TEST REPORT

Application No.:	SZEM2002000972CR
Applicant:	SKULLCANDY, INC.
Address of Applicant:	6301 N Landmark Dr Park City UT 84098, Utah United States of America
Manufacturer:	SKULLCANDY, INC.
Address of Manufacturer:	6301 N Landmark Dr Park City UT 84098, Utah United States of America
Equipment Under Test (EUT):	
EUT Name:	Crusher EVO
Model No.:	S6EVW
Trade mark:	Skullcandy
FCC ID:	Y22-S6EVW
Standard(s) :	47 CFR Part 15, Subpart C 15.247
Date of Receipt:	2020-02-26
Date of Test:	2020-03-04 to 2020-04-10
Date of Issue:	2020-04-16
Test Result:	**Pass***

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

Keny Xu
EMC Laboratory Manager

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Revision Record				
Version	**Chapter**	**Date**	**Modifier**	**Remark**
01		2020-04-16		Original

Authorized for issue by:				
		Benson Wang /Project Engineer		
		Eric Fu /Reviewer		

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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(b)(4)	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 11.9.1	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 11.13.3.2	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 11.11	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:	Rechargeable battery: 3.8V 1200mAh (Charged by Type-port)
Cable:	Type-C cable: 56.5cm unshielded Aux in cable: 120.5cm unshielded
Bluetooth Version:	V5.0 Dual mode
Operation Frequency:	2402MHz to 2480MHz
Modulation Type:	GFSK
Number of Channels:	40
Channel Spacing:	2MHz
Antenna Type:	Integral Antenna
Antenna Gain:	3.51dBi

4.2 Description of Support Units

Description	Manufacturer	Model No.	Serial No.
Adapter	Apple	A1399	Provided by applicant

4.3 Measurement Uncertainty

Item	Measurement Uncertainty
Radio Frequency	± 7.25 x 10^{-8}
Conduction emission	± 3.0dB (150kHz to 30MHz)
RF conducted power	± 0.75dB
RF power density	± 2.84dB
Conducted Spurious emissions	± 0.75dB
RF Radiated power	± 4.5dB (Below 1GHz)
	± 4.8dB (Above 1GHz)
Radiated Spurious emission test	± 4.5dB (Below 1GHz)
	± 4.8dB (Above 1GHz)
Temperature test	± 1℃
Humidity test	± 3%
Supply voltages	± 1.5%
Time	± 3%

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4.4 Test Location

All tests were performed at:

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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:

• **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

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5 Equipment List

Conducted Emissions at AC Power Line (150kHz-30MHz)					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
Shielding Room	ZhongYu Electron	GB-88	SEM001-06	2019-06-13	2022-06-12
Measurement Software	AUDIX	e3 V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM024-01	2019-07-11	2020-07-10
LISN	Rohde & Schwarz	ENV216	SEM007-01	2019-09-24	2020-09-23
LISN	ETS-LINDGREN	3816/2	SEM007-02	2019-04-02	2020-04-01
LISN	ETS-LINDGREN	3816/2	SEM007-02	2020-04-01	2021-03-31
EMI Test Receiver	Rohde & Schwarz	ESCI	SEM004-02	2020-03-24	2021-03-23

Radiated Emissions and Radiated Emission 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	2018-03-13	2021-03-12
Measurement Software	AUDIX	e3 V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM026-01	2019-07-11	2020-07-10
EXA Spectrum Analyzer	AgilentTechnologies Inc	N9010A	SEM004-12	2019-04-10	2020-04-09
EXA Spectrum Analyzer	AgilentTechnologies Inc	N9010A	SEM004-12	2020-04-09	2021-04-08
Horn Antenna	Rohde & Schwarz	HF907	SEM003-07	2018-04-13	2021-04-12
Horn Antenna	Schwarzbeck	BBHA 9170	SEM003-15	2017-10-17	2020-10-16
Pre-Amplifier	Compliance Directions Systems Inc.	PAP-0126	SEM004-11	2019-09-24	2020-09-23
Pre-amplifier	Rohde & Schwarz	CH14-H052	SEM005-17	2019-04-02	2020-04-01
Pre-amplifier	Rohde & Schwarz	CH14-H052	SEM005-17	2020-04-01	2021-03-31
Pre-amplifier	Compliance Directions Systems Inc.	PAP-2640-50	SEM005-08	2019-04-02	2020-04-01
Pre-amplifier	Compliance Directions Systems Inc.	PAP-2640-50	SEM005-08	2020-04-01	2021-03-31
DC Power Supply	Zhao Xin	KXN-6020D	SEM011-08	2019-09-24	2020-09-23
Active Loop Antenna	ETS-Lindgren	6502	SEM003-08	2017-08-22	2020-08-21

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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(3Hz-3.6GHz)	KEYSIGHT	N9038A	SEM004-15	2019-12-16	2020-12-15
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	2019-04-02	2020-04-01
Pre-amplifier (0.1-1300MHz)	Agilent Technologies	8447D	SEM005-01	2020-04-01	2021-03-31
Measurement Software	AUDIX	e3 V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM025-01	2019-07-11	2020-07-10

RF conducted					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
Shielding Room	SAEMC	MSR733	SEM001-09	2019-06-13	2022-06-12
DC Power Supply	Rohde & Schwarz	NGSM 32/10	SEM011-04	2020-03-24	2021-03-23
Spectrum Analyzer	Rohde & Schwarz	FSP	SEM004-06	2019-09-24	2020-09-23
Measurement Software	JS Tonscend	JS1120-2 BT/WIFI V2.	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM031-02	2019-07-11	2020-07-10
Attenuator	Weinschel Associates	WA41	SEM021-09	N/A	N/A
Signal Generator	KEYSIGHT	N5173B	SEM006-05	2019-09-24	2020-09-23
Power Meter	Rohde & Schwarz	NRVS	SEM014-02	2019-09-24	2020-09-23
Electric and Magnetic Field Analyzer	Narda	EHP-50F	SEM022-05	2019-11-28	2020-11-27
Electric Field Probe	WANDEL & GOLTERMANN	EMR-20	EMC0907	2019-05-21	2020-05-20
EMF Tester	Narda	ELT-400	SZE039-4	2019-07-08	2020-07-07

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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	2019-09-26	2020-09-25
Humidity/ Temperature Indicator	Shanghai Meteorological Industry Factory	ZJ1-2B	SEM002-04	2019-09-26	2020-09-25
Humidity/ Temperature Indicator	Mingle	N/A	SEM002-08	2019-09-26	2020-09-25
Barometer	Changchun Meteorological Industry Factory	DYM3	SEM002-01	2019-04-08	2020-04-07
Barometer	Changchun Meteorological Industry Factory	DYM3	SEM002-01	2020-04-07	2021-04-06

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6 Radio Spectrum Technical Requirement

6.1 Antenna Requirement

6.1.1 Test Requirement:

47 CFR Part 15, Subpart C 15.203 & 15.247(b)(4)

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 3.51dBi.

Antenna location: Refer to internal photo.

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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(dBμV)	
	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

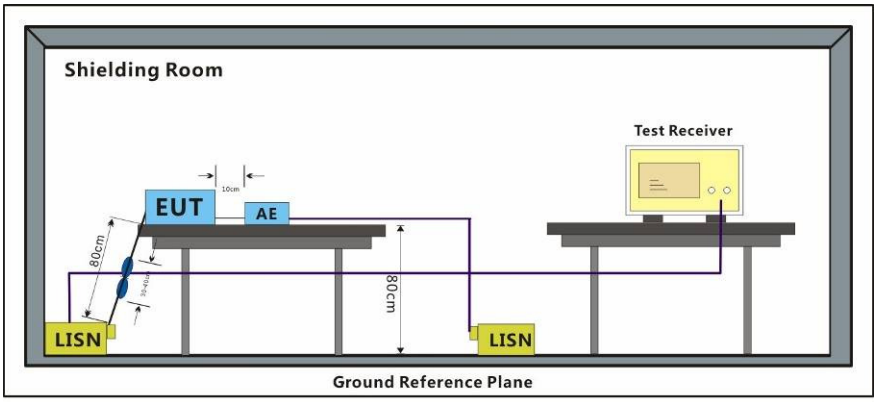
Operating Environment:

Temperature: 22.6 °C Humidity: 57.1 % RH Atmospheric Pressure: 1020 mbar

Pretest these modes to find the worst case: f:Charge + TX mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation.

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

7.1.2 Test Setup Diagram



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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/50μH + 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

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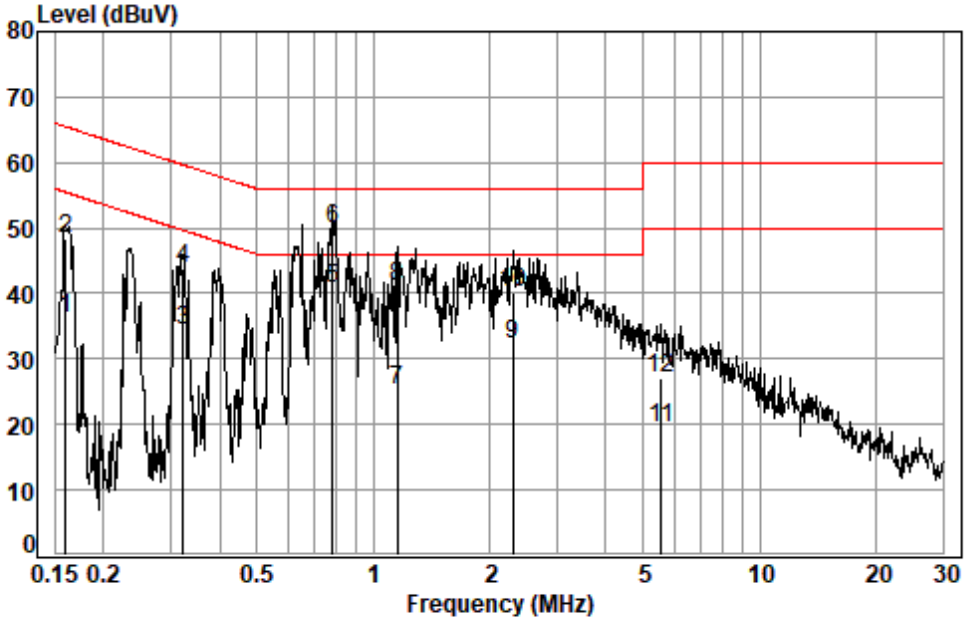
Mode:f; Line:Live Line



Site : Shielding Room
Condition: Line
Job No. : 00972CR
Test mode: f

	Freq	Cable Loss	LISN Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB	dBuV	dBuV	dBuV	dB	
1	0.1598	0.01	9.59	26.57	36.17	55.47	-19.30	Average
2	0.1598	0.01	9.59	38.77	48.37	65.47	-17.10	QP
3	0.3217	0.04	9.59	24.82	34.45	49.66	-15.21	Average
4	0.3217	0.04	9.59	34.28	43.91	59.66	-15.75	QP
5	0.7835	0.08	9.60	31.18	40.86	46.00	-5.14	Average
6	0.7835	0.08	9.60	40.16	49.84	56.00	-6.16	QP
7	1.1534	0.10	9.60	15.59	25.29	46.00	-20.71	Average
8	1.1534	0.10	9.60	31.24	40.94	56.00	-15.06	QP
9	2.2968	0.16	9.63	22.45	32.24	46.00	-13.76	Average
10	2.2968	0.16	9.63	30.32	40.11	56.00	-15.89	QP
11	5.5641	0.17	9.69	9.59	19.45	50.00	-30.55	Average
12	5.5641	0.17	9.69	17.16	27.02	60.00	-32.98	QP

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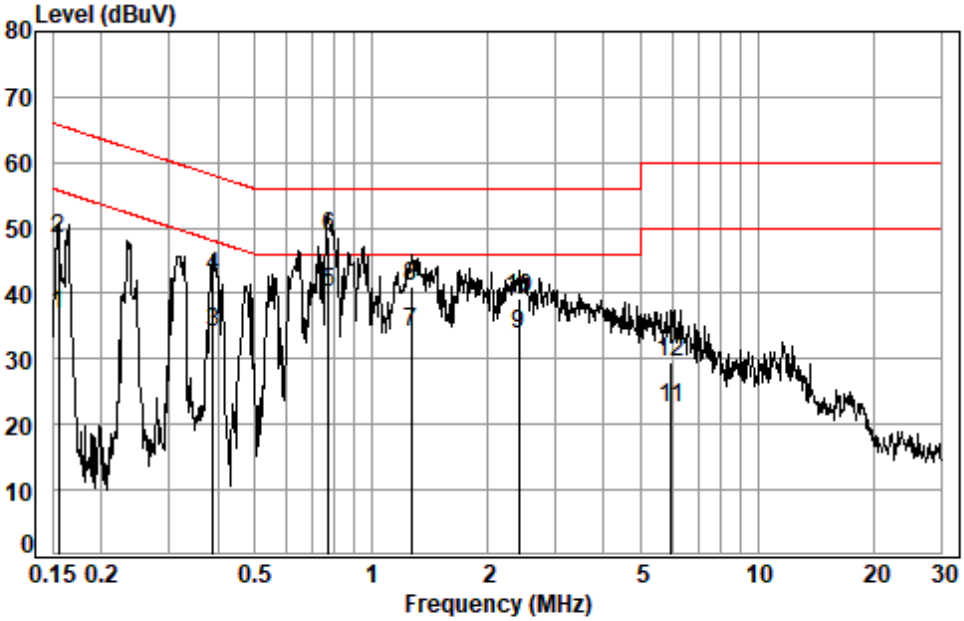
Mode:f; Line:Neutral Line



Site : Shielding Room
Condition: Neutral
Job No. : 00972CR
Test mode: f

	Freq	Cable Loss	LISN Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB	dBuV	dBuV	dBuV	dB	
1	0.1548	0.01	9.55	27.27	36.83	55.74	-18.91	Average
2	0.1548	0.01	9.55	38.88	48.44	65.74	-17.30	QP
3	0.3893	0.05	9.55	24.36	33.96	48.08	-14.12	Average
4	0.3893	0.05	9.55	32.88	42.48	58.08	-15.60	QP
5	0.7752	0.08	9.55	30.59	40.22	46.00	-5.78	Average
6	0.7752	0.08	9.55	39.03	48.66	56.00	-7.34	QP
7	1.2688	0.11	9.55	24.52	34.18	46.00	-11.82	Average
8	1.2688	0.11	9.55	31.34	41.00	56.00	-15.00	QP
9	2.4090	0.16	9.57	23.92	33.65	46.00	-12.35	Average
10	2.4090	0.16	9.57	29.59	39.32	56.00	-16.68	QP
11	5.9925	0.17	9.66	12.69	22.52	50.00	-27.48	Average
12	5.9925	0.17	9.66	19.76	29.59	60.00	-30.41	QP

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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

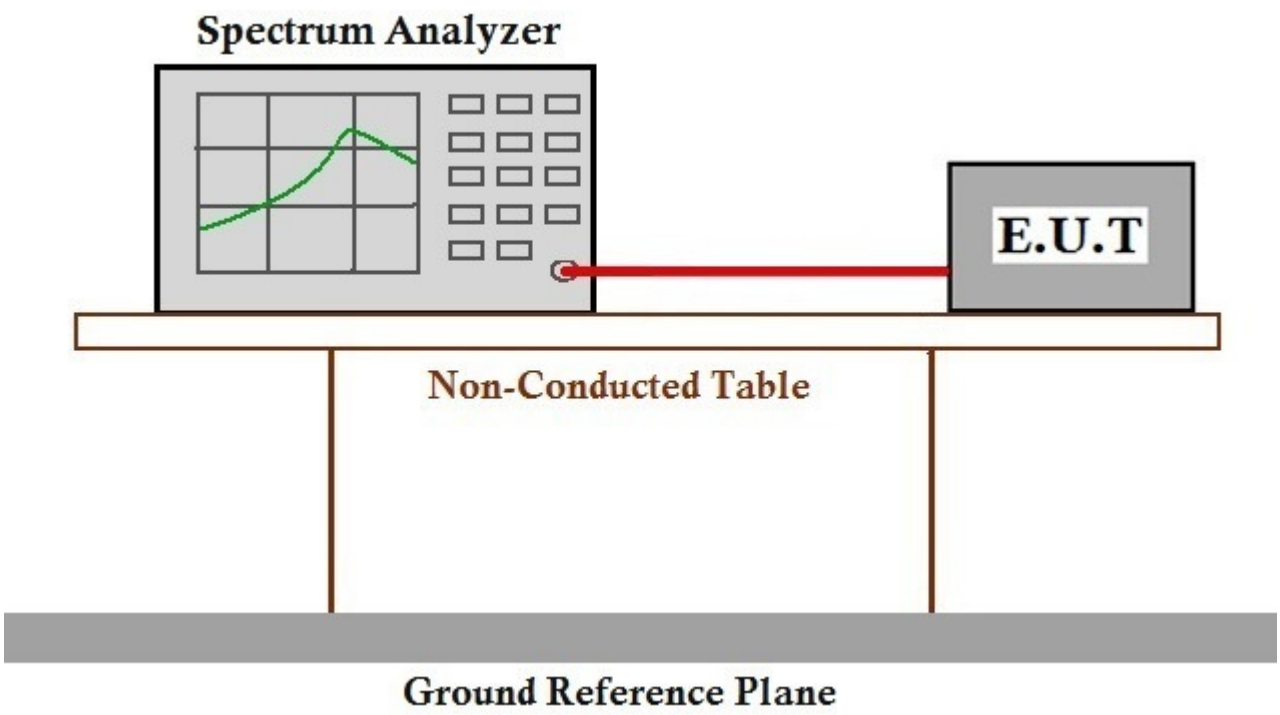
7.2.1 E.U.T. Operation

Operating Environment:

Temperature: 22.6 °C Humidity: 57.1 % RH Atmospheric Pressure: 1020 mbar

Test mode e:TX mode_Keep the EUT in 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

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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 11.9.1
Limit:

Frequency range(MHz)	Output power of the intentional radiator(watt)
902-928	1 for ≥50 hopping channels
	0.25 for 25≤ 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

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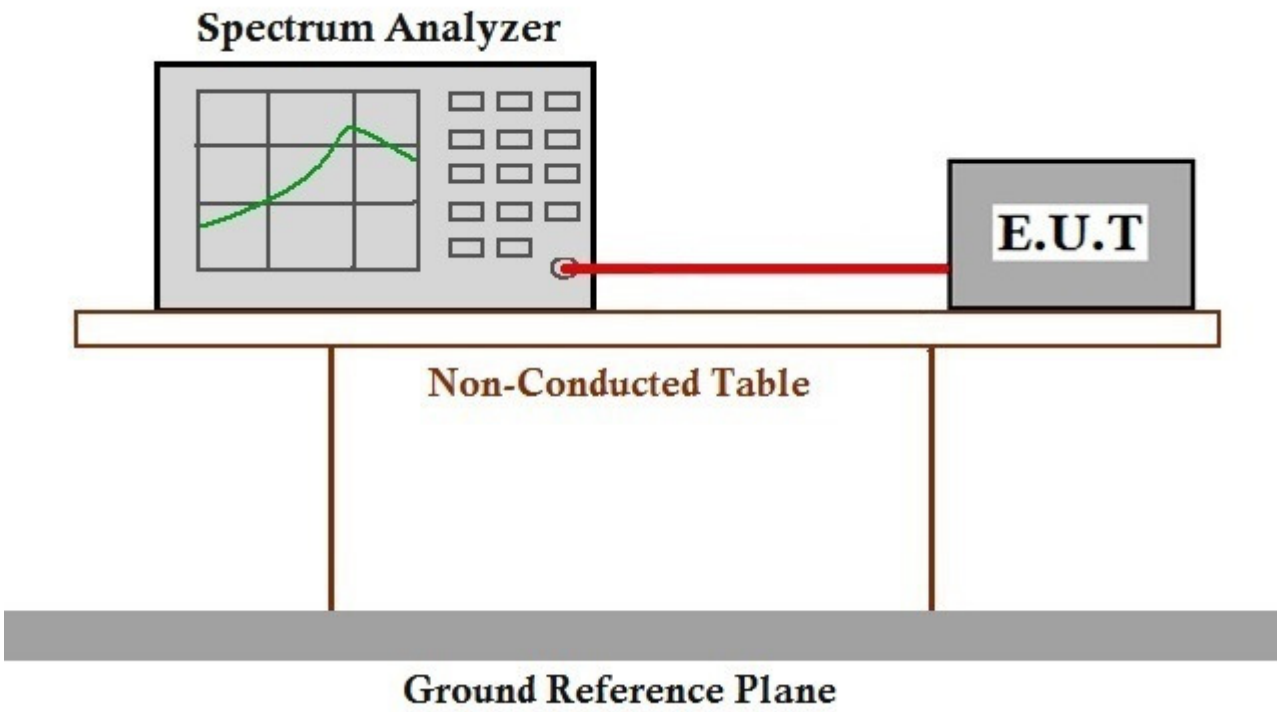
7.3.1 E.U.T. Operation

Operating Environment:

Temperature: 22.6 °C Humidity: 57.1 % RH Atmospheric Pressure: 1020 mbar

Test mode e: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

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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: ≤8dBm in any 3 kHz band during any time interval of continuous transmission

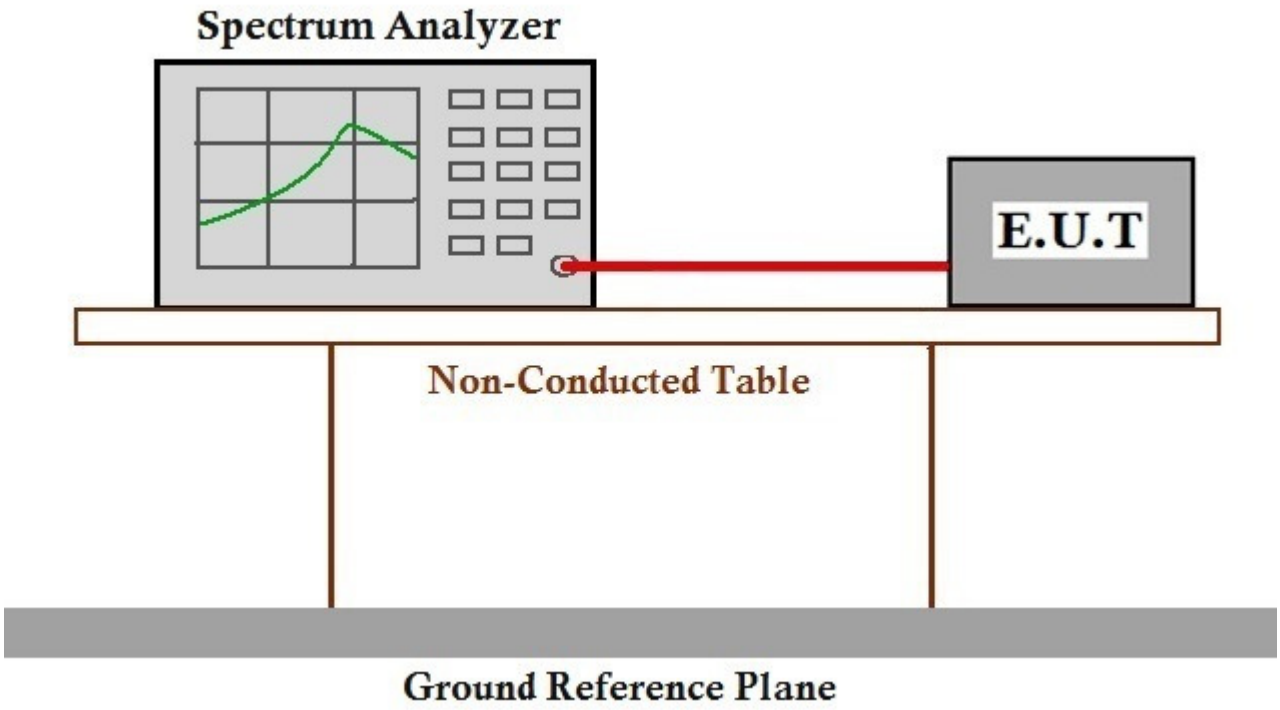
7.4.1 E.U.T. Operation

Operating Environment:

Temperature: 22.6 °C Humidity: 57.1 % RH Atmospheric Pressure: 1020 mbar

Test mode e: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

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7.5 Conducted Band Edges Measurement

Test Requirement	47 CFR Part 15, Subpart C 15.247(d)
Test Method:	ANSI C63.10 (2013) Section 11.13.3.2
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)

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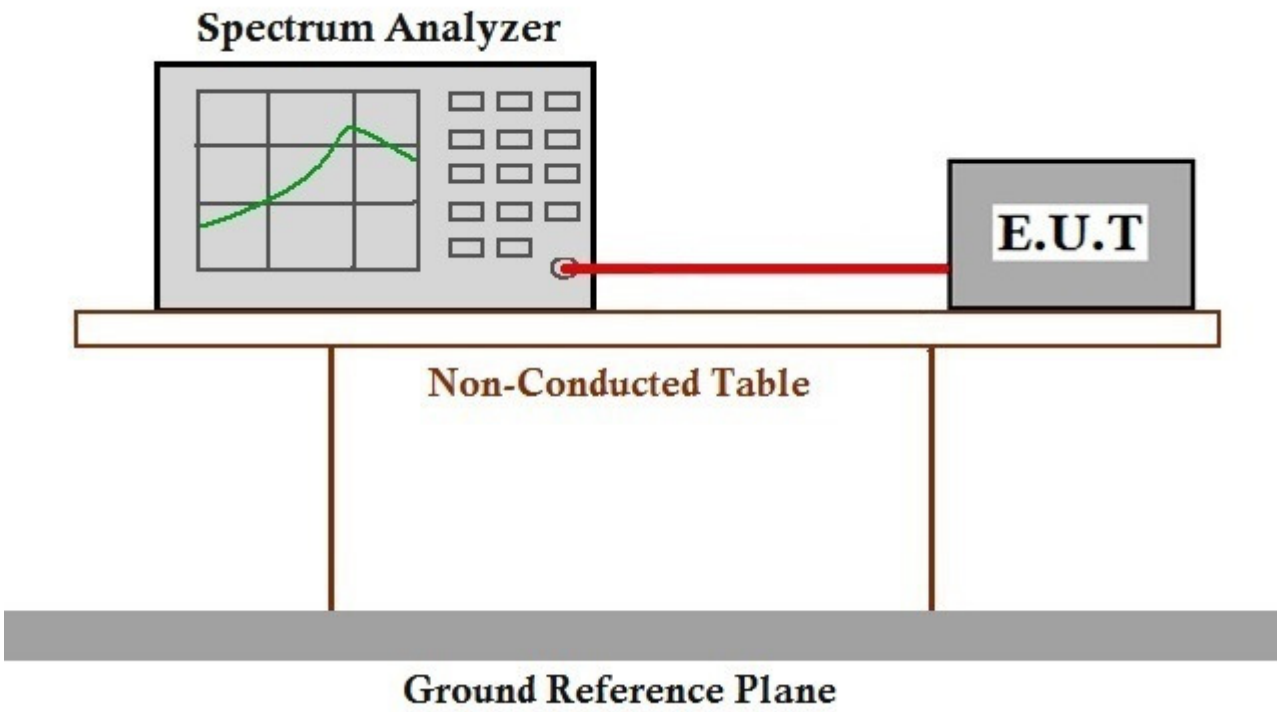
7.5.1 E.U.T. Operation

Operating Environment:

Temperature: 22.6 °C Humidity: 57.1 % RH Atmospheric Pressure: 1020 mbar

Test mode e: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

The detailed test data see: Appendix 15.247

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7.6 Conducted Spurious Emissions

Test Requirement	47 CFR Part 15, Subpart C 15.247(d)
Test Method:	ANSI C63.10 (2013) Section 11.11
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)

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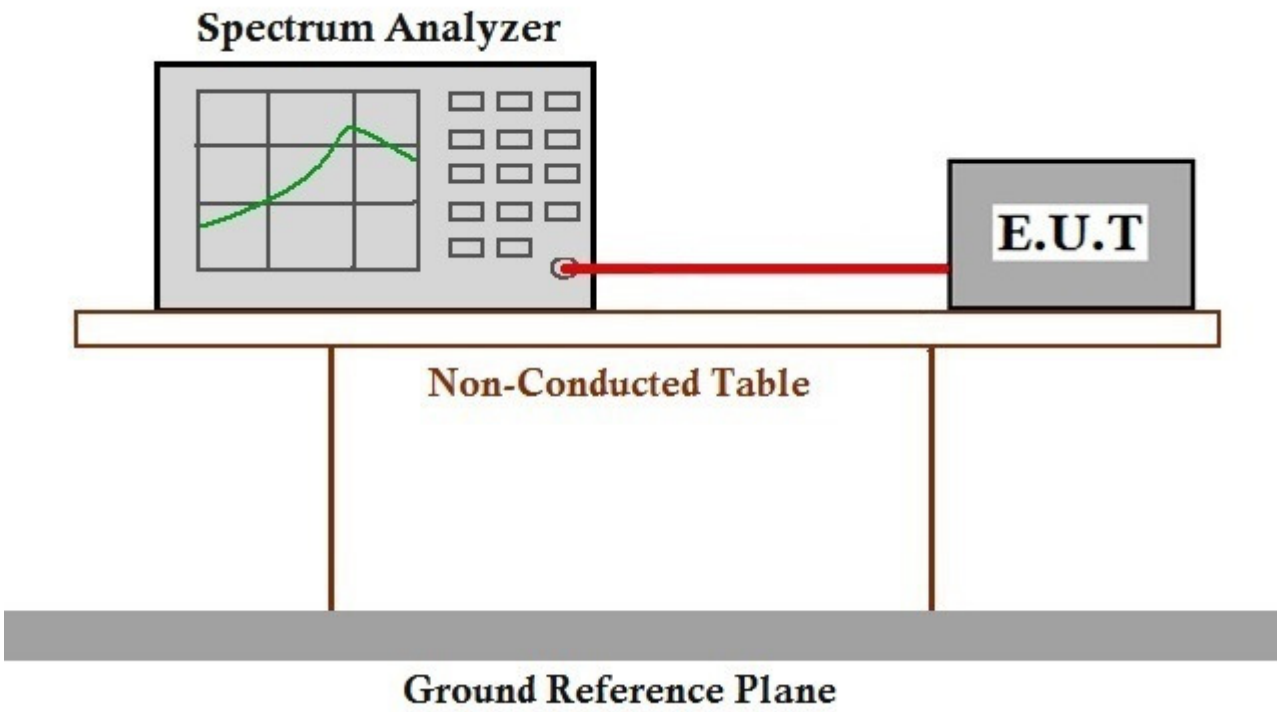
7.6.1 E.U.T. Operation

Operating Environment:

Temperature: 22.6 °C Humidity: 57.1 % RH Atmospheric Pressure: 1020 mbar

Test mode e: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

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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:

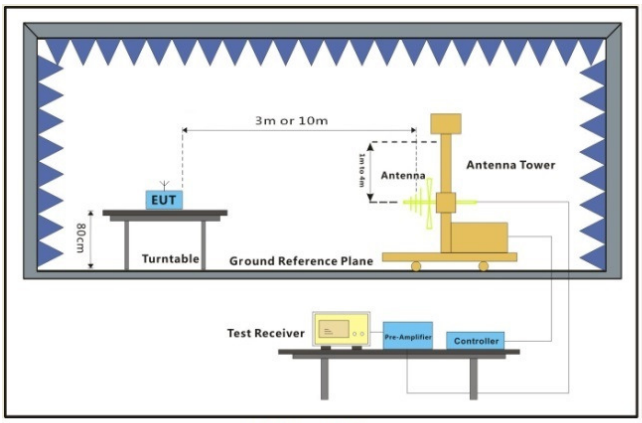
Temperature: 23.5 °C Humidity: 56.3 % RH Atmospheric Pressure: 1015 mbar

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

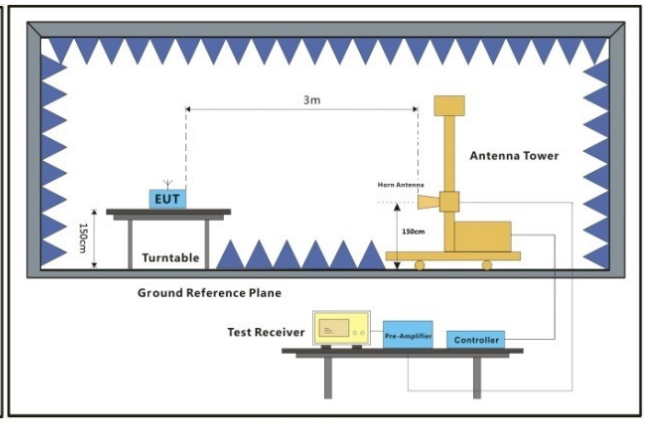
f:Charge + TX mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation.

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

7.7.2 Test Setup Diagram



30MHz-1GHz



Above 1GHz

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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.

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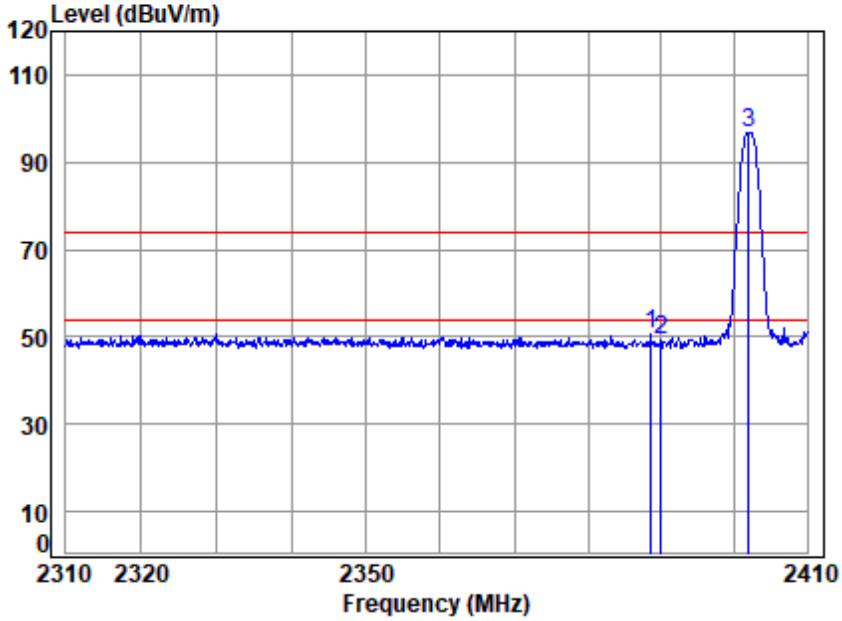
Mode:f; Polarization:Horizontal; Modulation:GFSK; Channel:Low



Site : chamber
Condition: 3m HORIZONTAL
Job No : 00972CR\00973CR
Mode : 2402 Band edge
Note : BLE

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	2388.546	3.70	28.52	40.97	59.31	50.56	74.00	-23.44	peak
2	2390.000	3.69	28.52	40.97	57.91	49.15	74.00	-24.85	peak
3 *	2402.000	3.63	28.54	40.98	105.52	96.71	74.00	22.71	peak

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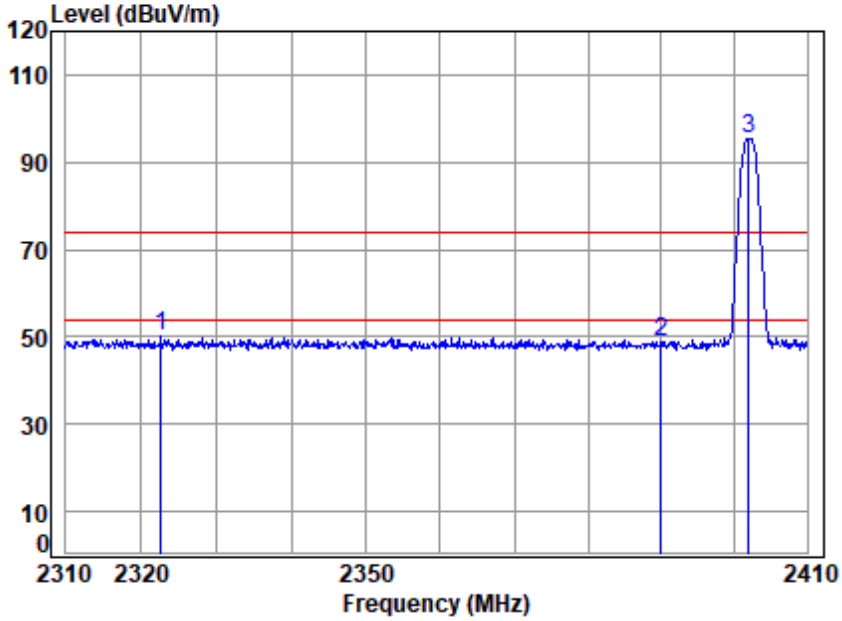
Mode:f; Polarization:Vertical; Modulation:GFSK; Channel:Low



Site : chamber
Condition: 3m VERTICAL
Job No : 00972CR\00973CR
Mode : 2402 Band edge
Note : BLE

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	2322.663	4.14	28.40	40.94	58.41	50.01	74.00	-23.99	peak
2	2390.000	3.69	28.52	40.97	57.39	48.63	74.00	-25.37	peak
3 *	2402.000	3.63	28.54	40.98	104.14	95.33	74.00	21.33	peak

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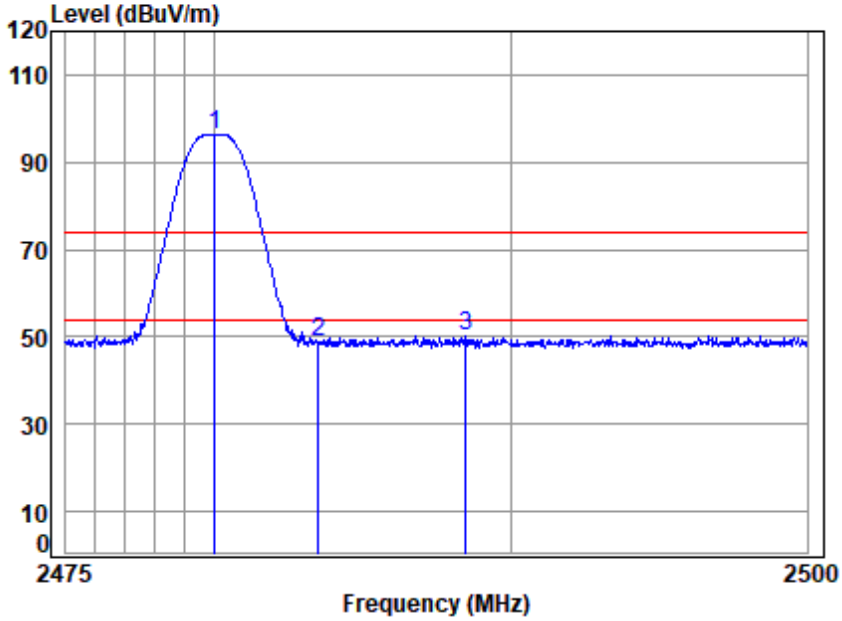
Mode:f; Polarization:Horizontal; Modulation:GFSK; Channel:High



Site : chamber
Condition: 3m HORIZONTAL
Job No : 00972CR\00973CR
Mode : 2480 Band edge
Note : BLE

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1 *	2480.000	3.99	28.67	41.01	104.74	96.39	74.00	22.39	peak
2	2483.500	4.01	28.67	41.01	57.29	48.96	74.00	-25.04	peak
3	2488.469	4.03	28.68	41.01	58.59	50.29	74.00	-23.71	peak

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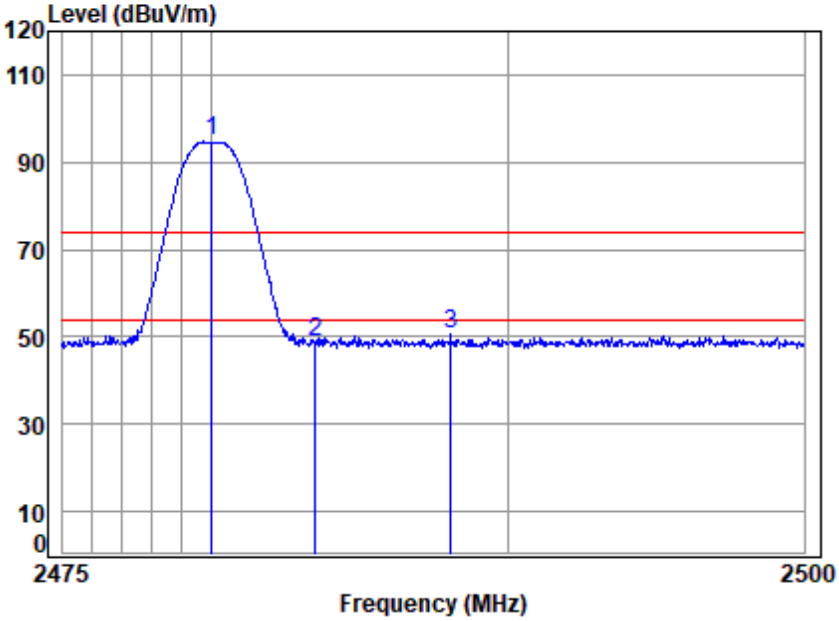
Mode:f; Polarization:Vertical; Modulation:GFSK; Channel:High



Site : chamber
Condition: 3m VERTICAL
Job No : 00972CR\00973CR
Mode : 2480 Band edge
Note : BLE

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1 *	2480.000	3.99	28.67	41.01	103.03	94.68	74.00	20.68	peak
2	2483.500	4.01	28.67	41.01	57.09	48.76	74.00	-25.24	peak
3	2488.044	4.03	28.68	41.01	58.81	50.51	74.00	-23.49	peak

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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.		

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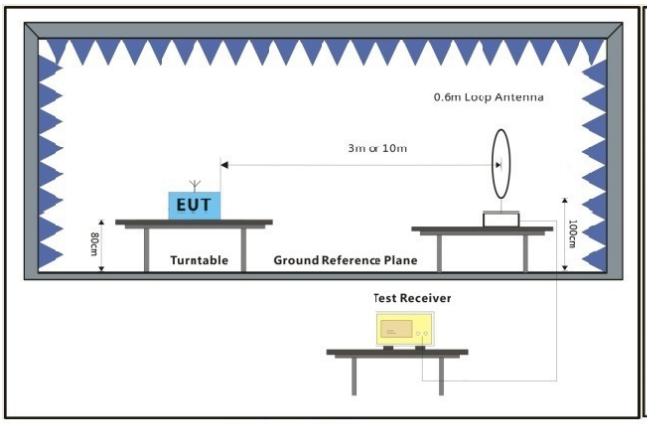
7.8.1 E.U.T. Operation

Operating Environment:

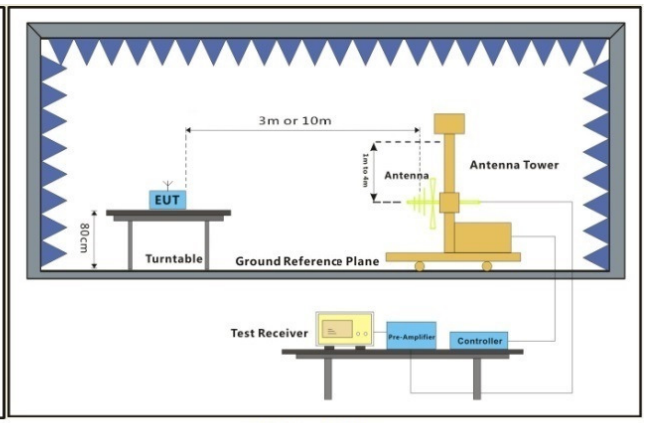
Temperature: 25 °C Humidity: 51 % RH Atmospheric Pressure: 1020 mbar

Pretest these modes to find the worst case:	e:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation f:Charge + TX mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation.
The worst case for final test:	f:Charge + TX mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation.

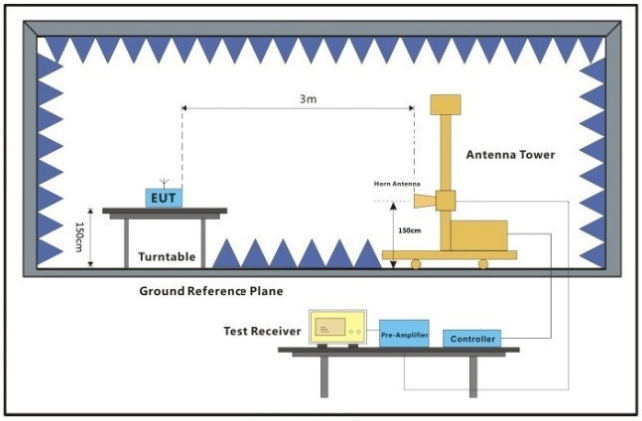
7.8.2 Test Setup Diagram



Below 30MHz



30MHz-1GHz



Above 1GHz

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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.

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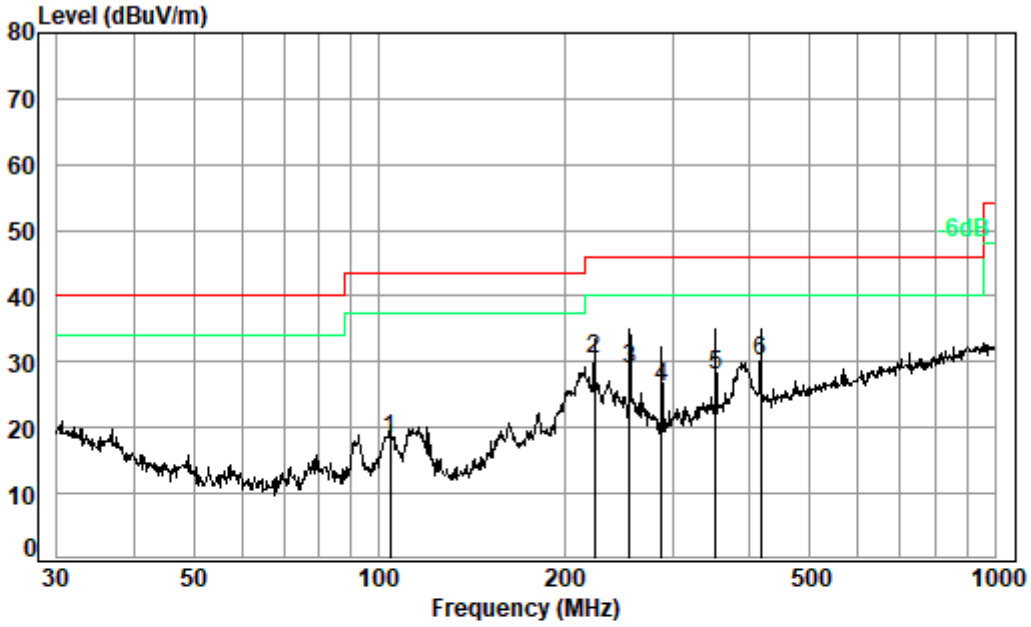
Radiated emission below 1GHz

Mode:f; Polarization:Horizontal



Condition: 3m HORIZONTAL
Job No. : 00972CR
Test mode: f

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	104.17	1.21	13.80	27.61	30.90	18.30	43.50	-25.20	QP
2 pp	223.73	1.54	17.51	27.09	38.56	30.52	46.00	-15.48	QP
3	255.62	1.70	19.04	27.00	35.23	28.97	46.00	-17.03	QP
4	287.99	1.85	19.13	26.92	32.12	26.18	46.00	-19.82	QP
5	351.71	2.06	21.15	27.18	32.10	28.13	46.00	-17.87	QP
6	416.18	2.27	22.79	27.49	32.45	30.02	46.00	-15.98	QP

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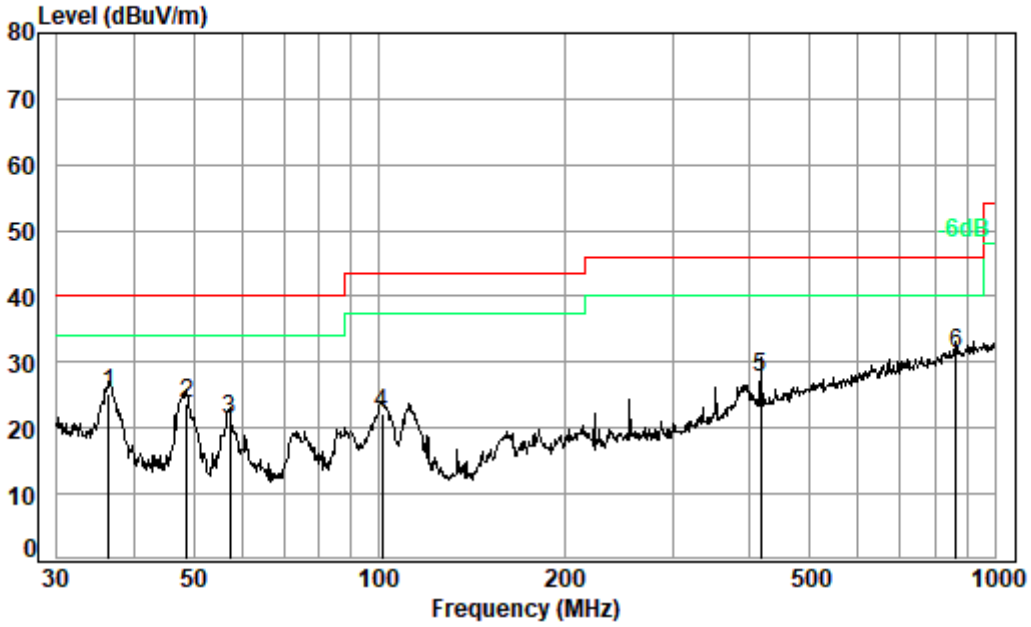
Mode:f; Polarization:Vertical



Condition: 3m VERTICAL
Job No. : 00972CR
Test mode: f

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	36.38	0.60	19.15	27.71	33.14	25.18	40.00	-14.82	QP
2	48.84	0.78	14.55	27.69	36.08	23.72	40.00	-16.28	QP
3	57.19	0.80	13.46	27.68	34.58	21.16	40.00	-18.84	QP
4	101.29	1.20	13.94	27.63	34.66	22.17	43.50	-21.33	QP
5	416.18	2.27	22.79	27.49	30.00	27.57	46.00	-18.43	QP
6 pp	866.09	3.47	29.38	27.43	25.81	31.23	46.00	-14.77	QP

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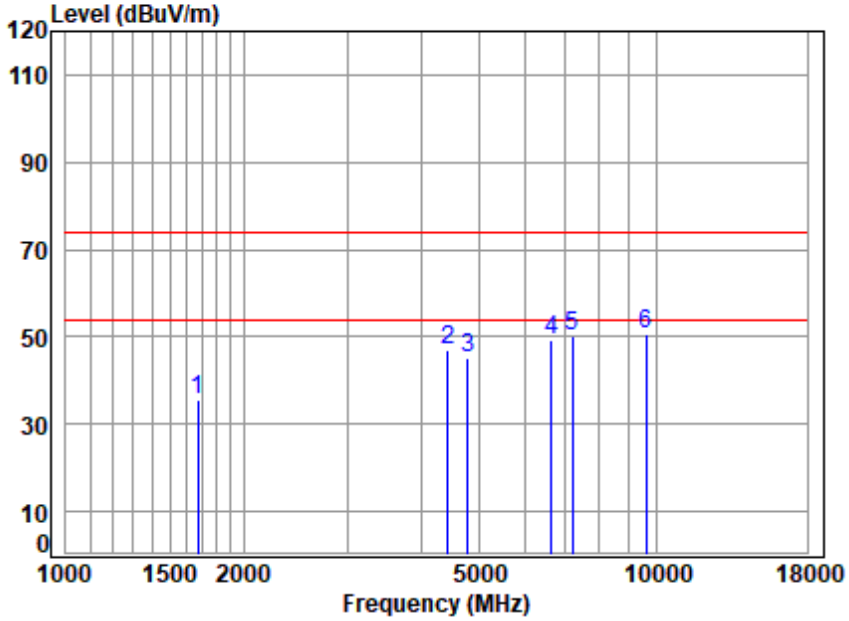
Above 1GHz

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



Site : chamber
Condition: 3m HORIZONTAL
Job No : 00972CR\00973CR
Mode : 2402 TX SE
Note : BLE

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	1672.779	3.21	26.56	40.62	46.64	35.79	74.00	-38.21	peak
2	4443.453	6.55	33.50	42.51	49.37	46.91	74.00	-27.09	peak
3	4804.000	6.80	33.97	42.77	47.17	45.17	74.00	-28.83	peak
4	6640.542	8.14	35.69	41.87	47.38	49.34	74.00	-24.66	peak
5	7206.000	8.44	36.07	41.58	47.14	50.07	74.00	-23.93	peak
6	9608.000	9.17	37.67	38.57	42.41	50.68	74.00	-23.32	peak

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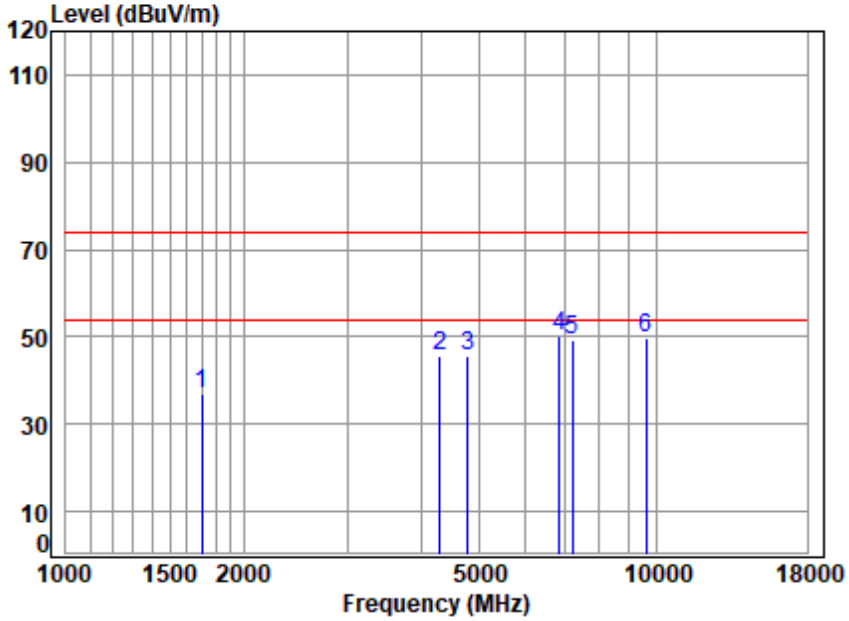
Mode:f; Polarization:Vertical; Modulation:GFSK; Channel:Low



Site : chamber
Condition: 3m VERTICAL
Job No : 00972CR\00973CR
Mode : 2402 TX SE
Note : BLE

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	1697.129	3.30	26.66	40.63	47.47	36.80	74.00	-37.20	peak
2	4304.400	6.32	33.26	42.40	48.45	45.63	74.00	-28.37	peak
3	4804.000	6.80	33.97	42.77	47.67	45.67	74.00	-28.33	peak
4	6855.063	7.90	35.82	41.76	48.43	50.39	74.00	-23.61	peak
5	7206.000	8.44	36.07	41.58	46.55	49.48	74.00	-24.52	peak
6	9608.000	9.17	37.67	38.57	41.61	49.88	74.00	-24.12	peak

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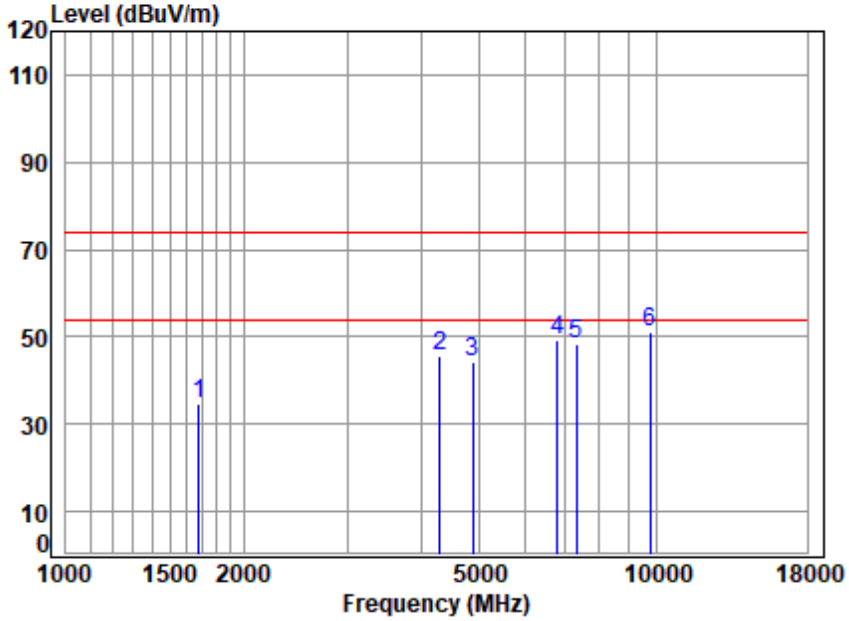
Mode:f; Polarization:Horizontal; Modulation:GFSK; Channel:middle



Site : chamber
Condition: 3m HORIZONTAL
Job No : 00972CR\00973CR
Mode : 2440 TX SE
Note : BLE

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	1677.621	3.23	26.58	40.62	45.42	34.61	74.00	-39.39	peak
2	4304.400	6.32	33.26	42.40	48.26	45.44	74.00	-28.56	peak
3	4880.000	7.02	34.06	42.82	46.01	44.27	74.00	-29.73	peak
4	6795.879	8.00	35.78	41.79	47.16	49.15	74.00	-24.85	peak
5	7323.000	8.36	36.16	41.52	45.31	48.31	74.00	-25.69	peak
6	9764.000	9.30	37.76	38.34	42.28	51.00	74.00	-23.00	peak

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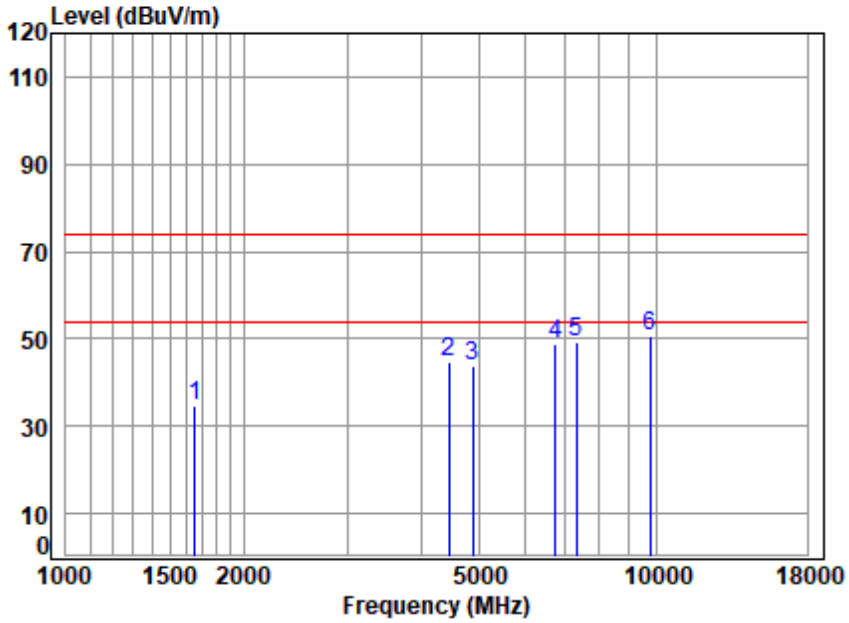
Mode:f; Polarization:Vertical; Modulation:GFSK; Channel:middle



Site : chamber
Condition: 3m VERTICAL
Job No : 00972CR\00973CR
Mode : 2440 TX SE
Note : BLE

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	1653.550	3.15	26.48	40.60	45.73	34.76	74.00	-39.24	peak
2	4456.315	6.51	33.53	42.52	47.06	44.58	74.00	-29.42	peak
3	4880.000	7.02	34.06	42.82	45.46	43.72	74.00	-30.28	peak
4	6756.708	8.14	35.76	41.81	46.69	48.78	74.00	-25.22	peak
5	7323.000	8.36	36.16	41.52	46.09	49.09	74.00	-24.91	peak
6	9764.000	9.30	37.76	38.34	41.84	50.56	74.00	-23.44	peak

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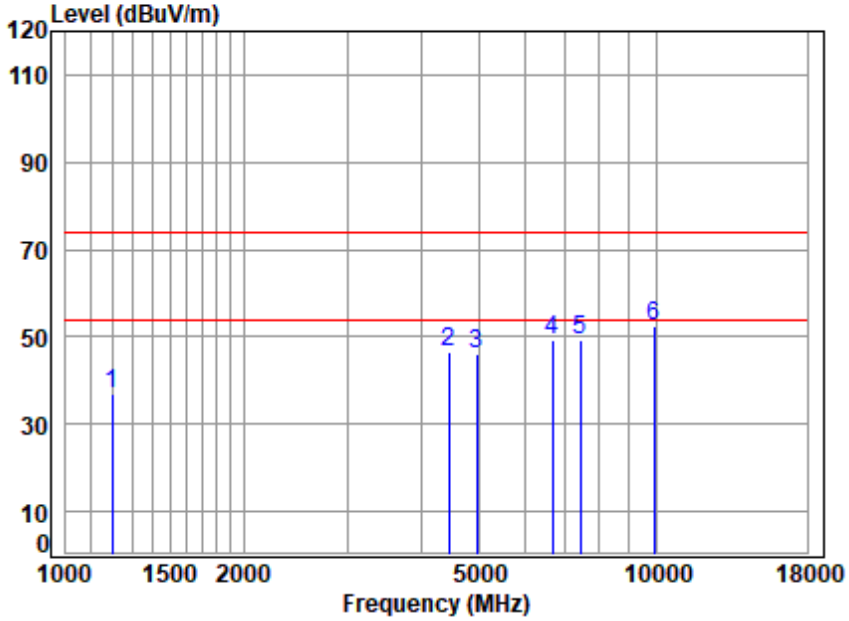
Mode:f; Polarization:Horizontal; Modulation:GFSK; Channel:High



Site : chamber
Condition: 3m HORIZONTAL
Job No : 00972CR\00973CR
Mode : 2480 TX SE
Note : BLE

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	1196.264	2.61	24.57	40.28	49.97	36.87	74.00	-37.13	peak
2	4456.315	6.51	33.53	42.52	48.81	46.33	74.00	-27.67	peak
3	4960.000	7.02	34.15	42.87	47.83	46.13	74.00	-27.87	peak
4	6659.763	8.21	35.70	41.86	47.36	49.41	74.00	-24.59	peak
5	7440.000	8.10	36.25	41.46	46.34	49.23	74.00	-24.77	peak
6	9920.000	8.96	37.85	38.12	43.91	52.60	74.00	-21.40	peak

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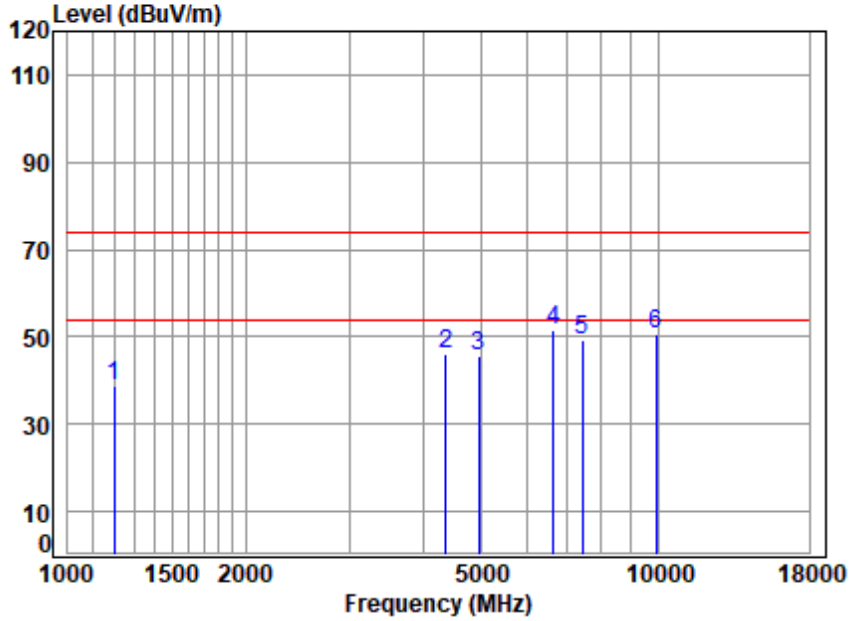
Mode:f; Polarization:Vertical; Modulation:GFSK; Channel:High



Site : chamber
Condition: 3m VERTICAL
Job No : 00972CR\00973CR
Mode : 2480 TX SE
Note : BLE

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	1196.264	2.61	24.57	40.28	51.82	38.72	74.00	-35.28	peak
2	4367.058	6.56	33.37	42.45	48.51	45.99	74.00	-28.01	peak
3	4960.000	7.02	34.15	42.87	47.37	45.67	74.00	-28.33	peak
4	6640.542	8.14	35.69	41.87	49.74	51.70	74.00	-22.30	peak
5	7440.000	8.10	36.25	41.46	46.25	49.14	74.00	-24.86	peak
6	9920.000	8.96	37.85	38.12	42.12	50.81	74.00	-23.19	peak

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8 Photographs

8.1 Test Setup

Please Refer to external and internal photos for details.

8.2 EUT Constructional Details (EUT Photos)

Please Refer to external and internal photos for details.

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9 Appendix

9.1 Appendix 15.247

1.6dB Bandwidth

Test Mode	Test Channel	Ant	EBW[MHz]	Limit[MHz]	Verdict
BLE	2402	Ant1	0.723	>=0.5	PASS
BLE	2440	Ant1	0.717	>=0.5	PASS
BLE	2480	Ant1	0.720	>=0.5	PASS

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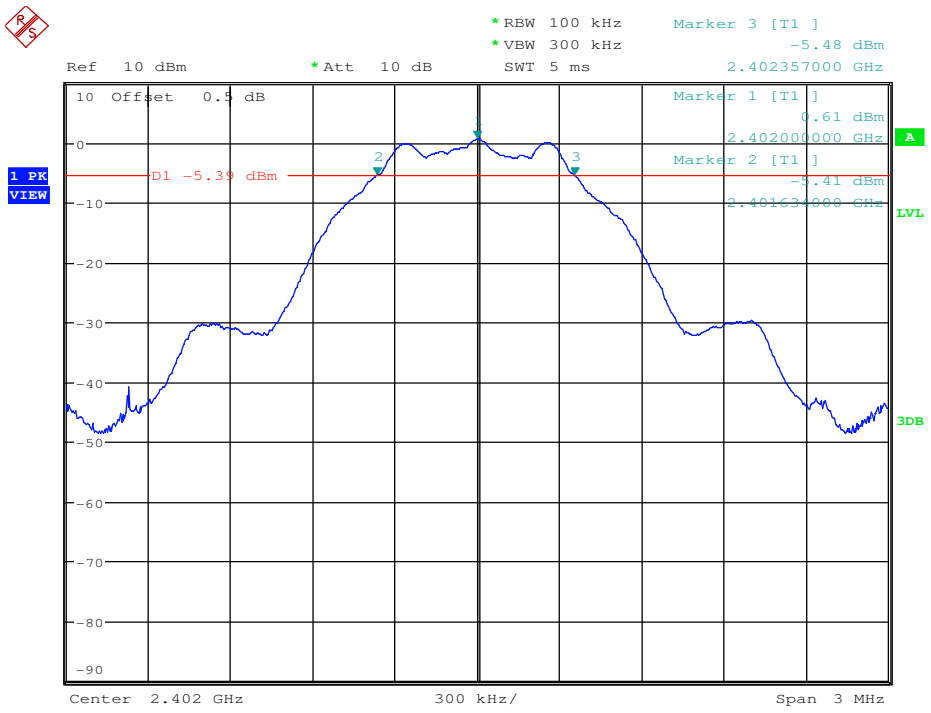
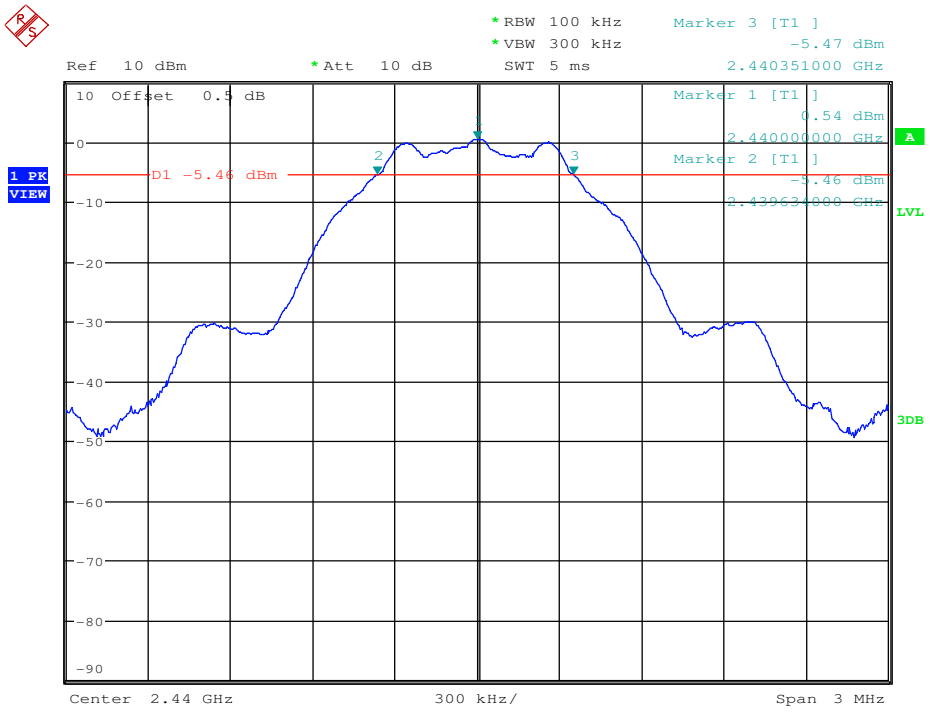
6dB Bandwidth_BLE_2402_Ant1



6dB Bandwidth_BLE_2440_Ant1



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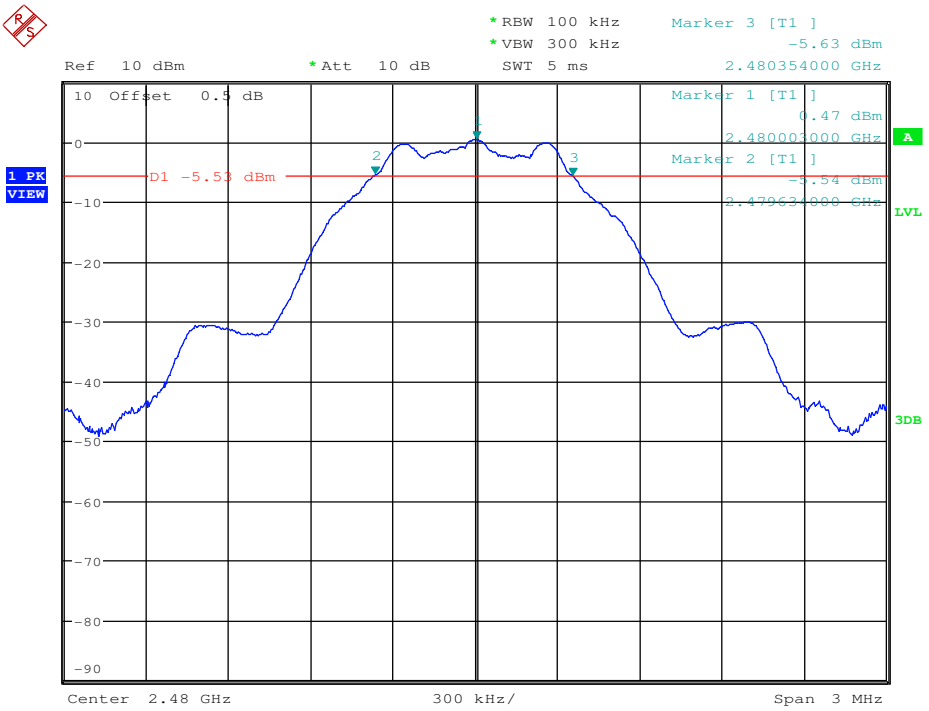
6dB Bandwidth_BLE_2480_Ant1



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2.Maximum peak conducted output power

Test Mode	Test Channel	Ant	Power[dBm]	Limit[dBm]	Verdict
BLE	2402	Ant1	1.25	<30	PASS
BLE	2440	Ant1	1.19	<30	PASS
BLE	2480	Ant1	1.1	<30	PASS

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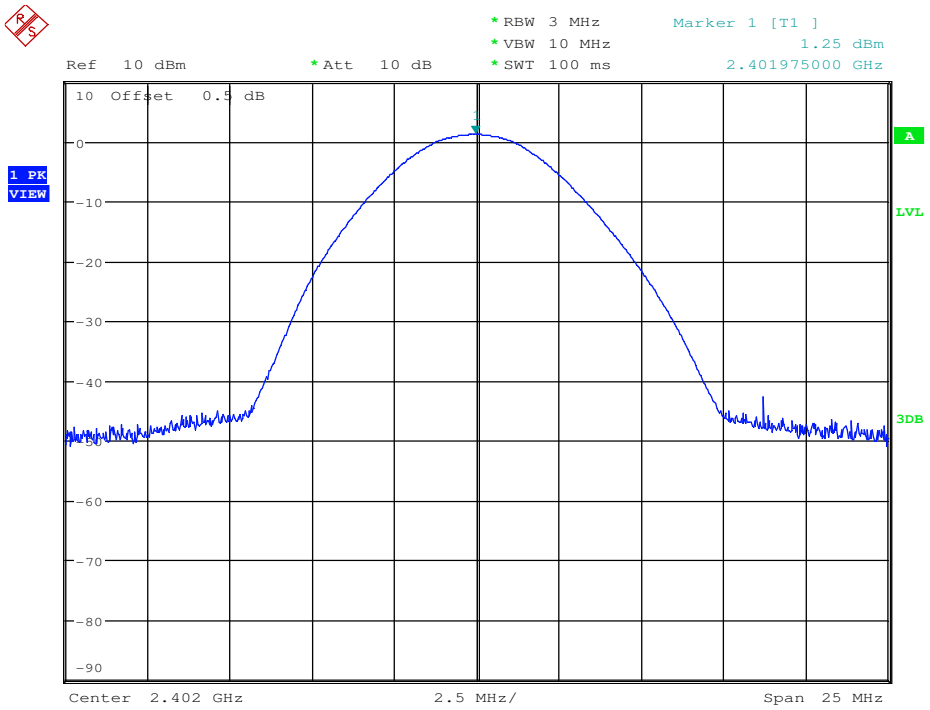
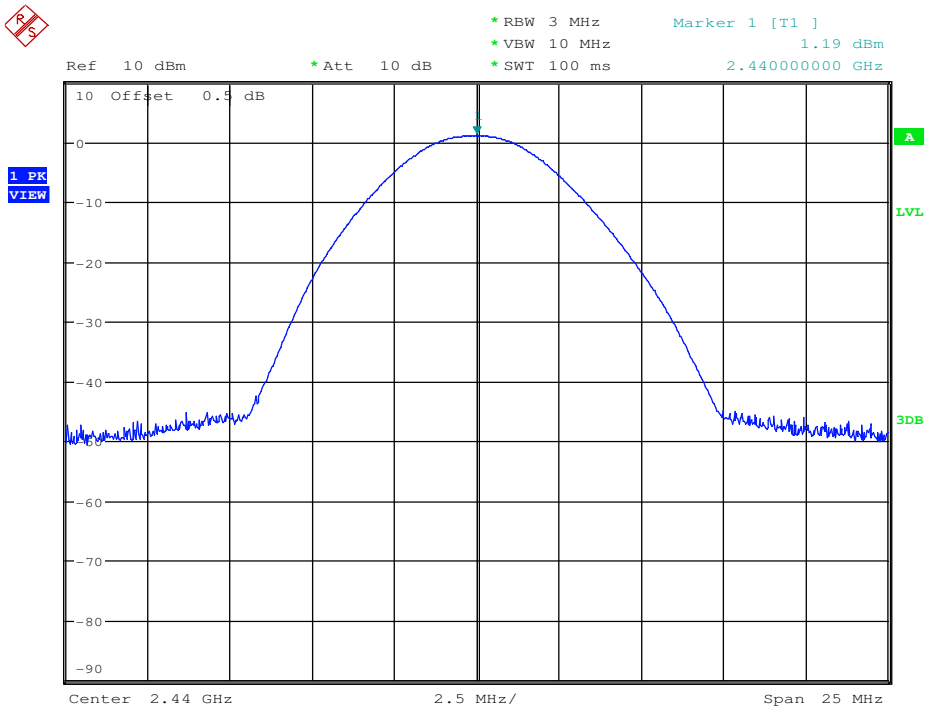
Maximum peak conducted output power_BLE_2402_Ant1



Maximum peak conducted output power_BLE_2440_Ant1



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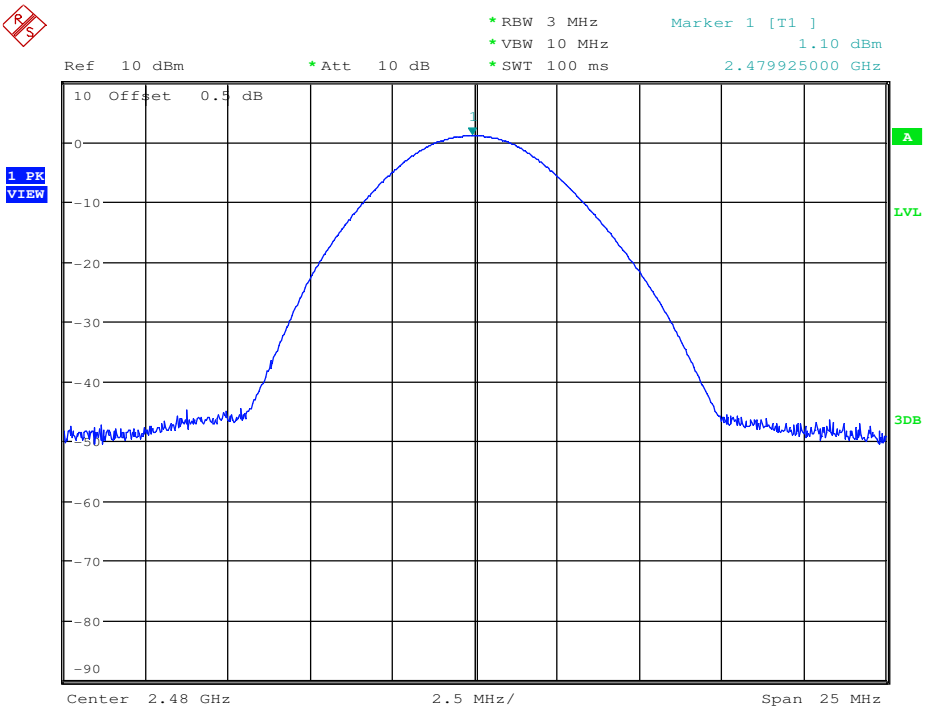
Maximum peak conducted output power_BLE_2480_Ant1



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3.Maximum Peak power spectral density

Test Mode	Test Channel	Ant	PSD[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
BLE	2402	Ant1	-14.55	<8.00	PASS
BLE	2440	Ant1	-14.57	<8.00	PASS
BLE	2480	Ant1	-14.62	<8.00	PASS

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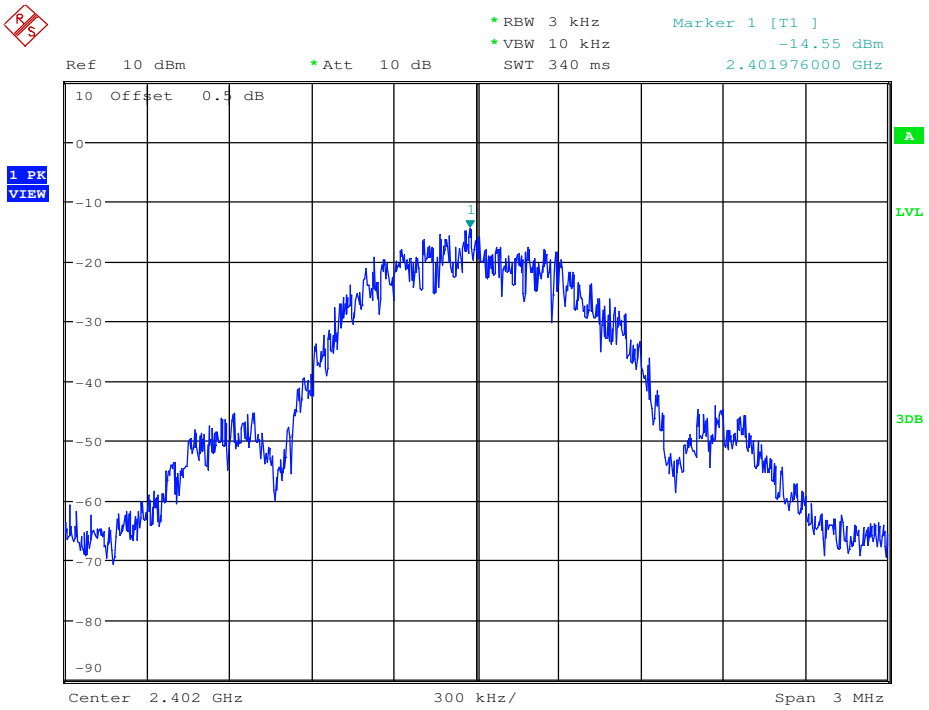
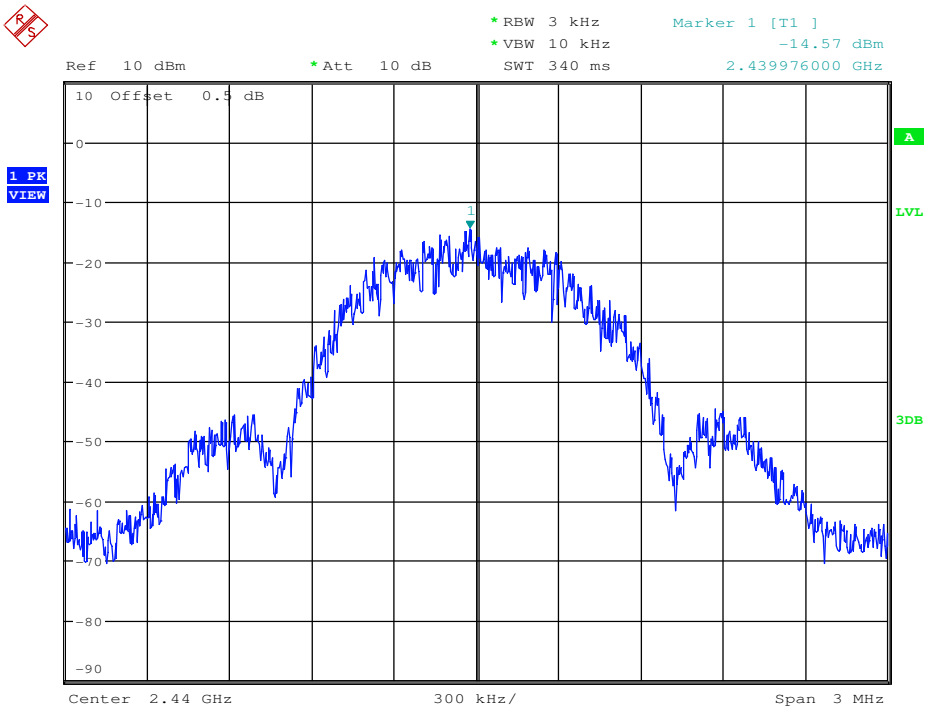
Maximum Peak power spectral density_BLE_2402_Ant1



Maximum Peak power spectral density_BLE_2440_Ant1



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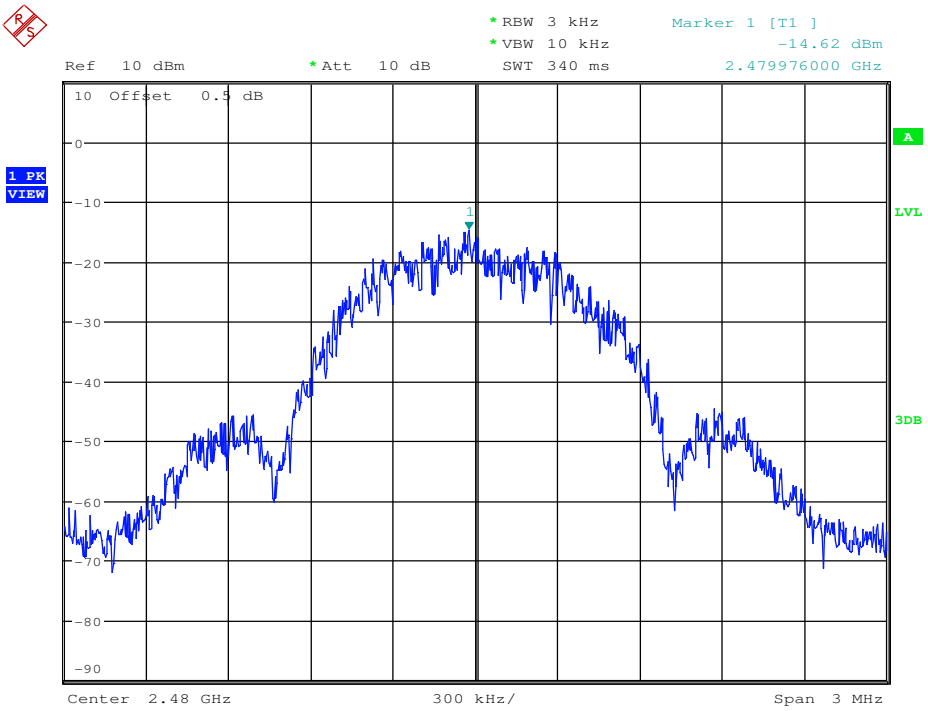
Maximum Peak power spectral density_BLE_2480_Ant1



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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	0.710	-64.669	<-19.29	PASS
BLE	2480	Ant1	0.480	-55.524	<-19.52	PASS

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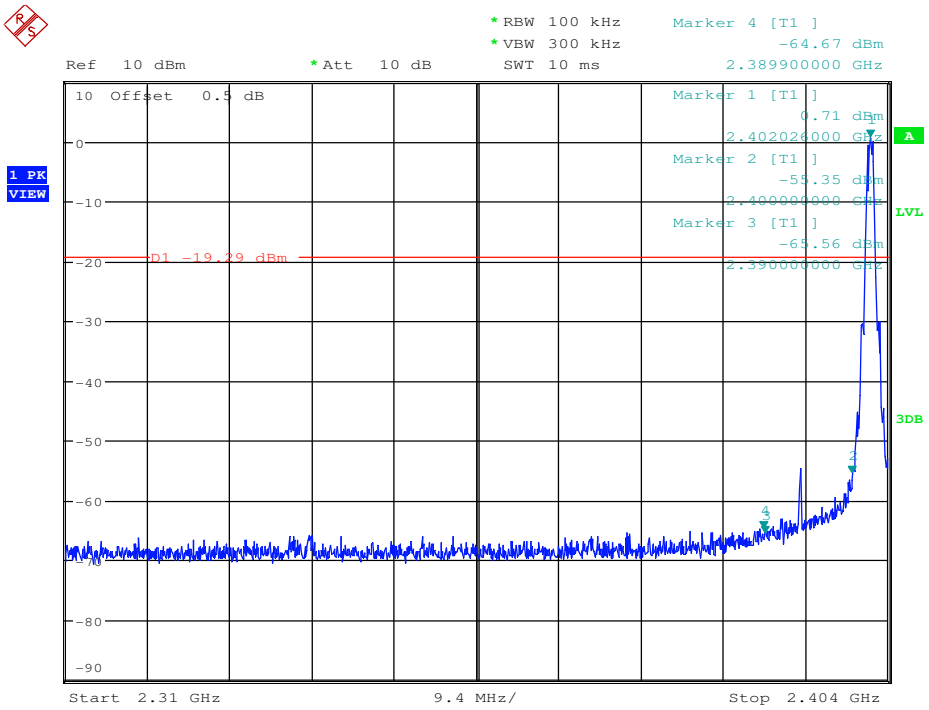
Band-edge for RF Conducted Emissions_BLE_2402_Ant1



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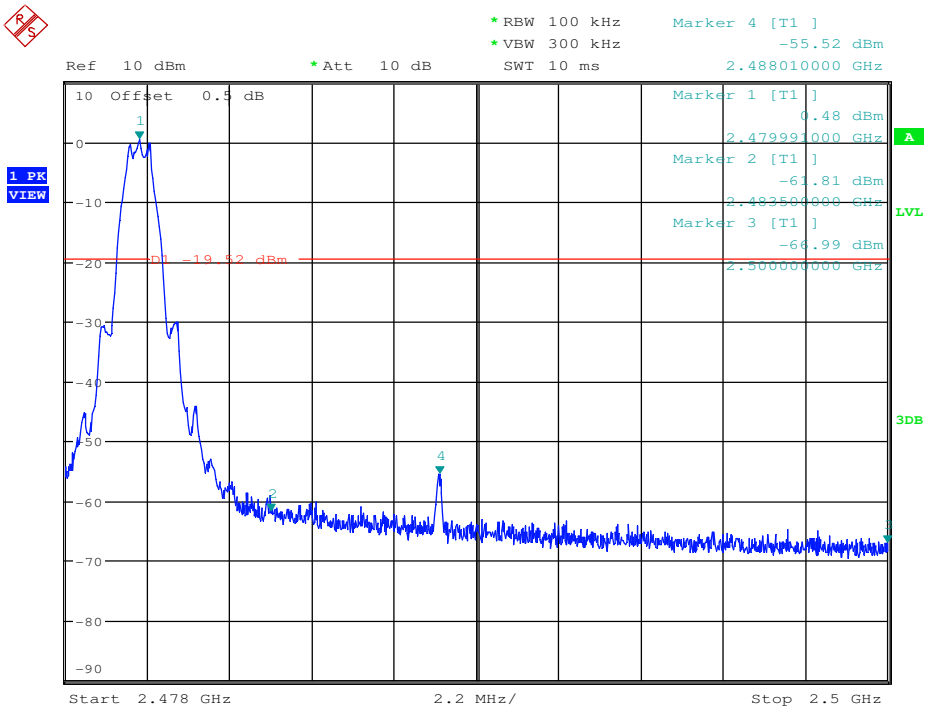

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5.RF Conducted Spurious Emissions

Test Mode	Test Channel	StartFre [MHz]	StopFre [MHz]	RBW [kHz]	VBW [kHz]	Pref[dBm]	Max. Level [dBm]	Limit [dBm]	Verdict
BLE	2402	30	10000	100	300	0.69	-56.060	<-19.31	PASS
BLE	2402	10000	25000	100	300	0.69	-55.770	<-19.31	PASS
BLE	2440	30	10000	100	300	0.79	-55.630	<-19.21	PASS
BLE	2440	10000	25000	100	300	0.79	-55.680	<-19.21	PASS
BLE	2480	30	10000	100	300	0.59	-55.290	<-19.41	PASS
BLE	2480	10000	25000	100	300	0.59	-55.690	<-19.41	PASS

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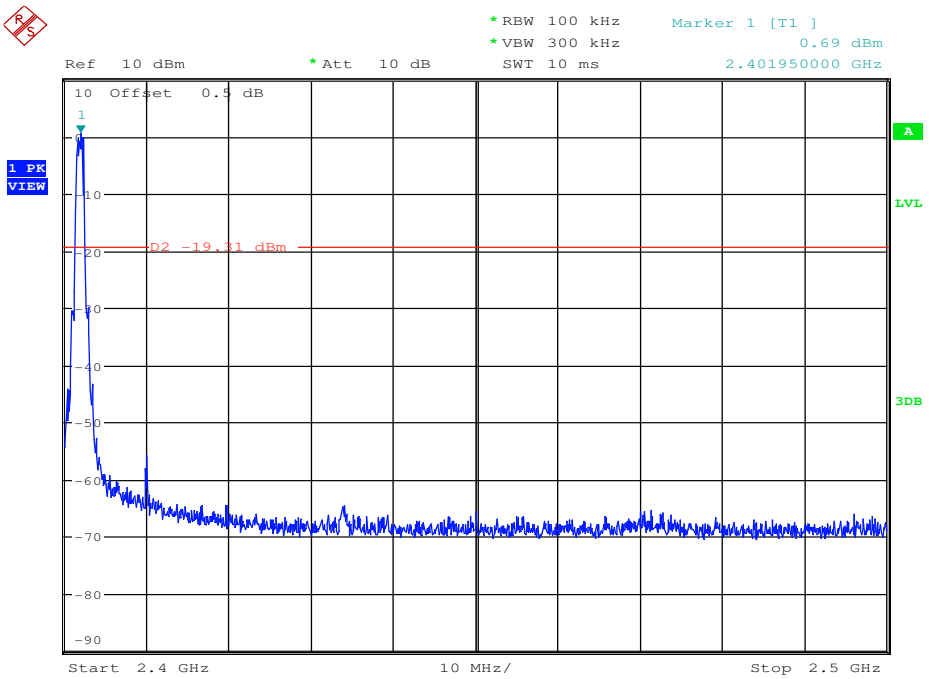
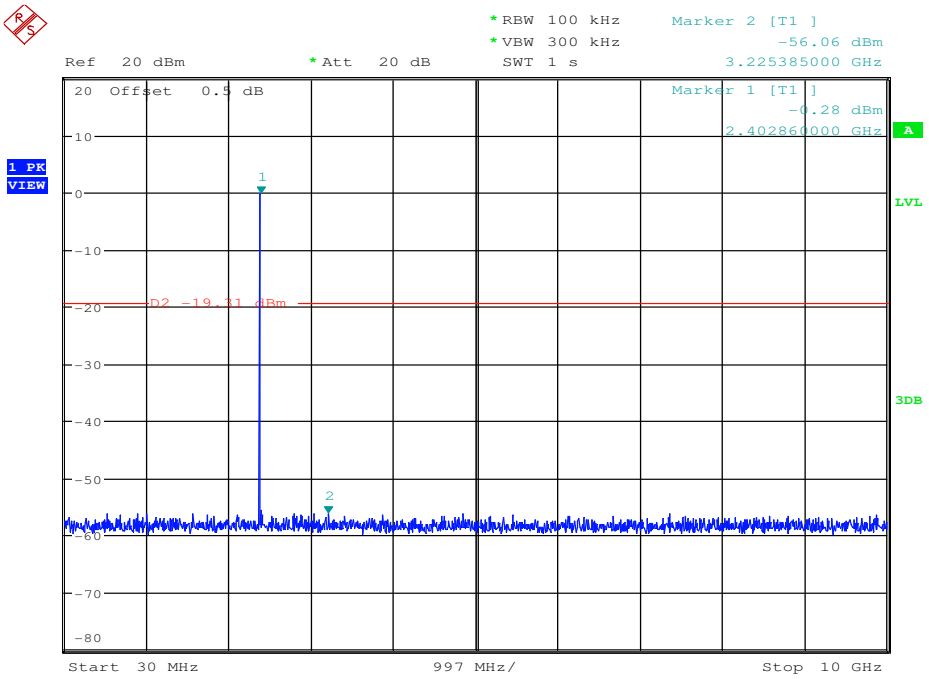
Pref	
CSE_1	

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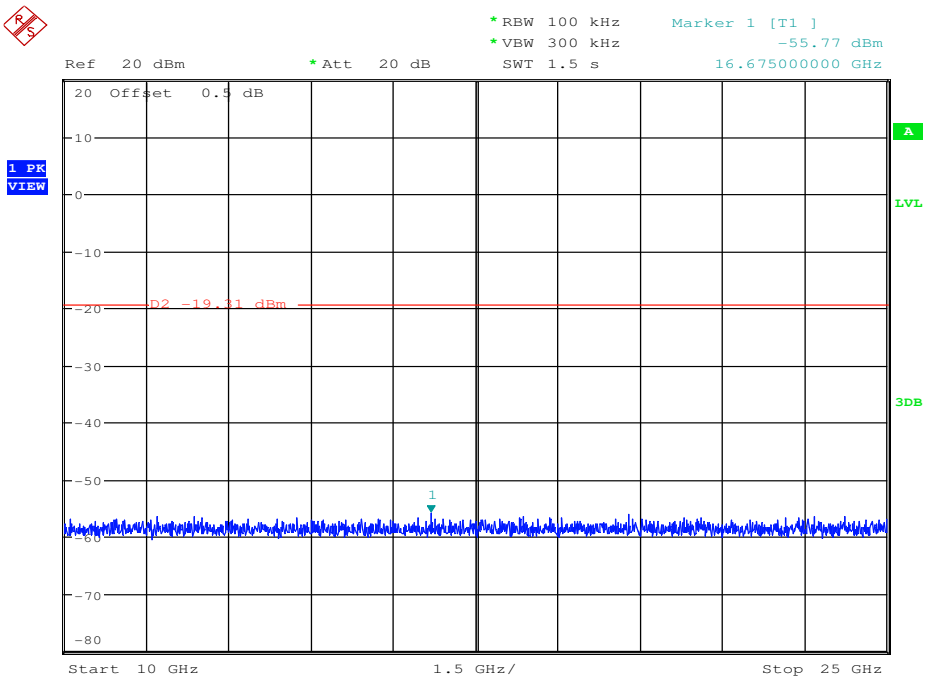
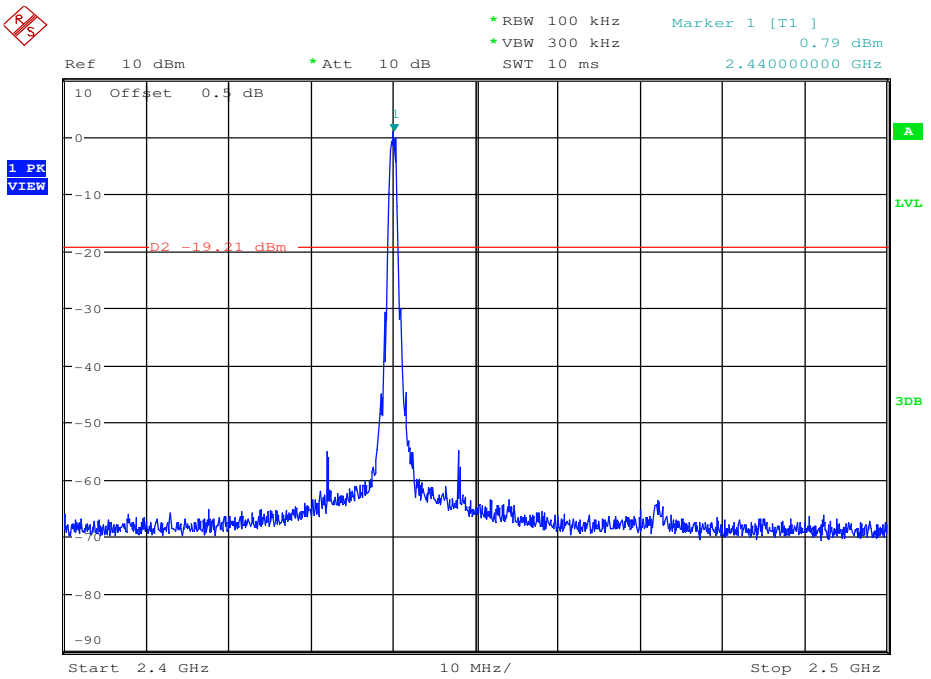
CSE_2



RF Conducted Spurious Emissions_BLE_2440_Ant1

Pref



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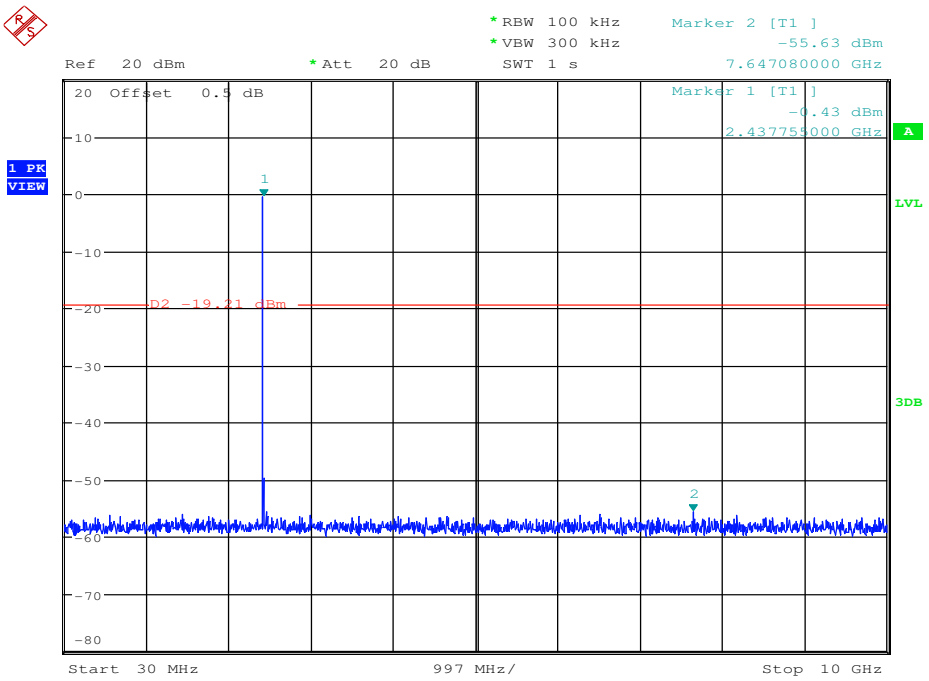
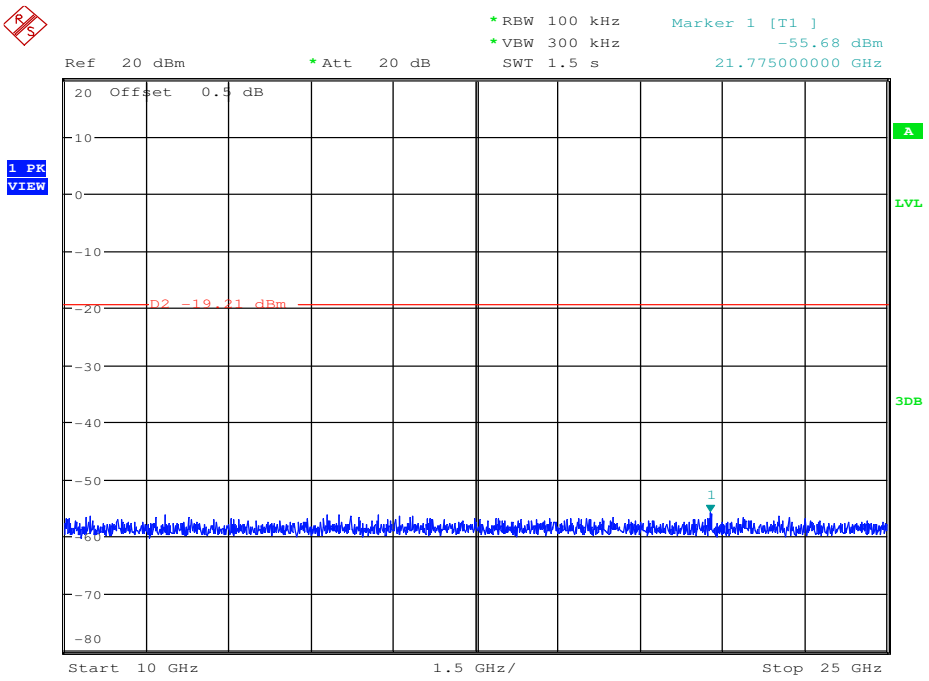
CSE_1	
CSE_2	

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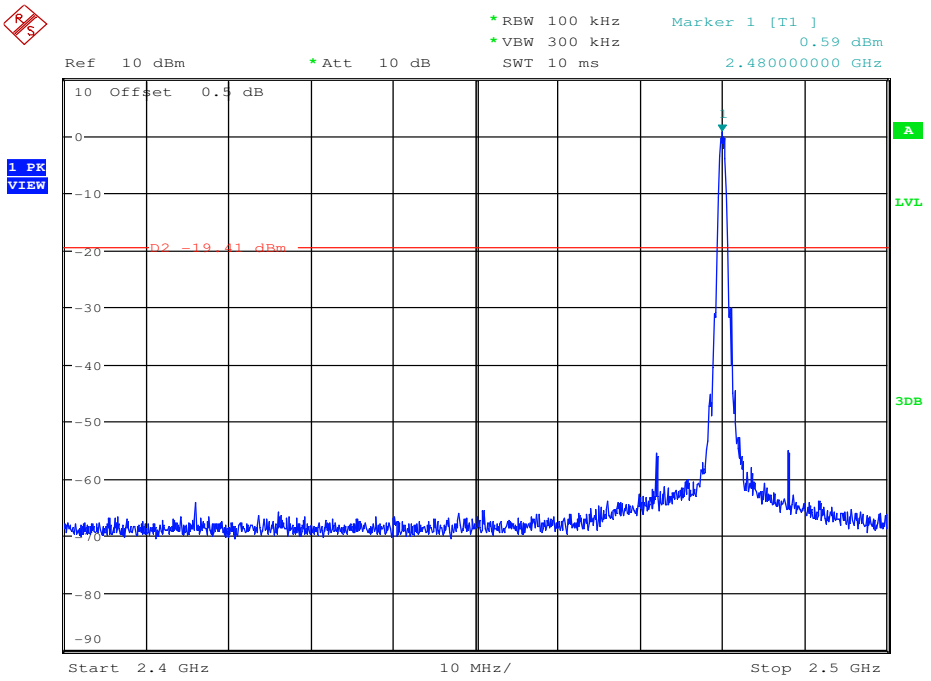
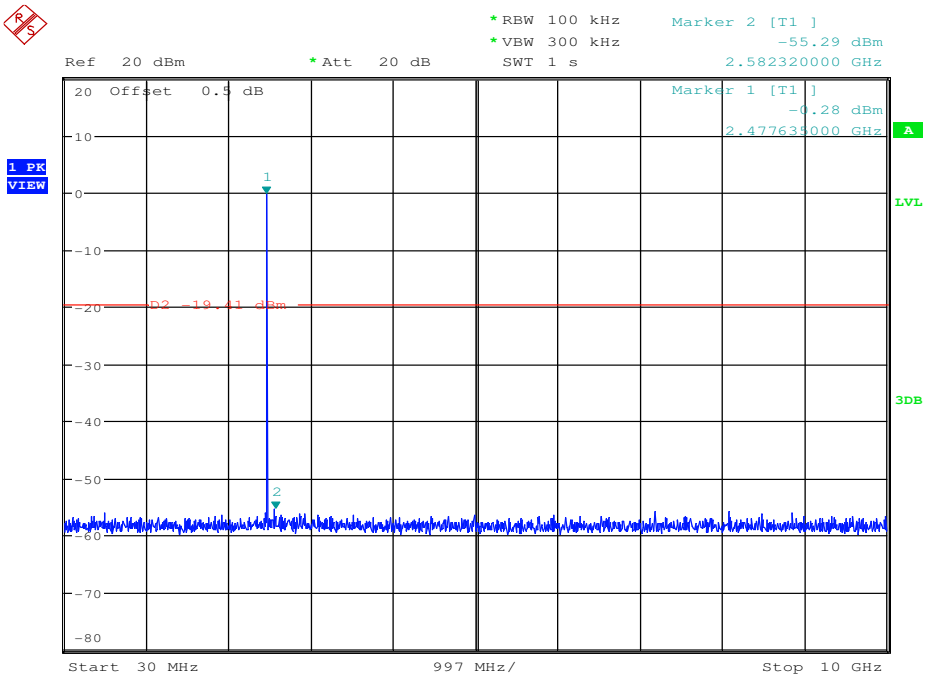
RF Conducted Spurious Emissions_BLE_2480_Ant1	
Pref	
CSE_1	

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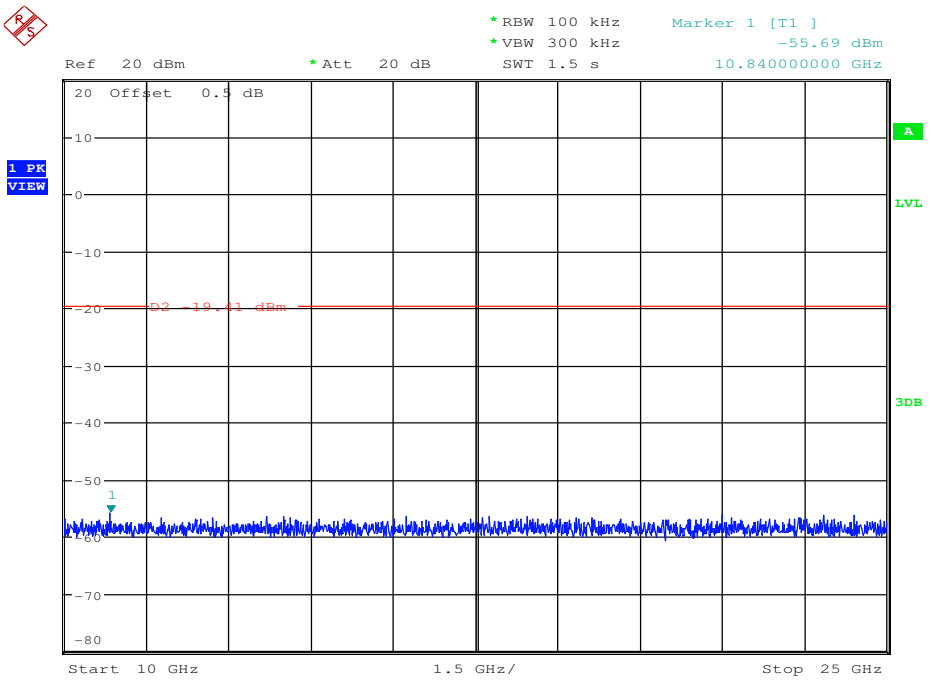
CSE_2	

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