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CERTIFICATION TEST REPORT

Manufacturer:	**Glassboard, LLC** **1060 N Capitol Ave** **Suite E-120** **Indianapolis, IN 46204 USA**
Applicant:	**Same as Above**
Product Name:	**WFM1MW**
Product Description:	**Wi-Fi & Bluetooth Wireless Module**
Model:	**WFM1MW**
FCC ID:	**2AWBKWFM1MW**
Testing Commenced:	2020-05-28
Testing Ended:	2020-09-16
Summary of Test Results:	**In Compliance** The EUT complies with the EMC requirements when manufactured identically as the unit tested in this report, including any required modifications and/or manufacturer's statement. Any changes to the design or build of this unit subsequent to this testing may deem it non-compliant.

Standards:

- **FCC Part 15 Subpart C, Section 15.247***
- **ANSI C63.10:2013**

**Test report reflects limited testing for PCII.*

Evaluation Conducted by:

Julius Chiller, EMC/Wireless Engineer

Report Reviewed by:

Ken Littell, Vice President of EMC

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1 ADMINISTRATIVE INFORMATION

1.1 Measurement Location:

F2 Labs in Middlefield, Ohio. Site description and attenuation data are on file with the FCC's Sampling and Measurement Branch at the FCC Laboratory in Columbia, MD.

1.2 Measurement Procedure:

All measurements were performed according to the 2013 version of ANSI C63.10 and recommended FCC procedure of measurement of DTS operating under Section 15.247 and in KDB558074. A list of the measurement equipment can be found in Section 6.

1.3 Uncertainty Budget:

The uncertainty in EMC measurements arises from several factors which affect the results, some associated with environmental conditions in the measurement room, the test equipment being used, and the measurement techniques adopted.

The measurement uncertainty budgets detailed below are calculated from the test and calibration data and are expressed with a 95% confidence factor. Note: Only measurements listed below which relate to tests included in this Test Report are applicable to it.

Measurement Range	Expanded Uncertainty	Combined Uncertainly
Radiated Emissions <1 GHz @ 3m	±5.07dB	±2.54
Radiated Emissions <1 GHz @ 10m	±5.09dB	±2.55
Radiated Emissions 1 GHz to 2.7 GHz	±3.62dB	±1.81
Radiated Emissions 2.7 GHz to 18 GHz	±3.10dB	±1.55
AC Power Line Conducted Emissions, 150kHz to 30 MHz	±2.76dB	±1.38

This Uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

1.4 Document History:

Document Number	Description	Issue Date	Approved By
F2P22918C-01E	First Issue	2020-09-16	K. Littell

2 SUMMARY OF TEST RESULTS

Test Name	Standard(s)	Results
Radiated Spurious Emission	CFR 47 Part 15.247(d) / Part 15.209 / KDB558074	Complies

Modifications Made to the Equipment
No modifications were made to the EUT.

3 ENGINEERING STATEMENT

This report has been prepared on behalf of Glassboard, LLC to provide documentation for the testing described herein. This equipment has been tested and found to comply with Part 15.247 of the FCC Rules using ANSI C63.10:2013 and KDB558074 standards. The test results found in this test report relate only to the items tested.

4 EUT INFORMATION AND DATA

4.1 Equipment Under Test:

Product: Wi-Fi & Bluetooth Wireless Module
Model: WFM1MW
Serial No.: Rev 2
FCC ID: **2AWBKWFM1MW**

4.2 Trade Name:

Glassboard, LLC

4.3 Power Supply:

N/A

4.4 Applicable Rules:

CFR 47, Part 15.247, subpart C

4.5 Equipment Category:

Radio Transmitter-DTS

4.6 Antenna:

Chip Antenna – Ethertronics M830520, 1.0dBi Gain
PCB Dipole Antenna – Molex 146187, 3.4dBi Gain

4.7 Accessories:

Development PCB – Embedded Artist model V2 Rev E
AC Adaptor – PhiHong PSAA30R-120

4.8 Test Item Condition:

The equipment to be tested was received in good condition.

4.9 Testing Algorithm:

EUT was set to provide a continuous modulated carrier on selected low, mid and high channels in the 2.4 GHz band. Band edge and spurious emissions were investigated. For 2.4 GHz spurs, Channel 11 (2462) was worst case with HT20 modulation. The highest emissions were recorded in the data tables.

5 LIST OF MEASUREMENT INSTRUMENTATION

Equipment Type	Asset Number	Manufacturer	Model	Serial Number	Calibration Due Date
Shielded Chamber	CL166-E	AlbatrossProjects	B83117-DF435-T261	US140023	2021-01-03
Temp/Hum. Recorder	CL261	Extech	445814	04	2021-02-12
Receiver	CL151	Rohde & Schwarz	ESU40	100319	2020-10-21
Antenna, Bilog	CL211	Sunol Sciences, Inc.	JB1	A021017	2021-10-03
Low Loss Cable Set	--	Pasternack	PE3C0666-252 / PE3C066-50CM	None Spec.	2020-09-30
Horn Antenna	CL098	Emco	3115	9809-5580	2021-01-31
Antenna, Horn	CL114	A. H. Systems, Inc.	SAS-572	237	2021-02-04
Pre-Amplifier	CL250	Com-Power	PAM-118A	18040011	2021-06-21
Pre-Amplifier	CL153	Agilent	83006-69007	MY39500791	2020-09-30
Amplifier w/Monopole & 18” Loop	CL163-Loop	AH Systems, Inc.	EHA-52B	100	2020-07-24
Software:	Tile Version 3.4.B.3.		Software Verified: 2020-05-28 to 2020-09-16		
Software:	EMC 32, Version 8.53.0		Software Verified: 2020-05-28 to 2020-09-16		

6 RADIATED SPURIOUS EMISSION

The EUT antenna port was fitted with its 1 dBi integral/internal chip antenna, and then with its 3.4 dBi dipole antenna. Radiated emissions were measured in a Semi-Anechoic Chamber. All emissions generated that fall in the restricted bands per FCC Part 15.205 were examined.

6.1 Requirements:

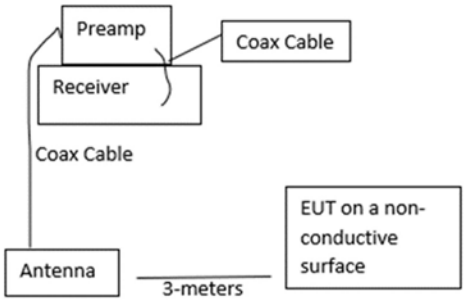
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30dB instead of 20dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

6.2 Radiated Spurious Emission Test Data

Test Date(s):	2020-05-28 to 2020-09-16	**Test Engineer:**	J. Chiller
Standards:	CFR 47 Part 15.247(d); Part 15.209 / KDB558074	**Air Temperature:**	23.9ºC
		Relative Humidity:	34%

Notes: Plots are peak, max hold prescan data included only to determine what frequencies to investigate and measure. The EUT was initially placed in a semi-anechoic chamber and rotated in all three orthogonal positions to maximize the emissions. Characterization measurements were then performed to determine at which frequencies significant emissions occurred. These graphs are shown below.

The equipment was fully exercised with all cabling attached to the EUT and was positioned on the OATS for maximum emissions. While the equipment was energized, the receiving antenna was scanned from 1.0 meter to 4.0 meters in both vertical and horizontal polarities while the turntable was adjusted 360 degrees to determine the maximum field strength. The tables of measured results can be found below.



In the following plots, the black line indicates the active scan and the green line indicates the Max Peak with the EUT on during rotation. Emissions to be found by the EUT were measured and listed in tables. The plots are for reference only and the limit lines are not actual limit lines but merely a guide.

Channel 11 (2462) was determined to be worst case with HT20 modulation.

PCB Dipole Antenna

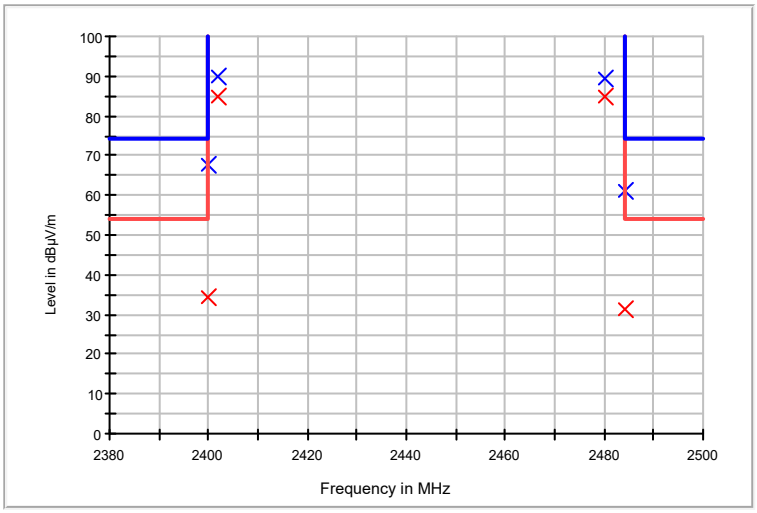
BLE Band Edge

MaxPeak

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2400.000000	H	150.00	92.00	59.9	7.8	67.70	74.0	-6.3
2402.000000	H	150.00	92.00	82.2	7.8	90.00	--	--
2480.000000	H	150.00	92.00	81.3	8.3	89.60	--	--
2484.000000	H	150.00	92.00	52.7	8.4	61.10	74.0	-12.9

Average

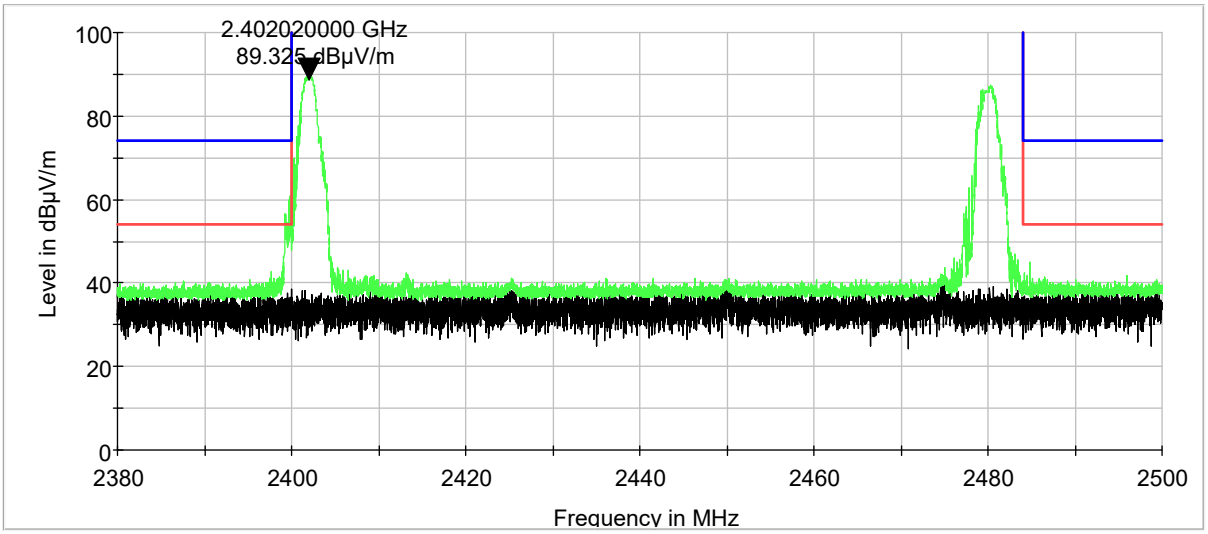
Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2400.000000	H	150.00	92.00	26.8	7.8	34.60	54.0	-19.4
2402.000000	H	150.00	92.00	77.3	7.8	85.10	--	--
2480.000000	H	150.00	92.00	76.4	8.3	84.70	--	--
2484.000000	H	150.00	92.00	22.9	8.4	31.30	54.0	-22.7



Note: In the following graphs, the green emissions are the peak emissions. The red limit line is the Average limit and the blue limit line is the Peak limit.

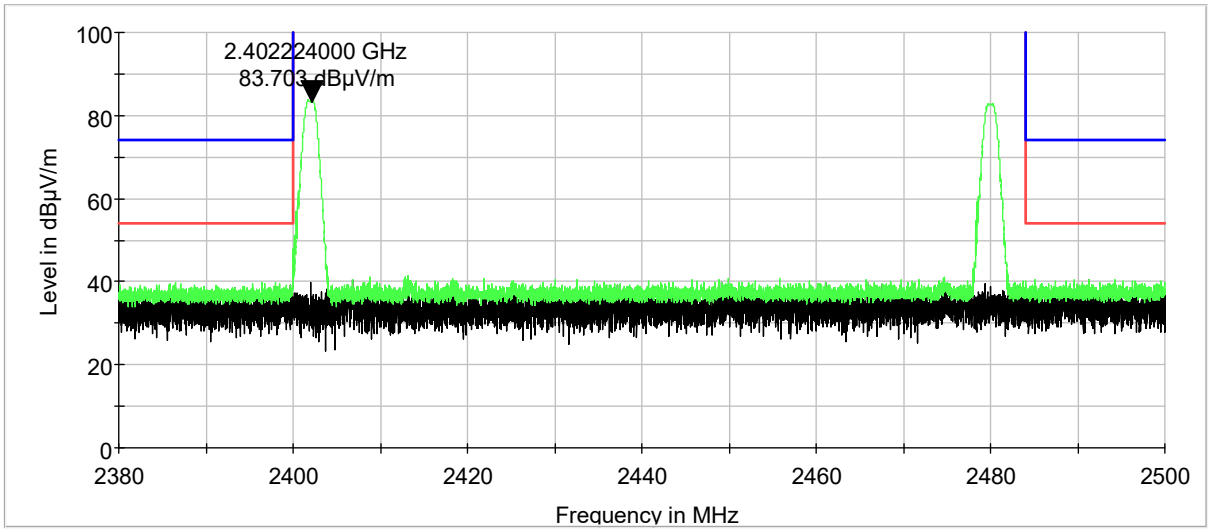
Dipole Antenna

BLE Band Edge Horizontal



Dipole Antenna

BLE Band Edge Vertical



PCB Dipole Antenna

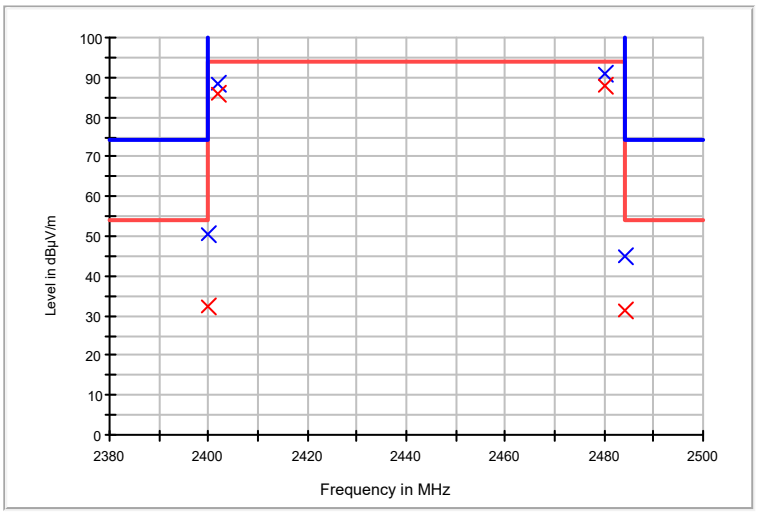
Bluetooth BT1 Band Edge

MaxPeak

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2400.000000	H	150.00	112.00	42.6	7.8	50.40	74.0	-23.6
2402.000000	H	150.00	112.00	80.7	7.8	88.50	--	--
2480.000000	H	150.00	112.00	82.6	8.3	90.90	--	--
2484.000000	H	150.00	112.00	36.6	8.4	45.00	74.0	-29.0

Average

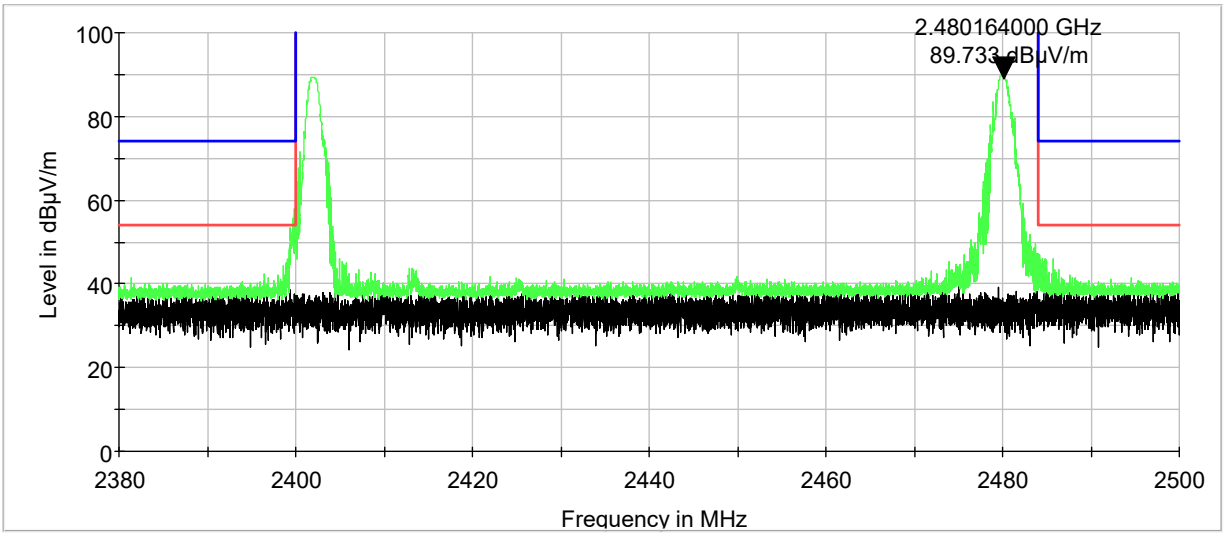
Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2400.000000	H	150.00	112.00	24.5	7.8	32.30	54.0	-21.7
2402.000000	H	150.00	112.00	77.9	7.8	85.70	--	--
2480.000000	H	150.00	112.00	79.8	8.3	88.10	--	--
2484.000000	H	150.00	112.00	23.0	8.4	31.40	54.0	-22.6



In the following graphs, the green emissions are the peak emissions. The red limit line is the Average limit and the blue limit line is the Peak limit.

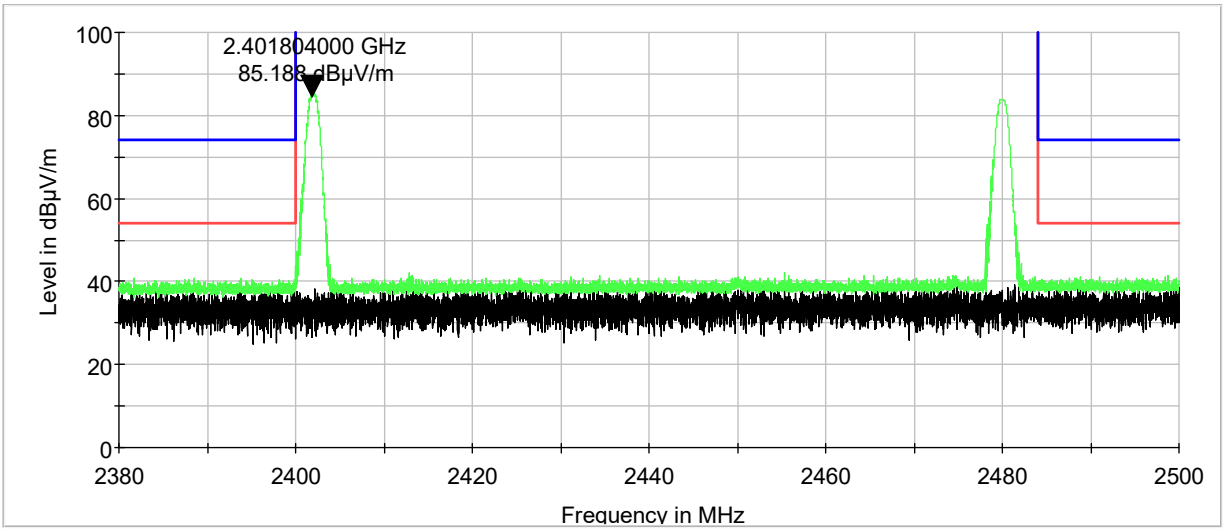
Dipole Antenna

Bluetooth BT1 Band Edge Horizontal



Dipole Antenna

Bluetooth BT1 Band Edge Vertical



PCB Dipole Antenna

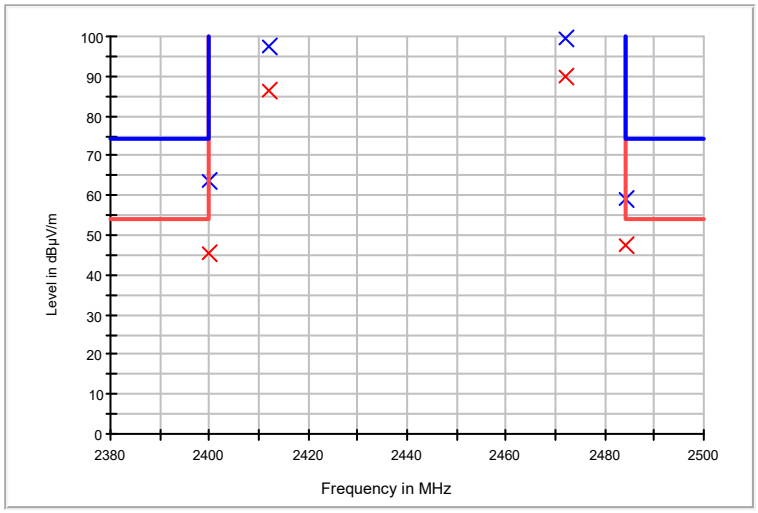
CCK

MaxPeak

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2400.000000	H	150.00	92.00	55.6	7.8	63.40	74.0	-10.6
2412.000000	H	150.00	92.00	89.6	7.9	97.50	--	--
2472.000000	H	150.00	92.00	91.0	8.3	99.30	--	--
2484.000000	H	150.00	92.00	50.5	8.4	58.90	74.0	-15.1

Average

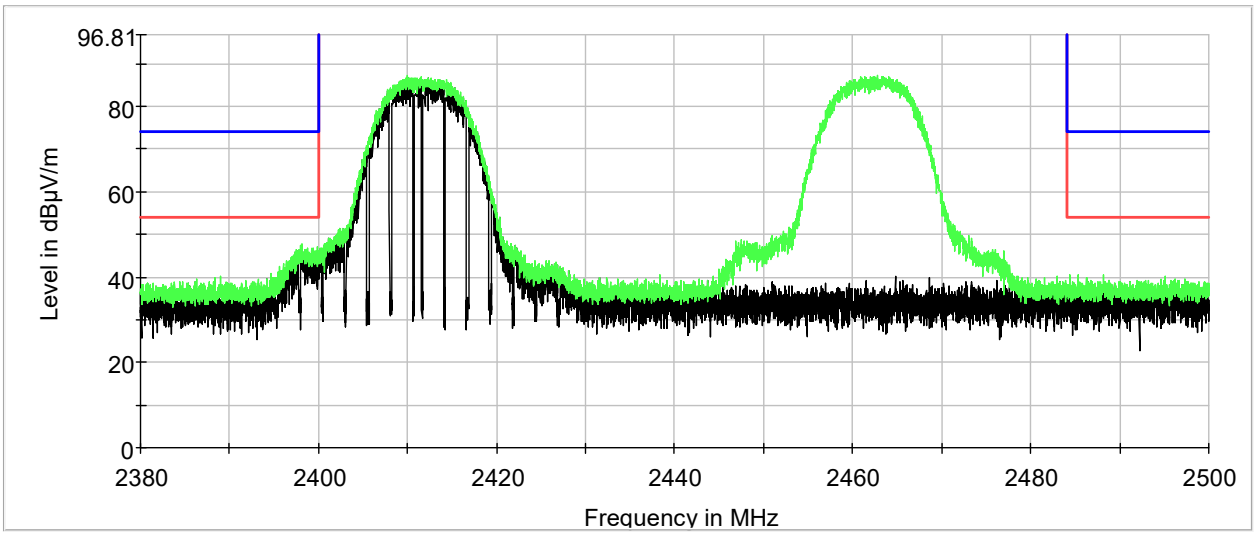
Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2400.000000	H	150.00	92.00	37.5	7.8	45.30	54.0	-8.7
2412.000000	H	150.00	92.00	78.4	7.9	86.30	--	--
2472.000000	H	150.00	92.00	81.8	8.3	90.10	--	--
2484.000000	H	150.00	92.00	39.0	8.4	47.40	54.0	-6.6



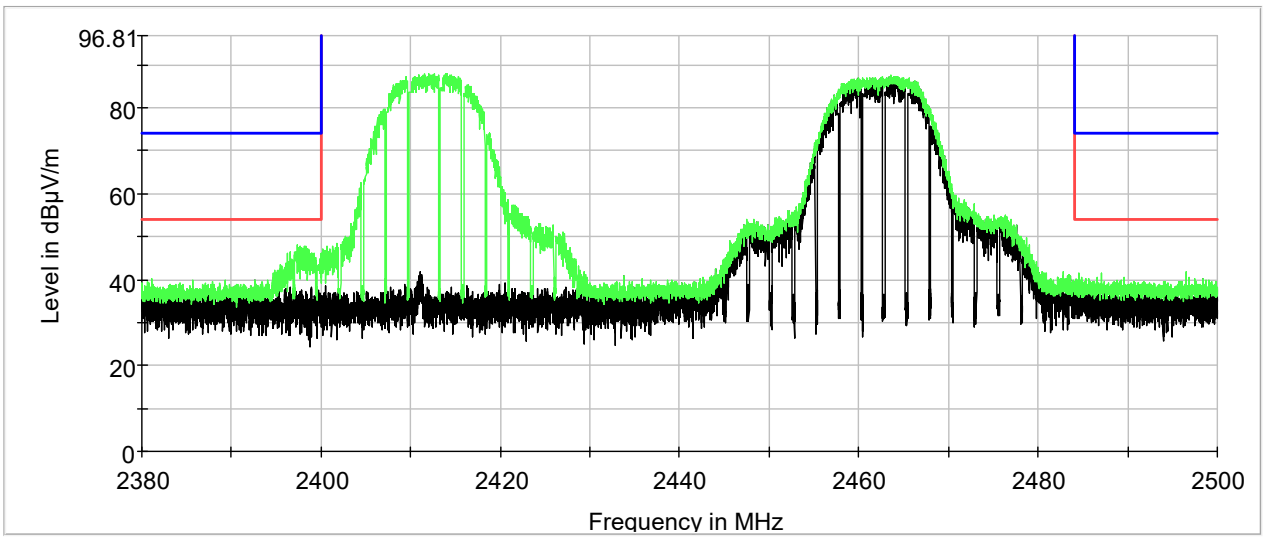
In the following graphs, the green emissions are the peak emissions. The red limit line is the Average limit and the blue limit line is the Peak limit.

Dipole Antenna

CCK Vertical



CCK Horizontal



PCB Dipole Antenna

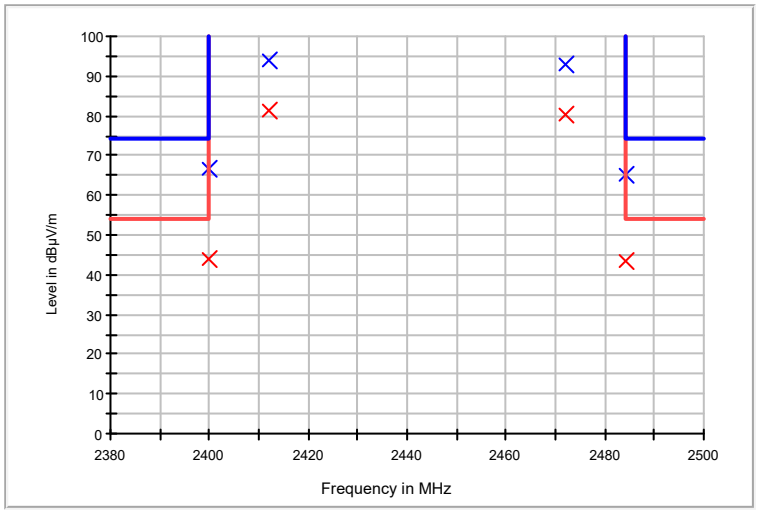
HT20

MaxPeak

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2400.000000	H	150.00	92.00	58.7	7.8	66.50	74.0	-7.5
2412.000000	H	150.00	92.00	85.9	7.9	93.80	--	--
2472.000000	H	150.00	92.00	84.8	8.3	93.10	--	--
2484.000000	H	150.00	92.00	56.7	8.4	65.10	74.0	-8.9

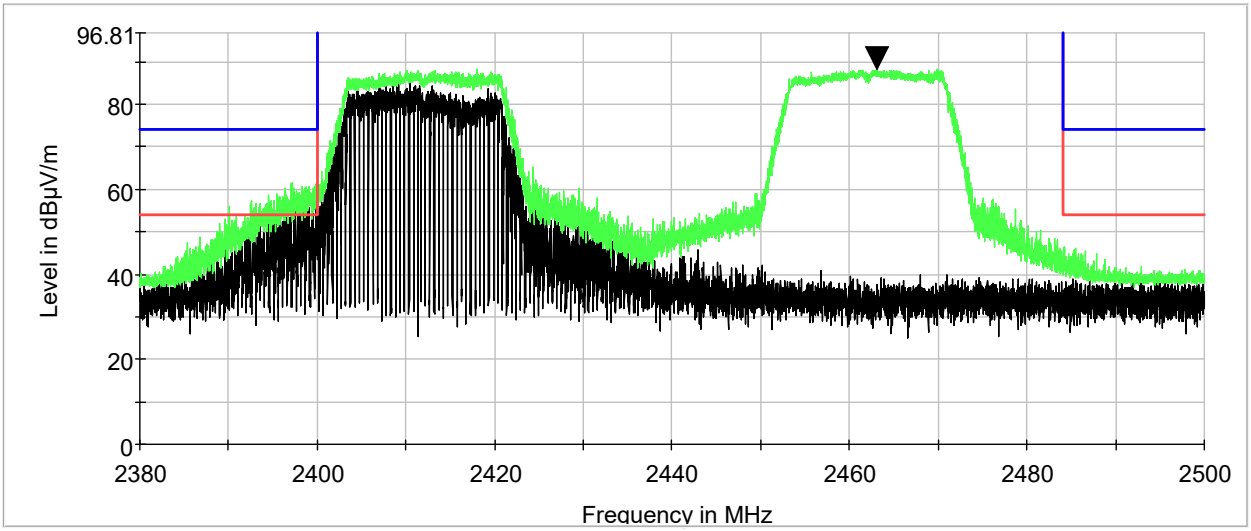
Average

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2400.000000	H	150.00	92.00	36.3	7.8	44.10	54.0	-9.9
2412.000000	H	150.00	92.00	73.3	7.9	81.20	--	--
2472.000000	H	150.00	92.00	71.9	8.3	80.20	--	--
2484.000000	H	150.00	92.00	35.0	8.4	43.40	54.0	-10.6

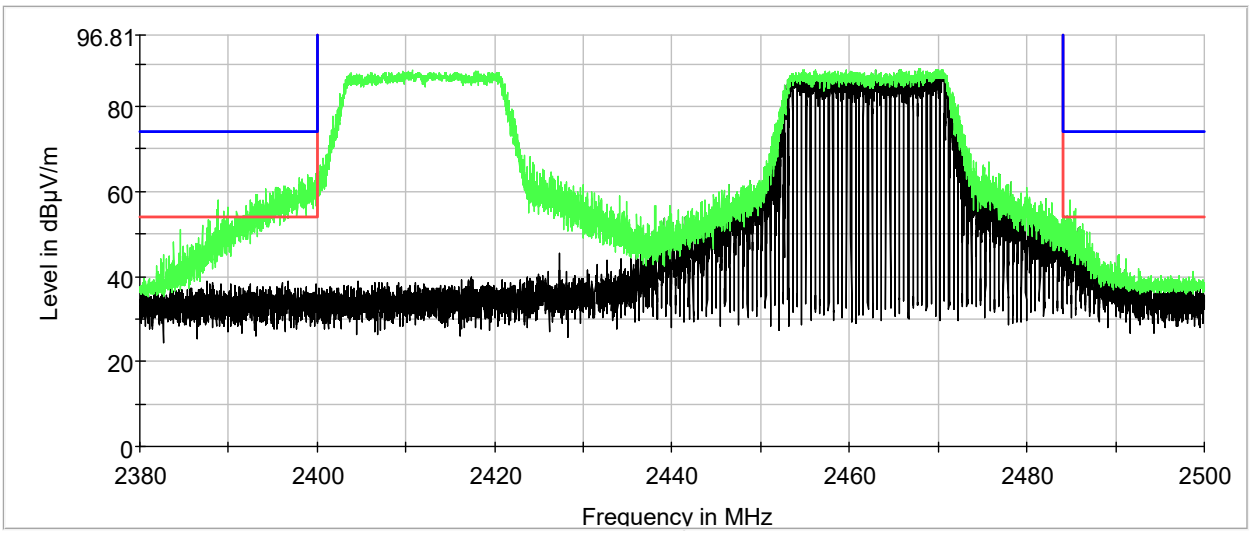


In the following graphs, the green emissions are the peak emissions. The red limit line is the Average limit and the blue limit line is the Peak limit.

Dipole Antenna HT20 Vertical



Dipole Antenna HT20 Horizontal



PCB Dipole Antenna

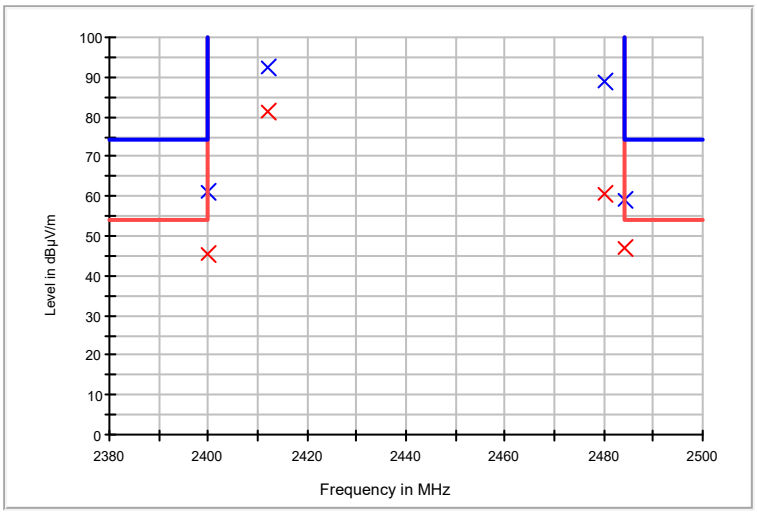
OFDM

MaxPeak

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2400.000000	H	150.00	92.00	53.4	7.8	61.20	74.0	-12.8
2412.000000	H	150.00	92.00	84.5	7.9	92.40	--	--
2480.000000	H	150.00	92.00	80.7	8.3	89.00	--	--
2484.000000	H	150.00	92.00	50.5	8.4	58.90	74.0	-15.1

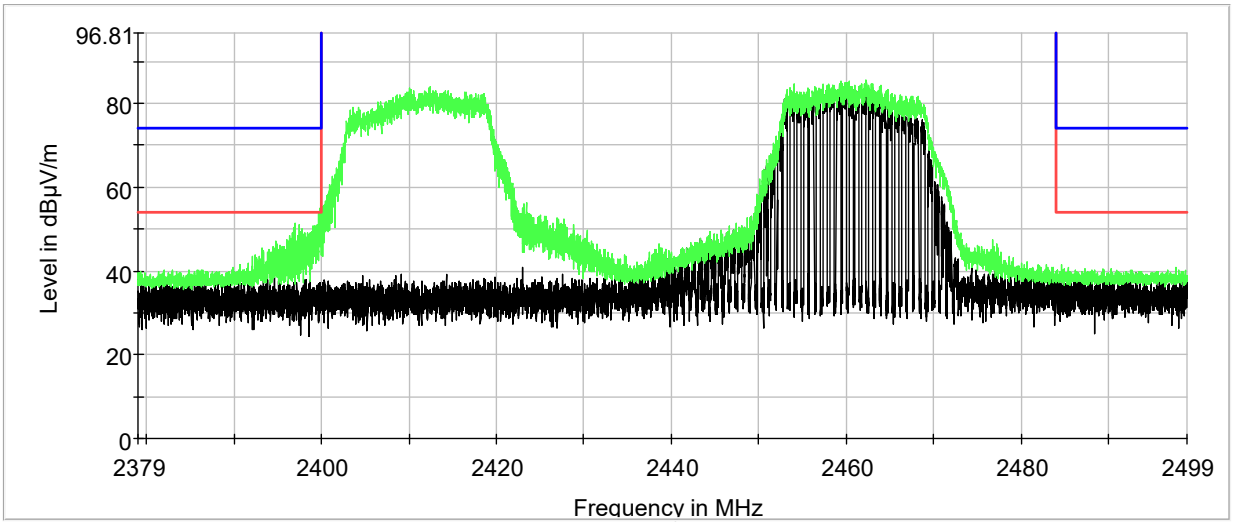
Average

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2400.000000	H	150.00	92.00	37.8	7.8	45.60	54.0	-8.4
2412.000000	H	150.00	92.00	73.4	7.9	81.30	--	--
2480.000000	H	150.00	92.00	52.5	8.3	60.80	--	--
2484.000000	H	150.00	92.00	38.8	8.4	47.20	54.0	-6.8

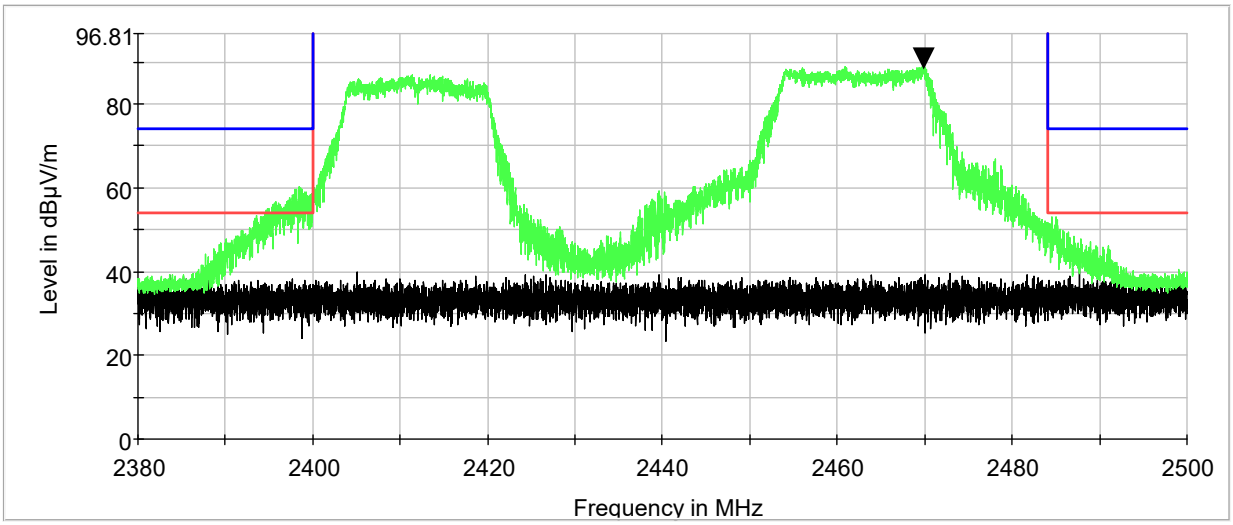


In the following graphs, the green emissions are the peak emissions. The red limit line is the Average limit and the blue limit line is the Peak limit.

Dipole Antenna OFDM Vertical

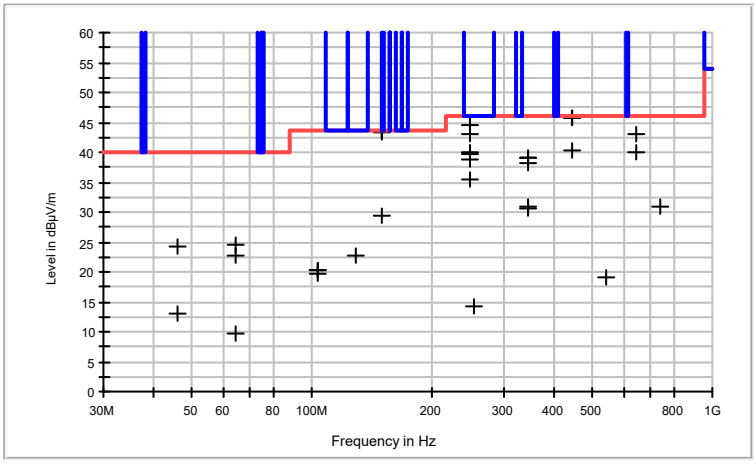


Dipole Antenna OFDM Horizontal



PCB Dipole Antenna - All Channels: 30 MHz to 1000 MHz

Note: All emissions recorded are from the development board used for testing.
The radio was turned off and removed, and all emissions remained at the same levels.



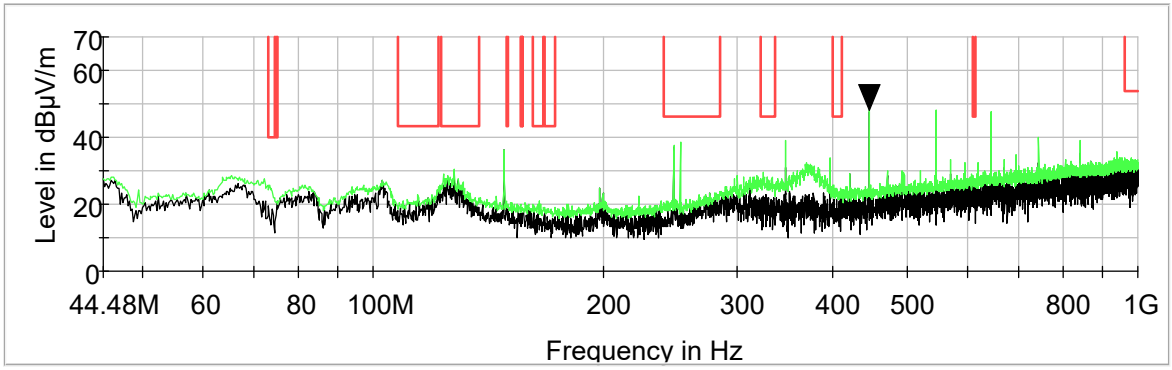
Frequency (MHz)	QuasiPeak (dBµV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV/m)
46.000000	24.2	120.000	100.0	V	355.0	-4.5	15.8	40.0
46.000000	13.0	120.000	100.0	H	359.0	-4.5	27.0	40.0
64.560000	22.7	120.000	100.0	V	29.0	-6.7	17.3	40.0
64.560000	9.8	120.000	100.0	H	0.0	-6.7	30.2	40.0
64.560000	24.6	120.000	100.0	V	0.0	-6.7	15.4	40.0
103.160000	20.3	120.000	100.0	V	0.0	-3.0	23.2	43.5
103.160000	19.8	120.000	100.0	V	345.0	-3.0	23.7	43.5
103.160000	20.3	120.000	100.0	V	0.0	-3.0	23.2	43.5
127.800000	22.6	120.000	100.0	V	4.0	0.2	20.9	43.5
148.440000	29.5	120.000	100.0	V	136.0	-1.0	14.0	43.5
148.520000	43.5	120.000	100.0	H	355.0	-1.0	0.0	43.5
148.520000	43.5	120.000	100.0	H	355.0	-1.0	0.0	43.5
148.520000	43.3	120.000	100.0	H	0.0	-1.0	0.2	43.5
247.480000	35.5	120.000	100.0	V	197.0	-0.7	10.5	46.0
247.480000	42.9	120.000	100.0	H	178.0	-0.7	3.1	46.0
247.480000	39.6	120.000	100.0	V	354.0	-0.7	6.4	46.0
247.480000	38.9	120.000	100.0	V	251.0	-0.7	7.1	46.0
247.480000	44.6	120.000	100.0	H	107.0	-0.7	1.4	46.0
247.480000	39.9	120.000	100.0	H	258.0	-0.7	6.1	46.0
252.400000	14.3	120.000	100.0	V	0.0	-0.7	31.7	46.0
346.400000	39.0	120.000	100.0	H	142.0	2.6	7.0	46.0
346.400000	39.0	120.000	100.0	H	142.0	2.6	7.0	46.0
346.400000	30.5	120.000	100.0	V	116.0	2.6	15.5	46.0
346.400000	38.0	120.000	100.0	H	131.0	2.6	8.0	46.0
346.400000	30.9	120.000	100.0	V	67.0	2.6	15.1	46.0
445.400000	40.2	120.000	100.0	V	322.0	5.1	5.8	46.0
445.400000	45.8	120.000	100.0	H	0.0	5.1	0.2	46.0
445.400000	45.7	120.000	100.0	H	0.0	5.1	0.3	46.0
544.600000	19.0	120.000	100.0	V	355.0	7.1	27.0	46.0
643.400000	40.0	120.000	100.0	V	355.0	9.1	6.0	46.0
643.440000	43.0	120.000	100.0	H	131.0	9.1	3.0	46.0
742.560000	30.9	120.000	100.0	H	352.0	10.3	15.1	46.0

Note: Chart contains data from all channels tested.

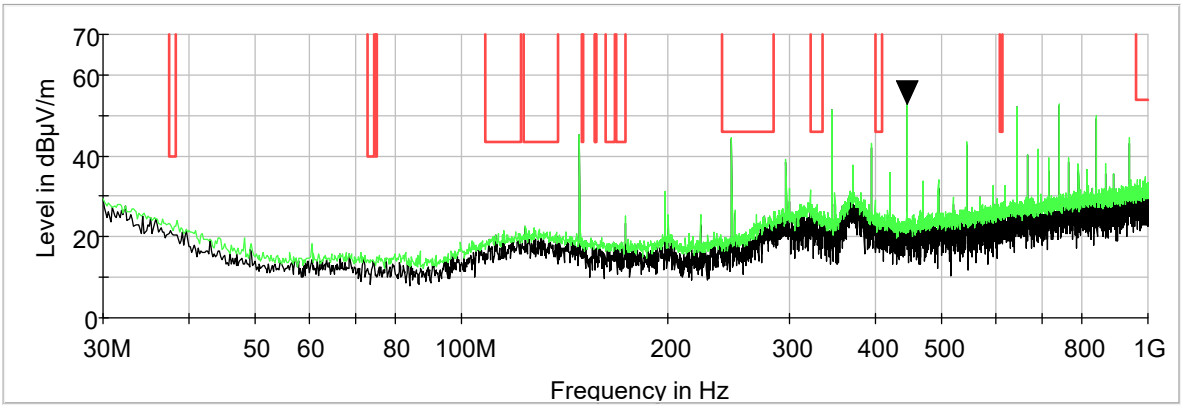
PCB Dipole Antenna, All Channels

Note: In the following graphs, the green emission lines are Peak emissions and the limit line is a Quasi-Peak limit.

Characterization Scan, 30 MHz to 1000 MHz, Vertical

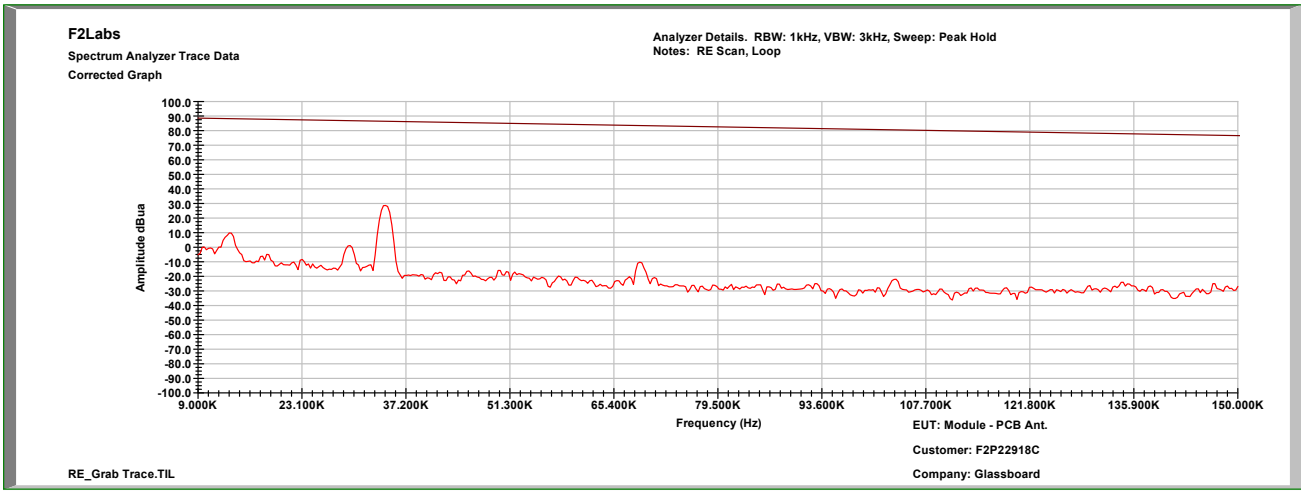


Characterization Scan, 30 MHz to 1000 MHz, Horizontal

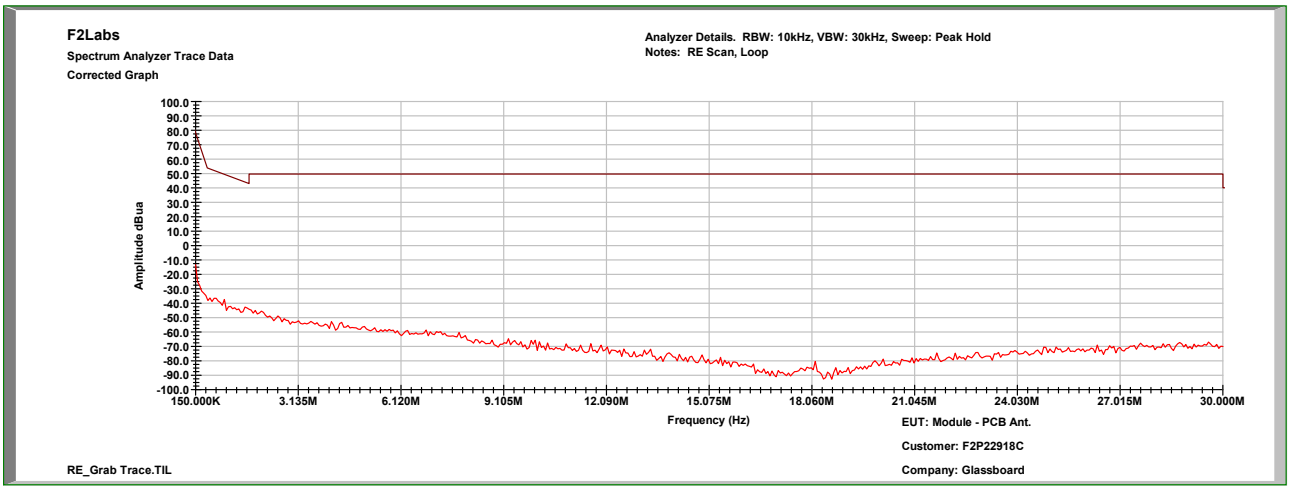


PCB Dipole Antenna

Characterization Scan, 0.009 MHz to 0.15 MHz

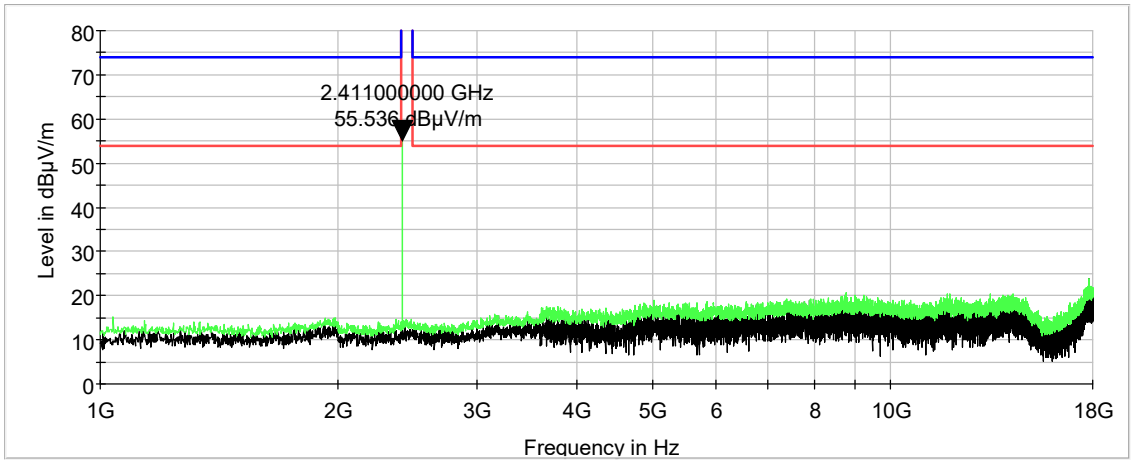


Characterization Scan, 0.15 MHz to 30 MHz



PCB Dipole Antenna

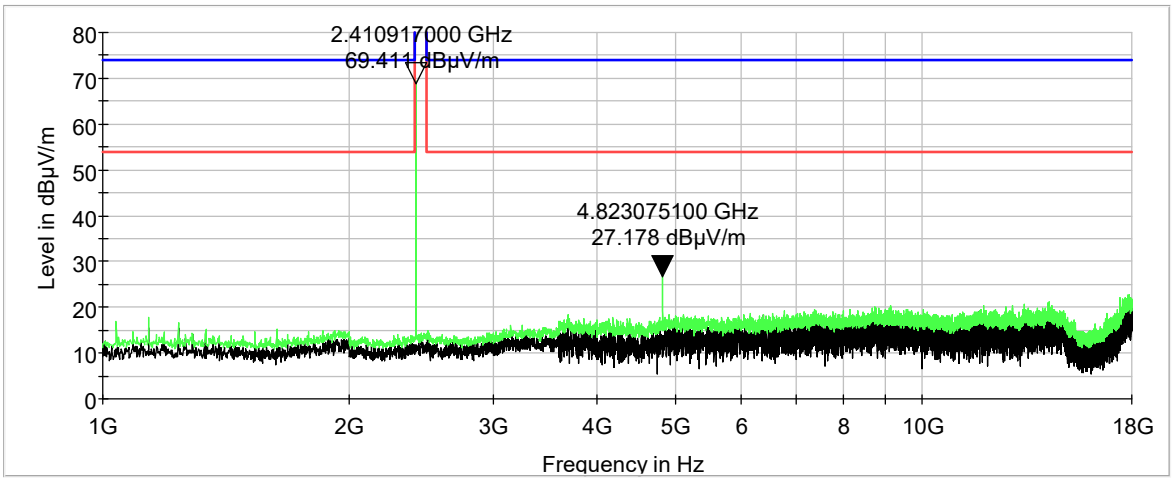
Characterization Scan, 1 GHz to 18 GHz, Vertical



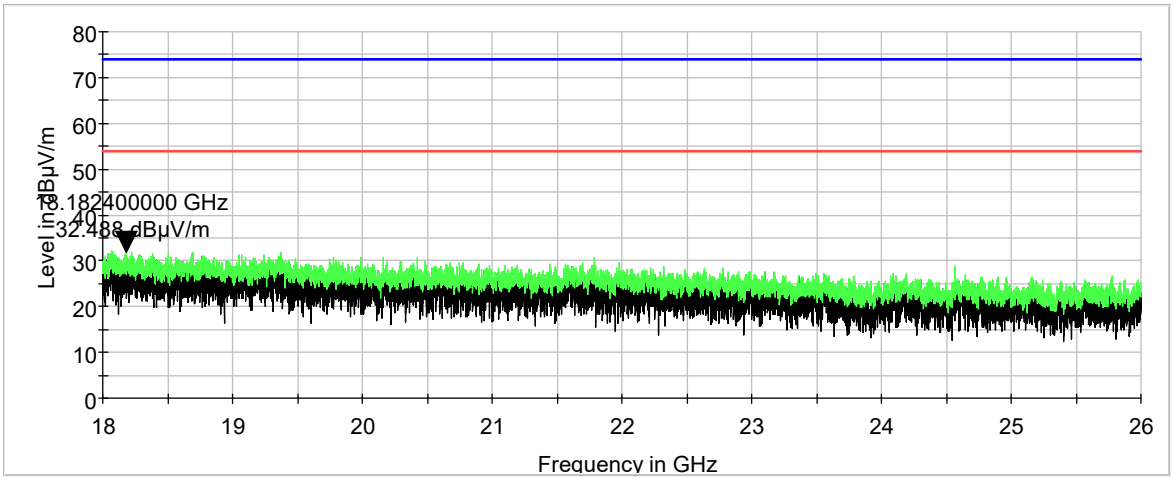
Characterization Scan, 18 GHz to 26 GHz, Vertical

PCB Dipole Antenna

Characterization Scan, 1 GHz to 18 GHz, Horizontal



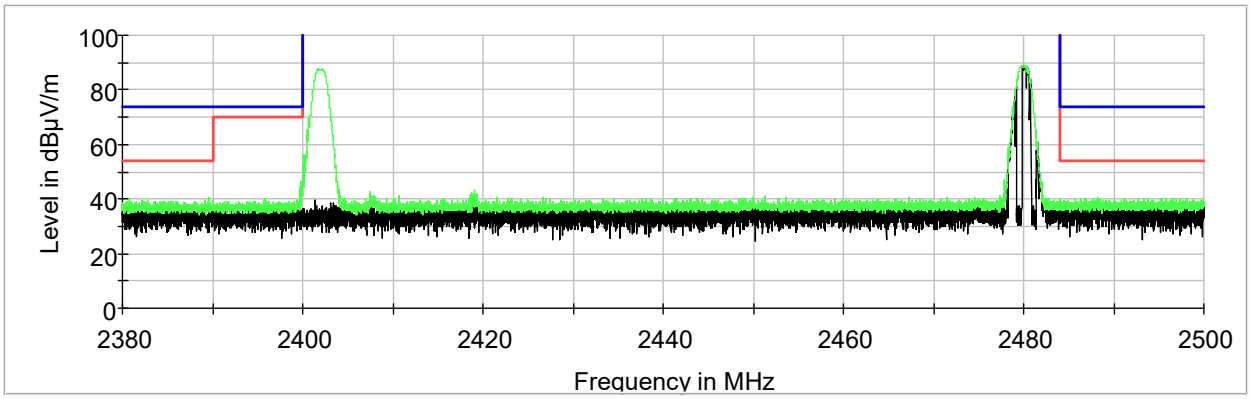
Characterization Scan, 18 GHz to 26 GHz, Horizontal



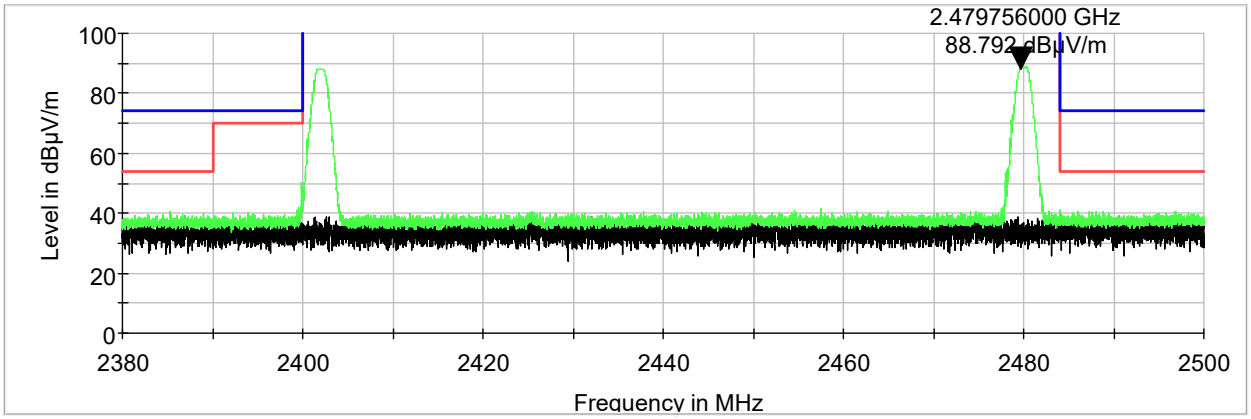
Chip Antenna
BLE Band Edge

In the following graphs, the green emissions are the peak emissions. The red limit line is the Average limit and the blue limit line is the Peak limit.

Vertical



Horizontal

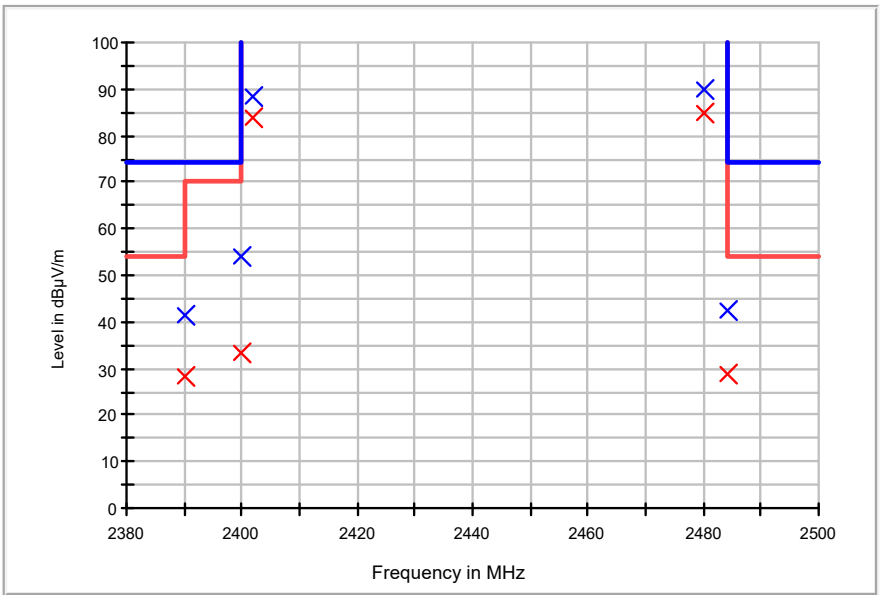


MaxPeak

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2400.000000	H	150.00	104.00	46.1	7.8	53.90	74.0	-20.1
2402.000000	H	150.00	104.00	80.8	7.8	88.60	--	--
2480.000000	H	150.00	112.00	81.4	8.3	89.70	--	--
2484.000000	H	150.00	112.00	34.1	8.4	42.50	74.0	-31.5

Average

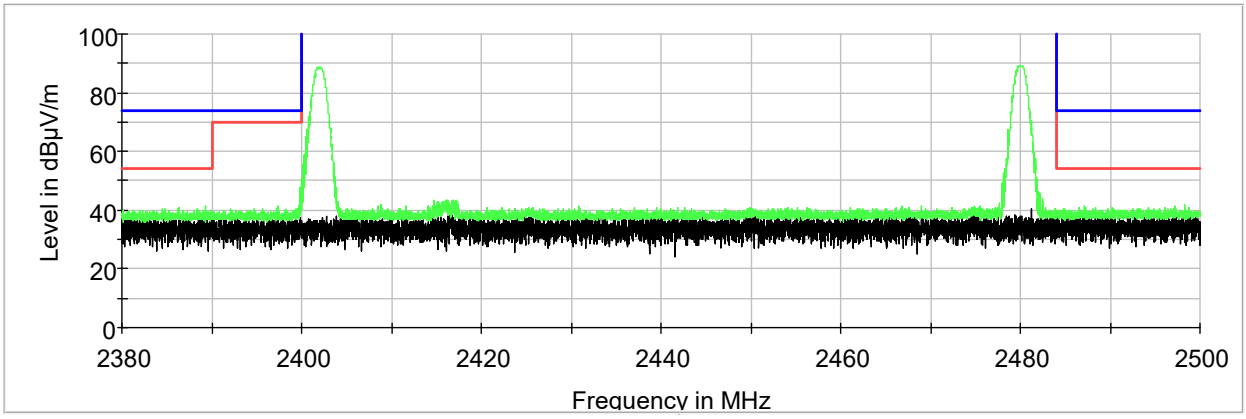
Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2400.000000	H	150.00	104.00	25.6	7.8	33.40	54.0	-20.6
2402.000000	H	150.00	104.00	76.0	7.8	83.80	--	--
2480.000000	H	150.00	112.00	76.4	8.3	84.70	--	--
2484.000000	H	150.00	112.00	21.6	8.4	29.00	54.0	-25.0



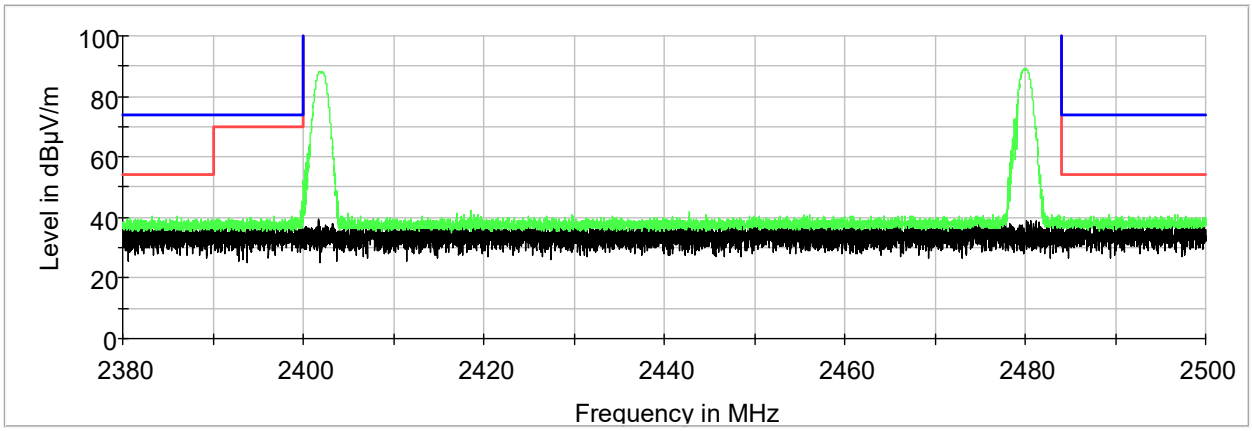
Chip Antenna
Bluetooth BT1 Band Edge

In the following graphs, the green emissions are the peak emissions. The red limit line is the Average limit and the blue limit line is the Peak limit.

Horizontal



Vertical



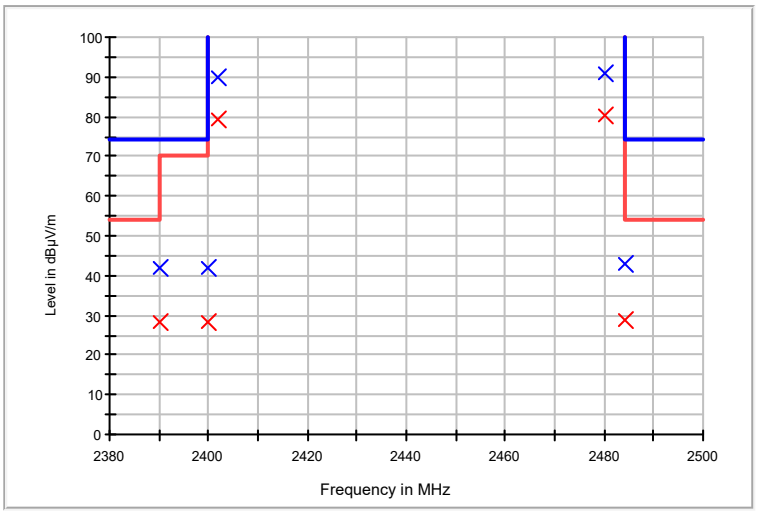
Bluetooth BT1 Band Edge

MaxPeak

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2390.000000	H	150.00	314.00	47.4	-5.7	41.70	74.0	-32.3
2400.000000	H	150.00	314.00	47.5	-5.7	41.80	74.0	-32.2
2402.000000	H	150.00	314.00	95.4	-5.7	89.70	--	--
2480.000000	H	150.00	314.00	96.3	-5.3	91.00	--	--
2484.000000	H	150.00	314.00	48.1	-5.2	42.90	74.0	-31.1

Average

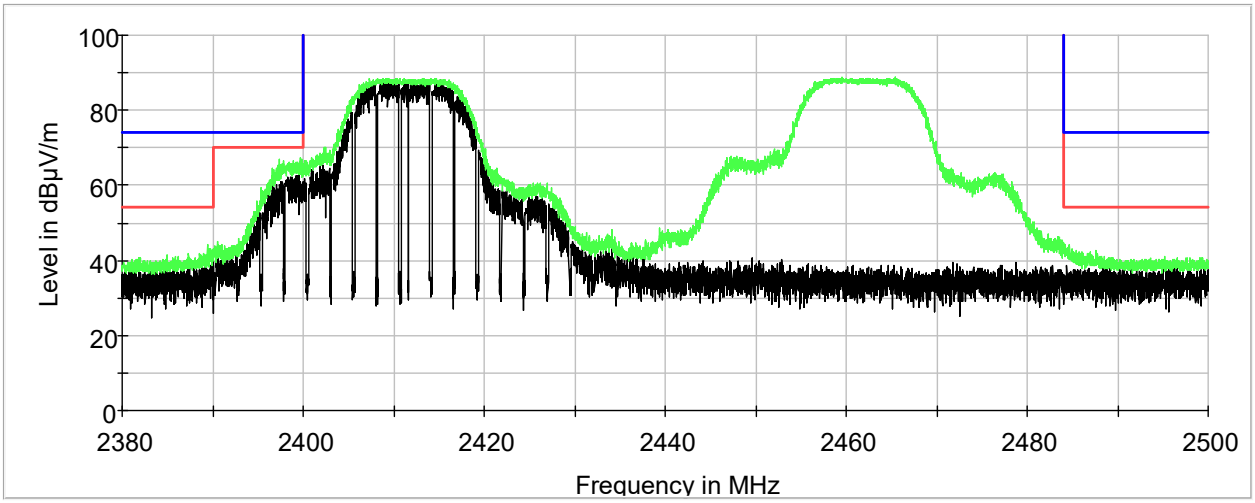
Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2390.000000	H	150.00	314.00	34.0	-5.7	28.30	54.0	-25.7
2400.000000	H	150.00	314.00	34.1	-5.7	28.40	54.0	-25.6
2402.000000	H	150.00	314.00	84.8	-5.7	79.10	--	--
2480.000000	H	150.00	314.00	85.7	-5.3	80.40	--	--
2484.000000	H	150.00	314.00	34.2	-5.2	29.00	54.0	-25.0



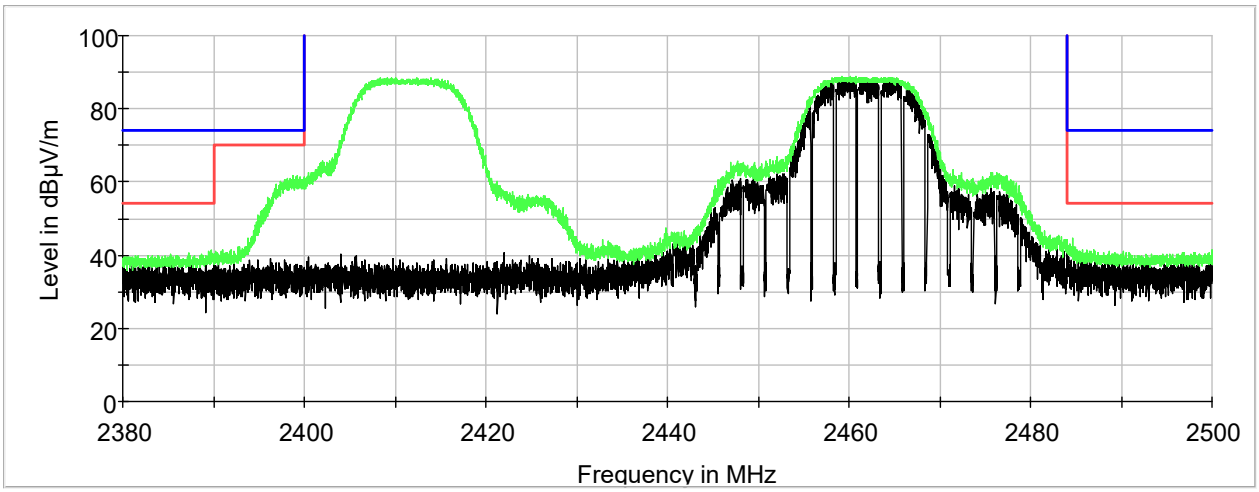
Chip Antenna
CCK

In the following graphs, the green emissions are the peak emissions. The red limit line is the Average limit and the blue limit line is the Peak limit.

Horizontal



Vertical



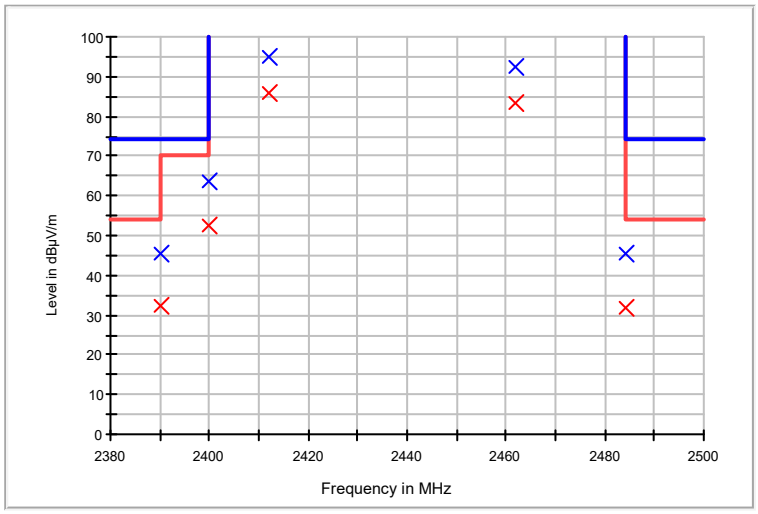
Chip Antenna
CCK

MaxPeak

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2390.000000	H	150.00	359.00	51.2	-5.7	45.50	74.0	-28.5
2400.000000	H	150.00	359.00	69.5	-5.7	63.80	74.0	-10.2
2412.000000	H	150.00	359.00	100.6	-5.6	95.00	--	--
2462.000000	H	150.00	359.00	97.7	-5.4	92.30	--	--
2484.000000	H	150.00	359.00	50.7	-5.2	45.50	74.0	-28.5

Average

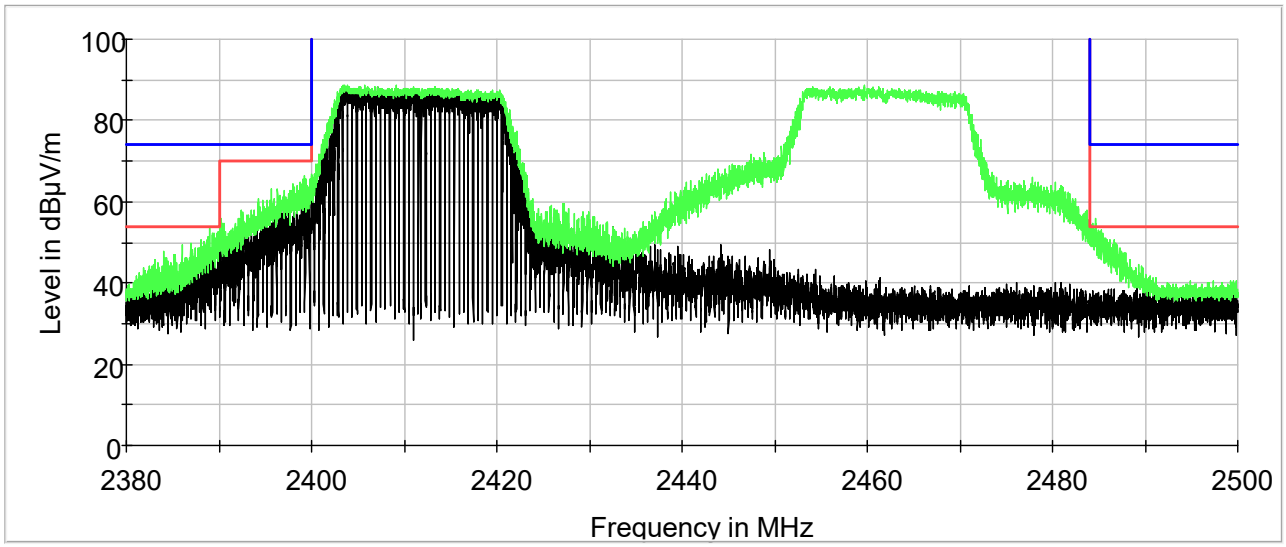
Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2390.000000	H	150.00	359.00	38.2	-5.7	32.50	54.0	-21.5
2400.000000	H	150.00	359.00	58.1	-5.7	52.40	54.0	-1.6
2412.000000	H	150.00	359.00	91.4	-5.6	85.80	--	--
2462.000000	H	150.00	359.00	88.6	-5.4	83.20	--	--
2484.000000	H	150.00	359.00	37.1	-5.2	31.90	54.0	-22.1



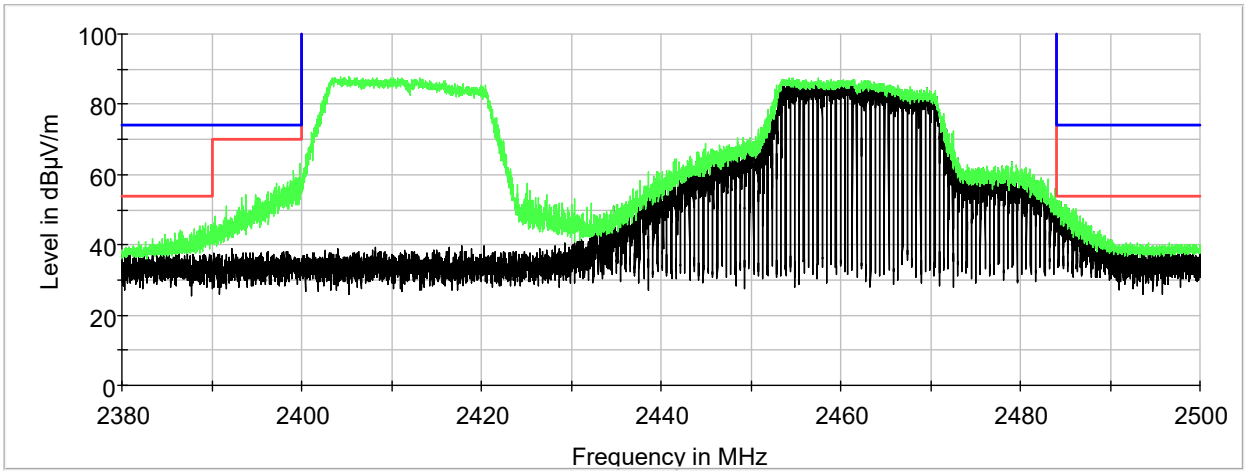
Chip Antenna
HT20

In the following graphs, the green emissions are the peak emissions. The red limit line is the Average limit and the blue limit line is the Peak limit.

Horizontal



Vertical



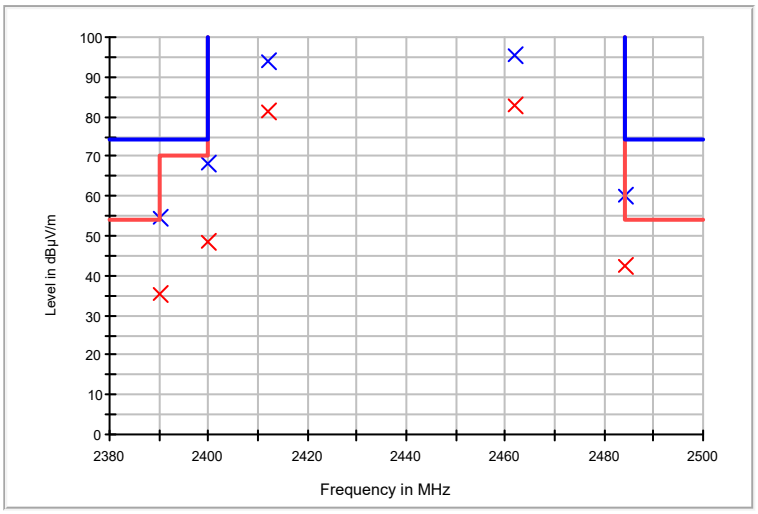
Chip Antenna
HT20

MaxPeak

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2390.000000	H	150.00	330.00	60.0	-5.7	54.30	74.0	-19.7
2400.000000	H	150.00	330.00	73.9	-5.7	68.20	74.0	-5.8
2412.000000	H	150.00	330.00	99.3	-5.6	93.70	--	--
2462.000000	H	150.00	330.00	100.7	-5.4	95.30	--	--
2484.000000	H	150.00	330.00	65.4	-5.2	60.20	74.0	-13.8

Average

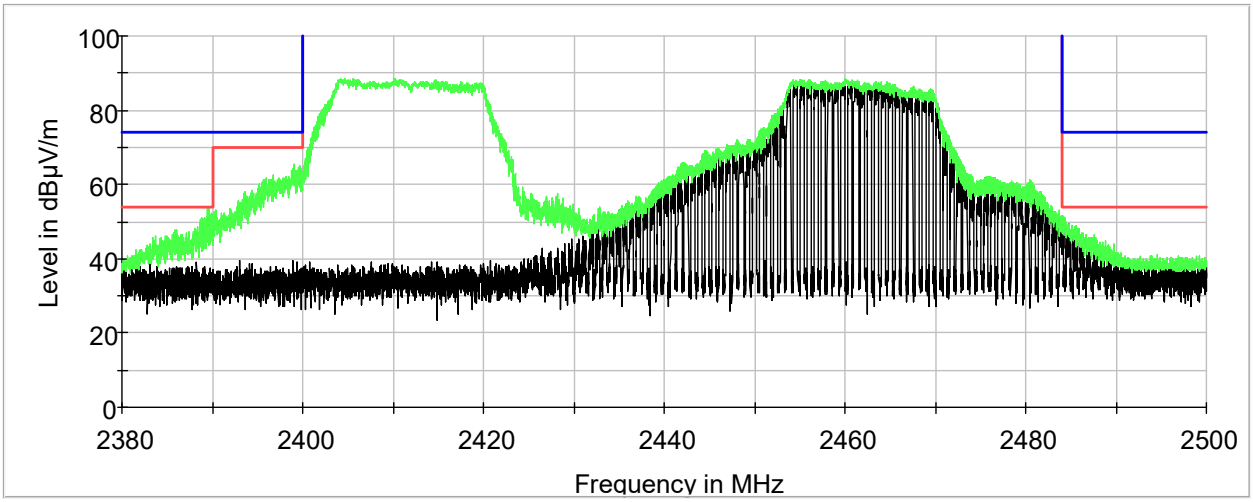
Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2390.000000	H	150.00	330.00	41.0	-5.7	35.30	54.0	-18.7
2400.000000	H	150.00	330.00	54.1	-5.7	48.40	54.0	-5.6
2412.000000	H	150.00	330.00	87.0	-5.6	81.40	--	--
2462.000000	H	150.00	330.00	88.2	-5.4	82.80	--	--
2484.000000	H	150.00	330.00	47.6	-5.2	42.40	54.0	-11.6



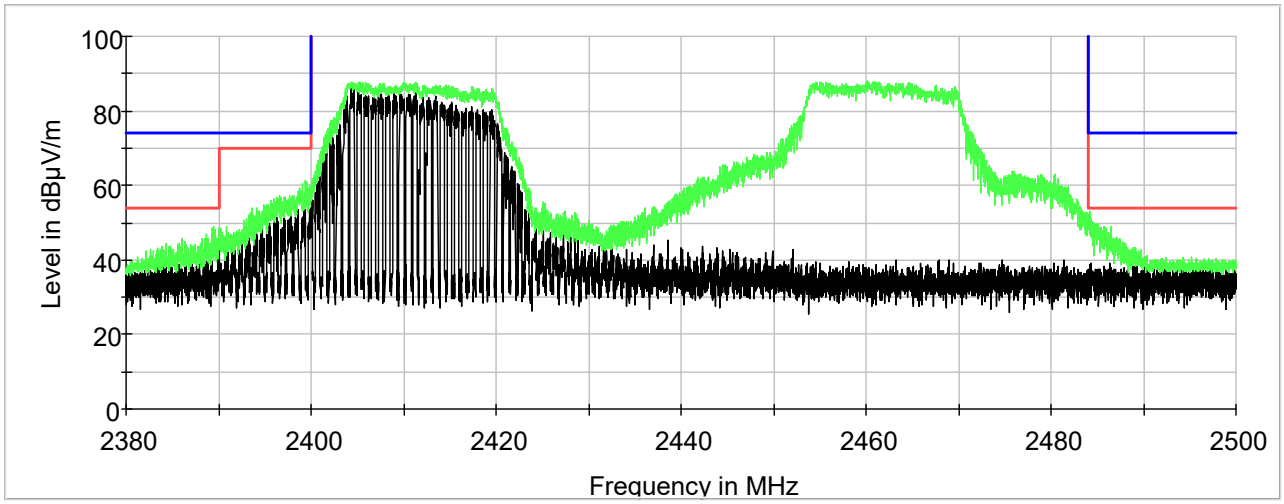
Chip Antenna
OFDM

In the following graphs, the green emissions are the peak emissions. The blue limit line is the Peak limit, and the red limit line is the Average limit and the blue limit line is the Peak limit.

Horizontal



Vertical



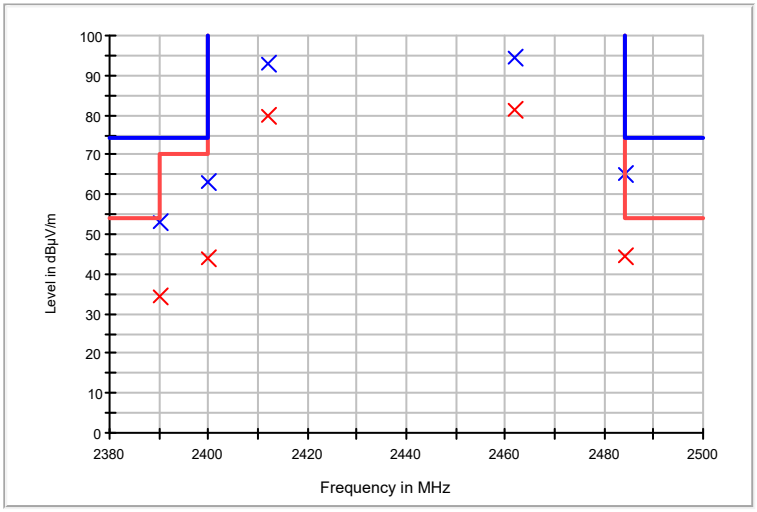
Chip Antenna
OFDM

MaxPeak

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Limit (dBµV/m)	Margin (dB)
2390.000000	H	150.00	329.00	58.8	-5.7	74.0	-20.9
2400.000000	H	150.00	329.00	78.8	-5.7	74.0	-0.9
2412.000000	H	150.00	329.00	79.3	-5.6	--	--
2462.000000	H	150.00	329.00	100.0	-5.4	--	--
2484.000000	H	150.00	329.00	70.6	-5.2	74.0	-8.6

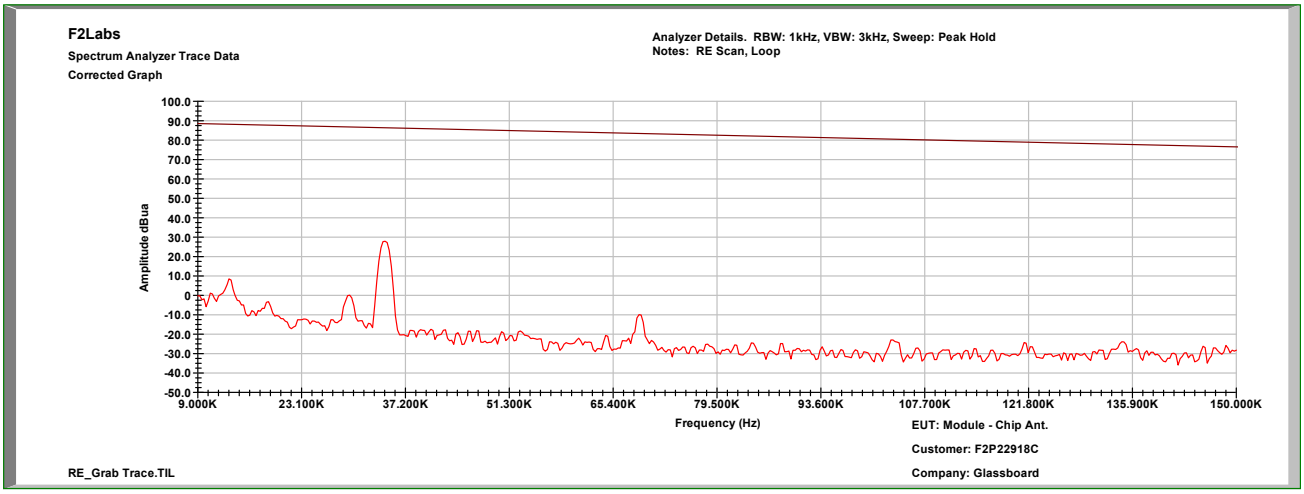
Average

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Limit (dBµV/m)	Margin (dB)
2390.000000	H	150.00	329.00	40.1	-5.7	54.0	-19.6
2400.000000	H	150.00	329.00	78.8	-5.7	54.0	19.1
2412.000000	H	150.00	329.00	79.3	-5.6	--	--
2462.000000	H	150.00	329.00	86.9	-5.4	--	--
2484.000000	H	150.00	329.00	49.8	-5.2	54.0	-9.4

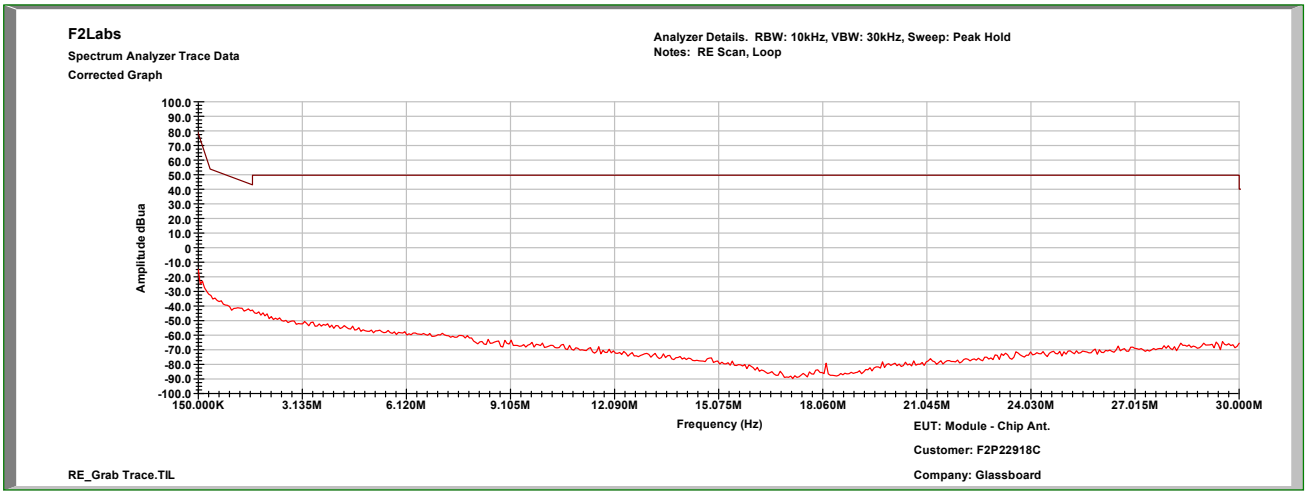


Chip Antenna

Characterization Scan, 0.009 MHz to 0.15 MHz

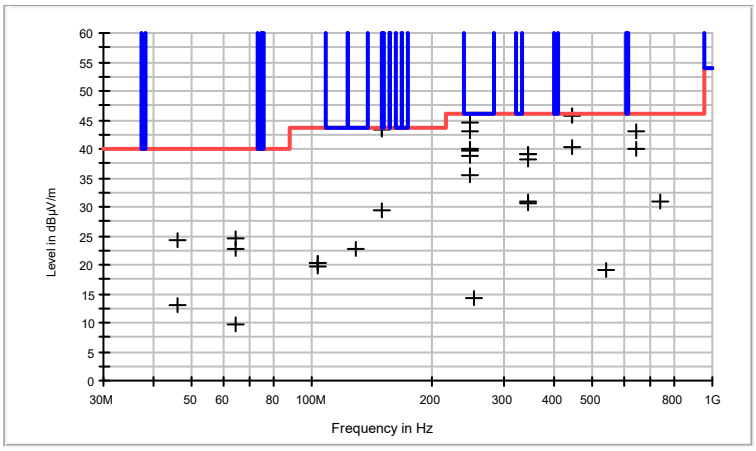


Characterization Scan, 0.15 MHz to 30 MHz



Chip Antenna - 30 MHz to 1000 MHz

Note: All emissions recorded are from the development board used for testing.
The radio was turned off and removed, and all emissions remained at the same levels.

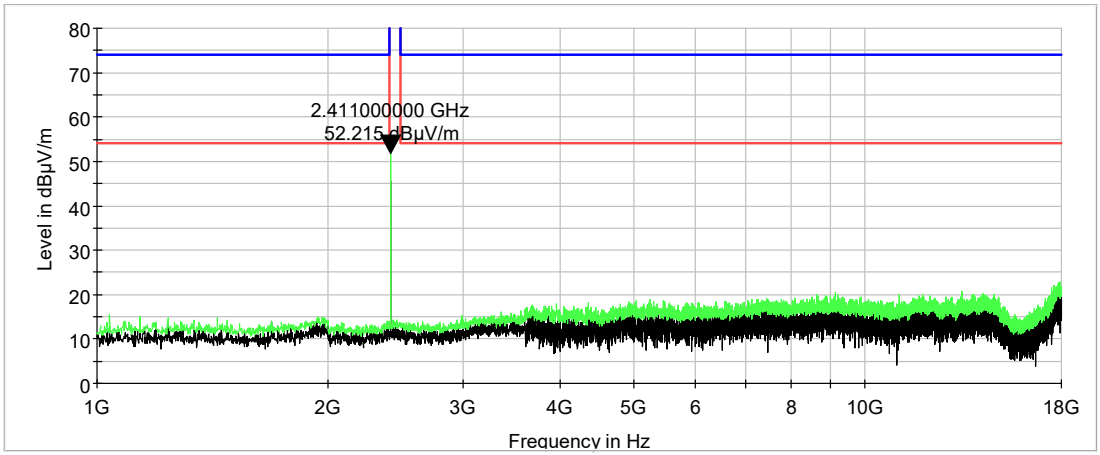


Frequency (MHz)	QuasiPeak (dBµV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV/m)
46.000000	24.2	120.000	100.0	V	355.0	-4.5	15.8	40.0
46.000000	13.0	120.000	100.0	H	359.0	-4.5	27.0	40.0
64.560000	22.7	120.000	100.0	V	29.0	-6.7	17.3	40.0
64.560000	9.8	120.000	100.0	H	0.0	-6.7	30.2	40.0
64.560000	24.6	120.000	100.0	V	0.0	-6.7	15.4	40.0
103.160000	20.3	120.000	100.0	V	0.0	-3.0	23.2	43.5
103.160000	19.8	120.000	100.0	V	345.0	-3.0	23.7	43.5
103.160000	20.3	120.000	100.0	V	0.0	-3.0	23.2	43.5
127.800000	22.6	120.000	100.0	V	4.0	0.2	20.9	43.5
148.440000	29.5	120.000	100.0	V	136.0	-1.0	14.0	43.5
148.520000	43.5	120.000	100.0	H	355.0	-1.0	0.0	43.5
148.520000	43.5	120.000	100.0	H	355.0	-1.0	0.0	43.5
148.520000	43.3	120.000	100.0	H	0.0	-1.0	0.2	43.5
247.480000	35.5	120.000	100.0	V	197.0	-0.7	10.5	46.0
247.480000	42.9	120.000	100.0	H	178.0	-0.7	3.1	46.0
247.480000	39.6	120.000	100.0	V	354.0	-0.7	6.4	46.0
247.480000	38.9	120.000	100.0	V	251.0	-0.7	7.1	46.0
247.480000	44.6	120.000	100.0	H	107.0	-0.7	1.4	46.0
247.480000	39.9	120.000	100.0	H	258.0	-0.7	6.1	46.0
252.400000	14.3	120.000	100.0	V	0.0	-0.7	31.7	46.0
346.400000	39.0	120.000	100.0	H	142.0	2.6	7.0	46.0
346.400000	39.0	120.000	100.0	H	142.0	2.6	7.0	46.0
346.400000	30.5	120.000	100.0	V	116.0	2.6	15.5	46.0
346.400000	38.0	120.000	100.0	H	131.0	2.6	8.0	46.0
346.400000	30.9	120.000	100.0	V	67.0	2.6	15.1	46.0
445.400000	40.2	120.000	100.0	V	322.0	5.1	5.8	46.0
445.400000	45.8	120.000	100.0	H	0.0	5.1	0.2	46.0
445.400000	45.7	120.000	100.0	H	0.0	5.1	0.3	46.0
544.600000	19.0	120.000	100.0	V	355.0	7.1	27.0	46.0
643.400000	40.0	120.000	100.0	V	355.0	9.1	6.0	46.0
643.440000	43.0	120.000	100.0	H	131.0	9.1	3.0	46.0
742.560000	30.9	120.000	100.0	H	352.0	10.3	15.1	46.0

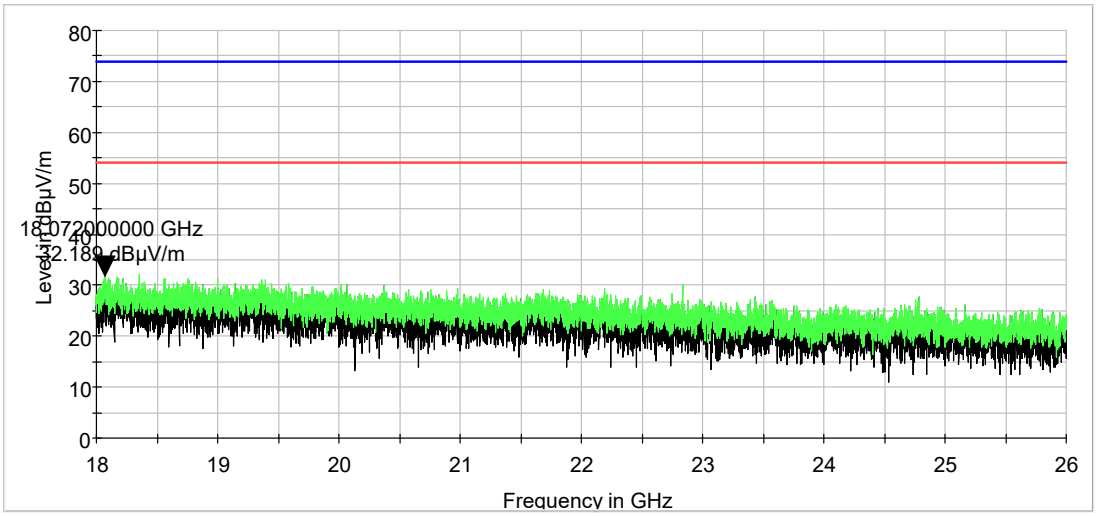
Note: Chart contains data from all channels tested.

Chip Antenna

Characterization Scan, 1 GHz to 18 GHz, Vertical

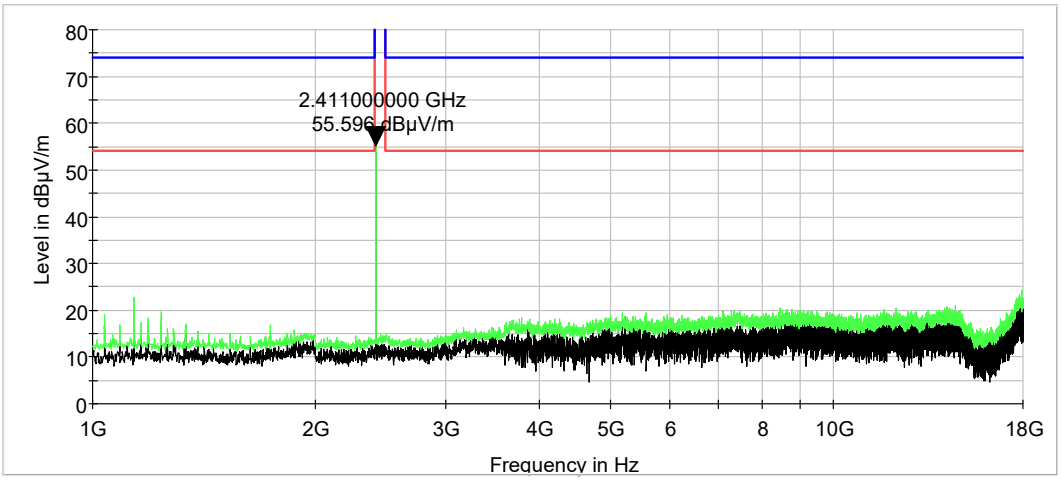


Characterization Scan, 18 GHz to 26 GHz, Vertical

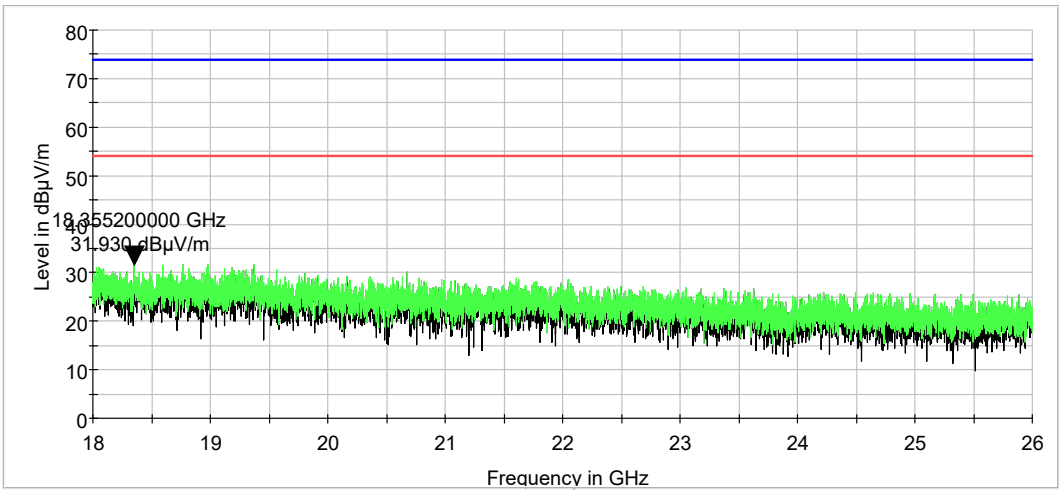


Chip Antenna

Characterization Scan, 1 GHz to 18 GHz, Horizontal

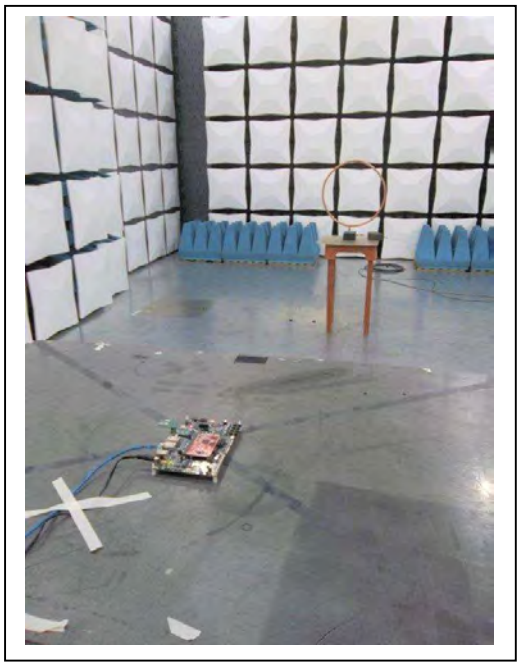


Characterization Scan, 18 GHz to 26 GHz, Horizontal

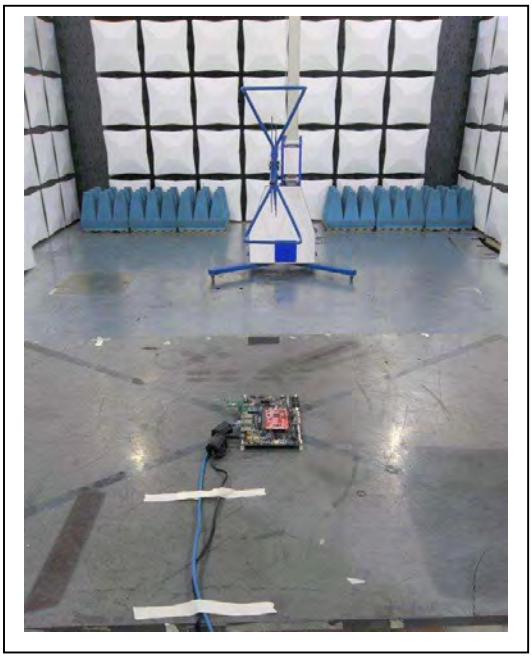


7 PHOTOGRAPHS

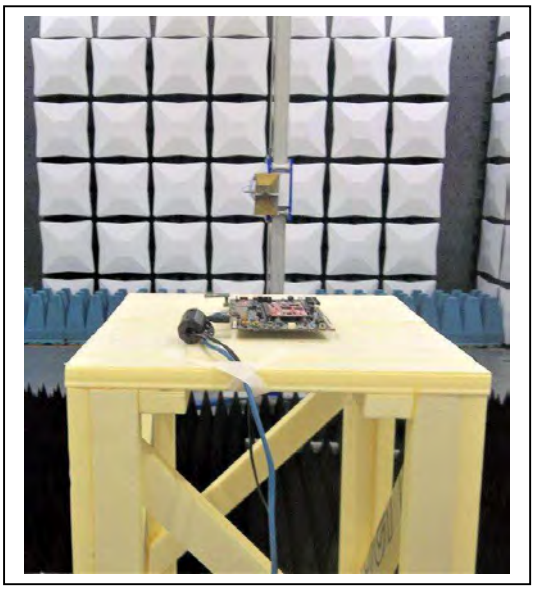
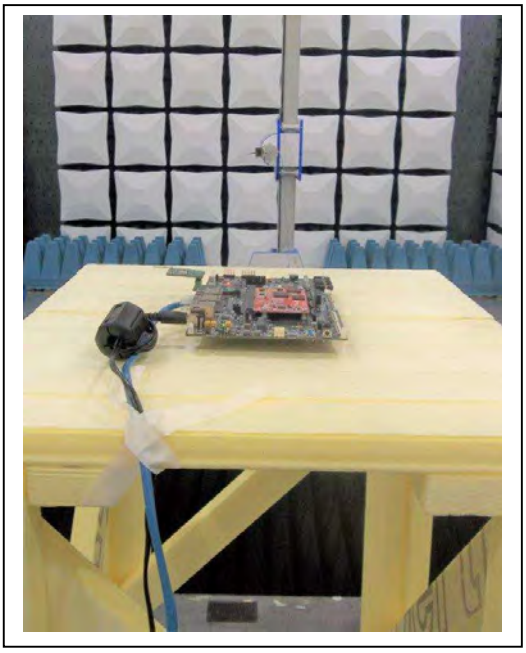
Loop Antenna



30 MHz to 1000 MHz



1 to 18 GHz



18 to 26 GHz