FCC IC Test Report

Report No: FCS202007067

Issued for

Applicant:	CRYPTODATA TECH SRL
Address:	Bucuresti,Sectorul 1,Soldat Gheorghe Buciumat,nr.14 Mansarda,Romania
Product Name:	Laptop
Brand Name:	CryptoData
Model Name:	WHIM Business
Series Model:	Whim Pro, Whim Book, N141
FCC ID:	2AWZ7-WHIM
IC:	26331-WHIM

Issued By: Flux Compliance Service Laboratory
Add: Room 105 Floor Bao hao Technology Building 1 NO.15 Gong yeWest Road Hi-Tech Industrial, Song shan lake Dongguan
Tel: 769-27280901 Fax:769-27280901 http://www.FCS-lab.com

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Revision History

Rev.	Issue Date	Effect Page	Contents
01	07 July 2020	All	Initial Issue

TEST RESULT CERTIFICATION

Applicant's Name ..... :	CRYPTODATA TECH SRL
Address ..... :	Bucuresti,Sectorul 1,Soldat Gheorghe Buciumat,nr.14 Mansarda,Romania
Manufacture's Name ..... :	Shenzhen KEP Technology Co., Ltd
Address ..... :	4th Floor, Building B20, Heng Feng Industrial Area, Xixiang Town, Bao'an District, Shenzhen, Guangdong, China 518126

Product Description

Product Name ..... :	Laptop
Brand Name ..... :	CryptoData
Model Name ..... :	WHIM Business
Series Model ..... :	Whim Pro, Whim Book, N141
Test Standards..... :	FCC Rules and Regulations Part 15 Subpart C(15.247) RSS-247 Issue 2: February 2017, RSS-Gen Issue 5: March 2019
Test Procedure ..... :	ANSI C63.10:2013.

This device described above has been tested FCS, the test results show that the equipment under test (EUT) is in compliance with the FCC requirements. And it is applicable only to the tested sample identified in the report.
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Date of Test.....:

Date (s) of performance of tests .:	30 June 2020 ~ 07 July 2020
Date of Issue .....:	07 July 2020
Test Result .....:	Pass

Prepared By : Chris chen

(Chris Chen)

Approved By : Brown lu

(Brown Lu)

1. Summary of Test Results

Standard Section	Test Item	Judgment	Remark
FCC Part 15.247(b)(1) ANSI C63.10:2013 RSS-Gen clause 6.12	Maximum Peak Output Power	PASS	
FCC Part 15.215 ANSI C63.10:2013 RSS-Gen clause 6.6 &ANSI C63.10: Clause 6.9	20dB Bandwidth and 99% Bandwidth	PASS	
FCC Part 15.247(a)(1) ANSI C63.10:2013 RSS-247 Issue 2:5.1(2)	Carrier Frequency Separation	PASS	--
FCC Part 15.247(a)(iii) ANSI C63.10:2013 RSS-247 Issue 2:5.1(4)	Number of Hopping Frequency	PASS	
FCC Part 15.247(a)(iii) ANSI C63.10:2013	Dwell Time	PASS	
FCC Part 15.209 FCC Part 15.247(d) ANSI C63.10:Clause 6.4, 6.6 and 6.7	Radiated Emission	PASS	
FCC Part 15.247(d) ANSI C63.10:2013 RSS-Gen clause 4.9	Band Edge Compliance	PASS	
FCC Part 15.207 ANSI C63.10:2013 RSS-Gen clause 4.9	Conducted Emission	PASS	--
FCC Part 15.203 RSS-Gen clause 8.3	Antenna Requirement	PASS	--

NOTE:

(1)" N/A" denotes test is not applicable in this Test Report

(2)All tests are according to ANSI C63.10-2013

(3)Test procedures according to the technical standards:KDB 558074 D01 15.247 Meas Guidance v05r02

1.1 Test Laboratory

Company Name:	Flux Compliance Service Laboratory
Address:	Room 105 Floor Bao hao Technology Building 1 NO.15 Gong yeWest Road Hi-Tech Industrial, Song shan lake Dongguan
Telephone:	+86-769-27280901
Fax:	+86-769-27280901
FCC Test Firm Registration Number: 514908 Designation number: CN0127 A2LA accreditation number：5545.01	

1.2 Measurement Uncertainty

The reported uncertainty of measurement **y ±U**,where expended uncertainty **U** is based on a standard uncertainty multiplied by a coverage factor of **k=2**,providing a level of confidence of approximately **95** %.

No.	Items	Uncertainty
1	RF output power, conducted	±0.71dB
2	Unwanted Emissions, conducted	±2.988 dB
3	Conducted Emission (9KHz-150KHz)	±4.13 dB
4	Conducted Emission (150KHz-30MHz)	±4.74 dB
5	All emissions,radiated(<1G) 30MHz-1000MHz	±5.2 dB
6	All emissions,radiated(>1G) 1000MHz -3000MHz	±4.66 dB
7	All emissions,radiated(<1G) 3000MHz -6000MHz	±5.31 dB

1.3 Test Environment Conditions

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

Temperature rang:	20-26℃
Humidity range:	40-65%
Pressure range:	86-106Kpa

2. General Information

2.1 General Description of The EUT

Product Name	Laptop
Trade Name	CryptoData
Model Name	WHIM Business
Series Model	Whim Pro, Whim Book, N141
Operation Frequency	2402 – 2480 MHz
Modulation	GFSK(1Mbps), π/4-DQPSK(2Mbps), 8DPSK(3Mbps)
Bluetooth Configuration	BR+ERD
Antenna Type	FPCB antenna, maximu PK gain: 1.68 dBi
Bluetooth Version	4.1
Adapter	WA-65B19R INPUT: 100-240V~ 50/60Hz 1.5A OUTPUT: DC 19V 3.43A
Battery	DC 7.6V 6000mAh Li Battery
Hardware version number	KEP-N141GKR4 MB V11 PCBA SKU1
Software versionnumber	win10_pro_64b_1909_18363.836
Connecting I/O Port(s)	Please refer to the User's Manual
Note: For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual.	

2.2 Channel List

Channel List					
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
00	2402	27	2429	54	2456
01	2403	28	2430	55	2457
02	2404	29	2431	56	2458
03	2405	30	2432	57	2459
04	2406	31	2433	58	2460
05	2407	32	2434	59	2461
06	2408	33	2435	60	2462
07	2409	34	2436	61	2463
08	2410	35	2437	62	2464
09	2411	36	2438	63	2465
10	2412	37	2439	64	2466
11	2413	38	2440	65	2467
12	2414	39	2441	66	2468
13	2415	40	2442	67	2469
14	2416	41	2443	68	2470
15	2417	42	2444	69	2471
16	2418	43	2445	70	2472
17	2419	44	2446	71	2473
18	2420	45	2447	72	2474
19	2421	46	2448	73	2475
20	2422	47	2449	74	2476
21	2423	48	2450	75	2477
22	2424	49	2451	76	2478
23	2425	50	2452	77	2479
24	2426	51	2453	78	2480
25	2427	52	2454		
26	2428	53	2455		

2.3 Assistant Equipment Used For Test

Assistant equipment	Manufacturer	Model number
/	/	/
/	/	/

2.4 Description of The Test Modes

To investigate the maximum EMI emission characteristics generates from EUT, the test system was pre-scanning tested base on the consideration of following EUT operation mode or test configuration mode which possible have effect on EMI emission level. Each of these EUT operation mode(s) or test configuration mode(s) mentioned above was evaluated respectively.

Worst Mode	Description	Data Rate/Modulation
Mode 1	TX CH00	1Mbps/GFSK
Mode 2	TX CH39	1Mbps/GFSK
Mode 3	TX CH78	1Mbps/GFSK
Mode 4	TX CH00	2 Mbps/π/4-DQPSK
Mode 5	TX CH39	2 Mbps/π/4-DQPSK
Mode 6	TX CH78	2 Mbps/π/4-DQPSK
Mode7	TX CH00	3 Mbps/8DPSK
Mode 8	TX CH39	3 Mbps/8DPSK
Mode 9	TX CH78	3 Mbps/8DPSK

2.5 Block Digram Showing The Configuration of System Tested

During testing channel & power controlling software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product power parameters of FHSS

2.6 Equipments List

Radiation Test equipment

Kind of Equipment	Manufacturer	Type No.	Company No.	Last calibration	Calibrated until
EMI Test Receiver	R&S	ESRP 3	FCS-E001	2020.05.31	2021.05.30
Signal Analyzer	R&S	FSV40-N	FCS-E012	2020.06.05	2021.06.04
Active loop Antenna	ZHINAN	ZN30900C	FCS-E013	2019.10.11	2020.10.10
Bilog Antenna	SCHWARZBECK	VULB 9168	FCS-E002	2019.10.26	2020.10.25
Horn Antenna	SCHWARZBECK	BBHA 9120D	FCS-E003	2020.05.31	2021.05.30
SHF-EHF Horn Antenna (18G-40GHz)	A-INFO	LB-180400-KF	FCS-E018	2020.05.31	2021.05.30
Pre-Amplifier(0.1M-3G Hz)	EMCI	EM330N	FCS-E004	2020.05.31	2021.05.30
Pre-Amplifier (1G-18GHz)	N/A	TSAMP-0518SE	FCS-E014	2019.10.03	2020.10.02
Temperature & Humidity	HTC-1	victor	FCS-E005	2020.05.31	2021.05.30

Conduction Test equipment

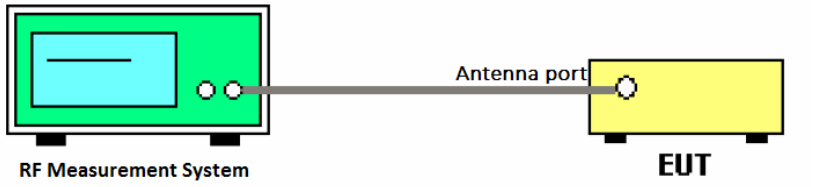
Kind of Equipment	Manufacturer	Type No.	Company No.	Last calibration	Calibrated until
EMI Test Receiver	R&S	ESPI	FCS-E020	2020.05.31	2021.05.30
LISN	R&S	ENV216	FCS-E007	2020.05.15	2021.05.14
LISN	ETS	3810/2NM	FCS-E009	2019.10.15	2020.10.14
Temperature & Humidity	HTC-1	victor	FCS-E008	2020.05.31	2021.05.30

RF Connected Test

Kind of Equipment	Manufacturer	Type No.	Company No.	Last calibration	Calibrated until
MXA SIGNAL Analyzer	Keysight	N9020A	FCS-E015	2019.10.02	2020.10.01

3. Maximum Peak Output Power

3.1 Block Diagram of Test Setup



3.2 Limit

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band:1watt.
For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts,
The e.i.r.p shall not exceed 4W.

3.3 Test Procedure

(1) Connect EUT's antenna output to spectrum analyzer by RF cable.

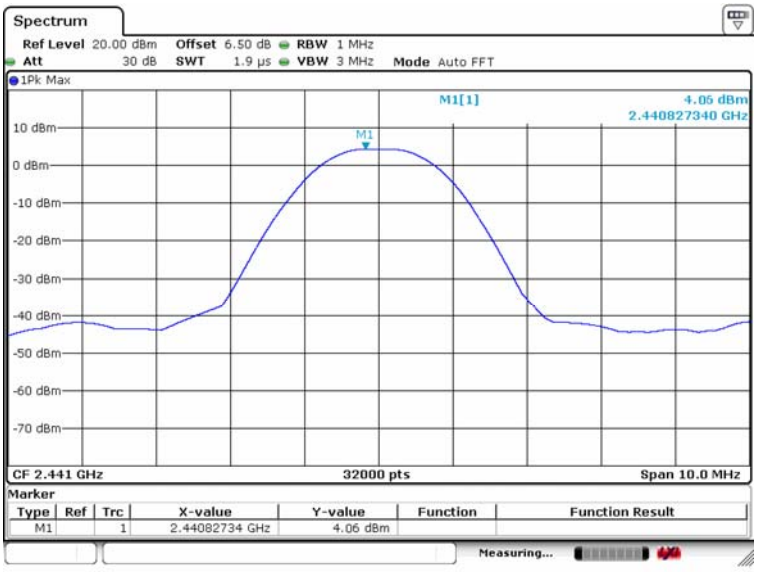
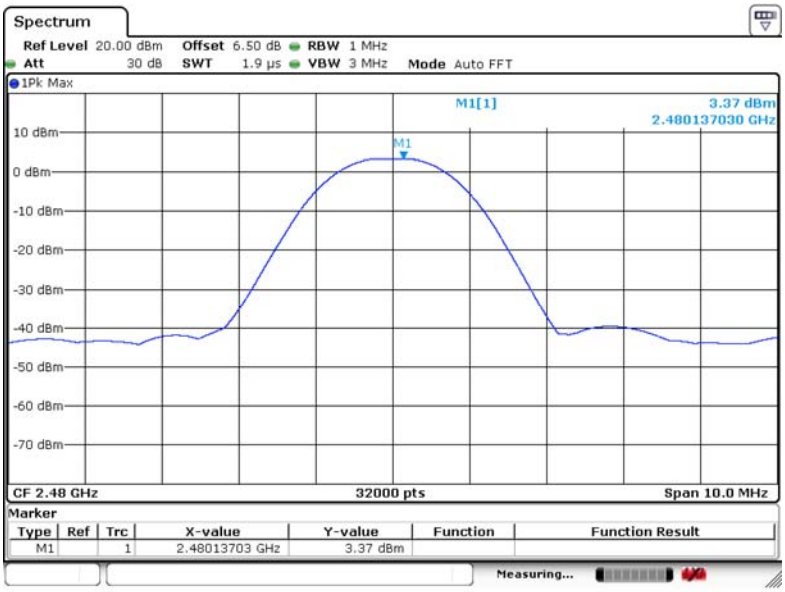
(2) Measure the maximum output power of EUT by spectrum analyzer with PK detector and RBW=3 MHz (above 20 dB bandwidth of measured signal), VBW=10 MHz

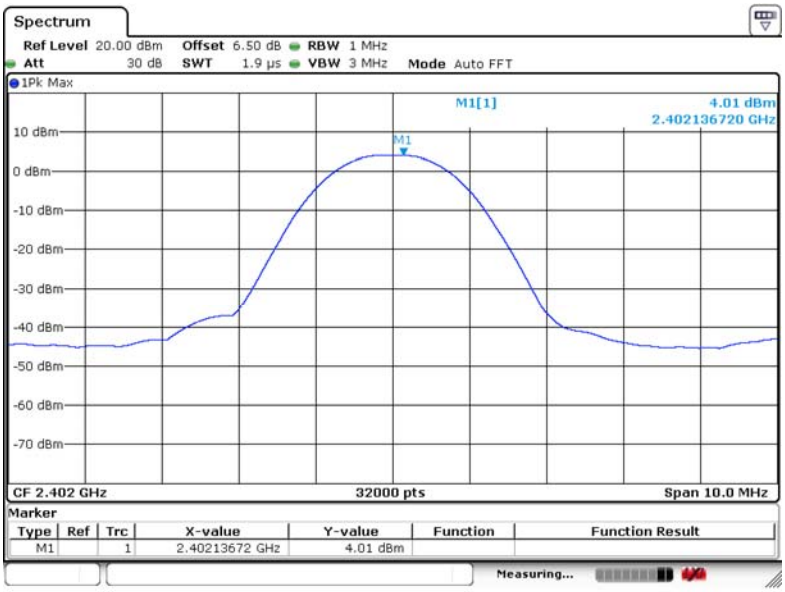
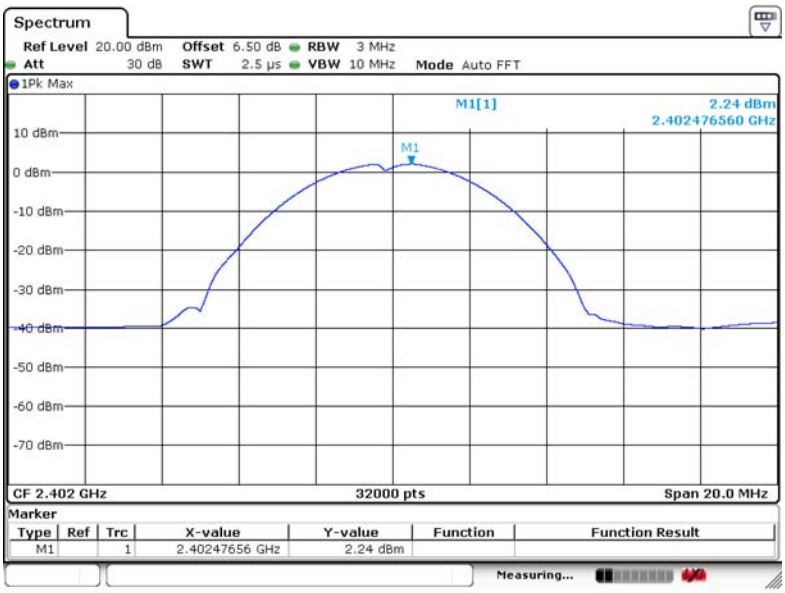
Note: The attenuator loss was inputted into spectrum analyzer as amplitude offset.

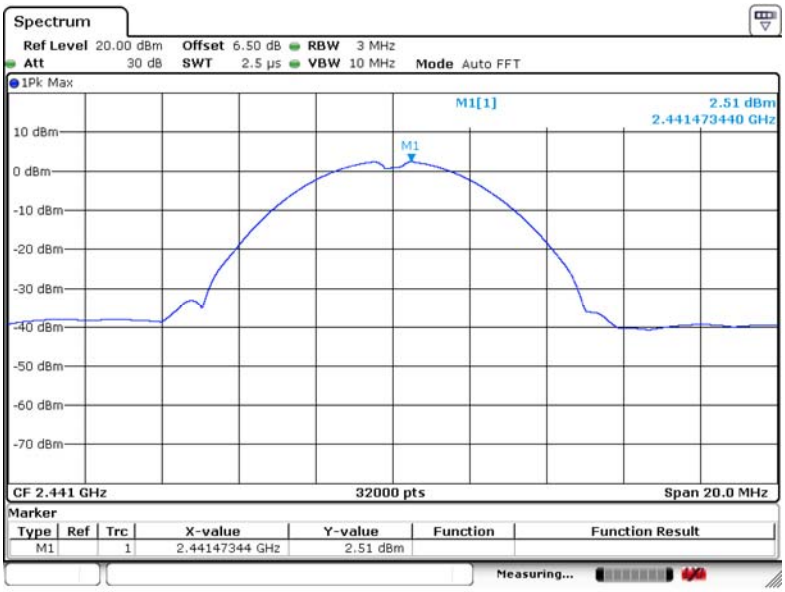
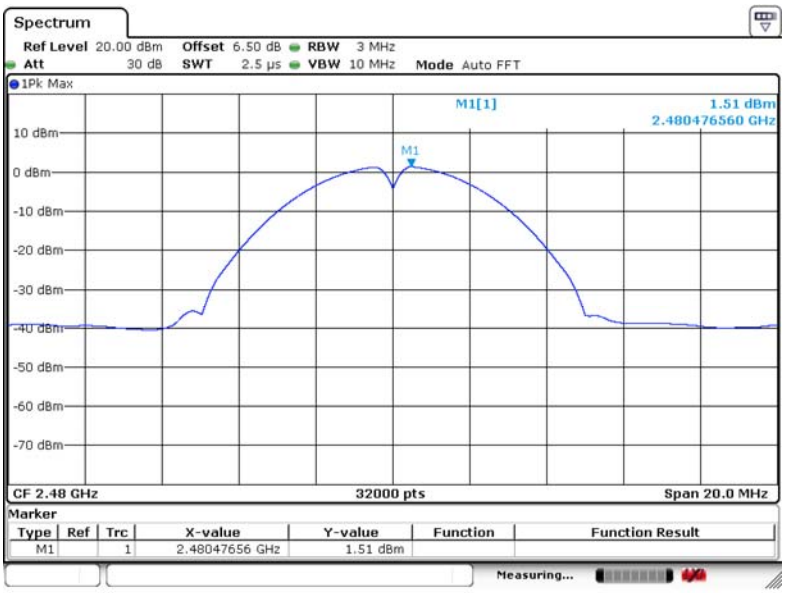
3.5 Test Result

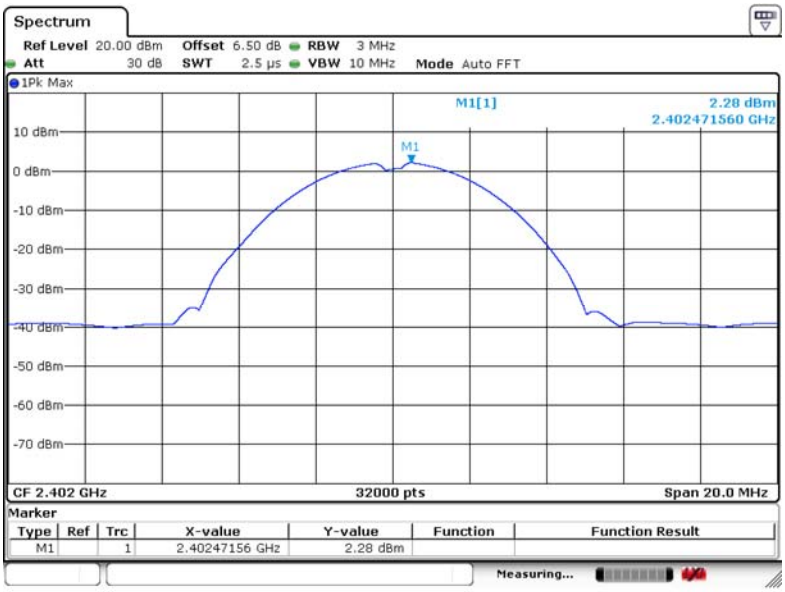
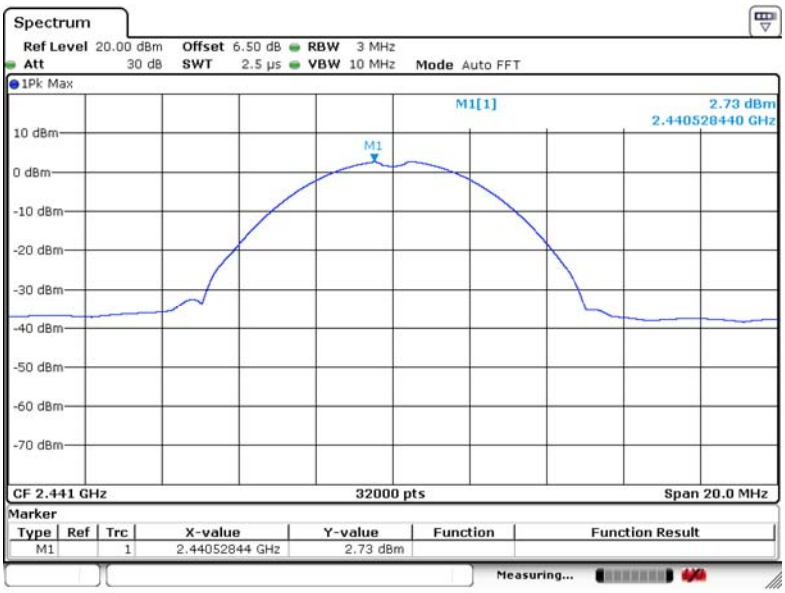
Mode	Frequency(MHz)	Result(dBm)	Limit(dBm)	Conclusion
GFSK	2402	4.06	21	Pass
	2441	3.37	21	Pass
	2480	4.01	21	Pass
π/4-DQPSK	2402	2.24	21	Pass
	2441	2.51	21	Pass
	2480	1.51	21	Pass
8DPSK	2402	2.28	21	Pass
	2441	2.73	21	Pass
	2480	1.67	21	Pass

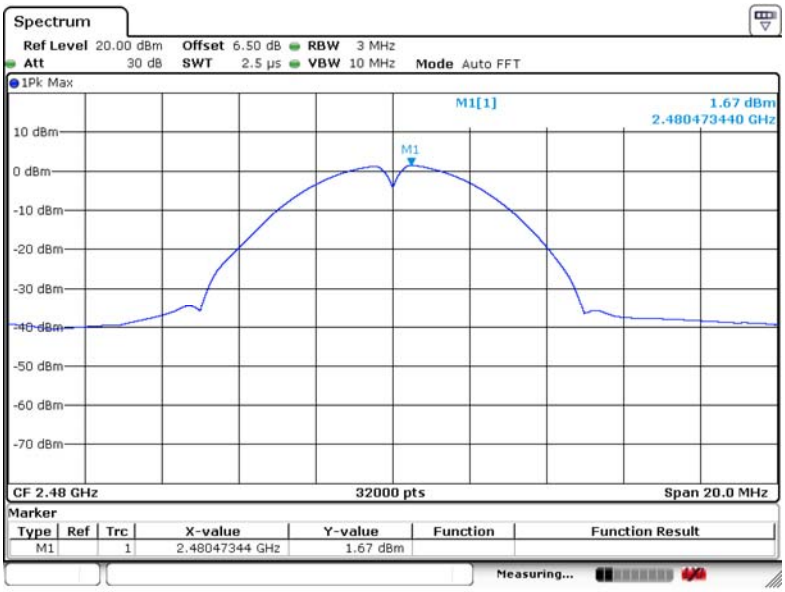
3.6 Original test data

DH5-2402MHZ	
DH5-2441MHZ	

DH5-2480MHZ	
2DH5-2402MHZ	

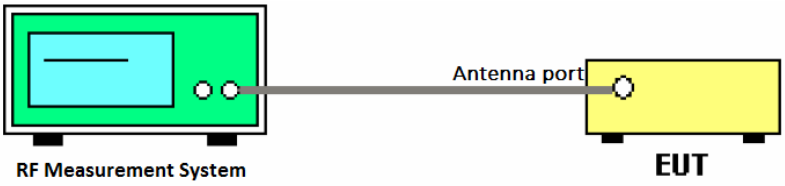
2DH5-2441MHZ	
2DH5-2480MHZ	

3DH5-2402MHZ	
3DH5-2441MHZ	

3DH5-2480MHZ	

4. 20dB Bandwidth And 99% Bandwidth

4. 1 Block Diagram of Test Setup



4.2Limit

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in § 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated

4.3 Test Procedure

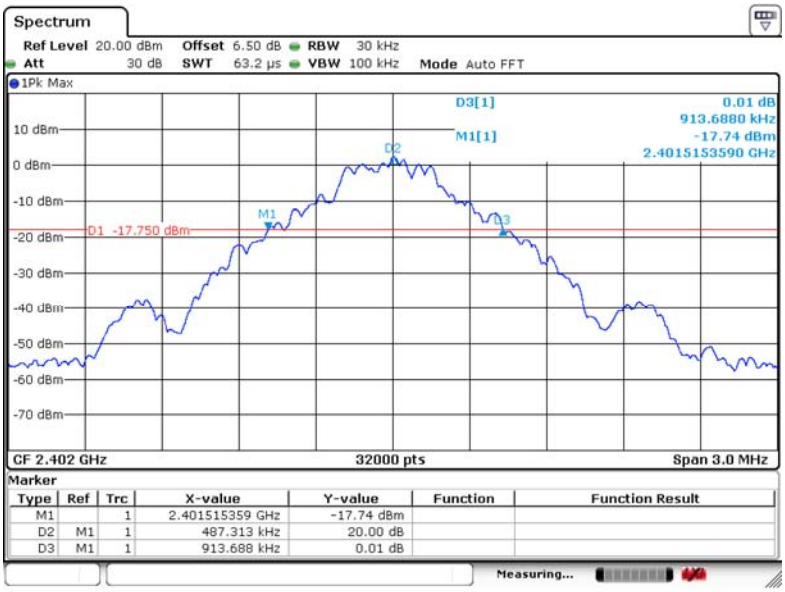
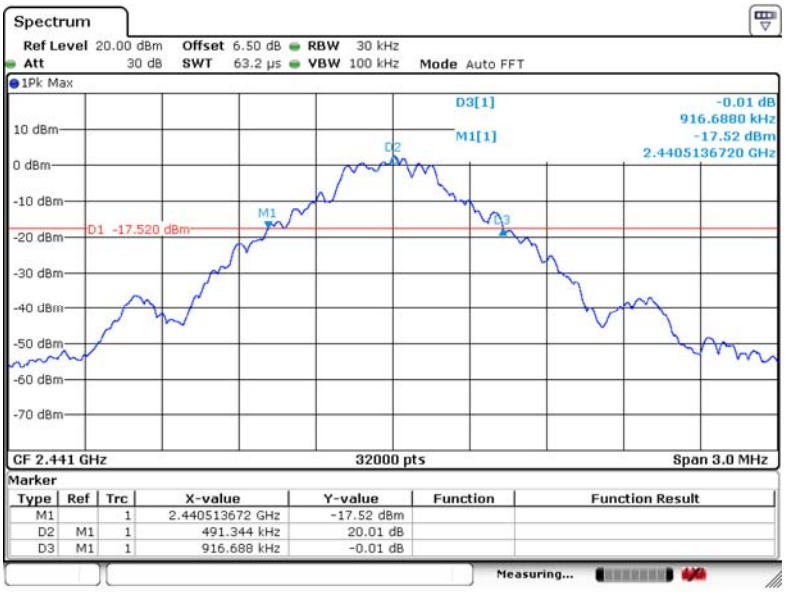
(1)Connect EUT's antenna output to spectrum analyzer by RF cable

(2) The bandwidth of the fundamental frequency was measured by spectrum analyzer with 30 kHz RBW and 100 kHz VBW. The 20 dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20 dB.

4.4 Test Result

Mode	Frequency(MHz)	20dB bandwidth Result(MHz)	99% bandwidth Result(MHz)	Conclusion
GFSK	2402	0.913	0.859	Pass
	2441	0.917	0.860	Pass
	2480	0.925	0.855	Pass
8DPSK	2402	1.439	1.335	Pass
	2441	1.439	1.334	Pass
	2480	1.437	1.335	Pass

4.5 Original Test data

DH5-2402MHZ	
DH5-2441MHZ	

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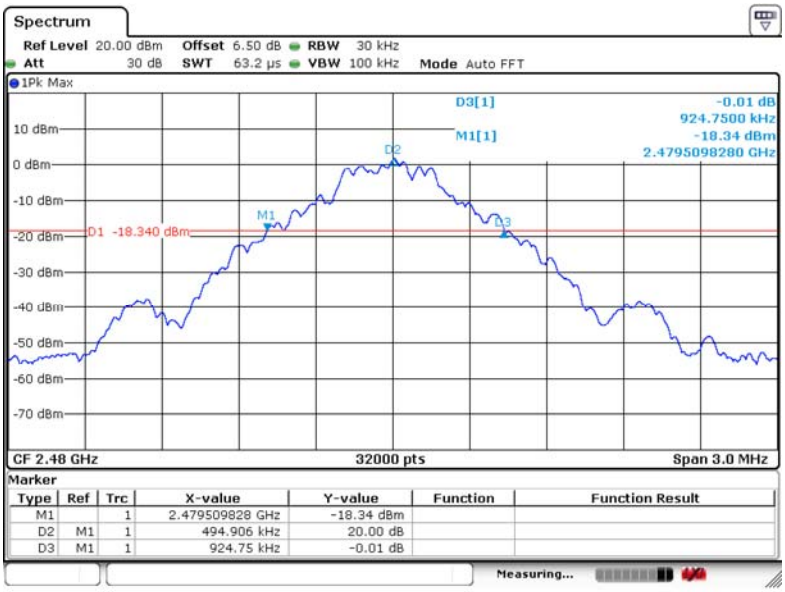

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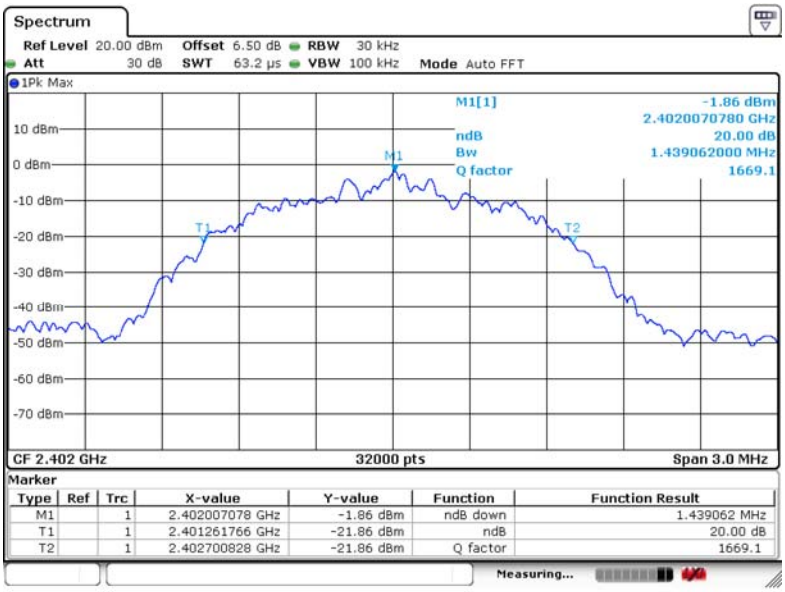
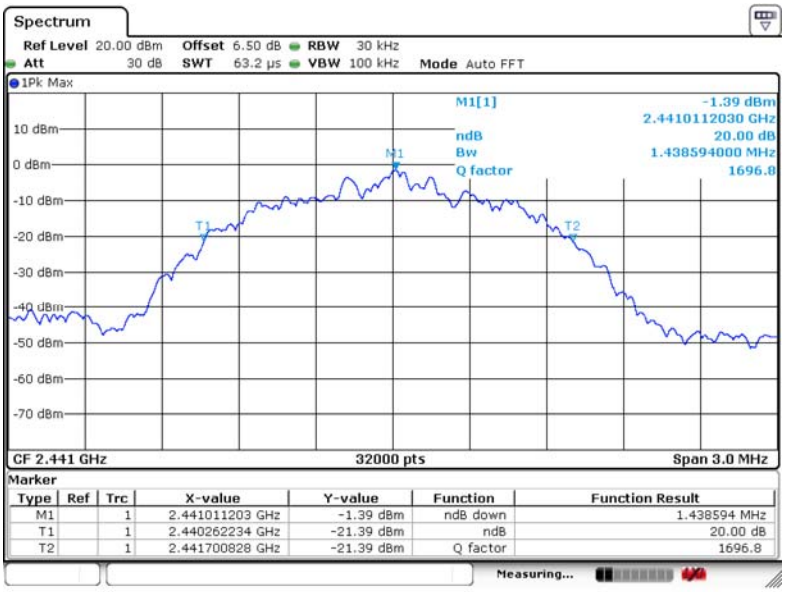
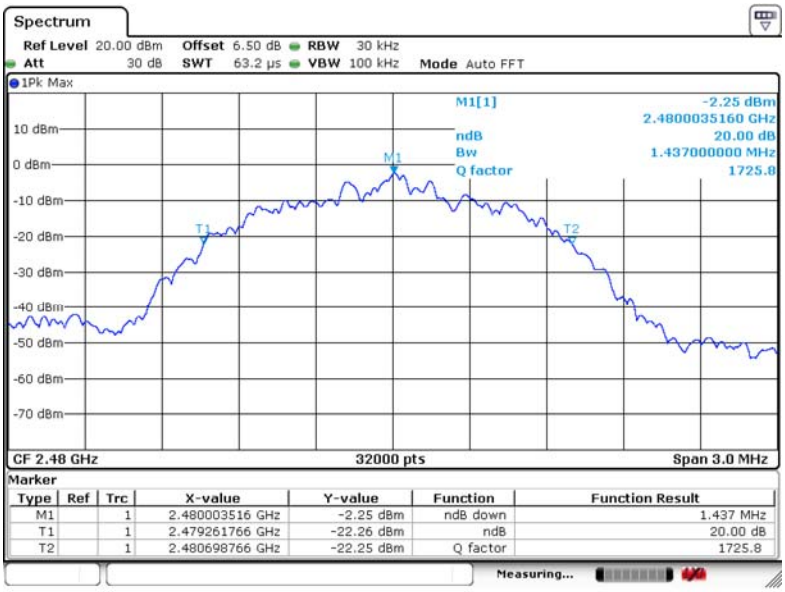


3DH5-2441MHZ	
3DH5-2480MHZ	

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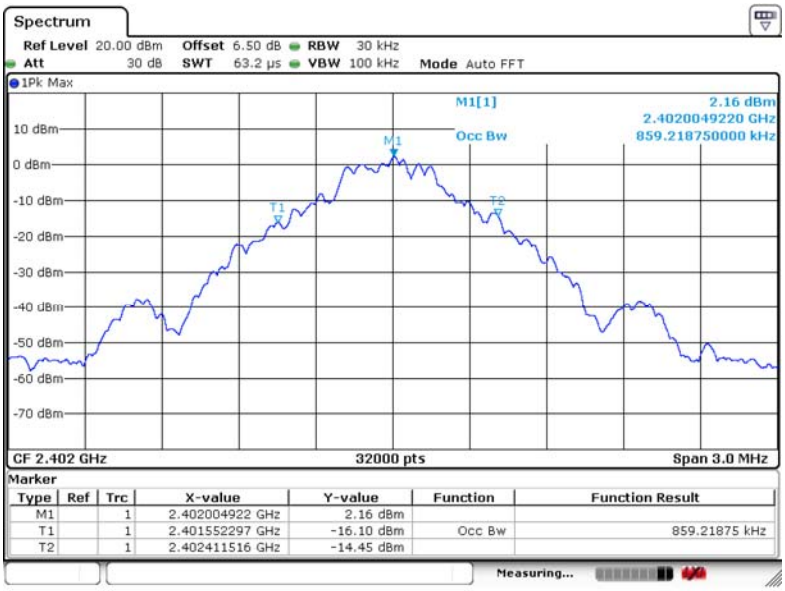

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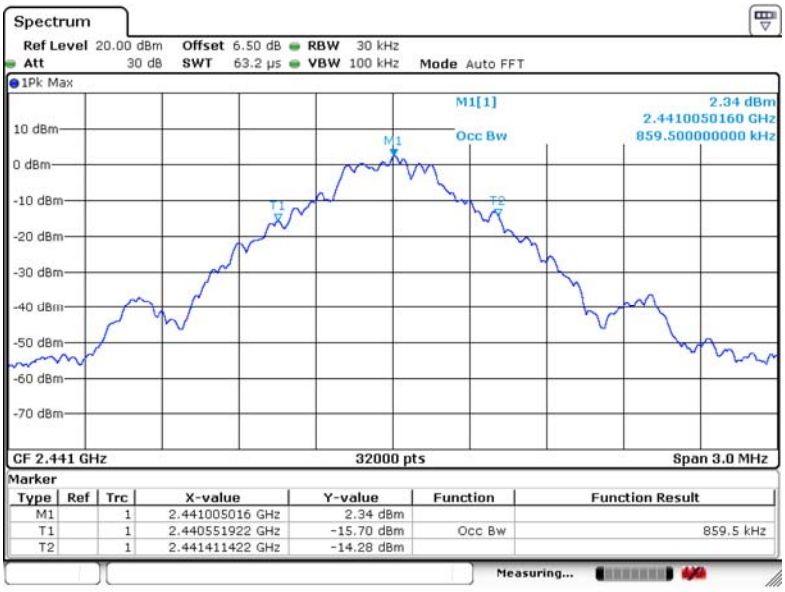
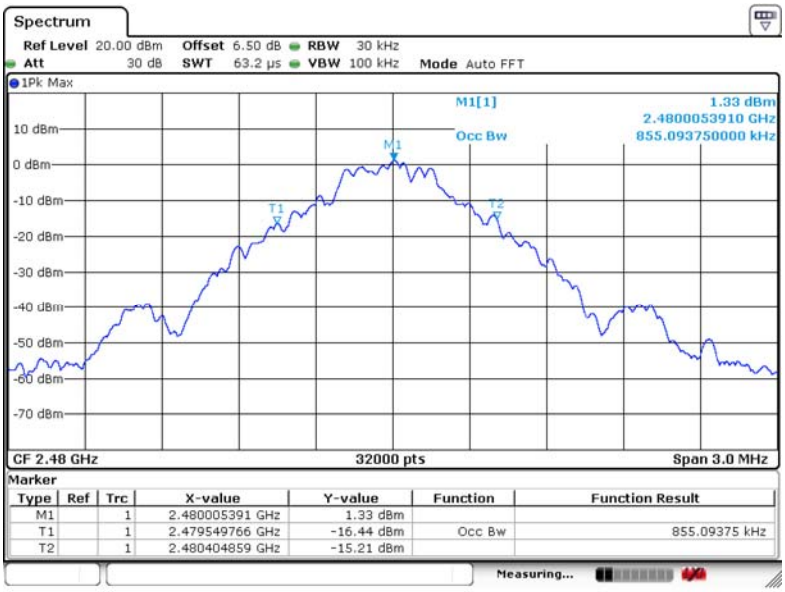
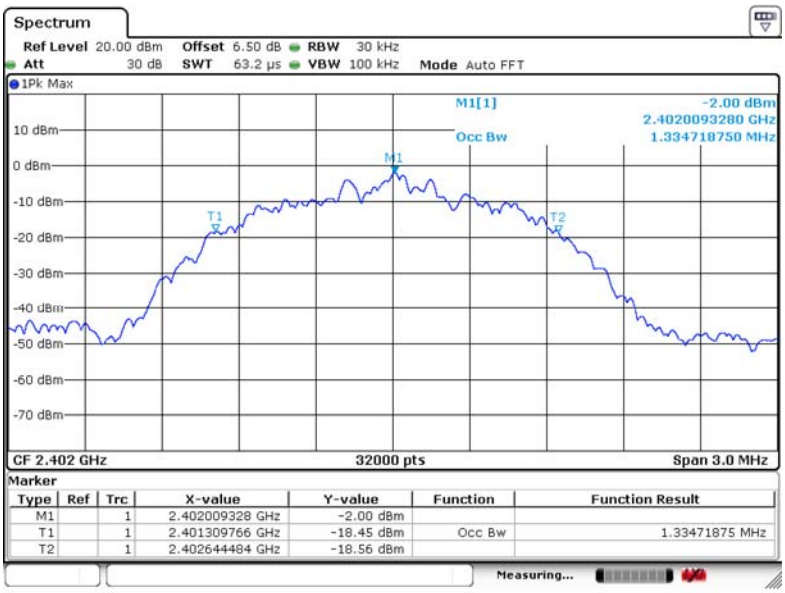


DH5-2480MHZ	
3DH5-2402MHZ	

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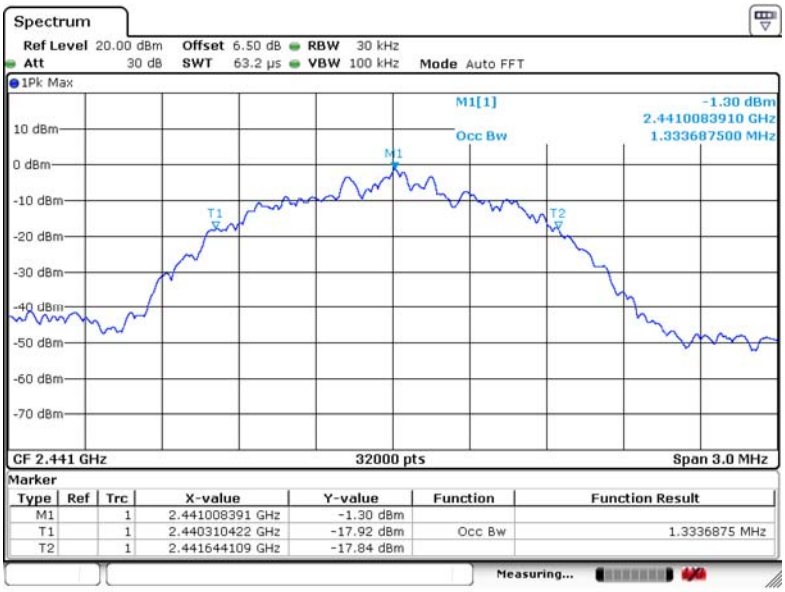

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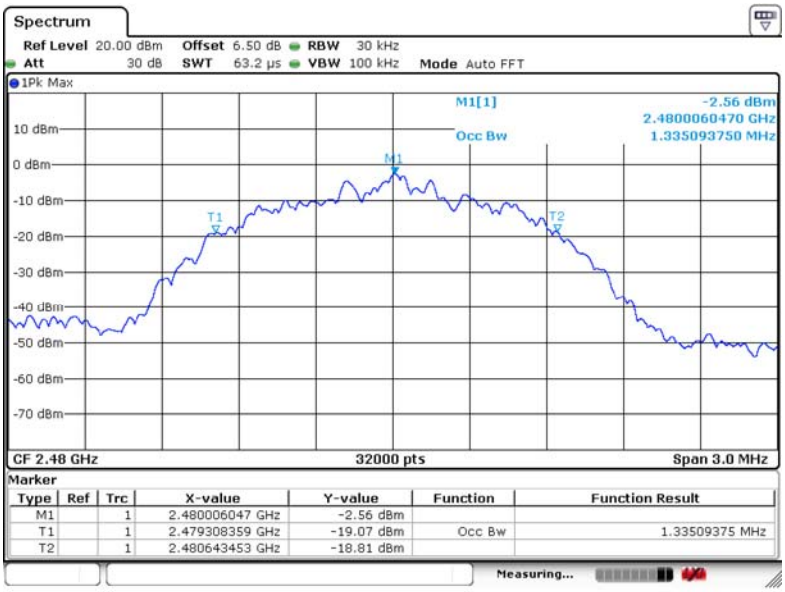
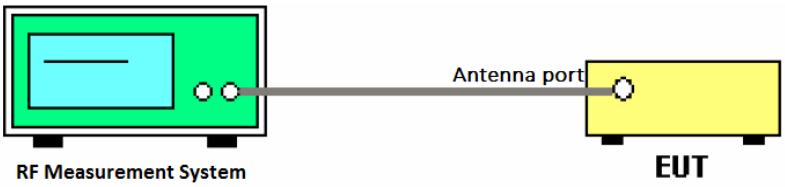


5. Carrier Frequency Separation

5.1Block Diagram of Test Setup



5.2Limit

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

5.3 Test Procedure

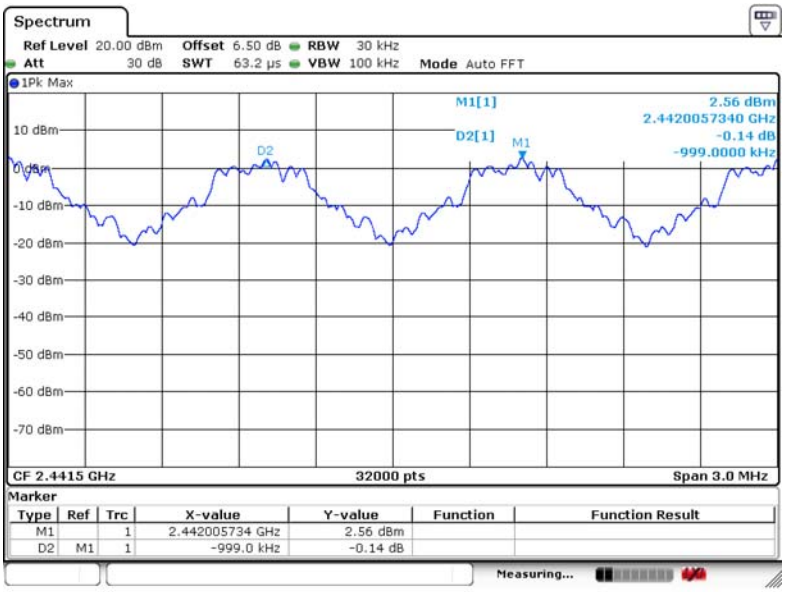
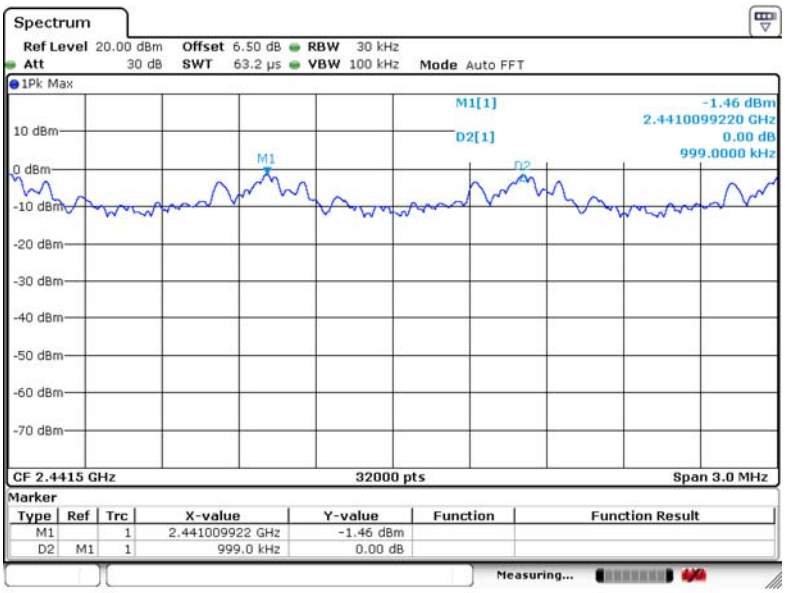
(1)Connect EUT's antenna output to spectrum analyzer by RF cable

(2) The carrier frequency was measured by spectrum analyzer with 100 kHz RBW and 300 kHz VBW

5.4 Test Result

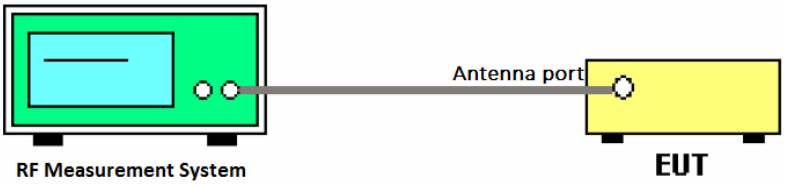
Mode	Channel separation (MHz)	20dB bandwidth Result(MHz) (worse case)	Limit(MHz) 2/3 of 20dB bandwidth	Conclusion
GFSK	1	0.999	≥0.585	Pass
8DPSK	1	0.999	≥0.955	Pass

5.5 Original Test data

DH5-HOP	
3DH5-HOP	

6. Number of Hopping Channel

6.1Block Diagram of Test Setup



6.2Limit

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

6.3 Test Procedure

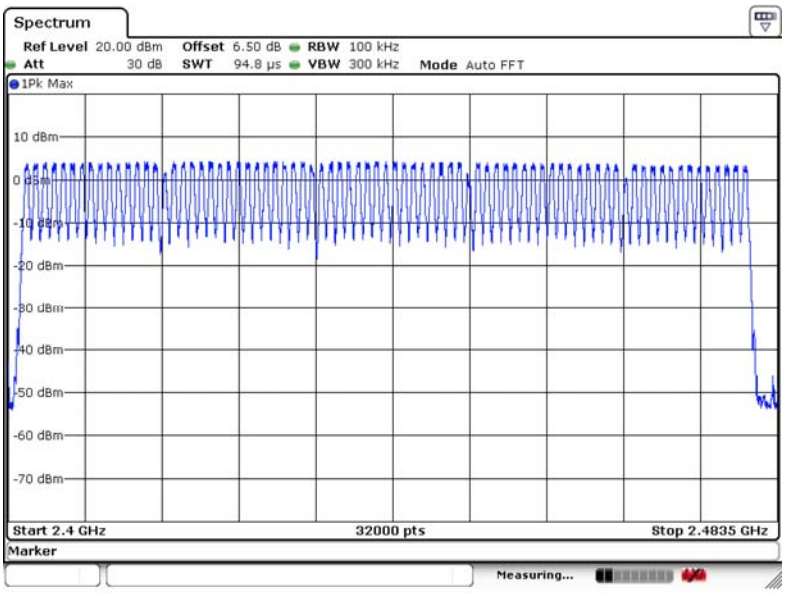
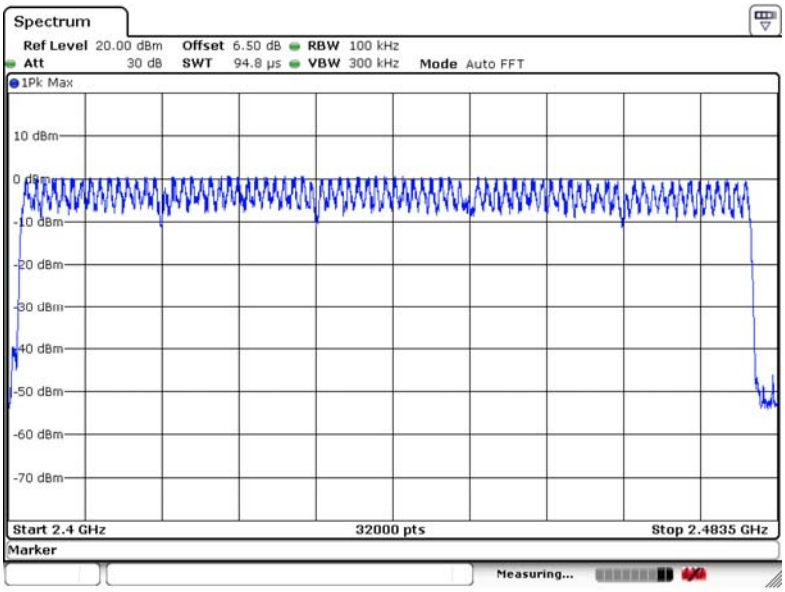
(1)Connect EUT's antenna output to spectrum analyzer by RF cable

(2) The carrier frequency was measured by spectrum analyzer with 100 kHz RBW and 300 kHz VBW

6.4 Test Result

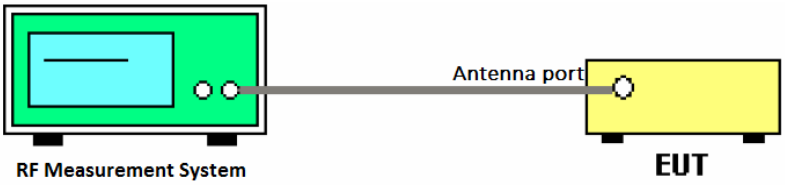
Mode	Number of hopping channel	Limit	Conclusion
GFSK	79CH	≥15CH	Pass
8DPSK	79CH	≥15CH	Pass

6.5 Original Test data

DH5-HOP	
3DH5-HOP	

7. Dwell Time

7.1Block Diagram of Test Setup



7.2Limit

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

7.3 Test Procedure

(1)Connect EUT's antenna output to spectrum analyzer by RF cable

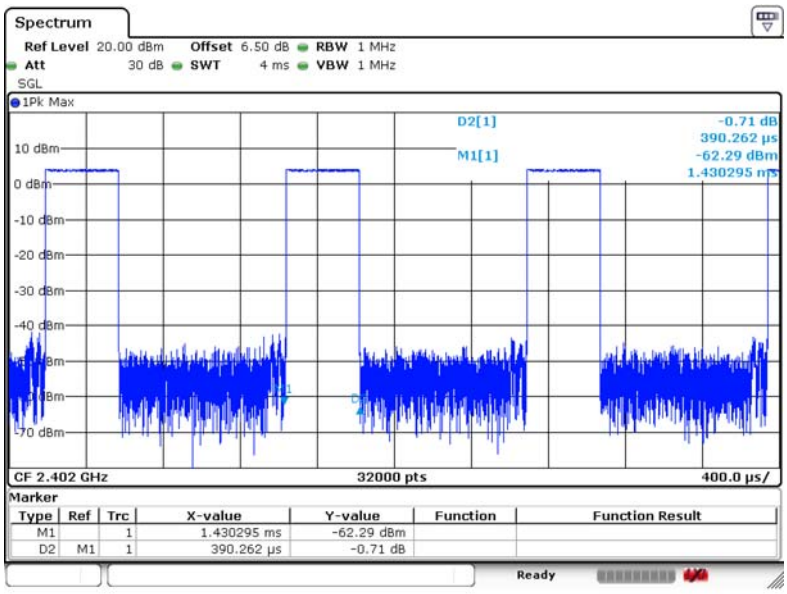
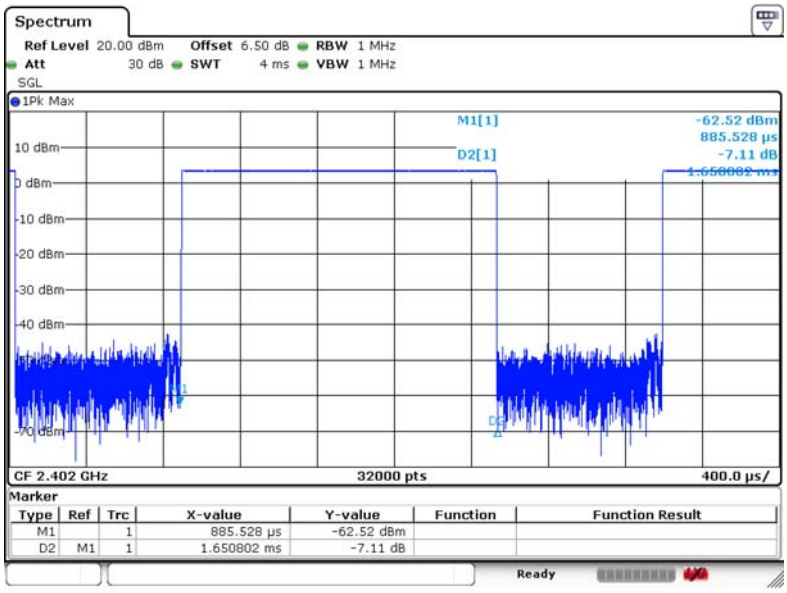
(2)The test period: T=0.4 second/channel*79 channel=31.6s

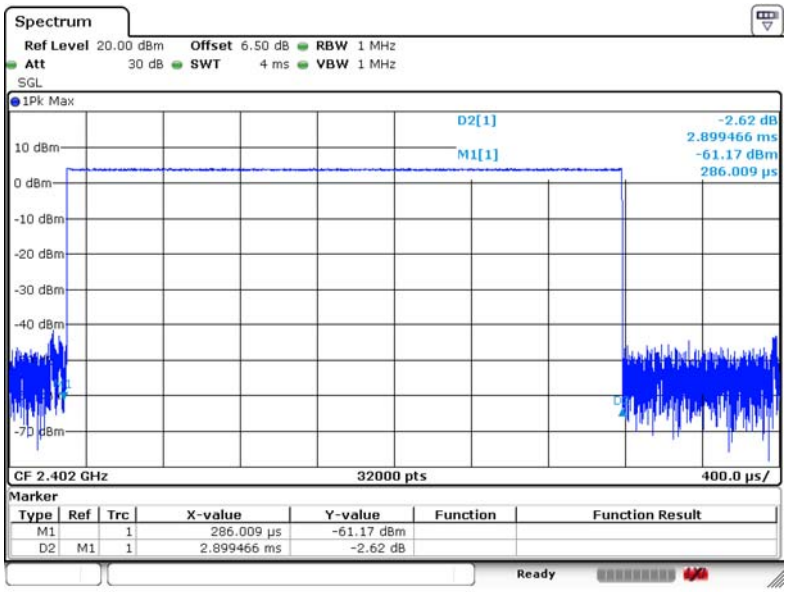
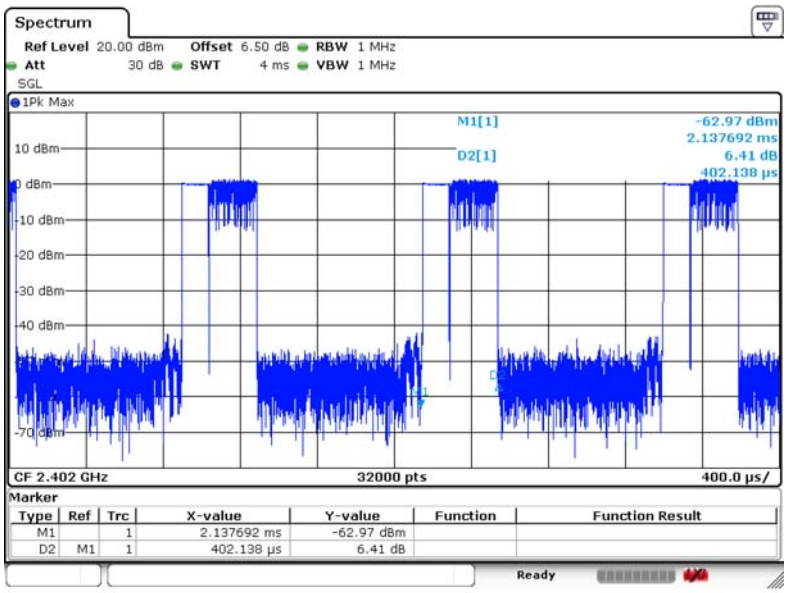
(3) The Measure the hopping number and on time of each pulse with spectrum analyzer in zero span set, and calculate dwell time with formula Dwell time=total hops*pulse's on time.

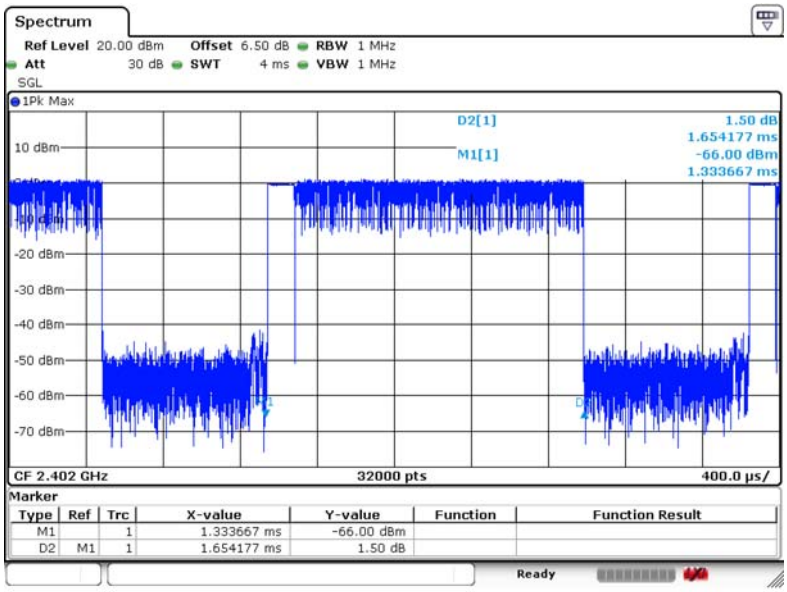
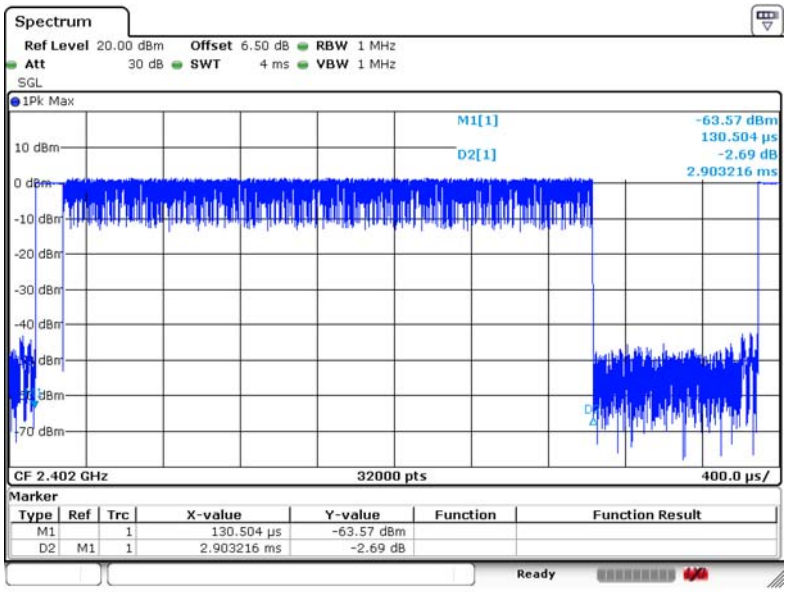
7.4 Test Result

Mode	Dwell time(ms)	Pulse's on time(ms)	Limit	Conclusion
DH1	124.800	0.390	<400ms	Pass
DH3	264.160	1.651	<400ms	Pass
DH5	309.227	2.899	<400ms	Pass
3DH1	128.640	0.402	<400ms	Pass
3DH3	264.640	1.654	<400ms	Pass
3DH5	309.653	2.903	<400ms	Pass
Remark: Dwell time = total hops *pulse's on time.				

7.5 Original Test data

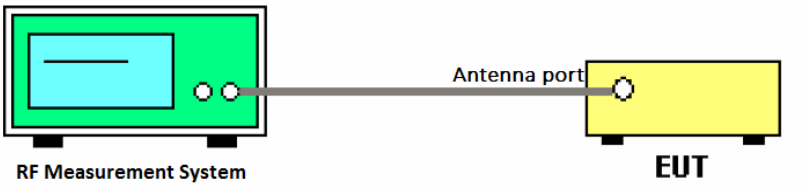
DH1-HOP	
DH3-HOP	

DH5-HOP	
3DH1-HOP	

3DH3-HOP	
3DH5-HOP	

8. Band Edge Compliance (conducted method)

8.1Block Diagram of Test Setup



8.2Limit

All restriction band should comply with 15.209, other emission should be at least 20dB below the fundamental.

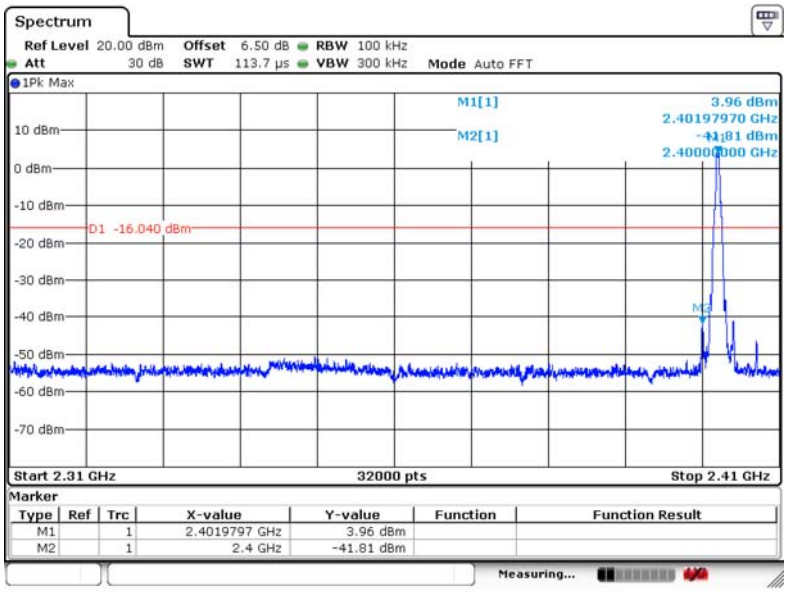
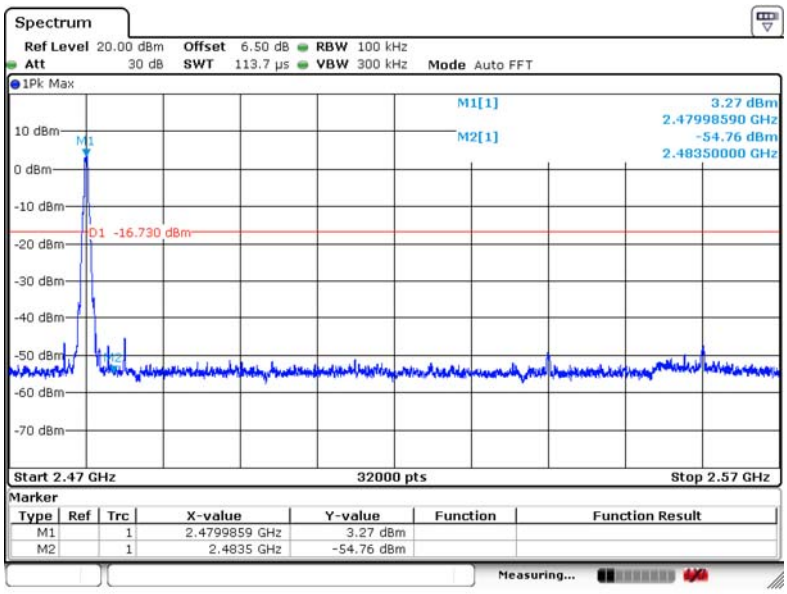
8.3 Test Procedure

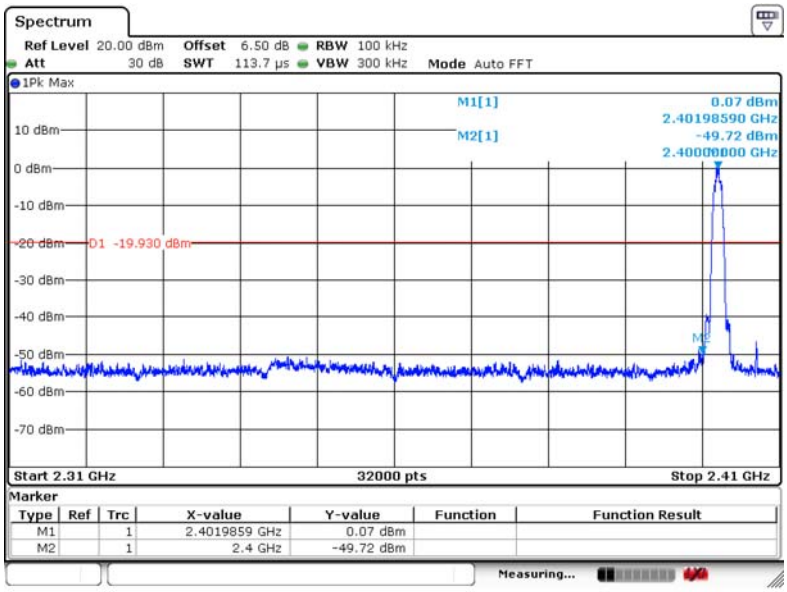
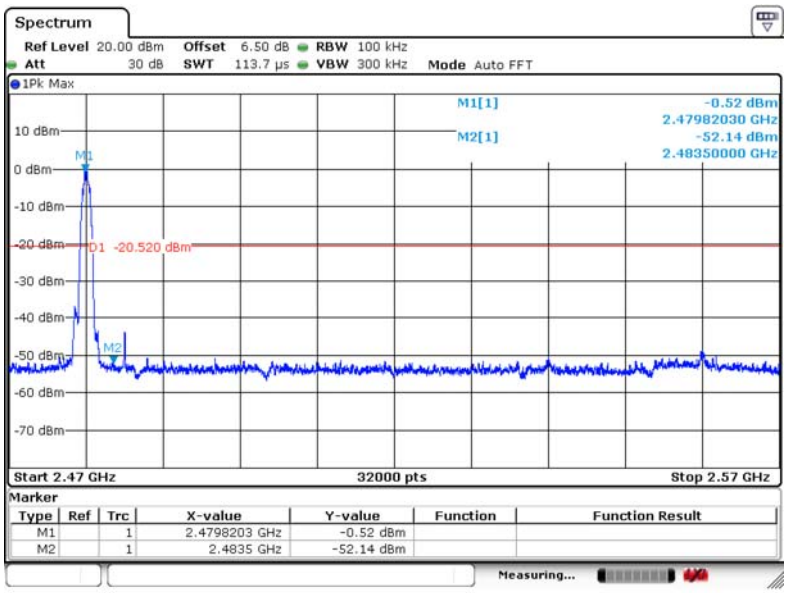
(1)Connect EUT's antenna output to spectrum analyzer by RF cable

8.4 Test Result

Mode	Frequency(MHz)	Conclusion
GFSK	Low 2402MHz	Pass
	High 2480MHz	Pass
8DPSK	Low 2402MHz	Pass
	High 2480MHz	Pass

8.5 Original Test data

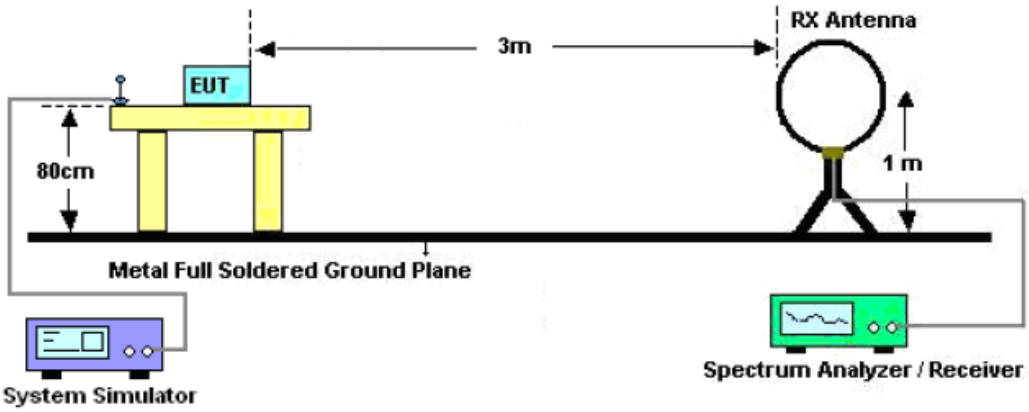
DH5-Low	
DH5-High	

3DH5-Low	
3DH5-High	

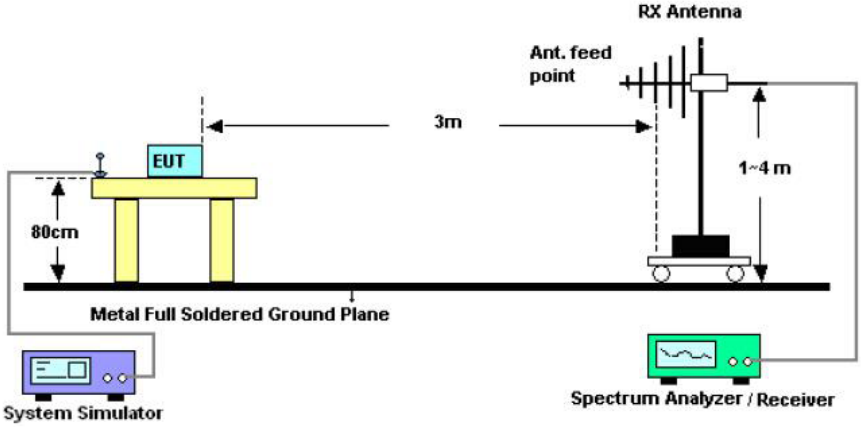
9. Radiated Emission

9.1Block Diagram of Test Setup

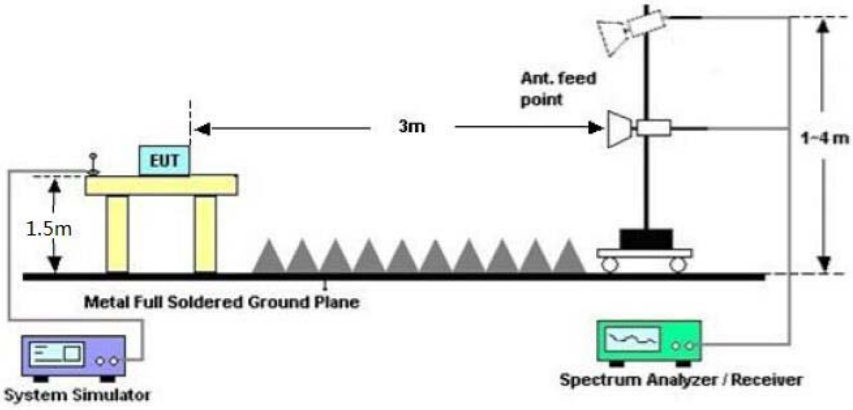
Radiated Emission Test-Setup Frequency Below 30MHz



Radiated Emission Test-Setup Frequency 30MHz-1000MHz



Radiated Emission Test-Setup Frequency Above 1000MHz



9.2 FCC 15.209 Limit

Frequency(MHz)	Distance Meters	Field Strengths Limit	
		μV/m	dB(μV)/m
0.009~0.490	300	2400/F(KHz)	67.6-20log(F)
0.490~1.705	30	24000/F(KHz)	87.6-20log(F)
1.705~30.0	30	30	29.54
30~88	3	100	40.0
88~216	3	150	43.5
216~960	3	200	46.0
960~1000	3	500	54.0
Above 1000	3	74.0dBμV/m—Peak 54.0 dBμV/m--Average	

Remark:
(1) The emission limits shown in the above table are based on measurements employing a CISPR QP detector except for the frequency bands 9-90kHz, 110-490kHz and above 1000MHz, radiated emissions limits in these three bands are based on measurements employing an average detector.

(2) At frequencies below 30MHz, measurement may be performed at a distance closer than that specified, and the limit at closer measurement distance can be extrapolated by below formula:

All restriction band should comply with 15.209, other emission should be at least 20dB below the fundamental.

$Limit_{3m}$ (dBuV/m)= $Limit_{30m}$(dBuV/m) + 40Log(30m/3m)

(3) Limit for this EUT

All the emissions appearing within 15.205 restricted frequency bands shall not exceed the limits shown in 15.209, all the other emissions shall be at least 20dB below the fundamental emissions or comply with 15.209 limits

9.3 Test Procedure

(1)EUT was place on a non-metallic table, 80 cm above the ground plane inside a semi-anechoic chamber for below 1G and 150 cm above the ground plane inside a semi-anechoic chamber for above 1G.

(2) Test antenna was located 3m from the EUT on an adjustable mast, and the antenna used asbelow table.

Test frequency range	Test antenna used	Test antenna distance
9kHz-30MHz	Active Loop antenna	3m
30MHz-1GHz	Trilog Broadband Antenna	3m
1GHz-18GHz	Double Ridged Horn Antenna(1GHz-18GHz)	3m
18GHz-40GHz	Horn Antenna(18GHz-40GHz)	3m

According ANSI C63.10:2013 clause 6.4.4.2 and 6,5.3, for measurements below 30 MHz, the loop antenna was positioned with its plane vertical from the EUT and rotated about its vertical axis for maximum response at each azimuth position around the EUT. And the loop antenna alsobe positioned with its plane horizontal at the specified distance from the EUT. The center of the loop is 1 m above the ground. for measurement above 30MHz, the trilog Broadband Antenna or Horn Antenna was located 3m from EUT, Measurements were made with the antenna positioned in both the horizontal and vertical planes of Polarization, and the measurement antenna was varied from 1 m to 4 m. in height above the reference ground plane to obtain the maximum signal strength.

(3) Below pre-scan procedure was first performed in order to find prominent frequency spectrum radiated emissions from 9 kHz to 25 GHz:

(a) Scanning the peak frequency spectrum with the antenna specified in step (3), and the EUT was rotated 360 degree, the antenna height was varied from 1m to 4m (Except loop antenna, it's fixed 1m above ground.)

(b) Change work frequency or channel of device if practicable.

(c) Change modulation type of device if practicable.

(d) Change power supply range from 85% to 115% of the rated supply voltage

(e) Rotated EUT though three orthogonal axes to determine the attitude of EUT arrangement produces highest emissions.

Spectrum frequency from 9 kHz to 25 GHz (tenth harmonic of fundamental frequency) was investigated, and no any obvious emission were detected from 18 GHz to 25 GHz, so below final test was performed with frequency range from 9 kHz to 18 GHz.

(4) For final emissions measurements at each frequency of interest, the EUT was rotated and the antenna height was varied between 1m and 4m in order to maximize the emission. Measurements in both horizontal and vertical polarities were made and the data was recorded. In order to find the maximum emission, the relative positions of equipment and all of the interface cables were changed according to ANSI C63.10:2013 on Radiated Emission test.

(5) The emissions from 9 kHz to 1GHz were measured based on CISPR QP detector except for the frequency bands 9-90 kHz, 110-490 kHz, for emissions from 9 kHz-90 kHz,110 kHz-490 kHz and above 1 GHz were measured based on average detector, for emissions above 1 GHz, peak emissions also be measured and need comply with Peak limit.

(6) The emissions from 9 kHz to 1 GHz, QP or average values were measured with EMI receiver with below

RBW

Frequency band	RBW
9 kHz-150 kHz	200 Hz
150 kHz-30 MHz	9 kHz
30 MHz-1 GHz	120 kHz

(7) For emissions above 1GHz, both Peak and Average level were measured with Spectrum Analyzer, and the RBW is set at 1 MHz, VBW is set at 3 MHz for Peak measure; RBW 1 MHz VBW 10 Hz for Average measure (according ANSI C63.10:2013 clause 4.1.4.2.2 procedure for average measure).

(8) X axis, Y axis, Z axis are tested, and worse setup X axis is reported

9.4 Test Result

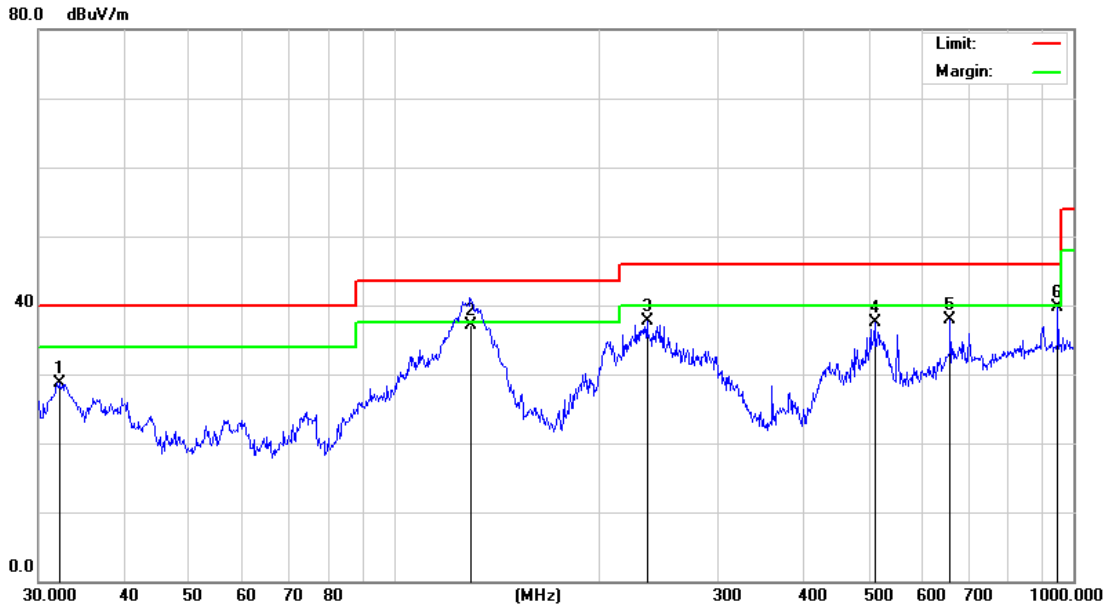
Pass

All the emissions except fundamental emission from 9 kHz to 25 GHz were comply with 15.209 limits.

Note1: According exploratory test no any obvious emission was detected from 9 kHz to 30 MHz and 18 GHz to 25 GHz.

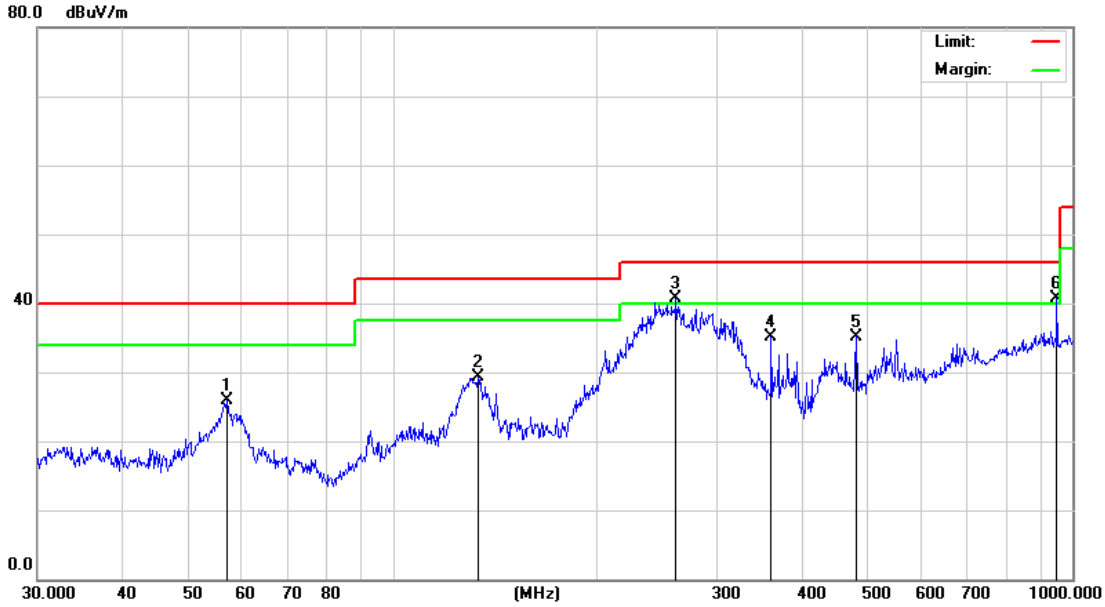
Note2: For emissions below 1GHz, according exploratory explorer test, when change Tx mode and channel, have no distinct influence on emissions level, so for emissions below 1 GHz, the final test was only performed with EUT working in 8DPSK, Tx 2441 MHz mode.

Note3: For emissions above 1 GHz. If peak results comply with AV limit, AV Result is deemed to comply with AV limit.



Vertical

Horizontal


80.0 dBuV/m
Limit:
Margin:
40
0.0
1
2
3
4
5
6
30.000
40
50
60
70
80
(MHz)
300
400
500
600
700
1000.000

2.1 TEST RESULT AND DATA (BETWEEN 1~25 GHZ)

Power :	7.4V from battery	Pol/Phase :	HORIZONTAL
Test Mode 1 :	TX 1Mbps CH0	Temperature :	20 °C
Memo :		Humidity :	59 %

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4804.000	48.41	5.06	53.47	74.00	-20.53	peak
4804.000	39.26	5.06	44.32	54.00	-9.68	AVG
7206.000	42.97	7.03	50.00	74.00	-24.00	peak
7206.000	32.52	7.03	39.55	54.00	-14.45	AVG
9608.000	40.31	10.63	50.94	74.00	-23.06	peak
9608.000	30.39	10.63	41.02	54.00	-12.98	AVG

Power :	7.4V from battery	Pol/Phase :	VERTICAL
Test Mode 1 :	TX 1Mbps CH0	Temperature :	20 °C
Memo :		Humidity :	59 %

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4804.000	47.52	5.06	52.58	74.00	-21.42	peak
4804.000	37.87	5.06	42.93	54.00	-11.07	AVG
7206.000	43.16	7.03	50.19	74.00	-23.81	peak
7206.000	32.45	7.03	39.48	54.00	-14.52	AVG
9608.000	39.89	10.63	50.52	74.00	-23.48	peak
9608.000	30.42	10.63	41.05	54.00	-12.95	AVG

Note:
The disturbance above 18GHz was very low, and the above harmonics were the highest point could be found when testing, so only the above harmonics had been displayed.

Power :	7.4V from battery	Pol/Phase :	HORIZONTAL
Test Mode 1 :	TX 1Mbps CH39	Temperature :	20 °C
Memo :		Humidity :	59 %

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4882.000	47.93	5.14	53.07	74.00	-20.93	peak
4882.000	37.48	5.14	42.62	54.00	-11.38	AVG
7323.000	43.16	7.54	50.70	74.00	-23.30	peak
7323.000	33.52	7.54	41.06	54.00	-12.94	AVG
9764.000	39.74	11.39	51.13	74.00	-22.87	peak
9764.000	30.63	11.39	42.02	54.00	-11.98	AVG

Power :	7.4V from battery	Pol/Phase :	VERTICAL
Test Mode 1 :	TX 1Mbps CH39	Temperature :	20 °C
Memo :		Humidity :	59 %

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4882.000	47.74	5.14	52.88	74.00	-21.12	peak
4882.000	37.42	5.14	42.56	54.00	-11.44	AVG
7323.000	42.65	7.54	50.19	74.00	-23.81	peak
7323.000	32.25	7.54	39.79	54.00	-14.21	AVG
9764.000	40.13	11.39	51.52	74.00	-22.48	peak
9764.000	30.42	11.39	41.81	54.00	-12.19	AVG

Note:
The disturbance above 18GHz was very low, and the above harmonics were the highest point could be found when testing, so only the above harmonics had been displayed.

Power :	7.4V from battery	Pol/Phase :	HORIZONTAL
Test Mode 1 :	TX 1Mbps CH78	Temperature :	20 °C
Memo :		Humidity :	59 %

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4960.000	47.52	5.22	52.74	74.00	-21.26	peak
4960.000	37.46	5.22	42.68	54.00	-11.32	AVG
7440.000	40.98	8.06	49.04	74.00	-24.96	peak
7440.000	33.36	8.06	41.42	54.00	-12.58	AVG
9920.000	40.24	12.1	52.34	74.00	-21.66	peak
9920.000	30.15	12.1	42.25	54.00	-11.75	AVG

Power :	7.4V from battery	Pol/Phase :	VERTICAL
Test Mode 1 :	TX 1Mbps CH78	Temperature :	20 °C
Memo :		Humidity :	59 %

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4960.000	47.87	5.22	53.09	74.00	-20.91	peak
4960.000	37.49	5.22	42.71	54.00	-11.29	AVG
7440.000	42.52	8.06	50.58	74.00	-23.42	peak
7440.000	32.41	8.06	40.47	54.00	-13.53	AVG
9920.000	40.33	12.1	52.43	74.00	-21.57	peak
9920.000	30.27	12.1	42.37	54.00	-11.63	AVG

Note:
The disturbance above 18GHz was very low, and the above harmonics were the highest point could be found when testing, so only the above harmonics had been displayed.

Power :	7.4V from battery	Pol/Phase :	HORIZONTAL
Test Mode 1 :	TX 3Mbps CH0	Temperature :	20 °C
Memo :		Humidity :	59 %

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4804.000	47.58	5.06	52.64	74.00	-21.36	peak
4804.000	37.96	5.06	43.02	54.00	-10.98	AVG
7206.000	42.53	7.03	49.56	74.00	-24.44	peak
7206.000	32.87	7.03	39.90	54.00	-14.10	AVG
9608.000	40.16	10.63	50.79	74.00	-23.21	peak
9608.000	30.49	10.63	41.12	54.00	-12.88	AVG

Power :	7.4V from battery	Pol/Phase :	VERTICAL
Test Mode 1 :	TX 3Mbps CH0	Temperature :	20 °C
Memo :		Humidity :	59 %

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4804.000	48.75	5.06	53.81	74.00	-20.19	peak
4804.000	37.25	5.06	42.31	54.00	-11.69	AVG
7206.000	42.63	7.03	49.66	74.00	-24.34	peak
7206.000	32.49	7.03	39.52	54.00	-14.48	AVG
9608.000	40.25	10.63	50.88	74.00	-23.12	peak
9608.000	30.58	10.63	41.21	54.00	-12.79	AVG

Note:
The disturbance above 18GHz was very low, and the above harmonics were the highest point could be found when testing, so only the above harmonics had been displayed.

Power :	7.4V from battery	Pol/Phase :	HORIZONTAL
Test Mode 1 :	TX 3Mbps CH39	Temperature :	20 °C
Memo :		Humidity :	59 %

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4882.000	46.99	5.14	52.13	74.00	-21.87	peak
4882.000	36.48	5.14	41.62	54.00	-12.38	AVG
7323.000	41.25	7.54	48.79	74.00	-25.21	peak
7323.000	31.42	7.54	38.96	54.00	-15.04	AVG
9764.000	38.49	11.39	49.88	74.00	-24.12	peak
9764.000	29.63	11.39	41.02	54.00	-12.98	AVG

Power :	7.4V from battery	Pol/Phase :	VERTICAL
Test Mode 1 :	TX 3Mbps CH39	Temperature :	20 °C
Memo :		Humidity :	59 %

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4882.000	47.16	5.14	52.30	74.00	-21.70	peak
4882.000	37.49	5.14	42.63	54.00	-11.37	AVG
7323.000	42.35	7.54	49.89	74.00	-24.11	peak
7323.000	31.48	7.54	39.02	54.00	-14.98	AVG
9764.000	38.99	11.39	50.38	74.00	-23.62	peak
9764.000	30.16	11.39	41.55	54.00	-12.45	AVG

Note:
The disturbance above 18GHz was very low, and the above harmonics were the highest point could be found when testing, so only the above harmonics had been displayed.

Power :	7.4V from battery	Pol/Phase :	HORIZONTAL
Test Mode 1 :	TX 3Mbps CH78	Temperature :	20 °C
Memo :		Humidity :	59 %

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4960.000	47.14	5.22	52.36	74.00	-21.64	peak
4960.000	37.63	5.22	42.85	54.00	-11.15	AVG
7440.000	41.25	8.06	49.31	74.00	-24.69	peak
7440.000	31.56	8.06	39.62	54.00	-14.38	AVG
9920.000	40.14	12.10	52.24	74.00	-21.76	peak
9920.000	30.02	12.10	42.12	54.00	-11.88	AVG

Power :	7.4V from battery	Pol/Phase :	VERTICAL
Test Mode 1 :	TX 3Mbps CH78	Temperature :	20 °C
Memo :		Humidity :	59 %

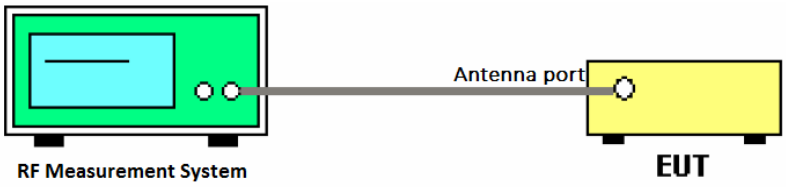
Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4960.000	47.89	5.22	53.11	74.00	-20.89	peak
4960.000	37.63	5.22	42.85	54.00	-11.15	AVG
7440.000	41.47	8.06	49.53	74.00	-24.47	peak
7440.000	31.85	8.06	39.91	54.00	-14.09	AVG
9920.000	39.44	12.10	51.54	74.00	-22.46	peak
9920.000	29.91	12.10	42.01	54.00	-11.99	AVG

Note:

1. The disturbance above 18GHz was very low, and the above harmonics were the highest point could be found when testing, so only the above harmonics had been displayed.
2. GFSK, Pi/4 DQPSK,8DPSK all have been tested, only report worse case GFSK, 8DPSK is reported.

10. Conducted Spurious Emissions

10.1Block Diagram of Test Setup



10.2Limit

In any 100 kHz 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 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power

10.3 Test Procedure

(1)Connect EUT's antenna output to spectrum analyzer by RF cable.
(2) Establish a reference level by using the following procedure:

Center frequency	Test frequency
RBW:	100 kHz
VBW:	300 kHz
Span	Wide enough to capture the peak level of the in-band emission
Detector Mode:	Peak
Sweep time:	auto
Trace mode	Max hold

(3) Allow the trace to stabilize, use the peak marker function to determine the maximum peak power level to establish the reference level

(4)Set the spectrum analyzer as follows:

RBW:	100 kHz
VBW:	300 kHz
Span	Encompass frequency range to be measured
Number of measurement points	≥span/RBW
Detector Mode:	peak
Sweep time:	auto
Trace mode	Max hold

(5)Allow the trace to stabilize, use the peak marker function to determine the maximum amplitude of all unwanted emissions outside of the authorized frequency band

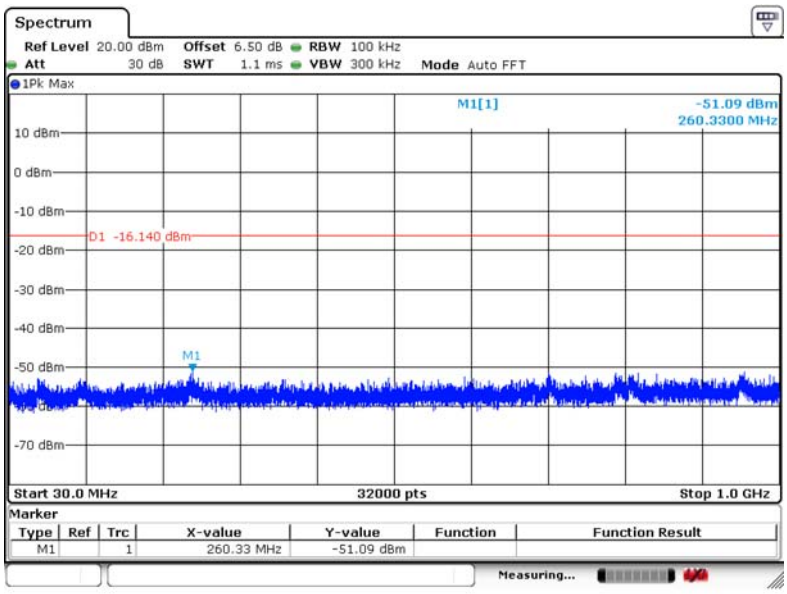
10.4 Test Result

Mode	Frequency(MHz)	Conclusion
GFSK	Low 2402MHz	Pass
	Middle 2441MHz	Pass
	High 2480MHz	Pass
8DPSK	Low 2402MHz	Pass
	Middle 2441MHz	Pass
	High 2480MHz	Pass

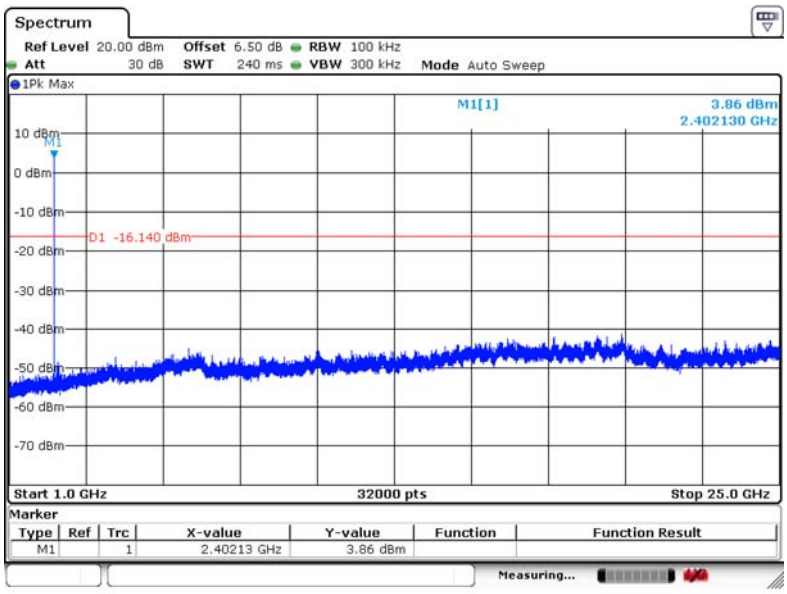
10.5 Original Test data

DH5-Low

2402MHz



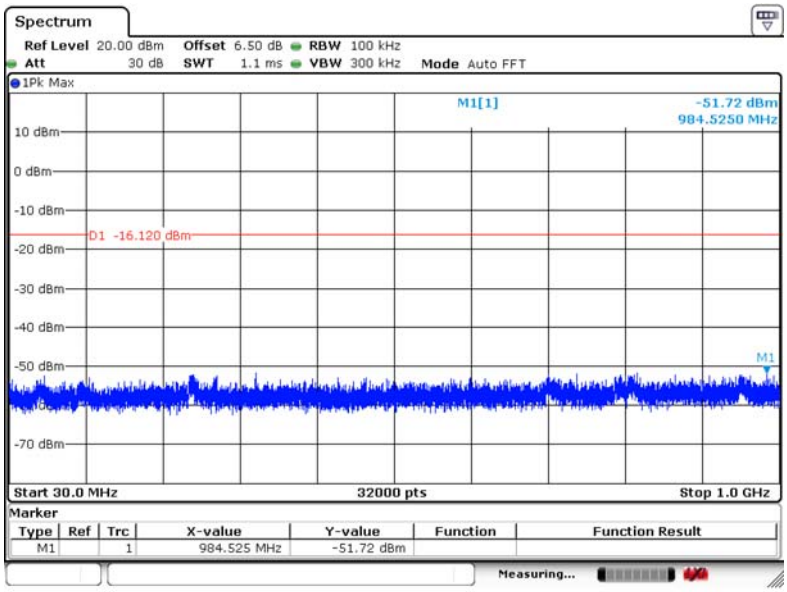
2402MHz_30~1000



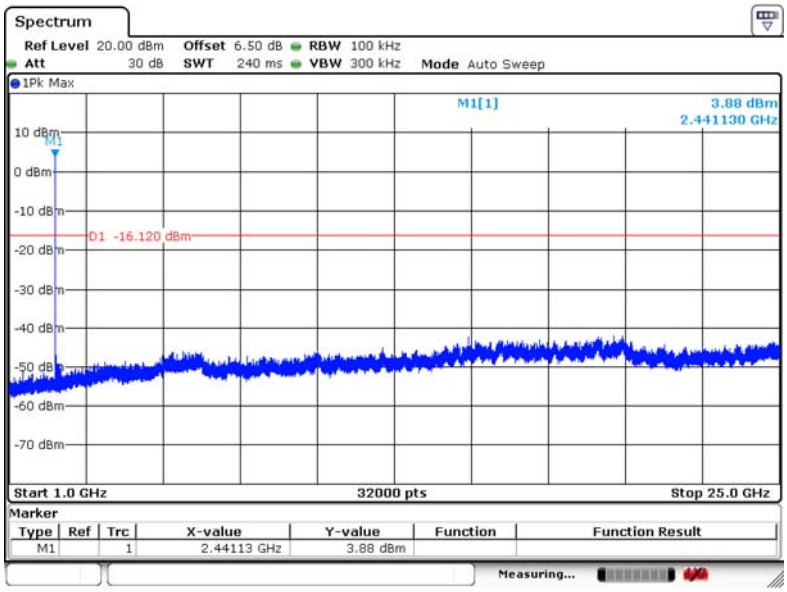
2402MHz_1G~26.5GHz

DH5-Middle

2441MHz



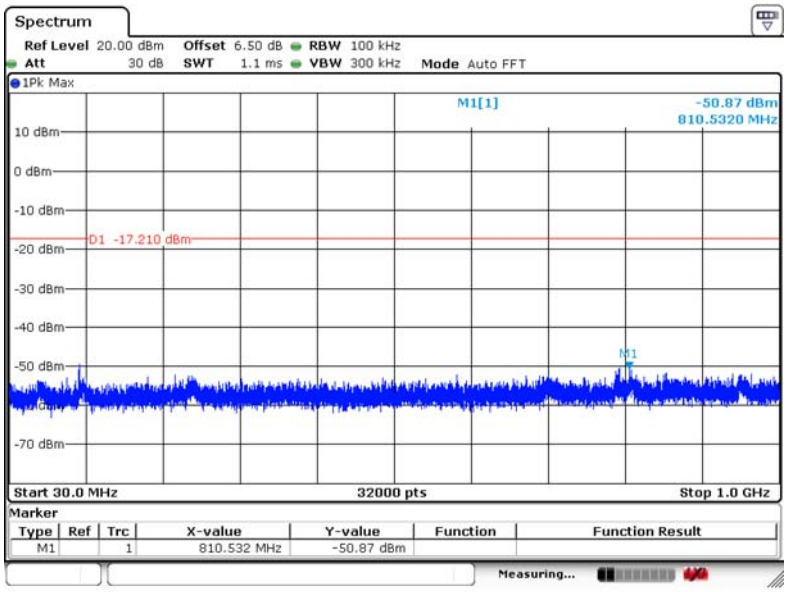
2441MHz_30~1000



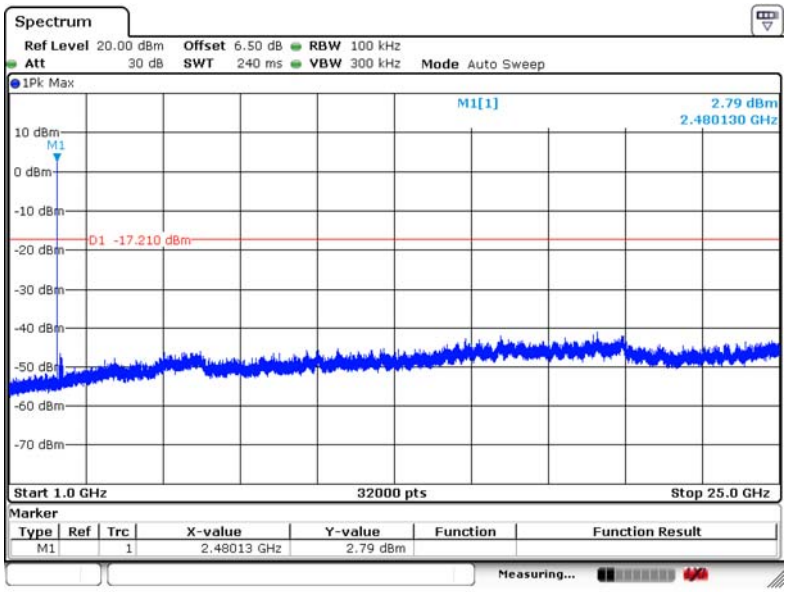
2441MHz_1G~26.5GHz

DH5-High

2480MHz



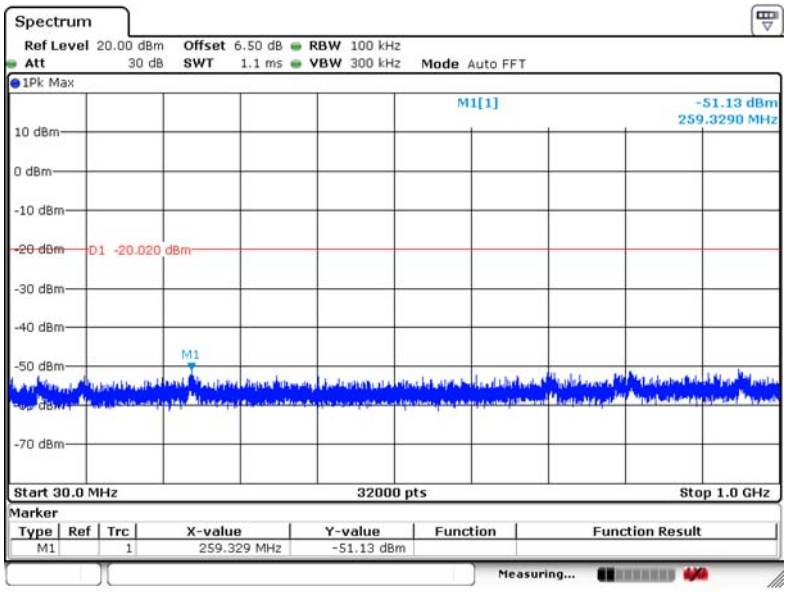
2480MHz_30~1000



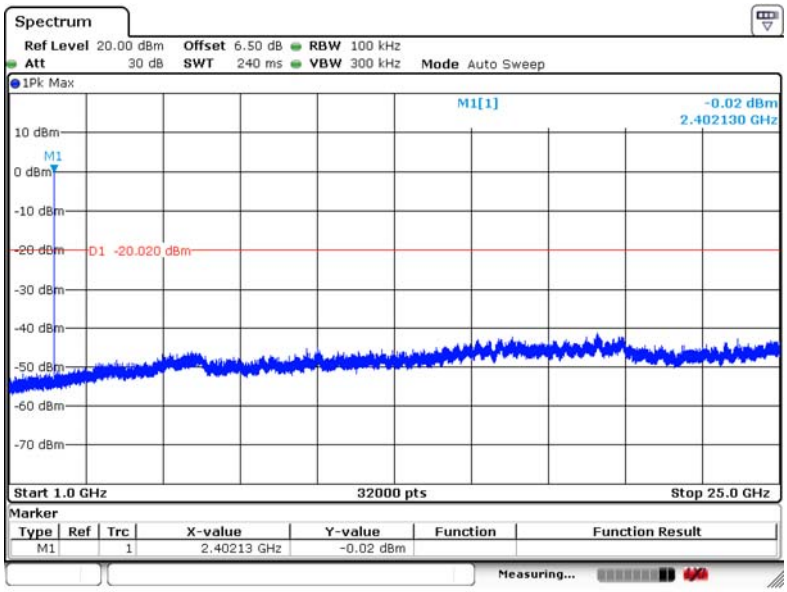
2480MHz_1G~26.5GHz

3DH5-Low

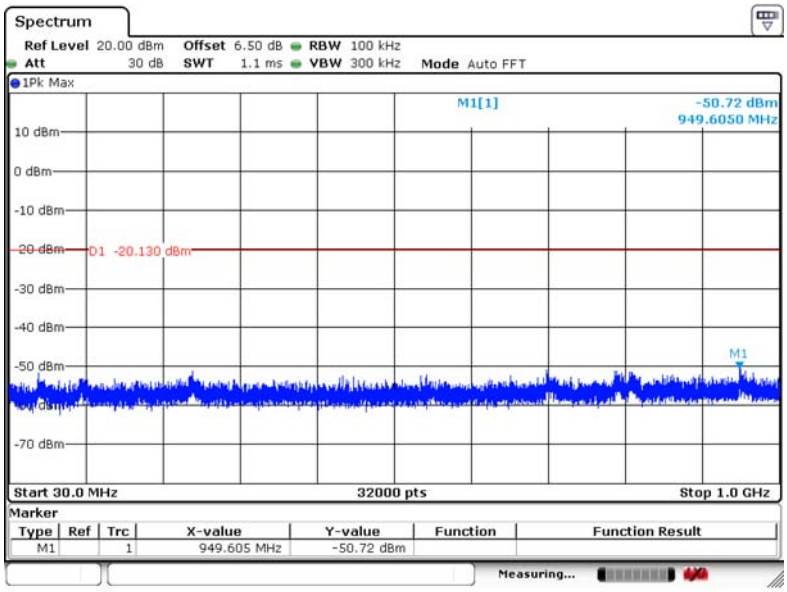
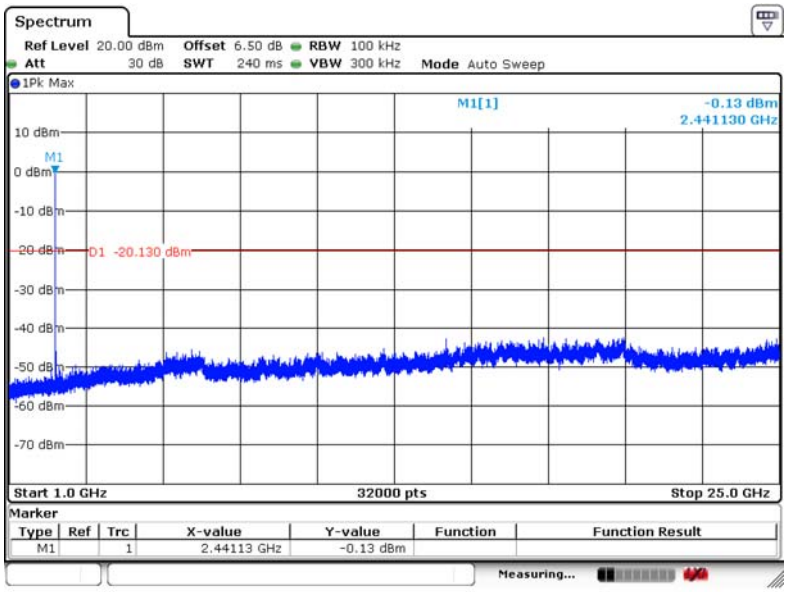
2402MHz



2402MHz_30~1000

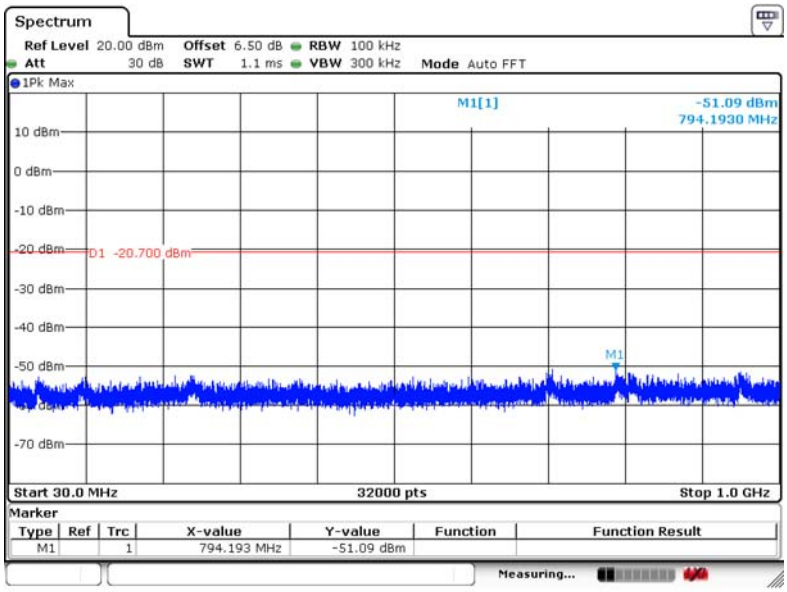


2402MHz_1G~26.5GHz

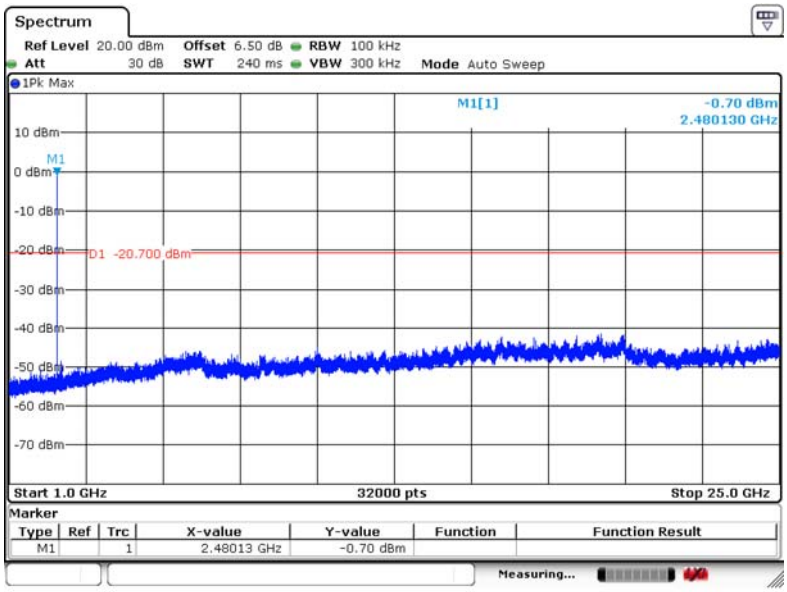
3DH5-Middle 2441MHz	 2441MHz_30~1000  2441MHz_1G~26.5GHz

3DH5-High

2480MHz



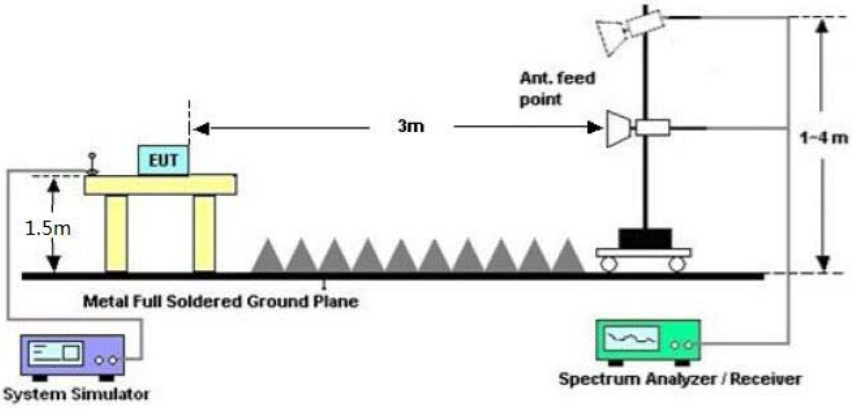
2480MHz_30~1000



2480MHz_1G~26.5GHz

11. Band Edge Compliance(radiated method)

11.1Block Diagram of Test Setup



11.2Limit

All restriction band should comply with 15.209, other emission should be at least 20dB below the fundamental.

11.3 Test Procedure

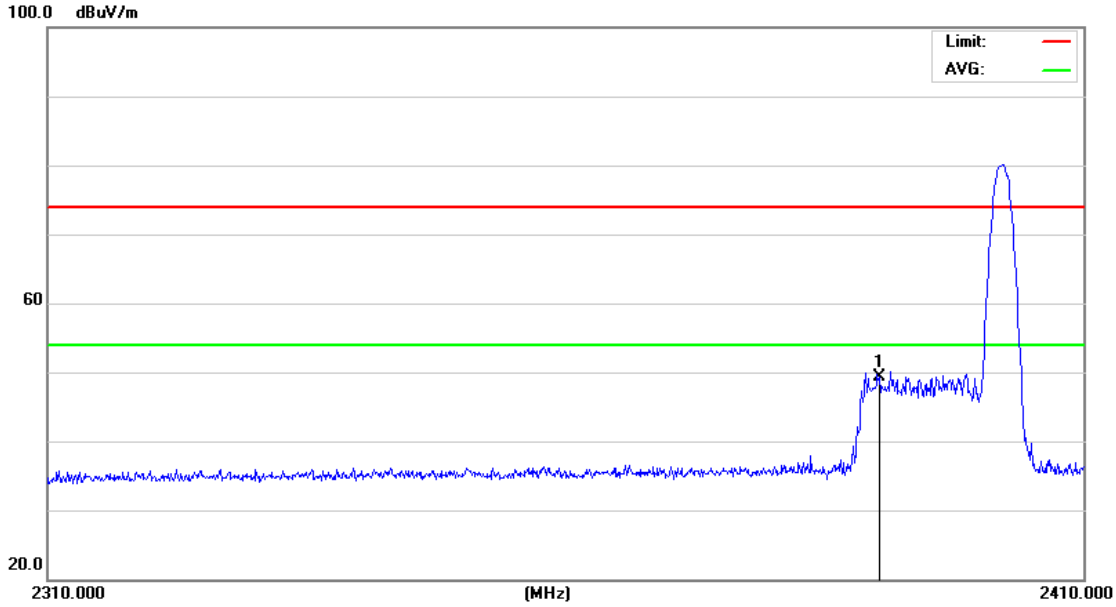
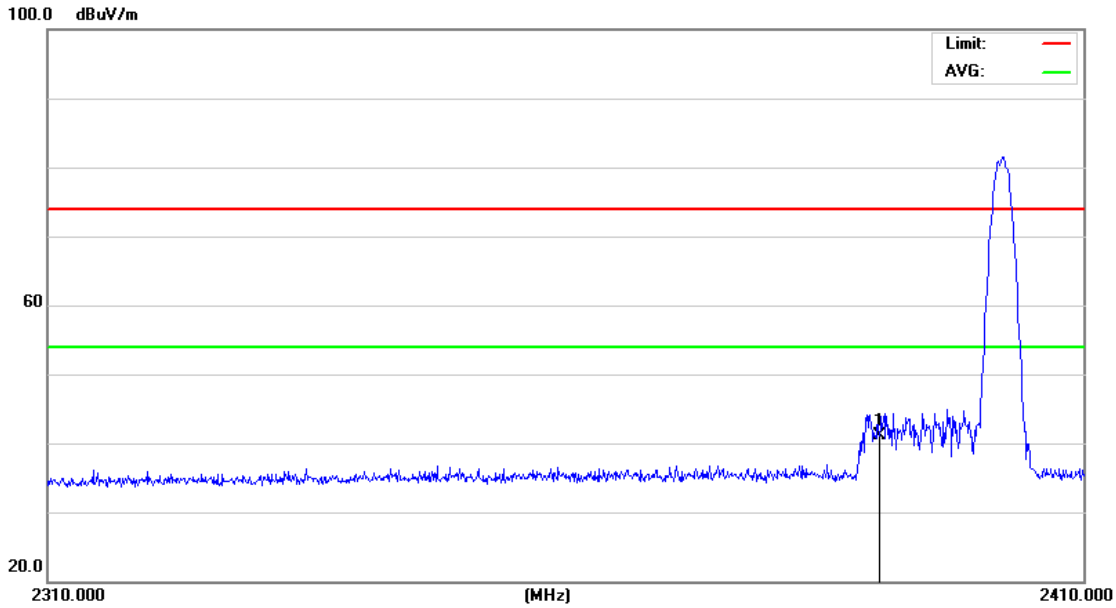
Same with clause 10.3 except change investigated frequency range from 2310 MHz to 2410 MHz and 2475 MHz to 2500 MHz.

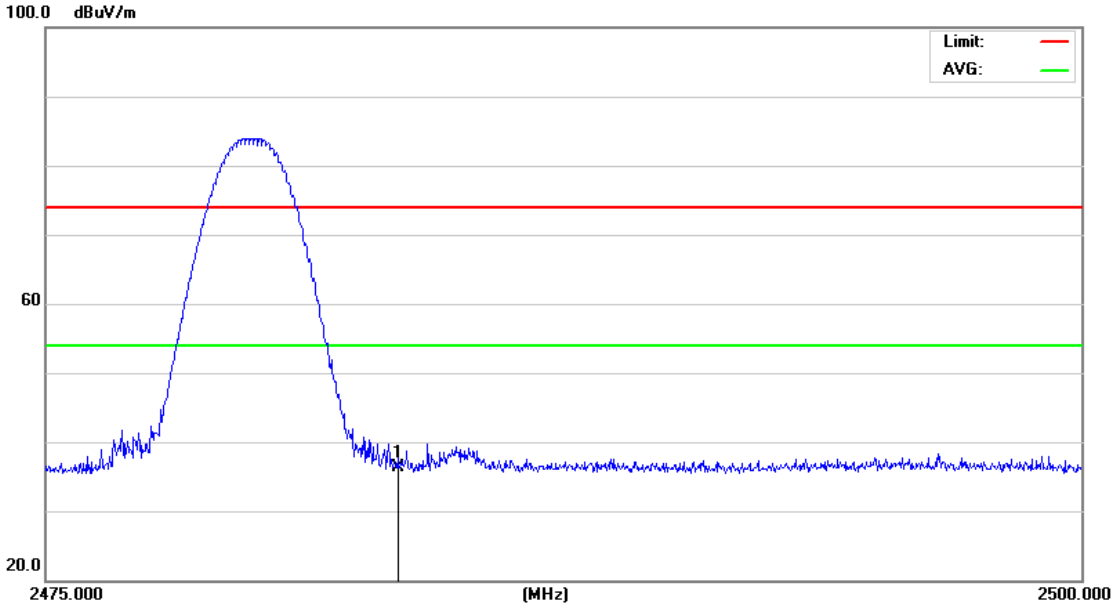
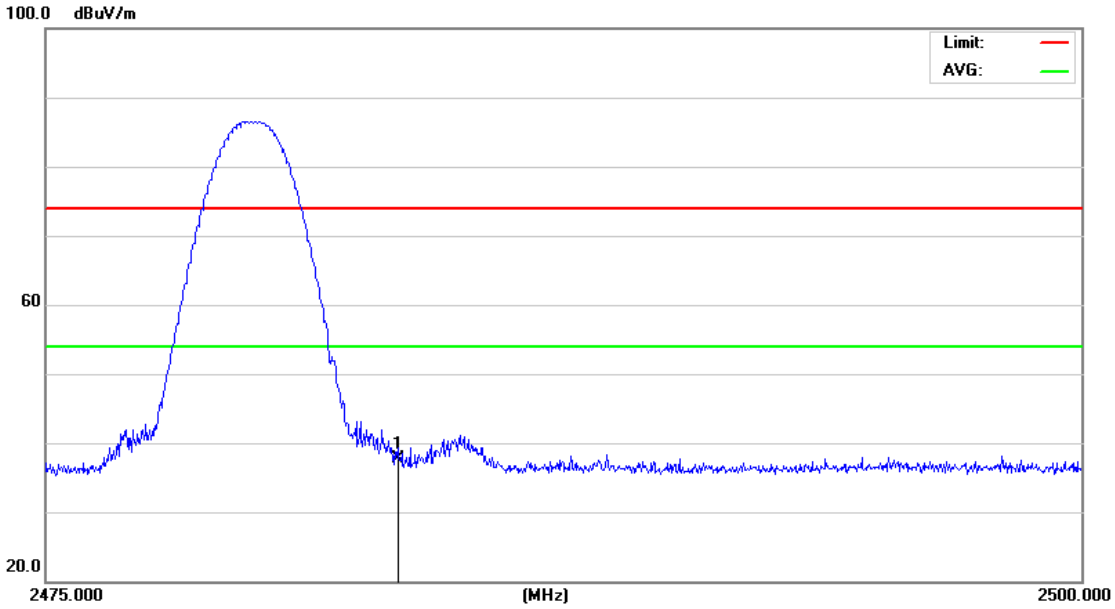
11.4 Test Result

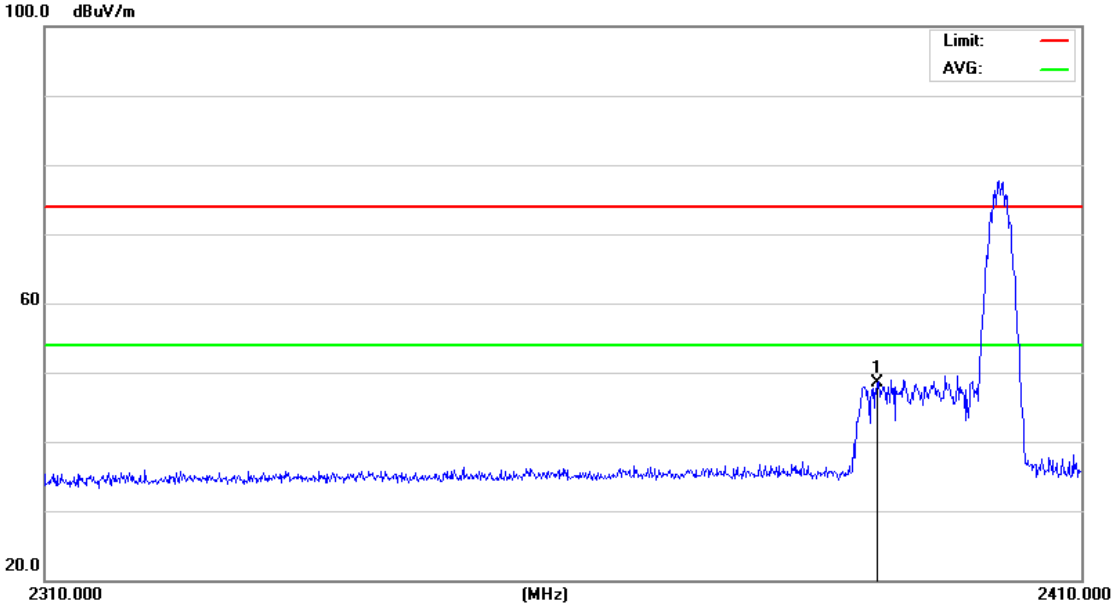
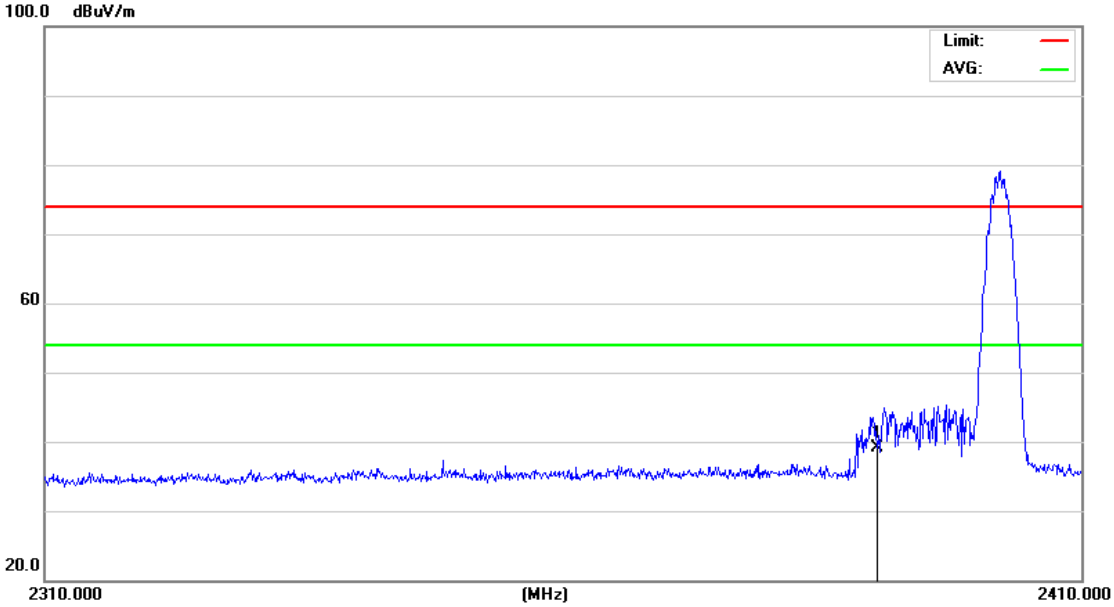
PASS. (See below detailed test result)

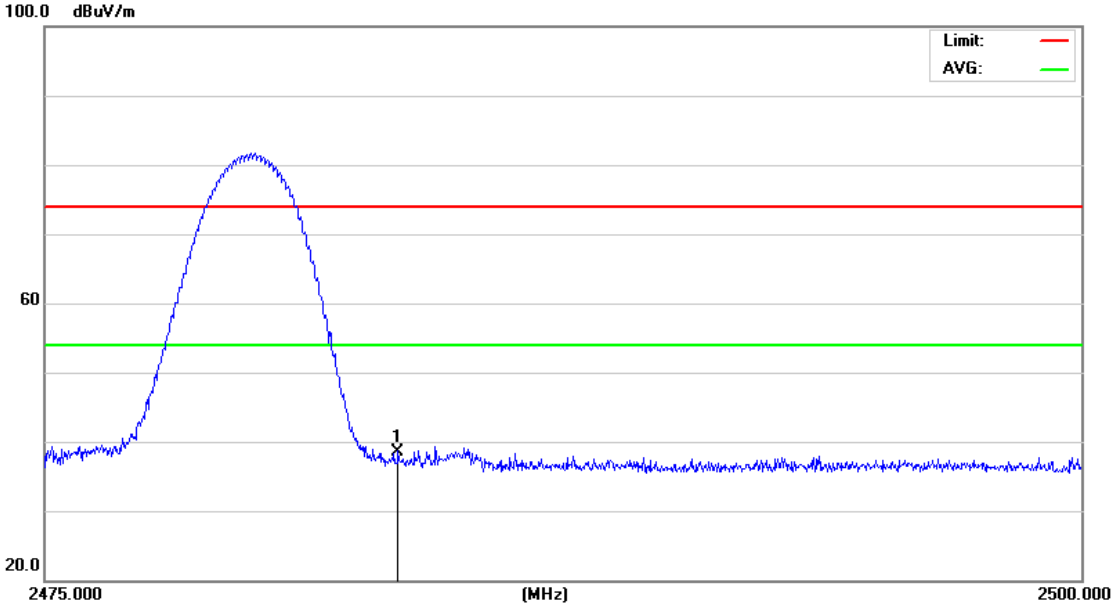
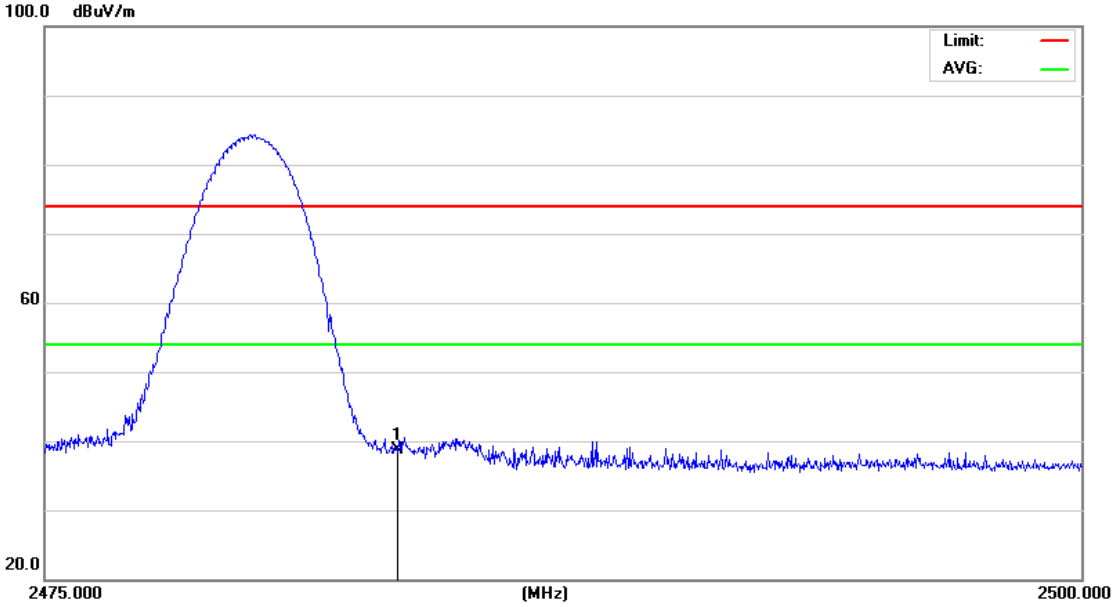
Remark: hopping on and hopping off mode all have been test, hopping off mode is worse and reported only.

11.5 Original Test data

DH5-Low 2402MHz	V  H 

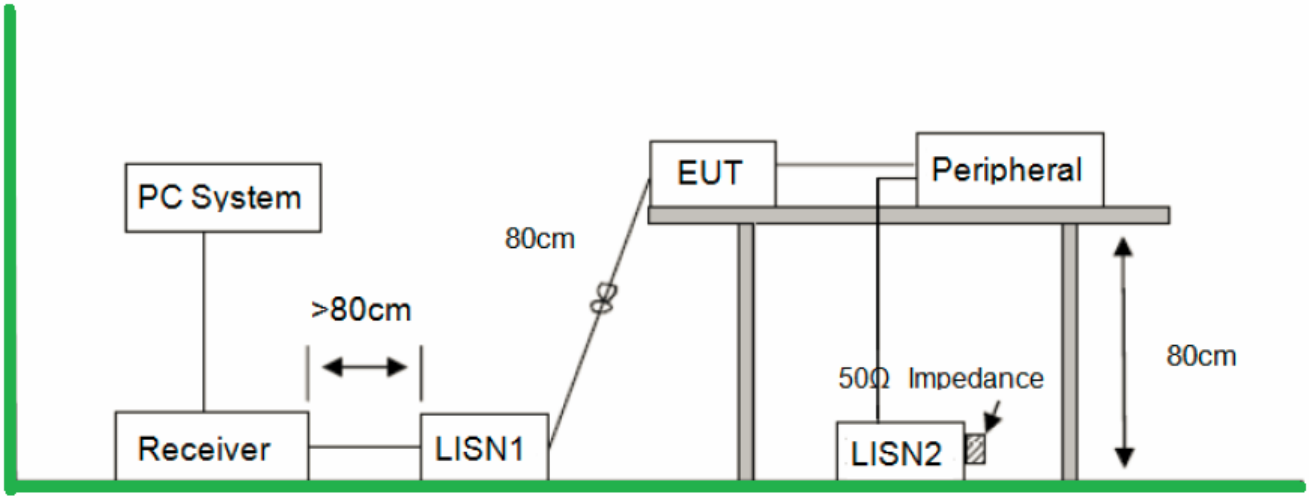
DH5-High 2480MHz	V  H 

3DH5-Low 2402MHz	V  H 

3DH5-High 2480MHz	V  H 

12. Power Line Conducted Emission

12.1Block Diagram of Test Setup



12.2Limit

Frequency	Quasi-Peak Level dB(μV)	Average Level dB(μV)
150KHz-500KHz	66 ~ 56*	56 ~ 46*
500KHz-5MHz	56	46
5MHz-30MHz	60	50

Note 1: * Decreasing linearly with logarithm of frequency.
Note 2: The lower limit shall apply at the transition frequencies

12.3 Test Procedure

The EUT and Support equipment, if needed, were put placed on a non-metallic table, 80cm above the ground plane.

Configuration EUT to simulate typical usage as described in clause 2.4 and test equipment as described in clause 10.2 of this report.

All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10.

All support equipment power received from a second LISN.

Emissions were measured on each current carrying line of the EUT using an EMI Test Receiver connected to the LISN powering the EUT.

The Receiver scanned from 150 kHz to 30MHz for emissions in each of the test modes.

During the above scans, the emissions were maximized by cable manipulation.

The test mode(s) described in clause 2.4 were scanned during the preliminary test.

After the preliminary scan, we found the test mode producing the highest emission level.

The EUT configuration and worse cable configuration of the above highest emission levels were recorded for reference of the final test.

EUT and support equipment were set up on the test bench as per the configuration with highest emission level in the preliminary test.

A scan was taken on both power lines, Neutral and Line, recording at least the six highest emissions.

Emission frequency and amplitude were recorded into a computer in which correction factors were used to calculate the emission level and compare reading to the applicable limit.

The test data of the worst-case condition(s) was recorded.

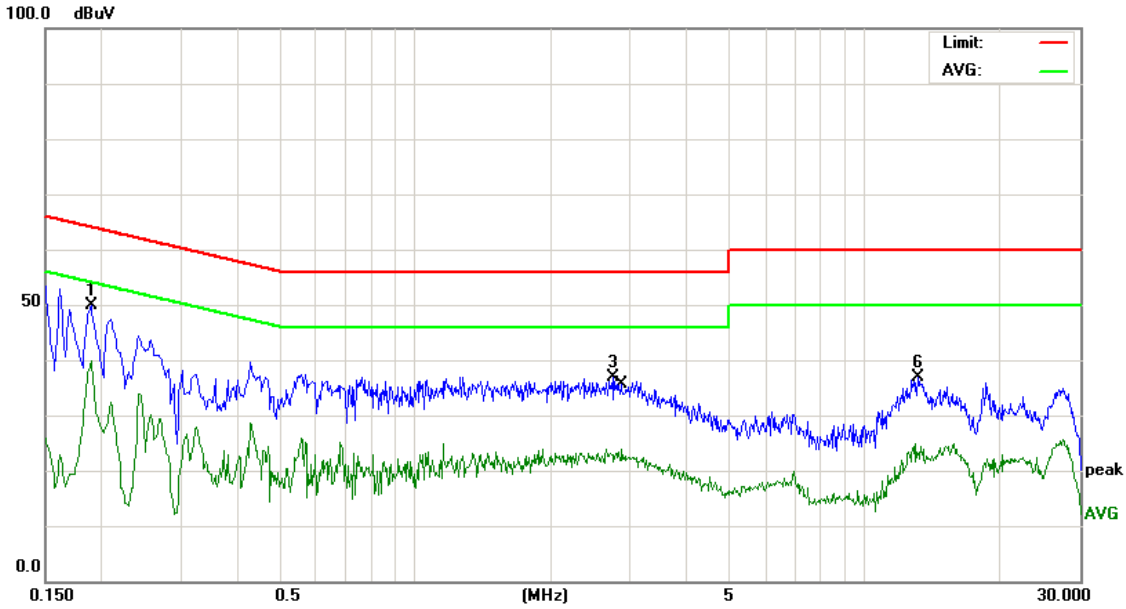
The bandwidth of test receiver is set at 9 kHz.

12.4 Test Result

PASS. (See below detailed test result)

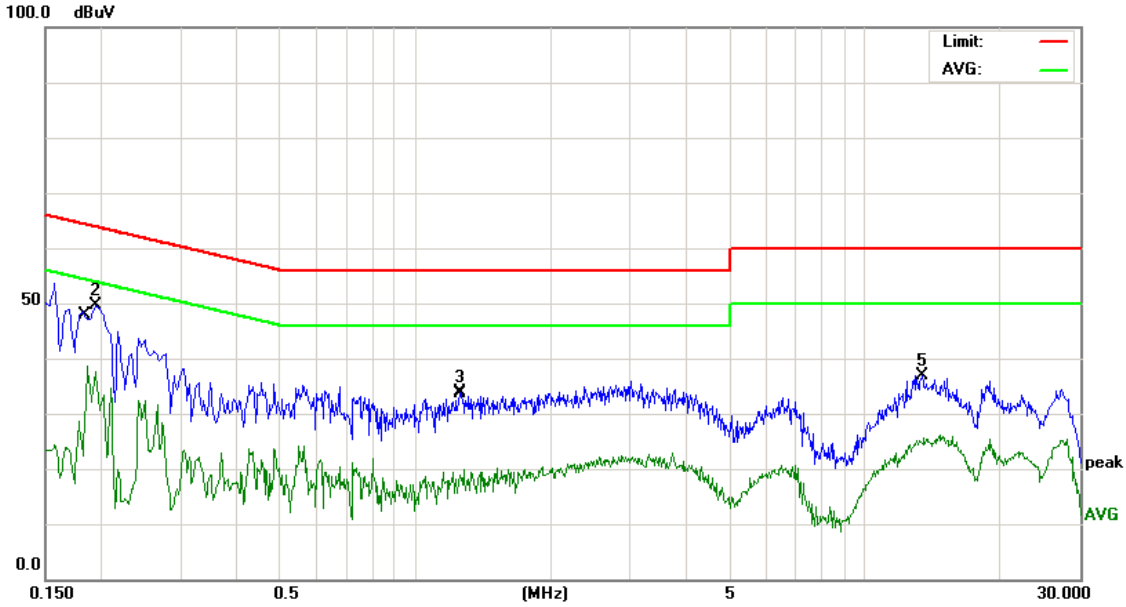
12.5 Original Test data

L



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector
1		0.1900	38.61	11.26	49.87	64.03	-14.16	peak
2	*	0.1900	28.67	11.26	39.93	54.03	-14.10	AVG
3		2.7380	26.86	9.98	36.84	56.00	-19.16	peak
4		2.8820	13.90	9.99	23.89	46.00	-22.11	AVG
5		12.9540	23.73	1.23	24.96	50.00	-25.04	AVG
6		13.0940	35.63	1.23	36.86	60.00	-23.14	peak

N



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector
1		0.1860	27.28	11.31	38.59	54.21	-15.62	AVG
2	*	0.1940	38.36	11.21	49.57	63.86	-14.29	peak
3		1.2579	23.88	9.92	33.80	56.00	-22.20	peak
4		1.2780	9.84	9.92	19.76	46.00	-26.24	AVG
5		13.3620	35.63	1.24	36.87	60.00	-23.13	peak
6		13.5420	24.40	1.24	25.64	50.00	-24.36	AVG

13. Antenna Requirements

13.1 Limit

For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. And according to FCC 47 CFR Section 15.247 (b), if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

13.2 Result

The antennas used for this product are FPCB antenna and that no antenna other than that furnished by the responsible party shall be used with the device, the maximum peak gain of the transmit antenna is only 2.0dBi.

※※※※※**END OF REPORT**※※※※※