Testing Tomorrow's Technology

Application
For

Title 47 USC, Part 2, Subpart J, Paragraph 2.902, Equipment Authorization of Verification for an Unintentional Radiator per Part 15, Subpart B, Paragraphs 15.107 and 15.109

And

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

And

Innovation, Science, and Economic Development Canada
Certification Per
IC RSS-Gen General Requirements for Radio Apparatus
And
RSS-247Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices

For the

Matrix Design Group LLC

Model Number: RM-10002705

FCC ID: USKRM-10002705
IC: 11898A-10002705

UST Project: 18-0382
Issue Date: February 6, 2019

Total Pages: 60

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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: February 6, 2019

NVLAP LAB CODE 200162-0

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MEASUREMENT TECHNICAL REPORT

COMPANY NAME: Matrix Design Group, LLC
MODEL: RM-10002705
FCC ID: USKRM-10002705
IC: 11898A-10002705
DATE: February 6, 2019

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

Equipment type: 2.4 GHz Transmitter Module(802.15.4)

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 IC RSS-247 and FCC Rules and Regulations Part 15, Section 247.

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 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 radio 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 802.15.4 (ZigBee) radio was tested. Test Results from the other two radios are documented in separate reports.

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* for the intentional radiator aspect of the device 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)* for the unintentional radiator aspect of the device as well as FCC subpart B and Cof Part 15 and per FCC KDB Publication number 558074 v05 for Digital Transmission Systems Operating Under section 15.247.

Digital RF conducted and radiated verification emissions data (FCC 15.107 and 109) below 1 GHz were taken with the measuring receiver (or spectrum analyzer's) resolution bandwidth adjusted to 9 kHz and 120 kHz, respectively. All measurements performed above 1.0 GHz were made with a RBW of 1 MHz. All measurements are peak unless stated otherwise. The video filter associated with the spectrum analyzer was set to 3 times the RBW or as required per the standard throughout the evaluation process.

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 for spurious and fundamental emissions 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 186022. 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 Submittal(s)/Grant(s)

The EUT is subject to the following FCC Equipment Authorizations:

a) Certification of the transmitter incorporated within the EUT; see test data presented herein.

b) Verification as a class Bdigital device.

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	FXP70	--	--	--

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

2 Tests and Measurements

2.1 Test Equipment

The tablebelow lists test equipment used to evaluate this product.Model numbers, serial numbers and their calibration status are included herein.

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.
(*)= used for power line conducted emissions testing

2.2 Modifications to EUT Hardware

No modifications were made by US Tech to bring the EUT into compliance with FCC Part 15.247 or IC RSS-210 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 as follows:

Table 3. Number of Test Frequencies for Intentional Radiators

FrequencyRange over which the device operates	Number ofFrequencies	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 2.4 GHz to 2.4835 GHz, 3 test frequencies will be used.

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 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 shall be 30 MHz to 1000 MHz, or to the range specified in 2.4.1 above, whichever is the higher range of investigation.

2.5 Measurement Detector Function and Bandwidth (CFR 15.35)

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

2.5.1 Detector Function and Associated Bandwidth

On frequencies below 1000 MHz, the limits herein are based upon measurement equipment employing a CISPRQuasi-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.

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 Resolution Bandwidth 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 also be expressed logarithmically in dB.

2.6 EUT Antenna Requirements (CFR 15.203)

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 module.

Table 4. Allowed Antenna(s)

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dB_i	TYPE OF CONNECTOR
External Antenna	Matrix Design Group, LLC	Trace	FXP70	+1.5	U.FL

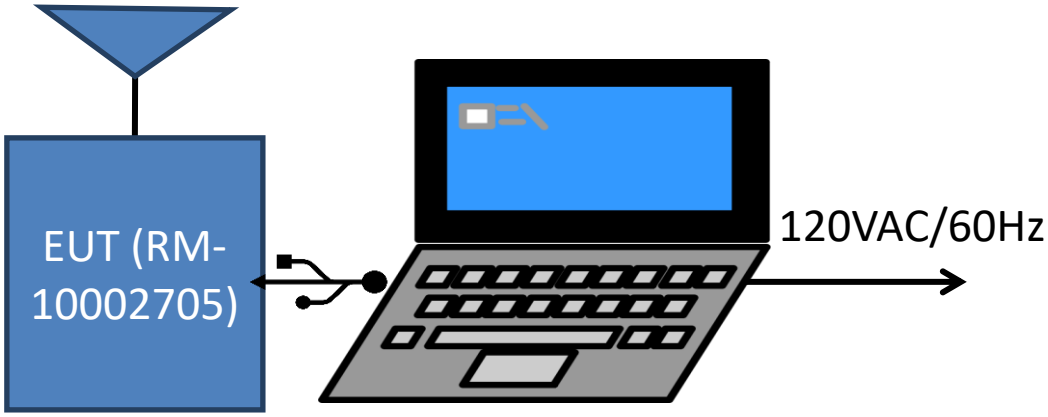


Figure 1.Block Diagram of Test Configuration

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

2.7 Restricted Bands of Operation (Part 15.205)

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

2.8 Transmitter Duty Cycle (Part15.35 (c))

The EUT employs pulse transmission however for testing purpose the EUT was programmed to transmit at a rate >98%. The pulse transmission requirements of this subpart were acknowledge and considered during testing.

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 also be expressed logarithmically in dB.

2.9 Antenna Conducted Intentional andSpurious Emissions(CFR 15.209, 15.247(d)) (IC RSS 210, A2.9 (a))

The EUT was put into a continuous-transmit mode of operation and tested per FCC KDB Publication 558074v05 for conducted out of band emissions emanating from the antenna port over thefrequency range of 30 MHz to ten times the highest clock frequency generate or used in this case, 25 GHz. A conducted scan was performed on the EUT to identify and record spurious signals that were related to the transmitter. Antenna Conducted Emissions of a significant magnitude that fell within restricted bands were then measured as radiated emissions on the OATS.The conducted emissions graphs are found in Figures 3through 8below.The limit for antenna conducted power is 1 Watt (30 dBm) per 15.247 (b)(3).

For Conducted RF antenna conducted tests, the RBW was set to 100 kHz, video bandwidth (VBW)> RBW, scan up through the 10^{th} harmonic of the fundamental frequency. All harmonics/spurs must be at least 20 dB down from the highest emission level within the authorized band.

For radiated measurements, the EUT was set into a continuous transmission mode. Below 1 GHz, the RBW of the measuring instrument was set equal to 120 kHz. Peak measurements above 1 GHz were measured using a RBW = 1 MHz, with a VBW ≥ RBW. The results of peak radiated spurious emissions falling within restricted bands are given inTable 6below.

For Average Voltage measurements above 1 GHz, the emissions were measured using RBW = 1 MHz and VBW = 10 Hz. For a pulse-modulated transmitter, the EUT's average emissions are further modified by adding to them the worst-case duty cycle, determined by adding the EUT's total pulsewidths (on time) over a 100 ms period and dividing by 100 ms.

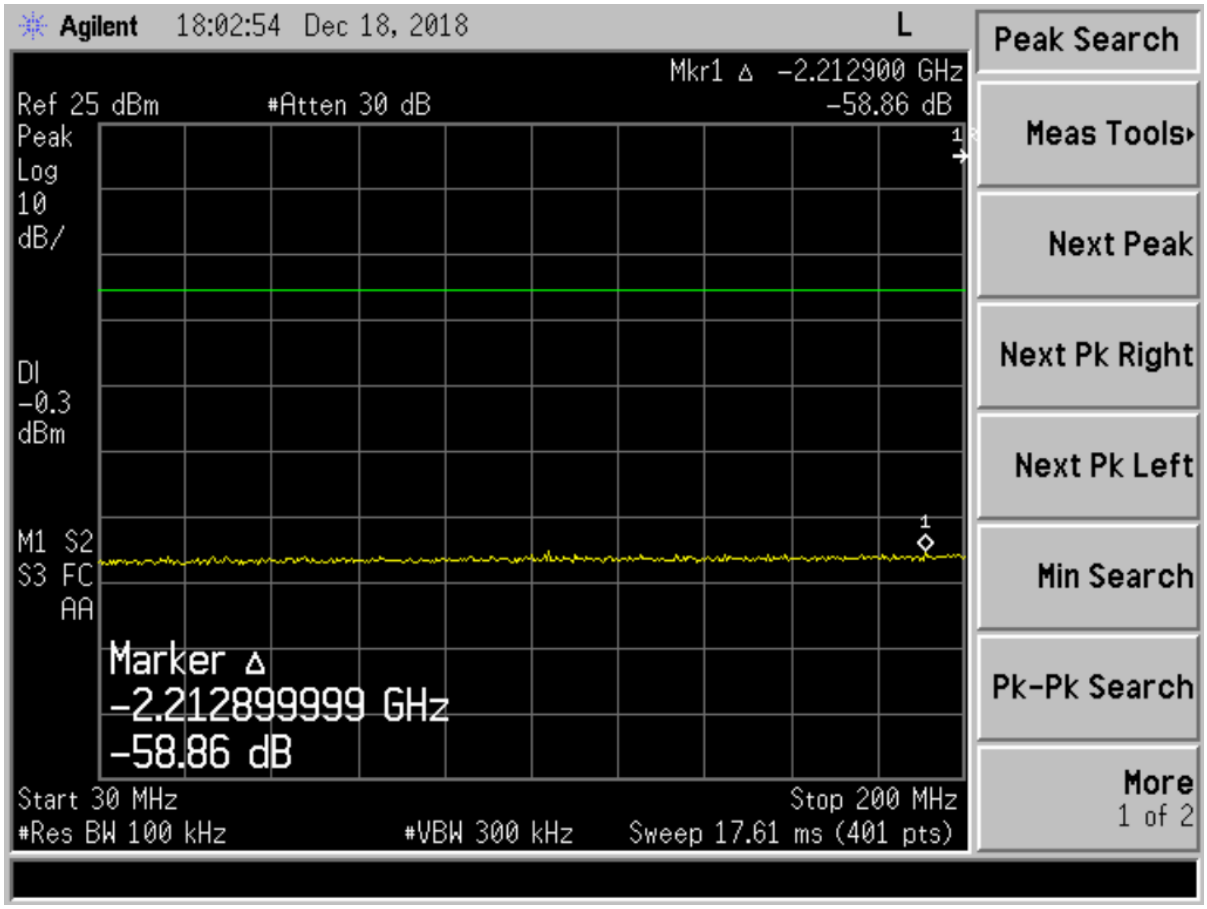


Figure 2. Conducted Spurious Emissions – Low Channel, 30 - 200 MHz

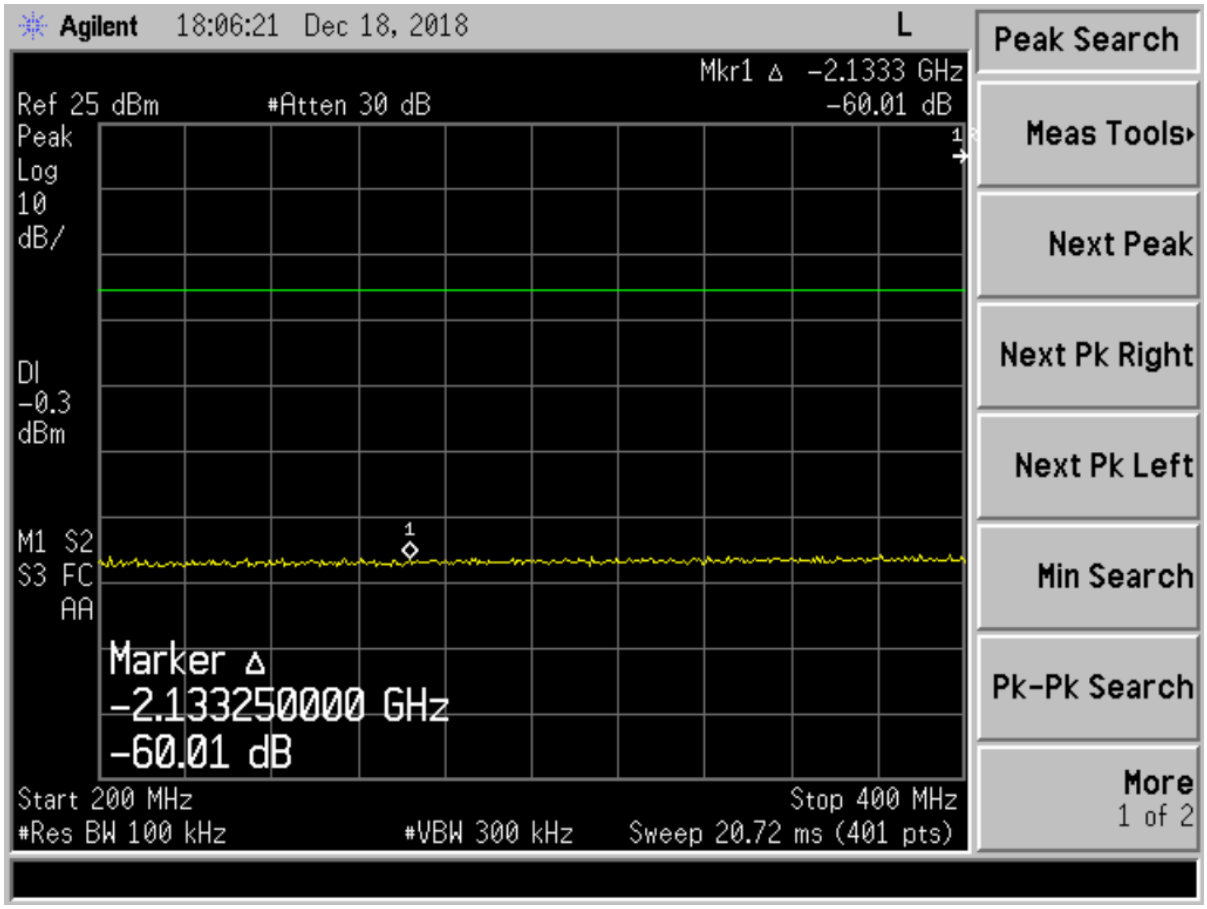


Figure 3. Conducted Spurious Emissions – Low Channel, 200 - 400 MHz

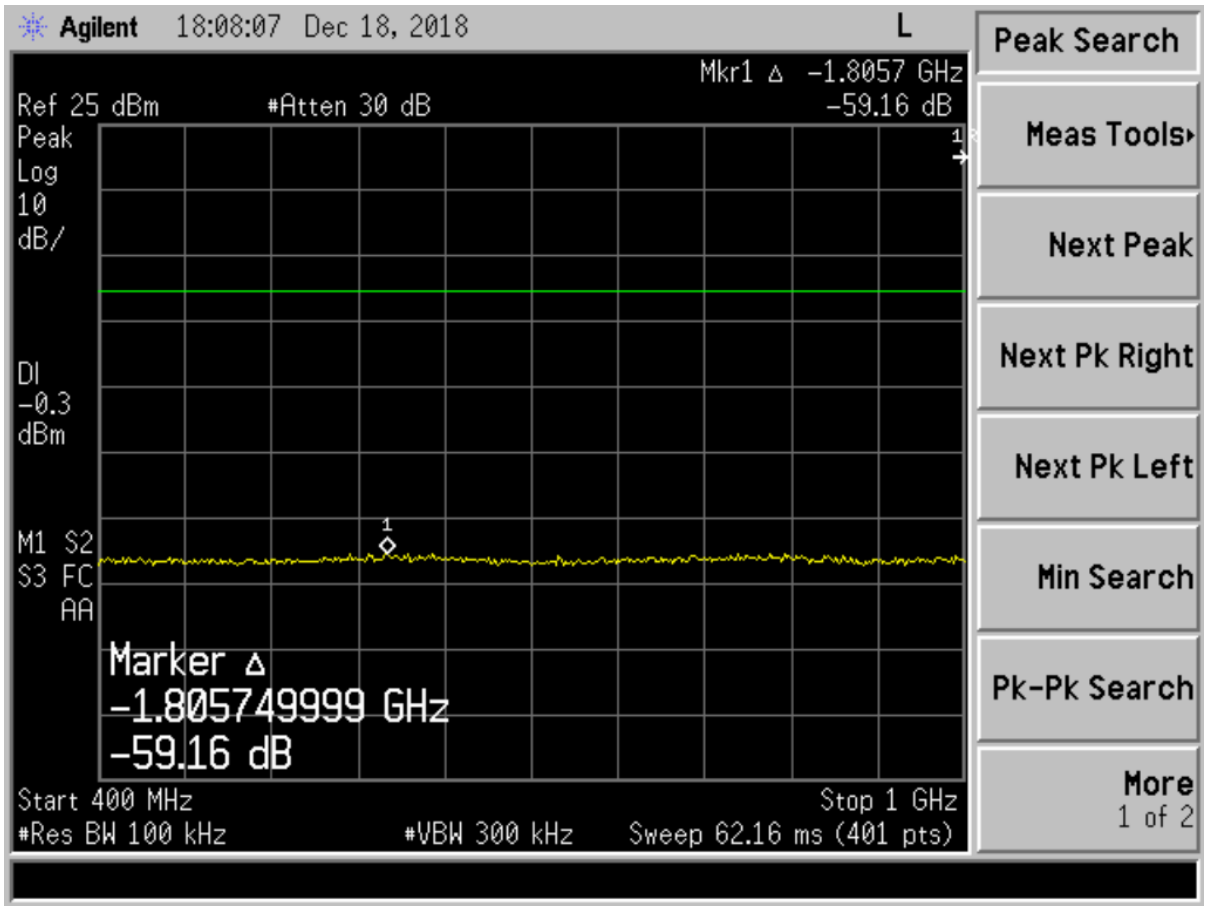


Figure 4. Conducted Spurious Emissions – Low Channel, 400 - 1000 MHz

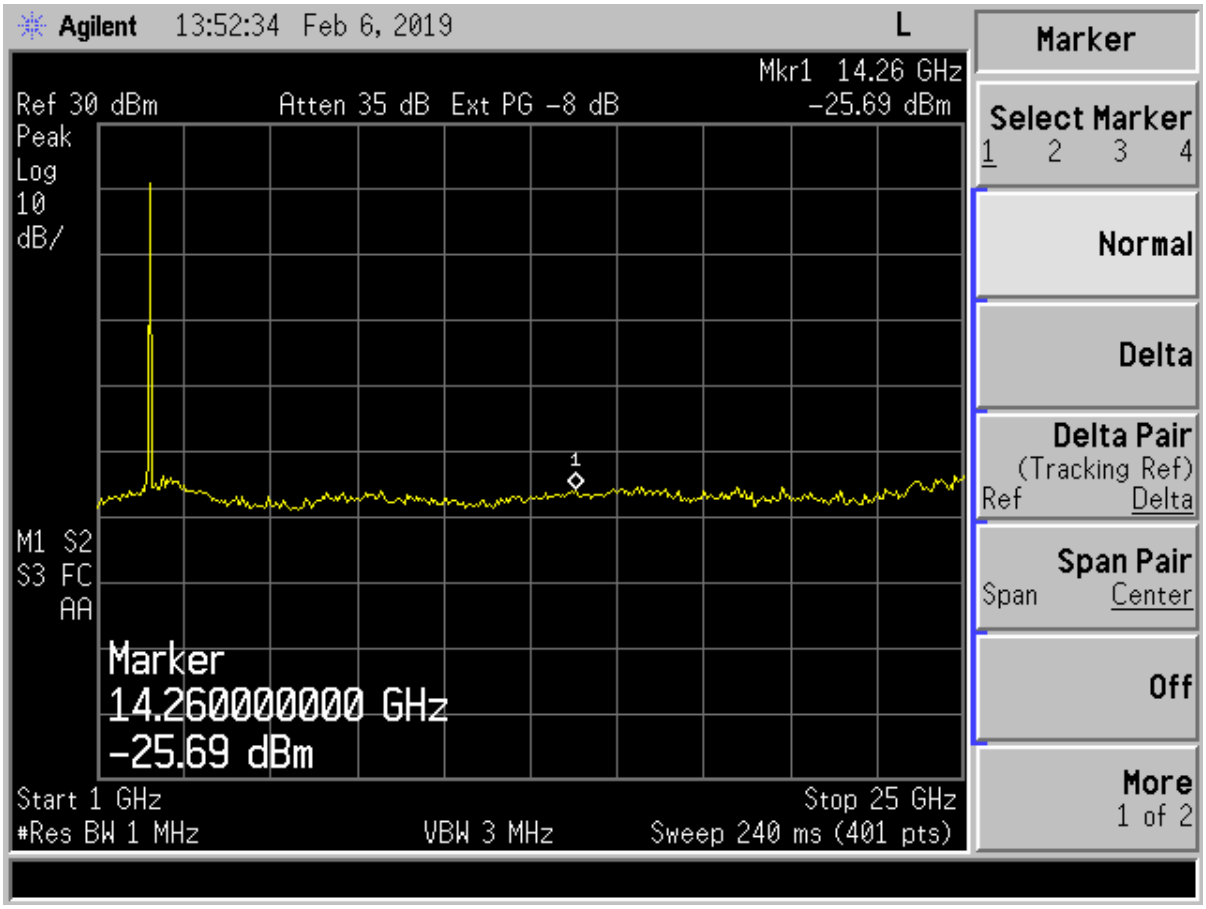


Figure 5. Conducted Spurious Emissions – Low Channel, 1 - 25 GHz

Note: Large Signal shown is Fundamental Frequency

Magnitude of Fundamental Frequency is less than 30 dBm.

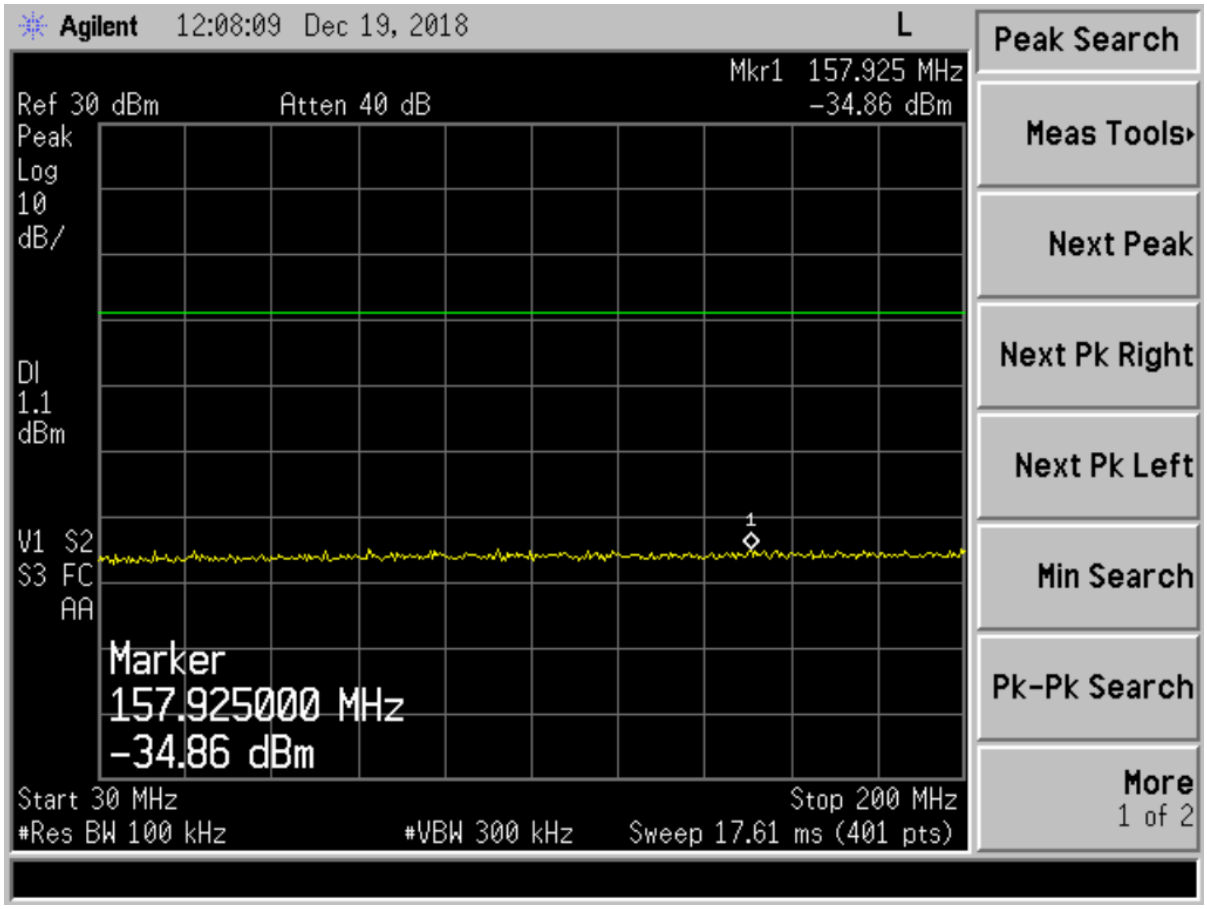


Figure 6. Conducted Spurious Emissions – Mid Channel, 30 - 200 MHz

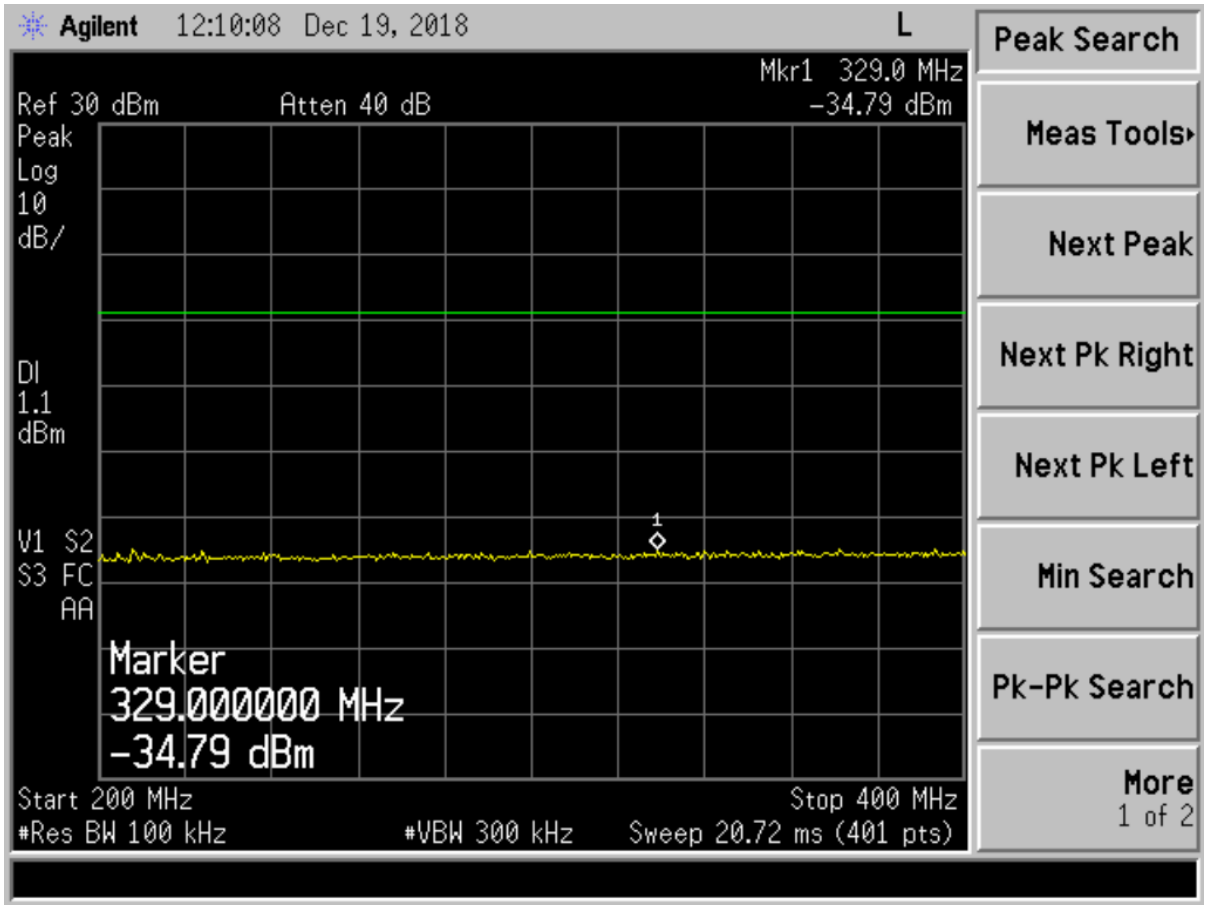


Figure 7. Conducted Spurious Emissions – Mid Channel, 200 - 400 MHz

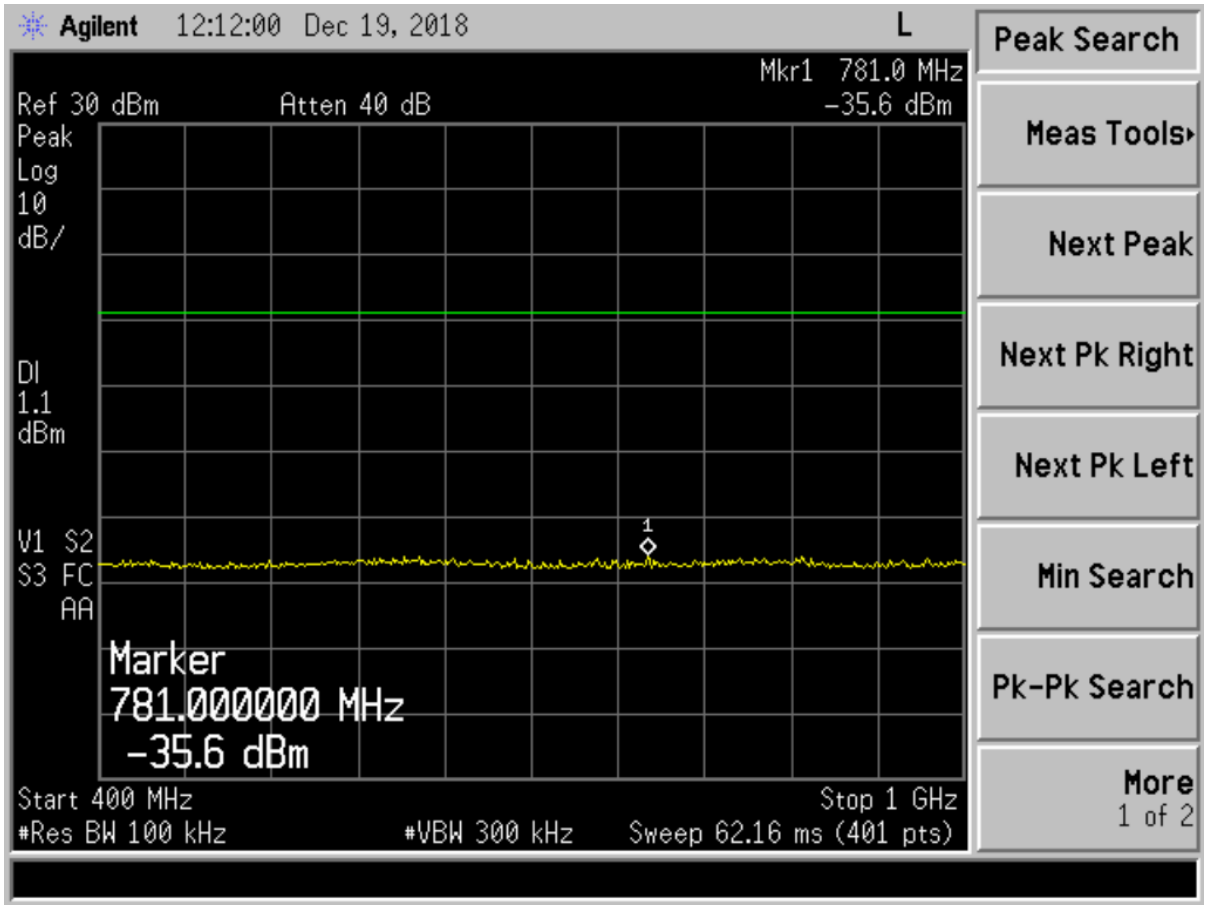


Figure 8. Conducted Spurious Emissions – Mid Channel, 400 - 1000 MHz

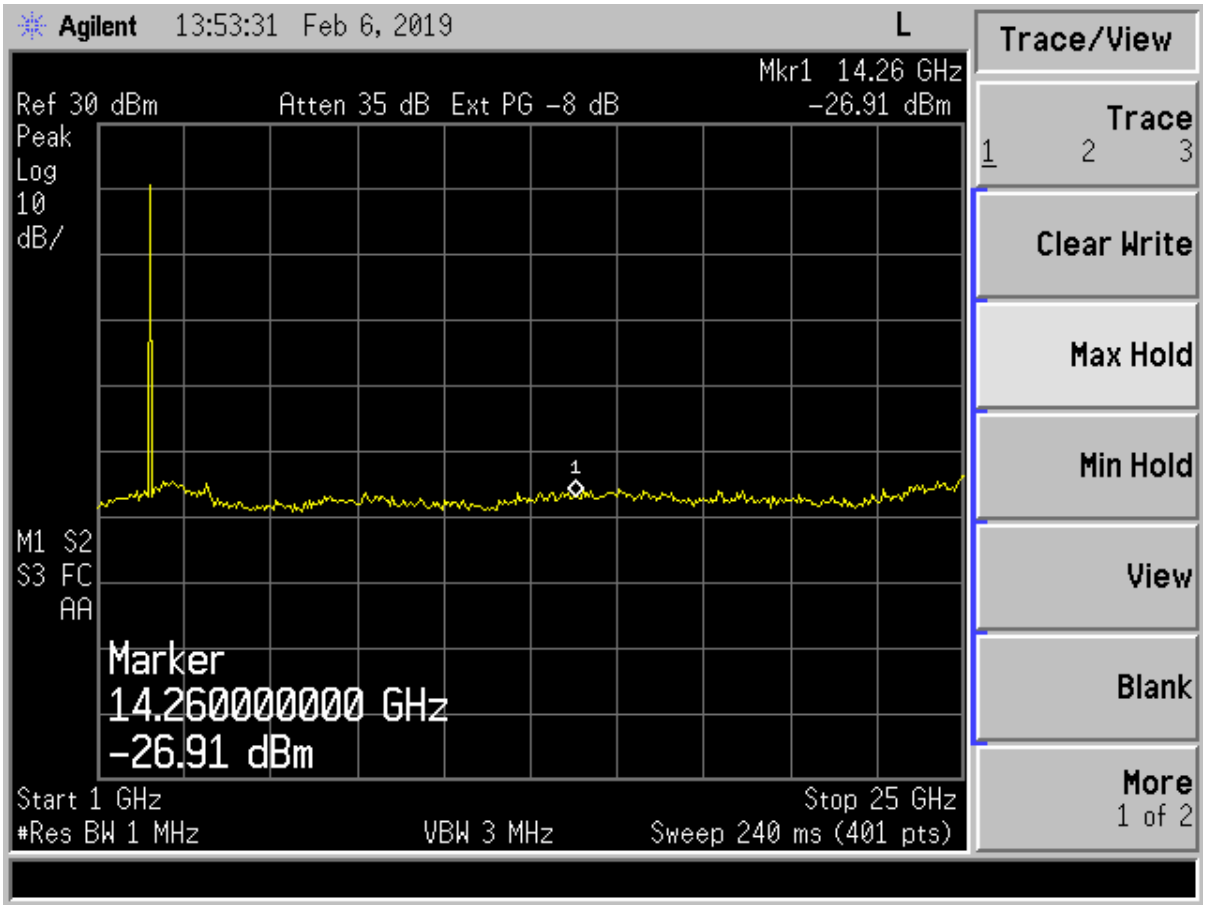


Figure 9. Conducted Spurious Emissions – Mid Channel, 1 - 25 GHz

Note: Large Signal shown is Fundamental Frequency

Magnitude of Fundamental Frequency is less than 30 dBm.

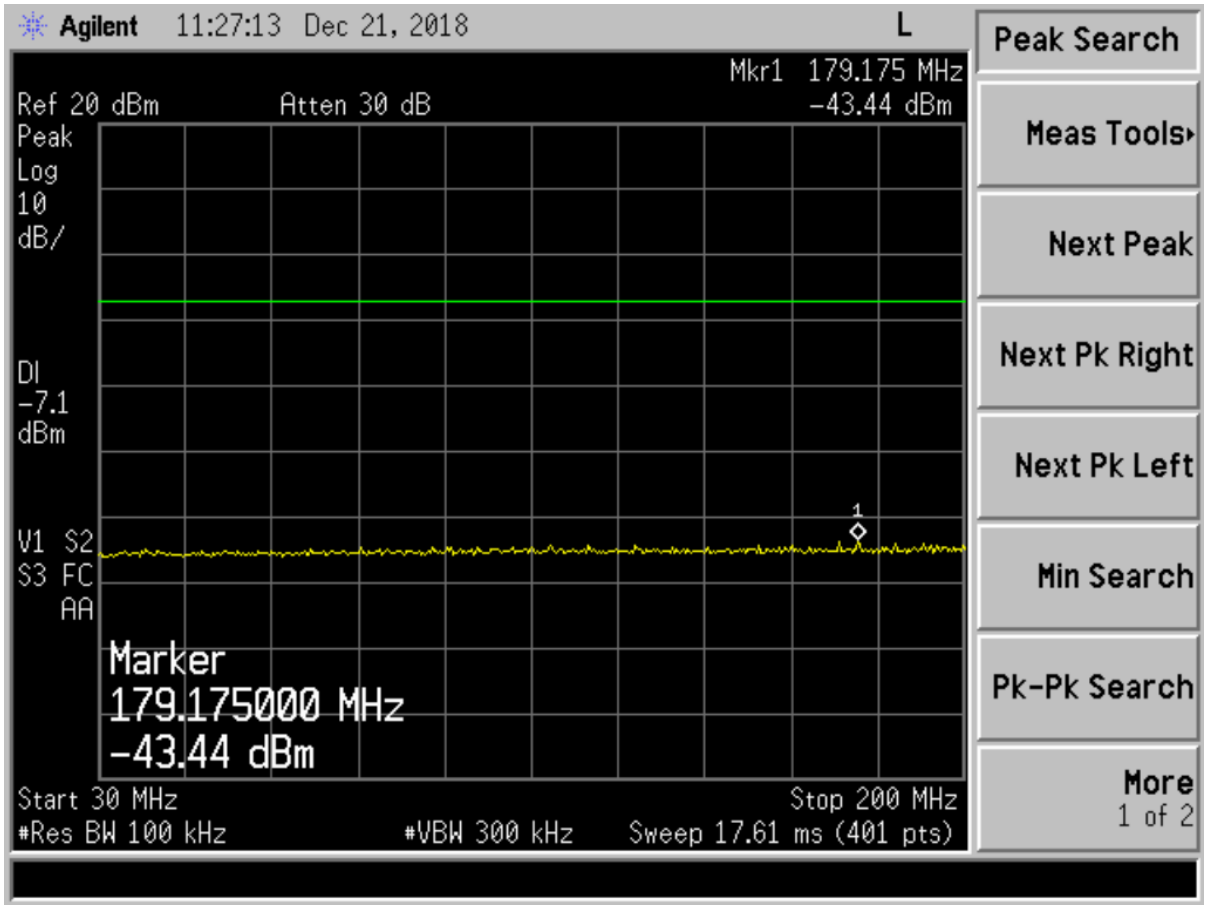


Figure 10. Conducted Spurious Emissions – High Channel, 30 - 200 MHz

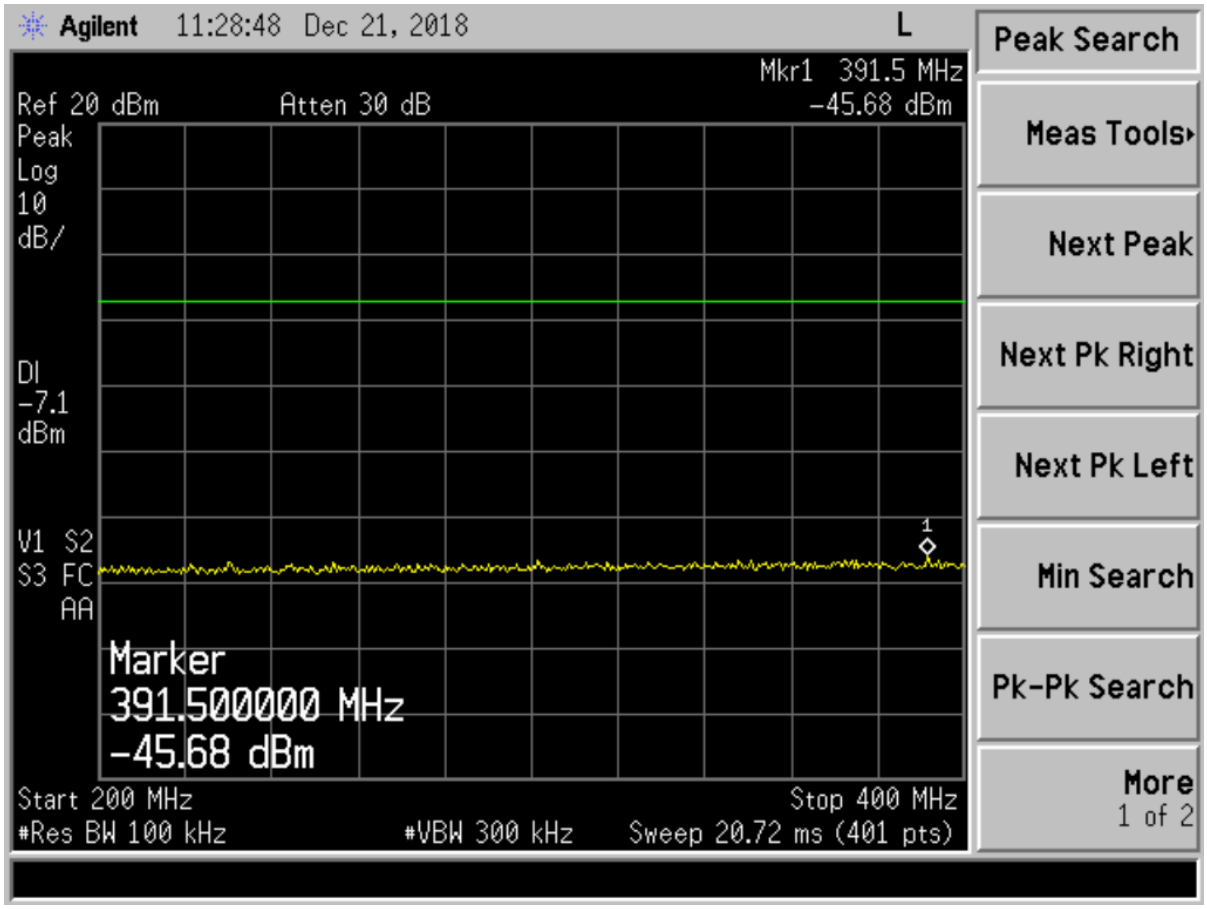


Figure 11. Conducted Spurious Emissions – High Channel, 200 - 400 MHz

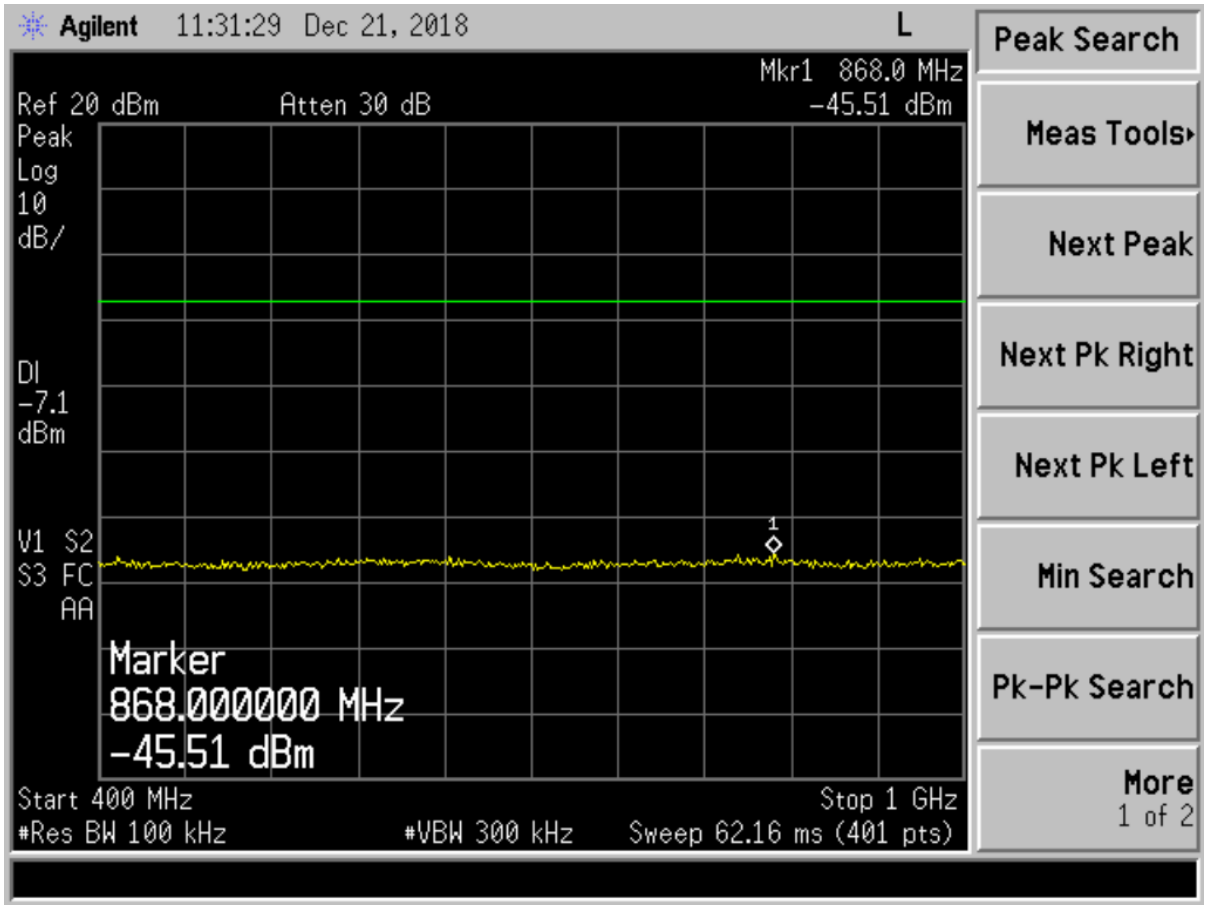


Figure 12. Conducted Spurious Emissions – High Channel, 400 - 1000 MHz

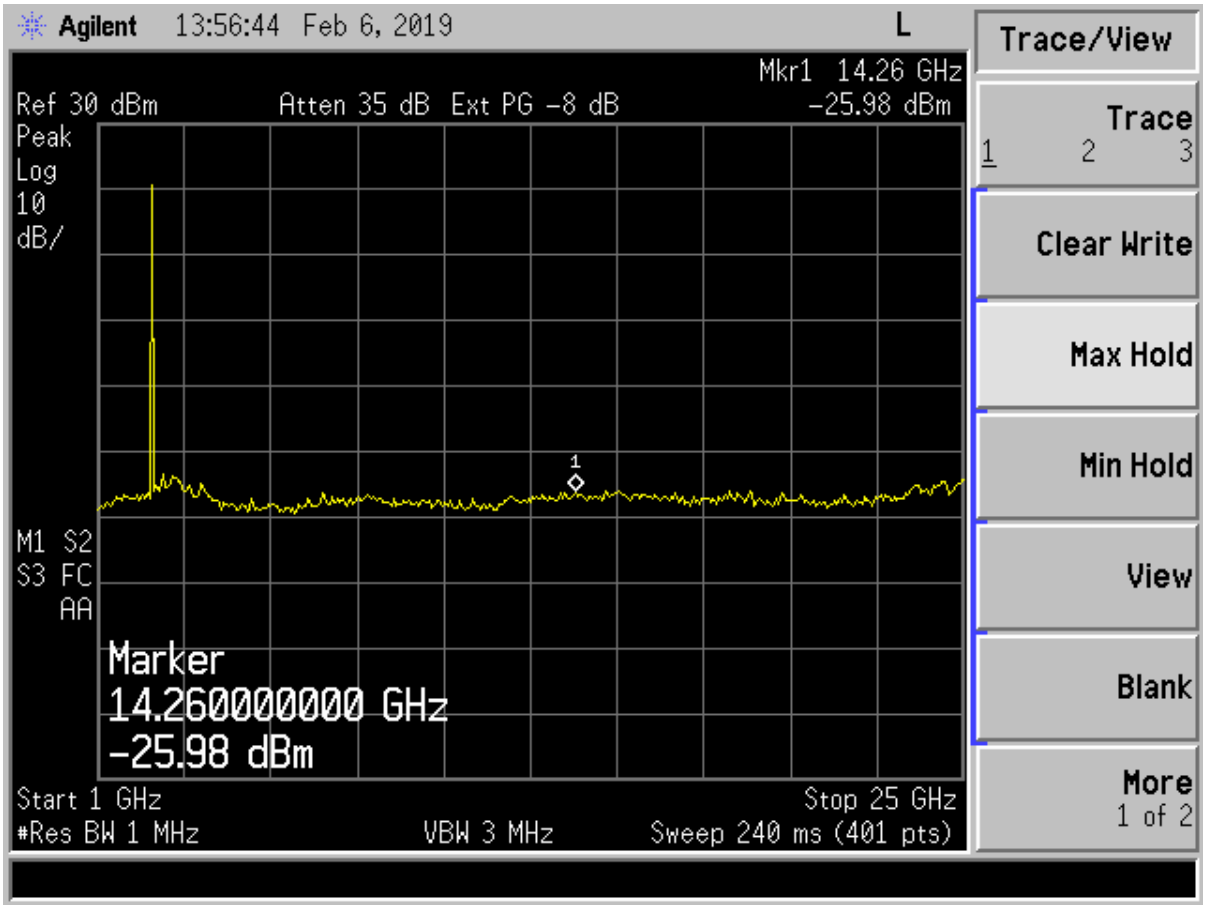


Figure 13. Conducted Spurious Emissions – High Channel, 1 - 25 GHz

Note: Large Signal shown is Fundamental Frequency

Magnitude of Fundamental Frequency is less than 30 dBm.

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

On the test site, the EUT was mounted on top of a non-conductive table, 80 cm above the floor, by placing it in the X-Z plane along the Z axis with its bottom cover in parallel with the ground. The front of the EUT faced the measurement antenna located 3 meters away. Each signal measured was maximized by raising and lowering the receive antenna between 1 and 4 meters in height while monitoring the ever changing spectrum analyzer display (with channel A in the Clear-Write mode and channel B in the Max-Hold mode) for the largest signal visible. That exact antenna height where the signal was maximized was recorded for reproducibility purposes. Also, the EUT was rotated about its Y-axis while monitoring the Spectrum Analyzer display for maximum. The EUT azimuth was recorded for reproducibility purposes. The EUT was measured when both maxima were simultaneously satisfied.

For radiated measurements, the EUT was set into a continuous transmission mode. Below 1 GHz, the RBW of the measuring instrument was set equal to 120 kHz. Peak measurements above 1 GHz were measured using a RBW = 1 MHz, with a VBW ≥ RBW. The results of peak radiated spurious emissions falling within restricted bands are given inTable 6below.

For Average measurements above 1 GHz, the emissions were measured using RBW = 1 MHz and VBW = 10 Hz or the duty cycle correction factor was applied to the Peak recorded value.

Table 5. Zigbee - Peak Radiated Fundamental & Harmonic Emissions

Tested By: AF	Test: FCC Part 15,247(d)			Client: Matrix Design Group, LLC				
	Project: 18-0382			Model: RM-10002705				
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factor**	**AF+CL-PA (dB/m)**	**Corrected Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector**
Low Channel - PEAK								
2405.00	85.77	0.00	32.85	118.62	--	3.0m./HORZ	--	**PK**
*4809.00	53.65	0.00	5.63	59.28	74.0	3.0m./HORZ	14.7	**PK**
*7214.00	62.12	-9.50	11.25	63.87	74.0	1.0m./HORZ	10.1	**PK**
Mid Channel - PEAK								
2440.00	75.11	0.00	34.05	115.50	--	3.0m./HORZ	--	**PK**
*4879.00	54.89	0.00	6.46	59.22	74.0	3.0m./HORZ	14.8	**PK**
*7320.00	61.17	-9.50	16.35	68.34	74.0	1.0m./HORZ	5.7	**PK**
High Channel– PEAK								
2480.00	74.36	0.00	34.06	108.80	--	3.0m./HORZ	--	**PK**
*4960.00	55.10	0.00	7.69	61.32	74.0	3.0m./HORZ	12.7	**PK**
*7440.00	60.75	-9.50	16.49	66.14	74.0	1.0m./HORZ	7.9	**PK**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209& 15.247.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic

Sample Calculation at 2405.00 MHz:

Magnitude of Measured Frequency	85.77	dBuV
+Additional Factor	0.00	dB
+Antenna Factor + Cable Loss+ Amplifier Gain	32.85	dB/m
Corrected Result	118.62	dBuV/m

Test Date: December 17, 2018
Tested By
Signature: Afzal Fazal Name: Afzal Fazal

Table 6. Zigbee - Average Radiated Fundamental & Harmonic Emissions

Tested By: AF	Test: FCC Part 15,247(d)			Client: Matrix Design Group, LLC				
	Project: 18-0382			Model: RM-10002705				
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factor**	**AF+CL-PA (dB/m)**	**Corrected Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector**
Low Channel - AVERAGE								
2405.00	74.69	0.00	32.85	107.54	--	3.0m./HORZ	--	**AVG**
*4809.00	44.68	0.00	5.63	50.31	54.0	3.0m./HORZ	3.7	**AVG**
*7214.00	51.82	-9.50	11.25	53.57	54.0	1.0m./HORZ	0.4	**AVG**
Mid Channel –AVERAGE								
2437.00	75.11	0.00	34.05	106.22	--	3.0m./HORZ	--	**AVG**
*4874.00	54.89	0.00	6.46	51.27	54.0	3.0m./HORZ	2.7	**AVG**
*7311.00	61.17	-9.50	16.35	53.20	54.0	1.0m./HORZ	0.8	**AVG**
High Channel–AVERAGE								
2462.00	74.36	0.00	34.06	98.55	--	3.0m./HORZ	--	**AVG**
*4924.00	55.10	0.00	7.69	47.95	54.0	3.0m./HORZ	6.0	**AVG**
*7386.00	60.75	-9.50	16.49	52.01	54.0	1.0m./HORZ	2.0	**AVG**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209& 15.247.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic

Sample Calculation at 2405.00 MHz:

Magnitude of Measured Frequency	74.69	dBuV
+Additional Factor	0.00	dB
+Antenna Factor + Cable Loss+ Amplifier Gain	32.85	dB/m
Corrected Result	107.54	dBuV/m

Test Date: December 17, 2018
Tested By
Signature: Afzal Fazal Name: Afzal Fazal

Note: The transmitter was programmed to transmit at >98% during all testing.

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

Band Edge measurements are made following the guidelines in FCC KDB Publication No. 558074v05with the EUT initially operating on the Lowest Channel and then operating on the Highest Channel within its band of operation. Antenna port conducted measurements are performed 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). Because these frequencies occur above 1000 MHz they have both a peak and average requirement.

To capture the band edge set the Spectrum Analyzer frequency span large enough (usually around 10 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. Conducted measurements are performed with RBW ≥1% of the frequency span. In all cases, the VBW is set ≥ RBW. See figures and calculations below for more detail.

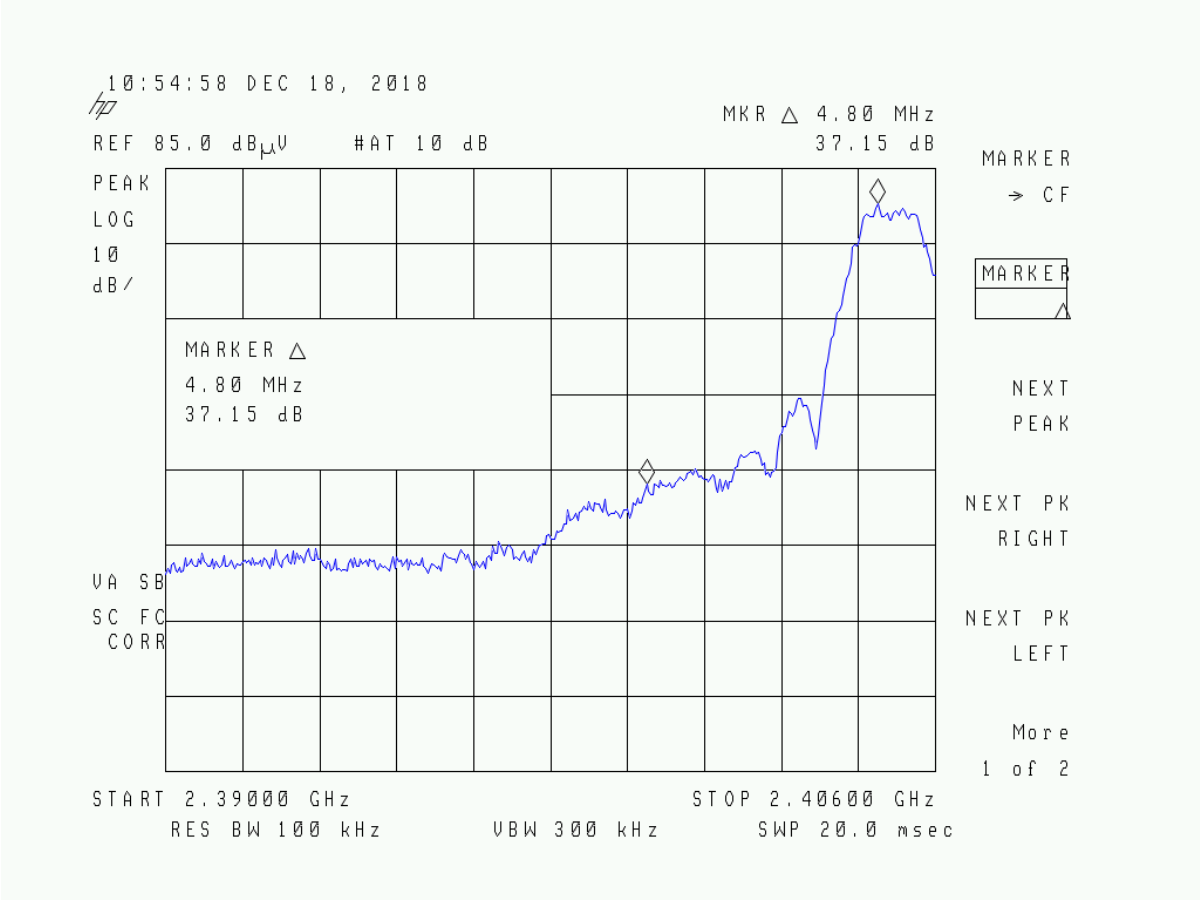


Figure 14. Band Edge Compliance – Low Channel Delta - Peak

Lower band edge must be 20 dB below the fundamental. This requirement is met.

Measured Result	37.15	dB
Band Edge Limit	20.00	dB
Band Edge Margin	17.15	dB

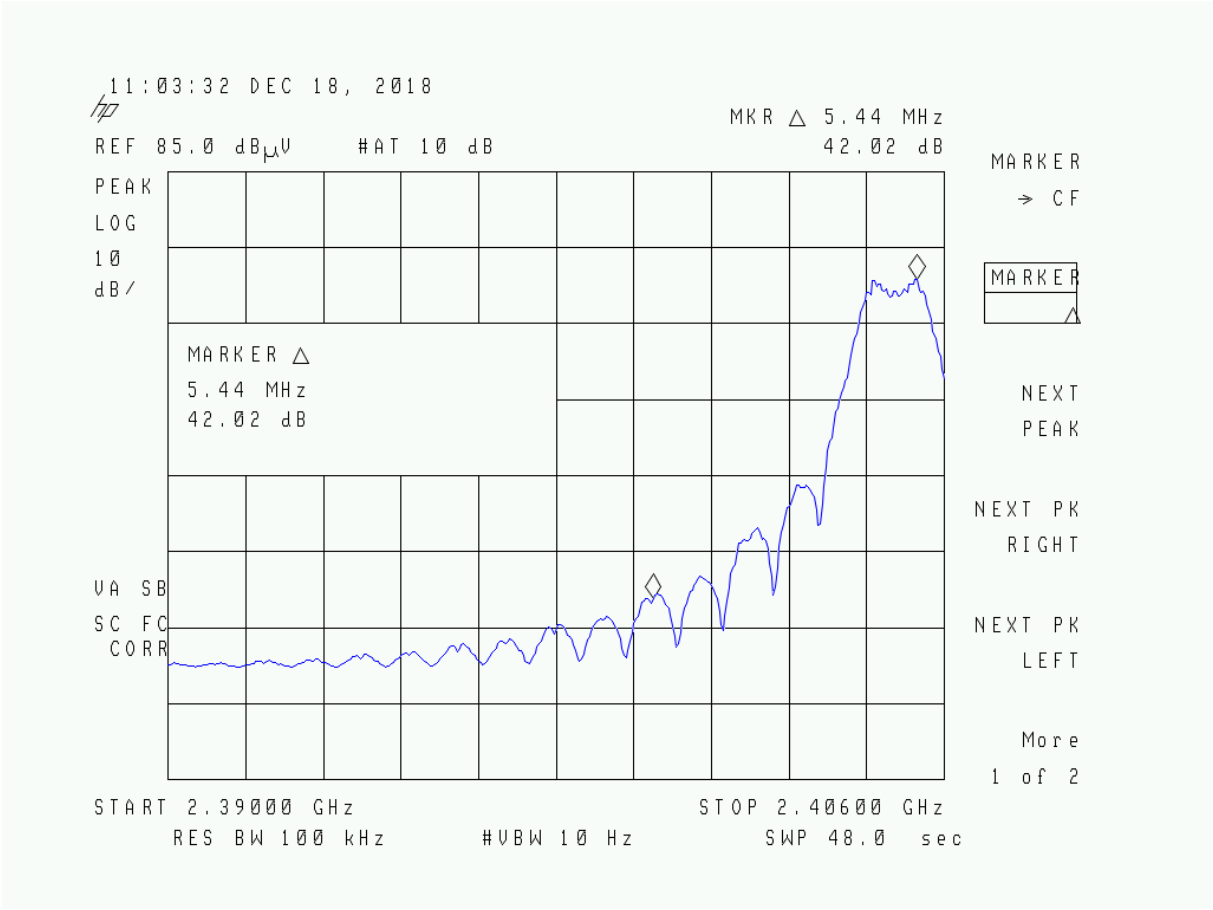


Figure 15. Band Edge Compliance – Low Channel Delta - Average

Lower band edge must be 20 dB below the fundamental. This requirement is met.

Measured Result	42.02	dB
Band Edge Limit	20.00	dB
Band Edge Margin	22.02	dB

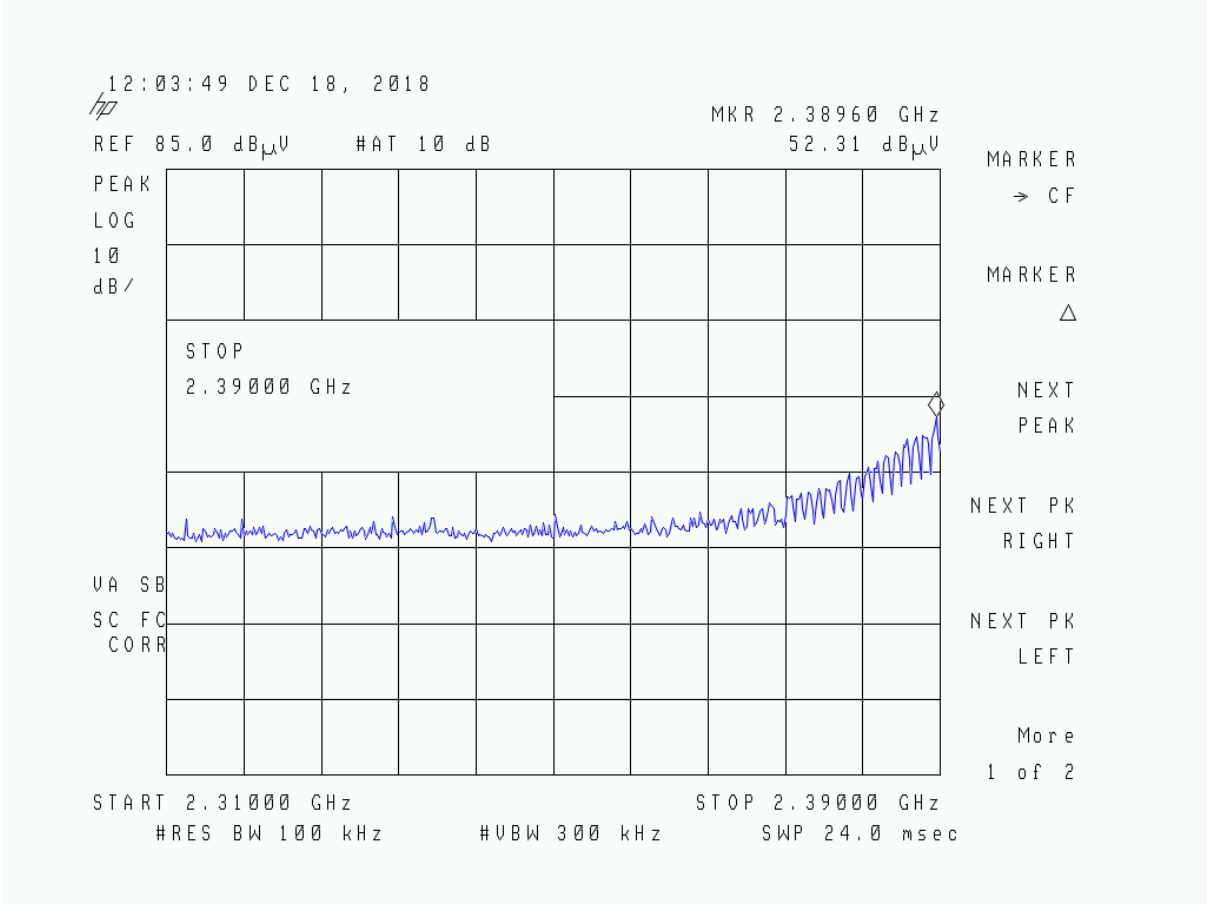


Figure 16. Low Channel Restricted Band - Peak

Frequency (MHz)	Test Data (dBuV)	AF+CA-AMP+DC (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detector PK/QP/AVG
2390.00	352.31	-2.95	49.36	74.0	3.0m./HORZ	24.6	**PK**

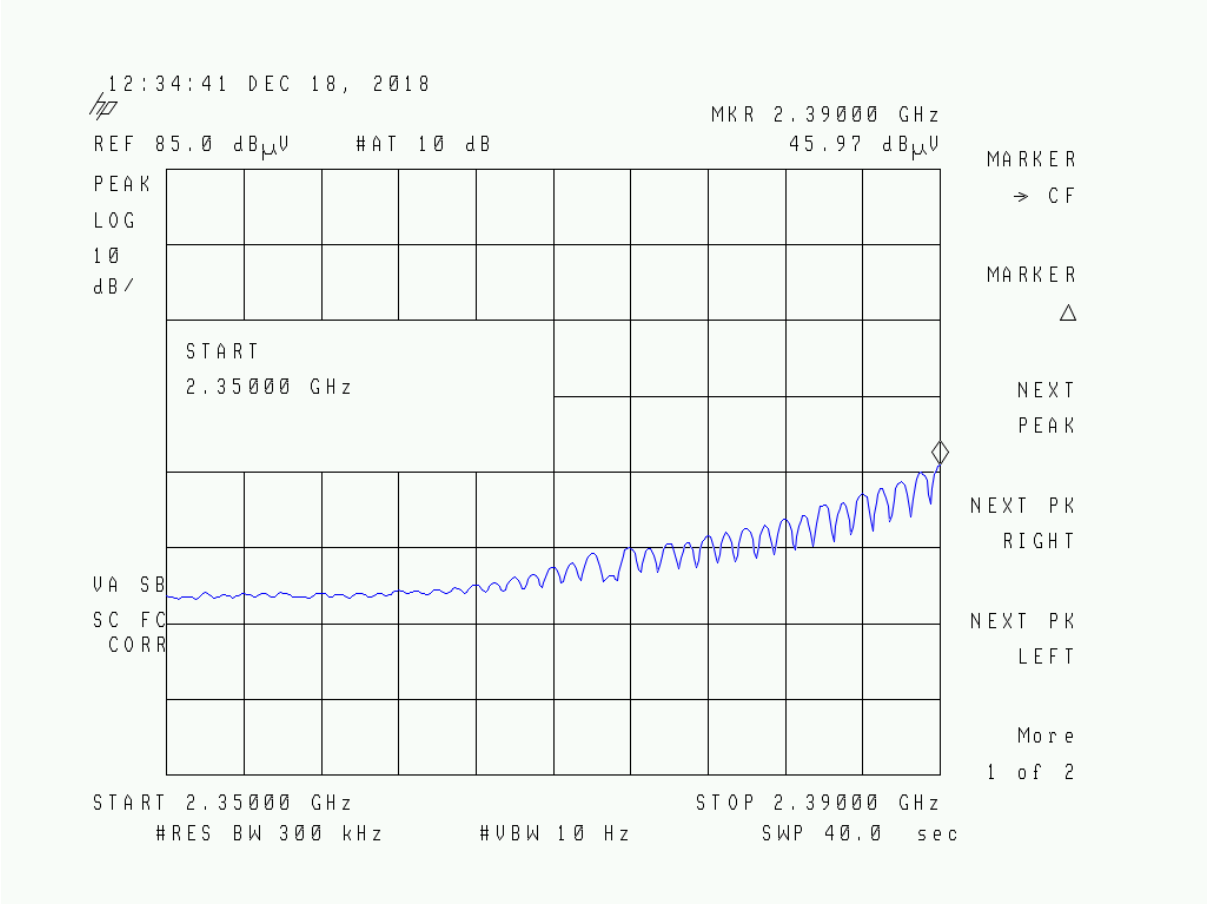


Figure 17. Low Channel Restricted Band - Average

Frequency (MHz)	Test Data (dBuV)	AF+CA-AMP+DC (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detector PK/QP/AVG
2390.00	45.97	-2.95	43.02	54.0	3.0m./HORZ	11.0	**AVG**

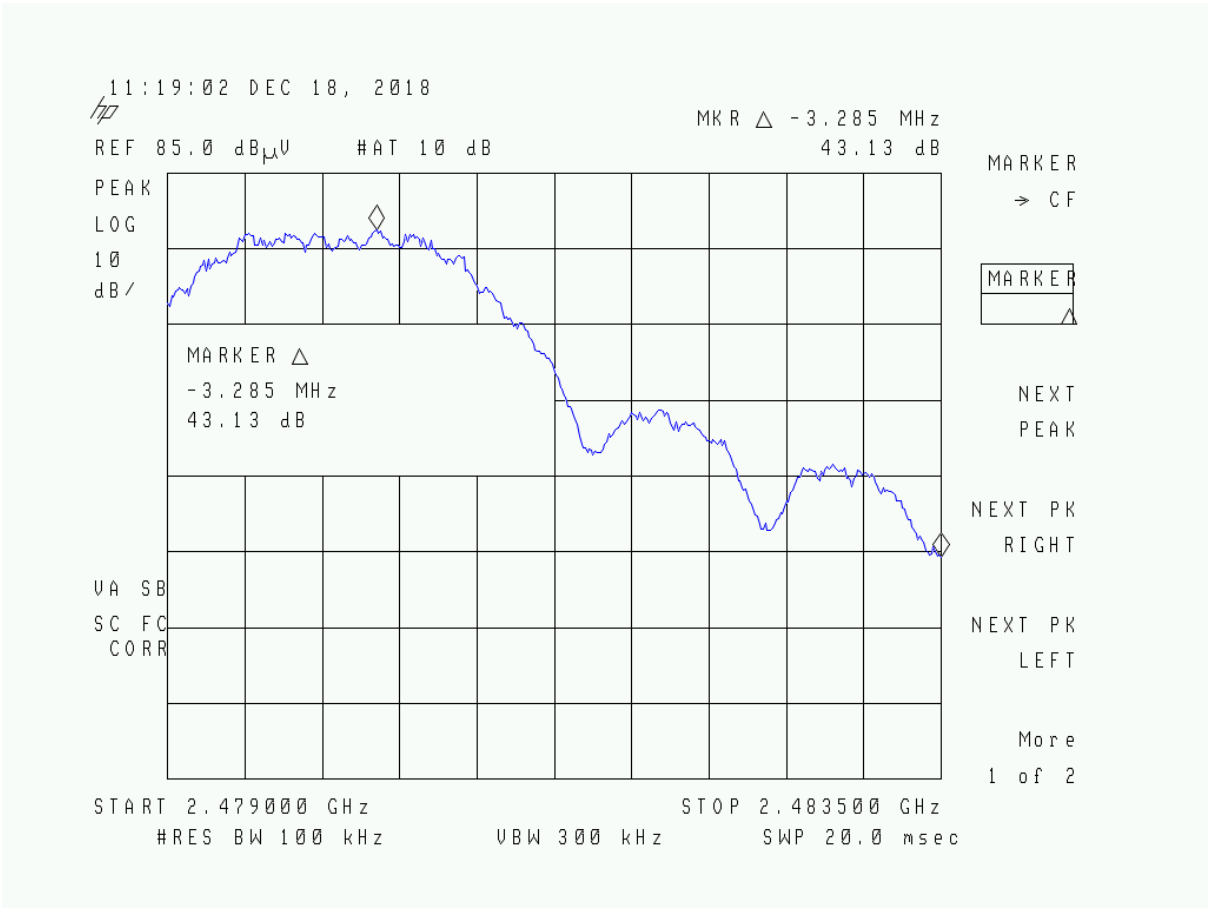


Figure 18. Band Edge Compliance – High Channel Delta - Peak

Higher band edge must be 20 dB below the fundamental. This requirement is met.

Measured Result	43.13	dB
Band Edge Limit	20.00	dB
Band Edge Margin	23.13	dB

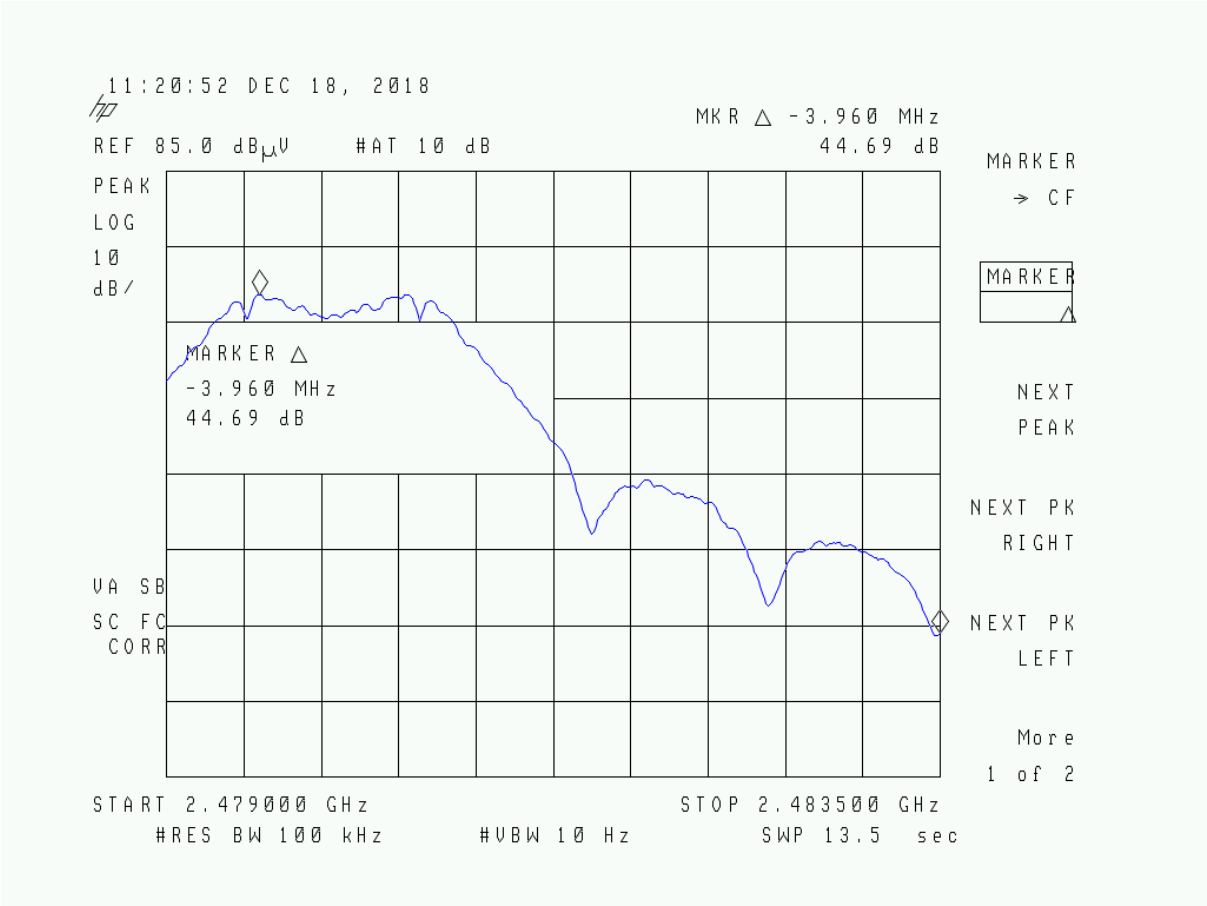


Figure 19. Band Edge Compliance – High Channel Delta - Average

Higher band edge must be 20 dB below the fundamental. This requirement is met.

Measured Result	44.69	dB
Band Edge Limit	20.00	dB
Band Edge Margin	24.69	dB

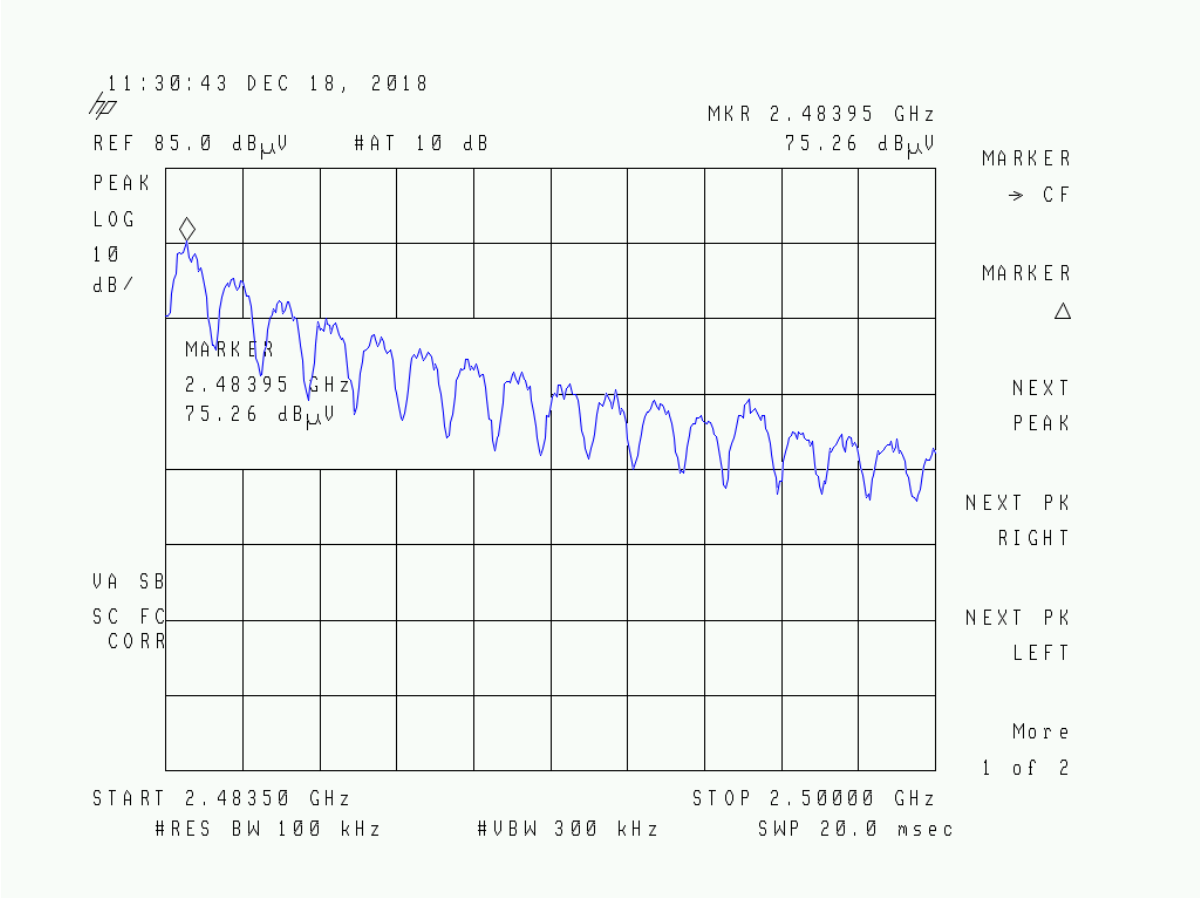


Figure 20. High Channel Restricted Band – Peak

Frequency (MHz)	Test Data (dBuV)	AF+CA-AMP+DC (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detector PK/QP/AVG
2483.95	75.26	-1.63	73.63	74.0	3.0m./HORZ	0.4	**PK**

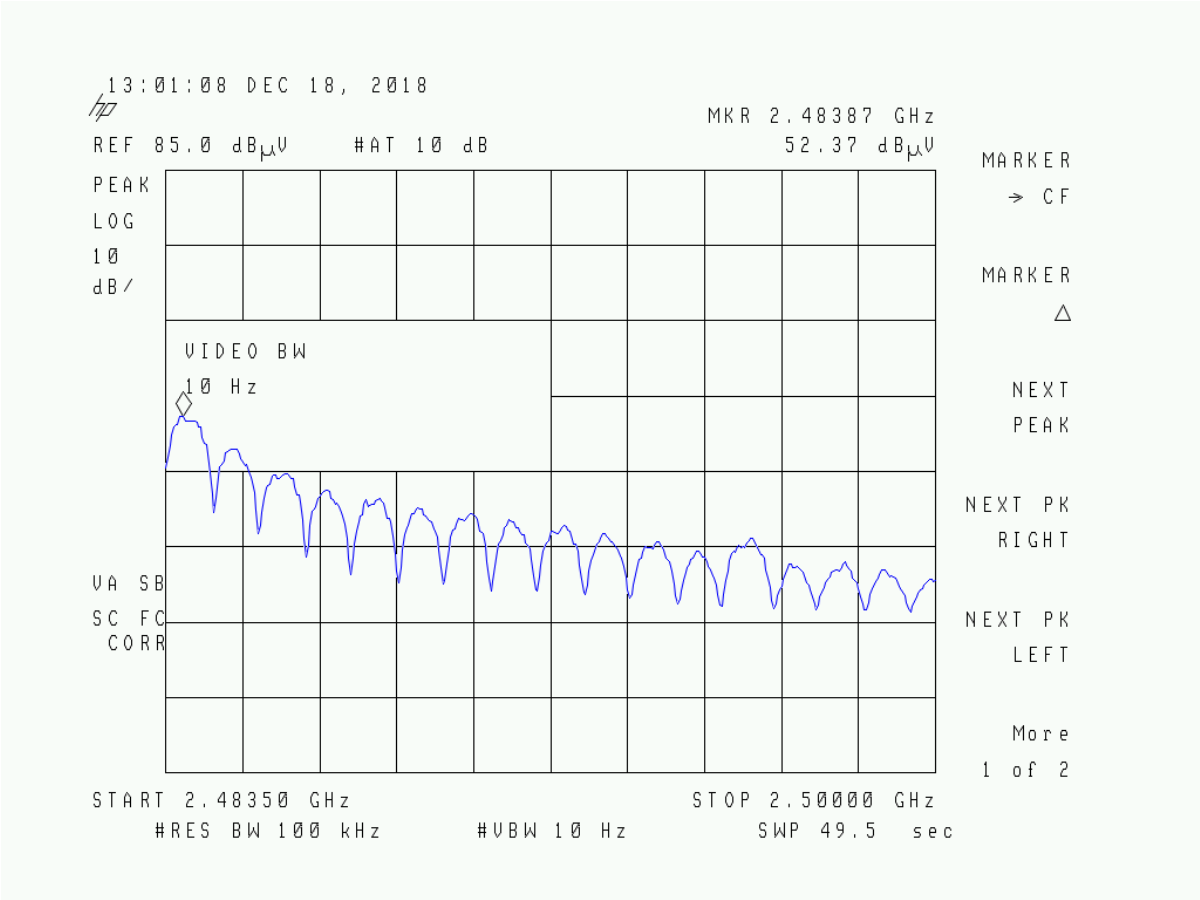


Figure 21. High Channel Restricted Band - Average

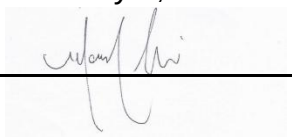
Frequency (MHz)	Test Data (dBuV)	AF+CA-AMP+DC (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detector PK/QP/AVG
2483.83	52.32	-1.63	50.69	54.0	3.0m./HORZ	3.3	**AVG**

2.12 Six (6) dB Bandwidth per CFR 15.247(a)(2)

The EUT antenna port was connected to a spectrum analyzer having a 50 Ωinput impedance. Measurements were performed similar to the method of FCC, KDB Publication No. 558074 v05for a bandwidth of 6 dB. 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 the table below and figures below.

Table 7. Six (6) dB Bandwidth

Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum FCC Bandwidth (MHz)
2405	1.466	0.5
2440	1.450	0.5
2480	1.576	0.5

Test Date: February 6, 2019
Tested By
Signature:  Name: Mark Afroozi

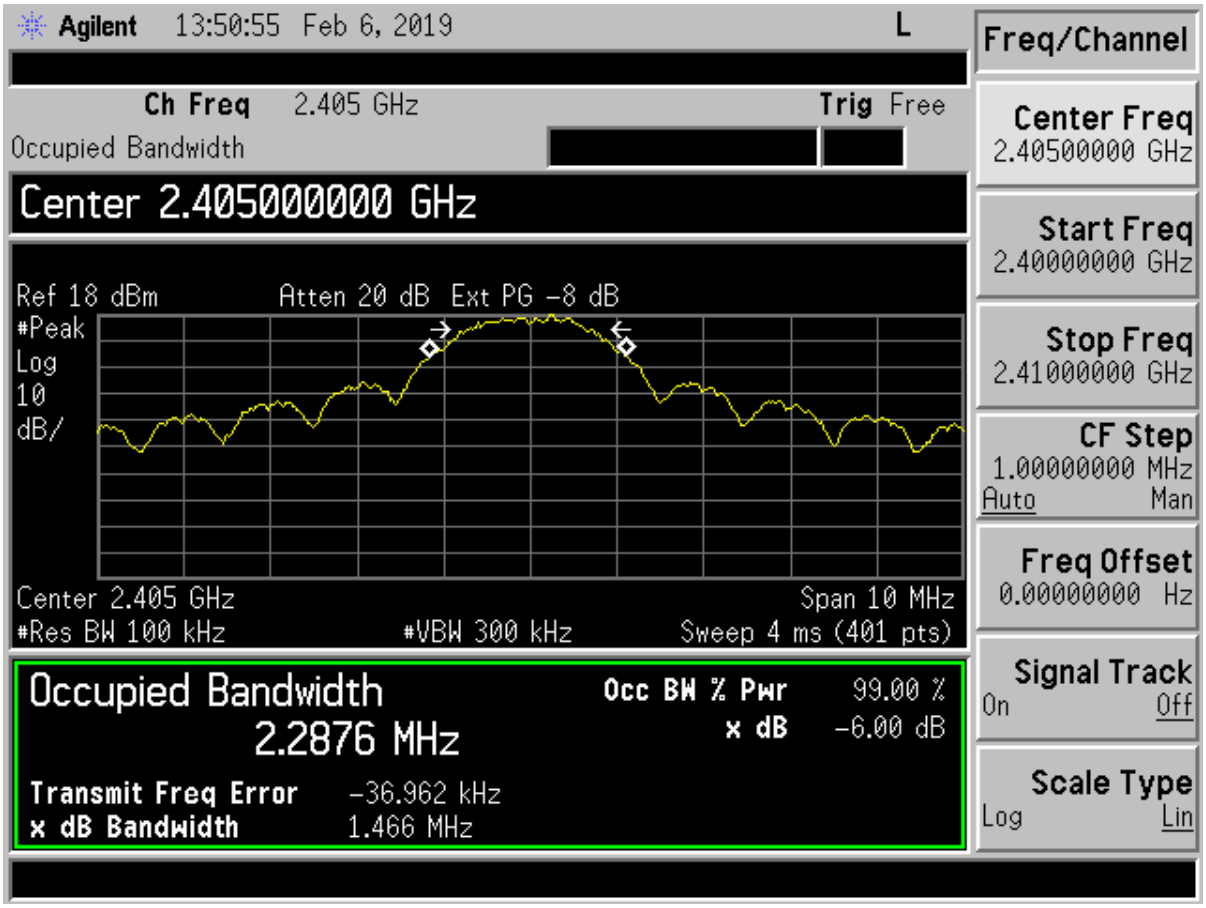


Figure 22. 6 dB Bandwidth Low Channel

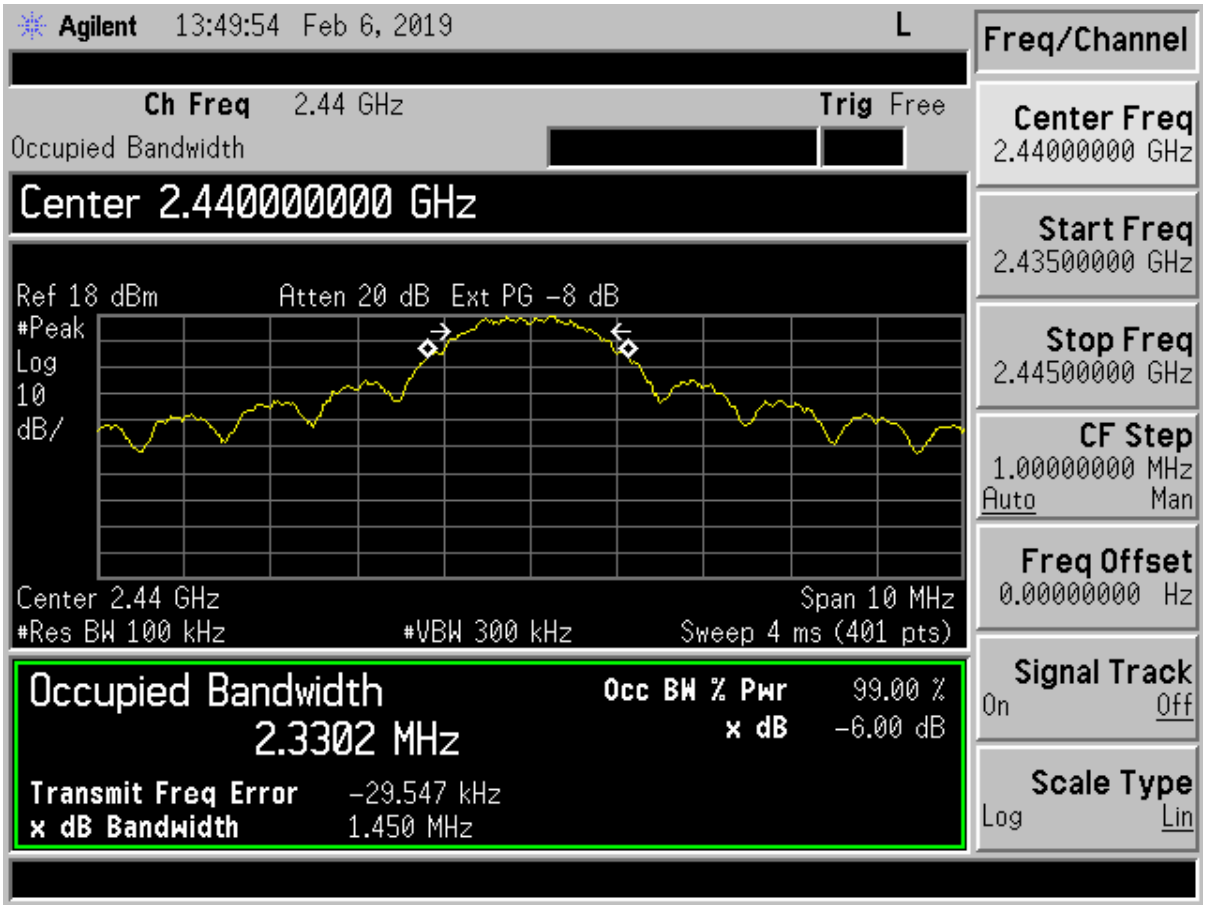


Figure 23. 6 dB Bandwidth Mid Channel

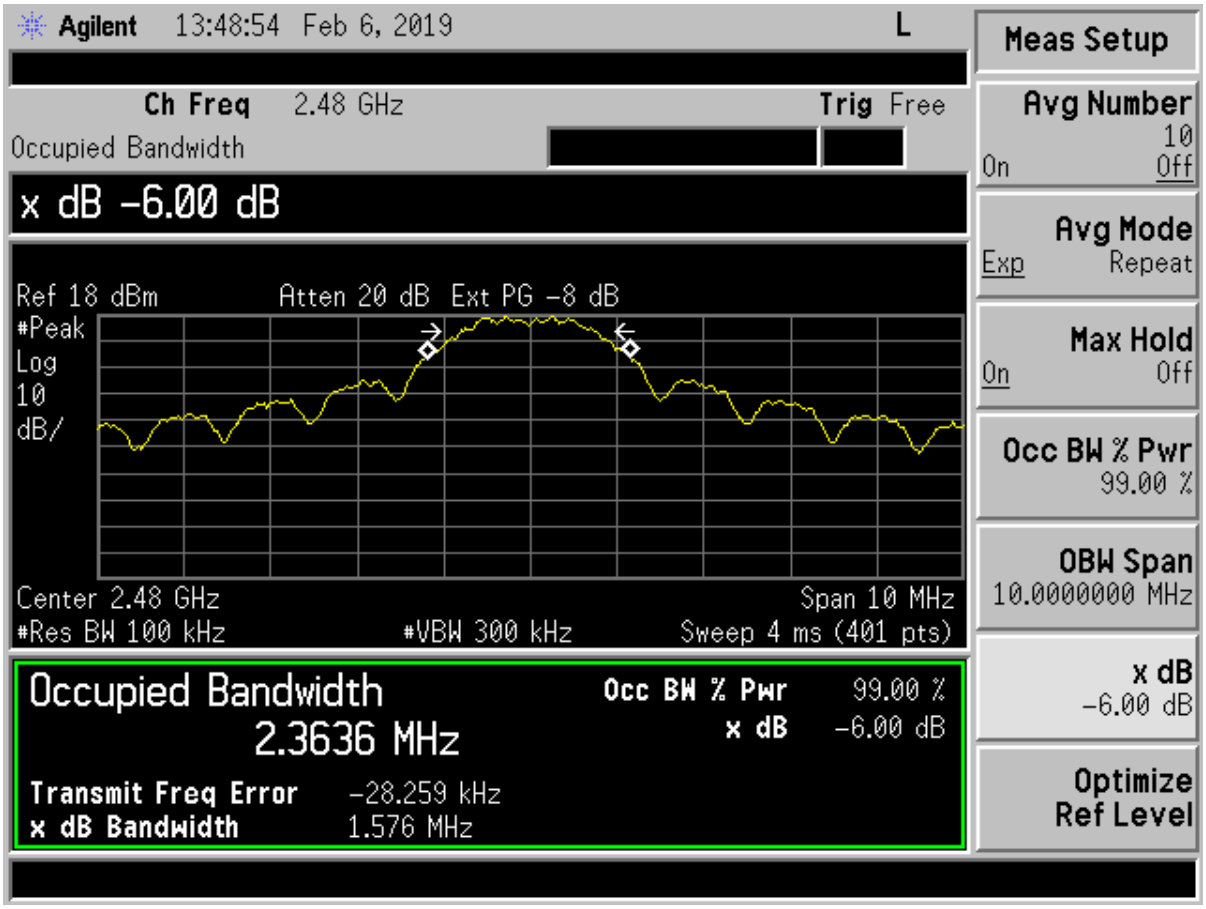


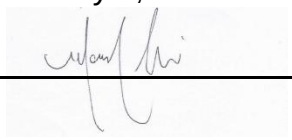
Figure 24. 6 dB Bandwidth High Channel

2.13 Occupied Bandwidth, 99% bandwidth(RSS-GEN (6.6))

The EUT antenna port was connected to a spectrum analyzer having a 50Ω input impedance. Measurements were performed similar to the method of ANSI C63.10-2013 Clause 6 & 11. 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 the table below and figures below.

Table 8. 99% Occupied Bandwidth

Frequency (MHz)	(99%) Occupied Bandwidth (MHz)
2405.0	2.288
2440.0	2.330
2480.0	2.364

Test Date: February 6, 2019
Tested By
Signature:  Name: Mark Afroozi

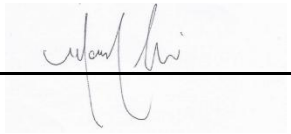
2.14 Maximum Peak Conducted Output Power (CFR 15.247 (b) (3))

For theRM-10002705, the transmitter was programmed to operate at a maximum output power across the bandwidth. For this test the output power of the radio was set to the highest level, 0XFF.

Peak power within the band 2400 MHz to 2483.5 MHz was measured per FCC KDB Publication 558074 v05 as an Antenna Conducted test with a spectrum analyzer by connecting the spectrum analyzer directly, via a short RF cable, and attenuators to the antenna output terminals on the EUT. The spectrum analyzer was set for an impedanceof 50 Ωwith the RBW set greater than the 6 dB bandwidth of the EUT, and the VBW ≥ RBW.Peak antenna conducted output power is tabulated in the table below.

Table 9. 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)
2405	21.37	137.08	1000
2440	21.23	132.74	1000
2480	21.22	132.43	1000

Test Date: December 18-19, 2018
Tested By
Signature:  Name: Mark Afroozi

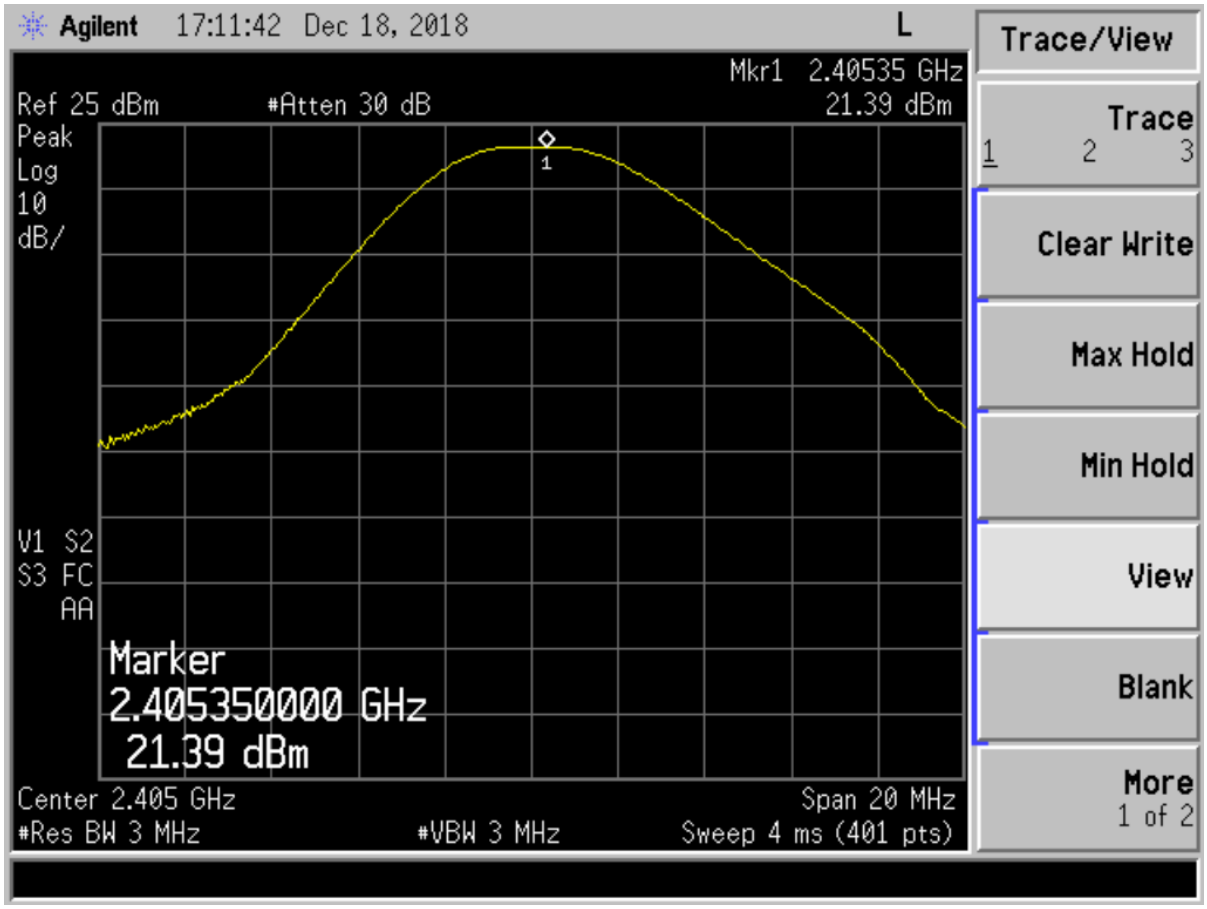


Figure 25. Peak Antenna Conducted Output Power, Low Channel

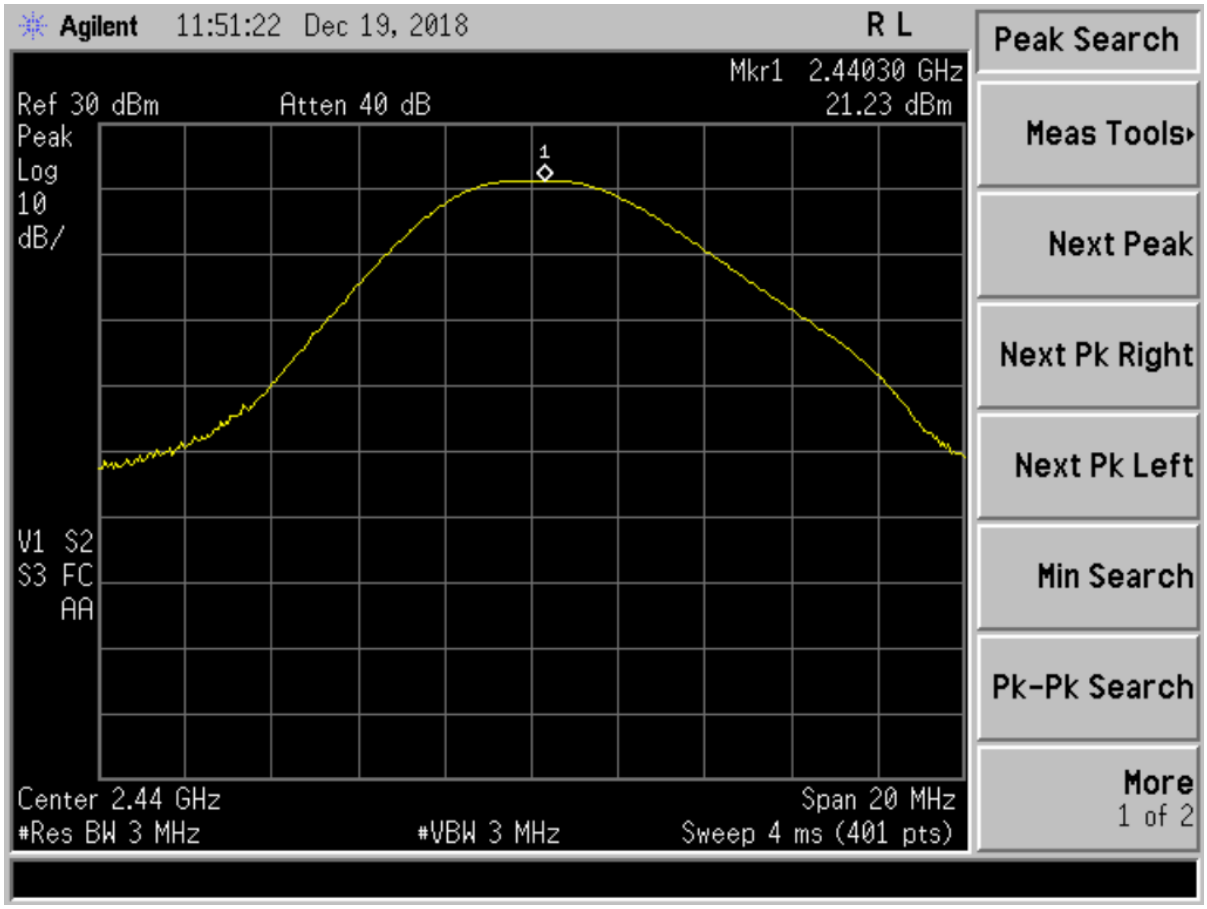


Figure 26. Peak Antenna Conducted Output Power, Mid Channel

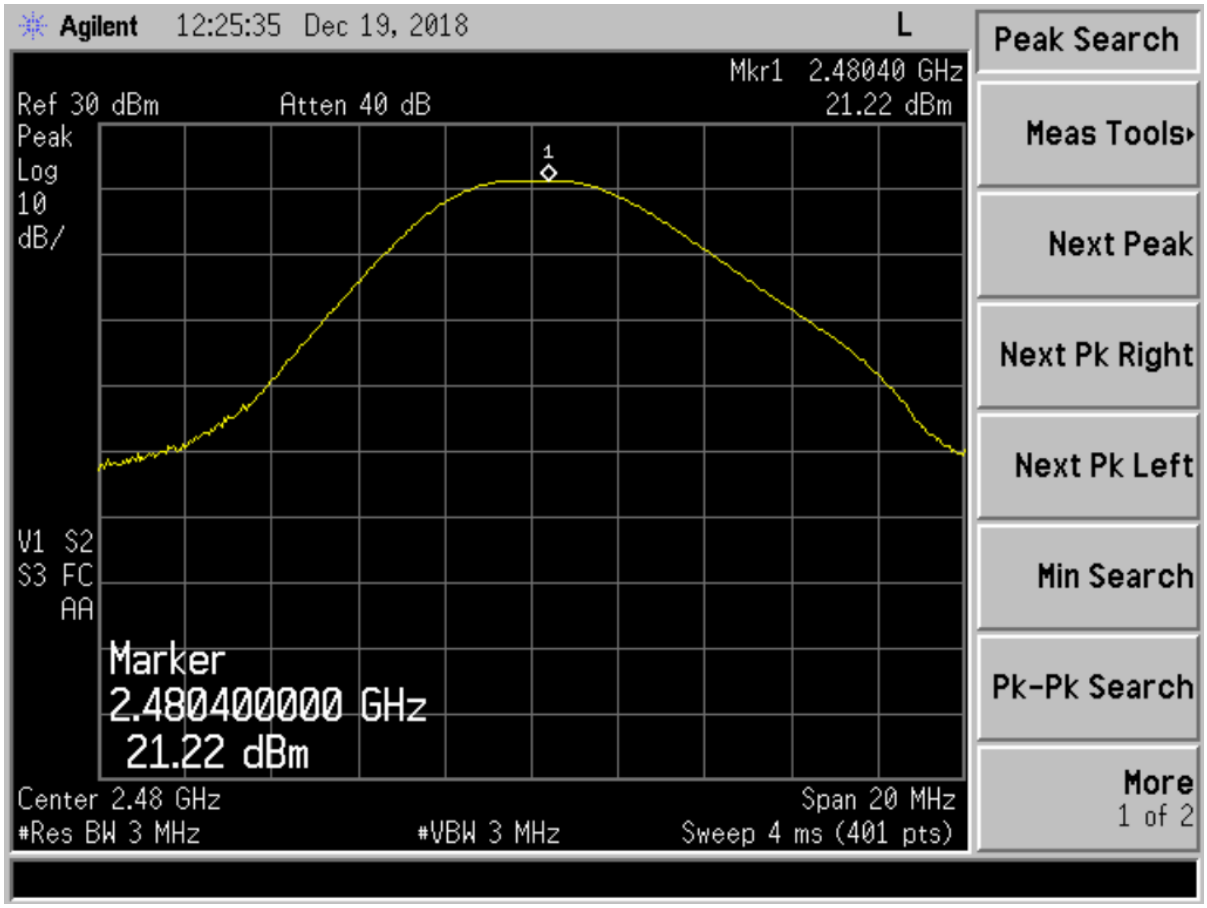


Figure 27. Peak Antenna Conducted Output Power, High Channel

2.15 Power Spectral Density (CFR 15.247(e))

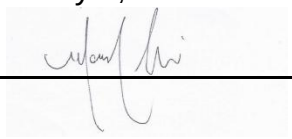
The transmitter was placed into a continuous mode of operation at all applicable frequencies. The measurements were performed per the procedures of FCC KDB Procedure 558074 v05. The RBW was set to 3 kHz and the Video Bandwidth was set to ≥RBW. The trace capture time was set to (Span/3 kHz).

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

Results are shown in the table below and figures below. All are less than +8 dBm per 3 kHz band.

Table 10. Power Spectral Density for Low, Mid and High Bands

Frequency (MHz)	Results (dBm/3 kHz)	FCC Limit (dBm/3 kHz)
Low-2405	5.58	+8.0
Mid-2440	4.84	+8.0
High-2480	4.59	+8.0

Test Date: February 6, 2019
Tested By
Signature:  Name: Mark Afroozi

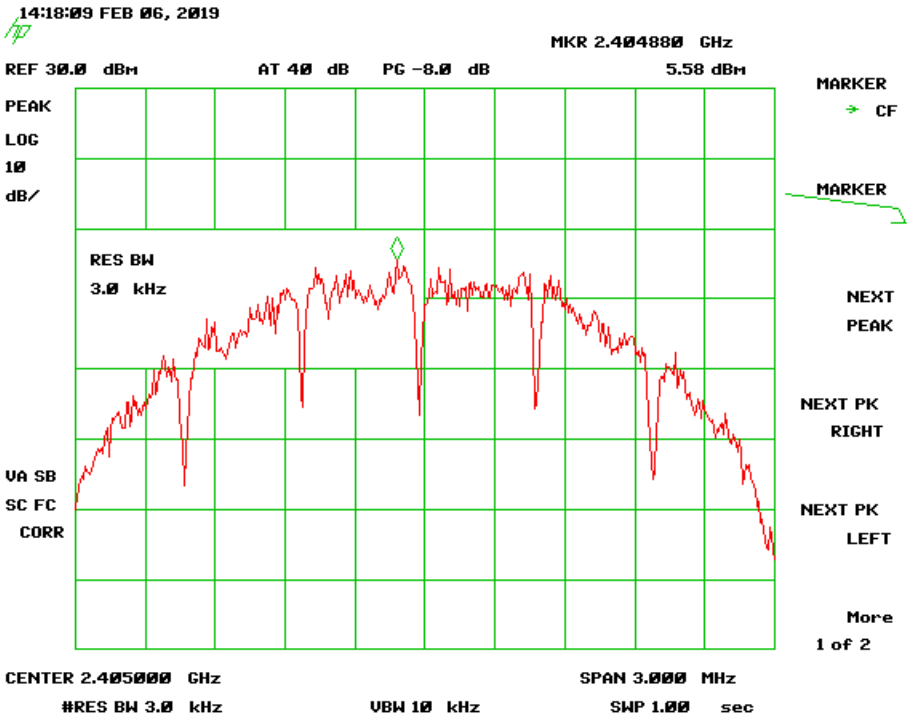


Figure 28. Low Channel, PSD

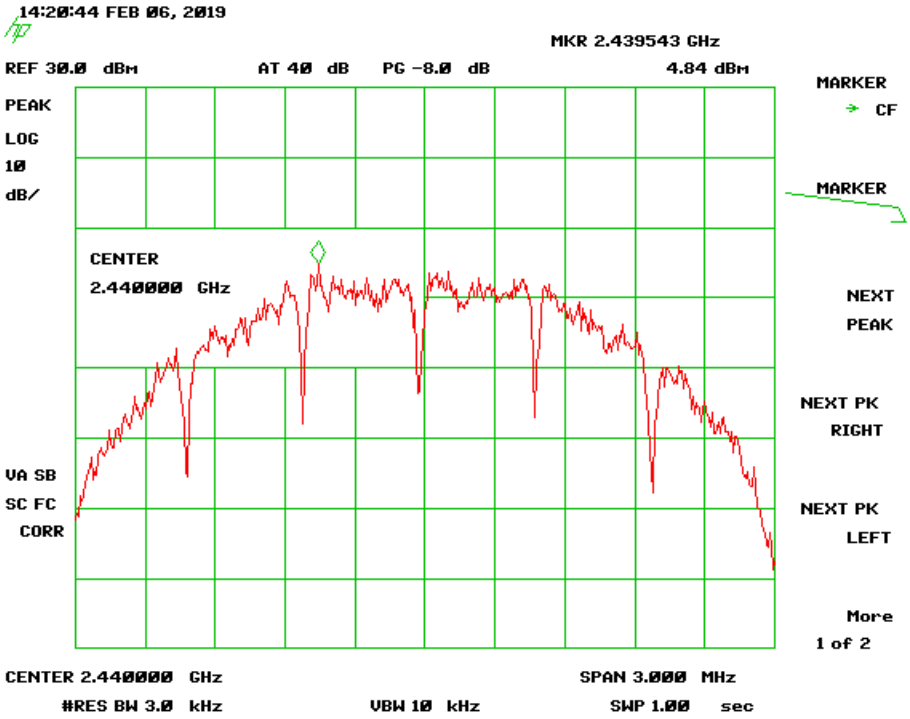


Figure 29. Mid Channel, PSD

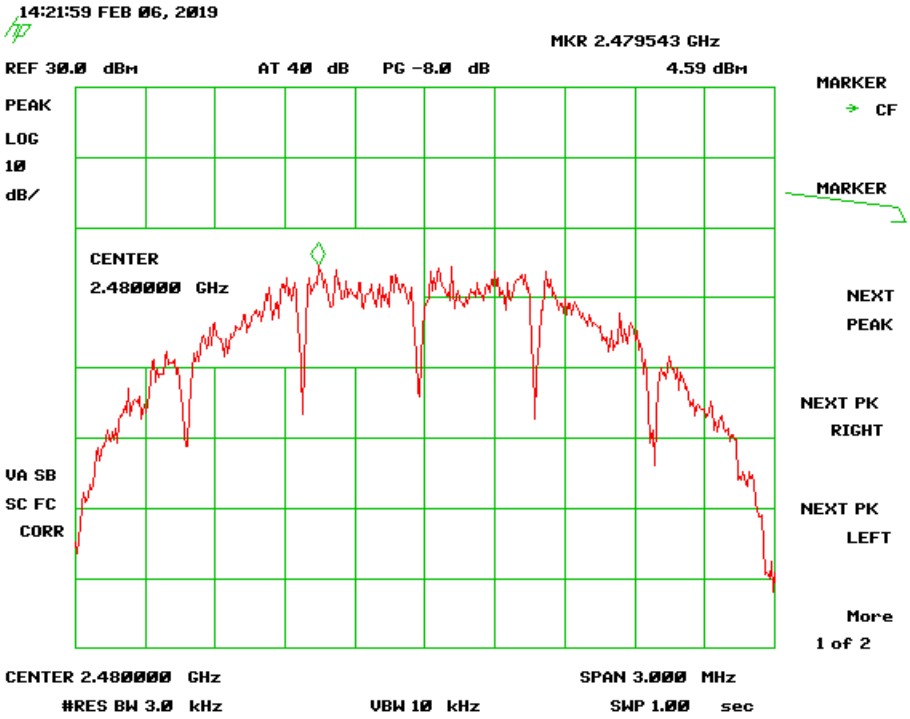


Figure 30. High Channel, PSD

2.16 Unintentional Radiator and Intentional Radiator Power Lines Conducted Emissions (CFR 15.107, 15.207)

The test data provided in this section is to support the Verification requirement for the digital apparatus. The power line conducted voltage measurements for Receiver and Digital Devices have been carried out in accordance with CFR 15.107 and ANSI C63.4:2014, Paragraph 7, with a spectrum analyzer connected to an LISN and the EUT placed into an idle condition or a continuous mode of receive (non-transmitting). Please refer to the results as shown in the table 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.

The worst-case results for conducted emissions were determined to be produced when the EUT was operating under continuous transmission. The worst case measurement was 1.8 dB from the applicable limit. All other emissions were at least 3.2 dB from the limit. Those results are given in the table below.

Table 11. Power Line Conducted Emissions

CONDUCTED EMISSIONS 150 kHz to 30 MHz						
Tested By: AF	Specification Requirement: FCC Part 15.207		Project No.: 18-0382	Manufacturer: Inventek Systems Model: RM-10002705		
Frequency (MHz)	**Test Data (dBuV)**	**LISN+CL (dB)**	**Corrected Results (dBuV)**	**Limits (dBuV)**	**Margin (dB)**	**Detector**
Phase @ 120VAC/60Hz						
0.1579	39.77	0.47	40.24	55.6	15.3	**PK**
0.7543	30.35	0.13	30.48	46.0	15.5	**PK**
3.6540	43.98	0.21	44.19	46.0	1.8	**QP**
3.6540	34.56	0.21	34.77	46.0	11.2	**AVG**
6.4260	45.27	0.28	45.55	50.0	4.5	**QP**
6.4260	31.56	0.28	31.84	50.0	18.2	**AVG**
12.1430	45.76	0.49	46.25	50.0	3.8	**QP**
12.1430	35.65	0.49	36.14	50.0	13.9	**AVG**
24.3400	41.76	0.73	42.49	50.0	7.5	**PK**
Neutral @ 120VAC/60Hz						
0.1623	38.86	0.55	39.41	55.3	15.9	**PK**
0.6208	28.40	0.28	28.68	46.0	17.3	**PK**
3.1670	42.42	0.34	42.76	46.0	3.2	**QP**
3.1670	31.69	0.34	32.03	46.0	14.0	**AVG**
5.4580	38.86	0.40	39.26	50.0	10.7	**QP**
5.4580	30.48	0.40	30.88	50.0	19.1	**AVG**
11.9670	43.68	0.59	44.27	50.0	5.7	**QP**
11.9670	33.24	0.59	33.83	50.0	16.2	**AVG**
27.5830	42.25	1.00	43.25	50.0	6.8	**PK**

Test Date: January 7, 2019
Tested By
Signature:  Name: Afzal Fazal

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

The test data provided herein is to support the verification requirement for radiated emissions coming for the EUT in a transmitting state per 15.209 and were investigated from 9kHz or the lowest operating clock frequency to 25 GHz and tested as detailed in ANSI C63.10:2013, Clause 6.4-6.6. Data is presented in the table below.

Radiated emissions within the band of 9 kHz to 30 MHz were investigated using a calibrated Loop Antenna and per the requirements of ANSI C63.10:2013.

Measurements were made with the analyzer's resolution bandwidth set to 120 kHz for measurements made below 1 GHz and 1 MHz for measurements made above 1 GHz. The video bandwidth was set to three times the resolution bandwidth; 1 MHz RBW and 3 MHz VBW. The test data were maximized for magnitude by rotating the turn-table through 360 degrees and raising and lowering the receiving antenna between 1 to 4 meters in height as a part of the measurement procedure.

The measurements were taken at mid-channel 7 frequency.

The worst-case radiated emission was 6.1 dB below the specification limit at 842.82 MHz. All other measured signals were at least 7.2 dB below the specification limit. The results are shown in the table below. These results are meant to show that this EUT has met the intentional transmitter requirements of CFR Part 15.209.

Table 12. Spurious Radiated Emissions (150 KHz-30MHz)

Test By: AF	Test: FCC Part 15.209			Client: Matrix Design Group, LLC			
	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 were at least 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 13. Spurious Radiated Emissions (30 MHz – 1 GHz)

Test By: AF	Test: FCC Part 15.109/15.209				Client: Matrix Design Group, LLC			
	Project: 17-0382 Class B				Model: RM-10002705			
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factors**	**AF+CL-PA (dB)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**DETECTOR PK / QP/AVG**
	Tested from 30 MHz to 1 GHz							
66.83	50.33	-	-18.14	32.19	40.0	3m./VERT	7.8	**QP**
66.98	48.88	-	-17.44	31.44	40.0	3m./HORZ	8.6	**QP**
93.22	51.85	-	-15.88	35.97	43.5	3m./VERT	7.5	**QP**
96.40	52.08	-	-16.61	35.47	43.5	3m./HORZ	8.0	**QP**
200.12	49.54	-	-13.70	35.84	43.5	3m./VERT	7.7	**PK**
552.66	44.00	-	-6.56	37.44	46.0	3m./VERT	8.6	**PK**
842.82	40.74	-	-0.88	39.86	46.0	3m./HORZ	6.1	**PK**
All other emissions were more than 20 dB below the applicable limit.								

AF is antenna factor. CL is cable loss. PA is preamplifier gain.

SAMPLE CALCULATION AT: 65.53 MHz

Magnitude of Measured Frequency	66.83	dBuV
Additional Factor	0.00	dB
+Antenna Factor + Cable Loss+ Amplifier Gain	-18.14	dB
Corrected Result	32.19	dBuV/m

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

Table 14. Spurious Radiated Emissions (1 GHz – 25 GHz)

Test By: AF	Test: FCC Part 15.109/15.209				Client: Matrix Design Group, LLC			
	Project: 17-0382 Class B				Model: RM-10002705			
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factors**	**AF+CL-PA (dB)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**DETECTOR PK / QP/AVG**
	Tested from 30 MHz to 1 GHz							
1287.50	50.79	-	-5.51	45.28	54.0	3.0m./VERT	8.7	**PK**
1312.50	49.76	-	-6.12	43.64	54.0	3.0m./HORZ	10.4	**PK**
8646.67	39.54	-9.50	16.79	46.83	54.0	1.0m./VERT	7.2	**PK**
8770.71	40.01	-9.50	15.76	46.27	54.0	1.0m./HORZ	7.7	**PK**
All other emissions were more than 20 dB below the applicable limit.								

AF is antenna factor. CL is cable loss. PA is preamplifier gain.

SAMPLE CALCULATION AT: 1287.50 MHz

Magnitude of Measured Frequency	50.79	dBuV
Additional Factor	0.00	dB
+Antenna Factor + Cable Loss+ Amplifier Gain	-5.51	dB
Corrected Result	45.28	dBuV/m

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

2.18 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%.

2.18.1 Conducted Emissions Measurement Uncertainty

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

2.18.2 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 have met the requirements of the standards cited within the test report when tested as detailed herein.