FCC & ISED CANADA CERTIFICATION TEST REPORT

for the

BATTERY PACK MODULE

FCC ID: YJ7-NA091171

IC ID: 9082A-NA091171

WLL REPORT# 18508-01 REV 2

Prepared for:

Stanley Black & Decker, Inc.

701 East Joppa Road

Towson, Maryland 21286

Prepared By:

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Frederick, Maryland 21703

Testing Certificate AT-1448

FCC & ISED Canada Certification Test Report

for the

Stanley Black & Decker, Inc.

Battery Pack Module, Model: NA091171

FCC ID: YJ7-NA091171

ISED ID: 9082A-NA091171

April 23, 2024

WLL Report# 18508-01 Rev 2

Prepared by:

Ryan Mascaro
RF Test Engineer

Reviewed by:

Steven D. Koster
President

Abstract

This report has been prepared on behalf of Stanley Black & Decker, Inc. to support the attached Application for Equipment Authorization. The test report and application are submitted for a Digital Transmission System (DTS) transmitter under Part 15.247 of the FCC Rules and Regulations (current at the time of testing) and under Innovation, Science and Economic Development (ISED) Canada RSS-247 Issue 3 (8/2023). This certification test report documents the test configuration and test results for the Stanley Black & Decker, Inc., Battery Pack Module model number NA091171. The information provided in this report is only applicable to device herein documented as the EUT.

Radiated testing was performed in the Free-space Anechoic Chamber Test-site (FACT) 3m chamber of Washington Laboratories, Ltd., located at: 4840 Winchester Boulevard, Suite #5., Frederick, MD 21703. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Certificate AT-1448 as an independent FCC test laboratory. The ISED Canada number for Washington Laboratories is 3035A.

The Stanley Black & Decker, Inc., Battery Pack Module (NA091171) [FCC ID: YJ7-NA091171] complies with the requirements for a Digital Transmission System (DTS) hybrid transmitter device under FCC Part 15.247 and ISED Canada RSS-247 Issue 3 (8/2023).

Revision History	Description of Change	Date
Rev 0	Initial Release	April 23, 2024
Rev 1	Typos Repaired, Added AC Powerline Data	June 14, 2024
Rev 2	Removed non-applicable reference	June 17, 2024

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1 Introduction

1.1 Compliance Statement

The Stanley Black & Decker, Inc., Battery Pack Module (NA091171) complies with the requirements for a Digital Transmission System (DTS) hybrid transmitter device under FCC Part 15.247 and ISED Canada RSS-247 Issue 3 (8/2023).

1.2 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed. All measurements were performed in accordance with ANSI C63.10-2020 "ANSI Procedures for Compliance Testing of Unlicensed Wireless Devices". The measurement equipment conforms to ANSI C63.2 "Specifications for Electromagnetic Noise and Field Strength Instrumentation". The modules were tested "stand alone" as required for modular testing and approval.

1.3 Contract Information

Customer:	Stanley Black & Decker, Inc.
Purchase Order Number:	M866023C
Quotation Number:	74621

1.4 Test and Support Personnel

Washington Laboratories, LTD	Ryan Mascaro
Customer Representative	Kirwan Magdamo

1.5 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Frederick, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The ISED Canada OATS number for Washington Laboratories, Ltd. is 3035A. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Testing Certificate AT-1448 as an independent FCC test laboratory.

2 Equipment Under Test

2.1 EUT Identification

Table 1: Device Summary

Manufacturer:	Stanley Black & Decker, Inc.
FCC ID:	YJ7-NA091171
IC ID:	9082A-NA091171
EUT Model:	Battery Pack Module
Part Number:	NA091171
FCC Rule Parts:	§ 15.247
ISED Rule Parts:	RSS-247
ISED HVIN:	NA091171
Frequency Range:	2402 to 2480 MHz
Peak Output Power:	1.25 dBm (1.33 mW)
Antenna Type:	PCB meander trace, peak gain: -5.44 dBi
FCC Emission Designator:	712KG1D
IC Emission Designator:	1M1G1D
6dB Occupied Bandwidth:	712.3 kHz
99% Occupied Bandwidth:	1.08 MHz
Protocol:	Bluetooth Low Energy (BLE)
Modulation and Data Rate:	GFSK, 1Mbps
Keying:	Automatic
Type of Information:	Digital
Number of Channels:	40
Interface Cables:	N/A
Power Source & Voltage:	20VDC battery
Worst-Case TX Spurious Emission:	Antenna Port Conducted: -47.09 dBm (see Figure 25)
Software/Firmware Version:	Not Declared by Applicant
Testing Dates:	4/9/2024, 4/10/2024, & 6/14/2024 (also see Table 13).

2.2 EUT Description

The NA091171 is a BLE (Bluetooth Low Energy) battery management module. The device is intended to be powered from a host 20V (5S1P) Li-ion battery pack.

2.3 Test Configuration and Algorithm

The NA091171 Battery Pack Module was provided in a variety of engineering samples that were configured for testing. The EUT samples were loaded with test-mode software/firmware to allow individual samples to dwell, hop, sweep, and/or receive only as needed for required testing. The EUT was tested in a powered on, steady state. The 2.4GHz BLE radio was exercised as necessary to meet the requirements of the testing. For conducted methods of measurement, the BLE radio was observed through the uFl antenna port. For radiated emissions below 1GHz, the EUT was set to transmit in a hopping enabled mode. For radiated emissions above 1GHz, the EUT was set to transmit at the each of the Low, Center, and High Channels. Only the worst-case emissions are provided throughout this report. Additionally, for transmit power setting, or transmit gain setting, please note that the test-mode software was set to a value of "3". This setting was maintained for all testing. The modules were tested "stand alone" as required for modular testing and approval.

The EUT was comprised of the following equipment, provided on the following page. All Modules, PCBs, etc. listed were considered as part of the EUT, as tested.

Table 2: System Configuration List

Name / Description	Model Number	Part Number	Serial Number	Rev. #
NA091171	-	NA091171	1	E2
NA091171	-	NA091171	2	E2
NA091171	-	NA091171	3	E2
NA091171	-	NA091171	4	E2
NA091171	-	NA091171	5	E2
NA091171	-	NA091171	6	E2
NA091171	-	NA091171	7	E2
NA091171	-	NA091171	8	E2
NA091171	-	NA091171	9	E2
NA091171	-	NA091171	10	E2

Table 3: Support Equipment

Name / Description	Manufacturer	Model Number	Calibration Data
20V Power Supply	BK Precision	9110	N/A
AC Mains Cords	-	-	N/A
Banana to mini-grabber (Black)	Pomona	EM3782-72-0#	N/A
Banana to mini-grabber (Red)	Pomona	EM3782-72-2#	N/A

Table 4: Cable Configuration

Ref. ID	EUT Port Name	Cable Description	Qty.	Length (m)	Shielded	Termination Port ID
1	BUS1	B- (GND)	1	1.8 m	No	
2	CT1	Not Tested/Needed	0	-	No	
3	CT2	Not Tested/Needed	0	-	No	
4	CT3	Not Tested/Needed	0	-	No	
5	CT4	Not Tested/Needed	0	-	No	
6	CT5 (Cell Tap 5)	B+ (20V)	1	1.8 m	No	
7	J2 - RF Out	Coax with u.fl connector	1	-	Yes	EMC Receiver
8	T1 (Terminal Block)	Not Tested/Needed	0	-	No	

3 Test Results

The table below shows the results of testing for compliance with a Digital Transmission System in accordance with FCC Part 15.247 and RSS-247 Issue 3. Full test results are shown in subsequent sub-sections.

Table 5: Testing and Results Summary

Digital Transmission System			
FCC Rule Part	**IC Rule Part**	**Description**	**Result**
15.247(a)(2)	RSS-247 [5.2 (a)]	Occupied Channel Bandwidth	Pass
15.247 (b)(3)	RSS-247 [5.4 (d)]	Transmit Output Power	Pass
15.247 (e)	RSS-247 [5.2 (b)]	Power Spectral Density	Pass
15.247 (d)	RSS-247 [5.5]	Out-of-Band Emissions (Band Edge @ 20dB below)	Pass
15.205 15.209	RSS-Gen [8.9/8.10]	General Field Strength Limits (Restricted Bands & RE Limits)	Pass
15.207	RSS-Gen [8.8]	AC Conducted Emissions	Pass

3.1 Deviations to the Test Standard

There were no deviations to the requirements of the standard(s).

3.2 Occupied Bandwidth, Digital Transmission System

For a DTS operating in the 2.4GHz band, FCC Rule Part 15.247(a)(2) and RSS-247, 5.2(a) require the minimum 6dB bandwidth be at least 500 kHz. The 99% BW shall also be recorded.

The transmitter occupied bandwidth was measured conducted at the antenna port, by coupling the output of the EUT transmitter to the input of a spectrum analyzer. The measurement level was corrected for any cable and attenuator losses.

3.2.1 Measurement Method

This test was performed in accordance with Clause 11.8.2, Option 2, of ANSI C63.10-2020.

3.2.2 Test Data

The EUT test data is provided below.

The EUT was configured to transmit a 1Mbps, QPSK modulated signal, with channel hopping disabled.

Table 6: Occupied Bandwidth Results

Frequency	6dB Bandwidth	99% Bandwidth	Result
Low Channel, 2402 MHz	712.3 kHz	1.08 MHz	Pass
Center Channel, 2440 MHz	751.5 kHz	1.08 MHz	Pass
High Channel, 2480 MHz	717.4 kHz	1.08 MHz	Pass

Figure 1: Occupied Bandwidth, Low Channel

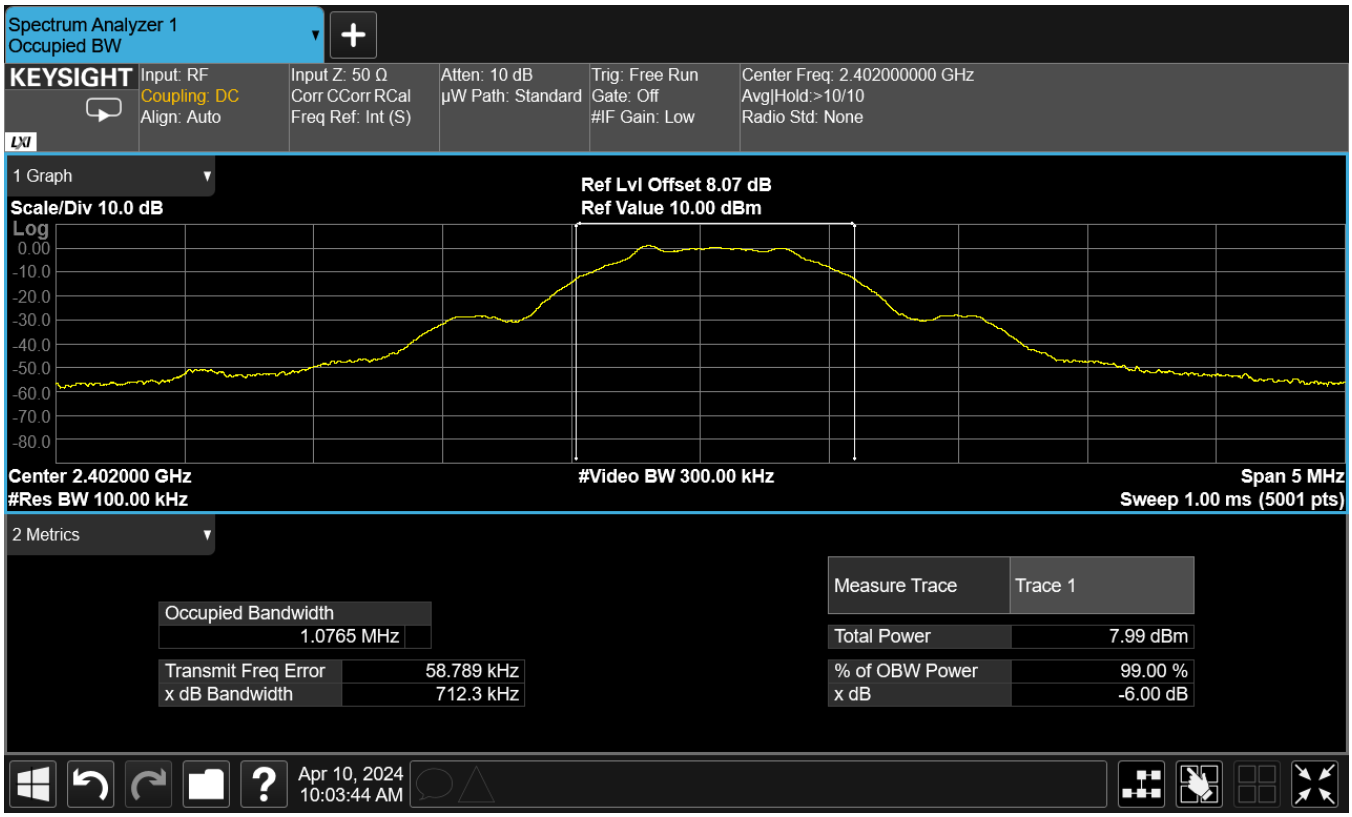


Figure 2: Occupied Bandwidth, Center Channel

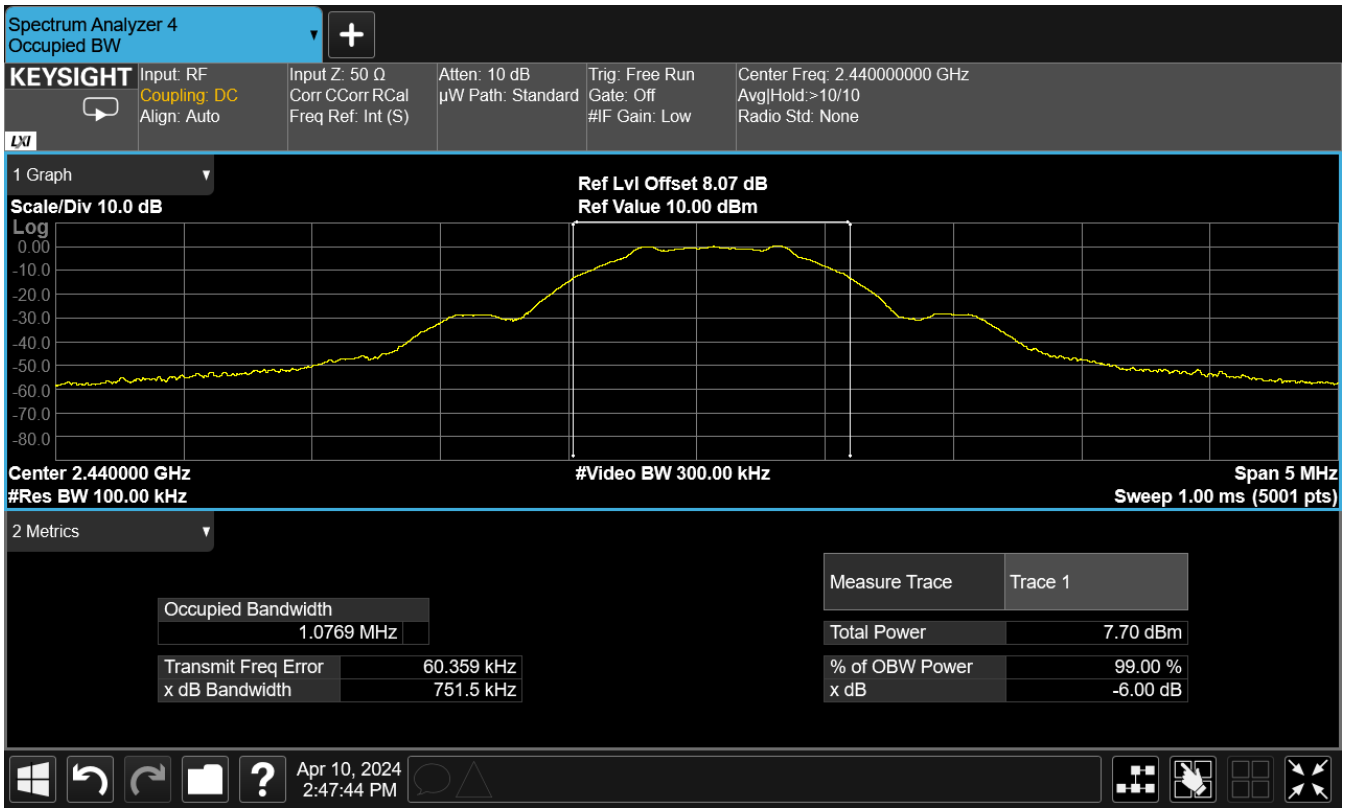
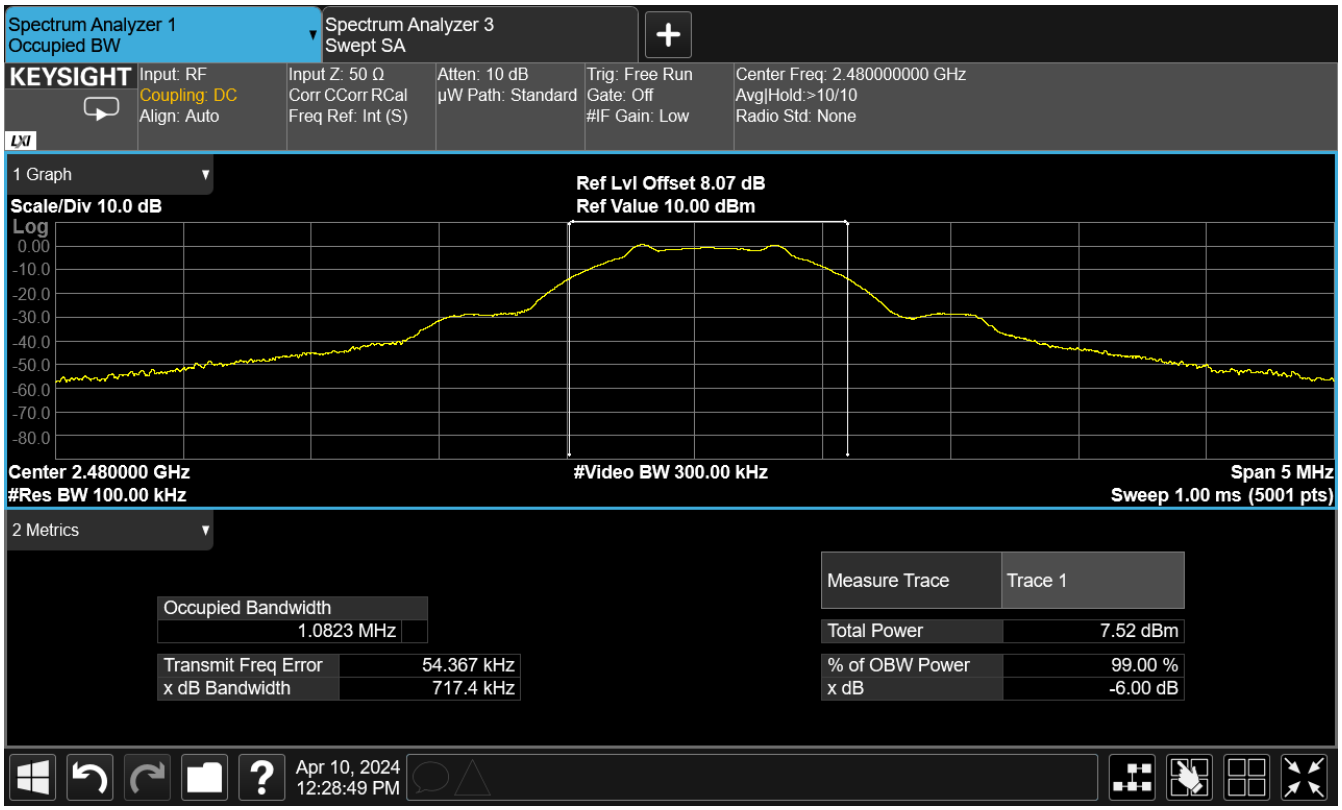


Figure 3: Occupied Bandwidth, High Channel



3.3 Conducted Peak Output Power

For a DTS operating in the 2.4GHz band, FCC Rule Part 15.247(b)(3) and RSS-247, 5.4(d) require that the maximum peak conducted output power shall not exceed 30 dBm, or 1W. Additionally, the EIRP shall not exceed 36 dBm, or 4W.

The transmitter power was measured conducted at the antenna port, by coupling the output of the EUT transmitter to the input of a spectrum analyzer. The measurement level was corrected for any cable and attenuator losses.

3.3.1 Measurement Method

This test was performed in accordance with Clause 11.9.1.1 of ANSI C63.10-2020.

3.3.2 Test Data

The EUT test data is provided below.

The EUT was configured to transmit a 1Mbps, QPSK modulated signal, with channel hopping disabled.

The EUT employs a PCB trace antenna with a peak gain of -5.44 dBi.

Table 7: Conducted Output Power Results

Frequency	Power (dBm)	EIRP (dBm)	Result
Low Channel, 2402 MHz	1.25	-4.19	Pass
Center Channel, 2440 MHz	1.10	-4.34	Pass
High Channel, 2480 MHz	0.73	-4.71	Pass

Figure 4: Peak Output Power, Low Channel

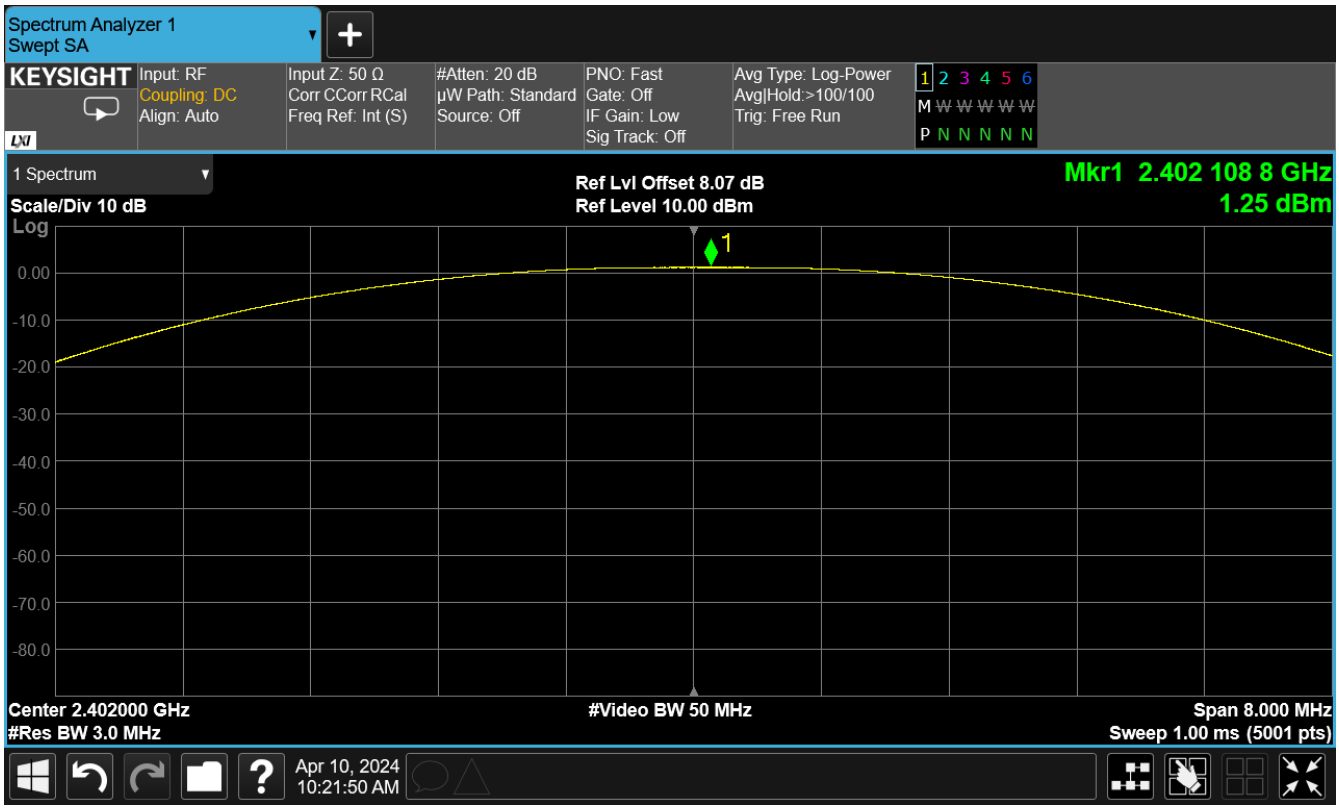


Figure 5: Peak Output Power, Center Channel

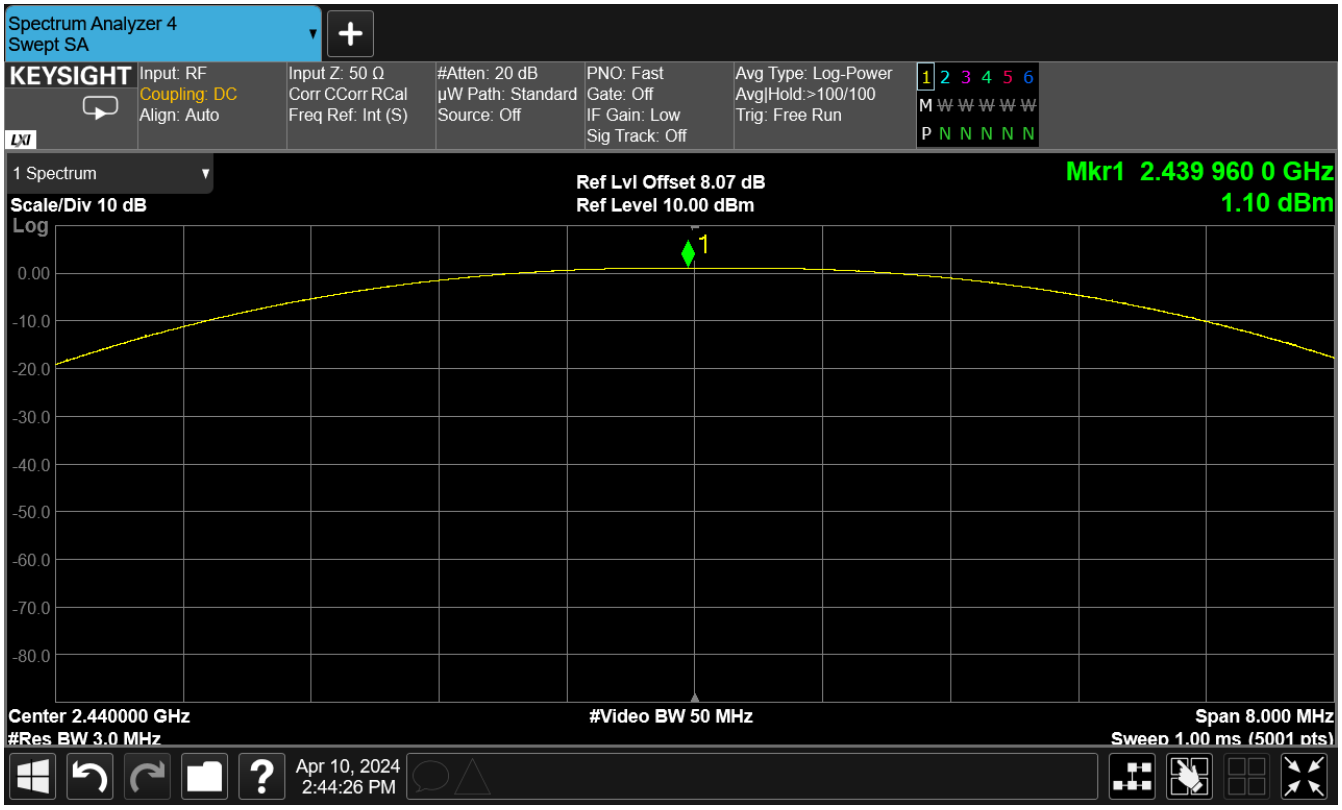
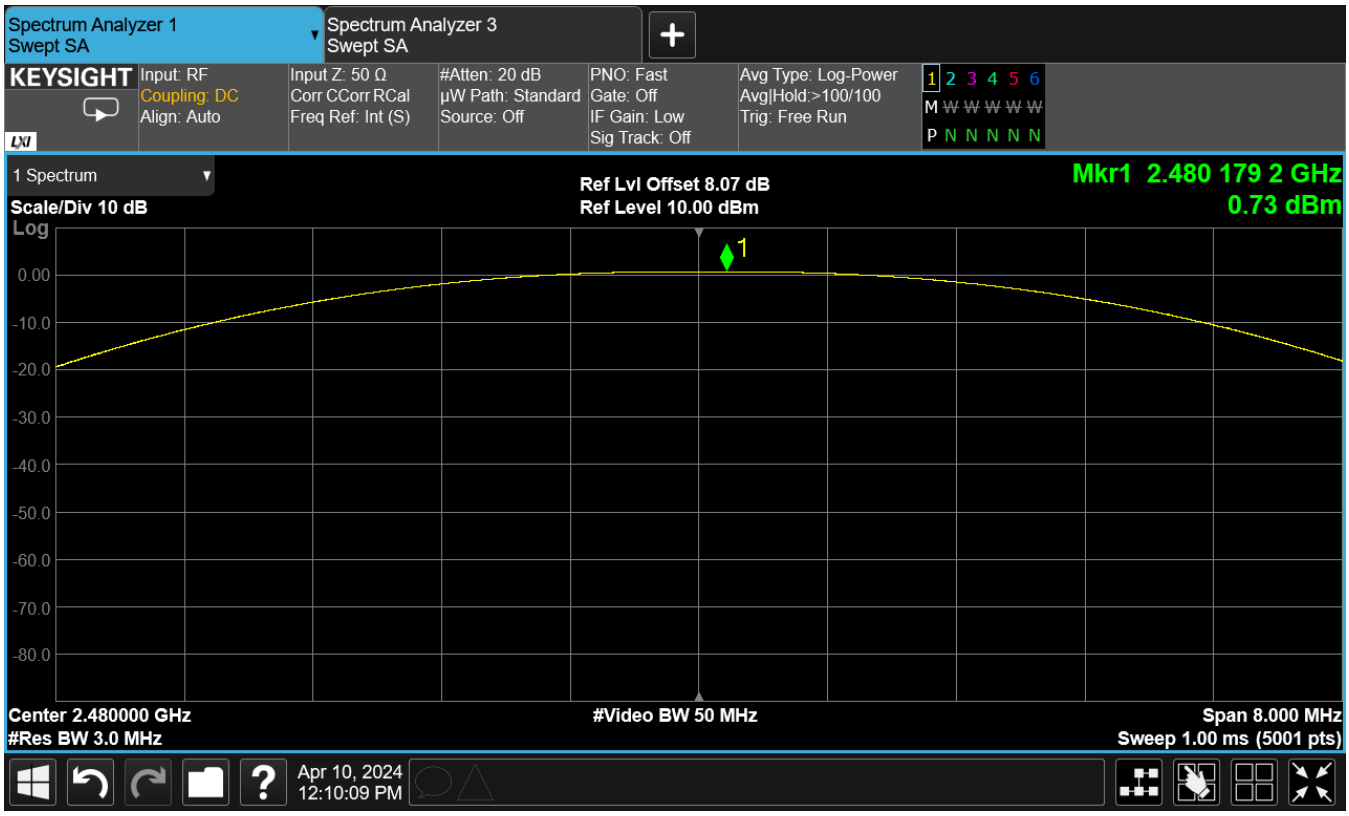


Figure 6: Peak Output Power, High Channel



3.4 Power Spectral Density

For a DTS operating in the 2.4GHz band, FCC Rule Part 15.247(e) and RSS-247, 5.2(b) require that the maximum peak power spectral density shall not exceed 8 dBm in any 3 kHz band.

The transmitter peak power spectral density was measured conducted at the antenna port, by coupling the output of the EUT transmitter to the input of a spectrum analyzer. The measurement level was corrected for any cable and attenuator losses.

3.4.1 Measurement Method

This test was performed in accordance with Clause 11.10.2 of ANSI C63.10-2020.

3.4.2 Test Data

The EUT test data is provided below.

The EUT was configured to transmit a 1Mbps, QPSK modulated signal, with channel hopping disabled.

Table 8: Power Spectral Density

Frequency	Power (dBm)	Limit (dBm)	Result
Low Channel, 2402 MHz	1.12	8	Pass
Center Channel, 2440 MHz	0.50	8	Pass
High Channel, 2480 MHz	0.59	8	Pass

Figure 7: Power Spectral Density, Low Channel

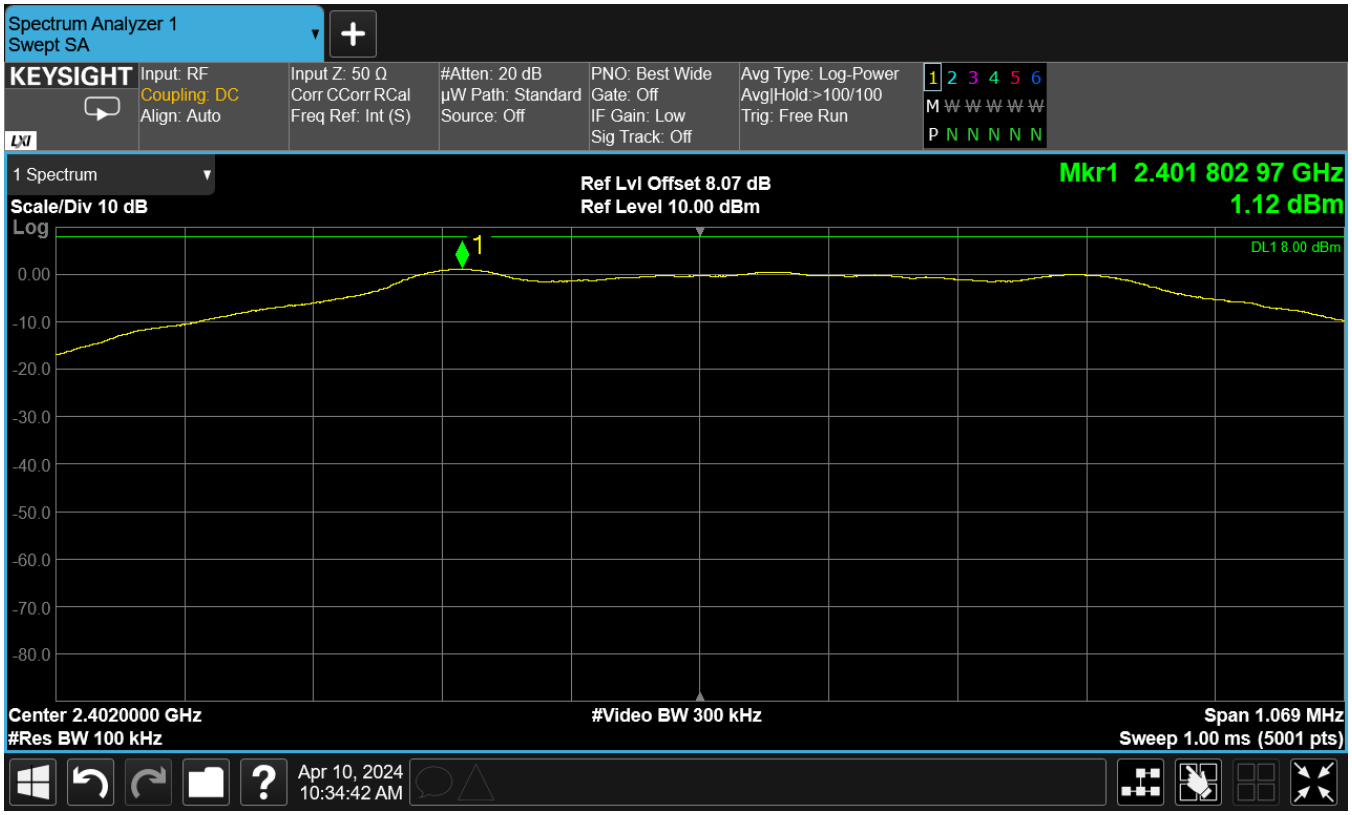


Figure 8: Power Spectral Density, Center Channel

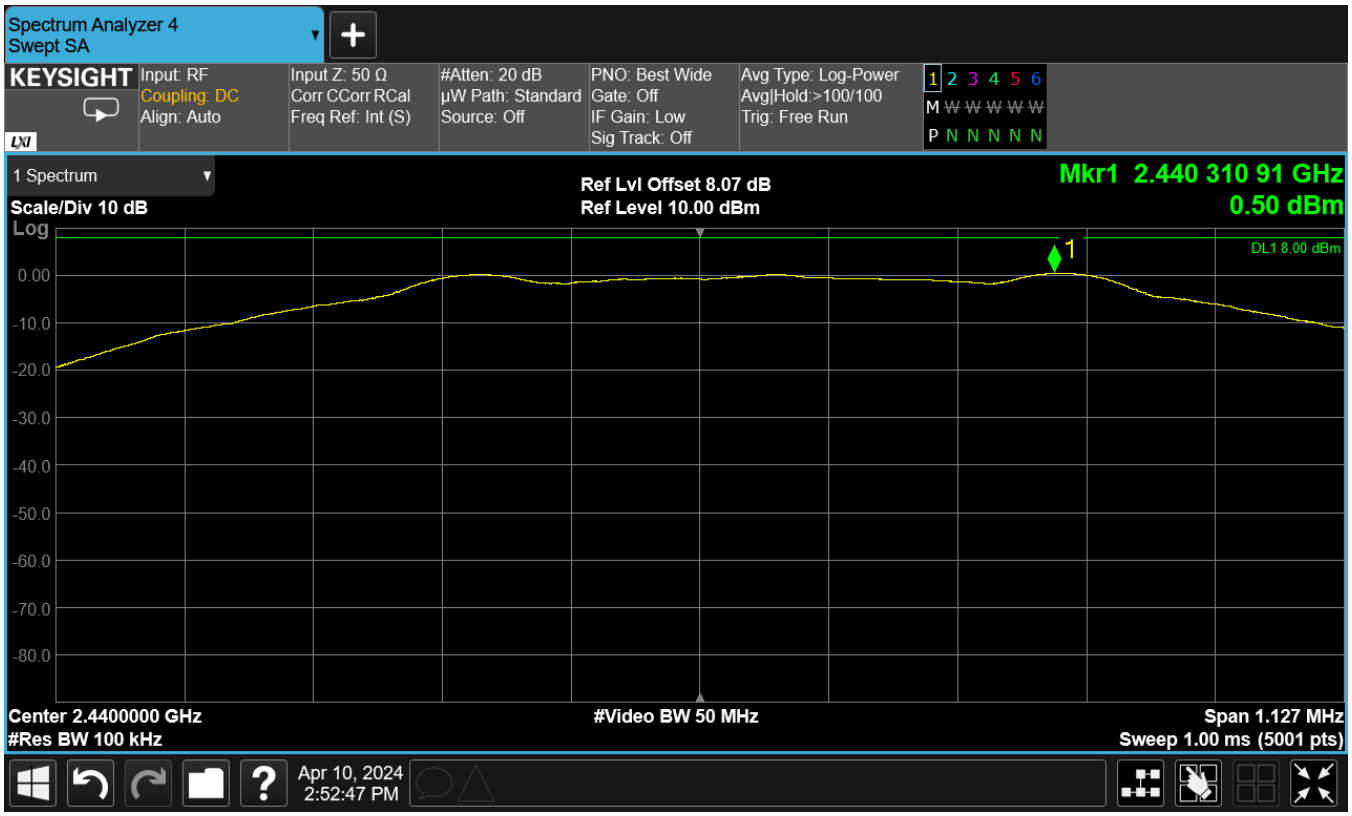
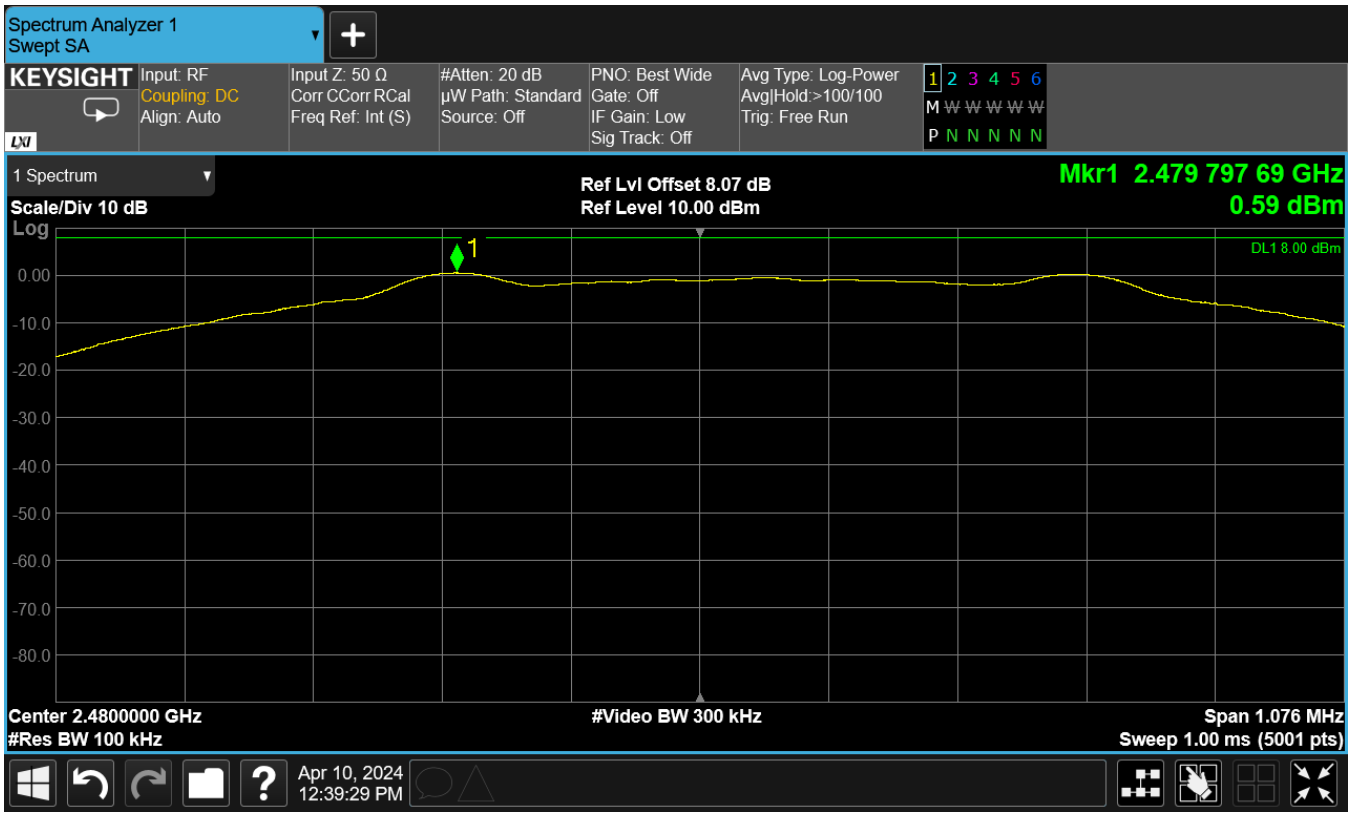


Figure 9: Power Spectral Density, High Channel



3.5 Conducted Band-edge Testing

This section provides close-up band-edge plots of the low and high channel, with respect to the nearest authorized band-edge.

For a DTS operating in the 2.4GHz band, FCC Rule Part 15.247(d) and RSS-247, 5.5 require that in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the unwanted radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

Band-edge measurements were made conducted at the antenna port, by coupling the output of the EUT transmitter to the input of a spectrum analyzer. The measurement level was corrected for any cable and attenuator losses.

3.5.1 Measurement Method

This test was performed in accordance with Clause 6.10 through Clause 6.10.4 of ANSI C63.10-2020.

3.5.2 Test Data

The EUT test data is provided below.

The EUT was configured to transmit a 1Mbps, QPSK modulated signal. The EUT was evaluated in two modes, channel hopping enabled and channel hopping disabled. The hopping function had no impact on the results of this test.

Figure 10: Low Channel Band-Edge

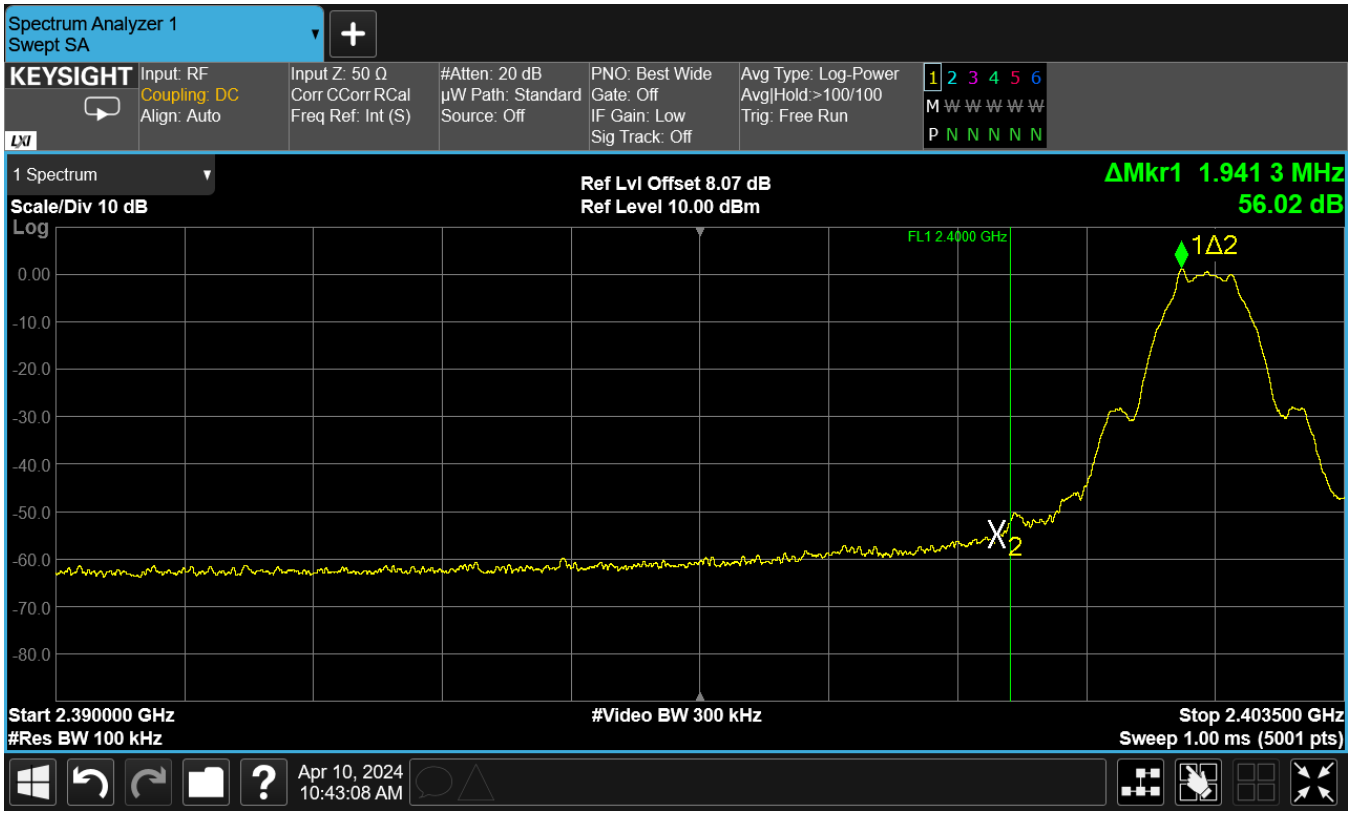
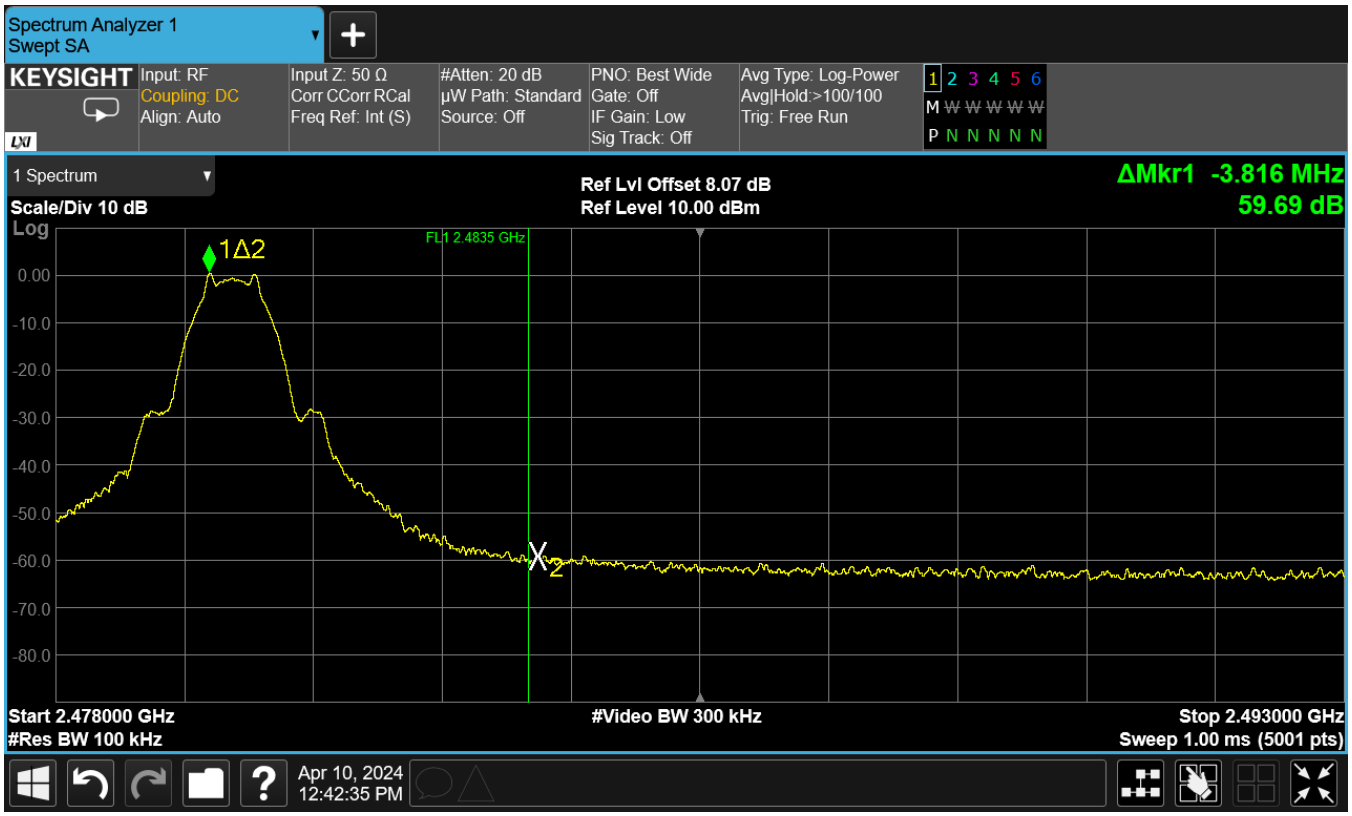


Figure 11: High Channel Band-Edge



3.6 Conducted Unwanted Spurious Emissions

For a DTS operating in the 2.4GHz band, FCC Rule Part 15.247(d) and RSS-247, 5.5 require that in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the unwanted radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

The transmitter unwanted spurious emissions were evaluated and measured conducted at the antenna port, by coupling the output of the EUT transmitter to the input of a spectrum analyzer. The measurement level was corrected for any cable and attenuator losses.

3.6.1 Measurement Method

This test was performed in accordance with Clause 11.11 of ANSI C63.10-2020.

3.6.2 Test Data

The EUT test data for the low, center, and high channels are provided below.

The EUT was configured to transmit a 1Mbps, QPSK modulated signal. The EUT was evaluated in two modes, channel hopping enabled and channel hopping disabled.

Figure 12: Low Channel Conducted Spurious Plot 1

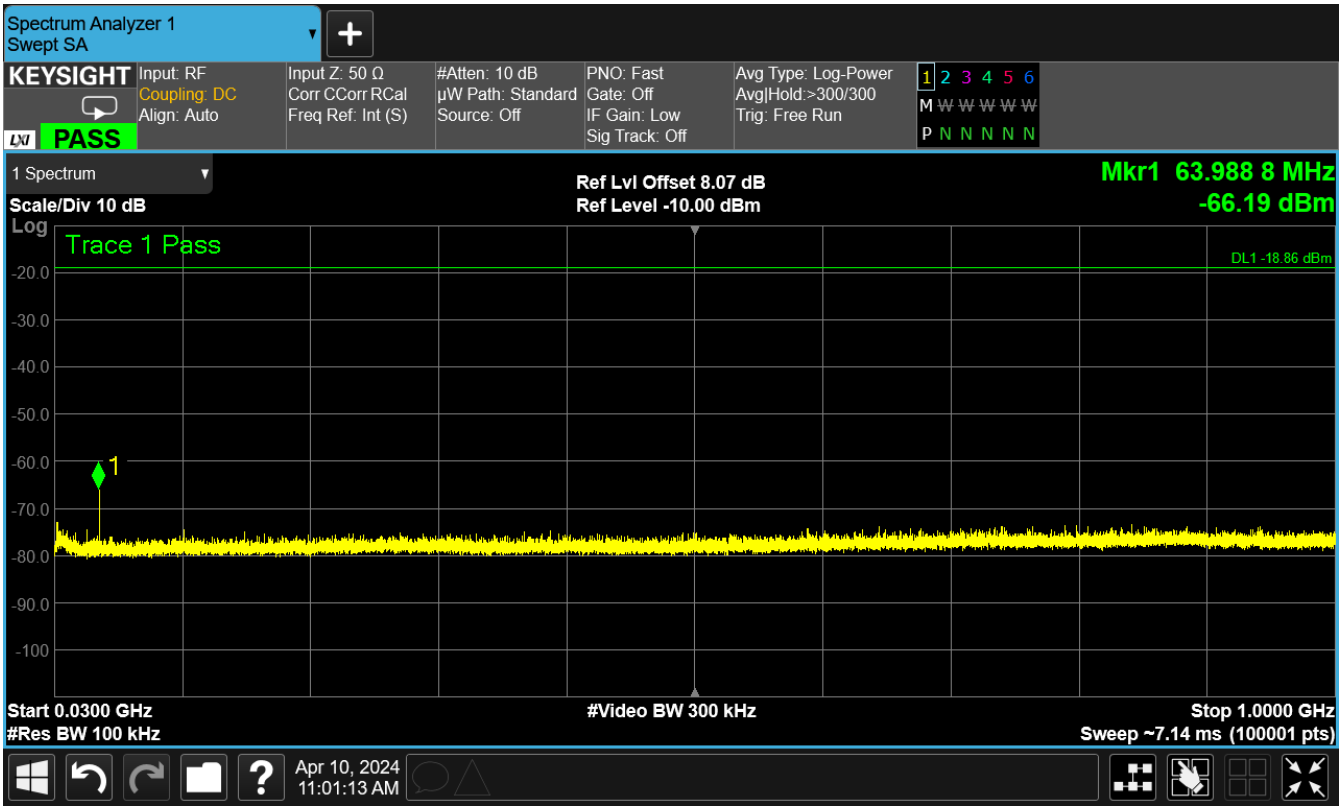


Figure 13: Low Channel Conducted Spurious Plot 2

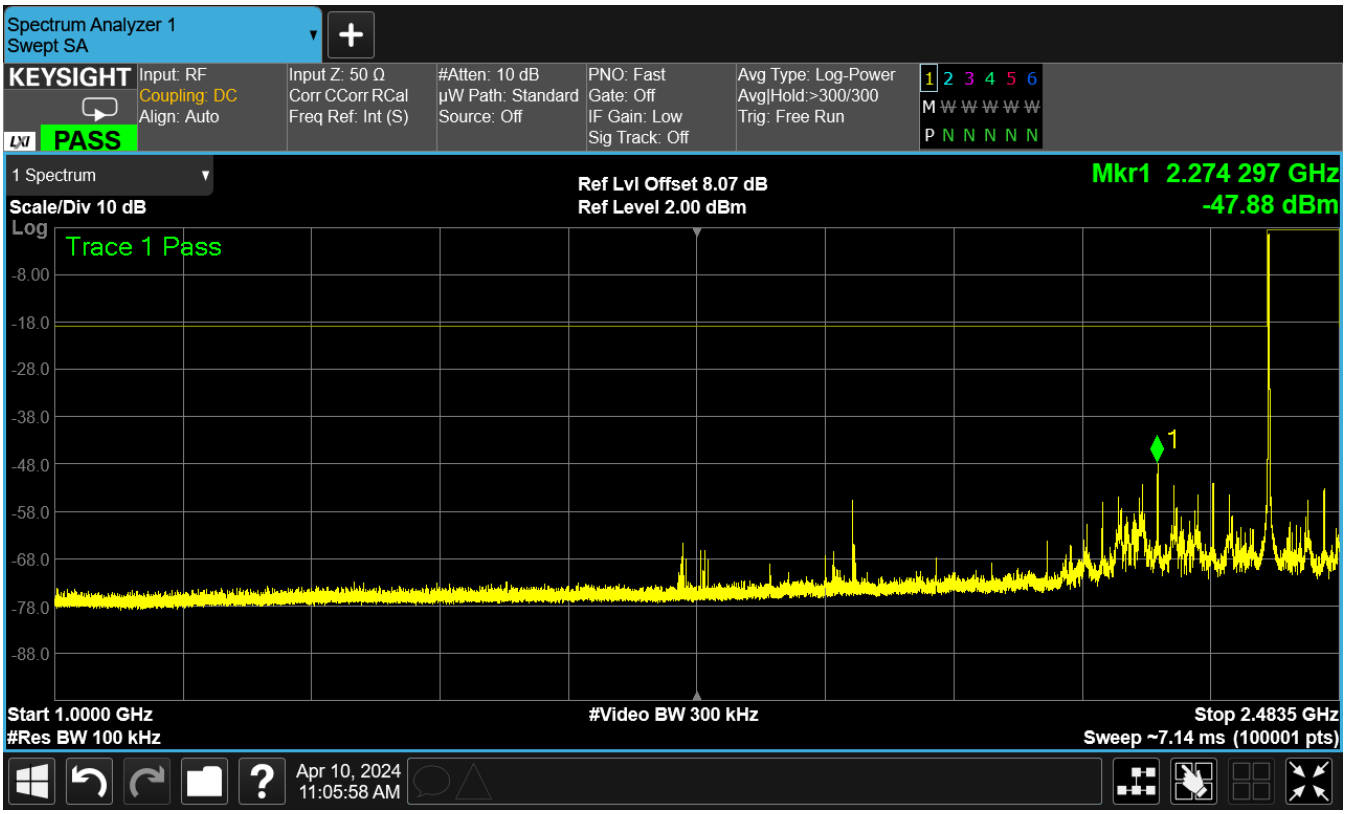


Figure 14: Low Channel Conducted Spurious Plot 3

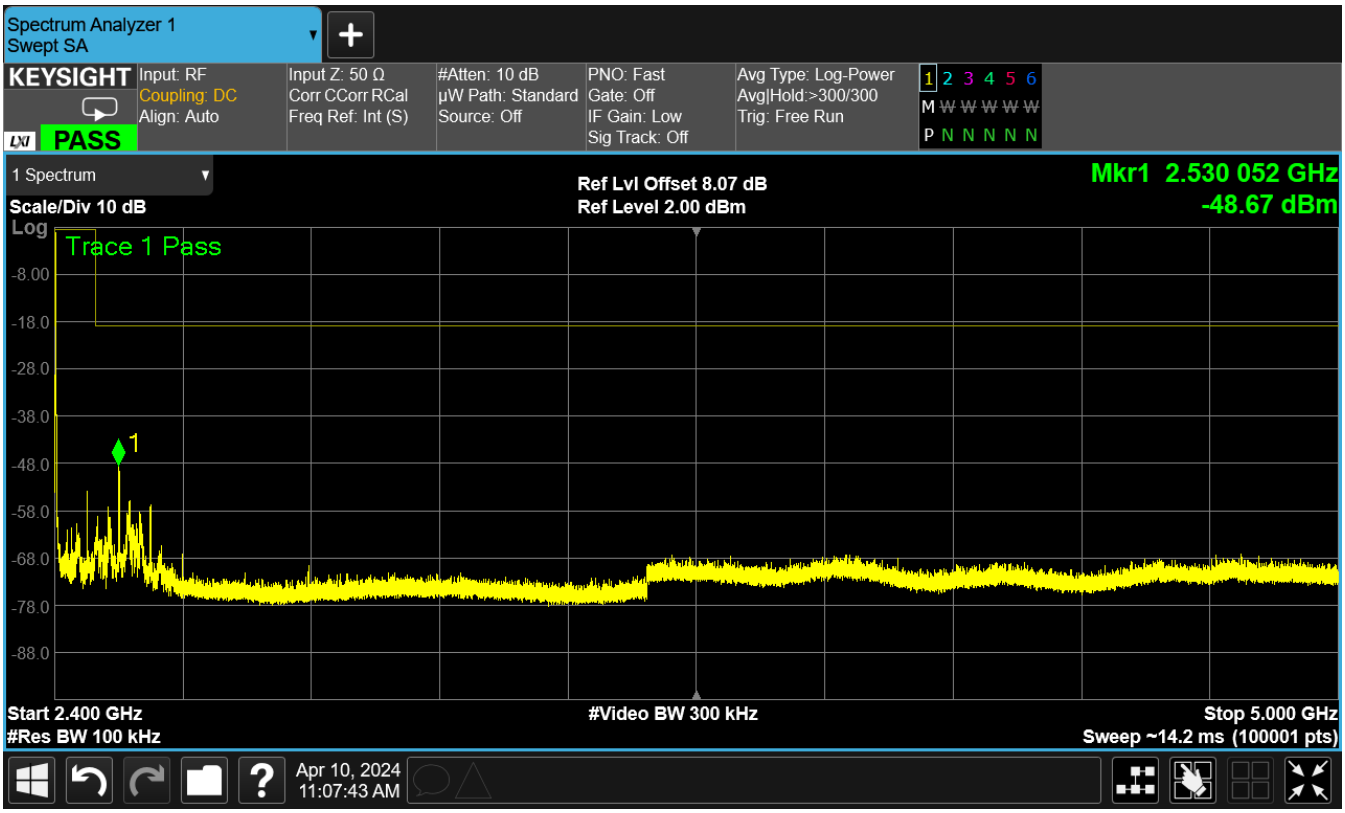


Figure 15: Low Channel Conducted Spurious Plot 4

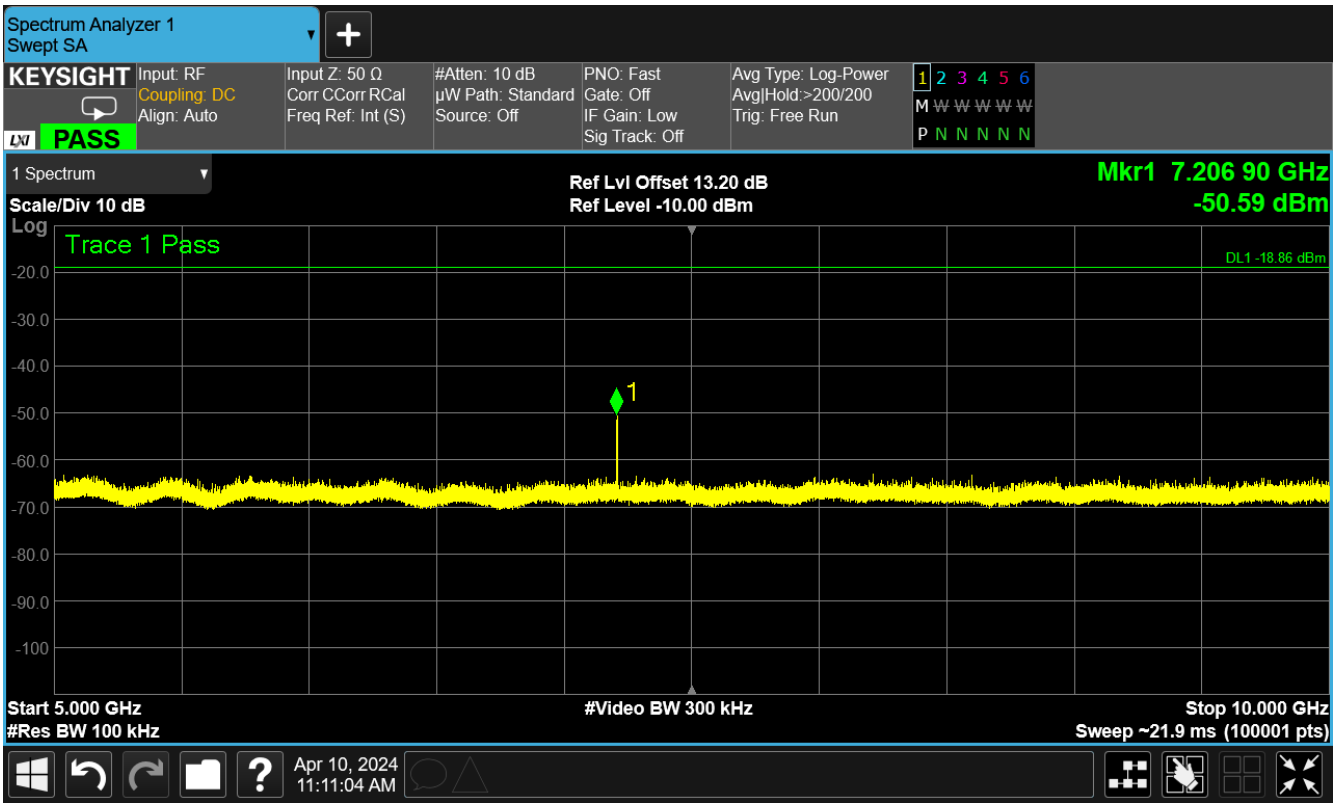


Figure 16: Low Channel Conducted Spurious Plot 5

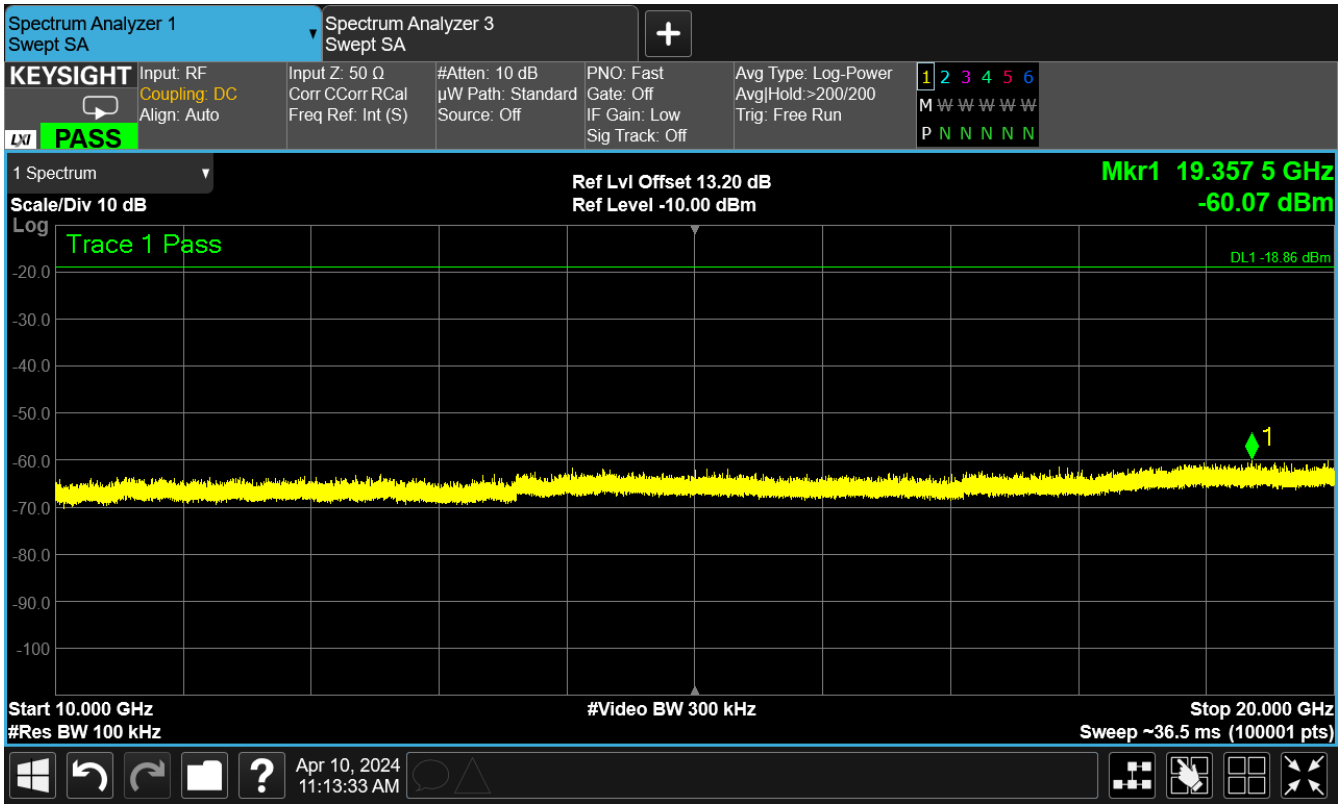


Figure 17: Low Channel Conducted Spurious Plot 6

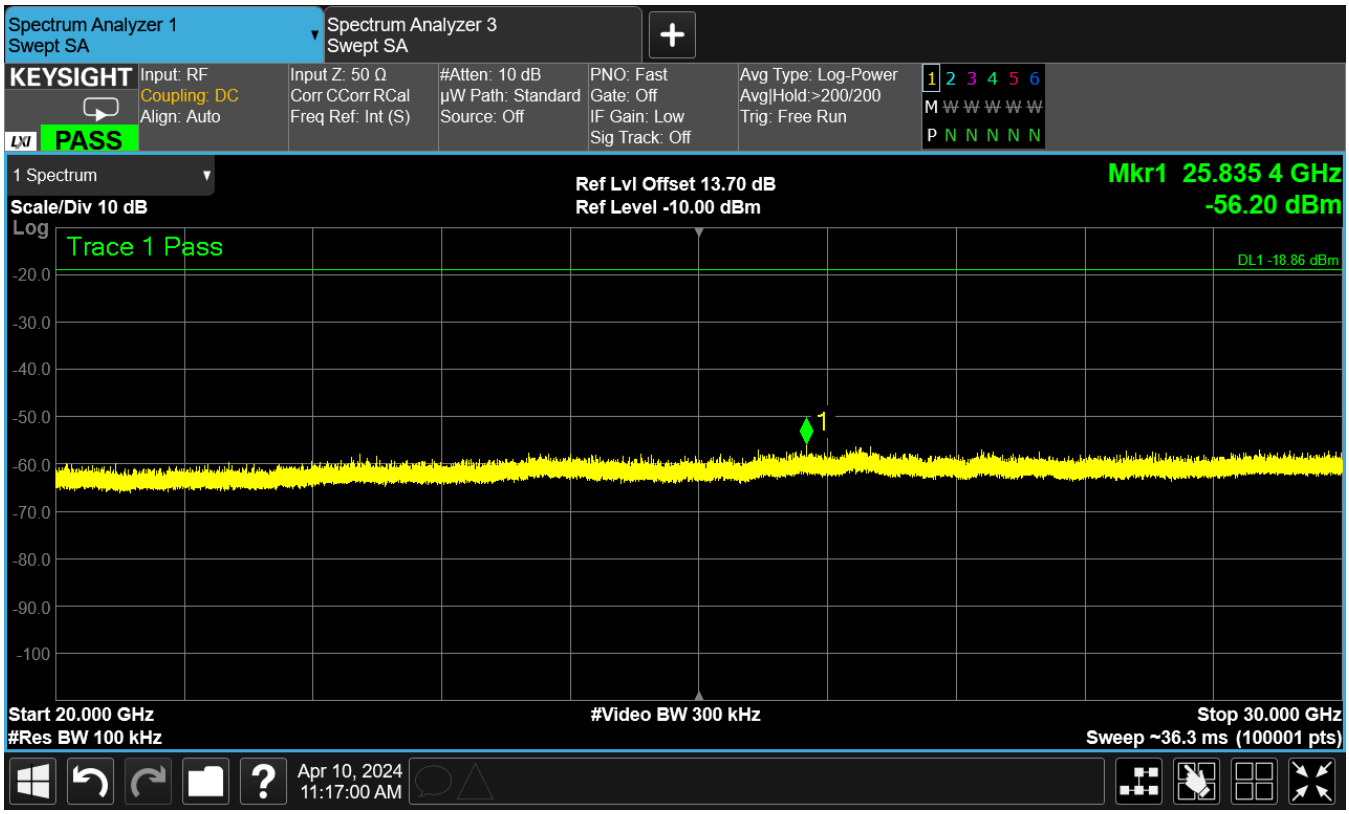


Figure 18: Center Channel Conducted Spurious Plot 1

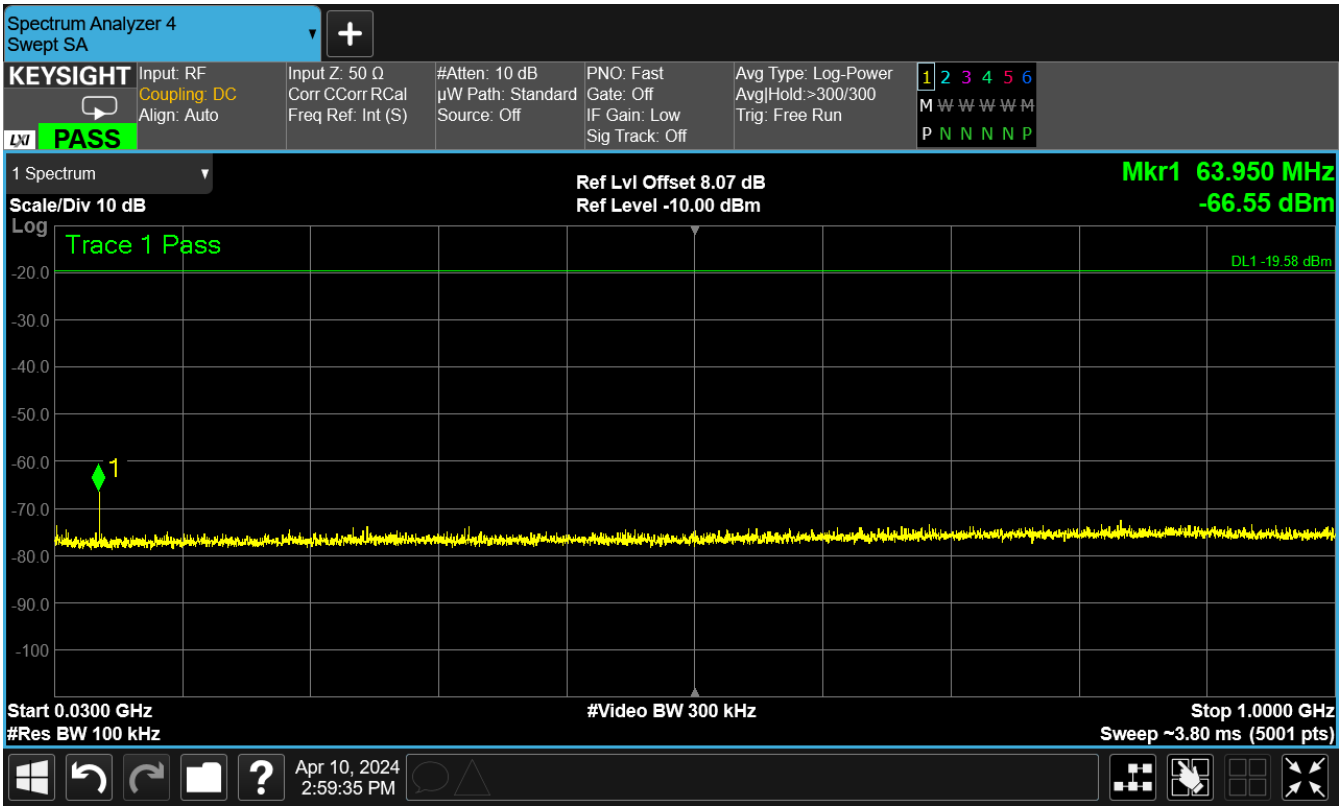


Figure 19: Center Channel Conducted Spurious Plot 2

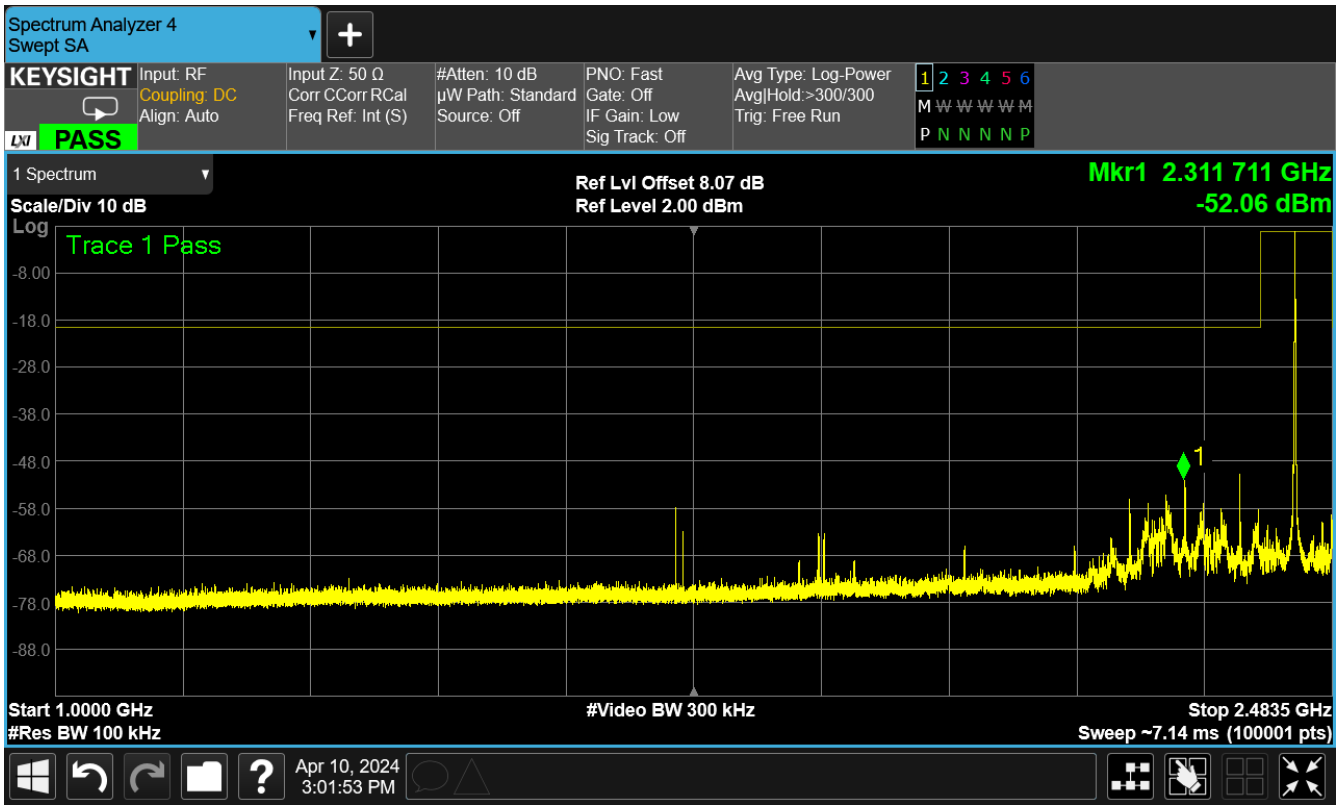


Figure 20: Center Channel Conducted Spurious Plot 3

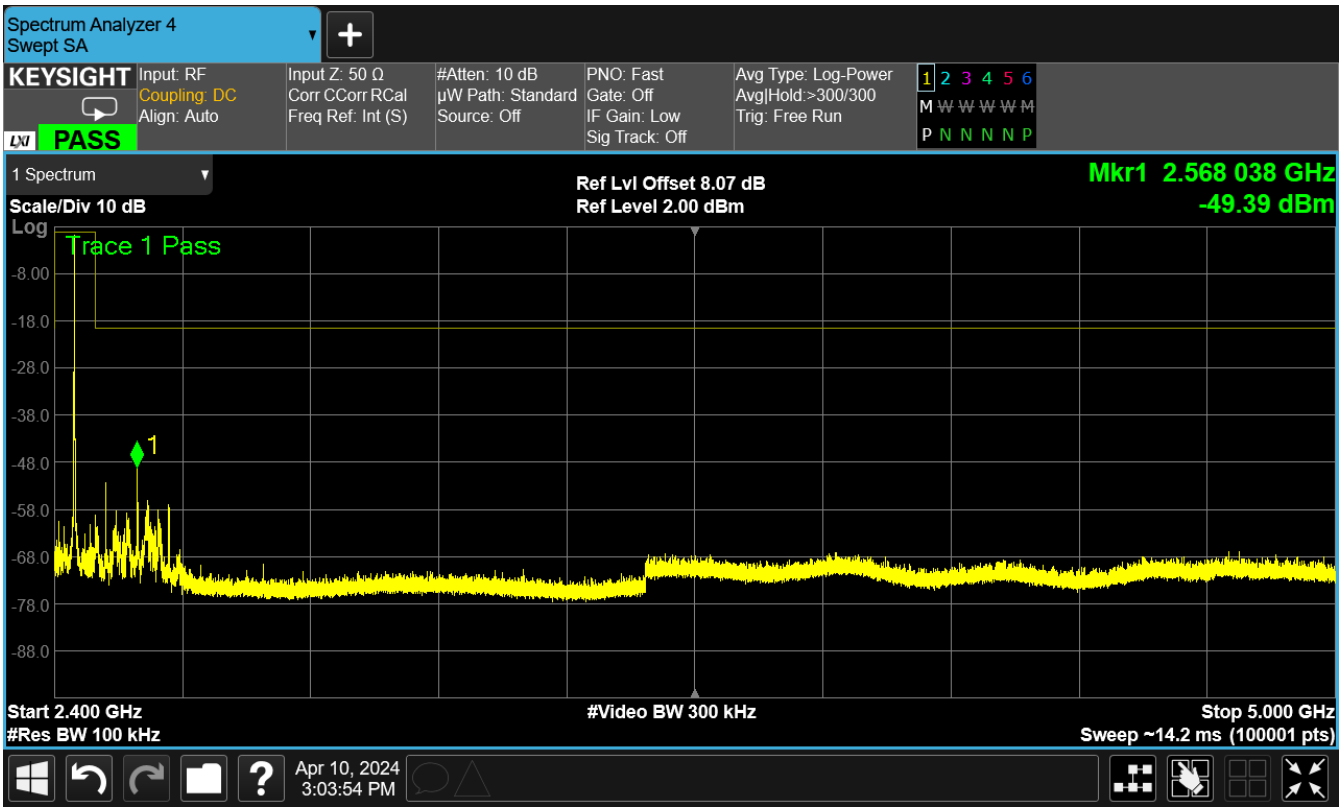


Figure 21: Center Channel Conducted Spurious Plot 4

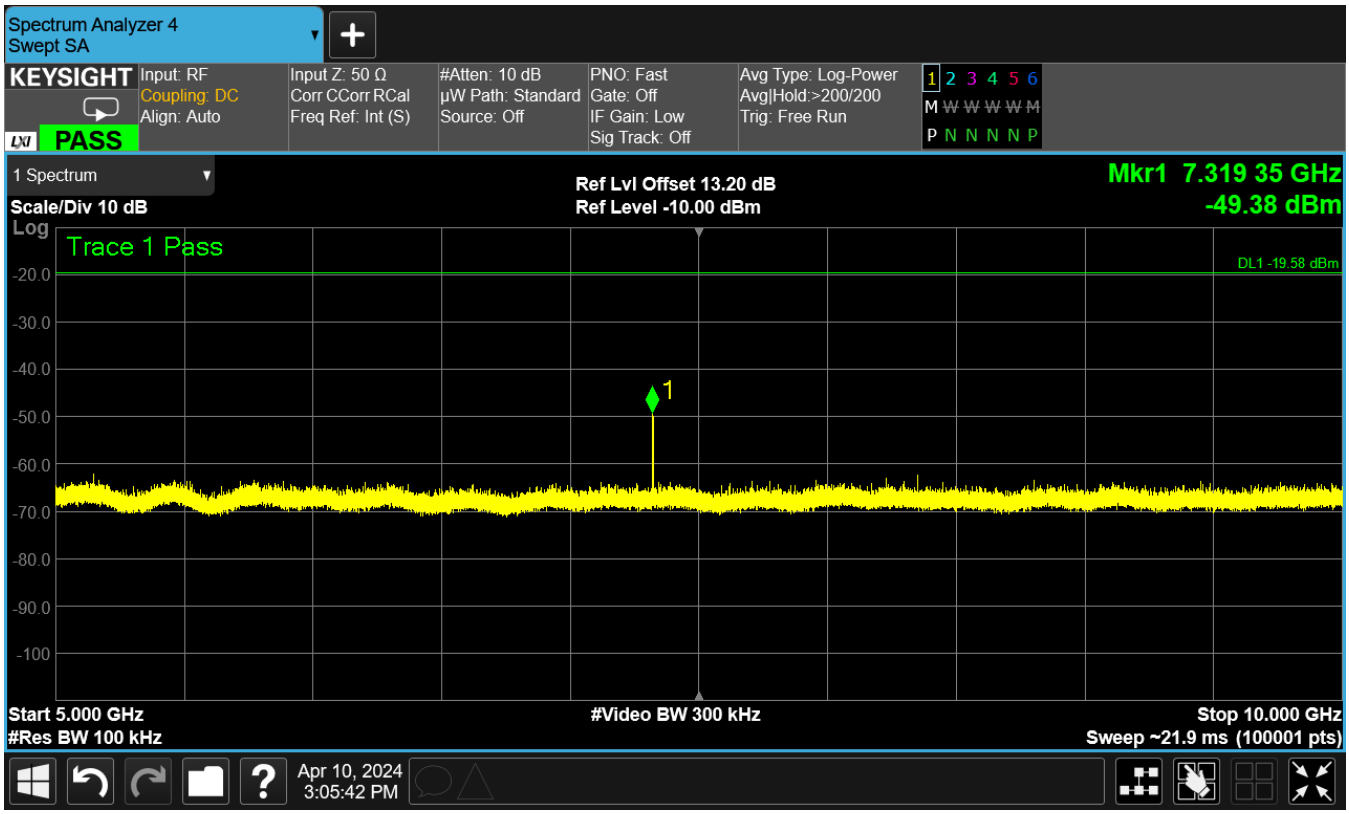


Figure 22: Center Channel Conducted Spurious Plot 5

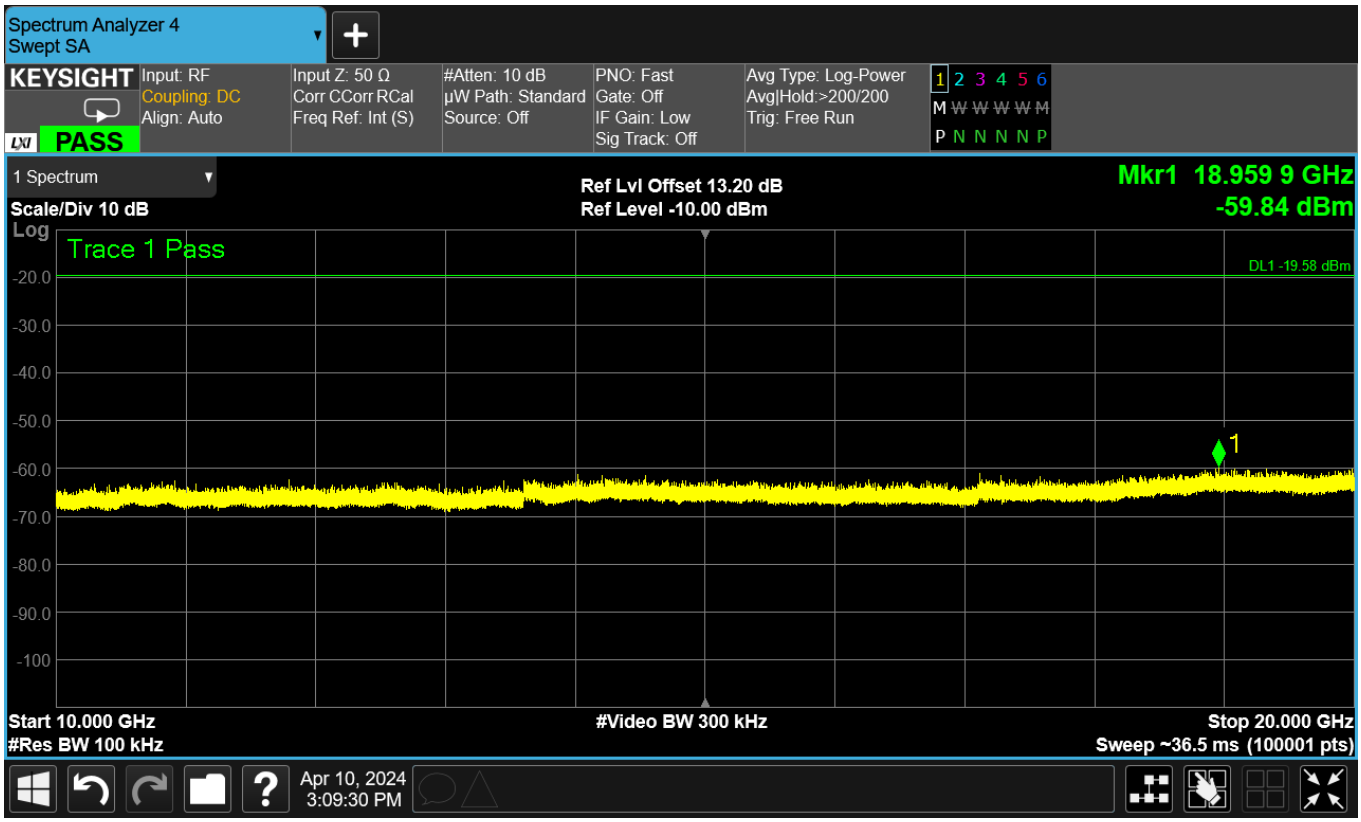


Figure 23: Center Channel Conducted Spurious Plot 6

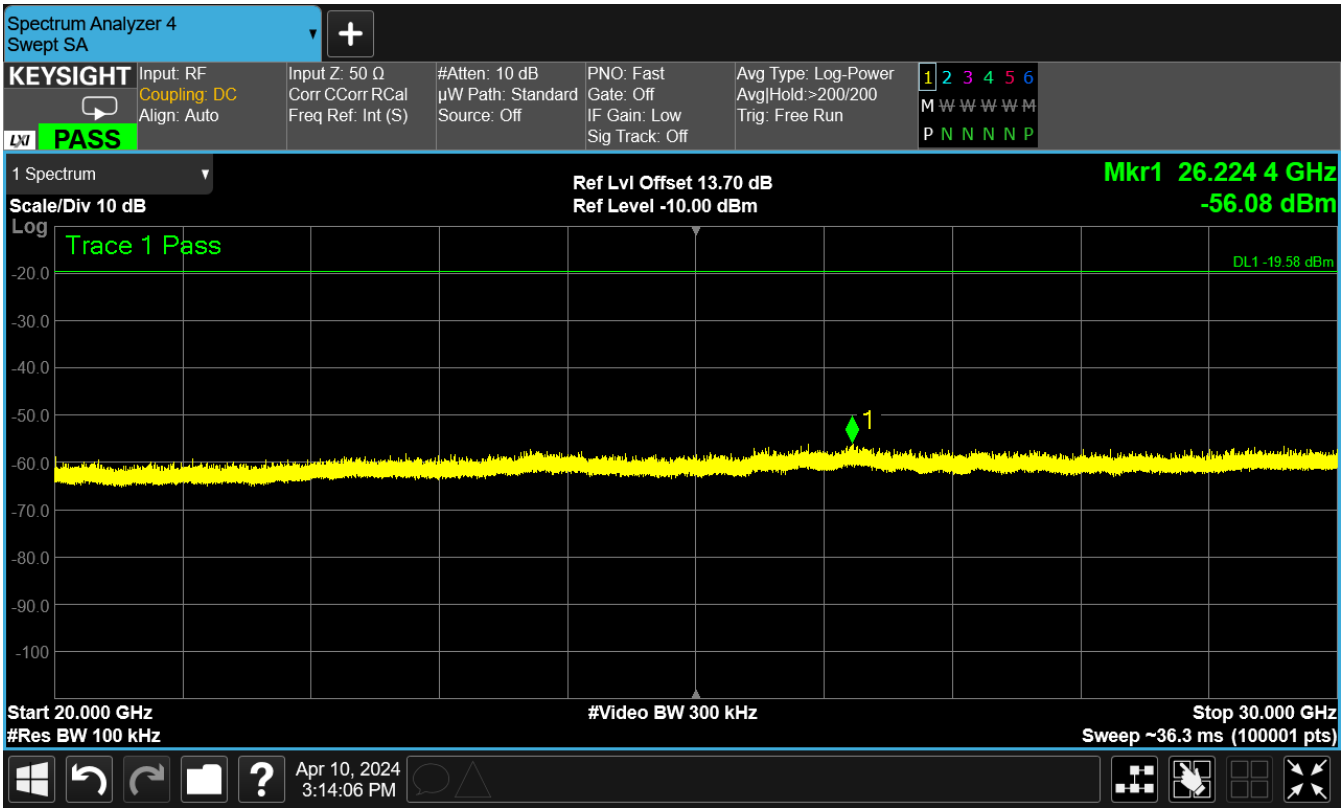


Figure 24: High Channel Conducted Spurious Plot 1

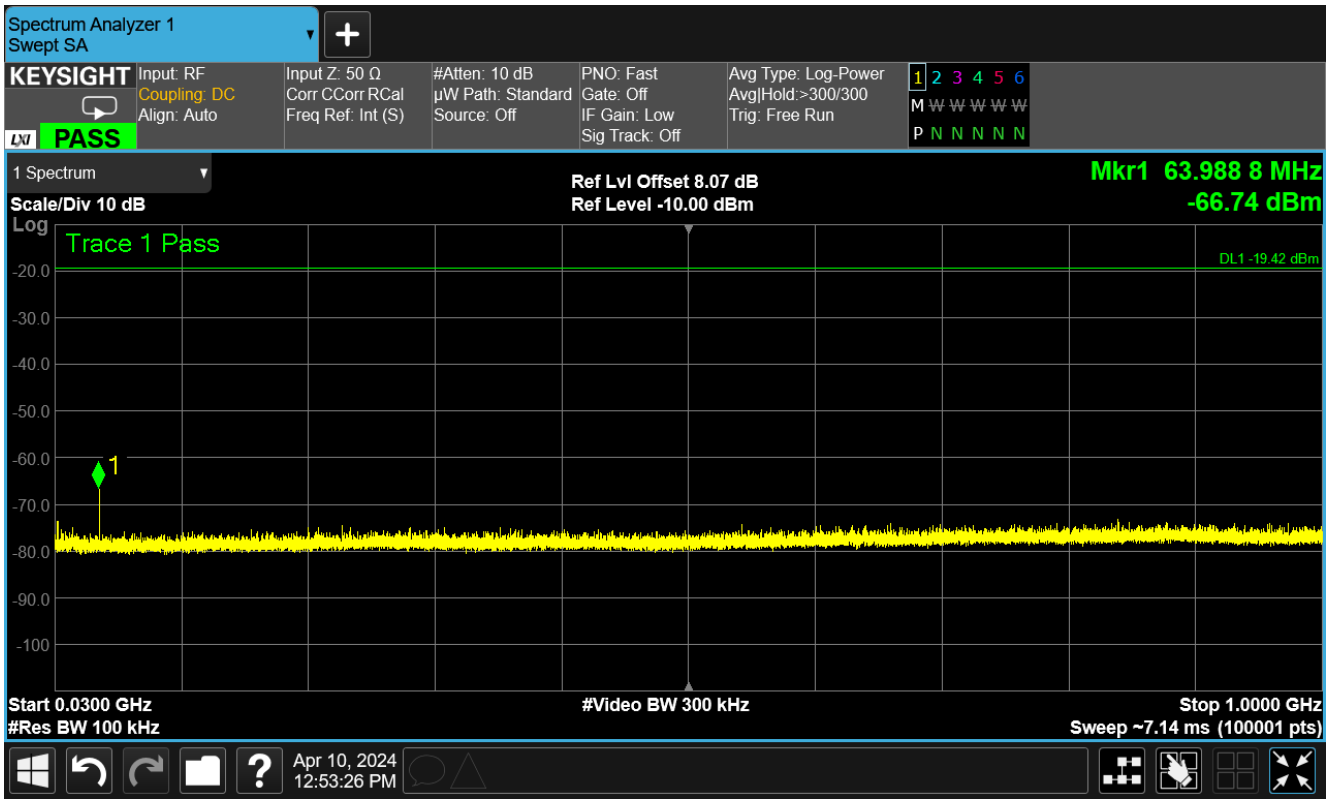


Figure 25: High Channel Conducted Spurious Plot 2

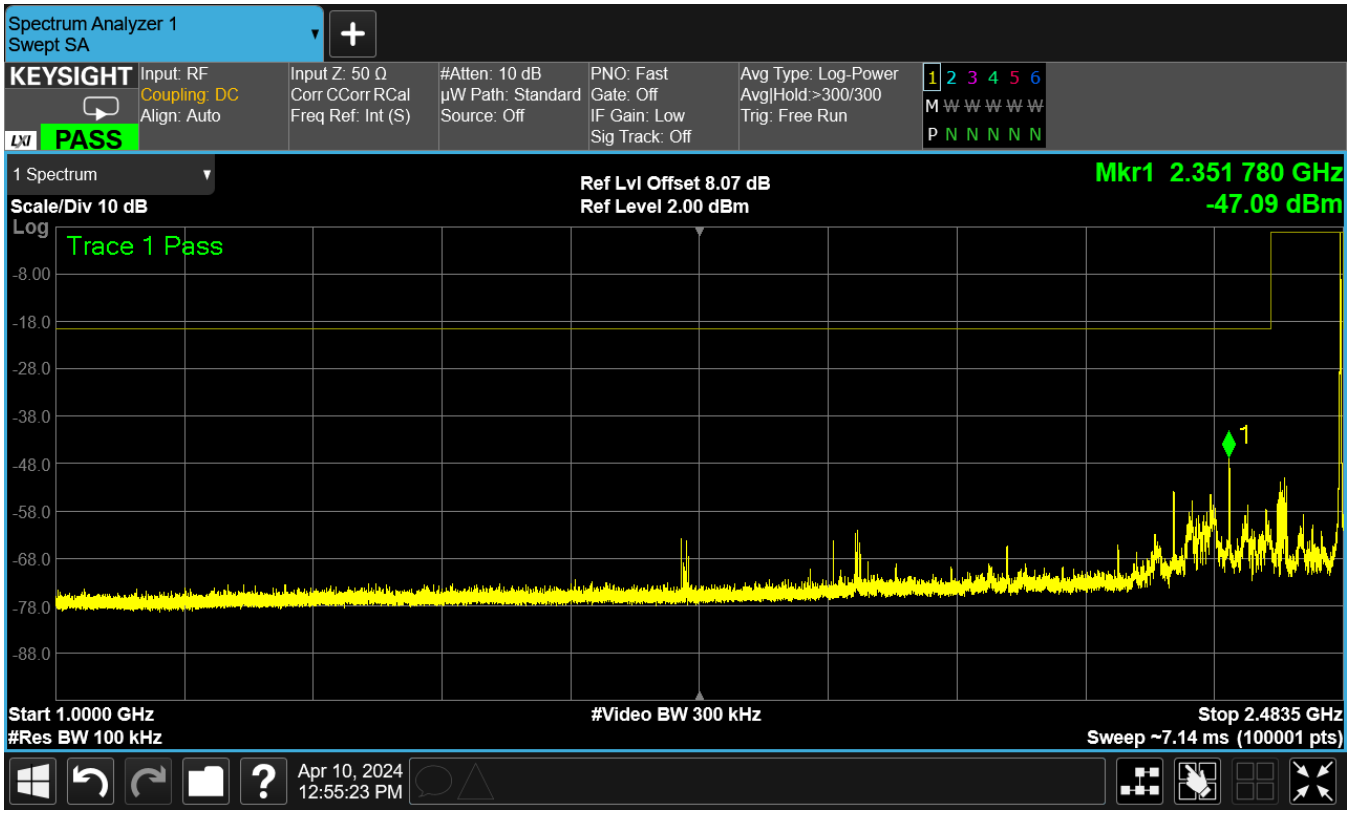


Figure 26: High Channel Conducted Spurious Plot 3

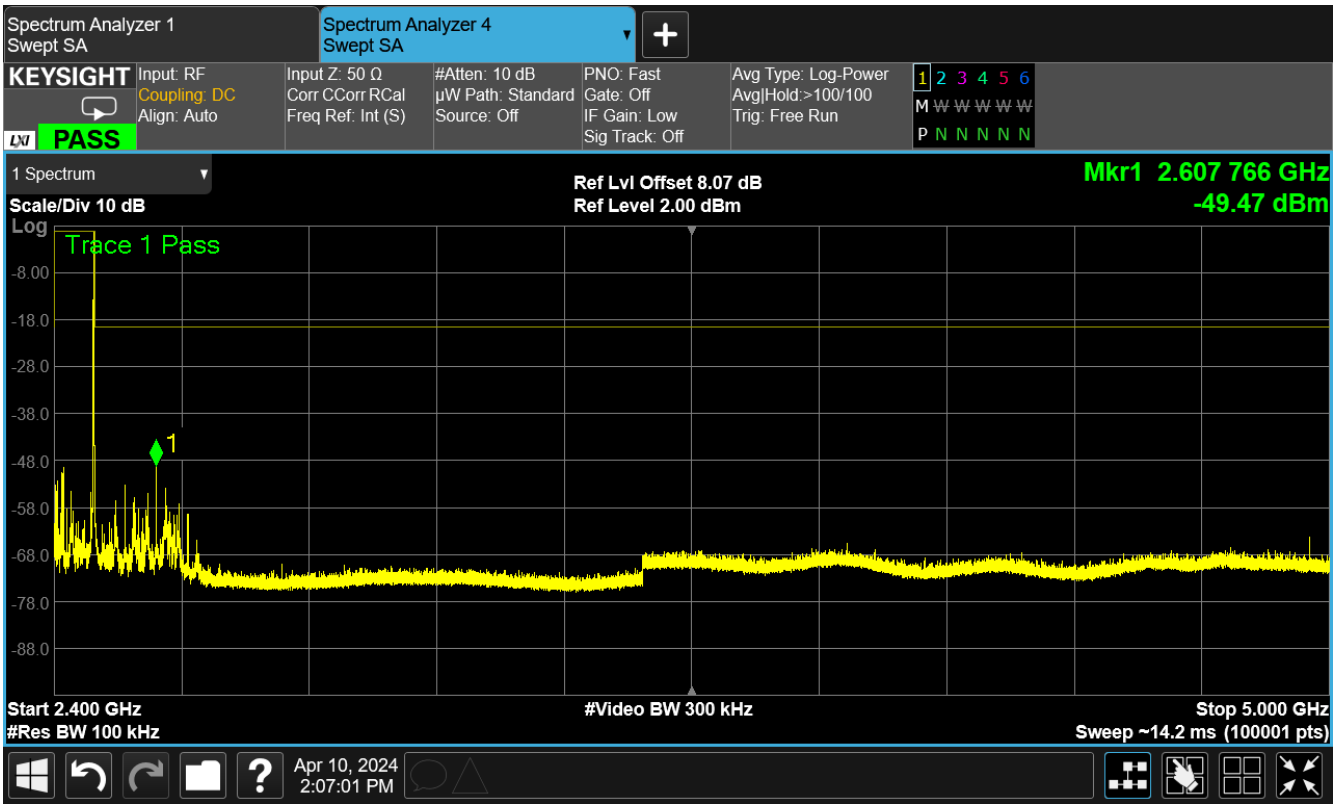


Figure 27: High Channel Conducted Spurious Plot 4

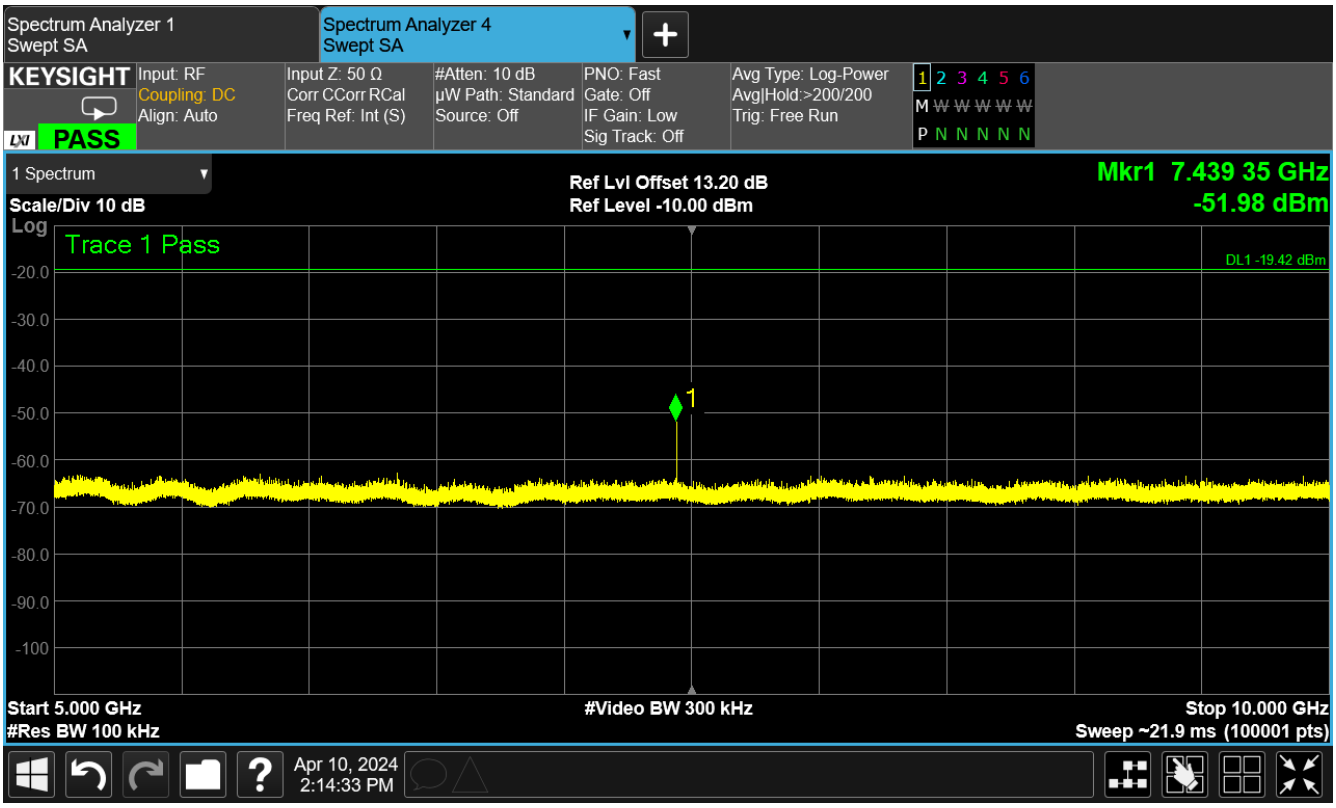


Figure 28: High Channel Conducted Spurious Plot 5

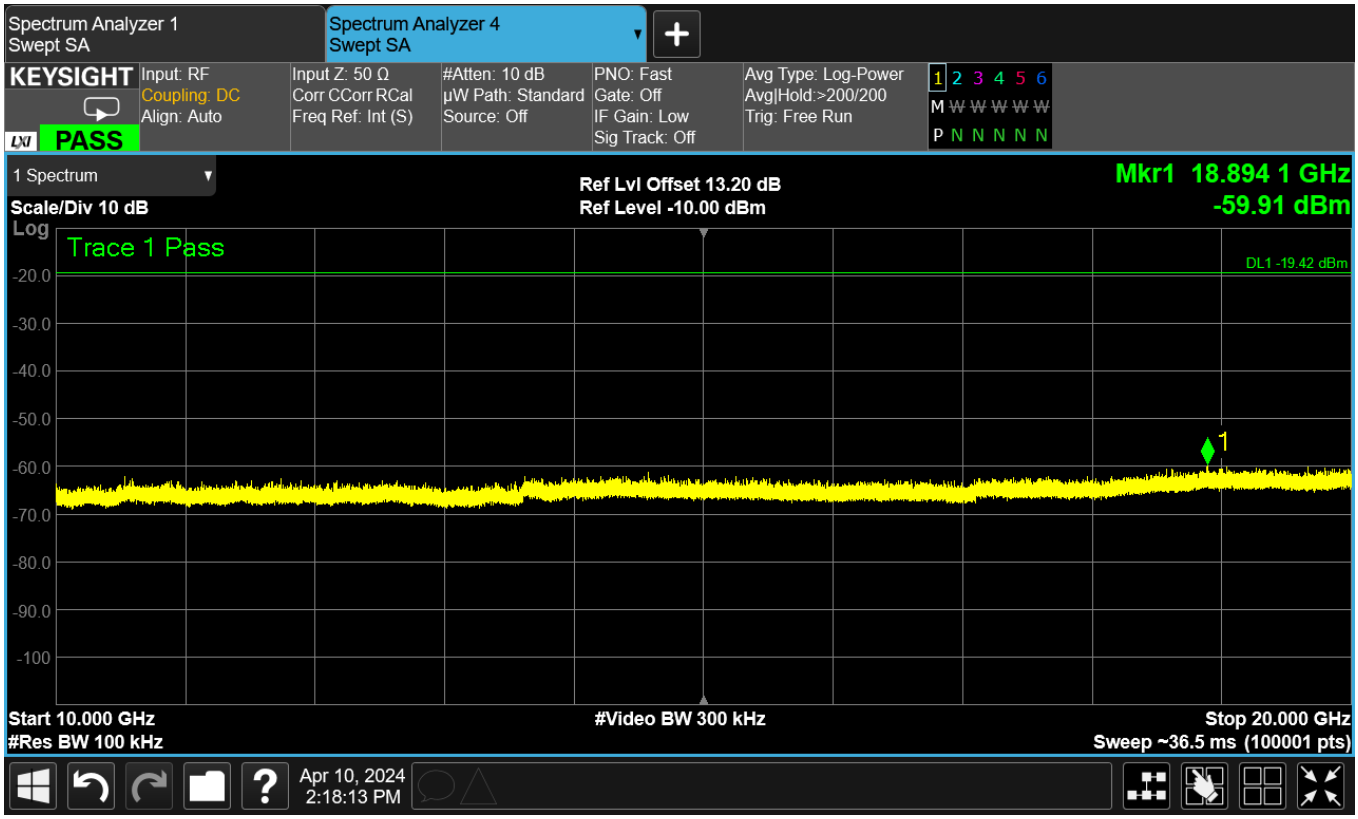
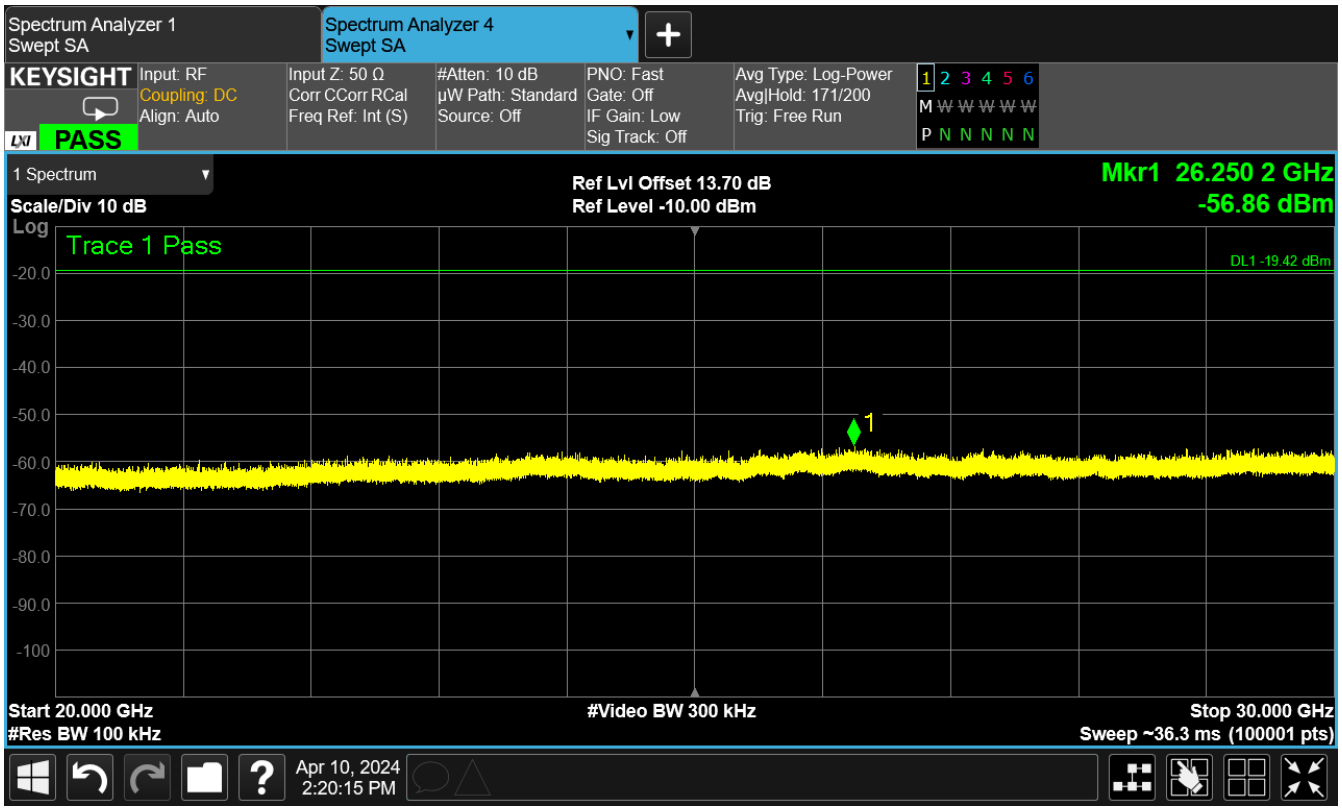


Figure 29: High Channel Conducted Spurious Plot 6



3.7 Conducted Unwanted Receiver Emissions

For a license-exempt radio apparatus RSS-GEN, 7.4 requires the spurious emissions from the receiver at any discrete frequency, measured at the antenna port by the antenna-conducted method, shall not exceed 2 nW in the frequency range 30-1000 MHz and 5 nW above 1 GHz.

3.7.1 Measurement Method

This test was performed in accordance with Clause 11.11.3 of ANSI C63.10-2020.

3.7.2 Test Data

The EUT test data is provided below.

The transmitter was disable via test software.

The EUT was configured in a receive only mode. The receiver was set to sweep the 2.4GHz ISM band, in an active receiver mode.

Figure 30: Conducted Unwanted Receiver Emissions, Plot 1

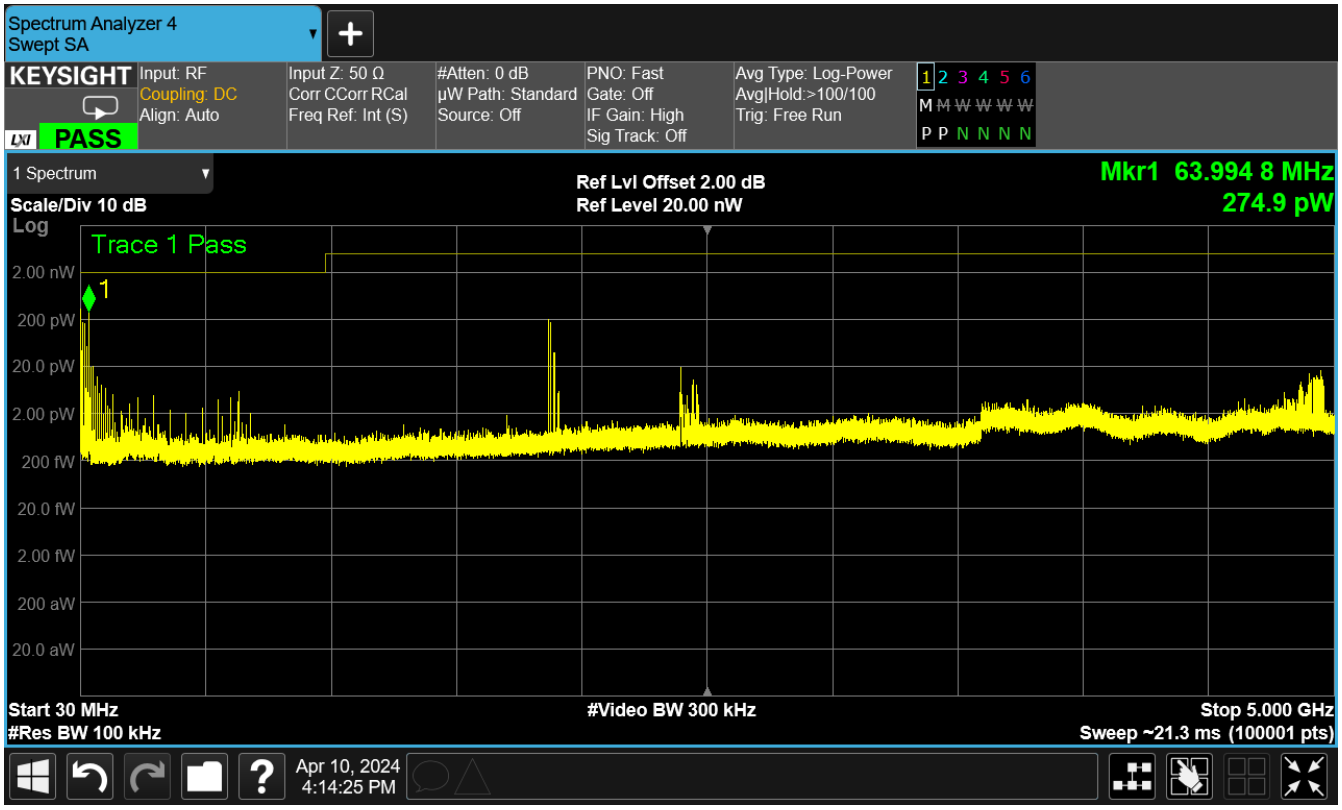


Figure 31: Conducted Unwanted Receiver Emissions, Plot 2

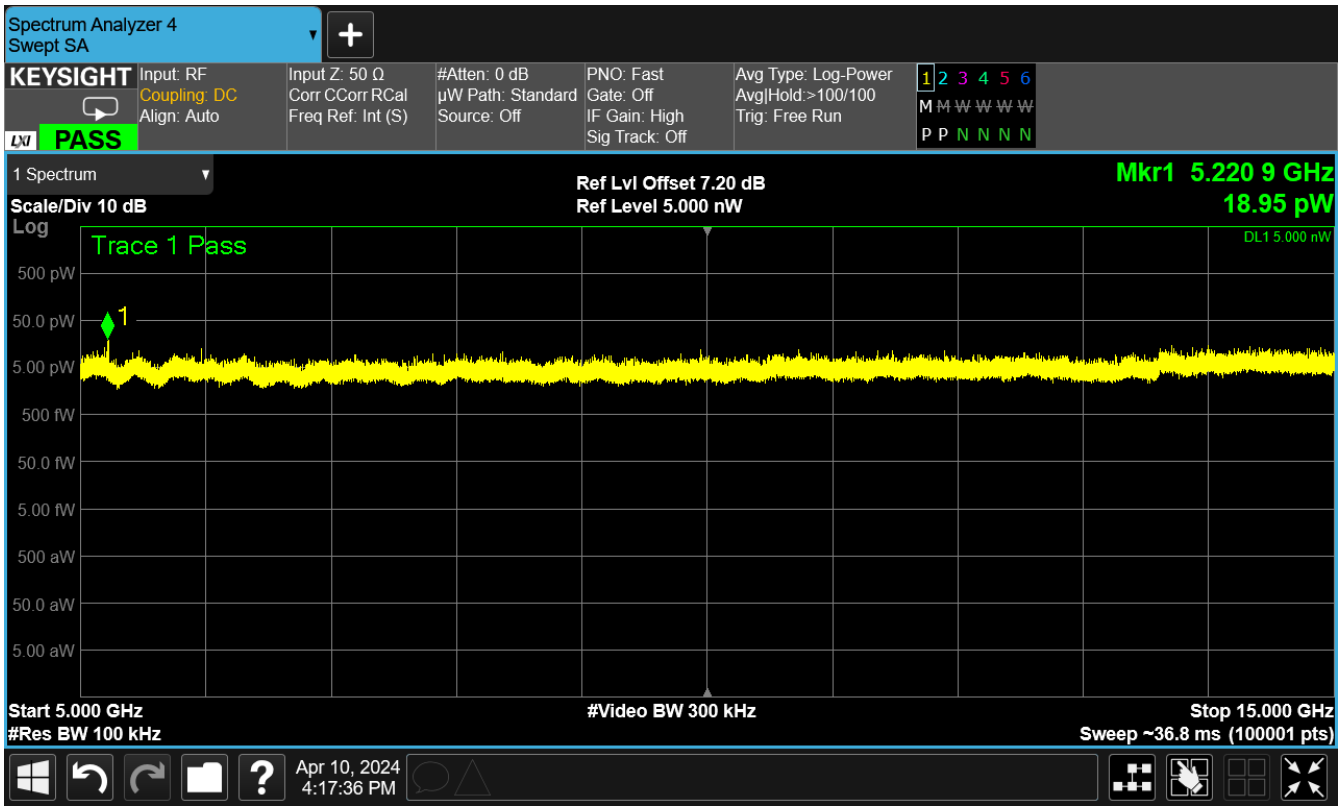


Figure 32: Conducted Unwanted Receiver Emissions, Plot 3

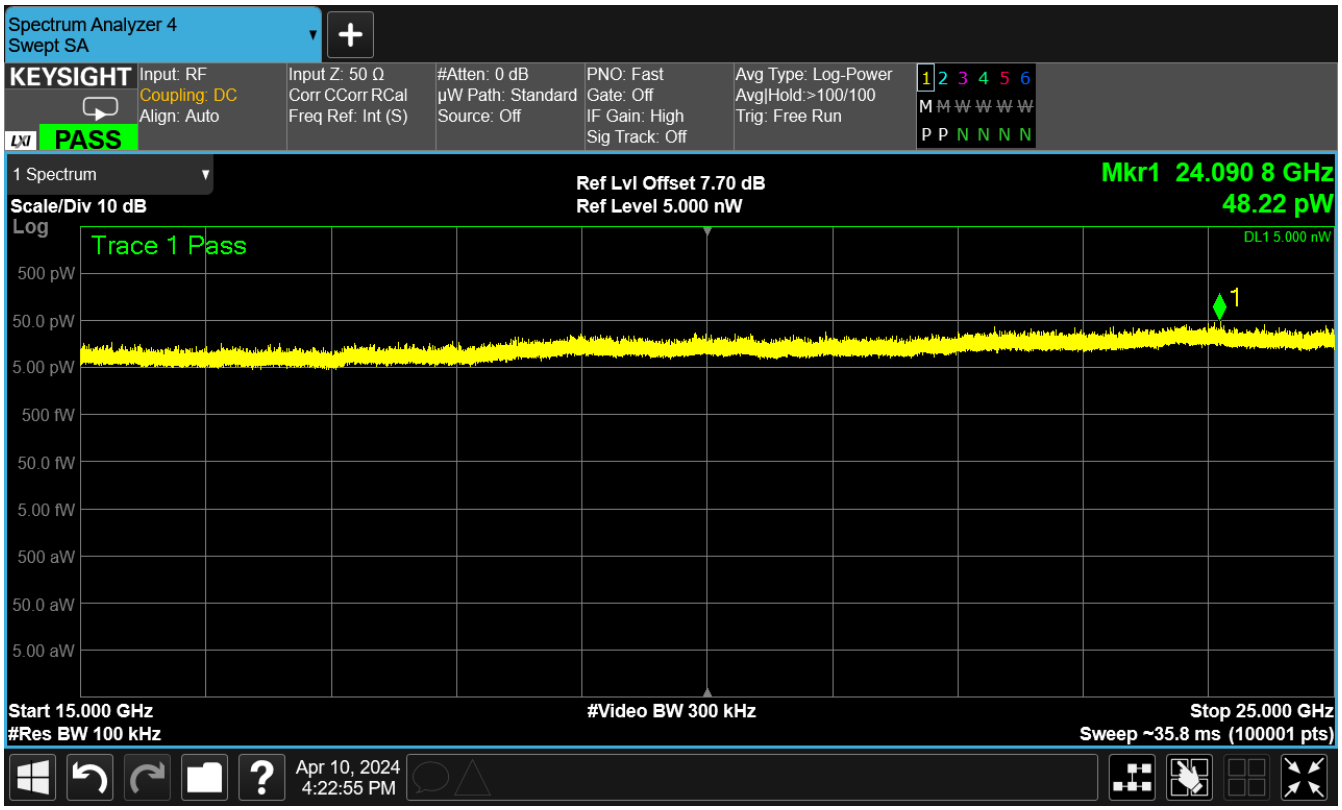
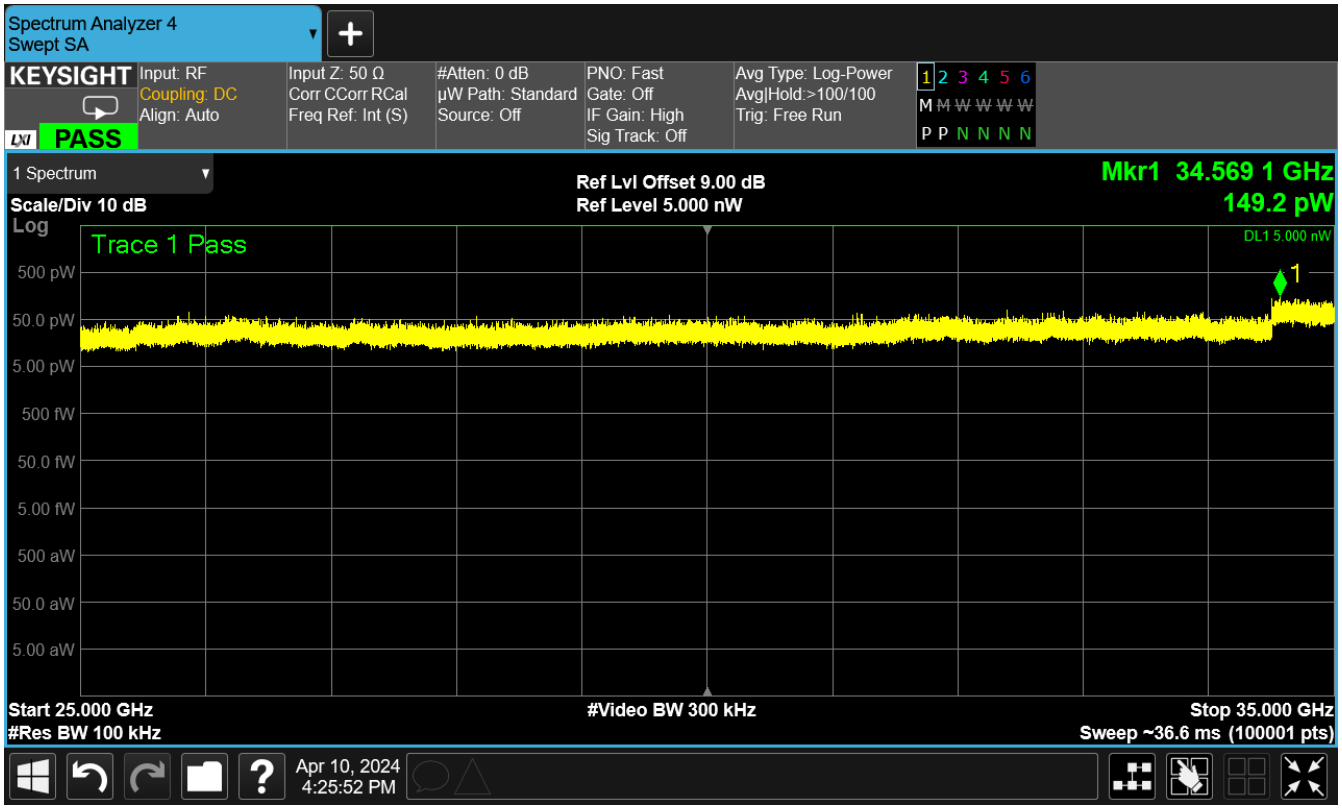


Figure 33: Conducted Unwanted Receiver Emissions, Plot 4



3.8 Radiated Emissions

3.8.1 Requirements

Compliance Standard: FCC Part 15.247, 15.209, 15.205

Radiated Emissions, Compliance Limits		
Frequency Range	Limit (distance)	
	Class A (10 meter)	Class B (3 meter)
30 – 88 MHz	90 µV/m	100 µV/m
88 – 216 MHz	150 µV/m	150 µV/m
216 – 960 MHz	210 µV/m	200 µV/m
> 960 MHz	300 µV/m	500 µV/m

3.8.2 Test Procedure

The requirements of FCC Part 15 and ICES-003 call for the EUT to be placed on an 80 cm high 1 X 1.5 meters non-conductive motorized turntable for radiated testing on a 3-meter open air test site.

The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Bi-conical and log periodic broadband antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The output of the antenna was connected to the input of the spectrum analyzer and the emissions in the frequency range of 30 MHz to 26.5 GHz were measured. Both the horizontal and vertical field components were measured.

The output from the antenna was connected, via a preamplifier, to the input of the spectrum analyzer. The detector function was set to quasi-peak or peak, as appropriate. Above 1GHz average measurement are recorded. The measurement bandwidth of the spectrum analyzer system was set to at least 120 kHz, with all post-detector filtering no less than 10 times the measurement bandwidth. Frequencies above 1GHz were performed using a measurement bandwidth of 1 MHz with a video bandwidth setting of 10 Hz for the average measurement.

3.8.3 Test Results Summary

The EUT complies with the Class B Radiated Emissions requirements.

3.8.4 Radiated Data Reduction and Reporting

To convert the raw spectrum analyzer radiated data into a form that can be compared with the FCC limits, it is necessary to account for various calibration factors that are supplied with the antennas and other measurement accessories. These factors are included into the antenna factor (AF) column of the table and in the cable factor (CF) column of the table. The AF (in dB/m) and the CF (in dB) is algebraically added to the raw Spectrum Analyzer Voltage in dBµV to obtain the Radiated Electric Field in dBµV/m. This logarithm amplitude is converted to a linear amplitude, then compared to the FCC limit.

Example:

Spectrum Analyzer Voltage: VdBµV
Antenna Correction Factor: AFdB/m
Cable Correction Factor: CFdB
Pre-Amplifier Gain (if applicable): GdB
Electric Field: EdBµV/m = V dBµV + AFdB/m + CFdB - GdB
To convert to linear units of measure:: EdBµV/m/20 Inv log

3.8.5 Test Data

The EUT is fully compliant, and the test data is provided on the pages below.

A complete investigation of the radiated fundamental field strength was performed. The EUT was evaluated in three orthogonal axes (x, y, z). The EUT position the produced the highest radiated power was maintained during all testing.

The EUT was configured to transmit a 1Mbps, QPSK modulated signal as follows:

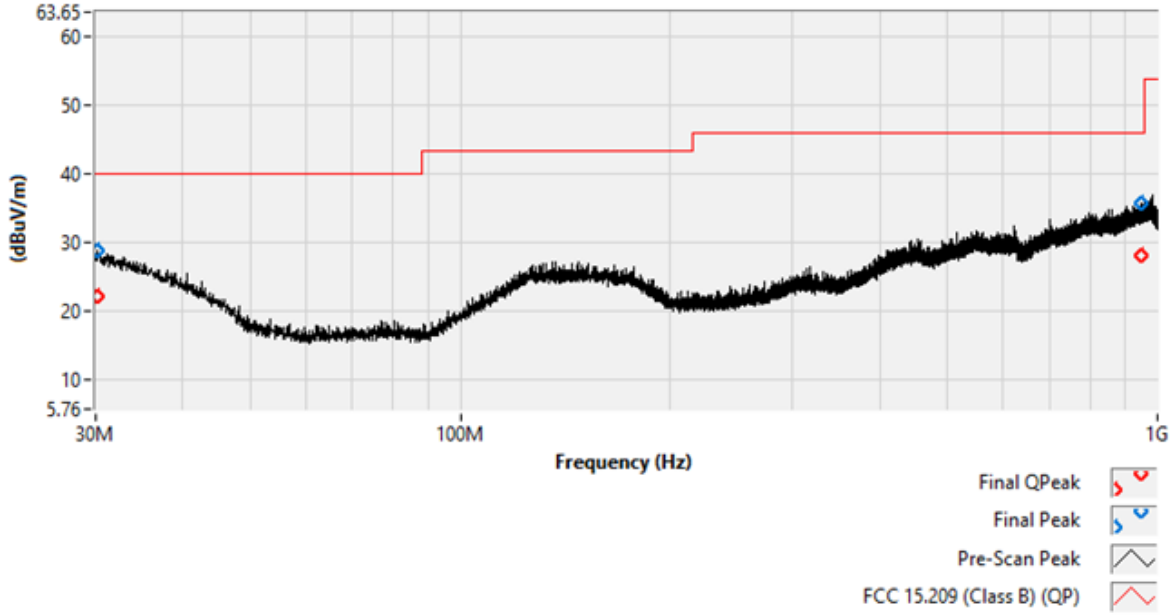
a) for testing of 30 MHz to 1 GHz, the EUT was set to a transmitter enabled mode, the BLE transceiver was set to sweep the 2.4GHz ISM band, in an active advertising mode.

b) for testing of 1 GHz to 26.5 GHz, the EUT was set to a transmitter enabled mode, the BLE transceiver was set to dwell on the low, center, and high channels.

The following page provides the 30MHz-1GHz test data. Please accept this data to cover the digital portion under the provisions of 15.109(a).

Frequency (MHz)	Detector	Corr. Meas (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Table (deg)	Antenna (cm)
30.240	Peak	28.968	--	--	0	Vert, 100
	QP	22.083	40	-17.917	0	Vert, 100
947.023	Peak	35.836	--	--	0	Vert, 120
	QP	28.158	46	-17.842	0	Vert, 120

Pre-scan and Final Data (Vertical)



Pre-scan and Final Data (Horizontal)

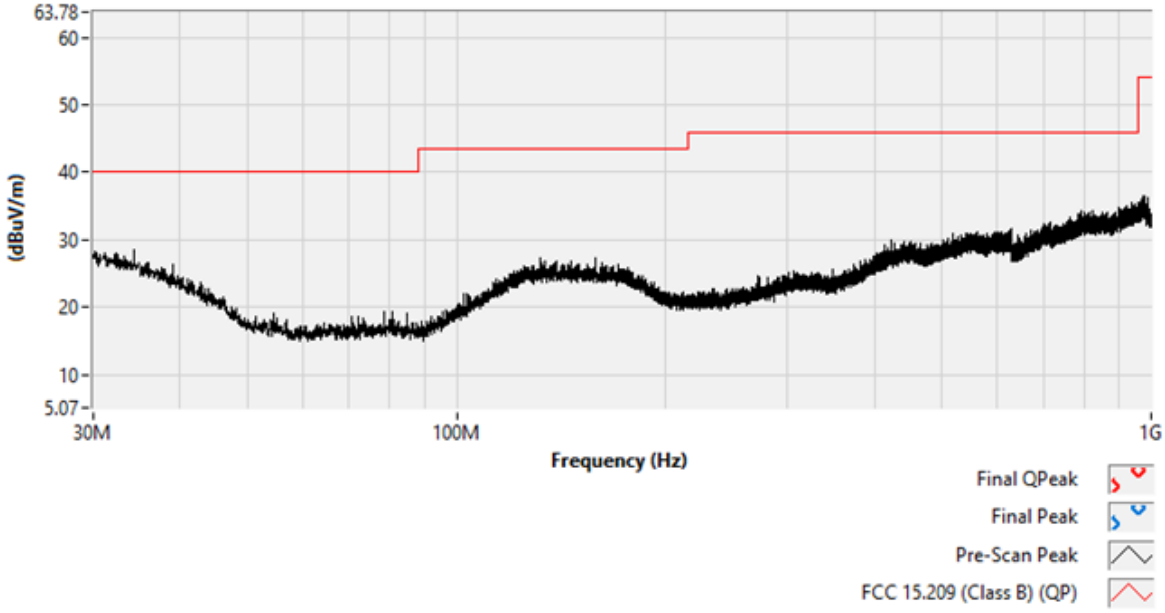
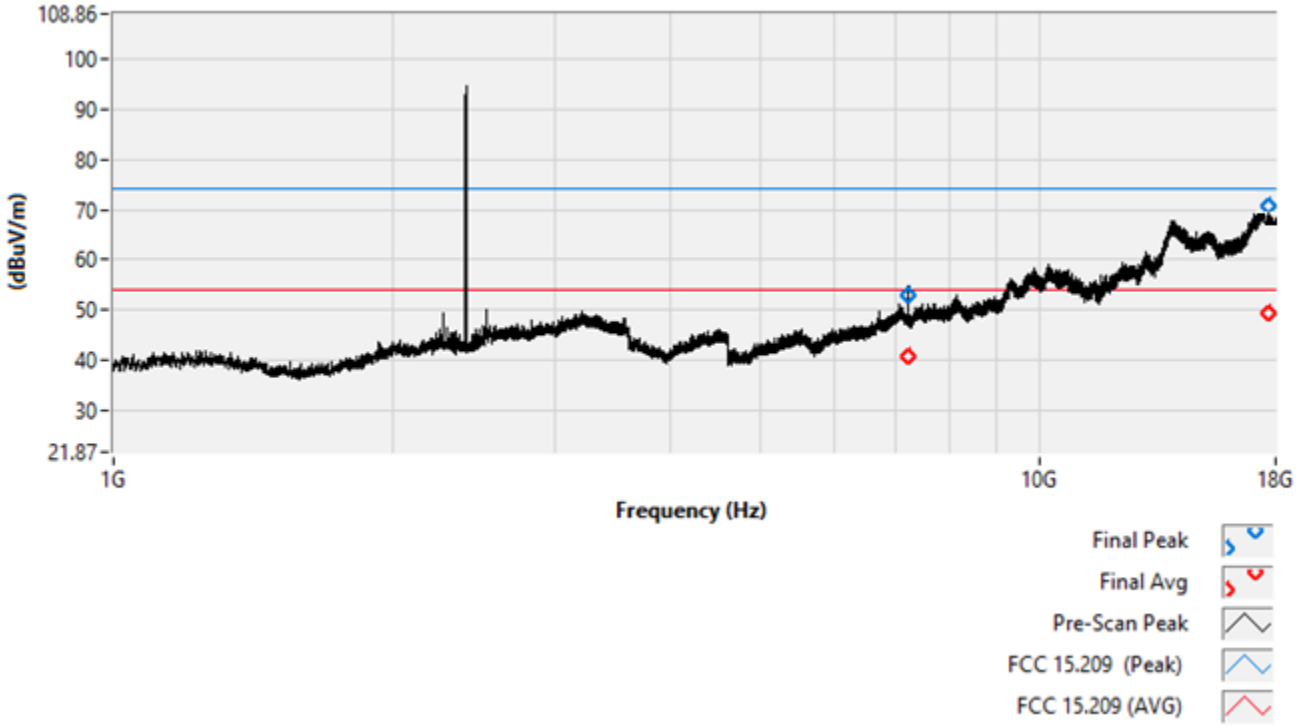


Table 9: Radiated Emissions Test Data, Low Channel

Frequency (GHz)	Detector	Corr. Meas (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Turn Table (deg)	Antenna (cm)
2.390 [1]	Peak	41.258	74	-32.742	35	Horiz, 155
	Avg	28.254	54	-25.746	35	Horiz, 155
2.403 [2]	Peak	94.942	--	--	35	Horiz, 155
	Avg	88.67	--	--	35	Horiz, 155
7.205	Peak	52.876	74	-21.124	145	Vert, 160
	Avg	40.674	54	-13.326	145	Vert, 160
10.299	Peak	59.233	74	-14.767	35	Horiz, 150
	Avg	42.293	54	-11.707	35	Horiz, 150
17.653	Peak	69.004	74	-4.996	145	Vert, 145
	Avg	49.337	54	-4.663	145	Vert, 145

[1] Restricted BE
[2] Low Chan TX

Low Chan., Pre-scan and Final Data (Vertical)



Low Chan., Pre-scan and Final Data (Horizontal)

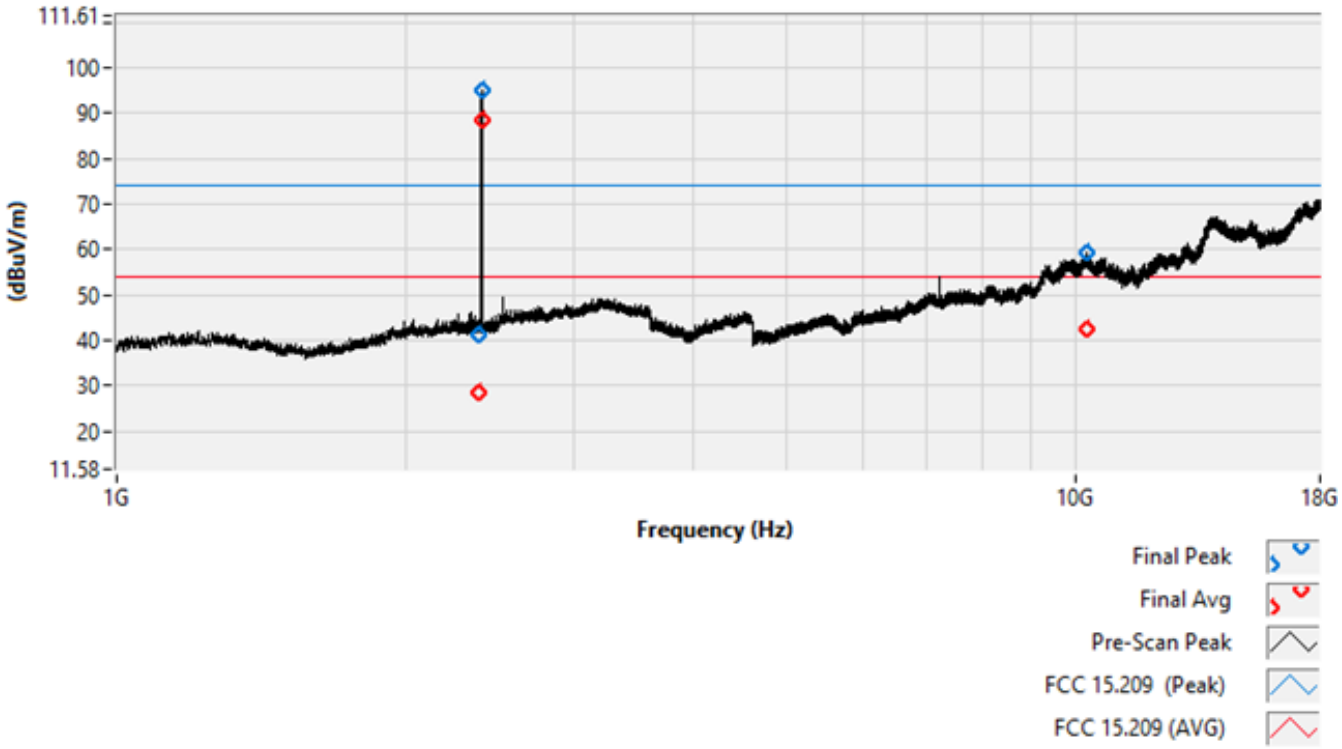
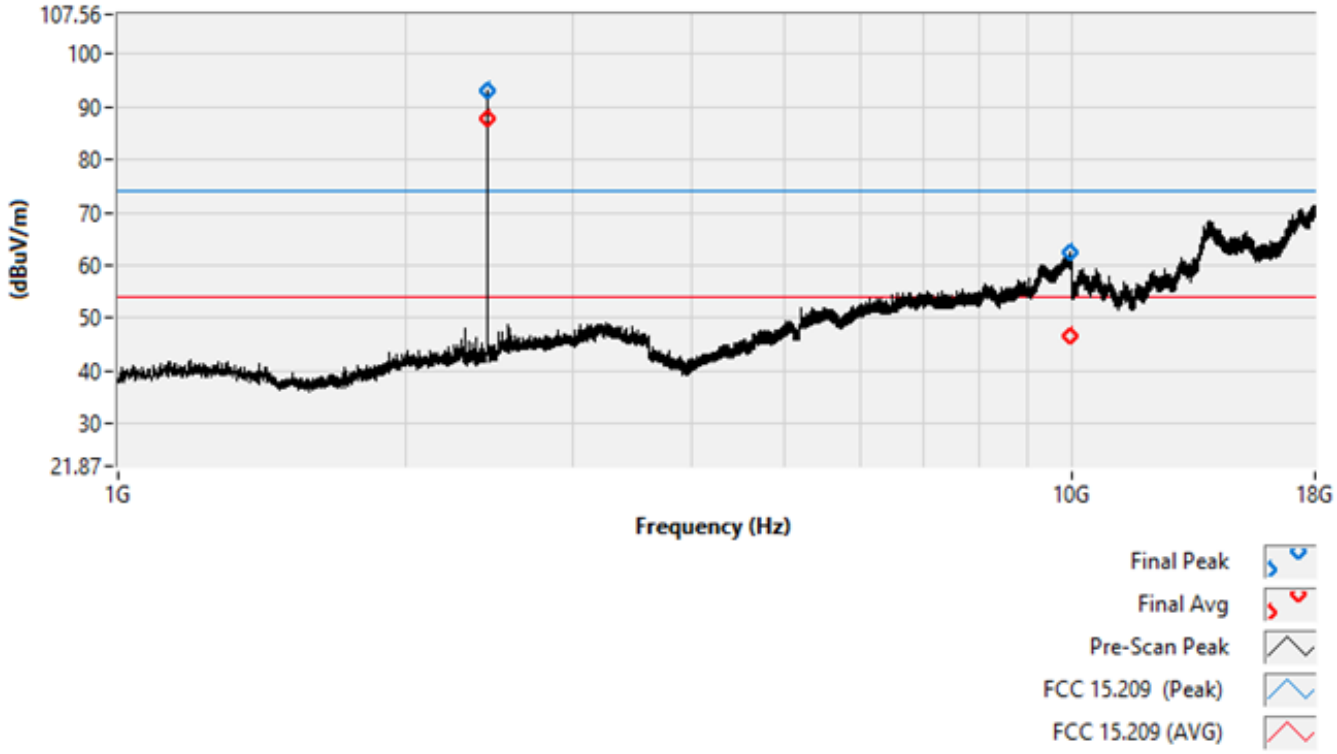


Table 10: Radiated Emissions Test Data, Center Channel

Frequency (GHz)	Detector	Corr. Meas (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Turn Table (deg)	Antenna (cm)
2.441	Peak	93.277	--	--	145	Vert, 150
	Avg	--	--	--	145	Vert, 150
9.039	Peak	55.487	74	-18.513	40	Horiz, 155
	Avg	41.78	54	-12.22	40	Horiz, 155
9.985	Peak	62.525	74	-11.475	145	Vert, 145
	Avg	46.433	54	-7.567	145	Vert, 145
17.442	Peak	71.02	74	-2.98	40	Horiz, 150
	Avg	49.945	54	-4.055	40	Horiz, 150

Center Chan., Pre-scan and Final Data (Vertical)



Center Chan., Pre-scan and Final Data (Horizontal)

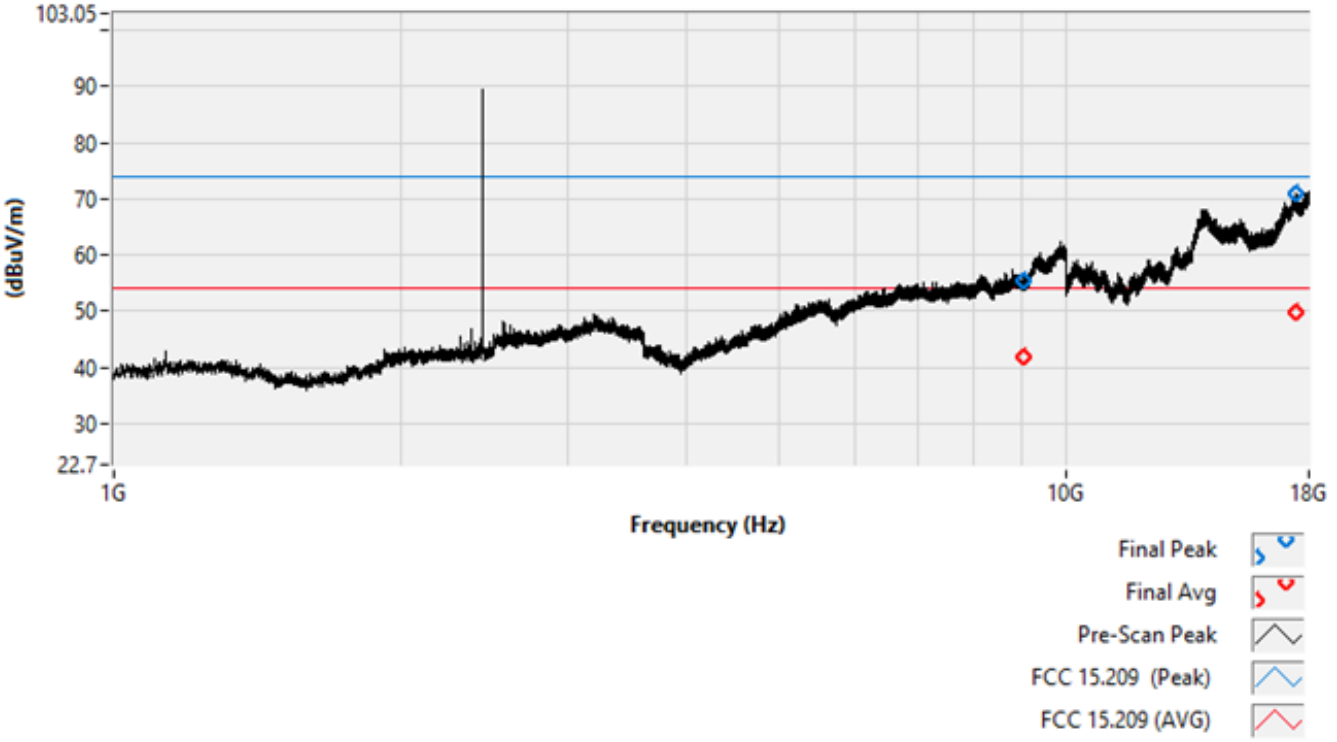
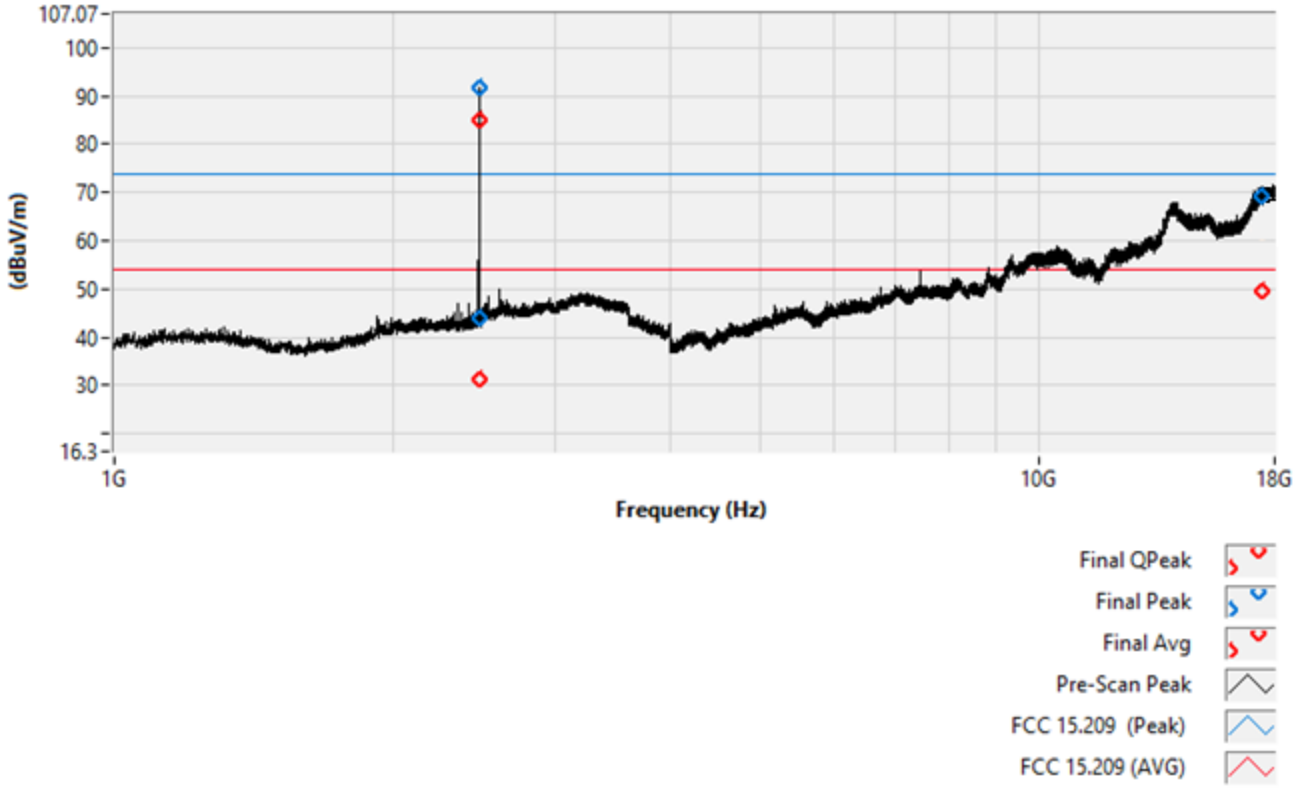


Table 11: Radiated Emissions Test Data, High Channel

Frequency (GHz)	Detector	Corr. Meas (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Turn Table (deg)	Antenna (cm)
2.481 [1]	Peak	91.939	74	17.939	0	Vert, 100
	Avg	85.023	54	31.023	0	Vert, 100
2.4835 [2]	Peak	43.962	74	-30.038	0	Vert, 100
	Avg	31.426	54	-22.574	0	Vert, 100
10.523	Peak	58.939	74	-15.061	0	Horiz, 100
	Avg	44.066	54	-9.934	0	Horiz, 100
17.464	Peak	62.280	74	-11.72	0	Vert, 100
	Avg	49.689	54	-4.311	0	Vert, 100

[1] High Chan TX
[2] Restricted BE

High Chan., Pre-scan and Final Data (Vertical)



High Chan., Pre-scan and Final Data (Horizontal)

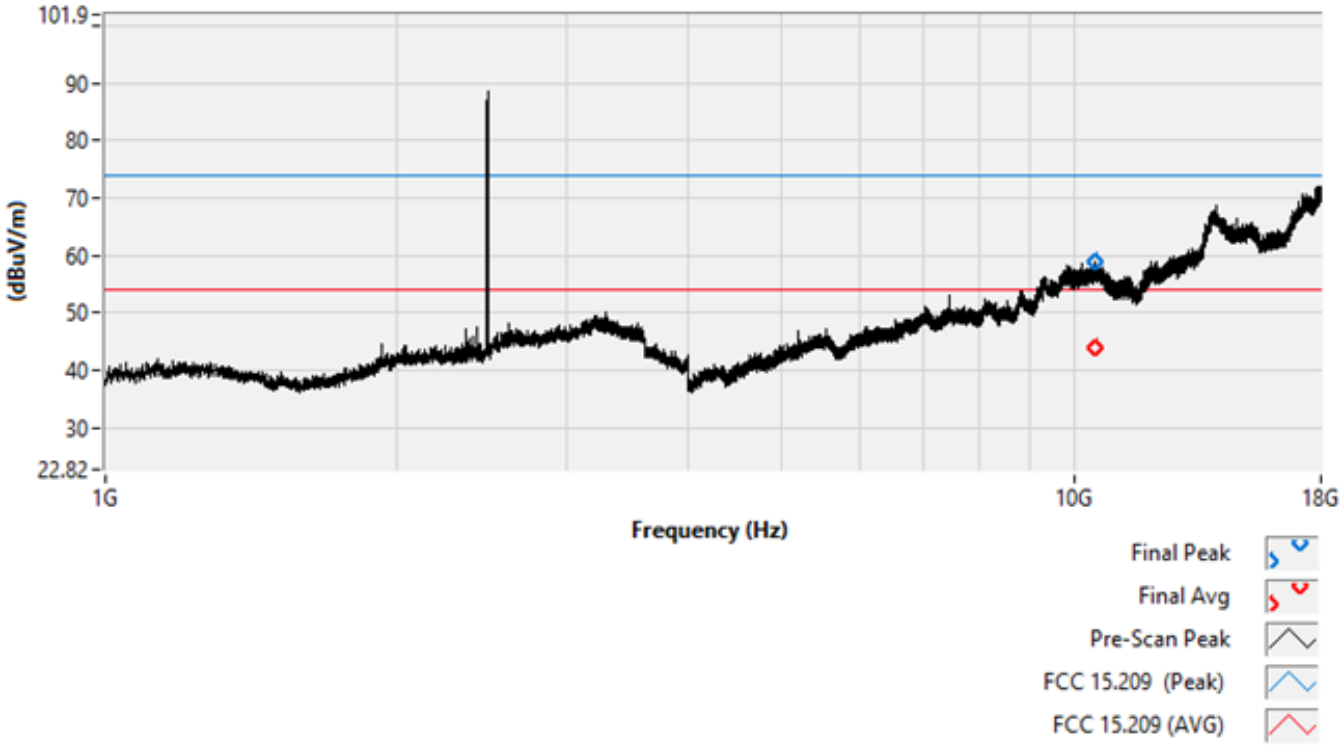
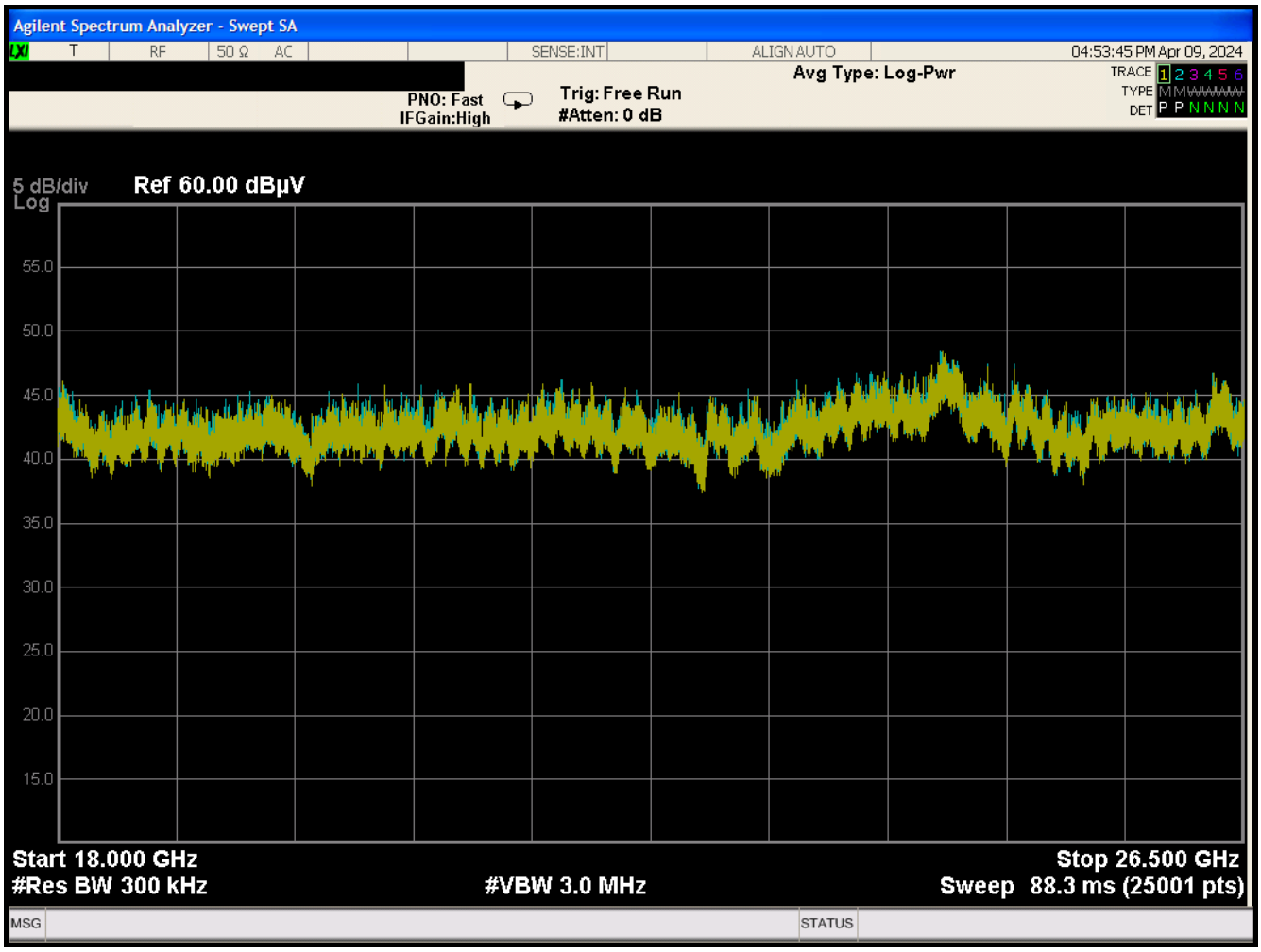
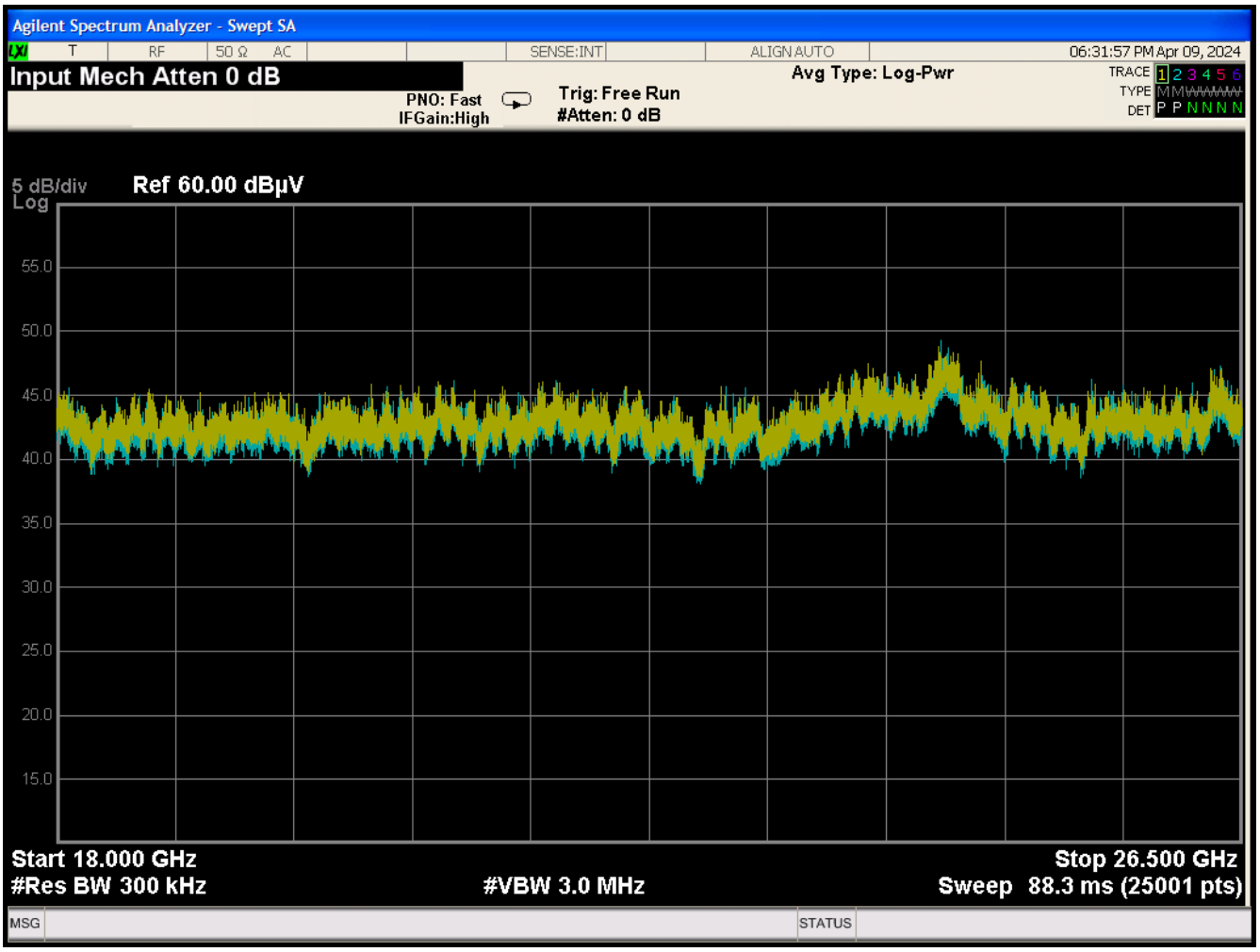


Figure 34: Radiated Emissions Test Data, Low Channel (18GHz to 26.5GHz)



- EUT emissions are not detected in this frequency range.
- Trace 1 = EUT TX On
- Trace 2 = Ambient

Figure 35: Radiated Emissions Test Data, High Channel (18GHz to 26.5GHz)



- EUT emissions are not detected in this frequency range.
- Trace 1 = EUT TX On
- Trace 2 = Ambient

3.9 AC Powerline Conducted Emissions

3.9.1 Requirements

Compliance Standard: FCC Part 15.207

FCC Compliance Limits				
Frequency Range	~~Class A Digital Device~~		Class B Digital Device	
	~~Quasi-peak~~	~~Average~~	Quasi-peak	Average
0.15 – 0.5 MHz	~~79 dBµV~~	~~66 dBµV~~	66 to 56 dBµV	56 to 46 dBµV
0.5 – 5 MHz	~~79 dBµV~~	~~66 dBµV~~	56 dBµV	46 dBµV
0.5 – 30 MHz	~~73 dBµV~~	~~60 dBµV~~	60 dBµV	50 dBµV

3.9.2 Test Procedure

The requirements of FCC Part 15 and ICES-003 call for the EUT to be placed on an 80cm-high non-conductive table above a ground plane. Power to the EUT was provided through a Solar Corporation 50 Ω/50 µH Line Impedance Stabilization Network bonded to a 3 X 2-meter ground plane. The LISN has its AC input supplied from a filtered AC power source. Power was supplied to the peripherals through a second LISN. The peripherals were placed on the table in accordance with ANSI C63.4. Power and data cables were moved about to obtain maximum emissions.

The 50 Ω output of the LISN was connected to the input of the spectrum analyzer and the emissions in the frequency range of 150 kHz to 30 MHz were measured. The detector function was set to quasi-peak, peak, or average as appropriate, and the resolution bandwidth during testing was at least 9 kHz, with all post-detector filtering no less than 10 times the resolution bandwidth. For average measurements, the post-detector filter was set to 10 Hz.

These emissions must meet the limits specified in §15.207 for quasi-peak and average measurements.

Environmental Conditions During AC Conducted Emissions Testing

Ambient Temperature:	21 °C
Relative Humidity:	55 %

3.9.3 Conducted Data Reduction and Reporting

The comparison between the Conducted emissions level and the FCC limit is calculated as shown in the following example:

Spectrum Analyzer Voltage: VdBµV(raw)

LISN Correction Factor: LISN dB

Cable Correction Factor: CF dB

Voltage: VdBµV = V dBµV (raw) + LISN dB + CF dB

3.9.4 Test Data

The EUT complies with the Class B Conducted Emissions requirements.

The EUT indirectly couples to the AC mains network via the battery pack charger.

The EUT was evaluated in both the TX enabled and TX disabled modes.

The worst-case emission test data is provided below.

Table 12: AC Power Conducted Emissions Test Data

NEUTRAL / L1										
Frequency (MHz)	**Level QP (dBµV)**	**Level AVG (dBµV)**	**Cable Loss (dB)**	**LISN Corr (dB)**	**Level QP Corr (dBµV)**	**Level Avg Corr (dBµV)**	**Limit QP (dBµV)**	**Limit AVG (dBµV)**	**Margin QP (dB)**	**Margin AVG (dB)**
0.150	47.6	16.8	9.9	0.5	58.0	27.2	66.0	56.0	-8.0	-28.8
0.154	44.0	14.9	9.9	0.4	54.4	25.3	65.8	55.8	-11.4	-30.5
0.256	39.0	15.0	9.9	0.3	49.3	25.3	61.6	51.6	-12.3	-26.3
0.426	27.0	7.8	9.9	0.3	37.2	18.0	57.3	47.3	-20.1	-29.3
0.598	38.1	11.1	9.9	0.3	48.3	21.3	56.0	46.0	-7.7	-24.7
0.766	26.0	10.0	9.9	0.3	36.2	20.2	56.0	46.0	-19.8	-25.8
0.932	22.0	9.0	9.9	0.3	32.2	19.2	56.0	46.0	-23.8	-26.8
2.762	17.0	9.0	10.2	0.3	27.5	19.5	56.0	46.0	-28.5	-26.5
0.150	47.6	16.8	9.9	0.5	58.0	27.2	66.0	56.0	-8.0	-28.8
PHASE / L2										
Frequency (MHz)	**Level QP (dBµV)**	**Level AVG (dBµV)**	**Cable Loss (dB)**	**LISN Corr (dB)**	**Level QP Corr (dBµV)**	**Level Avg Corr (dBµV)**	**Limit QP (dBµV)**	**Limit AVG (dBµV)**	**Margin QP (dB)**	**Margin AVG (dB)**
0.151	48.3	17.5	9.9	0.6	58.9	28.1	65.9	55.9	-7.1	-24.9
0.156	48.1	17.1	9.9	0.6	58.7	27.7	65.7	55.7	-7.0	-28.0
0.201	43.2	15.1	9.9	0.5	53.6	25.5	63.6	53.6	-9.9	-28.0
0.243	37.6	12.9	9.9	0.4	48.0	23.3	62.0	52.0	-14.0	-28.7
0.409	27.1	8.0	9.9	0.3	37.4	18.3	57.7	47.7	-20.3	-29.4
0.573	21.5	9.0	9.9	0.3	31.7	19.2	56.0	46.0	-24.3	-26.8
0.736	18.0	8.0	9.9	0.3	28.2	18.2	56.0	46.0	-27.8	-27.8
0.902	17.9	7.0	9.9	0.3	28.1	17.2	56.0	46.0	-27.9	-28.8
1.232	14.0	6.0	9.9	0.3	24.2	16.2	56.0	46.0	-31.8	-29.8

4 Test Equipment

The table below provides a list of the test equipment used for measurements along with the calibration information.

Table 13: Test Equipment List

Test Name:	**Radiated Emissions**	Test Date(s): 4/9/2024 & 4/10/2024	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00942	AGILENT, MXA	SPECTRUM ANALYZER	12/19/2024
00644	SUNOL SCIENCES CORP.	ANTENNA, LOGPERIOD	11/7/2024
00626	ARA, DRG-118/A	ANTENNA, HORN	6/19/2024
00066	AGILENT	RF PRE-AMPLIFIER	5/24/2024
00065	ELECTRO-METRICS	RF PRE-AMPLIFIER	5/9/2024
00806	MINI-CIRCUITS, 3061	HF COAX CABLE, SMA	12/26/2024
00977	JUNKOSHA, USA MX-322	6M COAXIAL CABLE, SMA/N	12/26/2024

Test Name:	**Conducted RF Emissions**	Test Date: 4/10/2024	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00993 [1]	KEYSIGHT N9020B	MXA SIGNAL ANALYZER	11/6/2025
00637	MOLEX, 025799-0001	SMA COAXIAL CABLE	9/1/2024
00826	MEGAPHASE, TM40-K1K5	HF COXIAL CABLE	7/17/2024
00992	KEYSIGHT N5173B	EXG SIGNAL GENERATOR	11/27/2024
N/A	WEINSCHEL, 3.5MM	6dB ATTENUATOR	Cal. Before Use

[1] the N9020B, MXA has the following instrument software version installed: A.33.03 (2023).

Test Equipment List, Continued

Test Name: **AC Powerline Emissions**		Test Date: 6/14/2024	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00993 [1]	KEYSIGHT N9020B	MXA SIGNAL ANALYZER	11/6/2025
00125	SOLAR 8028-50-TS-24-BNC	LISN	4/18/2025
00126	SOLAR 8028-50-TS-24-BNC	LISN	4/18/2025
00053	HP 11947A	LIMITER TRANSIENT	1/11/2025
00825	CABLE ASSOCIATES	6-METER COAXIAL CABLE	6/1/2025
00125	SOLAR 8028-50-TS-24-BNC	LISN	4/18/2025

[1] the N9020B, MXA has the following instrument software version installed: A.33.03 (2023).

5 Measurements

5.1.1 References

ANSI C63.2 (Jan-2016) Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 (Jan 2014) American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

ANSI C63.10 (Jun 2013) American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

5.2 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 (R2002) with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in Equation 1. to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

Equation 1: Standard Uncertainty

$$u_c = \pm\sqrt{\frac{a^2}{div_a{}^2} + \frac{b^2}{div_b{}^2} + \frac{c^2}{div_c{}^2} + ...}$$

where,

uc	= standard uncertainty
a, b, c,..	= individual uncertainty elements
Diva, b, c	= the individual uncertainty element divisor based on the probability distribution
Divisor	= 1.732 for rectangular distribution
Divisor	= 2 for normal distribution
Divisor	= 1.414 for trapezoid distribution

Equation 2: Expanded Uncertainty

$$U = ku_c$$

where,

U = expanded uncertainty
k = coverage factor
k ≤ 2 for 95% coverage (ANSI/NCSL Z540-2 Annex G)
uc = standard uncertainty

The measurement uncertainty complies with the maximum allowed uncertainty from CISPR 16-4-2. Measurement uncertainty is not used to adjust the measurements to determine compliance. The expanded uncertainty values for the various scopes in the WLL accreditation are provided in the table below.

Table 14: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	CISPR11, CISPR22, CISPR32, CISPR14, FCC Part 15	± 2.63 dB
Radiated Emissions	CISPR11, CISPR22, CISPR32, CISPR14, FCC Part 15	± 4.55 dB

5.3 Environmental Conditions

Environmental Conditions During All Measurements

Ambient Temperature:	17.2 °C
Relative Humidity:	49 %