Testing Tomorrow's Technology

Application

For

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

And

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.

Model: L900

FCC ID: P2SL900M2
IC: 4171B-L900M2

UST Project: 17-0479
Issue Date: January 3, 2018

Total Pages in This Report: 54

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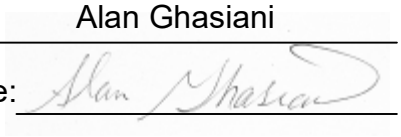
Testing Tomorrow's Technology

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 3, 2018

TESTING
NVLAP LAB CODE 200162-0

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Testing Tomorrow's Technology

MEASUREMENT TECHNICAL REPORT

COMPANY NAME: Neptune Technology Group Inc.

MODEL: L900

FCC ID: P2SL900M2

IC: 4171B-L900M2

DATE: January 3, 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:

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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: DTS (903.0 – 914.2 MHz)
Maximum Output Power: 30 dBm (Rated)

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 DTS 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 and per FCC KDB Publication number 558074 for Digital Transmission Systems Operating Under section 15.247. 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 following. 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 AND MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC and IC ID	CABLES P/D
EUT Neptune Technology Group Inc.	L900	Engineering Sample	P2SL900M2 (Pending) 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	5//1/2019 2 yr.
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 11.2 MHz, 3 test frequencies were used: 903.0, 907.8, and 914.2 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 Antennas

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

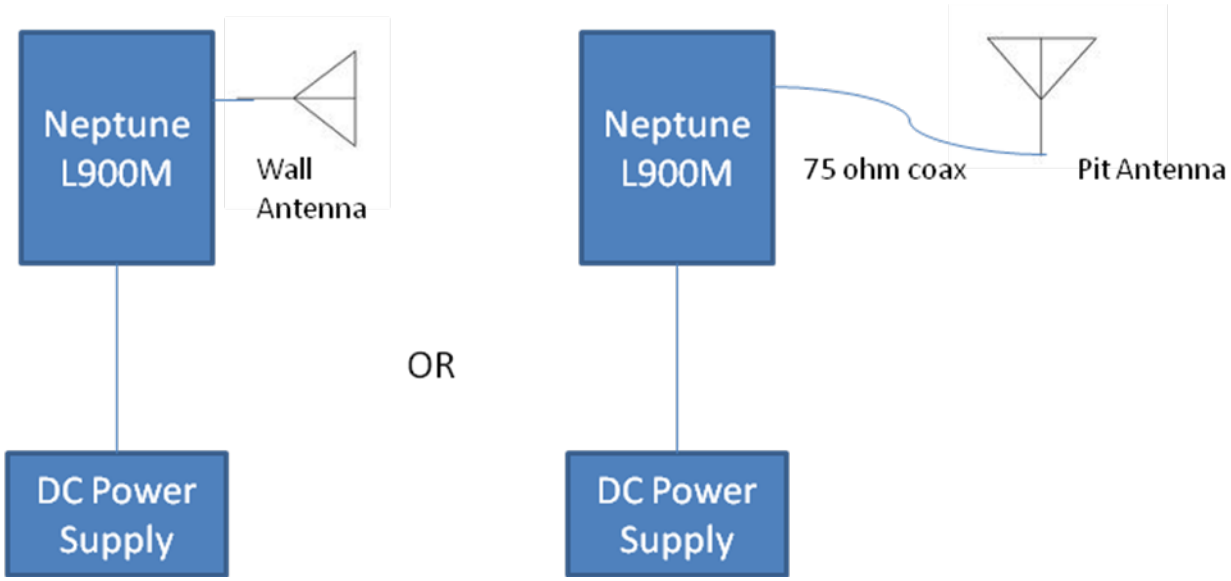


Figure 1. Block Diagram of Test Configuration

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 emissions 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 operates for longer than 0.1 seconds therefore the AVG absolute method was use for all AVG measurements.

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; herefore, 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, 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: 17-0479				**Model:** L900			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limit (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel – AVERAGE							
902.84@	101.6	25.19	106.79@	--	3m./VERT	--	PK
1807.3	40.81	-5.01	35.80	54.0	3.0m./VERT	18.2	AVG
2709.00	34.34	-1.00	33.34	54.0	3.0m./VERT	20.7	AVG
Mid Channel – AVERAGE							
907.62@	101.3	25.19	106.49@	--	3m./VERT	--	PK
1816.00	43.11	-4.86	38.25	54.0	3.0m./VERT	15.7	AVG
High Channel – AVERAGE							
914.26@	100.30	25.19	105.49@	--	3m./VERT	--	PK
1829.80	40.02	-4.86	35.16	54.0	3.0m./VERT	18.8	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 used to represent the AVG. The results were corrected by subtracting 20 dB from the Peak value.

Sample Calculation at 1807.30 MHz:

Magnitude of Measured Frequency	40.81	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-5.01	dB/m
Corrected Result	35.80	dBuV/m

Test Date: December 11, 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: 17-0479				**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							
902.84	101.6	25.19	126.79	--	3m./VERT	--	PK
1805.50	87.09	-5.01	83.06	106.8	3.0m./VERT	23.7	PK
2709.00	49.47	-1.00	48.47	74.0*	3.0m./VERT	25.5	PK
Mid Channel – PK							
907.62	101.3	25.19	126.49	--	3m./VERT	--	PK
1815.30	85.14	-4.86	80.28	106.5	3.0m./VERT	26.2	PK
High Channel – PK							
914.26	100.30	25.19	125.49	--	3m./VERT	--	PK
1828.70	85.40	-4.86	80.54	105.5	3.0m./VERT	24.9	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 902.84 MHz:

Magnitude of Measured Frequency	101.6	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	25.19	dB/m
Corrected Result	126.79	dBuV/m

Test Date: December 11, 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: 17-0479				**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							
903.10@	102.50	25.19	107.69@		3m./VERT		PK
1806.40	48.38	-5.01	43.37	54.0	3.0m./VERT	10.6	AVG
Mid Channel – AVERAGE							
907.56@	102.70	25.19	107.89@		3m./VERT		PK
1816.70	40.88	-4.86	36.02	54.0	3.0m./VERT	18.0	AVG
High Channel – AVERAGE							
914.10@	103.10	25.19	108.29@		3m./VERT		PK
1829.20	40.77	-4.86	35.91	54.0	3.0m./VERT	18.1	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 used to represent the AVG. The results were corrected by subtracting 20 dB from the Peak value.

Sample Calculation at 1806.40 MHz:

Magnitude of Measured Frequency	48.38	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-5.01	dB/m
Corrected Result	43.37	dBuV/m

Test Date: December 11, 2017
Tested By
Signature: 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: 17-0479				**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							
903.10	102.50	25.19	127.69		3m./VERT		PK
1805.50	87.09	-5.01	82.08	107.7	3.0m./VERT	25.6	PK
Mid Channel – PK							
907.56	102.70	25.19	127.89		3m./VERT		PK
1815.60	85.77	-4.86	80.91	107.9	3.0m./VERT	27.0	PK
High Channel – PK							
914.10	103.10	25.19	128.29		3m./VERT		PK
1828.10	84.94	-4.86	80.08	108.3	3.0m./VERT	28.2	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 903.1 MHz:

Magnitude of Measured Frequency	102.50	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	25.19	dB/m
Corrected Result	127.69	dBuV/m

Test Date: December 11, 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: 17-0479				**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							
902.78@	105.70	25.19	110.89@		3m./VERT		PK
1806.80	40.68	-5.01	35.67	54.0	3.0m./VERT	18.3	AVG
Mid Channel – AVERAGE							
907.56@	105.20	25.19	110.39@		3m./VERT		PK
1816.10	40.33	-4.86	35.47	54.0	3.0m./VERT	18.5	AVG
High Channel – AVERAGE							
914.16@	104.20	25.19	109.39@		3m./VERT		PK
1828.90	39.84	-4.86	34.98	54.0	3.0m./VERT	19.0	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 used to represent the AVG. The results were corrected by subtracting 20 dB from the Peak value.

Sample Calculation at 1806.80 MHz:

Magnitude of Measured Frequency	40.68	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-5.01	dB/m
Corrected Result	35.67	dBuV/m

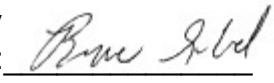
Test Date: December 11, 2017
Tested By
Signature:  Name: Bruce Arnold

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: 17-0479				**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							
902.78	105.70	25.19	130.89		3m./VERT		PK
1806.20	76.94	-5.01	71.93	110.9	3.0m./VERT	39.0	PK
Mid Channel – PK							
907.56	105.20	25.19	130.39		3m./VERT		PK
1815.54	73.24	-4.86	68.38	110.4	3.0m./VERT	42.0	PK
High Channel – PK							
914.16	104.20	25.19	129.39		3m./VERT		PK
1828.50	69.49	-4.86	64.63	109.4	3.0m./VERT	44.8	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 1806.20 MHz:

Magnitude of Measured Frequency	76.94	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-5.01	dB/m
Corrected Result	71.93	dBuV/m

Test Date: December 11, 2017
Tested By
Signature:  Name: Bruce Arnold

Conducted Spurious Emissions

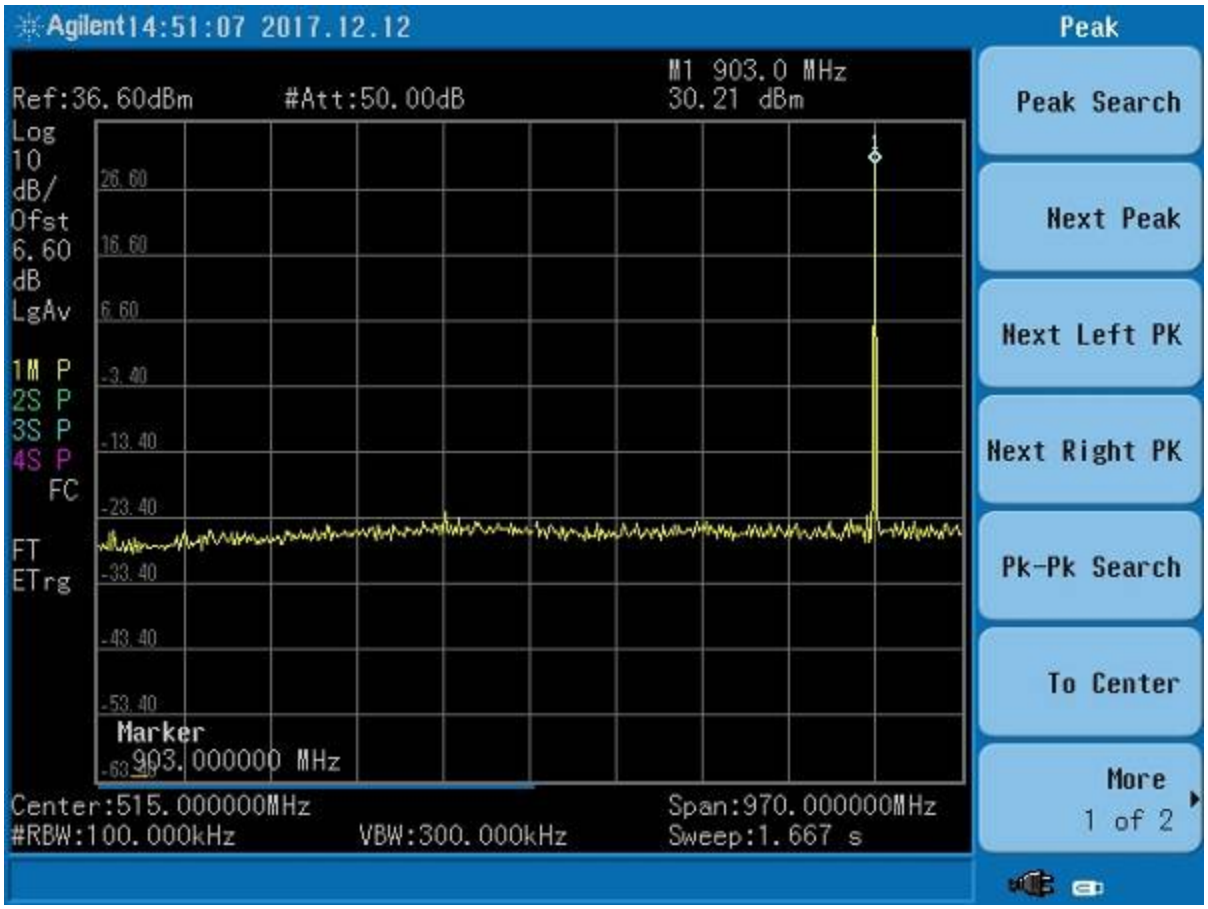


Figure 2. Antenna Conducted Emissions Low, 30 MHz to 1 GHz

Note: Large emission seen is the fundamental emission.

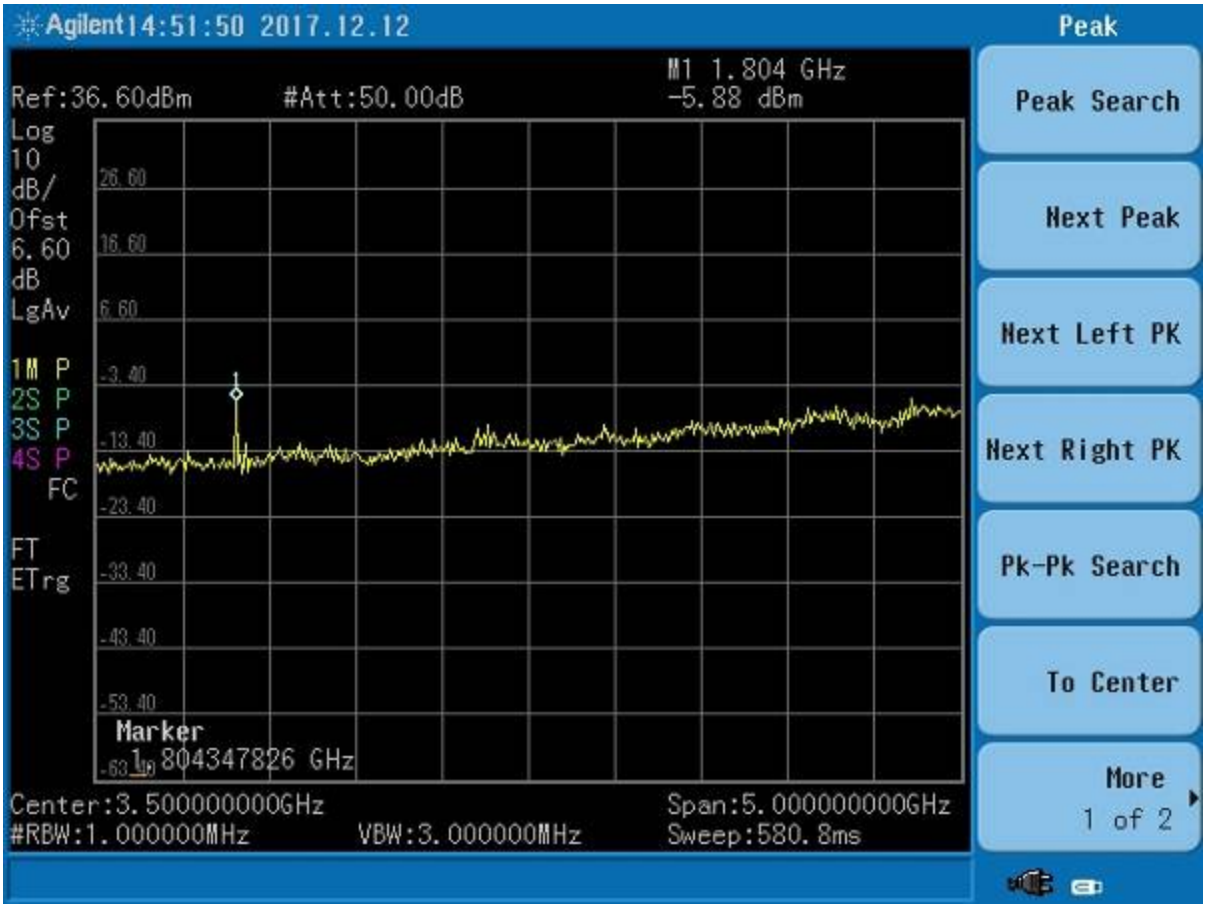


Figure 3. Antenna Conducted Emissions Low, 1 to 6 GHz

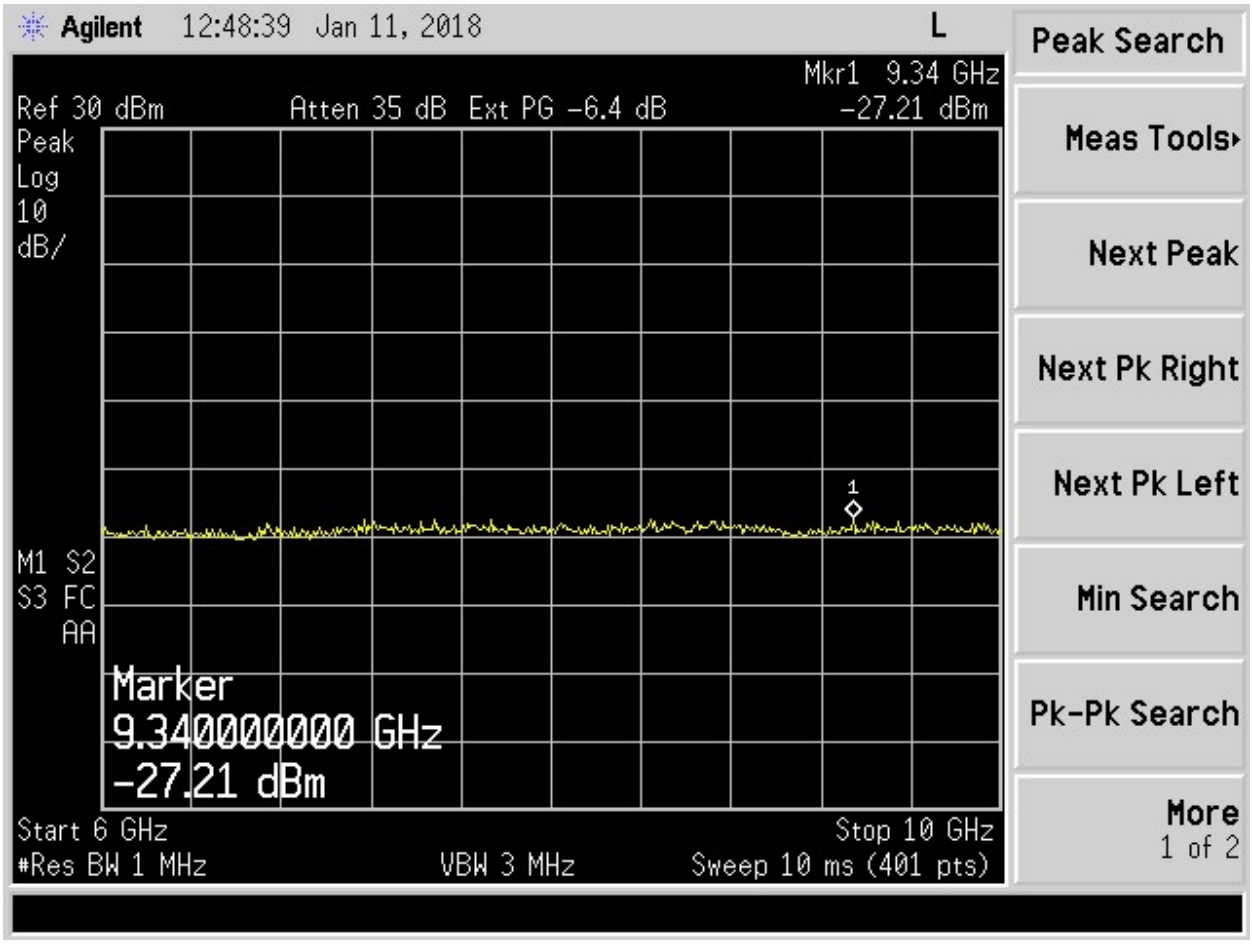


Figure 4. Antenna Conducted Emissions Low, 6 to 10 GHz

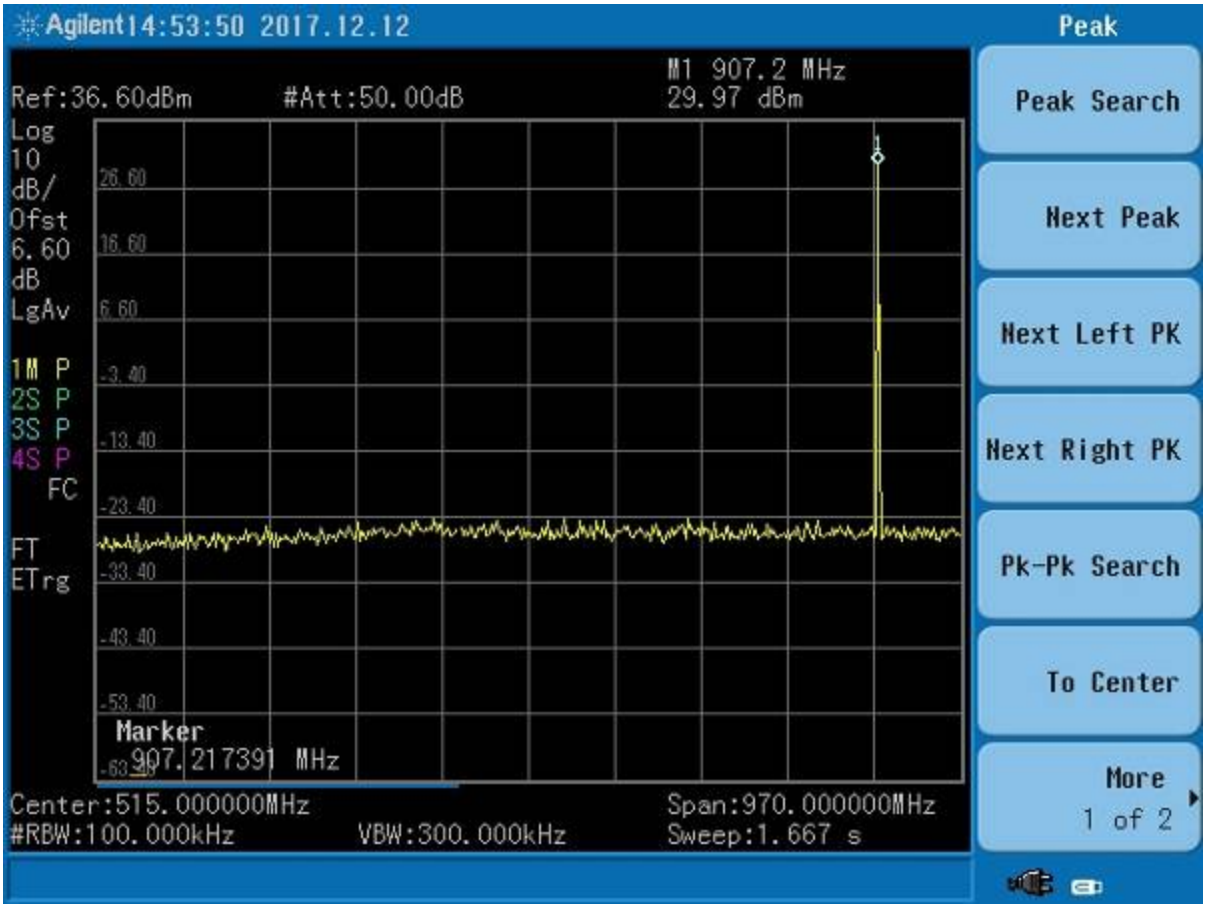


Figure 5. Antenna Conducted Emissions Mid, 30 MHz to 1 GHz

Note: Large emission seen is the fundamental emission.

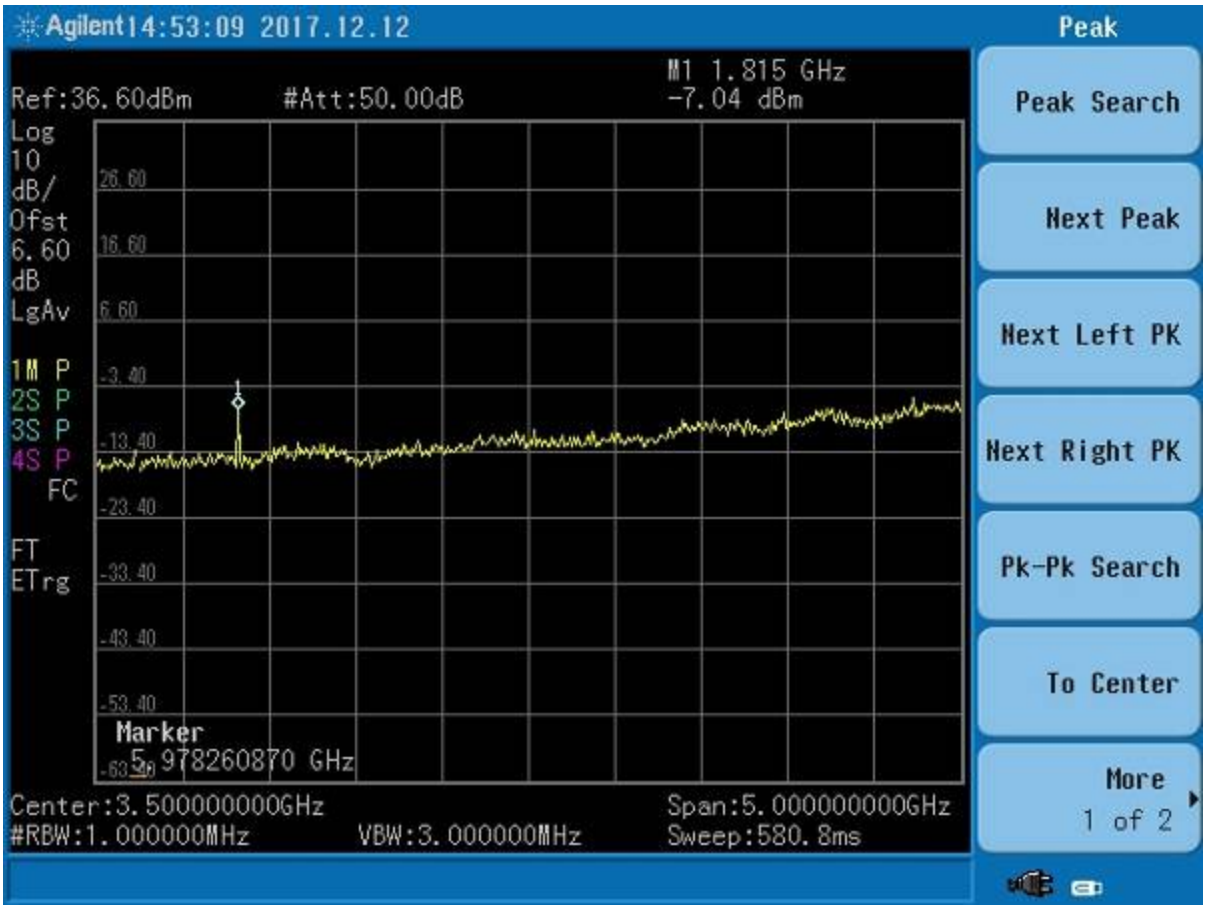


Figure 6. Antenna Conducted Emissions Mid, 1 to 6 GHz

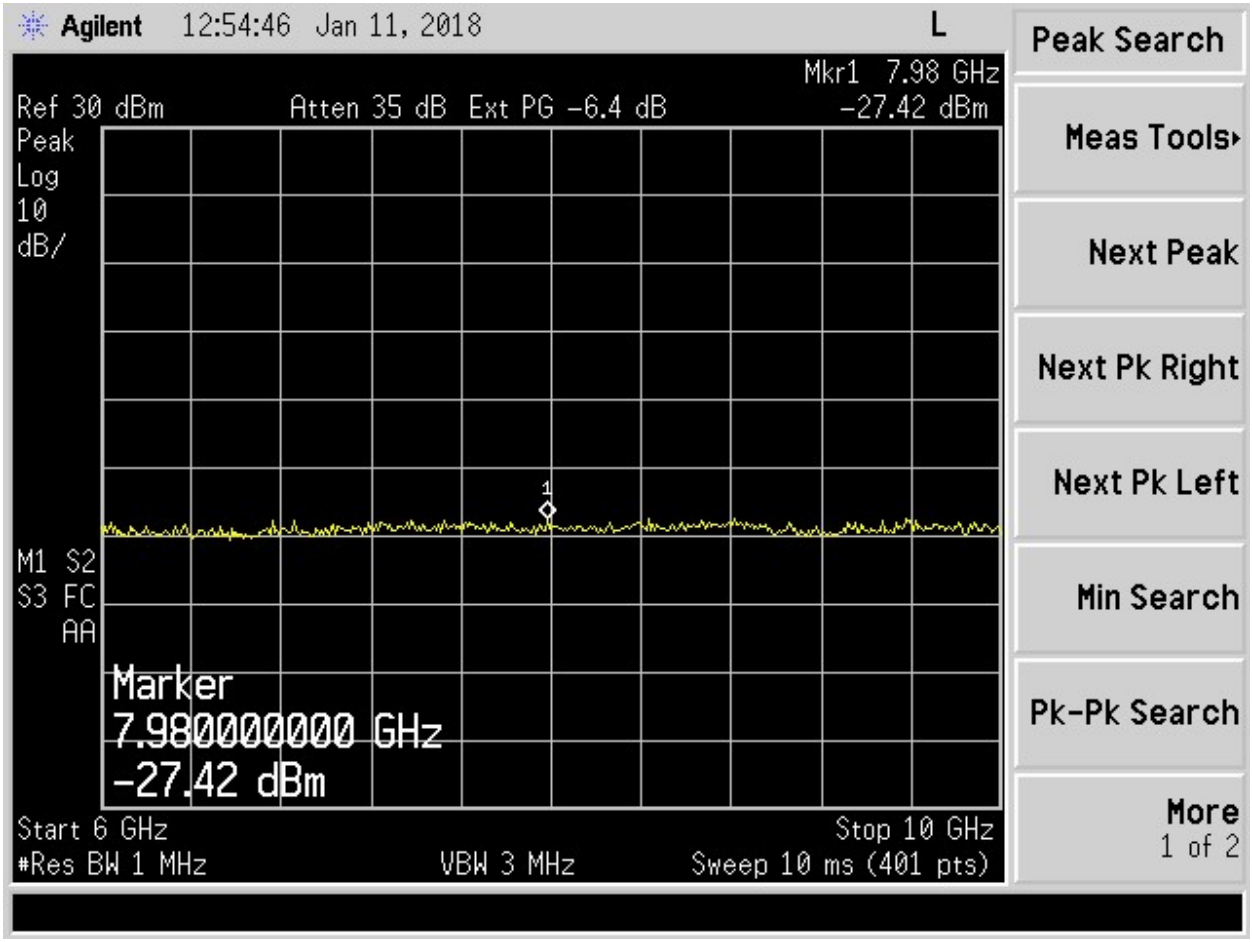


Figure 7. Antenna Conducted Emissions Mid, 6 to 10 GHz

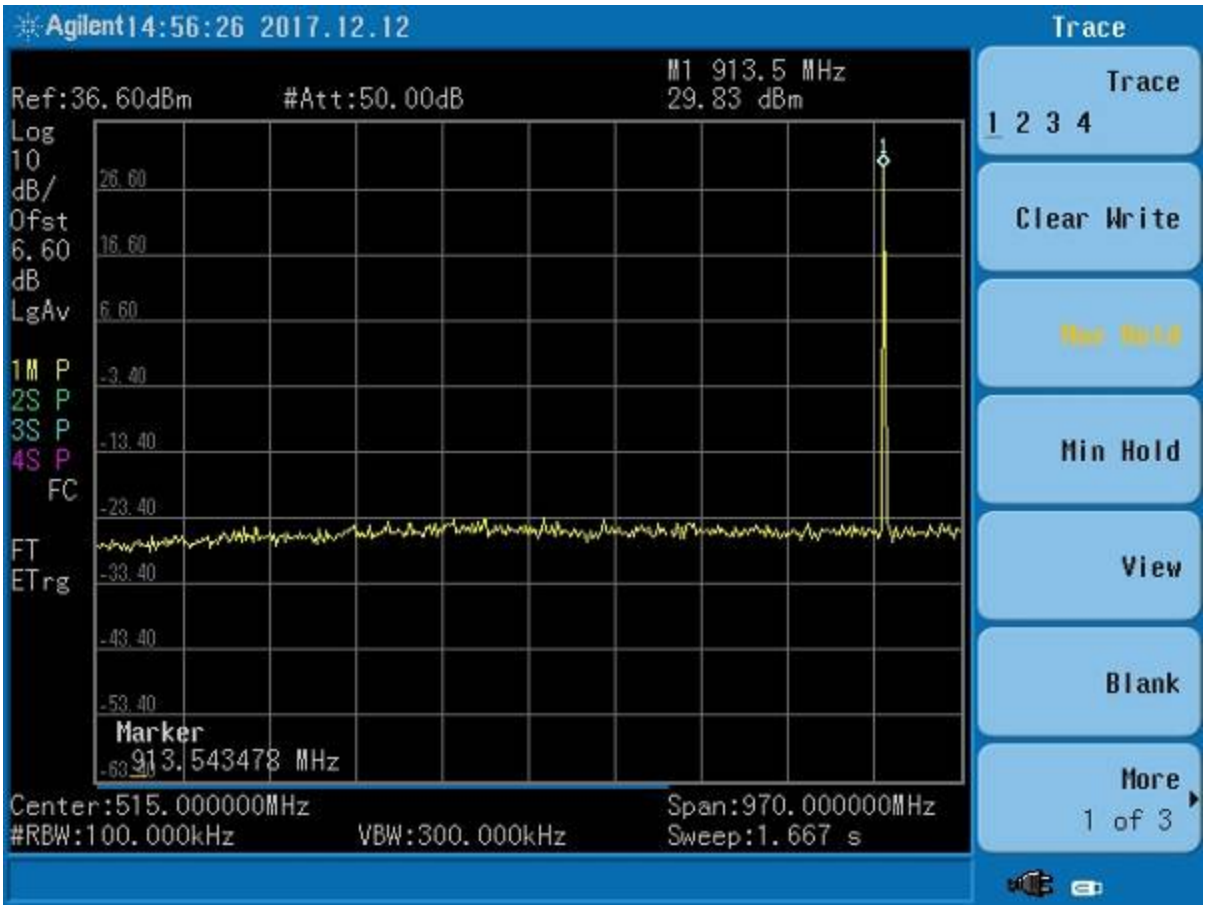


Figure 8. Antenna Conducted Emissions High, 30 MHz to 1 GHz

Note: Large emission seen is the fundamental emission.

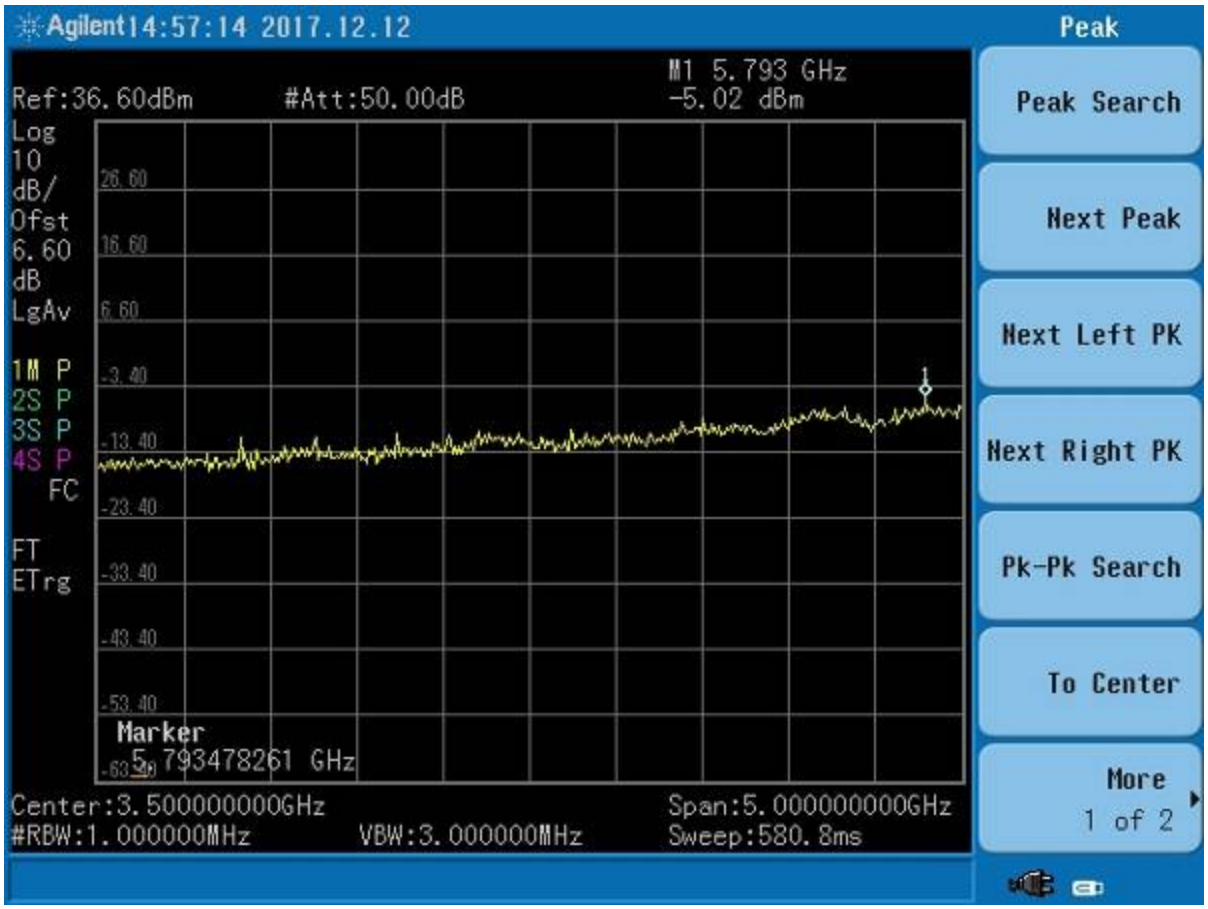


Figure 9. Antenna Conducted Emissions High, 1 to 6 GHz

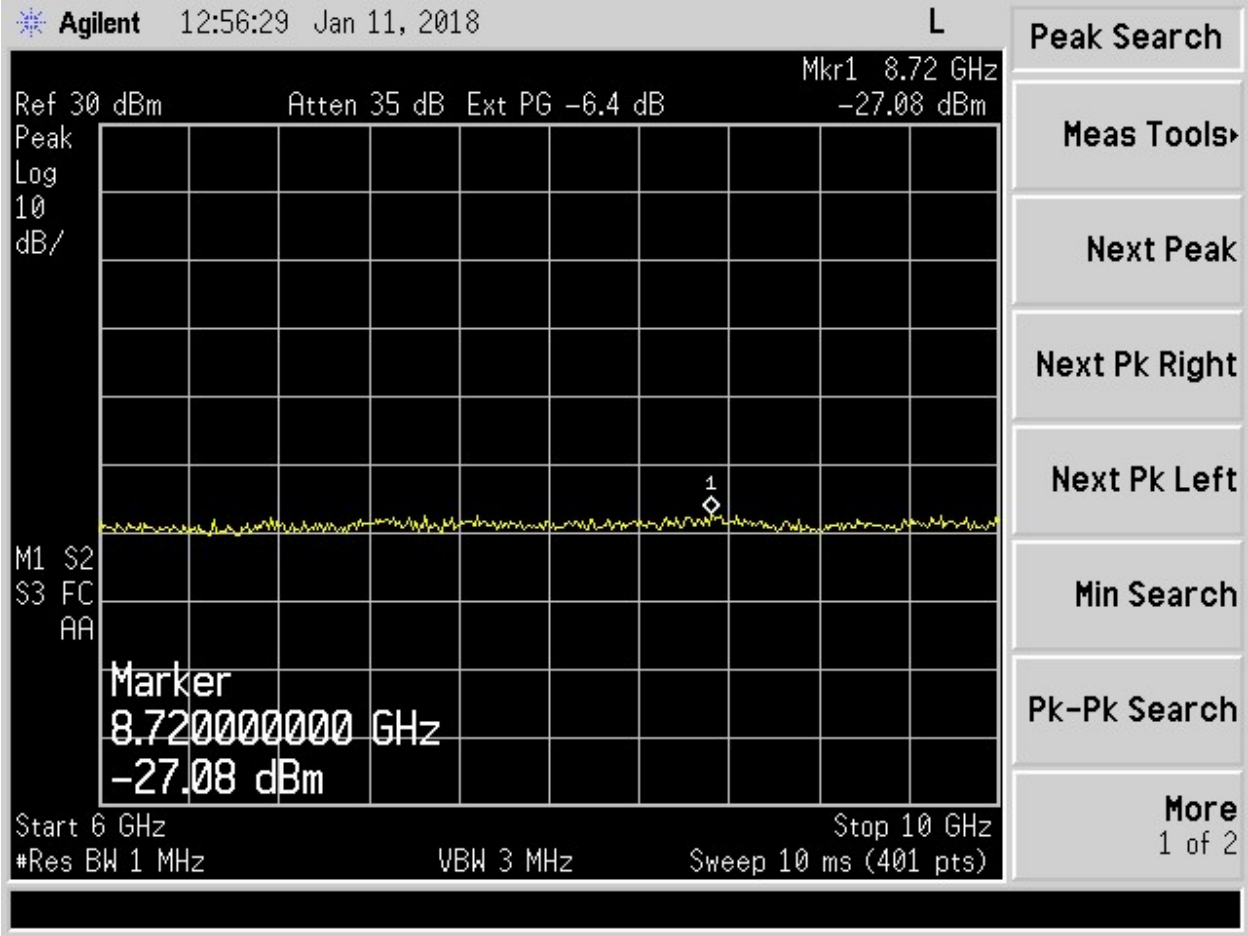


Figure 10. Antenna Conducted Emissions High, 6 to 10 GHz

2.11 Maximum Peak Conducted Output Power (CFR 15.247 (b) (3))

For DTS radios the maximum conducted output power is limited to 1 watt (30 dBm). 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 -6.6 dB offset in the analyzer measurements. The results of this test are given in the Table and Figures below.

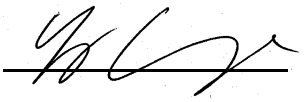
Note: The alternate average method was used to perform these measurements. The detector was set to sampling.

Table 11. Peak Antenna Conducted Output Power per Part 15.247 (b) (3)

Frequency of Fundamental (MHz)	Raw Test Data dBm	Converted Data (mW)	FCC Limit (mW Maximum)
903.0	28.27	671.43	1000
907.8	28.11	647.14	1000
914.2	27.77	598.41	1000

Sample Calculation at 903.0 MHz:

Raw Test Data	28.27	dBm
+ Calculation	10^2.827	
Converted Data	671.43	mW

Test Date: December 13, 2017
Tested By
Signature:  Name: George Yang

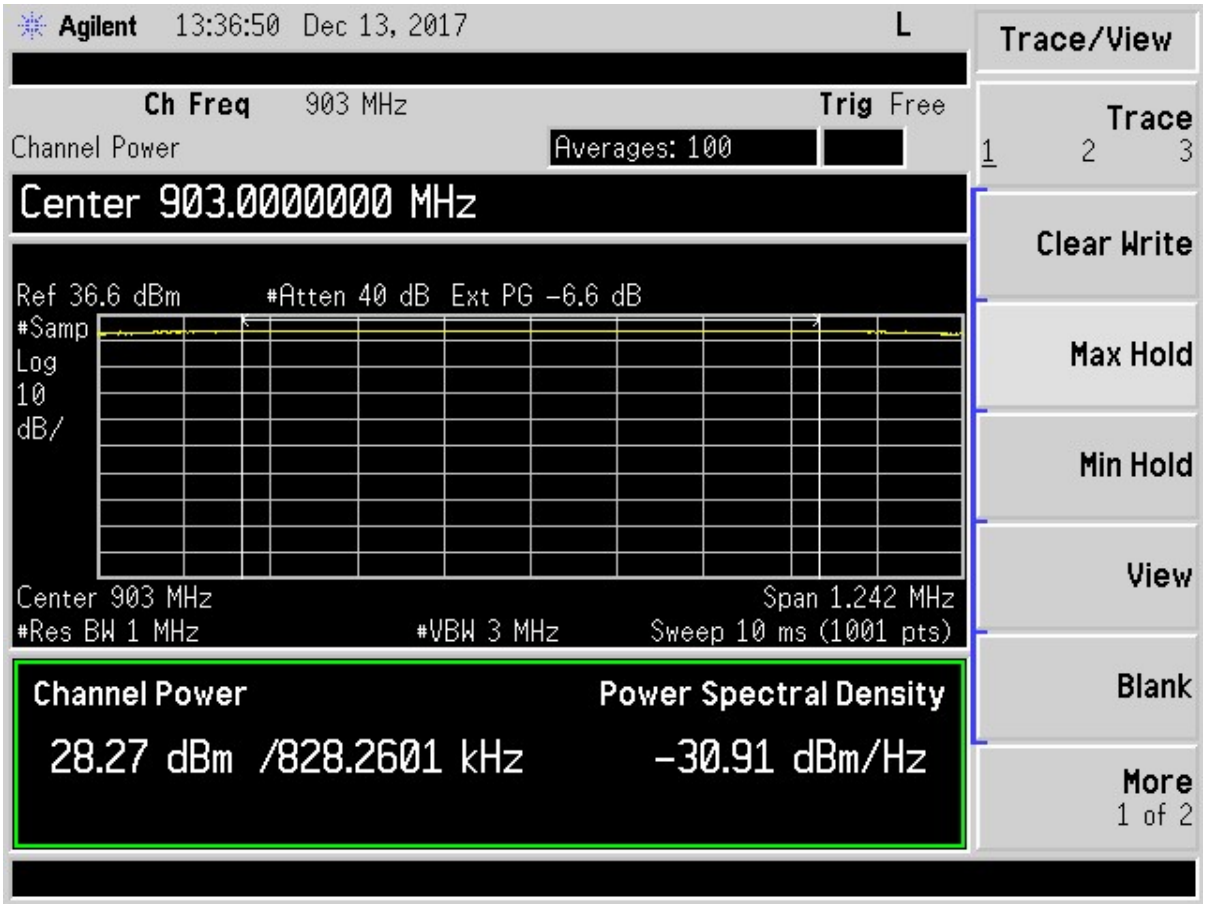


Figure 11. Maximum Antenna Conducted Output Power and Power Spectral Density, Low Channel

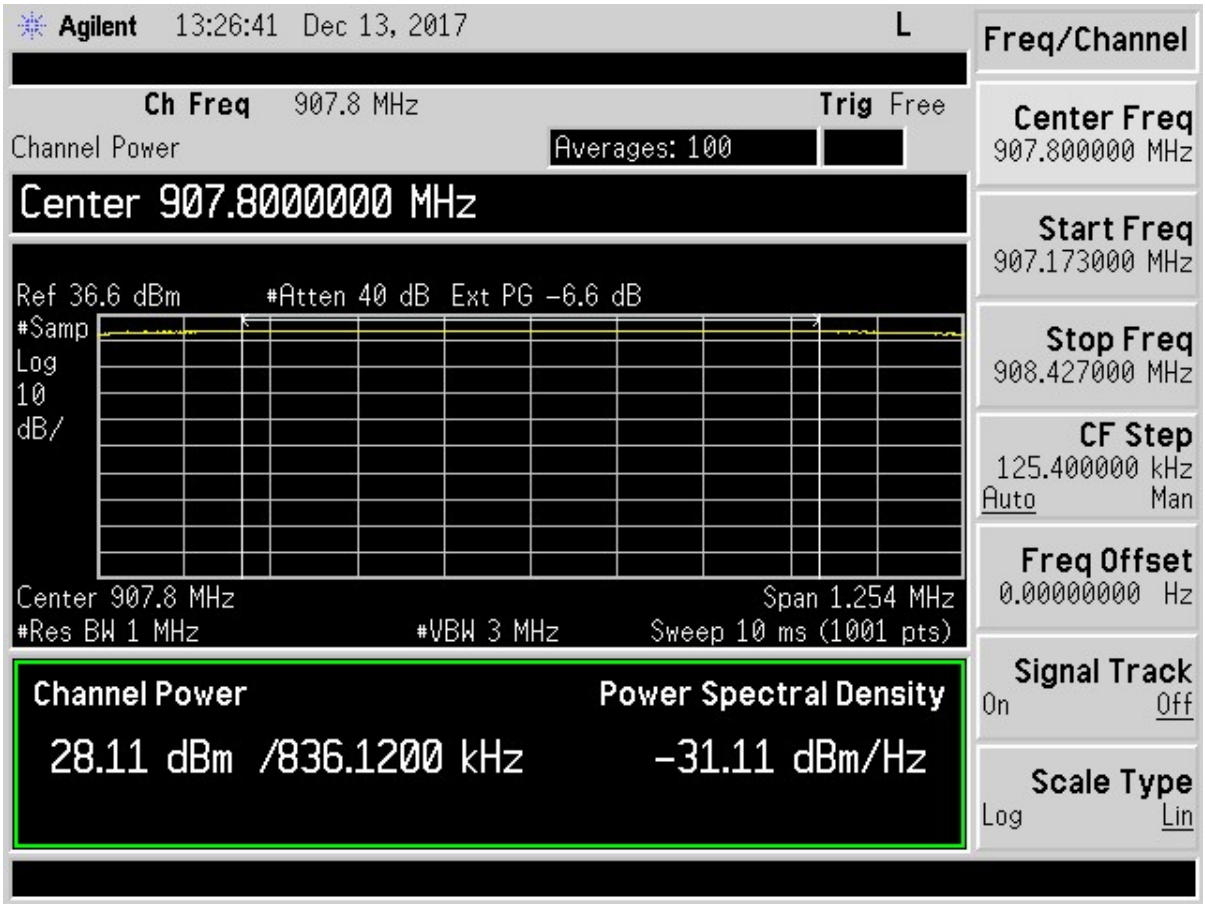


Figure 12. Maximum Antenna Conducted Output Power and Power Spectral Density, Mid Channel

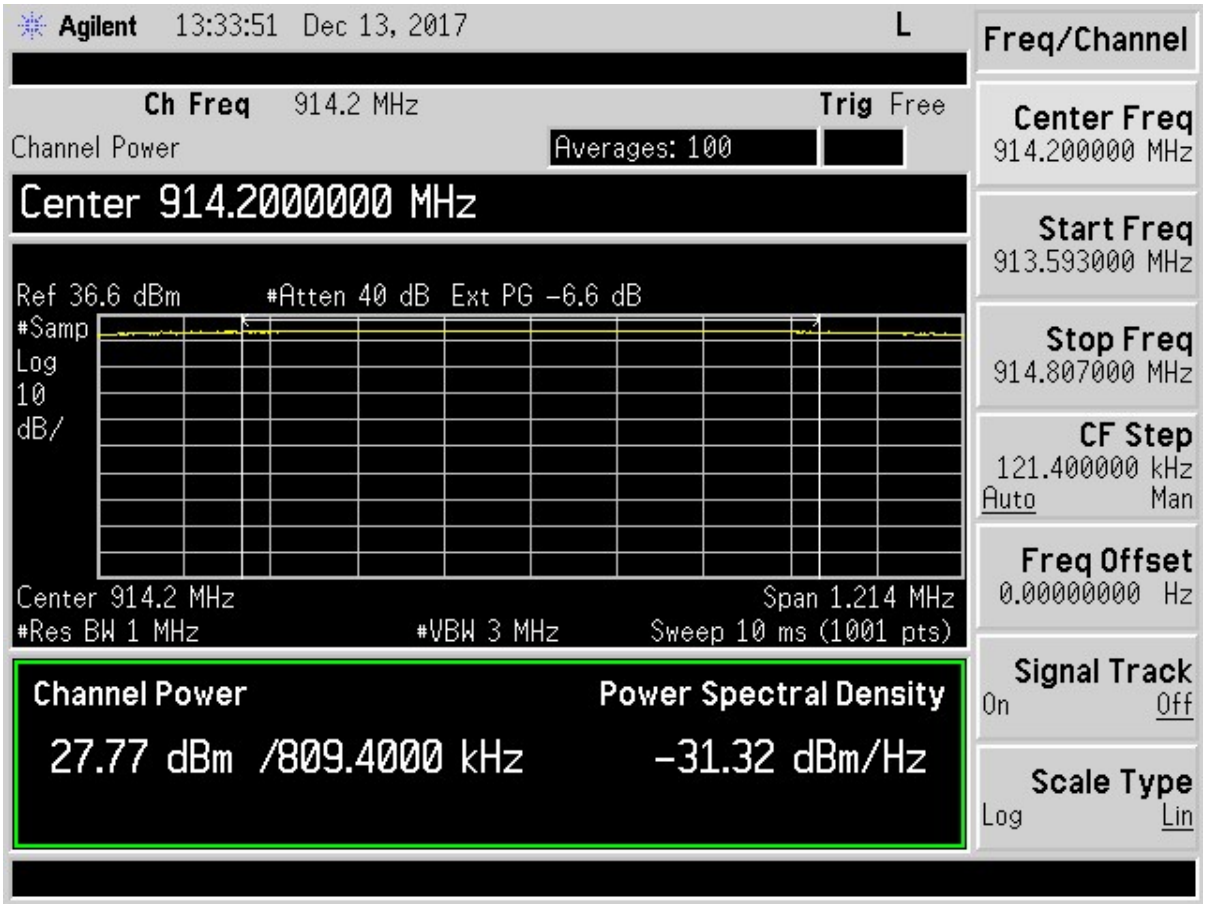


Figure 13. Maximum Antenna Conducted Output Power and Power Spectral Density, High Channel

2.12 Power Spectral Density (CFR 15.247(f))

The transmitter was placed into a continuous mode of operation at all applicable frequencies. The measurements were performed per the procedures of FCC KDB Procedure 558074. The RBW was set to 1 MHz and the Video Bandwidth was set to ≥ RBW. The span was set to 1.5 times the OBW.

In accordance with 15.247 (e), the power spectral density shall be no greater than +8 dBm per any 3 kHz band.

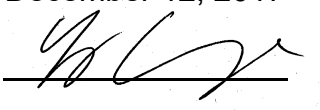
The results of this test are given in the Table below and Figures above.

Table 12. Power Spectral Density for Low, Mid and High Bands

Frequency (MHz)	Test Data (dBm/Hz)	Corrected Data (dBm/3 KHz)	FCC Limit (dBm/3 kHz)
903.0	-30.91	3.86	+8.0
907.8	-31.11	3.66	+8.0
914.2	-31.32	3.45	+8.0

Sample Calculation at 914.20 MHz:

Test Data	-31.32	dBm/Hz
+Correction Factor (10 x Log 3000)	34.77	dB
Corrected Result	3.45	dBm/3kHz

Test Date: December 12, 2017
Tested By
Signature:  Name: George Yang

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

Band Edge measurements are made, following the guidelines in FCC KDB Publication No. 558074 for the DTS 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, the Spectrum Analyzer frequency span is set 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. See the figures and calculations below for more detail.

2.13.1 Antenna 1 Data

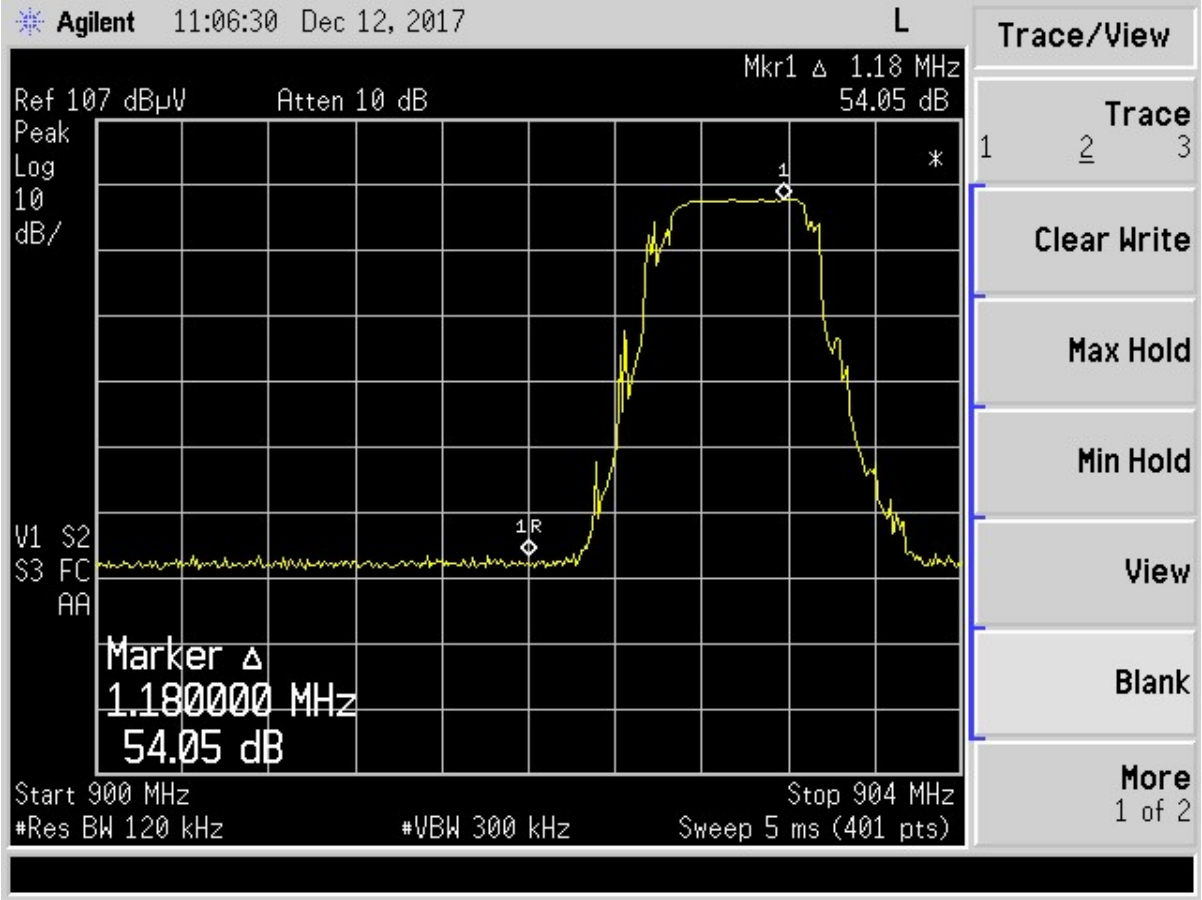


Figure 14. Band Edge Compliance, Low Channel Delta – Antenna 1

Measured Delta (from Figure 8)	54.05	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	34.05	dB

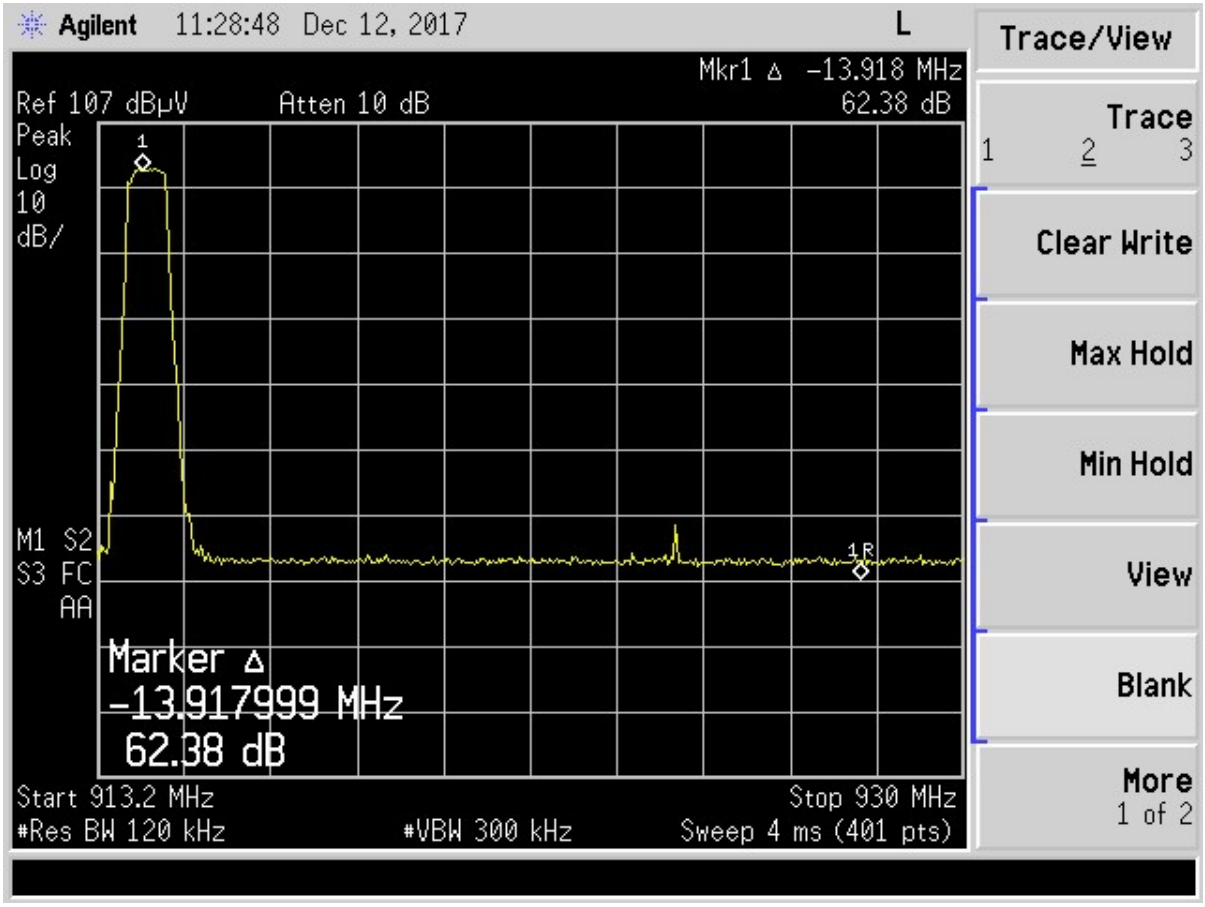


Figure 15. Band Edge Compliance, High Channel Delta – Antenna 1

Measured Delta (from Figure 9)	62.38	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	42.38	dB

2.13.2 Antenna 2 Data

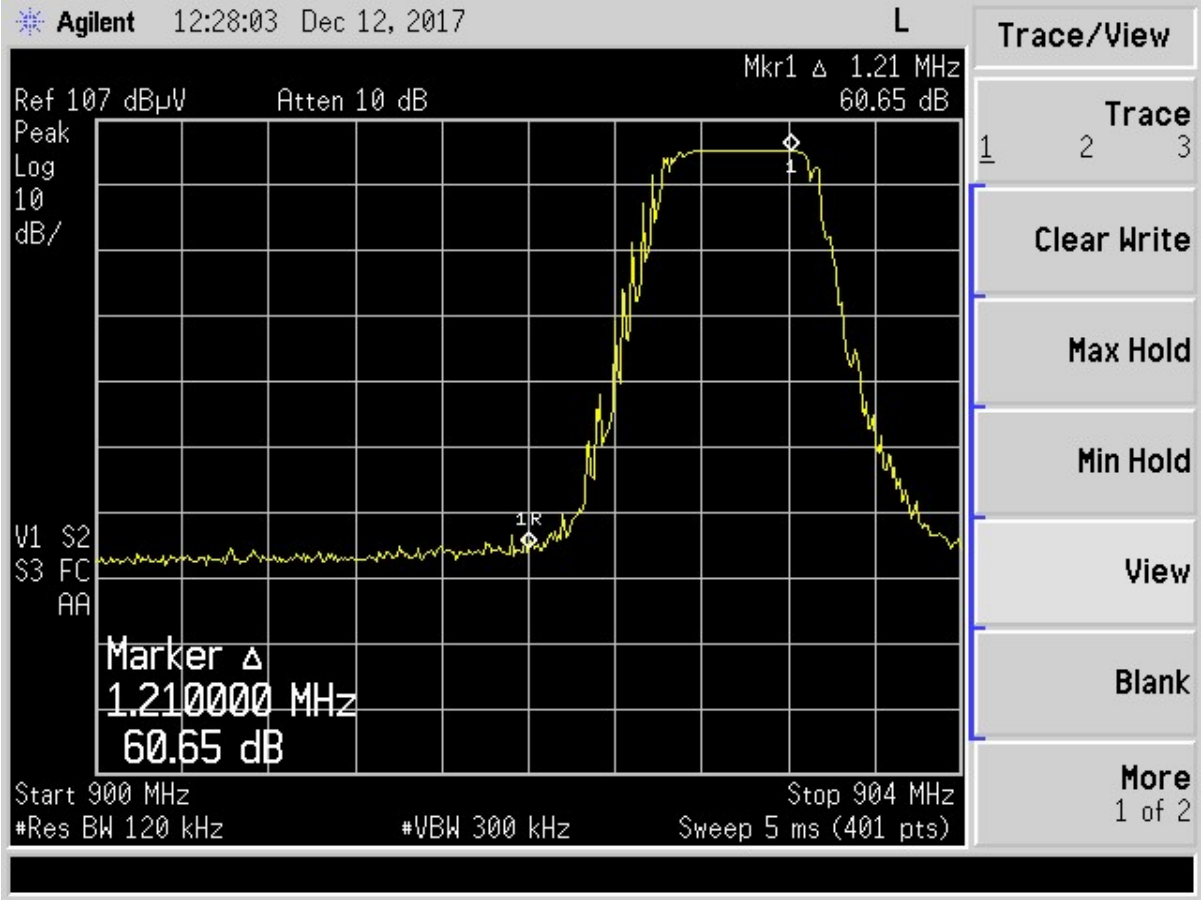


Figure 16. Band Edge Compliance, Low Channel Delta – Antenna 2

Measured Delta (from Figure 10)	60.65	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	40.65	dB

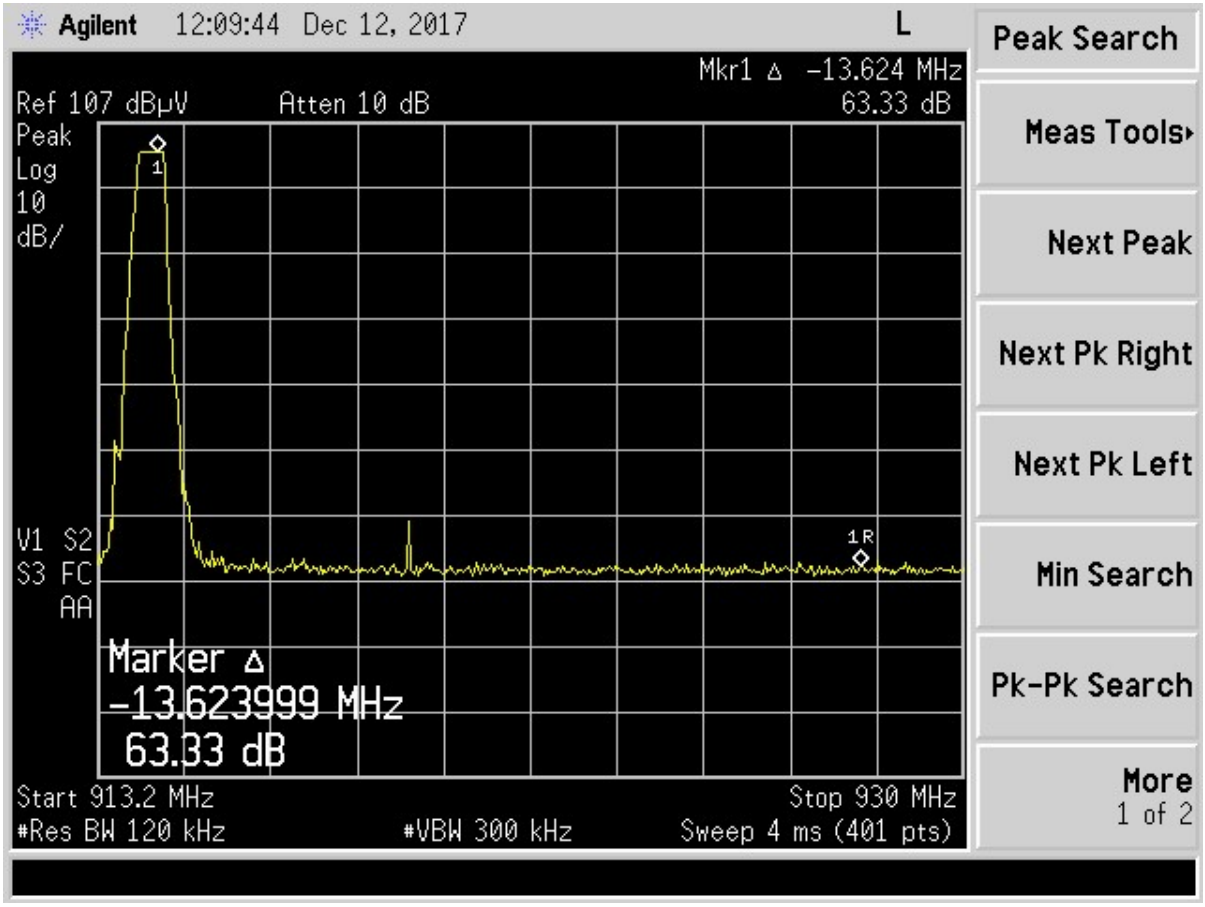


Figure 17. Band Edge Compliance, High Channel Delta – Antenna 2

Measured Delta (from Figure 11)	63.33	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	43.33	dB

2.13.3 Antenna 3 Data

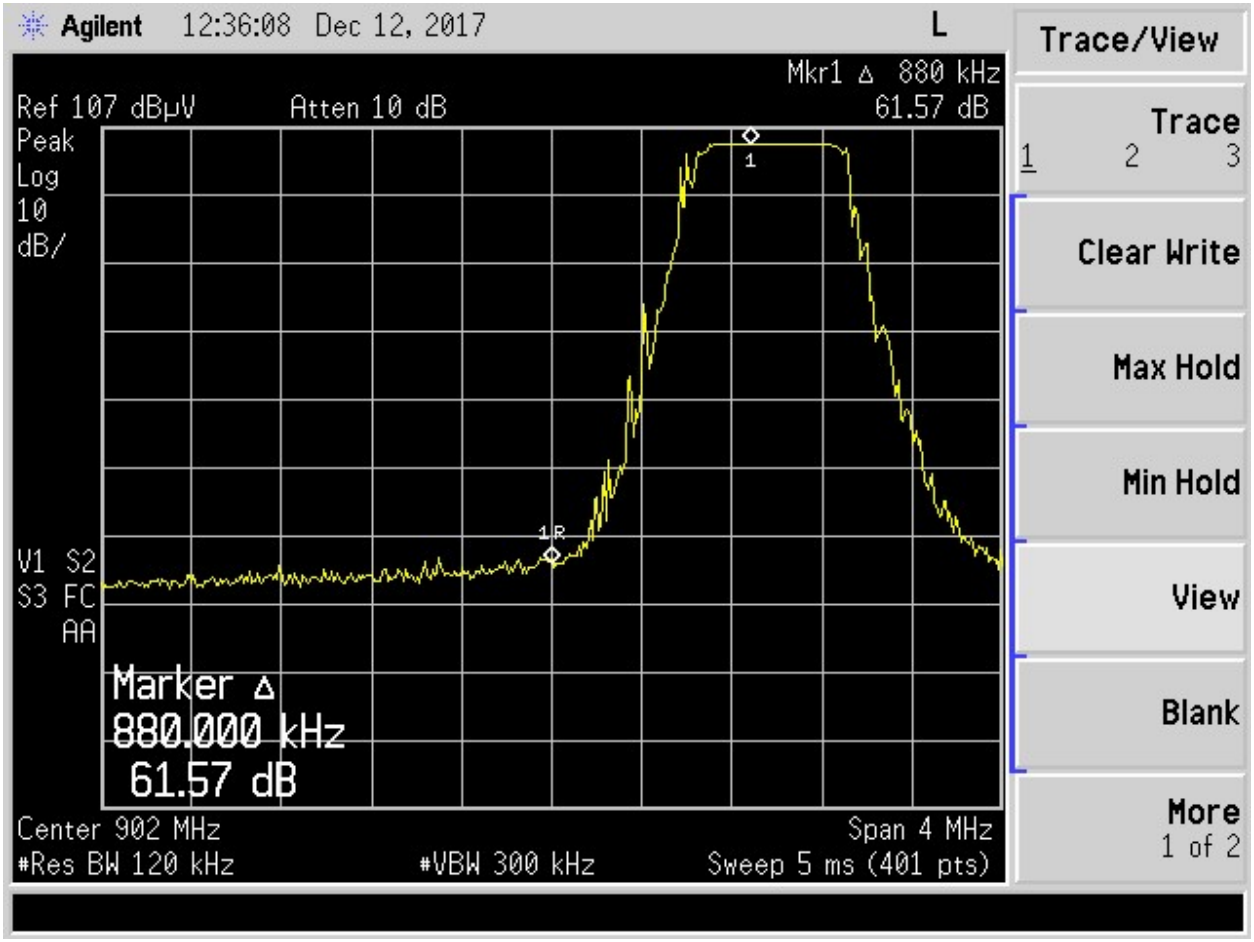


Figure 18. Band Edge Compliance, Low Channel Delta – Antenna 3

Measured Delta (from Figure 12)	61.57	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	41.57	dB

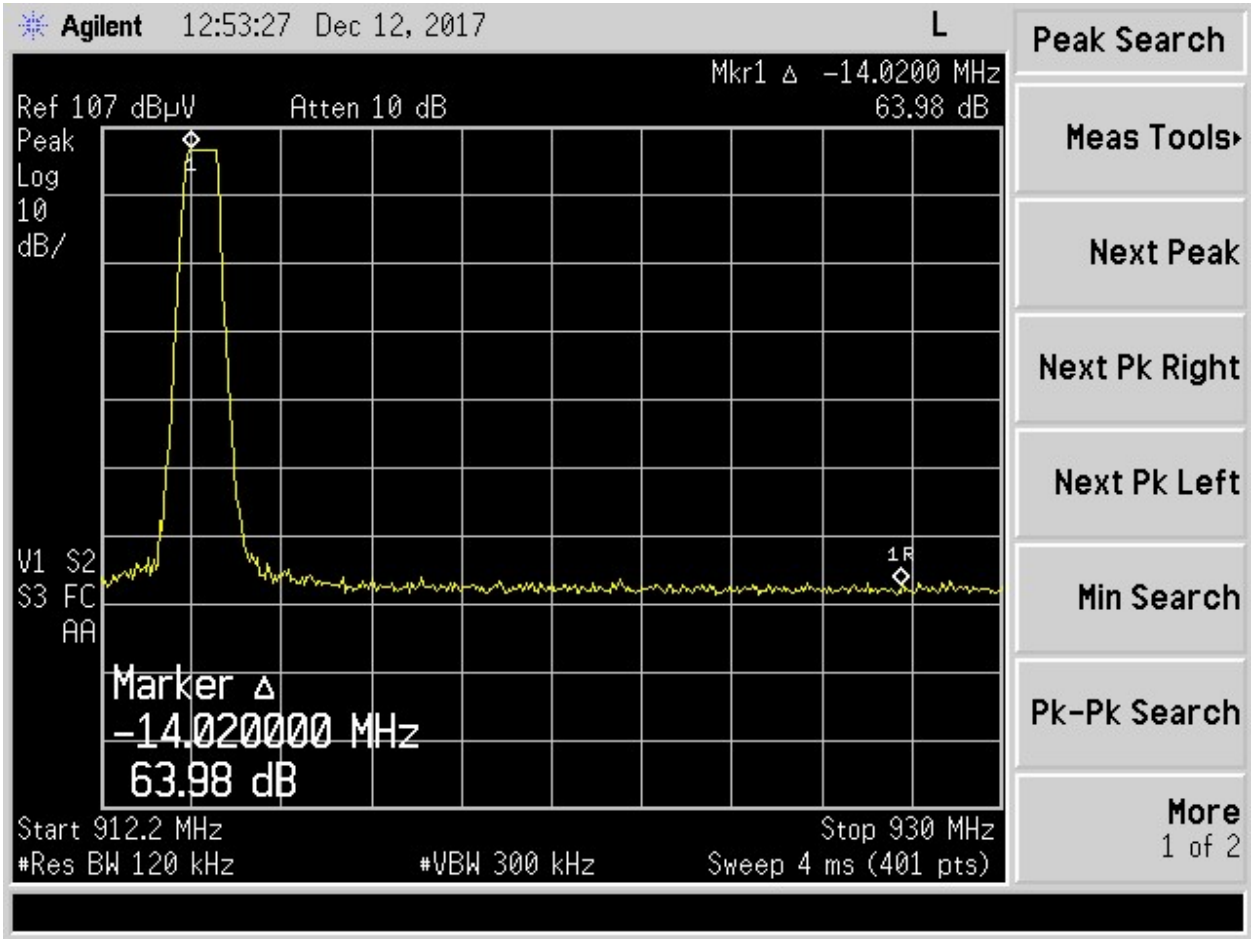


Figure 19. Band Edge Compliance, High Channel Delta – Antenna 3

Measured Delta (from Figure 13)	63.98	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	43.98	dB

2.14 Six (6) dB and 99% Bandwidth per CFR 15.247(a)(2), RSS-247

The EUT antenna port was connected to a spectrum analyzer having a 50 Ω input impedance using a 75 to 50 Ω adaptor. Measurements were performed similar to the method of ANSI C63.10-2013 for a bandwidth of 6 dB. The RBW was set to 100 kHz and with the VBW ≥ RBW. The results of this test are given in the Table and Figures below.

Table 13. Six (6) dB Bandwidth

Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum FCC Bandwidth (MHz)	99 % Occupied Bandwidth (MHz)
903.0	0.740	0.500	0.816
907.8	0.814	0.500	0.822
914.2	0.749	0.500	0.839

Test Date: December 12, 2017
Tested By
Signature:  Name: Bruce Arnold

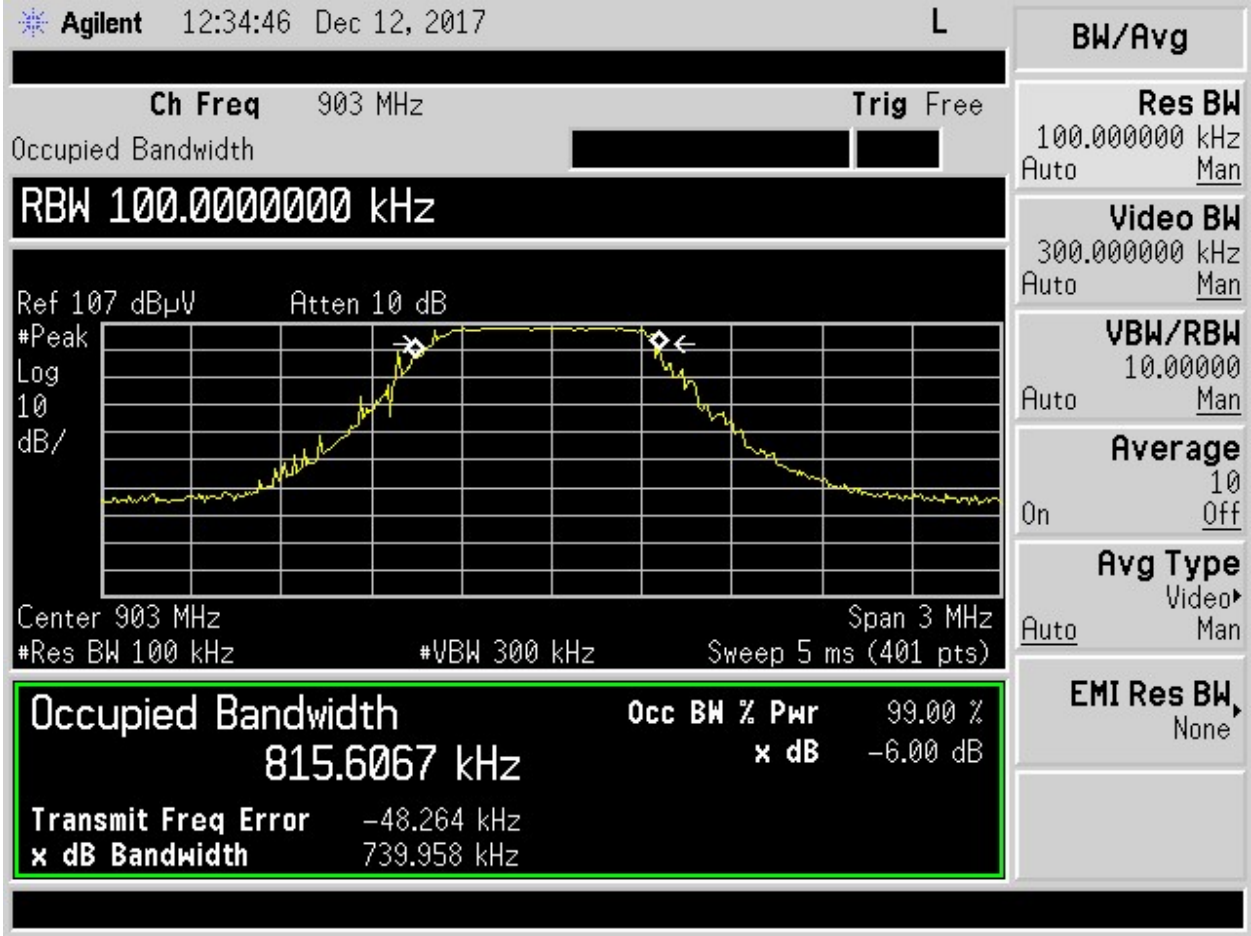


Figure 20. Six dB Bandwidth - 15.247 - Low Channel

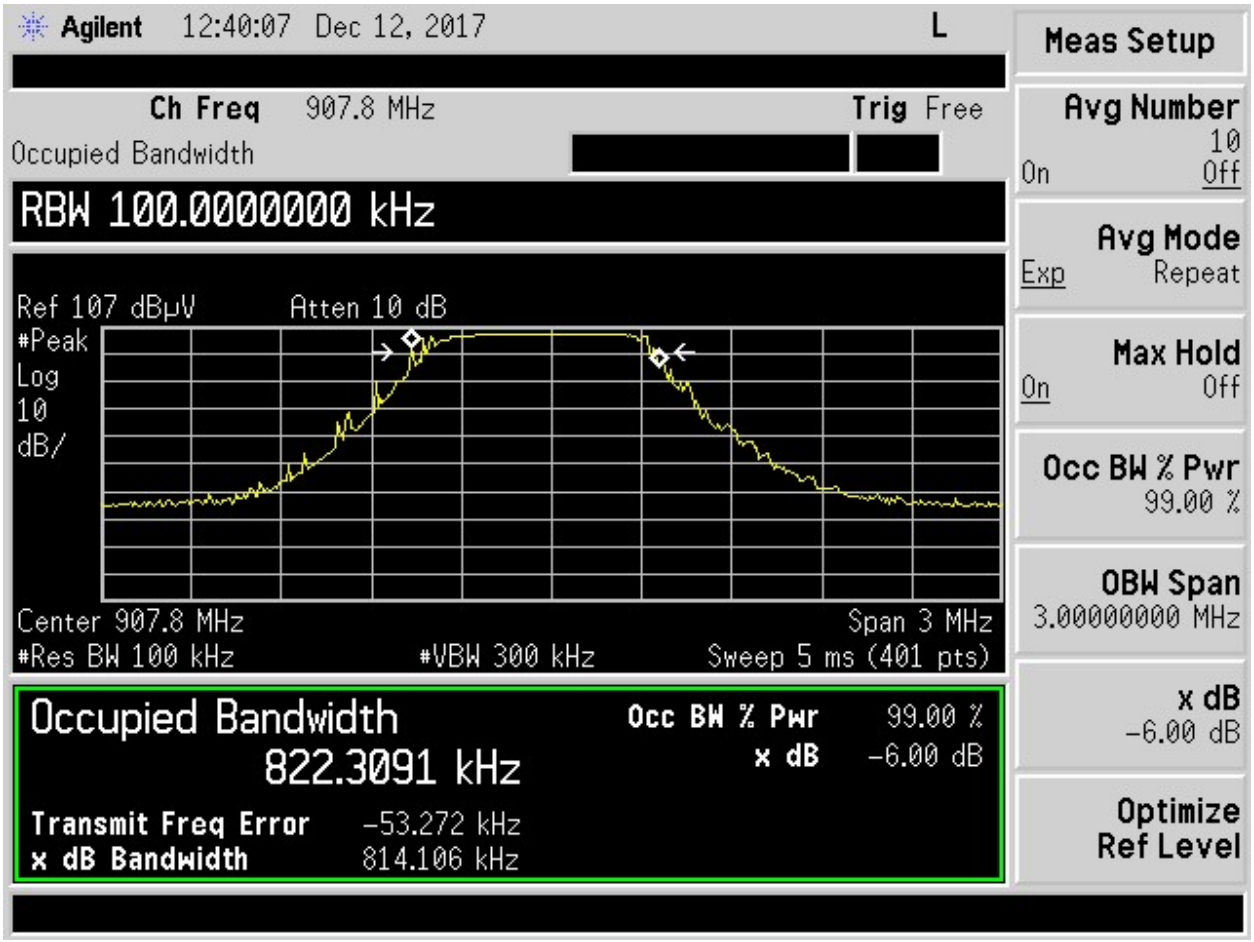


Figure 21. Six dB Bandwidth - 15.247 - Mid Channel

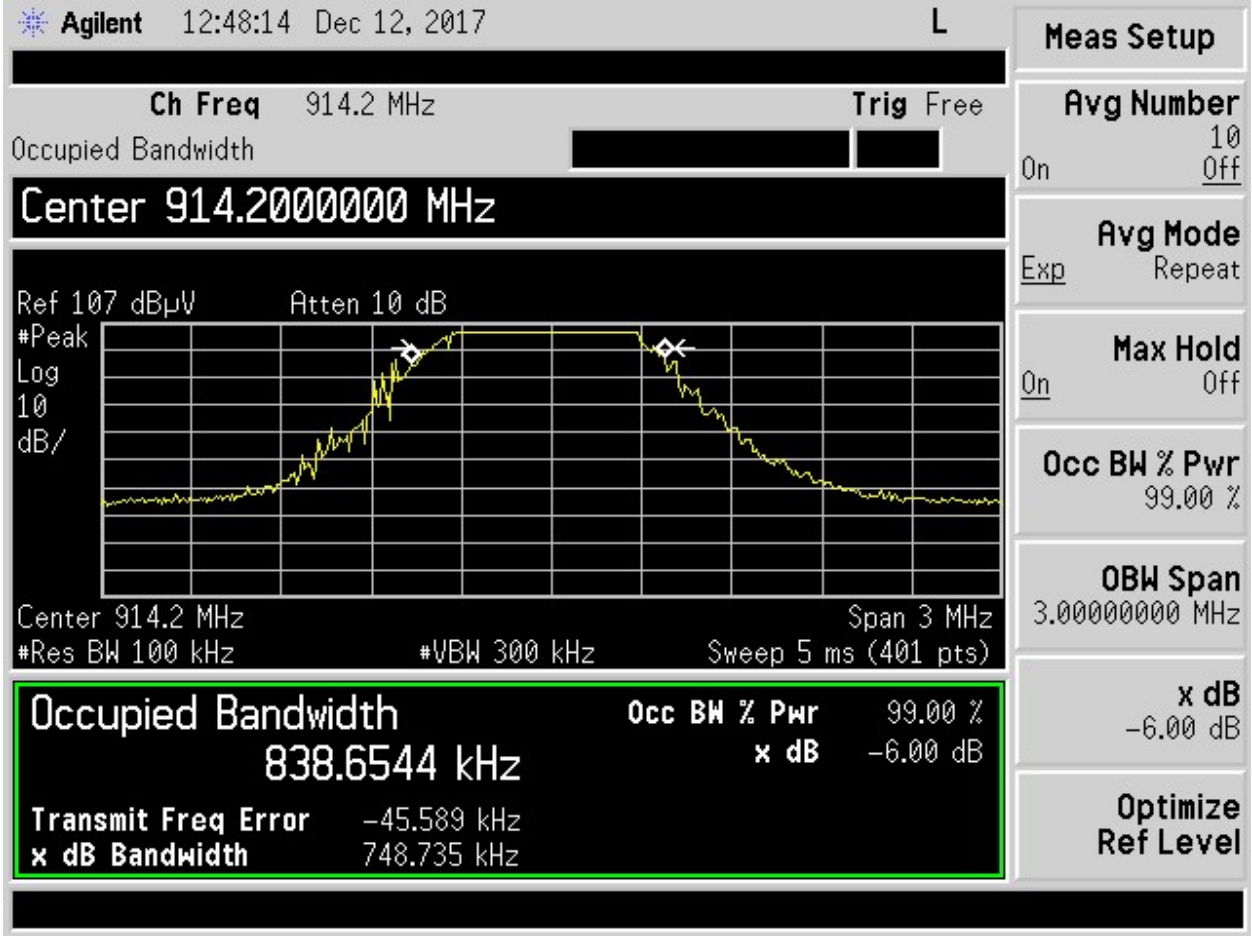


Figure 22. Six dB Bandwidth - 15.247 - High Channel

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

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

2.16 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 2.4 dB below the limit at 6360 MHz. This signal is found in Table 19. All other radiated emissions were 4.4 dB or more below the limit.

Table 14. 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: 17-0479				**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. 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: 17-0479				**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 16. 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: 17-0479				**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**
46.96	29.39	-16.38	13.01	40.0	3m./HORZ	27.0	**PK**
49.56	31.41	-17.20	14.21	40.0	3m./VERT	25.8	**PK**
89.40	29.51	-17.04	12.47	43.5	3m./VERT	31.0	**PK**
155.76	29.58	-13.78	15.80	43.5	3m./HORZ	27.7	**PK**
308.30	51.28	-9.71	41.57	46.0	3m./VERT	4.4	**PK**
494.00	38.58	-7.91	30.67	46.0	3m./HORZ	15.3	**PK**

Tested from 30 MHz to 1 GHz

SAMPLE CALCULATION at 46.96 MHz:

Magnitude of Measured Frequency	29.39	dBuV
+ Cable Loss+Antenna Factor-Amp Gain	-16.38	dB
=Corrected Result	13.01	dBuV
Limit	40.00	dBuV
-Corrected Result	13.01	dBuV
Margin	26.99	dB

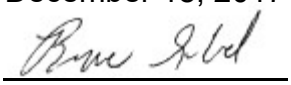
Test Date: December 18, 2017
Tested By
Signature:  Name: Bruce Arnold

Table 17. Unintentional and Intentional Radiator, Spurious Radiated Emissions (CFR 15.109, 15.209) 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: 17-0479				**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**
79.59	33.20	-17.69	15.51	40.0	3m./HORZ	24.5	**PK**
80.02	33.31	-18.19	15.12	40.0	3m./VERT	24.9	**PK**
189.92	33.49	-12.08	21.41	43.5	3m./HORZ	22.1	**PK**
192.44	33.60	-11.48	22.12	43.5	3m./VERT	21.4	**PK**
310.00	47.29	-10.14	37.15	46.0	3m./VERT	8.8	**PK**
578.00	39.85	-6.93	32.92	46.0	3m./HORZ	13.1	**PK**

Tested from 30 MHz to 1 GHz

SAMPLE CALCULATION at 79.59 MHz:

Magnitude of Measured Frequency	33.20	dBuV
+ Cable Loss+Antenna Factor-Amp Gain	-17.69	dB
=Corrected Result	15.51	dBuV
Limit	40.00	dBuV
-Corrected Result	15.51	dBuV
Margin	24.49	dB

Test Date: December 18, 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 2)

1 GHz to 10 GHz with Class B Limits							
Test: Radiated Emissions				**Client:** Neptune Technology Group Inc.			
Project: 17-0479				**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**
1012.70	35.55	-9.97	25.58	54.0	3.0m./HORZ	28.4	**AVG**
1024.50	35.20	-9.80	25.40	54.0	3.0m./VERT	28.6	**AVG**
3187.50	47.62	1.22	48.84	54.0	3.0m./HORZ	5.2	**PK**
3060.00	47.97	0.59	48.56	54.0	3.0m./VERT	5.4	**PK**
6360.00	46.79	4.86*	51.65	54.0	1.0m./VERT	2.4	**PK**
6354.90	32.97	4.78*	37.75	54.0	1.0m./VERT	16.3	**AVG**

*Measurements taken above 6 GHz are performed at a distance of 1m (vs. 3m). This correction includes an additional factor of -9.5 dB to account for this change.

SAMPLE CALCULATION at 1012.7 MHz:

Magnitude of Measured Frequency	35.55	dBuV
+ Cable Loss+Antenna Factor-Amp Gain	-9.97	dB
=Corrected Result	25.58	dBuV
Limit	54.00	dBuV
-Corrected Result	25.58	dBuV
Margin	28.42	dB

Test Date: December 14, 2017
Tested By
Signature:  Name: Bruce Arnold

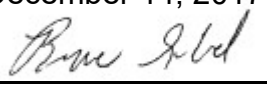
Table 19. Unintentional and Intentional Radiator, Spurious Radiated Emissions (CFR 15.109, 15.209) 1 GHz to 10 GHz (Antenna 3)

1 GHz to 10 GHz with Class B Limits							
Test: Radiated Emissions				**Client:** Neptune Technology Group Inc.			
Project: 17-0479				**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**
1046.00	34.55	-9.55	25.00	54.0	3.0m./VERT	29.0	**AVG**
1004.00	35.56	-9.90	25.66	54.0	3.0m./HORZ	28.3	**AVG**
3232.00	47.51	1.56	49.07	54.0	3.0m./VERT	4.9	**PK**
3000.00	47.51	1.20	48.71	54.0	3.0m./HORZ	5.3	**PK**
6210.00	45.19	3.90*	49.09	54.0	1.0m./HORZ	4.9	**PK**

*Measurements taken above 6 GHz are performed at a distance of 1m (vs. 3m). This correction includes an additional factor of -9.5 dB to account for this change.

SAMPLE CALCULATION at 1046.0 MHz:

Magnitude of Measured Frequency	34.55	dBuV
+ Cable Loss+Antenna Factor-Amp Gain	-9.55	dB
=Corrected Result	25.00	dBuV
Limit	54.00	dBuV
-Corrected Result	25.00	dBuV
Margin	29.00	dB

Test Date: December 14, 2017
Tested By
Signature:  Name: Bruce Arnold

2.17 Measurement Uncertainty

The measurement uncertainties given were calculated using the method detailed in CISPR 16-4. 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 not have sufficient margin to negate the effects of uncertainty. Therefore, the EUT conditionally meets this requirement.

3. Conclusions

The EUT meets the requirements of Part 15.247 when tested as described in this test report.