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 B, paragraph 15.109, Subpart C, paragraphs 15.207, 15.209 and 15.249

And

Innovation Science and Economic Development Canada Certification Per
IC RSS-Gen General Requirements for Radio Apparatus (Issue 5)
And
RSS-210, License Exempt Radio Apparatus Category I Equipment (Issue 9)

For the

Cognosos, Inc

Model: RT-300

FCC ID: 2AKFQ10016
IC ID: 22165-10016

UST Project: 19-0422
Issue Date: December 2, 2019

Total Pages in This Report: 28

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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: George Yang

Name: 

Title: Laboratory Manager

Date December 2, 2019

TESTING
NVLAP LAB CODE 200162-0

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MEASUREMENT TECHNICAL REPORT

COMPANY NAME: Cognosos

MODEL: RT-300

FCC ID: 2AKFQ10016

IC ID: 22165-10016

DATE: November 15, 2019

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

Equipment type: 2402 – 2480 MHz Transmitter Module

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.

Transmitter details:
BLE 5.0 SiP transmitter module
Operating frequency: 2402 – 2480 MHz

Summary of Test Results

FCC Rule	Description of Test	Result
15.207	Power line conducted emissions	N/A
15.209	Radiated spurious emissions	PASS
15.249(a)	Radiated spurious emissions	PASS
15.249(d)	Out of band spurious emissions	PASS

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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 249 and RSS-210 Issue 9.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on October 11, 2019 in good operating condition.

1.3 Product Description

The Equipment Under Test (EUT) is the Cognosos, Model: RT-300. It is a battery powered RTLS tag that senses when an asset is moved and transmits its location into the RadioCloud® network. Every tag transmits its unique ID and location information only when an asset has ceased movement. The EUT uses BLE (Bluetooth Low Energy) beacons that are installed in ceilings, parking decks and similar structures to determine its location. The EUT is also equipped with a 900 MHz radio. This test report is for the BLE radio.

1.4 Configuration of Tested System

The Test Sample was tested per *ANSI C63.10.2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices* and *ANSI C63.4:2014, Methods of Measurement of Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2014)*.

A list of 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 under designation number US5301. Additionally, this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1.

1.6 Related Submittals

The EUT is subject to the following additional FCC authorizations:

a) Certification under section 15.249 as a transmitter.

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC/IC ID	CABLES P/D
EUT Cognosos	RT-300	Engineering Sample	FCC ID: 2AKFQ10016 IC ID: 22165-10016	N/A
Antenna See antenna details	--	--	--	--

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

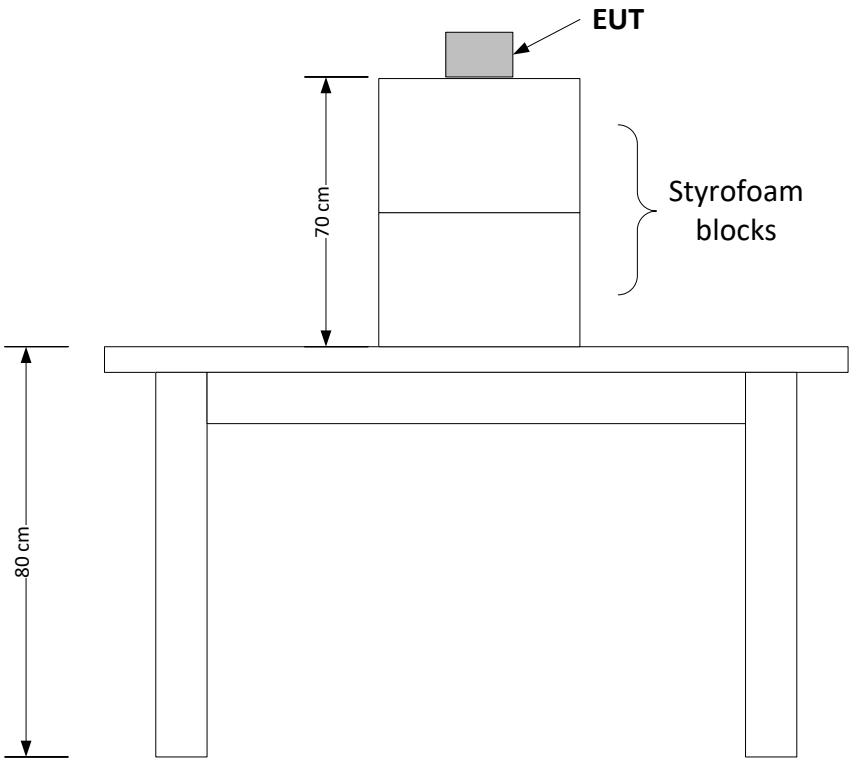


Figure 1. Block Diagram of Test Configuration

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	E4407B	AGILENT	US41442935	8/17/2020 2 yr.
BICONICAL ANTENNA	3110B	EMCO	9306-1708	6/27/2021
LOG PERIODIC ANTENNA	3146	EMCO	9305-3600	2/1/2021 2 yr
HORN ANTENNA	3115	EMCO	9107-3723	11/28/2020 2 yr
RF PREAMP 100 kHz to 1.3 GHz	8447E	HEWLETT-PACKARD	1937A01828	5/7/2020
RF PREAMP 1.0 GHz to 26.0 GHz	8449B	HEWLETT-PACKARD	3008A00480	4/8/2020
HIGH PASS FILTER	H3R020G2	MICROWAVE CHIRCUITS	001DC9528	4/2/2020

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 (CFR 15.31(m), RSS-Gen 6.8)

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 at 2402 MHz to 2480 MHz, 3 test frequencies were used.

2.4 Frequency Range of Radiated Measurements (CFR 15.33, RSS-Gen 6.13)

2.4.1 Intentional Radiator

The spectrum was investigated for the intentional radiator from the lowest RF signal generated in the EUT, without going below 9 kHz to the 10^{th} 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 tested was 30 MHz to 1000 MHz or to five times the highest internal clock frequency.

2.5 Measurement Detector Function and Bandwidth (CFR 15.35, RSS-Gen 6.9, 6.13)

The radiated and conducted emissions limits shown herein are based on the parameters listed below.

2.5.1 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 RBW from 150 kHz to 30 MHz and 120 kHz RBW 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.

2.5.2 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 RBW shall be at least 1 MHz.

2.5.3 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.

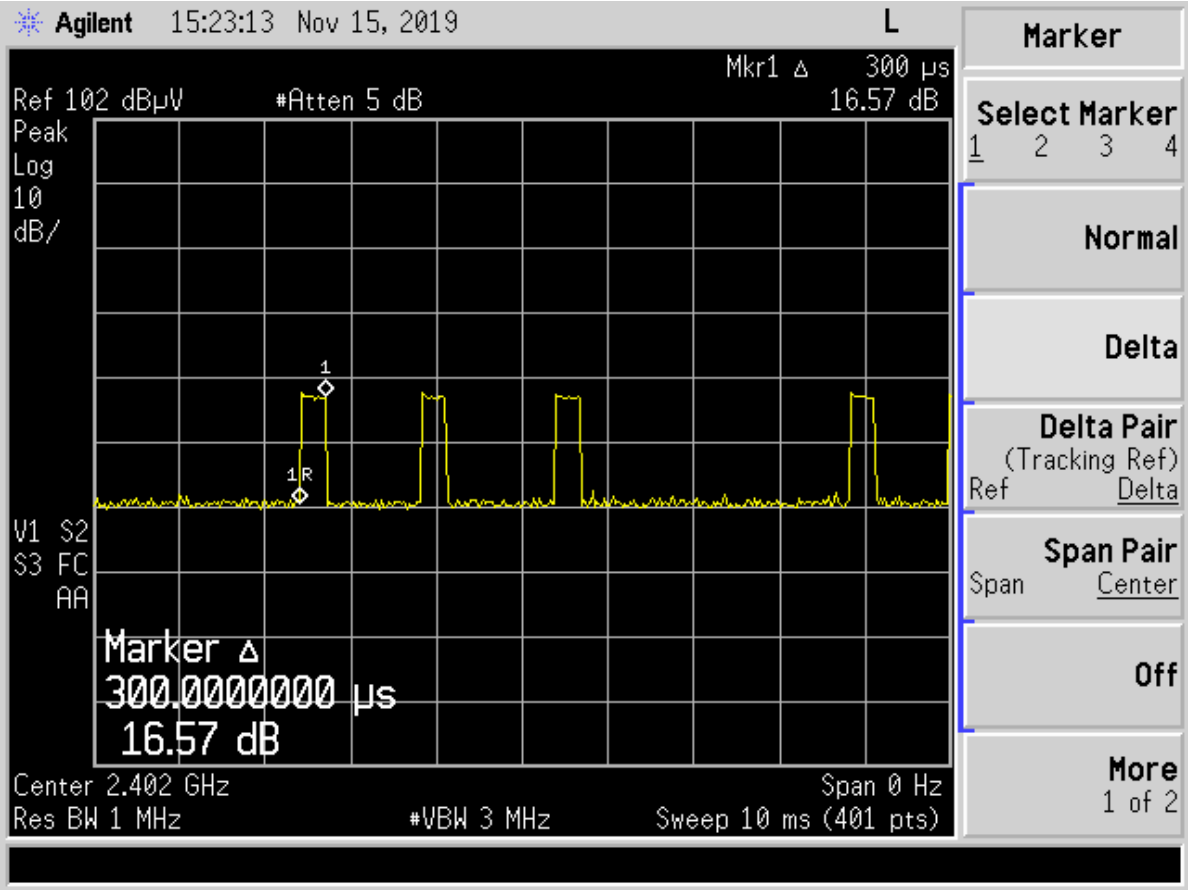


Figure 2. Duty Cycle Plot

Duty Cycle correction factor is:

300uSec x 4 = 1.2 mSec, 1.2 mSec x 10 = 12 mSec per 100 mSec
12/100 = 0.12, 20 log 0.12 = **-18.4 dB**

2.6 EUT Antenna Requirements (CFR 15.203, RSS-Gen 6.7)

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. Only the antenna(s) listed in Table 4 will be used with this device.

Table 4. Allowed Antenna(s)

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dB_i	TYPE OF CONNECTOR
Antenna	Cognosos	Trace	None	3.0	Trace

2.7 Restricted Bands of Operation (CFR 15.205, RSS-Gen 8.10)

Only spurious emissions can fall in the frequency bands of CFR 15.205. The field strength of these spurious emissions cannot exceed the limits of 15.209. Radiated harmonics and other spurious emissions are examined for this requirement see paragraph 2.1

2.8 Intentional Radiator, Power Line Conducted Emissions (CFR 15.207, RSS-8.8)

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

2.9 Intentional Radiator, Radiated Emissions (CFR 15.209, 15.249(a),(c), RSS 210, A2.9 (a))

Radiated Spurious measurements: the EUT was programmed to transmit at its maximum rated output power level, +6.0 dBm and placed into a continuous transmit mode of operation transmitting at >98% duty cycle and tested per ANSI C63.10:2013. A preliminary scan was performed on the EUT to find signal frequencies that were caused by the transmitter part of the device. To obtain worse case results the EUT was tested in X, Y and Z axis or in the orientation of normal operation if the device is designed to operation in a fixed position.

Radiated measurements were then conducted between the frequency range of 9 KHz (or lowest frequency used/generated by the device) up to the 10^{th} harmonic of the device (no greater than 40 GHz). In the band below 30 MHz a resolution bandwidth (RBW) of 9 kHz was used; emissions below 1 GHz were tested with a RBW of 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 was investigated to CFR 15.209, general requirements for unwanted spurious emissions.

Table 5. Spurious Radiated Emissions Below 30 MHz

9 kHz to 30 MHz, 15.209 limits							
Test: Radiated Emissions				**Client:** Cognosos			
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 AVG**
All emissions were more than 20 dB below the applicable limit.							

Sample Calculation: N/A

Test Date: October 28, 2019
Tested By

Signature: _____ Name: John Freeman

Table 6. Spurious Radiated Emissions (9 kHz – 18 GHz)

Test: FCC Part 15, Paragraph 15.209, 15.249(a)					**Client:** Cognosos			
Frequency (MHz)	**Test Data (dBuV)**	**DC Factor (dB)**	**AF+CA -AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
91.47	43.62	-	-22.50	21.12	43.5	3m./HORZ	22.4	**PK**
671.72	44.17	-	-9.60	34.57	46.4	3m./HORZ	11.8	**PK**
97.13	49.34	-	-21.04	28.30	43.5	3m./VERT	15.2	**PK**
99.75	49.65	-	-20.82	28.83	43.5	3m./VERT	14.7	**PK**
107.57	47.57	-	-20.76	26.81	43.5	3m./VERT	16.7	**PK**
All other emissions were greater than 20 dB below the applicable limit.								

1. No other signals detected within 20 dB of specification limit.
2. The EUT was placed in three orthogonal positions and the transmitter was in constant broadcast mode, with the duty cycle programmed for >98% ON time in continuous transmit mode.
3. 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: 91.47 MHz

Magnitude of Measured Frequency	43.62	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-22.50	dB/m
Duty Cycle Correction Factor	None	dB
Corrected Result	21.12	dBuV/m

Test Date: October 28, 2019
Tested By

Signature: _____ Name: John Freeman

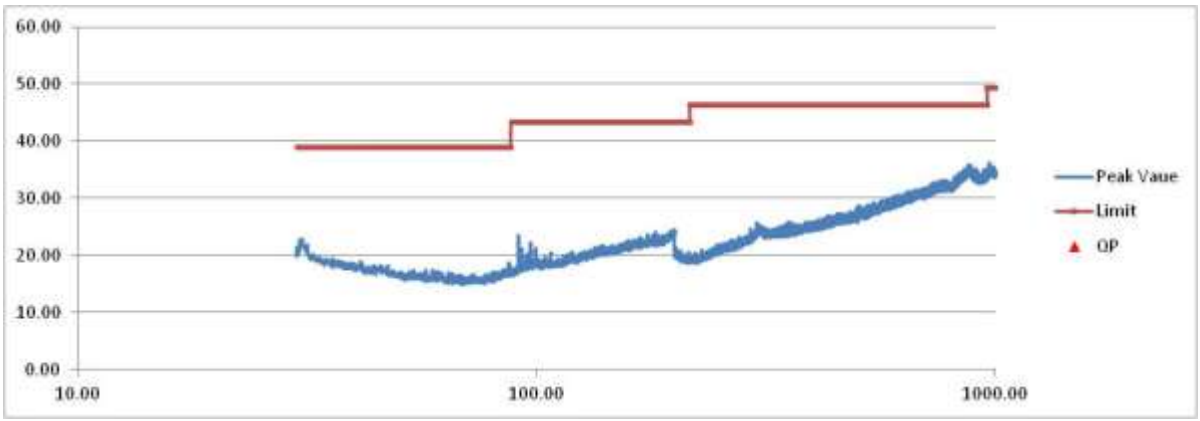


Figure 3. Radiated Emissions Graphical Data, 30 MHz – 1000 MHz Vertical

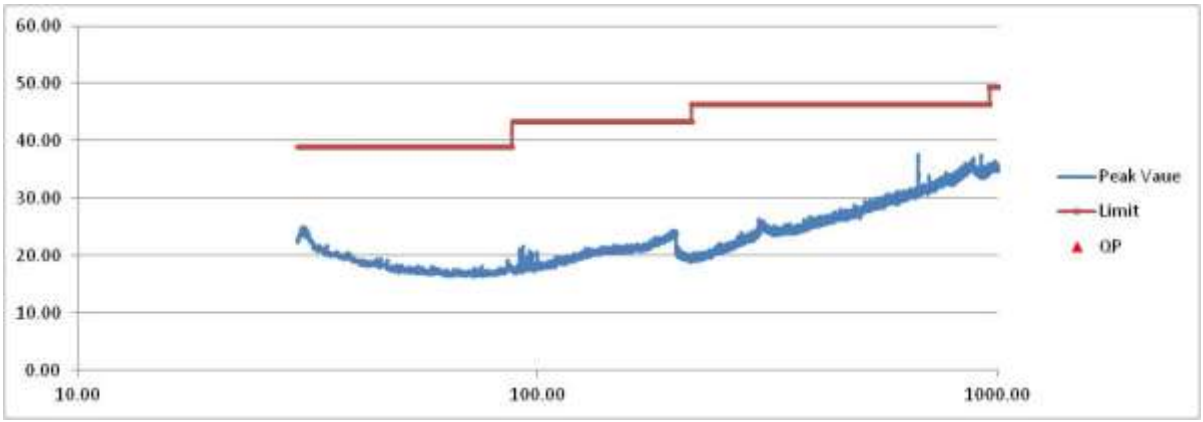


Figure 4. Radiated Emissions Graphical Data, 30 MHz – 1000 MHz Horizontal

Table 7. Intentional Radiated Emissions – Fundamental

Test: FCC Part 15, Paragraph 15.209, 15.249(a)					**Client:** Cognosos			
Frequency (MHz)	**Test Data (dBuV)**	**Factor (dB)**	**AF+CA -AMP (dB/m)**	**Results (dBuV/m)**	**AVG Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel								
2402.00	71.72	--	32.28	104.00	114.0	3.0m./VERT	10.0	**PK**
2402.00	71.09	-18.40	32.28	84.97	94.0	3.0m./VERT	9.0	**AVG**
Mid Channel								
2426.00	55.15	--	32.32	87.47	114.0	3.0m./HORZ	26.5	**PK**
2426.00	50.38	--	32.32	82.70	94.0	3.0m./HORZ	11.3	**AVG**
High Channel								
2480.00	55.00	--	31.57	86.57	114.0	3.0m./HORZ	27.4	**PK**
2480.00	48.11	--	31.57	79.68	94.0	3.0m./HORZ	14.3	**AVG**

Notes:
1. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
2. The EUT was placed in three orthogonal positions and the transmitter was in constant broadcast mode, with the duty cycle programmed for >98% ON time in continuous transmit mode.
3. A duty cycle correction factor of -18.4 dB was applied to the average for emissions that were exceeding average limits.
4. 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: 2402.00 Mhz

Magnitude of Measured Frequency	71.09	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	32.28	dB/m
Duty Cycle Correction Factor	-18.40	dB
Corrected Result	84.97	dBuV/m

Test Date: October 1, 2019

Tested By

Signature:  Name: John Freeman

Table 8. Intentional Radiated Emissions – Harmonics

Test: FCC Part 15, Paragraph 15.209, 15.249(a)					**Client:** Cognosos			
Frequency (MHz)	**Test Data (dBuV)**	**Factor (dB)**	**AF+CA -AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel								
4804.00	49.15	--	7.85	57.00	74.0	3.0m./HORZ	17.0	**PK**
4804.00	27.15	--	7.85	35.00	54.0	3.0m./HORZ	19.0	**AVG**
7206.00	49.09	--	16.69	65.78	74.0	1.0m./HORZ	8.2	**PK**
7206.00	26.96	--	16.69	43.65	54.0	1.0m./HORZ	10.3	**AVG**
Mid Channel								
4852.00	48.73	--	8.07	56.80	74.0	3.0m./HORZ	17.2	**PK**
4852.00	27.16	--	8.07	35.23	54.0	3.0m./HORZ	18.8	**AVG**
7278.00	48.90	--	17.26	66.16	74.0	1.0m./HORZ	7.8	**PK**
7278.00	26.41	--	17.26	43.67	54.0	1.0m./HORZ	10.3	**AVG**
High Channel								
4960.00	48.57	--	8.52	57.09	74.0	3.0m./HORZ	16.9	**PK**
4960.00	26.89	--	8.52	35.41	54.0	3.0m./HORZ	18.6	**AVG**
7440.00	49.70	--	19.32	69.02	74.0	1.0m./VERT	5.0	**PK**
7440.00	25.72	--	19.32	45.04	54.0	1.0m./VERT	9.0	**AVG**

Notes:
1. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
2. The EUT was placed in three orthogonal positions and the transmitter was in constant broadcast mode, with the duty cycle programmed for >98% ON time in continuous transmit mode.
3. 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: 4804.00 MHz

Magnitude of Measured Frequency	49.15	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain – Duty Cycle	7.85	dB/m
Duty Cycle Correction Factor	None	dB
Corrected Result	57.00	dBuV/m

Test Date: October 1, 2019
Tested By

Signature: _____ Name: John Freeman

2.10 Band Edge Measurements (CFR 15.249(d), RSS-Gen 8.10)

Band Edge measurements are made following the guidelines in FCC KDB Publication No. 558074 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 to demonstrate compliance with the requirement of 15.249(d) that all emissions outside of the band edges be attenuated by at least 50 dB or 15.209 limits, 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 to 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. See figure and calculations following for more detail.

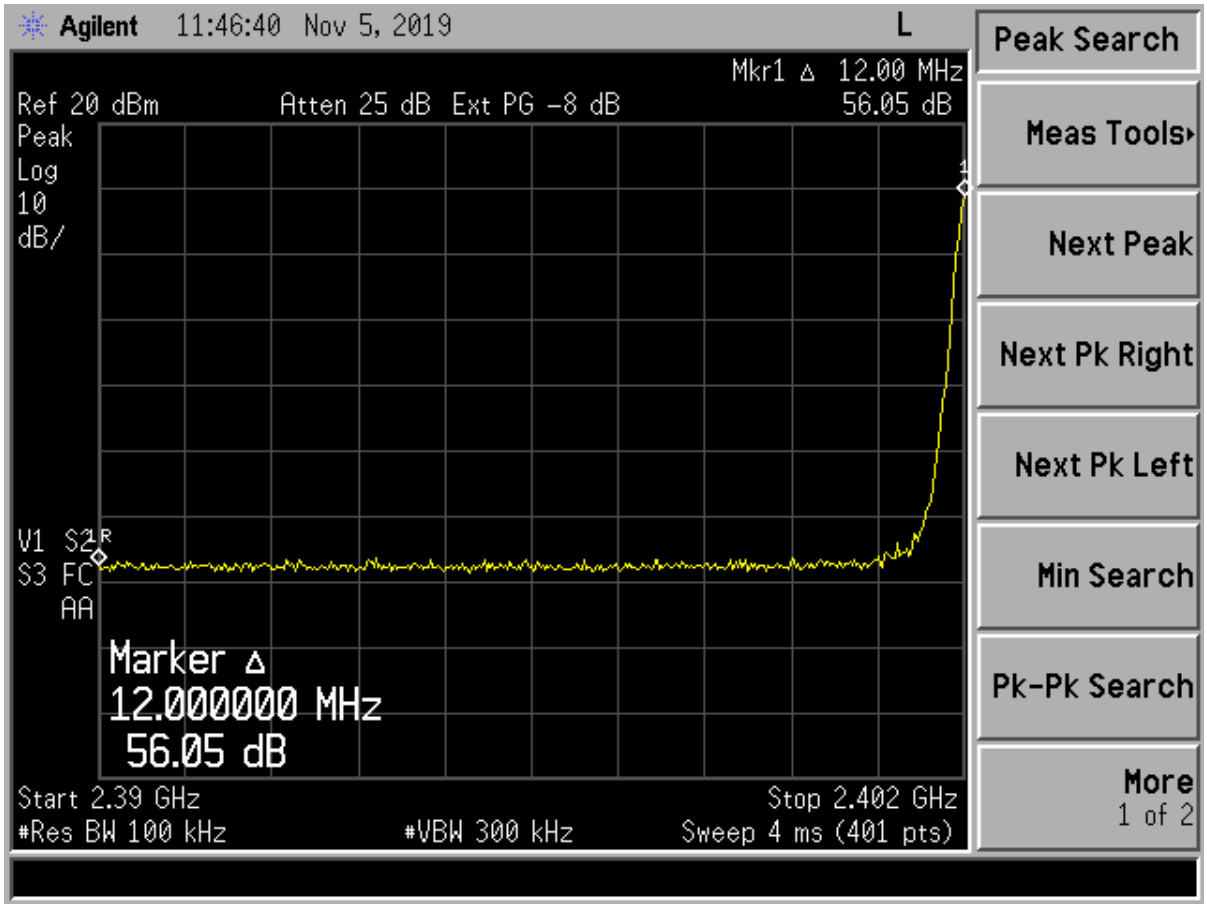


Figure 5. Band Edge Compliance – Low Channel

Low Channel Corrected Measured Value from Table 9	104.00	dBuV
Low Channel Band Edge Delta from Figure 10	-56.05	dB
Calculated Result	47.95	dBuV/m
Band Edge Limit	54.00	dBuV/m
Calculated Result	47.95	dBuV/m
Band Edge Margin	6.05	dBuV/m

Peak value meets AVG limit.

Test Date: November 5, 2019

Tested By
Signature: _____ Name: Mark Afroozil

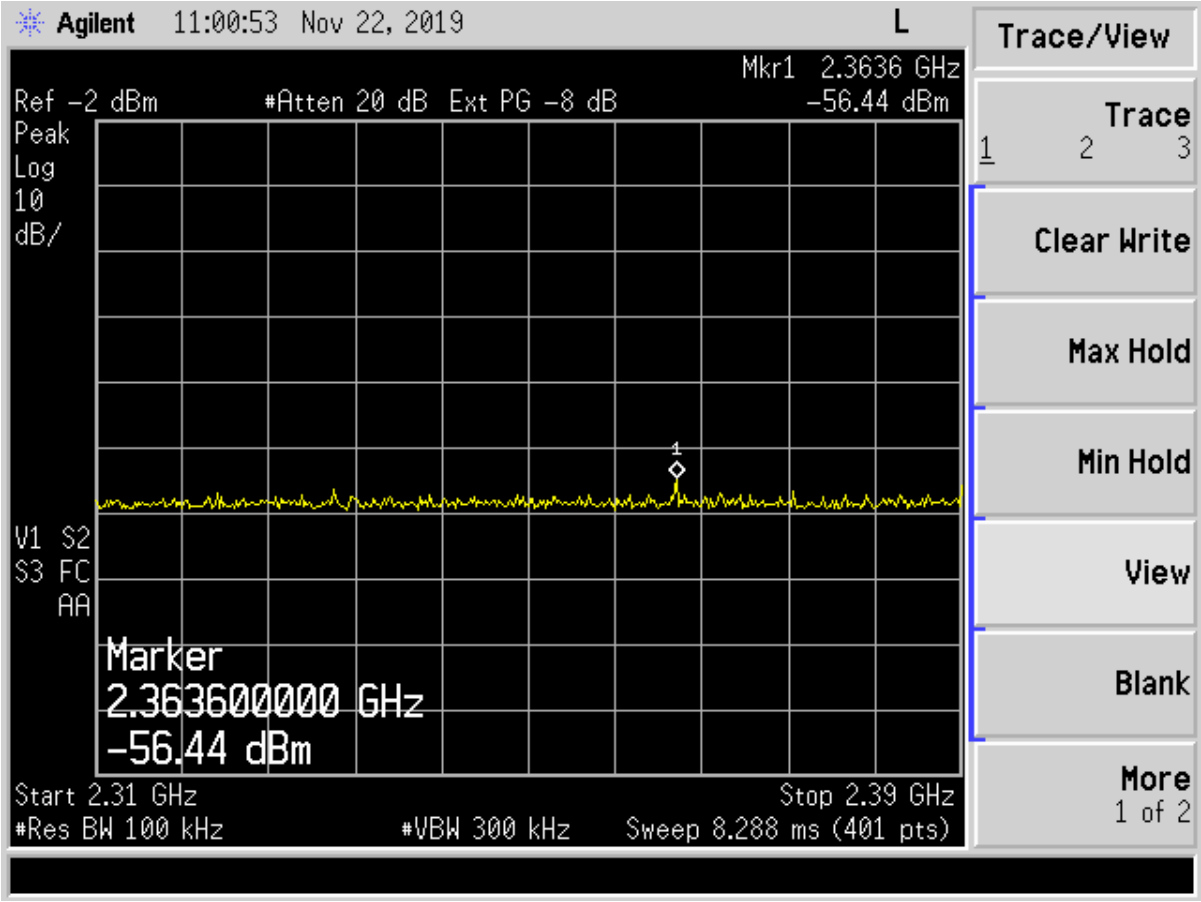


Figure 6. Restricted Band 2310 MHz to 2390 MHz

EIRP to dBuV/m= EIRP(dBm) – 20 log (3) + 104.8, where 3 is the test distance in meters.

-56.44 – 20log (3) + 104.8 = 38.84 dBuV/m, less than 54 dBuV/m
Peak value meets AVG limit.

Test Date: November 22, 2019

Tested By
Signature: _____ Name: Mark Afroozil

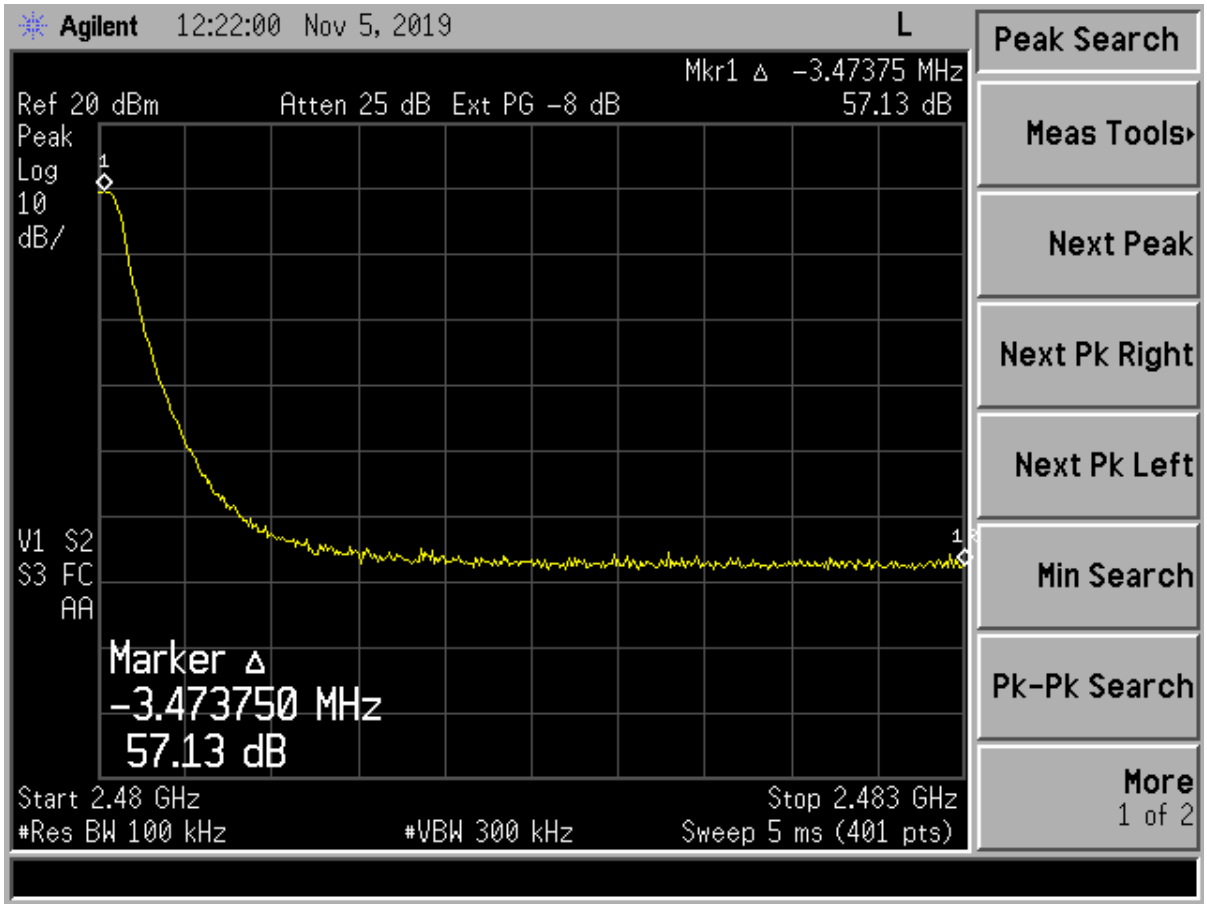


Figure 7. Band Edge Compliance – High Channel

High Channel Corrected Measured Value from Table 9	86.57	dBuV
High Channel Band Edge Delta from Figure 12	-57.13	dB
Calculated Result	29.44	dBuV/m
Band Edge Limit	54.00	dBuV/m
Calculated Result	29.44	dBuV/m
Band Edge Margin	24.56	dBuV/m

Peak value meets AVG limit.

Test Date: November 5, 2019

Tested By
Signature: _____ Name: Mark Afroozi

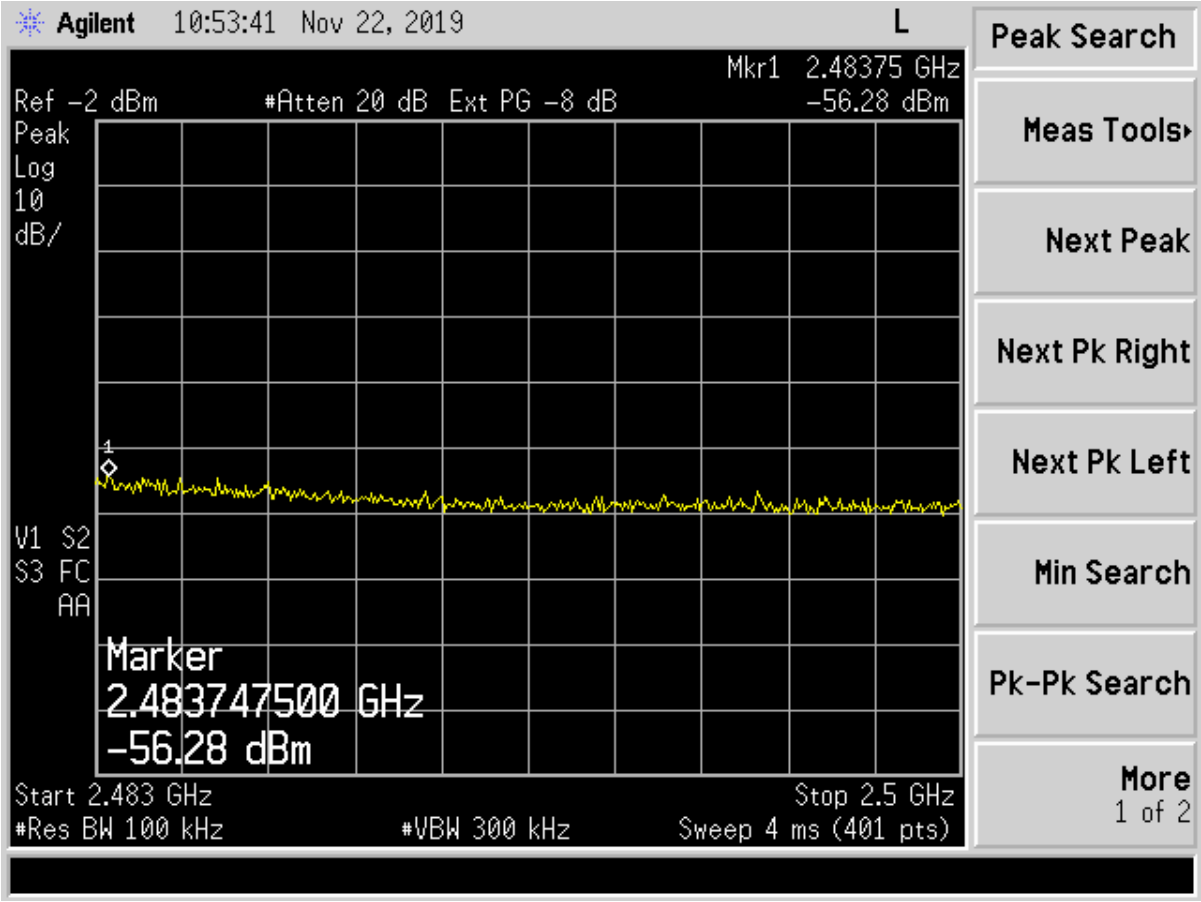


Figure 8. Restricted Band Edge 2483.5 MHz to 2500 MHz

EIRP to dBuV/m= EIRP(dBm) – 20 log (3) + 104.8, where 3 is the test distance in meters.

-56.28 – 20log (3) + 104.8 = 38.97 dBuV/m, less than 54 dBuV/m,
Peak value meets AVG limit.

Test Date: November 22, 2019

Tested By
Signature: _____ Name: Mark Afroozi

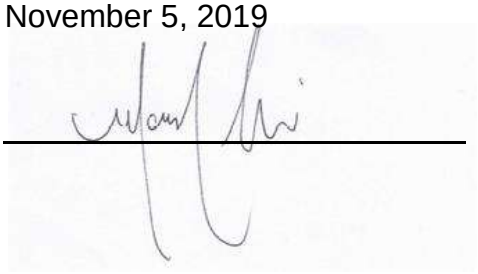
2.11 99% Occupied Bandwidth (CFR 2.1049, RSS-Gen 6.6)

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 approximately 1/100 of the manufacturers claimed RBW and with the VBW ≥ RBW. The results of this test are given in Table 20 and Figures 16-18.

Table 9. 6 dB Bandwidth and 99% Occupied Bandwidth

Frequency (MHz)	6 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)
2402	0.1778	0.3299
2426	0.1766	0.3268
2480	0.1756	0.3265

Test Date: November 5, 2019

Tested By
Signature:  Name: Mark Afroozi

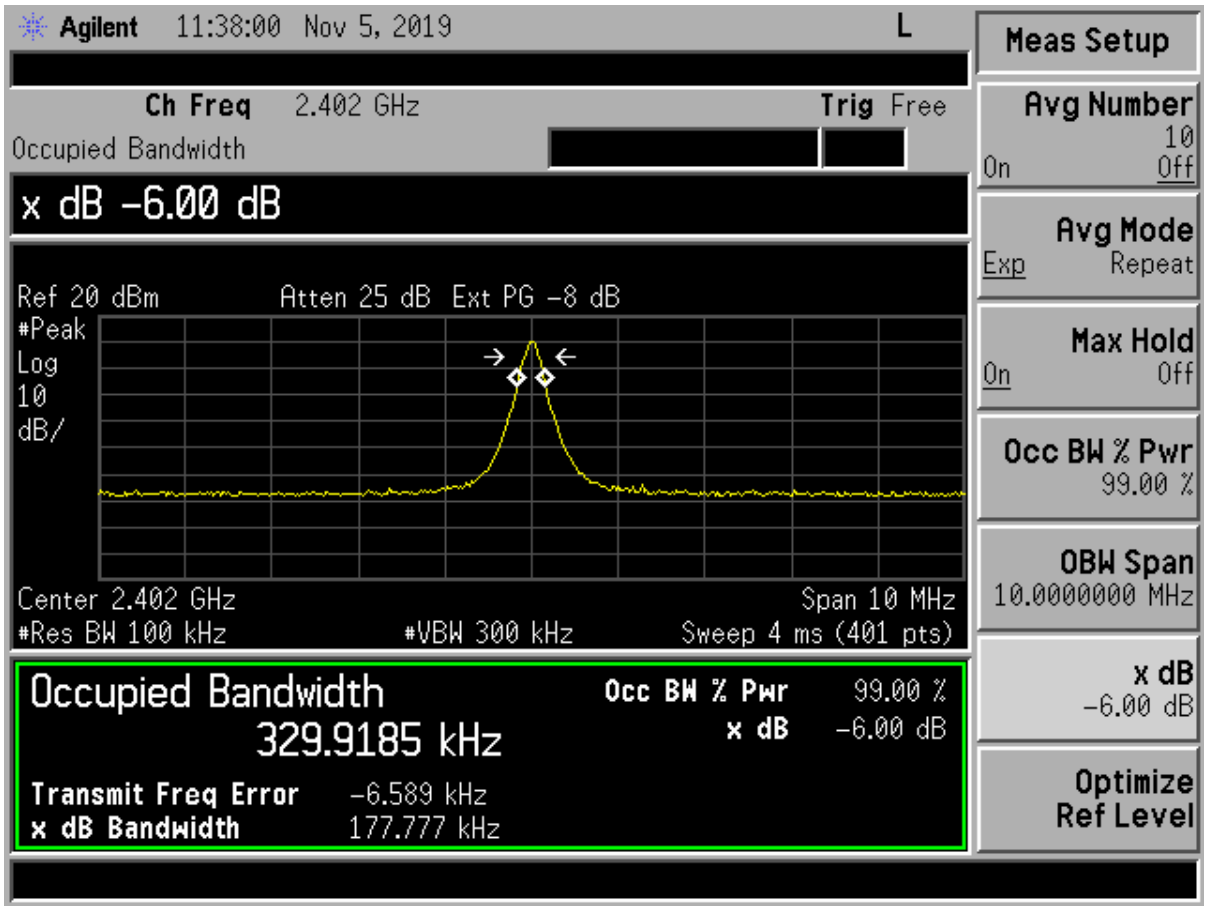


Figure 9. 99% Occupied Bandwidth – Low Channel

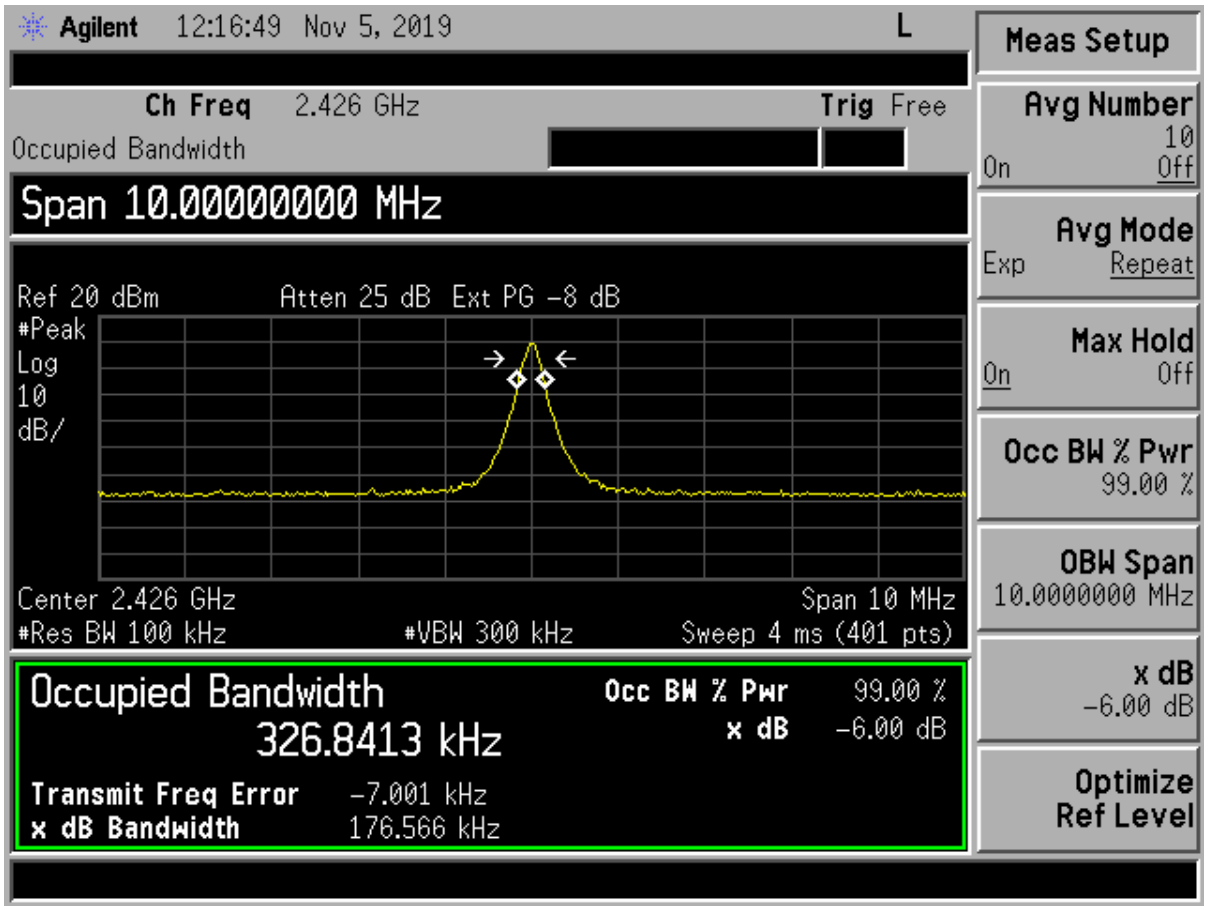


Figure 10. 99% Occupied Bandwidth – Mid Channel

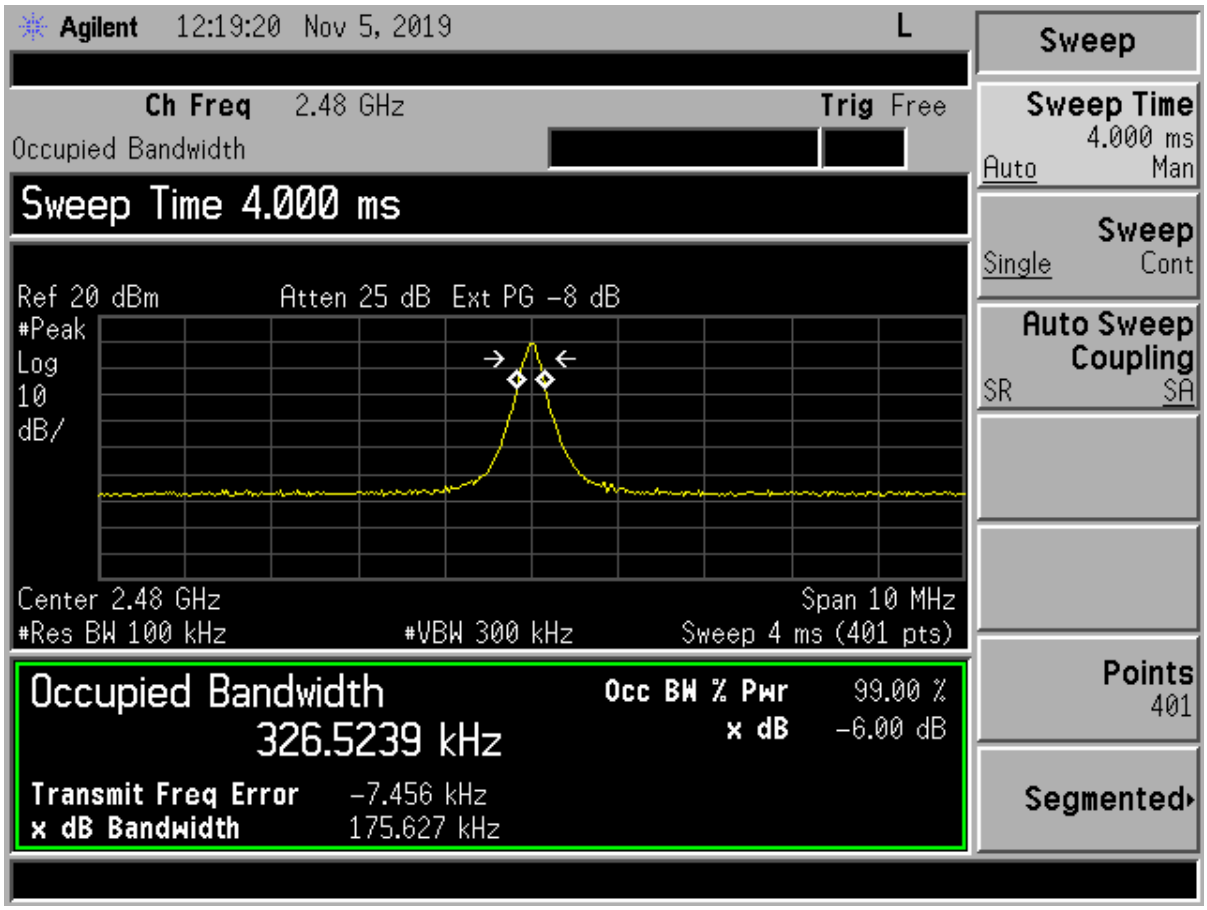


Figure 11. 99% Occupied Bandwidth – High Channel

2.12 Measurement Uncertainty

The measurement uncertainties given were calculated using the method detailed in CISPR 16-4-2:2011. A coverage factor of k=2 was used to give a level of confidence of approximately 95%.

2.12.1 Conducted Emissions Measurement Uncertainty

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

2.12.2 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 ± 5.3 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 ± 5.1 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna is ± 5.1 dB.

3 Conclusions

The EUT is deemed to meet the requirements of the test standards cited herein when tested in the configuration detailed in this test report.