FCC & ISED CANADA CERTIFICATION TEST REPORT

FOR THE

RFN-630CP3

FCC ID: PX9-630CP3

IC ID: 6766A-630CP3

WLL REPORT # 18998-01 REV 2

Prepared for:

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

Prepared By:

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Testing Certificate AT-1448

FCC & ISED Canada Certification Test Report

for the

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January 6, 2025

WLL Report# 18998-01 Rev 2

Prepared by:

Ryan Mascaro
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Reviewed by:

Steven D. Koster
President

Abstract

This report has been prepared on behalf of Eaton's Cooper Power Systems to support the attached application for a 900MHz ISM Single Modular Transmitter. The test report and module application are being submitted for a Frequency Hopping Spread Spectrum (FHSS) Transmitter under Part 15.212 and 15.247 of the FCC Rules 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, RFN-630CP3. The information provided in this report is only applicable to the device herein documented, as the EUT. The device is being certified as a single modular approval.

The radiated emissions portion of the testing was performed on the Open Area Test Site (OATS) 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 Testing Certificate AT-1448 as an independent test laboratory. The Washington Laboratories, Ltd. ISED Canada number is 3035A.

The Eaton's Cooper Power Systems, RFN-630CP3 complies with the requirements for a single modular FHSS transmitter device under Part 15.212 and 15.247 of the FCC Rules and under Innovation Science and Economic Development (ISED) Canada RSS-247, Issue 3 (8/2023).

Revision History	Description of Change	Date
Rev 0	Initial Release	January 6, 2025
Rev 1	ACB Comments, Dated: 1/21/2025	January 24, 2025
Rev 2		

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1 Introduction

1.1 Compliance Statement

The Eaton's Cooper Power Systems, RFN-630CP3 complies with the requirements for a single modular FHSS transmitter device under Part 15.212 and 15.247 of the FCC Rules and under Innovation Science and Economic Development (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 the 2020 version 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 device is being certified a Single Module Transmitter. The single module is a 900MHz ISM transceiver PCB assembly. The EUT was tested in a stand-alone configuration, only using a support laptop for programming. For testing purposes, the EUT was powered by 4.0VDC. When the RFN-630CP3 is inside a host meter, it operates from a power source of 4V, which is provided from the host, via a 10-pin connector. The EUT was provided to the test laboratory, configurable both for conducted at the antenna port, and radiated emissions. The transmitter antenna is detachable via a common uFL style port on the module's PCB. The EUT was controlled by terminal command using the Tera Term interface. The EUT was tested across five (5) different data rates: 9.6kbps, 19.2kbps, 38.4kbps, 76.8kbps, and 153.6kbps. Prior to testing, the transmitter output power was tuned on the bench via the software commands. The intent was to achieve the highest possible power output level, without exceeding 30.0dBm. The software setting of "PWR-E 4(3)" produced the measured result in section 2.1.1 of this report. Prior to radiated testing, the EUT PCB assembly, along with the transmitting antenna, were varied in position across three orthogonal planes (x, y, z). The EUT position that produced the highest radiated power, was maintained during all testing. The EUT was investigated for radiated emissions from 9kHz to 10GHz. For the 9kHz to 30MHz portion, a loop antenna was mounted at a fixed-height of 1-meter and rotated about its vertical and horizontal axis in accordance with ANSI C63.10-2020, clause 6.4.6 and 6.11.2. For the 30MHz to 1GHz radiated portion, the EUT PCB assembly, along with the adhesively mounted PCB antenna, were varied in position across three orthogonal planes (x, y, z). The EUT position that produced the highest radiated power, was maintained during all testing. Both the horizontal and vertical field components were investigated. For above 1GHz, the EUT was evaluated beyond the 10th harmonic of the fundamental transmitter frequency.

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:	221564
Quotation Number:	74962

1.6 Test and Support Personnel

Washington Laboratories, LTD	Ryan Mascaro
Customer Representative	Steven Seymour

1.7 Test Dates

12/2/2024 to 12/13/2024

(also see Section 5 of this report)

Table 1: Certification Testing Summary and Compliance Results

FCC Rule Part	ISED Canada Rule Part	Test Description	Result
15.247(b)(2)	RSS-247; 5.4(a)	Transmit Output Power	Pass
15.247(a)(1)(i) 2.1049	RSS-247; 5.1	Channel Occupied Bandwidth	Pass
15.247 (a)(1)(i)	RSS-247; 5.1	Number of Channels Used	Pass
15.247 (a)(1)(i)	RSS-247; 5.1	Time of Occupancy (Dwell Time)	Pass
15.247(a)(1)	RSS-247; 5.1	Channel Carrier Separation	Pass
15.247(d) DA 00-705	RSS-247; 5.5	Bandedge Compliance (20dB)	Pass
15.247(d)	RSS-247; 5.5	Conducted Spurious Emissions	Pass
15.205(a) 15.209(a)	RSS-Gen; 8.9 RSS-Gen; 8.10	General Field Strength Requirements	Pass
15.207	RSS-Gen; 8.8	AC Powerline Conducted Emissions	N/A

2 Equipment Under Test

2.1 EUT Identification & Description

The RFN-630CP3 is a single module transmitter used in electric metering products. It enables communication between the meter and a remotely located Gateway or Relay Node. The backhaul data is sent over a 900MHz ISM mesh network. The RFN-630CP3 operates from a power source of 4VDC, received from the final host meter device, via a 10-pin connector.

2.2 Test Configuration

For the purposes of testing, the RFN-630CP3 was powered by 4VDC. The support laptop was connected to the EUT via a USB-UART cable for commands only.

Figure 1: Testing Configuration Diagram (Example Only)

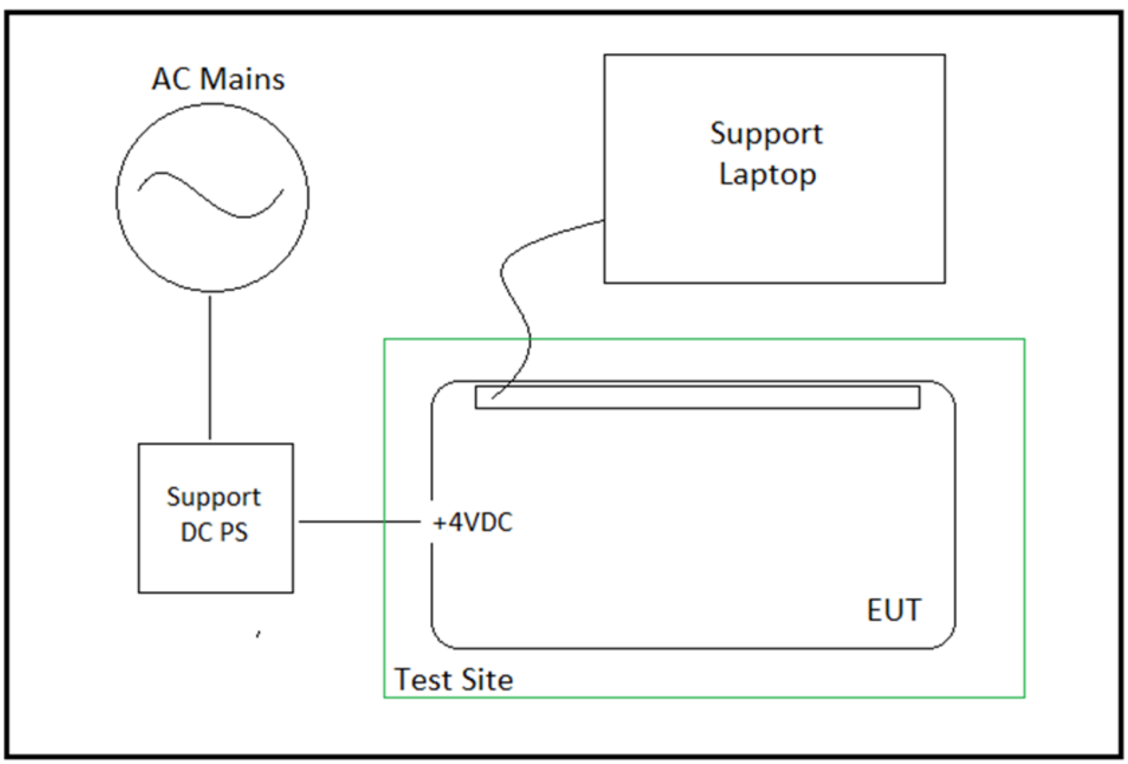


Table 2: Radio Device Summary

Manufacturer and Applicant:	Eaton's Cooper Power Systems
FCC ID:	PX9-630CP3
IC ID:	6766A-360CP3
HVIN & PMN (for ISED):	RFN-630CP3
Serial Number of Unit Tested:	5
FCC Rule Part:	15.212 & 15.247 (Single Module Transmitter)
TX Frequency Range:	902.75 MHz to 927.25 MHz
Maximum Peak Output Power:	29.83 dBm (0.96 Watts)
20dB Bandwidth:	468.0 kHz
99% Bandwidth:	433.8 kHz
Modulation:	FSK
Date Rates:	9.6kbps, 19.2kbps, 38.4kbps, 76.8kbps, and 153.6kbps
Number of Channels:	50
FCC Emission Designator:	468KG1D
ISED Emission Designator:	434KG1D
Keying:	Automatic
Type of Information:	Data Backhaul
900MHz ISM Antenna:	Pulse/Larsen, P/N: W3538B0200 (Peak Gain: +0.53 dBi)
Antenna Type:	adhesively mounted PCB trace assembly via 200mm coax feed
Antenna Connector:	uFL
Calculated EIRP:	30.36 dBm (Peak)
Software/Firmware:	not declared by applicant
Hardware Version:	1
Power Source & Voltage:	+4VDC from Final Host
Worst-Case Emission from Module:	312.5 MHz, measuring 143.8 uV/m (see Table 12)

Table 3: System Configuration List

Description	Model (HVIN)	Part Number	Serial Number	Revision
Single Module	RFN630-CP3	RFN630-CP3	5	1

Table 4: Support Equipment (as tested)

Item	Model/Part Number	Serial Number
Laptop	--	--
DC Power Supply	--	--

Table 5: Cable Configuration (as tested)

Port Identification	Connector Type	Cable Length	Shielded (Y/N)	Termination Point
PWR	VDC	20cm	N	Power Supply
CMD	UART	20cm	Y	Laptop

3 Test Results

3.1 Transmitter Output Power

For frequency hopping systems operating in the 902 MHz to 928 MHz band, the maximum peak conducted output power of the intentional radiator shall not exceed 1 Watt (30dBm) for systems employing at least 50 hopping channels; and 0.25 Watts for systems employing less than 50 hopping channels, but at least 25 hopping channels. Additionally, ISED Canada requires that the EIRP shall not exceed 4 Watts, except as provided in RSS-247, Section 5.4(e).

3.1.1 Measurement Method and Results

This test was performed (antenna port conducted) as specified in ANSI C63.10 (2020), Section 7.8.5.

The EUT was configured in a FSK modulated mode, with the hopping stopped.

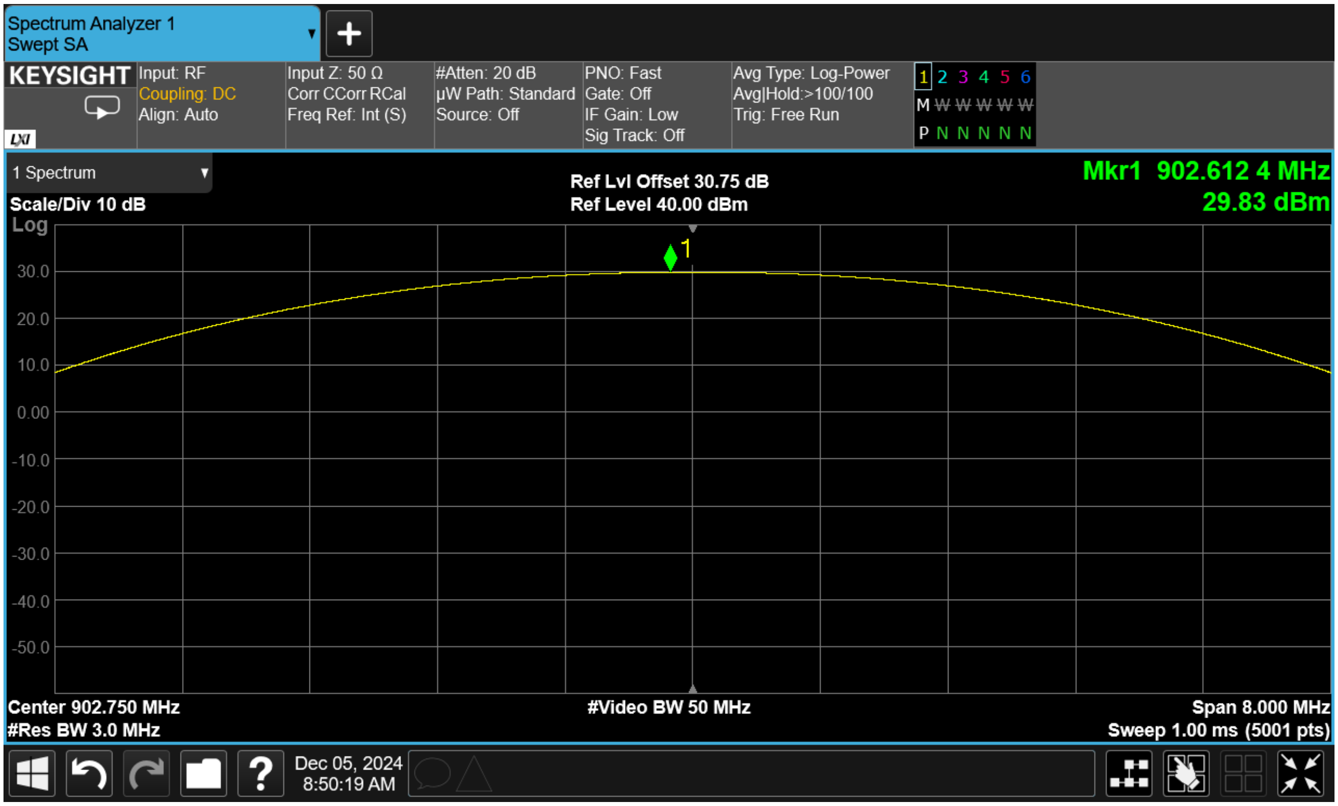
The EUT employs a PCB trace antenna with a maximum gain of +0.53 dBi.

29.83 + .53 = 30.36 dBm Peak EIRP (calculated), which is below the 4W limit.

Table 6: Transmitter Conducted Output Power, Test Results

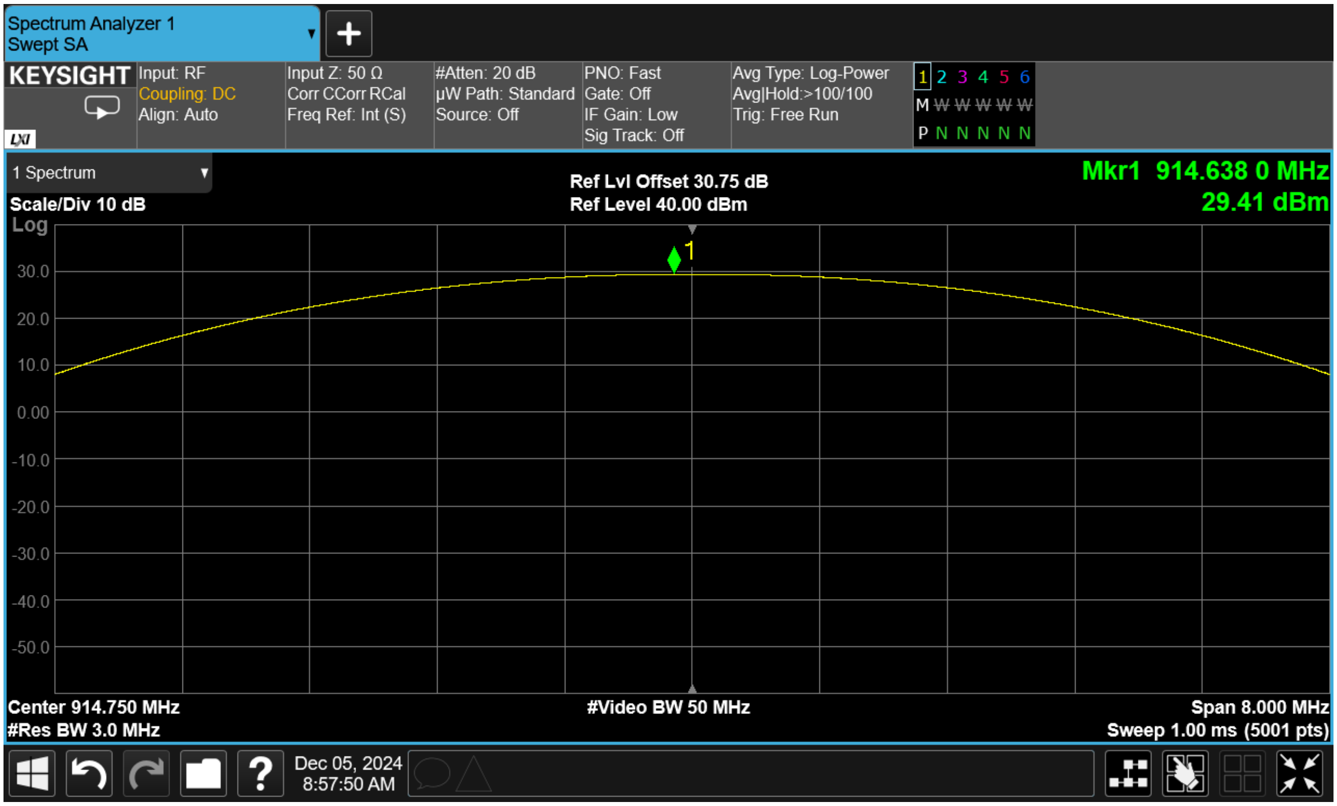
Data Rate (kbps)	Frequency (MHz)	Peak Power (dBm)	Peak Power (Watts)
9.6	902.75	29.83	0.962
	914.75	29.41	0.873
	927.25	28.44	0.698
19.2	902.75	29.46	0.883
	914.75	28.84	0.766
	927.25	28.37	0.687
38.4	902.75	29.71	0.935
	914.75	29.19	0.830
	927.25	28.72	0.745
76.8	902.75	29.80	0.955
	914.75	29.24	0.839
	927.25	28.76	0.752
153.6	902.75	29.74	0.942
	914.75	29.22	0.836
	927.25	28.74	0.748

Figure 2: Worst-Case Output Power Test Result, Low Channel



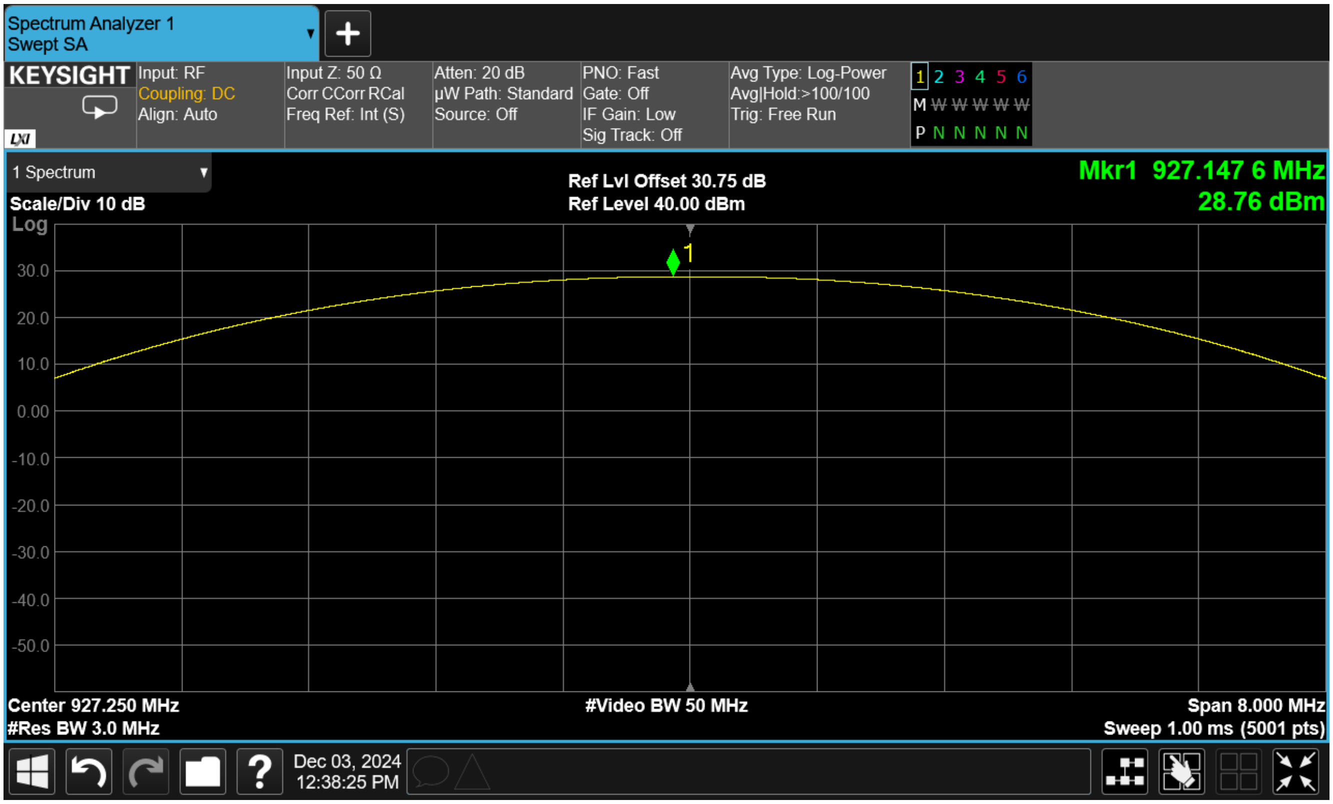
the 9.6kbps mode had the worst-case power level for the low channel position

Figure 3: Worst-Case Output Power Test Result, Center Channel



the 9.6kbps mode had the worst-case power level for the center channel position

Figure 4: Worst-Case Output Power Test Result, High Channel



the 76.8kbps mode had the worst-case power level for the high channel position

3.2 Channel Occupied Bandwidth

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

3.2.1 Measurement Method and Results

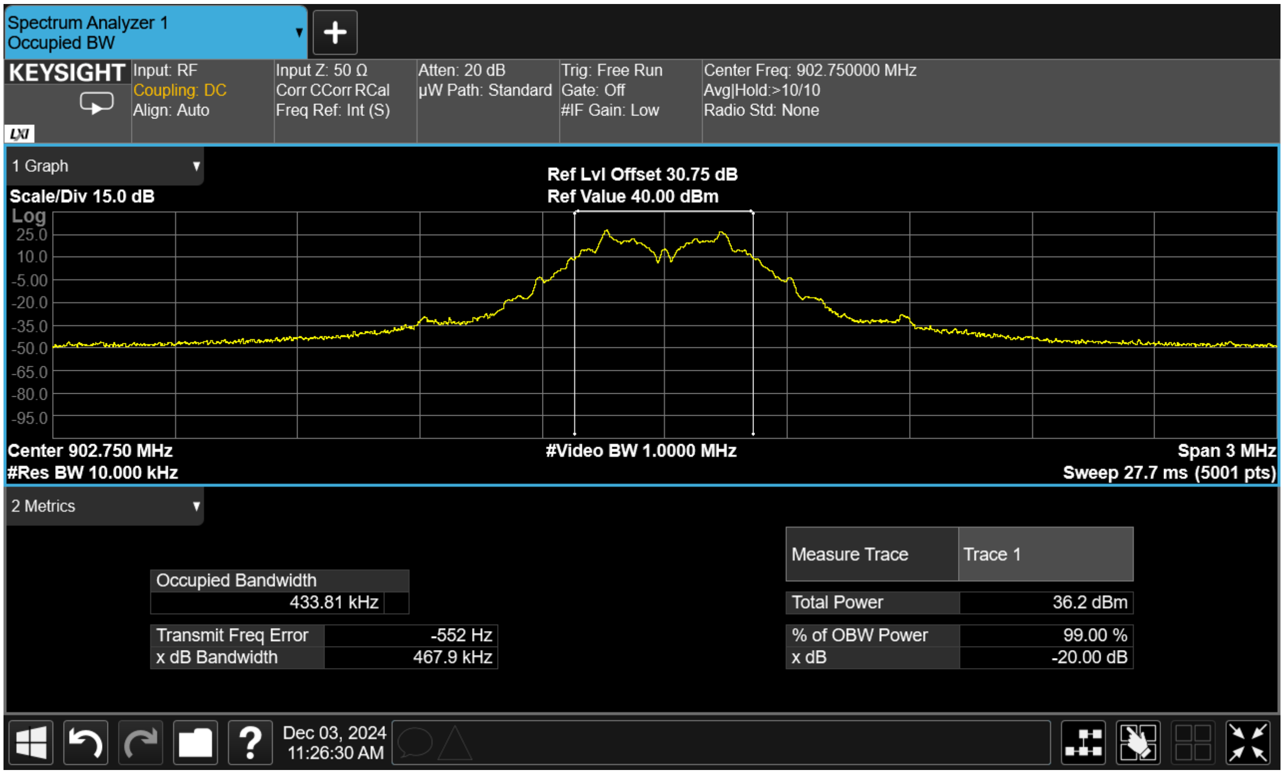
This test was performed (antenna port conducted) as specified in ANSI C63.10 (2020), Section 7.8.6.

The EUT was configured in a FSK modulated mode, with the hopping stopped.

Table 7: Channel Occupied Bandwidth, Test Results

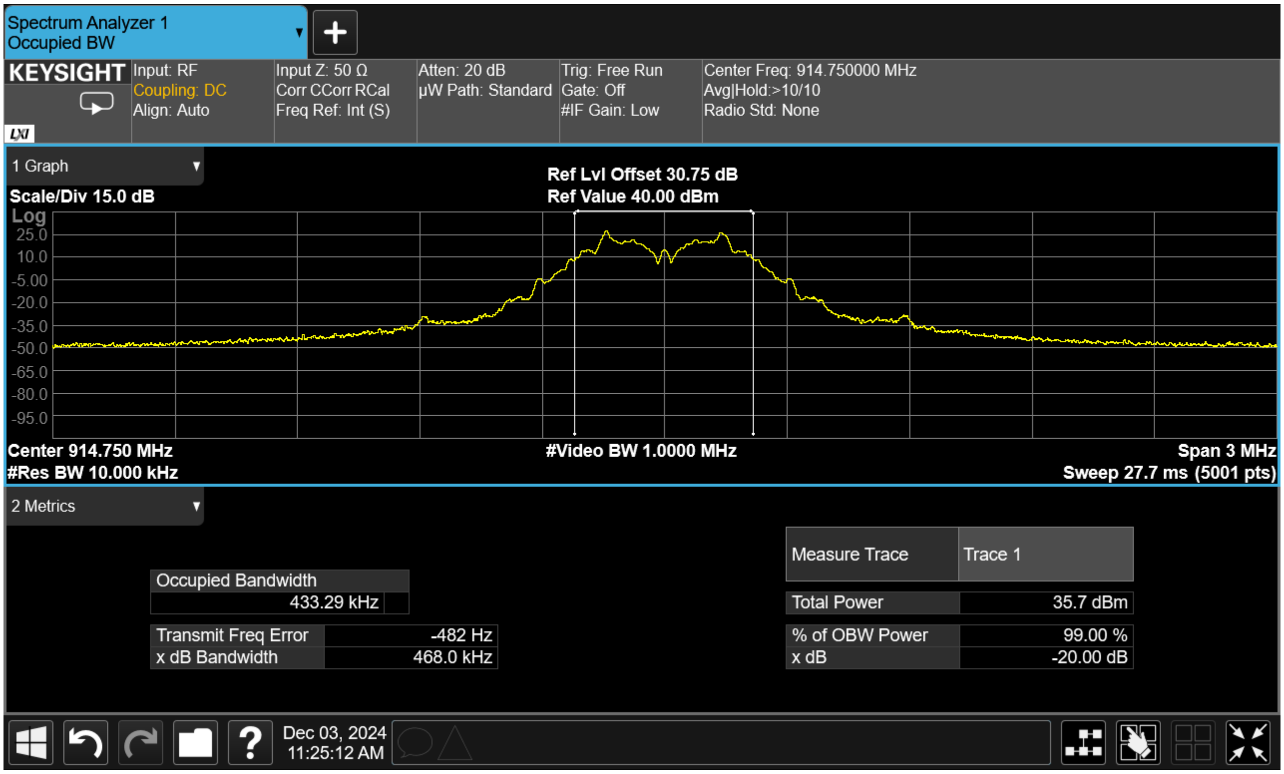
Data Rate (kbps)	Frequency (MHz)	20dB OBW (kHz)	99% OBW (kHz)
9.6	902.75	274.3	301.5
	914.75	273.6	300.9
	927.25	273.9	301.9
19.2	902.75	279.8	305.3
	914.75	279.2	305.2
	927.25	279.8	305.8
38.4	902.75	273.9	270.4
	914.75	274.3	271.0
	927.25	273.8	270.5
76.8	902.75	271.9	306.9
	914.75	272.0	307.9
	927.25	272.3	308.3
153.6	902.75	467.9	433.8
	914.75	468.0	433.3
	927.25	468.0	433.2

Figure 5: Worst-Case Occupied Bandwidth Test Result, Low Channel



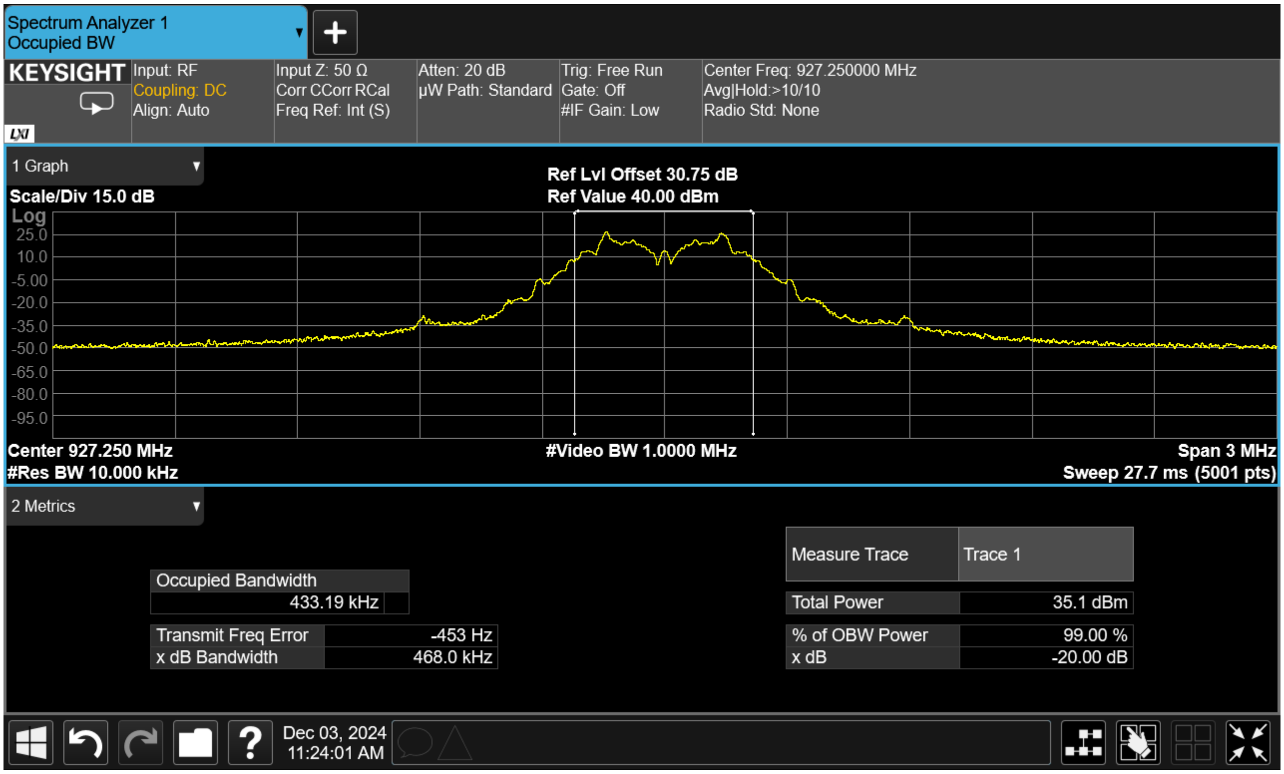
the 156.3kbps mode had the worst-case OBW for the low channel position

Figure 6: Worst-Case Occupied Bandwidth Test Result, Center Channel



the 156.3kbps mode had the worst-case OBW for the center channel position

Figure 7: Worst-Case Occupied Bandwidth Test Result, High Channel



the 156.3kbps mode had the worst-case OBW for the high channel position

3.3 Number of Channels Used

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

3.3.1 Measurement Method and Results

This test was performed (antenna port conducted) as specified in ANSI C63.10 (2020), Section 7.8.3.

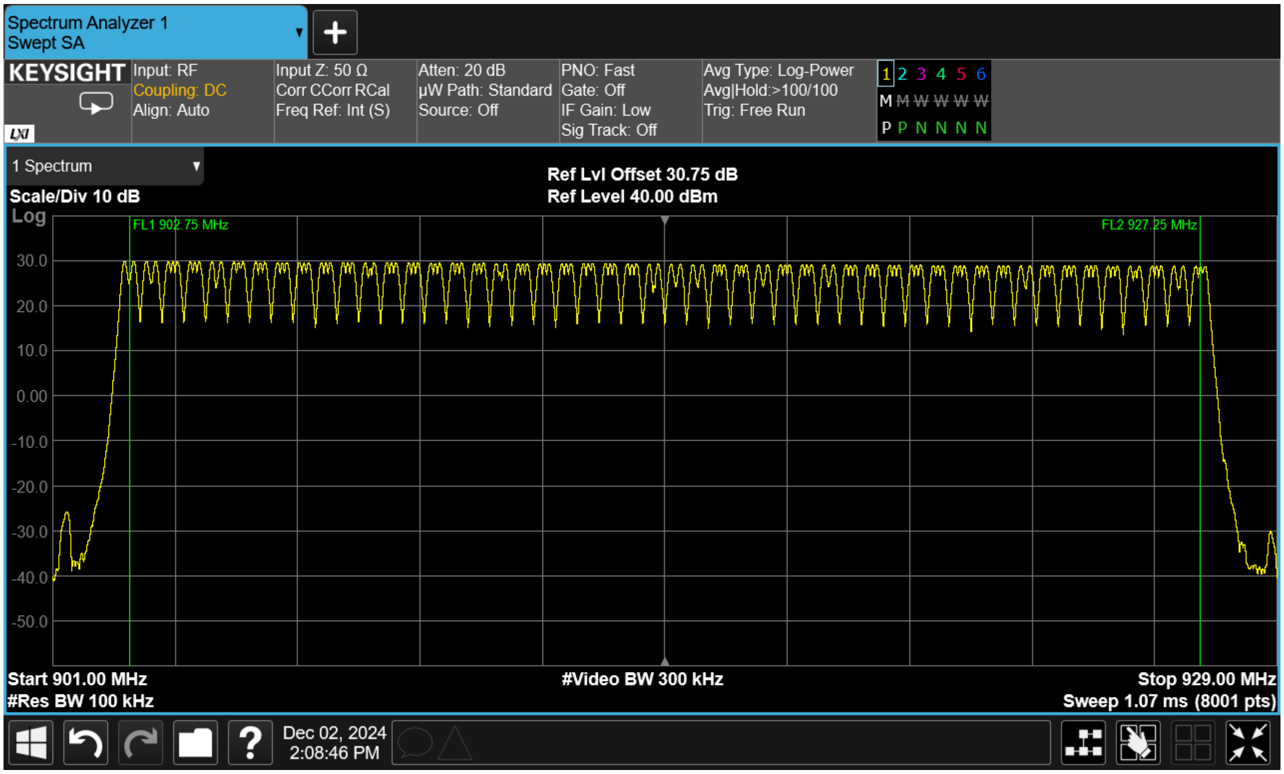
When the device shares the same channel plan (carrier frequencies and number of channels) across multiple data rates, then the number of channels need only be measured for one of the data rate modes.

The EUT was configured in a FSK modulated mode, with the hopping enabled.

Table 8: Number of Channels Used, Test Results

Data Rate (kbps)	EUT Channels Used	Minimum Requirement
9.6	50	25
	50	25
	50	25
19.2	50	25
	50	25
	50	25
38.4	50	25
	50	25
	50	25
76.8	50	25
	50	25
	50	25
153.6	50	25
	50	25
	50	25

Figure 8: Number of Channels Used Test Data



all five data rates employ exactly 50 channels; the modulation is always FSK and cannot be changed

3.4 Time of Occupancy (Dwell Time)

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

3.4.1 Measurement Method and Results

This test was performed (antenna port conducted) as specified in ANSI C63.10 (2013), Section 7.8.4.

The EUT was configured in a FSK modulated mode, with the hopping enabled.

Table 9: Time of Occupancy (Dwell Time), Test Results

Data Rate (kbps)	Transmissions in 10 seconds	Single Transmission Period	EUT Time of Occupancy	Occupancy Limit
9.6	4	38.56 ms	154.24 ms	400 ms
19.2	10	19.43 ms	194.30 ms	400 ms
38.4	7	19.28 ms	134.96 ms	400 ms
76.8	9	19.13 ms	172.17 ms	400 ms
153.6	10	9.13 ms	91.30 ms	400 ms

Dozens of investigative measurements were made to determine the worst-case timing. Please note that the EUT was evaluated at the low, center, and high channels for each data rate. The channel position does not impact the final time of occupancy. However, changing the data rate does impact the time of occupancy. The worst-case test data is provided below.

Figure 9: Worst-Case 10-second Evaluation, Hopping Enabled

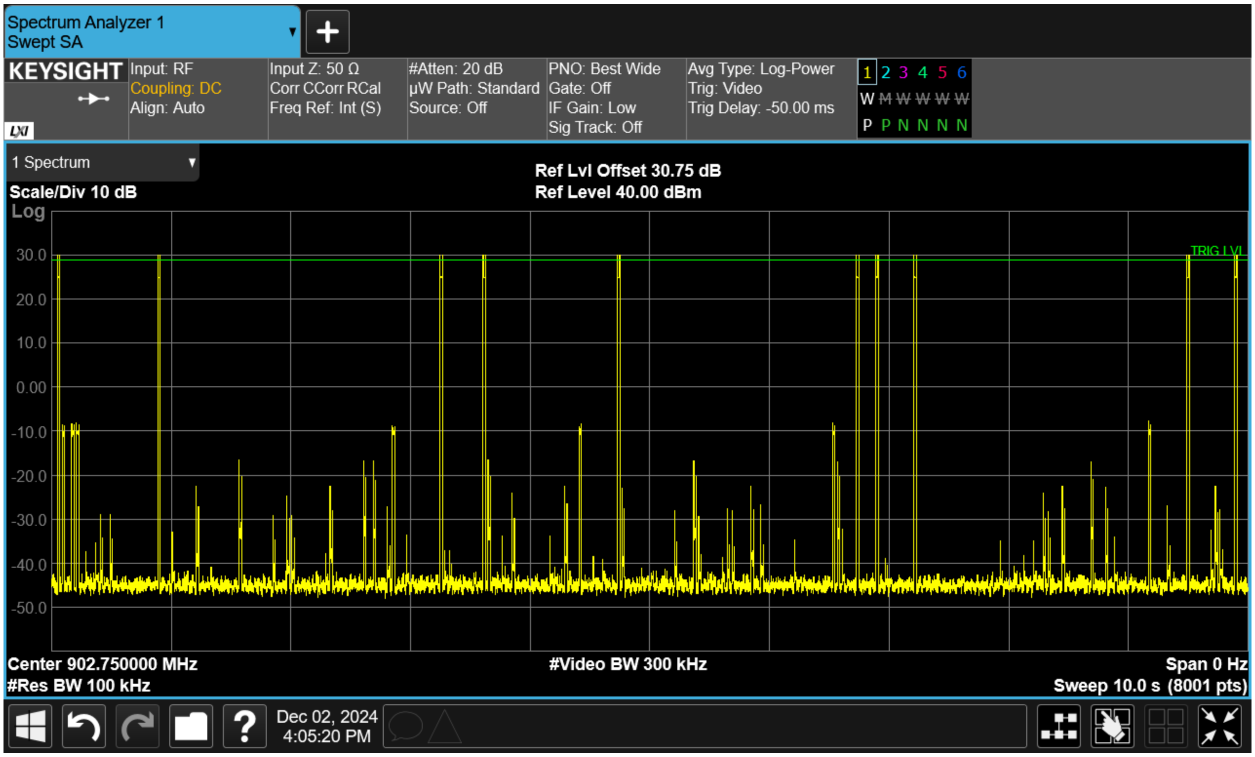
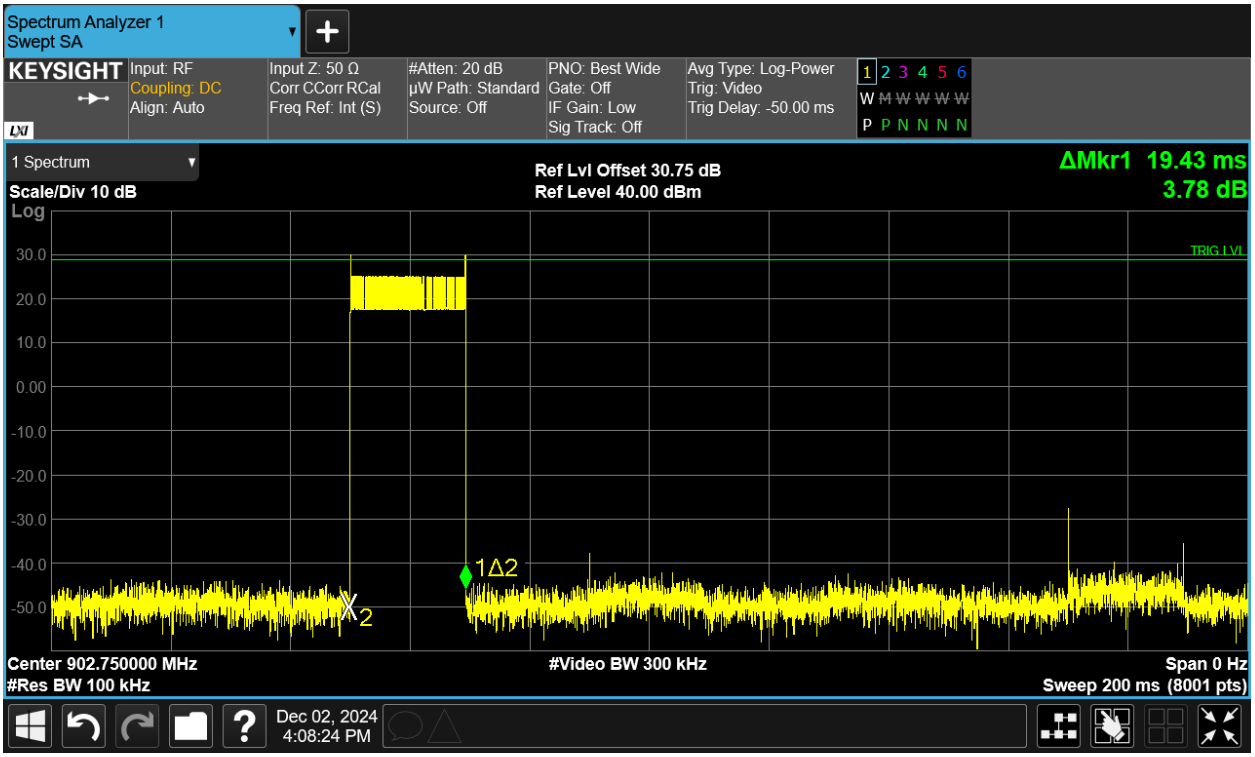


Figure 10: Worst-Case Single Period Evaluation, Hopping Enabled



3.5 Channel Carrier Separation

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

3.5.1 Measurement Method and Results

This test was performed (antenna port conducted) as specified in ANSI C63.10 (2020), Section 7.8.2

When the device shares the same channel plan (carrier frequencies and number of channels) across multiple data rates, then the carrier separation need only be measured for one of the data rate modes

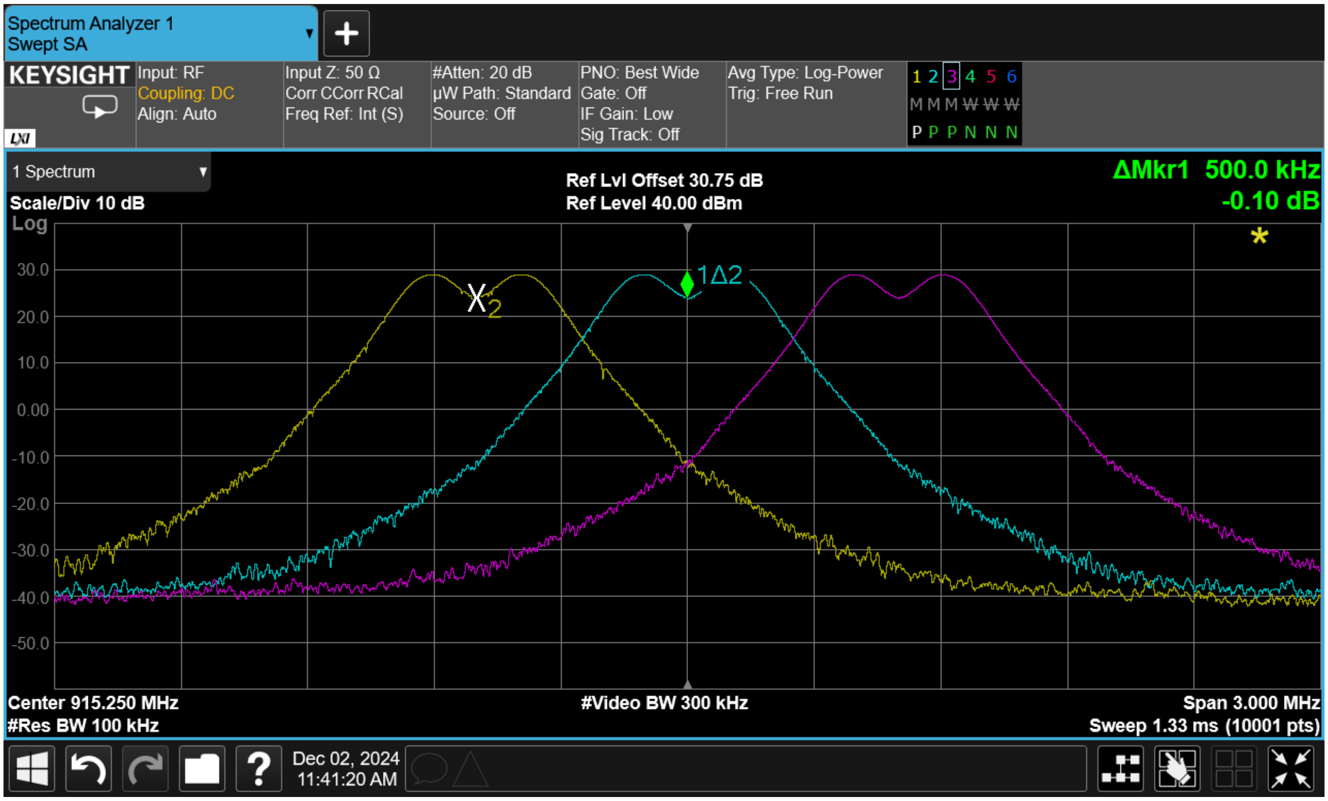
The EUT was configured in a FSK modulated mode, with the hopping enabled.

Table 10: Channel Carrier Separation, Test Results

Minimum Separation Requirement	Smallest Measured 20dB OBW	Final Carrier Separation	Result
25 kHz	271.9 kHz	500 kHz	Pass

The EUT was evaluated at the low, center, and high channels, and a few other random channels. All the hopping channel carriers are separated by exactly 500 kHz, regardless of position in the band. It was also confirmed that changing the data rate has no impact on this measurement. The modulation is always FSK and cannot be changed

Figure 11: Channel Carrier Separation, Test Results



3.6 Bandedge Compliance

In any 100 kHz bandwidth, outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the 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.

3.6.1 Measurement Method and Results

This test was performed (antenna port conducted) as specified in ANSI C63.10 (2020), Section 7.8.7.2

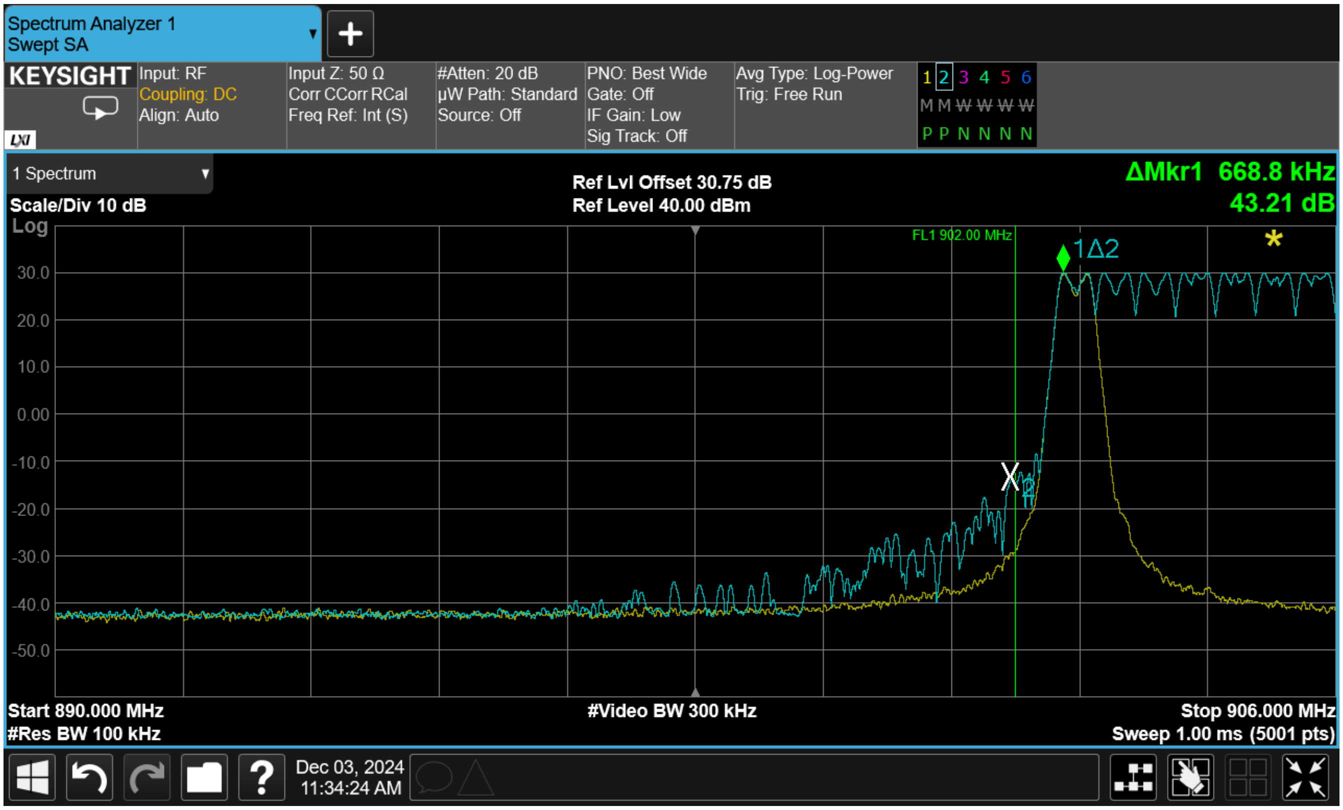
The EUT was configured in a FSK modulated mode. The EUT was investigated in both a hopping enabled mode and a hopping disabled mode.

The worst-case data is provided below.

Table 11: Bandedge Compliance, Test Results

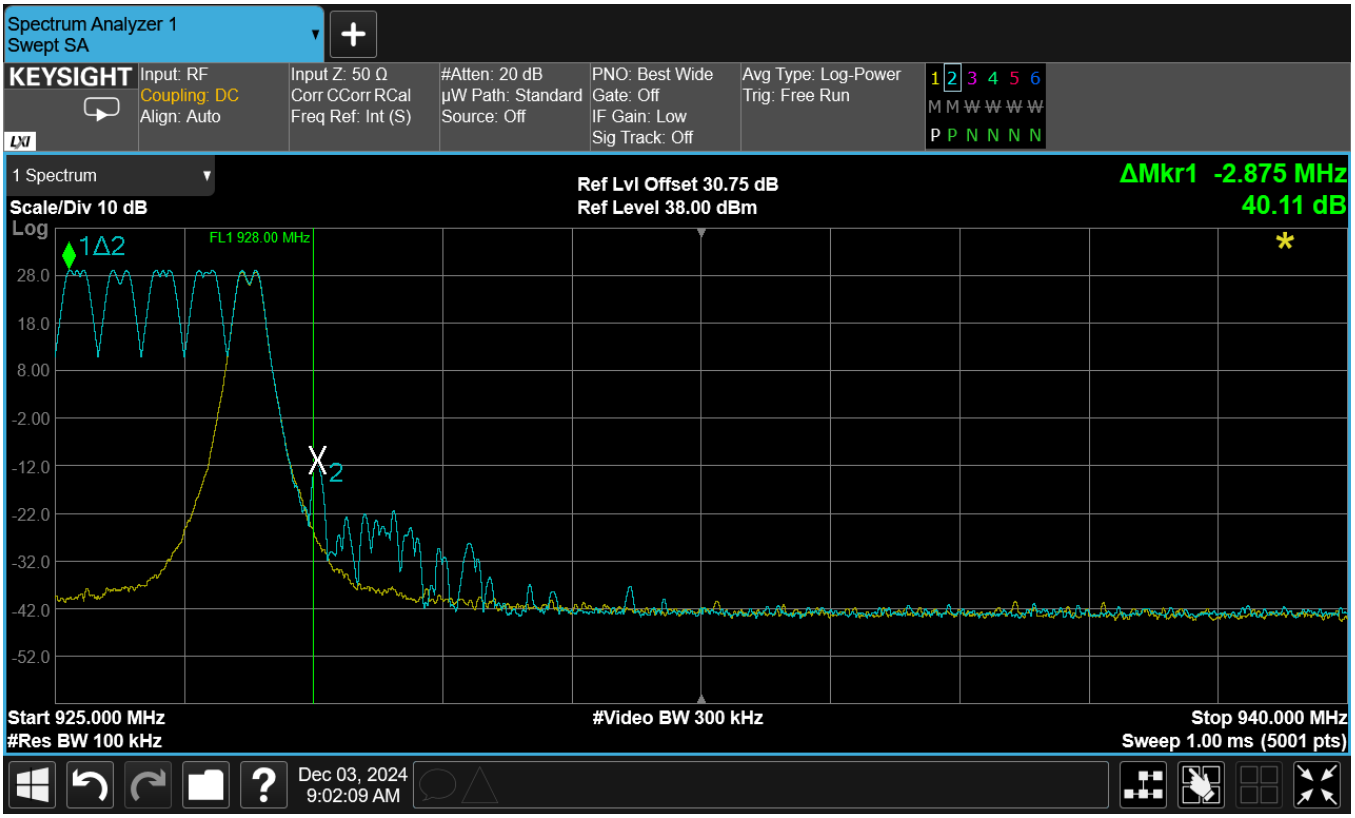
Data Rate (kbps)	Low Channel (dBc)	High Channel (dBc)	Result
9.6	54.82	55.29	Pass
19.2	54.71	44.44	Pass
38.4	46.28	40.11	Pass
76.8	51.44	45.03	Pass
153.6	43.21	44.68	Pass

Figure 12: Worst-Case Low Channel Band Edge



the 156.3kbps mode had the worst-case bandedge for the low channel position

Figure 13: Worst-Case High Channel Band Edge



the 38.4kbps mode had the worst-case bandedge for the high channel position

3.7 Conducted Spurious Emissions

In any 100 kHz bandwidth, outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the 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.

3.7.1 Measurement Method and Results

This test was performed (antenna port conducted) as specified in ANSI C63.10 (2020), Section 7.8.7.

Please note that in some cases, all measurements of all modes and all channels is not always necessary to demonstrate compliance. In accordance with ANSI C63.10 (2020), Section 5.6.2, the number of total compliance measurements was slightly reduced for this test section. The following measurement testing protocol was employed:

Data Rate	Channel(s) Tested	Test Result
9.6 kbps	Low, Center, High	Pass
19.2 kbps	Low, High	Pass
38.4 kbps	Low, High	Pass
76.8 kbps	Low, High	Pass
153.6 kbps	Low, Center, High	Pass

The EUT was configured in a FSK modulated mode, with the hopping stopped.

The EUT complies with the requirements for spurious emissions at the antenna port.

The EUT was tested from 1MHz to 10GHz. The worst-case conducted spurious emission was found to be 1805.32 MHz, measuring -11.47 dBm. This spur is still > 20dB below the limit. Please see Figure 36.

The final test data is provided below.

Figure 14: 9.6kbps, Low Channel, Conducted Spurious, Plot 1

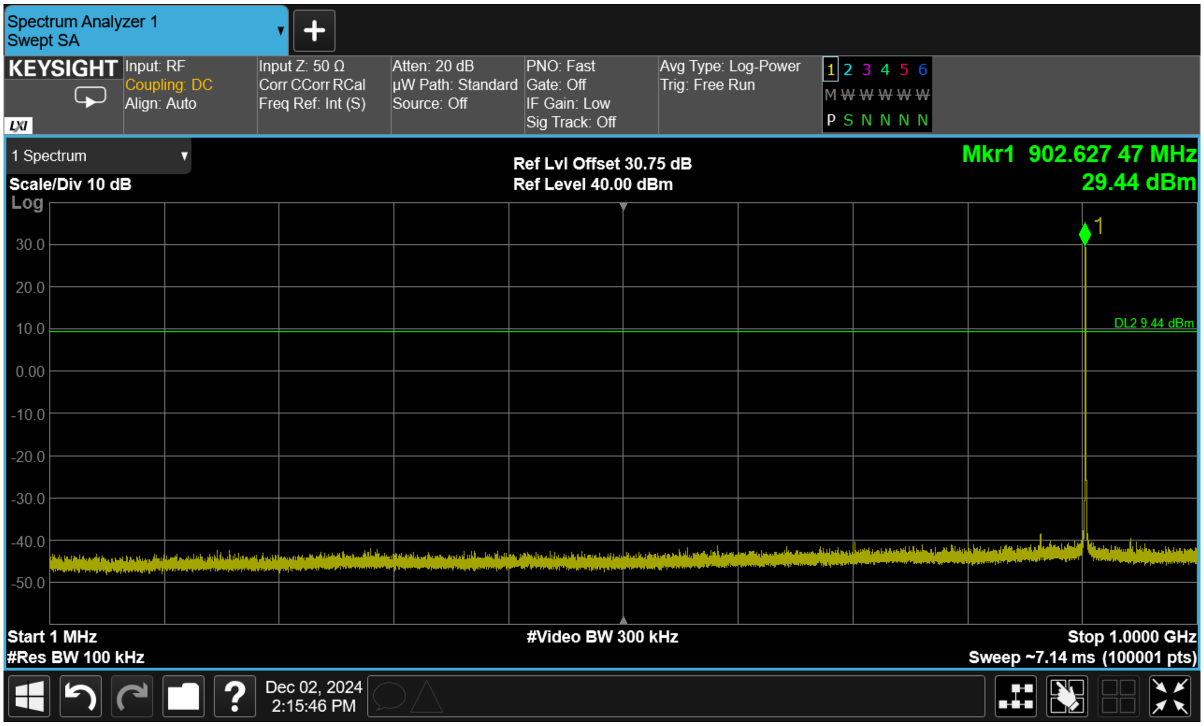


Figure 15: 9.6kbps, Low Channel, Conducted Spurious, Plot 2

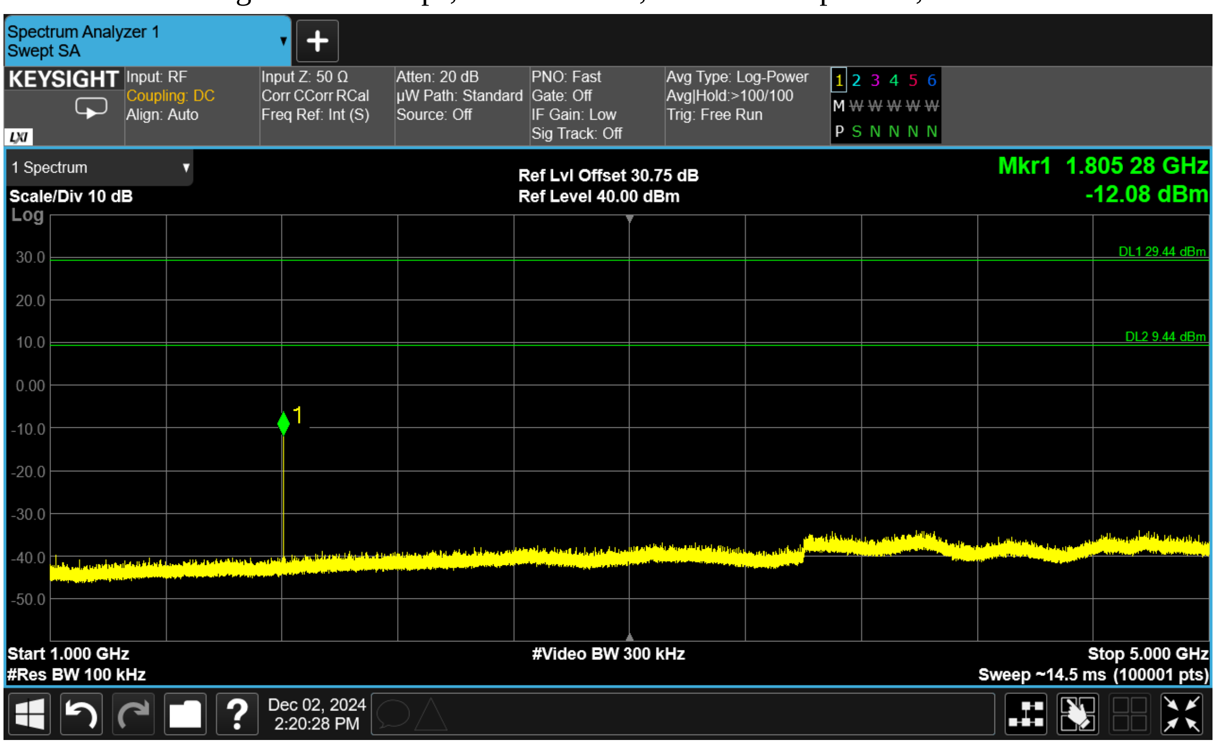


Figure 16: 9.6kbps, Low Channel, Conducted Spurious, Plot 3

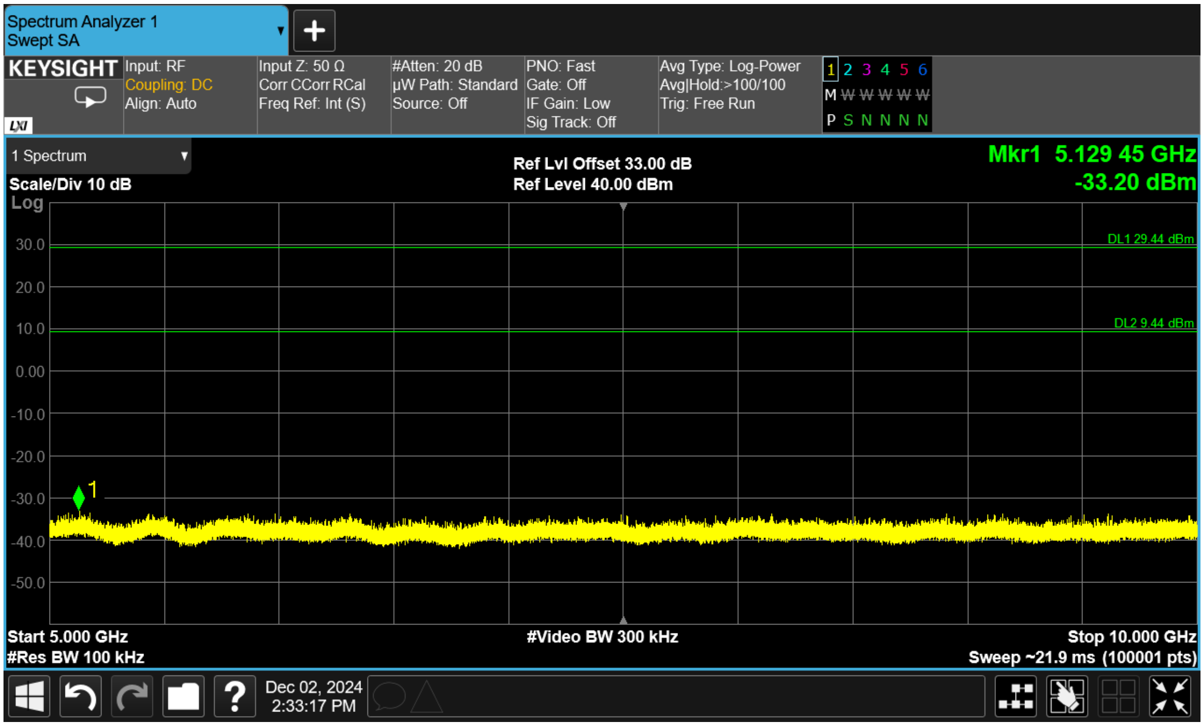


Figure 17: 9.6kbps, Center Channel, Conducted Spurious, Plot 1

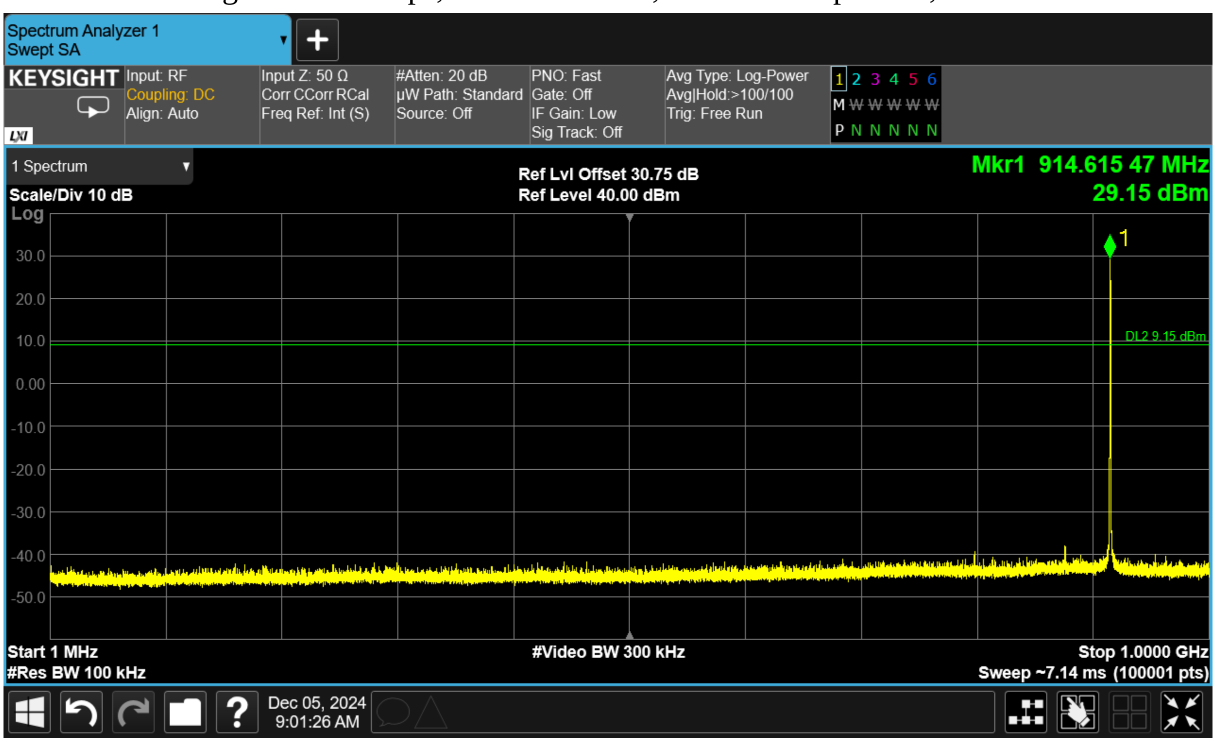


Figure 18: 9.6kbps, Center Channel, Conducted Spurious, Plot 2

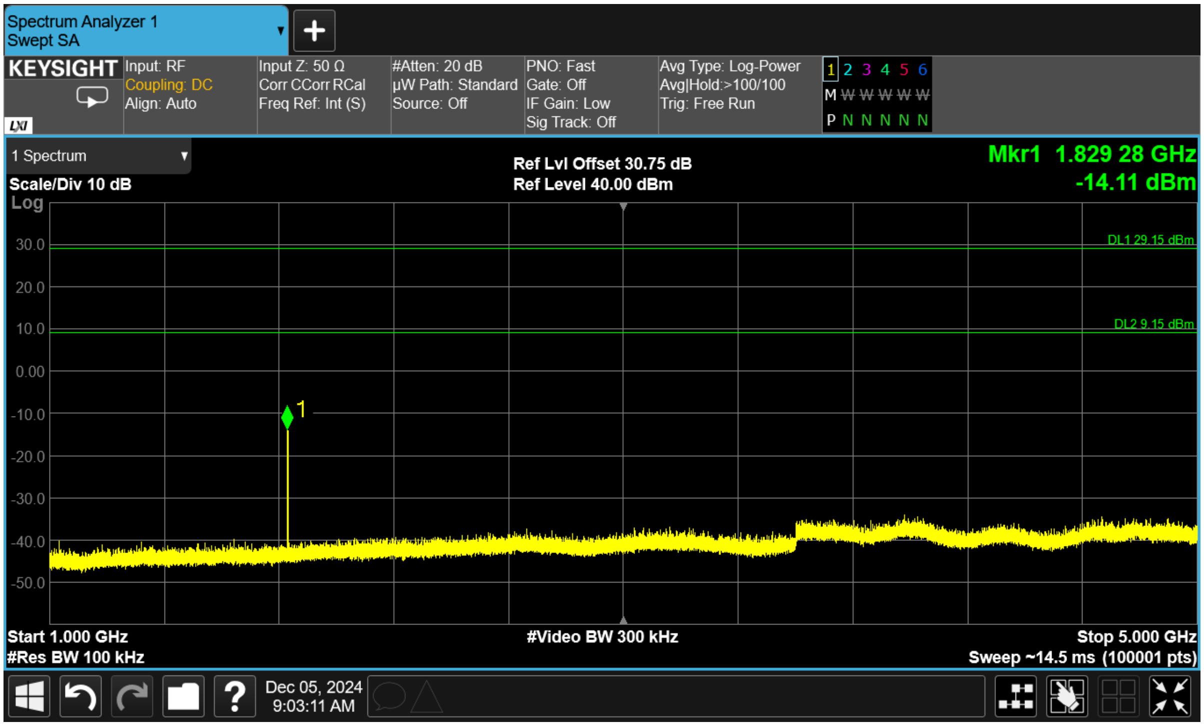


Figure 19: 9.6kbps, Center Channel, Conducted Spurious, Plot 3

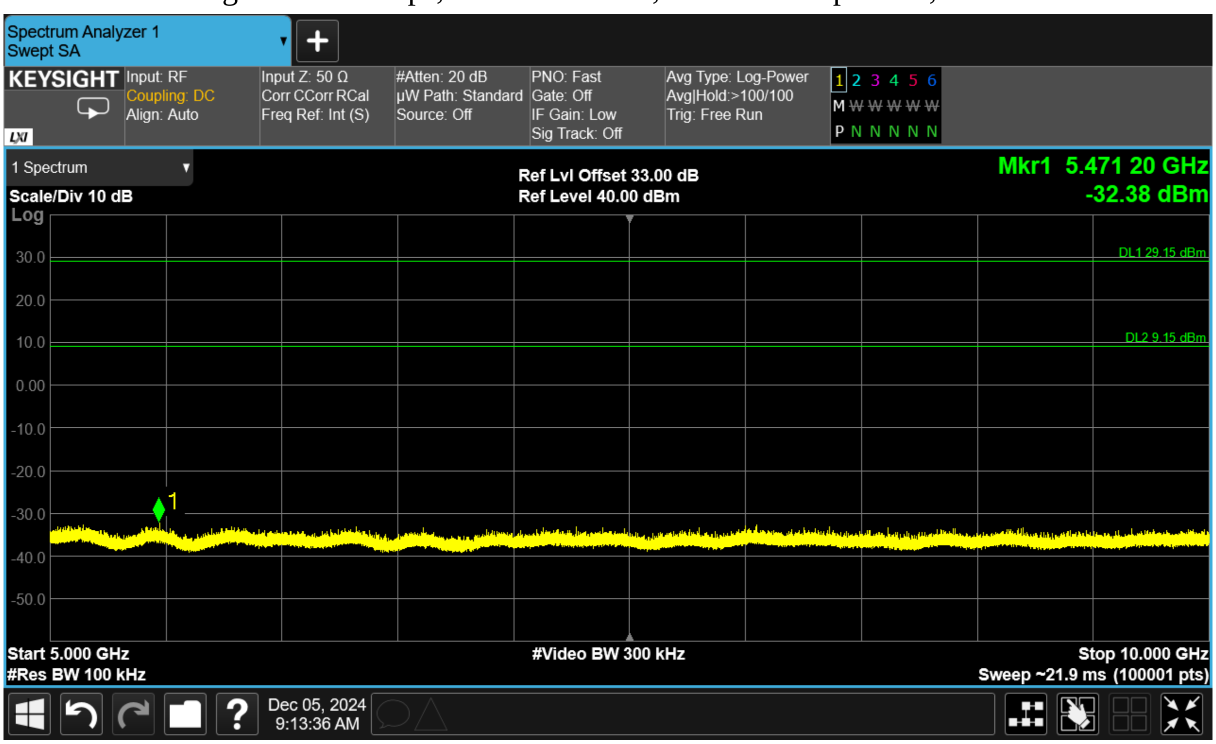


Figure 20: 9.6kbps, High Channel, Conducted Spurious, Plot 1

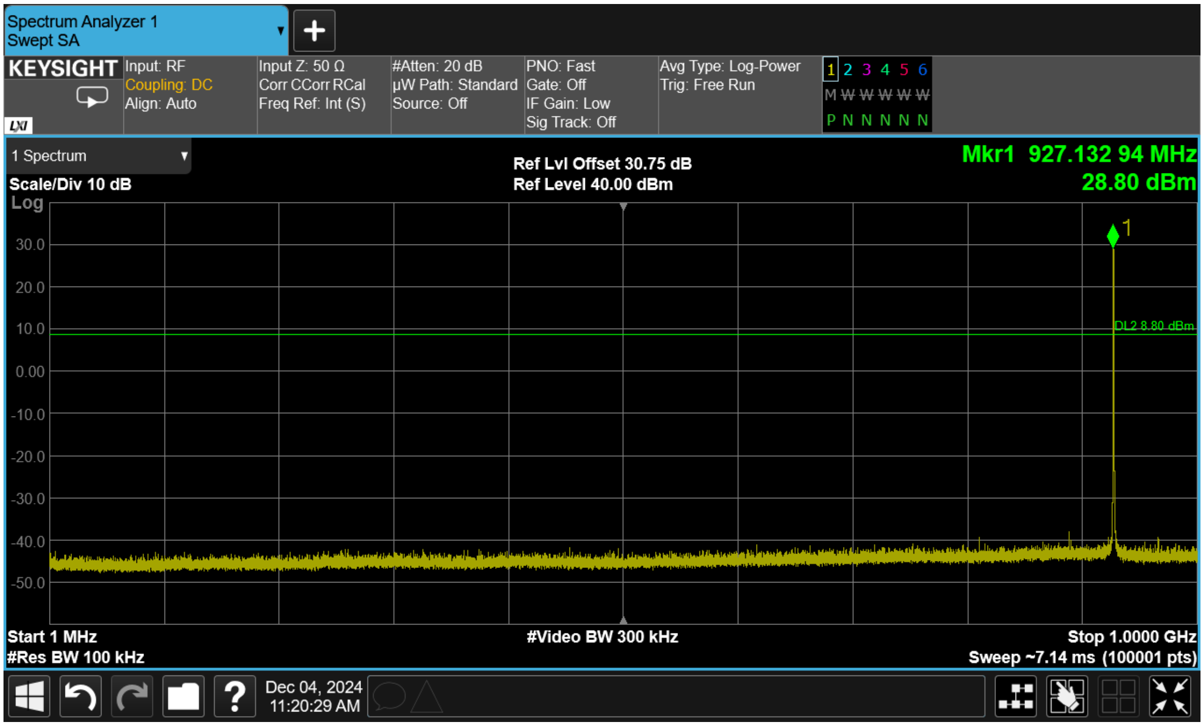


Figure 21: 9.6kbps, High Channel, Conducted Spurious, Plot 2

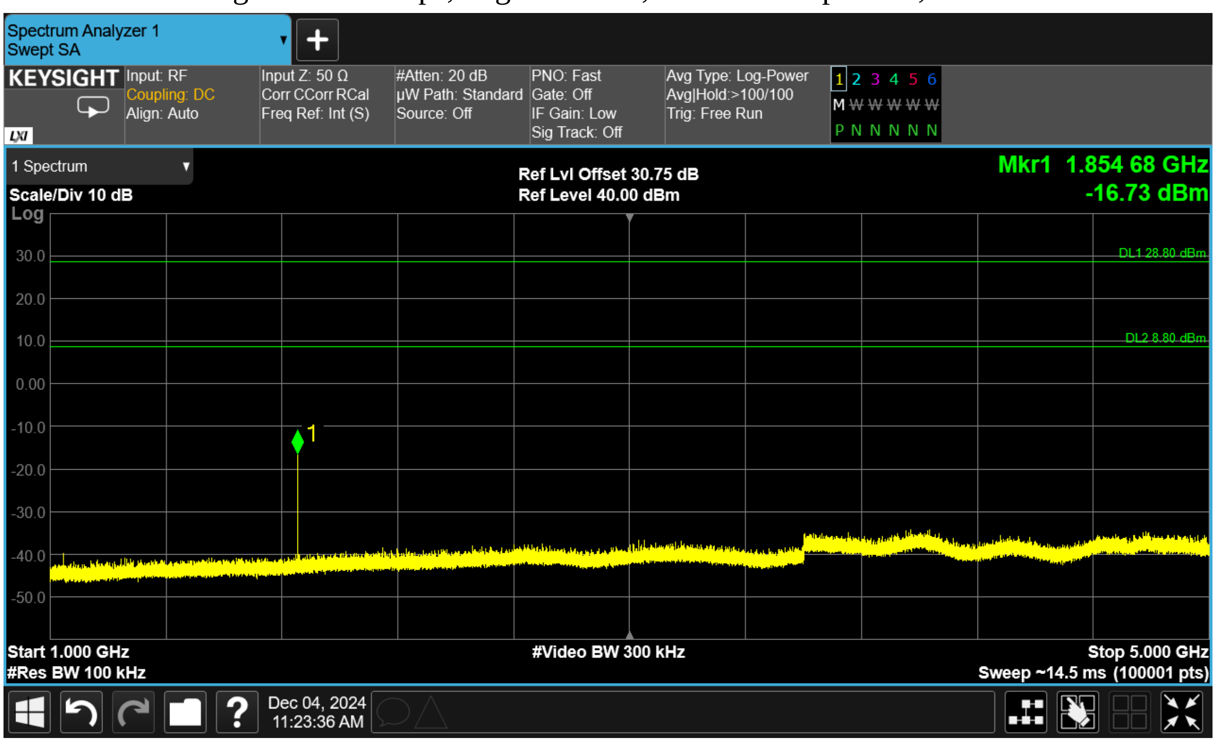


Figure 22: 9.6kbps, High Channel, Conducted Spurious, Plot 3

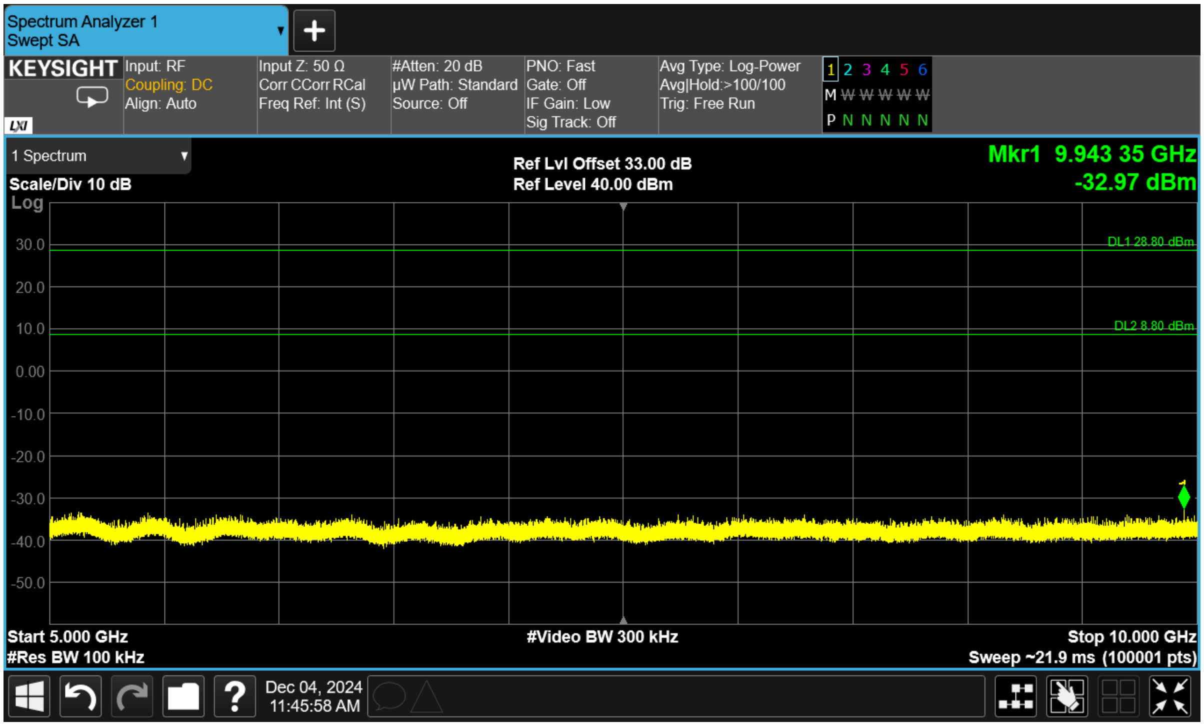


Figure 23: 19.2kbps, Low Channel, Conducted Spurious, Plot 1

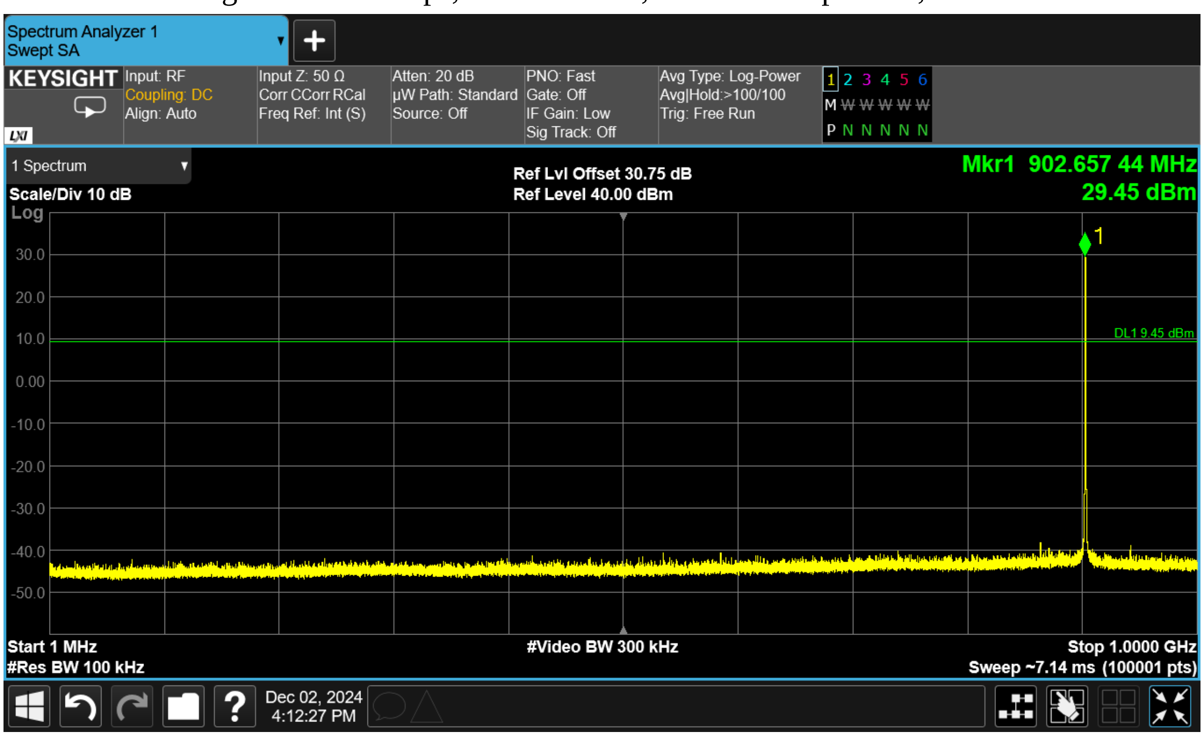


Figure 24: 19.2kbps, Low Channel, Conducted Spurious, Plot 2

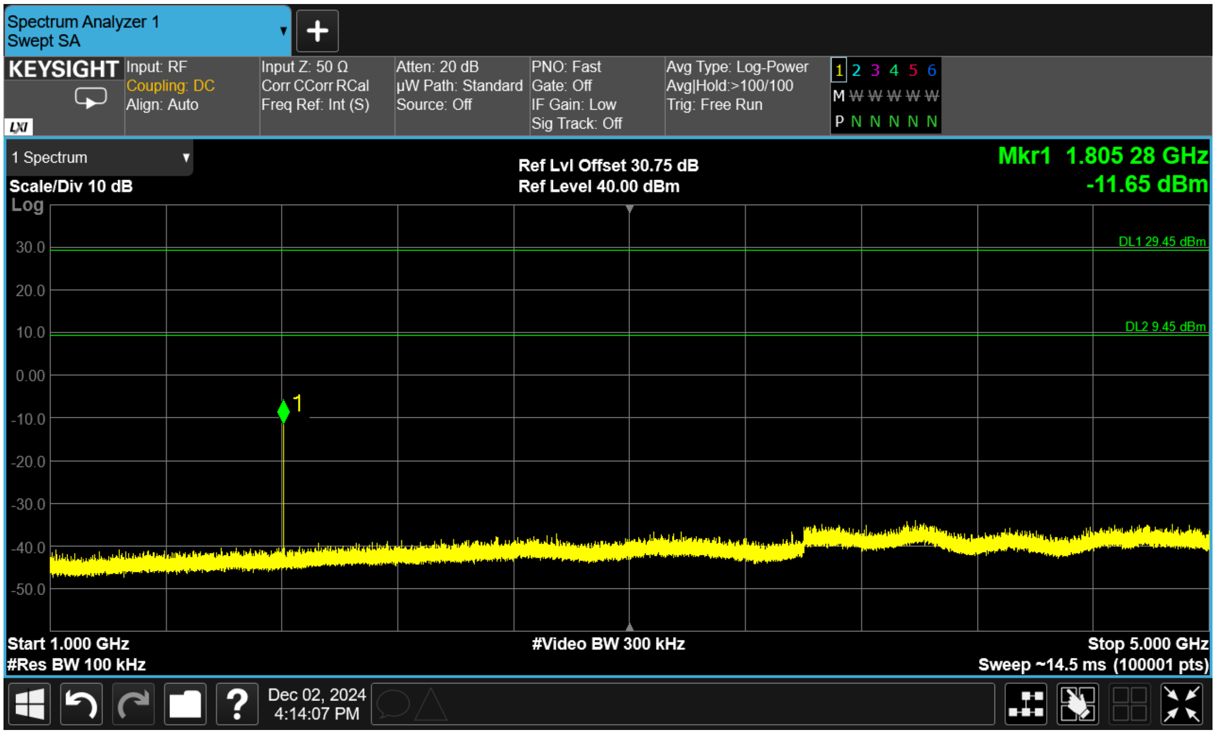


Figure 25: 19.2kbps, Low Channel, Conducted Spurious, Plot 3

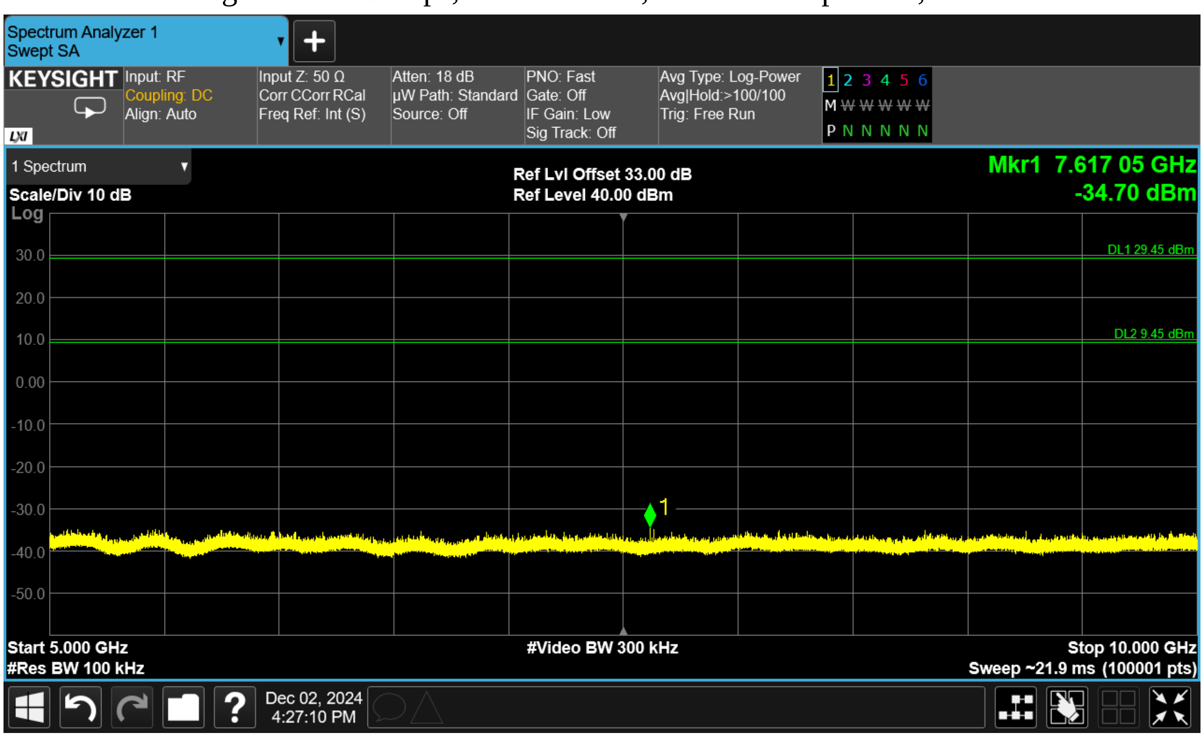


Figure 26: 19.2kbps, High Channel, Conducted Spurious, Plot 1

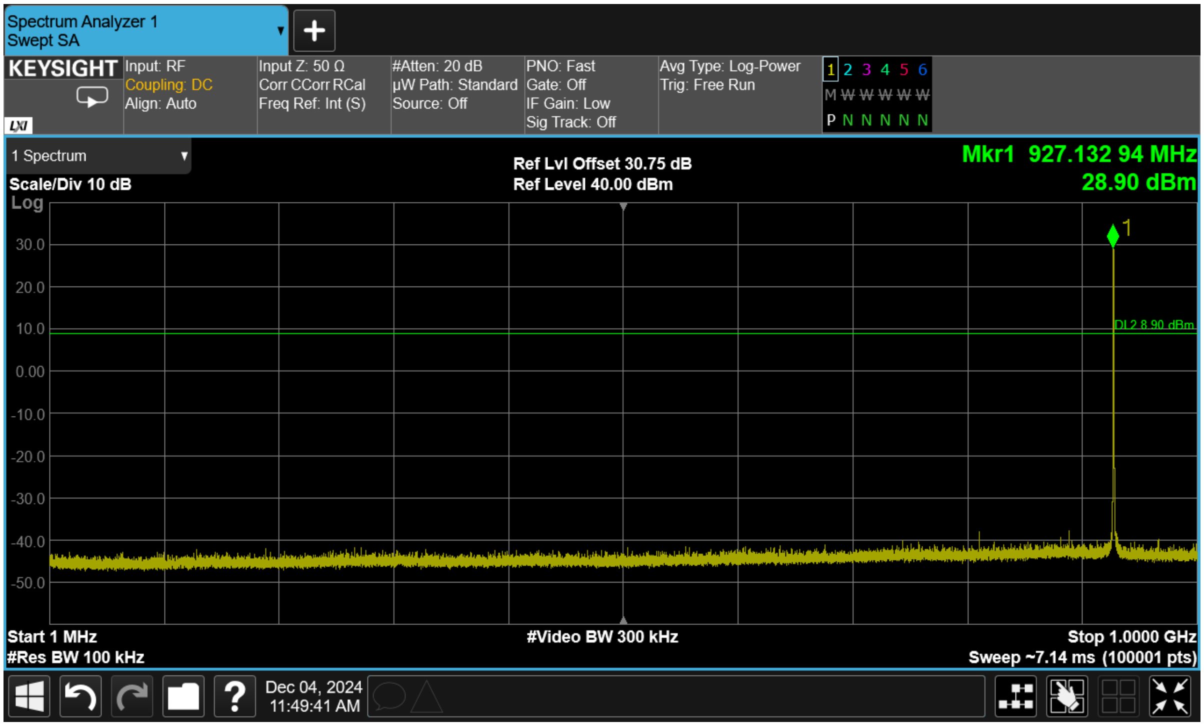


Figure 27: 19.2kbps, High Channel, Conducted Spurious, Plot 2

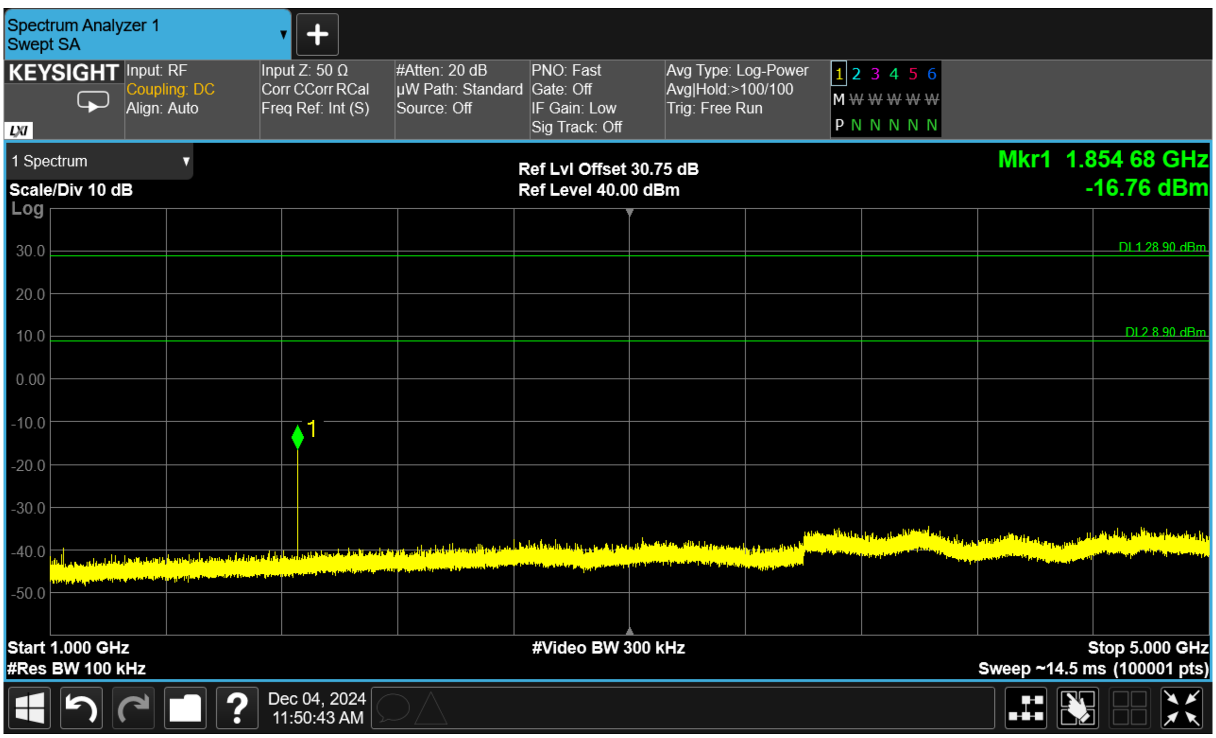


Figure 28: 19.2kbps, High Channel, Conducted Spurious, Plot 3

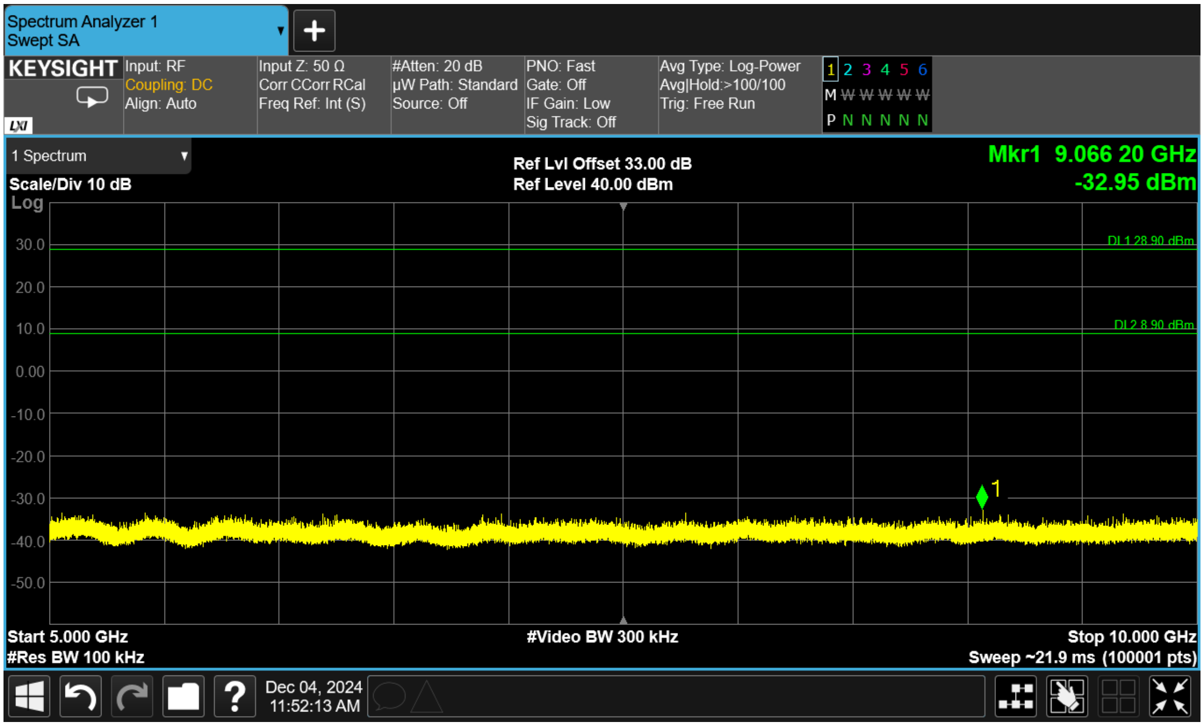


Figure 29: 38.4kbps, Low Channel, Conducted Spurious, Plot 1

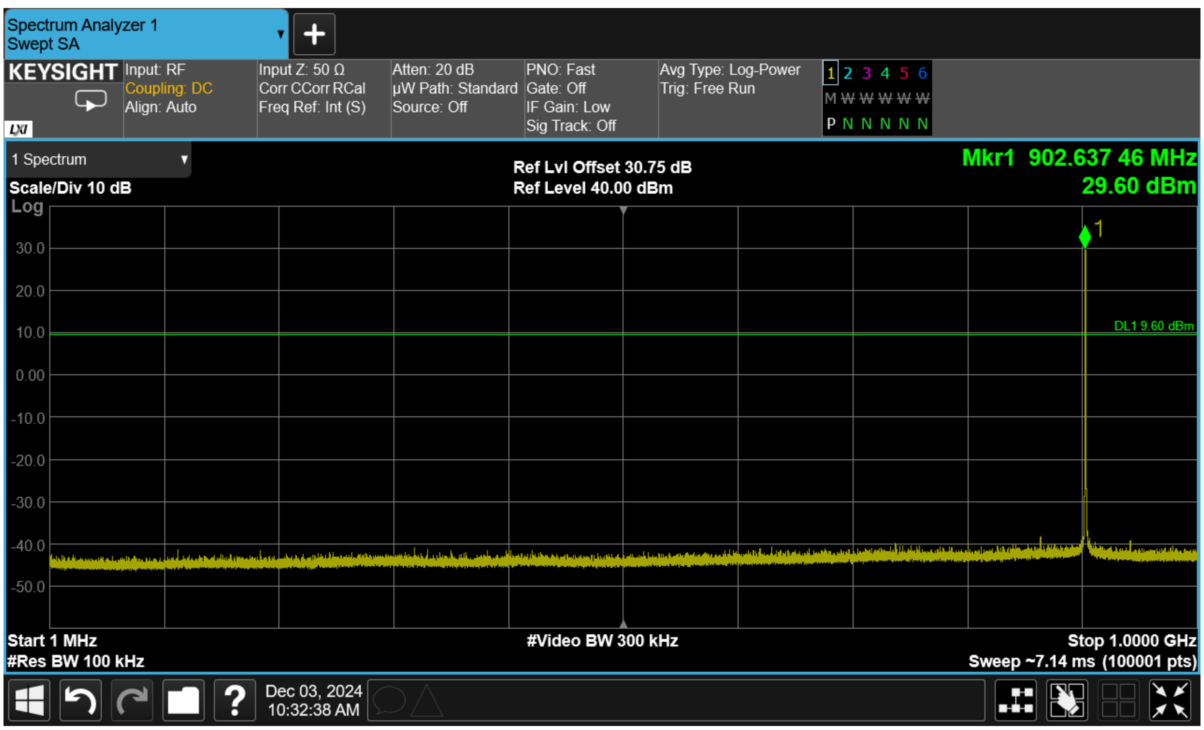


Figure 30: 38.4kbps, Low Channel, Conducted Spurious, Plot 2

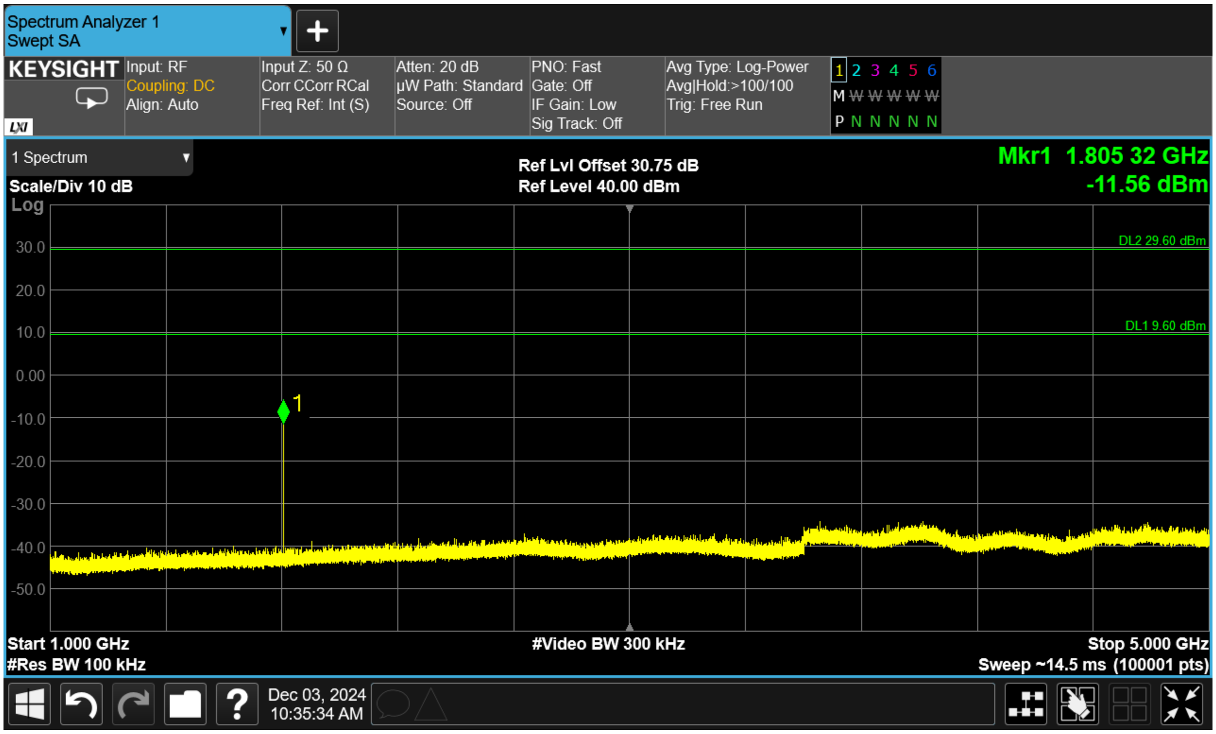


Figure 31: 38.4kbps, Low Channel, Conducted Spurious, Plot 3

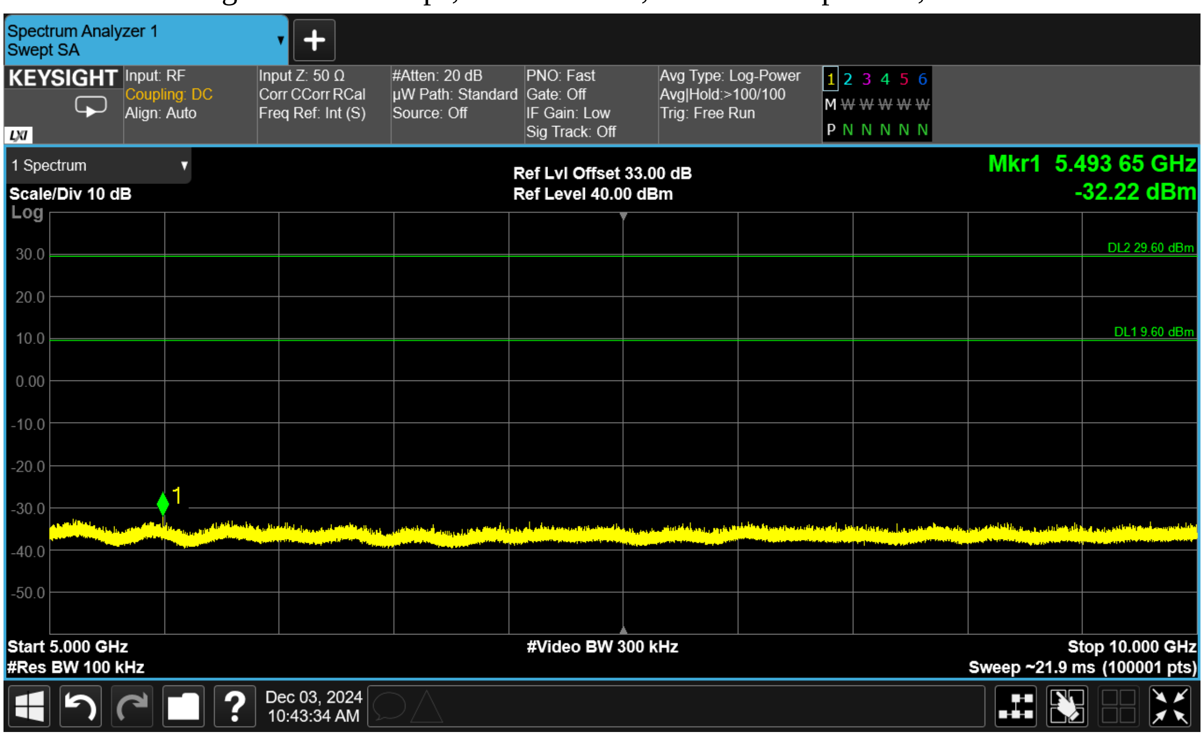


Figure 32: 38.4kbps, High Channel, Conducted Spurious, Plot 1

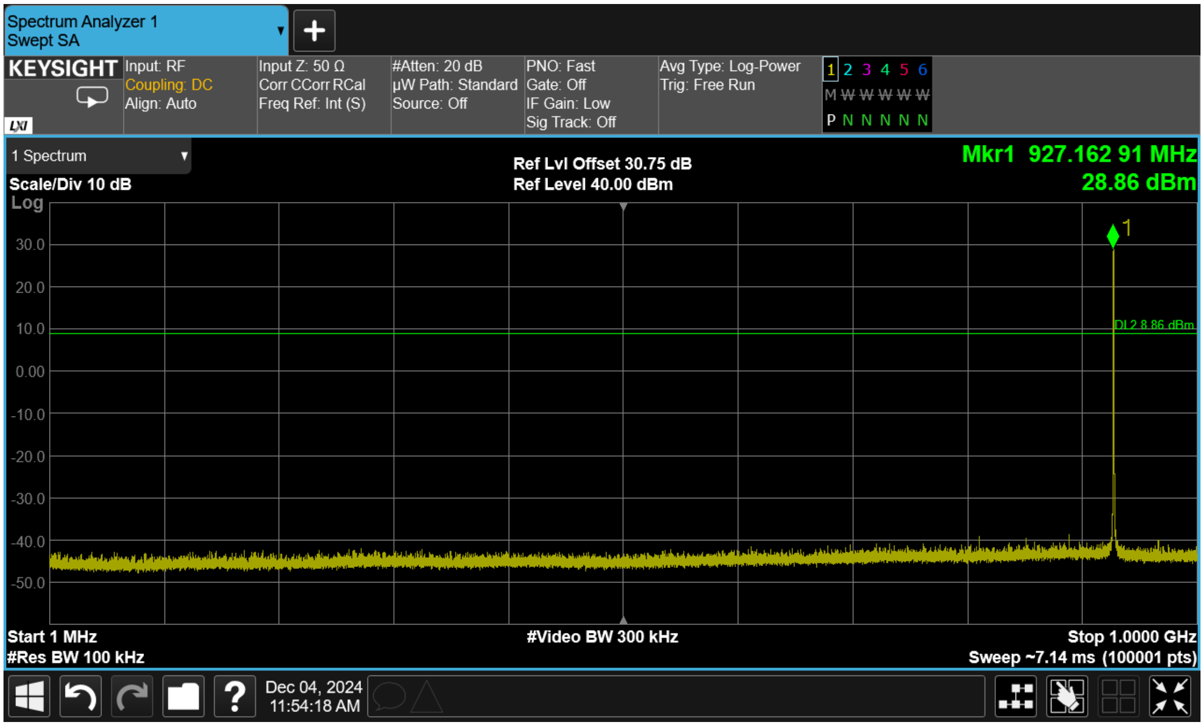


Figure 33: 38.4kbps, High Channel, Conducted Spurious, Plot 2

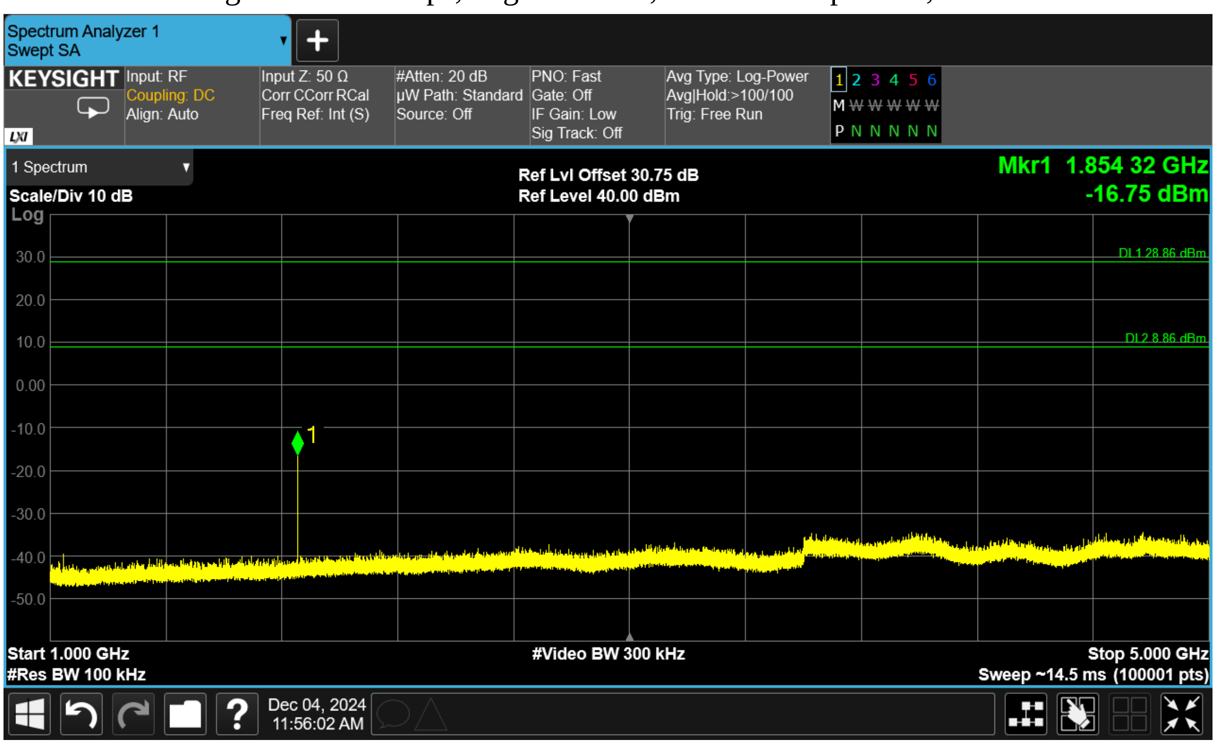


Figure 34: 38.4kbps, High Channel, Conducted Spurious, Plot 3

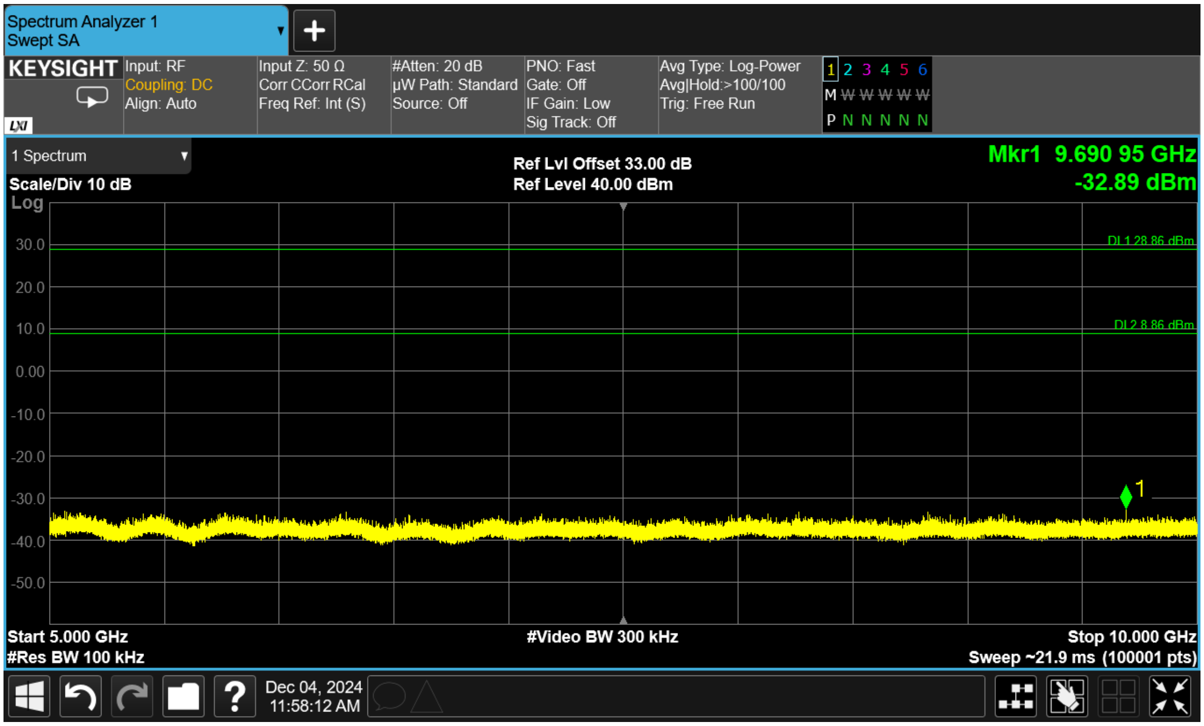


Figure 35: 76.8kbps, Low Channel, Conducted Spurious, Plot 1

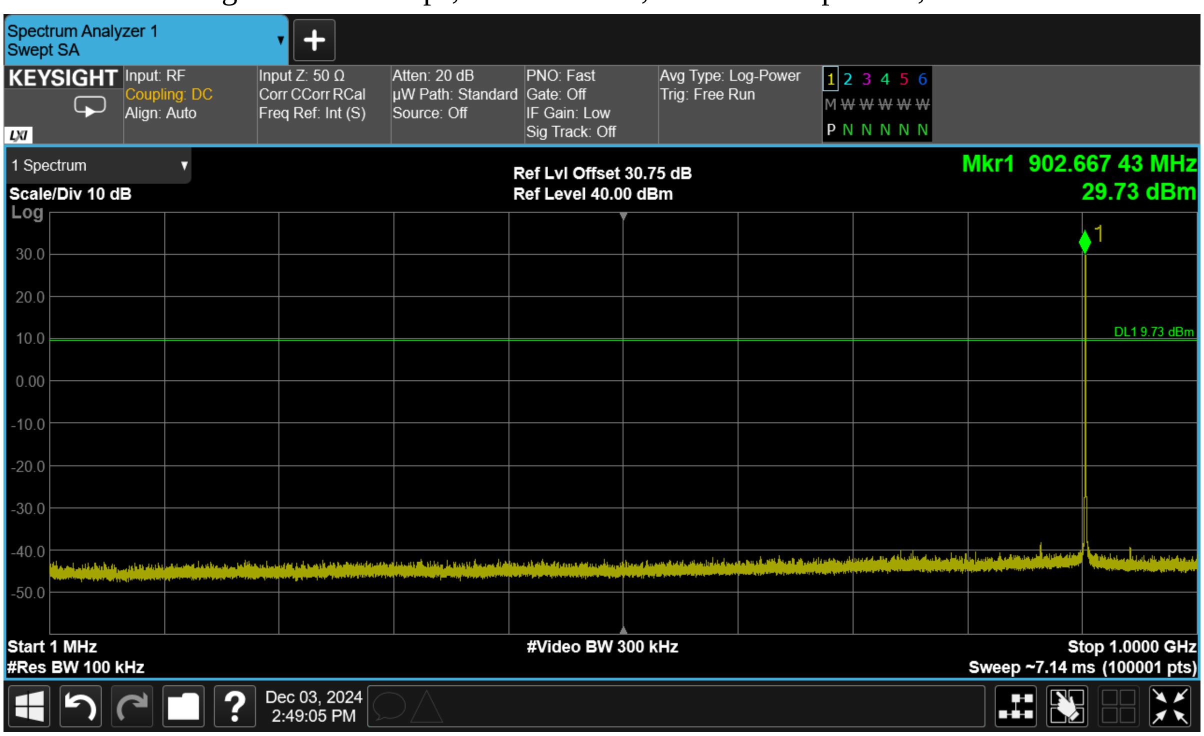


Figure 36: 76.8kbps, Low Channel, Conducted Spurious, Plot 2

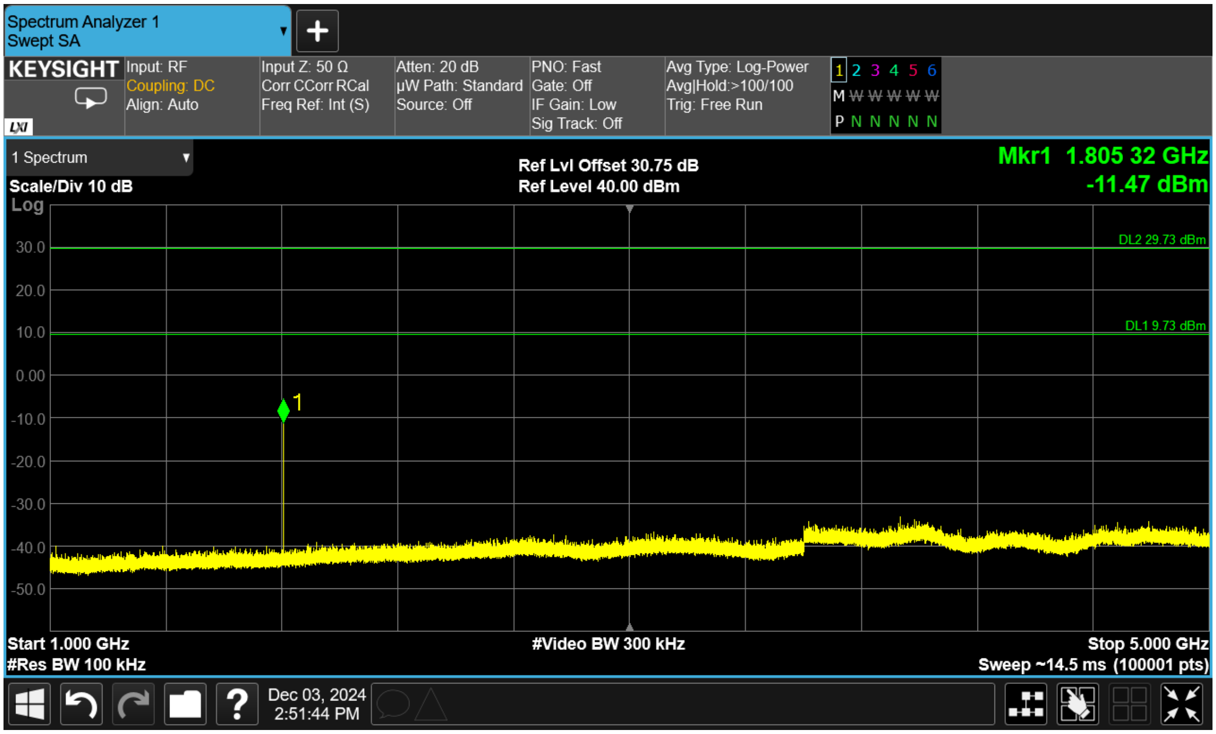


Figure 37: 76.8kbps, Low Channel, Conducted Spurious, Plot 3

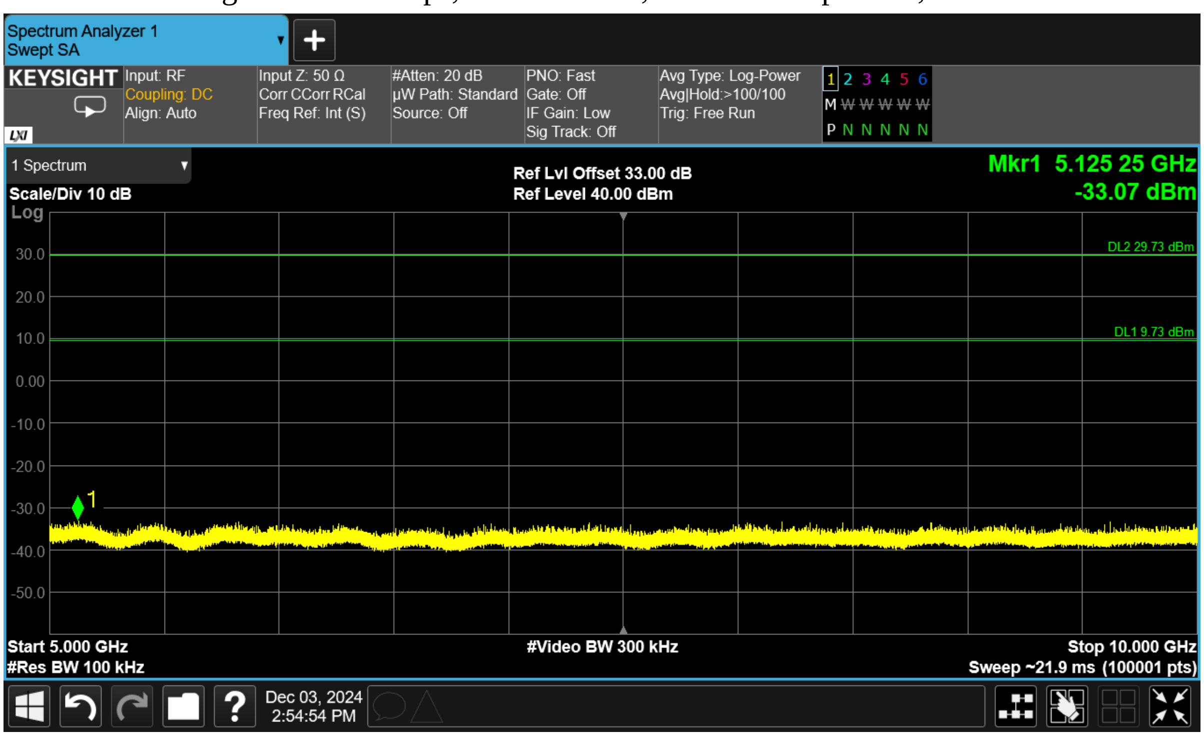


Figure 38: 76.8kbps, High Channel, Conducted Spurious, Plot 1

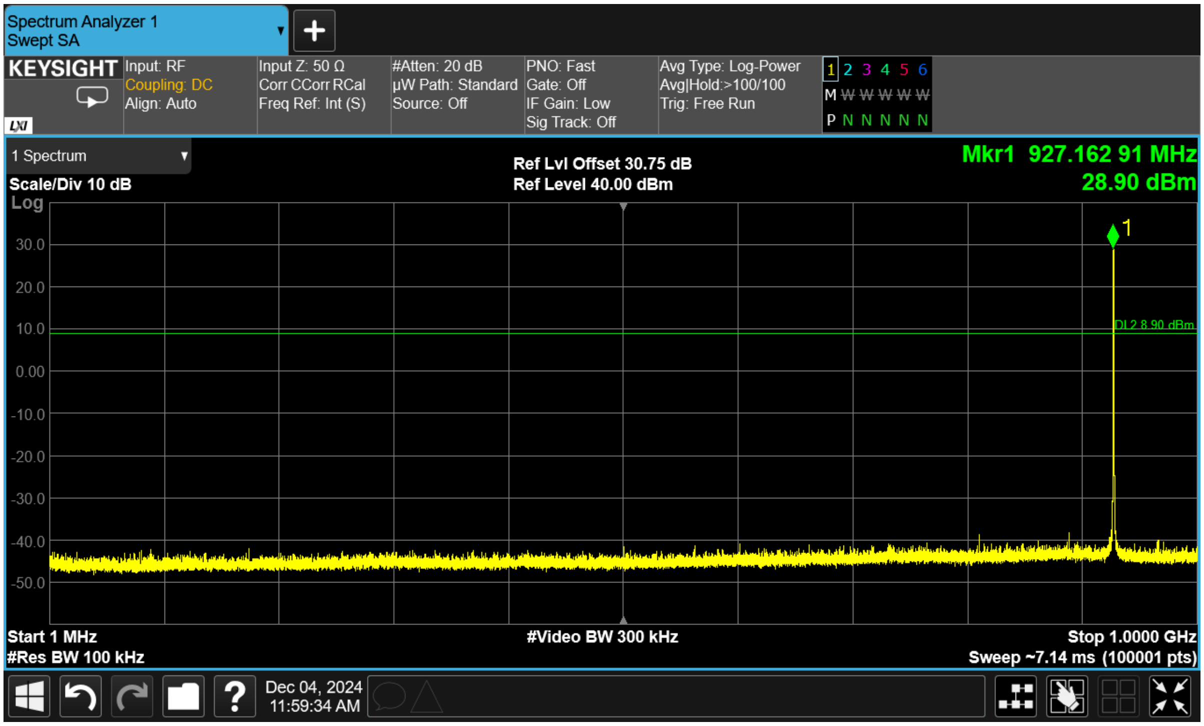


Figure 39: 76.8kbps, High Channel, Conducted Spurious, Plot 2

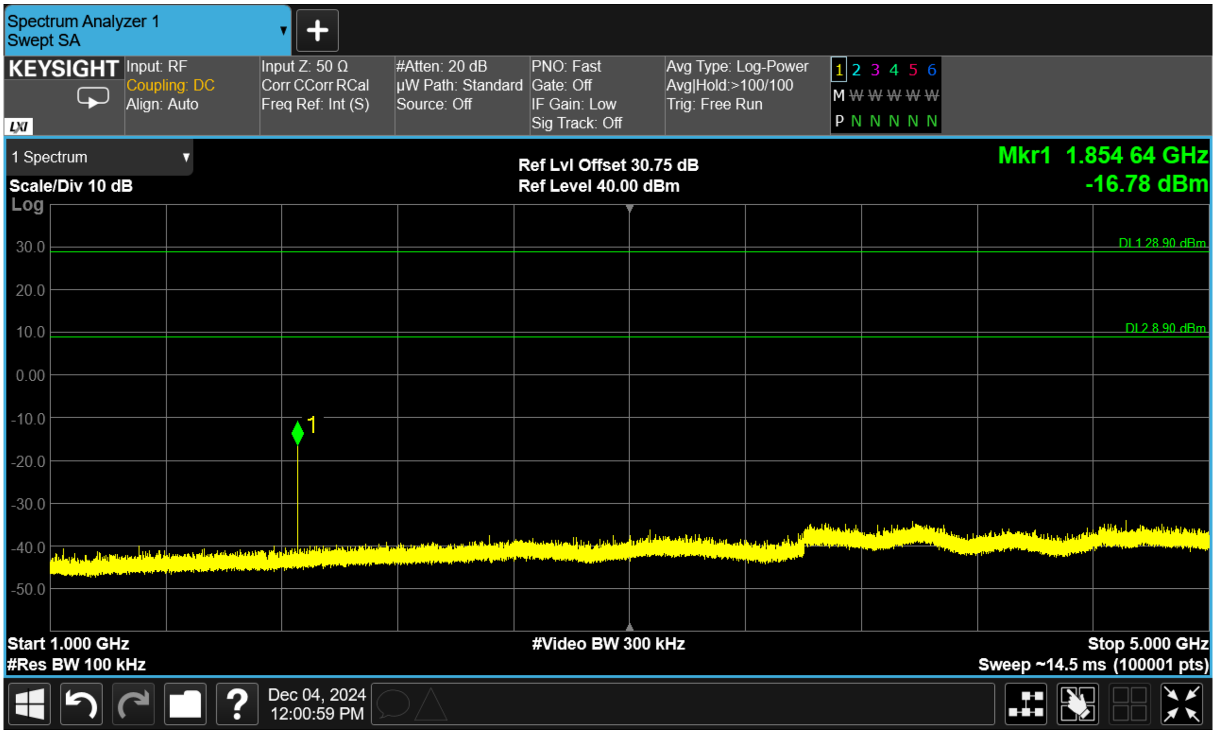


Figure 40: 76.8kbps, High Channel, Conducted Spurious, Plot 3

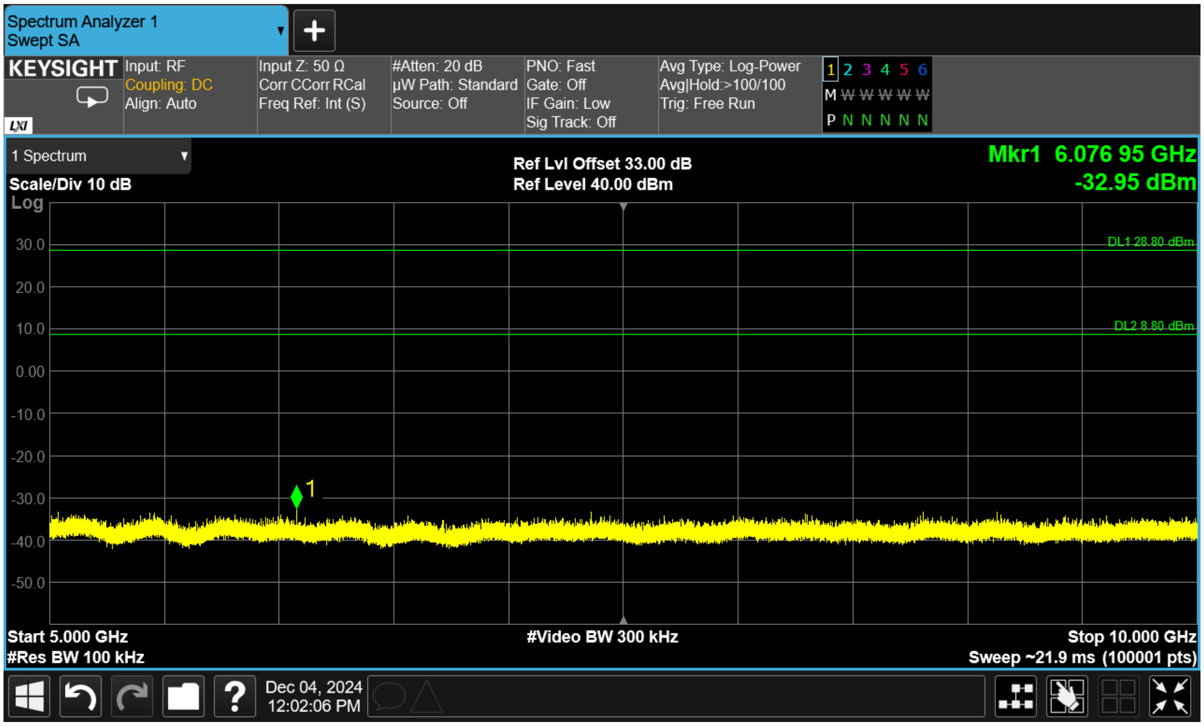


Figure 41: 153.6kbps, Low Channel, Conducted Spurious, Plot 1

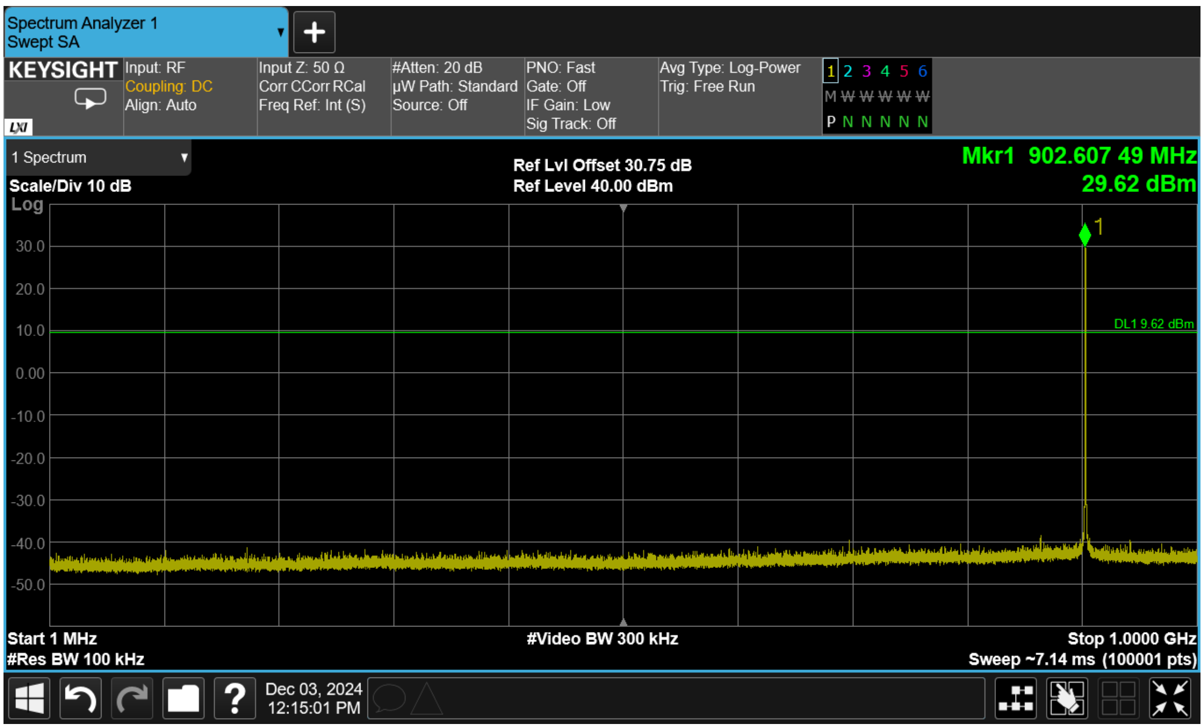


Figure 42: 153.6kbps, Low Channel, Conducted Spurious, Plot 2

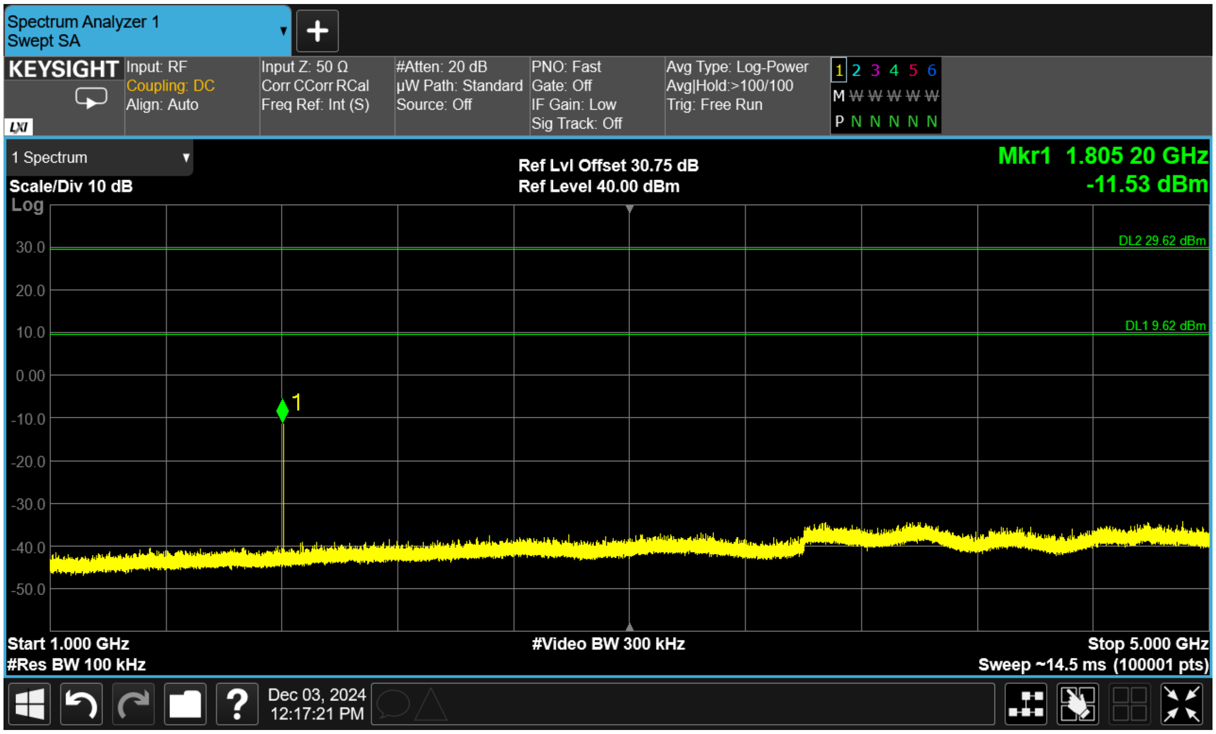


Figure 43: 153.6kbps, Low Channel, Conducted Spurious, Plot 3

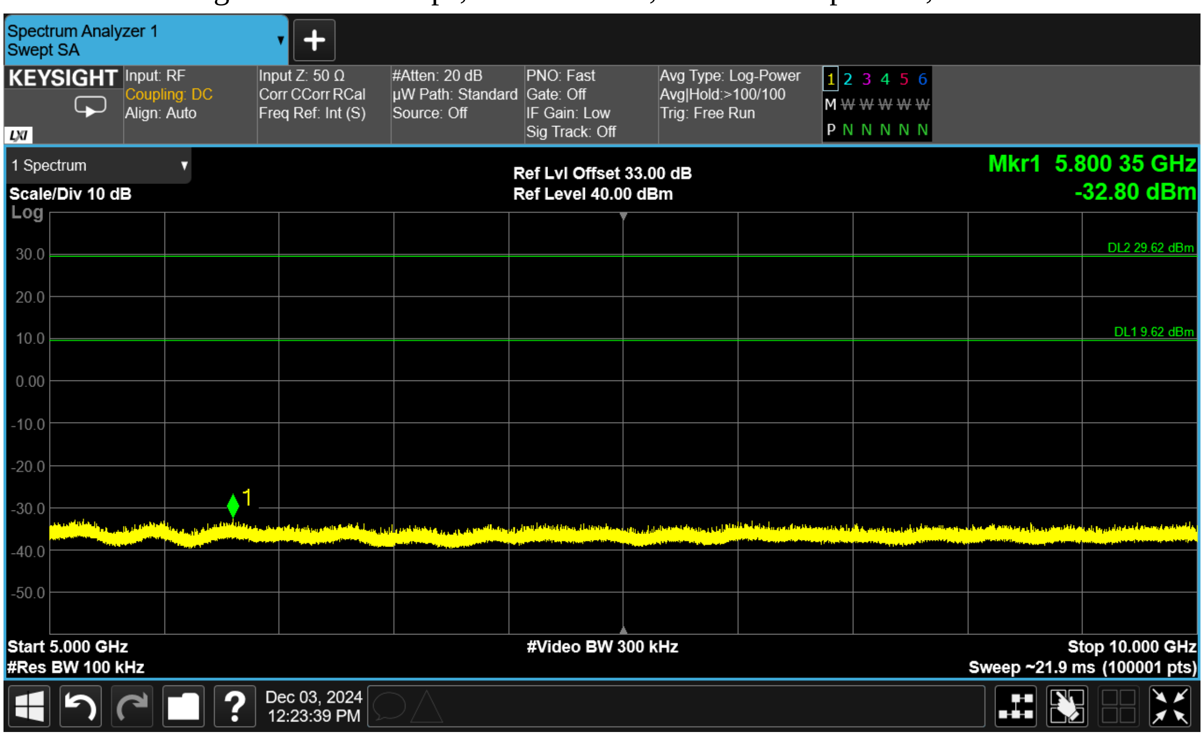


Figure 44: 153.6kbps, Center Channel, Conducted Spurious, Plot 1

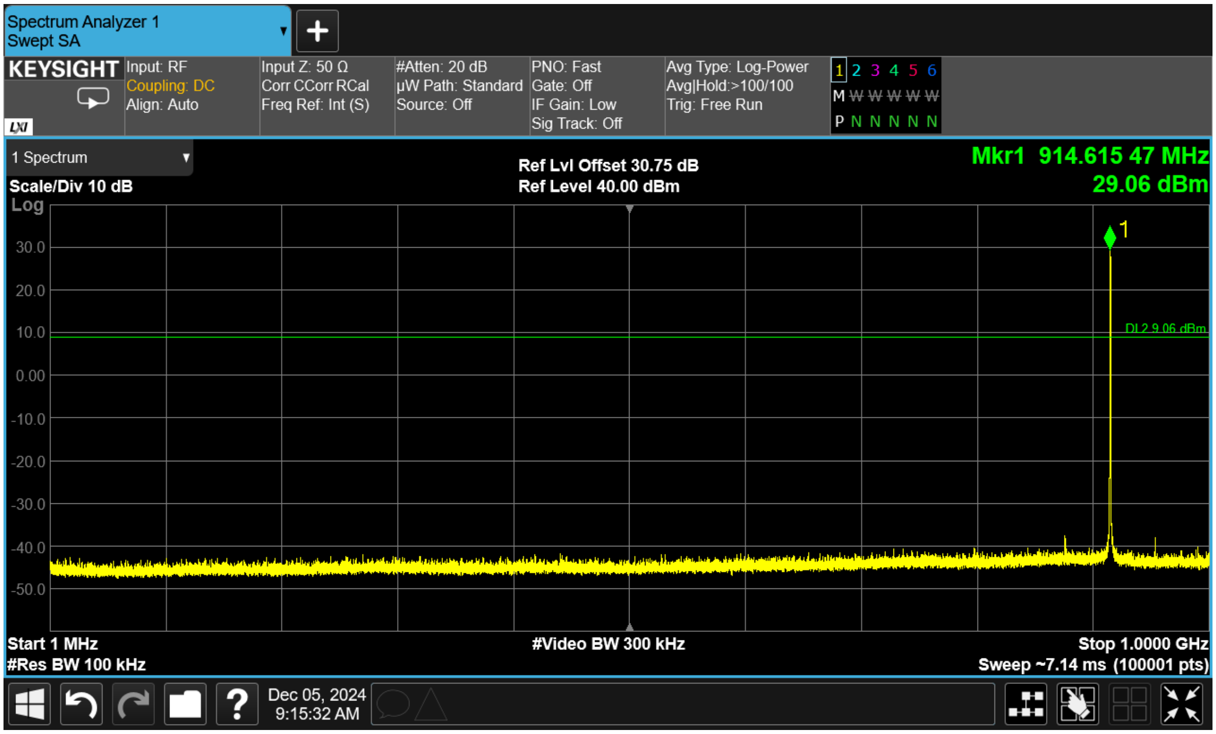


Figure 45: 153.6kbps, Center Channel, Conducted Spurious, Plot 2

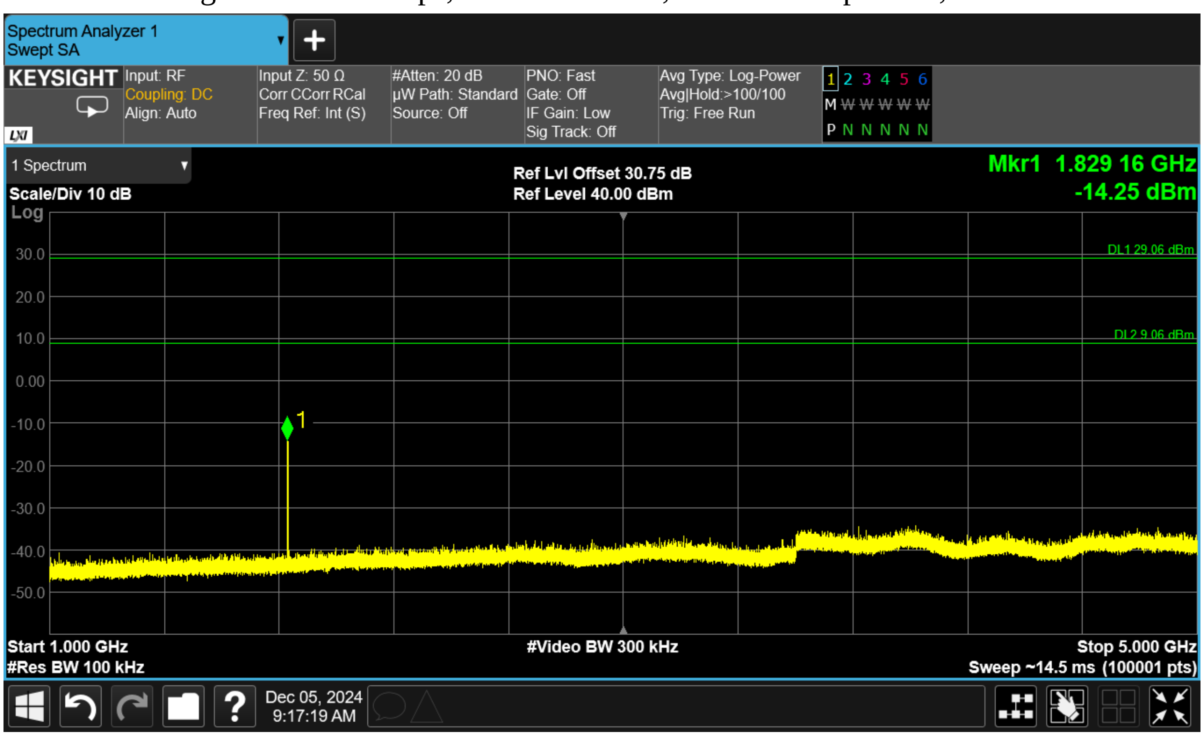


Figure 46: 153.6kbps, Center Channel, Conducted Spurious, Plot 3

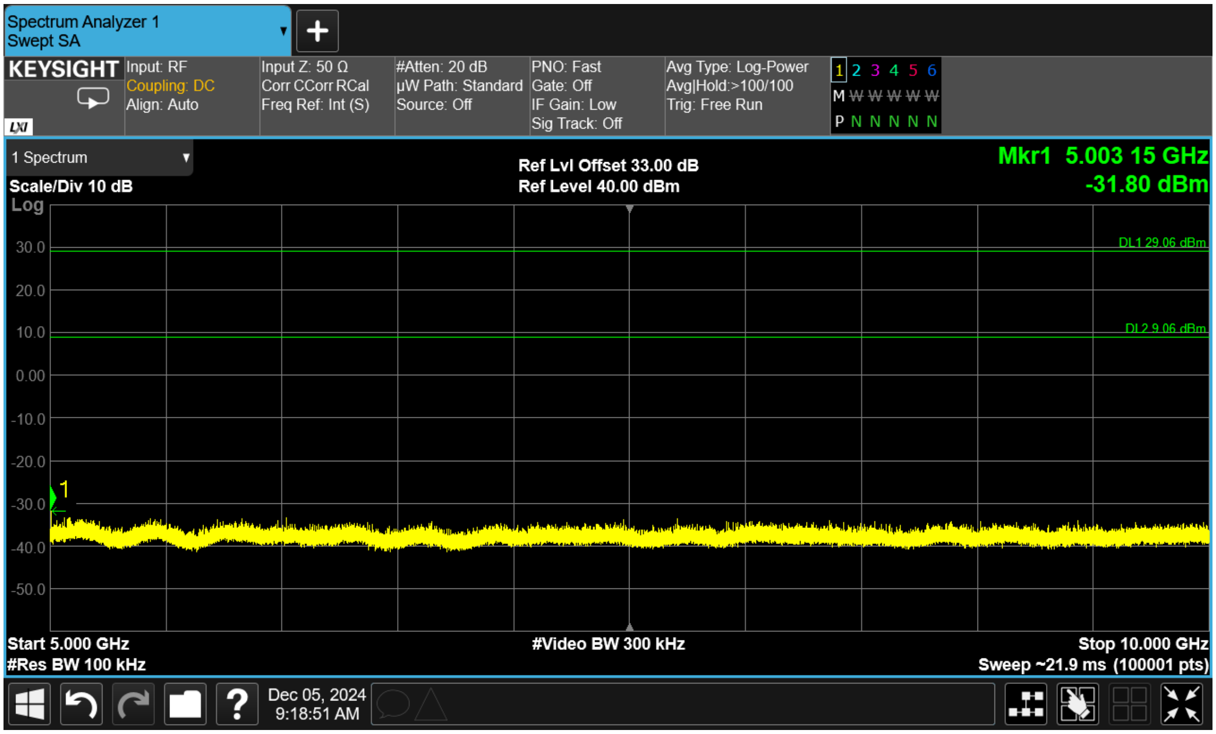


Figure 47: 153.6kbps, High Channel, Conducted Spurious, Plot 1

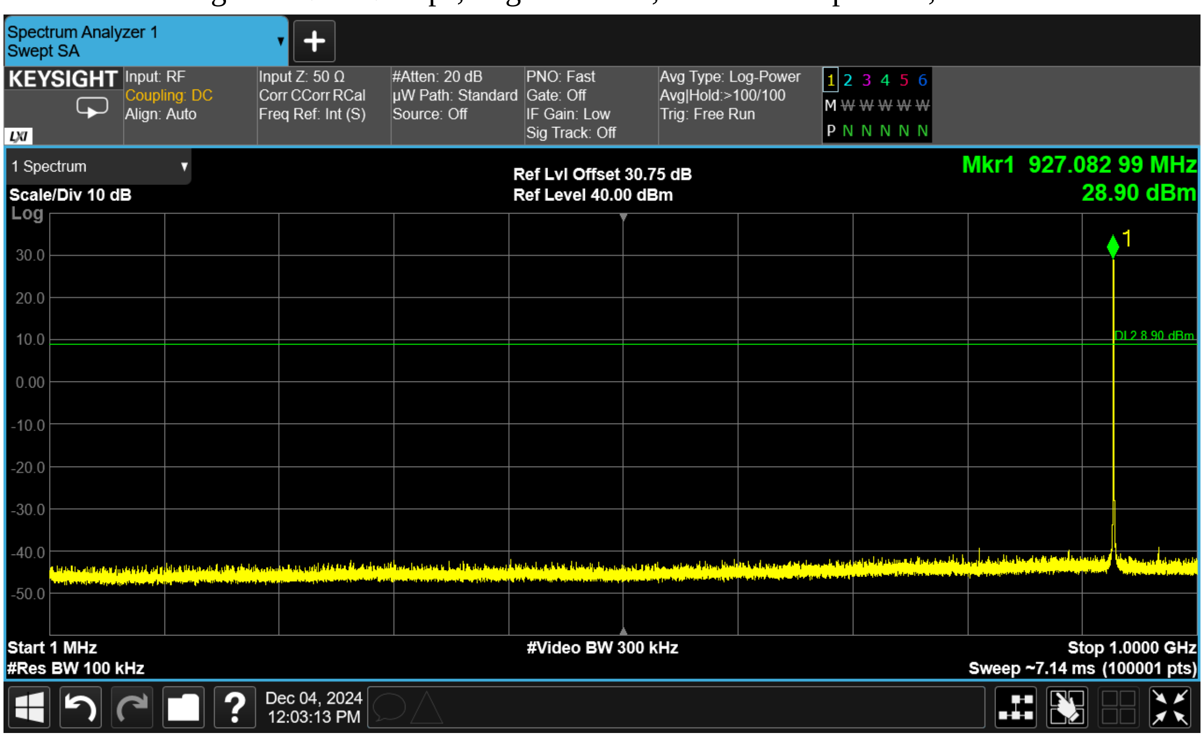


Figure 48: 153.6kbps, High Channel, Conducted Spurious, Plot 2

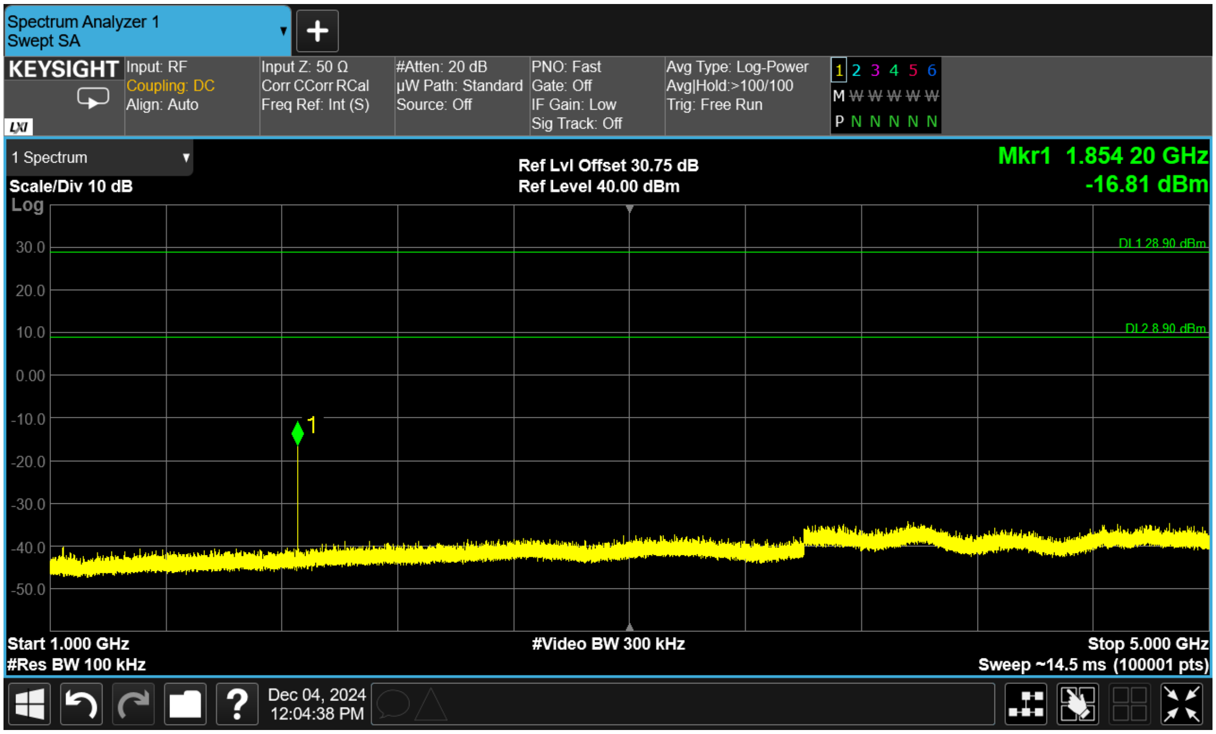
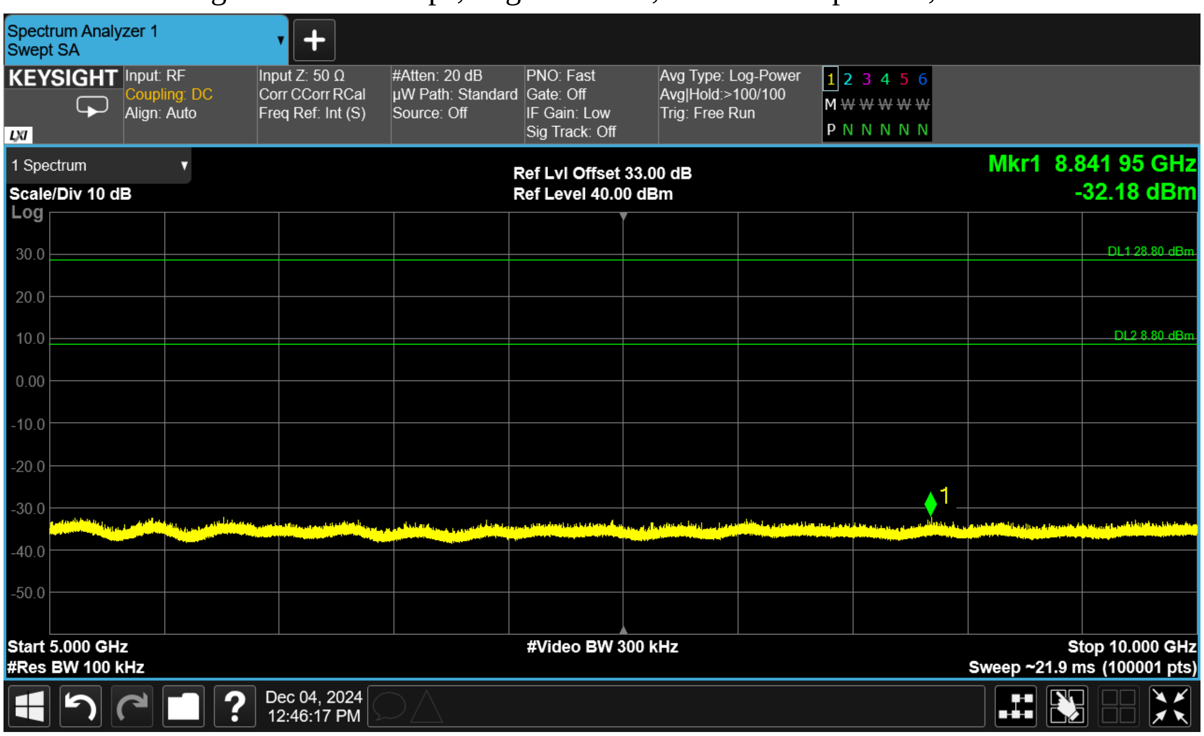


Figure 49: 153.6kbps, High Channel, Conducted Spurious, Plot 3



3.8 General Field Strength Requirements, Radiated Emissions

3.8.1 Requirements

Compliance Standard: FCC Part 15.205 and 15.209

FCC Compliance Limits		
Frequency Range	**3m Limit**	
30 – 88 MHz	100 µV/m (QP)	
88 – 216 MHz	150 µV/m (QP)	
216 – 960 MHz	200 µV/m (QP)	
> 960 MHz	500 µV/m (AVG)	5000 µV/m (Peak)

3.8.2 Test Procedure Summary

The requirements of FCC Rule Part 15 and RSS-Gen call for the EUT to be placed on a 1m X 1.5m non-conductive motorized turntable at a height of 80cm for radiated testing of frequencies up to 1000 MHz, and a height of 1.5m for testing of frequencies above 1000 MHz. Please note that the radiated emissions measured during this testing, were performed at a distance of 3-meters.

An initial pre-scan of the EUT was performed to identify any emissions that exceed, or come within 6dB of, the applicable limit. This pre-scan was performed a with the employment of a spectrum analyzer peak detector function. The highest amplitude (worst-case) emissions noted during the pre-scan were selected for final compliance measurements.

The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Broadband log periodic and double-ridged horn 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 30MHz to 10 GHz were measured. The EUT peripherals were placed on the table in accordance with ANSI C63.4. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

The detector function was set to quasi-peak for measurements below 1 GHz. 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. For measurements above 1 GHz, both the peak and the average levels are recorded, using a measurement bandwidth of 1 MHz. For average measurements, a video bandwidth setting of 10 Hz was used, in the case of video averaging; otherwise, an EMI AVG detector shall be employed.

3.8.3 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 antenna(s) and other measurement equipment. These factors include the antenna factor ((AF)(in dB/m)), cable loss factors ((CF)(in dB)), and the pre-amplifier gain [if applicable] ((G)(in dB)). These correction values are algebraically added to the raw Spectrum Analyzer Voltage (in dBµV) to obtain the corrected radiated electric field, which shall be the final corrected logarithm amplitude ((Corr. Meas.)(in dBµV/m)). This logarithm amplitude is then compared to the FCC limit, which has been converted to a unit of log in dBµV/m.

Example:

Spectrum Analyzer Voltage:	VdBµV (SA)
Antenna Correction Factor:	AFdB/m
Cable Correction Factor:	CFdB
Pre-Amplifier Gain (if applicable):	GdB
Electric Field:	EdBµV/m = V dBµV (SA) + AFdB/m + CFdB - GdB
To convert from linear units of measure:	dBuV/m = 20LOG(uV/m)
To convert FCC limits, based on $D_{Measure}$:	3m Limit = 10m Limit + 20LOG(10/3)

Environmental Conditions During Radiated Emissions Testing

Ambient Temperature:	5 °C
Relative Humidity:	50 %

3.8.4 Measurement Method and Final Results

The frequency range of 9kHz to 10GHz was investigated. This ranges covers the 10th harmonic of the fundamental. It also covers the lowest internally generated frequency within module.

A complete investigation of the EUT radiated emissions was performed. Prior to final testing, the EUT assembly, along with the transmitting antenna, were varied in position across three orthogonal planes (x, y, z). The EUT position that produced the highest radiated power, was maintained during all testing.

For the 9kHz to 30MHz portion, a loop antenna was mounted at a fixed-height of 1-meter and rotated about its vertical and horizontal axis in accordance with ANSI C63.10-2020, clause 6.4.6 and 6.11.2. Please note that when scanned at 3-meters, there were no emissions detected from the EUT. All signals in this range were confirmed to be ambient.

For the 30MHz to 10GHz, both the horizontal and vertical field components were scanned and investigated. EUT emissions that comply with the limits by more than 20dB were discarded and not elected for final measurements. Only the worst-case emissions are provided in the section.

In accordance with ANSI C63.10 (2020), Section 5.6.2.2(b) for radiated spurious emissions: to demonstrate compliance, it is only necessary to measure the mode with the highest output power and the mode with the highest output power spectral density for each modulation family (e.g., OFDM or direct sequence spread spectrum).

In this case, the EUT only employs one modulation type of FSK and a single FHSS scheme. Therefore, the number data rates, and band-channelization testing was slightly reduced for this test section. The following investigation/scanning protocol was employed:

Data Rate	Channel(s) Tested	Reason for Selection
9.6 kbps	Low, Center, High	Highest Output Power
76.8 kbps	Low	Worst-Case Conducted Spurious Emission
153.6 kbps	Low, High	Worst-Case Conducted Bandedge, Worst-Case OBW

2.8.4.1 Test Data

The EUT is fully compliant and meets the radiated emissions requirements of this section.

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

There were no EUT emissions detected in the frequency range of 4GHz to 10GHz.

Only the worst-case EUT emissions are provided. Ambient conditions are not reported.

The worst-case radiated emission was found to be 312.5 MHz, measuring 143.8 uV/m, which is 2.9 dB under the 15.209 limit.

Table 12: Worst-Case Radiated Test Data, Low Channel, 9.6kbps Mode (30MHz to 10GHz)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (cm)	SA Level (dBuV)	Corr. Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Detector
890.25	V	345.0	100.0	31.9	6.1	79.3	200	-8.0	QP
900.00	V	340.0	155.0	32.4	6.2	85.0	305492.1	-71.1	Peak
960.00	V	20.0	120.0	34.6	6.7	41.3	5000	-32.7	Peak
960.00	V	20.0	120.0	34.6	6.7	41.3	500	-12.7	Peak
1029.87	V	175.0	155.0	73.1	-9.1	1591.1	5000	-9.9	Peak
1029.87	V	175.0	155.0	45.1	-9.1	63.3	500	-17.9	AVG
1805.50	V	175.0	155.0	86.4	-5.2	11423.1	305492.1	-28.5	Peak
1805.50	V	175.0	155.0	84.4	-5.2	9073.7	30549.2	-10.5	AVG
2708.25	V	200.0	145.0	53.2	0.0	454.8	5000	-20.8	Peak
2708.25	V	200.0	145.0	48.2	0.0	255.7	500	-5.8	AVG
3611.00	V	175.0	150.0	39.8	2.5	129.7	5000	-31.7	Peak
3611.00	V	175.0	150.0	39.8	2.5	129.7	500	-11.7	Peak
180.30	H	270.0	175.0	43.4	-6.9	66.9	150	-7.0	QP
312.55	H	345.0	185.0	47.3	-4.1	143.8	200	-2.9	QP
344.73	H	180.0	120.0	44.1	-3.4	108.3	200	-5.3	QP
890.25	H	340.0	125.0	33.2	6.1	92.1	200	-6.7	QP
902.75	H	20	165.0	94.13	35.6 *	3054921.1	--	--	Peak
1029.87	H	170.0	165.0	69.7	-9.1	1075.7	5000	-13.3	Peak
1029.87	H	170.0	165.0	40.5	-9.1	37.1	500	-22.6	AVG
1805.50	H	170.0	165.0	87.5	-5.2	12965.3	305492.1	-27.4	Peak
1805.50	H	170.0	165.0	85.2	-5.2	9949.1	30549.2	-9.7	AVG
2708.25	H	220.0	165.0	52.1	0.0	400.7	5000	-21.9	Peak
2708.25	H	220.0	165.0	43.9	0.0	155.9	500	-10.1	AVG
3611.00	H	220.0	165.0	39.7	2.5	128.2	5000	-31.8	Peak
3611.00	H	220.0	165.0	39.7	2.5	128.2	500	-11.8	Peak

* pre-amp removed for 902.75MHz fundamental (correction factor is different by 30dB)

Table 13: Worst-Case Radiated Test Data, Center Channel, 9.6kbps Mode (30MHz to 10GHz)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (cm)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Detector
312.60	V	340.0	155.0	39.5	-4.1	58.6	200	-10.7	QP
197.27	V	90.0	100.0	36.8	-6.3	33.4	150	-13.0	QP
336.37	V	340.0	200.0	33.0	-3.7	29.1	200	-16.7	QP
613.90	V	345.0	130.0	31.4	1.8	33.2	150	-10.3	QP
1829.50	V	175.0	155.0	85.9	-5.0	80.9	305492.1	-28.8	Peak
1829.50	V	175.0	155.0	84.1	-5.0	79.1	30549	-10.5	AVG
2744.25	V	175.0	155.0	53.0	0.2	53.2	5000	-20.8	Peak
2744.25	V	175.0	155.0	47.5	0.2	47.7	500	-6.3	AVG
195.28	H	340.0	190.0	39.7	-6.7	44.7	150	-10.5	QP
333.38	H	345.0	100.0	32.3	-3.9	26.2	200	-17.7	QP
992.09	H	345.0	170.0	31.2	7.2	38.4	5000	-35.6	Peak
992.09	H	345.0	170.0	31.2	7.2	38.4	500	-15.6	Peak
1829.50	H	220.0	165.0	85.7	-5.0	80.7	305492.1	-28.9	Peak
1829.50	H	220.0	165.0	83.9	-5.0	78.9	30549.2	-10.7	AVG
2744.25	H	220.0	165.0	52.9	0.2	53.1	5000	-20.9	Peak
2744.25	H	220.0	165.0	47.7	0.2	47.9	500	-6.1	AVG

Table 14: Worst-Case Radiated Test Data, High Channel, 9.6kbps Mode (30MHz to 10GHz)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (cm)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Detector
180.30	V	340.0	200.0	34.6	-6.9	24.3	150	-15.8	QP
614.00	V	340.0	155.0	31.0	1.8	43.6	200	-13.2	Peak
960.00	V	25.0	180.0	32.3	6.7	39.0	5000	-35.0	Peak
960.00	V	25.0	180.0	32.3	6.7	39.0	500	-15.0	Peak
1854.50	V	170.0	155.0	85.1	-5.0	10131.1	305492.1	-29.6	Peak
1854.50	V	170.0	155.0	85.1	-5.0	10131.1	30549.2	-9.6	Peak
2781.75	V	200.0	180.0	51.8	0.1	392.1	5000	-22.1	Peak
2781.75	V	200.0	180.0	42.7	0.1	137.5	500	-11.2	AVG
3709.00	V	200.0	180.0	49.6	2.7	412.2	5000	-21.7	Peak
3709.00	V	200.0	180.0	34.8	2.7	75.0	500	-16.5	AVG
344.73	H	345.0	130.0	35.6	-3.4	40.7	200	-13.8	QP
614.00	H	20.0	155.0	30.7	1.8	42.2	200	-13.5	Peak
900.00	H	20.0	155.0	33.4	6.2	95.4	200	-6.4	Peak
1854.50	H	340.0	165.0	84.2	-5.0	9133.9	305492.1	-30.5	Peak
1854.50	H	340.0	165.0	84.2	-5.0	9133.9	30549.2	-10.5	AVG
2781.75	H	340.0	165.0	51.3	0.1	370.2	5000	-22.6	Peak
2781.75	H	340.0	165.0	42.3	0.1	131.3	500	-11.6	AVG
3709.00	H	340.0	165.0	51.5	2.7	513.0	5000	-19.8	Peak
3709.00	H	340.0	165.0	34.6	2.7	73.3	500	-16.7	AVG

Table 15: Worst-Case Radiated Test Data, Low Channel, 76.8kbps Mode (30MHz to 10GHz)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (cm)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Detector
180.30	V	340.0	200.0	34.6	-6.9	24.3	150	-15.8	QP
614.00	V	340.0	155.0	31.0	1.8	43.6	200	-13.2	Peak
900.00	V	340.0	155.0	32.6	6.2	87.1	305492.1	-70.8	Peak
993.58	V	345.0	155.0	32.2	7.2	39.4	5000	-34.6	Peak
993.58	V	345.0	155.0	32.2	7.2	39.4	500	-14.6	Peak
1805.50	V	180.0	150.0	85.0	-5.2	9681.3	305492.1	-30.0	Peak
1805.50	V	180.0	150.0	85.0	-5.2	9722.6	30549.2	-9.9	Peak
312.55	H	350.0	185.0	44.2	-4.1	101.2	200	-5.9	QP
344.73	H	350.0	130.0	35.6	-3.4	40.7	200	-13.8	QP
614.00	H	25.0	155.0	30.7	1.8	42.2	200	-13.5	Peak
900.00	H	25.0	155.0	33.4	6.2	95.4	200	-6.4	Peak
1805.50	H	200.0	165.0	86.1	-5.2	10988.3	305492.1	-28.9	Peak
1805.50	H	200.0	165.0	86.1	-5.2	11035.3	30549.2	-8.8	Peak

Table 16: Worst-Case Radiated Test Data, Low Channel, 153.6kbps Mode (30MHz to 10GHz)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (cm)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Detector
195.28	V	340.0	120.0	36.1	-6.7	29.5	150	-14.1	QP
614.00	V	10.0	165.0	29.9	1.8	38.4	200	-14.3	Peak
900.00	V	10.0	165.0	37.0	6.2	144.3	305492.1	-66.7	Peak
1805.50	V	180.0	150.0	85.0	-5.2	9681.3	305492.1	-30.0	Peak
1805.50	V	180.0	150.0	85.0	-5.2	9722.6	30549.2	-9.9	Peak
197.27	H	270.0	150.0	31.2	-6.3	17.5	150	-18.6	QP
900.00	H	350.0	275.0	38.5	6.2	171.5	305492.1	-65.1	Peak
1805.50	H	200.0	165.0	86.1	-5.2	10988.3	305492.1	-28.9	Peak
1805.50	H	200.0	165.0	86.1	-5.2	11035.3	30549.2	-8.8	Peak
2708.25	H	200.0	165.0	60.0	0.0	994.9	5000	-14.0	Peak
2708.25	H	200.0	165.0	45.0	0.0	176.9	500	-9.0	AVG

Table 17: Worst-Case Radiated Test Data, High Channel, 153.6kbps Mode (30MHz to 10GHz)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (cm)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Detector
333.38	V	90.0	110.0	29.0	-3.9	17.9	200	-21.0	QP
336.37	V	345.0	100.0	35.8	-3.7	40.2	200	-13.9	QP
614.00	H	350.0	275.0	35.5	1.8	73.3	200	-8.7	Peak
927.25	H	350.0	275.0	116.2	6.2	1315463.9	--	--	Peak
960.0	H	350.0	275.0	39.6	6.7	46.3	5000	-27.7	Peak
960.0	H	350.0	275.0	39.6	6.7	46.3	500	-7.7	Peak
1854.50	H	200.0	165.0	87.4	-5.0	13202.5	305492.1	-27.3	Peak
1854.50	H	200.0	165.0	87.4	-5.0	13202.5	30549.2	-7.3	Peak
2781.75	H	200.0	165.0	56.6	0.1	681.4	5000	-17.3	Peak
2781.75	H	200.0	165.0	35.9	0.1	62.9	500	-18.0	AVG
3709.00	H	200.0	165.0	53.7	2.7	660.8	5000	-17.6	Peak
3709.00	H	200.0	165.0	34.3	2.7	70.8	500	-17.0	AVG

3.9 AC Conducted Emissions

3.9.1 Requirements

Compliance Standard: FCC Part 15.207, Class B

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

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 1 X 1.5-meter 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 §15.107 for quasi-peak and average measurements. At frequencies where quasi-peak or peak measurements comply with the average limit, no average measurements need be performed.

Environmental Conditions during Conducted Emissions Testing

Ambient Temperature:	19 °C
Relative Humidity:	24%

3.9.3 Conducted Data Reduction and Reporting

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

Spectrum Analyzer Voltage: VdBµV (SA)

LISN Correction Factor: LISN dB

Cable Correction Factor: CF dB

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

3.9.4 Test Data

The EUT complied with the Class B Conducted Emissions requirements. The conducted emissions test data results are provided in the following table.

Table 18: AC Conducted Emissions Test Data

NEUTRAL										
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)**
0.298	22.7	15.9	10.04	0.4	33.1	26.4	60.3	50.3	-27.2	-20.9
0.459	18.4	11.6	10.04	0.3	28.7	22.0	56.7	46.7	-28.0	-24.7
0.601	18.4	11.9	10.04	0.3	28.8	22.2	56.0	46.0	-27.2	-23.8
1.402	13.9	6.6	10.04	0.3	24.2	17.0	56.0	46.0	-31.8	-29.0
2.070	13.1	6.2	10.04	0.3	23.5	16.5	56.0	46.0	-32.5	-29.5
28.339	12.0	5.1	10.32	3.0	25.2	18.4	60.0	50.0	-34.8	-31.6
PHASE / 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)**
0.393	19.6	12.9	10.04	0.3	29.9	23.2	58.0	48.0	-28.1	-24.8
0.728	15.6	8.8	10.04	0.3	25.9	19.1	56.0	46.0	-30.1	-26.9
0.860	15.1	8.3	10.04	0.3	25.4	18.6	56.0	46.0	-30.6	-27.4
1.081	17.3	8.8	10.04	0.3	27.6	19.1	56.0	46.0	-28.4	-26.9
2.203	12.5	5.5	10.04	0.3	22.8	15.9	56.0	46.0	-33.2	-30.1
21.145	12.0	5.8	10.20	1.1	23.3	17.1	60.0	50.0	-36.7	-32.9

4 Measurements

4.1.1 References

ANSI C63.2 (1/2016) Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 (1/2014) 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 (9/2020) American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

4.2 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

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

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 19 below.

Table 19: Expanded Uncertainty List

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

5 Test Equipment

Table 20: Test Equipment List

Test Name:	**Benchtop RF Emissions**	Test Date: 12/2/2024 to 12/9/2024	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00993	KEYSIGHT MXA-N9020B	SPECTRUM ANALYZER	11/6/2025
00834	ULTIFLEX, MFLEX-0300	SMA COAXIAL CABLE	Verify Before Use
N/A	WEINSCHEL, 10W MAX	30DB ATTENUATOR	Verify Before Use

Test Name:	**Radiated Emissions**	Test Date: 12/9/2024 to 12/13/2024	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00993	KEYSIGHT MXA-N9020B	SPECTRUM ANALYZER	11/6/2025
00382	SUNOL SCIENCES CORP.	BICONALOG ANTENNA	6/12/2027
00004	ARA, DRG-118/A	HORN ANTENNA	6/7/2027
00977	JUNKOSHA, MWX322	ARMORED COAX. CABLE	12/26/2024
00806	MINI-CIRCUITS	SMA COAXIAL CABLE	12/26/2024
00731	NARDA 4779-3	2W, 3DB ATTENUATOR	6/20/2025
00276	ELECTRO-METRICS	RF PRE-AMPLIFIER	6/25/2025
00066	B&Z (HP), BZ-01002650	PRE-AMPLIFIER	3/29/2025
00742	PENN ENG., WR284	WAVEGUIDE PASS FILTER	6/27/2025
00281	ITC. 21A-3A1	WAVEGUIDE PASS FILTER	6/27/2025
00885	ULTIFLEX, UFA-2108-360	SMA COAXIAL CABLE	6/25/2025
00721	WEINSCHEL, DS109	TUNABLE ATTENUATOR	Verify Before Use

Test Name: **AC Powerline Conducted**		Test Date: 2/10/2025	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00823	AGILENT N9010A	EXA SPECTRUM ANALYZER	6/21/2026
00053	HP 11947A	LIMITER TRANSIENT	1/11/2026
00330	WLL CE SITE CABLE	BNC COAXIAL CABLE	6/25/2025
00125	SOLAR 8028-50-TS-24-BNC	LISN	4/18/2025
00126	SOLAR 8028-50-TS-24-BNC	LISN	4/18/2025