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RF report for Wireless multiroom speaker
Models BM5B/37, BM5B/17, BM5C/37, BM5C/17, BM5W/37, BM5W/17

Guangzhou, date of issue: 2015-07-31

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By order of Gibson Innovations Limited at Hong Kong, China

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CONTENTS

1 CONCLUSION

The device under test (DUT) as mentioned in this report complies with the stated requirements of the FCC Part 15, Subpart C.

FCC ID: 2AANU-BM5

This report is based on the product operating at Bluetooth mode.

The test results in this report belong to model BM5B/37, and the results are also representative for other models.

The conclusion and results stated in this test report are based on a non-recurrent examination of sample(s) provided by the applicant.

2 SUMMARY

This chapter presents an overview of standards and results. Refer to the next chapters for details of measured test results and applied test levels.

2.1 Applied standards

Standard	Year	Title
FCC part 15, Subpart C	2014	Federal Communications Commission (FCC) – Radio Frequency Devices

2.2 Reference standards

Standard	Year	Title
ANSI C63.10	2013	American National Standard for Testing Unlicensed Wireless Devices

2.3 Overview of results

Test Item	Standard	Result
Maximum Peak Output Power	FCC Part 15: 15.247(b)(1) ANSI C63.10: 2013	PASS
20 dB Bandwidth	FCC Part 15: 15.215 ANSI C63.10: 2013	PASS
Carrier Frequency Separation	FCC Part 15: 15.247(a)(1) ANSI C63.10: 2013	PASS
Number of Hopping Channel	FCC Part 15: 15.247(a)(1)(iii) ANSI C63.10: 2013	PASS
Dwell Time	FCC Part 15: 15.247(a)(1)(iii) ANSI C63.10: 2013	PASS
Radiated Emission	FCC Part 15: 15.247(d) FCC Part 15: 15.209 ANSI C63.10: 2013	PASS
Band Edge Equipment & Conducted Spurious Emissions	FCC Part 15: 15.247(d) ANSI C63.10: 2013	PASS
Power Line Conducted Emission	FCC Part 15: 15.207 ANSI C63.10: 2013	PASS
Antenna requirement	FCC Part 15: 15.203	PASS

3 GENERAL INFORMATION

3.1 Model description

The apparatus as supplied for the test is Wireless multiroom speaker, model BM5B/37 intended for residential use, the product contains electronic control circuitry.

According to customer's declaration,

1, the characteristics of Bluetooth module are:

Operating Frequency	2402 MHz – 2480 MHz	
Operating Temperature Range	0 – 35 ℃	
Antenna Assembly	Type	Internal, PCB antenna
	Gain	Maximum 2,12 dBi
Modulation Type	FHSS: GFSK, (π/4)DQPSK, 8DPSK	
Adaptivity	Adaptive	
Version	V2.1+EDR	

For FHSS channels are:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	27	2429	54	2456
1	2403	28	2430	55	2457
2	2404	29	2431	56	2458
3	2405	30	2432	57	2459
4	2406	31	2433	58	2460
5	2407	32	2434	59	2461
6	2408	33	2435	60	2462
7	2409	34	2436	61	2463
8	2410	35	2437	62	2464
9	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, the characteristics of IEEE 802.11b/g/n HT20 module are:

Operating Frequency	IEEE 802.11b/g: 2412 MHz – 2472 MHz		
	IEEE 802.11n HT20: 2412 MHz – 2472 MHz		
Operating Temperature Range	0 – 35 ℃		
Antenna Assembly	Type	Internal, assembly antenna	
	Gain	Mains (one)	Max. 3,75 dBi
		Mains (two)	Max. 3,75 dBi
Remark: There is only one antenna active at any moment in time after detecting the larger power (Operating mode 1, Single antenna).			
Modulation Type	IEEE 802.11b: DSSS (CCK, QPSK, BPSK)		
	IEEE 802.11g: OFDM (BPSK, QPSK, 16QAM, 64QAM)		
	IEEE 802.11n HT20: OFDM (BPSK, QPSK, 16QAM, 64QAM)		
Adaptivity	Adaptive		
	q	32	

For IEEE 802.11b, 802.11g and 802.11n20, the 13 channels are:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2412	8	2447
2	2417	9	2452
3	2422	10	2457
4	2427	11	2462
5	2432	/	/
6	2437	/	/
7	2442	/	/

According to the declaration from the applicant, the circuit, PCB layout, electrical parts and outlook of the products are identical to all models

Hence, model BM5B/37 was chosen for full testing, and the corresponding data is representative of other models as well.

The provided ports are AC mains, Aux in, USB port (for software upgrade only exclude the software of Bluetooth and IEEE 802.11b/g/n module) and enclosure.

Figure 1 Model BM5B/37

The operating modes are On (Aux in, Bluetooth mode and IEEE 802.11b/g/n HT20 mode) and OFF mode.

1.1 Product Information

Equipment under test	Wireless multiroom speaker
Trade mark	PHILIPS
Tested Type	BM5B/37
Rating	5,0 Vdc, 2 A

Represented type(s)	BM5B/17, BM5C/37, BM5C/17, BM5W/37, BM5W/17
Rating	5,0 Vdc, 2 A

AC/DC Adapter	AS100-050-AA200
Trade mark	PHILIPS
Rating	Input: 100-120 Vac, 50-60 Hz, 0,5 A Output: 5.0 Vdc, 2.0 A

1.2 Customer Information

Applicant/ Manufacturer	Gibson Innovations Limited
Contact person	Wenke
Telephone	+86 755 8300 8803
Telefax	/
Address	5/F.-6F., Philips Electronics Building, 5 Science Park East Avenue, Hong Kong Science Park, New Territories, Hong Kong

Factory	Zhang Shan City LI TAI Electronic industrial Co., Ltd.
Contact person	Yuki Cai
Telephone	+86 760 2380 8322
Telefax	+86 760 2380 8800
Address	No.3 Industrial district, Wu guishan, Cheng gui Road, Zhangshan city, Guangdong, China

4 TEST INFORMATION

4.1 Test configuration

The Bluetooth module of the EUT was connected to a special test jig provided by manufacturer which has a USB connector to link with PC, and the PC will run a special test software “RDA_BT_Tester” supplied by manufacturer to control the EUT work in test mode as below table.

Mode	Channel	Frequency (MHz)
Hopping on Tx Mode	CH0 to CH78	2402 to 2480
GFSK hopping off Tx Mode	CH0	2402
	CH39	2441
	CH78	2480
Л/4 QPSK hopping off Tx Mode	CH0	2402
	CH39	2441
	CH78	2480
8-DPSK hopping off Tx Mode	CH0	2402
	CH39	2441
	CH78	2480

4.2 Modulation configuration

Modulation	Packet	Packet Type	Packet Size
GFSK	DH1	4	24
	DH3	11	183
	DH5	15	339
(π/4)DQPSK	2DH1	20	54
	2DH3	26	367
	2DH5	30	379
8DPSK	3DH1	24	83
	3DH3	27	552
	3DH5	31	1021

4.3 Special accessories of the EUT

No.

4.4 Assistant equipment used on the test

Description	Manufacturer	Model	Other
HP Pro 3330 Small (PC)	HP	A6T13PA#AB2	AC line: 1,5 m, unshielded
LCD Color Display	HP	GV537A	AC line: 1,5 m, unshielded VGA line: 1,5 m, Shielded
Keyboard	HP	KB-0316	Signal line: 1,5 m, unshielded
Mouse	HP	M-SBF96	Signal line: 1,5 m, unshielded

Note: the equipment only used to configure the engineering mode in the report and not during the test

4.5 Test laboratory

Location	DEKRA Testing and Certification (Shanghai) Ltd. Guangzhou Branch
Address	Building A3, No.3 Qiyun Road, Science City, Guangzhou Hi-Tech Industrial Development Zone, Guangzhou, P.R. China
Date	2015-07-04 to 2015-07-20
Supervised by	Jazz Liang

4.6 Environmental conditions

Tests have been performed in a controlled laboratory environment, where the environmental conditions are maintained within the applicable ranges.

Ambient temperature	15 °C – 25 °C
Relative Humidity air	30% - 60%

4.7 Measurement Uncertainty

Test Item	Uncertainty
Occupied Channel Bandwidth	±1%
RF Output power, conducted	±0,6dB
Power Spectral Density, Conducted	±1,2dB
Unwanted Emissions, Conducted	±0,6dB
Temperature	±0,2℃
Humidity	±1%
DC and Low frequency voltage	±0,5%
Time	±1%
Duty Cycle	±1%
Uncertainty for Radiation Emission test (30MHz-1GHz)	3,14 dB (Polarize: V)
	3,16 dB (Polarize: H)
Uncertainty for Radiation Emission test (1GHz to 25GHz)	2,08dB(Polarize: V)
	2,56dB (Polarize: H)

Remark：

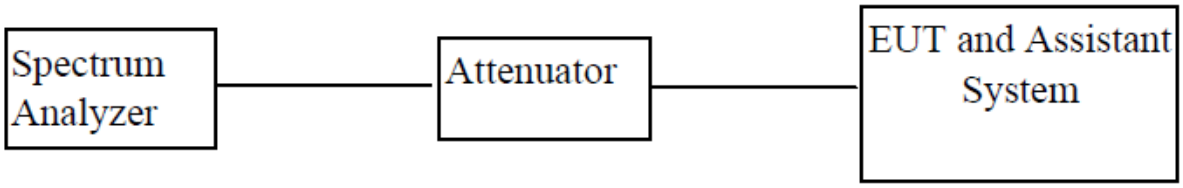
This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

5 MAXIMUM PEAK OUTPUT POWER

5.1 Test equipment

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1	Spectrum analyzer	R&S	FSV	SN101012	2014/09/11	1 Year
2	Attenuator	Mini-Circuits	BW-S10W2	101109	2014/11/26	1 Year
3	RF Cable	Micable	C10-01-01-1	100309	2014/11/26	1 Year

5.2 Block diagram of test setup



5.3 Test Procedure

(1) Configure EUT and Assistant system according to 4.1 and 5.2;
(2) Connect EUT's antenna output to spectrum analyzer by RF cable;
(3) Configure EUT working in test mode as state in 4.1;
(4) Measure the maximum output power of EUT by spectrum analyzer with PK detector and RBW=2 MHz (above 6 dB bandwidth of measured signal), VBW= 3 MHz;

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

5.4 Limits

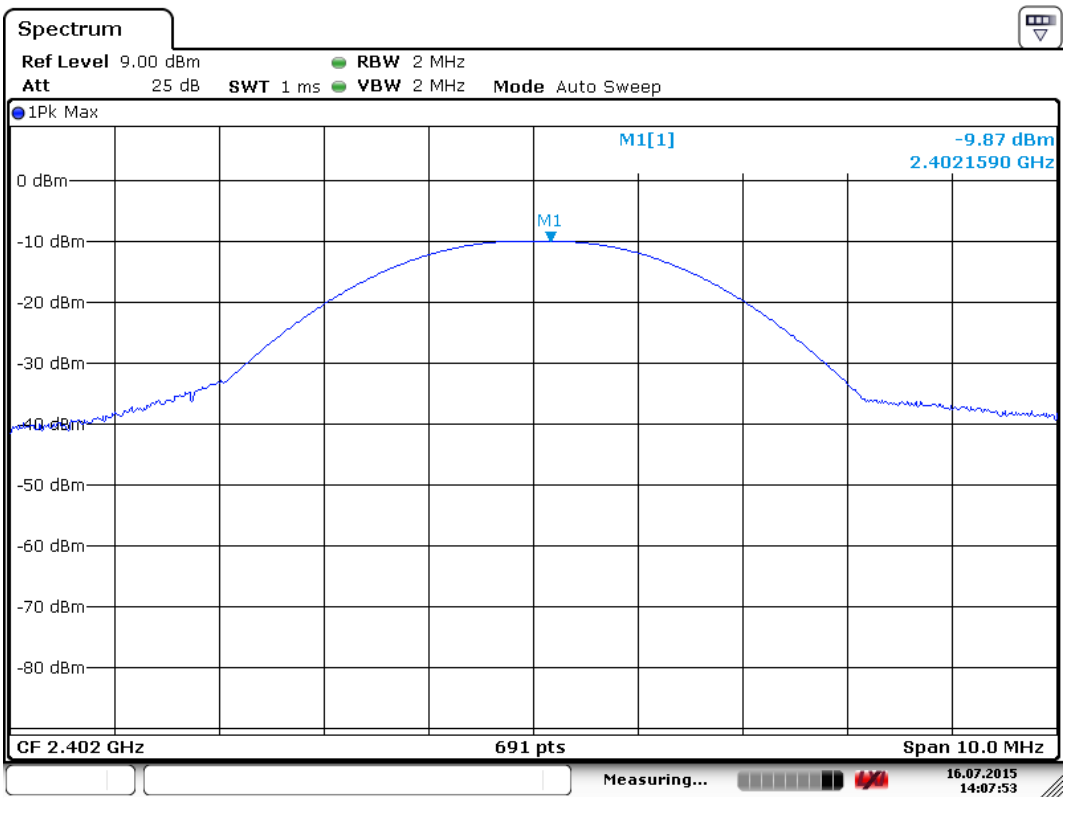
For frequency hopping systems operating in the 2400 – 2483,5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725 – 5850 MHz band: 1 watt.

5.5 Test results

Mode	Frequency (MHz)	Results (dBm)	Limit (dBm)	Margin (dB)	Conclusion
GFSK	2402	-9.87	30	-39.87	PASS
	2441	-9.27	30	-39.27	PASS
	2480	-8.44	30	-38.44	PASS
Л/4 QPSK	2402	-10.02	30	-40.02	PASS
	2441	-9.37	30	-39.37	PASS
	2480	-8.48	30	-38.48	PASS
8-DPSK	2402	-9.92	30	-39.92	PASS
	2441	-9.30	30	-39.30	PASS
	2480	-8.45	30	-38.45	PASS
Remark: Margin = Results – Limits.					

5.6 Original test data

GFSK CH0



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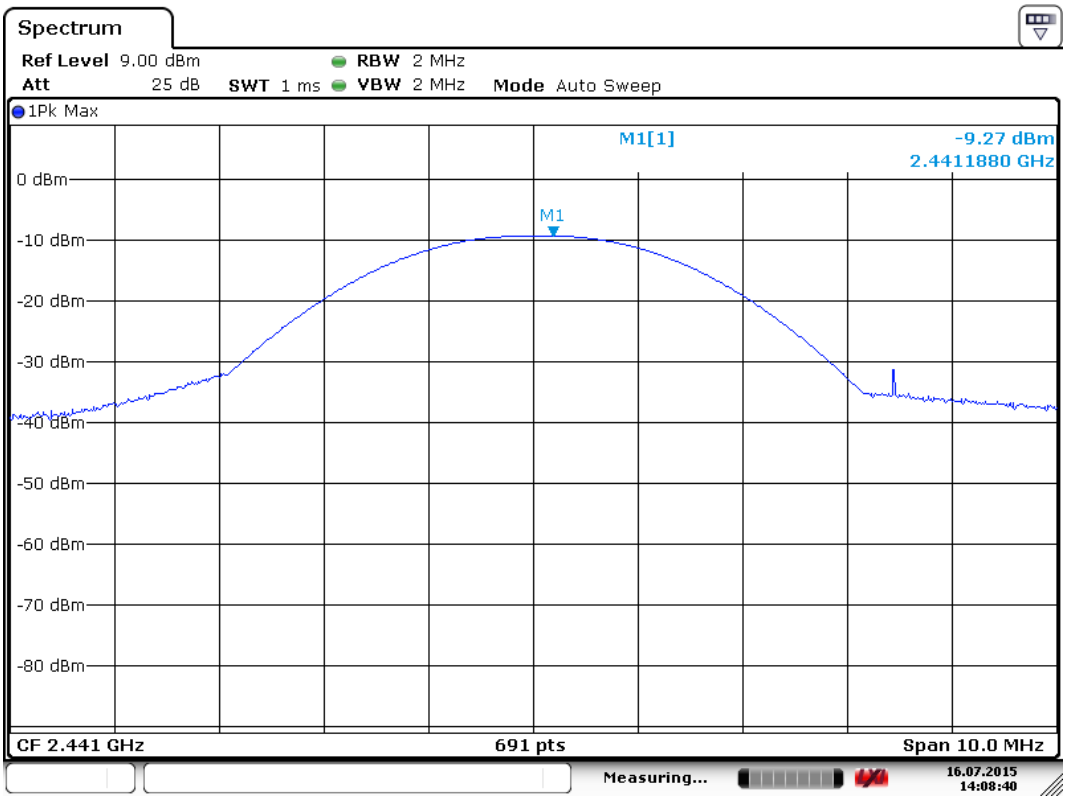

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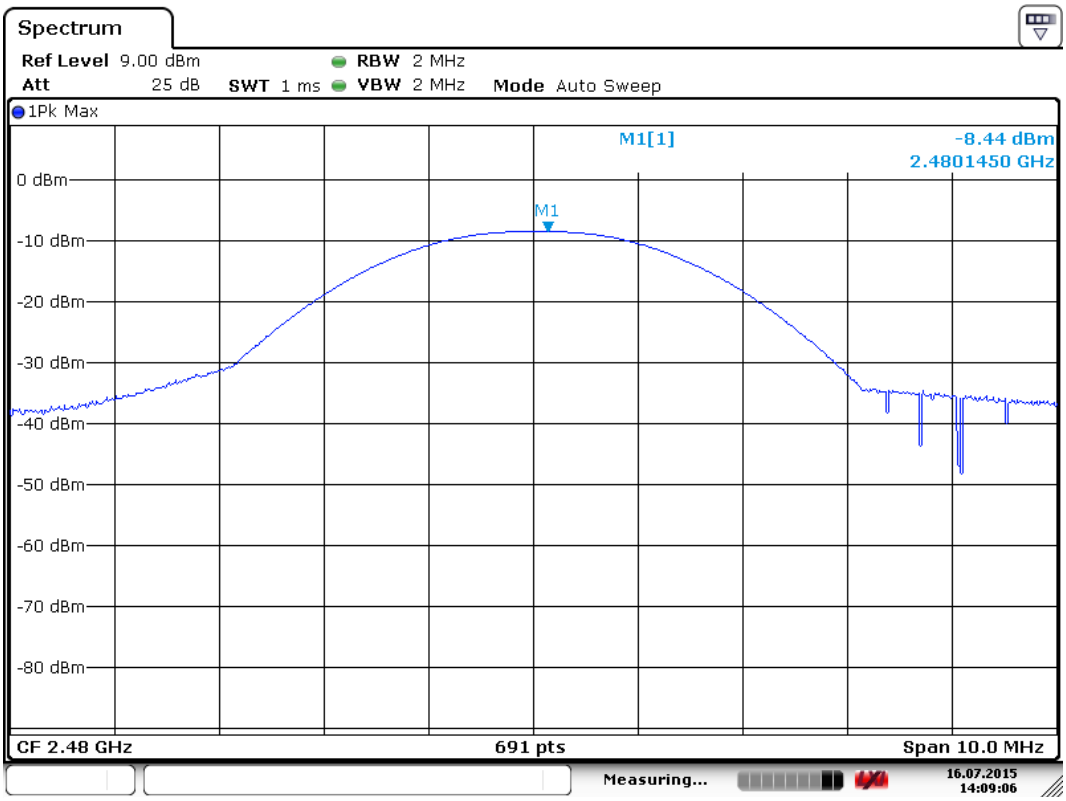
GFSK CH79



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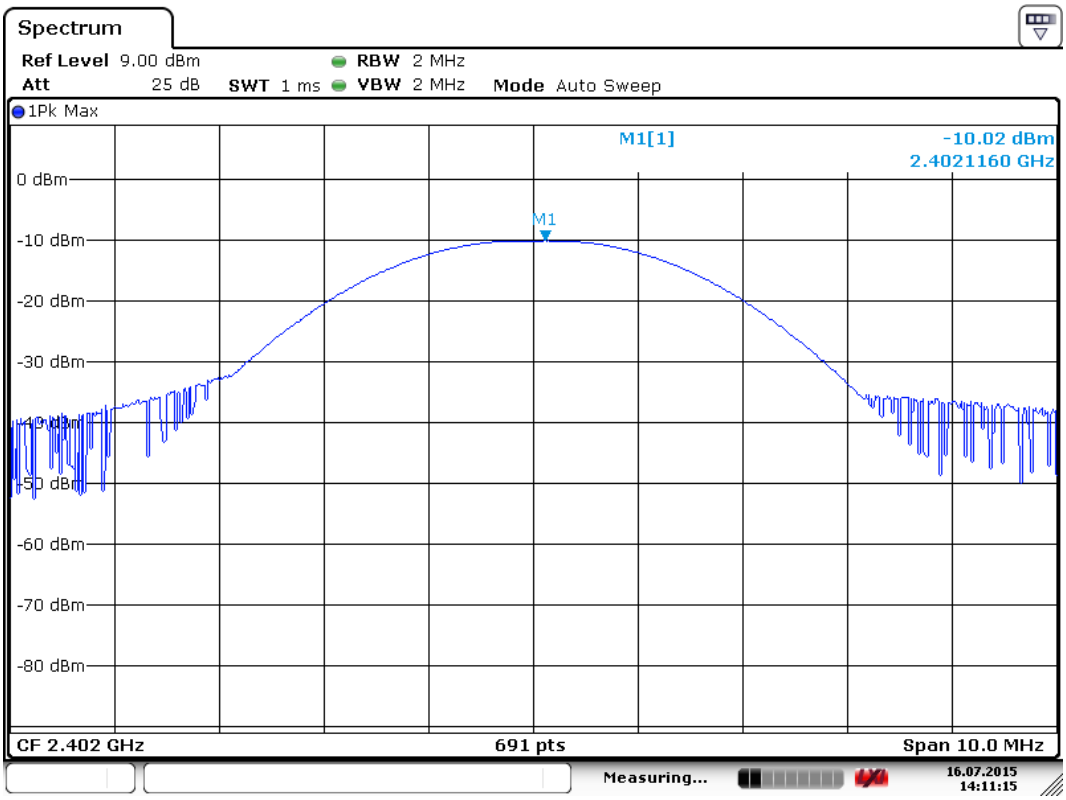
Л/4 QPSK CH0



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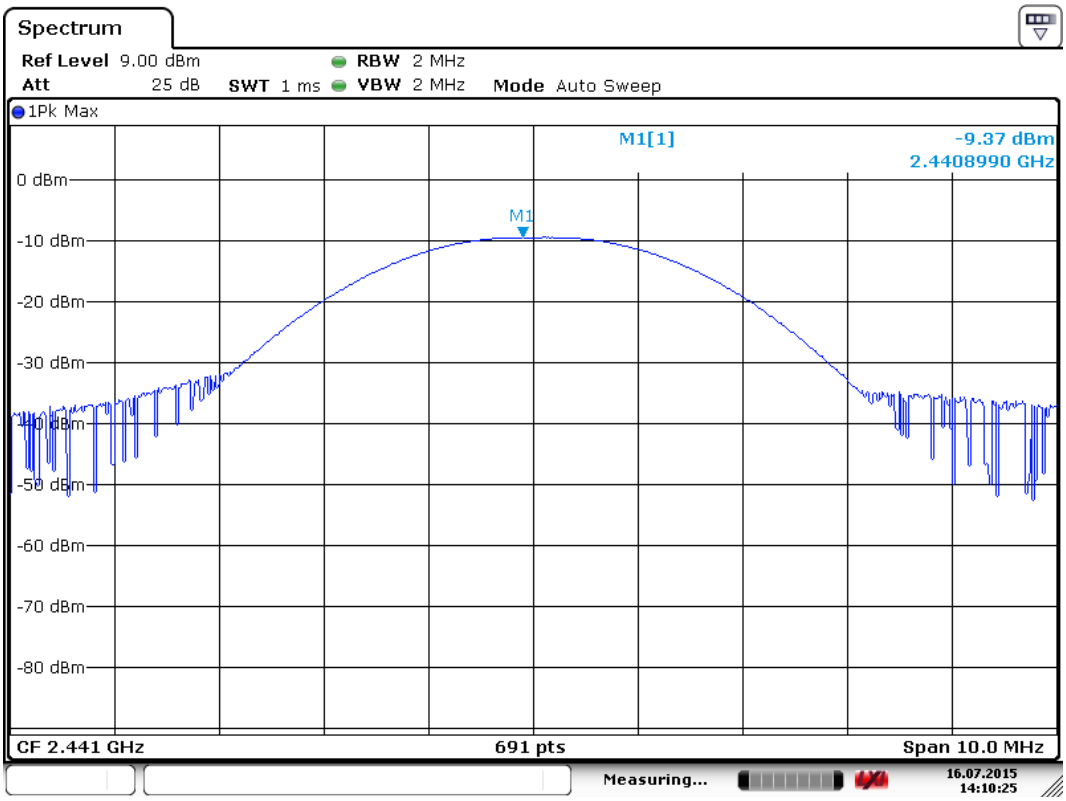

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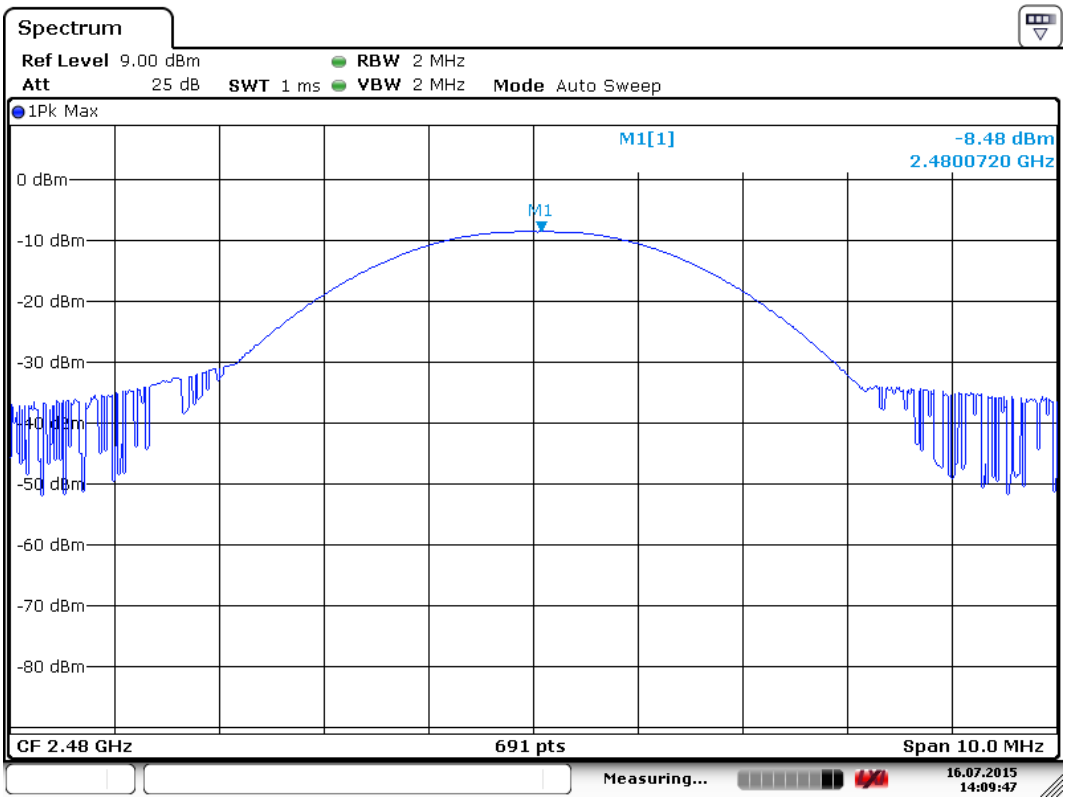
Л/4 QPSK CH79



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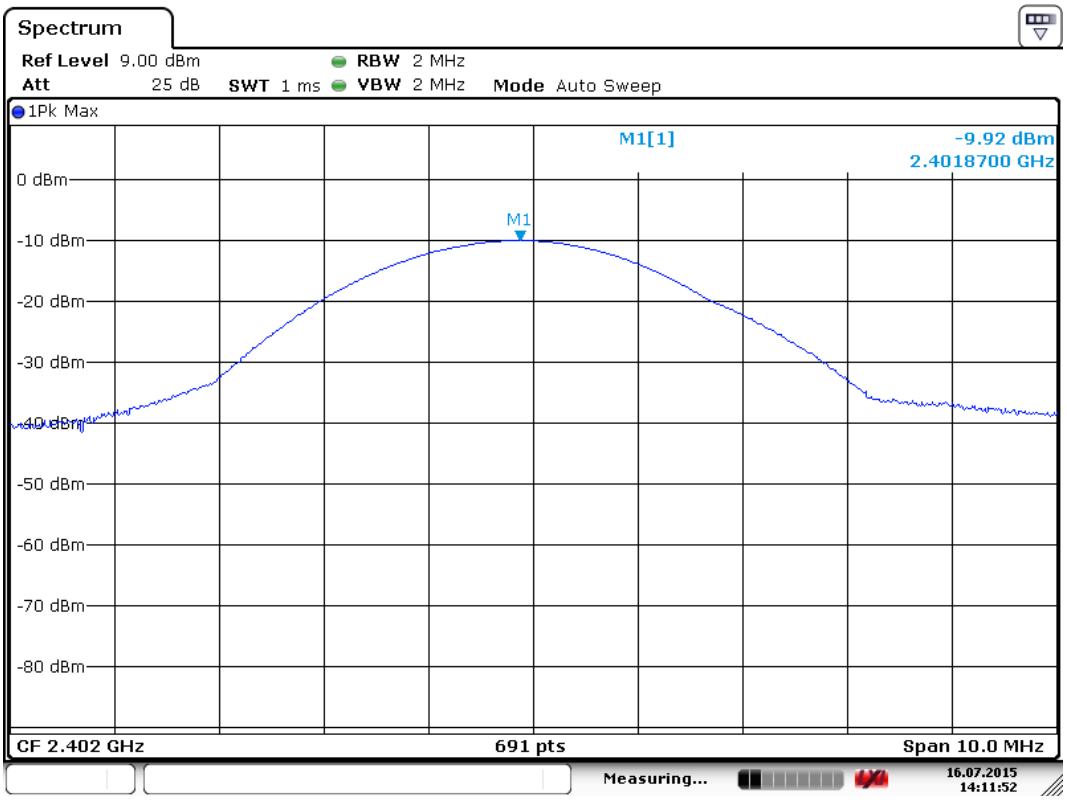
8-DPSK CH0



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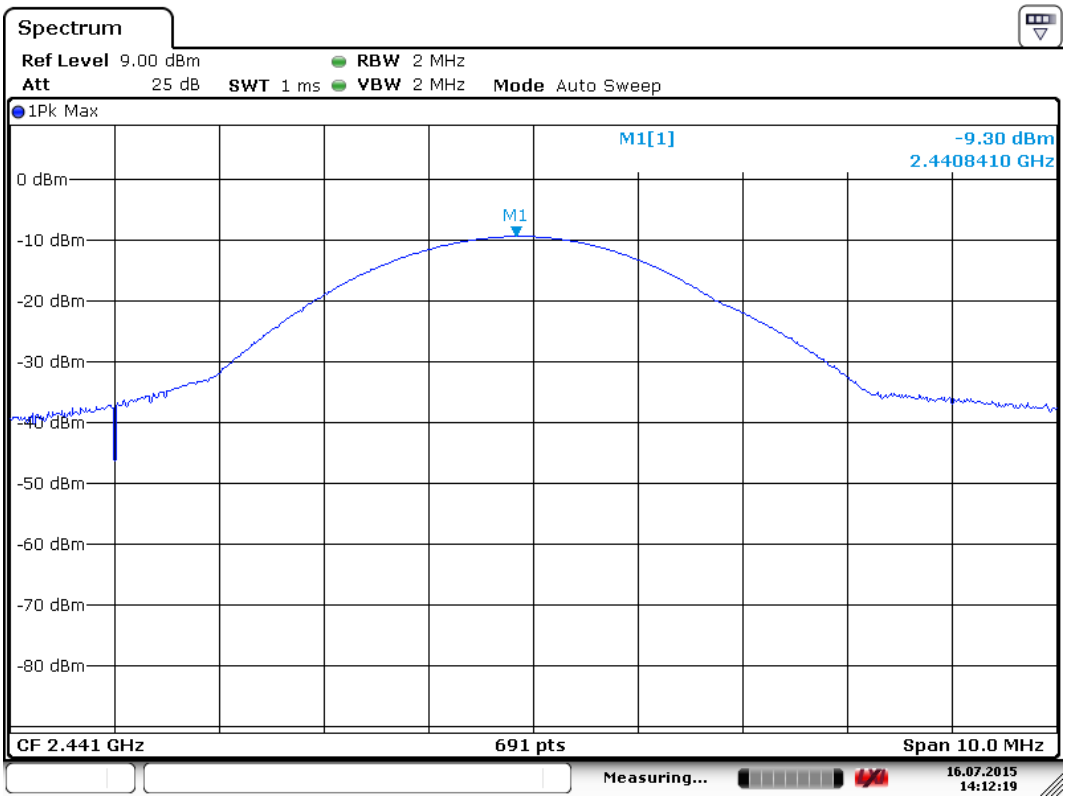
8-DPSK CH39



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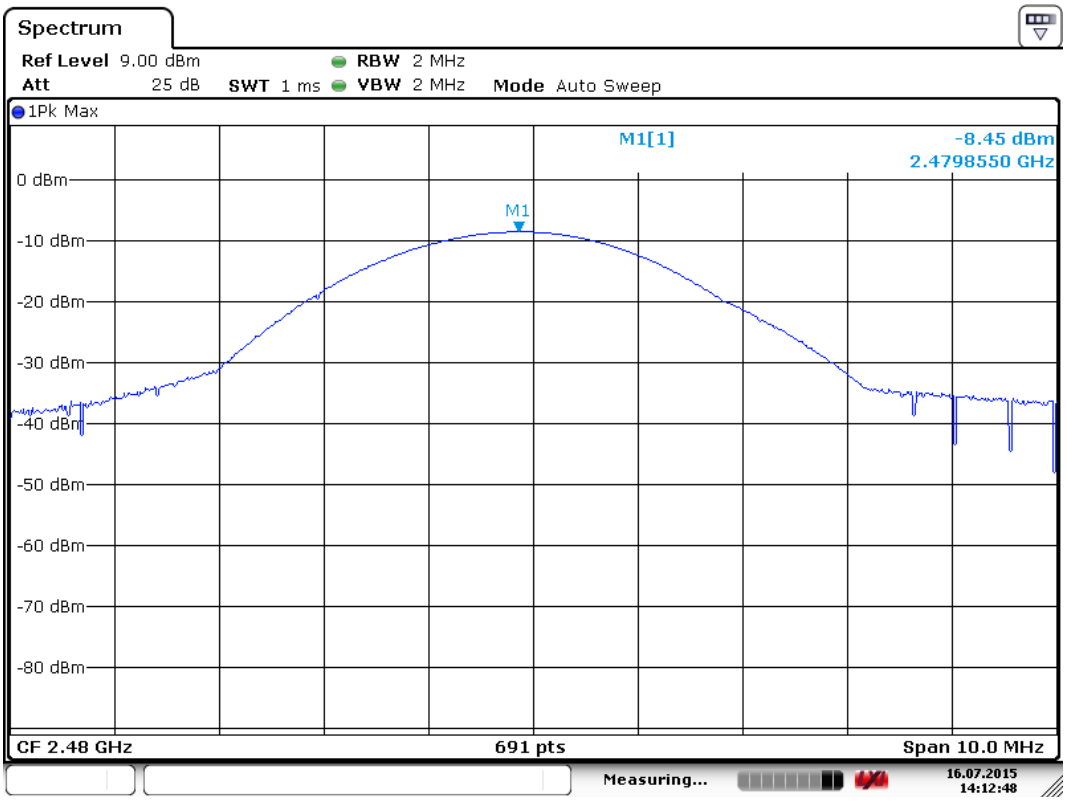
8-DPSK CH79



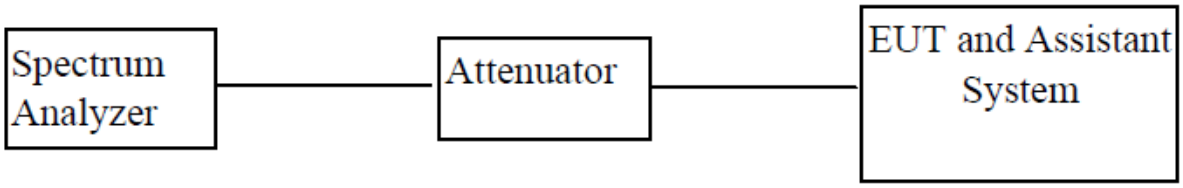
Date: 16.JUL.2015 14:12:47

6 20 DB BANDWIDTH

6.1 Test equipment

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1	Spectrum analyzer	R&S	FSV	SN101012	2014/09/11	1 Year
2	Attenuator	Mini-Circuits	BW-S10W2	101109	2014/11/26	1 Year
3	RF Cable	Micable	C10-01-01-1	100309	2014/11/26	1 Year

6.2 Block diagram of test setup



6.3 Test Procedure

(1) Configure EUT and Assistant system according to 4.1 and 5.2;
(2) Connect EUT's antenna output to spectrum analyzer by RF cable;
(3) Configure EUT working in test mode as state in 4.1;
(4) The bandwidth of the fundamental frequency was measured by spetrum 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.

6.4 Limits

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 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within frequency band designated in the rule section under which the equipment is operated.

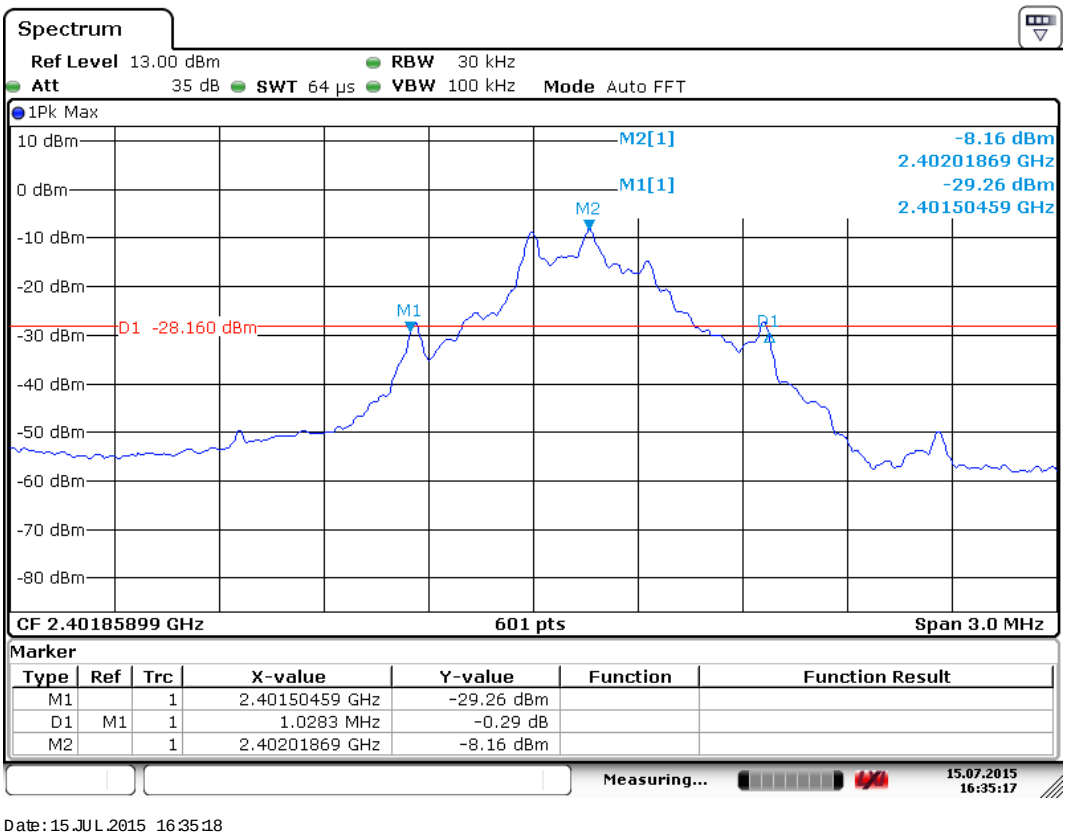
6.5 Test results

Mode	Frequency (MHz)	Results (MHz)	Limit (MHz)	Margin (MHz)	Conclusion
GFSK	2402	1.0283	2400 -2483,5	/	PASS
	2441	1.0233	2401 -2483,5	/	PASS
	2480	1.0233	2402 -2483,5	/	PASS
Л/4 QPSK	2402	1.0183	2403 -2483,5	/	PASS
	2441	1.0233	2404 -2483,5	/	PASS
	2480	1.0233	2405 -2483,5	/	PASS
8-DPSK	2402	1.0233	2406 -2483,5	/	PASS
	2441	1.0233	2407 -2483,5	/	PASS
	2480	1.0233	2408 -2483,5	/	PASS

6.6 Original test data

GFSK Mode

2402



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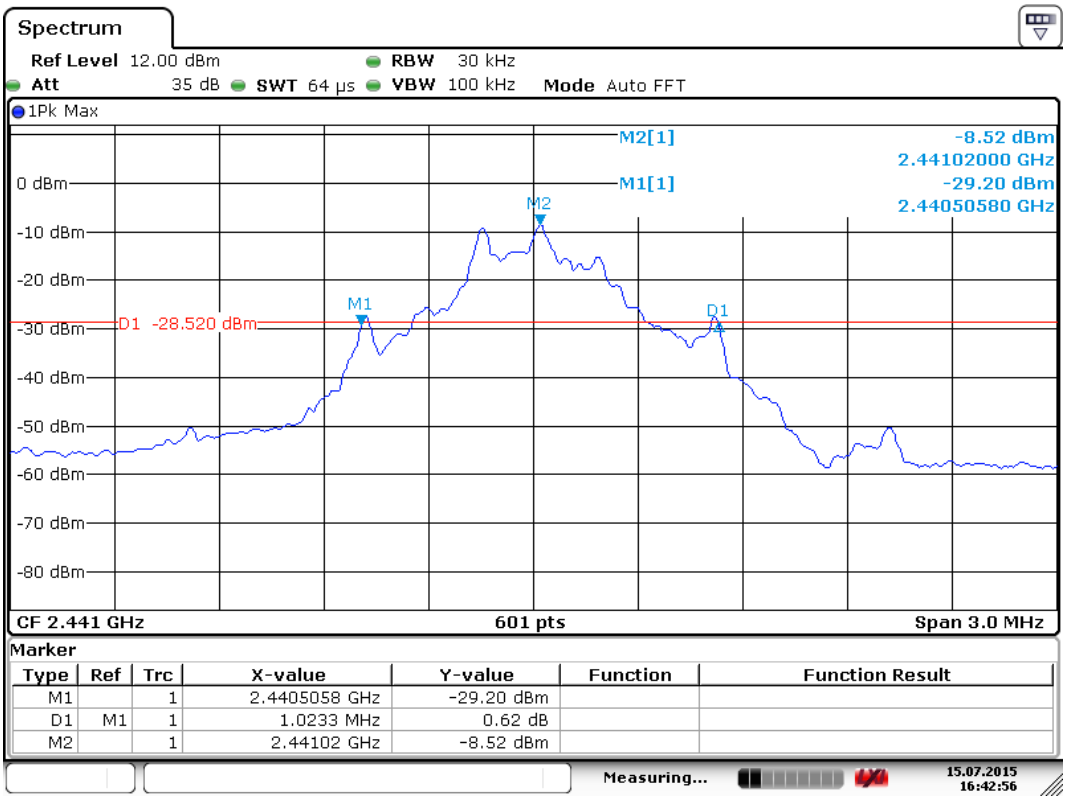
2441



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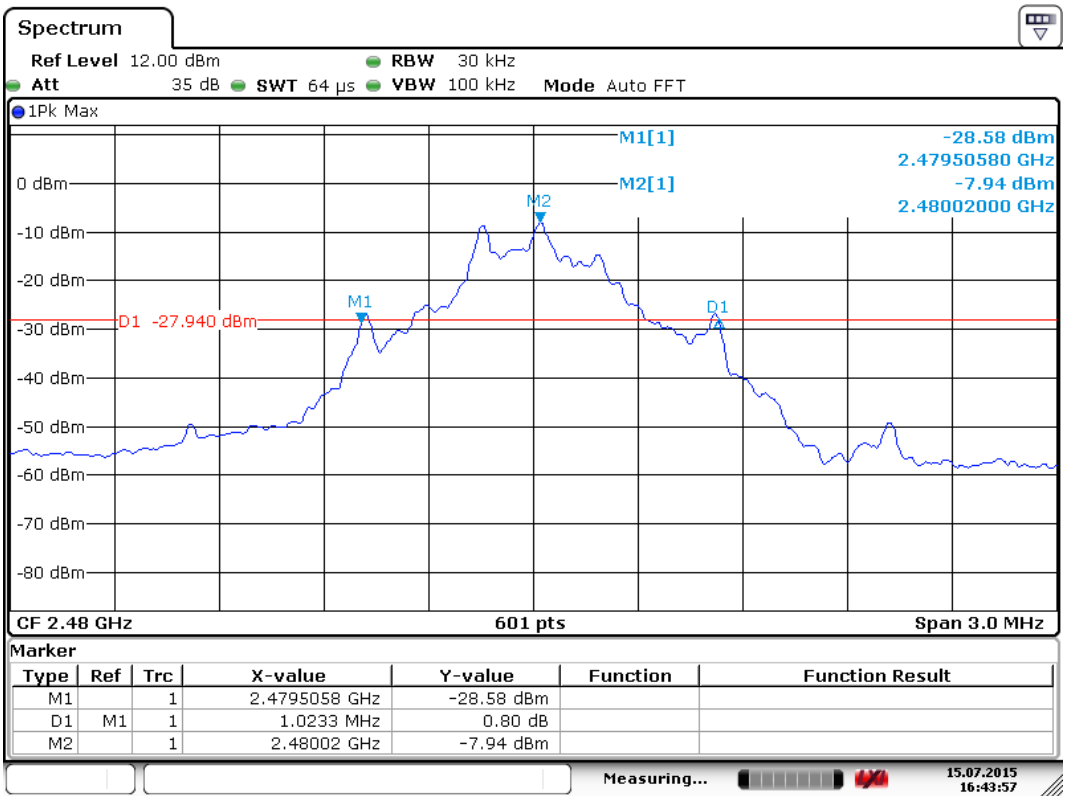
2480



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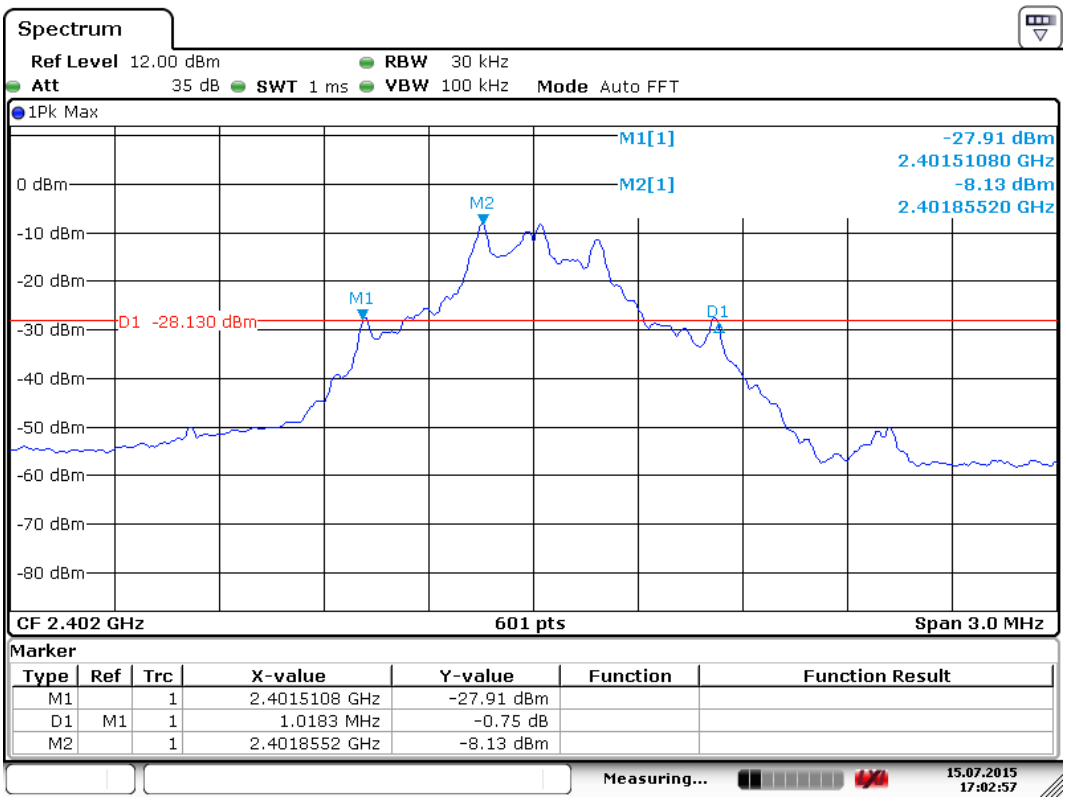
Л/4 QPSK mode

2402



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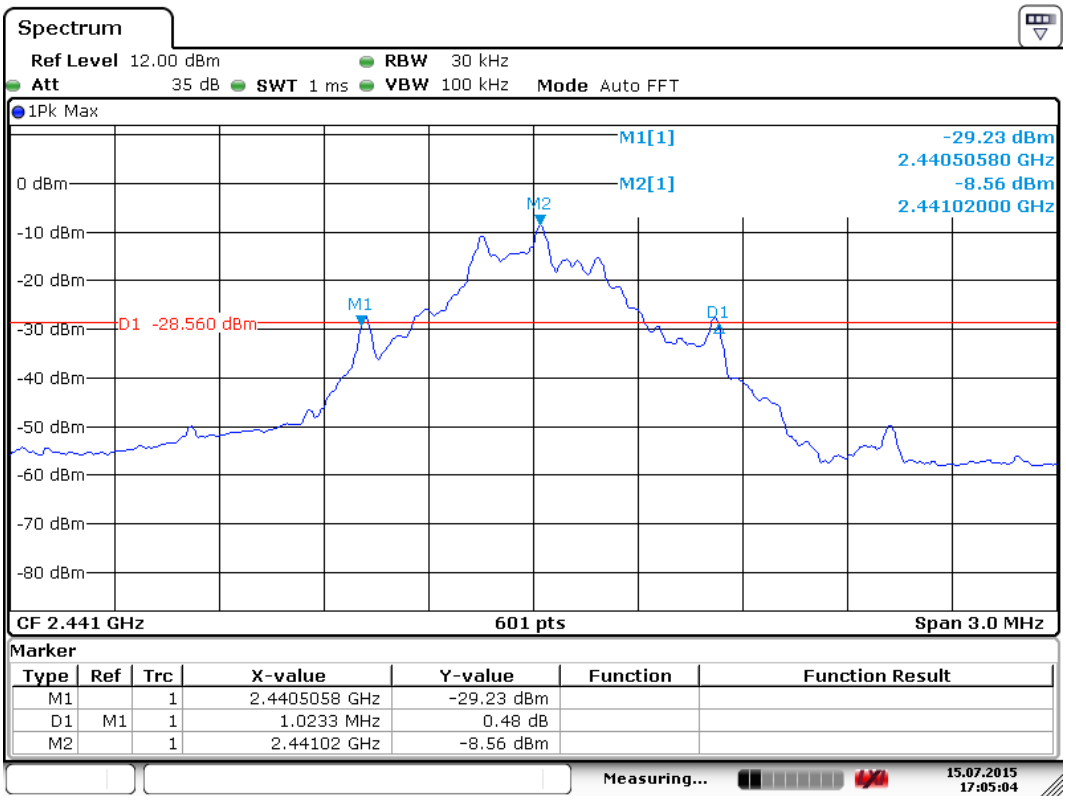
2441



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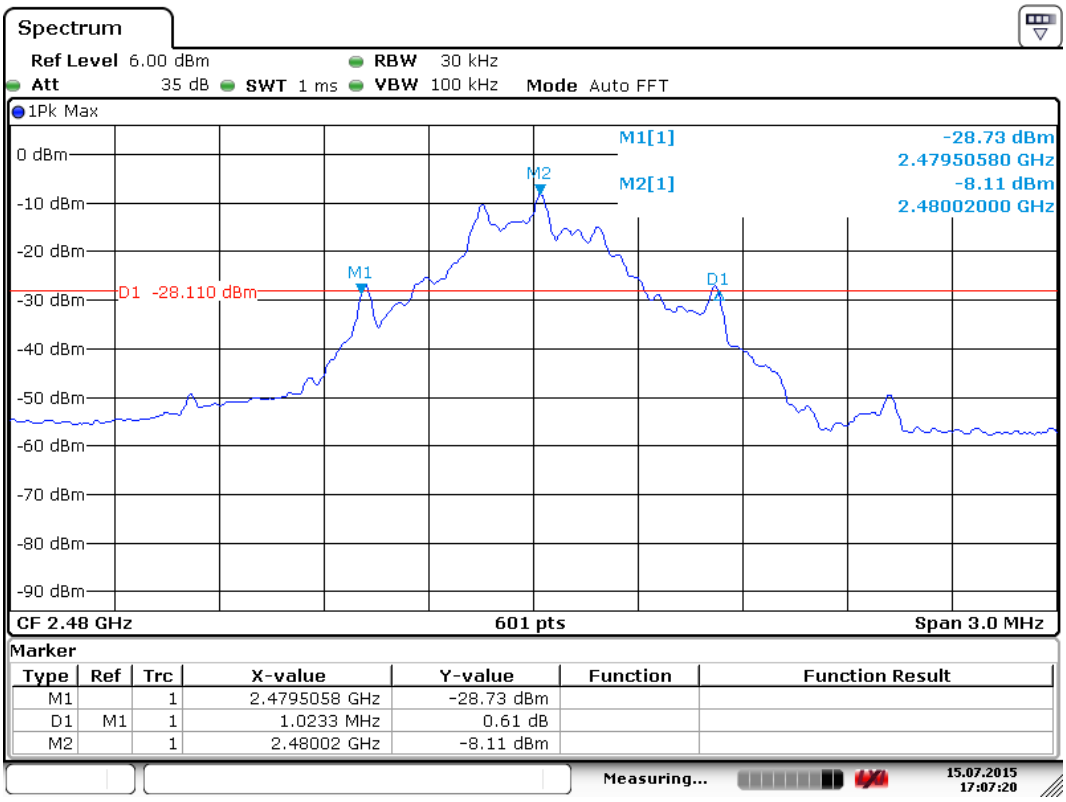
2480



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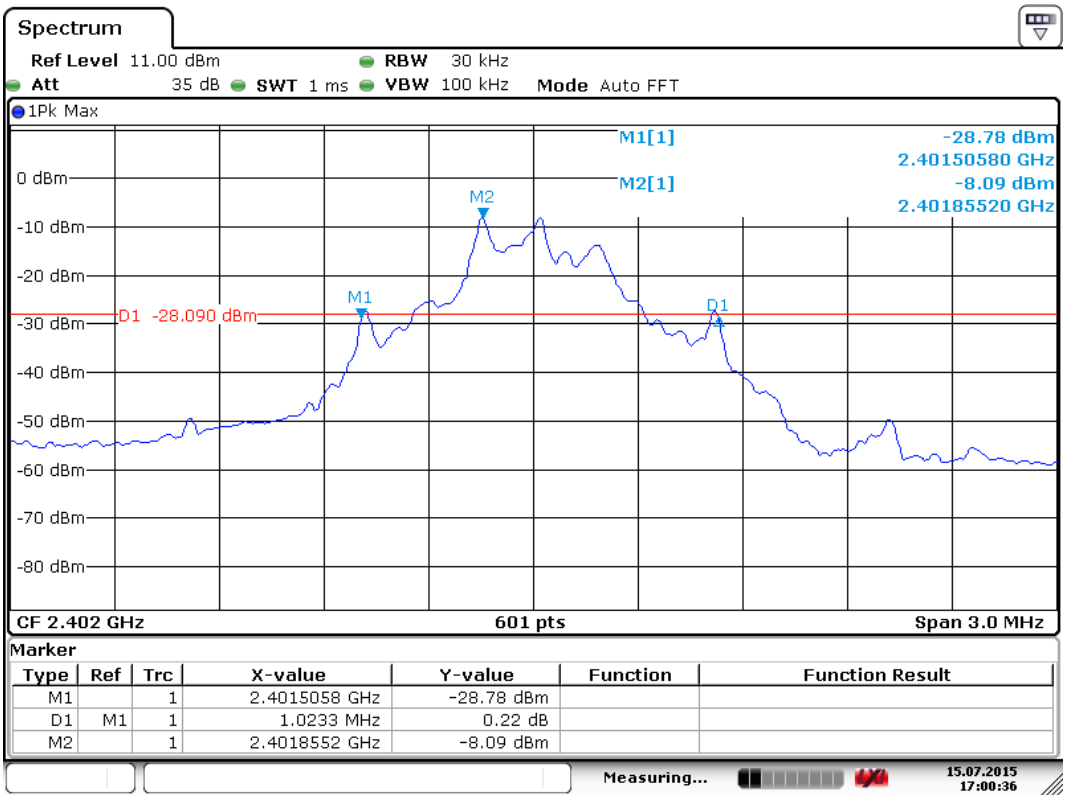
8-DPSK mode

2402



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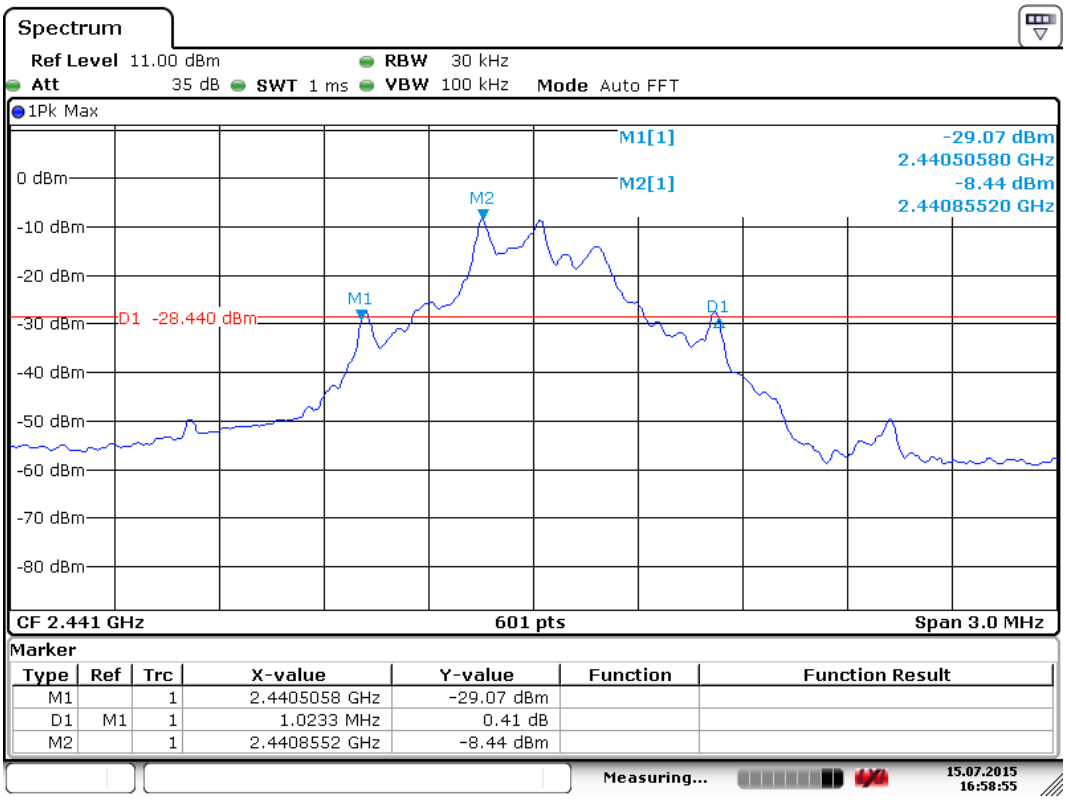
2441



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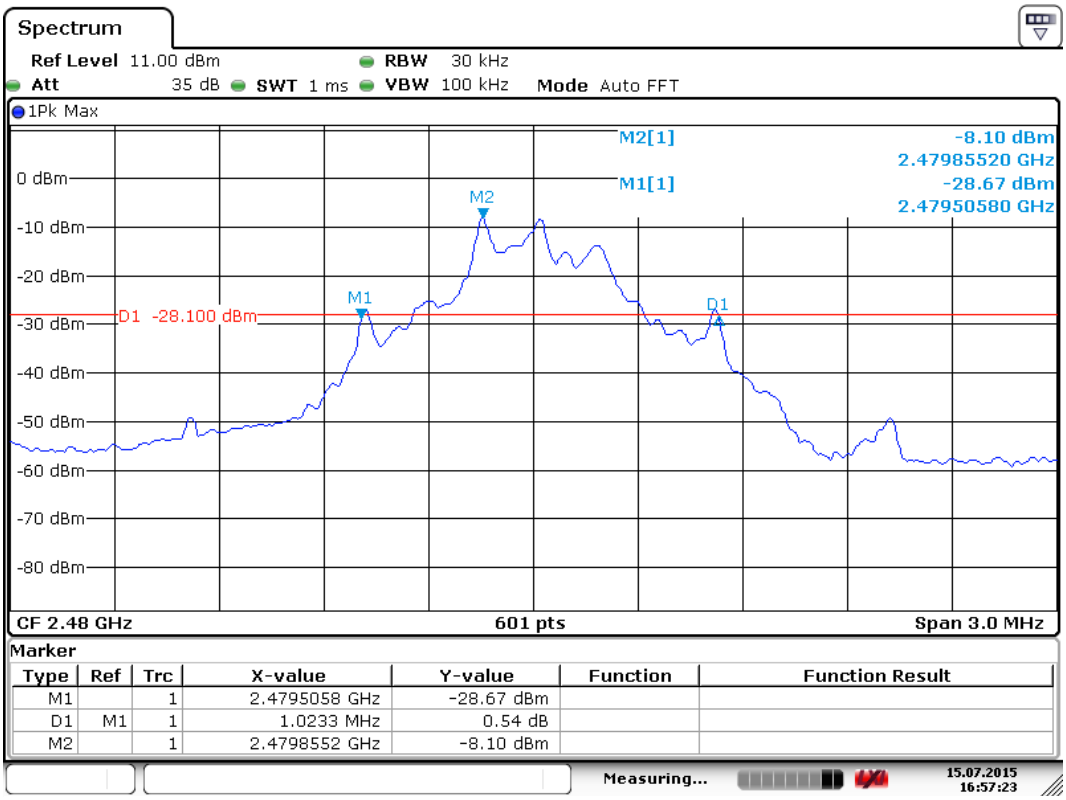
2480



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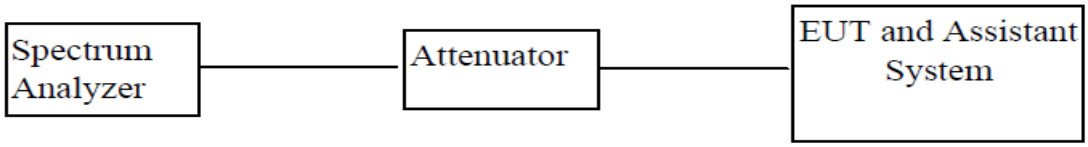
7 CARRIER FREQUENCY SEPARATION

7.1 Test equipment

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1	Spectrum analyzer	R&S	FSV	SN101012	2014/09/11	1 Year
2	Attenuator	Mini-Circuits	BW-S10W2	101109	2014/11/26	1 Year
3	RF Cable	Micable	C10-01-01-1	100309	2014/11/26	1 Year

7.2 Block diagram of test setup



7.3 Test Procedure

(1) Configure EUT and Assistant system according to 4.1 and 7.2;
(2) Connect EUT's antenna output to spectrum analyzer by RF cable;
(3) Configure EUT working in test mode as state in 4.1;

7.4 Limits

Frequency hopping systems shall have hopping channel frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400 – 2483,5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operste with an output power no greater than 125 mW.

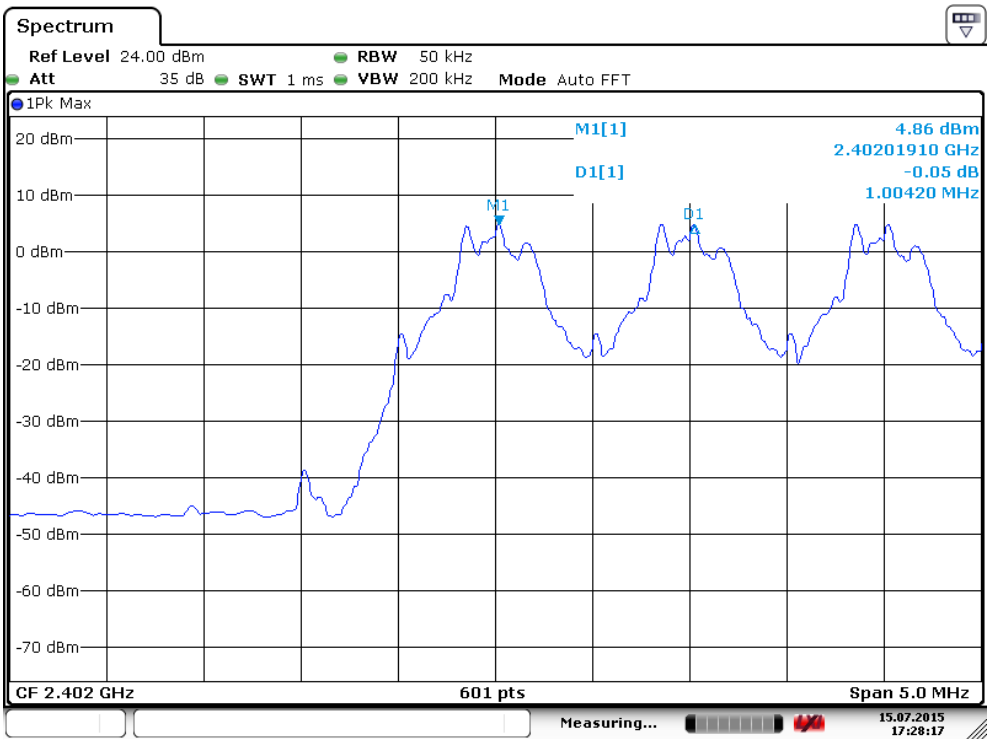
7.5 Test results

Mode	Channel separation (MHz)	20 dB Bandwidth(MHz)	Limit (MHz) 2/3 of 20 dB Bandwidth	Conclusion
GFSK	1,0042	1.0283	0.6855	PASS

Note1: The limit is two-thirds of the 20dB bandwidth 8DPSK (3DH5) mode due to the transmission power is less than 0.125 W shown on section 5.5 of this report.
Note2: For Л/4 QPSK, 8-DPSK in modulation type, and based exploratory test, there is no significant difference of GFSK test result, except output power, Test were performed GFSK only.

7.6 test data

GFSK



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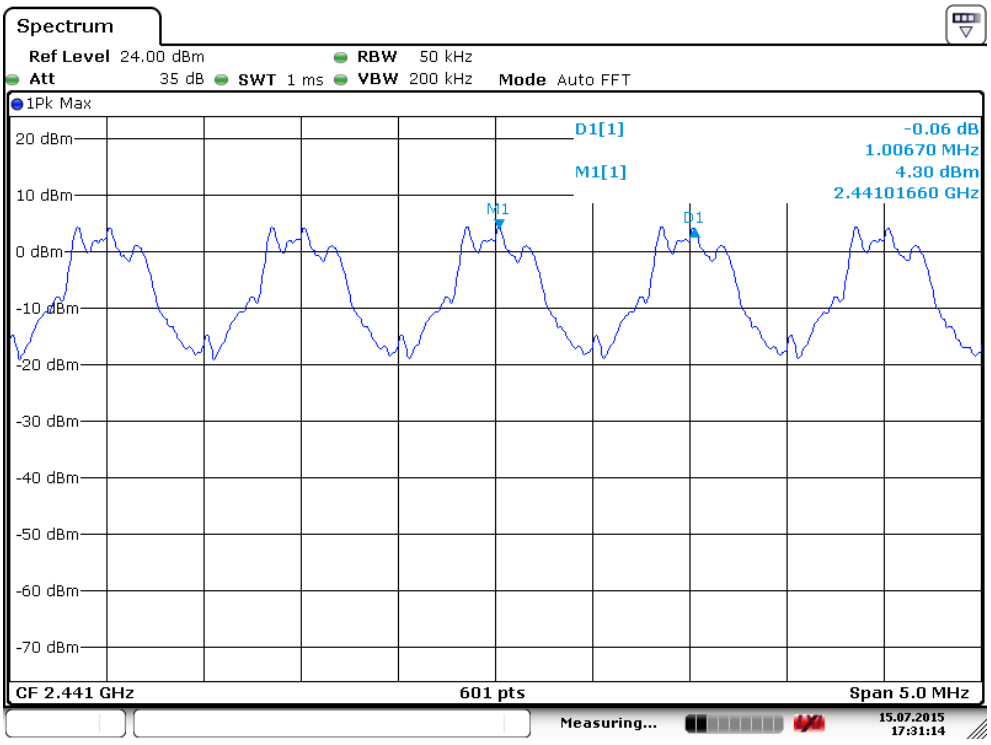

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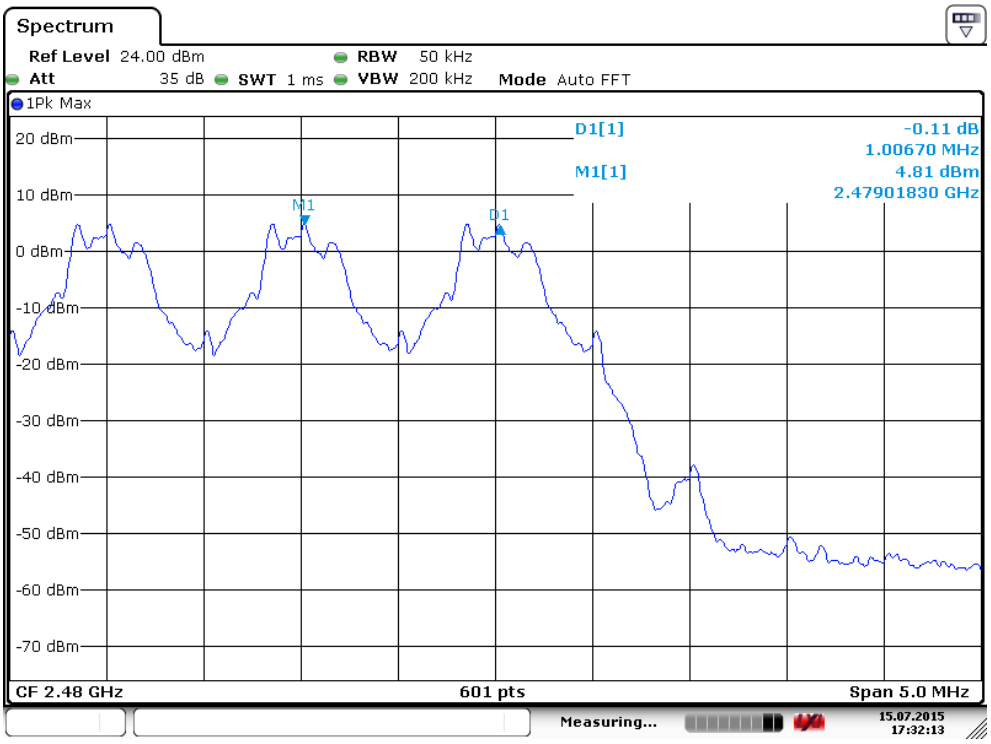


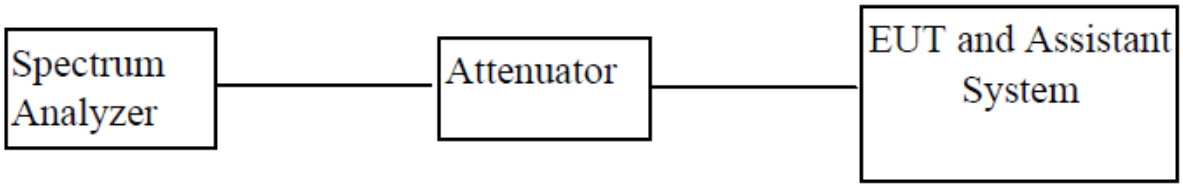
Date: 15.JUL.2015 17:32:13

8 NUMBER OF HOPPING CHANNEL

8.1 Test equipment

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1	Spectrum analyzer	R&S	FSV	SN101012	2014/09/11	1 Year
2	Attenuator	Mini-Circuits	BW-S10W2	101109	2014/11/26	1 Year
3	RF Cable	Micable	C10-01-01-1	100309	2014/11/26	1 Year

8.2 Block diagram of test setup



8.3 Test Procedure

(1) Configure EUT and Assistant system according to 4.1 and 8.2;
(2) Connect EUT's antenna output to spectrum analyzer by RF cable;
(3) Configure EUT working in test mode as state in 4.1;
(4) The carrier frequency was measured by spetrum analyzer with 100 kHz RBW and 300 KHz VBW.

8.4 Limits

Frequency hopping systems in the 2400 – 2483,5 MHz band shall used at least 15 channels.

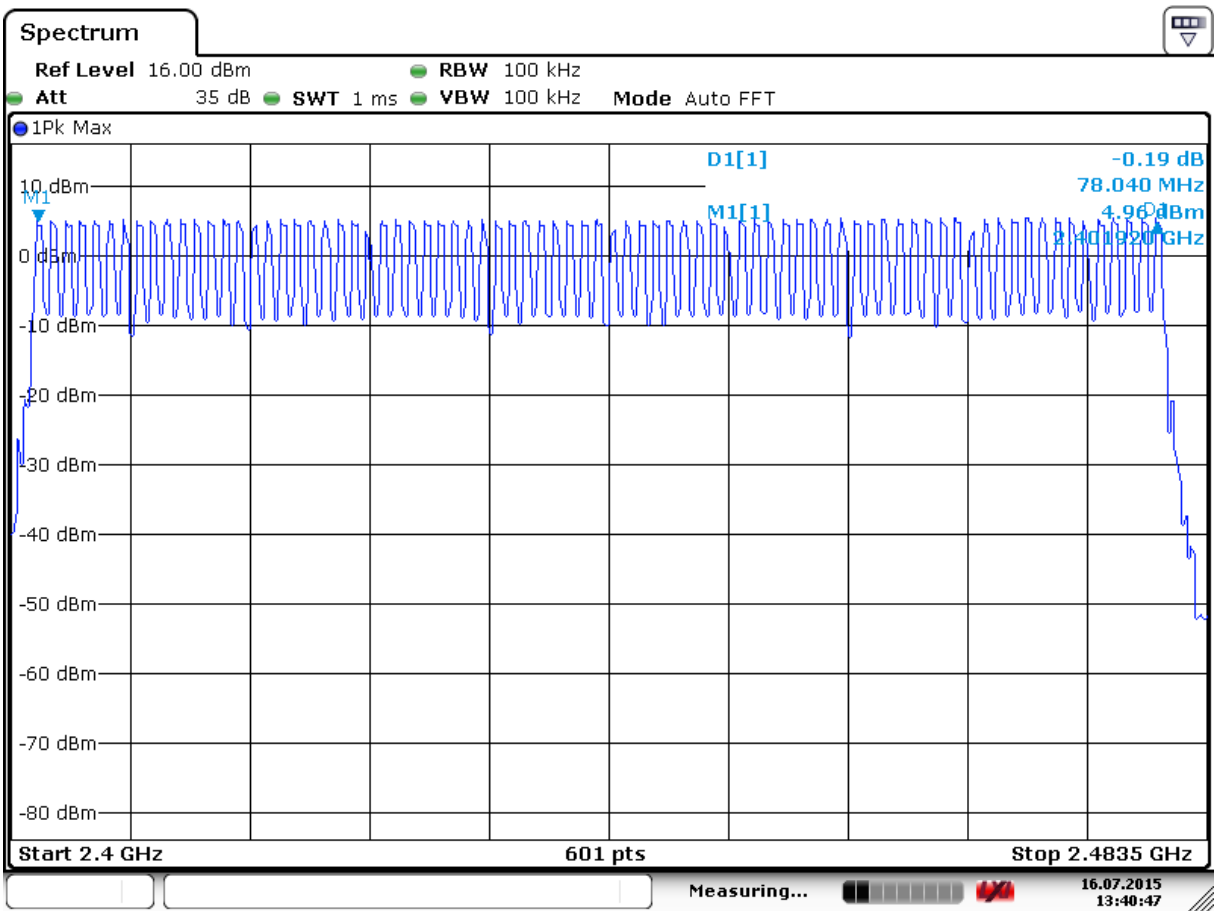
8.5 Test results

Mode	Number of hopping channel	Limit	Conclusion
GFSK	79	>15	PASS

Note : For Л/4 QPSK, 8-DPSK in modulation type, and based exploratory test, there is no significant difference of GFSK test result, except output power, Test were performed GFSK only.

8.6 Original test data

GFSK



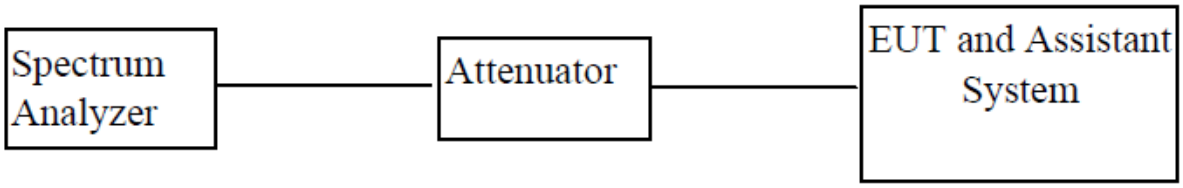
Date: 16.JUL.2015 13:40:47

9 DWELL TIME

9.1 Test equipment

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1	Spectrum analyzer	R&S	FSV	SN101012	2014/09/11	1 Year
2	Attenuator	Mini-Circuits	BW-S10W2	101109	2014/11/26	1 Year
3	RF Cable	Micable	C10-01-01-1	100309	2014/11/26	1 Year

9.2 Block diagram of test setup



9.3 Test Procedure

(1) Configure EUT and Assistant system according to 4.1 and 9.2;
(2) Connect EUT's antenna output to spectrum analyzer by RF cable;
(3) Configure EUT working in test mode as state in 4.1;

9.4 Limits

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.

9.5 Test results

For channel 0:2.402GHz

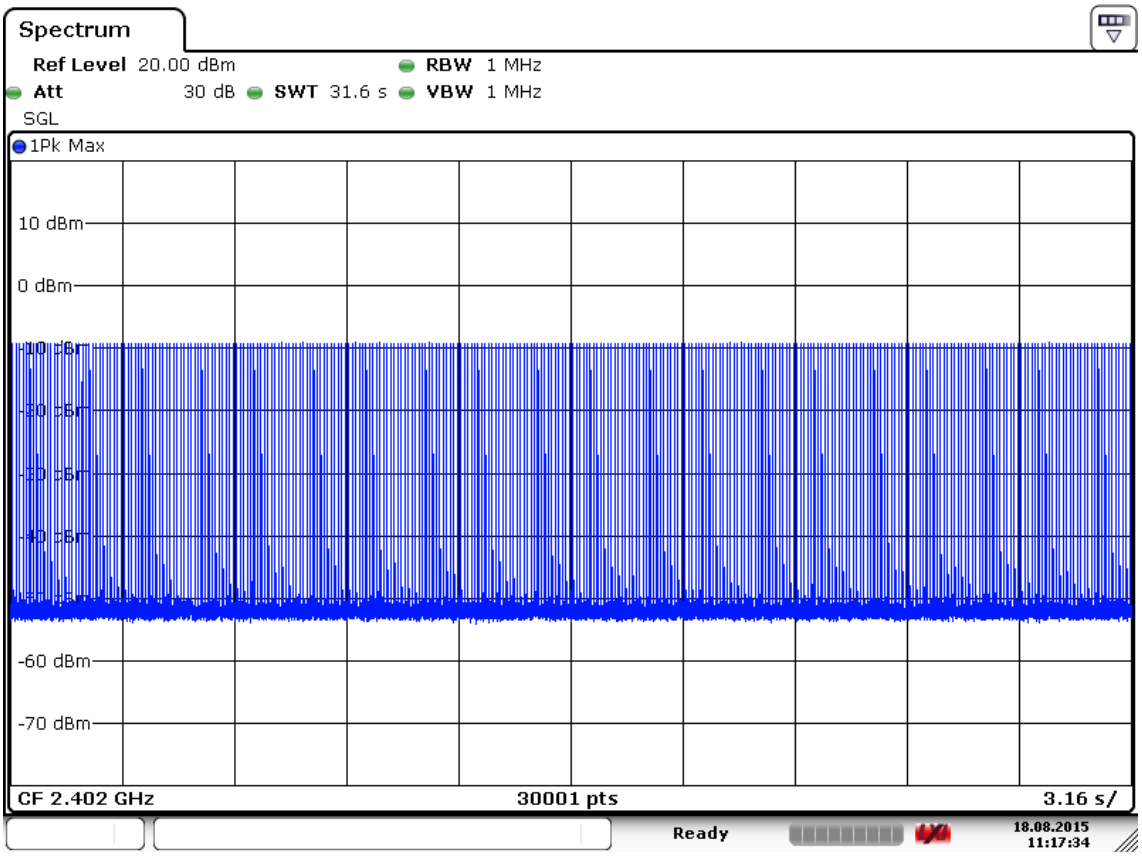
EUT Mode (worst case)	Results	Limit
	The accumulated Dwell time(ms)	
3DH1	372.9	≤ 400 ms
3DH3	379.2	
3DH5	389.7	

Remark:

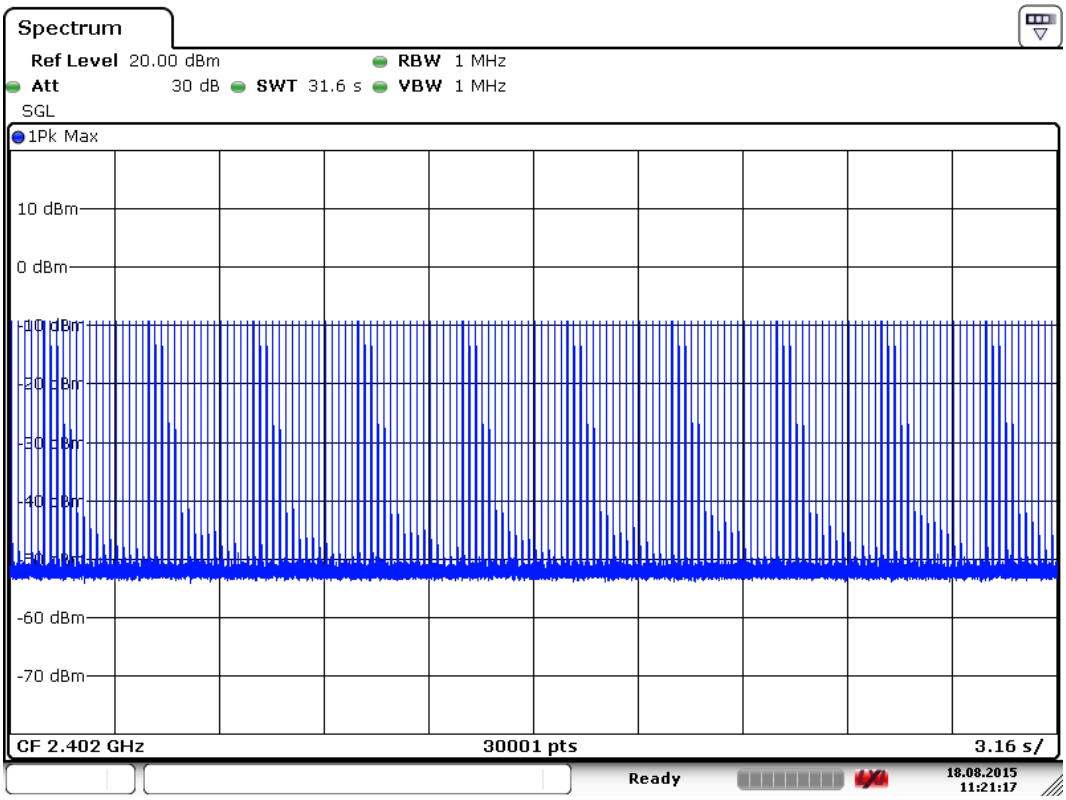
The accumulated Dwell time =

the total points of the much higher level * Sweep time (31.6 s)/ Sweep points (30000)

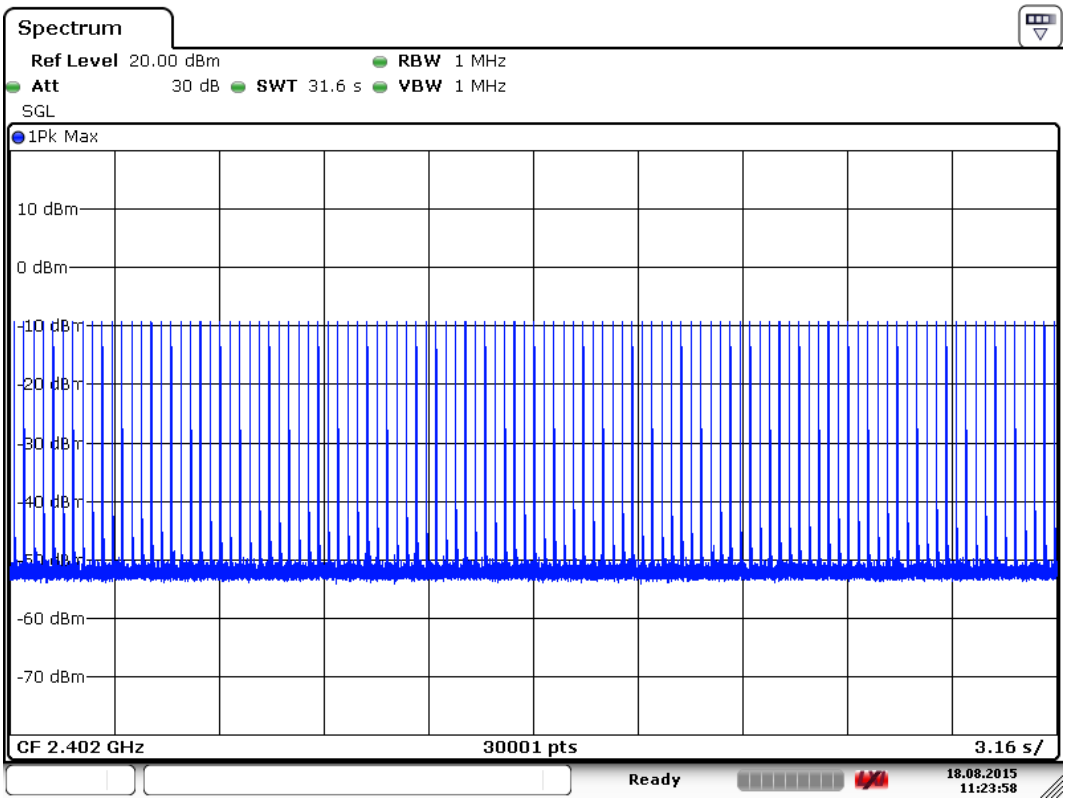
Test figure (3DH1 for representative, total points of the much higher level=354):



Test figure (3DH3 for representative, total points of the much higher level=360):



Test figure (3DH5 for representative, total points of the much higher level=370):



For channel 78:2.480GHz

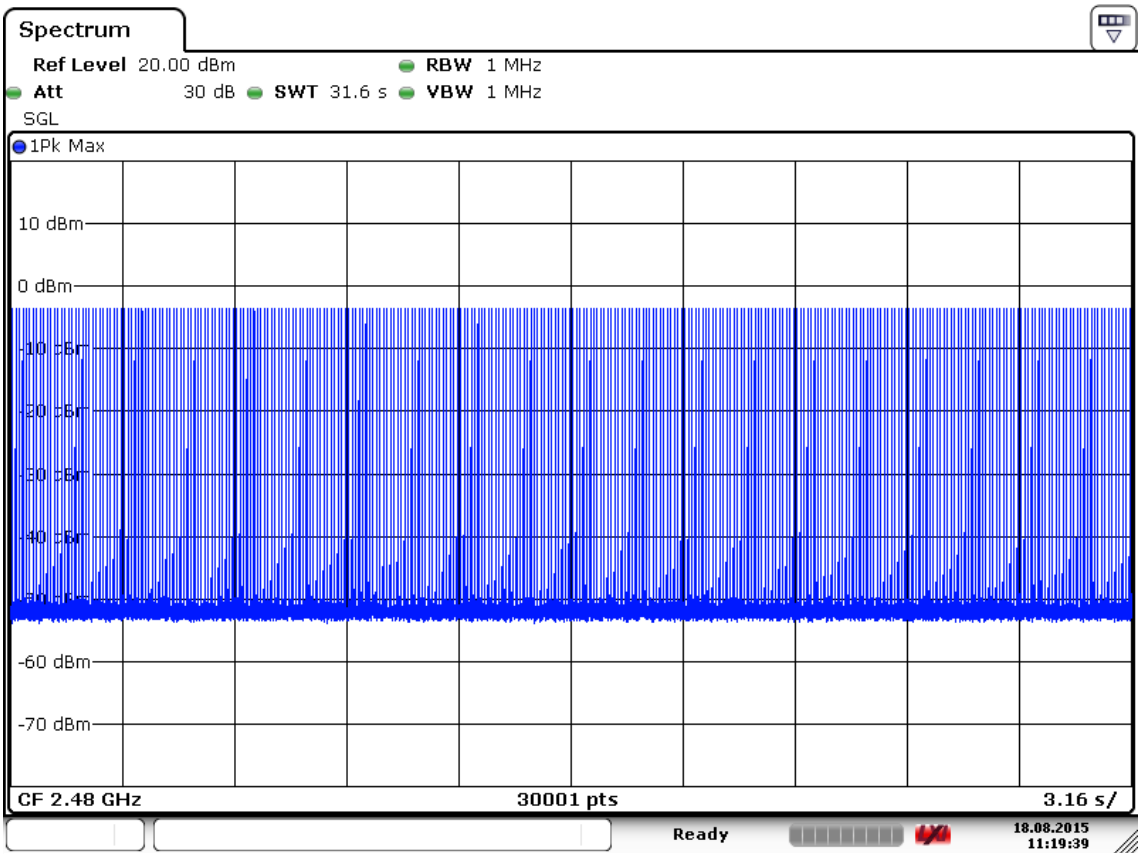
EUT Mode (worst case)	Results	Limit
	The accumulated Dwell time(ms)	
3DH1	385.5	≤ 400 ms
3DH3	331.8	
3DH5	337.1	

Remark:

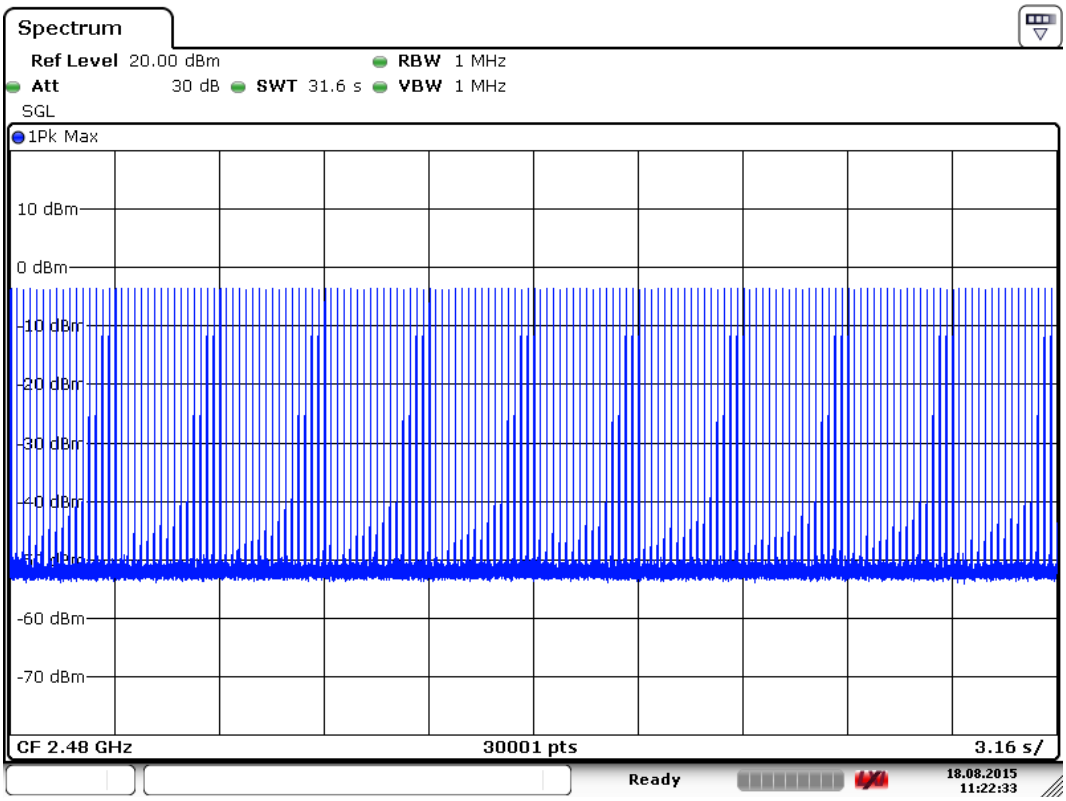
The accumulated Dwell time =

the total points of the much higher level * Sweep time (31.6 s)/ Sweep points (30000)

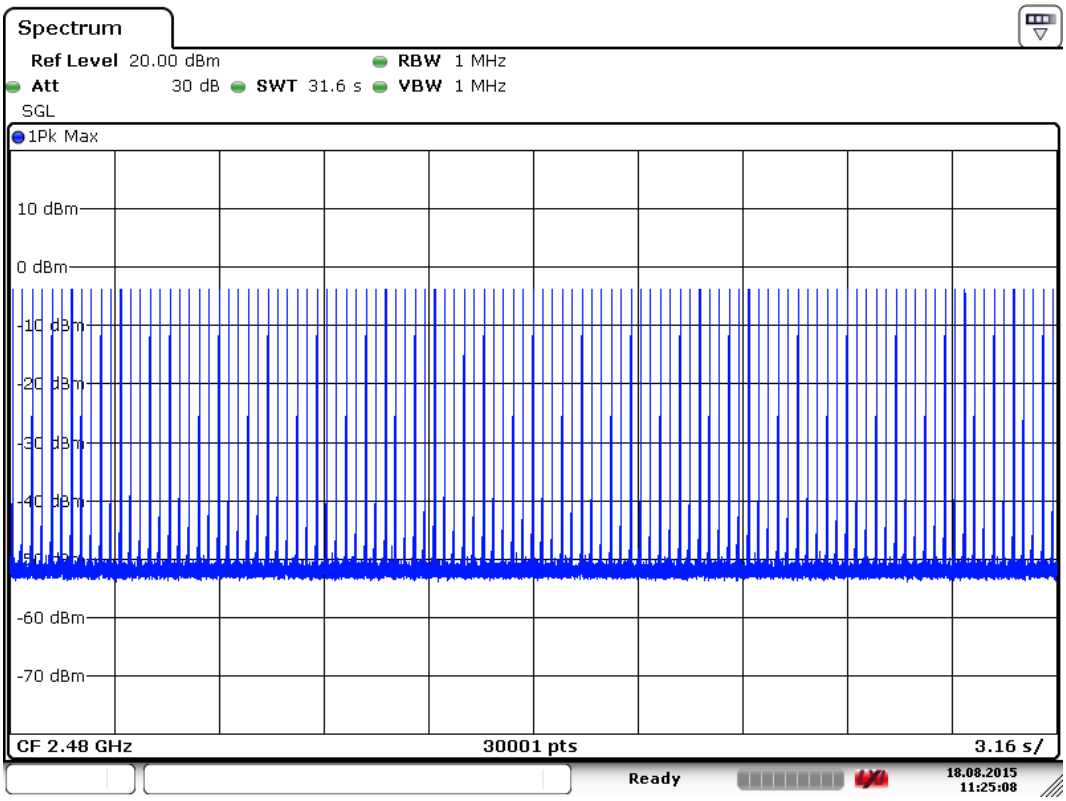
Test figure (3DH5 for representative, total points of the much higher level=366):



Test figure (3DH3 for representative, total points of the much higher level=315):



Test figure (3DH5 for representative, total points of the much higher level=320):

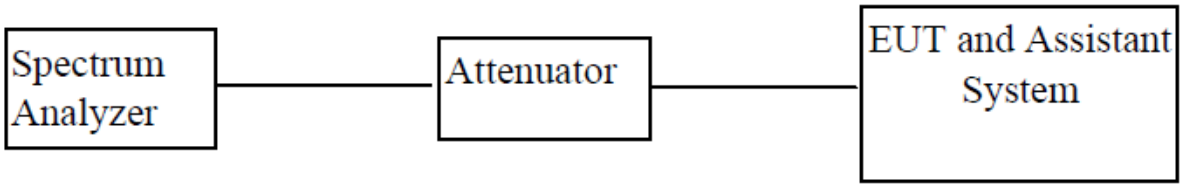


10 BAND EDGES REQUIREMENT& CONDUCTED SPURIOUS EMISSIONS

10.1 Test equipment

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1	Spectrum analyzer	R&S	FSV	SN101012	2014/09/11	1 Year
2	Attenuator	Mini-Circuits	BW-S10W2	101109	2014/11/26	1 Year
3	RF Cable	Micable	C10-01-01-1	100309	2014/11/26	1 Year

10.2 Block diagram of test setup



10.3 Test Procedure

(1) Configure EUT and Assistant system according to 4.1 and 8.2;
(2) Connect EUT's antenna output to spectrum analyzer by RF cable;
(3) Configure EUT working in test mode as state in 4.1;
(4) The carrier frequency was measured by spetrum analyzer with 100 kHz RBW and 300 KHz VBW.

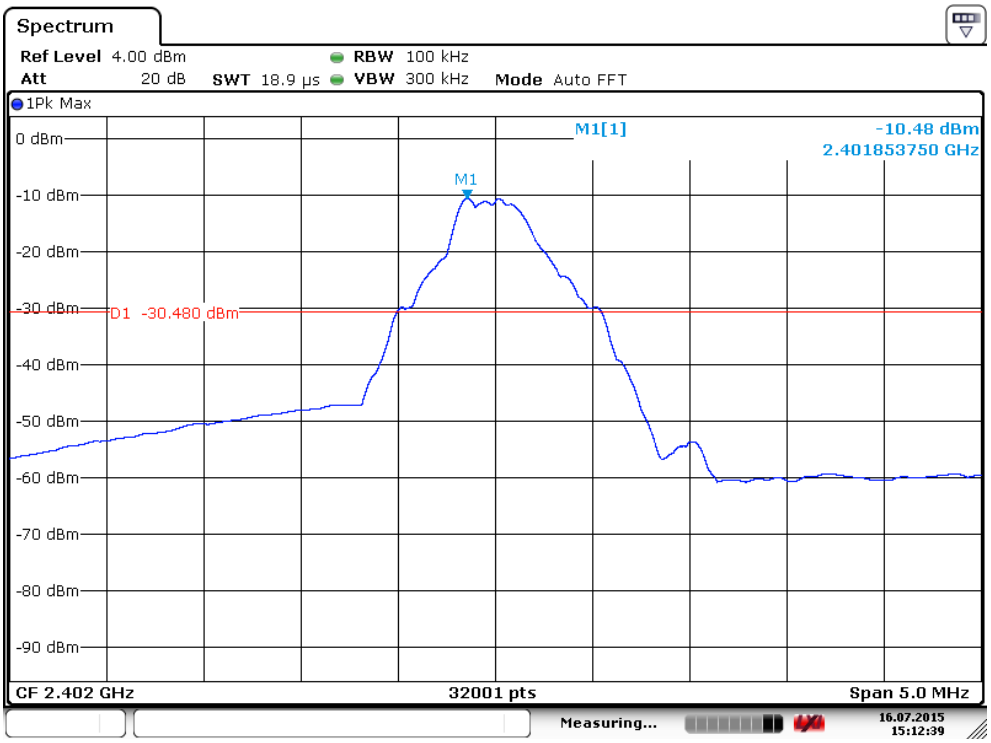
10.4 Requirement and limit

(d) 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 Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

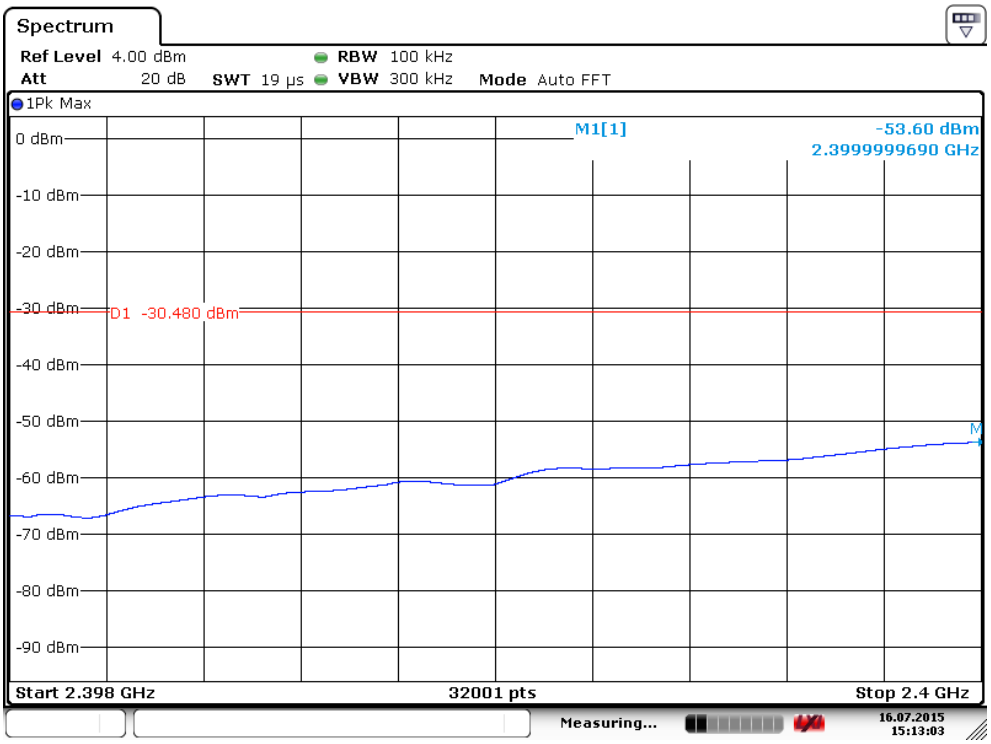
10.5 Test results

10.5.1 Band edge

GFSK 2402

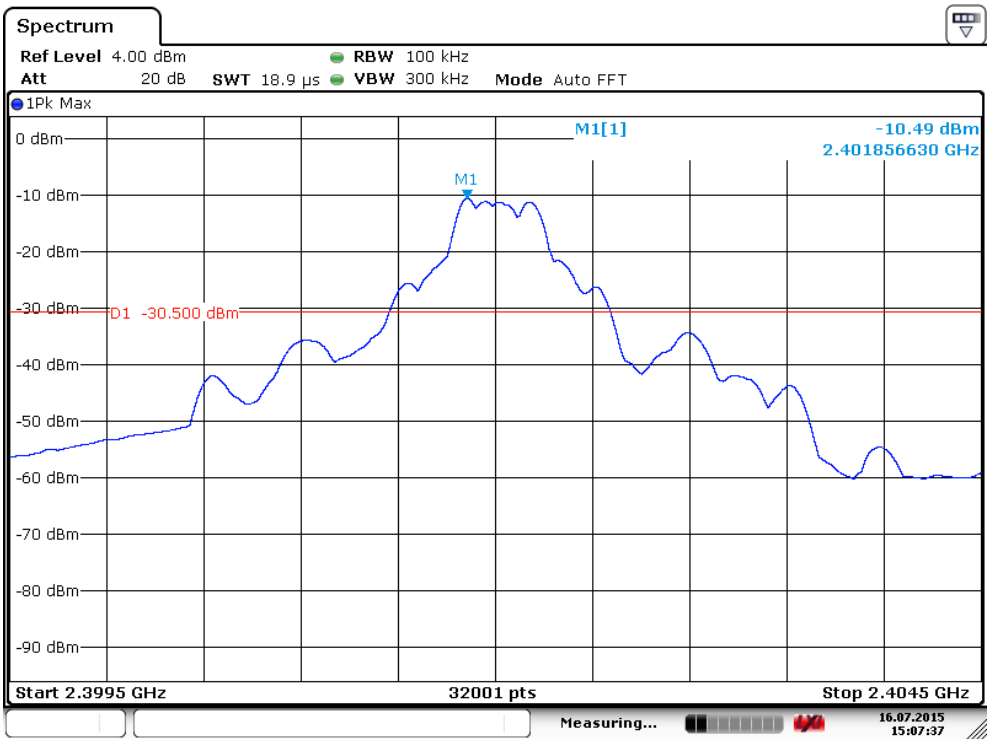


Date: 16.JUL.2015 15:12:39

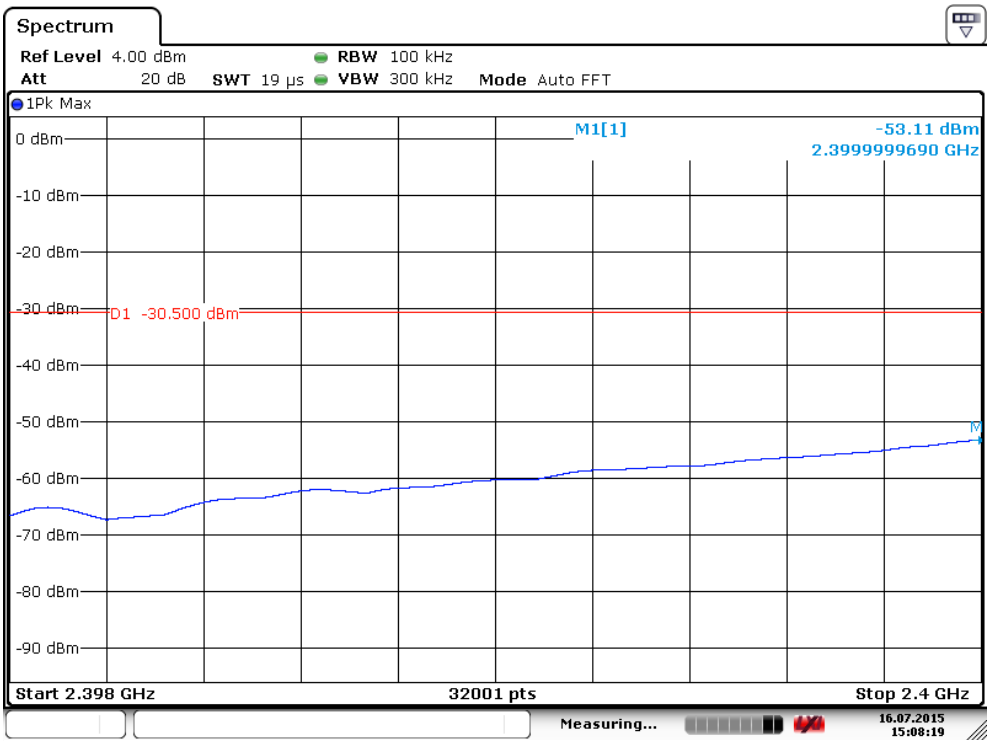


Date: 16.JUL.2015 15:13:04

Л/4 QPSK 2402

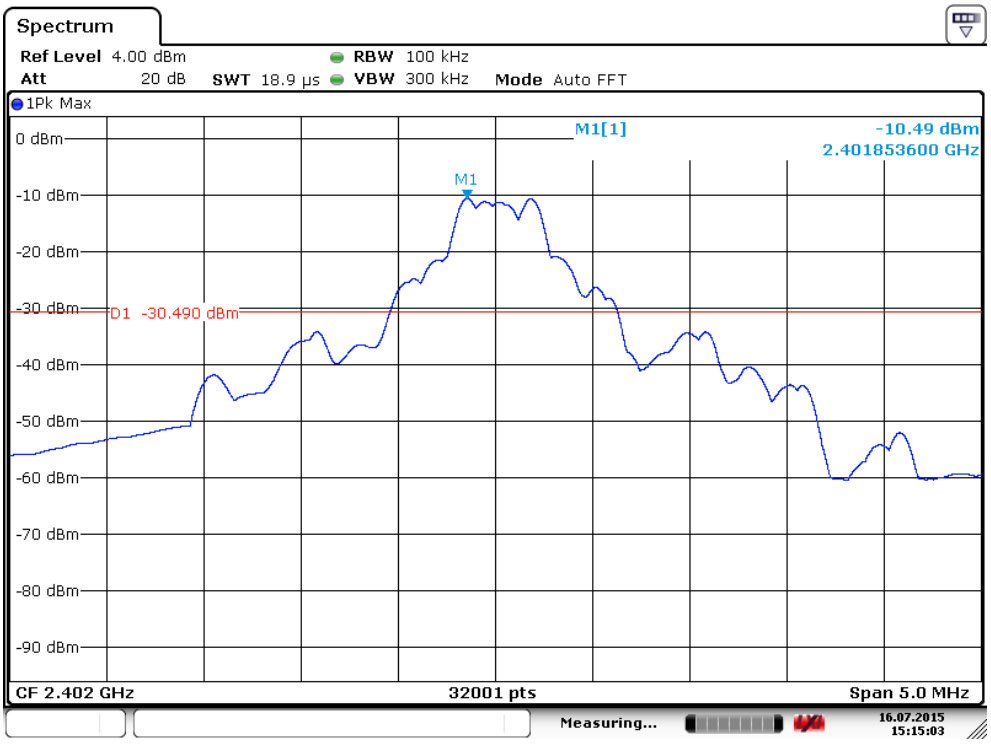


Date: 16.JUL.2015 15:07:37

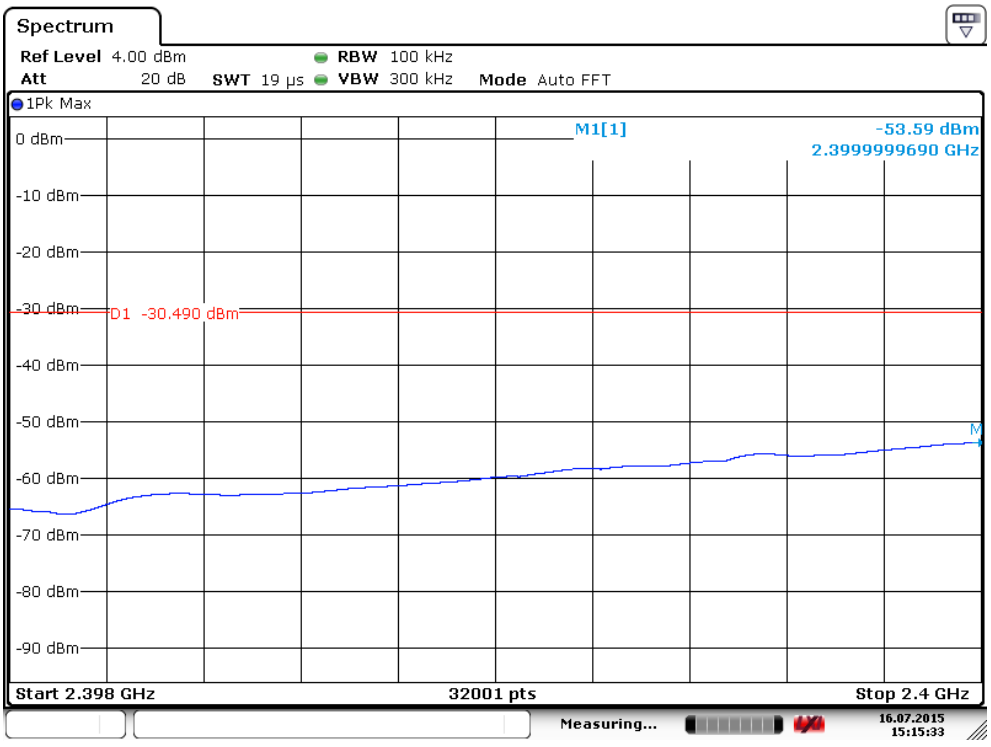


Date: 16.JUL.2015 15:08:19

8-DPSK 2402

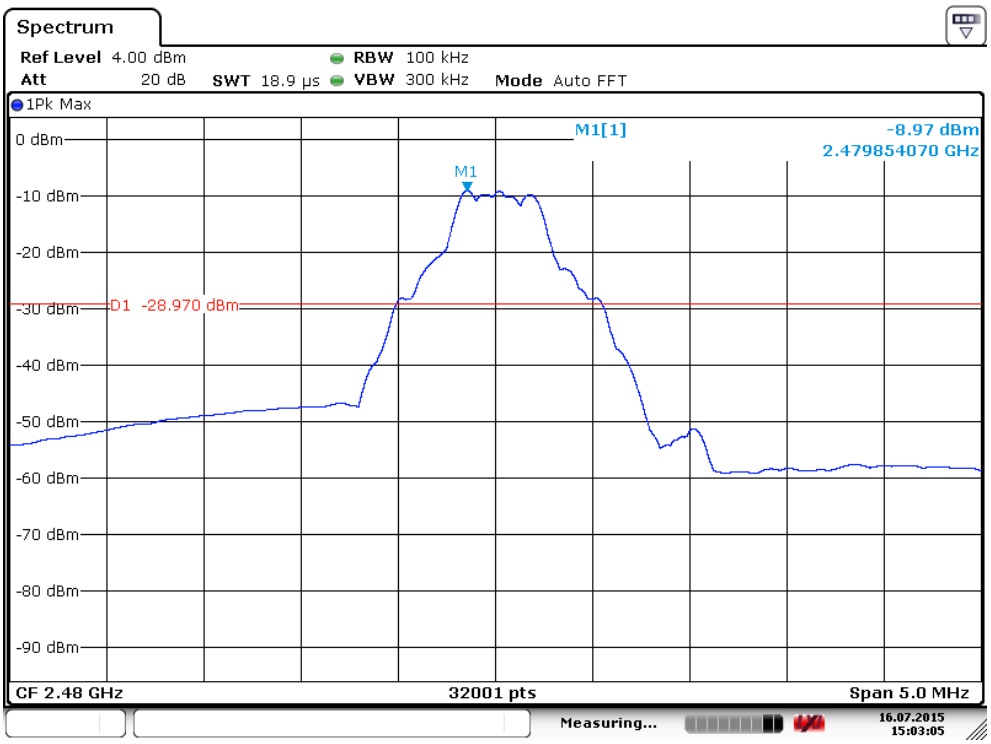


Date: 16.JUL.2015 15:15:03

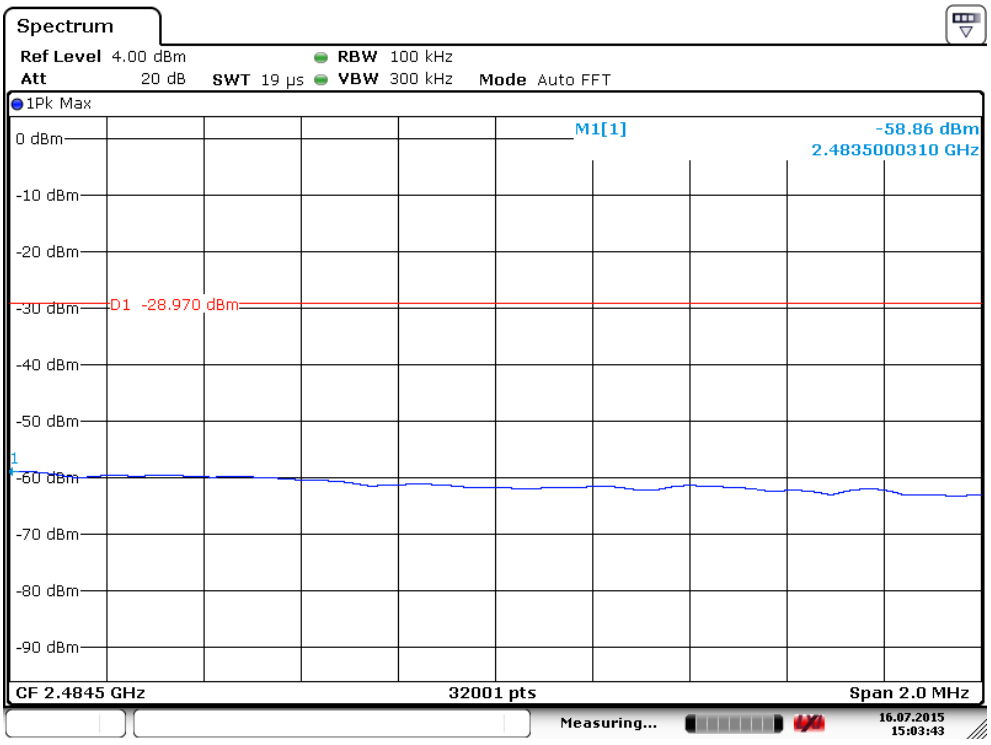


Date: 16.JUL.2015 15:15:33

GFSK 2480

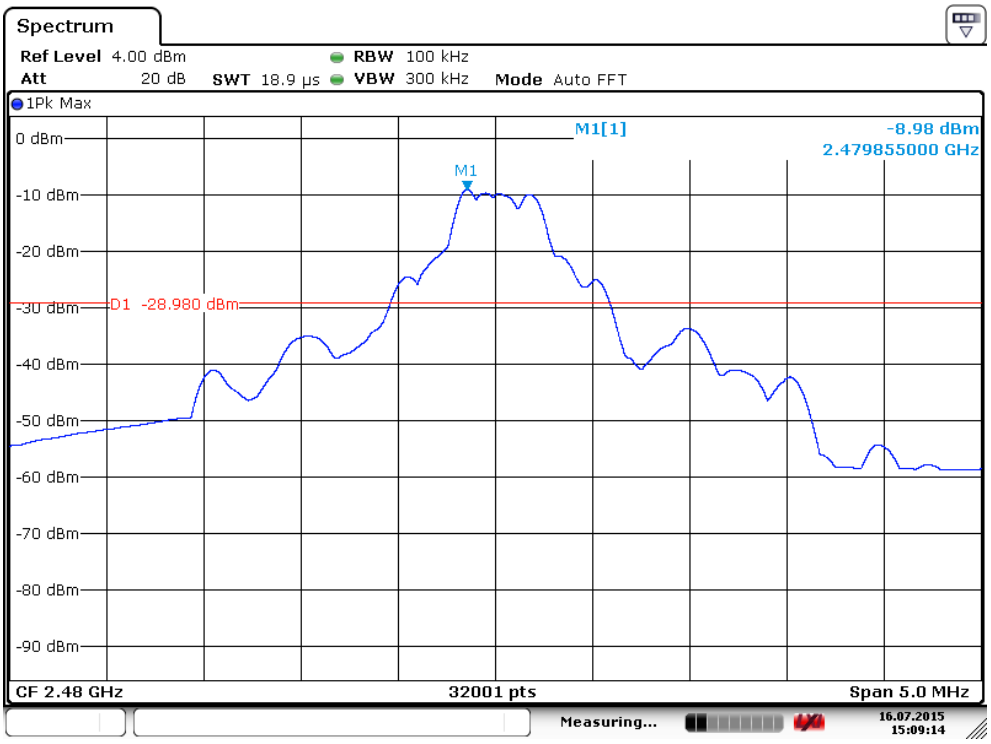


Date: 16.JUL.2015 15:03:06

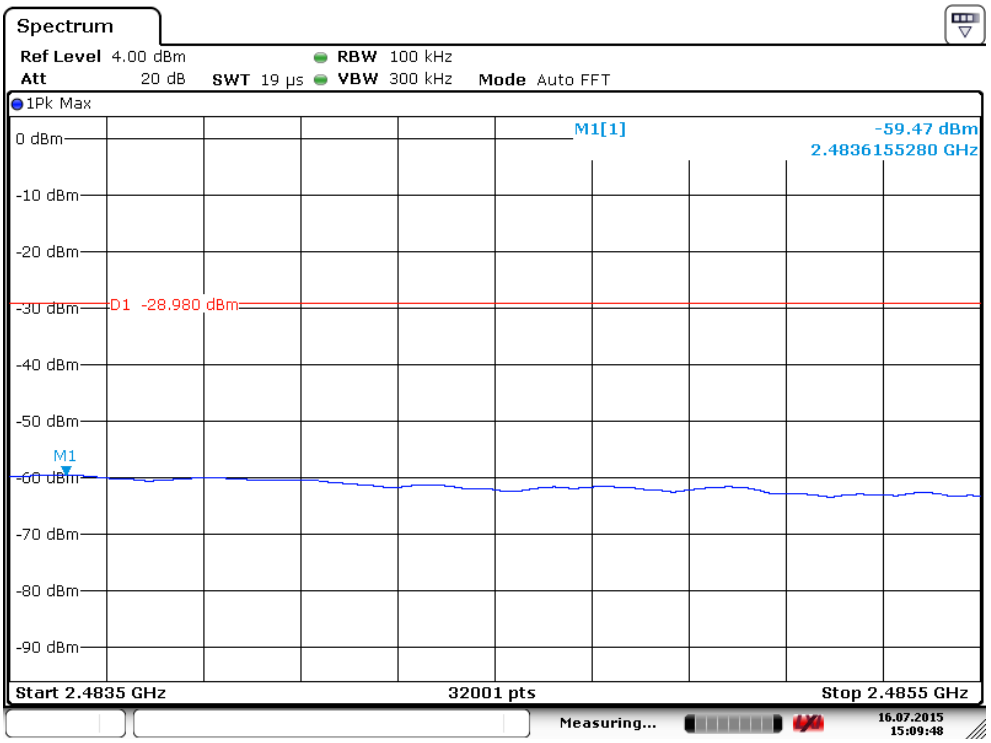


Date: 16.JUL.2015 15:03:43

Л/4 QPSK 2480

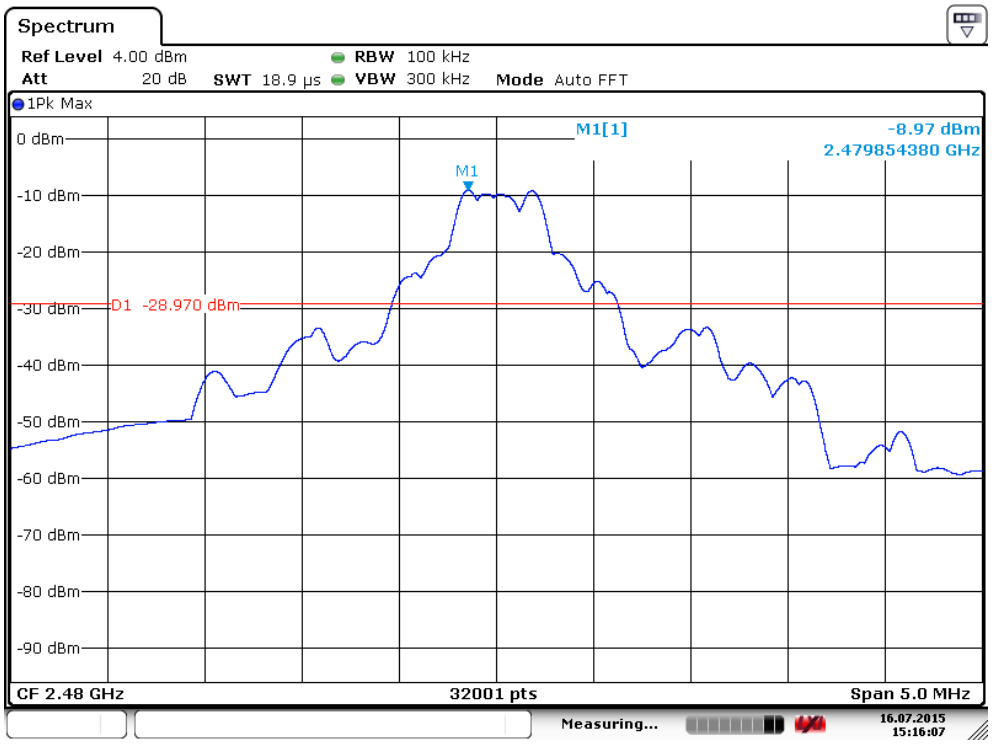


Date: 16.JUL.2015 15:09:14



Date: 16.JUL.2015 15:09:48

8-DPSK 2480



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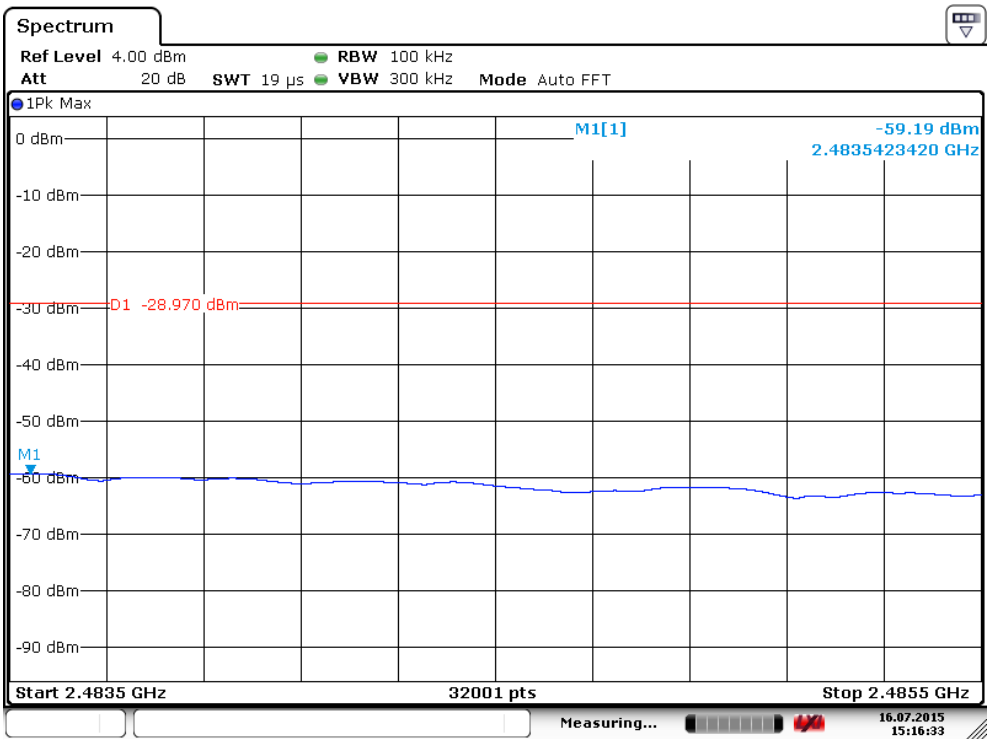


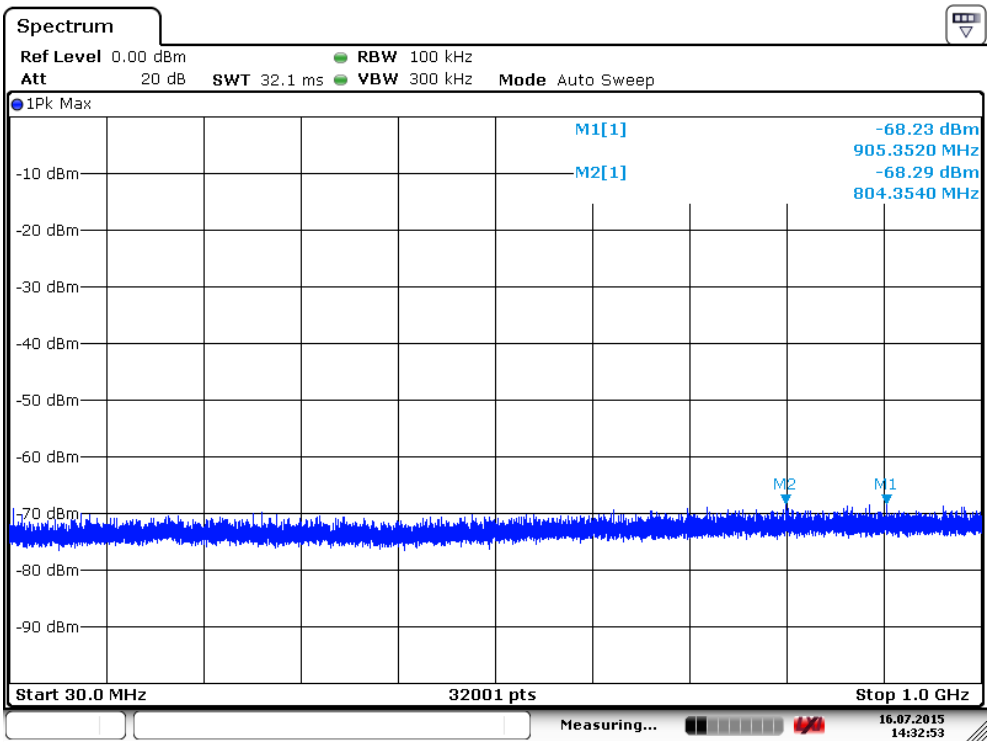
Date: 16.JUL.2015 15:16:33

Compare with the output power of the lowest frequency, the Lower Edges attenuated more than 20dB
Compare with the output power of the highest frequency, the Upper Edges attenuated more than 20dB.

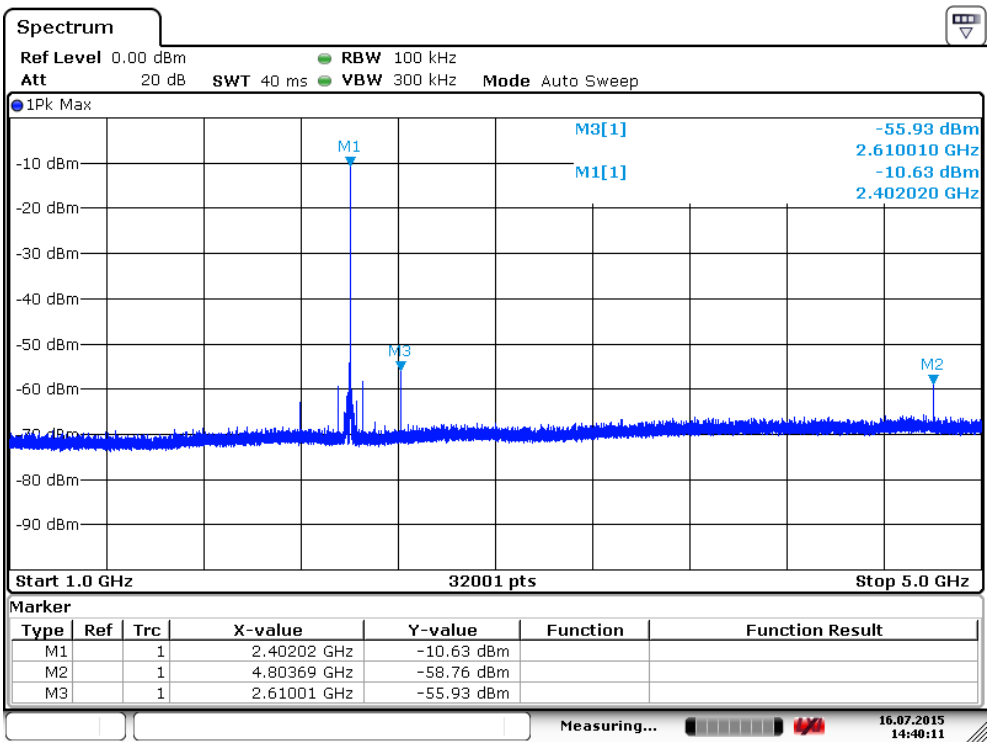
10.5.2 Conducted spurious emissions

For Л/4 QPSK, 8-DPSK in modulation type, and based exploratory test, there is no significant difference of GFSK test result, except output power, Test were performed GFSK only.

GFSK 2402



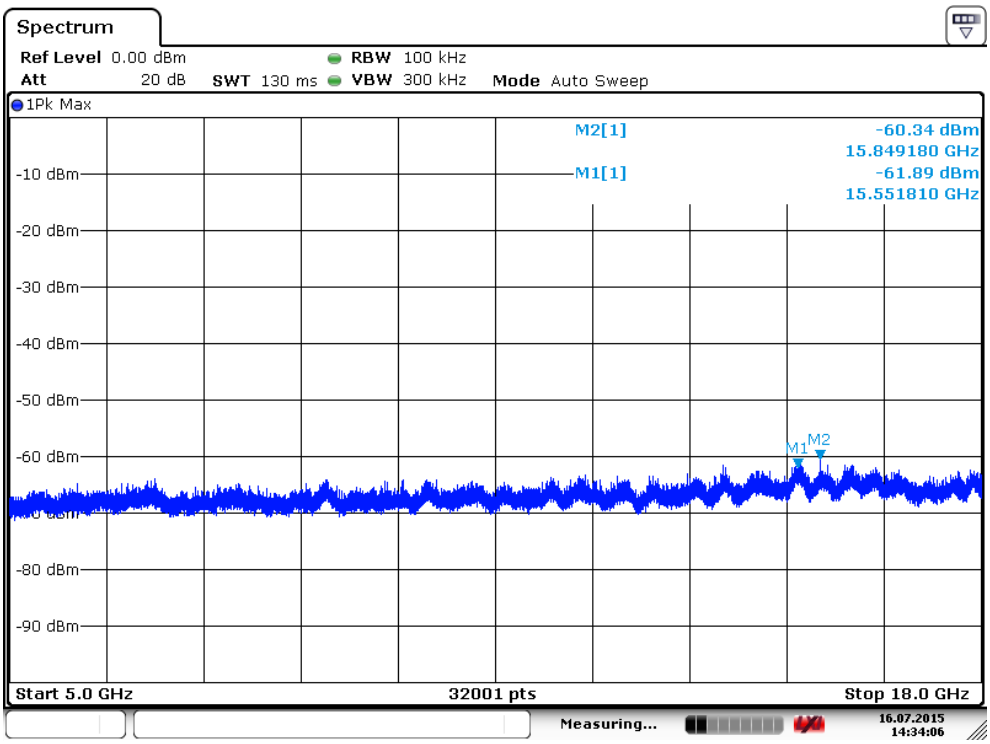
Date: 16.JUL.2015 14:32:53



Marker

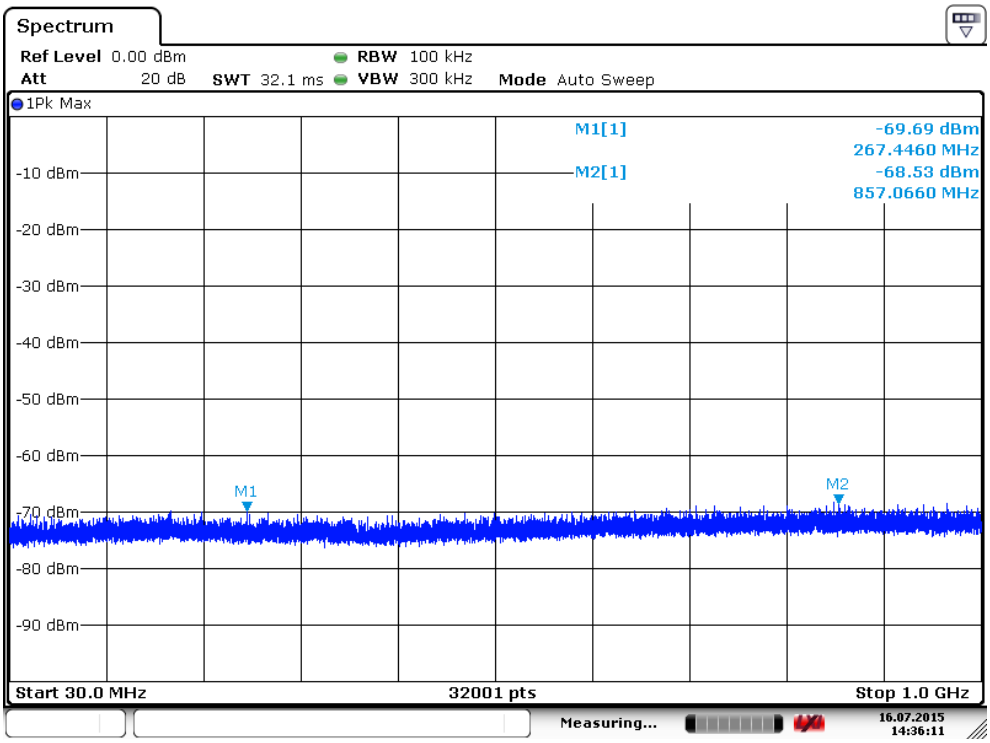
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40202 GHz	-10.63 dBm		
M2		1	4.80369 GHz	-58.76 dBm		
M3		1	2.61001 GHz	-55.93 dBm		

Date: 16.JUL.2015 14:40:12

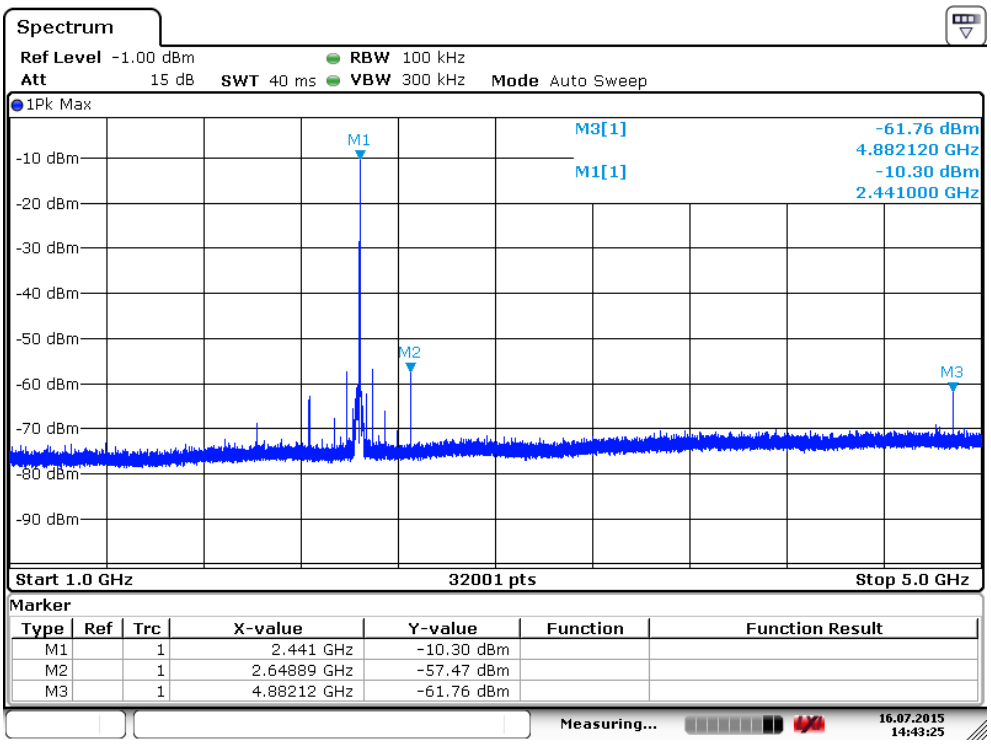


Date: 16.JUL.2015 14:34:06

GFSK 2441



Date: 16.JUL.2015 14:36:10



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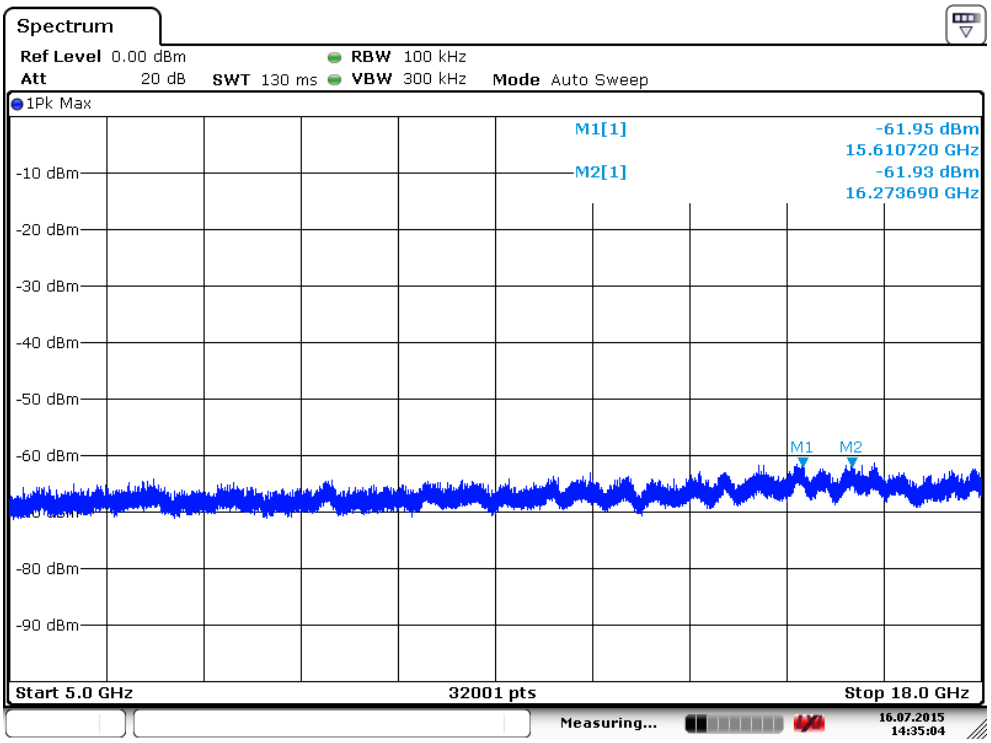
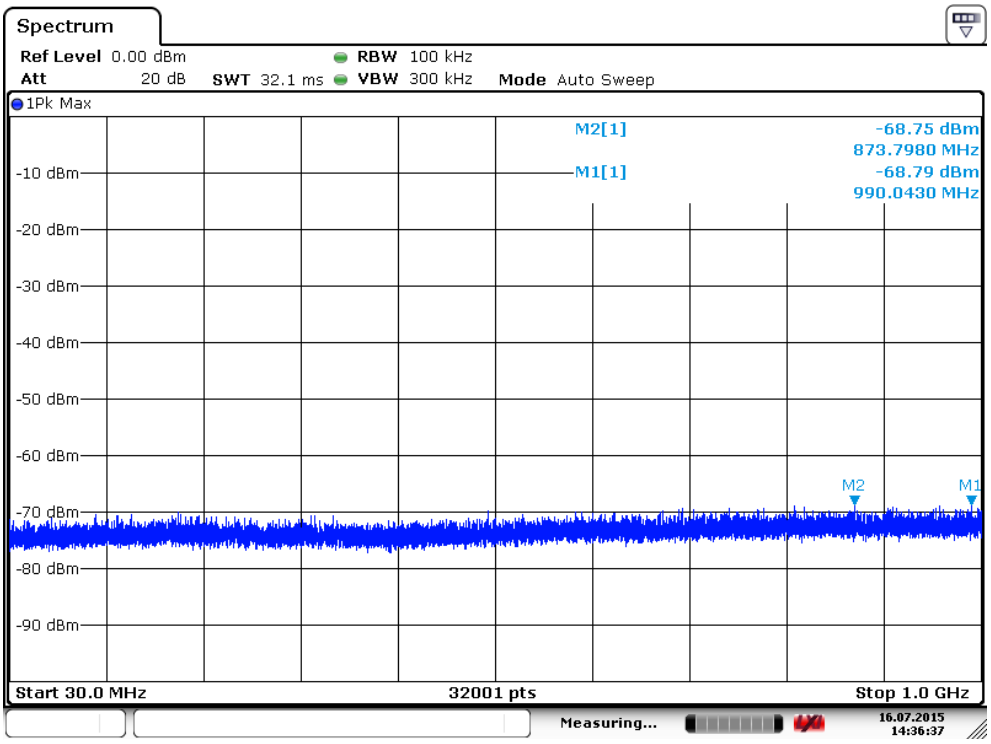


Date: 16.JUL.2015 14:35:04

GFSK 2480



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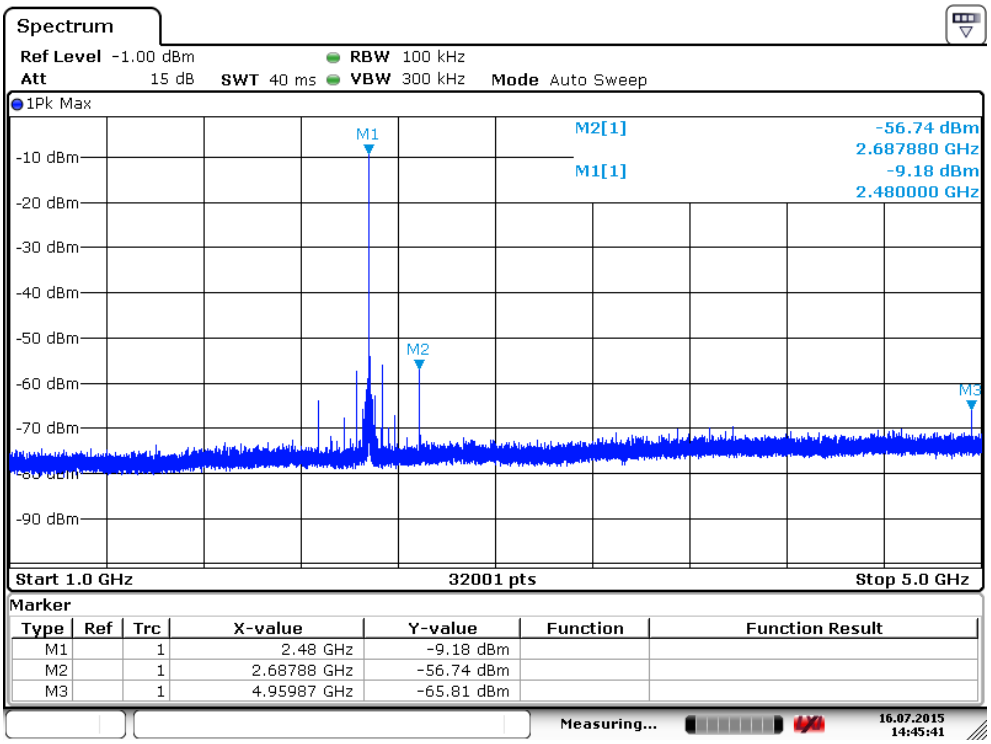

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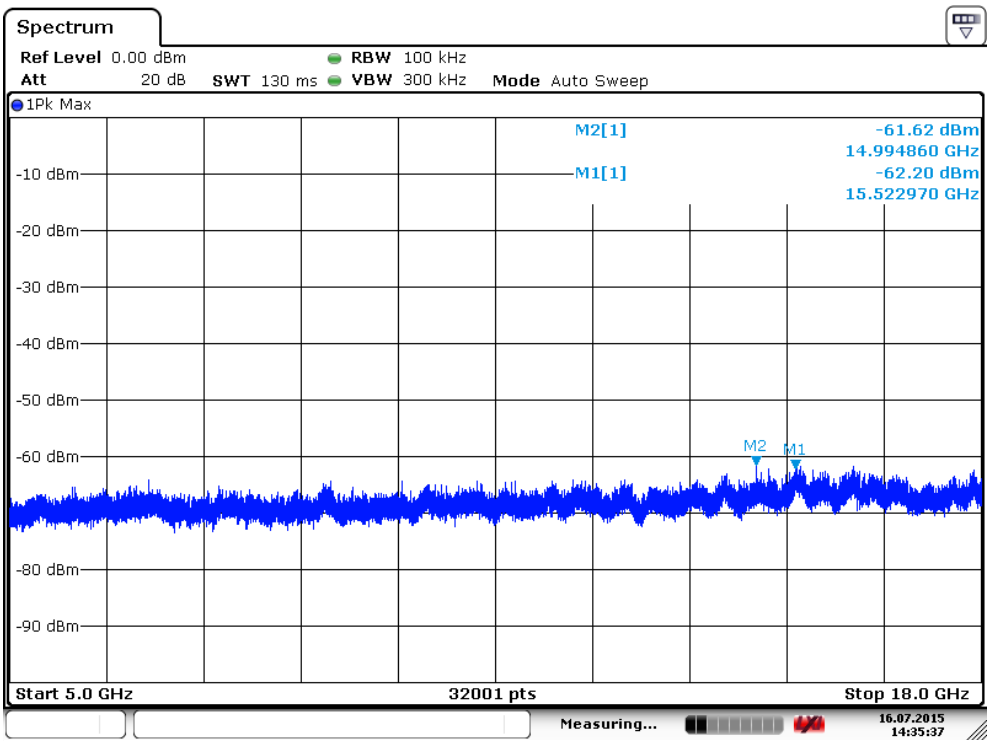


Date: 16.JUL.2015 14:35:37

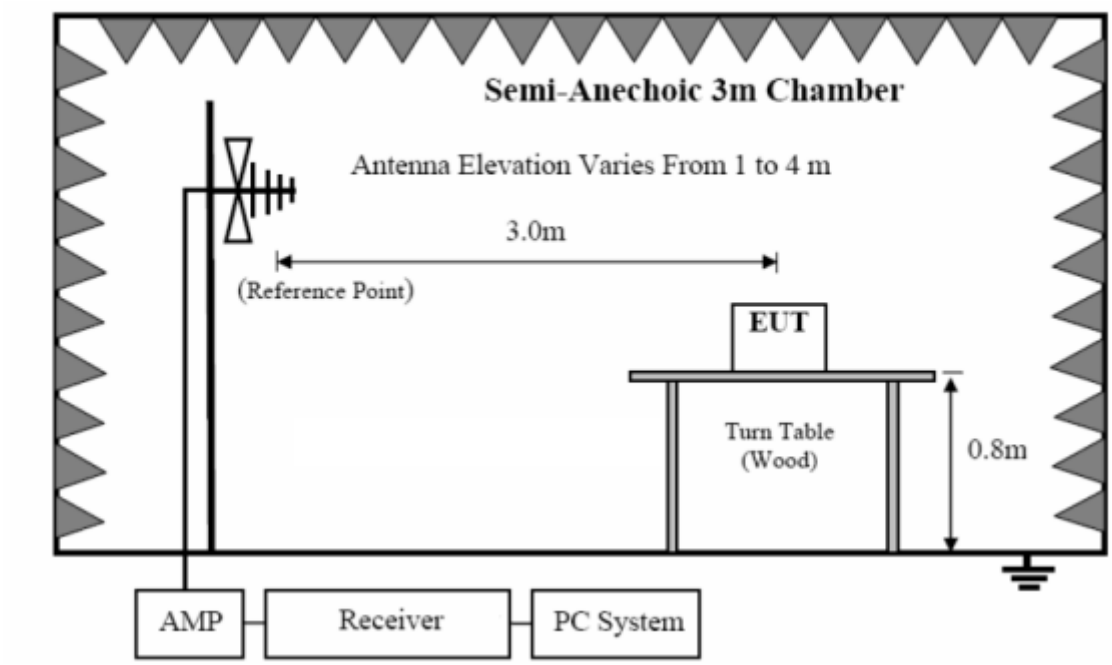
11 RADIATED EMISSION

11.1 Test equipment

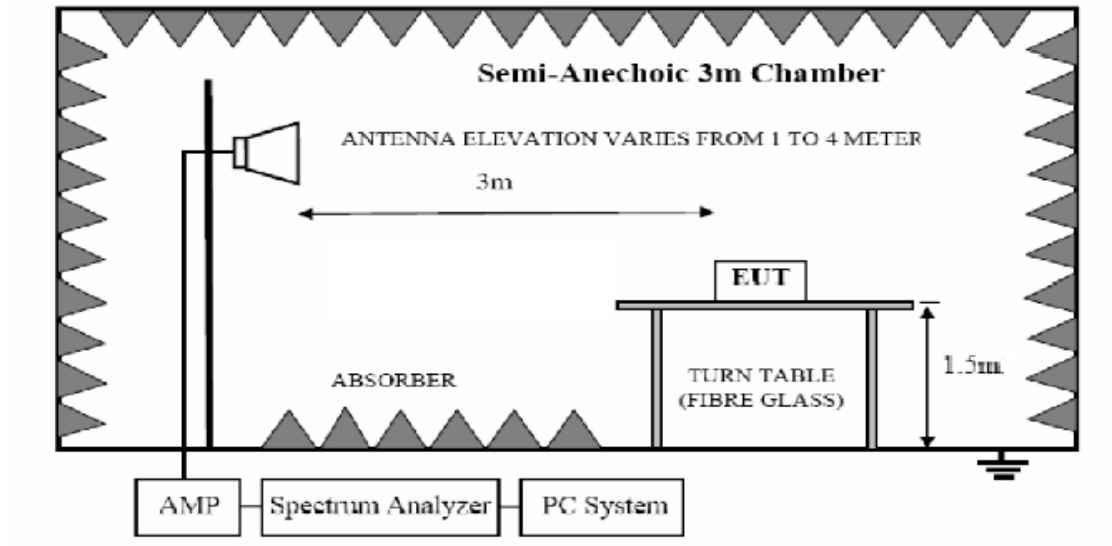
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1	EMI Receiver	R&S	ESU8	100316	2014/11/26	1 Year
2	Spectrum Analyzer	R&S	FSU	1166.1660.26	2014/11/26	1 Year
3	Loop Antenna	TESEQ	HLA6120	20129	2014/11/26	1 Year
4	Trilog Broadband Antenna	Schwarzbeck	VULB9163	9163-462	2014/11/26	1 Year
5	Double Ridged Horn Antenna	R&S	HF907	100276	2014/11/26	1 Year
6	Horn Antenna	EMCO	3116	00060095	2014/11/26	1 Year
7	Pre-Amplifier	R&S	SCU-01	10049	2014/11/26	1 Year
8	Pre-Amplifier	A.H.	PAM0-0118	360	2014/11/26	1 Year
9	Pre-Amplifier	A.H.	PAM-1840VH	562	2014/11/26	1 Year
10	RF Cable	R&S	R01	10403	2014/11/26	1 Year
11	RF Cable	R&S	R02	10512	2014/11/26	1 Year
12	Notch filter	EM electronics corp	BRM50701	S/N-037	2014/11/26	1 Year

11.2 Block diagram of test setup

In 3m Anechoic Chamber Test Setup Diagram for below 1GHz



In 3m Anechoic Chamber Test Setup Diagram for frequency above 1GHz



Note: For harmonic emissions test a appropriate high pass filter was inserted in the input port of AMP.

11.3 Limits

11.3.1 FCC 15.205 restricted frequency band

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])

11.3.2 FCC 15.209 limit

Frequency (MHz)	Distance (m)	Field Strength Limit	
		uV/m	dB(uV)/m
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	74,0 dB(uV)/m for Peak 54,0 dB(uV/m) for Average	

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 20 dB below the fundamental emissions, or comply with 15.209 limits.

Note1: For Л/4 QPSK, 8-DPSK in modulation type, and based exploratory test, there is no significant difference of GFSK test result, except output power. Compliance test in continuous transmitting mode with GFSK as the worst case was found. Hence, the test (Harmonic and other spurious emissions) was performed GFSK only.

Note2: In order to protect the instrument, the notch filter (stop band from 2400MHz to 2500MHz) is used in the test (Harmonic and other spurious emissions above 1G).

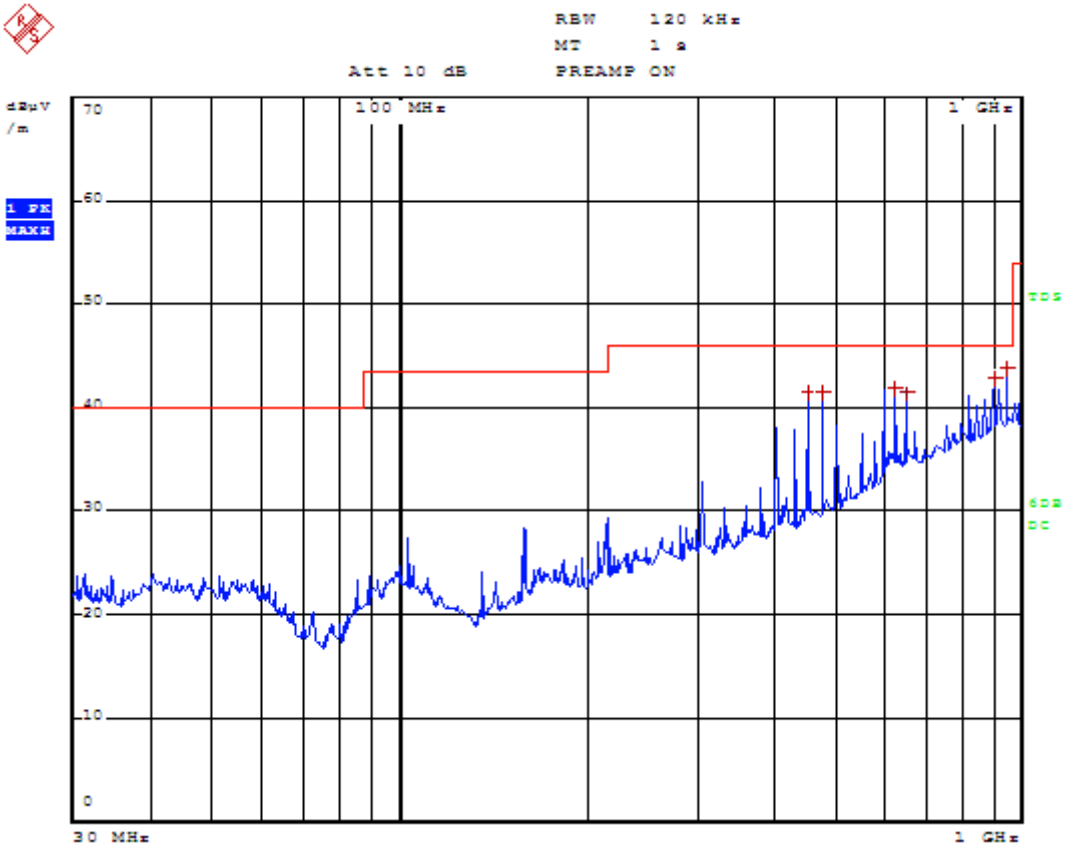
11.4 Harmonic and other spurious emissions

Test Result

Below 1G:

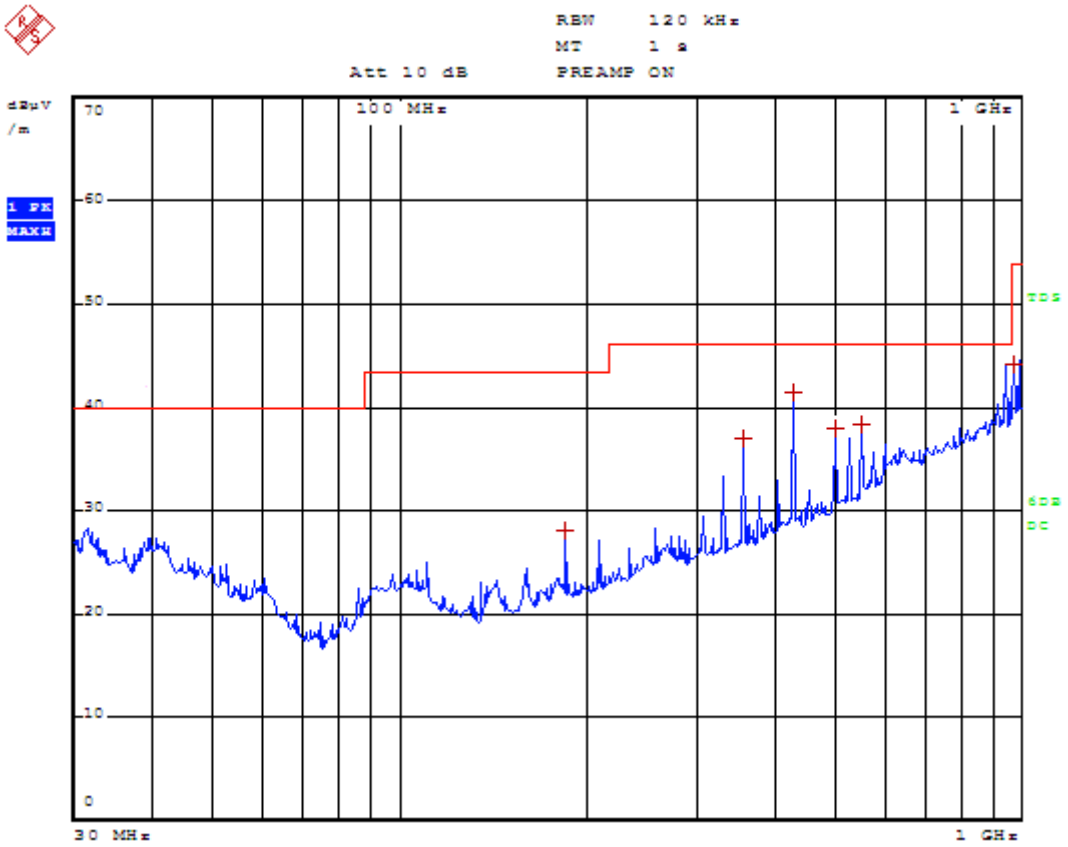
2402MHz

Horizontal:



Trace	Frequency(MHz)	Level (dBμV/m)	Margin(dB)
QP	425.26	41.21	-4.79
QP	430.08	41.41	-4.59
QP	625.21	42.21	-3.79
QP	634.01	41.15	-4.85
QP	901.25	41.25	-4.75
QP	970.76	44.13	-9.86

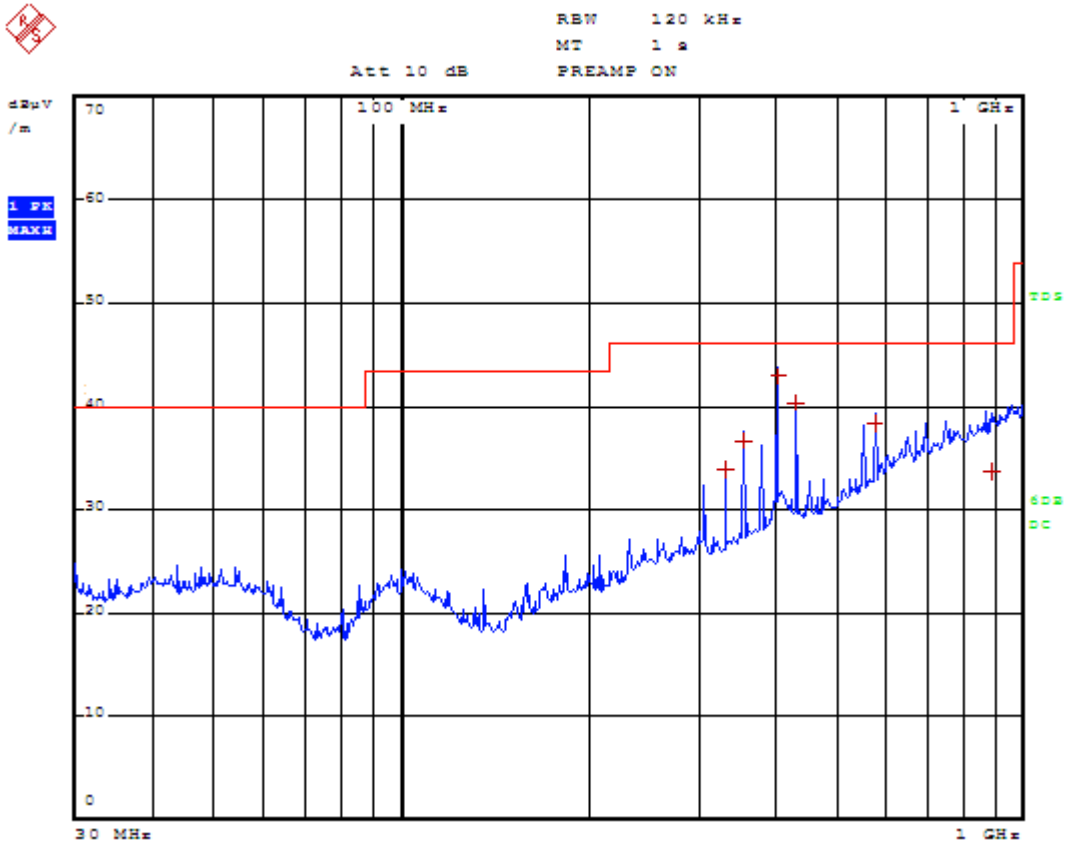
Vertical:



Trace	Frequency(MHz)	Level (dBμV/m)	Margin(dB)
QP	190.25	27.21	-16.29
QP	350.18	38.01	-7.99
QP	454.64	41.41	-4.59
QP	504.01	39.25	-6.75
QP	541.95	39.75	-6.25
QP	970.76	44.23	-9.77

2441MHz

Horizontal:

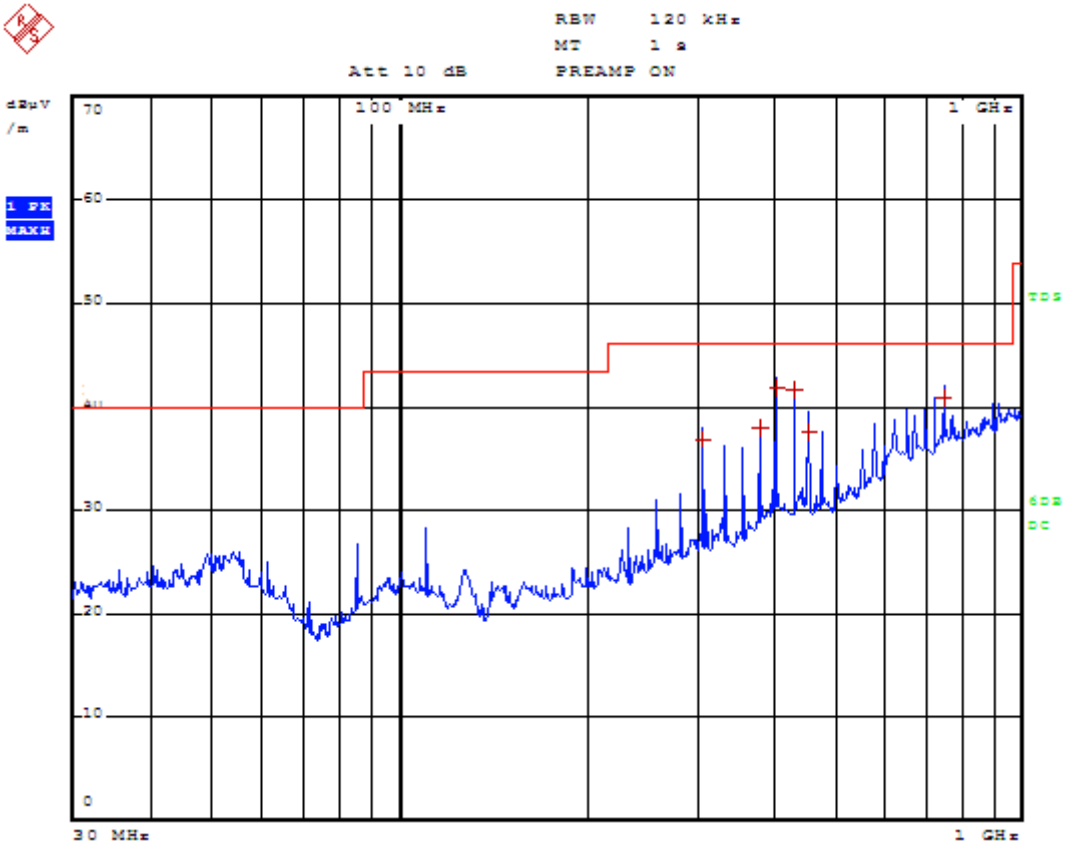


EDIT PEAK LIST (Final Measurement Results)

Trace1:
Trace2: ---
Trace3: ---

TRACE	FREQUENCY	LEVEL dBµV/m	DELTA LIMIT dB
1 Quasi Peak	405.52 MHz	42.90	-3.09
1 Quasi Peak	430.08 MHz	40.40	-5.59
1 Quasi Peak	577.52 MHz	38.30	-7.69
1 Quasi Peak	356.36 MHz	36.63	-9.36
1 Quasi Peak	331.76 MHz	33.88	-12.11
1 Quasi Peak	892.04 MHz	33.69	-12.30

Vertical:



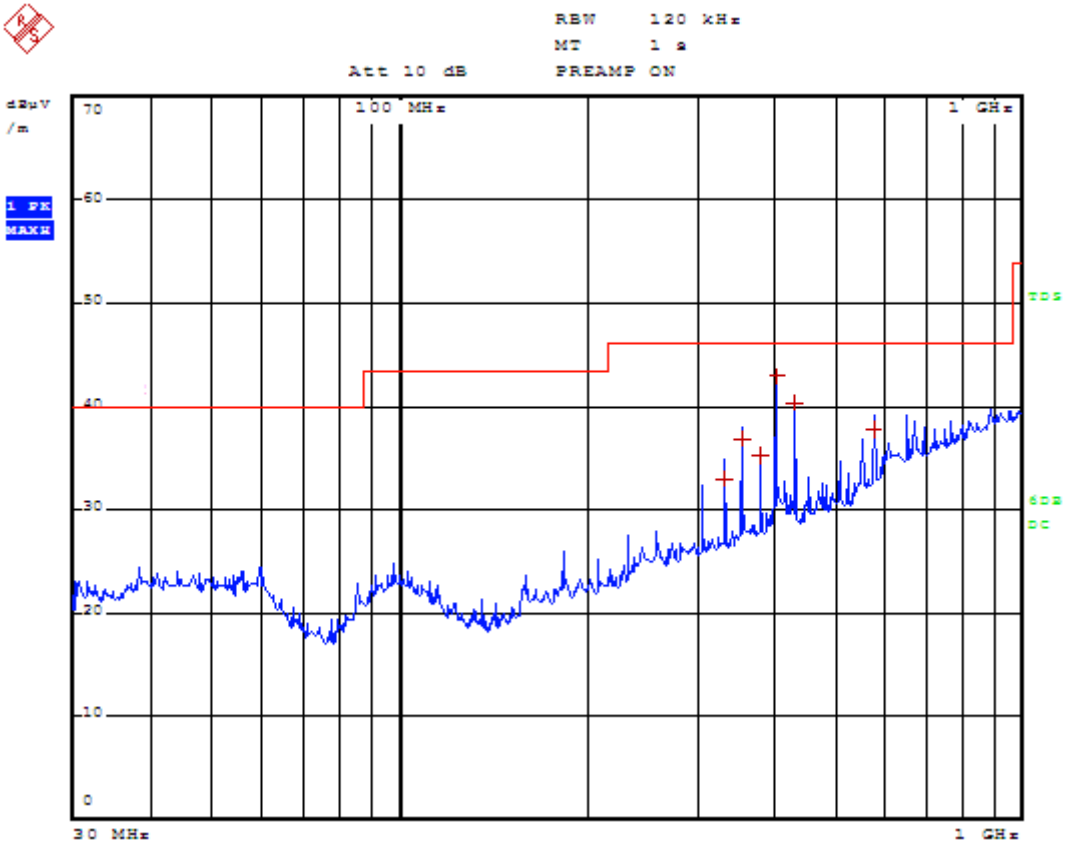
EDIT PEAK LIST (Final Measurement Results)

Trace1:
Trace2: ---
Trace3: ---

TRACE	FREQUENCY	LEVEL dBµV/m	DELTA LIMIT dB
1 Quasi Peak	405.52 MHz	41.86	-4.13
1 Quasi Peak	430.08 MHz	41.70	-4.29
1 Quasi Peak	749.56 MHz	40.85	-5.14
1 Quasi Peak	380.92 MHz	37.99	-8.00
1 Quasi Peak	454.68 MHz	37.63	-8.36
1 Quasi Peak	307.2 MHz	36.88	-9.11

2480MHz

Horizontal:

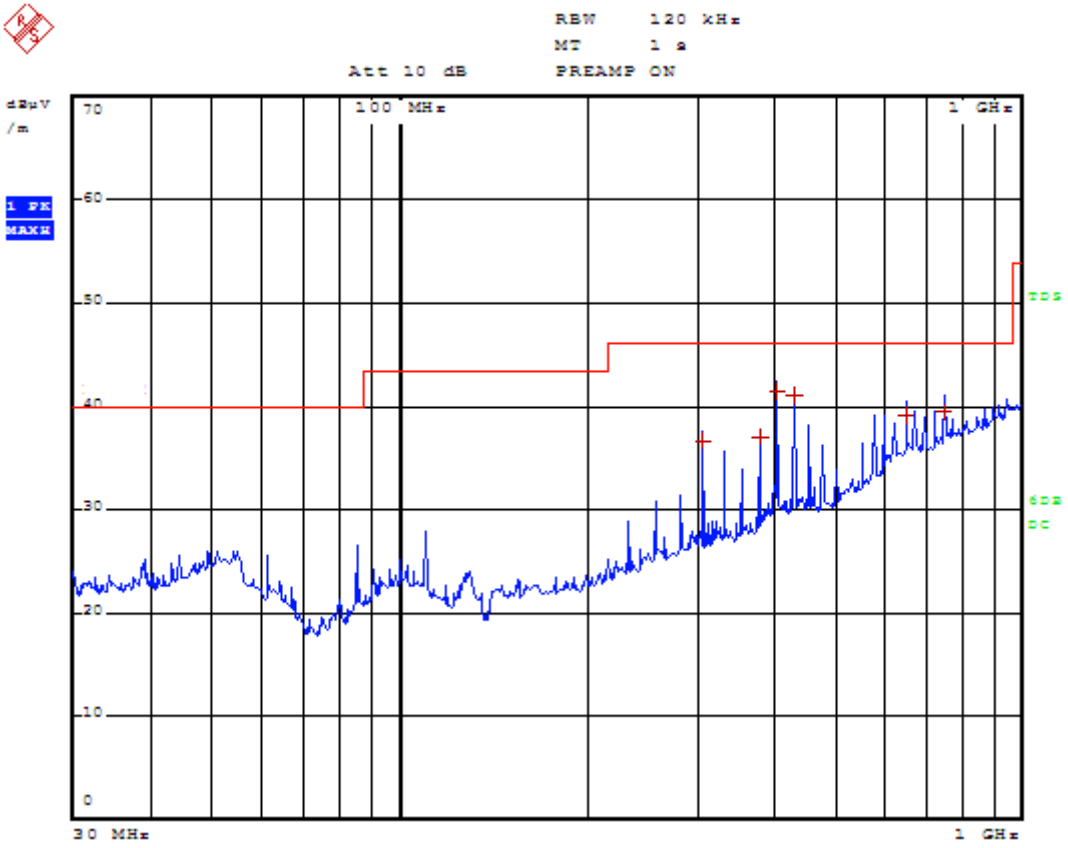


EDIT PEAK LIST (Final Measurement Results)

Trace1:
Trace2: ---
Trace3: ---

TRACE	FREQUENCY	LEVEL dBµV/m	DELTA LIMIT dB
1 Quasi Peak	405.52 MHz	42.89	-3.10
1 Quasi Peak	430.08 MHz	40.32	-5.67
1 Quasi Peak	577.52 MHz	37.71	-8.28
1 Quasi Peak	356.36 MHz	36.88	-9.11
1 Quasi Peak	380.92 MHz	35.22	-10.77
1 Quasi Peak	331.8 MHz	32.99	-13.00

Vertical:



EDIT PEAK LIST (Final Measurement Results)

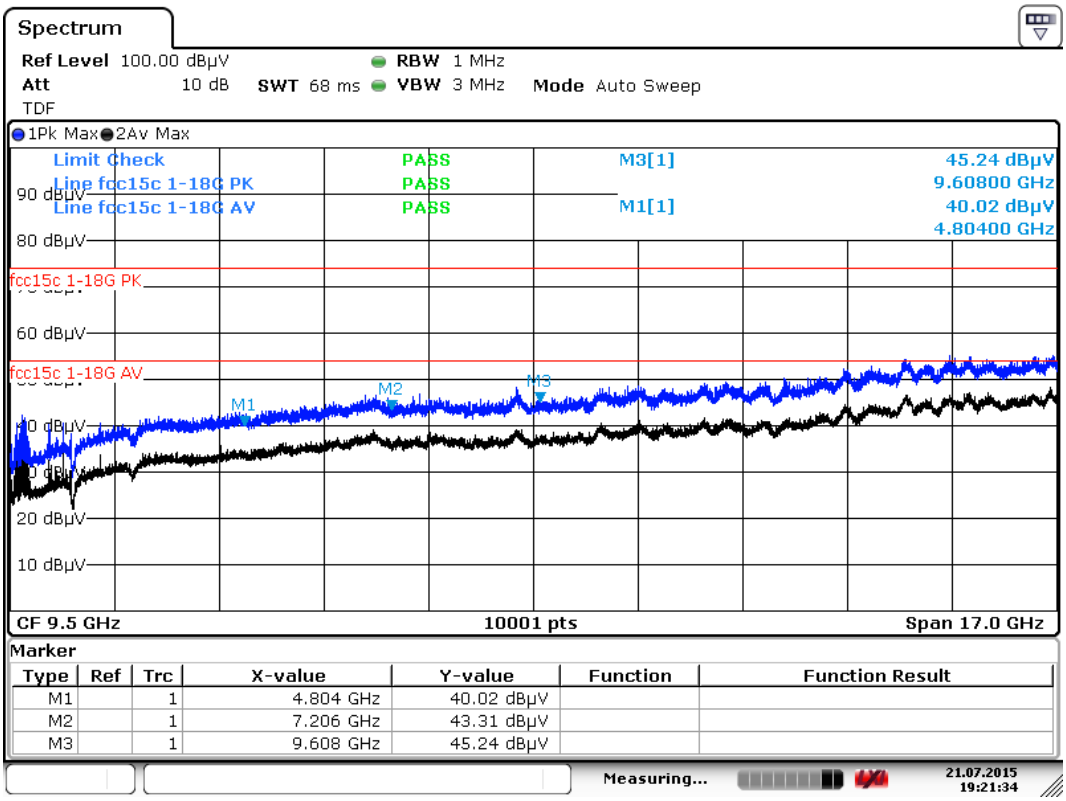
Trace1:
Trace2: ---
Trace3: ---

TRACE	FREQUENCY	LEVEL dBµV/m	DELTA LIMIT dB
1 Quasi Peak	405.52 MHz	41.51	-4.48
1 Quasi Peak	430.08 MHz	41.12	-4.87
1 Quasi Peak	749.56 MHz	39.45	-6.54
1 Quasi Peak	651.24 MHz	39.01	-6.98
1 Quasi Peak	380.92 MHz	37.06	-8.93
1 Quasi Peak	307.2 MHz	36.66	-9.33

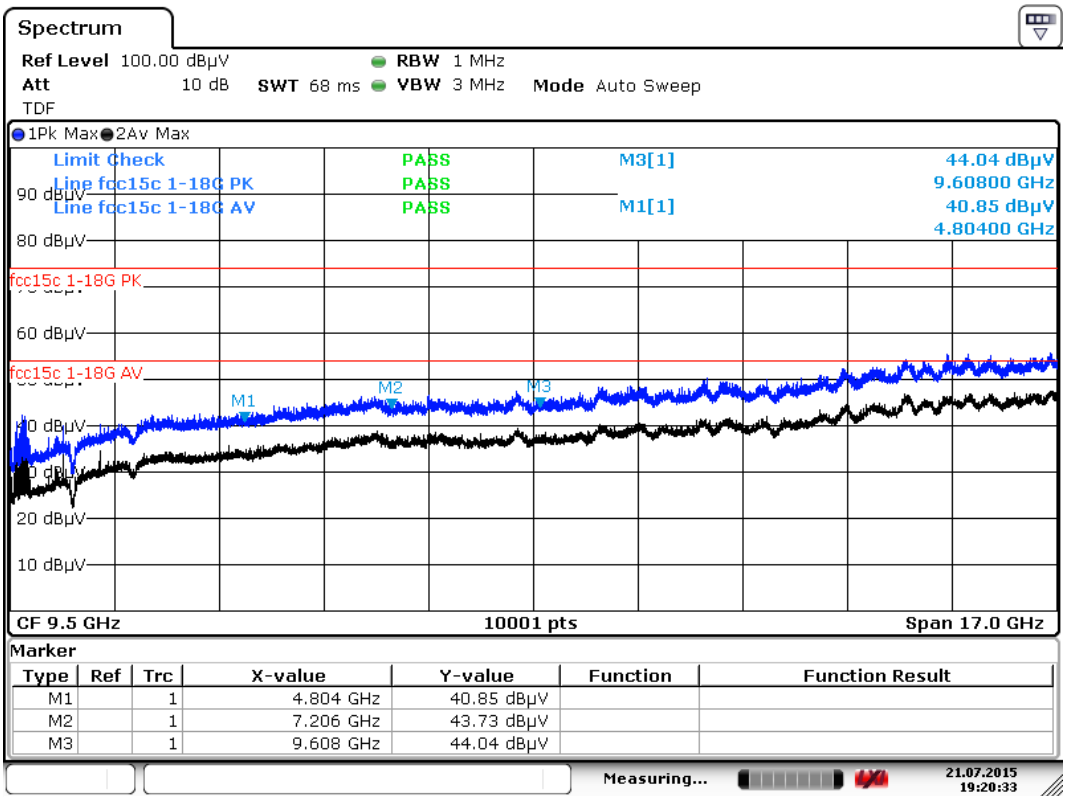
Above 1G

GFSK 2402MHz

Vertical:

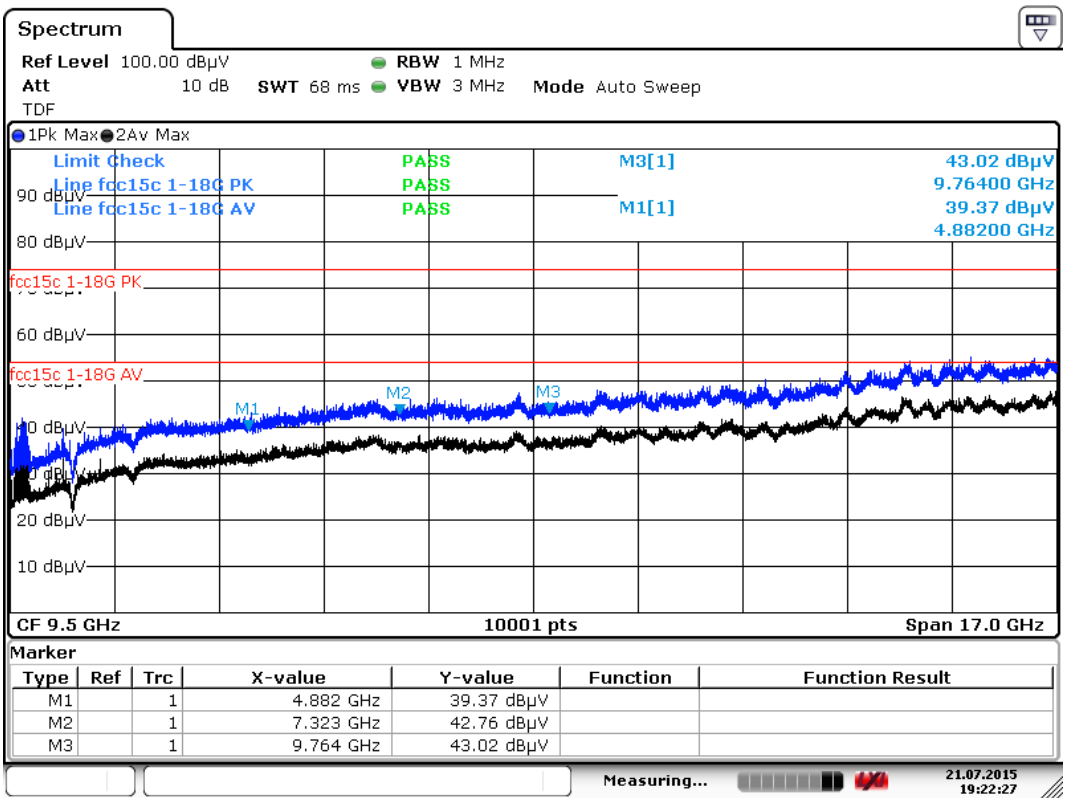


Horizontal

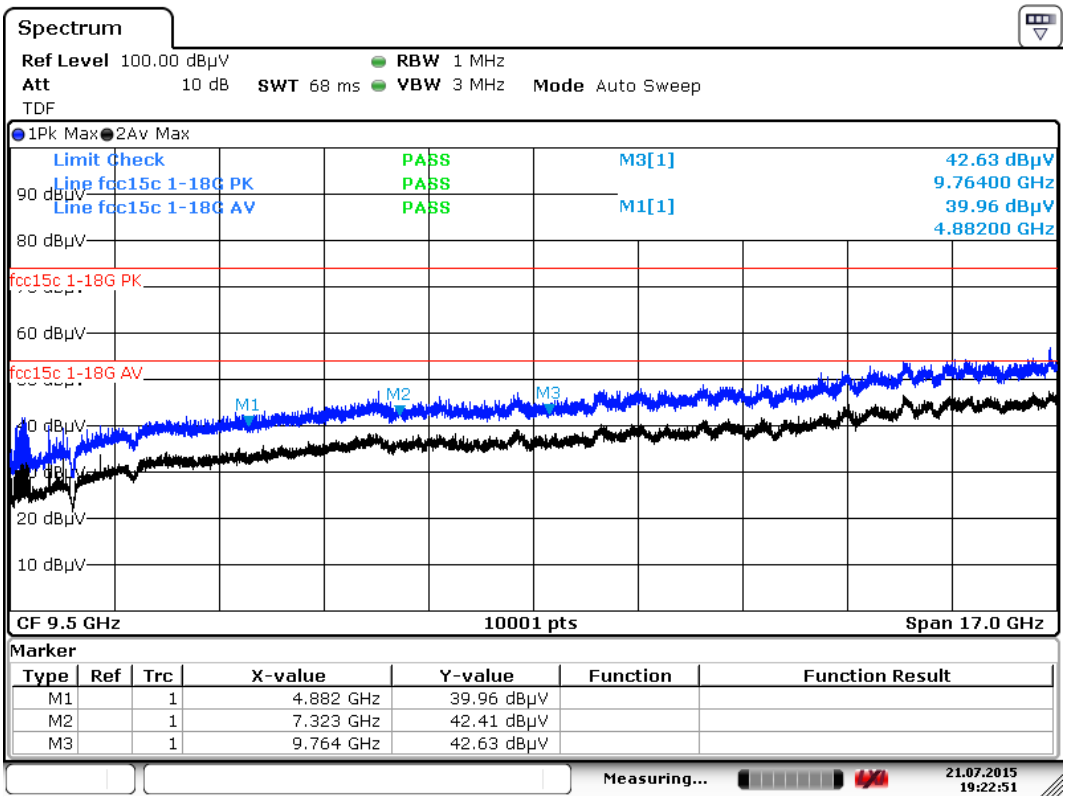


GFSK 2441MHz

Vertical:

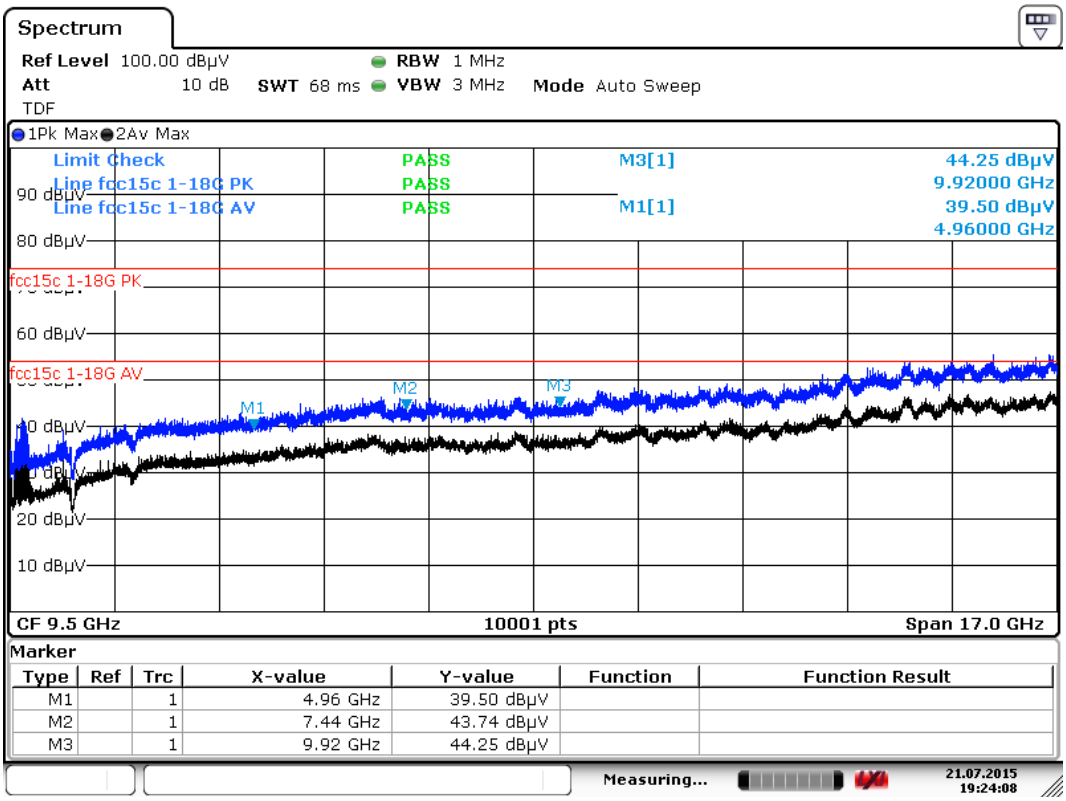


Horizontal

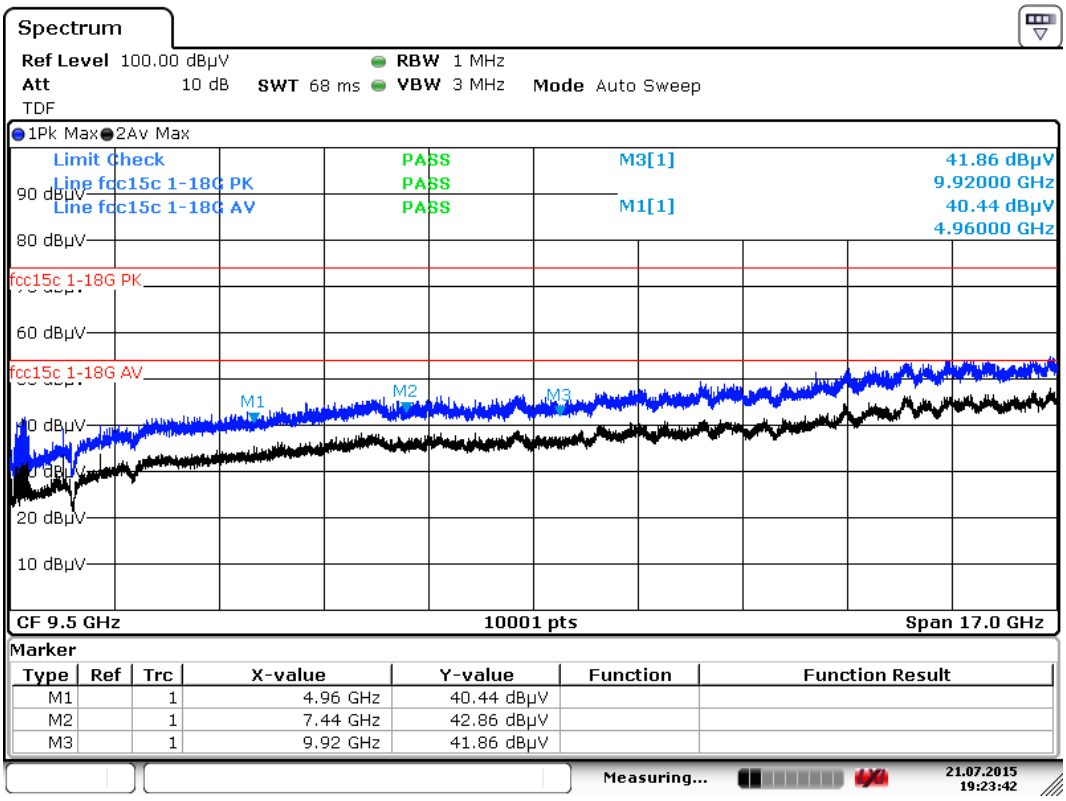


GFSK 2480MHz

Vertical:



Horizontal

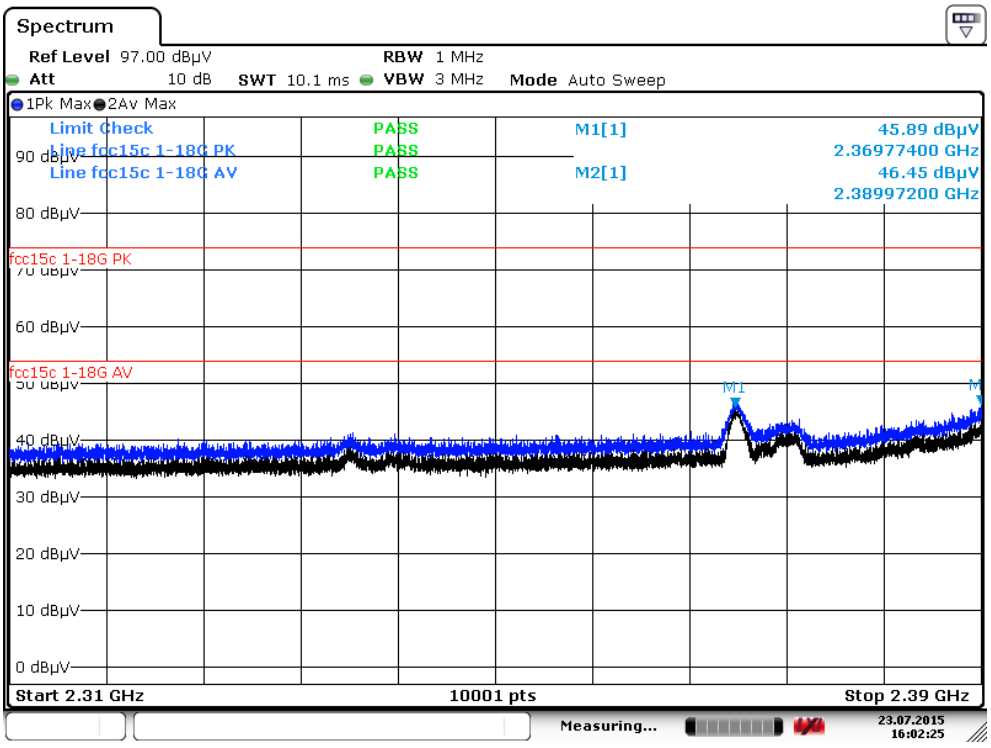


11.5 Radiated Emissions which fall in the restricted bands

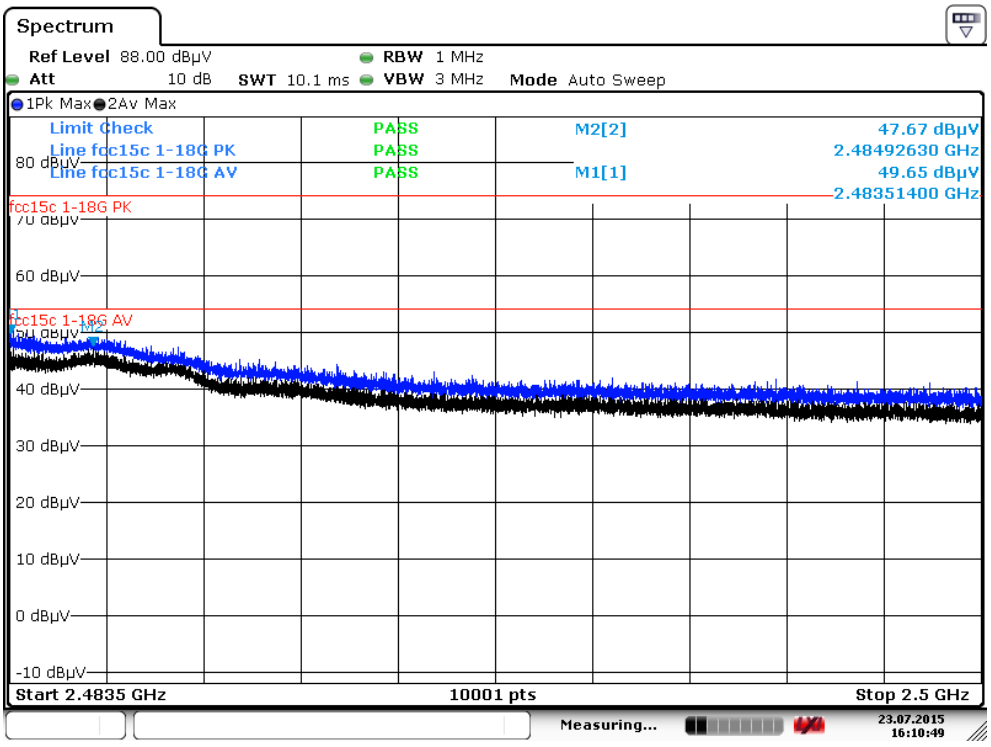
Test Result

GFSK

2402MHz

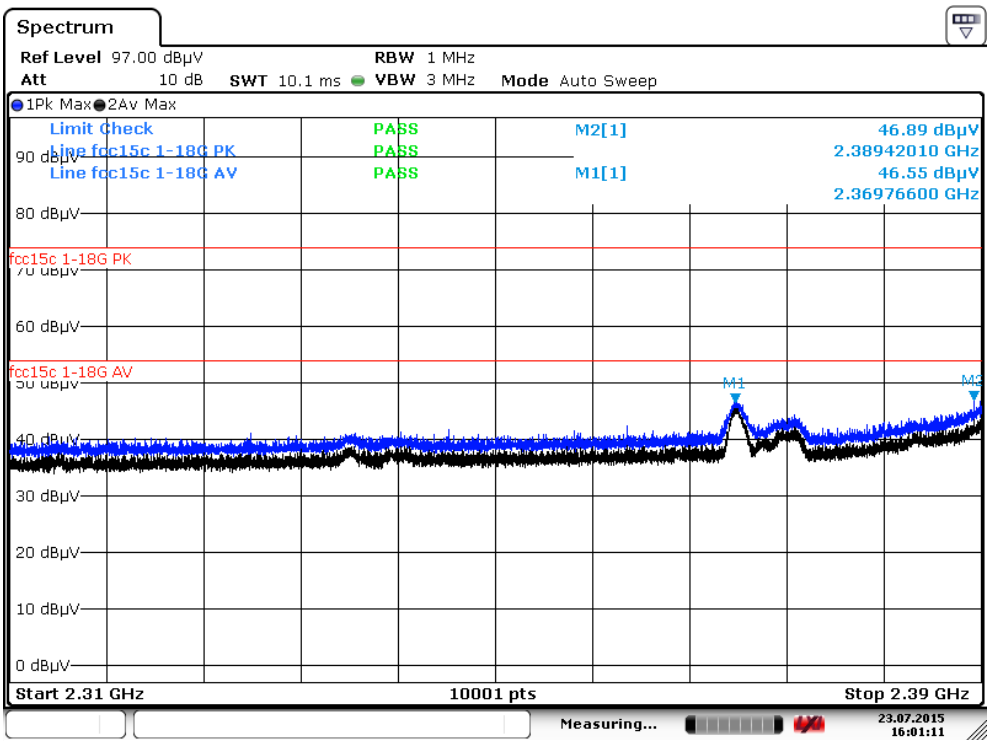


2480MHz



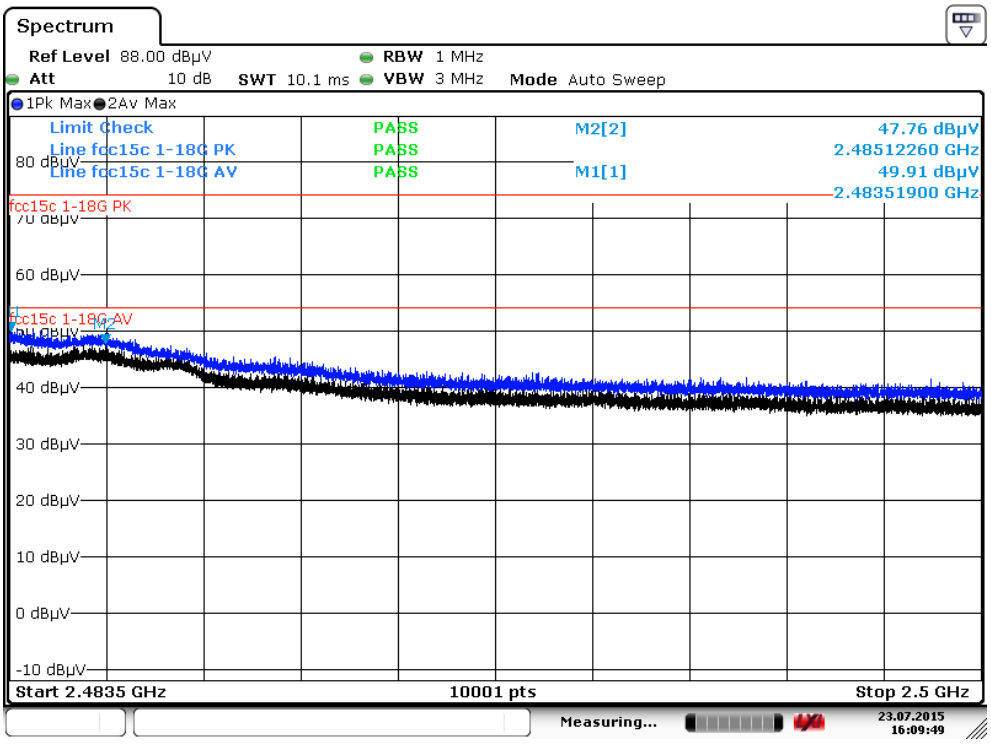
Л/4 QPSK

2402MHz



Date: 23.JUL.2015 16:01:11

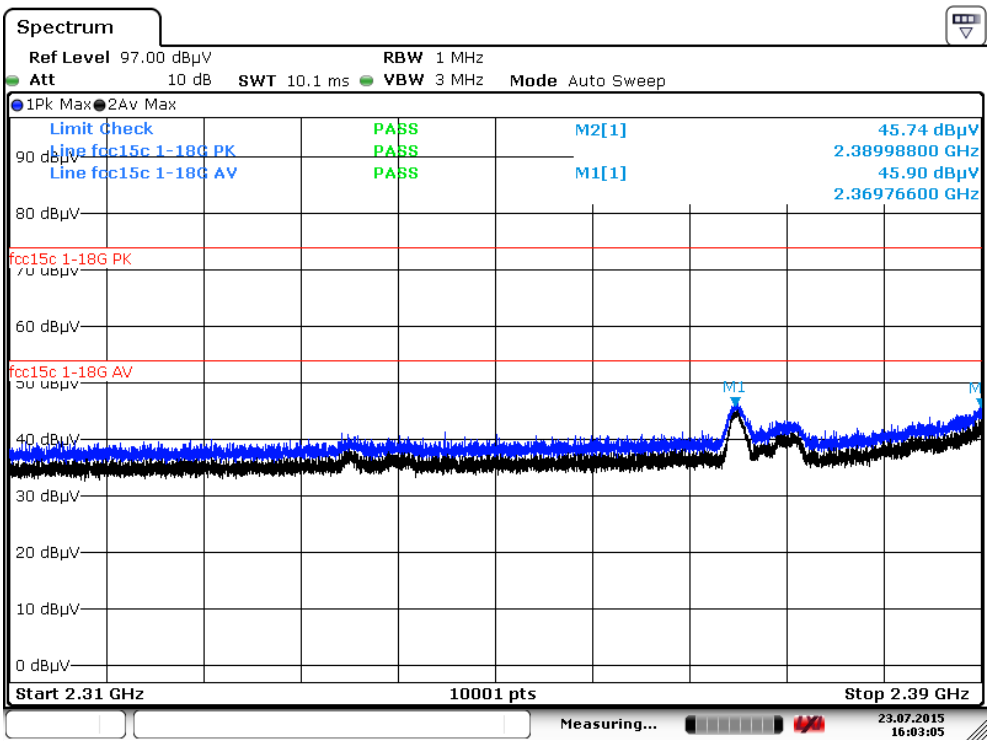
2480MHz



Date: 23.JUL.2015 16:09:49

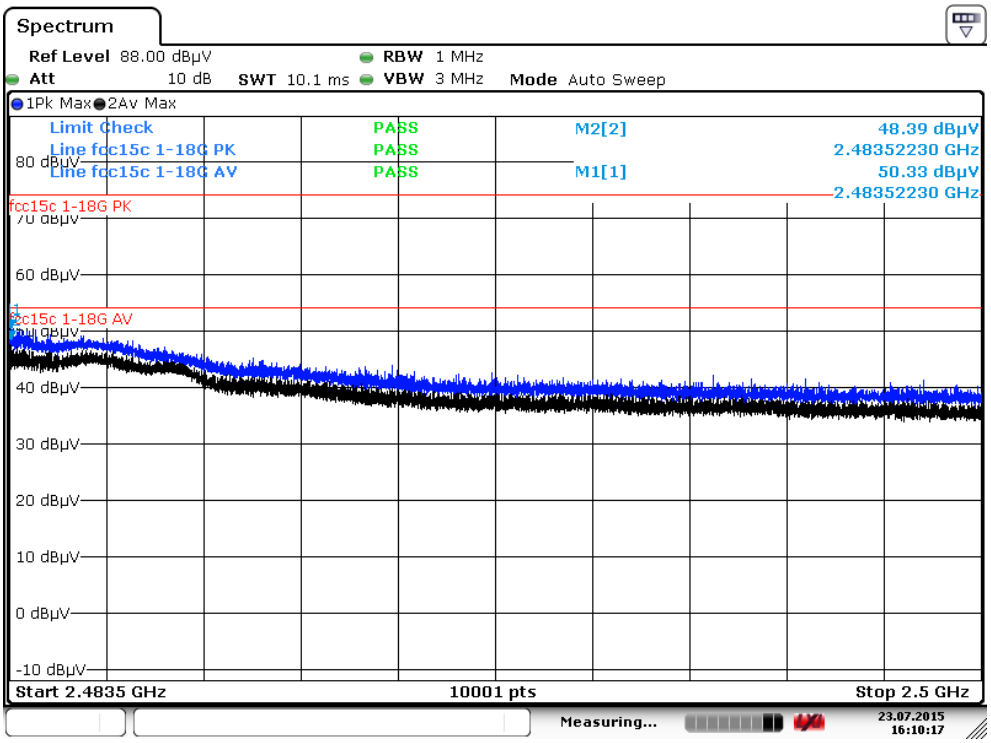
8-DPSK

2402MHz



Date: 23.JUL.2015 16:03:05

2480MHz



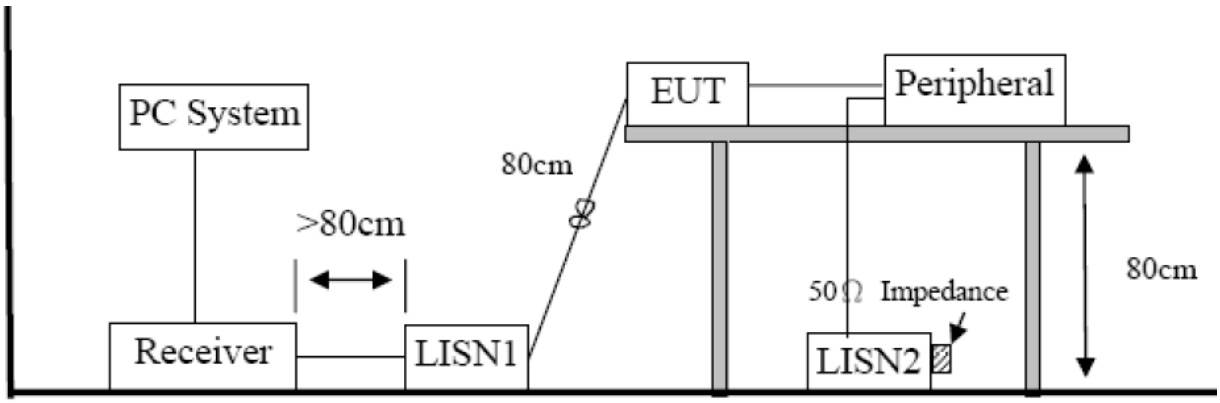
Date: 23.JUL.2015 16:10:17

12 POWER LINE CONDUCTED EMISSIONS

12.1 Test equipment

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1	EMI Receiver	R&S	ESU8	100316	2014/11/26	1 Year
2	LISN 1	R&S	ENV216	101109	2014/11/26	1 Year
3	LISN 1	R&S	ESH2-Z5	100309	2014/11/26	1 Year
4	Pulse Limiter	R&S	ESH3-Z2	101242	2014/11/26	1 Year

12.2 Block diagram of test setup



12.3 Limits

Frequency [MHz]	Limit - QP [dB(μV)]	Limit - AV [dB(μV)]
0,15 – 0,50	66 to 56 *	56 to 46 *
0,50 – 5	56	46
5 – 30	60	50

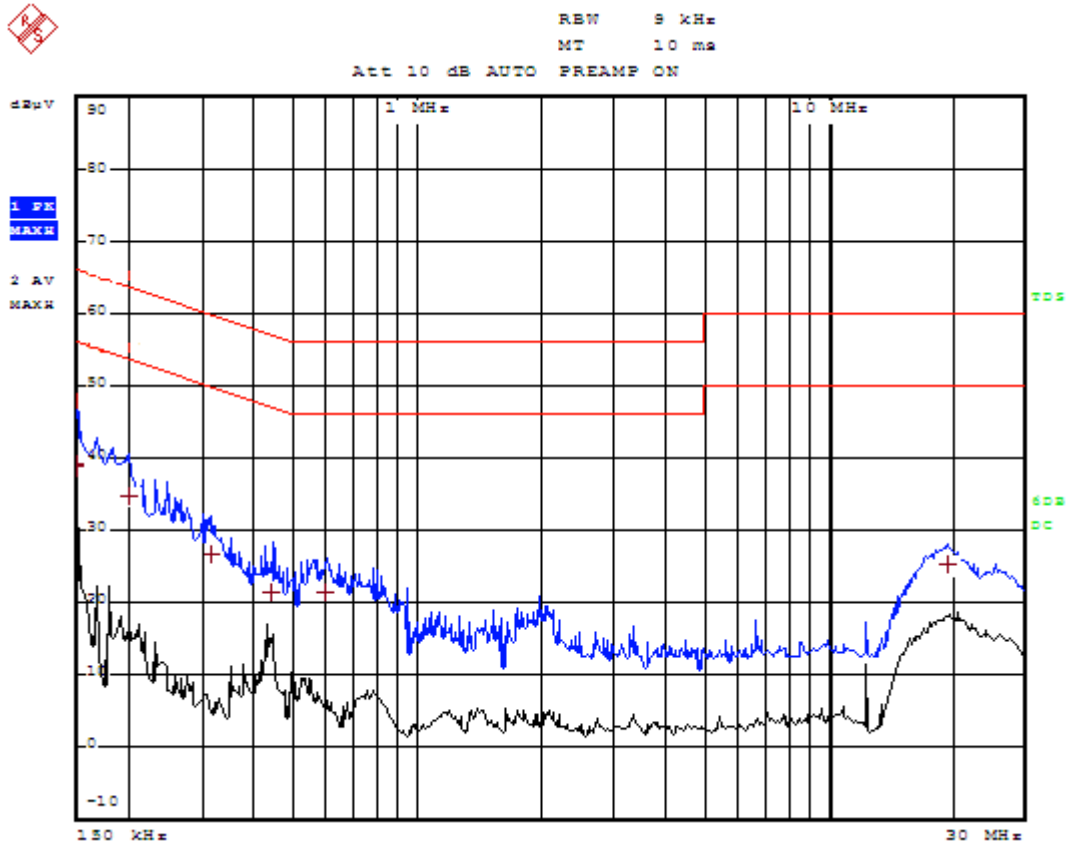
Note 1: * Limits decreasing linearly with the logarithm of the frequency

Note 2: The lower limit shall apply at the transition frequencies.

Note 3: Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture). Compliance test in continuous transmitting mode with GFSK (DH5) as the worst case was found.

12.4 Test results

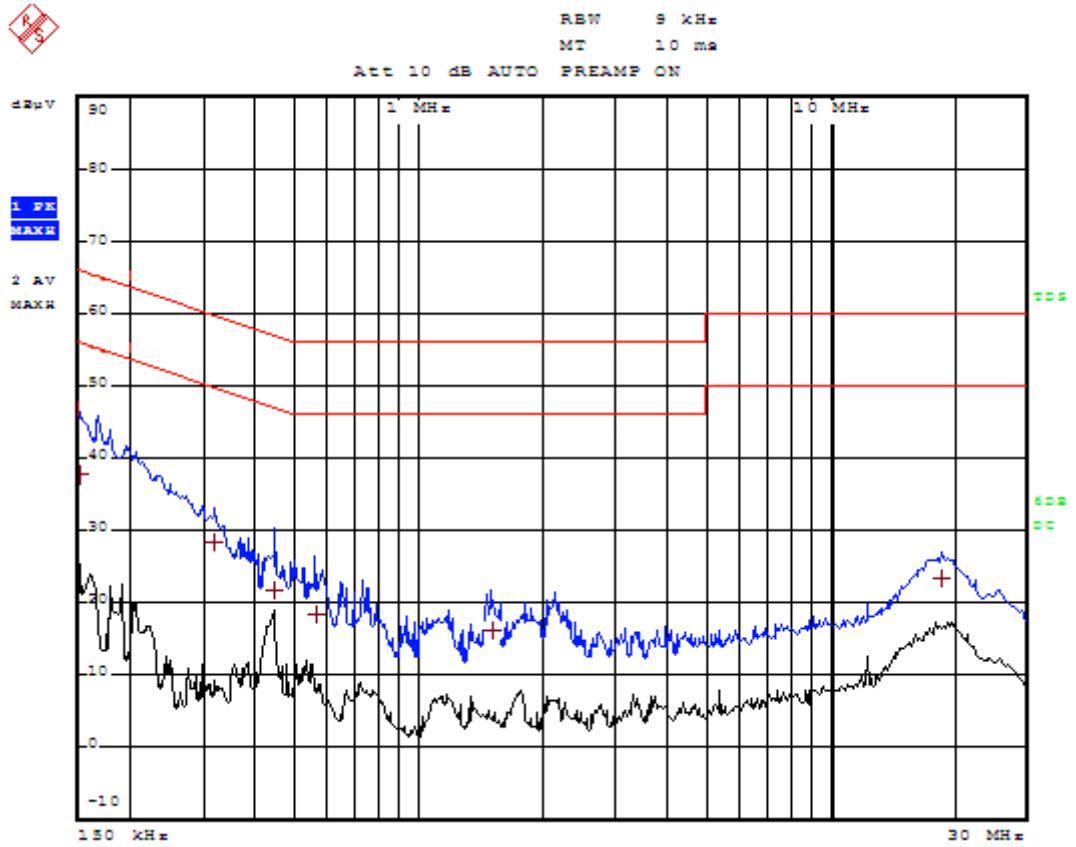
Live:



Trace	Frequency(MHz)	Level (dBμV/m)	Margin(dB)
QP	0.153	38.21	-27.70
QP	0.206	35.46	-28.94
QP	0.325	28.51	-32.49
QP	0.456	21.25	-36.00
QP	0.501	21.45	-34.55
QP	19.542	27.63	-32.37

No other significant emissions were measured at the frequency range of interest employing both the QP and AV detectors.

Neutral:



Trace	Frequency(MHz)	Level (dBµV/m)	Margin(dB)
QP	0.150	38.65	-27.35
QP	0.315	29.46	-31.83
QP	0.465	22.51	-34.49
QP	0.579	18.25	-37.75
QP	1.636	17.45	-38.55
QP	19.623	25.93	-34.07

No other significant emissions were measured at the frequency range of interest employing both the QP and AV detectors.

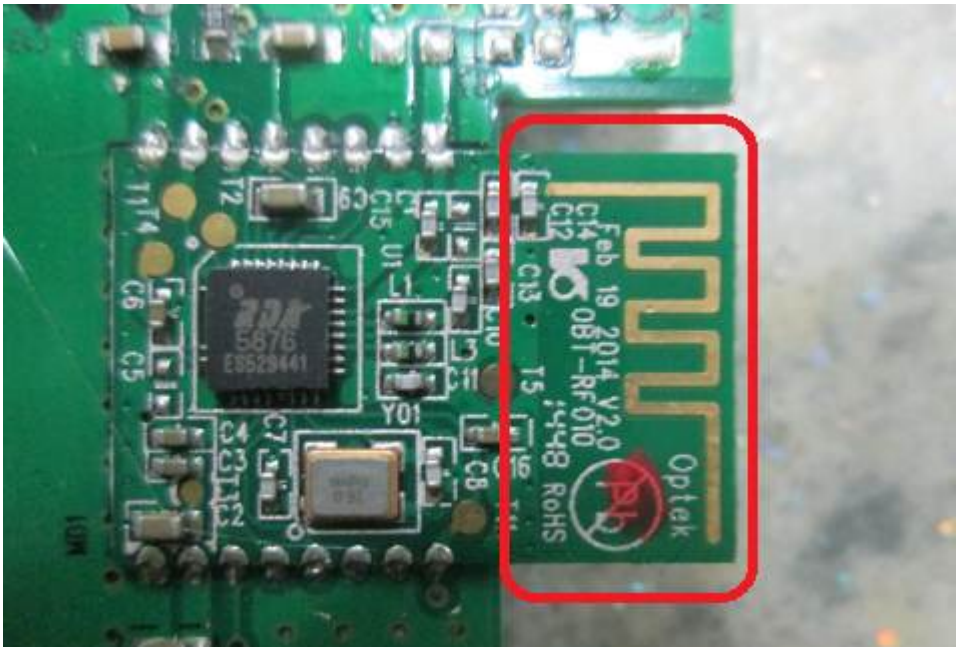
13 ANTENNA REQUIREMENT

13.1 Limits

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 funished 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 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

13.2 Test results

The antenna used for this product is built-in PCB trace antenna, and no antenna other than that funished by the responsible part shall be used, the maximum peak gain of the transmit antenna is only 2,12 dBi.



14 PSEUDORANDOM FREQUENCY HOPPING SEQUENCE

14.1.1 Standard requirement

15.247(a)(1) requirement:

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

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

14.1.2 Other requirements Frequency Hopping Spread Spectrum System

Test Requirement:	47 CFR Part 15**C Section 15.247 (a)(1), (h) requirement:**

The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

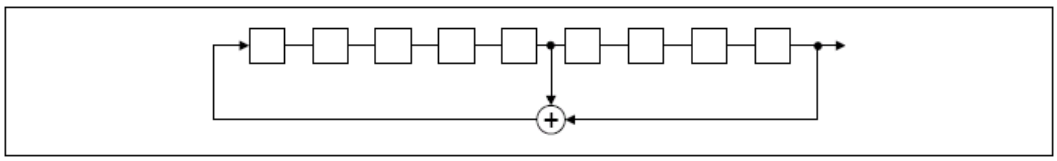
Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

Compliance for section 15.247(a)(1)

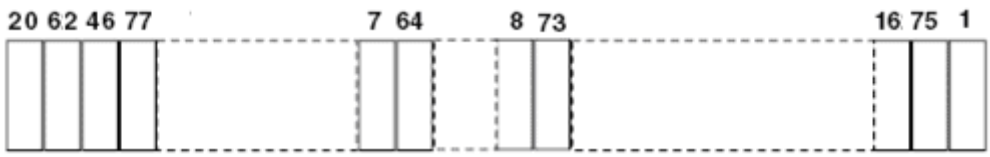
According to Bluetooth Core Specification, the pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage
outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive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

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



Linear Feedback Shift Register for Generation of the PRBS sequence

An example of Pseudorandom Frequency Hopping Sequence as follow:



Each frequency used equally on the average by each transmitter.
According to Bluetooth Core Specification, Bluetooth receivers are designed to have input and IF bandwidths that match the hopping channel bandwidths of any Bluetooth transmitters and shift

frequencies in synchronization with the transmitted signals.
Compliance for section 15.247(g)
According to Bluetooth Core Specification, the Bluetooth system transmits the packet with the pseudorandom hopping frequency with a continuous data and the short burst transmission from the Bluetooth system is also transmitted under the frequency hopping system with the pseudorandom hopping frequency system.
Compliance for section 15.247(h)
According to Bluetooth Core specification, the Bluetooth system incorporates with an adaptive system to detect other user within the spectrum band so that it individually and independently to avoid hopping on the occupied channels. According to the Bluetooth Core specification, the Bluetooth system is designed not have the ability to coordinated with other FHSS System in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitter.

15 TEST SETUP AND ARRANGEMENT

The photograph shows the tested device.

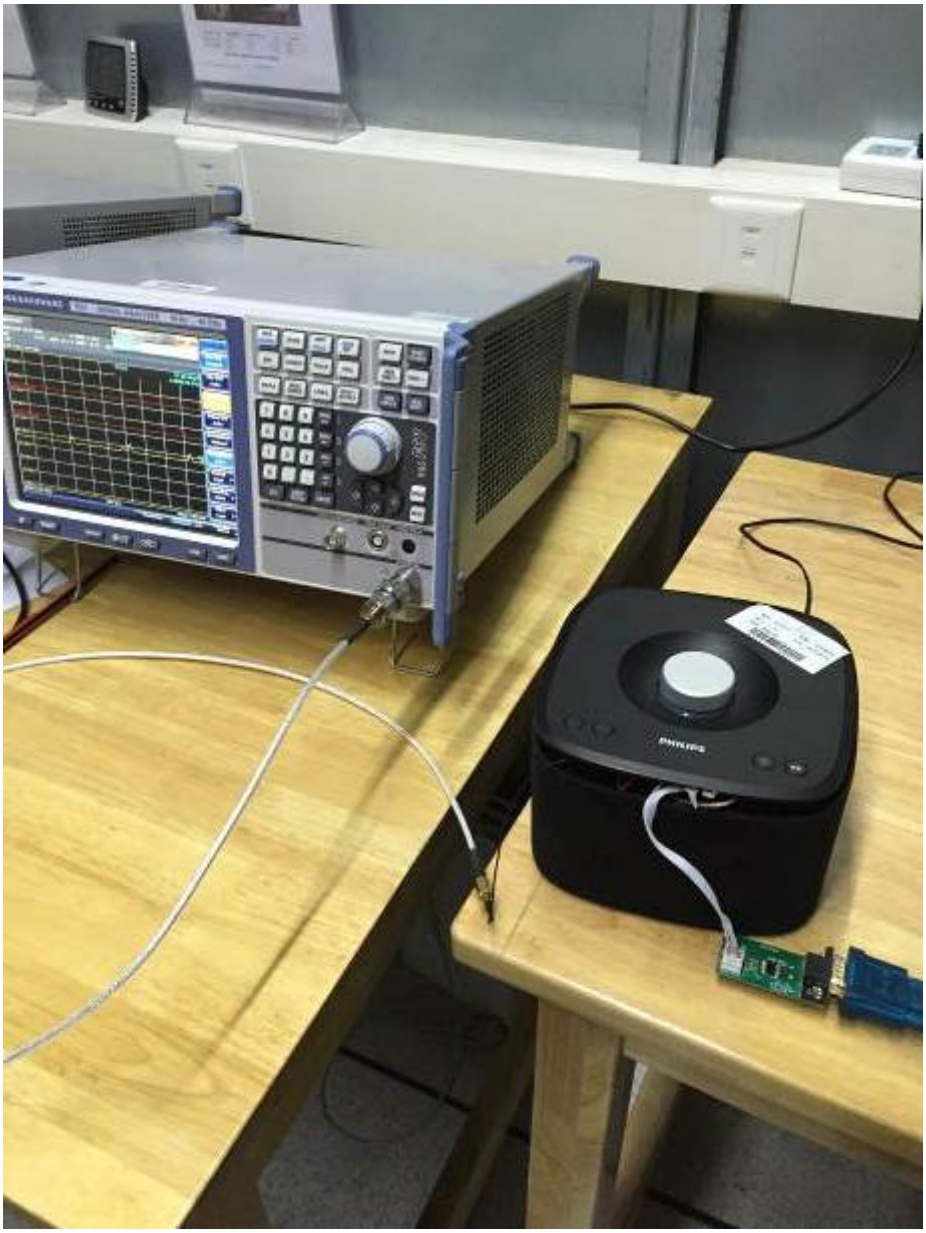


Figure 2 Conducted measurement Test setup

Figure 3 Conducted Emission test setup

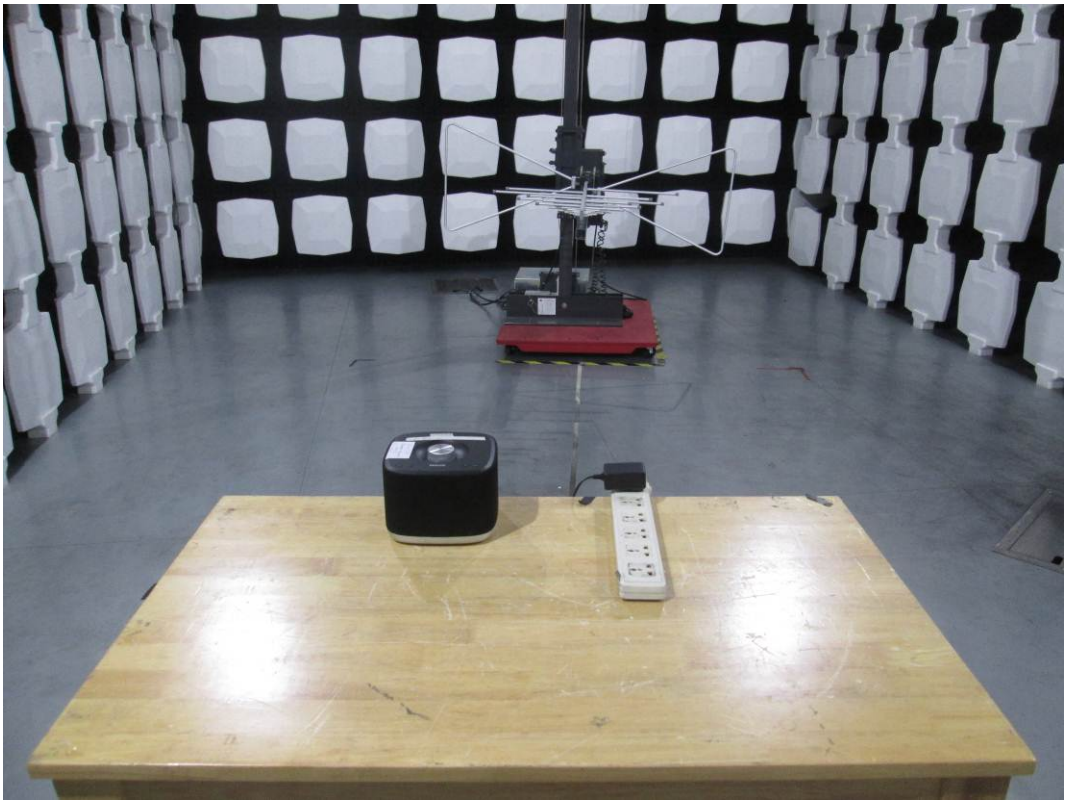


Figure 4 Radiated emission test setup (below 1 GHz)

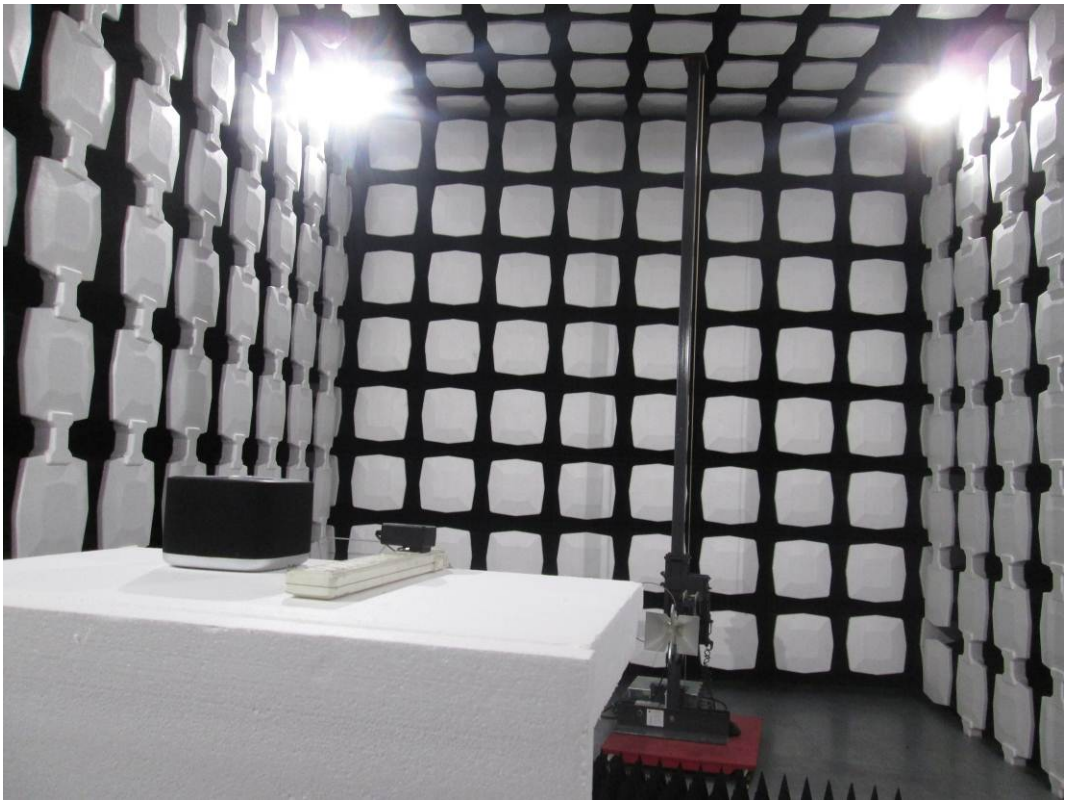
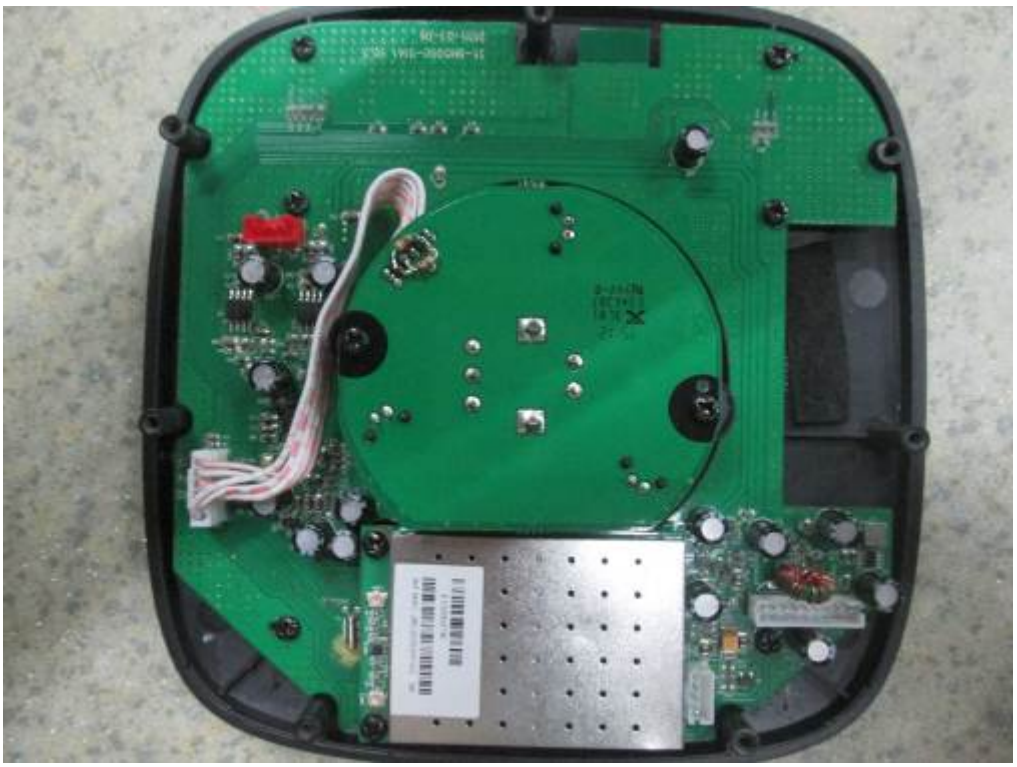
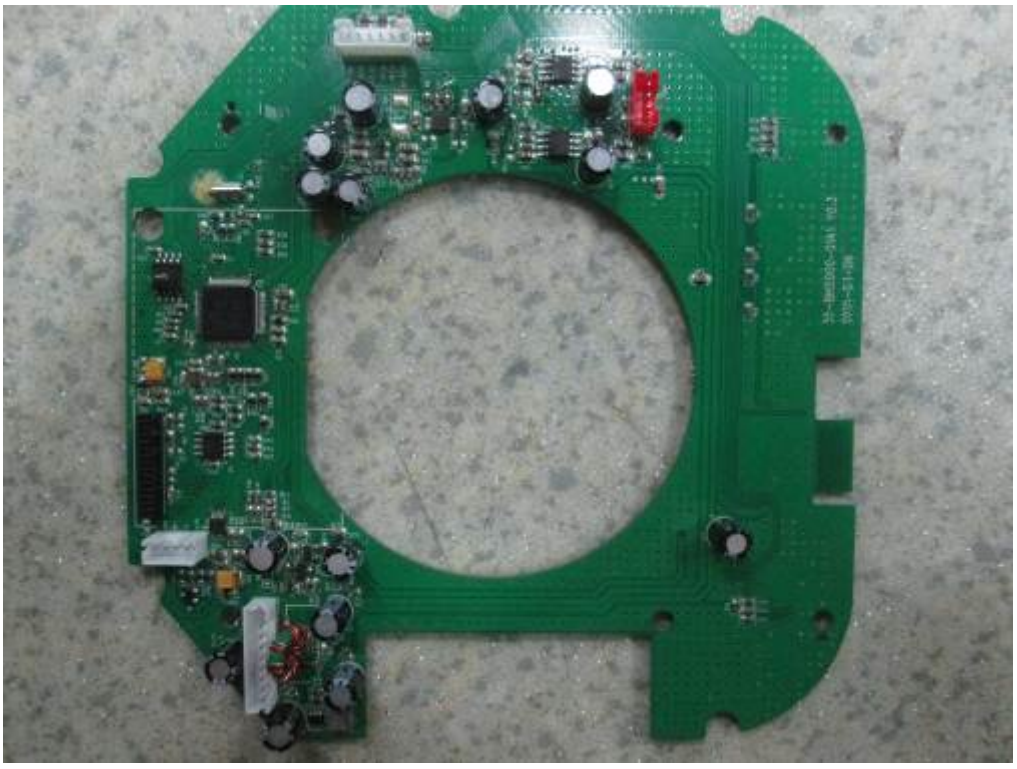


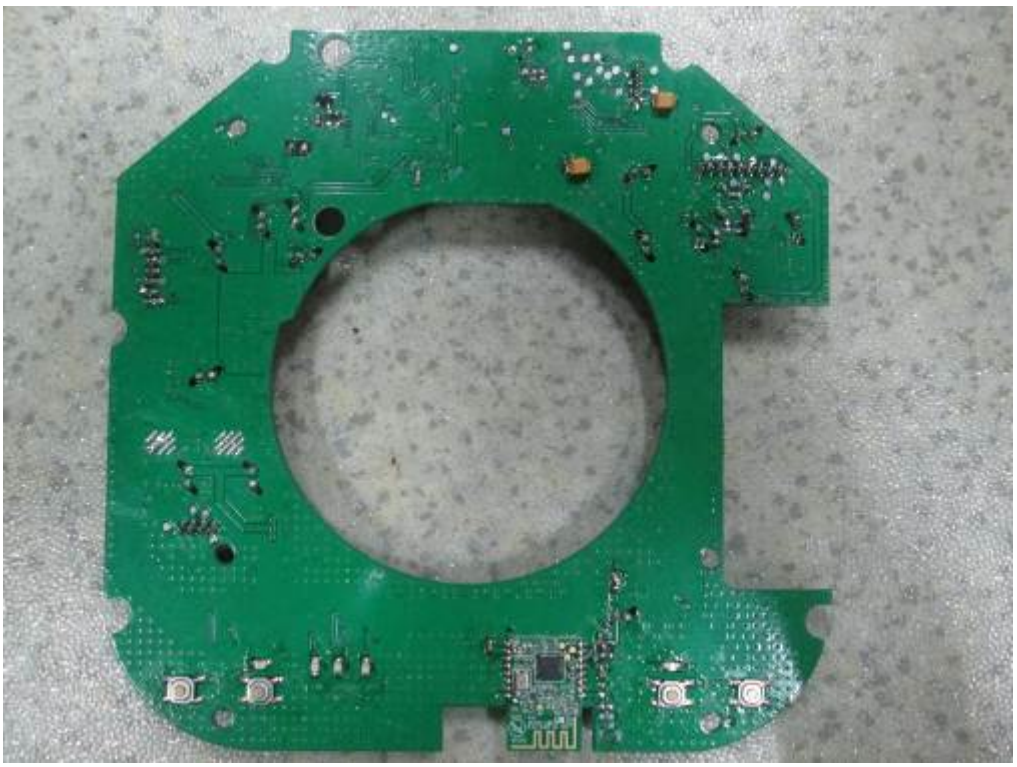
Figure 5 Radiated emission test setup (above 1 GHz)

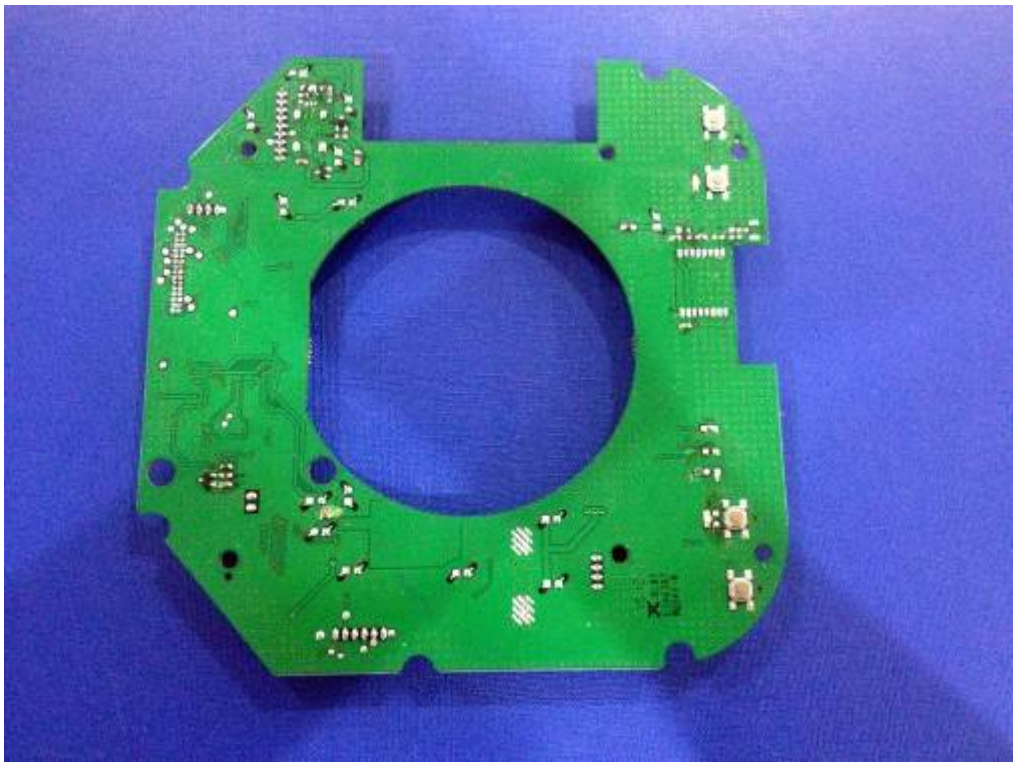
16 PHOTOS OF EUT

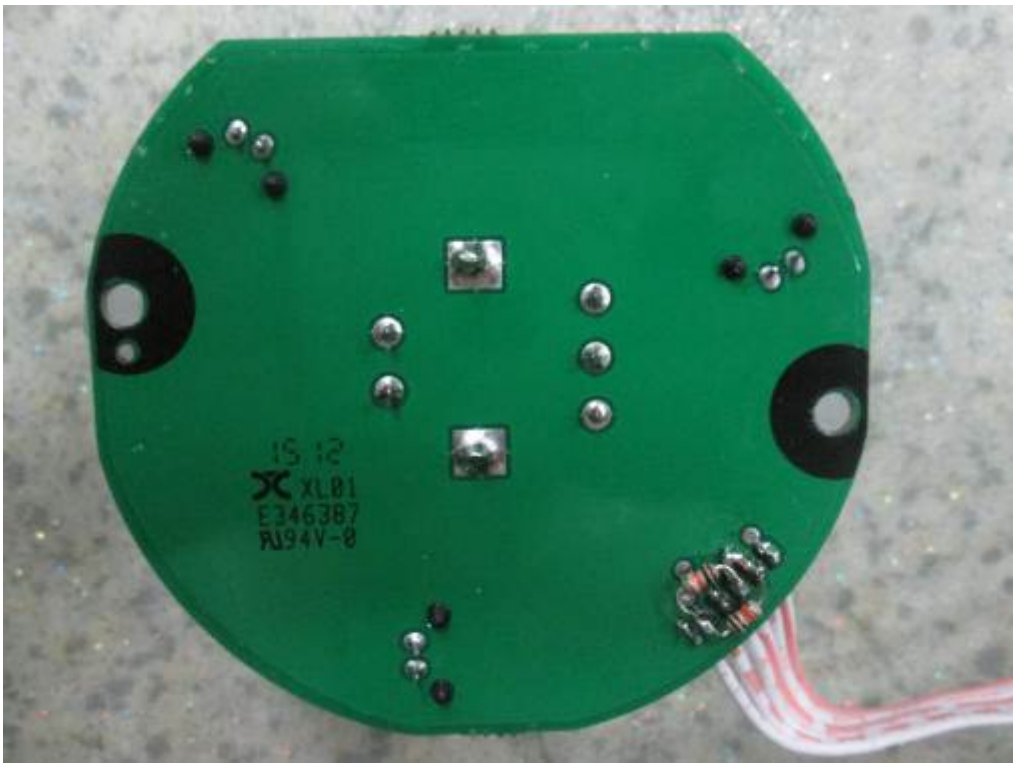
Internal Photos:



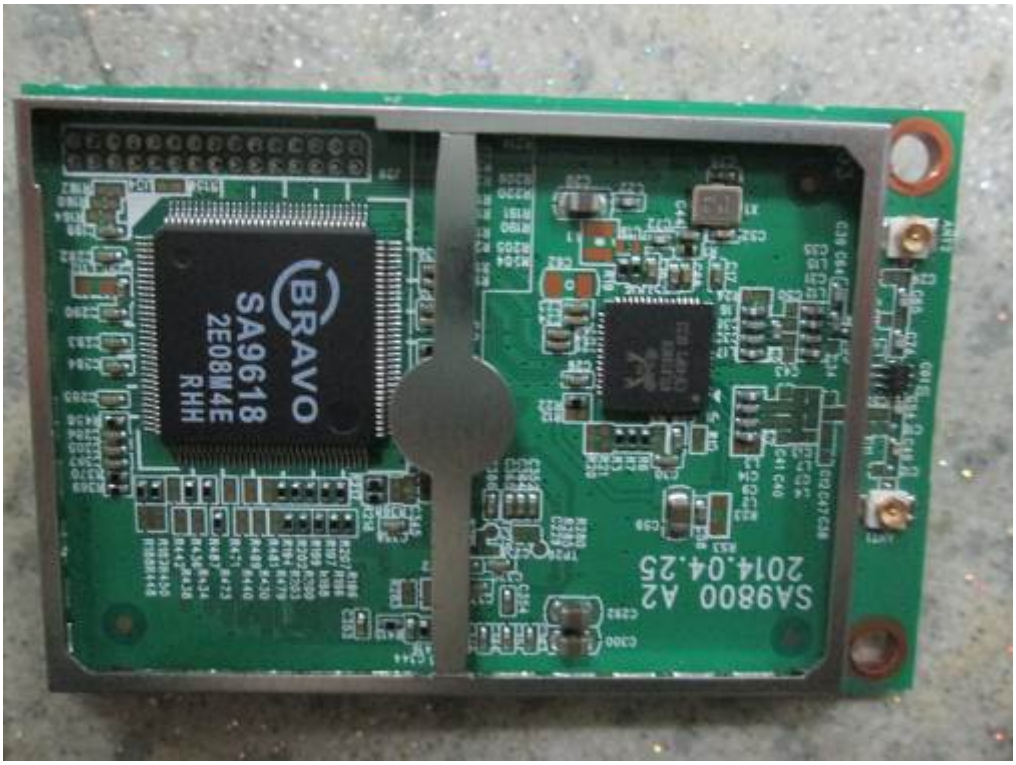


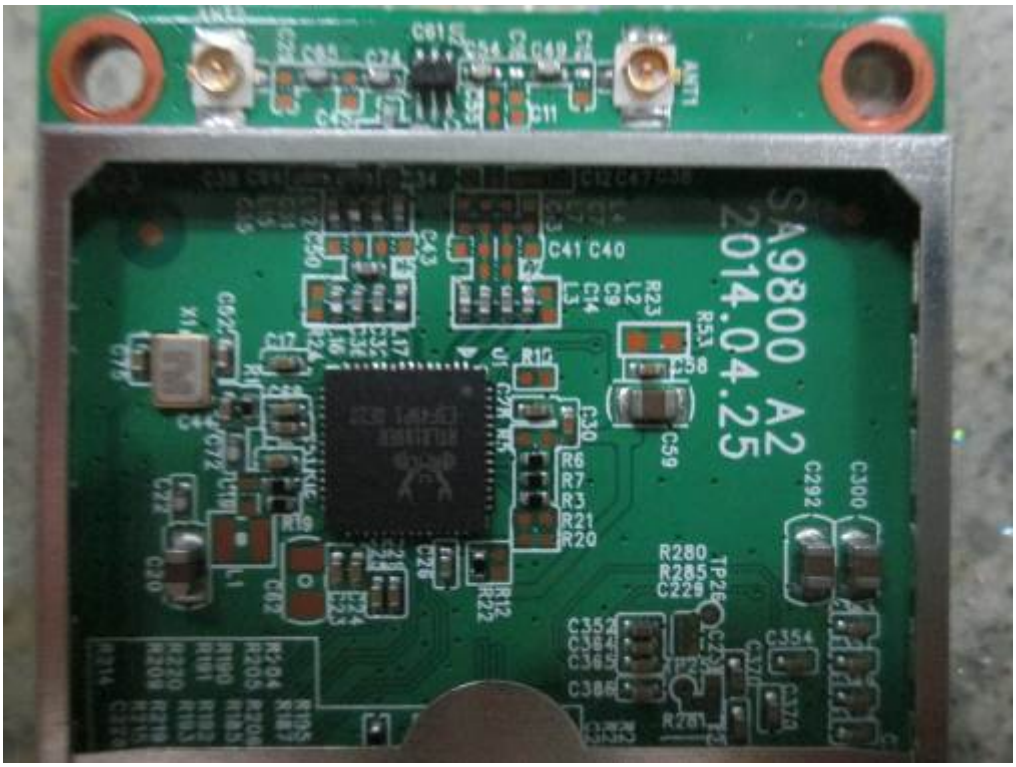




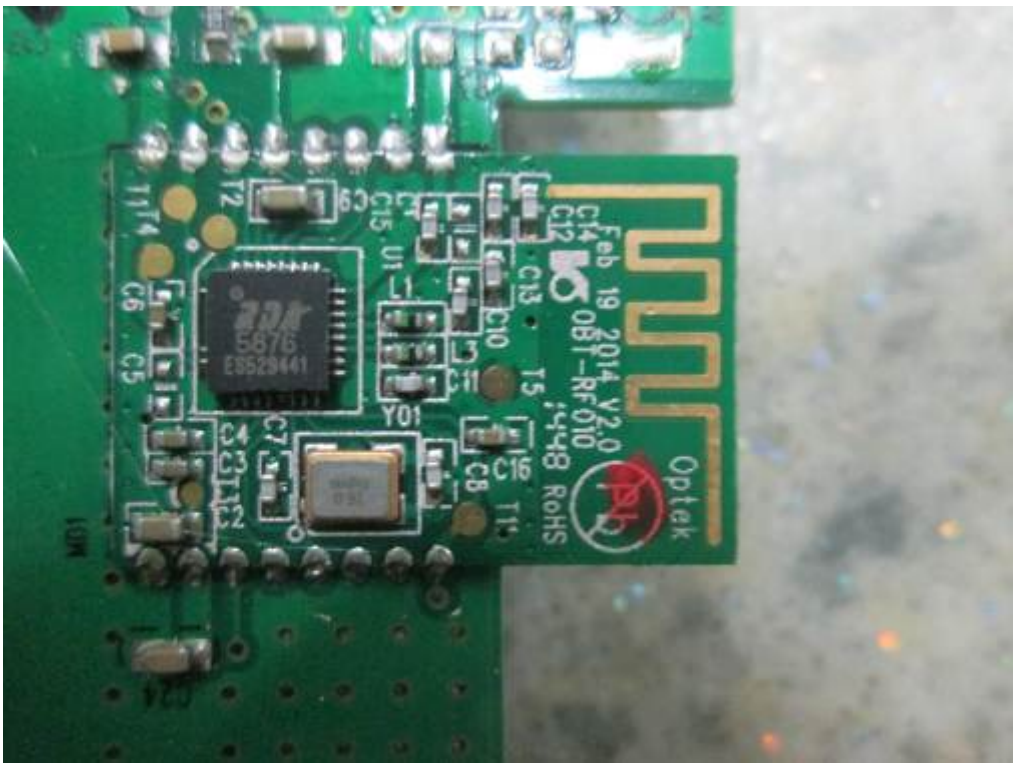

XL01
E346387
94V-0

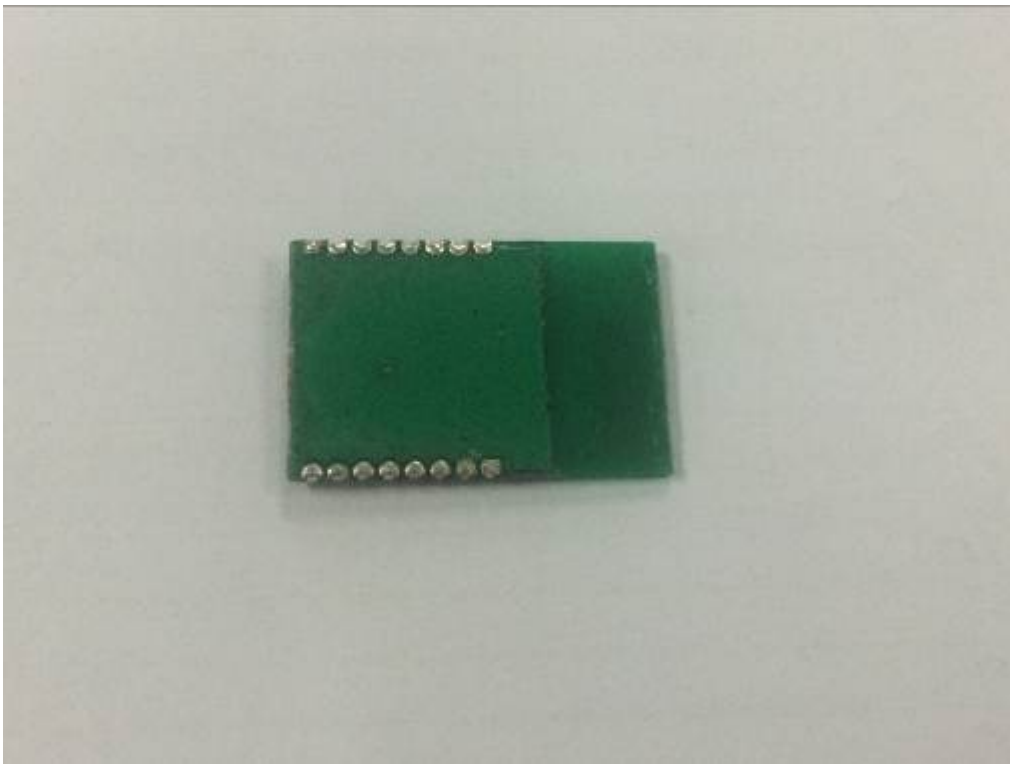
Wi-Fi module


BRAVO
SA9618
2E08M4E
RHH
SA9800 A2
2014.04.25


SA9800 A2
2014.04.25

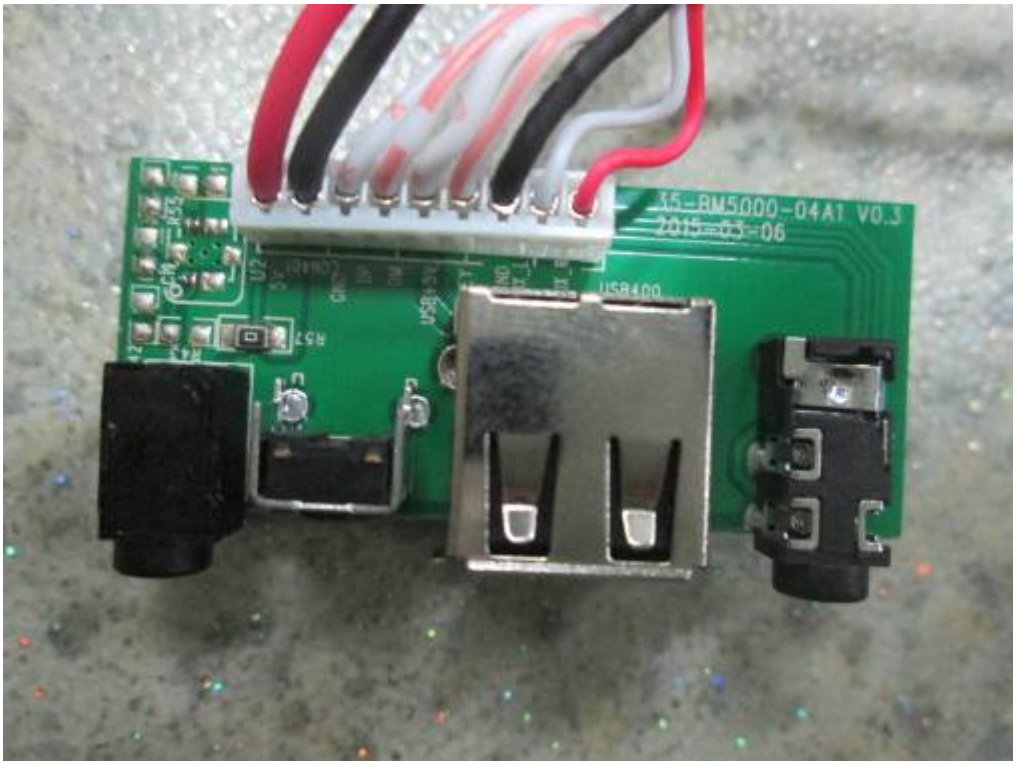
Wi-Fi module

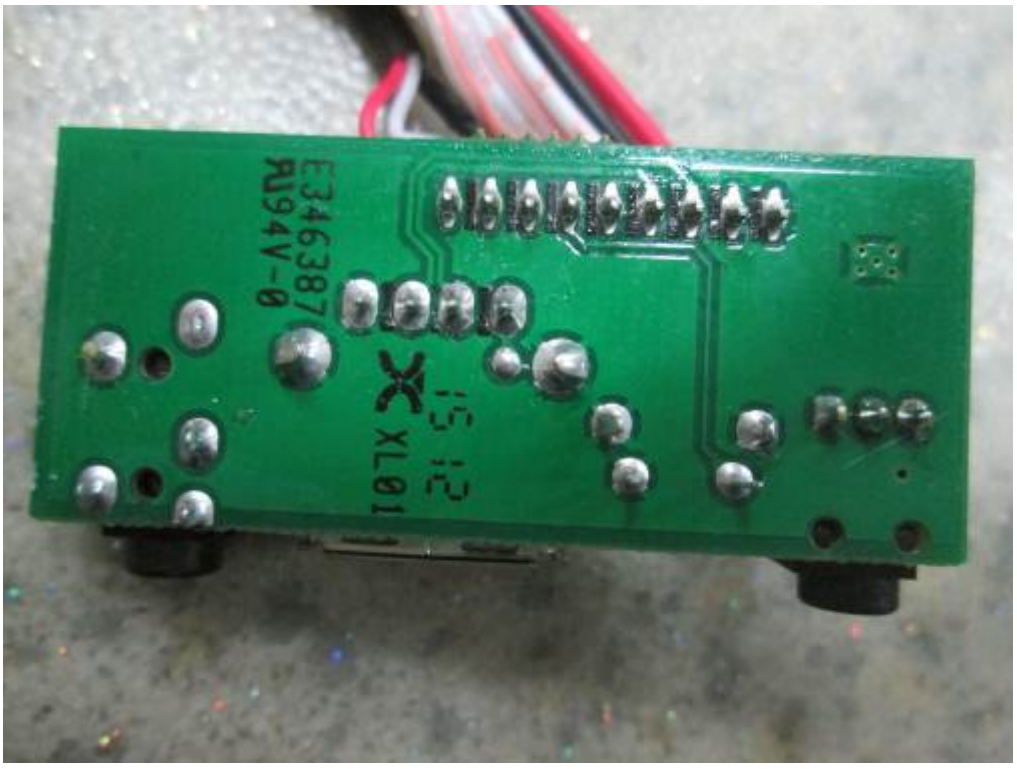


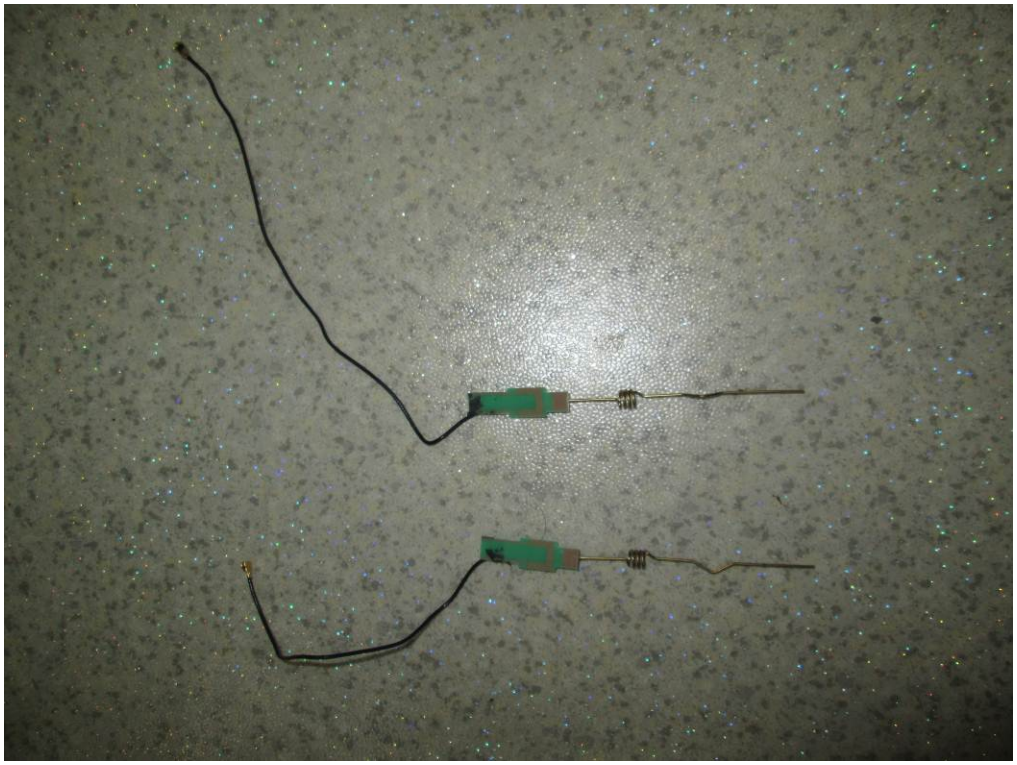


Bluetooth module


SOFTWARE
UPGRADE


15-BM5000-04A1 V0.3
2015-03-06
USB400


E346387
94V-0
XL01



Wi-Fi antenna