FCC RF Test Report

For

Purism SPC

Test Standards:	Part 15C Subpart C §15.247
Product Description:	Librem Mini
Tested Model:	LMv1-01
FCC ID:	2AT9R-LMV1-01
Classification	Digital Spread Spectrum (DSS)
Report No.:	EC2005029RF03
Tested Date:	2020-05-29 to 2020-06-15
Issued Date:	2020-06-15
Prepared By:	Jerry Wang / Engineer
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Report Revise Record

Report Version	Revise Time	Issued Date	Valid Version	Notes
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Summary of Test Result

FCC Rule	Description	Limit	Result	Remark
15.247(a)(1)	20dB Bandwidth	NA	Pass	-
-	99% Bandwidth	-	Pass	-
15.247(a)(1)	Hopping Channel Separation	≥ 2/3 of 20dB BW	Pass	-
15.247(a)(1)	Number of Channels	≥ 15Chs	Pass	-
15.247(a)(1)	Average Time of Occupancy	≤ 0.4sec in 31.6sec period	Pass	-
15.247(b)(1)	Peak Output Power	≤ 125 mW	Pass	-
15.247(d)	Conducted Band Edges	≤ 20dBc	Pass	-
15.247(d)	Conducted Spurious Emission	≤ 20dBc	Pass	-
15.247(d)	Radiated Band Edges and Radiated Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 6.17 dB at 209.45 MHz
15.207	AC Conducted Emission	15.207(a)	Pass	Under limit 8.24 dB at 7.566 MHz
15.203 & 15.247(b)	Antenna Requirement	N/A	Pass	-

1 Test Laboratory

1.1 Test facility

CNAS (accreditation number:L11138)

Hunan Ecloud Testing Technology Co., Ltd. has obtained the accreditation of China National Accreditation Service for Conformity Assessment (CNAS).

FCC (Designation number:CN1244 , Test Firm Registration Number:793308)

Hunan Ecloud Testing Technology Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform electromagnetic emissions measurements.

ISED(CAB identifier: CN0012, ISED# :24347)

Hunan Ecloud Testing Technology Co., Ltd. has been listed on the Wireless Device Testing Laboratories list of innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements.

A2LA (Certificate Number:4895.01)

Hunan Ecloud Testing Technology Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement.

2 General Description

2.1 Applicant

Purism SPC
1 Market Street, 36th Floor, San Francisco, CA94105, United States

2.2 Manufacturer

Purism, SPC
One Market Street, 36th Floor, San Francisco, CA 94105, USA

2.3 General Description Of EUT

Product	Librem Mini
Model No.	LMv1-01
Additional NO.	N/A
Difference Description	N/A
FCC ID	2AT9R-LMV1-01
Power Supply	120Vac for adapter
Modulation Technology	FHSS
Modulation Type	GFSK, 8DPSK, π/4 DQPSK
Operating Frequency	2402MHz~2480MHz
Number Of Channel	79
Max. Output Power	Bluetooth BR(1Mbps) : 3.62 dBm (0.0023W) Bluetooth BR(2Mbps) : 2.91 dBm (0.0020W) Bluetooth BR(3Mbps) : 2.12 dBm (0.0016W)
Antenna Type	FPC Antenna with 3dBi gain
HW Version	N/A
SW Version	N/A
I/O Ports	Refer to user's manual
Cable Supplied	N/A

NOTE:

1. For a more detailed features description, please refer to the manufacturer's specifications or the user's manual.

2. For the test results, the EUT had been tested with all conditions. But only the worst case was shown in test report.

3. The EUT was powered by the following adapters:

MODEL:	ADS-40SI-19-3 19040E
INPUT:	100-240V~50/60Hz 1.0A MAX
OUTPUT:	19V DC 2.1A
DC LINE:	2.5 m

2.4 Modification of EUT

No modifications are made to the EUT during all test items.

2.5 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- FCC Part 15 Subpart C §15.247
- ANSI C63.10-2013
- KDB 558074 D01 15.247 Meas Guidance v05r02

Remark:

1. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.

3 Test Configuration of Equipment Under Test

3.1 Descriptions of Test Mode

The transmitter has a maximum peak conducted output power as follows:

Mode	Channel	Frequency	Bluetooth RF Output Power
GFSK	Ch00	2402MHz	3.62
	Ch39	2441MHz	3.36
	Ch78	2480MHz	3.09
4π-DQPSK	Ch00	2402MHz	2.91
	Ch39	2441MHz	2.65
	Ch78	2480MHz	2.36
8DPSK	Ch00	2402MHz	2.12
	Ch39	2441MHz	1.92
	Ch78	2480MHz	1.59

Remark:

1. All the test data for each data rate were verified, but only the worst case was reported.
2. The data rate was set in 1Mbps for all the test items due to the highest RF output power.

3.2 Test Mode

3.2.1 Antenna Port Conducted Measurement

Summary table of Test Cases			
Test Item	Data Rate / Modulation		
	Bluetooth BR 1Mbps GFSK	Bluetooth EDR 2Mbps π/4-DQPSK	Bluetooth EDR 3Mbps 8-DPSK
Conducted Test Cases	Mode 1: CH00_2402 MHz Mode 2: CH39_2441 MHz Mode 3: CH78_2480 MHz	Mode 4: CH00_2402 MHz Mode 5: CH39_2441 MHz Mode 6: CH78_2480 MHz	Mode 7: CH00_2402 MHz Mode 8: CH39_2441 MHz Mode 9: CH78_2480 MHz

3.2.2 Radiated Emission Test (Below 1GHz)

Radiated Test Cases	Bluetooth BR 1Mbps GFSK
	Mode 1: CH00_2402MHz

Note : 1. Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, XYZ axis, antenna ports (if EUT with antenna diversity architecture) and packet type. Y orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in Y orientation.

2. Following channel(s) was (were) selected for the final test as listed above

3.2.3 Radiated Emission Test (Above 1GHz)

Radiated Test Cases	Bluetooth BR 1Mbps GFSK
	Mode 1: CH00_2402 MHz
	Mode 2: CH39_2441 MHz
	Mode 3: CH78_2480 MHz

Note : 1. The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z it was determined that Y orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in Y orientation.

2. Following channel(s) was (were) selected for the final test as listed above

3. For frequency above 18GHz, the measured value is much lower than the limit, therefore, it is not reflected in the report.

3.2.4 Power Line Conducted Emission Test:

AC Conducted Emission	Mode 1 : Bluetooth Link + HDMI + Earphone + Burnin test + ping

3.3 Support Equipment

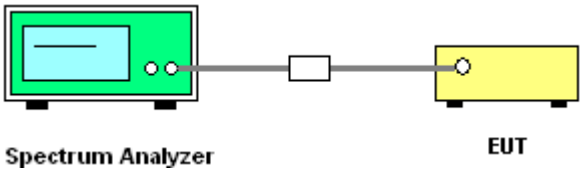
Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	WLAN AP	NETGARE	R7800	PY315100319	N/A	unshielded AC I/P cable1.2 m
2.	Notebook	Lenovo	E470C	FCC DoC	N/A	shielded cable DC O/P 1.8 m unshielded AC I/P cable1.2 m
3.	Flat Panel Monitor	Dell	P2317H	FCC DoC	N/A	Unshielded, 1.5 m
4.	Bluetooth Keyboard	Sariana LLC	ST-ACBKM	ZE9-ST-ACBKM	N/A	N/A

3.4 Test Setup

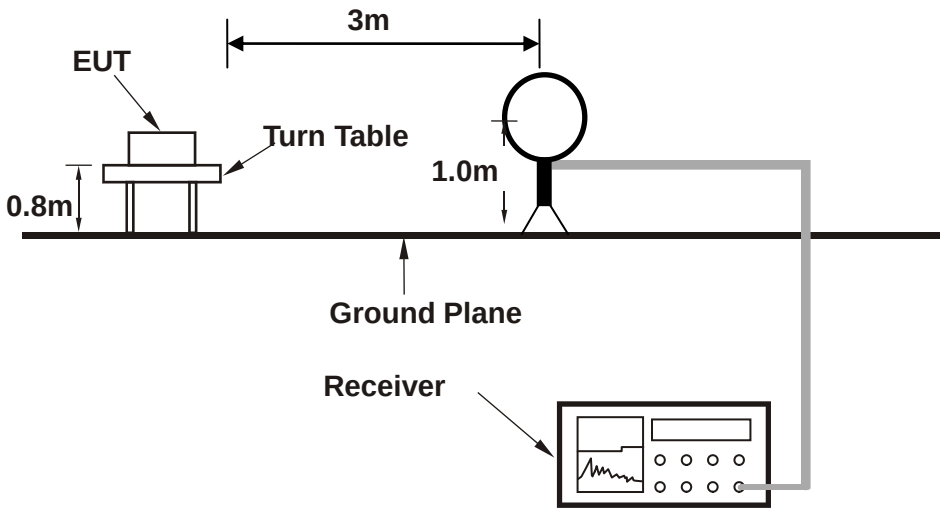
The EUT is continuously communicating to the Bluetooth tester during the tests.

EUT was set in the Hidden menu mode to enable BT communications.

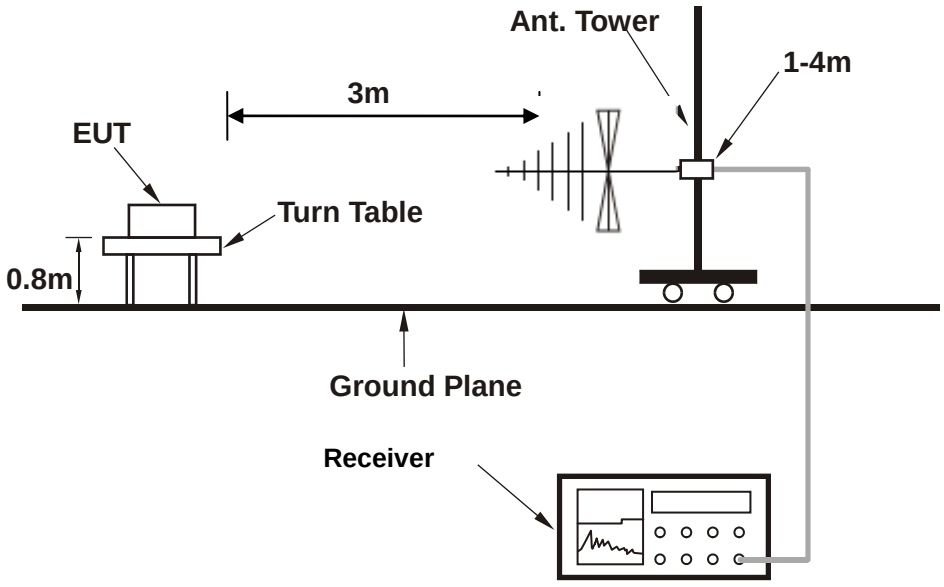
Setup diagram for Conducted Test



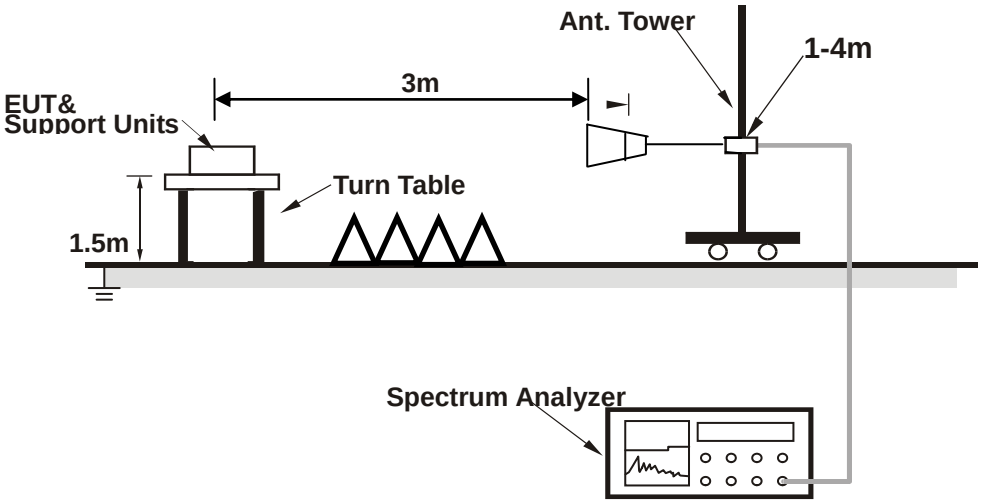
Setup diagram for Raidation(9KHz~30MHz) Test



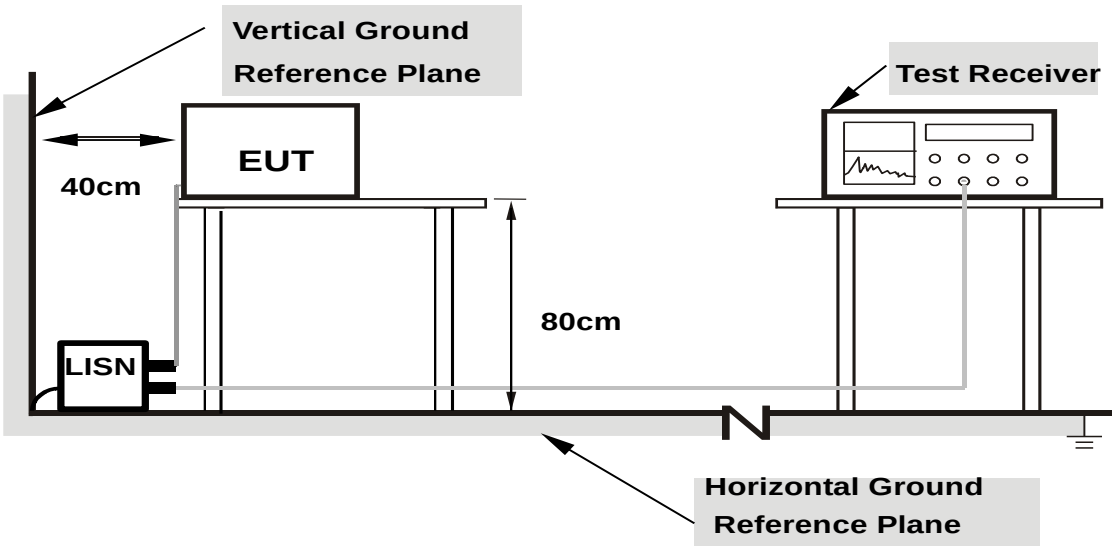
Setup diagram for Raidation(Below 1G) Test



Setup diagram for Raidation(Above1G) Test



Setup diagram for AC Conducted Emission Test



Note: 1.Support units were connected to second LISN.

2.Both of LISNs (AMN) are 80 cm from EUT and at least 80 from other units and other metal planes

3.5 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Example:

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Offset = RF cable loss + attenuator factor.

Following shows an offset computation example with cable loss 5 dB and 10dB attenuator.

Offset(dB) = RF cable loss(dB) + attenuator factor(dB).

= 5 + 10 = 15 (dB)

For all radiated test items:

Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level

Over Limit (dB μ V/m) = Level(dB μ V/m) - Limit Level (dB μ V/m)

4 Test Result

4.1 20dB and 99% Bandwidth Measurement

4.1.1 Limit of 20dB and 99% Bandwidth

None; for reporting purposes only.

4.1.2 Test Procedures

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. Use the following spectrum analyzer settings for 20dB Bandwidth measurement.

   Span = approximately 2 to 5 times the 20 dB bandwidth, centered on a hopping channel;

   RBW ≥ 1% of the 20 dB bandwidth; VBW ≥ RBW; Sweep = auto; Detector function = peak;

   Trace = max hold.
4. Use the following spectrum analyzer settings for 99 % Bandwidth measurement.

   Span = approximately 1.5 to 5 times the 99% bandwidth, centered on a hopping channel;

   RBW ≥ 1% of the 99% bandwidth; VBW ≥ RBW; Sweep = auto; Detector function = sample;

   Trace = max hold.

4.1.3 Test Result of 20dB Bandwidth

Refer to Appendix A of this test report.

4.1.4 Test Result of 99% Bandwidth

Refer to Appendix B of this test report.

4.2 Peak Output Power Measurement

4.2.1 Limit of Peak Output Power

Section 15.247 (b) The maximum peak conducted output power of the intentional radiator shall not exceed the following: (1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band 0.125 watts.

4.2.2 Test Procedures

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

4.2.3 Test Result of Peak Output Power

Refer to Appendix C of this test report.

4.3 Carrier Frequency Separation Measurement

4.3.1 Limit of Hopping Channel Separation

FCC §15.247 (a) (1)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hoping channel, whichever is greater.

Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

4.3.2 Test Procedures

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. The transmitter output is connected to a spectrum analyzer. The RBW is set to 300 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

4.3.3 Test Result of Hopping Channel Separation

Refer to Appendix D of this test report.

4.4 Time of Occupancy Measurement

4.4.1 Limit of Average Time of Occupancy

FCC §15.247 (a) (1) (iii)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

4.4.2 Test Procedures

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. The transmitter output is connected to a spectrum analyzer. The span is set to 0 Hz, centered on a single, selected hopping channel. The width of a single pulse is measured in a fast scan The number of pulses is measured in a 3.16 second scan, to enable resolution of each occurrence.
4. The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements.

The test period: T= 0.4 Second/Channel x 79 Channel = 31.6 s

Test channel: 2441MHz as below：

DH1 time slot= Burst Width (ms)*(1600/ (2*79))*31.6

DH3 time slot= Burst Width (ms)*(1600/ (4*79))*31.6

DH5 time slot= Burst Width (ms)*(1600/ (6*79))*31.6

4.4.3 Test Result of Dwell Time

Refer to Appendix E of this test report.

4.5 Number of Hopping Channels Measurement

4.5.1 Limits of Number of Hopping Channels

FCC § 15.247(a)(1)(iii)

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

4.5.2 Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to 100KHz. The analyzer is set to Max Hold.

4.5.3 Test Result of Number of Hopping Channels

Refer to Appendix F of this test report.

4.6 Conducted Band Edges Measurement

4.6.1 Limit of Band Edges

In any 100 kHz bandwidth outside the intentional radiation frequency band, the radio frequency power shall be at least 20 dB below the highest level of the radiated power. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.

4.6.2 Test Procedures

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. Set RBW = 100kHz, VBW = 300kHz. Band edge emissions must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100kHz RBW. The attenuation shall be 30 dB instead of 20 dB when RMS conducted output power procedure is used.
4. Enable hopping function of the EUT and then repeat step 1~3.

4.6.3 Test Result of Conducted Band Edges

Refer to Appendix G of this test report.

4.7 Conducted Spurious Emission Measurement

4.7.1 Limit of Spurious Emission Measurement

In any 100 kHz bandwidth outside the intentional radiation frequency band, the radio frequency power shall be at least 20 dB below the highest level of the radiated power. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.

4.7.2 Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW = 300kHz, scan up through 10th harmonic. All harmonics / spurs must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100 kHz RBW.
5. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

4.7.3 Test Result of Conducted Spurious Emission

Refer to Appendix H of this test report.

4.8 Radiated Band Edges and Spurious Emission Measurement

4.8.1 Limit of Radiated Band Edges and Spurious Emission

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. In addition, radiated emissions which fall in the restricted bands must also comply with the FCC section 15.209 limits as below.

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

Note: The frequency range from 9KHz to 10th harmonic (25GHz) are checked, and no any emissions were found from 18GHz to 25GHz, So the radiated emissions from 18GHz to 25GHz were not record.

4.8.2 Test Procedures

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Use the following spectrum analyzer settings:
   (1) Span shall wide enough to fully capture the emission being measured;
   (2) Set RBW=100 kHz for f < 1 GHz, RBW=1MHz for f>1GHz ; VBW=3RBW; Sweep = auto; Detector function = peak; Trace = max hold for peak
   (3) For average measurement:
   VBW = 10 Hz, when duty cycle is no less than 98 percent.
   VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.
5. Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP.
6. Convert the resultant EIRP to an equivalent electric field strength using the following relationship:

   $E = EIRP - 20 \log d + 104.8$

   Where:

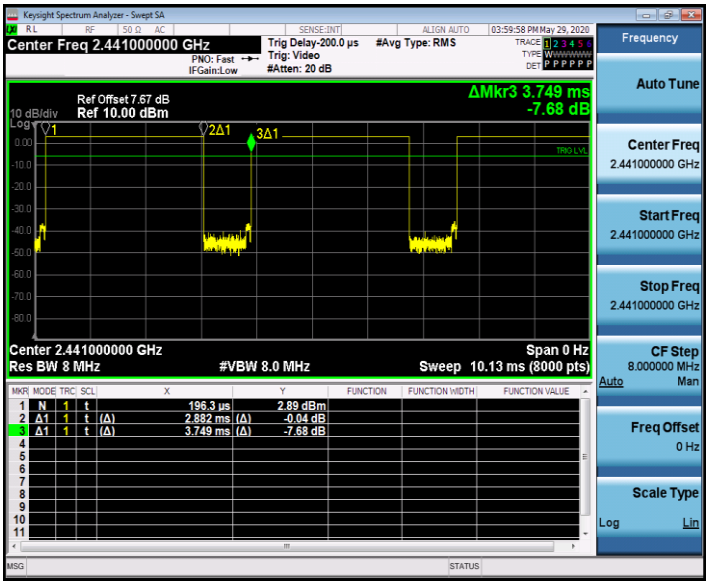
   E is the electric field strength in dBμV/m

   EIRP is the equivalent isotropically radiated power in dBm

   d is the specified measurement distance in m

   E[dBμV/m] = EIRP[dBm] + 95.2, for d = 3 m.
7. Compare the resultant electric field strength level with the applicable regulatory limit.

Band	Duty Cycle(%)	T(ms)	1/T(kHz)	VBW Setting
1Mbps	76.86	2.88	0.347	1kHz



4.8.3 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

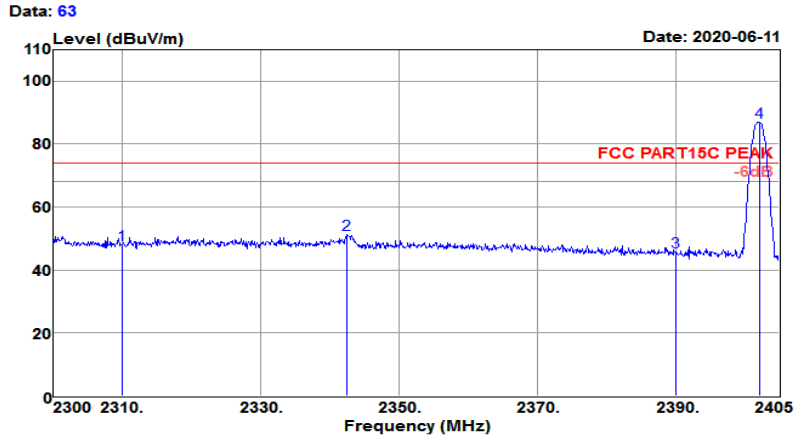
The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.

4.8.4 Test Result of Radiated Spurious at Band Edges

Test Mode :	Bluetooth (1Mbps) CH00 (2402MHz)	**Temperature :**	21~23℃
Test Engineer :	Jack Liu	**Relative Humidity :**	63~65%
Frequencey Range	2.3GHz~2.405GHz	**Polarization :**	Horizontal

Test Site : 3m Chamber
Tested by : Jack
Test Mode : BT CH00(2402MHz)
EUT : Librem Mini
Model No. : LMv1-01

Temp/Humi : 25℃/64%
Pol/Phase : HORIZONTAL
Power rating: 120VAc



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2310.000	52.18	27.38	4.11	35.61	48.06	74.00	-25.94	Peak
2342.420	55.49	27.45	4.14	35.68	51.40	74.00	-22.60	Peak
2390.000	49.79	27.56	4.18	35.79	45.74	74.00	-28.26	Peak
2402.165	90.93	27.58	4.19	35.82	86.88	74.00	12.88	Peak

Test Mode :	Bluetooth (1Mbps) CH00 (2402MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.3GHz~2.405GHz	Polarization :	Horizontal

```
Test Site    : 3m Chamber                Temp/Humi    : 25℃/64%
               --------------------------               ----------------
Tested by    : Jack                      Pol/Phase    : HORIZONTAL
               --------------------------               ----------------
Test Mode    : BT CH00(2402MHz)          Power rating: 120VAc
               --------------------------               ----------------
EUT          : Librem Mini
               --------------------------
Model No.    : LMv1-01
               --------------------------
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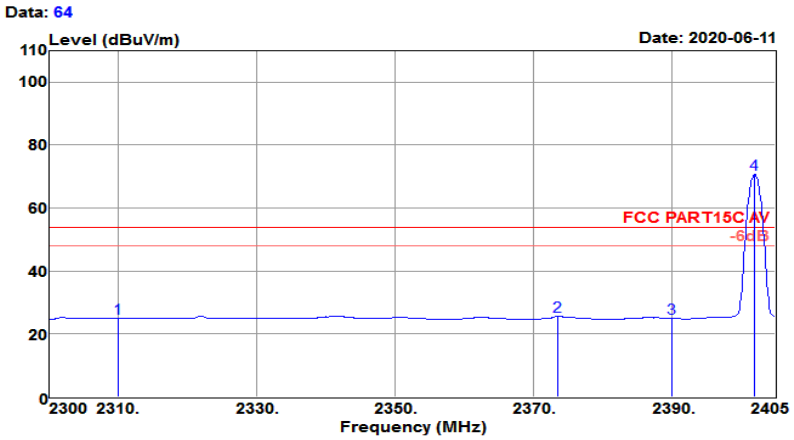
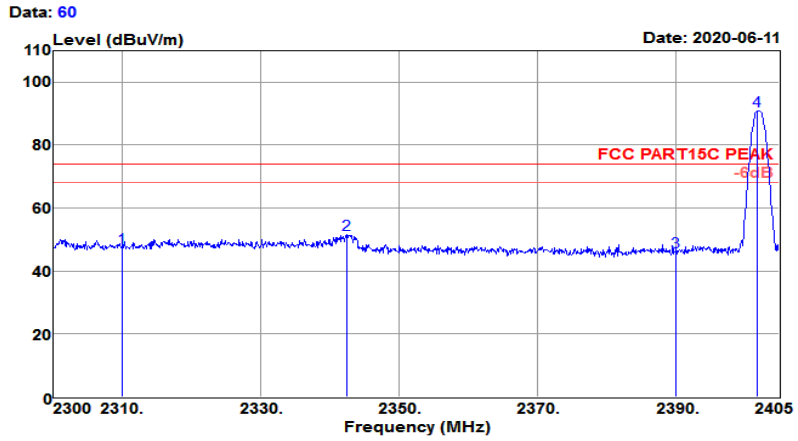


Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2310.000	29.15	27.38	4.11	35.61	25.03	54.00	-28.97	Average
2373.605	29.87	27.52	4.17	35.75	25.81	54.00	-28.19	Average
2390.000	29.00	27.56	4.18	35.79	24.95	54.00	-29.05	Average
2402.060	74.81	27.58	4.19	35.82	70.76	54.00	16.76	Average

Test Mode :	Bluetooth (1Mbps) CH00 (2402MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.3GHz~2.405GHz	Polarization :	Vertical

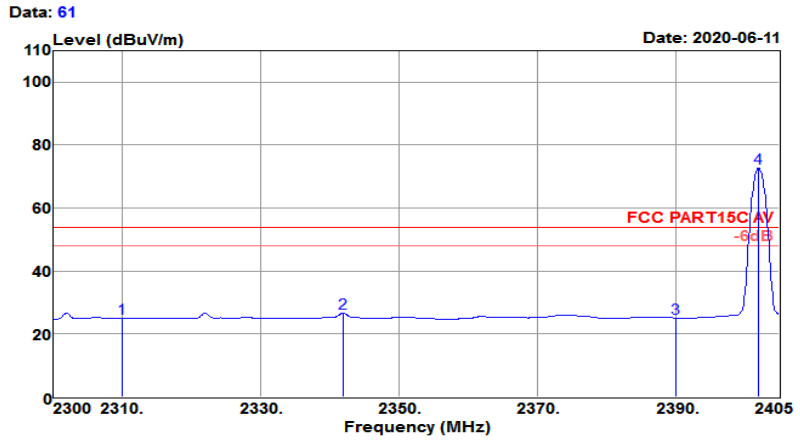
```
Test Site    : 3m Chamber                Temp/Humi    : 25℃/64%
Tested by    : Jack                      Pol/Phase    : VERTICAL
Test Mode    : BT CH00(2402MHz)          Power rating: 120VAc
EUT          : Librem Mini
Model No.    : LMv1-01
```



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2310.000	51.63	27.38	4.11	35.61	47.51	74.00	-26.49	Peak
2342.525	55.60	27.45	4.14	35.68	51.51	74.00	-22.49	Peak
2390.000	50.20	27.56	4.18	35.79	46.15	74.00	-27.85	Peak
2401.850	94.93	27.58	4.19	35.82	90.88	74.00	16.88	Peak

Test Mode :	Bluetooth (1Mbps) CH00 (2402MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.3GHz~2.405GHz	Polarization :	Vertical

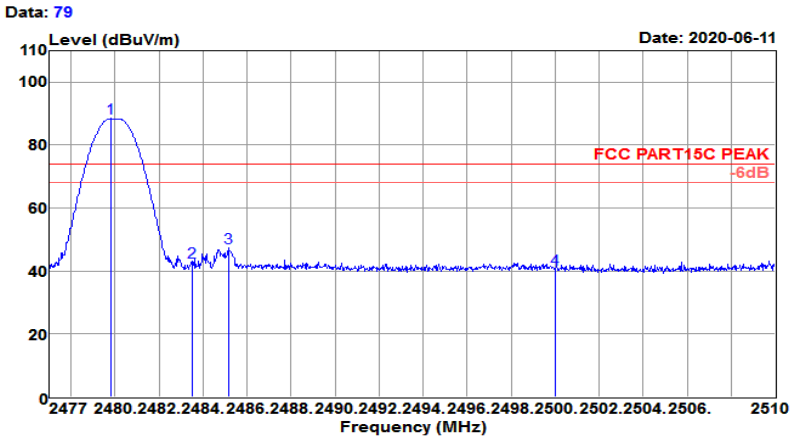
```
Test Site    : 3m Chamber                Temp/Humi    : 25℃/64%
               --------------------------                -----------------
Tested by    : Jack                      Pol/Phase    : VERTICAL
               --------------------------                -----------------
Test Mode    : BT CH00(2402MHz)          Power rating: 120VAc
               --------------------------                -----------------
EUT          : Librem Mini
               --------------------------
Model No.    : LMv1-01
               --------------------------
```



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2310.000	29.12	27.38	4.11	35.61	25.00	54.00	-29.00	Average
2342.000	30.80	27.45	4.14	35.68	26.71	54.00	-27.29	Average
2390.000	29.20	27.56	4.18	35.79	25.15	54.00	-28.85	Average
2402.060	76.91	27.58	4.19	35.82	72.86	54.00	18.86	Average

Test Mode :	Bluetooth (1Mbps) CH78 (2480MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.477GHz~2.51GHz	Polarization :	Horizontal

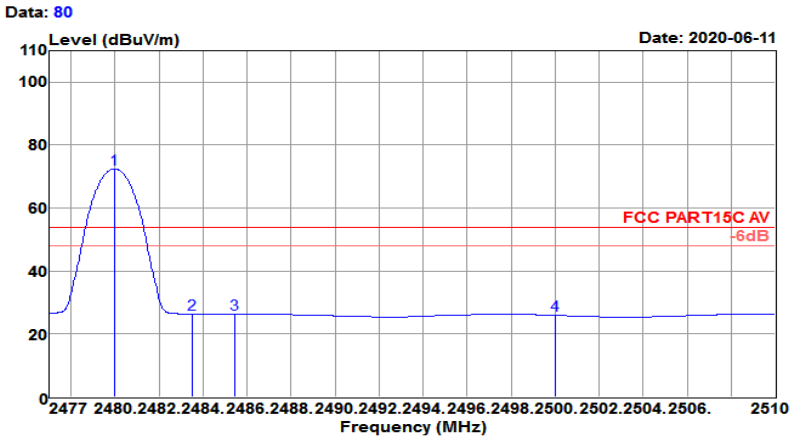
```
Test Site    : 3m Chamber                Temp/Humi    : 25℃/64%
               --------------------------               ----------------
Tested by    : Jack                      Pol/Phase    : HORIZONTAL
               --------------------------               ----------------
Test Mode    : BT CH79(2480MHz)          Power rating: 120VAc
               --------------------------               ----------------
EUT          : Librem Mini
               --------------------------
Model No.    : LMv1-01
               --------------------------
```



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2479.805	92.41	27.76	4.26	35.99	88.44	74.00	14.44	Peak
2483.500	46.96	27.76	4.26	36.00	42.98	74.00	-31.02	Peak
2485.151	51.30	27.77	4.26	36.01	47.32	74.00	-26.68	Peak
2500.000	44.64	27.80	4.28	36.04	40.68	74.00	-33.32	Peak

Test Mode :	Bluetooth (1Mbps) CH78 (2480MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.477GHz~2.51GHz	Polarization :	Horizontal

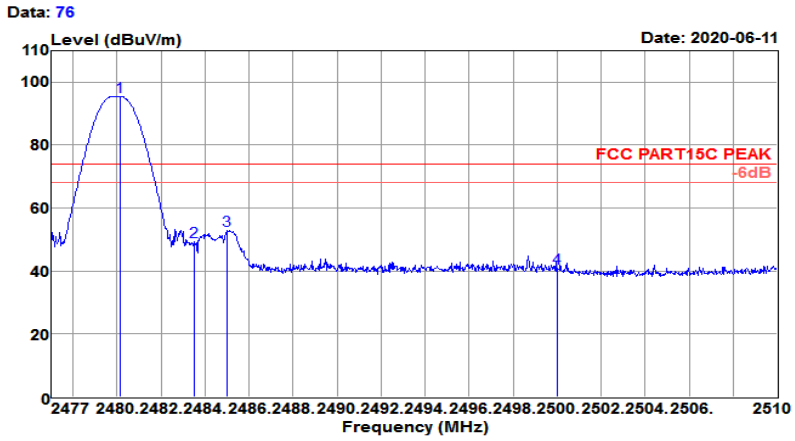
```
Test Site    : 3m Chamber                Temp/Humi    : 25℃/64%
               --------------------                     ----------
Tested by    : Jack                      Pol/Phase    : HORIZONTAL
               --------------------                     ----------
Test Mode    : BT CH79(2480MHz)          Power rating: 120VAc
               --------------------                     ----------
EUT          : Librem Mini
               --------------------
Model No.    : LMv1-01
               --------------------
```



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2479.970	76.45	27.76	4.26	35.99	72.48	54.00	18.48	Average
2483.500	30.18	27.76	4.26	36.00	26.20	54.00	-27.80	Average
2485.415	30.42	27.77	4.26	36.01	26.44	54.00	-27.56	Average
2500.000	29.90	27.80	4.28	36.04	25.94	54.00	-28.06	Average

Test Mode :	Bluetooth (1Mbps) CH78 (2480MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.477GHz~2.51GHz	Polarization :	Vertical

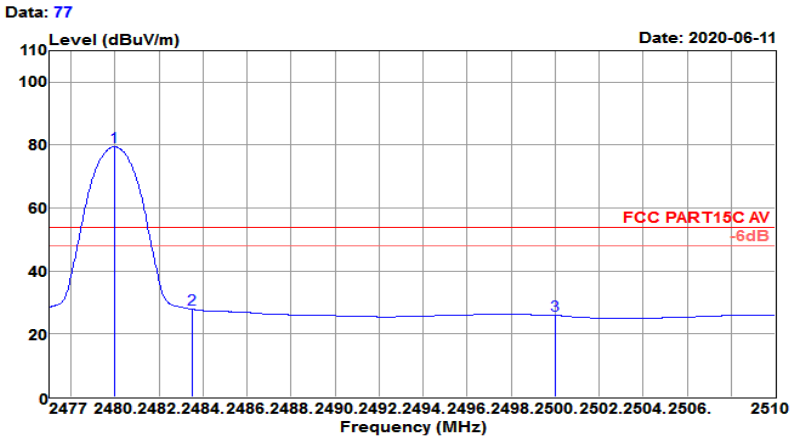
```
Test Site    : 3m Chamber                Temp/Humi    : 25℃/64%
               --------------------------               ----------------
Tested by    : Jack                      Pol/Phase    : VERTICAL
               --------------------------               ----------------
Test Mode    : BT CH79(2480MHz)          Power rating: 120VAc
               --------------------------               ----------------
EUT          : Librem Mini
               --------------------------
Model No.    : LMv1-01
               --------------------------
```



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2480.135	99.51	27.76	4.26	35.99	95.54	74.00	21.54	Peak
2483.500	53.23	27.76	4.26	36.00	49.25	74.00	-24.75	Peak
2485.019	56.79	27.77	4.26	36.01	52.81	74.00	-21.19	Peak
2500.000	44.77	27.80	4.28	36.04	40.81	74.00	-33.19	Peak

Test Mode :	Bluetooth (1Mbps) CH78 (2480MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	2.477GHz~2.51GHz	Polarization :	Vertical

```
Test Site    : 3m Chamber                Temp/Humi    : 25℃/64%
               --------------------                     ----------
Tested by    : Jack                      Pol/Phase    : VERTICAL
               --------------------                     ----------
Test Mode    : BT CH79(2480MHz)          Power rating: 120VAc
               --------------------                     ----------
EUT          : Librem Mini
               --------------------
Model No.    : LMv1-01
               --------------------
```

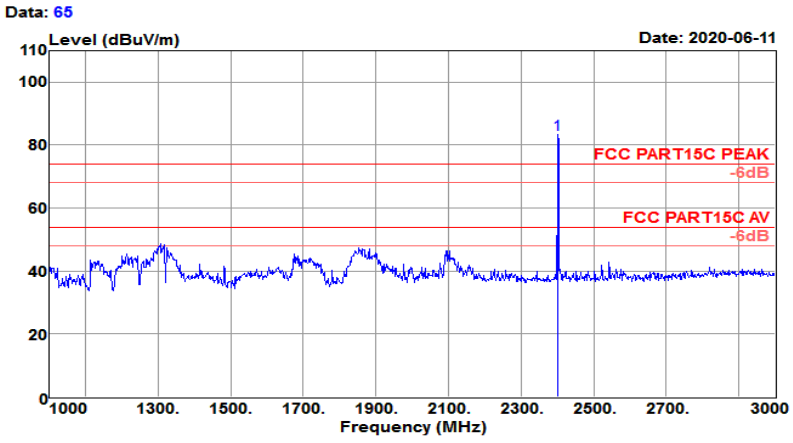


Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2479.970	83.43	27.76	4.26	35.99	79.46	54.00	25.46	Average
2483.500	31.85	27.76	4.26	36.00	27.87	54.00	-26.13	Average
2500.000	29.94	27.80	4.28	36.04	25.98	54.00	-28.02	Average

4.8.5 Test Result of Radiated Spurious Emission (1GHz ~ 10th Harmonic)

Test Mode :	Bluetooth (1Mbps) CH00 (2402MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	1GHz~3GHz	Polarization :	Horizontal

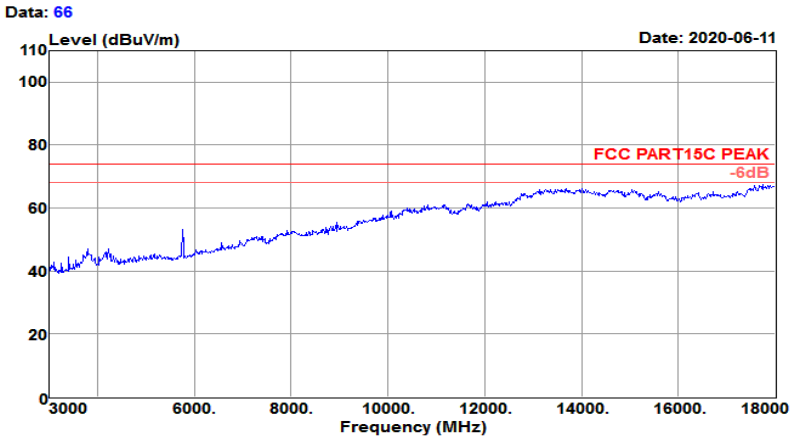
```
Test Site    : 3m Chamber                Temp/Humi    : 25℃/64%
Tested by    : Jack                      Pol/Phase    : HORIZONTAL
Test Mode    : BT CH00(2402MHz)          Power rating: 120VAc
EUT          : Librem Mini
Model No.    : LMv1-01
```



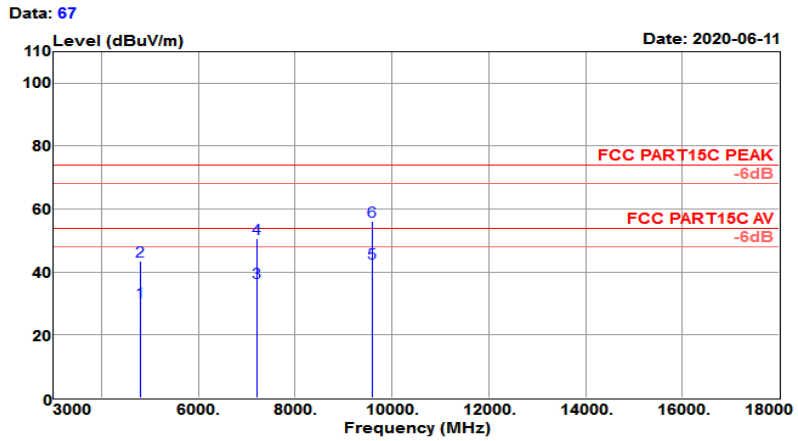
Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
2402.000	87.59	27.58	4.19	35.82	83.54	74.00	9.54	Peak

Test Mode :	Bluetooth (1Mbps) CH00 (2402MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	3GHz~18GHz	Polarization :	Horizontal

```
Test Site    : 3m Chamber                Temp/Humi    : 25℃/64%
               --------------------------               ----------------
Tested by    : Jack                      Pol/Phase    : HORIZONTAL
               --------------------------               ----------------
Test Mode    : BT CH00(2402MHz)          Power rating: 120VAc
               --------------------------               ----------------
EUT          : Librem Mini
               --------------------------
Model No.    : LMv1-01
               --------------------------
```



Test Site	: 3m Chamber	Temp/Humi	: 25℃/64%
Tested by	: Jack	Pol/Phase	: HORIZONTAL
Test Mode	: BT CH00(2402MHz)	Power rating	: 120VAc
EUT	: Librem Mini		
Model No.	: LMv1-01		

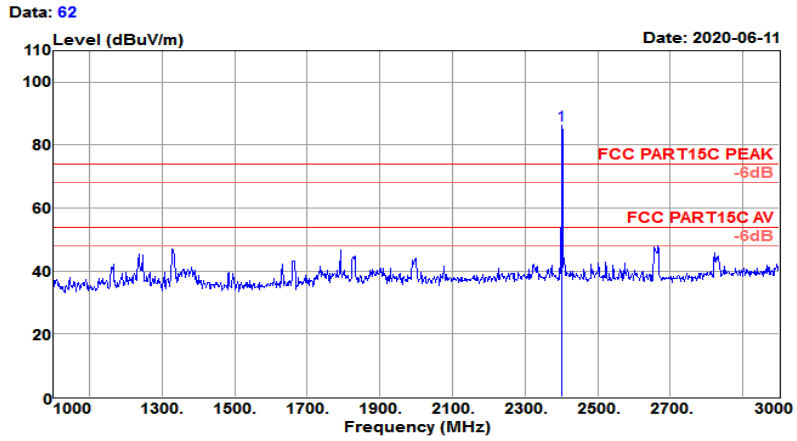


Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
4804.000	51.63	30.93	6.09	58.26	30.39	54.00	-23.61	Average
4804.000	64.60	30.93	6.09	58.26	43.36	74.00	-30.64	Peak
7206.000	50.48	35.39	9.22	58.52	36.57	54.00	-17.43	Average
7206.000	64.44	35.39	9.22	58.52	50.53	74.00	-23.47	Peak
9608.000	50.32	38.39	12.26	58.06	42.91	54.00	-11.09	Average
9608.000	63.67	38.39	12.26	58.06	56.26	74.00	-17.74	Peak

Note: Emission was scanned up to 26GHz; No emissions were detected above the noise floor which was at least 20dB below the specification limit.

Test Mode :	Bluetooth (1Mbps) CH00 (2402MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	1GHz~3GHz	Polarization :	Vertical

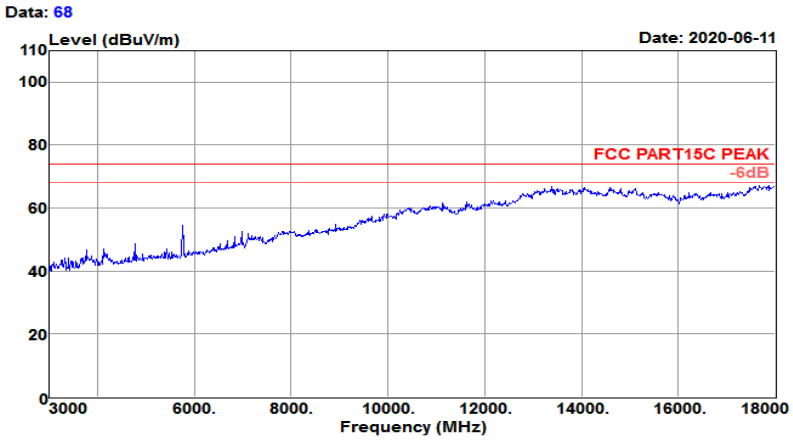
```
Test Site    : 3m Chamber                Temp/Humi    : 25℃/64%
               --------------------                     ----------
Tested by    : Jack                      Pol/Phase    : VERTICAL
               --------------------                     ----------
Test Mode    : BT CH00(2402MHz)          Power rating: 120VAc
               --------------------                     ----------
EUT          : Librem Mini
               --------------------
Model No.    : LMv1-01
               --------------------
```



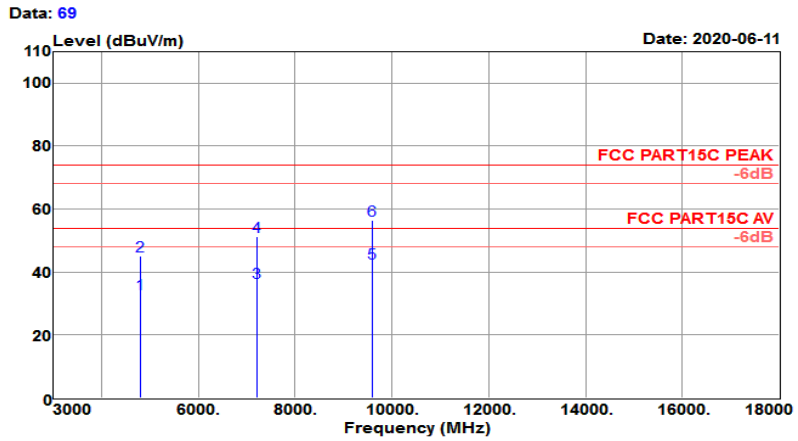
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2402.000	90.28	27.58	4.19	35.82	86.23	74.00	12.23	Peak

Test Mode :	Bluetooth (1Mbps) CH00 (2402MHz)	**Temperature :**	21~23℃
Test Engineer :	Jack Liu	**Relative Humidity :**	63~65%
Frequencey Range	3GHz~18GHz	**Polarization :**	Vertical

```
Test Site    : 3m Chamber                Temp/Humi    : 25℃/64%
               --------------------------                -----------------
Tested by    : Jack                      Pol/Phase    : VERTICAL
               --------------------------                -----------------
Test Mode    : BT CH00(2402MHz)          Power rating: 120VAc
               --------------------------                -----------------
EUT          : Librem Mini
               --------------------------
Model No.    : LMv1-01
               --------------------------
```



Test Site	: 3m Chamber	Temp/Humi	: 25℃/64%
Tested by	: Jack	Pol/Phase	: VERTICAL
Test Mode	: BT CH00(2402MHz)	Power rating	: 120VAc
EUT	: Librem Mini		
Model No.	: LMv1-01		

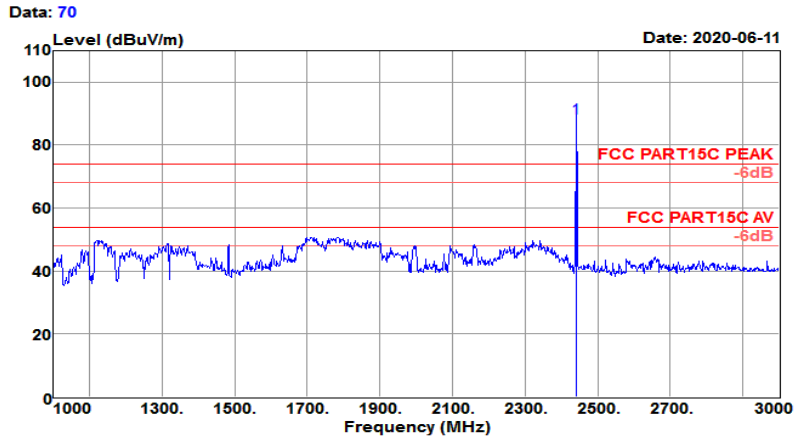


Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
4804.000	54.21	30.93	6.09	58.26	32.97	54.00	-21.03	Average
4804.000	66.21	30.93	6.09	58.26	44.97	74.00	-29.03	Peak
7206.000	50.55	35.39	9.22	58.52	36.64	54.00	-17.36	Average
7206.000	65.27	35.39	9.22	58.52	51.36	74.00	-22.64	Peak
9608.000	50.34	38.39	12.26	58.06	42.93	54.00	-11.07	Average
9608.000	63.74	38.39	12.26	58.06	56.33	74.00	-17.67	Peak

Note: Emission was scanned up to 26GHz; No emissions were detected above the noise floor which was at least 20dB below the specification limit.

Test Mode :	Bluetooth (1Mbps) CH39 (2441MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	1GHz~3GHz	Polarization :	Horizontal

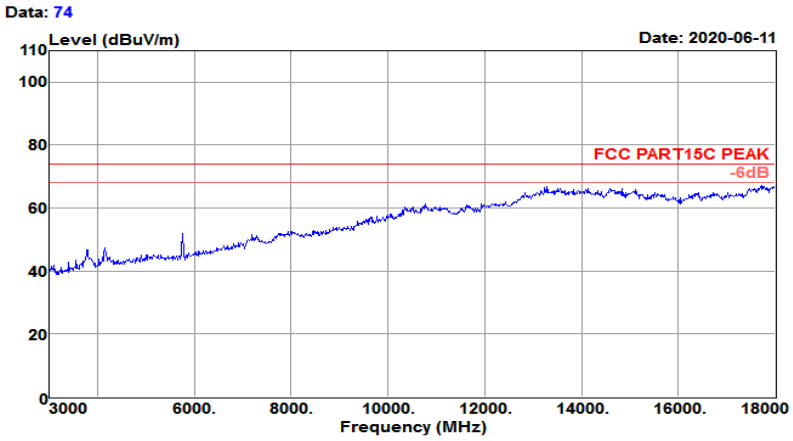
```
Test Site    : 3m Chamber                Temp/Humi    : 25℃/64%
               --------------------------                -----------------
Tested by    : Jack                      Pol/Phase    : HORIZONTAL
               --------------------------                -----------------
Test Mode    : BT CH39(2441MHz)          Power rating: 120VAc
               --------------------------                -----------------
EUT          : Librem Mini
               --------------------------
Model No.    : LMv1-01
               --------------------------
```



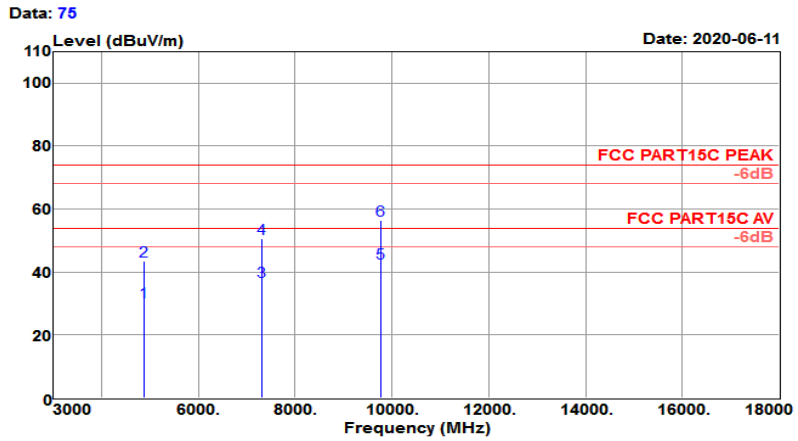
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2441.000	92.63	27.67	4.22	35.91	88.61	74.00	14.61	Peak

Test Mode :	Bluetooth (1Mbps) CH39 (2441MHz)	**Temperature :**	21~23℃
Test Engineer :	Jack Liu	**Relative Humidity :**	63~65%
Frequencey Range	3GHz~18GHz	**Polarization :**	Horizontal

```
Test Site    : 3m Chamber                Temp/Humi    : 25℃/64%
               --------------------------                -----------------
Tested by    : Jack                      Pol/Phase    : HORIZONTAL
               --------------------------                -----------------
Test Mode    : BT CH39(2441MHz)          Power rating: 120VAc
               --------------------------                -----------------
EUT          : Librem Mini
               --------------------------
Model No.    : LMv1-01
               --------------------------
```



Test Site	: 3m Chamber	Temp/Humi	: 25℃/64%
Tested by	: Jack	Pol/Phase	: HORIZONTAL
Test Mode	: BT CH39(2441MHz)	Power rating	: 120VAc
EUT	: Librem Mini		
Model No.	: LMv1-01		

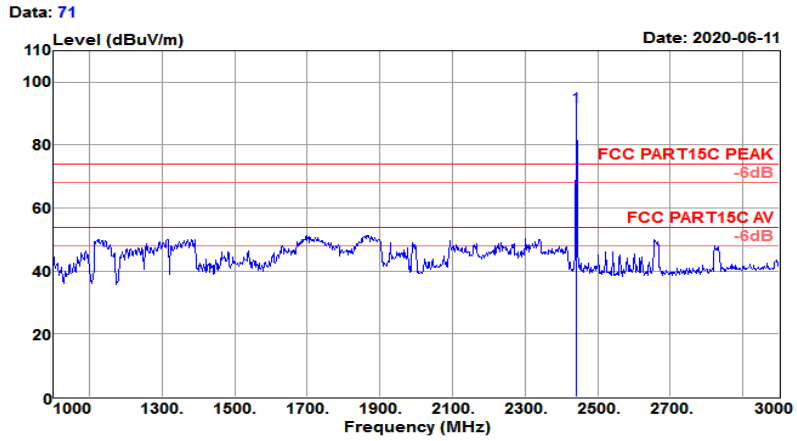


Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
4882.000	51.64	31.03	6.08	58.16	30.59	54.00	-23.41	Average
4882.000	64.41	31.03	6.08	58.16	43.36	74.00	-30.64	Peak
7323.000	50.56	35.68	9.20	58.56	36.88	54.00	-17.12	Average
7323.000	64.38	35.68	9.20	58.56	50.70	74.00	-23.30	Peak
9764.000	49.81	38.51	12.50	57.95	42.87	54.00	-11.13	Average
9764.000	63.52	38.51	12.50	57.95	56.58	74.00	-17.42	Peak

Note: Emission was scanned up to 26GHz; No emissions were detected above the noise floor which was at least 20dB below the specification limit.

Test Mode :	Bluetooth (1Mbps) CH39 (2441MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	1GHz~3GHz	Polarization :	Vertical

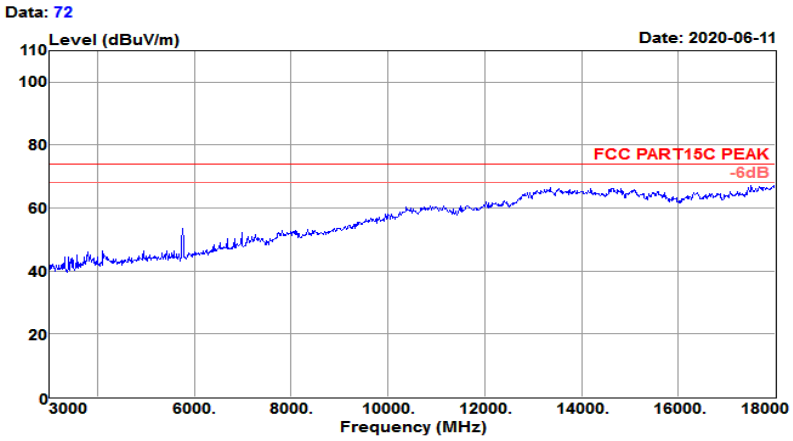
```
Test Site    : 3m Chamber                Temp/Humi    : 25℃/64%
Tested by    : Jack                      Pol/Phase    : VERTICAL
Test Mode    : BT CH39(2441MHz)          Power rating: 120VAc
EUT          : Librem Mini
Model No.    : LMv1-01
```



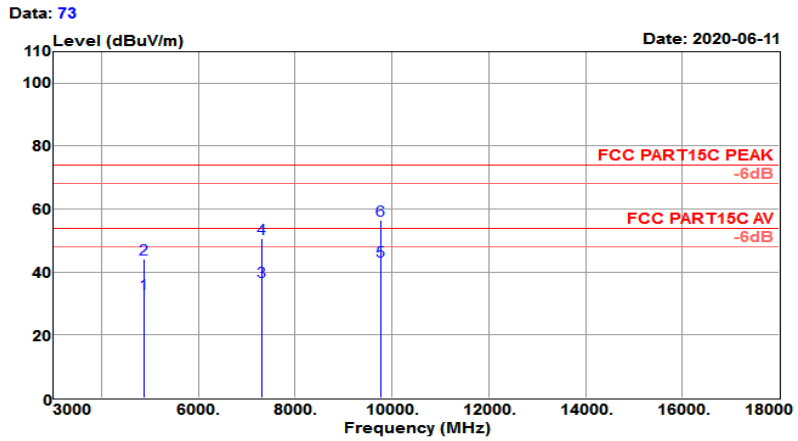
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2441.000	96.07	27.67	4.22	35.91	92.05	74.00	18.05	Peak

Test Mode :	Bluetooth (1Mbps) CH39 (2441MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	3GHz~18GHz	Polarization :	Vertical

```
Test Site    : 3m Chamber                Temp/Humi    : 25℃/64%
               --------------------                     ----------
Tested by    : Jack                      Pol/Phase    : VERTICAL
               --------------------                     ----------
Test Mode    : BT CH39(2441MHz)          Power rating: 120VAc
               --------------------                     ----------
EUT          : Librem Mini
               --------------------
Model No.    : LMv1-01
               --------------------
```



Test Site	: 3m Chamber	Temp/Humi	: 25℃/64%
Tested by	: Jack	Pol/Phase	: VERTICAL
Test Mode	: BT CH39(2441MHz)	Power rating	: 120VAc
EUT	: Librem Mini		
Model No.	: LMv1-01		

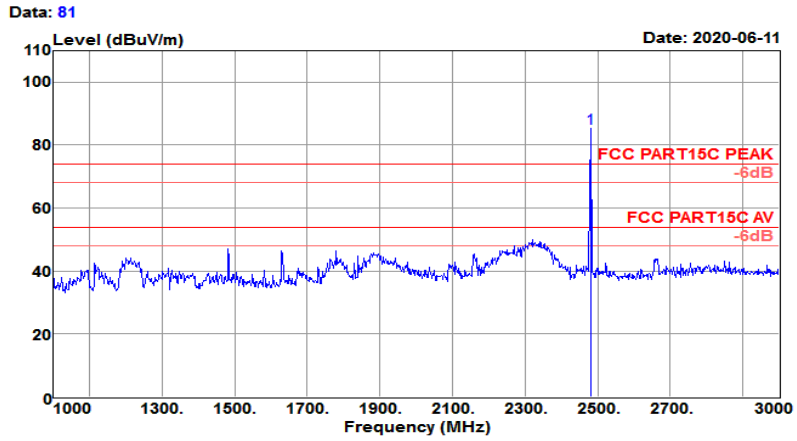


Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
4882.000	54.07	31.03	6.08	58.16	33.02	54.00	-20.98	Average
4882.000	65.19	31.03	6.08	58.16	44.14	74.00	-29.86	Peak
7323.000	50.57	35.68	9.20	58.56	36.89	54.00	-17.11	Average
7323.000	64.43	35.68	9.20	58.56	50.75	74.00	-23.25	Peak
9764.000	50.56	38.51	12.50	57.95	43.62	54.00	-10.38	Average
9764.000	63.36	38.51	12.50	57.95	56.42	74.00	-17.58	Peak

Note: Emission was scanned up to 26GHz; No emissions were detected above the noise floor which was at least 20dB below the specification limit.

Test Mode :	Bluetooth (1Mbps) CH78 (2480MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	1GHz~3GHz	Polarization :	Horizontal

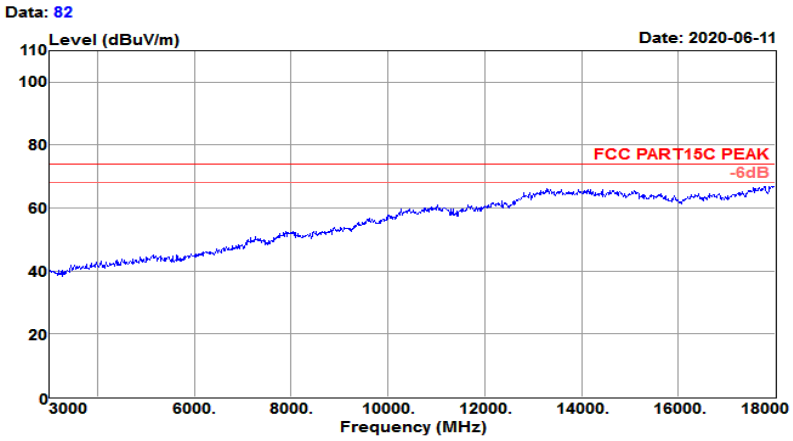
```
Test Site    : 3m Chamber                Temp/Humi    : 25℃/64%
               --------------------------               ----------------
Tested by    : Jack                      Pol/Phase    : HORIZONTAL
               --------------------------               ----------------
Test Mode    : BT CH79(2480MHz)          Power rating: 120VAc
               --------------------------               ----------------
EUT          : Librem Mini
               --------------------------
Model No.    : LMv1-01
               --------------------------
```



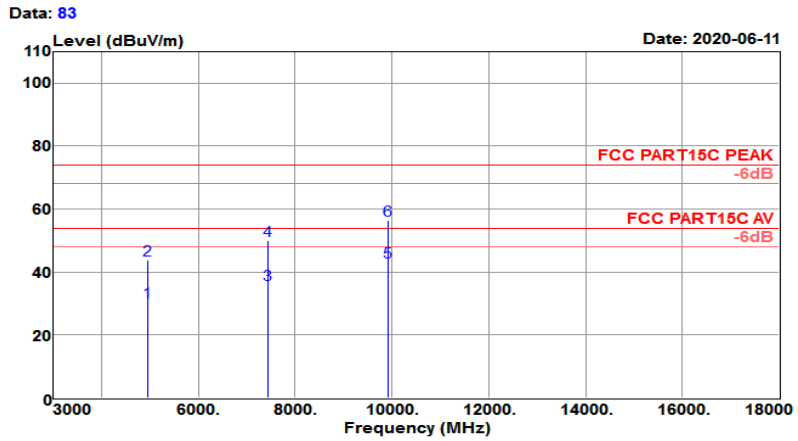
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2480.000	89.31	27.76	4.26	35.99	85.34	74.00	11.34	Peak

Test Mode :	Bluetooth (1Mbps) CH78 (2480MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	3GHz~18GHz	Polarization :	Horizontal

```
Test Site    : 3m Chamber                Temp/Humi    : 25℃/64%
               --------------------                     ----------
Tested by    : Jack                      Pol/Phase    : HORIZONTAL
               --------------------                     ----------
Test Mode    : BT CH79(2480MHz)          Power rating: 120VAc
               --------------------                     ----------
EUT          : Librem Mini
               --------------------
Model No.    : LMv1-01
               --------------------
```



Test Site	: 3m Chamber	Temp/Humi	: 25℃/64%
Tested by	: Jack	Pol/Phase	: HORIZONTAL
Test Mode	: BT CH79(2480MHz)	Power rating	: 120VAc
EUT	: Librem Mini		
Model No.	: LMv1-01		

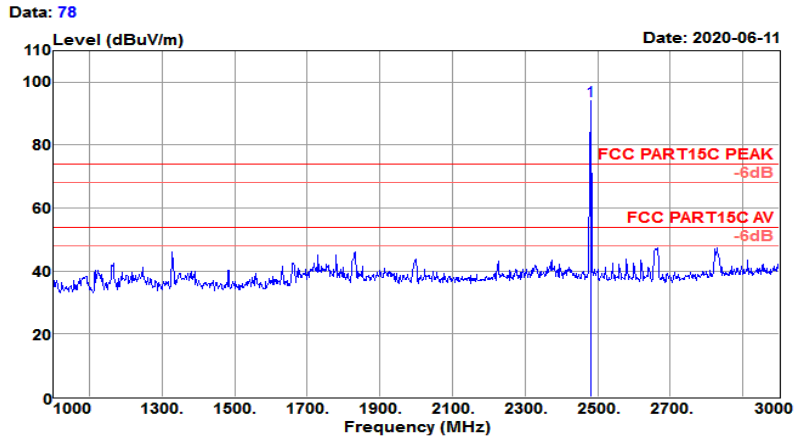


Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
4960.000	51.53	31.14	6.07	58.06	30.68	54.00	-23.32	Average
4960.000	64.61	31.14	6.07	58.06	43.76	74.00	-30.24	Peak
7440.000	49.70	35.96	9.04	58.61	36.09	54.00	-17.91	Average
7440.000	63.48	35.96	9.04	58.61	49.87	74.00	-24.13	Peak
9920.000	49.12	38.64	13.24	57.84	43.16	54.00	-10.84	Average
9920.000	62.50	38.64	13.24	57.84	56.54	74.00	-17.46	Peak

Note: Emission was scanned up to 26GHz; No emissions were detected above the noise floor which was at least 20dB below the specification limit.

Test Mode :	Bluetooth (1Mbps) CH78 (2480MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	1GHz~3GHz	Polarization :	Vertical

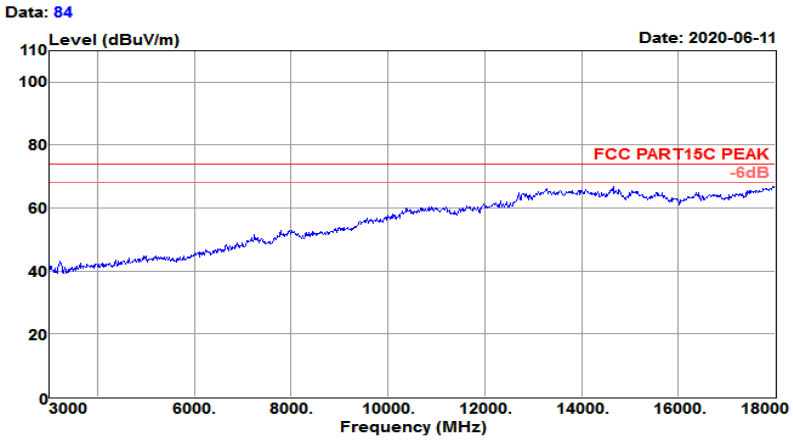
```
Test Site    : 3m Chamber                Temp/Humi    : 25℃/64%
               --------------------------               ----------------
Tested by    : Jack                      Pol/Phase    : VERTICAL
               --------------------------               ----------------
Test Mode    : BT CH79(2480MHz)          Power rating: 120VAc
               --------------------------               ----------------
EUT          : Librem Mini
               --------------------------
Model No.    : LMv1-01
               --------------------------
```



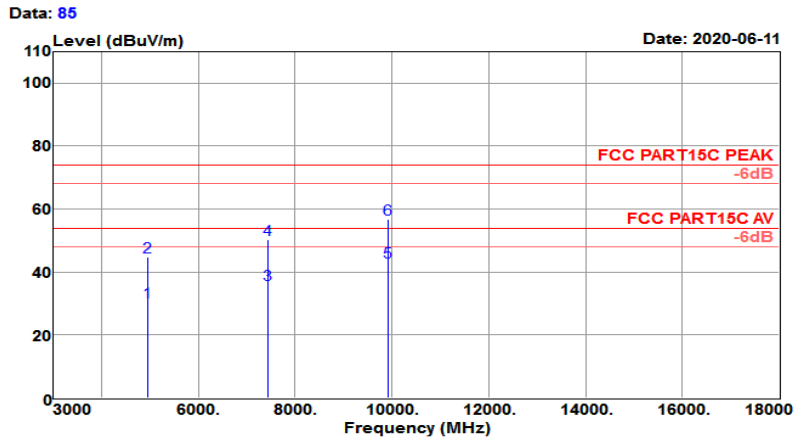
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
2480.000	98.01	27.76	4.26	35.99	94.04	74.00	20.04	Peak

Test Mode :	Bluetooth (1Mbps) CH78 (2480MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	3GHz~18GHz	Polarization :	Vertical

```
Test Site    : 3m Chamber                Temp/Humi    : 25℃/64%
               --------------------                     ----------
Tested by    : Jack                      Pol/Phase    : VERTICAL
               --------------------                     ----------
Test Mode    : BT CH79(2480MHz)          Power rating: 120VAc
               --------------------                     ----------
EUT          : Librem Mini
               --------------------
Model No.    : LMv1-01
               --------------------
```



Test Site	: 3m Chamber	Temp/Humi	: 25℃/64%
Tested by	: Jack	Pol/Phase	: VERTICAL
Test Mode	: BT CH79(2480MHz)	Power rating	: 120VAc
EUT	: Librem Mini		
Model No.	: LMv1-01		



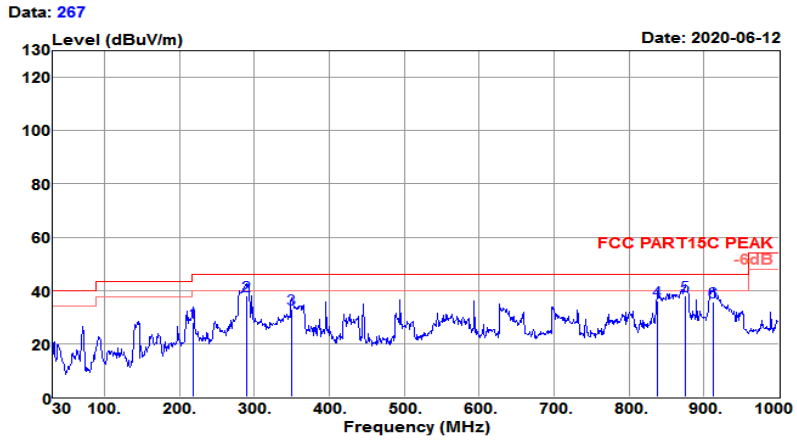
Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
4960.000	51.21	31.14	6.07	58.06	30.36	54.00	-23.64	Average
4960.000	65.60	31.14	6.07	58.06	44.75	74.00	-29.25	Peak
7440.000	49.75	35.96	9.04	58.61	36.14	54.00	-17.86	Average
7440.000	64.04	35.96	9.04	58.61	50.43	74.00	-23.57	Peak
9920.000	49.14	38.64	13.24	57.84	43.18	54.00	-10.82	Average
9920.000	62.86	38.64	13.24	57.84	56.90	74.00	-17.10	Peak

Note: Emission was scanned up to 26GHz; No emissions were detected above the noise floor which was at least 20dB below the specification limit.

4.8.6 Test Result of Radiated Spurious Emission (30MHz ~ 1GHz)

Test Mode :	Bluetooth (1Mbps) CH00 (2402MHz)	**Temperature :**	21~23℃
Test Engineer :	Jack Liu	**Relative Humidity :**	63~65%
Frequencey Range	30MHz~1GHz	**Polarization :**	Horizontal

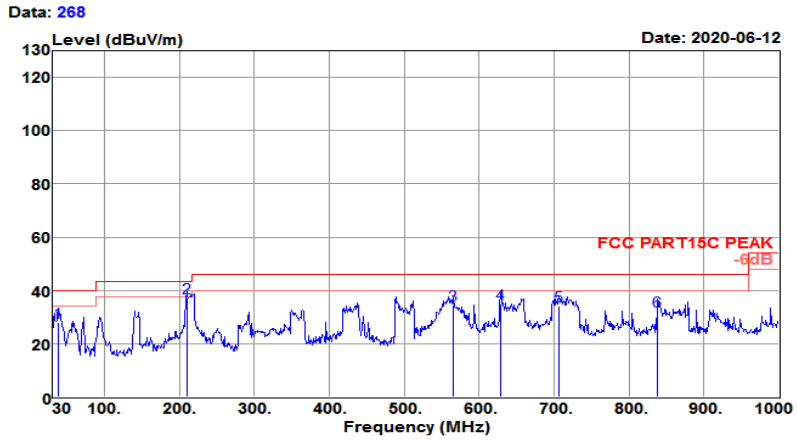
```
Test Site    : 3m Chamber                Temp/Humi    : 19℃/60%
Tested by    : Jack                      Pol/Phase    : HORIZONTAL
Test Mode    : BT CH00(2402MHz)          Power rating: 19V±10%
EUT          : Librem Mini
Model No.    : LMv1-01
```



Freq	Reading level	Antenna factor	Cable loss	Preamp factor	level	Limit level	Over limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
218.180	46.29	11.51	2.87	32.47	28.20	46.00	-17.80	QP
289.960	53.16	13.98	3.34	32.49	37.99	46.00	-8.01	QP
349.130	46.93	14.79	3.68	32.52	32.88	46.00	-13.12	QP
837.040	39.82	22.70	5.85	32.27	36.10	46.00	-9.90	QP
874.870	41.09	23.15	6.01	32.22	38.03	46.00	-7.97	QP
912.700	38.16	23.73	6.12	32.18	35.83	46.00	-10.17	QP

Test Mode :	Bluetooth (1Mbps) CH00 (2402MHz)	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	63~65%
Frequencey Range	30MHz~1GHz	Polarization :	Vertical

```
Test Site    : 3m Chamber                Temp/Humi    : 19℃/60%
Tested by    : Jack                      Pol/Phase    : VERTICAL
Test Mode    : BT CH00(2402MHz)          Power rating: 19V±10%
EUT          : Librem Mini
Model No.    : LMv1-01
```



Freq MHz	Reading level dBuV	Antenna factor dB/m	Cable loss dB	Preamp factor dB	level dBuV/m	Limit level dBuV/m	Over limit dB	Remark
37.760	46.91	12.41	1.20	32.47	28.05	40.00	-11.95	QP
209.450	55.93	11.07	2.80	32.47	37.33	43.50	-6.17	QP
564.470	42.98	19.36	4.75	32.67	34.42	46.00	-11.58	QP
628.490	42.20	20.40	4.98	32.68	34.90	46.00	-11.10	QP
707.060	40.18	21.34	5.29	32.62	34.19	46.00	-11.81	QP
838.010	35.86	22.70	5.85	32.26	32.15	46.00	-13.85	QP

4.9 AC Conducted Emission Measurement

4.9.1 Limit of AC Conducted Emission

For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

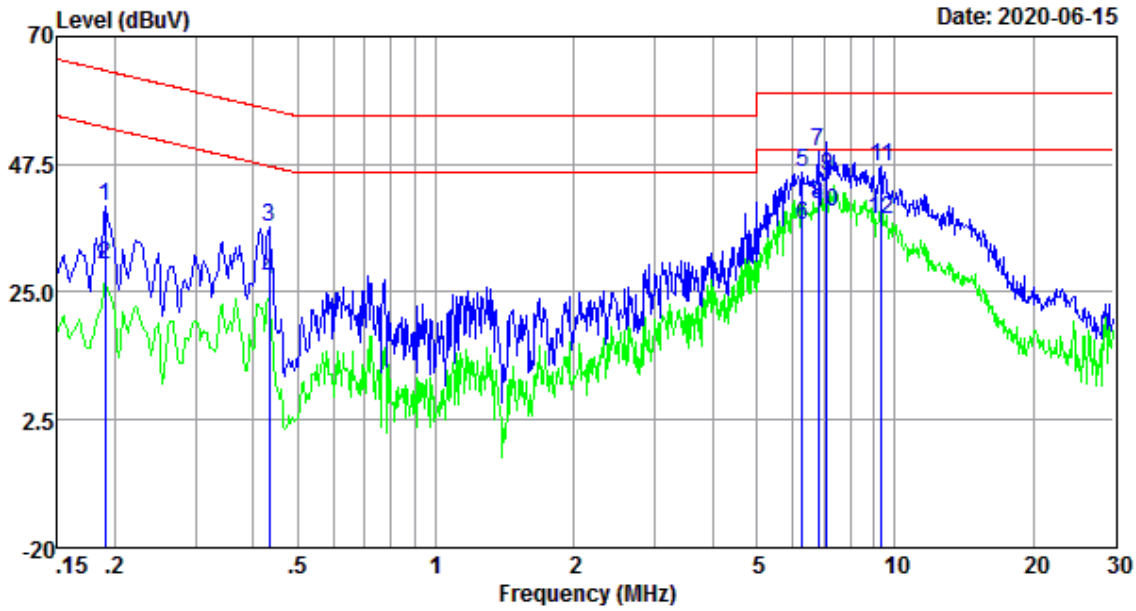
*Decreases with the logarithm of the frequency.

4.9.2 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

4.9.3 Test Result of AC Conducted Emission

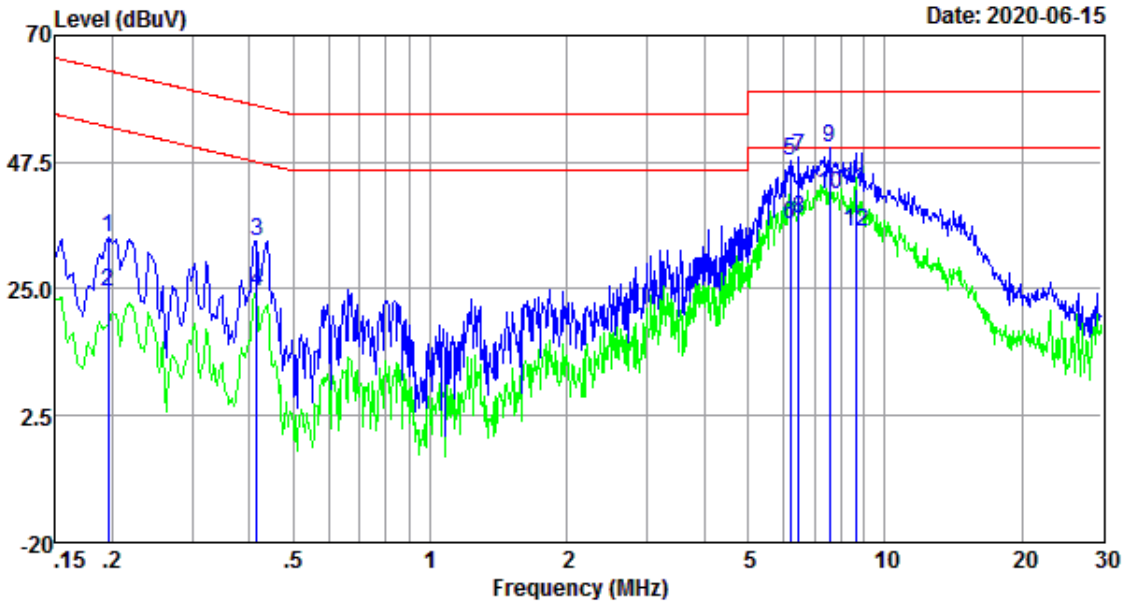
Test Mode :	Mode 1	**Temperature :**	21~23℃
Test Engineer :	Jack Liu	**Relative Humidity :**	41~43%
Test Voltage :	120Vac / 60Hz	**Phase :**	Line
Function Type :	Bluetooth Link + HDMI + Earphone + Burnin test + RJ45 ping		



Freq MHz	Reading level dBuV	LISN/ISN factor dB	Cable loss dB	Result level dBuV	Limit level dBuV	Over limit dB	Remark
0.190	30.62	9.55	0.03	40.20	64.02	-23.82	QP
0.190	20.13	9.55	0.03	29.71	54.02	-24.31	Average
0.433	26.99	9.56	0.02	36.57	57.20	-20.63	QP
0.433	17.53	9.56	0.02	27.11	47.20	-20.09	Average
6.285	36.31	9.71	0.05	46.07	60.00	-13.93	QP
6.285	27.02	9.71	0.05	36.78	50.00	-13.22	Average
6.805	39.91	9.73	0.06	49.70	60.00	-10.30	QP
6.805	30.72	9.73	0.06	40.51	50.00	-9.49	Average
7.100	35.51	9.74	0.06	45.31	60.00	-14.69	QP
7.100	29.31	9.74	0.06	39.11	50.00	-10.89	Average
9.352	37.15	9.83	0.08	47.06	60.00	-12.94	QP
9.352	27.86	9.83	0.08	37.77	50.00	-12.23	Average

Result Level= Reading Level + LISN Factor + Cable Loss

Test Mode :	Mode 1	Temperature :	21~23℃
Test Engineer :	Jack Liu	Relative Humidity :	41~43%
Test Voltage :	120Vac / 60Hz	Phase :	Neutral
Function Type :	Bluetooth Link + HDMI + Earphone + Burnin test + RJ45 ping		



Freq MHz	Reading level dBuV	LISN/ISN factor dB	Cable loss dB	Result level dBuV	Limit level dBuV	Over limit dB	Remark
0.195	24.66	9.56	0.03	34.25	63.80	-29.55	QP
0.195	14.77	9.56	0.03	24.36	53.80	-29.44	Average
0.415	23.87	9.58	0.02	33.47	57.55	-24.08	QP
0.415	14.92	9.58	0.02	24.52	47.55	-23.03	Average
6.186	37.92	9.78	0.05	47.75	60.00	-12.25	QP
6.186	26.55	9.78	0.05	36.38	50.00	-13.62	Average
6.454	38.59	9.79	0.06	48.44	60.00	-11.56	QP
6.454	27.62	9.79	0.06	37.47	50.00	-12.53	Average
7.566	40.17	9.84	0.07	50.08	60.00	-9.92	QP
7.566	31.85	9.84	0.07	41.76	50.00	-8.24	Average
8.637	32.90	9.88	0.08	42.86	60.00	-17.14	QP
8.637	25.30	9.88	0.08	35.26	50.00	-14.74	Average

Result Level= Reading Level + LISN Factor + Cable Loss

4.10 Antenna Requirements

4.10.1 Standard Applicable

According to antenna requirement of §15.203.

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 re-placed 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..

And according to §15.247(4)(1), system operating in the 2400-2483.5MHz bands that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.

4.10.2 Antenna Connected Construction

An FPC antenna design is used.

4.10.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

5 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Due Date	Remark
Spectrum Analyzer	Keysight	N9010A	MY56070788	2020-01-15	2021-01-14	Conducted
Power Sensor	Keysight	U2021XA	MY56510025	2020-01-16	2021-01-15	Conducted
Power Sensor	Keysight	U2021XA	MY57030005	2020-01-16	2021-01-15	Conducted
Power Sensor	Keysight	U2021XA	MY56510018	2020-01-16	2021-01-15	Conducted
Power Sensor	Keysight	U2021XA	MY56480002	2020-01-16	2021-01-15	Conducted
Thermal Chamber	Howkin	UHL-34	19111801	2020-05-09	2021-05-08	Conducted
Base Station	R&S	CMW 270	101231	2020-01-16	2021-01-15	Conducted
Signal Generator (Interferer)	Keysight	N5182B	MY56200384	2020-02-21	2021-02-20	Conducted

Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Due Date	Remark
Spectrum Analyzer	R&S	FSV 40	101433	2020-01-16	2021-01-15	Radiation
Amplifier	Sonoma	310	363917	2020-01-15	2021-01-14	Radiation
Amplifier	Schwarzbeck	BBV 9718	327	2020-01-15	2021-01-14	Radiation
Amplifier	Narda	TTA1840-35-HG	2034380	2020-05-14	2021-05-15	Radiation
Loop Antenna	Schwarzbeck	FMZB 1519B	1519B-051	2020-02-14	2023-02-13	Radiation
Broadband Antenna	Schwarzbeck	VULB 9168	9168-757	2018-08-31	2021-08-30	Radiation
Horn Antenna	Schwarzbeck	BBHA 9120 D	1677	2020-02-14	2023-02-13	Radiation
Horn Antenna	COM-POWER	AH-1840	101117	2018-06-20	2021-06-19	Radiation
Test Software	Auidx	E3	6.111221a	N/A	N/A	Radiation
Filter	Micro-Tronics	BRM 50702	G266	N/A	N/A	Radiation

Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Due Date	Remark
LISN	R&S	ENV216	102125	2020-01-08	2021-01-07	Conducted
LISN	R&S	ENV432	101327	2020-01-08	2021-01-07	Conducted
EMI Test Receiver	R&S	ESR3	102143	2020-01-16	2021-01-15	Conducted
EMI Test Software	Audix	E3	N/A	N/A	N/A	Conducted

N/A: No Calibration Required

6 Uncertainty of Evaluation

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

MEASUREMENT	FREQUENCY	UNCERTAINTY
Conducted emissions	9kHz~30MHz	2.42dB
Radiated emission	30MHz ~ 1GMHz	2.50dB
	1GHz ~ 18GHz	3.51dB
	18GHz ~ 40GHz	3.96dB

MEASUREMENT	UNCERTAINTY
Occupied Channel Bandwidth	±196.4Hz
RF output power, conducted	±2.31dB
Power density, conducted	±2.31dB

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Appendix A: 20dB Emission Bandwidth

Test Result

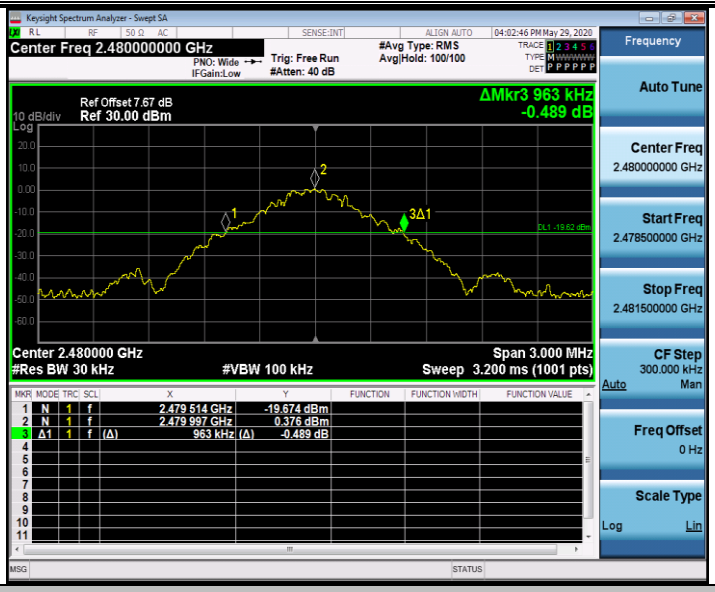
TestMode	Antenna	Channel	20db EBW[MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
DH5	Ant1	2402	0.954	2401.520	2402.474	---	PASS
		2441	0.957	2440.523	2441.480	---	PASS
		2480	0.963	2479.514	2480.477	---	PASS
2DH5	Ant1	2402	1.488	2401.253	2402.741	---	PASS
		2441	1.524	2440.229	2441.753	---	PASS
		2480	1.536	2479.217	2480.753	---	PASS
3DH5	Ant1	2402	1.560	2401.202	2402.762	---	PASS
		2441	1.494	2440.250	2441.744	---	PASS
		2480	1.509	2479.238	2480.747	---	PASS

Test Graphs

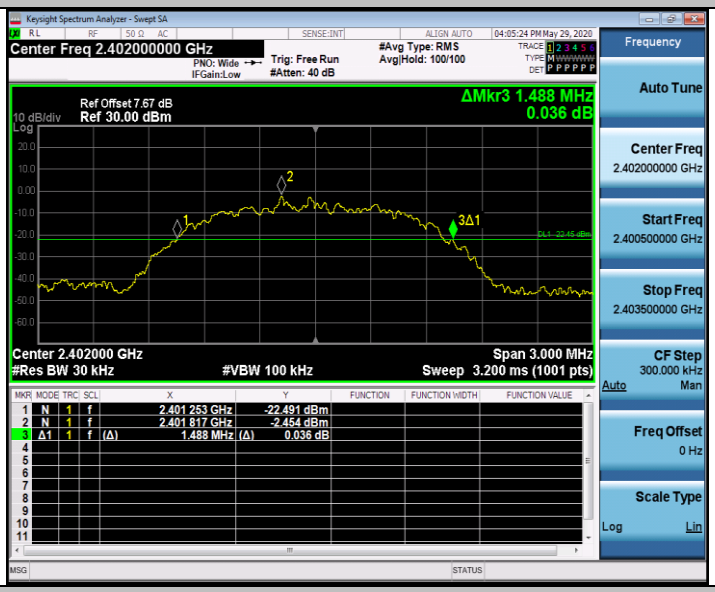
DH5_Ant1_2402

DH5_Ant1_2441

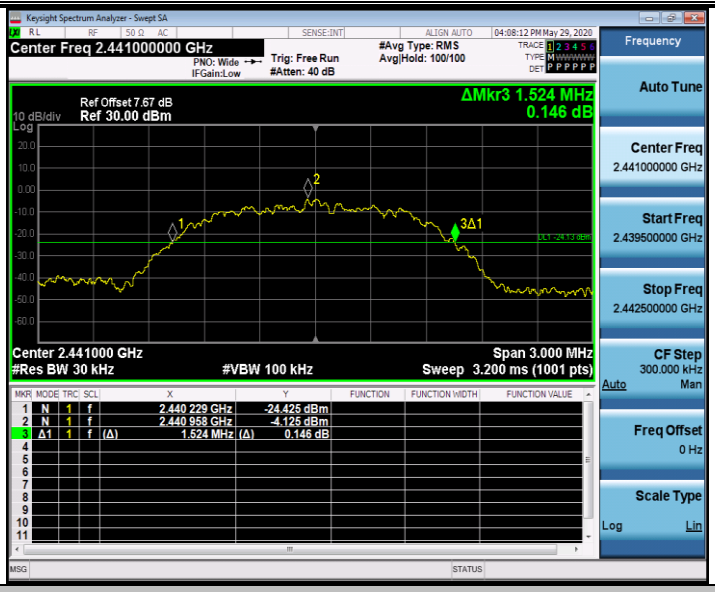
DH5_Ant1_2480



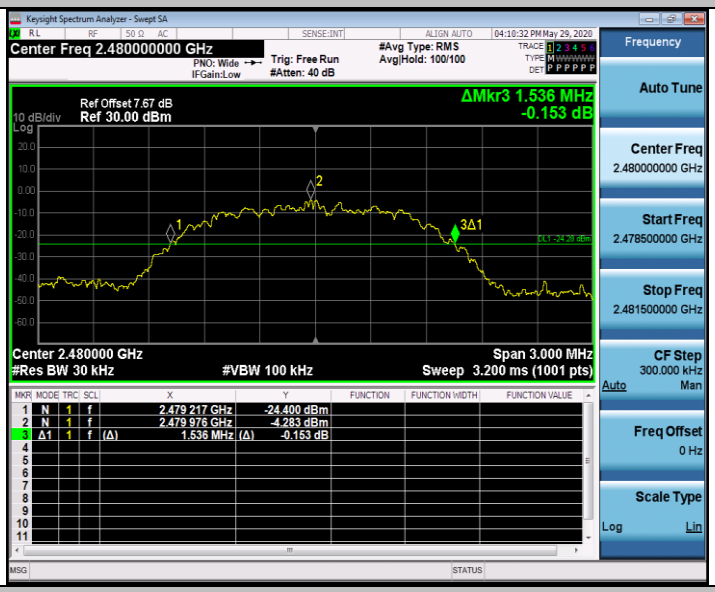
2DH5_Ant1_2402



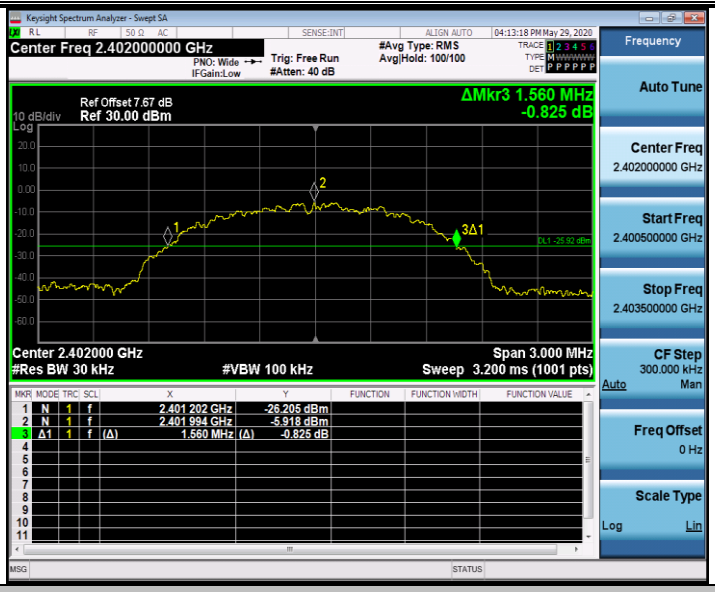
2DH5_Ant1_2441



2DH5_Ant1_2480



3DH5_Ant1_2402



3DH5_Ant1_2441

3DH5_Ant1_2480


Keysight Spectrum Analyzer - Swept SA
Center Freq 2.480000000 GHz
PNO: Wide
IFGain:Low
Trig: Free Run
#Atten: 40 dB
#Avg Type: RMS
Avg|Hold: 100/100
04:18:13 PM May 29, 2020
Ref Offset 7.67 dB
10 dB/div
Ref 30.00 dBm
ΔMkr3 1.509 MHz
-0.232 dB
Center 2.480000 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 3.000 MHz
Sweep 3.200 ms (1001 pts)
1 N 1 f 2.479 238 GHz -24.664 dBm
2 N 1 f 2.479 970 GHz -4.619 dBm
3 Δ1 1 f (Δ) 1.509 MHz (Δ) -0.232 dB
Frequency
Auto Tune
Center Freq
2.480000000 GHz
Start Freq
2.478500000 GHz
Stop Freq
2.481500000 GHz
CF Step
300.000 kHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin

Appendix B: Occupied Channel Bandwidth

Test Result

TestMode	Antenna	Channel	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
DH5	Ant1	2402	0.86263	2401.551	2402.414	---	PASS
		2441	0.86644	2440.549	2441.416	---	PASS
		2480	0.86455	2479.552	2480.417	---	PASS
2DH5	Ant1	2402	1.3587	2401.301	2402.660	---	PASS
		2441	1.3564	2440.303	2441.660	---	PASS
		2480	1.3525	2479.304	2480.656	---	PASS
3DH5	Ant1	2402	1.3653	2401.302	2402.667	---	PASS
		2441	1.3645	2440.302	2441.667	---	PASS
		2480	1.3571	2479.306	2480.663	---	PASS

Test Graphs

DH5_Ant1_2402

DH5_Ant1_2441

DH5_Ant1_2480

2DH5_Ant1_2402

2DH5_Ant1_2441

2DH5_Ant1_2480

3DH5_Ant1_2402

3DH5_Ant1_2441

3DH5_Ant1_2480


Keysight Spectrum Analyzer - Occupied BW
Center Freq 2.480000000 GHz
Center Freq: 2.480000000 GHz
Trig: Free Run
Avg|Hold: 100/100
#Atten: 40 dB
#IFGain:Low
Radio Std: None
Radio Device: BTS
Frequency
Ref Offset 7.67 dB
10 dB/div
Ref 30.00 dBm
Log
Mkr1 2.48015 GHz
-5.4778 dBm
Center Freq
2.480000000 GHz
Center 2.48 GHz
#Res BW 20 kHz
#VBW 75 kHz
Span 3 MHz
Sweep 7.133 ms
CF Step
300.000 kHz
Auto
Man
Occupied Bandwidth
1.3571 MHz
Total Power
6.09 dBm
Transmit Freq Error
-15.433 kHz
% of OBW Power
99.00 %
x dB Bandwidth
1.660 MHz
x dB
-26.00 dB
Freq Offset
0 Hz
MSG
STATUS

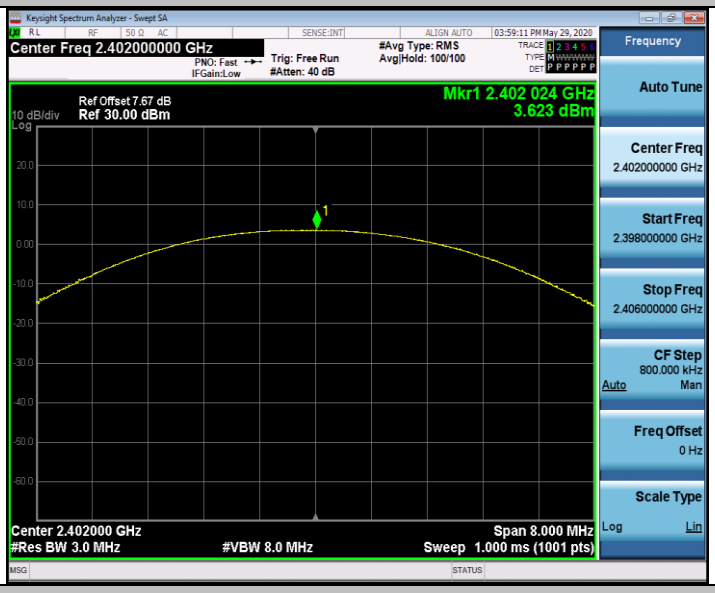
Appendix C: Maximum conducted output power

Test Result

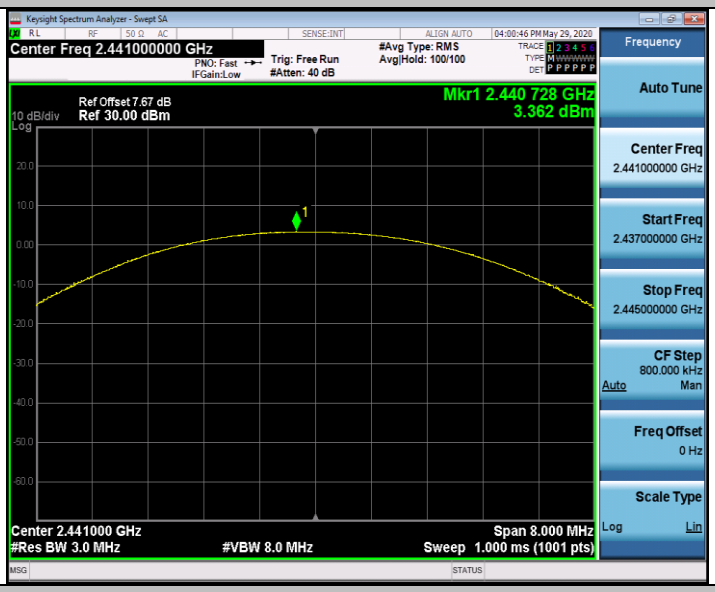
TestMode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
DH5	Ant1	2402	3.62	<=20.97	PASS
		2441	3.36	<=20.97	PASS
		2480	3.09	<=20.97	PASS
2DH5	Ant1	2402	2.91	<=20.97	PASS
		2441	2.65	<=20.97	PASS
		2480	2.36	<=20.97	PASS
3DH5	Ant1	2402	2.12	<=20.97	PASS
		2441	1.92	<=20.97	PASS
		2480	1.59	<=20.97	PASS

Test Graphs

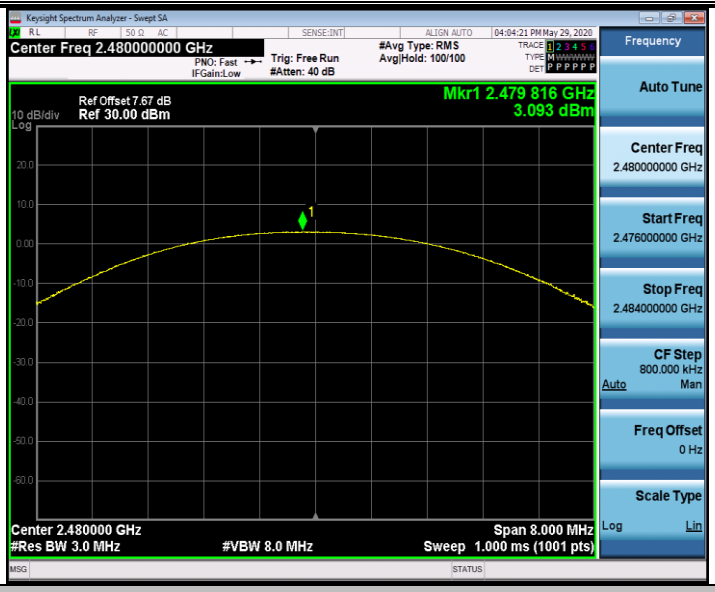
DH5_Ant1_2402



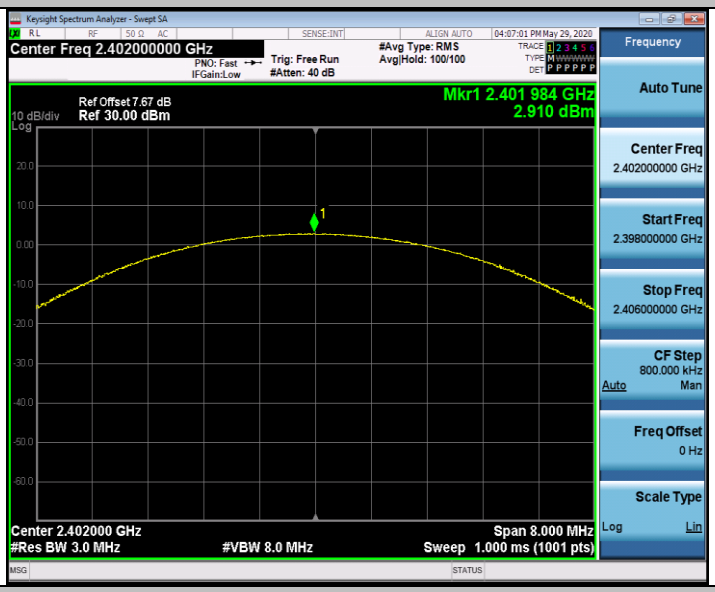
DH5_Ant1_2441



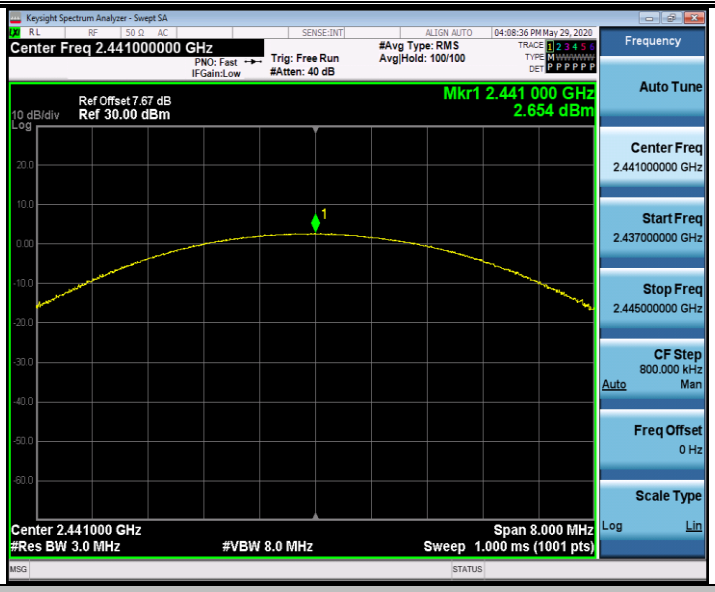
DH5_Ant1_2480



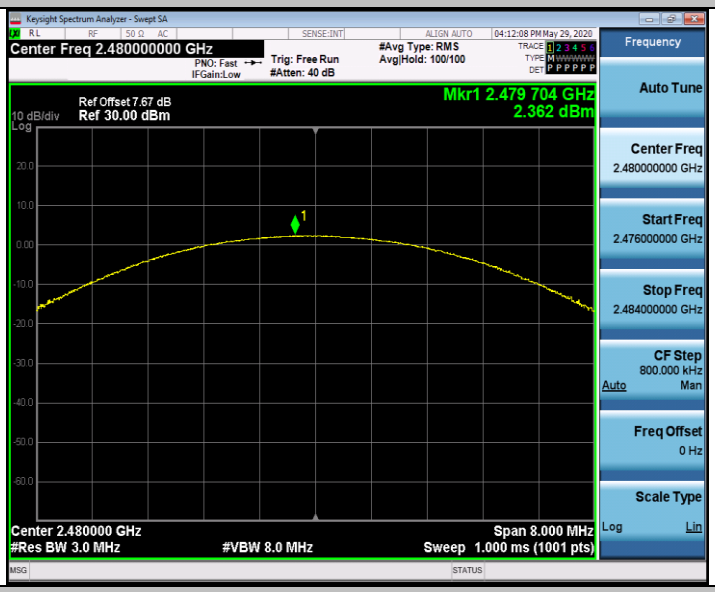
2DH5_Ant1_2402



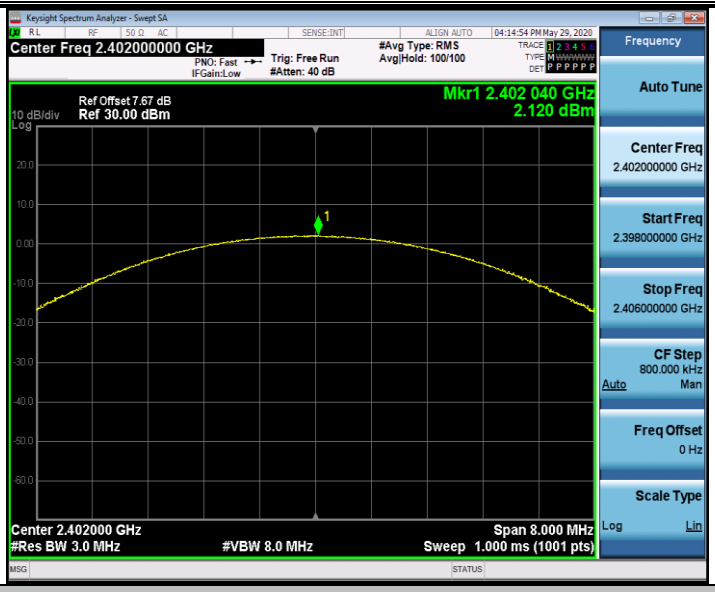
2DH5_Ant1_2441



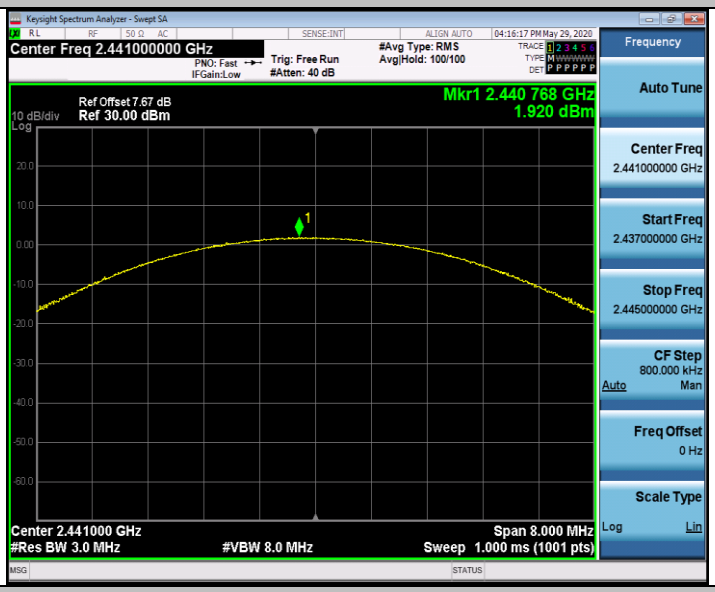
2DH5_Ant1_2480



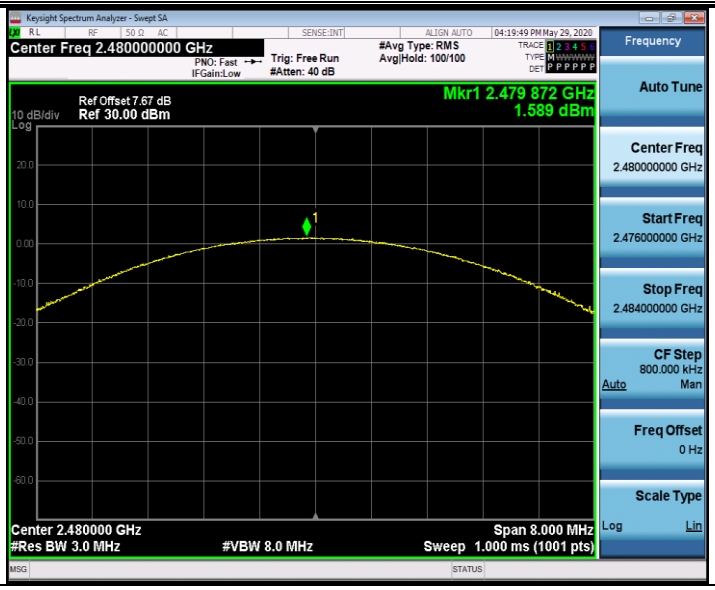
3DH5_Ant1_2402



3DH5_Ant1_2441



3DH5_Ant1_2480

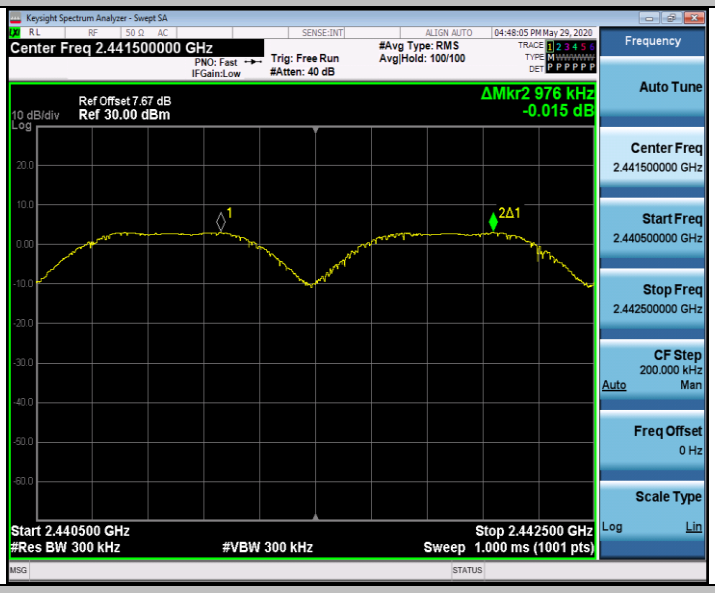

Keysight Spectrum Analyzer - Swept SA
Center Freq 2.480000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 40 dB
#Avg Type: RMS
Avg|Hold: 100/100
04:19:49 PM May 29, 2020
Ref Offset 7.67 dB
10 dB/div
Ref 30.00 dBm
Log
Mkr1 2.479 872 GHz
1.589 dBm
Center 2.480000 GHz
#Res BW 3.0 MHz
#VBW 8.0 MHz
Span 8.000 MHz
Sweep 1.000 ms (1001 pts)
Frequency
Auto Tune
Center Freq
2.480000000 GHz
Start Freq
2.476000000 GHz
Stop Freq
2.484000000 GHz
CF Step
800.000 kHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin
MSG
STATUS

Appendix D: Carrier frequency separation

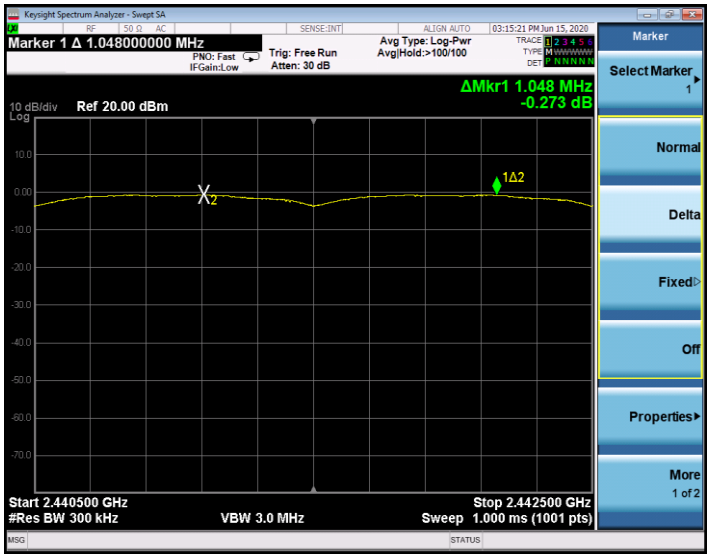
Test Result

TestMode	Antenna	Channel	Result[MHz]	Limit[MHz]	Verdict
DH5	Ant1	Hop_2441	0.976	>=0.963	PASS
2DH5	Ant1	Hop_2441	1.026	>=1.024	PASS
3DH5	Ant1	Hop_2441	1.048	>=1.040	PASS

Test Graphs

DH5_Ant1_Hop

2DH5_Ant1_Hop

3DH5_Ant1_Hop

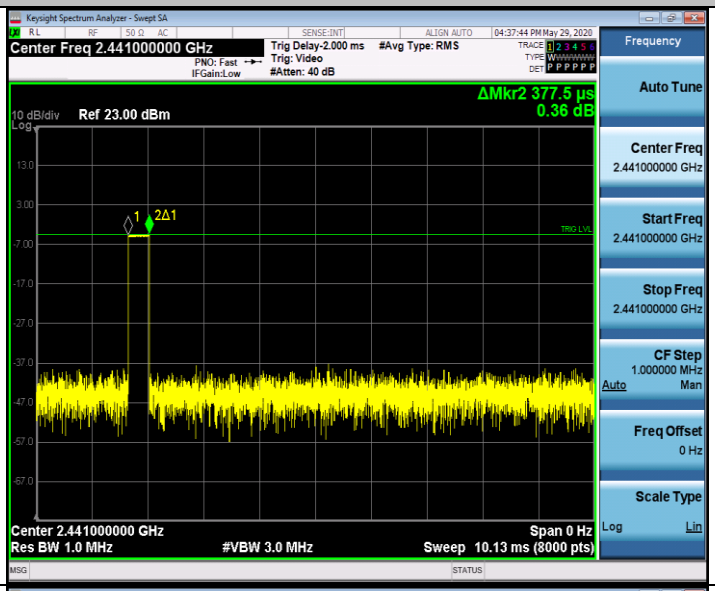
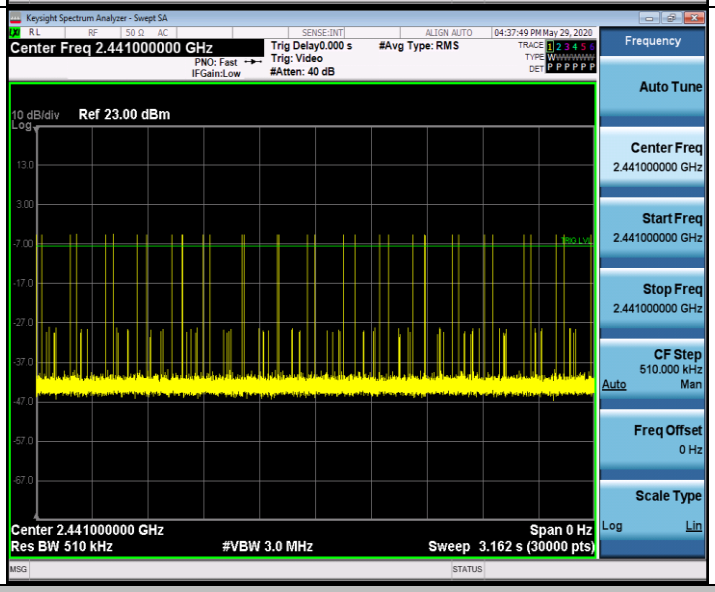

Keysight Spectrum Analyzer - Swept SA
Marker 1 Δ 1.048000000 MHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
03:15:21 PM Jun 15, 2020
ΔMkr1 1.048 MHz
-0.273 dB
10 dB/div
Log
Ref 20.00 dBm
1Δ2
Start 2.440500 GHz
#Res BW 300 kHz
VBW 3.0 MHz
Stop 2.442500 GHz
Sweep 1.000 ms (1001 pts)
Marker
Select Marker
1
Normal
Delta
Fixed
Off
Properties
More
1 of 2
MSG
STATUS

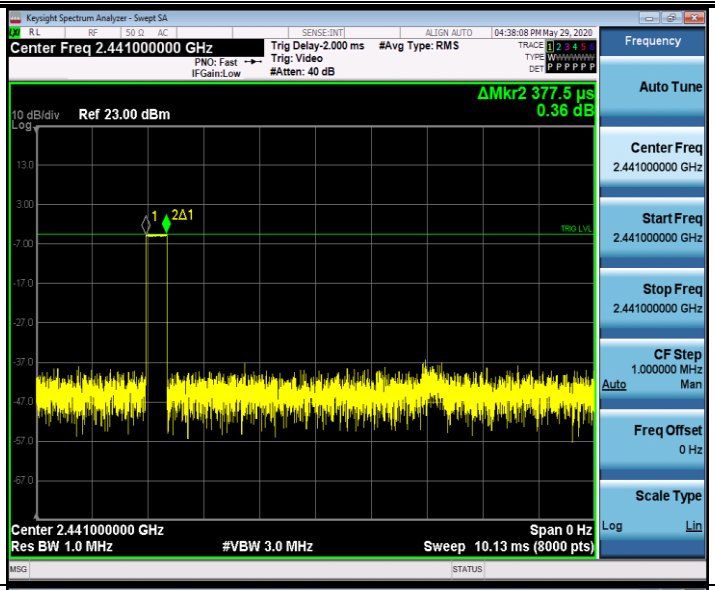
Appendix E: Time of occupancy

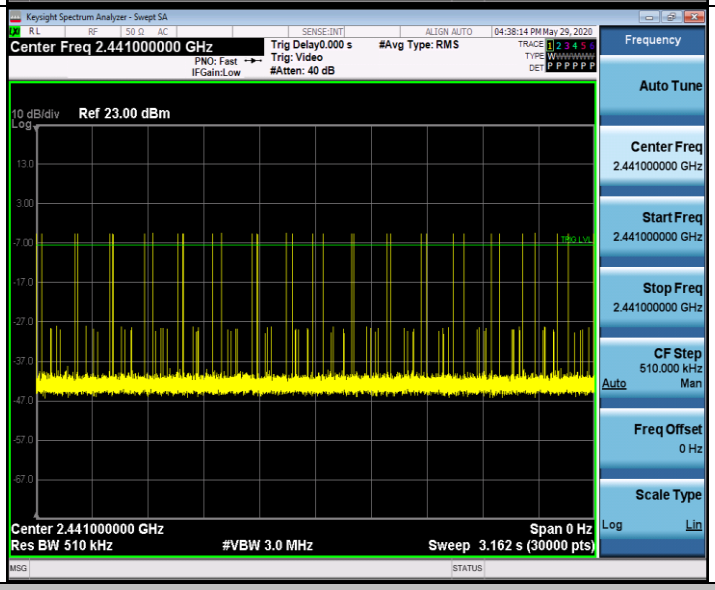
Test Result

TestMode	Antenna	Channel	BurstWidth [ms]	TotalHops [Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Hop_2402	0.38	330	0.125	<=0.4	PASS
		Hop_2441	0.38	330	0.125	<=0.4	PASS
		Hop_2480	0.38	330	0.125	<=0.4	PASS
DH3	Ant1	Hop_2402	1.63	170	0.278	<=0.4	PASS
		Hop_2441	1.63	150	0.245	<=0.4	PASS
		Hop_2480	1.63	170	0.278	<=0.4	PASS
DH5	Ant1	Hop_2402	2.88	90	0.259	<=0.4	PASS
		Hop_2441	2.88	130	0.374	<=0.4	PASS
		Hop_2480	2.88	70	0.202	<=0.4	PASS
2DH1	Ant1	Hop_2402	0.39	330	0.128	<=0.4	PASS
		Hop_2441	0.39	330	0.128	<=0.4	PASS
		Hop_2480	0.39	330	0.127	<=0.4	PASS
2DH3	Ant1	Hop_2402	1.64	200	0.328	<=0.4	PASS
		Hop_2441	1.64	140	0.23	<=0.4	PASS
		Hop_2480	1.64	180	0.295	<=0.4	PASS
2DH5	Ant1	Hop_2402	2.89	40	0.116	<=0.4	PASS
		Hop_2441	2.89	90	0.26	<=0.4	PASS
		Hop_2480	2.89	110	0.318	<=0.4	PASS
3DH1	Ant1	Hop_2402	0.39	330	0.127	<=0.4	PASS
		Hop_2441	0.39	320	0.124	<=0.4	PASS
		Hop_2480	0.39	330	0.127	<=0.4	PASS
3DH3	Ant1	Hop_2402	1.64	130	0.213	<=0.4	PASS
		Hop_2441	1.64	200	0.328	<=0.4	PASS
		Hop_2480	1.64	180	0.295	<=0.4	PASS
3DH5	Ant1	Hop_2402	2.89	90	0.26	<=0.4	PASS
		Hop_2441	2.89	100	0.289	<=0.4	PASS
		Hop_2480	2.89	130	0.375	<=0.4	PASS

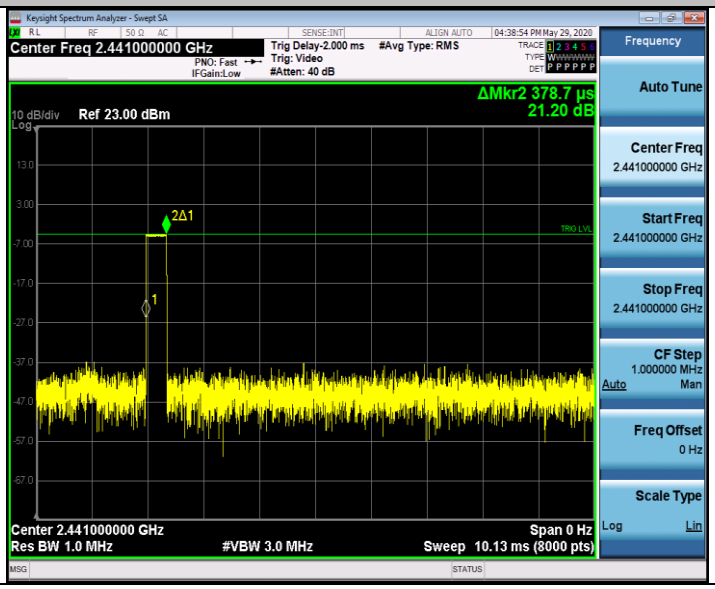
Test Graphs

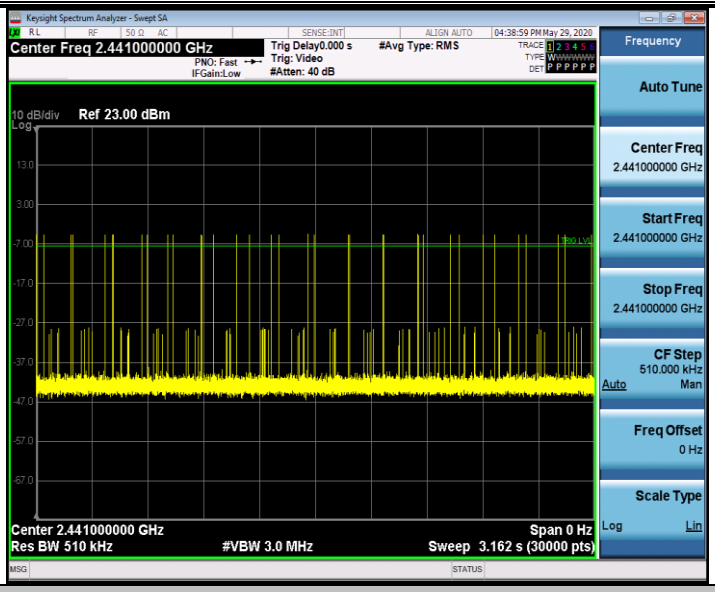
DH1_Ant1_Hop_2402


DH1_Ant1_Hop_2441





DH1_Ant1_Hop_2480





DH3_Ant1_Hop_2402