



TEST REPORT

Application No.: SHEM1906014338CR
FCC ID: 2ARXS-ZAPC
Applicant: Hangzhou Zkong Networks Co., Ltd.
Address of Applicant: Room 1208-1210, 17 Block 57, Baiyang Street Science Park Road,
Hangzhou Economic and Technological Development Zone, Zhejiang
Province
Manufacturer: Hangzhou Zkong Networks Co., Ltd.
Address of Manufacturer: Room 1208-1210, 17 Block 57, Baiyang Street Science Park Road,
Hangzhou Economic and Technological Development Zone, Zhejiang
Province
Factory: Zhejiang Sunparl Information Technology Co., Ltd.
Address of Factory: No. 19, Xinxing Road, Haining Lianhang Economic Zone, Zhejiang, China
Equipment Under Test (EUT):
EUT Name: Bluetooth Wireless Base Station
Model No.: ZAP-C
Trade mark: Zkong
Standard(s) : 47 CFR Part 15, Subpart C 15.247
Date of Receipt: 2019-06-20
Date of Test: 2019-06-27 to 2019-08-15
Date of Issue: 2019-08-19

Test Result:	Pass*
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* In the configuration tested, the EUT complied with the standards specified above.

Parlam Zhan

Parlam Zhan
E&E Section 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	Description	Date	Remark
00	Original	2019-08-19	/

Authorized for issue by:				
				
		<hr/>		
		Vincent Zhu / Project Engineer		
				
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		Parlam Zhan / Reviewer		



2 Test Summary

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

N/A: Not applicable

Radio Spectrum Matter Part			
Item	FCC Requirement	Method	Result
Conducted Emissions at AC Power Line (150kHz-30MHz)	47 CFR Part 15, Subpart C 15.207	ANSI C63.10 (2013) Section 6.2	Pass
Minimum 6dB Bandwidth	47 CFR Part 15, Subpart C 15.247a(2)	ANSI C63.10 (2013) Section 11.8.1	Pass
Conducted Peak Output Power	47 CFR Part 15, Subpart C 15.247(b)(3)	ANSI C63.10 (2013) Section 11.9.1	Pass
Power Spectrum Density	47 CFR Part 15, Subpart C 15.247(e)	ANSI C63.10 (2013) Section 11.10.2	Pass
Conducted Band Edges Measurement	47 CFR Part 15, Subpart C 15.247(d)	ANSI C63.10 (2013) Section 11.13.3.2	Pass
Conducted Spurious Emissions	47 CFR Part 15, Subpart C 15.247(d)	ANSI C63.10 (2013) Section 11.11	Pass
Radiated Emissions which fall in the restricted bands	47 CFR Part 15, Subpart C 15.209 & 15.247(d)	ANSI C63.10 (2013) Section 6.10.5	Pass
Radiated Spurious Emissions	47 CFR Part 15, Subpart C 15.209 & 15.247(d)	ANSI C63.10 (2013) Section 6.4,6.5,6.6	Pass



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4 General Information

4.1 Details of E.U.T.

Power supply: DC 48V by POE
POE:
Model.:G1081-480-032
Input:100-240V~50/60Hz 0.5A MAX
Output:48V 0.32A
Test voltage: AC 120V 60Hz
Cable: AC Cable 0.5m for POE
Antenna Gain 5 dBi
Antenna Type Integral Antenna
Channel Spacing 2MHz
Modulation Type GFSK
Number of Channels 40
Operation Frequency 2402MHz to 2480MHz

4.2 Description of Support Units

Description	Manufacturer	Model No.	Serial No.
Laptop	Lenovo	ThinkPad X100e	/
SecureCRT	VanDyke	V 6.2.0	/
Serial port adapter plate	/	Test Plate 3	/



4.3 Measurement Uncertainty

No.	Item	Measurement Uncertainty
1	Radio Frequency	$\pm 8.4 \times 10^{-8}$
2	Timeout	$\pm 2s$
3	Duty cycle	$\pm 0.37\%$
4	Occupied Bandwidth	$\pm 3\%$
5	RF conducted power	$\pm 0.6dB$
6	RF power density	$\pm 2.84dB$
7	Conducted Spurious emissions	$\pm 0.75dB$
8	RF Radiated power	$\pm 4.6dB$ (Below 1GHz)
		$\pm 4.1dB$ (Above 1GHz)
9	Radiated Spurious emission test	$\pm 4.2dB$ (Below 30MHz)
		$\pm 4.4dB$ (30MHz-1GHz)
		$\pm 4.8dB$ (1GHz-18GHz)
		$\pm 5.2dB$ (Above 18GHz)
10	Temperature test	$\pm 1^{\circ}C$
11	Humidity test	$\pm 3\%$
12	Supply voltages	$\pm 1.5\%$
13	Time	$\pm 3\%$

Note: The measurement uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=2$.



4.4 Test Location

All tests were performed at:

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

588 West Jindu Road, Xinqiao, Songjiang, 201612 Shanghai, China

Tel: +86 21 6191 5666 Fax: +86 21 6191 5678

No tests were sub-contracted.

4.5 Test Facility

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

- **CNAS (No. CNAS L0599)**

CNAS has accredited SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd. 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.

- **NVLAP (Certificate No. 201034-0)**

SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd. is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP). Certificate No. 201034-0.

- **FCC –Designation Number: CN5033**

SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd. has been recognized as an accredited testing laboratory.

Designation Number: CN5033. Test Firm Registration Number: 479755.

- **Innovation, Science and Economic Development Canada**

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

IC Registration No.: 8617A-1. CAB identifier: CN0020.

- **VCCI (Member No.: 3061)**

The 3m Semi-anechoic chamber and Shielded Room of SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd. has been registered in accordance with the Regulations for Voluntary Control Measures with Registration No.: R-13868, C-14336, T-12221, G-10830 respectively.

4.6 Deviation from Standards

None

4.7 Abnormalities from Standard Conditions

None



5 Equipment List

Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
Conducted Emission at AC Power Line					
EMI test receiver	R&S	ESR7	SHEM162-1	2018-12-20	2019-12-19
LISN	Schwarzbeck	NSLK8127	SHEM061-1	2018-12-20	2019-12-19
LISN	EMCO	3816/2	SHEM019-1	2018-12-20	2019-12-19
Pulse limiter	R&S	ESH3-Z2	SHEM029-1	2018-12-20	2019-12-19
CE test Cable	/	CE01	/	2018-12-26	2019-12-25
Conducted Test					
Spectrum Analyzer	R&S	FSP-30	SHEM002-1	2018-12-20	2019-12-19
Spectrum Analyzer	Agilent	N9020A	SHEM181-1	2019-08-12	2020-08-11
Signal Generator	R&S	SMR20	SHEM006-1	2019-08-12	2020-08-11
Signal Generator	Agilent	N5182A	SHEM182-1	2019-08-12	2020-08-11
Communication Tester	R&S	CMW270	SHEM183-1	2019-08-12	2020-08-11
Switcher	Tonscend	JS0806	SHEM184-1	2019-08-12	2020-08-11
Power Sensor	Keysight	U2021XA * 4	SHEM184-1	2019-08-12	2020-08-11
Splitter	Anritsu	MA1612A	SHEM185-1	/	/
Coupler	e-meca	803-S-1	SHEM186-1	/	/
High-low Temp Cabinet	Suzhou Zhihe	TL-40	SHEM087-1	2017-09-25	2020-09-24
AC Power Stabilizer	WOCEN	6100	SHEM045-1	2018-12-26	2019-12-25
DC Power Supply	MCN	MCH-303A	SHEM210-1	2018-12-26	2019-12-25
Conducted test Cable	/	RF01~RF04	/	2018-12-26	2019-12-25
Radiated Test					
EMI test Receiver	R&S	ESU40	SHEM051-1	2018-12-20	2019-12-19
Spectrum Analyzer	R&S	FSP-30	SHEM002-1	2018-12-20	2019-12-19
Loop Antenna (9kHz-30MHz)	Schwarzbeck	FMZB1519	SHEM135-1	2017-04-10	2020-04-09
Antenna (25MHz-2GHz)	Schwarzbeck	VULB9168	SHEM048-1	2017-02-28	2020-02-27
Antenna (25MHz-3GHz)	Schwarzbeck	HL562	SHEM010-1	2017-02-28	2020-02-27
Horn Antenna (1-8GHz)	Schwarzbeck	HF906	SHEM009-1	2017-10-24	2020-10-23
Horn Antenna (1-18GHz)	Schwarzbeck	BBHA9120D	SHEM050-1	2017-01-14	2020-01-13
Horn Antenna (14-40GHz)	Schwarzbeck	BBHA 9170	SHEM049-1	2017-12-03	2020-12-02
Pre-amplifier (9kHz-2GHz)	CLAVIO	BDLNA-0001	SHEM164-1	2019-08-12	2020-08-11
Pre-amplifier (1-18GHz)	CLAVIO	BDLNA-0118	SHEM050-2	2019-08-12	2020-08-11
High-amplifier (14-40GHz)	Schwarzbeck	10001	SHEM049-2	2018-12-20	2019-12-19
Signal Generator	R&S	SMR40	SHEM058-1	2019-08-12	2020-08-11
Band Filter	LORCH	9BRX-875/X150	SHEM156-1	/	/
Band Filter	LORCH	13BRX-1950/X500	SHEM083-2	/	/
Band Filter	LORCH	5BRX-2400/X200	SHEM155-1	/	/
Band Filter	LORCH	5BRX-5500/X1000	SHEM157-2	/	/
High pass Filter	Wainwright	WHK3.0/18G	SHEM157-1	/	/
High pass Filter	Wainwright	WHKS1700	SHEM157-3	/	/
Semi/Fully Anechoic	ST	11*6*6M	SHEM078-2	2017-07-22	2020-07-21
RE test Cable	/	RE01, RE02, RE06	/	2018-12-26	2019-12-25

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:

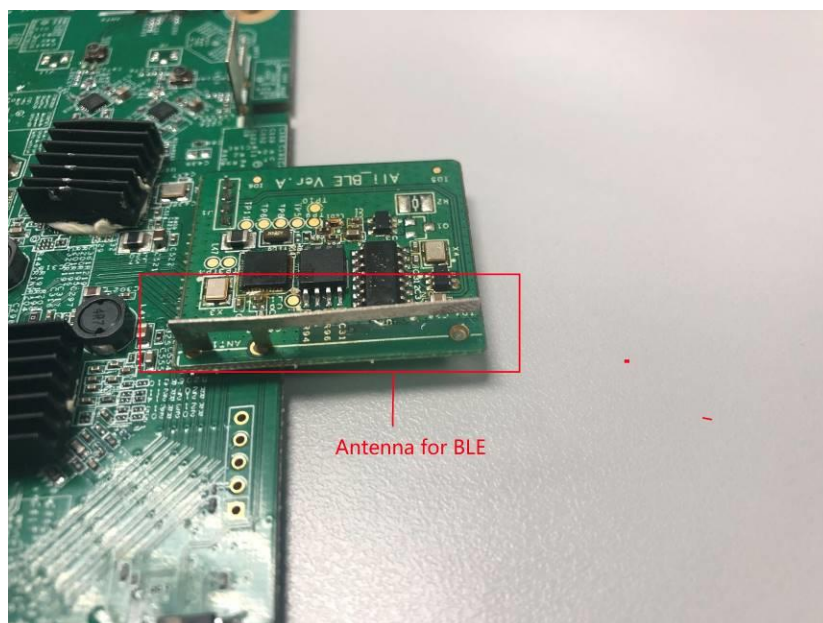
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit 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 integral antenna and no consideration of replacement. The best case gain of the antenna is 5dBi.



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.

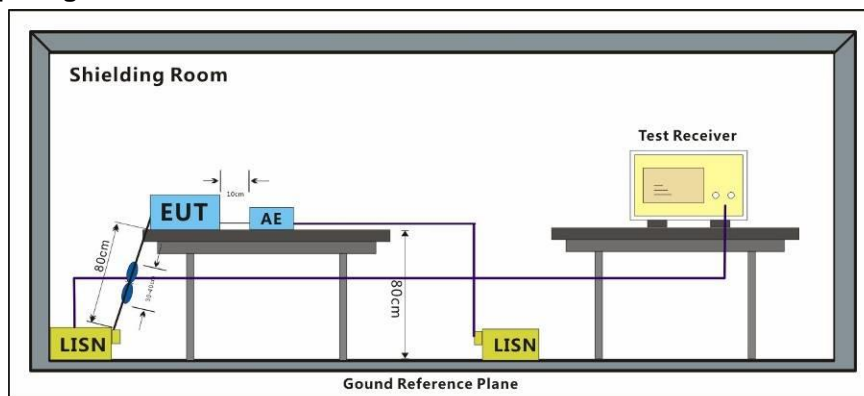
7.1.1 E.U.T. Operation

Operating Environment:

Temperature: 22 °C Humidity: 50 % RH Atmospheric Pressure: 1020 mbar

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

7.1.2 Test Setup Diagram





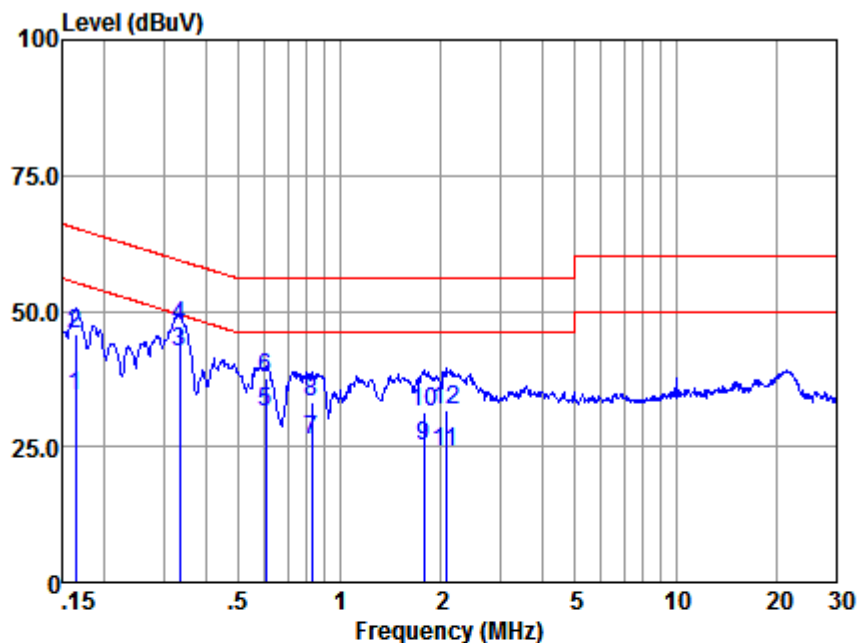
7.1.3 Measurement Procedure and Data

- 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/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



Mode:a; Line:Live Line



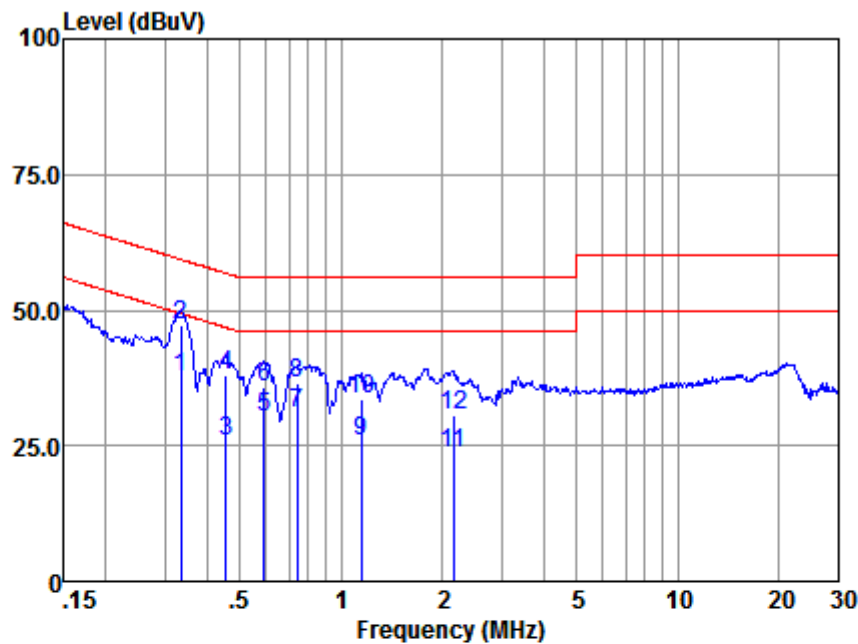
ISN : CAT5-2019
Test Mode : a

	Freq (MHz)	Read level (dBuV)	ISN Factor (dB)	Cable Loss (dB)	Emission Level (dBuV)	Limit (dBuV)	Over Limit (dB)	Remark
1	0.16	24.16	0.08	10.00	34.24	55.30	-21.06	Average
2	0.16	35.75	0.08	10.00	45.83	65.30	-19.47	QP
3	0.33	32.21	0.08	10.00	42.29	49.35	-7.06	Average
4	0.33	37.16	0.08	10.00	47.24	59.35	-12.11	QP
5	0.60	21.26	0.08	10.00	31.34	46.00	-14.66	Average
6	0.60	27.41	0.08	10.00	37.49	56.00	-18.51	QP
7	0.83	16.15	0.09	10.00	26.24	46.00	-19.76	Average
8	0.83	23.30	0.09	10.00	33.39	56.00	-22.61	QP
9	1.78	14.80	0.13	10.10	25.03	46.00	-20.97	Average
10	1.78	20.98	0.13	10.10	31.21	56.00	-24.79	QP
11	2.07	13.88	0.14	10.10	24.12	46.00	-21.88	Average
12	2.07	21.56	0.14	10.10	31.80	56.00	-24.20	QP

Notes: Emission Level = Read Level +ISN Factor + Cable loss



Mode:a; Line:Neutral Line



ISN : CAT5-2019
Test Mode : a

	Freq (MHz)	Read level (dBuV)	ISN Factor (dB)	Cable Loss (dB)	Emission Level (dBuV)	Limit (dBuV)	Over Limit (dB)	Remark
1	0.33	27.41	0.06	10.00	37.47	49.35	-11.88	Average
2	0.33	37.31	0.06	10.00	47.37	59.35	-11.98	QP
3	0.46	15.76	0.06	10.00	25.82	46.76	-20.94	Average
4	0.46	27.82	0.06	10.00	37.88	56.76	-18.88	QP
5	0.59	20.29	0.06	10.00	30.35	46.00	-15.65	Average
6	0.59	25.58	0.06	10.00	35.64	56.00	-20.36	QP
7	0.74	20.91	0.07	10.00	30.98	46.00	-15.02	Average
8	0.74	26.46	0.07	10.00	36.53	56.00	-19.47	QP
9	1.15	15.74	0.08	10.10	25.92	46.00	-20.08	Average
10	1.15	23.55	0.08	10.10	33.73	56.00	-22.27	QP
11	2.16	13.36	0.10	10.10	23.56	46.00	-22.44	Average
12	2.16	20.28	0.10	10.10	30.48	56.00	-25.52	QP

Notes: Emission Level = Read Level +ISN Factor + Cable loss

7.2 Minimum 6dB Bandwidth

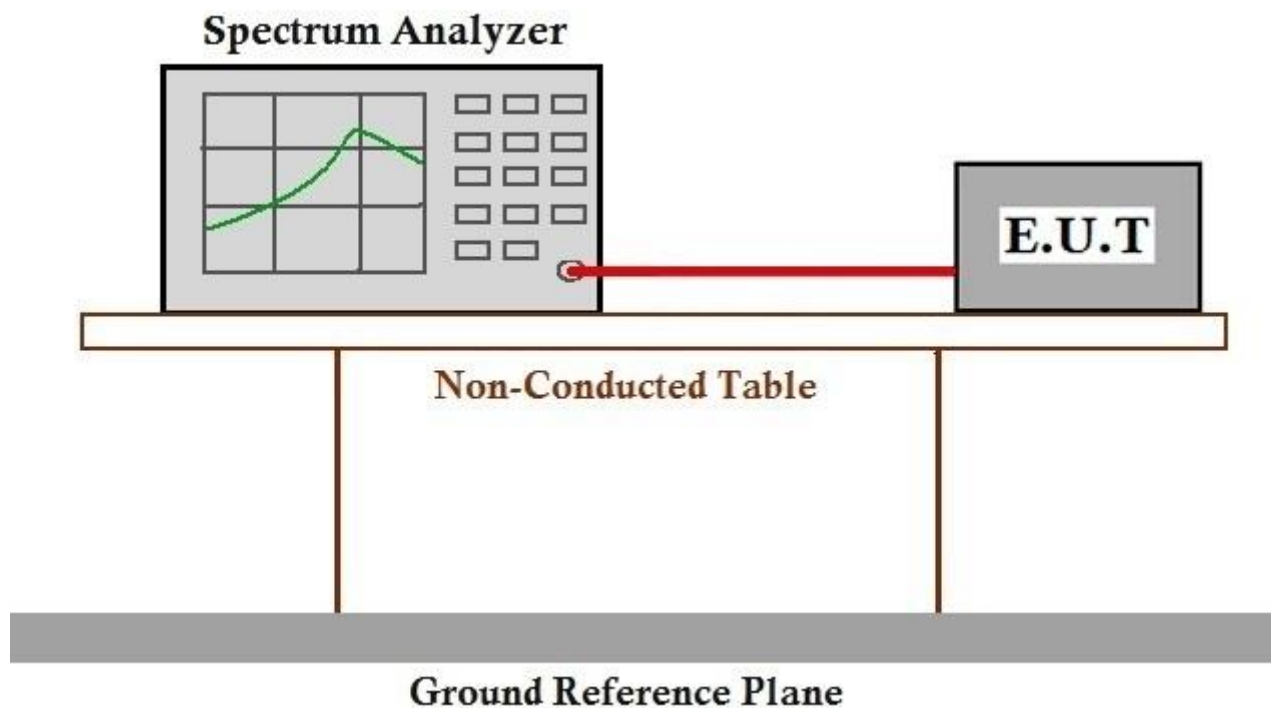
Test Requirement 47 CFR Part 15, Subpart C 15.247a(2)
Test Method: ANSI C63.10 (2013) Section 11.8.1
Limit: ≥ 500 kHz

7.2.1 E.U.T. Operation

Operating Environment:

Temperature: 20 °C Humidity: 50 % RH Atmospheric Pressure: 1010 mbar
Test mode a: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 A for SHEM190601433801

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 $25 \leq$ 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

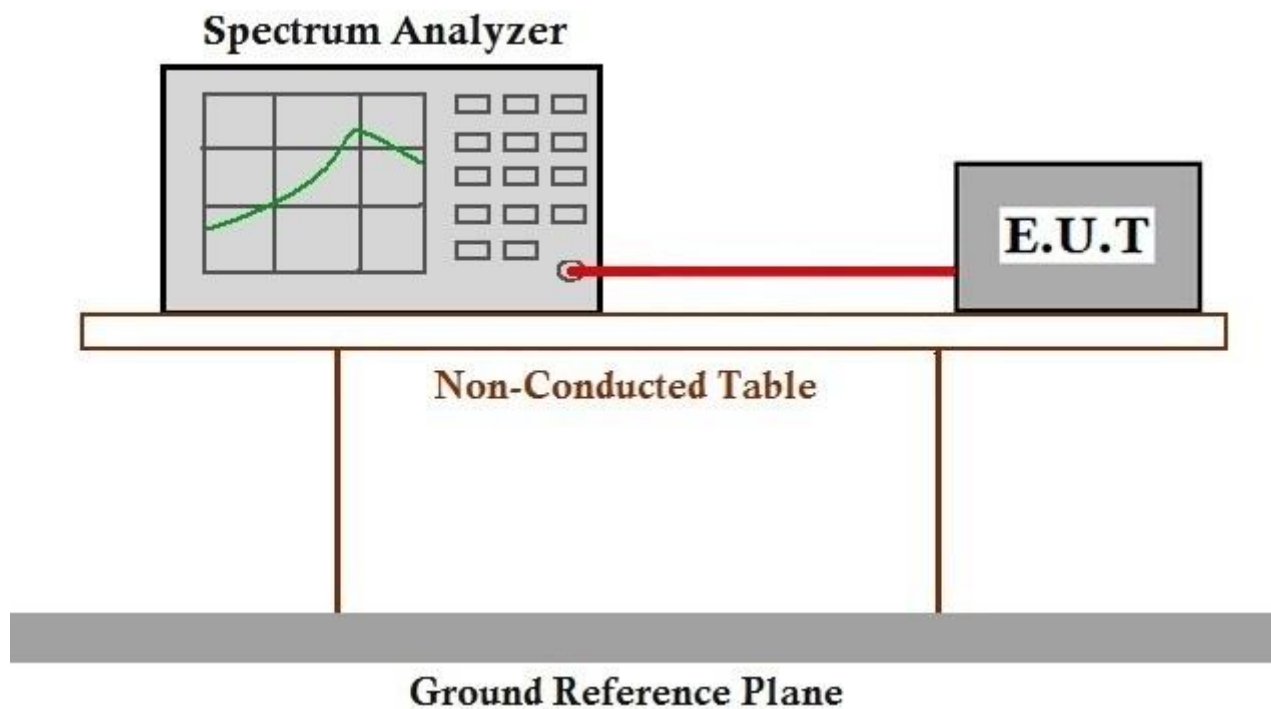
7.3.1 E.U.T. Operation

Operating Environment:

Temperature: 20 °C Humidity: 50 % RH Atmospheric Pressure: 1010 mbar

Test mode a: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 A for SHEM190601433801

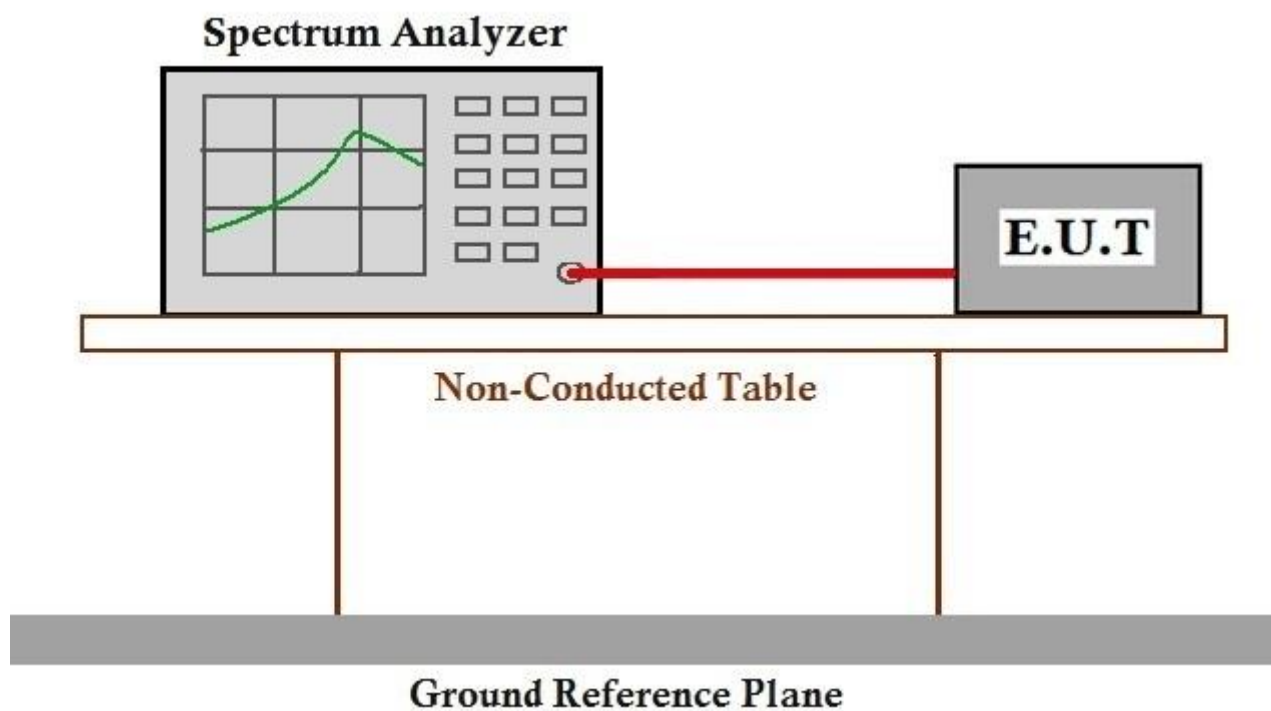
7.4 Power Spectrum Density

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: 20 °C Humidity: 50 % RH Atmospheric Pressure: 1010 mbar
Test mode a: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 A for SHEM190601433801

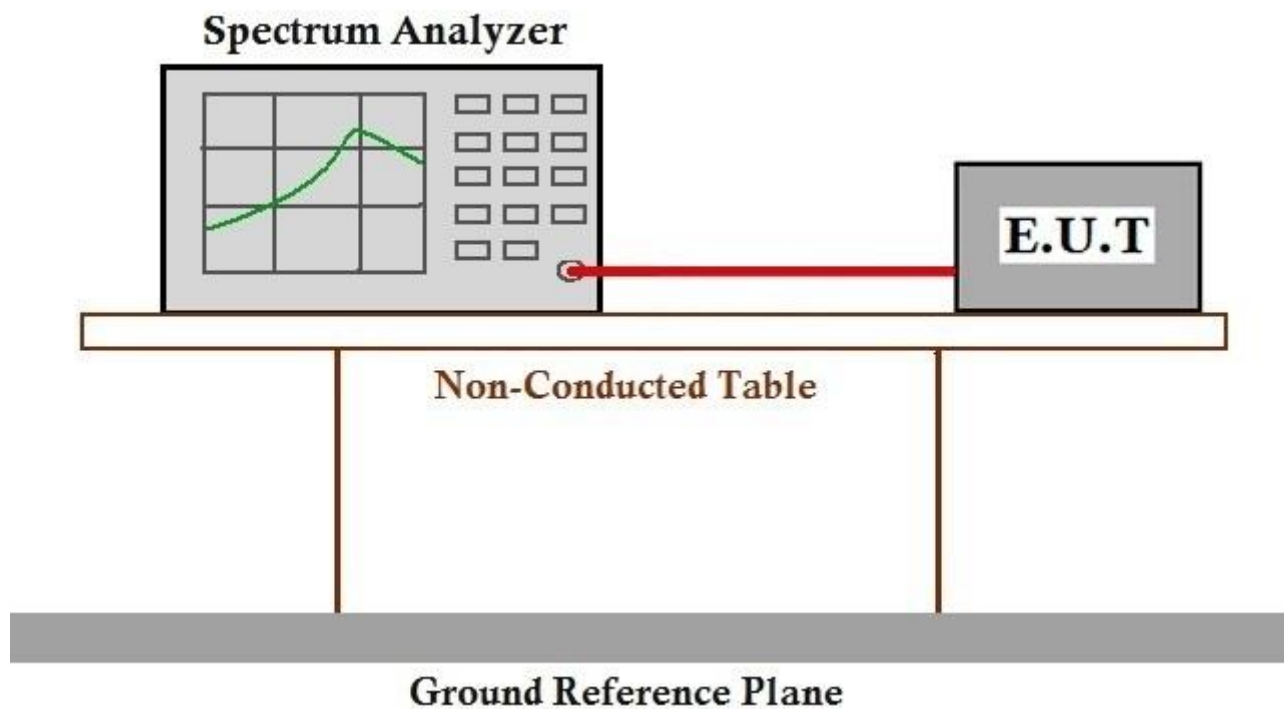
7.5 Conducted Band Edges Measurement

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))

7.5.1 E.U.T. Operation

Operating Environment:					
Temperature:	20 °C	Humidity:	50 % RH	Atmospheric Pressure:	1010 mbar
Test mode	a: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 A for SHEM190601433801

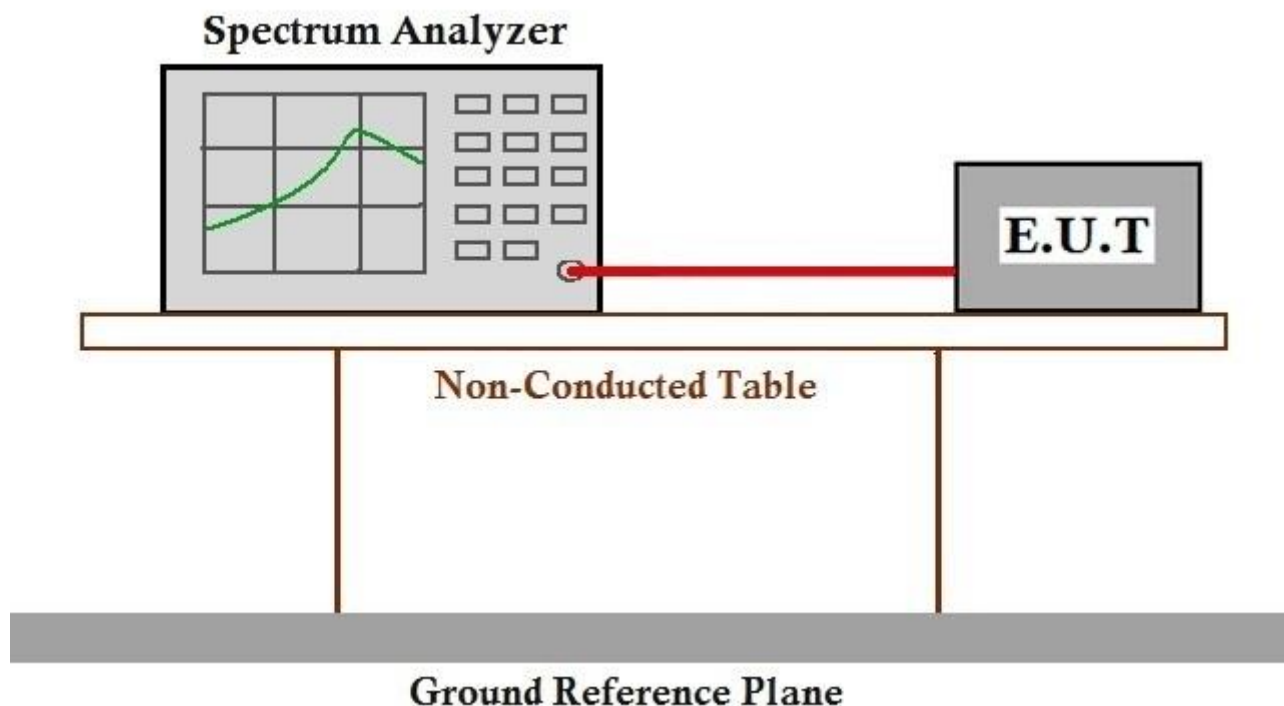
7.6 Conducted Spurious Emissions

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))

7.6.1 E.U.T. Operation

Operating Environment:					
Temperature:	20 °C	Humidity:	50 % RH	Atmospheric Pressure:	1010 mbar
Test mode	a: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 A for SHEM190601433801



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

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.

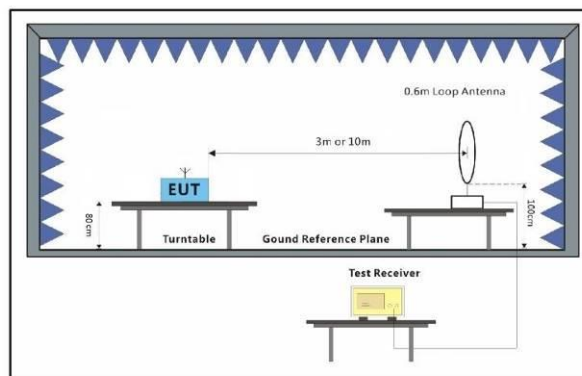
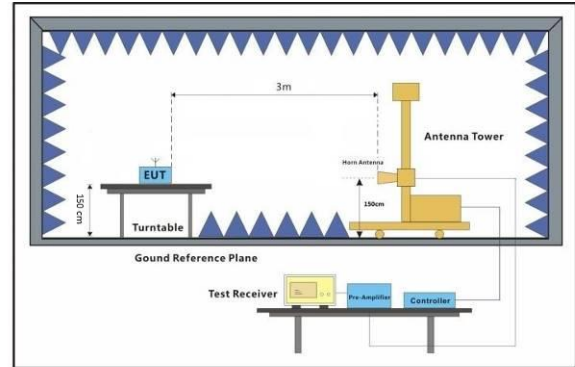
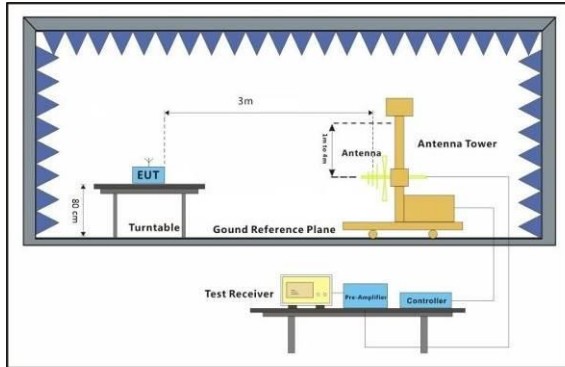
7.7.1 E.U.T. Operation

Operating Environment:

Temperature: 20 °C Humidity: 50 % RH Atmospheric Pressure: 1010 mbar

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

7.7.2 Test Setup Diagram





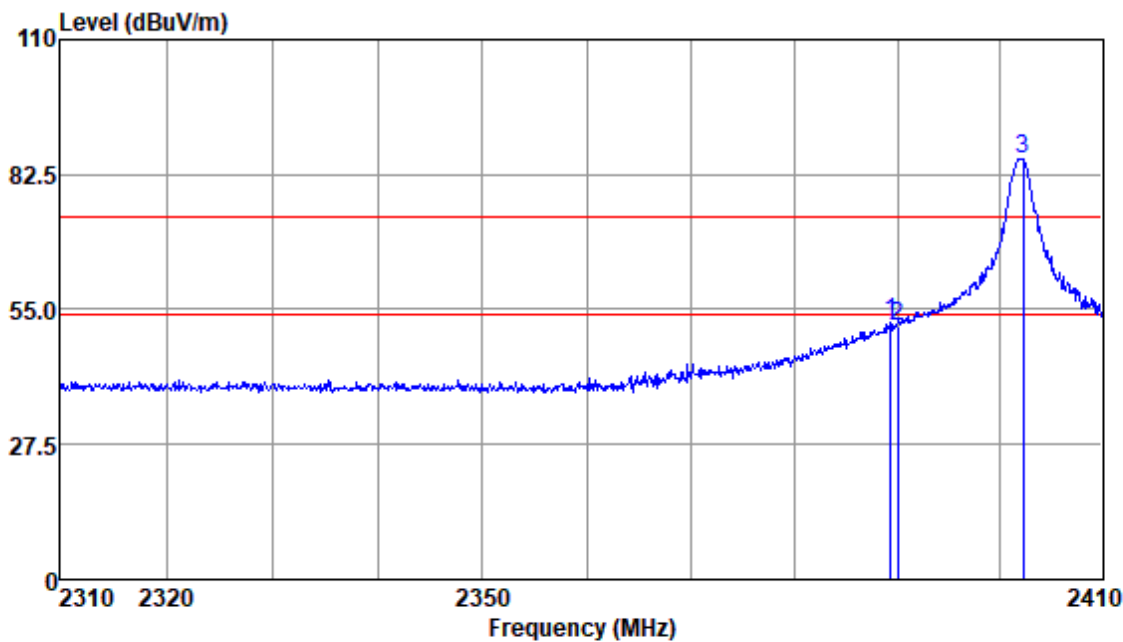
7.7.3 Measurement Procedure and Data

- 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: $\text{Level} = \text{Read Level} + \text{Cable Loss} + \text{Antenna Factor} - \text{Preamp Factor}$

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:a; Polarization:Horizontal; Modulation:GFSK; ; Channel:Low



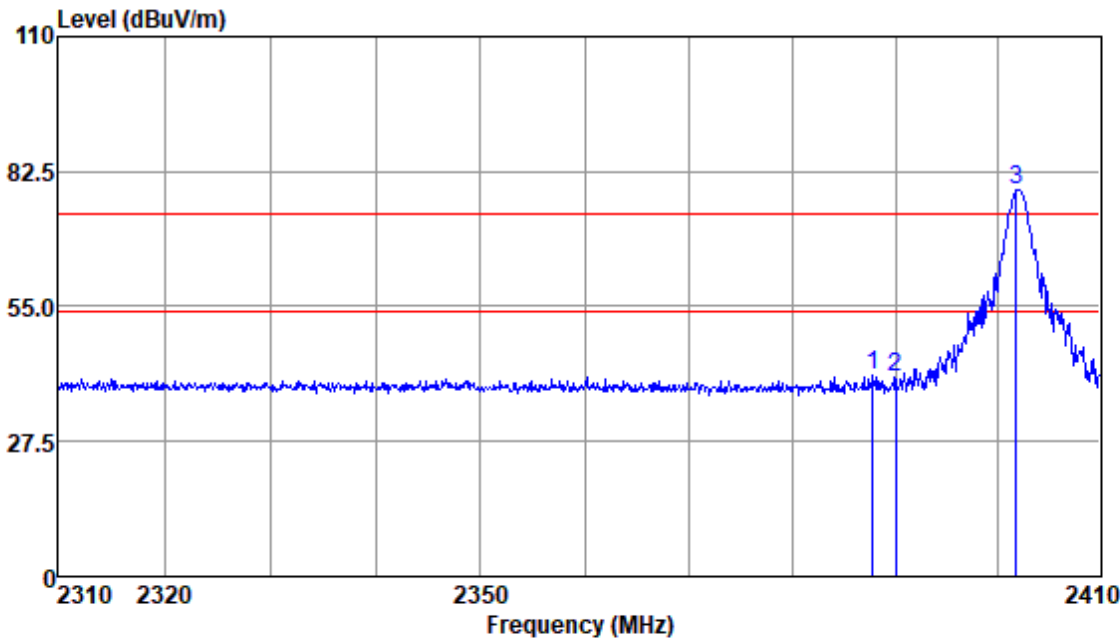
Antenna Polarity :HORIZONTAL

Freq	Read Level	Antenna Factor	Cable Loss	Preamplifier Factor	Emission Level	Limit Line	Over Limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
2389.36	60.48	26.03	3.15	37.40	52.26	74.00	-21.74	Peak
2390.00	59.95	26.03	3.15	37.40	51.73	74.00	-22.27	Peak
2402.25	93.79	26.05	3.14	37.40	85.58	74.00	11.58	Peak

Note:Emission Level=Read Level+Antenna Factor+Cable loss-Preamplifier Factor



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



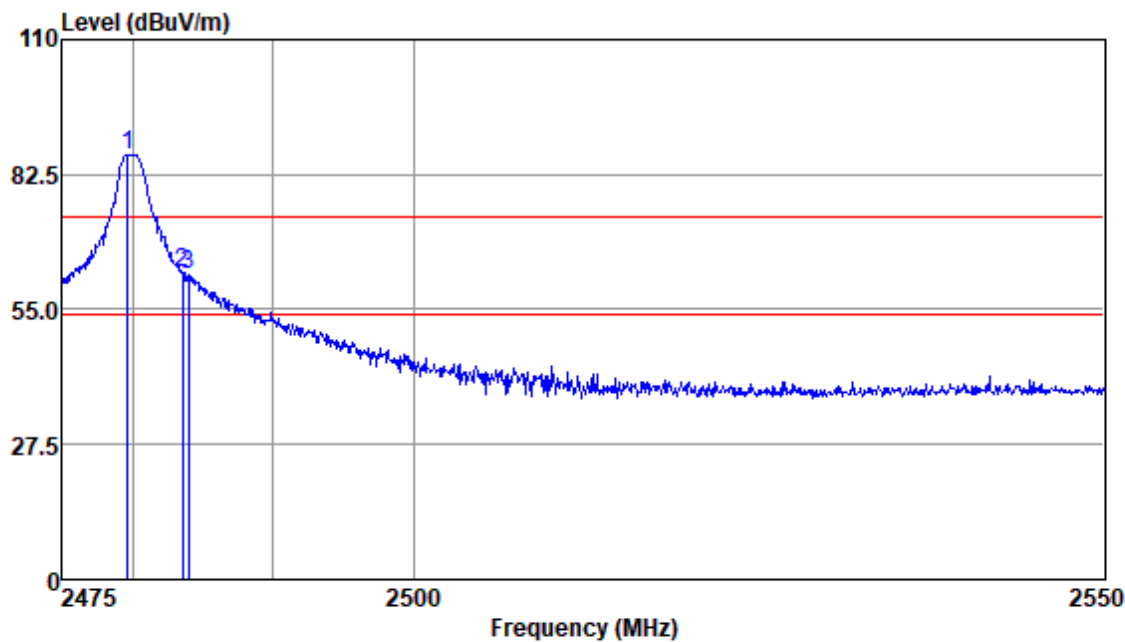
Antenna Polarity :VERTICAL

Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Emission Level	Limit Line	Over Limit	Remark
MHz	dBuv	dB/m	dB	dB	dBuv/m	dBuv/m	dB	
2387.84	49.41	26.03	3.15	37.40	41.19	74.00	-32.81	Peak
2390.00	48.65	26.03	3.15	37.40	40.43	74.00	-33.57	Peak
2401.74	87.00	26.05	3.15	37.40	78.80	74.00	4.80	Peak

Note:Emission Level=Read Level+Antenna Factor+Cable loss-Preamp Factor



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



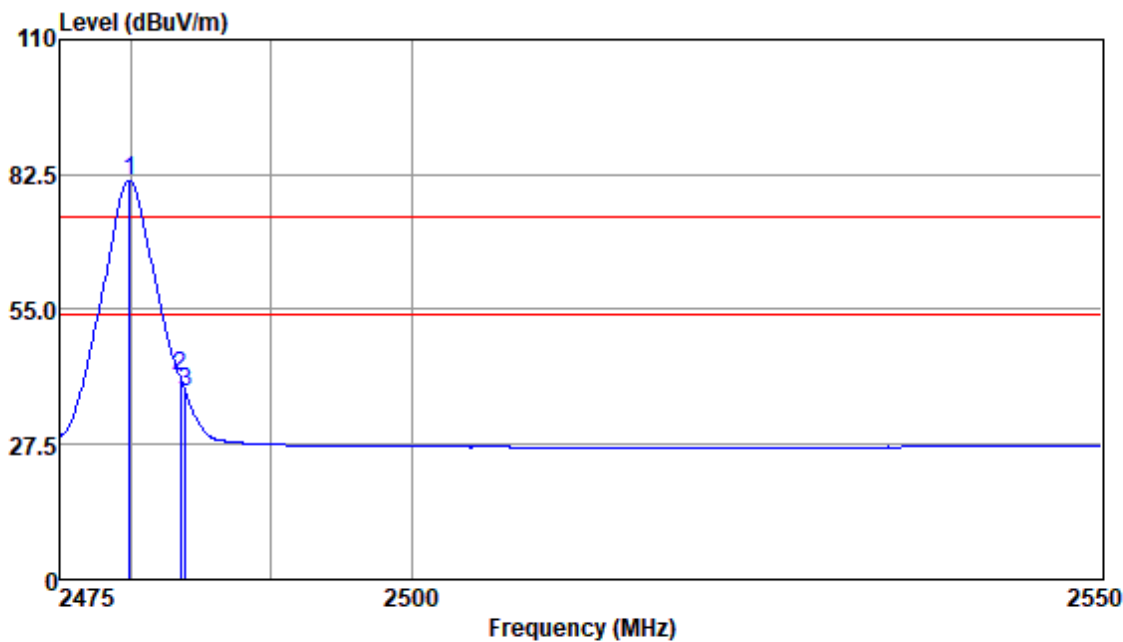
Antenna Polarity :HORIZONTAL

Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Emission Level	Limit Line	Over Limit	Remark
MHz	dBuv	dB/m	dB	dB	dBuv/m	dBuv/m	dB	
2479.66	94.91	26.17	3.14	37.57	86.65	74.00	12.65	Peak
2483.50	70.90	26.18	3.14	37.57	62.65	74.00	-11.35	Peak
2483.96	70.25	26.18	3.14	37.57	62.00	74.00	-12.00	Peak

Note:Emission Level=Read Level+Antenna Factor+Cable loss-Preamp Factor



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



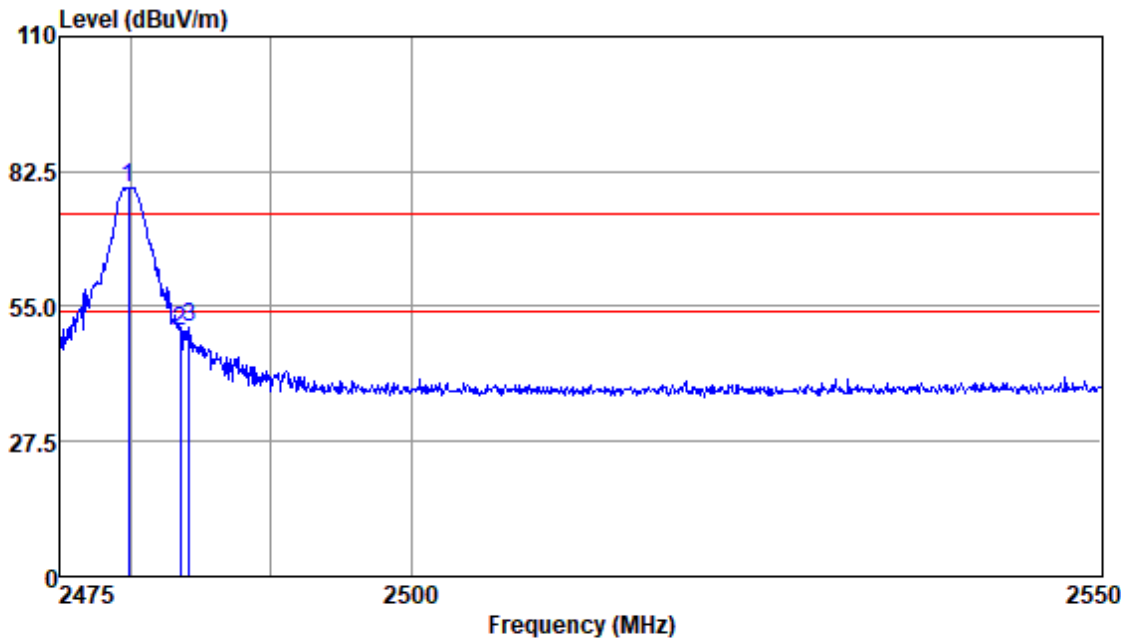
Antenna Polarity :HORIZONTAL

Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Emission Level	Limit Line	Over Limit	Remark
MHz	dBuv	dB/m	dB	dB	dBuv/m	dBuv/m	dB	
2479.88	89.63	26.17	3.14	37.57	81.37	54.00	27.37	Average
2483.50	49.54	26.18	3.14	37.57	41.29	54.00	-12.71	Average
2483.88	46.40	26.18	3.14	37.57	38.15	54.00	-15.85	Average

Note:Emission Level=Read Level+Antenna Factor+Cable loss-Preamp Factor



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



Antenna Polarity :VERTICAL

Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Emission Level	Limit Line	Over Limit	Remark
-----	-----	-----	-----	-----	-----	-----	-----	-----
MHz	dBuv	dB/m	dB	dB	dBuv/m	dBuv/m	dB	
2479.81	87.29	26.17	3.14	37.57	79.03	74.00	5.03	Peak
2483.50	58.34	26.18	3.14	37.57	50.09	74.00	-23.91	Peak
2484.18	59.07	26.18	3.14	37.57	50.82	74.00	-23.18	Peak

Note:Emission Level=Read Level+Antenna Factor+Cable loss-Preamp Factor



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

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.

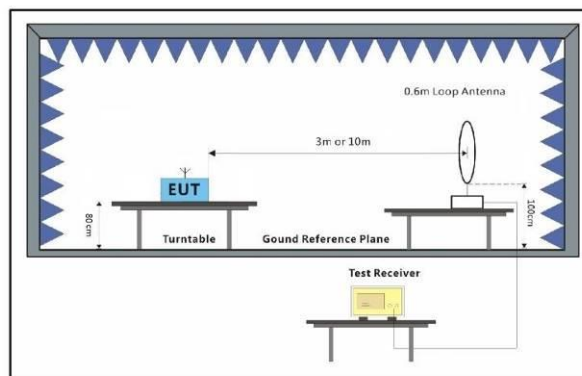
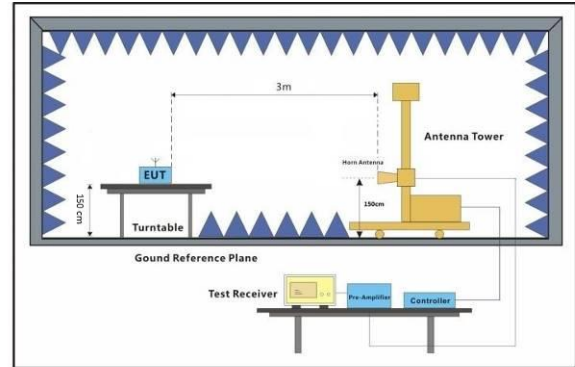
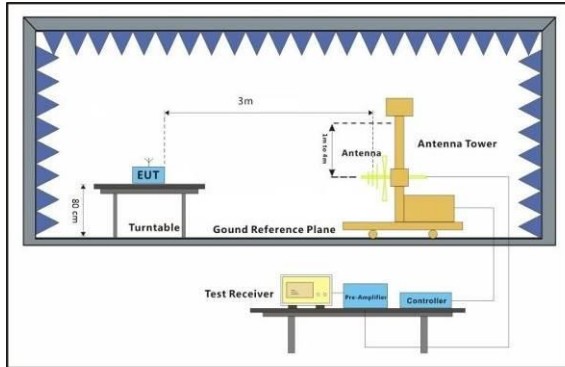
7.8.1 E.U.T. Operation

Operating Environment:

Temperature: 20 °C Humidity: 50 % RH Atmospheric Pressure: 1010 mbar

Test mode a: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

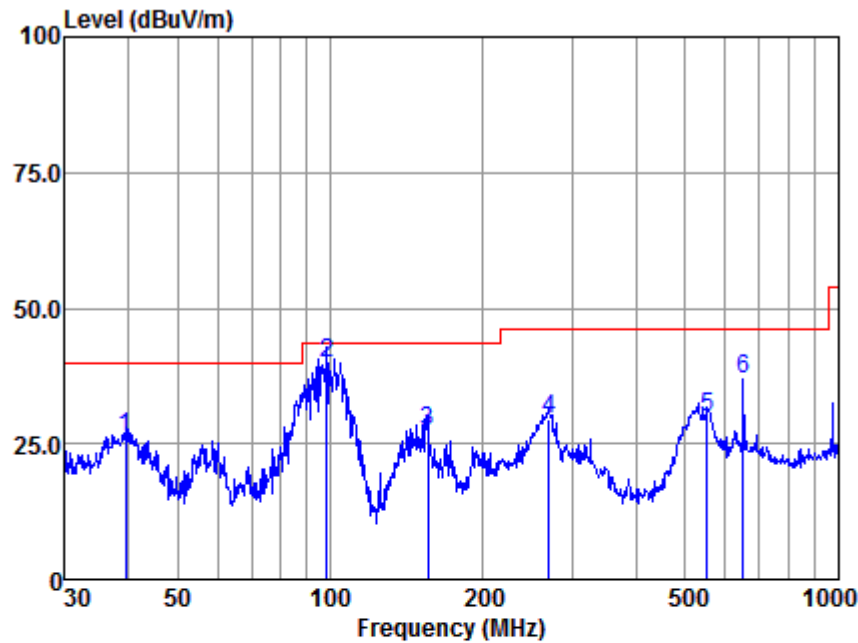
- a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 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



30MHz-1GHz
Mode:a; Polarization:Horizontal



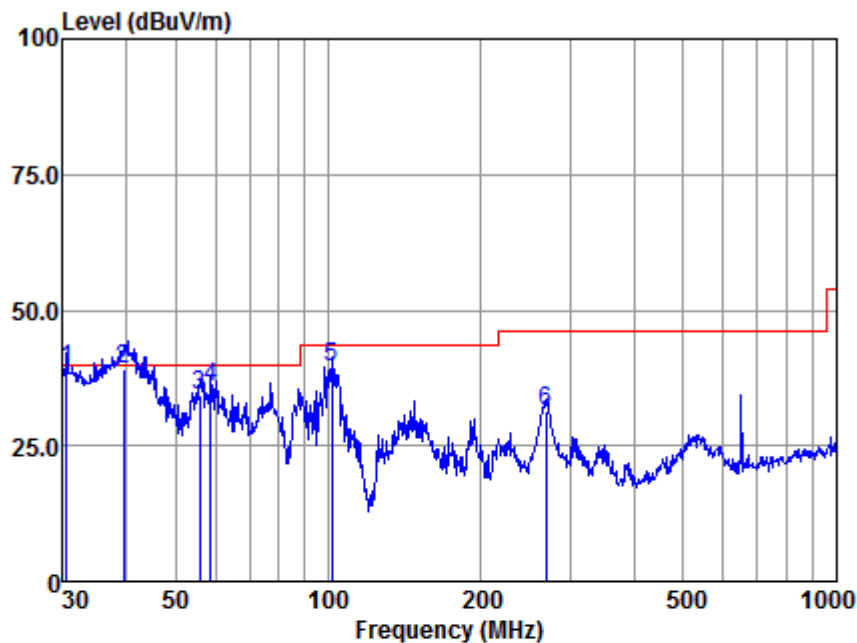
Antenna Polarity :HORIZONTAL
Test mode :a

	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Emission Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	39.437	51.98	16.25	0.30	42.33	26.20	40.00	-13.80	QP
2	98.487	71.66	9.31	1.10	42.32	39.75	43.50	-3.75	QP
3	155.364	55.58	12.59	1.40	42.22	27.35	43.50	-16.15	QP
4	269.428	57.19	12.21	2.21	42.11	29.50	46.00	-16.50	QP
5	552.883	49.40	18.41	3.65	41.68	29.78	46.00	-16.22	QP
6	651.942	54.68	19.84	3.94	41.71	36.75	46.00	-9.25	QP

Note:Emission Level=Read Level+Antenna Factor+Cable loss-Preamp Factor



Mode:a; Polarization:Vertical



Antenna_Polarity :VERTICAL
Test mode :a

	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Emission Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	30.531	65.78	15.36	0.45	42.38	39.21	40.00	-0.79	QP
2	39.440	64.90	16.25	0.30	42.33	39.12	40.00	-0.88	QP
3	55.805	64.31	11.80	0.55	42.33	34.33	40.00	-5.67	QP
4	58.613	65.07	12.30	0.58	42.33	35.62	40.00	-4.38	QP
5	101.644	71.11	9.52	1.13	42.32	39.44	43.50	-4.06	QP
6	268.485	59.22	12.16	2.21	42.11	31.48	46.00	-14.52	QP

Note:Emission Level=Read Level+Antenna Factor+Cable loss-Preamp Factor



Above 1GHz

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

Frequency	RX_R	Factor	Emission	Limit	Over Limit	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
4804	36.78	6.18	42.96	54	-11.04	peak
7206	35.67	10.63	46.3	54	-7.7	peak
9608	35.09	14.38	49.47	54	-4.53	peak

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

Frequency	RX_R	Factor	Emission	Limit	Over Limit	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
4804	39.34	6.18	45.52	54	-8.48	peak
7206	33.97	10.63	44.6	54	-9.4	peak
9608	37.14	14.38	51.52	54	-2.48	peak

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

Frequency	RX_R	Factor	Emission	Limit	Over Limit	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
4880	35.07	6.97	42.04	54	-11.96	peak
7320	36.25	11.12	47.37	54	-6.63	peak
9760	33.83	14.35	48.18	54	-5.82	peak

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

Frequency	RX_R	Factor	Emission	Limit	Over Limit	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
4880	36.79	6.97	43.76	54	-10.24	peak
7320	38.1	11.12	49.22	54	-4.78	peak
9760	34.51	14.35	48.86	54	-5.14	peak

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

Frequency	RX_R	Factor	Emission	Limit	Over Limit	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
4960	37.95	7.49	45.44	54	-8.56	peak
7440	38.22	11.65	49.87	54	-4.13	peak
9920	36.52	14.4	50.92	54	-3.08	peak

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

Frequency	RX_R	Factor	Emission	Limit	Over Limit	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
4960	38.43	7.49	45.92	54	-8.08	peak
7440	37.93	11.65	49.58	54	-4.42	peak
9920	36.37	14.4	50.77	54	-3.23	peak



8 Test Setup Photographs

Refer to the < Test Setup photos-FCC>.

9 EUT Constructional Details

Refer to the < External Photos > & < Internal Photos >.



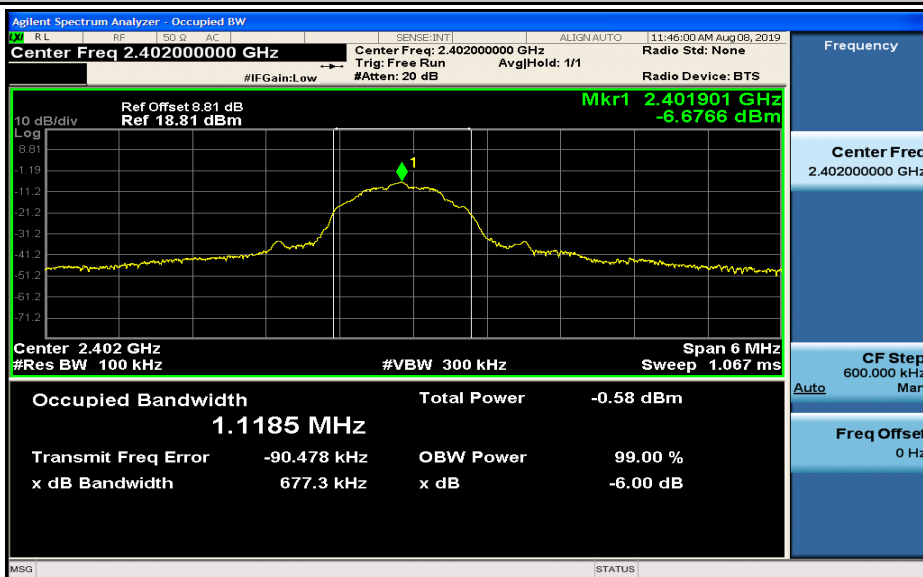
Appendix A for SHEM190601433801

1.6dB Bandwidth

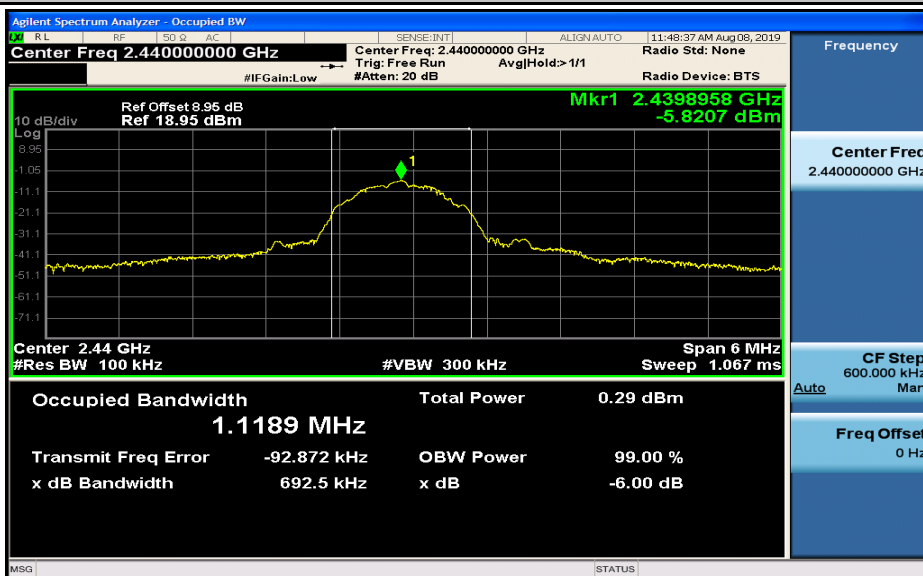
Test Mode	Test Channel	EBW[MHz]	Limit	Verdict
BLE	2402	0.68	0.5	PASS
BLE	2440	0.69	0.5	PASS
BLE	2480	0.69	0.5	PASS



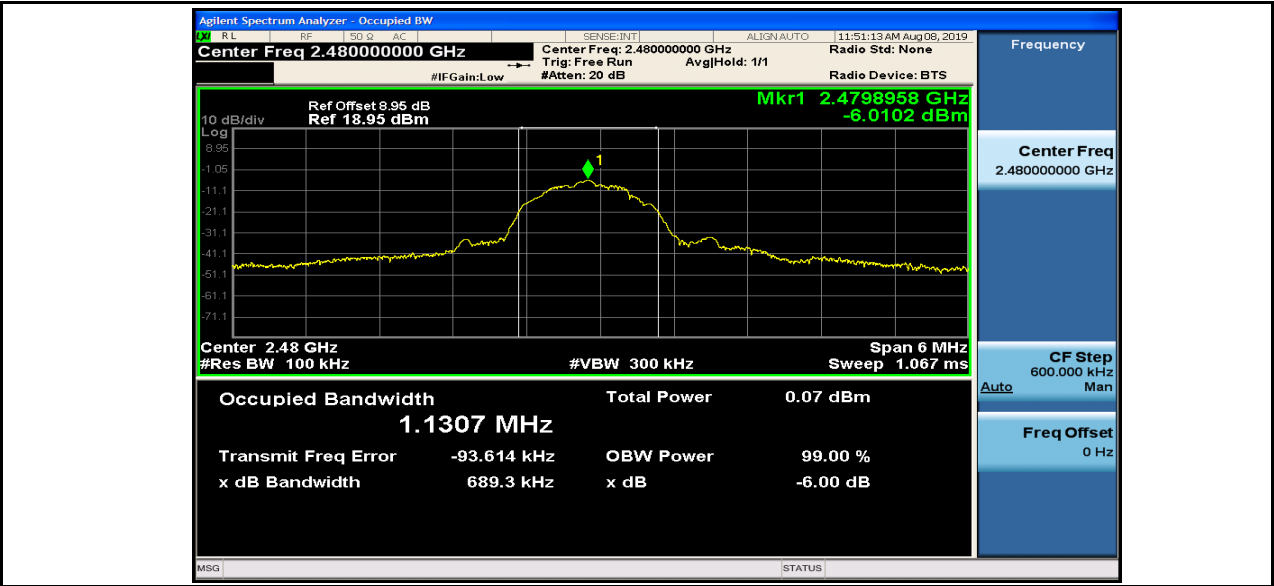
6dB Bandwidth_BLE_2402



6dB Bandwidth_BLE_2440



6dB Bandwidth_BLE_2480



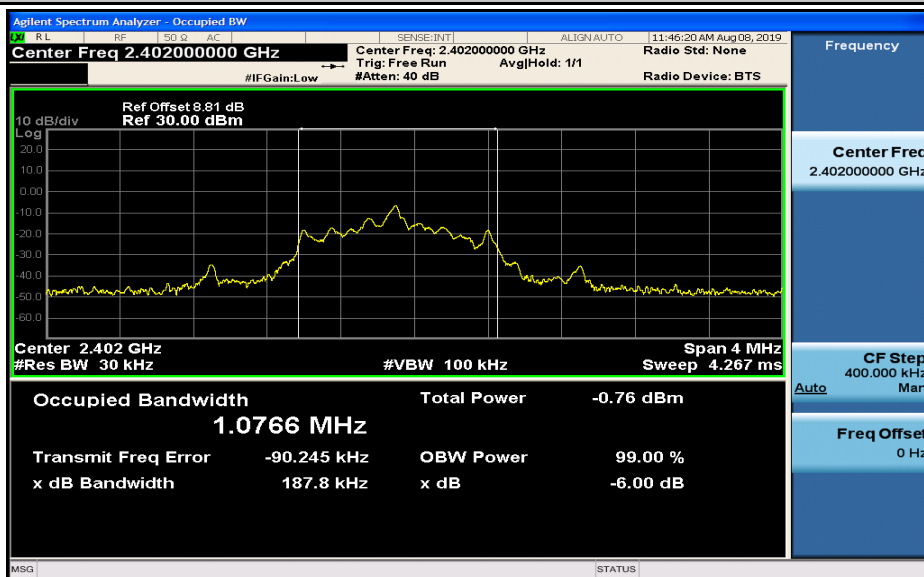


2.Occupied Bandwidth

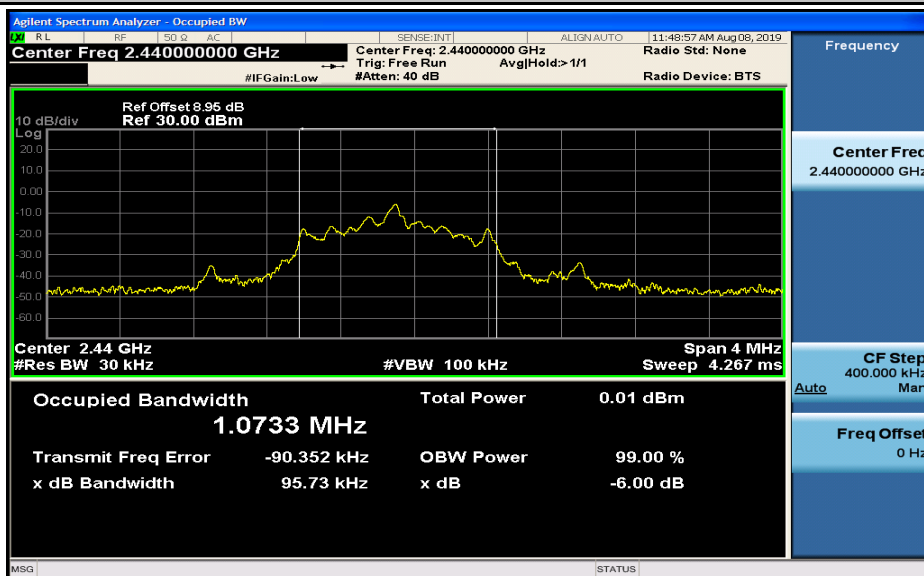
Test Mode	Test Channel	OBW[MHz]	Limit[MHz]	Verdict
BLE	2402	1.08	---	PASS
BLE	2440	1.07	---	PASS
BLE	2480	1.08	---	PASS



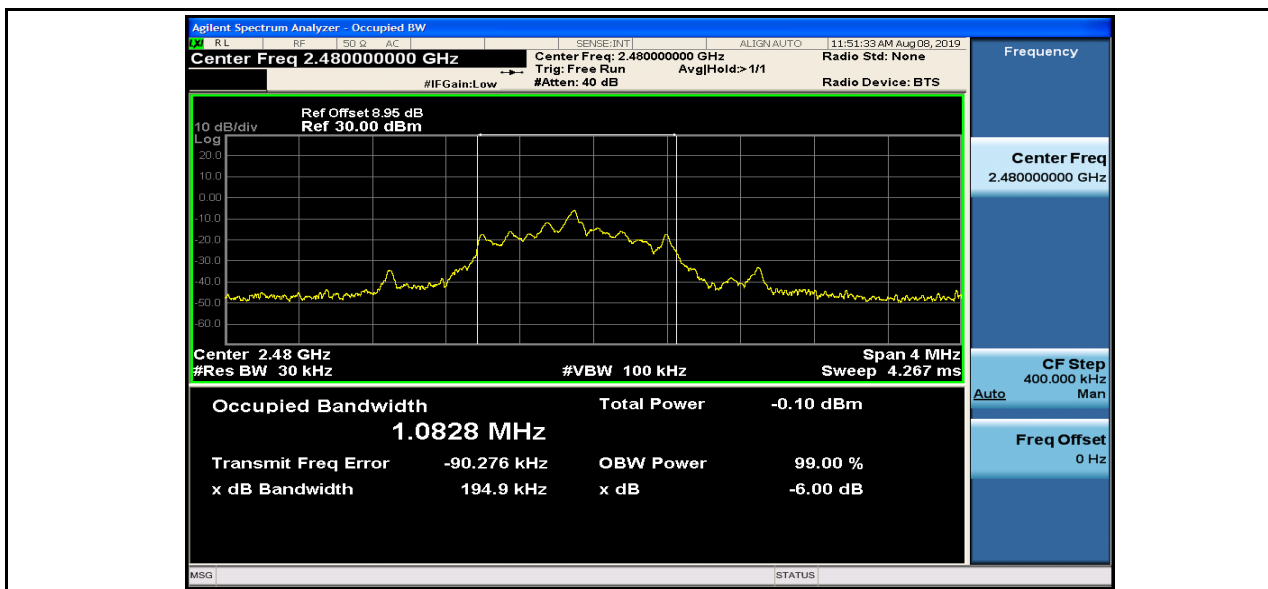
Occupied Bandwidth_BLE_2402



Occupied Bandwidth_BLE_2440



Occupied Bandwidth_BLE_2480



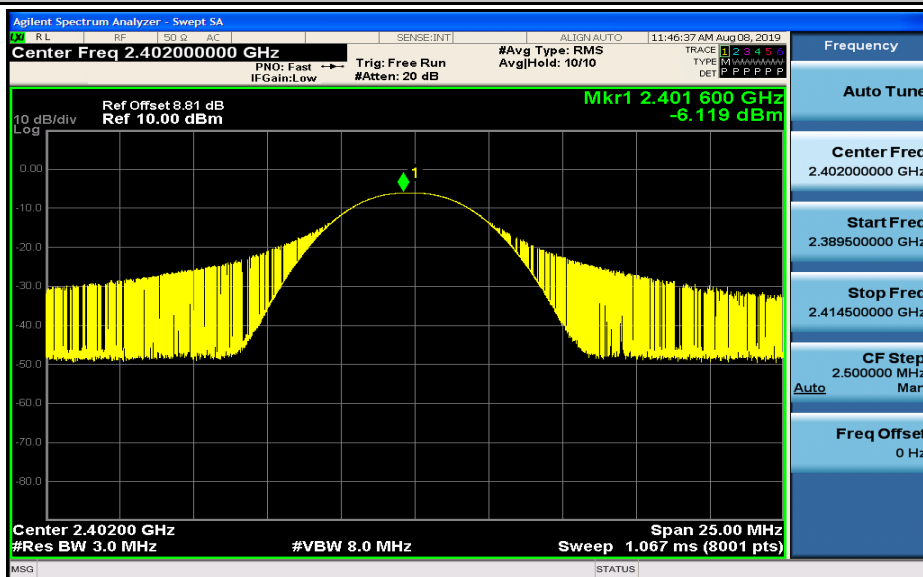


3.Maximum peak conducted output power

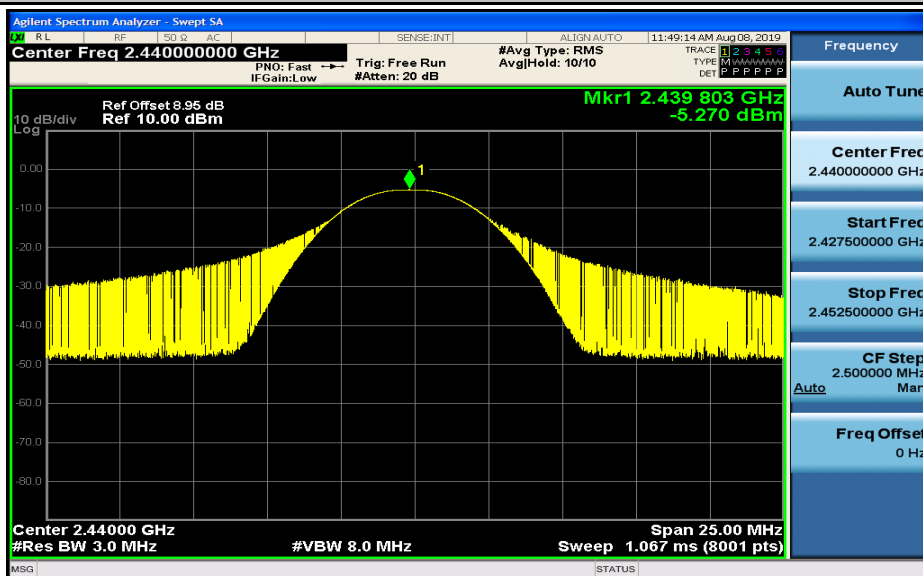
Test Mode	Test Channel	Power[dBm]	Limit[dBm]	Verdict
BLE	2402	-6.12	30	PASS
BLE	2440	-5.27	30	PASS
BLE	2480	-5.43	30	PASS



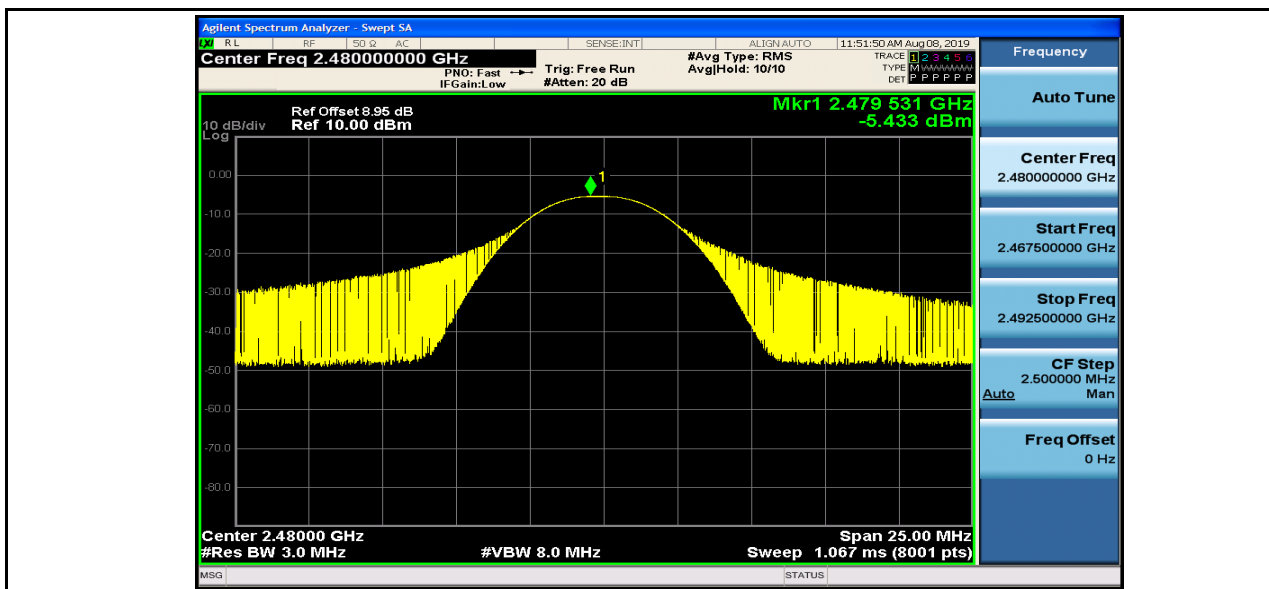
Maximum peak conducted output power_BLE_2402



Maximum peak conducted output power_BLE_2440



Maximum peak conducted output power_BLE_2480





4.Maximum Peak power spectral density

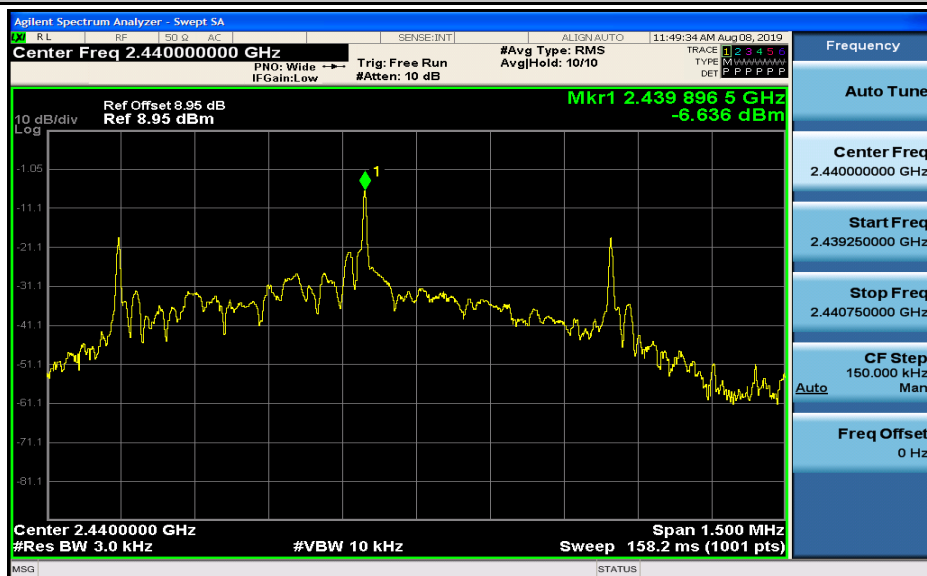
Test Mode	Test Channel	PSD[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
BLE	2402	-7.46	8.00	PASS
BLE	2440	-6.64	8.00	PASS
BLE	2480	-6.96	8.00	PASS



Maximum Peak power spectral density_BLE_2402



Maximum Peak power spectral density_BLE_2440



Maximum Peak power spectral density_BLE_2480



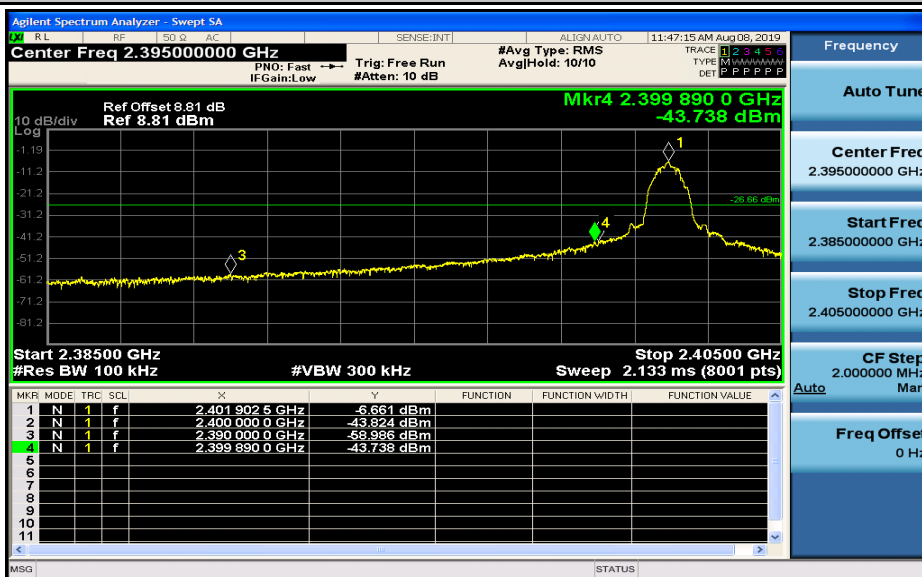


5.Band-edge for RF Conducted Emissions

Test Mode	Test Channel	Carrier Power[dBm]	Max. Spurious Level [dBm]	Limit [dBm]	Verdict
BLE	2402	-6.66	-43.74	-26.66	PASS
BLE	2480	-5.94	-49.94	-25.94	PASS



Band-edge for RF Conducted Emissions_BLE_2402_Hopping Off



Band-edge for RF Conducted Emissions_BLE_2480_Hopping Off



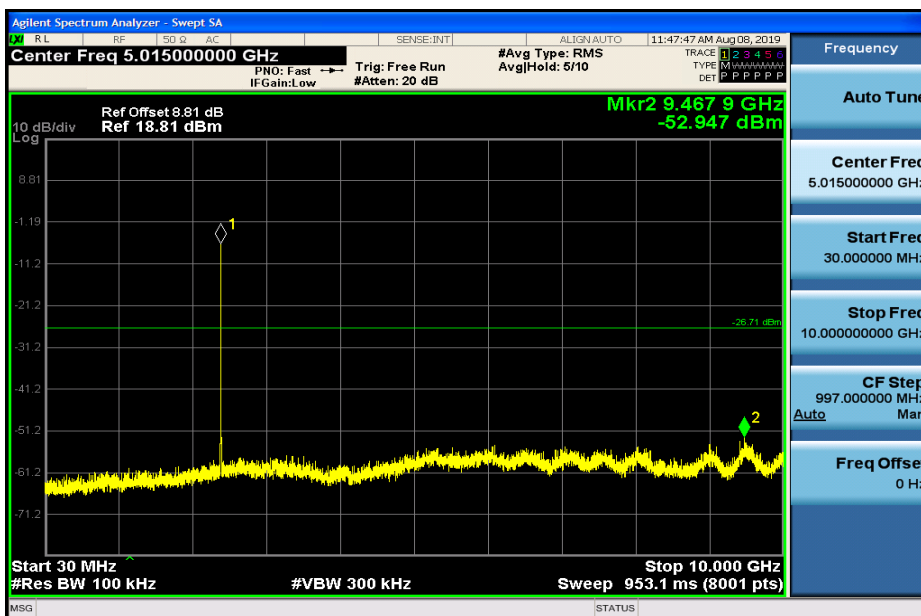


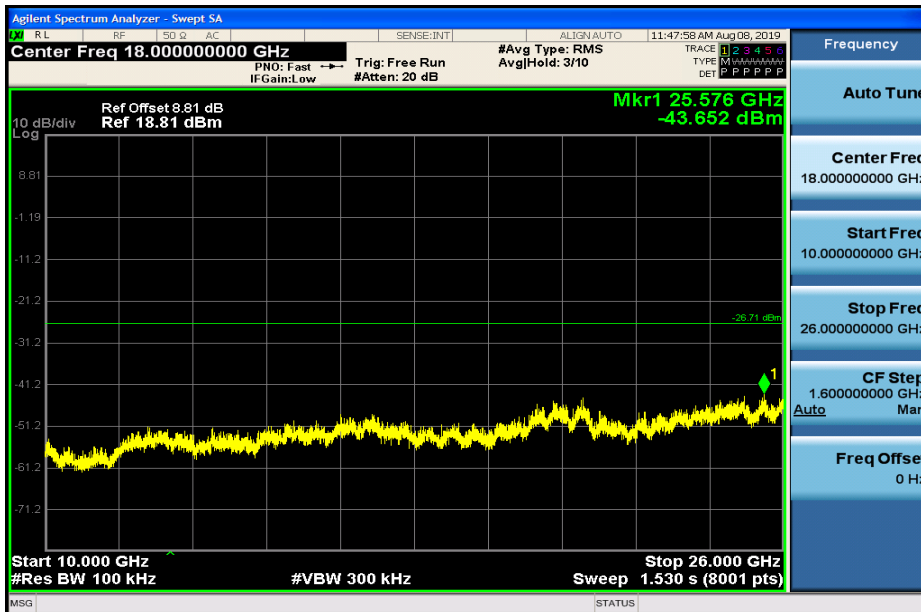
6.RF Conducted Spurious Emissions

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	-6.71	-52.95	<-26.71	PASS
BLE	2402	10000	26000	100	300	-6.712	-43.652	<-26.712	PASS
BLE	2440	30	10000	100	300	-5.85	-54.12	<-25.85	PASS
BLE	2440	10000	26000	100	300	-5.852	-43.071	<-25.852	PASS
BLE	2480	30	10000	100	300	-5.97	-53.01	<-25.97	PASS
BLE	2480	10000	26000	100	300	-5.973	-43.807	<-25.973	PASS

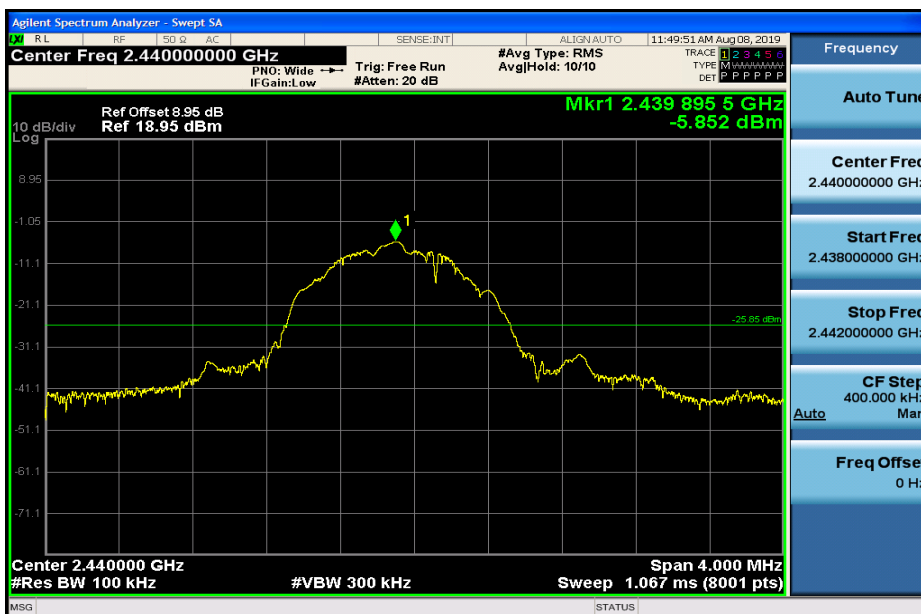


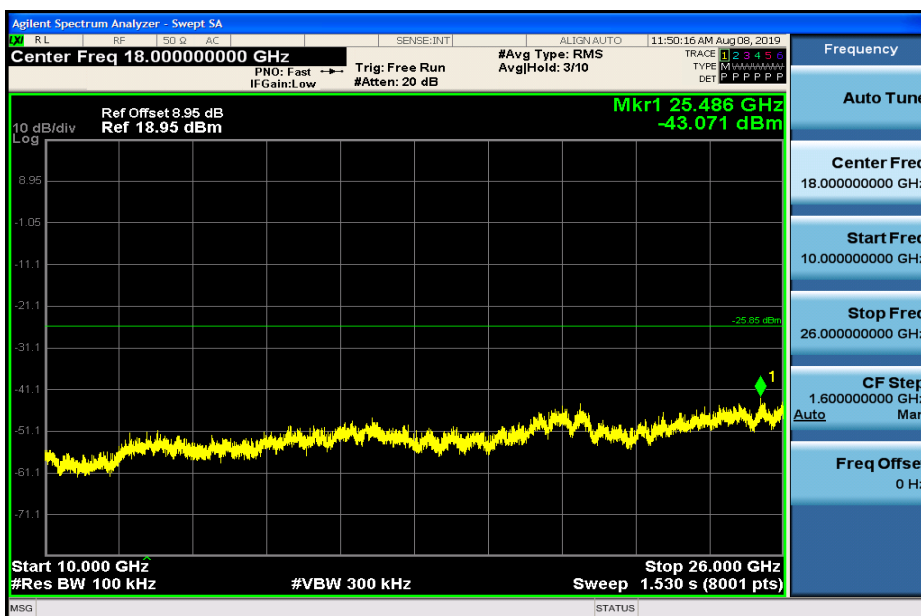
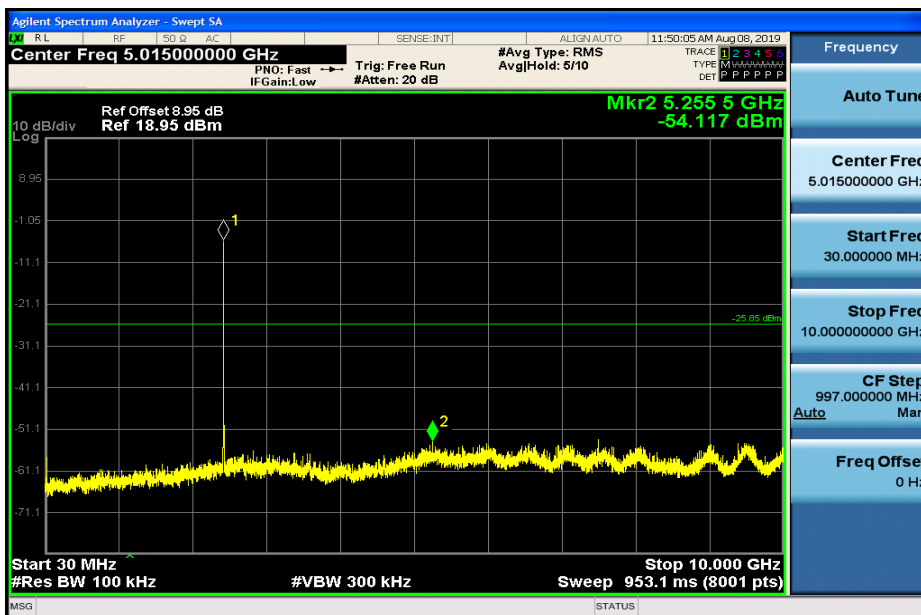
RF Conducted Spurious Emissions_BLE_2402





RF Conducted Spurious Emissions_BLE_2440



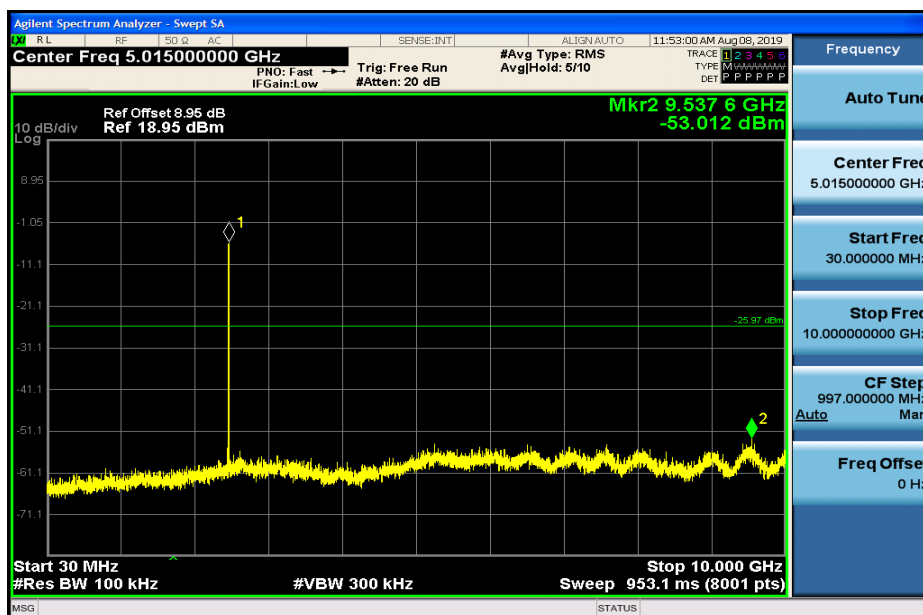


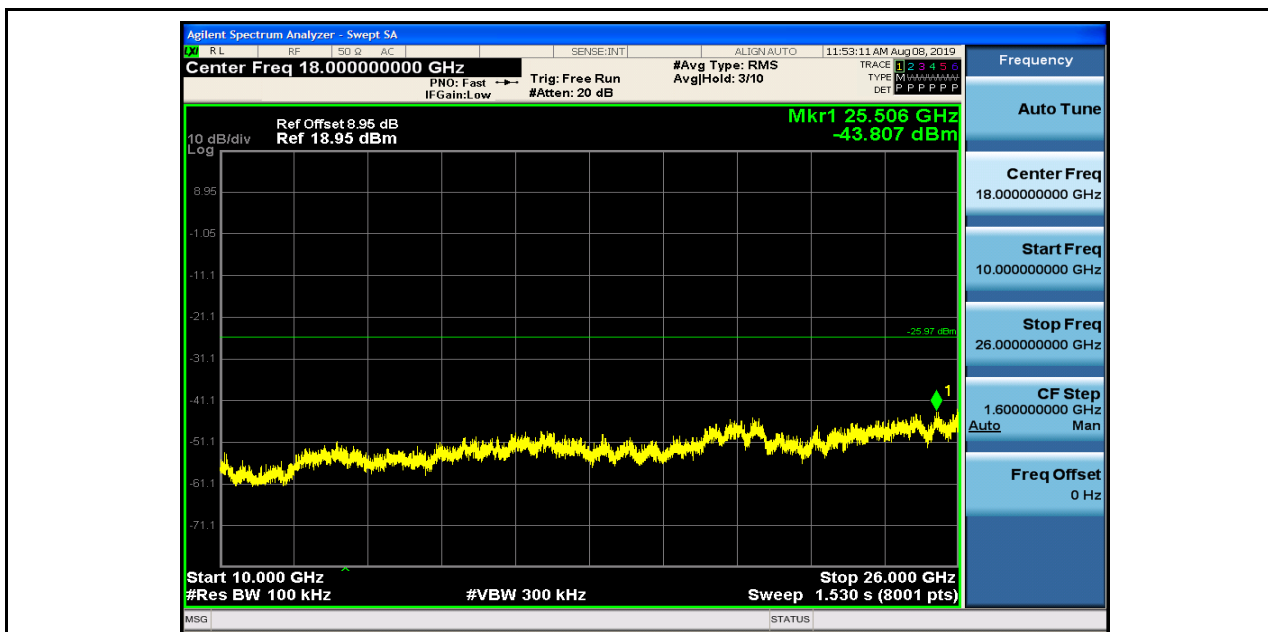
RF Conducted Spurious Emissions_BLE_2480



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