FCC RF TEST REPORT

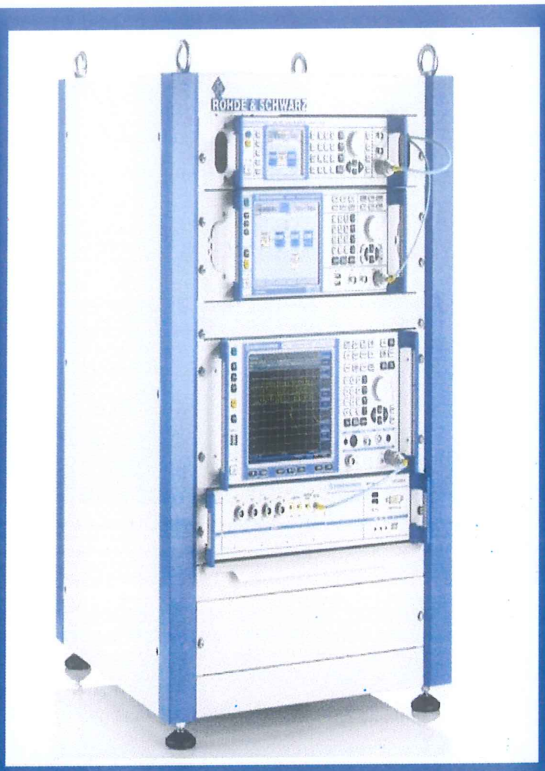
ISSUED BY
Shenzhen BALUN Technology Co., Ltd.

FOR

UPAIR

ISSUED TO
ShenZhen GTEN Innovation Technology Co., Ltd

Room N&L, 8th Floor, Tower A, TCL Building, NO. 6, Gaoxin South 1st Ave., Nanshan District, Shenzhen



Tested by: Zheng Muyi
(Engineer)
Date: Apr. 06. 2017

Approved by: Wei Yanquan
(Chief Engineer)
Date: Apr. 6. 2017

Report No.:	BL-SZ16A0135-601
EUT Name:	UPAIR
Model Name:	UPAIR ONE X
Brand Name:	UPAIR
Test Standard:	47 CFR Part 15 Subpart C
FCC ID:	2AH32UPAIRONEXR
Test conclusion:	Pass
Test Date:	Oct. 20, 2016 ~ Mar. 24 2017
Date of Issue:	Apr. 06, 2017

Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong, P. R. China 518055
TEL: +86-755-66850100, FAX: +86-755-61824271
Email: info@baluntek.com
www.baluntek.com

Revision History

Version	Issue Date	Revisions
Rev. 01	Mar. 28, 2017	Initial Issue
Rev. 02	Apr. 06, 2017	Updated the test setup photos.

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1 ADMINISTRATIVE DATA (GENERAL INFORMATION)

1.1 Identification of the Testing Laboratory

Company Name	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Phone Number	+86 755 6685 0100

1.2 Identification of the Responsible Testing Location

Test Location	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Accreditation Certificate	The laboratory has been listed by Industry Canada to perform electromagnetic emission measurements. The recognition numbers of test site are 11524A-1. The laboratory has been listed by US Federal Communications Commission to perform electromagnetic emission measurements. The recognition numbers of test site are 832625. The laboratory is a testing organization accredited by China National Accreditation Service for Conformity Assessment (CNAS) according to ISO/IEC 17025. The accreditation certificate number is L6791.
Description	All measurement facilities used to collect the measurement data are located at Block B, FL 1, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China 518055

1.3 Laboratory Condition

Ambient Temperature	20 to 25℃
Ambient Relative Humidity	45% - 55%
Ambient Pressure	100 kPa - 102 kPa

1.4 Announce

(1) The test report reference to the report template version v2.0.

(2) The test report is invalid if not marked with the signatures of the persons responsible for preparing and approving the test report.

(3) The test report is invalid if there is any evidence and/or falsification.

(4) The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein.

(5) This document may not be altered or revised in any way unless done so by BALUN and all revisions are duly noted in the revisions section.

(6) Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.

2 PRODUCT INFORMATION

2.1 Applicant Information

Applicant	ShenZhen GTEN Innovation Technology Co., Ltd
Address	Room N&L, 8th Floor, Tower A, TCL Building, NO. 6, Gaoxin South 1st Ave., Nanshan District, Shenzhen

2.2 Manufacturer Information

Manufacturer	ShenZhen GTEN Innovation Technology Co., Ltd
Address	Room N&L, 8th Floor, Tower A, TCL Building, NO. 6, Gaoxin South 1st Ave., Nanshan District, Shenzhen

2.3 Factory Information

Factory	ShenZhen Gten Innovation Technology Co. Ltd
Address	10th floor, 1st department, Hengcangrong high-tech industry park, No. 128, Shangnan East Rd., Hongtian village, Shajing street, Baoan district, shenzhen

2.4 General Description for Equipment under Test (EUT)

EUT Name	UPAIR
Model Name Under Test	UPAIR ONE X
Series Model Name	N/A
Description of Model name differentiation	N/A
Hardware Version	N/A
Software Version	N/A
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A
Network and Wireless connectivity	2.4G ISM Band(GFSK modulation)

2.5 Ancillary Equipment

Ancillary Equipment 1	Battery	
	Brand Name	N/A
	Model No.	JT battery II
	Serial No.	N/A
	Capacitance	1500 mAh
	Rated Voltage	11.1 V
	Limit Charge Voltage	12.0 V

2.6 Technical Information

The requirement for the following technical information of the EUT was tested in this report:

Modulation Technology	FHSS
Modulation Type	GFSK
Transfer Rate	0.25 Mbps
Frequency Range	The frequency range used is 2405.5 MHz – 2475 MHz; The frequency block is 2400 MHz to 2483.5 MHz.
Number of channel	70 (See note 1)
Tested Channel	Low channel (2406 MHz), Middle channel(2440 MHz), High channel (2475 MHz)
Antenna Type	Dipole Antenna
Antenna Gain	1.8 dBi (All involve the antenna gain test item, has been included in the final results)
Adaptive or non-adaptive	non-adaptive
The Max RF Output power	16.71 dBm
About the Product	The equipment is UPAIR, it contains Bluetooth and WIFI Modules operating at 2.4 GHz ISM band. Only the 2.4G ISM Band (GFSK modulation) was tested in this report.

All channel was listed on the following table:

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

Test Case	Test Conditions			
	Modulation Technology	Modulation Type	Date rate	channel
Number of Hopping Frequency	FHSS	GFSK	0.25 Mbps	Hopping
Peak Output Power	FHSS	GFSK	0.25 Mbps	Low/Middle/High
Occupied Bandwidth	FHSS	GFSK	0.25 Mbps	Low/Middle/High
Carrier Frequency Separation	FHSS	GFSK	0.25 Mbps	Hopping
Time of Occupancy (Dwell time)	FHSS	GFSK	0.25 Mbps	Hopping
Conducted Spurious Emission	FHSS	GFSK	0.25 Mbps	Low/Middle/High
Conducted Emission	FHSS	GFSK	0.25 Mbps	Low/Middle/High
Radiated Emission	FHSS	GFSK	0.25 Mbps	Low/Middle/High
Band Edge	FHSS	GFSK	0.25 Mbps	Low/High

3 SUMMARY OF TEST RESULTS

3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 15, Subpart C (10-1-15 Edition)	Miscellaneous Wireless Communications Services
2	FCC PUBLIC NOTICE DA 00-705 (Mar. 30, 2000)	Filling and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems
3	ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices

3.2 Verdict

No.	Description	FCC Part No.	Test Result	Verdict
1	Antenna Requirement	15.203	--	Pass Note 1
2	Number of Hopping Frequency	15.247(a)	ANNEX A.1	Pass
3	Peak Output Power	15.247(b)	ANNEX A.2	Pass
4	Occupied Bandwidth	15.247(a)	ANNEX A.3	Pass
5	Carrier Frequency Separation	15.247(a)	ANNEX A.4	Pass
6	Time of Occupancy (Dwell time)	15.247(a)	ANNEX A.5	Pass
7	Conducted Spurious Emission& Authorized-band band-edge	15.247(d)	ANNEX A.6	Pass
8	Conducted Emission	15.207	ANNEX A.7	N/A Note 2
9	Radiated Spurious Emission	15.209 15.247(d)	ANNEX A.8	Pass
10	Band Edge (Restricted-band band-edge)	15.209 15.247(d)	ANNEX A.9	Pass
Note [1]: The EUT has a permanently and irreplaceable attached antenna, which complies with the requirement FCC 15.203. Note [2]: The EUT is only powered by the battery, so the Conducted Emission is not applicable.				

4 GENERAL TEST CONFIGURATIONS

4.1 Test Environments

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

Relative Humidity	45% - 55%	
Atmospheric Pressure	100 kPa - 102 kPa	
Temperature	NT (Normal Temperature)	20℃ to +25℃
Working Voltage of the EUT	NV (Normal Voltage)	5 V

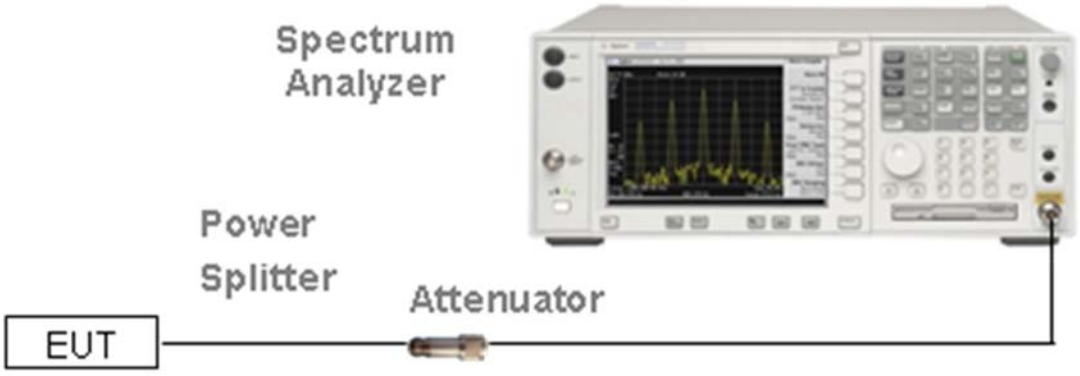
4.2 Test Equipment List

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
Spectrum Analyzer	ROHDE&SCHWARZ	FSV-30	103118	2016.07.13	2017.07.12
Vector Signal Generator	ROHDE&SCHWARZ	SMBV100A	177746	2016.07.13	2017.07.12
Signal Generator	ROHDE&SCHWARZ	SMB100A	260592	2016.07.13	2017.07.12
Switch Unit with OSP-B157	ROHDE&SCHWARZ	OSP120	101270	2016.07.13	2017.07.12
Spectrum Analyzer	AGILENT	E4440A	MY45304434	2016.11.08	2017.11.07
EMI Receiver	ROHDE&SCHWARZ	ESRP	101036	2016.07.05	2017.07.04
LISN	SCHWARZBECK	NSLK 8127	8127-687	2016.07.05	2017.07.04
Bluetooth Tester	ROHDE&SCHWARZ	CBT	101005	2016.07.13	2017.07.12
Power Splitter	KMW	DCPD-LDC	1305003215	--	--
Power Sensor	ROHDE&SCHWARZ	NRP-Z21	103971	2016.07.13	2017.07.12
Attenuator (20 dB)	KMW	ZA-S1-201	110617091	--	--
Attenuator (6 dB)	KMW	ZA-S1-61	1305003189	--	--
DC Power Supply	ROHDE&SCHWARZ	HMP2020	18141664	2016.07.13	2017.07.12
Temperature Chamber	ANGELANTIONI SCIENCE	NTH64-40A	1310	2016.07.13	2017.07.12
Test Antenna-Rod(9 kHz-30 MHz)	SCHWARZBECK	VAMP 9243	9243-556	2015.07.22	2017.07.21
Test Antenna-Bi-Log(30 MHz-3 GHz)	SCHWARZBECK	VULB 9163	9163-624	2015.07.22	2017.07.21
Test Antenna-Horn(1-18 GHz)	SCHWARZBECK	BBHA 9120D	9120D-1148	2015.07.22	2017.07.21
Test Antenna-Horn(15-26.5 GHz)	SCHWARZBECK	BBHA 9170	9170-305	2015.07.22	2017.07.21
Anechoic Chamber	RAINFORD	9m*6m*6m	N/A	2017.02.21	2019.02.20
Anechoic Chamber	EMC TECHNOLOGY LTD	21.1m*11.6m*7.35m	N/A	2016.08.09	2018.08.08
Shielded Enclosure	ChangNing	CN-130701	130703	--	--
Signal Generator	ROHDE&SCHWARZ	SMB100A	177746	2016.07.13	2017.07.12
Power Amplifier	OPHIR RF	5225F	1037	2017.02.17	2018.02.16
Power Amplifier	OPHIR RF	5273F	1016	2017.02.17	2018.02.16
Directional Coupler	Werlantone	C5982-10	109275	N/A	N/A

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
Directional Coupler	Werlantone	CHP-273E	S00801z-01	N/A	N/A
Feld Strength Meter	Narda	EP601	511WX51129	2017.02.23	2018.02.22
Mouth Simulator	B&K	4227	2423931	2016.11.15	2017.11.14
Sound Calibrator	B&K	4231	2430337	2016.11.09	2017.11.08
Sound Level Meter	B&K	NL-20	00844023	2016.11.11	2017.11.10
Ear Simulator	B&K	4185	2409449	2016.11.15	2017.11.14
Ear Simulator	B&K	4195	2418189	2016.11.15	2017.11.14
Audio analyzer	B&K	UPL 16	100129	2016.11.08	2017.11.07

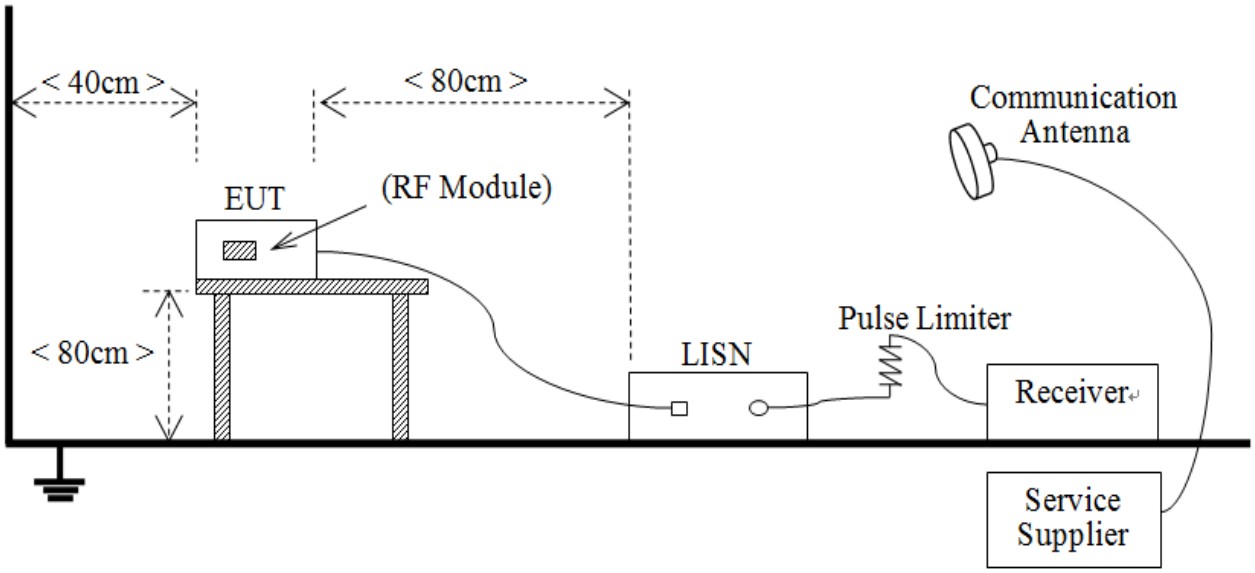
4.3 Description of Test Setup

4.3.1 For Antenna Port Test



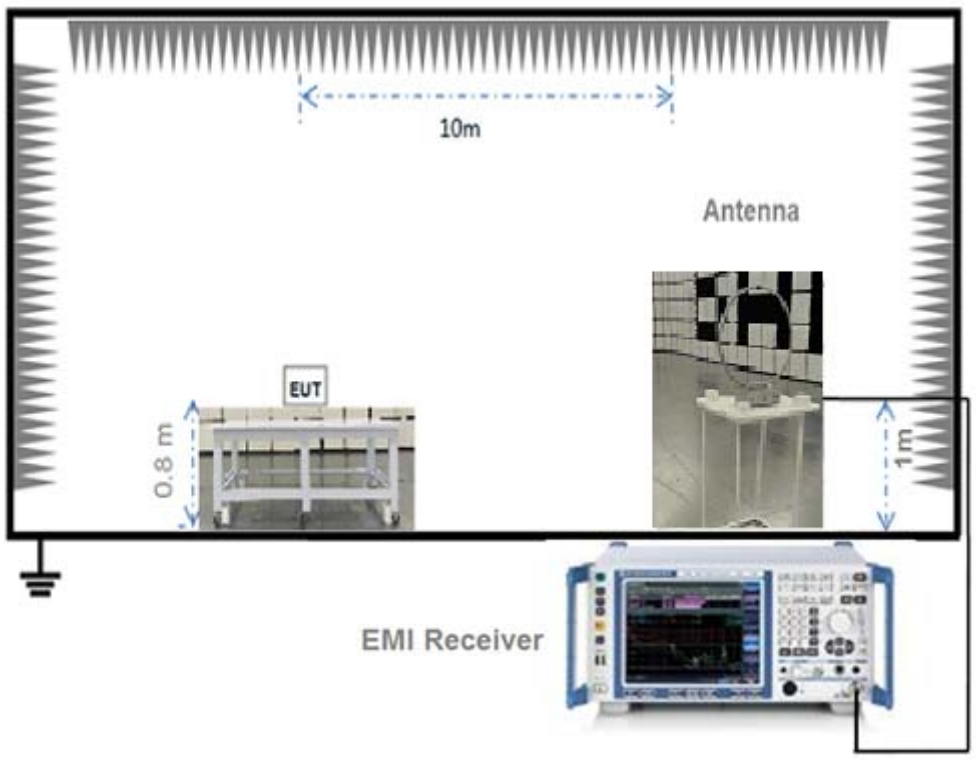
(Diagram 1)

4.3.2 For AC Power Supply Port Test



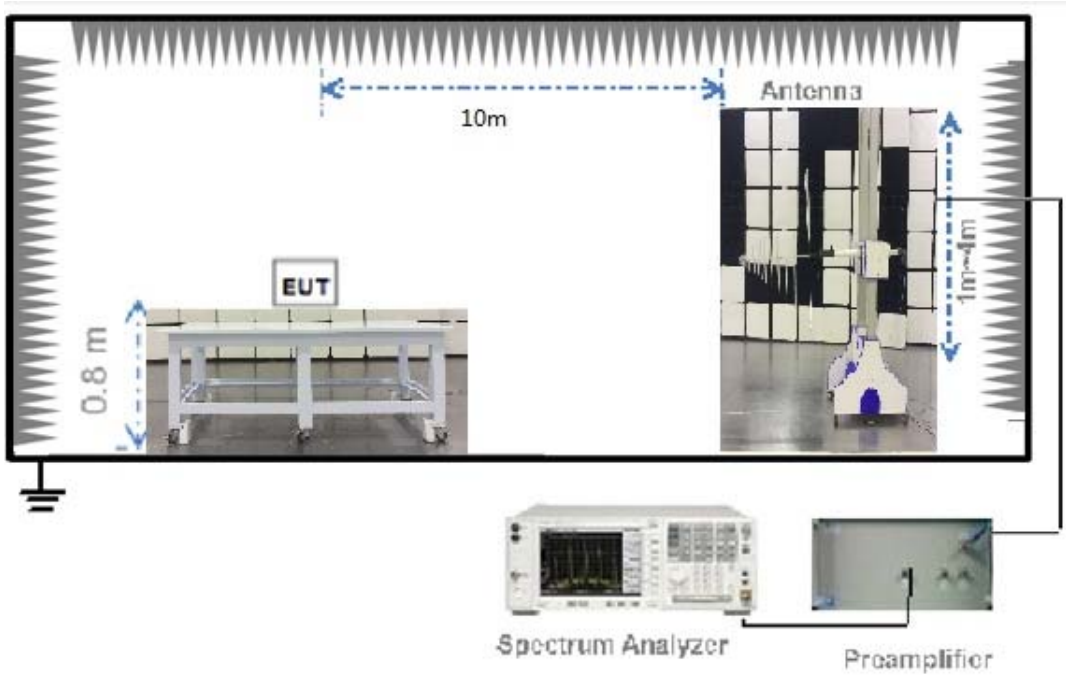
(Diagram 2)

4.3.3 For Radiated Test (Below 30 MHz)



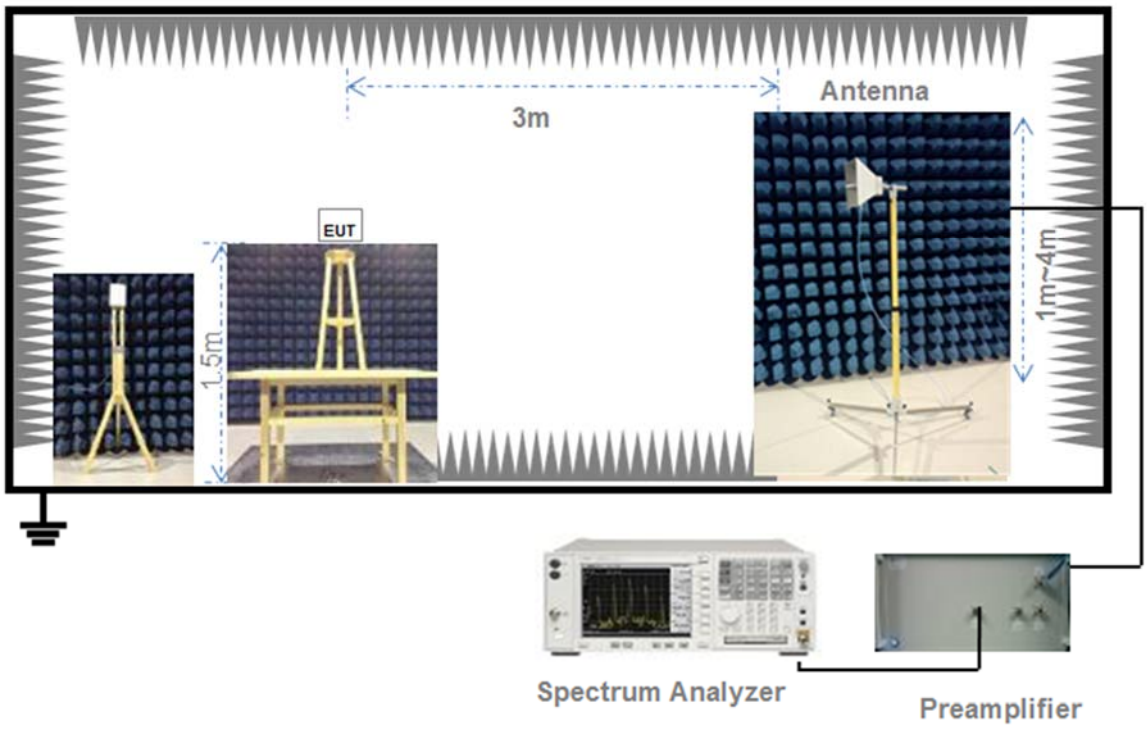
(Diagram 3)

4.3.4 For Radiated Test (30 MHz-1 GHz)



(Diagram 4)

4.3.5 For Radiated Test (Above 1 GHz)



(Diagram 5)

4.4 Measurement Results Explanation Example

4.4.1 For conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.
The spectrum analyzer offset is derived from RF cable loss and attenuator factor.
Offset = RF cable loss + attenuator factor.

4.4.2 For radiated band edges and spurious emission test:

Per part 15.35(c), the EUT Bluetooth average emission level could be determined by the peak emission level applying duty cycle correction factor, to represent averaging over the whole pulse train.
The average level is derived from the peak level corrected with “Duty cycle correction factor”.
Average Emission Level (dBuV/m) = Peak Emission Level (dBuV/m) + Duty cycle correction factor (dB)
Duty cycle correction factor (dB) = 20 * log (Duty cycle).
Duty cycle = on time / 100 milliseconds
On time = dwell time * hopping number in 100 ms
For example: bluetooth with dwell time 2.9 ms and 3 hops in 100 ms, then
Duty cycle correction factor (dB) = 20 * log ((2.9 * 3) / 100) = -21.21 dB
Following shows an average computation example with duty cycle correction factor = -21.21 dB, and the peak emission level is 45.61 dBuV/m.
Example:
Average Emission Level (dBuV/m) = Peak Emission Level (dBuV/m) + duty cycle correction factor (dB)
= 45.61 + (-21.21) = 24.4 (dBuV/m)

5 TEST ITEMS

5.1 Antenna Requirements

5.1.1 Standard Applicable

FCC §15.203 & 15.247(b); RSS-247, 5.4 (6)

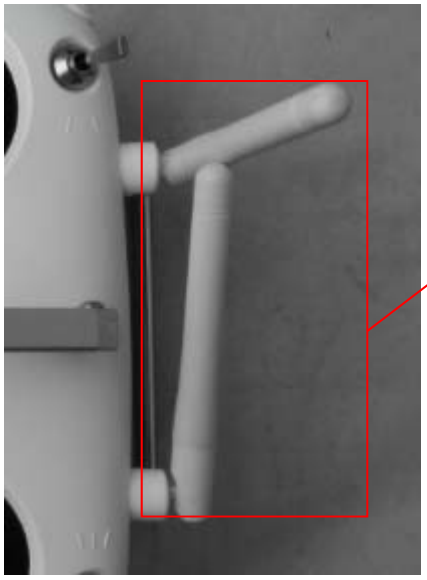
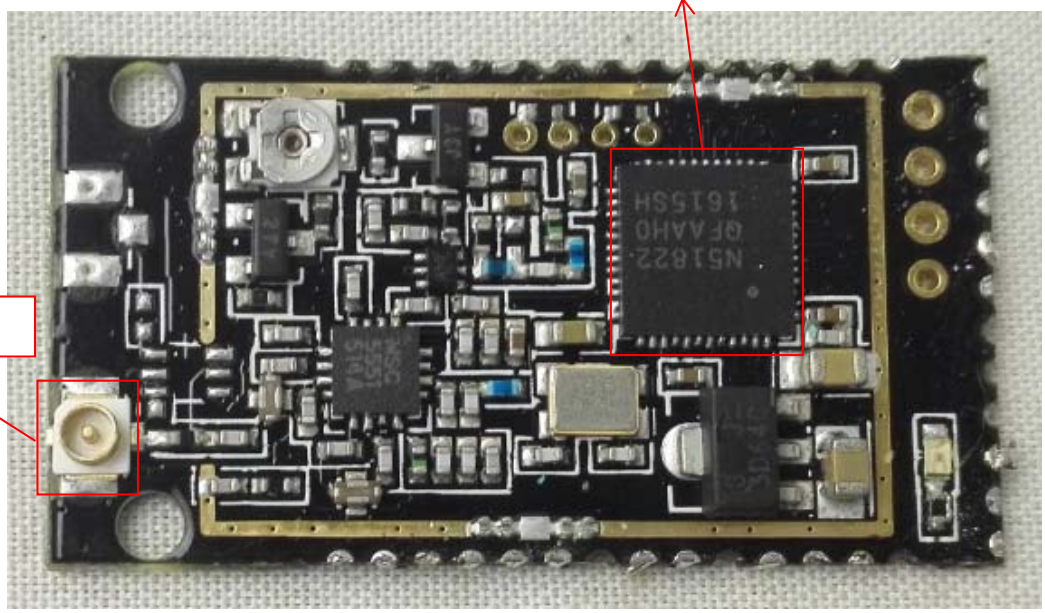
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of § 15.211, § 15.213, § 15.217, § 15.219, or § 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

If directional gain of transmitting antennas is greater than 6 dBi, the power shall be reduced by the same level in dB comparing to gain minus 6 dBi. For the fixed point-to-point operation, the power shall be reduced by one dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the FCC rule.

5.1.2 Antenna Anti-Replacement Construction

The Antenna Anti-Replacement as following method:

Protected Method	Description
Compliance with 15.203, use of a standard antenna jack or electrical connector is prohibited.	The antenna is the unique connector with a wire antenna.

Reference Documents	Item
Photo	 

5.1.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

5.2 Number of Hopping Frequency

5.2.1 Limit

FCC §15.247(a) (1) (iii); RSS-247, 5.1 (4)

Frequency hopping systems operating in the 2400 MHz to 2483.5 MHz bands shall use at least 15 hopping frequencies.

5.2.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.2.3 Test Procedure

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = the frequency band of operation

RBW ≥ 1% of the span

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize

5.2.4 Test Result

Please refer to ANNEX A.1.

5.3 Peak Output Power

5.3.1 Test Limit

FCC § 15.247(b)

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

RSS-247, 5.4 (2)

For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W and the e.i.r.p. shall not exceed 4 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W and the e.i.r.p. shall not exceed 0.5 W if the hopset uses less than 75 hopping channels (see Section 5.4(5) for exceptions).

5.3.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.3.3 Test Procedure

The Bluetooth Module operates at hopping-off test mode. The lowest, middle and highest channels are selected to perform testing to verify the conducted RF output peak power of the Module.

Use the following spectrum analyzer settings:

Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel

RBW > the 20 dB bandwidth of the emission being measured

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize.

5.3.4 Test Result

Please refer to ANNEX A.2.

5.4 Occupied Bandwidth

5.4.1 Limit

FCC §15.247(a); RSS-247, 5.1 (1)

Measurement of the 20dB bandwidth of the modulated signal.

5.4.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.4.3 Test Procedure

Use the following spectrum analyzer settings:

Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel

RBW ≥ 1% of the 20 dB bandwidth

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

The EUT should be transmitting at its maximum data rate, Allow the trace to stabilize.

5.4.4 Test Result

Please refer to ANNEX A.3.

5.5 Carrier Frequency Separation

5.5.1 Limit

FCC §15.247(a); RSS-247, 5.1 (2)

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 shall have hopping channel carrier frequencies separated by a minimum of 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.

5.5.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.5.3 Test Procedure

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = wide enough to capture the peaks of two adjacent channels

Resolution (or IF) Bandwidth (RBW) ≥ 1% of the span

Video (or Average) Bandwidth (VBW) ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

5.5.4 Test Result

Please refer to ANNEX A.4.

5.6 Time of Occupancy (Dwell time)

5.6.1 Limit

FCC §15.247(a); RSS-247, 5.1 (4)

Frequency hopping systems in the 2400 MHz - 2483.5 MHz band shall use at least 15 non-overlapping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

5.6.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.6.3 Test Procedure

The lowest, middle and highest channels are selected to perform testing to record the dwell time of each occupation measured in this channel, which is called Pulse Time here.

5.6.4 Test Result

Please refer to ANNEX A.5

5.7 Conducted Spurious Emission & Authorized-band band-edge

5.7.1 Limit

FCC §15.247(d); RSS-247, 5.5

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.

5.7.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.7.3 Test Procedure

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
RBW = 100 kHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
Allow the trace to stabilize

5.7.4 Test Result

Please refer to ANNEX A.6.

5.8 Conducted Emission

5.8.1 Limit

FCC §15.207; RSS-GEN, 8.8

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50μH/50Ω line impedance stabilization network (LISN).

Frequency range (MHz)	Conducted Limit (dBμV)	
	Quai-peak	Average
0.15 - 0.50	66 to 56	56 to 46
0.50 - 5	56	46
0.50 - 30	60	50

5.8.2 Test Setup

See section 4.4.2 for test setup description for the AC power supply port. The photo of test setup please refer to ANNEX B.

5.8.3 Test Procedure

The maximum conducted interference is searched using Peak (PK), if the emission levels more than the AV and QP limits, and that have narrow margins from the AV and QP limits will be re-measured with AV and QP detectors. Tests for both L phase and N phase lines of the power mains connected to the EUT are performed. Refer to recorded points and plots below.

5.8.4 Test Result

Please refer to ANNEX A.7.

5.9 Radiated Spurious Emission

5.9.1 Limit

FCC §15.209&15.247(d); RSS-247, 5.5

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

According to FCC section 15.209 (a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

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

Note:

1. Field Strength (dBμV/m) = 20*log[Field Strength (μV/m)].
2. In the emission tables above, the tighter limit applies at the band edges.
3. For Above 1000 MHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20dB above the maximum permitted average limit.
4. For above 1000 MHz, limit field strength of harmonics: 54dBuV/m@3m (AV) and 74dBuV/m@3m (PK).

5.9.2 Test Setup

See section 4.4.3 to 4.4.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.9.3 Test Procedure

The measurement frequency range is from 9 kHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ RBW

Sweep = auto
Detector function = peak
Trace = max hold
For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported, Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

5.9.4 Test Result

Please refer to ANNEX A.8.

5.10 Band Edge (Restricted-band band-edge)

5.10.1 Limit

FCC §15.209&15.247(d); RSS-247, 5.5

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

5.10.2 Test Setup

See section 4.4.3 to 4.4.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.10.3 Test Procedure

The measurement frequency range is from 9 kHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported, Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

5.10.4 Test Result

Please refer to ANNEX A.9.

ANNEX A TEST RESULT

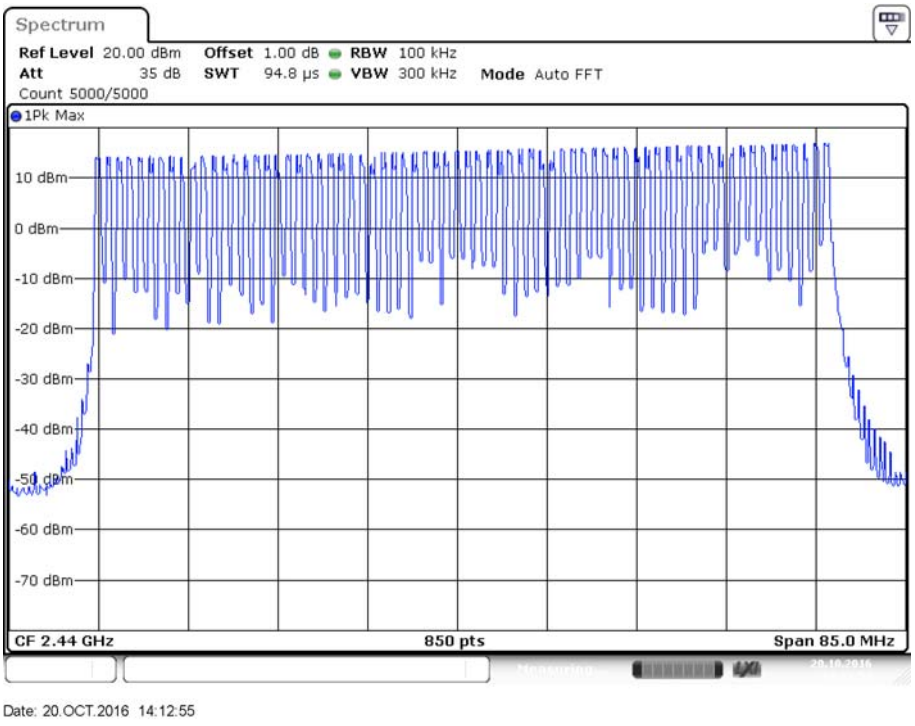
A.1 Number of Hopping Frequency

Test Data

Test Mode	Frequency Block (MHz)	Measured Channel Numbers	Min. Limit	Verdict
GFSK	2400 - 2483.5	70	15	Pass

Test plots

GFSK 2.4 GHz ~ 2.4835 GHz



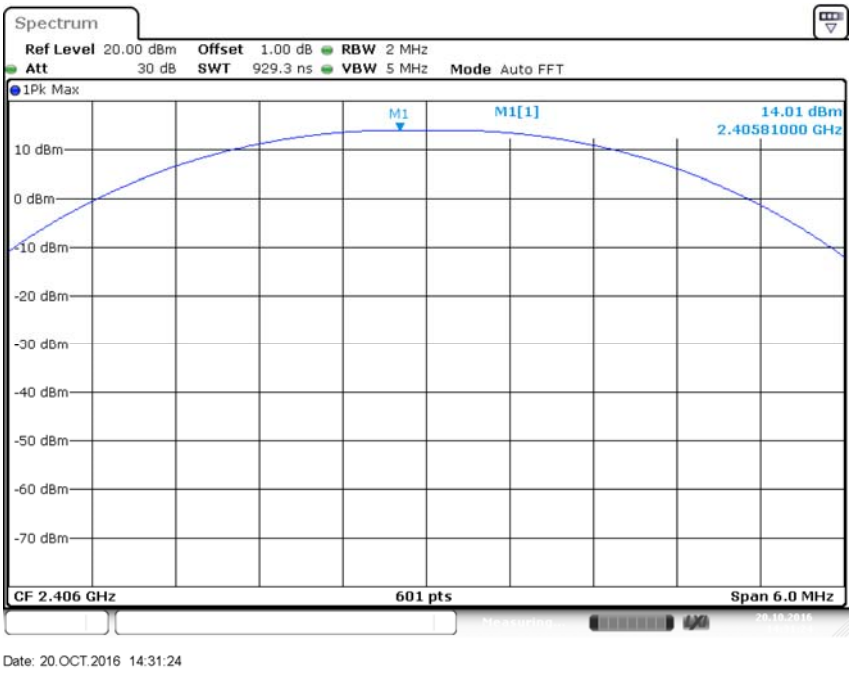
A.2 Peak Output Power

Peak Power Test Data

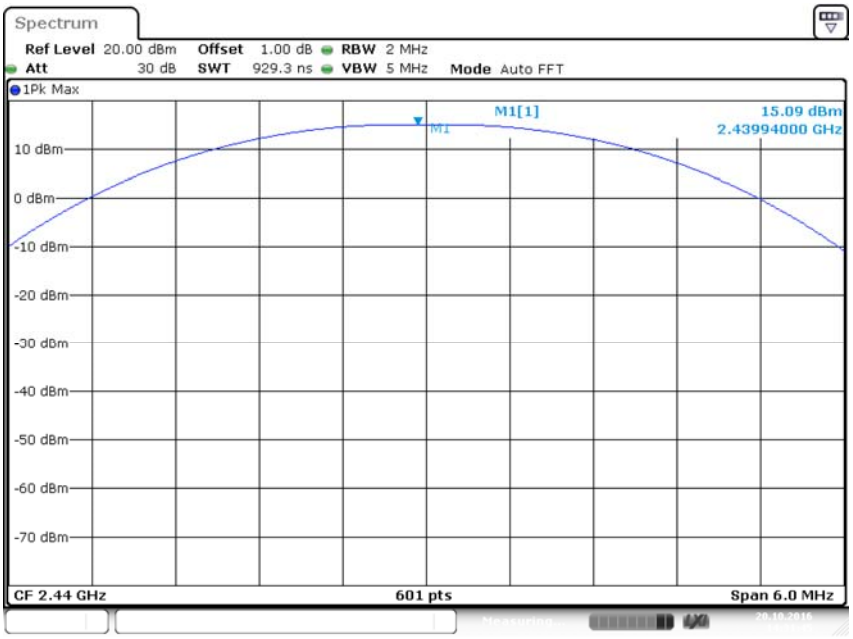
Channel	Measured Output Peak Power		Limit		Verdict
	dBm	mW	dBm	mW	
Low	14.01	25.18	21	125	Pass
Middle	15.09	32.28			Pass
High	16.71	46.88			Pass

Test plots

GFSK LOW CHANNEL

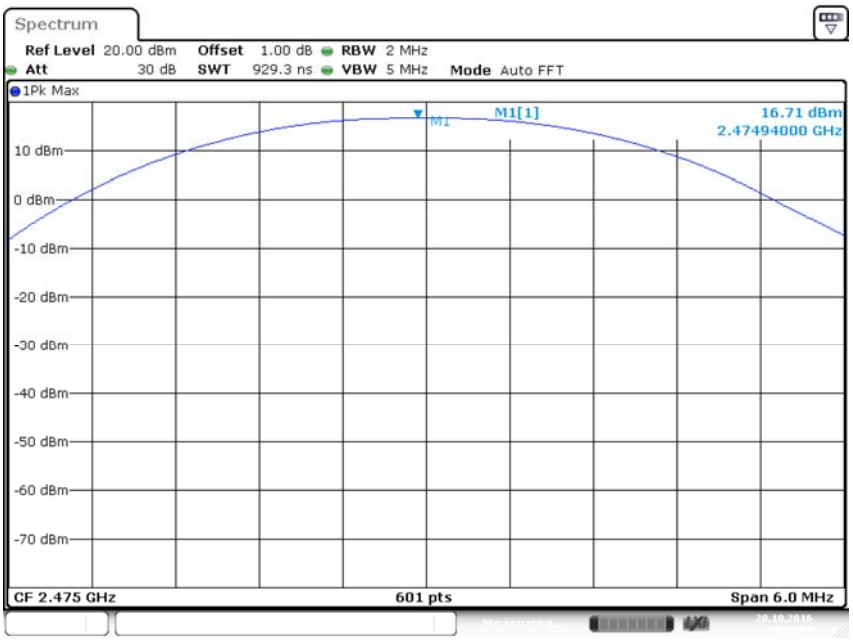


GFSK MIDDLE CHANNEL



Date: 20.OCT.2016 14:31:46

GFSK HIGH CHANNEL



Date: 20.OCT.2016 14:32:02

A.3 20 dB and 99% bandwidth

Test Data

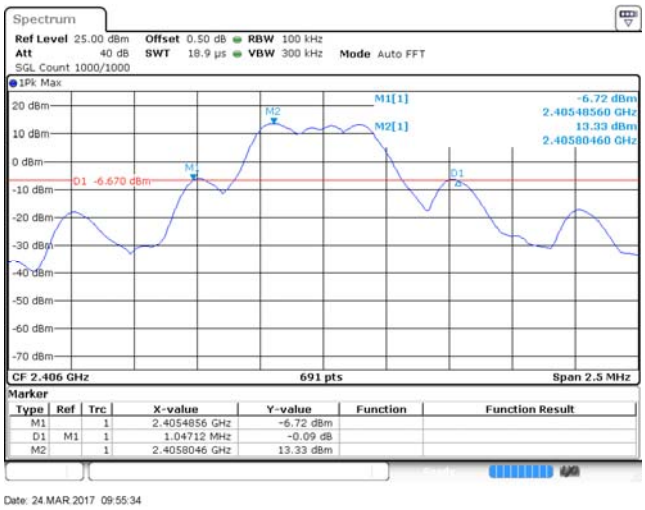
GFSK Mode:

Channel	20 dB Bandwidth (MHz)	99% Bandwidth (kHz)
Low	1.05	508
Middle	1.12	494
High	0.71	504

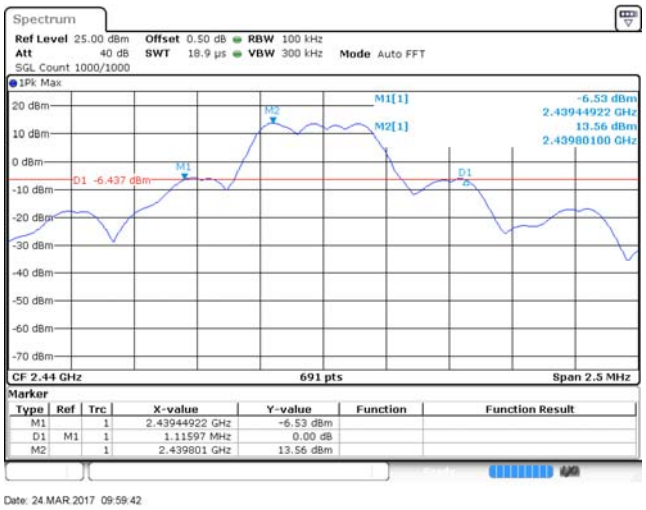
Test plots

20 dB Bandwidth

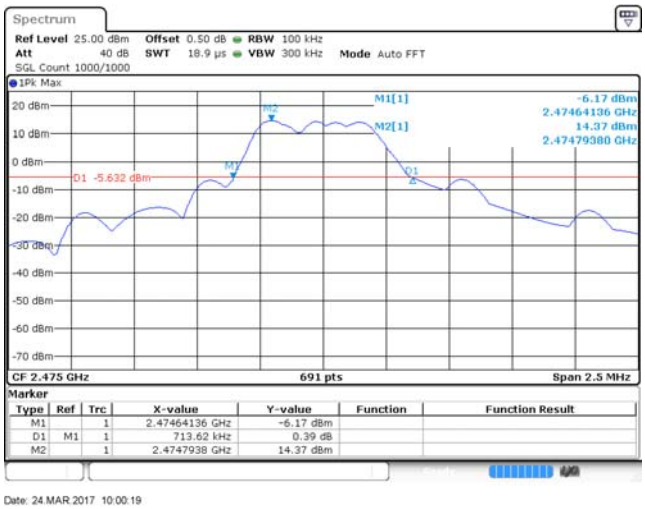
GFSK LOW CHANNEL



GFSK MIDDLE CHANNEL

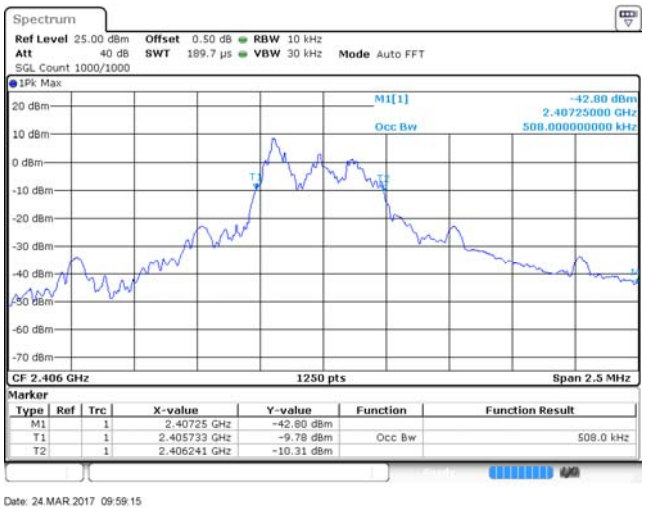


GFSK HIGH CHANNEL

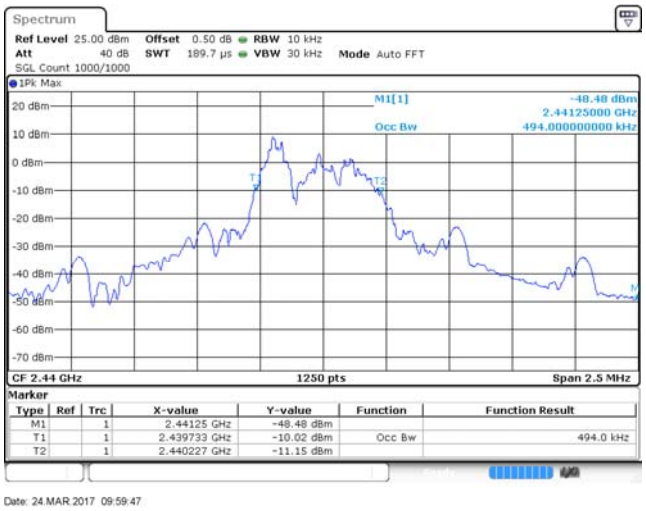


99% Bandwidth

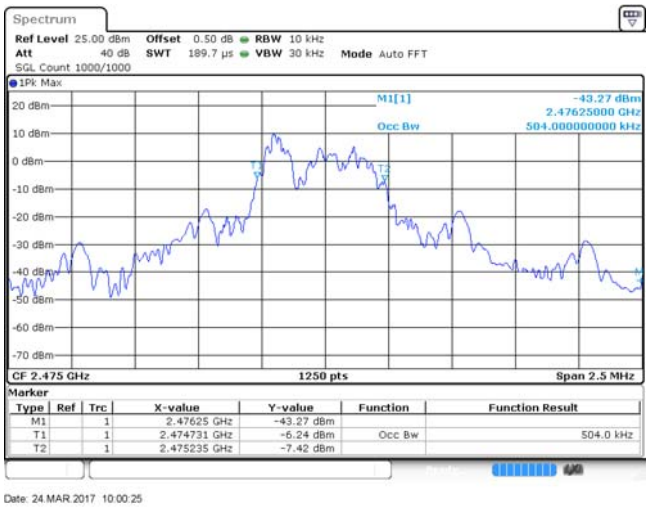
GFSK LOW CHANNEL



GFSK MIDDLE CHANNEL



GFSK HIGH CHANNEL



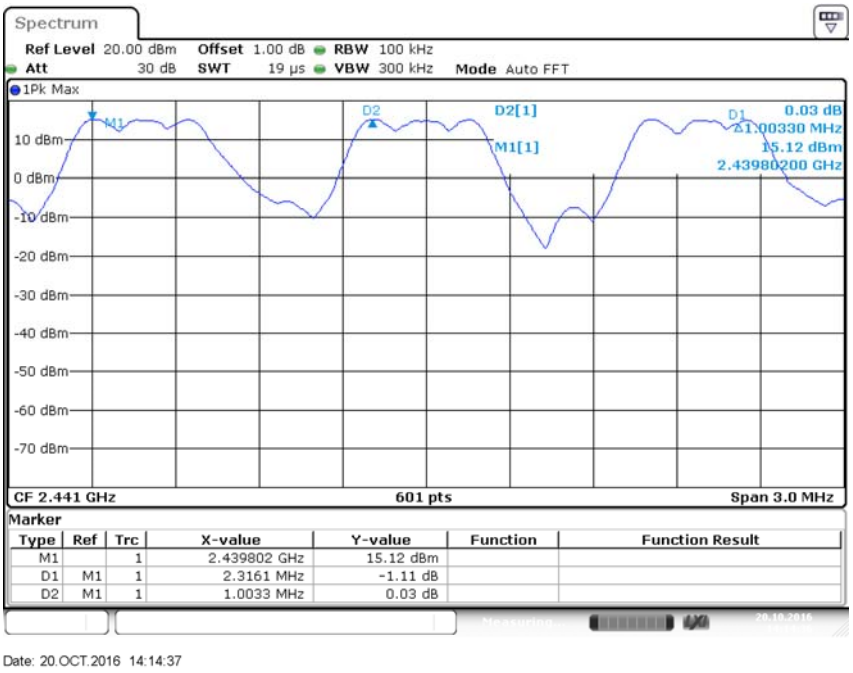
A.4 Hopping Frequency Separation

Test Data

Mode	Frequency separation (MHz)	Max 20 dB Bandwidth (MHz)	Two-thirds of the 20 dB bandwidth (MHz)	Verdict
GFSK	1.003	791.600	527.733	Pass

Test Plots

GFSK



A.5 Average Time of Occupancy

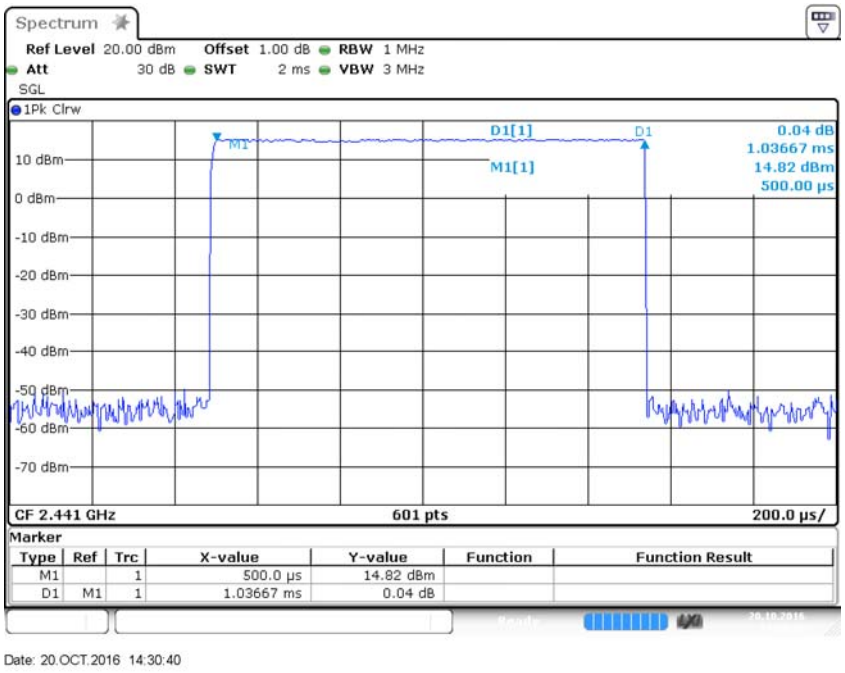
Test Data

GFSK Mode:

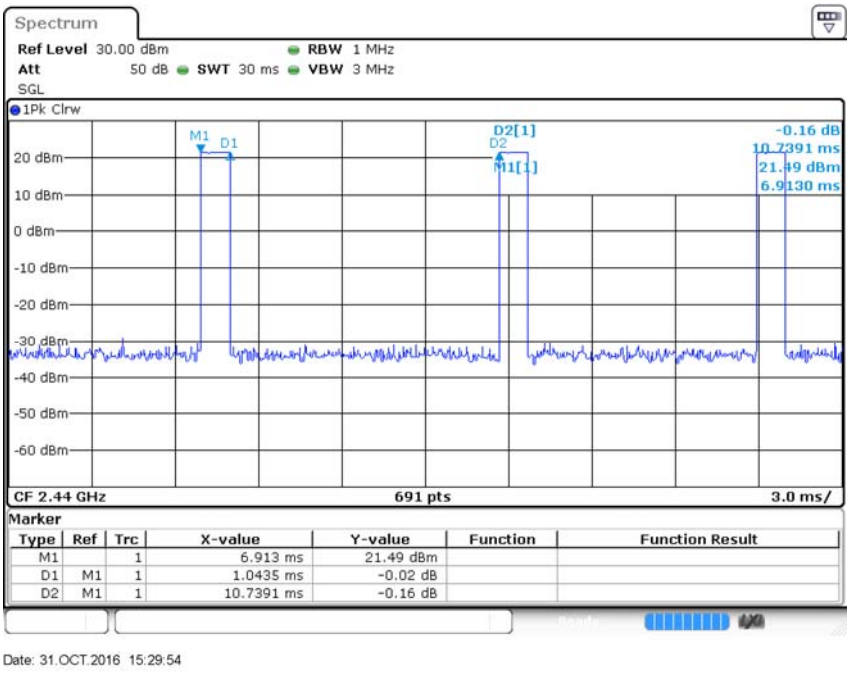
Pulse Width (ms)	Total of Dwell (ms)	Limit (sec)	Verdict
1.04	898.56	0.4	Pass

Test Plots

GFSK 1



GFSK 2



Period specified in the requirements = 0.4 s * Number of Hopping Frequency=0.4*72=28.8s;

Number of hops in the period specified in the requirements = (number of hops on spectrum analyzer) × (period specified in the requirements / analyzer sweep time) =3*(28.8/0.1) =864;

Total of Dwell = {Pulse Time} * (Number of hops in the period specified in the requirements)

=1.04 ms * 864

=898.56 ms.

A.7 Conducted Spurious Emissions & Authorized-band band-edge

Test Data

GFSK Mode:

Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low	-46.37	13.53	-6.47	Pass
Middle	-48.52	13.60	-6.40	Pass
High	-57.58	14.42	-5.58	Pass

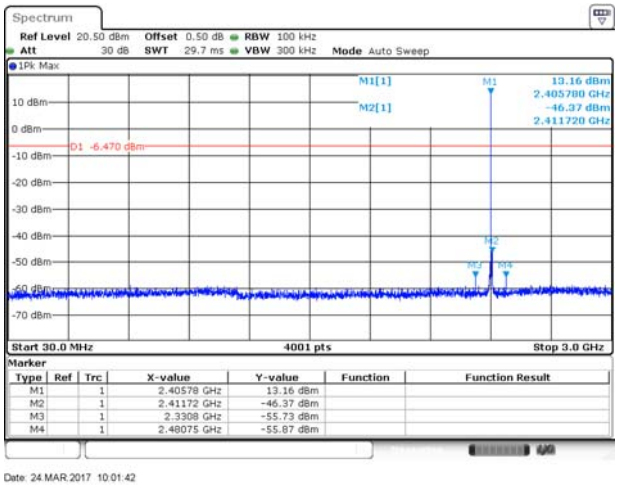
Hopping Mode:

Mode	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
GFSK	-57.88	14.17	-5.83	Pass

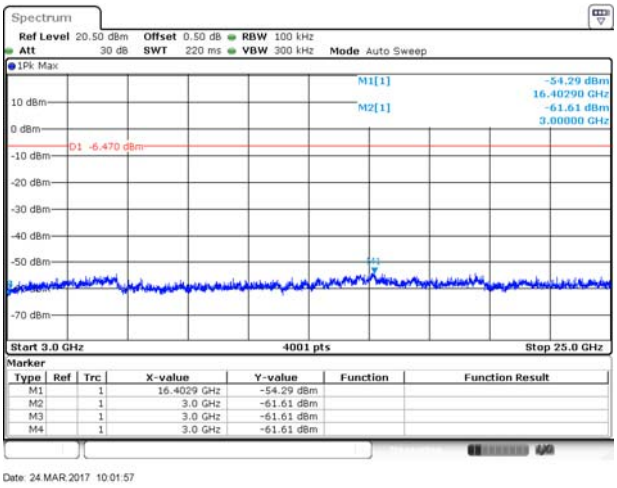
Test Plots

GFSK LOW CHANNEL , BAND EDGE

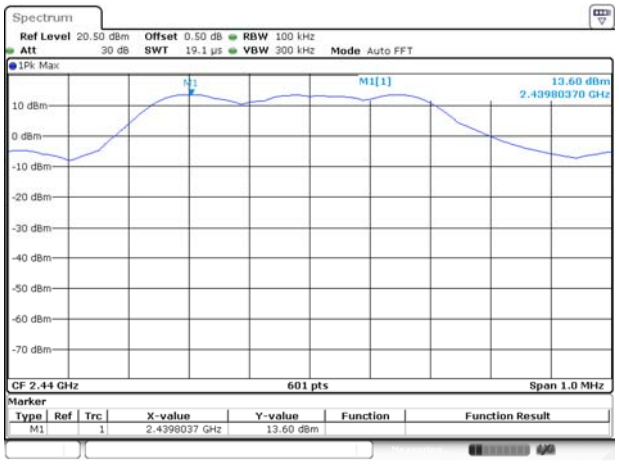
GFSK LOW CHANNEL , SPURIOUS 30 MHz ~ 3 GHz



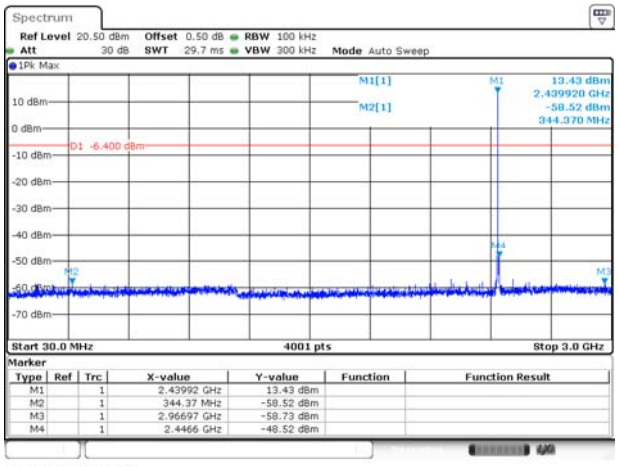
GFSK LOW CHANNEL , SPURIOUS 3 GHz ~ 25 GHz



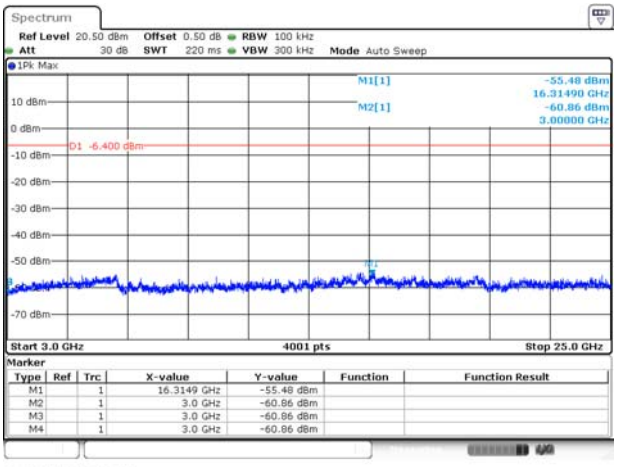
GFSK MIDDLE CHANNEL , BAND EDGE



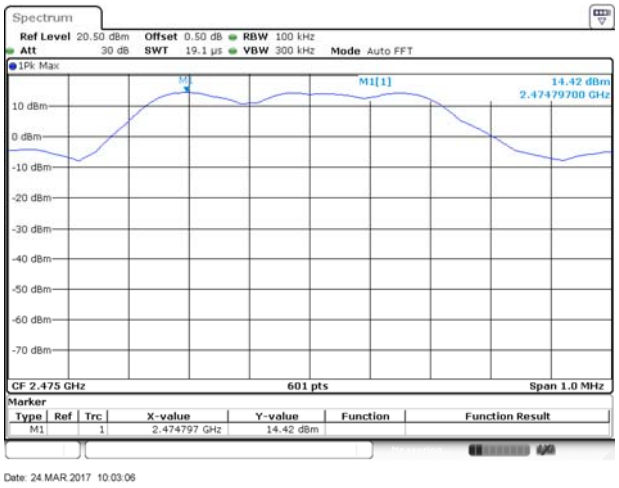
GFSK MIDDLE CHANNEL , SPURIOUS 30 MHz ~ 3 GHz



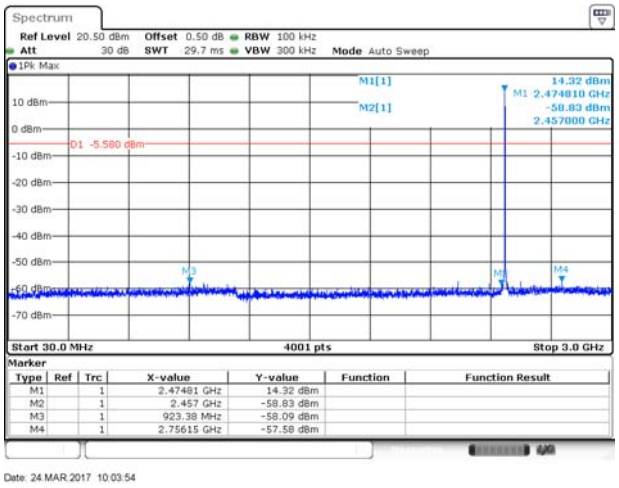
GFSK MIDDLE CHANNEL , SPURIOUS 3 GHz ~ 25 GHz



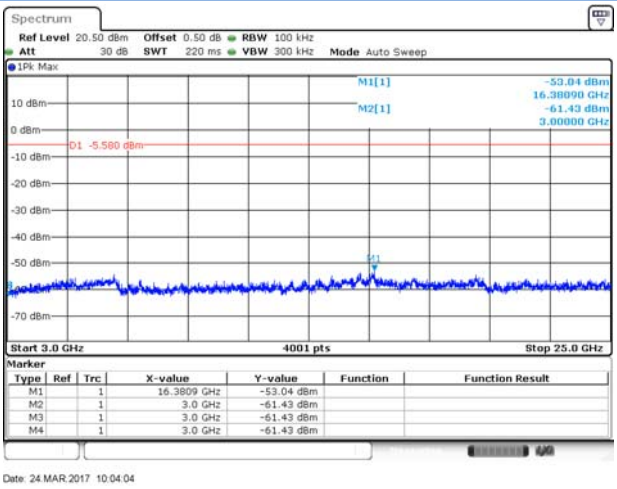
GFSK HIGH CHANNEL , BAND EDGE



GFSK HIGH CHANNEL , SPURIOUS 30 MHz ~ 3 GHz

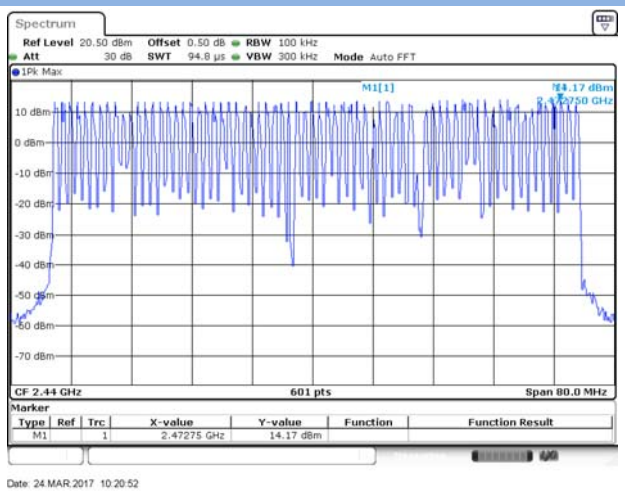


GFSK HIGH CHANNEL , SPURIOUS 3 GHz ~ 25 GHz

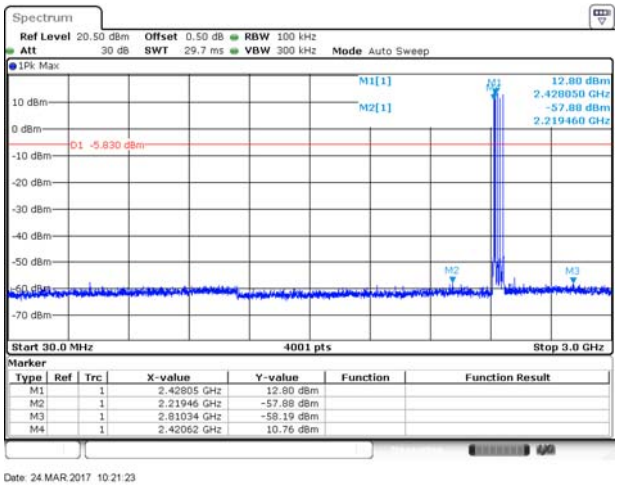


Hoppling mode:

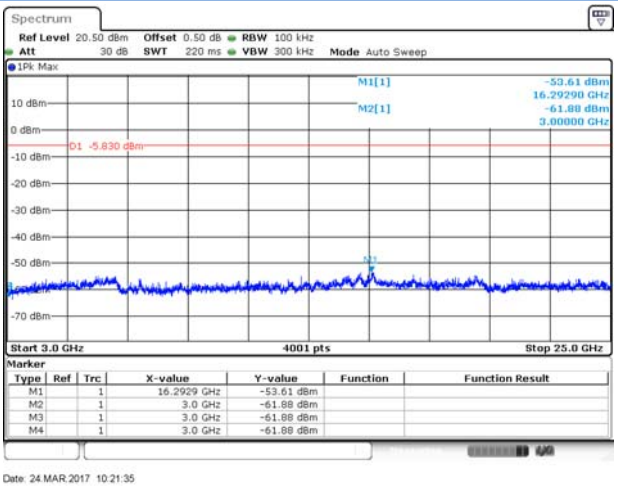
GFSK HOPPING, CARRIER LEVEL



GFSK HOPPING , SPURIOUS 30 MHz ~ 3 GHz



GFSK HOPPING , SPURIOUS 3 GHz ~ 25 GHz



A.8 Conducted Emissions

Note: Not applicable.

A.8 Radiated Emission

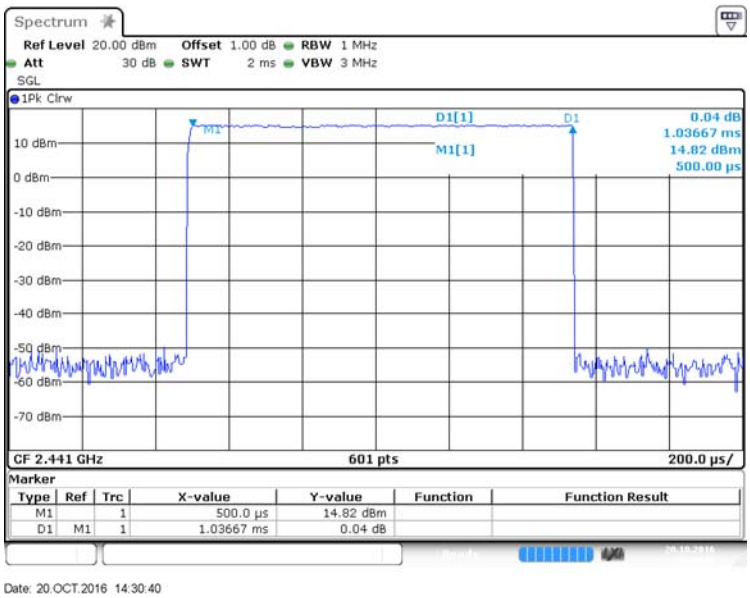
Duty cycle correction factor for average measurement.

Note:

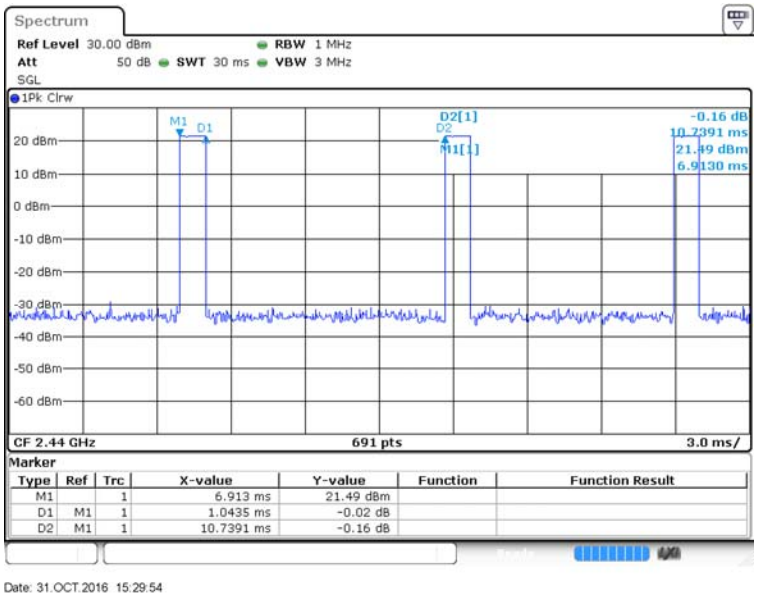
1. Duty cycle = on time/100 milliseconds = 3* 1.04 / 100 =3.12 %
2. Duty cycle correction factor = 20*log (Duty cycle) = -30.12 dB
3. GFSK has the highest duty cycle and is reported.

Test Plots

GFSK on time/100 ms (One Pulse) Plot on Channel 78



GFSK on time/100 ms (Count Pulses) Plot on Channel 78



Note [1]: The symbol of "--" in the table which means not application.

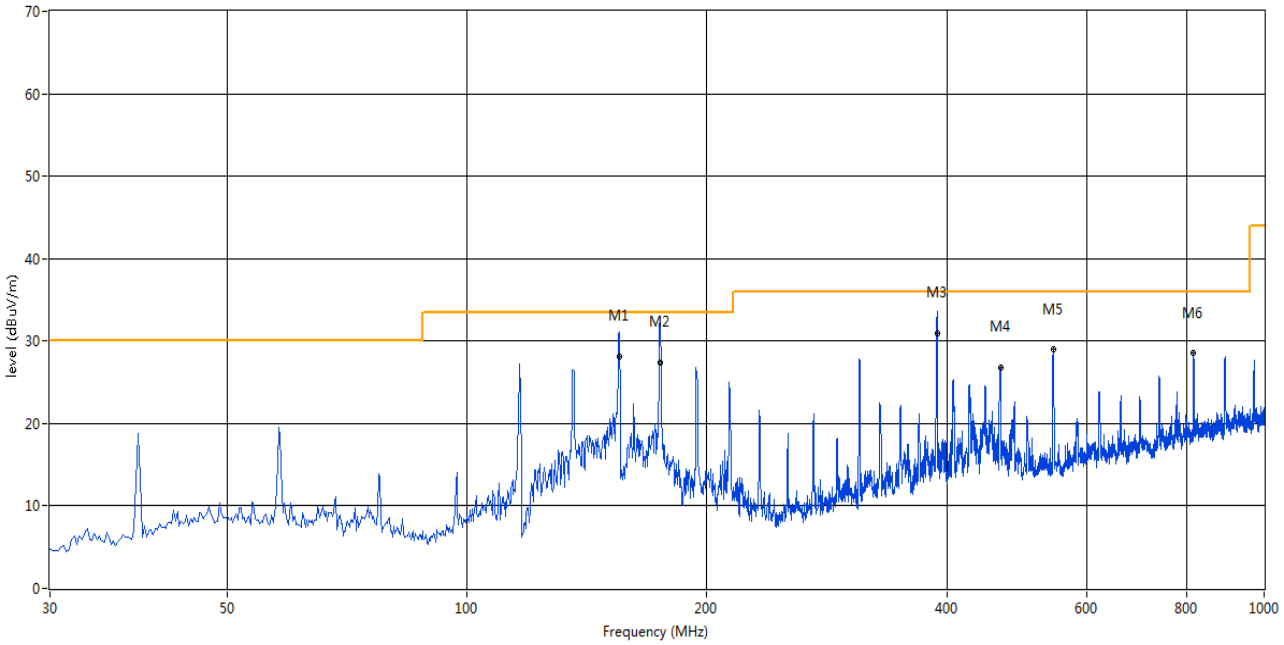
Note [2]: For the test data above 1 GHz, according the ANSI C63.4-2014, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.

Note [3]: All configurations have been tested, only the worst configuration (GFSK High Channel) shown here.

Test Data and Plots

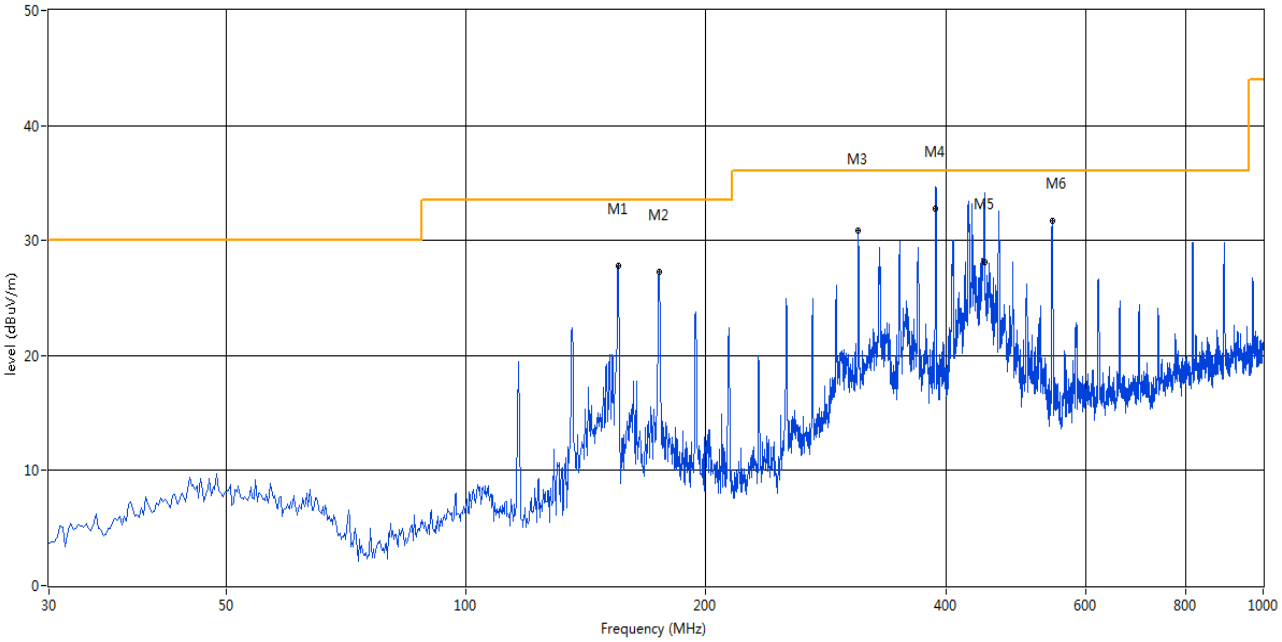
The low frequency, which started from 9 kHz to 30 MHz, was pre-scanned and the result which was 20 dB lower than the limit line per 15.31(o) was not reported.

30 MHz to 1 GHz, ANT V



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	155.295	32.23	-19.15	33.5	1.27	Peak	360.00	106.00	Vertical	N/A
1*	155.295	28.12	-19.15	33.5	5.38	QP	360.00	106.00	Vertical	Pass
2	174.743	30.90	-18.35	33.5	2.60	Peak	188.00	110.000	Vertical	N/A
2*	174.743	27.40	-18.35	33.5	6.10	QP	188.00	110.000	Vertical	Pass
3	388.813	33.33	-11.03	36.0	2.67	Peak	171.00	100.00	Vertical	N/A
3*	388.813	30.86	-11.03	36.0	5.14	QP	171.00	100.00	Vertical	Pass
4	466.876	26.76	-9.88	36.0	9.24	Peak	335.00	300	Vertical	Pass
5	544.699	28.94	-8.22	36.0	7.06	Peak	291.00	300	Vertical	Pass
6	814.776	28.50	-4.23	36.0	7.50	Peak	165.00	200	Vertical	Pass

30 MHz to 1 GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	155.341	27.84	-19.15	33.5	5.66	Peak	297.00	200	Horizontal	Pass
2	174.736	27.23	-18.39	33.5	6.27	Peak	297.00	200	Horizontal	Pass
3	310.260	30.85	-13.08	36.0	5.15	Peak	246.00	200	Horizontal	Pass
4	388.381	35.97	-11.13	36.0	0.03	Peak	267.00	227.00	Horizontal	N/A
4*	388.381	32.72	-11.13	36.0	3.28	QP	267.00	227.00	Horizontal	Pass
5	446.977	34.64	-10.10	36.0	1.36	Peak	249.00	234.00	Horizontal	N/A
5*	446.977	28.15	-10.10	36.0	7.85	QP	249.00	234.00	Horizontal	Pass
6	544.699	31.71	-8.22	36.0	4.29	Peak	119.00	200	Horizontal	Pass

Note: The marked spikes near 2400 MHz with circle should be ignored because they are Fundamental signal.

Test Data and Plots (1 GHz ~ 10th Harmonic)

GFSK LOW CHANNEL 1 GHz to 25 GHz, ANT V

No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	1126.468	41.30	-4.04	74.0	32.70	Peak	239.50	150	Vertical	Pass
2	1576.856	43.63	-2.40	74.0	30.37	Peak	69.70	150	Vertical	Pass
3	1978.255	43.66	0.54	74.0	30.34	Peak	25.60	150	Vertical	Pass
4**	2406.148	77.70	1.90	54.0	-23.70	AV	355.60	150	Vertical	N/A
4	2406.148	102.20	1.90	74.0	-28.20	Peak	355.60	150	Vertical	N/A
5	3553.362	46.87	9.82	74.0	27.13	Peak	138.80	150	Vertical	Pass
6	4812.297	68.58	13.93	74.0	5.42	Peak	259.30	150	Vertical	Pass
7	13717.14	47.71	9.84	74.0	26.30	Peak	120.2	150	Vertical	Pass
8	21845.26	47.23	13.88	74.0	26.77	Peak	228.2	150	Vertical	Pass

GFSK LOW CHANNEL 1 GHz to 25 GHz, ANT H

No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	1201.950	42.39	-3.17	74.0	31.61	Peak	114.30	150	Horizontal	Pass
2	2053.737	44.53	0.32	74.0	29.47	Peak	0.50	150	Horizontal	Pass
3**	2406.148	87.00	1.90	54.0	-33.00	AV	41.30	150	Horizontal	N/A
3	2406.148	117.90	1.90	74.0	-43.90	Peak	41.30	150	Horizontal	N/A
4	2873.532	48.21	7.08	74.0	25.79	Peak	315.70	150	Horizontal	Pass
5	4041.490	47.83	11.42	74.0	26.17	Peak	173.40	150	Horizontal	Pass
6	4811.547	66.32	13.91	74.0	7.68	Peak	107.80	150	Horizontal	Pass
7	14278.70	43.52	9.18	74.0	30.48	Peak	1.5	150	Horizontal	Pass
8	19658.90	47.42	11.12	74.0	26.58	Peak	205.1	150	Horizontal	Pass

GFSK MIDDLE CHANNEL 1 GHz to 25 GHz, ANT V

No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	1206.948	41.67	-3.25	74.0	32.33	Peak	243.60	150	Vertical	Pass
2	1504.874	41.45	-2.65	74.0	32.55	Peak	359.30	150	Vertical	Pass
3	2037.241	44.26	0.62	74.0	29.74	Peak	218.10	150	Vertical	Pass
4	2440.140	104.57	1.45	74.0	-30.57	Peak	122.70	150	Vertical	N/A
4''	2440.140	84.57	1.45	54.0	-50.57	Peak	122.70	150	Vertical	N/A
5	2896.526	49.77	5.88	74.0	24.23	Peak	240.60	150	Vertical	Pass
6	4879.780	66.45	13.61	74.0	7.55	Peak	360.00	150	Vertical	Pass
7	16223.38	43.02	10.00	74.0	30.98	Peak	128.9	150	Vertical	Pass
8	24920.13	50.43	8.45	74.0	23.57	Peak	221.2	150	Vertical	Pass

GFSK MIDDLE CHANNEL 1 GHz to 25 GHz, ANT H

No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	1358.910	41.41	-2.45	74.0	32.59	Peak	126.90	150	Horizontal	Pass
2	2129.718	45.20	0.70	74.0	28.80	Peak	150.10	150	Horizontal	Pass
3**	2440.140	89.45	1.45	54.0	-35.45	AV	68.60	150	Horizontal	N/A
3	2440.140	120.35	1.45	74.0	-46.35	Peak	68.60	150	Horizontal	N/A
4	2819.045	47.58	5.68	74.0	26.42	Peak	308.80	150	Horizontal	Pass
5	4183.204	48.88	11.49	74.0	25.12	Peak	221.50	150	Horizontal	Pass
6	4879.780	67.56	13.61	74.0	6.44	Peak	46.80	150	Horizontal	Pass
7	15942.60	50.53	9.02	74.0	23.47	Peak	52	150	Horizontal	Pass
8	22663.89	43.12	12.39	74.0	30.88	Peak	45.6	150	Horizontal	Pass

GFSK HIGH CHANNEL 1 GHz to 25 GHz, ANT V

No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	1120.32	50.26	-3.25	74.00	32.33	Peak	251.66	100	Vertical	Pass
2	1632.22	40.66	-2.65	74.00	32.55	Peak	322.36	100	Vertical	Pass
3	2100.25	44.52	0.63	74.00	29.74	Peak	219.42	100	Vertical	Pass
4	2476.32	103.62	1.42	74.00	-30.57	Peak	125.33	100	Vertical	N/A
5	2476.32	48.52	6.01	74.00	24.23	Peak	246.16	100	Vertical	N/A
6	4985.31	67.22	13.82	74.00	7.55	Peak	285.62	100	Vertical	Pass
7	16077.79	42.39	11.66	74.00	31.61	Peak	311.2	150	Vertical	Pass
8	18989.60	42.31	12.34	74.00	31.69	Peak	14.1	150	Vertical	Pass

GFSK HIGH CHANNEL 1 GHz to 25 GHz, ANT H

No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	1356.36	40.26	-2.44	74.00	33.74	Peak	100.32	100	Horizontal	Pass
2	2003.63	46.33	0.6	74.00	27.67	Peak	162.033	100	Horizontal	Pass
3**	2475.33	90.26	1.46	54.00	-36.26	AV	80	100	Horizontal	N/A
3	2475.33	121.11	1.46	74.00	-47.11	Peak	80	100	Horizontal	N/A
4	3100.32	46.32	5.85	74.00	27.68	Peak	321.3	100	Horizontal	Pass
5	4212.66	48.22	11.52	74.00	25.78	Peak	252.36	100	Horizontal	Pass
6	4936.32	67.13	13.62	74.00	6.87	Peak	49.26	100	Horizontal	Pass
7	13269.97	45.23	11.59	74.00	28.77	Peak	144.7	150	Horizontal	Pass
8	19489.19	47.21	9.12	74.00	26.79	Peak	158	150	Horizontal	Pass

Hopping Mode:

GFSK MODE 1 GHz to 25 GHz, ANT V

No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	1359.41	41.27	-4.81	74.00	32.73	Peak	355.6	150	Vertical	Pass
2	1509.87	40.63	-4.49	74.00	33.37	Peak	85.3	150	Vertical	Pass
3	1814.80	40.58	-3.77	74.00	33.42	Peak	119.1	150	Vertical	Pass
4	2452.140	100.57	1.45	74.00	-30.57	Peak	122.70	100	Vertical	N/A
4''	2452.140	80.57	1.45	54.00	-26.57	Peak	122.70	100	Vertical	N/A
5	12532.16	43.65	17.06	74.00	-26.57	Peak	11	150	Vertical	Pass
6	15526.30	44.55	18.96	74.00	-29.45	Peak	11	150	Vertical	Pass
7	16795.34	44.30	20.44	74.00	29.70	Peak	171	150	Vertical	Pass

GFSK MODE 1 GHz to 25 GHz, ANT H

No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	1671.33	42.60	-4.87	74.00	31.40	Peak	28.5	150	Horizontal	Pass
2	2456.32	100.62	1.42	74.00	-26.62	Peak	125.33	150	Horizontal	N/A
2'	2456.32	85.52	6.01	54.00	-31.52	Peak	246.16	150	Horizontal	N/A
3	3458.54	45.37	0.98	74.00	28.63	Peak	264.1	150	Horizontal	Pass
4	5724.28	49.07	10.31	74.00	24.93	Peak	6.6	150	Horizontal	Pass
5	7291.60	48.36	20.21	74.00	25.64	Peak	216.6	150	Horizontal	Pass
6	13186.77	44.48	9.68	74.00	29.52	Peak	218.8	150	Horizontal	Pass
7	23622.30	46.23	10.45	74.00	27.77	Peak	166	150	Horizontal	Pass

A.9 Band Edge (Restricted-band band-edge)

Test Data

Note [1]: The lowest and highest channels are tested to verify the band edge emissions. Please refer to the following the plots for emissions values.

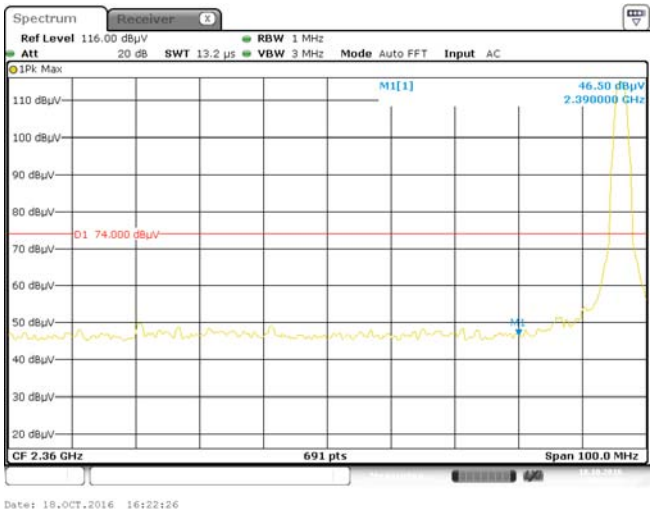
Note [2]: The test data all are tested in the vertical and horizontal antenna which the trace is max hold. So these plots have shown the worst case.

Note [3]: According the ANSI C63.10-2013, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.

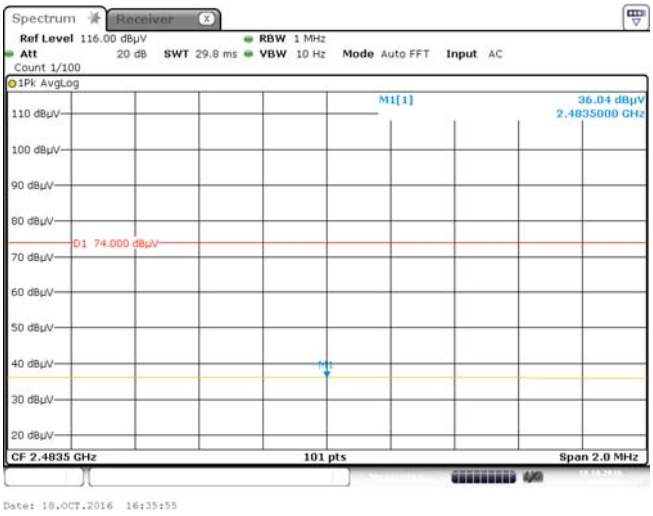
Test Plots

Test Mode	Test Channel	Frequency (MHz)	Level (dBuV/m)	Limit Line (dBuV/m)	Margin (dB)	Remark	Verdict
GFSK	Low	2390	46.50	74	27.50	PEAK	Pass
		2390	N/A	54	N/A	AVERAGE	Pass
GFSK	High	2491.3	56.27	74	17.73	PEAK	Pass
		2491.3	36.04	54	17.96	AVERAGE	Pass
GFSK(Hopping)	Low	2389.6	47.70	74	26.30	PEAK	Pass
		2389.6	N/A	54	N/A	AVERAGE	Pass
GFSK(Hopping	High	2484.8	46.89	74	27.11	PEAK	Pass
		2484.8	N/A	54	N/A	AVERAGE	Pass

GFSK LOW CHANNEL , PEAK

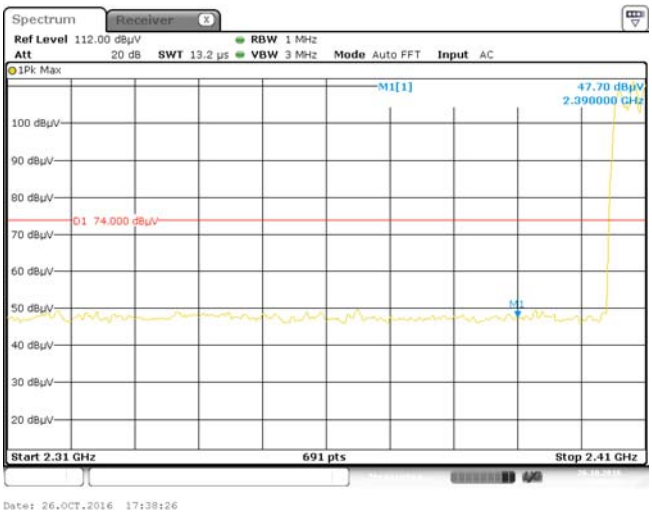


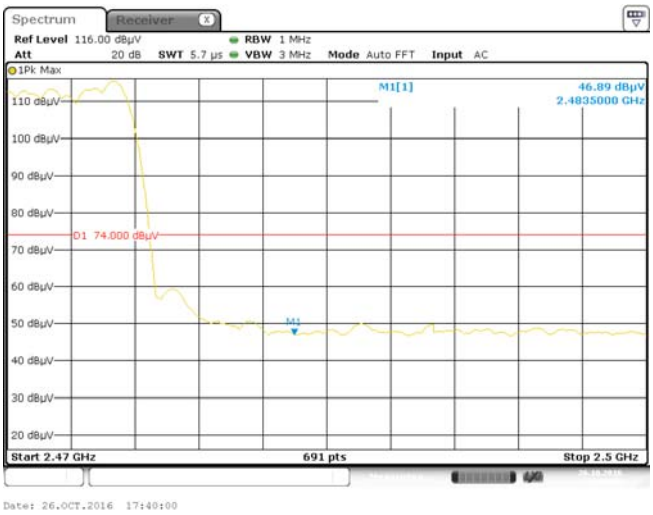
GFSK HIGH CHANNEL , PEAK	GFSK HIGH CHANNEL , AV



Hopping Mode:

GFSK LOW FREQUENCY BAND, PEAK	GFSK HIGH FREQUENCY BAND, PEAK





ANNEX B TEST SETUP PHOTOS

Please refer the document “BL-SZ16A0135-AR.PDF”.

ANNEX C EUT EXTERNAL PHOTOS

Please refer the document “BL-SZ16A0135-AW.PDF”.

ANNEX D EUT INTERNAL PHOTOS

Please refer the document “BL-SZ16A0135-AI.PDF”.

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