Testing Tomorrow's Technology

Application for Certification

Per
Title 47 USC Part 2, Subpart J, Equipment Authorization Procedures, Paragraph 2.907, Certification and Part 15, Subpart C, Intentional Radiators, Paragraph 15.231, Periodic Operation in the band 40.66 MHz to 40.70 MHz and above 70 MHz
And
Innovation, Science, and Economic Development Canada
Certification Per
ICRSS-Gen General Requirements for Radio Apparatus
And
RSS-210 License-Exempt Radio Apparatus: Category I Equipment

For the

Cognosos, Inc.

Models (HVIN): PCA10015-1, PCA10015-2, PCA10015-3, PCA10015-4
Product Marketing Name (PMN): PCA-10015

UST Project: 18-0167
Issue Date: July 26, 2018

Number of Pages in this report: 20

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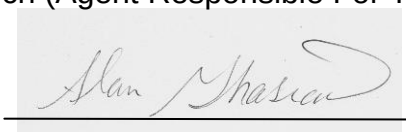
I certify that I am authorized to sign for the test facility and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US Tech (Agent Responsible For Test):

By: 

Name: Alan Ghasiani

Title: President – Consulting Engineer

Date: July 24, 2018

TESTING
NVLAP LAB CODE 200162-0

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MEASUREMENT/TECHNICAL REPORT

COMPANY NAME: Cognosos, Inc.
PMN: PCA-10015
MODELS: PCA10015-1, PCA10015-2, PCA10015-3, PCA10015-4
FCC ID: 2AKFQ10015
IC: 22165-10015
DATE: October 31, 2018

This report concerns (check one): Original grant X
Class II change_____

Equipment type: 433-435 MHz Transmitter Module

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

If yes, defer until:_____
date

N.A. 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
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1. General Information

This report is prepared as a means of presenting test data to be used by a Telecom Certification Body in determination of whether this product is permitted for unlicensed dissemination to the general public according to the Innovation, Science, and Economic Development Canada and FCC Rules and Regulations for RF Devices Intentional Radiators.

1.1 Product Description

The Equipment under Test (EUT) is the Cognosos, Inc. Model PCA10015-1. The EUT is a small battery powered 433 MHz UHF transceiver with an integrated motion detector and GPS receiver. The EUT is a low power device used to create end devices that operate on Cognosos' RadioCloud® radio network. The baseline application for the end products includes asset tracking and other applications across campus-wide facilities. The EUT module offers several methods of UHF communication:

- Long Range Mode (100 bps GFSK, burst operation)
- High Power Short Range (25.6 kbps GFSK, burst operation)
- Short range (25.6 kbps GFSK continuous operation)

The High Power Short Range Mode is the mode of operation evaluated in this test report. The other two modes are evaluated in separate test reports.

In addition to the PCA10015-1 device tested, the EUT will be sold with the following hardware variants: PCA10015-2, PCA10015-3, and PCA10015-4. All models are electrically and physically identical except from the orientation of LED's to shine upwards or downwards and the removal of an optional connector. All models use identical radio transceivers, MCU, crystals and PCB.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on June 13, 2018 in good operating condition.

1.3 Related Submittal(s)/Grant(s)

The EUT is subject to the following FCC Equipment Authorizations:

a) Certification of the transmitter.

b) Verification as a class B digital device.

2. Tests and Measurements

2.1 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* to show compliance to CFR 47, Part 15.231.

All measurements are peak unless stated otherwise. The video filter associated with the spectrum analyzer was set to 3 times the resolution bandwidth or off throughout the evaluation process. There were no interconnecting cables to manipulate in an attempt to maximize emissions; however, the physical position of the EUT was varied through the three mutually exclusive orthogonal planes in an attempt to maximize the emissions. The worse case position is the position used for final measurements and is gathered in this test report. A block diagram of the tested system is shown in Figure 1.

2.2 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA. This site has been fully described and registered with the FCC, under site registration number 186022. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1 and is also a NVLAP accredited test lab; lab code 200162-0.

2.3 Test Equipment

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC/IC ID	CABLES P/D
Tracker/ Cognosos, Inc. (EUT)	PCA10015-1	Engineering Sample	Pending: FCC ID: 2AKFQ10015 IC: 22165-10015	None

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

Table 2. Test Instruments

TEST INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	CALIBRATION DUE DATE
SPECTRUM ANALYZER	E4407B	AGILENT	US41442935	9/22/2018
SPECTRUM ANALYZER	8593E	HEWLETT PACKARD	3205A60124	10/28/2018
LOOP ANTENNA	6502	EMCO	9810-3246	1/22/2020 2 yr
BICONNICAL ANTENNA	3110B	EMCO	9307-1431	10/23/2019 2 yr
LOG PERIODIC ANTENNA	3146	EMCO	9305-3600	9/21/2018 2 yr.
HORN ANTENNA	3115	EMCO	9107-3723	9/22/2018 2 yr.
RF PREAMP 100 kHz to 1.3 GHz	8447D	HEWLETT-PACKARD	1937A02980	3/7/2019
PREAMP 1.0 GHz to 26.0 GHz	8449B	HEWLETT-PACKARD	3008A00480	12/01/2018
CALCULATION PROGRAM	N/A	N/A	Ver. 6.0	N/A

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

2.4 EUT Antenna Description (FCC Sec. 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.

The Cognosos Inc., Model PCA-10015 Incorporates the antennas detailed in Table 3 for the Lutron transmitter.

Table 3. Antenna Description

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dB_i	TYPE OF CONNECTOR
None	Cognosos, Inc.	Internal OCB	None	-5.1	PCB Trace

2.5 Modifications to Equipment

No modifications were needed to bring the EUT into compliance with the FCC Part or IC RSS requirements.

2.6 Test Procedure

The EUT was configured as shown in the following block diagram(s) and photograph(s). The sample was tested per ANSI C63.10:2013. Conducted and radiated emissions data were taken with the test receiver or spectrum analyzer's resolution bandwidth adjusted to 9 kHz and 120 kHz depending on the frequency range of testing, 150 kHz-30 MHz or 30 MHz to 1000 MHz, respectively. All measurements are peak unless stated otherwise. The video filter on the spectrum analyzer was OFF throughout the evaluation process. Interconnecting cables were manipulated as necessary to maximize emissions. The EUT was rotated 360 degrees with the turntable to maximize emissions. The physical position of the EUT was varied through the three mutually exclusive orthogonal planes in an attempt to maximize the emissions. The final setup description is found in the test section of this report.

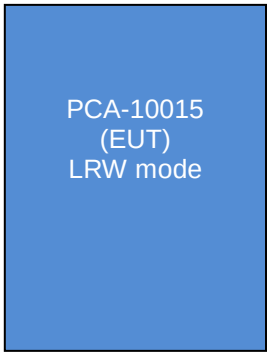

Figure 1. Block Diagram of Test Configuration

2.7 Compliance to CFR 15.231(a), RSS-210, A.1.1(a) Transmitter Activation/Deactivation

According to CFR 15.231(a) The provisions of this section are restricted to periodic operation within the band 40.66-40.70 MHz and above 70 MHz. Except as shown in paragraph (e) of this section, the intentional radiator is restricted to the transmission of a control signal such as those used with alarm systems, door openers, remote switches, etc. Continuous transmissions, voice, video and the radio control of toys are not permitted. Data is permitted to be sent with a control signal. The following conditions shall be met to comply with the provisions for this periodic operation:

(1) A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

The transmitter is not a manually operated transmitter.

(2) A transmitter activated automatically shall cease transmission within 5 seconds after activation.

The transmitter is classified as an automatically activated transmitter and the transmitter does comply with transmissions ceasing after 5 seconds. See Figure 2 below.

(3) Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, Including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.

This does not apply; the transmitter does not have periodic transmissions at pre-determined intervals, and does not have polling or supervision transmissions to determine system integrity. Transmissions from the Clear Connect transmitter in this product are always initiated by a user initiated event, such as a button press on a product in the system or a user interaction in a smart-phone app to adjust the position of the light dimmer or window shade.

(4) Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition.

This does not apply; the transmitter is not employed for radio control purposes during emergencies.

(5) Transmission of set-up information for security systems may exceed the transmission duration limits in paragraphs (a)(1) and (a)(2) of this section, provided such transmissions are under the control of a professional installer and do not exceed ten seconds after a manually operated switch is released or a transmitter is activated automatically. Such set-up information may Include data.

This does not apply; the transmitter is not used for security systems.

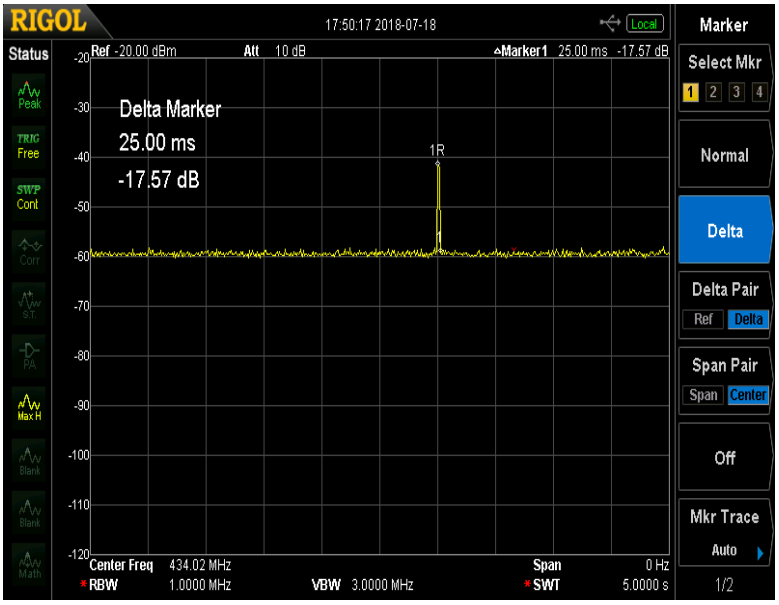

Figure 2. Deactivation per 15.231(a)(1), RSS-210, A.1.1(a)

The EUT deactivates within 5 seconds

Duty Cycle Factor=

20 * Log (T_{on}/T_{period}) = 20*log(25ms/100ms) = **-12.04 dB**

2.8 Field Strength of Fundamental (47 CFR 15.231(b), RSS-210, A.1.2(b))

The results of the measurements for peak fundamental emissions are given in Table 4. The EUT emissions measurement was started by setting up the Antenna in the vertical orientation at a distance of 3 meters from the EUT and at a height of 1.0 meters above the ground. The EUT's major axis was set normal to the direction of the measuring antenna.

The Spectrum Analyzer (SA) displays were set to: Channel A free-running, Channel B to Max-Hold. Choose a frequency or frequency range and scan it at a coupled rate. When a signal is detected, raise and lower the antenna to maximize the signal.

When the signal has been maximized, the antenna height is fixed the turn-table is rotated through 360 degrees to further maximize the signal.

When all signals have been maximized for antenna height and direction, the EUT case is carefully maneuvered in each of the three mutually exclusive orthogonal planes while observing the same Max-hold/free-running SA display indication. When the EUT position is found that further maximizes the signal, record the antenna height, rotation orientation, EUT orthogonal position and signal strength on the data sheet for that particular frequency.

Next, the measurement antenna is re-oriented to a Horizontal polarization at 1 meter height and the process described above is repeated. All signals within 6 dB of the limit are recorded.

Finally, the collected data is input into the calculation spread sheet. The spread sheet is designed to calculate for the true value that is collected. The spread sheet takes into account the SA reading, the antenna correction factor, cable losses and duty cycle factors. See the data tables herein.

2.9 Limits for Operation in the Band above 70 MHz (CFR15.231 (b), RSS-210, A.1.2(b))

This limit versus frequency table is as follows (test distance = 3.0 meters):

Fundamental Frequency (MHz)	Limit Fundamental (Average) uV/m	Limit Harmonics and other spurious (Average) uV/m
260 to 470	3750 to 12500[*, 1]	375 to 1250[*,2]
* Linear Interpolations		

Note: formula 1: $limit_1 = E = 41.667F – 7083.5$
2: $limit_2 = E = 4.1667F – 708.35$
E= Electric field strength
F= fundamental frequency in MHz

The frequency spectrum above the fundamental to its 10th harmonic was examined and measured for signals falling into the restricted bands of 15.205. If average emissions measurements are employed, the provisions in 15.35 for averaging pulsed emissions and for limiting peak emissions were applied. Spurious and harmonics signals meet the requirements of the above table or the requirements of 15.209, whichever requirement permits higher field strength.

Table 4. Intentional Radiated Emissions Peak Measurements

Tested By:	Test: Part 15C, Para 15.231	Client: Cognosos Inc.
JF	Project: 18-0167	

Frequency (MHz)	Test Data (dBuV)	AF+CL-PA (dB/m)	Corrected Results (dBuV/m)	PK Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detection Method
CH0							
433.10	62.29	18.75	81.04	100.5	3m./HORZ	19.5	**PK**
866.20	33.35	-0.15	33.20	80.5	3m./HORZ	47.3	**PK**
1299.30	47.47	-5.84	41.87	80.5	3m./HORZ	38.6	**PK**
CH8							
434.03	61.69	18.75	80.44	100.5	3m./HORZ	20.1	**PK**
868.06	35.05	-0.15	34.90	80.5	3m./HORZ	45.6	**PK**
1302.08	47.88	-6.14	41.74	80.5	3.0m./HORZ	38.8	**PK**
CH20							
435.32	62.45	18.75	81.20	100.5	3m./HORZ	19.3	**PK**
870.65	35.20	-0.15	35.05	80.5	3m./HORZ	45.5	**PK**
1305.97	48.50	-6.14	42.36	80.5	3.0m./HORZ	38.1	**PK**
No other emissions found greater than 20 dB below the applicable limit.							

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

Sample Calculation at 433.10:

Magnitude of Measured Frequency	62.29	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	18.75	dB/m
Corrected Result	81.04	dBuV/m

Test Date: July 13, 2018
Tested By

Signature: _____ Name: John Freeman

Note: The transmitter was programmed to transmit at >98% duty cycle; therefore wherever applicable, the duty cycle factor calculated above was applied to correct for the actual duty cycle of the transmitter.

Table 5. Intentional Radiated Emissions Average Measurements

Tested By:		Test: Part 15B, Para 15.231			Client: Cognosos Inc.			
JF		Project: 18-0167						
Frequency (MHz)	**Test Data (dBuV)**	**Duty Cycle Additional Factor**	**AF+CL-PA (dB/m)**	**Corrected Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detection Method**
CH0								
433.10	61.00	-12.04	18.75	67.71	80.5	3m./HORZ	12.8	**AVG**
866.20	33.35	-12.04	-0.95	20.36	60.5	3m./HORZ	40.1	**AVG**
1299.30	47.47	-12.04	-5.84	29.59	60.5	3m./HORZ	30.9	**AVG**
CH8								
434.03	61.69	-12.04	18.85	68.50	80.5	3m./HORZ	12.0	**AVG**
868.06	35.05	-12.04	-0.95	22.06	60.5	3m./HORZ	38.4	**AVG**
1302.08	47.88	-12.04	-6.14	29.70	60.5	3m./HORZ	30.8	**AVG**
CH20								
435.32	62.45	-12.04	18.75	69.16	80.5	3m./HORZ	11.3	**AVG**
870.65	35.20	-12.04	-0.95	23.01	60.5	3m./HORZ	37.5	**AVG**
1305.97	48.50	-12.04	-6.14	30.32	60.5	3m./HORZ	30.2	**AVG**
No other emissions found greater than 20 dB below the applicable limit.								

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR 15.209 & 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. EUT operating at > 98% Duty Cycle therefore the additional factor of -12.04 dB applied to correct for Duty Cycle Factor.

Sample Calculation at 433.10:

Magnitude of Measured Frequency	61.00	dBuV
+ Duty Cycle Additional Factor	-12.04	
+Antenna Factor + Cable Loss+ Amplifier Gain	+18.75	dB/m
Corrected Result	67.71	dBuV/m

Test Date: July 13, 2018
Tested By

Signature: _____ Name: John Freeman

2.10 Radiated Spurious Emissions and Power Line Conducted Emissions (CFR 15.209, 15.207, RSS-Gen 8.8, 8.9)

The EUT was placed in a state representative of how the device will function under normal operation. The radiated spurious emissions were measured over the frequency range of 9 KHz to 30MHz and 30 MHz to the 10th harmonic of the fundamental frequency of the intentional transmitter. The test results are shown below.

The EUT is battery operated and does not connect to the AC mains; therefore testing for compliance with 15.207 was not applicable.

Table 6. Intentional Radiated Emissions, 9 kHz - 30 MHz

9 kHz to 30 MHz, 15.209 limits						
Test: Radiated Emissions				**Client:** Cognosos Inc.		
Project: 18-0167						
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**QP Limits (dBuV/m)**	**Margin (dB)**	**Detector PK, or AVG**
Loop X position						
0.01	46.52	15.60	62.12	133.9	71.8	**PK**
0.16	43.77	11.94	55.71	86.9	31.2	**PK**
0.59	33.65	11.82	45.47	84.3	38.8	**PK**
1.71	24.09	11.77	35.86	49.5	13.7	**PK**
Loop Y position						
0.01	46.83	15.60	62.43	135.7	73.3	**PK**
0.16	44.51	11.94	56.45	87.4	30.9	**PK**
0.49	35.15	11.54	46.69	87.6	40.9	**PK**
1.71	23.78	11.77	35.55	49.5	14.0	**PK**
Loop Z position						
0.01	45.72	15.60	61.32	135.0	73.7	**PK**
0.16	44.72	11.94	56.66	86.7	30.1	**PK**
0.49	33.82	11.54	45.36	87.6	42.2	**PK**
1.71	24.30	11.77	36.07	49.5	13.5	**PK**

Sample Calculation at 0.010 MHz:

Magnitude of Measured Frequency	46.52	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	15.60	dB/m
Corrected Result	62.12	dBuV/m

Test Date: July 16, 2018
Tested By

Signature: _____ Name: John Freeman

Table 7. Spurious Radiated Emissions other than Fundamental & Harmonics

>30 MHz 15.209 Limits							
Test: Radiated Emissions				**Client:** Cognosos Inc.			
Project: 18-0167							
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**
920.90	36.63	-1.73	34.90	46.0	3m./HORZ	11.1	**PK**
1176.00	49.30	-6.78	42.52	54.0	3.0m./HORZ	11.5	**PK**
1247.00	48.97	-6.35	42.62	54.0	3.0m./VERT	11.4	**PK**
3220.00	32.95	3.71	36.66	54.0	3.0m./VERT	17.3	**AVG**
3483.00	33.18	4.58	37.76	54.0	3.0m./HORZ	16.2	**AVG**

Sample Calculation at 42.33 MHz:

Magnitude of Measured Frequency	36.63	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	-1.73	dB/m
Corrected Result	34.90	dBuV/m

Test Date: July 16, 2018
Tested By

Signature:  Name: John Freeman

2.11 Bandwidth of Fundamental (CFR15.231(c), RSS-210, A.1.3)

The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. Bandwidth is determined by those frequencies that are at least 20 dB down on either side of the center frequency of the pulse.

Bandwidth of Fundamental= 0.0025 x 433,100,000.00 = 1.0827 MHz

The WORST CASE measured bandwidth is 56.66 kHz, well within the limit. See the figure below

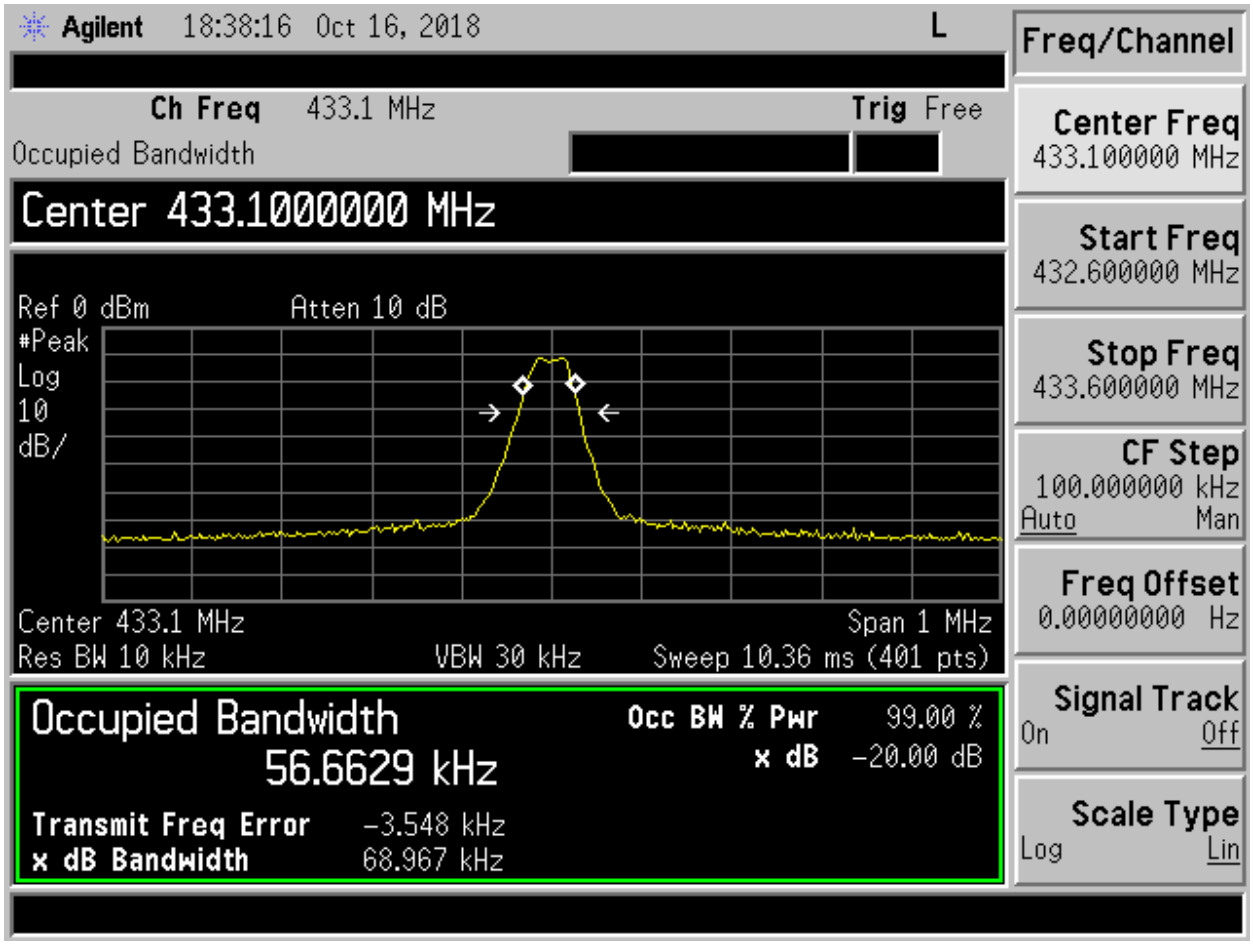

Figure 3. Occupied Bandwidth Low Channel

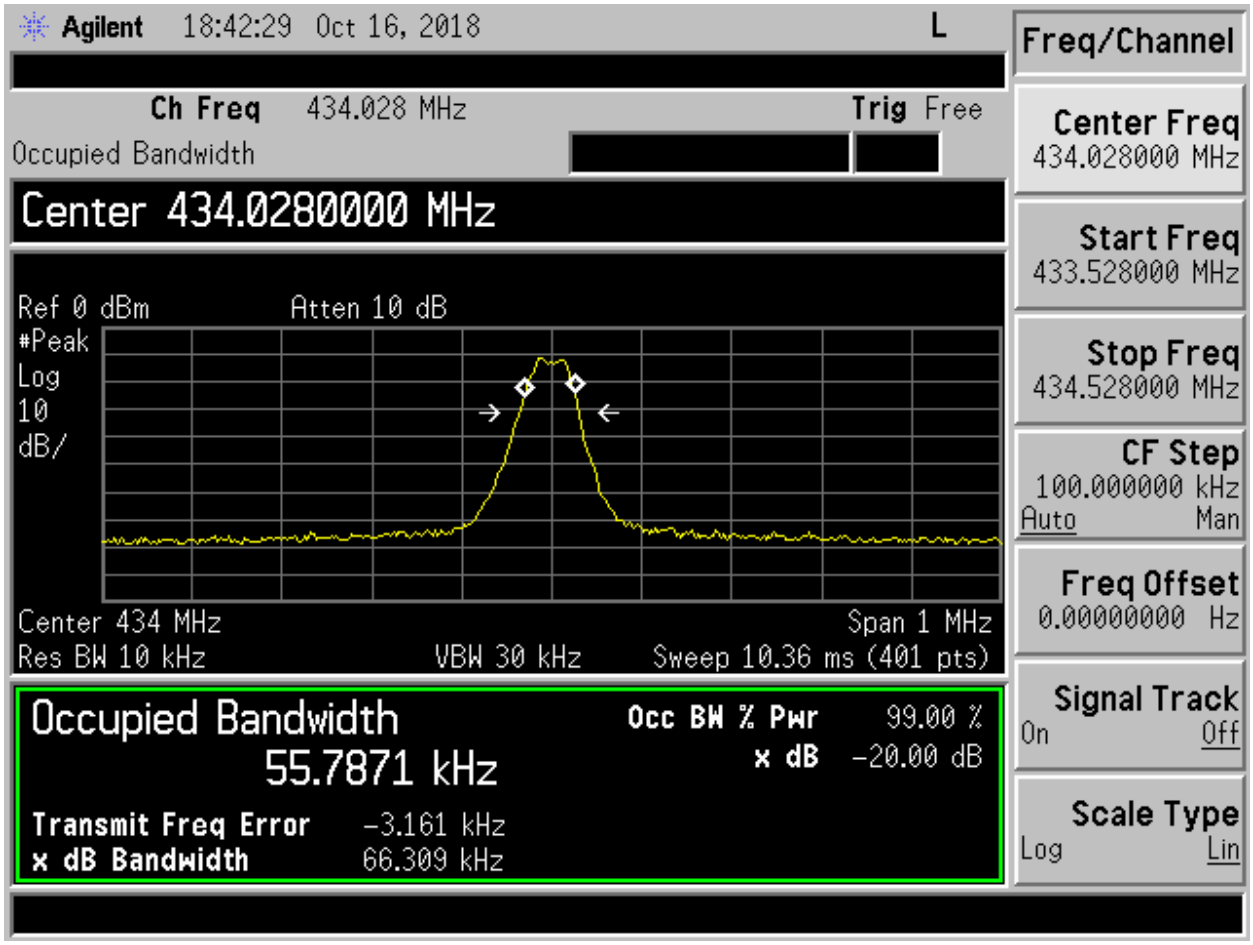

Figure 4. Occupied Bandwidth Mid Channel

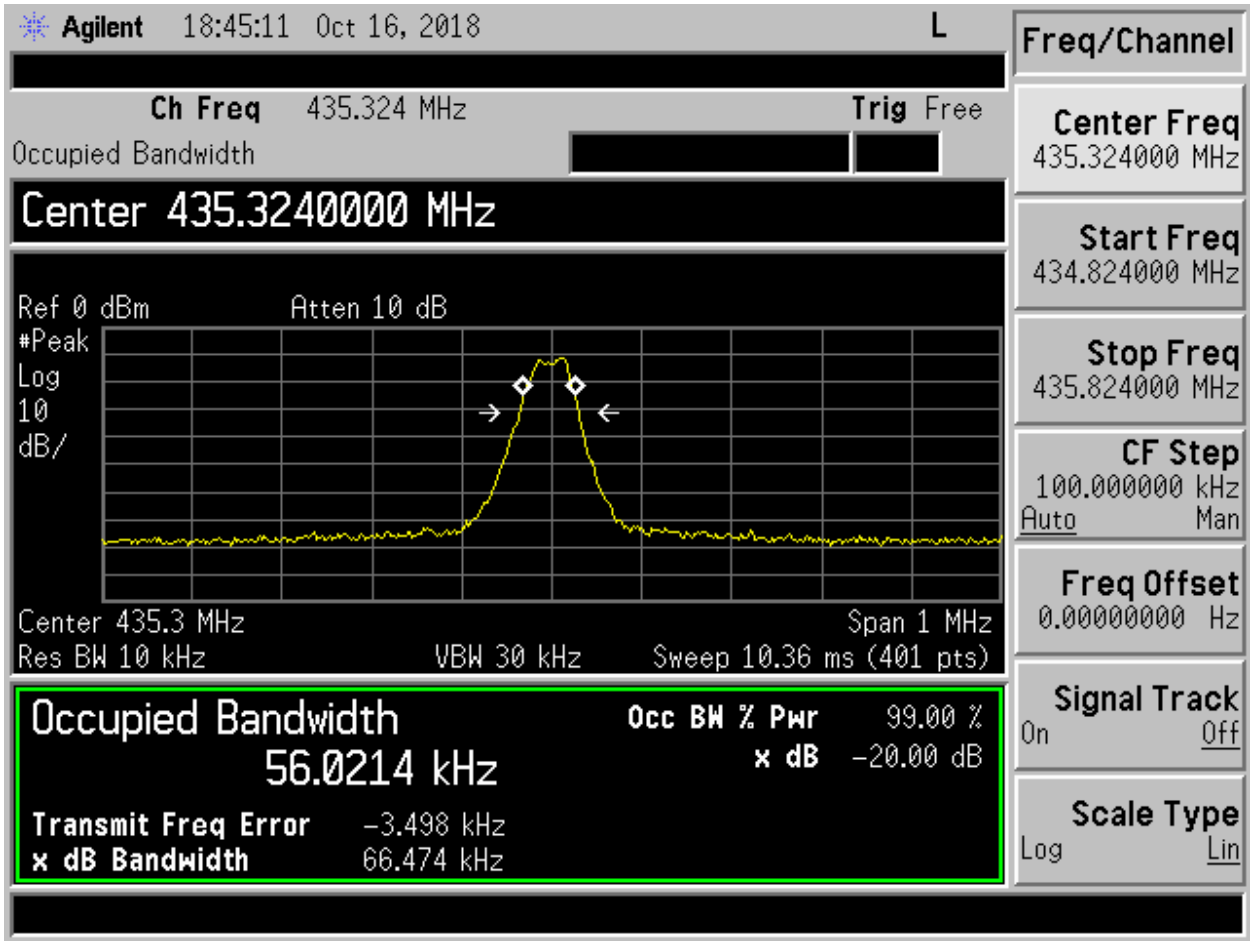

Figure 5. Occupied Bandwidth High Channel