FCC & ISED CANADA CERTIFICATION TEST REPORT

FOR THE

GRIDADVISOR 3

FCC ID: P9X-GA3BLE

IC ID: 6766A-GA3BLE

WLL REPORT # 18867-01 REV 1

Prepared for:

Eaton's Cooper Power Systems
540 Gaither Road, Suite 480
Rockville, Maryland 20878

Prepared By:

Washington Laboratories, Ltd.
4840 Winchester Boulevard, Suite 5
Frederick, Maryland 21703

Testing Certificate AT-1448

FCC & ISED Canada Certification Test Report

for the

Eaton's Cooper Power Systems

FCC ID: P9X-GA3BLE

IC ID: 6766A-GA3BLE

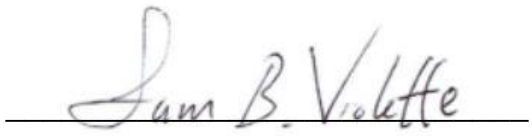
October 14, 2024

WLL Report# 18867-01 Rev 1

Prepared by:

Ryan Mascaro
RF Test Engineer

Reviewed by:



Samuel Violette
Vice President

Abstract

This report has been prepared on behalf of Eaton's Cooper Power Systems to support the attached application for equipment authorization for a 2.4GHz Bluetooth LE transmitter. 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 test report documents the test configuration and test results for the Eaton's Cooper Power Systems, GridAdvisor 3. 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 Eaton's Cooper Power Systems, GridAdvisor 3 complies with the requirements for a Digital Transmission System (DTS) 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	October 14, 2024
Rev 1	ACB comments dated 12/4/2024	December 7, 2024

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1 Introduction

1.1 Compliance Statement

The Eaton's Cooper Power Systems, GridAdvisor 3 complies with the requirements for a Digital Transmission System (DTS) 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 C63.10 "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. Table 1 provides the series and results of testing for compliance with for a FHSS device; full test results are shown in subsequent report sub-sections.

1.3 Testing Algorithm

The GridAdvisor 3 evaluated for radiated emissions. Testing of the AC powerline is not required, as the device is battery powered only. For the radiated portion, the EUT was tested while coupled to the support laptop, via a USB cable. This is not a typical configuration, as the laptop will never be coupled to the EUT while the device is installed in the field. The BLE transceiver was programmed into a test mode, to dwell on the low, center, and high channels. The EUT sample was not capable of hopping or sweeping the band. Therefore, no testing was performed in a hopping enabled mode. The EUT was evaluated with the BLE portion in four different data rates: 125kbps, 500kbps, 1Mbps, and 2Mbps. The embedded cellular modem was not enabled during the testing. The EUT was arranged on the test site to produce the worst-case emissions. Only the worst-case emissions are provided throughout this report.

1.4 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. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Testing Certificate AT-1448 as an independent test laboratory. The Washington Laboratories, Ltd. ISED Canada number is 3035A.

1.5 Contract Information

Customer:	Eaton's Cooper Power Systems
Purchase Order Number:	220331
Quotation Number:	74822

1.6 Test and Support Personnel

Washington Laboratories, LTD	Richard Quarcoo and Randon McIlwain
Customer Representative	Steven Seymour and Tuan Nguyen

1.7 Test Dates

9/16/2024 to 9/20/2024 & 12/6/2024 (also see Section 4 of this report)

Table 1: Certification Testing Summary and Compliance Results

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	N/A

1.8 Deviations to the Test Standard

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

2 Equipment Under Test

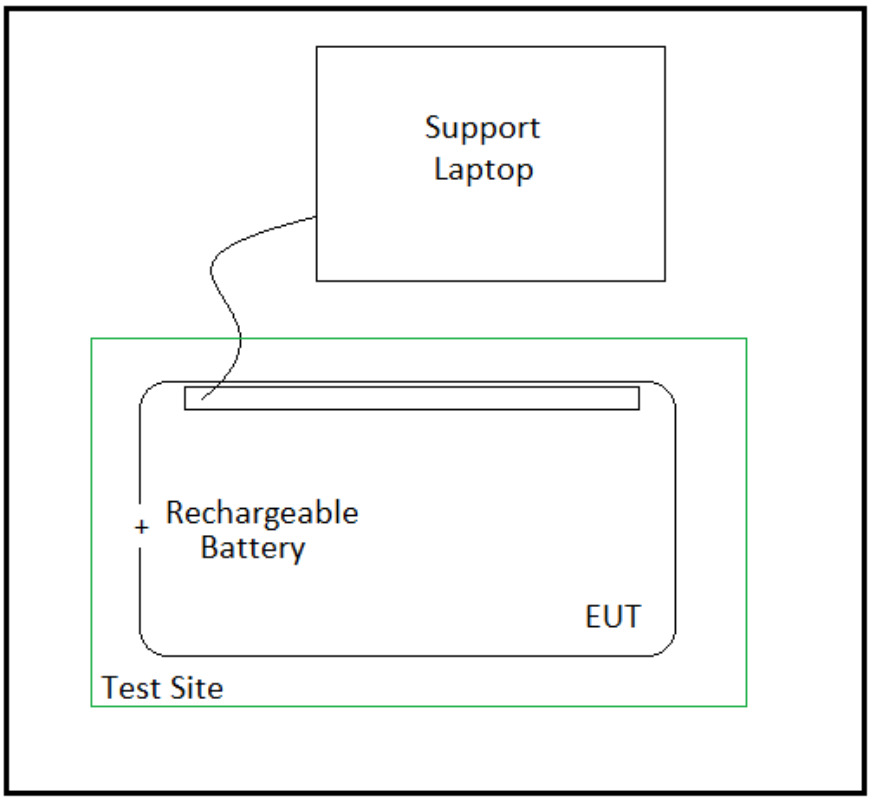
The EUT is being certified as a Bluetooth LE device under FCC ID: P9X-GA3BLE. The GridAdvisor 3 (GA3) is a powerline sensor, detecting current on the powerline on which it is installed. It is equipped with an energy harvesting system that uses the powerline itself to generate its operating power and charge its internal battery. It is equipped with a pre-certified cellular, single-module (currently authorized under FCC ID: 2ANPO00NRF9160) that allows communicating sensor information to the utility network. The two radios do not operate simultaneously. At the direction of the manufacturer, the cellular portion was not exercised during the testing for this report.

Table 2: Radio Device Summary

Manufacturer and Applicant:	Eaton's Cooper Power Systems
FCC ID:	P9X-GA3BLE
IC ID:	6766A-GA3BLE
Model:	GridAdvisor 3
Serial Number of Unit Tested:	11
EUT Primary Power:	3.3VDC, Battery
FCC Rule Part:	§15.247
TX Frequency Range:	2404 MHz to 2478 MHz
Maximum Peak Output Power:	-0.69 dBm (0.0009 Watts)
Antenna Manufacturer:	Eaton's Cooper Power Systems
Antenna Type:	PCB, F-type Trace Antenna
Maximum, Peak Gain:	-1.97 dBi
Data Rate:	125kbps, 500kbps, 1Mbps, 2Mbps
FCC Emission Designator:	690KG1D
ISED Emission Designator:	2M12G1D
Keying:	Automatic
Type of Information:	Digital Data
Highest TX Spurious Emission:	-44.1 dBm @ 9.913GHz (conducted) (see Figure 76)
Software/Firmware:	*Not declared by manufacturer*

2.1 Testing Arrangement

Figure 1: EUT Testing Diagram



2.2 EUT Test Configuration

Table 3: EUT System Configuration List

EUT Model	Manufacturer	Part Number	Serial Number	HW Revision
GA3	Eaton's Cooper Power Systems	GA3	11	3

Table 4: EUT Cable Configuration

Port Identification	Connector Type	Cable Length	Shielded (Y/N)	Termination Point
USB	USB	< 3m	Yes	Laptop

Table 5: Support Equipment

Item	Model/Part Number	Serial Number
uFl, RF Cable	--	--
USB Cable	--	--
Laptop	Lenovo	--

3 Test Results

3.1 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.

3.1.1 Measurement Method

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

3.1.2 Test Data

The EUT test data is provided below.

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

Table 6: Occupied Bandwidth Results

Data Rate	Frequency (MHz)	6dB Bandwidth	99% Bandwidth
125 kbps	2404 MHz	692.0 kHz	1.077 MHz
	2444 MHz	690.3 kHz	1.083 MHz
	2478 MHz	689.2 kHz	1.083 MHz
500 kbps	2404 MHz	703.2 kHz	1.084 MHz
	2444 MHz	705.3 kHz	1.088 MHz
	2478 MHz	704.1 kHz	1.086 MHz
1 Mbps	2404 MHz	713.7 kHz	1.082 MHz
	2444 MHz	711.5 kHz	1.087 MHz
	2478 MHz	710.7 kHz	1.084 MHz
2 Mbps	2404 MHz	1.275 MHz	2.122 MHz
	2444 MHz	1.276 MHz	2.122 MHz
	2478 MHz	1.273 MHz	2.122 MHz

Figure 2: 125kbps, Low Channel, OBW

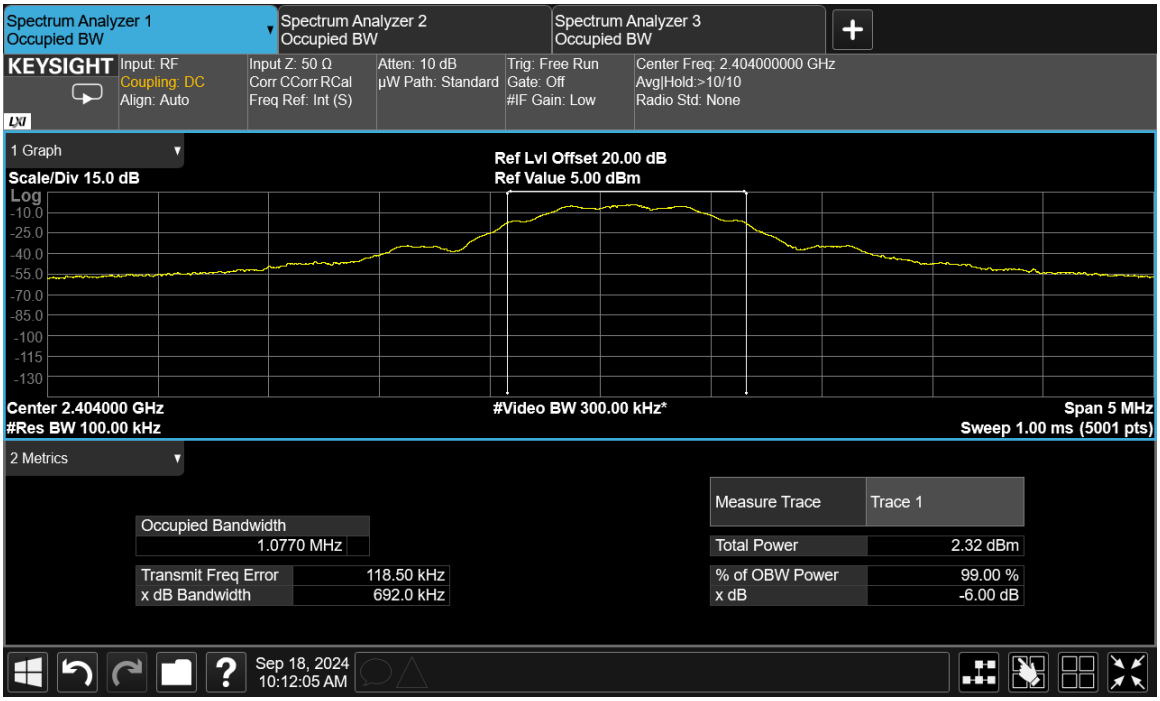


Figure 3: 125kbps, Center Channel, OBW

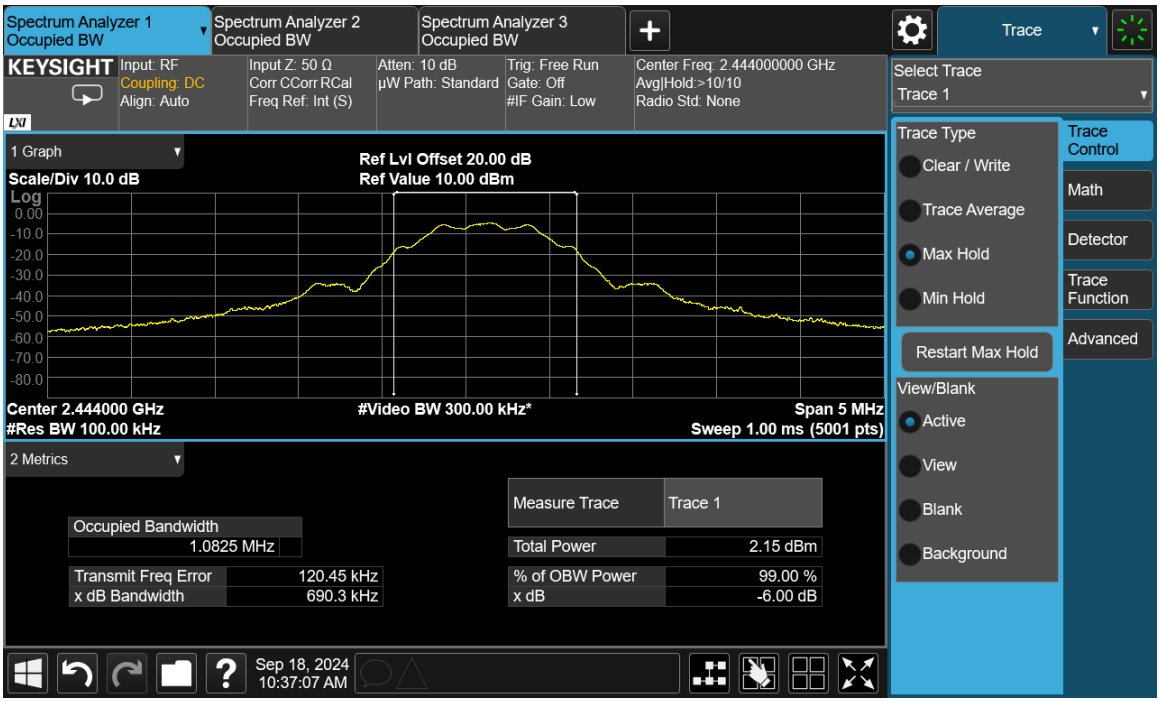


Figure 4: 125kbps, High Channel, OBW

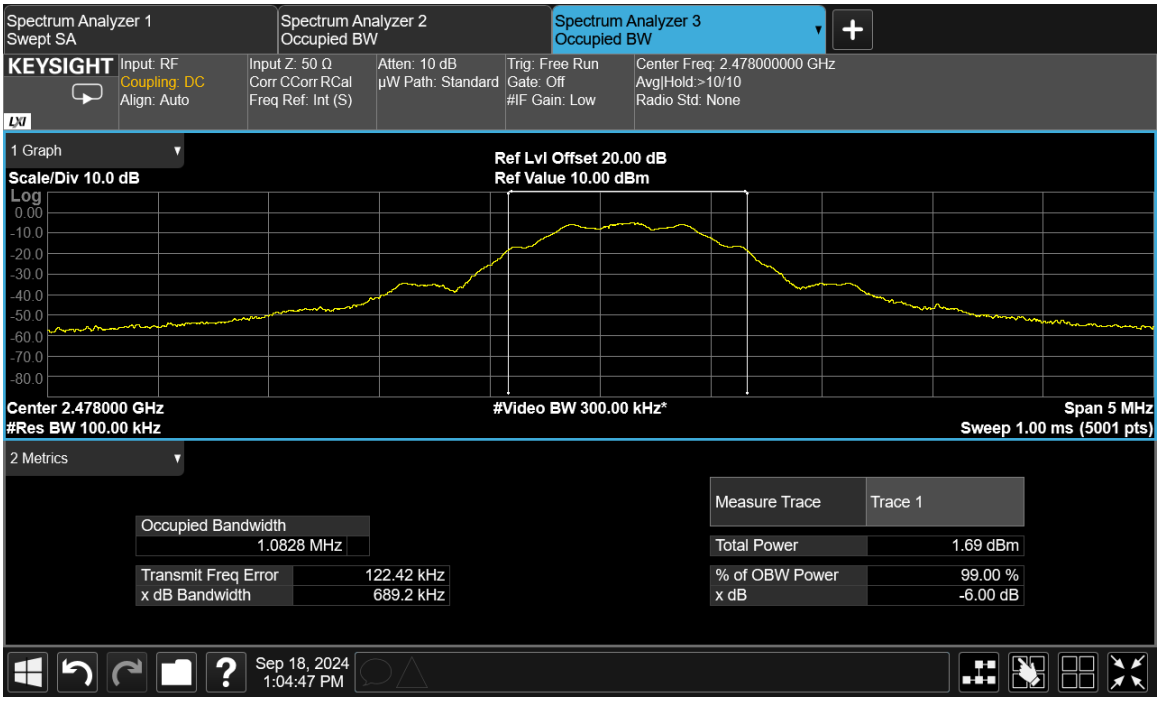


Figure 5: 500kbps, Low Channel, OBW

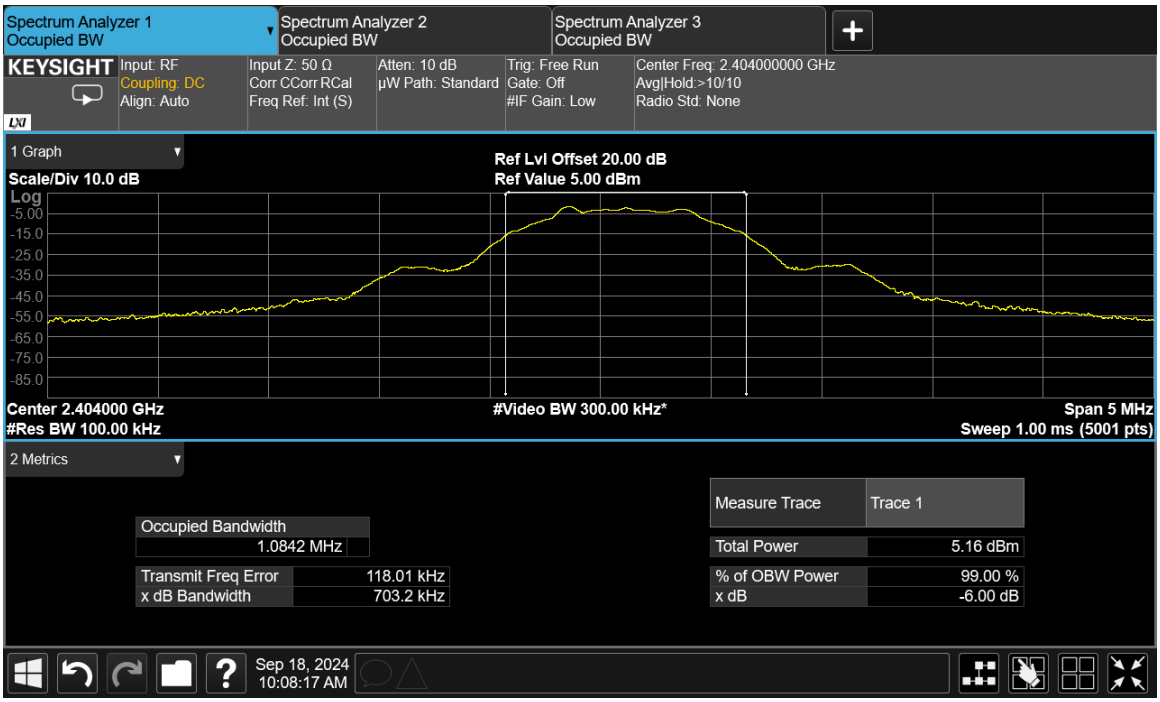


Figure 6: 500kbps, Center Channel, OBW

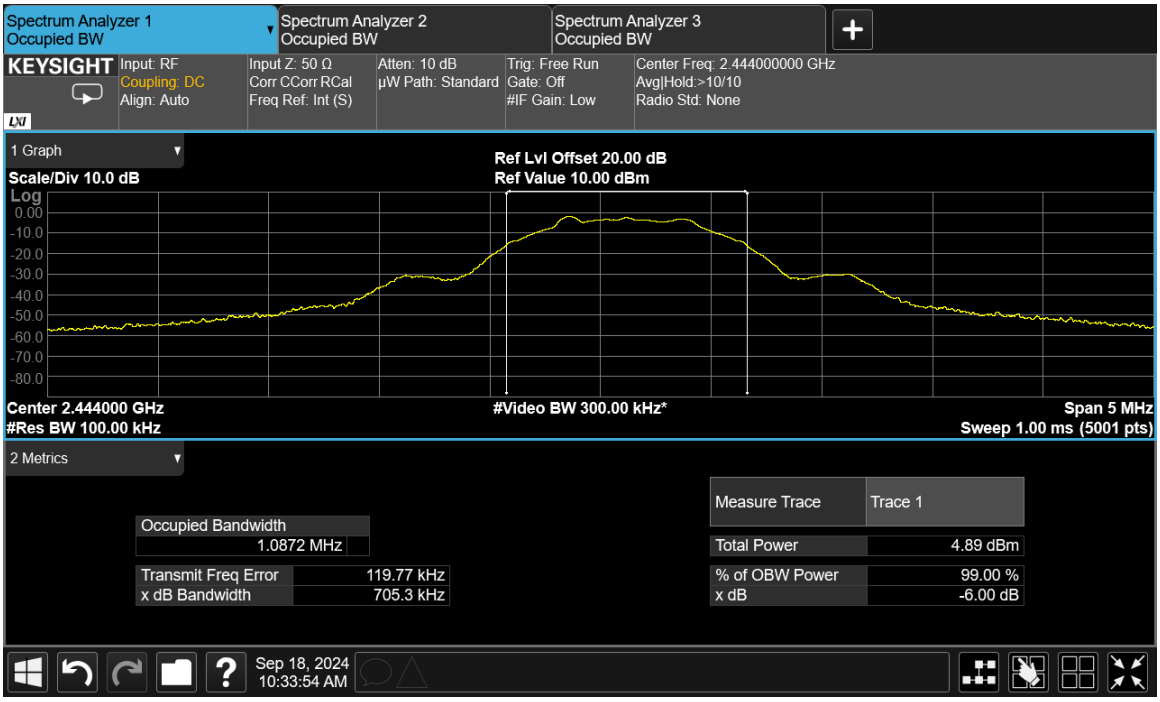


Figure 7: 500kbps, High Channel, OBW

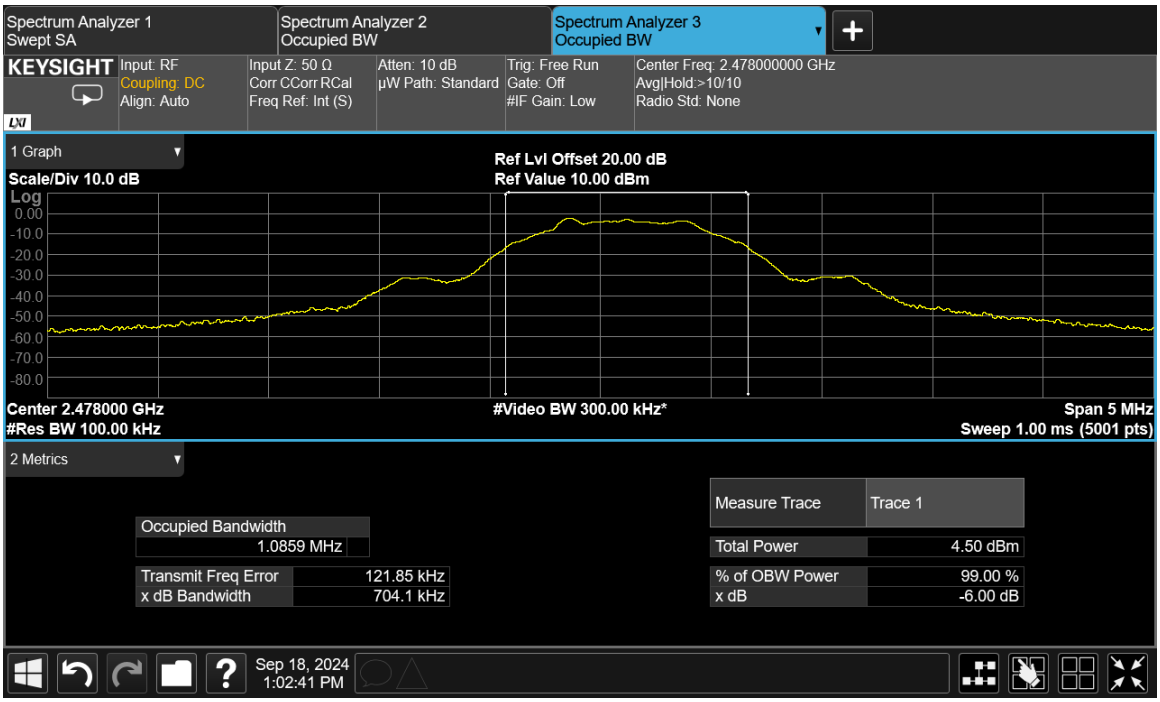


Figure 8: 1Mbps, Low Channel, OBW

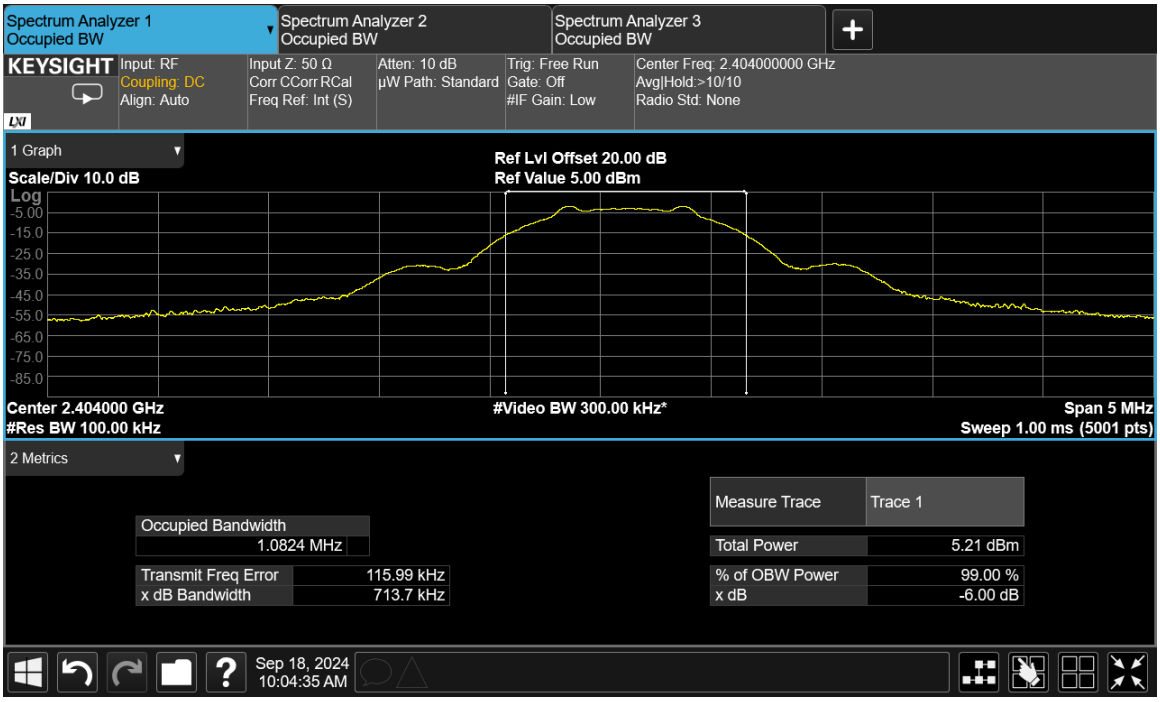


Figure 9: 1Mbps, Center Channel, OBW

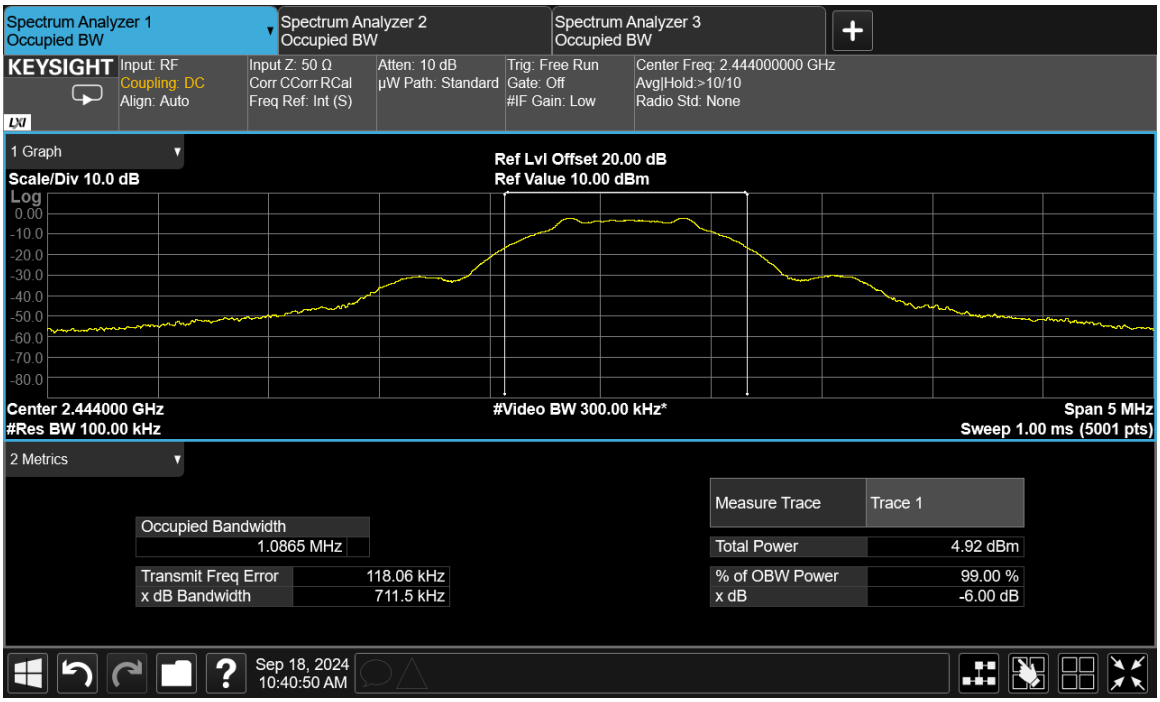


Figure 10: 1Mbps, High Channel, OBW

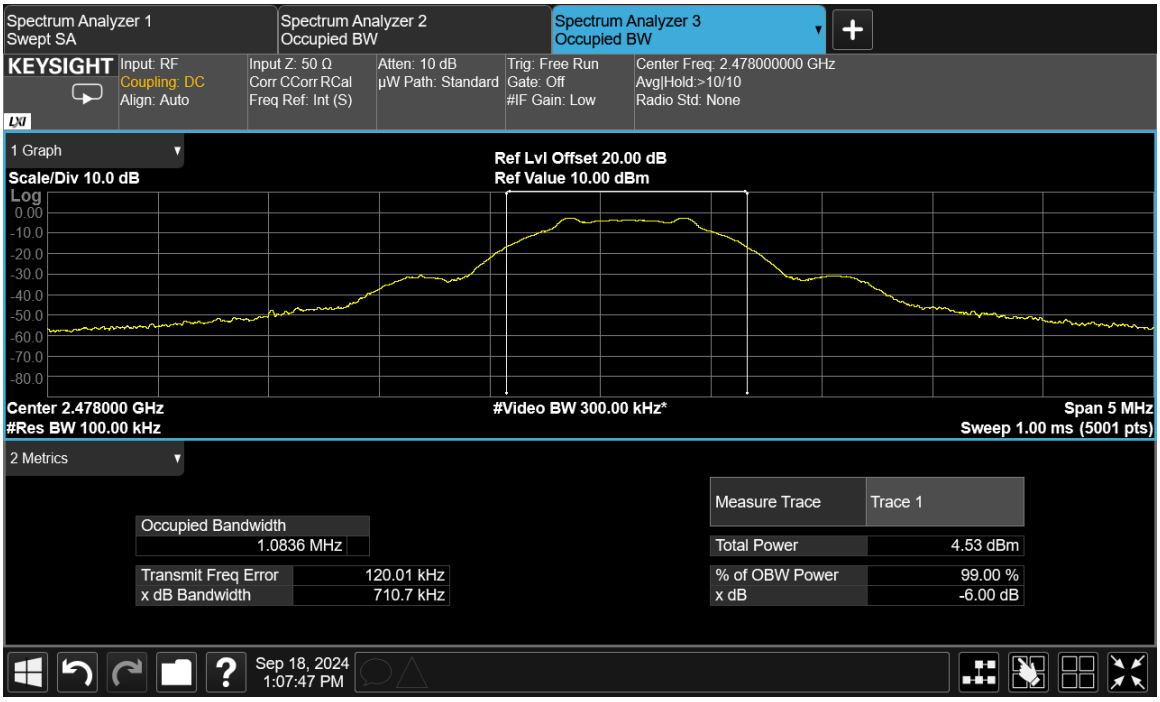


Figure 11: 2Mbps, Low Channel, OBW

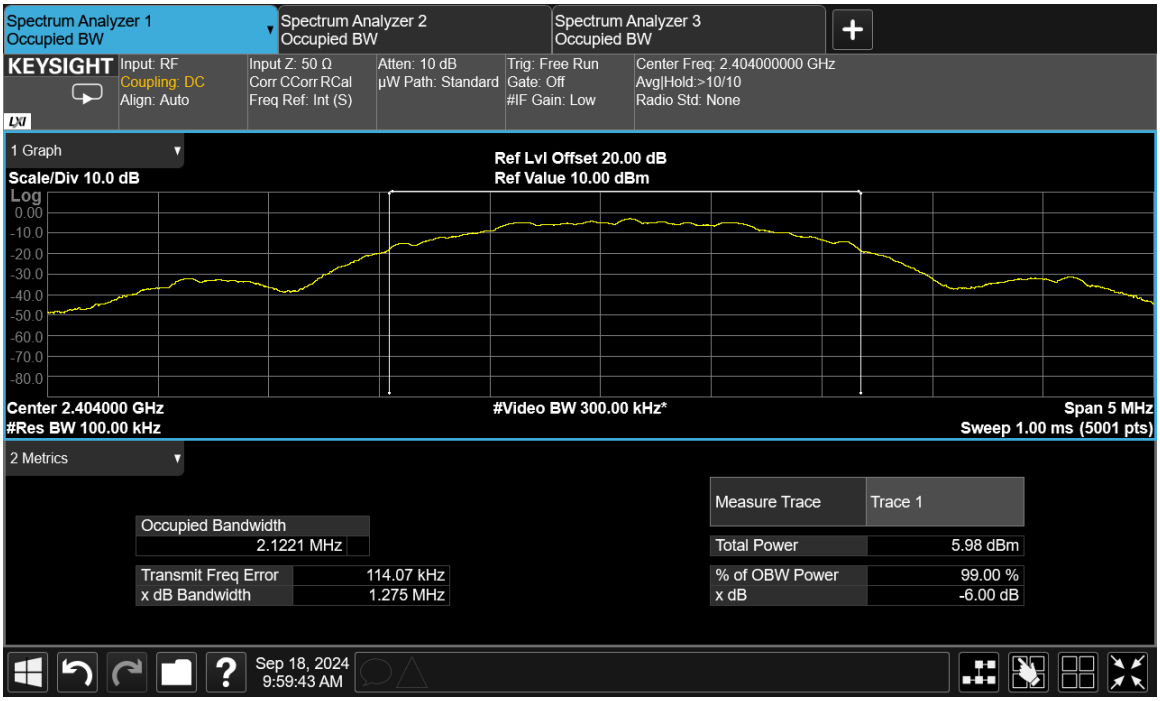


Figure 12: 2Mbps, Center Channel, OBW

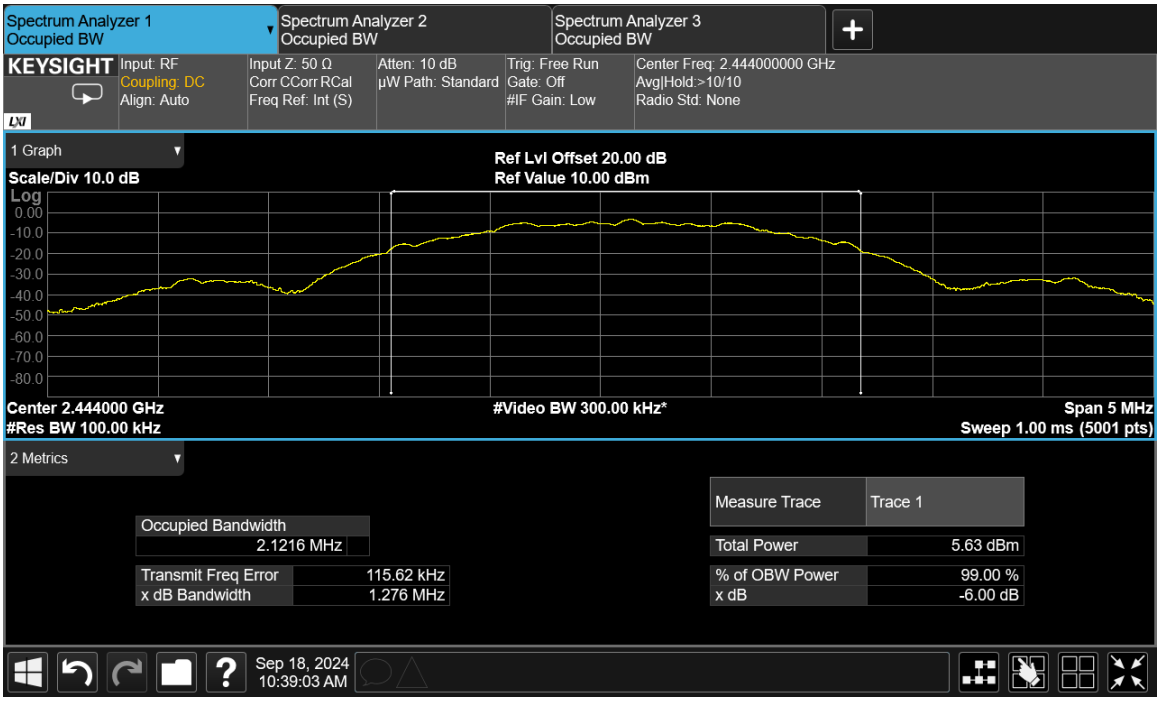
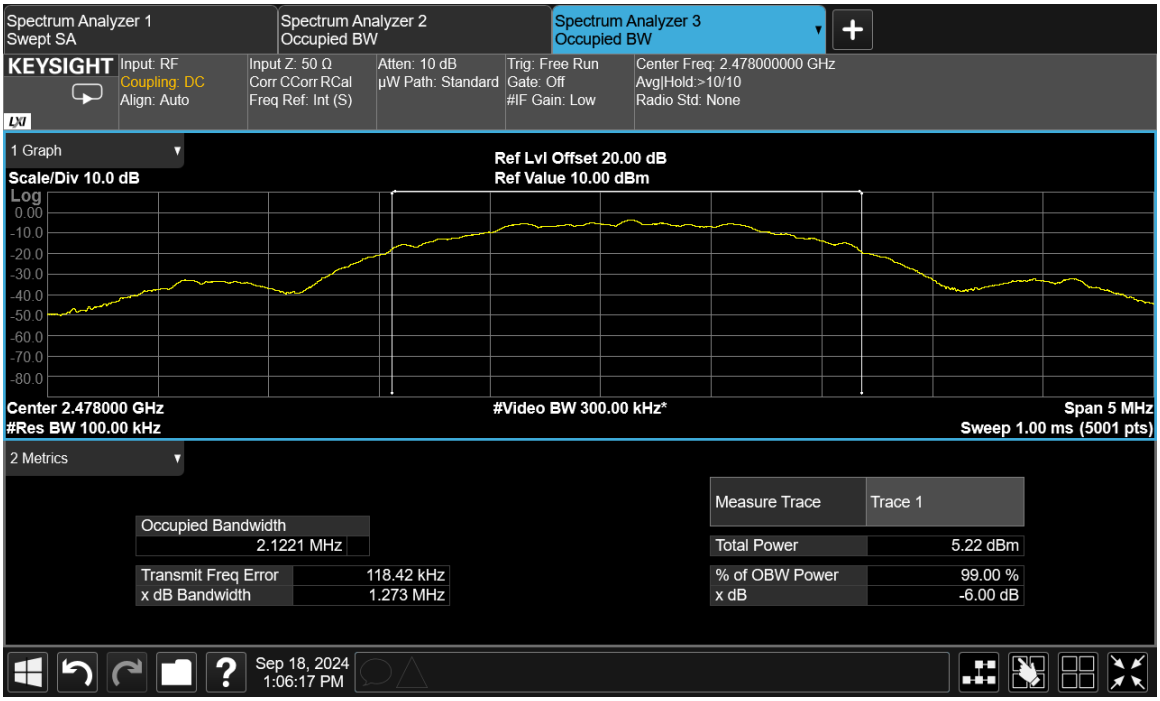


Figure 13: 2Mbps, High Channel, OBW



3.2 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.

3.2.1 Measurement Method

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

3.2.2 Test Data

The EUT test data is provided below.

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

The EUT employs a PCB trace antenna with a peak gain of -1.97 dBi.

Table 7: Conducted Output Power Results

Data Rate	Frequency (MHz)	Antenna Port Conducted Power (dBm)	EIRP (dBm)
125 kbps	2404 MHz	-0.71	-2.68
	2444 MHz	-1.02	-2.99
	2478 MHz	-1.30	-3.27
500 kbps	2404 MHz	-0.71	-2.68
	2444 MHz	-1.01	-2.98
	2478 MHz	-1.28	-3.25
1 Mbps	2404 MHz	-0.69	-2.66
	2444 MHz	-1.01	-2.98
	2478 MHz	-1.30	-3.27
2 Mbps	2404 MHz	-0.69	-2.66
	2444 MHz	-1.00	-2.97
	2478 MHz	-1.29	-3.26

Figure 14: 125kbps, Low Channel, Peak Power

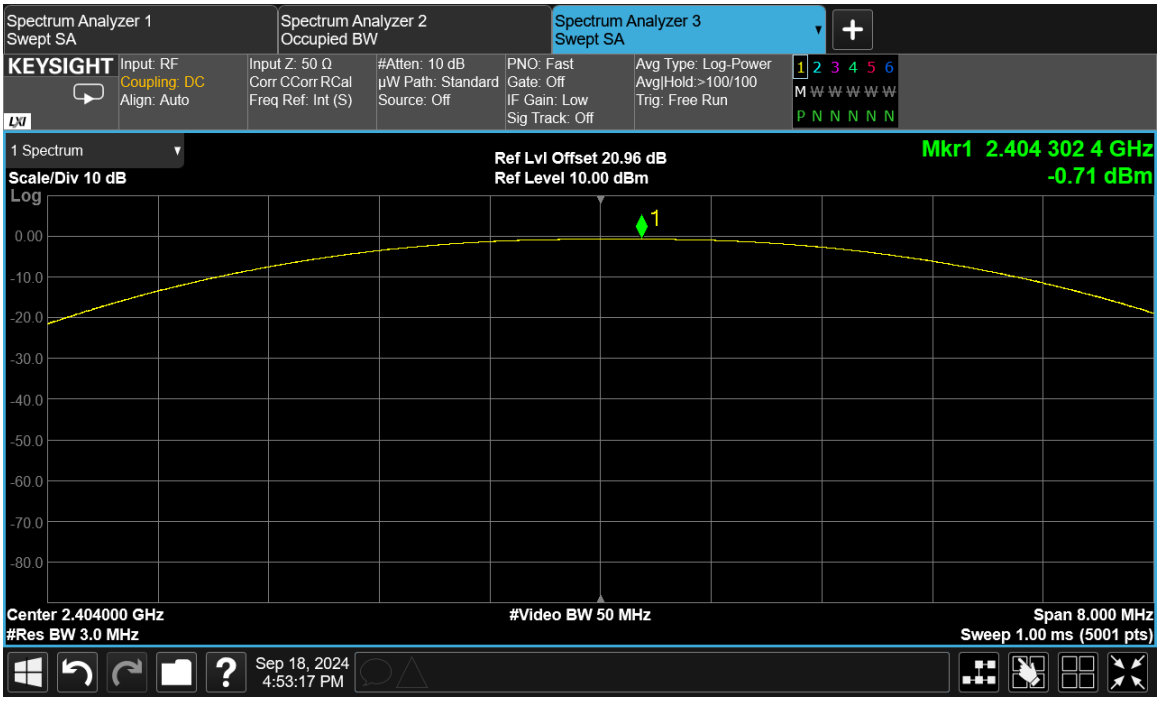


Figure 15: 125kbps, Center Channel, Peak Power

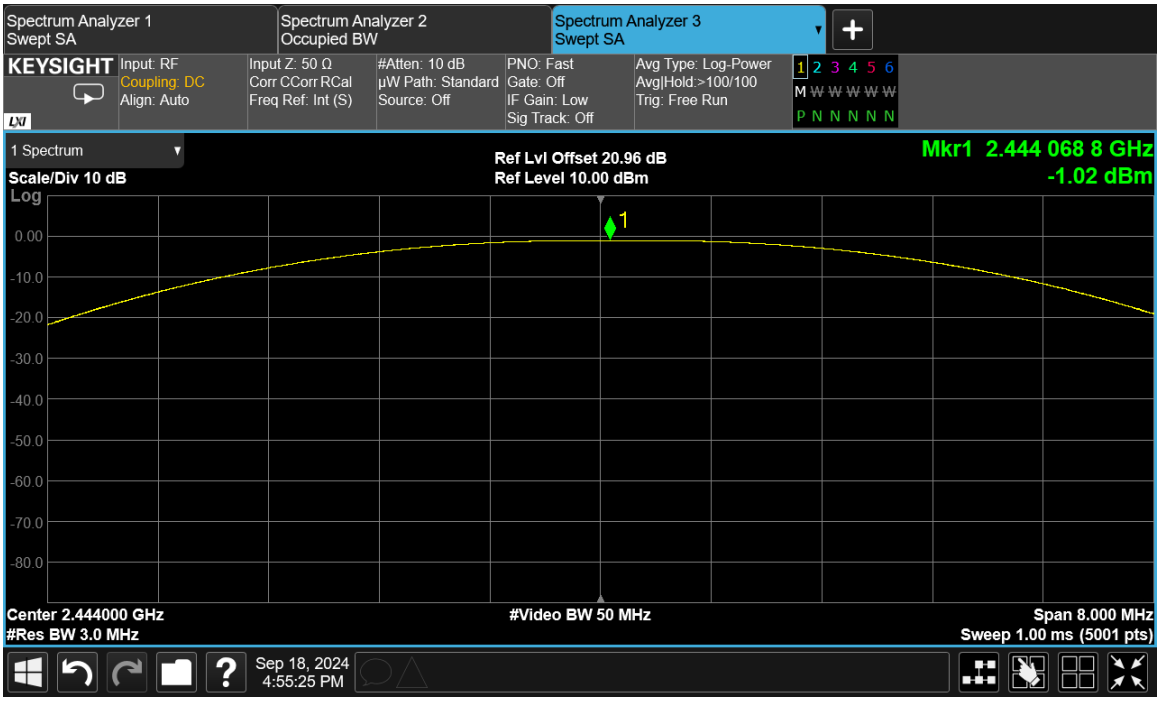


Figure 16: 125kbps, High Channel, Peak Power

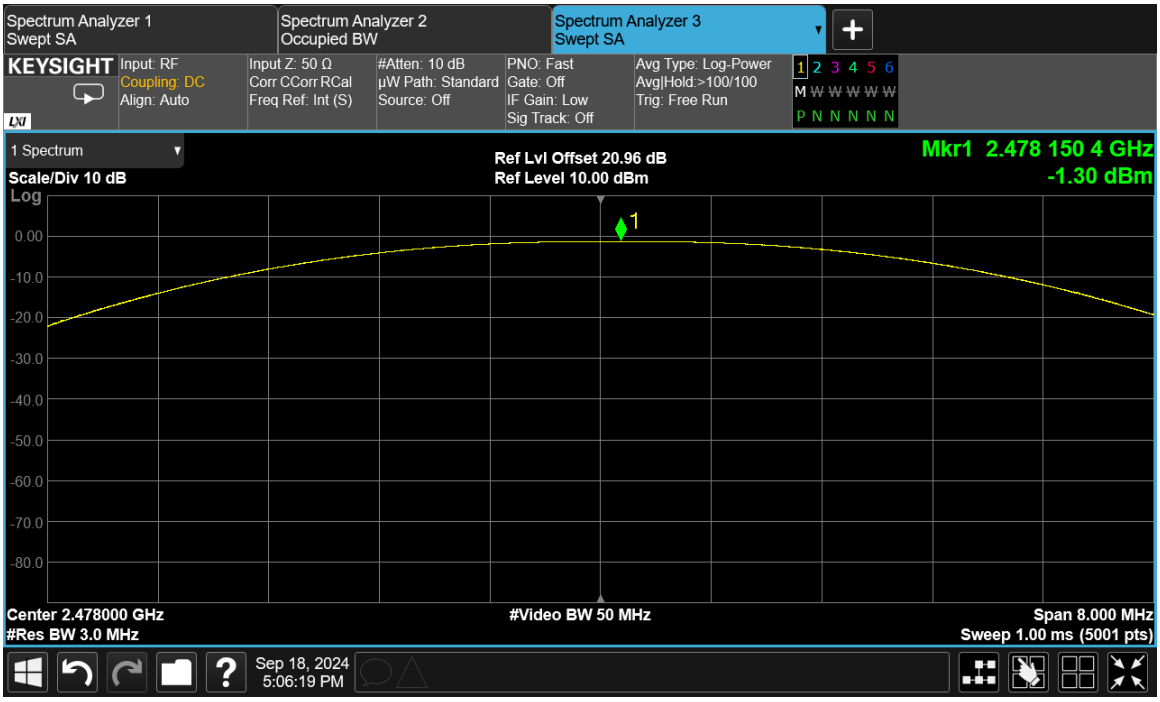


Figure 17: 500kbps, Low Channel, Peak Power

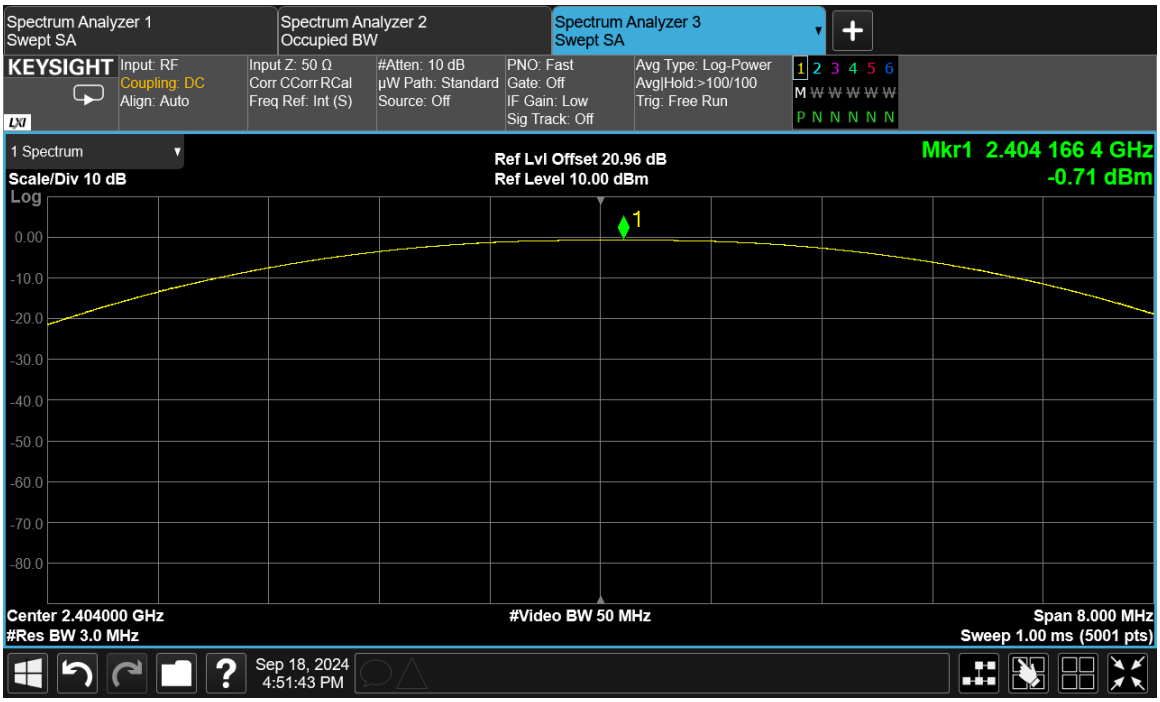


Figure 18: 500kbps, Center Channel, Peak Power

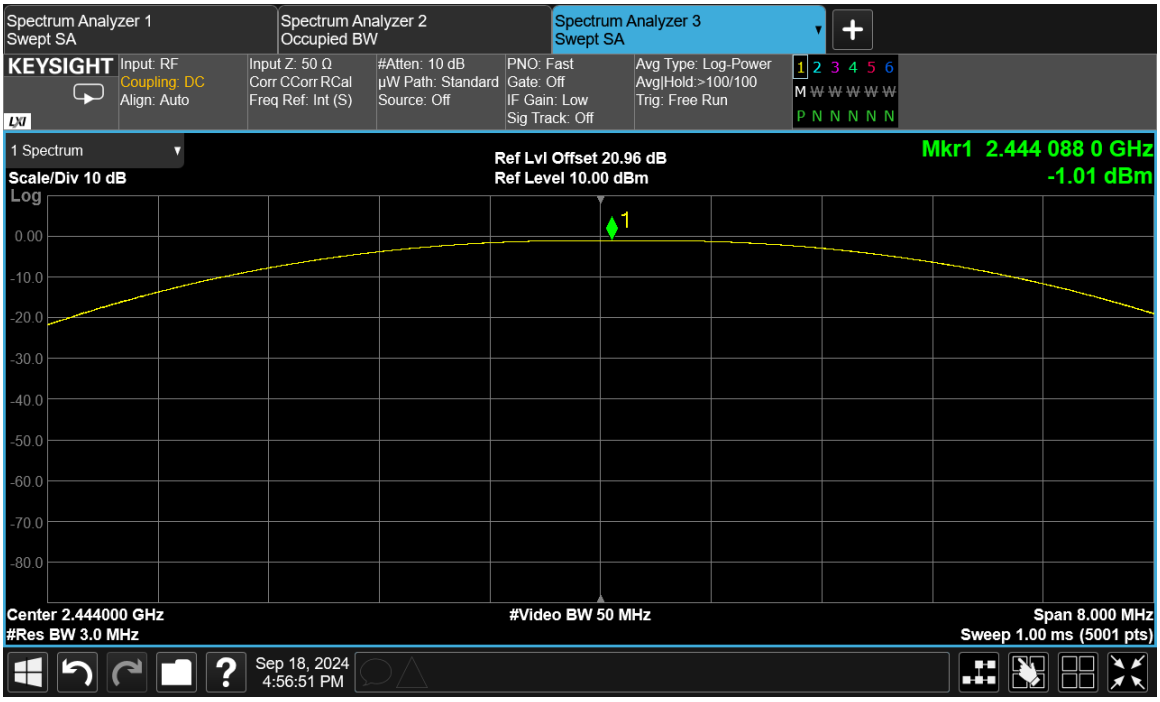


Figure 19: 500kbps, High Channel, Peak Power

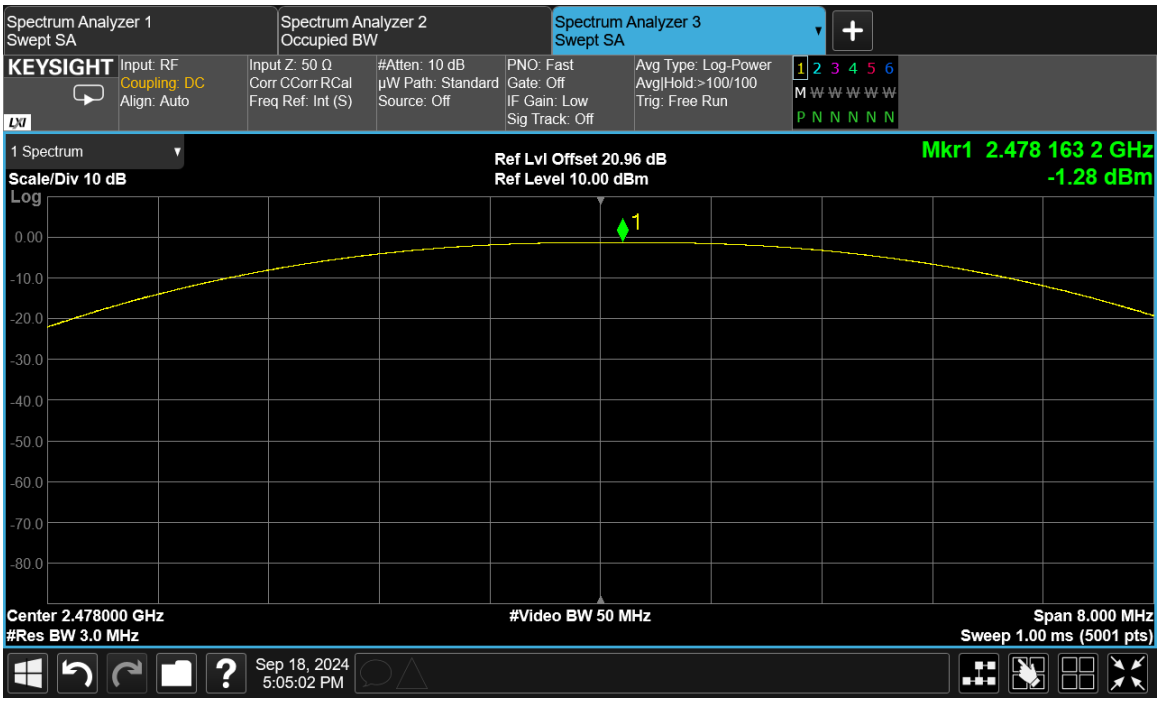


Figure 20: 1Mbps, Low Channel, Peak Power

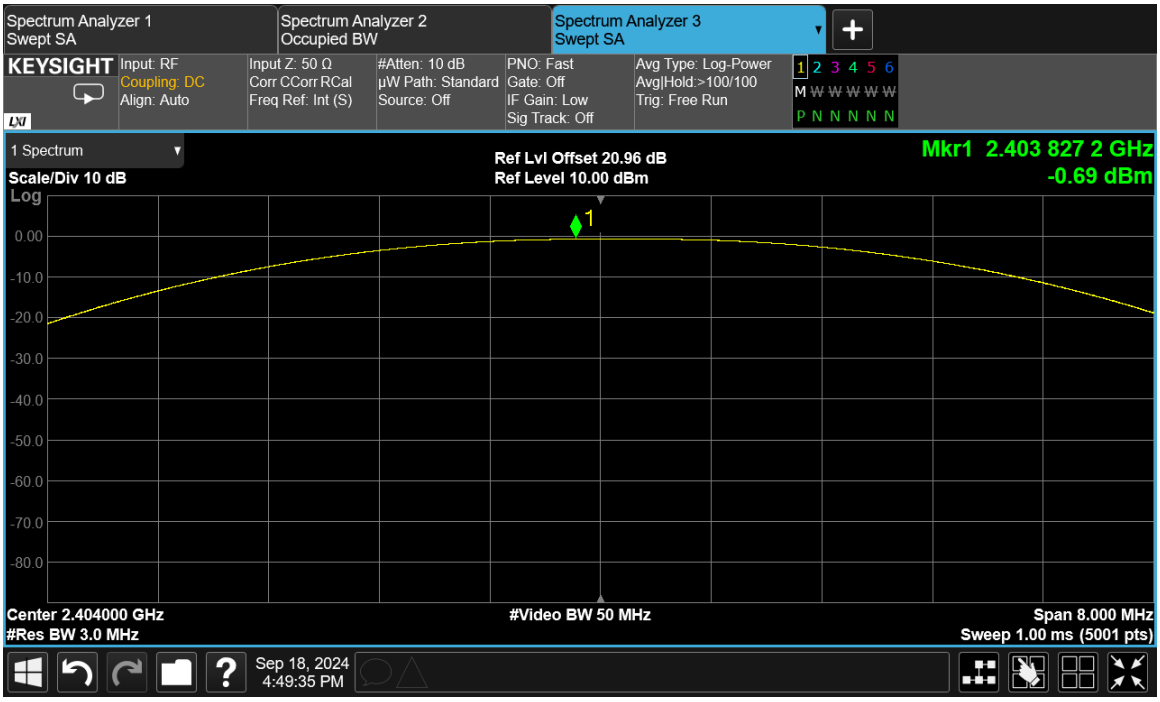


Figure 21: 1Mbps, Center Channel, Peak Power

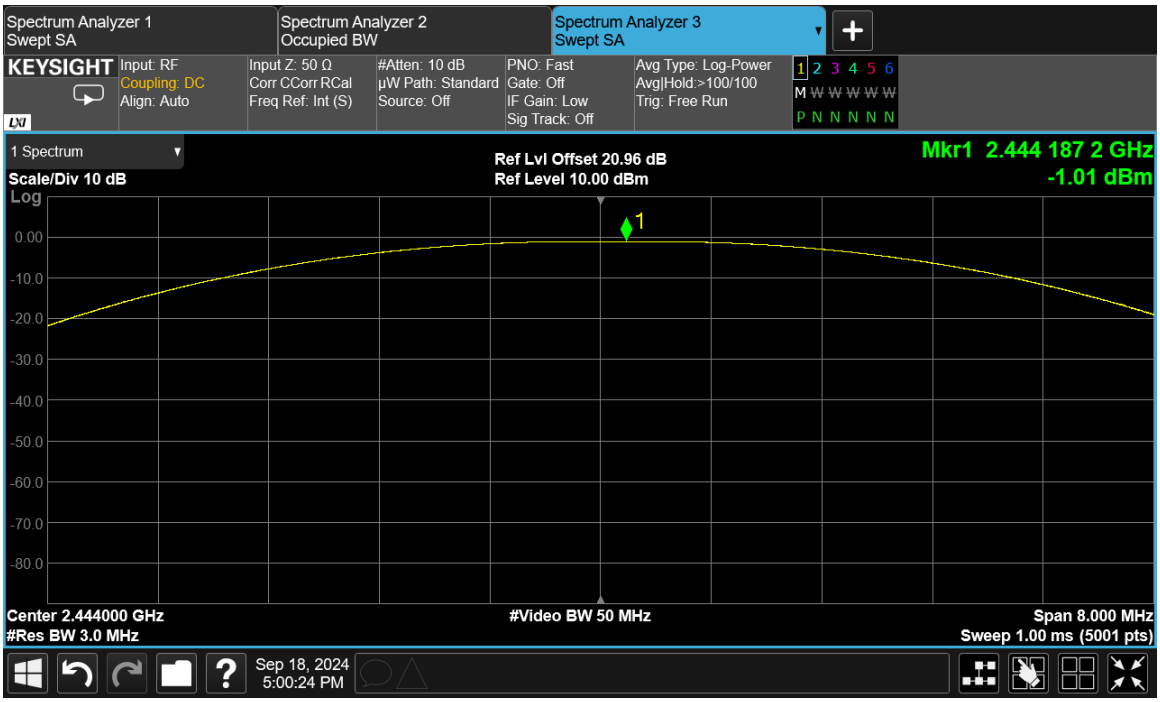


Figure 22: 1Mbps, High Channel, Peak Power

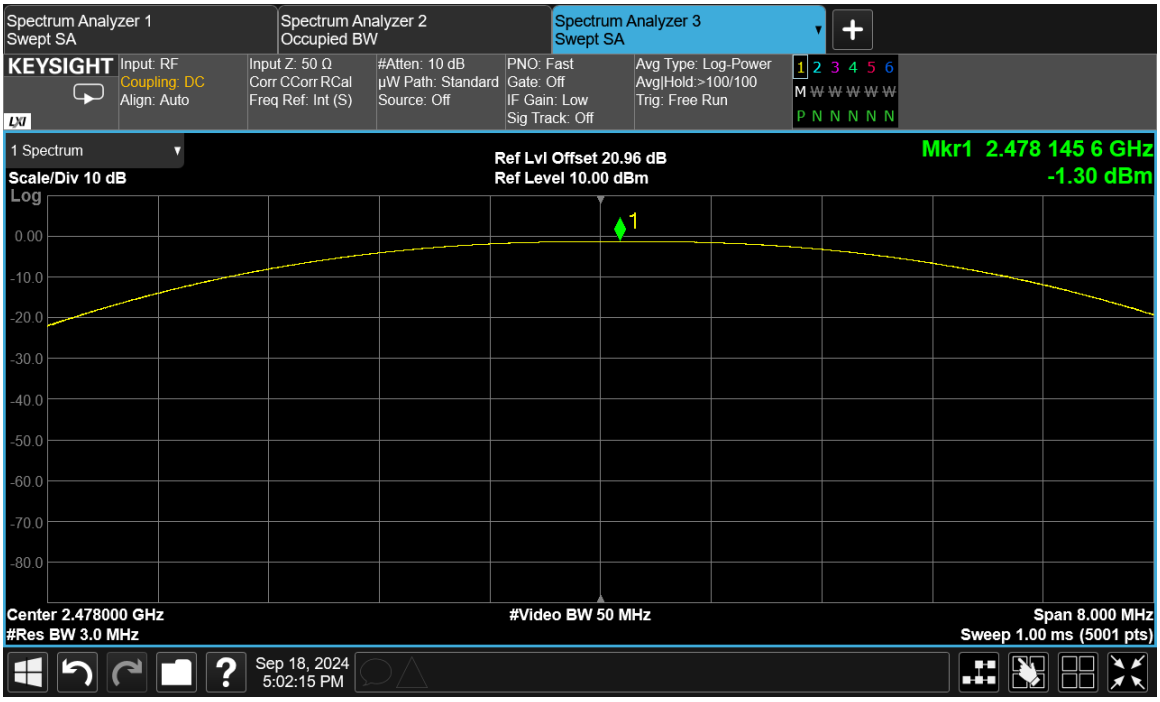


Figure 23: 2Mbps, Low Channel, Peak Power

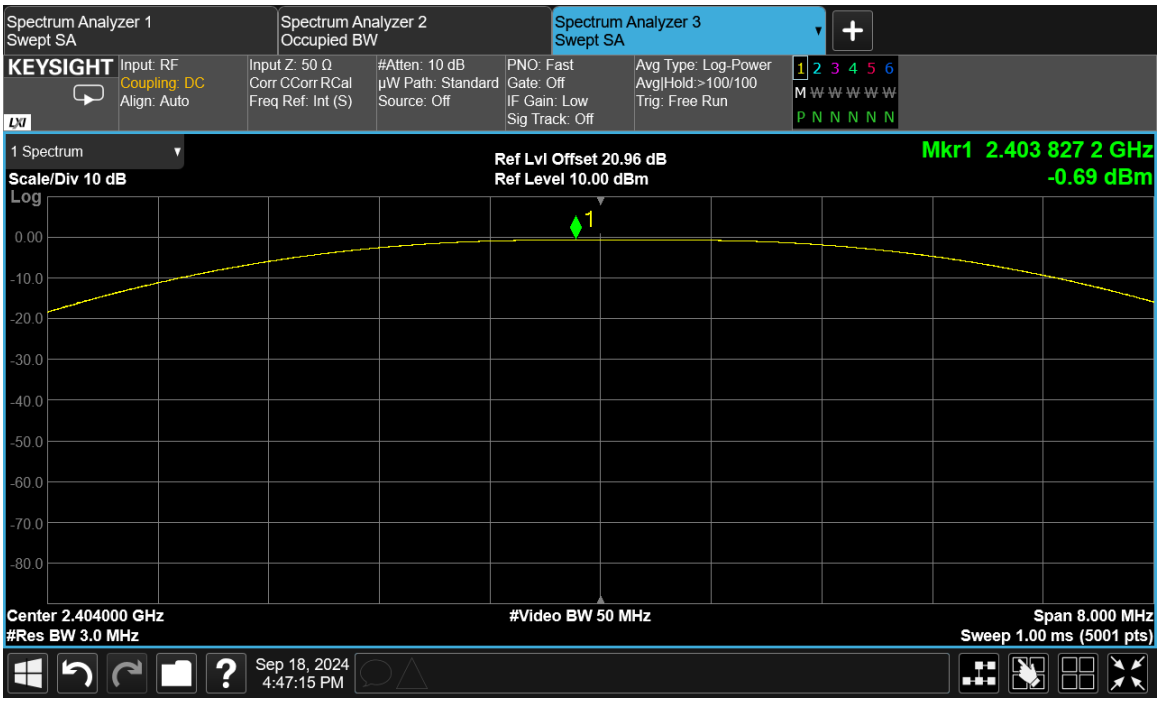


Figure 24: 2Mbps, Center Channel, Peak Power

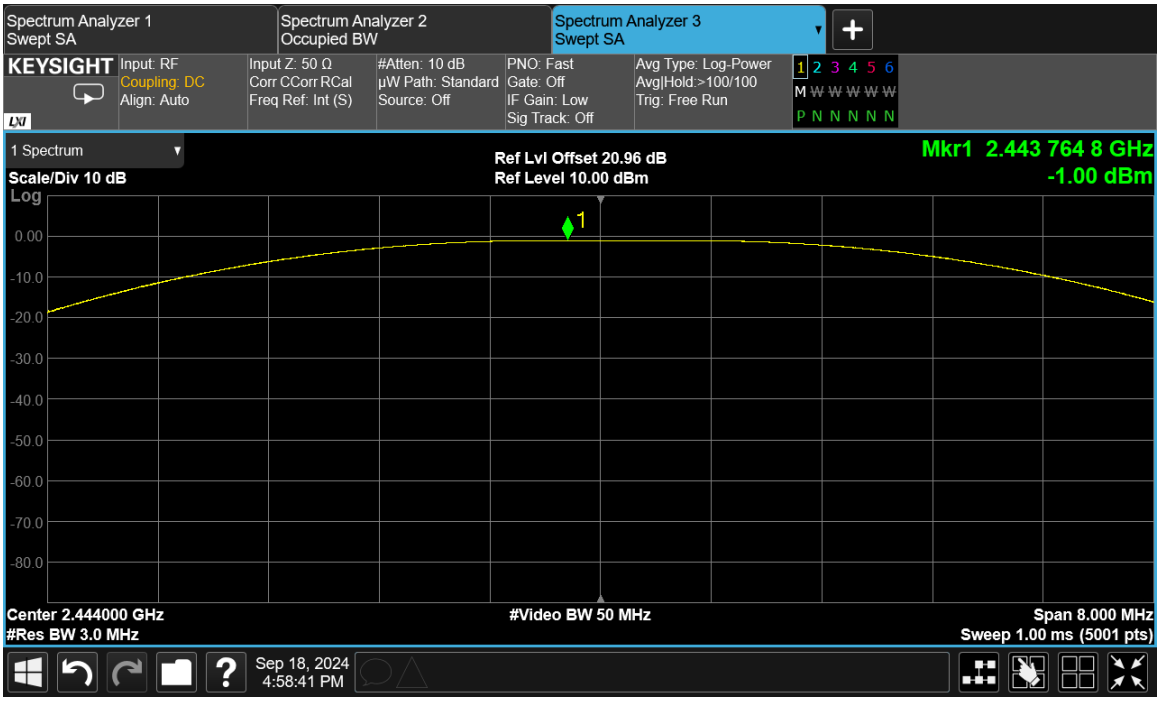
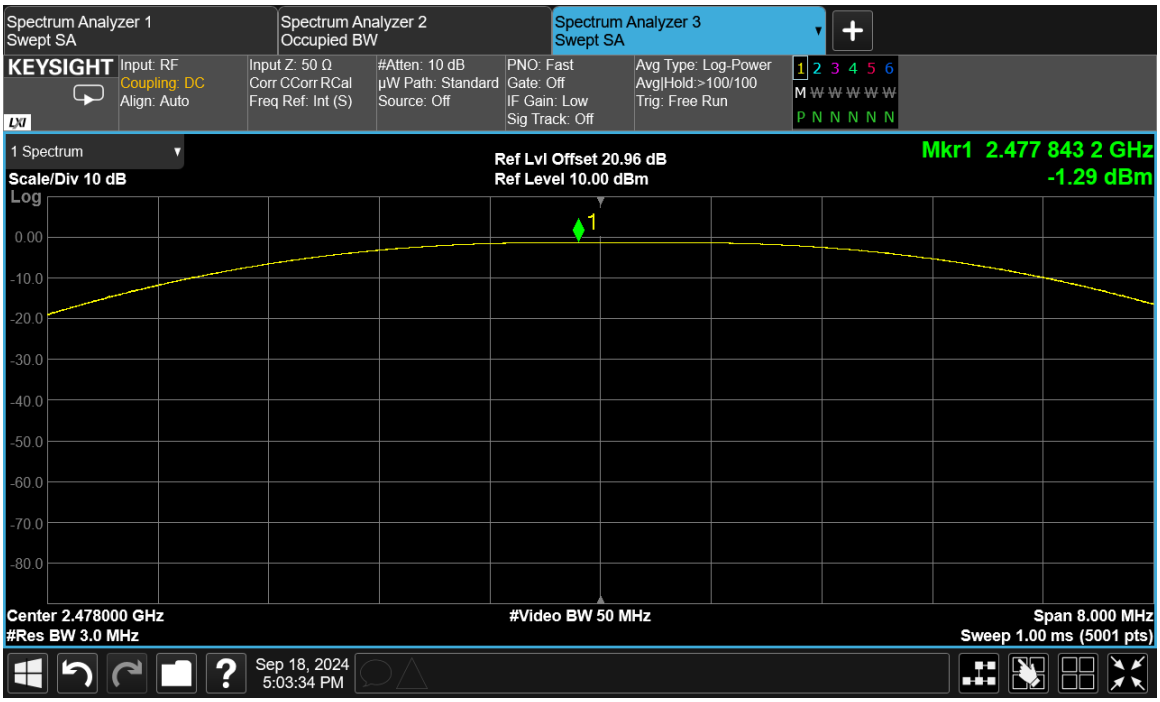


Figure 25: 2Mbps, High Channel, Peak Power



3.3 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.

3.3.1 Measurement Method

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

3.3.2 Test Data

The EUT test data is provided below.

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

Table 8: Power Spectral Density

Data Rate	Frequency (MHz)	PSD (dBm/100kHz)	Limit (dBm/3kHz)
125 kbps	2404 MHz	-3.73	8.0
	2444 MHz	-3.69	8.0
	2478 MHz	-3.86	8.0
500 kbps	2404 MHz	-0.74	8.0
	2444 MHz	-1.06	8.0
	2478 MHz	-1.31	8.0
1 Mbps	2404 MHz	-1.05	8.0
	2444 MHz	-1.37	8.0
	2478 MHz	-1.62	8.0
2 Mbps	2404 MHz	-2.18	8.0
	2444 MHz	-2.50	8.0
	2478 MHz	-2.68	8.0

Figure 26: 125kbps, Low Channel, PSD

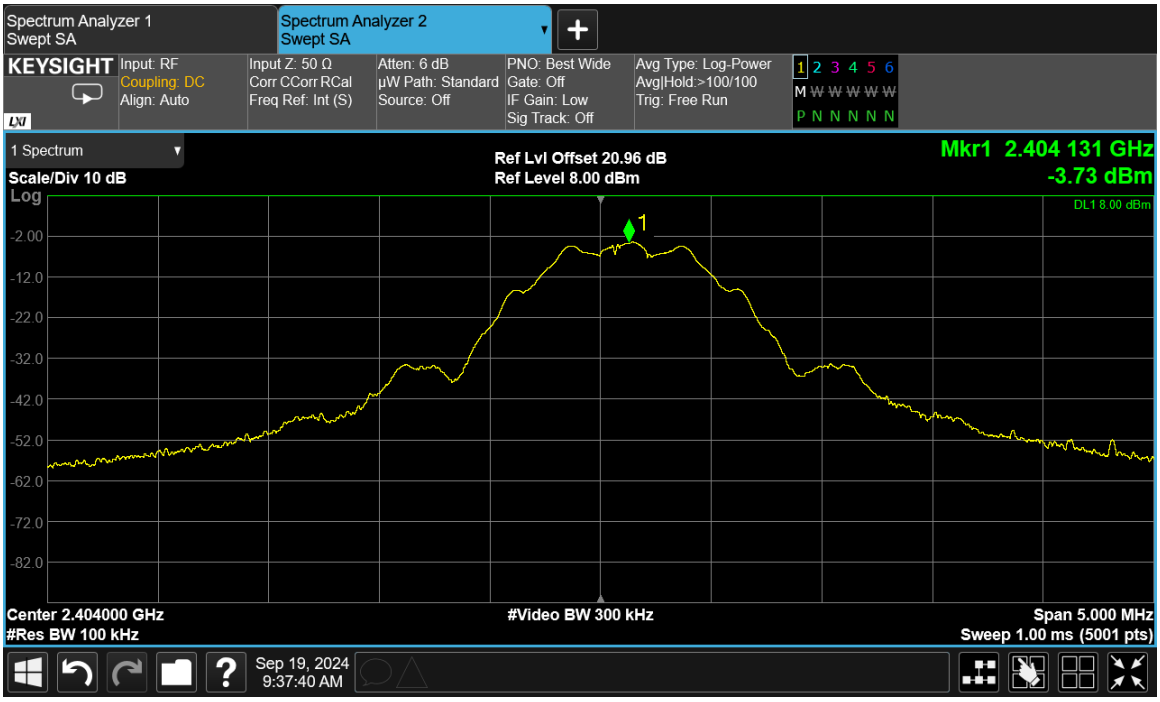


Figure 27: 125kbps, Center Channel, Peak Power

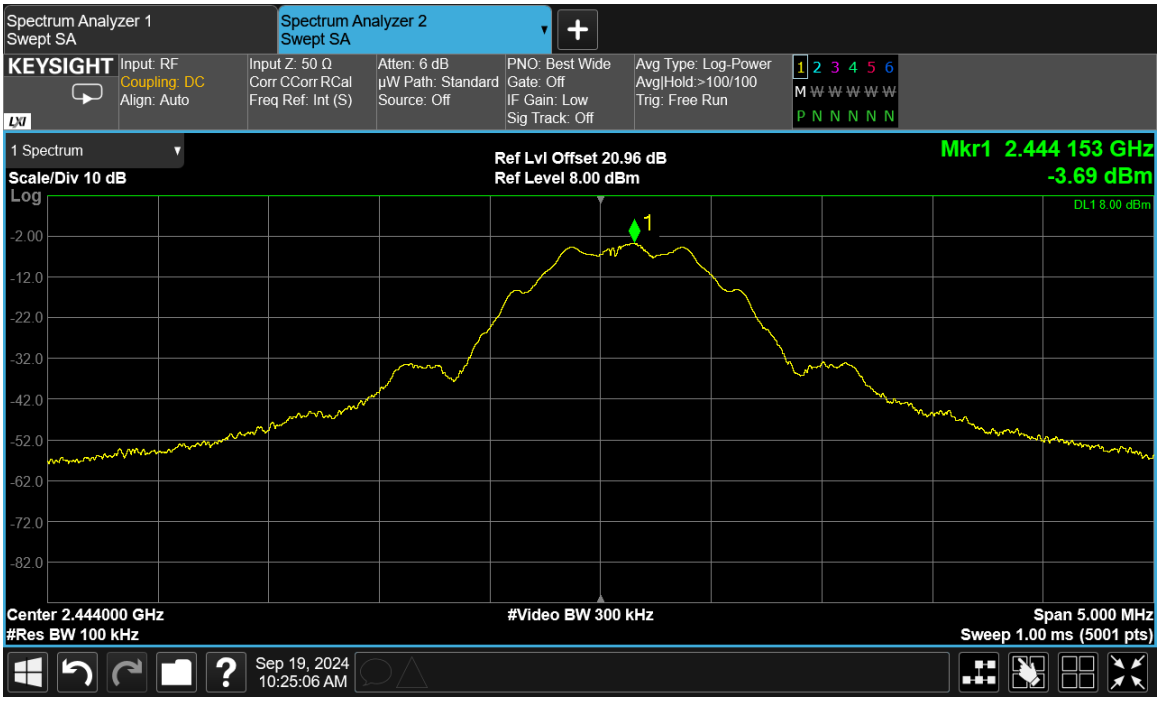


Figure 28: 125kbps, High Channel, PSD

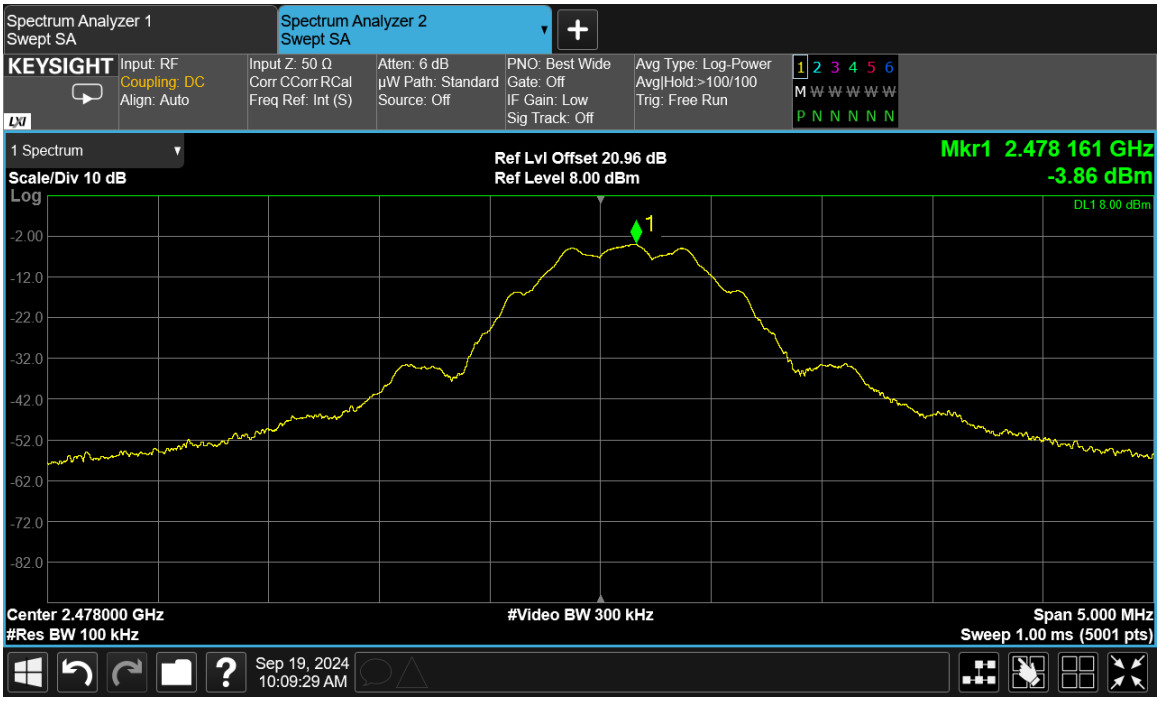


Figure 29: 500kbps, Low Channel, PSD

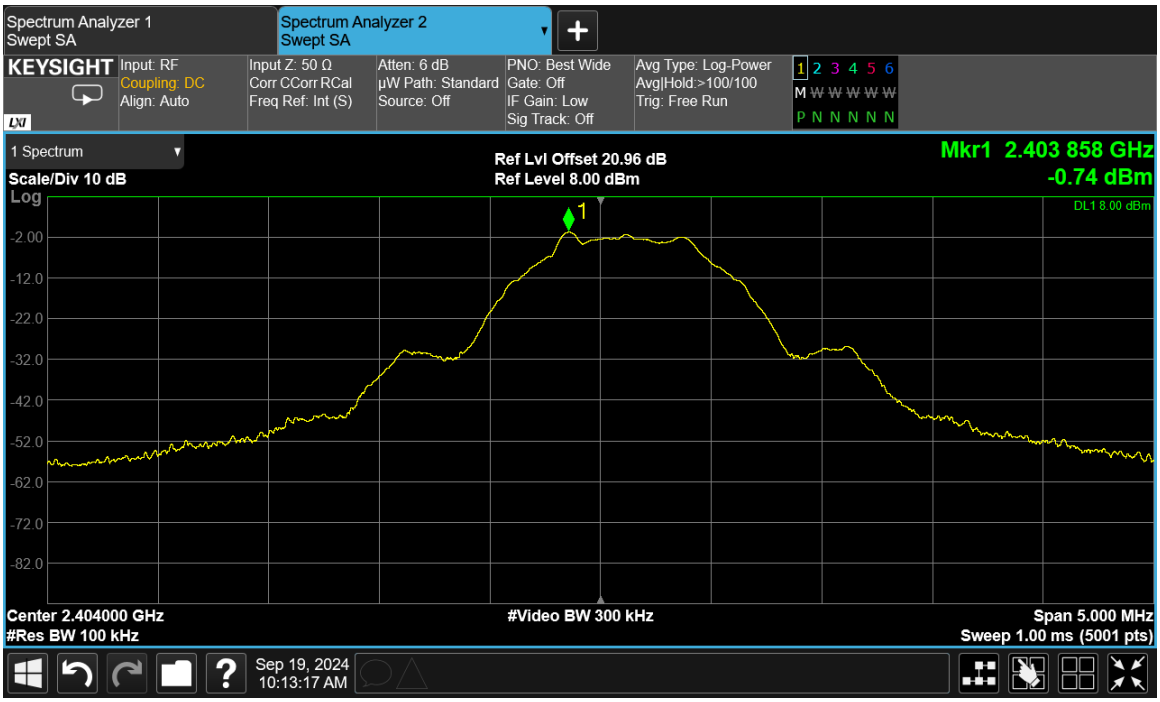


Figure 30: 500kbps, Center Channel, PSD

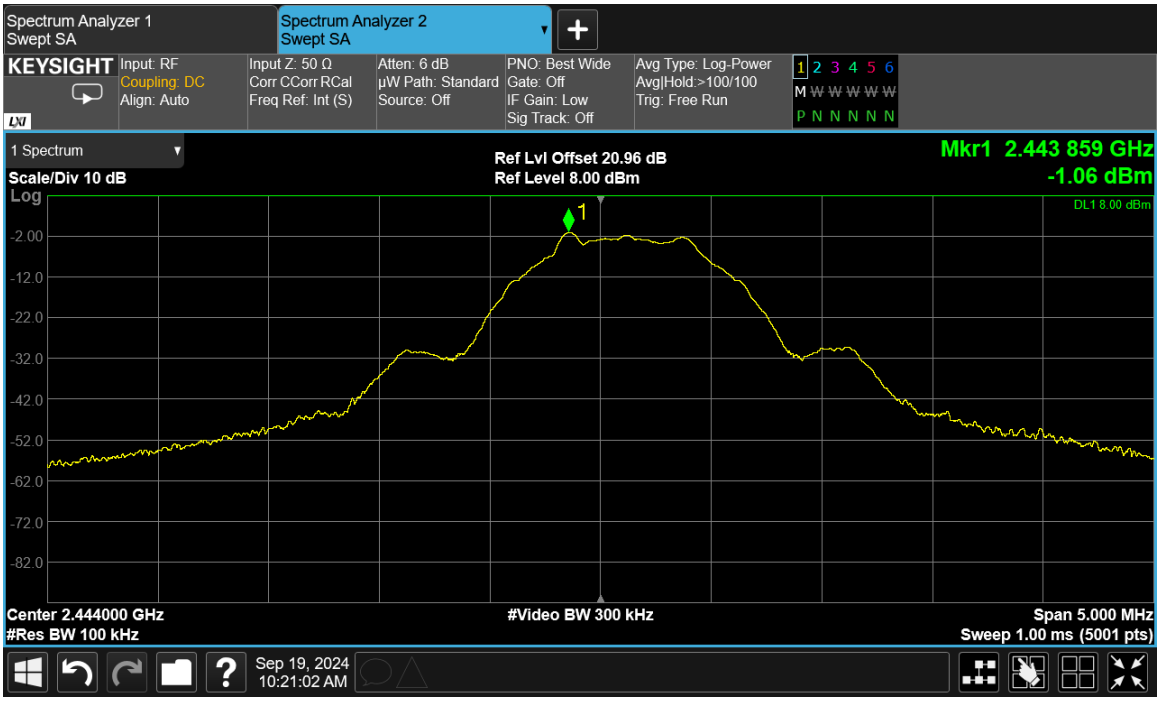


Figure 31: 500kbps, High Channel, PSD

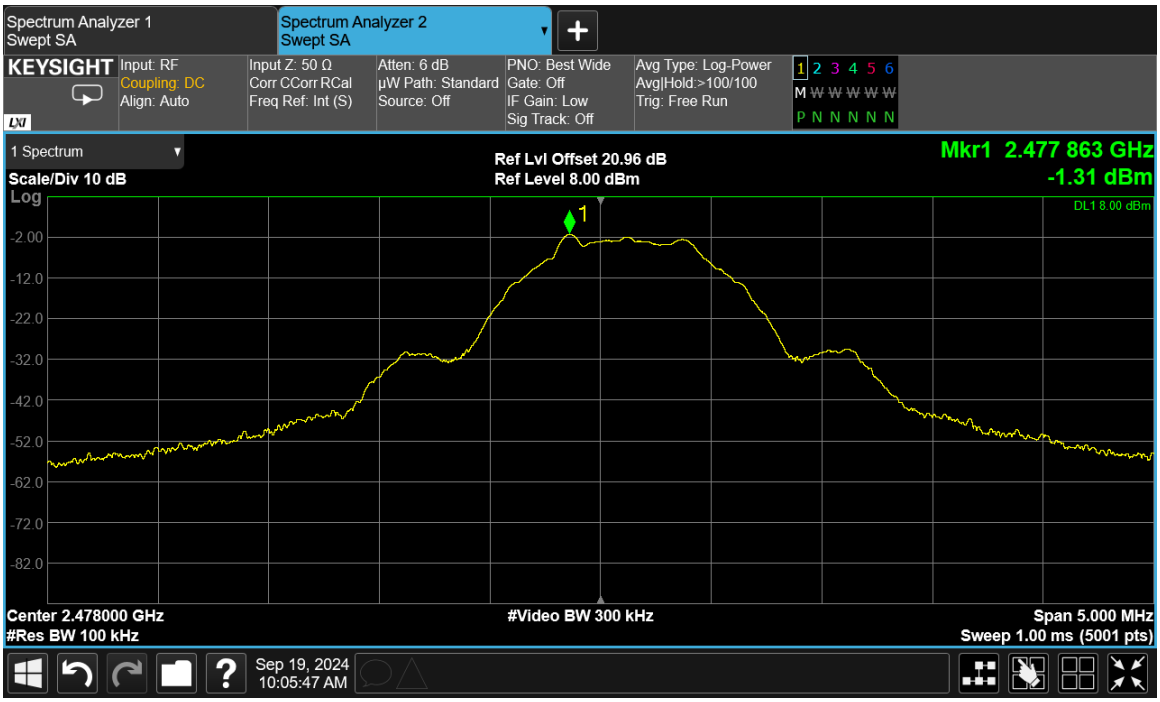


Figure 32: 1Mbps, Low Channel, PSD

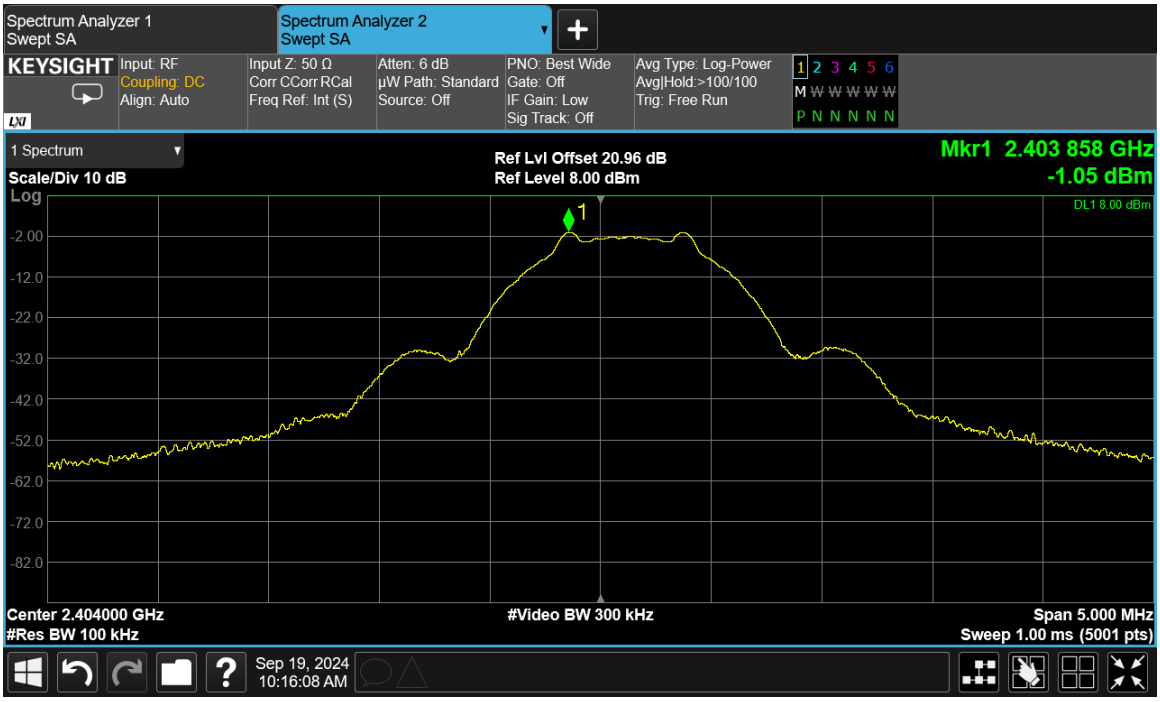


Figure 33: 1Mbps, Center Channel, PSD

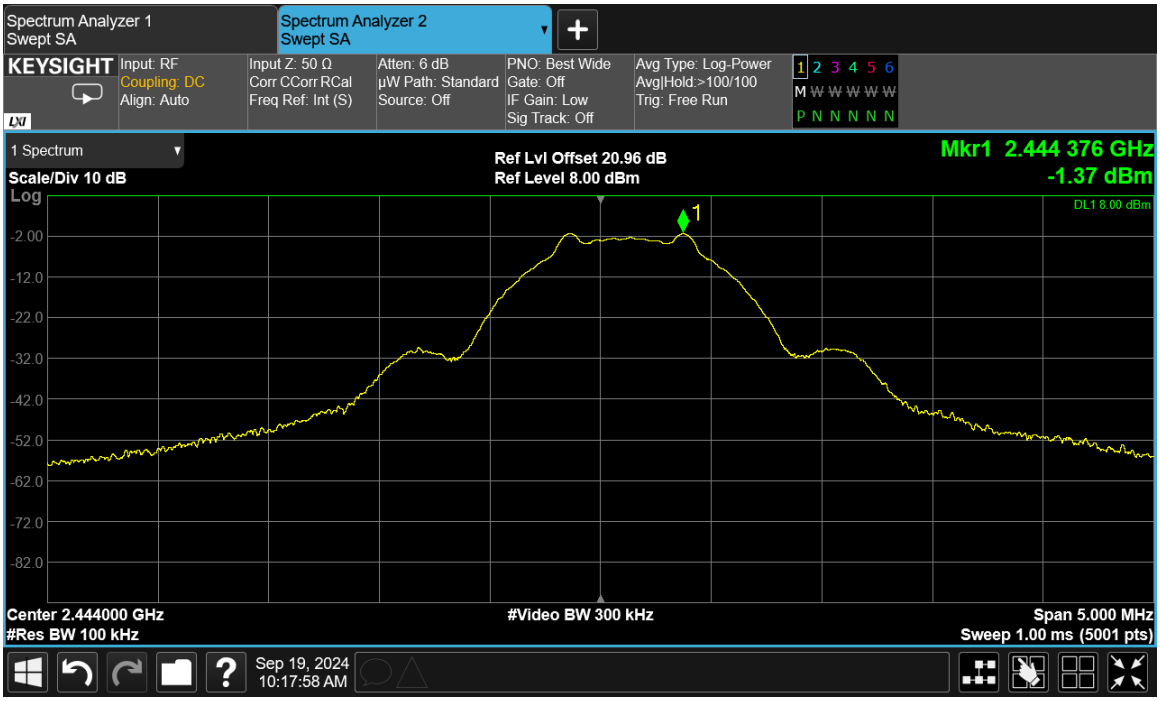


Figure 34: 1Mbps, High Channel, PSD

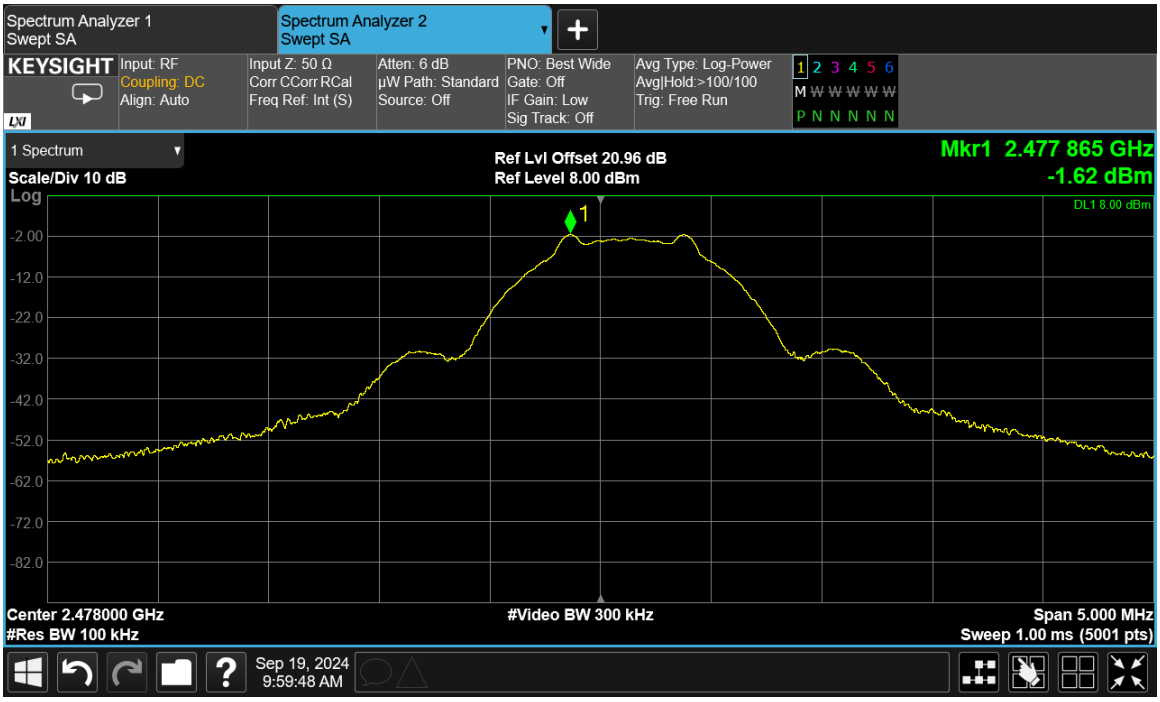


Figure 35: 2Mbps, Low Channel, PSD

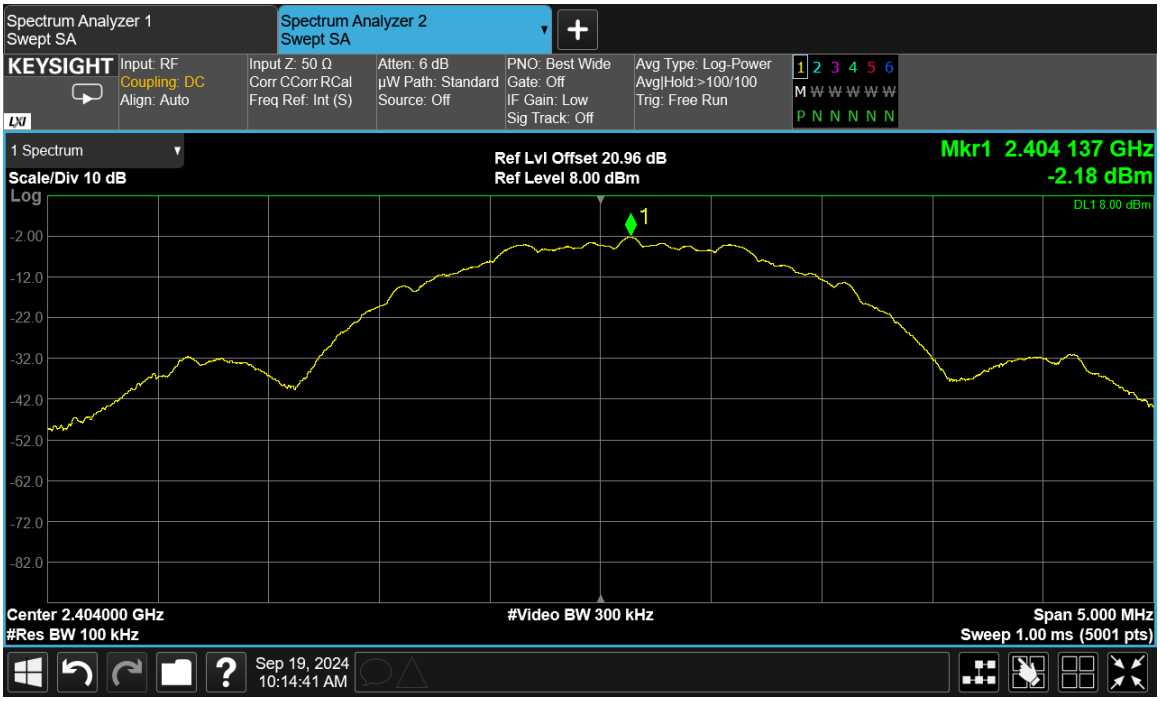


Figure 36: 2Mbps, Center Channel, PSD

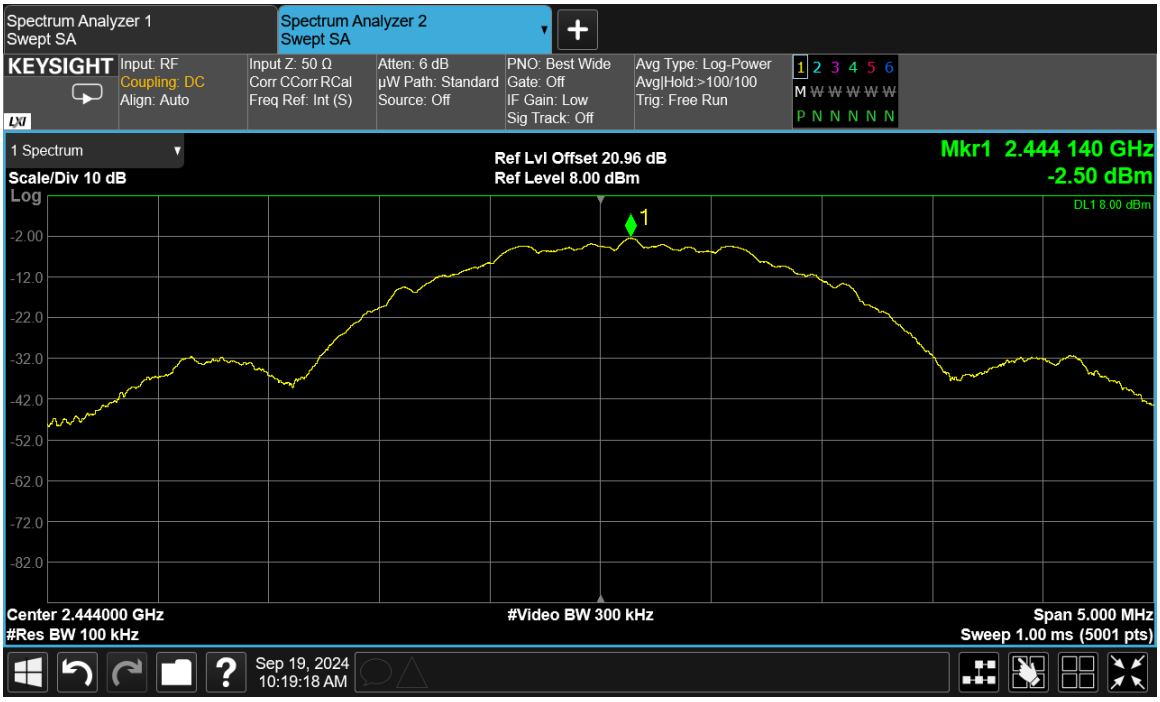
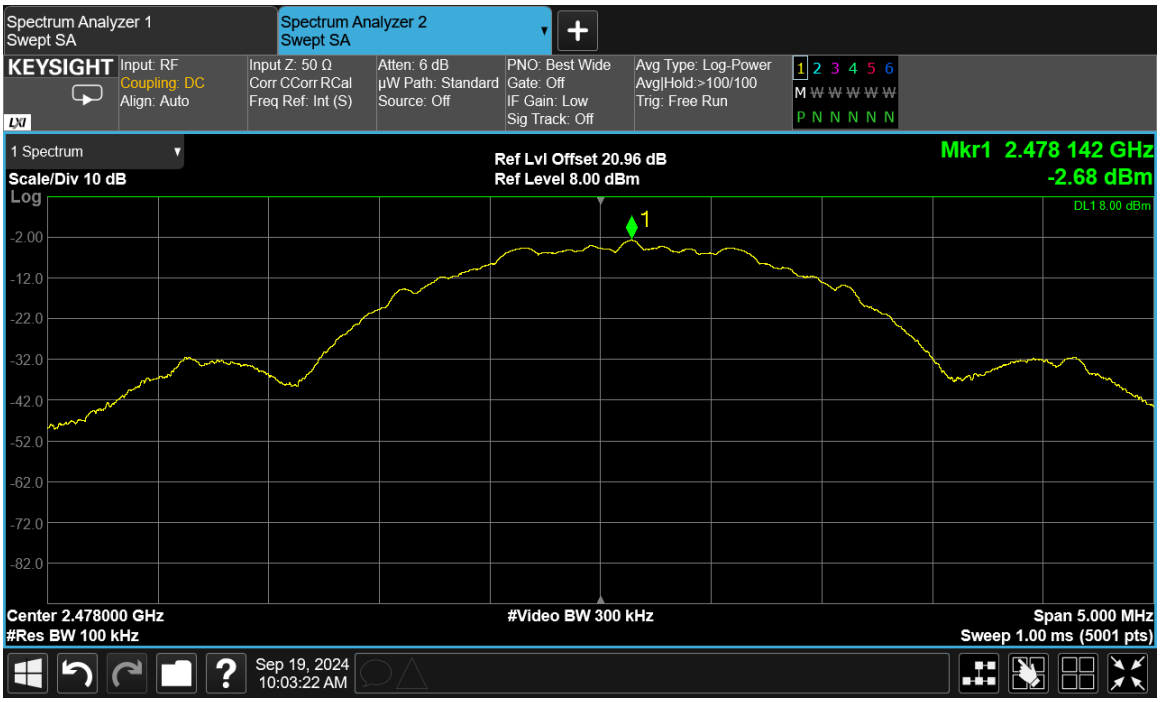


Figure 37: 2Mbps, High Channel, PSD



3.4 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.

3.4.1 Measurement Method

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

3.4.2 Test Data

The EUT test data is provided below.

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

Figure 38: 125kbps, Low Channel, Bandedge

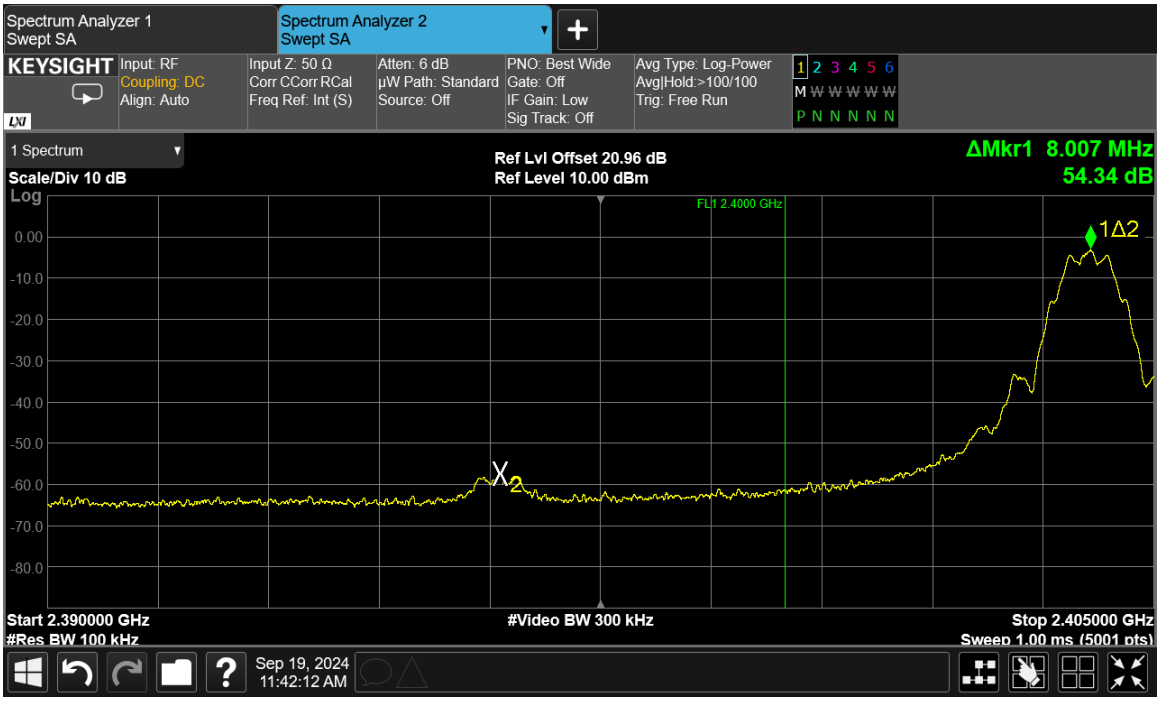


Figure 39: 125kbps, High Channel, Bandedge

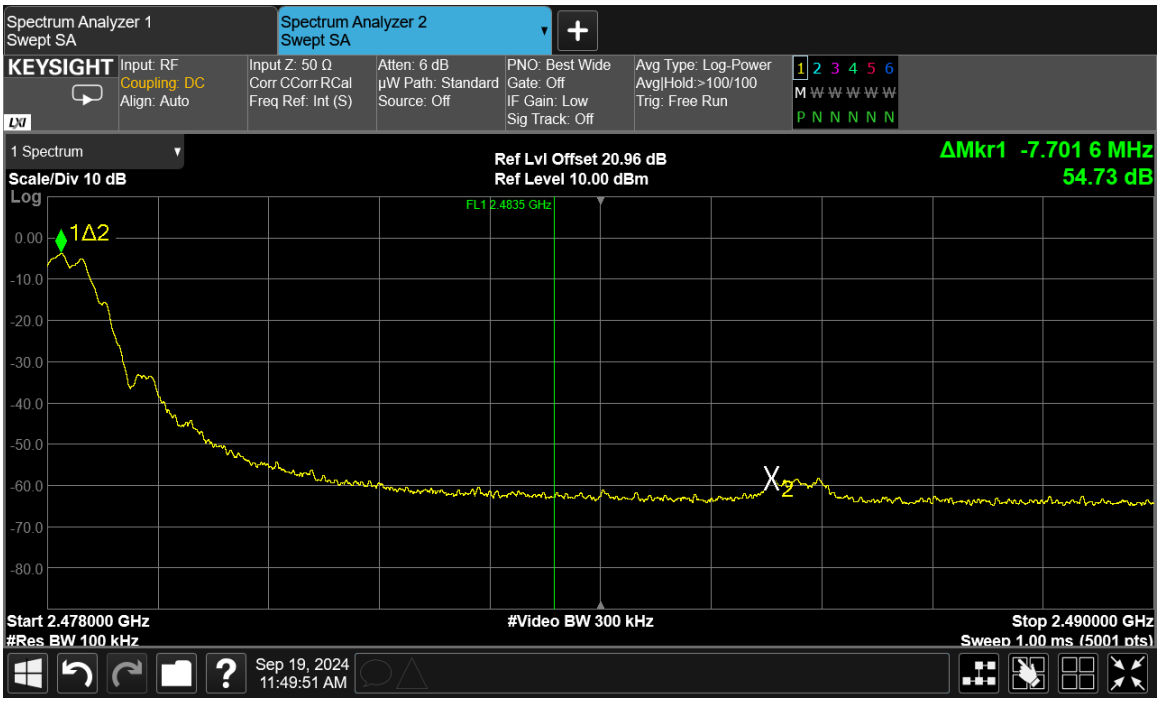


Figure 40: 500kbps, Low Channel, Bandedge

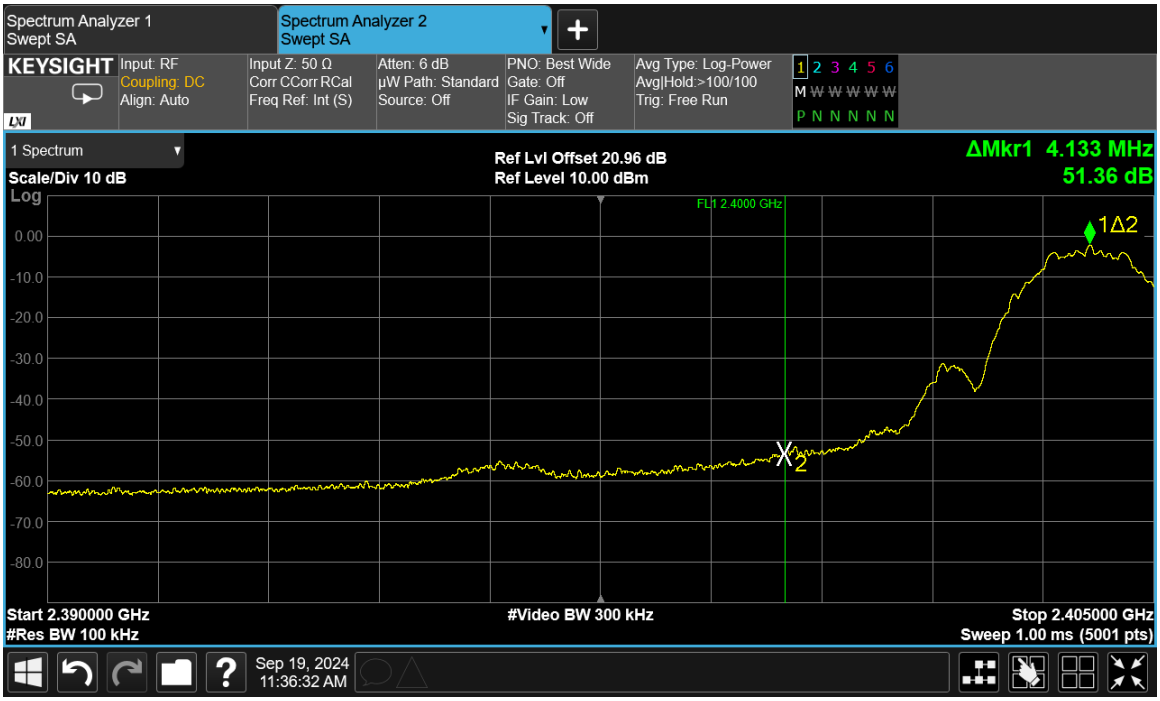


Figure 41: 500kbps, High Channel, Bandedge

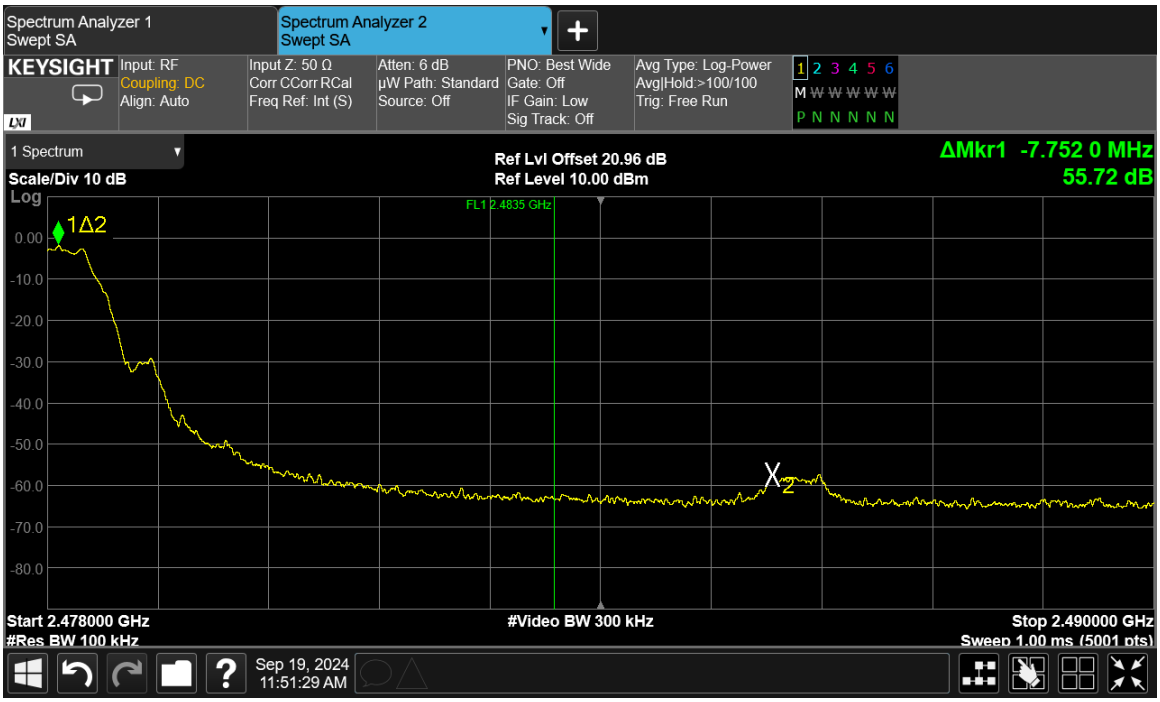


Figure 42: 1Mbps, Low Channel, Bandedge

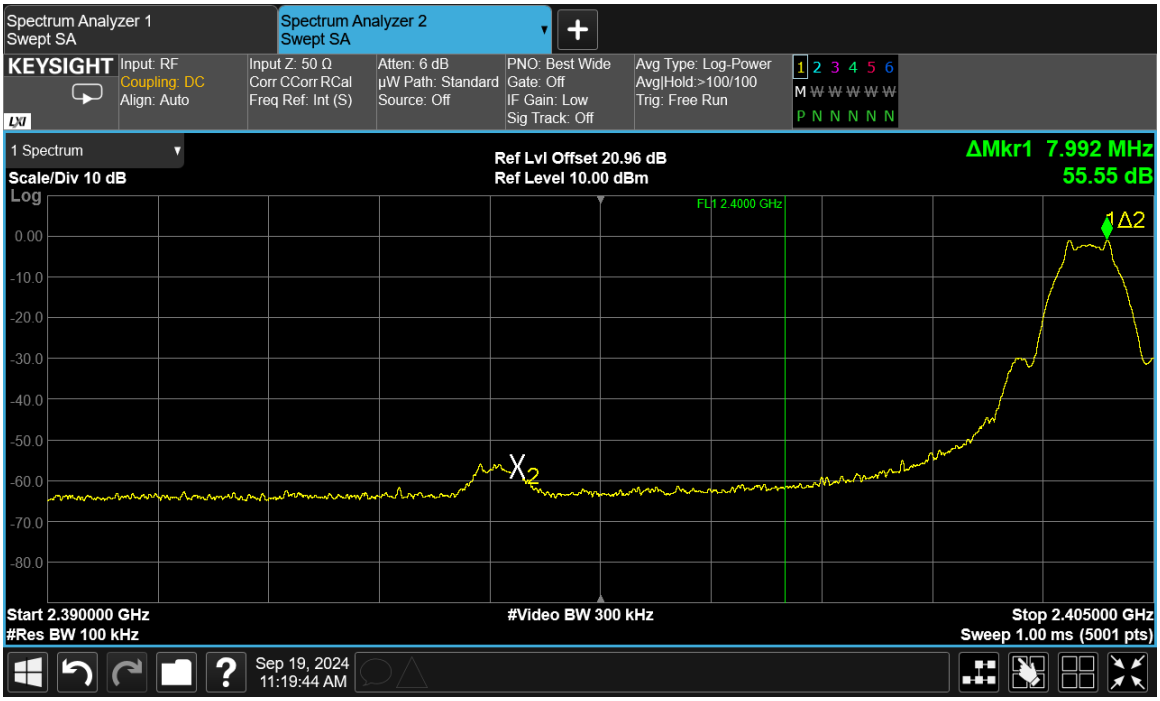


Figure 43: 1Mbps, High Channel, Bandedge

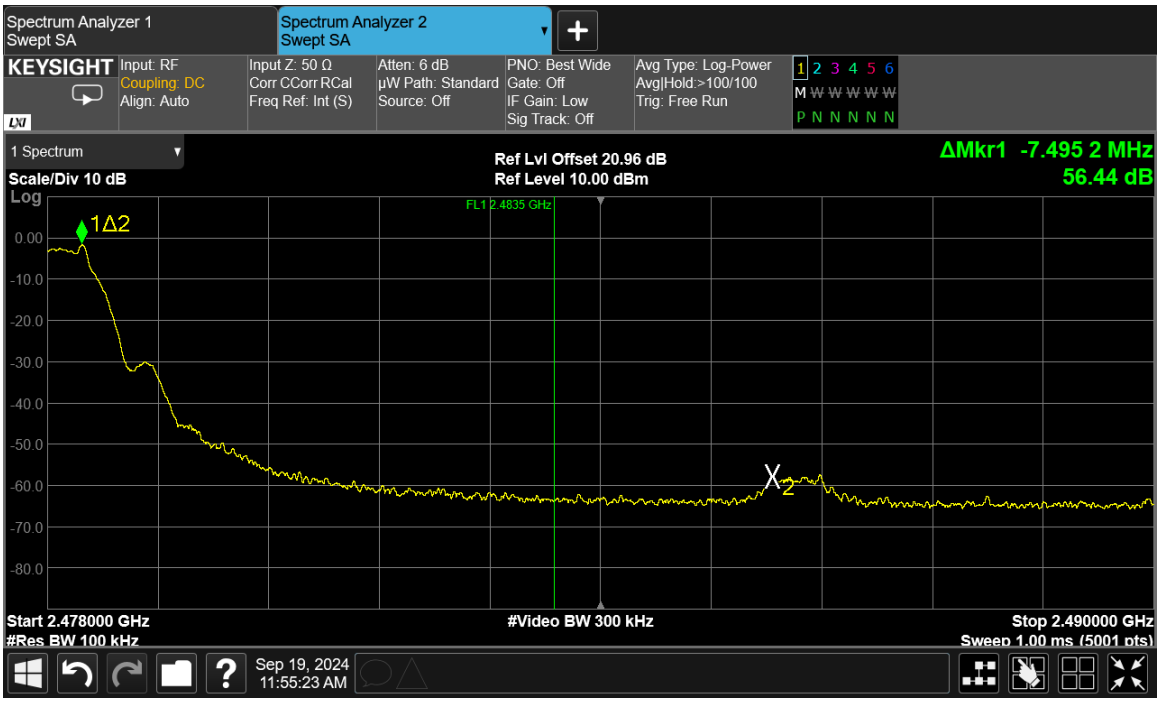


Figure 44: 2Mbps, Low Channel, Bandedge

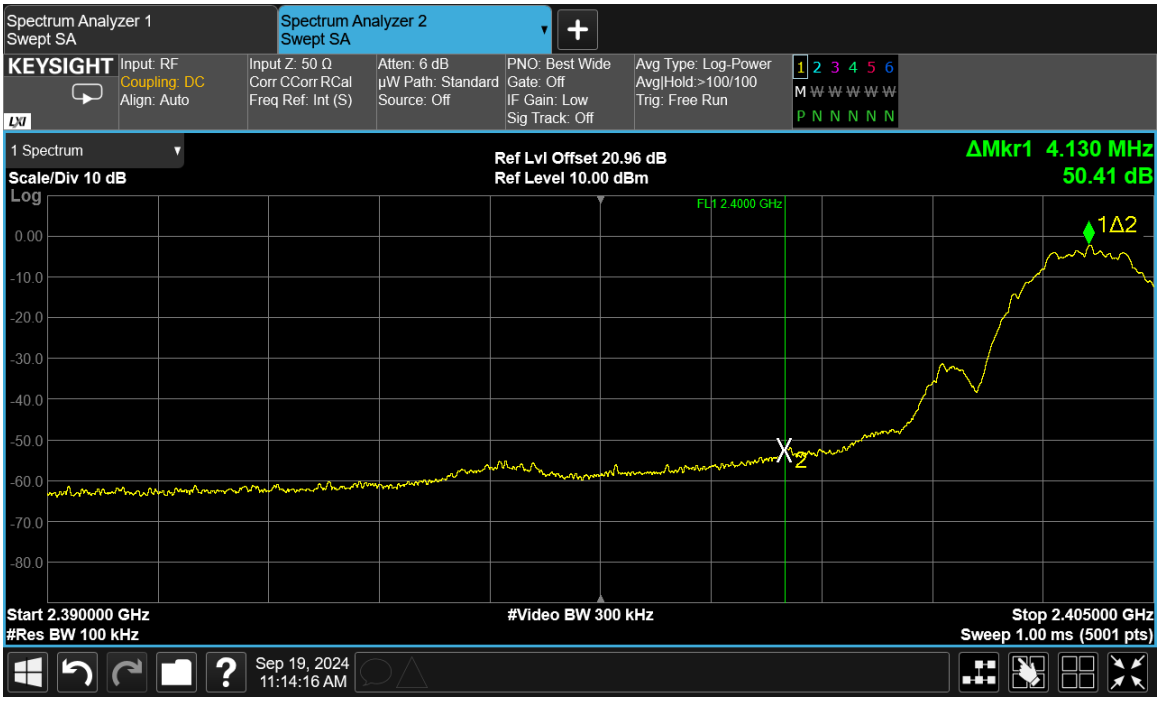
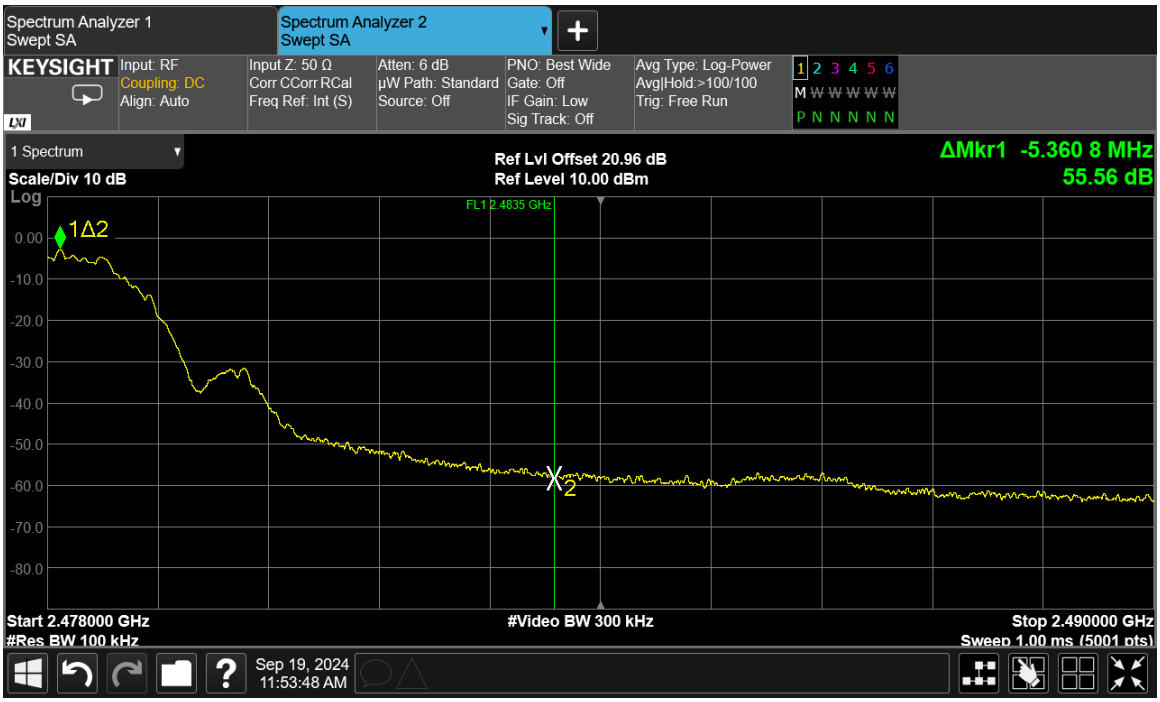


Figure 45: 2Mbps, High Channel, Bandedge



3.5 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.

3.5.1 Measurement Method

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

3.5.2 Test Data

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

The low channel was tested at all four data rates.

The center channel was tested in a 2Mbps mode only.

The high channel was tested in all four data rates.

The EUT test data is provided below.

Figure 46: 125kbps, Low Channel, Plot 1

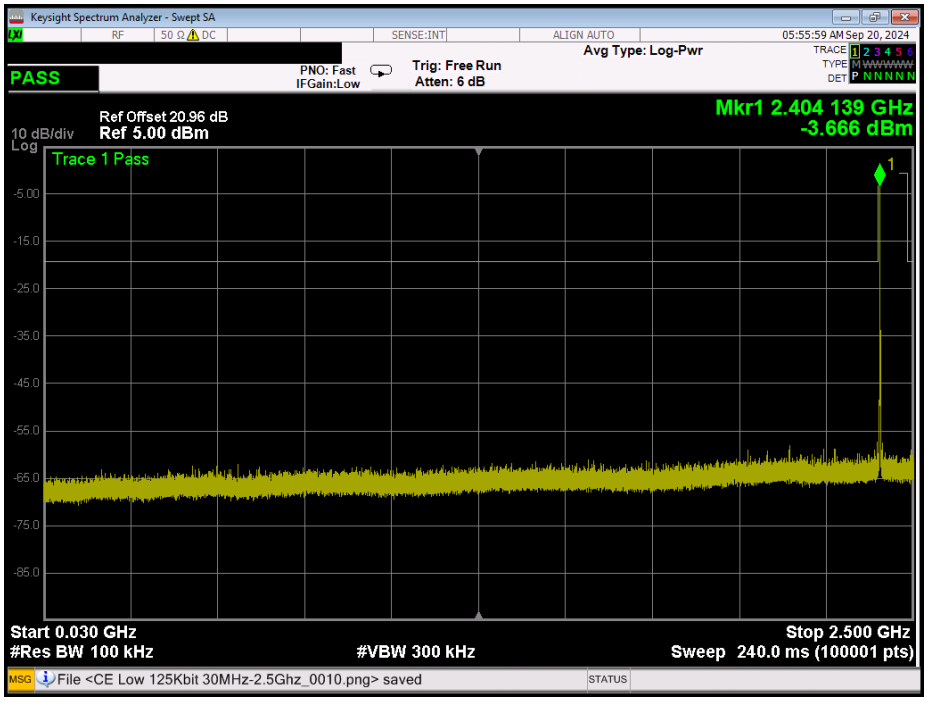


Figure 47: 125kbps, Low Channel, Plot 2

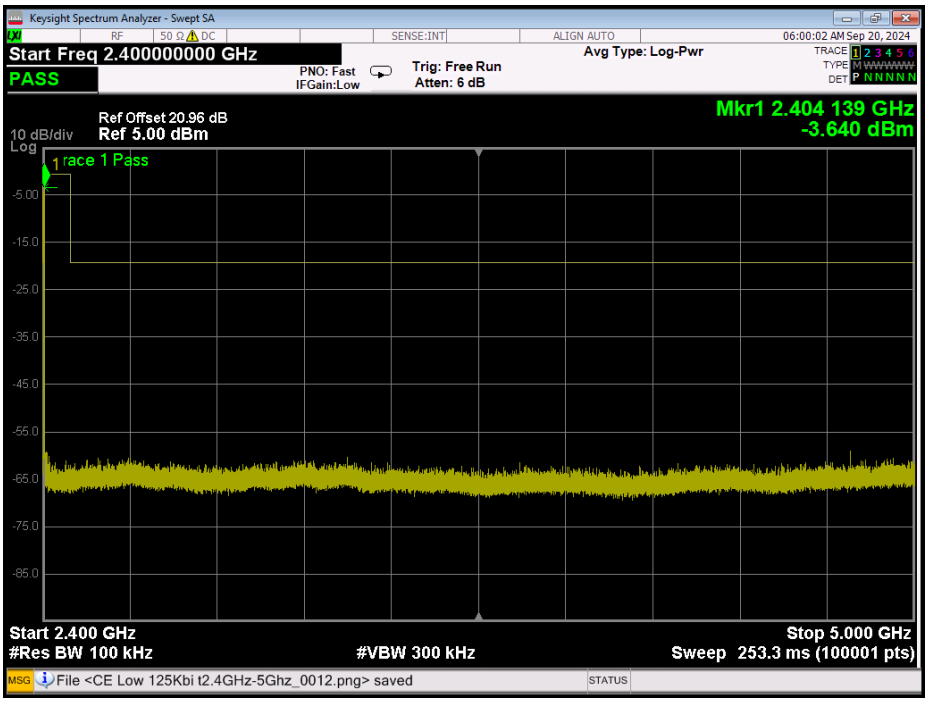


Figure 48: 125kbps, Low Channel, Plot 3

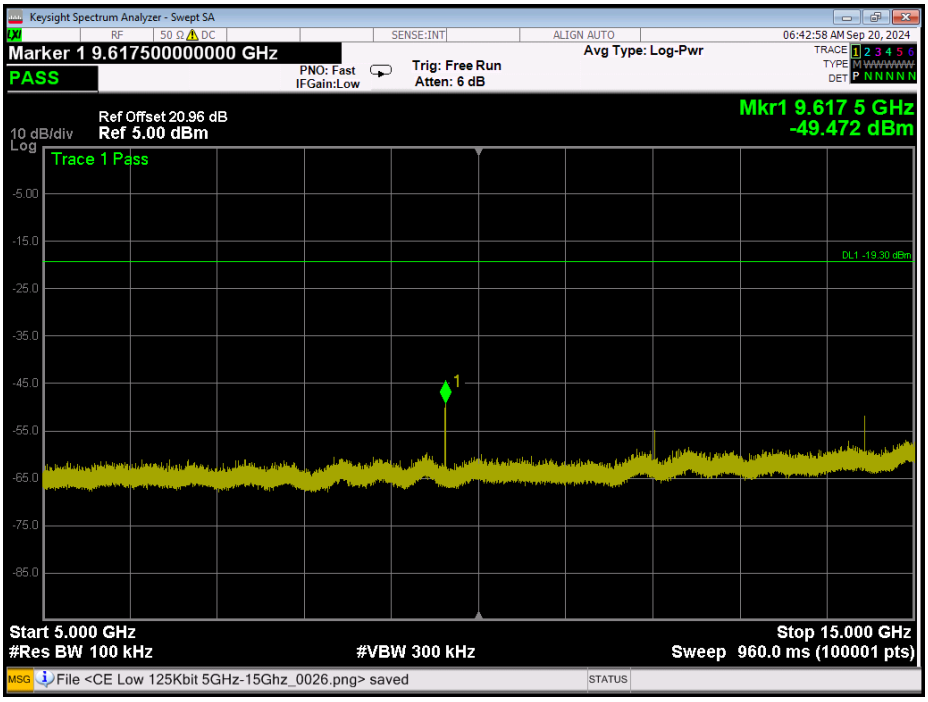


Figure 49: 125kbps, Low Channel, Plot 4

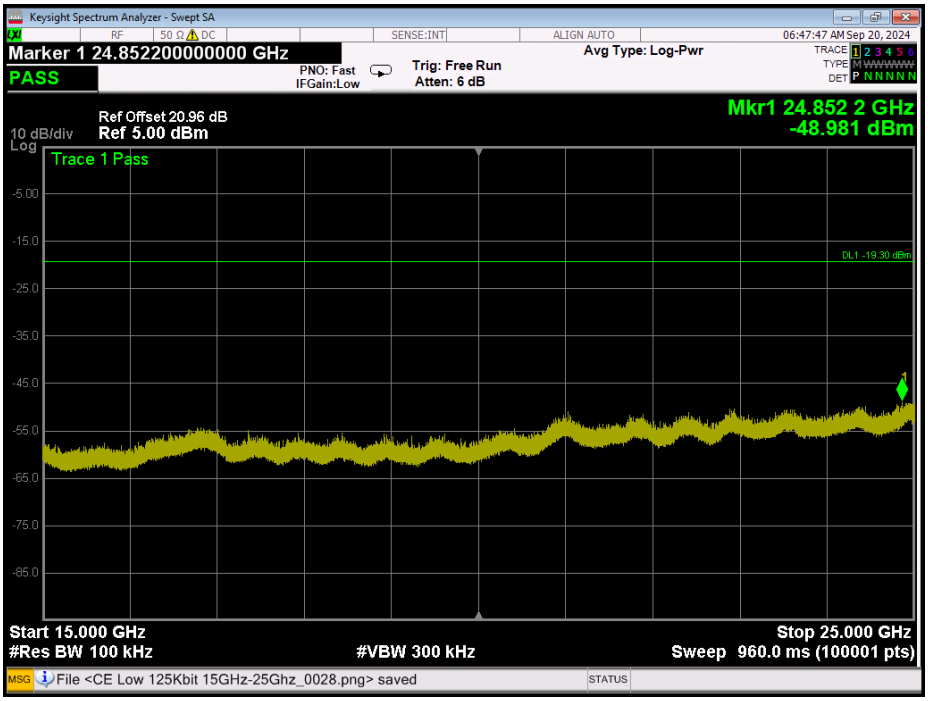


Figure 50: 500kbps, Low Channel, Plot 1

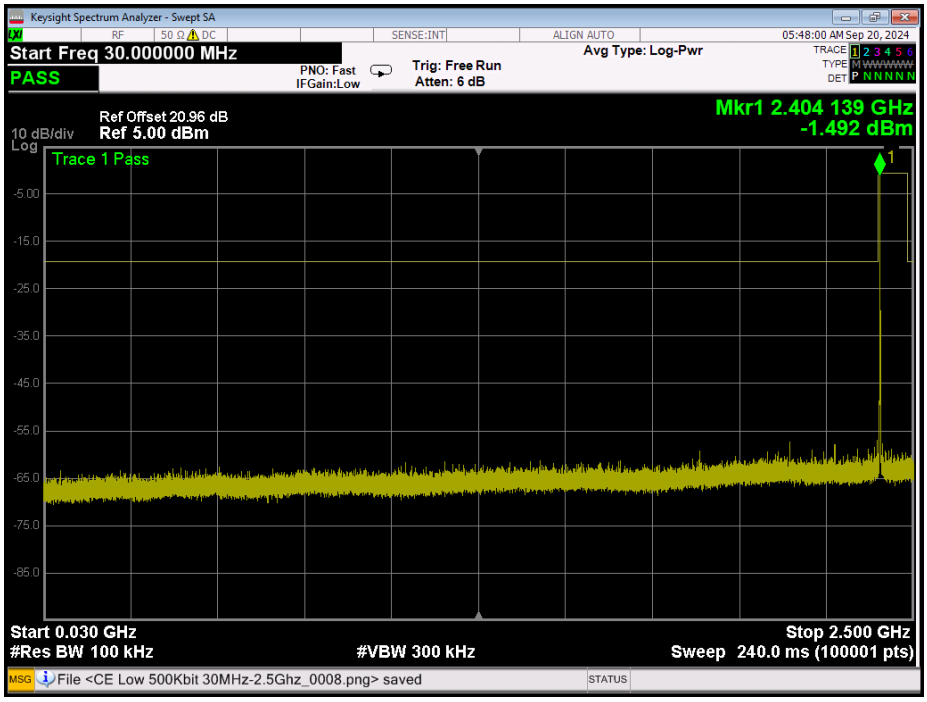


Figure 51: 500kbps, Low Channel, Plot 2

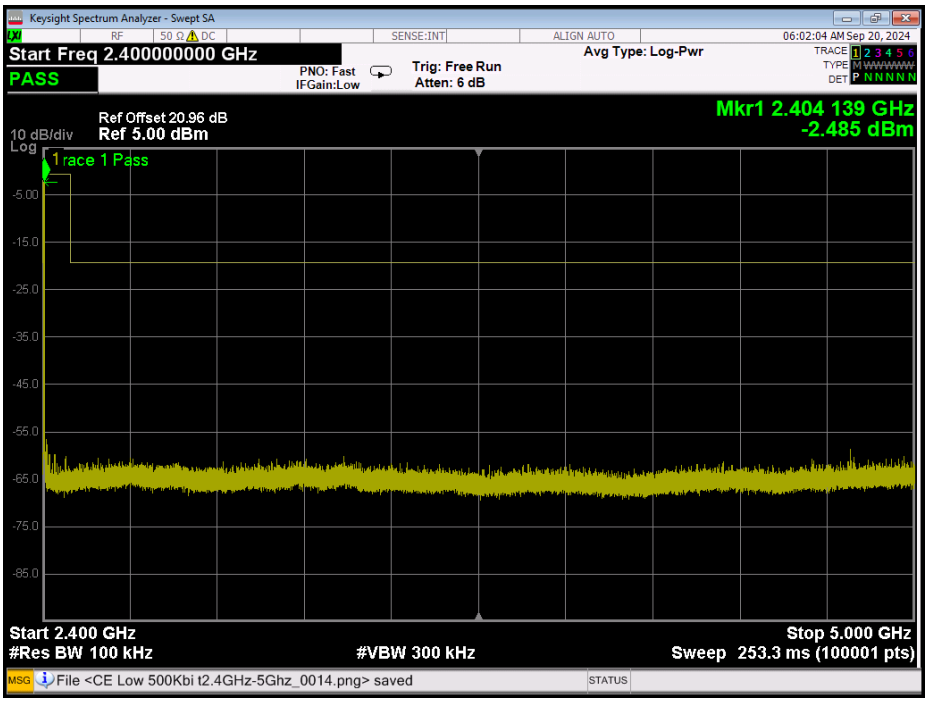


Figure 52: 500kbps, Low Channel, Plot 3

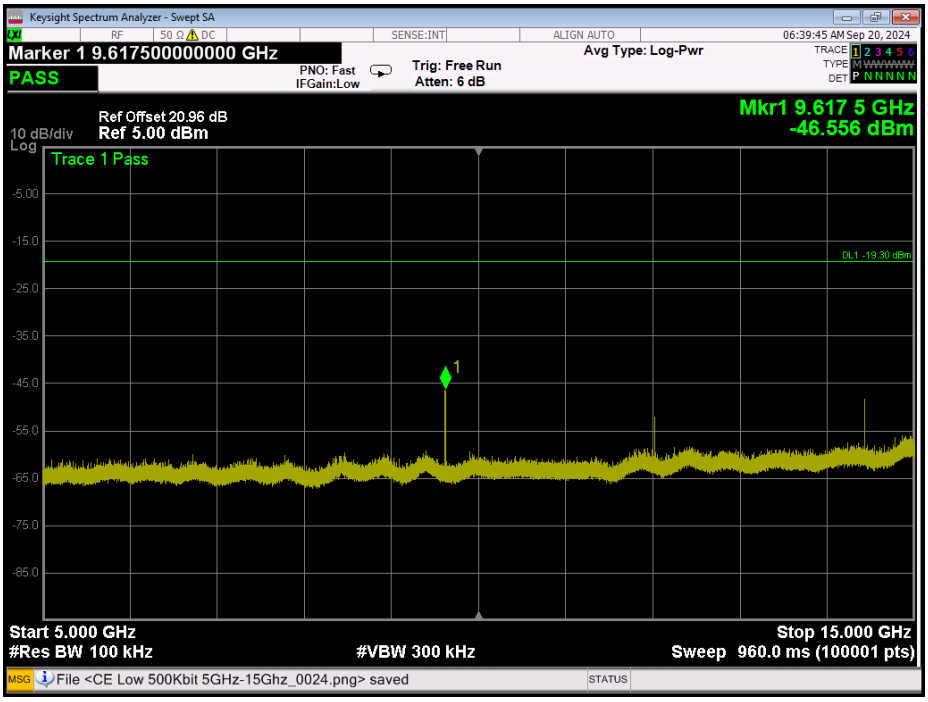


Figure 53: 500kbps, Low Channel, Plot 4

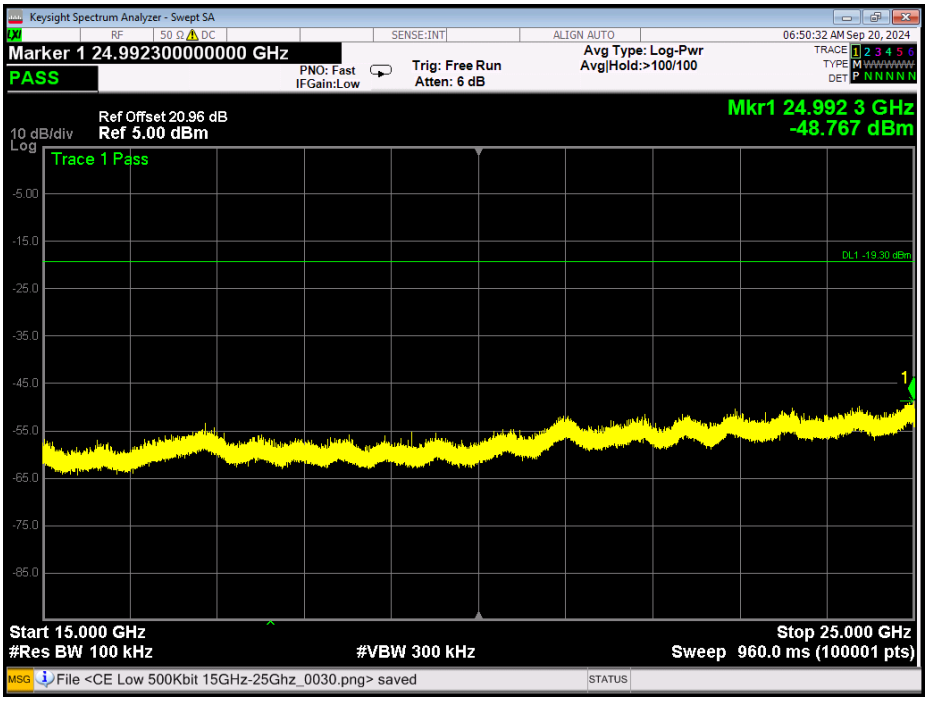


Figure 54: 1Mbps, Low Channel, Plot 1

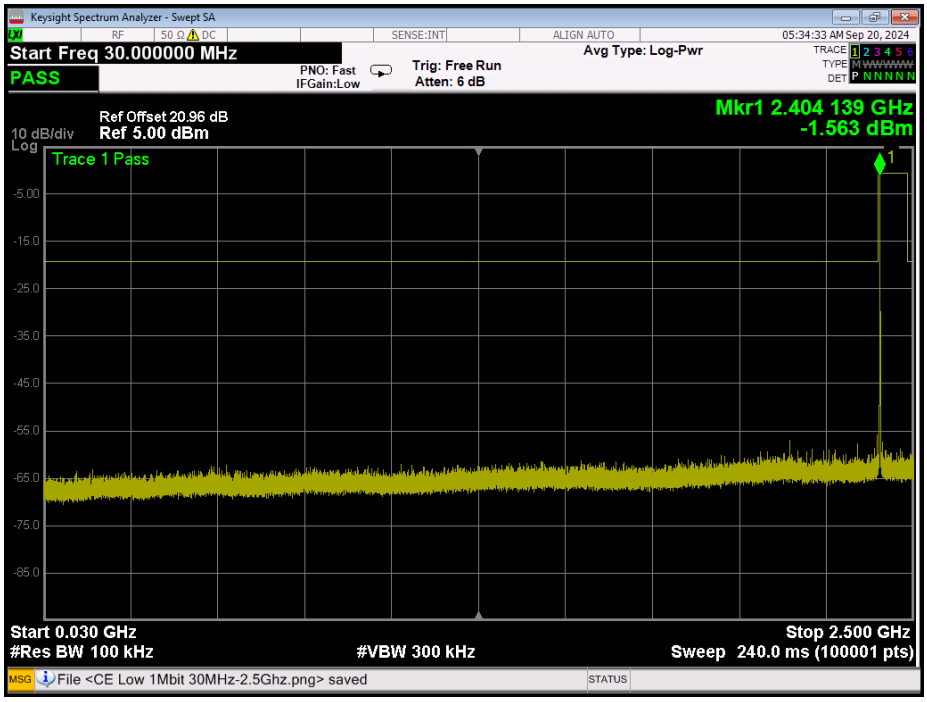


Figure 55: 1Mbps, Low Channel, Plot 2

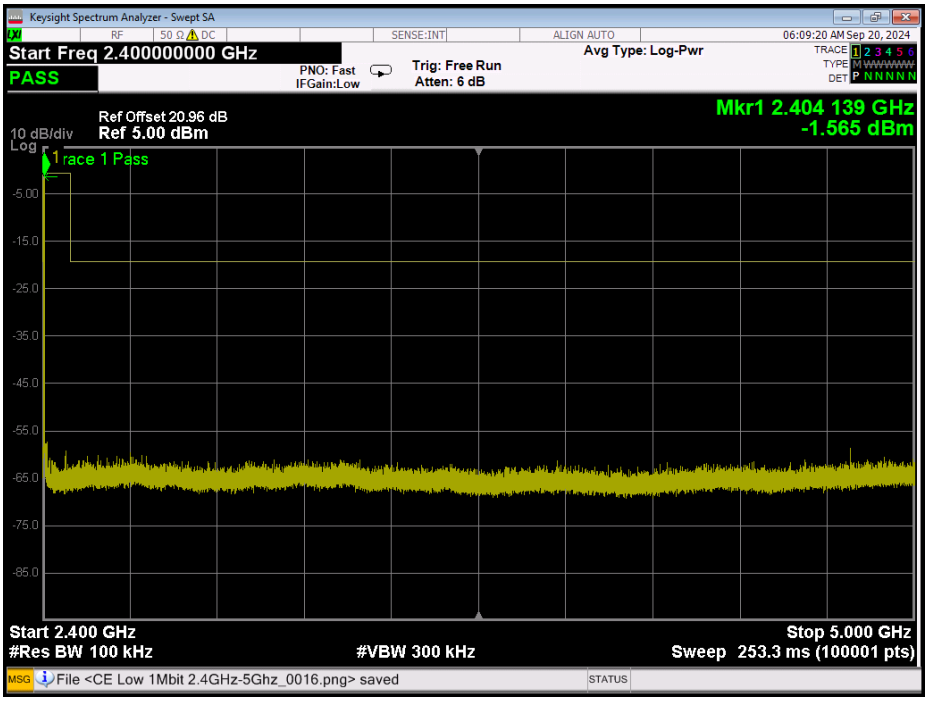


Figure 56: 1Mbps, Low Channel, Plot 3

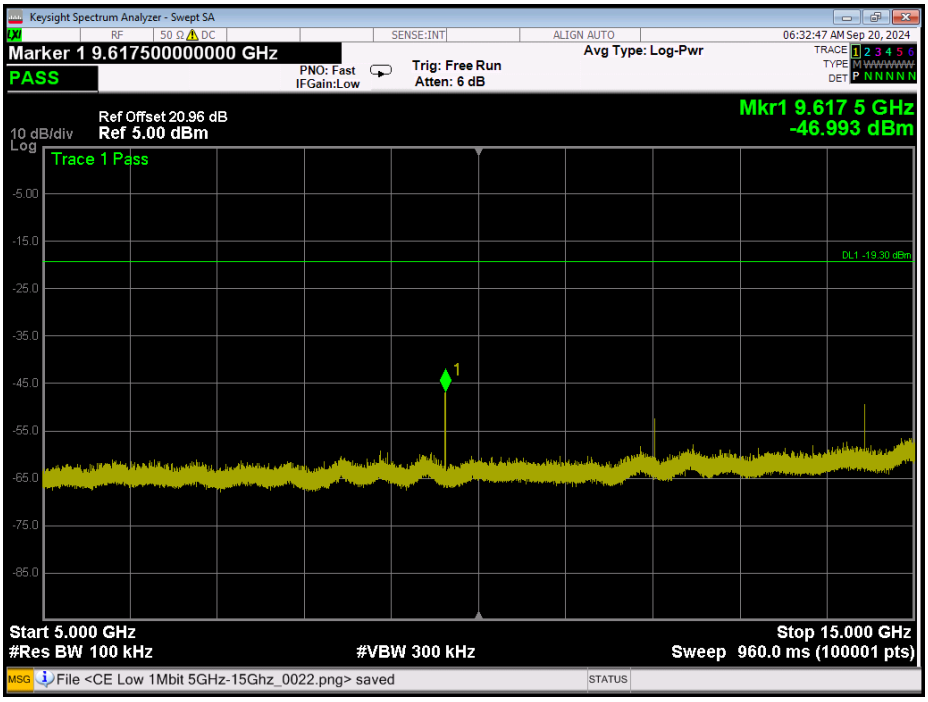


Figure 57: 1Mbps, Low Channel, Plot 4

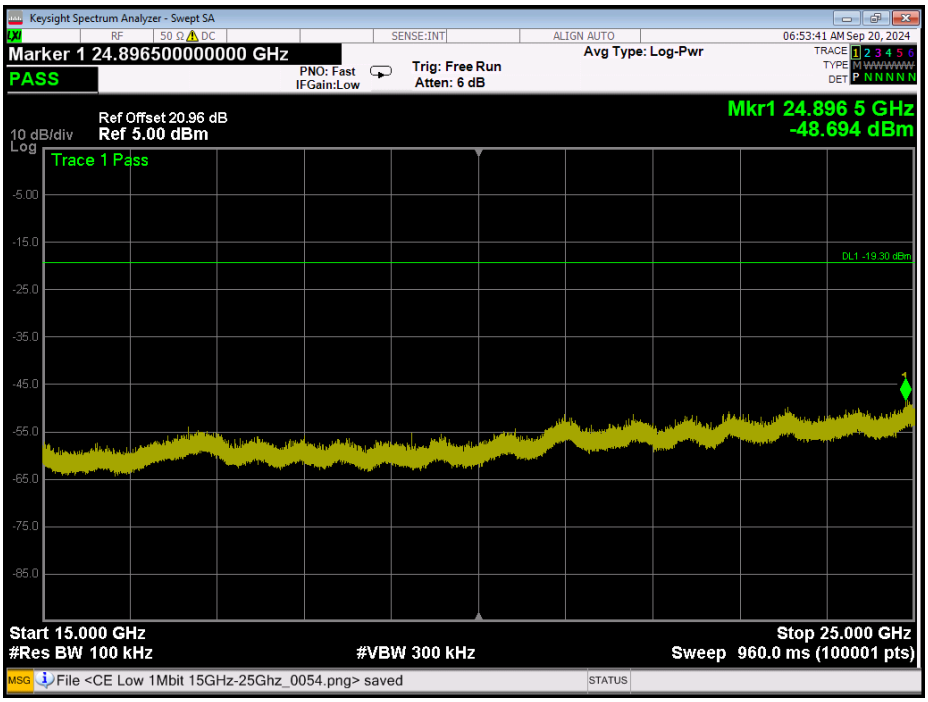


Figure 58: 2Mbps, Low Channel, Plot 1

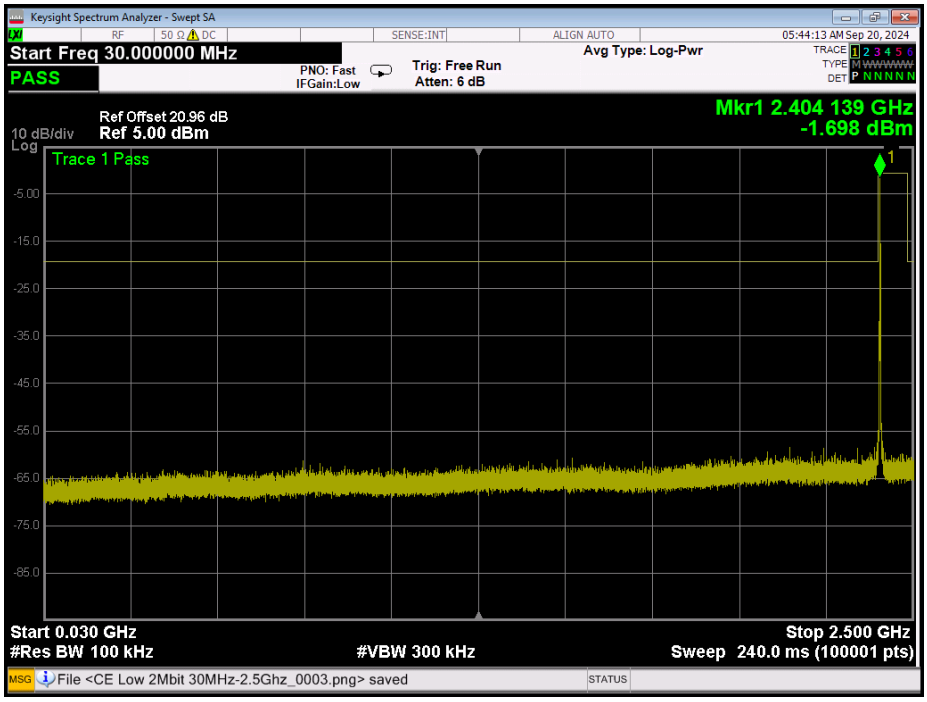


Figure 59: 2Mbps, Low Channel, Plot 2

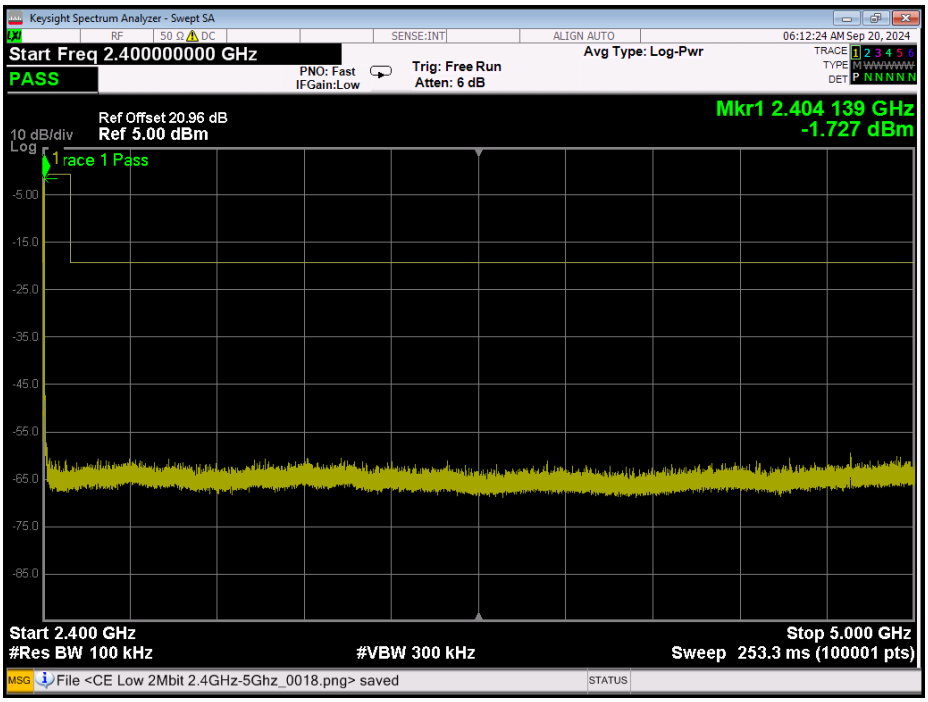


Figure 60: 2Mbps, Low Channel, Plot 3

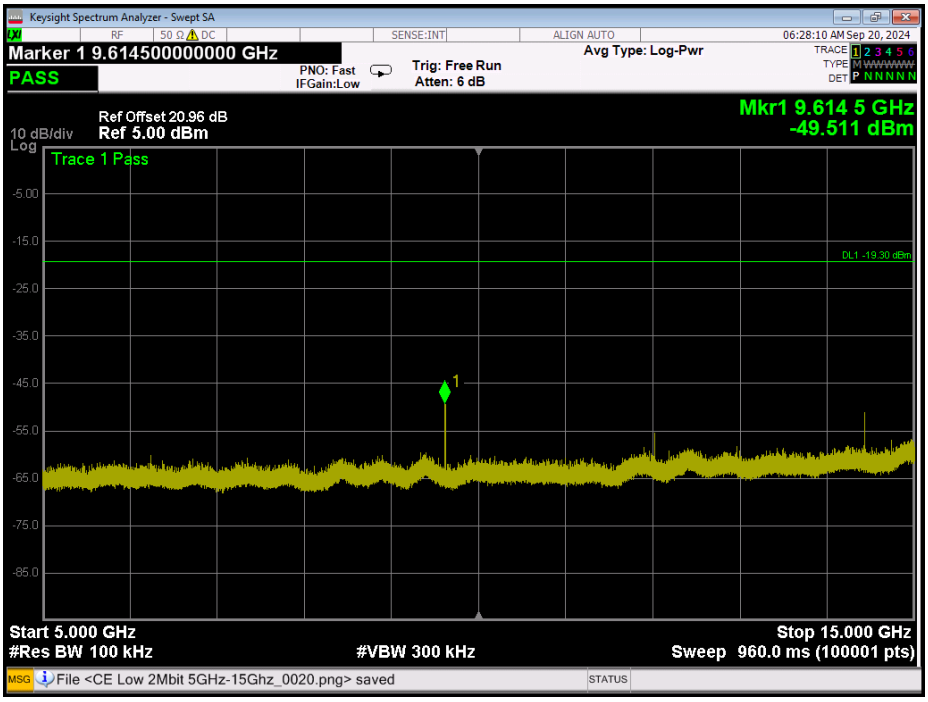


Figure 61: 2Mbps, Low Channel, Plot 4

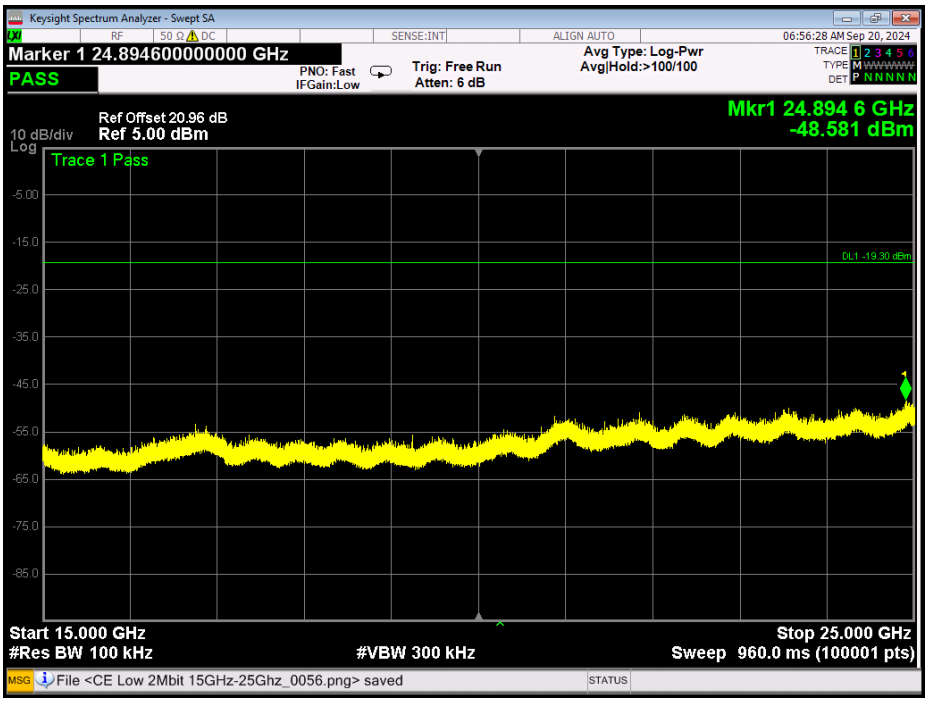


Figure 62: 2Mbps, Center Channel, Plot 1

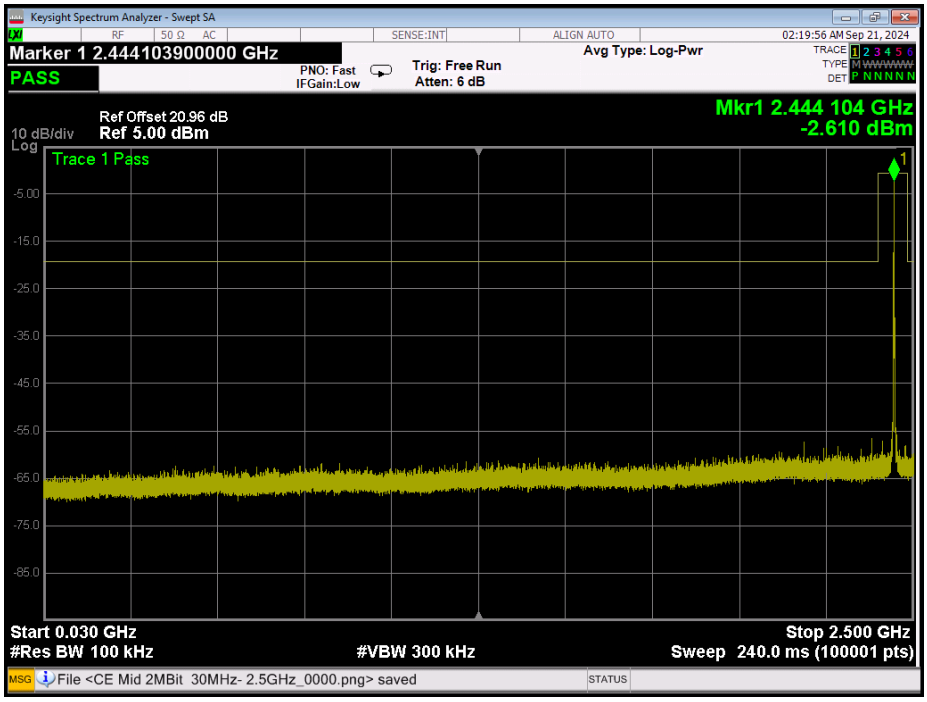


Figure 63: 2Mbps, Center Channel, Plot 2

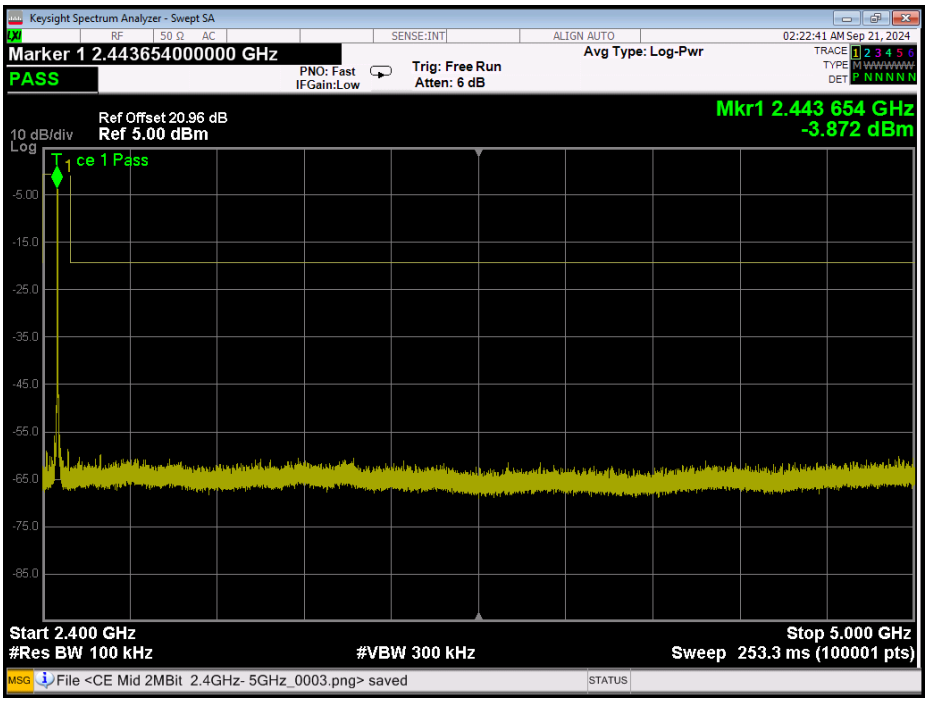


Figure 64: 2Mbps, Center Channel, Plot 3

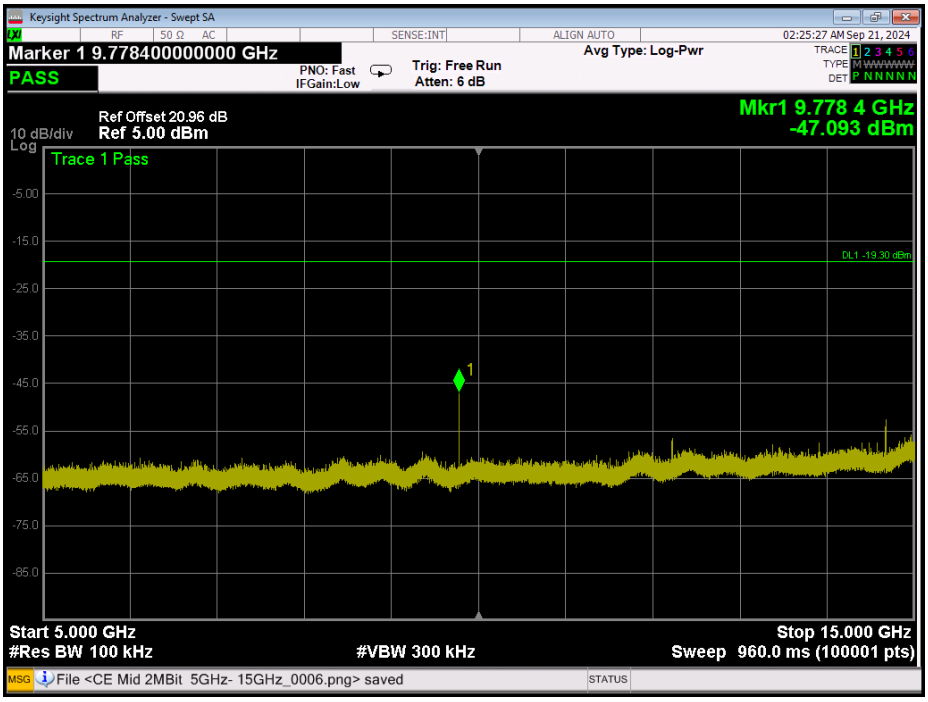


Figure 65: 2Mbps, Center Channel, Plot 4

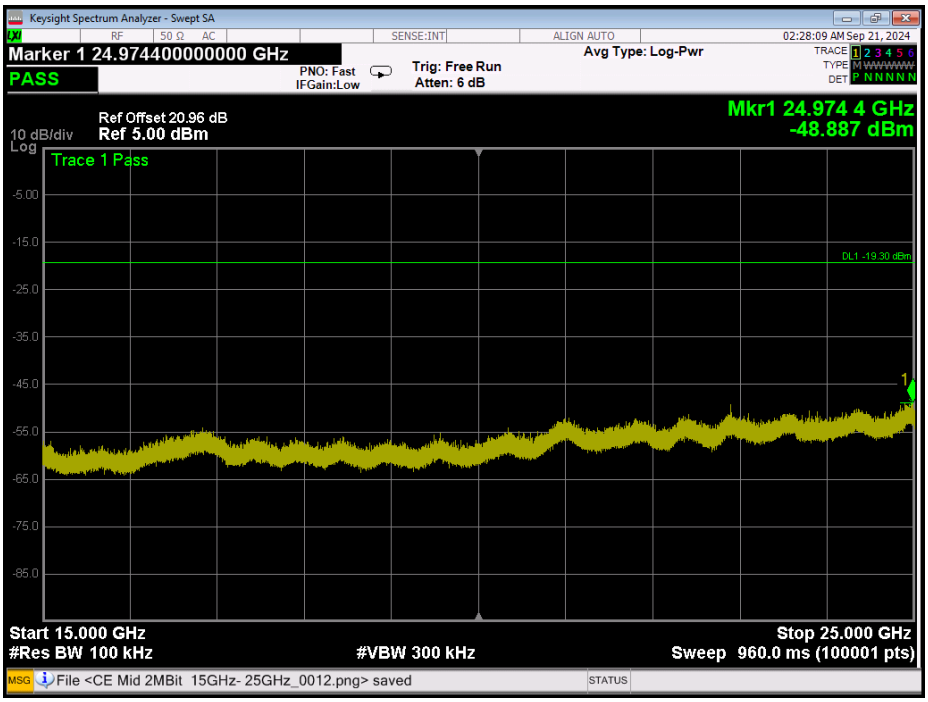


Figure 66: 125kbps, High Channel, Plot 1

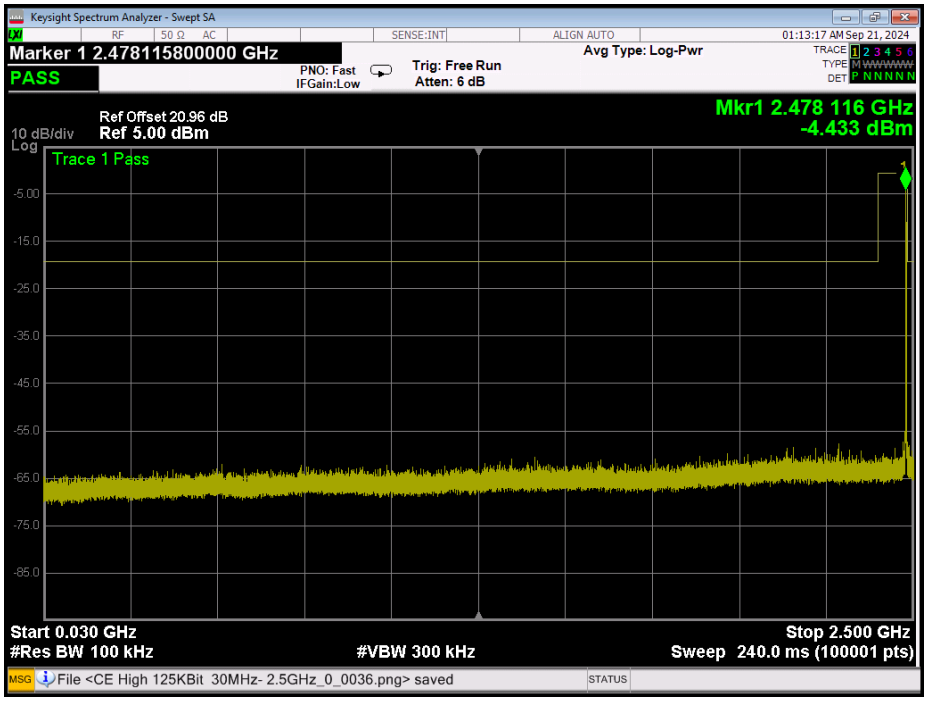


Figure 67: 125kbps, High Channel, Plot 2

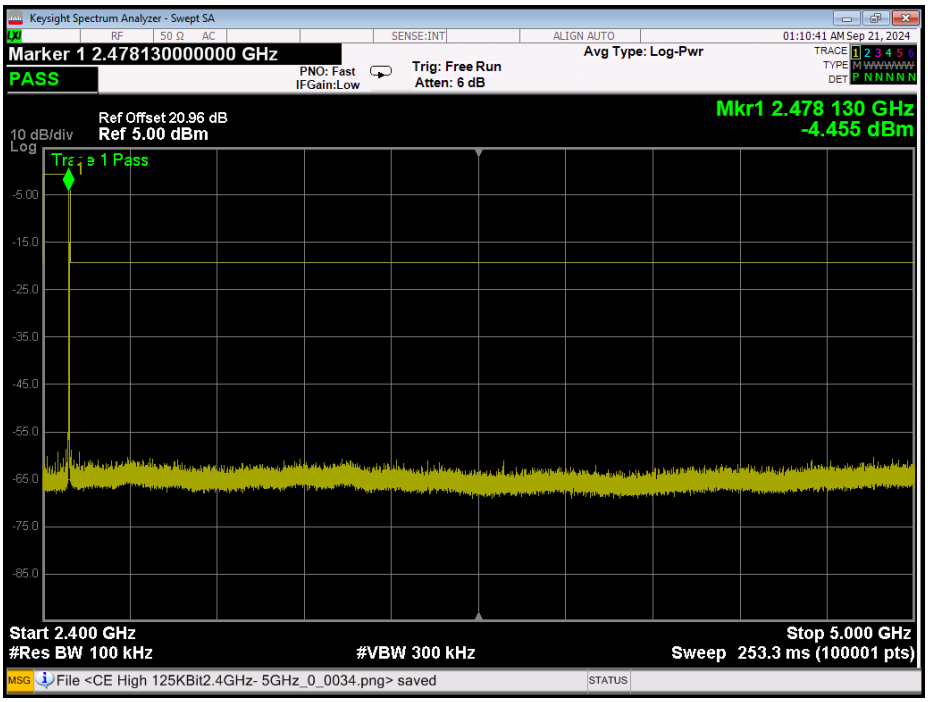


Figure 68: 125kbps, High Channel, Plot 3

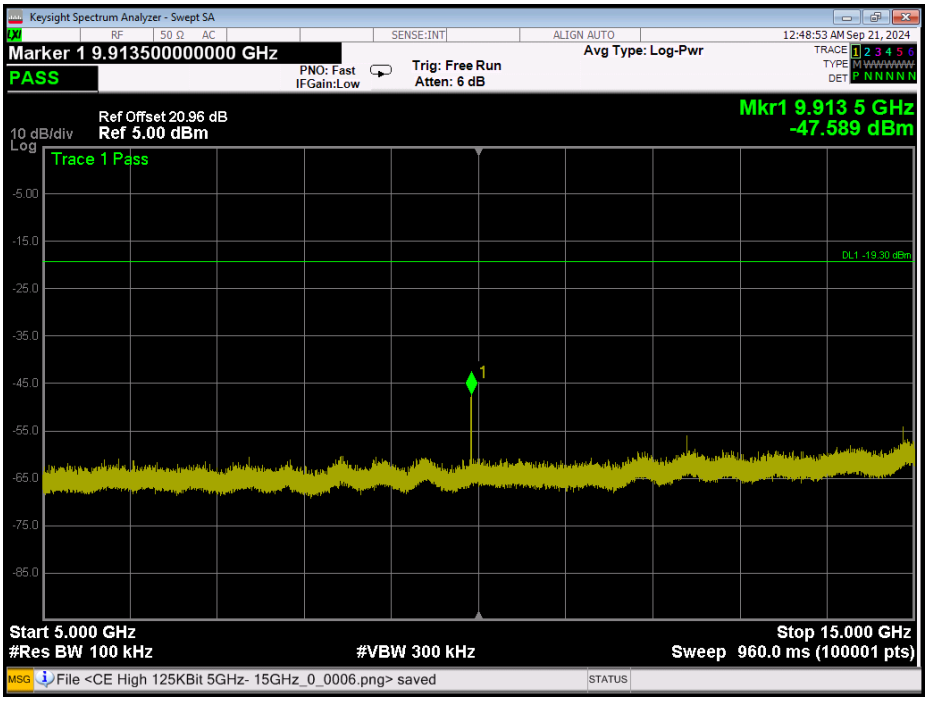


Figure 69: 125kbps, High Channel, Plot 4

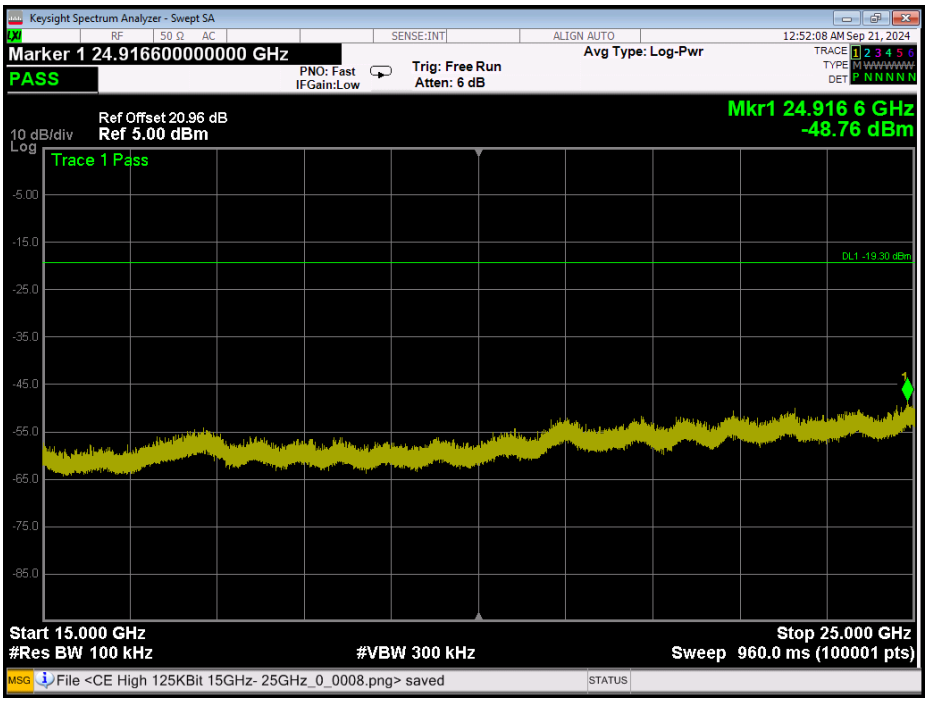


Figure 70: 500kbps, High Channel, Plot 1

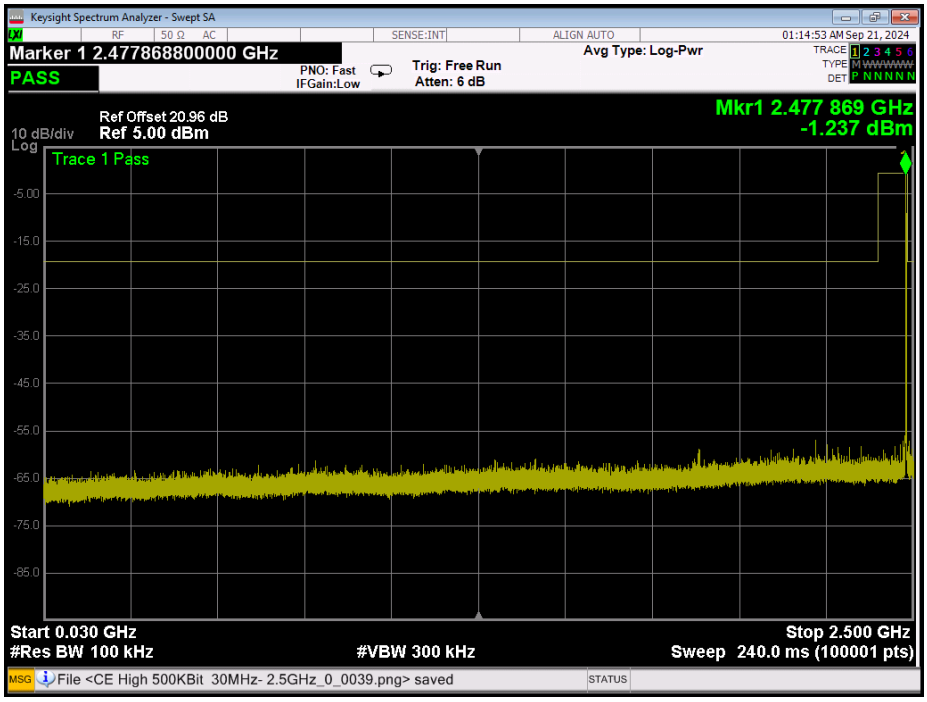


Figure 71: 500kbps, High Channel, Plot 2

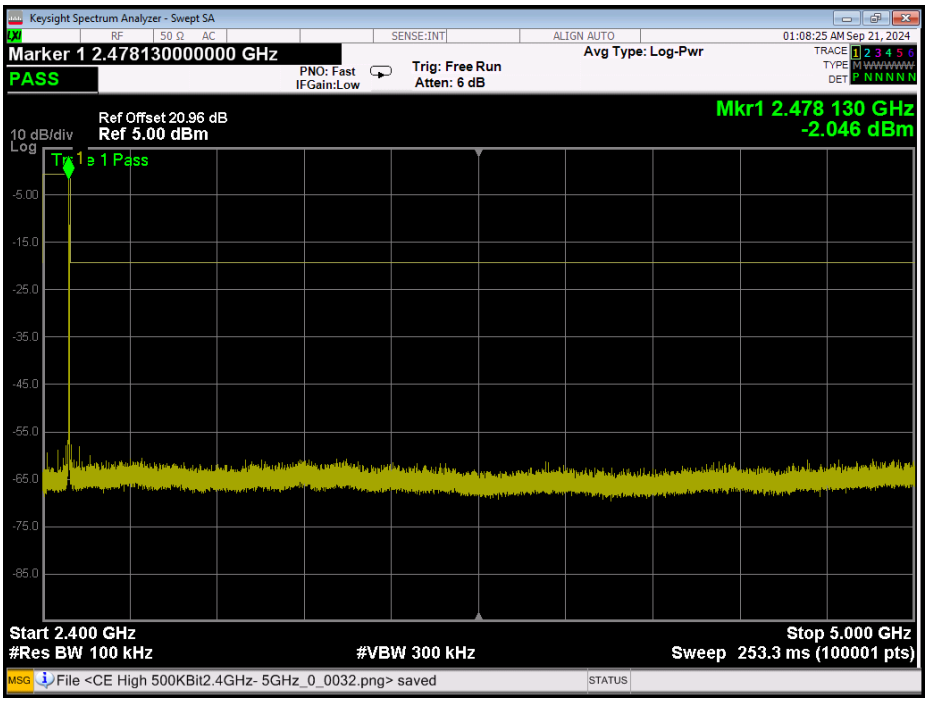


Figure 72: 500kbps, High Channel, Plot 3

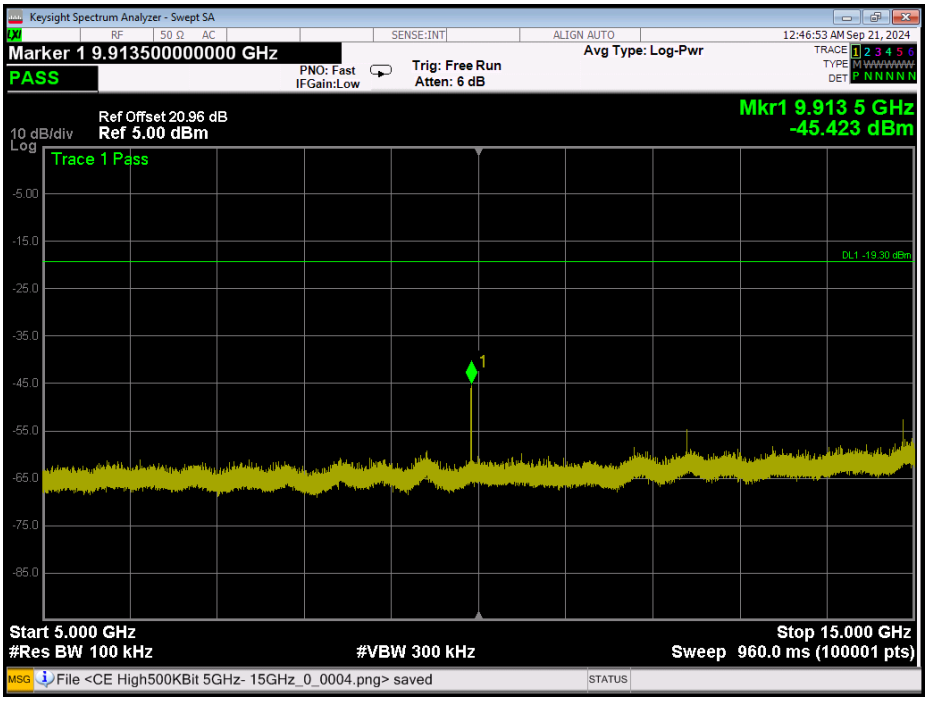


Figure 73: 500kbps, High Channel, Plot 4

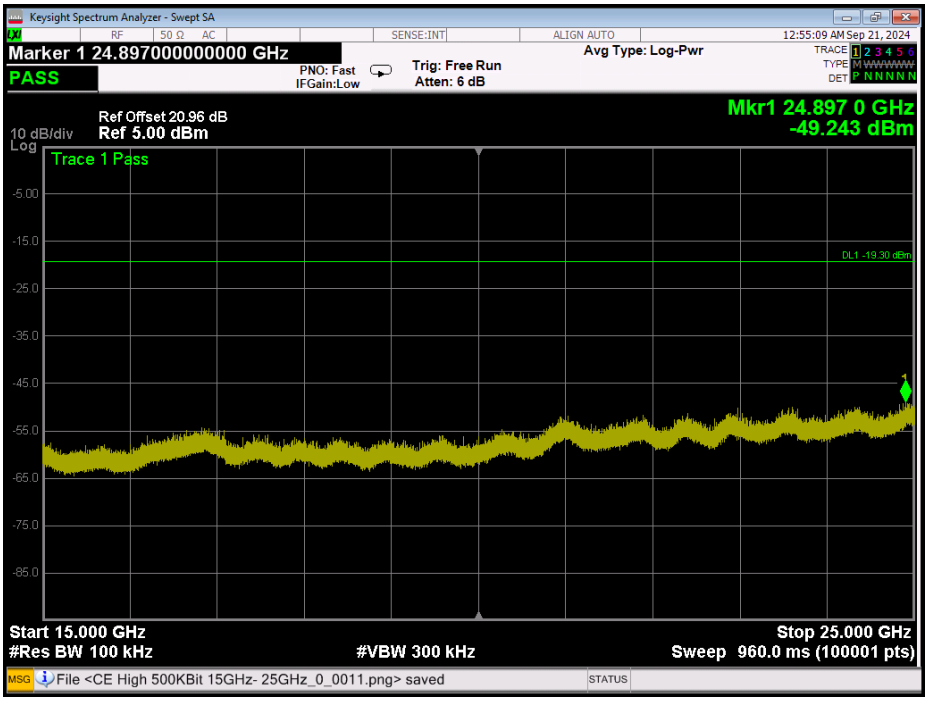


Figure 74: 1Mbps, High Channel, Plot 1

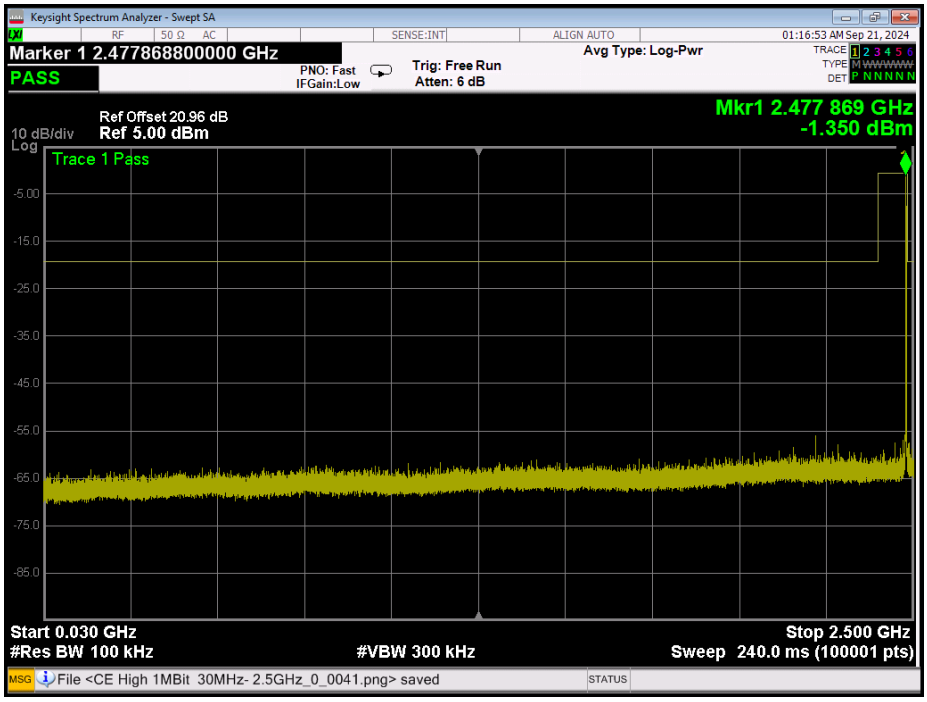


Figure 75: 1Mbps, High Channel, Plot 2

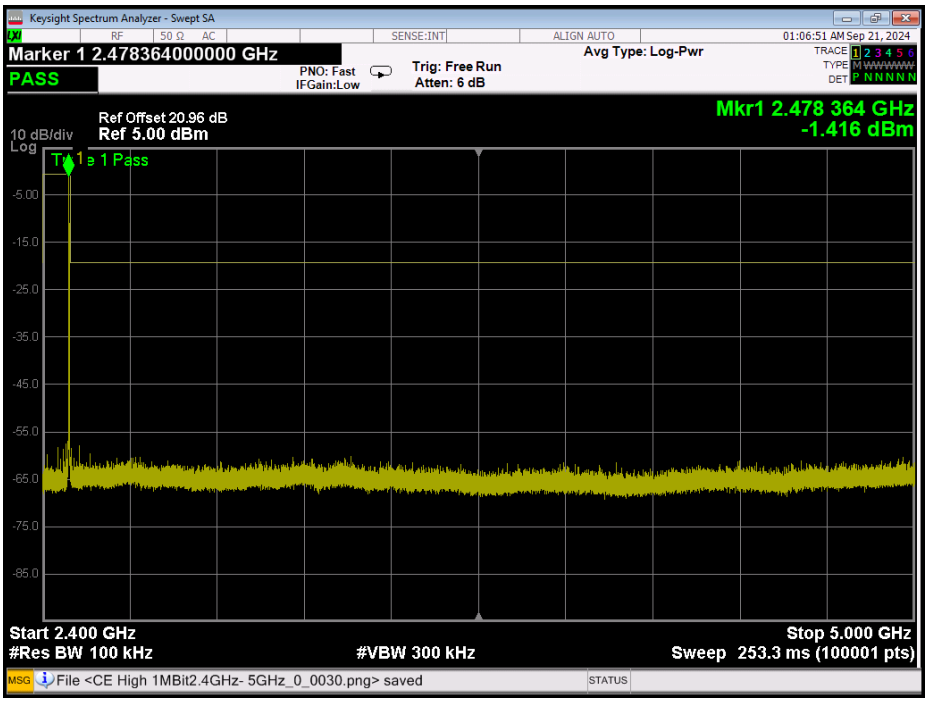


Figure 76: 1Mbps, High Channel, Plot 3

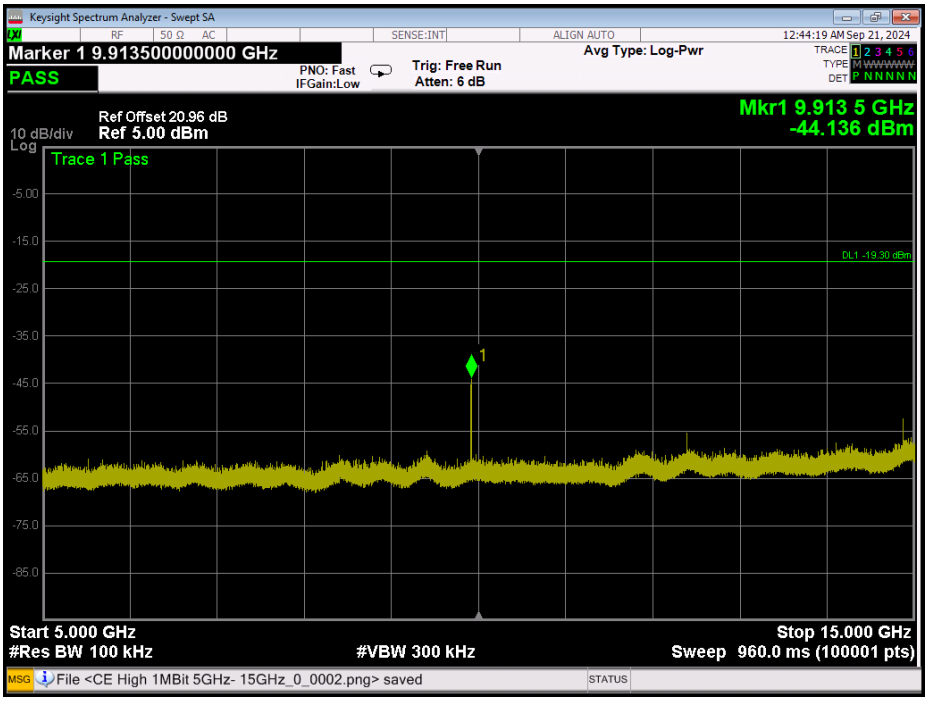


Figure 77: 1Mbps, High Channel, Plot 4

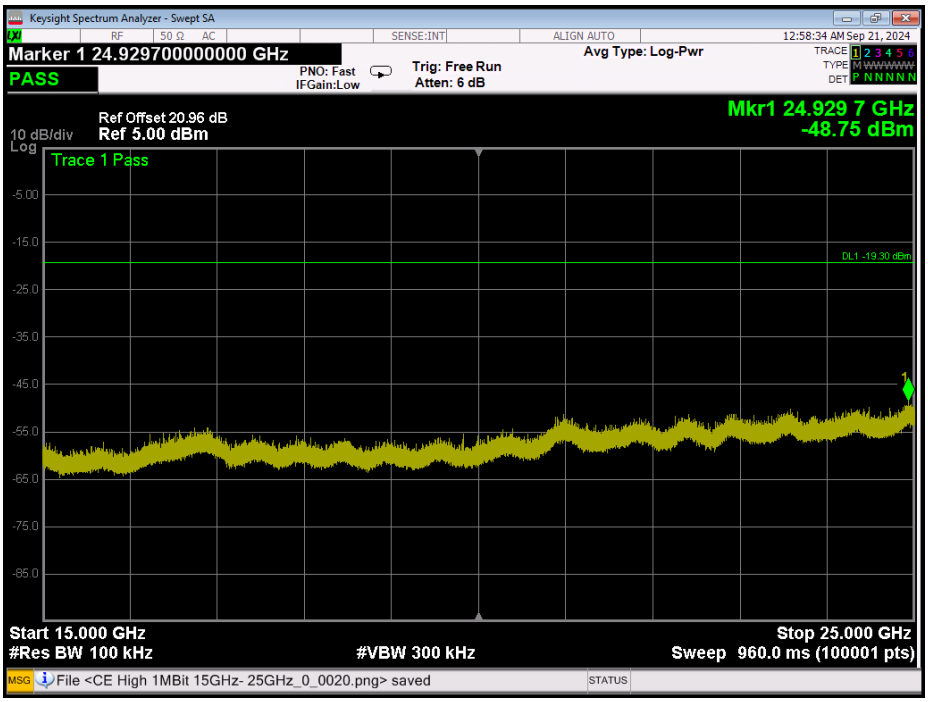


Figure 78: 2Mbps, High Channel, Plot 1

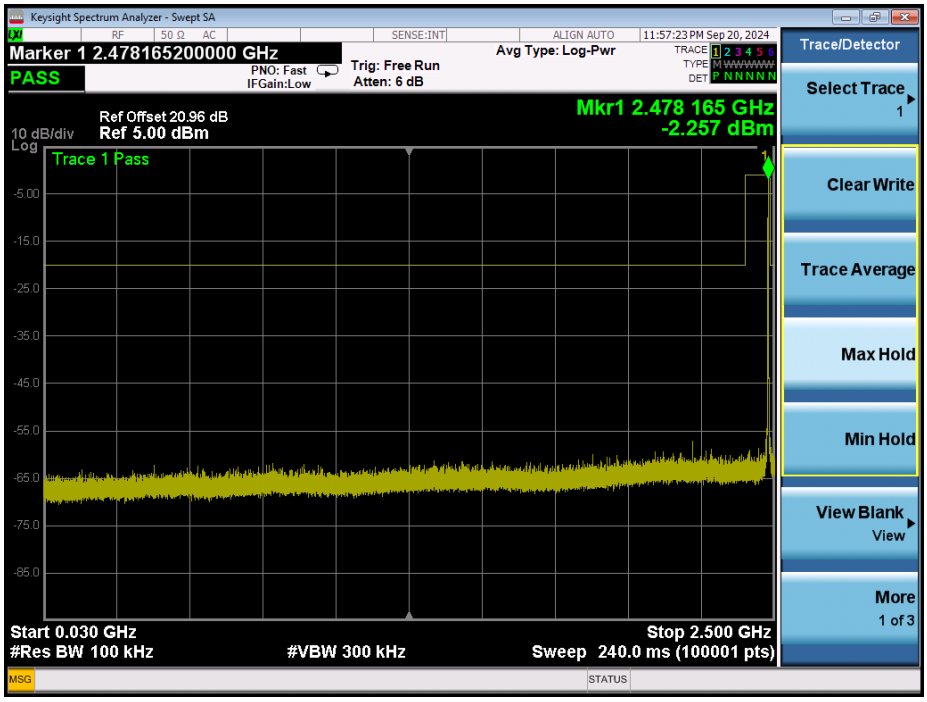


Figure 79: 2Mbps, High Channel, Plot 2

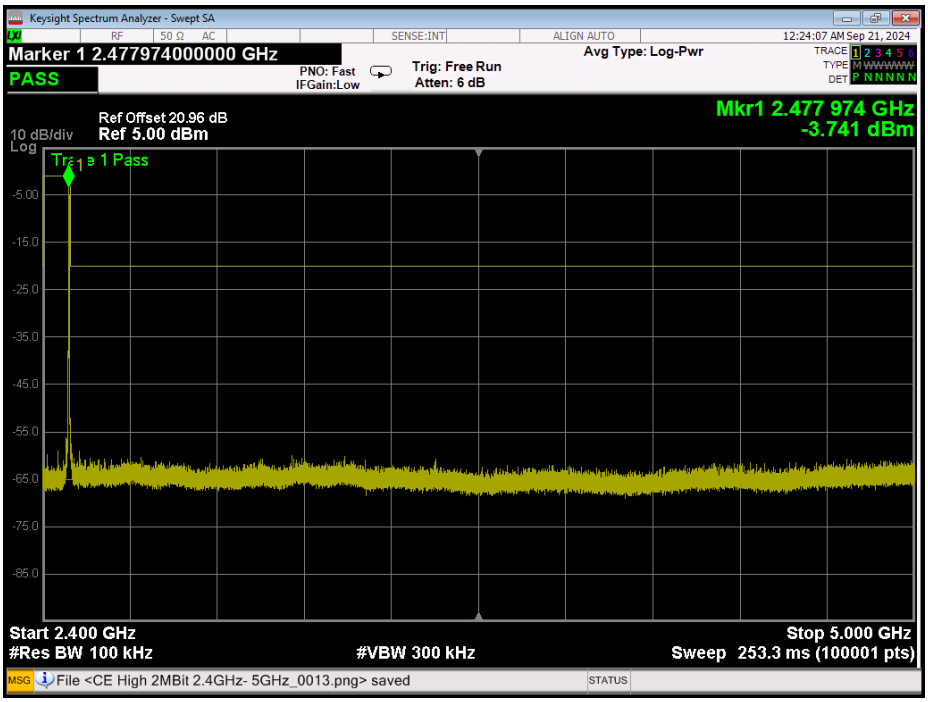


Figure 80: 2Mbps, High Channel, Plot 3

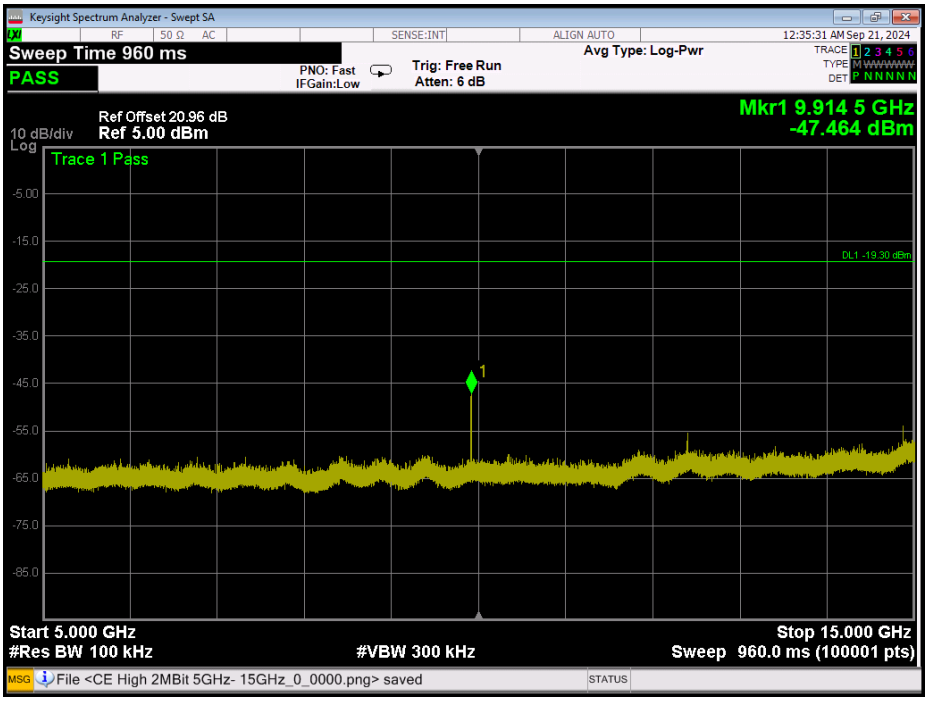
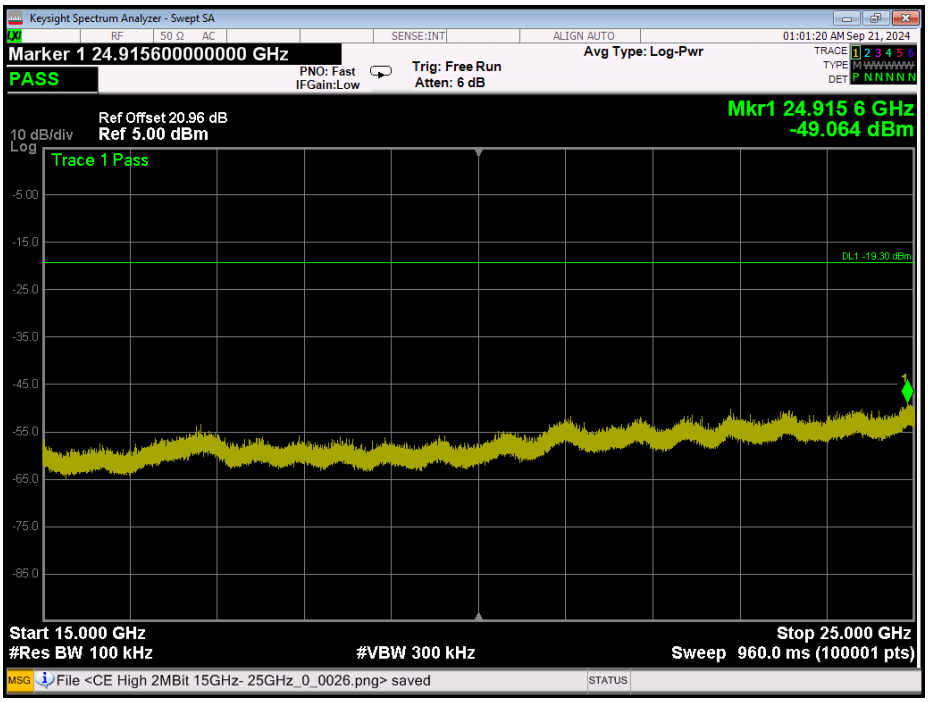


Figure 81: 2Mbps, High Channel, Plot 4



3.6 Radiated Emissions Above 30MHz

3.6.1 Requirements

Compliance Standard: FCC Part 15.247, 15.209, 15.205, and ISED Canada RSS-Gen

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

3.6.2 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 25 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.

3.6.3 Test Results Summary

The EUT complies with the radiated emissions requirements.

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

There are no emissions detected from the EUT in the range of 3GHz to 25GHz.

3.6.4 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 = VdBµV + AFdB/m + CFdB - GdB
To convert to linear units:	EdBµV/m/20 Inv log

3.6.5 Test Data

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 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 dwell on the low channel in a 125kbps mode.

b) for testing of 1 GHz to 25 GHz, the EUT was set to a transmitter enabled mode, the BLE transceiver was set to dwell on the low, center, and high channels.
   1. the low channel was tested at all four data rates.
   2. the center channel was tested in a 2Mbps mode only.
   3. the high channel was tested in all four data rates.

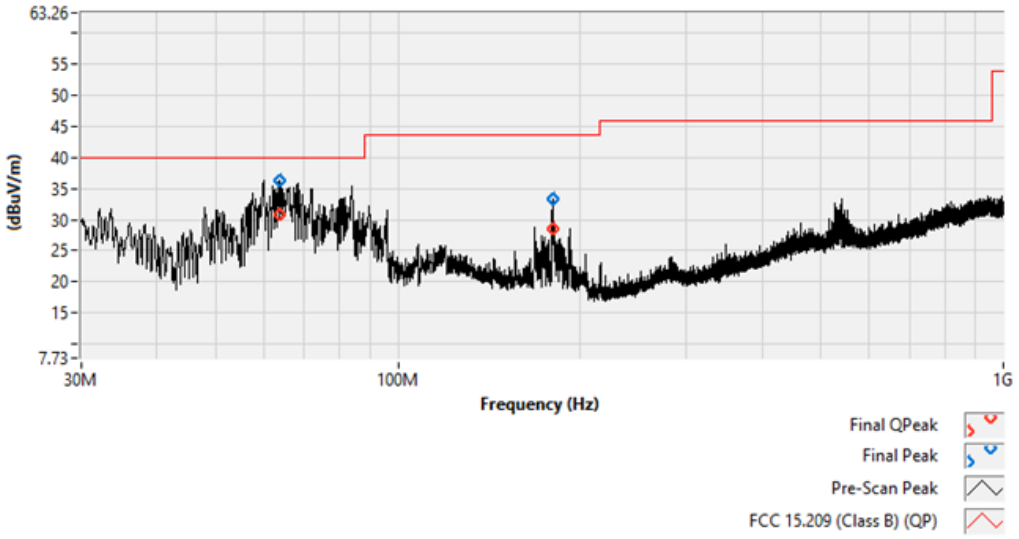
Please note that all measurements from 3GHz to 25GHz are ambient.

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).

Table 9: Radiated Emissions Test Data, 30 MHz to 1 GHz

Frequency (Hz)	Detector	Corr Meas (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Turn Table (deg)	Antenna (cm)
63.603M	Peak	36.379	--	--	0	Vert, 125
	QP	30.885	40	-9.115	0	Vert, 115
180.135M	Peak	33.417	--	--	155	Vert, 125
	QP	28.634	43.5	-14.866	180	Vert, 100
528.05M	Peak	40.004	--	--	180	Horiz, 115
	QP	35.923	46	-10.077	180	Horiz, 115

Pre-scan and Final Data (Vertical)



Pre-scan and Final Data (Horizontal)

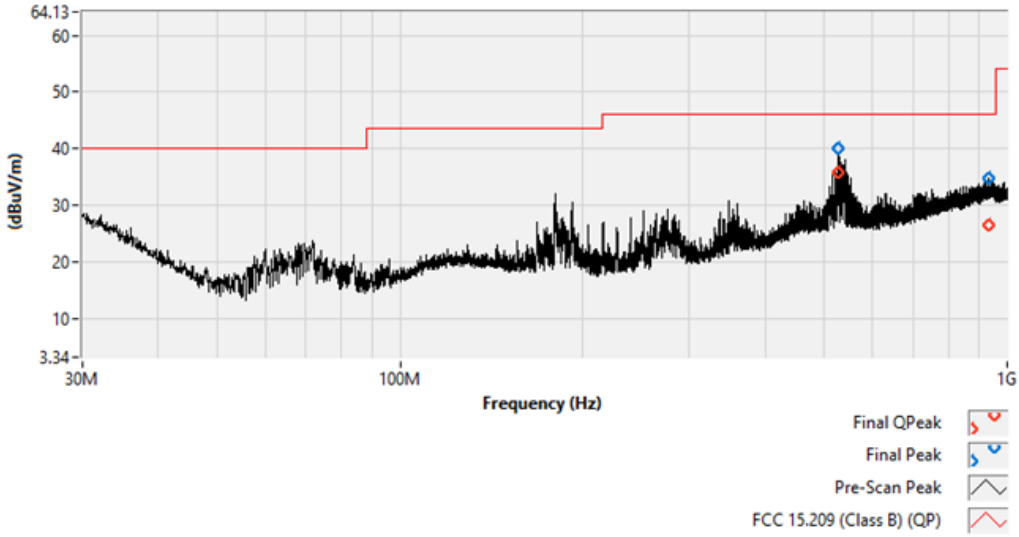
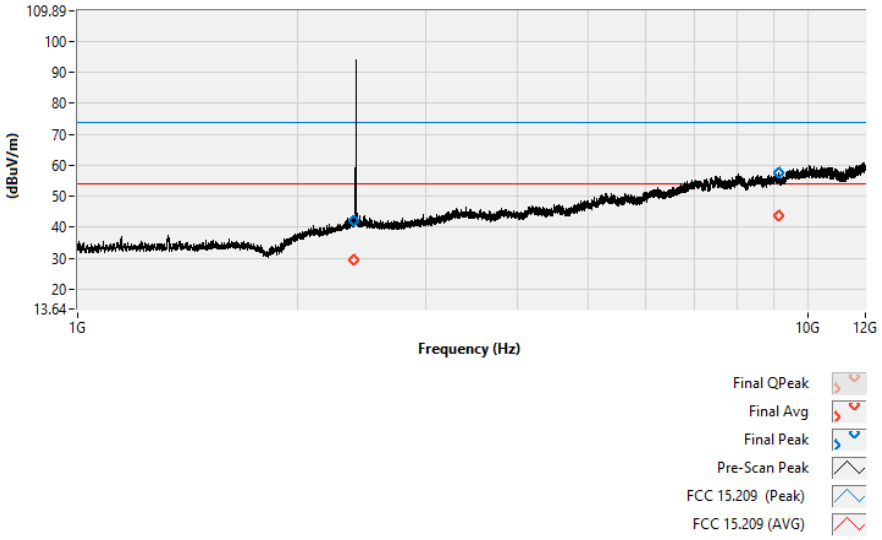


Table 10: Radiated Test Data >1GHz, Low Channel, 125kbps

Frequency (Hz)	Detector	Corr Meas (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Turn Table (deg)	Antenna (cm)
2.39G	Peak	42.248	74	-31.752	155	Vert, 150
	Avg	29.676	54	-24.324	155	Vert, 150
2.404G	Peak	95.956	--	--	0	Horiz, 150
9.114G	Peak	57.426	74	-16.574	155	Vert, 150
	Avg	43.803	54	-10.197	155	Vert, 150
11.991G	Peak	60.897	74	-13.103	0	Horiz, 150
	Avg	47.298	54	-6.702	0	Horiz, 150

Pre-scan and Final Data (Vertical)



Pre-scan and Final Data (Horizontal)

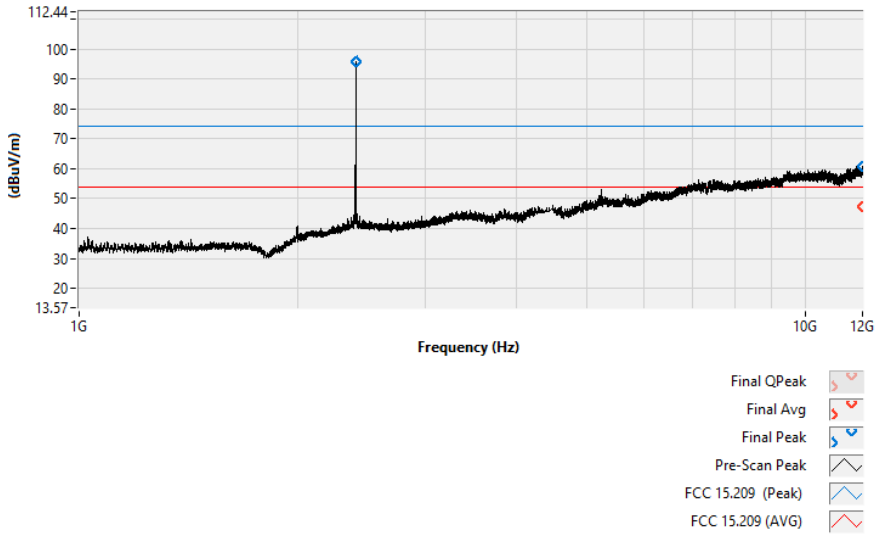
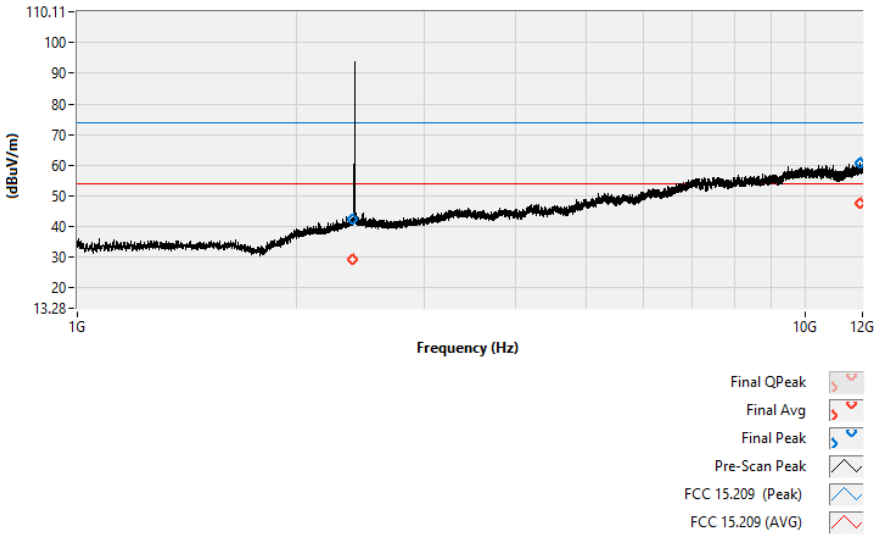


Table 11: Radiated Test Data >1GHz, Low Channel, 500kbps

Frequency (Hz)	Detector	Corr Meas (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Turn Table (deg)	Antenna (cm)
2.39G	Peak	42.216	74	-31.784	155	Vert, 150
	Avg	29.417	54	-24.583	155	Vert, 150
2.404G	Peak	95.675	--	--	0	Horiz, 150
8.831G	Peak	57.475	74	-16.525	0	Horiz, 150
	Avg	44.156	54	-9.844	0	Horiz, 150
11.909G	Peak	60.853	74	-13.147	155	Vert, 150
	Avg	47.556	54	-6.444	155	Vert, 150

Pre-scan and Final Data (Vertical)



Pre-scan and Final Data (Horizontal)

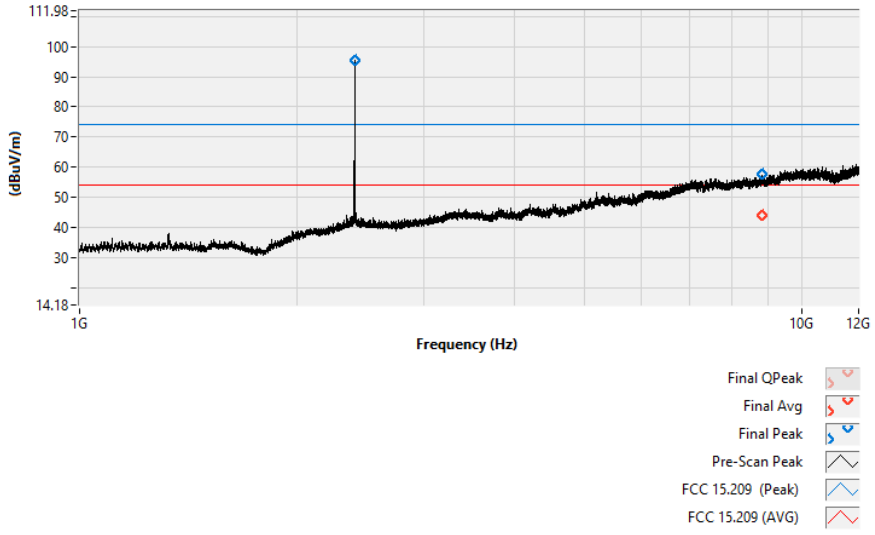
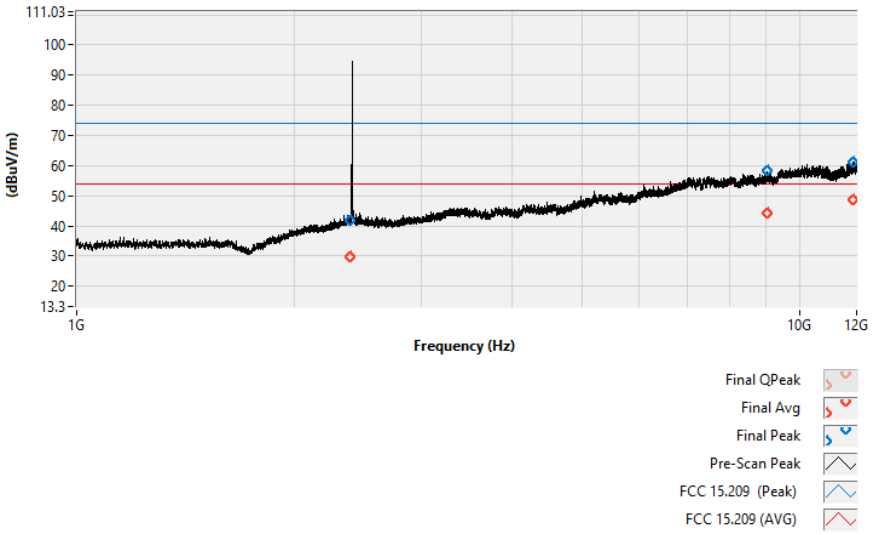


Table 12: Radiated Test Data >1GHz, Low Channel, 1Mbps

Frequency (Hz)	Detector	Corr Meas (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Turn Table (deg)	Antenna (cm)
2.39G	Peak	42.032	74	-31.968	155	Vert, 150
	Avg	29.592	54	-24.408	155	Vert, 150
2.404G	Peak	95.966	--	--	0	Horiz, 150
9.02G	Peak	58.213	74	-15.787	155	Vert, 150
	Avg	44.11	54	-9.89	155	Vert, 150
11.875G	Peak	61.3	74	-12.7	155	Vert, 150
	Avg	48.505	54	-5.495	155	Vert, 150

Pre-scan and Final Data (Vertical)



Pre-scan and Final Data (Horizontal)

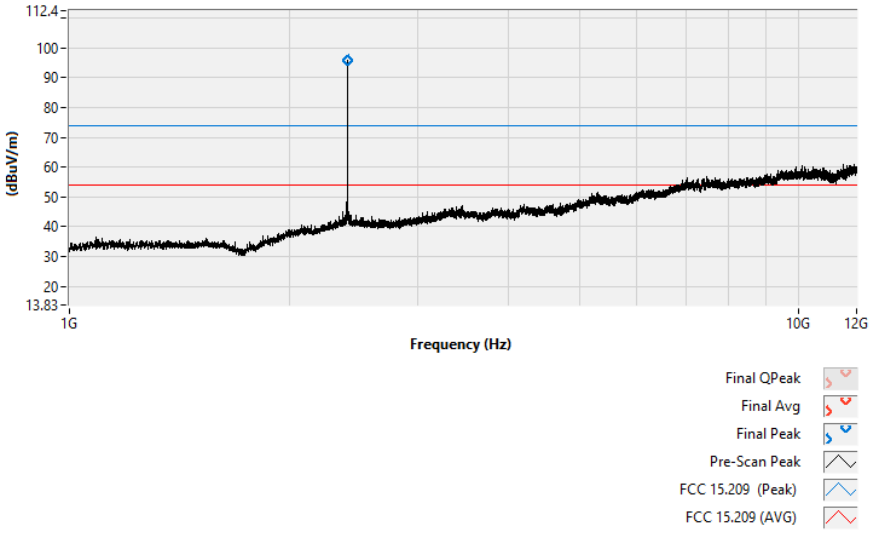
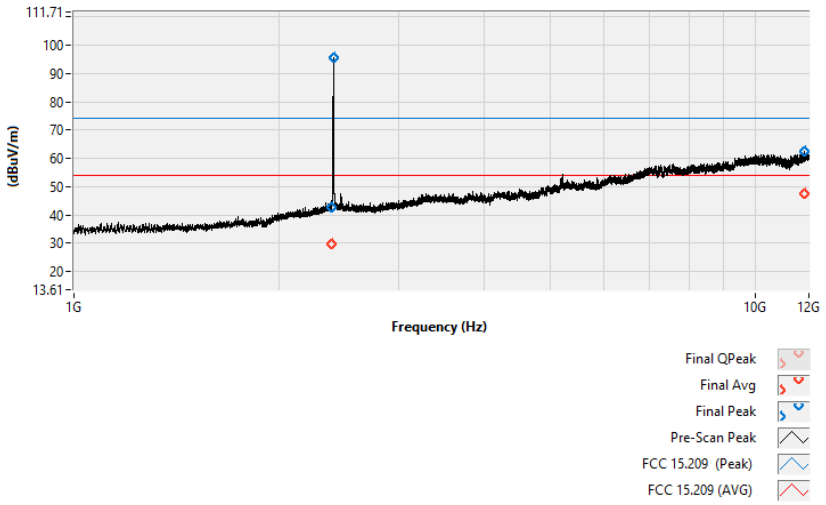


Table 13: Radiated Test Data >1GHz, Low Channel, 2Mbps

Frequency (Hz)	Detector	Corr Meas (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Turn Table (deg)	Antenna (cm)
2.39G	Peak	42.73	74	-31.27	155	Vert, 150
	Avg	29.958	54	-24.042	155	Vert, 150
2.404G	Peak	95.364	--	--	155	Vert, 150
7.482G	Peak	58.277	54	-15.723	0	Horiz, 150
	Avg	43.367	74	-10.633	0	Horiz, 150
11.804G	Peak	62.473	54	-11.527	155	Vert, 150
	Avg	47.451	74	-6.549	155	Vert, 150

Pre-scan and Final Data (Vertical)



Pre-scan and Final Data (Horizontal)

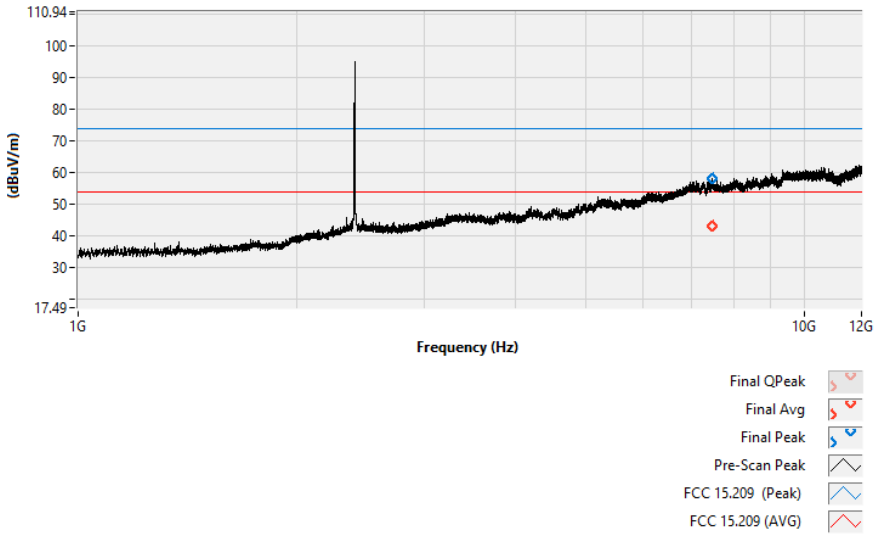
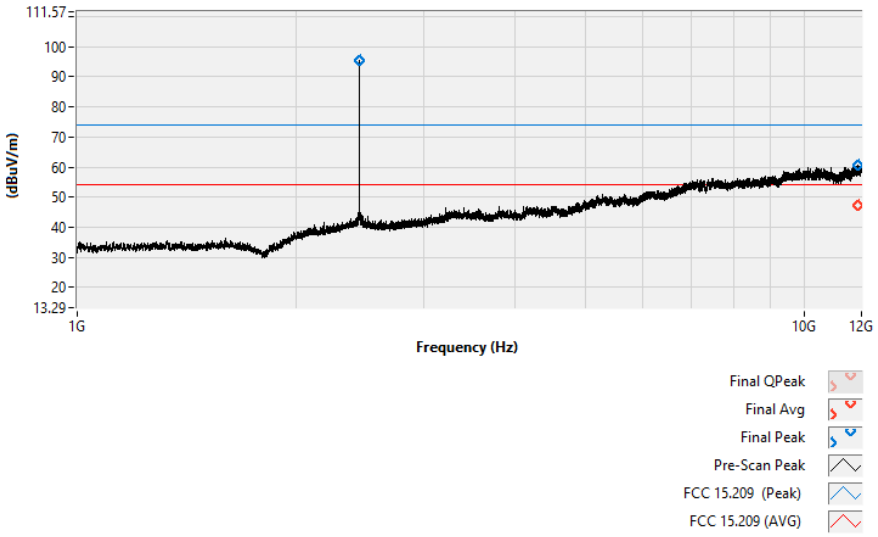


Table 14: Radiated Test Data >1GHz, Center Channel, 2Mbps

Frequency (Hz)	Detector	Corr Meas (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Turn Table (deg)	Antenna (cm)
2.444G	Peak	95.193	--	--	155	Vert, 150
8.994G	Peak	57.755	74	-16.245	0	Horiz, 150
	Avg	43.295	54	-10.705	0	Horiz, 150
11.845G	Peak	60.611	74	-13.389	155	Vert, 150
	Avg	47.43	54	-6.57	155	Vert, 150

Pre-scan and Final Data (Vertical)



Pre-scan and Final Data (Horizontal)

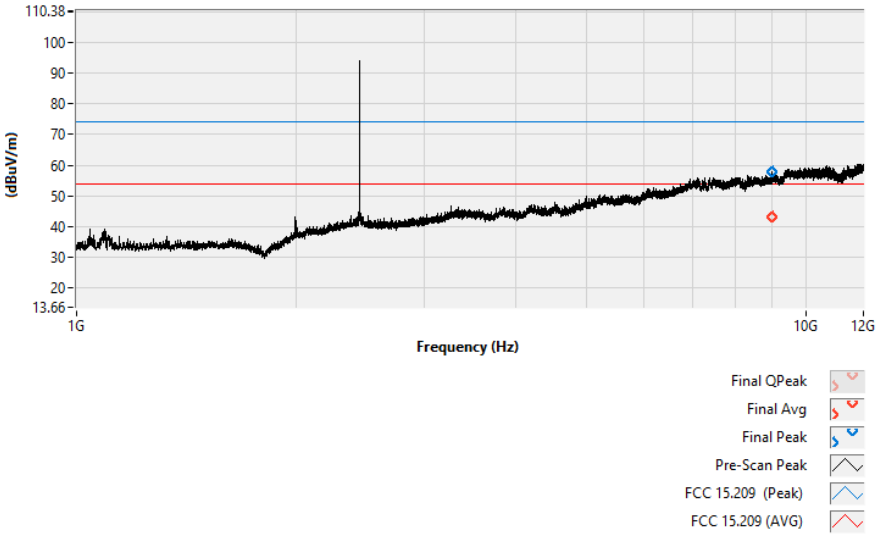
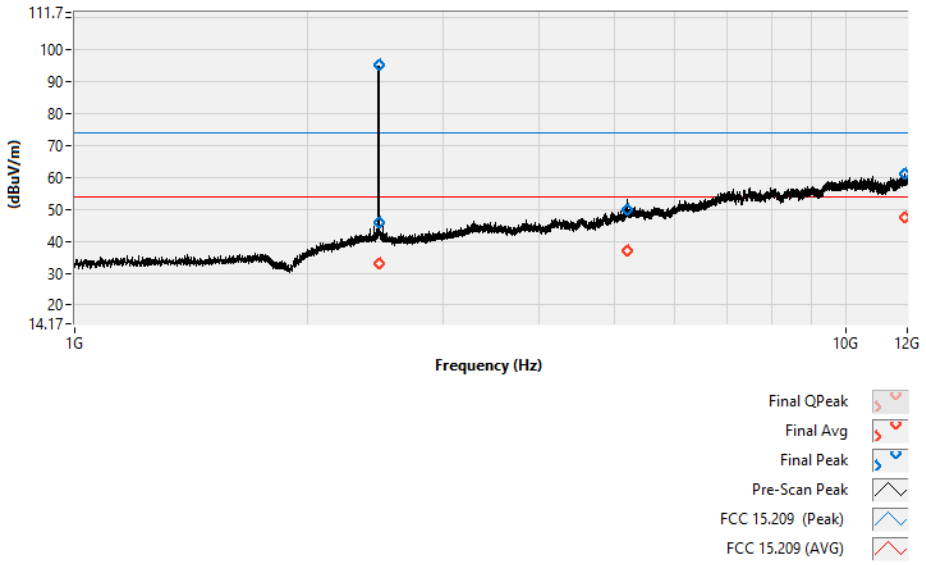


Table 15: Radiated Test Data >1GHz, High Channel, 125kbps

Frequency (Hz)	Detector	Corr Meas (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Turn Table (deg)	Antenna (cm)
2.478G	Peak	95.437	--	--	155	Vert, 150
2.4835G	Peak	46.034	74	-27.966	155	Vert, 150
	Avg	33.149	54	-20.851	155	Vert, 150
9.072G	Peak	57.499	74	-16.501	0	Horiz, 150
	Avg	43.813	54	-10.187	0	Horiz, 150

Pre-scan and Final Data (Vertical)



Pre-scan and Final Data (Horizontal)

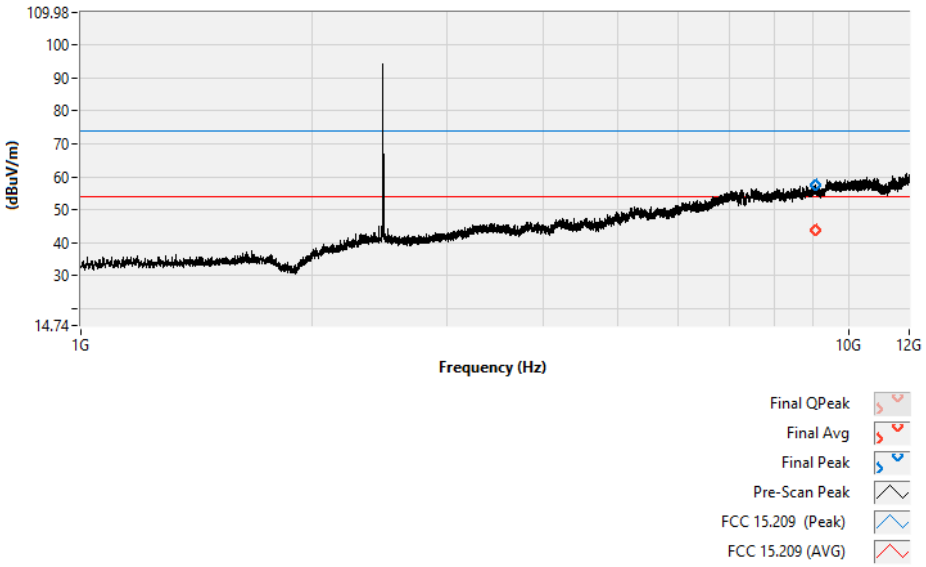
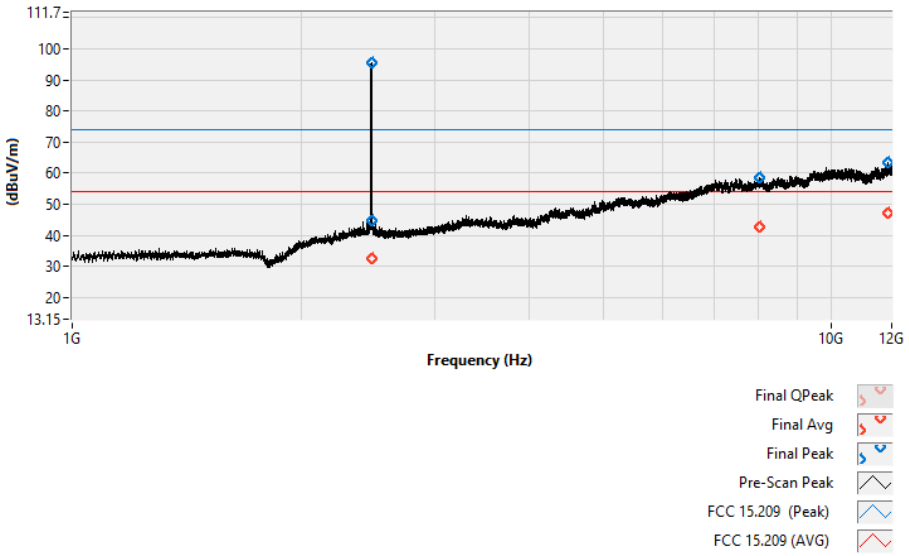


Table 16: Radiated Test Data >1GHz, High Channel, 500kbps

Frequency (Hz)	Detector	Corr Meas (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Turn Table (deg)	Antenna (cm)
2.478G	Peak	95.284	--	--	155	Vert, 150
2.4835G	Peak	44.635	74	-29.365	155	Vert, 150
	Avg	32.664	54	-21.336	155	Vert, 150
11.846G	Peak	63.267	74	-10.733	155	Vert, 150
	Avg	47.275	54	-6.725	155	Vert, 150

Pre-scan and Final Data (Vertical)



Pre-scan and Final Data (Horizontal)

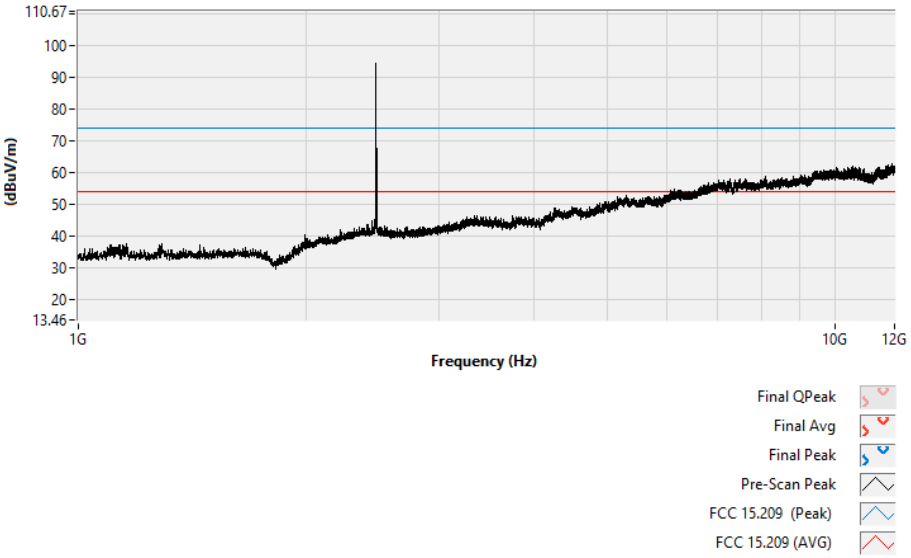
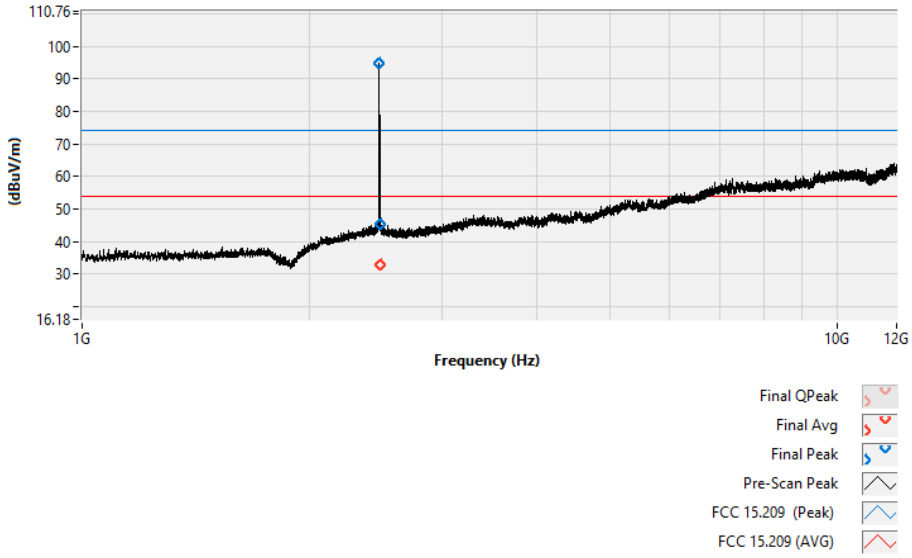


Table 17: Radiated Test Data >1GHz, High Channel, 1Mbps

Frequency (Hz)	Detector	Corr Meas (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Turn Table (deg)	Antenna (cm)
2.478G	Peak	94.995	--	--	155	Vert, 150
2.4835G	Peak	45.297	74	-28.703	155	Vert, 150
	Avg	33.067	54	-20.933	155	Vert, 150
10.456G	Peak	63.122	74	-10.878	0	Horiz, 150
	Avg	46.706	54	-7.294	0	Horiz, 150

Pre-scan and Final Data (Vertical)



Pre-scan and Final Data (Horizontal)

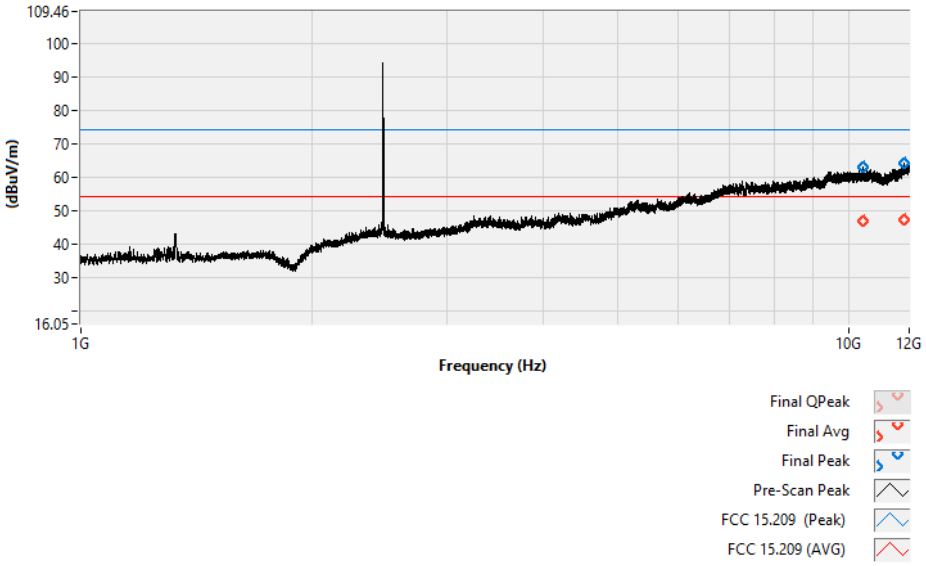
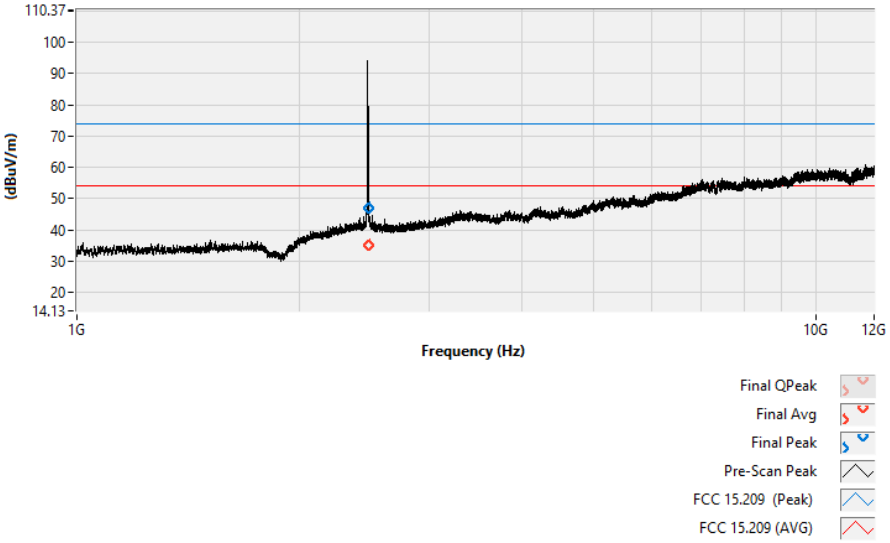


Table 18: Radiated Test Data >1GHz, High Channel, 2Mbps

Frequency (Hz)	Detector	Meas (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Turn Table (deg)	Antenna (cm)
2.478G	Peak	94.351	(1) 74	20.351	0	Horiz, 150
2.4835G	Peak	47.188	(1) 74	-26.812	155	Vert, 150
	Avg	35.296	(2) 54	-18.704	155	Vert, 150
8.09G	Peak	57.347	(1) 74	-16.653	0	Horiz, 150
	Avg	43.429	(2) 54	-10.571	0	Horiz, 150

Pre-scan and Final Data (Vertical)



Pre-scan and Final Data (Horizontal)

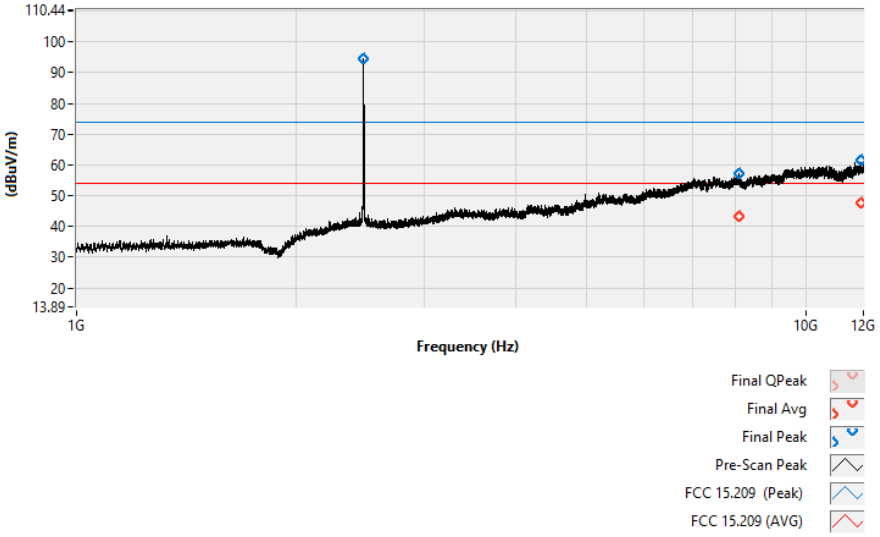
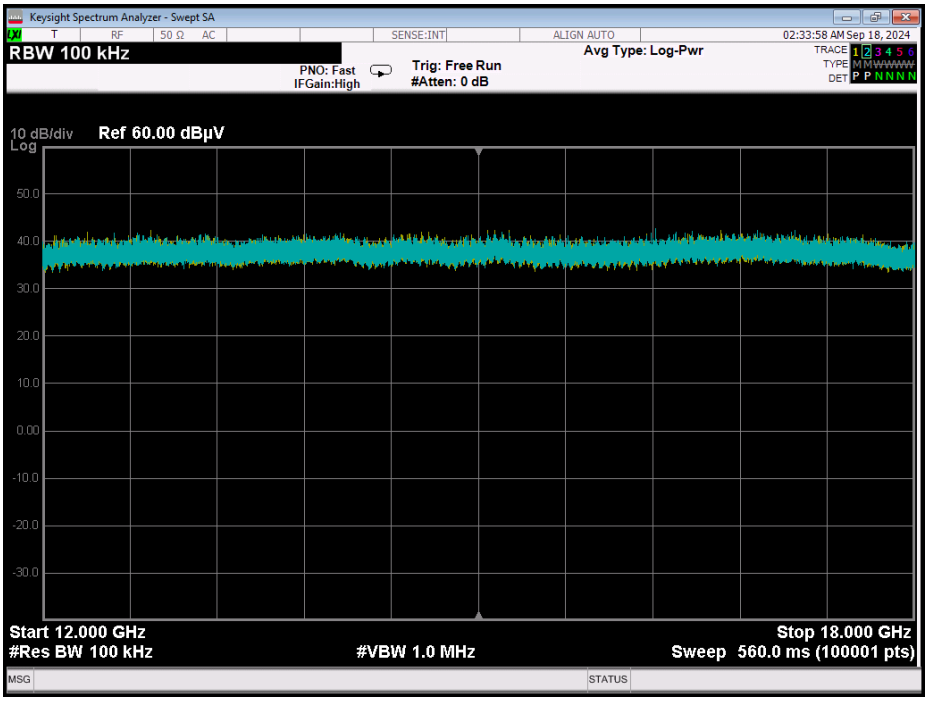
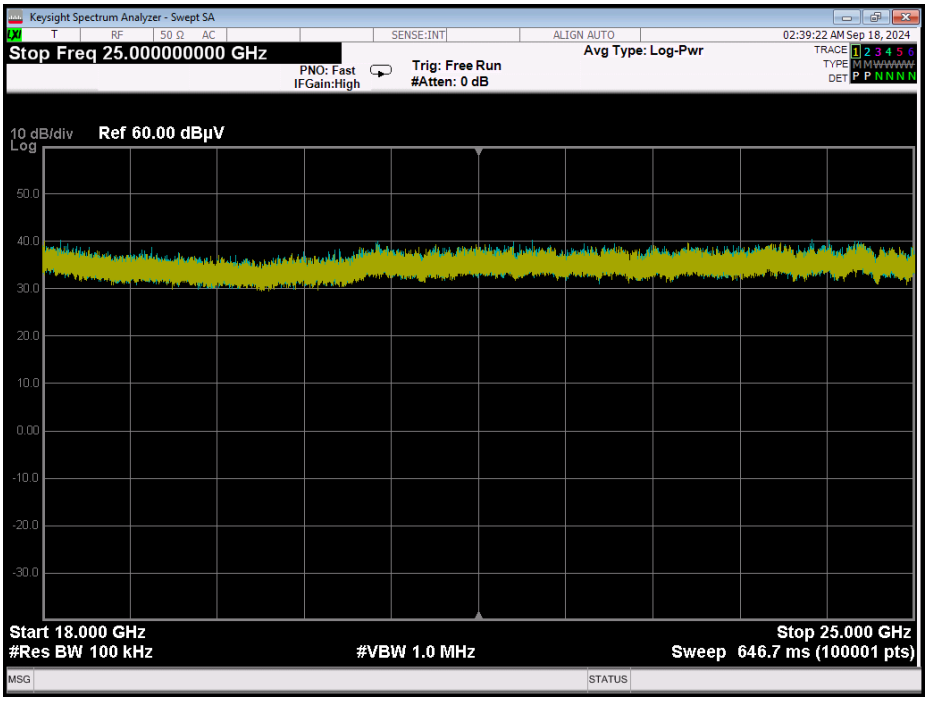


Figure 82: 12GHz to 18GHz, Investigation



* no emissions detected

Figure 83: 18GHz to 25GHz, Investigation



* no emissions detected

3.7 Radiated Emissions Below 30MHz

3.7.1 Requirements

Compliance Standard: FCC Part 15.209 and ISED Canada RSS-Gen

The EUT employs a 32.768 kHz crystal as part of the SOC assembly. Therefore, the EUT was investigated for radiated emissions in the frequency range of 9kHz to 30MHz. EUT emissions in this range must comply with the general field strength limits defined in the table below.

Frequency (MHz)	Field Strength (µV/m)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30

3.7.2 Test Procedure Summary

Prior to testing in this frequency range, 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 for testing below 30MHz.

The EUT was configured to transmit a modulated signal in a 2Mbps mode, set to dwell on the low channel.

A comprehensive near-field investigation of the EUT emissions was performed. An active loop antenna was mounted at a height of 1-meter, placed at a distance of 1-meter away from the EUT. The loop antenna was rotated about its axis to determine the highest emissions.

There were no EUT emissions detected in the frequency range of 9kHz to 30MHz.

All of the signals displayed on these plots were confirmed to be ambient conditions.

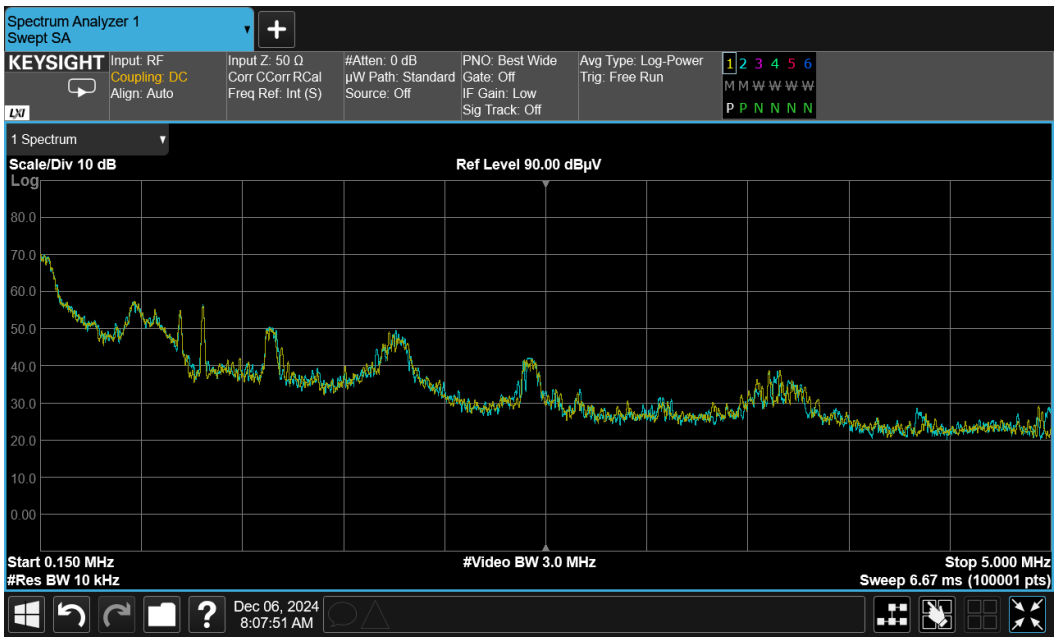
Trace 1 = EUT Transmitter Enabled

Trace 2 = Ambient

Figure 84: 9kHz to 150kHz, Investigation

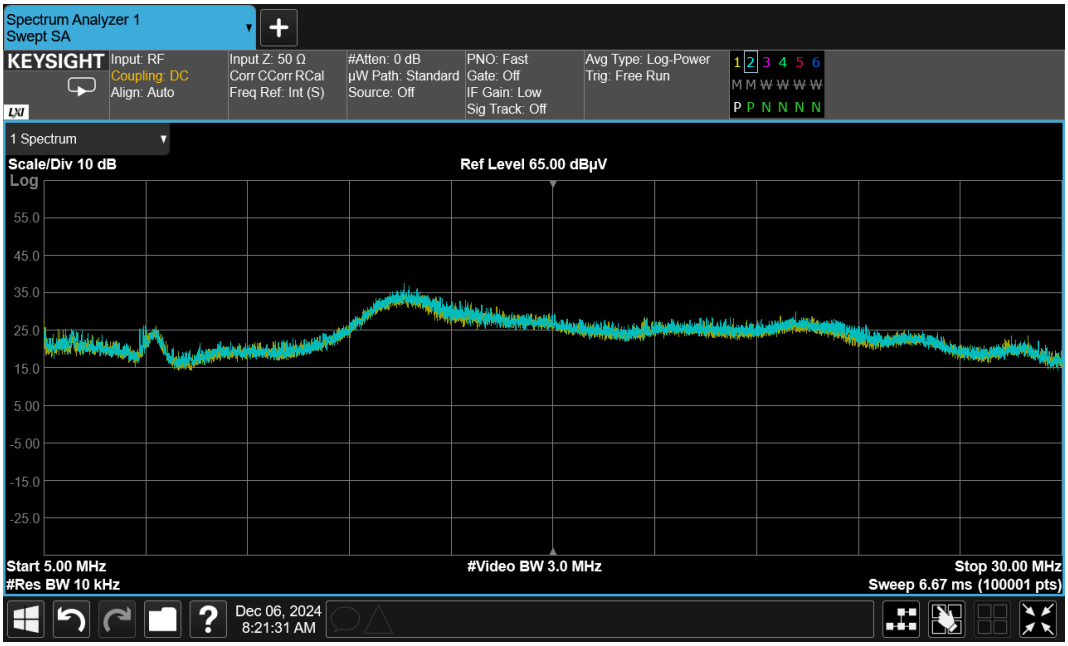
* no emissions detected

Figure 85: 150kHz to 5MHz, Investigation



* no emissions detected

Figure 86: 5MHz to 30MHz, Investigation



* no emissions detected

4 Test Equipment

Table 19: Test Equipment List

Test Name:	**Benchtop RF Emissions**	Test Dates: 9/16/2024 to 9/20/2024	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00993	KEYSIGHT N9020B	MXA SIGNAL ANALYZER	11/6/2025
00885	UTIFLEX UFA2108	HF COXIAL CABLE	6/25/2025
00942	AGILENT, MXA	SPECTRUM ANALYZER	12/19/2024
00992	KEYSIGHT N5173B	EXG SIGNAL GENERATOR	11/27/2024
N/A	WEINSCHEL, 3.5MM	3dB ATTENUATOR	Cal. Before Use

Test Name:	**Radiated Emissions**	Test Dates: 9/16/2024 to 9/20/2024 & 12/6/2024	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00942	AGILENT, MXA	SPECTRUM ANALYZER	12/19/2024
00644	SUNOL SCIENCES CORP.	ANTENNA, LOGPERIOD	11/7/2024
00004	ARA, DRG-118/A	ANTENNA, HORN	6/7/2027
00066	AGILENT	RF PRE-AMPLIFIER	8/21/2025
00065	ELECTRO-METRICS	RF PRE-AMPLIFIER	8/23/2025
00806	MINI-CIRCUITS, 3061	HF COAX CABLE, SMA	12/26/2024
00825	CABLE ASSOCIATES	SMA, COAXIAL CABLE	6/14/2025
00731	NARDA 4779-3	2W, 3DB ATTENUATOR	6/20/2025
00031	EMCO 6502	ANTENNA ACTIVE LOOP	6/17/2027
00330	WLL CE SITE CABLE	BNC COAXIAL CABLE	6/25/2025
00977	JUNKOSHA, USA MX-322	6M COAXIAL CABLE, SMA/N	12/26/2024

5 Measurements

5.1.1 References

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

ANSI C63.4 (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 (2020) 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 herein. 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 Table 20 below.

Table 20: 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