Test Report

Prepared for: Ink-U-Beta AG

Model: SUN02

Description: Wearable UV Tracker

Serial Number: N/A

FCC ID: 2BA7X-SUN02
IC: 30629-SUN02

To

FCC Part 15.247
And
IC RSS-247

Date of Issue: June 23, 2023

On the behalf of the applicant:	**Ink-U-Beta AG** **Gubelstrasse 7** **Zug, ZUG, 6300 Switzerland**
Attention of:	**Samuel Welten** **Ph: +41787617929** **E-mail: samuel.welten@ink-u-beta.com**

Prepared By
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Project No: p2340013

Test Result: PASS

John Michalowicz
Project Test Engineer
Reviewed By

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All results contained herein relate only to the sample tested.

Test Summary

FCC 15.247 Specification	RSS-247 Specification	Test Name	Pass, Fail, N/A	Comments
15.247(b)	Section 5.4(d)	Output Power	Pass	
15.247(d)	Section 5.5	Conducted Spurious Emissions	N/A	EUT does not have a conducted port
15.247(d), 15.209(a), 15.205	Section 5.5	Radiated Spurious Emissions	Pass	
15.247(d), 15.209(a), 15.205	Section 5.5	Emissions At Band Edges	Pass	
15.247(a)(2)	Sections 5.2(a)	Occupied Bandwidth	Pass	
15.247(e)	Section 5.2(b)	Transmitter Power Spectral Density	Pass	
15.207	RSS-GEN Section 8.8	A/C Powerline Conducted Emissions	N/A	EUT is a solar powered device

Statements of conformity are reported as:

- Pass - the measured value is below the acceptance limit, *acceptance limit = test limit*.
- Fail - the measured value is above the acceptance limit, *acceptance limit = test limit*.

References	Description
CFR47, Part 15, Subpart B	Unintentional Radiators
CFR47, Part 15, Subpart C	Intentional Radiators
ANSI C63.10-2013	American National standard for testing Unlicensed Wireless Devices
ANSI C63.4-2014	Method and Measurements of Radio-Noise Emissions from low-Voltage Electrical and Electronic Equipment in the range 9kHz to 40GHz.
ISO/IEC 17025:2005	General requirements for the Competence of Testing and Calibrations Laboratories
KDB 558074 D01 v04	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating under §15.247

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	6/22/23	John Michalowicz	Original Document
2.0	7/12/23	John Michalowicz	Updated page 7 to show 100% duty cycle Updated output power to show conducted output power Added worst case spurious emission to page 10
3.0	7/321/23	John Michalowicz	Added plots for Power

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ANAB

Compliance Testing, LLC, has been accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to the joint ISO-ILAC-IAF Communiqué dated January 2009).

The tests results contained within this test report all fall within our scope of accreditation.

Please refer to http://www.compliancetesting.com/labscope.html for current scope of accreditation.

FCC Site Reg. #349717

IC Site Reg. #2044A-2

The applicant has been cautioned as to the following

15.21 - Information to User

The user's manual or instruction manual for an intentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

15.27(a) - Special Accessories

Equipment marked to a consumer must be capable of complying with the necessary regulations in the configuration in which the equipment is marketed. Where special accessories, such as shielded cables and/or special connectors are required to enable an unintentional or intentional radiator to comply with the emission limits in this part, the equipment must be marketed with, i.e. shipped and sold with, those special accessories. However, in lieu of shipping or packaging the special accessories with the unintentional or intentional radiator, the responsible party may employ other methods of ensuring that the special accessories are provided to the consumer without an additional charge.

Information detailing any alternative method used to supply the special accessories for a grant of equipment authorization or retained in the verification records, as appropriate. The party responsible for the equipment, as detailed in § 2.909 of this chapter, shall ensure that these special accessories are provided with the equipment. The instruction manual for such devices shall include appropriate instructions on the first page of text concerned with the installation of the device that these special accessories must be used with the device. It is the responsibility of the user to use the needed special accessories supplied with the equipment.

Standard Test Conditions Engineering Practices

Except as noted herein, the following conditions and procedures were observed during the testing:

In accordance with ANSI C63.10-2013 and unless otherwise indicated in the specific measurement results, the ambient temperature of the actual EUT was maintained within the range of 10° to 40°C (50° to 104°F) unless the particular equipment requirements specified testing over a different temperature range. Also, unless otherwise indicated, the humidity levels were in the range of 10% to 90% relative humidity.

Measurement results, unless otherwise noted, are worst-case measurements.

Environmental Conditions		
Temperature (ºC)	**Humidity (%)**	**Pressure (mbar)**
24.3 – 26.3	24.4 – 26.9	966

EUT Description
Model: SUN02
Description: Wearable UV Tracker
Firmware: N/A
Software: N/A
Serial Number: N/A
Additional Information: The EUT is a wearable UV tracker which communicates data wirelessly to a user's personal device via BLE 2.4 GHz technology.

EUT Operation during Tests: 3 different samples were provided by the manufacturer. These were set to max power with a modulated signal with each sample set to 2402 MHz, 2440 MHz and 2480 MHz. The EUT is normal powered via a onboard solar cell and a supercapacitor but in order to TX continuously at 100% duty cycle, leads were attached to the board and 3.2v was applied using a DC power supply.

Accessories: None

Cables: None

Modifications: None

15.203: Antenna Requirement:

X	The antenna is permanently attached to the EUT
	The antenna uses a unique coupling
	The EUT must be professionally installed
	The antenna requirement does not apply

Output Power

Engineer: John Michalowicz

Test Date: 6/21/23

Test Procedure

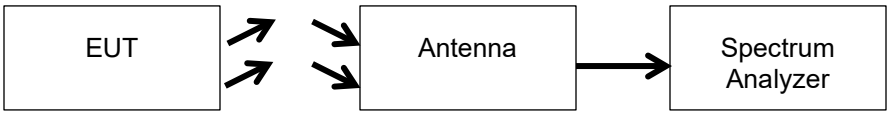
The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was set to transmit on the lowest, middle and highest frequency of operation at the maximum power level. The EUT was tested, in 3 orthogonal axis, by rotating it 360° with the receive antenna in both the vertical and horizontal orientation while raised from 1 to 4 meters to ensure the TX signal levels were maximized. A spectrum analyzer was used to verify that the EUT met the requirements for Output Power. A distance correction of 9.54 dB was added to the measurement to reflect EIRP.
The peak antenna gain, stated by the manufacturer, is 0 dBi.

The Spectrum Analyzer was set to the following:

RBW ≥ DTS Bandwidth
VBW ≥ 3 x RBW
Span ≥ 3 x RBW
Sweep time = auto couple
Detector = peak
Trace Mode = max hold

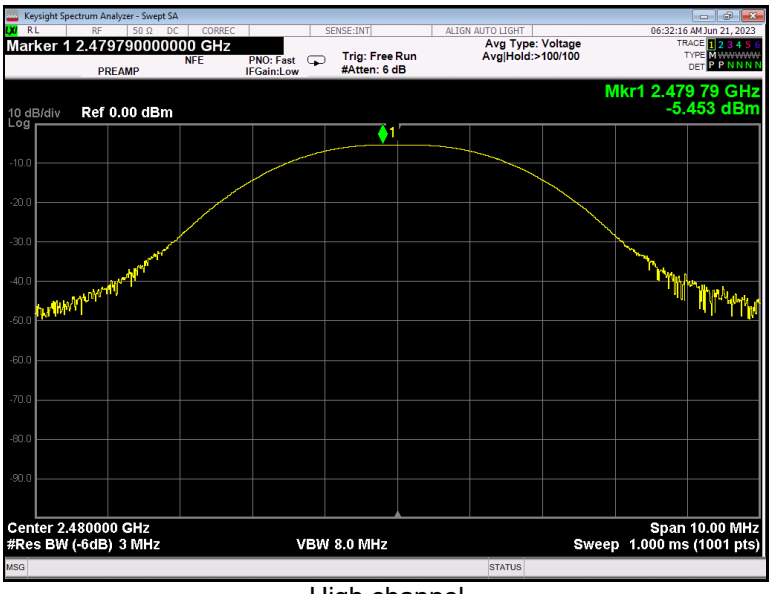
The RF output power was measured using the spectrum analyzer's marker peak function.

Test Setup

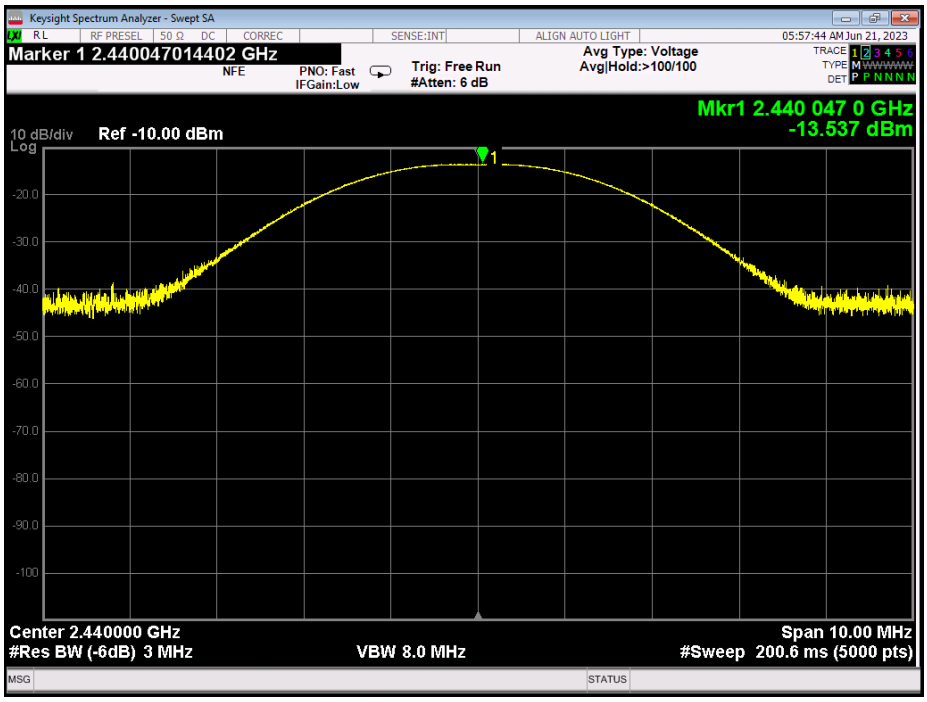


Transmitter Output Power Summary Table

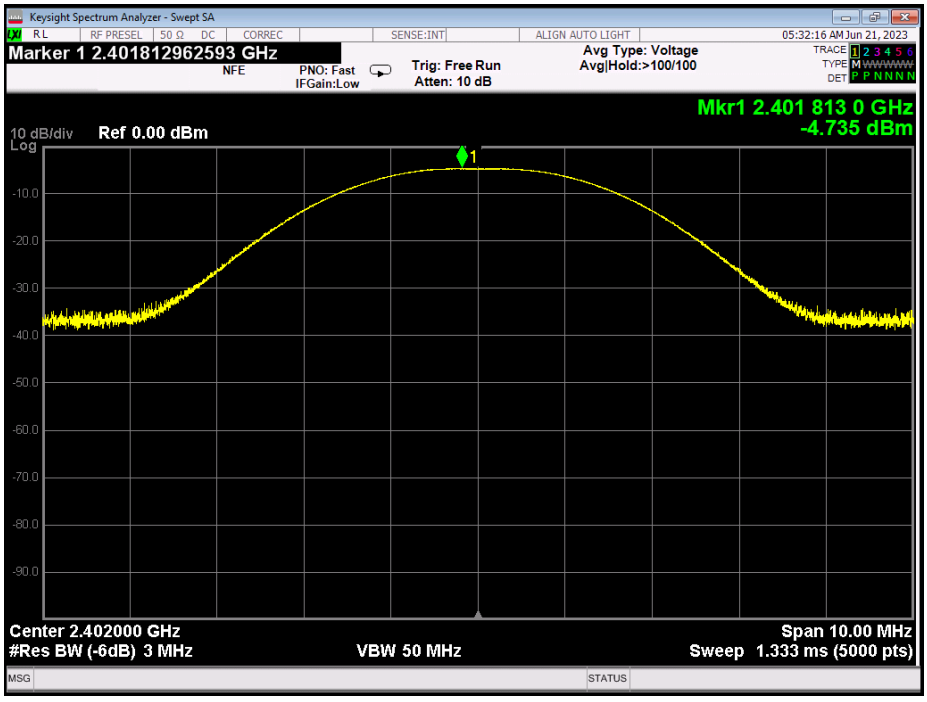
Tuned Frequency (MHz)	Measured Value (dBm)	Conducted Output Power (dBm)	Specification Limit	Result
2402	4.81	4.81	1 W (30 dBm)	Pass
2440	-3.99	-3.99	1 W (30 dBm)	Pass
2480	4.09	4.09	1 W (30 dBm)	Pass



High channel



Mid channel



Low Channel

Radiated Spurious Emissions

Engineer: John Michalowicz

Test Date: 6/21/23

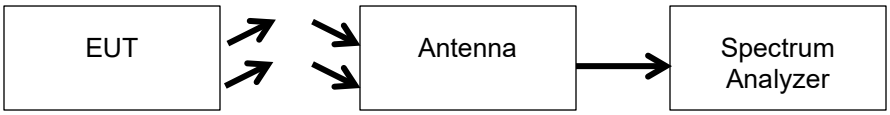
Test Procedure
Radiated Spurious Emissions: 30 – 1000 MHz

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was set to transmit on the lowest, middle and highest frequency of operation at the maximum power level. The EUT was tested, in 3 orthogonal axis, by rotating it 360° with the receive antenna in both the vertical and horizontal orientation while raised from 1 to 4 meters to ensure the TX signal levels were maximized. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Spurious Emissions.

All emissions from 30 MHz to 1 GHz were examined.
Measured Level includes antenna and receiver cable correction factors.
Correction factors were input into the spectrum analyzer before recording "Measured Level".

RBW = 100 KHz
VBW = 300 KHz
Detector – Quasi Peak

Test Setup

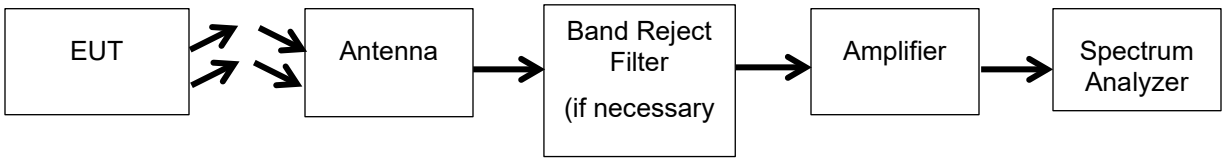


Test Procedure for
Radiated Spurious Emissions above 1 GHz

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was set to transmit on the lowest, middle and highest frequency of operation at the maximum power level. The EUT was tested, in 3 orthogonal axis, by rotating it 360° with the receive antenna in both the vertical and horizontal orientation while raised from 1 to 4 meters to ensure the TX signal levels were maximized. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Spurious Emissions.

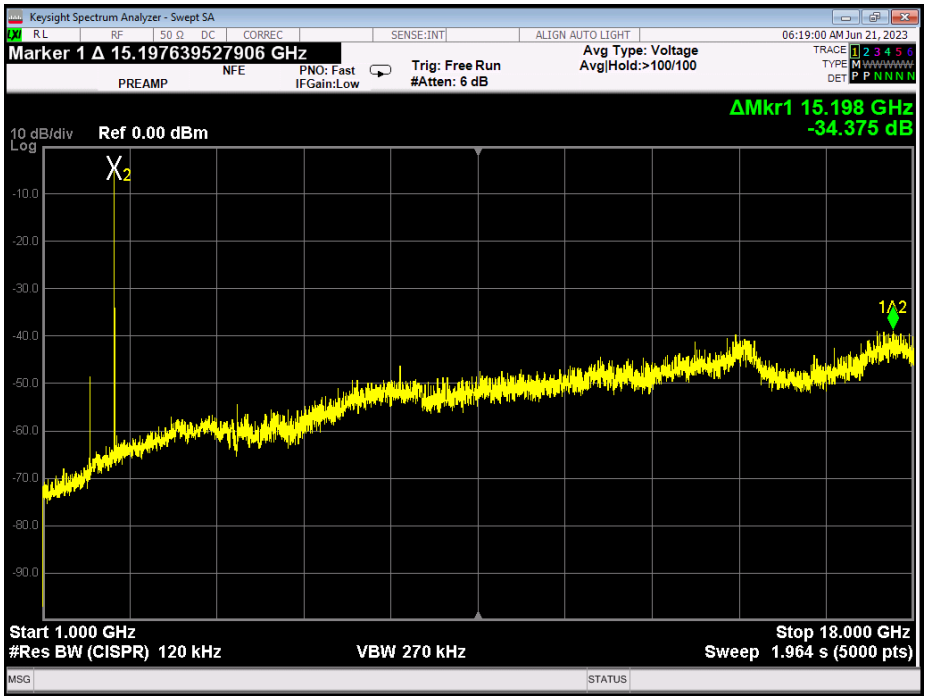
RBW = 100 KHz and 1 MHz (100 kHz to show compliance to 15.247, 1 MHz for 15.209)
VBW = 300 KHz and 3 MHz (300 kHz to show compliance to 15.247, 3 MHz for 15.209)
Detector – Peak

Test Setup

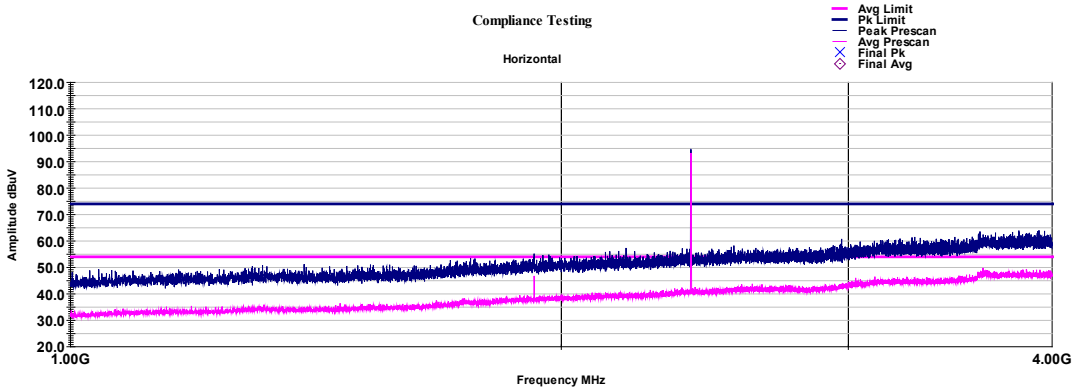


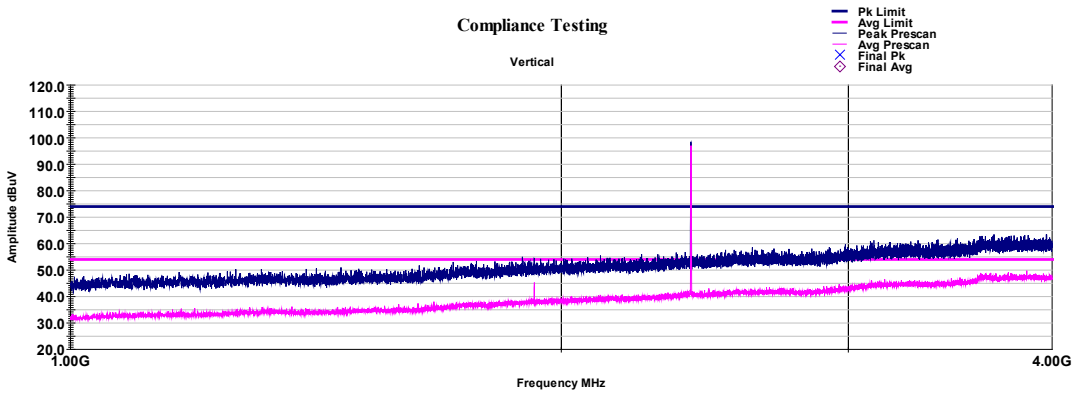
All emissions are below the limits.
The worst case occurs at 7.206 GHz with a peak value of 52 dBuv on the mid channel.

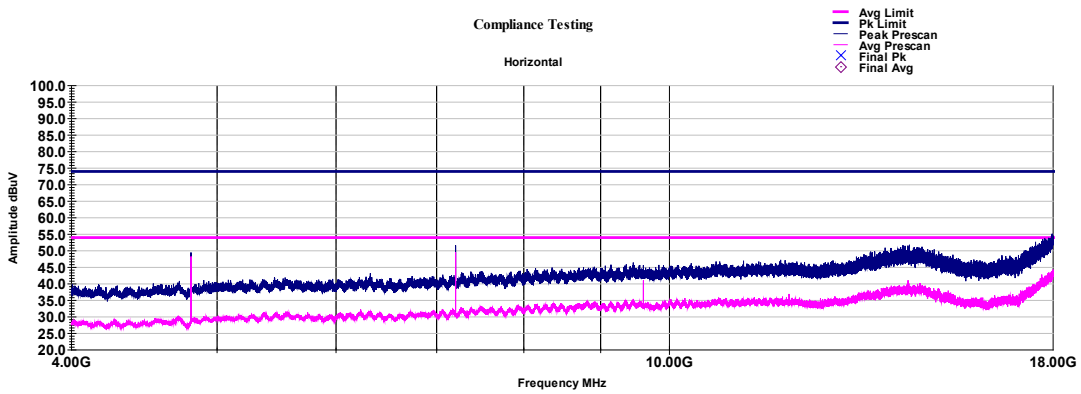
Low channel result



Low channel 15.247(d)



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Horizontal
Avg Limit
Pk Limit
Peak Prescan
Avg Prescan
Final Pk
Final Avg
Amplitude dBuV
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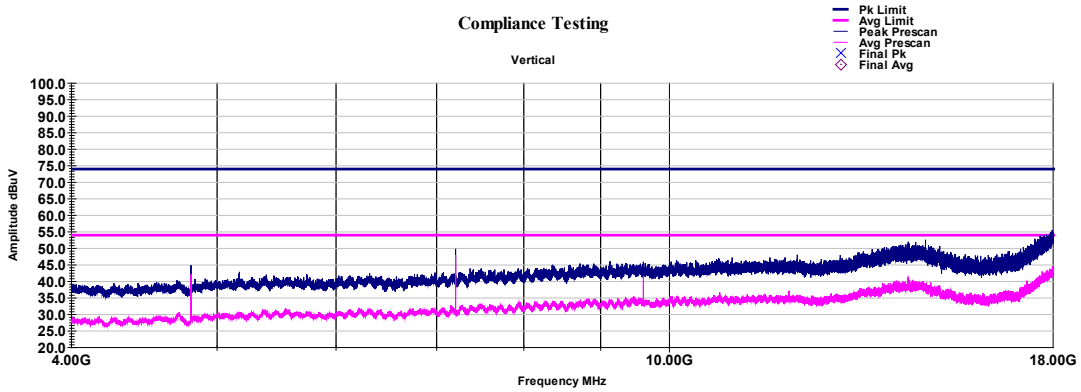
4.00G
10.00G
18.00G
Frequency MHz


Compliance Testing
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Pk Limit
Avg Limit
Peak Prescan
Avg Prescan
Final Pk
Final Avg
Amplitude dBuV
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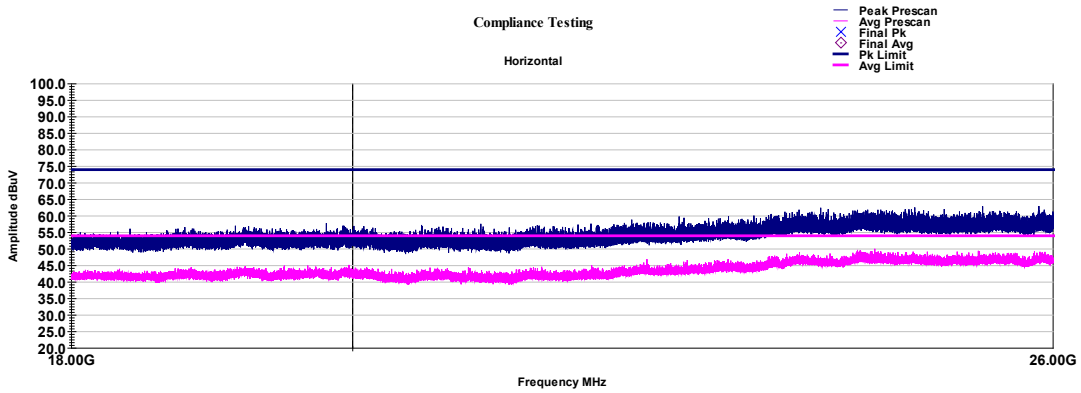
4.00G
10.00G
18.00G
Frequency MHz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Horizontal
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Avg Prescan
Final Pk
Final Avg
Pk Limit
Avg Limit
Amplitude dBuV
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85.0
80.0
75.0
70.0
65.0
60.0
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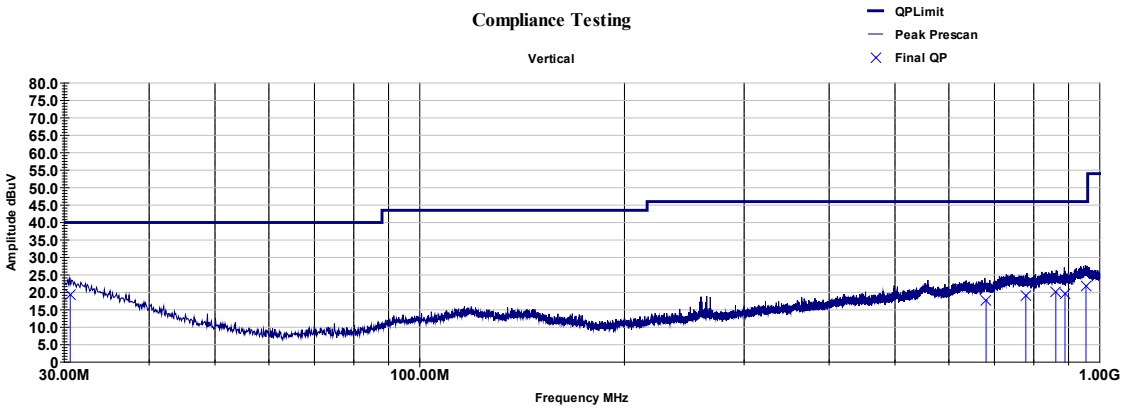
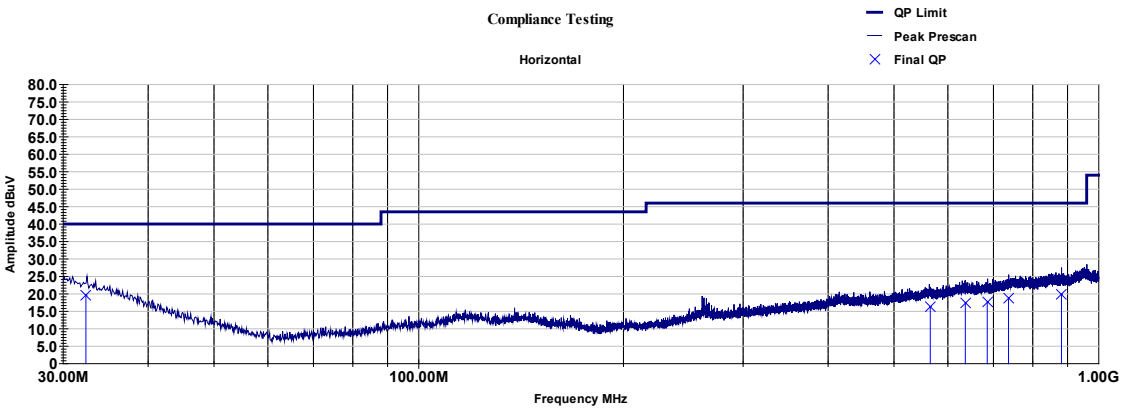
20.0
18.00G
26.00G
Frequency MHz

30 - 1000

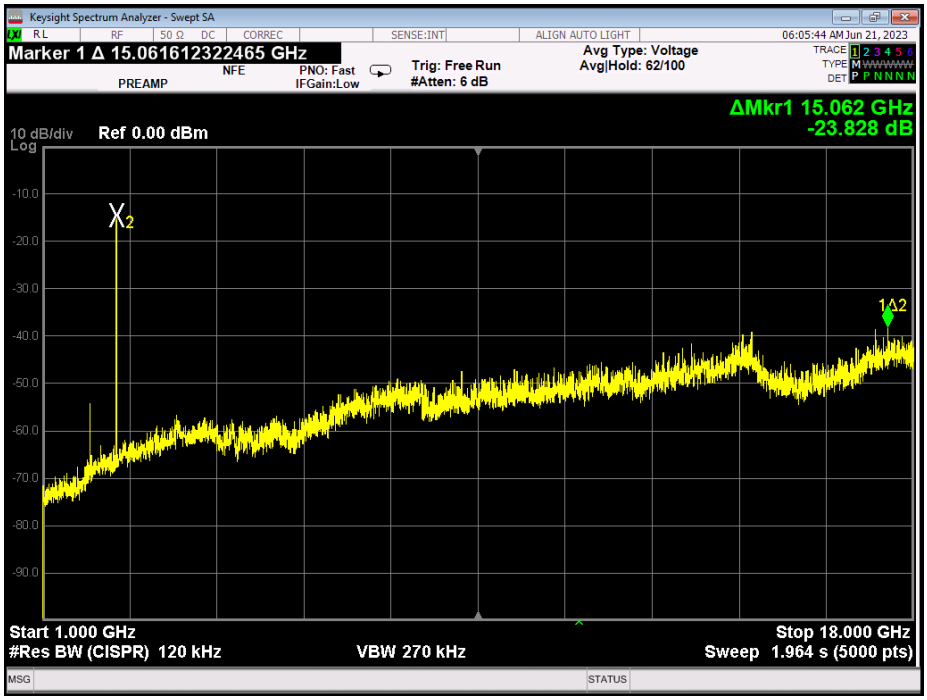


Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
30.618	325.00	125.00	40.45	-21.21	19.20	40.00	-20.80
680.691	234.00	100.00	33.00	-15.31	17.70	46.00	-28.30
778.625	87.00	294.00	32.71	-13.56	19.10	46.00	-26.90
861.883	328.00	163.00	32.45	-12.43	20.00	46.00	-26.00
889.185	253.00	389.00	32.19	-12.48	19.70	46.00	-26.30
954.717	159.00	355.00	32.53	-10.66	21.90	46.00	-24.10
Final = Raw + Path Loss							
Margin = Final - Limit							

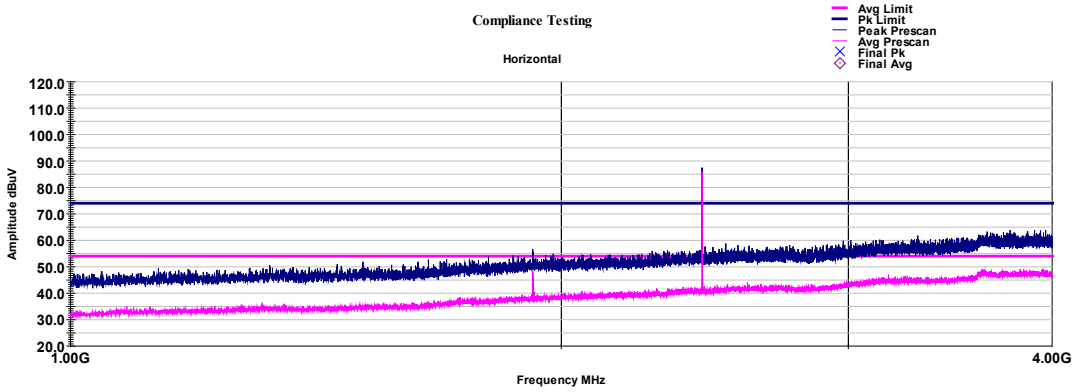


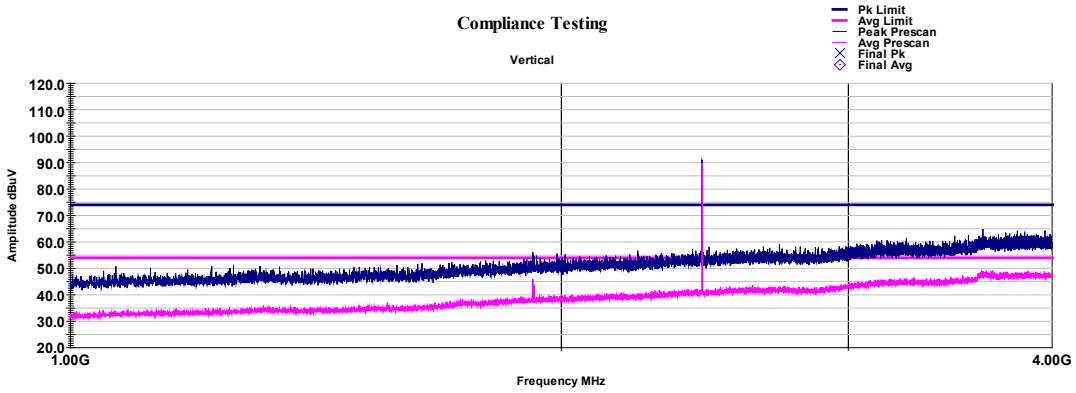
Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
32.405	284.00	268.00	40.27	-20.68	19.60	40.00	-20.40
565.217	71.00	325.00	33.05	-16.69	16.40	46.00	-29.60
636.481	182.00	167.00	33.13	-15.61	17.50	46.00	-28.50
685.682	272.00	394.00	32.64	-15.00	17.60	46.00	-28.40
736.688	261.00	330.00	32.84	-13.94	18.90	46.00	-27.10
881.379	198.00	100.00	32.38	-12.49	19.90	46.00	-26.10
Final = Raw + Path Loss							
Margin = Final - Limit							

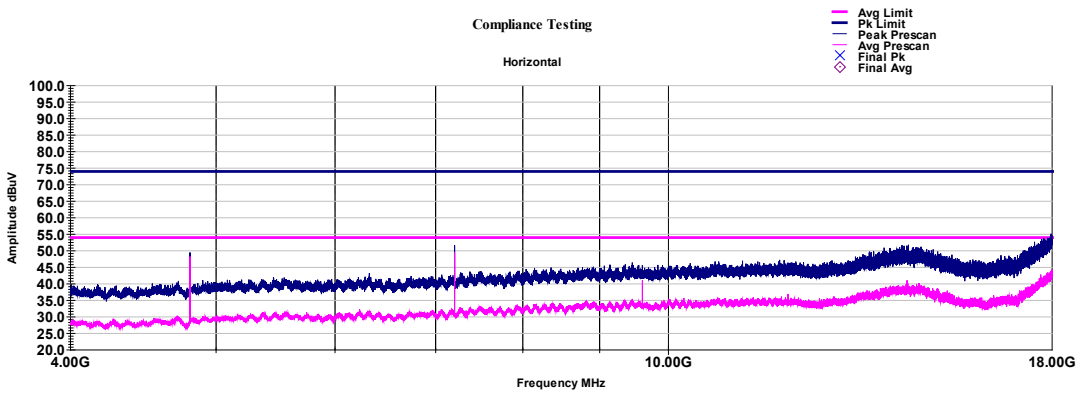
Mid channel result



Mid channel 15.247(d)






Compliance Testing
Horizontal
Avg Limit
Pk Limit
Peak Prescan
Avg Prescan
Final Pk
Final Avg
Amplitude dBuV
100.0
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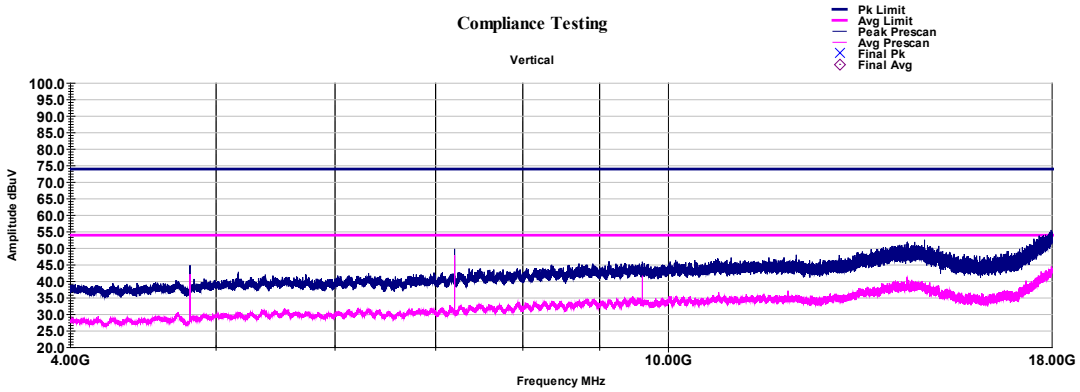
4.00G
10.00G
18.00G
Frequency MHz


Compliance Testing
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Avg Limit
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Final Avg
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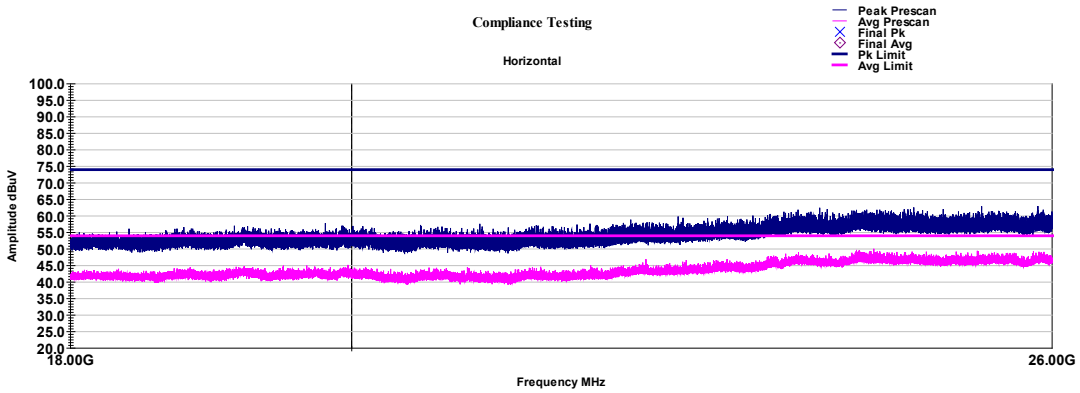
10.00G
18.00G
Frequency MHz


Compliance Testing
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Peak Prescan
Avg Prescan
Final Pk
Final Avg
Pk Limit
Avg Limit
Amplitude dBuV
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60.0
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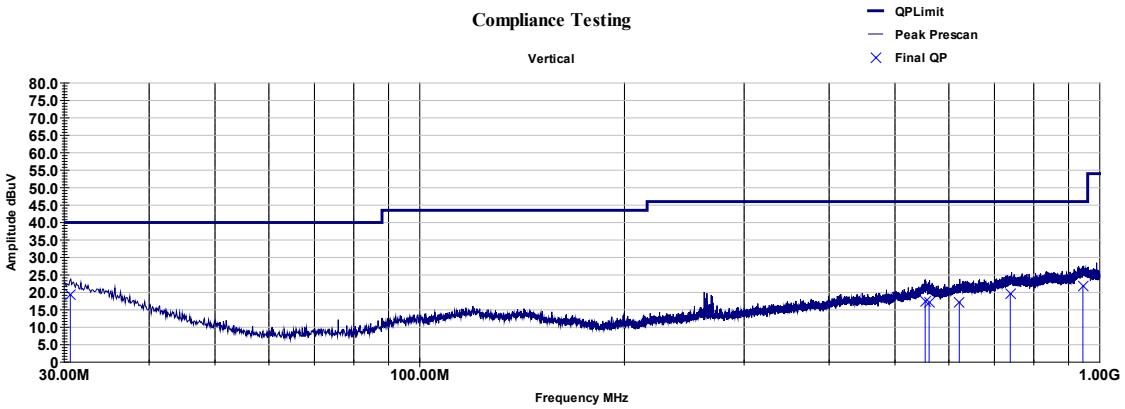
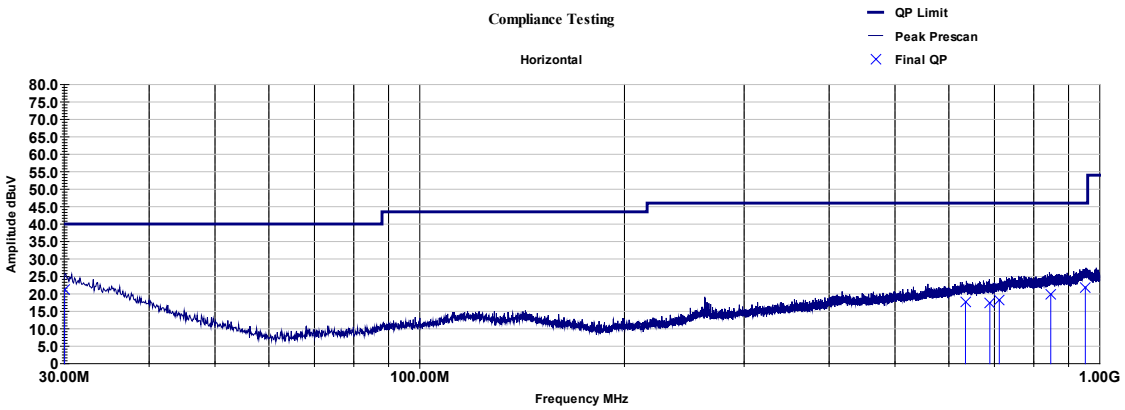
20.0
18.00G
26.00G
Frequency MHz

30 - 1000

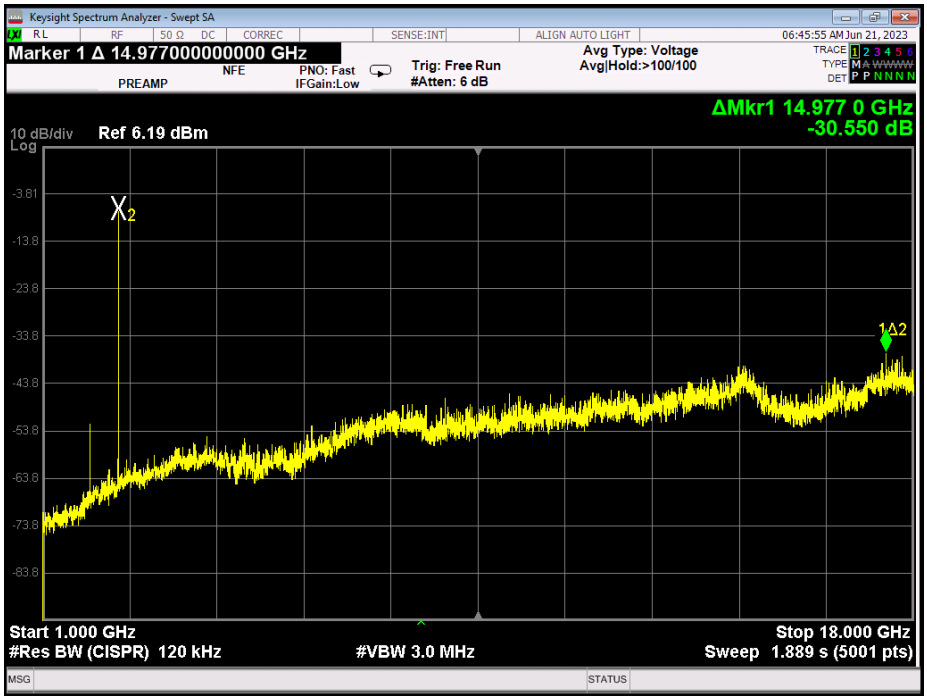


Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
30.635	81.00	325.00	40.43	-21.22	19.20	40.00	-20.80
553.769	264.00	381.00	33.23	-15.71	17.50	46.00	-28.50
561.15	80.00	100.00	33.20	-16.20	17.00	46.00	-29.00
621.556	344.00	285.00	33.07	-15.95	17.10	46.00	-28.90
738.586	198.00	163.00	32.92	-13.30	19.60	46.00	-26.40
944.642	27.00	359.00	32.36	-10.62	21.70	46.00	-24.30
Final = Raw + Path Loss							
Margin = Final - Limit							

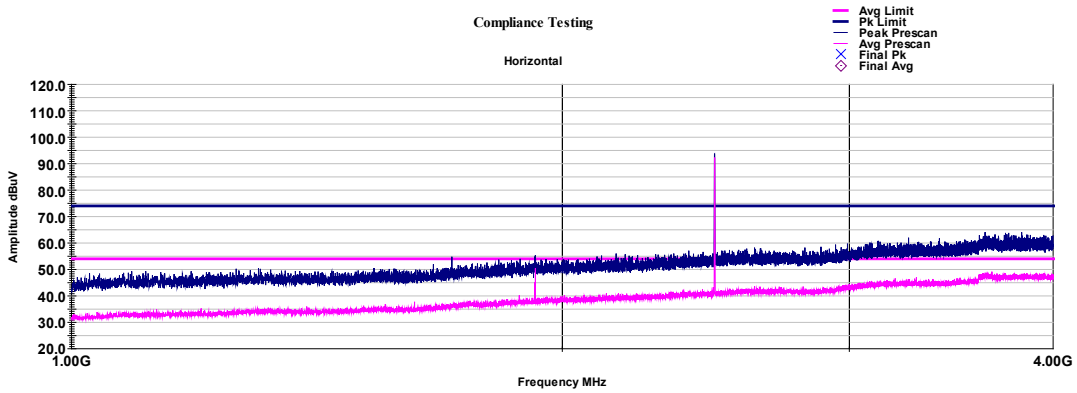


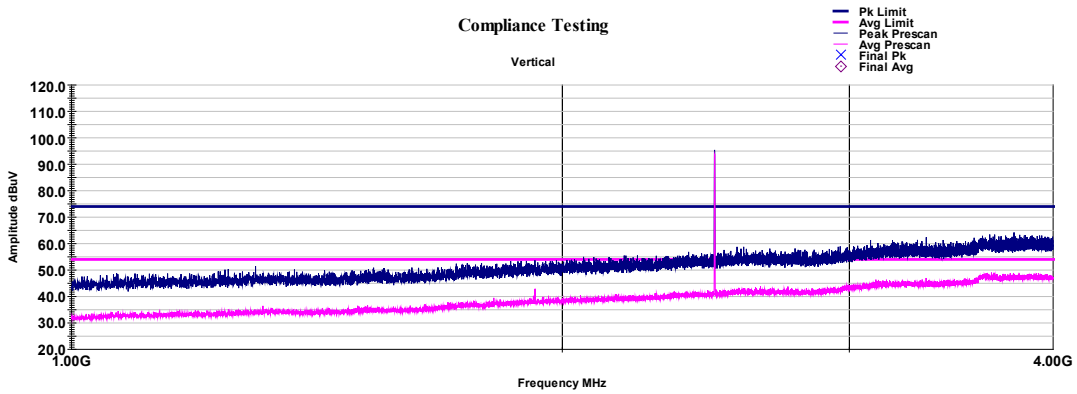
Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
30.044	259.00	268.00	40.46	-19.34	21.10	40.00	-18.90
634.799	63.00	400.00	33.16	-15.61	17.50	46.00	-28.50
689.364	308.00	128.00	32.50	-14.99	17.50	46.00	-28.50
711.793	213.00	100.00	32.95	-14.82	18.10	46.00	-27.90
847.206	290.00	136.00	32.49	-12.66	19.80	46.00	-26.20
952.519	37.00	400.00	32.57	-10.67	21.90	46.00	-24.10
Final = Raw + Path Loss							
Margin = Final - Limit							

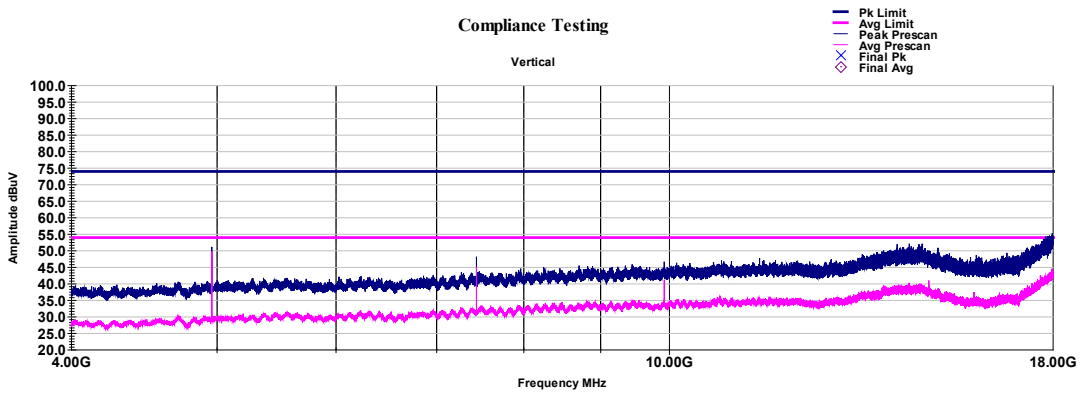
High channel result



High channel 15.247(d)






Compliance Testing
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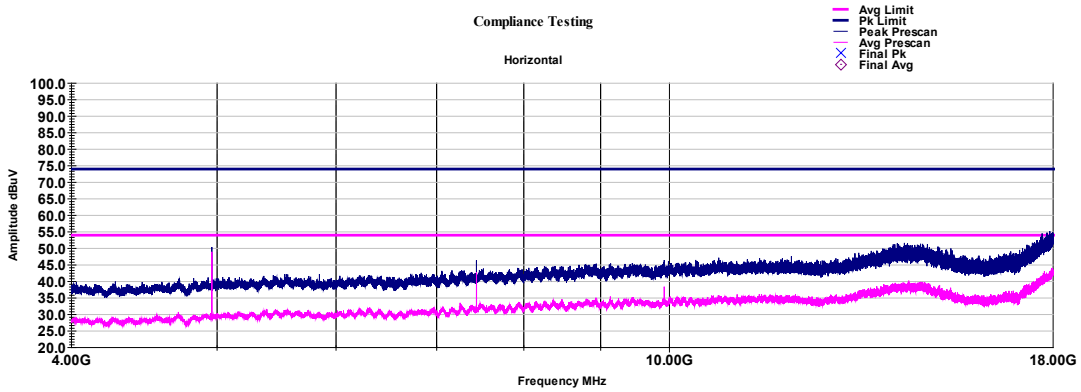
Pk Limit
Avg Limit
Peak Prescan
Avg Prescan
Final Pk
Final Avg
Amplitude dBuV
100.0
95.0
90.0
85.0
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
4.00G
10.00G
18.00G
Frequency MHz


Compliance Testing
Horizontal
Avg Limit
Pk Limit
Peak Prescan
Avg Prescan
Final Pk
Final Avg
Amplitude dBuV
100.0
95.0
90.0
85.0
80.0
75.0
70.0
65.0
60.0
55.0
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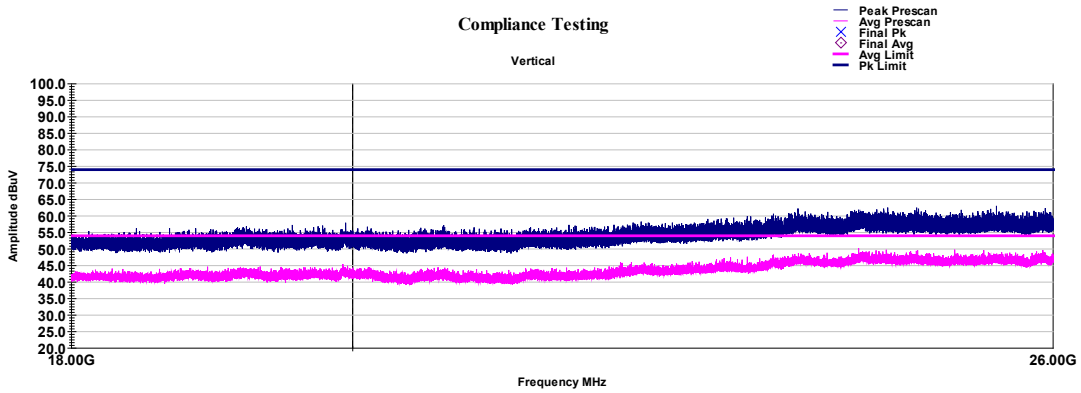
30.0
25.0
20.0
4.00G
10.00G
18.00G
Frequency MHz


Compliance Testing
Vertical
Peak Prescan
Avg Prescan
Final Pk
Final Avg
Avg Limit
Pk Limit
Amplitude dBuV
100.0
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85.0
80.0
75.0
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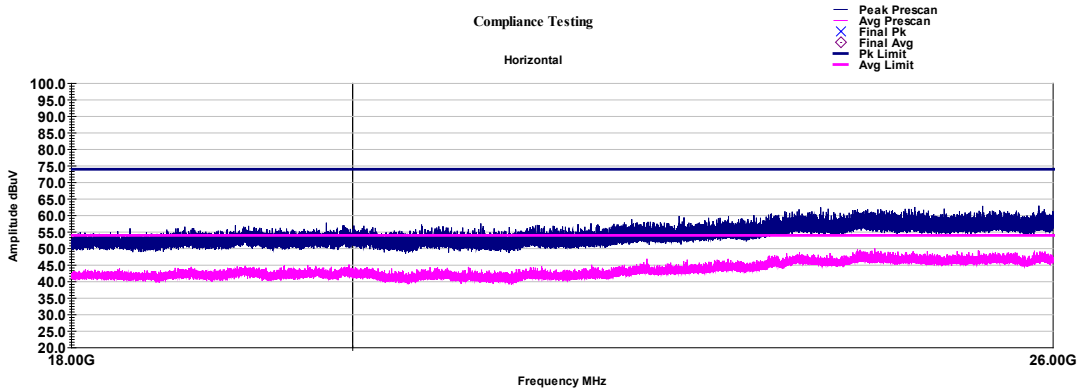
25.0
20.0
18.00G
26.00G
Frequency MHz


Compliance Testing
Horizontal
Peak Prescan
Avg Prescan
Final Pk
Final Avg
Pk Limit
Avg Limit
Amplitude dBuV
100.0
95.0
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85.0
80.0
75.0
70.0
65.0
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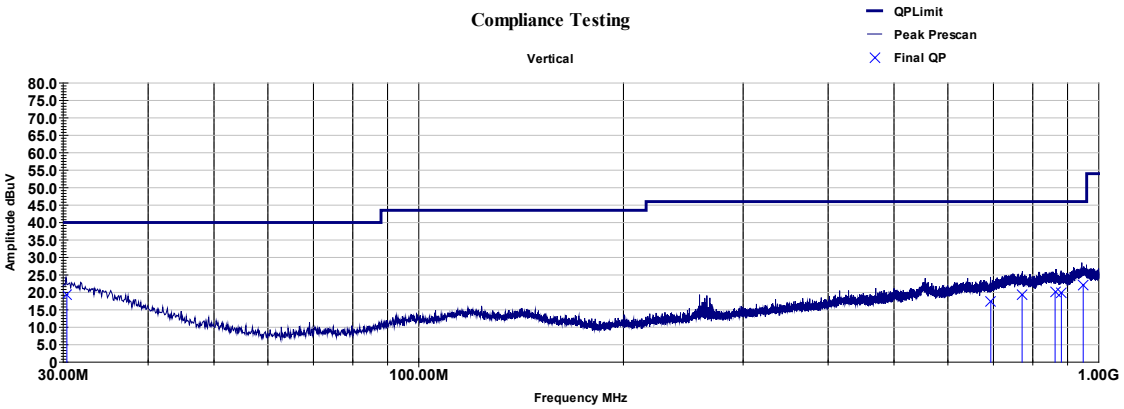
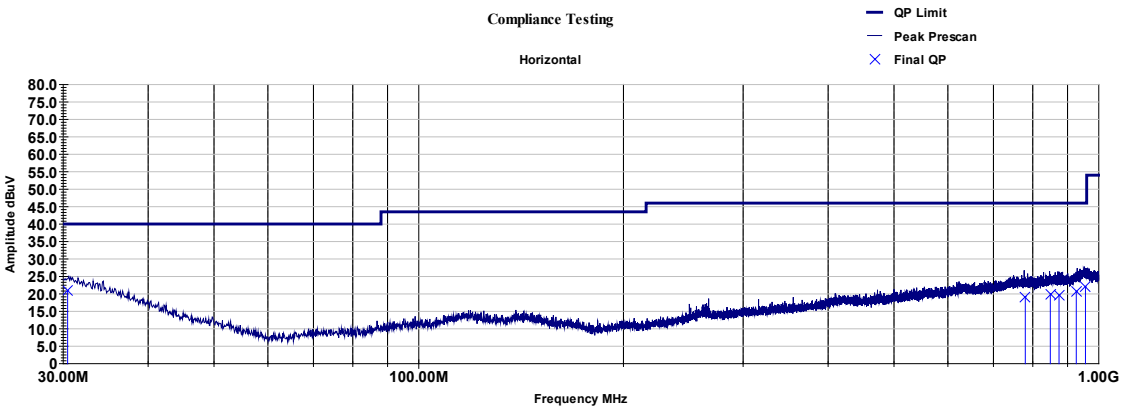
25.0
20.0
18.00G
26.00G
Frequency MHz



Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
30.381	150.00	325.00	40.48	-21.10	19.40	40.00	-20.60
693.818	175.00	100.00	32.56	-15.18	17.40	46.00	-28.60
771.549	222.00	347.00	32.72	-13.52	19.20	46.00	-26.80
862.613	40.00	325.00	32.47	-12.43	20.00	46.00	-26.00
881.144	284.00	136.00	32.46	-12.59	19.90	46.00	-26.10
948.847	190.00	105.00	32.65	-10.57	22.10	46.00	-23.90
Final = Raw + Path Loss							
Margin = Final - Limit							



Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
30.458	229.00	394.00	40.46	-19.58	20.90	40.00	-19.10
779.896	172.00	369.00	32.76	-13.60	19.20	46.00	-26.80
848.871	236.00	400.00	32.58	-12.65	19.90	46.00	-26.10
874.16	0.00	325.00	32.12	-12.51	19.60	46.00	-26.40
926.885	119.00	113.00	32.33	-11.61	20.70	46.00	-25.30
955.968	17.00	377.00	32.61	-10.66	22.00	46.00	-24.00
Final = Raw + Path Loss							
Margin = Final - Limit							

Emissions at Band Edges

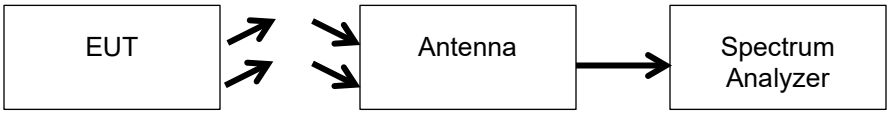
Engineer: John Michalowicz

Test Date: 6/21/23

Test Procedure

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was set to transmit on the lowest and highest frequency of operation at the maximum power level. The EUT was tested, in 3 orthogonal axis, by rotating it 360° with the receive antenna in both the vertical and horizontal orientation while raised from 1 to 4 meters to ensure the TX signal levels were maximized. A spectrum analyzer was used to verify that the EUT met the requirements for band edges.

Test Setup

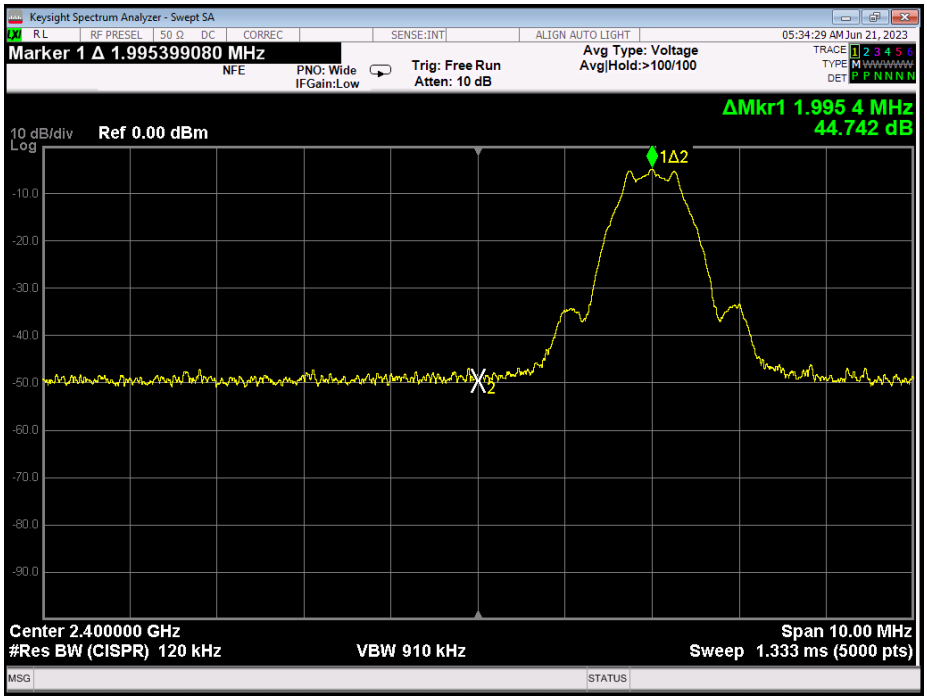


Band Edge Emissions Summary

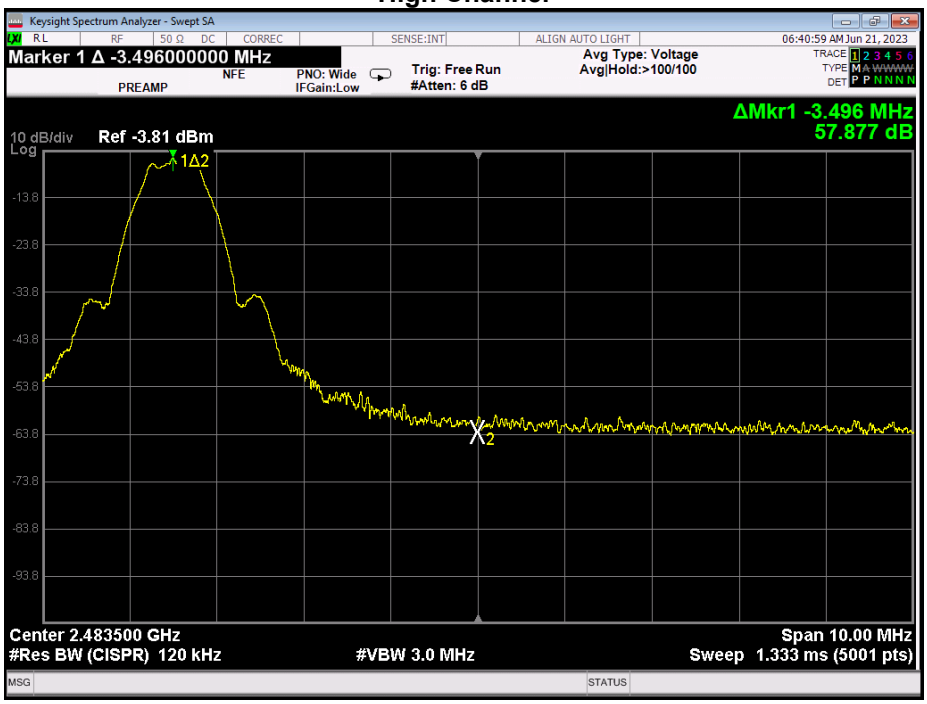
Tuned Frequency (MHz)	Emission Frequency (MHz)	Monitored Level	Detector	Limit	Result
2402	2400	-44.72	Peak	-20 dBc	Pass
2480	2483.5	-57.87	Peak	-20 dBc	Pass

Band Edge Plots

Low Channel



High Channel



DTS Bandwidth

Engineer: John Michalowicz

Test Date: 6/21/23

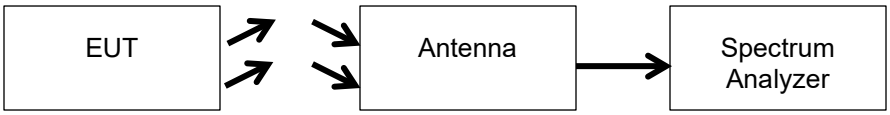
Test Procedure

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was set to transmit on the lowest, middle and highest frequency of operation at the maximum power level. The EUT was tested, in 3 orthogonal axis, by rotating it 360° with the receive antenna in both the vertical and horizontal orientation while raised from 1 to 4 meters to ensure the TX signal levels were maximized. A spectrum analyzer was used to verify that the EUT met the Bandwidth requirements.

The Spectrum Analyzer was set to the following:

RBW = 100 kHz
VBW ≥ 3 x RBW
Peak Detector
Trace mode = max hold
Sweep = auto couple
Span = 1.5 x EBW

Test Setup

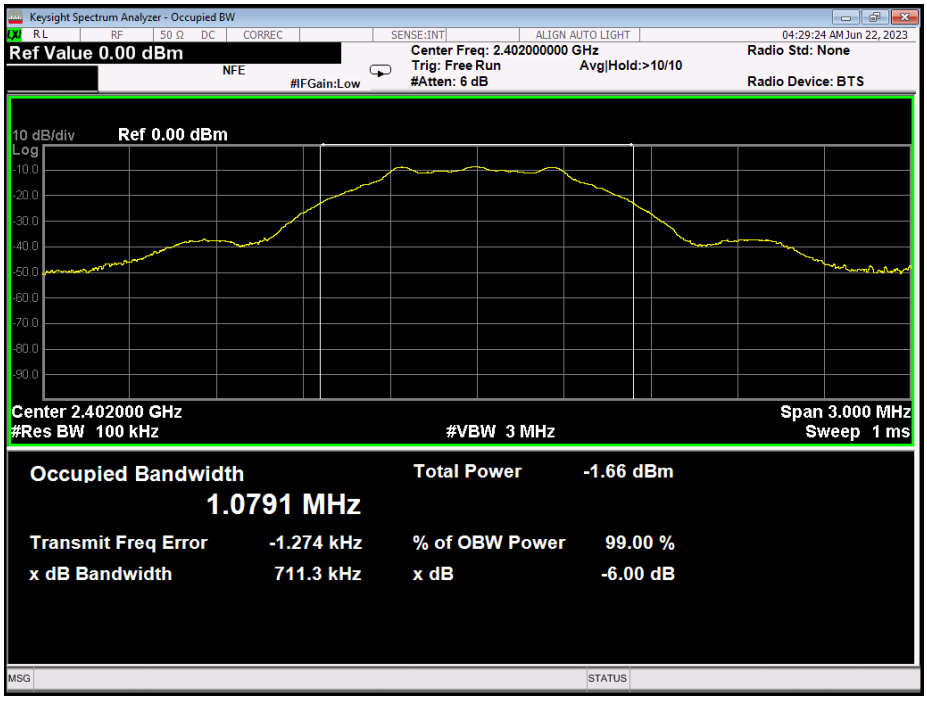


6 dB Occupied Bandwidth Summary

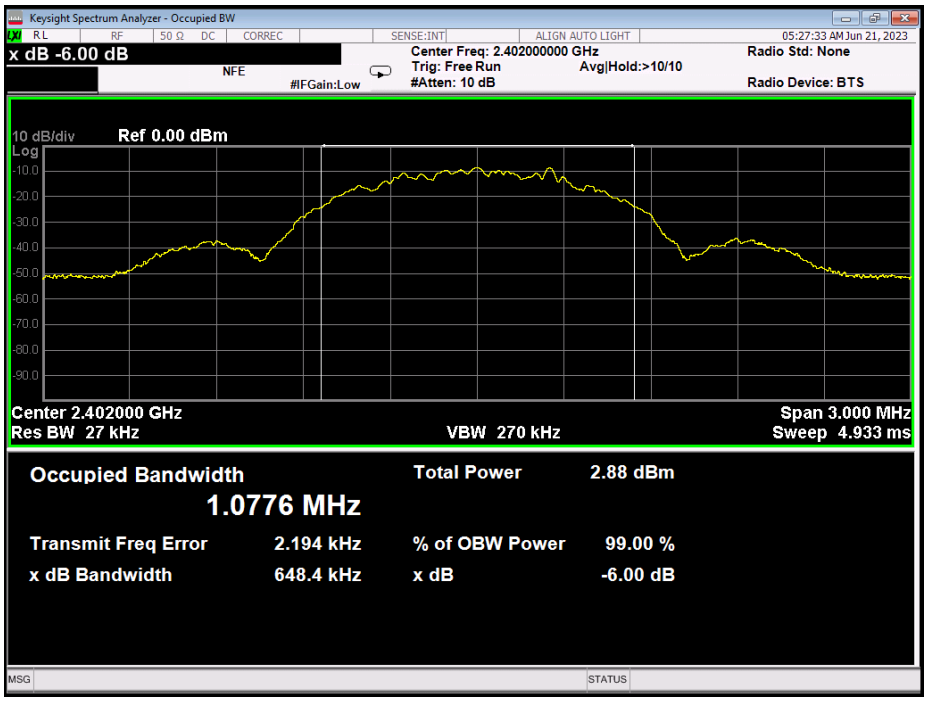
Frequency (MHz)	Measured Bandwidth (kHz)	Specification Limit (kHz)	Result
2402	711.3	≥ 500	Pass
2440	708.5	≥ 500	Pass
2480	712	≥ 500	Pass

99% Bandwidth Summary

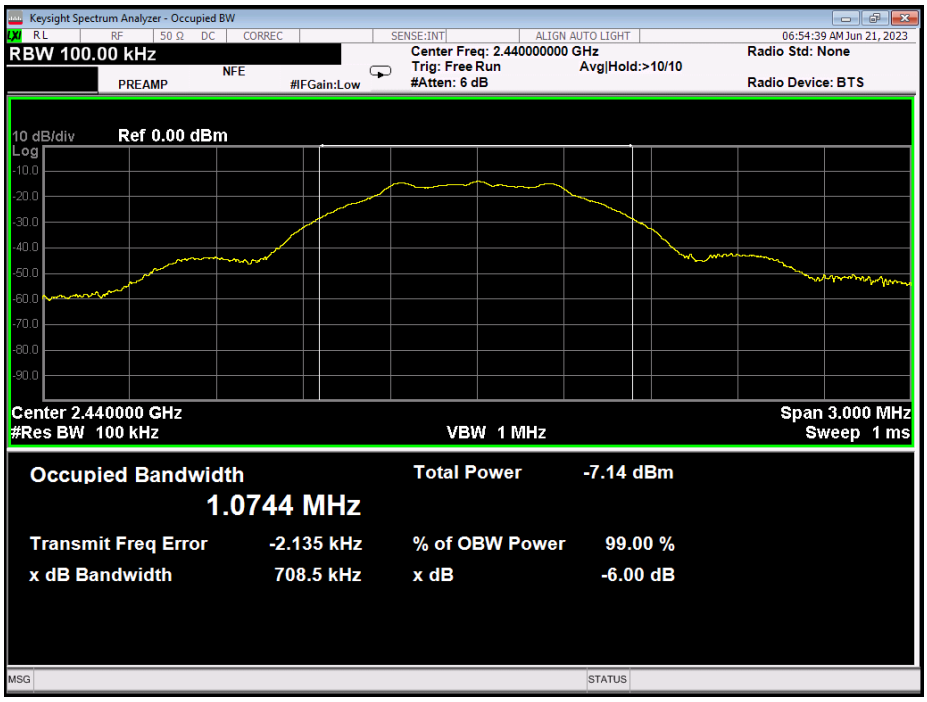
Frequency (MHz)	Measured Bandwidth (MHz)	Result
2402	1.077	Pass
2440	1.061	Pass
2480	1.054	Pass



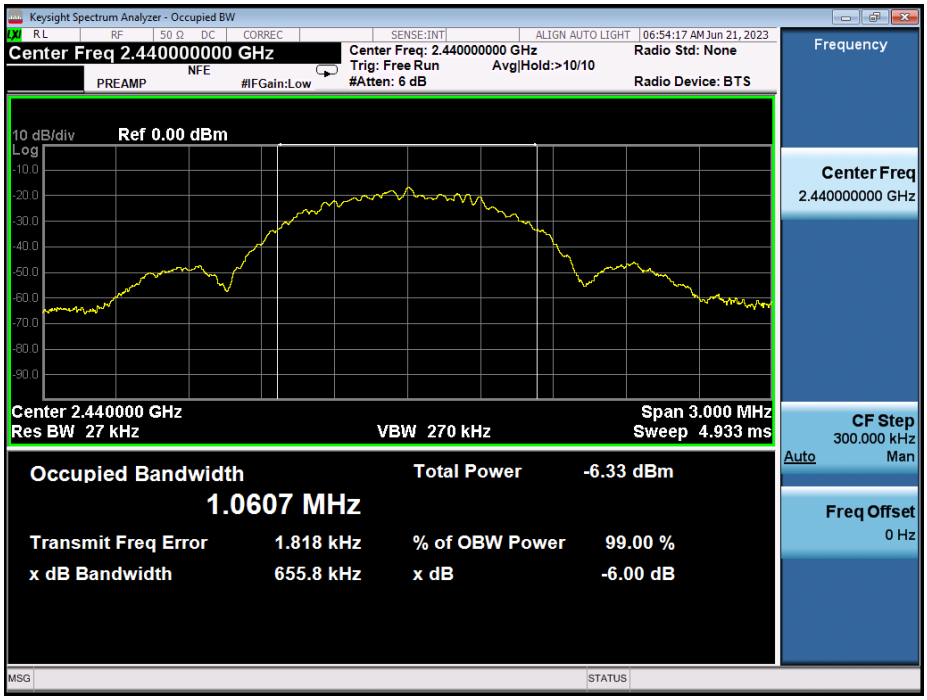
Low Channel DTS bandwidth



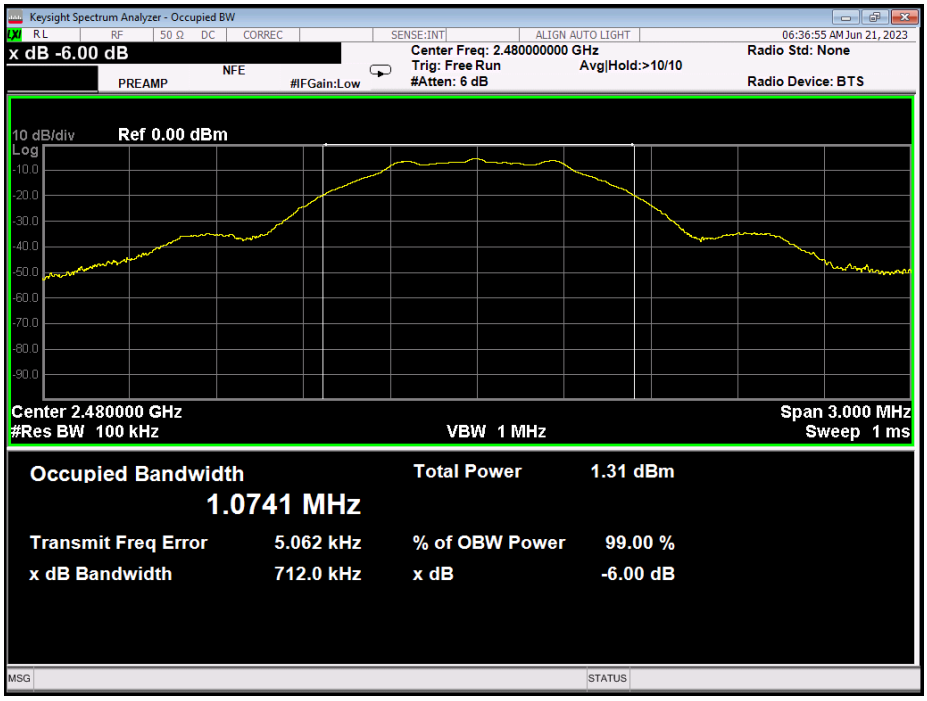
Low Channel OCBW



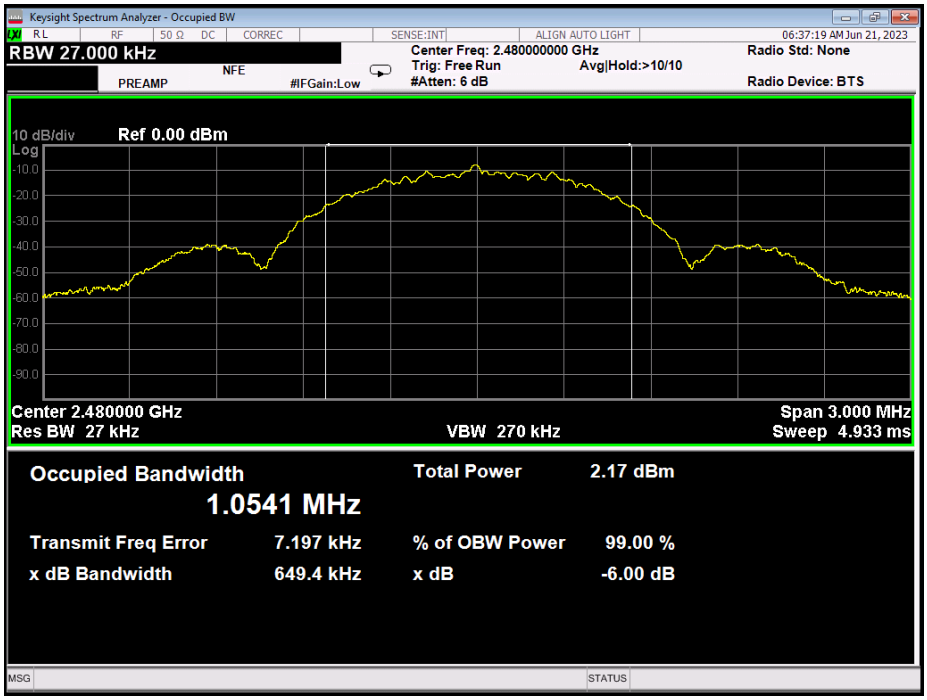
Mid Channel DTS bandwidth



Mid Channel OCBW



High Channel DTS bandwidth



High Channel OCBW

Transmitter Power Spectral Density (PSD)

Engineer: John Michalowicz

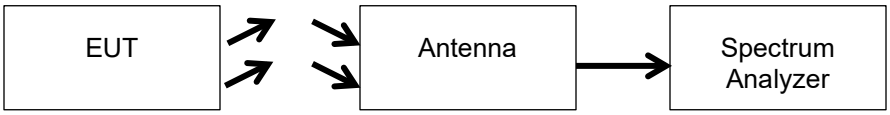
Test Date: 6/21/23

Test Procedure

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was set to transmit on the lowest, middle and highest frequency of operation at the maximum power level. The EUT was tested, in 3 orthogonal axis, by rotating it 360° with the receive antenna in both the vertical and horizontal orientation while raised from 1 to 4 meters to ensure the TX signal levels were maximized. A spectrum analyzer was used to verify that the EUT met the requirements. A distance correction of 9.54 dB was added to the measurement to reflect EIRP.
The Spectrum Analyzer was set to the following:

DTS channel center frequency
Span 1.5 x DTS bandwidth
RBW =3 kHz ≤ RBW ≤ 100 kHz
VBW ≥ 3 x RBW
Peak Detector
Sweep time = auto couple
Trace mode = max hold

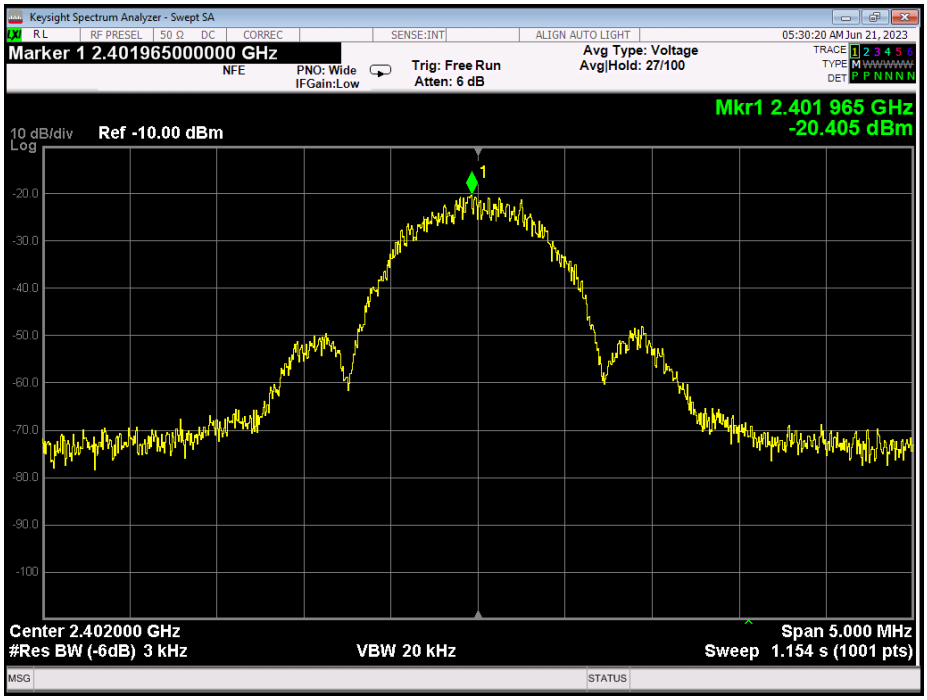
Test Setup



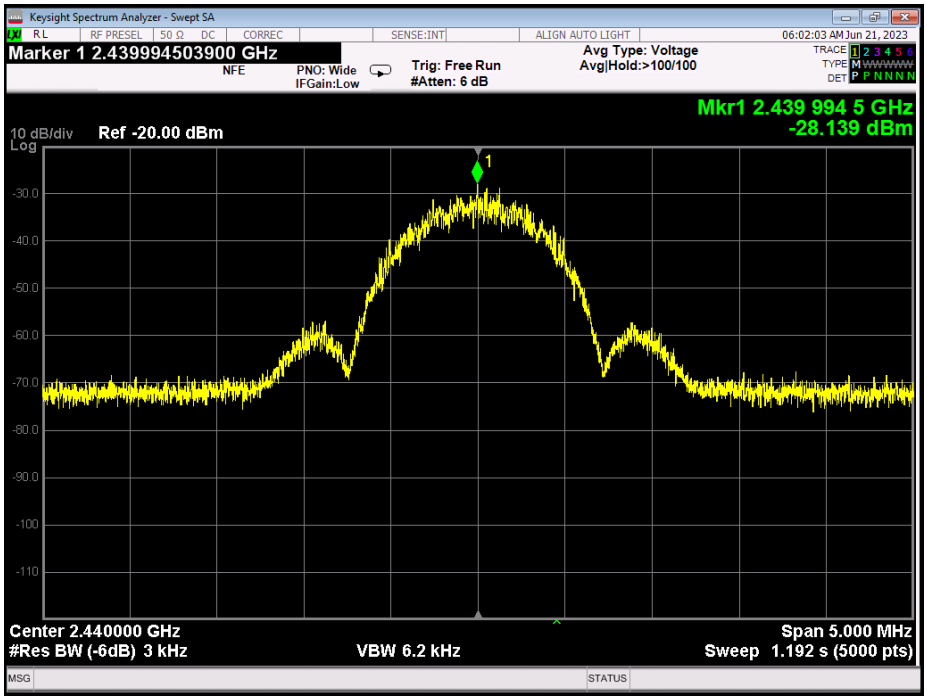
PSD Summary

Frequency (MHz)	Measured Data (dBm)	Specification Limit (dBm)	Result
2402	-11.25	8	Pass
2440	-18.60	8	Pass
2480	-10.86	8	Pass

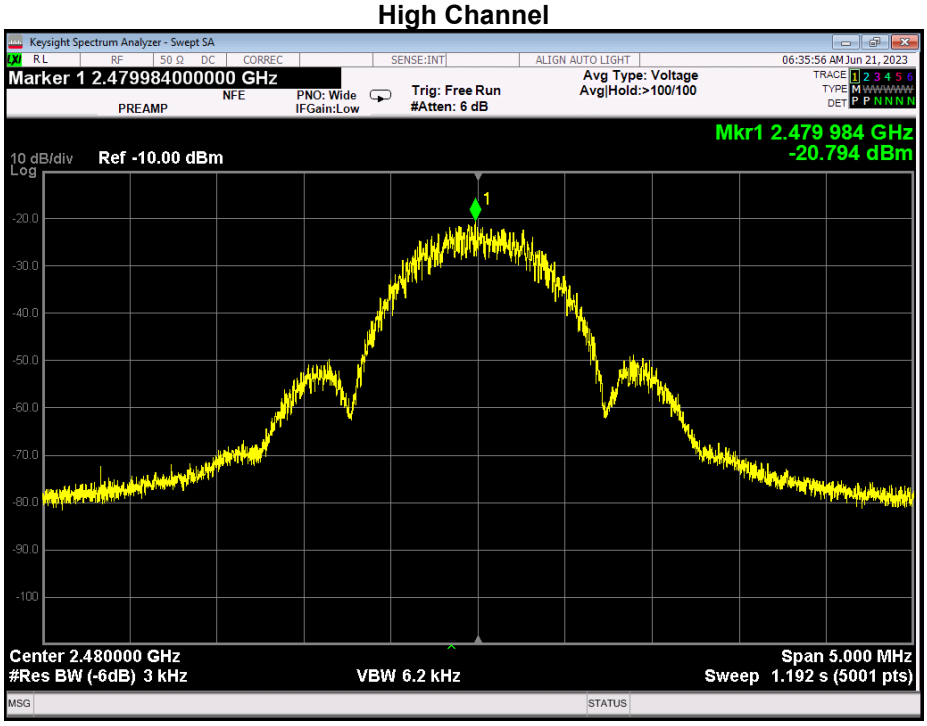
Low Channel



Mid Channel



High Channel



Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Horn Antenna	EMCO	3116	i00085	2/22/21	2/22/23
Horn Antenna	ARA	DRG-118/A	i00271	8/11/22	8/11/24
Bi-Log Antenna	Schaffner	CBL 6111D	i00349	2/7/23	2/7/25
3 Meter Semi-Anechoic Chamber	Panashield	3 Meter Semi-Anechoic Chamber	i00428	7/17/20	7/17/23
Preamplifier for 1-18GHz horn antenna	Miteq	AFS44 00101 400 23-10P-44	i00509	N/A	N/A
MXE EMI receiver	Keysight	N9038A	i00552	2/23/23	2/23/24

In addition to the above listed equipment standard RF connectors and cables were utilized in the testing of the described equipment. Prior to testing these components were tested to verify proper operation.

Measurement Uncertainty

Measurement Uncertainty (U_{lab}) for Compliance Testing is listed in the table below.

Measurement	U_{lab}
Radio Frequency	± 3.3 x 10^{-8}
RF Power, conducted	± 1.5 dB
RF Power Density, conducted	± 1.0 dB
Conducted Emissions	± 1.8 dB
Radiated Emissions	± 4.5 dB
Temperature	± 1.5 deg C
Humidity	± 4.3 %
DC voltage	± 0.20 VDC
AC Voltage	± 1.2 VAC

The reported expanded uncertainty +/- U_{lab}(dB) has been estimated at a 95% confidence level (k=2)

U_{lab} is less than or equal to U_{ETSI} therefore

- Compliance is deemed to occur if no measured disturbance exceeds the disturbance limit
- Non-Compliance is deemed to occur if any measured disturbance exceeds the disturbance limit

END OF TEST REPORT