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FCC Certification Test Report

For the

Zenner USA

Bluetooth Installation Radio (BTIR)

FCC ID: 2ACOABTIR

WLL JOB# **14832-01 Rev 1**
November 30, 2016
Revised January 8, 2017

Prepared for:

Zenner USA
15280 Addison Rd, Suite 340
Addison, TX 75001

Prepared By:

Washington Laboratories, Ltd.
7560 Lindbergh Drive
Gaithersburg, Maryland 20879

Testing Certificate AT-1448

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Prepared by:

James Ritter
Compliance Engineer

Reviewed by:

President

Abstract

This report has been prepared on behalf of Zenner USA to support the attached Application for Equipment Authorization. The test report and application are submitted for a Frequency Hopping Spread Spectrum Transmitter under Part 15.247 (10/2015) of the FCC Rules. This Certification Test Report documents the test configuration and test results for the Zenner USA Bluetooth Installation Radio (BTIR).

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. 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 Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Certificate AT-1448 as an independent FCC test laboratory.

The Zenner USA Bluetooth Installation Radio (BTIR) complies with the limits for a Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247.

Revision History	Description of Change	Date
Rev 0	Initial Release	November 30, 2016
Rev 1	Corrected method of programming on page 3	January 8, 2017

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1 Introduction

1.1 Compliance Statement

The Zenner USA Bluetooth Installation Radio (BTIR) FHSS Module complies with the limits for a Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247.

1.2 Test Scope

Tests for radiated emissions were performed. All measurements were performed in accordance with "C63.10 American National Standard of 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:	Zenner Performance Meters, Inc d.b.a. Zenner USA 15280 Addison Rd, Suite 340 Suite 150 Addison, TX 75001
Quotation Number:	69603A

1.4 Test Dates

Testing was performed on the following date(s):	11/21/2016 - 11/29/2016

1.5 Test and Support Personnel

Washington Laboratories, LTD	James Ritter
Client Representative	Dave Albert, Benard Nance, Ken Derry

1.6 Abbreviations

A	**A**mpere
ac	**a**lternating **c**urrent
AM	Amplitude Modulation
Amps	**Amp**ere**s**
b/s	**b**its per **s**econd
BW	**B**and**W**idth
CE	**C**onducted **E**mission
cm	**c**enti**m**eter
CW	**C**ontinuous **W**ave
dB	**d**eci**B**el
dc	**d**irect **c**urrent
EMI	**E**lectro**m**agnetic **I**nterference
EUT	**E**quipment **U**nder **T**est
FM	**F**requency **M**odulation
G	**g**iga - prefix for 10^9 multiplier
Hz	**H**ertz
IF	**I**ntermediate **F**requency
k	**k**ilo - prefix for 10^3 multiplier
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
M	**M**ega - prefix for 10^6 multiplier
m	**m**eter
µ	**m**icro - prefix for 10^{-6} multiplier
NB	**N**arrow**b**and
QP	**Q**uasi-**P**eak
RE	**R**adiated **E**missions
RF	**R**adio **F**requency
rms	**r**oot-**m**ean-**s**quare
SN	**S**erial **N**umber
S/A	**S**pectrum **A**nalyzer
V	**V**olt

2 Equipment Under Test

2.1 EUT Identification & Description

The BTIR is a self-contained transceiver radio that communicates between a Bluetooth equipped terminal device and a Zenner Stealth Reader. It contains a Laird Bluetooth module (FCC ID:SQGBT900) and a 902-928MHz radio. This product is used to accomplish field installations and maintenance of the Zenner Stealth Reader devices. This test report covers the 902-928MHz band radio. The Bluetooth Module is disabled during any 902-928MHz transmissions.

Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	Zenner Performance Meters, Inc d.b.a. Zenner USA
FCC ID Number	2ACOABTIR
EUT Name:	Bluetooth Installation Radio (BTIR)
Model:	100-0023-001
FCC Rule Parts:	15.247
Frequency Range:	902.5-927MHz
Maximum Output Power:	13.8mW (11.4dBm)
Modulation:	FHSS FSK
20dB Bandwidth:	137.77 kHz for mesh mode, 363.81 kHz for drive-by mode
Keying:	Automatic
Type of Information:	Data
Number of Channels:	50
Power Output Level	Fixed
Antenna Type	Tested with a -1dBi Chip antenna
Interface :	USB B connector
Power Source & Voltage:	4.2V Rechargeable Lithium Battery

2.2 Test Configuration

One device was submitted for testing, for conducted testing the manufacturer replaced the chip antenna with a temporary antenna port. The EUT was programmed via terminal commands to transmit at one of 3 frequencies (902.5, 915, & 927MHz) and hopping at either of 2 modes (40kHz Mesh mode or 80kHz Driveby mode) All tests were performed in accordance with ANSI C63.10. For testing the unit had its battery disabled and was powered via a USB connection (worst case).

2.3 Testing Algorithm

The Bluetooth Installation Radio (BTIR) was programmed and controlled via the internal programming header (J1) on the EUT from the support laptop. The support laptop used a terminal program to command the EUT to transmit on the lowest, center, and highest channels in either mesh or driveby modes. Commands were also sent to allow the unit to transmit in a hopping fashion. The unit was preloaded with a typical data payload to transmit.

Worst case emission levels are provided in the test results data.

2.4 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. 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 C63.10:2013 American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation"

2.5.2 Measurement Uncertainty

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

Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

Equation 1: Standard Uncertainty

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

Where 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 ≤ 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, CISPR14, FCC Part 15	±2.63 dB
Radiated Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	±4.55 dB

Parameter	Uncertainty	Actual (+/-)	Unit
Radio Frequency	±1 x 10^{-7}	8.64E-08	parts
RF Power conducted (up to 160 W)	±0.75 dB	0.3	dB
Conducted RF Power variations using a test fixture	±0.75 dB	0.3	dB
Transmitter transient frequency (frequency difference)	±250 Hz	160.7	Hz
Transmitter transient time	±20 %	9.2	%

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

Equipment List- Conducted Antenna Port Tests

Test Name: **Conducted Antenna Port Test**			Test Date: **11/22/2016**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
Rental	AGILENT – EXA N9010B	ANALYZER SPECTRUM SER# MY55460673	10/17/2017

Equipment List- Radiated Emissions Tests

Test Name: **Radiated Emissions**			Test Date: **11/28/2016**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
626	ARA - DRG-118/A	ANTENNA HORN	4/7/2018
627	AGILENT - 8449B	AMPLIFIER 1-26GHZ	11/07/2017
276	ELECTROMETRICS - BPA-1000	PRE-AMPLIFIER RF 50KHZ-1GHZ	05/23/2017
644	SUNOL SCIENCES CORPORATION - JB1 925-833-9936	BICONALOG ANTENNA	8/14/2017
RENTAL	AGILENT - 7405A	ANALYZER SPECTRUM SER # US39150132	05/03/2017

Equipment List- Conducted AC power line Emissions Tests

Test Name: **Conducted Emissions Voltage**			Test Date: **11/28/2016**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
125	SOLAR - 8028-50-TS-24-BNC	LISN	12/30/2016
126	SOLAR - 8028-50-TS-24-BNC	LISN	12/30/2016
53	HP - 11947A	LIMITER TRANSIENT	3/1/2017
RENTAL	AGILENT - 7405A	ANALYZER SPECTRUM SER # US39150132	05/03/2017

4 Test Summary

The Table Below shows the results of testing for compliance with a Frequency Hopping System in accordance with FCC Part 15.247: Full results are shown in section 5.

Table 4: Test Summary Table

TX Test Summary (Frequency Hopping Spread Spectrum)		
FCC Rule Part	**Description**	**Result**
15.247 (a)(1)(i)	Time of Occupancy	Pass
15.247 (b)(2)	Transmit Output Power	Pass
15.247 (a)(1)(i)	20dB Bandwidth	Pass
15.247 (a)(1)	Channel Separation	Pass
15.247 (a)(1)(i)	Number of Channels	Pass
15.247 (d)	Conducted Out-of-Band Emissions	Pass
15.247 (d)	Conducted Band Edge @ 20dB below	Pass
15.209 & 15.205	General Field Strength Limits (Restricted Bands)	Pass
15.207	AC Conducted Emissions	Pass
Receiver Test Summary (Frequency Hopping Spread Spectrum)		
FCC Rule Part	**Description**	**Result**
15.209	General Field Strength Limits	Pass

5 Test Results

5.1 Time of Occupancy

Tests were performed as specified in ANSI C63.10 section 7.8.4 “Time of occupancy (dwell time)”

The following figure shows the plot of the dwell time for the transmitter. Based on this plot, the dwell time per hop is 99.57ms for ‘Mesh Mode’ and 40.43ms for ‘Drive-by mode’. FCC part 15.247 also requires that for hopping signals with an occupied bandwidth of greater than 250kHz (Driveby Mode) that the total transmit dwell time must be no more than 0.4 seconds per 10 seconds . For signals less than 250 kHz (Mesh Mode) the limit is 0.4 seconds per 20 seconds. As the ‘Mesh mode bandwidth is less than 250kHz and the ‘Drive-by’ mode is more than 250kHz both modes were tested and complied.

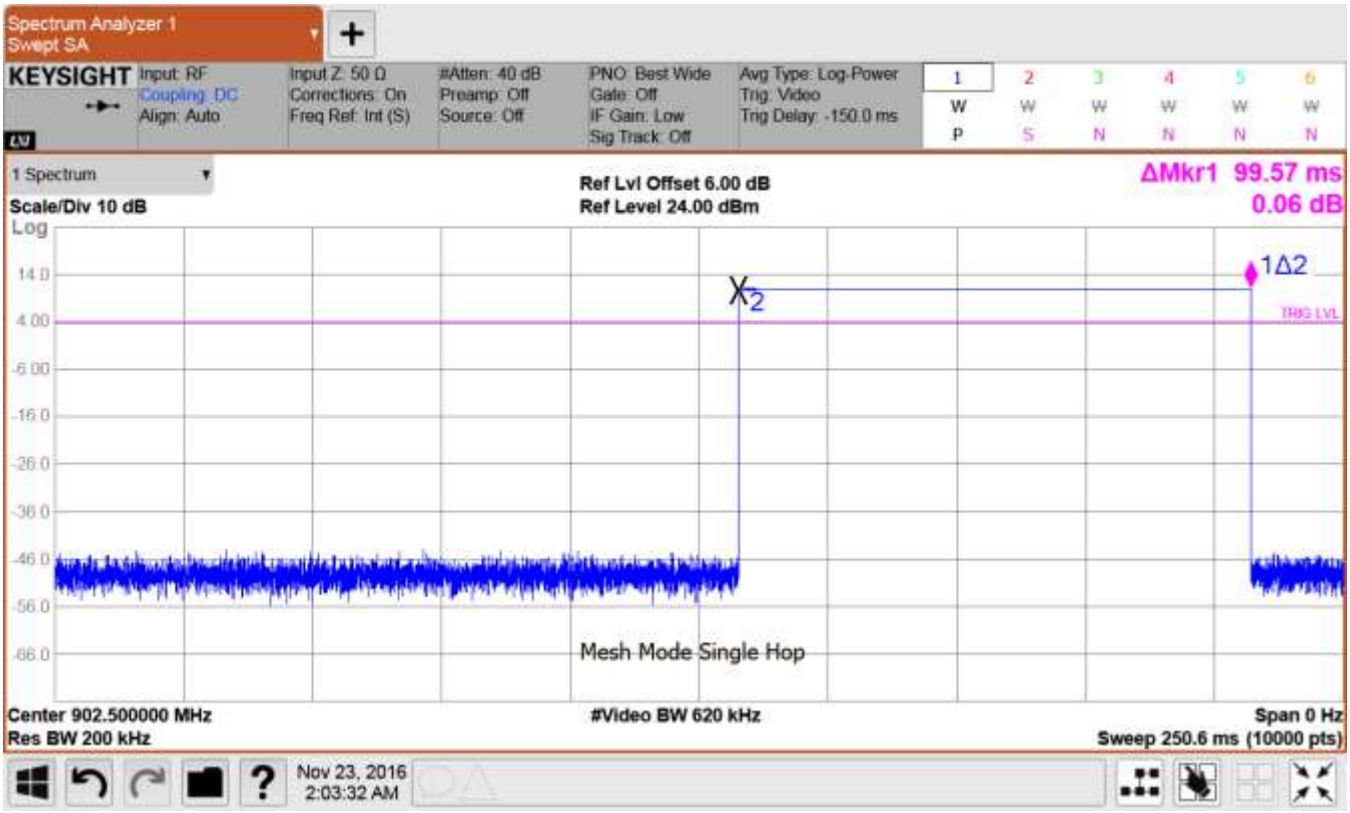

Figure 1: Dwell Time Per Hop, Mesh Mode

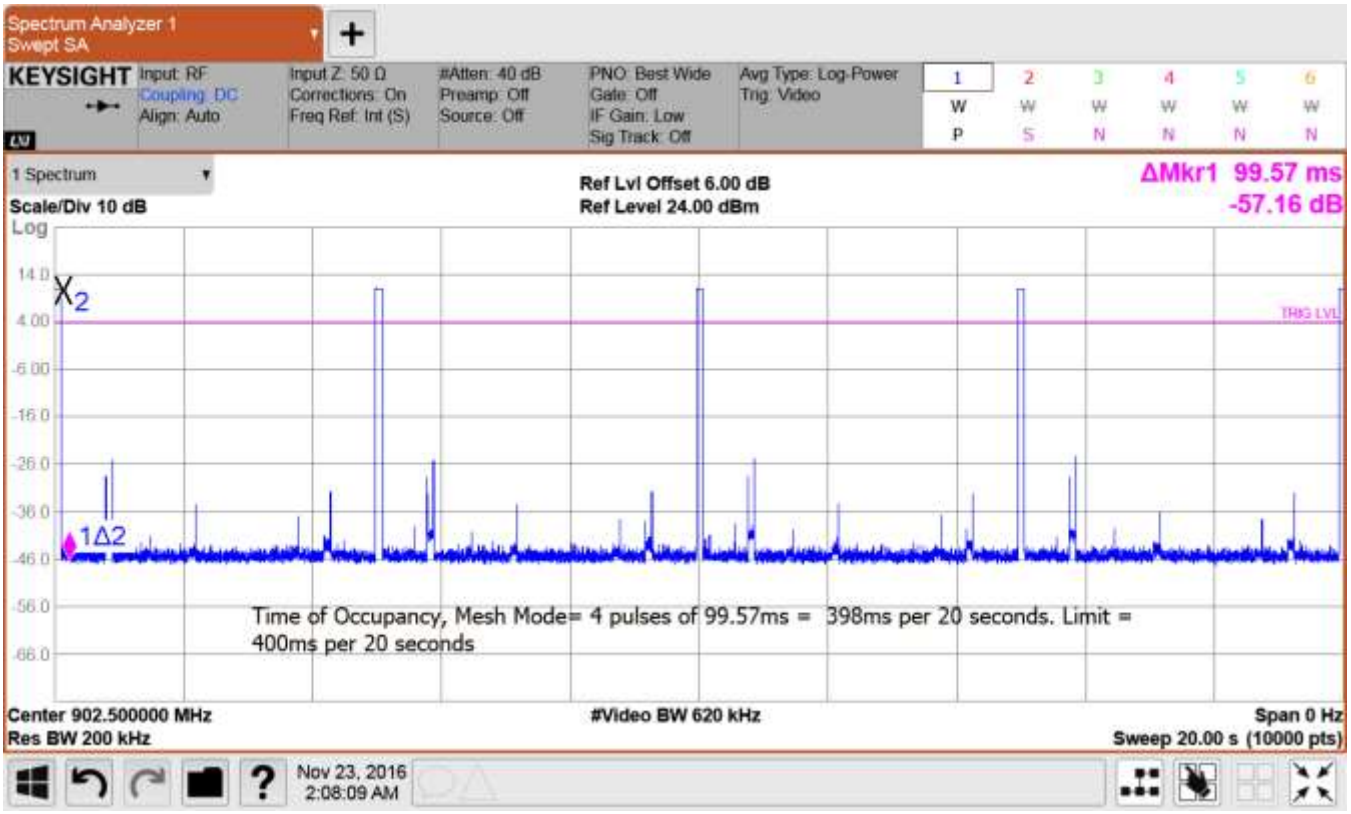

Figure 2: Time of Occupancy per 20 seconds, Mesh Mode

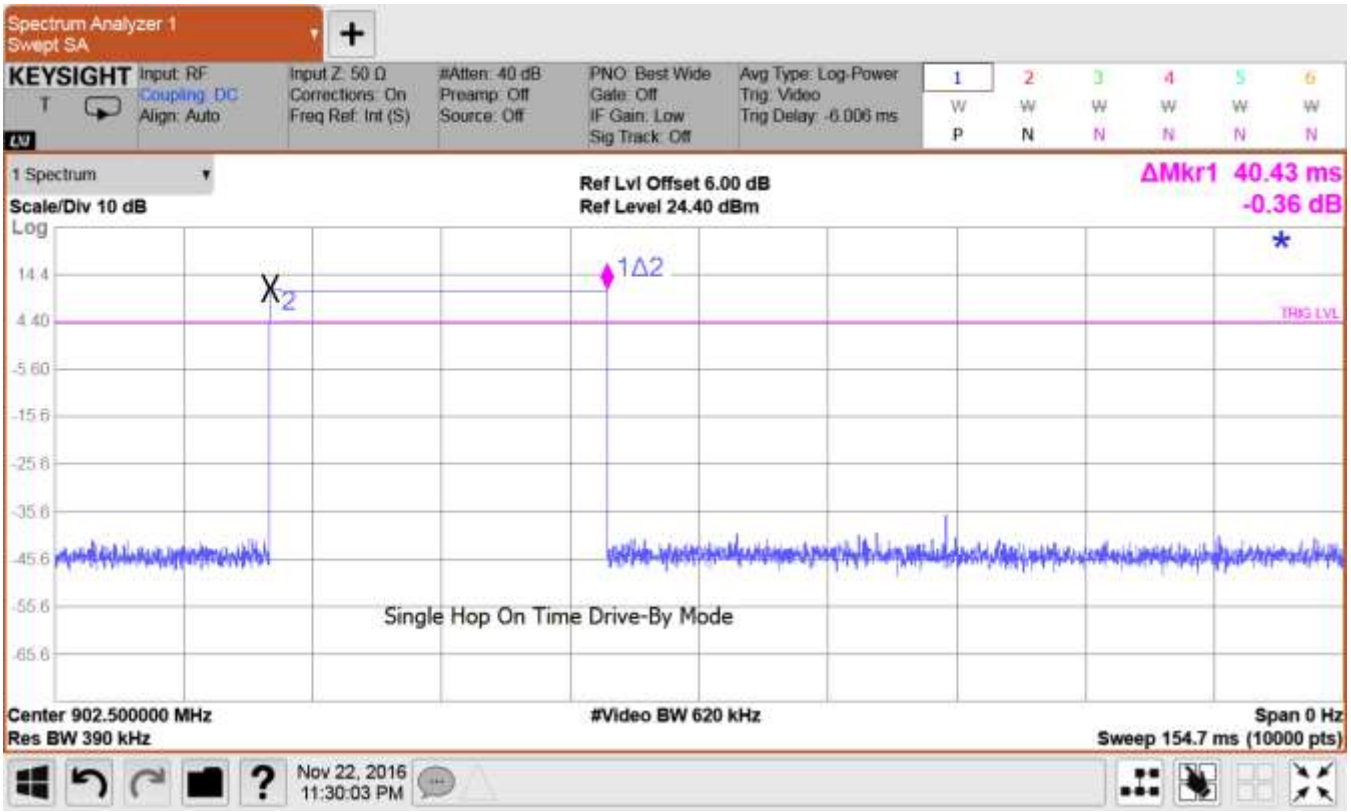

Figure 3: Dwell Time Per Hop, Drive-by Mode

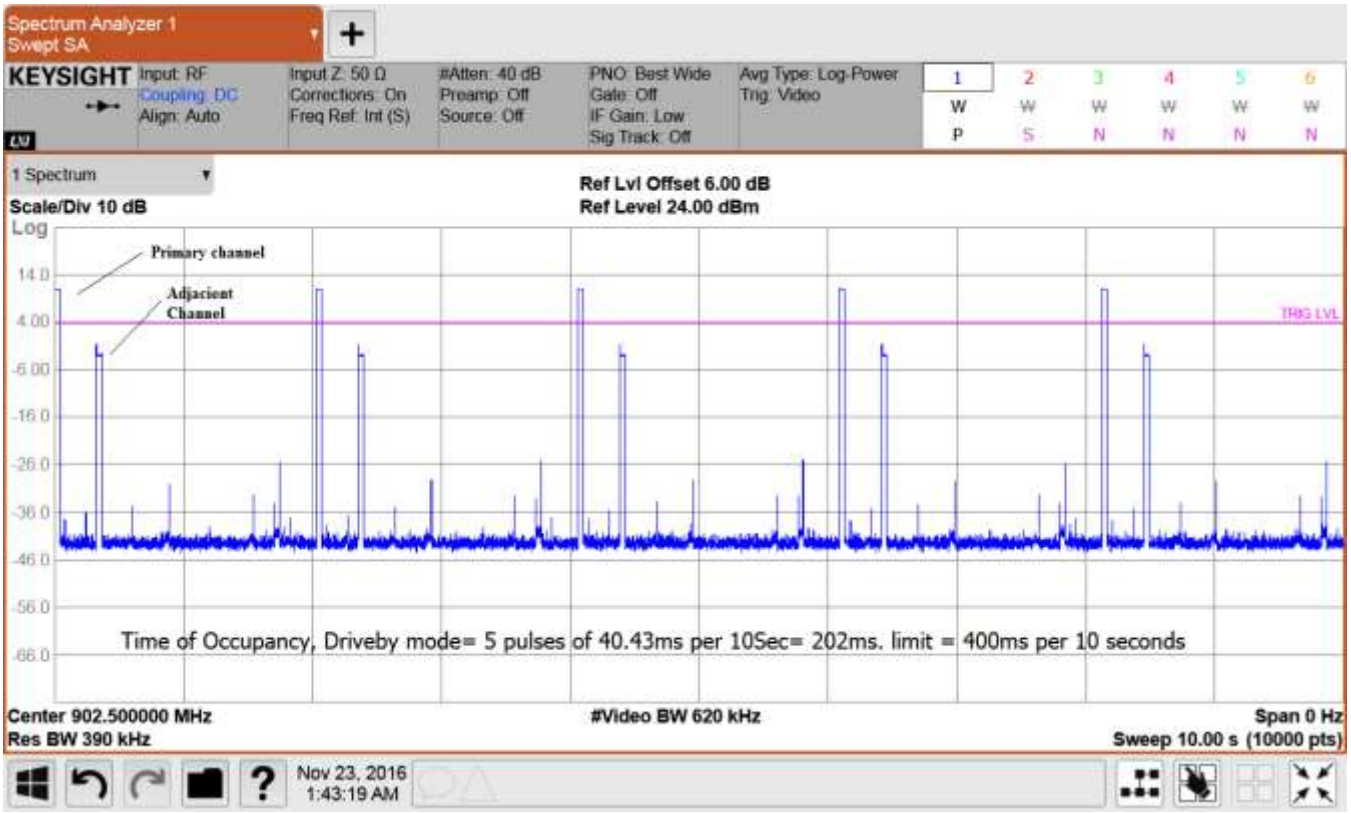

Figure 4: Time of Occupancy per 10 seconds, drive-by Mode

5.2 Duty Cycle Correction

Spurious radiated emissions measurements may be adjusted by using a duty cycle correction factor if the dwell time per channel of the hopping signal is less than 100 ms.

The duty cycle correction factor is calculated by:

20 x LOG (dwell time/100 ms)

As the on time of the Driveby mode is 99.57ms, rounded to 100ms, no duty cycle correction will be used.

Even though the drive-by mode is 40.43ms no duty cycle correction was applied as the ‘Mesh mode’ is 100ms (worst case mode).

5.3 RF Power Output: (FCC Part §2.1046)

Tests were performed as specified in ANSI C63.10 section 6.9.2 "Occupied bandwidth—relative measurement procedure" as required by 7.8.5 "Output power test procedure for frequency-hopping spread-spectrum (FHSS) devices".

To measure the output power the hopping sequence was stopped while the frequency dwelled on a low, high and middle channel. The output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum Analyzer. The analyzer offset was adjusted to compensate for the attenuator and other losses in the system.

2 modes of operation were available: a narrow bandwidth 'Mesh Mode' and a wider bandwidth 'Drive-by' mode.

Table 5: RF Power Output

Mode Tested	Frequency	Level	Limit	Pass/Fail
Mesh Mode	Low Channel: 902.5MHz	11.40 dBm	30 dBm	Pass
Mesh Mode	Center Channel: 915MHz	11.40 dBm	30 dBm	Pass
Mesh Mode	High Channel: 927MHz	11.39 dBm	30 dBm	Pass
Drive-by Mode	Low Channel: 902.5MHz	11.37 dBm	30 dBm	Pass
Drive-by Mode	Center Channel: 915MHz	11.38 dBm	30 dBm	Pass
Drive-by mode	High Channel: 927MHz	11.37 dBm	30 dBm	Pass

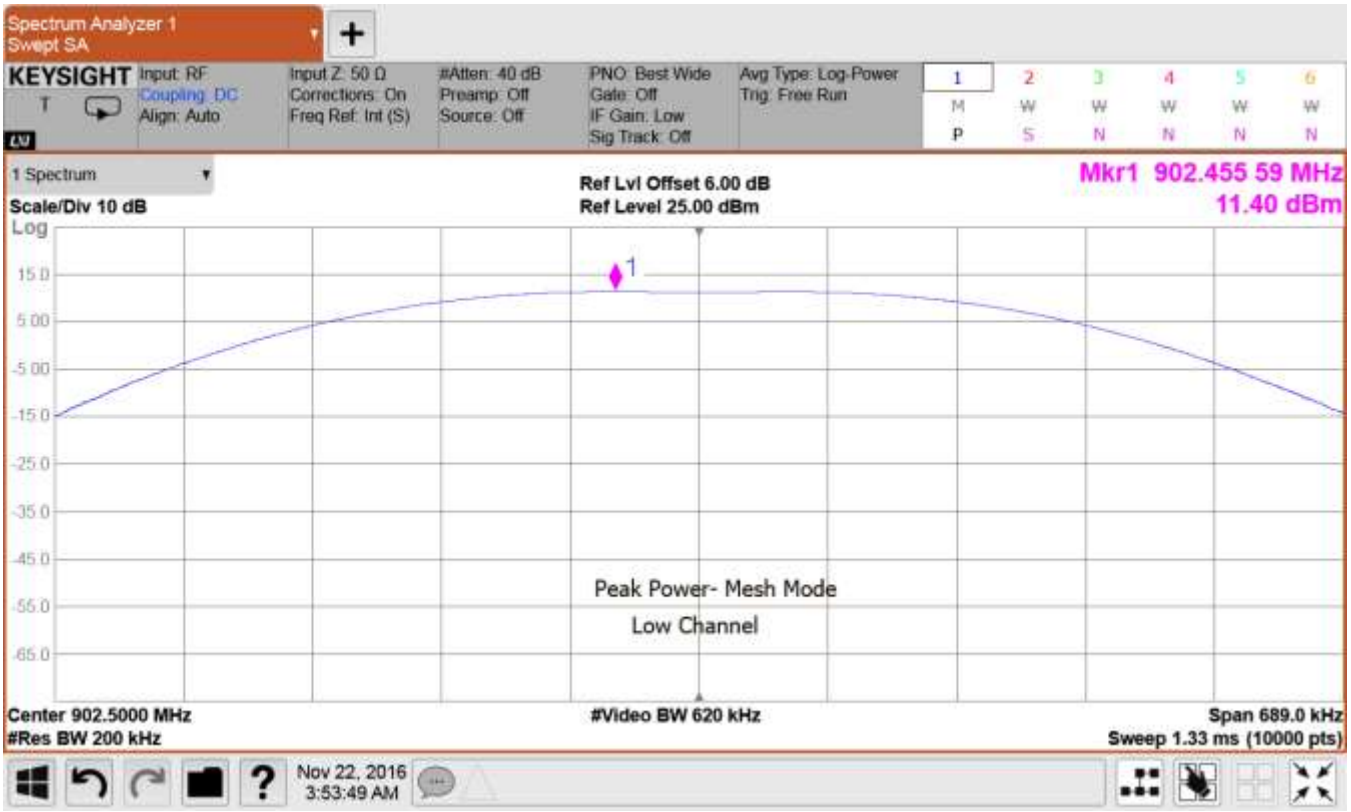

Figure 5: RF Peak Power, Mesh Mode, Low Channel

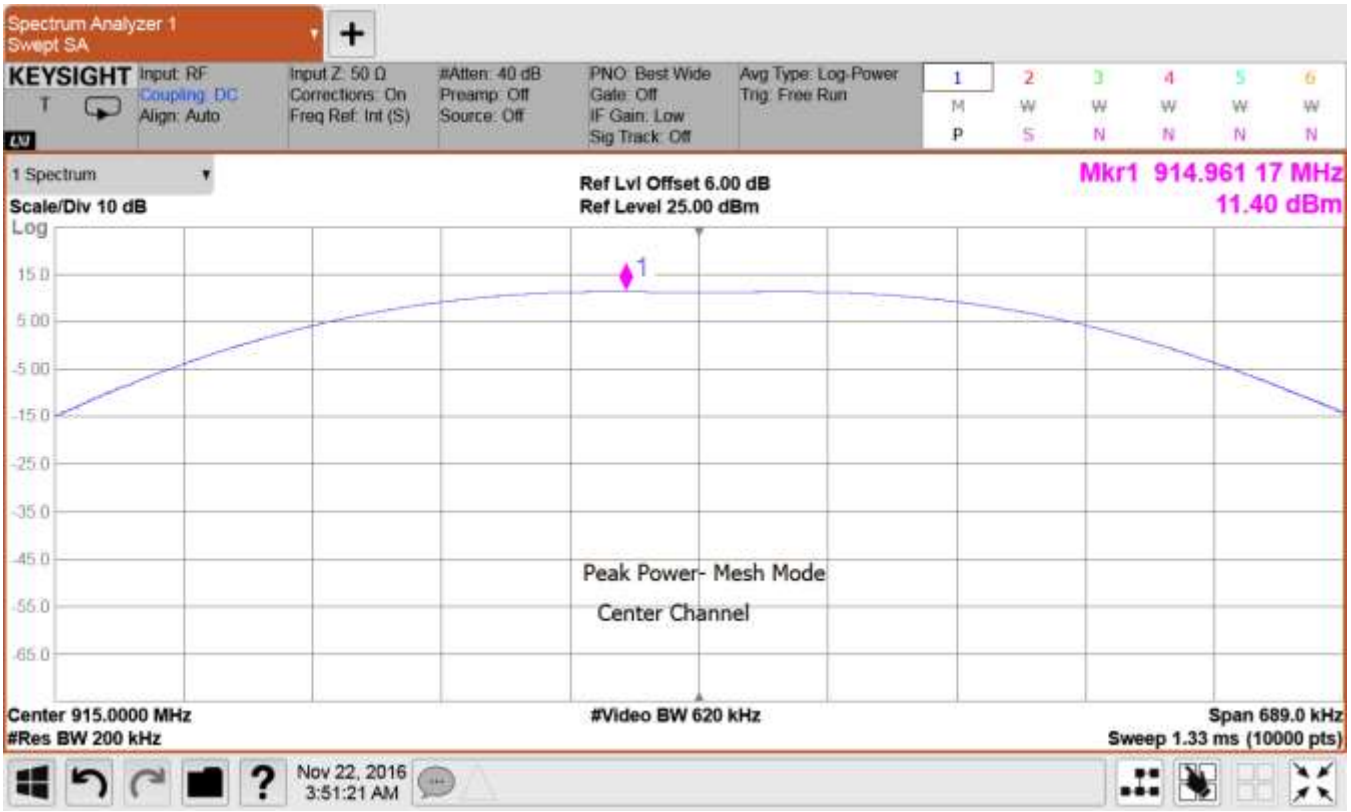

Figure 6: RF Peak Power, Mesh Mode, Center Channel

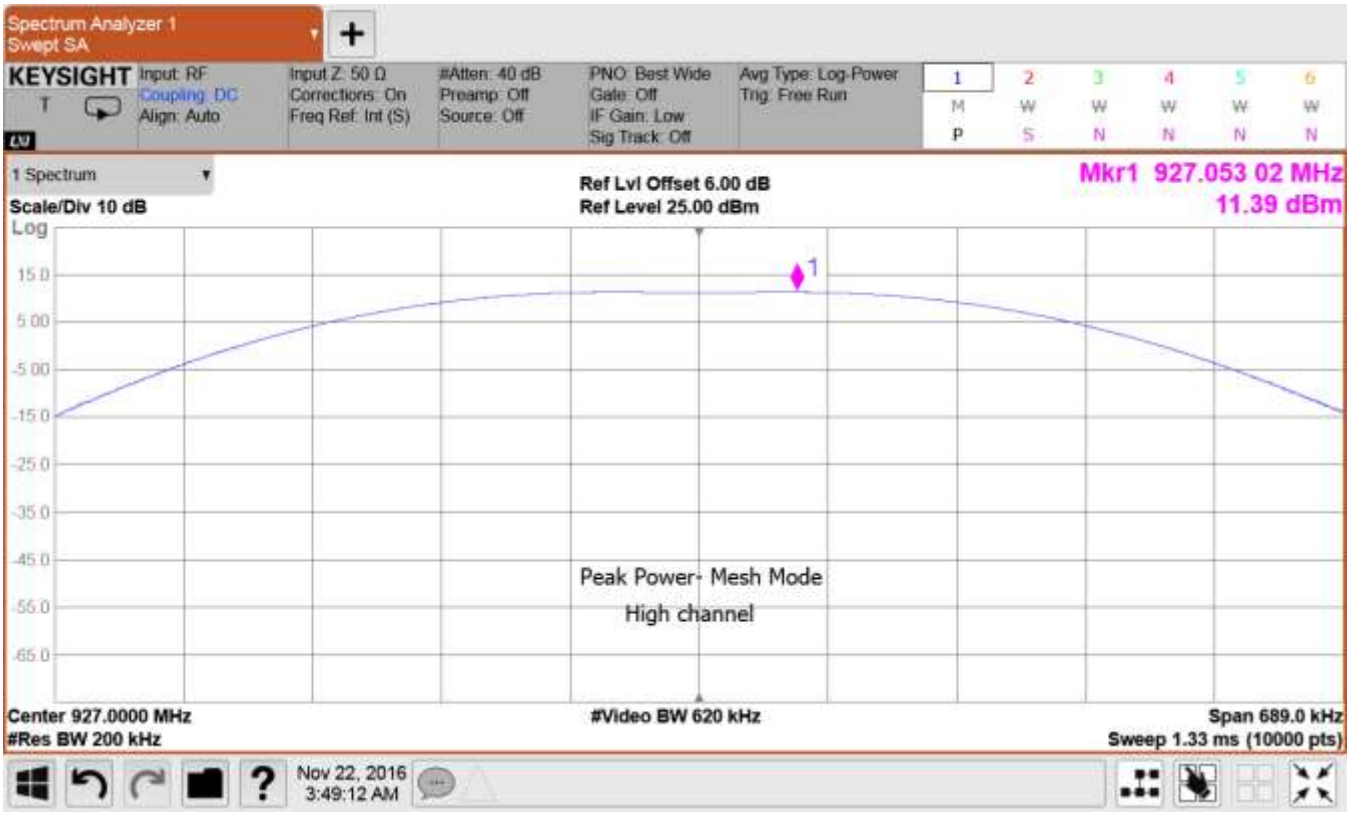

Figure 7: RF Peak Power, Mesh Mode, High Channel

Figure 8: RF Peak Power, Drive-by Mode, Low Channel

Figure 9: RF Peak Power, Drive-by Mode, Center Channel

Figure 10: RF Peak Power, Drive-by Mode, High Channel

5.4 Occupied Bandwidth: (FCC Part §2.1049)

Tests were performed as specified in ANSI C63.10 section 6.9.2 "Occupied bandwidth—relative measurement procedure" as required by 7.8.7 "Occupied bandwidth".

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer.

For Frequency Hopping Spread Spectrum Systems, FCC Part 15.247 requires the maximum 20 dB bandwidth not exceed 500 kHz.

Two modes of operation were available: a narrow bandwidth 'Mesh Mode' (40kHz) and a wider bandwidth 'Drive-by' (80kHz) mode, the occupied bandwidth was measured as shown:

Table 6: Occupied Bandwidth Results

Mode Tested	Frequency	Bandwidth	Limit	Pass/Fail
Mesh Mode	Low Channel: 902.5MHz	137.77 kHz	≤500 kHz	Pass
Mesh Mode	Center Channel: 915MHz	137.63 kHz	≤500 kHz	Pass
Mesh Mode	High Channel: 927MHz	137.77 kHz	≤500 kHz	Pass
Drive-by Mode	Low Channel: 902.5MHz	363.81 kHz	≤500 kHz	Pass
Drive-by Mode	Center Channel: 915MHz	363.29 kHz	≤500 kHz	Pass
Drive-by mode	High Channel: 927MHz	362.91 kHz	≤500 kHz	Pass

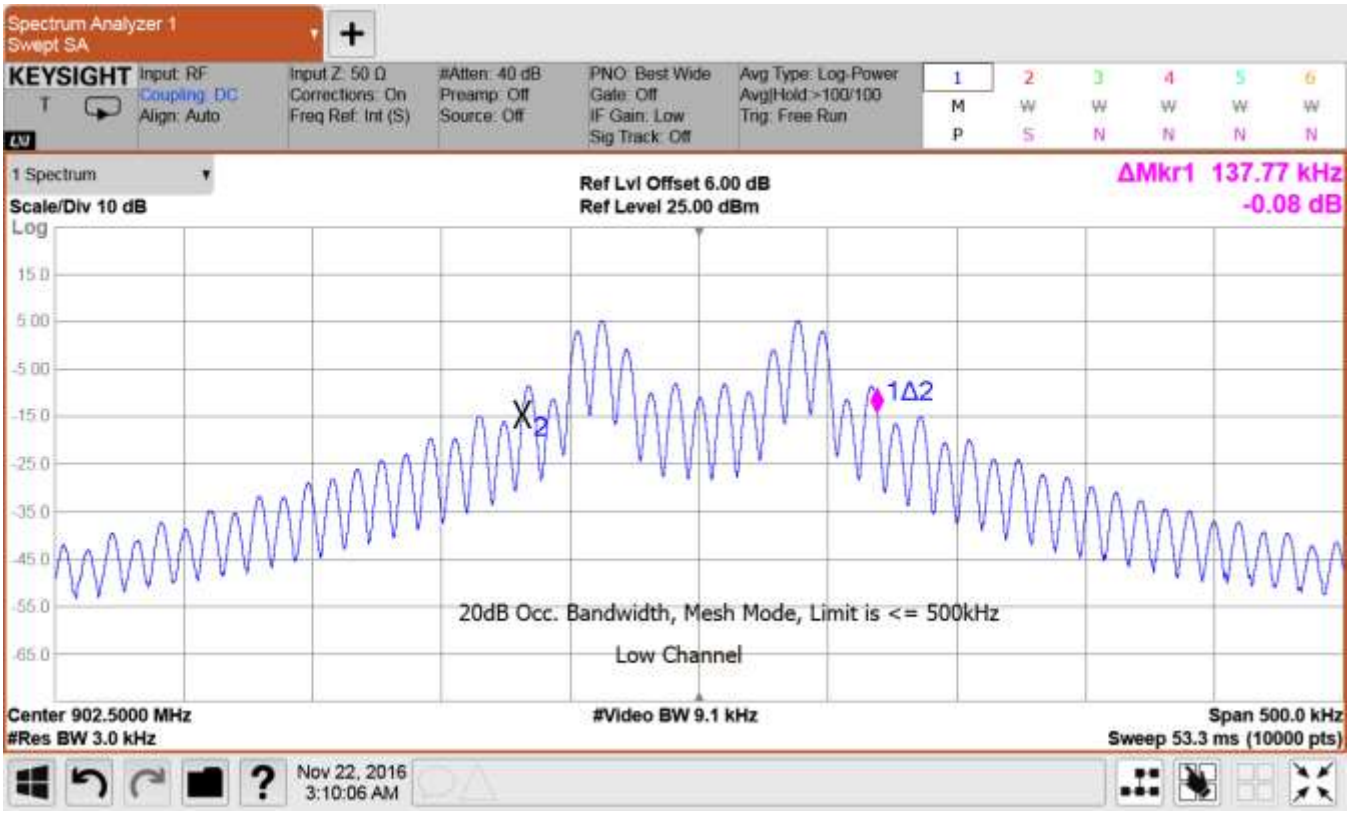

Figure 11: Occupied Bandwidth, Mesh Mode, Low Channel

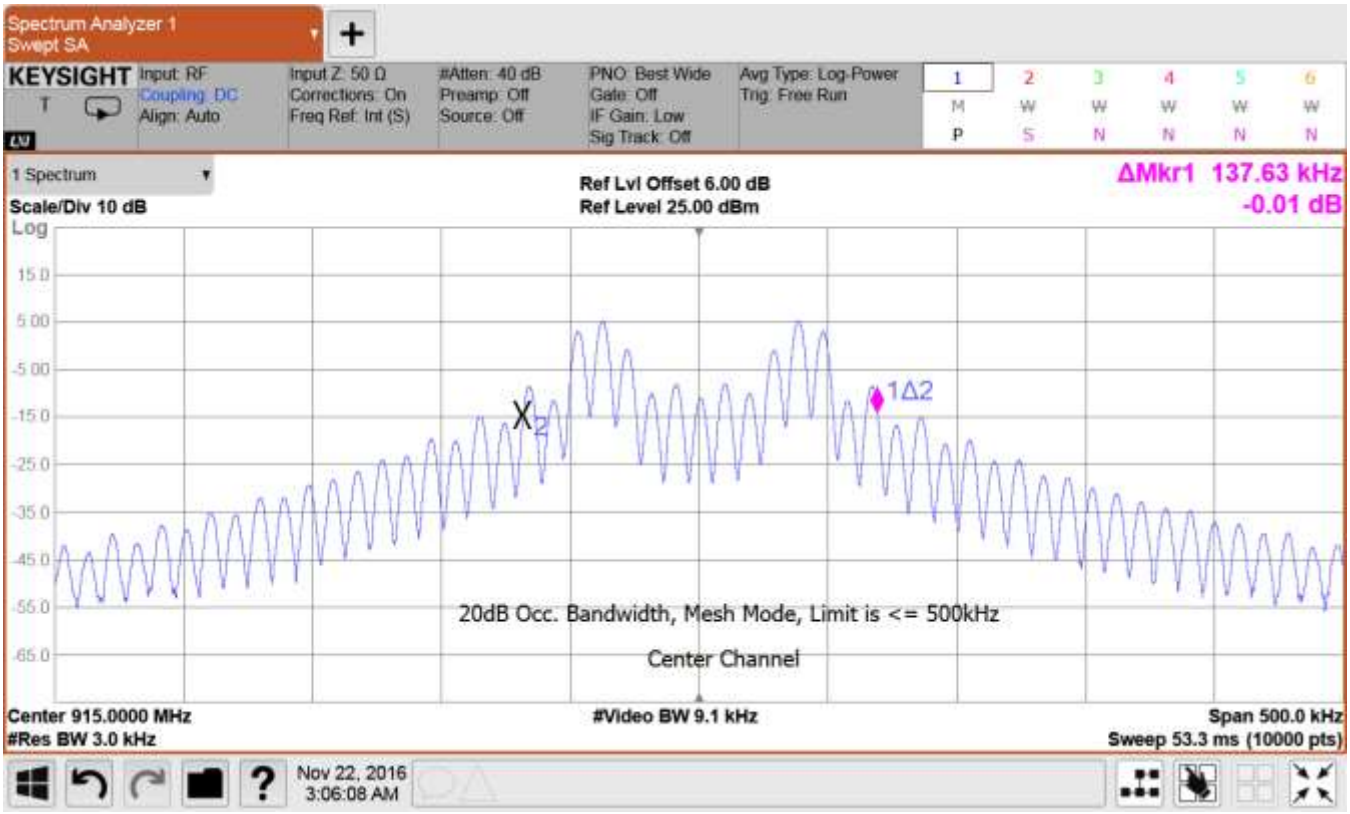

Figure 12: Occupied Bandwidth, Mesh Mode, Center Channel

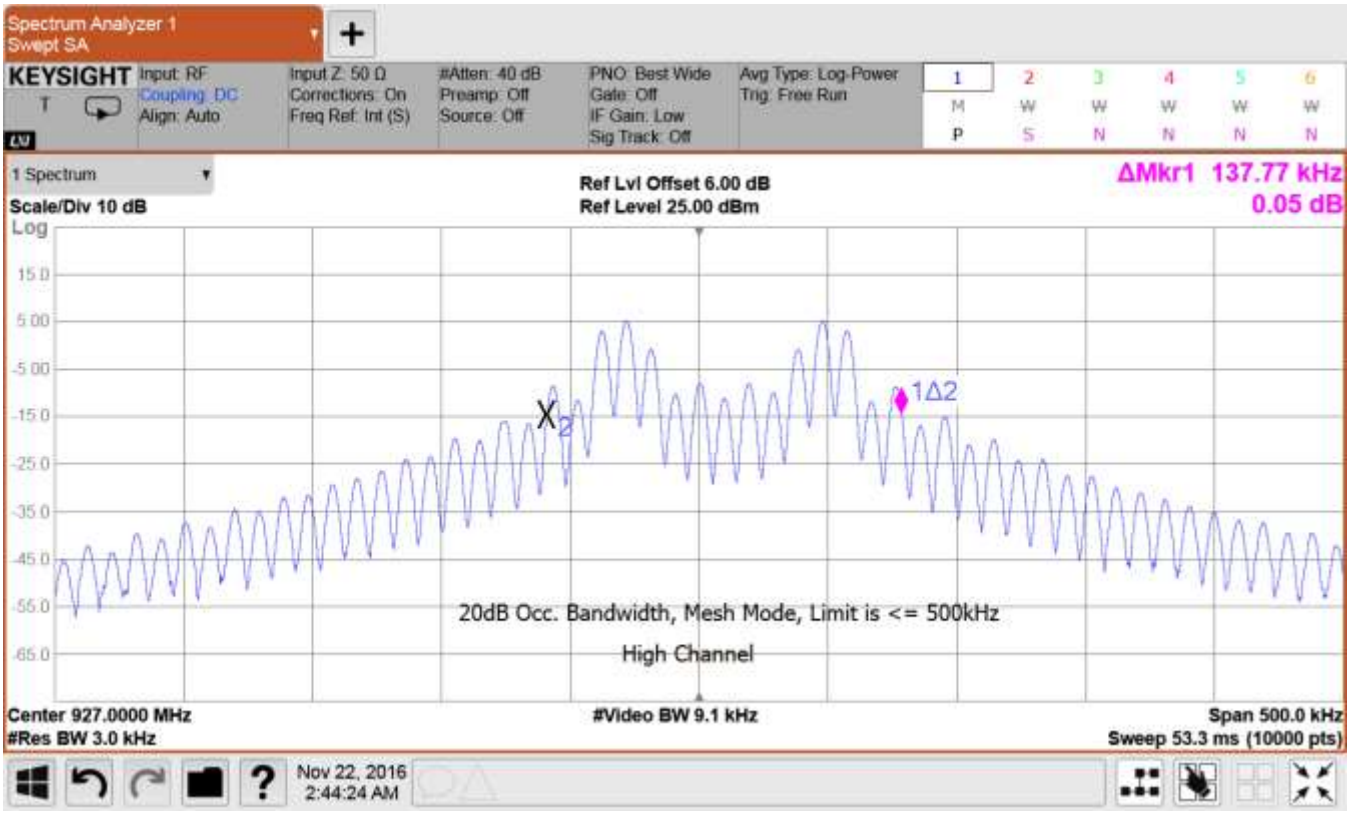

Figure 13: Occupied Bandwidth, Mesh Mode, High Channel

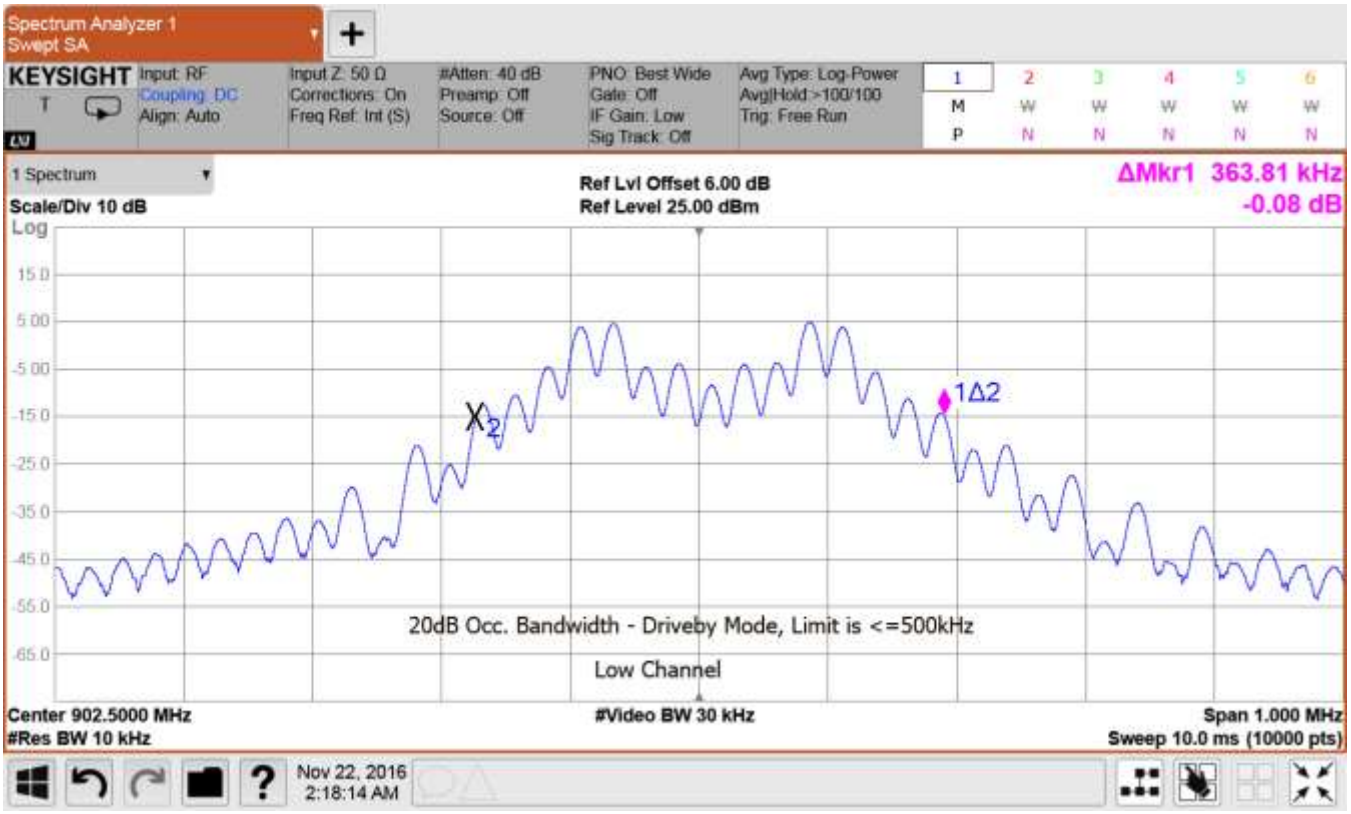

Figure 14: Occupied Bandwidth, Drive-by Mode, Low Channel

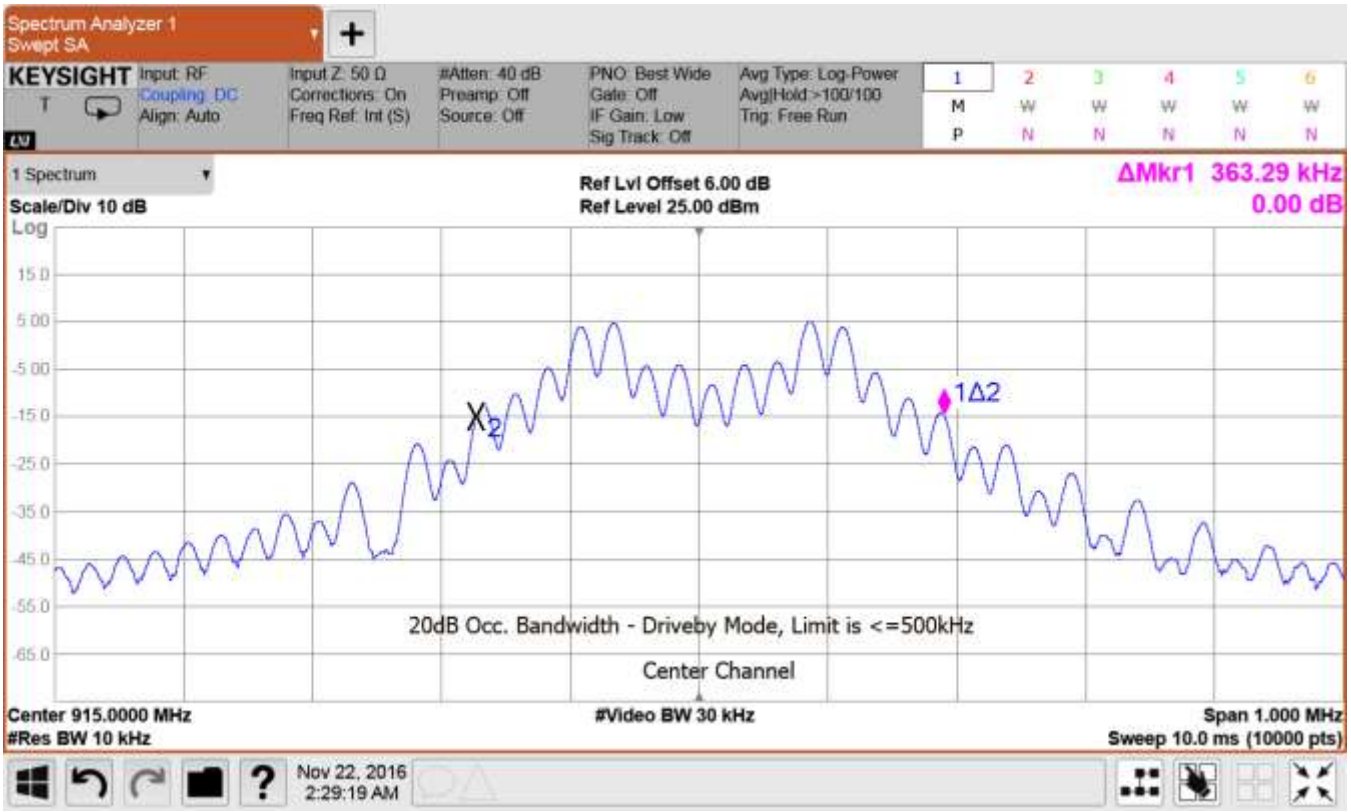

Figure 15: Occupied Bandwidth, Drive-by Mode, Center Channel

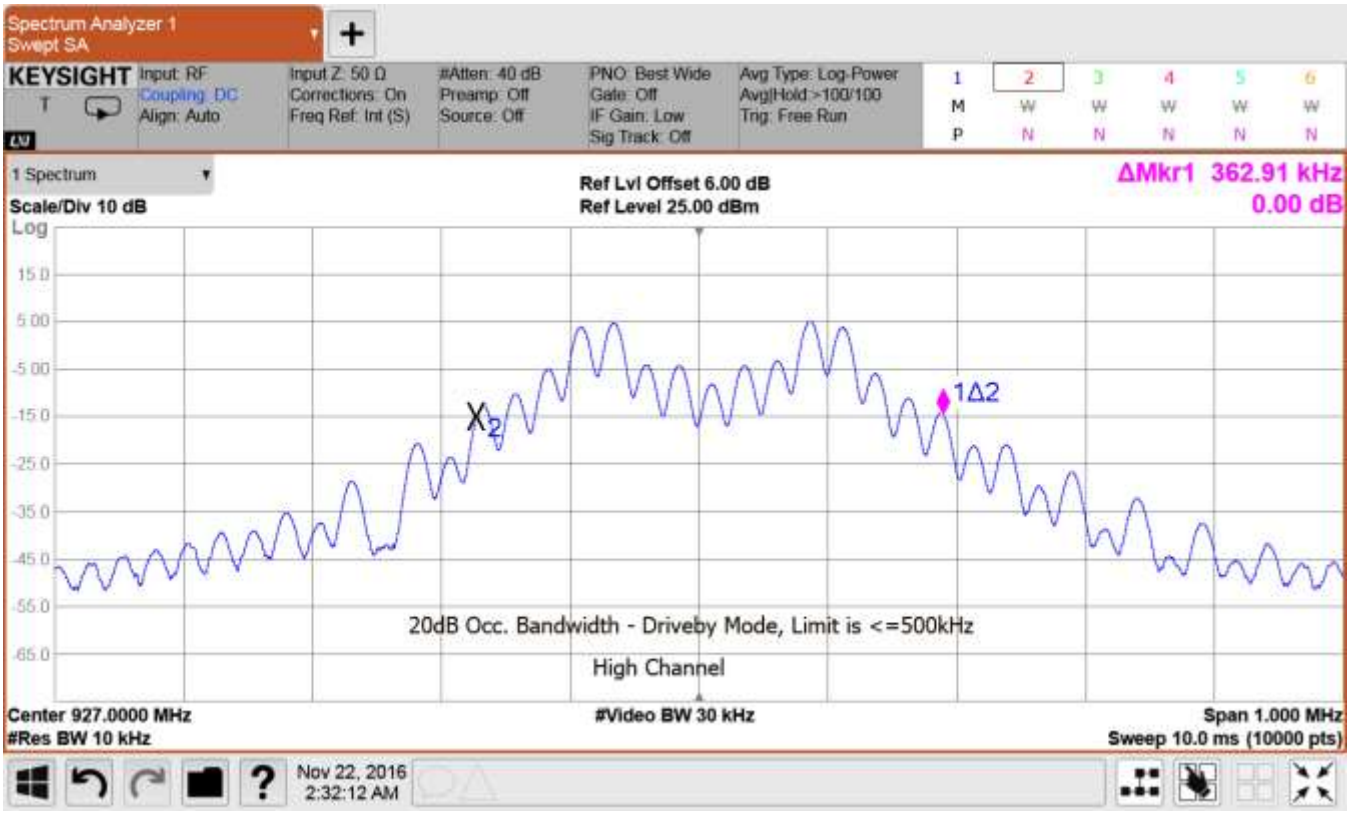

Figure 16: Occupied Bandwidth, Drive-by Mode, High Channel

5.5 Carrier Frequency Separation and Number of Hop Channels (FCC Part §15247(a)(1)

Tests were performed as specified in ANSI C63.10 section "7.8.2 Carrier frequency separation" and "7.8.3 Number of hopping frequencies".

Per the FCC requirements, frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20 dB bandwidth, whichever is greater. The maximum 20dB bandwidth measured is 137.8 kHz (mesh) so the channel spacing must be more than 137.8 kHz for mesh mode and 363.8 kHz for drive-by mode. In addition, the required number of hopping channels is 50 or more for a system with an occupied bandwidth greater than 250kHz.

The EUT antenna was removed and the cable was connected directly into a spectrum analyzer through a 6 dB attenuator. An offset was programmed into the spectrum analyzer to compensate for the loss of the external attenuator. The channel spacing of 2 adjacent channels was measured using a spectrum analyzer. Also, the number of hopping channels was measured from 902 to 928MHz (to encompass the passband).

The following are plots of the channel spacing and number of hopping channels data. The channel spacing was measured to be 500kHz in both Mesh and Drive-by Modes and the number of channels used is 50 in both modes (plot taken in Mesh mode).

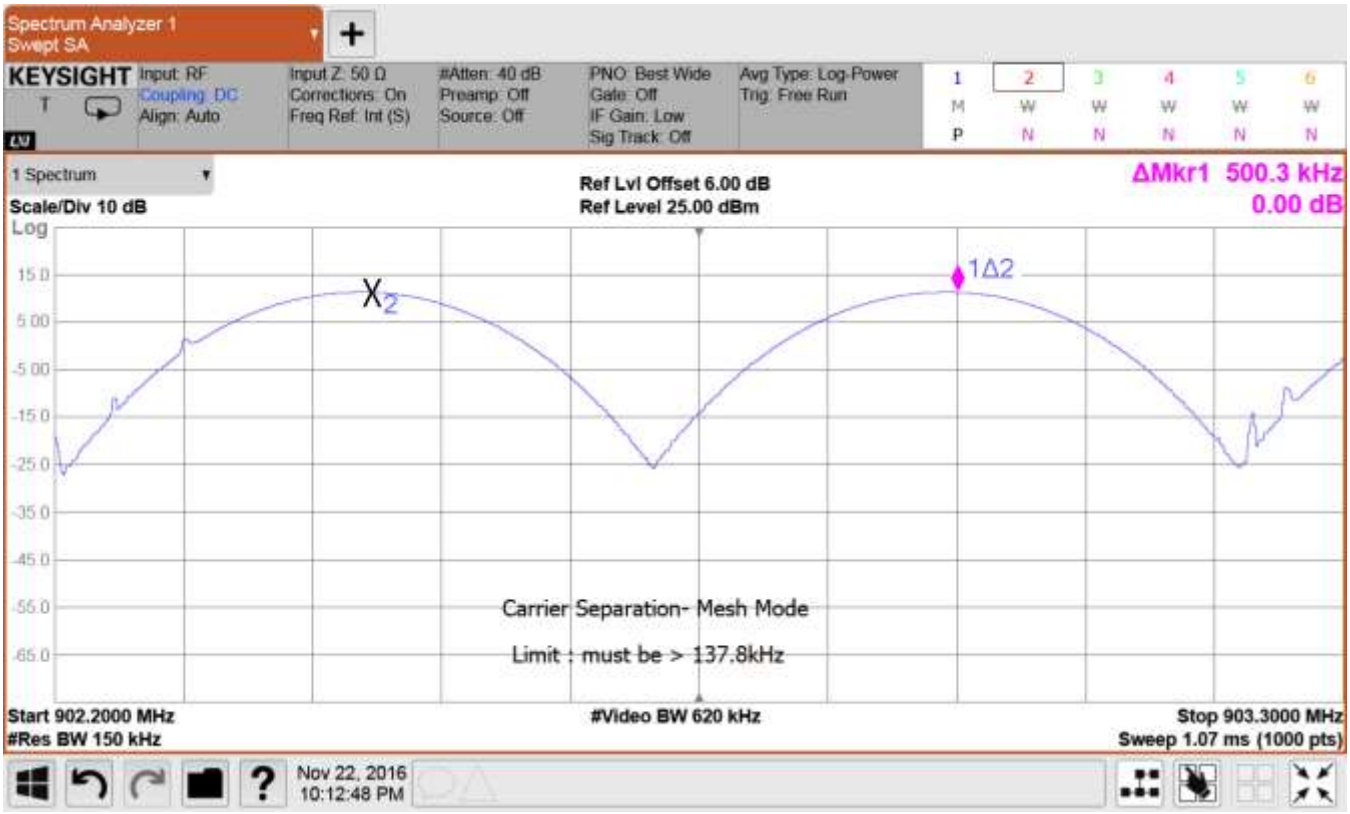

Figure 17: Channel Spacing, Mesh Mode

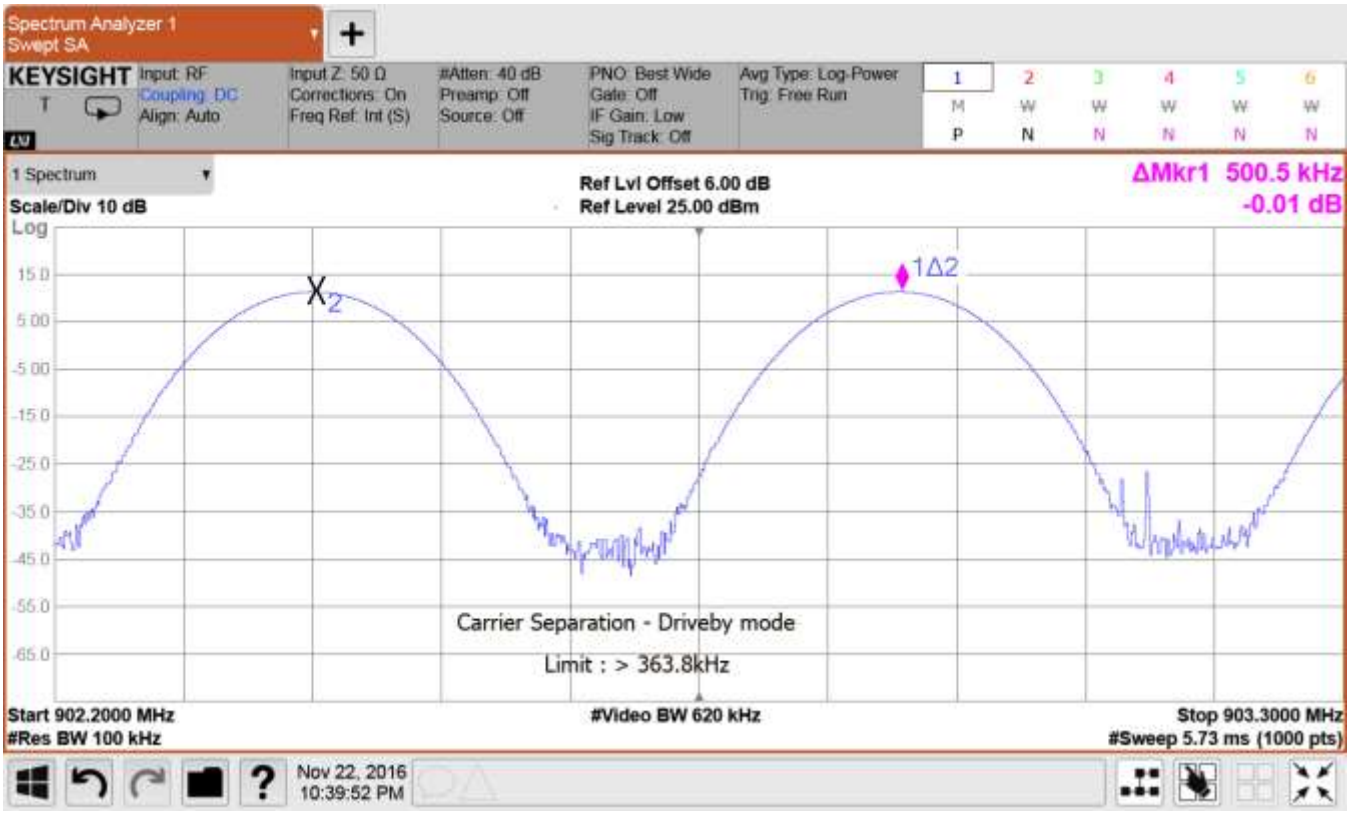

Figure 18: Channel Spacing, Drive-by Mode

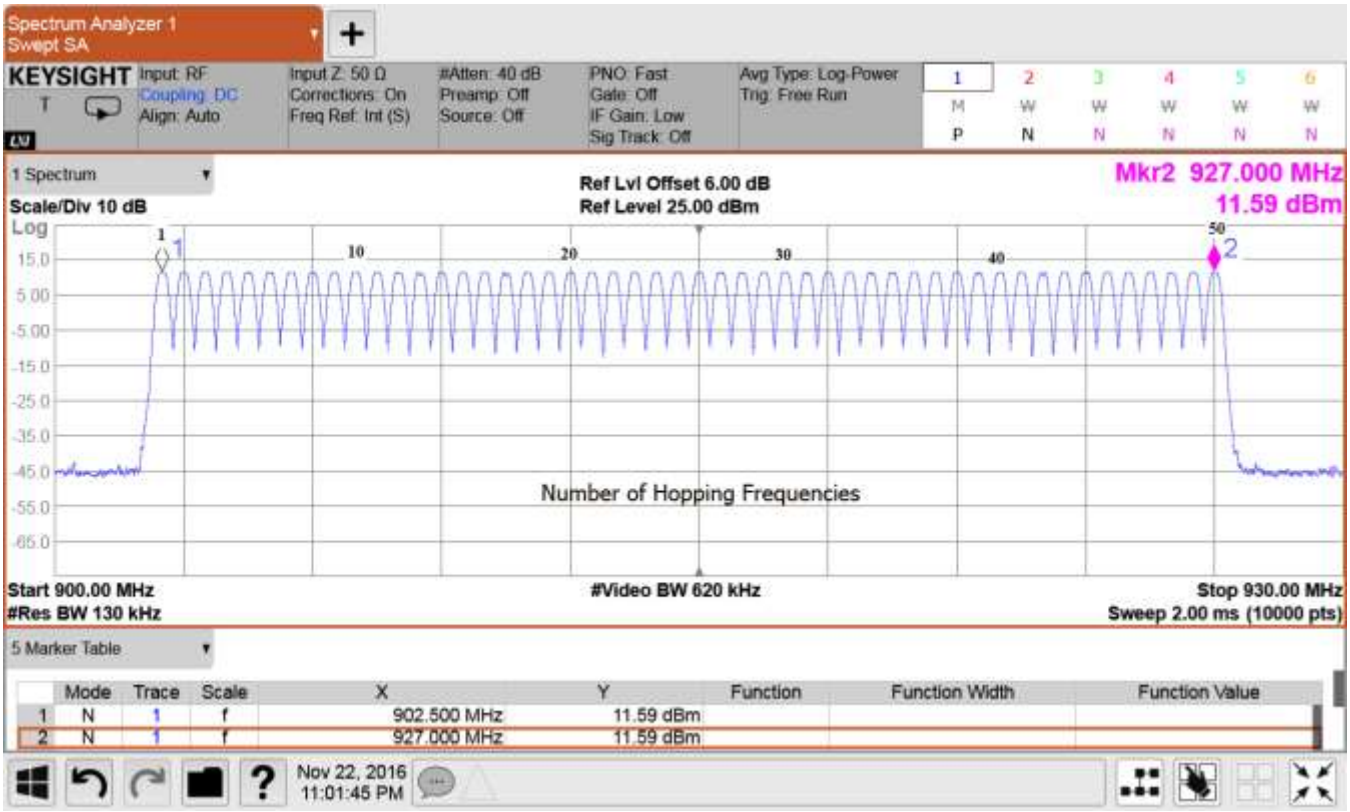

Figure 19: Number of Channels

5.6 Conducted Spurious Emissions at Antenna Terminals (FCC Part §2.1051)

Tests were performed as specified in ANSI C63.10 section "7.8.8 Conducted spurious emissions test methodology" and sections 5.5 and 5.6 (63.10).

Per section 5.6 Mesh mode was used as it had the highest recorded power.

The EUT must comply with requirements for spurious emissions at antenna terminals. Per §15.247(c) 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.

The EUT antenna was removed and the cable was connected directly into a spectrum analyzer through a 6 dB attenuator. An offset was programmed into the spectrum analyzer to compensate for the loss of the external attenuator. 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.

The following are plots of the conducted spurious emissions data.

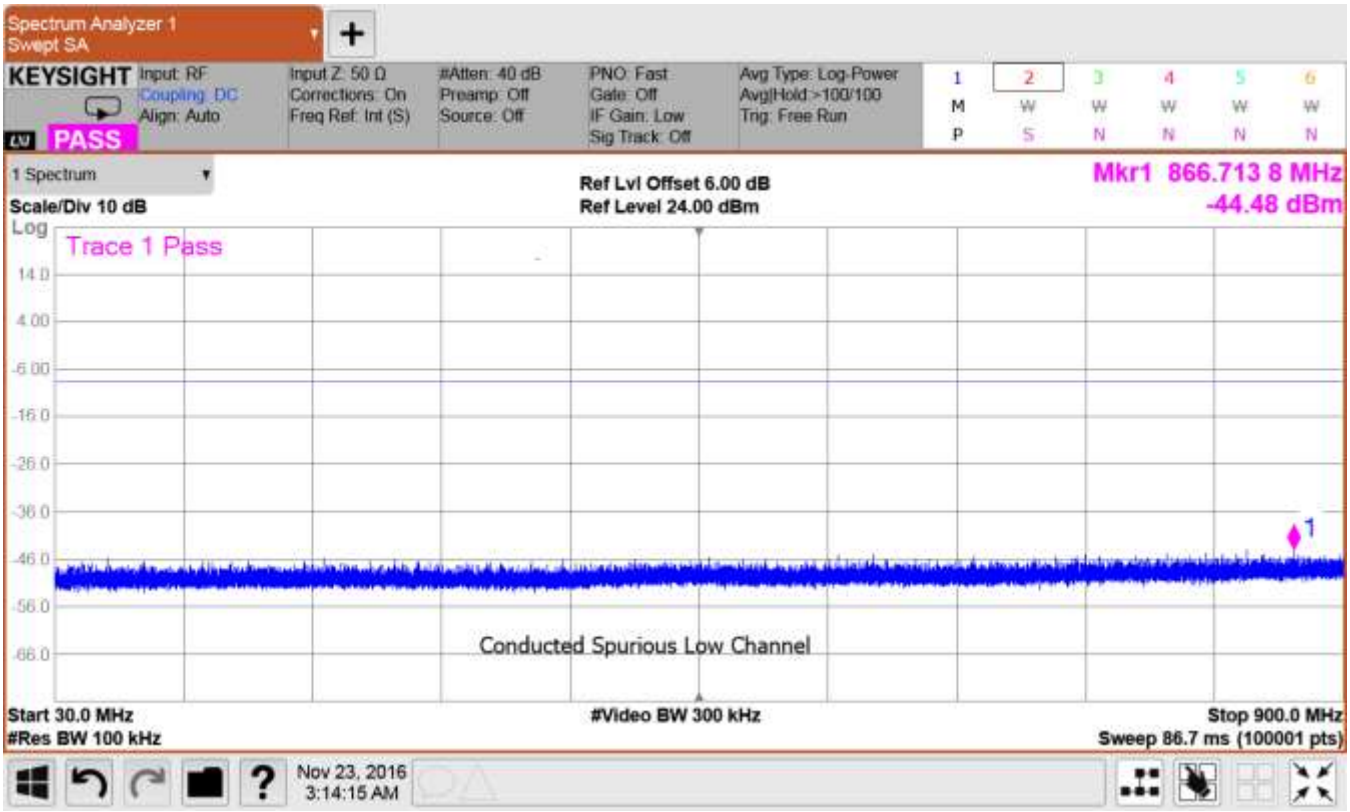

Figure 20: Conducted, Spurious Emissions, Low Channel 30 - 900MHz

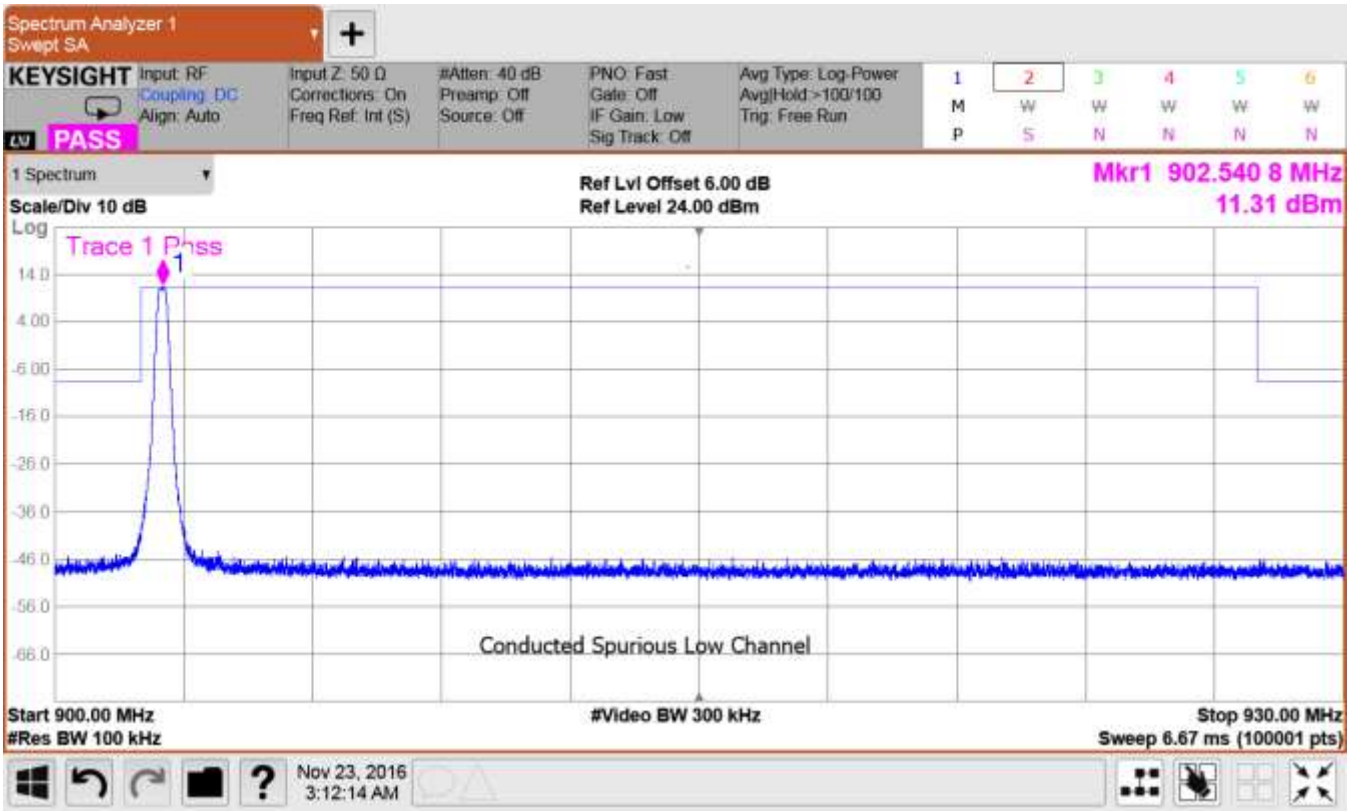

Figure 21: Conducted, Spurious Emissions, Low Channel 900 – 930MHz

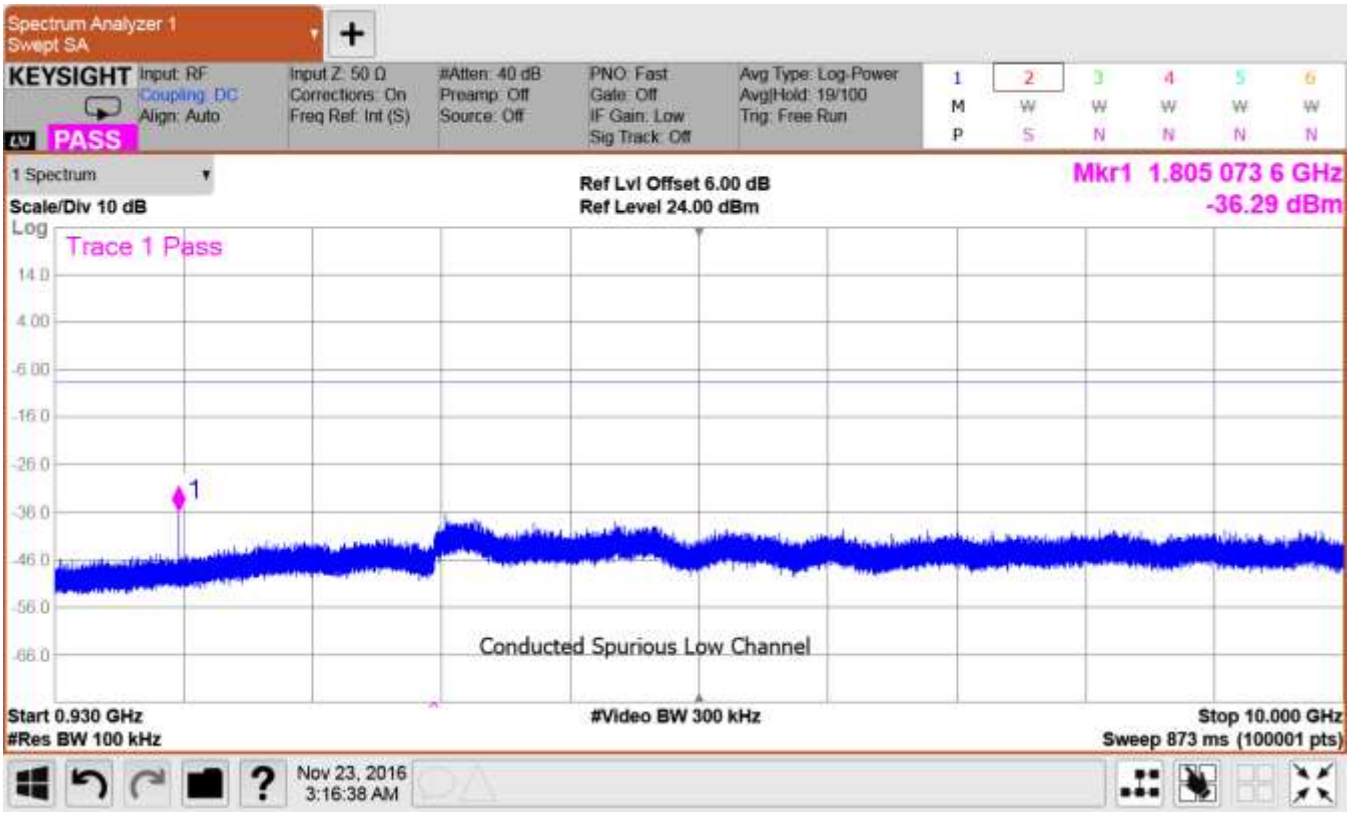

Figure 22: Conducted, Spurious Emissions, Low Channel 930MHz-10GHz

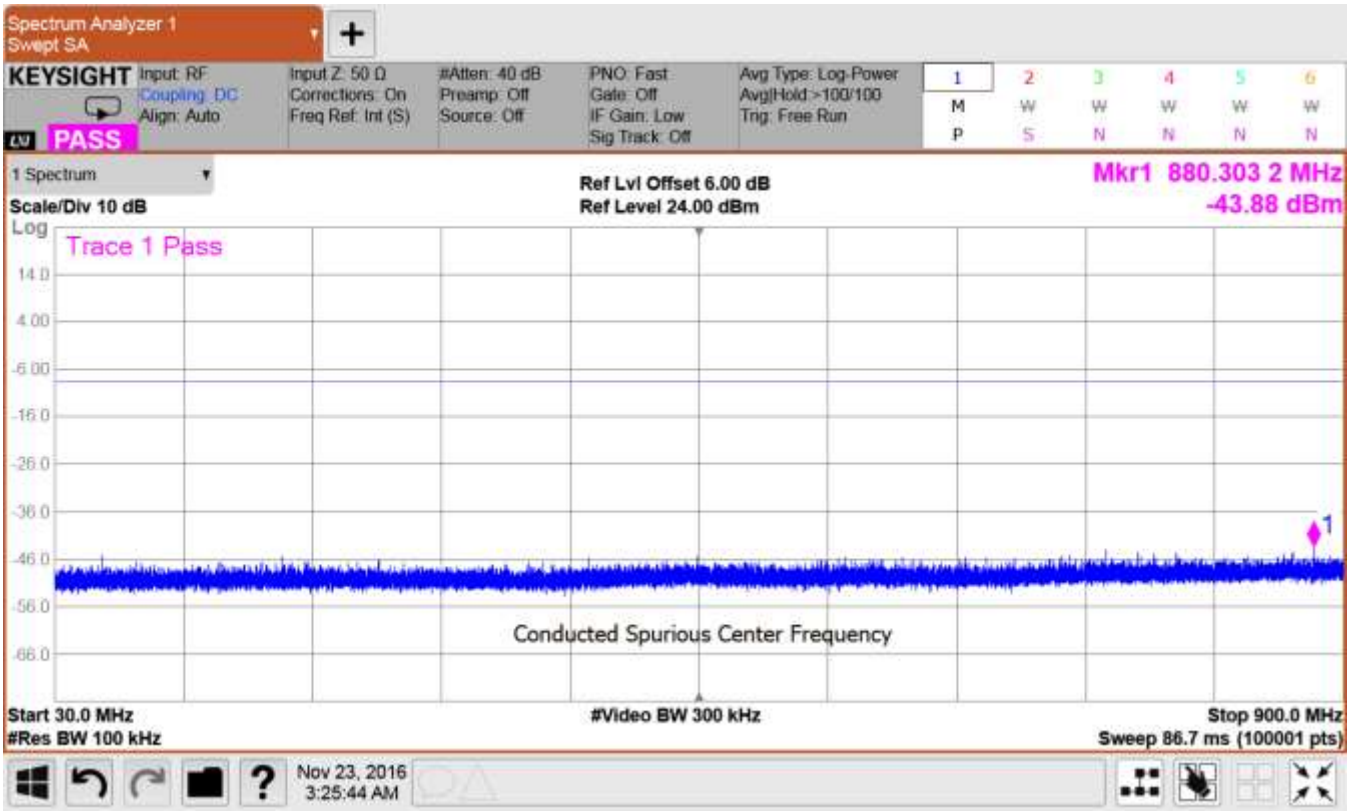

Figure 23: Conducted, Spurious Emissions, Center Channel 30-900 MHz

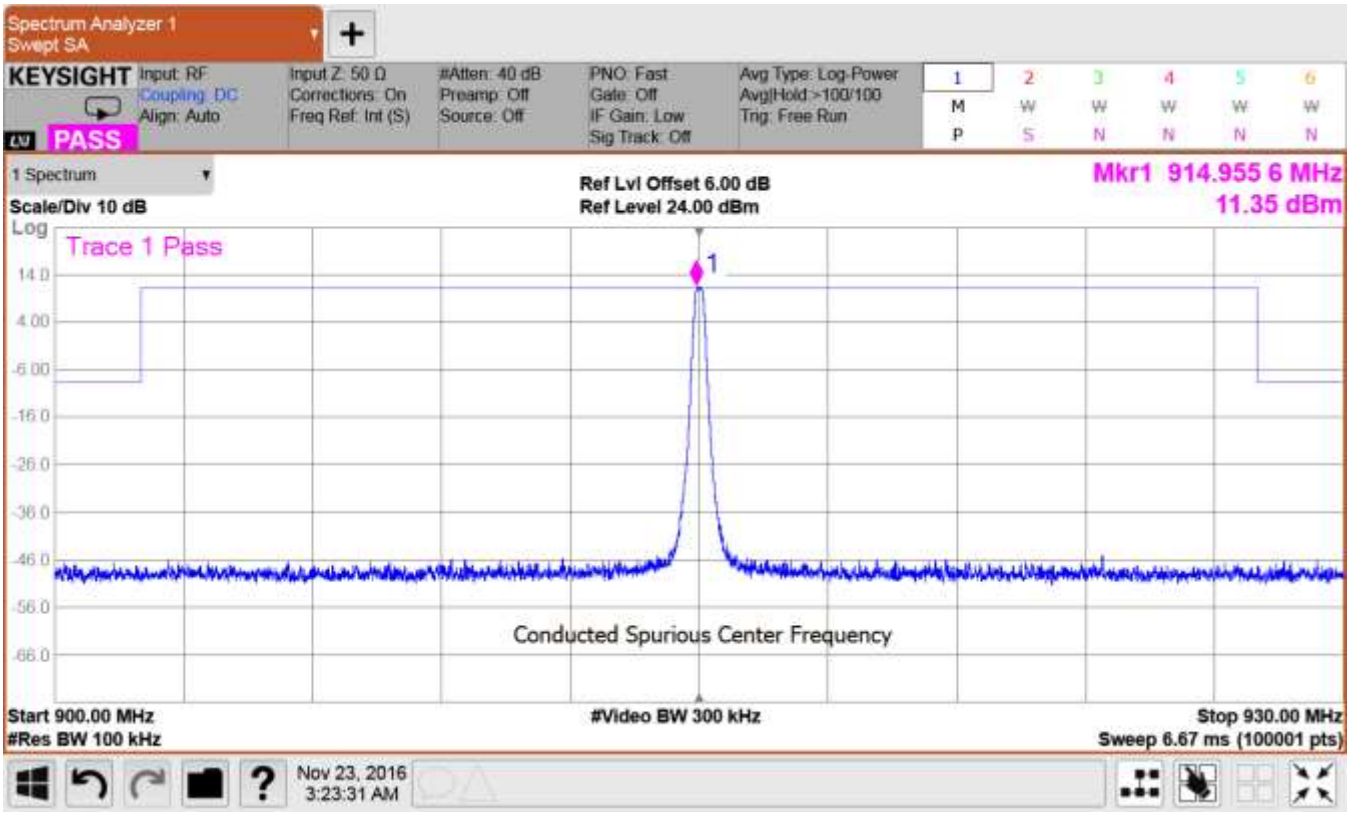

Figure 24: Conducted, Spurious Emissions, Center Channel 900-930 MHz

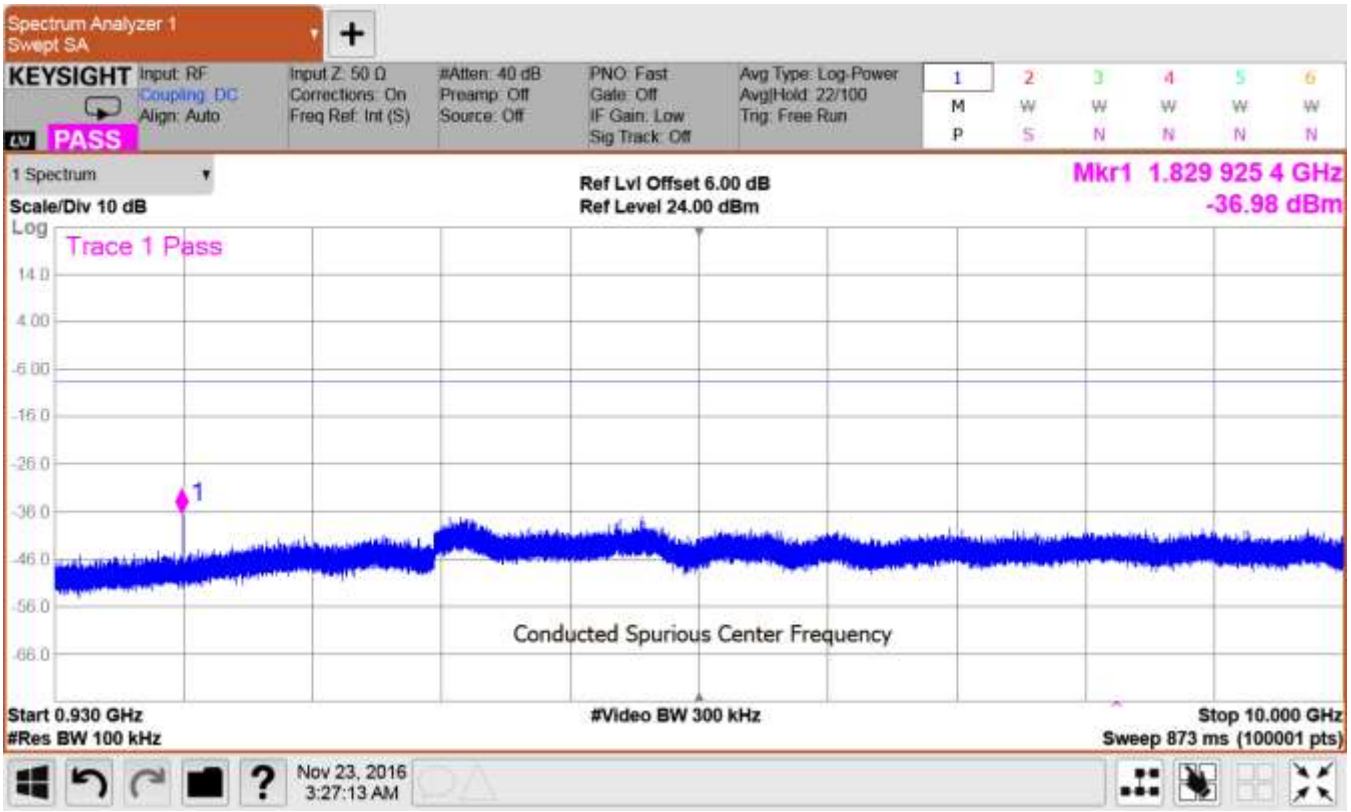

Figure 25: Conducted, Spurious Emissions, Center Channel 930MHz -10GHz

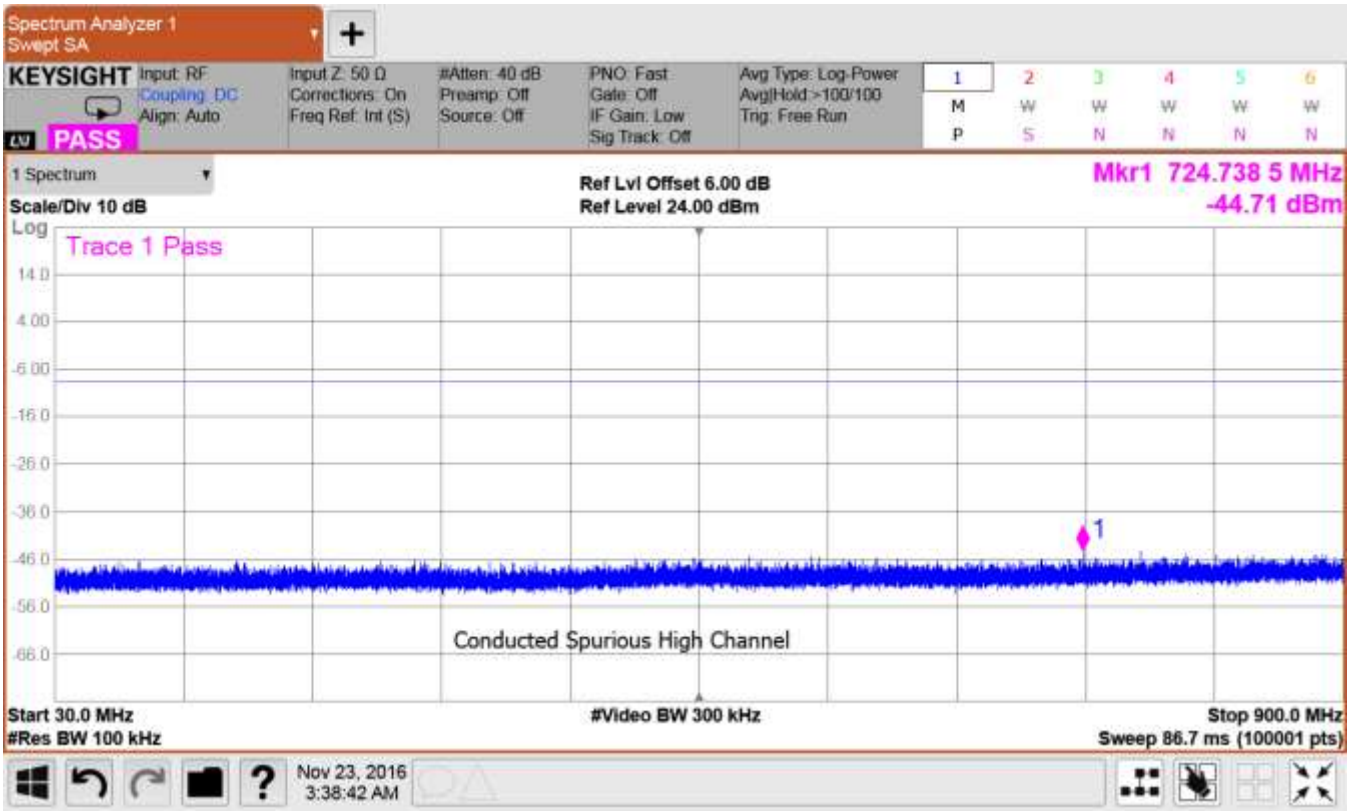

Figure 26: Conducted, Spurious Emissions, High Channel 30-900MHz

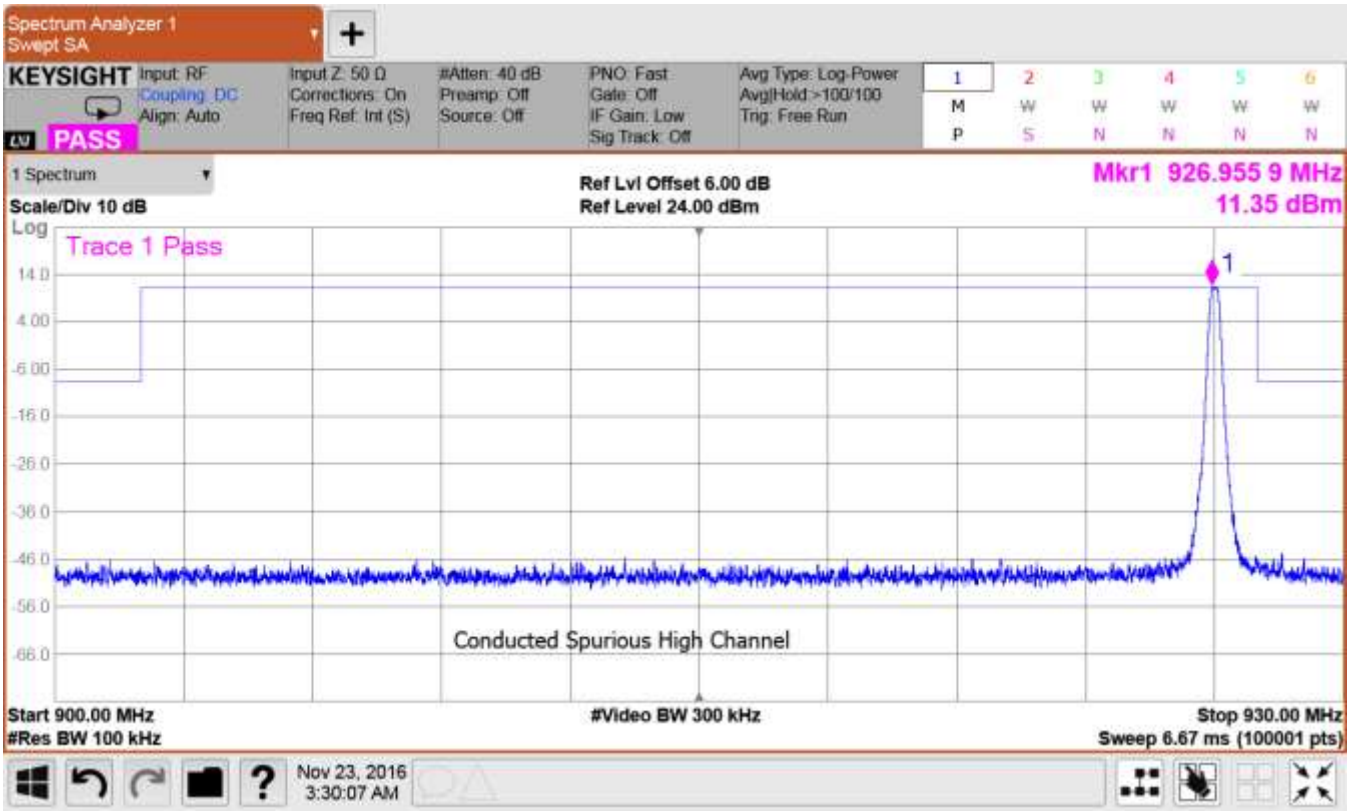

Figure 27: Conducted, Spurious Emissions, High Channel 900-930MHz

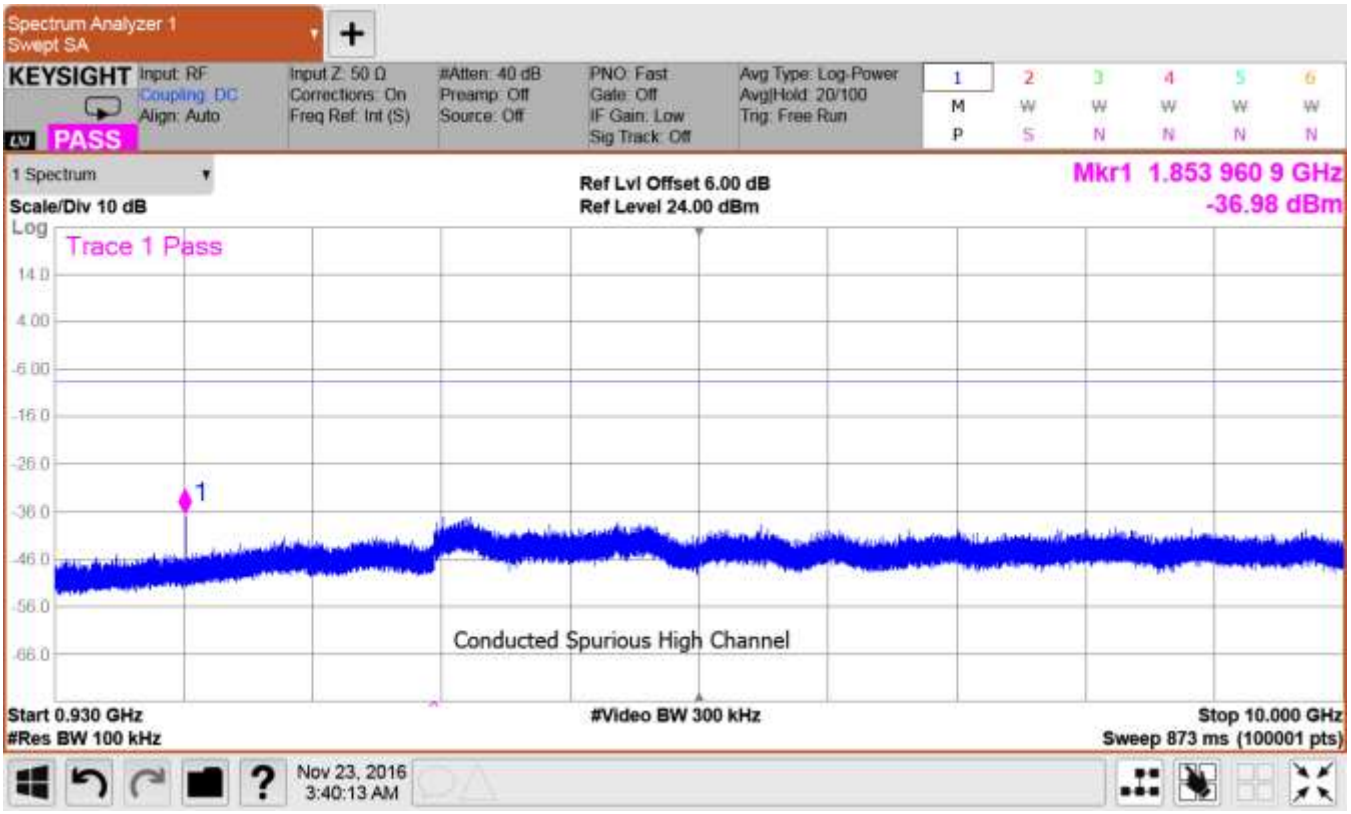

Figure 28: Conducted, Spurious Emissions, High Channel 930MHz-10GHz

5.7 Conducted Band Edge Requirements

Per ANSI C63.10 section 7.8.6 "Band-edge measurements for RF conducted emissions" Band-edge measurements were tested using the band-edge procedure in 6.10.4

Band-edge measurements were tested both on single channels and with the EUT hopping

Close up plots of the upper and lower 902-928MHz Band-edges in both Mesh and Drive-by modes are provided below with the EUT fixed at the lower and upper frequencies. Plots are also provided with the EUT hopping functions enabled. Emissions must be attenuated 20dB from the peak emission outside of the 902-928 Band.

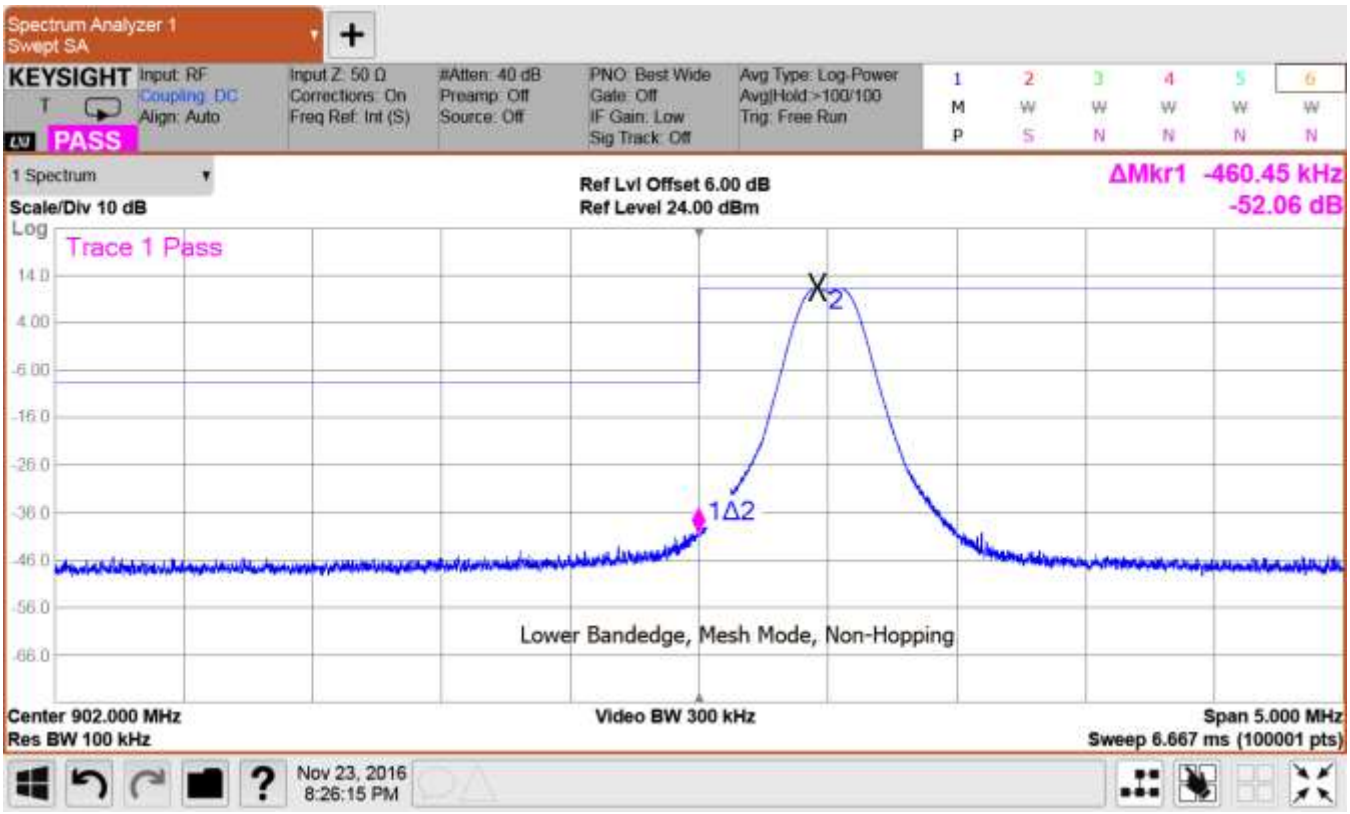

Figure 29: Conducted, Lower Band-edge, Mesh Mode, Low Channel

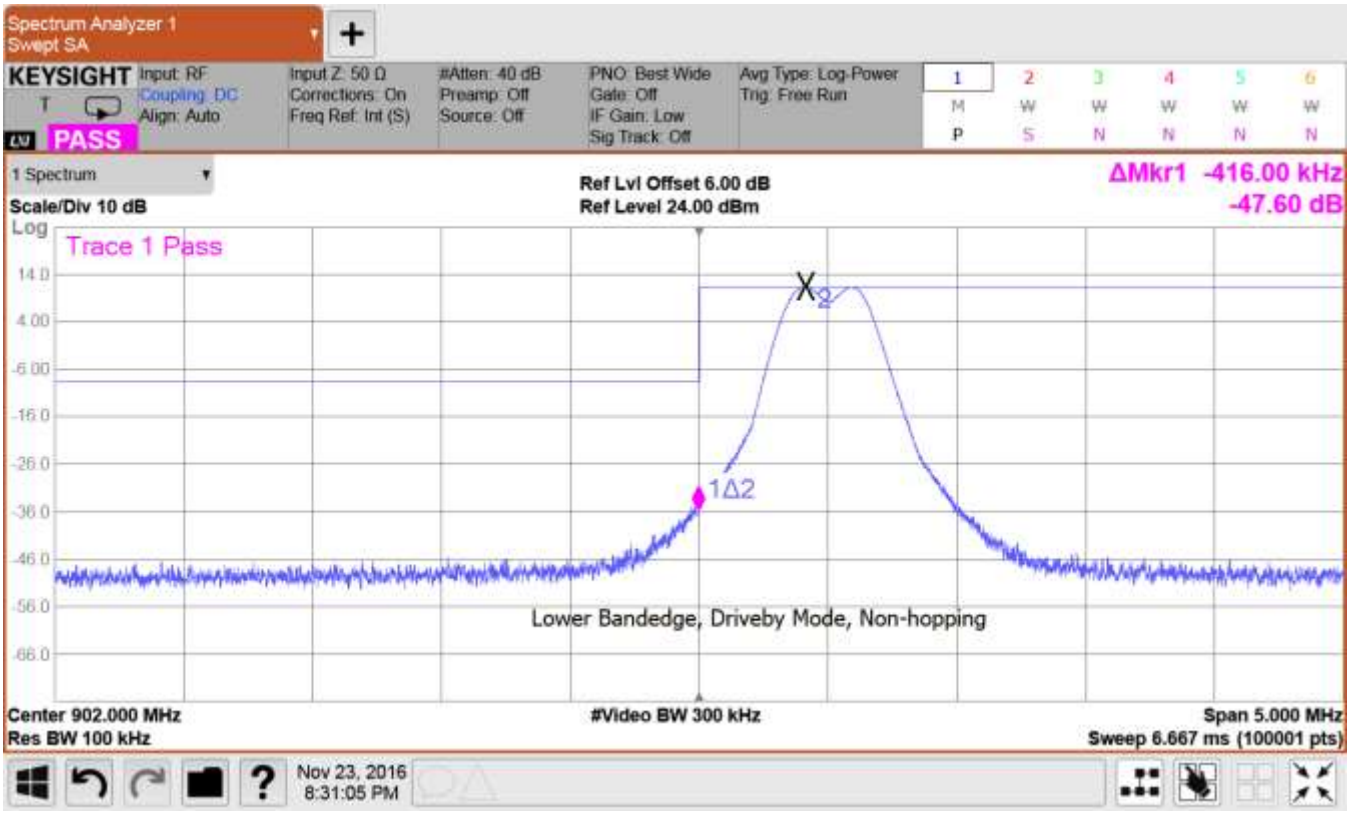

Figure 30: Conducted, Lower Band-edge, Drive-by Mode, Low Channel

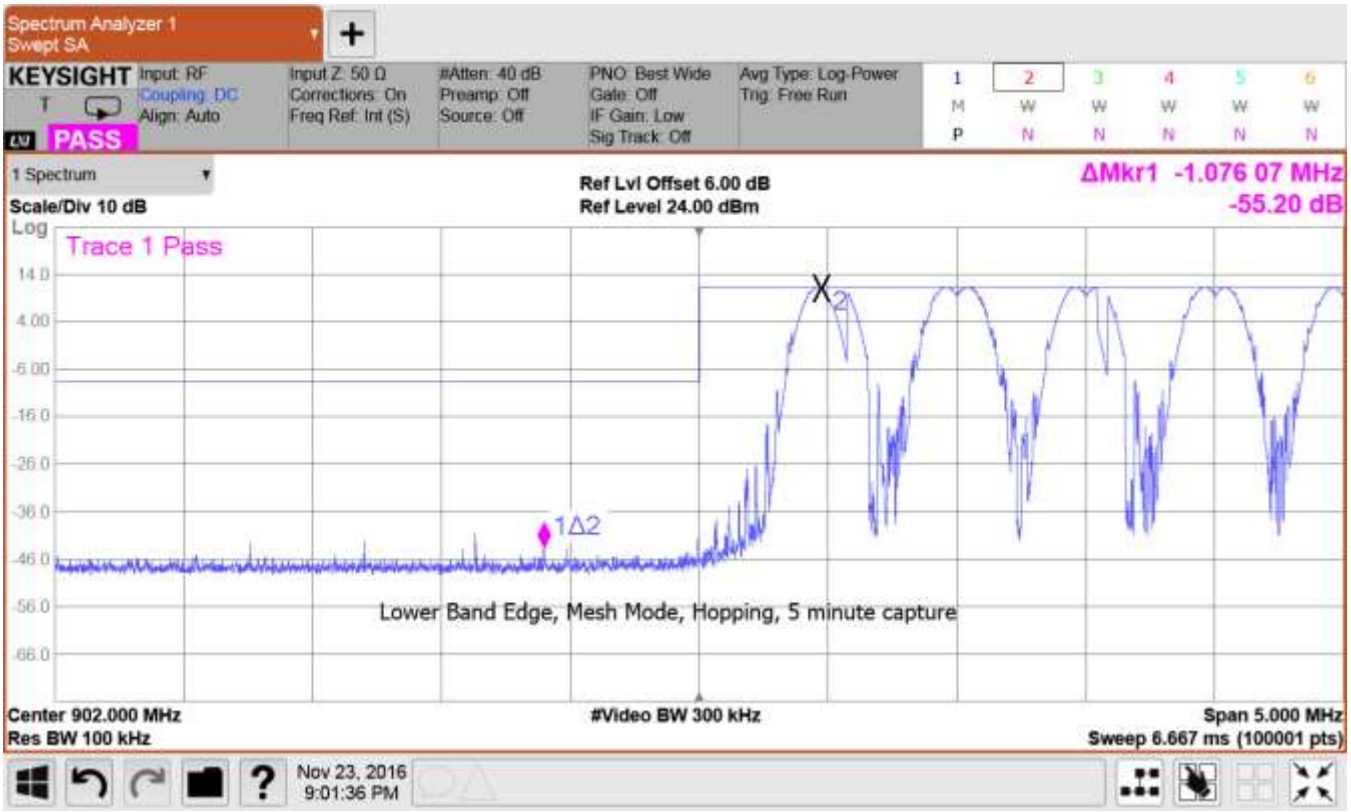

Figure 31: Conducted, Lower Band-edge, Mesh Mode, Hopping

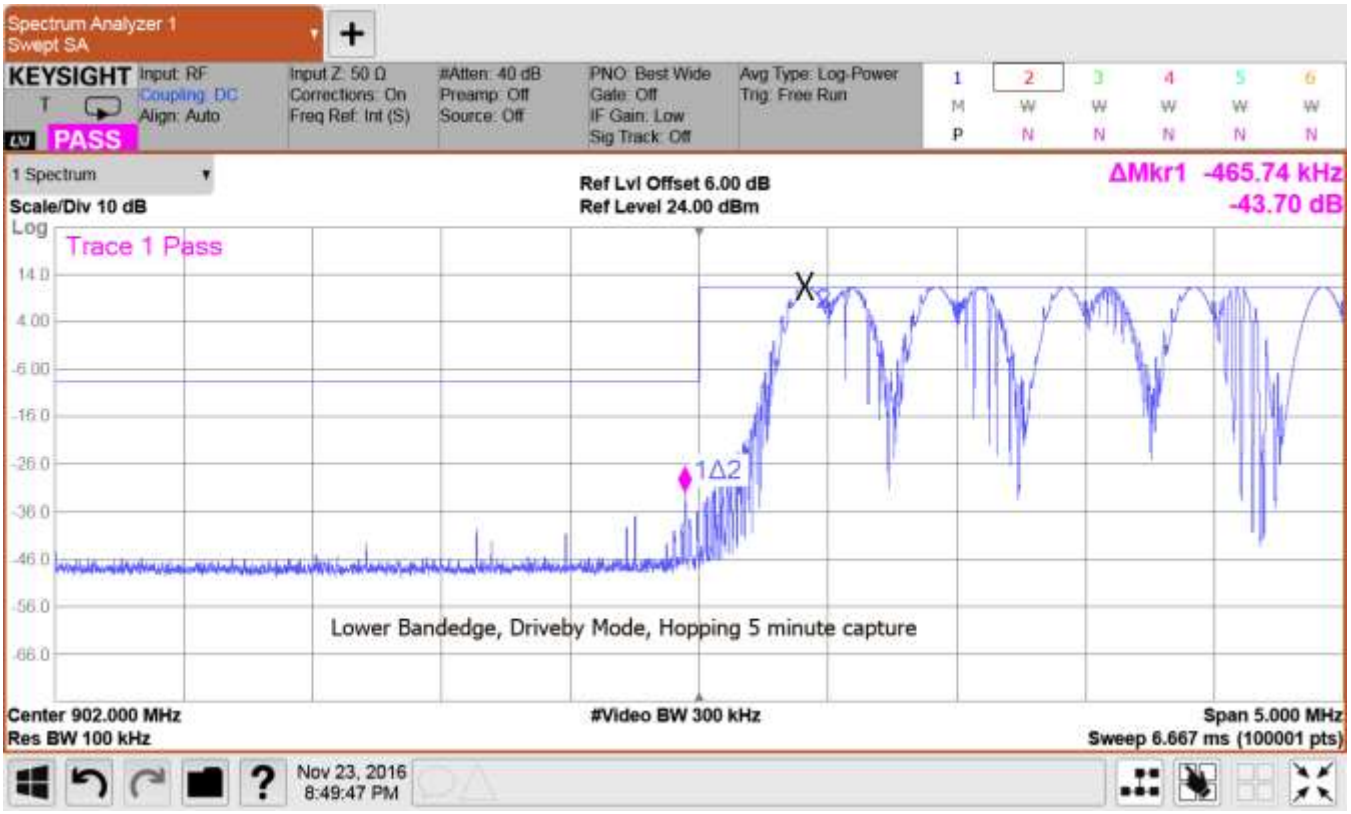

Figure 32: Conducted, Lower Band-edge, Drive-by Mode, Hopping

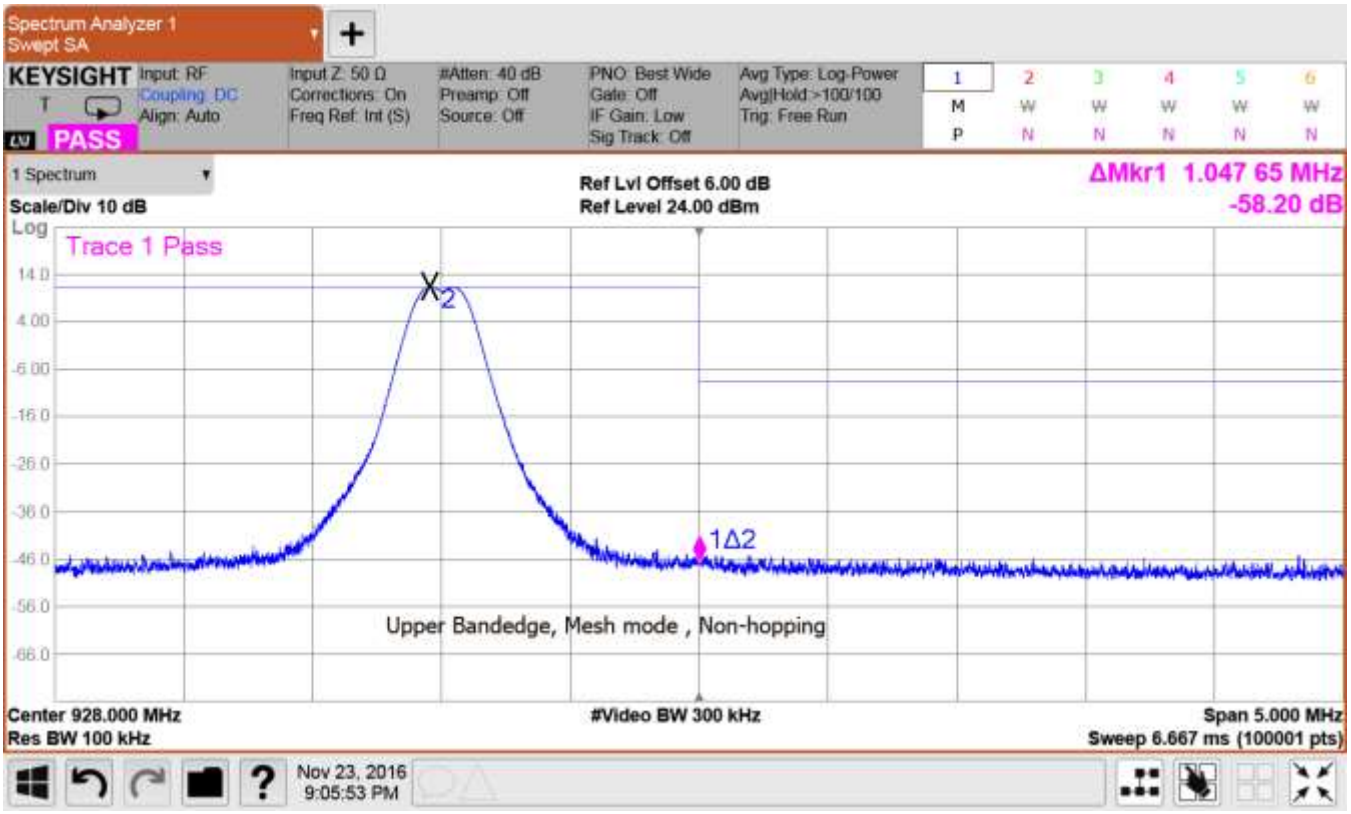

Figure 33: Conducted, Upper Band-edge, Mesh Mode, High Channel

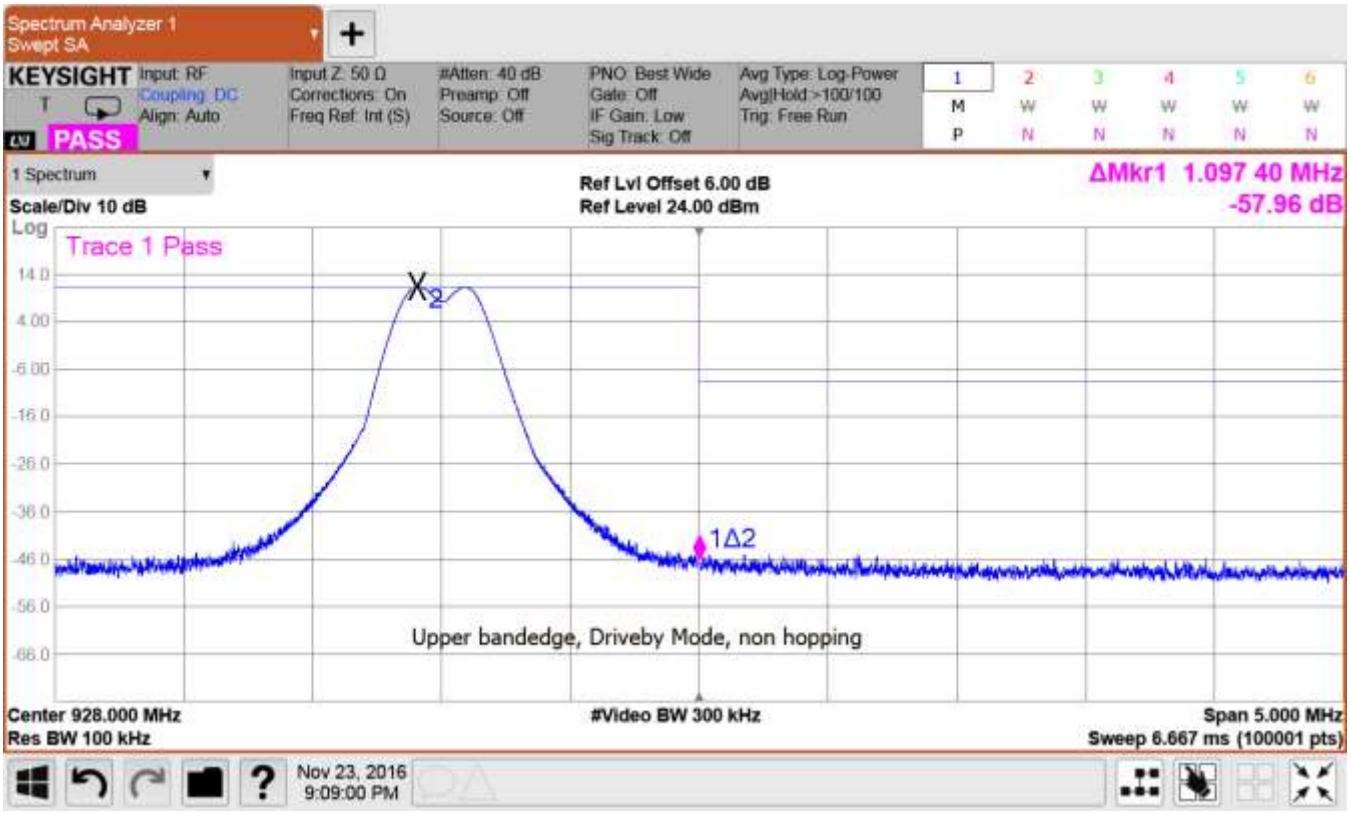

Figure 34: Conducted, Upper Band-edge, Drive-by Mode, High Channel

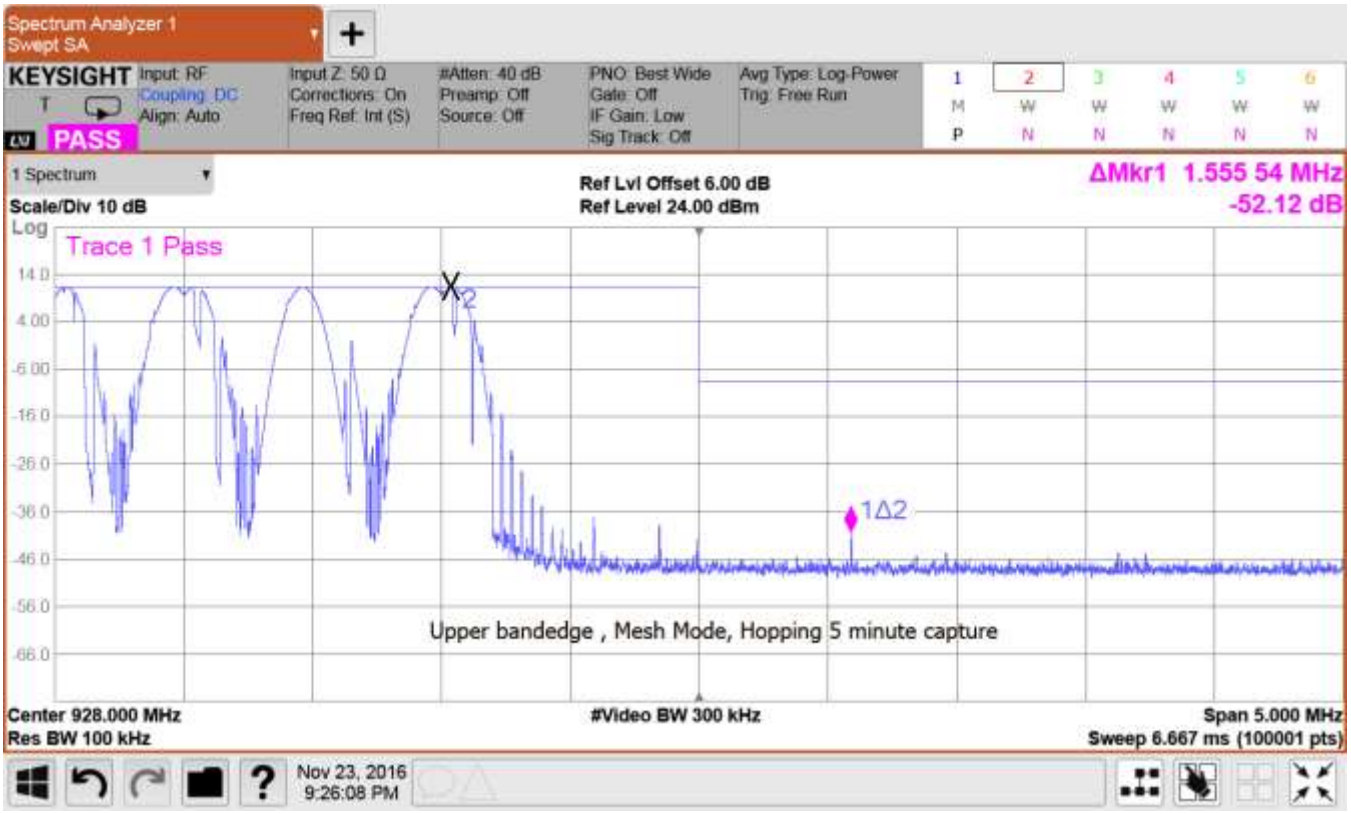

Figure 35: Conducted, Upper Band-edge, Mesh Mode, Hopping

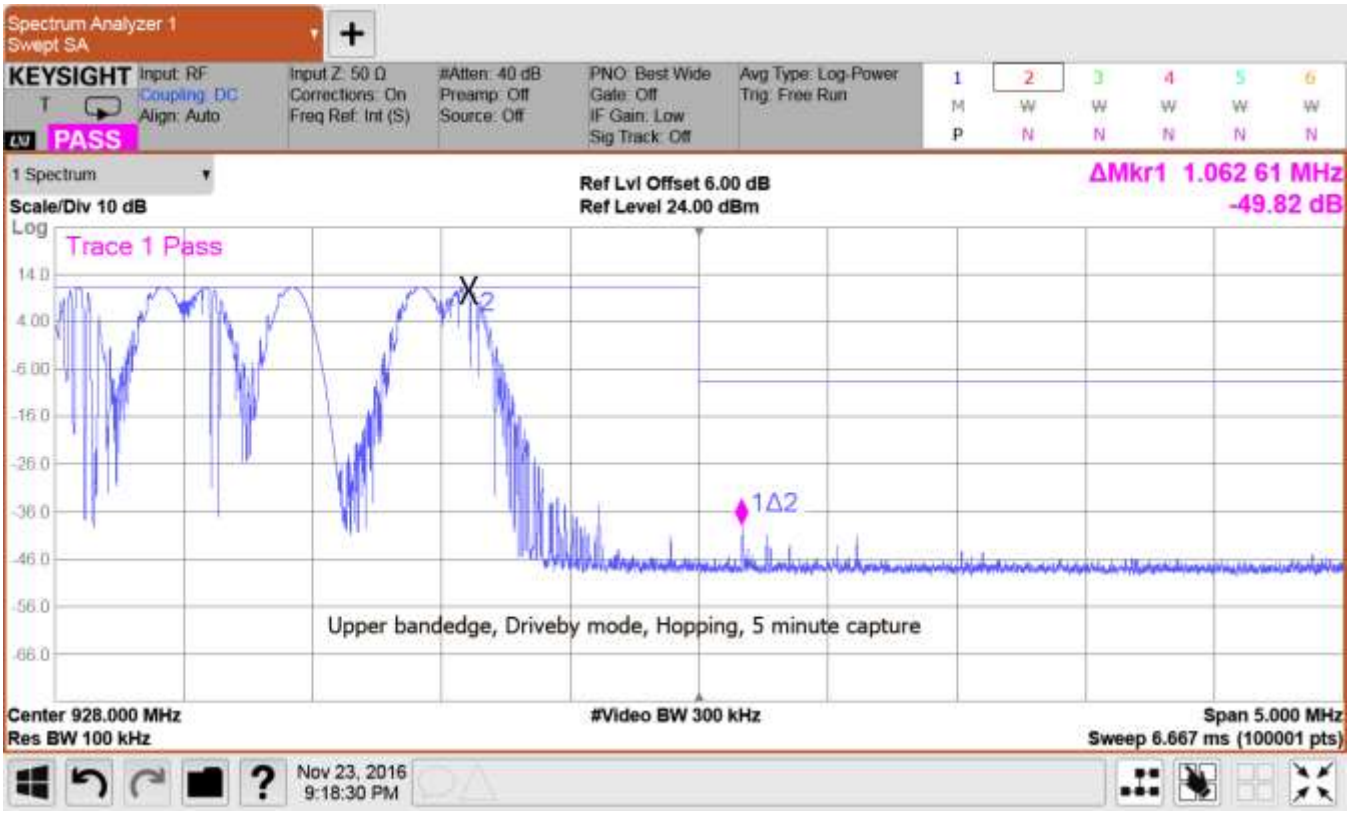

Figure 36: Conducted, Upper Band-edge, Drive-by Mode, Hopping

5.8 Radiated Spurious Emissions: (FCC Part §2.1053)

The EUT must comply with the requirements for radiated spurious emissions that fall within the restricted bands. These emissions must meet the limits specified in §15.209 and §15.35(b) for peak measurements.

5.8.1 Test Procedure

The EUT was placed on 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. Receiving 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. Both the horizontal and vertical field components were measured.

The EUT was tested in 3 orthogonals with the worst case readings reported.

Above 1GHz the EUT was placed on a 1.5meter table with RF absorber material between the EUT and Receive antenna.

The emissions were measured using the following resolution bandwidths:

Table 7: Spectrum Analyzer Settings

Frequency Range	Resolution Bandwidth	Video Bandwidth
30MHz-1000 MHz	120kHz	1MHz
>1000 MHz	1 MHz	3MHz

Average measurements above 1GHz were made with the Spectrum analyzer set to RMS Average. Correction factors were then applied and the resulting value was compared to the limit.

The EUT was scanned up to 10GHz. No duty cycle corrections were used.

Table 8: Radiated Emission Test Data (Restricted Bands), <1GHz (Common to all Channels)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)
117.00	V	0.00	1.00	46.49	-11.8	54.1	150.0	-8.9
123.95	V	10.00	1.40	37.68	-11.3	20.8	150.0	-17.2
964.00	V	180.00	1.40	34.80	-0.7	50.7	500.0	-19.9
116.27	H	10.00	3.68	36.75	-11.9	17.5	150.0	-18.7
123.95	H	20.00	3.64	38.82	-11.3	23.7	150.0	-16.0
964.30	H	180.00	1.80	37.40	-0.7	68.3	500.0	-17.3

Table 9: Radiated Emission Test Data (Restricted Bands), Low Channel, 902.5MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Detector
2707.50	V	45.00	3.20	44.41	-0.6	155.0	5000.0	-30.2	pk
2707.50	V	45.00	3.20	34.67	-0.6	50.5	500.0	-19.9	av
3610.00	V	220.00	3.50	44.66	1.5	202.5	5000.0	-27.9	pk
3610.00	V	220.00	3.50	34.70	1.5	64.3	500.0	-17.8	av
4512.50	V	180.00	2.60	43.26	3.4	214.4	5000.0	-27.4	pk
4512.50	V	180.00	2.60	34.26	3.4	76.1	500.0	-16.4	av
8122.50	V	45.00	3.20	45.93	11.2	719.2	5000.0	-16.8	pk
8122.50	V	45.00	3.20	36.80	11.2	251.4	500.0	-6.0	av
9025.00	V	90.00	3.60	44.93	12.5	744.5	5000.0	-16.5	pk
9025.00	V	90.00	3.60	35.90	12.5	263.2	500.0	-5.6	av
2707.50	H	90.00	2.60	45.03	-0.6	166.5	5000.0	-29.6	pk
2707.50	H	90.00	2.60	34.40	-0.6	49.0	500.0	-20.2	av
3610.00	H	45.00	3.20	45.58	1.5	225.1	5000.0	-26.9	pk
3610.00	H	45.00	3.20	35.48	1.5	70.4	500.0	-17.0	av
4512.50	H	90.00	2.80	43.33	3.4	216.1	5000.0	-27.3	pk
4512.50	H	90.00	2.80	33.32	3.4	68.3	500.0	-17.3	av
8122.50	H	0.00	3.50	48.00	11.2	912.8	5000.0	-14.8	pk
8122.50	H	0.00	3.50	39.20	11.2	331.4	500.0	-3.6	av

Table 10: Radiated Emission Test Data (Restricted Bands), Center Channel, 915MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Detector
2745.00	V	90.00	3.00	46.50	-0.6	196.3	5000.0	-28.1	pk
2745.00	V	90.00	3.00	38.60	-0.6	79.0	500.0	-16.0	av
3660.00	V	190.00	2.80	45.57	1.5	224.7	5000.0	-26.9	pk
3660.00	V	190.00	2.80	34.60	1.5	63.5	500.0	-17.9	av
4575.00	V	190.00	2.80	41.77	3.6	186.4	5000.0	-28.6	pk
4575.00	V	190.00	2.80	33.40	3.6	71.1	500.0	-16.9	av
7320.00	V	180.00	3.40	44.75	10.8	598.6	5000.0	-18.4	pk
7320.00	V	180.00	3.40	36.60	10.8	234.2	500.0	-6.6	av
8235.00	V	45.00	3.00	43.10	11.3	523.4	5000.0	-19.6	pk
8235.00	V	45.00	3.00	34.70	11.3	199.0	500.0	-8.0	av
2745.00	H	0.00	2.60	48.22	-0.6	239.2	5000.0	-26.4	pk
2745.00	H	0.00	2.60	37.70	-0.6	71.3	500.0	-16.9	av
3660.00	H	190.00	3.40	44.65	1.5	202.1	5000.0	-27.9	pk
3660.00	H	190.00	3.40	35.48	1.5	70.3	500.0	-17.0	av
4575.00	H	270.00	3.40	43.40	3.6	224.9	5000.0	-26.9	pk
4575.00	H	270.00	3.40	34.09	3.6	77.0	500.0	-16.2	av
7320.00	H	180.00	3.00	46.20	10.8	707.3	5000.0	-17.0	pk
7320.00	H	180.00	3.00	40.04	10.8	348.0	500.0	-3.1	av
8235.00	H	45.00	3.00	45.66	11.3	702.8	5000.0	-17.0	pk
8235.00	H	45.00	3.00	38.49	11.3	307.8	500.0	-4.2	av
9150.00	H	180.00	3.60	43.11	13.2	653.4	5000.0	-17.7	pk
9150.00	H	180.00	3.60	33.50	13.2	216.1	500.0	-7.3	av

Table 11: Radiated Emission Test Data (Restricted Bands), High Channel, 927MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Detector
2781.00	V	90.00	2.60	44.63	-0.7	157.6	5000.0	-30.0	pk
2781.00	V	90.00	2.60	33.97	-0.7	46.2	500.0	-20.7	av
3708.00	V	270.00	3.00	44.60	1.5	200.9	5000.0	-27.9	pk
3708.00	V	270.00	3.00	34.20	1.5	60.7	500.0	-18.3	av
7416.00	V	170.00	3.00	44.30	10.7	565.5	5000.0	-18.9	pk
7416.00	V	170.00	3.00	34.00	10.7	172.8	500.0	-9.2	av
8343.00	V	0.00	3.20	43.17	11.2	524.4	5000.0	-19.6	pk
8343.00	V	0.00	3.20	34.76	11.2	199.2	500.0	-8.0	av
2781.00	H	180.00	2.60	41.80	-0.7	113.8	5000.0	-32.9	pk
2781.00	H	180.00	2.60	30.40	-0.7	30.6	500.0	-24.3	av
3708.00	H	190.00	3.00	42.99	1.5	166.9	5000.0	-29.5	pk
3708.00	H	190.00	3.00	30.90	1.5	41.5	500.0	-21.6	av
4635.00	H	270.00	2.80	44.71	4.0	272.2	5000.0	-25.3	pk
4635.00	H	270.00	2.80	36.04	4.0	100.3	500.0	-14.0	av
7416.00	H	45.00	3.60	45.97	10.7	685.4	5000.0	-17.3	pk
7416.00	H	45.00	3.60	40.00	10.7	344.7	500.0	-3.2	av
8343.00	H	90.00	3.60	43.99	11.2	576.4	5000.0	-18.8	pk
8343.00	H	90.00	3.60	34.24	11.2	187.6	500.0	-8.5	av

5.9 Receiver Radiated Spurious Emissions: (FCC Part §15.209)

The EUT must comply with the requirements for radiated spurious emissions from the receiver. These emissions must meet the limits specified in §15.209.

5.9.1 Test Procedure

The emissions were measured using the following resolution bandwidths:

Table 12: Spectrum Analyzer Settings

Frequency Range	Resolution Bandwidth	Video Bandwidth
30MHz-1000 MHz	120kHz	1MHz
>1000 MHz	1 MHz	3MHz

Average measurements above 1GHz were made with the Spectrum analyzer set to RMS Average. Correction factors were then applied and the resulting value was compared to the limit.

The EUT was scanned up to 10GHz. No duty cycle corrections were used.

5.9.2 Test Summary

The EUT complied with the requirements for receiver radiated emissions FCC 15.209. Receiver Radiated Spurious Test Data. The receiver was scanned from 30-2781MHz (3 times the highest receiver frequency of 927MHz).

Table 13: Receiver Radiated Test Data

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)
44.23	V	0.00	1.00	33.94	-15.1	8.7	100.0	-21.2
49.78	V	190.00	1.00	42.10	-18.0	16.0	100.0	-15.9
117.00	V	0.00	1.00	46.49	-11.8	54.1	150.0	-8.9
123.95	V	10.00	1.40	37.68	-11.3	20.8	150.0	-17.2
182.79	V	90.00	1.67	35.79	-14.1	12.2	150.0	-21.8
195.00	V	10.00	1.50	38.22	-13.7	16.9	150.0	-19.0
429.11	V	180.00	1.90	40.34	-8.3	40.2	200.0	-13.9
964.00	V	180.00	1.40	34.80	-0.7	50.7	500.0	-19.9
44.23	H	180.00	4.00	34.21	-15.1	9.0	100.0	-20.9
49.78	H	170.00	4.00	41.68	-18.0	15.2	100.0	-16.4
116.27	H	10.00	3.68	36.75	-11.9	17.5	150.0	-18.7
123.95	H	20.00	3.64	38.82	-11.3	23.7	150.0	-16.0
184.00	H	180.00	3.38	45.50	-14.1	37.3	150.0	-12.1
195.80	H	90.00	3.38	45.90	-13.7	40.9	150.0	-11.3
429.11	H	180.00	2.40	38.11	-8.3	31.1	200.0	-16.2
286.08	H	190.00	3.00	38.50	-11.6	22.3	200.0	-19.1
964.30	H	180.00	1.80	37.40	-0.7	68.3	500.0	-17.3

No signals noted above 1GHz

5.10 AC Conducted Emissions (FCC Pt.15.207])

5.10.1 Requirements

Test Arrangement: Table Top

Compliance Standard: FCC Class B

FCC Compliance Limits		
Frequency	**Quasi-peak**	**Average**
0.15 - 0.5MHz	66 to 56dBµV	56 to 46dBµV
0.5 - 5MHz	56dBµV	46dBµV
5 - 30MHz	60dBµV	50dBµV

5.10.2 Test Procedure

The EUT was placed on an 80 cm high 1 X 1.5 m 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 C63.10 "6.2 Standard test method for ac power-line conducted emissions from unlicensed wireless devices".

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.

At frequencies where quasi-peak or peak measurements comply with the average limit, no average measurements need be performed.

At frequencies where quasi-peak or peak measurements comply with the average limit, no average measurements need be performed. The Conducted emissions level to be compared to the FCC limit is calculated as shown in the following example.

Example:

Spectrum Analyzer Voltage: VdBµV

LISN Correction Factor: LISN dB

Cable Correction Factor: CF dB

Electric Field: EdBµV = V dBµV + LISN dB + CF dB

5.10.3 Test Data

As a portable device the EUT typically will not be plugged in to mains power while transmitting. However since transmissions are not disabled in this mode the testing was performed.
The EUT complied with the Class B Conducted Emissions requirements.
The EUT was tested with a PHIHONG PSAA10A-050QL6 USB to AC power adaptor.
Table 14 provides the test results for phase and neutral line power line conducted emissions.

Emissions were tested in both "transmit on" and "transmit off "state with the EUT tuned to 915MHz. Both modes had identical readings

Table 14: Conducted Emissions Data

NEUTRAL

Frequency (MHz)	Level QP (dBµV)	Level AVG (dBµV)	Cable Loss (dB)	LISN Corr (dB)	Level QP Corr (dBµV)	Level Corr Avg (dBµV)	Limit QP (dBµV)	Limit AVG (dBµV)	Margin QP (dB)	Margin AVG (dB)
0.150	31.0	21.6	10.1	0.2	41.3	31.9	66.0	56.0	-24.7	-24.1
0.663	29.1	20.1	10.1	0.4	39.5	30.5	56.0	46.0	-16.5	-15.5
6.342	19.5	4.6	11.0	0.1	30.6	15.6	60.0	50.0	-29.4	-34.4
7.580	17.0	8.6	11.2	0.1	28.3	19.9	60.0	50.0	-31.7	-30.1
10.179	27.7	13.8	11.1	0.2	39.0	25.1	60.0	50.0	-21.0	-24.9
12.833	17.9	9.2	11.3	0.4	29.6	21.0	60.0	50.0	-30.4	-29.0

PHASE

Frequency (MHz)	Level QP (dBµV)	Level AVG (dBµV)	Cable Loss (dB)	LISN Corr (dB)	Level QP Corr (dBµV)	Level Corr Avg (dBµV)	Limit QP (dBµV)	Limit AVG (dBµV)	Margin QP (dB)	Margin AVG (dB)
10.205	29.1	11.5	11.1	0.2	40.5	22.8	60.0	50.0	-19.5	-27.2
0.150	29.7	7.8	10.1	0.2	40.0	18.1	66.0	56.0	-26.0	-37.9
0.646	26.7	14.6	10.1	0.4	37.2	25.1	56.0	46.0	-18.8	-20.9
6.200	17.5	5.9	11.0	0.1	28.5	16.9	60.0	50.0	-31.5	-33.1
7.978	18.4	6.8	11.2	0.1	29.6	18.0	60.0	50.0	-30.4	-32.0
11.500	19.8	7.5	11.2	0.3	31.4	19.0	60.0	50.0	-28.6	-31.0