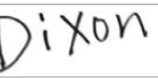
FCC PART 15 SUBPART C TEST REPORT

FCC PART 15.247

Report Reference No.....:	**MWR161000103**	
FCC ID.....:	**RQQHLT-L55UTM**	
Compiled by (position+printed name+signature)..:	File administrators Martin Ao	
Supervised by (position+printed name+signature)..:	Test Engineer Yuchao Wang	
Approved by (position+printed name+signature)..:	Manager Dixon Hao	
Date of issue.....:	October 24, 2016	
Representative Laboratory Name.:	**Maxwell International Co., Ltd.**	
Address .....:	Room 509, Hongfa center building, Baoan District, Shenzhen, Guangdong, China	
Testing Laboratory Name.....:	**Shenzhen CTL Testing Technology Co., Ltd.**	
Address .....:	Floor 1-A, Baisha Technology Park, No.3011, Shahexi Road, Nanshan District, Shenzhen, China 518055	
Applicant's name.....:	**HYUNDAI CORPORATION**	
Address .....:	140-2, Kye-dong, Chongro-ku, Seoul, South Korea	
Test specification.....**:**		
Standard .....:	**FCC Part 15.247: Operation within the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz**	
TRF Originator.....:	Maxwell International Co., Ltd.	

Test item description .....:	Mobile Phone
Trade Mark .....:	HYUNDAI
Manufacturer.....:	**Shenzhen Rainbow Time Technology Co.,Ltd**
Model/Type reference.....:	TITAN LTE
Listed Models .....:	/
Modulation Type .....:	GFSK,8DPSK,π/4DQPSK
Operation Frequency.....:	From 2402MHz to 2480MHz
Rating .....:	DC 3.80V
Hardware version .....:	5101SP_S52
Software version .....:	V1.0
Result.....:	**PASS**

T E S T R E P O R T

Test Report No. :	MWR161000103	October 24, 2016 Date of issue

Equipment under Test	:	Mobile Phone
Model /Type	:	TITAN LTE
Listed Models	:	/
Applicant	:	**HYUNDAI CORPORATION**
Address	:	140-2, Kye-dong, Chongro-ku, Seoul, South Korea
Manufacturer	:	**Shenzhen Rainbow Time Technology Co.,Ltd**
Address	:	Room 905, ChangHong Technology Building, Science and Technology Park, Nanshan District, Shenzhen, China

Test Result:	**PASS**

Revison History

Revision	Issue Date	Revisions	Revised By
00	2016-10-24	Initial Issue	Dixon Hao

Contents

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules Part 15.247: Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.
ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices
DA00-75 : Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems

2 SUMMARY

2.1 General Remarks

Date of receipt of test sample	:	September.18, 2016
Testing commenced on	:	September.19, 2016
Testing concluded on	:	October 24, 2016

2.2 Product Description

The **HYUNDAI CORPORATION**'s Model: TITAN LTE or the "EUT" as referred to in this report; more general information as follows, for more details, refer to the user's manual of the EUT.

Name of EUT	Mobile Phone
Model Number	TITAN LTE
Modilation Type	GMSK for GSM/GPRS/EDGE, 8-PSK for EDGE only downlink, QPSK for UMTS, QPSK/16QAM for LTE
Antenna Type	Internal
UMTS Operation Frequency Band	Device supported UMTS FDD Band II, FDD Band V
WLAN FCC Operation frequency	IEEE 802.11b:2412-2462MHz IEEE 802.11g:2412-2462MHz IEEE 802.11n HT20:2412-2462MHz IEEE 802.11n HT40:2422-2452MHz
BT FCC Operation frequency	2402MHz-2480MHz
HSDPA Release Version	Release 10
HSUPA Release Version	Release 6
DC-HSUPA Release Version	Not Supported
WCDMA Release Version	R99
WLAN FCC Modulation Type	IEEE 802.11b: DSSS(CCK,DQPSK,DBPSK) IEEE 802.11g: OFDM(64QAM, 16QAM, QPSK, BPSK) IEEE 802.11n HT20: OFDM (64QAM, 16QAM, QPSK,BPSK) IEEE 802.11n HT40: OFDM (64QAM, 16QAM, QPSK,BPSK)
BT Modulation Type	GFSK,8DPSK,π/4DQPSK(BT3.0+EDR),GFSK(BLE)
Hardware version	5101SP_S52
Software version	V1.0
Android version	Android 5.1
GPS function	Supported
WLAN	Supported 802.11b/802.11g/802.11n
Bluetooth	Supported BT 4.0/BT 3.0+EDR
GSM/EDGE/GPRS	Supported GSM/GPRS/EDGE
GSM/EDGE/GPRS Power Class	GSM850:Power Class 4/ PCS1900:Power Class 1
GSM/EDGE/GPRS Operation Frequency	GSM850 :824.2MHz-848.8MHz/PCS1900:1850.2MHz-1909.8MHz
GSM/EDGE/GPRS Operation Frequency Band	GSM850/PCS1900/GPRS850/GPRS1900/EDGE850/EDGE1900
GSM Release Version	R99
GPRS/EDGE Multislot Class	GPRS: Multi-slot Class 12
Extreme temp. Tolerance	-30°C to +50°C
Extreme vol. Limits	3.40VDC to 4.20VDC (nominal: 3.80VDC)
GPRS operation mode	Class B

2.3 Equipment Under Test

Power supply system utilised

Power supply voltage	:	○	120V / 60 Hz	○	115V / 60Hz
		○	12 V DC	○	24 V DC
		●	Other (specified in blank below)		

DC 3.80V

2.4 Short description of the Equipment under Test (EUT)

2.4.1 General Description

TITAN LTE is subscriber equipment in the WCDMA/GSM system. The HSPA/UMTS frequency band is Band I, Band II and Band V; The GSM/GPRS/EDGE frequency band includes GSM850 and GSM900 and DCS1800 and PCS1900, but only Band II, Band V , GSM850 and PCS1900 bands test data included in this report. The Mobile Phone implements such functions as RF signal receiving/transmitting, HSPA/UMTS and GSM/GPRS/EDGE protocol processing, voice, video MMS service, GPS and WIFI etc. Externally it provides micro SD card interface, earphone port (to provide voice service) and SIM card interface. It also provides Bluetooth module to synchronize data between a PC and the phone, or to use the built-in modem of the phone to access the Internet with a PC, or to exchange data with other Bluetooth devices.

NOTE: Unless otherwise noted in the report, the functional boards installed in the units shall be selected from the below list, but not means all the functional boards listed below shall be installed in one unit.

2.5 EUT operation mode

The EUT has been tested under typical operating condition. There are EDR (Enhanced Data Rate) and BDR (Basic Data Rate) mode.The Applicant provides communication tools software to control the EUT for staying in continous transmitting and receiving mode for testing. There are 79 channels of EUT, and the test carried out at the lowest channel, middle channel and highest channel .

Channel	Frequency(MHz)	Channel	Frequency(MHz)
0	**2402**	40	2442
1	2403	41	2443
2	2404	42	2444
3	2405	43	2445
4	2406	44	2446
5	2407	45	2447
6	2408	46	2448
7	2409	47	2449
8	2410	48	2450
9	2411	49	2451
10	2412	50	2452
11	2413	51	2453
12	2414	52	2454
13	2415	53	2455
14	2416	54	2456
15	2417	55	2457
16	2418	56	2458
17	2419	57	2459
18	2420	58	2460
19	2421	59	2461
20	2422	60	2462
21	2423	61	2463
22	2424	62	2464
23	2425	63	2465
24	2426	64	2466

25	2427	65	2467
26	2428	66	2468
27	2429	67	2469
28	2430	68	2470
29	2431	69	2471
30	2432	70	2472
31	2433	71	2473
32	2434	72	2474
33	2435	73	2475
34	2436	74	2476
35	2437	75	2477
36	2438	76	2478
37	2439	77	2479
38	2440	**78**	**2480**
39	**2441**		

2.6 Internal Identification of AE used during the test

AE ID*	Description
AE1	Charger

AE1
Model: DC500
INPUT: AC180-240V~ 50/60Hz 0.15A
OUTPUT: DC 5.0V 1000mA

*AE ID: is used to identify the test sample in the lab internally.

2.7 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for **FCC ID: RQQHLT-L55UTM** filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rules.

2.8 Modifications

No modifications were implemented to meet testing criteria.

3 TEST ENVIRONMENT

3.1 Address of the test laboratory

Shenzhen CTL Testing Technology Co., Ltd.
Floor 1-A, Baisha Technology Park, No. 3011, Shahexi Road, Nanshan, Shenzhen 518055 China

There is one 3m semi-anechoic chamber and two line conducted labs for final test. The Test Sites meet the requirements in documents ANSI C63.4, CISPR 22/EN 55022 and CISPR16-4-1 SVSWR requirements.

3.2 Test Facility

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

IC Registration No.: 9618B

The 3m alternate test site of Shenzhen CTL Testing Technology Co., Ltd. EMC Laboratory has been registered by Certification and Engineer Bureau of Industry Canada for the performance of with Registration No.: 9618B on November 13, 2013.

FCC-Registration No.: 970318

Shenzhen CTL Testing Technology 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 970318, December 19, 2013.

3.3 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	15-35 ° C
Humidity:	30-60 %
Atmospheric pressure:	950-1050mbar

3.4 Test Conditions

Test Case	Test Conditions	
	Configuration	Description
20dB Emission Bandwidth (EBW)	Meas. Method	ANSI C63.10:2013
	Test Environment	NTNV
	EUT Conf.	TM1_DH5_Ch00,TM1_DH5_Ch39,TM1_DH5_Ch78, TM3_3DH5_Ch00,TM3_3DH5_Ch39,TM3_3DH5_Ch78,
Carrier Frequency Separation	Meas. Method	ANSI C63.10:2013
	Test Environment	NTNV
	EUT Conf.	TM1_DH5_Hop, TM3_3DH5_Hop,
Number of Hopping Channel	Meas. Method	ANSI C63.10:2009
	Test Environment	NTNV
	EUT Conf.	TM1_DH5_Hop ,TM3_3DH5_Hop,
Time of Occupancy (Dwell Time)	Meas. Method	ANSI C63.10:2013
	Test Environment	NTNV
	EUT Conf.	TM1_DH5_Ch39 ,TM3_3DH5_Ch39.
Maximum Peak Conducted Output Power	Meas. Method	ANSI C63.10:2013
	Test Environment	NTNV
	EUT Conf.	TM1_DH3_Ch00,TM1_DH3_Ch39,TM1_DH3_Ch78,TM2_2DH3_Ch00,TM2_2DH3_Ch39,TM2_2DH3_Ch78,TM3_3DH3_Ch00,TM3_3DH3_Ch39,TM3_3DH3_Ch78,
Bandedge spurious emission (Conducted)	Meas. Method	ANSI C63.10:2013
	Test Environment	NTNV
	EUT Conf.	TM1_DH3_Ch00,TM1_DH3_Ch78, TM3_3DH3_Ch00,TM3_3DH3_Ch78,

Conducted RF Spurious Emission	Meas. Method	ANSI C63.10:2013
	Test Environment	NTNV
	EUT Conf.	TM1_DH5_Ch00, TM1_DH5_Ch39, TM1_DH5_Ch78, TM3_3DH5_Ch39, TM3_3DH5_Ch78.
Radiated Emissions in the Restricted Bands	Meas. Method	ANSI C63.10:2009 30 MHz to 1 GHz: Pre: RBW=100kHz; VBW=300kHz; Det. = Peak. Final: RBW=120kHz; Det. = CISPR Quasi-Peak. 1 GHz to 26.5GHz: Average: RBW=1 MHz; VBW= 10Hz; Det. = Peak; Sweep-time= Auto; Trace = Single. Peak: RBW=1 MHz; VBW= 3 MHz; Det. = Peak; Sweep-time= Auto; Trace≥ MaxHold * 100.
	Test Environment	NTNV
	EUT Conf.	30 MHz-1GHz TM1_DH5_Ch00 (Worst Conf.).
		1-18 GHz: TM1_DH5_Ch00, TM1_DH5_Ch39, TM1_DH5_Ch78, (Worst Conf.).

Test Case	Test Conditions	
	Configuration	Description
AC Power Line Conducted Emissions	Measurement Method	AC mains conducted.
	Test Environment	NTNV
	EUT Configuration	TM1_DH5_Ch39. (Worst Conf.).

Note:
1. For Radiated Emissions, By preliminary testing and verifying three axis (X, Y and Z) position of EUT transmitted status, it was found that “Z axis” position was the worst, then the final test was executed the worst condition and test data were recorded in this report.
2. For π/4 QPSK its same modulation type with 8-DPSK, and based exploratory test, there is no significant difference of that two types test result, so except output power, all other items final test were only performed with the worse case 8-DPSK and GFSK.
3. For AC Main conducted emission measured at both AC power adapter and charge from PC, recorded worst case in test report.
4. For AC Main conducted emission measured at both AC 120V/60Hz and AC 240V/50Hz, recorded worst case in test report.

3.5 Summary of measurement results

Test Specification clause	Test case	Test Mode	Test Channel	Recorded In Report		Pass	Fail	NA	NP	Remark
§15.247(b)(4)	Antenna gain	GFSK	☒ Lowest ☒ Middle ☒ Highest	GFSK	☒ Lowest ☒ Middle ☒ Highest	☒	☐	☐	☐	complies
§15.247(e)	Power spectral density	-/-	-/-	-/-	-/-	☐	☐	☒	☐	Not applicable for FHSS!
§15.247(a)(1)	Carrier Frequency separation	GFSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK 8DPSK	☒ Middle	☒ ☒	☐	☐	☐	complies
§15.247(a)(1)	Number of Hopping channels	GFSK 8DPSK	☒ Full	GFSK 8DPSK	☒ Full	☒ ☒	☐	☐	☐	complies
§15.247(a)(1)	Time of Occupancy (dwell time)	GFSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK 8DPSK	☒ Middle	☒ ☒	☐	☐	☐	complies
§15.247(a)(1)	Spectrum bandwidth of a FHSS system 20dB bandwidth	GFSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	☒ ☒	☐	☐	☐	complies
§15.247(b)(1)	Maximum output power	GFSK π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	☒ ☒ ☒	☐	☐	☐	complies

§15.247(d)	Band edge compliance conducted	GFSK 8DPSK	☒ Lowest ☒ Highest ☒ Hopping	GFSK 8DPSK	☒ Lowest ☒ Highest ☒ Hopping	☒ ☒	☐	☐	☐	complies
§15.205	Band edge compliance radiated	GFSK 8DPSK	☒ Lowest ☒ Highest ☒ Hopping	GFSK 8DPSK	☒ Lowest ☒ Highest	☒ ☒	☐	☐	☐	complies
§15.247(d)	TX spurious emissions conducted	GFSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	☒ ☒	☐	☐	☐	complies
§15.247(d)	TX spurious emissions radiated	GFSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK	☒ Lowest ☒ Middle ☒ Highest	☒	☐	☐	☐	complies
§15.109	RX spurious emissions radiated	-/-	-/-	-/-	-/-	☒	☐	☐	☐	complies
§15.209(a)	TX spurious Emissions radiated < 30 MHz	GFSK	-/-	GFSK	-/-	☒	☐	☐	☐	complies
§15.107(a) §15.207	Conducted Emissions < 30 MHz	GFSK	-/-	GFSK	-/-	☒	☐	☐	☐	complies

Remark:
1. *The measurement uncertainty is not included in the test result.*
2. *NA = Not Applicable; NP = Not Performed*
3. *We tested all test mode and recorded worst case in report*

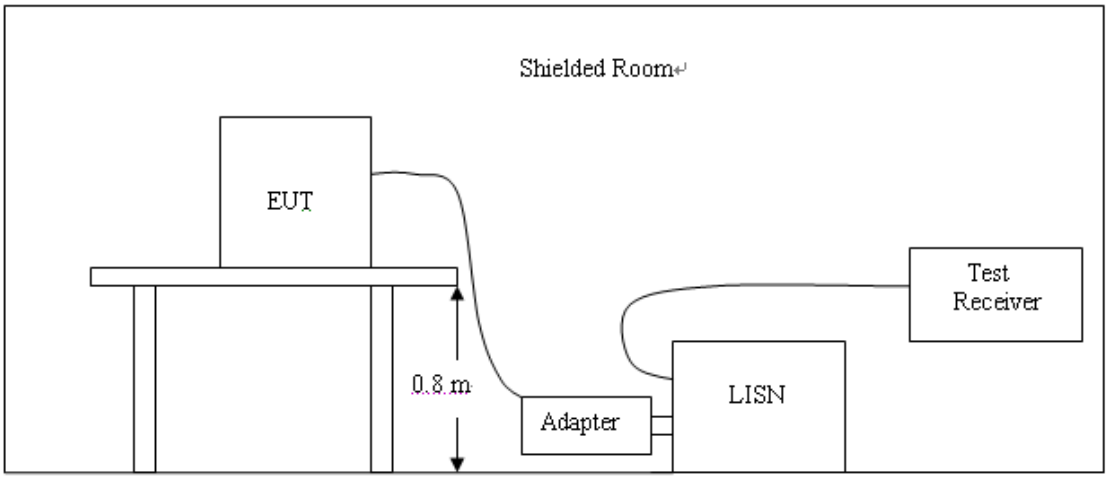
3.6 Equipments Used during the Test

Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
Bilog Antenna	Sunol Sciences Corp.	JB1	A061713	2016/06/02	2017/06/01
EMI Test Receiver	R&S	ESCI	103710	2016/06/02	2017/06/01
Spectrum Analyzer	Agilent	N9030A	MY49430428	2016/05/21	2017/05/20
Controller	EM Electronics	Controller EM 1000	N/A	2016/05/21	2017/05/20
Horn Antenna	SCHWARZBECK	BBHA9170D	BBH A9170179	2016/05/19	2017/05/18
Horn Antenna	Sunol Sciences Corp.	DRH-118	A062013	2016/05/19	2017/05/18
EMC Test Software	R&S	ES-K1	N/A	N/A	N/A
EMC Test Software	Audix	E3	N/A	N/A	N/A
Active Loop Antenna	SCHWARZBECK	FMZB1519	1519-037	2016/05/19	2017/05/18
Amplifier	Agilent	8349B	3008A02306	2016/05/19	2017/05/18
Amplifier	Agilent	8447D	2944A10176	2016/05/19	2017/05/18
Temperature/ Humidity Meter	Gangxing	CTH-608	02	2016/05/20	2017/05/19
High-Pass Filter	K&L	9SH10-2700/X12750-O/O	N/A	2016/05/20	2017/05/19
High-Pass Filter	K&L	41H10-1375/U12750-O/O	N/A	2016/05/20	2017/05/19
Coaxial Cables	HUBER+SUHNER	SUCOFLEX 104PEA-10M	10m	2016/06/02	2017/06/01
Coaxial Cables	HUBER+SUHNER	SUCOFLEX 104PEA-3M	3m	2016/06/02	2017/06/01
Coaxial Cables	HUBER+SUHNER	SUCOFLEX 104PEA-3M	3m	2016/06/02	2017/06/01
RF Cable	Megalon	RF-A303	N/A	2016/06/02	2017/06/01
Power Sensor	R&S	NRP-Z4	823.3618.03	2016/06/02	2017/06/01
Power Meter	R&S	NRVS	1020.1809.02	2016/06/02	2017/06/01
System Simulator	R&S	CMU200	115419	2016.05.22	2017.05.21

4 TEST CONDITIONS AND RESULTS

4.1 AC Power Conducted Emission

TEST CONFIGURATION



TEST PROCEDURE

1. The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. The EUT is a tabletop system; a wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10-2013.
2. Support equipment, if needed, was placed as per ANSI C63.10-2013
3. All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10-2013
4. The EUT received DC5V power from the adapter, the adapter received AC120V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.
5. All support equipments received AC power from a second LISN, if any.
6. The EUT test program was started. Emissions were measured on each current carrying line of the EUT using a spectrum Analyzer / Receiver connected to the LISN powering the EUT. The LISN has two monitoring points: Line 1 (Hot Side) and Line 2 (Neutral Side). Two scans were taken: one with Line 1 connected to Analyzer / Receiver and Line 2 connected to a 50 ohm load; the second scan had Line 1 connected to a 50 ohm load and Line 2 connected to the Analyzer / Receiver.
7. Analyzer / Receiver scanned from 150 KHz to 30MHz for emissions in each of the test modes.
8. During the above scans, the emissions were maximized by cable manipulation.

AC Power Conducted Emission Limit

For intentional device, according to § 15.207(a) AC Power Conducted Emission Limits is as following：

Frequency (MHz)	Maximum RF Line Voltage (dBμV)			
	CLASS A		CLASS B	
	Q.P.	Ave.	Q.P.	Ave.
0.15 - 0.50	79	66	66-56*	56-46*
0.50 - 5.00	73	60	56	46
5.00 - 30.0	73	60	60	50

* Decreasing linearly with the logarithm of the frequency

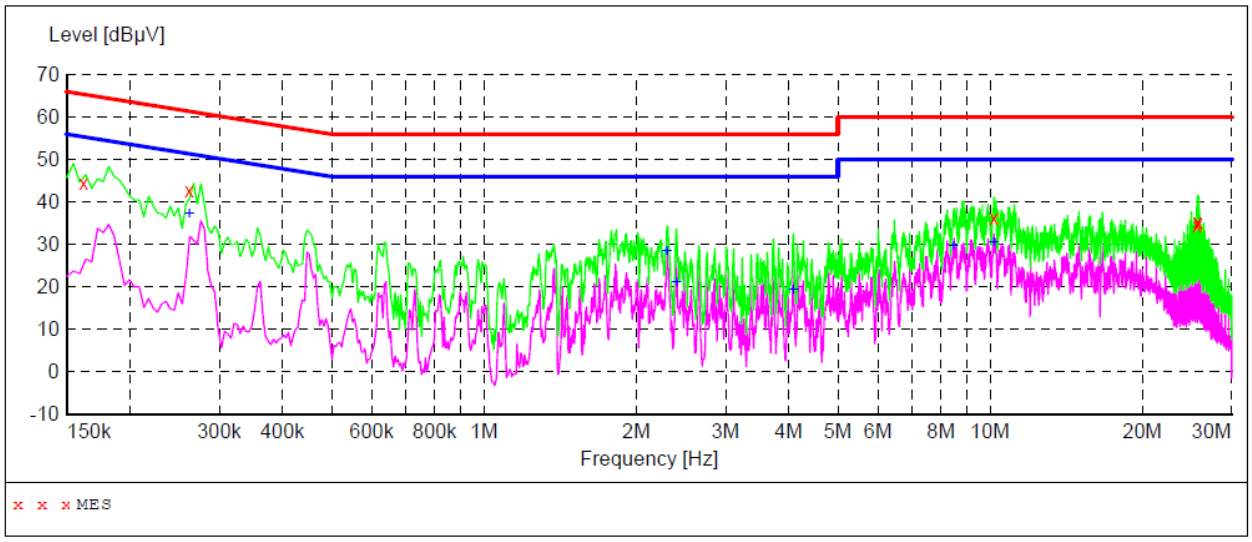
TEST RESULTS

Note:
1. We tested Conducted Emission of GFSK, π/4 DQPSK and 8DPSK mode from 0.15 KHz to 30MHz (DH1, DH3 and DH5) and all channels (low, middle and high), recorded the worst case data at GFSK DH5 middle channel.
2. Measured at power adapter charge and USB charge also at both AC 120V/60Hz and AC 240V/50Hz, recorded worst case at AC 120V/60Hz.

N

SCAN TABLE: "Voltage (9K-30M)FIN"

Short Description: 150K-30M Voltage



MEASUREMENT RESULT:

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.162000	44.50	10.2	65	20.9	QP	N	GND
0.262000	42.60	10.2	61	18.8	QP	N	GND
10.178000	36.30	10.6	60	23.7	QP	N	GND
25.658000	34.50	11.1	60	25.5	QP	N	GND
25.718000	35.30	11.1	60	24.7	QP	N	GND
25.778000	35.10	11.1	60	24.9	QP	N	GND

MEASUREMENT RESULT:

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.262000	37.50	10.2	51	13.9	AV	N	GND
2.300000	28.70	10.4	46	17.3	AV	N	GND
2.402000	21.20	10.4	46	24.8	AV	N	GND
4.088000	19.40	10.4	46	26.6	AV	N	GND
8.462000	29.60	10.6	50	20.4	AV	N	GND
10.160000	30.70	10.6	50	19.3	AV	N	GND

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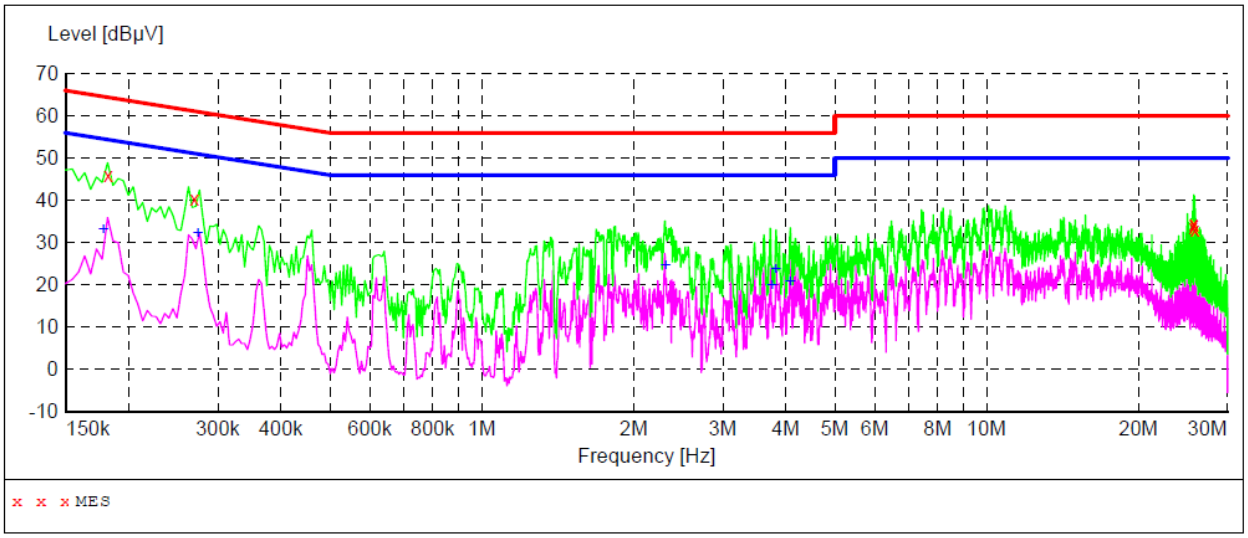
SCAN TABLE: "Voltage (9K-30M)FIN"

Short Description: 150K-30M Voltage



MEASUREMENT RESULT:

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.182000	45.90	10.2	64	18.5	QP	L1	GND
0.270000	40.30	10.2	61	20.8	QP	L1	GND
25.658000	33.60	11.1	60	26.4	QP	L1	GND
25.718000	34.30	11.1	60	25.7	QP	L1	GND
25.778000	34.10	11.1	60	25.9	QP	L1	GND
25.838000	33.10	11.1	60	26.9	QP	L1	GND

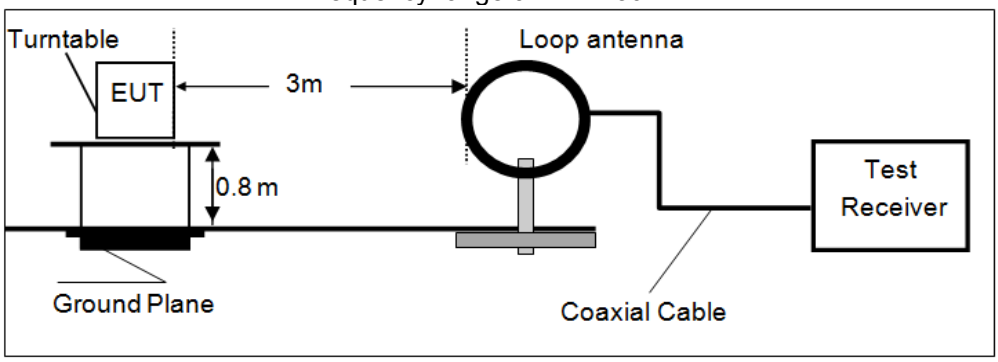
MEASUREMENT RESULT:

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.178000	33.20	10.2	55	21.4	AV	L1	GND
0.274000	32.30	10.2	51	18.7	AV	L1	GND
2.312000	24.90	10.4	46	21.1	AV	L1	GND
3.758000	20.00	10.4	46	26.0	AV	L1	GND
3.824000	23.80	10.4	46	22.2	AV	L1	GND
4.088000	20.80	10.4	46	25.2	AV	L1	GND

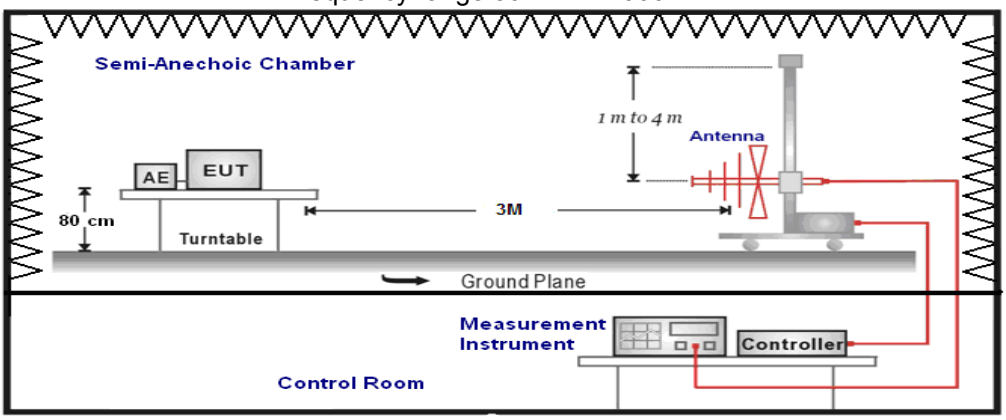
4.2 Radiated Emissions

TEST CONFIGURATION

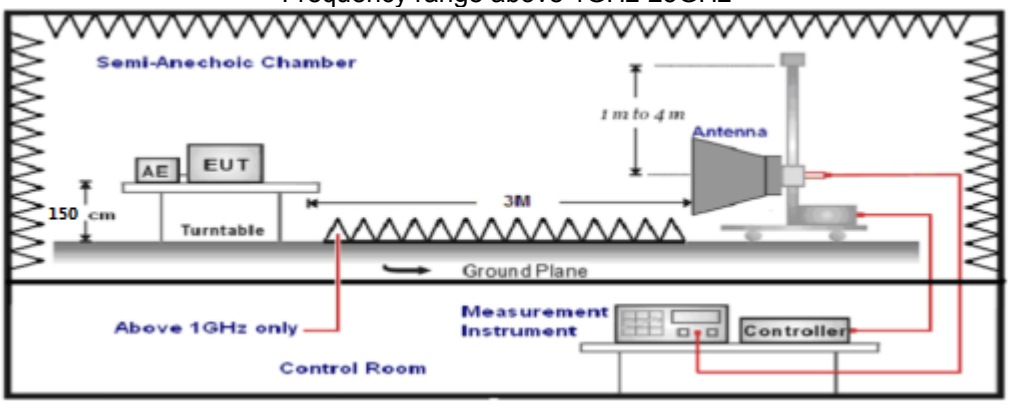
Frequency range 9 KHz – 30MHz



Frequency range 30MHz – 1000MHz



Frequency range above 1GHz-25GHz



TEST PROCEDURE

1. The EUT was placed on a turn table which is 0.8m above ground plane for below 1GHz and 1.50m above ground plane for above 1GHz.
2. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0℃ to 360℃ to acquire the highest emissions from EUT.
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measurements have been completed.
5. The EUT minimum operation frequency was 32.768 KHz and maximum operation frequency was 2480MHz.so radiated emission test frequency band from 9 KHz to 25GHz.
6. The distance between test antenna and EUT as following table states:

Test Frequency range	Test Antenna Type	Test Distance
9KHz-30MHz	Active Loop Antenna	3
30MHz-1GHz	Bilog Antenna	3
1GHz-18GHz	Horn Antenna	3
18GHz-25GHz	Horn Anternna	1

7. Setting test receiver/spectrum as following table states:

Test Frequency range	Test Receiver/Spectrum Setting	Detector
9KHz-150KHz	RBW=200Hz/VBW=3KHz,Sweep time=Auto	QP
150KHz-30MHz	RBW=9KHz/VBW=100KHz,Sweep time=Auto	QP
30MHz-1GHz	RBW=120KHz/VBW=1000KHz,Sweep time=Auto	QP
1GHz-40GHz	Peak Value: RBW=1MHz/VBW=3MHz, Sweep time=Auto	Peak
	Average Value: RBW=1MHz/VBW=10Hz, Sweep time=Auto	Peak

More procudre as follows;

1) Sequence of testing 9 kHz to 30 MHz

Setup:
--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
--- If the EUT is a tabletop system, a rotatable table with 0.8 m height is used.
--- If the EUT is a floor standing device, it is placed on the ground.
--- Auxiliary equipment and cables were positioned to simulate normal operation conditions.
--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
--- The measurement distance is 3 meter.
--- The EUT was set into operation.

Premeasurement:
--- The turntable rotates from 0° to 315° using 45° steps.
--- The antenna height is 1.0 meter.
--- At each turntable position the analyzer sweeps with peak detection to find the maximum of all emissions

Final measurement:
--- Identified emissions during the premeasurement the software maximizes by rotating the turntable position (0° to 360°) and by rotating the elevation axes (0° to 360°).
--- The final measurement will be done in the position (turntable and elevation) causing the highest emissions with QP detector.
--- The final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

2) Sequence of testing 30 MHz to 1 GHz

Setup:
--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
--- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.
--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
--- Auxiliary equipment and cables were positioned to simulate normal operation conditions
--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
--- The measurement distance is 3 meter.
--- The EUT was set into operation.

Premeasurement:
--- The turntable rotates from 0° to 315° using 45° steps.
--- The antenna is polarized vertical and horizontal.
--- The antenna height changes from 1 to 4 meter.
--- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement:
--- The final measurement will be performed with minimum the six highest peaks.
--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter.
--- The final measurement will be done with QP detector with an EMI receiver.

--- The final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

3) Sequence of testing 1 GHz to 18 GHz

Setup:
--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.
--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
--- Auxiliary equipment and cables were positioned to simulate normal operation conditions
--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
--- The measurement distance is 3 meter.
--- The EUT was set into operation.

Premeasurement:
--- The turntable rotates from 0° to 315° using 45° steps.
--- The antenna is polarized vertical and horizontal.
--- The antenna height scan range is 1 meter to 2.5 meter.
--- At each turntable position and antenna polarization the analyzer sweeps with peak detection to find the maximum of all emissions.

Final measurement:
--- The final measurement will be performed with minimum the six highest peaks.
--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter. This procedure is repeated for both antenna polarizations.
--- The final measurement will be done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and Average detector.
--- The final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

4) Sequence of testing above 18 GHz

Setup:
--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.
--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
--- Auxiliary equipment and cables were positioned to simulate normal operation conditions
--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
--- The measurement distance is 1 meter.
--- The EUT was set into operation.

Premeasurement:
--- The antenna is moved spherical over the EUT in different polarizations of the antenna.
Final measurement:
--- The final measurement will be performed at the position and antenna orientation for all detected emissions that were found during the premeasurements with Peak and Average detector.
--- The final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CL - AG

Where FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
RA = Reading Amplitude	AG = Amplifier Gain
AF = Antenna Factor	

For example

Frequency (MHz)	FS (dBμV/m)	RA (dBμV/m)	AF (dB)	CL (dB)	AG (dB)	Transd (dB)
300.00	40	58.1	12.2	1.6	31.90	-18.1

Transd=AF +CL-AG

RADIATION LIMIT

For intentional device, according to § 15.209(a), the general requirement of field strength of radiated emission out of authorized band shall not exceed the following table at a 3 meters measurement distance.
In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a)

The pre-test have done for the EUT in three axes and found the worst emission at position shown in test setup photos.

Frequency (MHz)	Distance (Meters)	Radiated (dBμV/m)	Radiated (μV/m)
0.009-0.49	300	20log(2400/F(KHz))+80	2400/F(KHz)
0.49-1.705	30	20log(24000/F(KHz))+40	24000/F(KHz)
1.705-30	30	20log(30)+40	30
30-88	3	40.0	100
88-216	3	43.5	150
216-960	3	46.0	200
Above 960	3	54.0	500

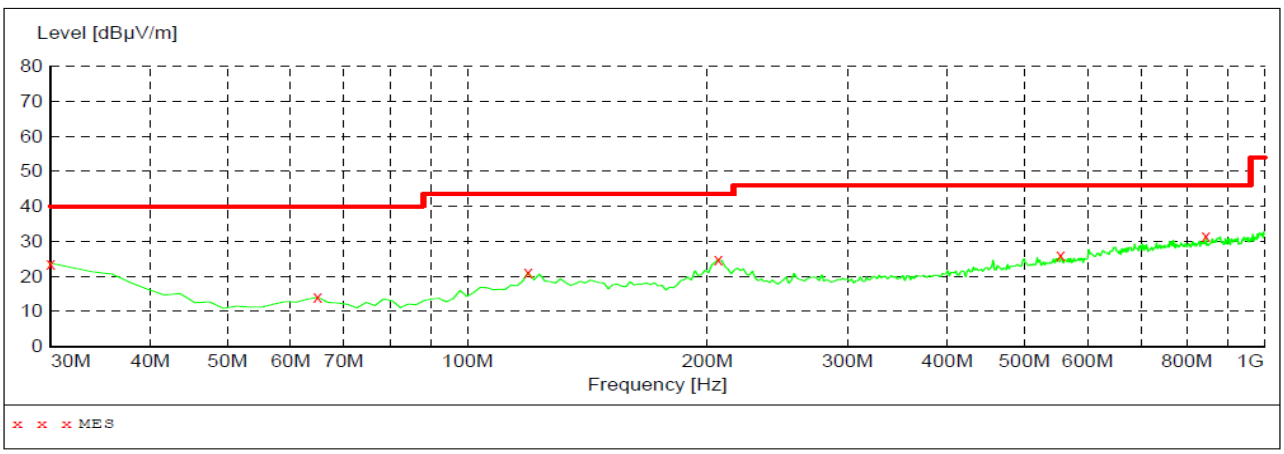
TEST RESULTS

Remark:
1. The radiated measurement are performed the each test mode and channel (low/mid/high), the data recorded below (GFSK mode, the middle channel) is the worst case for all the test mode and channel.
2. Bilog Antenna for the radiation emission test below 1G.
3. HORN ANTENNA for the radiation emission test above 1G.
4. "---" means not recorded as emission levels lower than limit.
6. Margin= Limit - Level

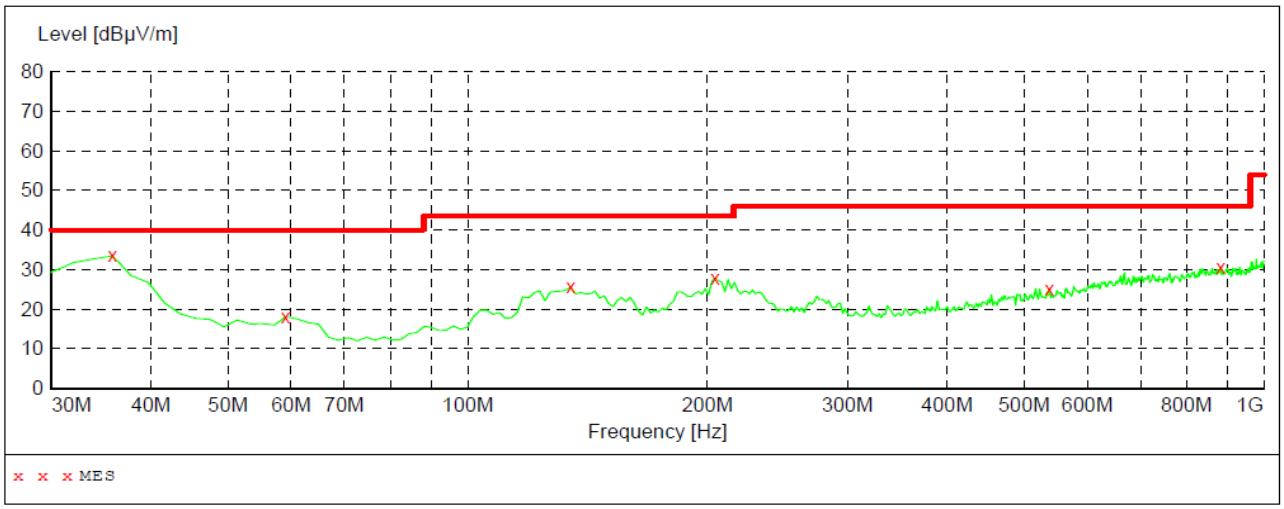
For 9KHz to 30MHz

Frequency (MHz)	Corrected Reading (dBμV/m)@3m	FCC Limit (dBμV/m) @3m	Margin (dB)	Detector	Result
12.56	48.74	69.54	20.36	QP	PASS
25.28	45.54	69.54	23.56	QP	PASS

For 30MHz to 1000MHz



Frequency	Level	Transd	Limit	Margin	Det.	Height	Azimuth	Polarization
MHz	dBµV/m	dB	dBµV/m	dB		cm	deg	
30.000000	23.62	20.84	40.00	16.38	Peak	100.00	126.00	HORIZONTAL
65.120000	14.09	8.12	40.00	25.91	Peak	100.00	155.00	HORIZONTAL
118.890000	21.44	14.75	43.50	22.06	Peak	124.00	155.00	HORIZONTAL
206.910000	24.92	14.16	43.50	18.58	Peak	100.00	313.00	HORIZONTAL
556.110000	26.13	21.13	46.00	19.87	Peak	300.00	244.00	HORIZONTAL
844.940000	31.46	25.11	46.00	14.54	Peak	300.00	86.00	HORIZONTAL



Frequency	Level	Transd	Limit	Margin	Det.	Height	Azimuth	Polarization
MHz	dBµV/m	dB	dBµV/m	dB		cm	deg	
36.040000	35.42	16.23	40.00	4.58	Peak	100.00	179.00	VERTICAL
59.970000	18.26	8.04	40.00	21.74	Peak	100.00	245.00	VERTICAL
136.460000	26.24	14.43	43.50	17.26	Peak	100.00	44.00	VERTICAL
205.160000	28.61	14.17	43.50	14.89	Peak	108.00	197.00	VERTICAL
540.340000	25.03	20.65	46.00	20.97	Peak	100.00	264.00	VERTICAL
882.470000	31.43	25.66	46.00	14.57	Peak	100.00	313.00	VERTICAL

For 1GHz to 25GHz

Low Channel @ Channel 0 @ 2402 MHz

Item (Mark)	Frequency (MHz)	Read Level (dBµV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBµV/m)	Limit Line (dBµV/m)	Margin (dB)	Detector	Polarization
1	4804.00	60.62	34.47	30.27	8.24	48.18	74.00	25.82	Peak	Horizontal
2	4804.00	47.98	34.47	30.27	8.24	35.54	54.00	18.46	AV[1]	Horizontal
3	7206.00	69.91	37.12	31.34	11.39	52.74	74.00	21.26	Peak	Horizontal
4	7206.00	58.12	37.12	31.34	11.39	40.95	54.00	13.05	AV[1]	Horizontal

Item (Mark)	Frequency (MHz)	Read Level (dBµV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBµV/m)	Limit Line (dBµV/m)	Margin (dB)	Detector	Polarization
1	4804.00	59.51	34.47	30.27	8.24	47.07	74.00	26.93	Peak	Vertical
2	4804.00	45.93	34.47	30.27	8.24	33.49	54.00	20.51	AV[1]	Vertical
3	7206.00	67.27	37.12	31.34	11.39	50.10	74.00	23.90	Peak	Vertical
4	7206.00	56.11	37.12	31.34	11.39	38.94	54.00	15.06	AV[1]	Vertical

Middle Channel @ Channel 39 @ 2441 MHz

Item (Mark)	Frequency (MHz)	Read Level (dBµV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBµV/m)	Limit Line (dBµV/m)	Margin (dB)	Detector	Polarization
1	4882.00	62.85	34.51	30.33	8.55	50.12	74.00	23.88	Peak	Horizontal
2	4882.00	52.39	34.51	30.33	8.55	39.66	54.00	14.34	AV[1]	Horizontal
3	7323.00	70.22	37.26	31.94	12.11	52.79	74.00	21.21	Peak	Horizontal
4	7323.00	61.60	37.26	31.94	12.11	44.17	54.00	9.83	AV[1]	Horizontal

Item (Mark)	Frequency (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	4882.00	61.72	34.51	30.33	8.55	48.99	74.00	25.01	Peak	Vertical
2	4882.00	49.80	34.51	30.33	8.55	37.07	54.00	16.93	AV[1]	Vertical
3	7323.00	68.76	37.26	31.94	12.11	51.33	74.00	22.67	Peak	Vertical
4	7323.00	59.34	37.26	31.94	12.11	41.91	54.00	12.09	AV[1]	Vertical

High Channel @ Channel 78 @ 2480 MHz

Item (Mark)	Frequency (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	4960.00	66.19	34.92	30.24	10.09	51.42	74.00	22.58	Peak	Horizontal
2	4960.00	53.66	34.92	30.24	10.09	38.89	54.00	15.11	AV[1]	Horizontal
3	7440.00	72.41	38.17	31.55	13.35	52.44	74.00	21.56	Peak	Horizontal
4	7440.00	62.06	38.17	31.55	13.35	42.09	54.00	11.91	AV[1]	Horizontal

Item (Mark)	Frequency (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	4960.00	63.15	34.92	30.24	10.09	48.38	74.00	25.62	Peak	Vertical
2	4960.00	52.41	34.92	30.24	10.09	37.64	54.00	16.36	AV[1]	Vertical
3	7440.00	71.30	38.17	31.55	13.35	51.33	74.00	22.67	Peak	Vertical
4	7440.00	61.44	38.17	31.55	13.35	41.47	54.00	12.53	AV[1]	Vertical

Remark:

1. Result Level = Read Level + Antenna Factor + Cable loss - PRM Factor.

2. The other emission levels were very low against the limit.

3. Margin = Limit - Emission Level.

4. The average measurement was not performed when the peak measured data under the limit of average detection.

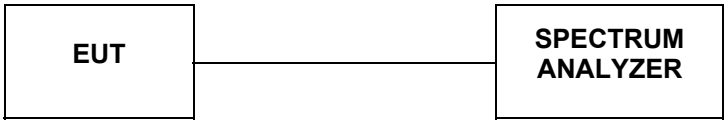
5. Detector AV is setting spectrum/receiver. RBW=1MHz/VBW=10Hz/Sweep time=Auto/Detector=Peak;

6."---" Mean the PK detector measured value is below average limit.

7. We measured GFSK Mode and 8DPSK*, rcorded the worst case at the GFSK (DH5) Mode.*

4.3 Duty Cycle

TEST CONFIGURATION



LIMIT

The Maximum Peak Output Power Measurement is 30dBm.
Preferably, all measurements of maximum conducted (average) output power will be performed with the EUT transmitting continuously (i.e., with a duty cycle of greater than or equal to 98%).

TEST PROCEDURE

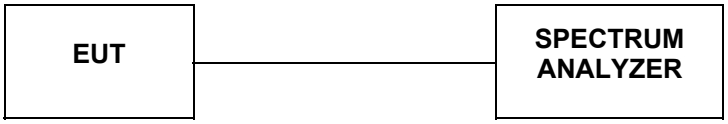
a. A diode detector and an oscilloscope that together have sufficiently short response time to permit accurate measurements of the on and off times of the transmitted signal.
b. The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value. Set VBW ≥ RBW. Set detector = peak or average. The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T ≤ 16.7 microseconds.)

TEST RESULTS

The Manufacturer provide engineer mode *#3646633#* to setp 100% continuous transmit for Bluetooth;

4.4 Maximum Peak Output Power

TEST CONFIGURATION



TEST PROCEDURE

According to ANSI C63.10:2013 7.8.5 Output power test procedure for frequency-hopping spread-spectrum (FHSS) devices; this is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test:

a) Use the following spectrum analyzer settings:
1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
2) RBW > 20 dB bandwidth of the emission being measured.
3) VBW ≥ RBW.
4) Sweep: Auto.
5) Detector function: Peak.
6) Trace: Max hold.
b) Allow trace to stabilize.
c) Use the marker-to-peak function to set the marker to the peak of the emission.
d) The indicated level is the peak output power, after any corrections for external attenuators and cables.

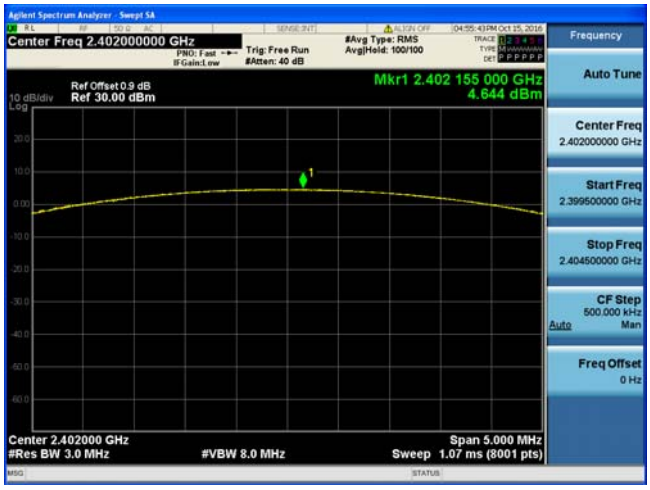
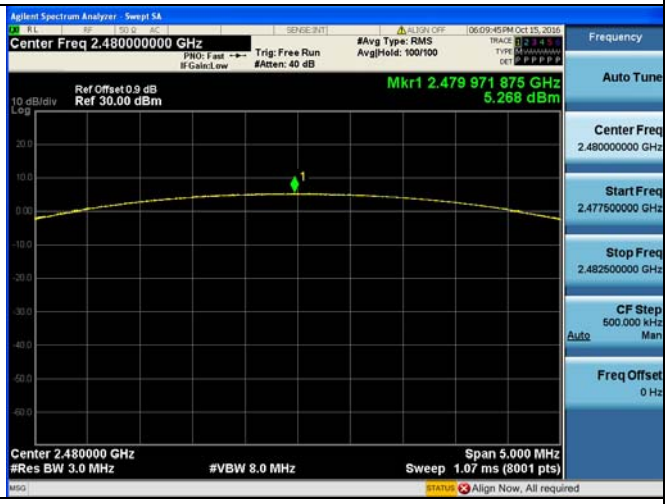
LIMIT

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

TEST RESULTS

Test Mode	Channel	Frequency (MHz)	Measured Maximum Peak Power (dBm)	Limits (dBm)	Verdict
GFSK	0	2402	5.765	30	PASS
	39	2441	6.013		
	78	2480	6.213		
π/4DQPSK	0	2402	4.798	21	PASS
	39	2441	5.064		
	78	2480	5.498		
8DPSK	0	2402	4.641	21	PASS
	39	2441	4.956		
	78	2480	5.268		

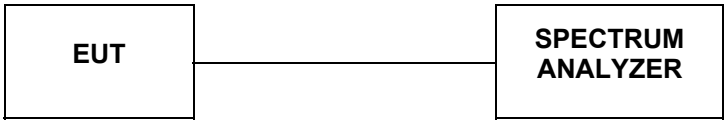
Remark:
1. *Test results including cable loss;*
2. *please refer to following plots;*
3. *Measured output power at difference Packet Type for each mode and recorded worst case for each mode.*
4. *Worst case data at DH5 for GFSK, π/4DQPSK, 8DPSK modulation type;*

Maximum Peak Output Power	
GFSK	*π/4DQPSK*
	
Channel 0 / 2402 MHz	*Channel 0 / 2402 MHz*
	
Channel 39 / 2441 MHz	*Channel 39 / 2441 MHz*
	
Channel 78 / 2480 MHz	*Channel 78 / 2480 MHz*

Maximum Peak Output Power	
8DPSK	
	
Channel 0 / 2402 MHz	
	
Channel 39 / 2441 MHz	
	
Channel 78 / 2480 MHz	

4.5 20dB Bandwidth

TEST CONFIGURATION



TEST PROCEDURE

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with RBW=30 KHz and VBW=100KHz.
The 20dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20dB.

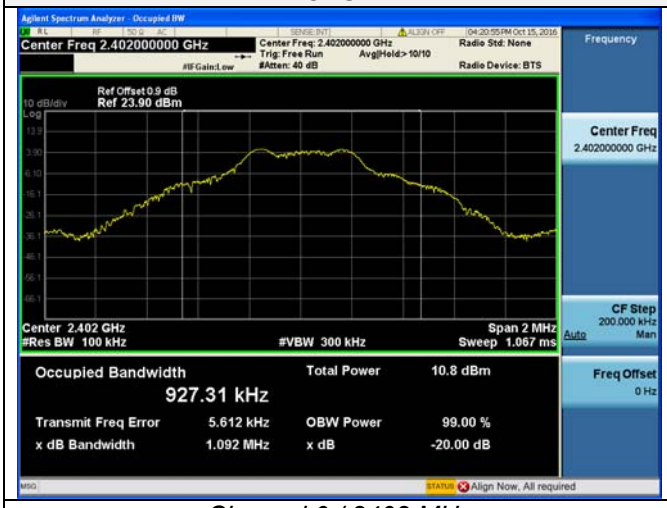
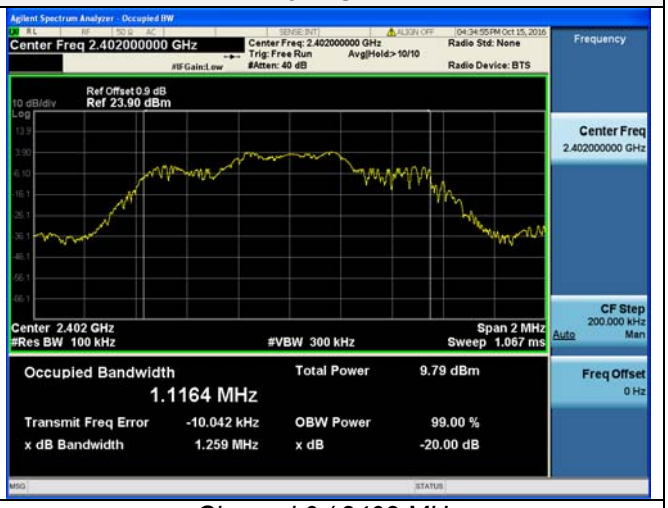
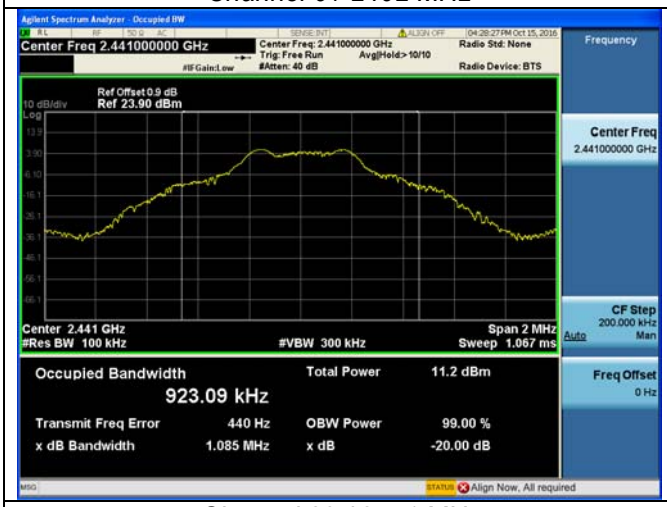
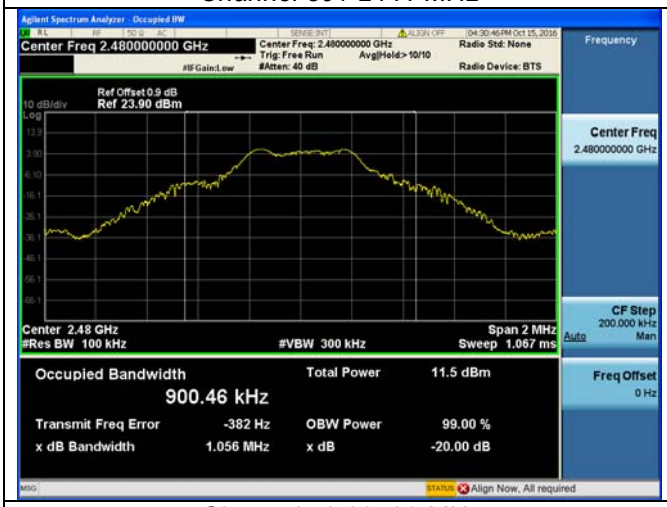
LIMIT

For frequency hopping systems operating in the 2400MHz-2483.5MHz no limit for 20dB bandwith.

TEST RESULTS

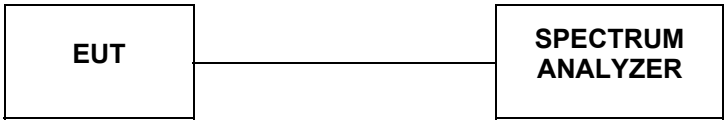
Channel	Frequency (MHz)	20dB Bandwidth (KHz)		Limits (KHz)	Verdict
		GFSK	8DPSK		
0	2402	1.092	1.259	/	PASS
39	2441	1.085	1.264	/	PASS
78	2480	1.056	1.269	/	PASS

Remark:
1. *Test results including cable loss;*
2. *please refer to following plots;*
3. *Measured at difference Packet Type for each mode and recorded worst case for each mode.*
4. *Worst case data at DH5 for GFSK, 8DPSK modulation type;*

20dB Bandwidth	
GFSK	*8DPSK*
	
Channel 0 / 2402 MHz	*Channel 0 / 2402 MHz*
	
Channel 39 / 2441 MHz	*Channel 39 / 2441 MHz*
	
Channel 78 / 2480 MHz	*Channel 78 / 2480 MHz*

4.6 Frequency Separation

TEST CONFIGURATION



TEST PROCEDURE

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:
a) Span: Wide enough to capture the peaks of two adjacent channels.
b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
c) Video (or average) bandwidth (VBW) ≥ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.

LIMIT

According to 15.247(a)(1),frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25KHz or the 2/3*20dB bandwidth of the hopping channel, whichever is greater.

TEST RESULTS

Test Mode	Channel	Frequency (MHz)	Frequency Separation (MHz)	Limits (MHz)	Verdict
GFSK	38	2440	1.001	0.728	PASS
	39	2441			
	40	2442			
8DPSK	38	2440	0.996	0.846	PASS
	39	2441			
	40	2442			

Remark:
1. *Test results including cable loss;*
2. *please refer to following plots;*
3. *Measured at difference Packet Type for each mode and recorded worst case for each mode.*
4. *Worst case data at DH5 for GFSK, 8DPSK modulation type;*

Frequency Separation

GFSK

Channel 39 / 2441 MHz

8DPSK

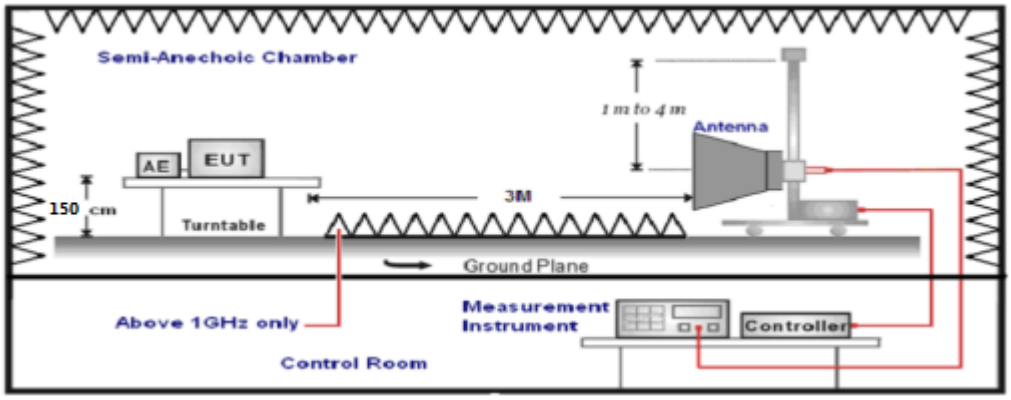
Channel 39 / 2441 MHz

4.7 Band-edge Measurements for Radiated Emissions

TEST REQUIREMENT

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

TEST CONFIGURATION



TEST PROCEDURE

Setup:
--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.
--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
--- Auxiliary equipment and cables were positioned to simulate normal operation conditions
--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
--- The measurement distance is 3 meter.
--- The EUT was set into operation.

Premeasurement:
--- The turntable rotates from 0° to 315° using 45° steps.
--- The antenna is polarized vertical and horizontal.
--- The antenna height scan range is 1 meter to 2.5 meter.
--- At each turntable position and antenna polarization the analyzer sweeps with peak detection to find the maximum of all emissions.

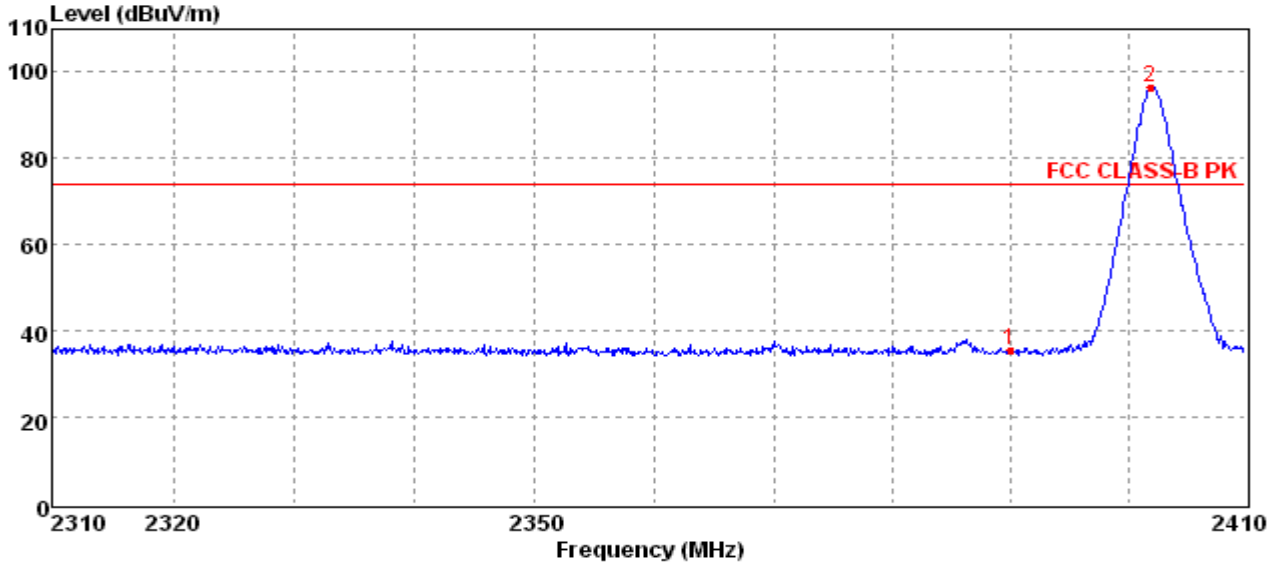
Final measurement:
--- The final measurement will be performed with minimum the six highest peaks.
--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter. This procedure is repeated for both antenna polarizations.
--- The final measurement will be done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and Average detector.
--- The final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

LIMIT

1. Below -20dB of the highest emission level in operating band.
2. Fall in the restricted bands listed in section 15.205. The maximum permitted average field strength is listed in section 15.209.

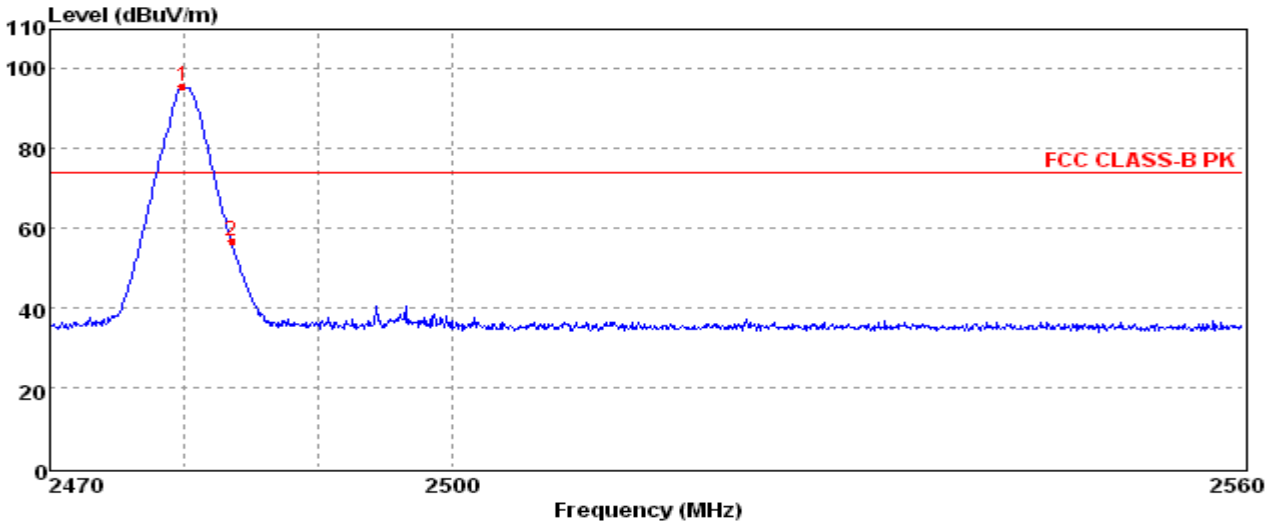
TEST RESULTS

Test mode:	2402 MHz (GFSK)	Polarization	Horizontal & Vertical



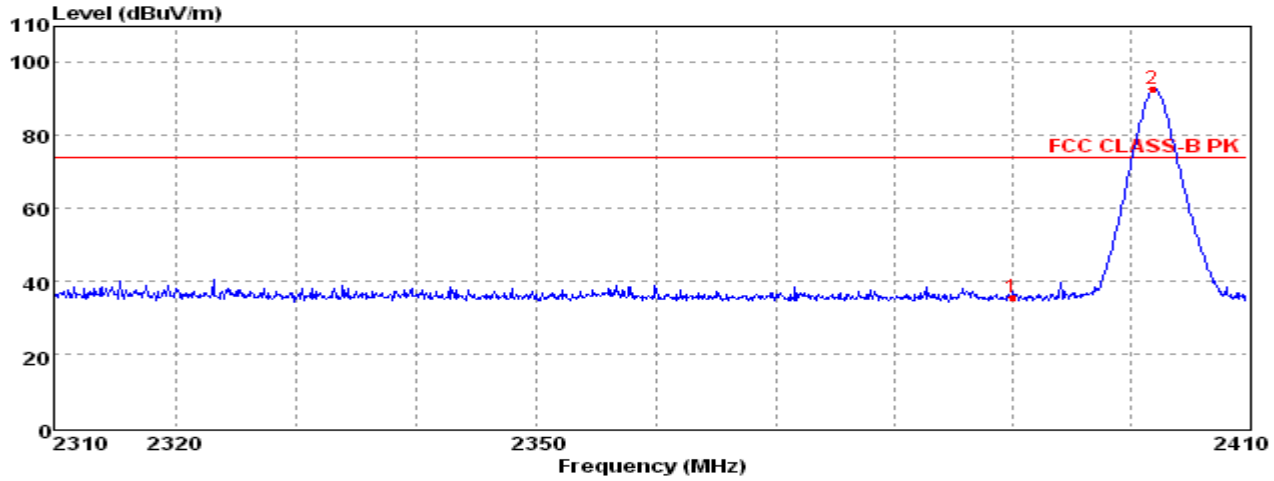
Item (Mark)	Frequency (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	2390.00	32.85	28.78	36.15	4.61	35.61	74.00	38.39	Peak	Horizontal
1	2390.00	---	28.78	36.15	4.61	---	54.00	---	AV[1]	Horizontal
2	2401.99	94.15	28.78	36.15	4.61	96.91	74.00	-22.91	Peak	Horizontal
2	2401.99	79.71	28.78	36.15	4.61	82.47	54.00	-28.47	AV[1]	Horizontal

Test mode:	2480 MHz (GFSK)	Polarization	Horizontal & Vertical



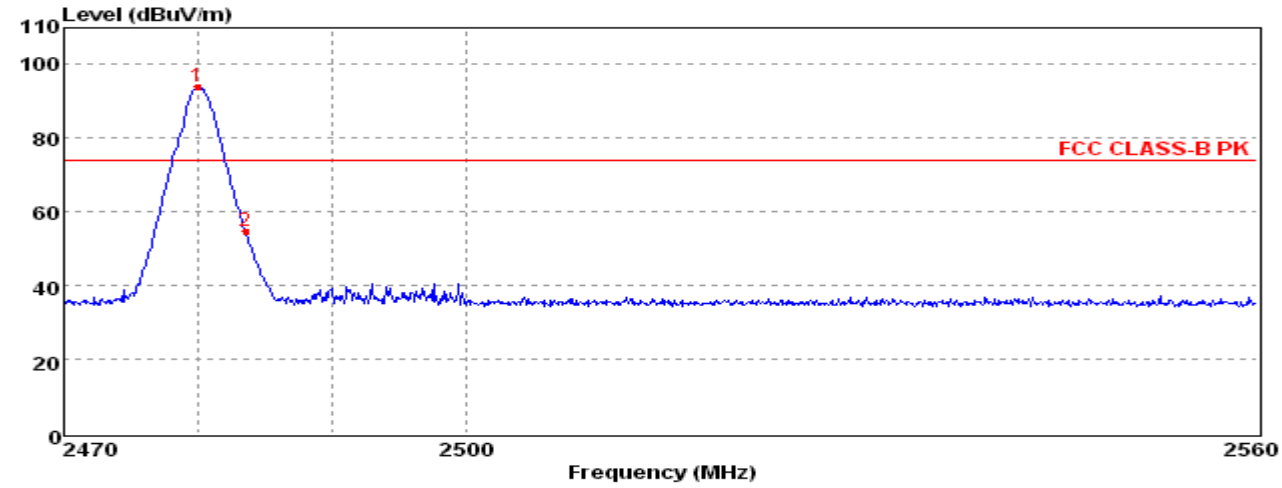
Item (Mark)	Frequency (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	2479.91	94.11	28.93	36.15	4.70	96.63	74.00	-26.63	Peak	Horizontal
1	2479.91	82.39	28.93	36.15	4.70	84.91	54.00	-20.94	AV[1]	Horizontal
2	2483.50	54.72	28.93	36.15	4.70	57.24	74.00	16.76	Peak	Horizontal
2	2483.50	42.65	28.93	36.15	4.70	45.17	54.00	8.83	AV[1]	Horizontal

Test mode:	2402 MHz (8DPSK)	Polarization	Horizontal & Vertical



Item (Mark)	Frequency (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	2390.00	34.12	28.78	36.15	4.61	36.88	74.00	37.12	Peak	Horizontal
1	2390.00	---	28.78	36.15	4.61	---	54.00	---	AV[1]	Horizontal
2	2401.99	91.01	28.78	36.15	4.61	93.77	74.00	-19.77	Peak	Horizontal
2	2401.99	79.33	28.78	36.15	4.61	82.09	54.00	-28.09	AV[1]	Horizontal

Test mode:	2480 MHz (8DPSK)	Polarization	Horizontal & Vertical



Item (Mark)	Frequency (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	2479.98	92.03	28.93	36.15	4.70	94.55	74.00	-20.55	Peak	Horizontal
1	2479.98	80.39	28.93	36.15	4.70	82.91	54.00	-28.91	AV[1]	Horizontal
2	2483.50	52.71	28.93	36.15	4.70	55.23	74.00	18.77	Peak	Horizontal
2	2483.50	40.20	28.93	36.15	4.70	42.72	54.00	11.28	AV[1]	Horizontal

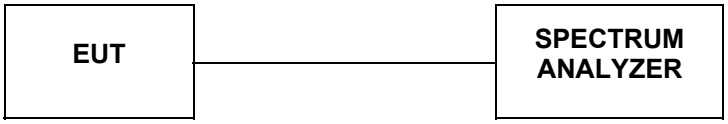
Remark:
1. *Measured at difference Packet Type for each mode and recorded worst case for each mode.*
2. *Worst case data at DH5 for GFSK, 8DPSK modulation type;*
3. *Measured at Hopping and no-Hopping mode, recorded worst at no-Hopping mode.*
4. *Result Level = Read Level + Antenna Factor + Cable loss - PRM Factor.*
5. *The other emission levels were very low against the limit.*
6. *Margin = Limit - Emission Level.*
7. *The average measurement was not performed when the peak measured data under the limit of average detection.*
8. *Detector AV is setting spectrum/receiver.*
   RBW=1MHz/VBW=330KHz/Sweep time=Auto/Detector=Peak;

4.8 Band-edge measurements for RF conducted emissions

LIMIT

1. Below -20dB of the highest emission level in operating band.
2. Fall in the restricted bands listed in section 15.205. The maximum permitted average field strength is listed in section 15.209.

TEST CONFIGURATION



TEST PROCEDURE

According to ANSI C63.10:2013 for Antenna-port conducted measurement.

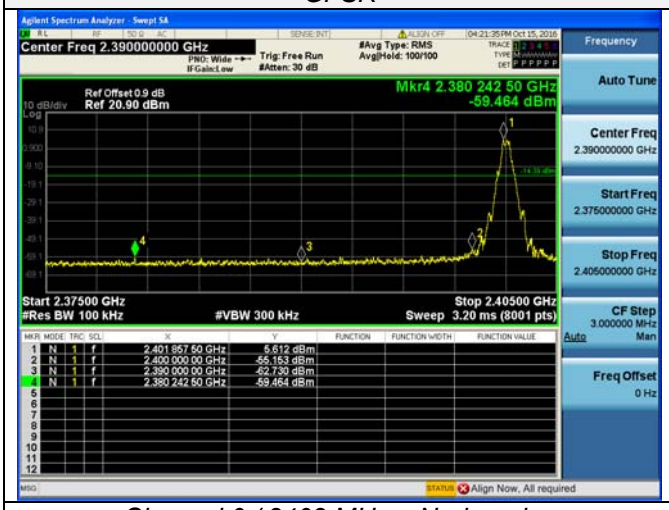
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set both RBW and VBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100kHz bandwidth from band edge,
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.
6. Measure the conducted output power (in dBm) using the detector specified by the appropriate regulatory agency.

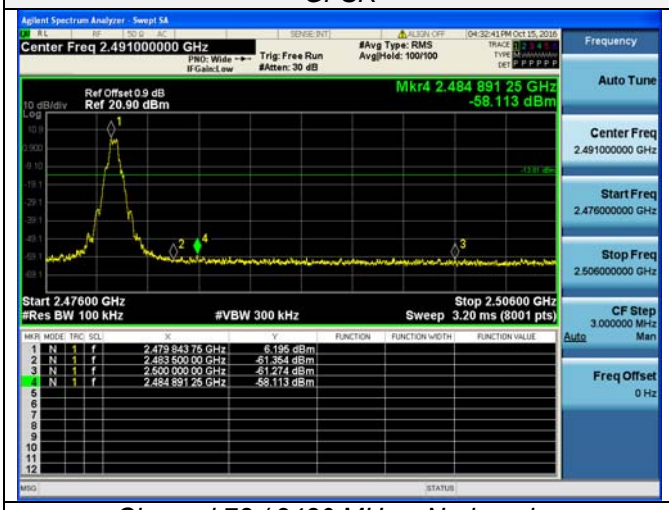
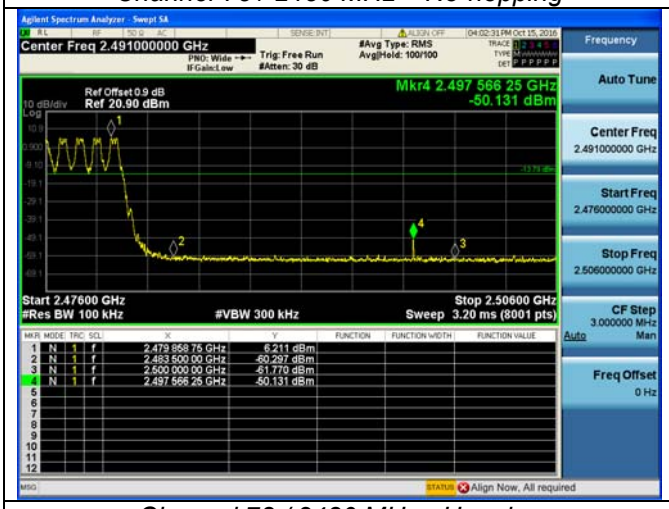
TEST RESULTS

Test Mode	Channel	Frequency (MHz)	Conductd Band-edge Emission (dBc)	Limits (dBc)	Verdict
GFSK	0	2402	<-20dBc	-20	PASS
	78	2480	<-20dBc	-20	
	Hopping	Full	<-20dBc	-20	
8DPSK	0	2402	<-20dBc	-20	PASS
	78	2480	<-20dBc	-20	
	Hopping	Full	<-20dBc	-20	

Remark:

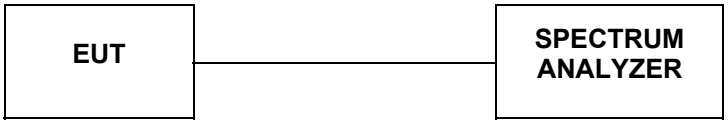
1. *Test results including cable loss;*
2. *please refer to following plots;*
3. *Measured at difference Packet Type for each mode and recorded worst case for each mode.*
4. *Worst case data at DH5 for GFSK, 8DPSK modulation type;*

Band-edge Measurements for RF Conducted Emissions	
GFSK	8DPSK
	
Channel 0 / 2402 MHz – No-hopping	Channel 0 / 2402 MHz – No-hopping
	
Channel 0 / 2402 MHz - Hopping	Channel 0 / 2402 MHz - Hopping

Band-edge Measurements for RF Conducted Emissions	
GFSK	*8DPSK*
	
Channel 78 / 2480 MHz – No-hopping	*Channel 78 / 2480 MHz – No-hopping*
	
Channel 78 / 2480 MHz - Hopping	*Channel 78 / 2480 MHz - Hopping*

4.9 Spurious RF Conducted Emission

TEST CONFIGURATION



TEST PROCEDURE

The Spurious RF conducted emissions compliance of RF radiated emission should be measured by following the guidance in ANSI C63.10-2013 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization etc. Set RBW=100kHz and VBW= 300KHz to measure the peak field strength , and mwasure frequeny range from 9KHz to 26.5GHz.

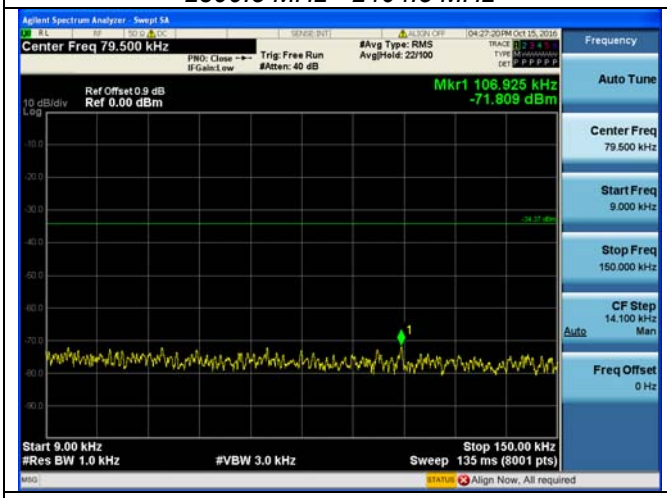
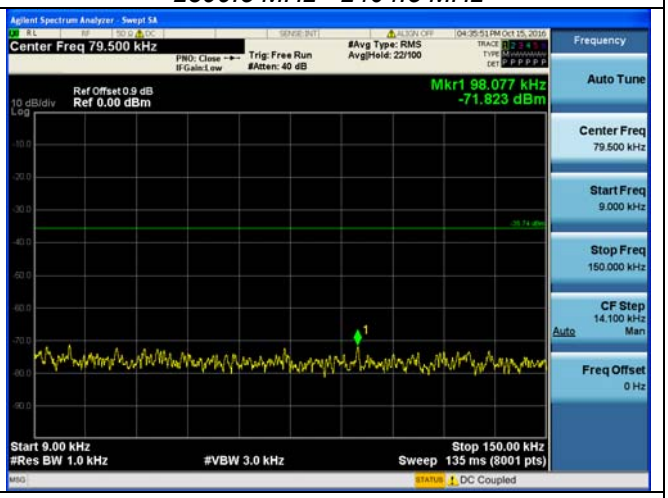
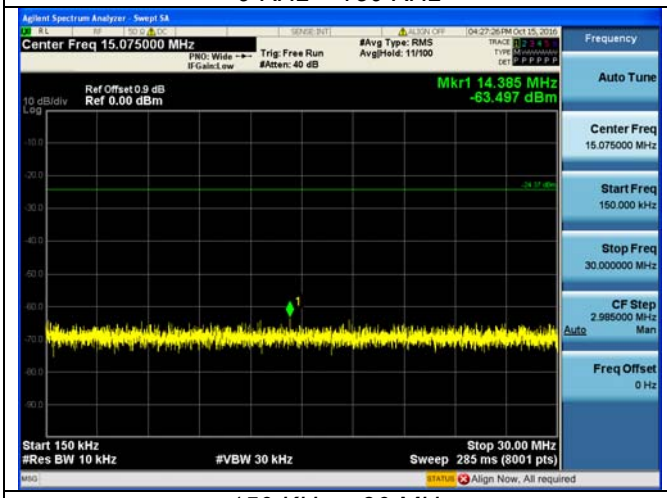
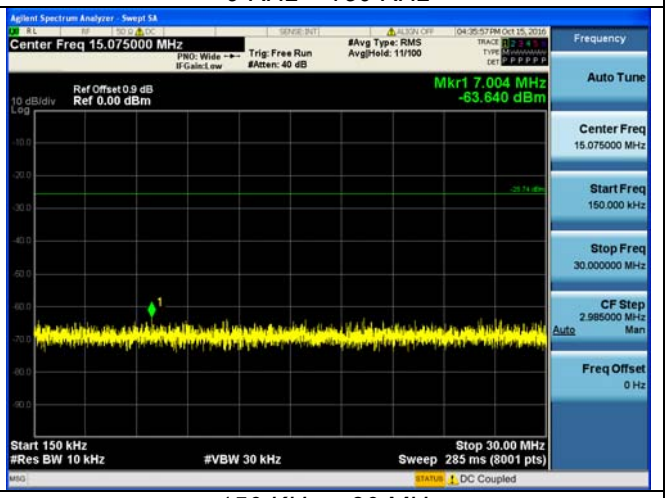
LIMIT

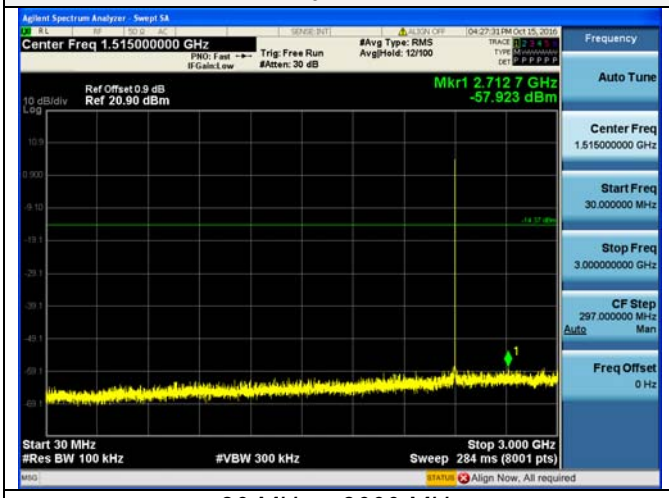
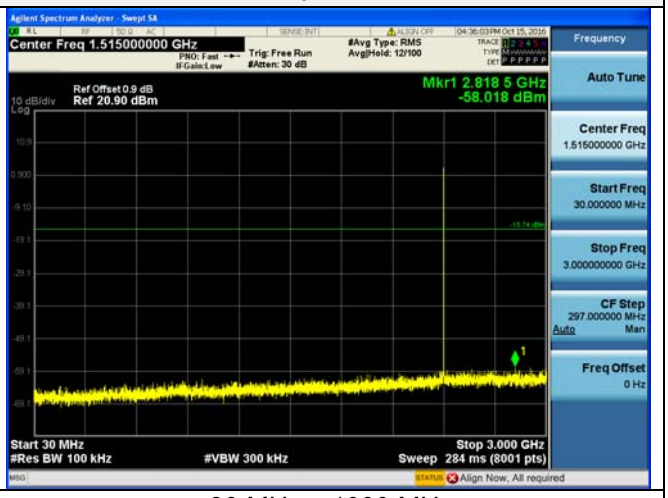
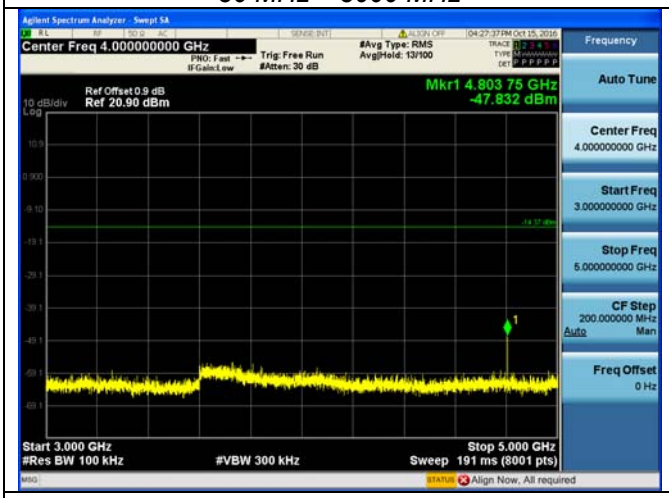
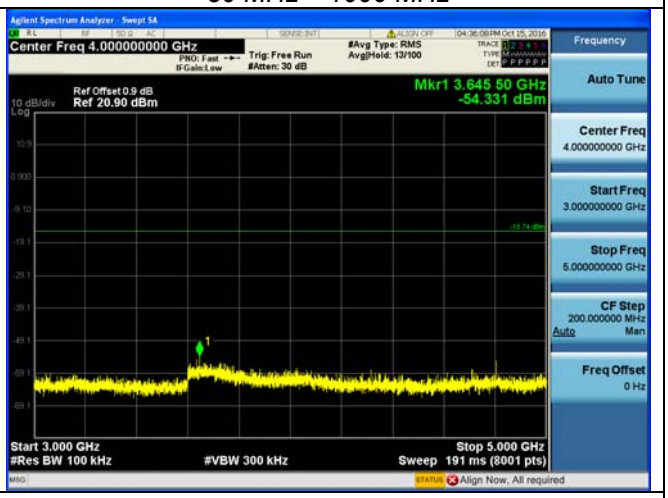
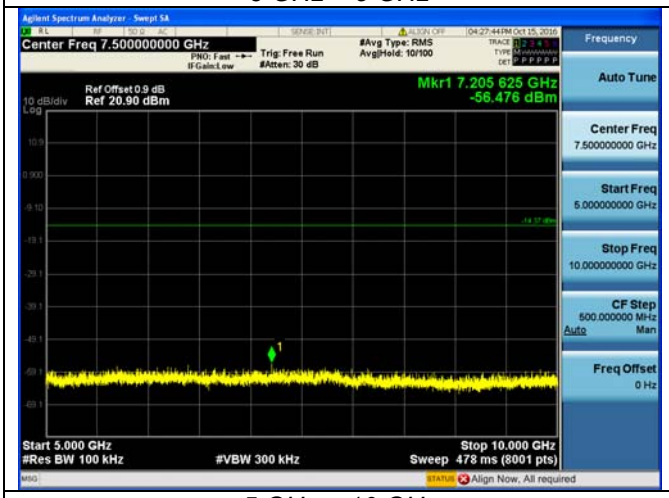
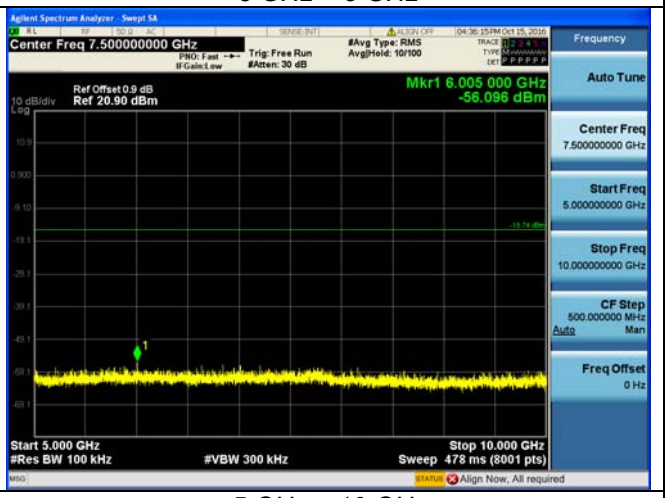
1. Below -20dB of the highest emission level in operating band.
2. Fall in the restricted bands listed in section 15.205. The maximum permitted average field strength is listed in section 15.209.

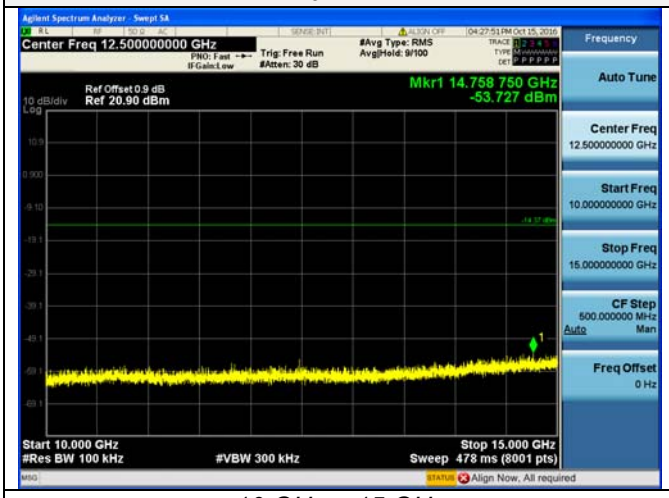
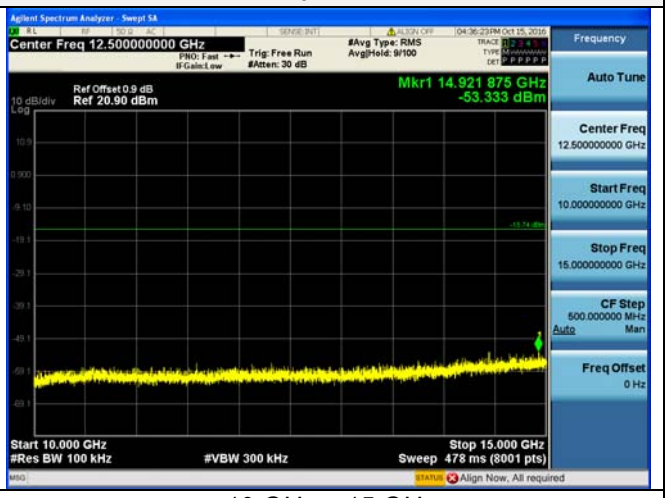
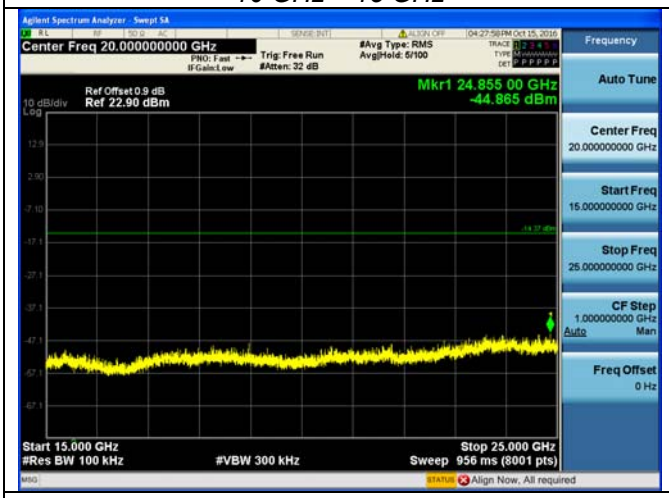
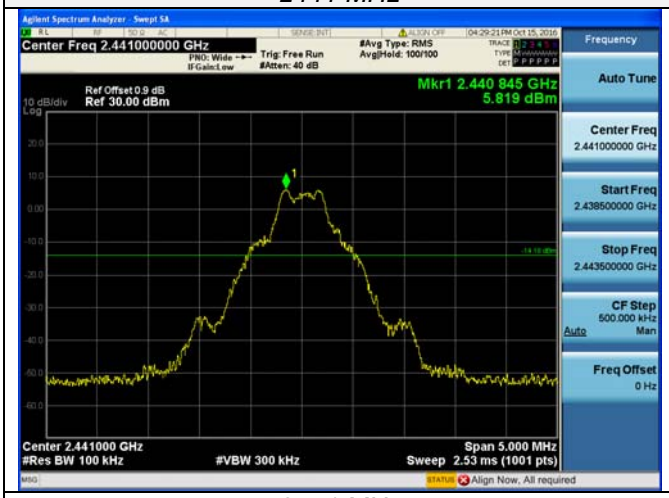
TEST RESULTS

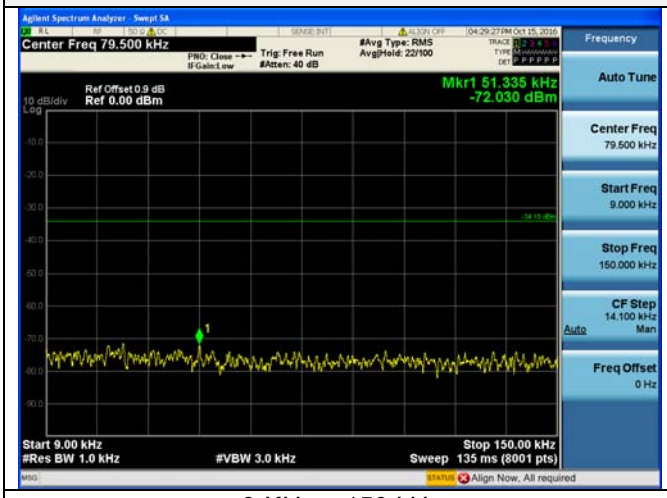
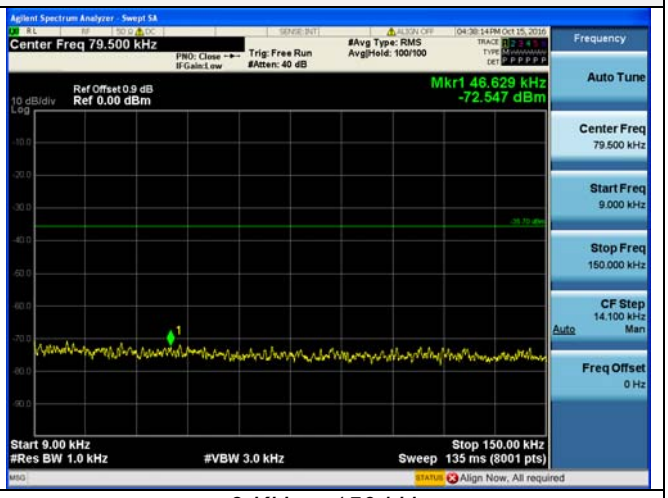
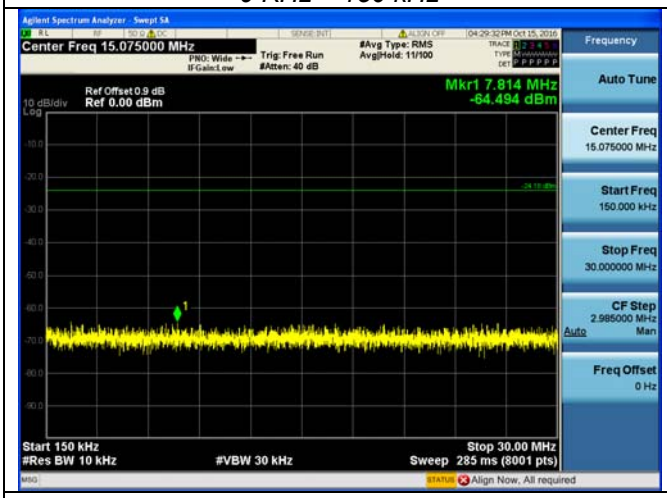
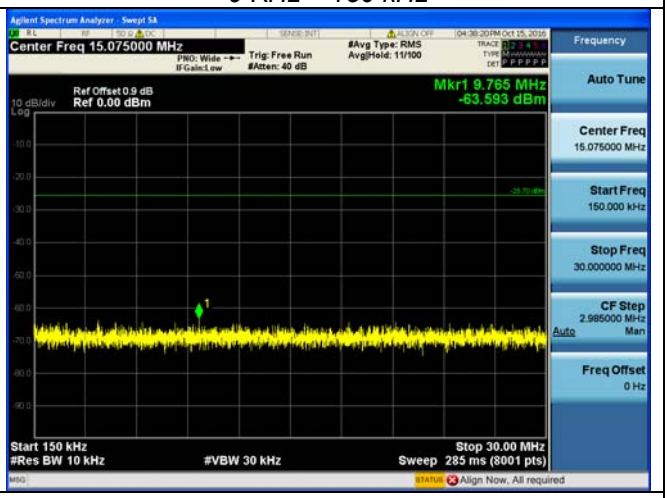
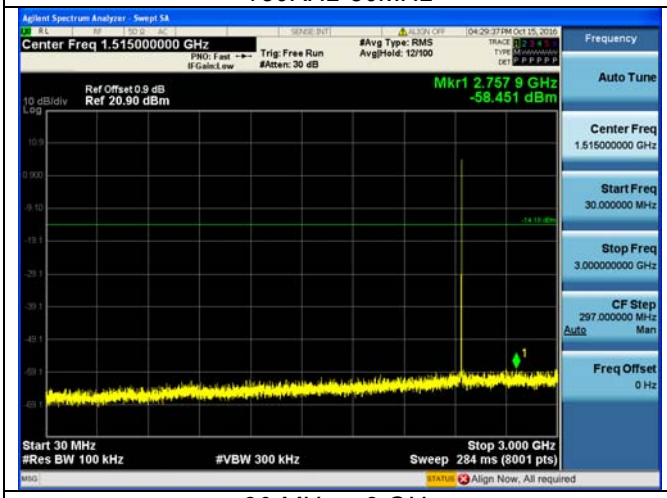
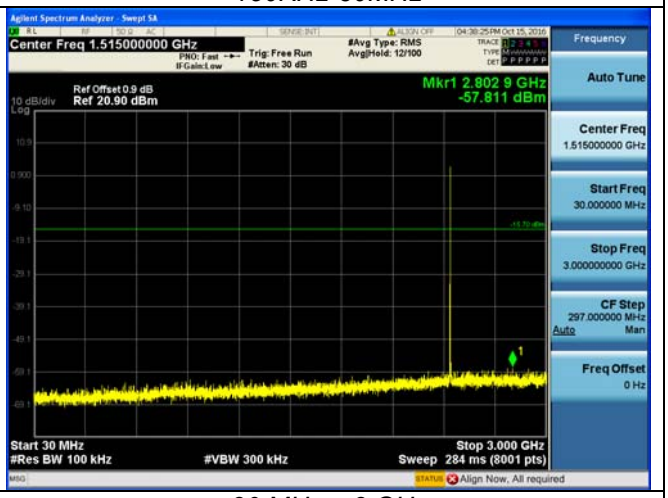
Test Mode	Channel	Frequency (MHz)	Spurious RF Conducted Emission (dBc)	Limits (dBc)	Verdict
GFSK	0	2402	<-20dBc	-20	PASS
	39	2441	<-20dBc	-20	
	78	2480	<-20dBc	-20	
8DPSK	0	2402	<-20dBc	-20	PASS
	39	2441	<-20dBc	-20	
	78	2480	<-20dBc	-20	

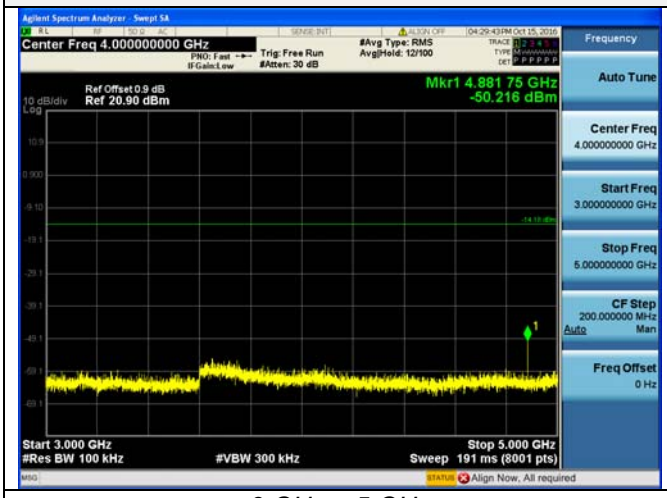
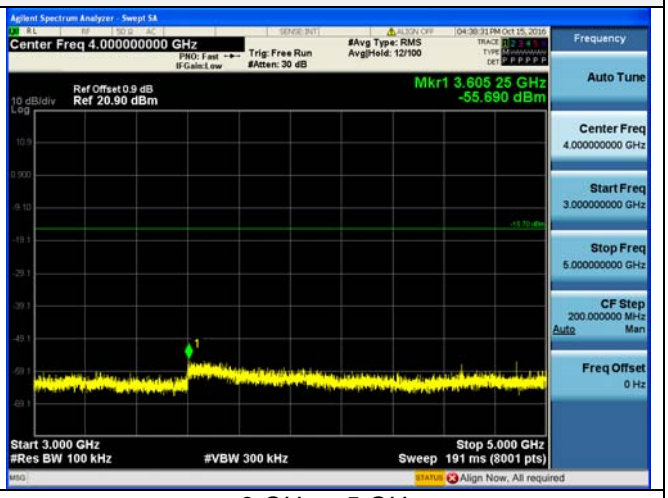
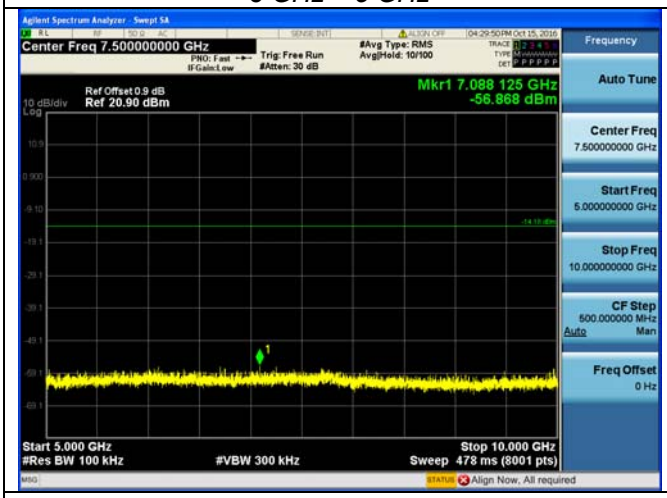
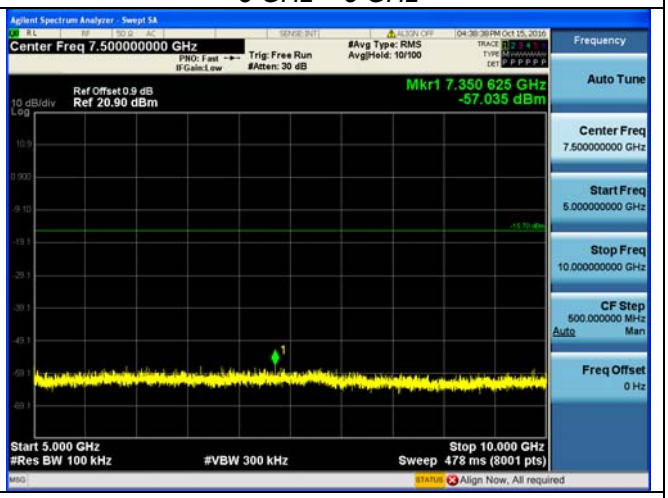
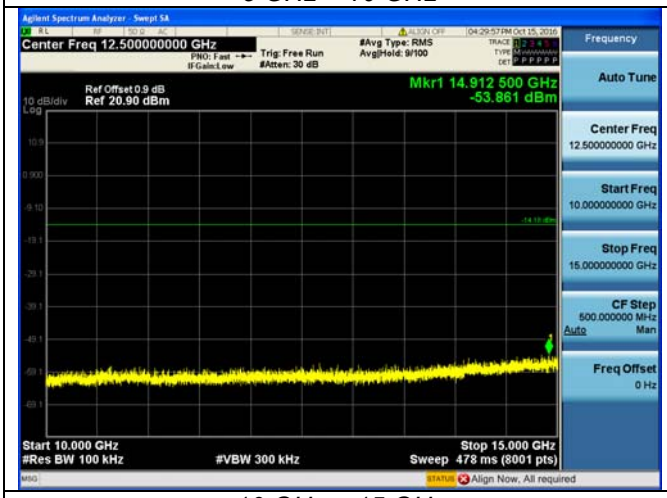
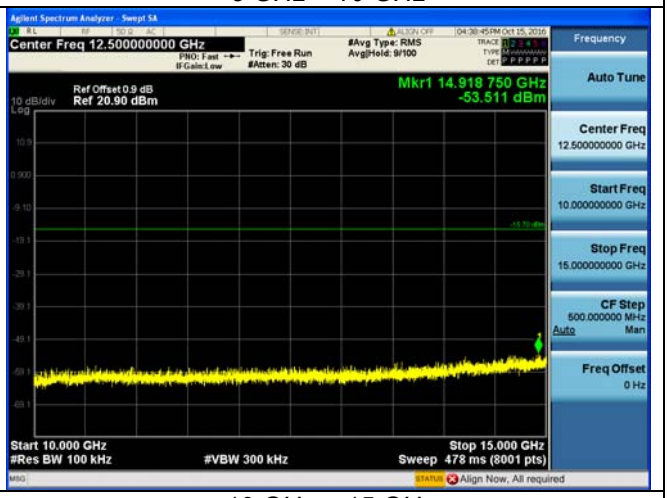
Remark:
1. *Test results including cable loss;*
2. *please refer to following plots;*
3. *Measured at difference Packet Type for each mode and recorded worst case for each mode.*
4. *Worst case data at DH5 for GFSK, 8DPSK modulation type;*

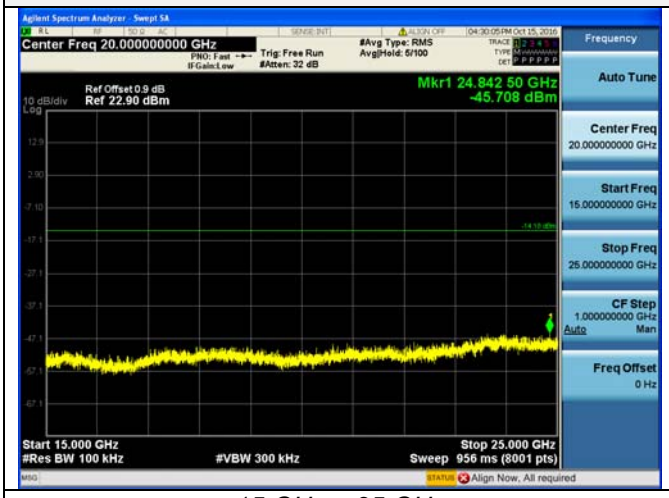
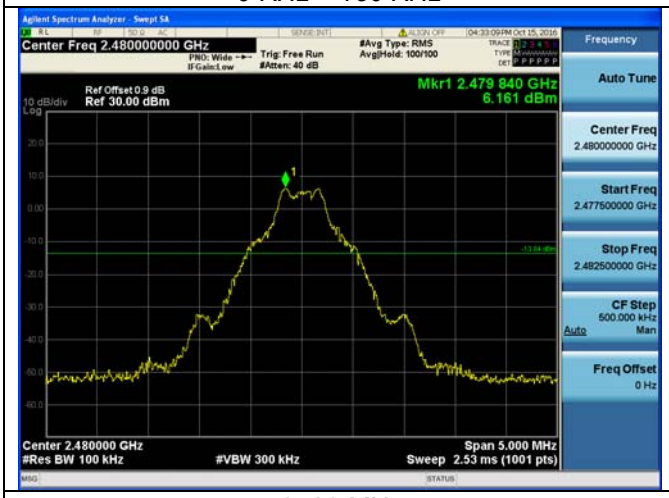
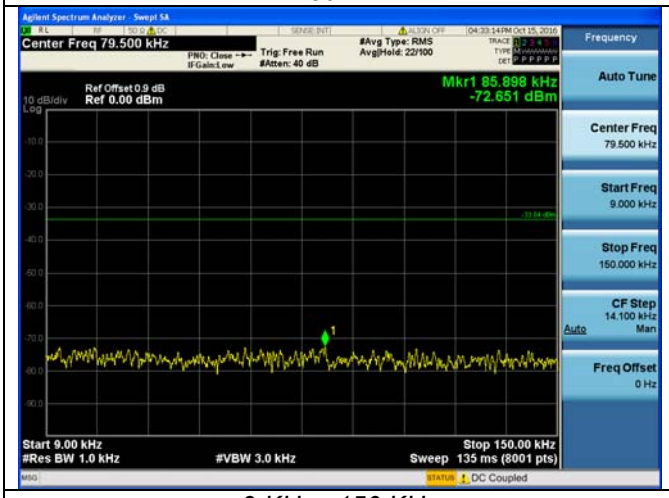
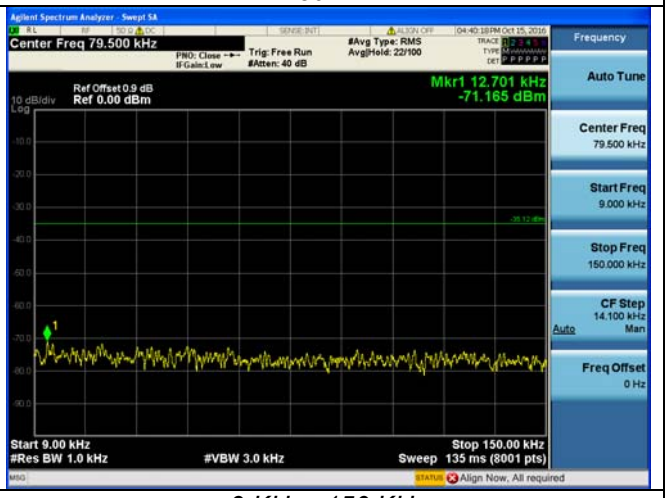
Spurious RF Conducted Emissions	
GFSK	*8DPSK*
2402 MHz	*2402 MHz*
	
2399.5 MHz - 2404.5 MHz	*2399.5 MHz - 2404.5 MHz*
	
9 KHz – 150 KHz	*9 KHz – 150 KHz*
	
150 KHz – 30 MHz	*150 KHz – 30 MHz*

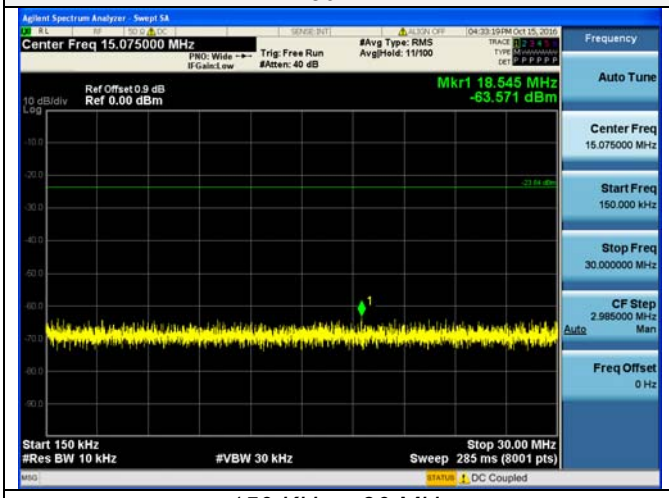
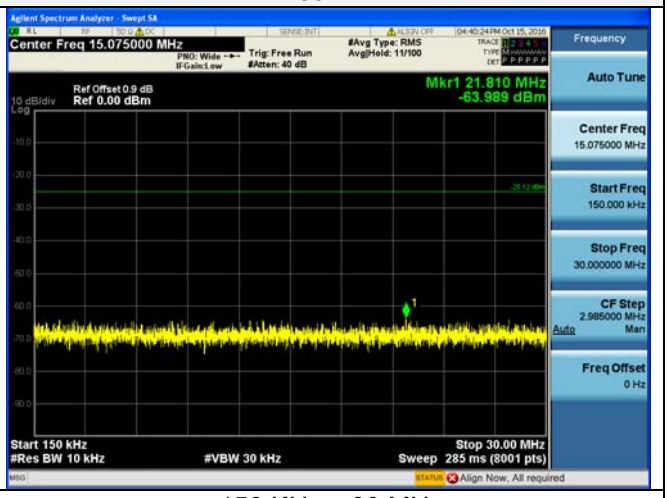
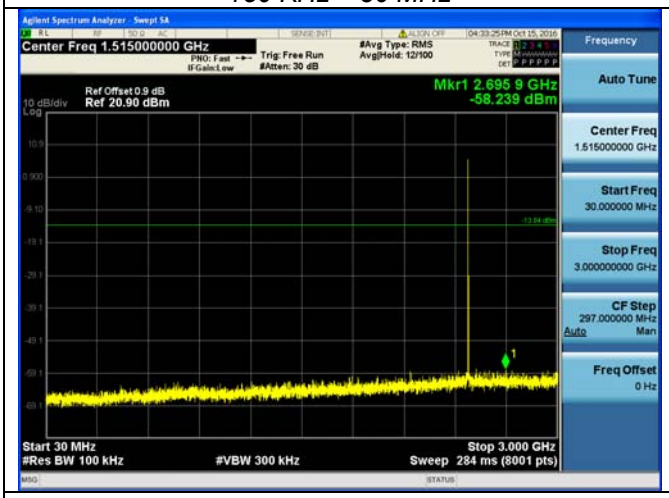
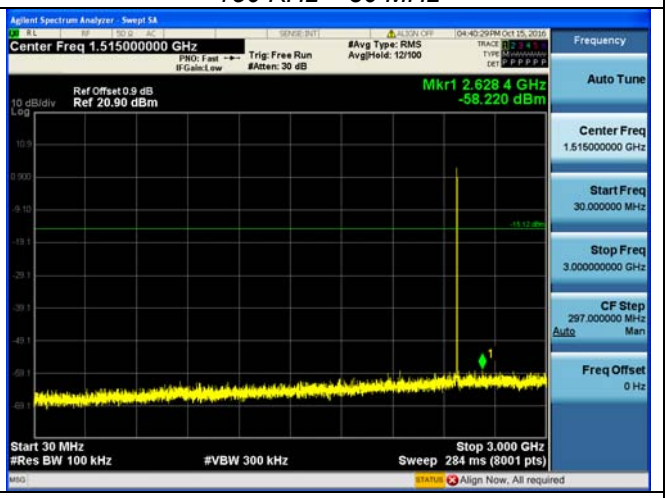
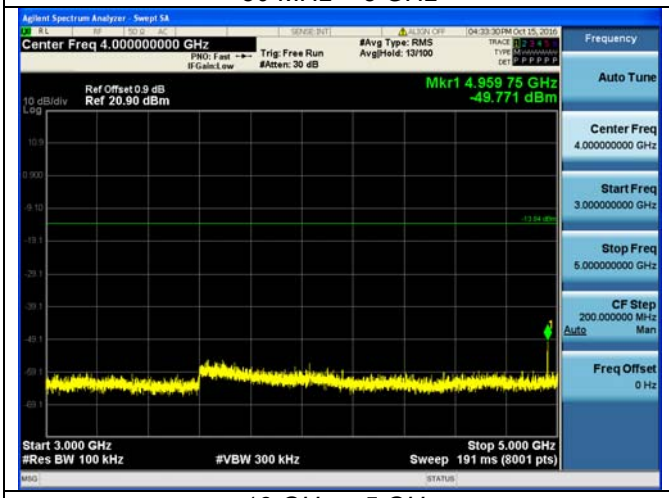
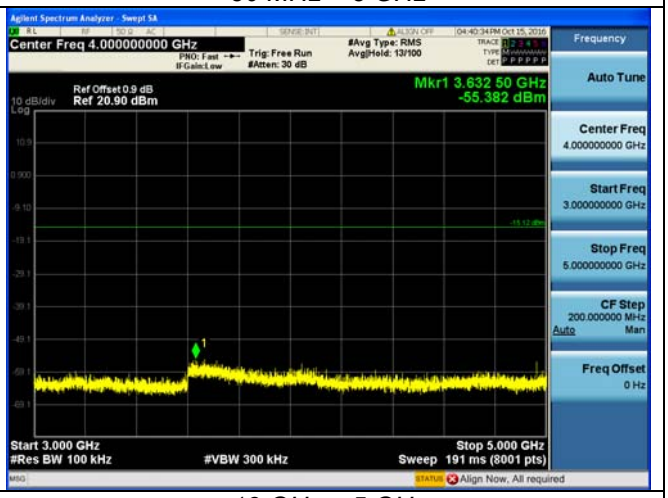
Spurious RF Conducted Emissions	
GFSK	*8DPSK*
2402 MHz	*2402 MHz*
	
30 MHz – 3000 MHz	*30 MHz – 1000 MHz*
	
3 GHz – 5 GHz	*3 GHz – 5 GHz*
	
5 GHz – 10 GHz	*5 GHz – 10 GHz*

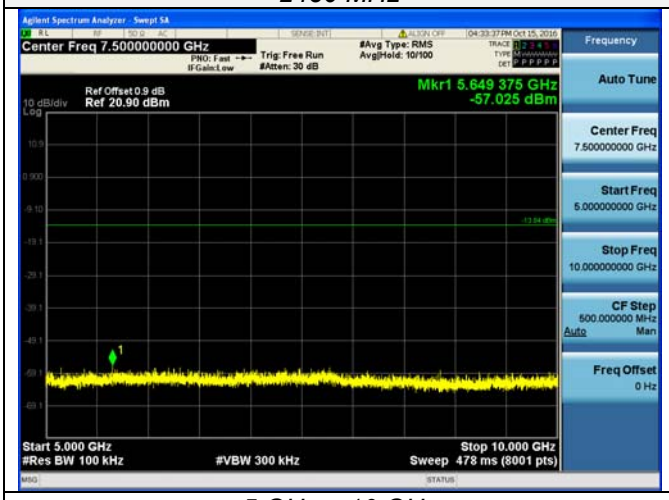
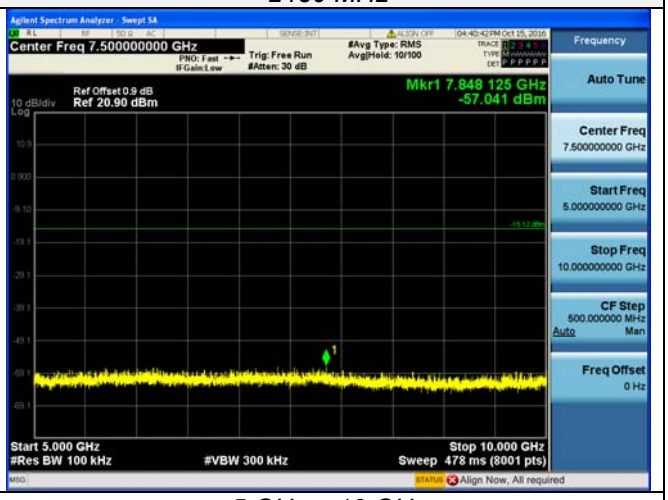
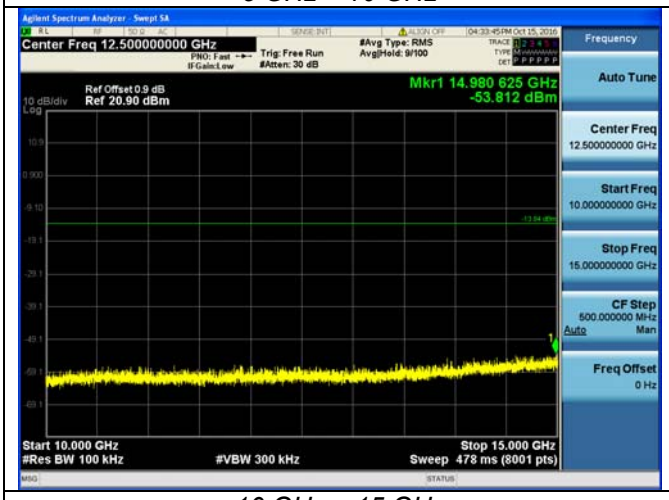
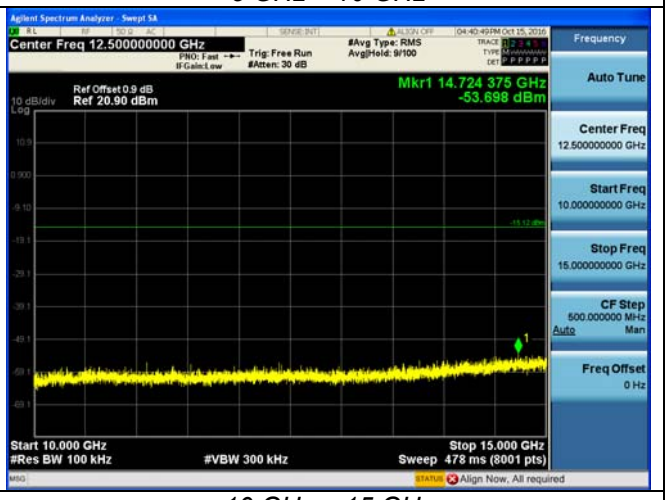
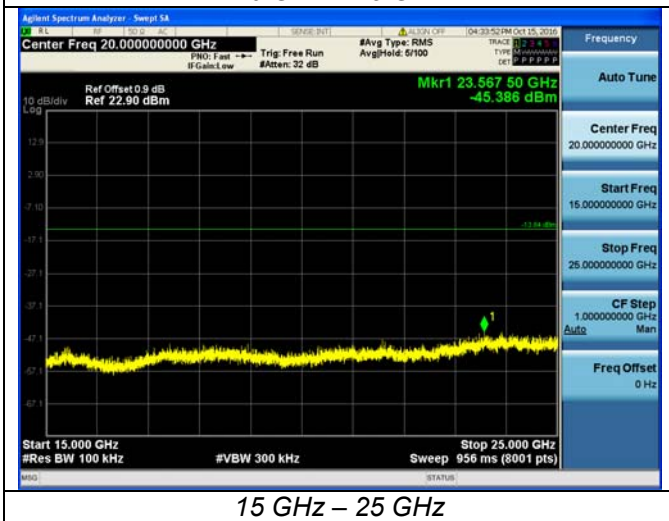
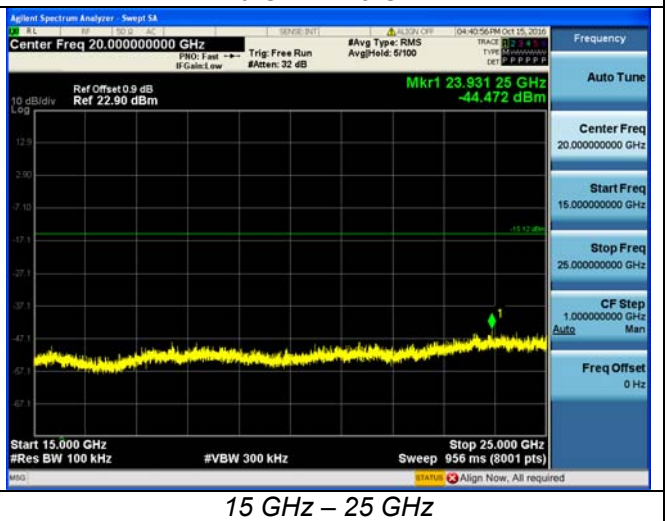
Spurious RF Conducted Emissions	
GFSK	*8DPSK*
2402 MHz	*2402 MHz*
	
10 GHz – 15 GHz	*10 GHz – 15 GHz*
	
15 GHz – 25 GHz	*15 GHz – 25 GHz*
2441 MHz	*2441 MHz*
	
2441 MHz	*2441 MHz*

Spurious RF Conducted Emissions	
GFSK	*8DPSK*
2441 MHz	*2441 MHz*
	
9 KHz – 150 kHz	*9 KHz – 150 kHz*
	
150KHz-30MHz	*150KHz-30MHz*
	
30 MHz – 3 GHz	*30 MHz – 3 GHz*

Spurious RF Conducted Emissions	
GFSK	*8DPSK*
2441 MHz	*2441 MHz*
	
3 GHz – 5 GHz	*3 GHz – 5 GHz*
	
5 GHz – 10 GHz	*5 GHz – 10 GHz*
	
10 GHz – 15 GHz	*10 GHz – 15 GHz*
2480 MHz	*2480 MHz*

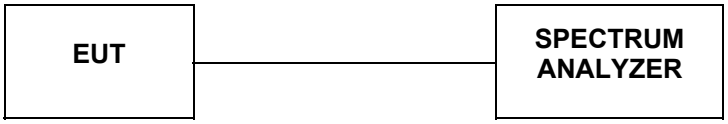
Spurious RF Conducted Emissions	
GFSK	*8DPSK*
2441 MHz	*2441MHz*
	
15 GHz – 25 GHz	*15 GHz – 25 GHz*
2480 MHz	*2480 MHz*
9 KHz – 150 KHz	*9 KHz – 150 KHz*
	
2480 MHz	*2480 MHz*
	
9 KHz –150 KHz	*9 KHz –150 KHz*

Spurious RF Conducted Emissions	
GFSK	*8DPSK*
2480 MHz	*2480 MHz*
	
150 KHz – 30 MHz	*150 KHz – 30 MHz*
	
30 MHz – 3 GHz	*30 MHz – 3 GHz*
	
13 GHz – 5 GHz	*13 GHz – 5 GHz*

Spurious RF Conducted Emissions	
GFSK	*8DPSK*
2480 MHz	*2480 MHz*
	
5 GHz – 10 GHz	*5 GHz – 10 GHz*
	
10 GHz – 15 GHz	*10 GHz – 15 GHz*
	
15 GHz – 25 GHz	*15 GHz – 25 GHz*

4.10 Number of hopping frequency

TEST CONFIGURATION



TEST PROCEDURE

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:
a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
b) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth;
c) VBW ≥ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.

LIMIT

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

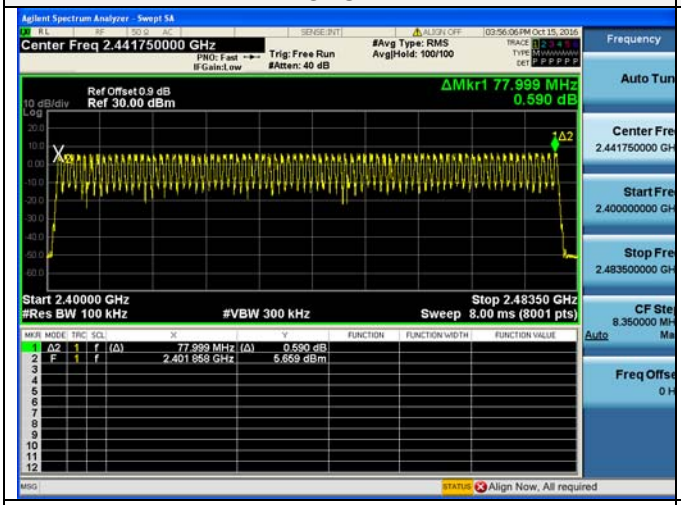
TEST RESULTS

Test Mode	Channel	Frequency (MHz)	Numbers of Channel	Limits	Verdict
GFSK	Full (hopping)	2402-2480	79	15	PASS
8DPSK	Full (hopping)	2402-2480	79	15	PASS

Remark:
1. *Test results including cable loss;*
2. *please refer to following plots;*
3. *Measured at difference Packet Type for each mode and recorded worst case for each mode.*
4. *Worst case data at DH5 for GFSK, 8DPSK modulation type;*

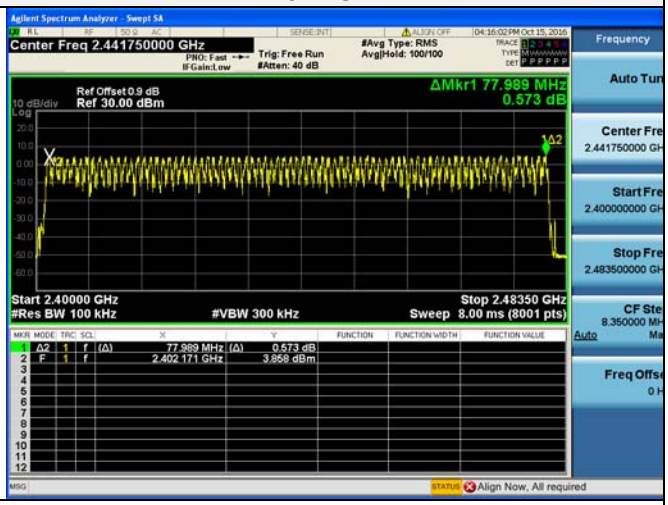
Number of hopping frequency

GFSK



2402 - 2480 MHz (Hopping)

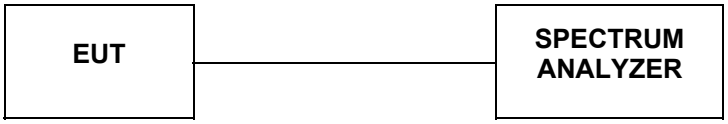
8DPSK



2402 - 2480 MHz (Hopping)

4.11 Time of Occupancy (Dwell Time)

TEST CONFIGURATION



TEST PROCEDURE

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:
a) Span: Zero span, centered on a hopping channel.
b) RBW shall be ≥ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.
c) Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
d) Detector function: Peak.
e) Trace: Max hold.

LIMIT

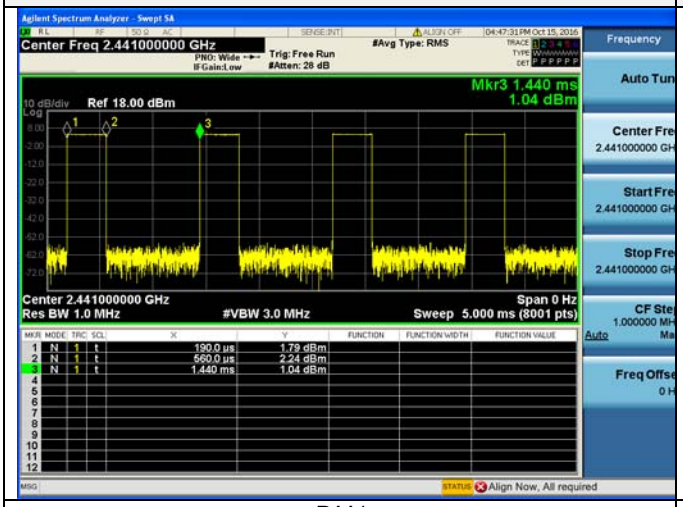
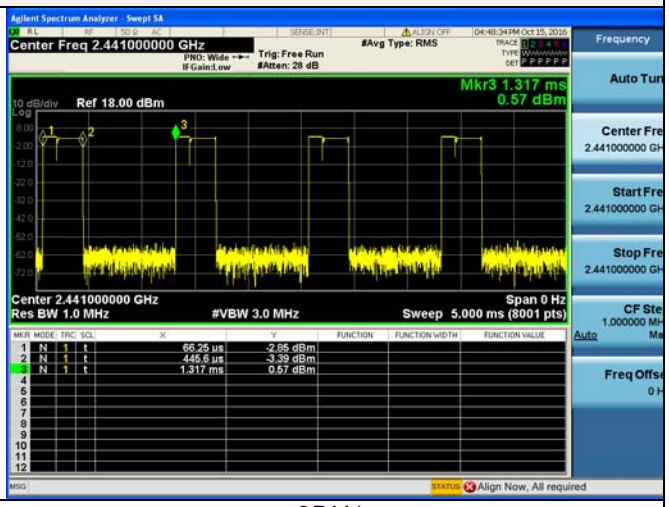
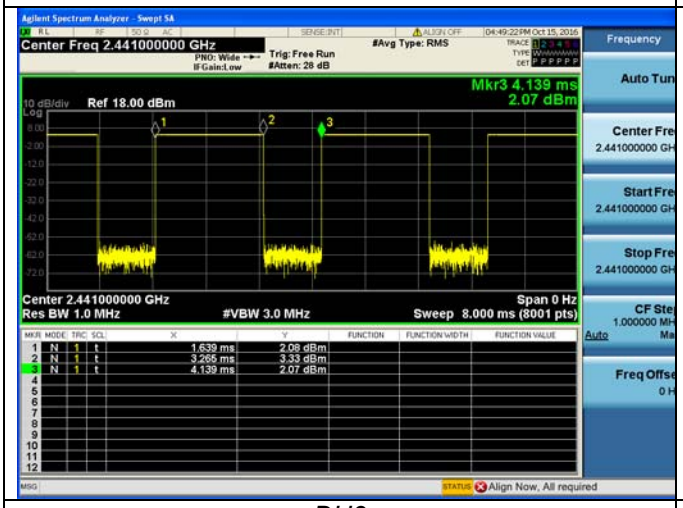
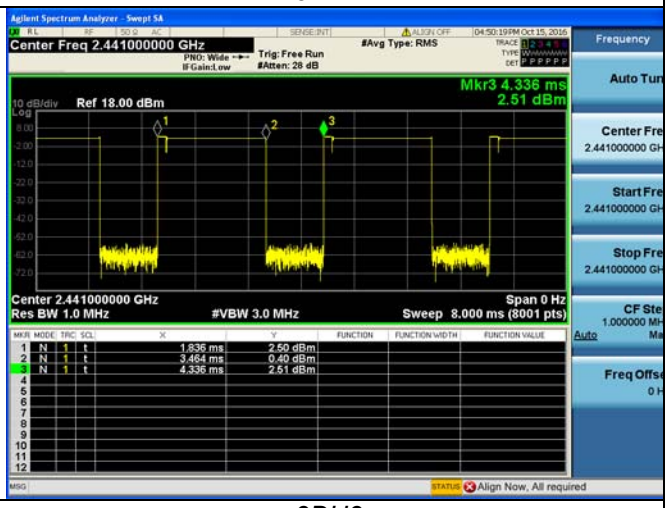
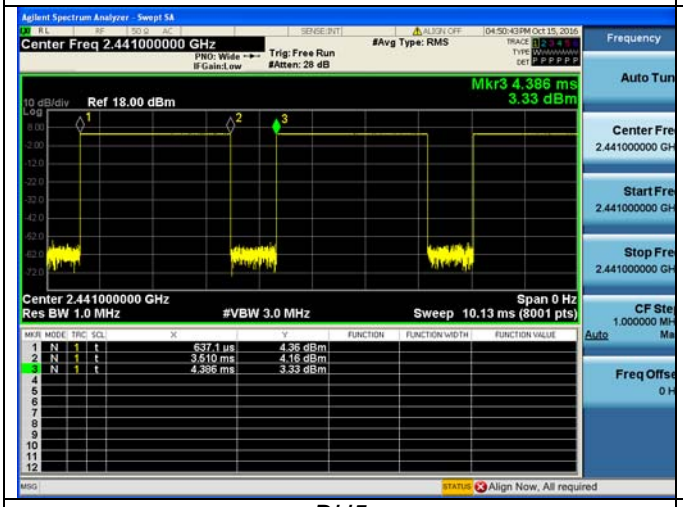
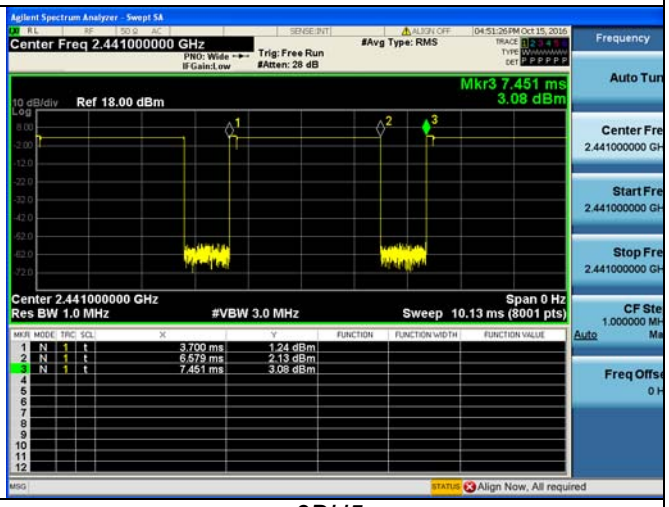
The average time of occupancy on any channel shall not be greater than 0.4 seconds within a pe-riod of 0.4 seconds multiplied by the number of hopping channels employed.

TEST RESULTS

The Dwell Time=Burst Width*Total Hops. The detailed calculations are showed as follows:
The duration for dwell time calculation:0.4[s]*hopping number=0.4[s]*79[ch]=31.6[s*ch];
The burst width [ms/hop/ch], which is directly measured, refers to the duration on one channel hop.
The hops per second for all channels: The selected EUT Conf uses a slot type of 5-Tx&1-Rx and a hopping rate of 1600 [ch*hop/s] for all channels. So the final hopping rate for all channels is 1600/6=266.67 [ch*hop/s]
The hops per second on one channel: 266.67 [ch*hops/s]/79 [ch]=3.38 [hop/s];
The total hops for all channels within the dwell time calculation duration: 3.38 [hop/s]*31.6[s*ch]=106.67 [hop*ch];
The dwell time for all channels hopping: 106.67 [hop*ch]*Burst Width [ms/hop/ch].

Mode	Frequency (MHz)	Burst Type	Pulse Width (ms)	Dwell Time (S)	Limit (S)	Verdict
GFSK	2441	DH1	0.370	0.1184	0.4	PASS
		DH3	1.626	0.2602	0.4	PASS
		DH5	2.873	0.3065	0.4	PASS
8DPSK	2441	DH1	0.379	0.1213	0.4	PASS
		DH3	1.628	0.2605	0.4	PASS
		DH5	2.879	0.3791	0.4	PASS

Remark:
1. *Test results including cable loss;*
2. *please refer to following plots;*
3. *Measured at difference Packet Type for each mode and recorded woest case for each mode.*
4. *Worst case data at DH5 for GFSK, 8DPSK modulation type;*
5. *Dwell Time Calculate formula:*
   DH1: Dwell time=Pulse time (ms) × (1600 ÷ 2 ÷ 79) ×31.6 Second
   DH3: Dwell time=Pulse time (ms) × (1600 ÷ 4 ÷ 79) ×31.6 Second
   DH5: Dwell time=Pulse Time (ms) × (1600 ÷ 6 ÷ 79) ×31.6 Second
6. *Measured at low, middle and high channel, recorded worst at middle channel;*

Time Of Occupancy (Dwell Time)	
GFSK	*8DPSK*
2441 MHz	*2441 MHz*
	
DH1	*3DH1*
	
DH3	*3DH3*
	
DH5	*3DH5*

4.12 Pseudorandom Frequency Hopping Sequence

TEST APPLICABLE

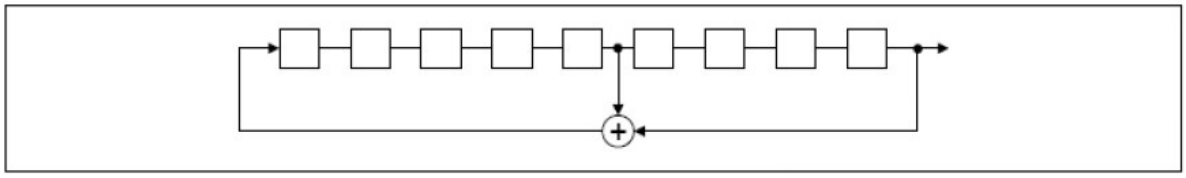
For 47 CFR Part 15C section 15.247 (a)(1) requirement:

Frequency hopping systems shall have hopping channel carrier fre-quencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hop-ping channel, whichever is greater. Al-ternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier fre-quencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to chan-nel frequencies that are selected at the system hopping rate from a pseudo ran-domly ordered list of hopping fre-quencies. Each frequency must be used equally on the average by each trans-mitter. The system receivers shall have input bandwidths that match the hop-ping channel bandwidths of their cor-responding transmitters and shall shift frequencies in synchronization with the transmitted signals.

EUT Pseudorandom Frequency Hopping Sequence Requirement

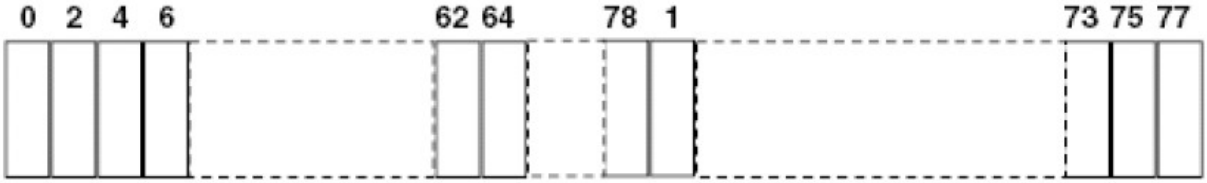
The pseudorandom frequency hopping sequence may be generated in a nice-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage.And the result is fed back to the input of the frist stage.The sequence begins with the frist one of 9 consecutive ones,for example:the shift register is initialized with nine ones.

- Number of shift register stages:9
- Length of pseudo-random sequence:29-1=511 bits
- Longest sequence of zeros:8(non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS sequence

An explame of pseudorandom frequency hopping sequence as follows:



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

4.13 Antenna Requirement

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 (c), 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.

Refer to statement below for compliance

The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited. Further, this requirement does not apply to intentional radiators that must be professionally installed.

Antenna Connected Construction

According to § 15.203 & RSS-Gen, 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.

Antenna Connector Construction

The directional gains of antenna used for transmitting is 0 dBi, and the antenna is an internal antenna connect to PCB board and no consideration of replacement. Please see EUT photo for details.
The WLAN and Bluetooth share same antenna.

Measurement

The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module.For normal BT devices, the GFSK mode is used.

Conducted power refer ANSI C63.10 :2013 Output power test procedure for frequency-hopping spread-spectrum (FHSS) devices
Radiated power refer to ANSI C63.10 :2013 Radiated emissions tests.

Measurement parameters

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	1MHz
Video bandwidth:	3MHz
Trace-Mode:	Max hold

Limits

FCC	IC
Antenna Gain	
6 dBi	

Results

T_{nom}	V_{nom}	Lowest Channel 2402 MHz	Middle Channel 2441 MHz	Highest Channel 2480 MHz
Conducted power [dBm] Measured with GFSK modulation		5.767	6.013	6.213
Radiated power [dBm] Measured with GFSK modulation		4.415	5.026	4.561
Gain [dBi] Calculated		-1.352	-0.987	-1.652
Measurement uncertainty		± 0.6 dB (cond.) / ± 2.56 dB (rad.)		

5 Test Setup Photos of the EUT

Please refer to separated files for Test Setup Photos of the EUT.

6 External Photos of the EUT

Please refer to separated files for External Photos of the EUT.

7 Internal Photos of the EUT

Please refer to separated files for Internal Photos of the EUT.

.....End of Report.....