TEST REPORT

Application No.:	SHCR2112000903MI
FCC ID:	2A3VDH3G-THWL
Applicant:	Hangzhou Huasu Technology Co Ltd
Address of Applicant:	Building 3, 1418-50 Moganshan Road, Hangzhou, Zhejiang, China
Manufacturer:	Hangzhou Huasu Technology Co Ltd
Address of Manufacturer:	Building 3, 1418-50 Moganshan Road, Hangzhou, Zhejiang, China
Factory:	Hangzhou Huasu Technology Co Ltd
Address of Factory:	Building 3, 1418-50 Moganshan Road, Hangzhou, Zhejiang, China
Equipment Under Test (EUT):	
EUT Name:	Wireless battery monitoring module
Model No.:	H3G-TH-02WL,H3G-TH-02WLF,H3G-TH-12WL,H3G-TH-12WLF
Standard(s) :	47 CFR Part 15, Subpart C 15.247
Date of Receipt:	2021-12-02
Date of Test:	2021-12-04 to 2021-12-18
Date of Issue:	2021-12-27
Test Result:	**Pass***

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

Parlam Zhan
Laboratory Manager

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Revision Record			
Version	**Description**	**Date**	**Remark**
00	Original	2021-12-27	/

Authorized for issue by:				
		Bill Wu		
		Bill Wu / Project Engineer		
		Parlam Zhan		
		Parlam Zhan / 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**
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 15.209 & 15.247(d)	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 15.209 & 15.247(d)	Pass

Note: Declaration of EUT Family Grouping:

Note: There are series models mentioned in this report, and they are the similar in electrical and electronic characters. Only the model H3G-TH-02WL was tested since their differences were the model number and software.

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4 General Information

4.1 Details of E.U.T.

Power supply:	DC 7-16V
Test voltage:	DC 12V
Antenna Gain:	5dBi (Provided by manufacturer)
Antenna Type:	PCB Antenna
Channel Spacing:	5MHz
Modulation Type:	O-QPSK
Number of Channels:	16
Operation Frequency:	2405MHz to 2480MHz

4.2 Description of Support Units

The EUT has been tested as an independent unit.

4.3 Power level setting using in test:

Channel	level
2405	default
2440	default
2480	default

4.4 Measurement Uncertainty

No.	Item	Measurement Uncertainty
1	Radio Frequency	8.4×10^{-8}
2	Timeout	2s
3	Duty Cycle	0.37%
4	Occupied Bandwidth	3%
5	RF Conducted Power	0.6dB
6	RF Power Density	2.9dB
7	Conducted Spurious Emissions	0.75dB
8	RF Radiated Power	5.2dB (Below 1GHz)
		5.9dB (Above 1GHz)
9	Radiated Spurious Emission Test	4.2dB (Below 30MHz)
		4.5dB (30MHz-1GHz)
		5.1dB (1GHz-18GHz)
		5.4dB (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.

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4.5 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 Fax: +86 21 6191 5678

No tests were sub-contracted.

4.6 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 17025:2017 General Requirements for the Competence of Testing and Calibration Laboratories (CNAS-CL01 Accreditation Criteria for the Competence of Testing and Calibration Laboratories) for the competence in the field of testing.

• A2LA (Certificate No. 6332.01)

SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd. is accredited by the American Association for Laboratory Accreditation(A2LA).

• FCC (Designation Number: CN1301)

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

• ISED (CAB Identifier: CN0020)

SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd. EMC Laboratory has been recognized by Innovation, Science and Economic Development Canada (ISED) as an accredited testing laboratory. Company Number: 8617A

• 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.

4.7 Deviation from Standards

None

4.8 Abnormalities from Standard Conditions

None

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5 Equipment List

Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
RF Conducted Test					
Spectrum Analyzer	R&S	FSP-30	SHEM002-1	2020-12-20	2021-12-19
Spectrum Analyzer	Keysight	N9020B	SHEM241-1	2021-08-30	2022-08-29
Spectrum Analyzer	Agilent	N9020A	SHEM181-1	2021-08-13	2022-08-12
Signal Generator	R&S	SMR20	SHEM006-1	2021-08-13	2022-08-12
Signal Generator	Agilent	N5182A	SHEM182-1	2021-08-13	2022-08-12
Communication Tester	R&S	CMW270	SHEM183-1	2021-07-28	2022-07-27
Communication Tester	R&S	CMW500	SHEM183-2	2021-04-16	2022-04-15
Switcher	Tonscend	JS0806	SHEM184-1	2021-08-13	2022-08-12
Power Sensor	Keysight	U2021XA * 4	SHEM184-1	2021-08-13	2022-08-12
Splitter	Anritsu	MA1612A	SHEM185-1	/	/
Coupler	e-meca	803-S-1	SHEM186-1	/	/
High-low Temp Cabinet	Suzhou Zhihe	TL-40	SHEM087-1	2019-09-25	2022-09-24
AC Power Stabilizer	APC	KDF-31020T-V0-F0	SHEM216-1	2020-12-20	2021-12-19
DC Power Supply	MCH	MCH-303A	SHEM210-1	2020-12-20	2021-12-19
Conducted test Cable	/	RF01~RF04	/	2020-12-20	2021-12-19
Test software	Tonscend	JS Tonscend BT/WIFI System	Version: 2.6	/	/
RF Radiated Test					
EMI test Receiver	R&S	ESU40	SHEM051-1	2020-12-20	2021-12-19
Spectrum Analyzer	R&S	FSP-30	SHEM002-1	2020-12-20	2021-12-19
Communication Tester	R&S	CMW500	SHEM183-2	2021-04-16	2022-04-15
Loop Antenna (9kHz-30MHz)	Schwarzbeck	FMZB1519	SHEM135-1	2020-12-20	2021-12-19
Antenna (25MHz-2GHz)	Schwarzbeck	VULB9168	SHEM048-1	2021-09-11	2023-09-10
Antenna (25MHz-2GHz)	Schwarzbeck	VULB9168	SHEM202-1	2020-04-30	2022-04-29
Horn Antenna (1-18GHz)	Schwarzbeck	HF906	SHEM009-1	2019-10-24	2022-10-23
Horn Antenna (1-18GHz)	Schwarzbeck	BBHA9120D	SHEM050-1	2021-09-18	2023-09-17
Horn Antenna (14-40GHz)	Schwarzbeck	BBHA 9170	SHEM049-1	2021-09-18	2023-09-17
Pre-Amplifier	HP	8447D	SHEM236-1	2021-05-27	2022-05-26
Pre-Amplifier	PANSHAN	LNA 1-18G	SHEM235-1	2021-05-27	2022-05-26
High-amplifier (14-40GHz)	Schwarzbeck	10001	SHEM049-2	2020-12-20	2021-12-19
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	2020-05-25	2023-05-24
RE test Cable	/	RE01, RE02, RE06	/	2020-12-20	2021-12-19
Test software	ESE	E3	Version: 6.111221a	/	/

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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 5dBi.

Antenna location: Refer to Appendix (Internal Photos)

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7 Radio Spectrum Matter Test Results

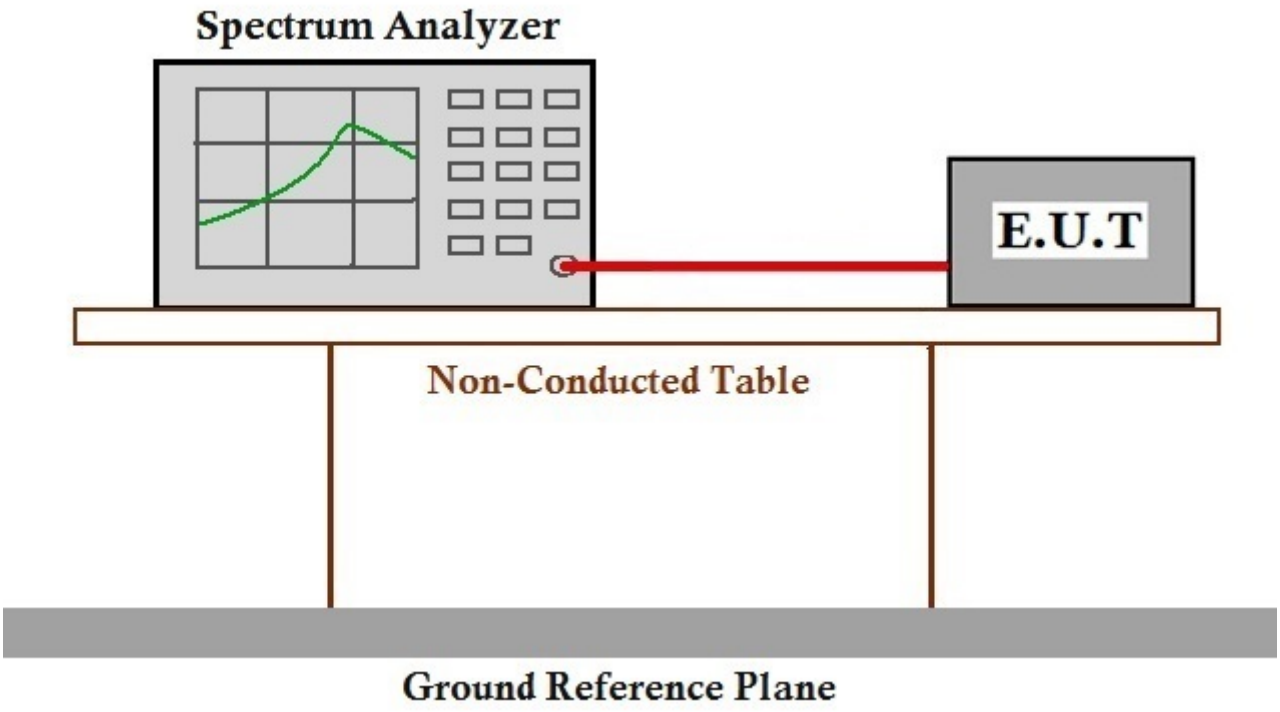
7.1 Minimum 6dB Bandwidth

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

7.1.1 E.U.T. Operation

Operating Environment:
Temperature: 22 °C Humidity: 50 % RH Atmospheric Pressure: 1001 mbar
Test mode a:TX mode_Keep the EUT in continuously transmitting with O-QPSK modulation mode.

7.1.2 Test Setup Diagram



7.1.3 Measurement Procedure and Data

The detailed test data see: Appendix A for SHCR211200090301

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7.2 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

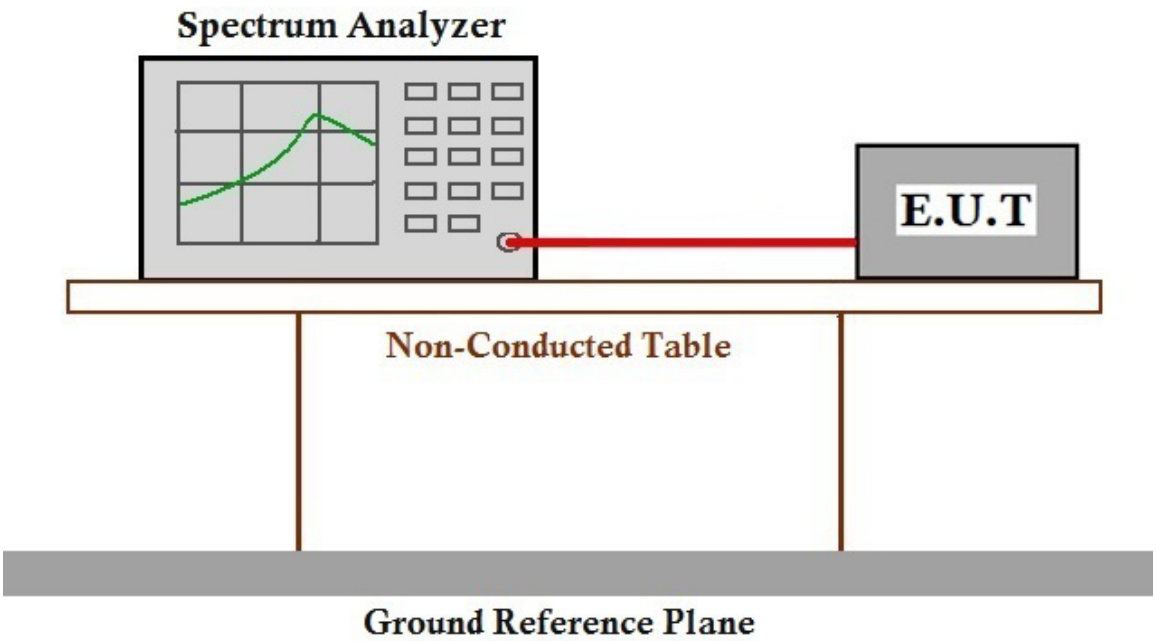
7.2.1 E.U.T. Operation

Operating Environment:

Temperature: 22 °C Humidity: 50 % RH Atmospheric Pressure: 1001 mbar

Test mode a:TX mode_Keep the EUT in continuously transmitting with O-QPSK modulation mode.

7.2.2 Test Setup Diagram



7.2.3 Measurement Procedure and Data

The detailed test data see: Appendix A for SHCR211200090301

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7.3 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

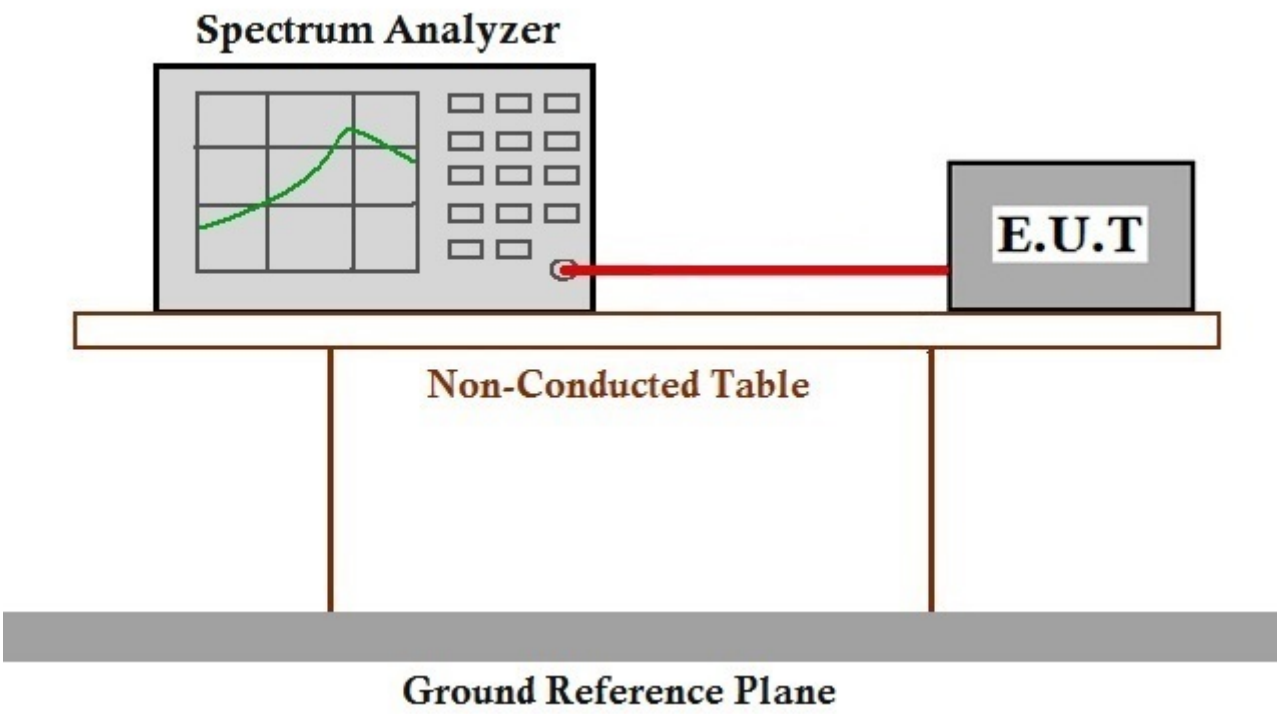
7.3.1 E.U.T. Operation

Operating Environment:

Temperature: 22 °C Humidity: 50 % RH Atmospheric Pressure: 1001 mbar

Test mode a:TX mode_Keep the EUT in continuously transmitting with O-QPSK modulation mode.

7.3.2 Test Setup Diagram



7.3.3 Measurement Procedure and Data

The detailed test data see: Appendix A for SHCR211200090301

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7.4 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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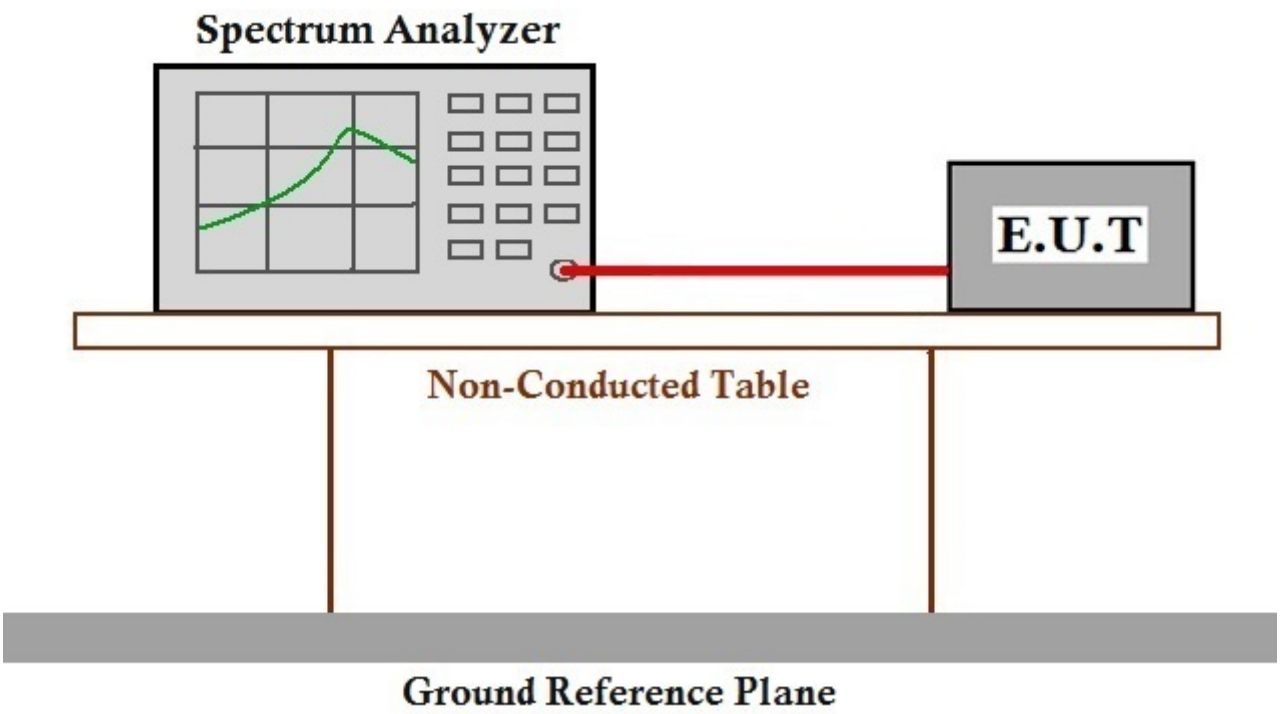
7.4.1 E.U.T. Operation

Operating Environment:

Temperature: 22 °C Humidity: 50 % RH Atmospheric Pressure: 1001 mbar

Test mode a:TX mode_Keep the EUT in continuously transmitting with O-QPSK modulation mode.

7.4.2 Test Setup Diagram



7.4.3 Measurement Procedure and Data

The detailed test data see: Appendix A for SHCR211200090301

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7.5 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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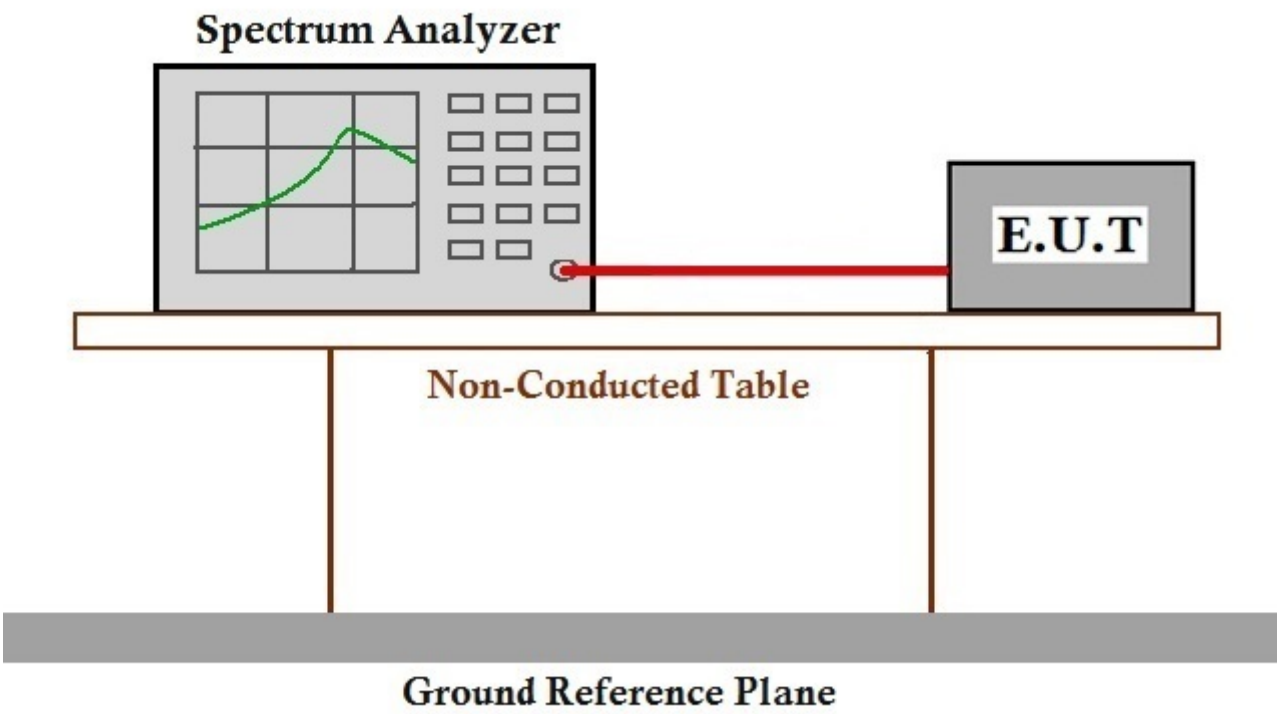
7.5.1 E.U.T. Operation

Operating Environment:

Temperature: 22 °C Humidity: 50 % RH Atmospheric Pressure: 1001 mbar

Test mode a:TX mode_Keep the EUT in continuously transmitting with O-QPSK modulation mode.

7.5.2 Test Setup Diagram



7.5.3 Measurement Procedure and Data

The detailed test data see: Appendix A for SHCR211200090301

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7.6 Radiated Emissions which fall in the restricted bands

Test Requirement 47 CFR Part 15, Subpart C 15.209 & 15.247(d)

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.		

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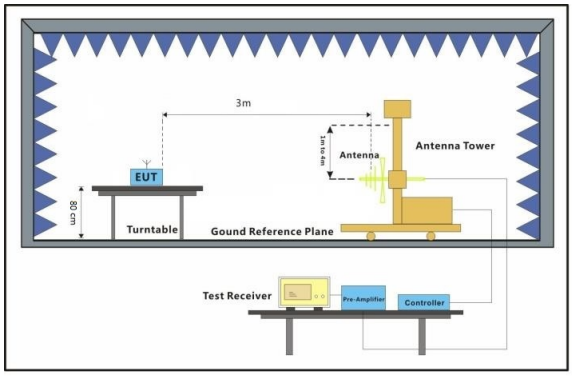
7.6.1 E.U.T. Operation

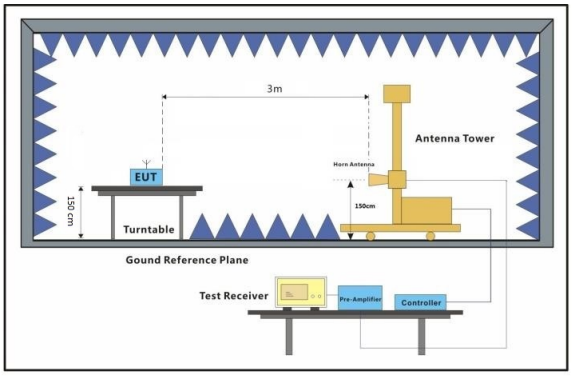
Operating Environment:

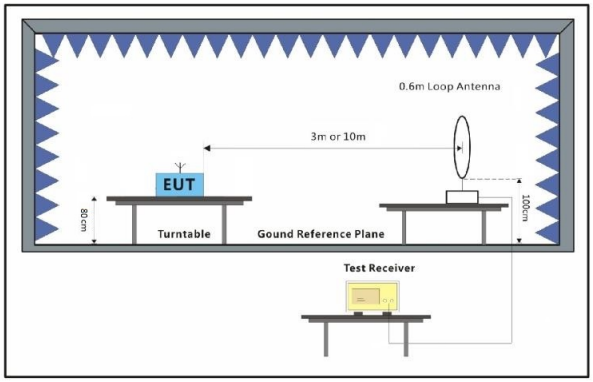
Temperature: 22 °C Humidity: 50 % RH Atmospheric Pressure: 1001 mbar

Test mode a:TX mode_Keep the EUT in continuously transmitting with O-QPSK modulation mode.

7.6.2 Test Setup Diagram







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7.6.3 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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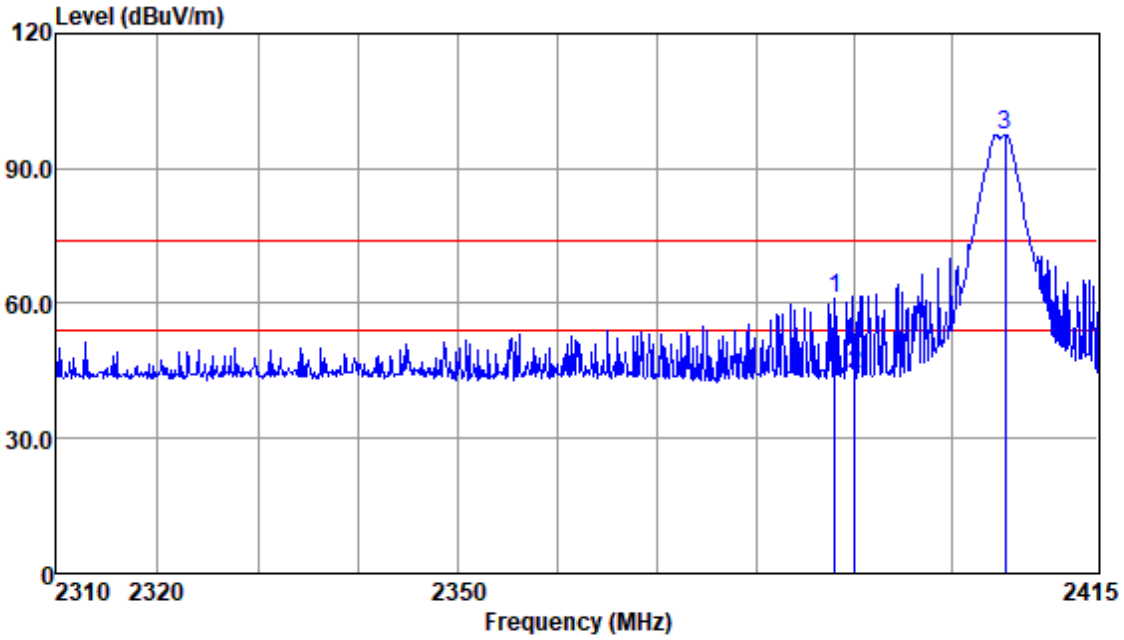
Mode:a; Polarization:Horizontal; Modulation:O-QPSK; ; Channel:Low



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	
2387.99	64.39	28.97	2.77	35.18	60.95	74.00	-13.05	Peak
2390.00	47.90	28.97	2.77	35.18	44.46	74.00	-29.54	Peak
2405.47	100.94	29.00	2.79	35.20	97.53	74.00	23.53	Peak

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

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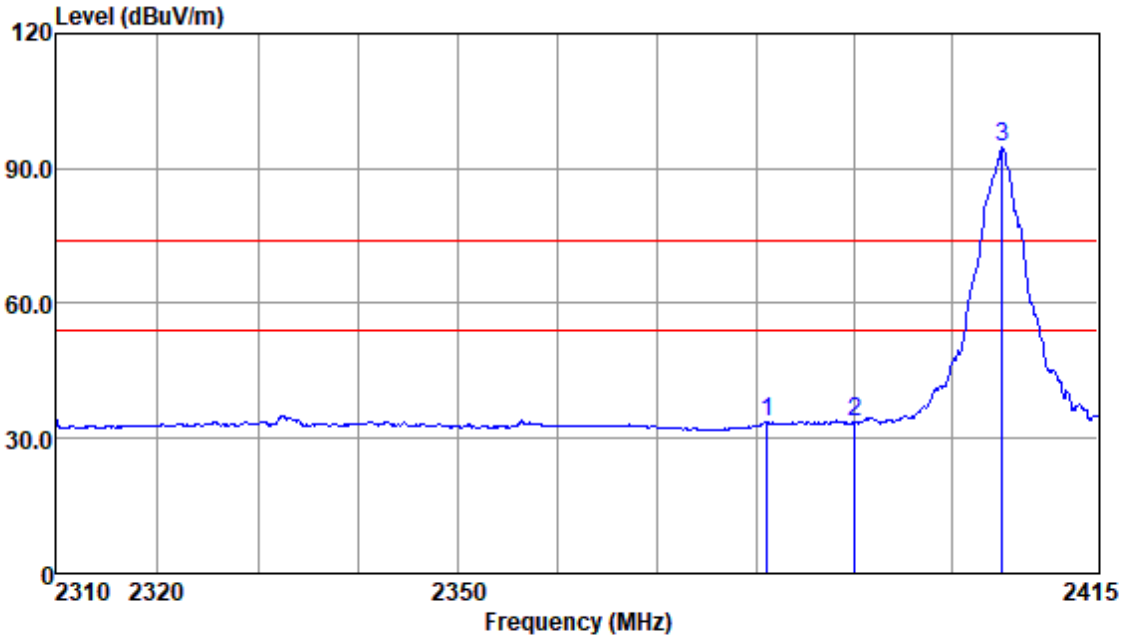
Mode:a; Polarization:Horizontal; Modulation:O-QPSK; ; Channel:Low



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	
2381.10	37.60	28.40	2.76	35.17	33.59	54.00	-20.41	Average
2390.00	36.99	28.97	2.77	35.18	33.55	54.00	-20.45	Average
2405.14	98.04	29.00	2.79	35.20	94.63	54.00	40.63	Average

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

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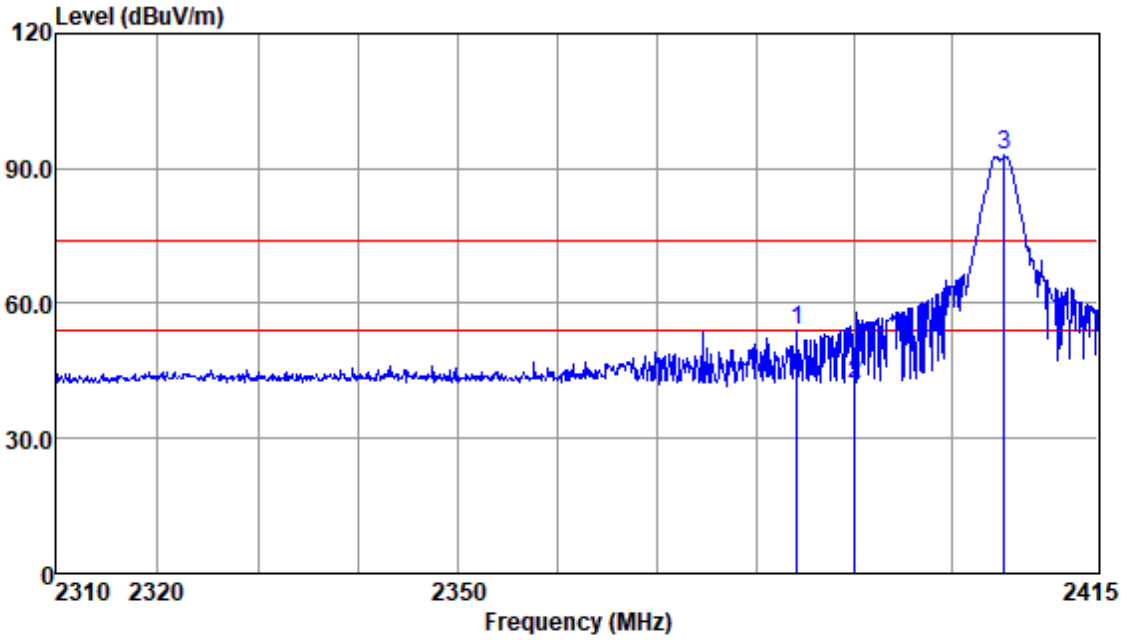
Mode:a; Polarization:Vertical; Modulation:O-QPSK; ; Channel:Low



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	
2384.17	57.56	28.97	2.77	35.18	54.12	74.00	-19.88	Peak
2390.00	45.69	28.97	2.77	35.18	42.25	74.00	-31.75	Peak
2405.36	96.22	29.00	2.79	35.20	92.81	74.00	18.81	Peak

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

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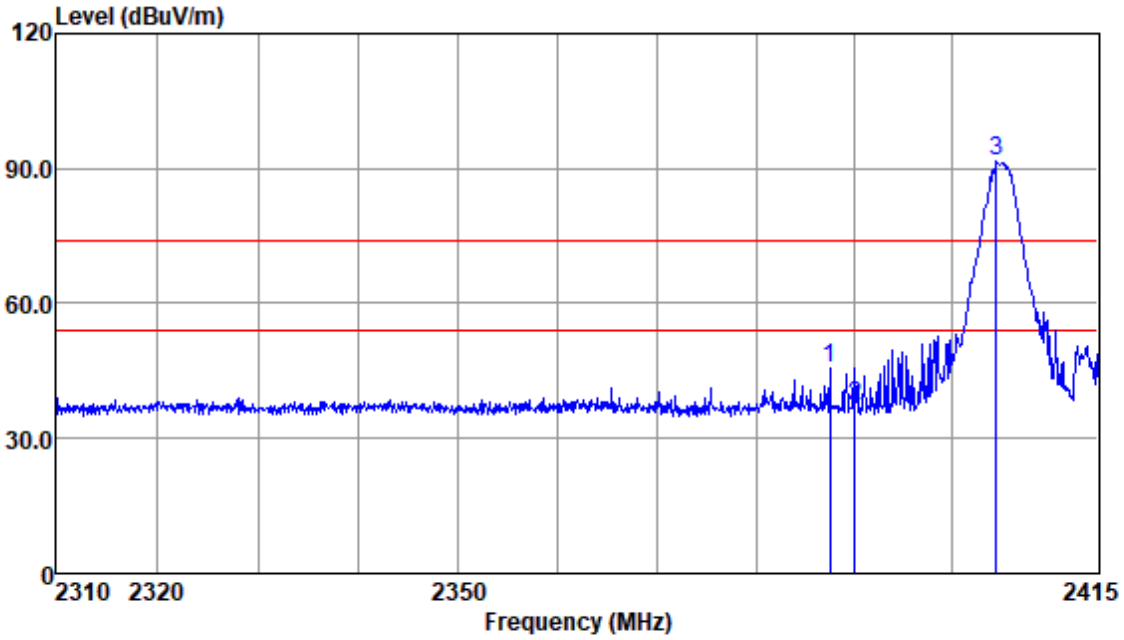
Mode:a; Polarization:Vertical; Modulation:O-QPSK; ; Channel:Low



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	
2387.46	48.94	28.97	2.77	35.18	45.50	54.00	-8.50	Average
2390.00	40.63	28.97	2.77	35.18	37.19	54.00	-16.81	Average
2404.50	95.01	29.00	2.79	35.20	91.60	54.00	37.60	Average

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

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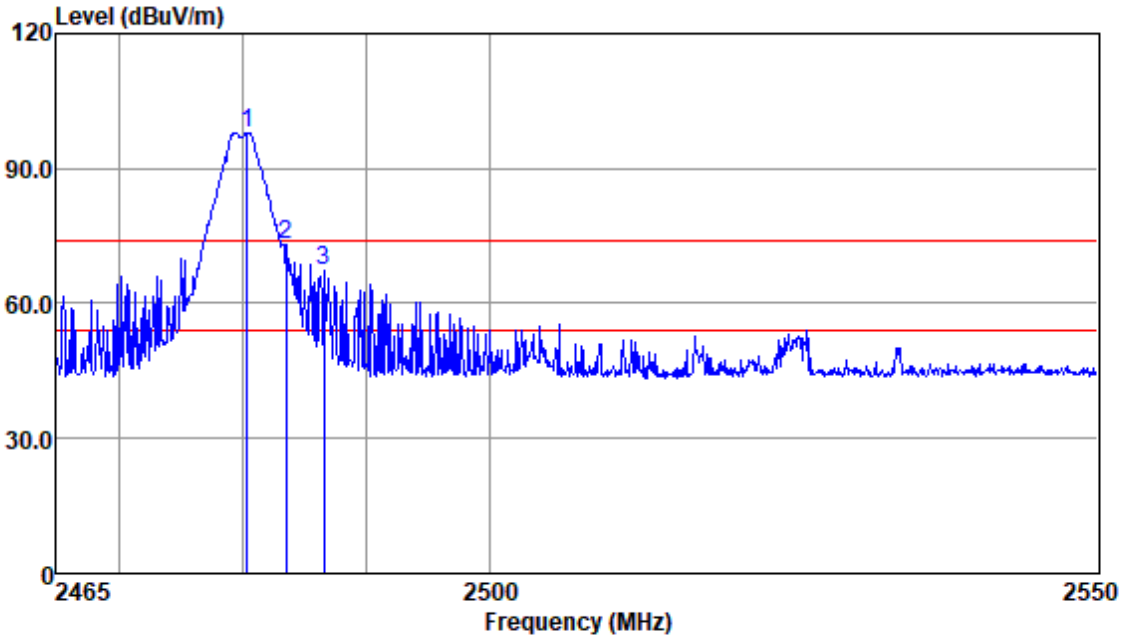
Mode:a; Polarization:Horizontal; Modulation:O-QPSK; ; Channel:High



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	
2480.34	101.23	29.10	2.88	35.25	97.96	74.00	23.96	Peak
2483.50	76.38	29.11	2.88	35.26	73.11	74.00	-0.89	Peak
2486.57	70.74	29.11	2.88	35.26	67.47	74.00	-6.53	Peak

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

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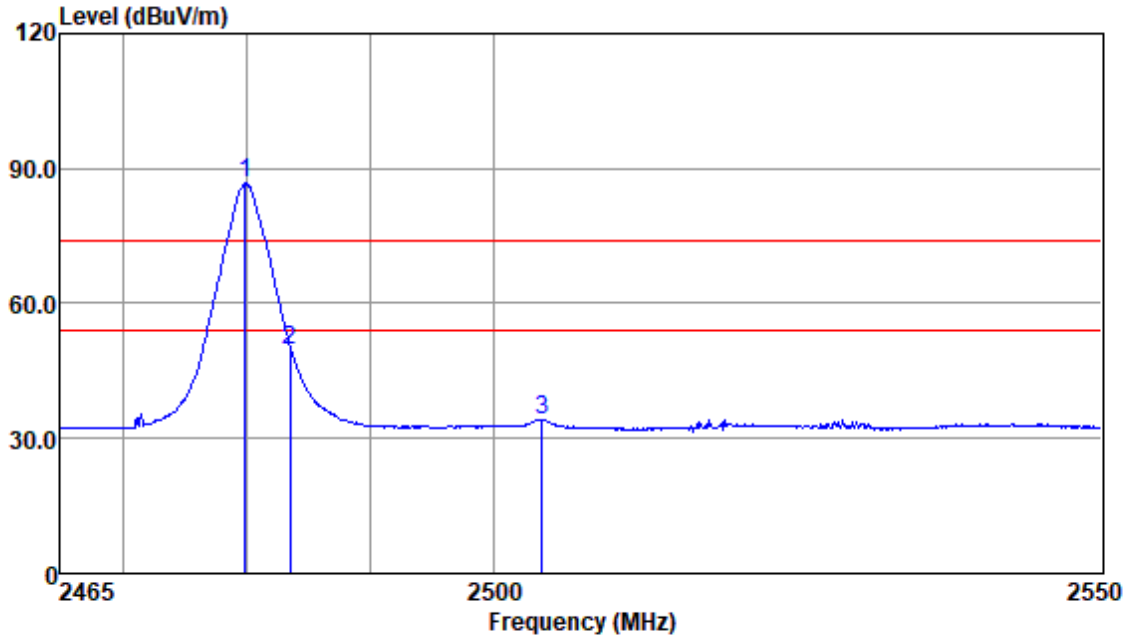
Mode:a; Polarization:Horizontal; Modulation:O-QPSK; ; Channel:High



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	
2479.84	89.87	29.10	2.88	35.25	86.60	54.00	32.60	Average
2483.50	53.05	29.11	2.88	35.26	49.78	54.00	-4.22	Average
2503.91	37.31	29.21	2.90	35.28	34.14	54.00	-19.86	Average

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

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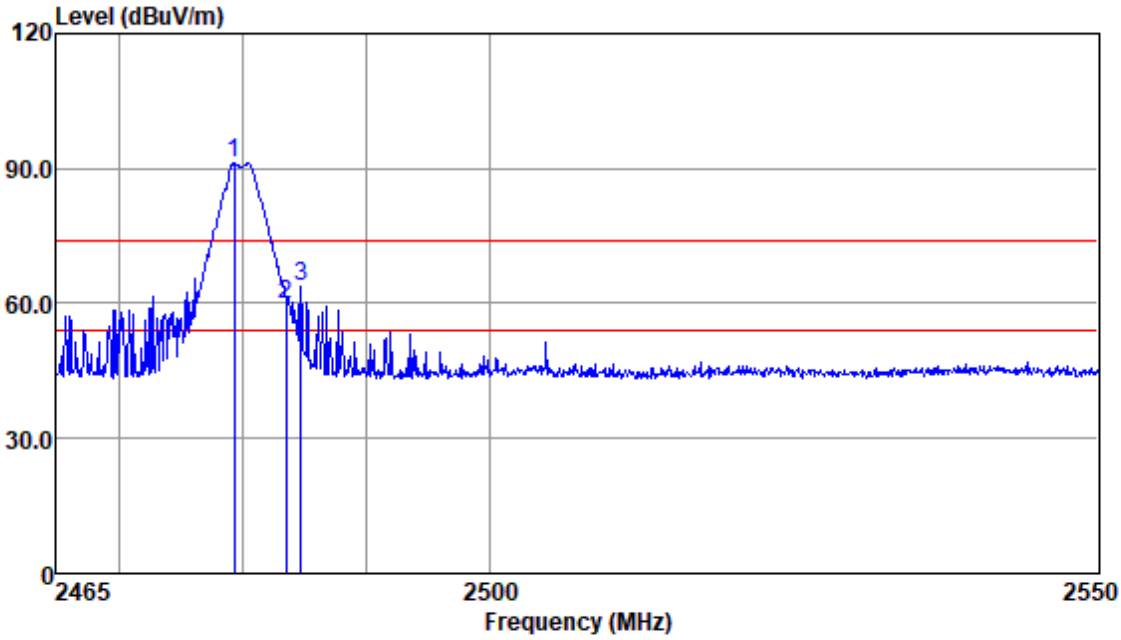
Mode:a; Polarization:Vertical; Modulation:O-QPSK; ; Channel:High



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	
2479.33	94.51	29.10	2.88	35.25	91.24	74.00	17.24	Peak
2483.50	63.23	29.11	2.88	35.26	59.96	74.00	-14.04	Peak
2484.72	66.99	29.11	2.88	35.26	63.72	74.00	-10.28	Peak

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

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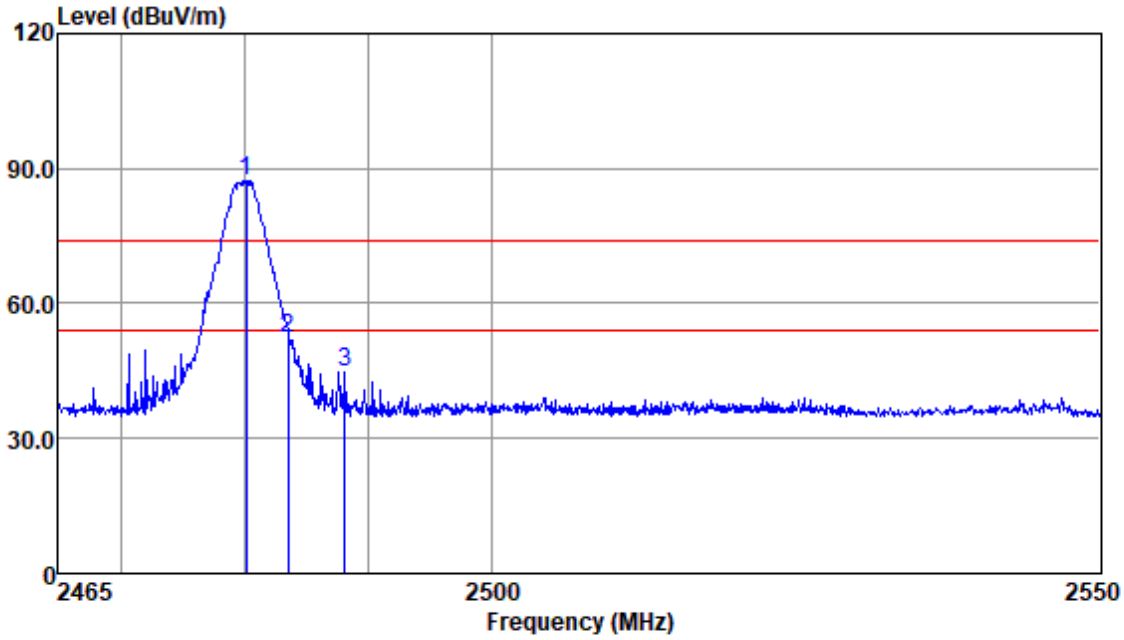
Mode:a; Polarization:Vertical; Modulation:O-QPSK; ; Channel:High



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	
2480.09	90.66	29.10	2.88	35.25	87.39	54.00	33.39	Average
2483.50	55.50	29.11	2.88	35.26	52.23	54.00	-1.77	Average
2488.09	48.03	29.11	2.88	35.26	44.76	54.00	-9.24	Average

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

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7.7 Radiated Spurious Emissions

Test Requirement 47 CFR Part 15, Subpart C 15.209 & 15.247(d)

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.		

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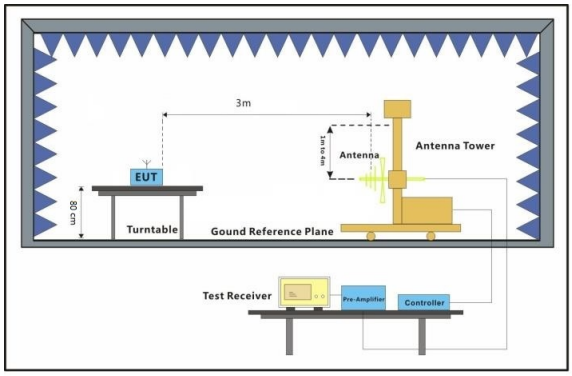
7.7.1 E.U.T. Operation

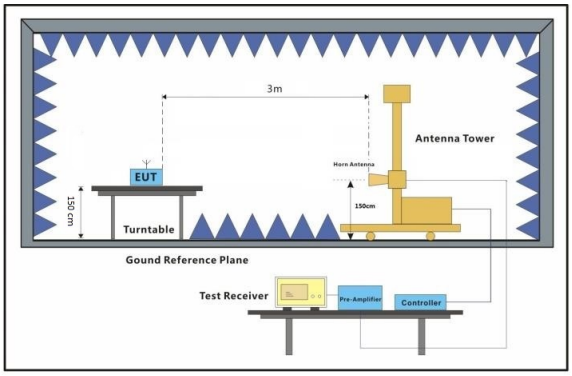
Operating Environment:

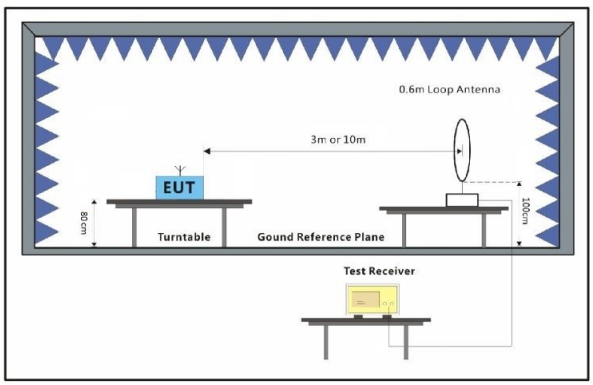
Temperature: 22 °C Humidity: 50 % RH Atmospheric Pressure: 1001 mbar

Test mode a:TX mode_Keep the EUT in continuously transmitting with O-QPSK modulation mode.

7.7.2 Test Setup Diagram







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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) 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

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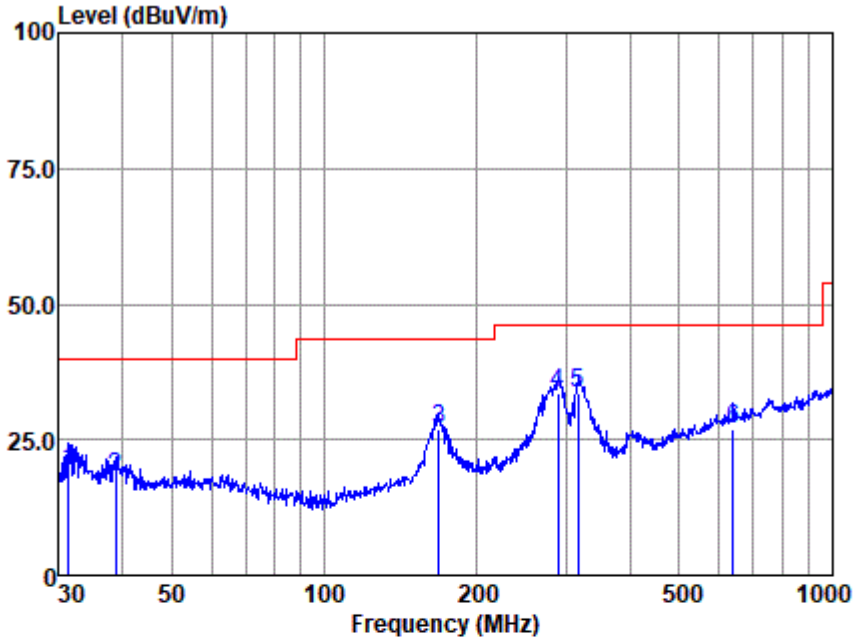
Below 1GHz
Mode:a; Polarization:Horizontal



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	
1	31.289	38.06	12.25	0.80	31.79	19.32	40.00	-20.68	QP
2	38.888	36.02	13.03	0.87	31.98	17.94	40.00	-22.06	QP
3	167.824	43.37	12.89	1.97	31.27	26.96	43.50	-16.54	QP
4	287.990	49.04	13.01	2.78	31.30	33.53	46.00	-12.47	QP
5	316.589	47.82	13.78	2.89	31.06	33.43	46.00	-12.57	QP
6	638.369	33.50	20.15	4.04	30.92	26.77	46.00	-19.23	QP

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

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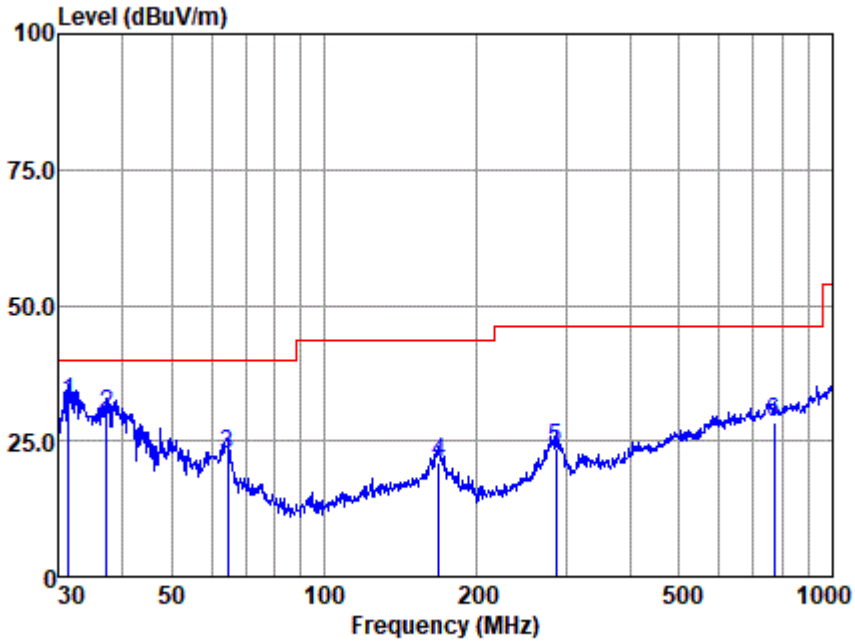
Mode:a; Polarization:Vertical



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	
1	31.289	51.02	12.25	0.80	31.79	32.28	40.00	-7.72	QP
2	37.285	48.10	12.78	0.84	31.93	29.79	40.00	-10.21	QP
3	64.433	40.26	12.46	1.16	31.44	22.44	40.00	-17.56	QP
4	167.824	37.30	12.89	1.97	31.27	20.89	43.50	-22.61	QP
5	285.978	39.35	12.96	2.78	31.34	23.75	46.00	-22.25	QP
6	768.748	33.53	22.18	4.43	31.88	28.26	46.00	-17.74	QP

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

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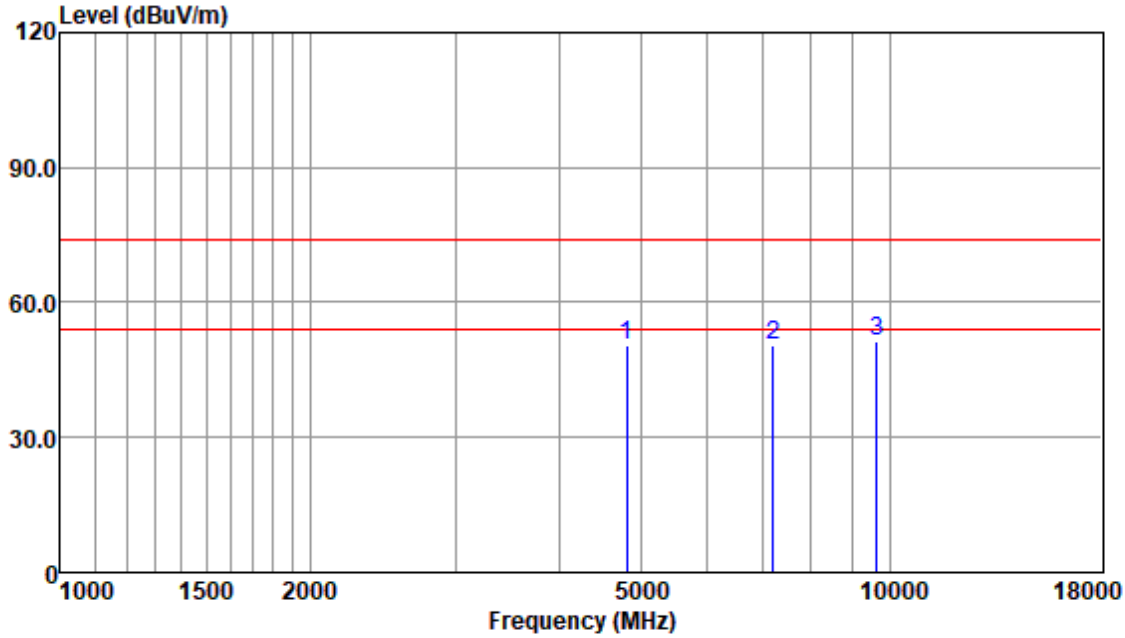
Above 1GHz

Mode:a; Polarization:Horizontal; Modulation:O-QPSK; ; 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	
4810.00	48.87	33.72	4.46	36.79	50.26	74.00	-23.74	Peak
7215.00	43.75	36.31	5.74	35.51	50.29	74.00	-23.71	Peak
9620.00	40.63	37.70	6.53	33.58	51.28	74.00	-22.72	Peak

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

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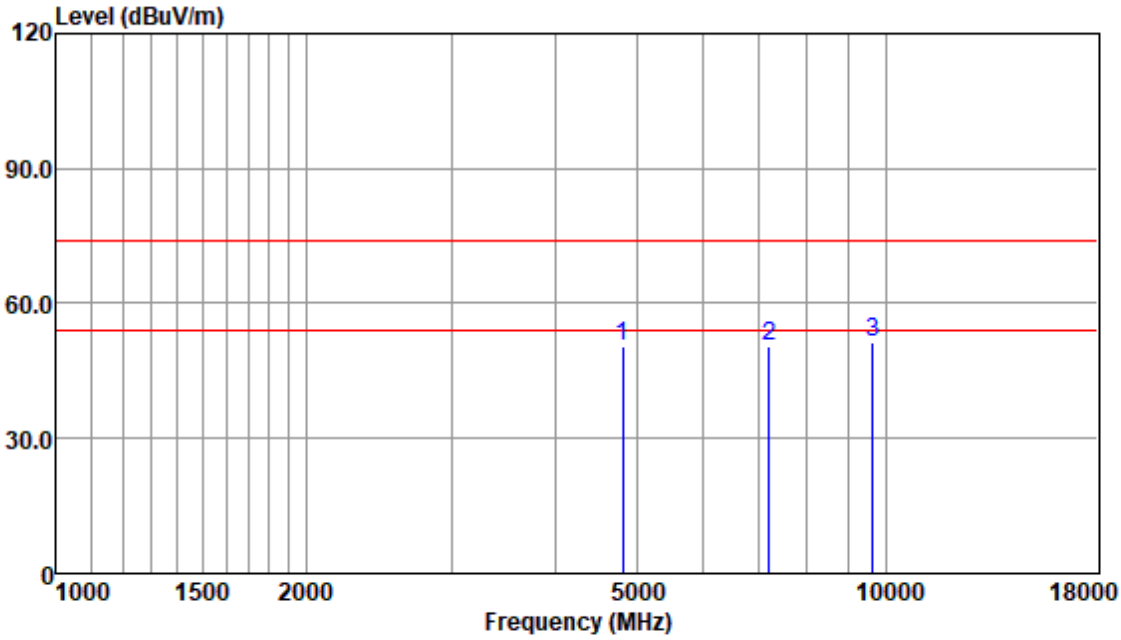
Mode:a; Polarization:Vertical; Modulation:O-QPSK; ; Channel:Low



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	
4810.00	48.90	33.72	4.46	36.79	50.29	74.00	-23.71	Peak
7215.00	43.75	36.31	5.74	35.51	50.29	74.00	-23.71	Peak
9620.00	40.93	37.70	6.53	33.58	51.58	74.00	-22.42	Peak

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

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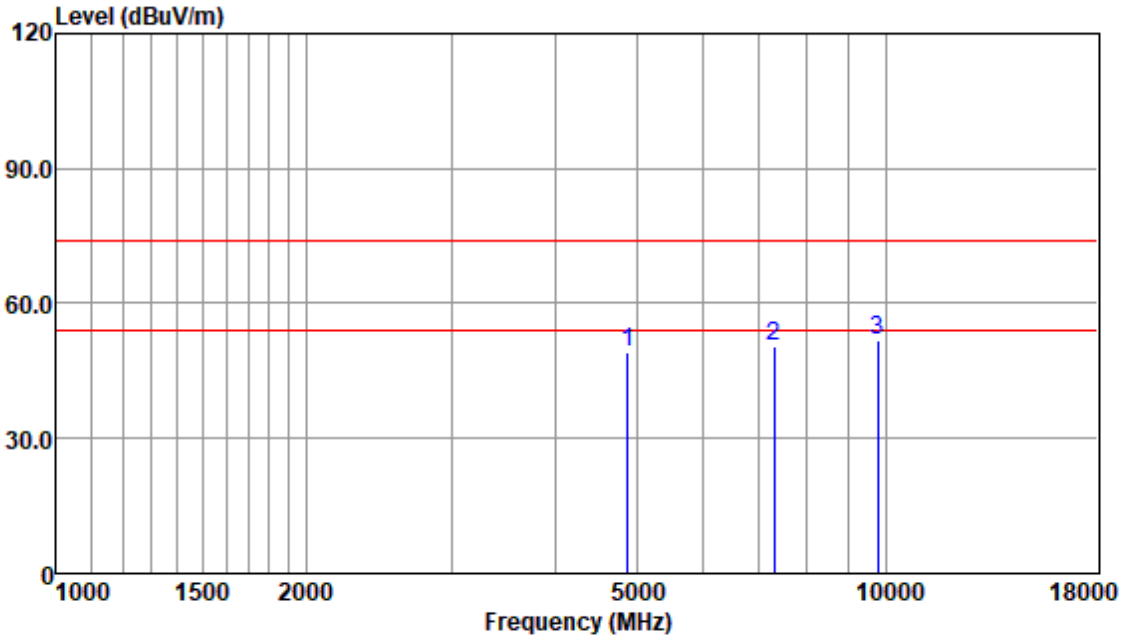
Mode:a; Polarization:Horizontal; Modulation:O-QPSK; ; Channel:middle



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	
4880.00	47.58	33.93	4.47	36.81	49.17	74.00	-24.83	Peak
7320.00	43.39	36.47	5.85	35.42	50.29	74.00	-23.71	Peak
9760.00	41.27	37.68	6.50	33.50	51.95	74.00	-22.05	Peak

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

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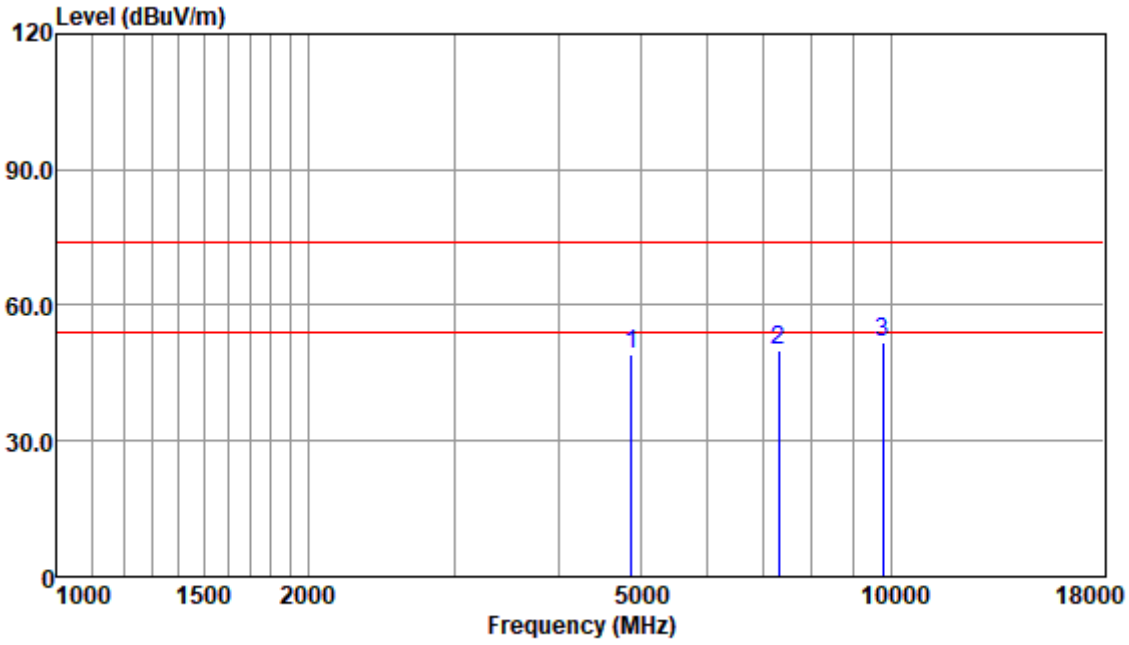
Mode:a; Polarization:Vertical; Modulation:O-QPSK; ; Channel:middle



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	
4880.00	47.67	33.93	4.47	36.81	49.26	74.00	-24.74	Peak
7320.00	43.27	36.47	5.85	35.42	50.17	74.00	-23.83	Peak
9760.00	41.24	37.68	6.50	33.50	51.92	74.00	-22.08	Peak

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

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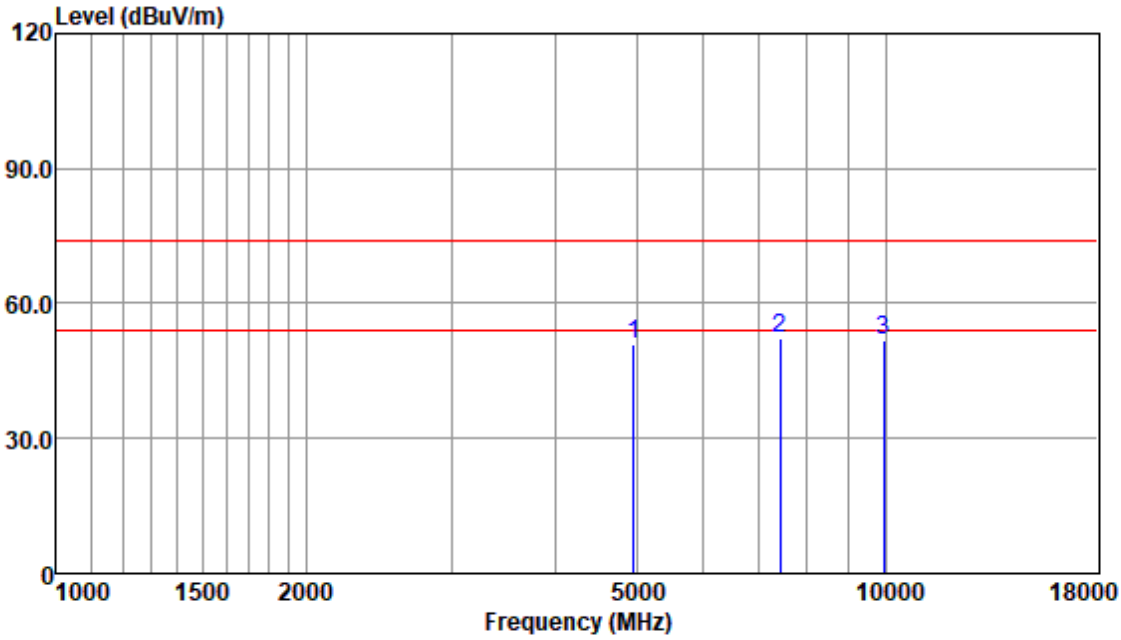
Mode:a; Polarization:Horizontal; Modulation:O-QPSK; ; Channel:High



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	
4960.00	49.43	33.98	4.48	36.83	51.06	74.00	-22.94	Peak
7440.00	45.22	36.40	5.97	35.34	52.25	74.00	-21.75	Peak
9920.00	41.12	37.81	6.47	33.41	51.99	74.00	-22.01	Peak

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

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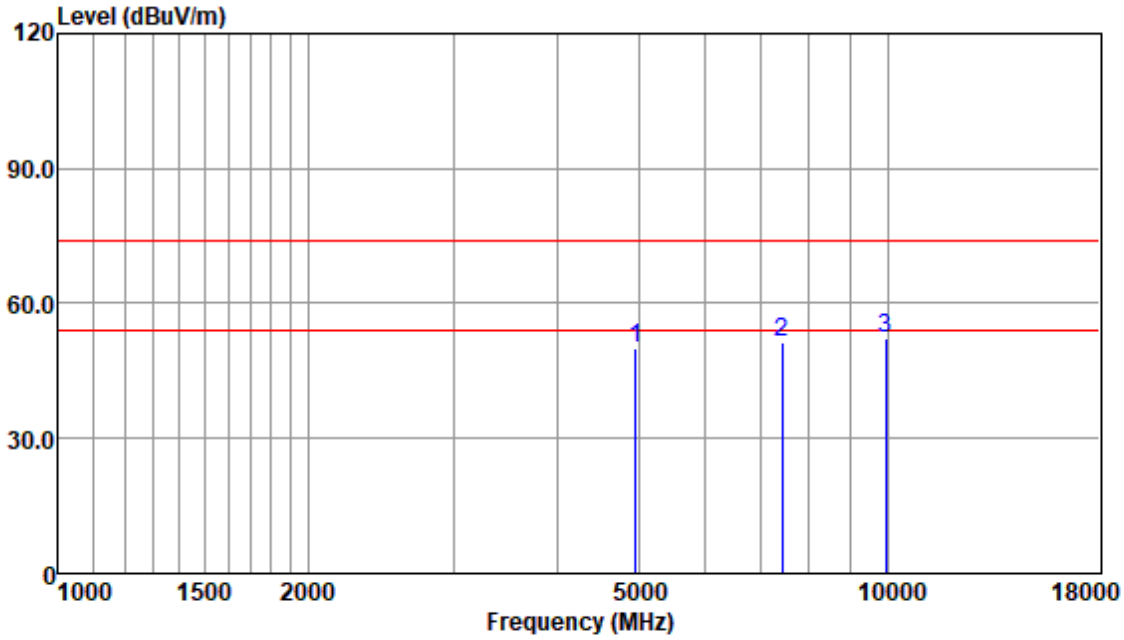
Mode:a; Polarization:Vertical; Modulation:O-QPSK; ; Channel:High



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	
4960.00	48.42	33.98	4.48	36.83	50.05	74.00	-23.95	Peak
7440.00	44.26	36.40	5.97	35.34	51.29	74.00	-22.71	Peak
9920.00	41.41	37.81	6.47	33.41	52.28	74.00	-21.72	Peak

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

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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 SHCR211200090301

1.6dB Bandwidth

Test Mode	Test Channel	EBW[MHz]	Limit	Verdict
ZIGBEE	2405	0.84	0.5	PASS
ZIGBEE	2440	1.65	0.5	PASS
ZIGBEE	2480	1.37	0.5	PASS

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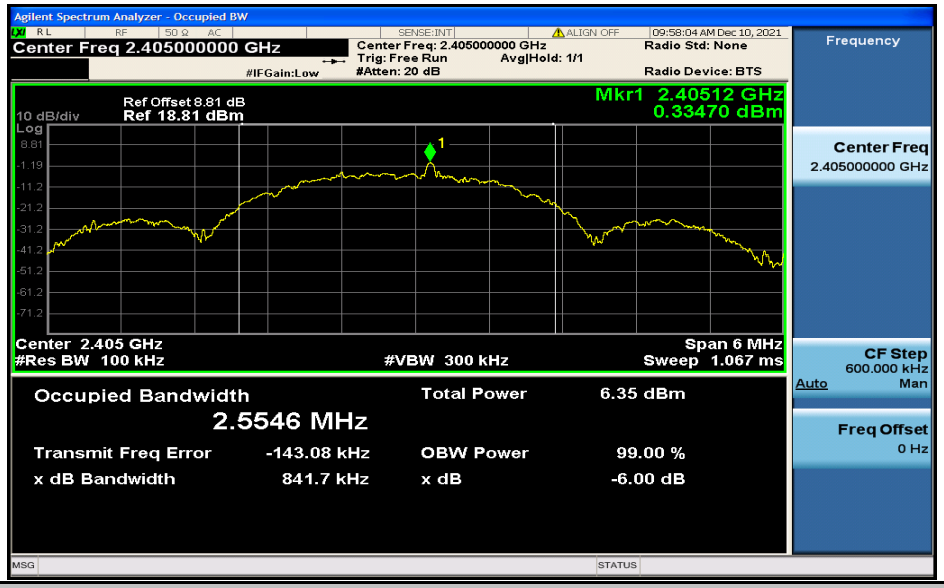
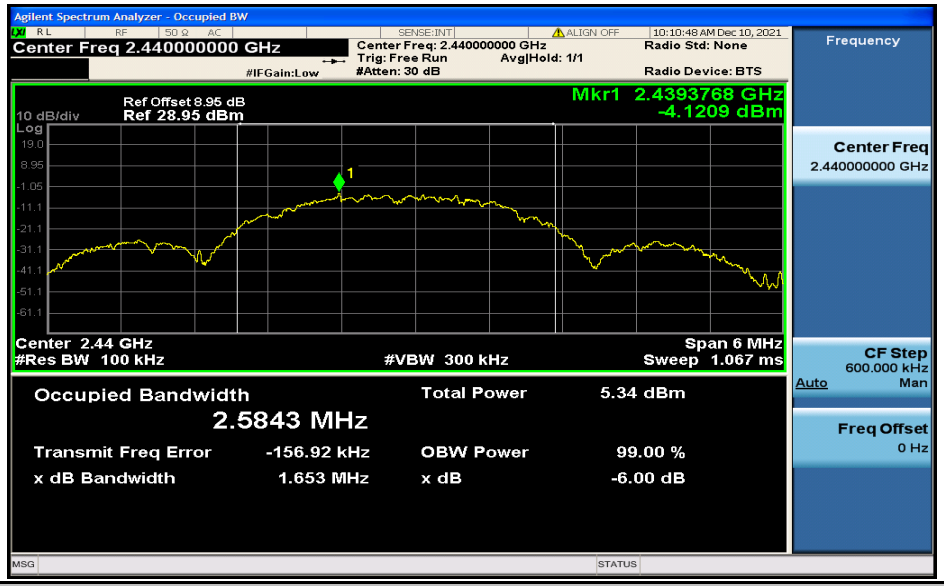
6dB Bandwidth_ZIGBEE_2405



6dB Bandwidth_ZIGBEE_2440



6dB Bandwidth_ZIGBEE_2480

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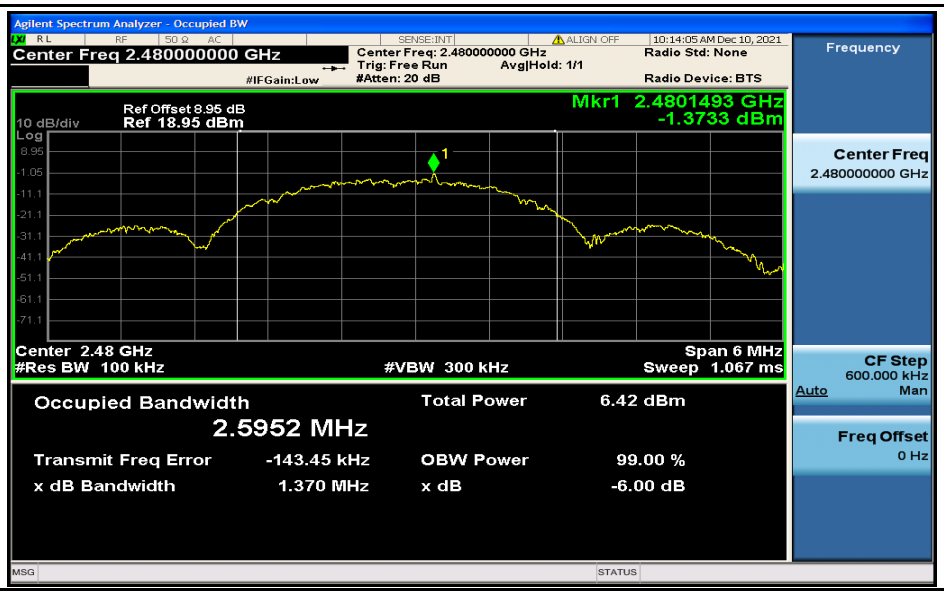

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2.Occupied Bandwidth

Test Mode	Test Channel	OBW[MHz]	Limit[MHz]	Verdict
ZIGBEE	2405	2.45	---	PASS
ZIGBEE	2440	2.46	---	PASS
ZIGBEE	2480	2.46	---	PASS

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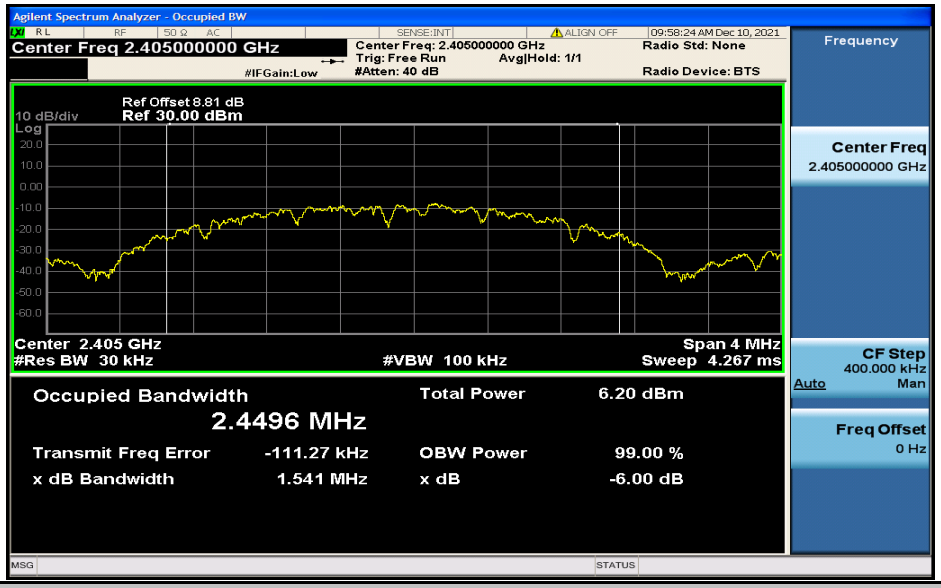
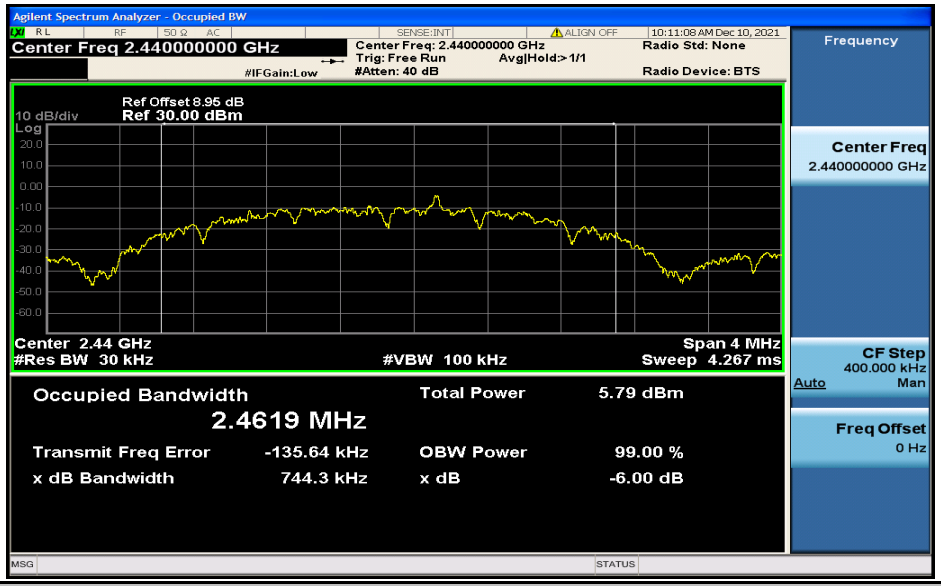
Occupied Bandwidth_ZIGBEE_2405



Occupied Bandwidth_ZIGBEE_2440



Occupied Bandwidth_ZIGBEE_2480

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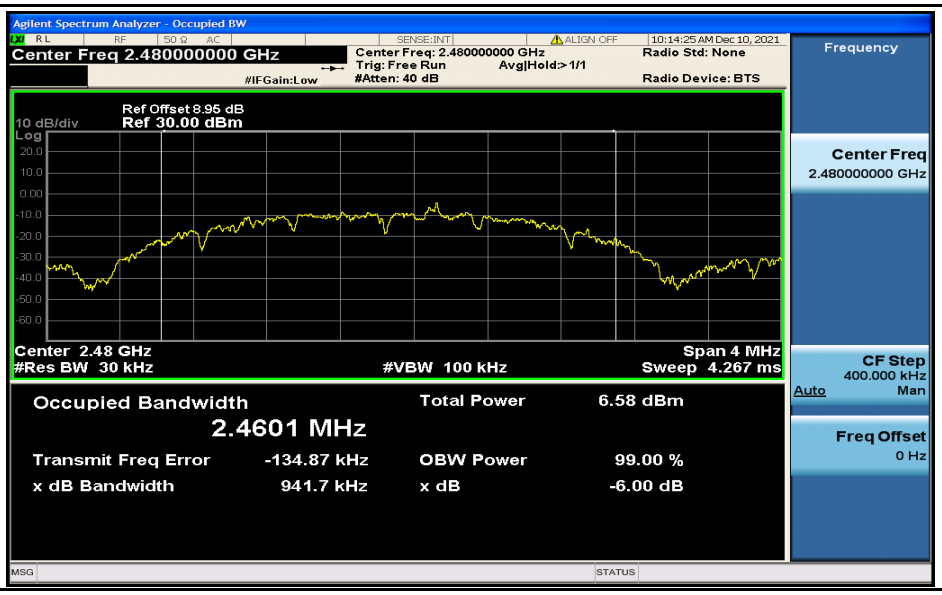

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3.Maximum peak conducted output power

Test Mode	Test Channel	Power[dBm]	Limit[dBm]	Verdict
ZIGBEE	2405	0.54	30	PASS
ZIGBEE	2440	0.27	30	PASS
ZIGBEE	2480	1.19	30	PASS

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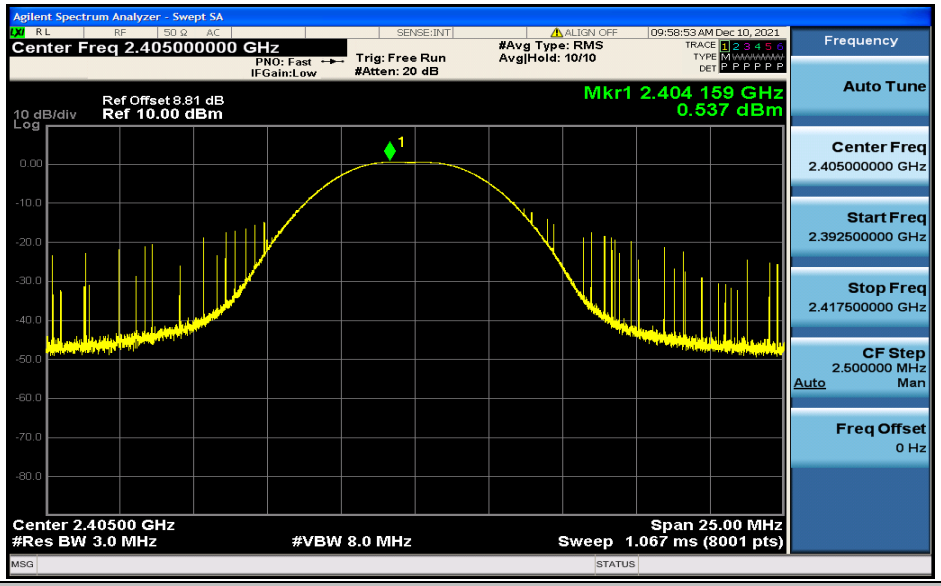
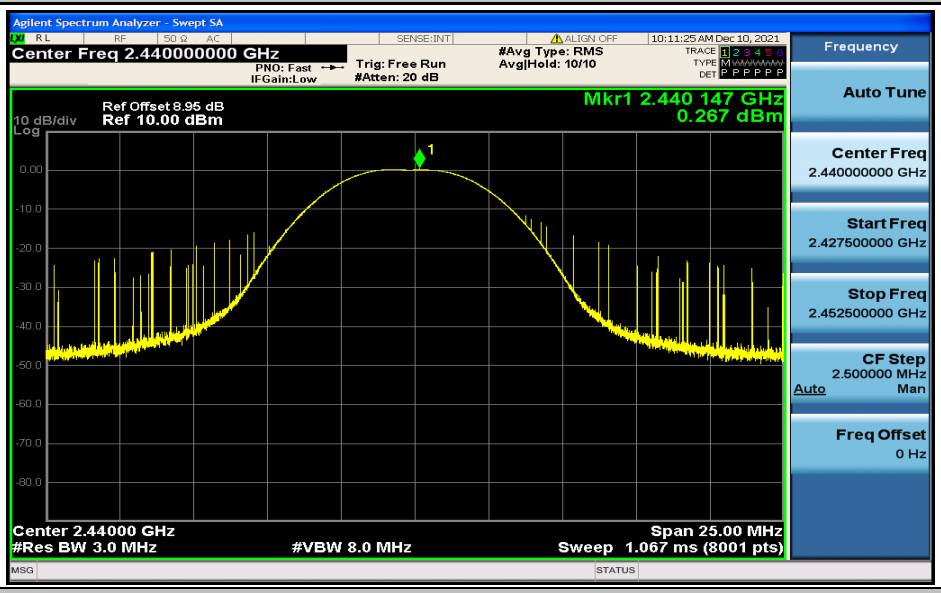
Maximum peak conducted output power_ZIGBEE_2405



Maximum peak conducted output power_ZIGBEE_2440



Maximum peak conducted output power_ZIGBEE_2480

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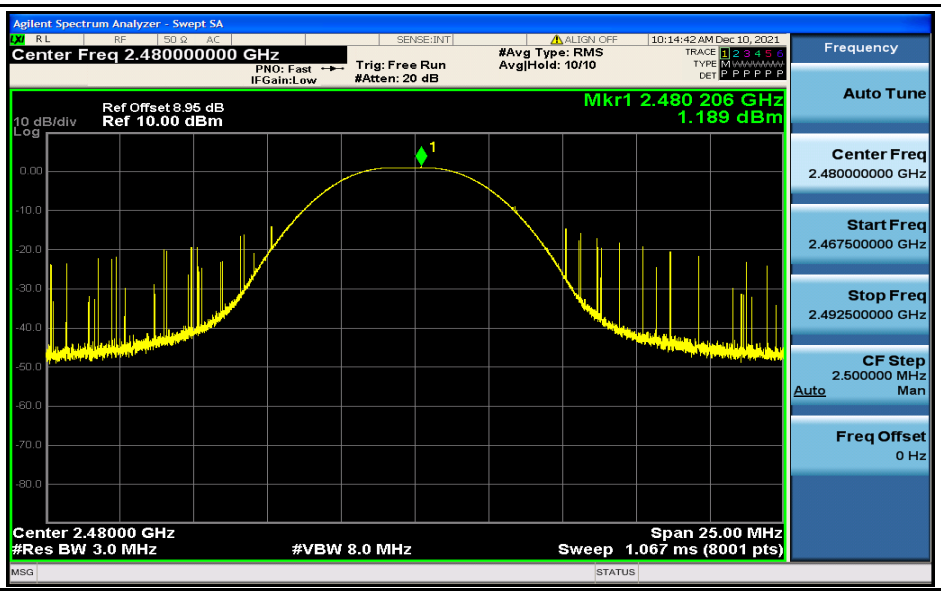

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4.Maximum Peak power spectral density

Test Mode	Test Channel	PSD[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
ZIGBEE	2405	-10.01	8.00	PASS
ZIGBEE	2440	-10.83	8.00	PASS
ZIGBEE	2480	-9.71	8.00	PASS

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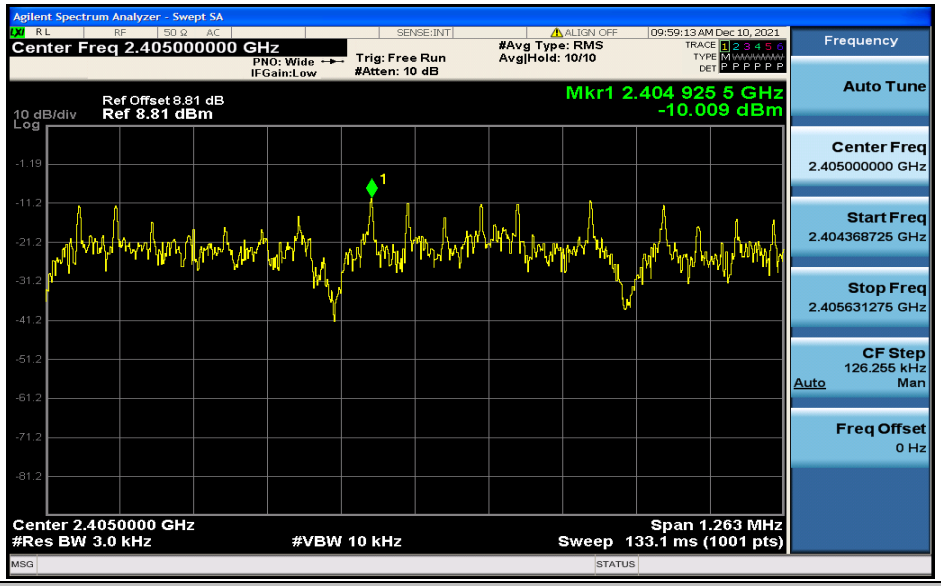
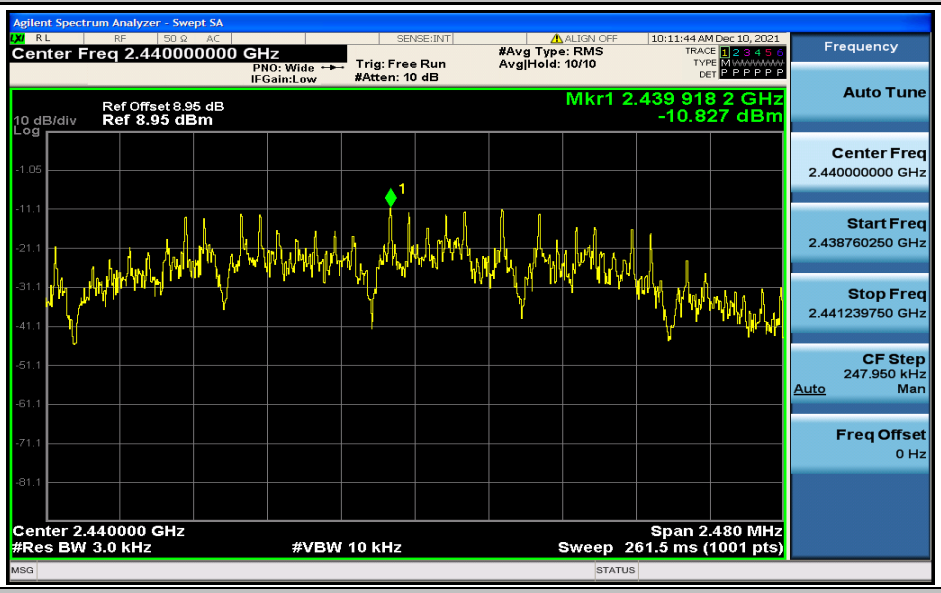
Maximum Peak power spectral density_ZIGBEE_2405



Maximum Peak power spectral density_ZIGBEE_2440



Maximum Peak power spectral density_ZIGBEE_2480

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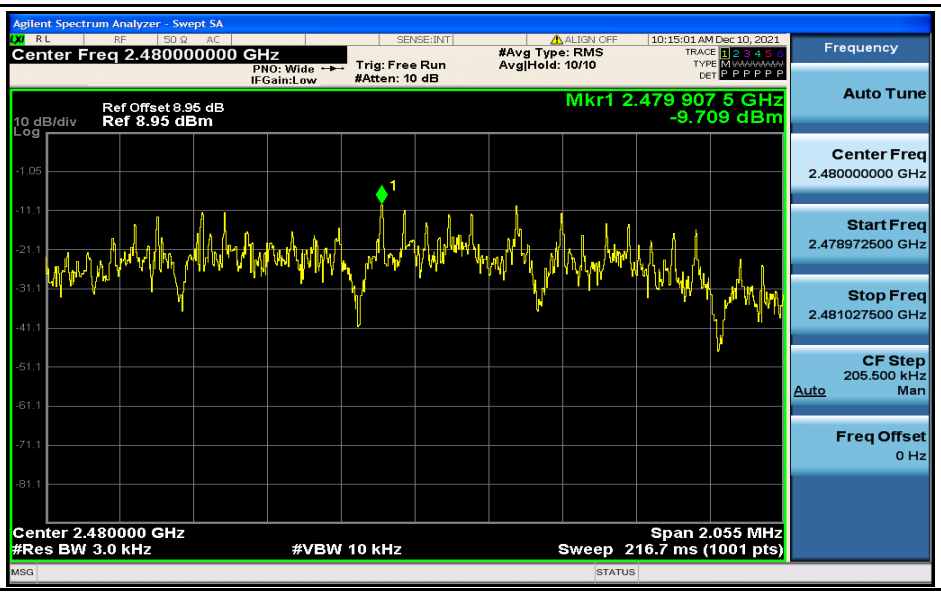

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5.Band-edge for RF Conducted Emissions

Test Mode	Test Channel	Carrier Power[dBm]	Max. Spurious Level [dBm]	Limit [dBm]	Verdict
ZIGBEE	2405	-3.90	-45.83	-23.90	PASS
ZIGBEE	2480	-2.48	-42.14	-22.48	PASS

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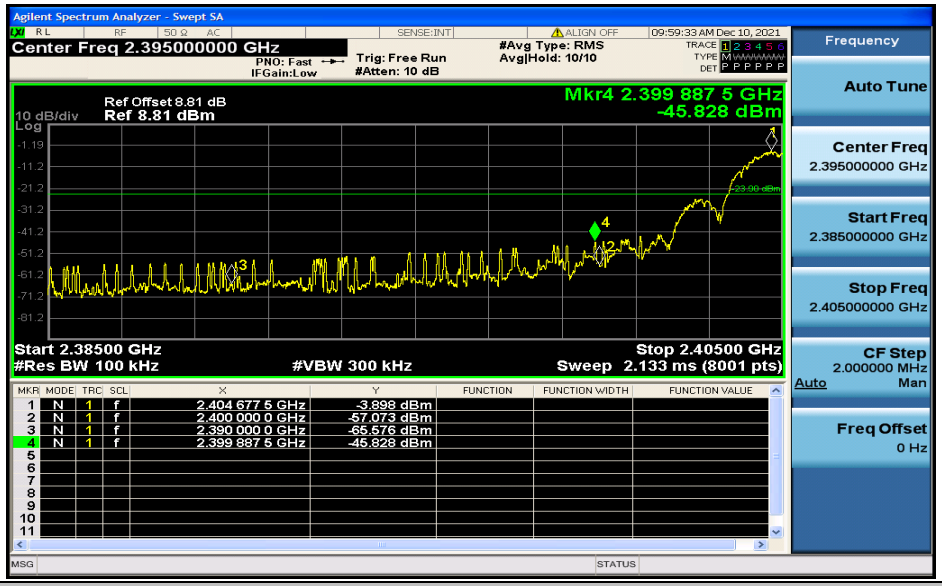
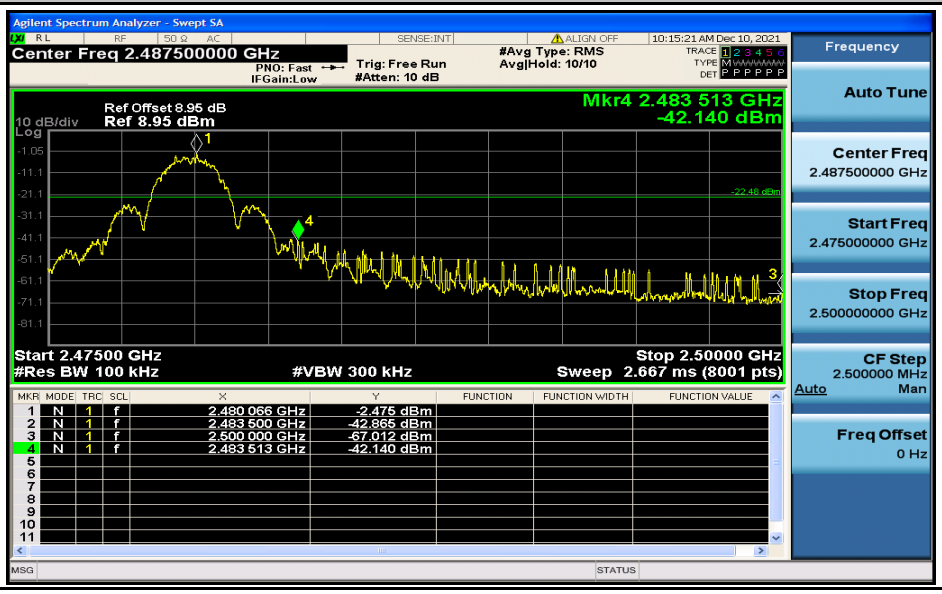
Band-edge for RF Conducted Emissions_ZIGBEE_2405_Hopping Off



Band-edge for RF Conducted Emissions_ZIGBEE_2480_Hopping Off



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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
ZIGBEE	2405	30	10000	100	300	-2.75	-37.37	<-22.75	PASS
ZIGBEE	2405	10000	26000	100	300	-2.75	-45.145	<-22.75	PASS
ZIGBEE	2440	30	10000	100	300	-0.33	-47.34	<-20.33	PASS
ZIGBEE	2440	10000	26000	100	300	-0.326	-44.324	<-20.326	PASS
ZIGBEE	2480	30	10000	100	300	-2.68	-53.65	<-22.68	PASS
ZIGBEE	2480	10000	26000	100	300	-2.675	-44.948	<-22.675	PASS

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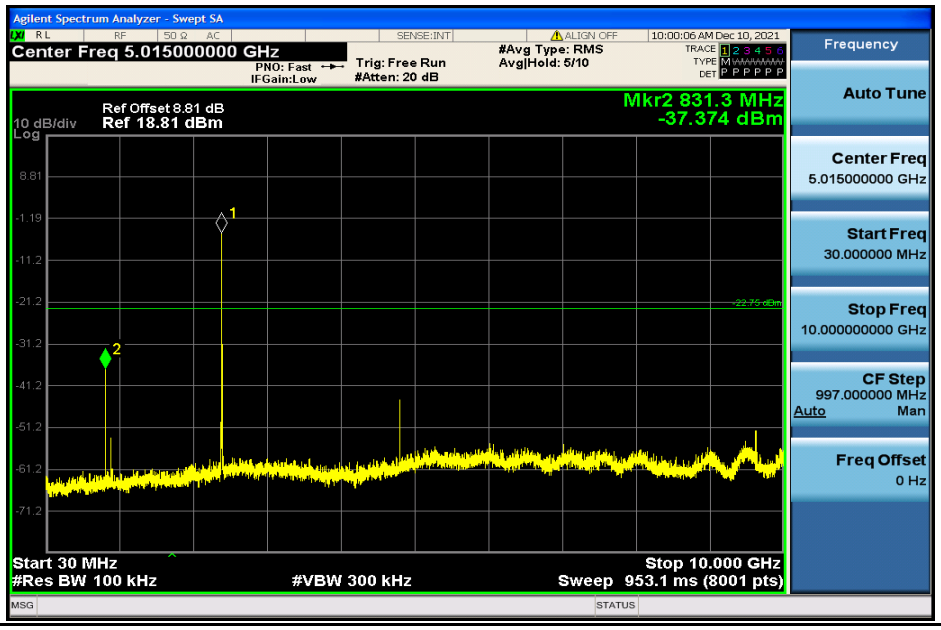
RF Conducted Spurious Emissions_ZIGBEE_2405



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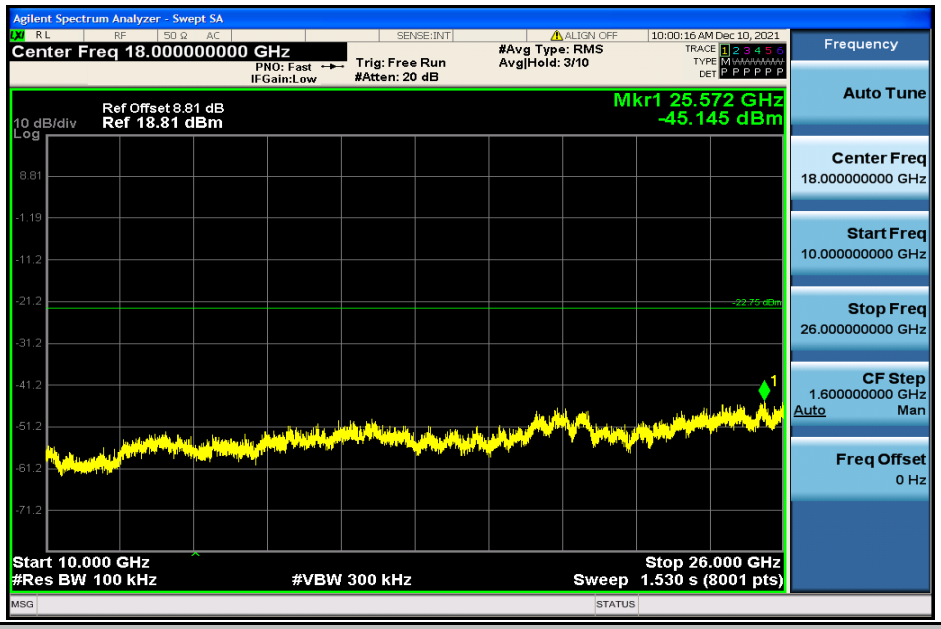

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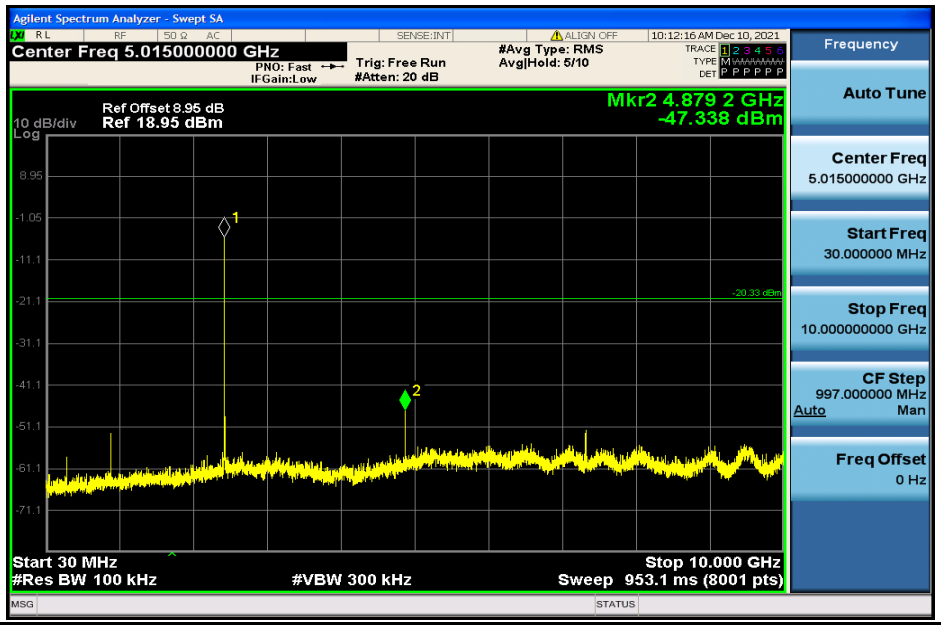

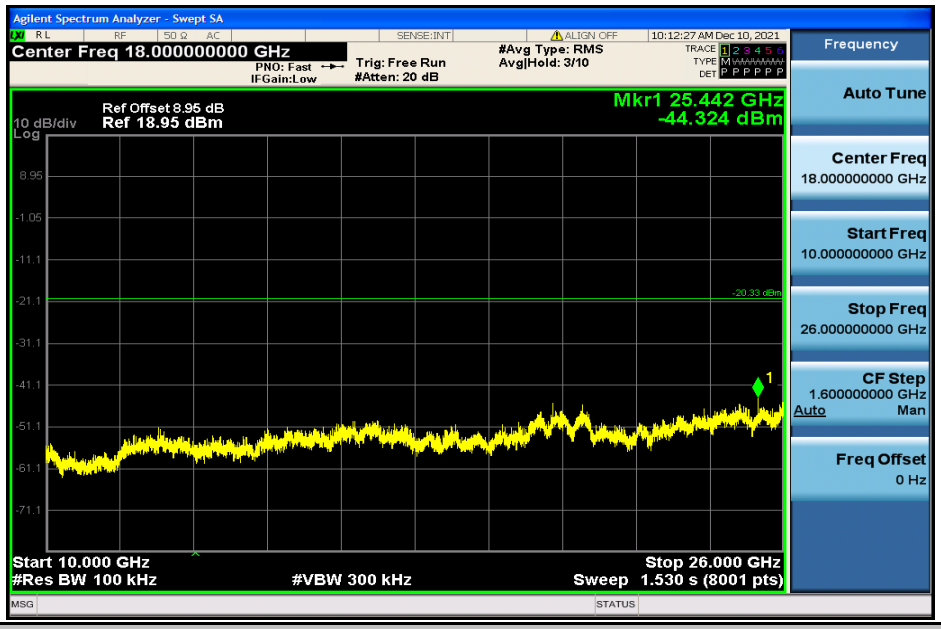

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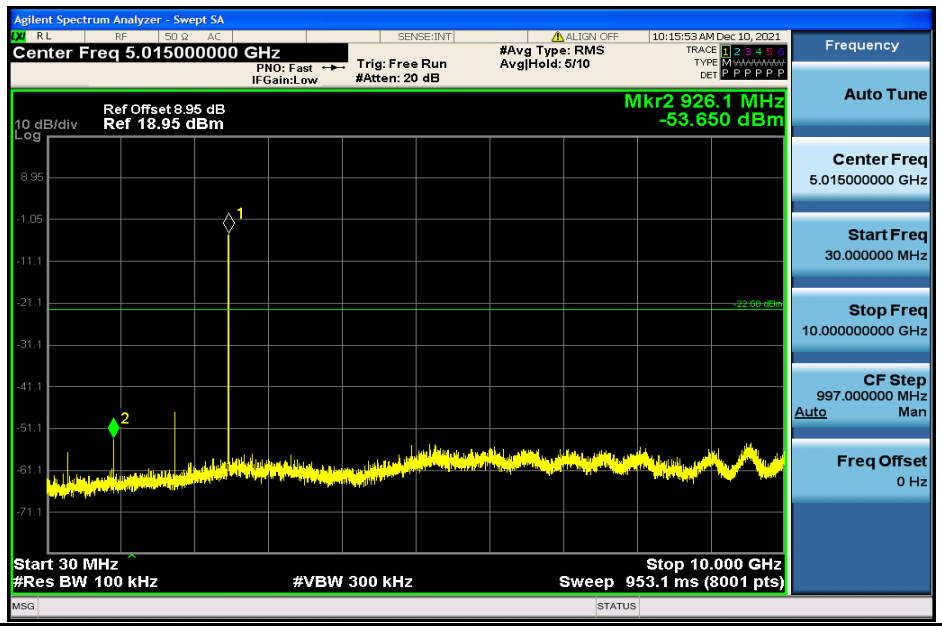

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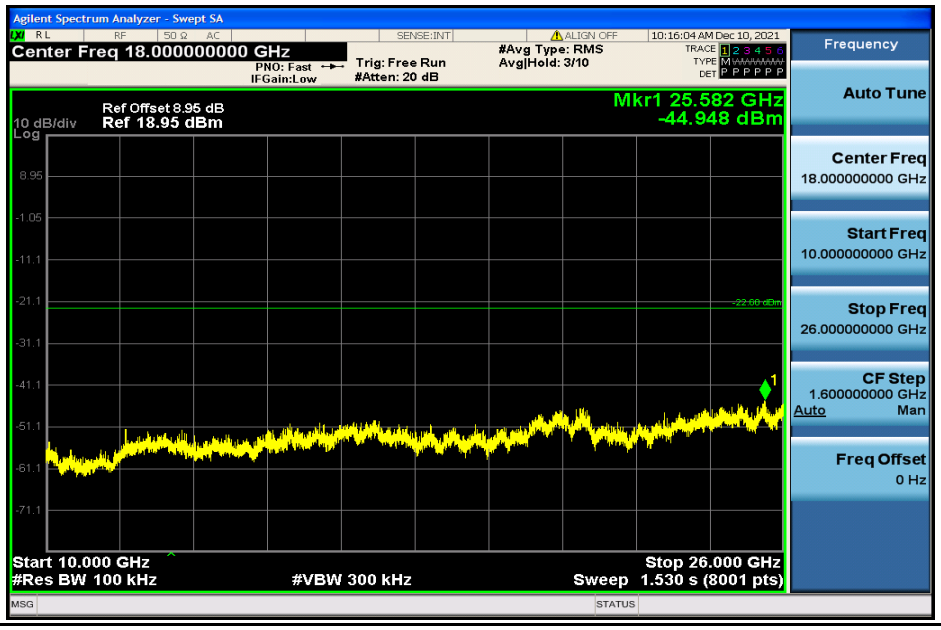

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