Test Report

Prepared for: Southwest Engineering Concepts

Model: i POP Wrist Sensor

Description: Wrist Sensor

Serial Number: 001
FCC ID: 2A9WT-CSW
IC ID: 30031-CSW
To

FCC Part 15.247
IC RSS-247 Issue 2

Date of Issue: February 17, 2023

On the behalf of the applicant:

Southwest Engineering Concepts
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Attention of:

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Prepared By
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Project No: p22c0009
Test Result - Pass

John Michalowicz
Project Test Engineer

Test Results Summary

FCC 15.247 Specification	RSS-247 Specification	Test Name	Pass, Fail, N/A	Comments
15.247(b)	Section 5.4(d)	Peak Output Power	Pass	
15.247(d)	Section 5.5	Conducted Spurious Emissions	Pass	
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 cannot transmit while charging

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	2/17/2023	John Michalowicz	Original Document

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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, unless noted below.

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

FCC Site Reg. #349717

IC Site Reg. #2044A-2

Non-accredited tests contained in this report:

N/A

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)**
21.2 – 23.4	24.1 – 37.8	

EUT Description
Model: Wrist Sensor
Description: Sensor placed on wrist
Firmware:
Software:
Serial Number:
Additional Information:
The EUT is a companion device to the Glove Sensor. The EUT has 1 transmit chain which is split into 2 sperate chip antennas. One path was measured and then doubled for the measurements required below.

EUT Operation during Tests
The EUT was placed into a constant transmit mode using command line instructions through Teraterm.

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

Conducted Output Power

Engineer: John Michalowicz
Test Date: 1/16/23

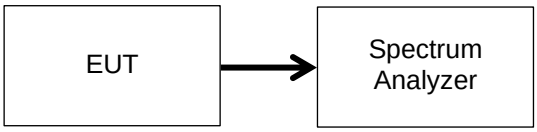
Test Procedure

The EUT was connected directly to a spectrum analyzer. The Spectrum Analyzer was set to the following:

a) Set the RBW ≥ DTS bandwidth.
b) Set VBW ≥ [3 × RBW].
c) Set span ≥ [3 × RBW].
d) Sweep time = auto couple.
e) Detector = peak.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use peak marker function to determine the peak amplitude level.

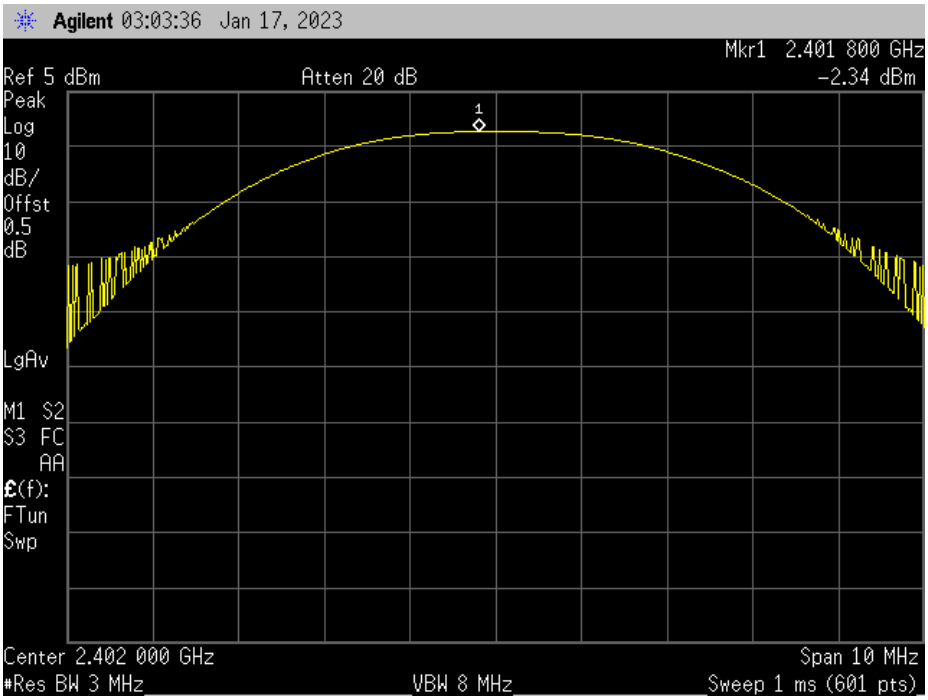
The EUT was set to transmit on the lowest, middle and highest frequencies at the maximum power level. The RF output power was measured using the spectrum analyzer's channel power function

Test Setup

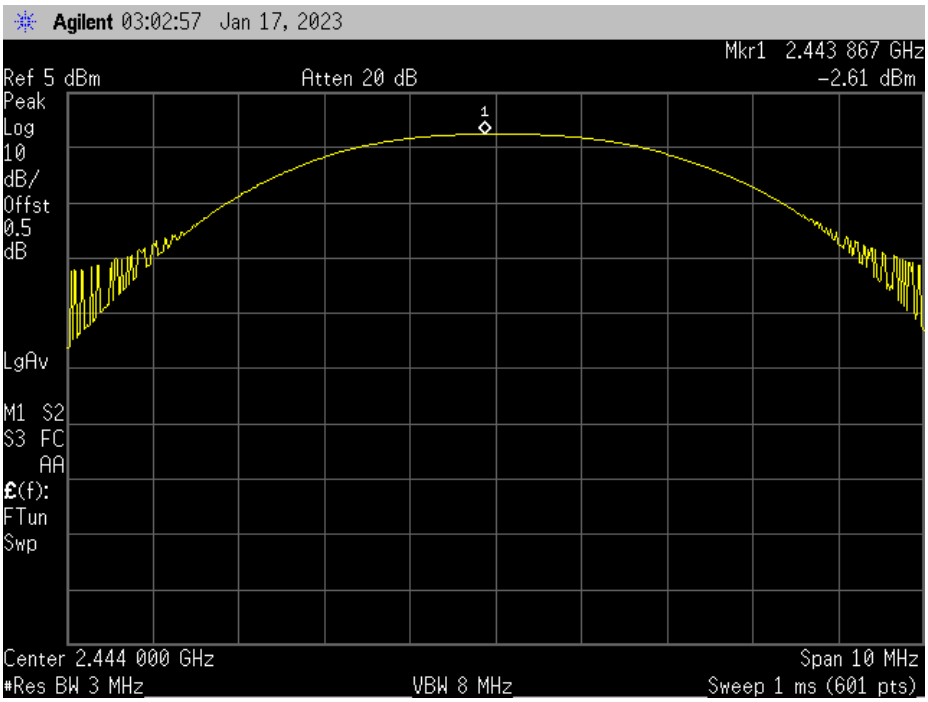


Transmitter Output Power

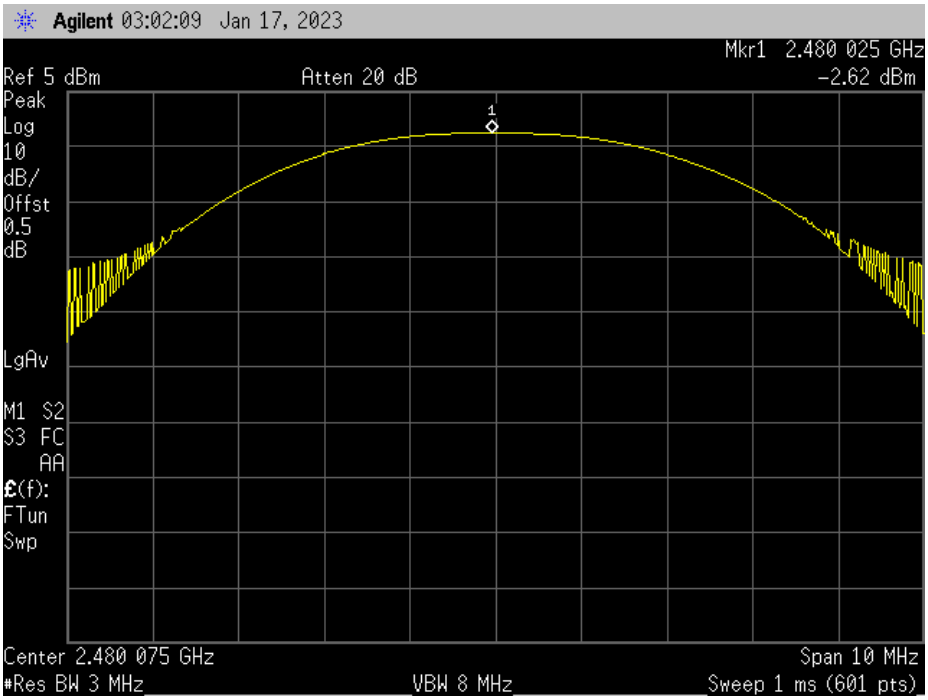
Tuned Frequency (MHz)	Measured Value (dBm)	Summed Value (dBm)	Specification Limit	Result
2402	-2.34	0.66	1 W (30 dBm)	Pass
2440	-2.61	0.39	1 W (30 dBm)	Pass
2480	-2.62	0.38	1 W (30 dBm)	Pass



Low Channel Peak Power



Mid Channel Peak Power



High Channel Peak Power

Conducted RF Measurements (15.209)

Engineer: John Michalowicz

Test Date: 1/16/23

Test Procedure

Antenna-port conducted measurements were performed as an alternative to radiated measurements for demonstrating compliance in the restricted frequency bands for 15.209.

The following offsets were added to the measurements:
The maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level
A maximum ground reflection factor to the EIRP level, 6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000MHz.

The following equations were used to determine the field strength from the conducted values.
E[dBµV/m] = EIRP[dBm] - 20 log(d[meters]) + 104.77, where E = field strength and d = 3m
E[dBµV/m] = EIRP[dBm] + 95.2, for d = 3 meters.

The Spectrum Analyzer was set to the following:

The Spectrum Analyzer was set to the following for emissions > 1000MHz:

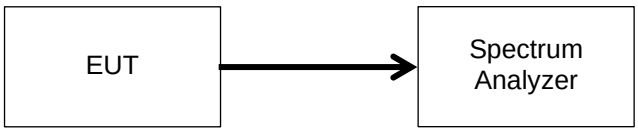
a. RBW = 1 MHz
b. VBW ≥ 3 MHz
c. Detector = Peak.
d. Sweep time = auto
e. Trace mode = max hold
    1. Note: For emissions where the peak exceeded that of the average 15.209 emission limit the following was performed.
f. RBW = 1 MHz
g. VBW ≤ RBW/100 (i.e., 10 kHz) but not less than 10 Hz

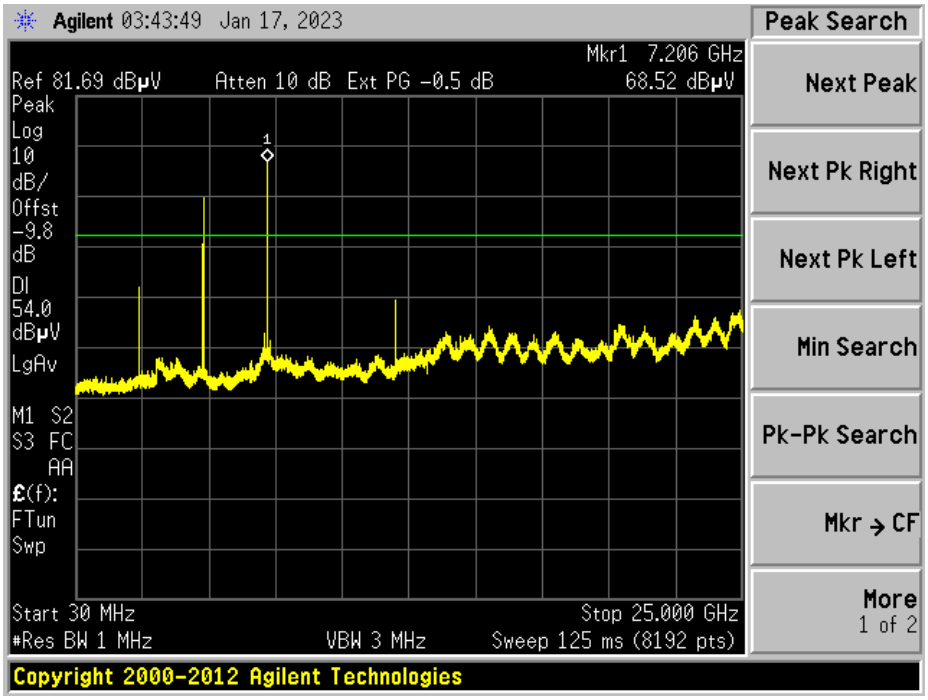
For emissions below 1000MHz the Spectrum Analyzer settings were as follows:

a. RBW = 100 kHz
b. VBW ≥ 300 kHz
c. Detector = Peak
d. Sweep time = auto
e. Trace mode = max hold

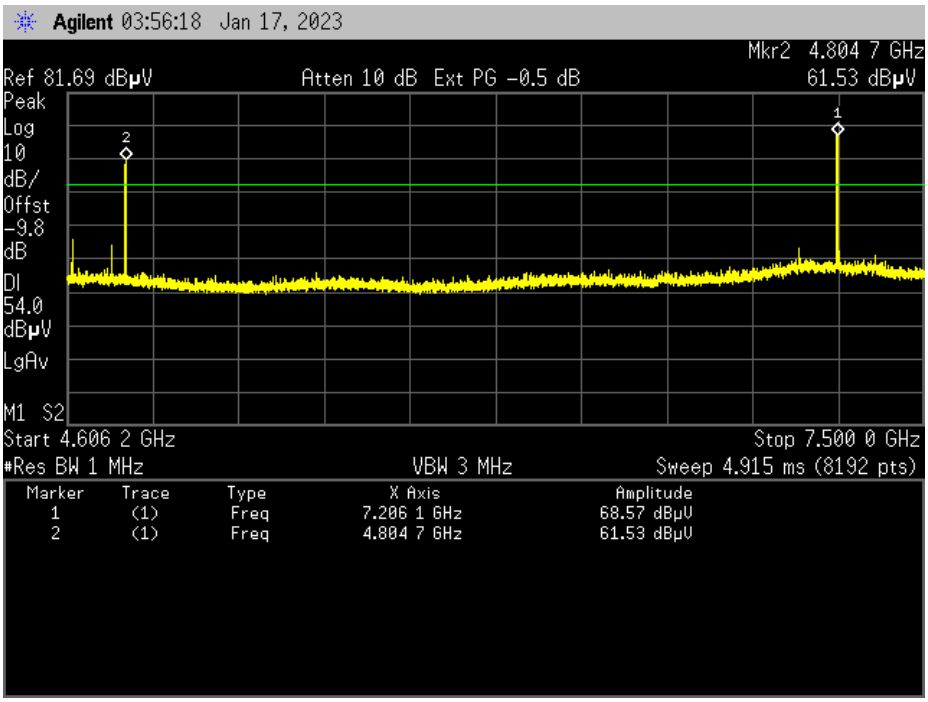
The EUT was connected to a spectrum analyzer to verify that the EUT met the requirements for spurious emissions. The EUT was set to transmit on the lowest, middle and highest frequencies at the maximum power level. The frequency range from 30 MHz to the 10th harmonic of the fundamental transmitter was investigated.

Test Setup

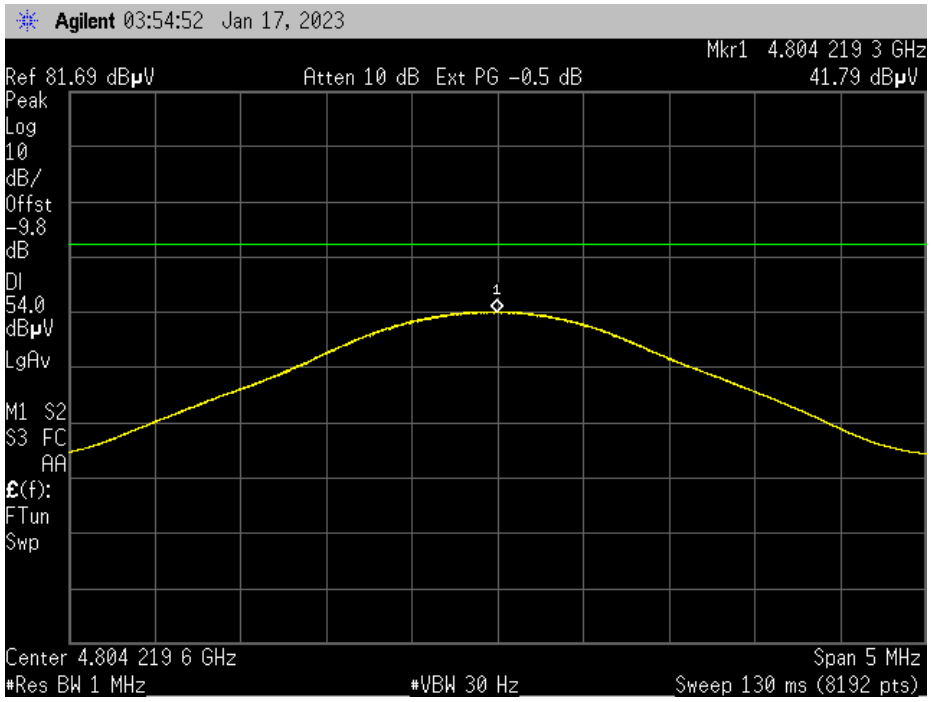




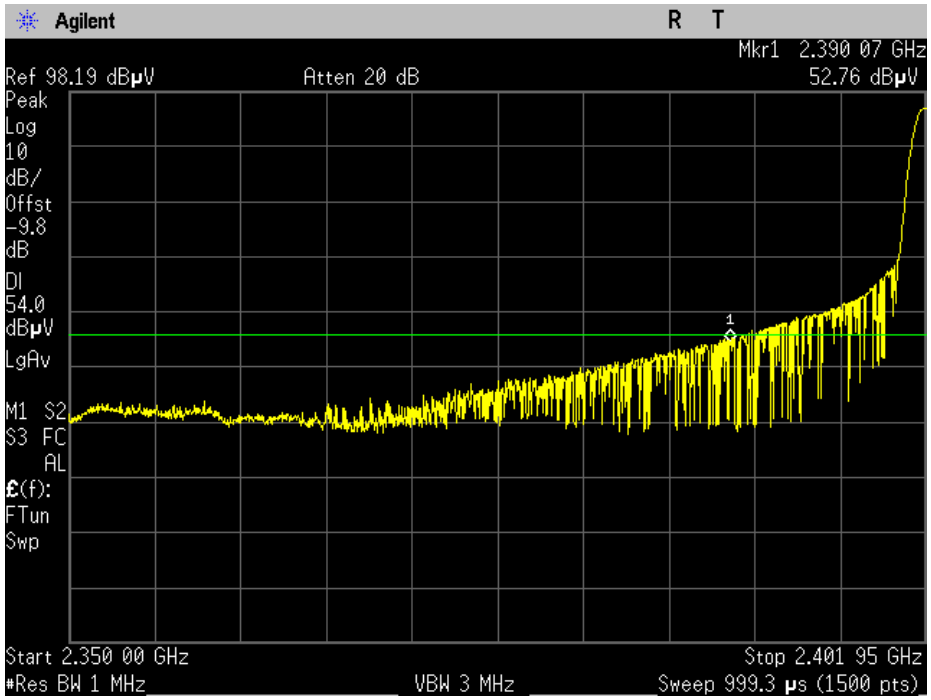
Low channel 30 – 25000 MHz



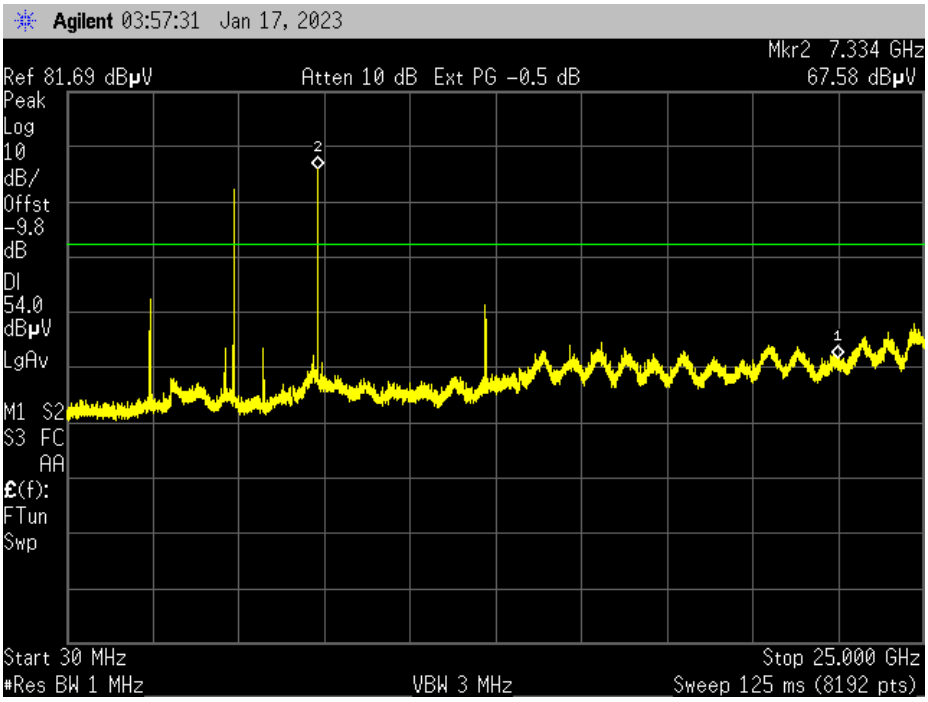
Low channel harmonics



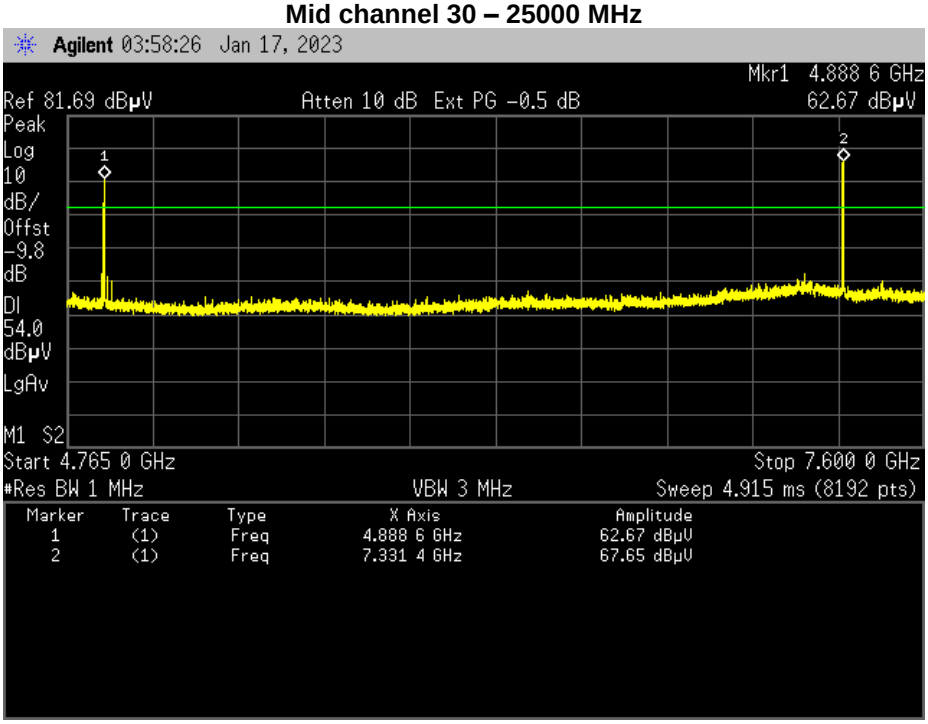
Low channel 2nd harmonic Average



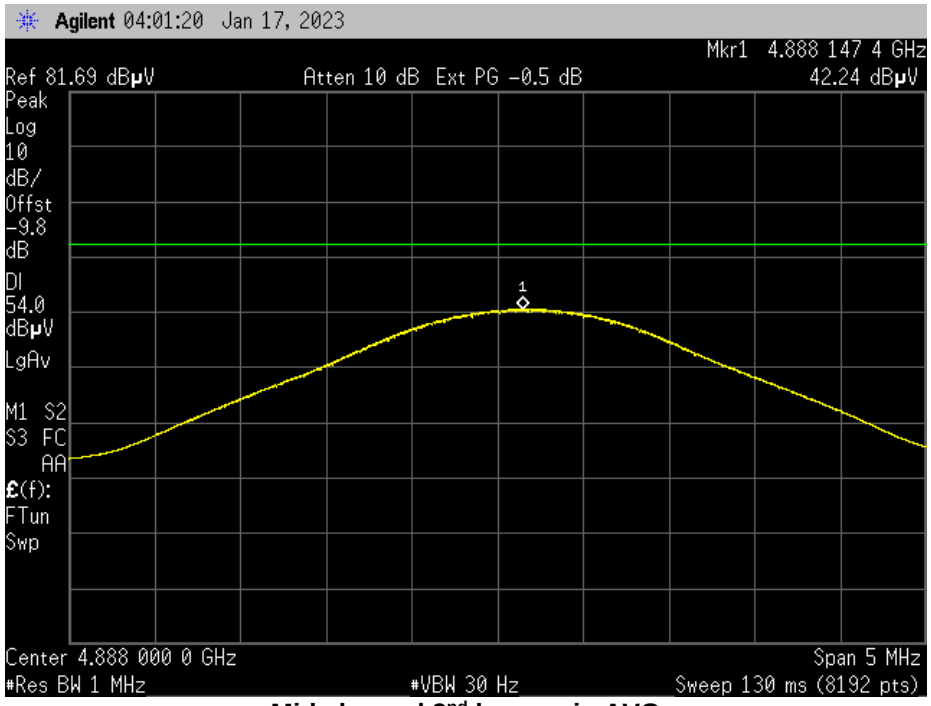
Low channel restricted band edge



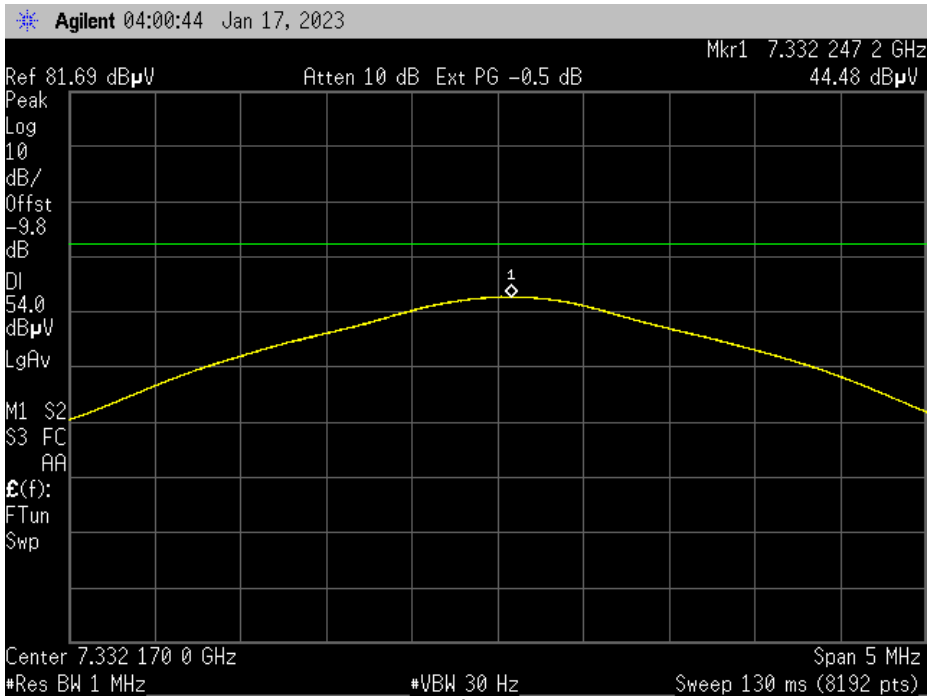
Mid channel 30 – 25000 MHz



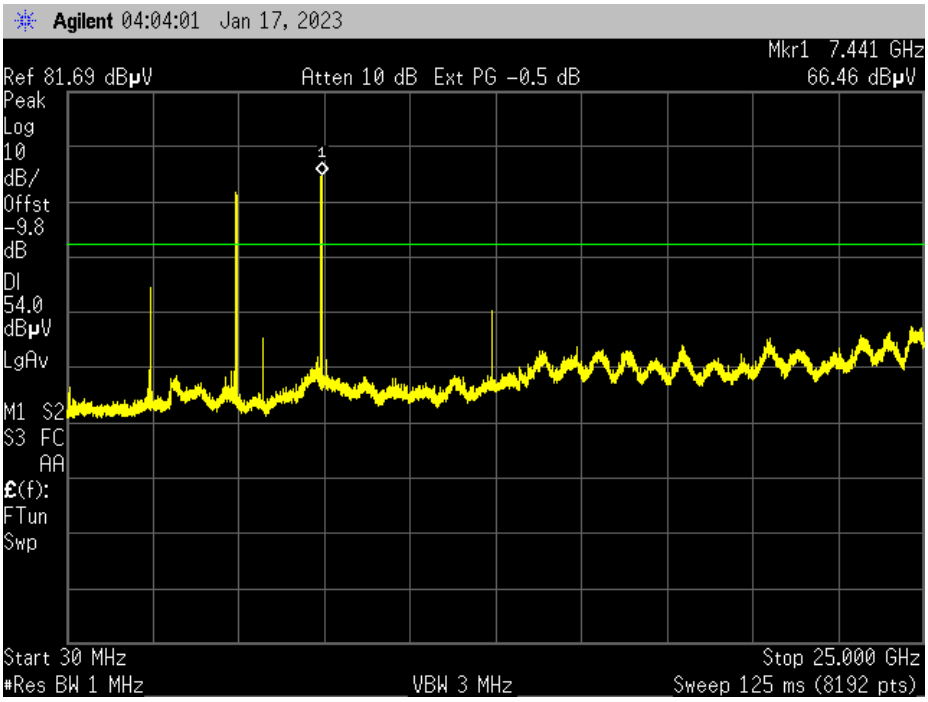
Mid channel Harmonics



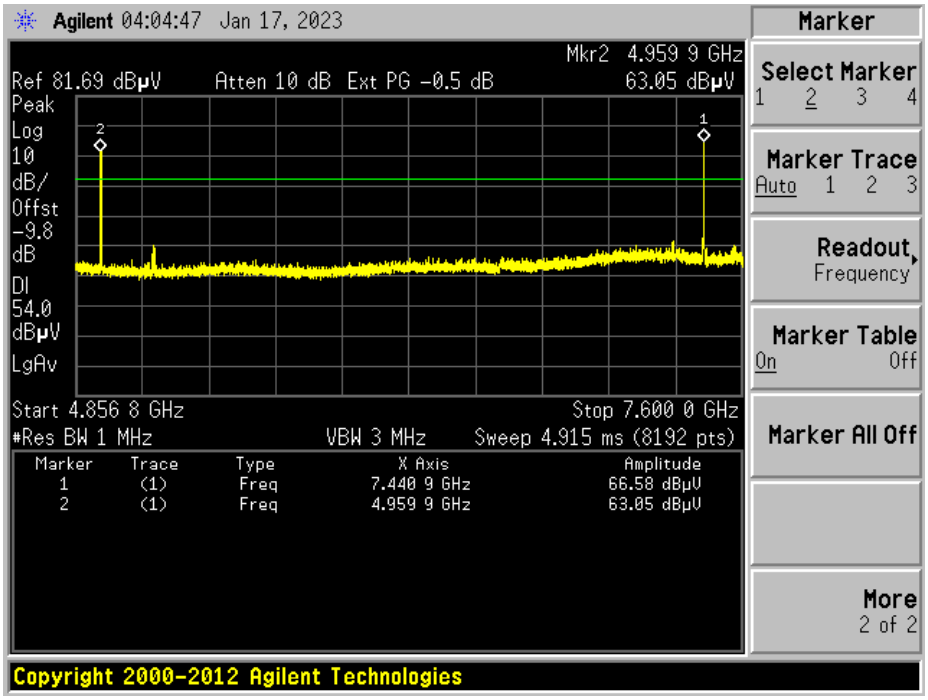
Mid channel 2nd harmonic AVG



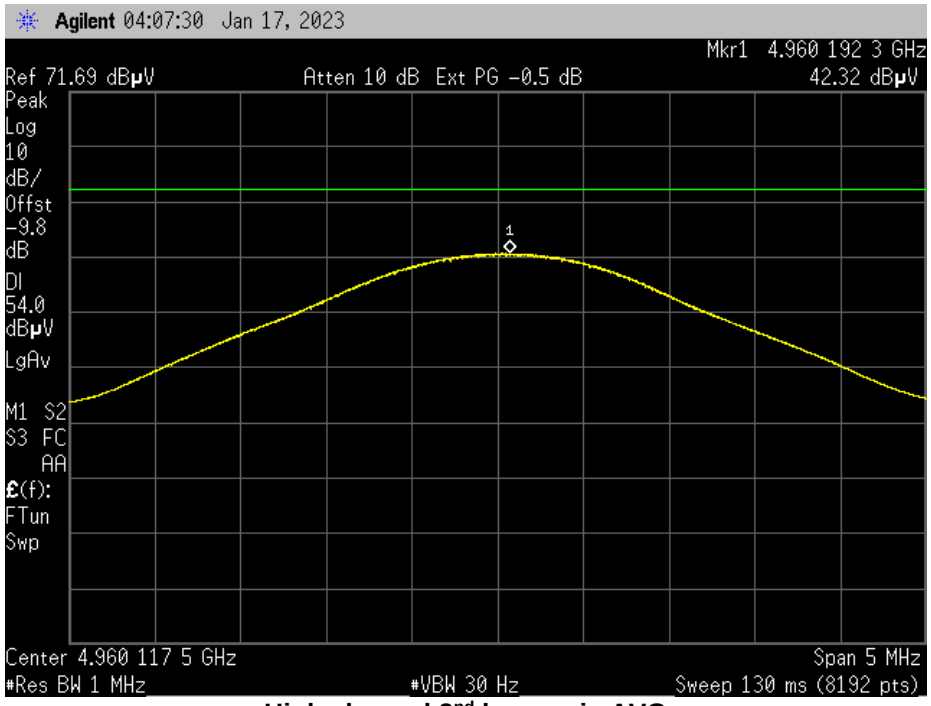
Mid channel 3rd harmonic AVG



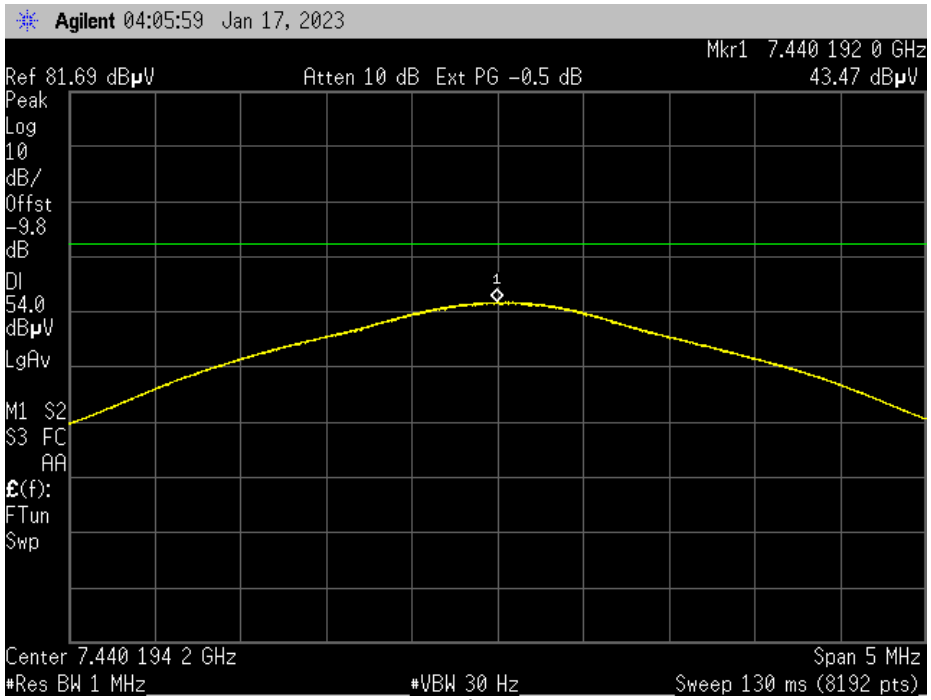
High channel 30 – 25000 MHz



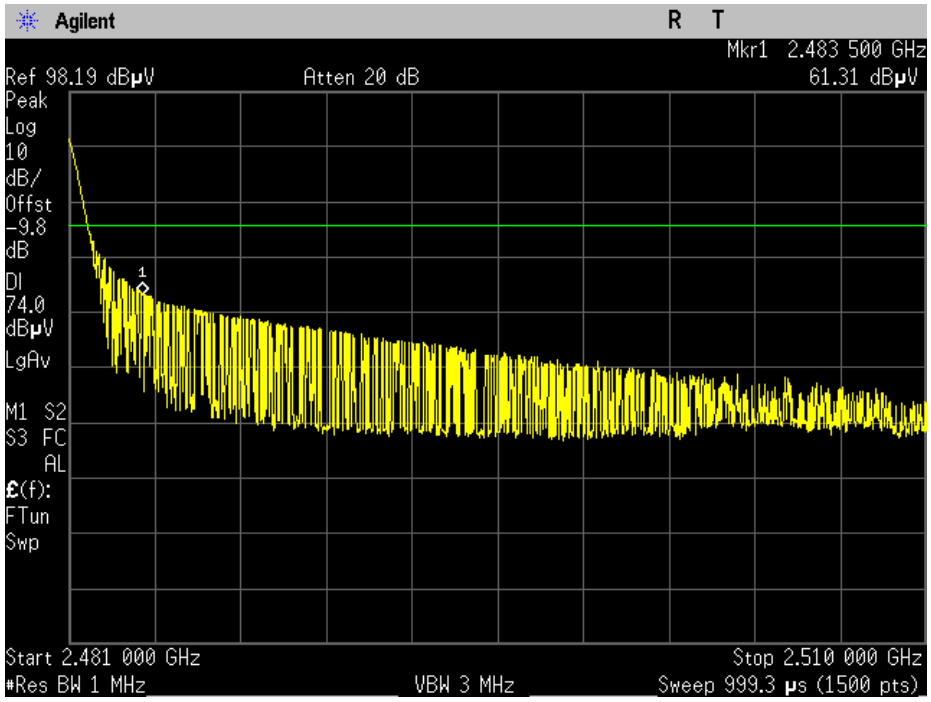
High channel harmonics



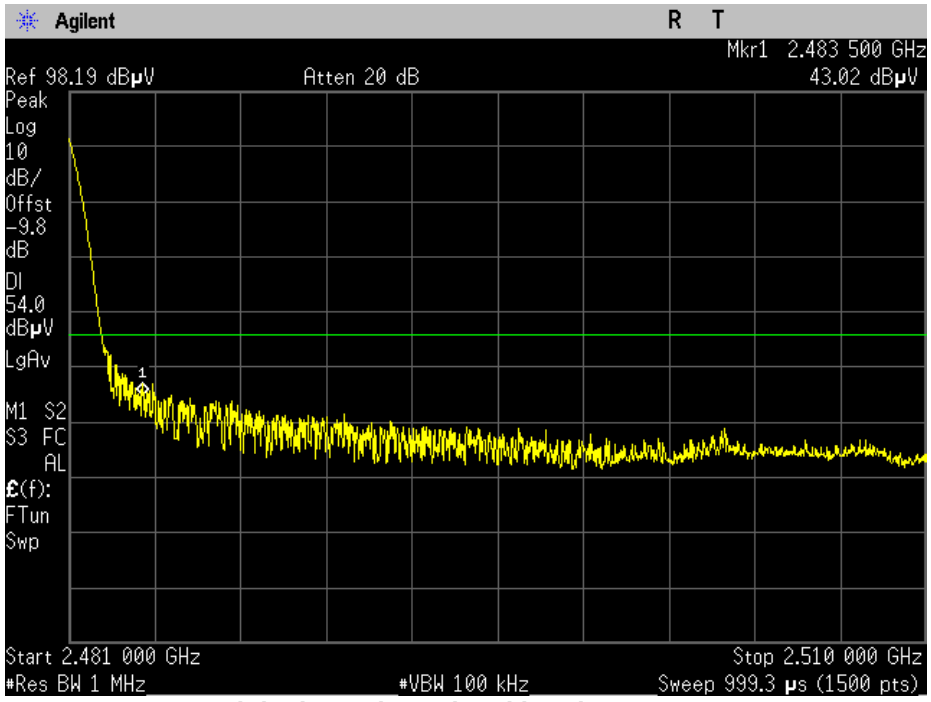
High channel 2nd harmonic AVG



High channel 3rd harmonic AVG



High channel restricted band - Peak



High channel restricted band - Average

Radiated Spurious Emissions

Engineer: John Michalowicz

Test Date: 2/16/23

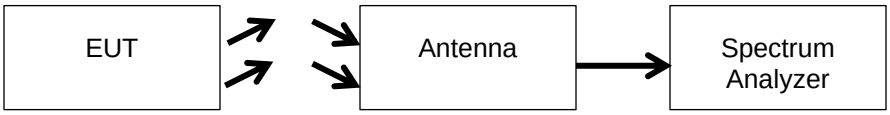
Test Procedure
Radiated Spurious Emissions: 30 – 1000 MHz

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

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

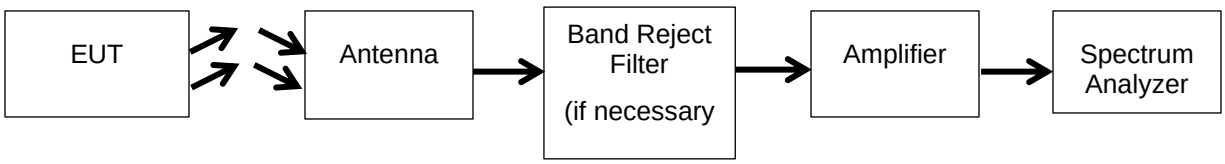
Test Setup

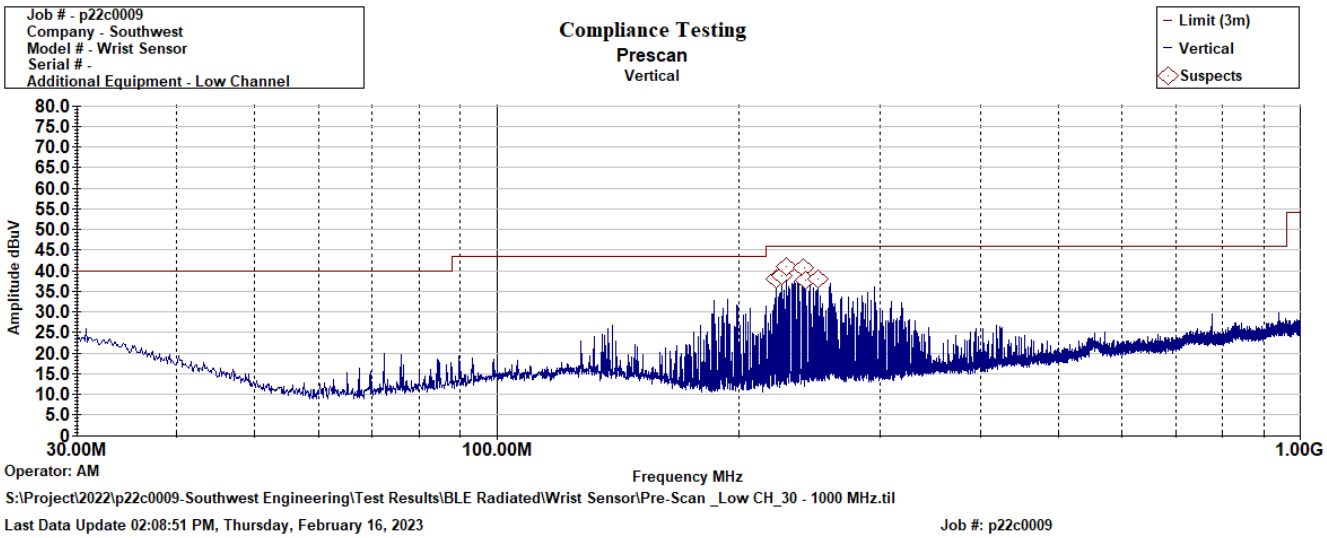


Test Procedure for
Radiated Spurious Emissions above 1 GHz

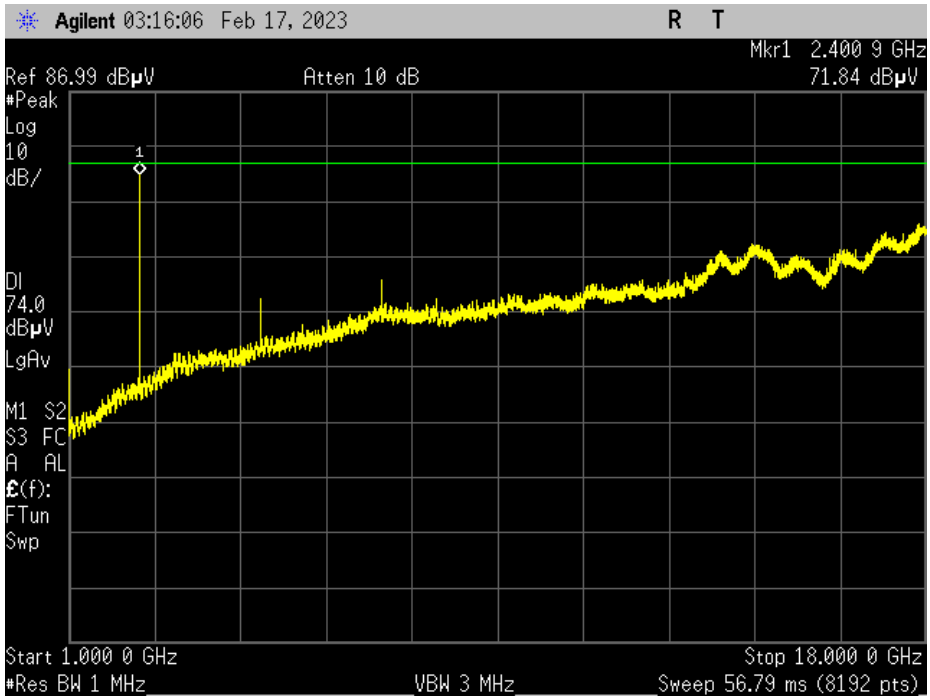
The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The output of the transmitter was connected to a non-radiating balance load. The EUT was set to transmit on the lowest, middle and highest frequencies at the maximum power level. A spectrum analyzer was used to verify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

Test Setup

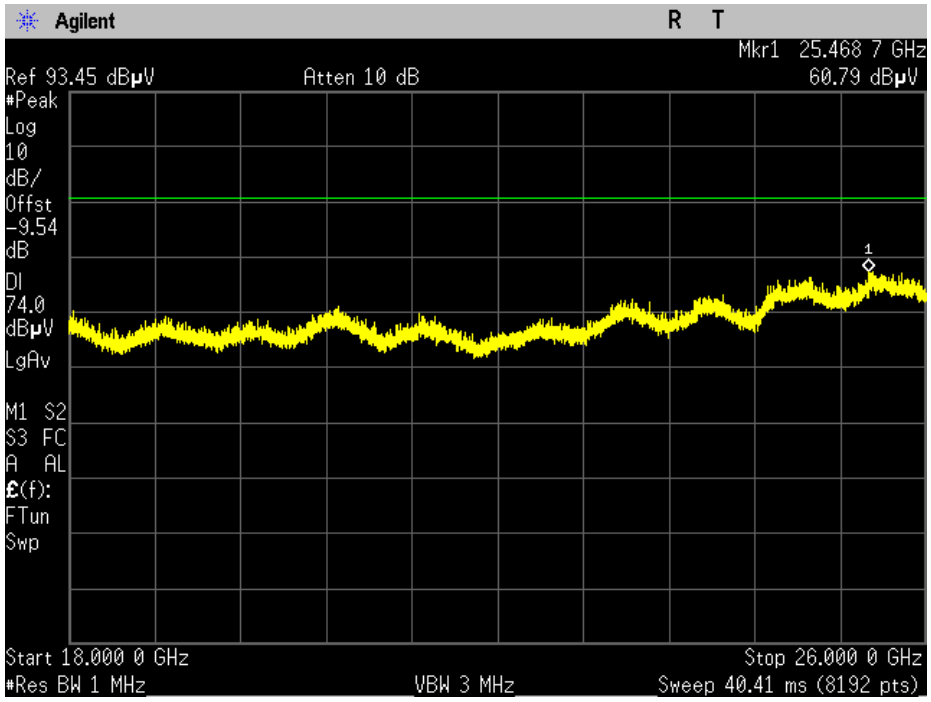




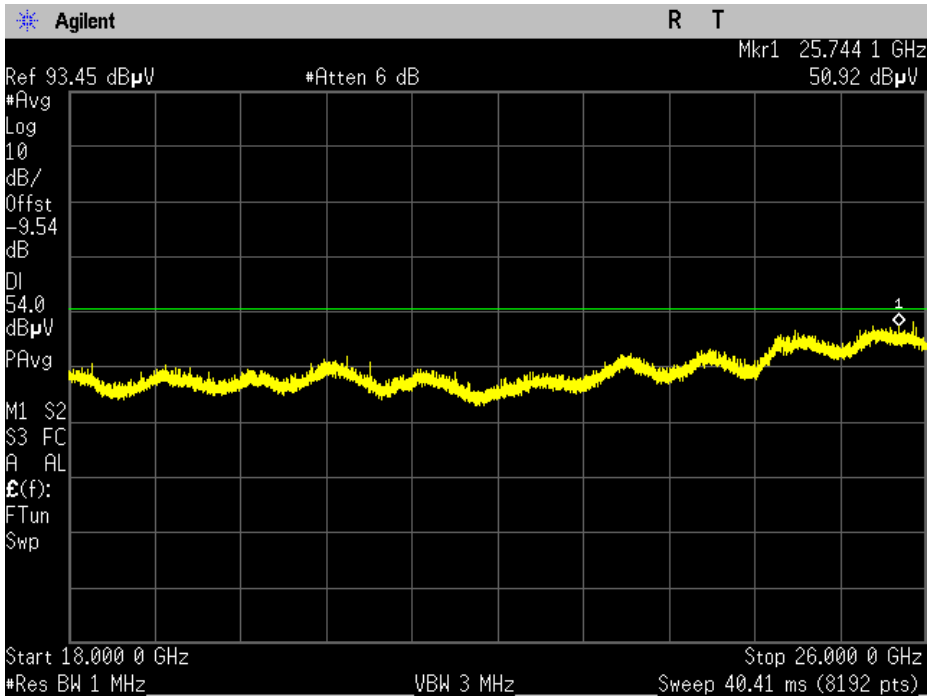
Low channel 30 -1000 MHz



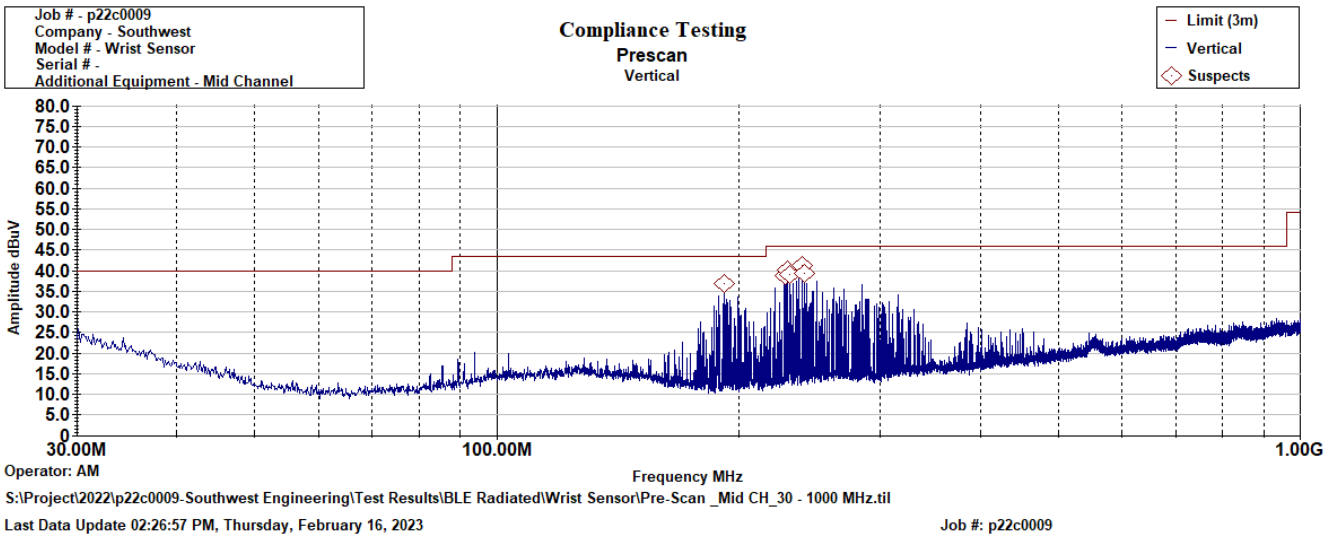
Low channel 1 – 18 GHz



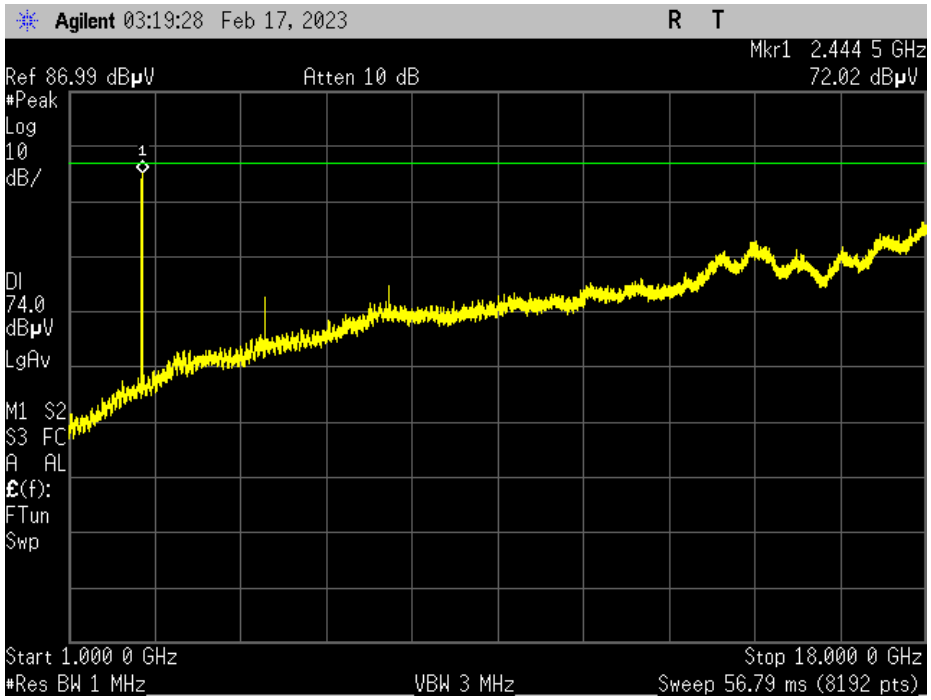
Low channel 18 – 26 GHz Peak



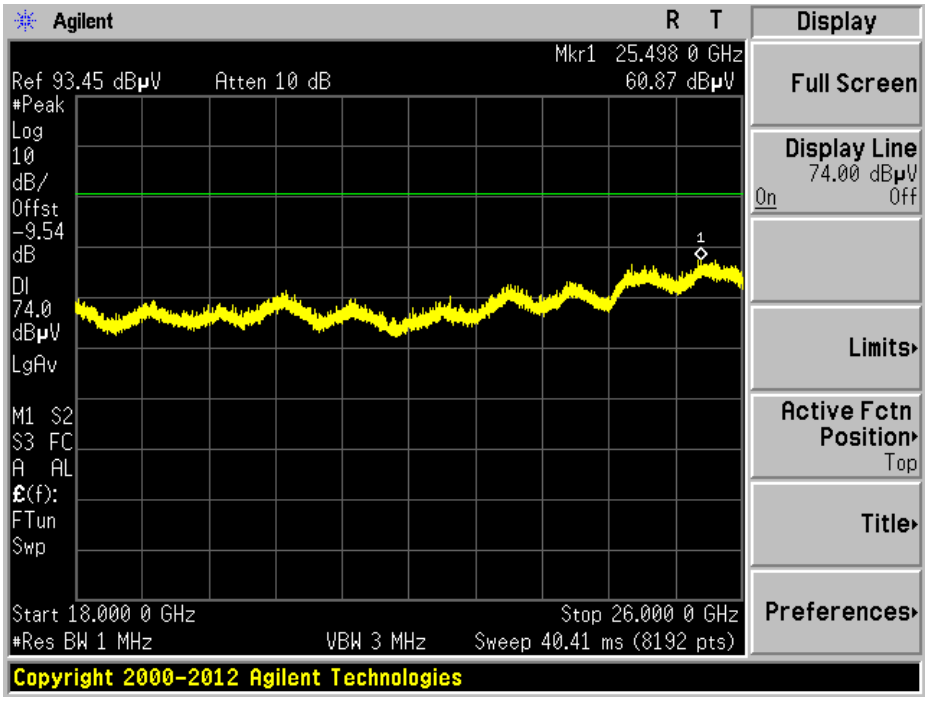
Low channel 18 – 26 GHz AVG



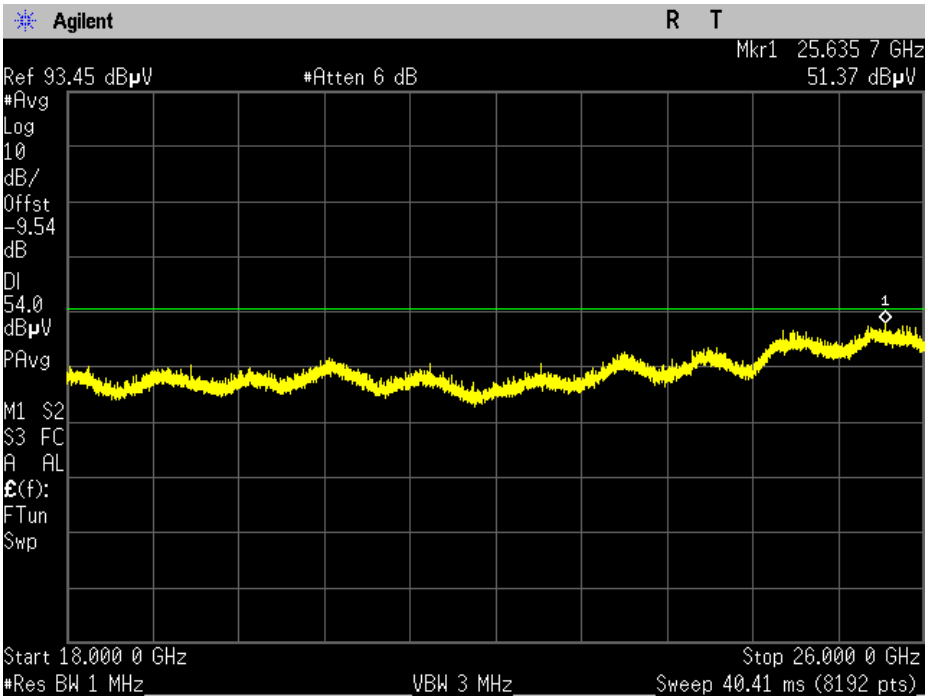
Mid channel 30 – 1000 MHz



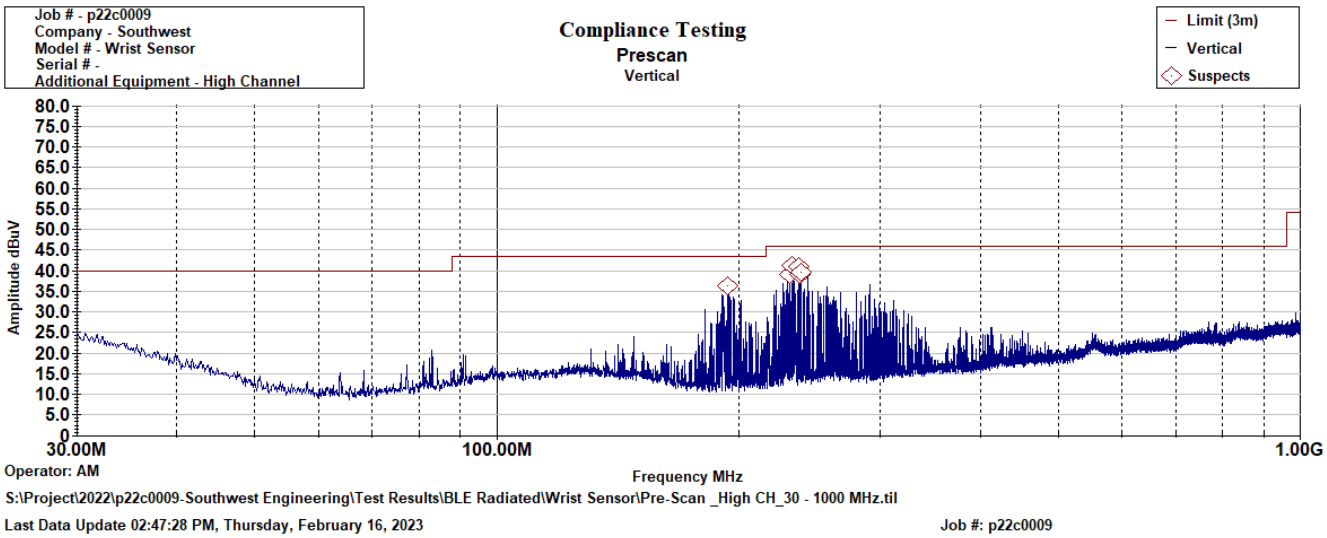
Mid channel 1 – 18 GHz



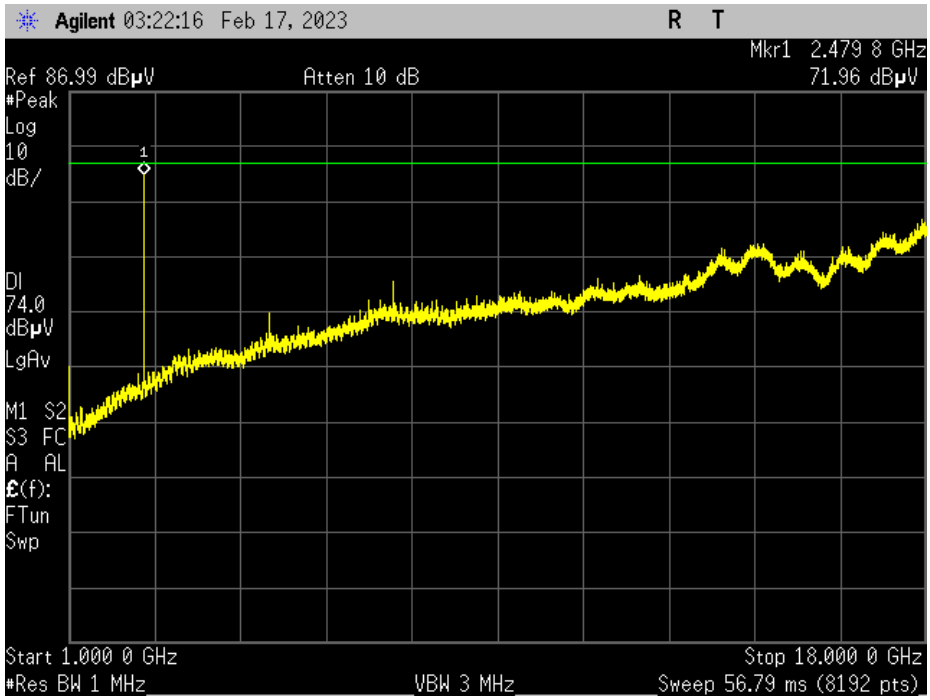
Mid channel 18 – 26 GHz Peak



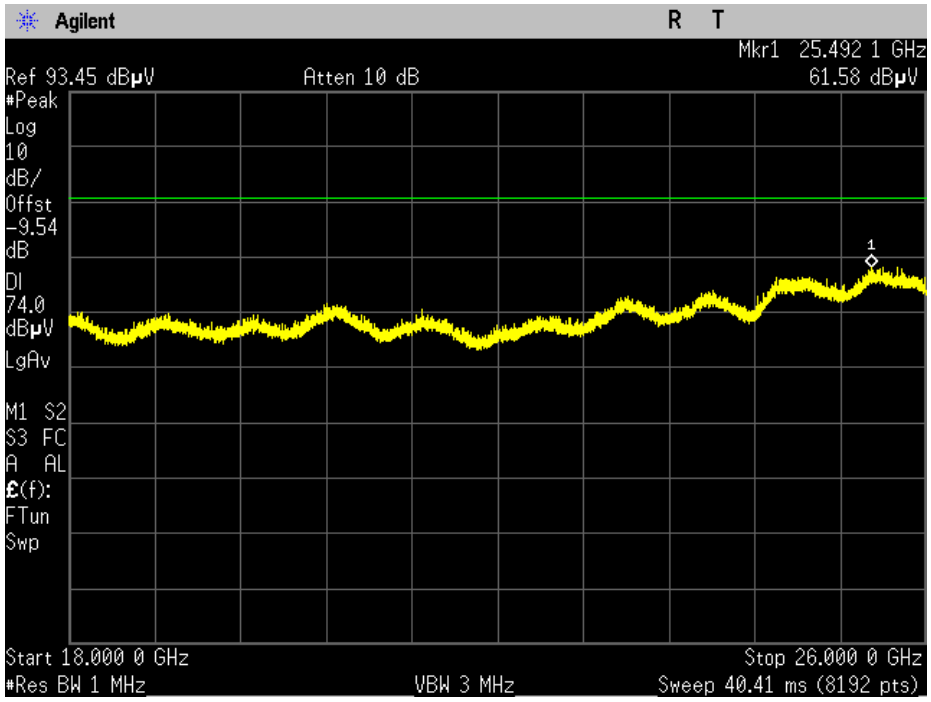
Mid channel 18 – 26 GHz AVG



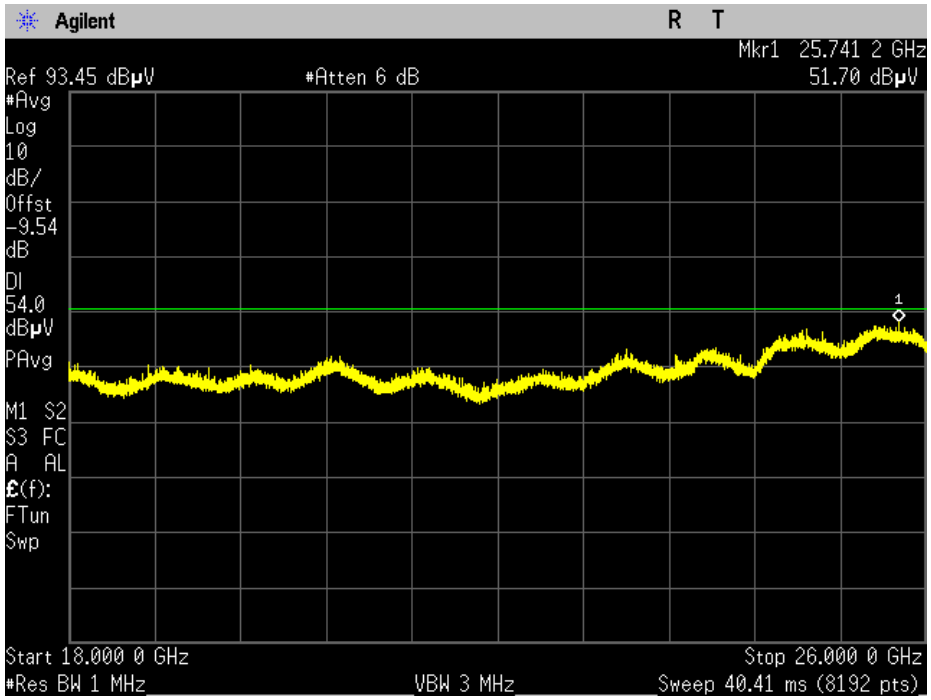
High channel 30 – 1000 MHz



High channel 1 – 18 GHz



High channel 18 – 26 GHz Peak



High channel 18 – 26 GHz AVG

Conducted Spurious Emissions

Engineer: John Michalowicz

Test Date: 1/16/23

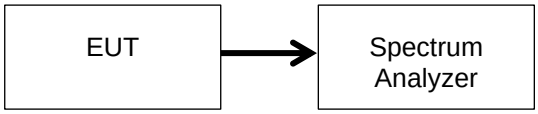
Test Procedure

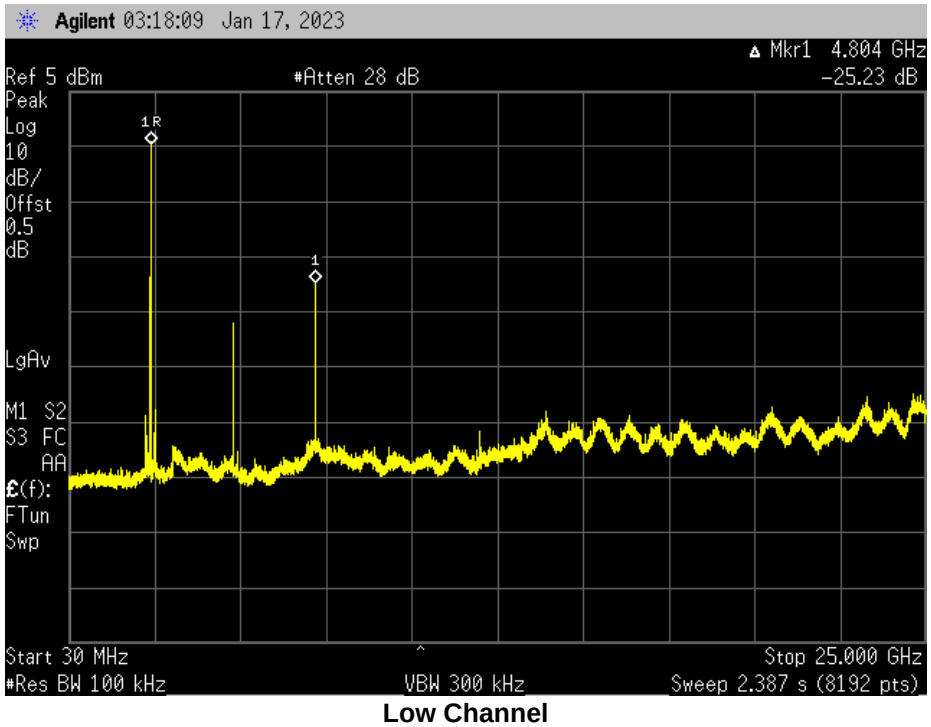
The EUT was connected directly to a spectrum analyzer. The Spectrum Analyzer was set to the following:

RBW = 100 kHz
VBW ≥ 3 x RBW
Peak Detector
Trace mode = max hold
Sweep = auto couple
Frequency Range = 30MHz – 10th Harmonic of the fundamental

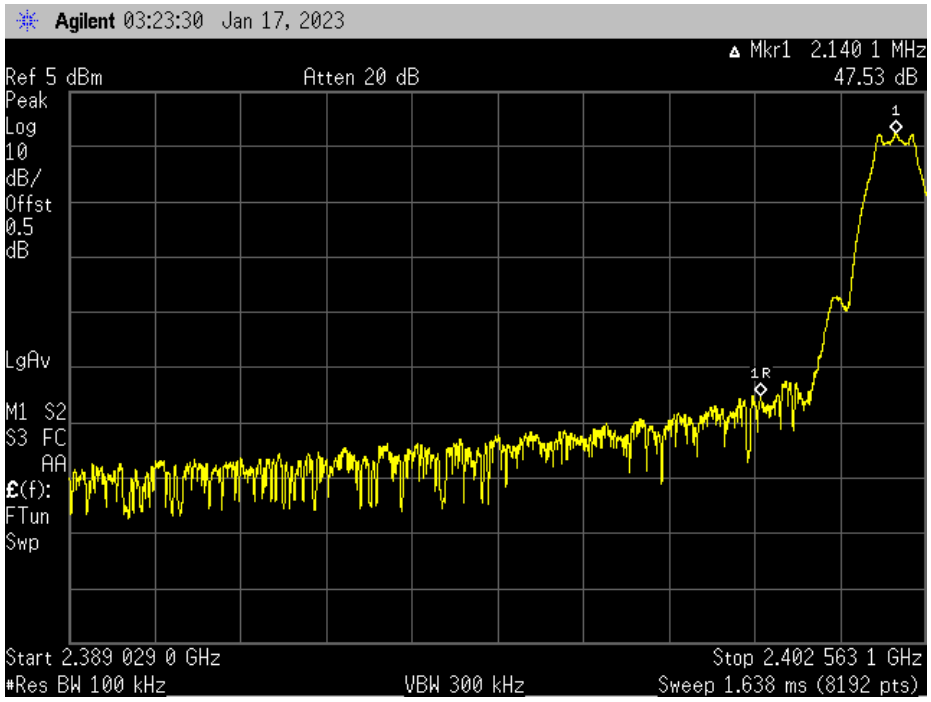
The EUT was set to transmit on the lowest, middle and highest frequencies at the maximum power level. The trace was allowed to stabilize. All emission were investigated to insure they were attenuated from the peak fundamental by at least 20dB. If the average power levels were measured then the out-of-band emissions needed to be attenuated by 30dB. In addition emissions were investigated at the band edges to insure all out-of-band emissions were attenuated 20 or 30dB as necessary.

Test Setup

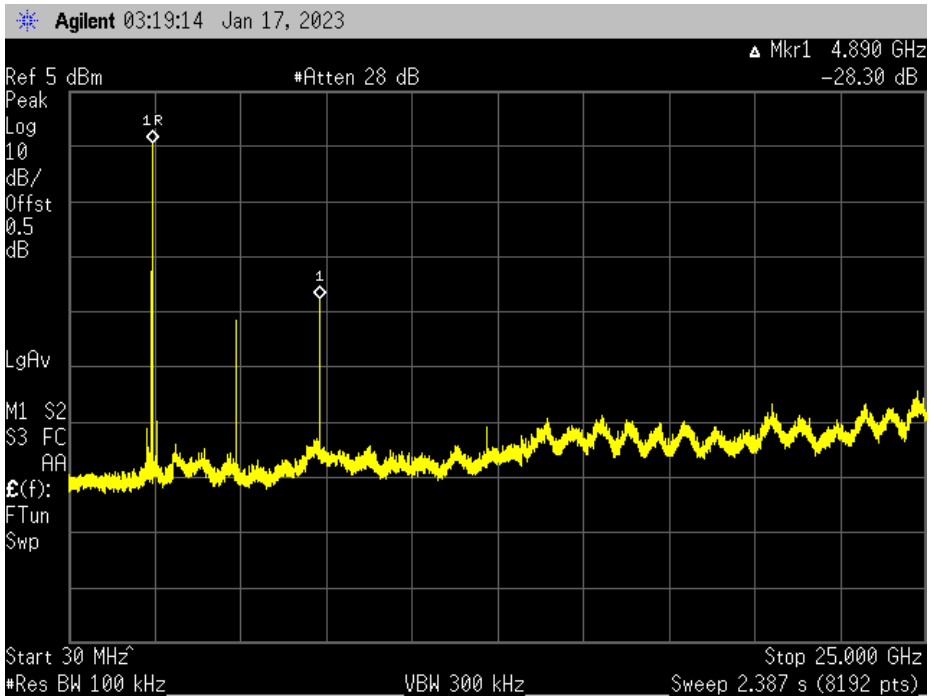




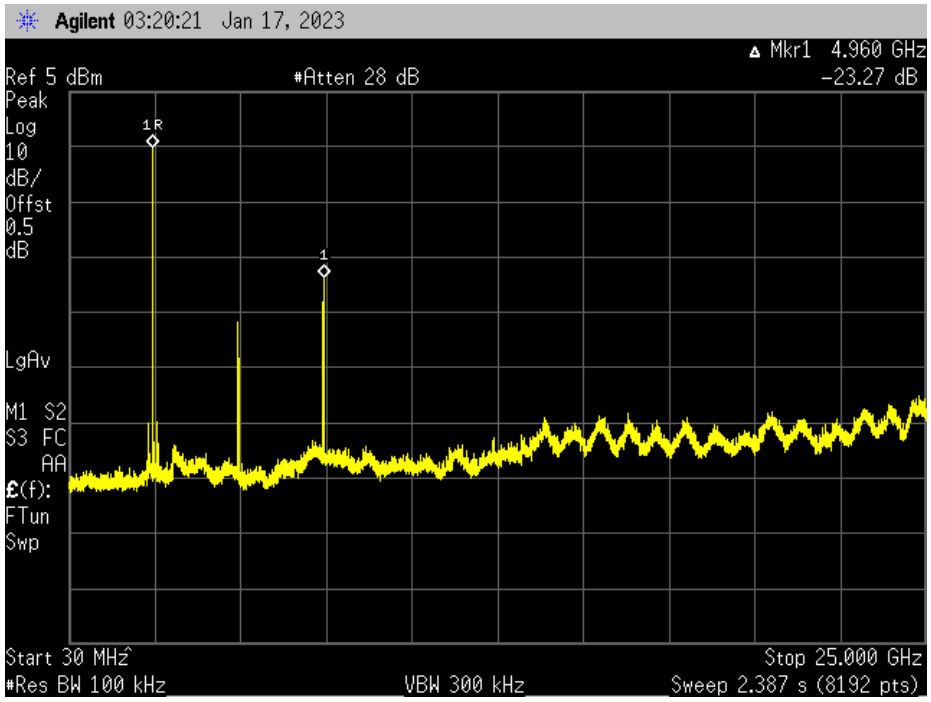
Low Channel



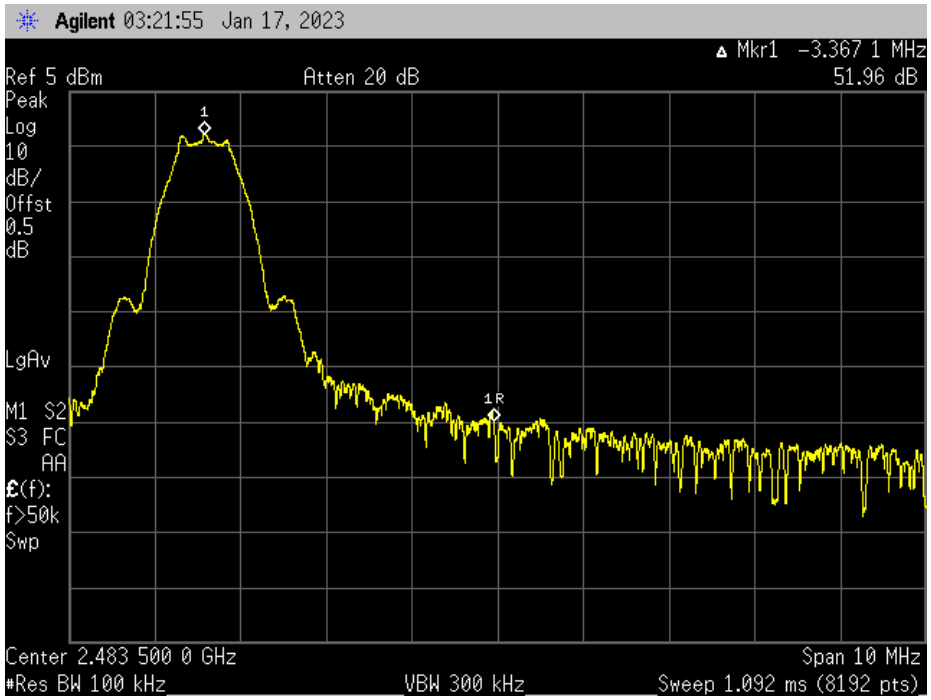
Low channel band edge



Mid channel



High channel



High channel band edge

DTS Bandwidth

Engineer: John Michalowicz
Test Date:1/16/23

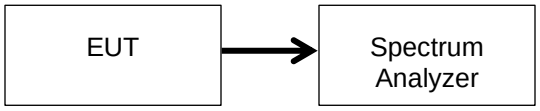
Test Procedure

The EUT was connected directly to a spectrum analyzer. 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

The EUT was set to transmit at the lowest, middle and highest channels of the band at the maximum power levels. The maximum width of the emission that was determined by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that were attenuated by 6db and this value was used to determine the width of the carrier. Alternatively the spectrum analyzer's automatic bandwidth capability was used.

Test Setup

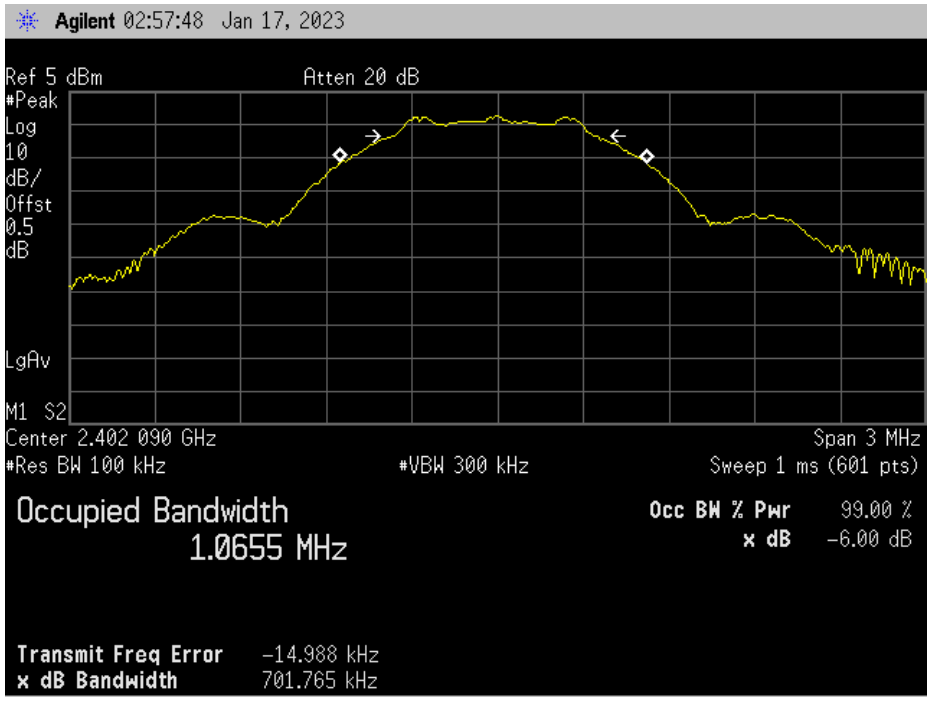


6 dB Occupied Bandwidth Summary

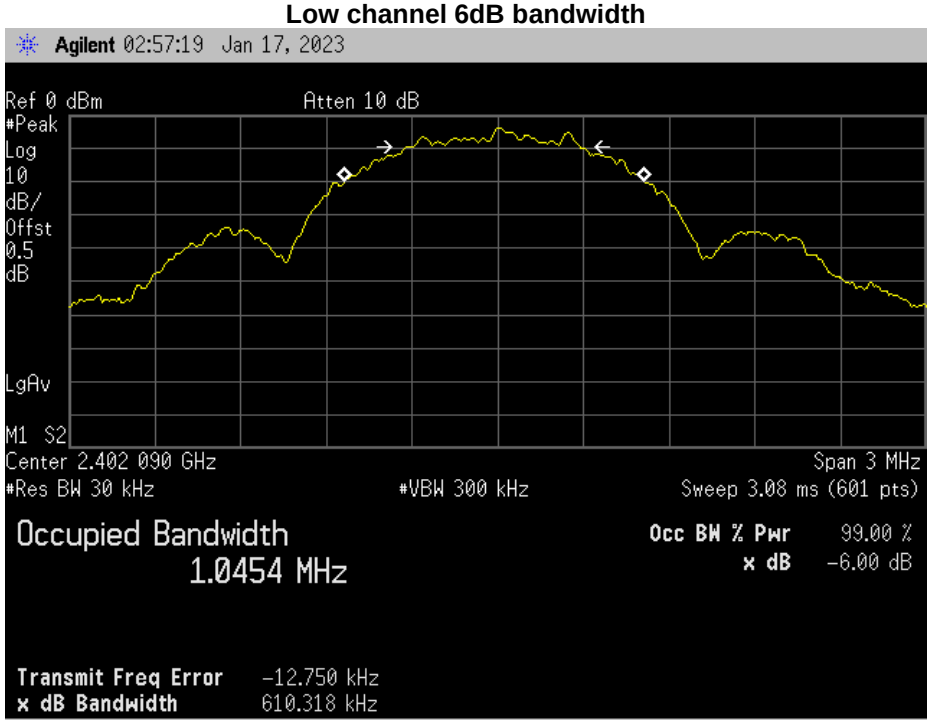
Frequency (MHz)	Measured Bandwidth (MHz)	Specification Limit (kHz)	Result
2402	0.701	≥ 500	Pass
2440	0.713	≥ 500	Pass
2480	0.685	≥ 500	Pass

99% Bandwidth Summary

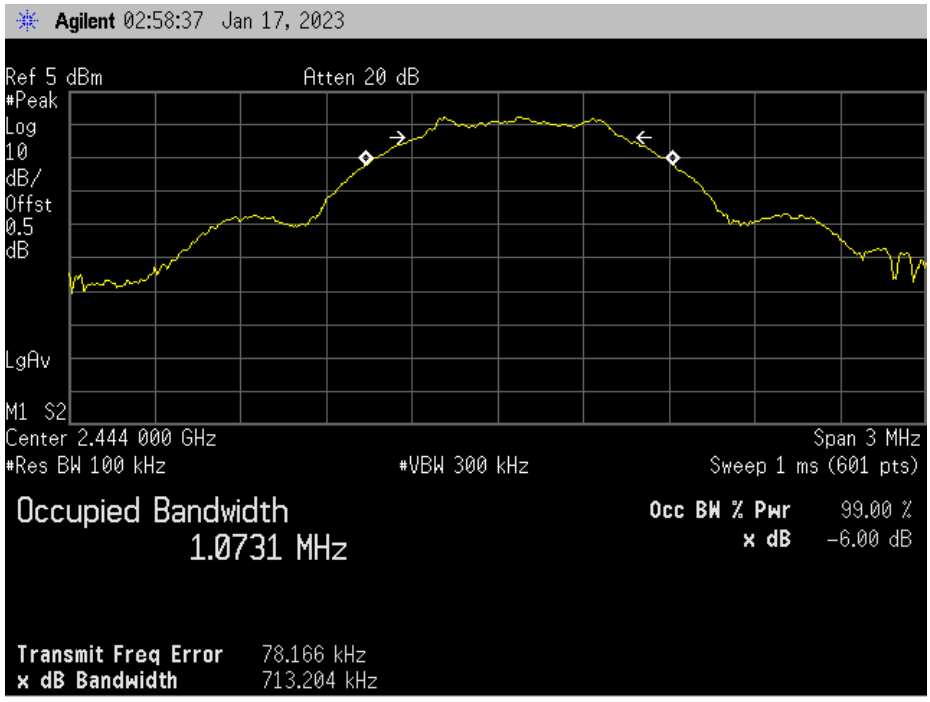
Frequency (MHz)	Measured Bandwidth (MHz)	Result
2402	1.0454	Pass
2440	1.0610	Pass
2480	1.0529	Pass



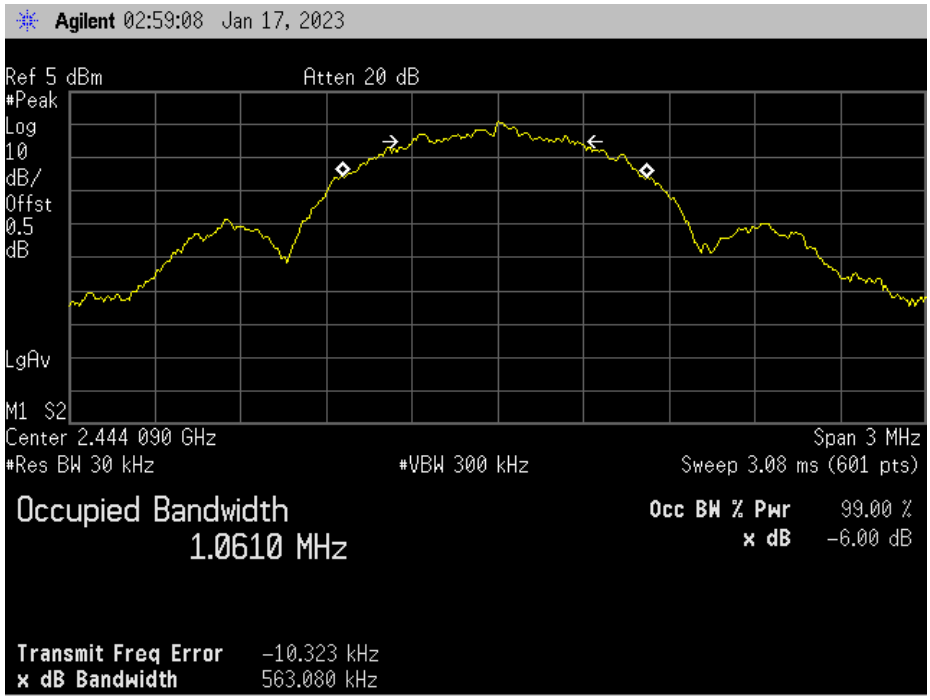
Low channel 6dB bandwidth



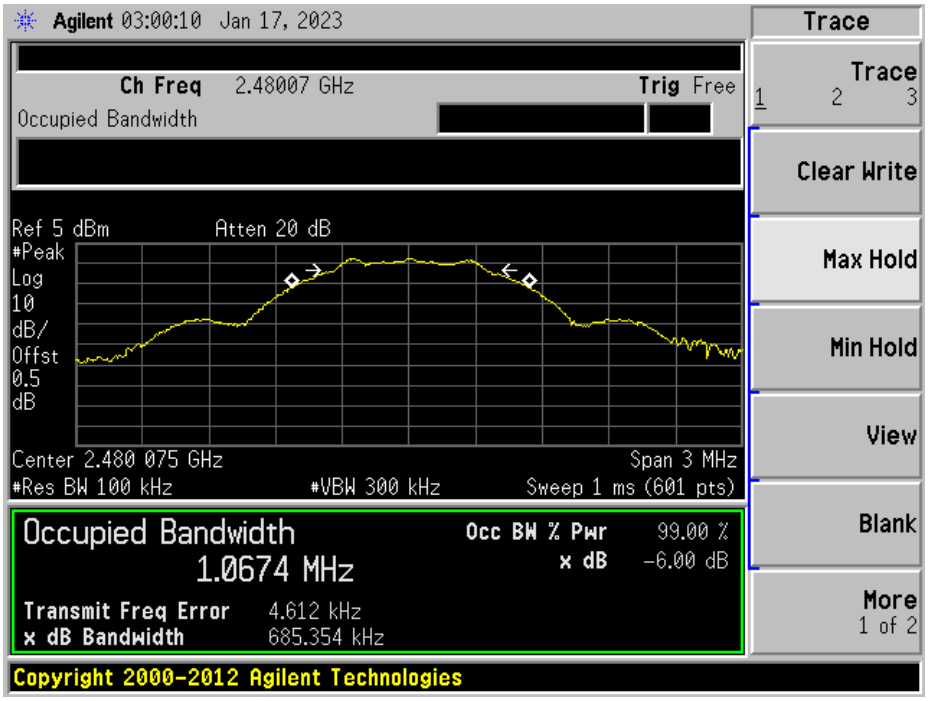
Low channel 99% bandwidth



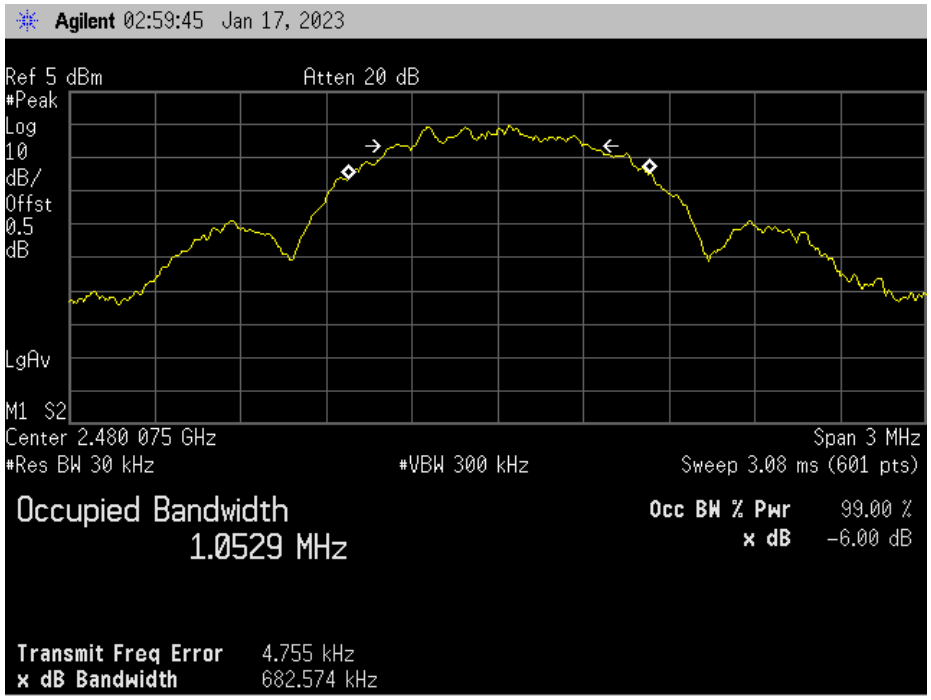
Mid channel 6 dB bandwidth



Mid channel 99%



High channel 6 dB bandwidth



High channel 99% bandwidth

Transmitter Power Spectral Density (PSD)

Engineer: John Michalowicz
Test Date: 1/16/23

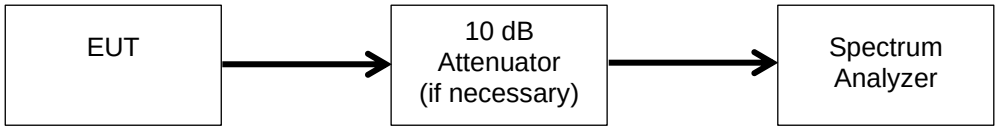
Test Procedure

The EUT was connected directly to a spectrum analyzer. 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

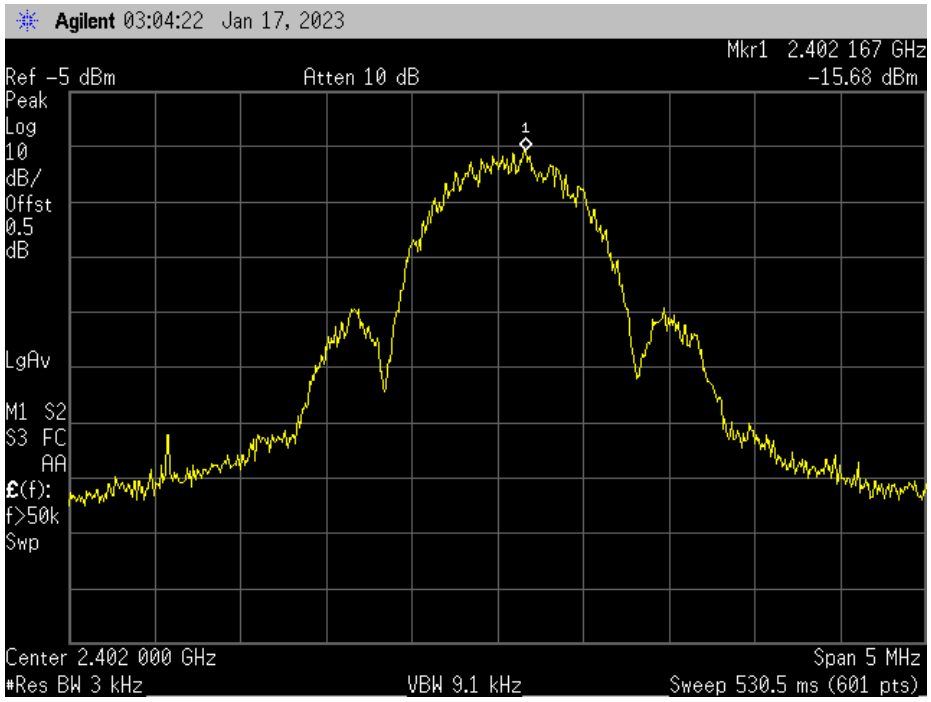
The EUT was set to transmit at the lowest, middle and highest channels of the band at the maximum power levels. Once the trace has stabilize the peak marker was used to determine the peak power spectral density.

Test Setup

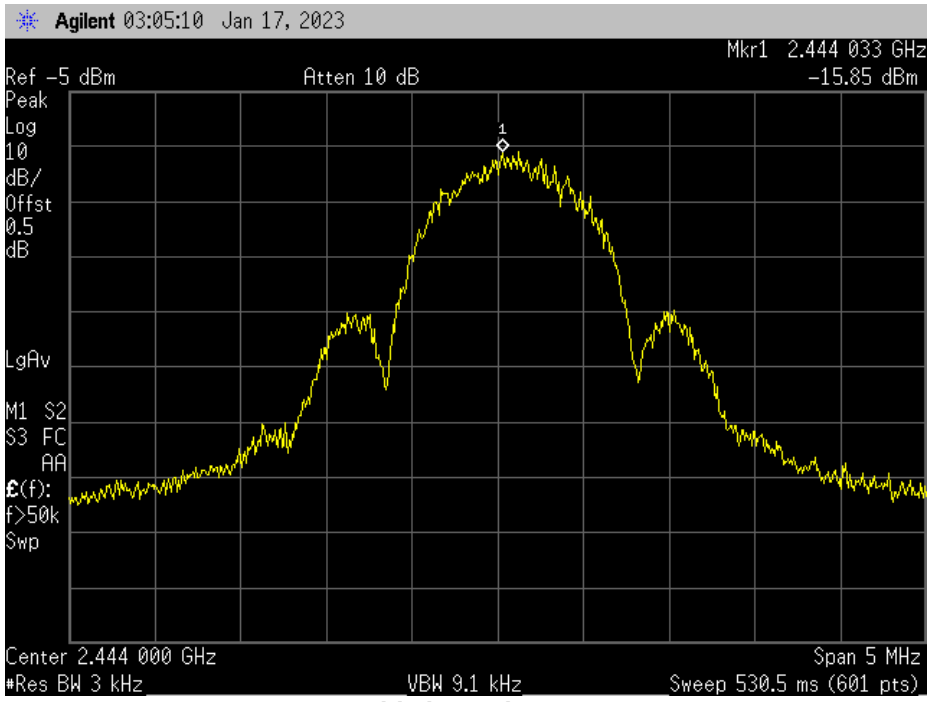


PSD Summary

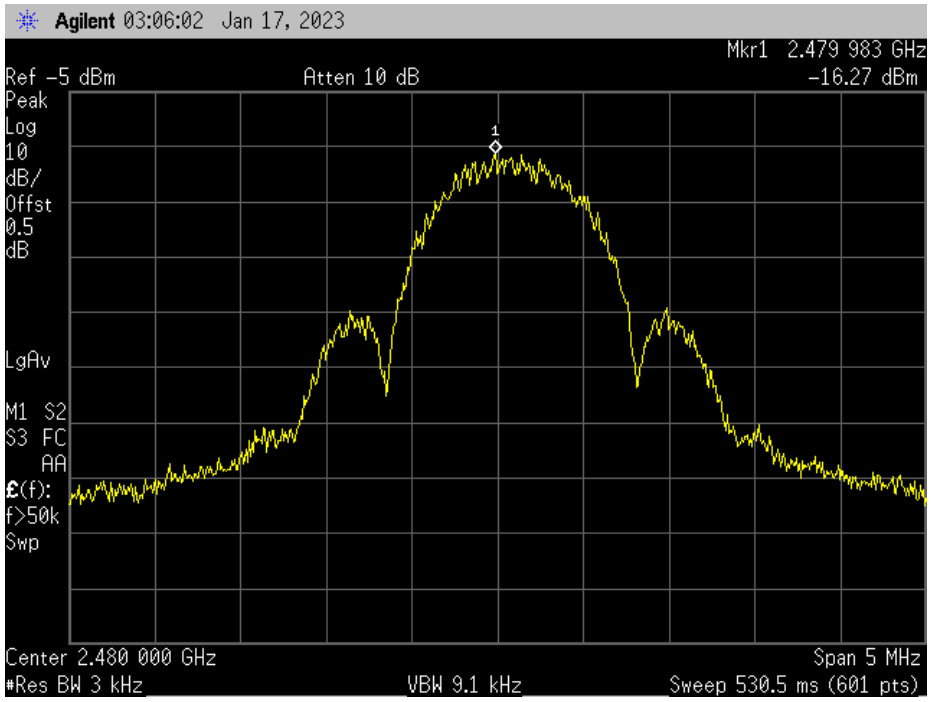
Frequency (MHz)	Measured Data (dBm)	Summed Value (dBm)	Specification Limit (dBm)	Result
2402	-15.68	-12.68	8	Pass
2440	-15.85	-12.85	8	Pass
2480	-16.27	-13.27	8	Pass



Low channel PSD



Mid channel PSD



High channel PSD

Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Horn Antenna (18-40GHz)	EMCO	3116	i00085	2/22/21	2/22/23
Bi-Log antenna	Chase	CBL6111C	i00267	8/10/22	8/10/24
Horn Antenna	ARA	DRG-118/A	i00271	8/11/22	8/11/24
44GHz EMI receiver	Keysight	N9038A	i00552	2/24/22	2/24/23
3 Meter Semi-Anechoic Chamber	Panashield	3 Meter Semi-Anechoic Chamber	i00428	7/17/20	7/17/23
Preamplifier	Eravant	SBB-0115034018-2F2F-E3	i00650	Verified on: 1/31/23	
Temp./humidity/pressure monitor	Omega Engineering	iBTHX-W-5	i00686	1/5/23	1/5/24
Spectrum Analyzer	Agilent	E4407B	i00687	11/18/22	11/18/23
PSA Spectrum Analyzer	Agilent	E4448A	i00688	11/8/22	11/8/23
Spectrum Analyzer	Rhode & Schwarz	FSW	SN: 102475	7/18/22	7/18/23

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