Testing Tomorrow's Technology

Application

For

Part 2, Subpart J, Paragraph 2.907 Equipment Authorization of Certification for an Intentional Radiator per Part 15, Subpart C, paragraphs 15.207, 15.209 and 15.247

And

Part 2, Subpart J, Verification
Per
Part 15, Subpart B, for Unintentional Radiators, section 15.101, 15.107 and 15.109

And

Industry Canada RSS-Gen, Issue 4 and RSS-247, Issue 2

For the

Neptune Technology Group Inc. (FCC Name)
Neptune Technology Group (IC Name)

Model: L900

FCC ID: P2SL900M2
IC: 4171B-L900M2

UST Project: 17-0481
Issue Date: January 9, 2018

Total Pages in This Report: 53

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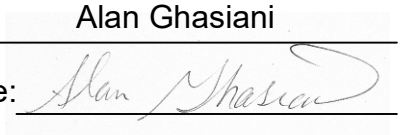
I certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: Alan Ghasiani

Name: 

Title: Compliance Engineer – President

Date January 9, 2018

TESTING
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Testing Tomorrow's Technology

MEASUREMENT TECHNICAL REPORT

COMPANY NAME: Neptune Technology Group Inc. (FCC Name)
Neptune Technology Group (IC Name)

MODEL: L900

FCC ID: P2SL900M2

IC: 4171B-L900M2

DATE: January 9, 2018

This report concerns (check one): Original grant [X]
Class II change

Equipment type: 902-928 MHz ISM Radio

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? yes_____ No X

If yes, defer until: _____N/A_____
date
agrees to notify the Commission by N/A
date
of the intended date of announcement of the product so that the grant can be issued on that date.

Report prepared by:

US Tech
3505 Francis Circle
Alpharetta, GA 30004

Phone Number: (770) 740-0717
Fax Number: (770) 740-1508

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1 General Information

1.1 Purpose of this Report

This report is prepared as a means of conveying test results and information concerning the suitability of this exact product for public distribution according to the FCC Rules and Regulations Part 15, Section 247 and Industry Canada RSS-247.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on December 11, 2017 in good operating condition.

1.3 Product Description

The Equipment under Test (EUT) is the Neptune Technology Group Model L900. The EUT is a transceiver designed to wirelessly provide RF telemetry readings for a water meter. It operates within the 902 -928 MHz ISM band. The EUT is battery powered (3.6Vdc) and spends the majority of its time in a low power consumption mode (asleep). The on-board microprocessor utilizes an internal clock to briefly “wake up” the EUT for periodic wireless communication of telemetry information from the water meter.

The EUT provide for several communication modes to accommodate different installation site requirements. Available communication modes are as follows:

- Neptune Proprietary Standard
    - Mode 1- SURF (OOK modulation)
    - Mode 2- Enhanced fixed network
    - Mode 3- Enhanced mobile network uplink/downlink (GFSK, Data log Retrieval)
- LoRaWAN, open protocol based on proprietary modulation scheme from Semtech

This test report documents the compliance of the LoRaWAN radio operating in DTS mode.

Antenna: Multiple antennas – see Table 4
Modulation: OOK (911.0815 – 919.0769 MHz)
Maximum Output Power: 20 dBm (rated)
Maximum Data rate: 32,768 bps

The equipment is designed to be installed with a water meter and is available only to qualifying utilities (not for sale to the consumer market). The

unit was tested with 3 different antennas and must be professionally installed only by trained utility installers. Also, the equipment is capable of several transmit modes of operation (hybrid). For this report only the OOK (FHSS) mode was used.

1.4 Configuration of Tested System

The Test Sample was tested per *ANSI C63.4:2014, Methods of Measurement of Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2014)* for FCC subpart A Digital equipment Verification requirements. Also, *ANSI C63.10:2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices* was used as a test procedure guide.

A list of the EUT and Peripherals is found in Table 1 below. A block diagram of the tested system is shown in Figure 1. Test configuration photographs are provided in separate Appendices.

1.5 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA 30004. This site has been fully described and registered with the FCC. Its designation number is US5301. Additionally this site has been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1.

1.6 Related Submittals

The Equipment Under Test (EUT) is subject to the following FCC/IC authorizations:

a) Certification under section 15.247/IC RSS-247 as a transmitter.
b) Verification under 15.101/ICES-003 as a digital device and receiver.

The Verification requirement shares many common report elements with the Certification report. Therefore, though this report is mostly intended to provide data for the Certification process, the Verification authorization report for the EUT is included herein.

1.7 Test Results

In our opinion, and as indicated by the test results documented following, when tested in the configuration as described in this report, the EUT meets the applicable requirements of FCC and IC, including: FCC Parts 2.902, 15.101, 15.107, 15.109, 15.207, 15.209, 15.247, RSS GEN, and RSS-247.

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC ID and IC ID	CABLES P/D
EUT Neptune Technology Group Inc.	L900M-GFSK	Engineering Sample	P2SL900M2 4171B-L900M2 (Pending)	None
Standard Pit Antenna	R900 (12527-000)	735976	--	0.61m S
High Gain Pit Antenna	R900 (13586-000)	151225-0120	--	0.61m S
Wall Antenna	13717-001A	15	--	None

U= Unshielded S= Shielded
P= Power D= Data

2 Tests and Measurements

2.1 Test Equipment

The table below lists test equipment used to evaluate this product. Model numbers, serial numbers and their calibration status are indicated.

Table 2. Test Instruments

TEST INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	CALIBRATION DUE DATE
SPECTRUM ANALYZER	N9342CN	Agilent	SG05310114	7/21/2018
SPECTRUM ANALYZER	E4407B	Agilent	US41442935	6/22/2018
PREAMP	8449B	HEWLETT-PACKARD	3008A00480	12/1/2018
PREAMP	8447D	HEWLETT-PACKARD	1937A02980	3/7/2018
LOOP ANTENNA	SAS-200/562	A. H. Systems	142	12/28/2017 2yr extended
BICONICAL ANTENNA	3110B	EMCO	9306-1708	5/2/2019 2 yr
LOG PERIODIC ANTENNA	3146	EMCO	9110-3236	9/21/2019 2 yr
HORN ANTENNA	3115	EMCO	9107-3723	9/22/2018 2 yr
DC Power Supply	6236B	HEWLETT-PACKARD	2438A17539	08/23/19 2 yr

Note: The calibration interval of the above test instruments are 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.

2.2 Modifications to EUT Hardware

No physical modifications were made by US Tech in order to bring the EUT into compliance with FCC Part 15, Subpart C Intentional Radiator Limits for the transmitter portion of the EUT or the Subpart B Unintentional Radiator Limits (Receiver and Digital Device) Requirements.

2.3 Number of Measurements for Intentional Radiators (15.31(m))

Measurements of intentional radiators or receivers shall be performed and reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in Table 3 below.

Table 3. Number of Test Frequencies for Intentional Radiators

Frequency Range over which the device operates	Number of Frequencies	Location in the Range of operation
1 MHz or less	1	Middle
1 to 10 MHz	2	1 near the top 1 near the bottom
Greater than 10 MHz	3	1 near top 1 near middle 1 near bottom

Because the EUT operates over a range of 8 MHz, 2 test frequencies were used: 911.08 and 919.08 MHz.

2.4 Frequency Range of Radiated Measurements (Part 15.33)

2.4.1 Intentional Radiator

The spectrum shall be investigated for the intentional radiator from the lowest RF signal generated in the EUT, without going below 9 kHz to the 10th harmonic of the highest fundamental frequency generated or 40 GHz, whichever is the lowest.

2.4.2 Unintentional Radiator

For the digital device, an unintentional radiator, the frequency range shall be 30 MHz to 1000 MHz, or to 5 times the highest internal clock frequency.

2.5 Measurement Detector Function and Bandwidth (CFR 15.35)

The radiated and conducted emissions limits shown herein are based on the following:

Detector Function and Associated Bandwidth

On frequencies below 1000 MHz, the limits herein are based upon measurement equipment employing a CISPR Quasi-peak detector function and related measurement bandwidths (i.e. 9 kHz from 150 kHz to 30 MHz and 120 kHz from 30 MHz to 1000 MHz). Alternatively, measurements may be made with equipment employing a peak detector function as long as the same bandwidths specified for the Quasi-peak device are used.

Corresponding Peak and Average Requirements

Above 1000 MHz, radiated limits are based on measuring instrumentation employing an average detector function. When average radiated emissions are specified there is also a corresponding Peak requirement, as measured using a peak detector, of 20 dB greater than the average limit. For all measurements above 1000 MHz the Resolution Bandwidth shall be at least 1 MHz.

Pulsed Transmitter Averaging

When the radiated emissions limit is expressed as an average value, and the transmitter is pulsed, the measured field strength shall be determined by applying a Duty Cycle Correction Factor based upon dividing the total ON time during the first 100 ms period by 100 ms (or by the period if less than 100 ms). The duty cycle may be expressed logarithmically in dB.

NOTE: If the transmitter was programmed to transmit at >98% duty cycle, then, wherever applicable (where the detection mode was AVG) the duty cycle factor calculated will be applied.

2.6 EUT Antenna Requirements (CFR 15.203)

This equipment is not available to the general public and will only be installed by a professional installer working for an approved utility. The equipment therefore meets the intent of the above requirement. Only the antennas listed in Table 4 will be used with this module.

Table 4. Allowed Antenna(s)

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dB_i	TYPE OF CONNECTOR
Antenna 1	Neptune	Standard Patch Antenna	R900 (12527-XXX)	1.0	F (75 Ohm)
Antenna 2	Neptune	High Gain Patch Antenna	R900 (13586-XXX)	1.2	F (75 Ohm)
Antenna 3	Neptune	Trace Antenna	13717-000	1.6	F (75 Ohm)

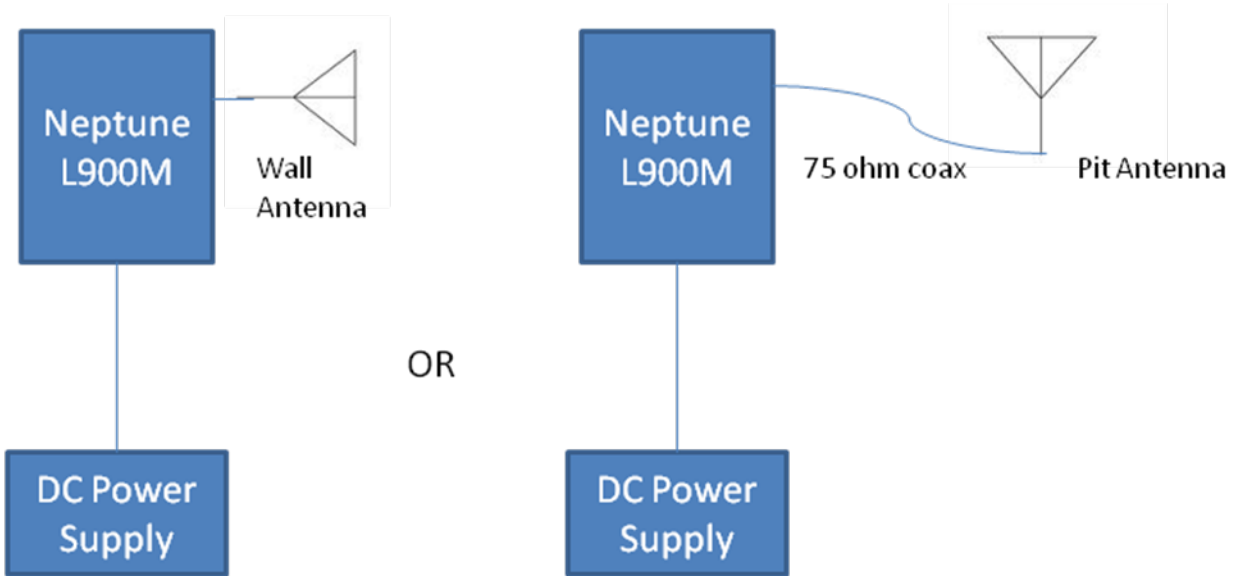


Figure 1. Block Diagram of Test Configuration

Note: Two test configurations were used for testing. The test configuration is dependent on the type of antenna being used.

2.7 Restricted Bands of Operation (Part 15.205)

Only spurious emissions can fall in the frequency bands of CFR 15.205. The field strength of these spurious cannot exceed the limits of 15.209. Radiated harmonics and other spurious emissions are examined for this requirement. See paragraph 2.10 of the test report.

2.8 Transmitter Duty Cycle (CFR 15.35 (c))

When the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification.

In this case the EUT pulse train does not exceed 0.1 seconds therefore a duty cycle factor was used.

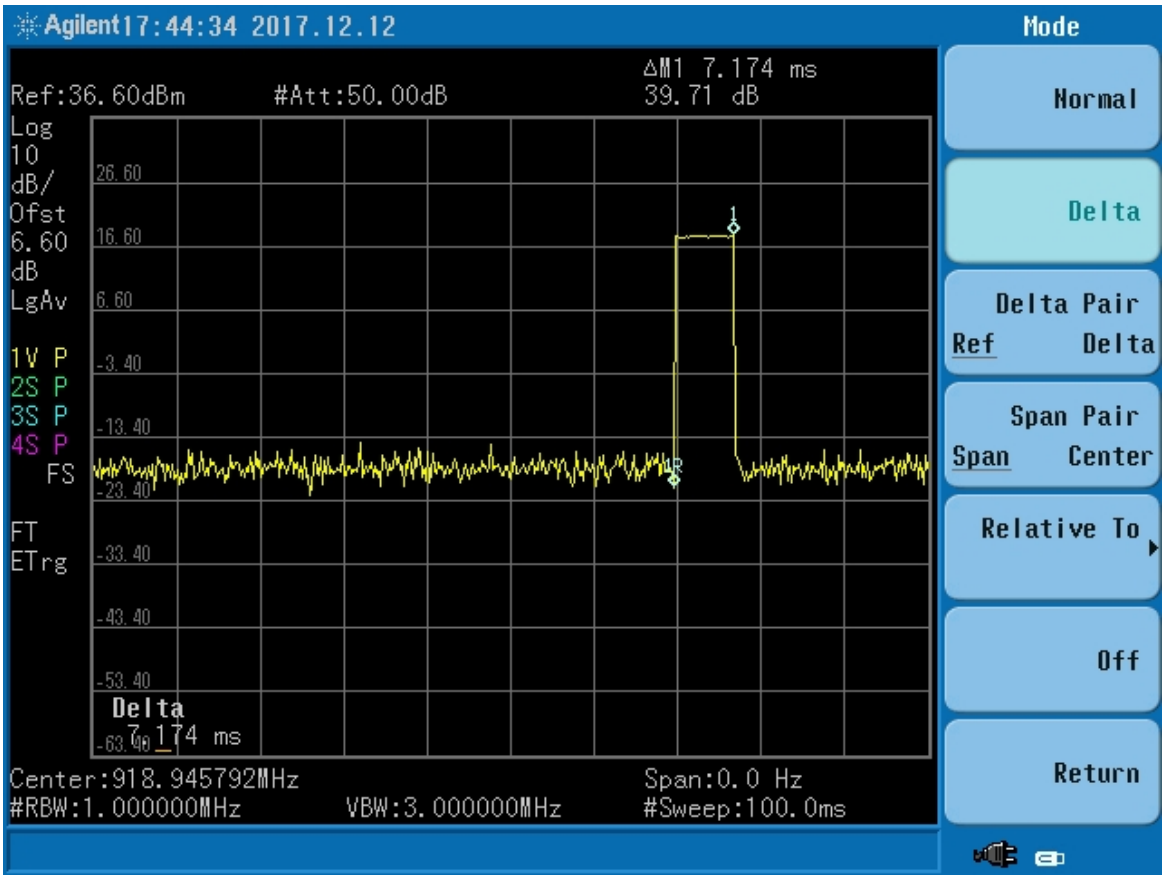


Figure 2. Pulse Width

TX On time = 7.17 ms
Duty cycle = 20 log (8.5 ms/100 ms) = -22.89 dB= duty cycle correction factor
Note: Duty cycle correction greater than -20 dB therefore -20 dB was used as the correction factor in this report.

2.9 Intentional Radiator, Power Line Conducted Emissions (CFR 15.207)

The EUT is powered by a 3.6 VDC Lithium battery**.** Since the EUT is battery powered, this test was not applicable. Due to the high duty cycles necessary for testing purposes battery life would be limited. Therefore, an external DC power supply was used to power the EUT during testing.

2.10 Intentional Radiator, Radiated Emissions (CFR 15.209, 15.247(d))

Radiated Spurious measurements: The EUT was placed into a continuous transmit mode of operation (>98% or max level possible duty cycle) and tested per ANSI C63.10:2013. The EUT was tested in the orientation of normal operation because the device is designed to operate in a fixed position.

Radiated measurements were conducted between the frequency range of 9 kHz (or lowest frequency used/generated by the device) up to the tenth harmonic of the device (not greater than 40 GHz). In the band below 125 kHz, a resolution bandwidth (RBW) of 200 Hz was used. In the band from 125 kHz to 30 MHz, a RBW of 9 kHz was used; emissions below 1 GHz were tested with a RBW of 100/120 kHz and emissions above 1 GHz were tested with a RBW of 1 MHz. All video bandwidth settings were at least three times the RBW value.

The EUT can be installed with one of three possible antennas. For the intentional emissions measurements data was taken with all 3 antennas. Because the performance of the 2 pit antennas is similar, spurious emissions testing was performed using the wall antenna and the high gain pit antenna (antennas 2 and 3) only. The high gain antenna data for spurious emissions will be used to represent both pit antennas.

The EUT was investigated per CFR 15.209, General requirements for unwanted spurious emissions. The conducted spurious method as described below was used to investigate all other emissions emanating from the antenna port.

Conducted Spurious measurements: The EUT was put into a continuous-transmit mode of operation (>98% or max level possible duty cycle) and tested per ANSI C63.10-2013 for conducted out of band emissions emanating from the antenna port over the frequency range of 9 kHz or lowest operating clock frequency to ten times the highest operating clock frequency. A conducted scan was performed on the EUT to identify and record the spurious signals that were related to the transmitter.

Table 5. Average Radiated Fundamental & Harmonic Emissions (Antenna 1)

Test: FCC Part 15, Para 15.209, 15.247(d)				**Client:** Neptune Technology Group Inc.			
Project: 17-0481				**Model:** L900			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel – AVERAGE							
911.08	89.23@	5.19	94.42@		3m./VERT		**PK**
1821.60	33.90	-4.86	29.04	54.0	3.0m./VERT	25.0	**AVG**
High Channel – AVERAGE							
919.07	89.43@	5.19	94.62@		3m./VERT		**PK**
1837.70	33.75	-4.86	28.89	54.0	3.0m./VERT	25.1	**AVG**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. (~) Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB).
4. The EUT was placed in its normal operating position and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98% or max level possible. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.
5. (@) Peak value was used to represent the AVG. The results were corrected by subtracting 20 dB from the Peak value.

Sample Calculation at 1821.6 MHz:

Magnitude of Measured Frequency	33.90	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-4.86	dB/m
Corrected Result	29.04	dBuV/m

Test Date: December 13, 2017
Tested By
Signature:  Name: Bruce Arnold

Table 6. Peak Radiated Fundamental & Harmonic Emissions (Antenna 1)

Test: FCC Part 15, Para 15.209, 15.247(d)				**Client:** Neptune Technology Group Inc.			
Project: 17-0481				**Model:** L900			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel – PK							
911.08	89.23	25.19	114.42		3m./VERT		PK
1822.16	81.86	-4.86	77.00	94.4	3.0m./VERT	17.4	PK
High Channel – PK							
919.07	89.43	25.19	114.62		3m./VERT		PK
1838.18	81.86	-4.86	77.00	94.6	3.0m./VERT	17.6	PK

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for **peak** measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. (~) Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB).
4. The EUT was placed in its normal operating position and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98% or max level possible. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 911.08 MHz:

Magnitude of Measured Frequency	89.23	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	25.19	dB/m
Corrected Result	114.42	dBuV/m

Test Date: December 13, 2017
Tested By
Signature: _____ Name: Bruce Arnold

Table 7. Average Radiated Fundamental & Harmonic Emissions (Antenna 2)

Test: FCC Part 15, Para 15.209, 15.247(d)				**Client:** Neptune Technology Group Inc.			
Project: 17-0481				**Model:** L900			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel – AVERAGE							
911.08	91.66@	5.19	96.85@		3m./VERT		PK
1821.90	34.80	-4.86	29.94	54.0	3.0m./VERT	24.1	AVG
High Channel – AVERAGE							
919.07	92.23@	5.19	97.42@		3m./VERT		PK
1837.70	33.78	-4.86	28.92	54.0	3.0m./VERT	25.1	AVG

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. (~) Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB).
4. The EUT was placed in its normal operating position and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98% or max level possible. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.
5. (@) Peak value was used to represent the AVG. The results were corrected by subtracting 20 dB from the Peak value.

Sample Calculation at 1821.90 MHz:

Magnitude of Measured Frequency	34.80	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-4.86	dB/m
Corrected Result	29.94	dBuV/m

Test Date: December 13, 2017
Tested By
Signature: Bruce Arnold Name: Bruce Arnold

Table 8. Peak Radiated Fundamental & Harmonic Emissions (Antenna 2)

Test: FCC Part 15, Para 15.209, 15.247(d)				**Client:** Neptune Technology Group Inc.			
Project: 17-0481				**Model:** L900			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel – PK							
911.08	91.66	25.19	116.85		3m./VERT		**PK**
1822.10	74.93	-4.86	70.07	96.9	3.0m./VERT	26.8	**PK**
High Channel – PK							
919.07	92.23	25.19	117.42		3m./VERT		**PK**
1838.10	77.83	-4.86	72.97	97.4	3.0m./VERT	24.4	**PK**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for **peak** measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. (~)Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB).
4. The EUT was placed in its normal operating position and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98% or max level possible. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 911.08 MHz:

Magnitude of Measured Frequency	91.66	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	25.19	dB/m
Corrected Result	116.85	dBuV/m

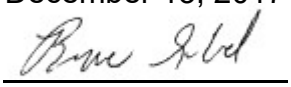
Test Date: December 13, 2017
Tested By
Signature:  Name: Bruce Arnold

Table 9. Average Radiated Fundamental & Harmonic Emissions (Antenna 3)

Test: FCC Part 15, Para 15.209, 15.247(d)				**Client:** Neptune Technology Group Inc.			
Project: 17-0481				**Model:** L900			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel – AVERAGE							
911.08	92.83@	5.19	98.02@		3m./VERT		**PK**
1822.00	34.27	-4.86	29.41	54.0	3.0m./VERT	24.6	**AVG**
High Channel – AVERAGE							
919.07	92.61@	5.19	97.80@		3m./VERT		**PK**
1838.00	33.86	-4.86	29.00	54.0	3.0m./VERT	25.0	**AVG**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. (~) Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB).
4. The EUT was placed in its normal operating position and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98% or max level possible. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.
5. (@) Peak value was used to represent the AVG. The results were corrected by subtracting 20 dB from the Peak value.

Sample Calculation at 1822.0 MHz:

Magnitude of Measured Frequency	34.27	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-4.86	dB/m
Corrected Result	29.41	dBuV/m

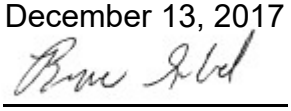
Test Date: December 13, 2017
Tested By
Signature:  Name: Bruce Arnold

Table 10. Peak Radiated Fundamental & Harmonic Emissions (Antenna 3)

Test: FCC Part 15, Para 15.209, 15.247(d)				**Client:** Neptune Technology Group Inc.			
Project: 17-0481				**Model:** L900			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel – PK							
911.08	92.83	25.19	118.02		3m./VERT		**PK**
1822.00	63.88	-4.86	59.02	98.0	3.0m./VERT	39.0	**PK**
High Channel – PK							
919.07	92.61	25.19	117.80		3m./VERT		**PK**
1838.00	63.98	-4.86	59.12	97.8	3.0m./VERT	38.7	**PK**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for **peak** measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. (~)Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB).
4. The EUT was placed in its normal operating position and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98% or max level possible. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 911.08 MHz:

Magnitude of Measured Frequency	92.83	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	25.19	dB/m
Corrected Result	118.02	dBuV/m

Test Date: December 13, 2017
Tested By
Signature:  Name: Bruce Arnold

Conducted spurious emissions

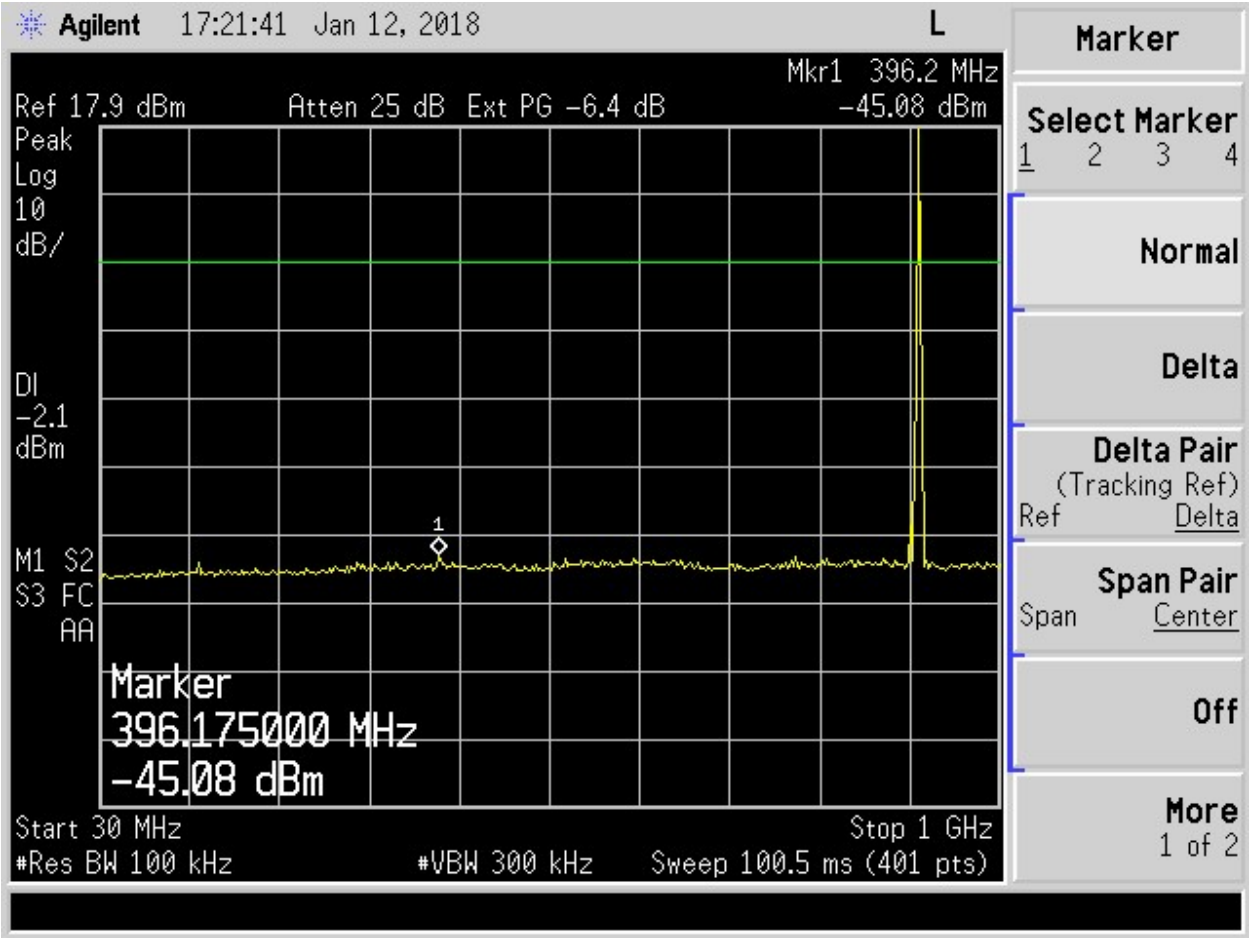


Figure 3. Antenna Conducted Emissions Low, 30 MHz to 1 GHz

Note: Large emission seen is the fundamental emission.

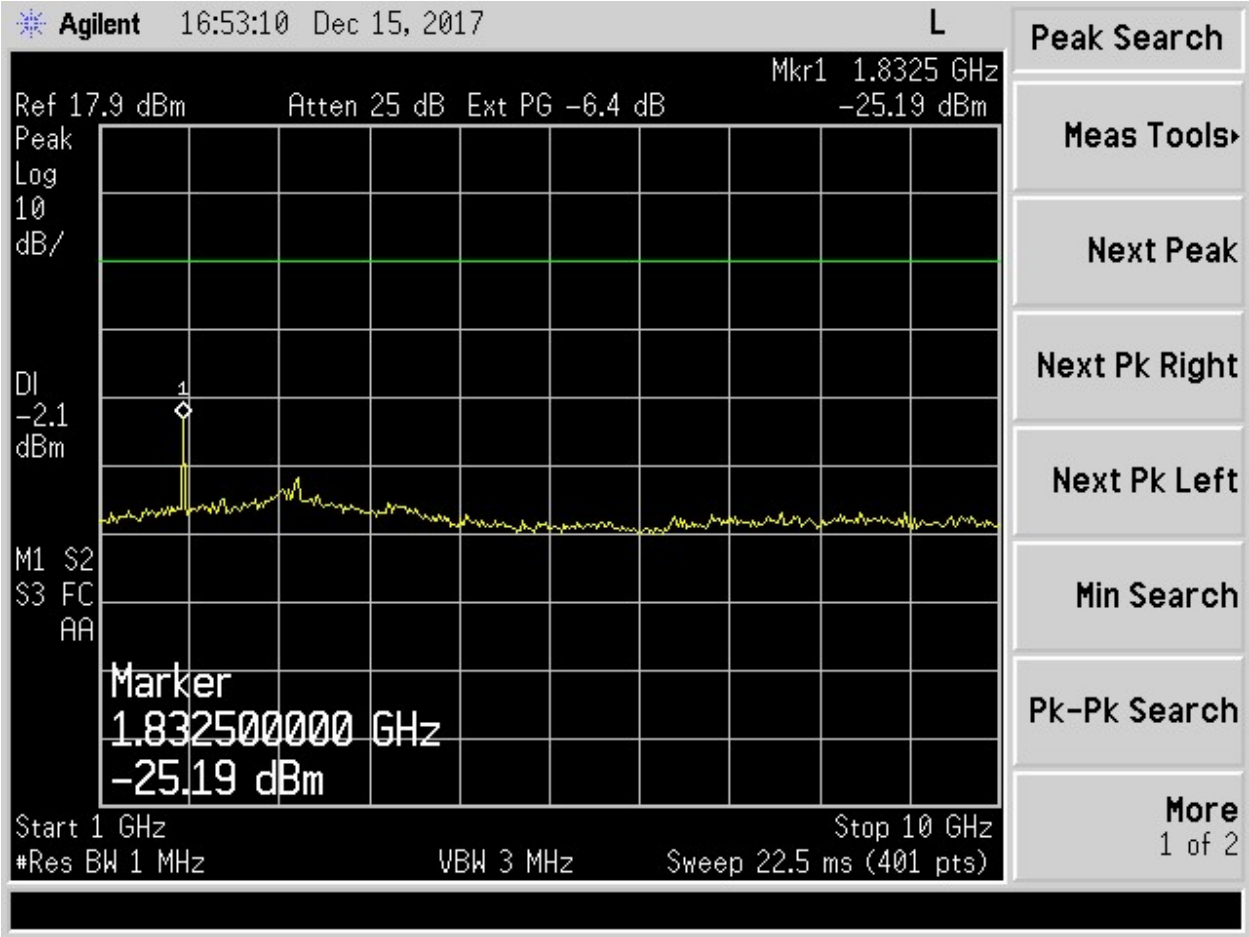


Figure 4. Antenna Conducted Emissions Low, 1 to 10 GHz

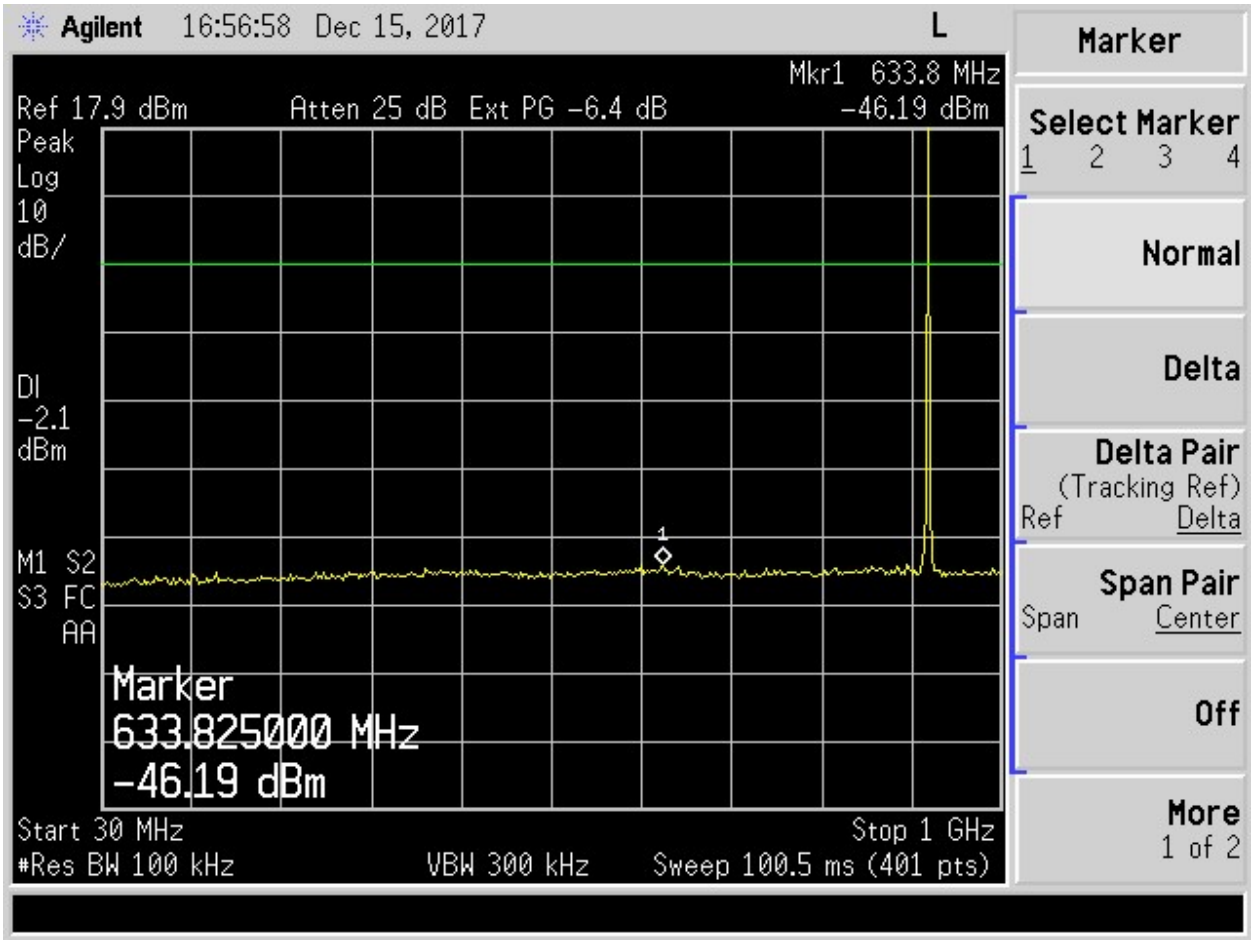


Figure 5. Antenna Conducted Emissions High, 30 MHz to 1 GHz

Note: Large emission seen is the fundamental emission.

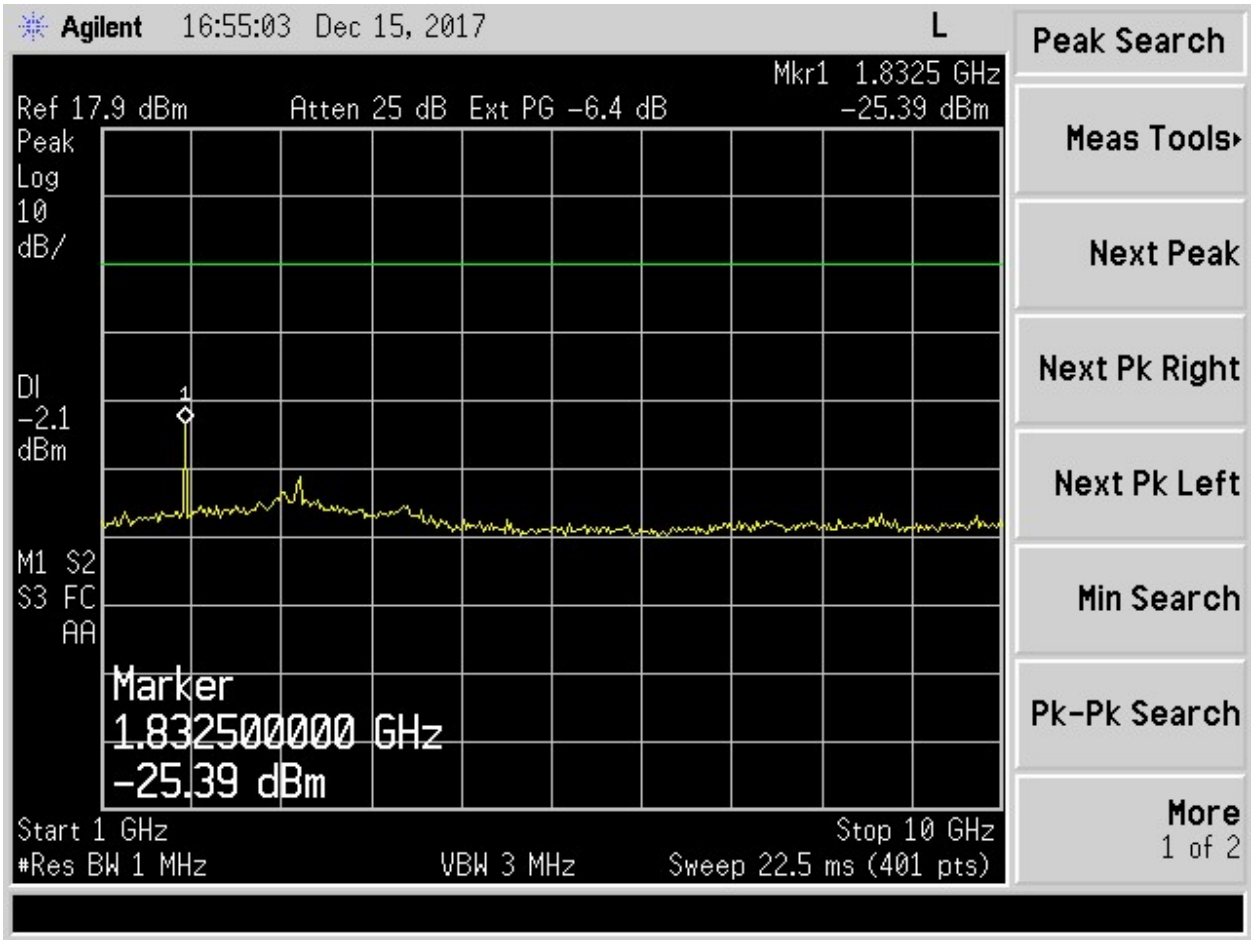


Figure 6. Antenna Conducted Emissions High, 1 to 10 GHz

2.11 Band Edge Measurements – (CFR 15.247 (d))

Band Edge measurements are made, following the guidelines in ANSI 63.10-2013 for the FHSS modulation, with the EUT initially operating on the Lowest Channel and then operating on the Highest Channel within its band of operation. Radiated measurements are performed for each antenna to demonstrate compliance with the requirement of 15.247(d) that all emissions outside of the band edges be attenuated by at least 20 dB when compared to its highest in-band value (contained in a 100 kHz band).

To capture the band edge, set the Spectrum Analyzer frequency span large enough (usually around 2 MHz) to capture the peak level of the emission operating on the channel closest to the band edge as well as any modulation products falling outside of the authorized band of operation. Radiated measurements are performed with RBW = 120 kHz. The VBW is set ≥ RBW. In all cases, the VBW is set ≥ RBW. See figure and calculations below for more detail.

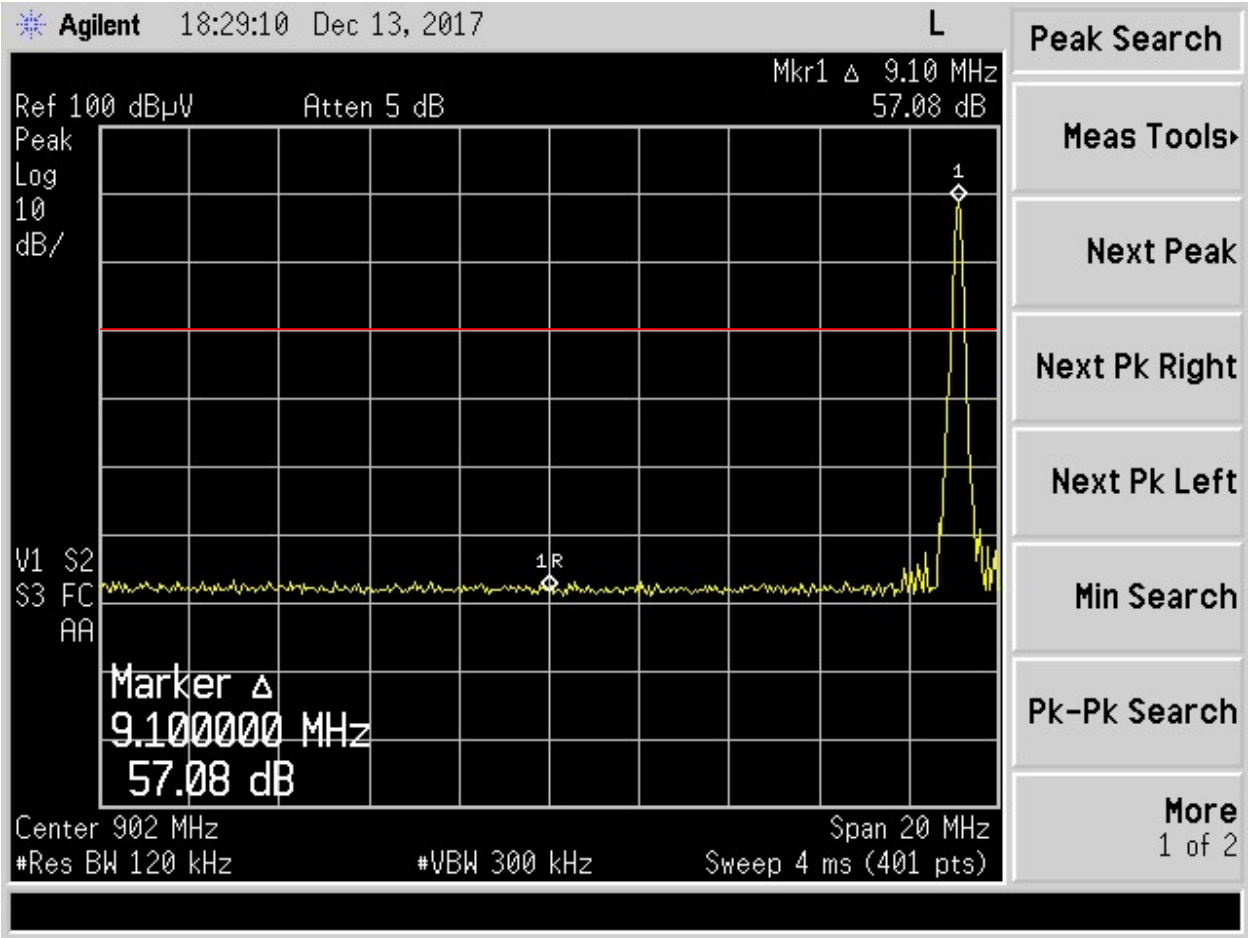


Figure 7. Band Edge Compliance, Low Channel Delta – Antenna 1

Measured Delta (from Figure 11)	57.08	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	37.08	dB

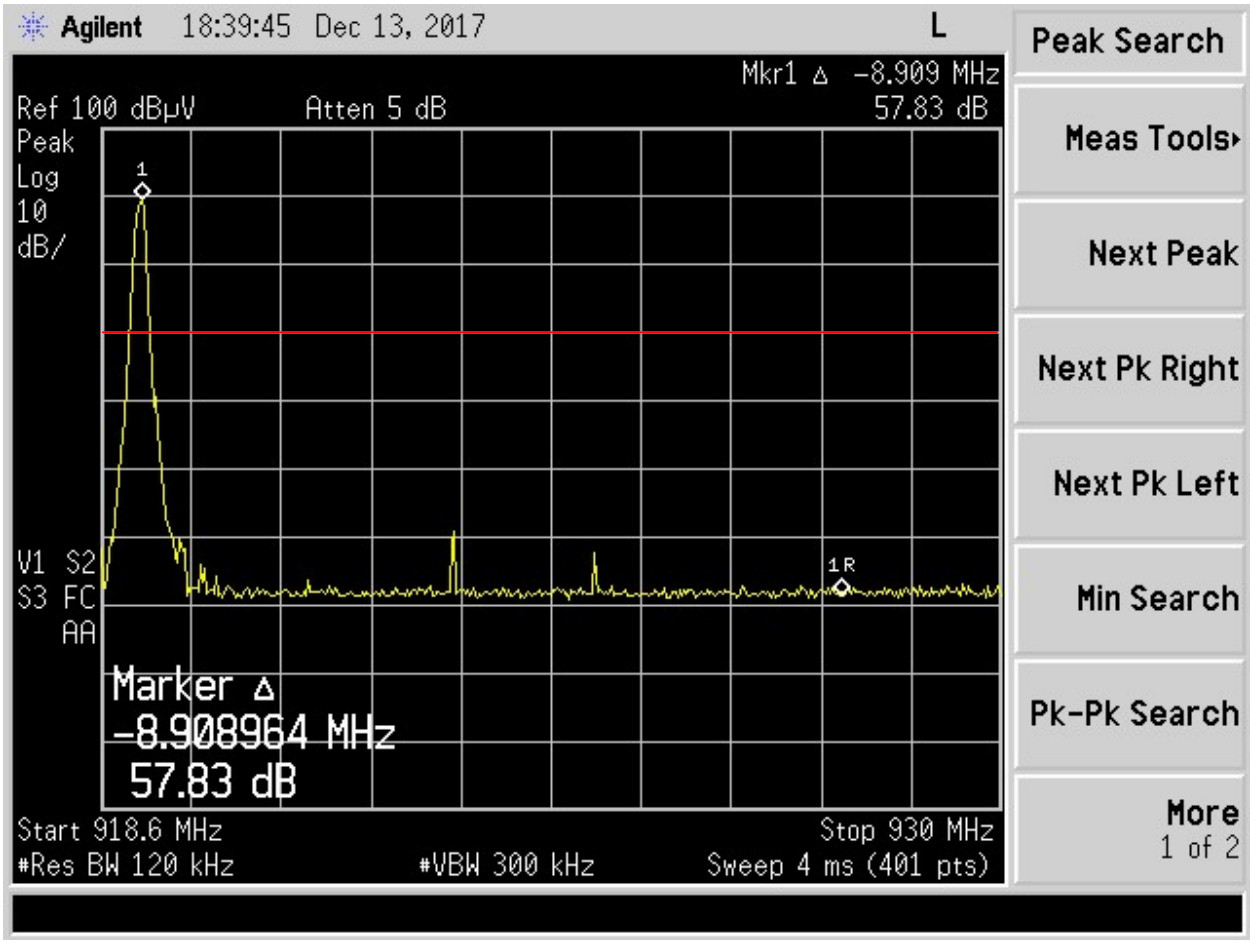


Figure 8. Band Edge Compliance, High Channel Delta – Antenna 1

Measured Delta (from Figure 13)	57.83	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	37.83	dB

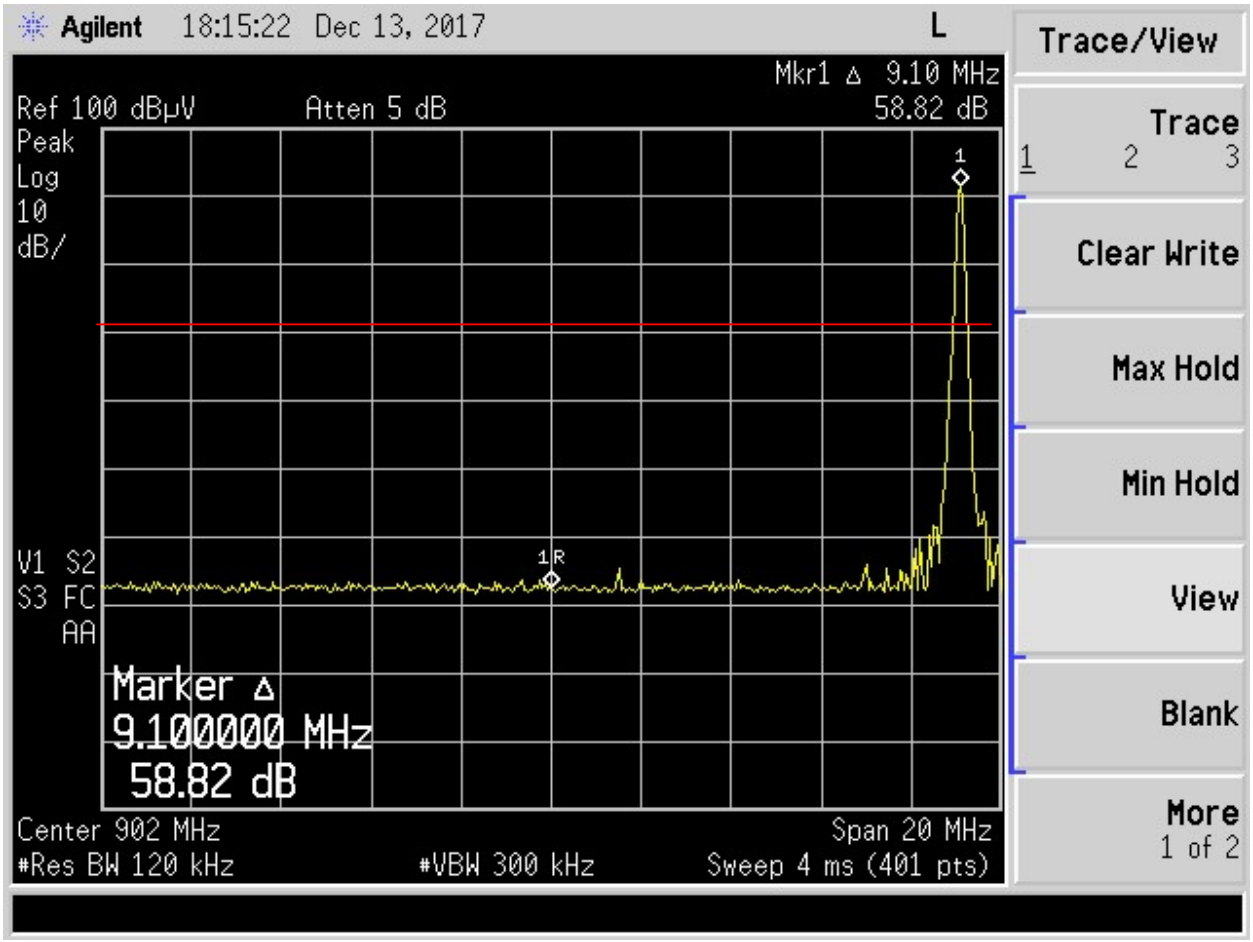


Figure 9. Band Edge Compliance, Low Channel Delta – Antenna 2

Measured Delta (from Figure 11)	58.82	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	38.82	dB

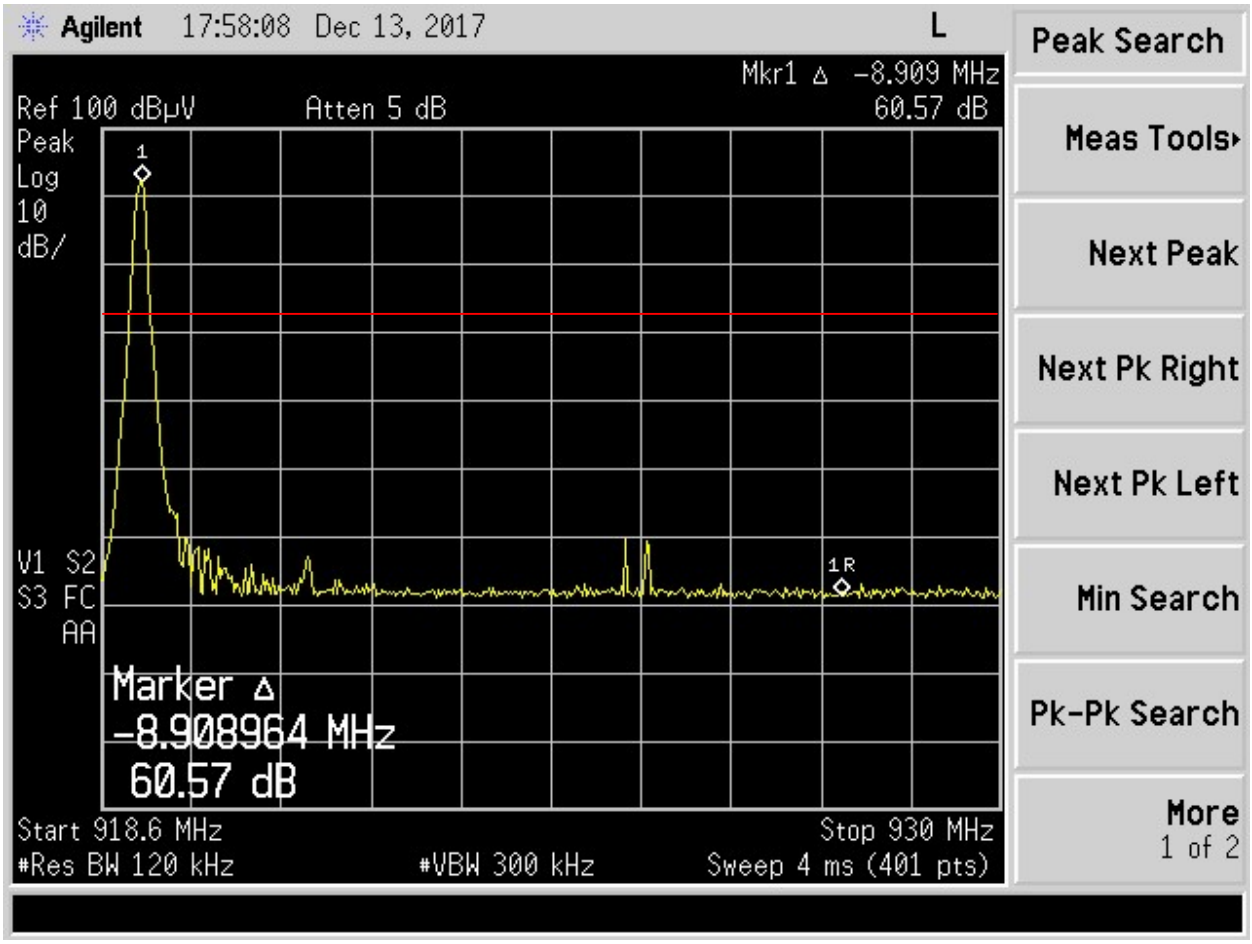


Figure 10. Band Edge Compliance, High Channel Delta – Antenna 2

Measured Delta (from Figure 13)	60.57	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	40.57	dB

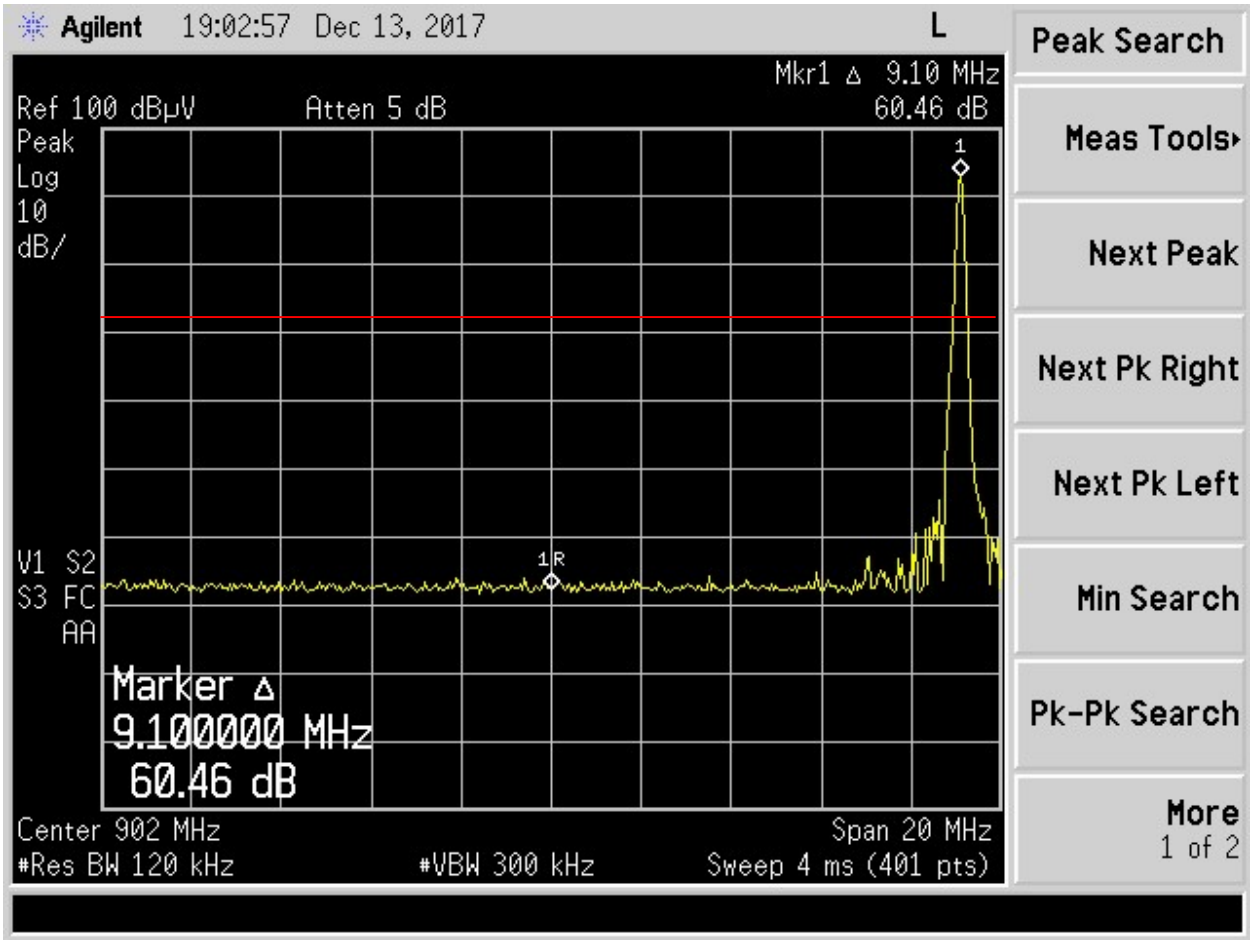


Figure 11. Band Edge Compliance, Low Channel Delta – Antenna 3

Measured Delta (from Figure 11)	60.46	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	40.46	dB

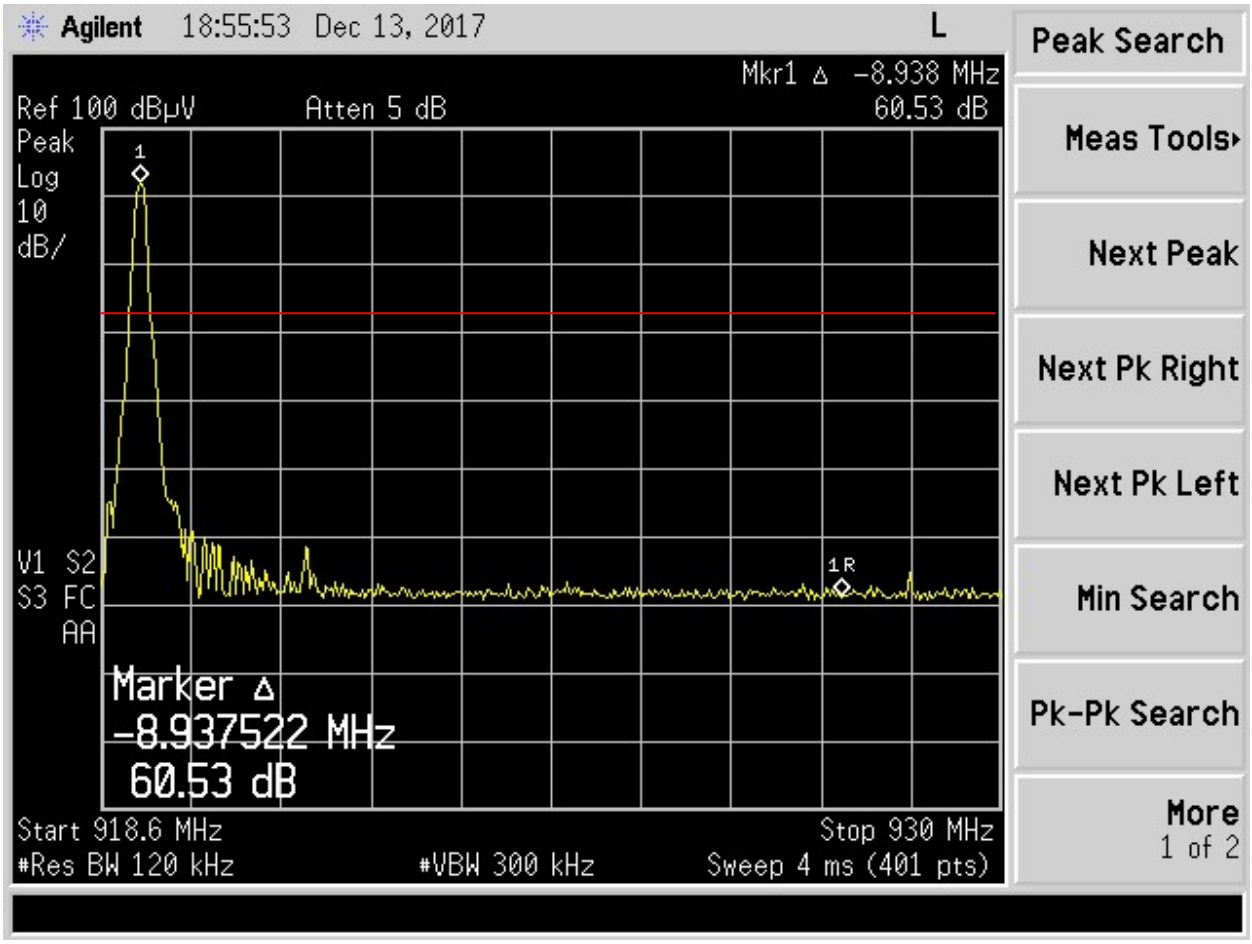


Figure 12. Band Edge Compliance, High Channel Delta – Antenna 3

Measured Delta (from Figure 13)	60.53	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	40.53	dB

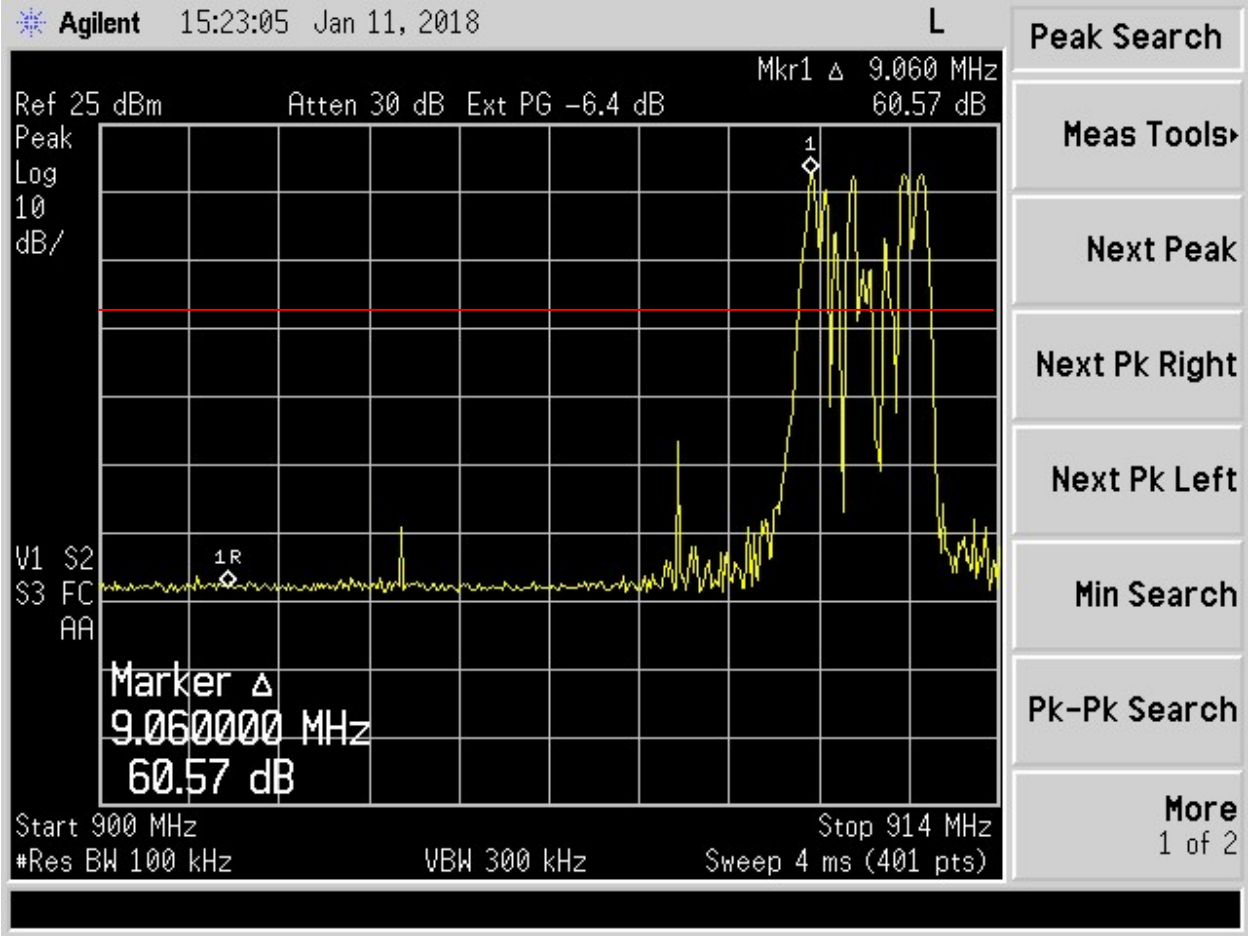


Figure 13. Band Edge Compliance, Low Channel Delta – Channel Hopping OOK Modulation (Conducted)

Measured Delta (from Figure 12)	60.57	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	40.57	dB

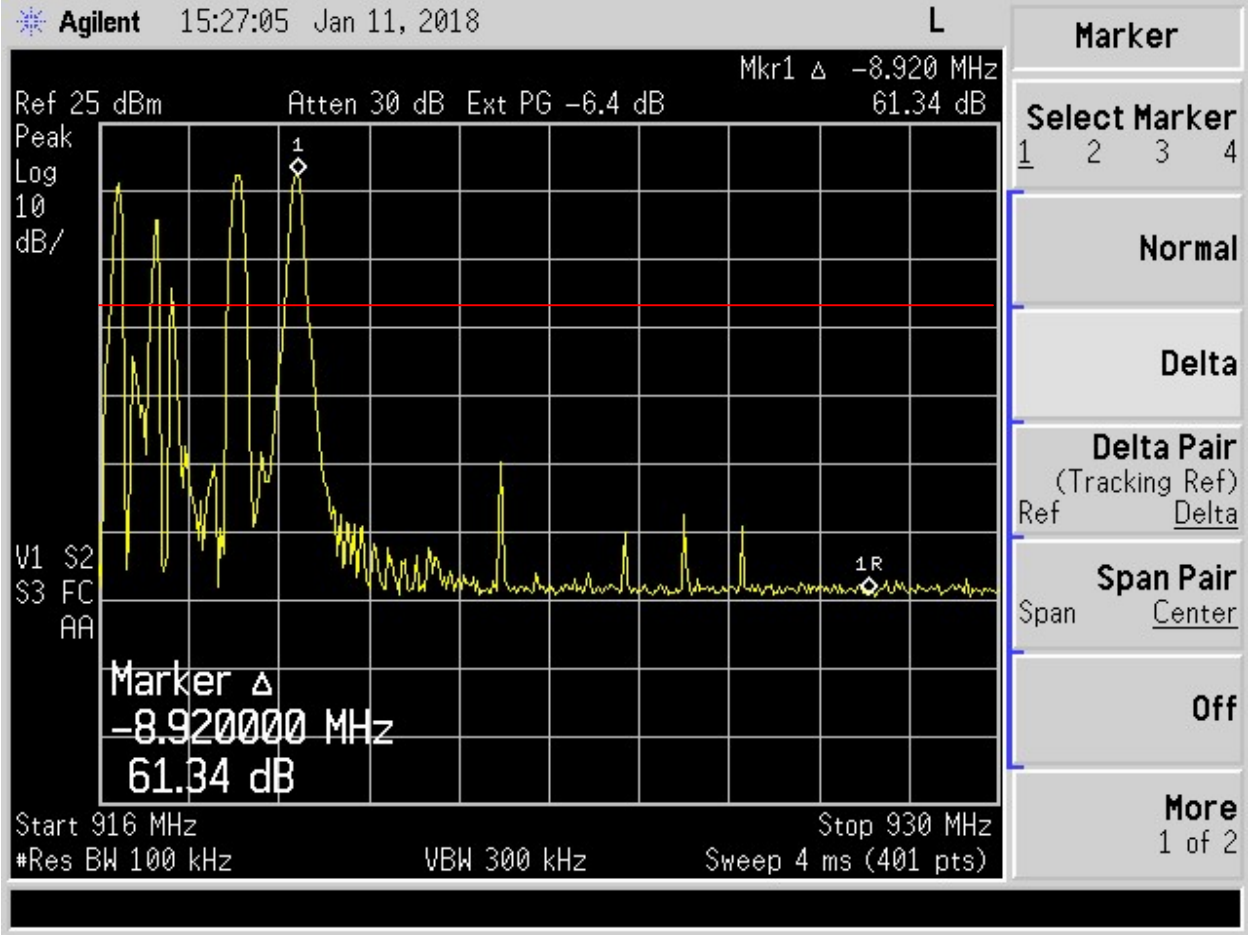


Figure 14. Band Edge Compliance, High Channel Delta – Channel Hopping OOK Modulation (Conducted)

Measured Delta (from Figure 14)	61.34	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	41.34	dB

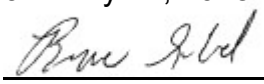
2.12 Twenty dB Bandwidth (CFR 15.247 (a) (1))

For frequency hopping systems operating in the 902-928 MHz band the maximum allowed 20 dB bandwidth is 500 kHz.

These measurements were performed while the EUT was in a constant transmit mode. A method similar to the marker delta method was used to capture the points. The RBW was set to 1 kHz and with the VBW ≥ RBW. The results of this test are given in Table and Figures following.

Table 11. Twenty (20) dB Bandwidth

Frequency (MHz)	20 dB Bandwidth (kHz)	Maximum Limit (kHz)	99% Occupied Bandwidth (kHz)
911.08	74.62	500	92.66
919.08	75.21	500	93.05

Test Date: January 11, 2018
Tested By
Signature:  Name: Bruce Arnold

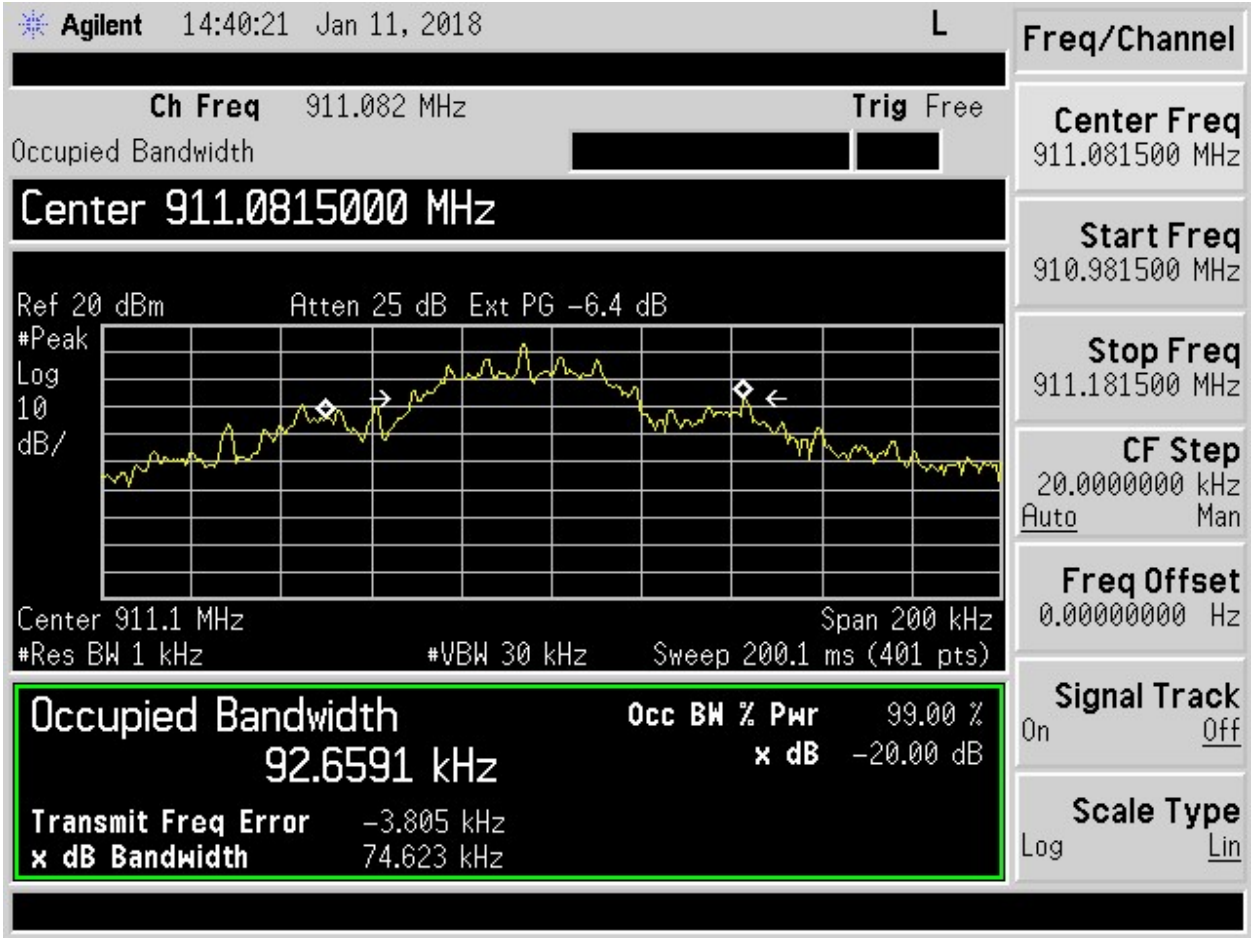


Figure 15. Twenty dB Bandwidth – Low Channel

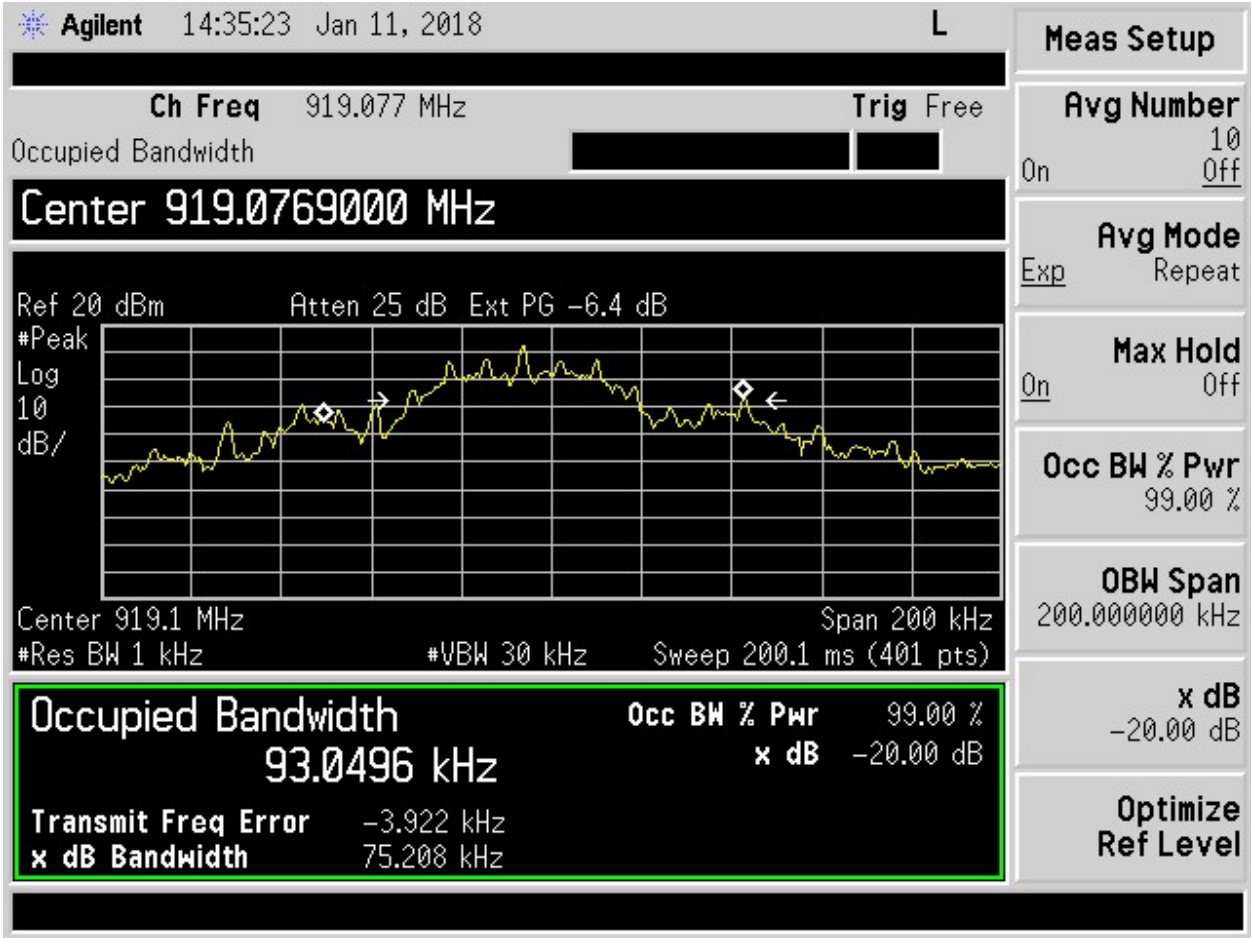


Figure 16. Twenty dB Bandwidth – High Channel

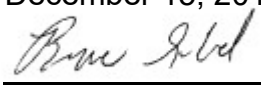
2.13 Maximum Peak Conducted Output Power (CFR 15.247 (b) (2))

For frequency hopping systems in the 902-928 MHz band with at least 50 hopping channels, the maximum peak conducted output power of the intentional radiator shall not exceed 1 watt. Systems with less than 50 hopping channels, but at least 25 hopping channels, the maximum peak conducted output power of the intentional radiator shall not exceed .25 watts. Since the EUT has 50 hopping channels, the maximum peak conducted output power shall not exceed 1 watt.

Peak power within the band 911.1 MHz to 919.1 MHz was measured per ANSI C63.10:20113 as an Antenna Conducted test with a spectrum analyzer. For these measurements the EUT antenna port was connected to a spectrum analyzer having a 50 Ω input impedance using a 75 to 50 Ω adaptor. The setup losses were corrected by using a -6.4 dB offset in the analyzer measurements. Peak antenna conducted output power is tabulated in the table below.

Table 12. Peak Antenna Conducted Output Power per Part 15.247 (b) (2)

Frequency of Fundamental (MHz)	Raw Test Data dBm	Converted Data (mW)	FCC Limit (mW Maximum)
911.0815	17.74	59.43	1000
919.0769	18.03	63.53	1000

Test Date: December 15, 2017
Tested By
Signature:  Name: Bruce Arnold

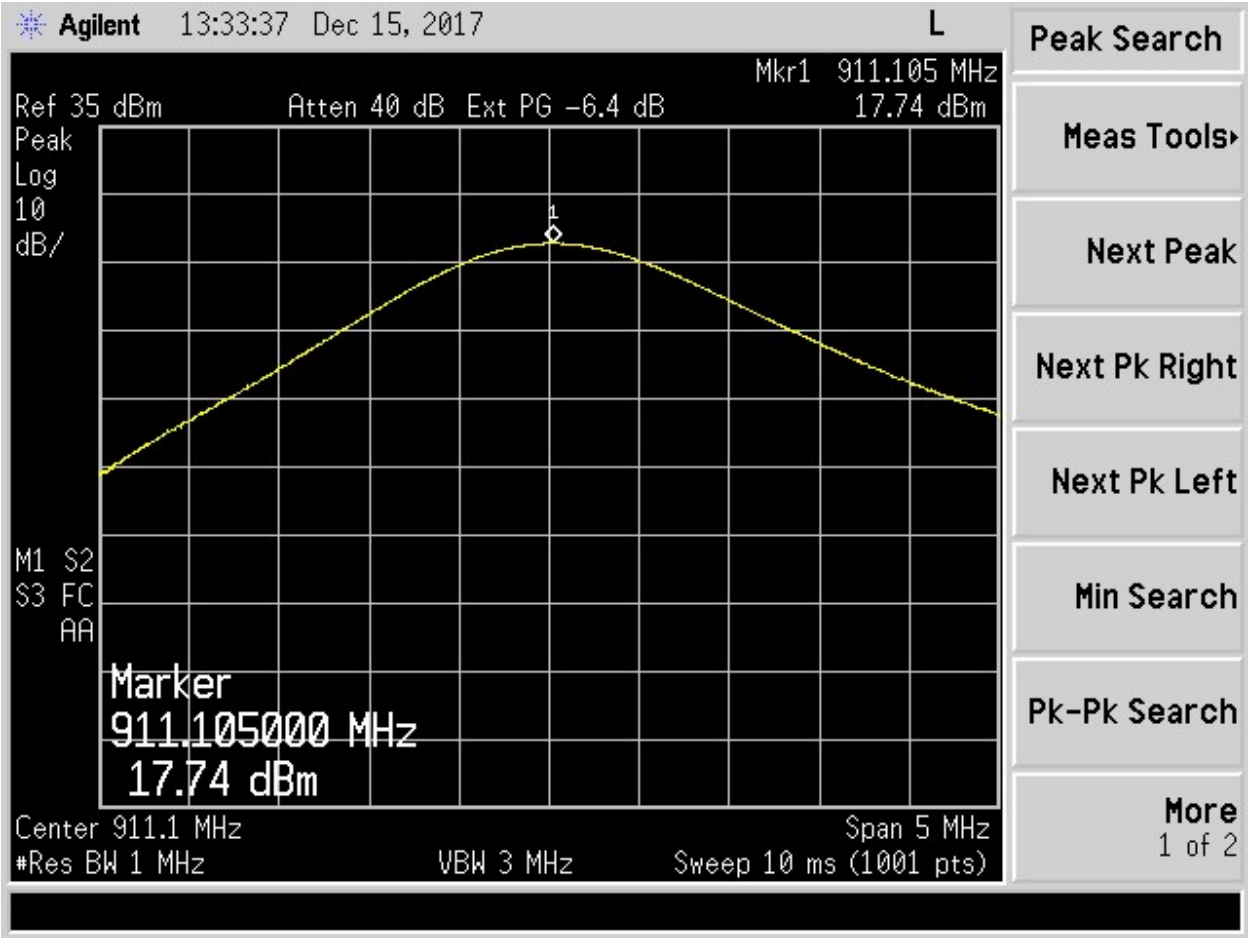


Figure 17. Peak Antenna Conducted Output Power, Low Channel

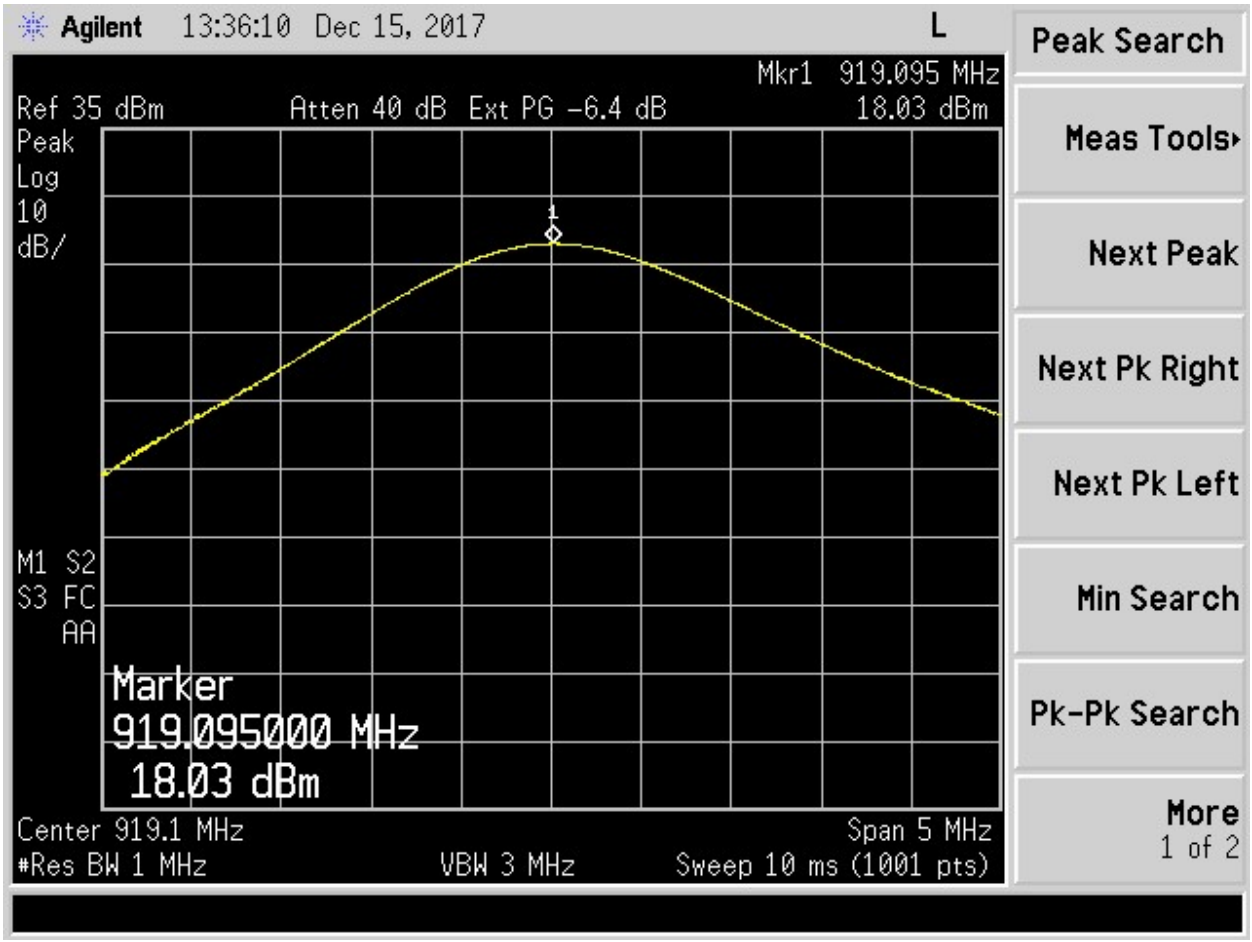


Figure 18. Peak Antenna Conducted Output Power, High Channel

2.14 Number of Hopping Frequencies (CFR 15.247 (a)(1))

Frequency hopping systems in the 902-928 MHz band shall have at least 50 hopping frequencies if the 20 dB bandwidth is less than 250 kHz. If the 20 dB bandwidth is 250 kHz or greater, then the system shall have at least 25 hopping frequencies. Since the EUT has a 20 dB bandwidth less than 250 kHz, then at least 50 hopping frequencies shall be used.

The test procedures outlined in C63.10-2013 were used to conduct measurements.

The table below lists all available channels. There are a total of 50 channels.

Channels

CH	Frequency
1	911.081472
2	915.931136
3	912.392192
4	917.241856
5	915.275776
6	918.552576
7	911.736832
8	916.586496
9	913.047552
10	917.897216
11	911.212544
12	916.062208
13	912.523264
14	917.372928
15	915.406848
16	918.683648
17	911.867904
18	916.717568
19	913.178624
20	918.028288
21	911.343616
22	916.193280
23	912.654336
24	917.504000
25	915.537920
26	918.814720
27	911.998976
28	916.848640
29	914.882560
30	918.159360
31	911.474688
32	916.324352
33	912.785408
34	917.635072
35	915.668992
36	918.945792
37	912.130048
38	916.979712
39	915.013632
40	918.290432
41	911.605760
42	916.455424
43	912.916480
44	917.766144
45	915.800064
46	919.076864
47	912.261120
48	917.110784
49	915.144704
50	918.421504

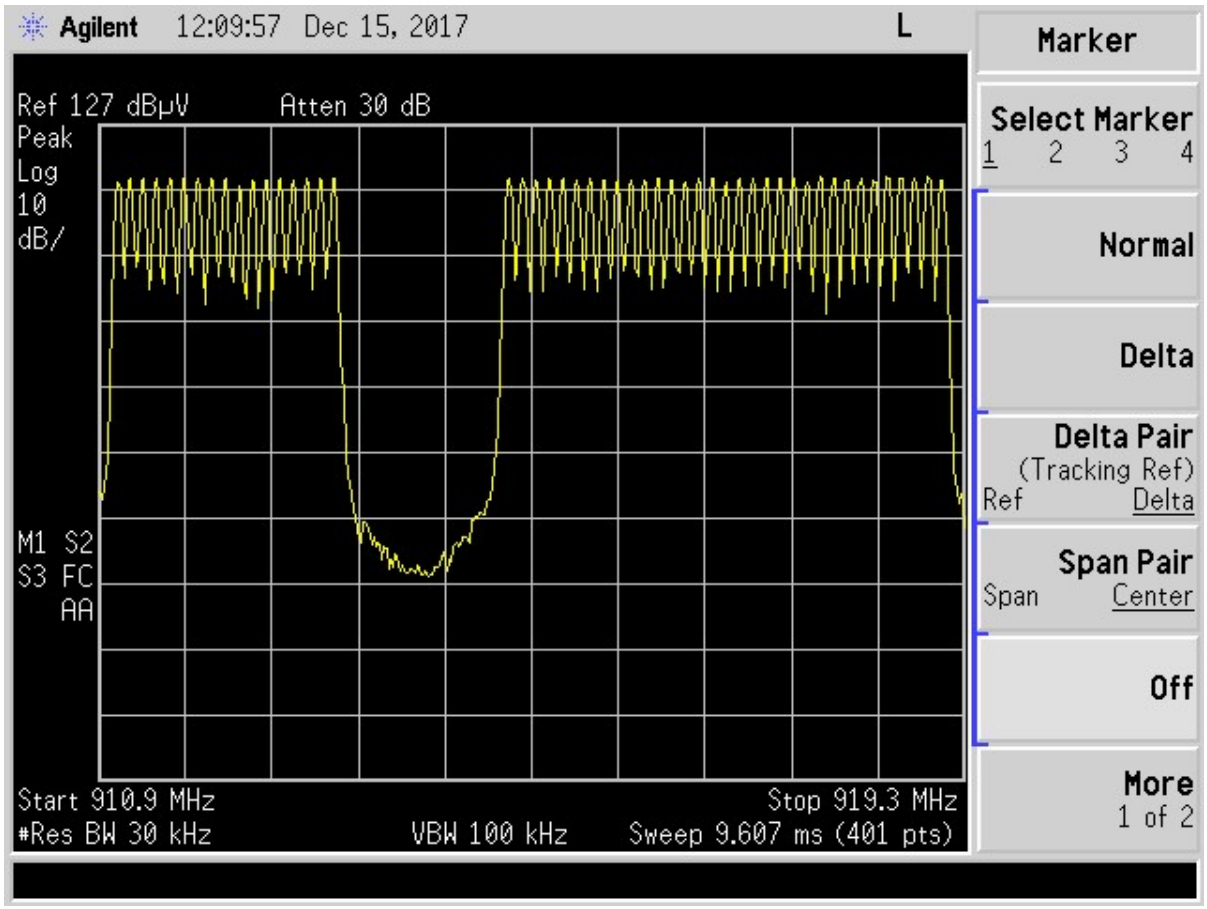


Figure 19. Hopping Channels 1 through 50

2.15 Frequency Separation (CRF 15.247(a)(1))

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. In this case, the 20 dB bandwidth of the Frequency hopping system is greater than 25 kHz, so the minimum requirement used was the 20 dB bandwidth, 75 kHz. Therefore the frequency separation must be greater than 75 kHz.

The EUT does meet the frequency separation requirement.

The test procedure outlined in ANSI C63.10-2013 was used to conduct measurements. The EUT hopping function was enabled during the testing.

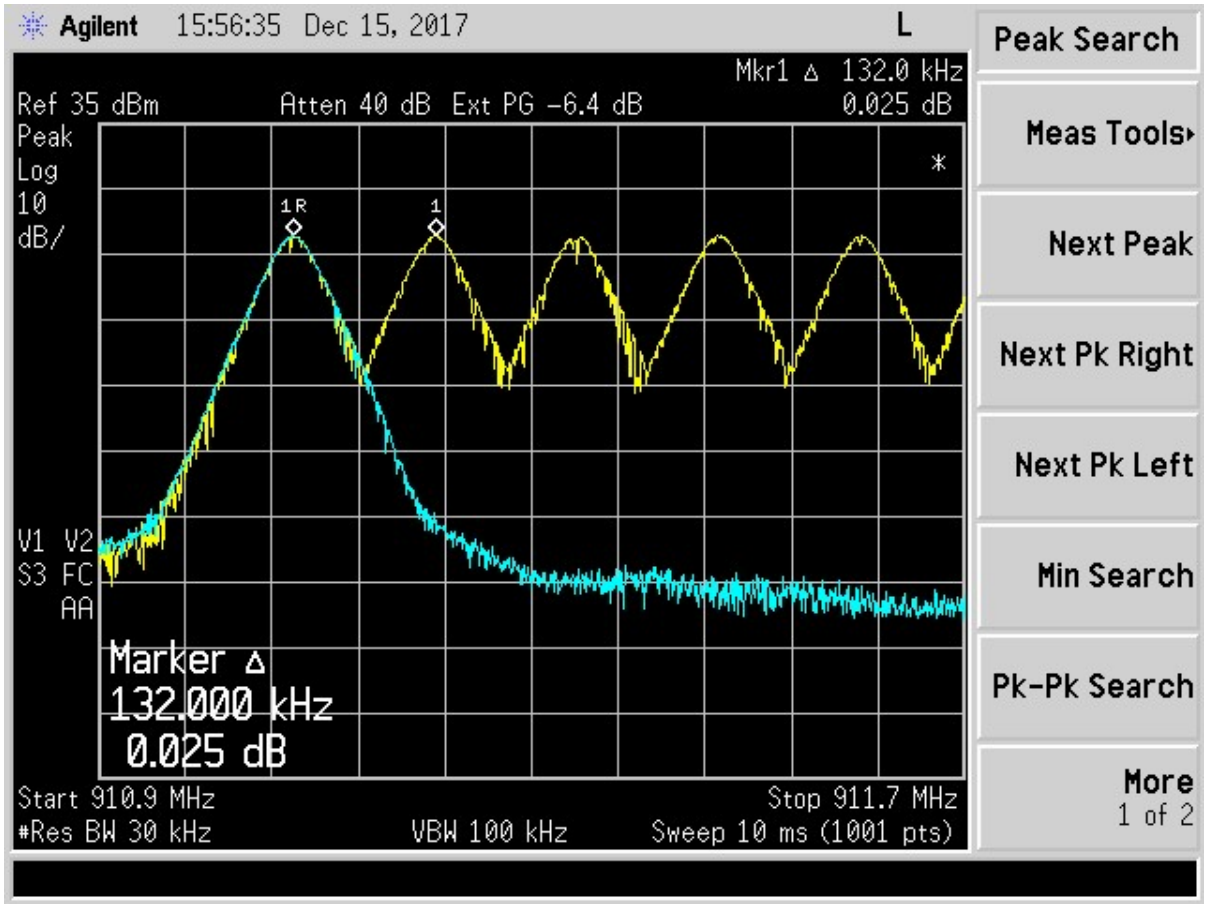


Figure 20. Channel Separation

Measured Delta (Figure 33 above)	132.0 kHz
-Limit (20 dB Bandwidth)	75.0 kHz
Margin	57.0 kHz

2.16 Average Time of Occupancy (CFR 15.247(f))

The customer considers this to be proprietary information. For details please see the Theory of Operation exhibit.

2.17 Unintentional and Intentional Radiator, Powerline Emissions (CFR 15.107/15.207)

The EUT was battery powered; therefore this test was not applicable.

2.18 Unintentional and Intentional Radiator, Radiated Emissions (CFR 15.109, 15.209)

Radiated emissions disturbance measurements were performed with the transmitter turned OFF and the test was repeated with the intentional transmitter circuit ON. The worst case mode of operation is with the transmitter circuit ON. That test data is presented below to show compliance to both parts.

An instrument having both peak and quasi-peak detectors was used to perform the test over the frequency range of 30 MHz to five times the highest clock frequency. Measurements of the radiated emissions were made with the receiver antenna at a distance of 3 m from the boundary of the test unit.

The test antenna was varied from 1 m to 4 m in height while watching the analyzers' display for the maximum magnitude of the signal at the test frequency. The antenna polarization (horizontal or vertical) and test sample azimuth were varied during the measurements to find the maximum field strength readings to record.

The worst-case radiated emission in the range of 30 MHz to 10 GHz was 15.7 dB below the limit at 766.0 MHz. This signal is found in Table 16. All other radiated emissions were 17.1 dB or more below the limit.

Table 13. Intentional Radiator, Spurious Radiated Emissions (CFR 15.209), 9 kHz to 30 MHz (Antenna 2)

30 kHz to 30 MHz							
Test: Radiated Emissions				**Client:** Neptune Technology Group Inc.			
Project: 17-0481				**Model:** L900			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**QP Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or QP**
All emissions seen were 20 dB or more below the limit.							

Tested from 30 kHz to 30 MHz

SAMPLE CALCULATION: N/A

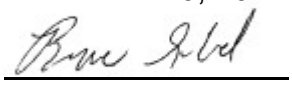
Test Date: December 20, 2017
Tested By
Signature:  Name: Bruce Arnold

Table 14. Intentional Radiator, Spurious Radiated Emissions (CFR 15.209), 9 kHz to 30 MHz (Antenna 3)

30 kHz to 30 MHz							
Test: Radiated Emissions				**Client:** Neptune Technology Group Inc.			
Project: 17-0481				**Model:** L900			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**QP Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or QP**
All emissions seen were 20 dB or more below the limit.							

Tested from 30 kHz to 30 MHz

SAMPLE CALCULATION: N/A

Test Date: December 20, 2017
Tested By
Signature:  Name: Bruce Arnold

Table 15. Unintentional and Intentional Radiator, Spurious Radiated Emissions (CFR 15.109, 15.209) 30 MHz to 1000 MHz (Antenna 2)

30 MHz to 1000 MHz with Class B Limits							
Test: Radiated Emissions				**Client:** Neptune Technology Group Inc.			
Project: 17-0481				**Model:** L900			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**QP Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or QP**
81.62	30.15	-17.73	12.42	40.0	3m./HORZ	27.6	**PK**
130.56	29.56	-14.56	15.00	43.5	3m./HORZ	28.5	**PK**
49.58	32.21	-17.20	15.01	40.0	3m./VERT	25.0	**PK**
127.76	29.96	-14.56	15.40	43.5	3m./VERT	28.1	**PK**
490.00	29.16	-5.81	23.35	46.0	3m./VERT	22.7	**PK**
406.00	30.10	-4.48	25.62	46.0	3m./HORZ	20.4	**PK**

Tested from 30 MHz to 1 GHz

SAMPLE CALCULATION at 81.62 MHz:

Magnitude of Measured Frequency	30.15	dBuV
+ Cable Loss+Antenna Factor-Amp Gain	-17.73	dB
=Corrected Result	12.42	dBuV
Limit	40.00	dBuV
-Corrected Result	12.42	dBuV
Margin	27.58	dB

Test Date: December 18, 2017
Tested By
Signature: Bruce Arnold Name: Bruce Arnold

Table 16. Unintentional and Intentional Radiator, Spurious Radiated Emissions (CFR 15.109, 15.209) 30 MHz to 1000 MHz (Antenna 3)

30 MHz to 1000 MHz with Class B Limits							
Test: Radiated Emissions				**Client:** Neptune Technology Group Inc.			
Project: 17-0481				**Model:** L900			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**QP Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or QP**
58.56	33.97	-17.41	16.56	40.0	3m./HORZ	23.4	**PK**
105.08	33.49	-16.42	17.07	43.5	3m./HORZ	26.4	**PK**
47.11	33.29	-16.98	16.31	40.0	3m./VERT	23.7	**PK**
200.00	33.27	-10.56	22.71	43.5	3m./VERT	20.8	**PK**
386.00	34.75	-5.83	28.92	46.0	3m./VERT	17.1	**PK**
766.00	33.36	-3.03	30.33	46.0	3m./HORZ	15.7	**PK**

Tested from 30 MHz to 1 GHz

SAMPLE CALCULATION at 58.56 MHz:

Magnitude of Measured Frequency	33.97	dBuV
+ Cable Loss+Antenna Factor-Amp Gain	-17.41	dB
=Corrected Result	16.56	dBuV
Limit	40.00	dBuV
-Corrected Result	16.56	dBuV
Margin	23.44	dB

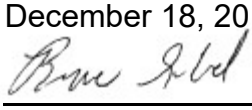
Test Date: December 18, 2017
Tested By
Signature:  Name: Bruce Arnold

Table 17. Unintentional and Intentional Radiator, Spurious Radiated Emissions (CFR 15.109, 15.209) 1 GHz to 10 GHz (Antenna 2)

1 GHz to 10 GHz with Class B Limits							
Test: Radiated Emissions				**Client:** Neptune Technology Group Inc.			
Project: 17-0481				**Model:** L900			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**AVG Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or AVG**
All emissions seen were 20 dB or more below the limit.							

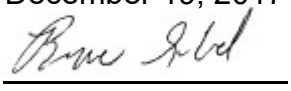
SAMPLE CALCULATION: N/A

Test Date: December 19, 2017
Tested By
Signature: _____ Name: Bruce Arnold

Table 18. Unintentional and Intentional Radiator, Spurious Radiated Emissions (CFR 15.109, 15.209) 1 GHz to 10 GHz (Antenna 3)

1 GHz to 10 GHz with Class B Limits							
Test: Radiated Emissions				**Client:** Neptune Technology Group Inc.			
Project: 17-0481				**Model:** L900			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**AVG Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or AVG**
All emissions seen were 20 dB or more below the limit.							

SAMPLE CALCULATION: N/A

Test Date: December 19, 2017
Tested By
Signature:  Name: Bruce Arnold

2.21 Measurement Uncertainty

The measurement uncertainties given were calculated using the method detailed in CISPR 16-4-2. A coverage factor of k=2 was used to give a level of confidence of approximately 95%.

Conducted Emissions Measurement Uncertainty

Measurement Uncertainty (within a 95% confidence level) for this test is ± 2.78 dB.

This test was not performed. The EUT is battery operated.

Radiated Emissions Measurement Uncertainty

For a measurement distance of 3 m the measurement uncertainty (with a 95% confidence level) for this test using a Biconical Antenna (30 MHz to 200 MHz) is ± 5.39 dB. This value includes all elements of measurement.

The measurement uncertainty (with a 95% confidence level) for this test using a Log Periodic Antenna (200 MHz to 1000 MHz) is ± 5.18 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna is ± 5.21dB.

The data listed in this test report does have sufficient margin to negate the effects of uncertainty. Therefore, the EUT unconditionally meets this requirement.