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Report No.: SZEM180900875703
Page: 1 of 57

TEST REPORT

Application No.:	SZEM1809008757CR
Applicant:	Fujian BelFone Communications Technology Co., Ltd.
Address of Applicant:	A15 Huaqiao Economic Development Zone, Shuangyang Luojiang, Quanzhou, Fujian, China
Manufacturer:	Fujian BelFone Communications Technology Co., Ltd.
Address of Manufacturer:	A15 Huaqiao Economic Development Zone, Shuangyang Luojiang, Quanzhou, Fujian, China
Factory:	Fujian BelFone Communications Technology Co., Ltd.
Address of Factory:	A15 Huaqiao Economic Development Zone, Shuangyang Luojiang, Quanzhou, Fujian, China
Equipment Under Test (EUT):	
EUT Name:	Digital Trunking Radio
Model No.:	BF-TD950
Trade mark:	
FCC ID:	2AARFBFTD95001
Standard(s) :	47 CFR Part 15, Subpart C 15.247
Date of Receipt:	2018-09-30
Date of Test:	2018-10-12 to 2018-11-14
Date of Issue:	2018-11-16
Test Result:	Pass*

* In the configuration tested, the EUT complied with the standards specified above.



Keny Xu

EMC Laboratory Manager

The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report. If the product in this report is used in any configuration other than that detailed in the report, the manufacturer must ensure the new system complies with all relevant standards. Any mention of SGS International Electrical Approvals or testing done by SGS International Electrical Approvals in connection with, distribution or use of the product described in this report must be approved by SGS International Electrical Approvals in writing.

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Revision Record				
Version	Chapter	Date	Modifier	Remark
01		2018-11-16		Original

Authorized for issue by:			
		 Edison Li /Project Engineer	
		 Eric Fu /Reviewer	

2 Test Summary

Radio Spectrum Technical Requirement				
Item	Standard	Method	Requirement	Result
Antenna Requirement	47 CFR Part 15, Subpart C 15.247	N/A	47 CFR Part 15, Subpart C 15.203 & 15.247(c)	Pass

Radio Spectrum Matter Part				
Item	Standard	Method	Requirement	Result
Conducted Emissions at AC Power Line (150kHz-30MHz)	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 6.2	47 CFR Part 15, Subpart C 15.207	Pass
Minimum 6dB Bandwidth	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 11.8.1	47 CFR Part 15, Subpart C 15.247a(2)	Pass
Conducted Peak Output Power	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 7.8.5	47 CFR Part 15, Subpart C 15.247(b)(3)	Pass
Power Spectrum Density	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 11.10.2	47 CFR Part 15, Subpart C 15.247(e)	Pass
Conducted Band Edges Measurement	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 7.8.6	47 CFR Part 15, Subpart C 15.247(d)	Pass
Conducted Spurious Emissions	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 7.8.8	47 CFR Part 15, Subpart C 15.247(d)	Pass
Radiated Emissions which fall in the restricted bands	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 6.10.5	47 CFR Part 15, Subpart C 15.205 & 15.209	Pass
Radiated Spurious Emissions	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 6.4,6.5,6.6	47 CFR Part 15, Subpart C 15.205 & 15.209	Pass

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4 General Information

4.1 Details of E.U.T.

Power supply:	Power Adapter Model: BS-24W1201500DUI Input: AC 100-240V, 50/60Hz, 0.6A Output: DC 12V, 1500mA Batteries Model: BF-A48 Lithium Ion Battery DC 7.4V, 3350mAh
Test voltage:	DC 7.4V
Frequency Range:	2402MHz to 2480MHz
Bluetooth Version:	V4.2 This report is for BLE mode.
Modulation Type	GFSK
Channel Spacing	2MHz
Number of Channels	40
Antenna Type:	Integral
Antenna Gain:	0dBi

4.2 Description of Support Units

The EUT has been tested as an independent unit.

4.3 Measurement Uncertainty

No.	Item	Measurement Uncertainty
1	Radio Frequency	7.25×10^{-8}
2	Duty cycle	0.37%
3	Occupied Bandwidth	3%
4	RF conducted power	0.75dB
5	RF power density	2.84dB
6	Conducted Spurious emissions	0.75dB
7	RF Radiated power	4.5dB (below 1GHz) 4.8dB (above 1GHz)
8	Radiated Spurious emission test	4.5dB (Below 1GHz) 4.8dB (Above 1GHz)
9	Temperature test	1 °C
10	Humidity test	3%
11	Supply voltages	1.5%
12	Time	3%

4.4 Test Location

All tests were performed at:

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen Branch

No. 1 Workshop, M-10, Middle Section, Science & Technology Park, Shenzhen, Guangdong, China.
518057.

Tel: +86 755 2601 2053 Fax: +86 755 2671 0594

No tests were sub-contracted.

4.5 Test Facility

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

- CNAS (No. CNAS L2929)**

CNAS has accredited SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch EMC

Lab to ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories (CNAS-CL01 Accreditation Criteria for the Competence of Testing and Calibration Laboratories) for the competence in the field of testing.

- A2LA (Certificate No. 3816.01)**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory is accredited by the American Association for Laboratory Accreditation(A2LA). Certificate No. 3816.01.

- VCCI**

The 3m Fully-anechoic chamber for above 1GHz, 10m Semi-anechoic chamber for below 1GHz, Shielded Room for Mains Port Conducted Interference Measurement and Telecommunication Port Conducted Interference Measurement of SGS-CSTC Standards Technical Services Co., Ltd. have been registered in accordance with the Regulations for Voluntary Control Measures with Registration No.: G-20026, R-14188, C-12383 and T-11153 respectively.

- FCC –Designation Number: CN1178**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory has been recognized as an accredited testing laboratory.

Designation Number: CN1178. Test Firm Registration Number: 406779.

- Innovation, Science and Economic Development Canada**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory has been recognized by ISED as an accredited testing laboratory.

CAB identifier: CN0006.

IC#: 4620C.

4.6 Deviation from Standards

None

4.7 Abnormalities from Standard Conditions

None

5 Equipment List

Conducted Emissions at Mains Terminals (150kHz-30MHz)					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
Shielding Room	ChangZhou ZhongYu	GB-88	SEM001-06	2017-05-10	2020-05-09
Measurement Software	AUDIX	e3 V5.4.1221d	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM024-01	2018-07-12	2019-07-11
LISN	Rohde & Schwarz	ENV216	SEM007-01	2018-09-25	2019-09-24
LISN	ETS-LINDGREN	3816/2	SEM007-02	2018-04-02	2019-04-01
EMI Test Receiver	Rohde & Schwarz	ESCI	SEM004-02	2018-04-02	2019-04-01

RF conducted test					
Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. Date	Cal. Due date
DC Power Supply	ZhaoXin	PS-3005D	SEM011-05	2018-09-25	2019-09-24
Spectrum Analyzer (20Hz-43GHz)	Rohde & Schwarz	FSU43	SEM004-08	2018-04-13	2019-04-12
Signal Generator (9kHz-40GHz)	KEYSIGHT	N5173B	SEM006-05	2018-09-27	2019-09-26
Measurement Software	JS Tonscend	JS1120-2 BT/WIFI V2.6	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM031-01	2018-07-12	2019-07-11
Attenuator	Weinschel Associates	WA41	SEM021-09	N/A	N/A

Radiated Emissions which fall in the restricted bands					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
3m Semi-Anechoic Chamber	AUDIX	N/A	SEM001-02	2017-05-02	2020-05-01
Measurement Software	AUDIX	e3 V8.2014-6- 27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM026-01	2018-07-11	2019-07-10
Spectrum Analyzer	Rohde & Schwarz	FSU43	SEM004-08	2018-03-31	2019-03-30
BiConiLog Antenna (26-3000MHz)	ETS-Lindgren	3142C	SEM003-01	2017-06-27	2020-06-26
Horn Antenna (1-18GHz)	Rohde & Schwarz	HF907	SEM003-07	2018-04-13	2021-04-12
Horn Antenna (15GHz-40GHz)	Schwarzbeck	BBHA 9170	SEM003-15	2017-10-17	2020-10-16
Pre-amplifier (0.1-1300MHz)	HP	8447D	SEM005-02	2018-09-25	2019-09-24
Low Noise Amplifier (100MHz-18GHz)	Black Diamond Series	BDLNA-0118- 352810	SEM005-05	2018-09-26	2019-09-25
Pre-amplifier (18-26GHz)	Rohde & Schwarz	CH14-H052	SEM005-17	2018-03-31	2019-03-30



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Pre-amplifier (26GHz-40GHz)	Compliance Directions Systems Inc.	PAP-2640-50	SEM005-08	2018-04-02	2019-04-01
DC Power Supply	Zhao Xin	RXN-305D	SEM011-02	2018-09-25	2019-09-24
Active Loop Antenna	ETS-Lindgren	6502	SEM003-08	2017-08-22	2020-08-21
Band filter	N/A	N/A	SEM023-01	N/A	N/A

Radiated Spurious Emissions					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
3m Semi-Anechoic Chamber	AUDIX	N/A	SEM001-02	2017-05-02	2020-05-01
Measurement Software	AUDIX	e3 V8.2014-6- 27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM026-01	2018-07-11	2019-07-10
Spectrum Analyzer	Rohde & Schwarz	FSU43	SEM004-08	2018-03-31	2019-03-30
BiConiLog Antenna (26-3000MHz)	ETS-Lindgren	3142C	SEM003-01	2017-06-27	2020-06-26
Horn Antenna (1-18GHz)	Rohde & Schwarz	HF907	SEM003-07	2018-06-12	2019-06-14
Horn Antenna (15GHz-40GHz)	Schwarzbeck	BBHA 9170	SEM003-15	2017-10-17	2020-10-16
Pre-amplifier (0.1-1300MHz)	HP	8447D	SEM005-02	2018-09-25	2019-09-24
Low Noise Amplifier (100MHz-18GHz)	Black Diamond Series	BDLNA-0118- 352810	SEM005-05	2018-09-26	2019-09-25
Pre-amplifier(18-26GHz)	Rohde & Schwarz	CH14-H052	SEM005-17	2018-04-02	2019-04-01
Pre-amplifier (26GHz-40GHz)	Compliance Directions Systems Inc.	PAP-2640-50	SEM005-08	2018-03-31	2019-03-30
DC Power Supply	Zhao Xin	RXN-305D	SEM011-02	2018-09-25	2019-09-24
Active Loop Antenna	ETS-Lindgren	6502	SEM003-08	2017-08-22	2020-08-21
Band filter	N/A	N/A	SEM023-01	N/A	N/A

RE in Chamber					
Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. Date	Cal. Due date
3m Semi-Anechoic Chamber	ETS-LINDGREN	N/A	SEM001-01	2017-08-05	2020-08-04
MXE EMI Receiver (20Hz-8.4GHz)	Agilent Technologies	N9038A	SEM004-05	2018-09-25	2019-09-24
BiConiLog Antenna (26-3000MHz)	ETS-LINDGREN	3142C	SEM003-01	2017-06-27	2020-06-26
Pre-amplifier (0.1-1300MHz)	Agilent Technologies	8447D	SEM005-01	2018-04-02	2019-04-01
Measurement Software	AUDIX	e3 V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM025-01	2018-07-12	2019-07-11

General used equipment					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
Humidity/ Temperature Indicator	Shanghai Meteorological Industry Factory	ZJ1-2B	SEM002-03	2018-09-27	2019-09-26
Humidity/ Temperature Indicator	Shanghai Meteorological Industry Factory	ZJ1-2B	SEM002-04	2018-09-27	2019-09-26
Humidity/ Temperature Indicator	Mingle	N/A	SEM002-08	2018-09-27	2019-09-26
Barometer	Changchun Meteorological Industry Factory	DYM3	SEM002-01	2018-04-08	2019-04-07

6 Radio Spectrum Technical Requirement

6.1 Antenna Requirement

6.1.1 Test Requirement:

47 CFR Part 15, Subpart C 15.203 & 15.247(c)

6.1.2 Conclusion

Standard Requirement:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

15.247(b) (4) requirement:

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

EUT Antenna:

The antenna is integrated on the main PCB and no consideration of replacement. The best case gain of the antenna is 0dBi.

Antenna Location: Please refer to appendix(Internal photos).

7 Radio Spectrum Matter Test Results

7.1 Conducted Emissions at AC Power Line (150kHz-30MHz)

Test Requirement 47 CFR Part 15, Subpart C 15.207

Test Method: ANSI C63.10 (2013) Section 6.2

Limit:

Frequency of emission(MHz)	Conducted limit(dB μ V)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

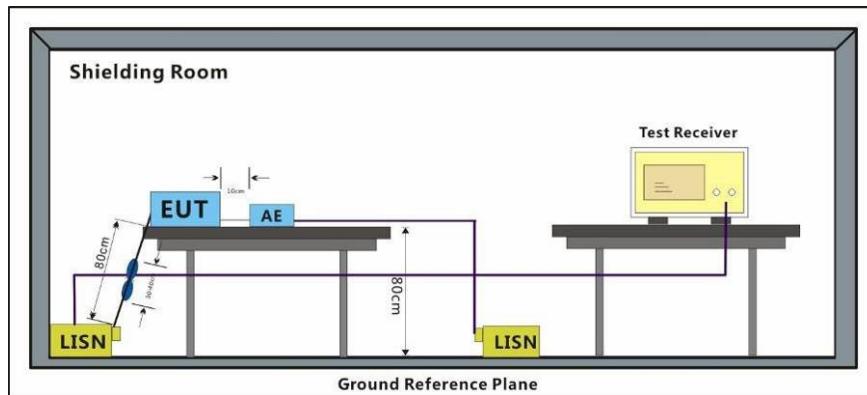
7.1.1 E.U.T. Operation

Operating Environment:

Temperature: 22.8 °C Humidity: 67.7 % RH Atmospheric Pressure: 1010 mbar

Test mode: d:Charge + TX mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation.

7.1.2 Test Setup Diagram

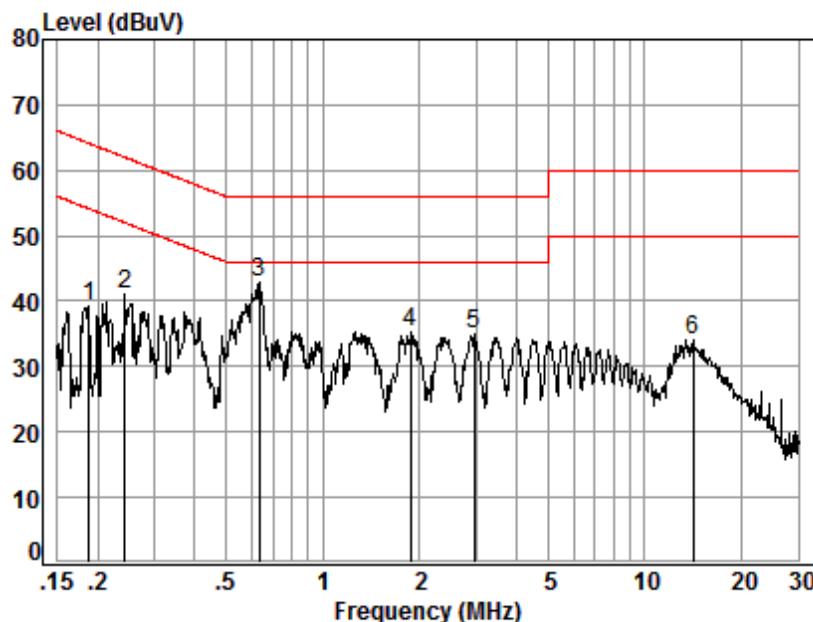


7.1.3 Measurement Procedure and Data

- 1) The mains terminal disturbance voltage test was conducted in a shielded room.
- 2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50ohm/50 μ H + 5ohm linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.
- 3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane,
- 4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2.
- 5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10 on conducted measurement.

Remark: LISN=Read Level+ Cable Loss+ LISN Factor

Mode:d; Line:Live Line



Site : Shielding Room

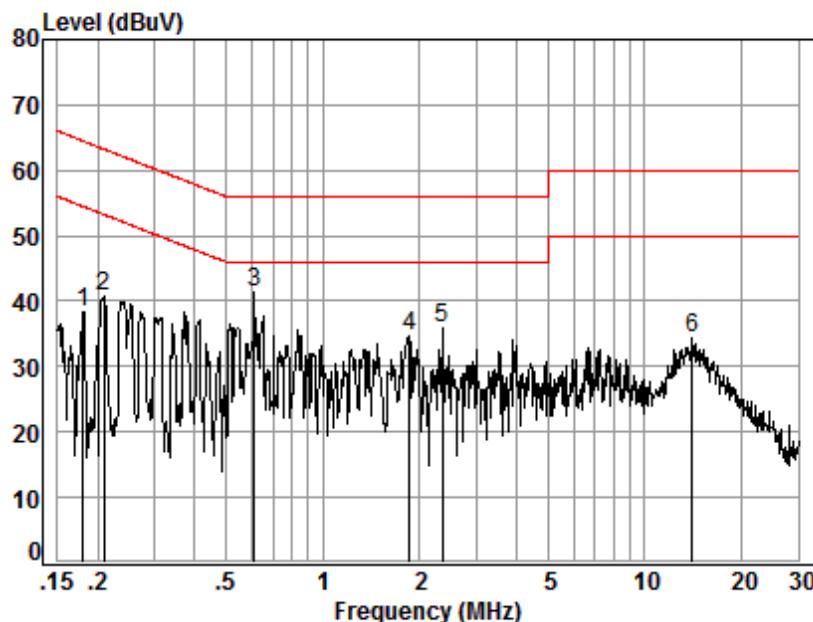
Condition: Line

Job No. : 08757CR

Test mode: d

Freq	Cable Loss	LISN Factor	Read Level		Limit Line		Over Limit	Remark
			dB	dBuV	dBuV	dBuV		
MHz	dB	dB	dBuV	dBuV	dBuV	dB		
1	0.19	0.02	9.66	29.59	39.27	54.15	-14.88	Peak
2	0.24	0.03	9.67	31.29	40.99	52.00	-11.01	Peak
3	0.63	0.07	9.67	33.25	42.99	46.00	-3.01	Peak
4	1.88	0.15	9.72	25.49	35.36	46.00	-10.64	Peak
5	2.95	0.16	9.71	25.14	35.01	46.00	-10.99	Peak
6	14.14	0.20	10.28	23.58	34.06	50.00	-15.94	Peak

Mode:k; Line:Neutral Line



Site : Shielding Room

Condition: Neutral

Job No. : 08757CR

Test mode: d

Freq	Cable	LISN	Read	Limit		Over	Remark
	MHz	Loss	Factor	Level	Level	Line	
1	0.18	0.02	9.64	28.59	38.25	54.50	-16.25 Peak
2	0.21	0.02	9.64	30.95	40.61	53.27	-12.66 Peak
3	0.61	0.07	9.64	31.76	41.47	46.00	-4.53 Peak
4	1.86	0.15	9.69	24.79	34.63	46.00	-11.37 Peak
5	2.36	0.16	9.68	25.98	35.82	46.00	-10.18 Peak
6	14.06	0.20	10.29	23.80	34.29	50.00	-15.71 Peak

7.2 Minimum 6dB Bandwidth

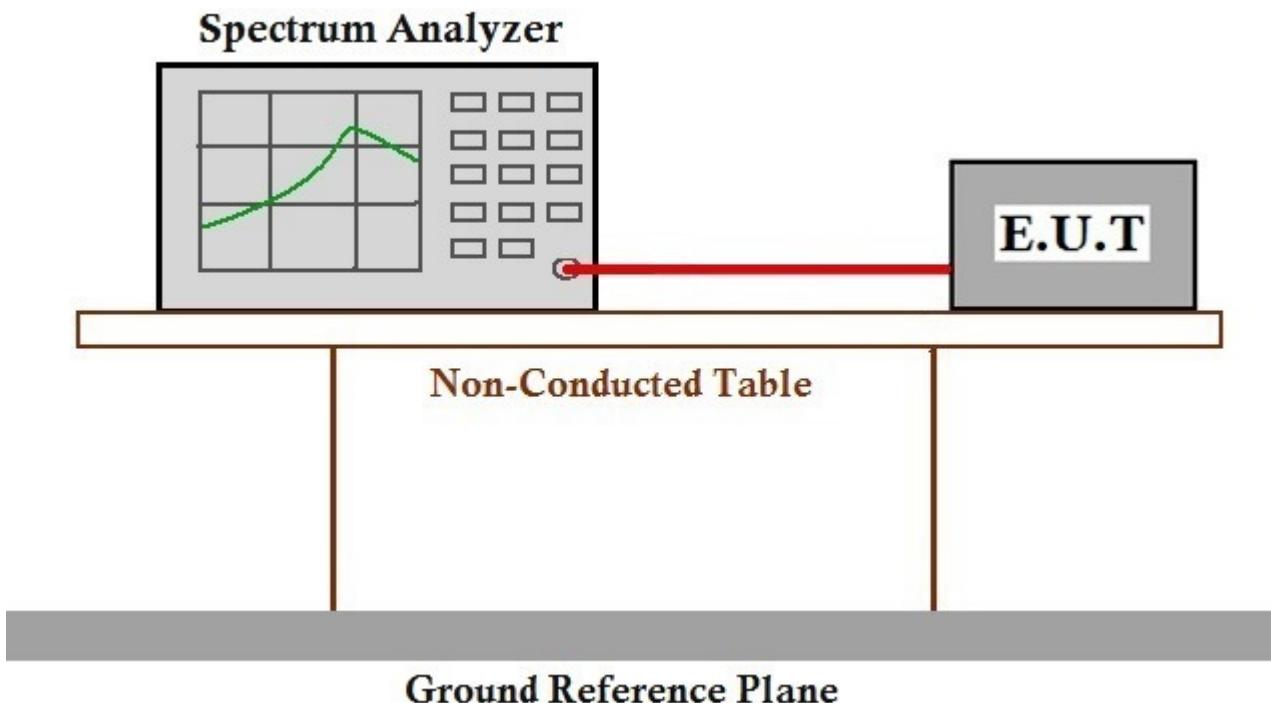
Test Requirement 47 CFR Part 15, Subpart C 15.247a(2)
Test Method: ANSI C63.10 (2013) Section 11.8.1
Limit: ≥ 500 kHz

7.2.1 E.U.T. Operation

Operating Environment:

Temperature: 23.9 °C Humidity: 58.8 % RH Atmospheric Pressure: 1010 mbar
Pretest these modes to find the worst case: j:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation
The worst case for final test: k:Charge + TX mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation.

7.2.2 Test Setup Diagram



7.2.3 Measurement Procedure and Data

The detailed test data see: Appendix 15.247

7.3 Conducted Peak Output Power

Test Requirement 47 CFR Part 15, Subpart C 15.247(b)(3)

Test Method: ANSI C63.10 (2013) Section 7.8.5

Limit:

Frequency range(MHz)	Output power of the intentional radiator(watt)
902-928	1 for ≥ 50 hopping channels
	0.25 for $25 \leq$ hopping channels < 50
	1 for digital modulation
2400-2483.5	1 for ≥ 75 non-overlapping hopping channels
	0.125 for all other frequency hopping systems
	1 for digital modulation
5725-5850	1 for frequency hopping systems and digital modulation

7.3.1 E.U.T. Operation

Operating Environment:

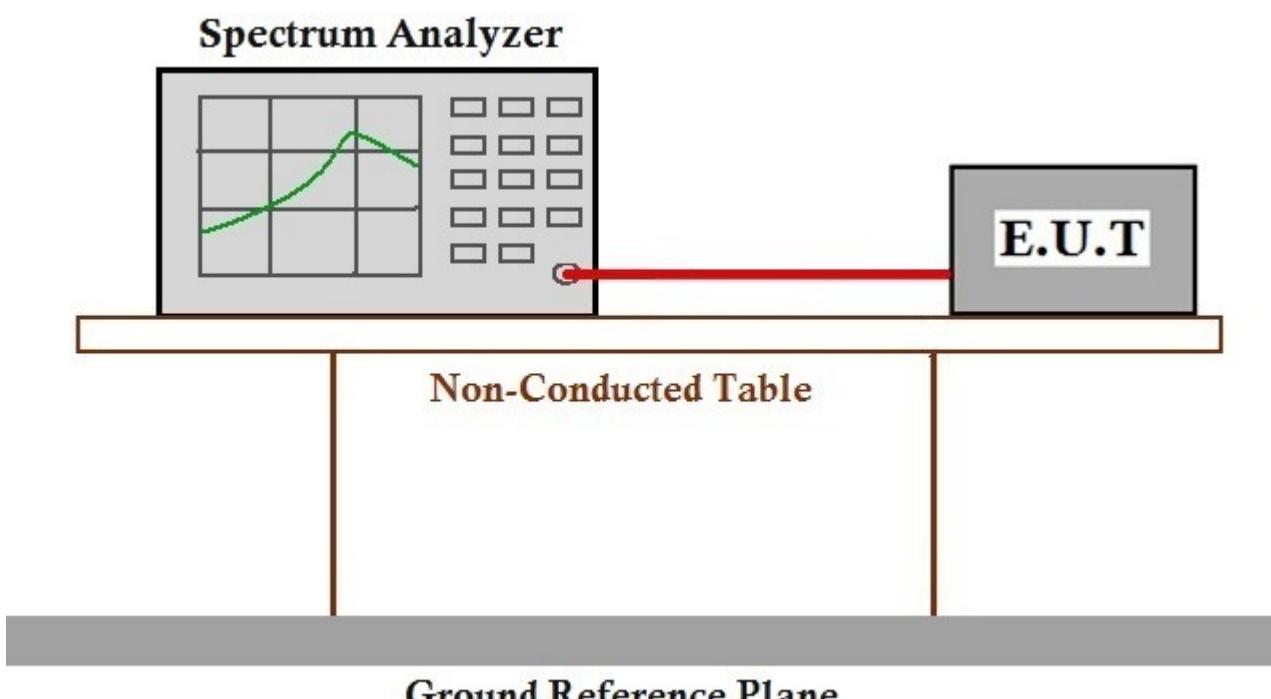
Temperature: 23.9 °C Humidity: 58.8 % RH Atmospheric Pressure: 1010 mbar

Pretest these modes to find the worst case: j:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation

The worst case for final test: k:Charge + TX mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation.

j:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation

7.3.2 Test Setup Diagram



7.3.3 Measurement Procedure and Data

The detailed test data see: Appendix 15.247

7.4 Power Spectrum Density

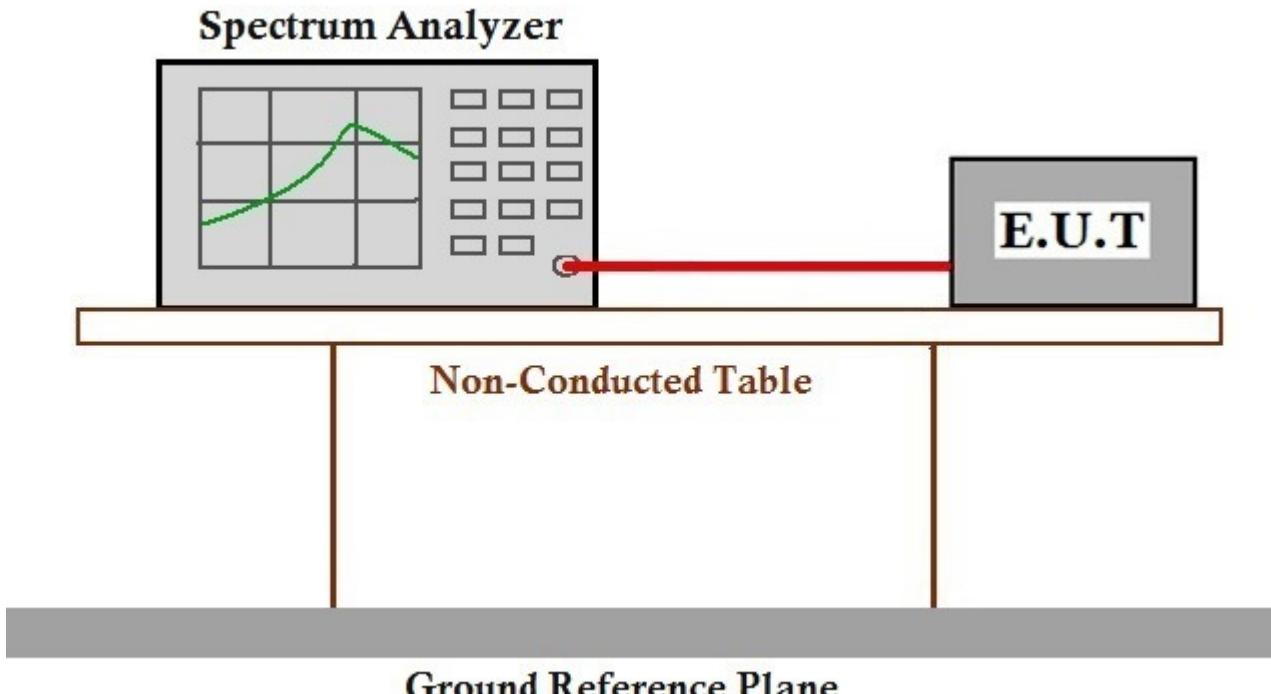
Test Requirement 47 CFR Part 15, Subpart C 15.247(e)
Test Method: ANSI C63.10 (2013) Section 11.10.2
Limit: $\leq 8\text{dBm}$ in any 3 kHz band during any time interval of continuous transmission

7.4.1 E.U.T. Operation

Operating Environment:

Temperature: 23.9 °C Humidity: 58.7 % RH Atmospheric Pressure: 1010 mbar
Pretest these modes to find the worst case: j:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation
k:Charge + TX mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation.
The worst case for final test: j:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation

7.4.2 Test Setup Diagram



7.4.3 Measurement Procedure and Data

The detailed test data see: Appendix 15.247

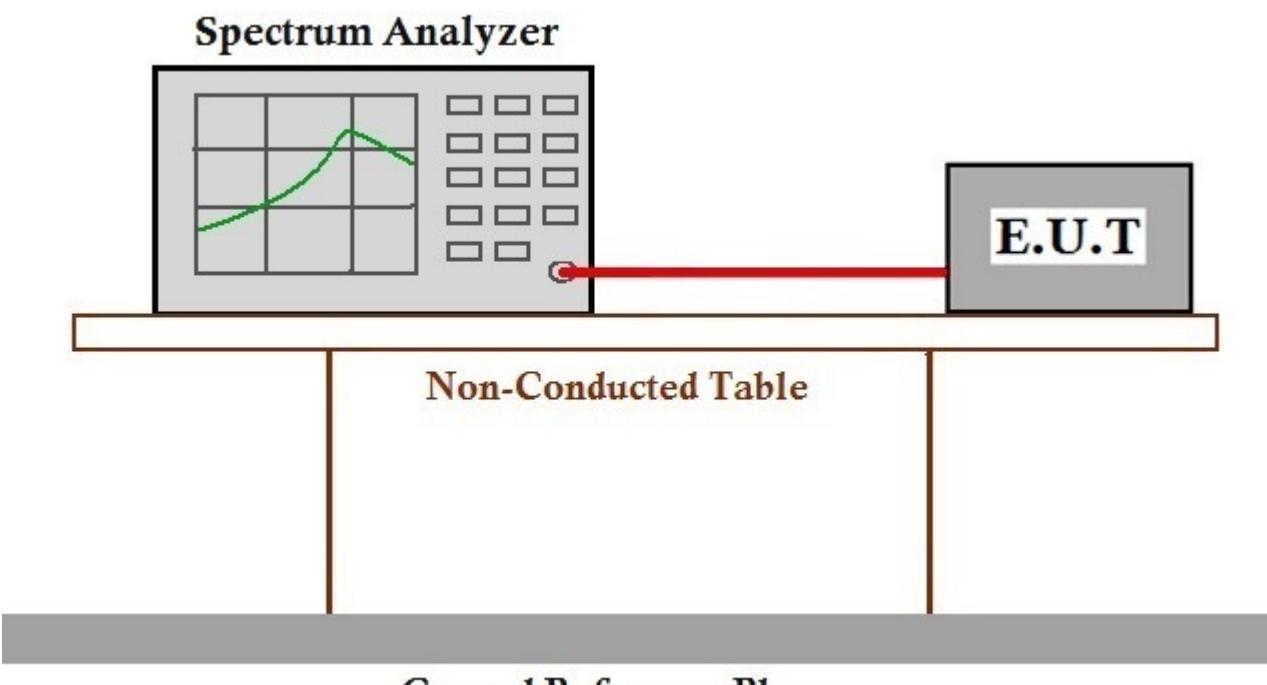
7.5 Conducted Band Edges Measurement

Test Requirement	47 CFR Part 15, Subpart C 15.247(d)
Test Method:	ANSI C63.10 (2013) Section 7.8.6
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c))

7.5.1 E.U.T. Operation

Operating Environment:	
Temperature:	23.9 °C
Pretest these modes to find the worst case:	Humidity: 58.7 % RH Atmospheric Pressure: 1010 mbar j:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation
The worst case for final test:	k:Charge + TX mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation.
	j:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation

7.5.2 Test Setup Diagram



7.5.3 Measurement Procedure and Data

Refer to EUT external and internal photos.

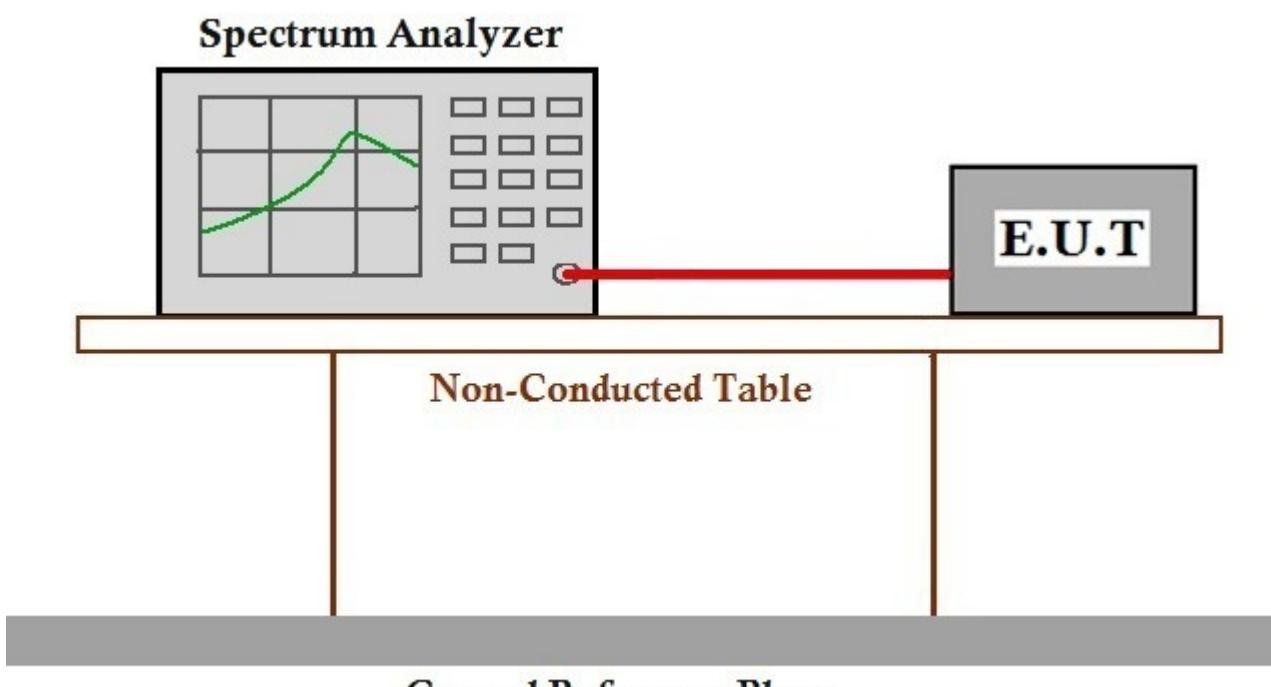
7.6 Conducted Spurious Emissions

Test Requirement: 47 CFR Part 15, Subpart C 15.247(d)
Test Method: ANSI C63.10 (2013) Section 7.8.8
Limit: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c))

7.6.1 E.U.T. Operation

Operating Environment:
Temperature: 23.9 °C Humidity: 58.7 % RH Atmospheric Pressure: 1010 mbar
Pretest these modes to find the worst case: j:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation
The worst case for final test: k:Charge + TX mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation.
j:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation

7.6.2 Test Setup Diagram



7.6.3 Measurement Procedure and Data

The detailed test data see: Appendix 15.247

7.7 Radiated Emissions which fall in the restricted bands

Test Requirement 47 CFR Part 15, Subpart C 15.205 & 15.209

Test Method: ANSI C63.10 (2013) Section 6.10.5

Measurement Distance: 3m

Limit:

Frequency(MHz)	Field strength(microvolts/meter)	Measurement distance(meters)
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

Remark: The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90kHz, 110-490kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

7.7.1 E.U.T. Operation

Operating Environment:

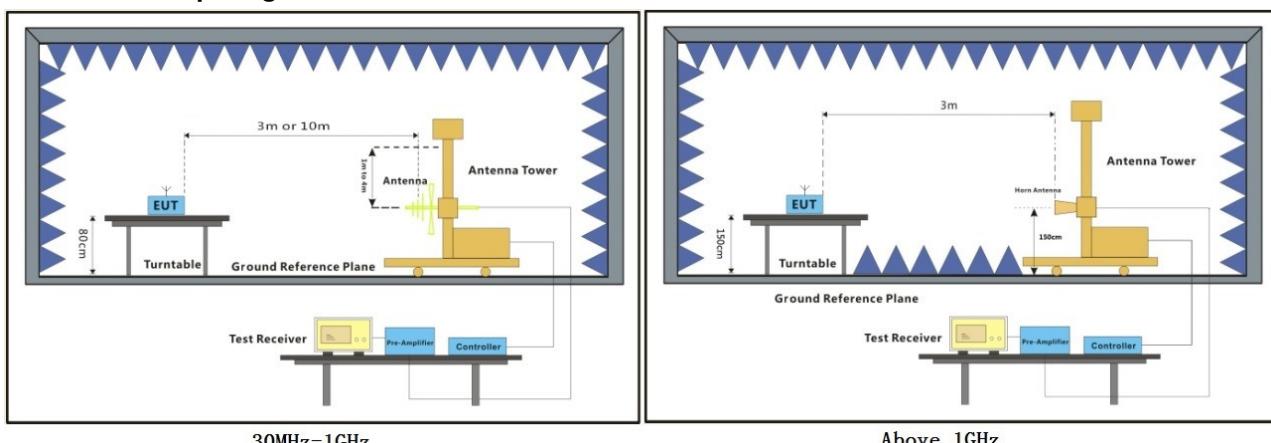
Temperature: 22.7 °C Humidity: 64.4 % RH Atmospheric Pressure: 1010 mbar

Pretest these modes to find the worst case: j:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation

The worst case for final test: k:Charge + TX mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation.

The worst case for final test: k:Charge + TX mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation.

7.7.2 Test Setup Diagram



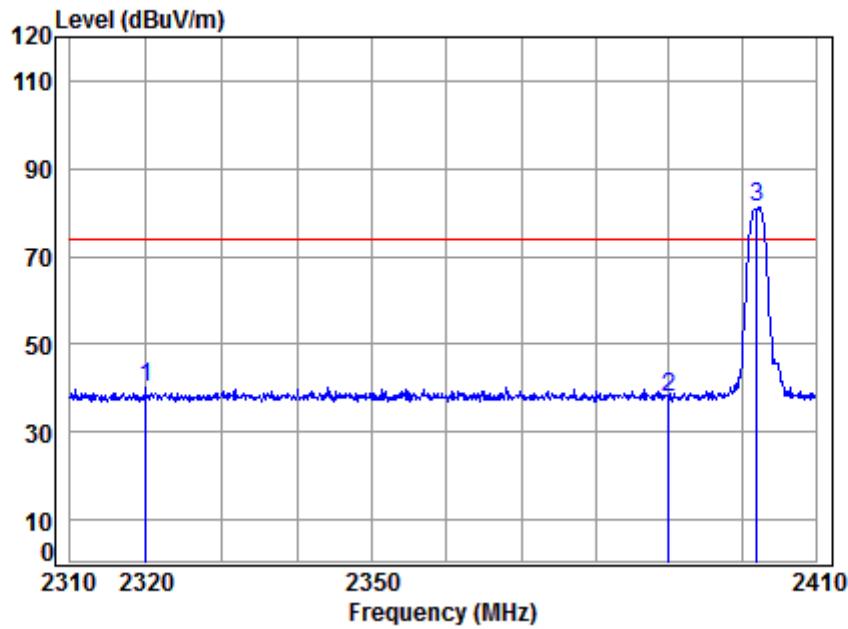
7.7.3 Measurement Procedure and Data

- a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter fully-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- d. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- e. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- g. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.
- h. Test the EUT in the lowest channel, the middle channel, the Highest channel.
- i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.
- j. Repeat above procedures until all frequencies measured was complete.

Remark 1: Level= Read Level+ Cable Loss+ Antenna Factor- Preamp Factor

Remark 2: For frequencies above 1GHz, the field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For the emissions whose peak level is lower than the average limit, only the peak measurement is shown in the report.

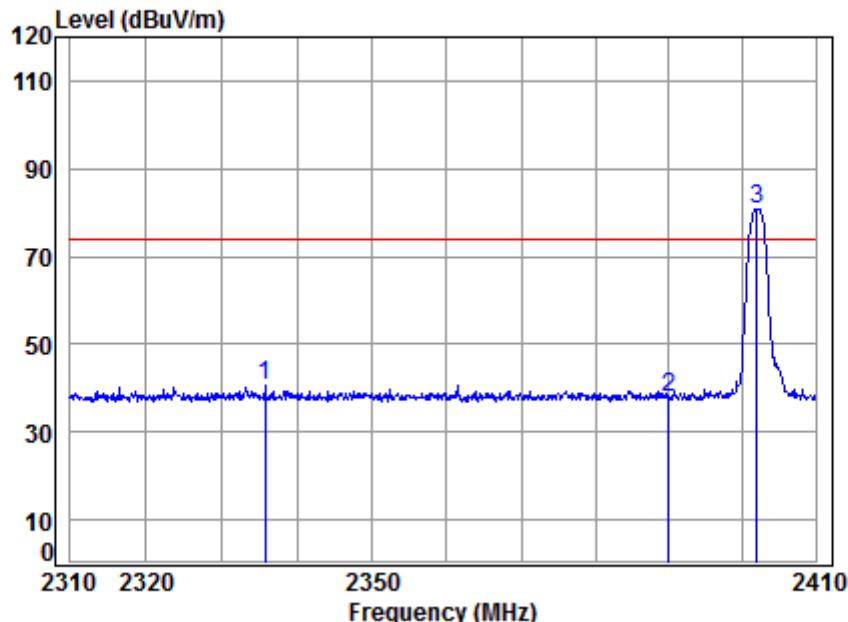
Mode:k; Polarization:Horizontal; Modulation:GFSK; Channel:Low



Site : chamber
Condition: 3m HORIZONTAL
Job No : 08757CR
Mode : 2402 Band edge
Note : BLE

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Limit Level	Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	2319.909	5.38	28.40	41.84	48.36	40.30	74.00	-33.70	peak
2	2390.000	5.47	28.52	41.87	45.96	38.08	74.00	-35.92	peak
3 *	2402.000	5.49	28.54	41.88	88.96	81.11	74.00	7.11	peak

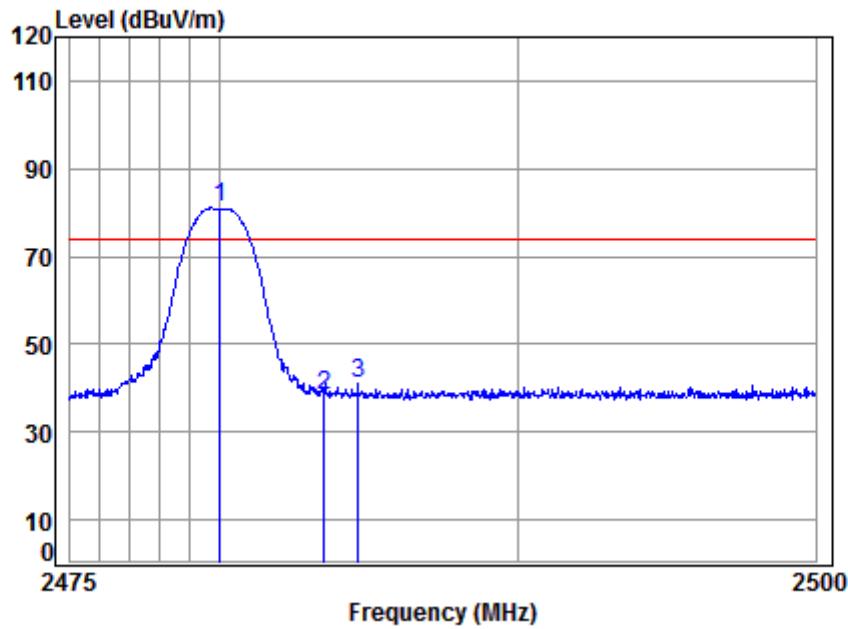
Mode:k; Polarization:Vertical; Modulation:GFSK; Channel:Low



Site : chamber
Condition: 3m VERTICAL
Job No : 08757CR
Mode : 2402 Band edge
Note : BLE

Freq	Cable	Ant	Preamp	Read	Limit	Over	Remark	
	Loss	Factor	Factor	Level	Level	Line		
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1	2335.693	5.40	28.43	41.85	48.65	40.63	74.00	-33.37 peak
2	2390.000	5.47	28.52	41.87	45.96	38.08	74.00	-35.92 peak
3 *	2402.000	5.49	28.54	41.88	88.82	80.97	74.00	6.97 peak

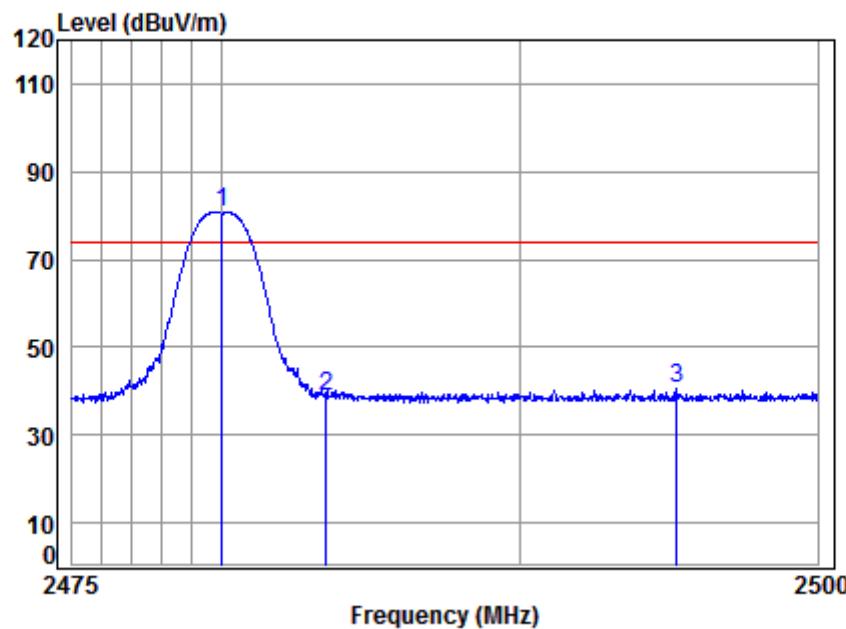
Mode:k; Polarization:Horizontal; Modulation:GFSK; Channel:High



Site : chamber
Condition: 3m HORIZONTAL
Job No : 08757CR
Mode : 2480 Band edge
Note : BLE

Freq	Cable	Ant	Preamp	Read	Limit	Over	Remark	
	Loss	Factor	Factor	Level	Level	Line		
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1 *	2480.000	5.59	28.67	41.91	88.68	81.03	74.00	7.03 peak
2	2483.500	5.60	28.67	41.91	46.15	38.51	74.00	-35.49 peak
3	2484.620	5.60	28.68	41.91	48.57	40.94	74.00	-33.06 peak

Mode:k; Polarization:Vertical; Modulation:GFSK; Channel:High



Site : chamber
Condition: 3m VERTICAL
Job No : 08757CR
Mode : 2480 Band edge
Note : BLE

Freq	Cable	Ant	Preamp	Read	Limit	Over	Remark	
	Loss	Factor	Factor	Level	Level	Line		
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1 *	2480.000	5.59	28.67	41.91	88.40	80.75	74.00	6.75 peak
2	2483.500	5.60	28.67	41.91	46.23	38.59	74.00	-35.41 peak
3	2495.256	5.61	28.69	41.92	48.06	40.44	74.00	-33.56 peak

7.8 Radiated Spurious Emissions

Test Requirement 47 CFR Part 15, Subpart C 15.205 & 15.209

Test Method: ANSI C63.10 (2013) Section 6.4,6.5,6.6

Measurement Distance: 3m

Limit:

Frequency(MHz)	Field strength(microvolts/meter)	Measurement distance(meters)
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

Remark: The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90kHz, 110-490kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

7.8.1 E.U.T. Operation

Operating Environment:

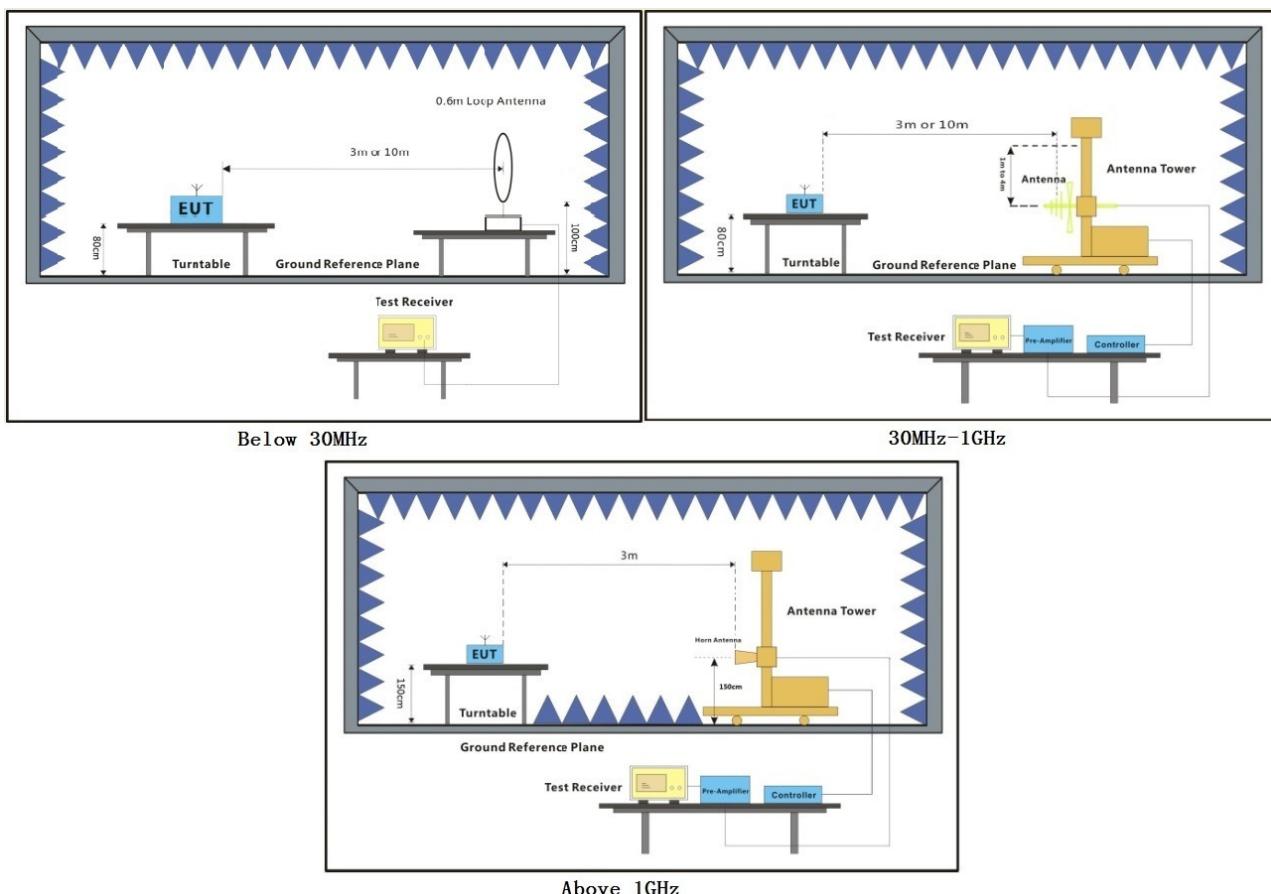
Temperature: 22.4 °C Humidity: 76.4 % RH Atmospheric Pressure: 1015 mbar

Pretest these modes to find the worst case: j:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation

The worst case for final test: k:Charge + TX mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation.

j:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation

7.8.2 Test Setup Diagram



7.8.3 Measurement Procedure and Data

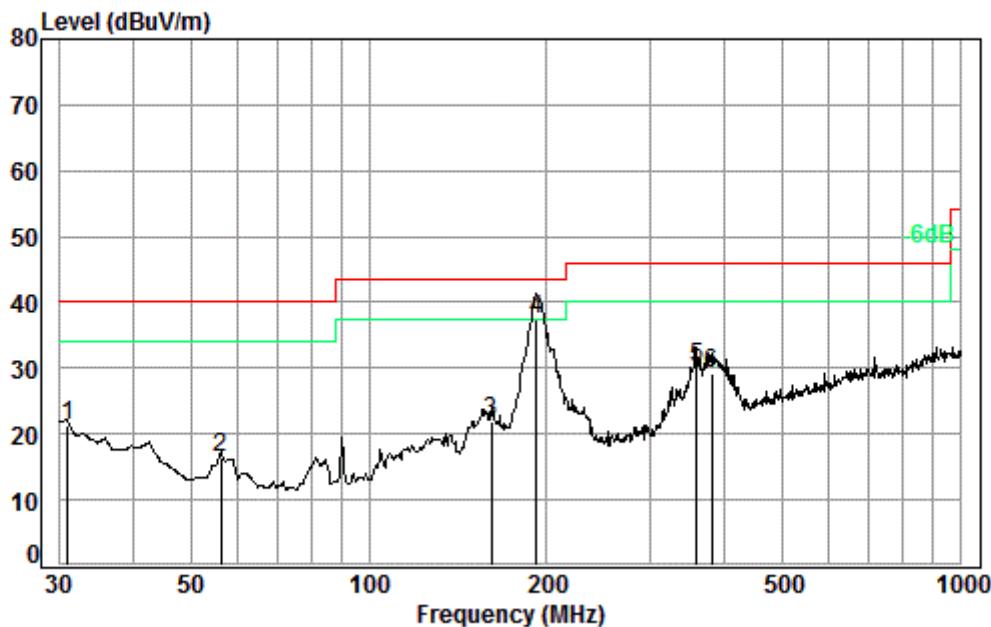
- a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter fully-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- d. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- e. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- g. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.
- h. Test the EUT in the lowest channel, the middle channel, the Highest channel.
- i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.
- j. Repeat above procedures until all frequencies measured was complete.

Remark:

- 1) For emission below 1GHz, through pre-scan found the worst case is the lowest channel. Only the worst case is recorded in the report.
- 2) The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:
Final Test Level = Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor
- 3) Scan from 9kHz to 25GHz, the disturbance above 18GHz and below 30MHz was very low. The points marked on above plots are the highest emissions could be found when testing, so only above points had been displayed. The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.
- 4) For frequencies above 1GHz, the field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For the emissions whose peak level is lower than the average limit, only the peak measurement is shown in the report.

Radiated emission below 1GHz

Mode:j; Polarization:Horizontal



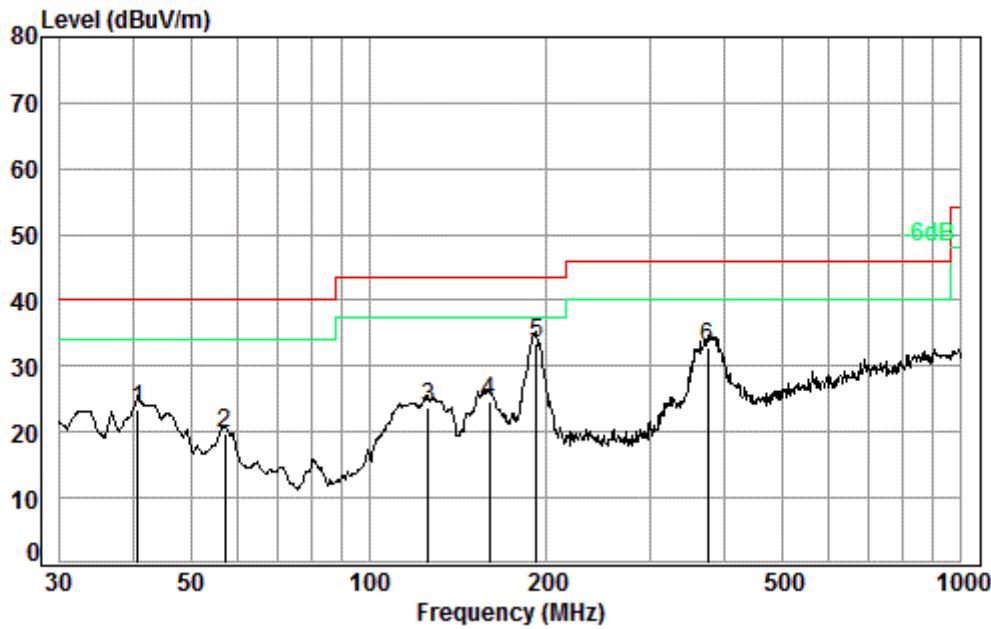
Condition: 3m HORIZONTAL

Job No. : 08757CR

Test mode: J

Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level		Limit Line	Over Line
				Level	Level		
1	30.96	0.60	21.95	27.45	26.10	21.20	40.00 -18.80
2	56.20	0.80	13.56	27.40	29.45	16.41	40.00 -23.59
3	160.91	1.34	15.52	27.04	32.22	22.04	43.50 -21.46
4 pp	191.75	1.39	16.26	26.93	46.71	37.43	43.50 -6.07
5	357.93	2.08	21.32	26.97	33.77	30.20	46.00 -15.80
6	379.91	2.15	21.90	27.09	32.27	29.23	46.00 -16.77

Mode:j; Polarization:Vertical



Condition: 3m VERTICAL

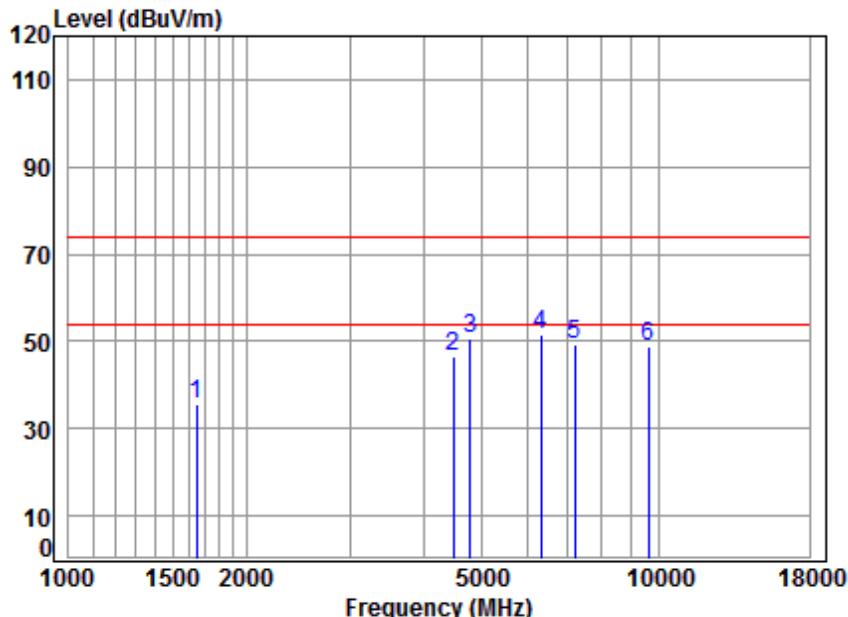
Job No. : 08757CR

Test mode: J

Freq	Cable	Ant	Preamp	Read	Limit	Over		
	Loss	Factor	Factor	Level				
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1	40.70	0.62	17.24	27.43	33.00	23.43	40.00	-16.57
2	57.19	0.80	13.46	27.40	33.05	19.91	40.00	-20.09
3	125.89	1.27	13.29	27.20	36.23	23.59	43.50	-19.91
4	159.78	1.34	15.48	27.05	34.79	24.56	43.50	-18.94
5 pp	191.75	1.39	16.26	26.93	42.64	33.36	43.50	-10.14
6	374.62	2.13	21.76	27.06	36.00	32.83	46.00	-13.17

Transmitter emission above 1GHz

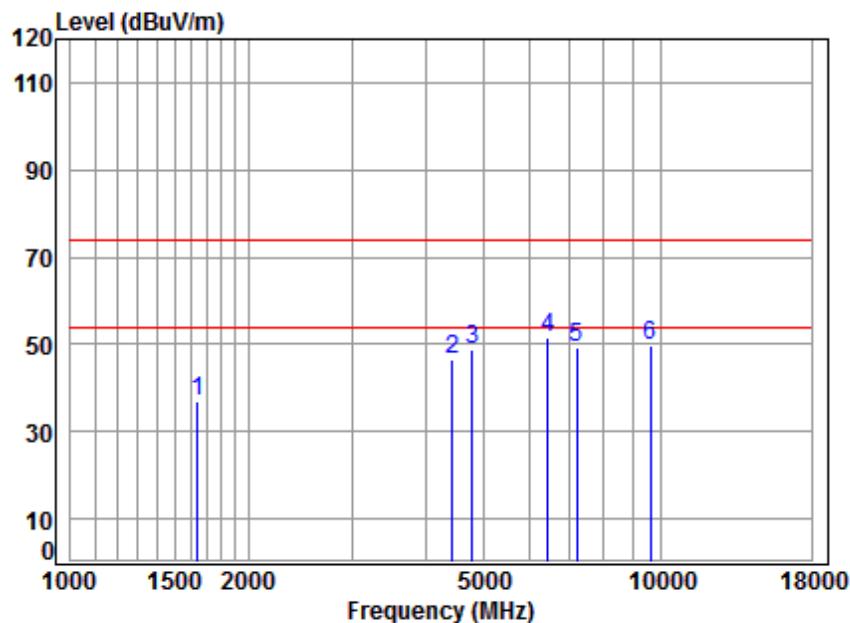
Mode:k; Polarization:Horizontal; Modulation:GFSK; Channel:Low



Site : chamber
Condition: 3m HORIZONTAL
Job No : 08757CR
Mode : 2402 TX SE
Note : BLE

Freq	Cable	Ant	Preamp	Read	Limit	Over	Remark
	Loss	Factor	Factor	Level	Level	Line	
MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1 1648.778	5.29	26.46	41.50	45.57	35.82	74.00	-38.18 peak
2 4482.150	7.54	33.57	42.41	47.83	46.53	74.00	-27.47 peak
3 4804.000	7.89	33.97	42.47	51.21	50.60	74.00	-23.40 peak
4 6322.136	11.20	35.43	41.35	46.50	51.78	74.00	-22.22 peak
5 7206.000	10.08	36.07	40.71	43.91	49.35	74.00	-24.65 peak
6 9608.000	10.75	37.67	37.74	38.34	49.02	74.00	-24.98 peak

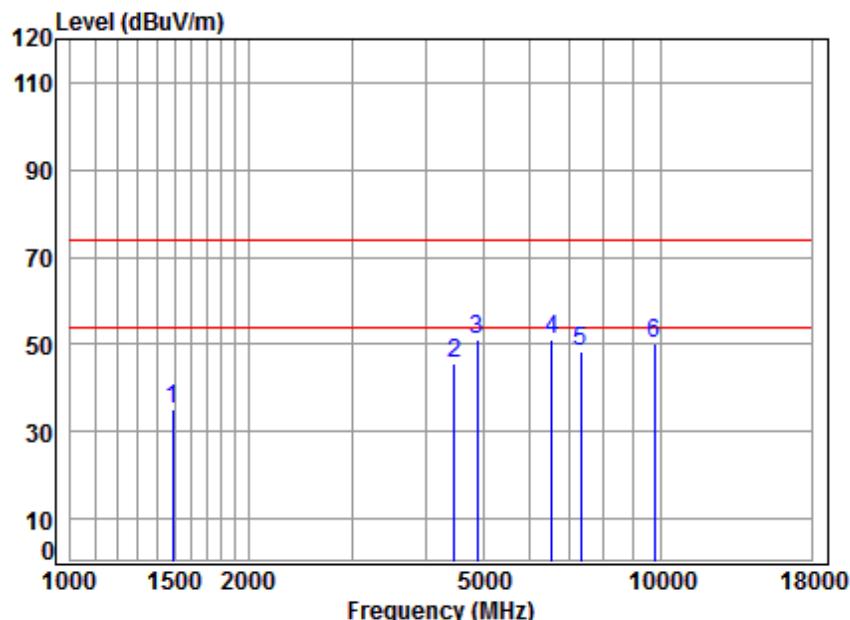
Mode:k; Polarization:Vertical; Modulation:GFSK; Channel:Low



Site : chamber
Condition: 3m VERTICAL
Job No : 08757CR
Mode : 2402 TX SE
Note : BLE

Freq	Cable	Ant	Preamp	Read	Limit	Over	Remark	
	Loss	Factor	Factor	Level	Level	Line		
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1	1644.019	5.30	26.44	41.50	46.71	36.95	74.00	-37.05 peak
2	4443.453	7.50	33.50	42.41	48.08	46.67	74.00	-27.33 peak
3	4804.000	7.89	33.97	42.47	49.52	48.91	74.00	-25.09 peak
4	6451.353	11.45	35.55	41.25	45.88	51.63	74.00	-22.37 peak
5	7206.000	10.08	36.07	40.71	43.92	49.36	74.00	-24.64 peak
6	9608.000	10.75	37.67	37.74	39.06	49.74	74.00	-24.26 peak

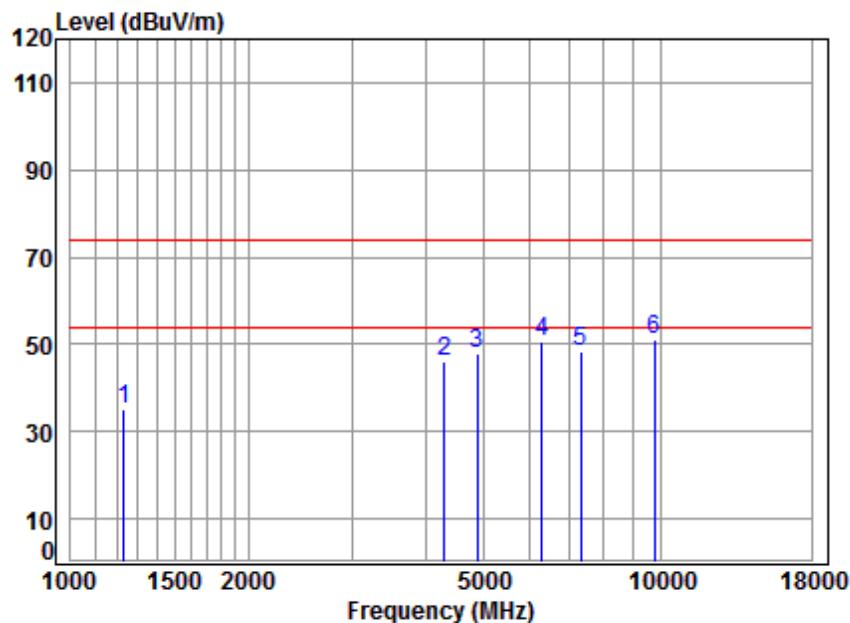
Mode:k; Polarization:Horizontal; Modulation:GFSK; Channel:middle



Site : chamber
Condition: 3m HORIZONTAL
Job No : 08757CR
Mode : 2440 TX SE
Note : BLE

Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Limit Level	Limit Line	Over Limit	Remark	
								dB	
MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB		
1 1490.142	5.45	25.76	41.40	45.11	34.92	74.00	-39.08	peak	
2 4469.214	7.53	33.55	42.41	46.94	45.61	74.00	-28.39	peak	
3 4880.000	7.97	34.06	42.48	51.56	51.11	74.00	-22.89	peak	
4 6545.263	11.41	35.63	41.18	45.28	51.14	74.00	-22.86	peak	
5 7320.000	10.05	36.16	40.63	42.97	48.55	74.00	-25.45	peak	
6 9760.000	10.82	37.76	37.53	39.06	50.11	74.00	-23.89	peak	

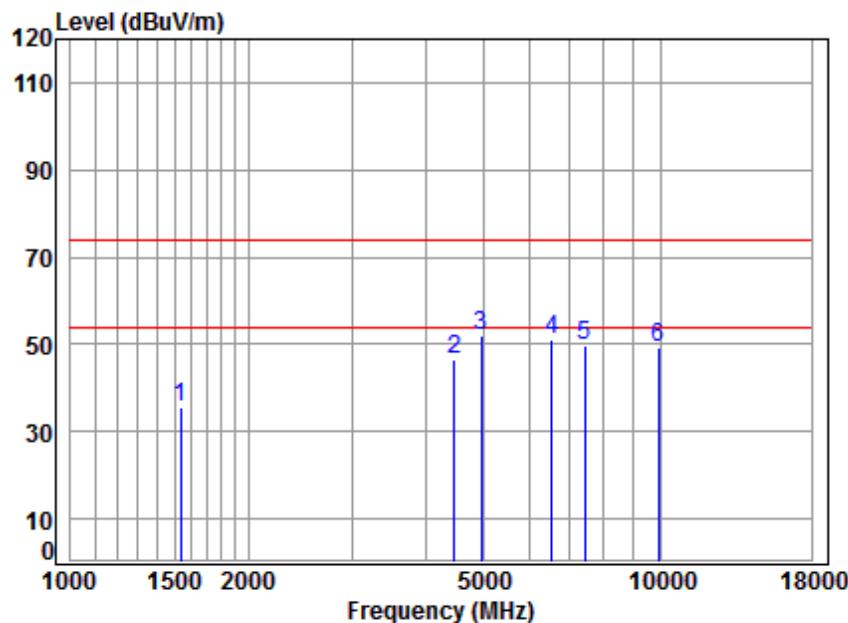
Mode:k; Polarization:Vertical; Modulation:GFSK; Channel:middle



Site : chamber
Condition: 3m VERTICAL
Job No : 08757CR
Mode : 2440 TX SE
Note : BLE

Freq	Cable	Ant	Preamp	Read	Limit	Line	Over	Remark
	Loss	Factor	Factor	Level				
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1	1231.345	4.54	24.73	41.21	47.04	35.10	74.00	-38.90 peak
2	4304.400	7.34	33.26	42.38	47.71	45.93	74.00	-28.07 peak
3	4880.000	7.97	34.06	42.48	48.17	47.72	74.00	-26.28 peak
4	6285.695	11.13	35.39	41.38	45.43	50.57	74.00	-23.43 peak
5	7320.000	10.05	36.16	40.63	42.56	48.14	74.00	-25.86 peak
6	9760.000	10.82	37.76	37.53	40.12	51.17	74.00	-22.83 peak

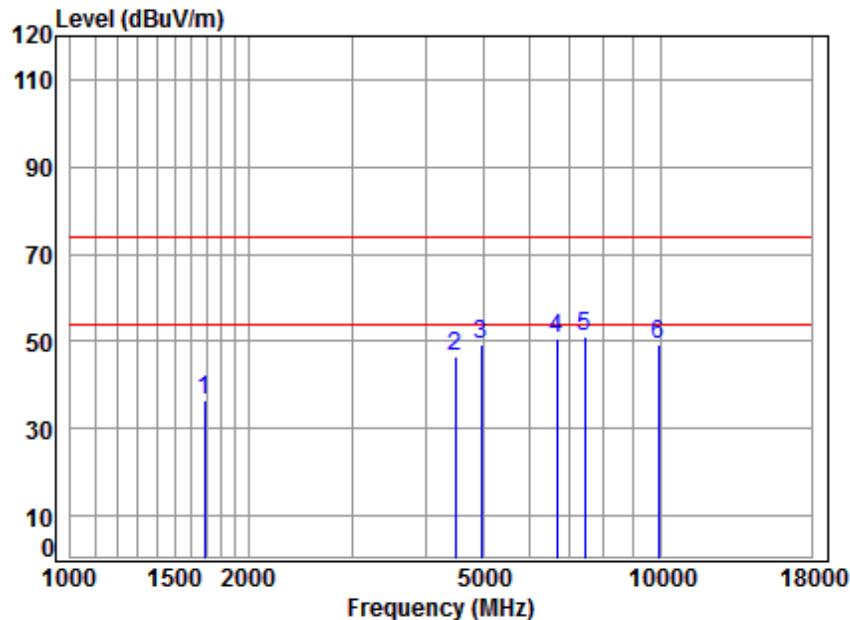
Mode:k; Polarization:Horizontal; Modulation:GFSK; Channel:High



Site : chamber
Condition: 3m HORIZONTAL
Job No : 08757CR
Mode : 2480 TX SE
Note : BLE

Freq	Cable	Ant	Preamp	Read	Limit	Over	Remark	
	Loss	Factor	Factor	Level	Level	Line		
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1	1538.281	5.43	25.98	41.43	45.65	35.63	74.00	-38.37 peak
2	4469.214	7.53	33.55	42.41	47.66	46.33	74.00	-27.67 peak
3	4960.000	8.05	34.15	42.49	52.24	51.95	74.00	-22.05 peak
4	6545.263	11.41	35.63	41.18	45.24	51.10	74.00	-22.90 peak
5	7440.000	10.02	36.25	40.56	44.18	49.89	74.00	-24.11 peak
6	9920.000	10.90	37.85	37.31	37.79	49.23	74.00	-24.77 peak

Mode:k; Polarization:Vertical; Modulation:GFSK; Channel:High



Site : chamber
Condition: 3m VERTICAL
Job No : 08757CR
Mode : 2480 TX SE
Note : BLE

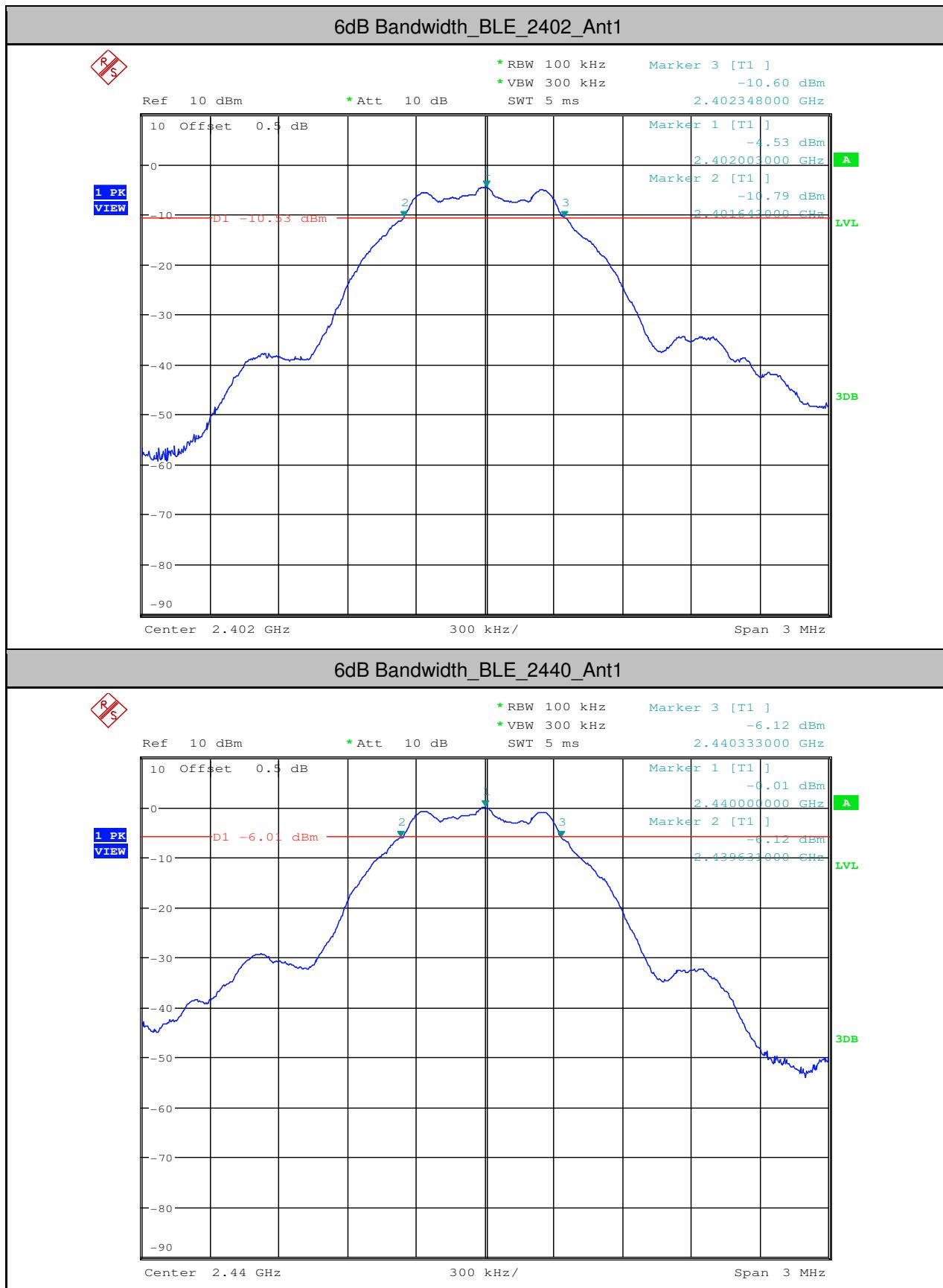
Freq	Cable	Ant	Preamp	Read	Limit	Line	Over	Remark
	Loss	Factor	Factor	Level				
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1	1687.347	5.24	26.62	41.52	46.28	36.62	74.00	-37.38 peak
2	4495.125	7.55	33.59	42.42	47.72	46.44	74.00	-27.56 peak
3	4960.000	8.05	34.15	42.49	49.75	49.46	74.00	-24.54 peak
4	6659.763	11.08	35.70	41.10	44.79	50.47	74.00	-23.53 peak
5	7440.000	10.02	36.25	40.56	45.18	50.89	74.00	-23.11 peak
6	9920.000	10.90	37.85	37.31	37.85	49.29	74.00	-24.71 peak

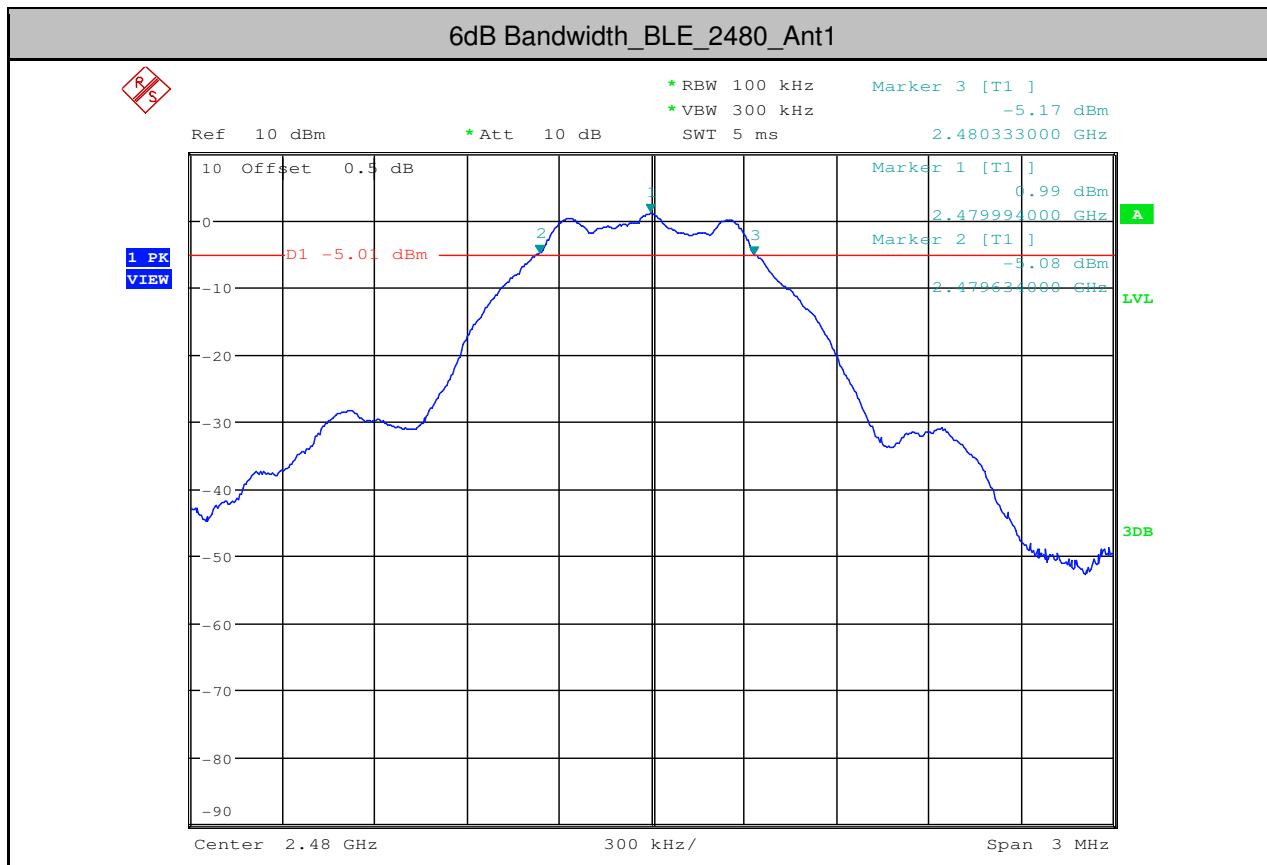
8 Appendix

8.1 Appendix 15.247

1.6dB Bandwidth

Test Mode	Test Channel	Ant	EBW[MHz]	Limit[MHz]	Verdict
BLE	2402	Ant1	0.705	>=0.5	PASS
BLE	2440	Ant1	0.702	>=0.5	PASS
BLE	2480	Ant1	0.699	>=0.5	PASS

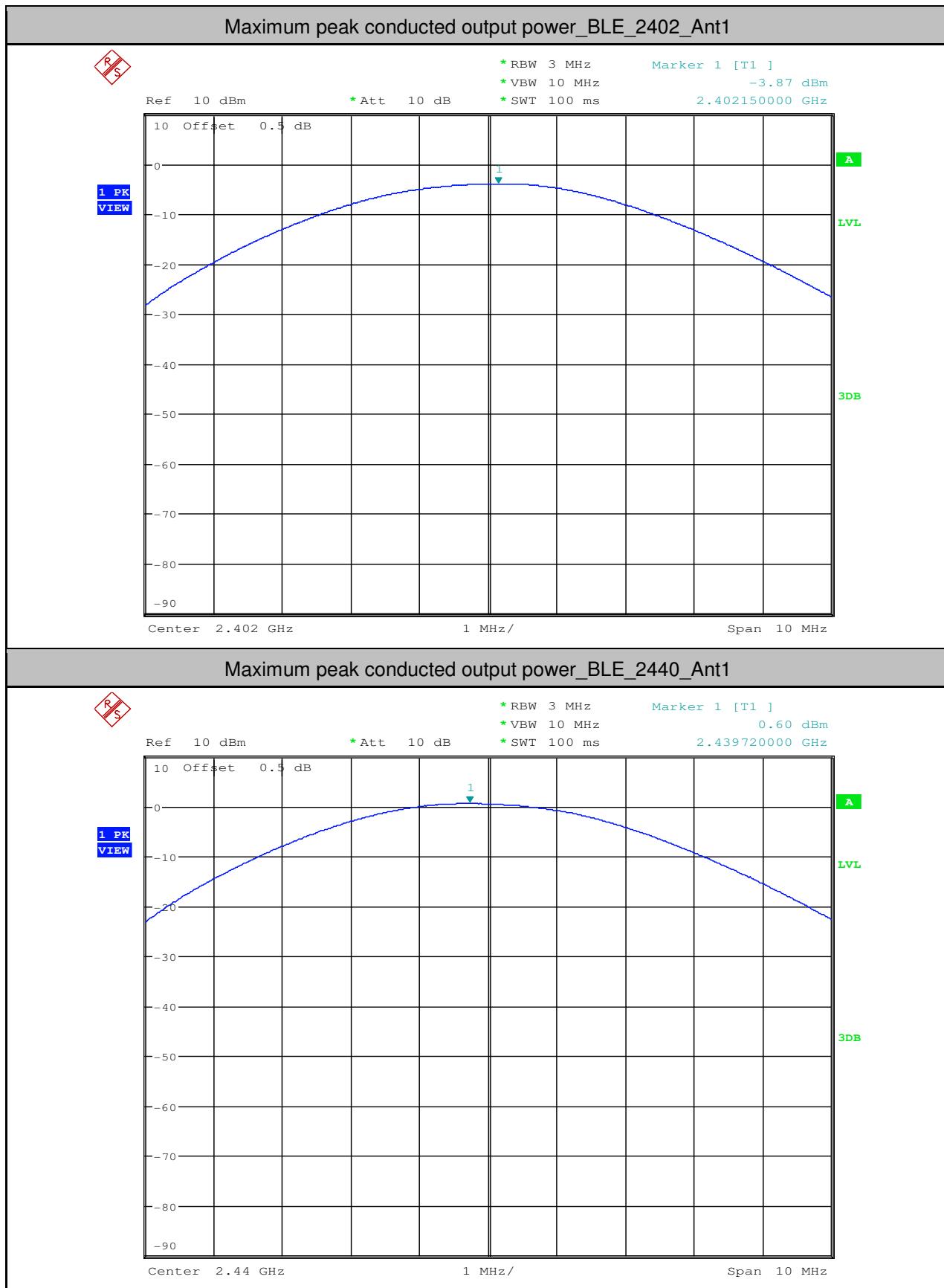


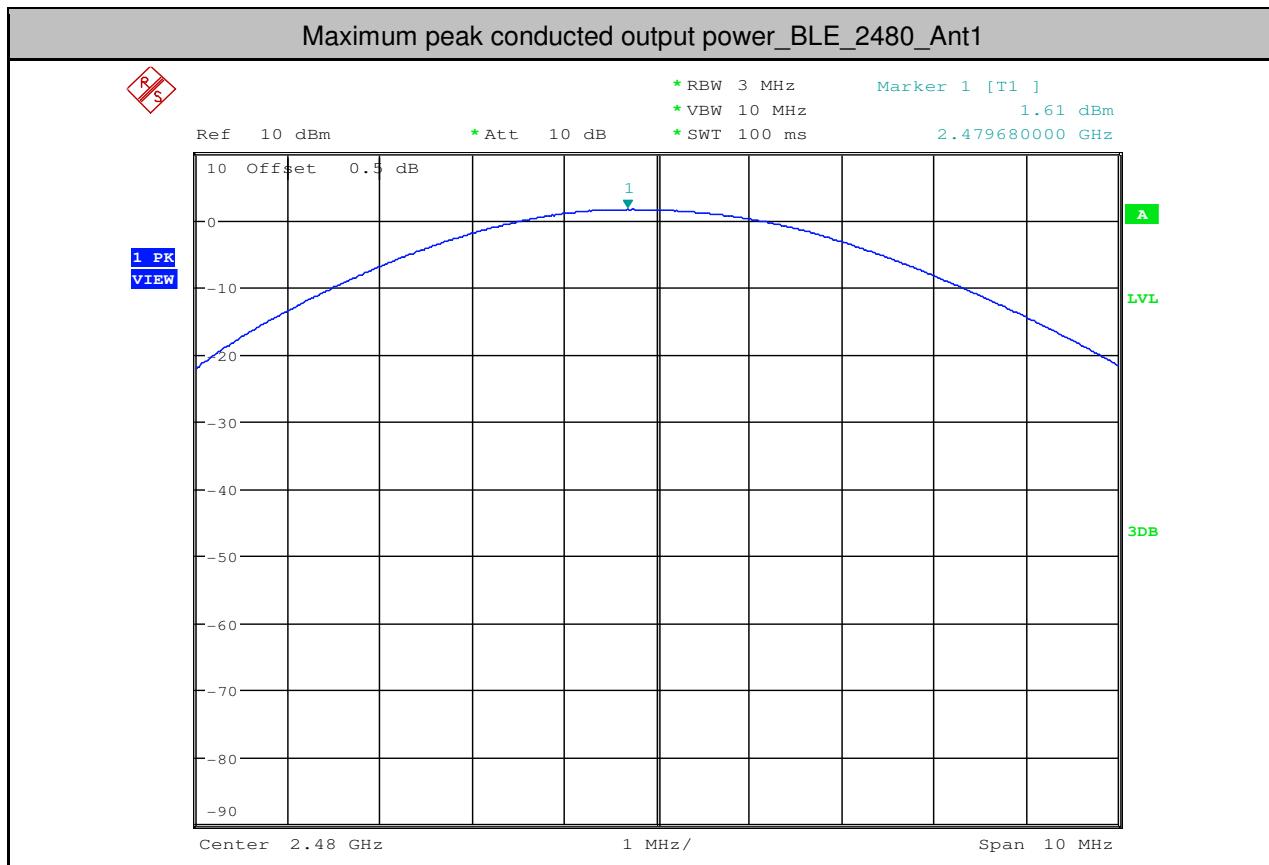




2. Maximum peak conducted output power

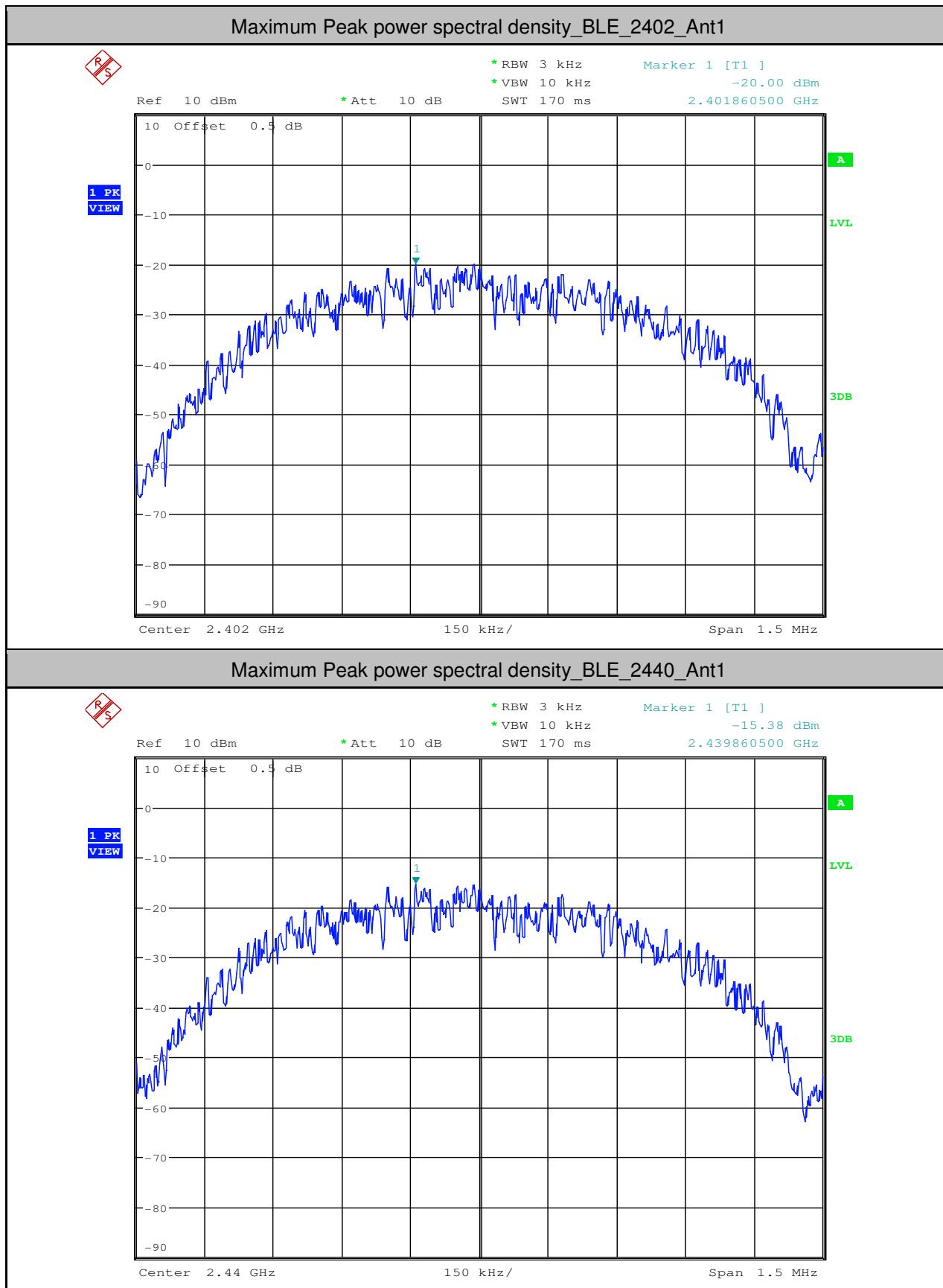
Test Mode	Test Channel	Ant	Power[dBm]	Limit[dBm]	Verdict
BLE	2402	Ant1	-3.87	<30	PASS
BLE	2440	Ant1	0.60	<30	PASS
BLE	2480	Ant1	1.61	<30	PASS

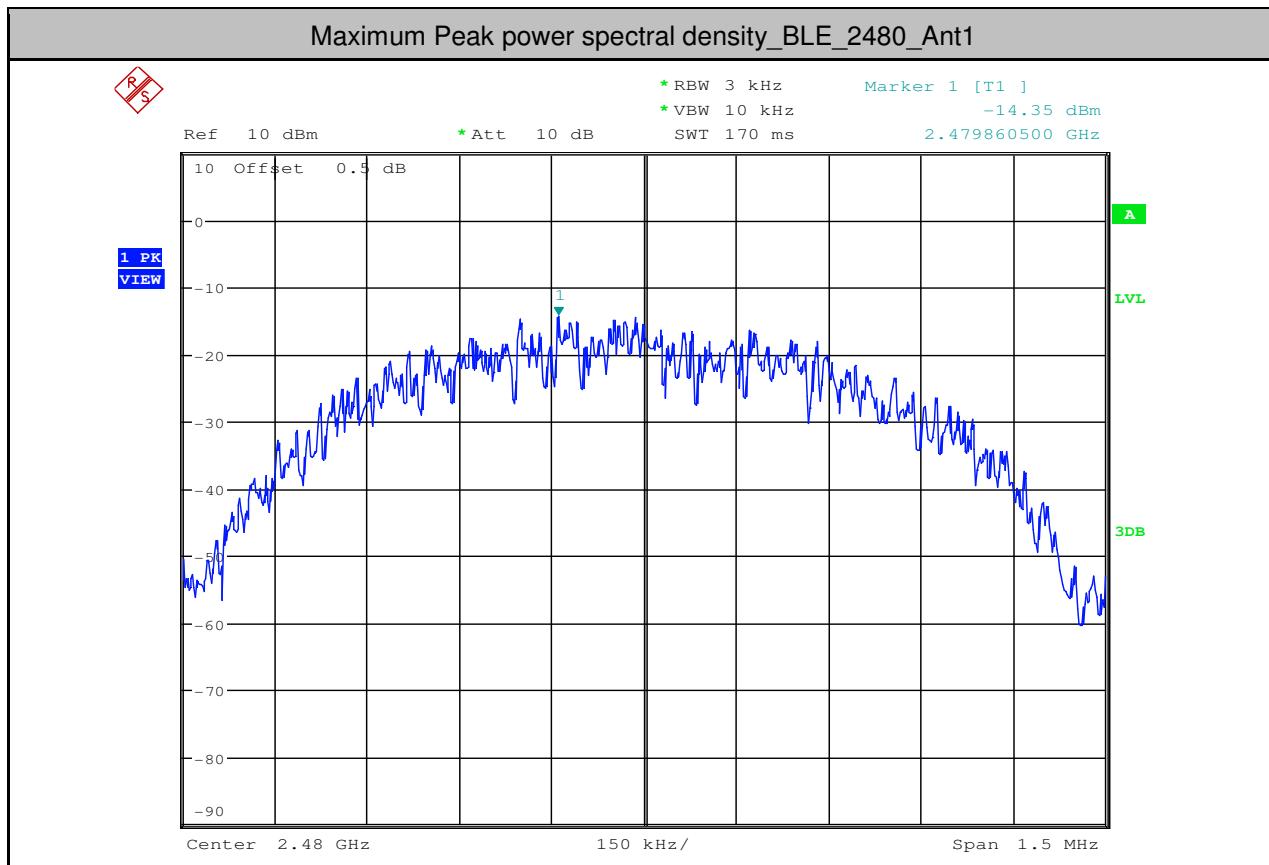




3. Maximum Peak power spectral density

Test Mode	Test Channel	Ant	PSD[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
BLE	2402	Ant1	-20	<8.00	PASS
BLE	2440	Ant1	-15.38	<8.00	PASS
BLE	2480	Ant1	-14.35	<8.00	PASS

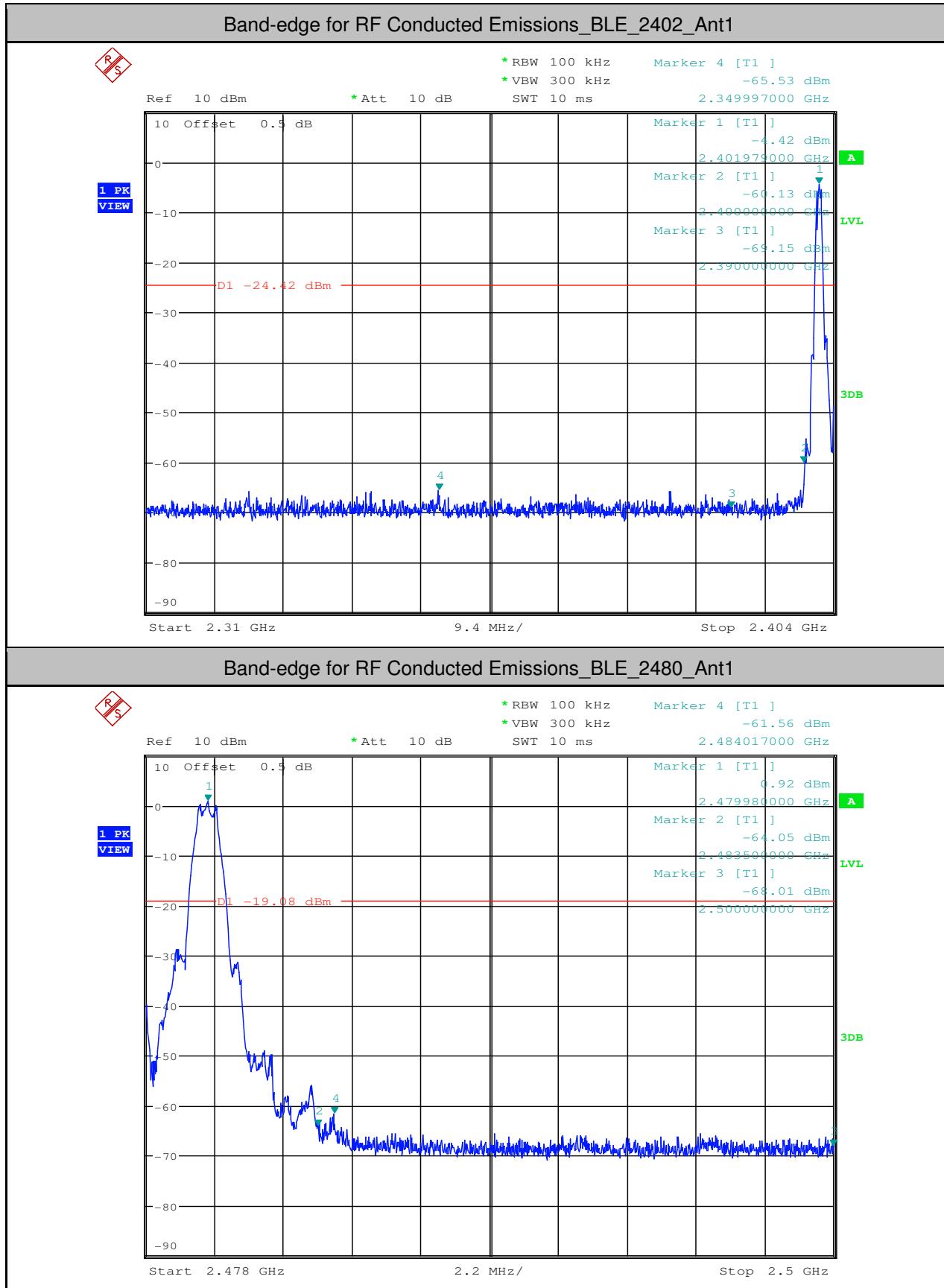






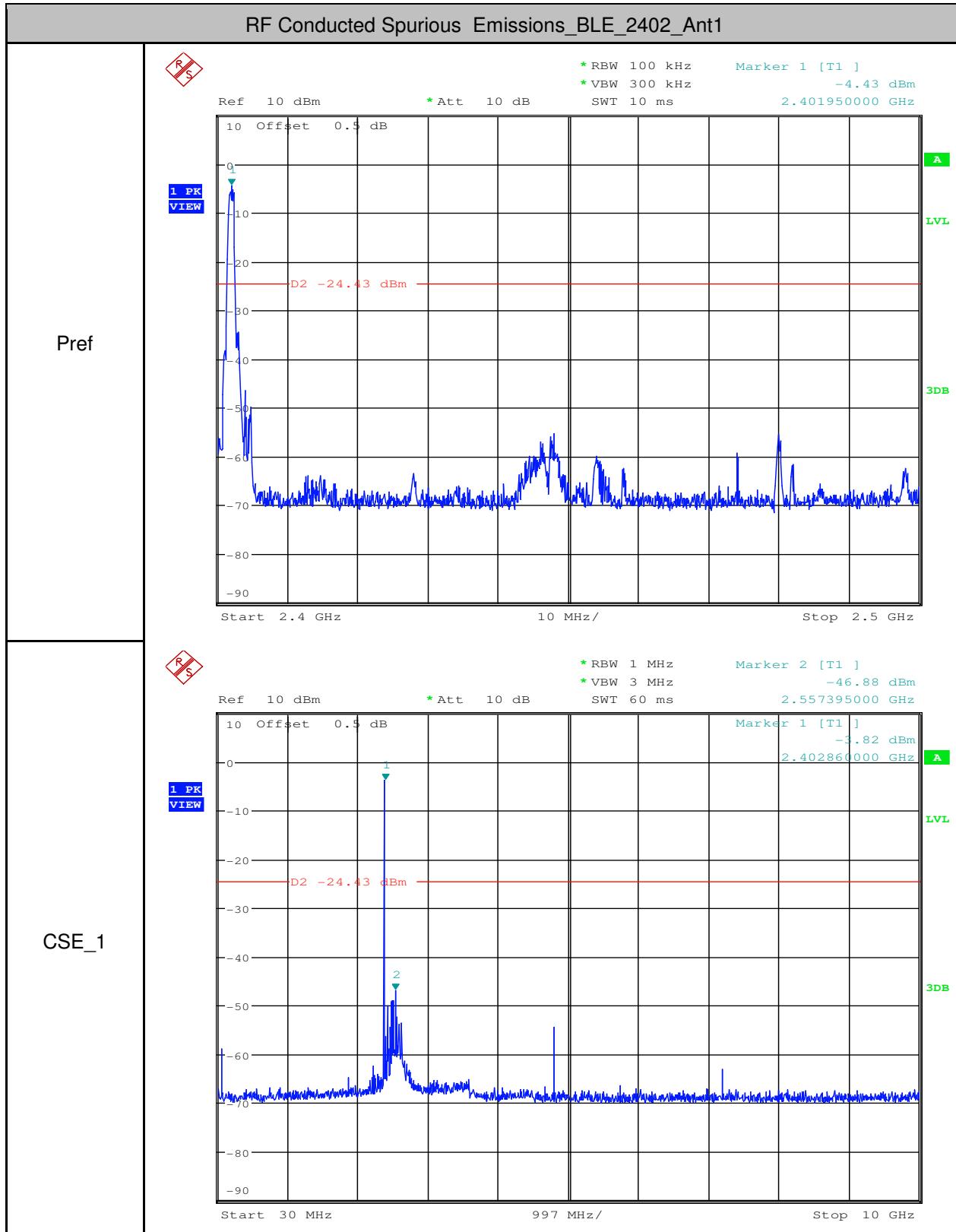
4. Band-edge for RF Conducted Emissions

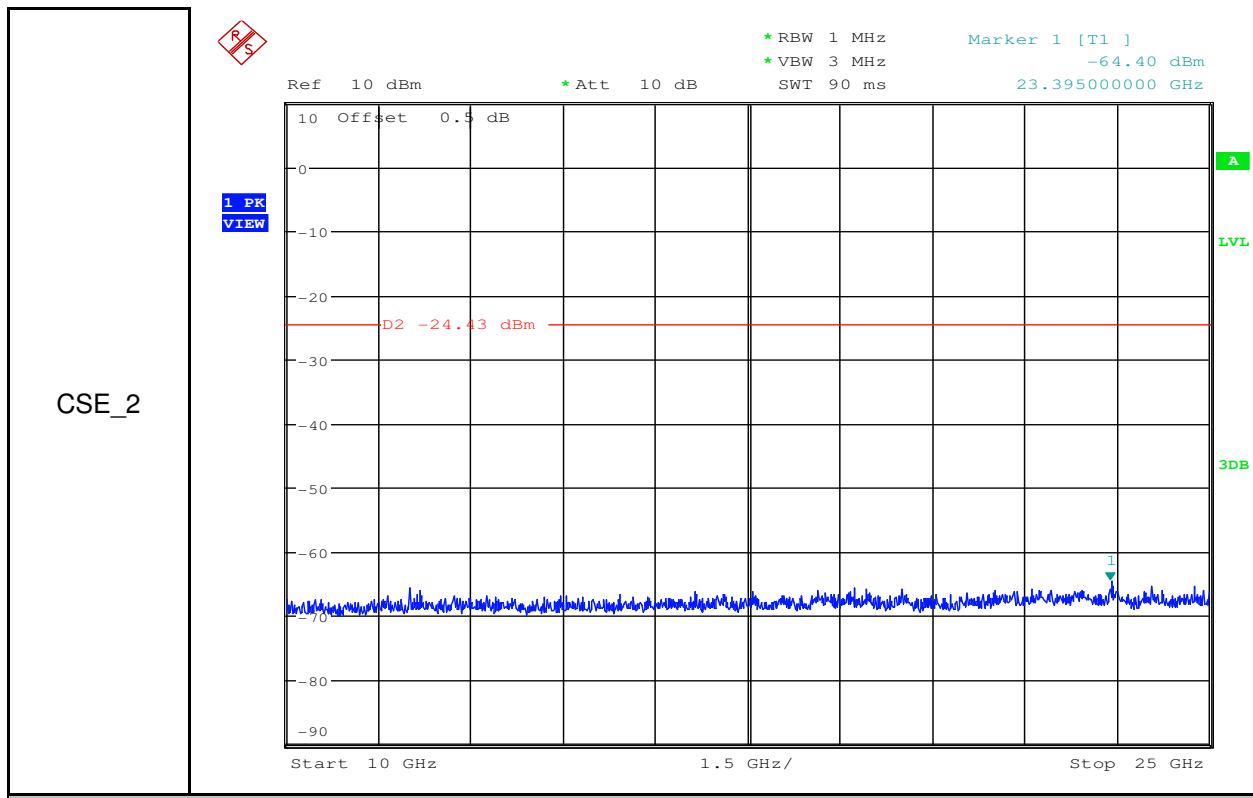
Test Mode	Test Channel	Ant	Carrier Power[dBm]	Max. Spurious Level [dBm]	Limit [dBm]	Verdict
BLE	2402	Ant1	-4.420	-65.530	<-24.42	PASS
BLE	2480	Ant1	0.920	-61.561	<-19.08	PASS



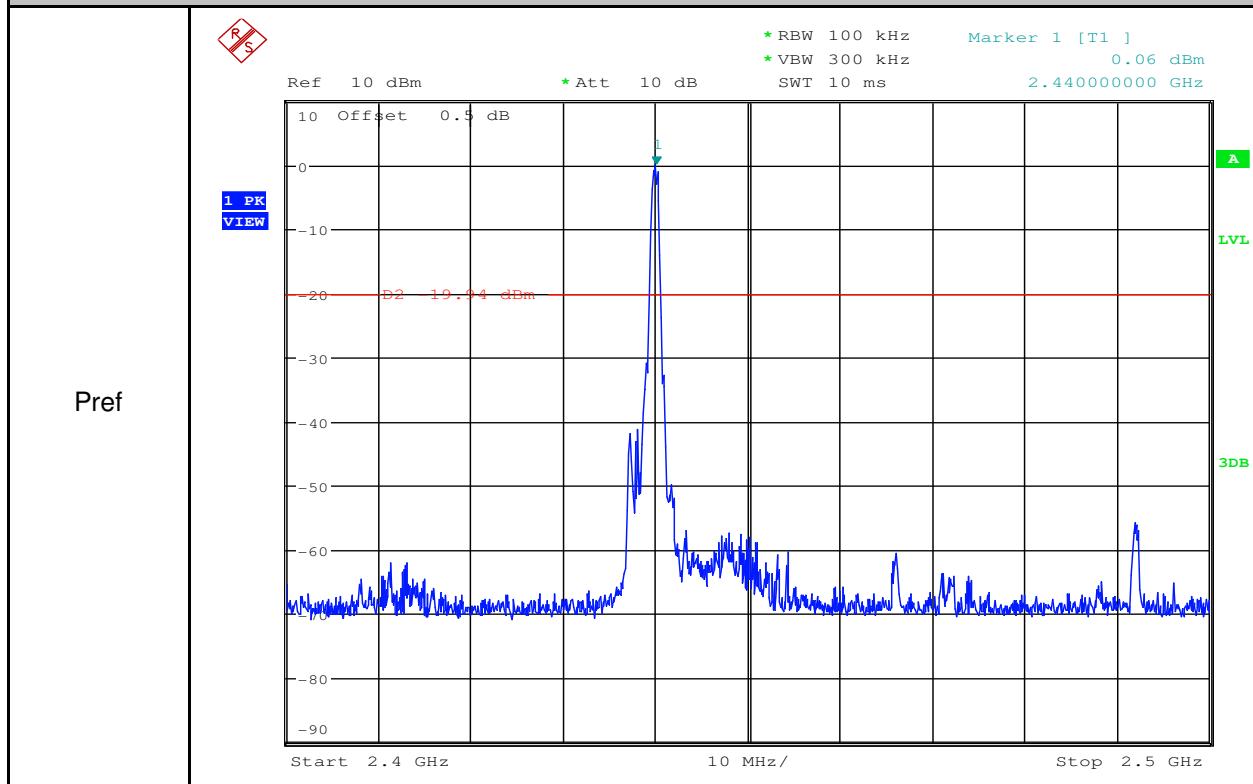
5.RF Conducted Spurious Emissions

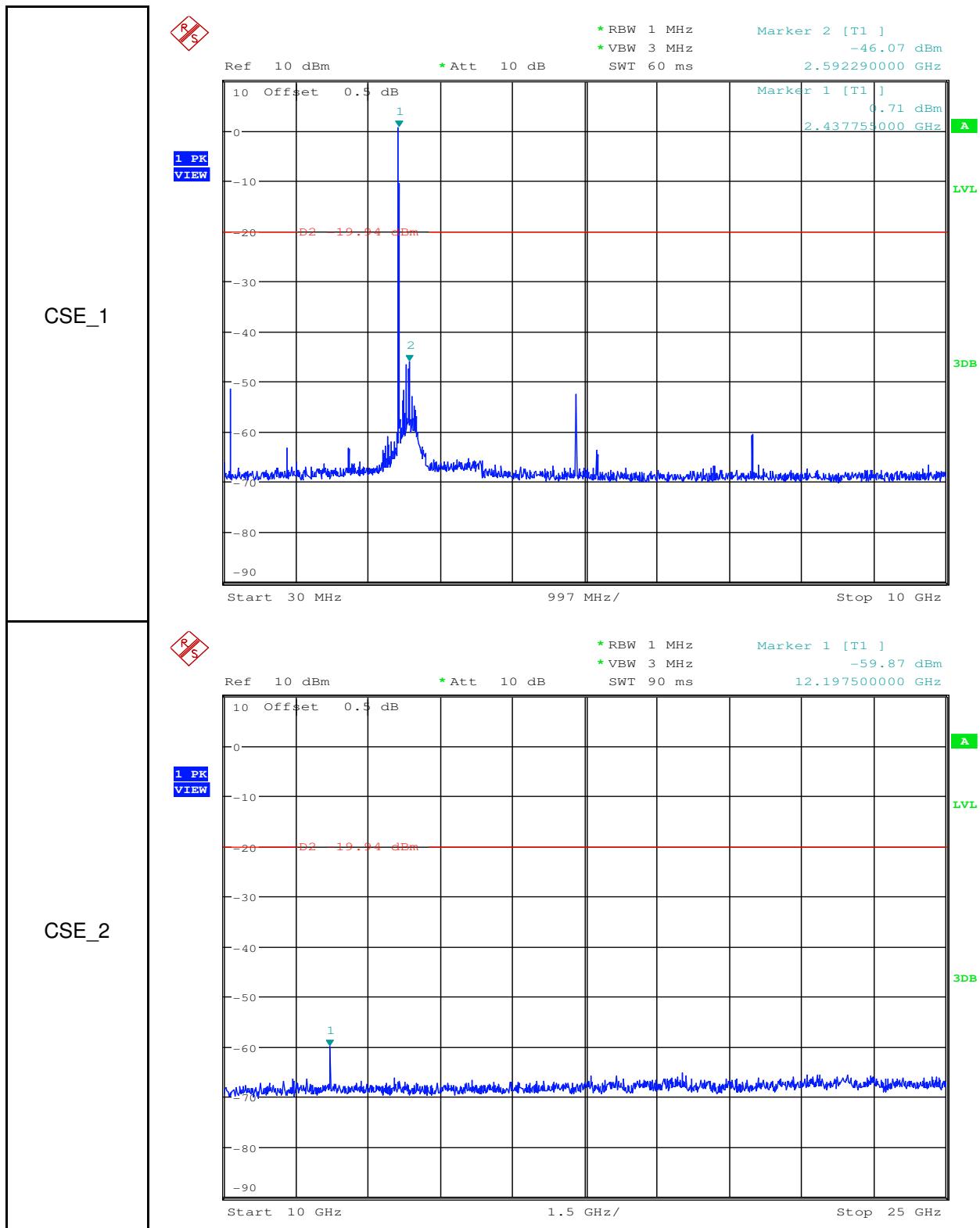
Test Mode	Test Channel	StartFre [MHz]	StopFre [MHz]	RBW [kHz]	VBW [kHz]	Pref[dBm]	Max. Level [dBm]	Limit [dBm]	Verdict
BLE	2402	30	10000	1000	3000	-4.43	-46.880	<-24.43	PASS
BLE	2402	10000	25000	1000	3000	-4.43	-64.400	<-24.43	PASS
BLE	2440	30	10000	1000	3000	0.06	-46.070	<-19.94	PASS
BLE	2440	10000	25000	1000	3000	0.06	-59.870	<-19.94	PASS
BLE	2480	30	10000	1000	3000	0.26	-45.900	<-19.74	PASS
BLE	2480	10000	25000	1000	3000	0.26	-59.560	<-19.74	PASS

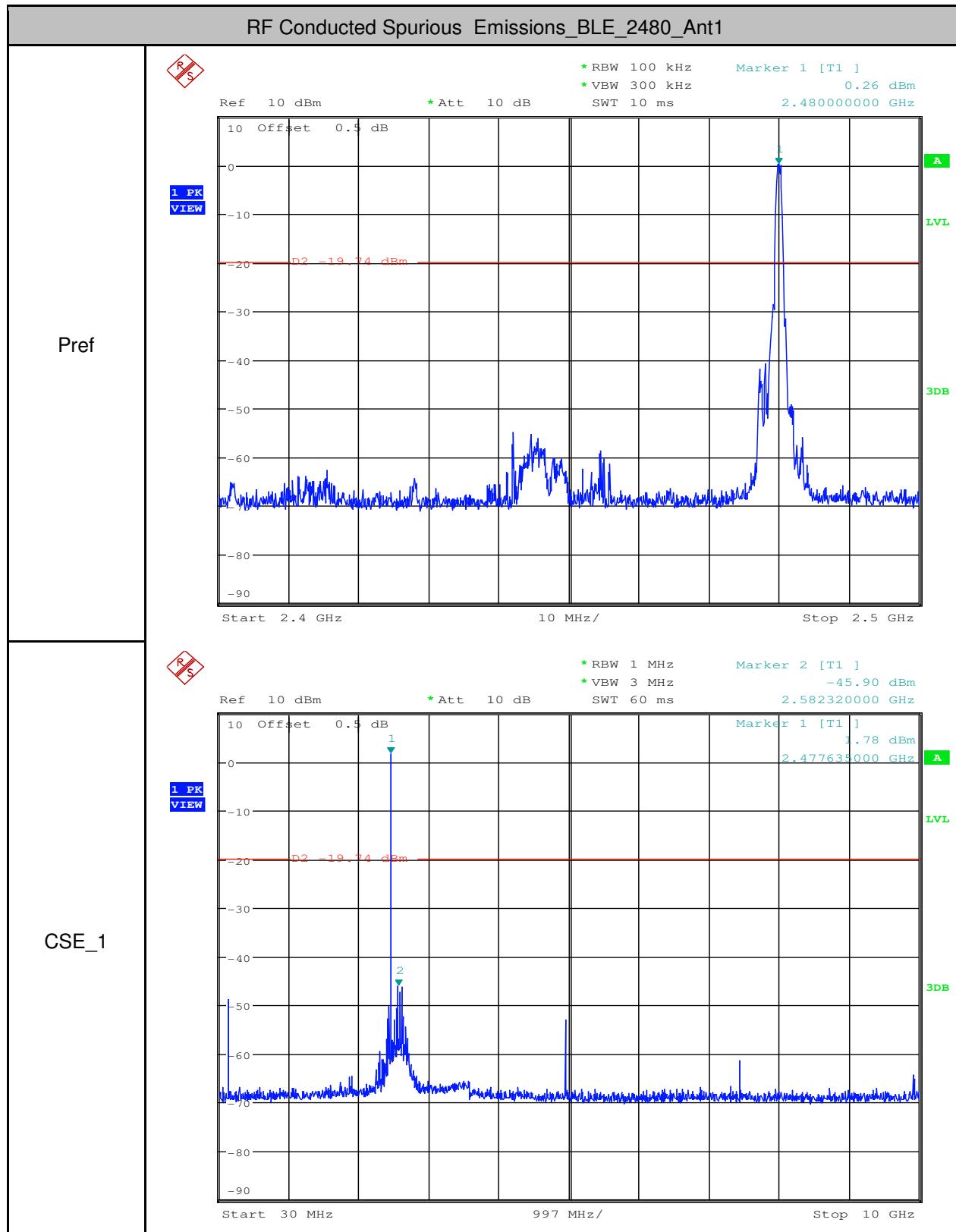


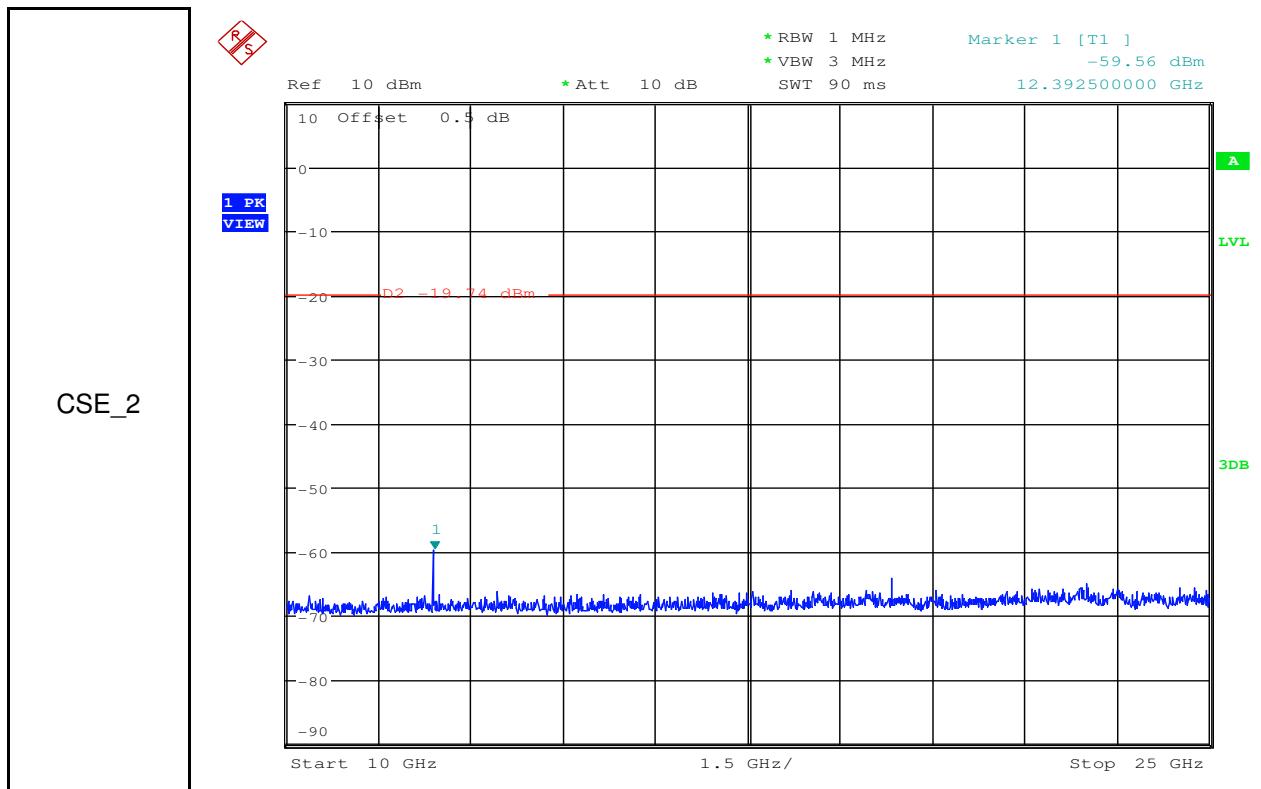


RF Conducted Spurious Emissions_BLE_2440_Ant1









- End of the Report -