Washington Laboratories, Ltd.

FCC PCII Test Report

for the

Bluetooth Dock

FCC ID: RS2SXBTD1

REPORT# 16385-01 -01 REV 3

Prepared for:

Sirius XM Satellite Radio

1500 Eckington Place NE

Washington, District of Columbia 20002

Prepared By:

Washington Laboratories, Ltd.

4840 Winchester Blvd., Suite 5

Frederick, Maryland 21703

FCC & ISED Canada PCII Test Report

for the

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Bluetooth Dock

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Re-Issued

WLL REPORT# 16385-01 -01 REV 3

Prepared by:

John P. Repella
Manager, EMC & Wireless Services

Reviewed by:

Steven D. Koster
President

ABSTRACT

This report has been prepared on behalf of Sirius XM Satellite Radio to support the Permissive Change II . The test report and application are submitted for a Frequency Hopping Spread Spectrum (FHSS) Transmitter under Part 15.247 of the FCC Rules and Regulations and Spectrum Management and Telecommunications Policy and under RSS-247 of Innovation, Science and Economic Development Canada (ISED). This PCII Test Report documents the test configuration and test results for the Sirius XM Satellite Radio Bluetooth Dock (PCB) and hardware changes.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 4840 Winchester Blvd. 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. The ISED Canada OATS number is 3035A for Washington Laboratories, Ltd. Site 1. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Certificate AT-1448 as an independent FCC test laboratory.

The Sirius XM Satellite Radio Bluetooth Dock complies with the limits for a Frequency Hopping Spread Spectrum (FHSS) Transmitter device under FCC Part 15.247.

Revision History	Description of Change	Date
Rev 0	Initial Release	February 21, 2020
Rev 1	Corrected typos in Table 1, and the correct antenna description	February 24, 2020
Rev 2	Updated to the correct FHSS report	April 9, 2020
Rev 3	Corrected measurement reference for C63.10	April 10, 2020

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1 INTRODUCTION

1.1 COMPLIANCE STATEMENT

The Sirius XM Satellite Radio Bluetooth Dock complies with the limits for a Frequency Hopping Spread Spectrum (FHSS) Transmitter device under FCC Part 15.247.

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.

1.3 CONTRACT INFORMATION

Customer:	Sirius XM Satellite Radio
Address	1500 Eckington Place NE
	Washington, District of Columbia 20002
Purchase Order Number:	PO 405400 .
Quotation Number:	71867

1.4 TEST DATES

Testing was performed on the following date(s): 1/27/2020, 1/28/2020 & 1/29/2020

1.5 TEST AND SUPPORT PERSONNEL

Washington Laboratories, LTD	John P. Repella
Customer Representative	Beejay Jolayemi

2 EQUIPMENT UNDER TEST

2.1 EUT IDENTIFICATION & DESCRIPTION

Table 1: Device Summary

Item	Bluetooth Dock
Manufacturer:	Sirius XM Satellite Radio
FCC ID:	RS2SXBTD1
ISED ID:	[ICID]
Model:	Bluetooth Dock
Serial Number of Unit Tested	Test Sample 1(Conducted) & Test Sample 2(Radiated)
FCC Rule Parts:	§15.247 (10/2014)
ISED Rule Parts:	RSS-247 Issue 2, RSS-247
Operating Frequency Range:	2402-2480MHz
Maximum Output Power:	0.0051W (7.06dBm)
Modulation:	GFSK; Π/4DQPSK, Π/8DPSK(BE +EDR)
Data Rate(s):	1Mbps, 2Mbps & 3Mbps
Occupied Bandwidth (6dB):	1.102MHz @2440MHz
Occupied Bandwidth (99%):	1.2589MHz
FCC Emission Designator:	1M10G1D
ISED Emissions Designators:	1M25G1D
Keying:	Automatic
Type of Information:	Data
Power Output Level	Fixed
Highest TX Spurious Emission:	357.1uV/m @4880.0MHz
Highest RX Spurious Emission:	57.6uV/m @ 71.91MHz
Antenna Connector	N/A
Antenna Type	PCB Trace
Interface Cables:	DC Power
Power Source & Voltage:	12Vdc Provided from vehicle battery

The Equipment Under Test (EUT) is a Bluetooth Dock for Sirius XM Satellite Radio.

2.2 TEST CONFIGURATION

The Bluetooth Dock was configured for bench conducted and radiated emissions testing. Two devices were provided to allow for this testing. One device was configured for antenna port conducted emissions where the antenna was removed and replaced with an SMA connector. The second device was configured as would normally be constructed for the radiated emissions testing.

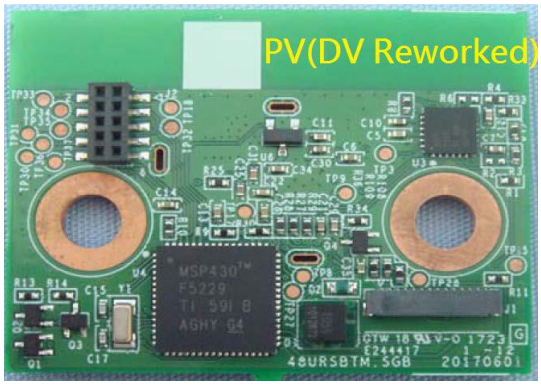
2.3 HARDWARE & PCB CHANGES

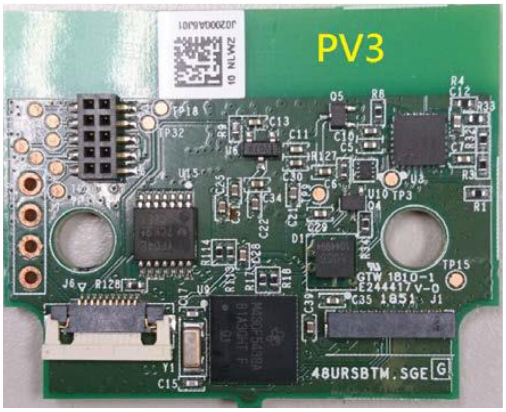
Component changes to improve overall performance of the device.

Schematic:

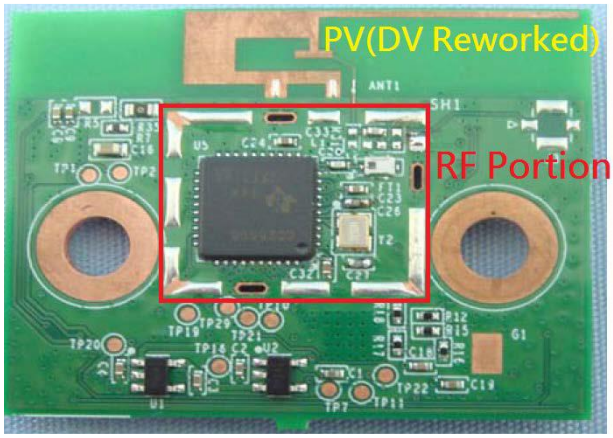
1. Changed the value of R108 to 1.2Kohm.
2. Changed the value of R109 to 270Kohm.
3. Removed U4, C18, C19, C14, R10, R12, R15 and R30.
4. Removed R25, R27, R28 and R29.
5. Added Q206, Q209, D3, U9, U10, U11 and U15.
6. Added R111, R128, R129, R130, R131, R132, R133, R114 and R113.
7. Added C36, C43, C38, C39, C40 and C41.
8. Added J6.

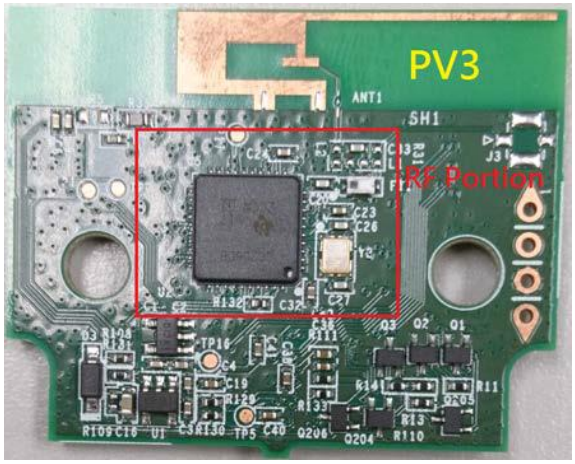
Photograph 1: Top Side Changes





Photograph 2: Bottom Side Changes





2.4 TEST LOCATION

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 4840 Winchester Blvd. 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. The ISED Canada OATS number is 3035A for Washington Laboratories, Ltd. Site 1. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Certificate AT-1448 as an independent FCC test laboratory.

2.5 MEASUREMENTS

2.5.1 References

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

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

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

ANSI C63.26 (Dec 2015) American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services

2.6 MEASUREMENT UNCERTAINTY

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

Equation 1: Standard Uncertainty

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

Where u_c = standard uncertainty

a, b, c,.. = individual uncertainty elements

$Div_{a, b, c}$ = 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

$k \leq 2$ for 95% coverage (ANSI/NCSL Z540-2 Annex G)

u_c = 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 2 below.

Table 2: 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

3 TEST EQUIPMENT

Table 3 shows a list of the test equipment used for measurements along with the calibration information.

Table 3: Test Equipment List

Test Name:	**Bench Conducted & Radiated Emissions**	Test Date:	**01/29/2020**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00382	SUNOL SCIENCES CORP/ JB1	HHYBRID ANTENNA	3/21/2020
00558	HP/8447D	RF PREAMP	4/3/2020
00522	HP/8449B	RF PREAMP	4/4/2020
00849	AH SYSTEMS/ SAC-18G-16	RF COAXIAL CABLE	1/20/2020
00915	WLL STAFF/ LMR-240	RF COAXIAL CABLE	10/12/2020
00626	ARA/ DRG-118/A	DOUBLE RIDGE HORN ANTENNA	3/7/2020
00823	AGILENT/ N9010A	SPECTRUM ANALYZER	3/21/2020
Loaner(HNS) MY57431184	AGILENT/9020B	SPECTRUM ANALYZER	08/10/2020

4 TEST RESULTS

The Table Below shows the results of testing for compliance with a FHSS device in accordance with FCC Part 15.247 10/2014 and RSS-247 Issue 3. Full test results are shown in subsequent sub-sections.

Table 4: Test Summary Table

FCC Rule Part	Description	Result
15.247 (b)(1)	Transmit Output Power	Pass
15.247 (d)	Out-of-Band Emissions (Band Edge @ 20dB below)	Pass
15.205 15.209	General Field Strength Limits (Restricted Bands & RE Limits)	Pass
15.207	AC Conducted Emissions	Not Applicable

4.1 OCCUPIED BANDWIDTH:

Occupied bandwidth was performed by monitoring the output of the EUT antenna port with a spectrum analyzer corrected for any cable/attenuator losses.

Table 5: Occupied Bandwidth Spectrum Analyzer Settings

Resolution Bandwidth	Video Bandwidth
100kHz	300kHz

At full modulation, the occupied bandwidth was measured as shown in Figures 1-6. Visual inspection shows the unit still meets the FCC 15.247a,1 requirements.

Table 6 provides a summary of the Occupied Bandwidth Results.

Table 6: Occupied Bandwidth Results

(2edr)

Frequency	Bandwidth(6dB)	Bandwidth(99%)	Limit	Pass/Fail
Low Channel 2402MHz	1.091MHz	1.2431MHz	None	Pass
Center Channel 2440MHz	1.087MHz	1.2429MHz	None	Pass
High Channel 2480MHz	1.087MHz	1.2506MHz	None	Pass

(3edr)

Frequency	Bandwidth(6dB)	Bandwidth(99%)	Limit	Pass/Fail
Low Channel 2402MHz	1.097MHz	1.2525MHz	None	Pass
Center Channel 2440MHz	1.102MHz	1.2514MHz	None	Pass
High Channel 2480MHz	1.092MHz	1.2589MHz	None	Pass

Figure 1: Occupied Bandwidth, Low Channel (2edr)

Figure 2: Occupied Bandwidth, Center Channel (2edr)

Figure 3: Occupied Bandwidth, High Channel(2edr)

Figure 4: Occupied Bandwidth, Low Channel (3edr)

Figure 5: Occupied Bandwidth, Center Channel (3edr)

Figure 6: Occupied Bandwidth, High Channel (3edr)

4.2 RF POWER OUTPUT:

To measure the output power the unit was set to dwell on the low, high and middle channel with a continuous 100% duty cycle.

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

Output power and spurious emissions were tested unmodulated mode and represents the worst-case results.

4.2.1 Measurement Method:

ANSI C63.10 section "7.8.5 output power test procedure for FHSS.

Table 7: Spectrum Analyzer Settings

Resolution Bandwidth	Video Bandwidth
1MHz	3MHz

Table 8: RF Power Output Summary

Frequency	Level (dBm)	Limit (dBm)	Pass/Fail
Low Channel: 2402MHz	5.76dBm	30 dBm	Pass
Center Channel: 2442MHz	6.43dBm	30 dBm	Pass
High Channel: 2480MHz	7.06dBm	30 dBm	Pass

Figure 7: RF Peak Power, Low Channel

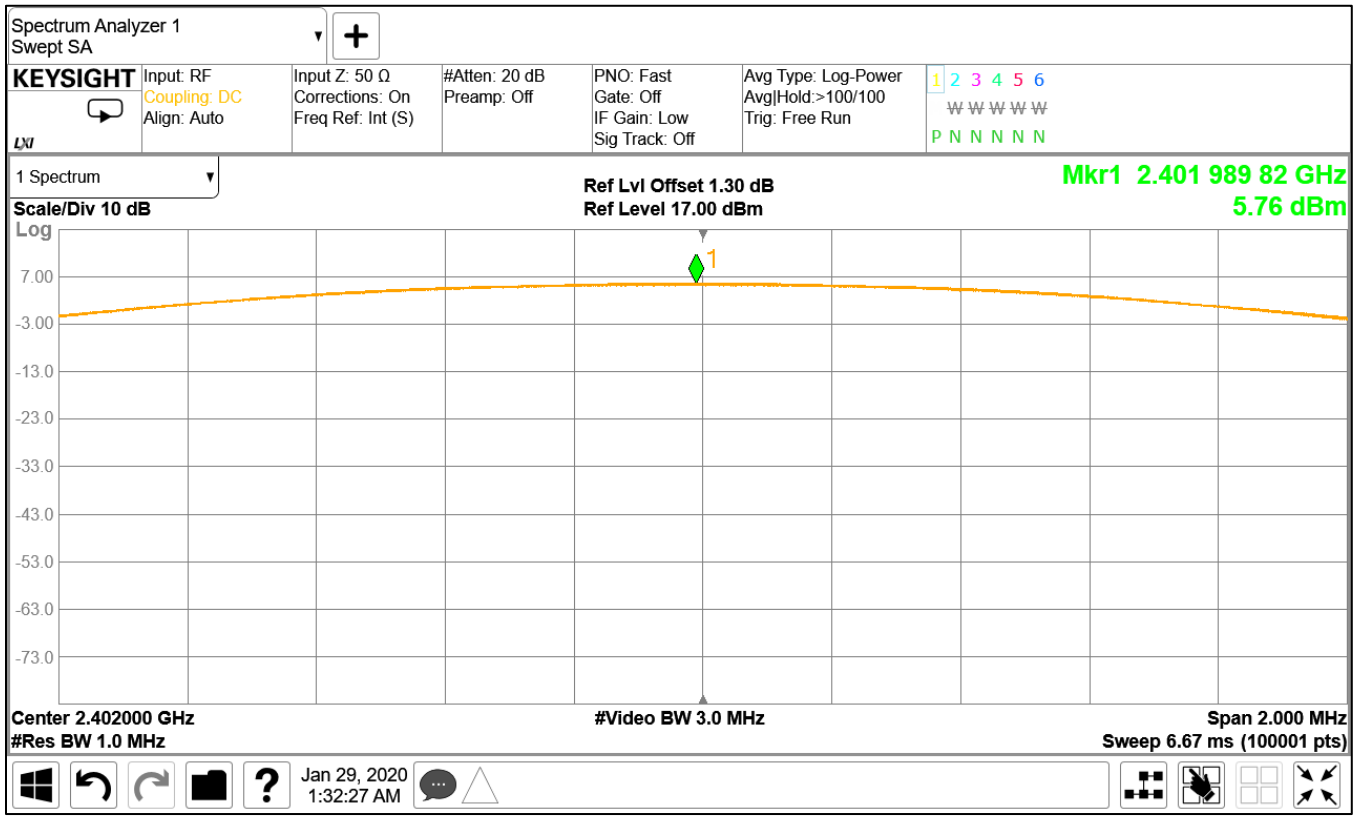
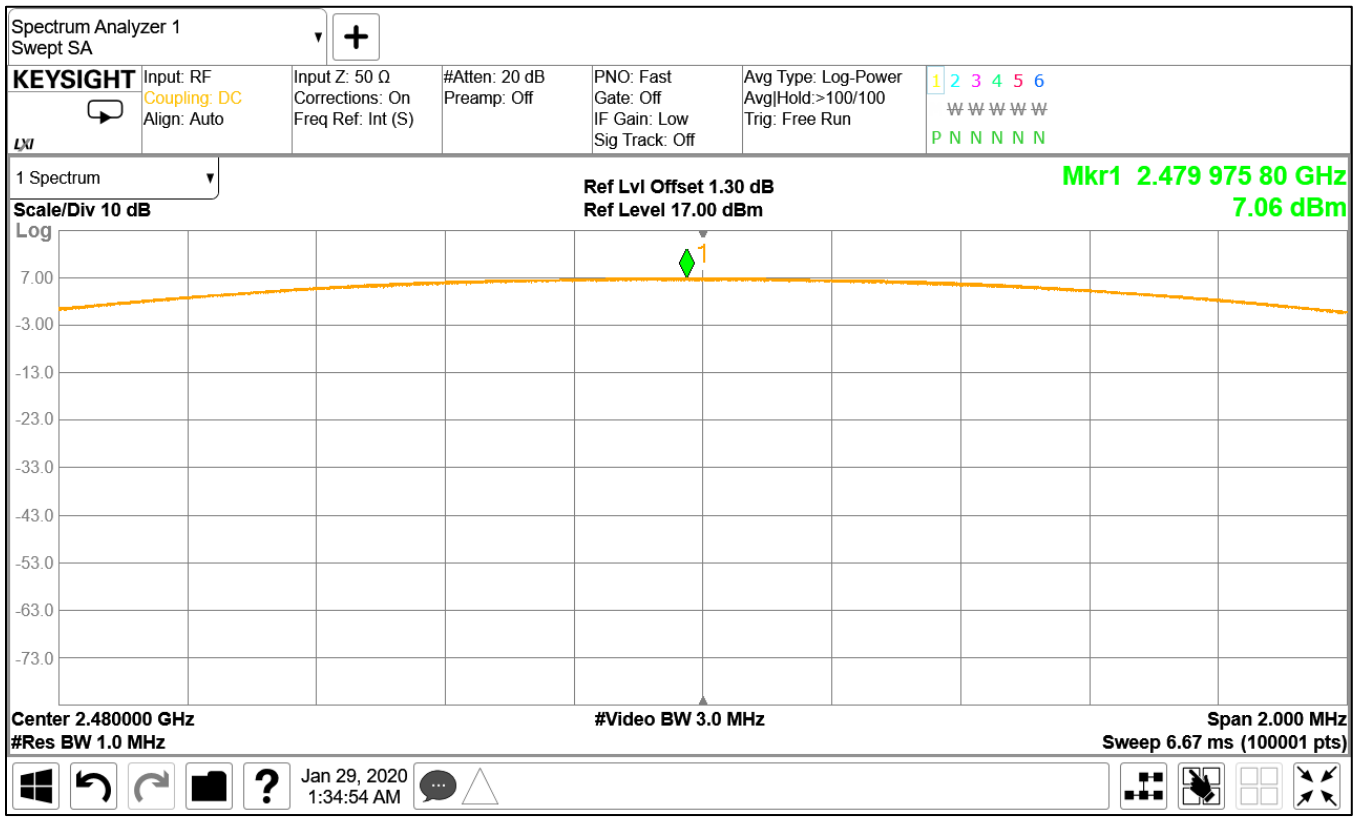


Figure 8: RF Peak Power, Mid Channel

Figure 9: RF Peak Power, High Channel



4.3 CONDUCTED SPURIOUS EMISSIONS COMPLIANCE

The EUT must comply with requirements for spurious emissions. Per §15.247(d) all spurious emissions in any 100 kHz bandwidth outside the frequency band in which the spread spectrum device is operating shall be attenuated 20 dB below the highest power level in a 100 kHz bandwidth within the band containing the highest level of the desired power.

Per ANSI C63.10 section 11.11 "Emissions in non-restricted frequency bands" this test may be performed in an antenna port conducted manner. The spectrum analyzer resolution bandwidth was set to 100 kHz and the video bandwidth was set to 300 kHz. The amplitude of the EUT carrier frequency was measured to determine the emissions limit (20 dB below the carrier frequency amplitude). The emissions outside of the allocated frequency band were then scanned from 30 MHz up to the tenth harmonic of the carrier.

As per ANSI C63.10 section 11.11.2 the center channel has the highest PSD in a 100 kHz bandwidth and the limit for all channels was based on this level.

The following table shows the spurious emissions data.

4.3.1 Test Summary

The EUT complied with the requirements for Spurious emissions at the antenna port.

Figure 10: Band Edge Compliance (Low Channel Non-hop)

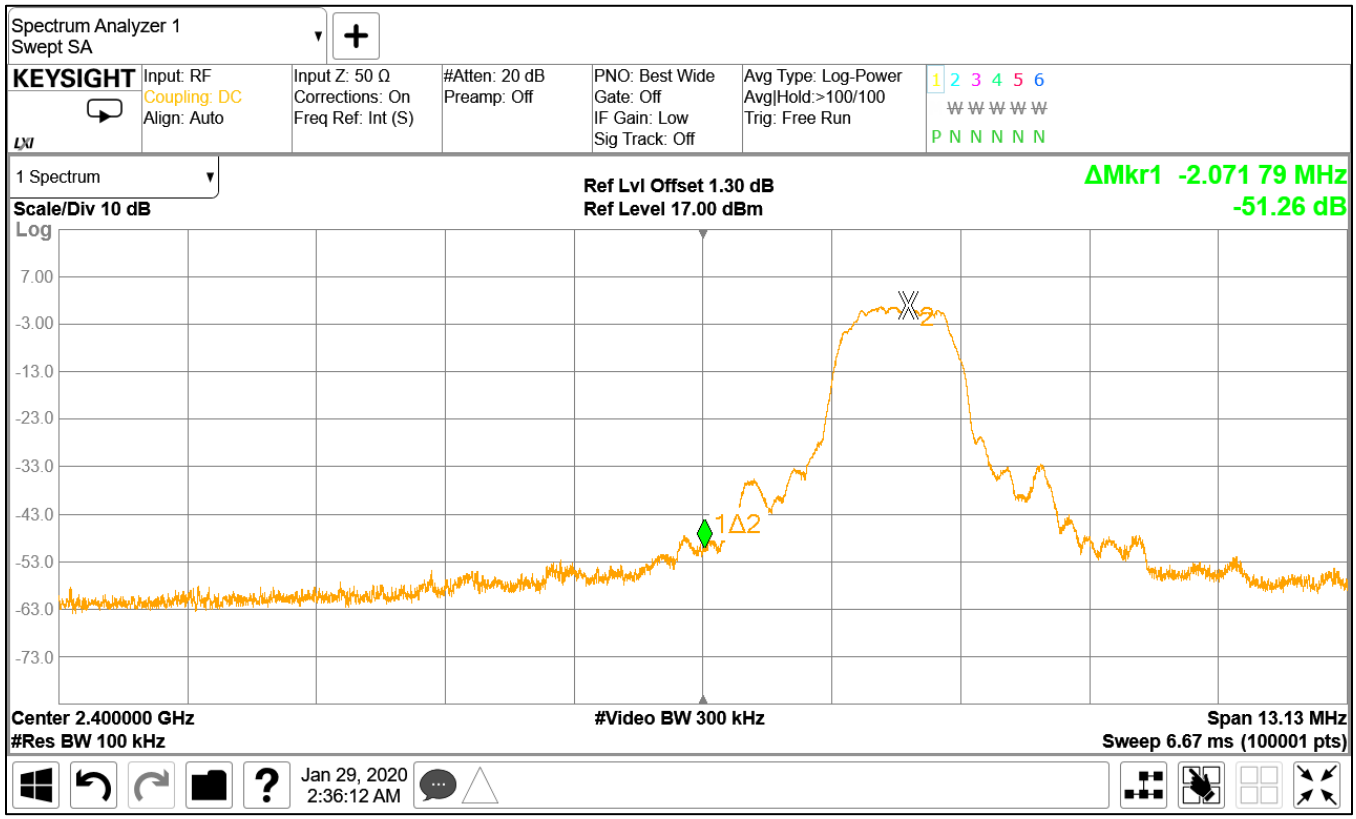


Figure 11: Band Edge Compliance (Low Channel Hopping)

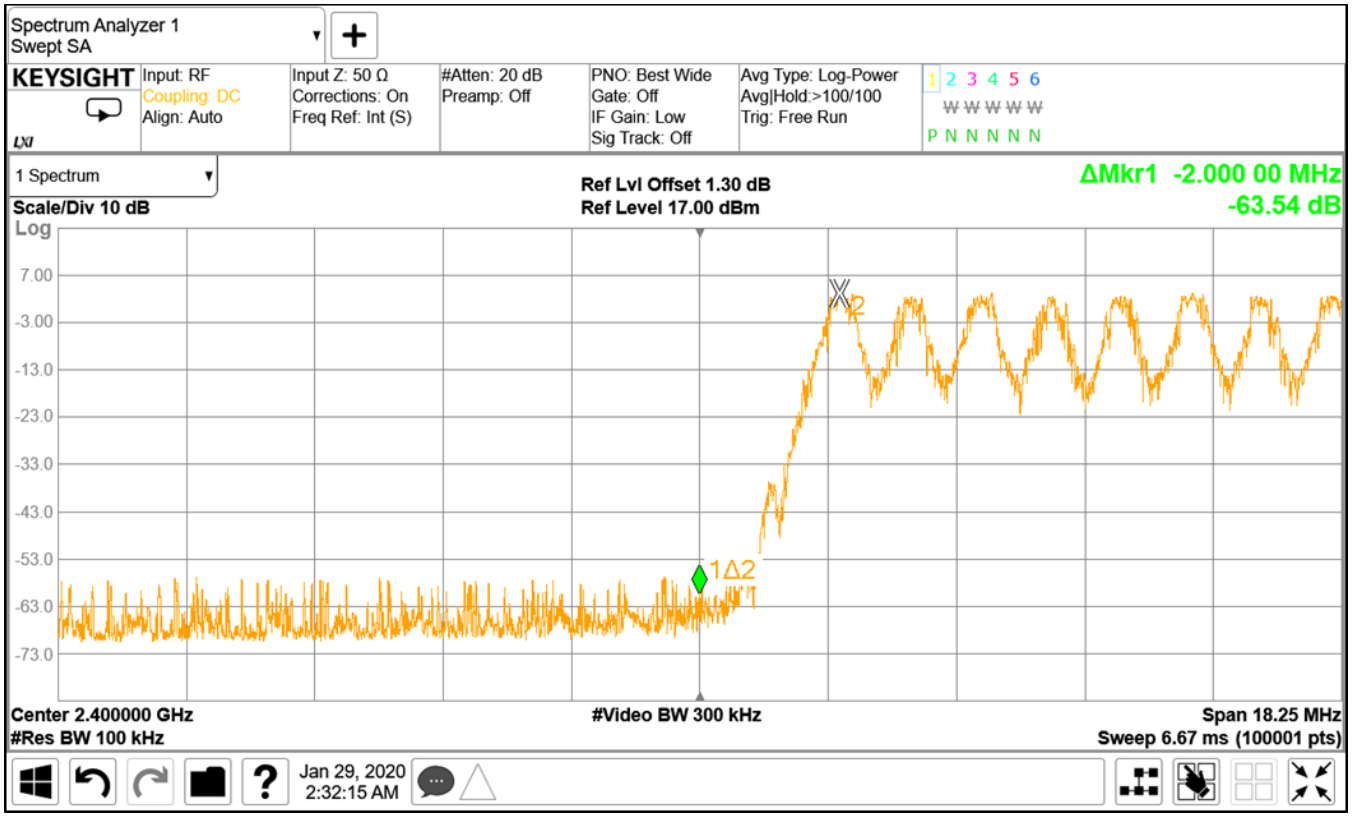


Figure 12: Band Edge Compliance (High Channel Non-Hop)

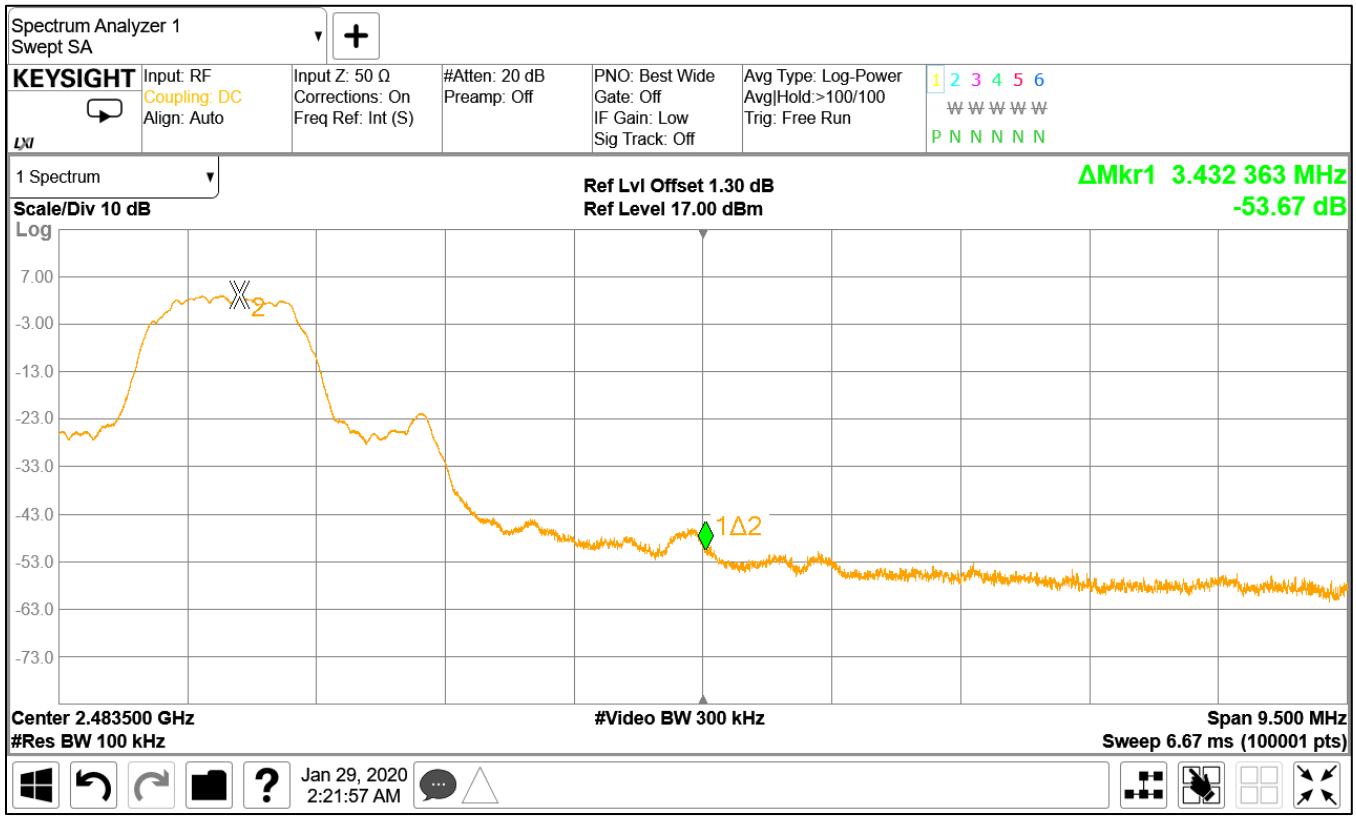


Figure 13: Band Edge Compliance (High Channel Hopping)

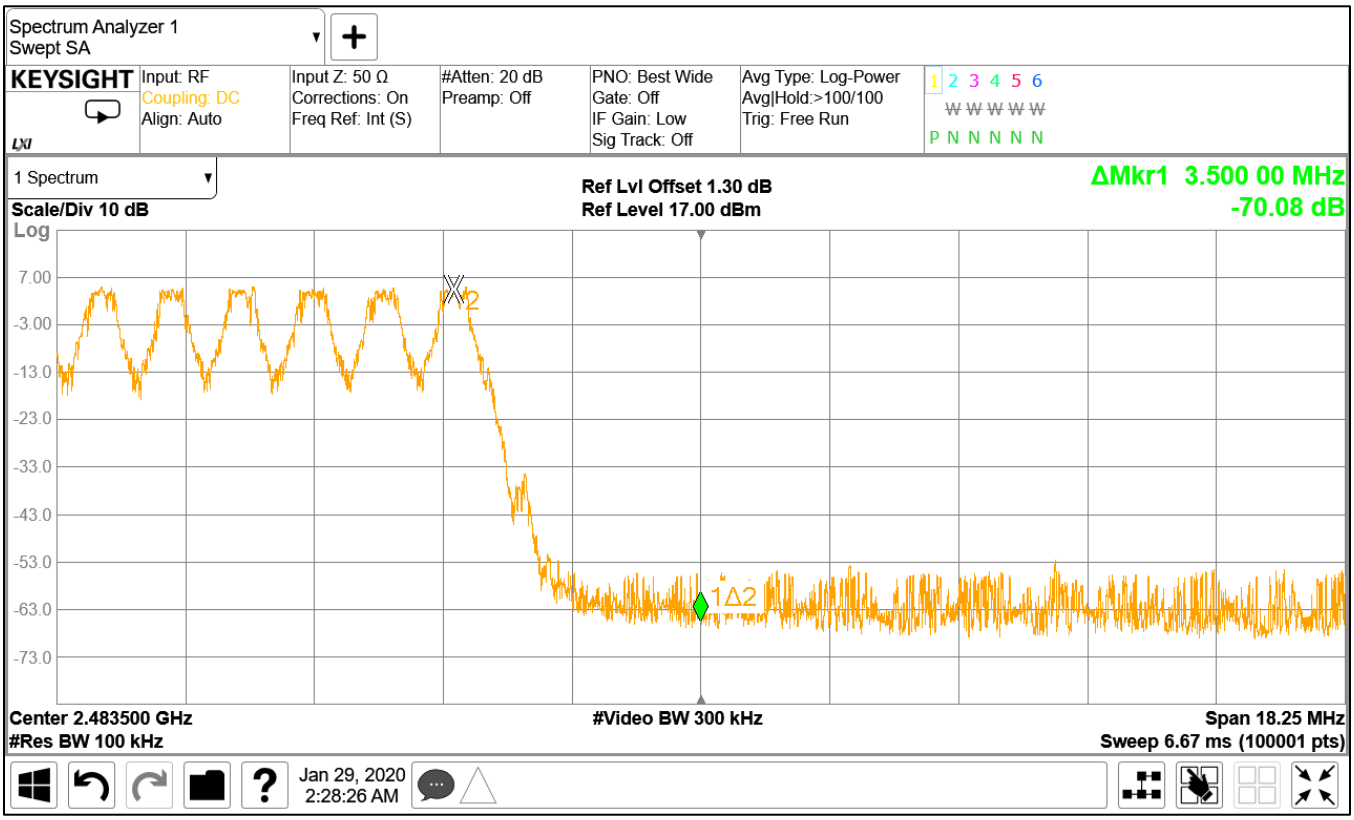


Figure 14: Low Channel Conducted Spurious Plot 1

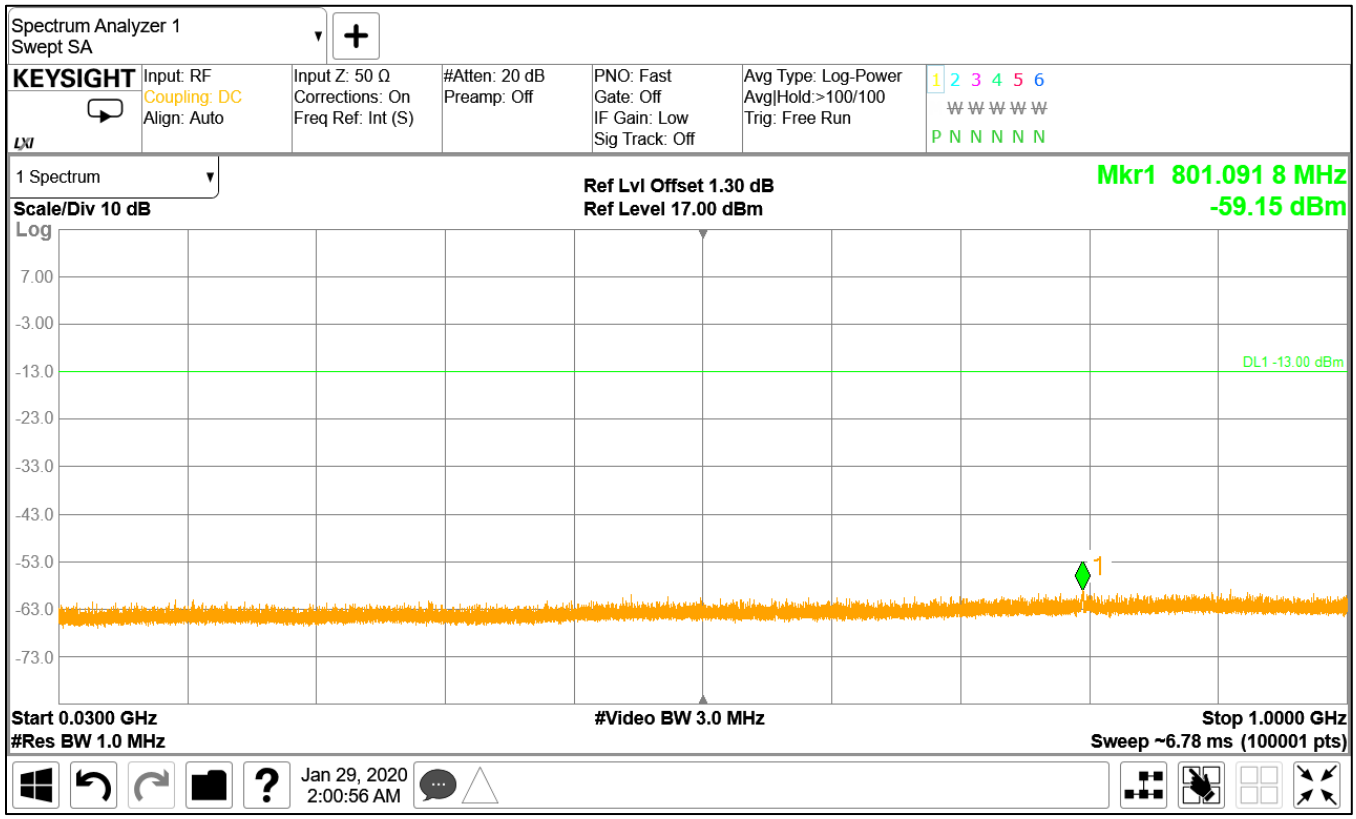


Figure 15: Low Channel Conducted Spurious Plot 2

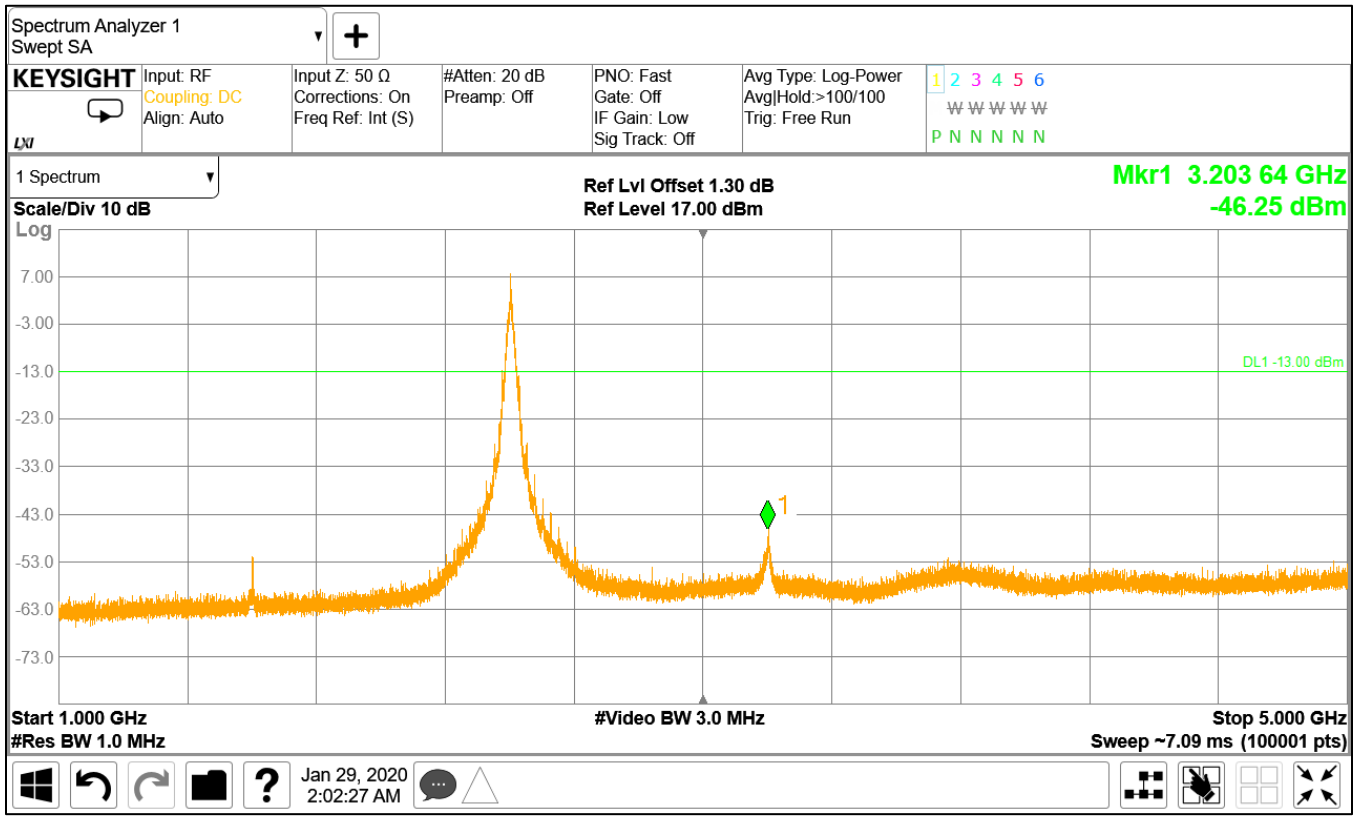


Figure 16: Low Channel Conducted Spurious Plot 3

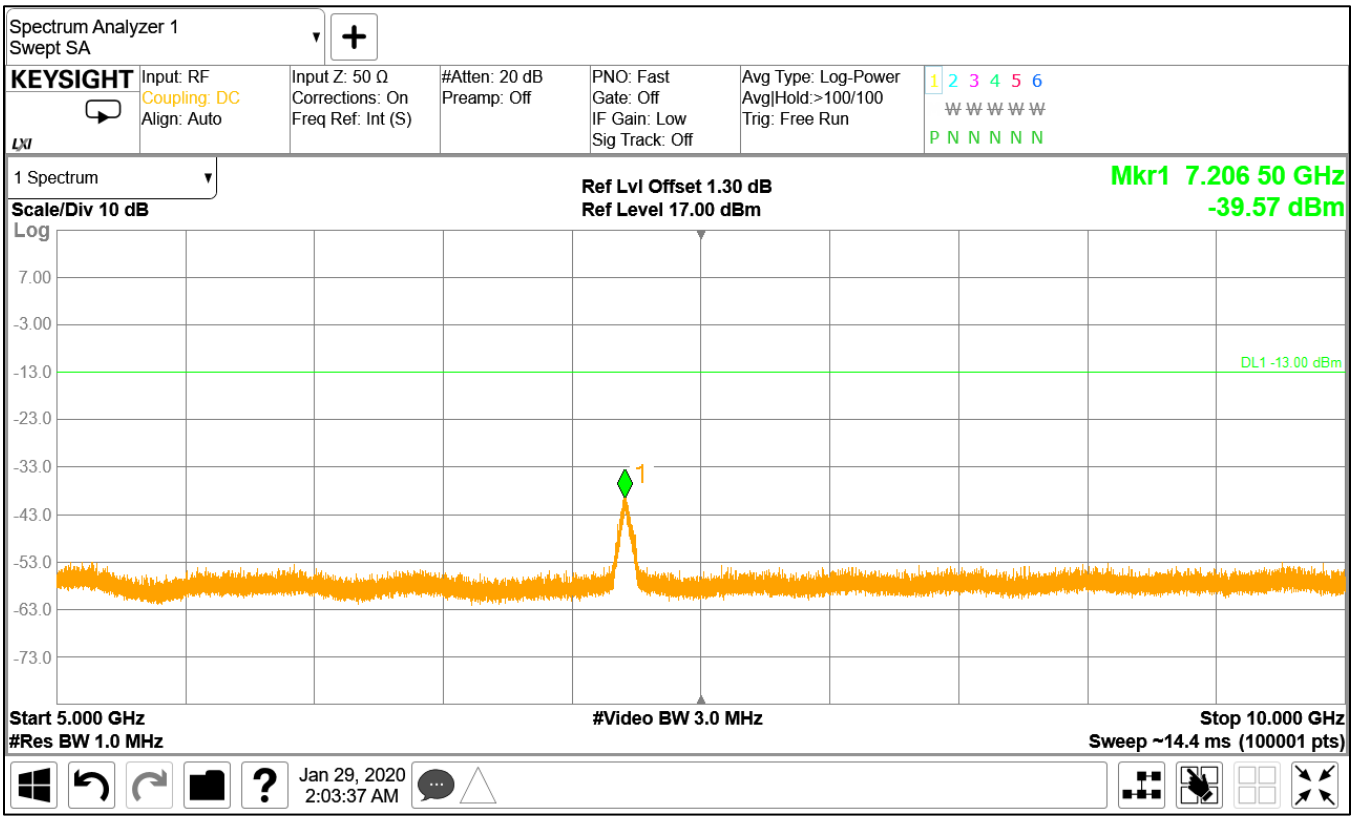


Figure 17: Low Channel Conducted Spurious Plot 4

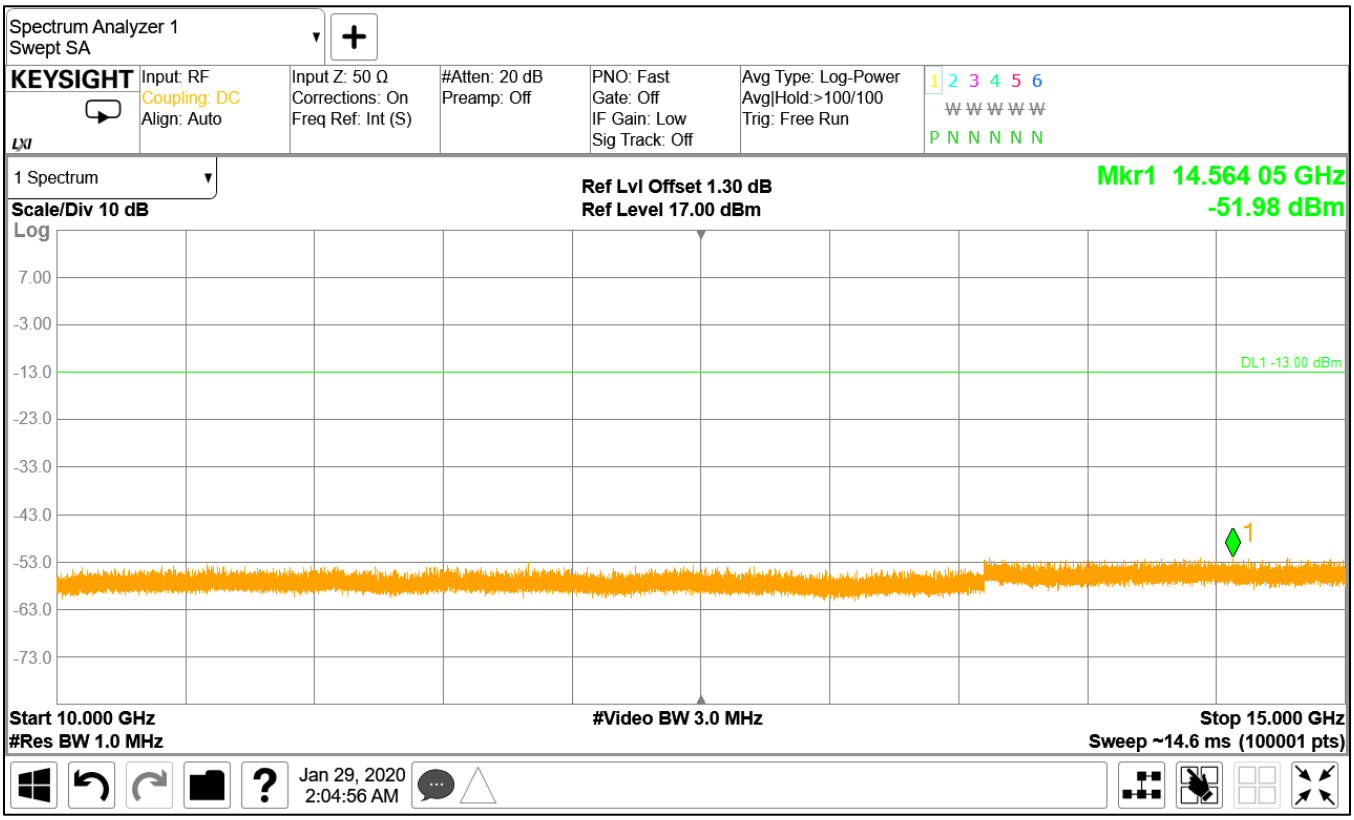


Figure 18: Low Channel Conducted Spurious Plot 5

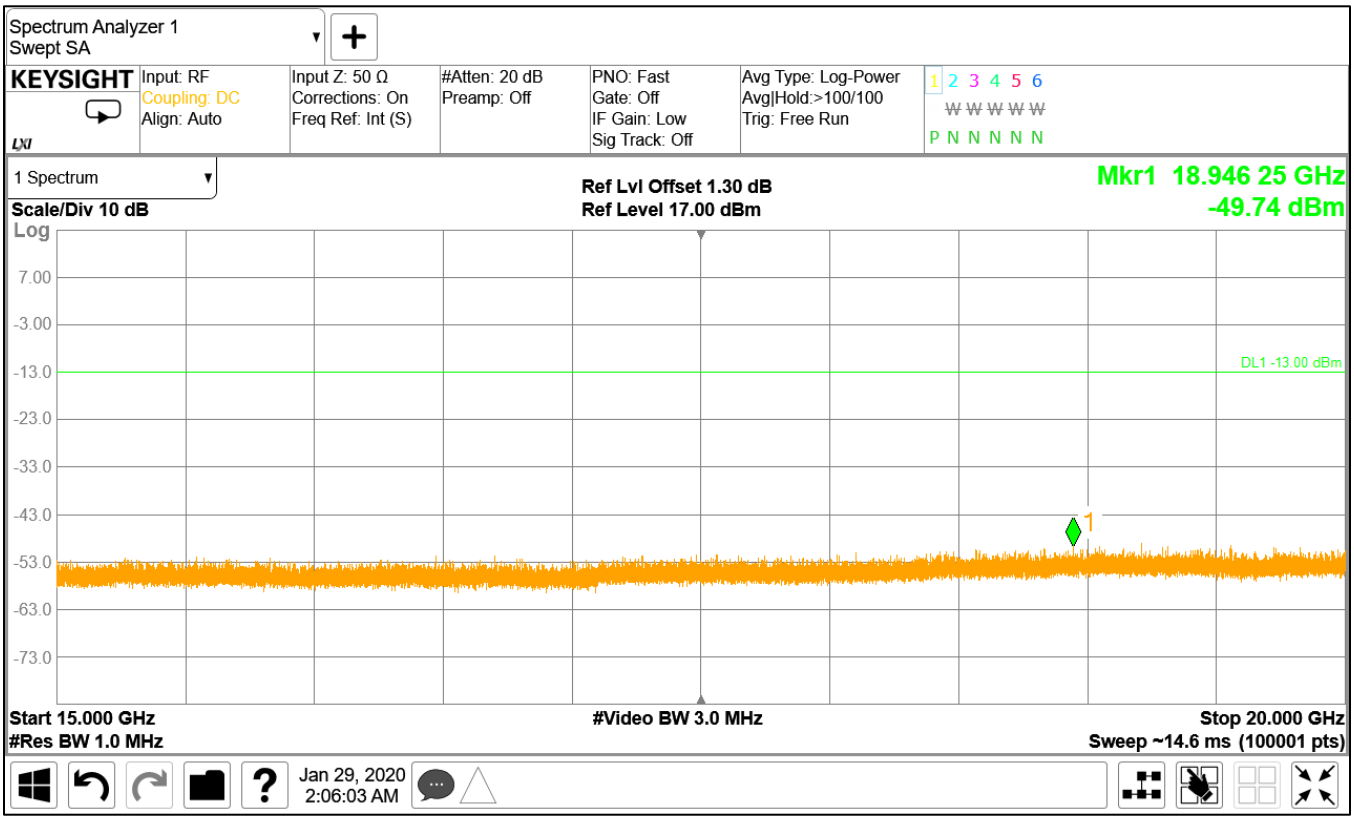


Figure 19: Low Channel Conducted Spurious Plot 6

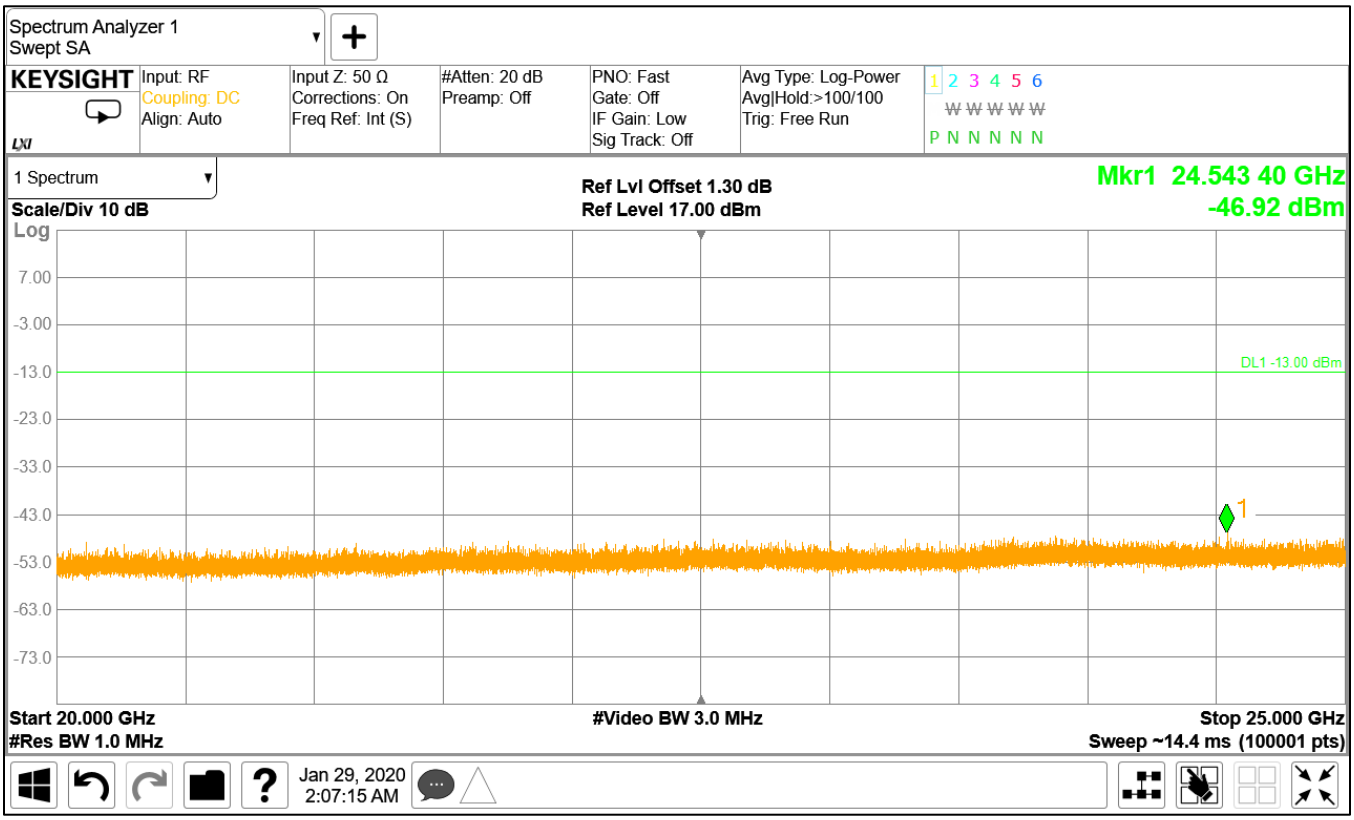


Figure 20: Center Channel Conducted Spurious Plot 1

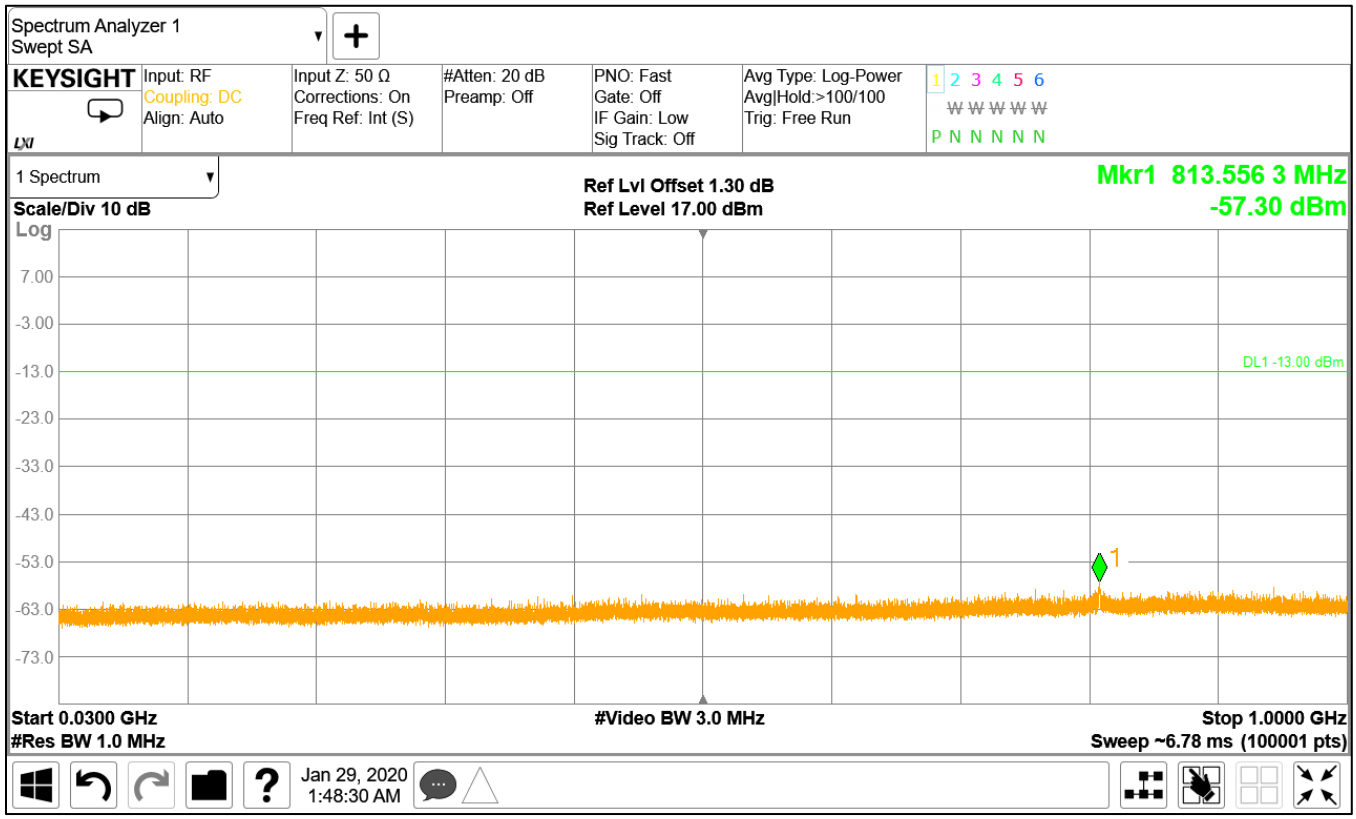


Figure 21: Center Channel Conducted Spurious Plot 2

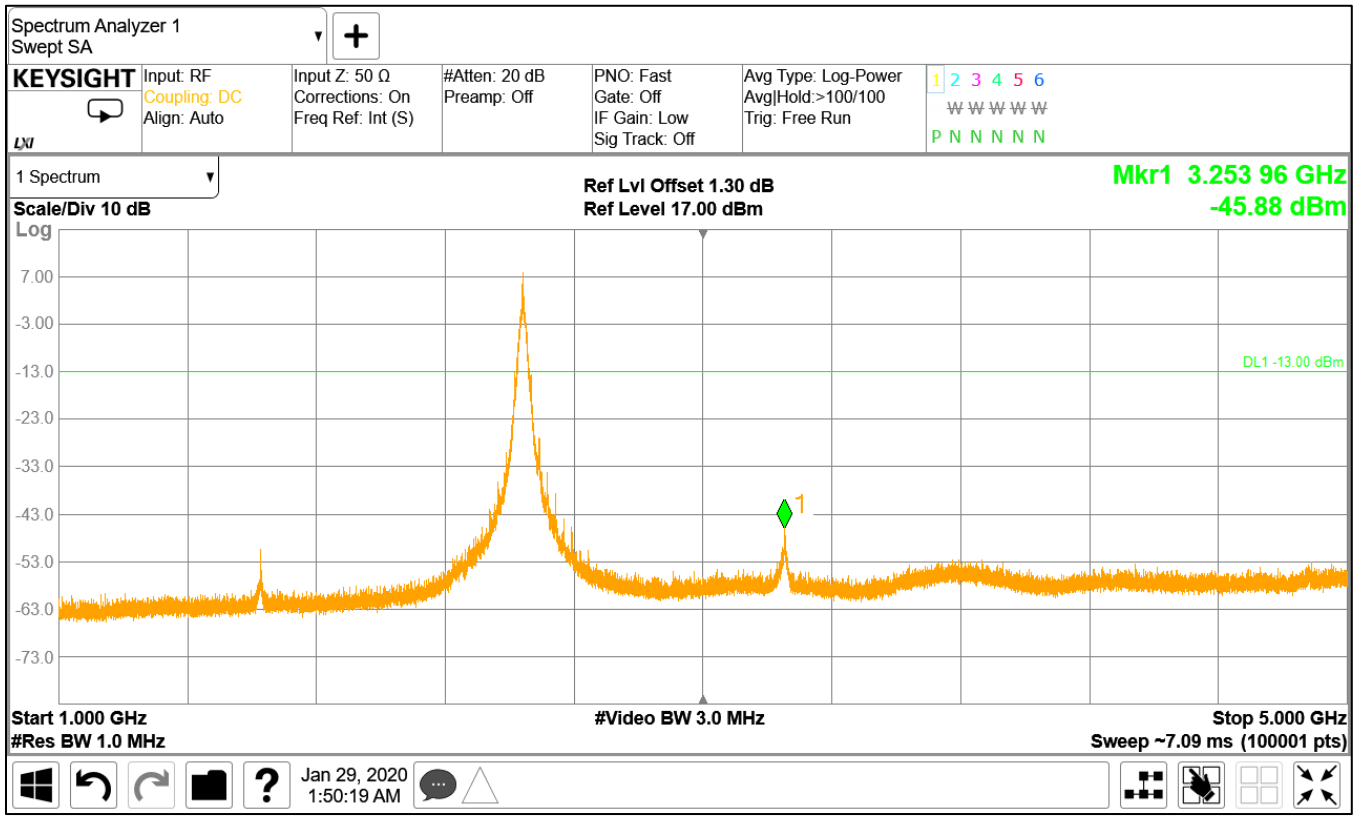


Figure 22: Center Channel Conducted Spurious Plot 3

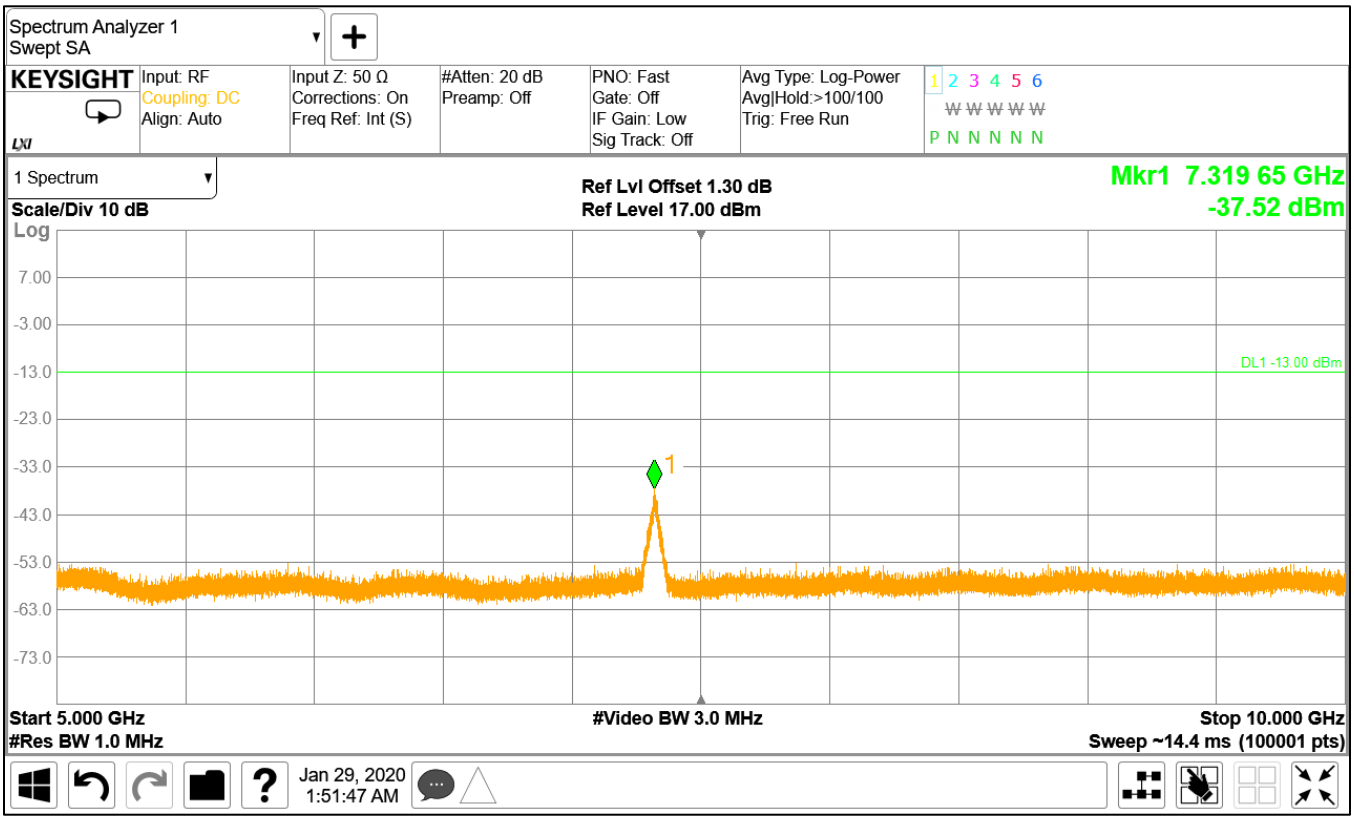


Figure 23: Center Channel Conducted Spurious Plot 4

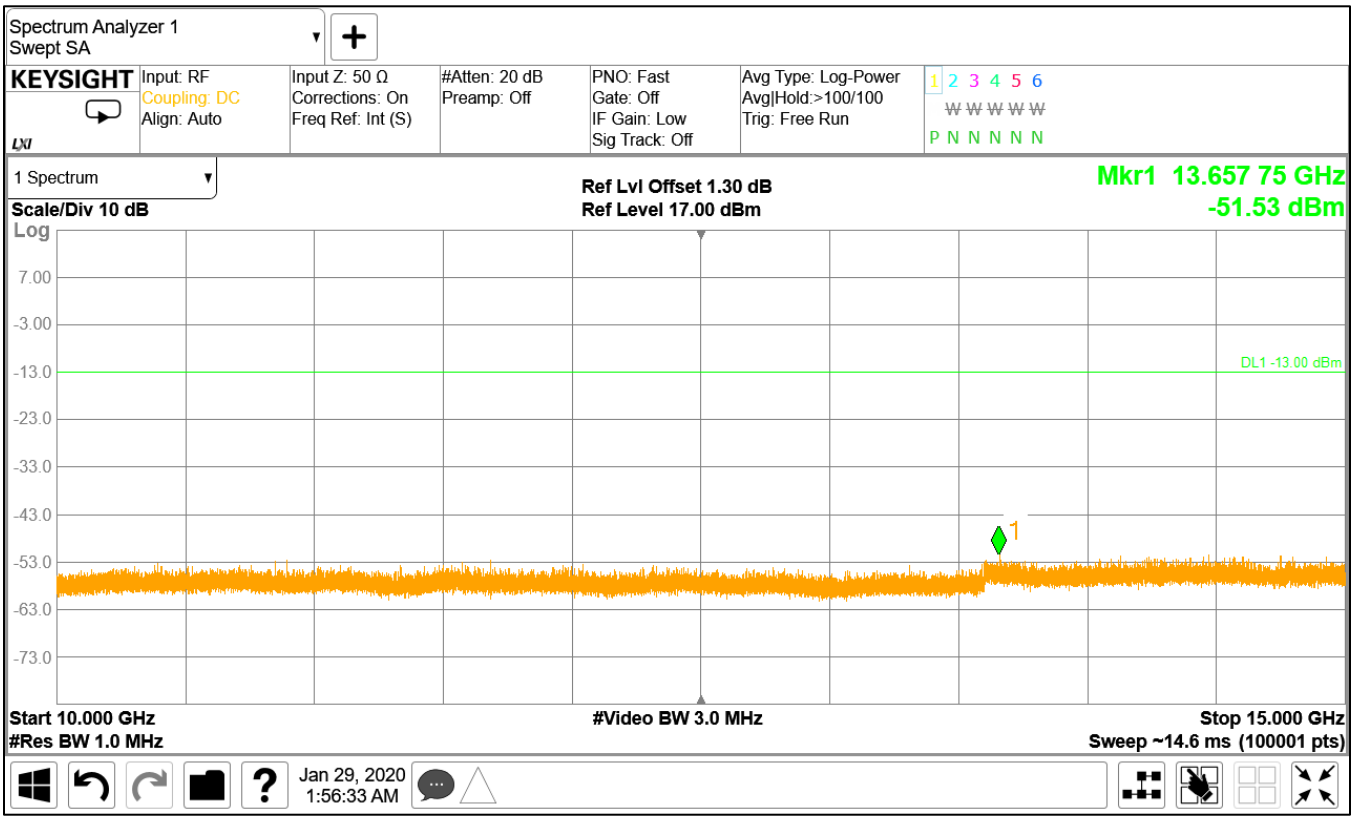


Figure 24: Center Channel Conducted Spurious Plot 5

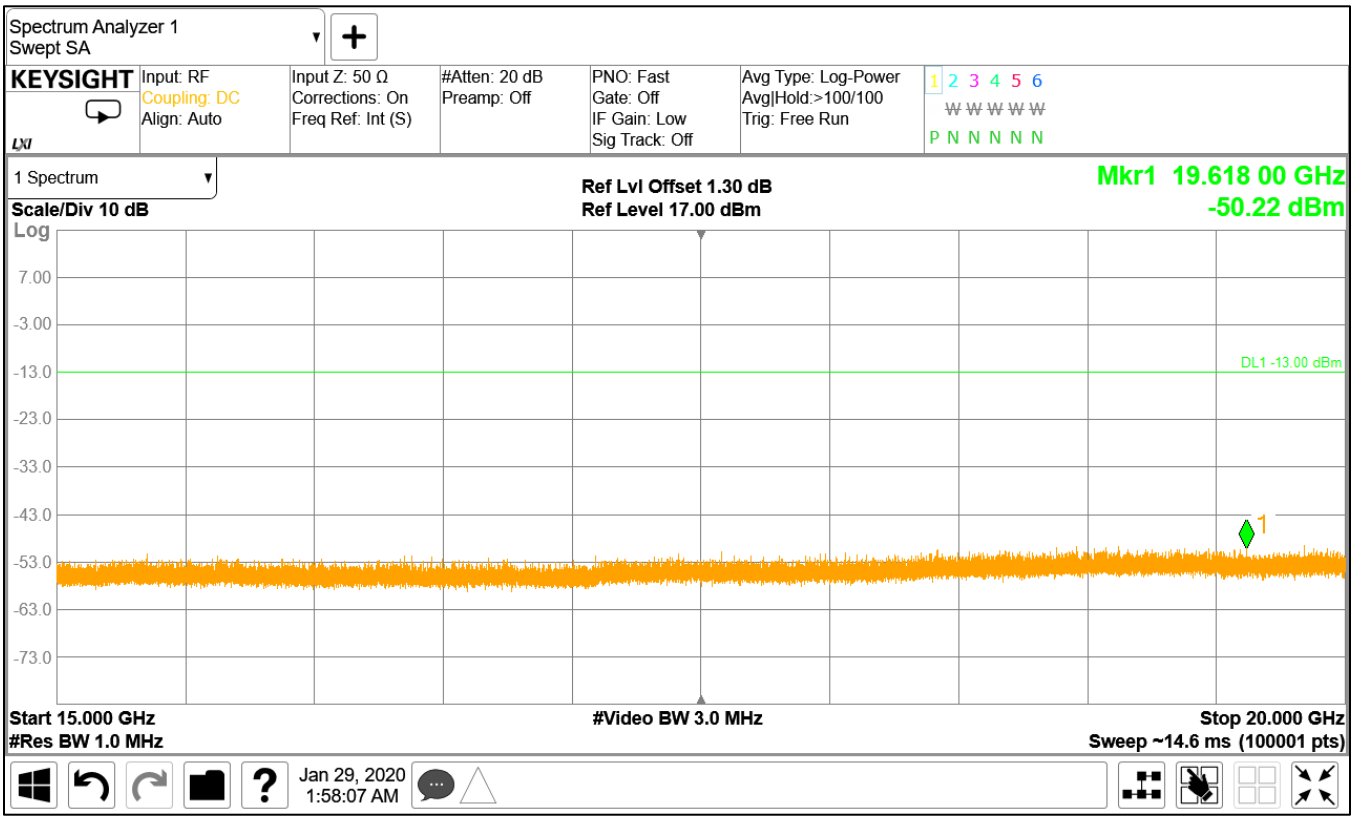


Figure 25: Center Channel Conducted Spurious Plot 6

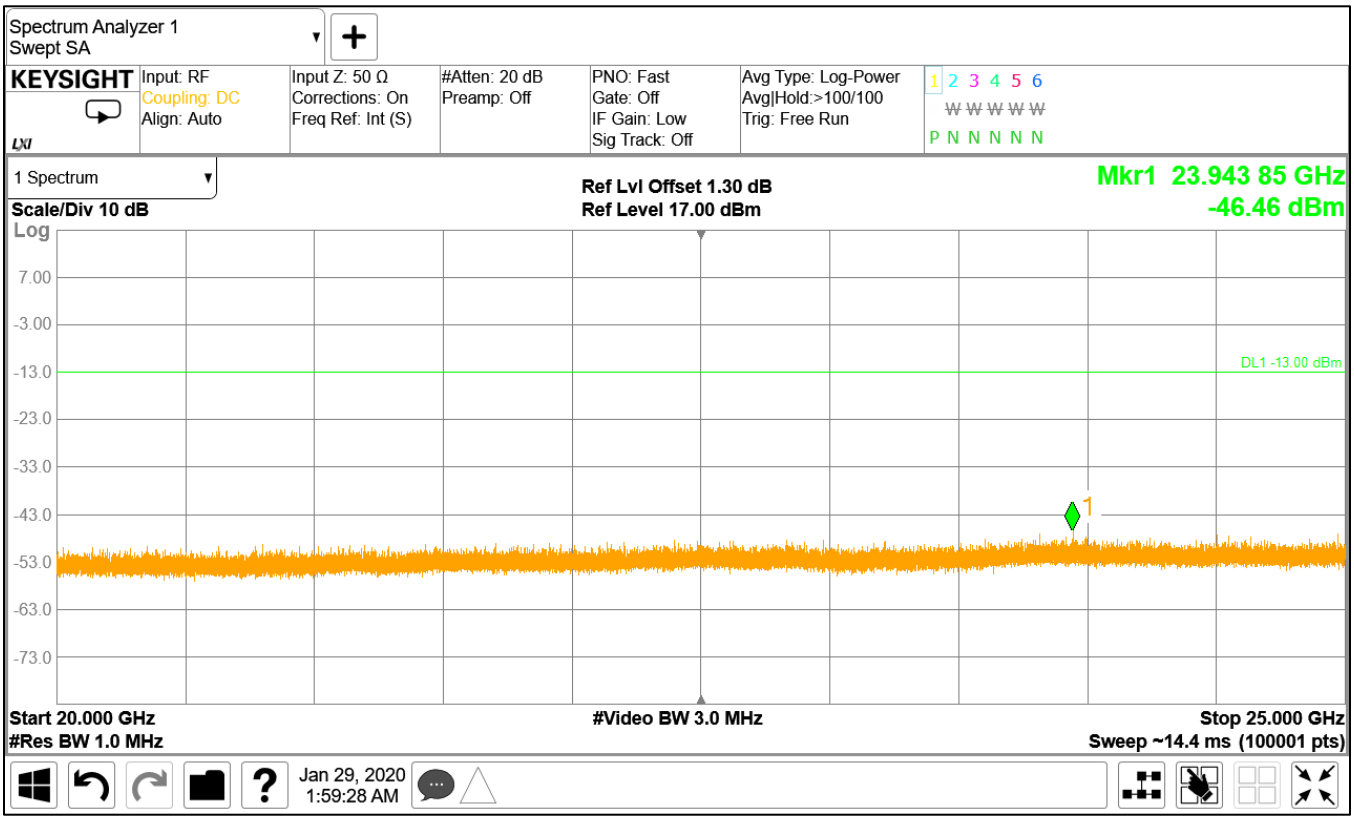


Figure 26: High Channel Conducted Spurious Plot 1

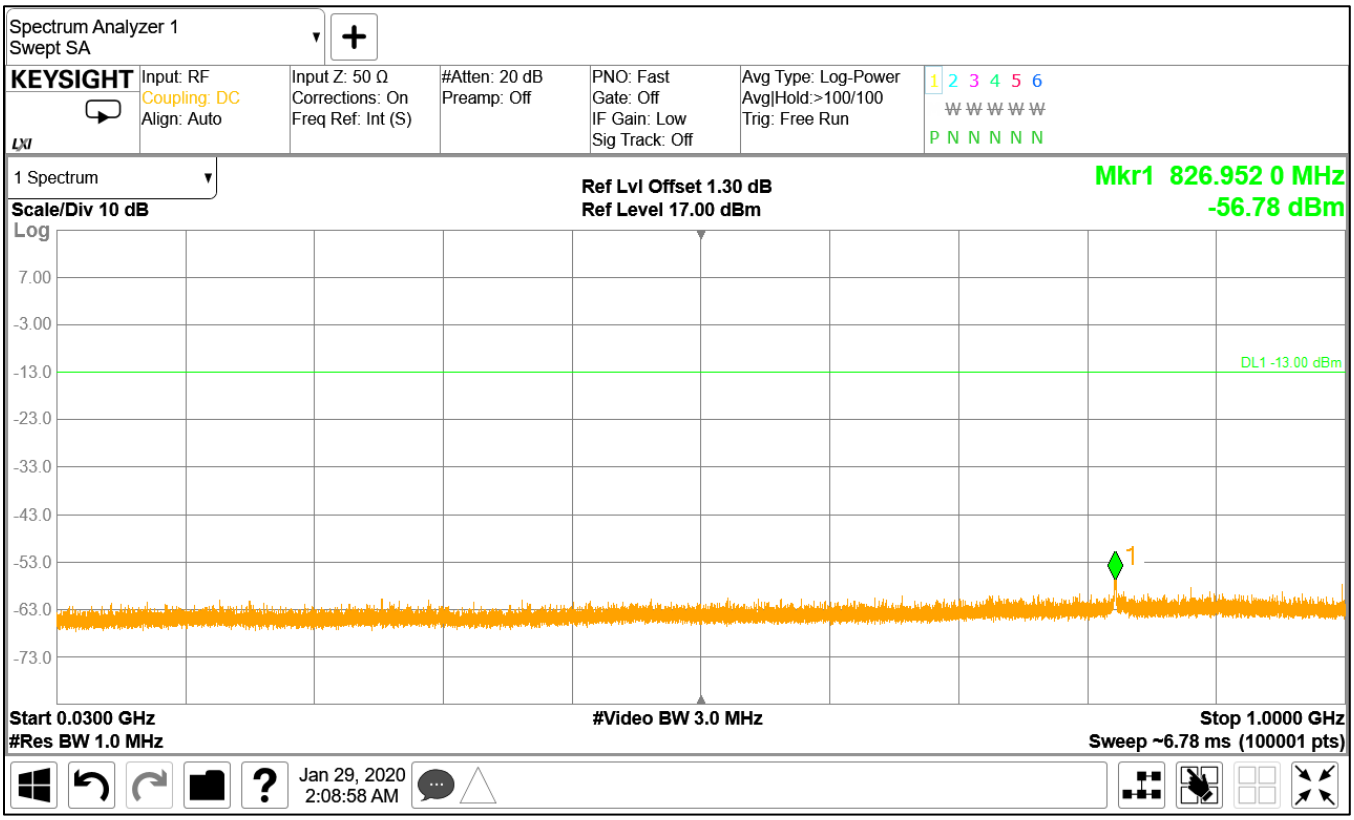


Figure 27: High Channel Conducted Spurious Plot 2

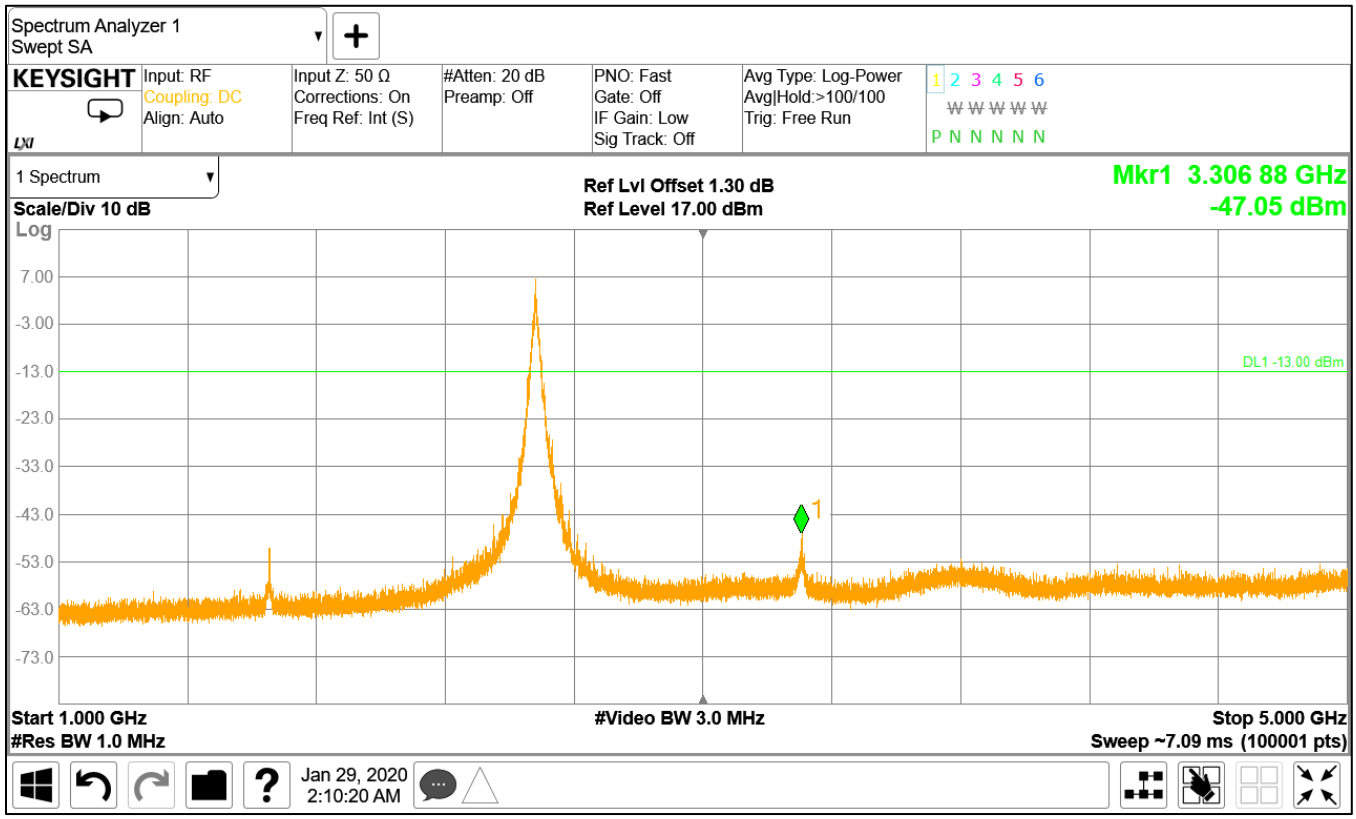


Figure 28: High Channel Conducted Spurious Plot 3

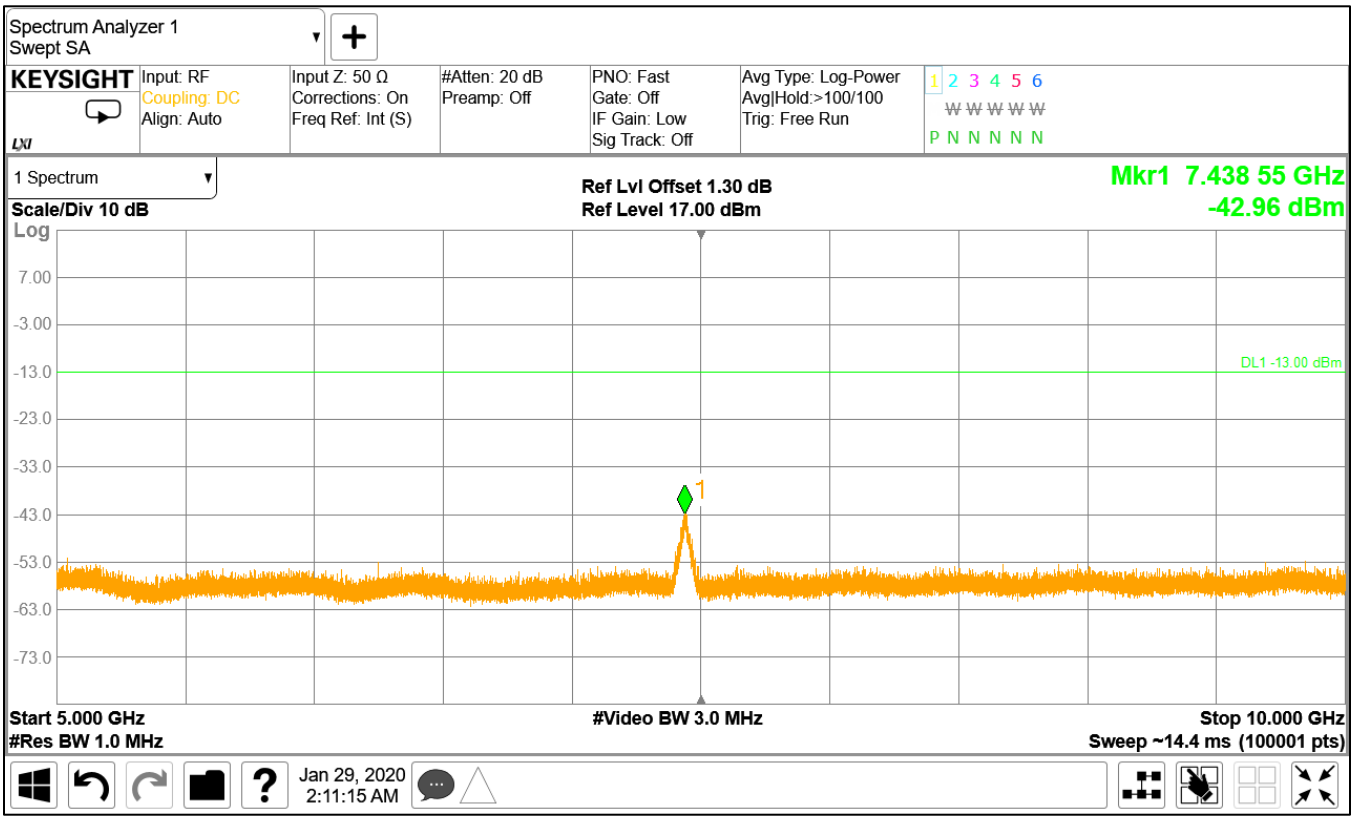


Figure 29: High Channel Conducted Spurious Plot 4

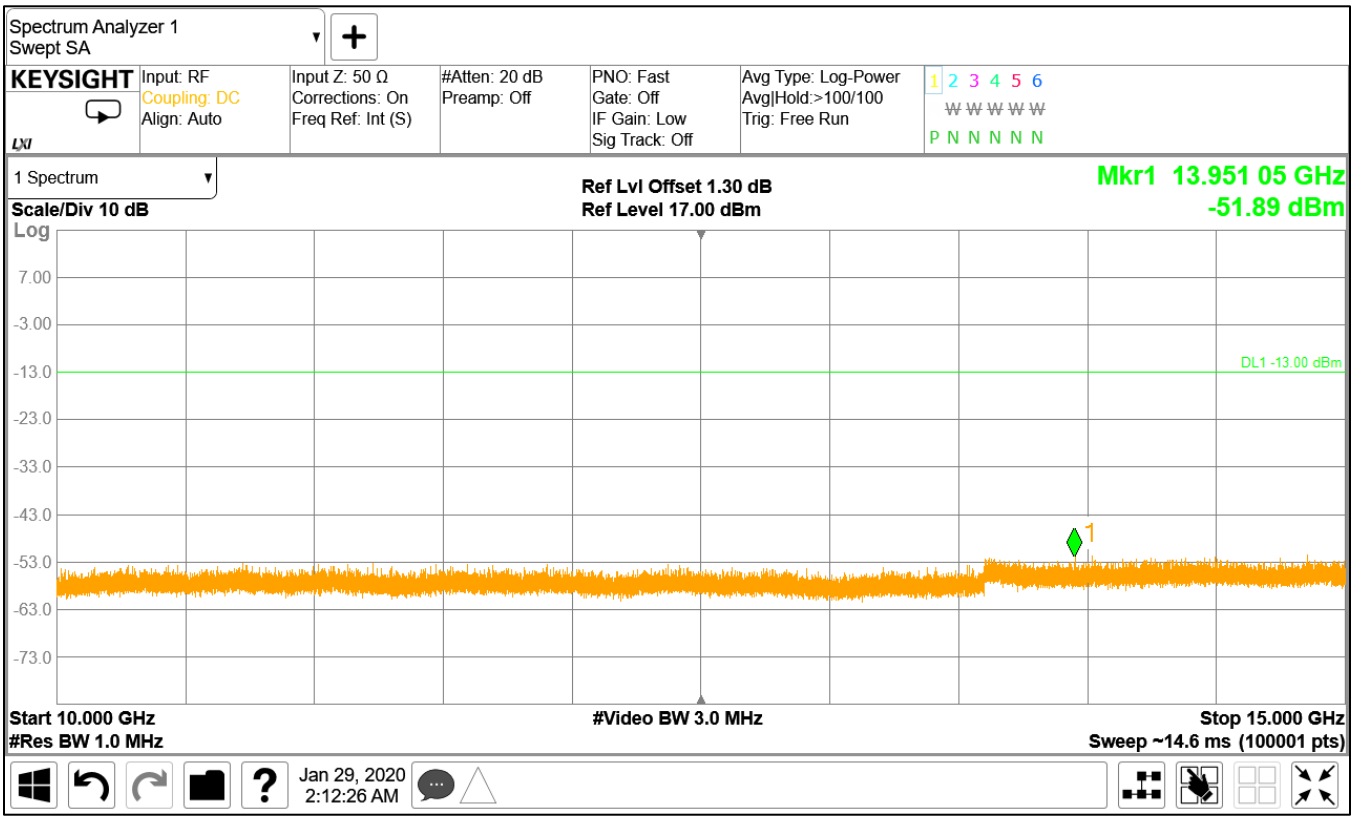


Figure 30: High Channel Conducted Spurious Plot 5

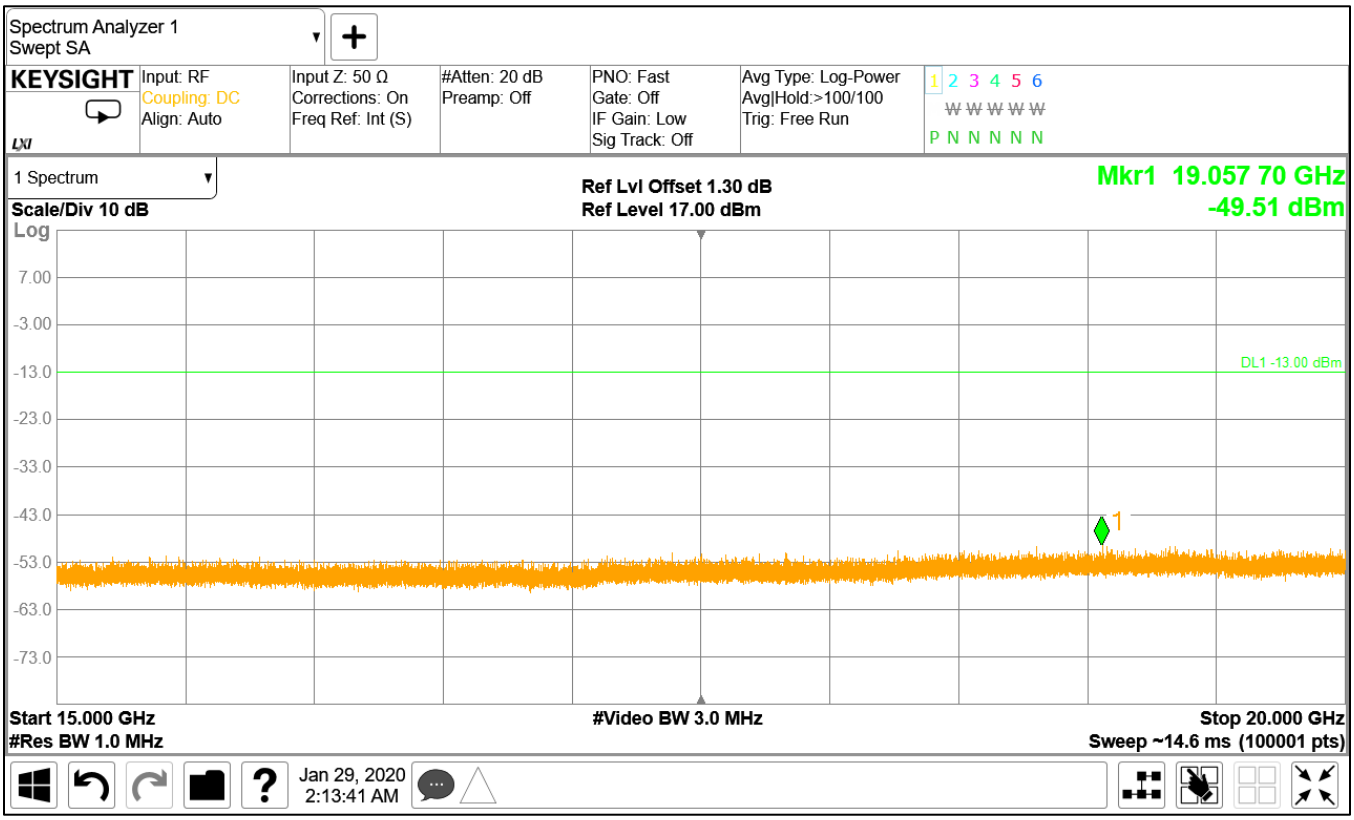
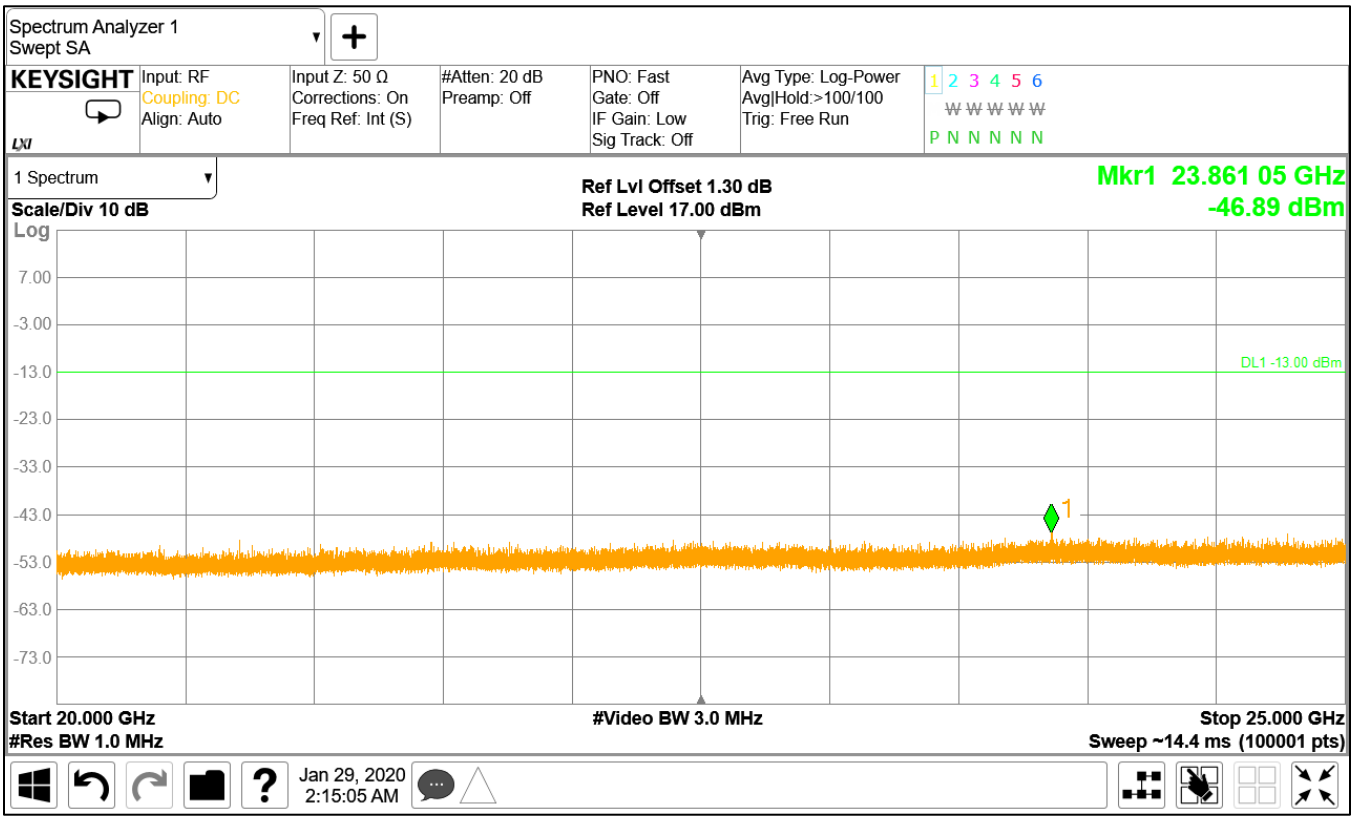


Figure 31: High Channel Conducted Spurious Plot 6



4.4 RADIATED EMISSIONS

4.4.1 Requirements

Compliance Standard: FCC Part 15, Class B

FCC 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
>960MHz	300 µV/m	500 µV/m

4.4.2 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 field 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 1 GHz were measured. The 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 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 1MHz with a video bandwidth setting of 10 Hz for the average measurement.

4.4.3 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 antennas and other measurement accessories. These factors are included into the antenna factor (AF) column of the table and in the cable factor (CF) column of the table. The AF (in dB/m) and the CF (in dB) is algebraically added to the raw Spectrum Analyzer Voltage in dBµV to obtain the Radiated Electric Field in dBµV/m. This logarithm amplitude is converted to a linear amplitude, then compared to the FCC limit.

Example:

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

4.4.4 Test Data

The EUT complied with the Class B Radiated Emissions requirements. Table 9 provides the test results for radiated emissions.

Table 9: Radiated Emission Test Data

Freq (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comm
74.50	V	270.0	1.0	42.2	-17.4	17.4	100.0	-15.2	
263.72	V	0.0	1.0	41.7	-11.6	31.9	200.0	-15.9	
380.50	V	0.0	1.0	40.4	-8.3	40.3	200.0	-13.9	
640.91	V	0.0	1.0	42.6	-1.9	108.1	200.0	-5.3	
75.27	H	180.0	4.0	48.7	-17.4	36.7	100.0	-8.7	
263.72	H	0.0	4.0	47.2	-11.6	59.7	200.0	-10.5	
380.50	H	270.0	3.5	30.7	-8.3	13.2	200.0	-23.6	
640.91	H	270.0	3.5	40.5	-1.9	85.1	200.0	-7.4	

Freq (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comm
2400.00	V	0.0	1.0	40.5	0.8	115.3	5000.0	-32.7	BE-P
2400.00	V	0.0	1.0	32.5	0.8	45.9	500.0	-20.7	BE-A
2483.50	V	0.0	1.0	40.1	1.8	124.6	5000.0	-32.1	BE-P
2483.50	V	0.0	1.0	31.8	1.8	48.1	500.0	-20.3	BE-A
4804.00	V	180.0	1.2	42.1	12.5	537.1	5000.0	-19.4	P
4804.00	V	180.0	1.2	35.7	12.5	258.9	500.0	-5.7	A
4880.00	V	180.0	1.1	42.5	12.9	583.1	5000.0	-18.7	P
4880.00	V	180.0	1.1	36.0	12.9	278.1	500.0	-5.1	A
4960.00	V	180.0	1.1	42.6	13.2	620.1	5000.0	-18.1	P
4960.00	V	180.0	1.1	36.4	13.2	303.7	500.0	-4.3	A
2400.00	H	0.0	1.2	40.1	0.8	110.6	5000.0	-33.1	BE-P
2400.00	H	0.0	1.2	32.1	0.8	44.0	500.0	-21.1	BE-A
2483.50	H	0.0	1.2	39.6	1.8	117.9	5000.0	-32.6	BE-P
2483.50	H	0.0	1.2	31.8	1.8	47.9	500.0	-20.4	BE-A
4804.00	H	180.0	1.7	44.7	12.5	727.9	5000.0	-16.7	P
4804.00	H	180.0	1.7	37.5	12.5	317.4	500.0	-3.9	A
4880.00	H	180.0	1.7	47.6	12.9	1050.2	5000.0	-13.6	P
4880.00	H	180.0	1.7	38.2	12.9	357.1	500.0	-2.9	A
4960.00	H	180.0	1.7	47.6	13.2	1104.0	5000.0	-13.1	P
4960.00	H	180.0	1.7	37.5	13.2	344.7	500.0	-3.2	A

BE-Band Edge
P-Peak Measurement
A-Average Measurement

Receiver Spurious

Freq (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
31.13	V	0.0	1.0	28.7	-5.7	14.1	100.0	-17.0	
33.71	V	0.0	1.0	34.3	-7.5	21.8	100.0	-13.2	
39.22	V	0.0	1.0	44.8	-11.5	46.2	100.0	-6.7	
47.93	V	0.0	1.0	48.1	-17.3	34.8	100.0	-9.2	
71.91	V	270.0	1.0	52.5	-17.3	57.6	100.0	-4.8	
160.00	V	0.0	1.0	29.1	-12.7	6.6	150.0	-27.1	
300.00	V	0.0	1.0	33.1	-10.6	13.4	200.0	-23.5	
399.98	V	180.0	1.2	26.9	-8.2	8.6	200.0	-27.3	
420.22	V	180.0	1.2	34.4	-7.1	23.1	200.0	-18.8	
638.73	V	180.0	1.2	36.2	-2.1	50.3	200.0	-12.0	
31.13	H	0.0	4.0	17.7	-5.7	4.0	100.0	-28.1	
33.71	H	0.0	4.0	25.6	-7.5	8.1	100.0	-21.9	
39.22	H	0.0	4.0	29.8	-11.5	8.2	100.0	-21.7	
47.93	H	0.0	4.0	42.4	-17.3	17.9	100.0	-14.9	
71.91	H	180.0	4.0	48.4	-17.3	35.9	100.0	-8.9	
160.00	H	0.0	3.0	38.8	-12.7	20.1	150.0	-17.5	
300.00	H	0.0	3.0	38.8	-10.6	25.7	200.0	-17.8	
380.50	H	90.0	3.0	32.7	-8.3	16.6	200.0	-21.6	
399.98	H	180.0	3.0	27.1	-8.2	8.8	200.0	-27.1	
420.22	H	180.0	2.5	35.7	-7.1	26.8	200.0	-17.5	
638.73	H	180.0	2.0	38.5	-2.1	66.0	200.0	-9.6	