requirement: 47 CFR Part 15 Subpart C Section 15.247 (a)(1)

Test Method: DA 00-705

Limit: For frequency hopping system operating in the 2400-2483.5 MHz, if the 20 dB bandwidth of hopping channel is greater than 25 kHz, two-thirds 20 dB bandwidth of hopping channel shell be a minimum limit for the hopping channel separation.

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Use the following spectrum analyzer settings:

a) Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
b) RBW ≥ 1% of the 20 dB bandwidth
c) VBW ≥ RBW
d) Sweep = auto;
e) Detector function = peak
f) Trace = max hold
g) All the trace to stabilize, use the marker-to-peak function to set the marker to the peak of the emission, use the marker-delta function to measure and record the 20dB down bandwidth of the emission.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.1.1 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Transmitter mode

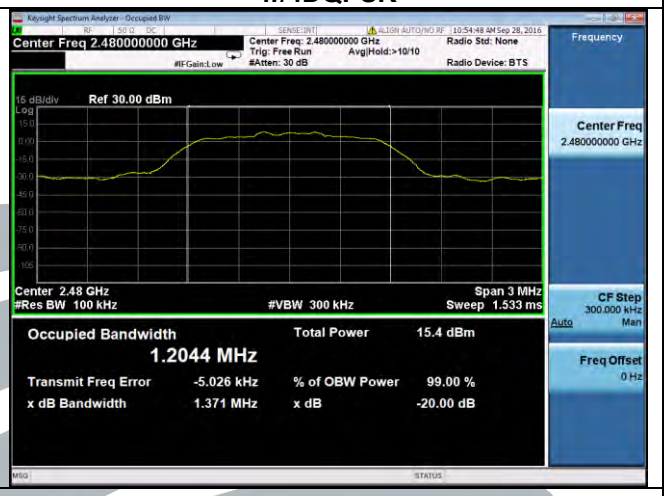
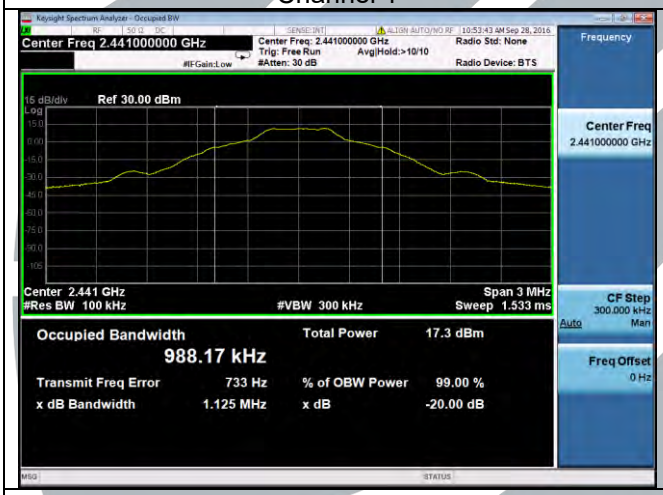
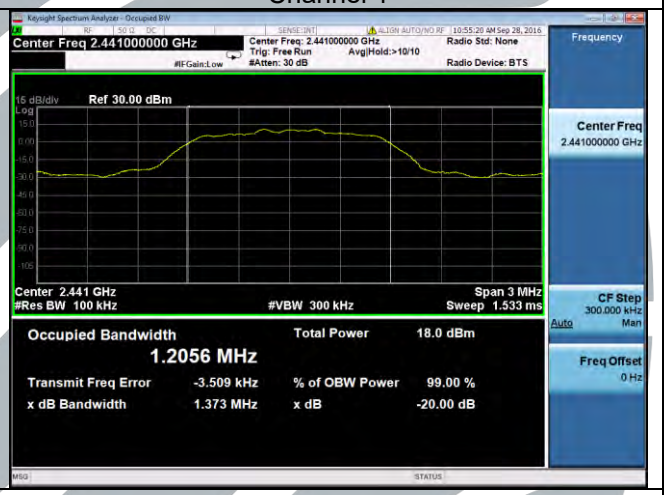
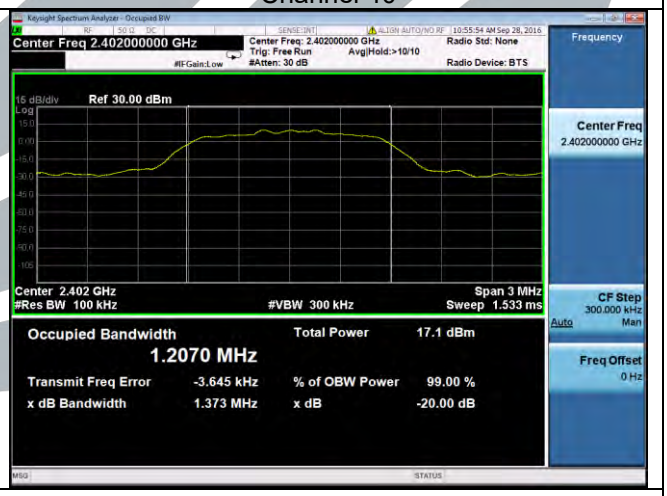
Test Results: Pass

Test Data:

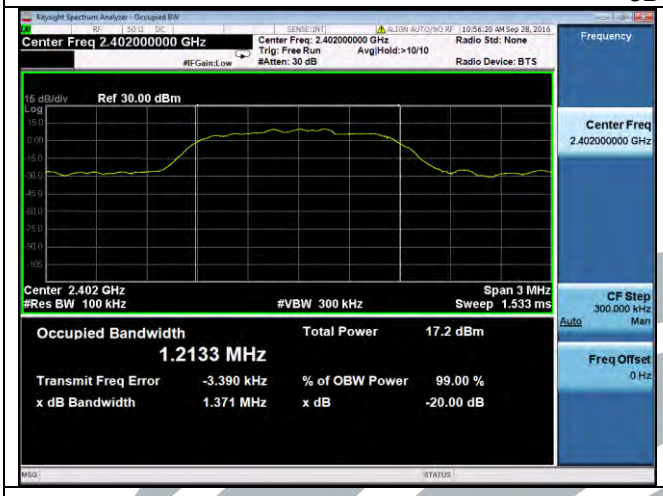
Occupied Bandwidth:

Channel	20 dB Bandwidth (MHz)			99% Bandwidth (MHz)		
	GFSK	π/4 DQPSK	8DPSK	GFSK	π/4 DQPSK	8DPSK
1	1.125	1.371	1.371	0.989	1.204	1.213
40	1.125	1.373	1.375	0.988	1.206	1.213
79	1.124	1.373	1.375	0.986	1.207	1.212

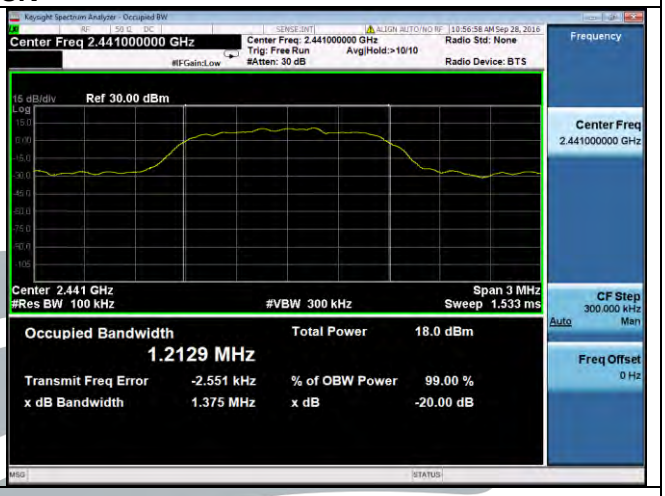
The test plot as follows:

GFSK	π/4DQPSK
	
Channel 1	Channel 1
	
Channel 40	Channel 40
	
Channel 79	Channel 79

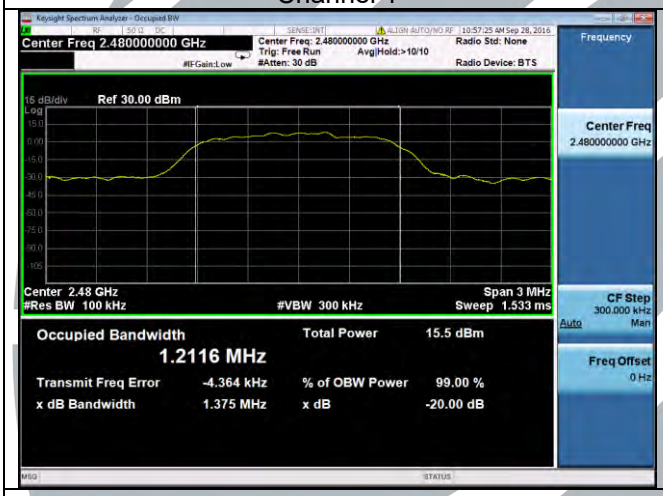
8DPSK



Channel 1



Channel 40



Channel 79

5.5 Carrier Frequencies Separation

Test Requirement: 47 CFR Part 15 Subpart C Section 15.247 (a)(1)

Test Method: DA 00-705

Limit: 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.

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Use the following spectrum analyzer settings:

a) Set span = wide enough to capture the peaks of two adjacent channels
b) Resolution (or IF) Bandwidth (RBW) ≥ 1% of the span
c) Video (or Average) Bandwidth (VBW) ≥ RBW
d) Sweep = auto;
e) Detector function = peak;
f) Trace = max hold
g) 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.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.1.1 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Hopping Frequencies Transmitter mode

Test Results: Pass

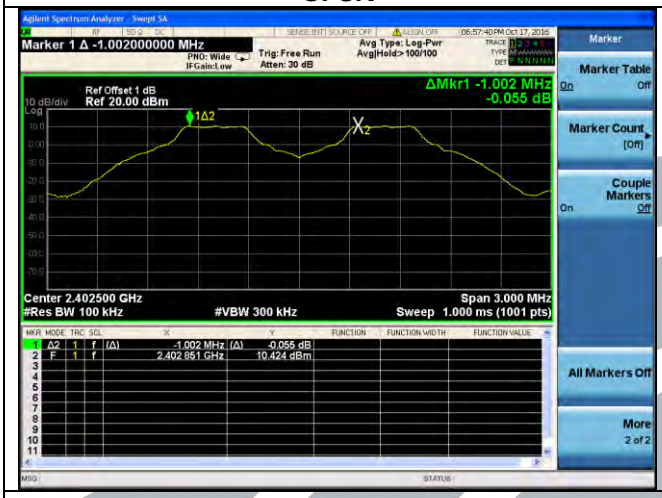
Test Data:

Carrier Frequencies Separation:

Channel	Adjacent Channel Separation (MHz)			20 dB Bandwidth (MHz)			Minimum Limit (MHz)		
	GFSK	π/4 DQPSK	8DPSK	GFSK	π/4 DQPSK	8DPSK	GFSK	π/4 DQPSK	8DPSK
1	1.002	1.002	0.999	1.125	1.371	1.371	0.75	0.91	0.91
40	0.999	0.999	0.999	1.125	1.373	1.375	0.75	0.92	0.92
79	1.002	0.999	1.002	1.124	1.373	1.375	0.75	0.92	0.92

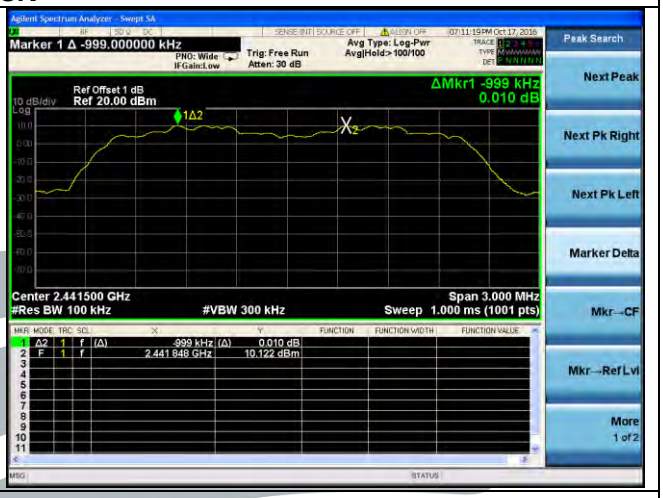
Note: The minimum limit is two-third 20 dB bandwidth.

The test plot as follows:

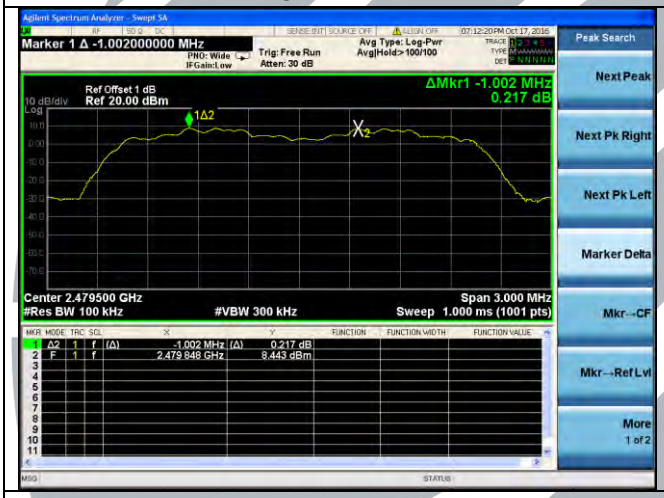
GFSK	π/4DQPSK
	
Channel 1	Channel 1
	
Channel 40	Channel 40
	
Channel 79	Channel 79

8DPSK

Channel 1



Channel 40



Channel 79

5.6 Number of Hopping Channel

Test Requirement: 47 CFR Part 15 Subpart C Section 15.247(b)(1)

Test Method: DA 00-705

Limit: For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels.

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Use the following spectrum analyzer settings:

a) Span = the frequency band of operation
b) RBW ≥ 1% of the span
c) VBW ≥ RBW
d) Sweep = auto
e) Detector function = peak
f) Trace mode = max hold
g) Allow the trace to stabilize, observed the band of 2400MHz to 2483.5MHz, than count it out the number of channels for comparing with the FCC rules.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.1.1 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Hopping Frequencies Transmitter mode

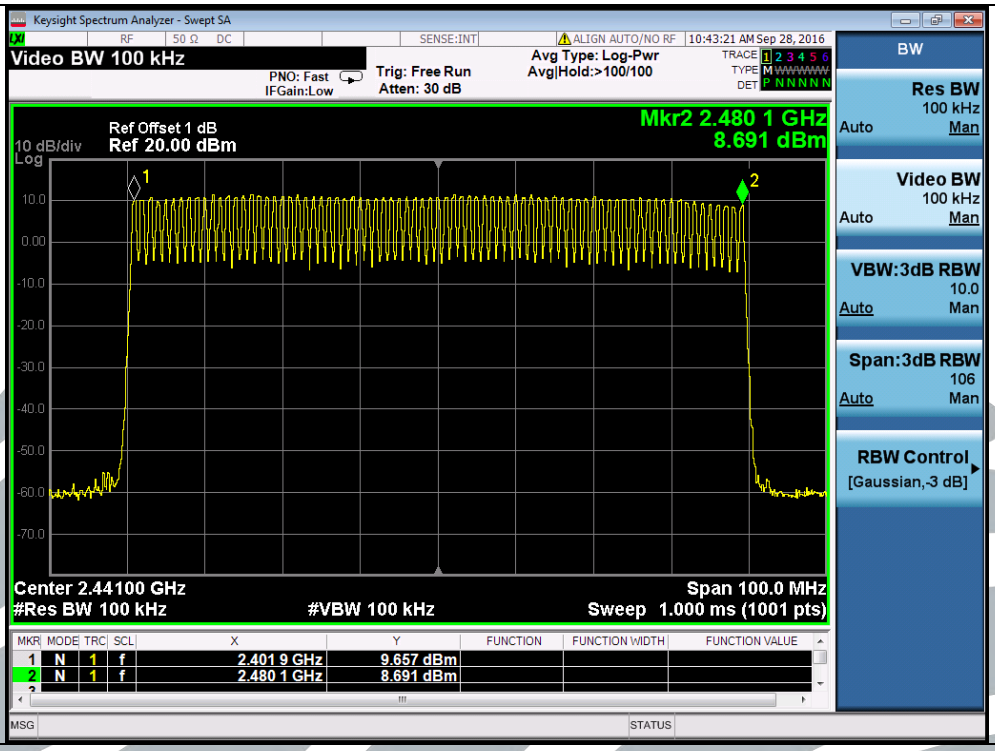
Test Results: Pass

Test Data:

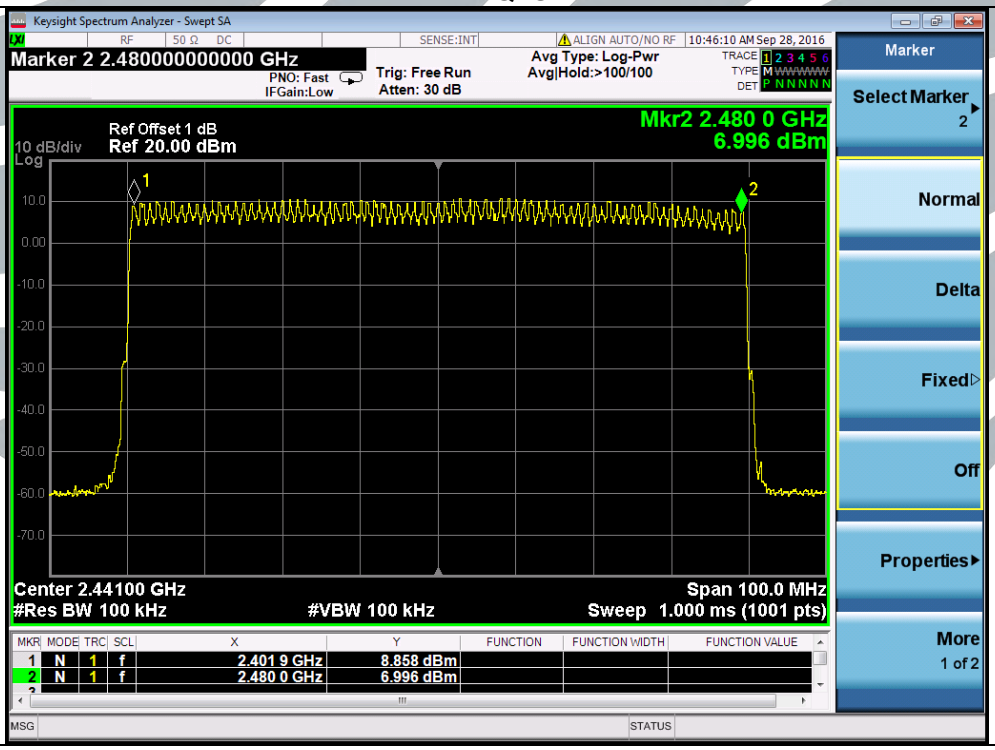
Modulation Type	GFSK	π/4 DQPSK	8DPSK
Number of Hopping Channel	79	79	79

The test plot as follows:

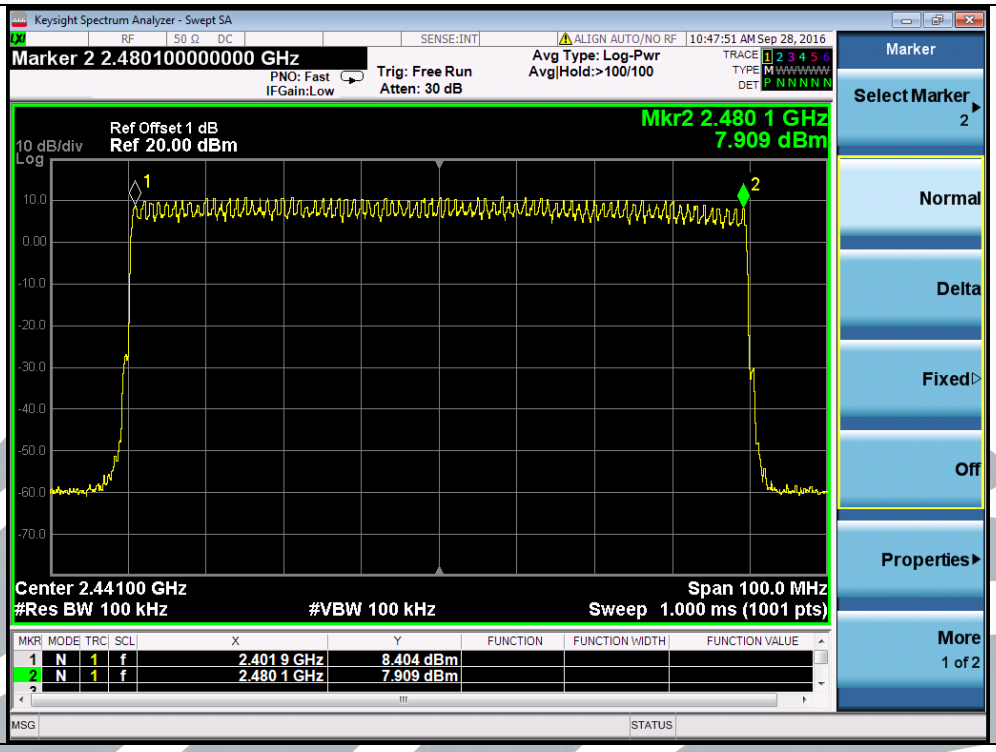
GFSK



π/4 DQPSK



8DPSK


Keysight Spectrum Analyzer - Swept SA
Marker 2 2.480100000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
10:47:51 AM Sep 28, 2016
Ref Offset 1 dB
10 dB/div
Log
Ref 20.00 dBm
Mkr2 2.480 1 GHz
7.909 dBm
Center 2.44100 GHz
#Res BW 100 kHz
#VBW 100 kHz
Span 100.0 MHz
Sweep 1.000 ms (1001 pts)
1 N 1 f 2.401 9 GHz 8.404 dBm
2 N 1 f 2.480 1 GHz 7.909 dBm
Marker
Select Marker 2
Normal
Delta
Fixed
Off
Properties
More 1 of 2
MSG
STATUS

5.7 Dwell Time

Test Requirement: 47 CFR Part 15 Subpart C Section 15.247(a)(1)

Test Method: DA 00-705

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.

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Use the following spectrum analyzer settings:

a) Span = zero span, centered on a hopping channel
b) RBW = 1 MHz
c) VBW ≥ RBW
d) Sweep = as necessary to capture the entire dwell time per hopping channel
e) Detector function = peak
f) Trace = max hold
g) Use the marker-delta function to determine the dwell time

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.1.1 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Hopping Frequencies Transmitter mode

Test Results: Pass

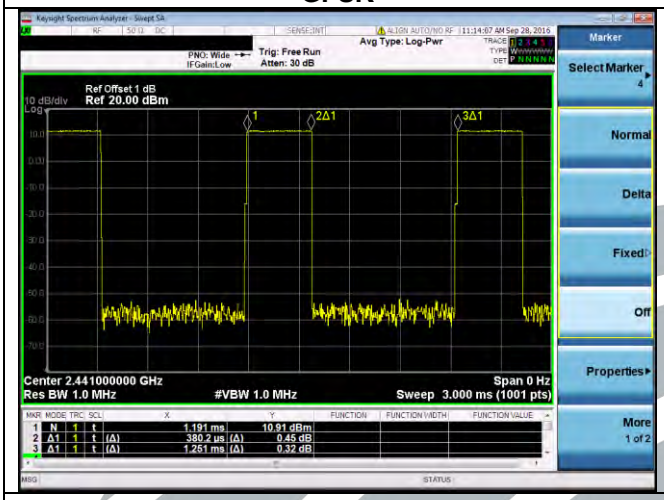
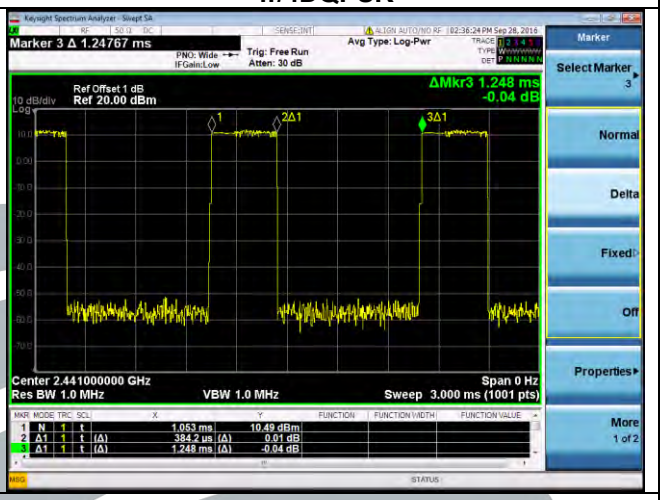
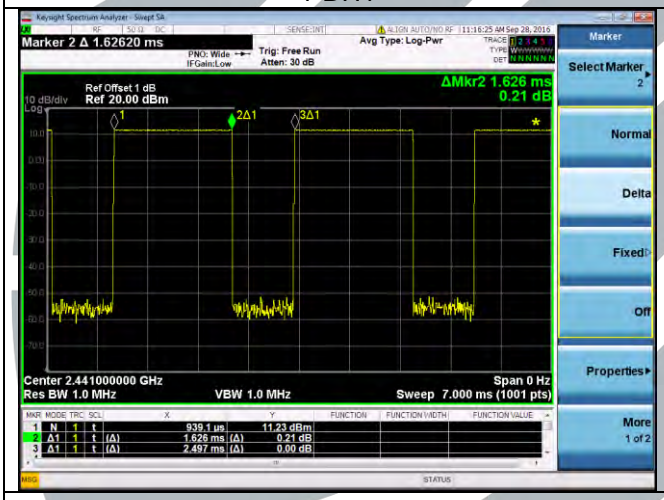
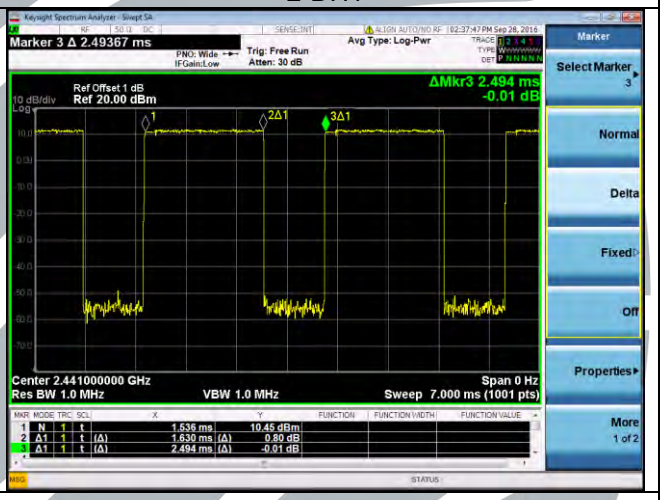
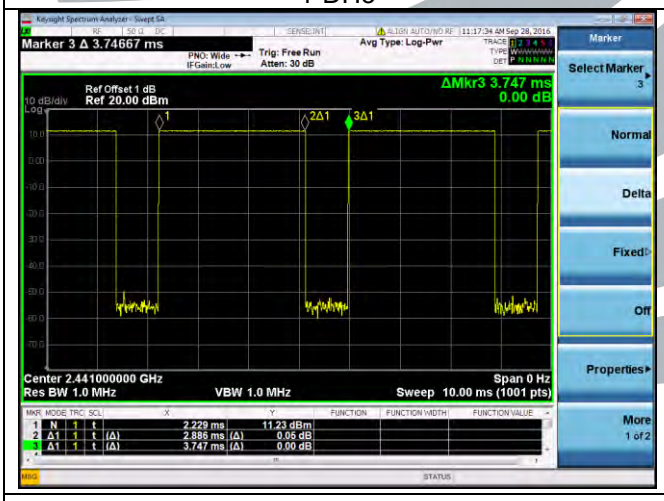
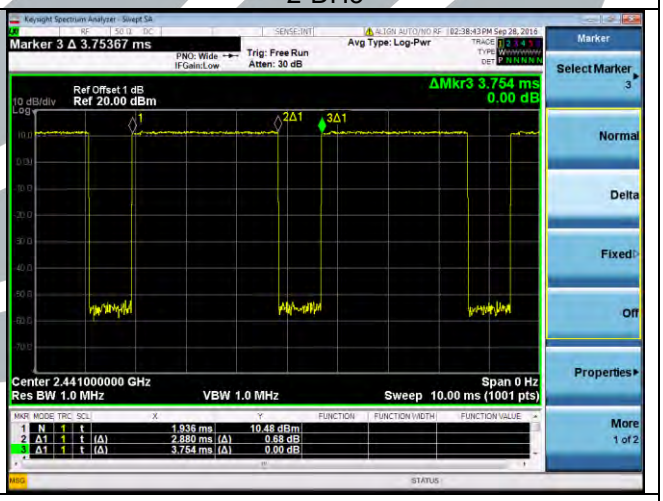
Test Data:

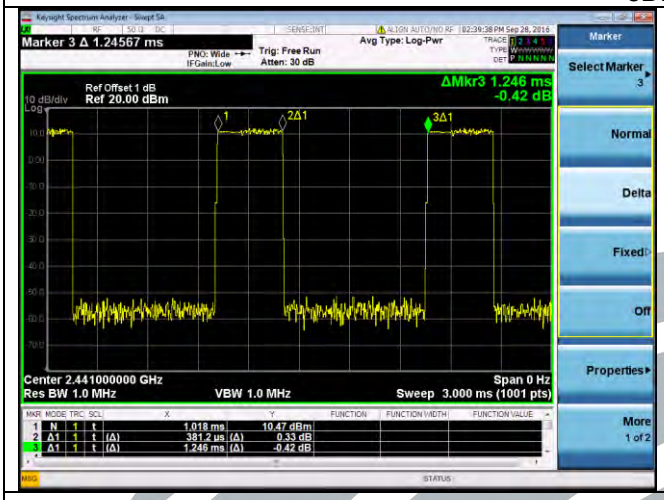
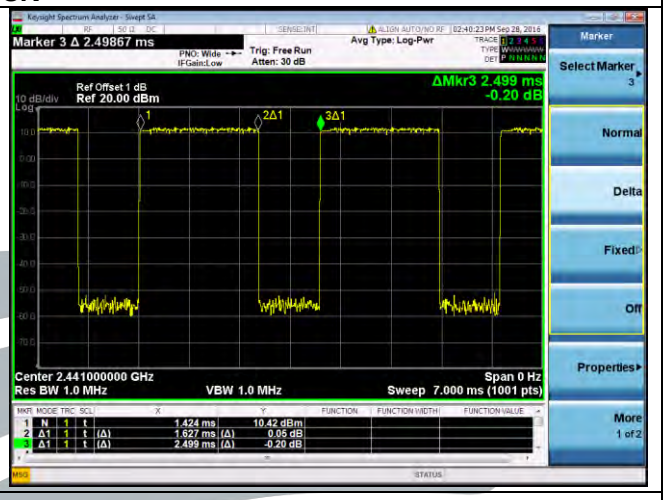
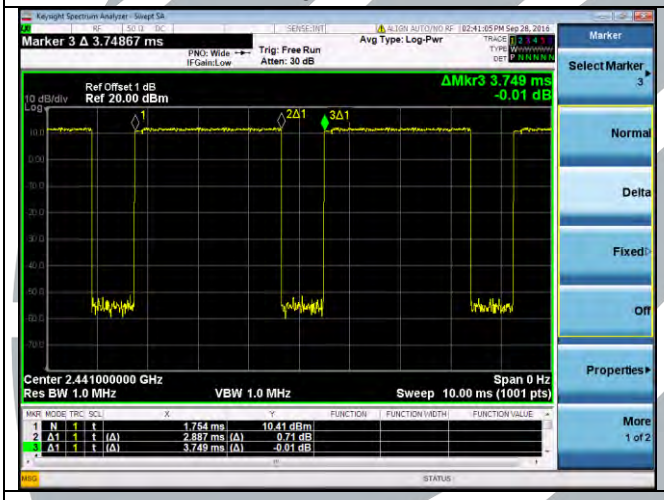
Modulation	Test Frequency	Packet	Time Slot Length	Dwell Time	Limit
			ms	ms	ms
GFSK	2441MHz	DH1	0.3802	121.664	< 400
		DH3	1.626	260.160	< 400
		DH5	2.886	307.840	< 400
π/4 DQPSK	2441MHz	3DH1	0.384	122.880	< 400
		3DH3	1.630	260.800	< 400
		3DH5	2.880	307.200	< 400
8DPSK	2441MHz	3DH1	0.381	121.920	< 400
		3DH3	1.627	260.320	< 400
		3DH5	2.887	307.947	< 400

Remark:

1. The test period: T = 0.4 Second * 79 Channel = 31.6 s
2. Dwell time = time slot length * (Hopping rate / Number of hopping channels) * Period

The test plot as follows:

GFSK	π/4DQPSK
	
1-DH1	2-DH1
	
1-DH3	2-DH3
	
1-DH5	2-DH5

8DPSK	
	
3-DH1	3-DH3
	
3-DH5	

5.8 Conducted Out of Band Emission

Test Requirement: 47 CFR Part 15 Subpart C Section 15.247(d)

Test Method: DA 00-705

Limit: In any 100kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator in 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.

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Use the following spectrum analyzer settings:

a) Suitable frequency span
b) RBW = 100 KHz
c) VBW ≥ RBW
d) Sweep = auto
e) Detector function = peak
f) Trace = max hold
g) The band edges was measured and recorded.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.1.1 for details.

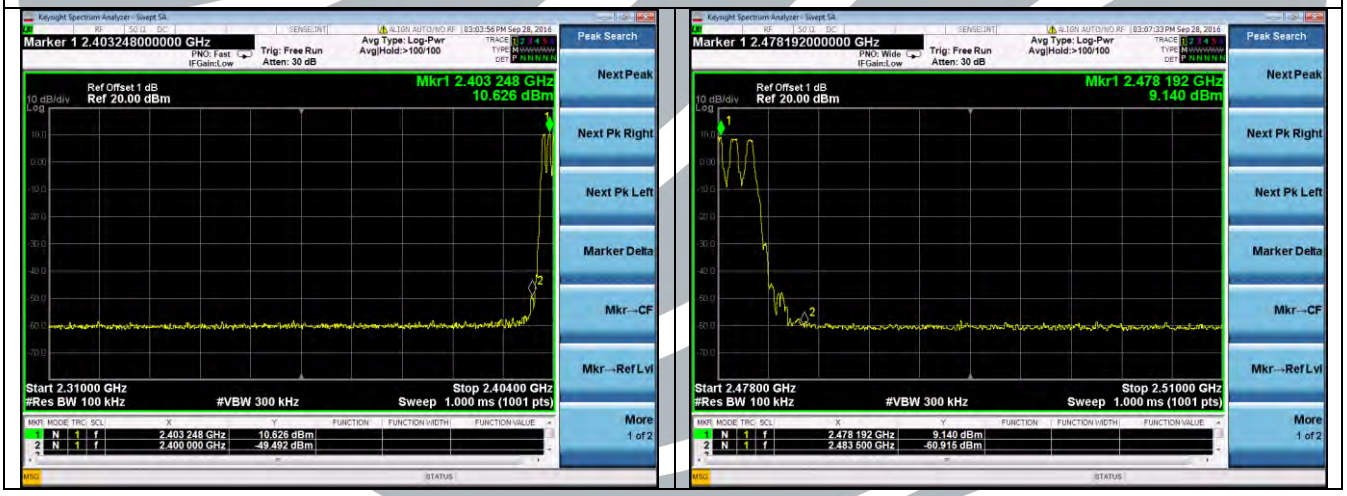
Instruments Used: Refer to section 3 for details

Test Mode: Hopping Frequencies Transmitter mode

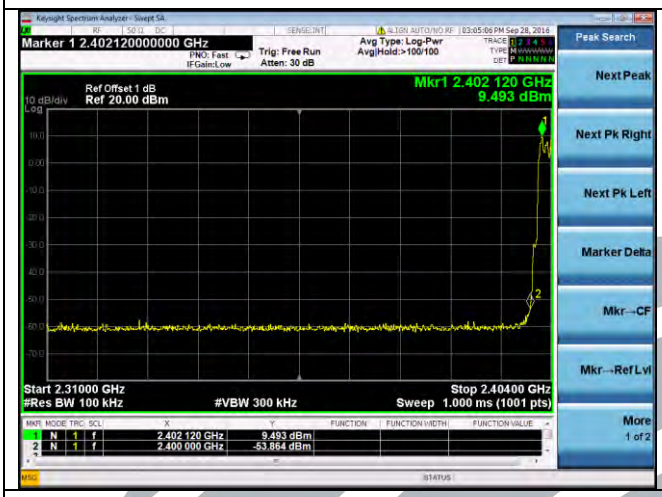
Test Results: Pass

The test plot as follows:

GFSK_IN-Band Emission

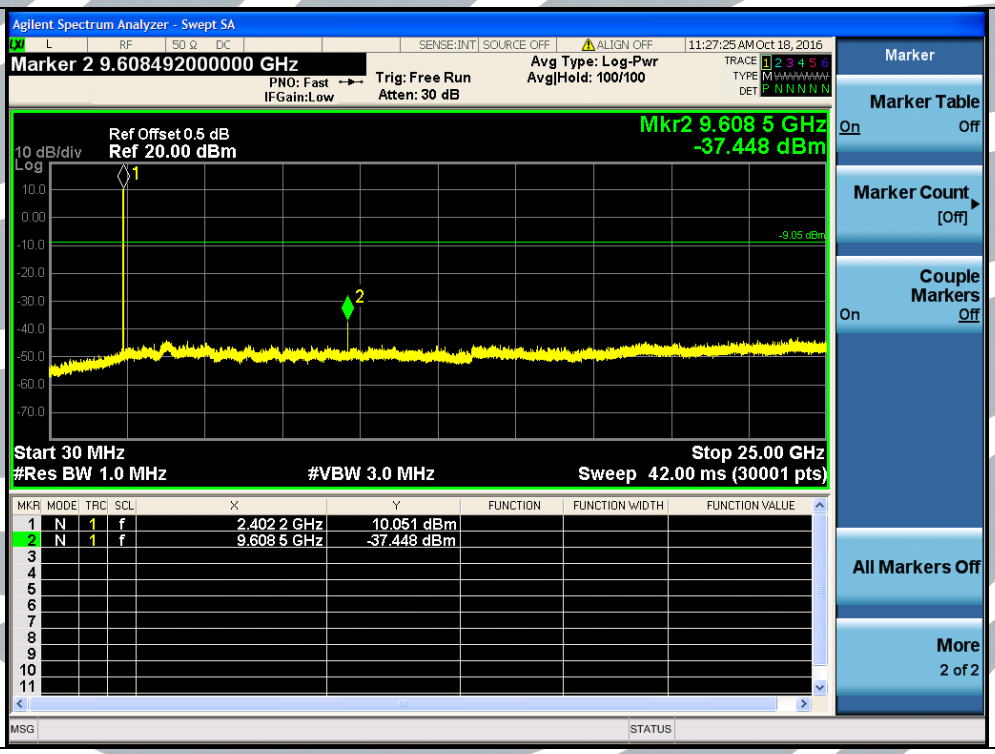


8DPSK_IN-Band Emission

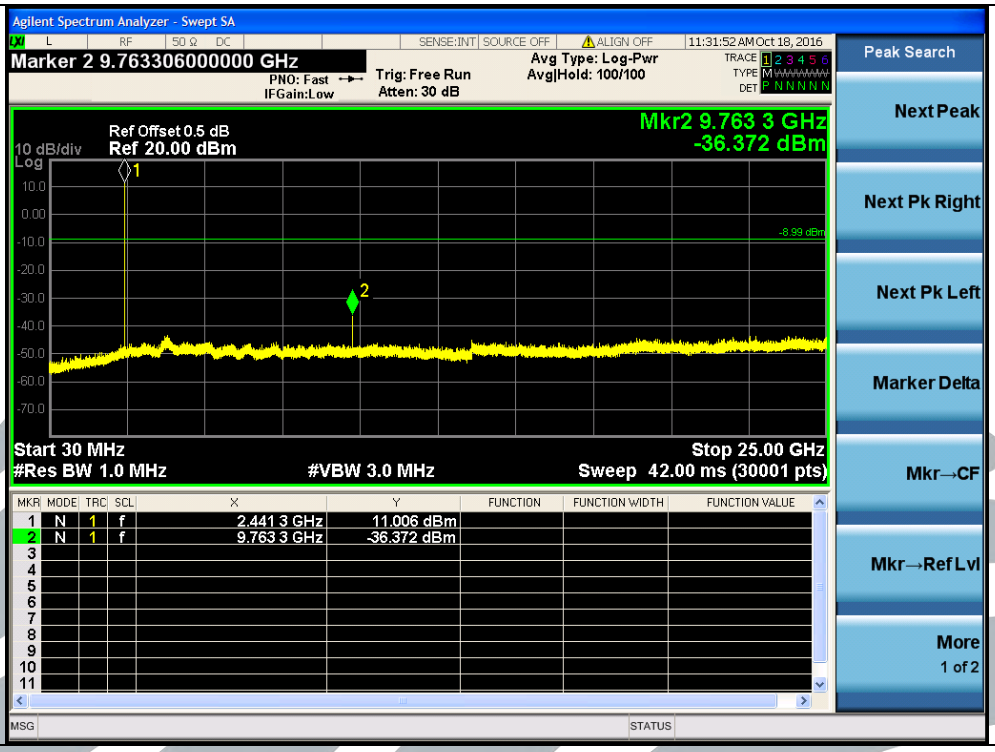


Out of Band Emission

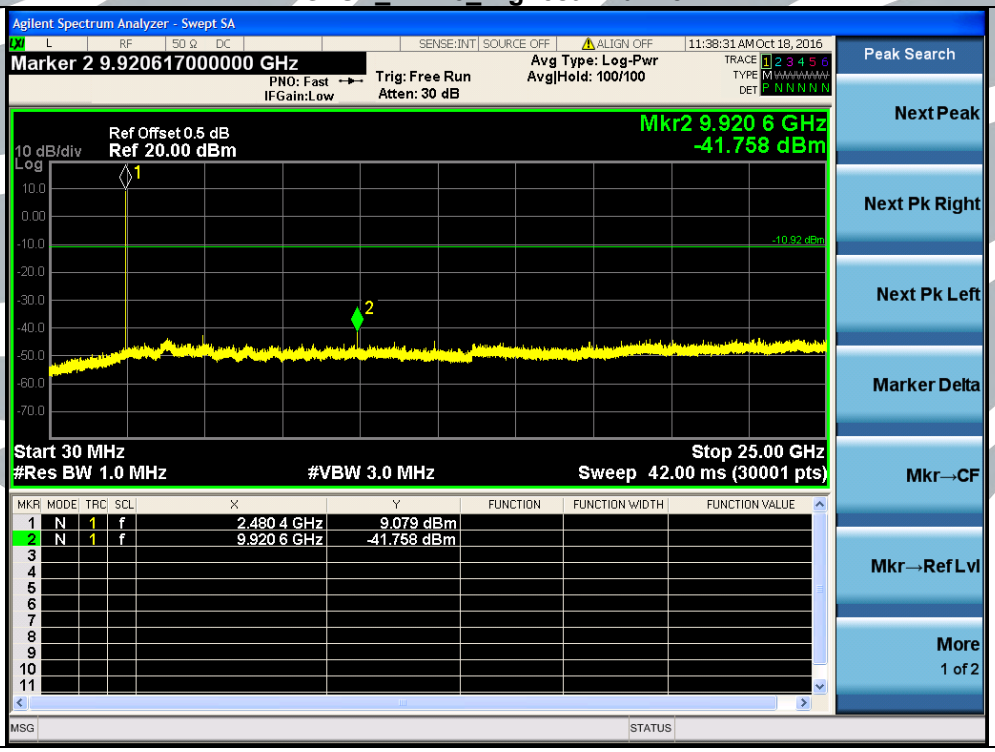
GFSK_1-DH5_Lowest Channel



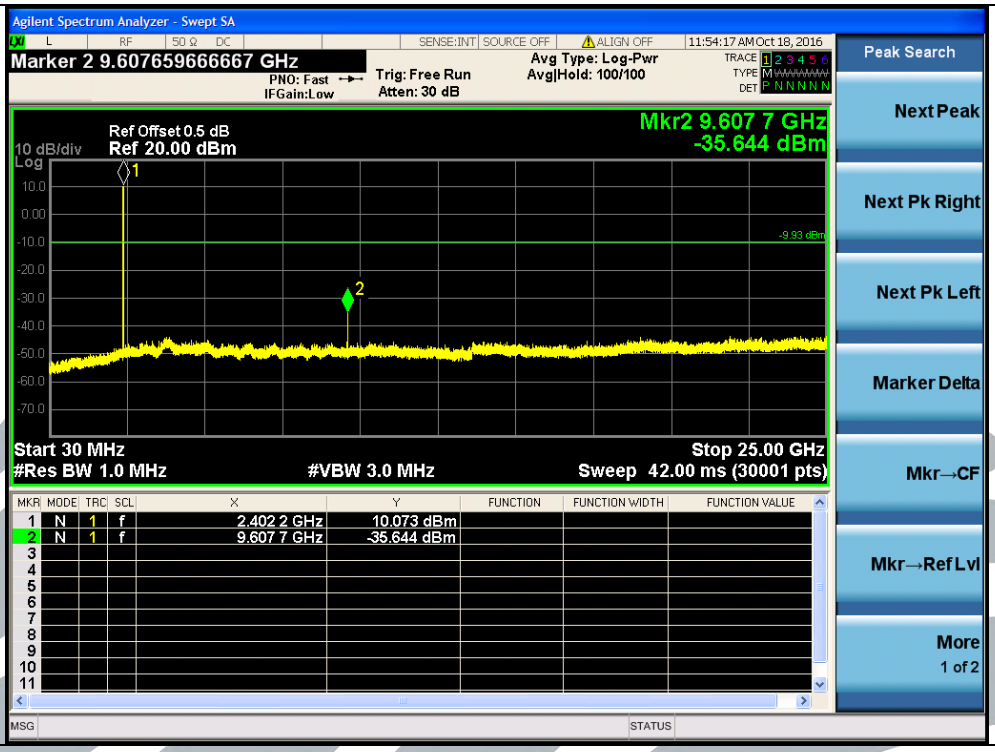
GFSK_1-DH5_Middle Channel



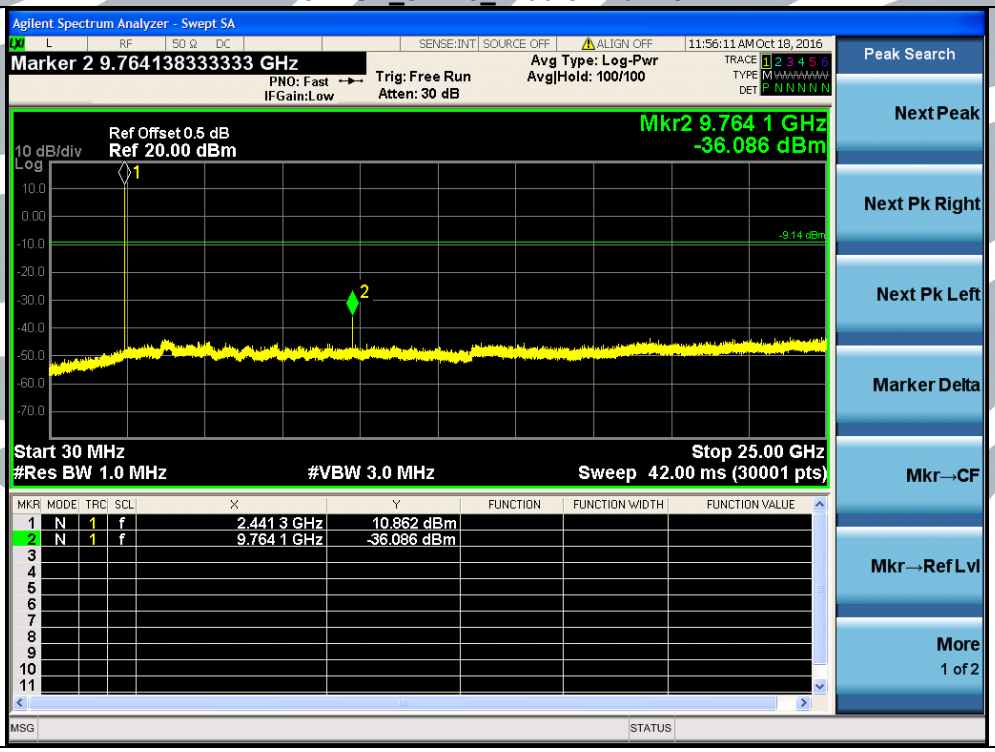
GFSK_1-DH5_Highest Channel



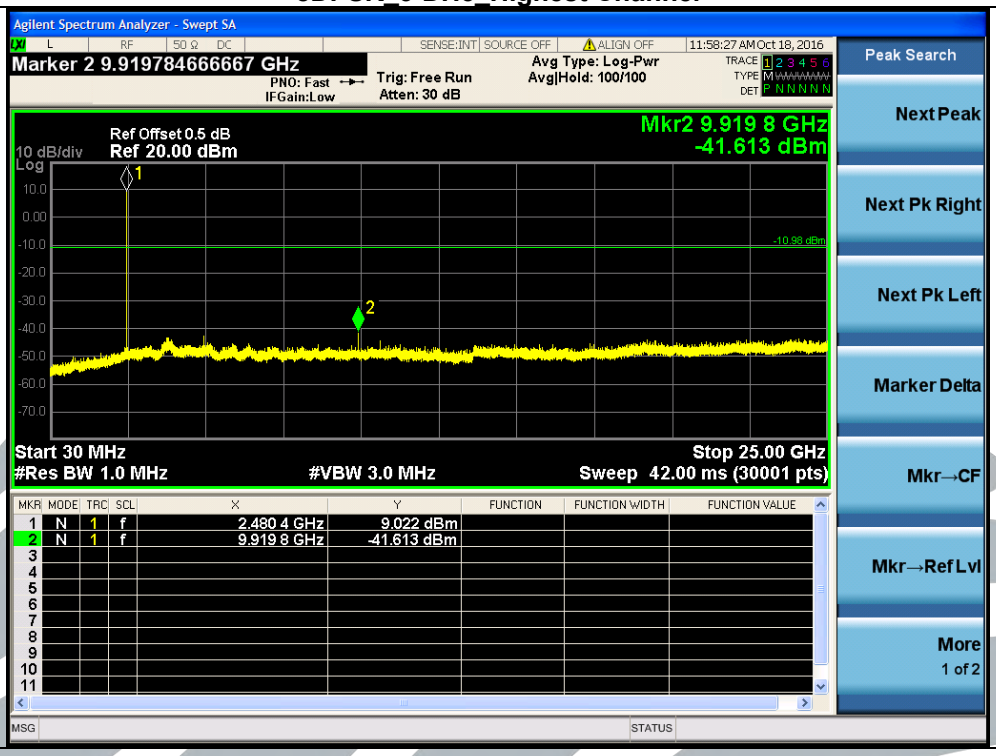
8DPSK_3-DH5_Lowest Channel



8DPSK_3-DH5_Middle Channel



8DPSK_3-DH5_Highest Channel



5.9 Radiated Spurious Emissions

Test Requirement: 47 CFR Part 15 Subpart C Section 15.205/15.209

Test Method: DA 00-705

Limit:

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.

Remark:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000 MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20 dB under any condition of modulation.

The emissions were measured using the following resolution bandwidths:

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	100 kHz	300kHz	Quasi-peak
Above 1GHz	Peak	1MHz	3MHz	Peak
	Peak	1MHz	10Hz	Average

Harmonic and Spurious emissions that were identified as coming from the EUT were checked in Peak and in Average Mode. The high frequency, which started from 10 to26.5GHz.

Peak measurements and average measurements are made. All emissions were determined to have a peak-to-average ratio of less than 20dB.

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 camber. 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 and the rotatable 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) Place a marker at the end of the restricted band closest to the transmit frequency to show compliance. Also measure any emissions in the restricted bands. Save the spectrum analyzer plot. Repeat for each power and modulation for lowest and highest channel

Above 1GHz test procedure as below:

g) Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber 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 Highest channel

i) The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is worse case.

j) Repeat above procedures until all frequencies measured was complete.

Test Setup: Refer to section 4.1.2 for details.

Instruments Used: Refer to section 3 for details

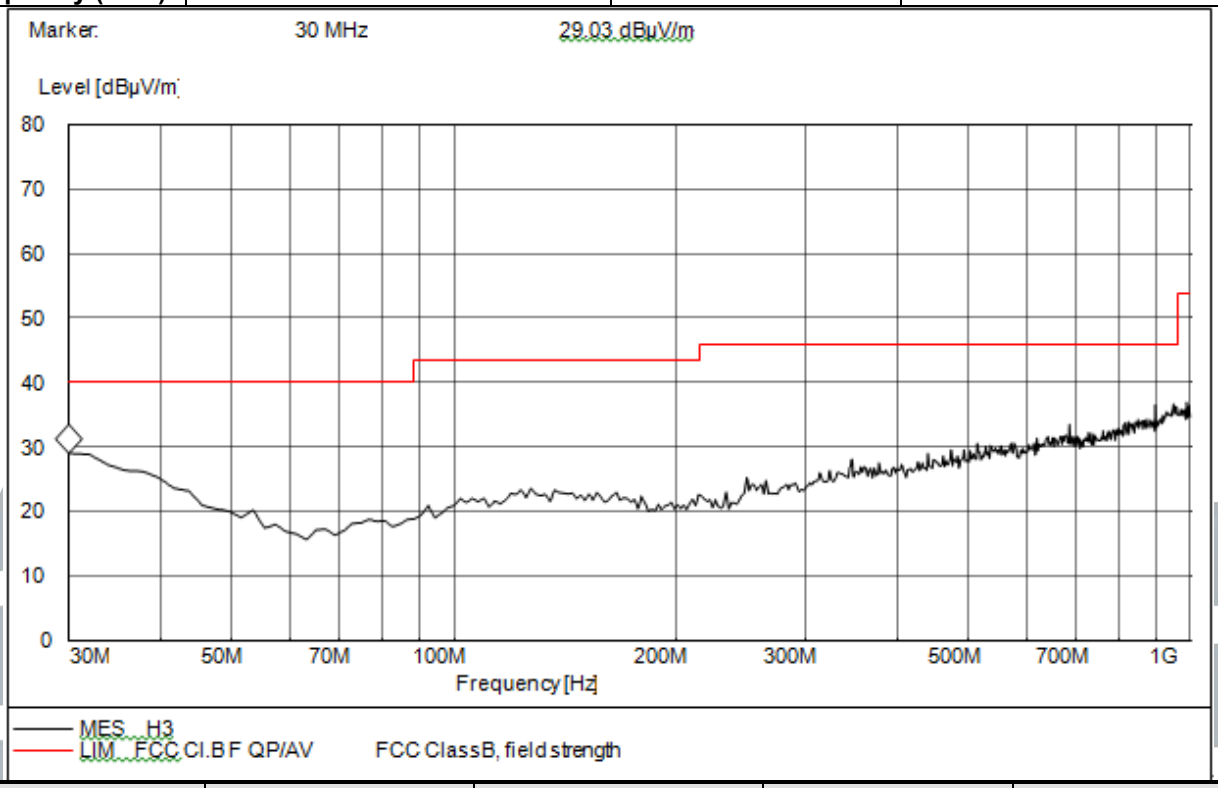
Test Mode: Transmitter mode

Test Results: Pass

Test Data:

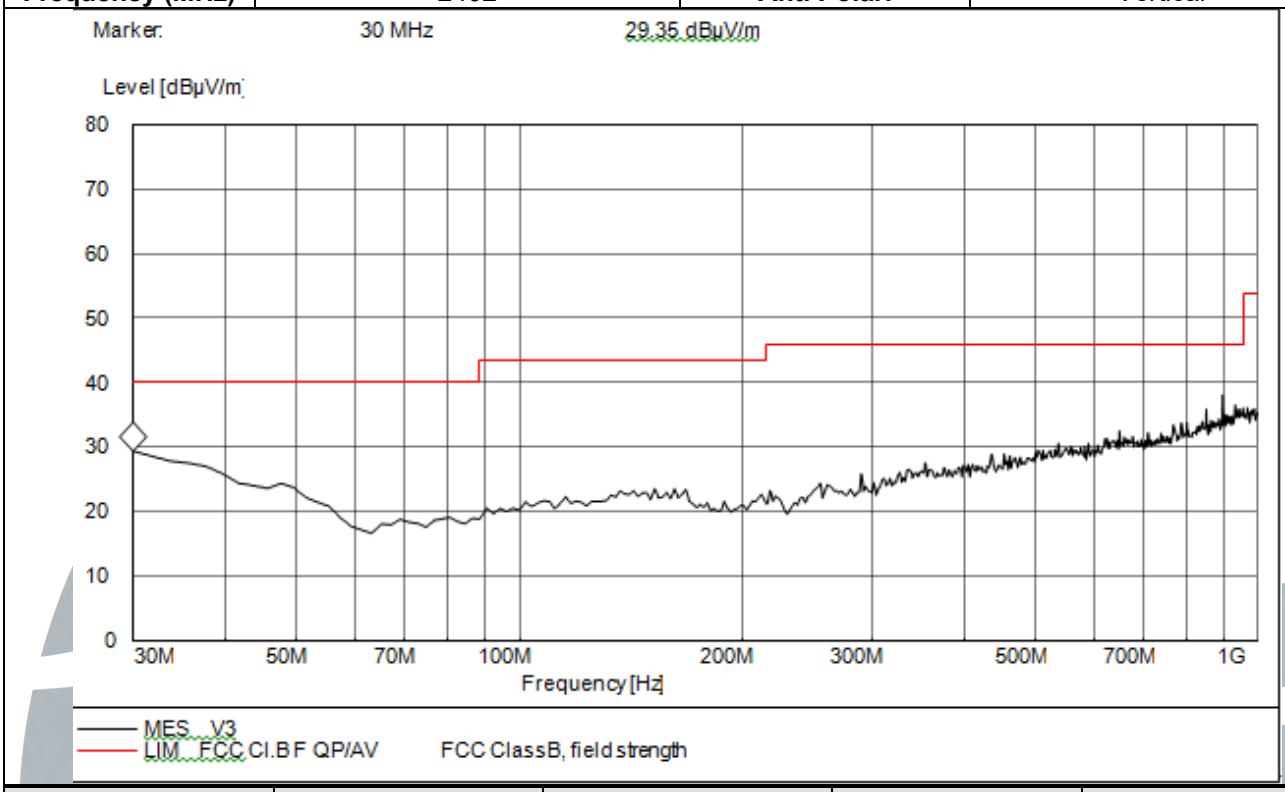
Radiated Emission Test Data (Below 1 GHz Worst Case):

Modulation Type	GFSK	Packets Type	1-DH5
Frequency (MHz)	2402	Ant. Polar.	Horizontal



.No.	Frequency (MHz)	Measurement Level (dBuV)	Limit (dBuV/m)	Result
1	30.000	28.84	40.0	PASS
2	128.140	22.58	43.5	PASS
3	359.210	25.89	46.0	PASS

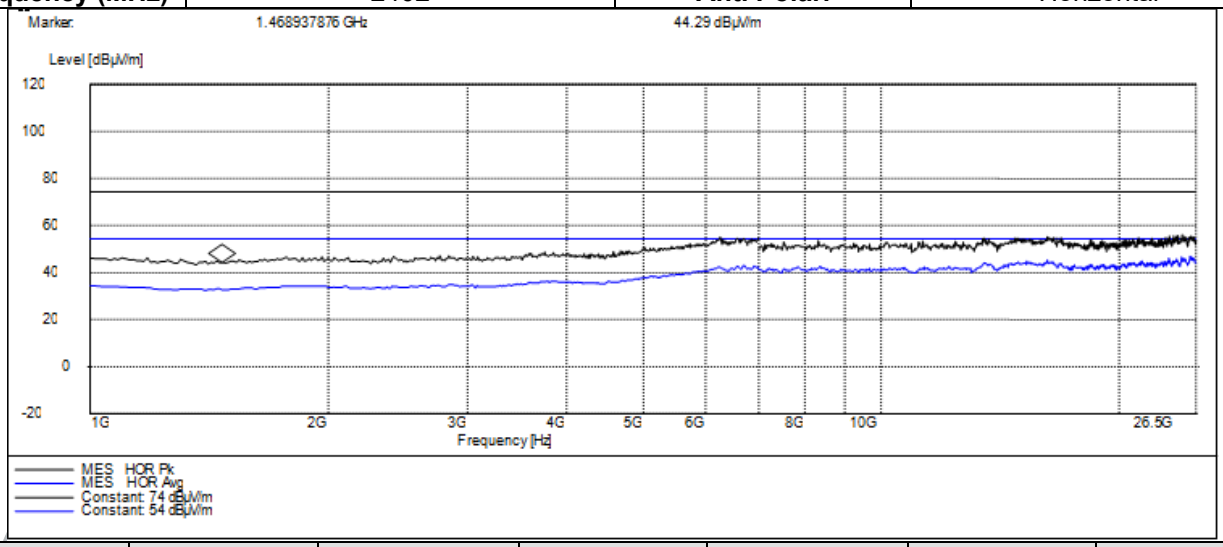
Modulation Type	GFSK	Packets Type	1-DH5
Frequency (MHz)	2402	Ant. Polar.	Vertical



.No.	Frequency (MHz)	Measurement Level (dBuV)	Limit (dBuV/m)	Result
1	30.000	27.89	40.00	PASS
2	136.580	23.01	43.50	PASS
3	378.070	26.99	46.00	PASS

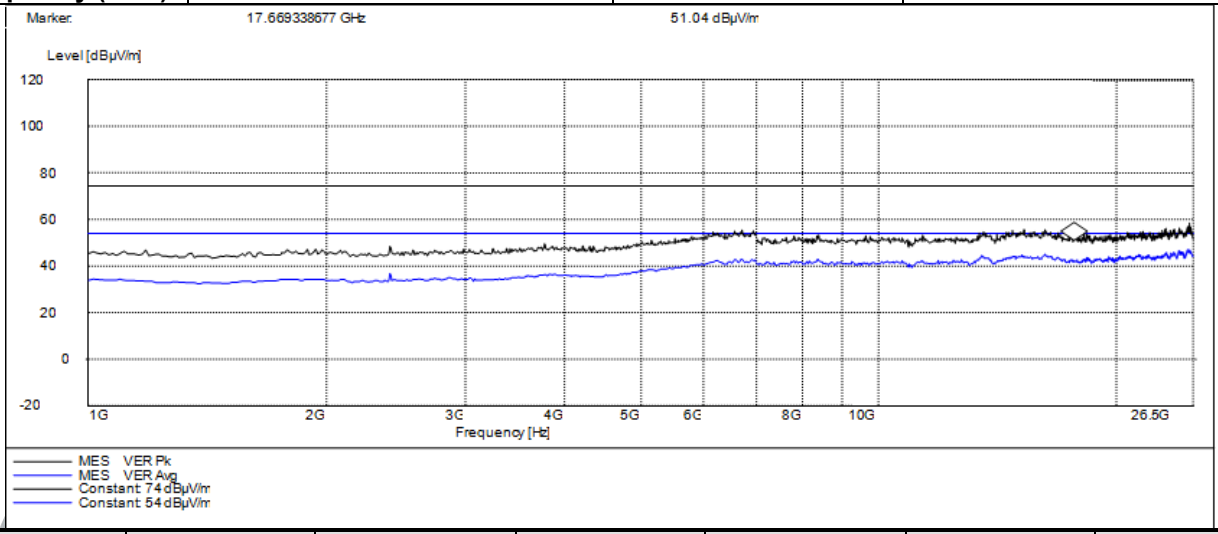
Radiated Emission Test Data (Above 1GHz):

Modulation Type	GFSK	Packets Type	1-DH5
Frequency (MHz)	2402	Ant. Polar.	Horizontal



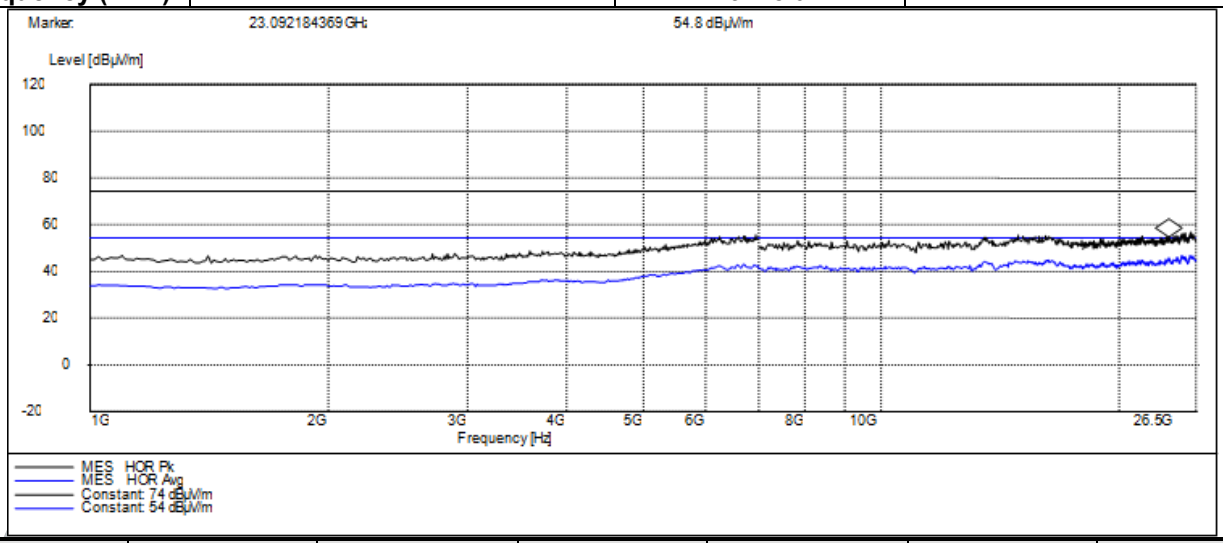
.No.	Frequency	Measurement Peak Level	Peak Limit	Measurement Avg Level	Avg Limit	Result
	(MHz)	(dBuV)	(dBuV/m)	(dBuV/m)	(dB)	
1	6218.400	53.70	74	42.35	54	PASS
2	13480.900	54.62	74	44.15	54	PASS
3	23975.900	54.67	74	46.64	54	PASS

Modulation Type	GFSK	Packets Type	1-DH5
Frequency (MHz)	2402	Ant. Polar.	Vertical



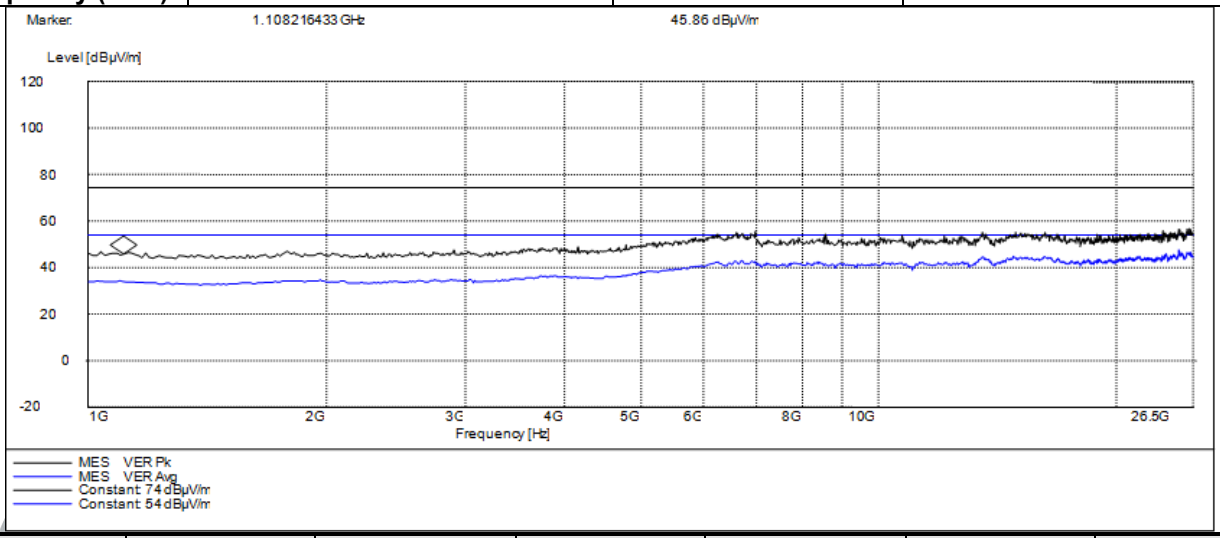
.No.	Frequency	Measurement Peak Level	Peak Limit	Measurement Avg Level	Avg Limit	Result
	(MHz)	(dBuV)	(dBuV/m)	(dBuV/m)	(dB)	
1	6278.500	53.76	74	41.85	54	PASS
2	13480.900	52.79	74	44.03	54	PASS
3	16192.300	52.65	74	44.59	54	PASS

Modulation Type	GFSK	Packets Type	1-DH5
Frequency (MHz)	2441	Ant. Polar.	Horizontal



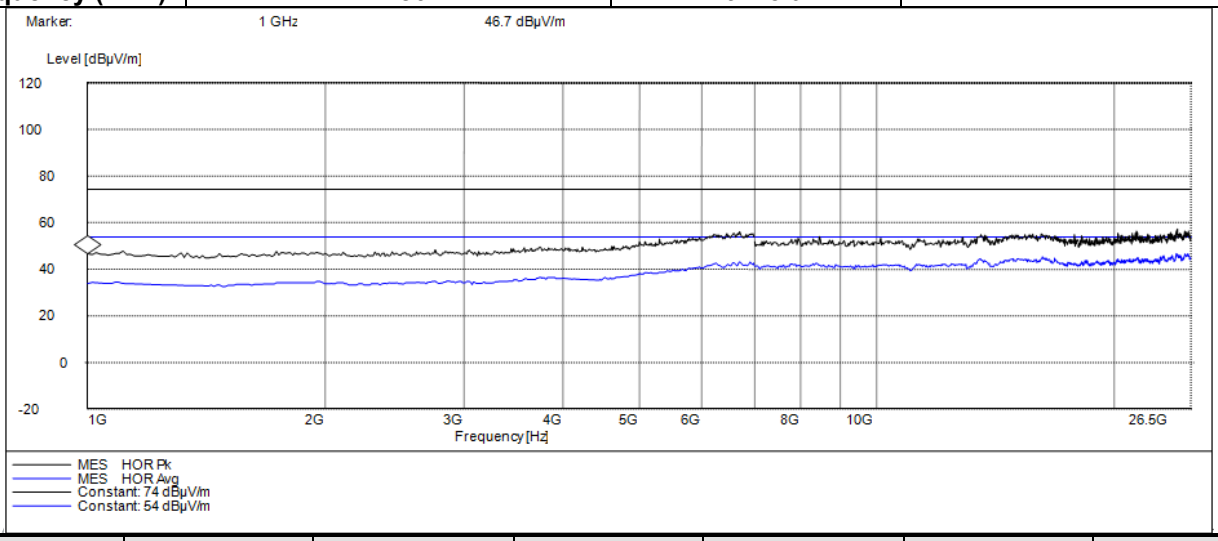
.No.	Frequency	Measurement Peak Level	Peak Limit	Measurement Avg Level	Avg Limit	Result
	(MHz)	(dBuV)	(dBuV/m)	(dBuV/m)	(dB)	
1	6206.400	53.41	74	42.10	54	PASS
2	13480.900	53.36	74	44.03	54	PASS
3	23078.100	56.91	74	45.55	54	PASS

Modulation Type	GFSK	Packets Type	1-DH5
Frequency (MHz)	2441	Ant. Polar.	Vertical



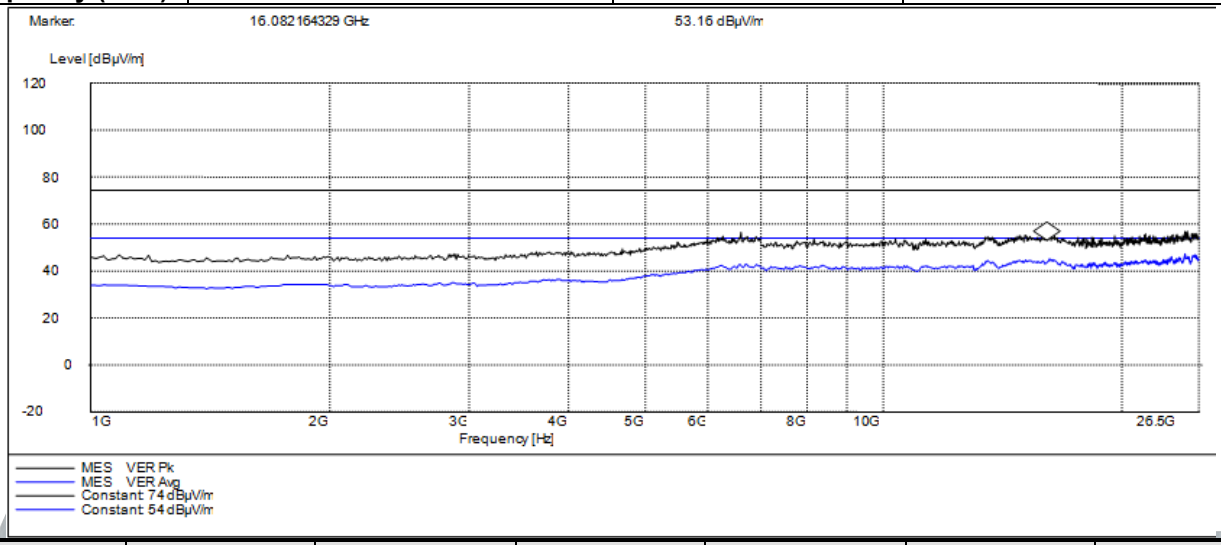
.No.	Frequency	Measurement Peak Level	Peak Limit	Measurement Avg Level	Avg Limit	Result
	(MHz)	(dBuV)	(dBuV/m)	(dBuV/m)	(dB)	
1	6266.500	53.01	74	42.38	54	PASS
2	13569.100	54.26	74	44.56	54	PASS
3	24032.100	56.28	74	46.83	54	PASS

Modulation Type	GFSK	Packets Type	1-DH5
Frequency (MHz)	2480	Ant. Polar.	Horizontal



.No.	Frequency	Measurement Peak Level	Peak Limit	Measurement Avg Level	Avg Limit	Result
	(MHz)	(dBuV)	(dBuV/m)	(dBuV/m)	(dB)	
1	6242.400	54.68	74	42.58	54	PASS
2	13525.000	54.29	74	44.52	54	PASS
3	24004.000	55.67	74	46.00	54	PASS

Modulation Type	GFSK	Packets Type	1-DH5
Frequency (MHz)	2480	Ant. Polar.	Vertical



.No.	Frequency	Measurement Peak Level	Peak Limit	Measurement Avg Level	Avg Limit	Result
	(MHz)	(dBuV)	(dBuV/m)	(dBuV/m)	(dB)	
1	6230.400	53.03	74	42.32	54	PASS
2	13569.100	53.93	74	44.10	54	PASS
3	24018.000	55.23	74	46.19	54	PASS

Note:

1) Through Pre-scan transmitting mode with all kind of modulation and data rate, find the 1-DH5 of rate is the worst case of GFSK,QPSK,DPSK and then Only the worst case is recorded in the report.

2) Scan from 9kHz to 26.5GHz, the disturbance below 30MHz was very low, and the above harmonics were the highest point could be found when testing, so only the above harmonics had been displayed. The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.

5.10 Band Edge Measurements (Radiated)

Test Requirement: 47 CFR Part 15 Subpart C Section 15.205/15.209

Test Method: DA 00-705

Limit:

Frequency	Limit (dBμV/m @3m)	Remark
30MHz-88MHz	40.0	Quasi-peak Value
88MHz-216MHz	43.5	Quasi-peak Value
216MHz-960MHz	46.0	Quasi-peak Value
960MHz-1GHz	54.0	Quasi-peak Value
Above 1GHz	54.0	Average Value
	74.0	Peak Value

Test Procedure: Radiated band edge measurements at 2390MHz and 2483MHz were made with the unit transmitting in the low end of the channel range and the high end closest to the restricted bands respectively. The emissions were made on the 966 Semi-Chamber. Use (resolution bandwidth (RBW) = 1 MHz, video bandwidth (VBW) = 3 MHz for peak levels and RBW = 1 MHz and VBW = 10 Hz or 1/T for average levels).

1. Use radiated spurious emission test procedure described in 5.9 clause. The transmitter output (antenna port) was connected to the test receiver.
2. Set the PK and AV limit line.
3. Record the fundamental emission and emissions out of the band-edge.
4. Determine band-edge compliance as required.

Test Setup: Refer to section 4.1.2 for details.

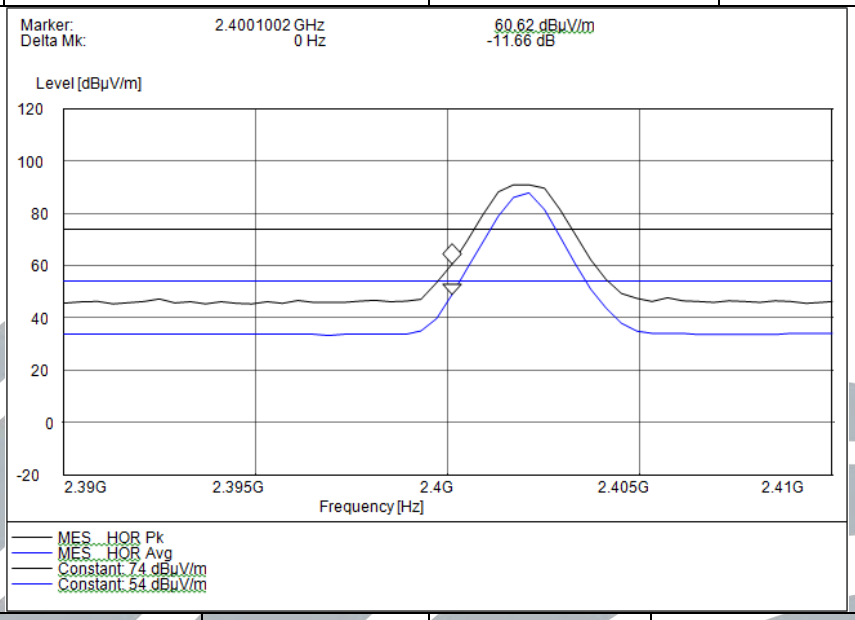
Instruments Used: Refer to section 3 for details

Test Mode: Transmitter mode

Test Results: Pass

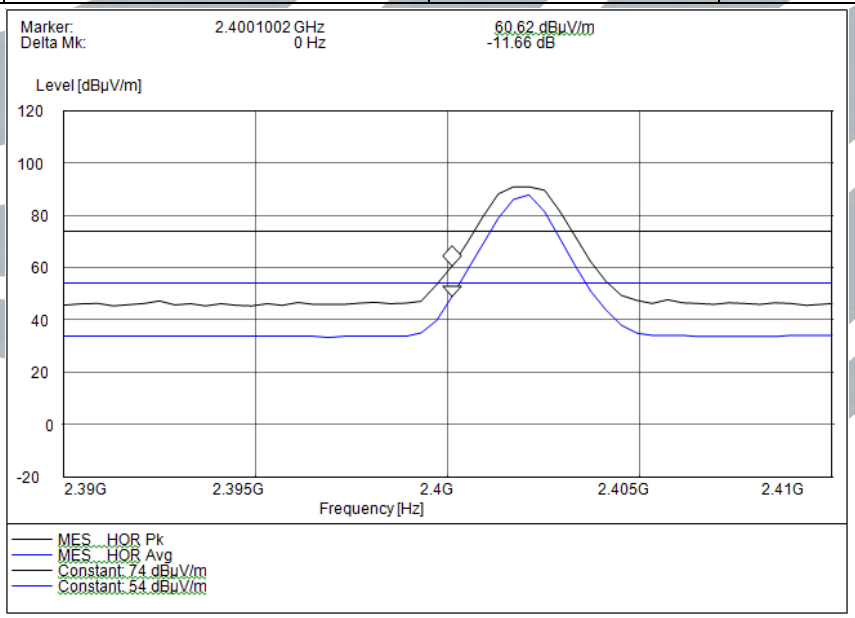
Test Data:

Modulation Type	GFSK	Packets Type	1-DH5
Frequency (MHz)	2402	Ant. Polar.	Horizontal



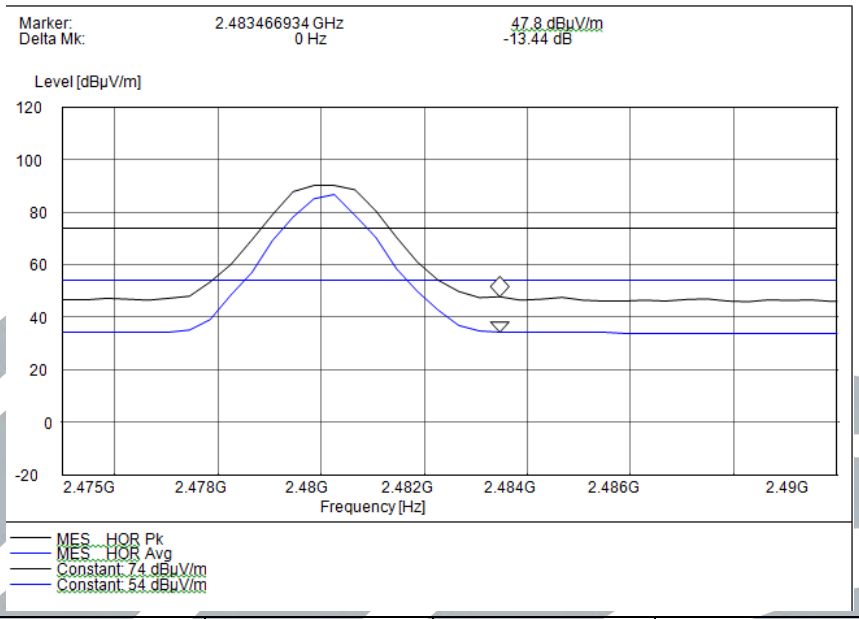
Frequency (MHz)	Peak level (dBuv/m)	Peak Limit (dBuv/m)	AV level (dBuv/m)	AV Limit (dBuv/m)	Conclusion
2400	60.62	74	48.96	54	Pass

Modulation Type	GFSK	Packets Type	1-DH5
Frequency (MHz)	2402	Ant. Polar.	Vertical



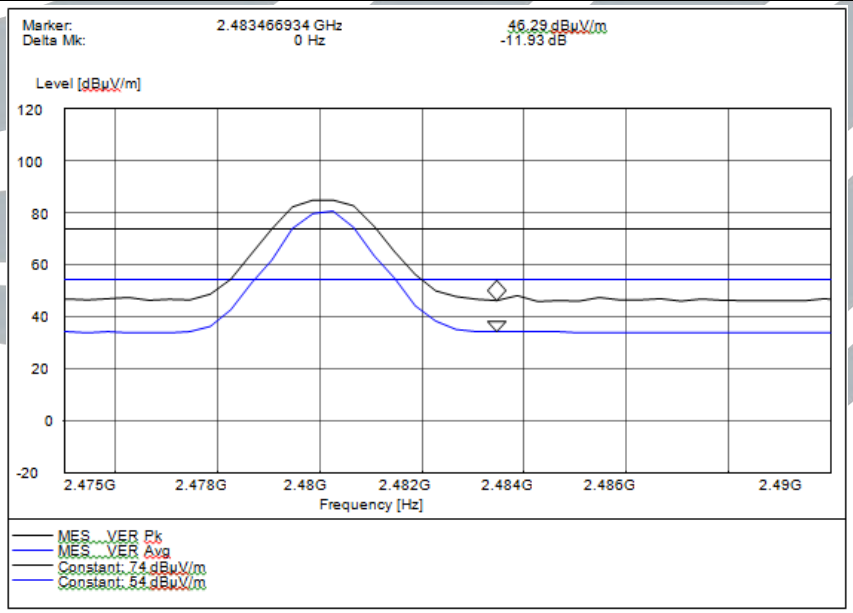
Frequency (MHz)	Peak level (dBuv/m)	Peak Limit (dBuv/m)	AV level (dBuv/m)	AV Limit (dBuv/m)	Conclusion
2400	60.62	74	48.96	54	Pass

Modulation Type	GFSK	Packets Type	1-DH5
Frequency (MHz)	2480	Ant. Polar.	Horizontal



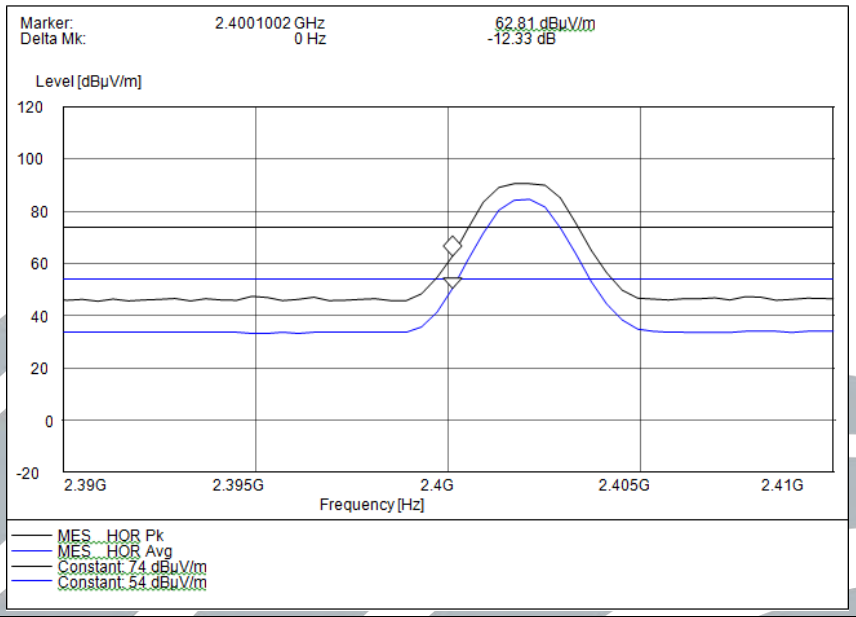
Frequency (MHz)	Peak level (dBuv/m)	Peak Limit (dBuv/m)	AV level (dBuv/m)	AV Limit (dBuv/m)	Conclusion
2483.5	47.80	74	34.36	54	Pass

Modulation Type	GFSK	Packets Type	1-DH5
Frequency (MHz)	2480	Ant. Polar.	Vertical



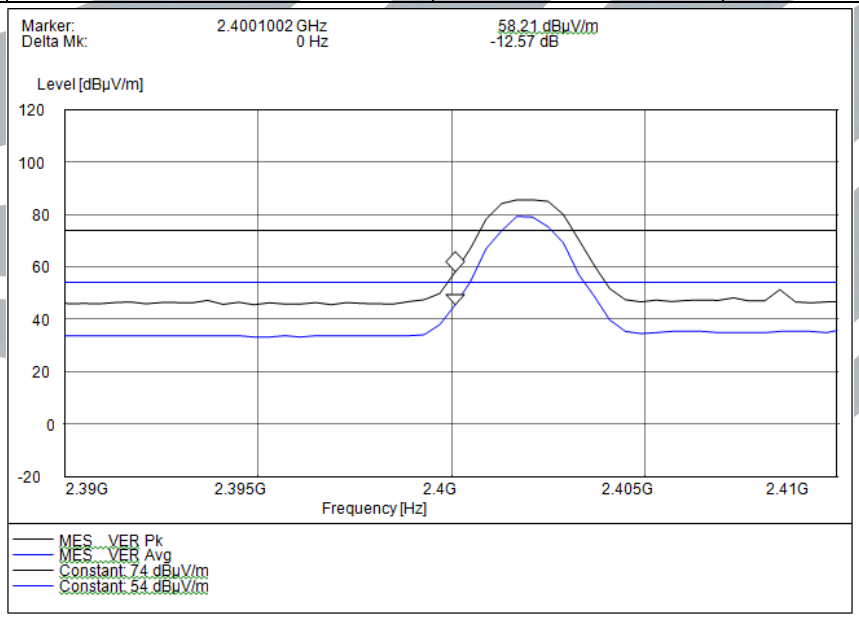
Frequency (MHz)	Peak level (dBuv/m)	Peak Limit (dBuv/m)	AV level (dBuv/m)	AV Limit (dBuv/m)	Conclusion
2483.5	46.29	74	34.36	54	Pass

Modulation Type	8DPSK	Packets Type	3-DH5
Frequency (MHz)	2402	Ant. Polar.	Horizontal



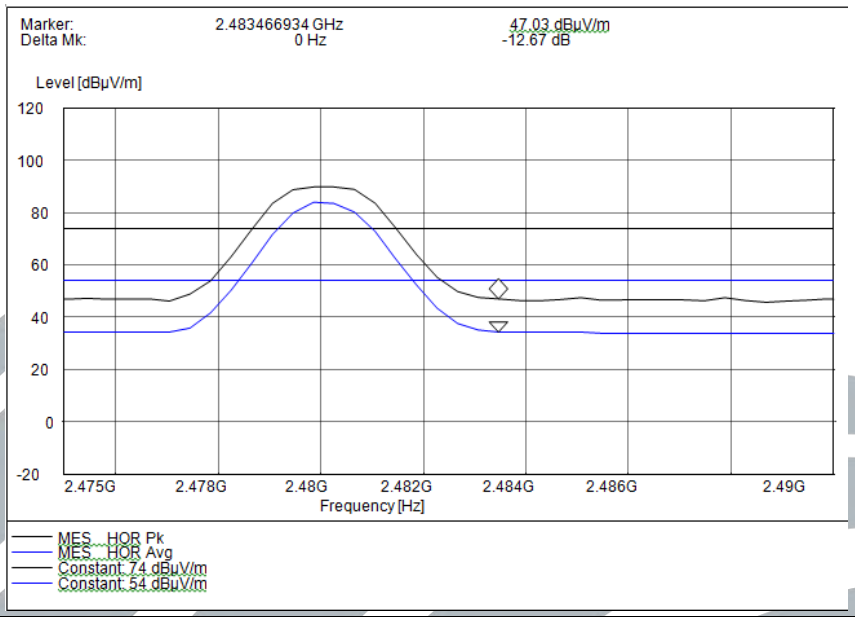
Frequency (MHz)	Peak level (dBuv/m)	Peak Limit (dBuv/m)	AV level (dBuv/m)	AV Limit (dBuv/m)	Conclusion
2400	62.81	74	50.48	54	Pass

Modulation Type	8DPSK	Packets Type	3-DH5
Frequency (MHz)	2402	Ant. Polar.	Vertical



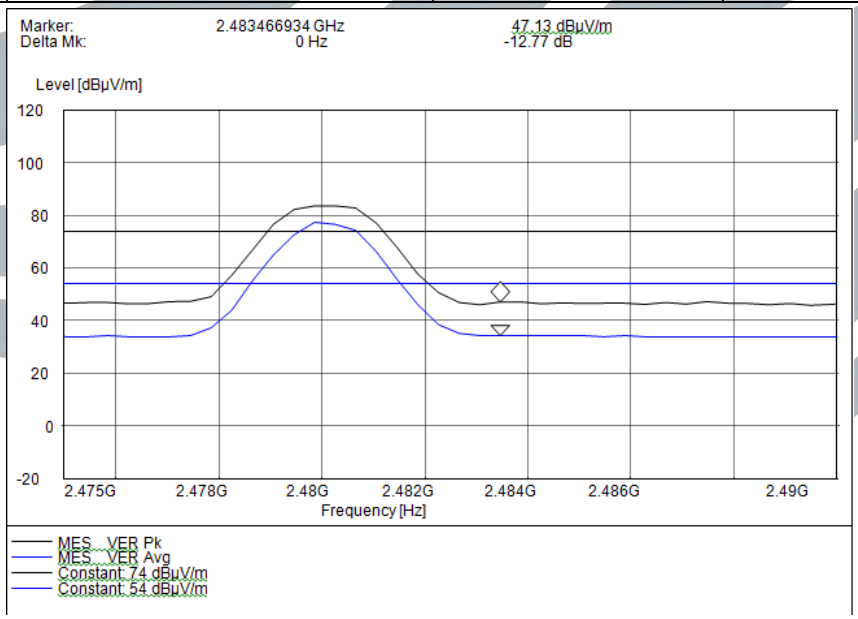
Frequency (MHz)	Peak level (dBuv/m)	Peak Limit (dBuv/m)	AV level (dBuv/m)	AV Limit (dBuv/m)	Conclusion
2400	58.21	74	45.64	54	Pass

Modulation Type	8DPSK	Packets Type	3-DH5
Frequency (MHz)	2480	Ant. Polar.	Horizontal



Frequency (MHz)	Peak level (dBuv/m)	Peak Limit (dBuv/m)	AV level (dBuv/m)	AV Limit (dBuv/m)	Conclusion
2483.5	47.03	74	34.36	54	Pass

Modulation Type	8DPSK	Packets Type	3-DH5
Frequency (MHz)	2480	Ant. Polar.	Vertical



Frequency (MHz)	Peak level (dBuv/m)	Peak Limit (dBuv/m)	AV level (dBuv/m)	AV Limit (dBuv/m)	Conclusion
2483.5	47.13	74	34.36	54	Pass

Note:

1) Find the 1-DH5 of rate is the worst case of GFSK, 3-DH5 of rate is the worst case of DQPSK,8DPSK and then Only the worst case is recorded in the report.
2) Through testing, the point of 2400 MHz test result is the worst in 2310-2400 MHz band.

5.11 Conducted Emissions

Test Requirement: 47 CFR Part 15C Section 15.207

Test Method: ANSI C63.10

Test Frequency Range: 150KHz to 30MHz

Limit:

Frequency range (MHz)	Limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

* The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

NOTE : The lower limit is applicable at the transition frequency

Test Procedure:

Test frequency range :150KHz-30MHz

1) The mains terminal disturbance voltage test was conducted in a shielded room.

2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50Ω/50μH + 5Ω linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.

3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane,

4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was 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.

Test Setup: Refer to section 4.1.3 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Transmitter mode

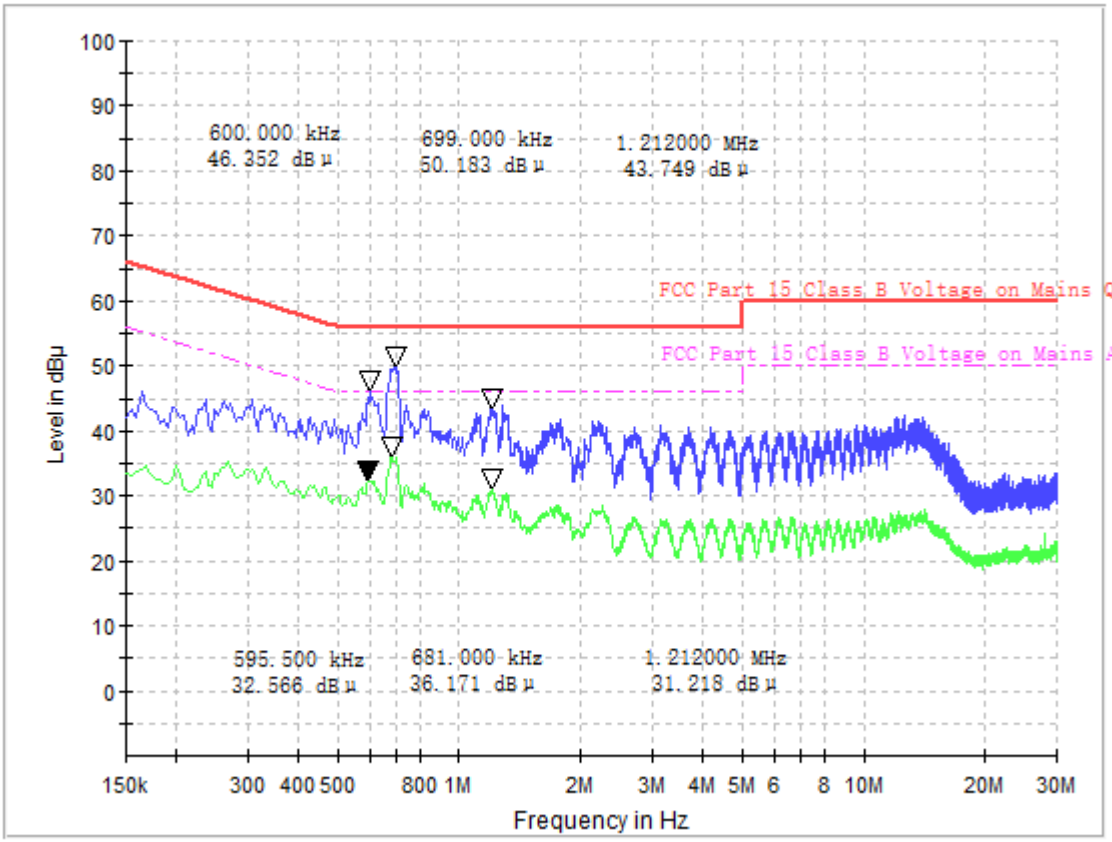
Test Results: Pass

Measurement Data

An initial pre-scan was performed on the live and neutral lines with peak detector.

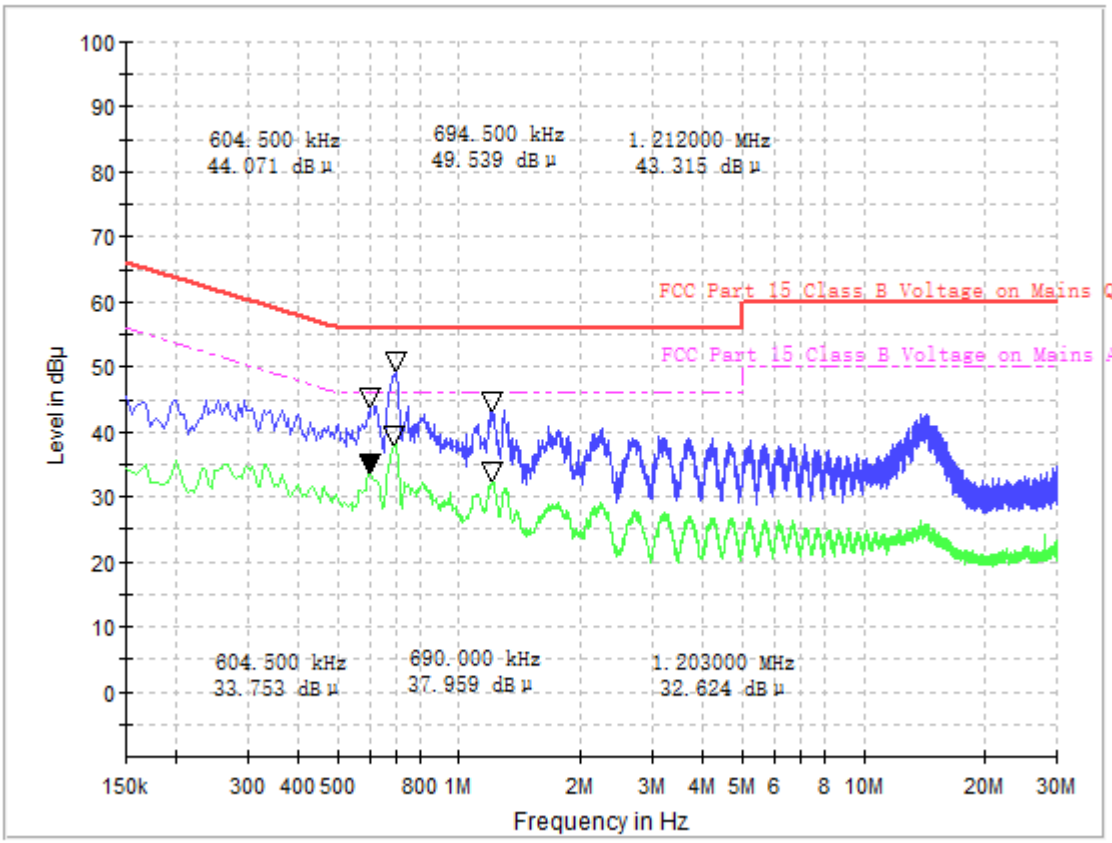
Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission were detected.

Test plot as follows:
Live Line:



.No.	Frequency	Measurement QP Level	QP Limit	Measurement AVg Level	Avg Limit	Result
	(MHz)	(dBuV)	(dBuV/m)	(dBuV/m)	(dB)	
1	0.600	44.36	56	32.42	46	PASS
2	0.699	48.12	56	36.27	46	PASS
3	1.212	41.21	56	31.46	46	PASS

Neutral Line:



.No.	Frequency	Measurement QP Level	QP Limit	Measurement AVg Level	Avg Limit	Result
	(MHz)	(dBuV)	(dBuV/m)	(dBuV/m)	(dB)	
1	0.605	42.13	56	32.72	46	PASS
2	0.695	47.88	56	37.87	46	PASS
3	1.212	41.54	56	32.27	46	PASS

Notes:

1. The following Quasi-Peak and Average measurements were performed on the EUT:

APPENDIX 1 PHOTOGRAPHS OF TEST SETUP

See test photographs attached in Appendix 1 for the actual connections between Product and support equipment.

APPENDIX 2 PHOTOGRAPHS OF EUT CONSTRUCTIONAL DETAILS

Refer to Appendix 2 for EUT external and internal photographs.

*** End of Report ***