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Report No.: SHEM180800704102

Page: 1 of 54

TEST REPORT

Application No.: SHEM1808007041CR
FCC ID: SVC-PM2I
IC: 152C-PM2I
Applicant: Lenbrook Industries Limited
Address of Applicant: 633 Granite Court, Pickering Ontario, Canada L1W 3K1,
Manufacturer: Lenbrook Industries Limited
Address of Manufacturer: 633 Granite Court, Pickering Ontario, Canada L1W 3K1,
Factory: HANSONG(NANJING) TECHNOLOGY LTD.
Address of Factory: 8th Kangping Road, Jiangning Economy and Technology Development Zone, Nanjing, 211106, China.

Equipment Under Test (EUT):

EUT Name: Compact Wireless Streaming Speaker

Model No.: Pulse Mini 2i

Trade mark: Bluesound

Standard(s) : 47 CFR Part 15, Subpart C 15.247

RSS-247 Issue 2, February 2017

RSS-Gen Issue 5, April 2018

Date of Receipt: 2018-08-16

Date of Test: 2018-08-27 to 2018-09-12

Date of Issue: 2018-09-21

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



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	2018-09-21	/

Authorized for issue by:			
		Bill Wu	
		Bill Wu / Project Engineer	
		Parlam Zhan	
		Parlam Zhan /Reviewer	



2 Test Summary

Radio Spectrum Technical Requirement				
Item	FCC Requirement	IC Requirement	Method	Result
Antenna Requirement	47 CFR Part 15, Subpart C 15.203 & 15.247(c)	RSS-Gen Clause 6.8	N/A	Customer Declaration

Radio Spectrum Matter Part				
Item	FCC Requirement	IC Requirement	Method	Result
Conducted Emissions at AC Power Line (150kHz-30MHz)	47 CFR Part 15, Subpart C 15.207	RSS-Gen Clause 8.8	ANSI C63.10 (2013) Section 6.2	Pass
Minimum 6dB Bandwidth	47 CFR Part 15, Subpart C 15.247a(2)	RSS-247 Clause 5.2(a)	ANSI C63.10 (2013) Section 11.8.1	Pass
Conducted Peak Output Power	47 CFR Part 15, Subpart C 15.247(b)(3)	RSS-247 Clause 5.4(d)	ANSI C63.10 (2013) Section 11.9.1	Pass
Power Spectrum Density	47 CFR Part 15, Subpart C 15.247(e)	RSS-247 Clause 5.2(b)	ANSI C63.10 (2013) Section 11.10.2	Pass
Conducted Band Edges Measurement	47 CFR Part 15, Subpart C 15.247(d)	RSS-247 Clause 5.5	ANSI C63.10 (2013) Section 11.13.3.2	Pass
Conducted Spurious Emissions	47 CFR Part 15, Subpart C 15.247(d)	RSS-247 Clause 5.5	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)	RSS-247 Clause 5.5	ANSI C63.10 (2013) Section 6.10.5	Pass
Radiated Spurious Emissions	47 CFR Part 15, Subpart C 15.209 & 15.247(d)	RSS-247 Clause 5.5	ANSI C63.10 (2013) Section 6.4,6.5,6.6	Pass
99% Bandwidth	-	RSS-Gen Section 6.6	ANSI C63.10 Section 6.9.3	Pass
Frequency Stability	-	RSS-Gen Section 8.11	RSS-Gen Section 6.11	Pass



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4 General Information

4.1 Details of E.U.T.

Power supply:	100-240V~50/60Hz
Test voltage:	AC 120V/60Hz
Cable:	AC Cable 1.8m
Antenna Gain	4.2dBi
Antenna Type	PIFA 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.
Router	FIR302M	FIR302M	/
Laptop	LENOVO	R400	/

4.3 Measurement Uncertainty

No.	Item	Measurement Uncertainty
1	Radio Frequency	7.25×10^{-8}
2	Timeout	2s
3	Duty cycle	0.37%
4	Occupied Bandwidth	3%
5	RF conducted power	0.75dB
6	RF power density	2.84dB
7	Conducted Spurious emissions	0.75dB
8	RF Radiated power	4.5dB (Below 1GHz) 4.8dB (Above 1GHz)
9	Radiated Spurious emission test	4.2dB (Below 30MHz) 4.4dB (30MHz-1GHz) 4.6dB (1GHz-18GHz) 5.2dB (Above 18GHz)
10	Temperature test	1°C
11	Humidity test	3%
12	Supply voltages	1.5%
13	Time	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 (Shanghai) Co., Ltd. E&E Lab

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

Tel: +86 21 6191 5666

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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.

- **Industry Canada (IC) – IC Assigned Code: 8617A**

The 3m Semi-anechoic chamber of SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 8617A-1.

- **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	2017-12-20	2018-12-19
LISN	Schwarzbeck	NSLK8127	SHEM061-1	2017-12-20	2018-12-19
LISN	EMCO	3816/2	SHEM019-1	2017-12-20	2018-12-19
Pulse limiter	R&S	ESH3-Z2	SHEM029-1	2017-12-20	2018-12-19
CE test Cable	/	CE01	/	2017-12-26	2018-12-25
Conducted Test					
Spectrum Analyzer	R&S	FSP-30	SHEM002-1	2017-12-20	2018-12-19
Spectrum Analyzer	Agilent	N9020A	SHEM181-1	2018-08-13	2019-08-12
Signal Generator	R&S	SMR20	SHEM006-1	2018-08-13	2019-08-12
Signal Generator	Agilent	N5182A	SHEM182-1	2018-08-13	2019-08-12
Communication Tester	R&S	CMW270	SHEM183-1	2018-08-13	2019-08-12
Switcher	Tonscend	JS0806	SHEM184-1	2018-08-13	2019-08-12
Power Sensor	Keysight	U2021XA * 4	SHEM184-1	2018-08-13	2019-08-12
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	2017-12-26	2018-12-25
DC Power Supply	QJE	QJ30003SII	SHEM046-1	2017-12-26	2018-12-25
Conducted test Cable	/	RF01~RF04	/	2017-12-26	2018-12-25
Radiated Test					
EMI test Receiver	R&S	ESU40	SHEM051-1	2017-12-20	2018-12-19
Spectrum Analyzer	R&S	FSP-30	SHEM002-1	2017-12-20	2018-12-19
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	2018-08-13	2019-08-12
Pre-amplifier (1-18GHz)	CLAVIO	BDLNA-0118	SHEM050-2	2018-08-13	2019-08-12
High-amplifier (14-40GHz)	Schwarzbeck	10001	SHEM049-2	2017-12-20	2018-12-19
Signal Generator	R&S	SMR40	SHEM058-1	2018-08-13	2019-08-12
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	/	2017-12-26	2018-12-25



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6 Radio Spectrum Technical Requirement

6.1 E.U.T. test conditions

Requirements: 15.31(e) For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

**Operating
Environment:**

Temperature:	20.0 -25.0 °C
Humidity:	35-75 % RH
Atmospheric Pressure:	99.2 -102 kPa

Test frequencies:

According to the 15.31(m) Measurements on intentional radiators or receivers, other than TV broadcast receivers, shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table:

Frequency range over which device operates	Number of frequencies	Location in the range of operation
1 MHz or less	1	Middle
1 to 10 MHz	2	1 near top and 1 near bottom
More than 10 MHz	3	1 near top, 1 near middle and 1 near bottom

Pursuant to Part 15.31(c) For swept frequency equipment, measurements shall be made with the frequency sweep stopped at those frequencies chosen for the measurements to be reported.

Test frequency is the lowest channel: 0 channel (2402MHz), middle channel: 20 channel (2442MHz) and highest channel: 40 channel (2480MHz) with fixed at channel.

6.2 Antenna Requirement

6.2.1 Test Requirement:

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

6.2.2 Conclusion

Standard Requirement:

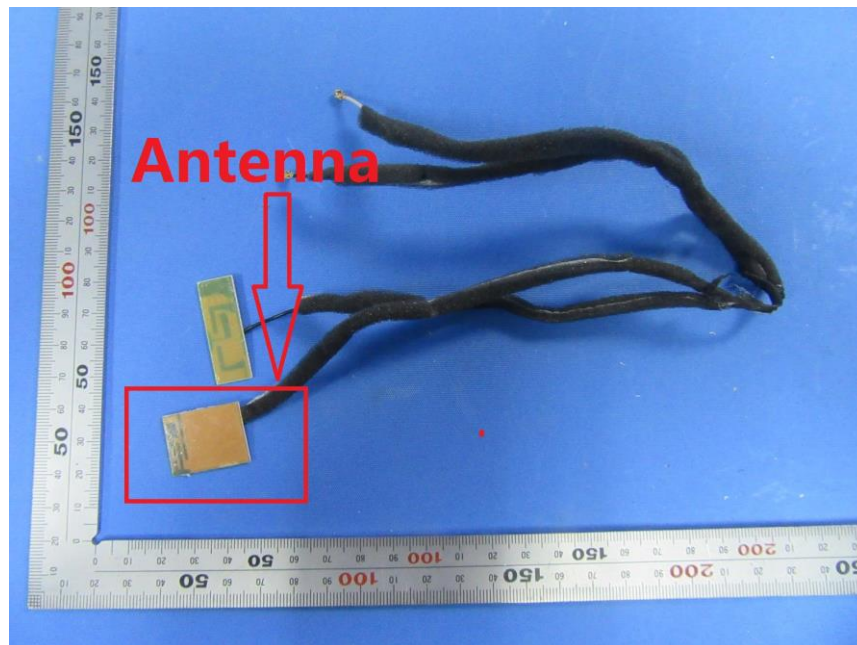
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit 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 4.2dBi.



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.

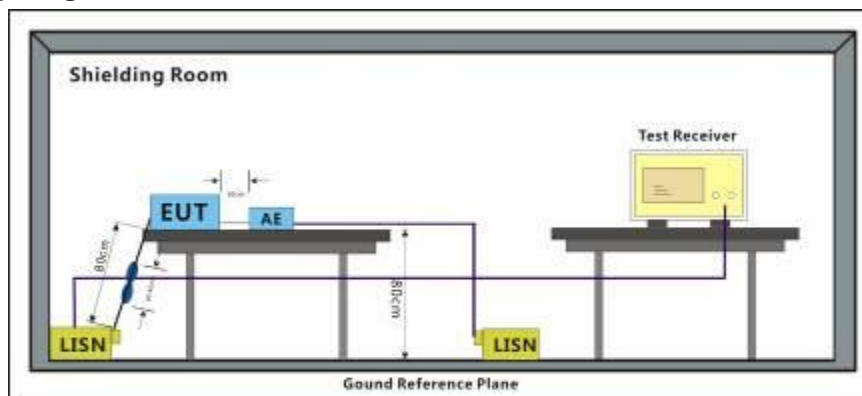
7.1.1 E.U.T. Operation

Operating Environment:

Temperature: 22 °C Humidity: 50 % RH Atmospheric Pressure: 1002 mbar

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

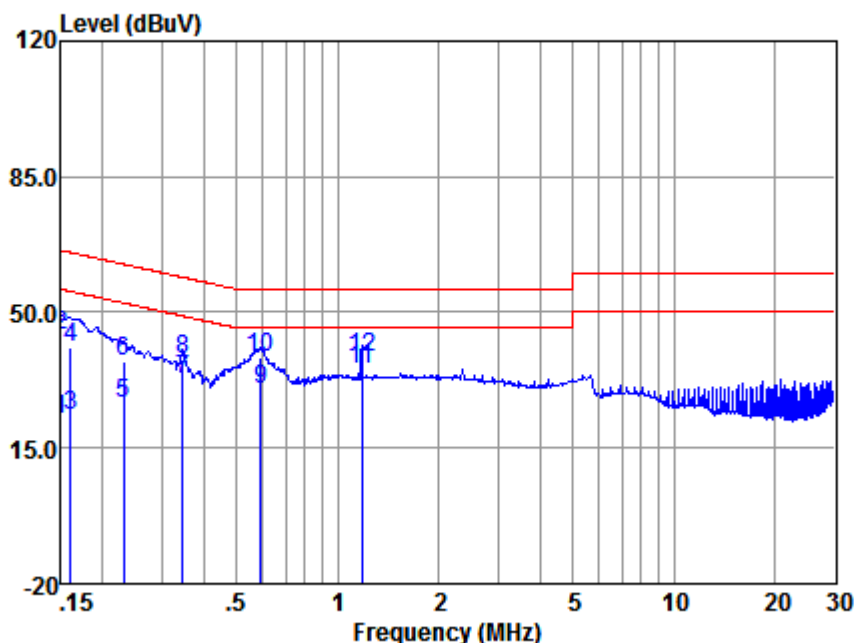
7.1.2 Test Setup Diagram





7.1.3 Measurement Procedure and Data

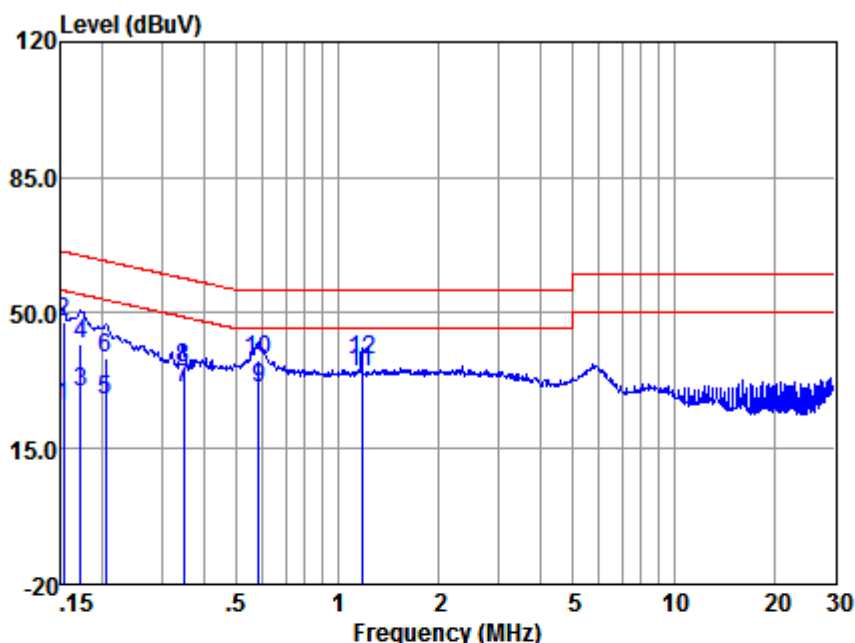
- 1) The mains terminal disturbance voltage test was conducted in a shielded room.
- 2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a $50\Omega/50\mu\text{H} + 50\Omega$ linear impedance. The power cables of all other units of the EUT 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.



LISN : LINE
EUT/Project No : 5213CR
Test Mode : c

	Freq (MHz)	Read level (dBuV)	LISN Factor (dB)	Cable Loss (dB)	Emission Level (dBuV)	Limit (dBuV)	Over Limit (dB)	Remark
1	0.15	12.55	0.11	9.82	22.48	56.00	-33.52	Average
2	0.15	34.09	0.11	9.82	44.02	66.00	-21.98	QP
3	0.16	13.49	0.11	9.82	23.42	55.47	-32.05	Average
4	0.16	31.08	0.11	9.82	41.01	65.47	-24.46	QP
5	0.23	16.76	0.11	9.84	26.71	52.44	-25.73	Average
6	0.23	27.40	0.11	9.84	37.35	62.44	-25.09	QP
7	0.35	22.52	0.11	9.84	32.47	49.05	-16.58	Average
8	0.35	27.66	0.11	9.84	37.61	59.05	-21.44	QP
9	0.59	20.31	0.11	9.77	30.19	46.00	-15.81	Average
10	0.59	28.47	0.11	9.77	38.35	56.00	-17.65	QP
11	1.18	25.14	0.11	9.82	35.07	46.00	-10.93	Average
12	1.18	28.58	0.11	9.82	38.51	56.00	-17.49	QP

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



LISN : NEUTRAL
EUT/Project No : 5213CR
Test Mode : c

	Freq (MHz)	Read level (dBUV)	LISN Factor (dB)	Cable Loss (dB)	Emission Level (dBUV)	Limit (dBUV)	Over Limit (dB)	Remark
1	0.15	16.09	0.12	9.82	26.03	55.87	-29.84	Average
2	0.15	37.94	0.12	9.82	47.88	65.87	-17.99	QP
3	0.17	19.48	0.12	9.83	29.43	54.86	-25.43	Average
4	0.17	32.07	0.12	9.83	42.02	64.86	-22.84	QP
5	0.20	17.48	0.12	9.83	27.43	53.45	-26.02	Average
6	0.20	28.59	0.12	9.83	38.54	63.45	-24.91	QP
7	0.35	20.70	0.11	9.84	30.65	49.00	-18.35	Average
8	0.35	26.02	0.11	9.84	35.97	59.00	-23.03	QP
9	0.58	20.71	0.11	9.77	30.59	46.00	-15.41	Average
10	0.58	27.88	0.11	9.77	37.76	56.00	-18.24	QP
11	1.18	25.08	0.11	9.82	35.01	46.00	-10.99	Average
12	1.18	28.11	0.11	9.82	38.04	56.00	-17.96	QP

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

7.2 Frequency Stability

Test Requirement RSS-Gen Section 8.11

Test Method: RSS-Gen Section 6.11

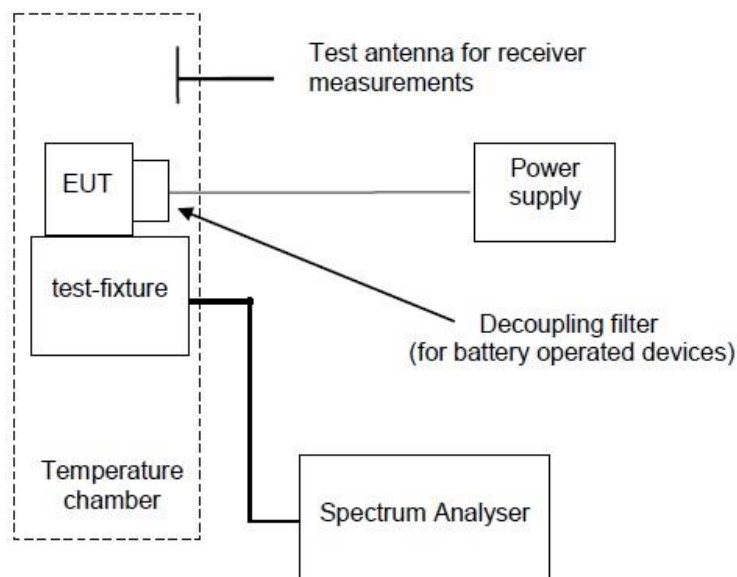
7.2.1 E.U.T. Operation

Operating Environment:

Temperature: 21 °C Humidity: 45 % RH Atmospheric Pressure: 1010 mbar

Test mode TX mode_Keep the EUT in continuously transmitting mode with unmodulated carrier frequency.

7.2.2 Test Setup Diagram



7.2.3 Measurement Procedure and Data

Test Conditions		Test Result		
Voltage	Temp (°C)	2402	2442	2480
Normal	Extreme (-20)	2402.011	2442.008	2480.010
	Extreme (+20)	2402.012	2442.012	2480.011
	Extreme (+50)	2402.016	2442.012	2480.012
Extreme (+15%)	Normal (20)	2402.011	2442.011	2480.013
Extreme (-15%)		2402.012	2442.013	2480.015

7.3 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

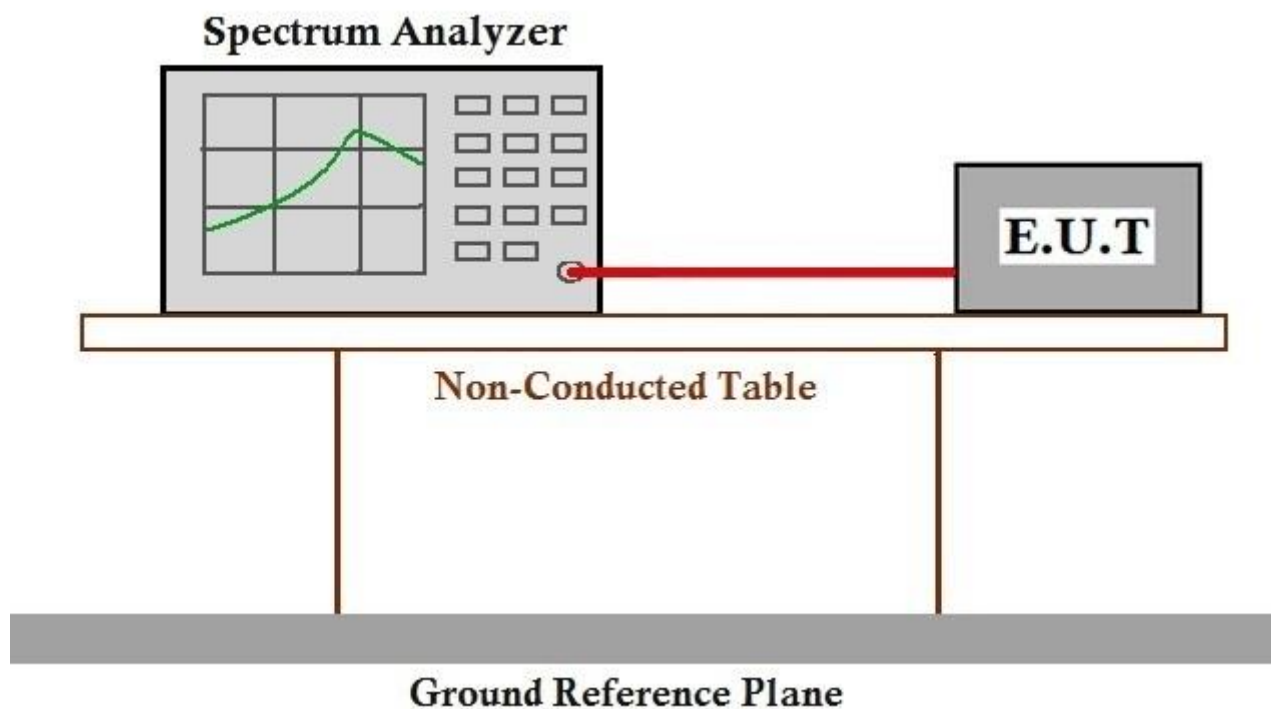
7.3.1 E.U.T. Operation

Operating Environment:

Temperature: 22 °C Humidity: 50 % RH Atmospheric Pressure: 1002 mbar

Test mode c: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 B SHEM180800704102

7.4 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

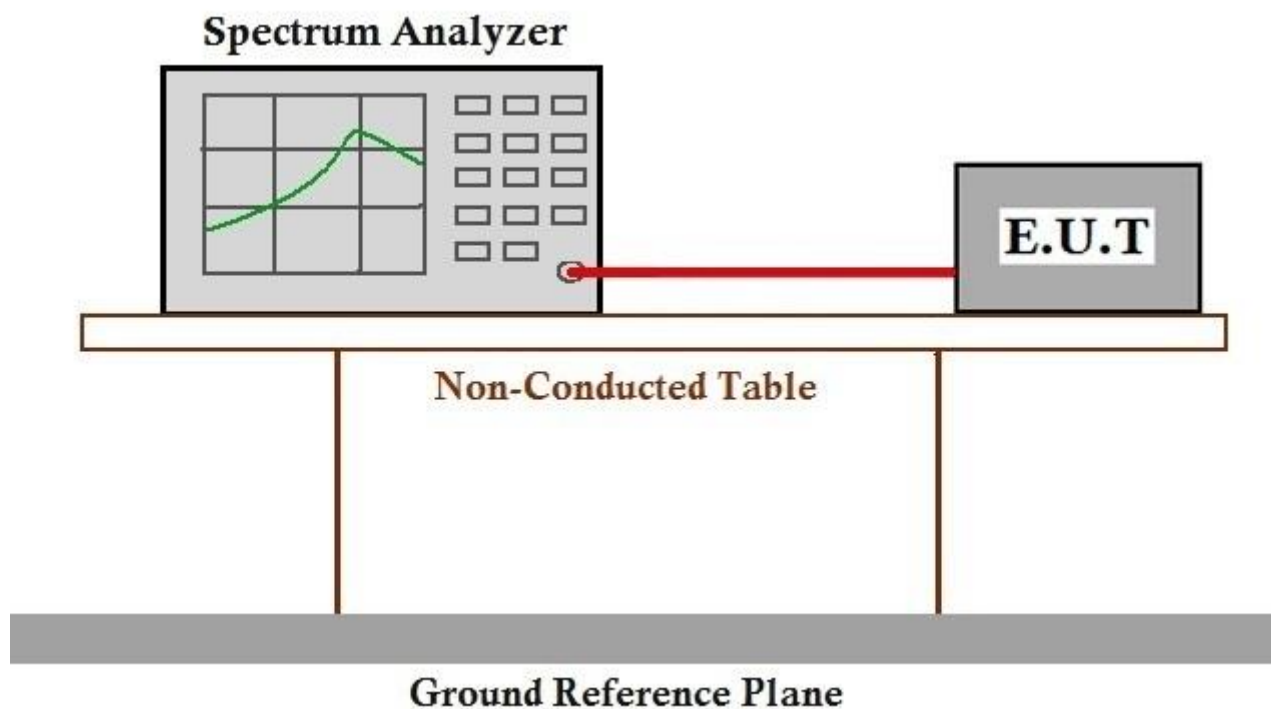
7.4.1 E.U.T. Operation

Operating Environment:

Temperature: 22 °C Humidity: 50 % RH Atmospheric Pressure: 1002 mbar

Test mode c: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 B SHEM180800704102

7.5 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

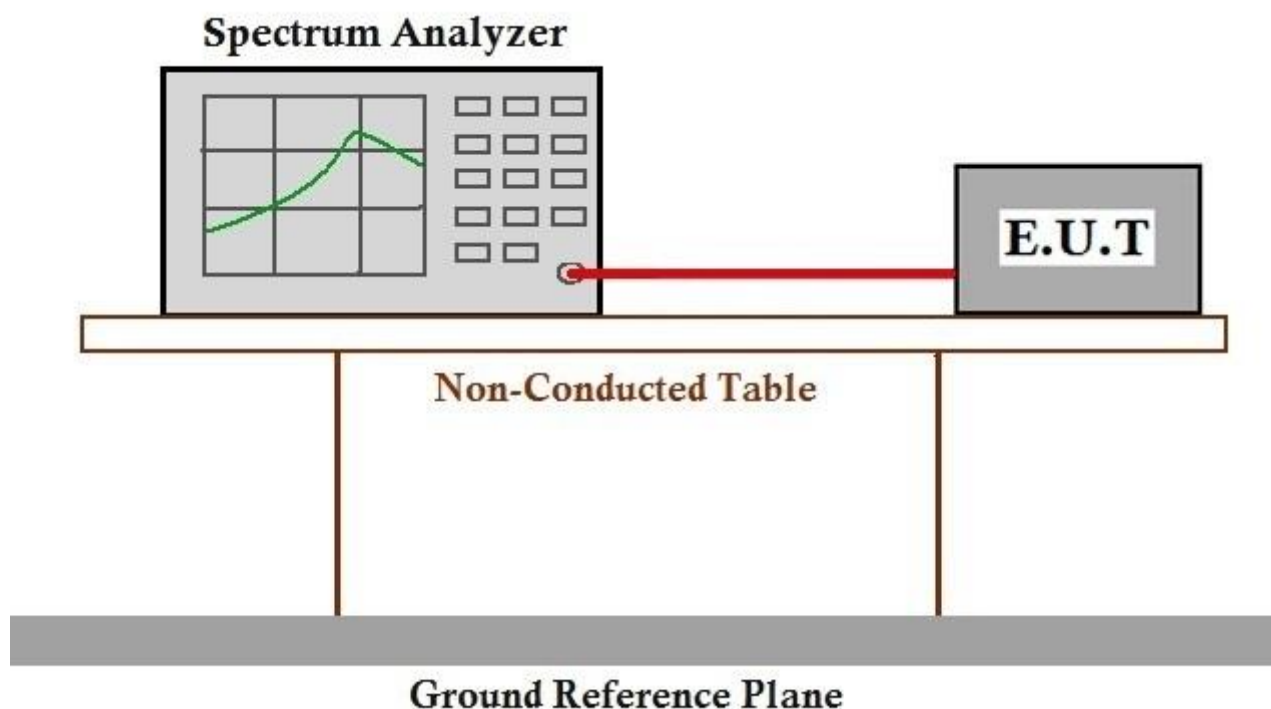
7.5.1 E.U.T. Operation

Operating Environment:

Temperature: 22 °C Humidity: 50 % RH Atmospheric Pressure: 1002 mbar

Test mode c: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 B SHEM180800704102

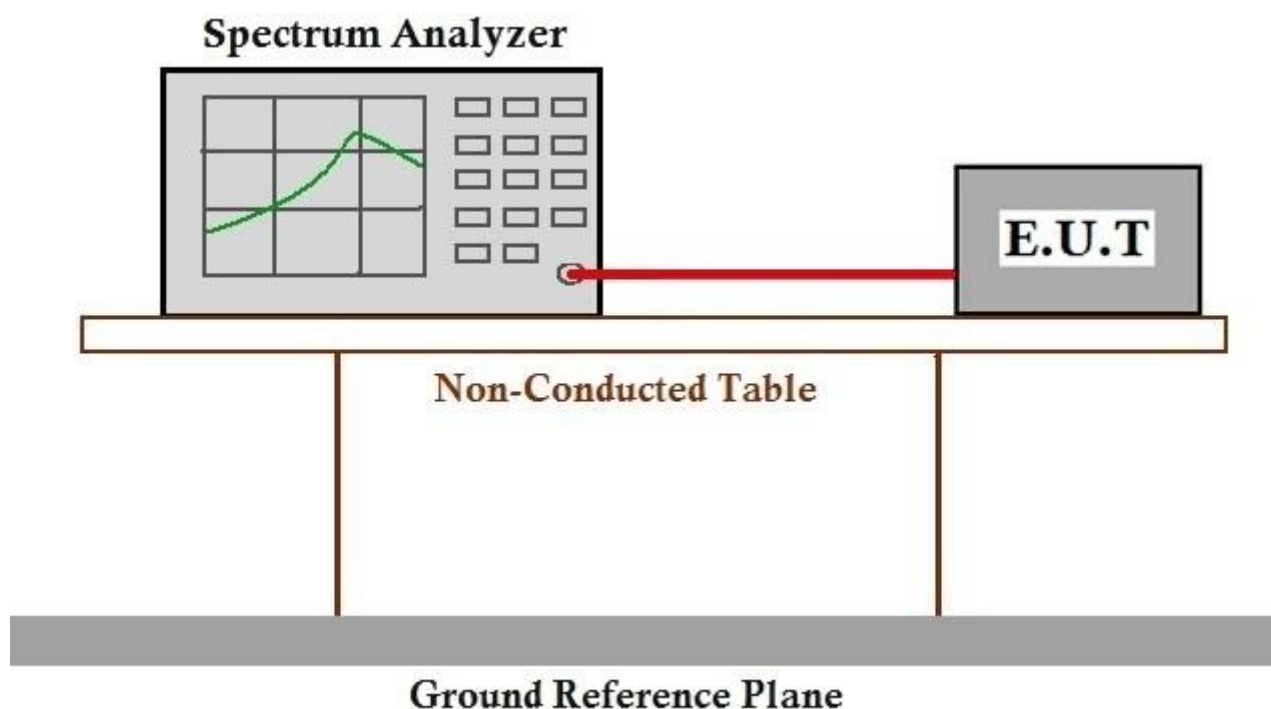
7.6 Conducted Band Edges Measurement

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))

7.6.1 E.U.T. Operation

Operating Environment:					
Temperature:	22 °C	Humidity:	50 % RH	Atmospheric Pressure:	1002 mbar
Test mode	c: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 B SHEM180800704102

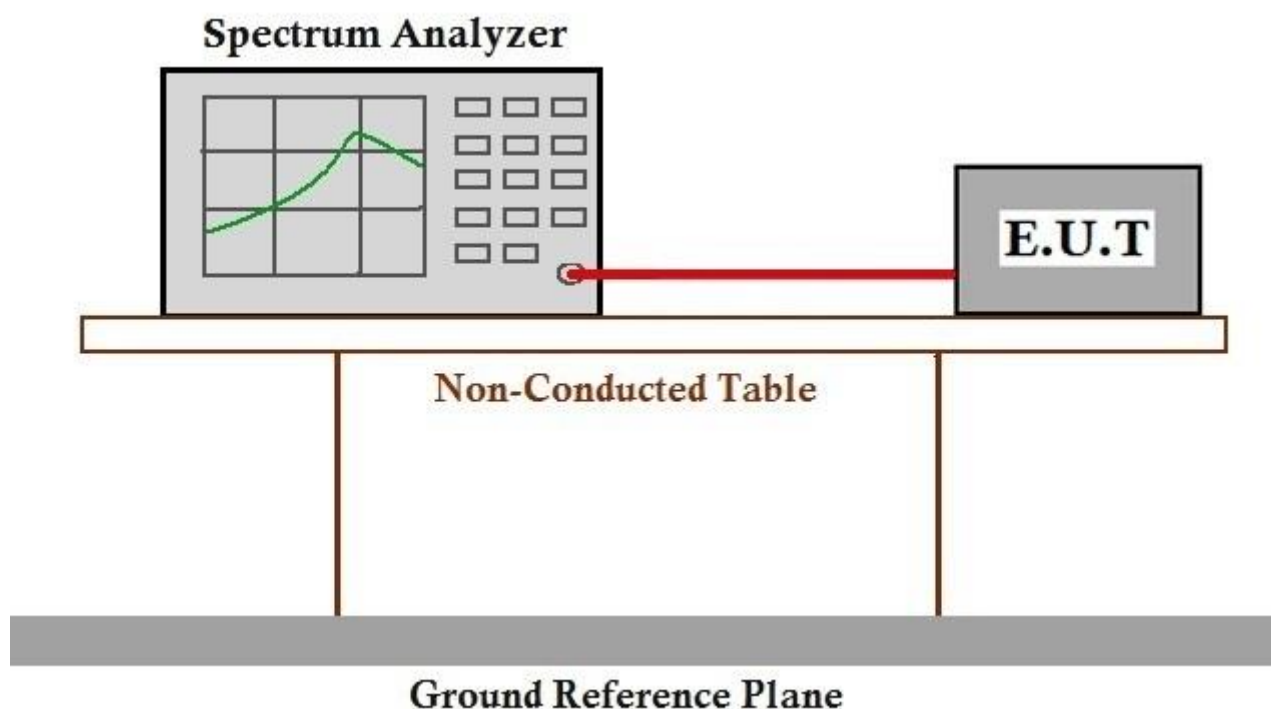
7.7 Conducted Spurious Emissions

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))

7.7.1 E.U.T. Operation

Operating Environment:					
Temperature:	22 °C	Humidity:	50 % RH	Atmospheric Pressure:	1002 mbar
Test mode	c: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

The detailed test data see: Appendix B SHEM180800704102

7.8 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.

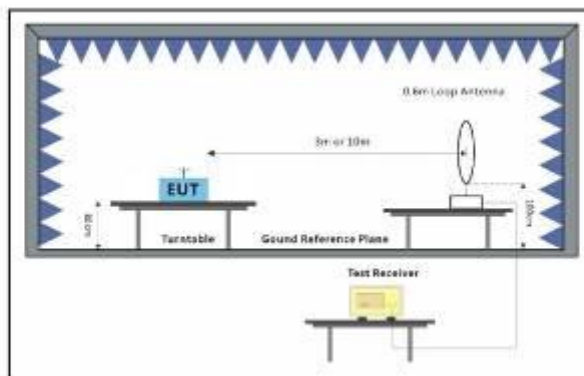
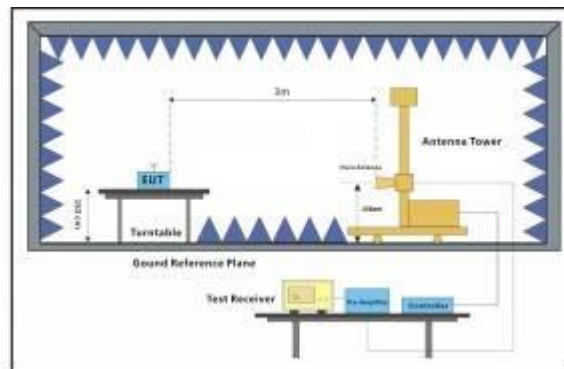
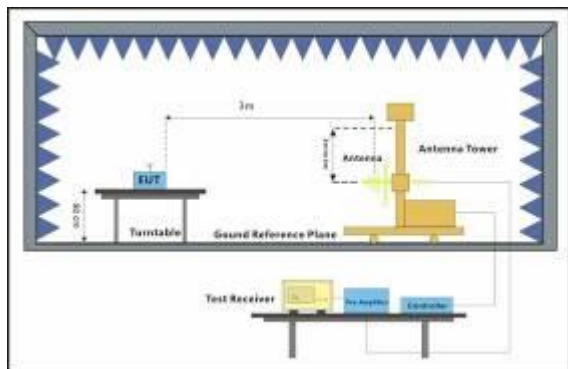
7.8.1 E.U.T. Operation

Operating Environment:

Temperature: 22 °C Humidity: 50 % RH Atmospheric Pressure: 1010 mbar

Test mode c: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

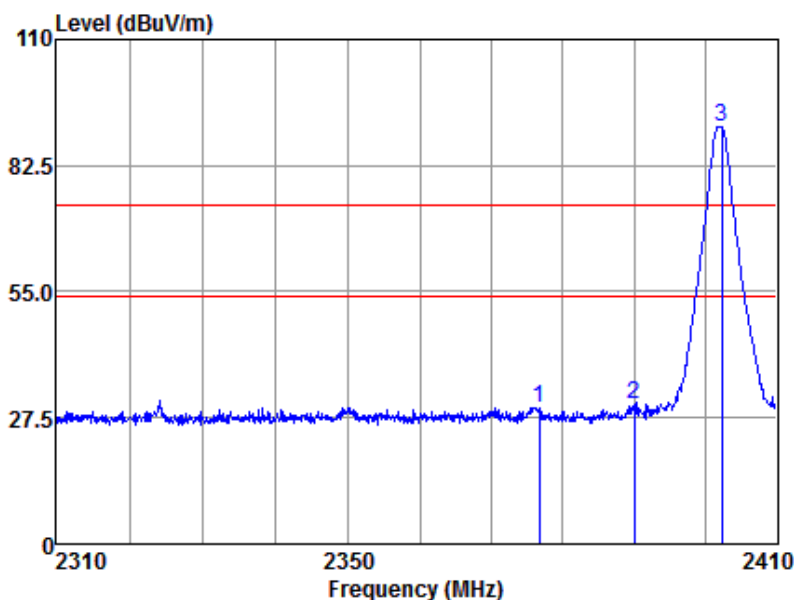
- a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 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: $\text{Level} = \text{Read Level} + \text{Cable Loss} + \text{Antenna Factor} - \text{Preamplifier Factor}$

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



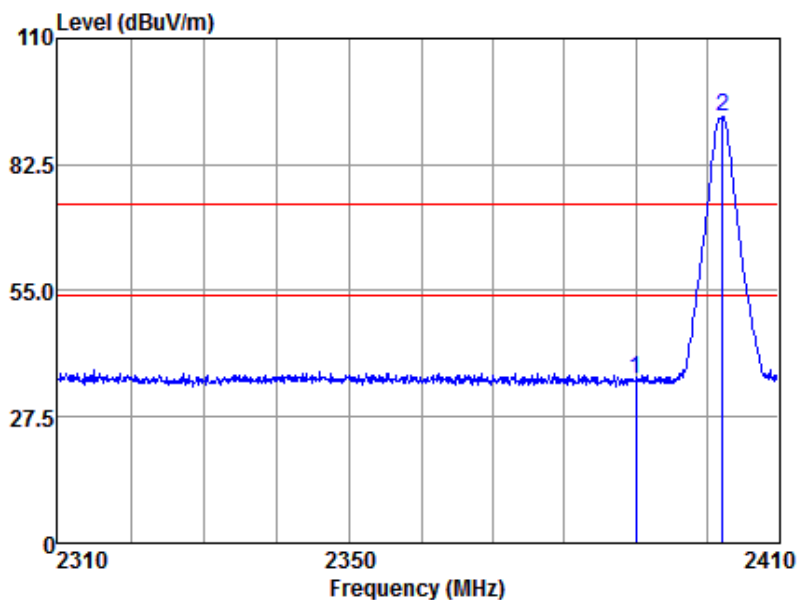
Antenna Polarity :HORIZONTAL

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	
2376.63	34.65	26.02	6.45	37.36	29.76	74.00	-44.24	Peak
2390.00	35.23	26.03	6.47	37.36	30.37	74.00	-43.63	Peak
2402.35	95.83	26.05	6.50	37.35	91.03	74.00	17.03	Peak

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



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



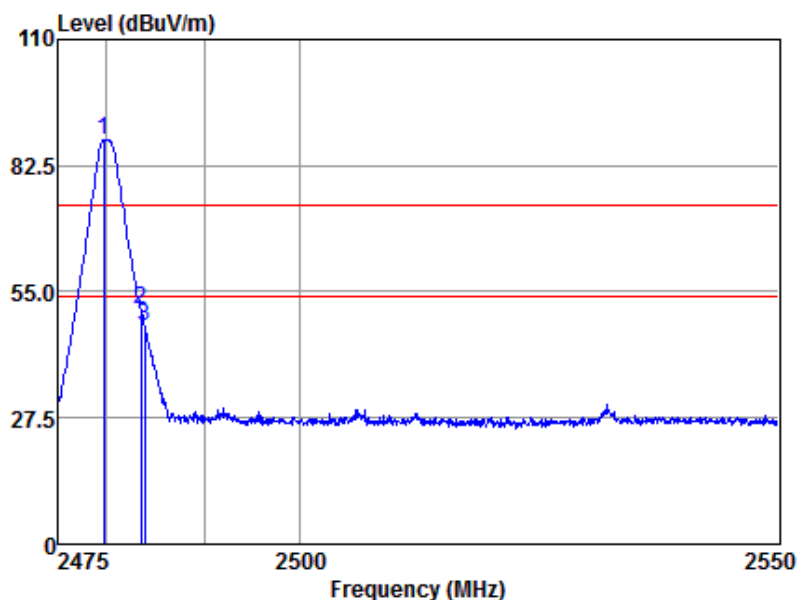
Antenna Polarity :VERTICAL

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	
2390.00	40.51	26.03	6.47	37.36	35.65	74.00	-38.35	Peak
2402.25	97.65	26.05	6.50	37.35	92.85	74.00	18.85	Peak

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



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



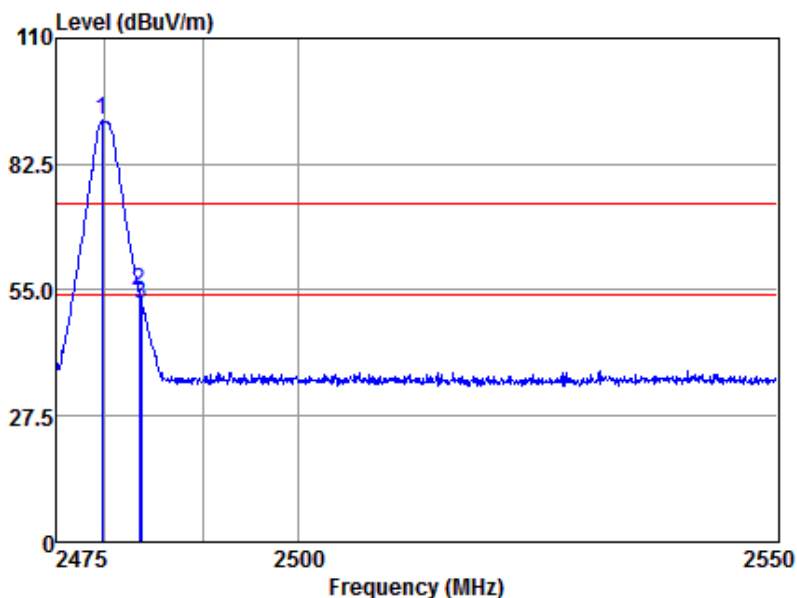
Antenna Polarity :HORIZONTAL

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	
2479.66	92.81	26.17	6.74	37.49	88.23	74.00	14.23	Peak
2483.50	55.57	26.18	6.80	37.51	51.04	74.00	-22.96	Peak
2483.88	52.16	26.18	6.80	37.51	47.63	74.00	-26.37	Peak

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



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



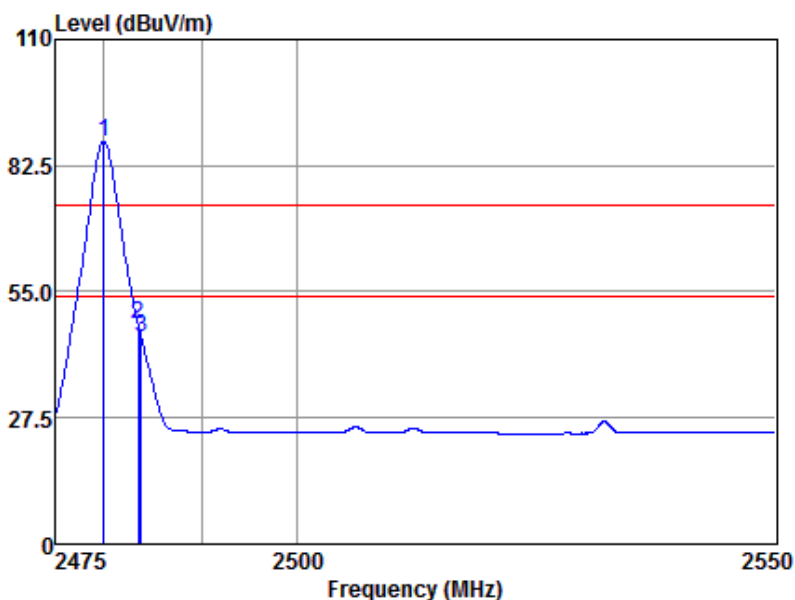
Antenna Polarity :VERTICAL

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	
2479.66	96.53	26.17	6.74	37.49	91.95	74.00	17.95	Peak
2483.51	59.17	26.18	6.80	37.51	54.64	74.00	-19.36	Peak
2483.73	56.65	26.18	6.80	37.51	52.12	74.00	-21.88	Peak

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



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



Antenna Polarity :VERTICAL

Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Emission Level	Limit	Over Limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
2479.96	92.37	26.17	6.74	37.49	87.79	54.00	33.79	Average
2483.51	52.61	26.18	6.80	37.51	48.08	54.00	-5.92	Average
2483.81	49.74	26.18	6.80	37.51	45.21	54.00	-8.79	Average

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

7.9 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.

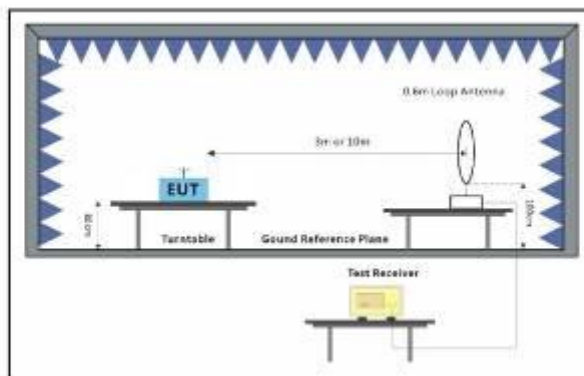
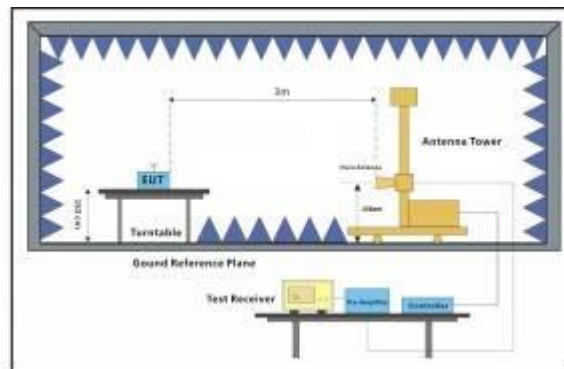
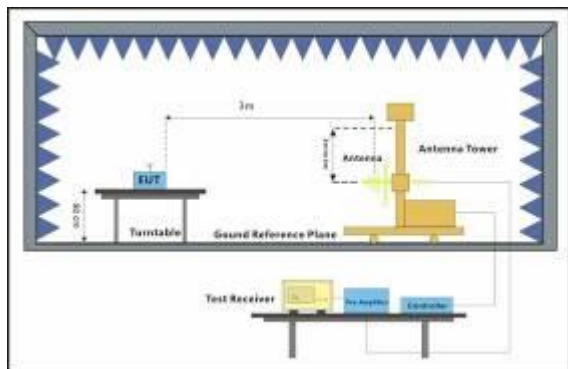
7.9.1 E.U.T. Operation

Operating Environment:

Temperature: 22 °C Humidity: 50 % RH Atmospheric Pressure: 1010 mbar

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

7.9.2 Test Setup Diagram





7.9.3 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:

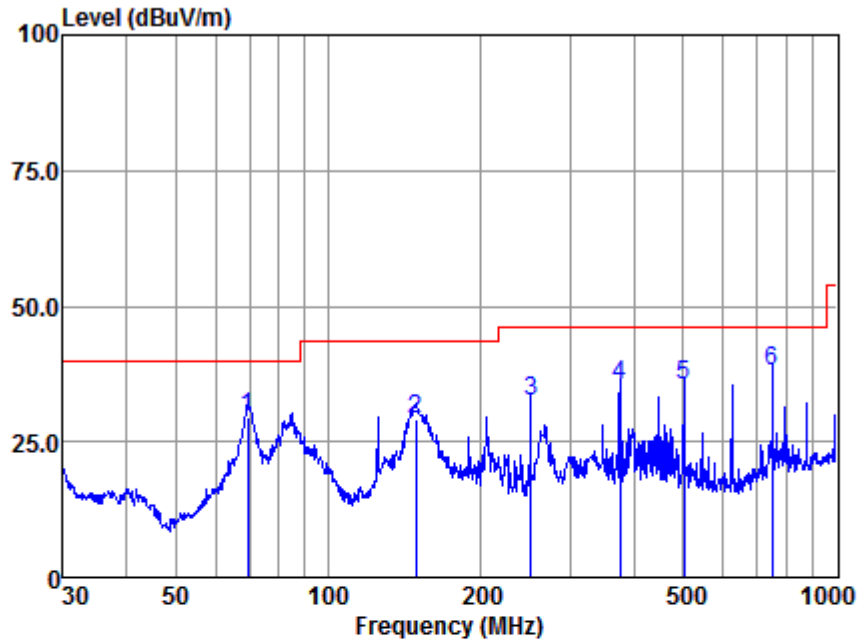
Final Test Level = Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor

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



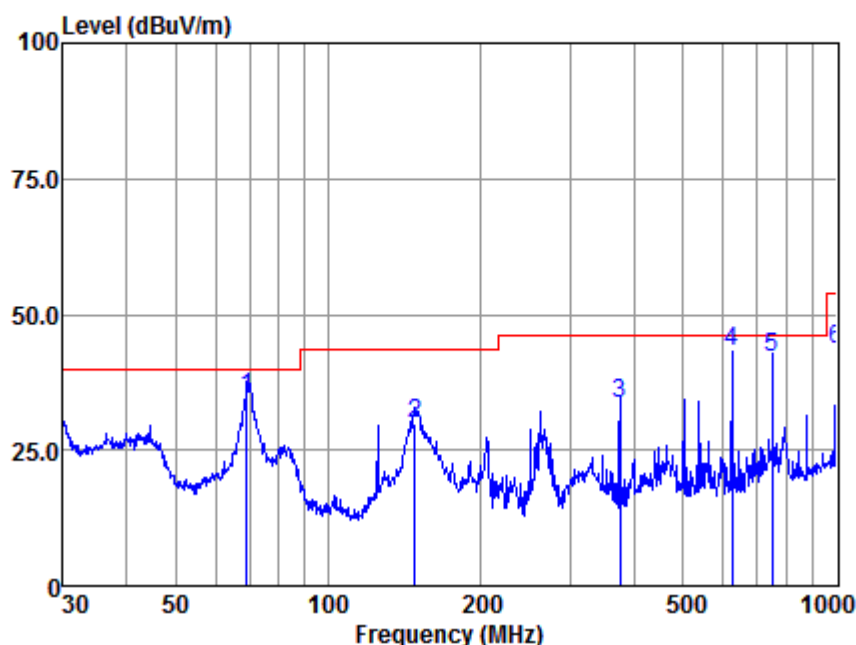
Below 1GHz:



Antenna Polarity :HORIZONTAL
EUT/Project :5213CR
Test mode :c

	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	69.36	60.32	11.48	0.34	42.66	29.48	40.00	-10.52	QP
2	148.96	59.28	11.84	0.62	42.61	29.13	43.50	-14.37	QP
3	250.30	62.74	11.50	0.77	42.46	32.55	46.00	-13.45	QP
4	375.94	61.92	14.68	0.95	42.16	35.39	46.00	-10.61	QP
5	501.18	59.27	17.24	1.18	42.14	35.55	46.00	-10.45	QP
6	750.11	57.61	21.09	1.88	42.57	38.01	46.00	-7.99	QP

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



Antenna Polarity : VERTICAL
EUT/Project : 5213CR
Test mode : c

	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	
1	69.11	65.43	11.51	0.34	42.66	34.62	40.00	-5.38	QP
2	147.92	60.08	11.78	0.62	42.61	29.87	43.50	-13.63	QP
3	375.94	60.13	14.68	0.95	42.16	33.60	46.00	-12.40	QP
4	625.08	64.16	19.62	1.41	42.19	43.00	46.00	-3.00	QP
5	750.11	61.51	21.09	1.88	42.57	41.91	46.00	-4.09	QP
6	1000.00	57.94	23.80	2.83	41.20	43.37	54.00	-10.63	QP

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



Above 1GHz:

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

Frequency	RX_R	Factor	Emission	Limit	Margin	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
4804	36.04	6.18	42.22	54	-11.78	peak
7206	37.96	10.63	48.59	54	-5.41	peak
9608	35.54	14.38	49.92	54	-4.08	peak

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

Frequency	RX_R	Factor	Emission	Limit	Margin	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
4804	37.21	6.18	43.39	54	-10.61	peak
7206	36.42	10.63	47.05	54	-6.95	peak
9608	36.32	14.38	50.7	54	-3.3	peak

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

Frequency	RX_R	Factor	Emission	Limit	Margin	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
4880	34.68	6.97	41.65	54	-12.35	peak
7320	34.97	11.12	46.09	54	-7.91	peak
9760	34.75	14.35	49.1	54	-4.9	peak

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

Frequency	RX_R	Factor	Emission	Limit	Margin	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
4880	37.46	6.97	44.43	54	-9.57	peak
7320	36.25	11.12	47.37	54	-6.63	peak
9760	35.35	14.35	49.7	54	-4.3	peak

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

Frequency	RX_R	Factor	Emission	Limit	Margin	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
4960	41.17	7.49	48.66	54	-5.34	peak
7440	37.22	11.65	48.87	54	-5.13	peak
9920	34.39	14.4	48.79	54	-5.21	peak

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

Frequency	RX_R	Factor	Emission	Limit	Margin	Detector
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
4960	39.17	7.49	46.66	54	-7.34	peak
7440	35.15	11.65	46.8	54	-7.2	peak
9920	32.63	14.4	47.03	54	-6.97	peak

7.10 99% Bandwidth

Test Requirement RSS-Gen Section 6.6

Test Method: ANSI C63.10 Section 6.9.3

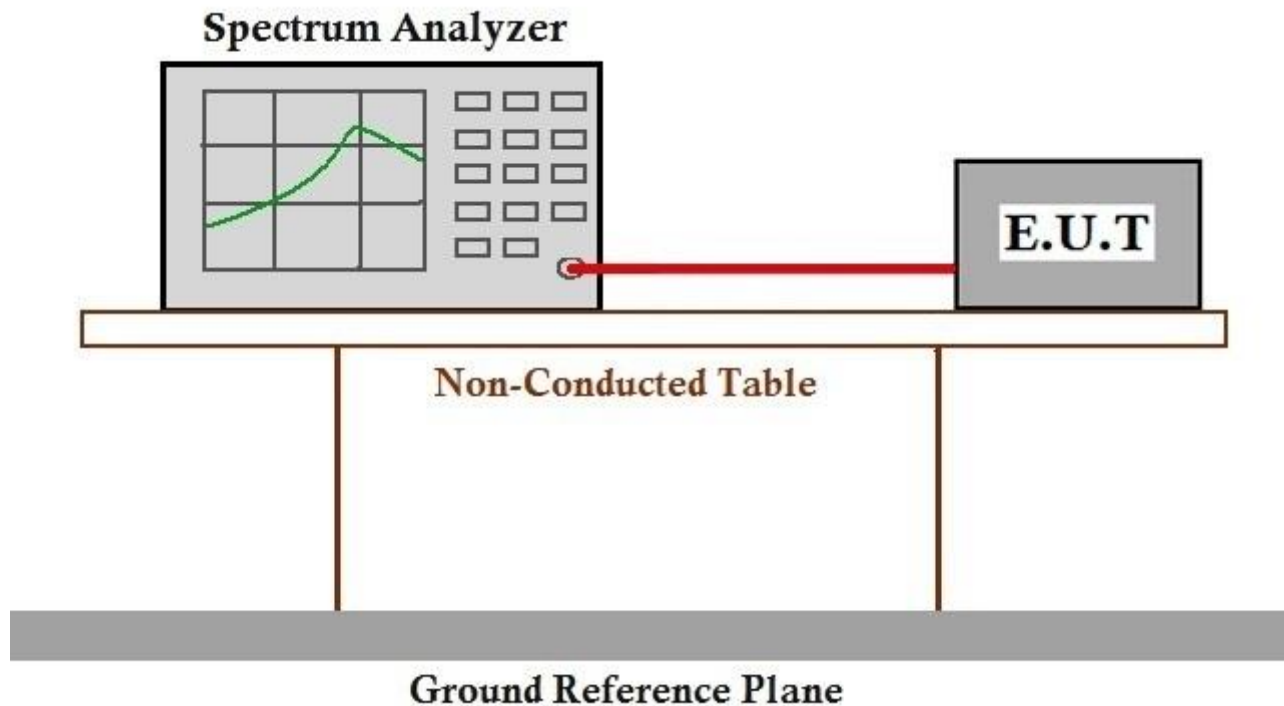
7.10.1 E.U.T. Operation

Operating Environment:

Temperature: 22 °C Humidity: 50 % RH Atmospheric Pressure: 1002 mbar

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

7.10.2 Test Setup Diagram



7.10.3 Measurement Procedure and Data

The detailed test data see: Appendix B SHEM180800704102



8 Test Setup Photographs

Refer to the < Test Setup photos-FCC>.

9 EUT Constructional Details

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

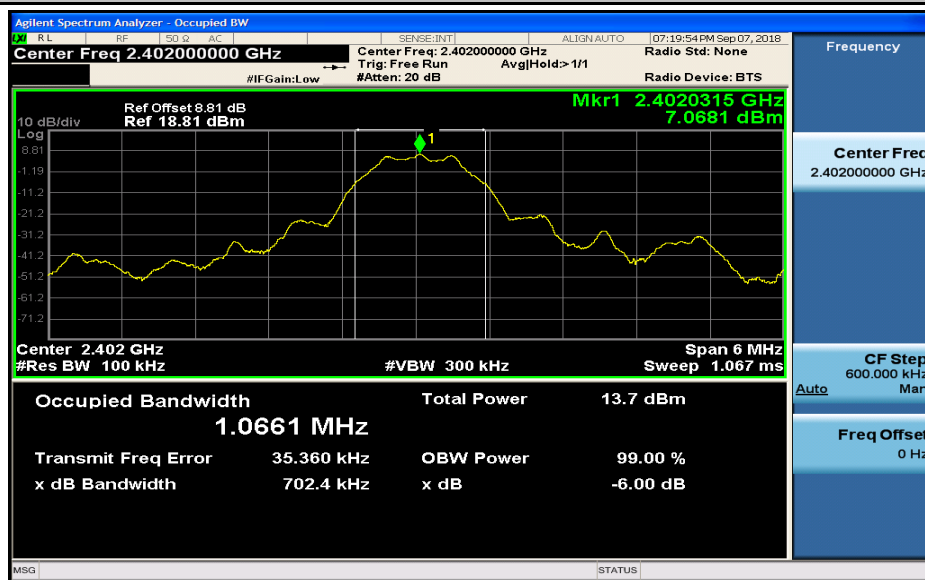


Appendix B for SHEM180800704102

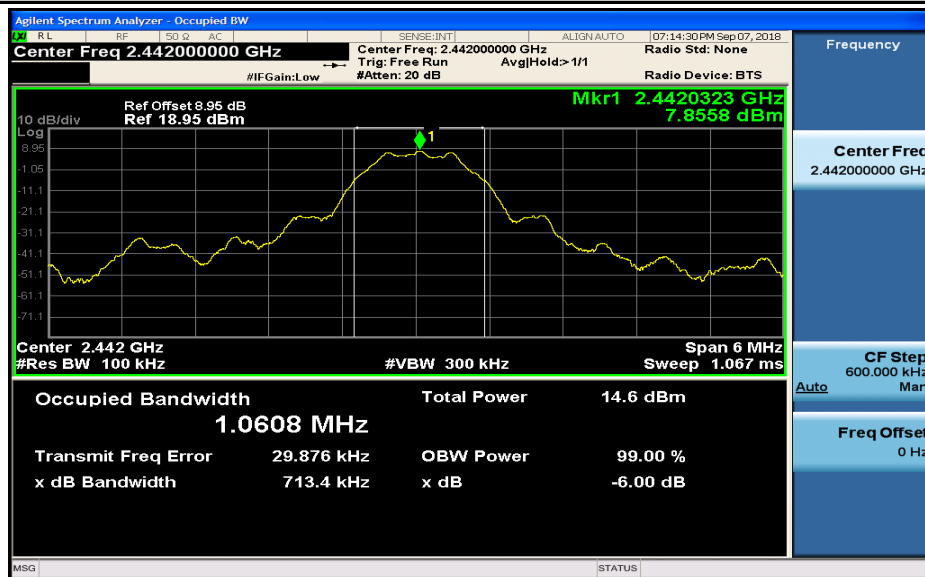
1.6dB Bandwidth

Test Mode	Test Channel	EBW[MHz]	Limit	Verdict
BLE	2402	0.70	0.5	PASS
BLE	2442	0.71	0.5	PASS
BLE	2480	0.71	0.5	PASS

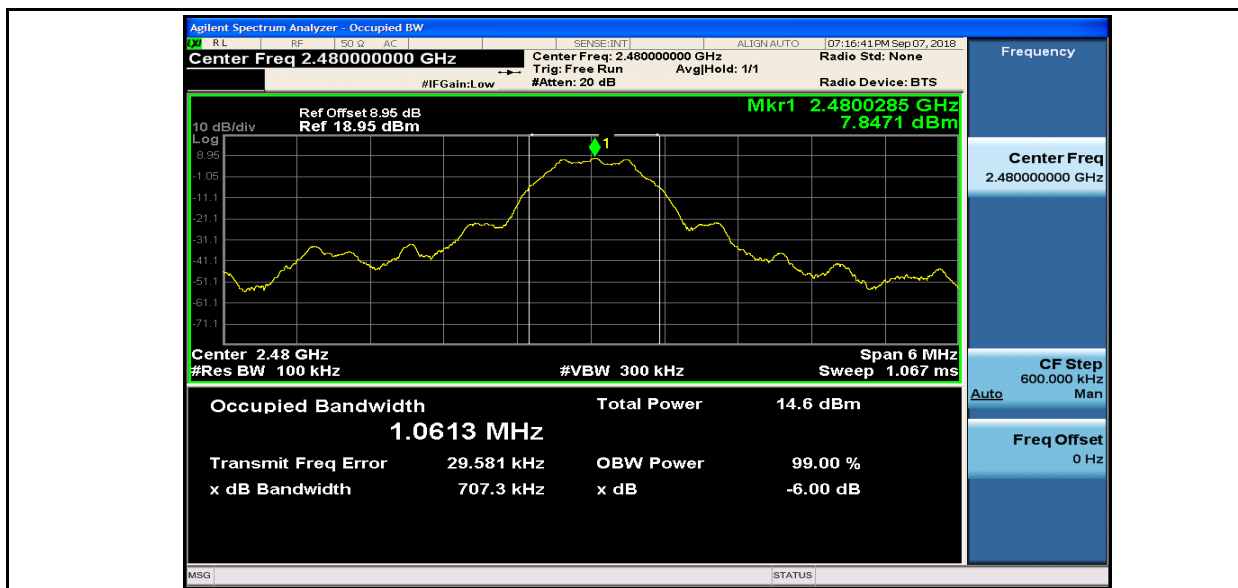
6dB Bandwidth_BLE_2402



6dB Bandwidth_BLE_2442



6dB Bandwidth_BLE_2480



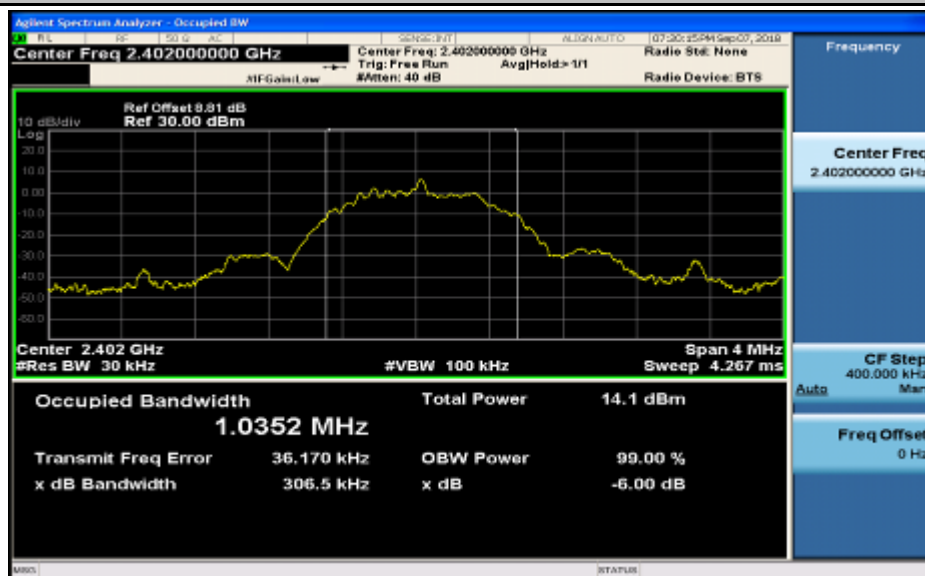


2.Occupied Bandwidth

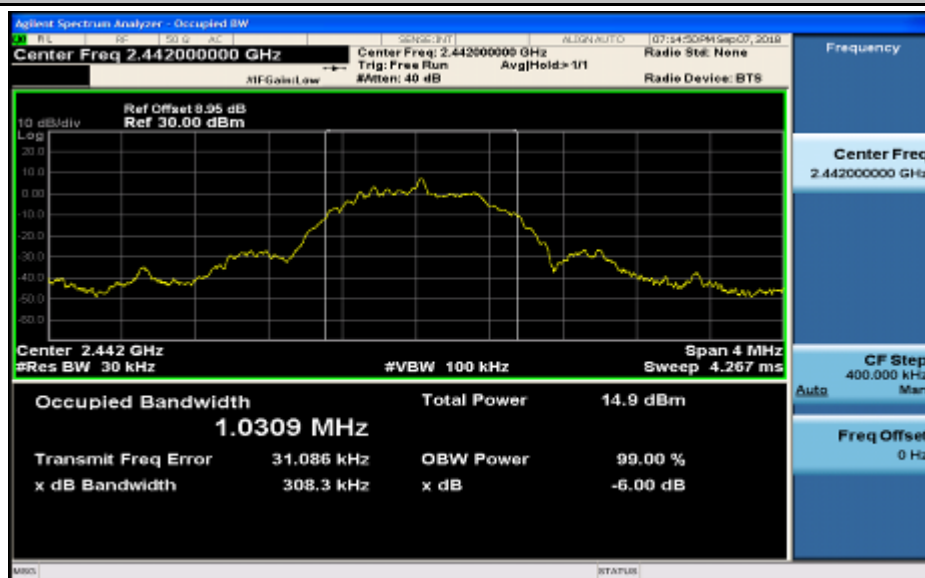
Test Mode	Test Channel	OBW[MHz]	Limit[MHz]	Verdict
BLE	2402	1.04	---	PASS
BLE	2442	1.03	---	PASS
BLE	2480	1.03	---	PASS



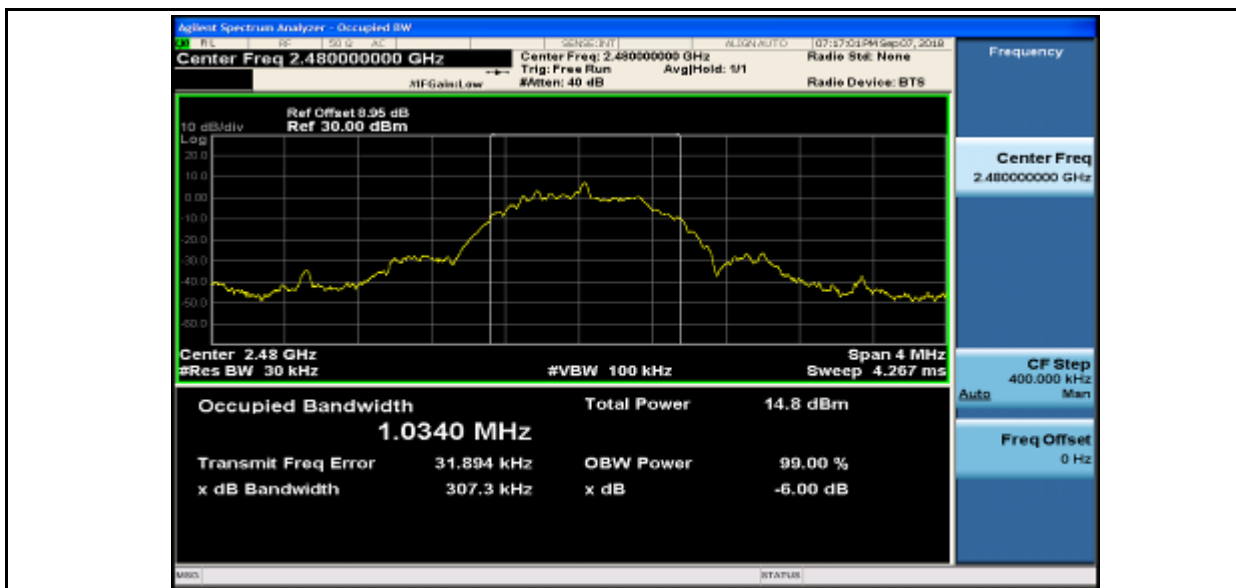
Occupied Bandwidth_BLE_2402



Occupied Bandwidth_BLE_2442



Occupied Bandwidth_BLE_2480

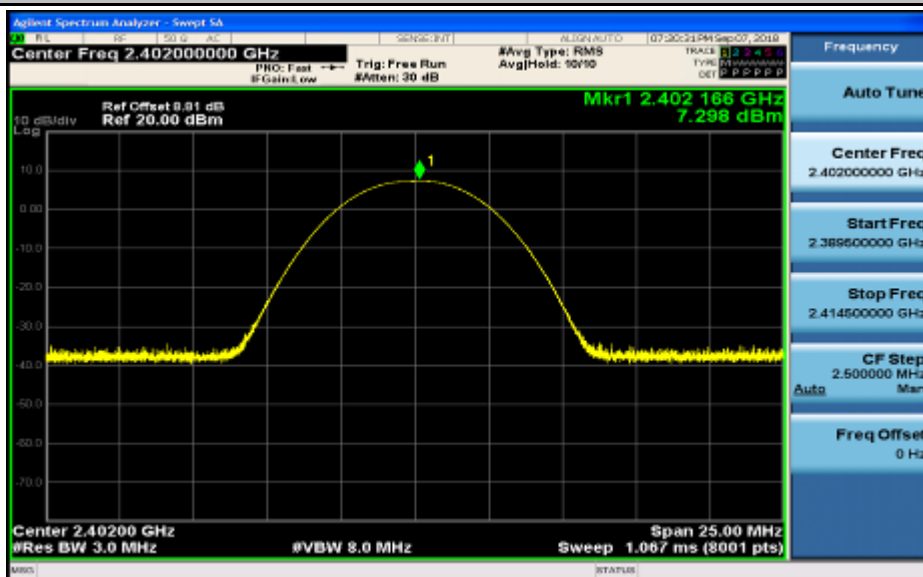




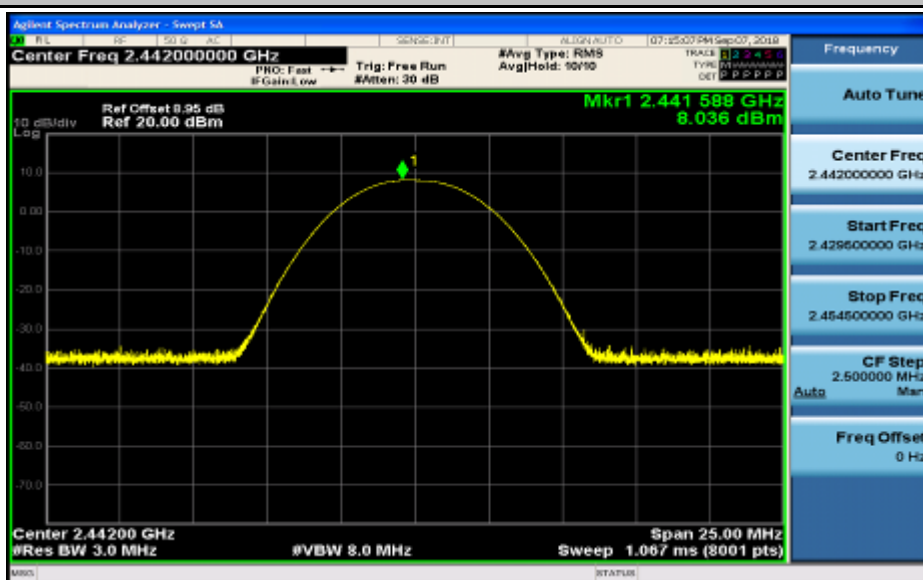
3.Maximum peak conducted output power

Test Mode	Test Channel	Power[dBm]	Limit[dBm]	Verdict
BLE	2402	7.30	30	PASS
BLE	2442	8.04	30	PASS
BLE	2480	8.07	30	PASS

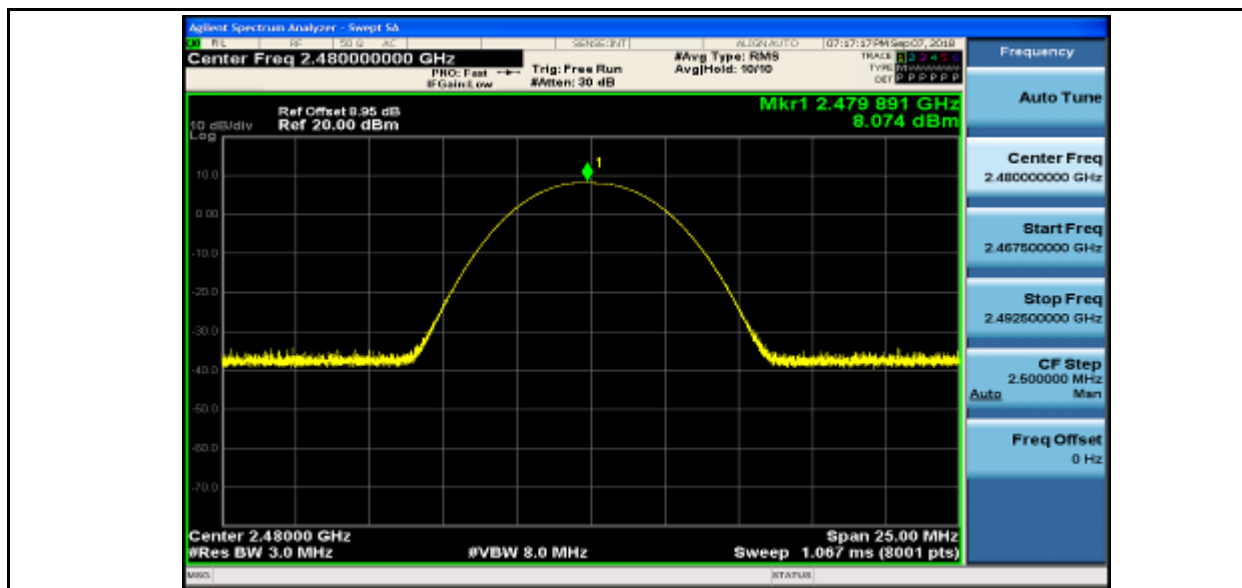
Maximum peak conducted output power_BLE_2402



Maximum peak conducted output power_BLE_2442



Maximum peak conducted output power_BLE_2480

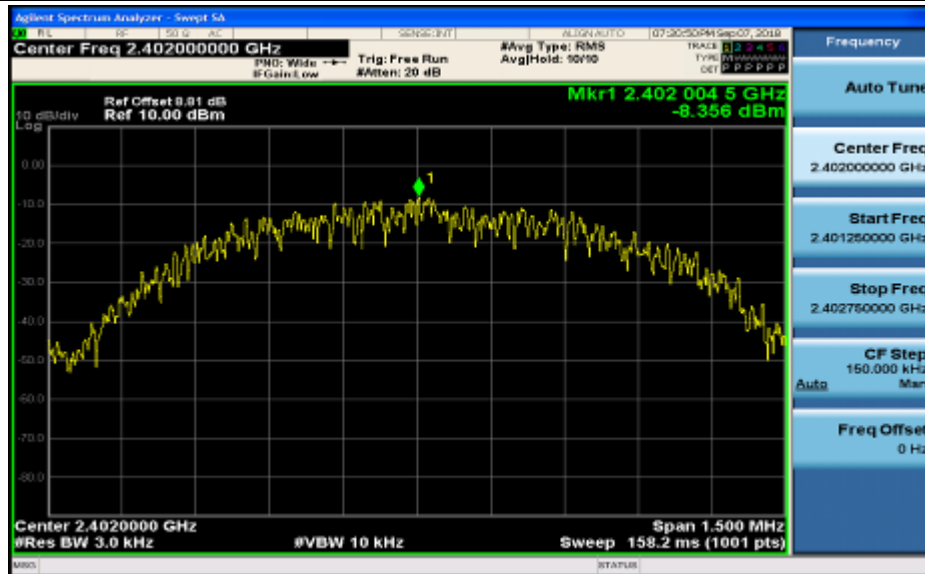




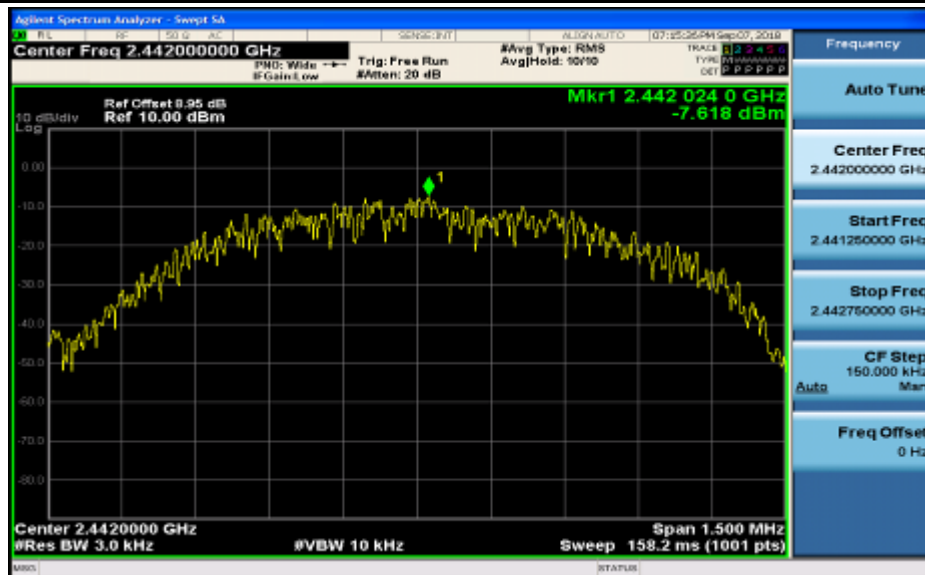
4.Maximum Peak power spectral density

Test Mode	Test Channel	PSD[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
BLE	2402	-8.36	8.00	PASS
BLE	2442	-7.62	8.00	PASS
BLE	2480	-7.61	8.00	PASS

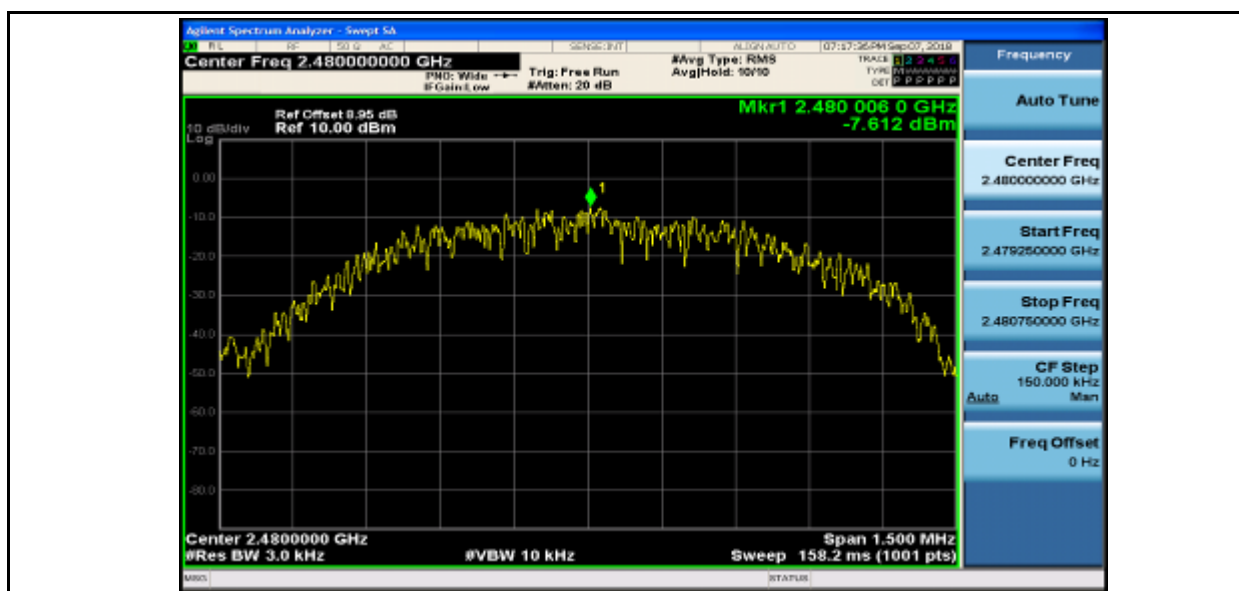
Maximum Peak power spectral density_BLE_2402



Maximum Peak power spectral density_BLE_2442



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	7.10	-39.66	-12.90	PASS
BLE	2480	7.81	-54.60	-12.19	PASS



Band-edge for RF Conducted Emissions_BLE_2402_Hopping Off



Band-edge for RF Conducted Emissions_BLE_2480_Hopping Off



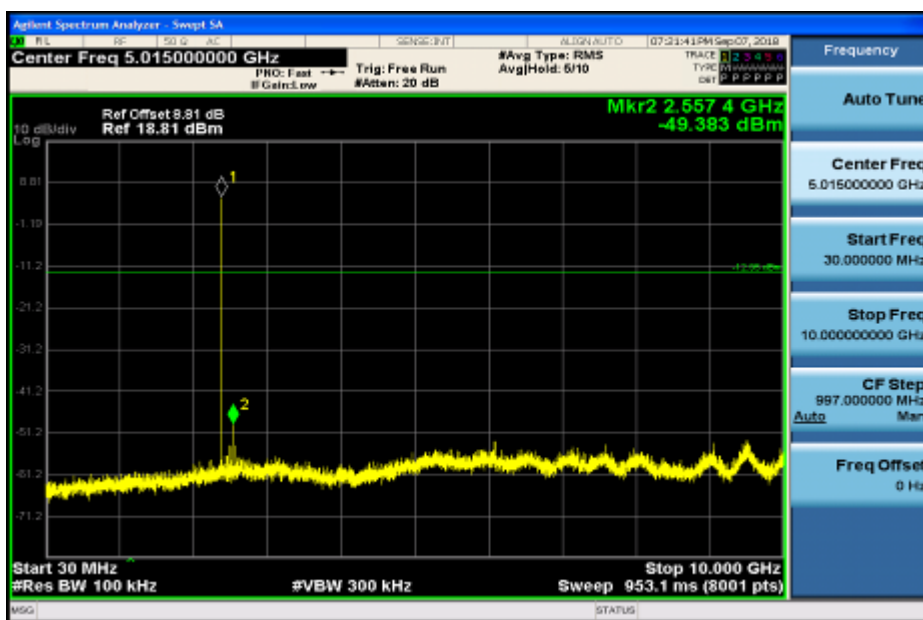


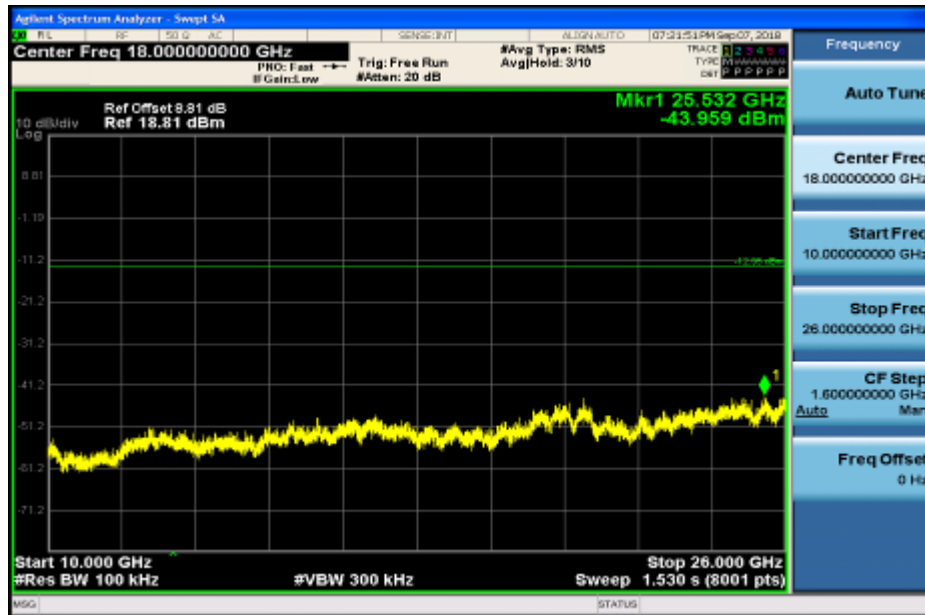
6.RF Conducted Spurious Emissions

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	7.05	-49.38	<-12.95	PASS
BLE	2402	10000	26000	100	300	7.046	-43.959	<-12.954	PASS
BLE	2442	30	10000	100	300	7.80	-51.01	<-12.20	PASS
BLE	2442	10000	26000	100	300	7.803	-42.769	<-12.197	PASS
BLE	2480	30	10000	100	300	7.82	-48.48	<-12.18	PASS
BLE	2480	10000	26000	100	300	7.82	-42.762	<-12.18	PASS



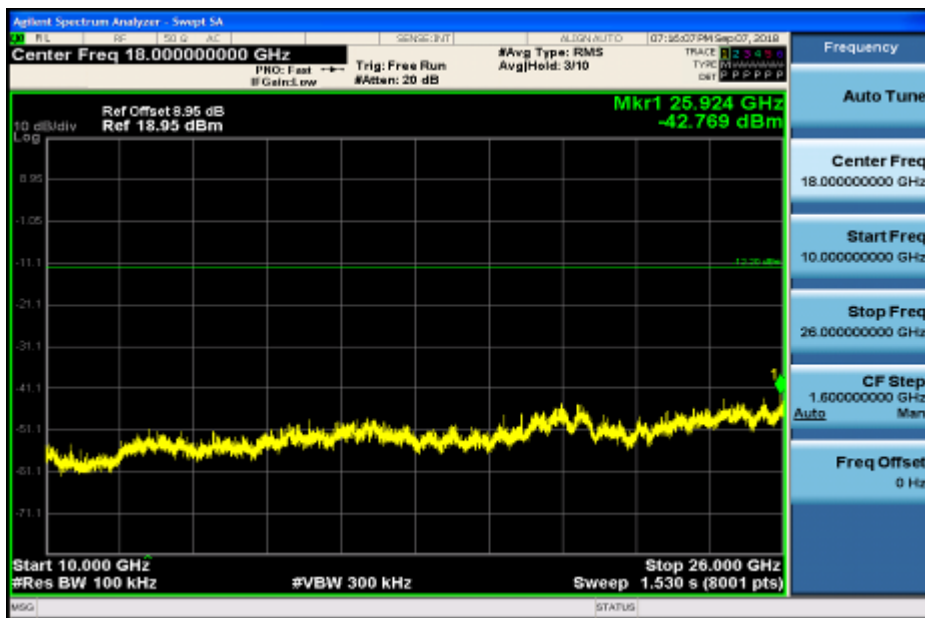
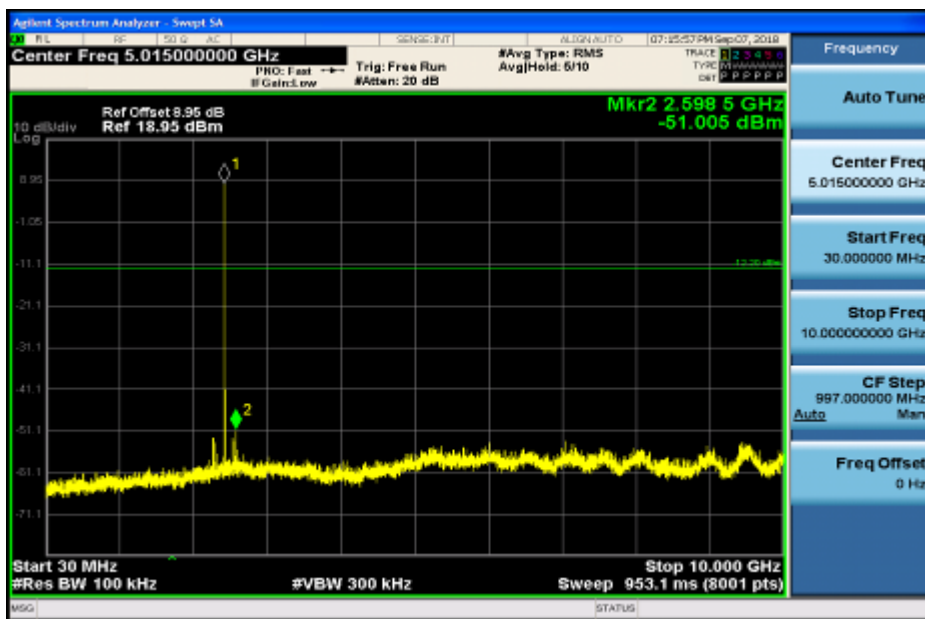
RF Conducted Spurious Emissions_BLE_2402





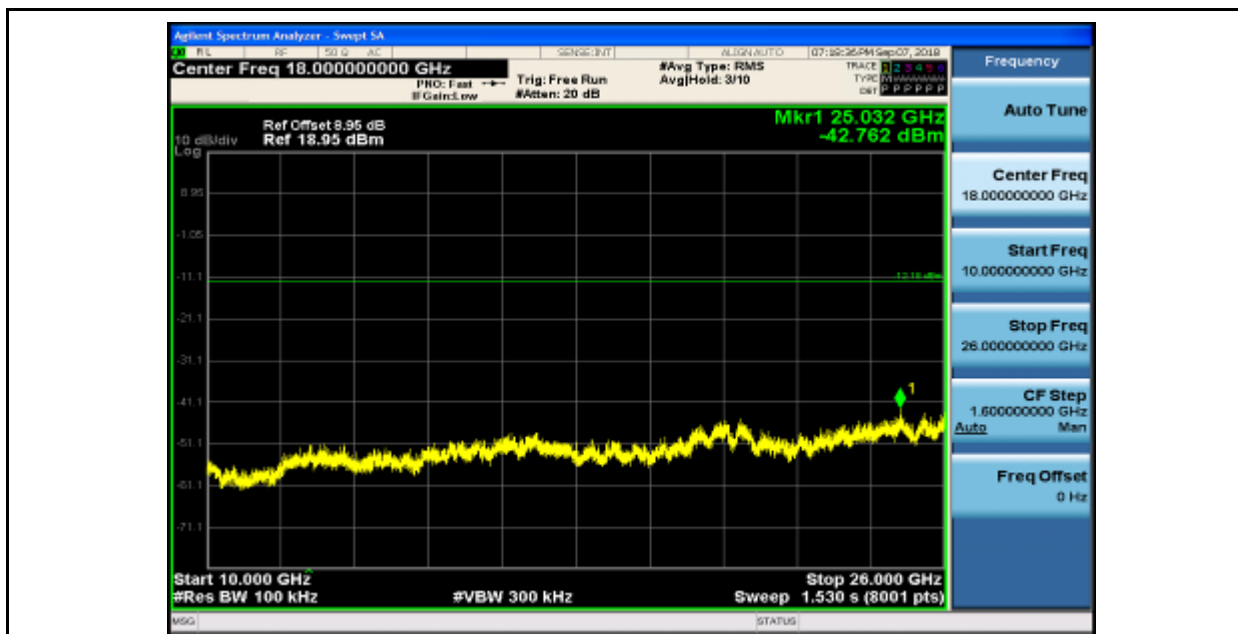
RF Conducted Spurious Emissions_BLE_2442





RF Conducted Spurious Emissions_BLE_2480





- End of the Report -