TEST REPORT

of

FCC Part 15 Subpart C AND CANADA RSS-247

Full Modular Approval

☒ New Application; ☐ Class I PC; ☐ Class II PC

Product :	**Bluetooth Low Energy 5 Module**
Brand:	**Sunrise**
Model:	**AI00240**
Model Difference:	**N/A**
FCC ID:	**2AMPPAI00240**
IC:	**11471A-AI00240**
FCC Rule Part:	**§15.247, Cat: DTS**
IC Rule Part:	**RSS-247 issue 2: 2017** **RSS-Gen issue 5, Amendment 2: 2021**
Applicant:	**Sunrise Technology Co., Ltd**
Address:	**No.106, Zhongshan 3rd Rd., Daya Dist., Taichung City 428, Taiwan (R.O.C.)**

Test Performed by:

International Standards Laboratory Corp. LT Lab.
TEL: +886-3-263-8888 FAX: +886-3-263-8899
No. 120, Lane 180, Hsin Ho Rd., Lung-Tan Dist., Tao Yuan City 325, Taiwan

Report No.: **ISL-21LR253FC**
Issue Date : **2021/10/21**

Test results given in this report apply only to the specific sample(s) tested and are traceable to national or international standard through calibration of the equipment and evaluating measurement uncertainty herein.
The uncertainty of the measurement does not include in consideration of the test result unless the customer required the determination of uncertainty via the agreement, regulation or standard document specification.
This test report shall not be reproduced except in full, without the written approval of International Standards Laboratory Corp.

VERIFICATION OF COMPLIANCE

Applicant:	Sunrise Technology Co., Ltd
Product Description:	Bluetooth Low Energy 5 Module
Brand Name:	Sunrise
Model No.:	AI00240
Model Difference:	N/A
FCC ID:	2AMPPAI00240
IC:	11471A-AI00240
Date of test:	2021/10/07 ~ 2021/10/20
Date of EUT Received:	2021/10/07

We hereby certify that:

All the tests in this report have been performed and recorded in accordance with the standards described above and performed by an independent electromagnetic compatibility consultant, International Standards Laboratory Corp.

The test results contained in this report accurately represent the measurements of the characteristics and the energy generated by sample equipment under test at the time of the test. The sample equipment tested as described in this report is in compliance with the limits of above standards.

Test By:	Weitin Chen	***Date:***	2021/10/21
	Weitin Chen / Senior Engineer		
Prepared By:	Elisa Chen	***Date:***	2021/10/21
	Elisa Chen / Senior Engineer		
Approved By:	Jerry Liu	***Date:***	2021/10/21
	Jerry Liu / Assistant Manager		

Version

Version No.	Date	Description
00	2021/10/21	Initial creation of document

Measurement Uncertainty (K=2)

Description Of Test	Uncertainty
Conducted Emission (AC power line)	2.586 dB
Field Strength of Spurious Radiation	<=30MHz: 2.96dB 30-1GHz: 4.22 dB 1-40 GHz: 4.08 dB
Conducted Power	2.412 GHz: 1.30 dB 5.805 GHz: 1.55 dB
Power Density	2.412 GHz:1.30 dB 5.805 GHz: 1.67 dB
Frequency	0.0032%

Table of Contents

1 General Information 6
1.1 Related Submittal(s) / Grant (s) 7
1.2 Test Methodology 7
1.3 Test Facility 7
1.4 Special Accessories 7
1.5 Equipment Modifications 7
1.6 Reference 7
2 System Test Configuration 8
2.1 EUT Configuration 8
2.2 EUT Exercise 8
2.3 Test Procedure 8
2.4 Configuration of Tested System 9
3 Summary of Test Results 10
4 Description of Test Modes 10
5 Conduced Emission Test 11
5.1 Standard Applicable: 11
5.2 EUT Setup: 11
5.3 Measurement Procedure: 11
5.4 Measurement Result: 11
6 Peak Output Power Measurement 12
6.1 Standard Applicable: 12
6.2 Measurement Equipment Used: 13
6.3 Test Set-up: 14
6.4 Measurement Procedure: 14
6.5 Measurement Result: 15
7 6dB Bandwidth & 99% Bandwidth 16
7.1 Standard Applicable: 16
7.2 Measurement Equipment Used: 16
7.3 Test Set-up: 16
7.4 Measurement Procedure: 16
7.5 Measurement Result: 17
8 Spurious Emission Test 24
8.1 Standard Applicable 24
8.2 Measurement Equipment Used: 24
8.3 Test SET-UP: 24
8.4 Measurement Procedure: 25
8.5 Field Strength Calculation 26
8.6 Measurement Result: 26
9 100kHz Bandwidth of Band Edges Measurement 33
9.1 Standard Applicable: 33
9.2 Measurement Equipment Used: 34
9.3 Test SET-UP: 35
9.4 Measurement Procedure: 36
9.5 Field Strength Calculation: 36
9.6 Measurement Result: 36

10 Peak Power Spectral Density 45
10.1 Standard Applicable: 45
10.2 Measurement Equipment Used: 45
10.3 Test Set-up: 45
10.4 Measurement Procedure: 45
10.5 Measurement Result: 46
11 Antenna Requirement 50
11.1 Standard Applicable: 50
11.2 Antenna Connected Construction: 51

1 General Information

General:

Product Name:	Bluetooth Low Energy 5 Module
Brand Name:	Sunrise
Model Name:	AI00240
Model Difference:	N/A
Power Supply:	3Vdc from Battery

IC RSS-Gen:

Product HW version	V1.0
Radio SW version	V1.0
PMN (Product Marketing Name)	AI00240
HVIN (Hardware Version Identification Number)	AI00240
FVIN (Firmware Version Identification Number)	N/A
Test Software Version	N/A
RF power setting	N/A

Bluetooth Version	BLE (1M)	BLE (2M)
Frequency Range	2402MHz-2480MHz	2402MHz-2480MHz
Tune-up Power	-1.839 dBm Peak	-1.933 dBm Peak
Modulation Type	GFSK	GFSK
Channel Number	40 channels, 2MHz step	40 channels, 2MHz step
Antenna Designation	PCB Antenna, 1 dBi	

Remark: The above DUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

1.1 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for **FCC ID: 2AMPPAI00240** filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rules and **IC: 11471A-AI00240** filing to comply with Industry Canada RSS-247 issue 2: 2017.

1.2 Test Methodology

Both conducted and radiated testing were performed according to the procedures in ANSI C63.10: 2013. Radiated testing was performed at an antenna to EUT distance 3 meters.

1.3 Test Facility

The measurement facilities used to collect the 3m Radiated Emission and AC power line conducted data are located on the address of **International Standards Laboratory Corp.**<LT Lab.> No. 120, Lane 180, Hsin Ho Rd., Lung-Tan Dist., Tao Yuan City 325, Taiwan which are constructed and calibrated to meet the FCC requirements in documents ANSI C63.10: 2013. FCC Registration Number is: 487532; Designation Number is: TW0997, Canada Registration Number: 4067B-4.

1.4 Special Accessories

Not available for this EUT intended for grant.

1.5 Equipment Modifications

Not available for this EUT intended for grant.

1.6 Reference

KDB Document: 558074 D01 15.247 Meas Guidance v05r02.

2 System Test Configuration

2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

2.2 EUT Exercise

The EUT (Transmitter) was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements.

2.3 Test Procedure

2.3.1 Conducted Emissions

The EUT is a placed on as turn table which is 0.8 m above ground plane. According to the requirements in Section 6 of ANSI C63.10: 2013 and RSS-Gen issue 5 Amendment 2: 2021. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR 16-1-1 Quasi-Peak and Average detector mode.

2.3.2 Radiated Emissions

The EUT is a placed on as turn table which is 0.8 m/1.5m (frequency above 1GHz) above ground plane. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this hand-held transmitter(EUT) was rotated through three orthogonal axes according to the requirements in Section 6 and 11 of ANSI C63.10: 2013.

2.4 Configuration of Tested System

Fig. 2-1 Configuration

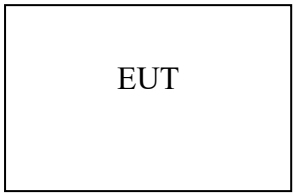


Table 2-1 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/ Type No.	Series No.	Data Cable	Power Cord
	N/A					

Note: All the above equipment/cables were placed in worse case positions to maximize emission signals during emission test.

Grounding: Grounding was in accordance with the manufacturer's requirements and conditions for the intended use.

3 Summary of Test Results

FCC Rules	Description Of Test	Result
§15.207(a) RSS-Gen §8.8	AC Power Line Conducted Emission	N/A
§15.247(b) (3),(4) RSS-247 issue 2,§5.4(d)	Peak Output Power/ EIRP	Compliant
§15.247(a)(2) RSS-247 issue 2, §5.2(a) RSS-Gen §6.7	6dB & 99% Power Bandwidth	Compliant
§15.247(d) RSS-247 issue 2, §5.5	100 kHz Bandwidth Of Frequency Band Edges	Compliant
§15.247(d) RSS-247 issue 2, §5.5	Spurious Emission	Compliant
§15.247(e) RSS-247 issue 2, §5.2(b)	Peak Power Density	Compliant
§15.203 RSS-Gen 6.8	Antenna Requirement	Compliant

4 Description of Test Modes

The EUT has been tested under engineering operating condition.
Test program used to control the EUT for staying in continuous transmitting mode is programmed.

BLE mode: Channel low (2402MHz), mid (2442MHz) and high (2480MHz) with data rate 1Mbps and 2Mbps are chosen for full testing.

5 Conduced Emission Test

5.1 Standard Applicable:

According to §15.207 and RSS-Gen §8.8, frequency range within 150kHz to 30MHz shall not exceed the Limit table as below.

Frequency range MHz	Limits dB(uV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

Note
1.The lower limit shall apply at the transition frequencies
2.The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

5.2 EUT Setup:

1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI C63.10-2013.
2. The AC/DC Power adaptor of PC was plug-in LISN. The EUT was placed flushed with the rear of the table.
3. The LISN was connected with 120Vac/60Hz power source.

5.3 Measurement Procedure:

1. The EUT was placed on a table which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured were complete.

5.4 Measurement Result:

N/A

6 Peak Output Power Measurement

6.1 Standard Applicable:

According to §15.247(b)(3), (b)(4), (c)

(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

(4) 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.

(c) Operation with directional antenna gains greater than 6 dBi.

(1) Fixed point-to-point operation:

(i) Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

(ii) Systems operating in the 5725-5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted output power.

According to RSS-247 issue 2, §5.4

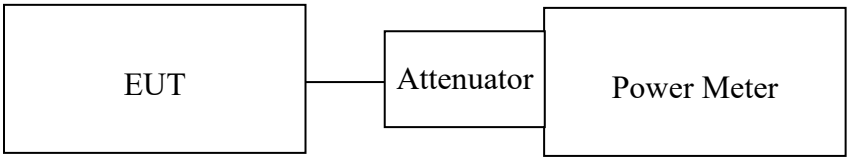
(d) For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. Except as provided in Section 5.4(5), the e.i.r.p. shall not exceed 4 W.

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

6.2 Measurement Equipment Used:

Location Conducted	Equipment Name	Brand	Model	S/N	Last Cal. Date	Next Cal. Date
Conducted	Power Meter	Anritsu	ML2495A	1116010	09/30/2021	09/30/2022
Conducted	Power Sensor	Anritsu	MA2411B	34NKF50	09/30/2021	09/30/2022
Conducted	Power Sensor	DARE	RPR3006W	13I00030SNO33	01/04/2021	01/04/2022
Conducted	Power Sensor	DARE	RPR3006W	13I00030SNO34	01/04/2021	01/04/2022
Conducted	Power Sensor	DARE	RPR3006W	14I00889SNO35	06/23/2021	06/23/2022
Conducted	Power Sensor	DARE	RPR3006W	14I00889SNO36	06/23/2021	06/23/2022
Conducted	Temperature Chamber	KSON	THS-B4H100	2287	04/26/2021	04/26/2022
Conducted	DC Power supply	ABM	8185D	N/A	01/05/2021	01/05/2022
Conducted	AC Power supply	EXTECH	CFC105W	NA	N/A	N/A
Conducted	Spectrum analyzer	Keysight	N9010A	MY56070257	09/28/2021	09/28/2022
Conducted	Test Software	DARE	Radiation Ver:2013.1.23	NA	NA	NA
Conducted	Test Software	R&S	CMUGO Ver:2.0.0	N/A	N/A	N/A
Conducted	Universal Digital Radio Communication Tester	R&S	CMU200	111968	11/29/2020	11/29/2021
Conducted	Wideband Radio Communication Tester	R&S	CMW500	1201.002K50108793-JG	10/28/2020	10/28/2021
Conducted	BT Simulator	Agilent	N4010A	MY48100200	NA	NA
Conducted	GPS Simulator	Welnavigate	GS-50	701523	NA	NA
Conducted (TS8997)	Wideband Radio Communication Tester	R&S	CMW500	168811	09/09/2021	09/09/2022
Conducted (TS8997)	Signal Generator	R&S	SMB100B	101085	09/09/2021	09/09/2022
Conducted (TS8997)	Vector Signal Generator	R&S	SMBV100A	263246	09/09/2021	09/09/2022
Conducted (TS8997)	Signal analyzer 40GHz	R&S	FSV40	101884	09/07/2021	09/07/2022
Conducted (TS8997)	OSP150 extension unit CAM-BUS	R&S	OSP150	101107	09/10/2021	09/10/2022
Conducted (TS8997)	Test Software	R&S	EMC32	NA	NA	NA

6.3 Test Set-up:



6.4 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter
3. Record the max. reading.
4. Repeat above procedures until all frequency measured were complete.

6.5 Measurement Result:

Peak Power

Mode	Freq. (MHz)	Total Output Power (dBm)	Output Power Limit (dBm)
BLE (1M)	2402	-4.81	30.00
	2442	-3.24	30.00
	2480	-1.84	30.00

Peak Power

Mode	Freq. (MHz)	Total Output Power (dBm)	Output Power Limit (dBm)
BLE (2M)	2402	-4.91	30.00
	2442	-3.33	30.00
	2480	-1.93	30.00

7 6dB Bandwidth & 99% Bandwidth

7.1 Standard Applicable:

According to §15.247(a)(2), Systems using digital modulation techniques may operate in the 902 - 928 MHz,2400 - 2483.5 MHz, and 5725 - 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500kHz.

According to RSS-247 issue 2, §5.2

(1) The minimum 6 dB bandwidth shall be 500 kHz.

7.2 Measurement Equipment Used:

Refer to section 6.2 for details.

7.3 Test Set-up:

Refer to section 6.3 for details.

7.4 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set the spectrum analyzer as RBW=100kHz, VBW = 3*RBW, Span= cover the complete power envelope of the signal of the UUT Sweep=auto
4. Mark the peak frequency and –6dB (upper and lower) frequency.
5. Repeat above procedures until all frequency measured were complete.

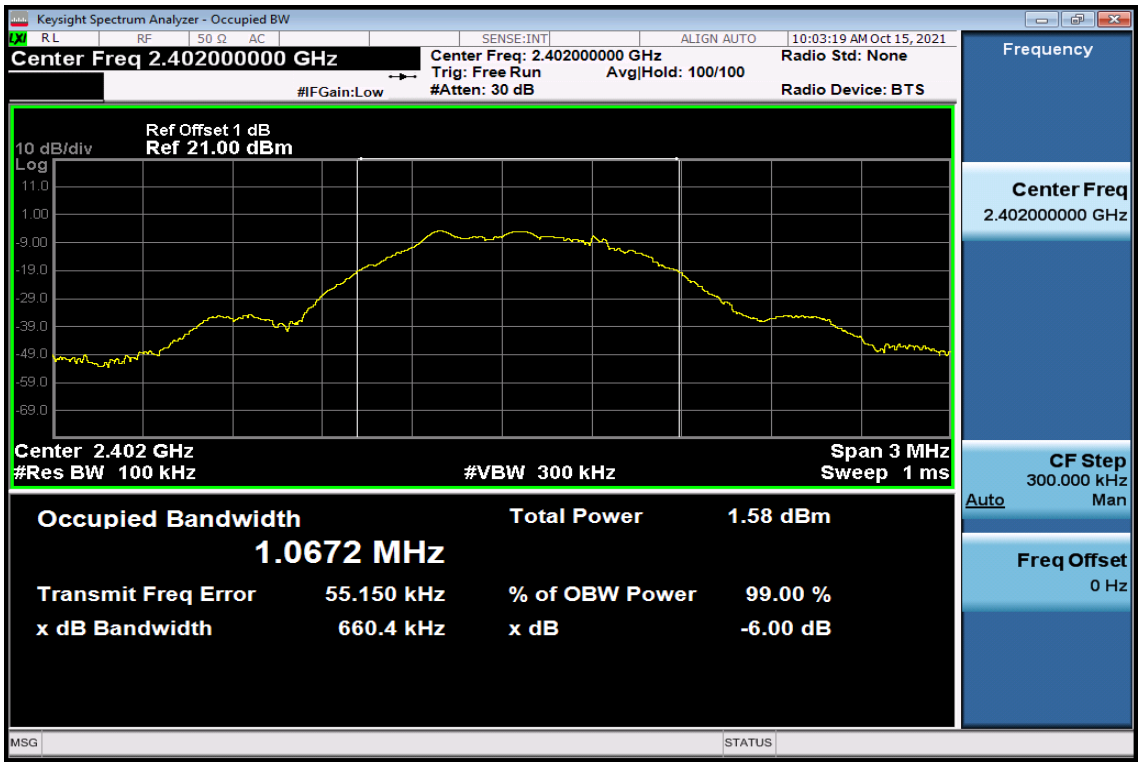
7.5 Measurement Result:

Mode	Frequency (MHz)	6dB Bandwidth (MHz)	99% OBW (MHz)	6dB BW Limit (kHz)
BLE (1M)	2402	0.660	1.043	> 500
	2442	0.695	1.040	> 500
	2480	0.692	1.045	> 500

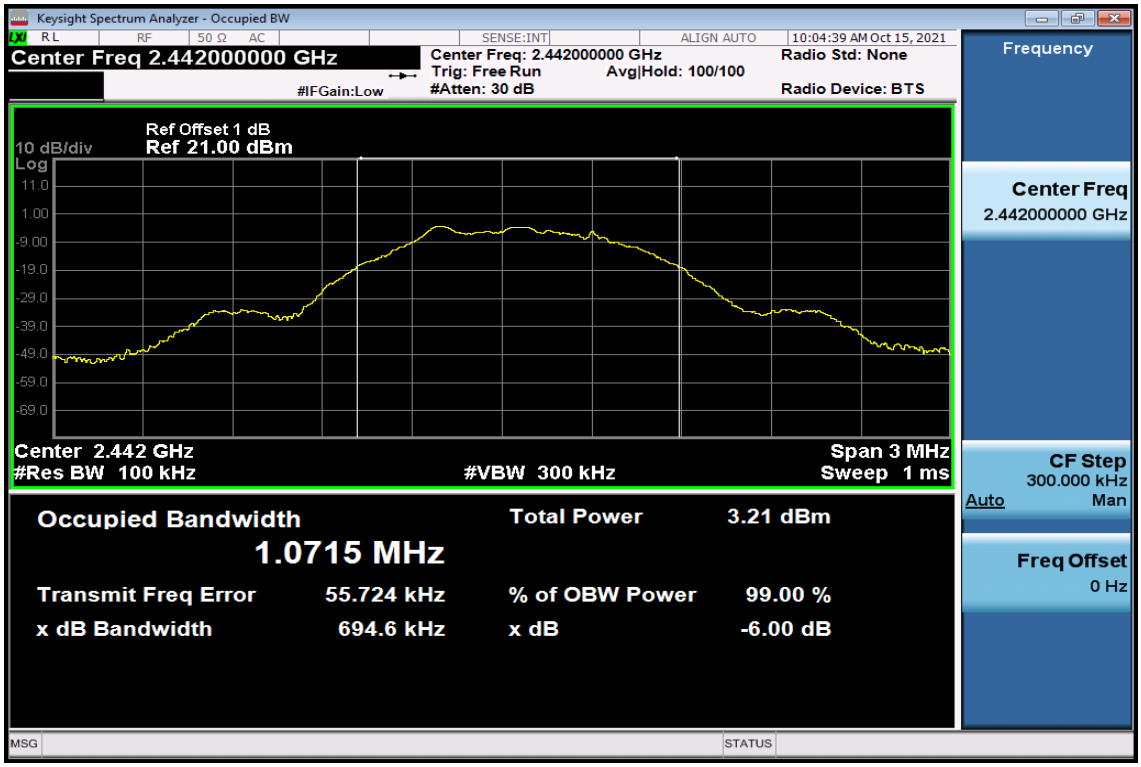
Mode	Frequency (MHz)	6dB Bandwidth (MHz)	99% OBW (MHz)	6dB BW Limit (kHz)
BLE (2M)	2402	0.706	1.040	> 500
	2442	0.693	1.041	> 500
	2480	0.706	1.045	> 500

Note: Refer to next page for plots.

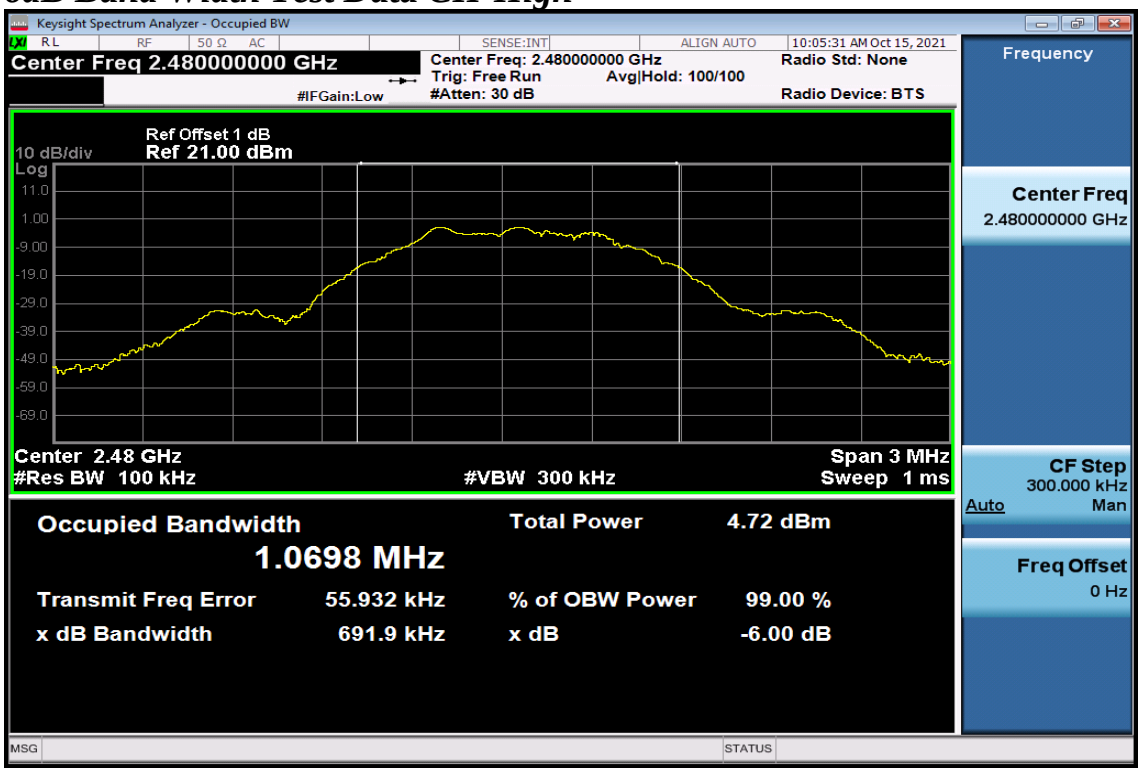
BLE (1M)
6dB Bandwidth Test Data CH-Low



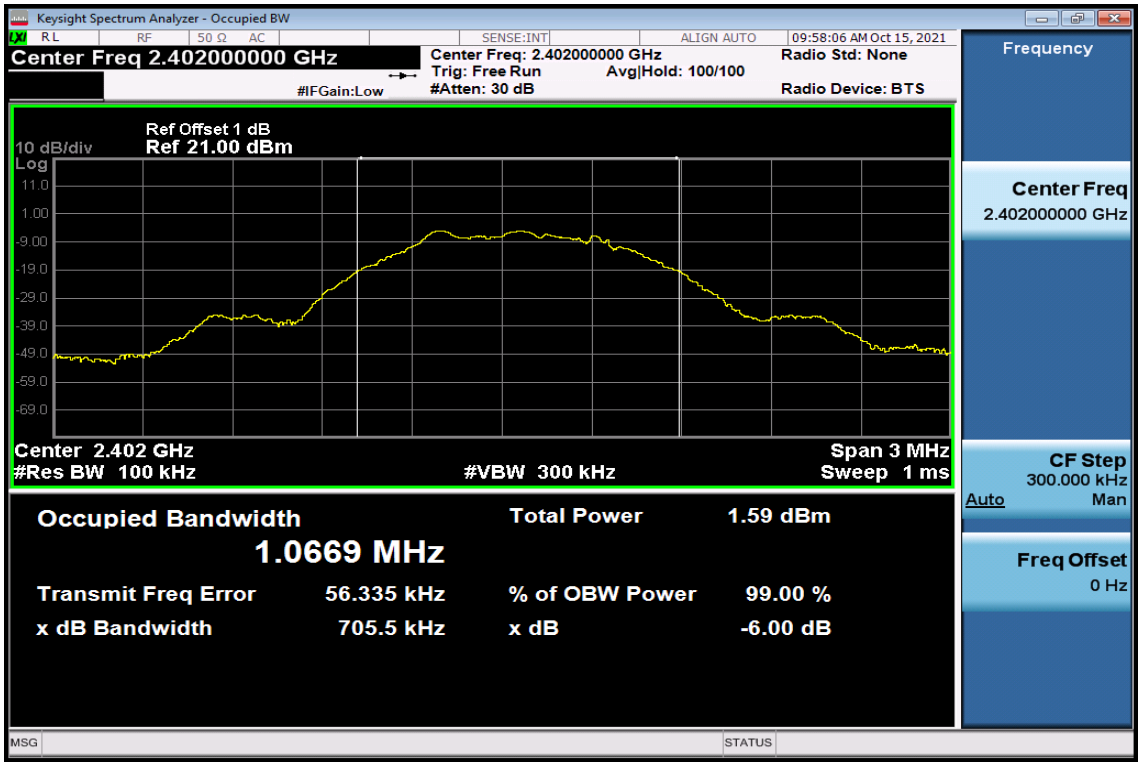
6dB Band Width Test Data CH-Mid



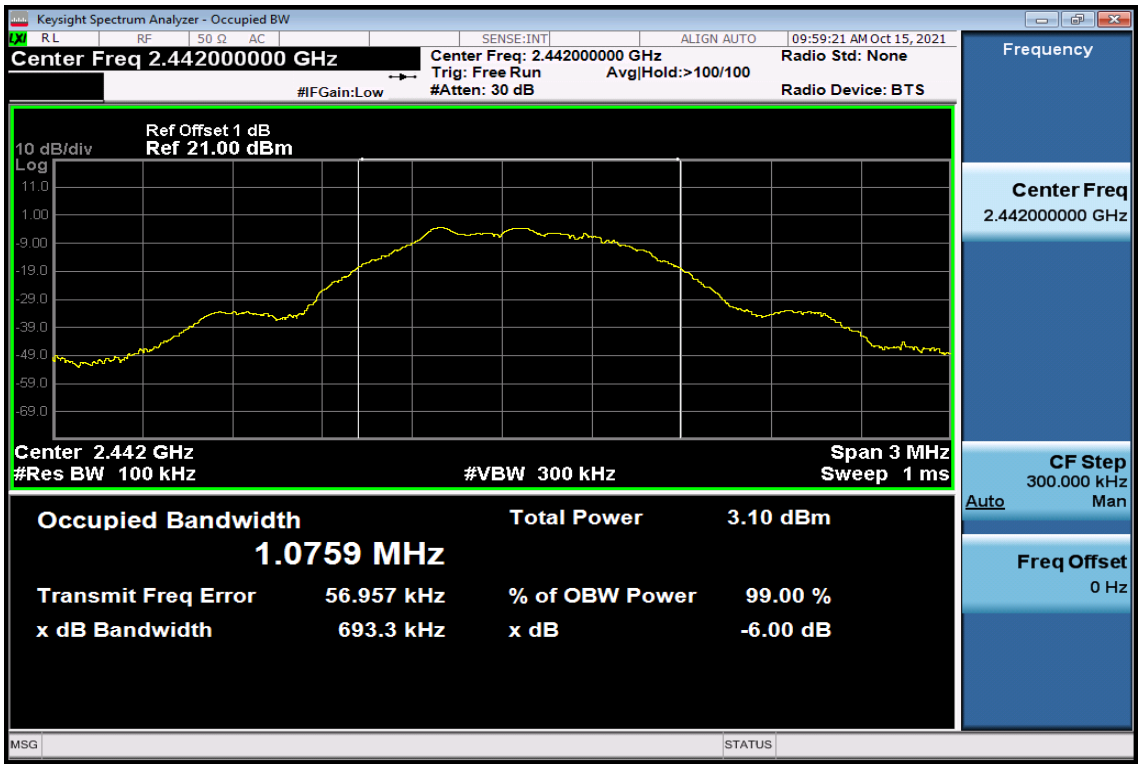
6dB Band Width Test Data CH-High



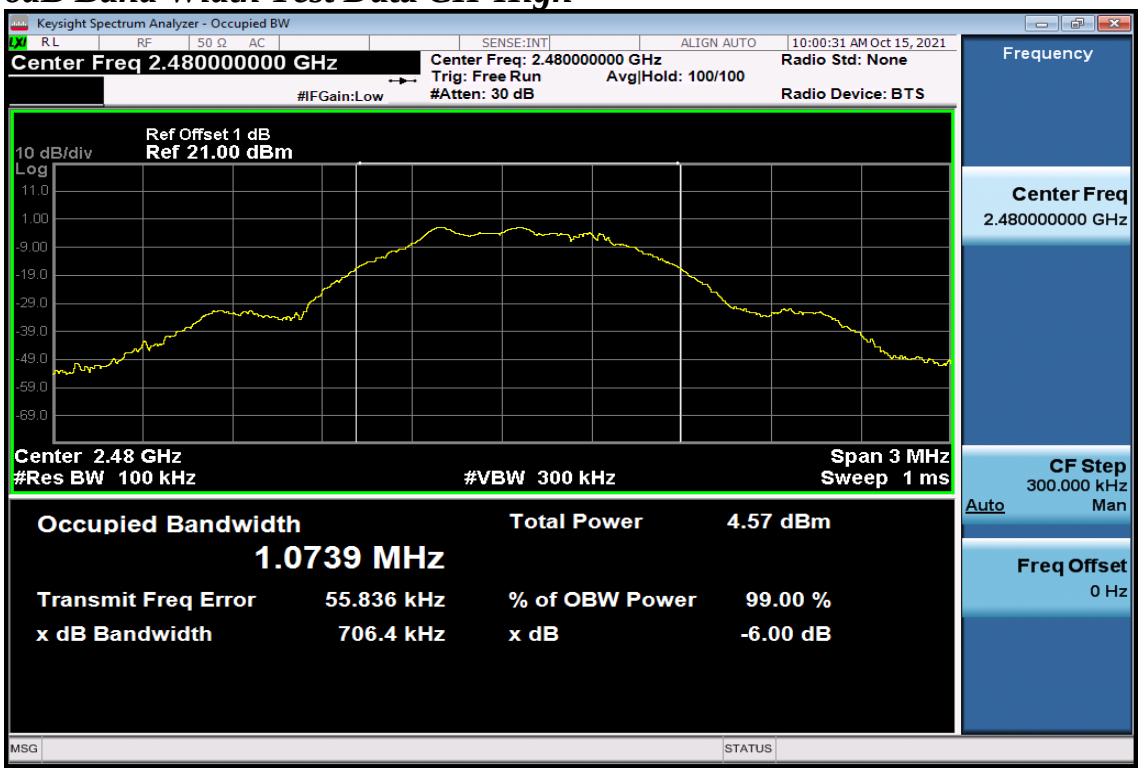
BLE (2M)
6dB Bandwidth Test Data CH-Low



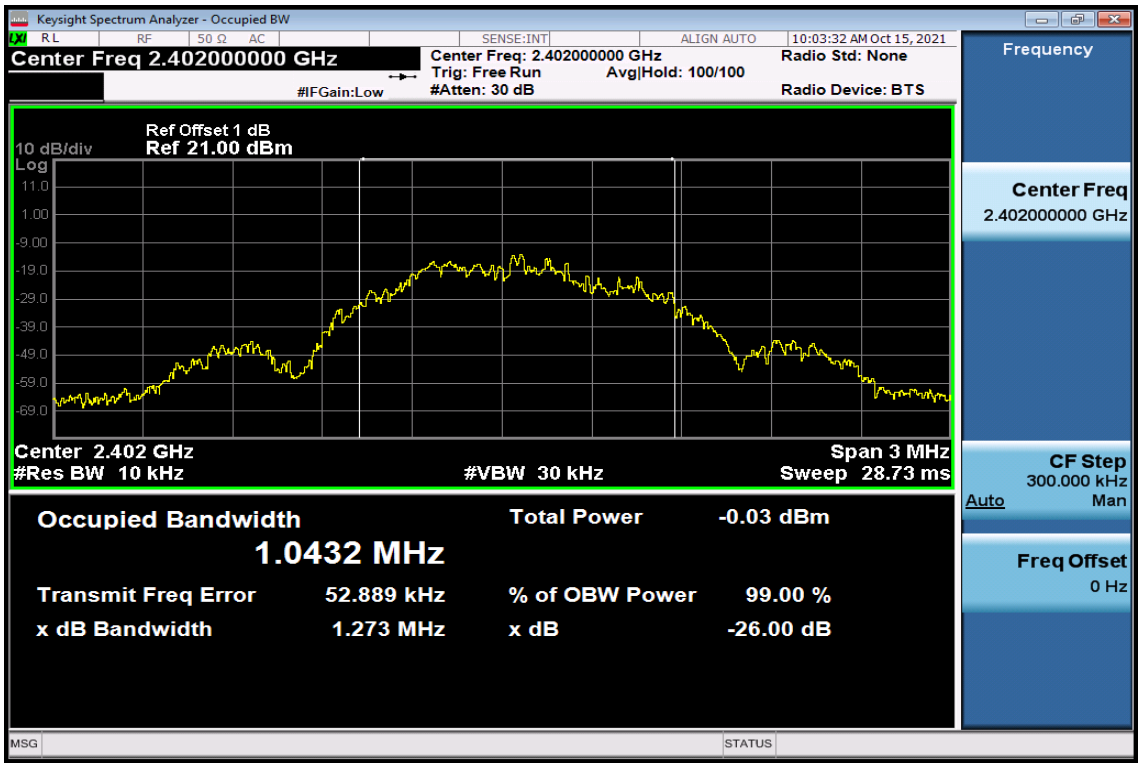
6dB Band Width Test Data CH-Mid



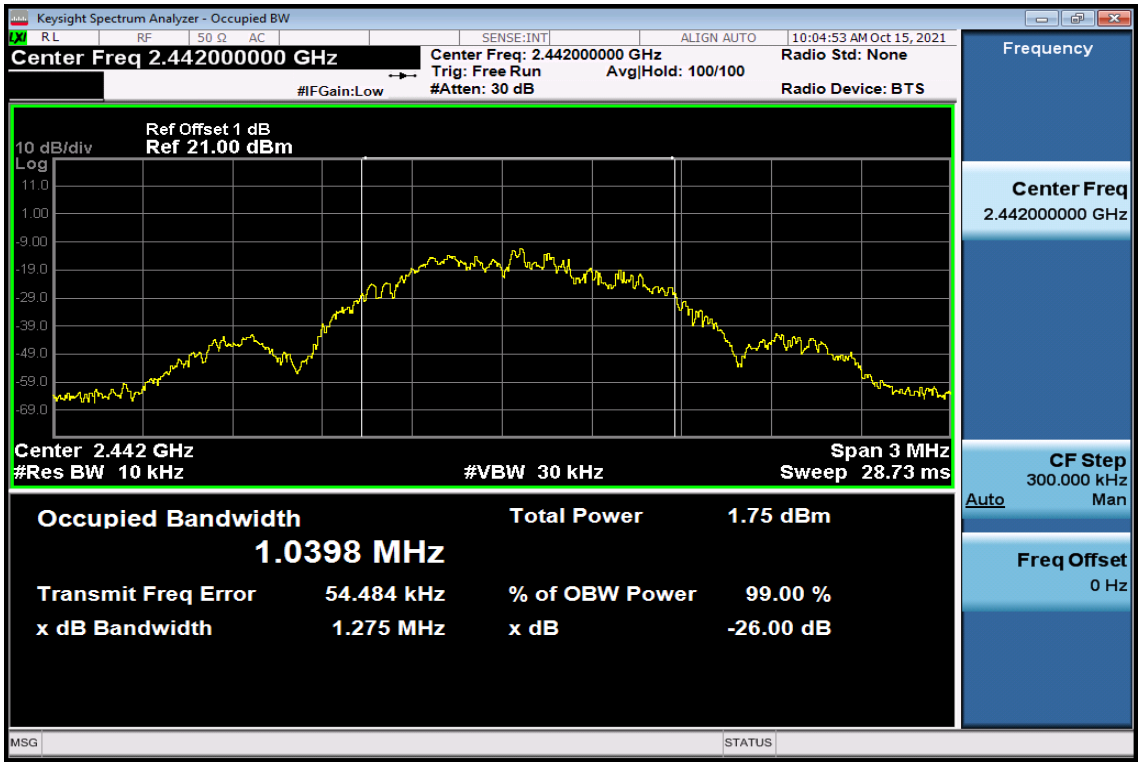
6dB Band Width Test Data CH-High



BLE (1M)
99% Bandwidth Test Data CH-Low

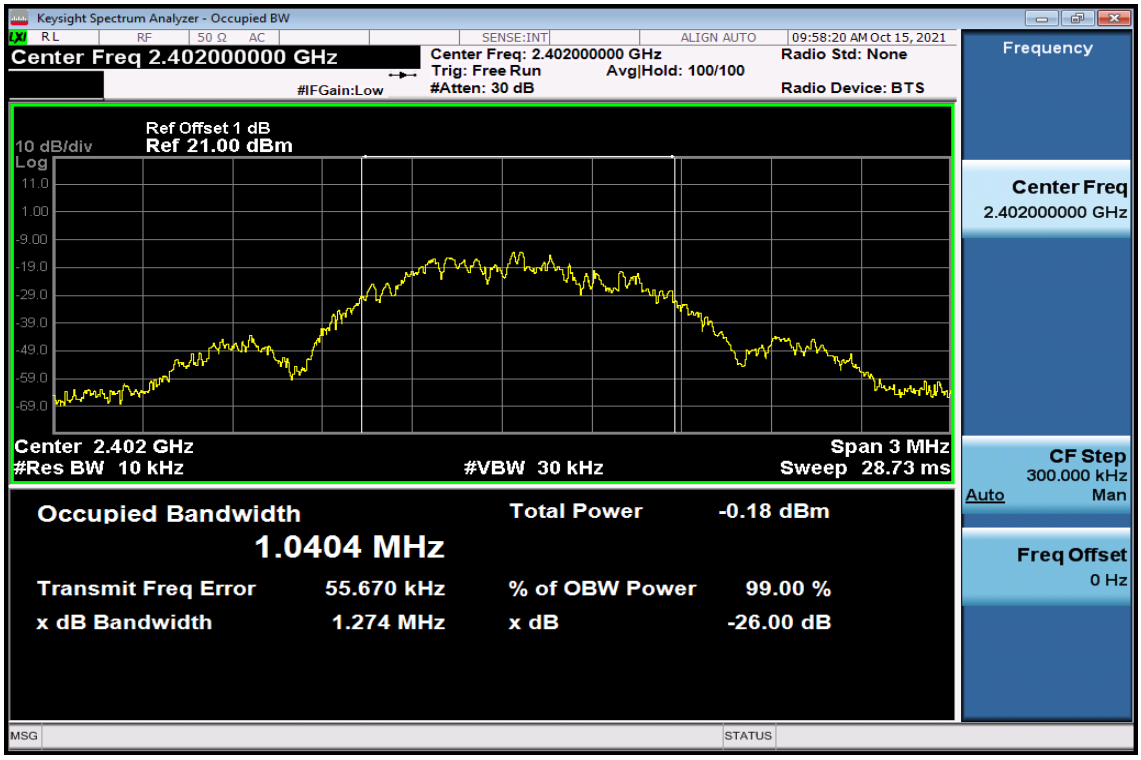


99% Band Width Test Data CH-Mid

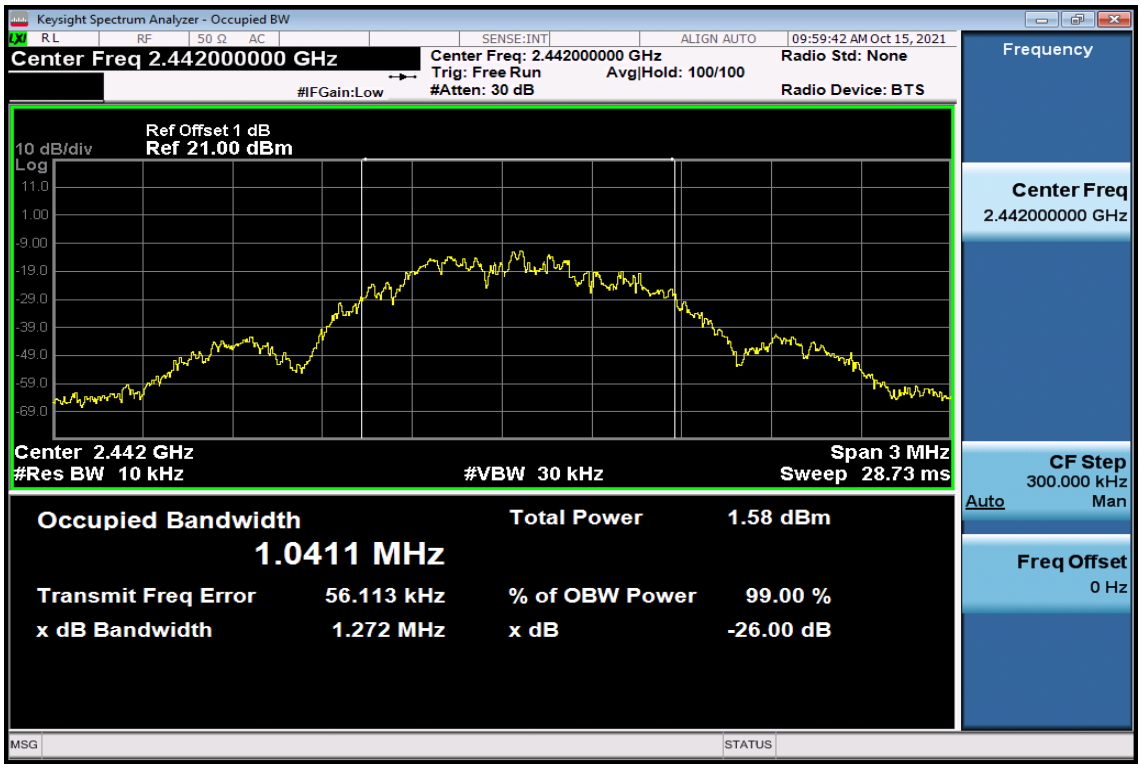


99% Band Width Test Data CH-High

BLE (2M)
99% Bandwidth Test Data CH-Low



99% Band Width Test Data CH-Mid



99% Band Width Test Data CH-High

8 Spurious Emission Test

8.1 Standard Applicable

According to §15.247(c), all other emissions outside these bands shall not exceed the general radiated emission limits specified in §15.209(a). And according to §15.33(a)(1), for an intentional radiator operates below 10GHz, the frequency range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower.

According to RSS-247 issue 2, §5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the de-sired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

8.2 Measurement Equipment Used:

8.2.1 Conducted Emission at antenna port:

Refer to section 6.2 for details.

8.2.2 Radiated emission:

Refer to section 9.2 for details.

8.3 Test SET-UP:

8.3.1 Conducted Emission at antenna port:

Refer to section 6.3 for details.

8.3.2 Radiated emission:

Refer to section 9.3 for details.

8.4 Measurement Procedure:

1. The EUT was placed on a turn table which is 0.8m above ground plane.
2. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
4. When measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." is still within the 3dB illumination BW of the measurement antenna.
5. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
6. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
7. Repeat above procedures until all frequency measured were complete.

Test receiver setting	:	Blew 1GHz
Detector	:	Average(9kHz – 90kHz, 110kHz – 90kHz), Quasi-Peak
Bandwidth	:	200Hz, 120kHz
Test spectrum setting	:	Above 1GHz
Peak	:	RBW=1MHz, VBW=3MHz,Sweep=auto
Average	:	RBW=1MHz, VBW≥1/Ton, Sweep=auto

Average Measurement Setting (VBW)

Mode	ON time (ms)	Total time (ms)	Duty Cycle	Duty Factor	1/Ton (kHz)	VBW for average detector (kHz)
BLE (1M)	0.110	1.450	7.586%	11.20	9.091	1
BLE (2M)	0.120	1.460	8.219%	10.85	8.333	1

8.5 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor(if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CL - AG

Where	FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
	RA = Reading Amplitude	AG = Amplifier Gain
	AF = Antenna Factor	

8.6 Measurement Result:

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

Radiated Spurious Emission Measurement Result (below 1GHz)

Operation Mode	TX CH Low	Test Date	2021/10/18
Fundamental Frequency	2402MHz	Pol	Ver./Hor
Temperature	20°C	Humidity	71%

No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol V/H
1	137.67	30.10	-6.34	23.76	43.50	-19.74	Peak	VERTICAL
2	356.89	27.29	-3.80	23.49	46.00	-22.51	Peak	VERTICAL
3	499.48	35.66	-1.26	34.40	46.00	-11.60	Peak	VERTICAL
4	520.82	35.74	-0.83	34.91	46.00	-11.09	Peak	VERTICAL
5	730.34	29.66	2.93	32.59	46.00	-13.41	Peak	VERTICAL
6	871.96	29.52	5.19	34.71	46.00	-11.29	Peak	VERTICAL
1	150.28	27.69	-5.72	21.97	43.50	-21.53	Peak	HORIZONTAL
2	499.48	37.36	-1.26	36.10	46.00	-9.90	Peak	HORIZONTAL
3	514.03	39.76	-0.96	38.80	46.00	-7.20	Peak	HORIZONTAL
4	634.31	28.29	1.51	29.80	46.00	-16.20	Peak	HORIZONTAL
5	824.43	27.66	4.62	32.28	46.00	-13.72	Peak	HORIZONTAL
6	931.13	27.60	6.44	34.04	46.00	-11.96	Peak	HORIZONTAL

Remark:

1 No further spurious emissions detected from the lowest internal frequency and 30MHz.

2 Measuring frequencies from the lowest internal frequency to the 1GHz.

3 Radiated emissions measured in frequency range from 9MHz to 1000MHz were made with an instrument detector setting 9-90kHz/110-490kHz using PK/AV and other Frequency Band using PK/QP

4 Measurement result within this frequency range shown " - " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

5 The IF bandwidth of SPA between 9kHz to 30MHz was 10kHz, VBW= 30kHz; between 30MHz to 1GHz was 100kHz, VBW=300kHz.

Radiated Spurious Emission Measurement Result (below 1GHz)

Operation Mode	TX CH Mid	Test Date	2021/10/18
Fundamental Frequency	2442MHz	Pol	Ver./Hor
Temperature	20℃	Humidity	71%

No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol V/H
1	134.76	30.31	-6.42	23.89	43.50	-19.61	Peak	VERTICAL
2	278.32	26.90	-5.27	21.63	46.00	-24.37	Peak	VERTICAL
3	396.66	27.73	-3.02	24.71	46.00	-21.29	Peak	VERTICAL
4	496.57	30.11	-1.31	28.80	46.00	-17.20	Peak	VERTICAL
5	521.79	39.96	-0.84	39.12	46.00	-6.88	Peak	VERTICAL
6	743.92	27.98	3.53	31.51	46.00	-14.49	Peak	VERTICAL
1	168.71	27.04	-5.75	21.29	43.50	-22.21	Peak	HORIZONTAL
2	320.03	26.95	-4.23	22.72	46.00	-23.28	Peak	HORIZONTAL
3	499.48	34.31	-1.26	33.05	46.00	-12.95	Peak	HORIZONTAL
4	522.76	42.36	-0.84	41.52	46.00	-4.48	Peak	HORIZONTAL
5	645.95	28.31	1.65	29.96	46.00	-16.04	Peak	HORIZONTAL
6	765.26	27.93	3.88	31.81	46.00	-14.19	Peak	HORIZONTAL

Remark:

1 No further spurious emissions detected from the lowest internal frequency and 30MHz.

2 Measuring frequencies from the lowest internal frequency to the 1GHz.

3 Radiated emissions measured in frequency range from 9MHz to 1000MHz were made with an instrument detector setting 9-90kHz/110-490kHz using PK/AV and other Frequency Band using PK/QP

4 Measurement result within this frequency range shown " - " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

5 The IF bandwidth of SPA between 9kHz to 30MHz was 10kHz, VBW= 30kHz; between 30MHz to 1GHz was 100kHz, VBW=300kHz.

Radiated Spurious Emission Measurement Result (below 1GHz)

Operation Mode	TX CH High	Test Date	2021/10/18
Fundamental Frequency	2480MHz	Pol	Ver./Hor
Temperature	20℃	Humidity	71%

No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol V/H
1	118.27	30.94	-8.20	22.74	43.50	-20.76	Peak	VERTICAL
2	350.10	28.04	-3.90	24.14	46.00	-21.86	Peak	VERTICAL
3	470.38	29.20	-1.56	27.64	46.00	-18.36	Peak	VERTICAL
4	520.82	33.55	-0.83	32.72	46.00	-13.28	Peak	VERTICAL
5	732.28	28.24	2.89	31.13	46.00	-14.87	Peak	VERTICAL
6	836.07	28.09	4.71	32.80	46.00	-13.20	Peak	VERTICAL
1	142.52	28.48	-5.95	22.53	43.50	-20.97	Peak	HORIZONTAL
2	310.33	26.82	-4.47	22.35	46.00	-23.65	Peak	HORIZONTAL
3	443.22	27.91	-1.89	26.02	46.00	-19.98	Peak	HORIZONTAL
4	515.00	39.12	-0.94	38.18	46.00	-7.82	Peak	HORIZONTAL
5	656.62	27.96	1.82	29.78	46.00	-16.22	Peak	HORIZONTAL
6	798.24	28.24	4.12	32.36	46.00	-13.64	Peak	HORIZONTAL

Remark:

1 No further spurious emissions detected from the lowest internal frequency and 30MHz.

2 Measuring frequencies from the lowest internal frequency to the 1GHz.

3 Radiated emissions measured in frequency range from 9MHz to 1000MHz were made with an instrument detector setting 9-90kHz/110-490kHz using PK/AV and other Frequency Band using PK/QP

4 Measurement result within this frequency range shown " - " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

5 The IF bandwidth of SPA between 9kHz to 30MHz was 10kHz, VBW= 30kHz; between 30MHz to 1GHz was 100kHz, VBW=300kHz.

Radiated Spurious Emission Measurement Result (above 1GHz)

Operation Mode	TX CH Low	Test Date	2021/10/18
Fundamental Frequency	2402MHz	Pol	Ver./Hor
Temperature	20°C	Humidity	71%

No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol V/H
1	4804.00	54.58	-7.36	47.22	74.00	-26.78	Peak	VERTICAL
2	7206.00	55.19	-3.62	51.57	74.00	-22.43	Peak	VERTICAL
1	4804.00	55.54	-7.36	48.18	74.00	-25.82	Peak	HORIZONTAL
2	7206.00	55.73	-3.62	52.11	74.00	-21.89	Peak	HORIZONTAL

Remark:

1 Measuring frequencies from the lowest internal frequency to the 10th of fundamental frequency

2 Field strength limits for frequency above 1000MHz are based on average limits. However, Peak mode field strength shall not exceed the average limits specified plus 20dB.

3 Measurement of data within this frequency range shown " - " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

Radiated Spurious Emission Measurement Result (above 1GHz)

Operation Mode	TX CH Mid	Test Date	2021/10/18
Fundamental Frequency	2442MHz	Pol	Ver./Hor
Temperature	20℃	Humidity	71%

No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol V/H
1	4884.00	51.05	-7.24	43.81	74.00	-30.19	Peak	VERTICAL
2	7326.00	54.90	-3.60	51.30	74.00	-22.70	Peak	VERTICAL
1	4884.00	57.69	-7.24	50.45	74.00	-23.55	Peak	HORIZONTAL
2	7326.00	55.71	-3.60	52.11	74.00	-21.89	Peak	HORIZONTAL

Remark:

1 Measuring frequencies from the lowest internal frequency to the 10th of fundamental frequency

2 Field strength limits for frequency above 1000MHz are based on average limits. However, Peak mode field strength shall not exceed the average limits specified plus 20dB.

3 Measurement of data within this frequency range shown " - " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

Radiated Spurious Emission Measurement Result (above 1GHz)

Operation Mode	TX CH High	Test Date	2021/10/18
Fundamental Frequency	2480MHz	Pol	Ver./Hor
Temperature	20℃	Humidity	71%

No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol V/H
1	4960.00	50.59	-7.07	43.52	74.00	-30.48	Peak	VERTICAL
2	7440.00	50.64	-3.58	47.06	74.00	-26.94	Peak	VERTICAL
1	4960.00	57.92	-7.07	50.85	74.00	-23.15	Peak	HORIZONTAL
2	7440.00	56.29	-3.58	52.71	74.00	-21.29	Peak	HORIZONTAL

Remark:

1 Measuring frequencies from the lowest internal frequency to the 10th of fundamental frequency

2 Field strength limits for frequency above 1000MHz are based on average limits. However, Peak mode field strength shall not exceed the average limits specified plus 20dB.

3 Measurement of data within this frequency range shown " - " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

9 100kHz Bandwidth of Band Edges Measurement

9.1 Standard Applicable:

According to §15.247(c), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator in operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, 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 in15.209(a).

According to RSS-247 issue 2, §5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB attenuation below the general field strength limits specified in RSS-Gen is not required.

9.2 Measurement Equipment Used:

9.2.1 Conducted Emission at antenna port:

Refer to section 6.2 for details.

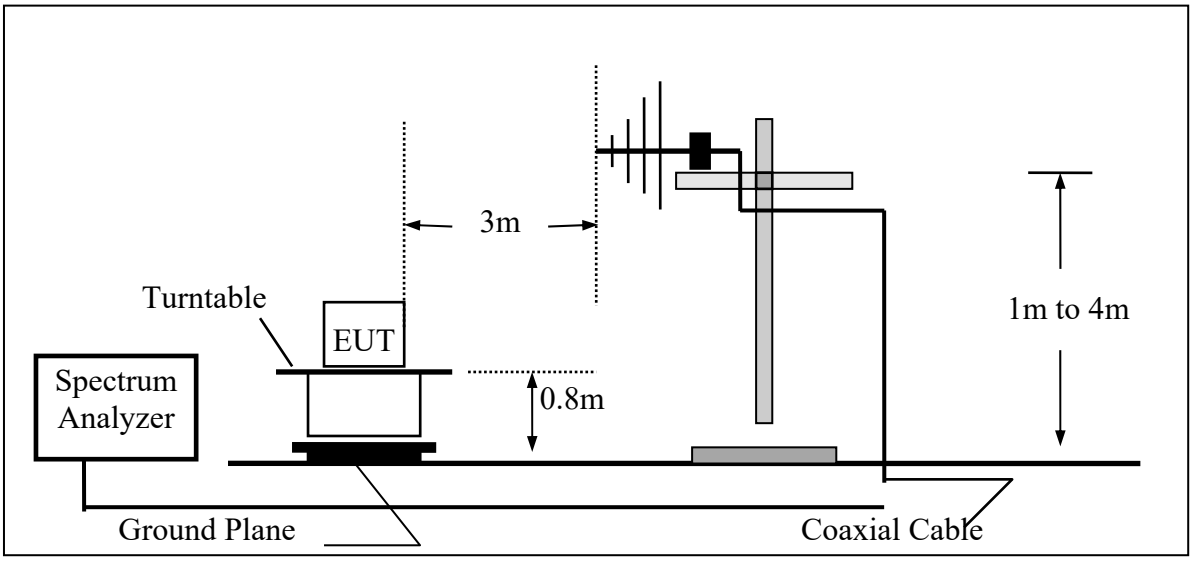
9.2.2 Radiated emission:

Location Conducted	Equipment Name	Brand	Model	S/N	Last Cal. Date	Next Cal. Date
Chamber 19	Spectrum analyzer	R&S	FSV40	101919	08/18/2021	08/18/2022
Chamber 19	EMI Receiver	R&S	ESR3	102461	05/05/2021	05/05/2022
Chamber 19	Loop Antenna	EM	EM-6879	271	09/29/2021	09/29/2022
Chamber 19	Bilog Antenna (30MHz-1GHz)	Schwarzbeck	VULB9168 w 6dB Att.	9168-736	02/22/2021	02/22/2022
Chamber 19	Horn antenna (1GHz-18GHz)	ETS	3117	00218718	10/12/2021	10/12/2022
Chamber 19	Horn antenna (18GHz-26GHz)	Com-power	AH-826	081001	11/23/2020	11/23/2021
Chamber 19	Horn antenna (26GHz-40GHz)	Com-power	AH-640	100A	03/11/2021	03/11/2022
Chamber 19	Preamplifier (9kHz-1GHz)	HP	8447F	3113A04621	06/22/2021	06/22/2022
Chamber 19	Preamplifier (1GHz-26GHz)	EM	EM01M26G	060681	05/07/2021	05/07/2022
Chamber 19	Preamplifier (26GHz-40GHz)	MITEQ	JS4-26004000-27-5A	818471	05/07/2021	05/07/2022
Chamber 19	RF Cable (9kHz-18GHz)	HUBER SU-HNER	Sucoflex 104A & 18GHz SMA(M)-SMA(M)-10M	MY817/4A & 20200525	12/25/2020	12/25/2021
Chamber 19	RF Cable (18GHz-40GHz)	HUBER SU-HNER	Sucoflex 102	27963/2&37421/2	11/19/2020	11/19/2021
Chamber 19	Signal Generator	Anritsu	MG3692A	20311	01/03/2021	01/03/2022
Chamber 19	Test Software	Audix	E3 Ver:6.12023	N/A	N/A	N/A

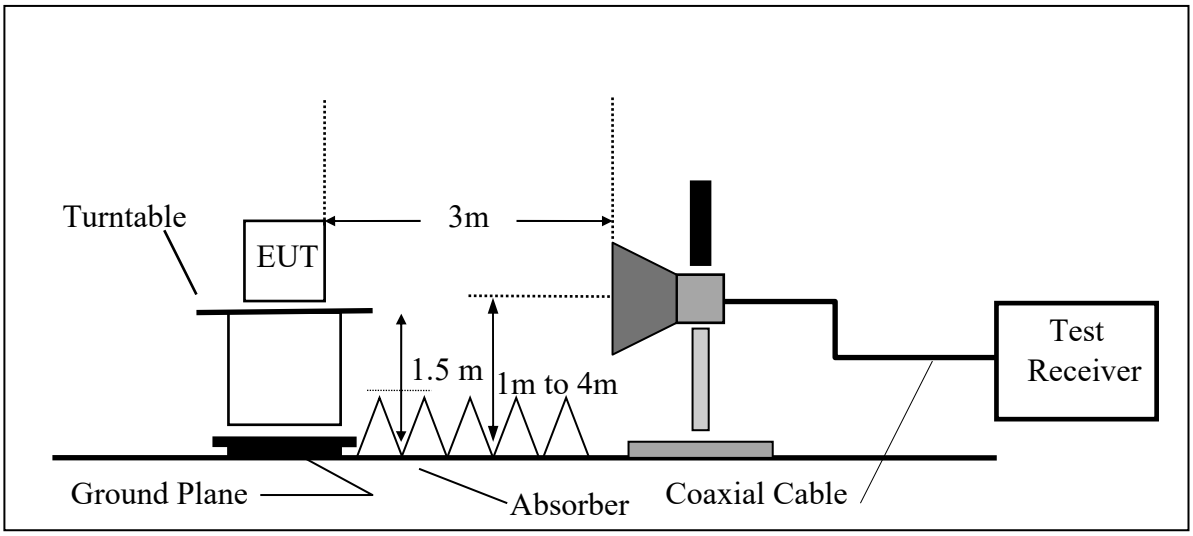
9.3 Test SET-UP:

9.3.1 Radiated emission:

(A) Radiated Emission Test Set-Up, Frequency Below 1000MHz



(B) Radiated Emission Test Set-Up Frequency Over 1 GHz



9.4 Measurement Procedure:

Refer to section 8.4 for details.

9.5 Field Strength Calculation:

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CL - AG

Where	FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
	RA = Reading Amplitude	AG = Amplifier Gain
	AF = Antenna Factor	

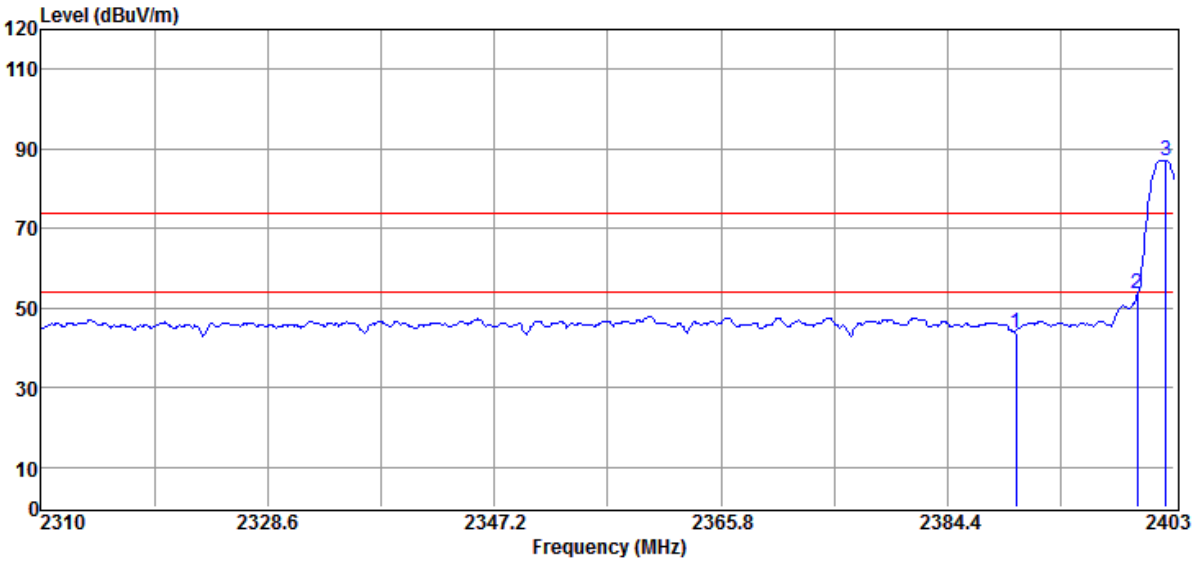
9.6 Measurement Result:

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

Radiated Emission:

BLE (1M)

Operation Mode	TX CH Low	Test Date	2021/10/18
Fundamental Frequency	2402 MHz		
Temperature	20℃	Humidity	71%



No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol V/H
1	2390.00	55.68	-11.82	43.86	74.00	-30.14	Peak	VERTICAL
2	2400.00	65.61	-11.81	53.80	67.11	-13.31	Peak	VERTICAL
3	2402.35	98.92	-11.81	87.11	F	--	Peak	VERTICAL

Remark:

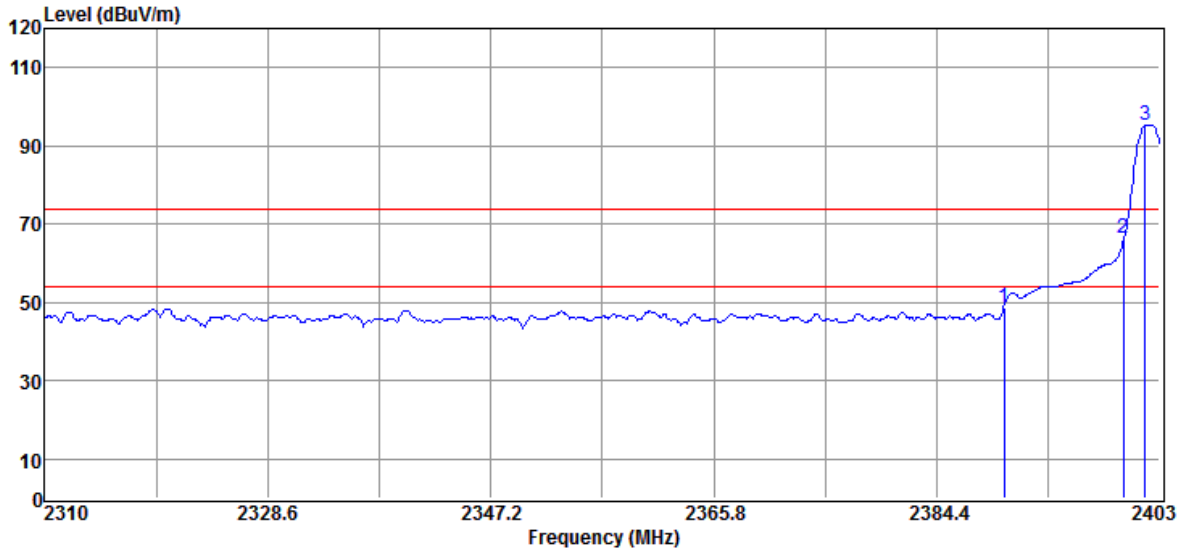
1 Measuring frequencies from the lowest internal frequency to the 10th of fundamental frequency

2 Field strength limits for frequency above 1000MHz are based on average limits. However, Peak mode field strength shall not exceed the average limits specified plus 20dB.

3 Measurement of data within this frequency range shown " - " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

Note: "F" denotes fundamental frequency

Operation Mode	TX CH Low	Test Date	2021/10/18
Fundamental Frequency	2402 MHz		
Temperature	20℃	Humidity	71%



No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol V/H
1	2390.00	60.29	-11.82	48.47	74.00	-25.53	Peak	HORIZONTAL
2	2400.00	78.20	-11.81	66.39	75.46	-9.07	Peak	HORIZONTAL
3	2401.79	107.27	-11.81	95.46	F	--	Peak	HORIZONTAL

Remark:

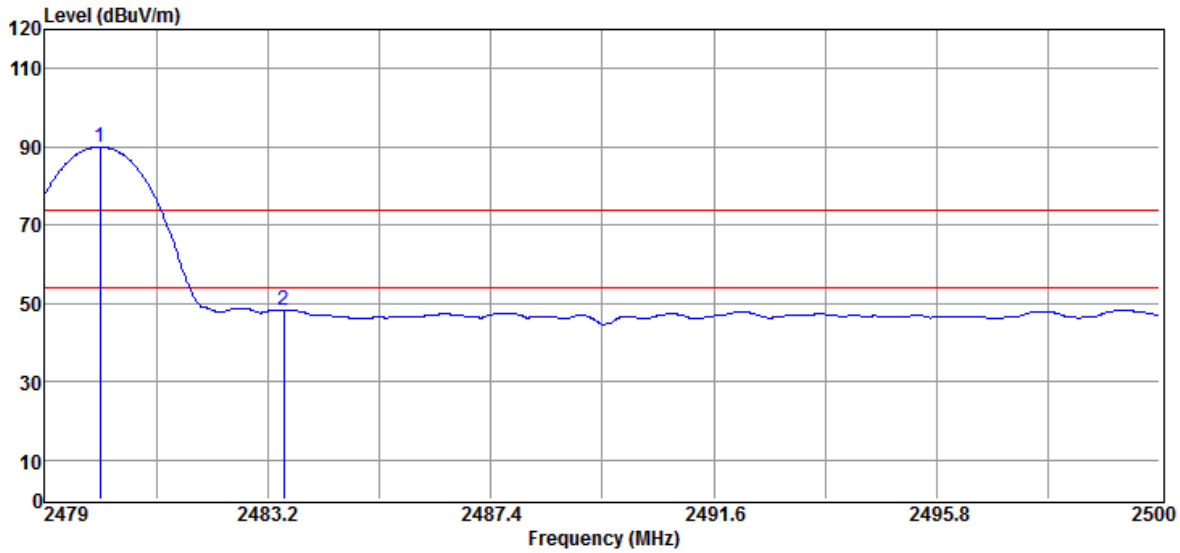
1 Measuring frequencies from the lowest internal frequency to the 10th of fundamental frequency

2 Field strength limits for frequency above 1000MHz are based on average limits. However, Peak mode field strength shall not exceed the average limits specified plus 20dB.

3 Measurement of data within this frequency range shown " - " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

Note: "F" denotes fundamental frequency

Operation Mode	TX CH High	Test Date	2021/10/18
Fundamental Frequency	2480 MHz		
Temperature	20℃	Humidity	71%



No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol V/H
1	2480.05	101.64	-11.70	89.94	F	--	Peak	VERTICAL
2	2483.50	60.13	-11.69	48.44	74.00	-25.56	Peak	VERTICAL

Remark:

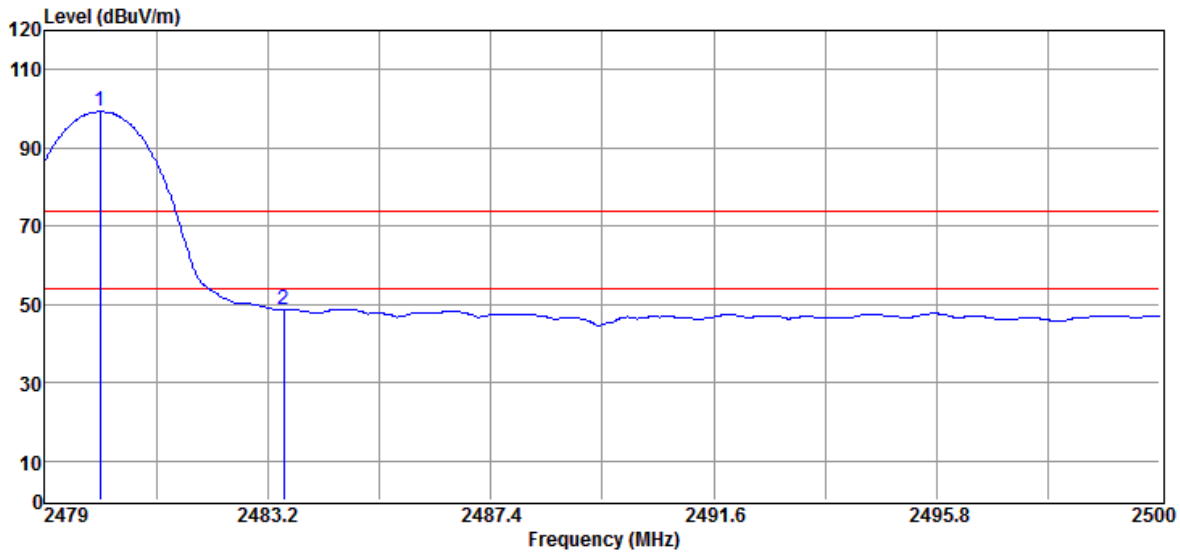
1 Measuring frequencies from the lowest internal frequency to the 10th of fundamental frequency

2 Field strength limits for frequency above 1000MHz are based on average limits. However, Peak mode field strength shall not exceed the average limits specified plus 20dB.

3 Measurement of data within this frequency range shown " - " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

Note: "F" denotes fundamental frequency

Operation Mode	TX CH High	Test Date	2021/10/18
Fundamental Frequency	2480 MHz		
Temperature	20°C	Humidity	71%



No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol V/H
1	2480.05	110.92	-11.70	99.22	F	--	Peak	HORIZONTAL
2	2483.50	60.37	-11.69	48.68	74.00	-25.32	Peak	HORIZONTAL

Remark:

1 Measuring frequencies from the lowest internal frequency to the 10th of fundamental frequency

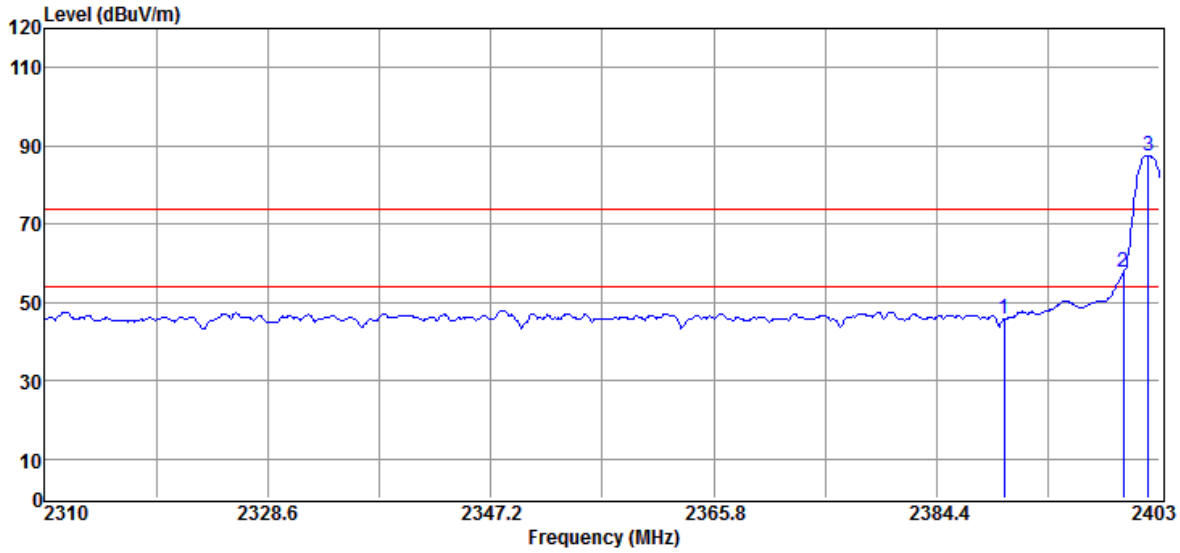
2 Field strength limits for frequency above 1000MHz are based on average limits. However, Peak mode field strength shall not exceed the average limits specified plus 20dB.

3 Measurement of data within this frequency range shown " - " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

Note: "F" denotes fundamental frequency

BLE (2M)

Operation Mode	TX CH Low	Test Date	2021/10/18
Fundamental Frequency	2402 MHz	Test By	Weitin
Temperature	20°C	Humidity	71%



No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol V/H
1	2390.00	57.51	-11.82	45.69	74.00	-28.31	Peak	VERTICAL
2	2400.00	69.65	-11.81	57.84	67.47	-9.63	Peak	VERTICAL
3	2402.07	99.28	-11.81	87.47	F	--	Peak	VERTICAL

Remark:

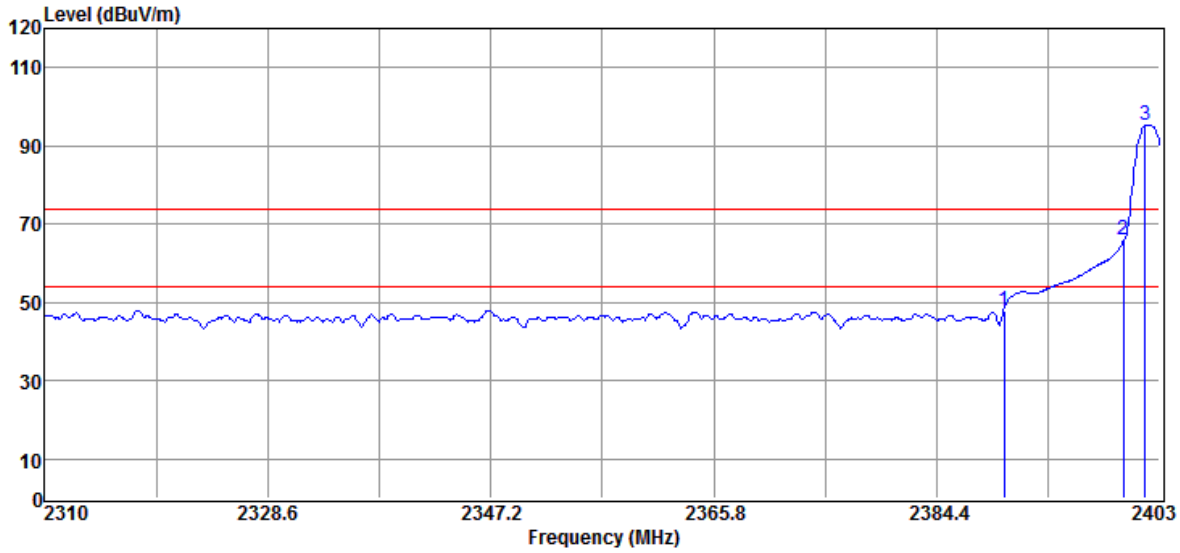
1 Measuring frequencies from the lowest internal frequency to the 10th of fundamental frequency

2 Field strength limits for frequency above 1000MHz are based on average limits. However, Peak mode field strength shall not exceed the average limits specified plus 20dB.

3 Measurement of data within this frequency range shown " - " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

Note: "F" denotes fundamental frequency

Operation Mode	TX CH Low	Test Date	2021/10/18
Fundamental Frequency	2402 MHz	Test By	Weitin
Temperature	20℃	Humidity	71%



No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol V/H
1	2390.00	59.72	-11.82	47.90	74.00	-26.10	Peak	HORIZONTAL
2	2400.00	77.65	-11.81	65.84	75.28	-9.44	Peak	HORIZONTAL
3	2401.79	107.09	-11.81	95.28	F	--	Peak	HORIZONTAL

Remark:

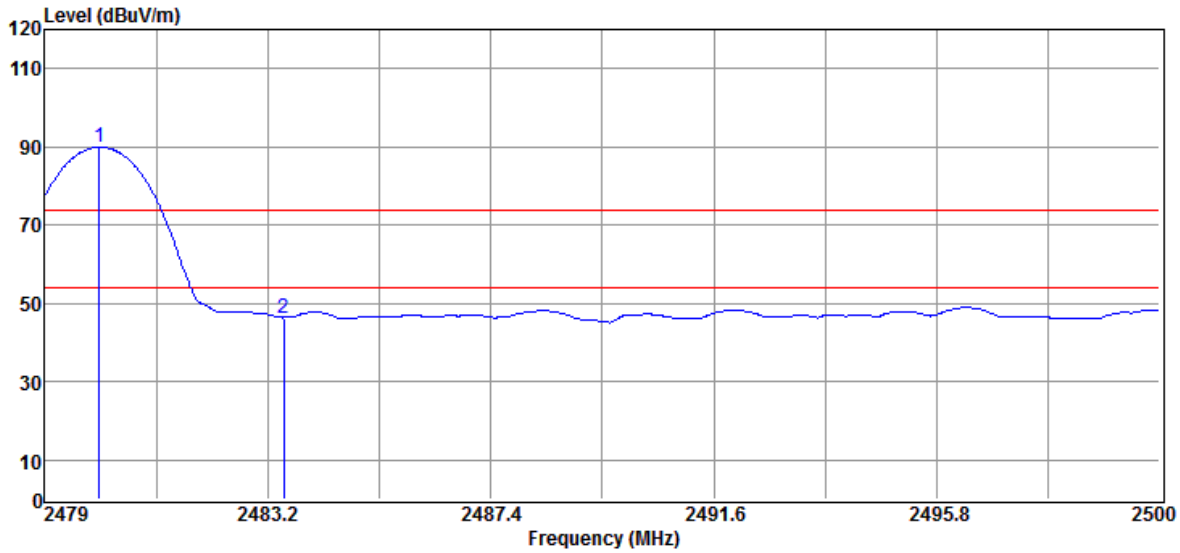
1 Measuring frequencies from the lowest internal frequency to the 10th of fundamental frequency

2 Field strength limits for frequency above 1000MHz are based on average limits. However, Peak mode field strength shall not exceed the average limits specified plus 20dB.

3 Measurement of data within this frequency range shown " - " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

Note: "F" denotes fundamental frequency

Operation Mode	TX CH High	Test Date	2021/10/18
Fundamental Frequency	2480 MHz	Test By	Weitin
Temperature	20°C	Humidity	71%



No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol V/H
1	2480.03	101.58	-11.70	89.88	F	--	Peak	VERTICAL
2	2483.50	58.08	-11.69	46.39	74.00	-27.61	Peak	VERTICAL

Remark:

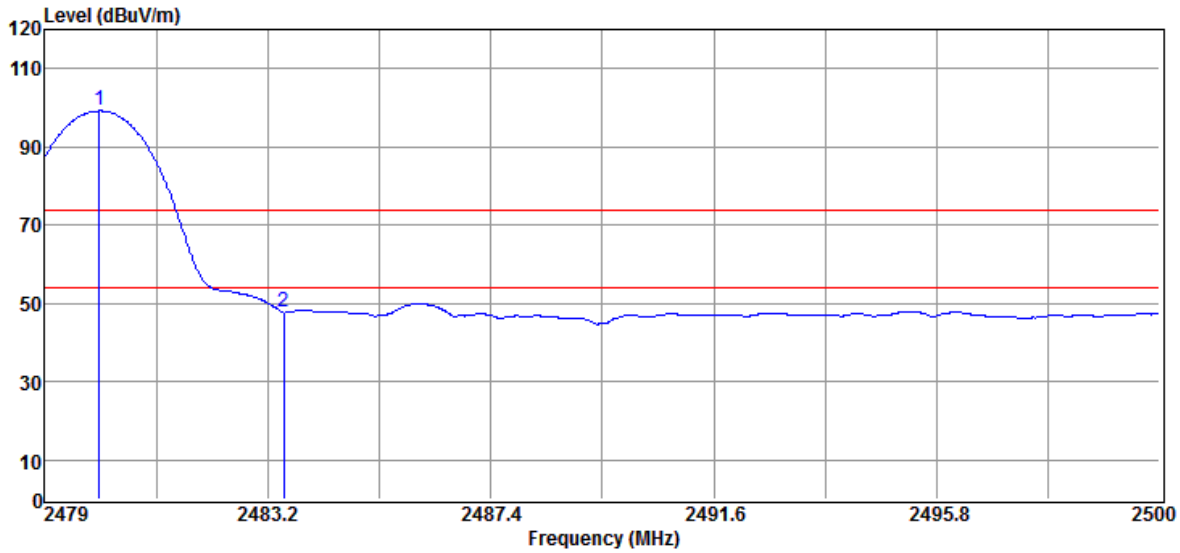
1 Measuring frequencies from the lowest internal frequency to the 10th of fundamental frequency

2 Field strength limits for frequency above 1000MHz are based on average limits. However, Peak mode field strength shall not exceed the average limits specified plus 20dB.

3 Measurement of data within this frequency range shown " - " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

Note: "F" denotes fundamental frequency

Operation Mode	TX CH High	Test Date	2021/10/18
Fundamental Frequency	2480 MHz		
Temperature	20℃	Humidity	71%



No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol V/H
1	2480.03	110.89	-11.70	99.19	F	--	Peak	HORIZONTAL
2	2483.50	59.41	-11.69	47.72	74.00	-26.28	Peak	HORIZONTAL

Remark:

1 Measuring frequencies from the lowest internal frequency to the 10th of fundamental frequency

2 Field strength limits for frequency above 1000MHz are based on average limits. However, Peak mode field strength shall not exceed the average limits specified plus 20dB.

3 Measurement of data within this frequency range shown " - " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

Note: "F" denotes fundamental frequency

10 Peak Power Spectral Density

10.1 Standard Applicable:

According to §15.247(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

According to RSS-247 issue 2, §5.2
(2)The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of Section 5.4(4), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

10.2 Measurement Equipment Used:

Refer to section 6.2 for details.

10.3 Test Set-up:

Refer to section 6.3 for details.

10.4 Measurement Procedure:

a) Set analyzer center frequency to DTS channel center frequency.
b) Set the span to 1.5 times the DTS bandwidth.
c) Set the RBW to 3 kHz ≤ RBW ≤ 100 kHz.
d) Set the VBW ≥ [3 x RBW].
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level within the RBW.

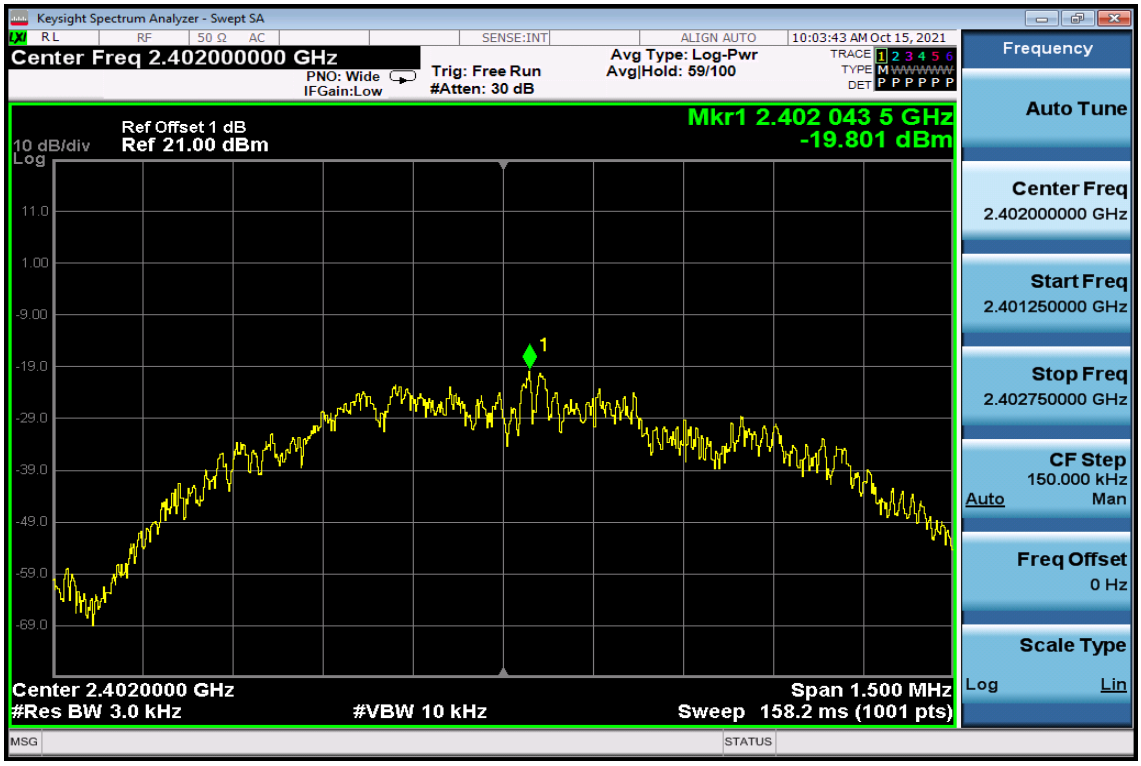
10.5 Measurement Result:

Mode	Frequency (MHz)	PSD (dBm/3kHz)	PSD Limit (dBm/3kHz)
BLE (1M)	2402	-19.801	8.00
	2442	-17.925	8.00
	2480	-16.381	8.00

Mode	Frequency (MHz)	PSD (dBm/3kHz)	PSD Limit (dBm/3kHz)
BLE (2M)	2402	-19.771	8.00
	2442	-18.663	8.00
	2480	-16.661	8.00

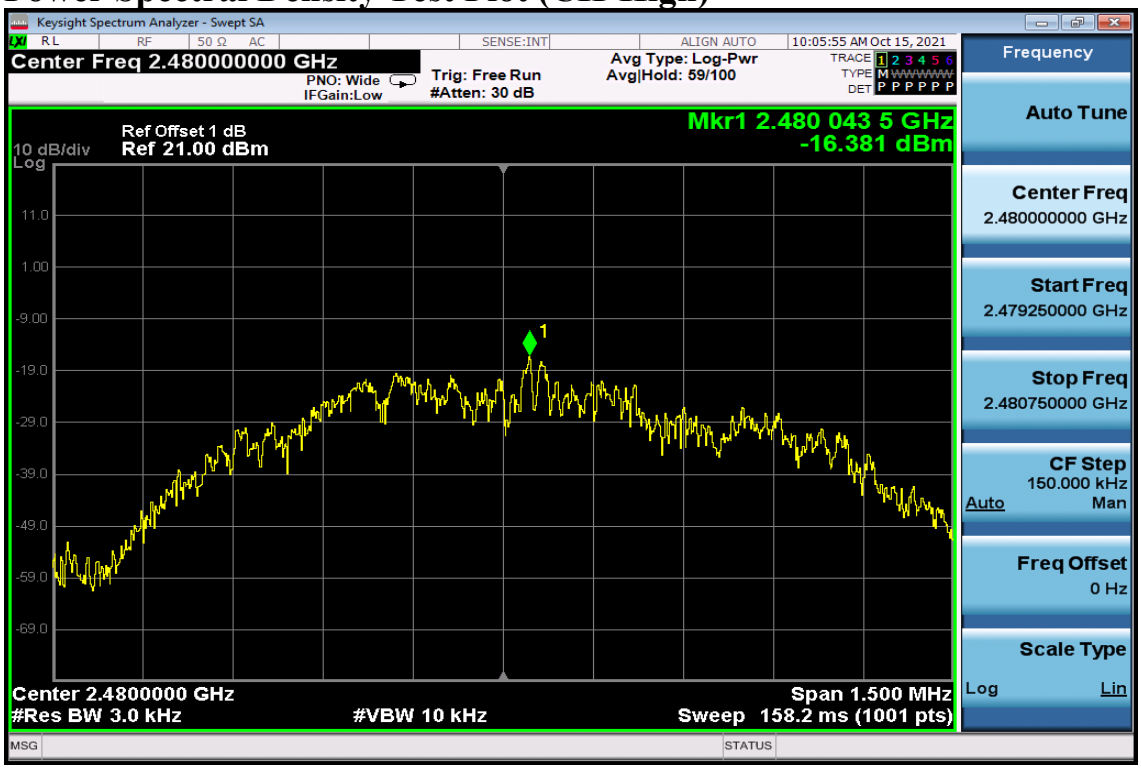
BLE (1M)

Power Spectral Density Test Plot (CH-Low)



Power Spectral Density Test Plot (CH-Mid)

Power Spectral Density Test Plot (CH-High)



BLE (2M)
Power Spectral Density Test Plot (CH-Low)

Power Spectral Density Test Plot (CH-Mid)

Power Spectral Density Test Plot (CH-High)

11 Antenna Requirement

11.1 Standard Applicable:

According to §15.203, Antenna 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 shall be considered sufficient to comply with the provisions of this Section. 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. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

According to RSS-GEN 6.8 antenna requirement: The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna.

The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.

For licence-exempt equipment with detachable antennas, the user manual shall also contain the following notice in a conspicuous location:

This radio transmitter [enter the device's ISED certification number] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type.

11.2 Antenna Connected Construction:

The directional gains of antenna used for transmitting as follow. Please see EUT photo and antenna spec. for details

Model	Antenna Type	Antenna Gain
AI00240-1	PCB	1 dBi