Lyman Products Corporation

TEST REPORT

SCOPE OF WORK
FCC TESTING–BORECAM PRO

REPORT NUMBER
200323013SZN-001

ISSUE DATE	**[REVISED DATE]**
23 June 2020	[----------]

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TEST REPORT

Intertek Report No.: 200323013SZN-001

Lyman Products Corporation

Application
For
Certification

FCC ID: 2AG7YBORECAMPRO

Borecam PRO Wireless Borescope

Model: Borecam PRO

2.4GHz Wi-Fi Transceiver

Report No.: 200323013SZN-001

We hereby certify that the sample of the above item is considered to comply with the requirements of FCC Part 15, Subpart C for Intentional Radiator, mention 47 CFR [10-1-19]

Prepared and Checked by:

Jeff Liang
Engineer

Approved by:

Kidd Yang
Technical Supervisor
Date: 23 June 2020

MEASUREMENT/TECHNICAL REPORT

This report concerns (check one) Original Grant ___X___ Class II Change _____

Equipment Type: DTS - Part 15 Digital Transmission Systems (Wi-Fi transmitter portion)

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? Yes _____ No ___X___

If yes, defer until : _____
date

Company Name agrees to notify the Commission by: _____
date

of the intended date of announcement of the product so that the grant can be issued on that date.

Transition Rules Request per 15.37? Yes _____ No ___X___

If no, assumed Part 15, Subpart C for intentional radiator - the new 47 CFR [10-01-19] Edition] provision.

Report prepared by:

Jeff Liang
Intertek Testing Services Shenzhen Ltd. Longhua Branch
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1.0 Summary of Test results

Applicant: Lyman Products Corporation
Applicant Address: 475 Smith St. Middletown, CT 06457, USA
Manufacturer: Lyman Products Corporation
Manufacturer Address: 475 Smith St. Middletown, CT 06457, USA

Model: Borecam PRO
FCC ID: 2AG7YBORECAMPRO

TEST ITEM	REFERENCE	RESULTS
Max. Output power	15.247(b)(3)	Pass
6 dB Bandwidth	15.247(a)(2)	Pass
Max. Power Density	15.247(e)	Pass
Out of Band Antenna Conducted Emission	15.247(d)	Pass
Radiated Emission in Restricted Bands	15.247(d), 15.209, FCC 15.205	Pass
AC Conducted Emission	15.207	Pass
Antenna Requirement	15.203	Pass (See Notes)

Notes: The EUT uses an Integral Antenna which in accordance to Section 15.203 is considered sufficient to comply with the provisions of this section.

2.0 General Description

2.1 Product Description

The Equipment Under Test (EUT) is a Borecam PRO Wireless Borescope with Wi-Fi function operating at 2437MHz for 802.11b/g/n-HT20/n-HT40. The EUT is powered by 3.7V with rechargeable battery and D.C. 5.0V from adaptor. For more detailed features description, please refer to the user's manual.

Type of Modulation: BPSK, QPSK, 16QAM, 64QAM for OFDM; CCK, DQPSK, DBPSK for DSSS.
Antenna Type: Integral Antenna
Antenna Gain: Each 0.5dBi

For electronic filing, the brief circuit description is saved with filename: descri.pdf.

2.2 Related Submittal(s) Grants

This is an application for certification of:
DTS- Part 15 Digital Transmission Systems (2.4GHz Wi-Fi transmitter portion).

Remaining portions are subject to the following procedures:
1. Receiver portion of WiFi: exempt from technical requirement of this Part.
2. Other Digital Function: Subject to FCC Part 15B SDoC.

2.3 Test Methodology

Both AC mains line-conducted and radiated emission measurements were performed according to the procedures in ANSI C63.10 (2013) and KDB 558074 D01 v05r02. Radiated emission measurement was performed in semi-anechoic chamber and conducted emission measurement was performed in shield room. For radiated emission measurement, preliminary scans were performed in the semi-anechoic chamber only to determine the worst case modes. All radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "**Justification Section**" of this Application.

2.4 Test Facility

The Semi-anechoic chamber and shielded room used to collect the radiated data and conducted data are **Intertek Testing Services Shenzhen Ltd. Longhua Branch** and located at 101, 201, Building B, No. 308 Wuhe Avenue, Zhangkengjing Community, GuanHu Subdistrict, LongHua District, Shenzhen, P.R. China. This test facility and site measurement data have been fully placed on file with File Number: CN1188.

3.0 System Test Configuration

3.1 Justification

For emissions testing, the equipment under test (EUT) setup to transmit continuously to simplify the measurement methodology. Care was taken to ensure proper power supply voltages during testing. During testing, all cables were manipulated to produce worst case emissions. The EUT was powered by 3.7V rechargeable battery and D.C. 5.0V from adaptor during the test, only the worst case data is shown in the report.

For maximizing emissions, the EUT was rotated through 360°, the EUT was placed on the styrene turntable with 0.8m up to 1GHz and 1.5 m above 1GHz. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters. Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance.

All readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance. Analyzer resolution is 100 kHz or greater for frequencies below 1000 MHz. The resolution is 1 MHz or greater for frequencies above 1000 MHz. The spurious emissions more than 20 dB below the permissible value are not reported.

The rear of unit shall be flushed with the rear of the table.

Radiated emission measurement were performed the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

3.2 EUT Exercising Software

The EUT exercise program (provided by client) used during radiated and conducted testing was designed to exercise the various system components in a manner similar to a typical use. The worst case configuration is used in all specified testing.

The parameters of test software setting:
During the test, Channel and power controlling software provided by the applicant was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the application and is going to be fixed on the firmware of the end product.

Test software: QATool

3.3 Special Accessories

Shielded USB cable with ferrite core.

3.4 Measurement Uncertainty

When determining of the test conclusion, the Measurement Uncertainty of test has been considered.

3.5 Equipment Modification

Any modifications installed previous to testing by Lyman Products Corporation will be incorporated in each production model sold / leased in the United States.

No modifications were installed by Intertek Testing Services Shenzhen Ltd. Longhua Branch.

3.6 Support Equipment List and Description

Description	Manufacturer	Model No.
Adapter	SHENZHEN FUJIA APPLIANCE CO., LTD.	Model: FJ-SW1160501500UN Input: 100-240V~ 50/60Hz 0.3A Max Output: 5.0V ⎓ 1.5A, 7.5W
Mini USB Cable	provided by applicant	Shielding with ferrite core, Length:130cm

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020 Model: Borecam PRO

4.0 Measurement Results

4.1 Maximum Conducted Output Power at Antenna Terminals, FCC Rules 15.247(b)(3):

The antenna power of the EUT was connected to the input of a broadband peak RF power meter. The power meter have a video bandwidth that is greater than DTS bandwidth and utilize a fast-responding diode detector. Power was read directly at the EUT antenna terminals with cable loss added.

For antennas with gains of 6 dBi or less, maximum allowed Transmitter output is 1 watt (+30 dBm).

SISO Mode, Ant1:

IEEE 802.11b (Antenna Gain = 0.5dBi) (CCK, 1Mbps)		
Frequency (MHz)	Output in dBm (Peak Reading)	Output in mWatt
2437	10.6	11.48

IEEE 802.11g (Antenna Gain = 0.5dBi) (16QAM, 6Mbps)		
Frequency (MHz)	Output in dBm (Peak Reading)	Output in mWatt
2437	19.2	83.18

IEEE 802.11n-HT20 (Antenna Gain = 0.5dBi) (64QAM, 6.5Mbps)		
Frequency (MHz)	Output in dBm (Peak Reading)	Output in mWatt
2437	19.3	85.11

IEEE 802.11n-HT40 (Antenna Gain = 0.5dBi) (64QAM, 13.5Mbps)		
Frequency (MHz)	Output in dBm (Peak Reading)	Output in mWatt
2437	19.4	87.10

SISO Mode, Ant2:

IEEE 802.11b (Antenna Gain = 0.5dBi) (CCK, 1Mbps)		
Frequency (MHz)	Output in dBm (Peak Reading)	Output in mWatt
2437	11.3	13.49

IEEE 802.11g (Antenna Gain = 0.5dBi) (16QAM, 6Mbps)		
Frequency (MHz)	Output in dBm (Peak Reading)	Output in mWatt
2437	18.4	69.18

IEEE 802.11n-HT20 (Antenna Gain = 0.5dBi) (64QAM, 6.5Mbps)		
Frequency (MHz)	Output in dBm (Peak Reading)	Output in mWatt
2437	18.5	70.79

IEEE 802.11n-HT40 (Antenna Gain = 0.5dBi) (64QAM, 13.5Mbps)		
Frequency (MHz)	Output in dBm (Peak Reading)	Output in mWatt
2437	18.5	70.79

MIMO Mode:

IEEE 802.11n-HT20 (Antenna Gain = 3.5dBi) (64QAM, 6.5Mbps)				
Frequency (MHz)	Output in dBm (Peak Reading)			Output in mWatt
	Ant 1	Ant 2	Total	
2437	16.7	15.8	19.3	85.11

IEEE 802.11n-HT40 (Antenna Gain = 3.5dBi) (64QAM, 13.5Mbps)				
Frequency (MHz)	Output in dBm (Peak Reading)			Output in mWatt
	Ant 1	Ant 2	Total	
2437	16.4	15.5	19.0	79.43

Average output power measurement results:

Operation mode	Output in dBm (Average Reading)
ANT1-IEEE 802.11b-2437MHz	8.7
ANT1-IEEE 802.11g-2437MHz	8.9
ANT1-IEEE 802.11n-HT20-2437MHz	8.7
ANT1-IEEE 802.11n-HT40-2437MHz	8.9
ANT2-IEEE 802.11b-2437MHz	9.3
ANT2-IEEE 802.11g-2437MHz	8.9
ANT2-IEEE 802.11n-HT20-2437MHz	8.9
ANT2-IEEE 802.11n-HT40-2437MHz	9.1
MIMO-IEEE 802.11n-HT20-2437MHz	8.3
MIMO-IEEE 802.11n-HT40-2437MHz	8.5

Cable loss: 0.5 dB External Attenuation: 0 dB

Cable loss, external attenuation has been included in OFFSET function

EUT max. peak output level = 19.4dBm
EUT max. average output level = 9.3dBm

For RF Exposure, the information is saved with filename: RF exposure.pdf.

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020 Model: Borecam PRO

4.2 Minimum 6 dB RF Bandwidth, FCC Rule 15.247(a) (2):

The antenna port of the EUT was connected to the input of a spectrum analyzer. Analyzer RES BW was set to 100 KHz according to FCC KDB 558074 D01 v05r02. For each RF output channel investigated, the spectrum analyzer center frequency was set to the channel carrier. A PEAK output reading was taken, a DISPLAY line was drawn 6 dB lower than PEAK level. The 6dB bandwidth was determined from where the channel output spectrum intersected the display line.

Limit: The 6 dB Bandwidth is at least 500 kHz.

IEEE 802.11b (CCK, 1Mbps)	
Frequency (MHz)	6 dB Bandwidth (MHz)
2437	10.029

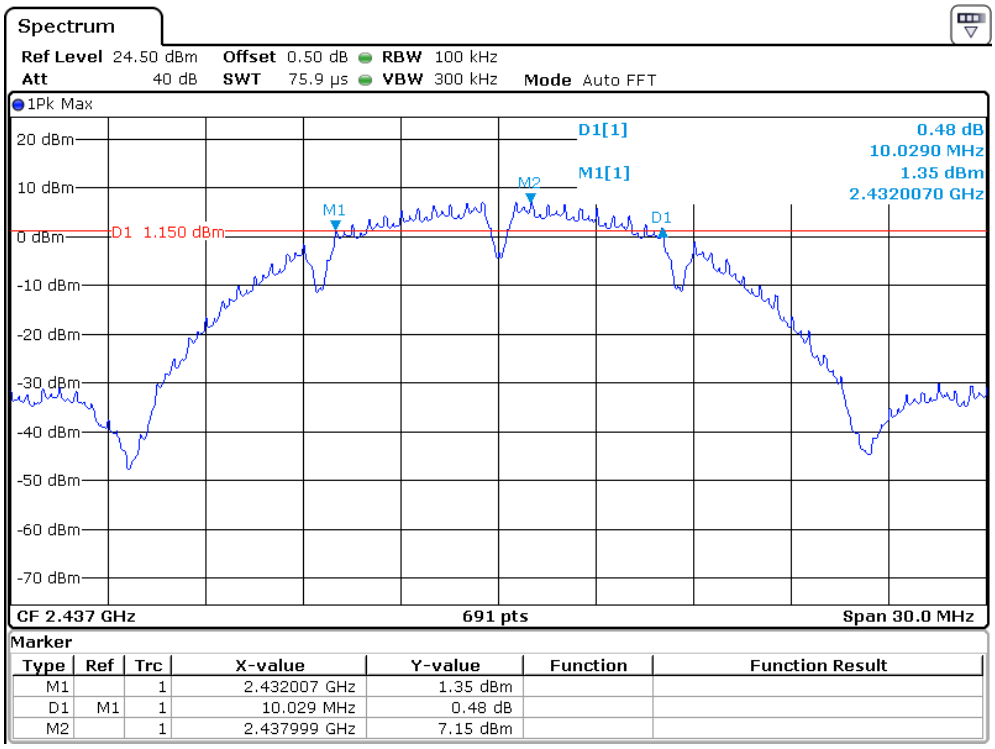
IEEE 802.11g (16QAM, 6Mbps)	
Frequency (MHz)	6 dB Bandwidth (MHz)
2437	15.109

IEEE 802.11n-HT20 (64QAM, 6.5Mbps)	
Frequency (MHz)	6 dB Bandwidth (MHz)
2437	15.065

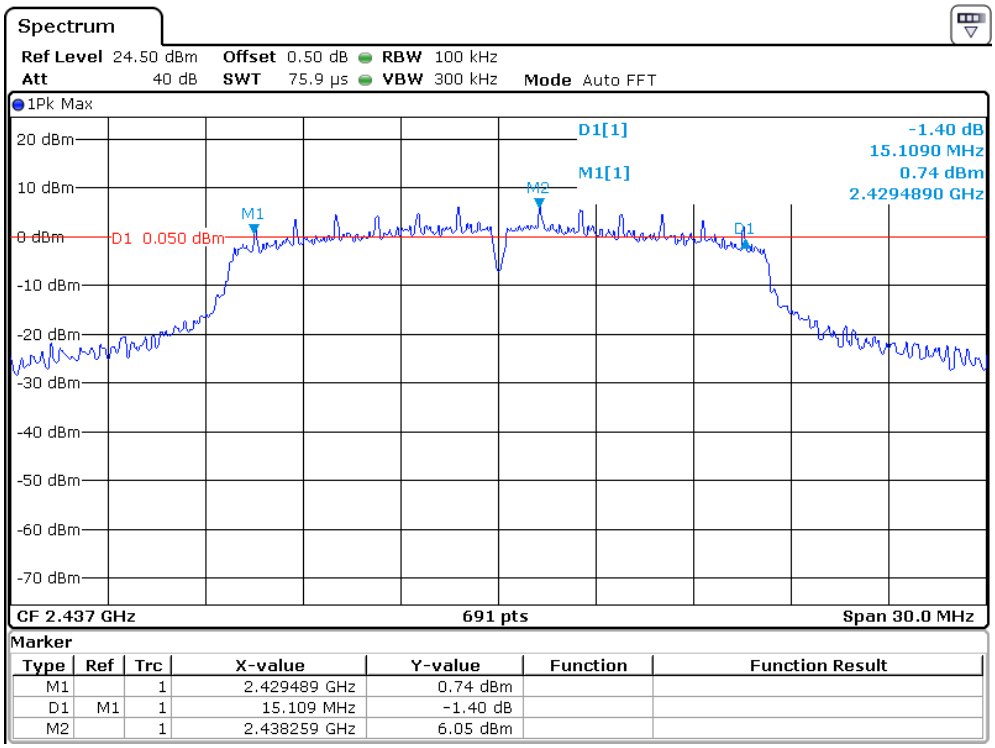
IEEE 802.11n-HT40 (64QAM, 13.5Mbps)	
Frequency (MHz)	6 dB Bandwidth (MHz)
2437	35.080

The test plots are attached as below.

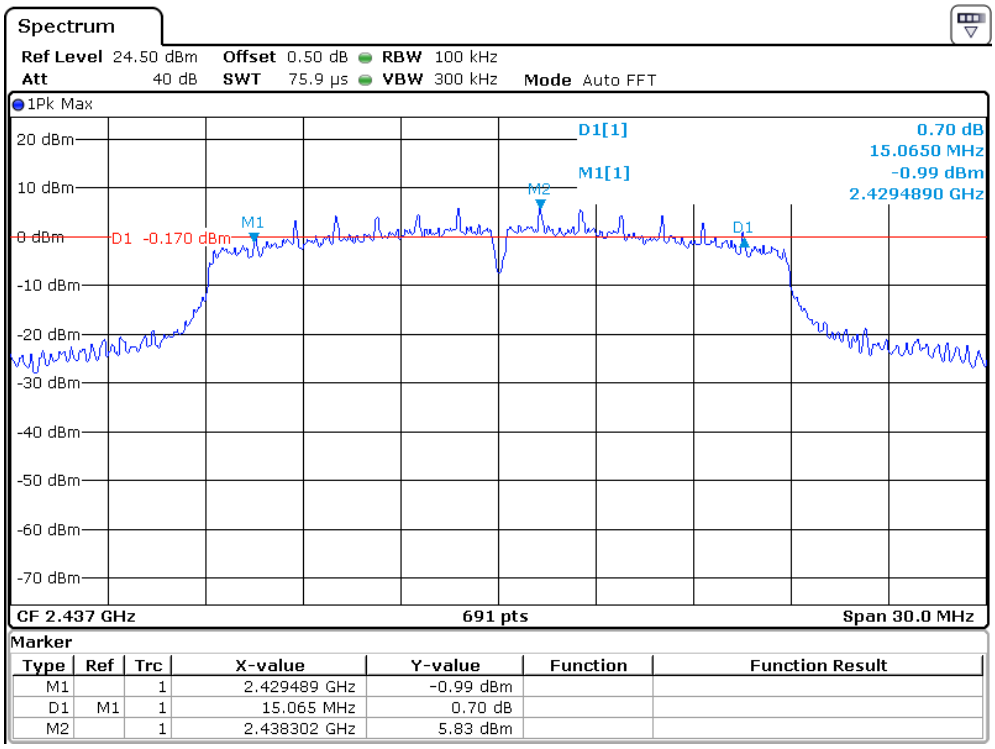
802.11b



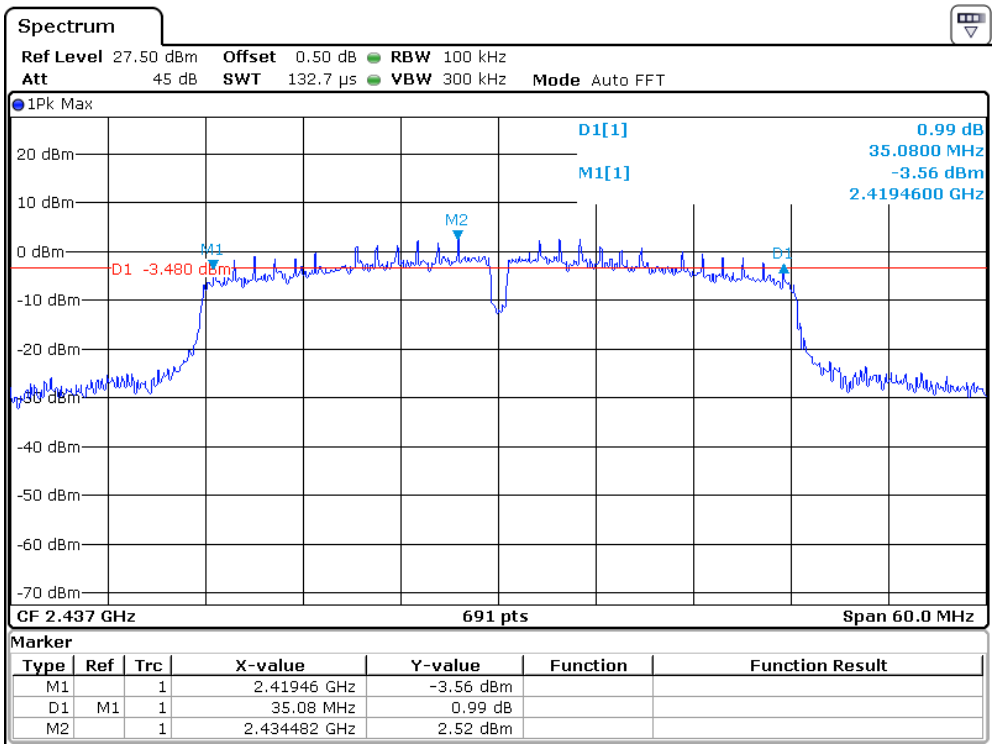
802.11g



802.11n-HT20



802.11n-HT40



Applicant: Lyman Products Corporation
Date of Test: June 21, 2020 Model: Borecam PRO

4.3 Maximum Power Density Reading, FCC Rule 15.247(e):

The Measurement Procedure PKPSD was set according to the FCC KDB 558074 D01 v05r02.

Antenna output of the EUT was coupled directly to spectrum analyzer; if an external attenuator and/or cable was used, these losses are compensated for with the analyzer OFFSET function.

Limit: The Power Density does not exceed 8dBm/3 kHz.

SISO Mode:

IEEE 802.11b (CCK, 1Mbps)		
Frequency (MHz)	Power Density with RBW 100KHz	
	Ant 1	Ant 2
2437	-1.99	-1.51

IEEE 802.11g (16QAM, 6Mbps)		
Frequency (MHz)	Power Density with RBW 100KHz	
	Ant 1	Ant 2
2437	-1.63	-1.62

IEEE 802.11n-HT20 (64QAM, 6.5Mbps)		
Frequency (MHz)	Power Density with RBW 100KHz	
	Ant 1	Ant 2
2437	-3.68	-1.57

IEEE 802.11n-HT40 (64QAM, 13.5Mbps)		
Frequency (MHz)	Power Density with RBW 100KHz	
	Ant 1	Ant 2
2437	-3.25	-3.15

MIMO Mode:

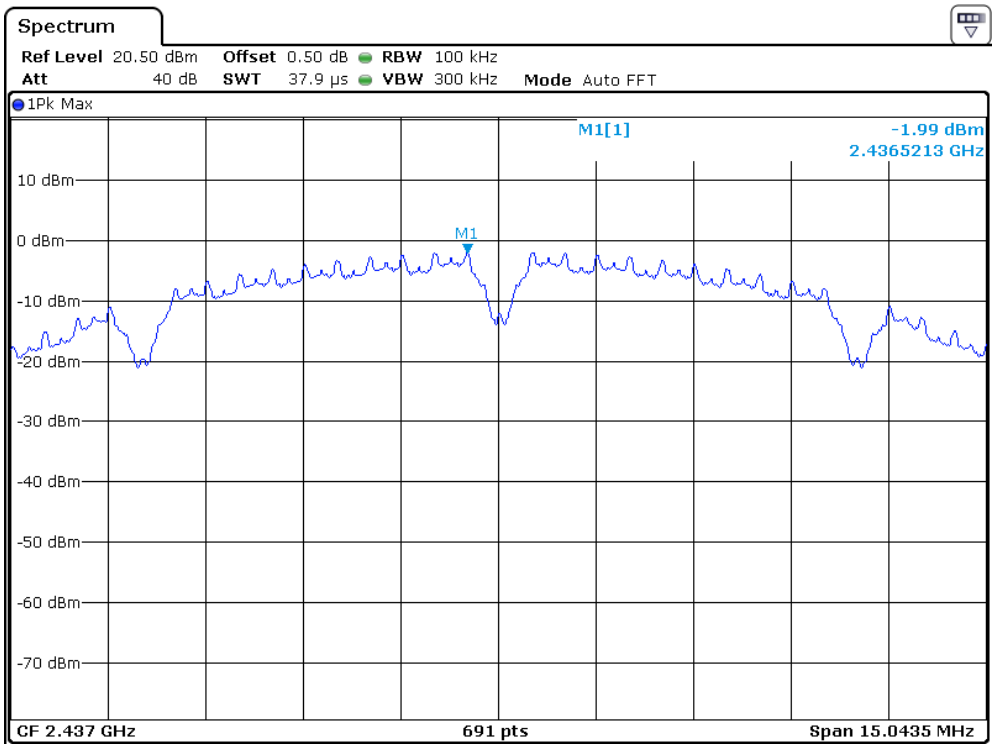
IEEE 802.11n-HT20 (64QAM, 6.5Mbps)			
Frequency (MHz)	Power Density with RBW 100KHz		
	Ant 1	Ant 2	Total
2437	-3.47	-5.01	-1.16

IEEE 802.11n-HT40 (64QAM, 13.5Mbps)			
Frequency (MHz)	Power Density with RBW 100KHz		
	Ant 1	Ant 2	Total
2437	-6.63	-7.07	-3.83

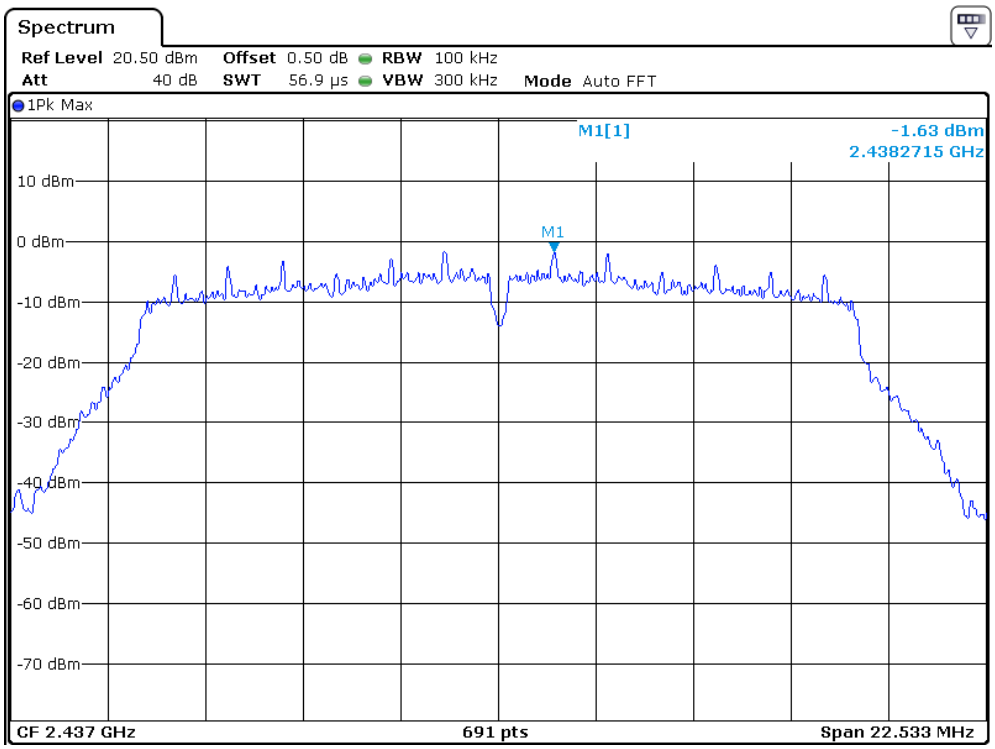
The test plots are attached as below.

SISO-ANT 1:

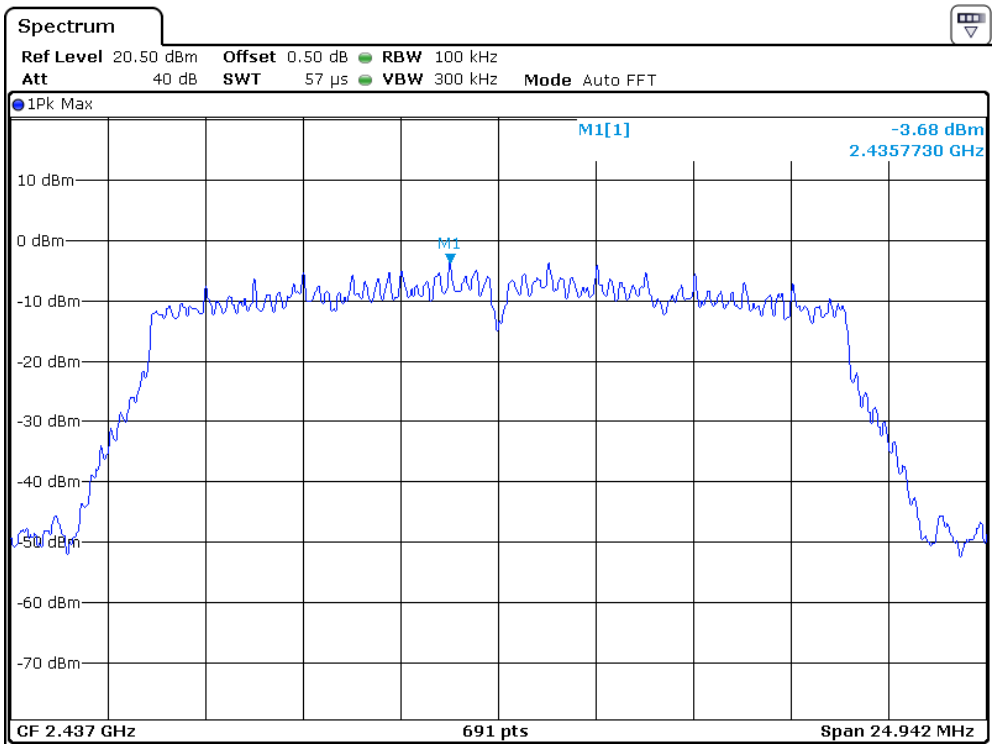
802.11b



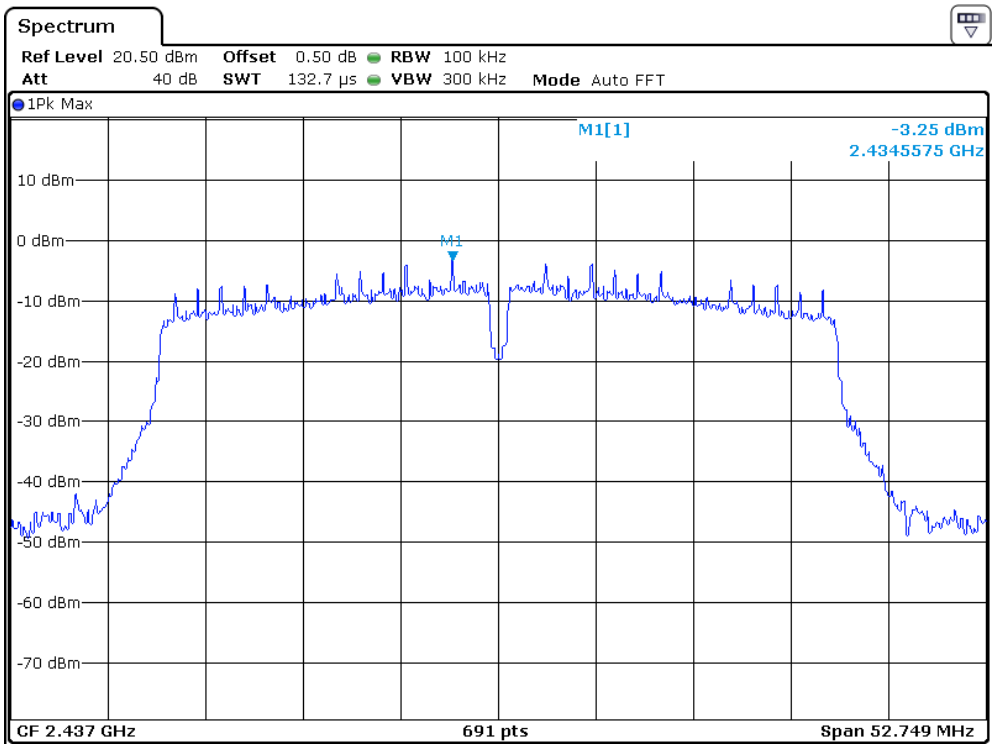
802.11g



802.11n-HT20

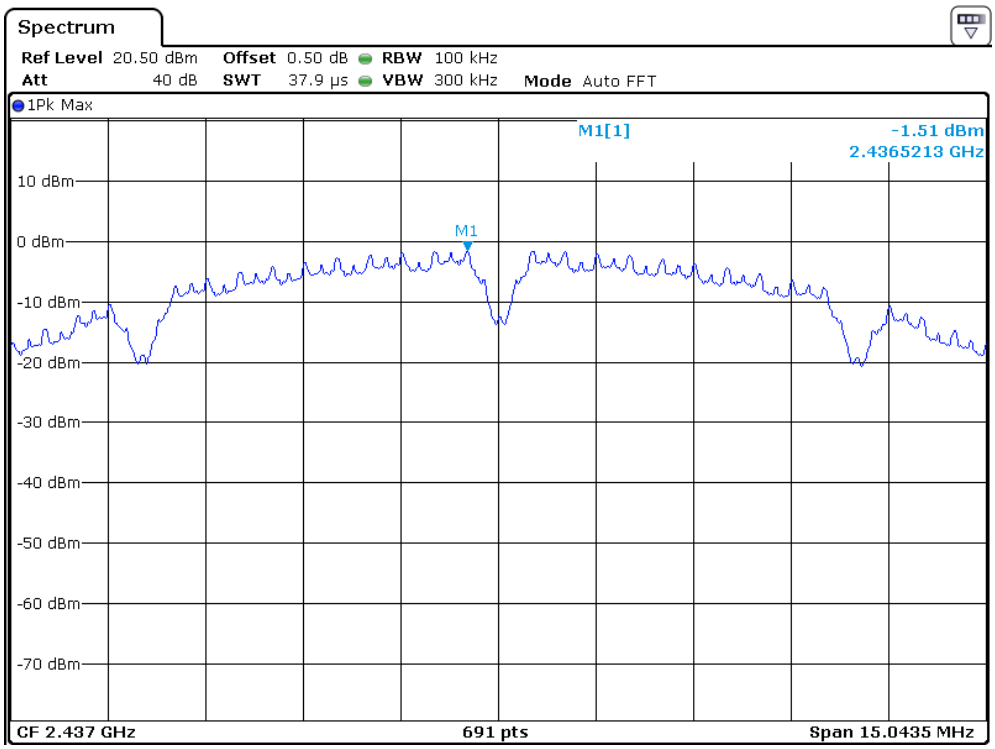


802.11n-HT40

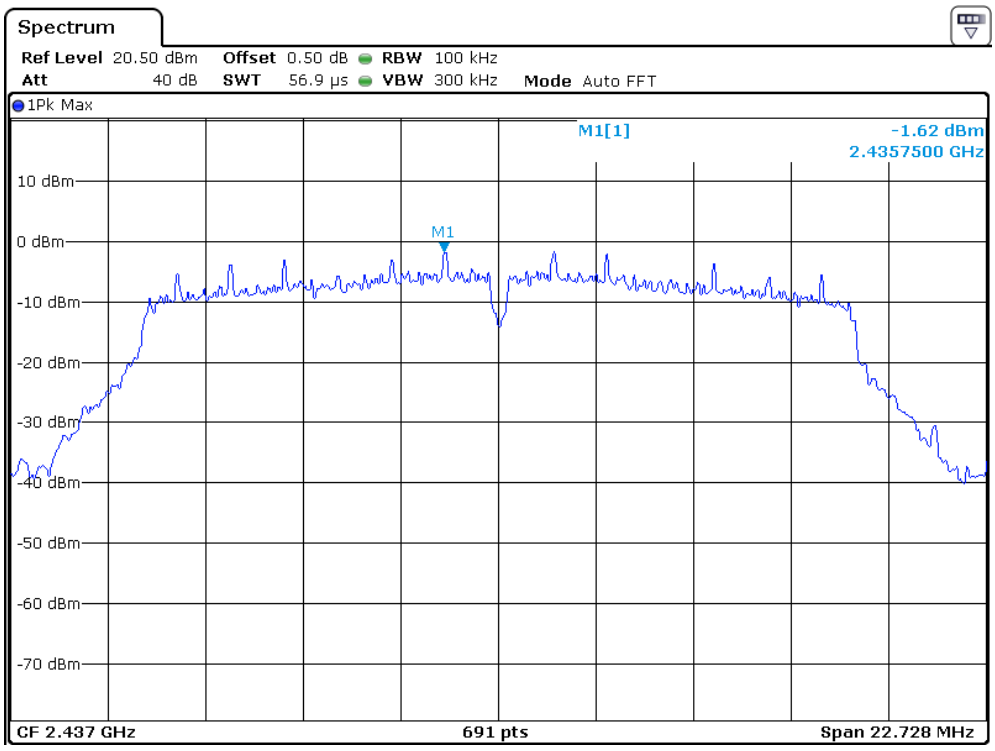


SISO-ANT 2:

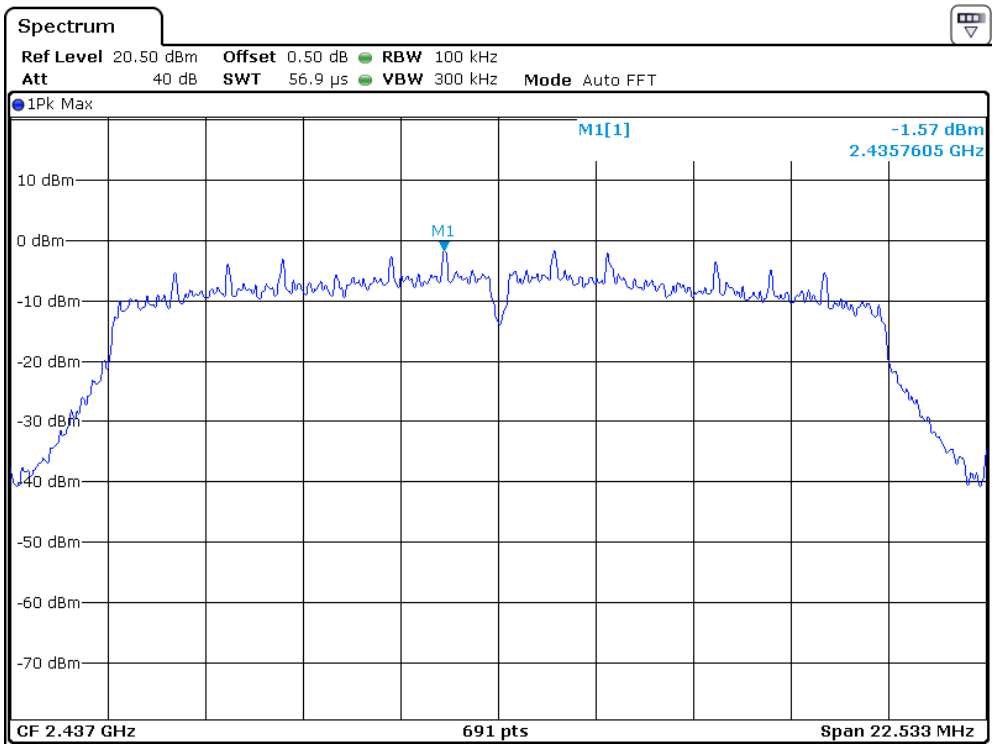
802.11b



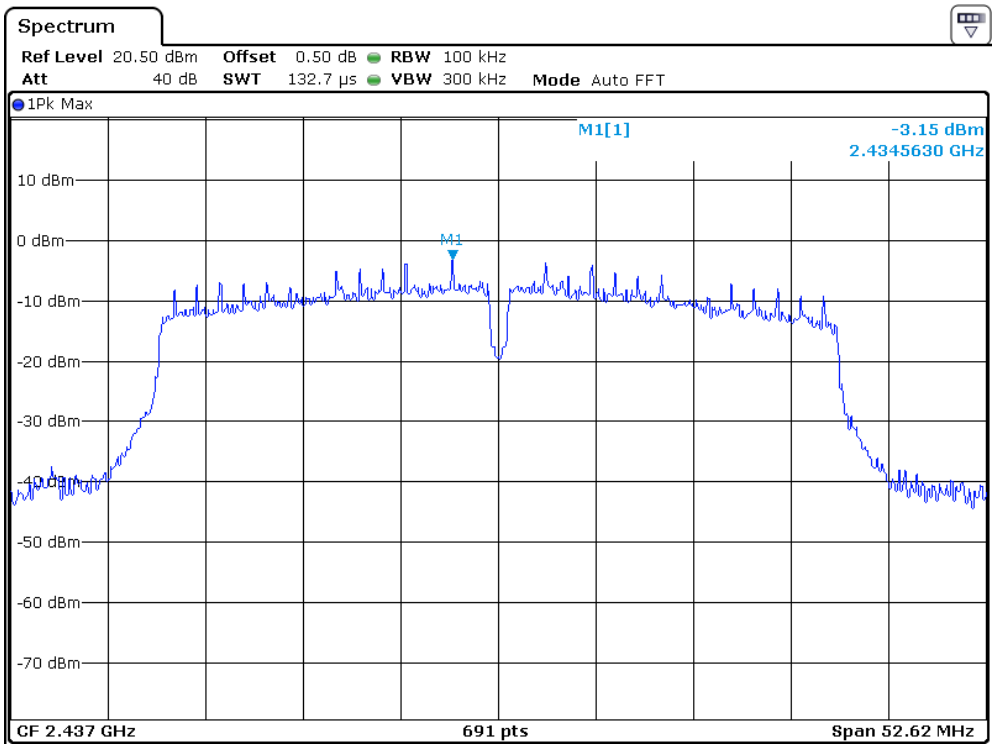
802.11g



802.11n-HT20

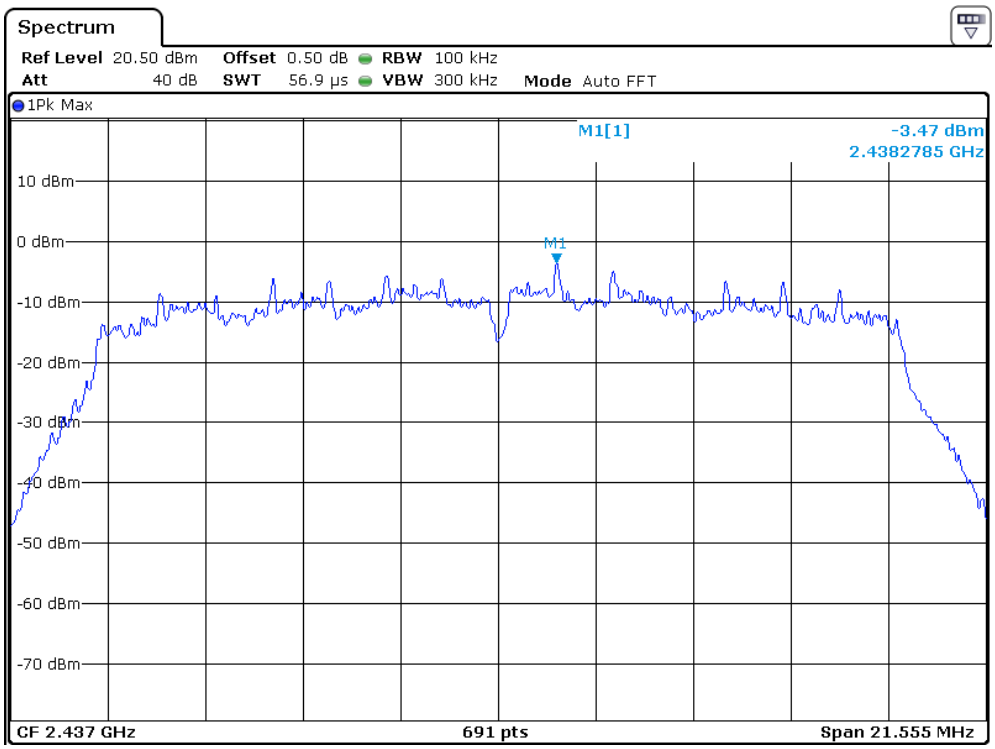


802.11n-HT40

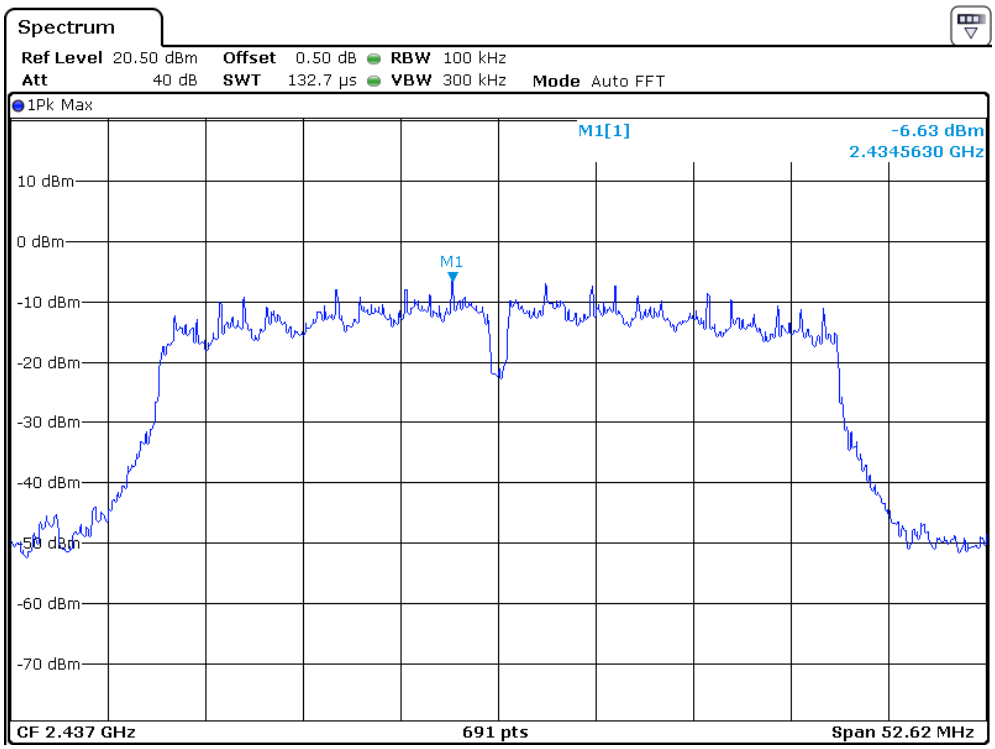


MIMO-ANT 1:

802.11n-HT20

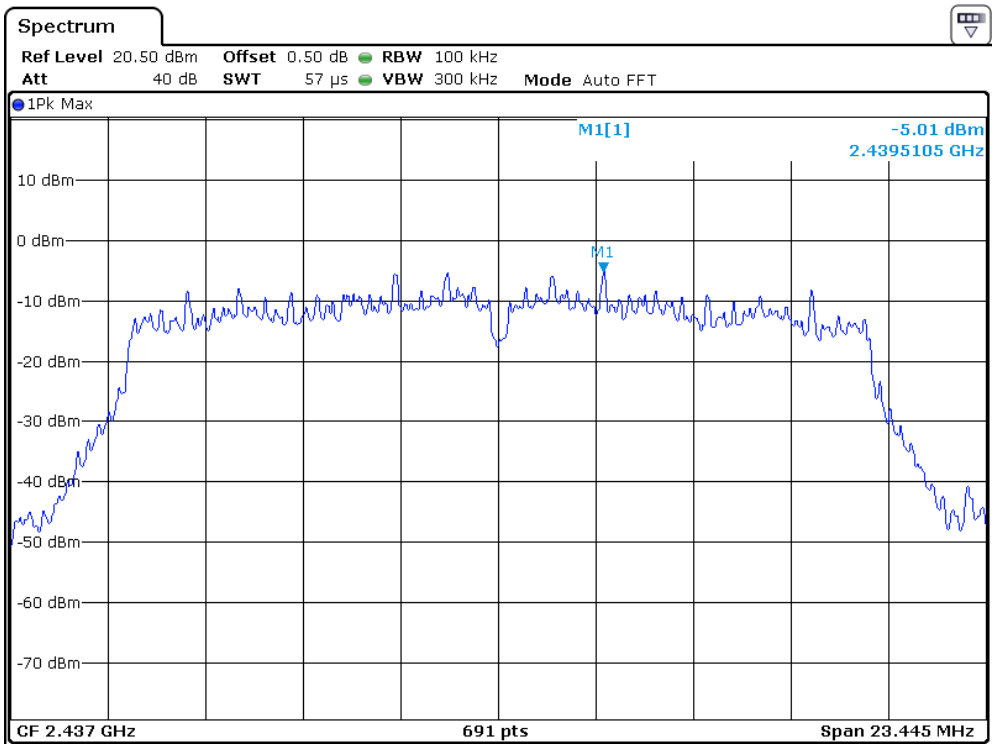


802.11n-HT40

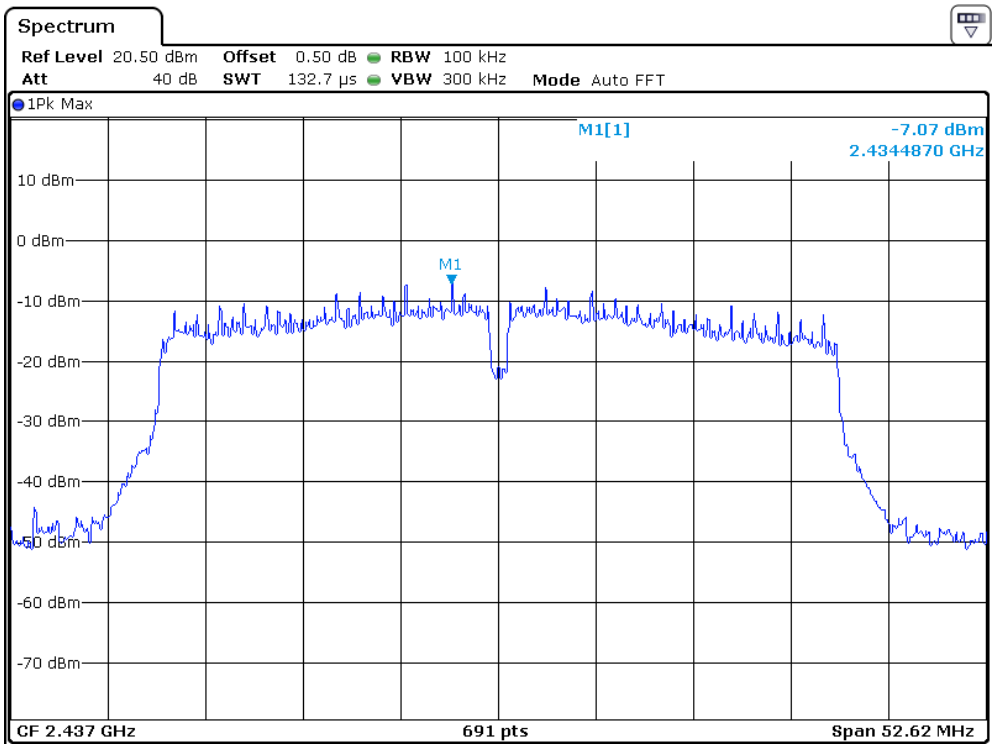


MIMO-ANT 2:

802.11n-HT20



802.11n-HT40



Applicant: Lyman Products Corporation
Date of Test: June 21, 2020 Model: Borecam PRO

4.4 Out of Band Conducted Emissions, FCC Rule 15.247(d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. The Measurement Procedure was set according to the FCC KDB 558074 D01 v05r02.

All other types of emissions from the EUT shall meet the general limits for radiated frequencies outside the passband.

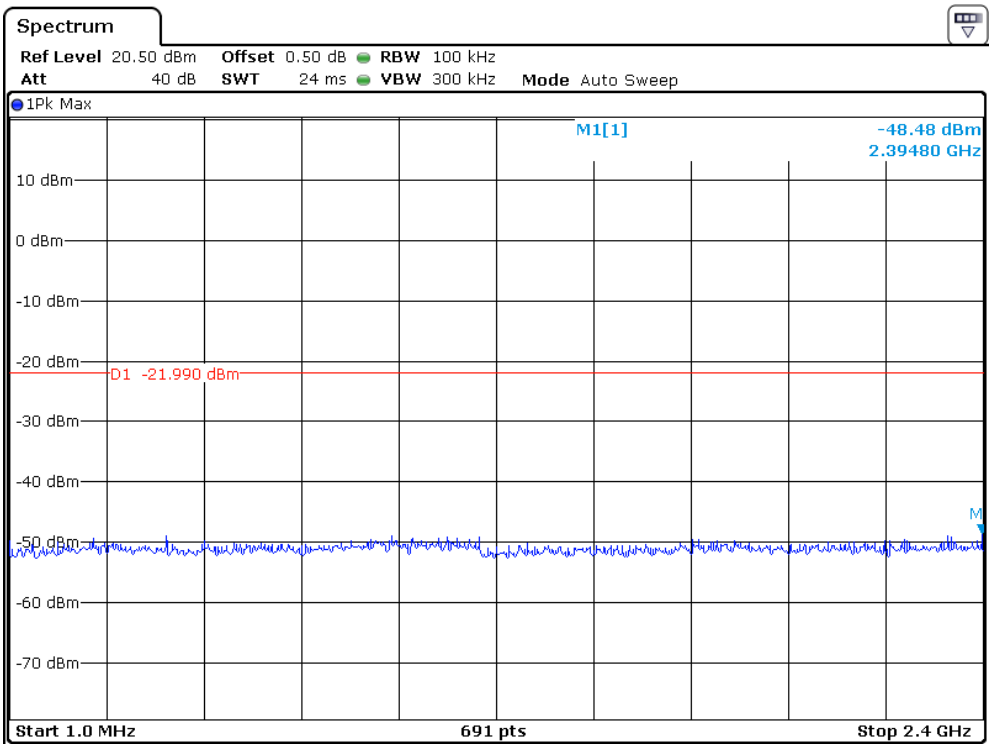
Refer to the attached test plots for out of band conducted emissions data with rate of 1Mbps for 802.11b and 6Mbps for 802.11g and 6Mbps for 802.11n-HT20 and 13.5Mbps for 802.11n-HT40.

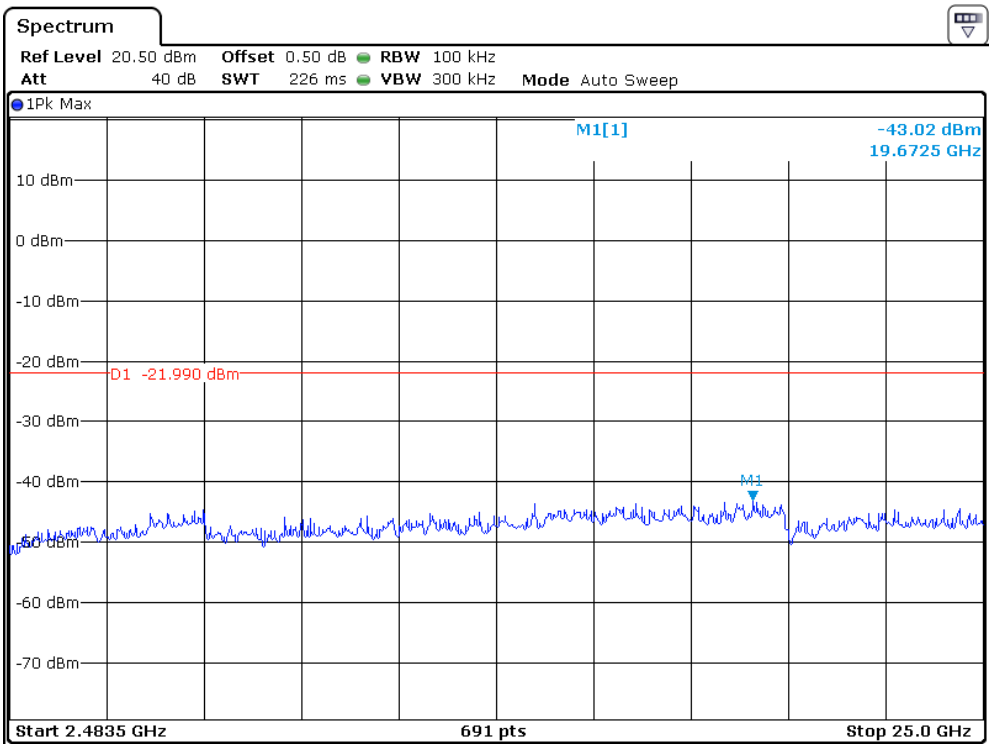
The test plots showed all spurious emission up to the tenth harmonic were measured and they were found to be at least 20 dB below the highest level of the desired power in the passband.

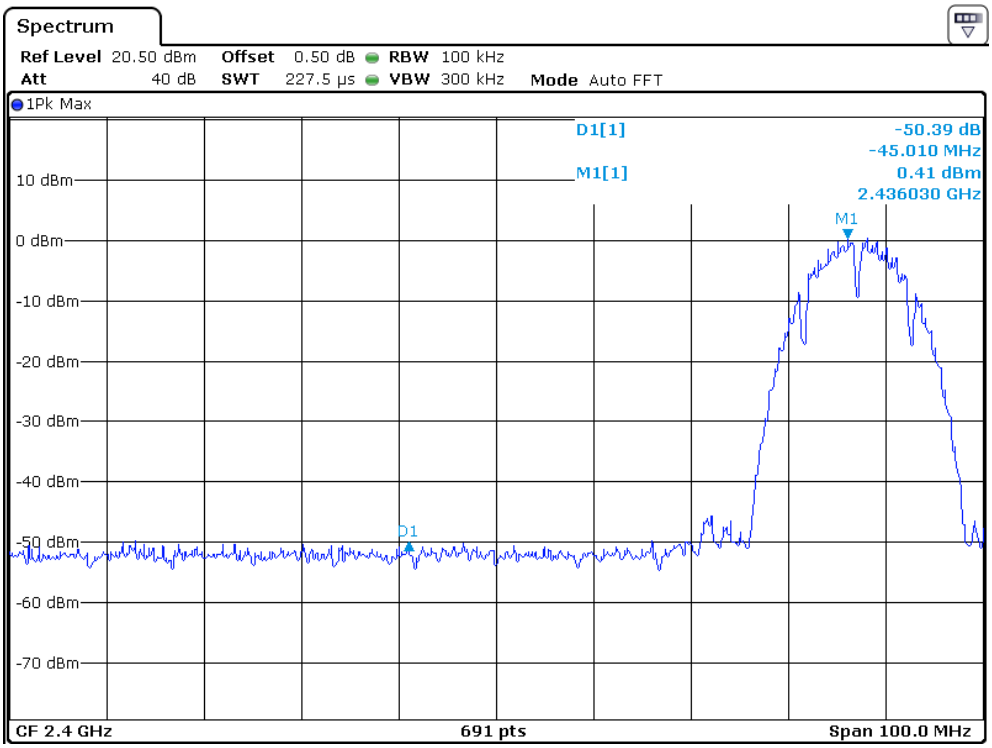
The test plots are attached as below.

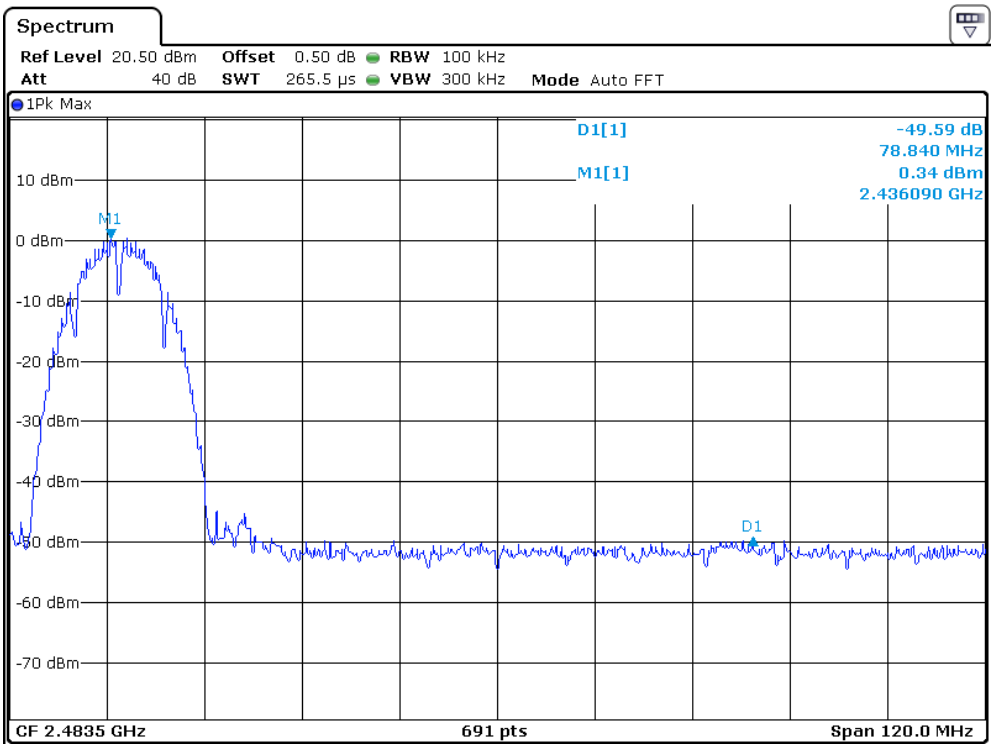
SISO Mode, Ant1

802.11b
Reference Level: -1.99dBm

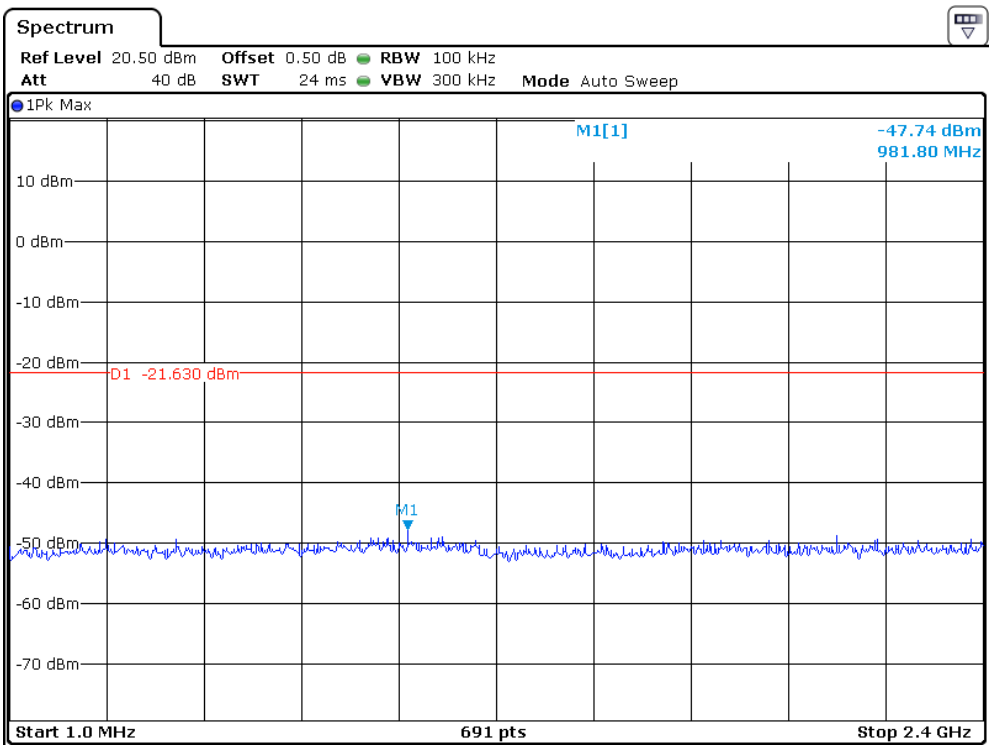


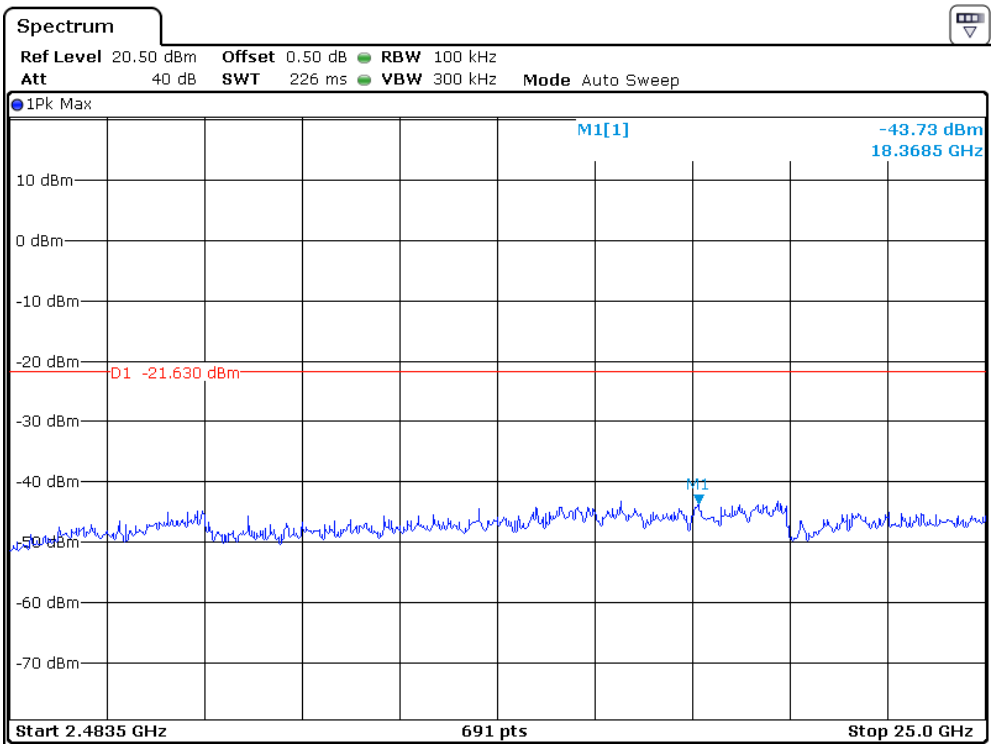


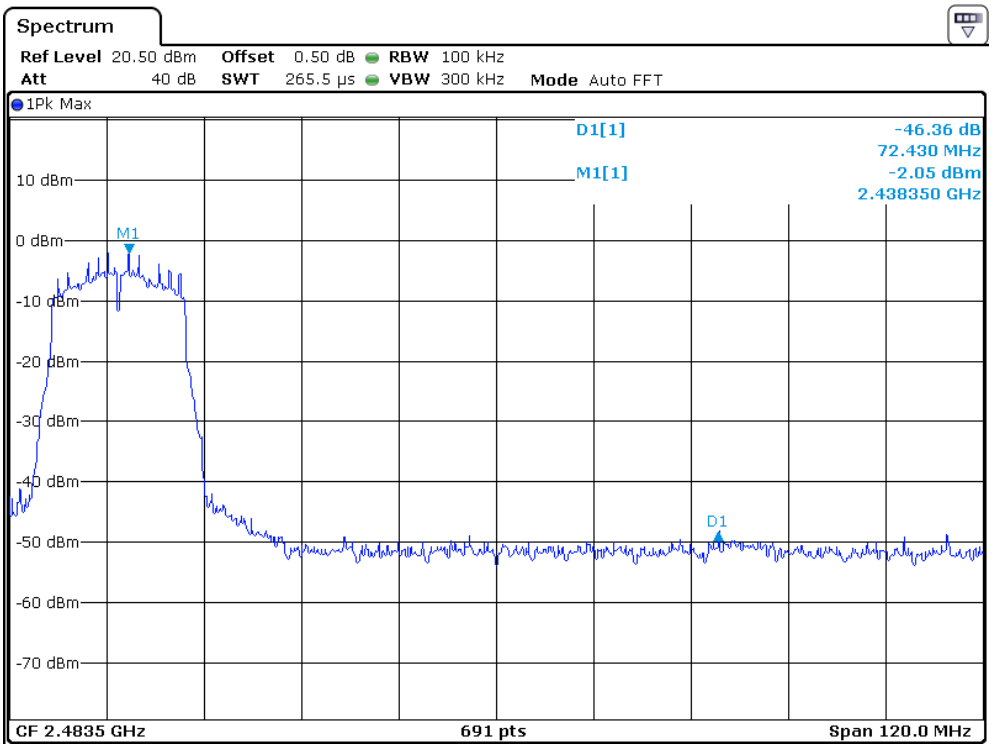

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 227.5 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -50.39 dB
-45.010 MHz
M1[1] 0.41 dBm
2.436030 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4 GHz
691 pts
Span 100.0 MHz

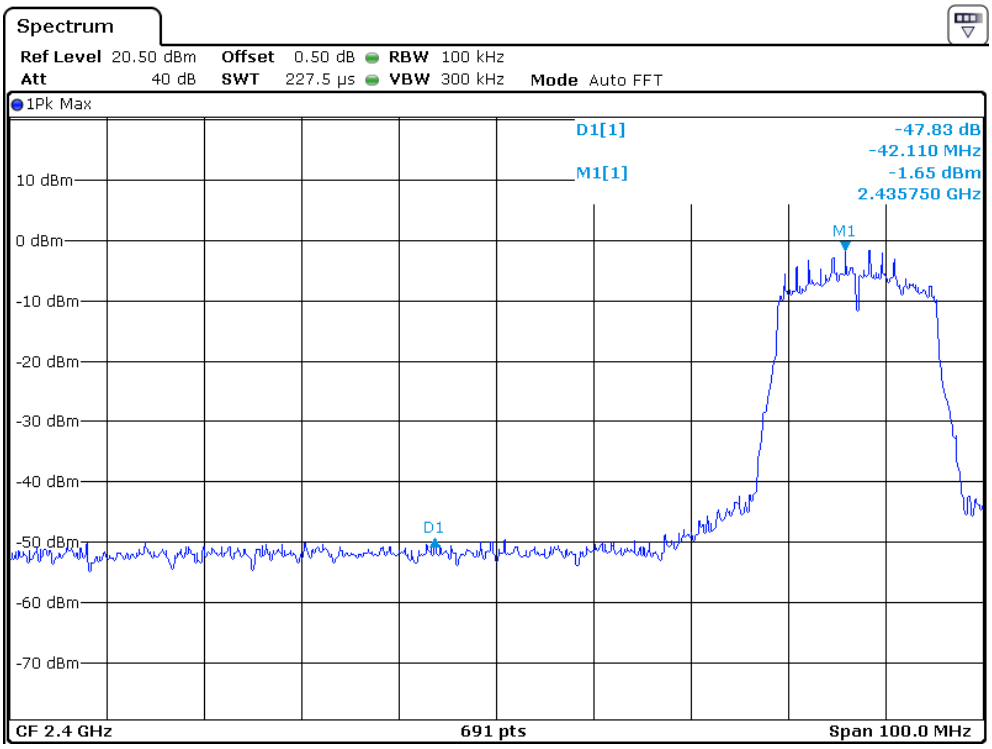

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 265.5 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -49.59 dB
78.840 MHz
M1[1] 0.34 dBm
2.436090 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4835 GHz
691 pts
Span 120.0 MHz

802.11g
Reference Level: -1.63dBm

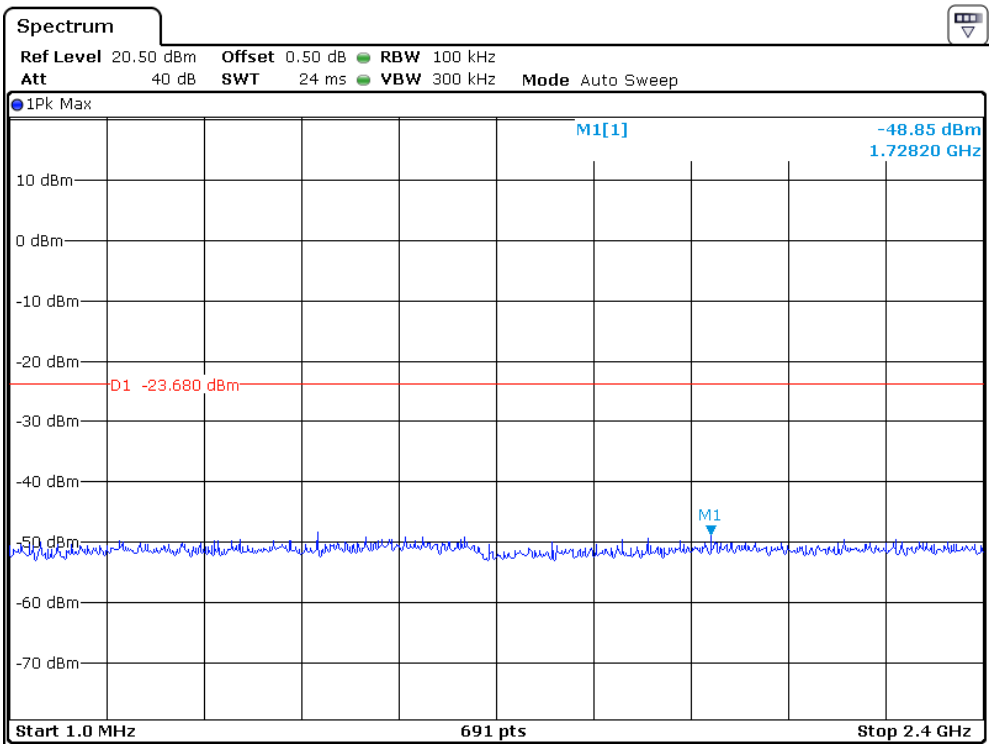


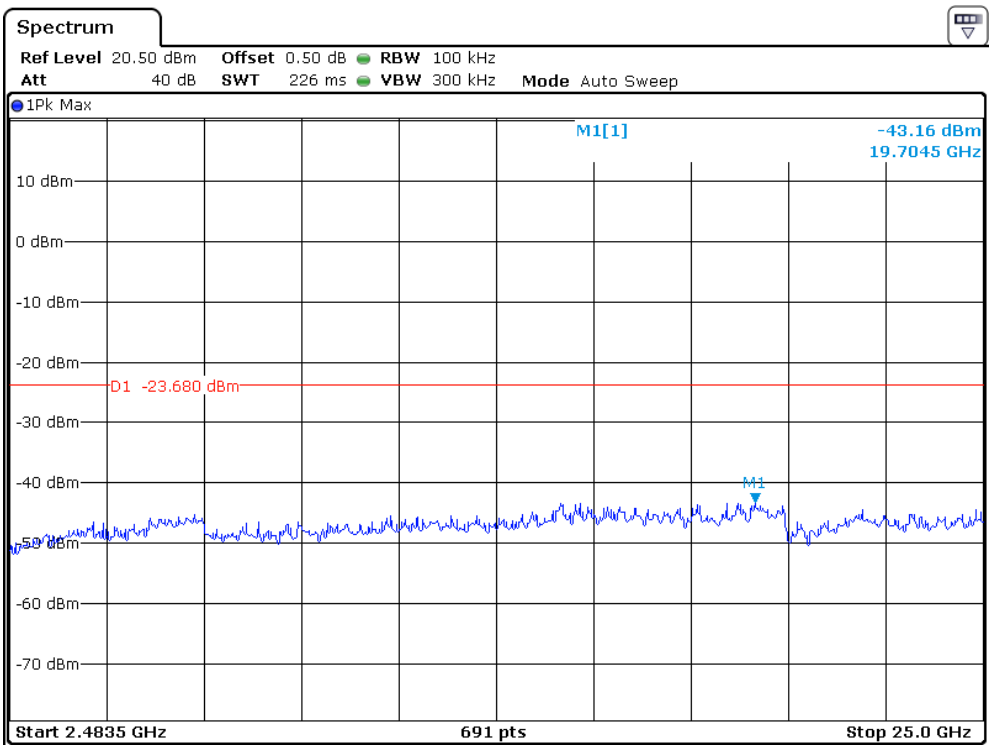


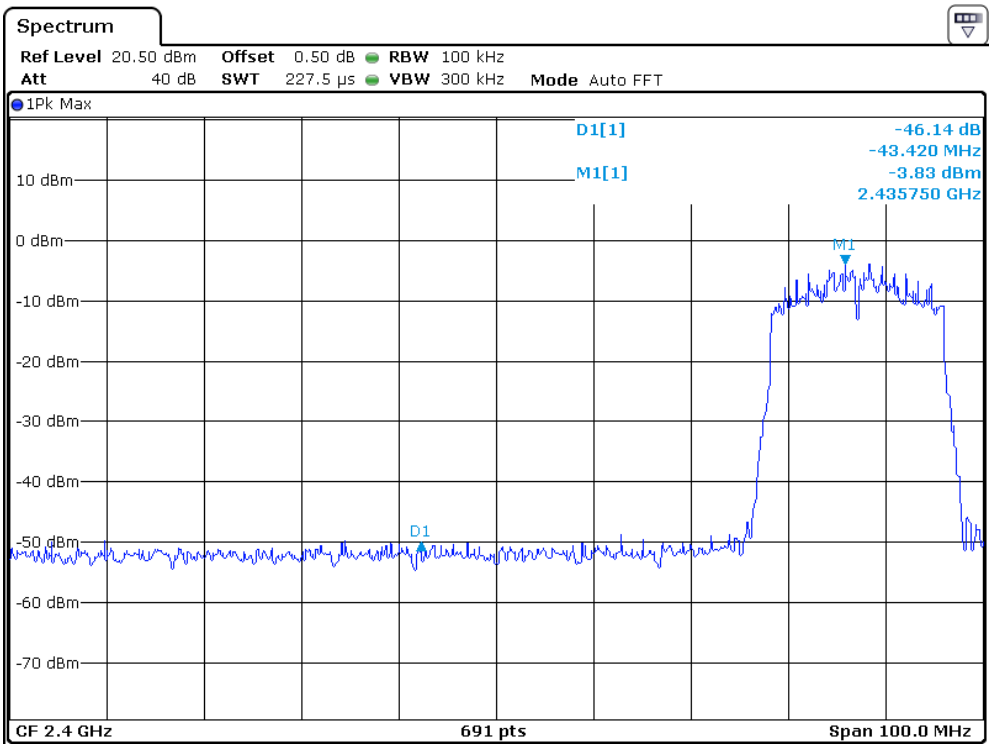

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 265.5 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -46.36 dB
72.430 MHz
M1[1] -2.05 dBm
2.438350 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4835 GHz
691 pts
Span 120.0 MHz

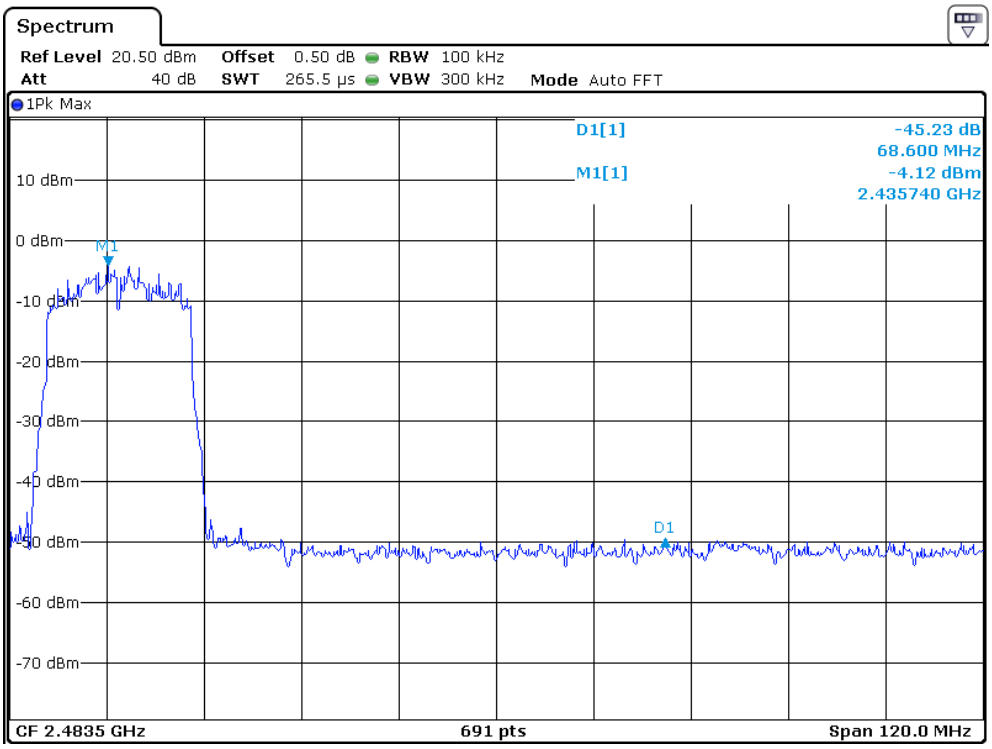

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 227.5 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -47.83 dB
-42.110 MHz
M1[1] -1.65 dBm
2.435750 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4 GHz
691 pts
Span 100.0 MHz

802.11n-HT20
Reference Level: -3.68dBm

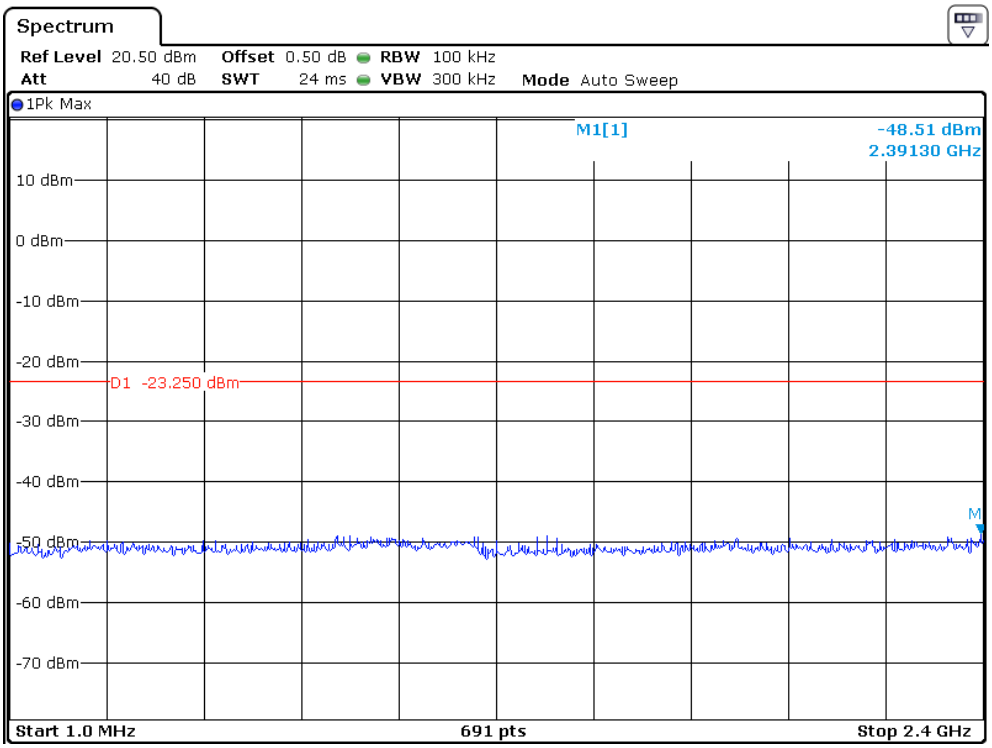


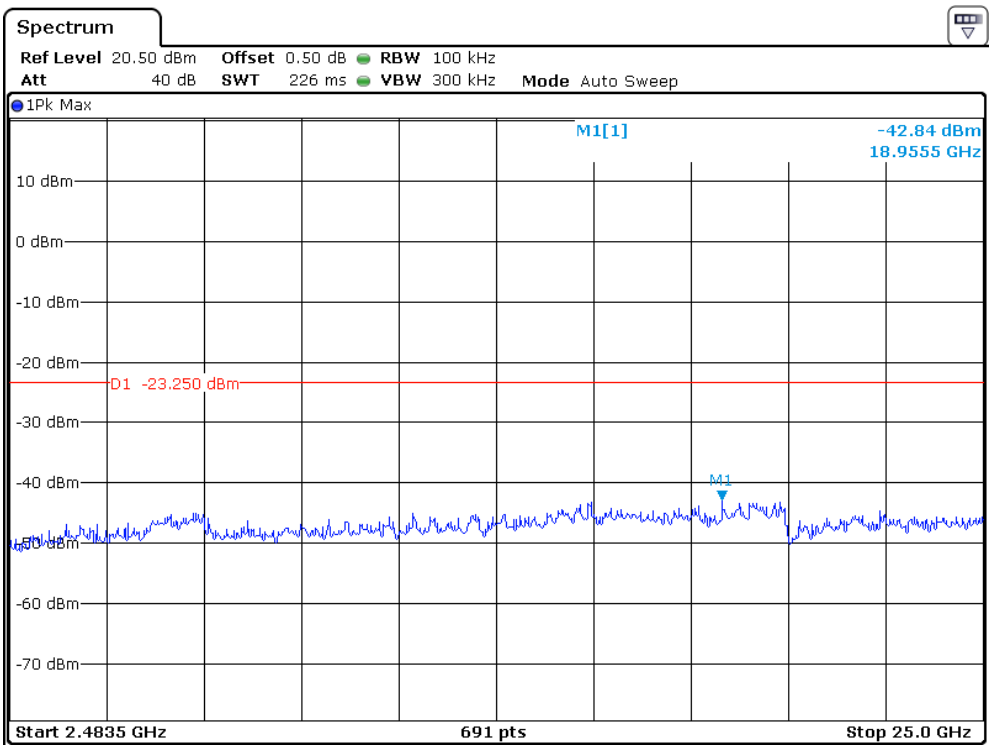


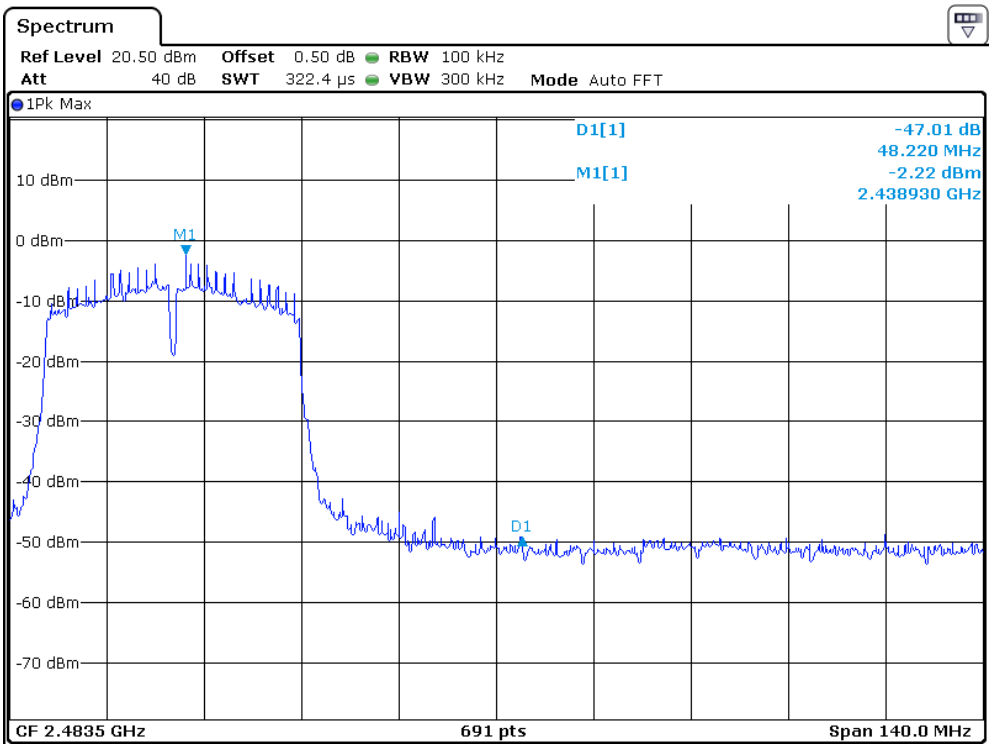

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 227.5 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -46.14 dB
-43.420 MHz
M1[1] -3.83 dBm
2.435750 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4 GHz
691 pts
Span 100.0 MHz

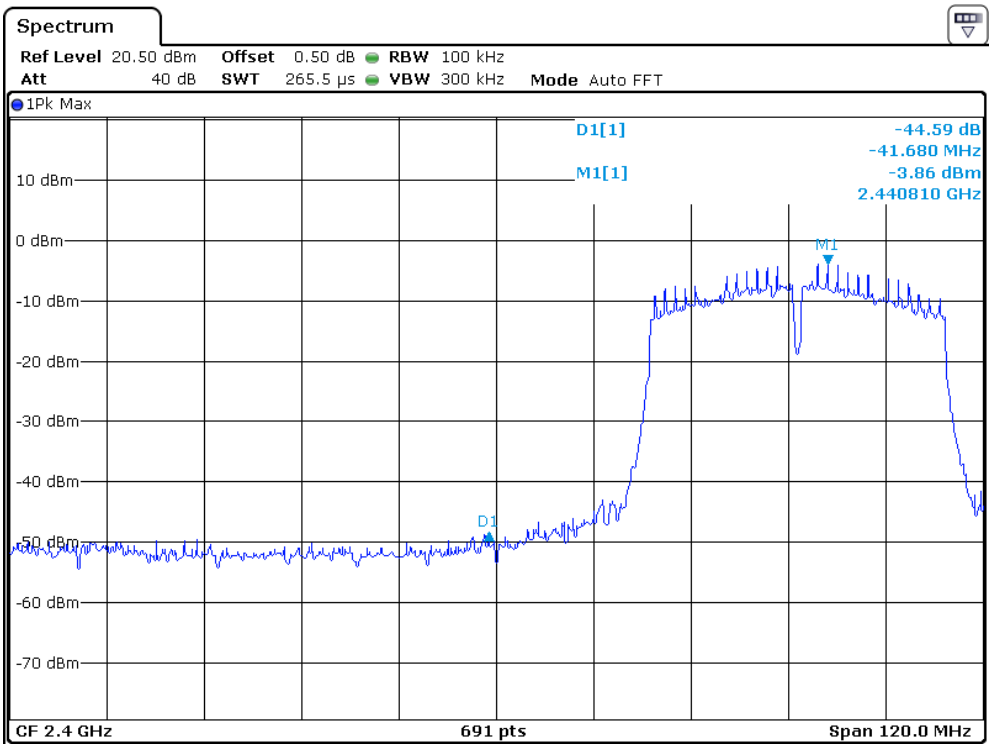

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 265.5 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -45.23 dB
68.600 MHz
M1[1] -4.12 dBm
2.435740 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4835 GHz
691 pts
Span 120.0 MHz

802.11n-HT40
Reference Level: -3.25dBm



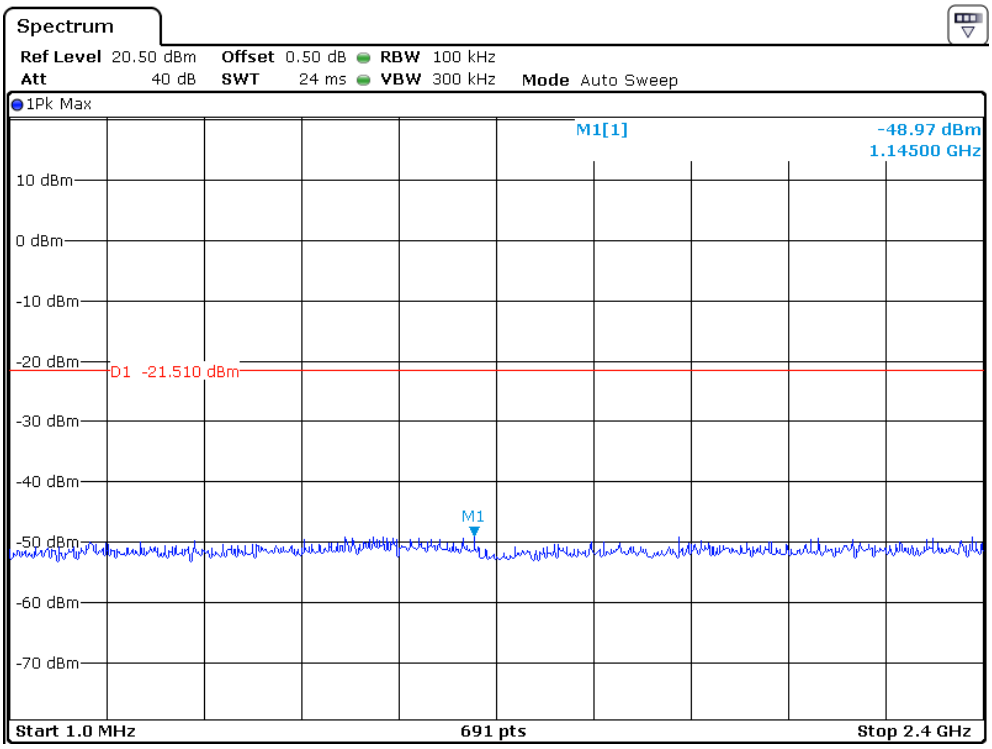


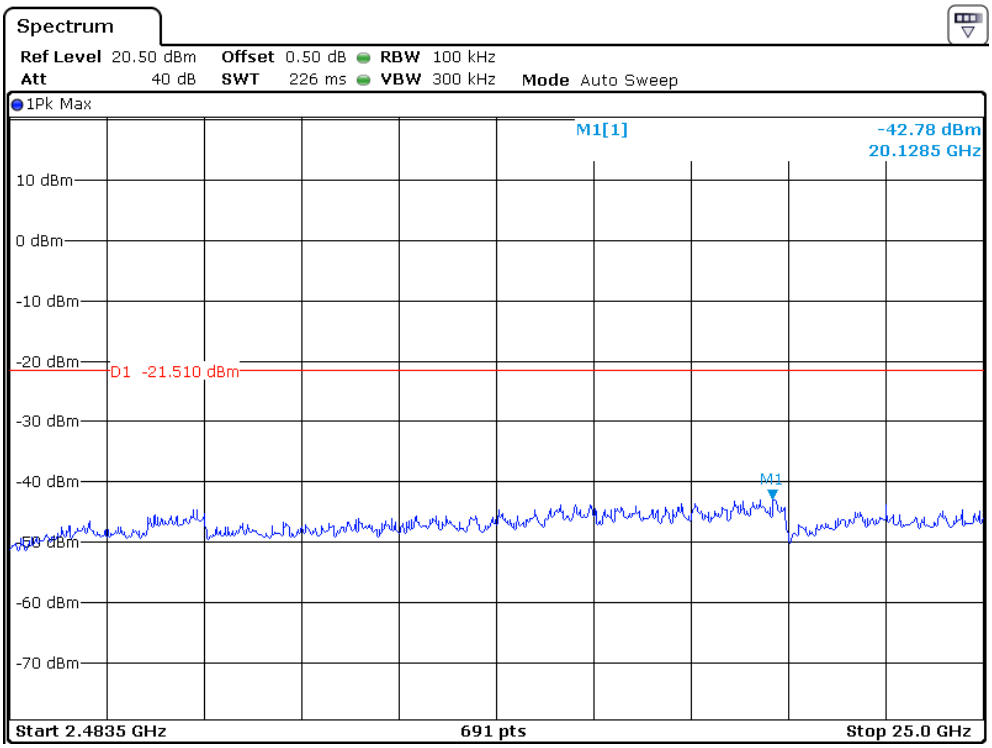

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 322.4 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -47.01 dB
48.220 MHz
M1[1] -2.22 dBm
2.438930 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4835 GHz
691 pts
Span 140.0 MHz

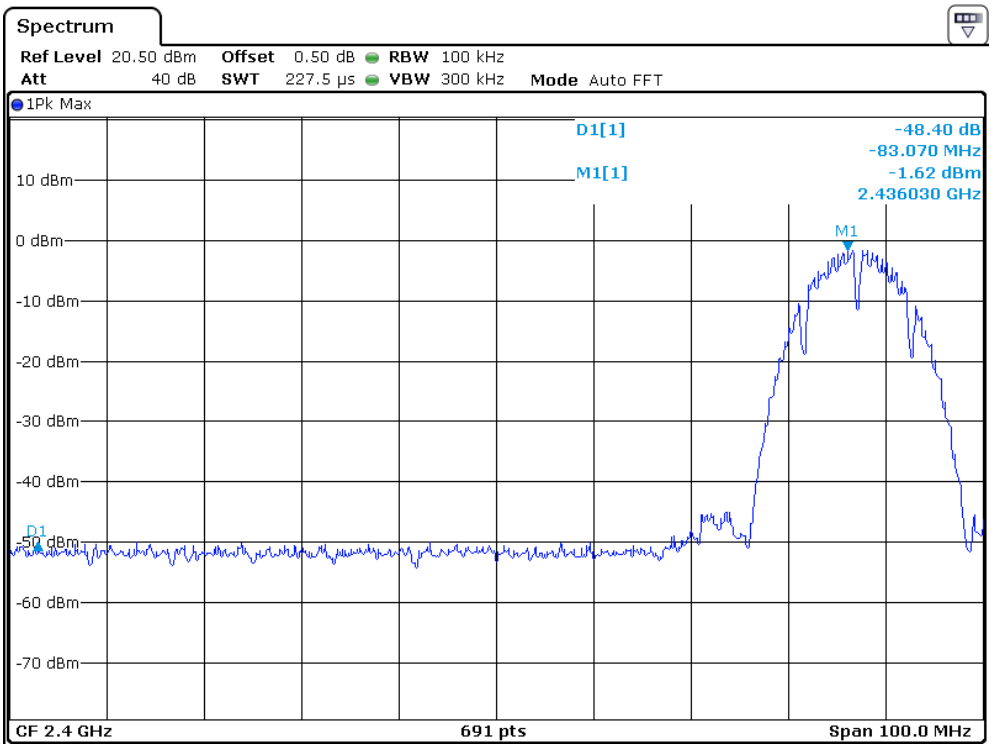

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 265.5 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -44.59 dB
-41.680 MHz
M1[1] -3.86 dBm
2.440810 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4 GHz
691 pts
Span 120.0 MHz

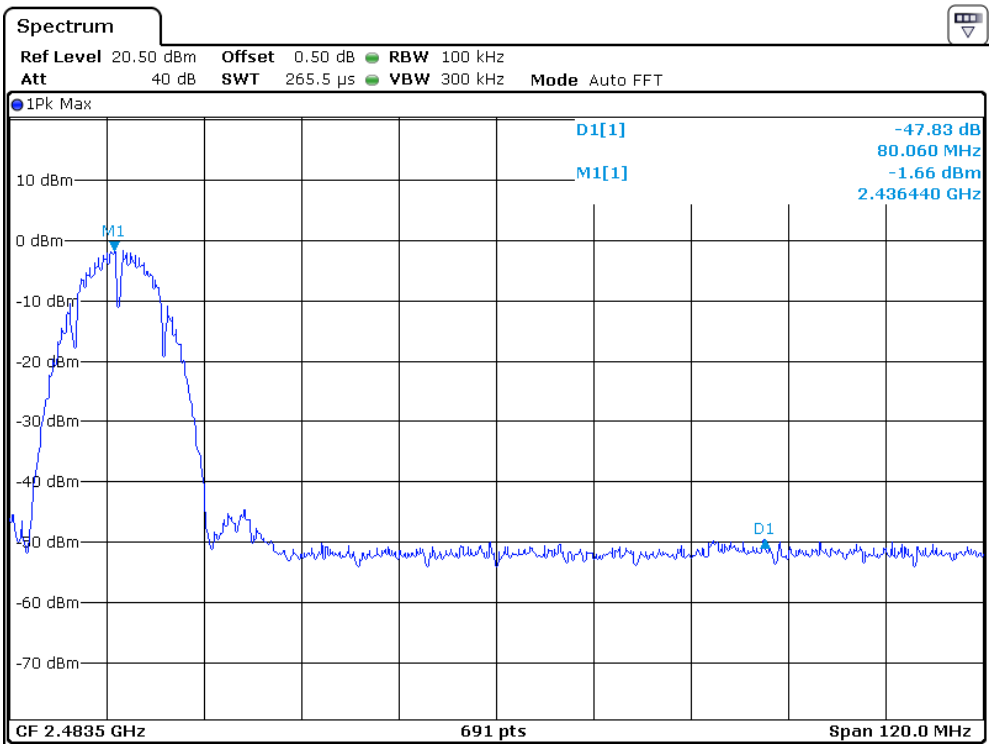
SISO Mode, Ant2

802.11b
Reference Level: -1.51dBm

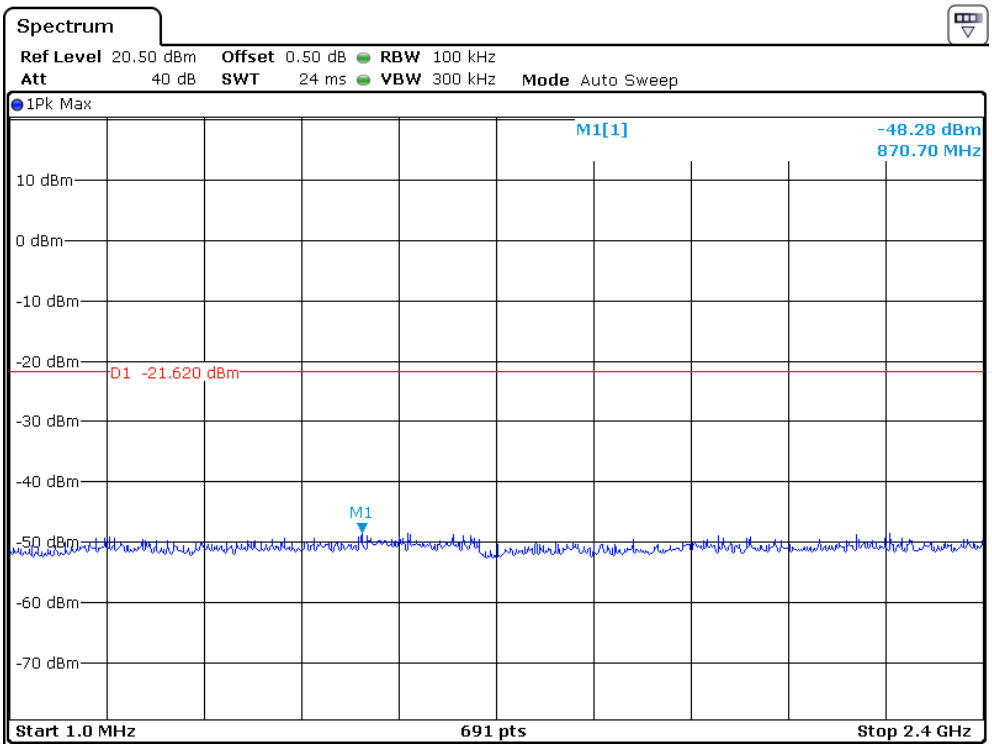


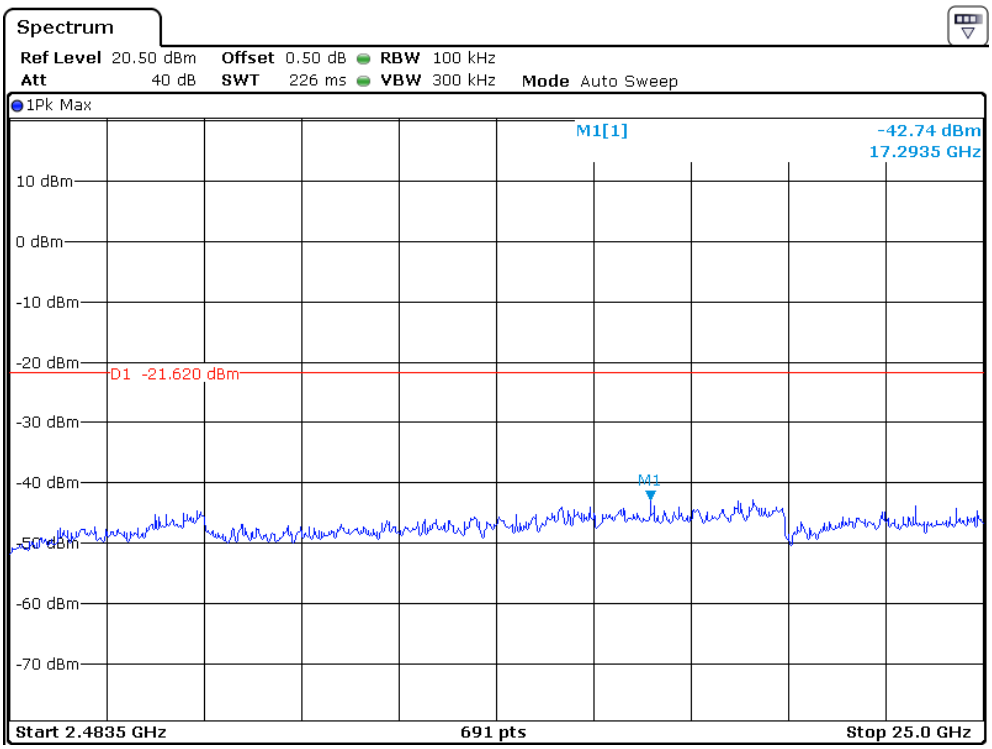


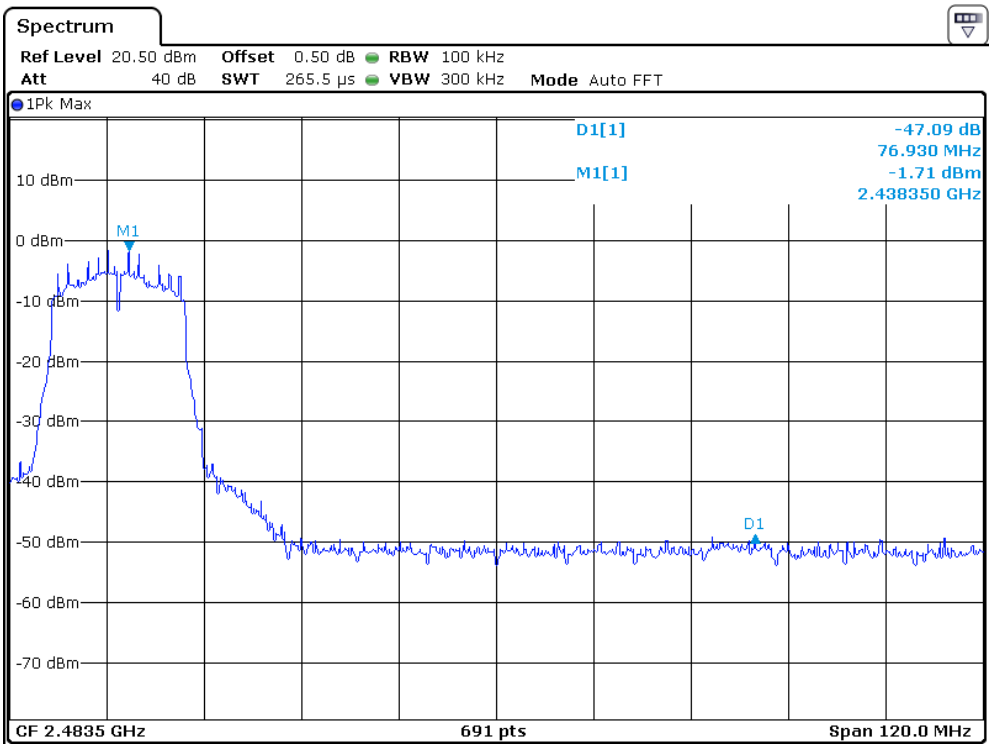

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 227.5 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -48.40 dB
-83.070 MHz
M1[1] -1.62 dBm
2.436030 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4 GHz
691 pts
Span 100.0 MHz

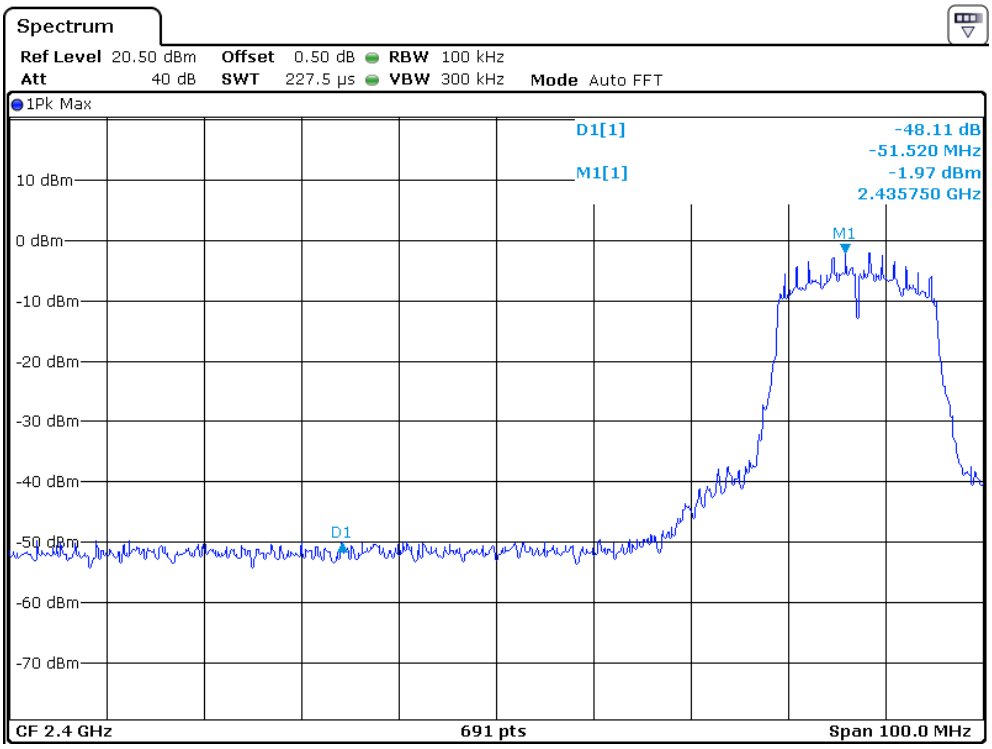

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 265.5 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -47.83 dB
80.060 MHz
M1[1] -1.66 dBm
2.436440 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4835 GHz
691 pts
Span 120.0 MHz

802.11g
Reference Level: -1.62dBm

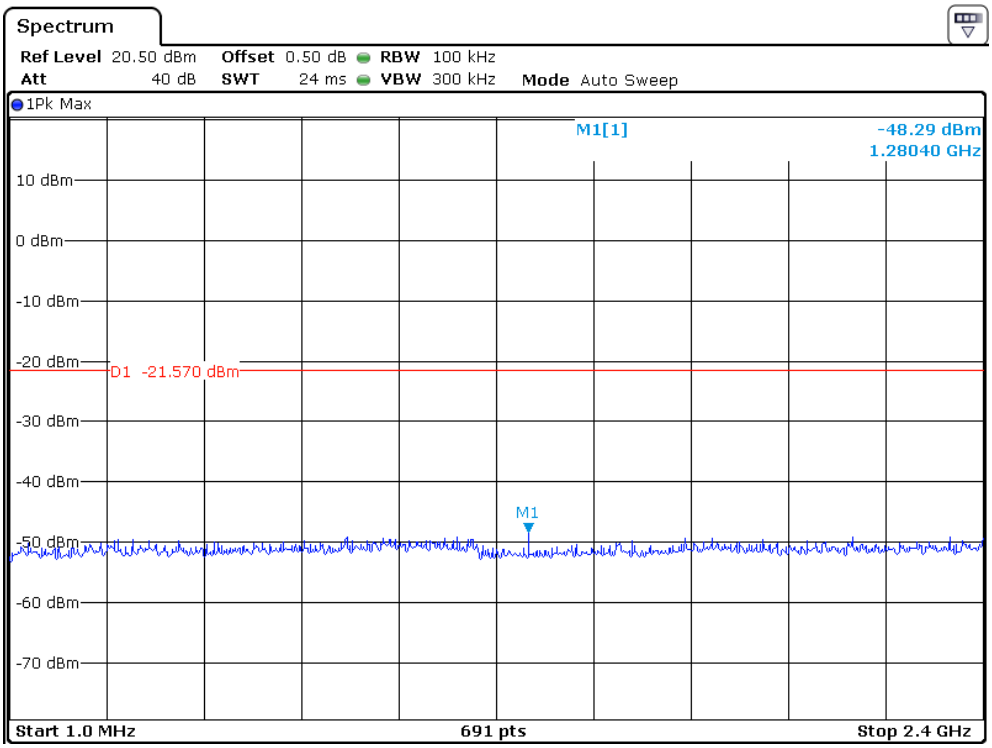


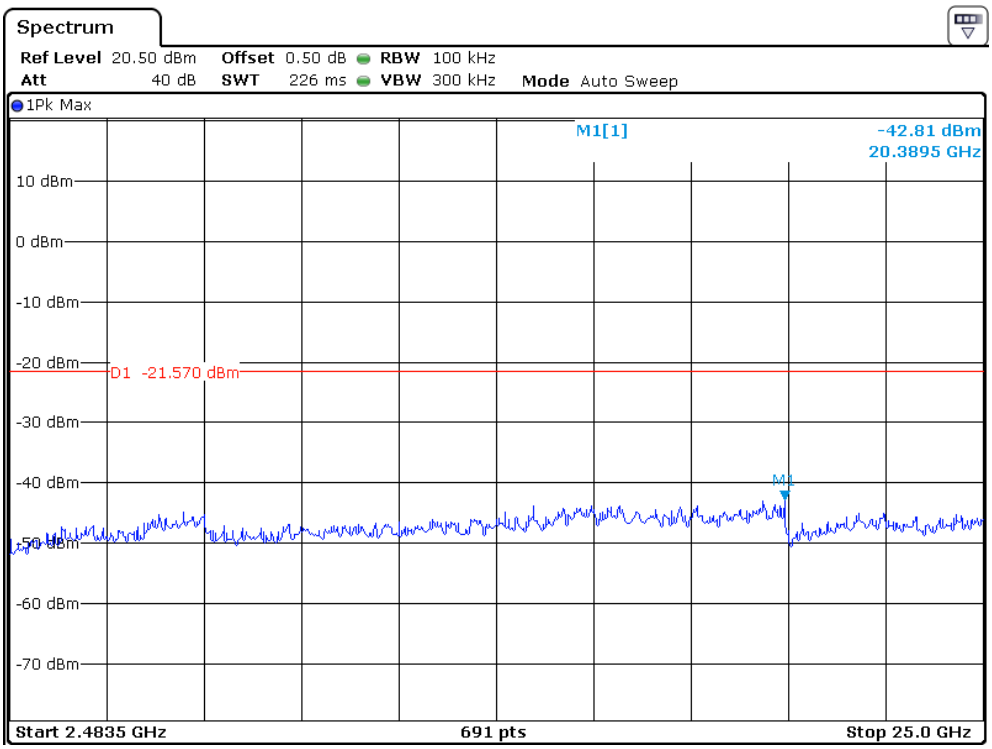


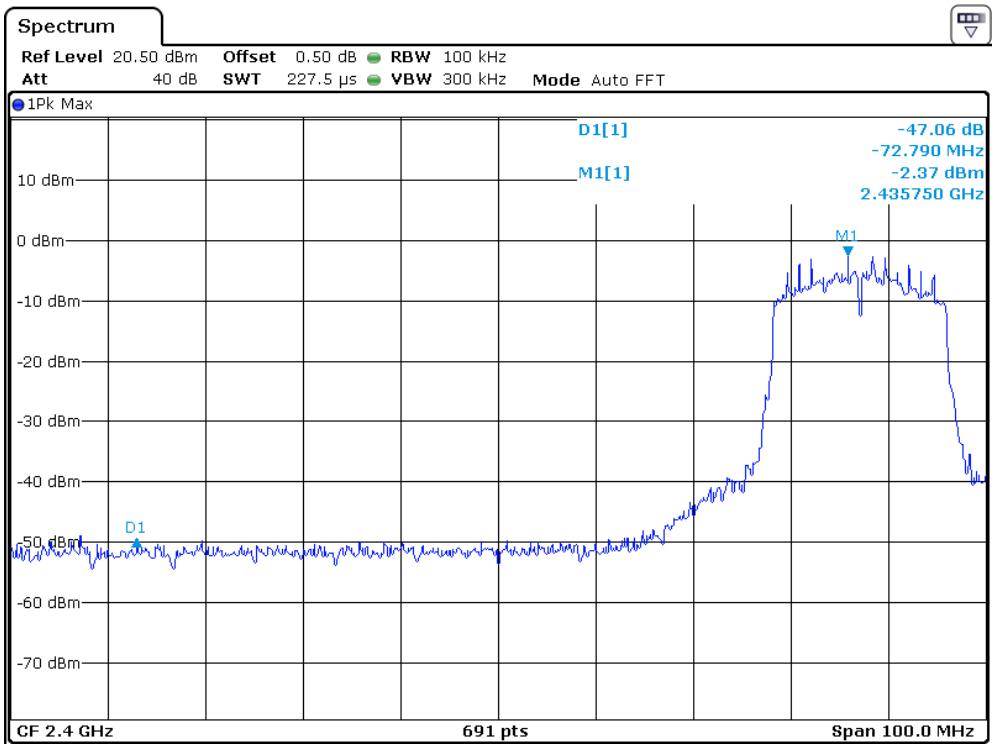

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 265.5 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -47.09 dB
76.930 MHz
M1[1] -1.71 dBm
2.438350 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4835 GHz
691 pts
Span 120.0 MHz

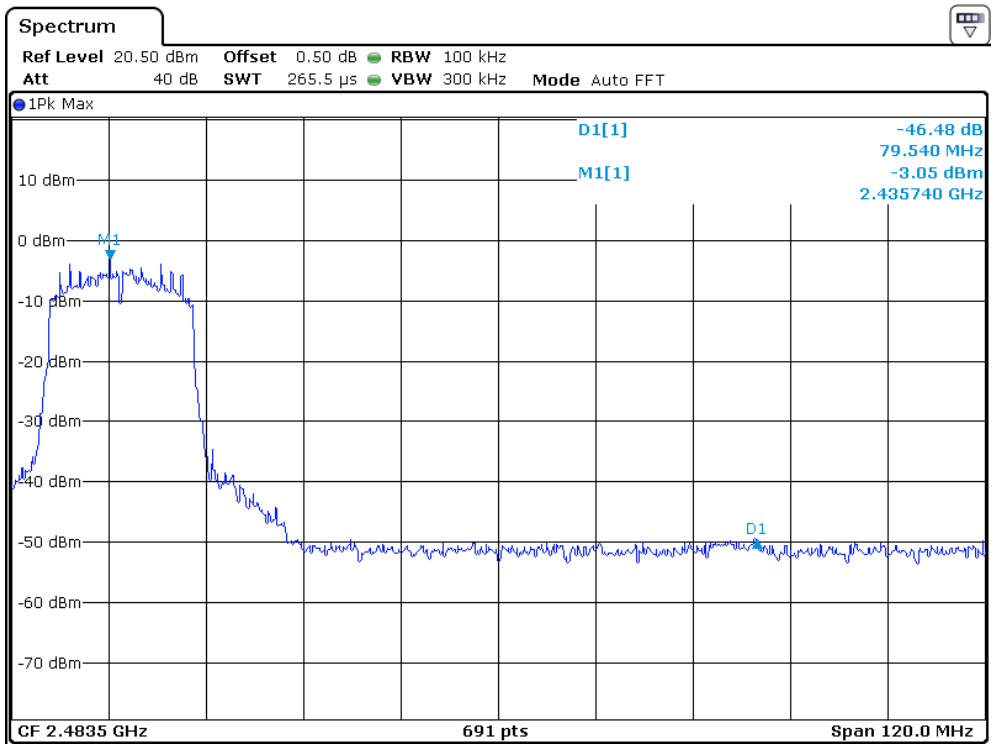

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 227.5 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -48.11 dB
-51.520 MHz
M1[1] -1.97 dBm
2.435750 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4 GHz
691 pts
Span 100.0 MHz

802.11-HT20
Reference Level: -1.57dBm

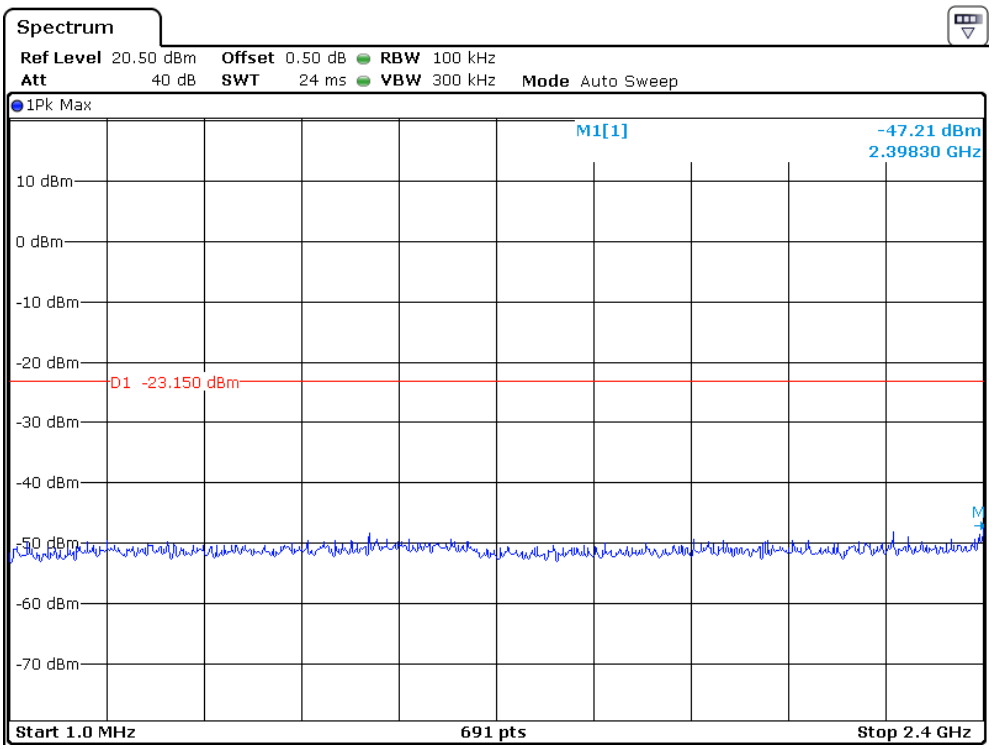


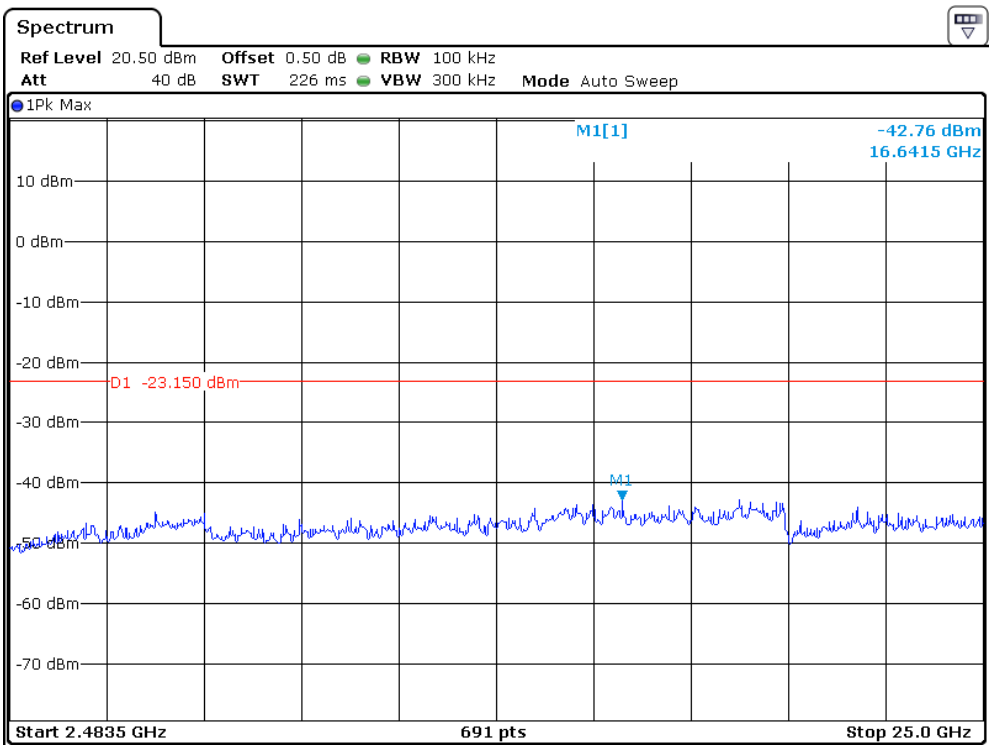


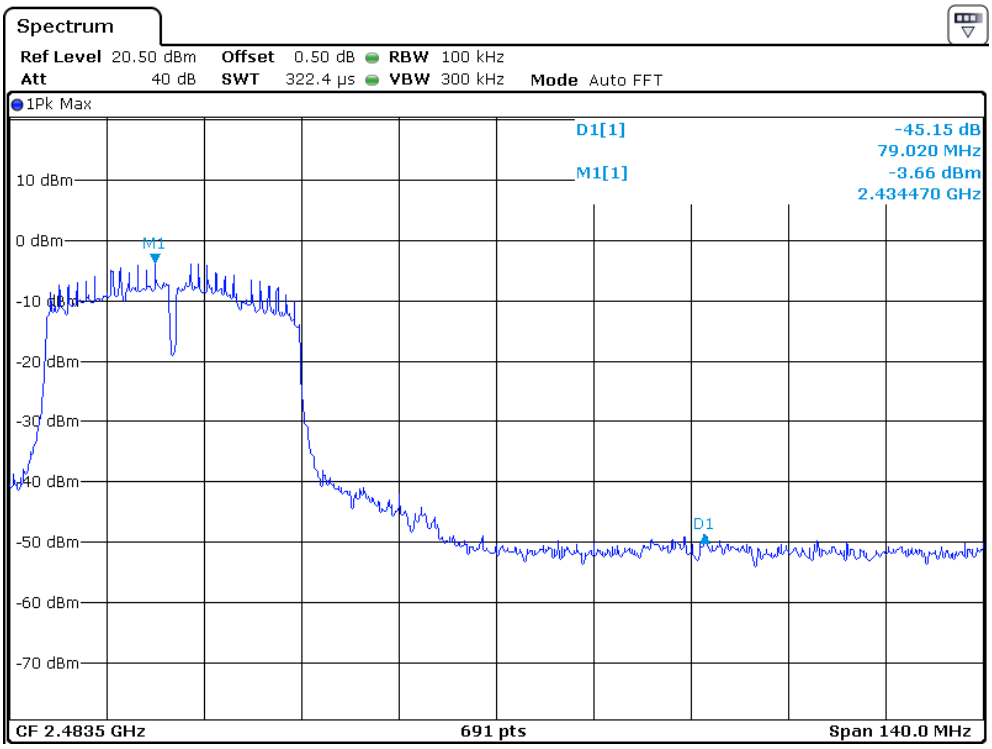

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 227.5 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -47.06 dB
-72.790 MHz
M1[1] -2.37 dBm
2.435750 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4 GHz
691 pts
Span 100.0 MHz

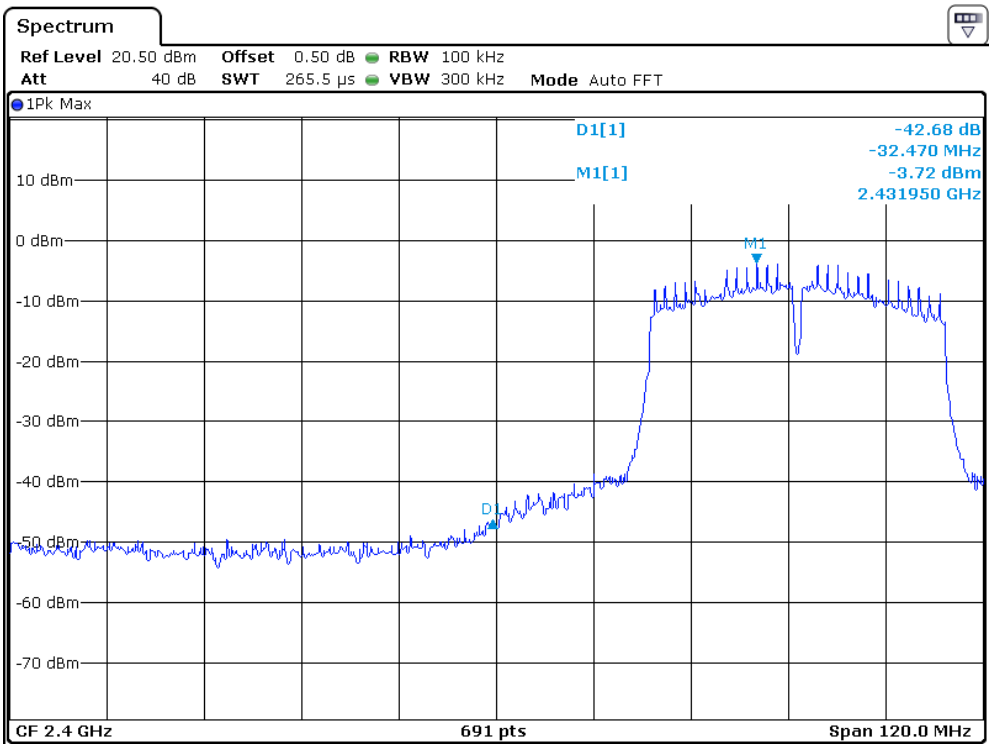

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 265.5 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -46.48 dB
79.540 MHz
M1[1] -3.05 dBm
2.435740 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4835 GHz
691 pts
Span 120.0 MHz

802.11-HT40
Reference Level: -3.15dBm



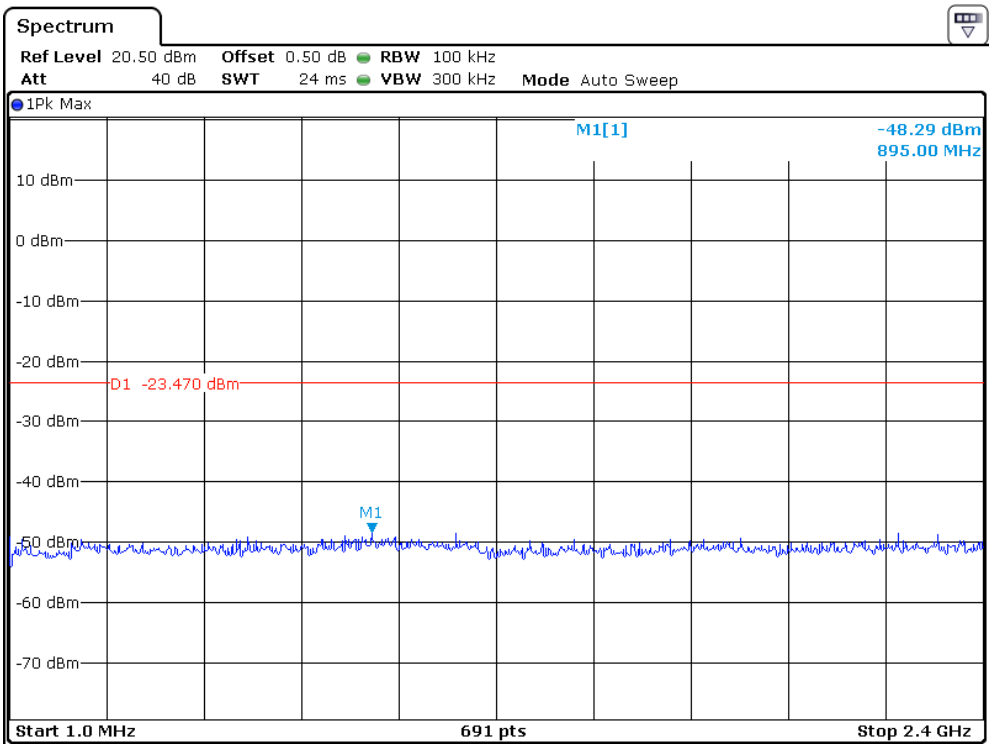


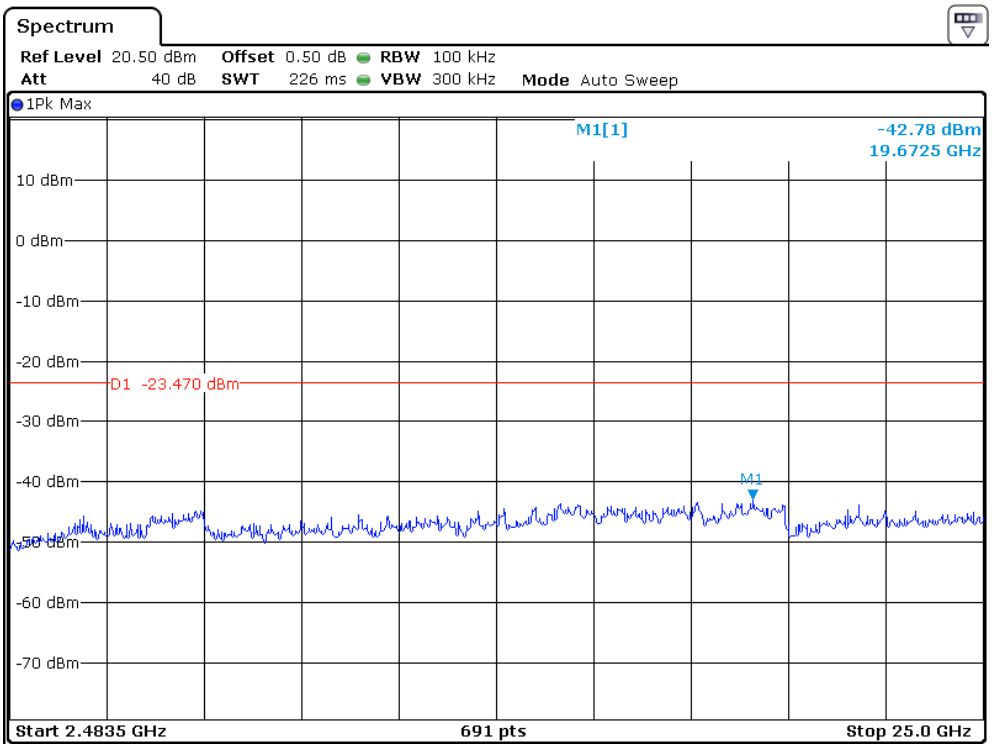

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 322.4 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -45.15 dB
79.020 MHz
M1[1] -3.66 dBm
2.434470 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4835 GHz
691 pts
Span 140.0 MHz

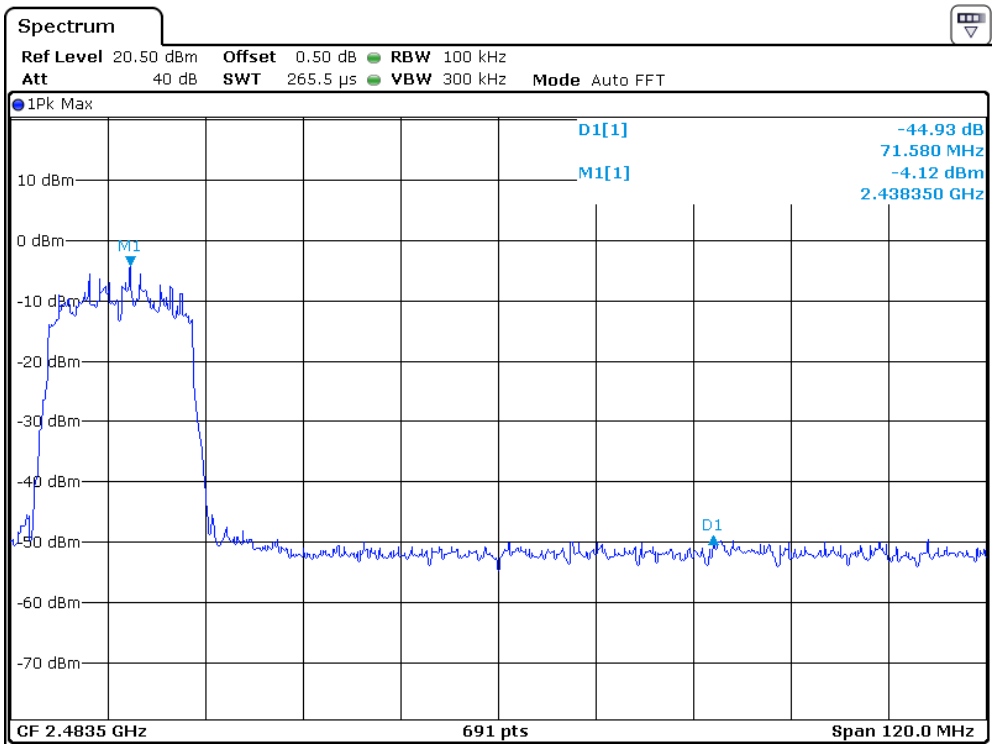

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 265.5 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -42.68 dB
-32.470 MHz
M1[1] -3.72 dBm
2.431950 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4 GHz
691 pts
Span 120.0 MHz

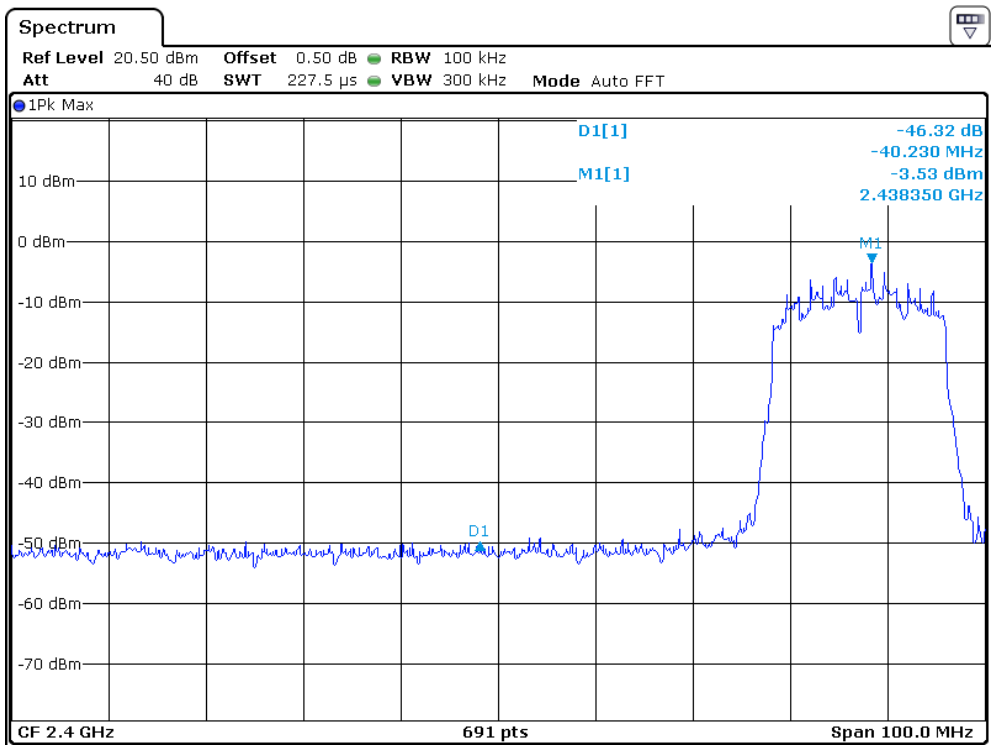
MIMO Mode, Ant1:

802.11n-HT20
Reference Level: -3.47dBm

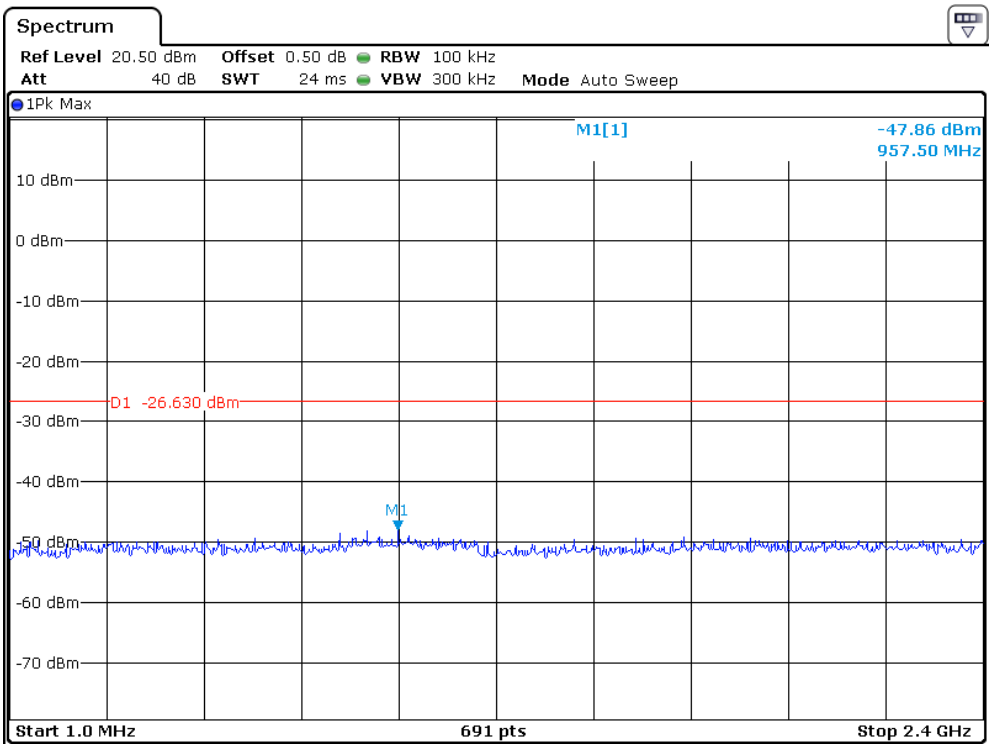


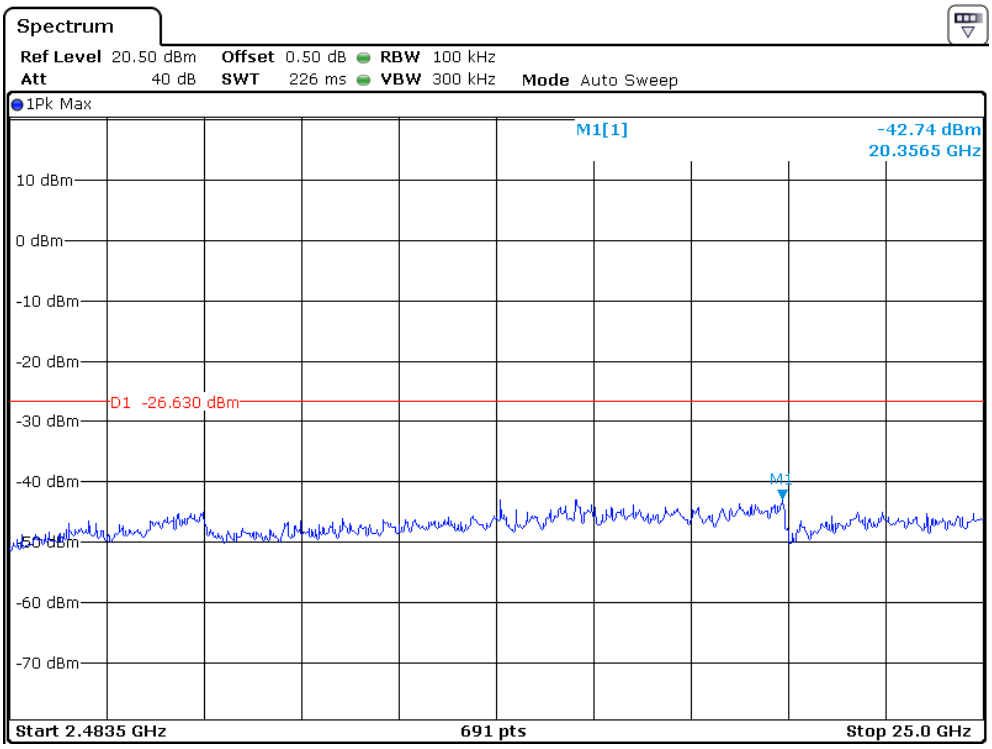


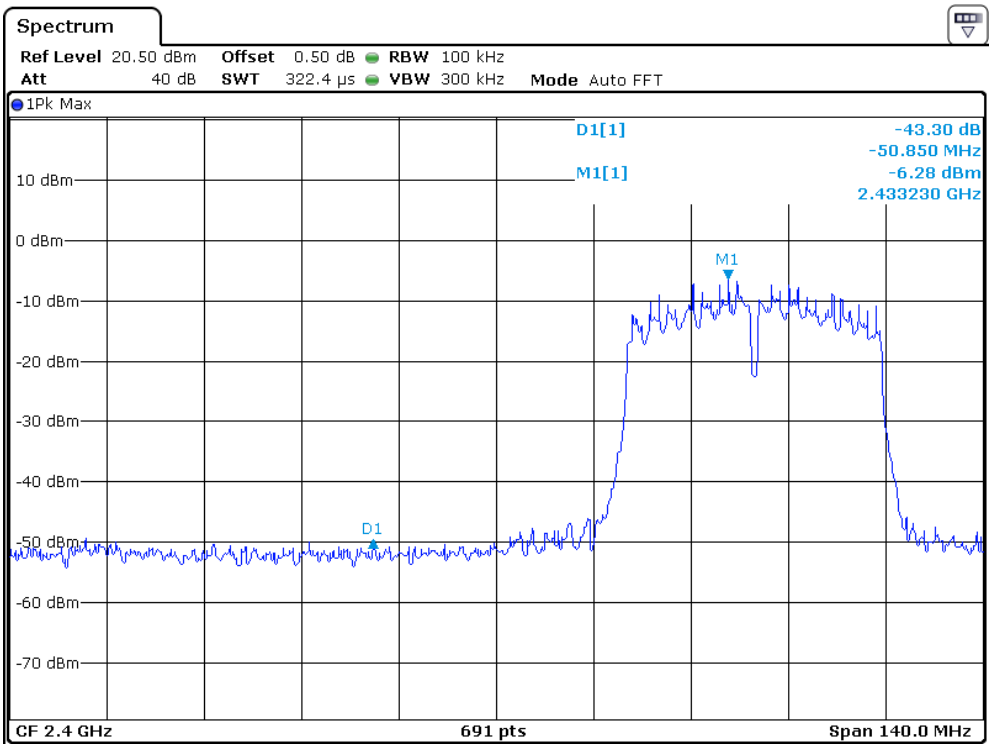

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 265.5 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -44.93 dB
71.580 MHz
M1[1] -4.12 dBm
2.438350 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4835 GHz
691 pts
Span 120.0 MHz

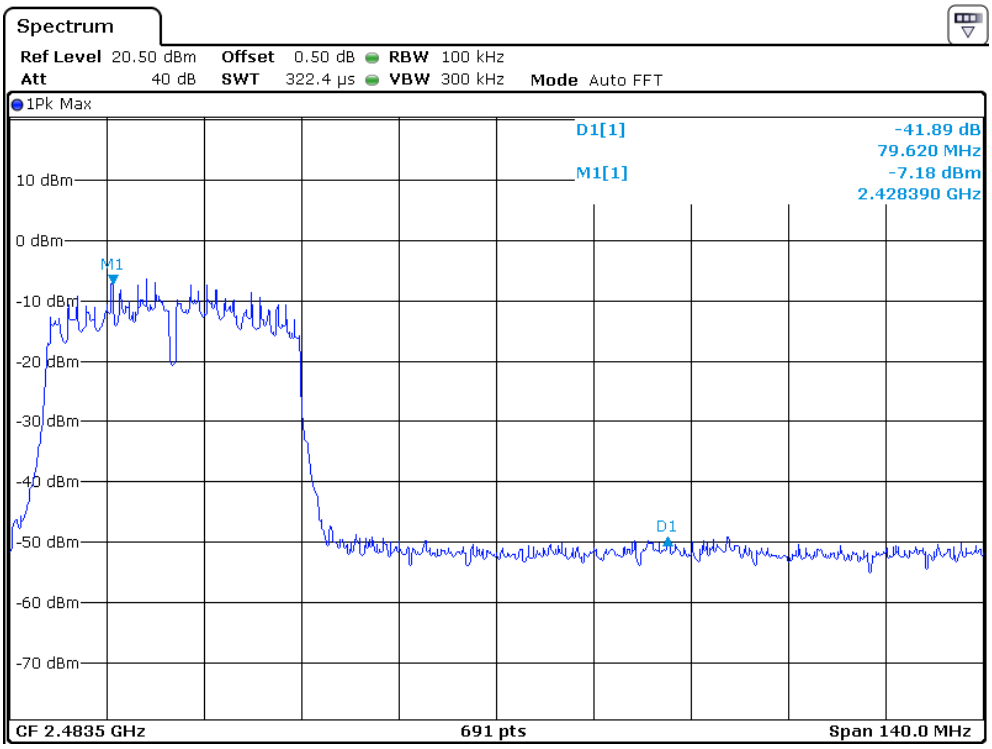

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 227.5 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -46.32 dB
-40.230 MHz
M1[1] -3.53 dBm
2.438350 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4 GHz
691 pts
Span 100.0 MHz

802.11n-HT40
Reference Level: -6.63dBm



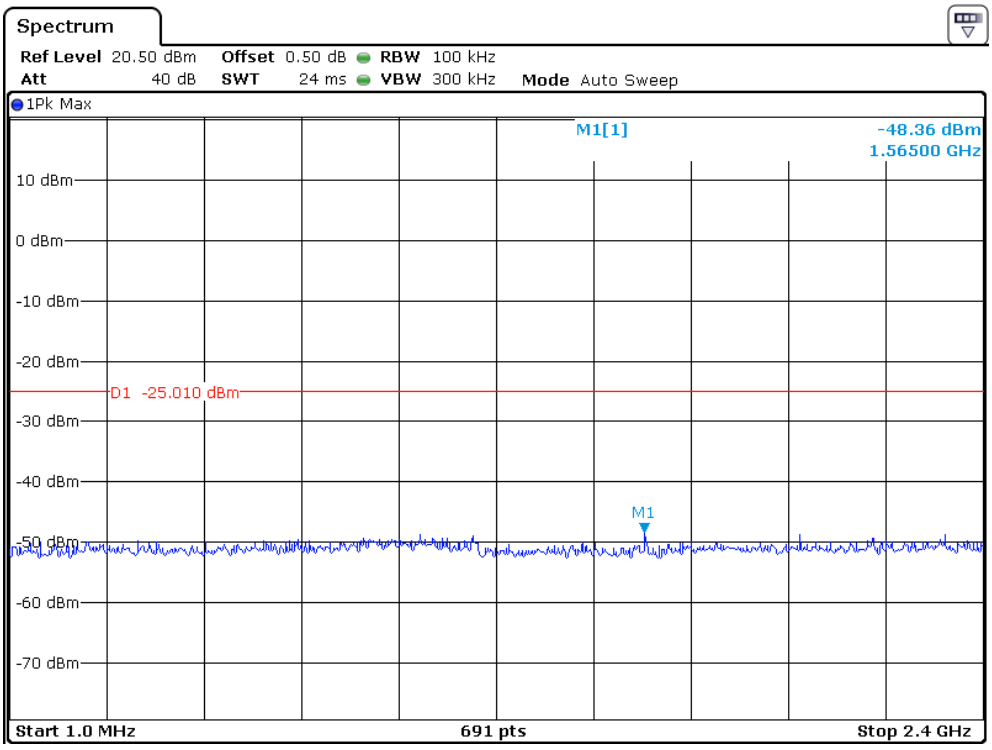


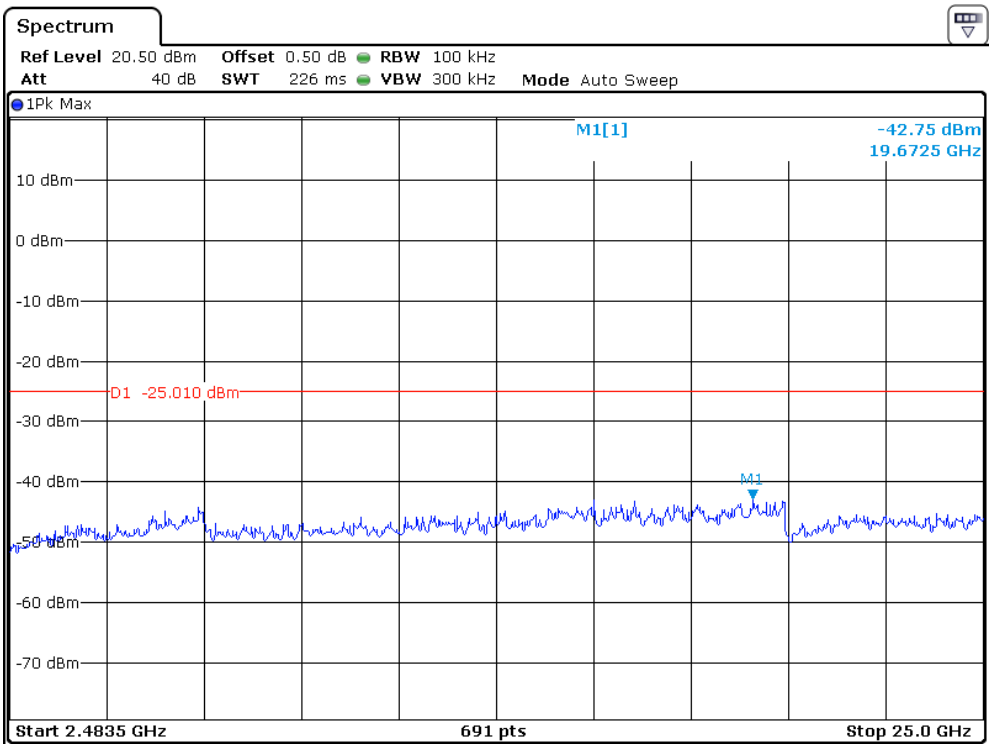

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 322.4 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -43.30 dB
-50.850 MHz
M1[1] -6.28 dBm
2.433230 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4 GHz
691 pts
Span 140.0 MHz

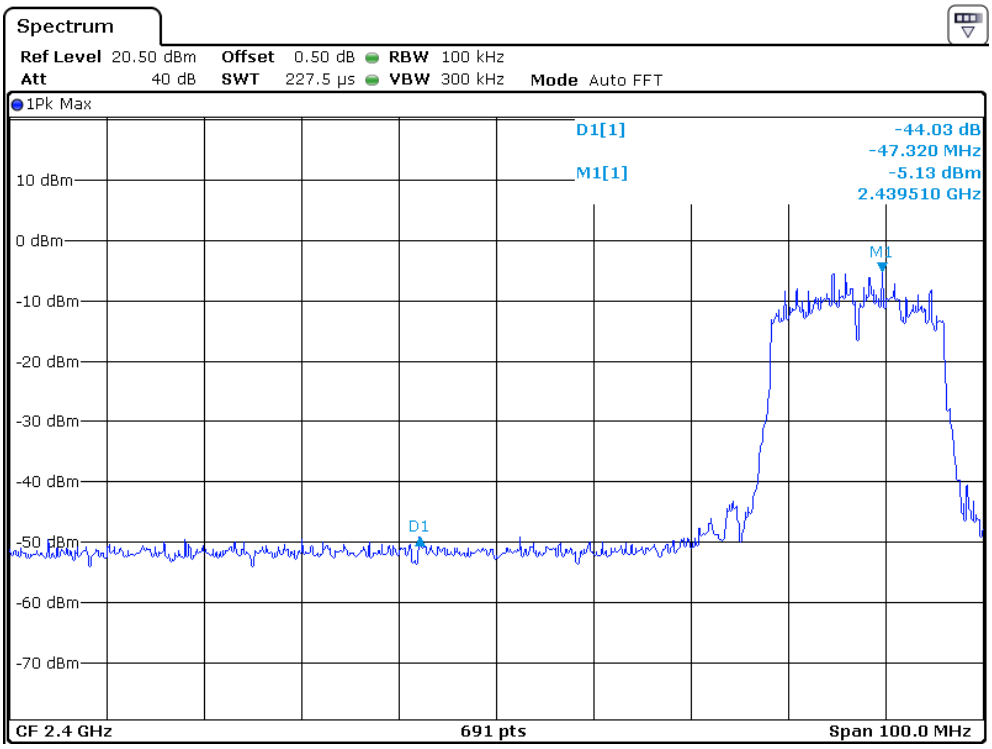

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 322.4 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -41.89 dB
79.620 MHz
M1[1] -7.18 dBm
2.428390 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4835 GHz
691 pts
Span 140.0 MHz

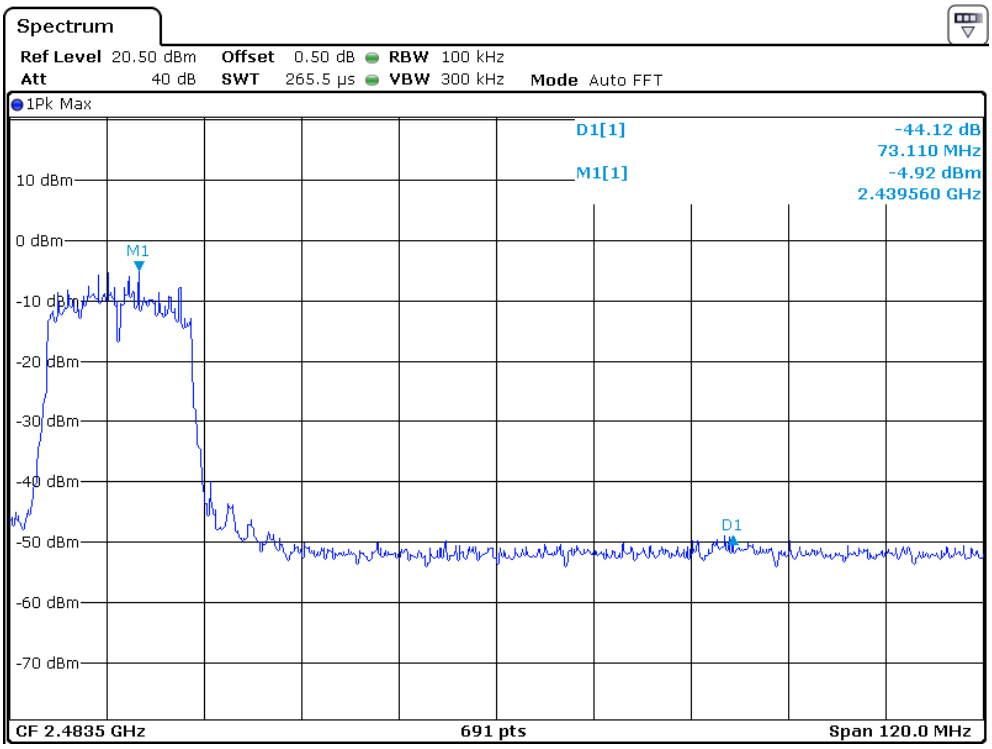
MIMO Mode, Ant2:

802.11n-HT20
Reference Level: -5.01dBm

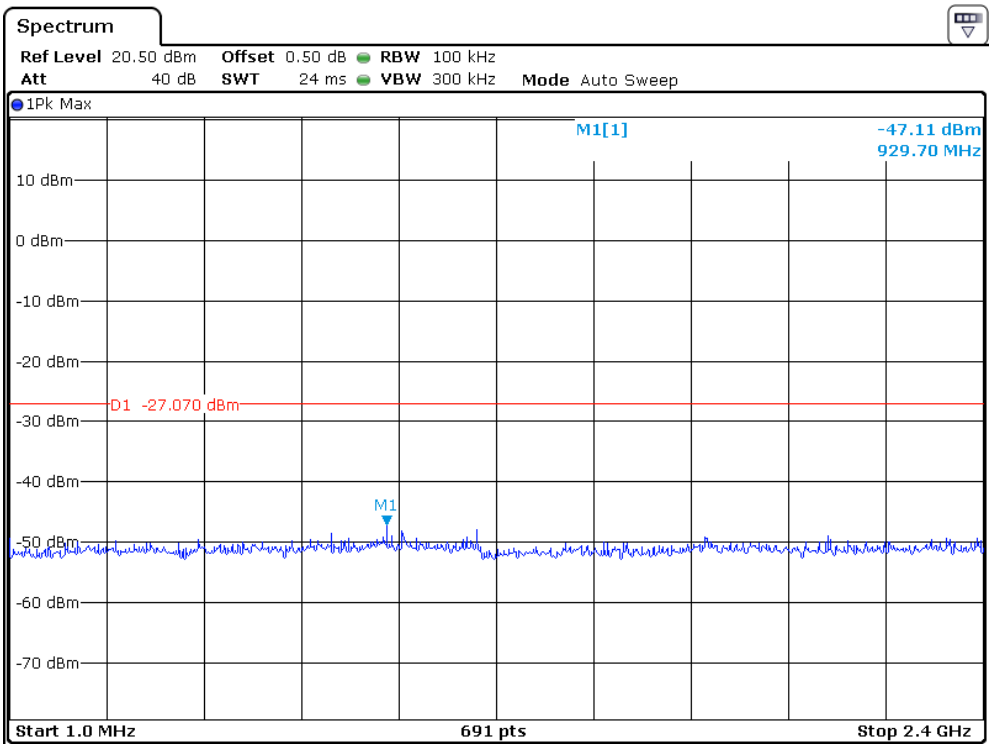


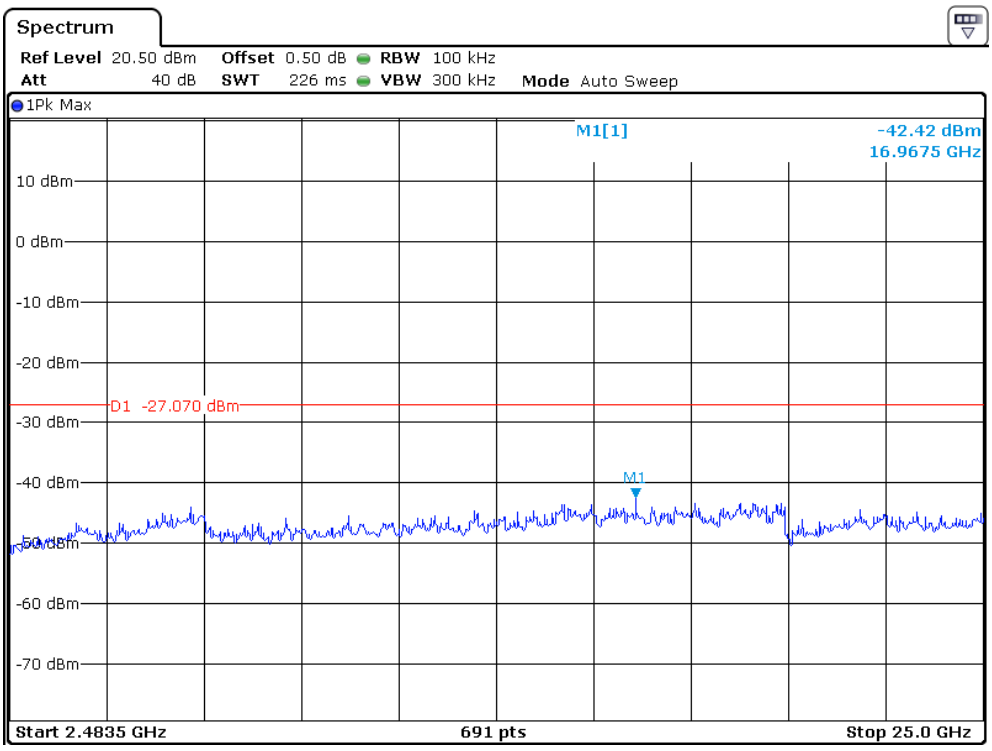


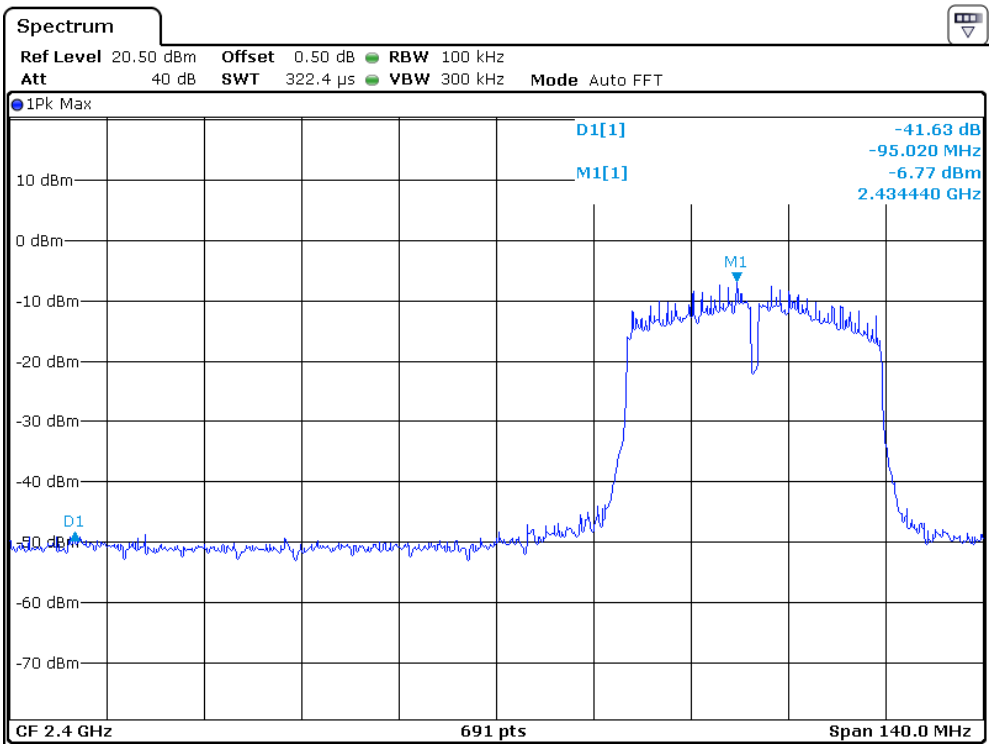

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 227.5 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -44.03 dB
-47.320 MHz
M1[1] -5.13 dBm
2.439510 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4 GHz
691 pts
Span 100.0 MHz

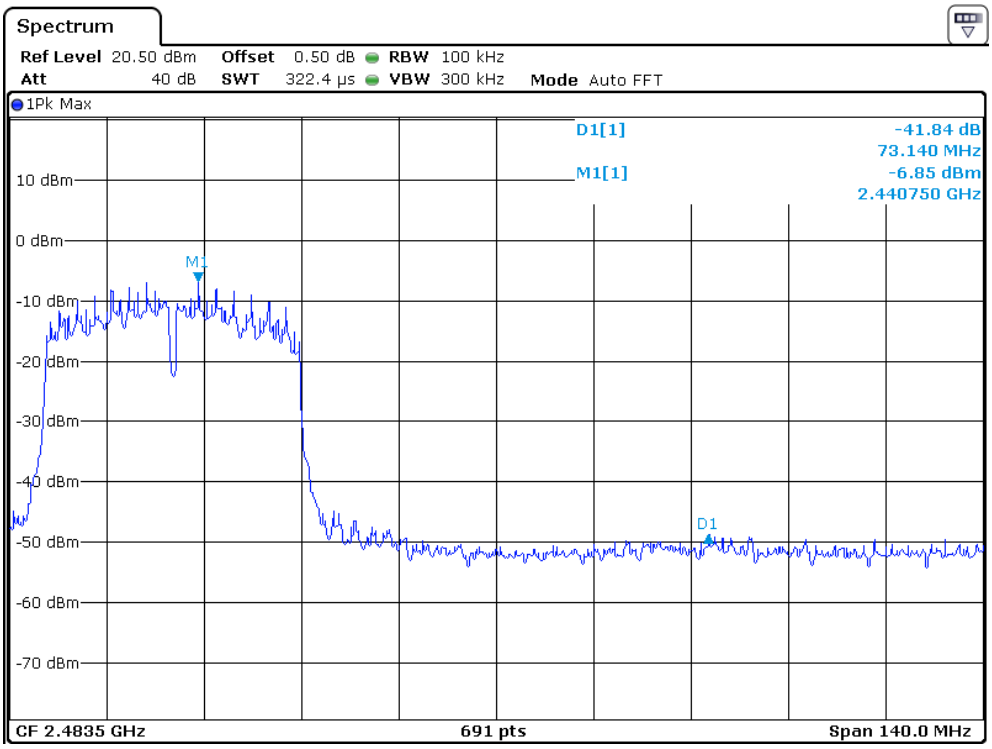

Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 265.5 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -44.12 dB
73.110 MHz
M1[1] -4.92 dBm
2.439560 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4835 GHz
691 pts
Span 120.0 MHz

802.11n-HT40
Reference Level: -7.07dBm






Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 322.4 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -41.63 dB
-95.020 MHz
M1[1] -6.77 dBm
2.434440 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4 GHz
691 pts
Span 140.0 MHz


Spectrum
Ref Level 20.50 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 322.4 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -41.84 dB
73.140 MHz
M1[1] -6.85 dBm
2.440750 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
CF 2.4835 GHz
691 pts
Span 140.0 MHz

4.5 Out of Band Radiated Emissions (for emissions in 4.4 above that are less than 20dB below carrier), FCC Rule 15.247(d):

For out of band emissions that are close to or that exceed the 20dB attenuation requirement described in the specification, radiated measurements were performed at a 3m separation distance to determine whether these emissions complied with the general radiated emission requirement.

[×] Not required, since all emissions are more than 20dB below fundamental
[ ] See attached data sheet

4.6 Transmitter Radiated Emissions in Restricted Bands, FCC Rule 15.35(b) (c):

Data is included of the worst case configuration (the configuration which resulted in the highest emission levels). A sample calculation, configuration photographs and data tables of the emissions are included. All measurements were performed with peak detection unless otherwise specified.

The data on the following pages list the significant emission frequencies, the limit and the margin of compliance.

4.7 Field Strength Calculation

The field strength is calculated by adding the reading on the Spectrum Analyzer to the factors associated with preamplifiers (if any), antennas, cables, pulse desensitization and average factors (when specified limit is in average and measurements are made with peak detectors). A sample calculation is included below.

FS = RA + AF + CF - AG + PD

Where FS = Field Strength in dBµV/m
RA = Receiver Amplitude (including preamplifier) in dBµV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB
PD = Pulse Desensitization in dB

In the radiated emission table which follows, the reading shown on the data table may reflect the preamplifier gain. An example of the calculations, where the reading does not reflect the preamplifier gain, follows:

FS = RA + AF + CF - AG + PD

Example

Assume a receiver reading of 62.0 dBµV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted. The pulse desensitization factor of the spectrum analyzer was 0 dB. The net field strength for comparison to the appropriate emission limit is 42 dBµV/m. This value in dBµV/m was converted to its corresponding level in µV/m.

RA = 62.0 dBµV
AF = 7.4 dB
CF = 1.6 dB
AG = 29.0 dB
PD = 0 dB
FS = 62 + 7.4 + 1.6 - 29 + 0 = 42 dBµV/m

Level in mV/m = Common Antilogarithm [(42 dBµV/m)/20] = 125.9 µV/m

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020 Model: Borecam PRO

4.8 Radiated Spurious Emission

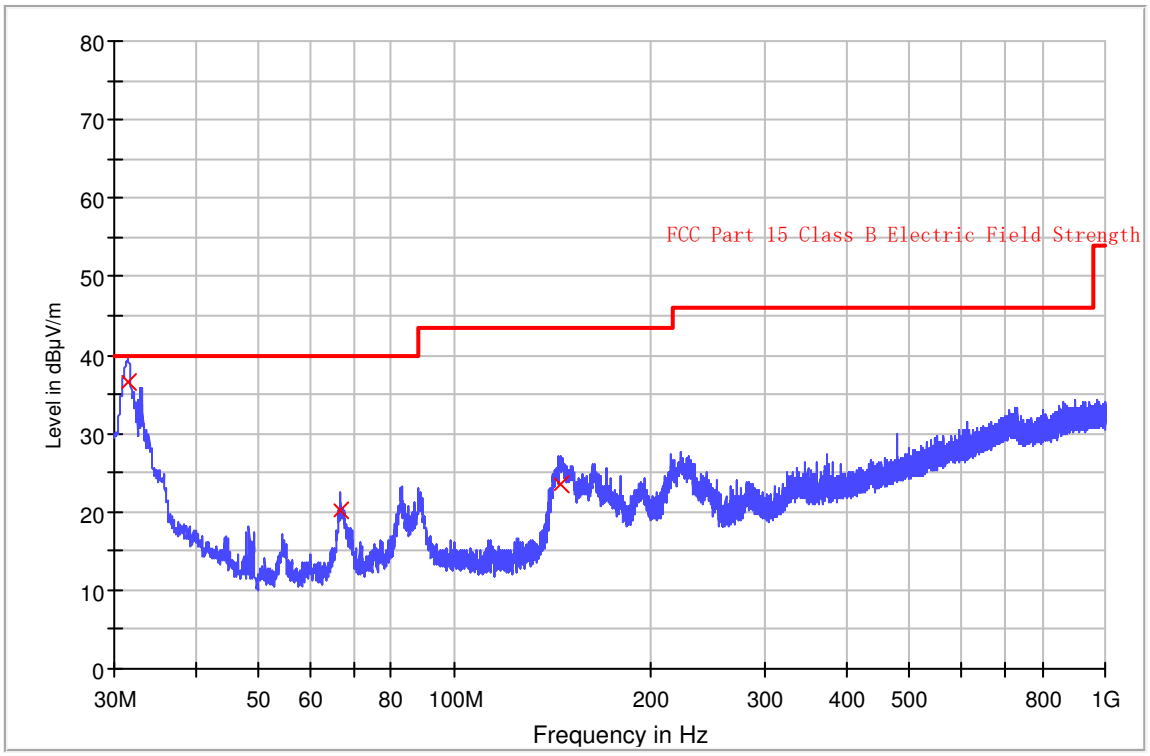
Worst Case Radiated Spurious Emission (ANT1-802.11b)
at 31.473482MHz
is passed by 3.5dB margin.

For the electronic filing, the worst case radiated emission configuration photographs are saved with filename: radiated photos.pdf. Simultaneous transmission was considered, only the worst case data was recorded in this report.

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020 Model: Borecam PRO
Worst Case Operating Mode: Transmitting(ANT1-802.11b)

ANT Polarity: Horizontal

FCC Part 15



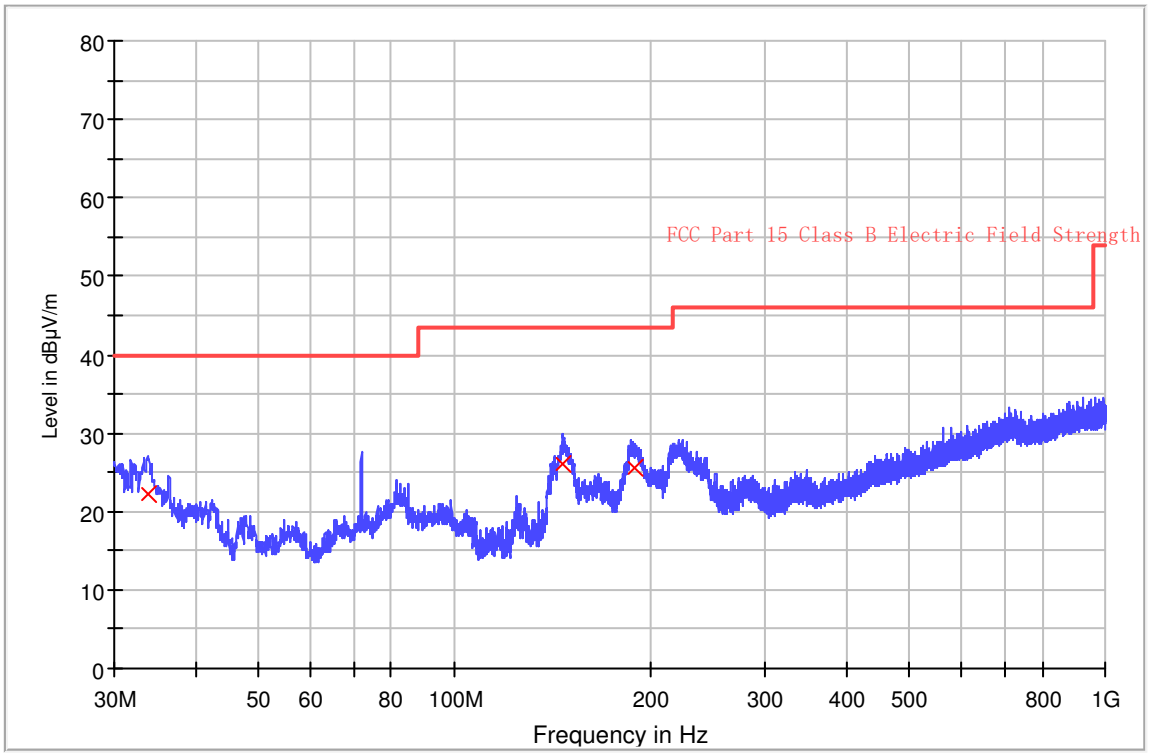
Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Polarization	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBuV/m)
31.473482	36.5	1000.0	120.000	H	17.6	3.5	40.0
66.666000	20.2	1000.0	120.000	H	8.6	19.8	40.0
145.365333	23.5	1000.0	120.000	H	10.7	20.0	43.5

Remark:
1. Corr. = Antenna Factor (dB/m) + Cable Loss (dB)
2. QuasiPeak (dBµV/m)= Corr. (dB/m)+ Read Level (dBµV)
3. Margin (dB) = Limit Line(dBµV/m) – Level (dBµV/m)

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020 Model: Borecam PRO
Worst Case Operating Mode: Transmitting(ANT1-802.11b)

ANT Polarity: Vertical

FCC Part 15



Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Polarization	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBuV/m)
33.880000	22.3	1000.0	120.000	V	16.5	17.7	40.0
146.723333	26.0	1000.0	120.000	V	10.7	17.5	43.5
189.403333	25.7	1000.0	120.000	V	12.7	17.8	43.5

Remark:
1. Corr. = Antenna Factor (dB/m) + Cable Loss (dB)
2. QuasiPeak (dBµV/m)= Corr. (dB/m)+ Read Level (dBµV)
3. Margin (dB) = Limit Line(dBµV/m) – Level (dBµV/m)

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020 Model: Borecam PRO
Worst Case Operating Mode: SISO-ANT1-Transmitting (802.11b)

Radiated Emissions (above 1GHz)

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	45.4	36.7	33.4	42.1	74.0	-31.9
Horizontal	*7311.000	42.4	36.6	35.8	41.6	74.0	-32.4

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	30.6	36.7	33.4	27.3	54.0	-26.7
Horizontal	*7311.000	34.2	36.6	35.8	33.4	54.0	-20.6

NOTES:
1. Peak detector is used, RBW=1MHz/VBW=3MHz for peak value and RBW=1MHz / VBW=10Hz for average value.

2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.

3. Negative value in the margin column shows emission below limit.

4. Horn antenna used for the emission over 1000MHz.

* Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted peak limit with a peak detector function.

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020 Model: Borecam PRO
Worst Case Operating Mode: SISO-ANT1-Transmitting (802.11g)

Radiated Emissions (above 1GHz)

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	37.8	36.7	33.4	34.5	74.0	-39.5
Horizontal	*7311.000	42.0	36.6	35.8	41.2	74.0	-32.8

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	31.0	36.7	33.4	27.7	54.0	-26.3
Horizontal	*7311.000	34.4	36.6	35.8	33.6	54.0	-20.4

NOTES:
1. Peak detector is used, RBW=1MHz/VBW=3MHz for peak value and RBW=1MHz / VBW=10Hz for average value.

2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.

3. Negative value in the margin column shows emission below limit.

4. Horn antenna used for the emission over 1000MHz.

* Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted peak limit with a peak detector function.

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020 Model: Borecam PRO
Worst Case Operating Mode: SISO-ANT1-Transmitting (802.11n20)

Radiated Emissions (above 1GHz)

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	41.2	36.7	33.4	37.9	74.0	-36.1
Horizontal	*7311.000	42.6	36.6	35.8	41.8	74.0	-32.2

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	30.9	36.7	33.4	27.6	54.0	-26.4
Horizontal	*7311.000	33.9	36.6	35.8	33.1	54.0	-20.9

NOTES:
1. Peak detector is used, RBW=1MHz/VBW=3MHz for peak value and RBW=1MHz / VBW=10Hz for average value.

2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.

3. Negative value in the margin column shows emission below limit.

4. Horn antenna used for the emission over 1000MHz.

* Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted peak limit with a peak detector function.

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020 Model: Borecam PRO
Worst Case Operating Mode: SISO-ANT1-Transmitting (802.11n40)

Radiated Emissions (above 1GHz)

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	38.7	36.7	33.4	35.4	74.0	-38.6
Horizontal	*7311.000	41.9	36.6	35.8	41.1	74.0	-32.9

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	30.7	36.7	33.4	27.4	54.0	-26.6
Horizontal	*7311.000	34.6	36.6	35.8	33.8	54.0	-20.2

NOTES:
1. Peak detector is used, RBW=1MHz/VBW=3MHz for peak value and RBW=1MHz / VBW=10Hz for average value.

2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.

3. Negative value in the margin column shows emission below limit.

4. Horn antenna used for the emission over 1000MHz.

* Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted peak limit with a peak detector function.

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020 Model: Borecam PRO
Worst Case Operating Mode: SISO-ANT2-Transmitting (802.11b)

Radiated Emissions (above 1GHz)

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	38.4	36.7	33.4	35.1	74.0	-38.9
Horizontal	*7311.000	41.8	36.6	35.8	41.0	74.0	-33.0

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	30.9	36.7	33.4	27.6	54.0	-26.4
Horizontal	*7311.000	34.5	36.6	35.8	33.7	54.0	-20.3

NOTES:
1. Peak detector is used, RBW=1MHz/VBW=3MHz for peak value and RBW=1MHz / VBW=10Hz for average value.

2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.

3. Negative value in the margin column shows emission below limit.

4. Horn antenna used for the emission over 1000MHz.

* Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted peak limit with a peak detector function.

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020 Model: Borecam PRO
Worst Case Operating Mode: SISO-ANT2-Transmitting (802.11g)

Radiated Emissions (above 1GHz)

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	38.0	36.7	33.4	34.7	74.0	-39.3
Horizontal	*7311.000	42.2	36.6	35.8	41.4	74.0	-32.6

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	30.7	36.7	33.4	27.4	54.0	-26.6
Horizontal	*7311.000	34.0	36.6	35.8	33.2	54.0	-20.8

NOTES:
1. Peak detector is used, RBW=1MHz/VBW=3MHz for peak value and RBW=1MHz / VBW=10Hz for average value.

2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.

3. Negative value in the margin column shows emission below limit.

4. Horn antenna used for the emission over 1000MHz.

* Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted peak limit with a peak detector function.

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020 Model: Borecam PRO
Worst Case Operating Mode: SISO-ANT2-Transmitting (802.11n20)

Radiated Emissions (above 1GHz)

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	41.8	36.7	33.4	38.5	74.0	-35.5
Horizontal	*7311.000	45.0	36.6	35.8	44.2	74.0	-29.8

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	33.5	36.7	33.4	30.2	54.0	-23.8
Horizontal	*7311.000	36.2	36.6	35.8	35.4	54.0	-18.6

NOTES:
1. Peak detector is used, RBW=1MHz/VBW=3MHz for peak value and RBW=1MHz / VBW=10Hz for average value.

2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.

3. Negative value in the margin column shows emission below limit.

4. Horn antenna used for the emission over 1000MHz.

* Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted peak limit with a peak detector function.

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020 Model: Borecam PRO
Worst Case Operating Mode: SISO-ANT2-Transmitting (802.11n40)

Radiated Emissions (above 1GHz)

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	38.4	36.7	33.4	35.1	74.0	-38.9
Horizontal	*7311.000	42.1	36.6	35.8	41.3	74.0	-32.7

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	30.9	36.7	33.4	27.6	54.0	-26.4
Horizontal	*7311.000	34.2	36.6	35.8	33.4	54.0	-20.6

NOTES:
1. Peak detector is used, RBW=1MHz/VBW=3MHz for peak value and RBW=1MHz / VBW=10Hz for average value.
2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.
3. Negative value in the margin column shows emission below limit.
4. Horn antenna used for the emission over 1000MHz.

* Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted peak limit with a peak detector function.

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020 Model: Borecam PRO
Worst Case Operating Mode: MIMO-Transmitting (802.11n20)

Radiated Emissions (above 1GHz)

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	42.8	36.7	33.4	39.5	74.0	-34.5
Horizontal	*7311.000	45.2	36.6	35.8	44.4	74.0	-29.6

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	35.4	36.7	33.4	32.1	54.0	-21.9
Horizontal	*7311.000	37.5	36.6	35.8	36.7	54.0	-17.3

NOTES:
1. Peak detector is used, RBW=1MHz/VBW=3MHz for peak value and RBW=1MHz / VBW=10Hz for average value.

2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.

3. Negative value in the margin column shows emission below limit.

4. Horn antenna used for the emission over 1000MHz.

* Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted peak limit with a peak detector function.

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020 Model: Borecam PRO
Worst Case Operating Mode: MIMO-Transmitting (802.11n40)

Radiated Emissions (above 1GHz)

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	50.9	36.7	33.4	47.6	74.0	-26.4
Horizontal	*7311.000	44.7	36.6	35.8	43.9	74.0	-30.1

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4874.000	33.5	36.7	33.4	30.2	54.0	-23.8
Horizontal	*7311.000	38.0	36.6	35.8	37.2	54.0	-16.8

NOTES:

1. Peak detector is used, RBW=1MHz/VBW=3MHz for peak value and RBW=1MHz / VBW=10Hz for average value.

2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.

3. Negative value in the margin column shows emission below limit.

4. Horn antenna used for the emission over 1000MHz.

* Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted peak limit with a peak detector function.

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020
Model: Borecam PRO

4.9 Conducted Emission

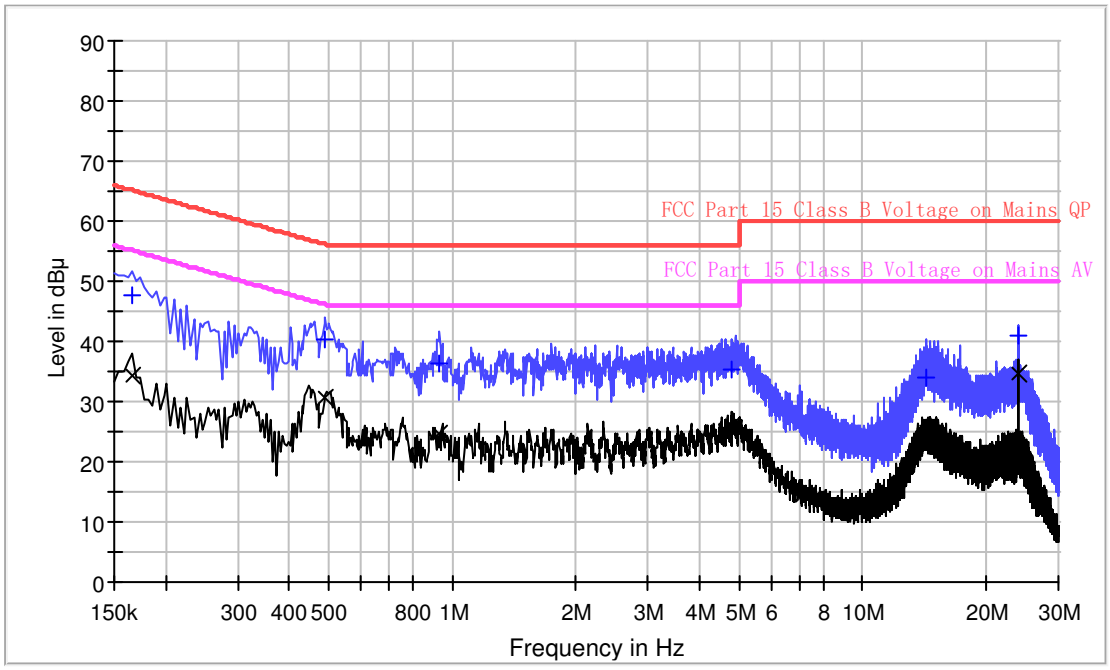
Worst Case Conducted Emission (ANT1-802.11b)
at 24.002MHz
is passed by 12.3dB margin.

For the electronic filing, the worst case radiated emission configuration photographs are saved with filename: conducted photos.pdf.

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020
Model: Borecam PRO
Worst Case Operating Mode: Transmitting (ANT1-802.11b)
Phase: Live

Graphic / Data Table

Conducted Emissions
Pursuant to FCC 15.207: Emissions Requirement



Limit and Margin QP

Frequency (MHz)	QuasiPeak (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.166000	47.7	9.000	L1	9.7	17.5	65.2
0.490000	40.2	9.000	L1	9.7	16.0	56.2
0.930000	36.4	9.000	L1	9.7	19.6	56.0
4.818000	35.4	9.000	L1	9.8	20.6	56.0
14.230000	34.1	9.000	L1	10.1	25.9	60.0
23.998000	41.1	9.000	L1	10.8	18.9	60.0

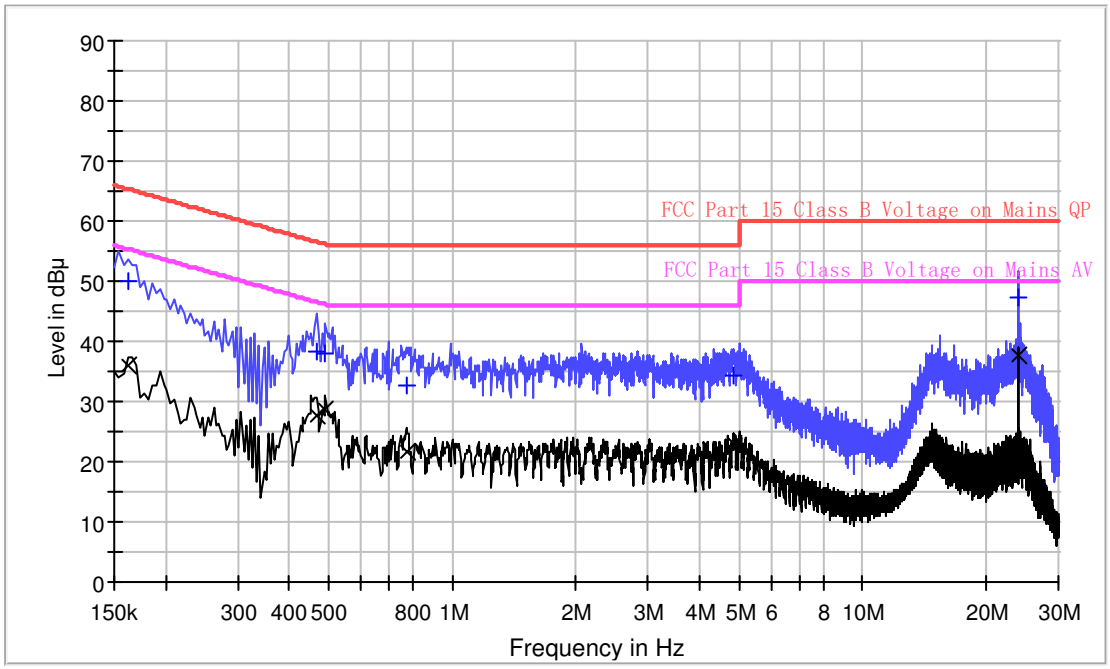
Limit and Margin AV

Frequency (MHz)	Average (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.166000	34.3	9.000	L1	9.7	20.9	55.2
0.490000	30.8	9.000	L1	9.7	15.4	46.2
0.930000	24.7	9.000	L1	9.7	21.3	46.0
4.818000	25.9	9.000	L1	9.8	20.1	46.0
14.230000	24.9	9.000	L1	10.1	25.1	50.0
23.998000	34.8	9.000	L1	10.8	15.2	50.0

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020
Model: Borecam PRO
Worst Case Operating Mode: Transmitting (ANT1-802.11b)
Phase: Neutral

Graphic / Data Table

Conducted Emissions
Pursuant to FCC 15.207: Emissions Requirement



Limit and Margin QP

Frequency (MHz)	QuasiPeak (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.162000	50.2	9.000	N	9.7	15.2	65.4
0.466000	38.2	9.000	N	9.7	18.4	56.6
0.490000	37.9	9.000	N	9.7	18.3	56.2
0.774000	32.6	9.000	N	9.7	23.4	56.0
4.834000	34.4	9.000	N	9.8	21.6	56.0
24.002000	47.4	9.000	N	10.9	12.6	60.0

Limit and Margin AV

Frequency (MHz)	Average (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.162000	36.1	9.000	N	9.7	19.3	55.4
0.466000	27.8	9.000	N	9.7	18.8	46.6
0.490000	28.5	9.000	N	9.7	17.7	46.2
0.774000	21.5	9.000	N	9.7	24.5	46.0
4.834000	22.9	9.000	N	9.8	23.1	46.0
24.002000	37.7	9.000	N	10.9	12.3	50.0

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020
Model: Borecam PRO

4.10 Radiated Emissions from Digital Section of Transceiver, FCC Ref: 15.109

[ ] Not required - No digital part

[ ] Test results are attached

[x] Included in the separated report.

Applicant: Lyman Products Corporation
Date of Test: June 21, 2020
Model: Borecam PRO

4.11 Transmitter Duty Cycle Calculation and Measurements, FCC Rule 15.35(b), (c)

The EUT antenna output port was connected to the input of the spectrum analyzer. The analyzer center frequency was set to EUT RF channel carrier. The SWEP function on the analyzer was set to ZERO SPAN. The Transmitter ON time was determined from the resultant time-amplitude display:

	See attached spectrum analyzer chart (s) for Transmitter timing
	See Transmitter timing diagram provided by manufacturer
x	Not applicable, duty cycle was not used.

5.0 Equipment Photographs

For electronic filing, the photographs are saved with filename: external photos.pdf & internal photos.pdf.

6.0 Product Labeling

For electronic filing, the FCC ID label artwork and location is saved with filename: label.pdf.

7.0 Technical Specifications

For electronic filing, the block diagram and circuit diagram are saved with filename: block.pdf and circuit.pdf respectively.

8.0 Instruction Manual

For electronic filing, a preliminary copy of the Instruction Manual is saved with filename: manual.pdf.

This manual will be provided to the end-user with each unit sold/leased in the United States.

9.0 Confidentiality Request

For electronic filing, the confidentiality request of the tested EUT is saved with filename: request.pdf.

10.0 Discussion of Pulse Desensitization

The determination of pulse desensitivity was made in accordance with Hewlett Packard Application Note 150-2, *Spectrum Analysis ... Pulsed RF.*

Pulse desensitivity is not applicable for this device since the transmitter transmits the RF signal continuously.

11.0 Test Equipment List

Equipment No.	Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Due Date
SZ182-02	RF Power Meter	Anritsu	ML2496A	1302005	2019-06-27	2020-06-27
SZ182-02-01	Power Sensor	Anritsu	MA2411B	1207429	2019-06-27	2020-06-27
SZ061-12	BiConiLog Antenna	ETS	3142E	00166158	2018-09-14	2020-09-14
SZ185-01	EMI Receiver	R&S	ESCI	100547	2019-12-24	2020-12-24
SZ061-08	Horn Antenna	ETS	3115	00092346	2019-09-07	2021-09-07
SZ061-06	Active Loop Antenna	Electro-Metrics	EM-6876	217	2019-05-24	2021-05-24
SZ056-03	Spectrum Analyzer	R&S	FSP 30	101148	2020-02-27	2021-02-27
SZ056-06	Signal Analyzer	R&S	FSV 40	101101	2020-02-27	2021-02-27
SZ181-04	Preamplifier	Agilent	8449B	3008A02474	2020-02-27	2021-02-27
SZ188-01	Anechoic Chamber	ETS	RFD-F/A-100	4102	2018-12-15	2021-12-15
SZ062-02	RF Cable	RADIALL	RG 213U	--	2020-02-26	2020-08-26
SZ062-05	RF Cable	RADIALL	0.04-26.5GHz	--	2020-02-26	2020-08-26
SZ062-12	RF Cable	RADIALL	0.04-26.5GHz	--	2020-02-26	2020-08-26
SZ067-04	Notch Filter	Micro-Tronics	BRM50702-02	--	2019-10-30	2020-10-30
SZ185-02	EMI Test Receiver	R&S	ESCI	100692	2019-10-29	2020-10-29
SZ187-01	Two-Line V-Network	R&S	ENV216	100072	2019-10-29	2020-10-29
SZ188-03	Shielding Room	ETS	RFD-100	4100	2020-01-07	2023-01-07

********** End of Report**********