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

Matrix Design Group, LLC

Model: RM-10002705

UST Project: 18-0382
Issue Date: January 21, 2019

Number of Pages in this report: 23

3505 Francis Circle Alpharetta, GA 30004
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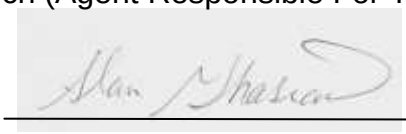
www.ustech-lab.com

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: January 21, 2018

TESTING
NVLAP LAB CODE 200162-0

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MEASUREMENT/TECHNICAL REPORT

COMPANY NAME: Matrix Design Group, LLC
PRODUCT: RM-10002705
FCC ID: USKRM-10002705
IC: 11898A-10002705
DATE: January 21, 2019

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

Equipment type: 433-434 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
Fax Number: (770) 740-1508

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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 Matrix Design Group, LLC model RM-10002705 radio module. The EUT contains three onboard radio chipsets, 802.15.4 (ZigBee), WiFi (802.11b,g,n) and 433 MHz chipsets. Each has its own RF antenna port and antenna. The radio chips are co-located on a single board but will not transmit simultaneously. This three chipset radio module is designed for use in host products that perform the following tasks: atmospheric monitoring sensor devices. These devices will collect data and send the data wireless to base stations or hubs using the radio module wireless capabilities.

For this test report only the 433 MHz radio was tested. The other two radio test results are reported in separate reports.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on December 14, 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.

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
Dell (Laptop)	Latitude E6510	266BYN1	Unknown	-
Dell (Power Supply Adapter)	PA-1900-02D	CND	Not Applicable	2.0 m UP
Antenna See antenna details	204287	--	--	--

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	8/17/2020
SPECTRUM ANALYZER	DSA815	RIGOL	DSA8A18030 0138	10/11/2019
SPECTRUM ANALYZER	8593E	HEWLETT-PACKARD	3205A00124	10/25/2019
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	2/28/2019
LOOP ANTENNA	SAS-200/562	A. H. Systems	142	1/22/2020 2 yr.
BICONICAL ANTENNA	3110B	EMCO	9307-1431	5/2/2019 2 yr
LOG PERIODIC ANTENNA	3146	EMCO	9305-3600	5/1/2019 2 yr
HORN ANTENNA	3115	EMCO	9107-3723	11/28/2020 2 yr
HIGH PASS FILTER	H3R020G2	MICROWAVE CHIRCUITS	001DC9528	3/08/2019
LISN x 2	9247-50-TS-50-N	SOLAR ELECTRONICS	955824 and 955825	3/19/2019
DC POWER SUPPLY	HY1803D	TEKPOWER	1072531	Verified Before Use
DC POWER SUPPLY	TP3005T	TEKPOWER	218311	Verified Before Use

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 Matrix Design Group LLC, RM-100002705 433 MHz Transmitter incorporates the antennas detailed in Table 3.

Table 3. Antenna Description

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dB_i	TYPE OF CONNECTOR
External Antenna with unique U.FL Connector	Matrix Design Group, LLC	Patch Trace (Flex Antenna)	204287	0.7	U.FL

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 Pulse Averaging/Duty Cycle (47 CFR 15.35 (c), RSS-Gen 8.2)

The duty cycle de-rating factor used in the calculation of average radiated limits (per CFR 15.209 and 15.35(c)) is described below. This factor was calculated by first determining the worst case scenario for system operation. With the worst case operating scenario the transmission duty cycle is calculated as:

27.5 mSec = ON time (Figure 1 below)
972.5 mSec = OFF time (Figure 1 below)

(27.5mS Total Time On)/(1000mS FCC Standard) = 0.0275 Numeric Duty Cycle
Duty Cycle = 20 Log (.028) = -31.2 dB

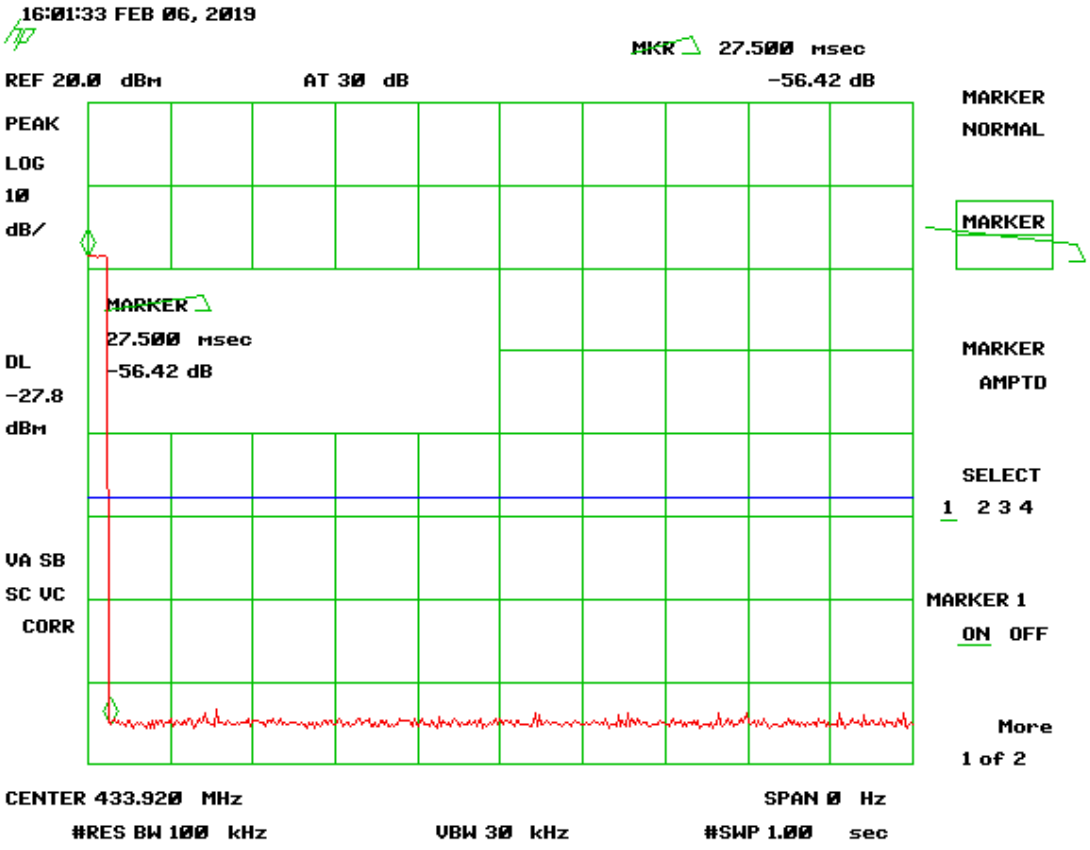


Figure 1. Duty Cycle

2.7 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.

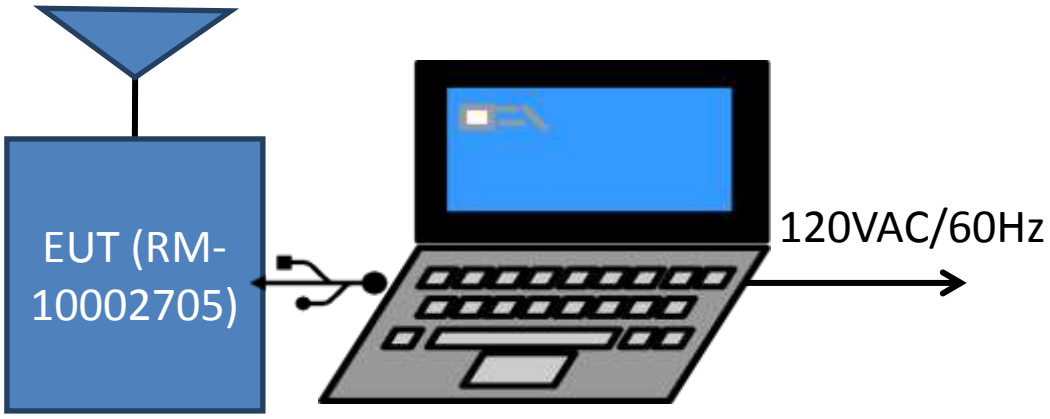


Figure 2. Block Diagram of Test Configuration

Note: The laptop is used for programming the radio module only.

2.8 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.

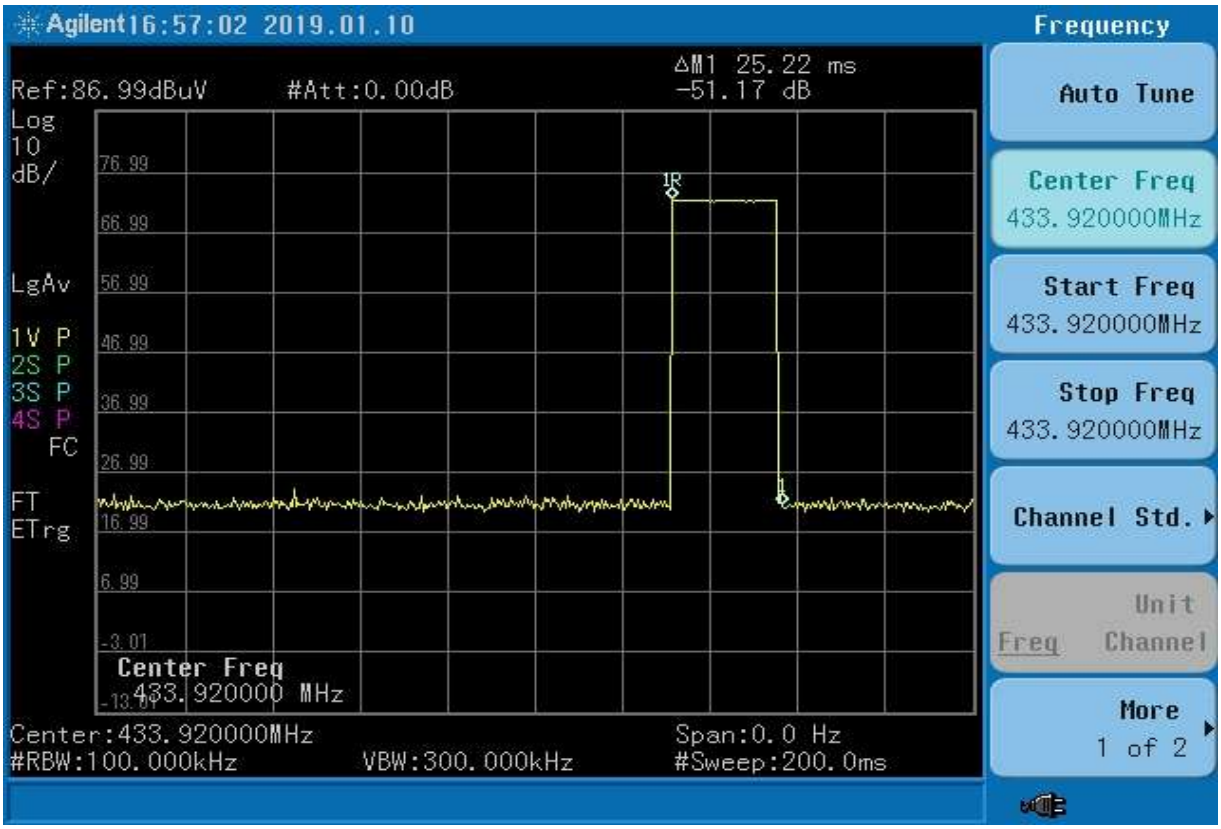


Figure 3. Deactivation per 15.231(a)(1), RSS-210, A.1.1(a)

The EUT deactivates within 5 seconds.

2.9 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.

2.10 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: Matrix Designs
AF	Project: 18-0382	Model: RM-10002705

Frequency (MHz)	Test Data (dBuV)	AF+CL-PA (dB/m)	Corrected Results (dBuV/m)	PK Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detection Method
CH-LOW							
433.02	77.12	18.85	95.97	100.8	3m./HORZ	4.8	**PK**
*866.04	76.99	-0.82	76.17	80.8	3m./HORZ	9.8	**PK**
*1299.06	35.65	-8.42	27.23	80.8	3m./HORZ	58.8	**PK**
CH-MID							
433.92	73.10	18.85	91.95	100.8	3m./HORZ	8.9	**PK**
*867.84	69.84	-0.82	69.02	80.8	3m./HORZ	17.0	**PK**
*1301.76	44.57	-8.44	36.13	80.8	3m./HORZ	49.9	**PK**
CH-HIGH							
434.00	72.29	18.85	91.64	100.8	3m./HORZ	9.2	**PK**
*868.00	72.15	-0.82	71.33	80.8	3m./HORZ	14.7	**PK**
*1302.00	46.12	-8.44	37.68	80.8	3m./HORZ	48.3	**PK**

(*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.

Sample Calculation at 433.02:

Magnitude of Measured Frequency	77.12	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	18.85	dB/m
Corrected Result	95.97	dBuV/m

Test Date: December 21, 2018
Tested By

Signature: Afzal Fazal Name: Afzal Fazal

Table 5. Intentional Radiated Emissions Average Measurements

Tested By:	Test: Part 15B, Para 15.231	Client: Matrix Designs
AF	Project: 18-0382	Model: RM-10002705

Frequency (MHz)	Test Data (dBuV)	AF+CL-PA (dB/m)	Corrected Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detection Method
CH-LOW							
433.02	48.98	18.85	67.83	80.8	3m./HORZ	13.0	**AVG**
*866.04	63.68	-0.82	62.86	60.8	3m./HORZ	3.1	**AVG**
*1299.06	32.96	-8.42	24.54	60.8	3m./HORZ	41.5	**AVG**
CH-MID							
433.92	46.86	18.85	65.71	80.8	3m./HORZ	15.1	**AVG**
*867.84	60.29	-0.82	59.47	60.8	3m./HORZ	6.5	**AVG**
*1301.76	42.12	-8.44	33.68	60.8	3m./HORZ	32.3	**AVG**
CH-HIGH							
434.00	48.15	18.85	67.00	80.8	3m./HORZ	13.8	**AVG**
*868.00	32.24	-0.82	60.94	60.8	3m./HORZ	5.1	**AVG**
*1302.00	43.53	-8.44	35.09	60.8	3m./HORZ	30.9	**AVG**

(*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.

Sample Calculation at 433.02:

Magnitude of Measured Frequency	48.98	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	18.85	dB/m
Corrected Result	67.83	dBuV/m

Test Date: December 21, 2018
Tested By

Signature: Afzal Fazal Name: Afzal Fazal

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.

2.11 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 power line conducted voltage emission measurements have been carried out in accordance with CFR 15.207, per ANSI C63.10:2013, Clause 6.2, with a spectrum analyzer connected to an LISN and the EUT placed into a continuous mode of transmission.

Table 6. Spurious Radiated Emissions (9kHz-30MHz)

Test By: AF	Test: FCC Part 15.209			Client: Matrix			
	Project: 18-0382 Class B			Model: RM-10002705			
Frequency (MHz)	**Test Data (dBuV)**	**AF+CL-PA (dB)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**DETECTOR PK / QP/AVG**
All emissions detected were more than 20 dB below the applicable limit.							

No other emissions detected other than those presented in this table and the tables in section 2.10 above.
AF is antenna factor. CL is cable loss. PA is preamplifier gain.

SAMPLE CALCULATION: N/A

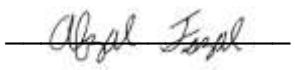
Test Date: January 4, 2019
Tested By
Signature:  Name: Afzal Fazal

Table 7. Spurious Radiated Emissions other than Fundamental & Harmonics

>30 MHz 15.209 Limits							
Test: Radiated Emissions			**Client:** Matrix				
Project: 18-0382			**Model:** RM-10002705				
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or AVG**
66.40	50.21	-18.14	32.07	40.0	3m./VERT	7.9	**QP**
67.27	46.07	-17.46	28.61	40.0	3m./HORZ	11.4	**QP**
92.76	51.49	-16.78	34.71	43.5	3m./HORZ	8.8	**QP**
95.56	52.66	-15.81	36.85	43.5	3m./VERT	6.6	**QP**
705.40	31.11	1.02	32.13	46.0	3m./VERT	13.9	**PK**
772.14	32.05	-0.16	31.89	46.0	3m./HORZ	14.1	**PK**
1075.00	48.95	-6.65	42.30	54.0	3.0m./HORZ	11.7	**PK**
1987.50	47.96	-0.82	47.14	54.0	3.0m./VERT	6.9	**PK**
6067.50	33.96	12.65	46.61	54.0	1.0m./HORZ	7.4	**PK**
6067.50	35.17	12.70	47.87	54.0	1.0m./VERT	6.1	**PK**

Sample Calculation at 66.40 MHz:

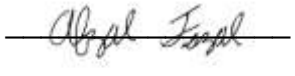
Magnitude of Measured Frequency	50.21	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	-18.14	dB/m
Corrected Result	32.07	dBuV/m

Test Date: January 4, 2019
Tested By
Signature:  Name: Afzal Fazal

Table 8. Power Line Conducted Emissions

CONDUCTED EMISSIONS 150 kHz to 30 MHz

Tested By: AF	Specification Requirement: FCC Part 15.207		Project No.: 18-0382	Client: Matrix Model: RM-10002705		
Frequency (MHz)	**Test Data (dBuV)**	**LISN+CL (dB)**	**Corrected Results (dBuV)**	**Limits (dBuV)**	**Margin (dB)**	**Detector**
Phase @ 120VAC/60Hz						
0.1687	40.73	0.42	41.15	55.0	13.9	**PK**
0.5383	36.87	0.15	37.02	46.0	9.0	**PK**
3.2000	43.11	0.19	43.30	46.0	2.7	**QP**
3.2000	36.70	0.19	36.89	46.0	9.1	**AVG**
5.0670	43.79	0.24	44.03	50.0	6.0	**PK**
18.9500	45.22	0.61	45.83	50.0	4.2	**QP**
18.9500	36.02	0.61	36.63	50.0	13.4	**AVG**
26.9800	44.21	0.80	45.01	50.0	5.0	**QP**
26.9800	31.89	0.80	32.69	50.0	17.3	**AVG**
Neutral @ 120VAC/60Hz						
0.4288	37.65	0.31	37.96	47.3	9.3	**PK**
0.9008	37.81	0.28	38.09	46.0	7.9	**PK**
3.3000	43.34	0.35	43.69	46.0	2.3	**QP**
3.3000	35.65	0.35	36.00	46.0	10.0	**AVG**
7.8250	42.94	0.46	43.40	50.0	6.6	**PK**
18.1500	45.11	0.67	45.78	50.0	4.2	**QP**
18.1500	37.23	0.67	37.90	50.0	12.1	**AVG**
20.4500	44.21	0.72	44.93	50.0	5.1	**QP**
20.4500	32.45	0.72	33.17	50.0	16.8	**AVG**

Test Date: January 3, 2019
Tested By
Signature:  Name: Afzal Fazal

2.12 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 433,055,000.00 = 1.0826 MHz

The WORST CASE measured bandwidth is 214.62 kHz, well within the limit. See the figures following.

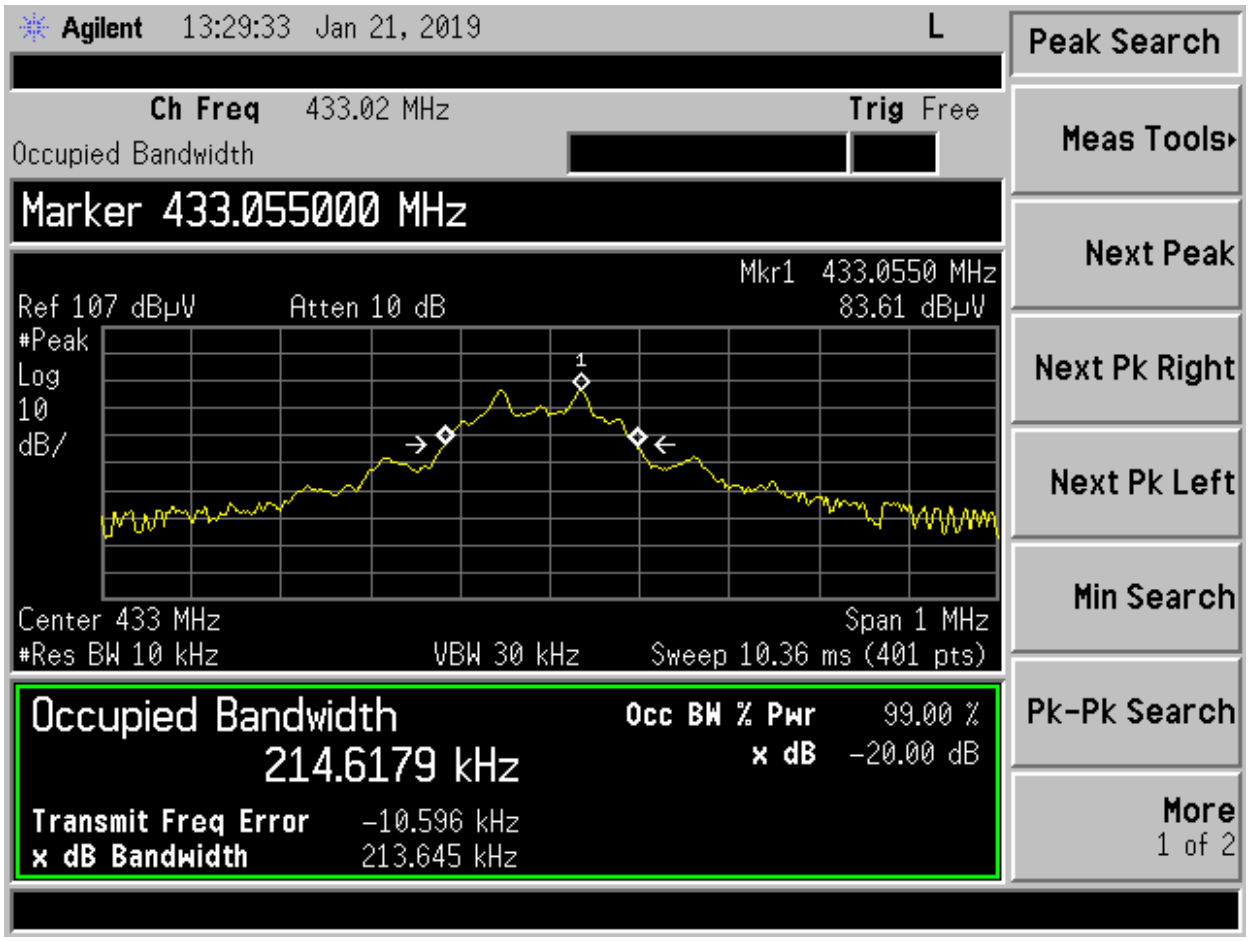


Figure 4. Occupied Bandwidth Low Channel

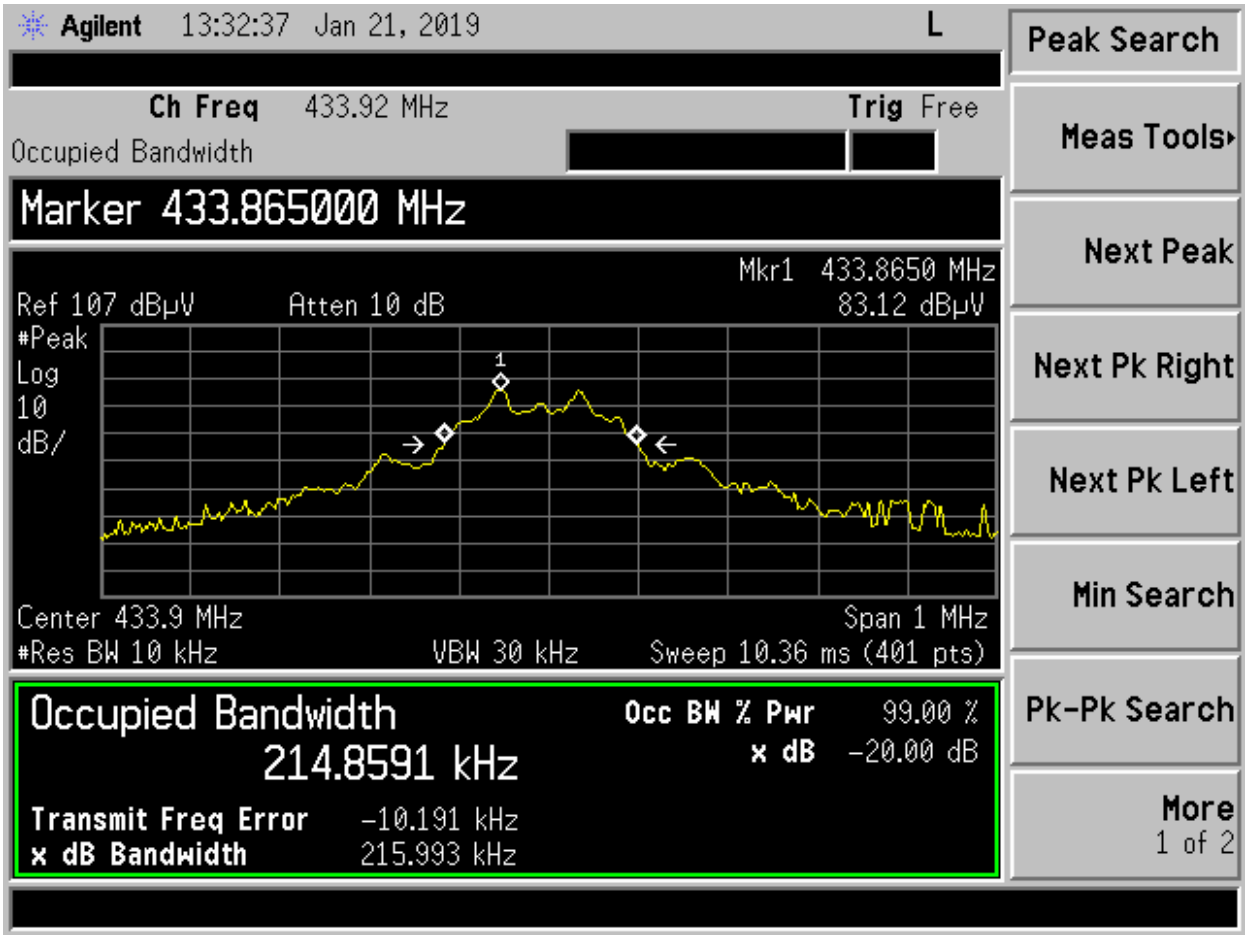


Figure 5. Occupied Bandwidth Mid Channel

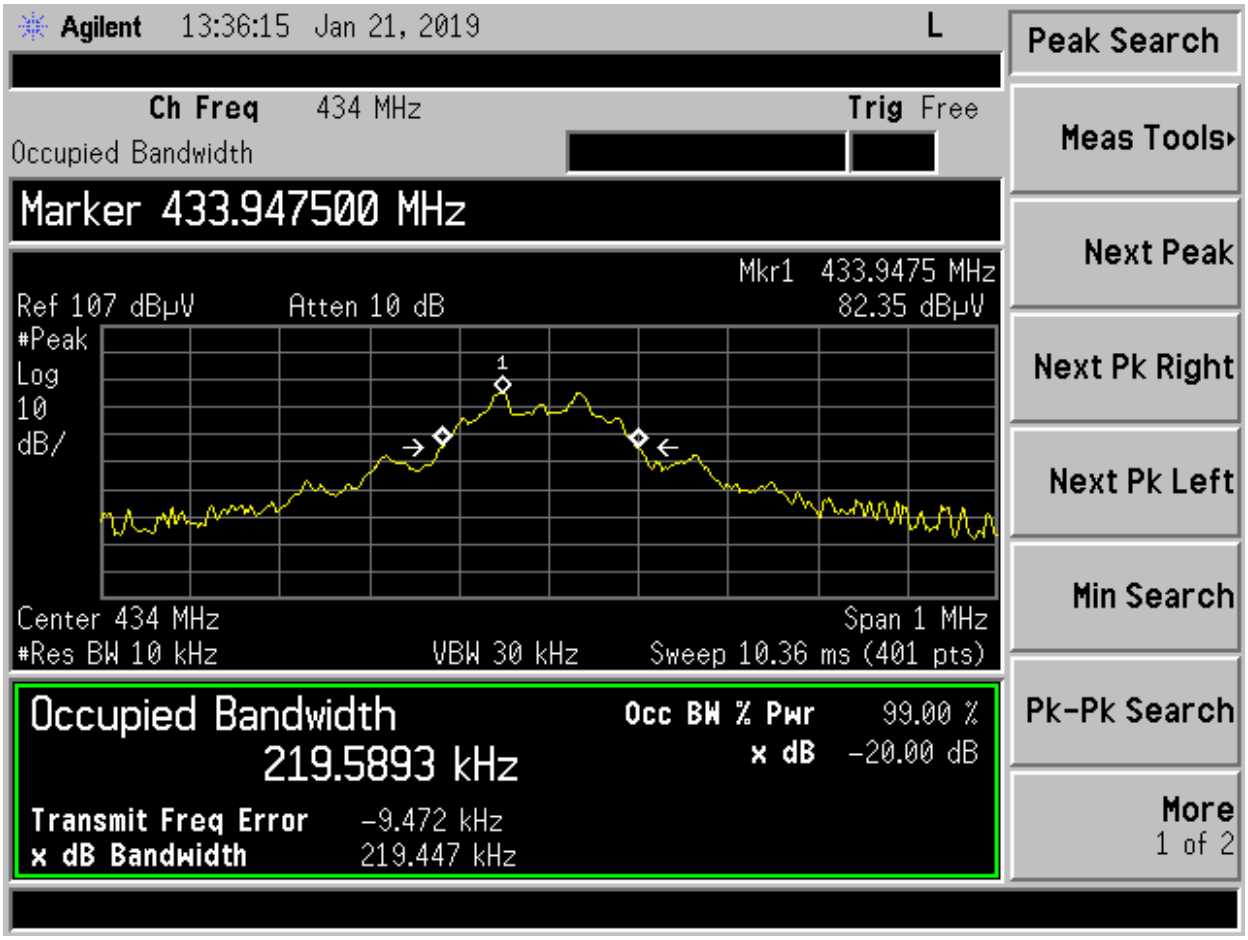


Figure 6. Occupied Bandwidth High Channel