



Engineering Solutions & Electromagnetic Compatibility Services

FCC Part 15.247 Certification Report

Test Lab: Rhein Tech Laboratories, Inc. Phone: 703-689-0368 360 Herndon Parkway Fax: 703-689-2056 Suite 1400 www.rheintech.com Herndon, VA 20170		Applicant: Innovative Wireless Technologies, Inc. (IWT) 1100 Main Street Tel: 434-316-5230 Lynchburg, VA 24504	
FCC ID	SP8-FAP5030030	Test Report Date	December 7, 2020
Platform	N/A	RTL Work Order Number	2020164
Model	FAP5030-030	RTL Quote Number	QRTL20-164A
American National Standard Institute	ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices		
FCC Classification	DTS – Part 15 Digital Transmission System		
FCC Rule Part(s)	FCC Rules Part 15.247: Operation within the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz (2019)		
Frequency Range (MHz)	Output Power (W)*	Frequency Tolerance	Emission Designator
2402-2480	0.001	N/A	N/A

*Power is conducted peak

I, the undersigned, hereby declare that the equipment tested and referenced in this report conforms to the identified standard(s) as described in this test report. No modifications were made to the equipment during testing in order to achieve compliance with these standards. Furthermore, there was no deviation from, additions to, or exclusions from, the applicable parts of FCC Part 2, FCC Part 15, ANSI C63.10.

Signature: 

Date: December 7, 2020

Typed/Printed Name: Desmond A. Fraser

Position: President

*This report may not be reproduced, except in full, without the written approval of Rhein Tech Laboratories, Inc. and Innovative Wireless Technologies. The test results relate only to the item(s) tested.
Replaces R0.1.*

*These tests are accredited and meet the requirements of ISO/IEC 17025 as verified by ANAB.
Refer to certificate and scope of accreditation AT-1445.*

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1 General Information

1.1 Scope

Applicable Standards:

FCC Part 15.247: Operation within the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz

1.2 Description of EUT

Equipment Under Test	Indoor Location Beacon (ILB)
Model #	FAP5030-030
Power Supply	Power over Ethernet (48VDC)
Modulation Type	GFSK
Frequency Range	2402 - 2480 MHz
Antenna Type	Trace

1.3 Test Facility

The open area test site and conducted measurement facility used to collect the radiated data is located at 360 Herndon Parkway, Suite 1400, Herndon, Virginia 20170. This site has been fully described in a report and approved by the Federal Communications Commission to perform AC line conducted and radiated emissions testing (ANSI C63.10-2013).

1.4 Related Submittal(s)/Grant(s)

This is an original application for certification for Innovative Wireless Technologies, Inc. Model # FAP5030-030, Indoor Location Beacon (ILB); FCC ID: SP8-FAP5030030.

1.5 Modifications

No modifications were required for compliance.

2 Test Information

2.1 Description of Test Modes

In accordance with FCC 15.31(m), and because the EUT utilizes an operating band greater than 10 MHz, the following frequencies were tested:

Table 2-1: Frequencies Tested

Channel	Frequency
Low	2402
Mid	2440
High	2480

2.2 Exercising the EUT

The EUT was tested in all three orthogonal planes in order to determine worst-case emissions. The EUT was provided with software to transmit during testing. The carrier was also checked to verify that information was being transmitted. There were no deviations from the test standard(s) and/or methods. The test results reported relate only to the item tested.

2.3 Test Result Summary

Table 2-2: Test Result Summary – FCC Part 15, Subpart C (Section 15.247)

FCC Reference	C63.10 Procedure	Test	Pass/Fail or N/A
FCC 15.207	6.2	AC Power Conducted Emissions	Pass
FCC 15.209	11.12.2.7	Radiated Emissions	Pass
FCC 15.247(b)	11.2	Maximum Peak Power Output	Pass
FCC 15.247(d)	11.12.2	Antenna Conducted Spurious Emissions	Pass
FCC 15.247(d)	11.13	Band Edge	Pass
FCC 15.247(a)(2)	11.8	6 dB Bandwidth	Pass
FCC 15.247(e)	11.10	Power Spectral Density	Pass

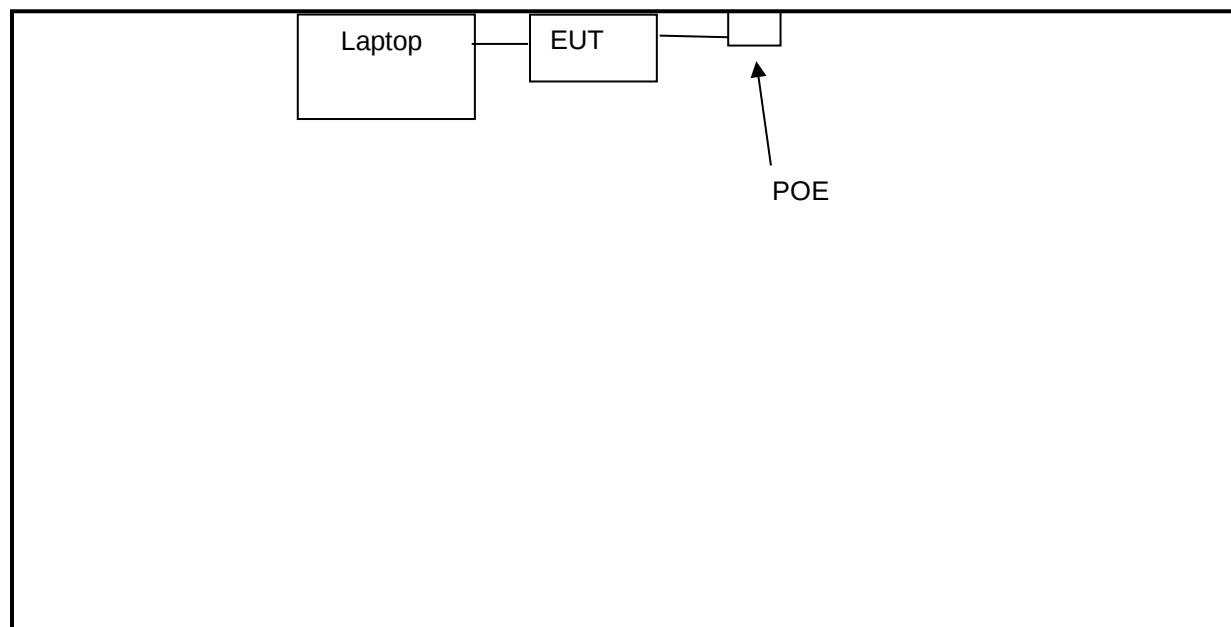
2.4 Test System Details

The test samples were received on November 17, 2020. The FCC identifiers for all applicable equipment, plus descriptions of all cables used in the tested system, are identified in the following tables.

Table 2-3: Equipment Under Test

Part	Manufacturer	Model #	Serial Number	FCC ID	RTL Bar Code
Indoor Location Beacon (ILB)	IWT	FAP5030-030	ILB2047001	SP8-FAP5030030	23748
Indoor Location Beacon (ILB) (Conducted Port Unit)	IWT	FAP5030-030	ILB2047002	SP8-FAP5030030	23747
POE	TP-Link	TL-POE150S	Y204045002515	N/A	23746
POE AC Adapter	TP-Link	T480050-2B1	N/A	N/A	23750

2.5 Configuration of Tested System



3 Maximum Conducted Output Power – FCC 15.247(b)(3)

3.1 Power Output Test Procedure

A conducted power measurement of the EUT was taken using a Rhode & Schwarz spectrum analyzer.

Procedure: C63.10-2013 11.9.1 Maximum peak conducted output power.

Table 3-1: Power Output Test Equipment

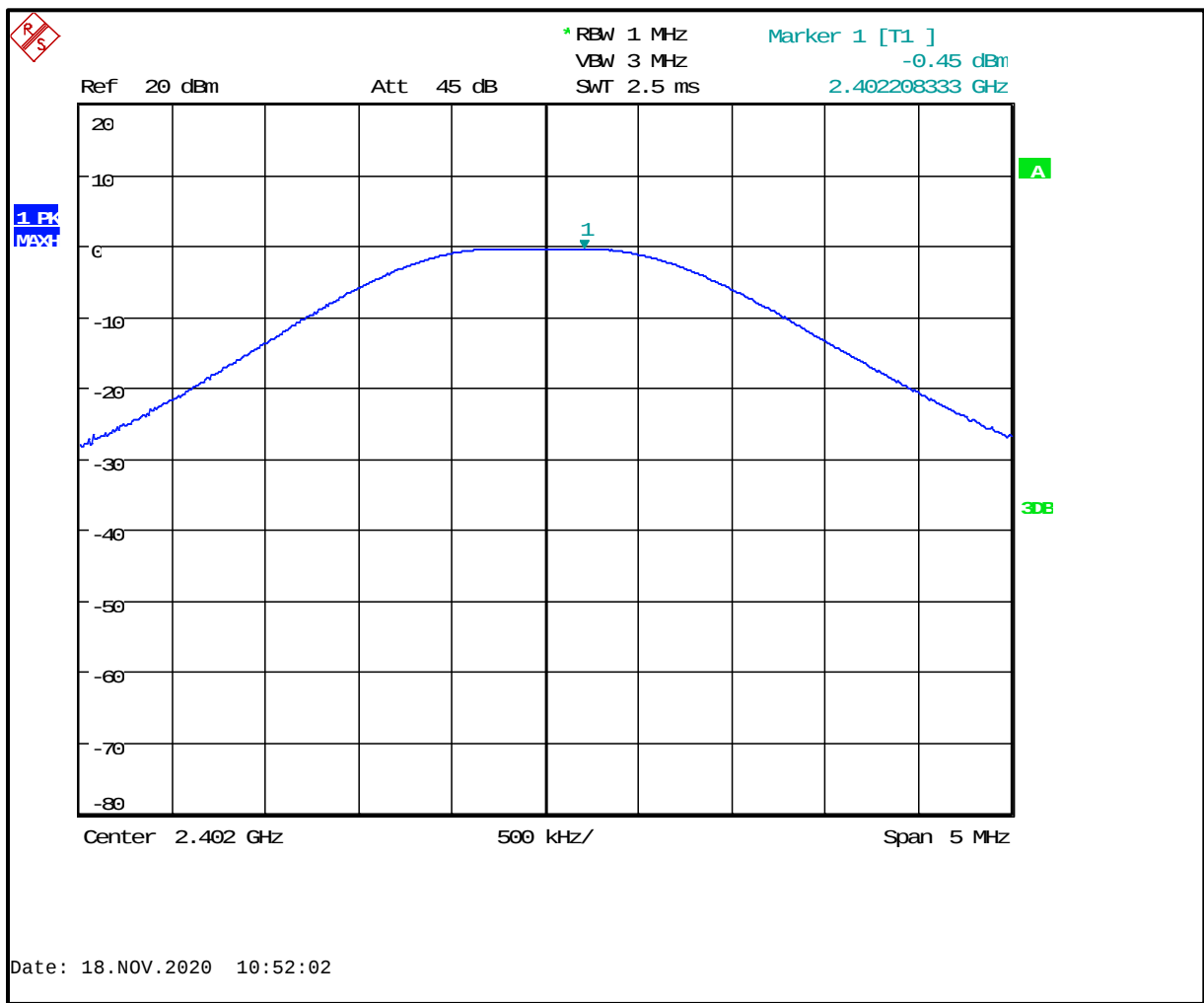
RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	4/26/21

3.2 Power Output Test Data

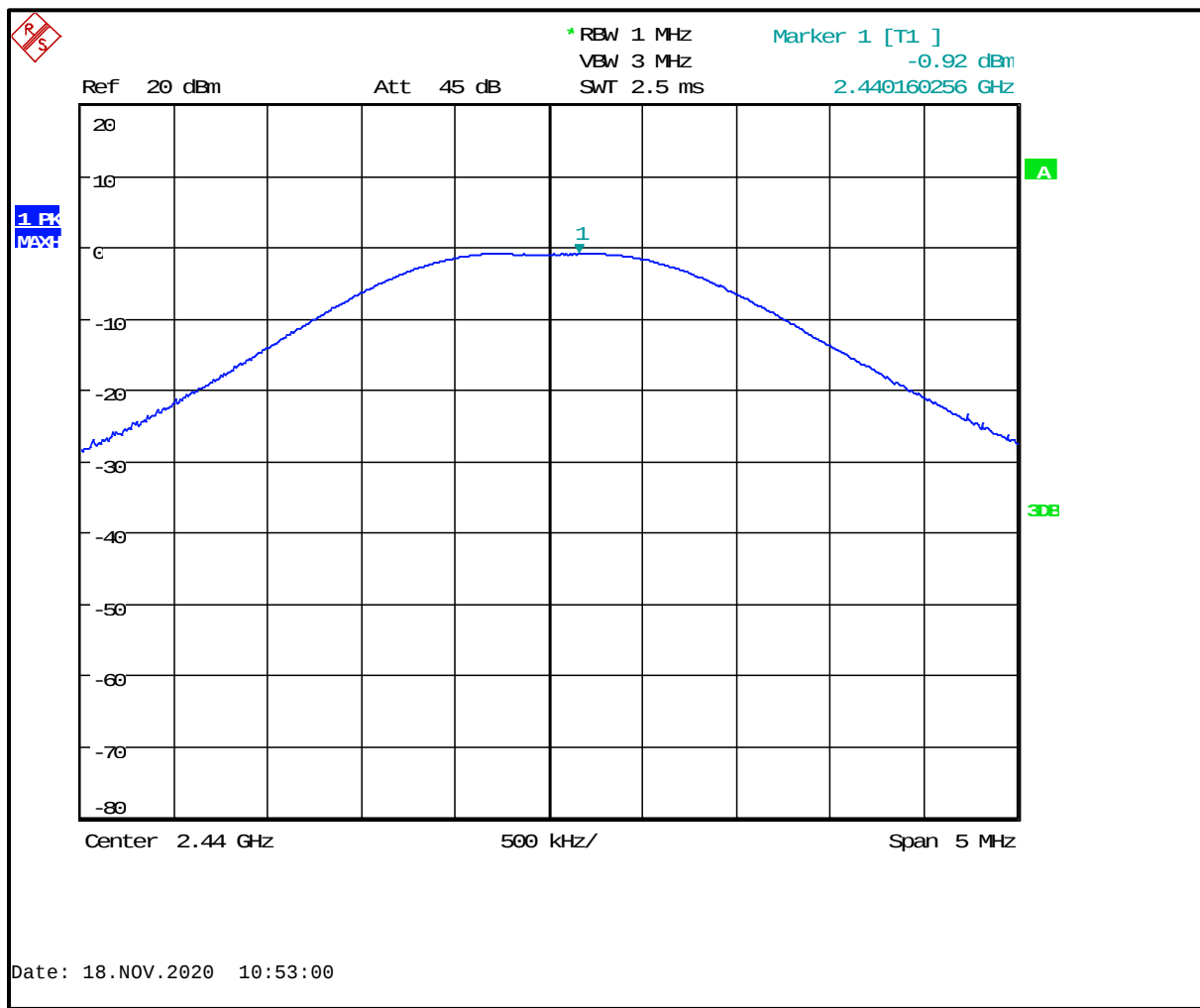
Table 3-2: Power Output Test Data

Frequency (MHz)	Conducted Power (dBm)
2402	-0.5
2440	-0.9
2480	-1.5

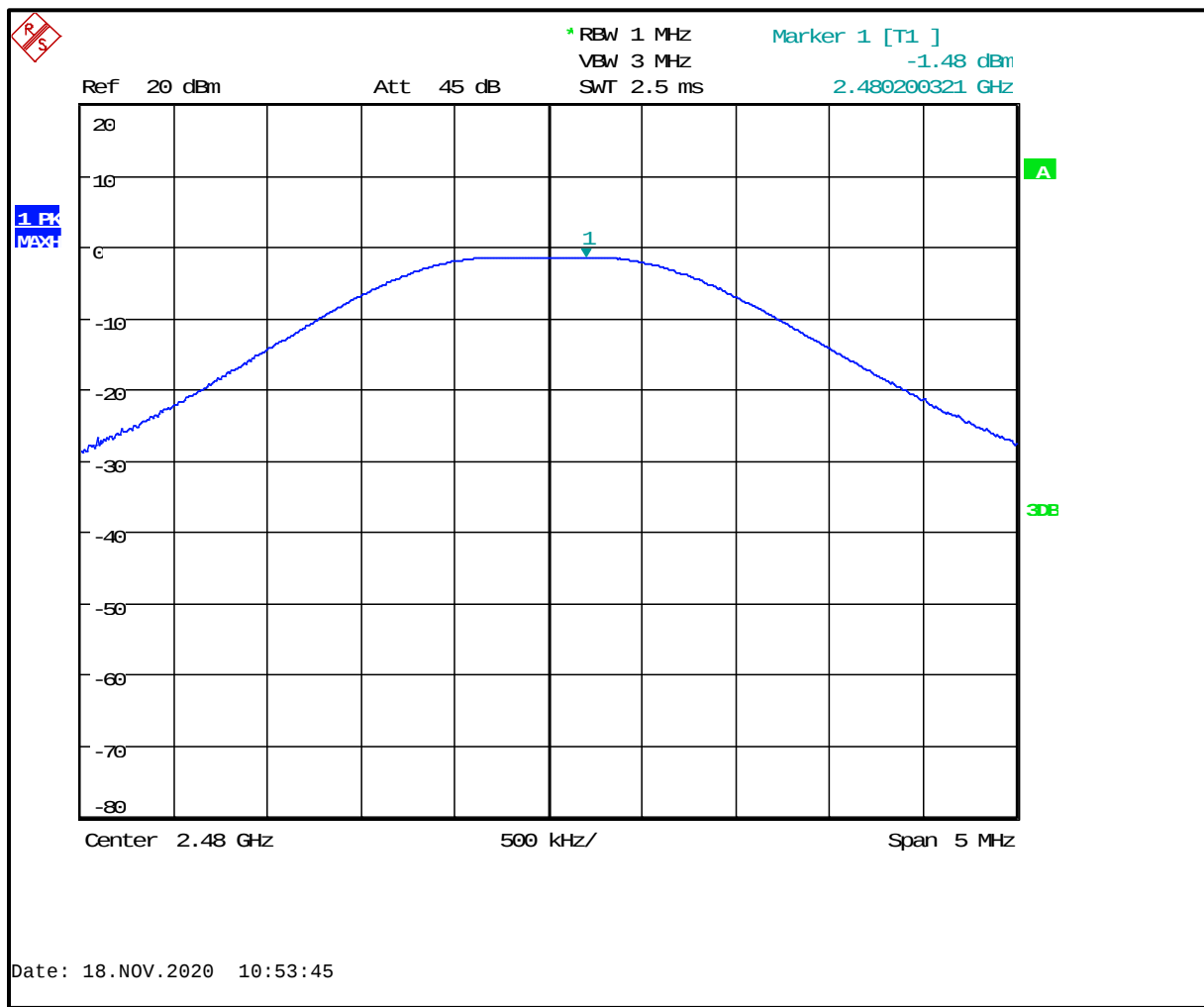
Plot 3-1: Maximum Conducted Output Power (2402 MHz)



Plot 3-2: Maximum Conducted Output Power (2440 MHz)



Plot 3-3: Maximum Conducted Output Power (2480 MHz)



Measurement uncertainties shown for these tests are expanded uncertainties expressed at the 95% confidence level using a coverage factor K=2. Measurement uncertainty: ± 0.5 dB

Results: Pass

Test Personnel:

Daniel W. Baltzell
 Test Engineer

Daniel W. Baltzell

Signature

November 18, 2020
 Date of Test

4 Band Edge Compliance of RF Conducted Emissions – FCC 15.247(d)

4.1 Band Edge Test Procedure

Procedure: C63.10-2013 11.13

The EUT was connected to the spectrum analyzer through suitable attenuation. The spectrum analyzer was set to the following:

Center Frequency: Frequency of the emissions to be measured
Span: 2 MHz
RBW: 100 kHz
VBW: 3 x RBW
Detector: Peak
Sweep: Auto
Trace: Max Hold

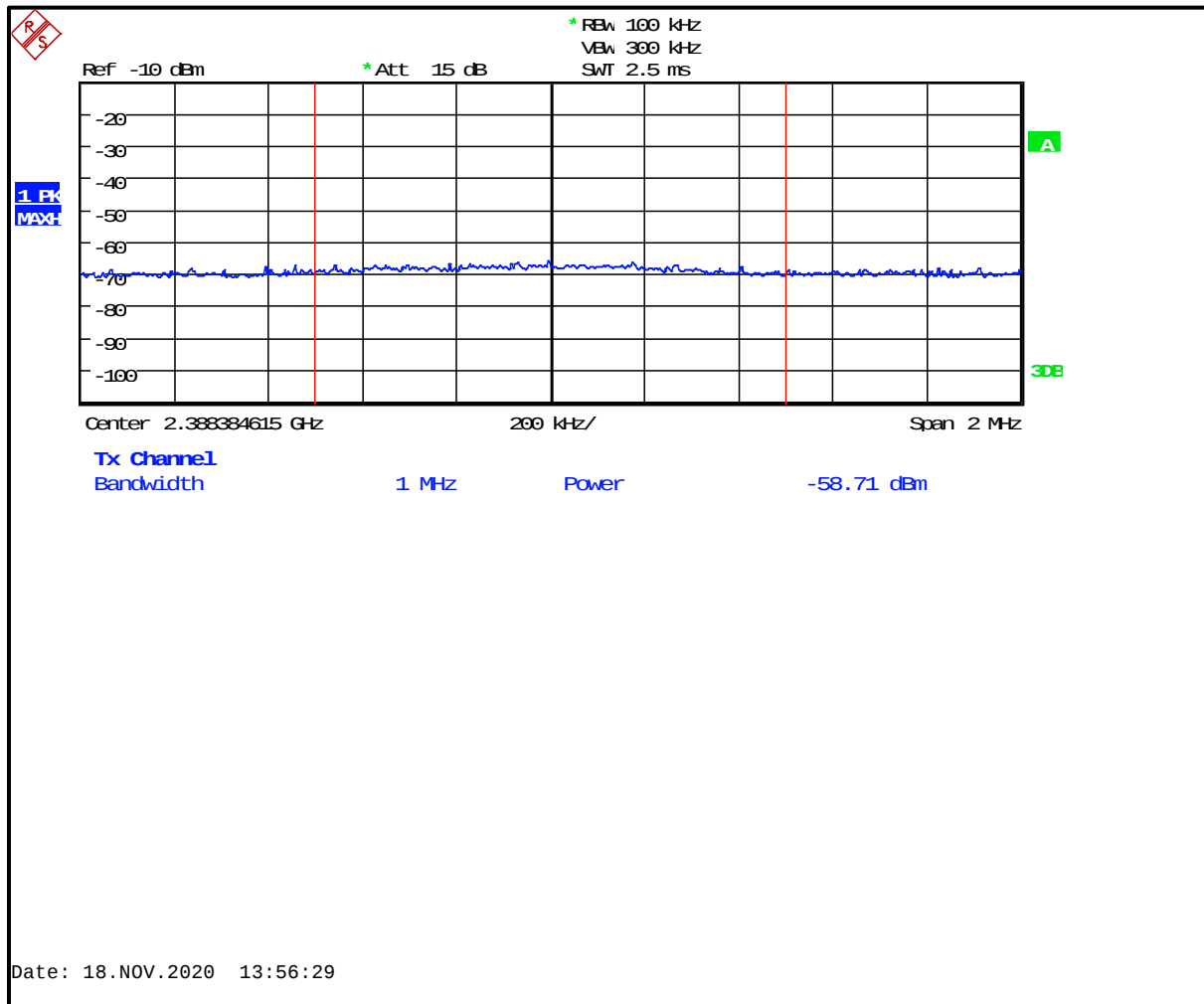
The trace was allowed to stabilize. The marker was set on the emission.

Table 4-1: Test Equipment

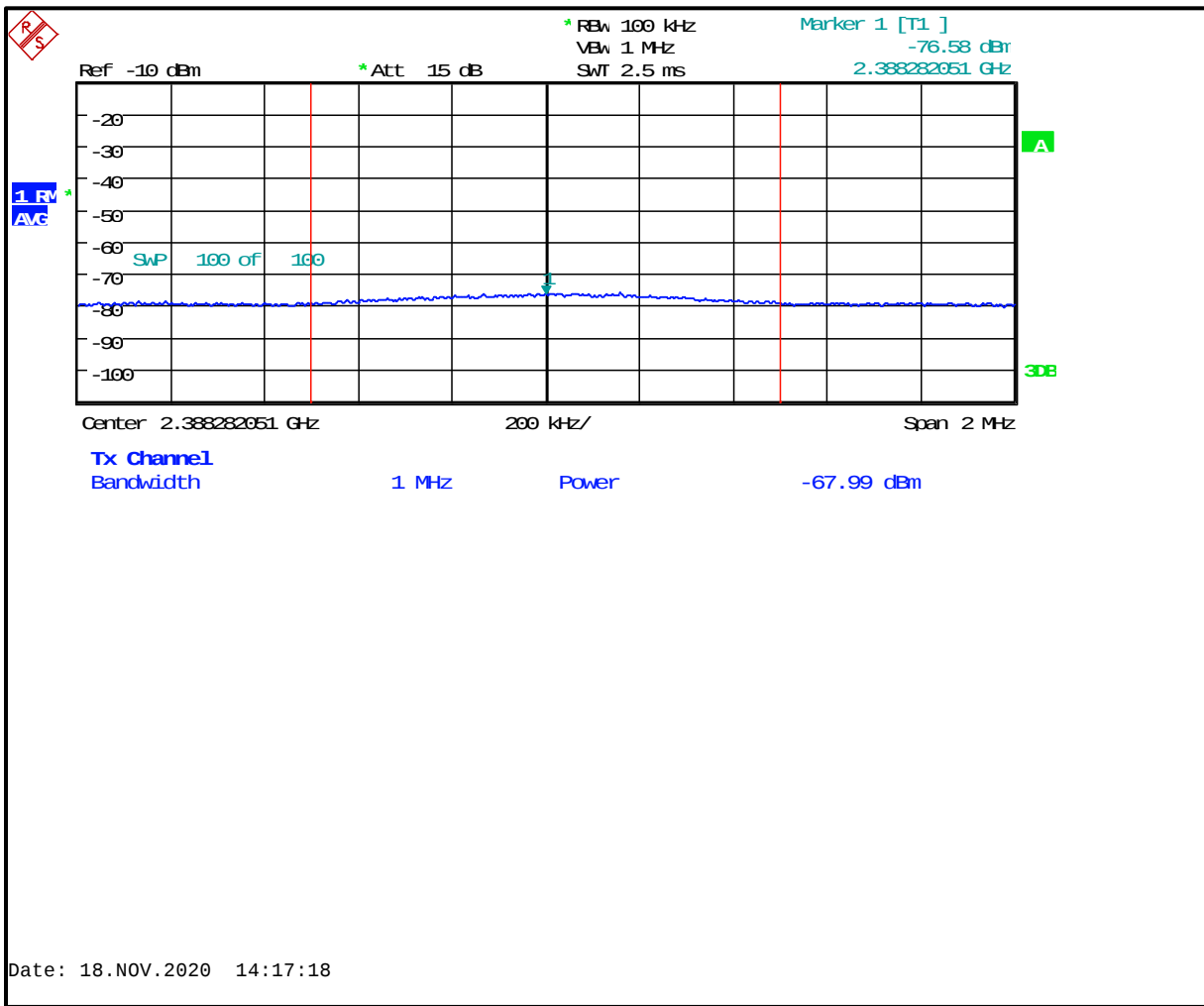
RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	4/26/21

4.2 Test Results

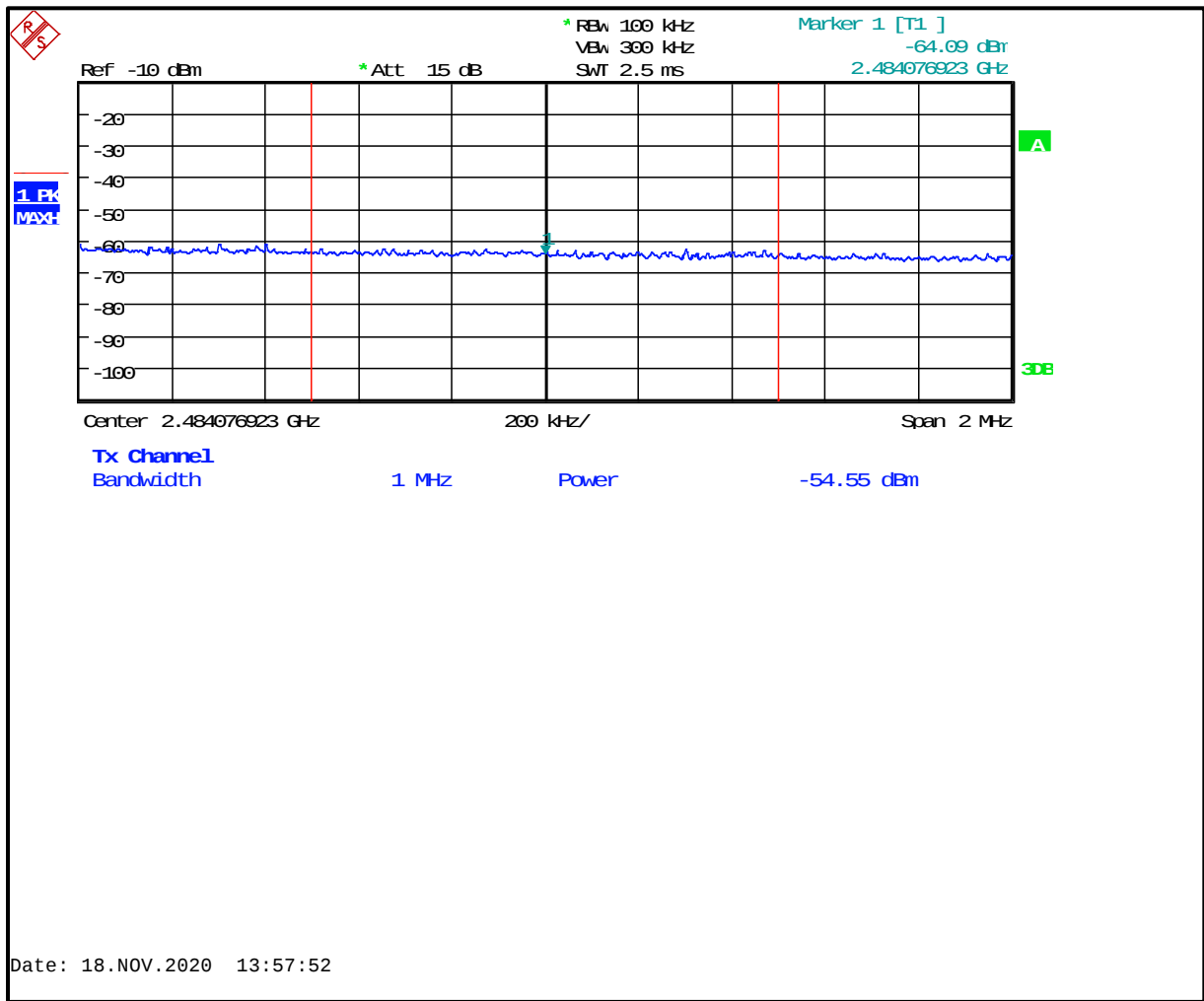
Plot 4-1: Lower Band Edge (Peak, 2402 MHz Carrier)



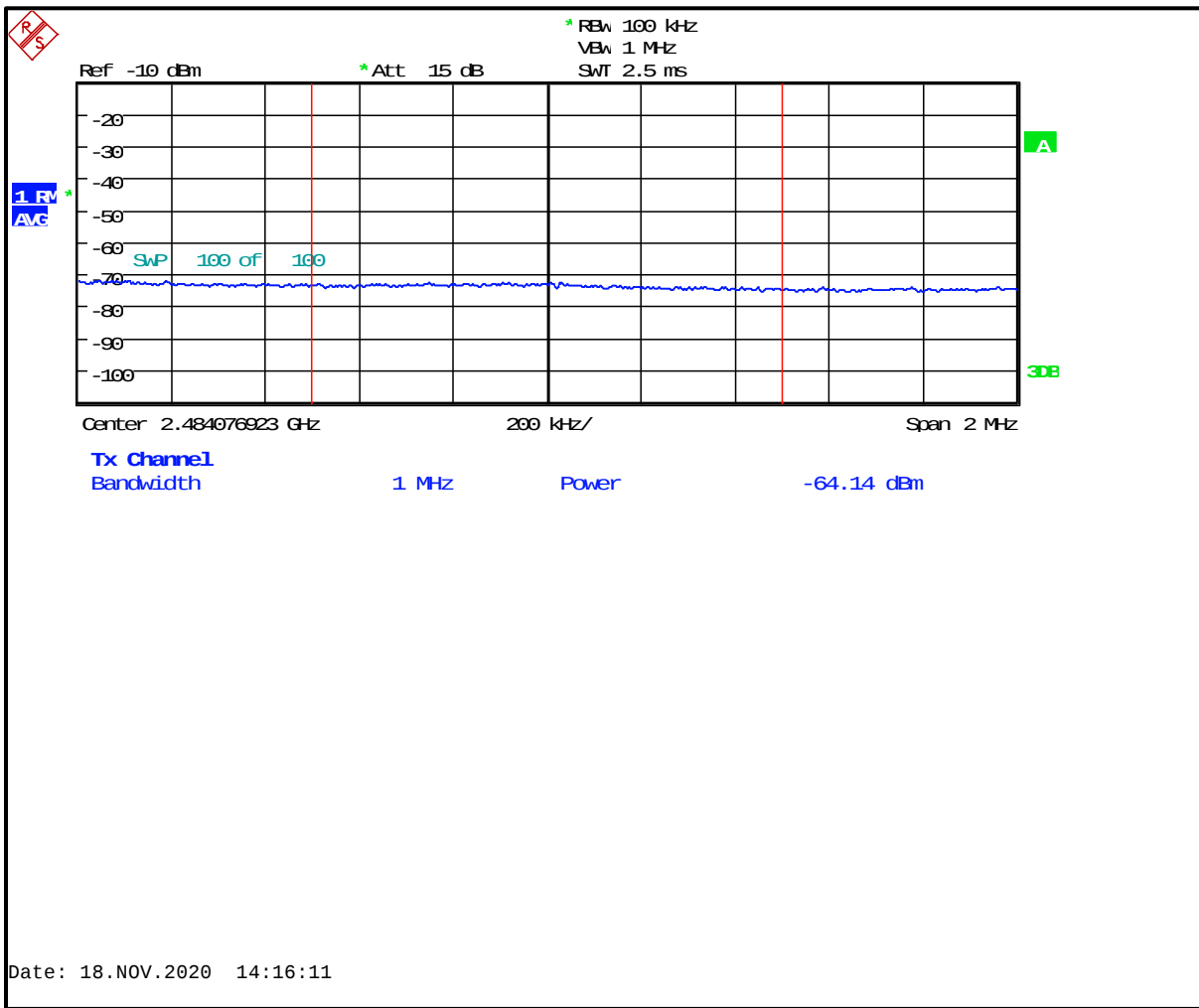
Plot 4-2: Lower Band Edge (Average, 2402 MHz Carrier)



Plot 4-3: Upper Band Edge (Peak, 2480 MHz Carrier)



Plot 4-4: Upper Band Edge (Average, 2480 MHz Carrier)



Measurement uncertainties shown for these tests are expanded uncertainties expressed at the 95% confidence level using a coverage factor K=2. Measurement uncertainty: ± 0.5 dB

Results: Pass

Test Personnel:

Daniel W. Baltzell
 Test Engineer

Signature

November 18, 2020
 Date of Test

5 Antenna Conducted Spurious Emissions – FCC 15.247(d)

5.1 Antenna Conducted Spurious Emissions Test Procedures

Procedure: C63.10-2013 11.12.2.

Antenna spurious emissions per FCC 15.247(d) were measured from the EUT antenna port using a 50-ohm spectrum analyzer with the resolution bandwidth set at 1 MHz, and the video bandwidth set at 3 MHz. The modulated carrier was identified at the following frequencies: 2402 MHz, 2440 MHz and 2480 MHz. The carrier to the 10th harmonic of the carrier frequency was investigated.

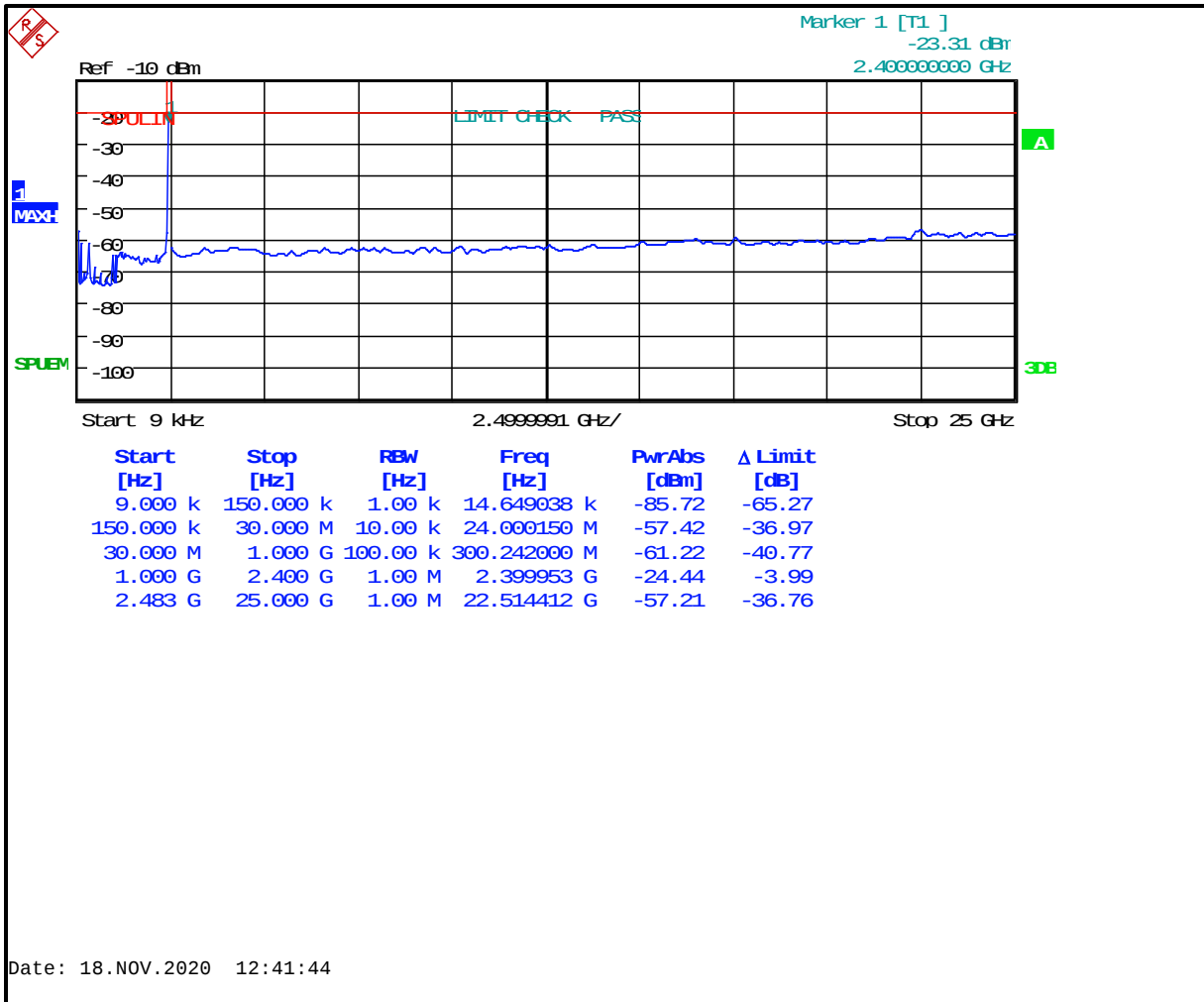
Table 5-1: Antenna Conducted Spurious Emissions Test Equipment

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	4/26/21

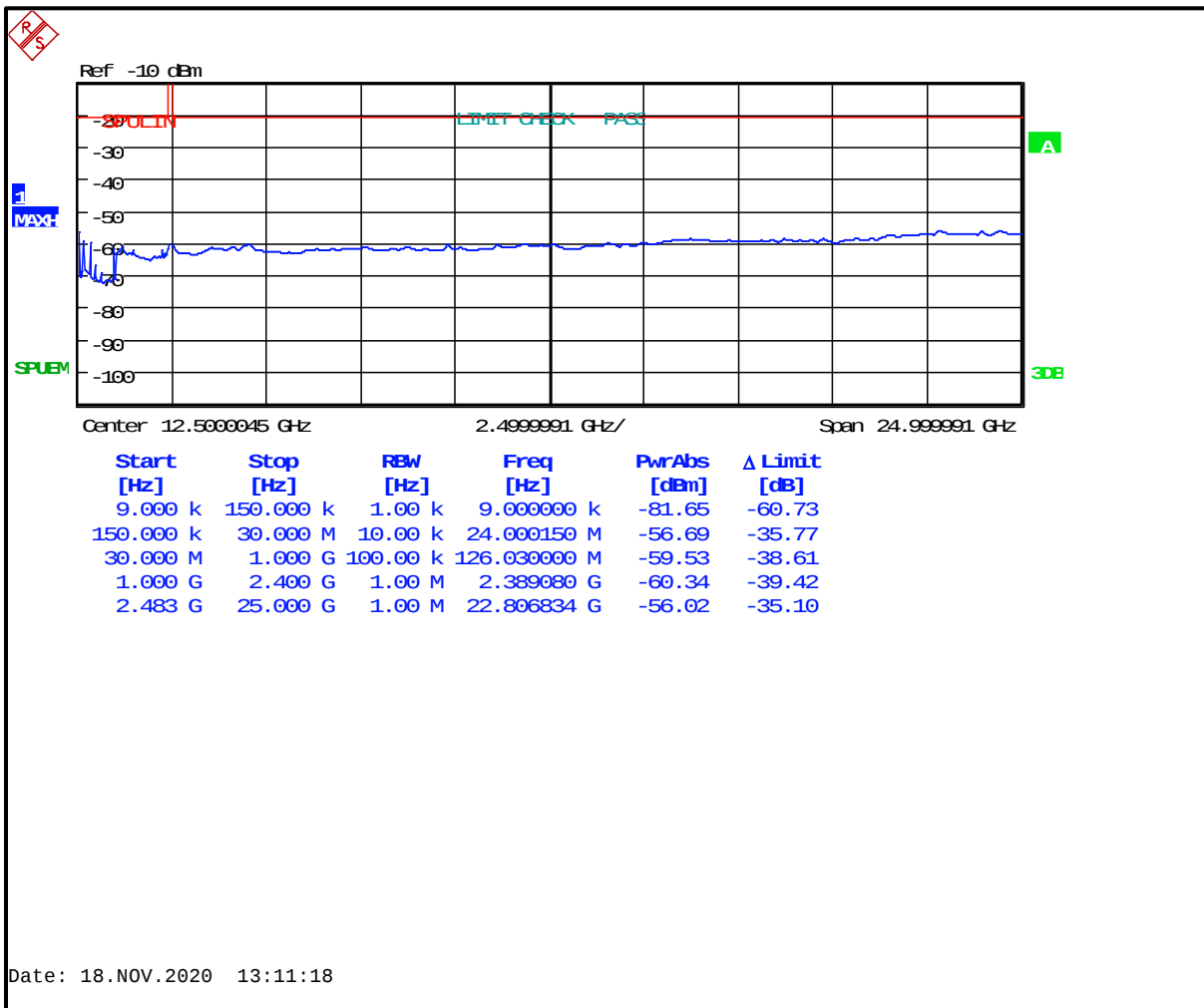
5.2 Antenna Conducted Spurious Emissions Test Results

All spurious emissions were greater than 20 dB below the limit.

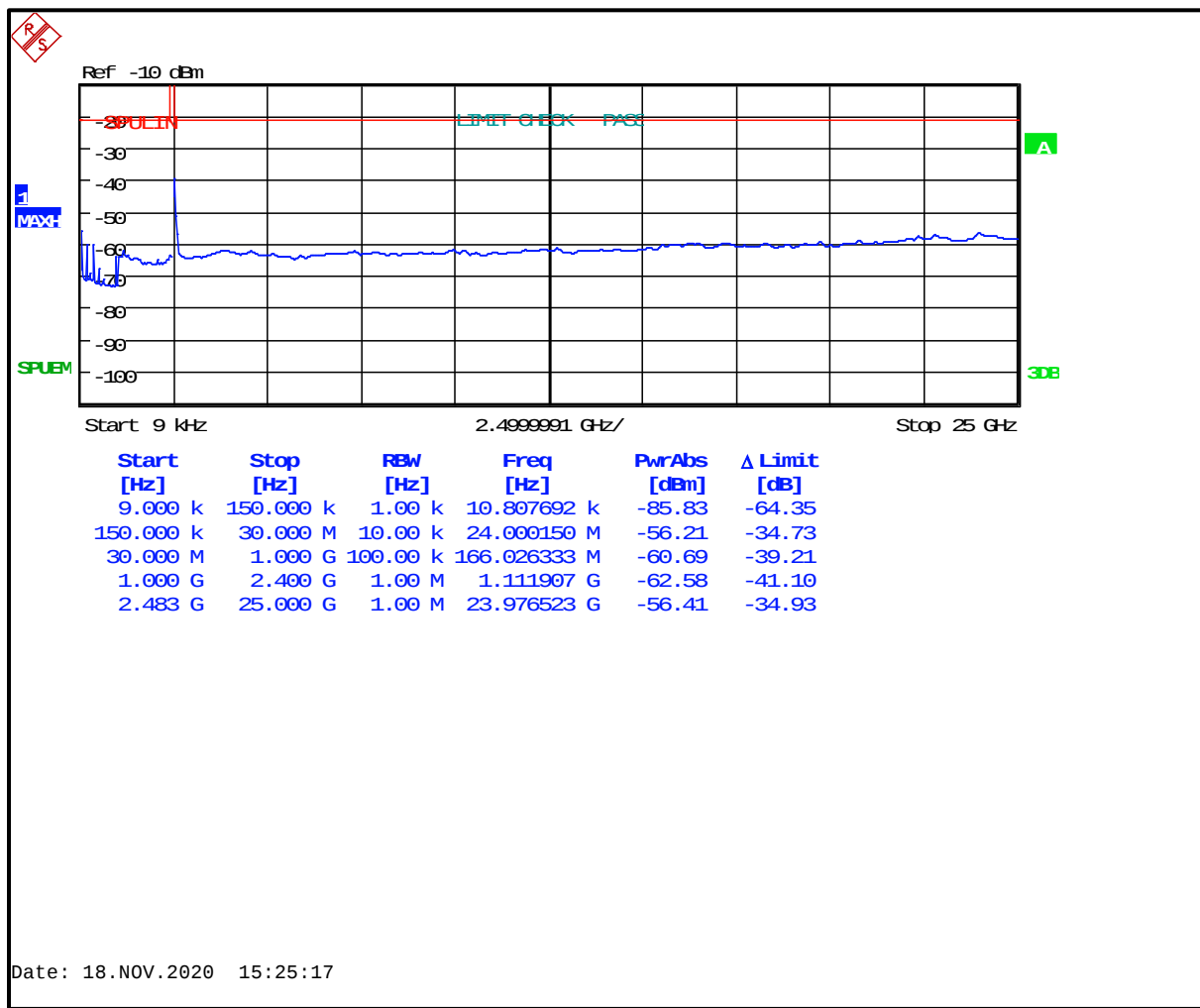
Plot 5-1: Antenna Conducted Spurious Emissions (2402 MHz)



Plot 5-2: Antenna Conducted Spurious Emissions (2440 MHz)



Plot 5-3: Antenna Conducted Spurious Emissions (2480 MHz)



Measurement uncertainties shown for these tests are expanded uncertainties expressed at the 95% confidence level using a coverage factor K=2. Measurement uncertainty: ± 0.5 dB

Results: Pass

Test Personnel:

Daniel W. Baltzell
Test Engineer

Signature

November 18, 2020
Date of Test

6 Bandwidth – FCC 15.247(a)(2)

6.1 Bandwidth Test Procedure

Procedure: C63.10-2013 11.8.

The minimum 6 dB bandwidths per FCC 15.247(a)(2) were measured using a 50-ohm spectrum analyzer with the resolution bandwidth set at 100 kHz, and the video bandwidth set at 300 kHz. The device was modulated. The minimum 6 dB bandwidths are presented below.

Table 6-1: 6 dB Bandwidth Test Equipment

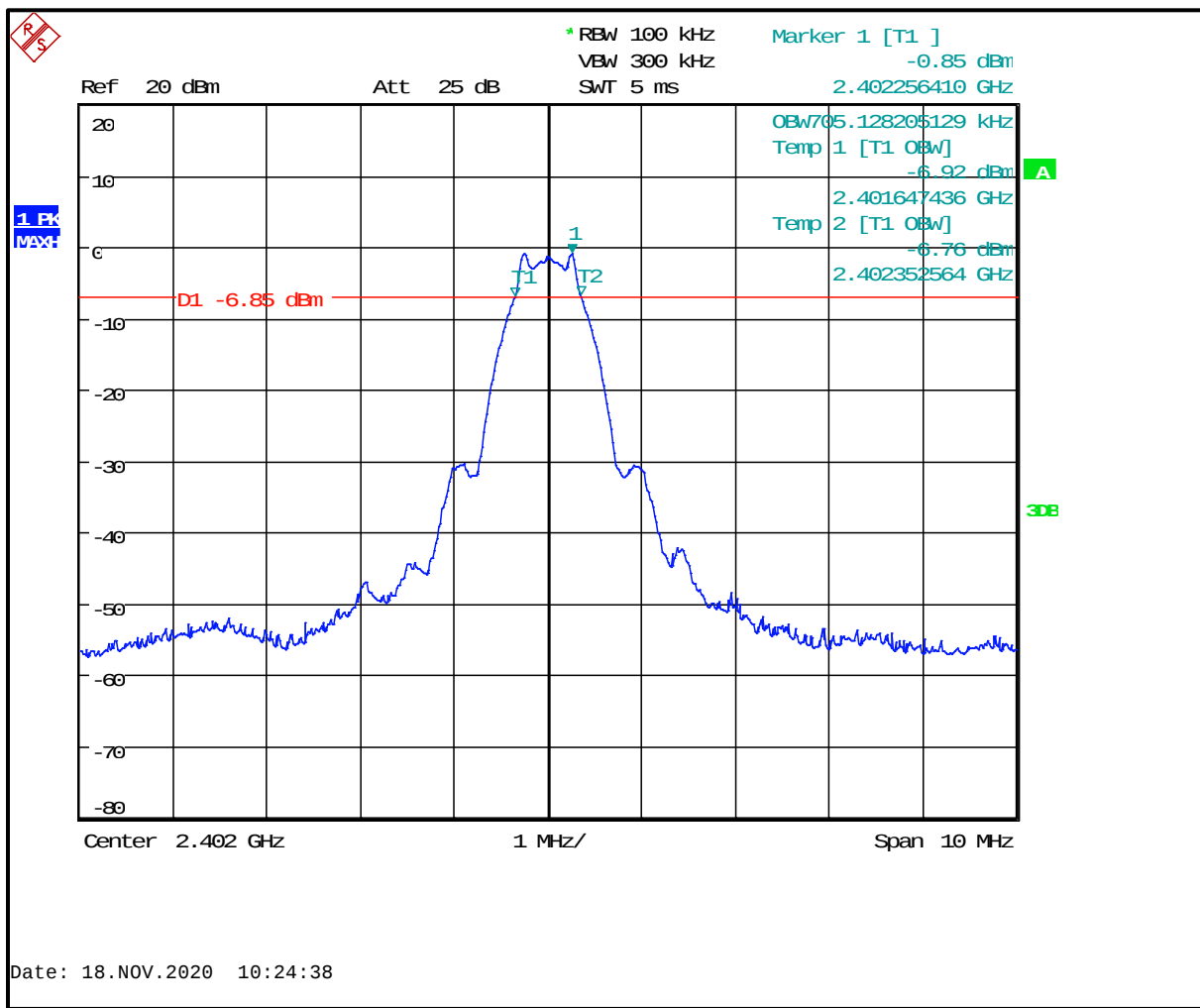
RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	4/26/21

6.2 Bandwidth Test Results

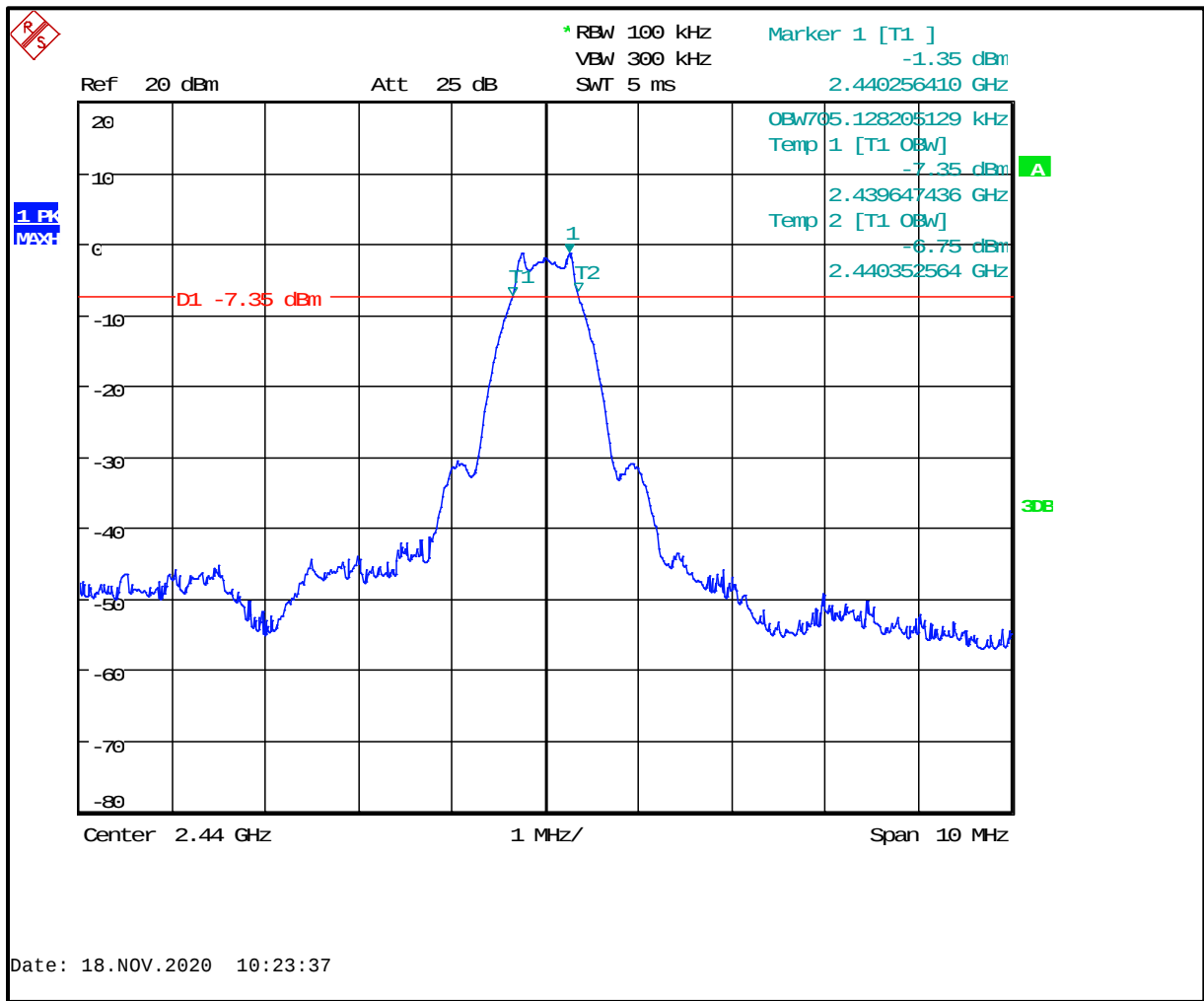
Table 6-2: 6 dB Bandwidth Test Data

Frequency (MHz)	Bandwidth (kHz)	Minimum Limit (kHz)	Pass/Fail
2402	705	500	Pass
2440	705	500	Pass
2480	705	500	Pass

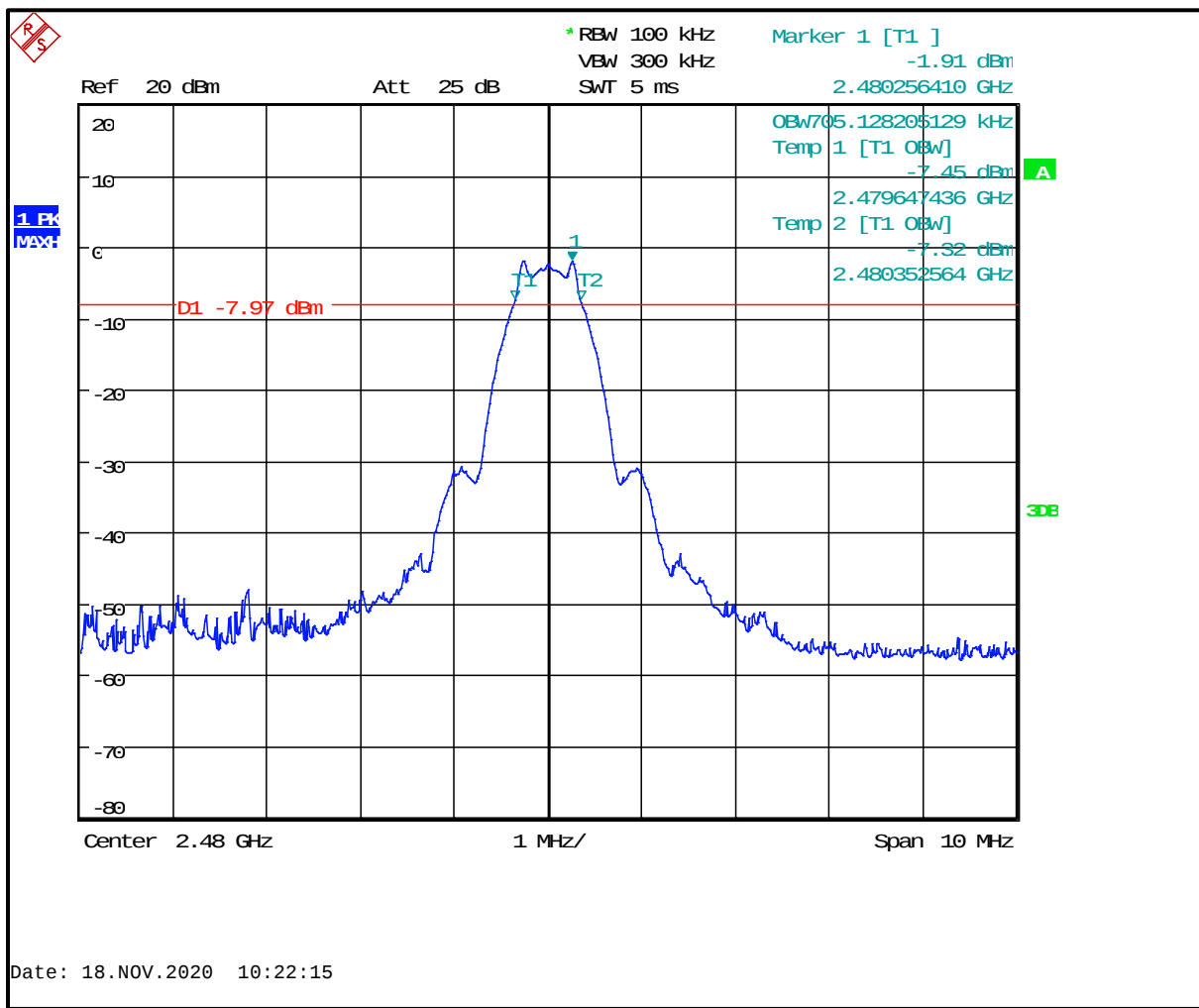
Plot 6-1: 6 dB Bandwidth – 2402 MHz



Plot 6-2: 6 dB Bandwidth – 2440 MHz



Plot 6-3: 6 dB Bandwidth – 2480 MHz



Measurement uncertainties shown for these tests are expanded uncertainty expressed at 95% confidence level using a coverage factor k=2. Measurement uncertainty $\pm 1.0 \times 10^{-6}$ Hz

Results: Pass

Test Personnel:

Daniel W. Baltzell
Test Engineer

Daniel W. Baltzell

Signature

November 18, 2020
Date of Test

7 Power Spectral Density – FCC 15.247(e)

7.1 Power Spectral Density Test Procedure

Procedure: C63.10-2013 11.10.2 Peak PSD

The power spectral density per FCC 15.247(e) was measured using a 50-ohm spectrum analyzer with the resolution bandwidth set at 3 kHz, the video bandwidth set at 10 kHz. RMS trace averaging over 100 sweeps was used to resolve the spectral density for the modulated carriers at 2402, 2440 and 2480 MHz. These levels are below the +8 dBm limit. See the power spectral density table and plots that follow.

Table 7-1: Power Spectral Density Test Equipment

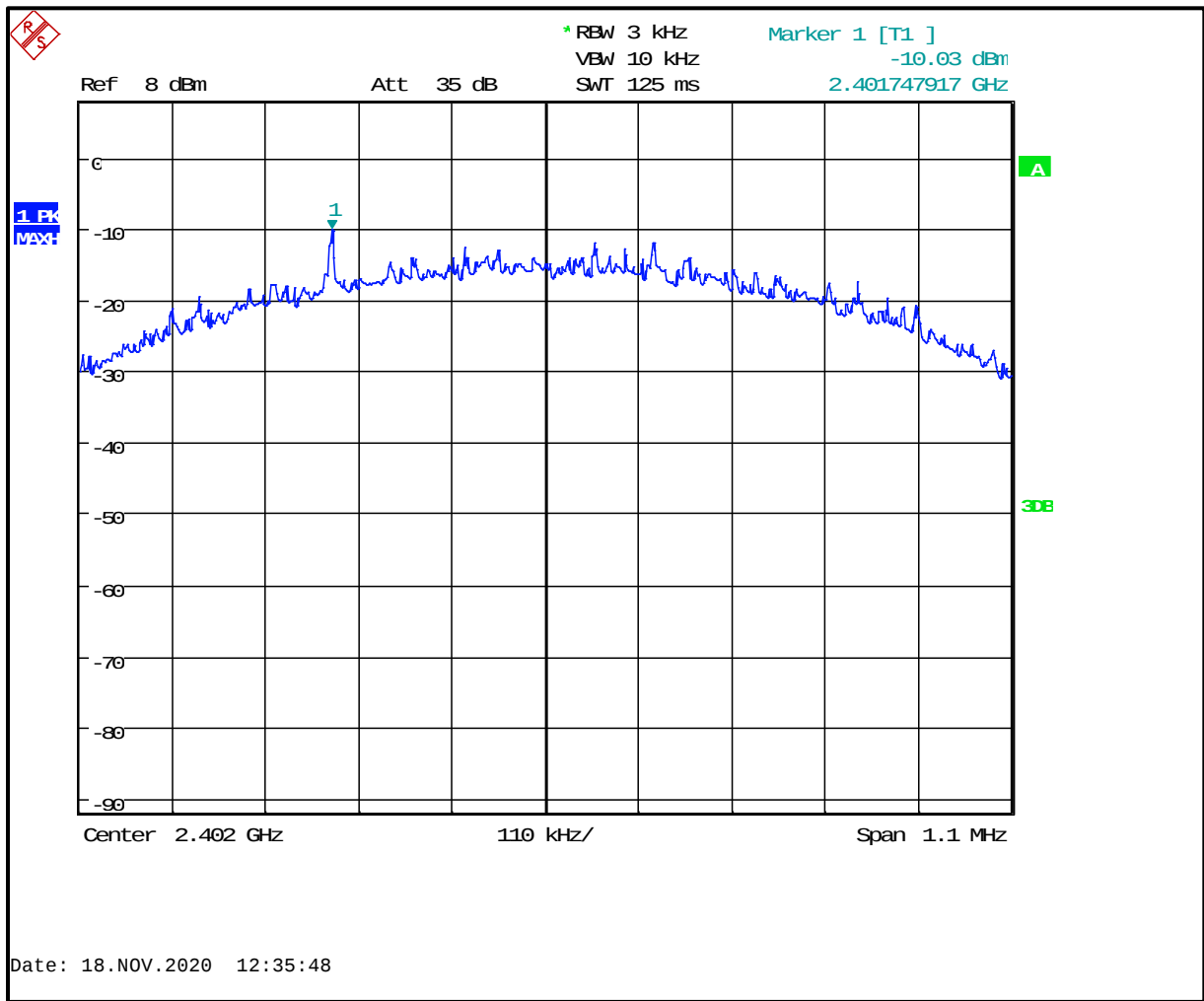
RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	4/26/21

7.2 Power Spectral Density Test Data

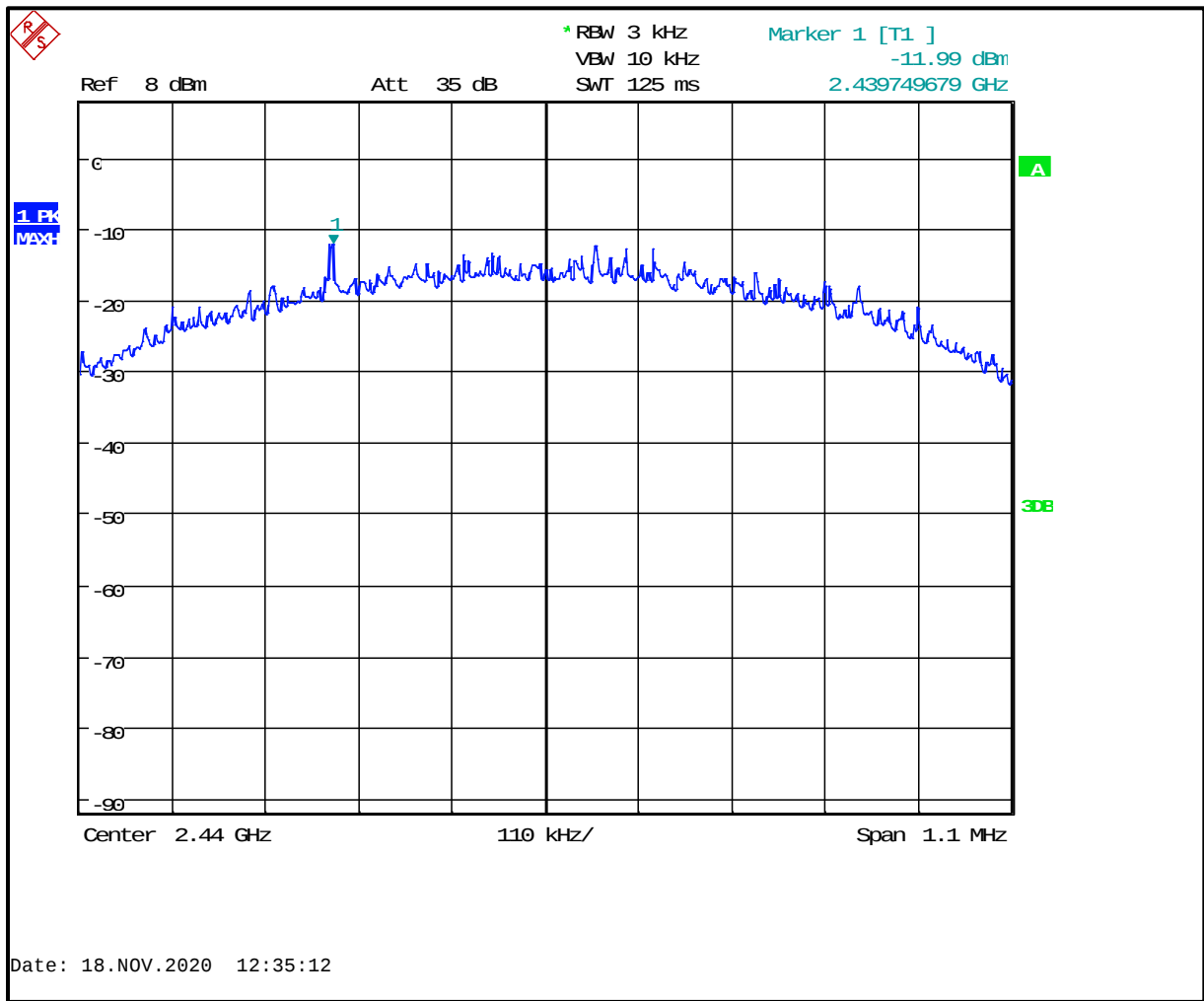
Table 7-2: Power Spectral Density Test Data

Frequency (MHz)	RF Power Level (dBm)	Maximum Limit +8 dBm	Pass/Fail
2402	-10.0	8	Pass
2440	-12.0	8	Pass
2480	-12.1	8	Pass

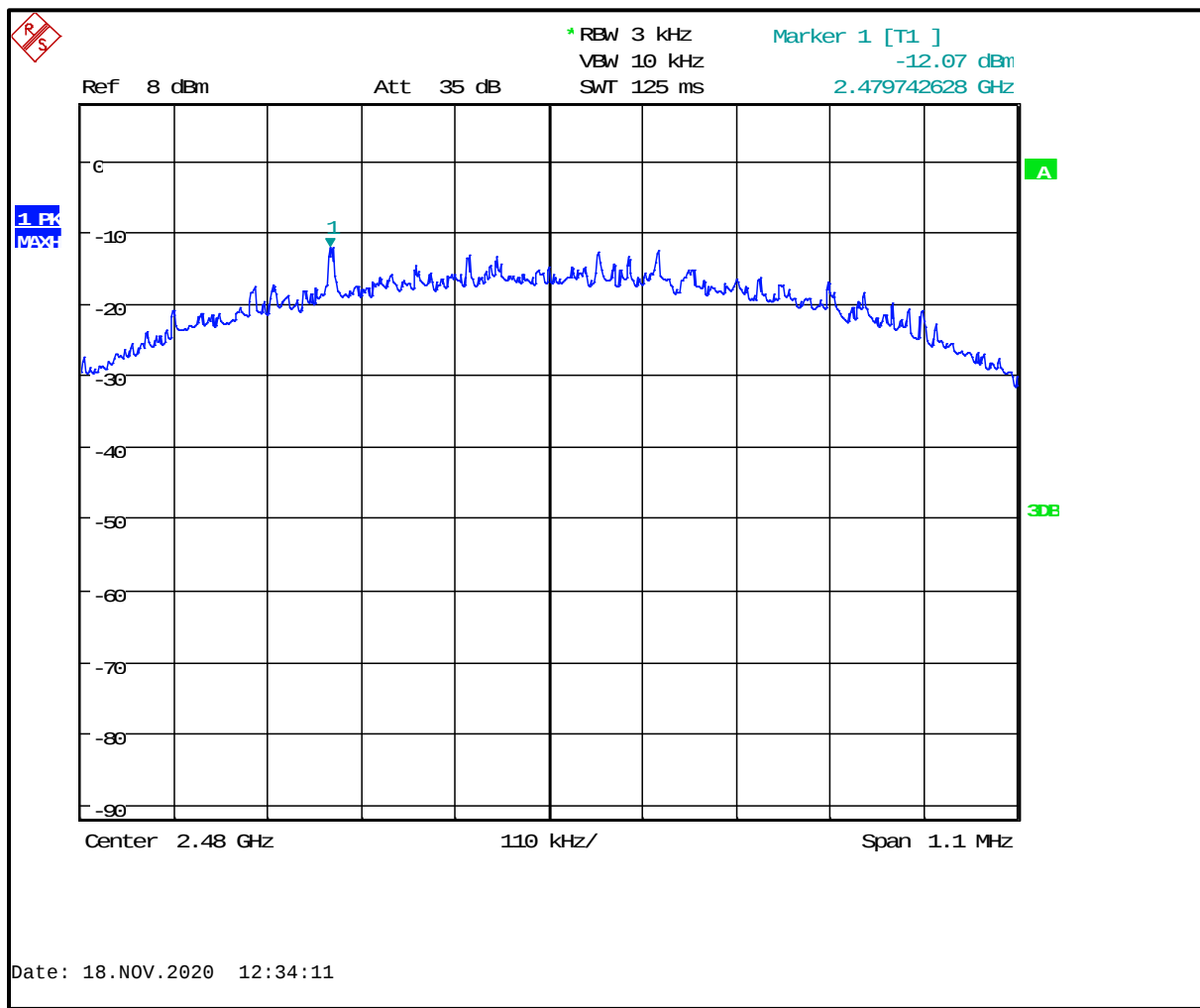
Plot 7-1: Power Spectral Density – 2402 MHz



Plot 7-2: Power Spectral Density – 2440 MHz



Plot 7-3: Power Spectral Density – 2480 MHz



Measurement uncertainties shown for these tests are expanded uncertainties expressed at the 95% confidence level using a coverage factor K=2. Measurement uncertainty: ± 0.5 dB

Results: Pass

Test Personnel:

Daniel W. Baltzell
 Test Engineer

Daniel W. Baltzell

Signature

November 18, 2020
 Date of Test

8 Conducted Emissions Measurement Limits – FCC 15.207

8.1 Limits of Conducted Emissions Measurement

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66-56	56-46
0.5-5.0	56	46
5.0-30.0	60	50

8.2 Conducted Emissions Measurement Test Procedure

Procedure: C63.10-2009 6.2

The power line conducted emission measurements were performed in a Series 81 type shielded enclosure manufactured by Rayproof. The EUT was assembled on a wooden table 80 centimeters high. Power was fed to the EUT through a 50-ohm / 50 micro Henry Line Impedance Stabilization Network (EUT LISN). The EUT LISN was fed power through an A.C. filter box on the outside of the shielded enclosure. The filter box and EUT LISN housing are bonded to the ground plane of the shielded enclosure. A second LISN, the peripheral LISN, provides isolation for the EUT test peripherals. This peripheral LISN was also fed A.C. power. A metal power outlet box, which is bonded to the ground plane and electrically connected to the peripheral LISN, powers the EUT host peripherals.

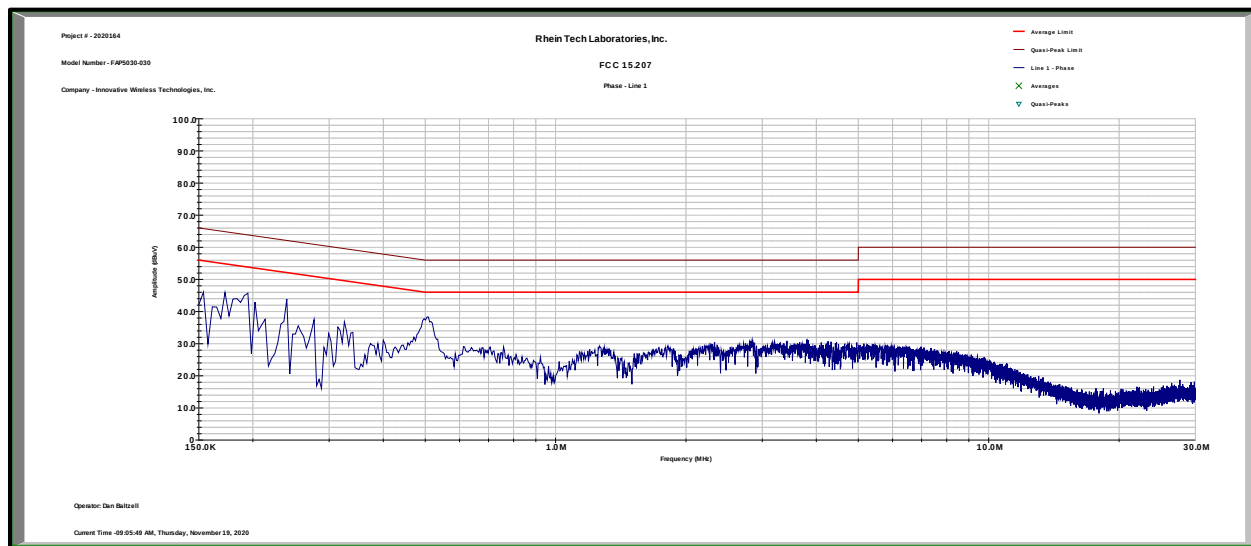
The spectrum analyzer was connected to the A.C. line through an isolation transformer. The 50-ohm output of the EUT LISN was connected to the spectrum analyzer input. Conducted emission levels were measured on each current-carrying line with the spectrum analyzer operating in the CISPR quasi-peak mode (or peak mode if applicable). The analyzer's 6 dB bandwidth was set to 9 kHz. No video filter less than 10 times the resolution bandwidth was used. Average measurements are performed in linear mode using a 10 kHz resolution bandwidth, a 1 Hz video bandwidth, and by increasing the sweep time in order to obtain a calibrated measurement. The emission spectrum was scanned from 150 kHz to 30 MHz. The highest emission amplitudes relative to the appropriate limit were measured and have been recorded in this report.

Table 8-1: Conducted Emissions Test Equipment

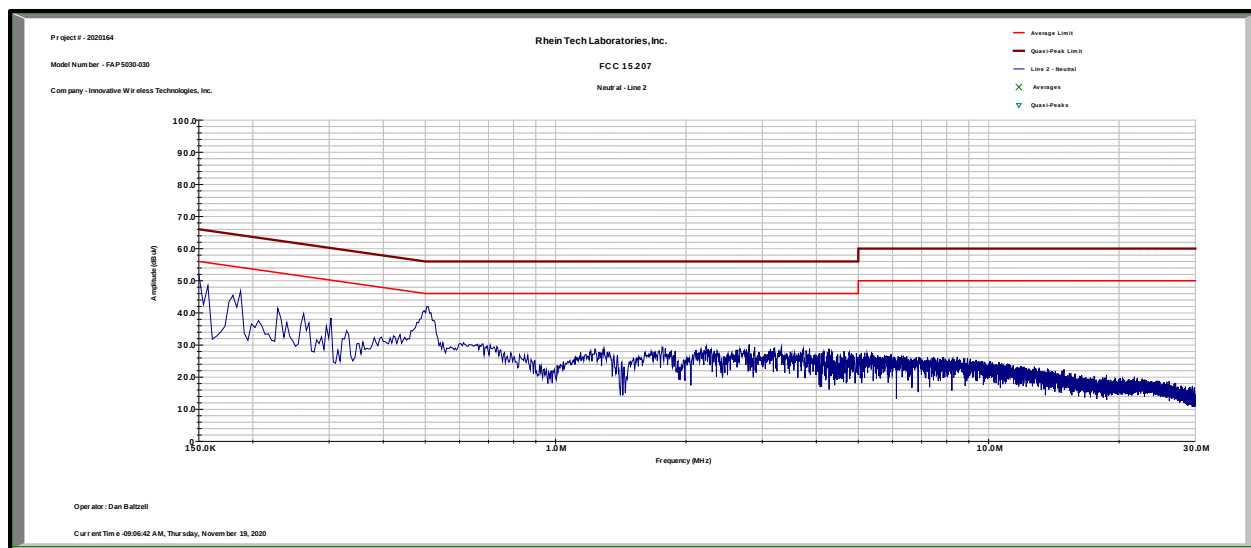
RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901083	AFJ International	LS16	16A LISN (110 V)	16010020080	2/13/21
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	4/26/21
900728	Solar	8130	Filter	947305	4/24/20

8.3 Conducted Line Emissions Test Data

Plot 8-1: Conducted Line Emissions – Phase



Plot 8-2: Conducted Line Emissions – Neutral



Measurement uncertainties shown for these tests are expanded uncertainties expressed at 95% confidence level using a coverage factor $k = 2$. Conducted Emissions: ± 3.6 dB

Results: Pass

Test Personnel:

Daniel W. Baltzell
EMC Test Engineer

Signature

November 19, 2020
Date of Test

9 Radiated Emissions – FCC 15.209

9.1 Limits of Radiated Emissions Measurement

Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
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

As shown in 15.35(b), for frequencies above 1000 MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20 dB under any circumstances of modulation.

9.2 Radiated Emissions Measurement Test Procedure

Procedure: C63.10-2013 11.11 and 11.12

Before final measurements of radiated emissions were made on the open-field three/ten meter range, the EUT was scanned indoors at one and three meter distances. This was done in order to determine its emissions spectrum signature. The physical arrangement of the test system and associated cabling was varied in order to determine the effect on the EUT's emissions in amplitude, direction and frequency. This process was repeated during final radiated emissions measurements on the open-field range, at each frequency, in order to ensure that maximum emission amplitudes were attained.

Final radiated emissions measurements were made on the three/ten-meter, open-field test site. The EUT was placed on a nonconductive turntable 0.8 meters above the ground plane. The spectrum was examined from 9 kHz to the 10th harmonic of the highest fundamental transmitter frequency (9 GHz).

At each frequency, the EUT was rotated 360°, and the antenna was raised and lowered from 1 to 4 meters in order to determine the emission's maximum level. Measurements were taken using both horizontal and vertical antenna polarizations. For frequencies between 30 and 1000 MHz, the spectrum analyzer's 6 dB bandwidth was set to 120 kHz, and the analyzer was operated in the CISPR quasi-peak detection mode. For emissions above 1,000 MHz, emissions are measured using the average detector function with a minimum resolution bandwidth of 1 MHz. No video filter less than 10 times the resolution bandwidth was used. The highest emission amplitudes relative to the appropriate limit were measured and recorded in this report.

Table 9-1: Radiated Emissions Test Equipment

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900878	Rhein Tech Laboratories, Inc.	AM3-1197-0005	3 meter antenna mast, polarizing	Outdoor Range 1	N/A
901729	Insulated Wire Inc.	KPS-1503-3150-KPR	SMK RF Cables 20'	NA	10/29/21
901242	Rhein Tech Laboratories, Inc.	WRT-000-0003	Wood rotating table	N/A	N/A
900772	EMCO	3161-02	Horn Antenna (2 - 4 GHz)	9804-1044	5/17/21
900321	EMCO	3161-03	Horn Antennas (4 – 8.2 GHz)	9508-1020	5/17/21
900323	EMCO	3160-7	Horn Antennas (8.2 – 12.4 GHz)	9605-1054	5/17/21
900356	EMCO	3160-08	Horn Antenna (12.4–18.0 GHz)	9607-1044	5/17/21
901218	EMCO	3160-09	Horn Antenna (18.0–26.5 GHz)	960281-003	5/5/21
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	4/26/21
901669	ETS-Lindgren	3142E	Biconilog Antenna (30 MHz – 6000 MHz)	00166065	4/24/22

9.3 Radiated Emissions Test Results

9.3.1 Radiated Emissions Unintentional

Table 9-2: Radiated Emissions Unintentional

Emission Frequency (MHz)	Detector Level (dBuV)	Site Correction Factor (dB/m)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
70.158	6.5	12.3	18.8	40.0	-21.2
96.557	16.6	12.8	29.4	43.5	-14.1
113.779	10.9	14.3	25.2	43.5	-18.3
144.583	12.4	15.1	27.5	43.5	-16.0
386.600	0.7	22.5	23.2	46.0	-22.8
408.654	7.0	24.3	31.3	46.0	-14.7
580.031	9.5	26.9	36.4	46.0	-9.6
1326.212	5.9	33.7	39.6	54.0	-14.4

NOTE: 120 kHz RBW/500 kHz VBW Quasi-Peak below 1 GHz; 1 MHz RBW/3 MHz VBW RMS detector above 1 GHz

9.3.2 Radiated Emissions Harmonics/Spurious

Table 9-3: Peak Radiated Emissions Harmonics/Spurious TX Frequency; 2402 MHz

Emission Frequency (MHz)	Peak Detector Level (dBuV) (1 MHz RBW/ 3 MHz VBW)	Site Correction Factor (dB/m)	Peak Emission Level (dBuV/m)	Peak Limit (dBuV/m)	Peak Margin (dB)
4804.0	14.4	33.9	48.3	74.0	-25.7
12010.0	13.7	43.9	57.6	74.0	-16.4
19216.0	5.7*	53.7	59.4	74.0	-14.6

Table 9-4: Average Radiated Emissions Harmonics/Spurious TX Frequency; 2402 MHz

Emission Frequency (MHz)	Average Detector Level (dBuV) (1 MHz RBW/ 3 MHz VBW)	Site Correction Factor (dB/m)	Average Emission Level (dBuV/m)	Average Limit (dBuV/m)	Average Margin (dB)
4804.0	4.3	33.9	38.2	54.0	-15.8
12010.0	2.4	43.9	46.3	54.0	-7.7
19216.0	-5.9*	53.7	47.8	54.0	-6.2

Table 9-5: Peak Radiated Emissions Harmonics/Spurious TX Frequency; 2440 MHz

Emission Frequency (MHz)	Peak Detector Level (dBuV) (1 MHz RBW/ 3 MHz VBW)	Site Correction Factor (dB/m)	Peak Emission Level (dBuV/m)	Peak Limit (dBuV/m)	Peak Margin (dB)
4880.0	14.0	34.0	48.0	74.0	-26.0
7320.0	13.6	36.5	50.1	74.0	-23.9
12200.0	13.7	43.7	57.4	74.0	-16.6
19520.0	6.5*	53.7	60.2	74.0	-13.8

Table 9-6: Average Radiated Emissions Harmonics/Spurious TX Frequency; 2440 MHz

Emission Frequency (MHz)	Average Detector Level (dBuV) (1 MHz RBW/ 3 MHz VBW)	Site Correction Factor (dB/m)	Average Emission Level (dBuV/m)	Average Limit (dBuV/m)	Average Margin (dB)
4880.0	4.5	34.0	38.5	54.0	-15.5
7320.0	2.0	36.5	38.5	54.0	-15.5
12200.0	2.7	43.7	46.4	54.0	-7.6
19520.0	-5.2	53.7	48.5	54.0	-5.5

Table 9-7: Peak Radiated Emissions Harmonics/Spurious TX Frequency; 2480 MHz

Emission Frequency (MHz)	Peak Detector Level (dBuV) (1 MHz RBW/ 3 MHz VBW)	Site Correction Factor (dB/m)	Peak Emission Level (dBuV/m)	Peak Limit (dBuV/m)	Peak Margin (dB)
4960.0	14.9	34.2	49.1	74.0	-24.9
7440.0	12.9	36.7	49.6	74.0	-24.4
12400.0	13.9	47.1	61.0	74.0	-13.0
19840.0	6.3*	53.9	60.2	74.0	-13.8
22320.0	5.2*	54.9	60.1	74.0	-13.9

Table 9-8: Average Radiated Emissions Harmonics/Spurious TX Frequency; 2480 MHz

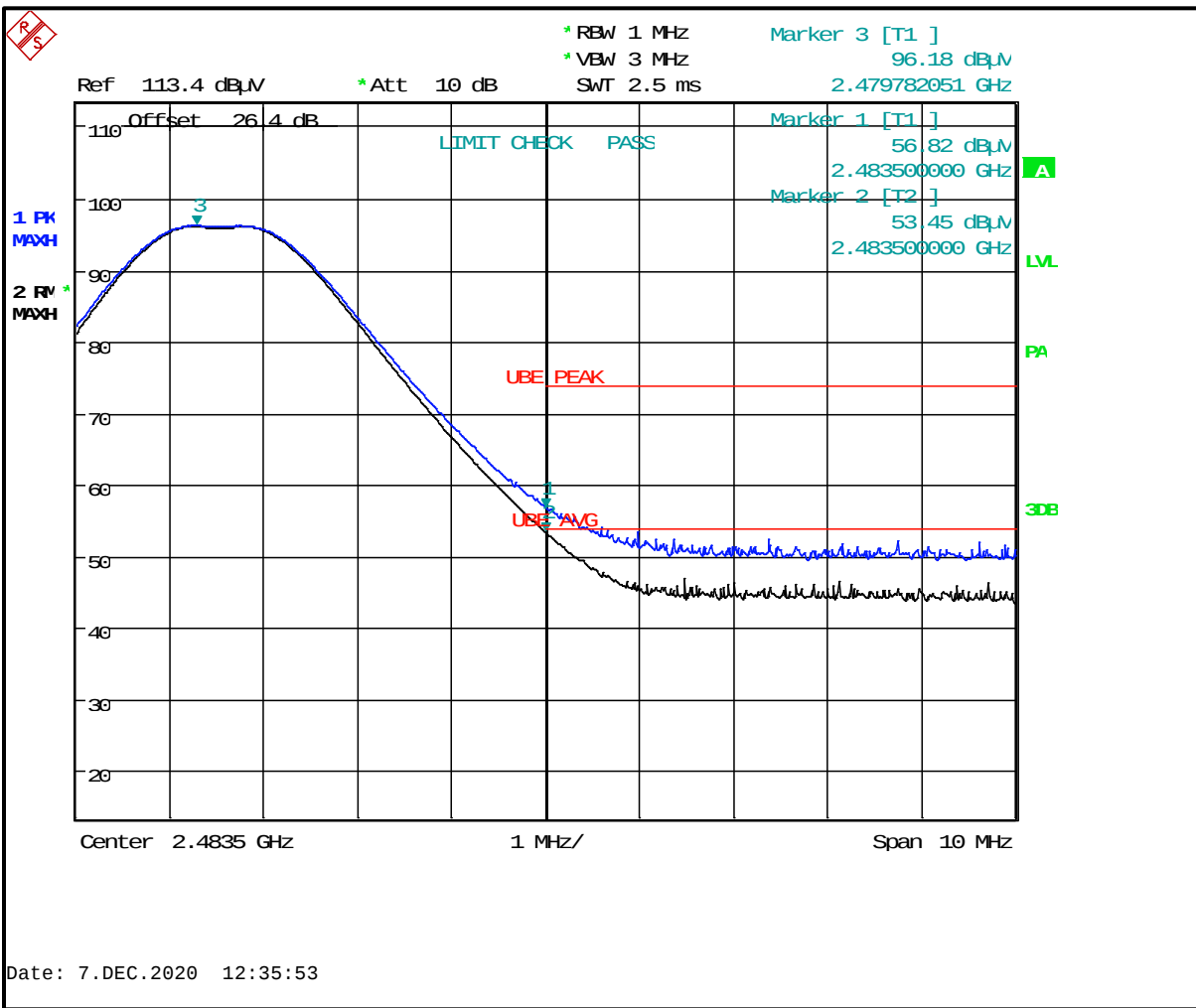
Emission Frequency (MHz)	Average Detector Level (dBuV) (1 MHz RBW/ 3 MHz VBW)	Site Correction Factor (dB/m)	Average Emission Level (dBuV/m)	Average Limit (dBuV/m)	Average Margin (dB)
4960.0	3.9	34.2	38.1	54.0	-15.9
7440.0	1.6	36.7	38.3	54.0	-15.7
12400.0	2.5	47.1	49.6	54.0	-4.4
19840.0	-5.2*	53.9	48.7	54.0	-5.3
22320.0	-6.0*	54.9	48.9	54.0	-5.1

*Measurements interpolated from 1m distance.

Radiated emissions were investigated with the BLE transceiver and the modularly approved Wi-Fi transceiver (FCC ID: 2AJVP-OMEGA2) transmitting simultaneously. No non-compliant emissions were found; per FCC guidance, no data is being reported.

Measurement uncertainty: ± 4.6 dB. This measurement uncertainty is an expanded uncertainty for 95% confidence level received with a coverage factor $k=2$

Plot 9-1: Restricted Upper Band Edge (Peak and Average, 2480 MHz Carrier)



Results: Pass

Test Personnel:

Daniel W. Baltzell
EMC Test Engineer

Daniel W. Baltzell

Signature

November 19-23,
December 7, 2020
Dates of Test

10 Conclusion

The data in this measurement report shows the Innovative Wireless Technologies, Inc. Model # FAP5030-030, Indoor Location Beacon (ILB), FCC ID: SP8-FAP5030030, complies with the applicable requirements of Parts 2 and 15 of the FCC rules and regulations.