

## Test Report for the FCC and ISED Testing of an Raspberry Pi Pico W (WiFi) to FCC Rule 47CFR 15.247 and ISED RSS-247 for Raspberry Pi Ltd

Test Report number: C14526TR4

Project number: B5109



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Issue	Description						Issue by	Date
4	Copy 1		Copy 2		PDF	X	MR	20 <sup>th</sup> June 2022

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**The results contained in this report are only applicable to the apparatus tested.**



1574

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## Test Report Change History

Issue	Date	Modification Details
1	7 <sup>th</sup> March 2022	First Issue
2	5 <sup>th</sup> May 2022	Customer name updated
3	17 <sup>th</sup> June 2020	Top channel reference updated
4	20 <sup>th</sup> June 2020	Typographical error corrected
5		
6		
7		
8		
9		
10		

**Section 1 Test Location**

All testing was performed at;

<b>Eurofins York</b>	Unit 5
	Speedwell Road
	Castleford
	WF10 5PY
<b>Tel:</b>	01977 731173
<b>Website</b>	<a href="http://www.yorkemc.co.uk">http://www.yorkemc.co.uk</a>
<b>UKAS Testing No.</b>	1574

**1.1 UKAS Accreditation**

Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation.

Eurofins York latest accreditation schedule can be found at:

[http://www.ukas.org/testing/lab\\_detail.asp?lab\\_id=989&location\\_id=&vMenuOption=3](http://www.ukas.org/testing/lab_detail.asp?lab_id=989&location_id=&vMenuOption=3)

Eurofins York Castleford Laboratory, is an Accredited facility recognised by the Federal Communications Commission (FCC) for certification testing. The appropriate FCC Designation Number is UK2013, dated 1<sup>st</sup> March 2021.

Eurofins York Castleford Laboratory is recognised by ISED for certification testing.

ISED Assigned Code: 22959

**Section 2 Customer Information**

<b>Company name</b>	Raspberry Pi Ltd
<b>Address</b>	Maurice Wilkes Building
	St. John's Innovation Park
	Cowley Road
	Cambridge
	CB4 0DS
	United Kingdom
<b>Contact</b>	Tom Westcott
<b>Email</b>	tom.westcott@raspberrypi.com

## Section 3 Equipment Details

## 3.1 Equipment Under Test (EUT)

<b>Date received:</b>	8 <sup>th</sup> February 2022		
<b>EUT name:</b>	Raspberry Pi Pico W		
<b>PMN:</b>	Raspberry Pi Pico W		
<b>HVIN:</b>	Raspberry Pi Pico W		
<b>FVIN:</b>	N/A		
<b>FCC ID:</b>	2ABCB-PICOW		
<b>ISED number:</b>	20953-PICOW		
<b>Serial no:</b>	Rad 1, Con 1		
<b>EUT description:</b>	The Raspberry Pi Pico W is a small single board microprocessor board. The user connects the board to a host via a micro USB connector. This connection provides power and operation functionality. The product is supplied with an operating system. The board has a CYW43439 Bluetooth and Wi-Fi combo chip which allows the user to connect to a 2.4GHz Wi-Fi networks, BT Classic 5 compliant devices and BT-LE devices. The system uses a single PCB Niche single band antenna with a centre frequency of 2450 MHz.		
<b>Antenna</b>	Integral Antenna		
<b>Transmission</b>	Digital Transmission System (DTS) WiFi		
<b>Modulation schemes</b>	IEEE 802.11b,g,n		
<b>Channel Bandwidth</b>	20 MHz		
<b>Operating frequency band</b>	2400MHz to 2483.5MHz		
<b>No of units tested:</b>	Two		
<b>EUT power:</b>	3.3V via USB port		
<b>Highest internal frequency:</b>	2.480GHz		
<b>Size of EUT (m)</b>	Width: 55 mm	Depth: 23 mm	Height: 4 mm
<b>Mode/s of operation:</b>	Continuous transmit of packetised data at top, middle and bottom channels. Channels used: 2412MHz, 2442MHz and 2462MHz		
<b>Test software:</b>	WLAN Test Firmware		
<b>Modifications incorporated during testing:</b>	For radiated measurements a Wurth 742 711 31 S ferrite was placed on the USB cable between the EUT and the Auxiliary PC. This encompassed 2 turns of the USB cable and was positioned approximately 1m from the EUT.		

Ports and Cables	Cable Length	Screened/ unscreened	Connected to
USB cable	5m	unscreened	External PC

**Output power Q values**

The output power of a specific channel was determined in the test mode software by a parameter referred to as a Q-value. The Q-values for each channel is detailed in the table below.

Modulation scheme	Channel number	Q value
802.11b	1	60
802.11b	2	60
802.11b	3	76
802.11b	4	76
802.11b	5	76
802.11b	6	76
802.11b	7	76
802.11b	8	76
802.11b	9	76
802.11b	10	76
802.11b	11	76
802.11g	1	36
802.11g	2	40
802.11g	3	40
802.11g	4	40
802.11g	5	40
802.11g	6	40
802.11g	7	40
802.11g	8	40
802.11g	9	40
802.11g	10	40
802.11g	11	40
802.11n	1	30
802.11n	2	40
802.11n	3	40
802.11n	4	40
802.11n	5	40
802.11n	6	40
802.11n	7	40
802.11n	8	40
802.11n	9	40
802.11n	10	40
802.11n	11	40



### **3.2 EUT Photographs**

Photographs are supplied separately.

### **3.3 Configuration of EUT**

The apparatus was supplied in one single possible configuration.

### **3.4 EUT Monitoring/Auxiliary Equipment**

None.

### **3.5 Monitoring Software**

None. The channel required was selected via software prior to the testing.

**Section 4 Test Specifications**

For USA:

<b>Regulation / Test Standard</b>	Regulation:  Title 47 of the Code of Federal Regulations (CFR) Part 15 (47CFR15) Subpart C – Intentional Radiators  Measurement standard:  ANSI C63.10-2013 American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
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<b>Requirement</b>	<b>FCC Rule Part</b>	<b>Comments</b>	<b>Result Summary</b>
6 dB Bandwidth	FCC § 15.247(a)(2)	Applies	Pass
Maximum peak conducted power	FCC § 15.247(b)(3)	Applies	Pass
Power spectral density	FCC § 15.247(e)	Applies	Pass
Band edge compliance	FCC § 15.247(d)	Applies	Pass
Conducted spurious emissions	FCC § 15.247(d)	Applies	Pass
Transmitter radiated spurious emissions – restricted bands	FCC § 15.247(d) FCC § 15.209	Applies	Pass

**For Canada**

<b>Regulation / Test Standard</b>	<p>RSS-247 Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices Issue 2 February 2017</p> <p>And,</p> <p>RSS-Gen — General Requirements for Compliance of Radio Apparatus Issue 5 April 2018 +A1 March 2019 +A2 February 2021</p>
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<b>Requirement</b>	<b>ISED Regulation</b>	<b>Comments</b>	<b>Results Summary</b>
Occupied Bandwidth	RSS-Gen 6.6	Applies	Pass
6 dB Bandwidth	ISED RSS-247 § 5.2	Applies	Pass
Maximum peak conducted power	ISED RSS-247 § 5.4	Applies	Pass
Power spectral density	ISED RSS-247 § 5.2	Applies	Pass
Band edge compliance	ISED RSS-247 § 3.3 and 5.5  RSS-GEN Issue 5 Section 8.10	Applies	Pass
Conducted spurious emissions	ISED RSS-247 § 5.5	Applies	Pass
Transmitter radiated spurious emissions	ISED RSS-GEN § 8.9	Applies	Pass

#### 4.1 Knowledge Database References

The following KDBs were referenced during the testing.

The latest knowledge database references are available via the FCC KDB website at:

<https://apps.fcc.gov/kdb>

##### 4.1.1 Radiated Emissions (30MHz to 1000MHz)

Publication Number	Keyword	Publication Date
913591	Measurement of radiated emissions at the band-edge for a Part 15 RF Device	04/05/2017

##### 4.1.2 Radiated Emissions (1GHz to 40GHz)

Publication Number	Keyword	Publication Date
704992	Test Site Validation Requirements above 1 GHz.	12/06/2015
149045	Comparison Noise Emitter (CNE), reference noise source, .pdf	05/04/2007
913591	Measurement of radiated emissions at the band-edge for a Part 15 RF Device	04/05/2017
934285	Comparison Noise Emitters (CNE), test equipment, Broadband.pdf	05/04/2007

#### 4.2 Compliance Statement

The Raspberry Pi Pico W, as tested, was shown to meet requirements of the standards listed in Section 4 of this report.

## Section 5 Spurious Emission Results – Radiated and Conducted

### 5.1 Test Specification

FCC Rule Part	47CFR 15.247 (d)
Standard	ANSI C63.10:2013
Measurement Uncertainty Radiated tests	The reported uncertainty of measurement $y \pm U$ , where expanded uncertainty U is based on a standard uncertainty multiplied by a coverage factor of $k=2$ , providing a level of confidence of approximately 95% is +/- 5.85dB for the frequency range 30MHz to 1GHz +/- 4.64dB for the frequency range from 1GHz to 6GHz +/- 4.96dB for the frequency range from 6GHz to 18GHz
Measurement Uncertainty Conducted tests	$\pm 1.4$ dB

### 5.2 Procedure and Test Software Version

#### Radiated tests:- 47CFR15.205 and 47CFR15.209

Eurofins York test procedure (30MHz to 1GHz)	CEP23b Issue 8
Eurofins York test procedure (1GHz to 40GHz)	CEP64b Issue 8
Test software	RadiMation Version 2016.2.8

#### Conducted Tests 47CFR 15.247(d)

ANSi C63.10-2013 Clause reference:	11.11.2 and 11.11.3
Test software	N/A

**5.3 Radiated Emissions (30MHz to 1GHz)**

Radiated electric field emission measurements are applied as defined in 47CFR15.205 and 47CFR15.209.

**5.3.1 Limits at 3m**

Frequency (MHz)	Limit (dBµV/m) at 3m measurement distance
	Quasi Peak
30 - 88	40.0
88 -216	43.5
216 - 960	46.0
960- 1000	54.0

Note: FCC 47 CFR Part 15 Section 15.209 and 15.205 specifies test limits at 3m

## Receiver Settings

Receiver Parameters	Setting
Detector Function	Quasi Peak
Start Frequency	30MHz
Stop Frequency	1000MHz
Resolution Bandwidth	120kHz
Video Bandwidth	Auto

**5.3.2 Emissions measurements****5.3.3 Date of Test**

17<sup>th</sup> February 2022

**5.3.4 Test Area**

LAB 1 (SAC)

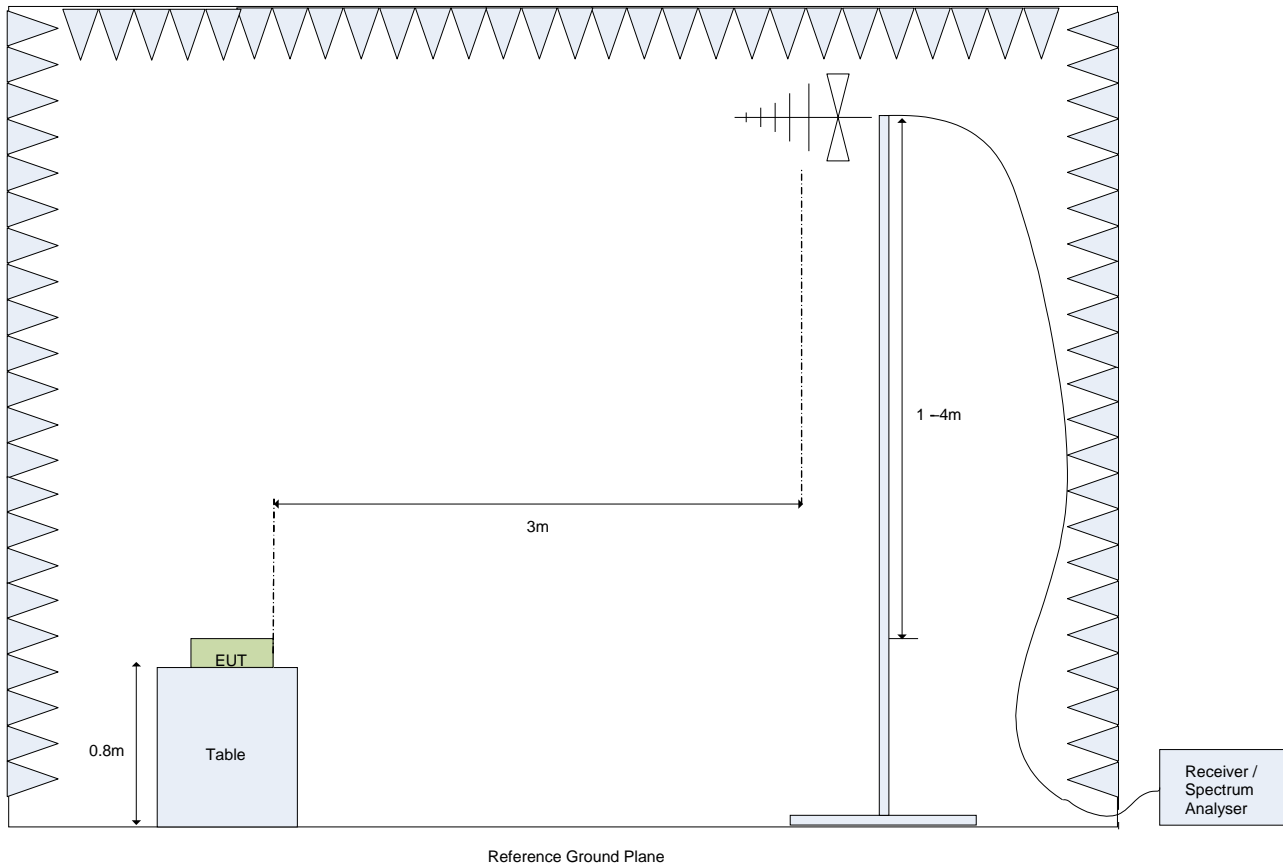
**5.3.5 Tested by**

M Dyster

### 5.3.6 Test Setup

The EUT was configured in the SAC on an 80cm high polystyrene table.

The measurement was performed with an antenna to EUT separation distance of 3m. The results were maximised in orientation 0-360 degrees and height 1-4m.



**Figure 5.3.6.1: Test Setup for E-Field Measurements from 30MHz to 1GHz**

Note 1 : With the EUT de-energized the ambient radio noise and signals met the 6dB peak detection requirement of ANSI C63.10-2013.

Note 2 : There were no significant environmental temperature changes during the test duration and hence it was not considered necessary to consider any variation in cable loss.

#### Operating Mode During testing

During spurious emission testing the equipment under test was set to transmit at the same frequency on the following channels: 2412MHz, 2442MHz and 2462MHz for each modulation scheme used

The equipment under test was pre-scanned using peak detection when operating on all three channels for all three modulation schemes. Final measurements were performed for each modulation scheme with the equipment under test operating on 2442MHz

5.3.7 Electric field emissions IEEE 802.11b, 30MHz to 1GHz

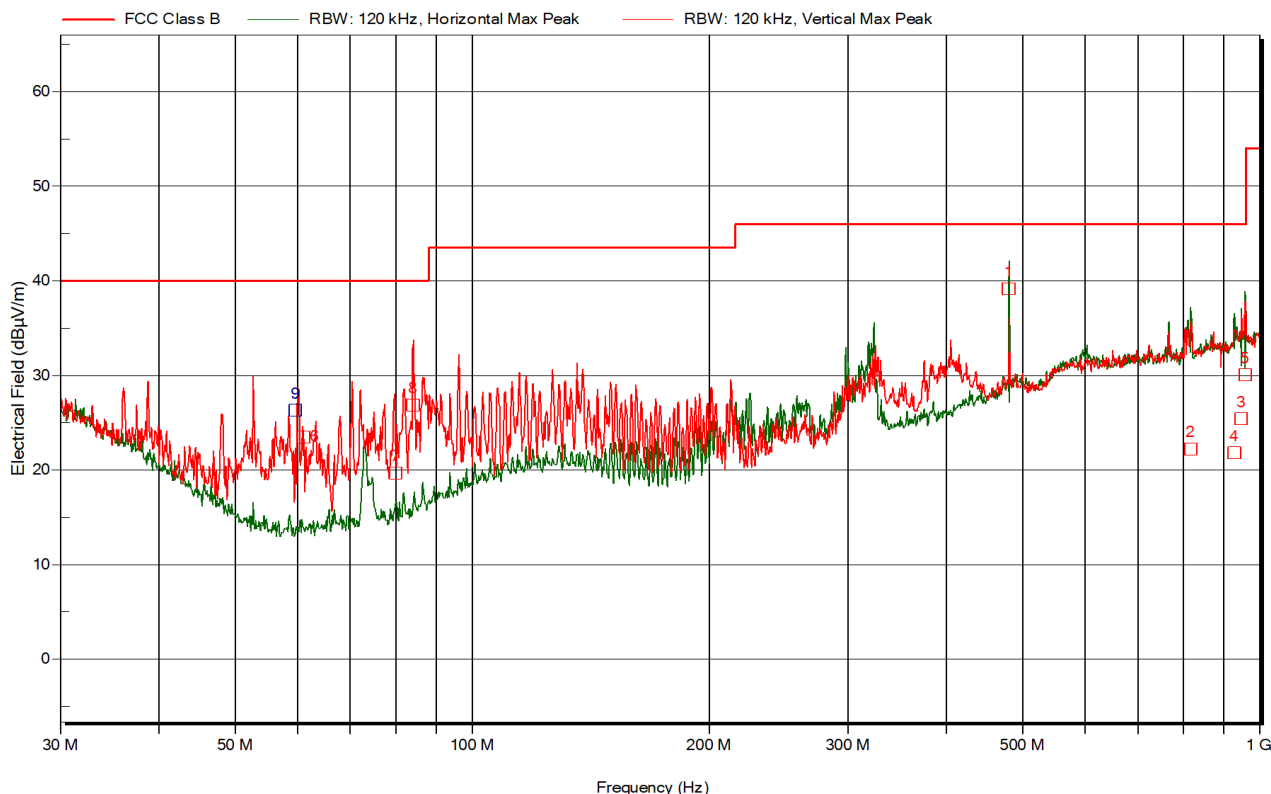


Figure 5.3.7.1: Electric field emissions Plot IEEE 802.11b, 30MHz to 1GHz, 2442MHz Operation

Frequency	Quasi-Peak	Quasi-Peak Limit	Quasi-Peak Difference	Quasi-Peak Status	Angle	Height	Polarization
MHz	dBµV/m	dBµV/m	dB		degrees	m	
480.072	39.2	46	-6.8	Pass	360	1.8	Horizontal
816.900	22.2	46	-23.8	Pass	25	2.4	Horizontal
947.280	25.4	46	-20.6	Pass	80	1.9	Horizontal
928.200	21.8	46	-24.2	Pass	260	2.0	Horizontal
958.044	30.1	46	-15.9	Pass	315	2.6	Horizontal
61.020	23.5	40	-16.5	Pass	180	2.1	Vertical
79.860	19.7	40	-20.3	Pass	40	1.0	Vertical
84.060	26.9	40	-13.1	Pass	325	1.0	Vertical
59.586	26.3	40	-13.7	Pass	265	4.0	Vertical

Table 5.3.7.1 Electric Field Emissions Peaks IEEE 802.11b, 30MHz to 1GHz. 2442MHz Operation



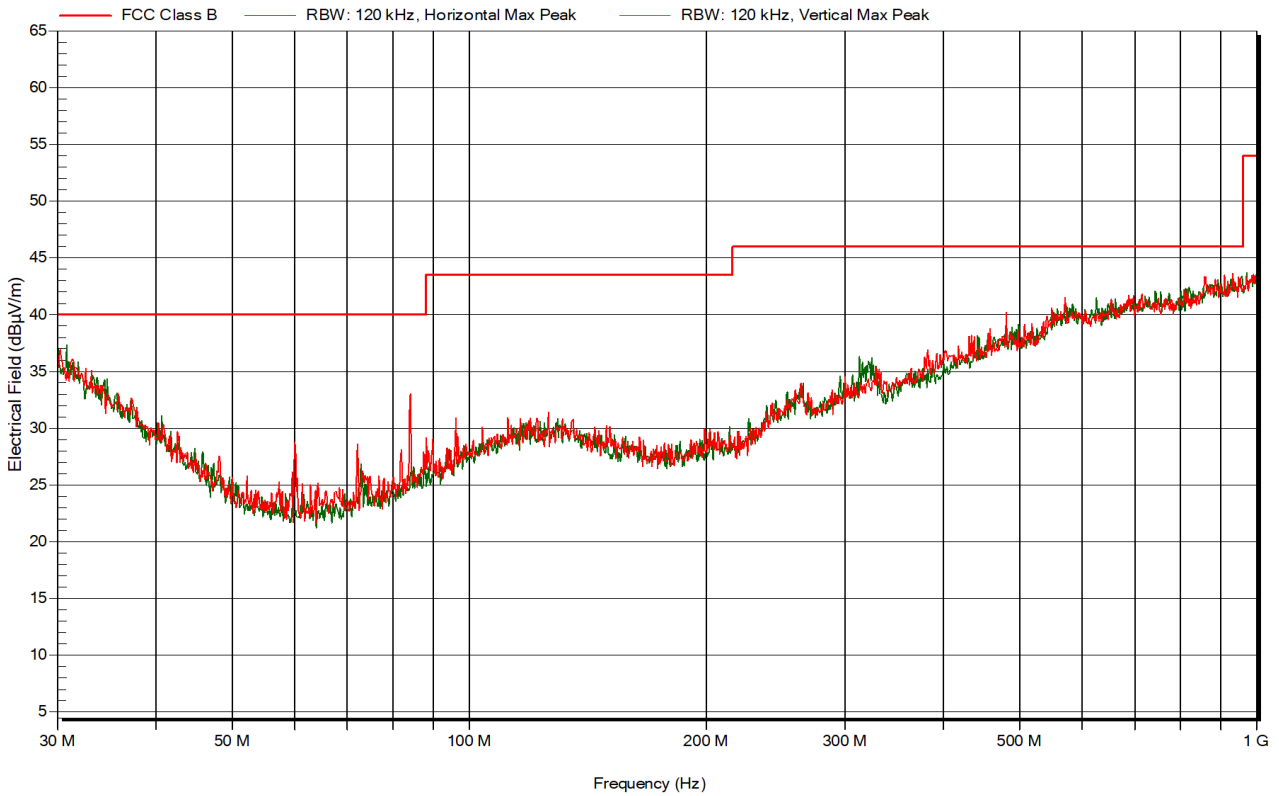


Figure 5.3.7.2: Electric field emissions Plot IEEE 802.11b, 30MHz to 1GHz, Operation on 2412MHz - Peak detector scan



Figure 5.3.7.3: Electric field emissions Plot IEEE 802.11b, 30MHz to 1GHz, Operation on 2462MHz - Peak detector scan

5.3.8 Electric field emissions IEEE 802.11g, 30MHz to 1GHz

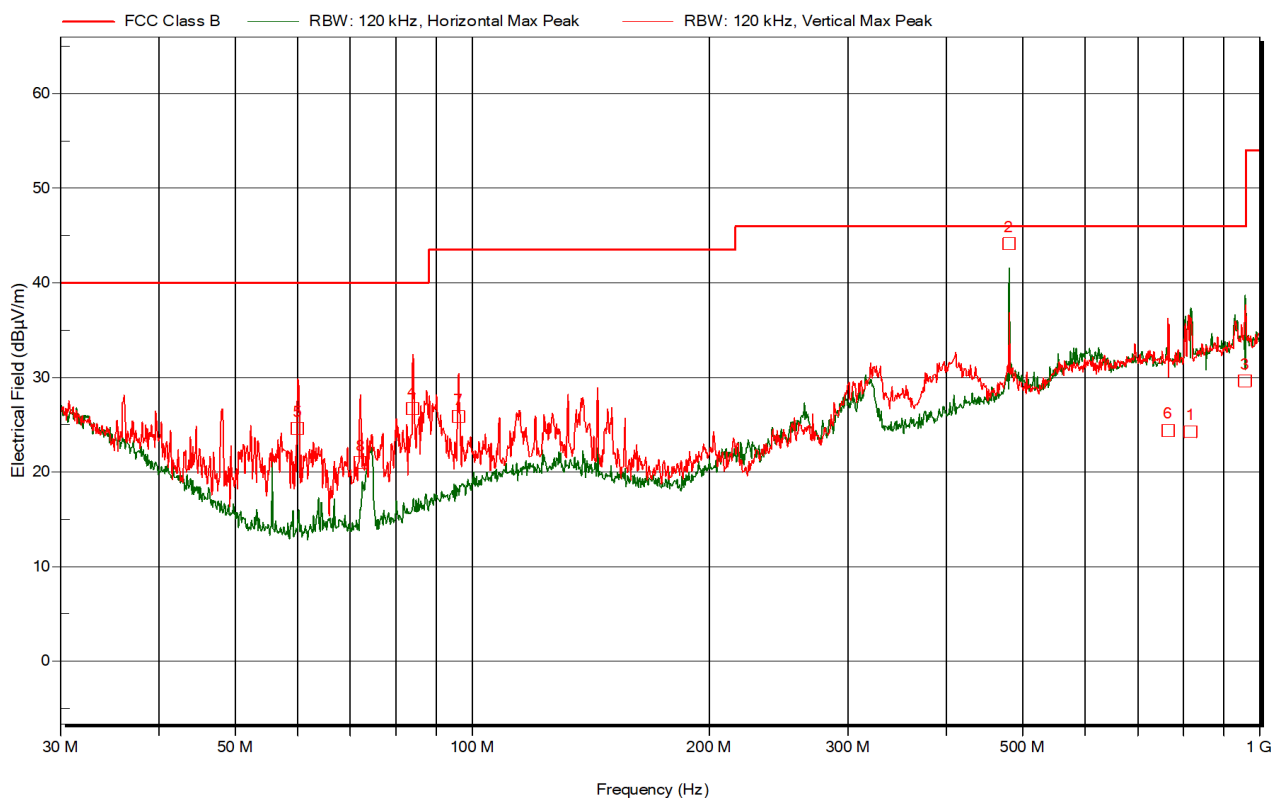


Figure 5.3.8.1: Electric field emissions Plot IEEE 802.11g, 30MHz to 1GHz, 2442MHz Operation

Frequency	Quasi-Peak	Quasi-Peak Limit	Quasi-Peak Difference	Quasi-Peak Status	Angle	Height	Polarization
MHz	dBµV/m	dBµV/m	dB		degrees	m	
816.270	24.3	46	-21.7	Pass	115	1.7	Horizontal
480.078	44.1	46	-1.9	Pass	170	2.1	Horizontal
958.008	29.7	46	-16.3	Pass	220	2.3	Horizontal
83.982	26.7	40	-13.3	Pass	305	1.0	Vertical
59.982	24.6	40	-15.4	Pass	120	1.0	Vertical
764.946	24.4	46	-21.6	Pass	200	1.9	Vertical
96.000	25.9	43.5	-17.6	Pass	240	1.0	Vertical
72.090	21.0	40	-19.0	Pass	355	1.5	Vertical

Table 5.3.8.1 Electric Field Emissions Peaks IEEE 802.11g, 30MHz to 1GHz. 2442MHz Operation

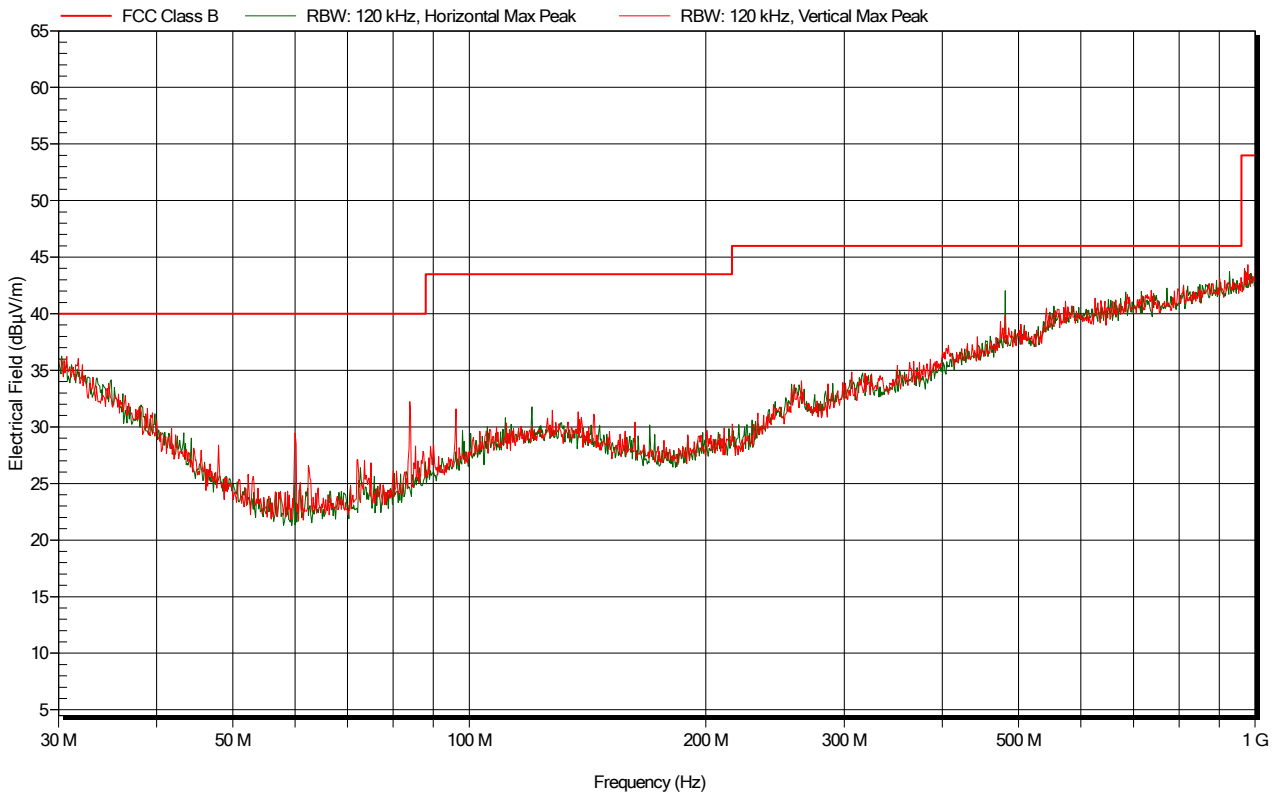


Figure 5.3.8.2: Electric field emissions Plot IEEE 802.11g, 30MHz to 1GHz, Operation on 2412MHz - Peak detector scan

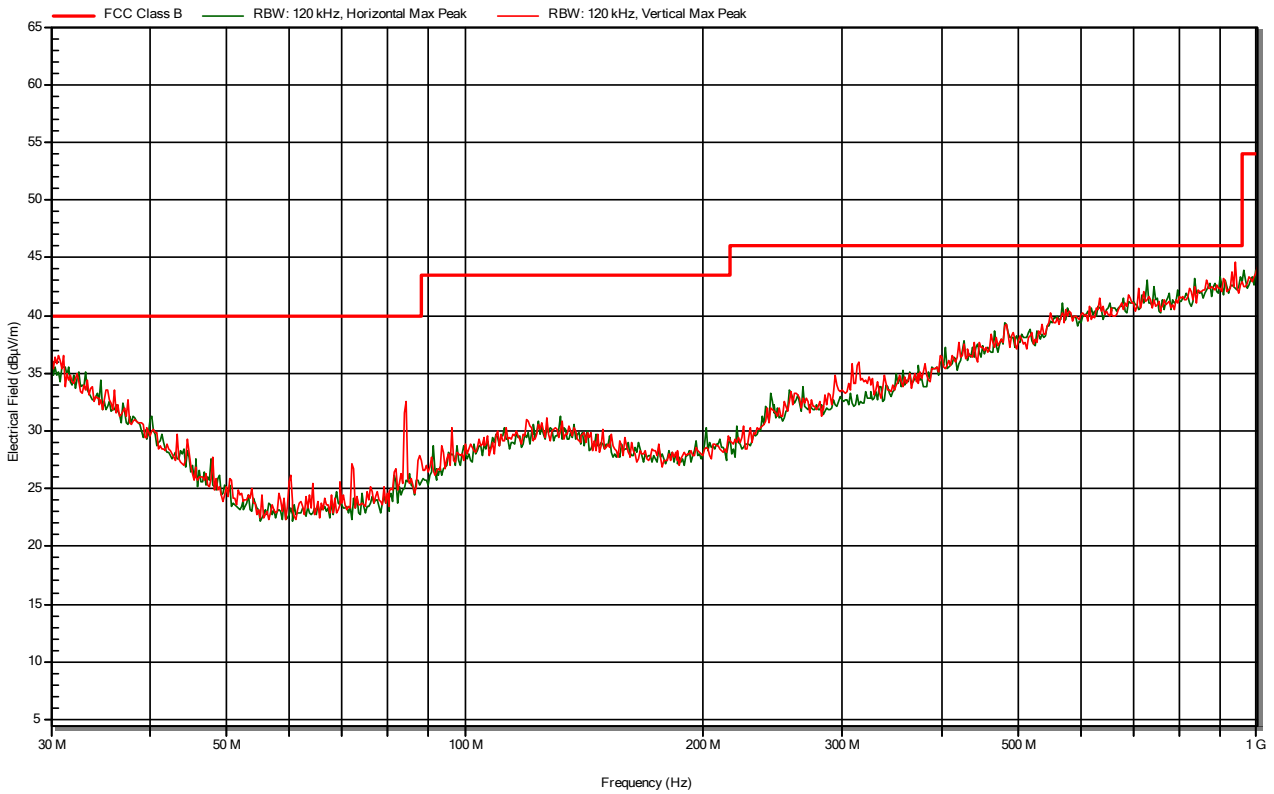


Figure 5.3.8.3: Electric field emissions Plot IEEE 802.11g, 30MHz to 1GHz, Operation on 2462MHz - Peak detector scan

5.3.9 Electric field emissions IEEE 802.11n, 30MHz to 1GHz

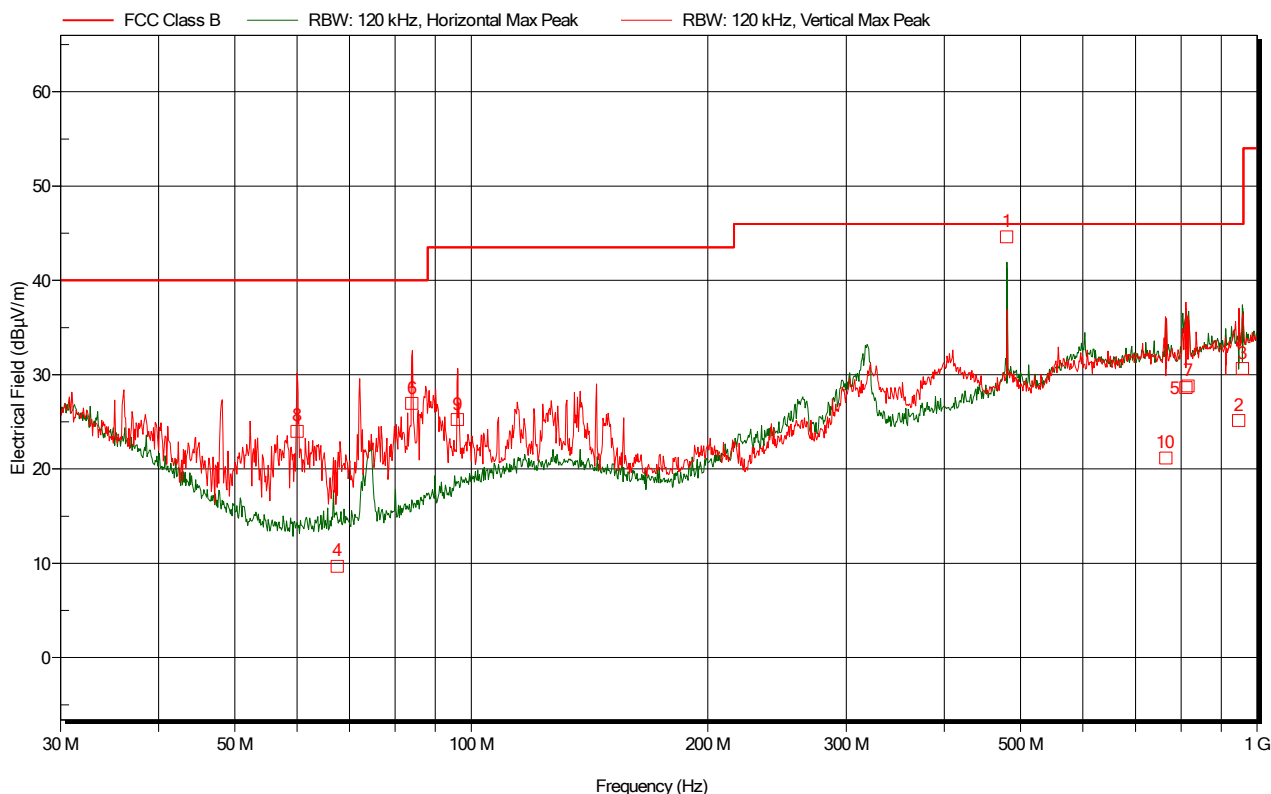


Figure 5.3.9.1: Electric field emissions Plot IEEE 802.11n, 30MHz to 1GHz, 2442MHz Operation

Frequency	Quasi-Peak	Quasi-Peak Limit	Quasi-Peak Difference	Quasi-Peak Status	Angle	Height	Polarization
MHz	dBµV/m	dBµV/m	dB		degrees	m	
480.072	44.6	46	-1.4	Pass	5	2.0	Horizontal
947.130	25.2	46	-20.8	Pass	50	2.1	Horizontal
957.414	30.7	46	-15.3	Pass	145	3.6	Horizontal
67.500	9.7	40	-30.3	Pass	250	1.6	Vertical
811.770	28.6	46	-17.4	Pass	235	3.6	Vertical
83.994	27.0	40	-13.0	Pass	120	1.0	Vertical
816.174	28.8	46	-17.2	Pass	360	2.6	Vertical
59.988	24	40	-16.0	Pass	50	1.0	Vertical
96.000	25.2	43.5	-18.3	Pass	90	1.0	Vertical
765.486	21.2	46	-24.8	Pass	225	1.4	Vertical

Table 5.3.9.1 Electric Field Emissions Peaks IEEE 802.11n, 30MHz to 1GHz. 2442MHz Operation

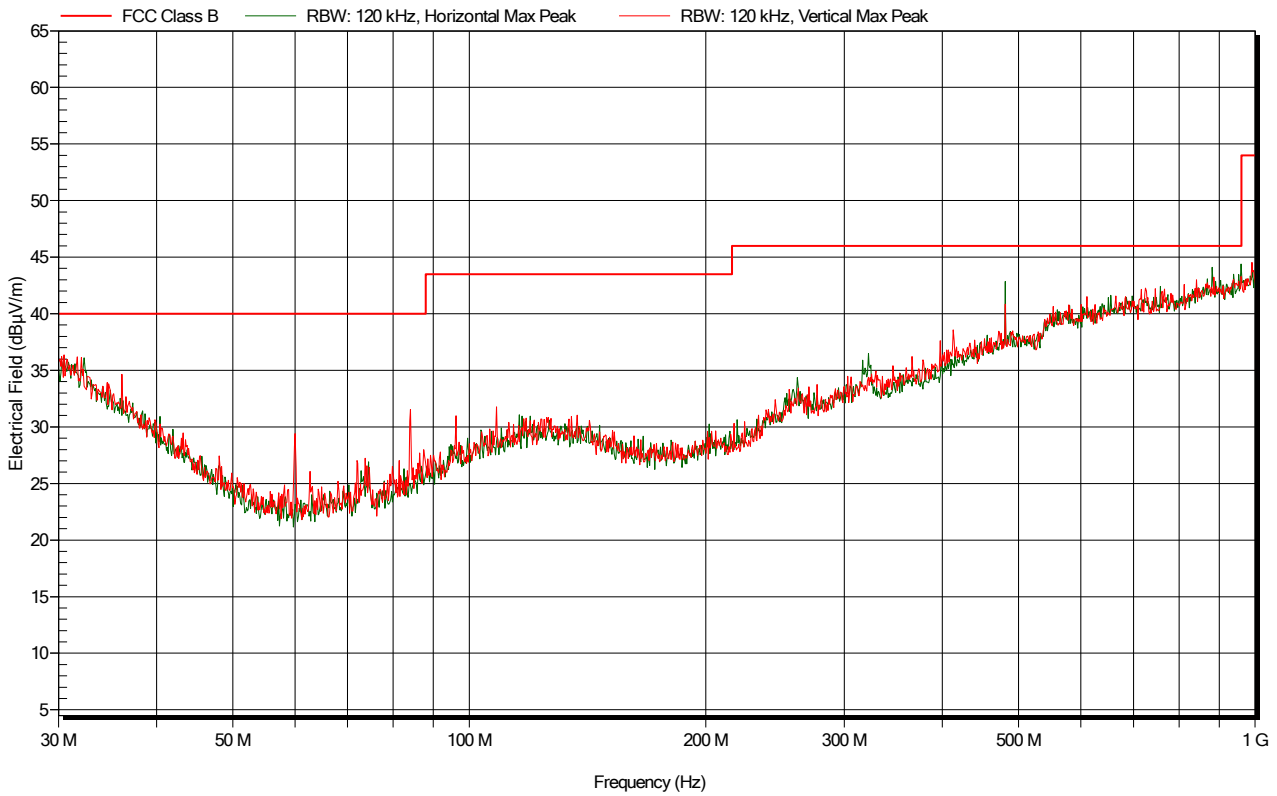


Figure 5.3.9.2: Electric field emissions Plot IEEE 802.11n, 30MHz to 1GHz, Operation on 2412MHz - Peak detector scan

Radiation

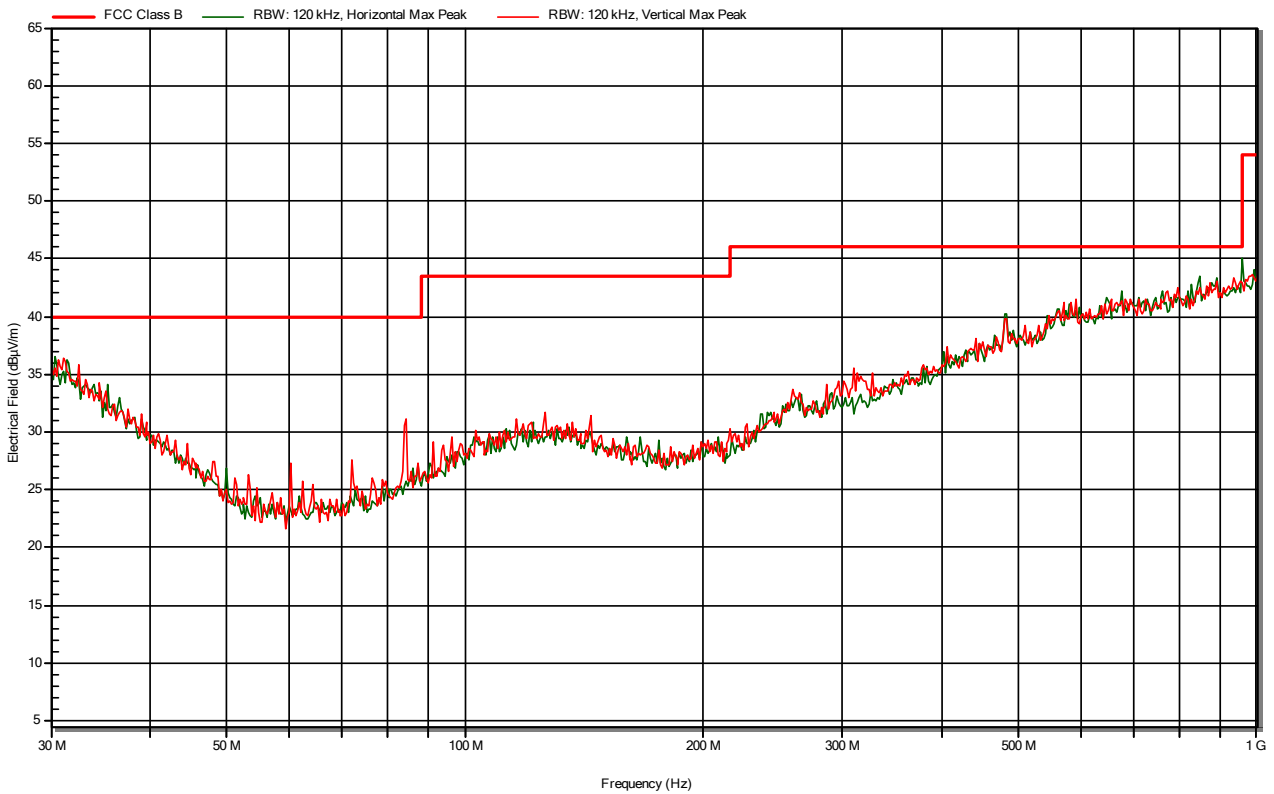


Figure 5.3.9.3: Electric field emissions Plot IEEE 802.11n, 30MHz to 1GHz, Operation on 2462MHz - Peak detector scan

### 5.3.10 Example field strength calculation

Field strength (FS) is calculated as follows:

$$\text{FS (dB}\mu\text{V/m)} = \text{Indicated Signal Level (dB}\mu\text{V)} + \text{AF (dB/m)} + \text{CL (dB)}$$

### 5.3.11 Sample Data

From Figure 5.3.9.1, table 5.3.9.1, the Quasi-Peak level at 765.486MHz is calculated as follows:

$$\text{FS (dB}\mu\text{V/m)} = -7.0(\text{dB}\mu\text{V}) + 25.6(\text{dB/m}) + 2.6 (\text{dB}) = 21.2 \text{ dB}\mu\text{V/m}$$

**5.4 Radiated Emissions (1GHz to 18GHz)****5.4.1 Limits**

Frequency (GHz)	Limit (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)
	Peak	Average
1-18	74.0	54.0

**5.4.2 Receiver Settings**

Receiver Parameters	Setting
Detector Function	Average and Peak
Start Frequency	1GHz
Stop Frequency	18GHz
Resolution Bandwidth	1MHz
Video Bandwidth	Auto

**5.4.3 Emissions measurements****5.4.4 Date of Test**22<sup>nd</sup> and 23<sup>rd</sup> February 2022**5.4.5 Test Area**

LAB 1 (SAC)

**5.4.6 Tested by**

M Dyster

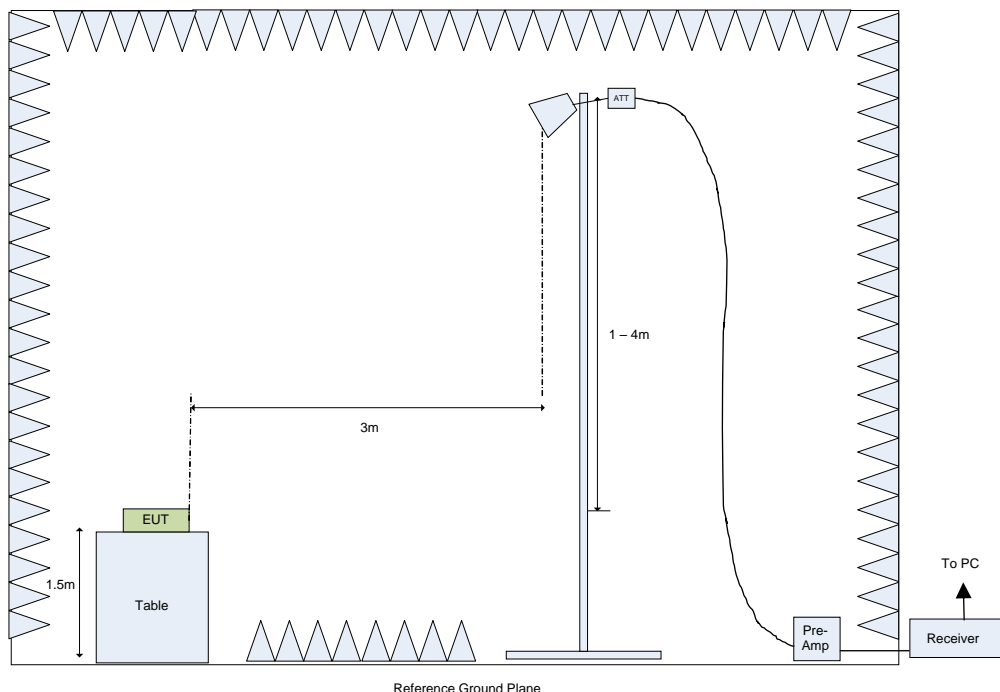
**5.4.7 Test Setup**

The EUT was configured in the SAC on an 1.5m high table. Exploratory measurements on the EUT were carried out to identify suspect frequencies and worst case orientations, see Section 5.4.8.

The measurement was then performed with an antenna to EUT separation distance of 3m.

The antenna was kept in the “cone of radiation” from the EUT and pointed at the area both in azimuth and elevation using the tilt mechanism on the antenna mast.

The results were maximised in orientation 0-360 degrees and height 1-4m.



**Figure 5.4.7.1: Test Setup for Final E-Field Measurements from 1GHz to 18GHz**

- Note 1 : With the EUT de-energized the ambient radio noise and signals met the 6dB peak detection requirement of ANSI C63.4-2010.
- Note 2 : There were no significant environmental temperature changes during the test duration and hence it was not considered necessary to consider any variation in cable loss.
- Note 3: For final measurements, between 10GHz and 18GHz the measurements were repeated with a measurement distance of 1m in order to reduce the measurement noise floor in this frequency range.
- Note 4: On all swept and final measurements made between 1GHz and 18GHz a 2.4GHz Microtronics BRM50702 notch filter was placed in the measurement chain between the antenna and pre-amplifier in order to prevent the artificial generation of harmonics within the pre-amplifier.



#### 5.4.8 Exploratory Radiated Emission Maximization

During exploratory testing, suspect emissions from the EUT were identified both in terms of the frequency and directionality. This was achieved by manually positioning the antenna close to the EUT and also by scanning it over all sides of the EUT whilst observing a spectral display. The typical distance between the surface of the EUT and the scanning antenna was circa 30cm.

Frequency (GHz)	Mode of operation	EUT face *	Emissions Angle (w.r.t. turntable)	Height	Polarization
3.624	Transmitting on channel 2412MHz, IEEE 802.11b, g, n	front face	0	1.5	V
1.025	Transmitting on channel 2412MHz, IEEE 802.11b, g, n	front face	0	1.5	V
1.008	Transmitting on channel 2412MHz, IEEE 802.11b, g, n	front face	0	1.5	V
4.864	Transmitting on channel 2412MHz, IEEE 802.11b, g, n	front face	0	1.5	V
3.658	Transmitting on channel 2442MHz, IEEE 802.11b, g, n	front face	0	1.5	V
4.881	Transmitting on channel 2442MHz, IEEE 802.11b, g, n	front face	0	1.5	V
3.699	Transmitting on channel 2462MHz, IEEE 802.11b, g, n	front face	0	1.5	V
4.929	Transmitting on channel 2462MHz, IEEE 802.11b, g, n	front face	0	1.5	V

#### Frequencies identified during Exploratory Radiated Emission maximization

Note 1 : The front face of the EUT is deemed to be 0°, which is then turned in a clockwise direction through 360°.

5.4.9 Electric field emissions IEEE 802.11b, 1GHz to 18GHz

The equipment under test was pre-scanned using peak detection when operating on all three channels. Final measurements were performed with the equipment under test operating on 2442MHz

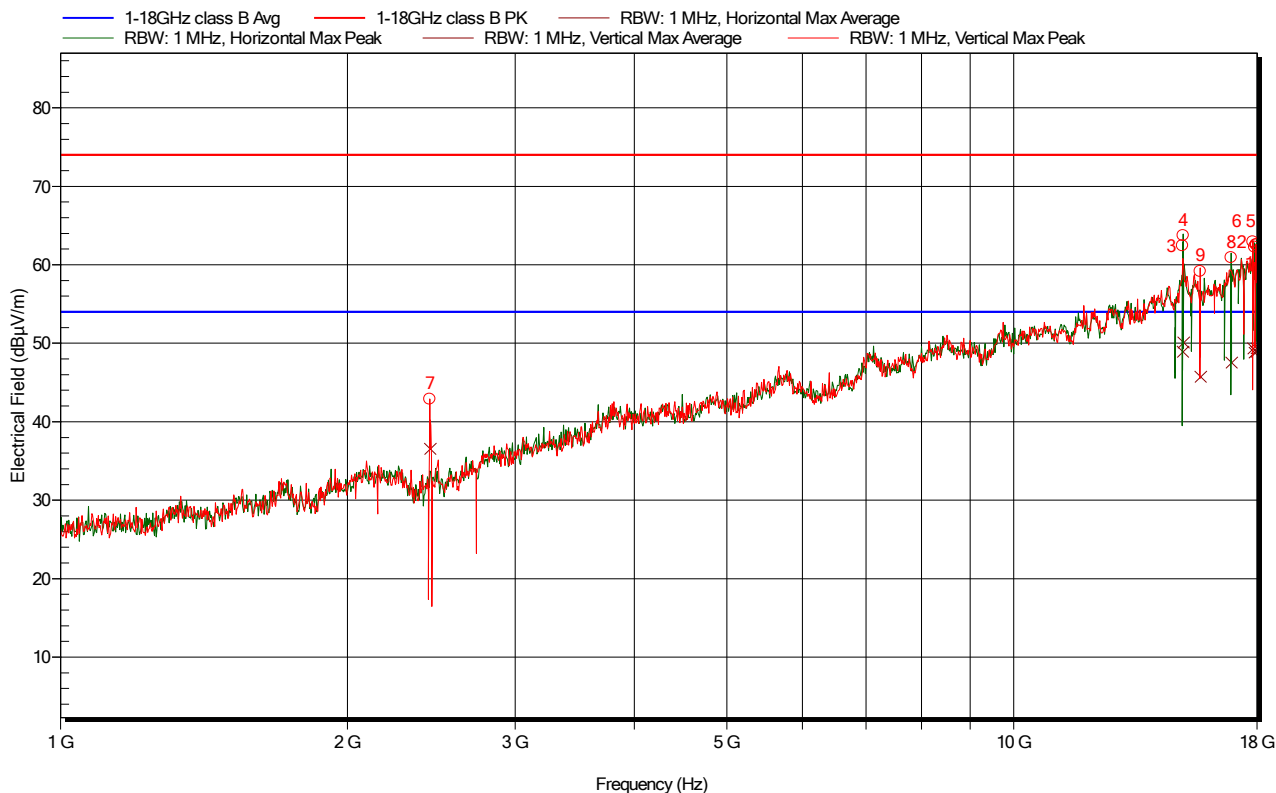


Figure 5.4.9.1: Electric field emissions Plot IEEE 802.11b, 1GHz to 18GHz. Operation on 2442MHz

Frequency	Average	Average Limit	Average Difference	Average Status	Angle	Height	Polarization
GHz	dBµV/m	dBµV/m	dB		degrees	m	
17.885	48.79	54	-5.21	Pass	145	1.6	Horizontal
17.810	49.37	54	-4.63	Pass	195	1.2	Vertical
15.026	48.97	54	-5.03	Pass	235	2.2	Horizontal
15.051	50.15	54	-3.85	Pass	270	1.4	Horizontal
17.985	49.34	54	-4.66	Pass	295	1.8	Horizontal
17.950	48.99	54	-5.01	Pass	335	2.3	Vertical
2.441	36.61	54	-17.39	Pass	310	1.4	Vertical
16.905	47.61	54	-6.39	Pass	200	4.0	Horizontal
15.680	45.78	54	-8.22	Pass	155	3.4	Vertical

Table 5.4.9.1 Electric Field Emissions Peaks IEEE 802.11b, 1GHz to 18GHz – Operation on 2442MHz

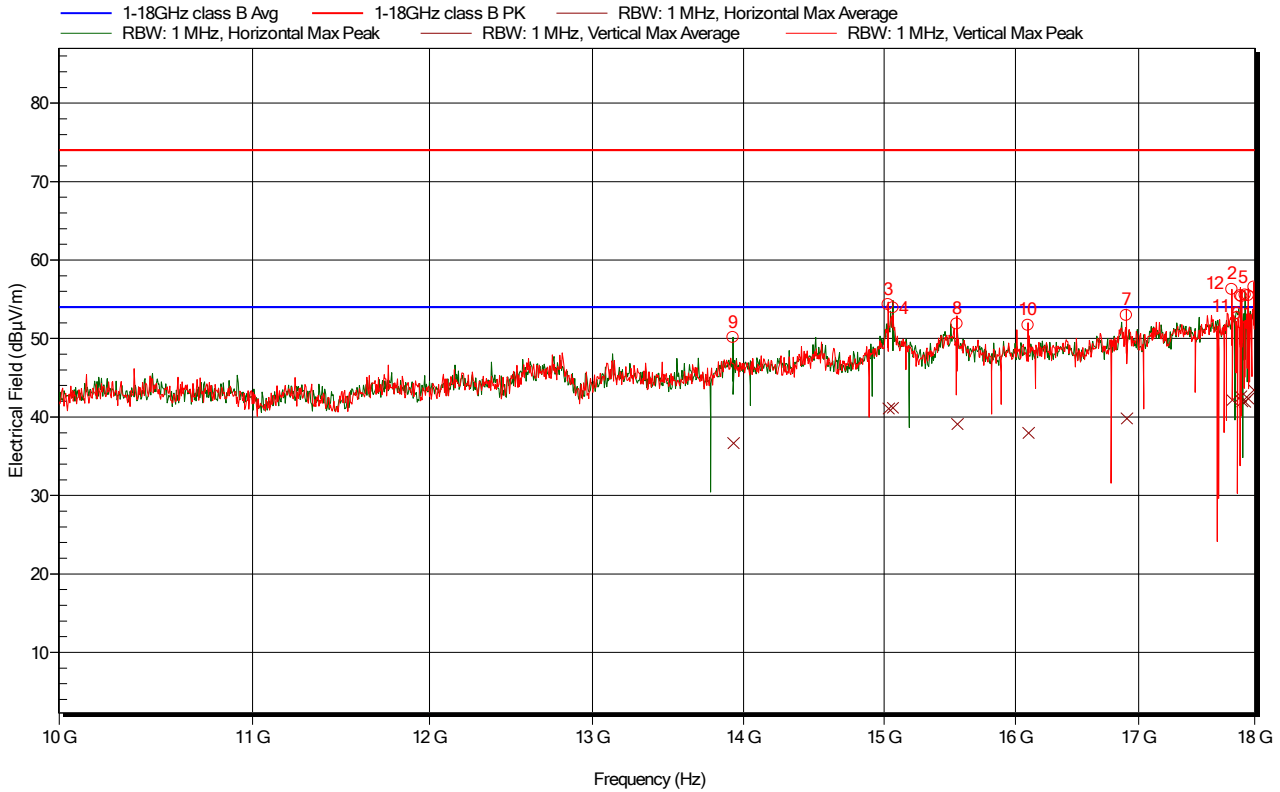


Figure 5.4.9.2: Electric field emissions Plot IEEE 802.11b, 10GHz to 18GHz. 1m measurement distance. Operation on 2442MHz

Frequency	Average	Average Limit	Average Difference	Average Status	Angle	Height	Polarization
GHz	dBµV/m	dBµV/m	dB		degrees	m	
17.881	42.05	54	-11.95	Pass	130	3.1	Vertical
17.796	42.22	54	-11.78	Pass	70	3.1	Vertical
15.030	41.13	54	-12.87	Pass	110	3.8	Vertical
15.065	41.17	54	-12.83	Pass	5	3.9	Horizontal
17.991	43.41	54	-10.59	Pass	185	4.0	Vertical
17.937	42.35	54	-11.65	Pass	300	2.3	Vertical
16.898	39.86	54	-14.14	Pass	100	1.0	Vertical
15.547	39.17	54	-14.83	Pass	335	1.7	Vertical
13.929	36.71	54	-17.29	Pass	250	3.4	Horizontal
16.101	38.02	54	-15.98	Pass	25	1.2	Vertical
17.870	42.67	54	-11.33	Pass	25	3.8	Vertical
17.912	41.94	54	-12.06	Pass	145	2.4	Horizontal

Table 5.4.9.2 Electric Field Emissions Peaks IEEE 802.11b, 10GHz to 18GHz. 1m measurement distance – Operation on 2442MHz

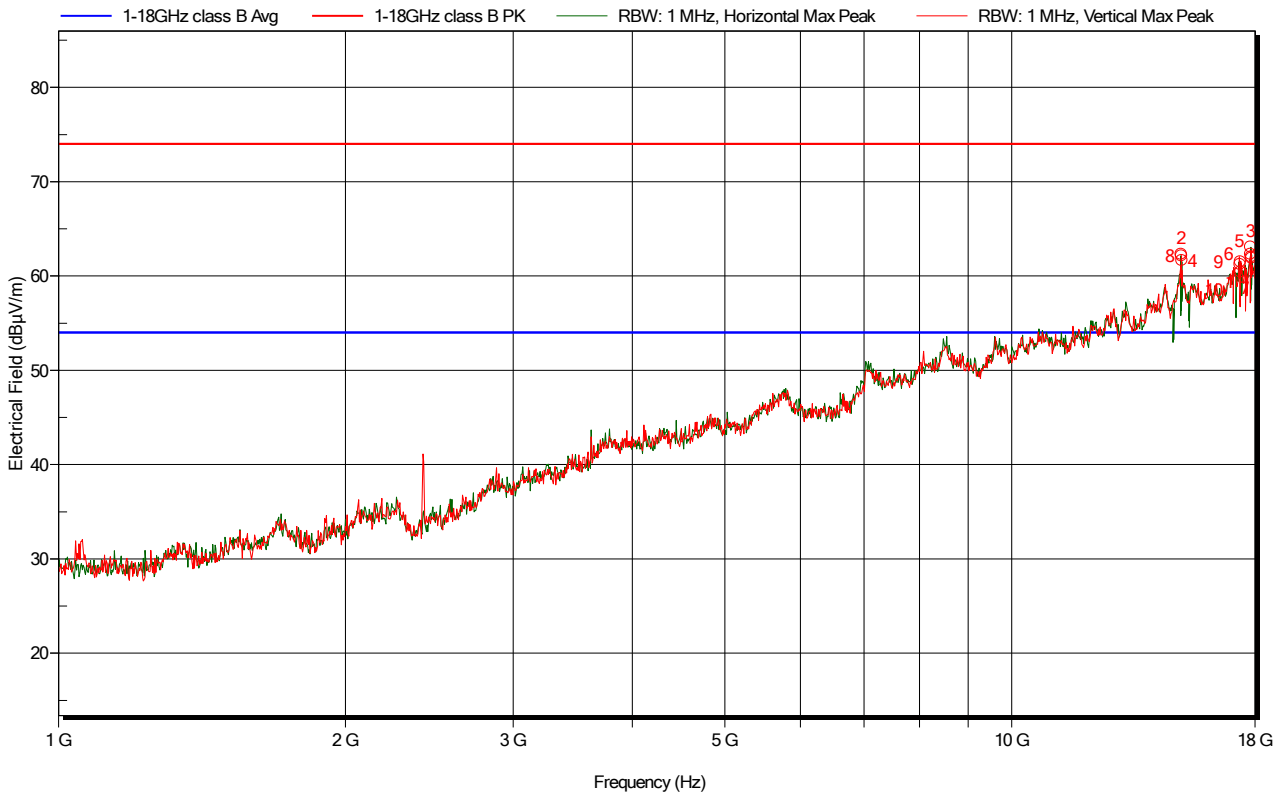


Figure 5.4.9.3: Electric field emissions Plot IEEE 802.11b, 1GHz to 18GHz, Operation on 2412MHz - Peak detector scan

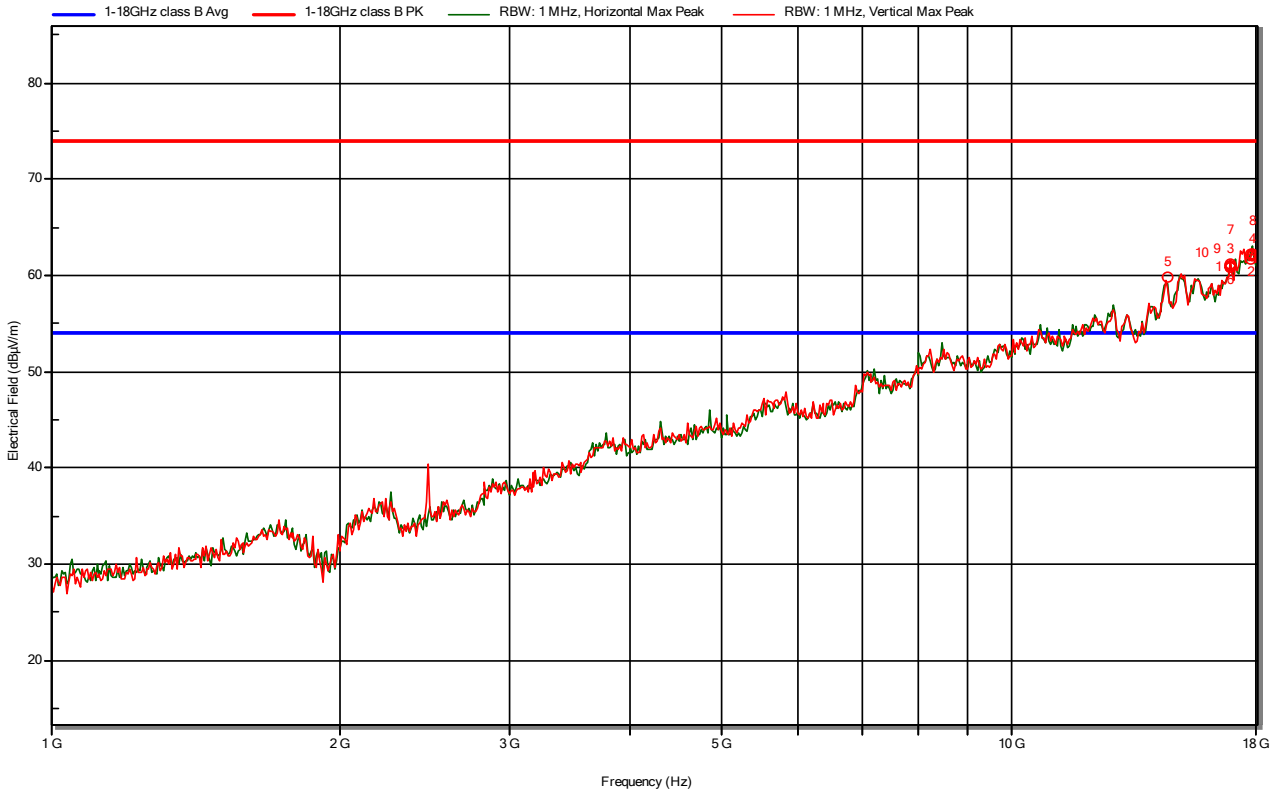


Figure 5.4.9.4: Electric field emissions Plot IEEE 802.11b, 1GHz to 18GHz, Operation on 2462MHz – Peak detector scan

5.4.10 Electric field emissions IEEE 802.11g, 1GHz to 18GHz

The equipment under test was pre-scanned using peak detection when operating on all three channels. Final measurements were performed with the equipment under test operating on 2442MHz

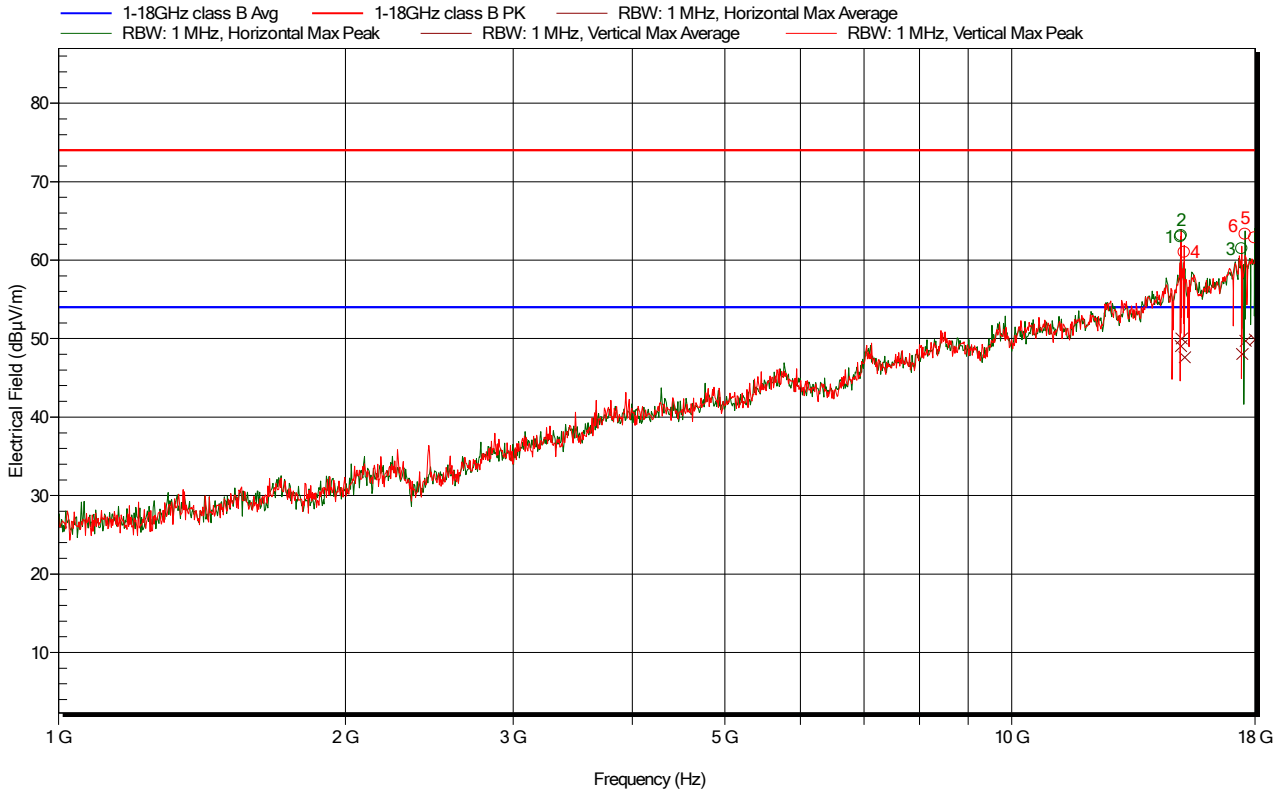


Figure 5.4.10.1: Electric field emissions Plot IEEE 802.11g, 1GHz to 18GHz. Operation on 2442MHz

Frequency	Average	Average Limit	Average Difference	Average Status	Angle	Height	Polarization
GHz	dBµV/m	dBµV/m	dB		degrees	m	
15.033	49.10	54	-4.90	Pass	345	2.8	Vertical
15.049	50.08	54	-3.92	Pass	45	3.8	Vertical
17.423	48.10	54	-5.90	Pass	255	1.3	Vertical
15.161	47.65	54	-6.35	Pass	300	1.5	Vertical
17.572	49.78	54	-4.22	Pass	300	1.8	Horizontal
17.975	49.94	54	-4.06	Pass	265	1.5	Horizontal

Table 5.4.10.1 Electric Field Emissions Peaks IEEE 802.11g, 1GHz to 18GHz – Operation on 2442MHz

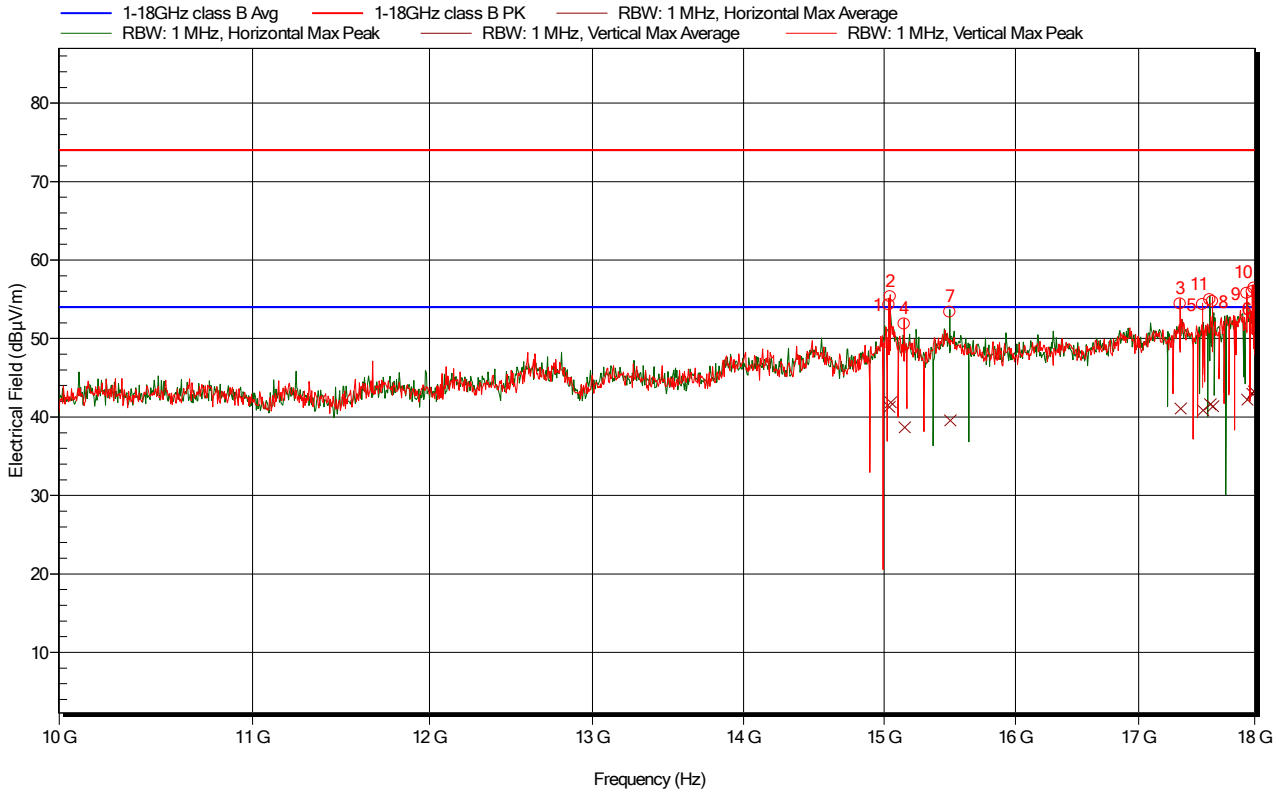


Figure 5.4.10.2: Electric field emissions Plot IEEE 802.11g, 10GHz to 18GHz. 1m measurement distance. Operation on 2442MHz

Frequency	Average	Average Limit	Average Difference	Average Status	Angle	Height	Polarization
GHz	dBµV/m	dBµV/m	dB		degrees	m	
15.036	41.33	54	-12.67	Pass	240	1.3	Vertical
15.046	41.93	54	-12.07	Pass	120	3.9	Vertical
17.349	41.11	54	-12.89	Pass	25	2.8	Vertical
15.150	38.73	54	-15.27	Pass	215	2.1	Vertical
17.540	40.90	54	-13.10	Pass	290	1.8	Vertical
17.975	42.96	54	-11.04	Pass	250	3.3	Vertical
15.493	39.61	54	-14.39	Pass	225	3.1	Horizontal
17.626	41.41	54	-12.59	Pass	165	3.0	Vertical
17.927	42.27	54	-11.73	Pass	295	3.4	Vertical
17.988	43.25	54	-10.75	Pass	10	1.6	Vertical
17.602	41.69	54	-12.31	Pass	255	3.0	Horizontal

Table 5.4.10.2 Electric Field Emissions Peaks IEEE 802.11g, 10GHz to 18GHz. 1m measurement distance – Operation on 2442MHz

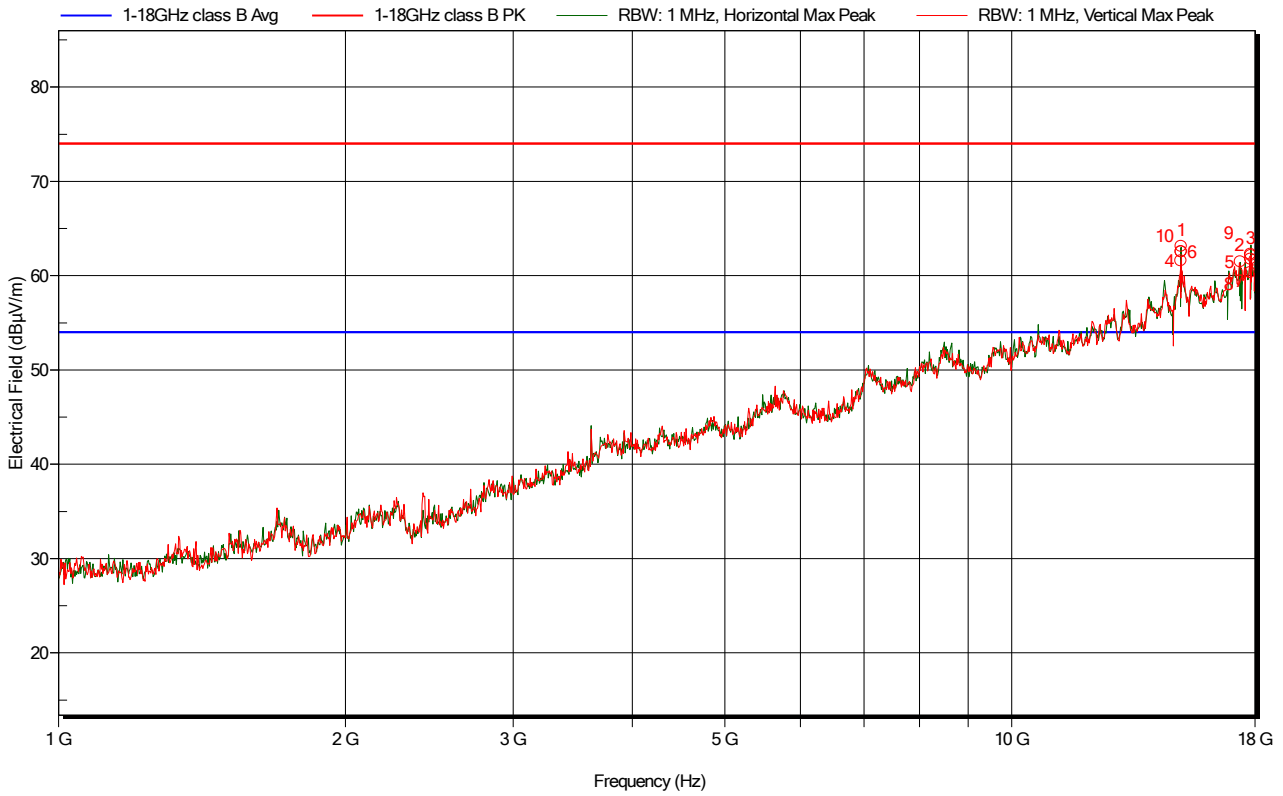


Figure 5.4.10.3: Electric field emissions Plot IEEE 802.11g, 1GHz to 18GHz, Operation on 2412MHz - Peak detector scan



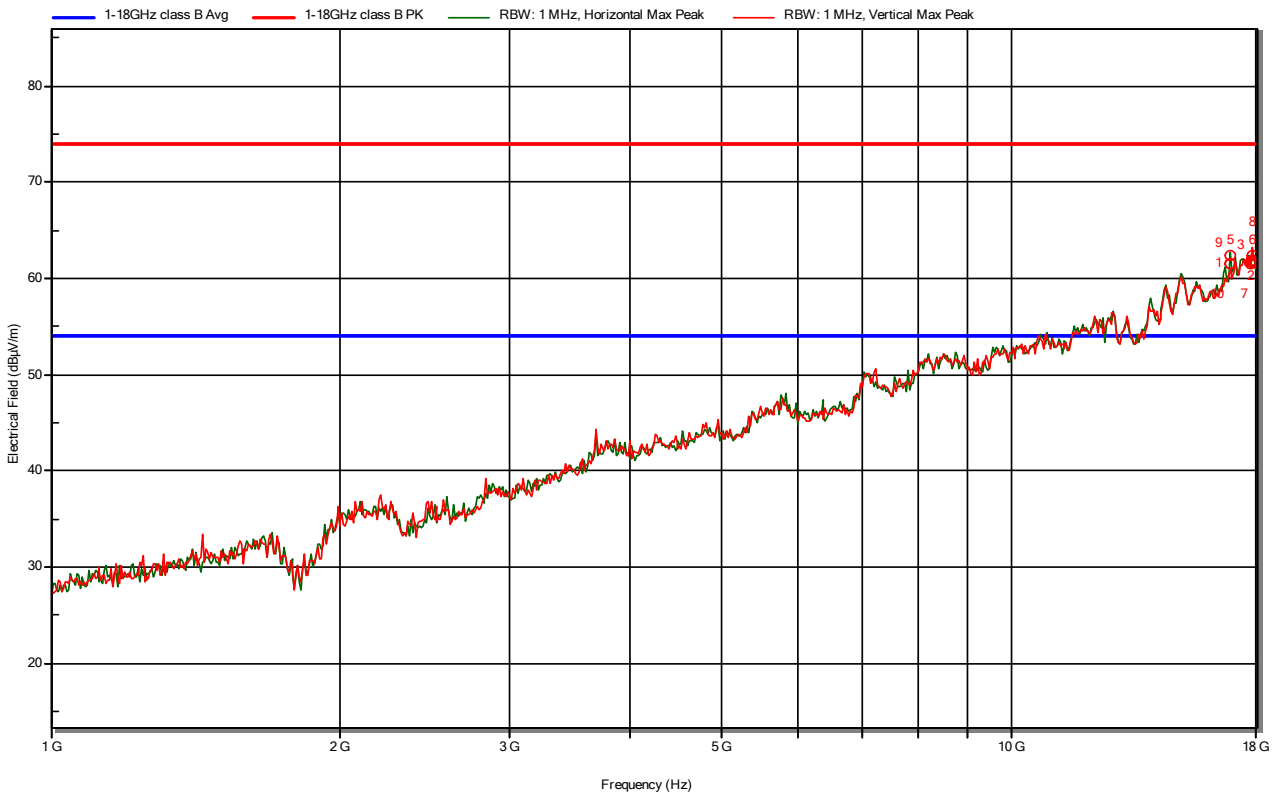


Figure 5.4.10.4: Electric field emissions Plot IEEE 802.11g, 1GHz to 18GHz, Operation on 2462MHz – Peak detector scan

5.4.11 Electric field emissions IEEE 802.11n, 1GHz to 18GHz

The equipment under test was pre-scanned using peak detection when operating on all three channels. Final measurements were performed with the equipment under test operating on 2442MHz

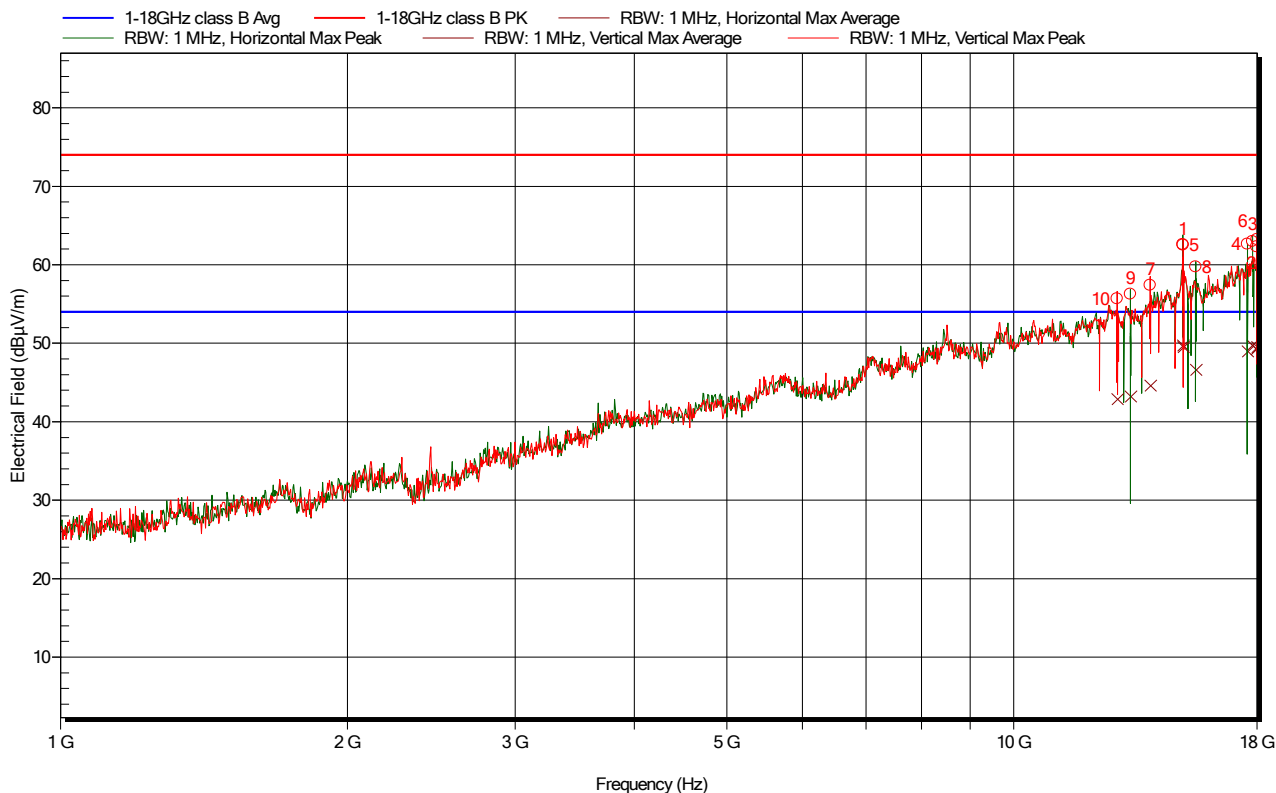


Figure 5.4.11.1: Electric field emissions Plot IEEE 802.11n, 1GHz to 18GHz. Operation on 2442MHz

Frequency	Average	Average Limit	Average Difference	Average Status	Angle	Height	Polarization
GHz	dBµV/m	dBµV/m	dB		degrees	m	
15.046	49.75	54	-4.25	Pass	25	3.3	Horizontal
17.985	49.22	54	-4.78	Pass	55	2.8	Horizontal
17.805	49.73	54	-4.27	Pass	215	3.5	Horizontal
17.580	49.03	54	-4.97	Pass	230	2.2	Horizontal
15.059	49.55	54	-4.45	Pass	210	3.9	Vertical
17.994	49.56	54	-4.44	Pass	345	1.1	Vertical
13.902	44.64	54	-9.36	Pass	225	1.6	Vertical
15.514	46.67	54	-7.33	Pass	210	2.0	Horizontal
13.256	43.25	54	-10.75	Pass	250	1.3	Horizontal
12.837	42.92	54	-11.08	Pass	60	2.7	Vertical

Table 5.4.11.1 Electric Field Emissions Peaks IEEE 802.11n, 1GHz to 18GHz – Operation on 2442MHz

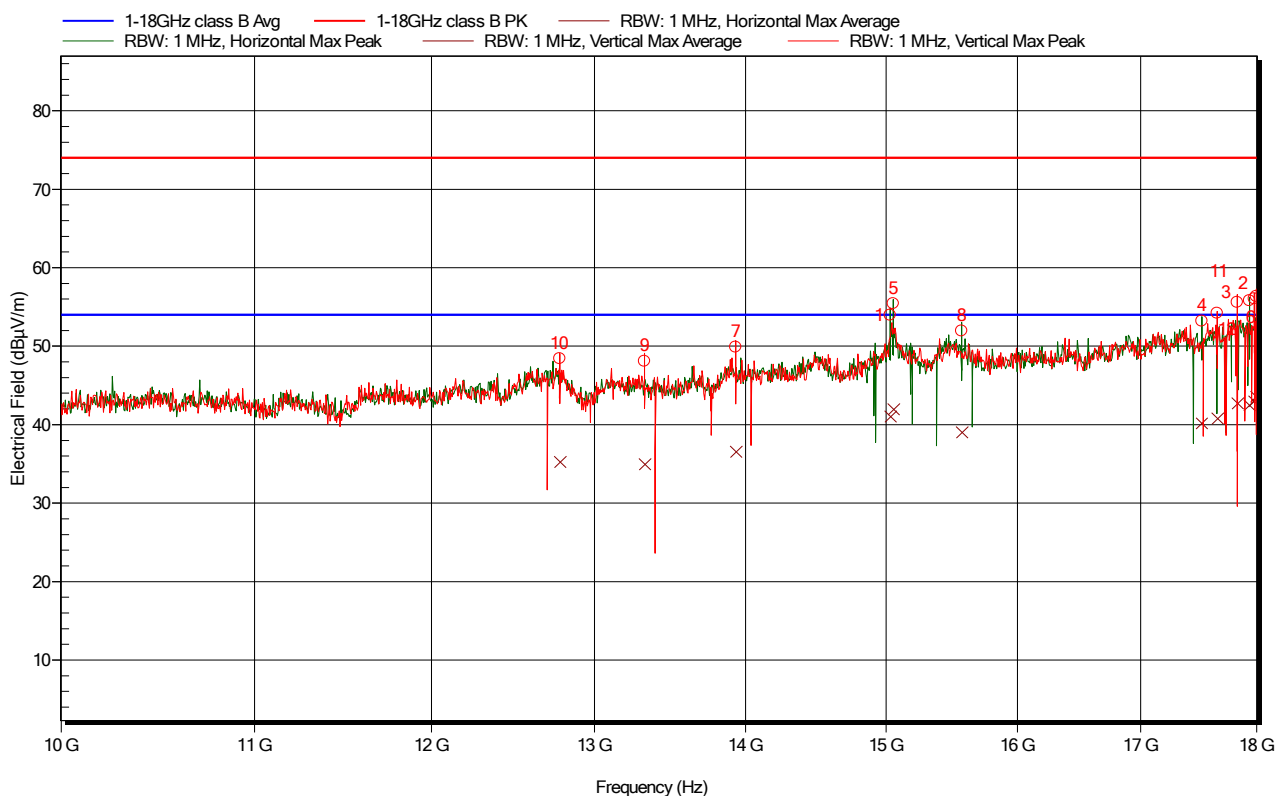


Figure 5.4.11.2: Electric field emissions Plot IEEE 802.11n, 10GHz to 18GHz. 1m measurement distance. Operation on 2442MHz

Frequency	Average	Average Limit	Average Difference	Average Status	Angle	Height	Polarization
GHz	dBµV/m	dBµV/m	dB		degrees	m	
15.031	41.10	54	-12.90	Pass	265	3.4	Horizontal
17.973	42.99	54	-11.01	Pass	15	1.6	Vertical
17.826	42.75	54	-11.25	Pass	140	2.3	Vertical
17.519	40.17	54	-13.83	Pass	315	2.8	Horizontal
15.053	42.02	54	-11.98	Pass	75	2.6	Horizontal
17.994	43.55	54	-10.45	Pass	130	3.8	Vertical
13.934	36.59	54	-17.41	Pass	70	2.7	Vertical
15.567	39.05	54	-14.95	Pass	165	2.1	Horizontal
13.322	35.01	54	-18.99	Pass	170	2.3	Vertical
12.779	35.30	54	-18.70	Pass	170	2.7	Vertical
17.933	42.48	54	-11.52	Pass	355	1.7	Horizontal
17.650	40.84	54	-13.16	Pass	145	3.5	Vertical

Table 5.4.11.2 Electric Field Emissions Peaks IEEE 802.11n, 10GHz to 18GHz. 1m measurement distance – Operation on 2442MHz

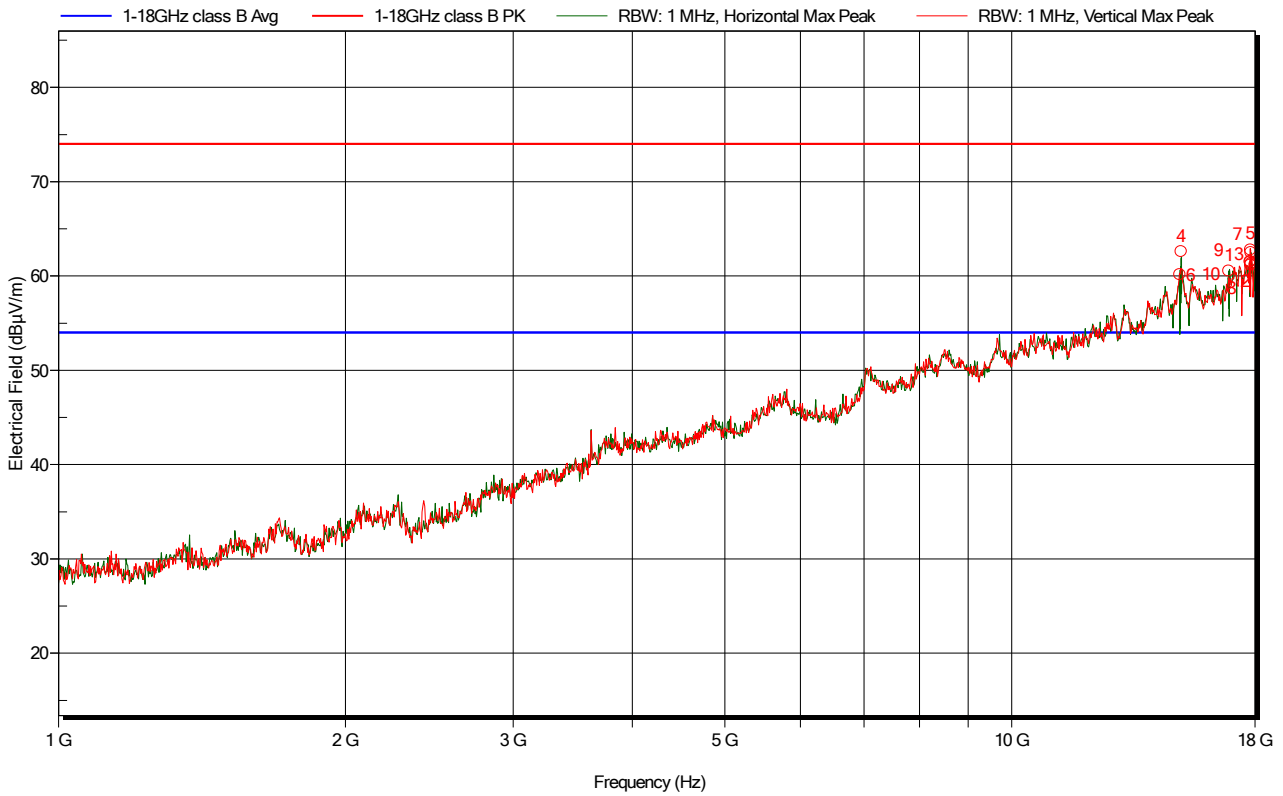


Figure 5.4.11.3: Electric field emissions Plot IEEE 802.11n, 1GHz to 18GHz, Operation on 2412MHz - Peak detector scan

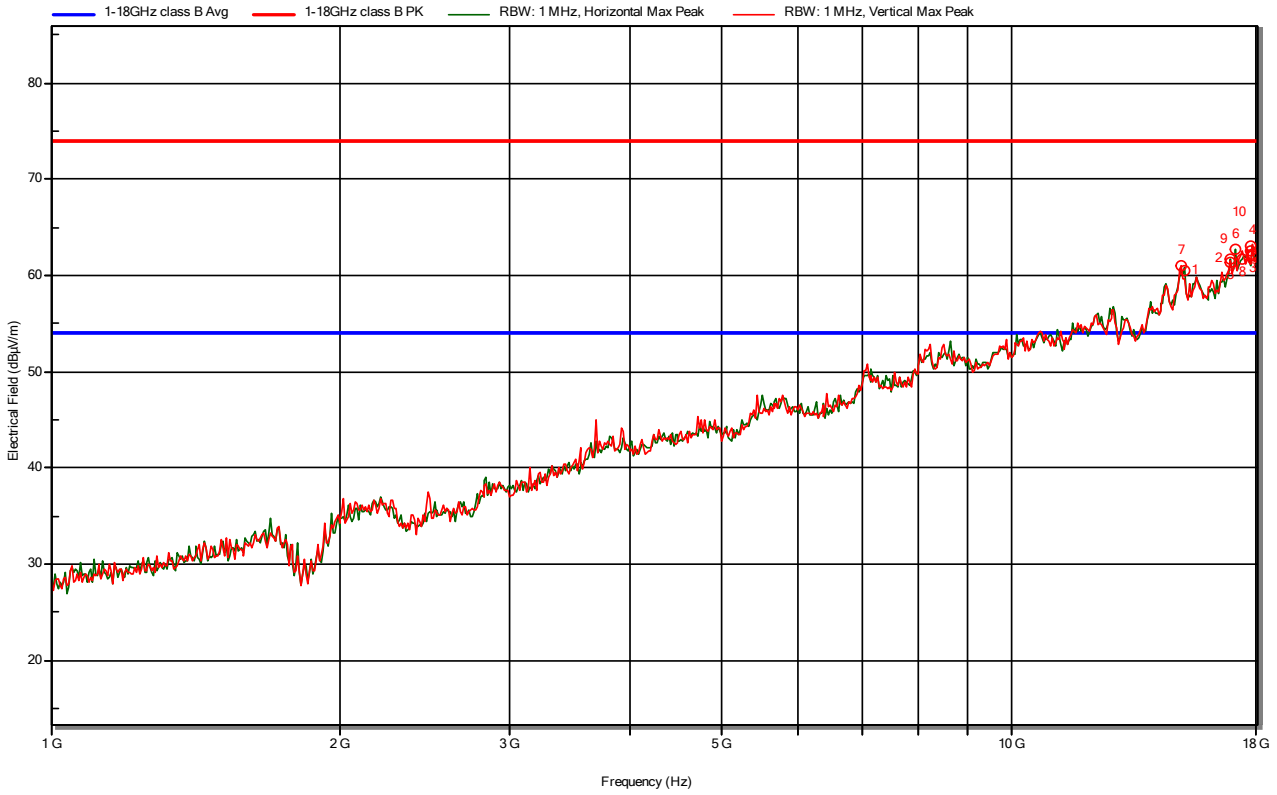


Figure 5.4.11.4: Electric field emissions Plot IEEE 802.11n, 1GHz to 18GHz, Operation on 2462MHz – Peak detector scan

#### 5.4.12 Example field strength calculation

The total average corrections are shown in the above table. This correction figure consists of Preamplifier gain (PG), Antenna factor (AF); and Cable loss (CL), and where necessary distance extrapolation factor (dB).

Field strength (FS) is calculated as follows:

$$\text{FS (dB}\mu\text{V/m)} = \text{Indicated Signal Level (dB}\mu\text{V)} + \text{extrap(dB)} - \text{PG (dB)} + \text{AF (dB)} + \text{CL (dB)}$$

#### 5.4.13 Sample Data

From Figure 5.4.11.2 and table 5.4.11.2, The Average level at 17.650GHz is calculated as follows:

$$\text{FS (dB}\mu\text{V/m)} = 40.0(\text{dB}\mu\text{V}) - 9.5(\text{dB}) - 49.73(\text{dB}) + 47.29(\text{dB/m}) + 12.78 (\text{dB}) = 40.84\text{B}\mu\text{V/m}$$

Between 10GHz and 18GHz the final measurement was made at 1m distance. The data was then extrapolated to the value expected at 3.

The extrapolation value was calculated as:

$$\begin{aligned} &= -20\log_{10}(\text{measurement distance (1m)} / \text{specification distance (3m)}) \\ &= 20\log_{10}(1/3) = -9.5\text{dB} \end{aligned}$$

**5.5 Radiated Emissions (18GHz to 26GHz)****5.5.1 Limits**

Frequency (GHz)	Limit (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)
	Peak	Average
18-26	74.0	54.0

**5.5.2 Receiver Settings**

Receiver Parameters	Setting
Detector Function	Average and Peak
Start Frequency	18GHz
Stop Frequency	26GHz
Resolution Bandwidth	1MHz
Video Bandwidth	Auto

**5.5.3 Emissions measurements****5.5.4 Date of Test**18<sup>th</sup> February 2022**5.5.5 Test Area**

LAB 1 (SAC)

**5.5.6 Tested by**

M Dyster

**5.5.7 Test Setup**

This is the same as for the 1-18GHz range for final measurements, except with a measurement distance of 1m.

### 5.5.8 Exploratory Radiated Emission Maximization

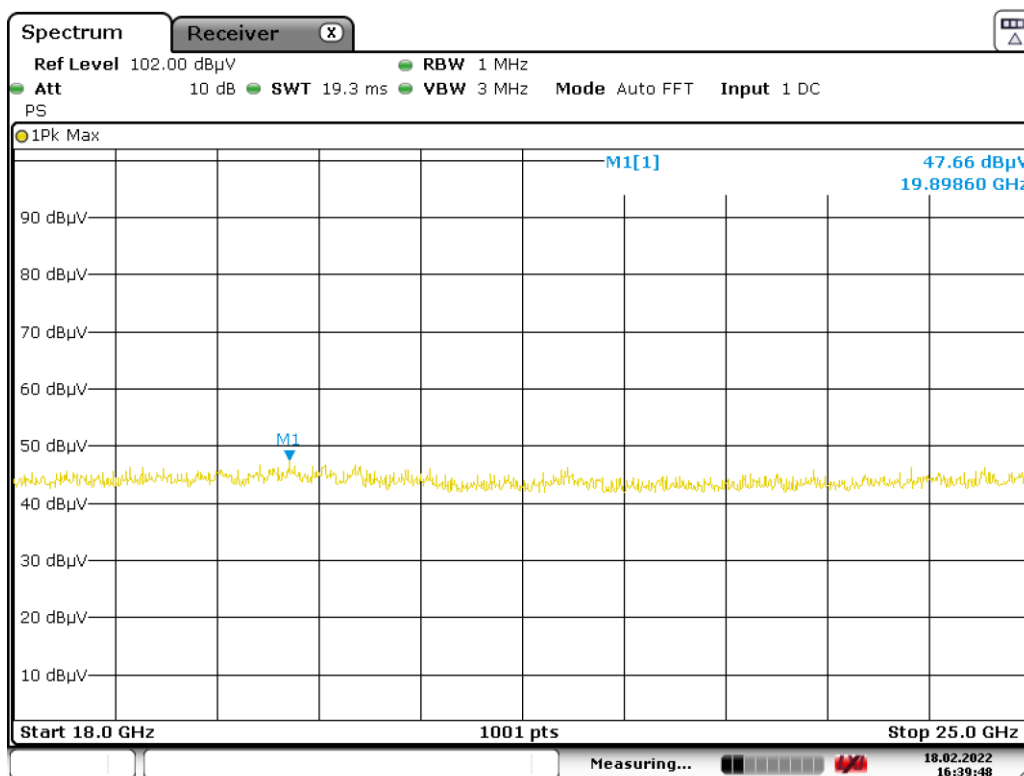
During exploratory testing, suspect emissions from the EUT were identified both in terms of the frequency and directionality. This was achieved by manually positioning the antenna close to the EUT and also by scanning it over all sides of the EUT whilst observing a spectral display. The typical distance between the surface of the EUT and the scanning antenna was circa 30cm.

Frequency (GHz)	Mode of operation	EUT face *	Emissions Angle (w.r.t. turntable)	Height	Polarization
-	Tx on channels 2412MHz, 2442MHz and 2462MHz.	-	-	-	-

**Table 4: Frequencies identified during Exploratory Radiated Emission maximization**

Note 2 : The front face of the EUT is deemed to be 0°, which is then turned in a clockwise direction through 360°.

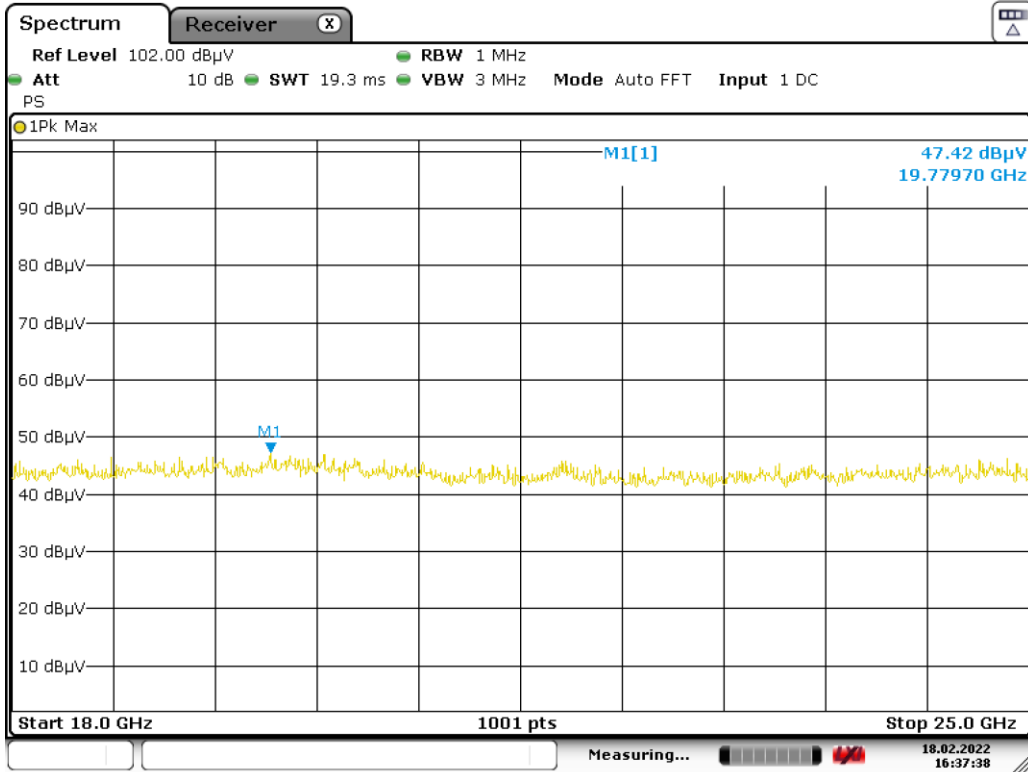
No emissions were identified for further investigation above 18GHz.



Date: 18.FEB.2022 16:39:48

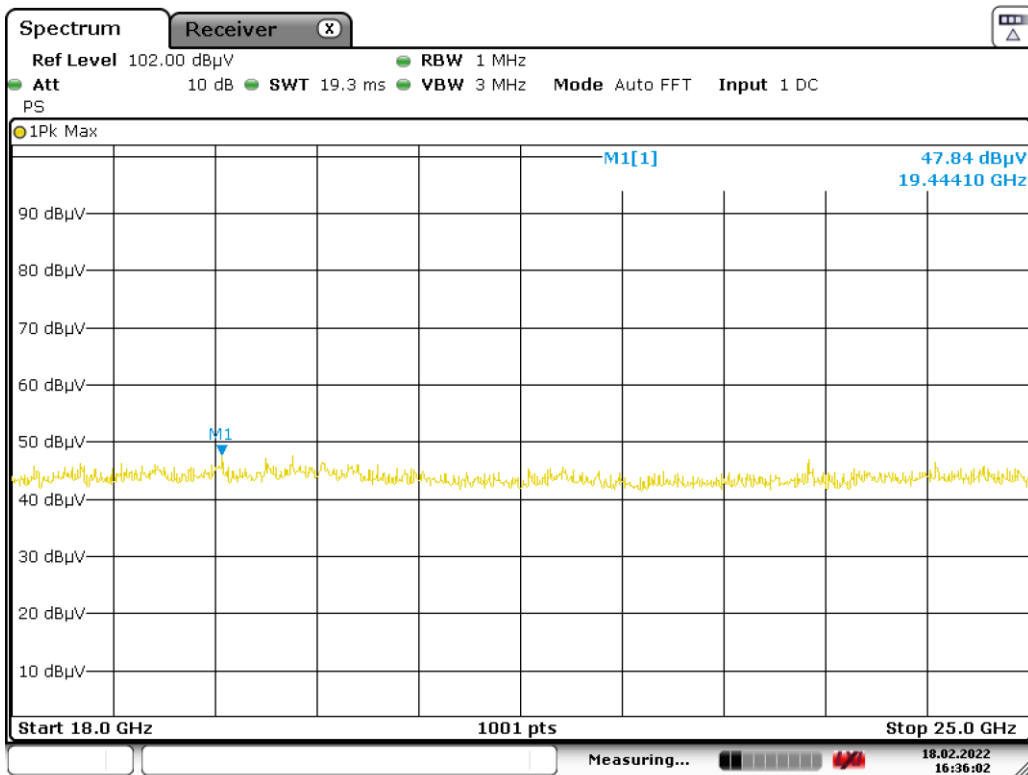
Figure 5.5.8.1 – manual investigation – Operating on IEEE 802.11b channel 2412MHz





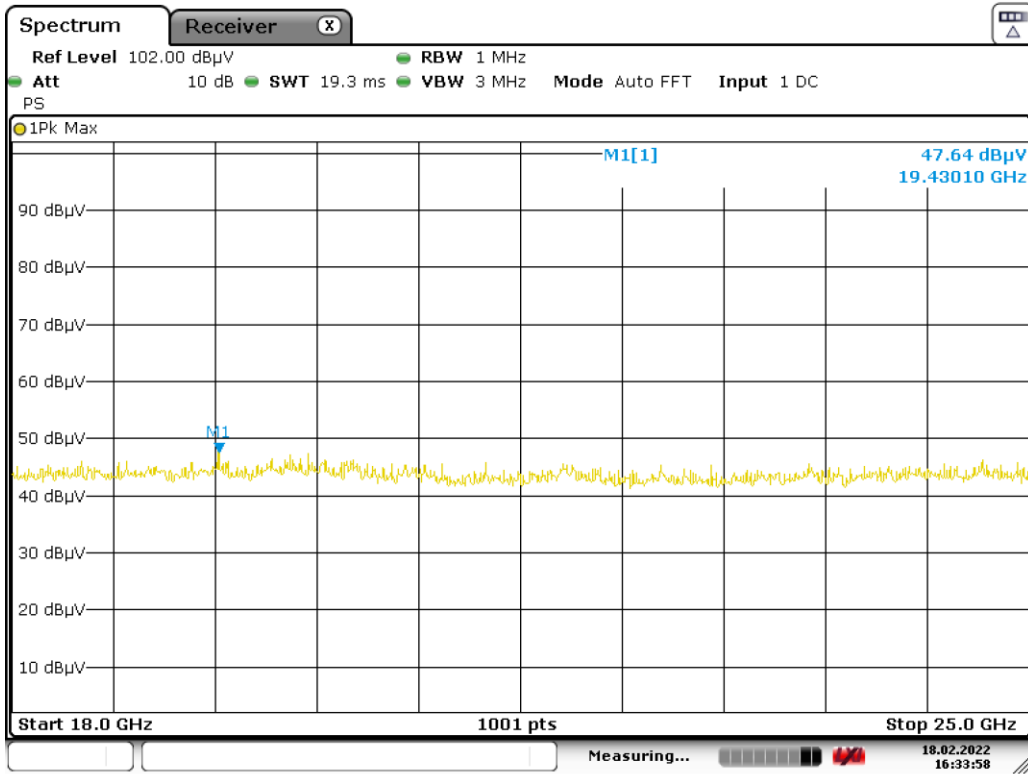
Date: 18.FEB.2022 16:37:39

Figure 5.5.8.2 – manual investigation – Operating on IEEE 802.11b channel 2442MHz



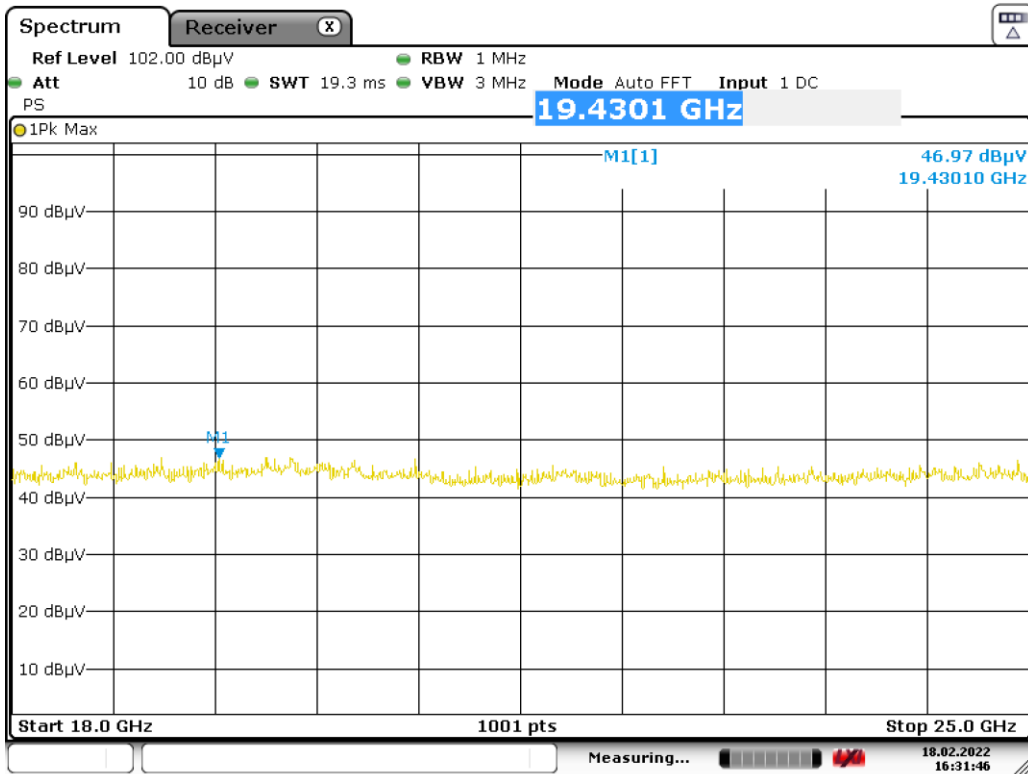
Date: 18.FEB.2022 16:36:02

Figure 5.5.8.3 – manual investigation – Operating on IEEE 802.11b channel 2462MHz



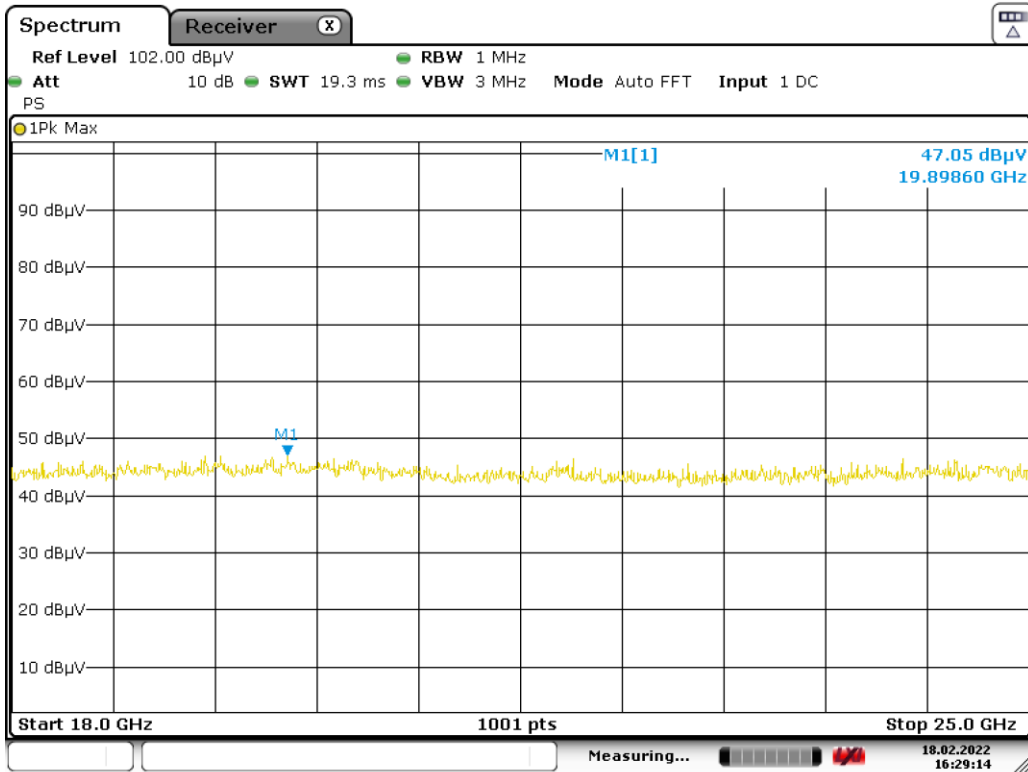
Date: 18.FEB.2022 16:33:59

Figure 5.5.8.4 – manual investigation – Operating on IEEE 802.11g channel 2412MHz



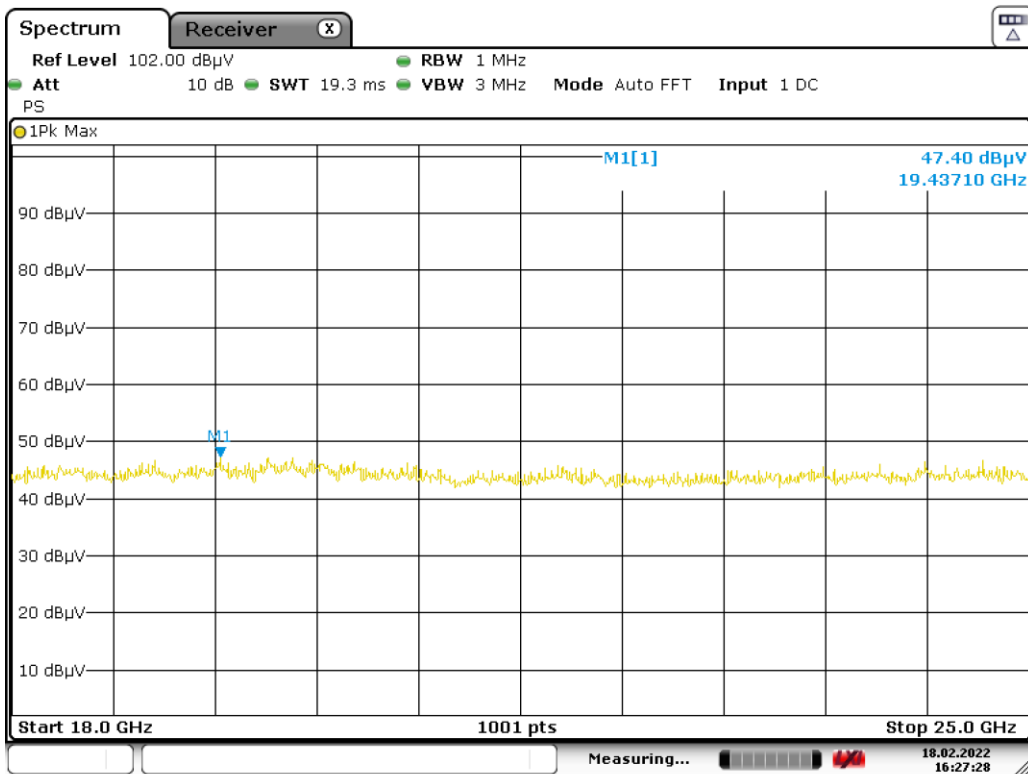
Date: 18.FEB.2022 16:31:46

Figure 5.5.8.5 – manual investigation – Operating on IEEE 802.11g channel 2442MHz



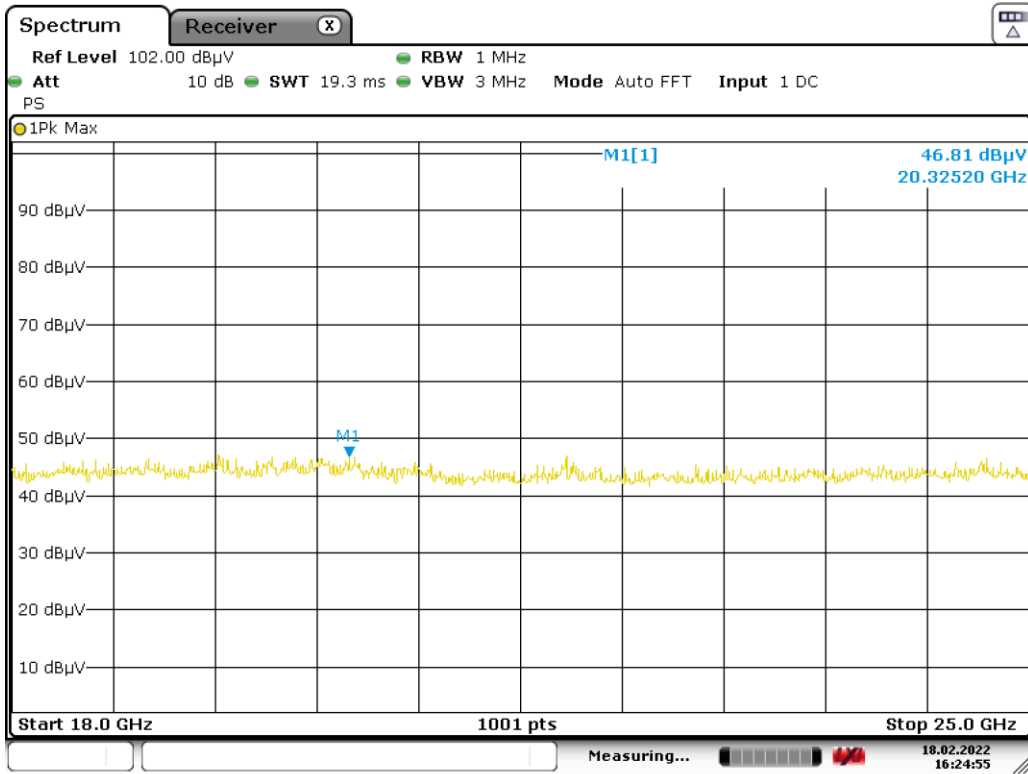
Date: 18.FEB.2022 16:29:13

Figure 5.5.8.6 – manual investigation – Operating on IEEE 802.11g channel 2462MHz



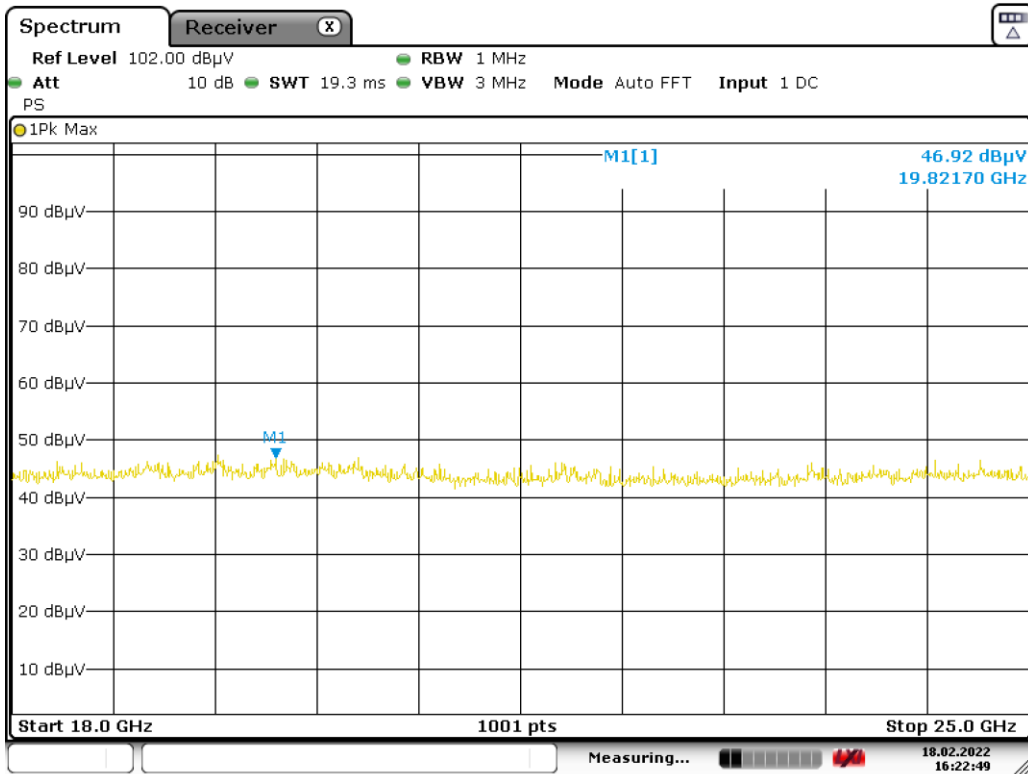
Date: 18.FEB.2022 16:27:28

Figure 5.5.8.7 – manual investigation – Operating on IEEE 802.11n channel 2412MHz



Date: 18.FEB.2022 16:24:56

Figure 5.5.8.8 – manual investigation – Operating on IEEE 802.11n channel 2442MHz



Date: 18.FEB.2022 16:22:49

Figure 5.5.8.9 – manual investigation – Operating on IEEE 802.11n channel 2462MHz

**5.6 Conducted Spurious Emissions 30MHz to 26GHz****5.6.1 Limits**

Frequency (MHz)	Limit, 47CFR 15.247(d)
	Peak
30 – 25000	-20dBc

Spectrum analyser settings as specified by ANSI C63.10-2013 Clause 11.11.2

Receiver Parameters	Setting
Detector Function	Peak
Start Frequency	30MHz
Stop Frequency	1000MHz
Start Frequency	1000MHz
Stop Frequency	25000MHz
Resolution Bandwidth	100kHz
Video Bandwidth	300kHz
Sweep rate	Auto couple
Trace mode	Max hold

**5.6.2 Emissions measurements****5.6.3 Date of Test**

17<sup>th</sup> February and 17<sup>th</sup> June 2022

**5.6.4 Test Area**

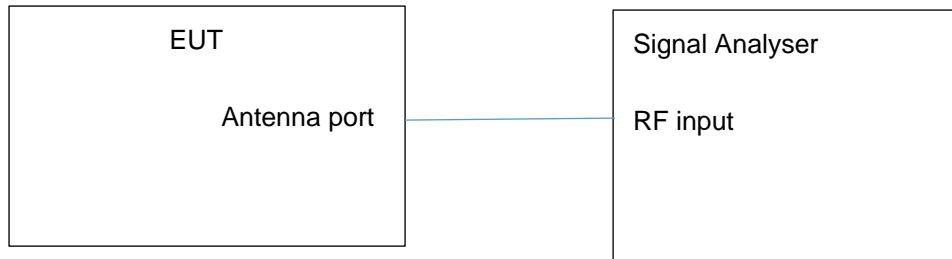
LAB 1

**5.6.5 Tested by**

J Beavers

### 5.6.6 Test Setup

The antenna port was connected directly to the signal analyser.

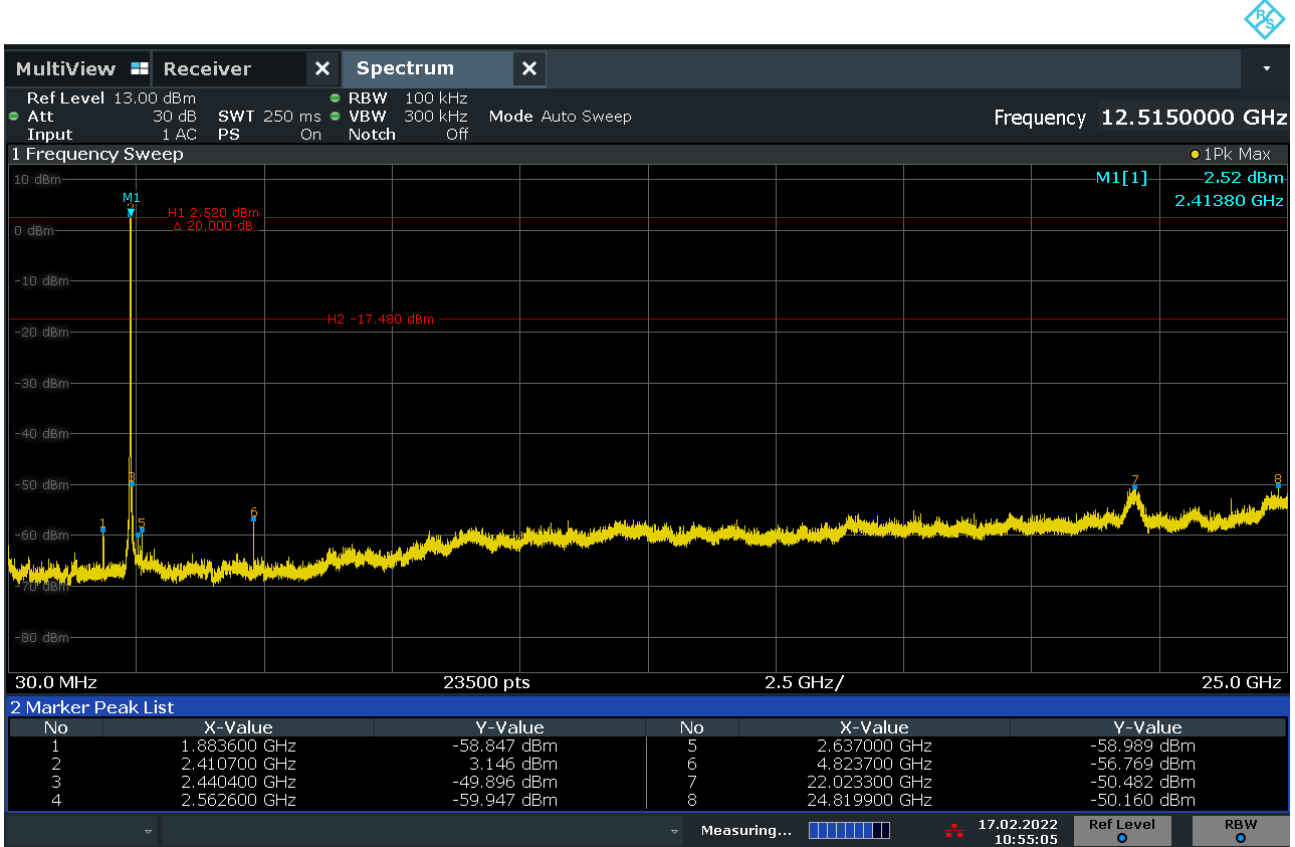


### 5.6.7 Test Results

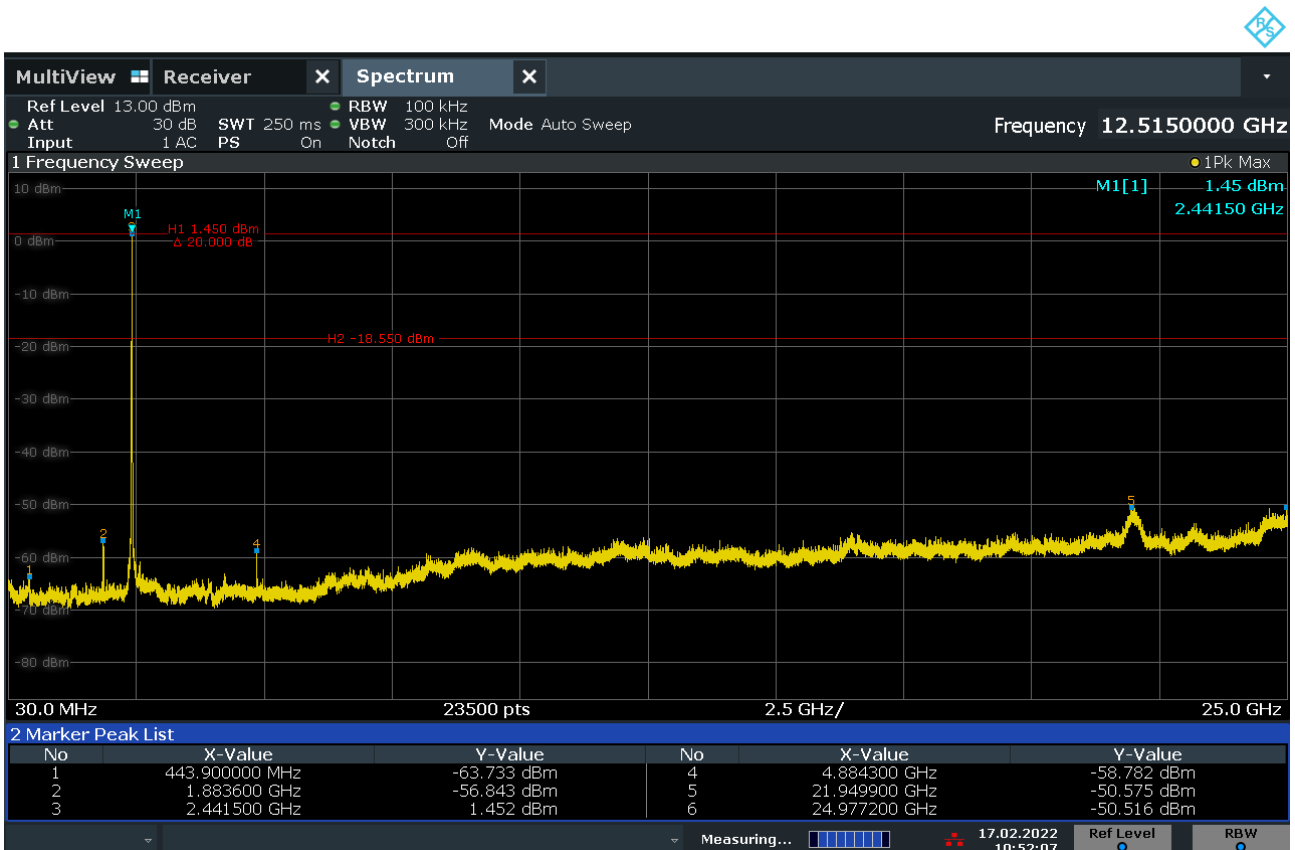
The results of the conducted spurious emissions are stated below and by the signal analyser images.

All disturbances detected were > 20dB below the carrier.

5.6.8 Antenna port conducted emissions IEEE 802.11b, 30MHz to 25GHz



Conducted emissions 30MHz to 25GHz. Operation on IEEE 802.11b channel 2412MHz.



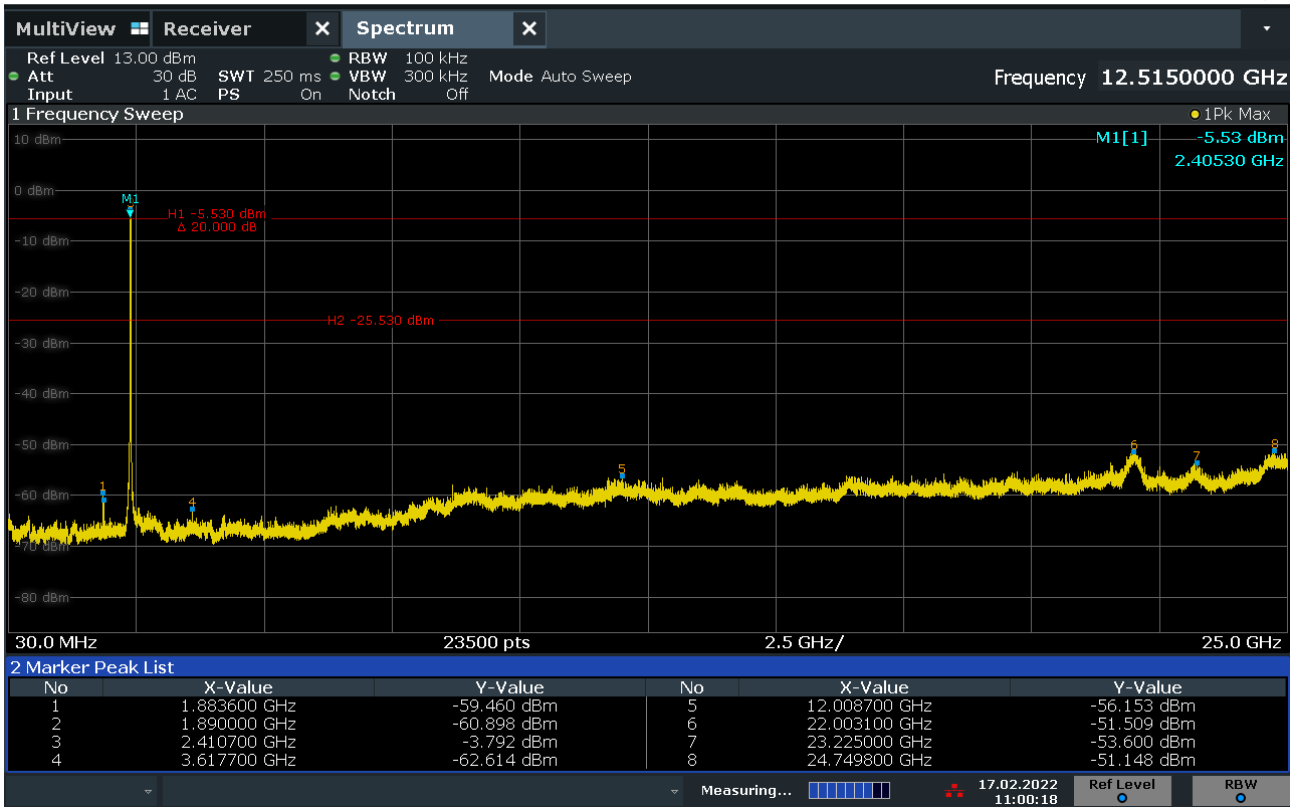
Conducted emissions 30MHz to 25GHz. Operation on IEEE 802.11b channel 2442MHz.



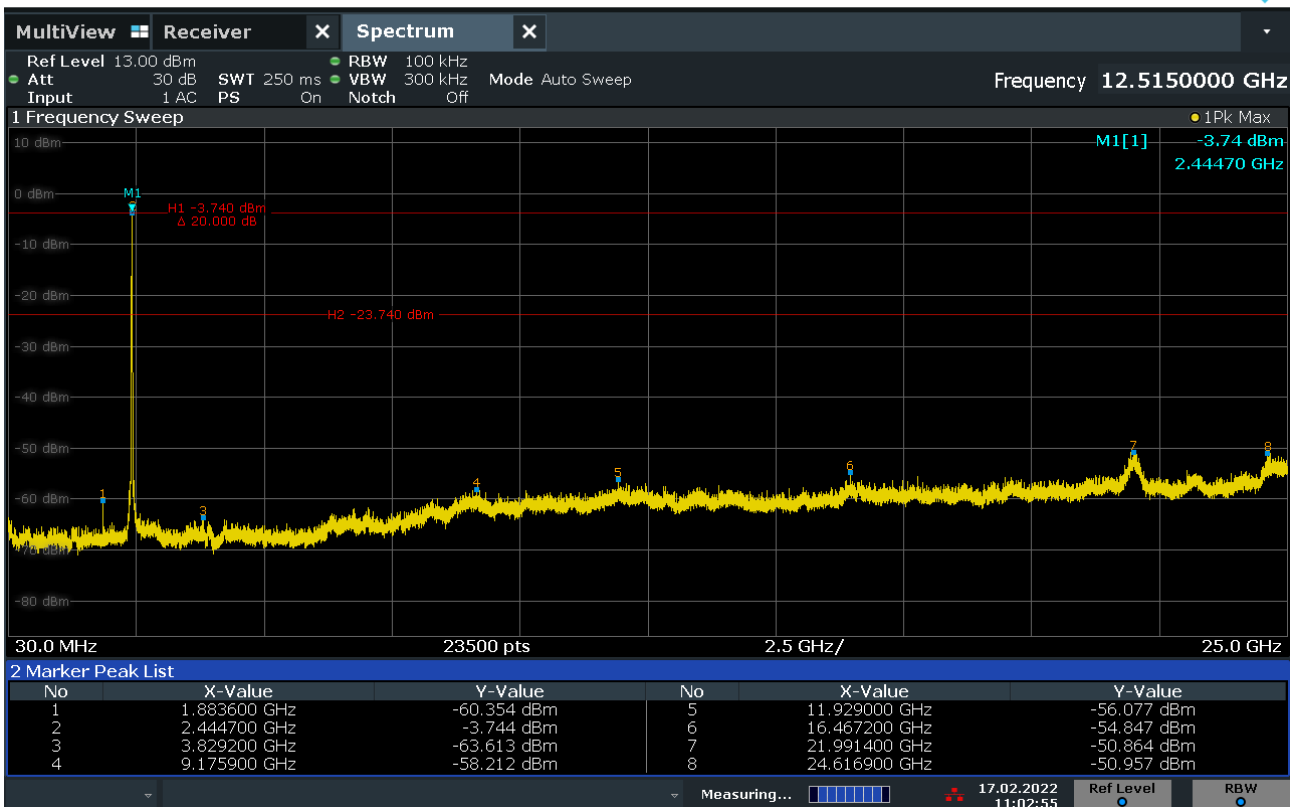
Conducted emissions 30MHz to 25GHz. Operation on IEEE 802.11b channel 2462MHz.



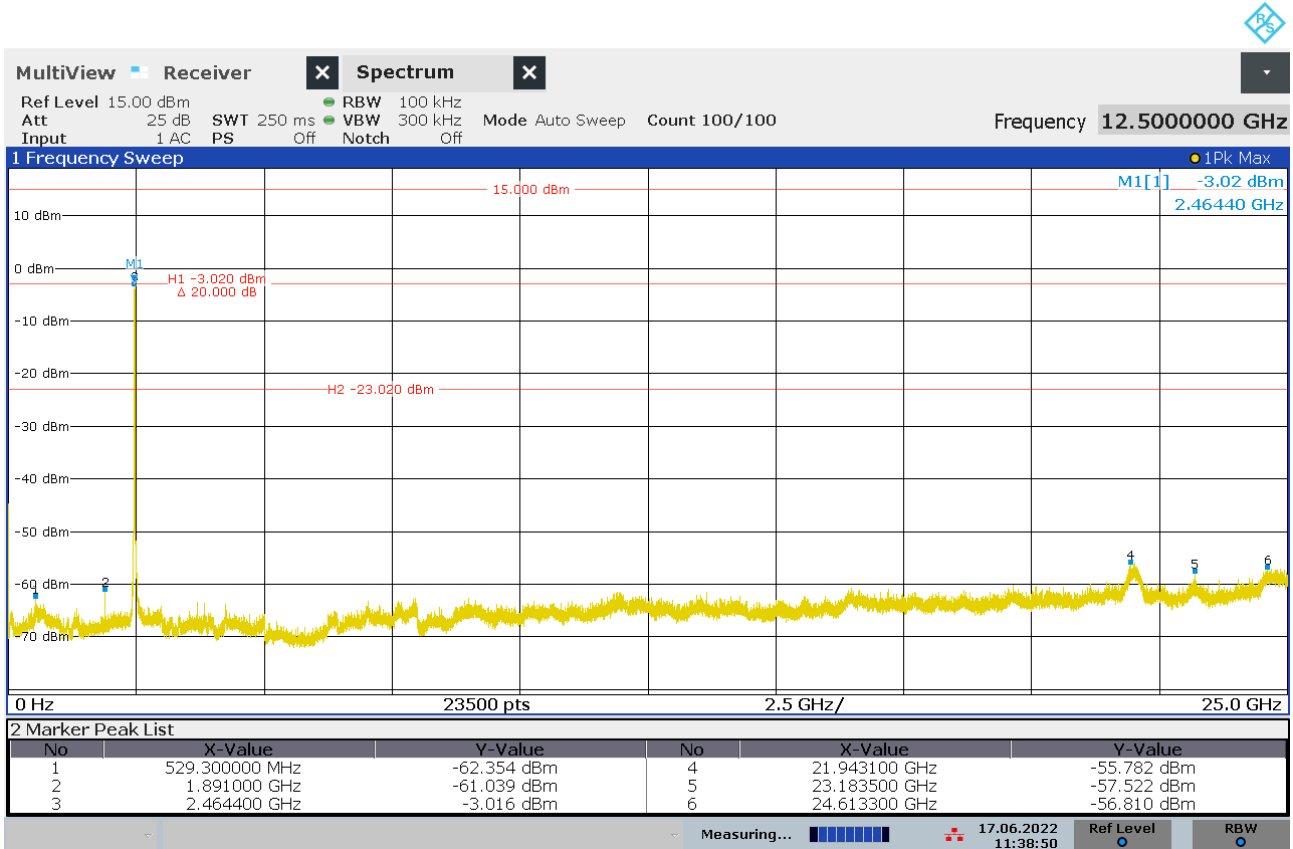
5.6.9 Antenna port conducted emissions IEEE 802.11g, 30MHz to 25GHz



Conducted emissions 30MHz to 25GHz. Operation on IEEE 802.11g channel 2412MHz.

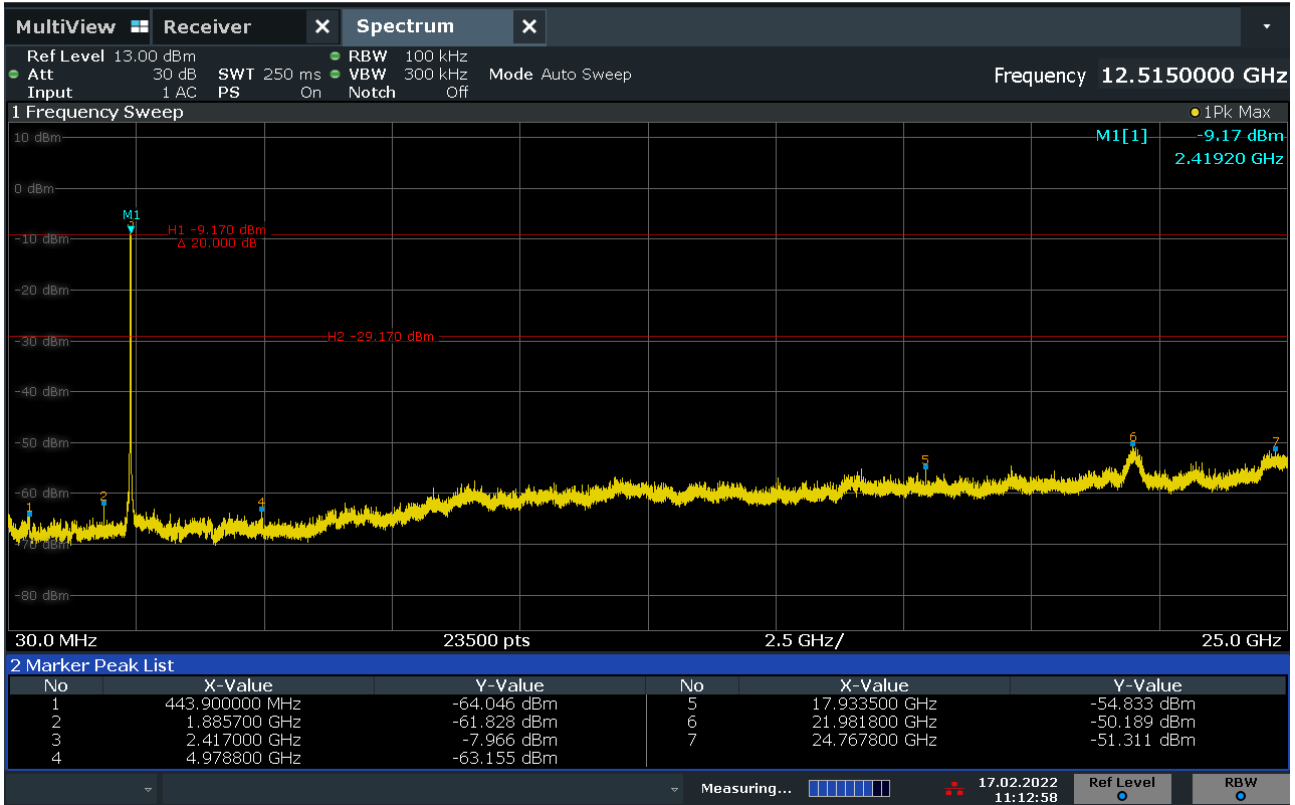


Conducted emissions 30MHz to 25GHz. Operation on IEEE 802.11g channel 2442MHz.

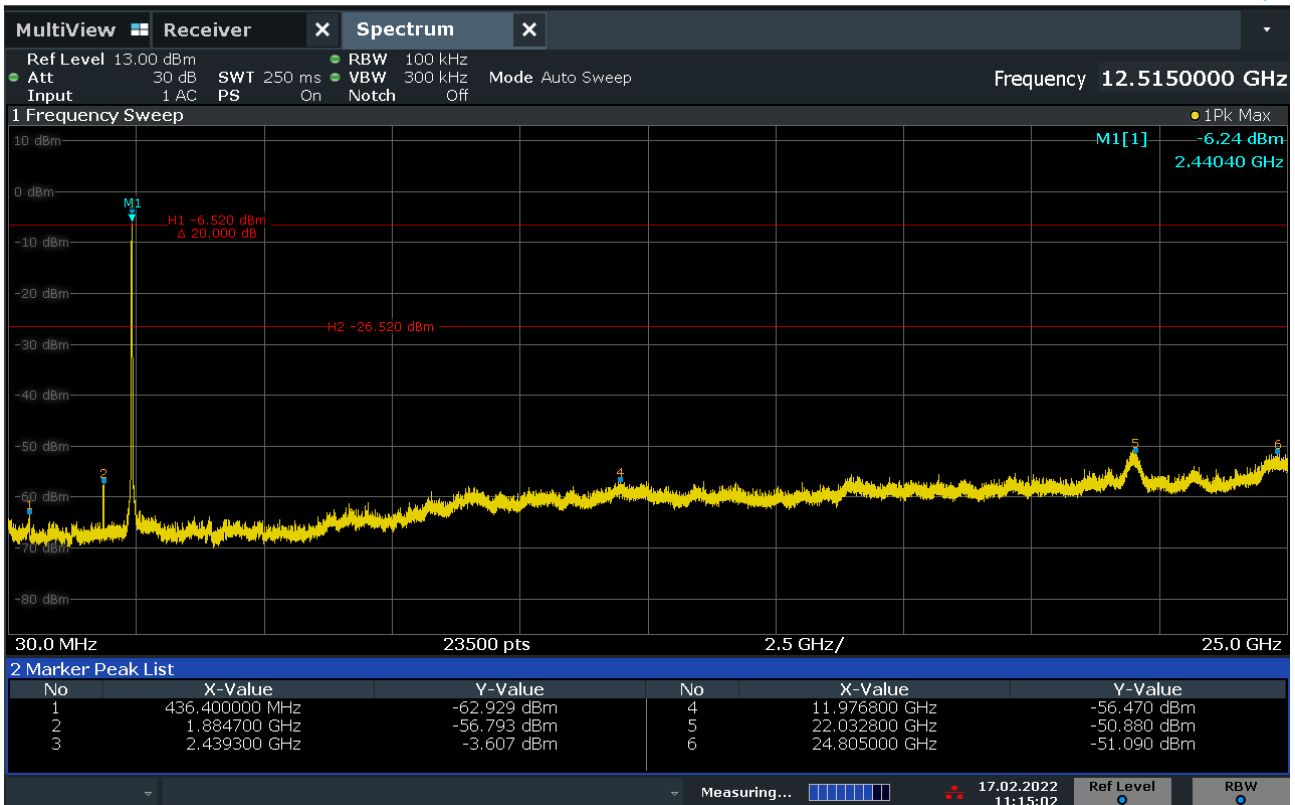


Conducted emissions 30MHz to 25GHz. Operation on IEEE 802.11g channel 2462MHz.

5.6.10 Antenna port conducted emissions IEEE 802.11n, 30MHz to 25GHz



Conducted emissions 30MHz to 25GHz. Operation on IEEE 802.11n channel 2412MHz.



Conducted emissions 30MHz to 25GHz. Operation on IEEE 802.11n channel 2442MHz.



Conducted emissions 30MHz to 25GHz. Operation on IEEE 802.11n channel 2462MHz.

## Section 6 6dB Bandwidth and 99% Occupied Bandwidth

### 6.1 Test Specification

FCC Rule Part	46CFR 15.247 (b)(2)
Standard	ANSI C63.10:2013

### 6.2 Procedure and Test Software Version

#### Conducted Tests

ANSi C63.10-2013 Clause reference:	11.9.1.1 (RBW>DTS bandwidth)
Test software	N/A

Frequency (MHz)	Limit, 47CFR 15.247(a)(2) 6dB bandwidth
	Peak
2400MHz to 2483.5MHz	At least 500kHz

Spectrum analyser settings as specified by ANSI C63.10-2013 Clause 11.8.1

Receiver Parameters	Setting
Detector Function	Peak
Span	3 x RBW
Resolution Bandwidth	100kHz
Video Bandwidth	300kHz
Sweep rate	Auto couple
Trace mode	Max hold

**6.2.1 Emissions measurements**

**6.2.2 Date of Test**

8<sup>th</sup> February and 17<sup>th</sup> June 2022

**6.2.3 Test Area**

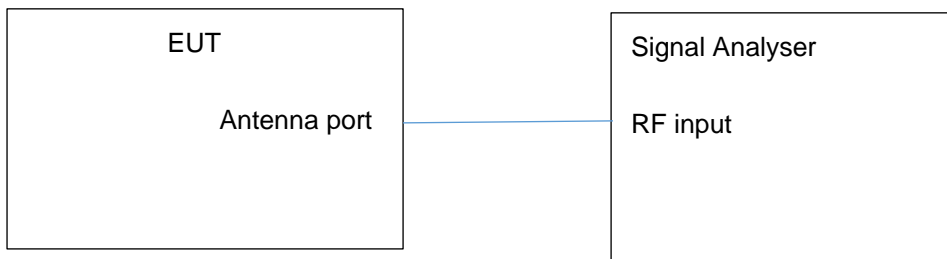
LAB 1

**6.2.4 Tested by**

J Beavers

**6.2.5 Test Setup**

The antenna port was connected directly to the signal analyser.



**6.2.6 Test Results**

The results of the 6dB bandwidth measurements are stated in the table below and by the signal analyser images.

Channel (MHz)	99% Occupied Bandwidth (MHz)	Measured 6dB bandwidth (MHz)	Minimum requirement (kHz)	Figure	Result
2412.0	14.0223	8.49	500.0	6.2.6.1 and 6.2.6.10	Pass
2442.0	14.0667	8.59	500.0	6.2.6.2 and 6.2.6.11	Pass
2462.0	14.0421	8.89	500.0	6.2.6.3 and 6.2.6.12	Pass

**IEEE 802.11b Bandwidth Measurements**

Channel (MHz)	99% Occupied Bandwidth (MHz)	Measured 6dB bandwidth (MHz)	Minimum requirement (kHz)	Figure	Result
2412.0	16.2806	15.68	500.0	6.2.6.4 and 6.2.6.13	Pass
2442.0	16.2806	15.88	500.0	6.2.6.5 and 6.2.6.14	Pass
2462.0	16.3152	15.58	500.0	6.2.6.6 and 6.2.6.15	Pass

IEEE 802.11g Bandwidth Measurements

Channel (MHz)	99% Occupied Bandwidth (MHz)	Measured 6dB bandwidth (MHz)	Minimum requirement (kHz)	Figure	Result
2412.0	17.4880	15.78	500.0	6.2.6.7 and 6.2.6.16	Pass
2442.0	17.4881	16.58	500.0	6.2.6.8 and 6.2.6.17	Pass
2462.0	17.4219	15.08	500.0	6.2.6.9 and 6.2.6.18	Pass

IEEE 802.11n Bandwidth Measurements

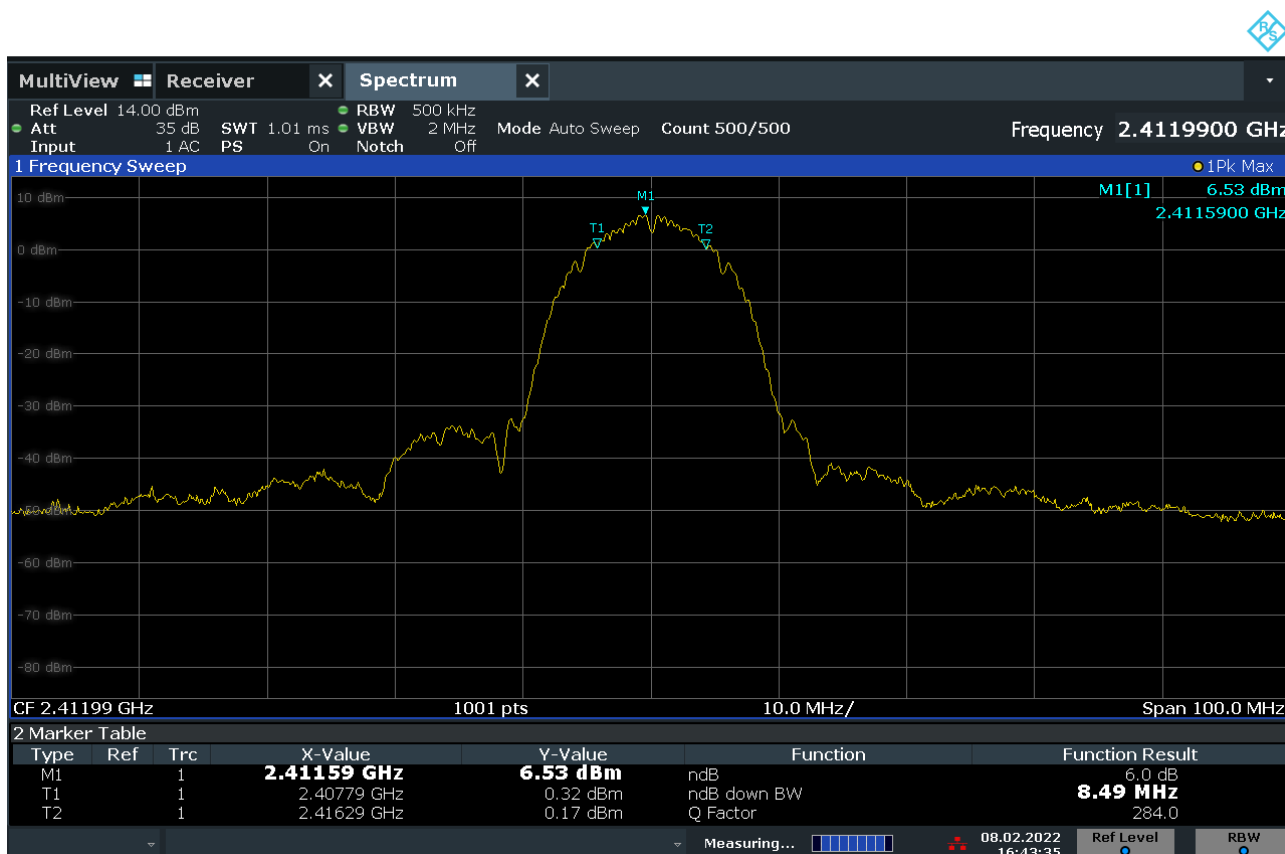


Figure 6.2.6.1 Bandwidth at 6dB Point. Operation on IEEE 802.11b channel 2412MHz

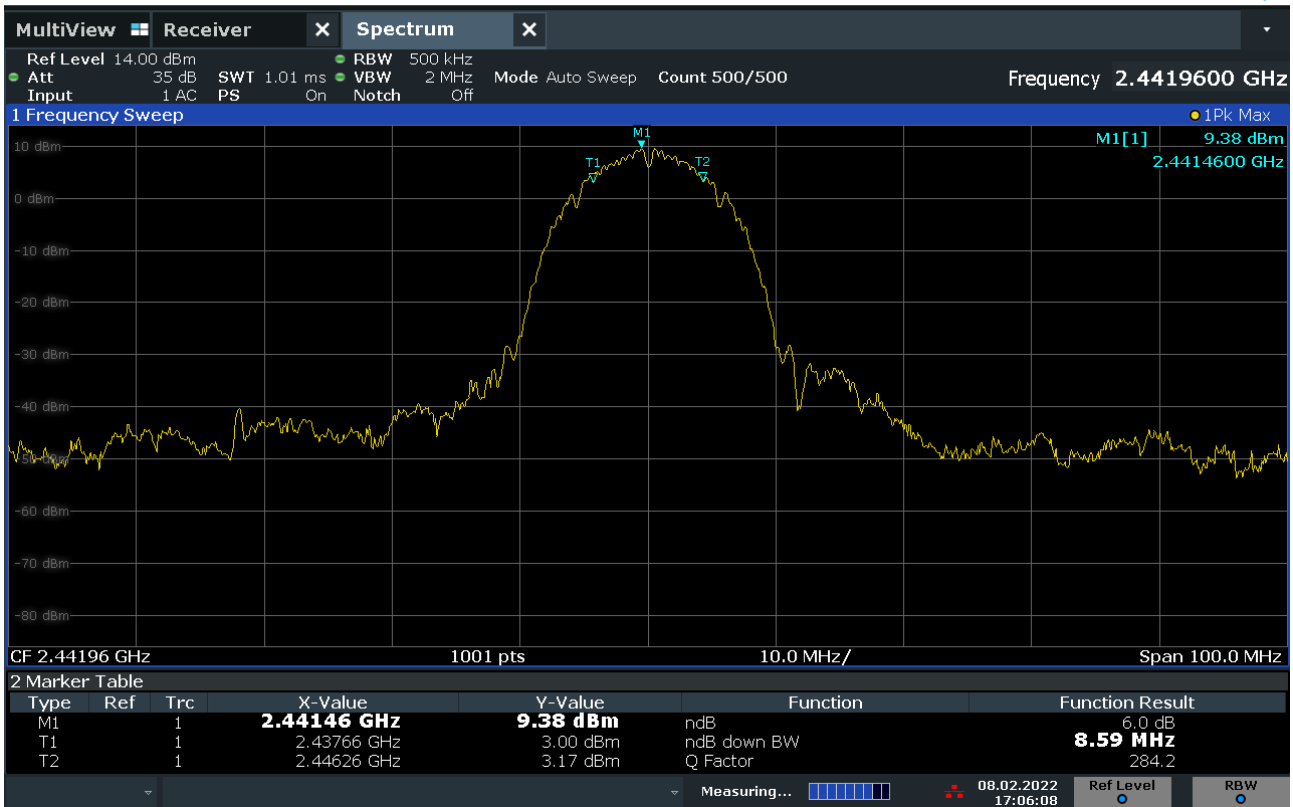


Figure 6.2.6.2 Bandwidth at 6dB Point. Operation on IEEE 802.11b channel 2442MHz

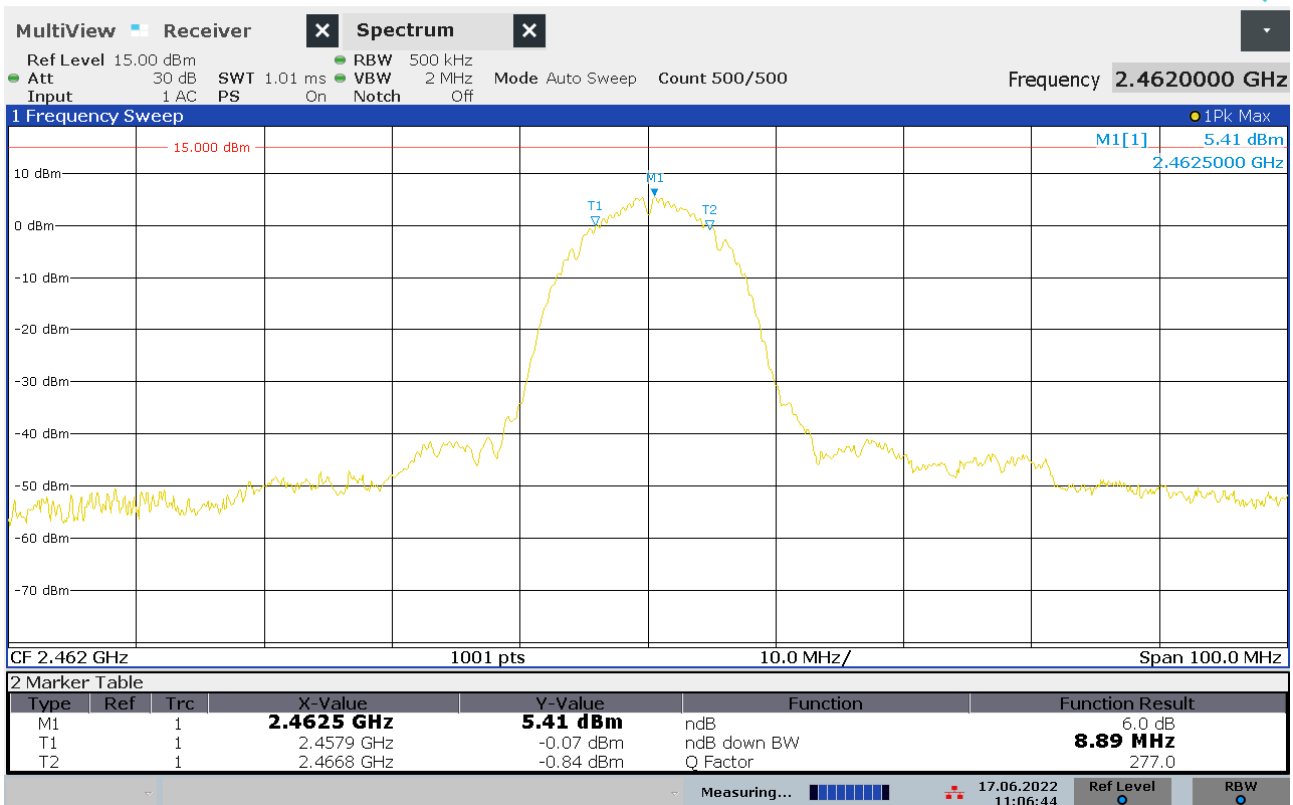


Figure 6.2.6.3 Bandwidth at 6dB Point. Operation on IEEE 802.11b channel 2462MHz



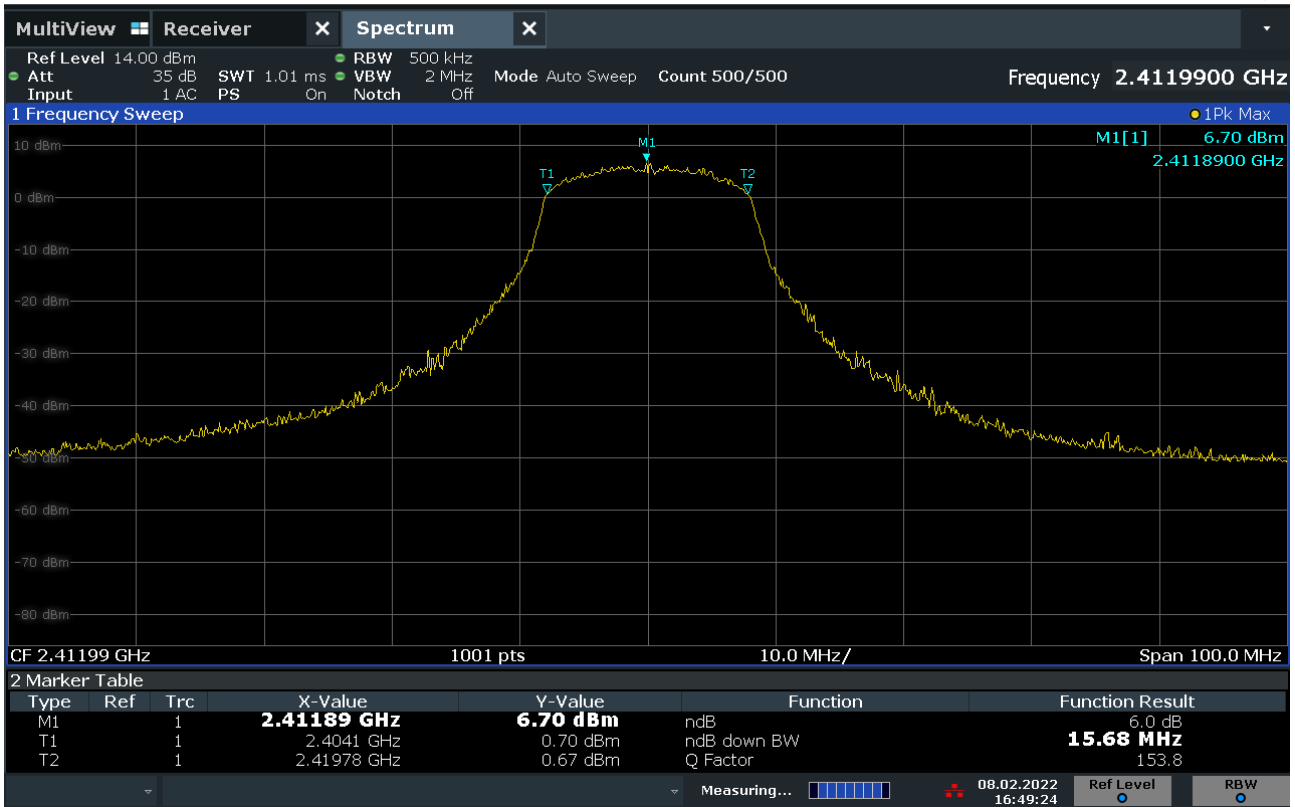


Figure 6.2.6.4 Bandwidth at 6dB Point. Operation on IEEE 802.11g channel 2412MHz

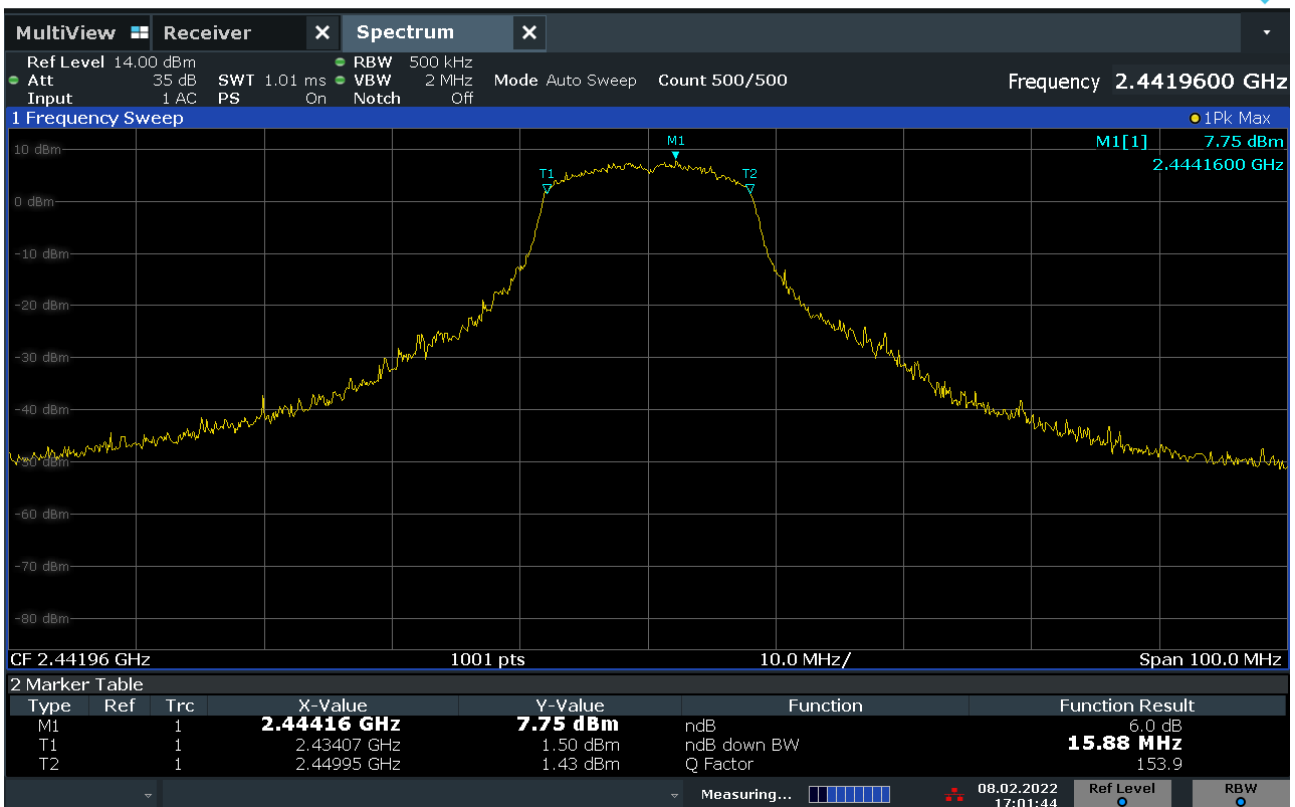


Figure 6.2.6.5 Bandwidth at 6dB Point. Operation on IEEE 802.11g channel 2442MHz

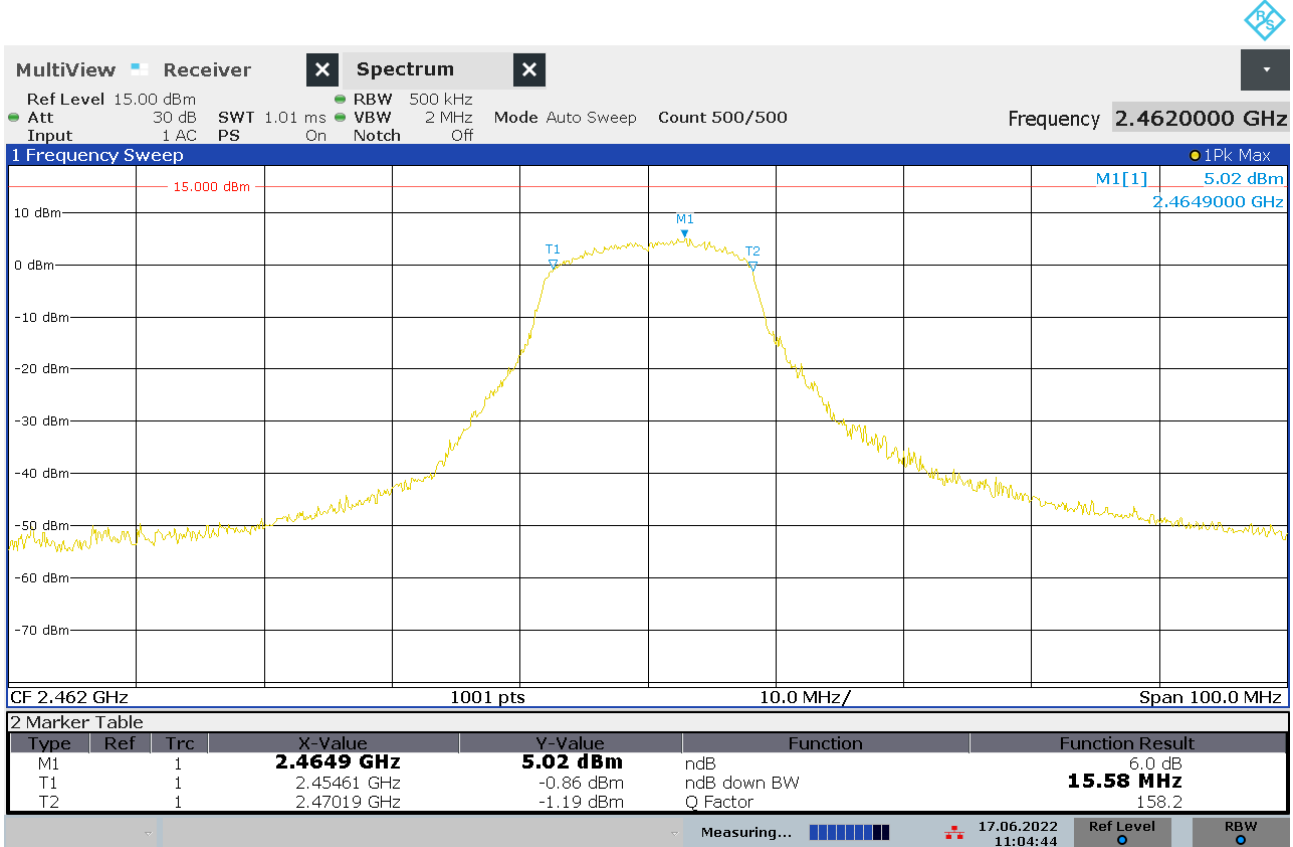


Figure 6.2.6.6 Bandwidth at 6dB Point. Operation on IEEE 802.11g channel 2462MHz

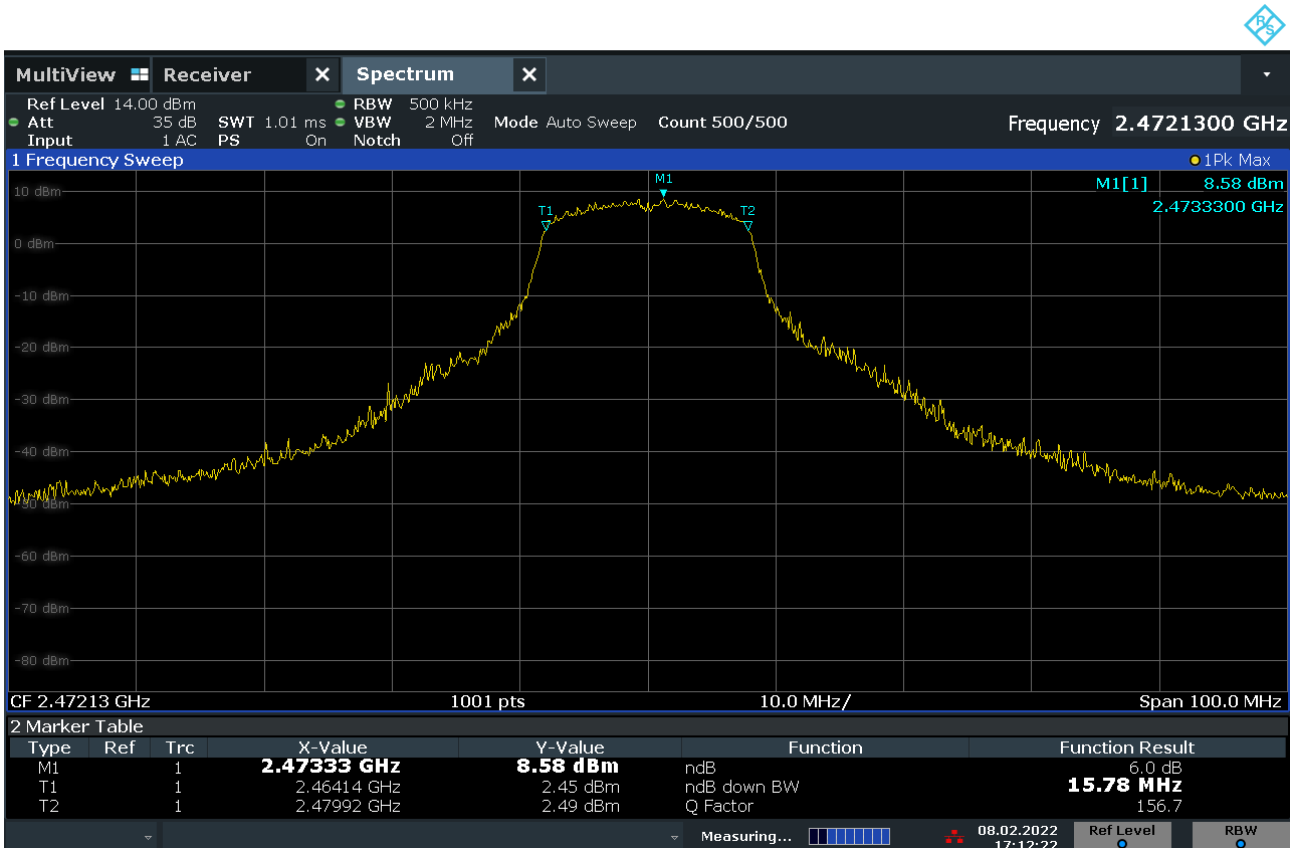


Figure 6.2.6.7 Bandwidth at 6dB Point. Operation on IEEE 802.11n channel 2412MHz

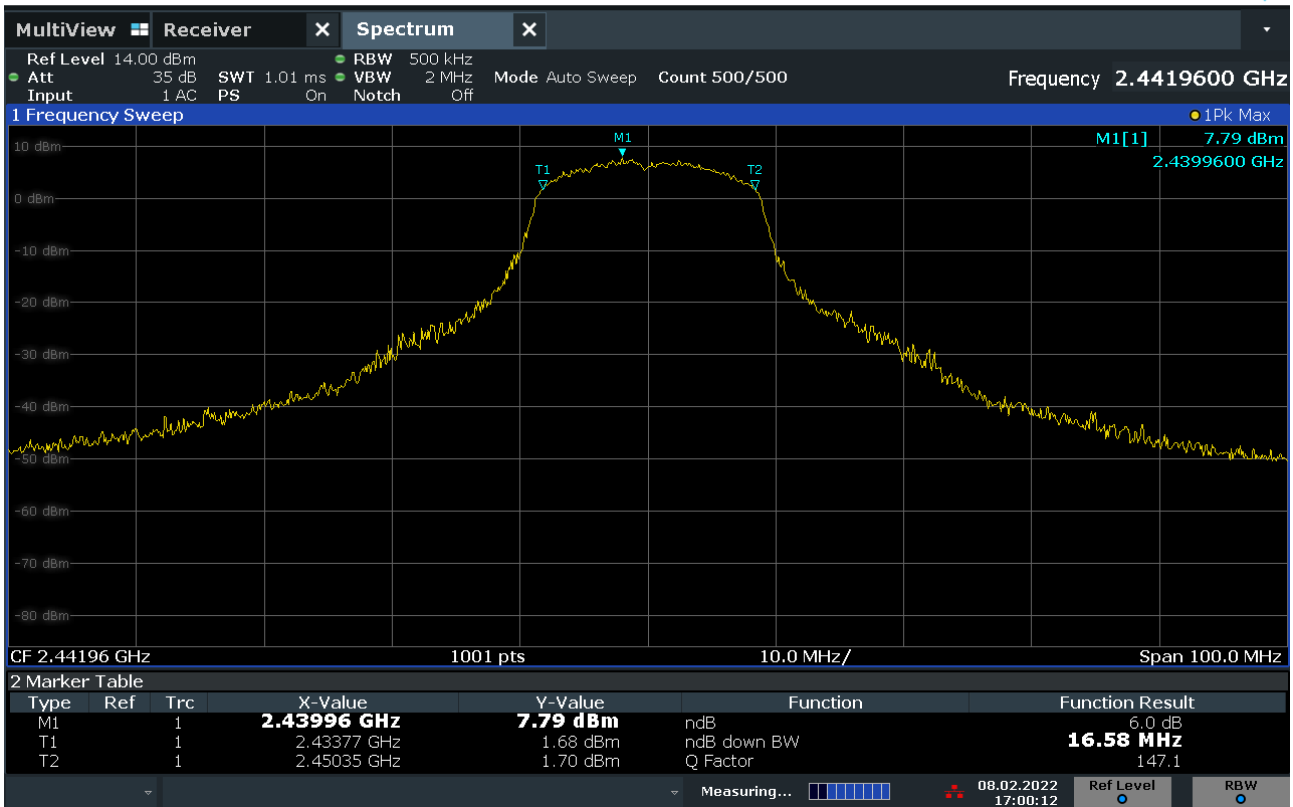


Figure 6.2.6.8 Bandwidth at 6dB Point. Operation on IEEE 802.11n channel 2442MHz

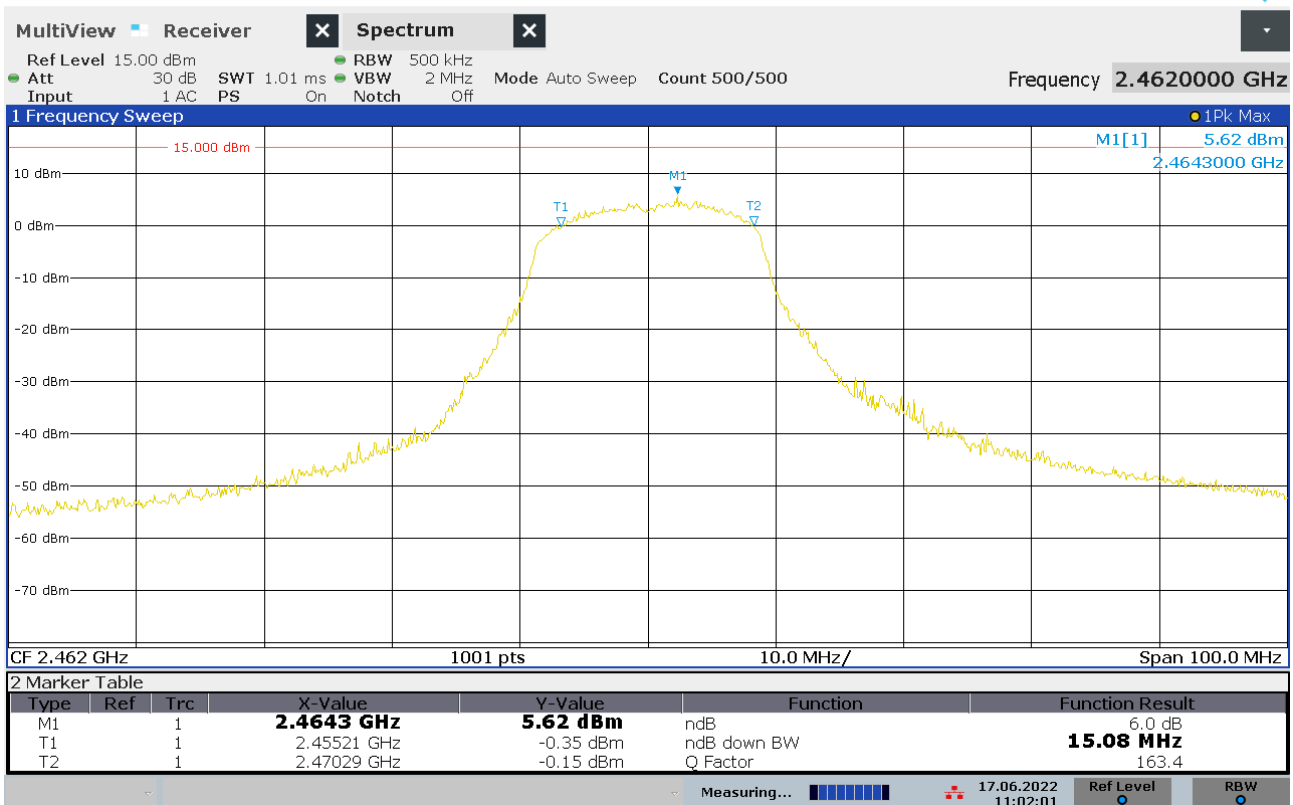


Figure 6.2.6.9 Bandwidth at 6dB Point. Operation on IEEE 802.11n channel 2462MHz

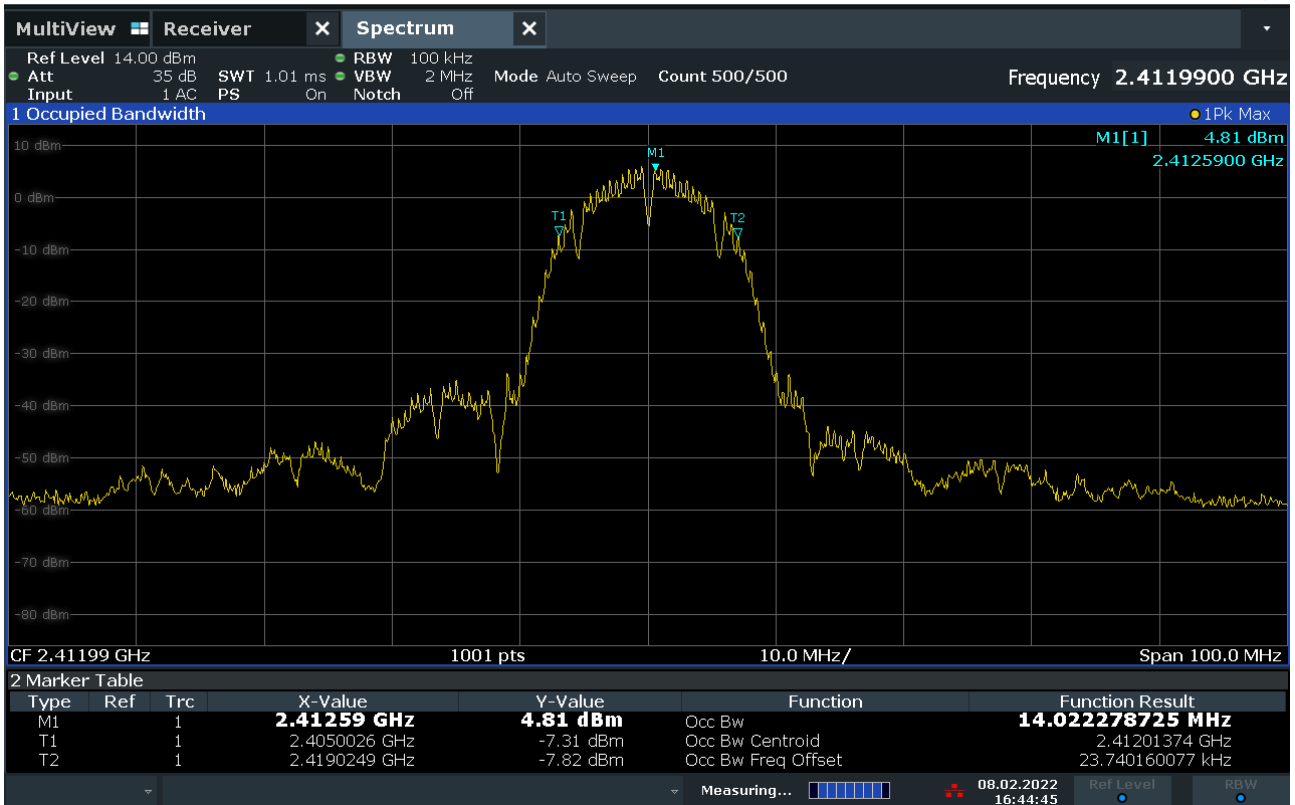


Figure 6.2.6.10 99% Occupied Bandwidth. Operation on IEEE 802.11b channel 2412MHz

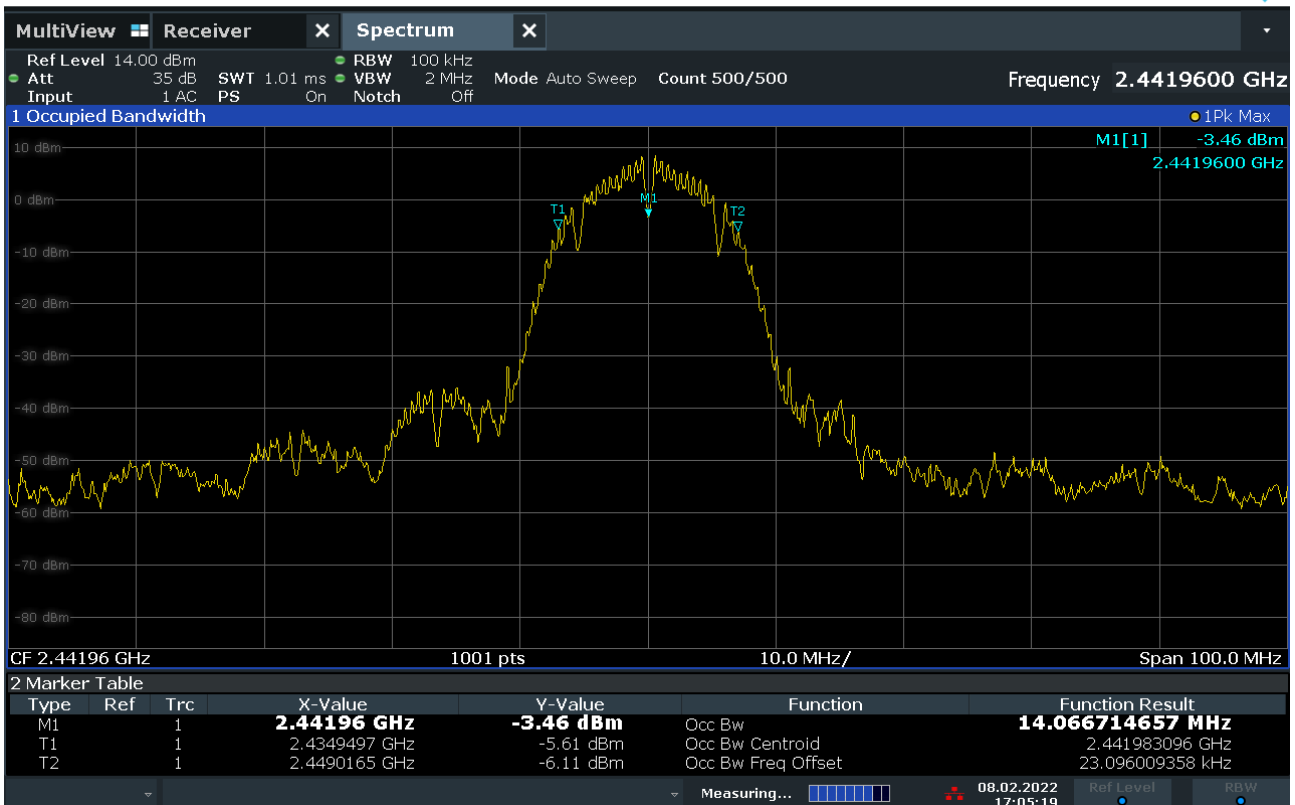


Figure 6.2.6.11 99% Occupied Bandwidth. Operation on IEEE 802.11b channel 2442MHz

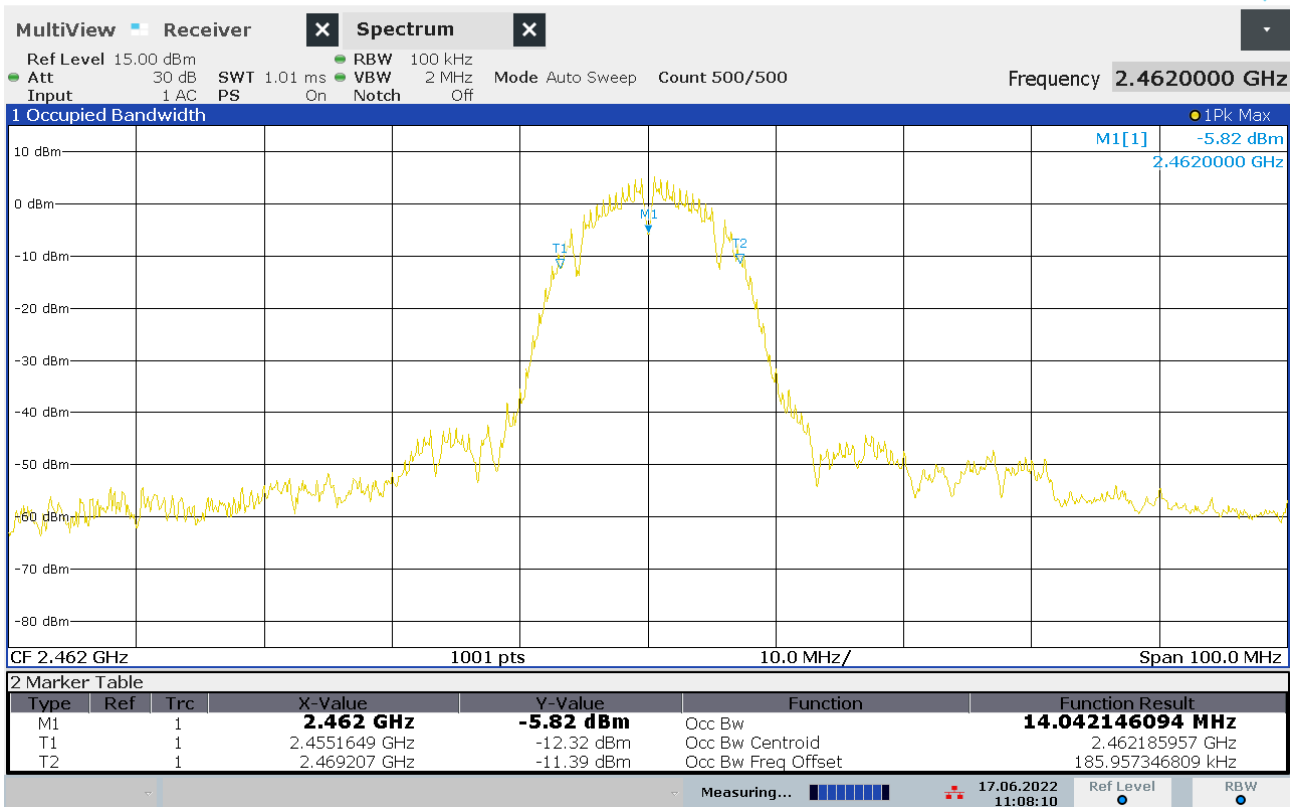


Figure 6.2.6.12 99% Occupied Bandwidth. Operation on IEEE 802.11b channel 2462MHz

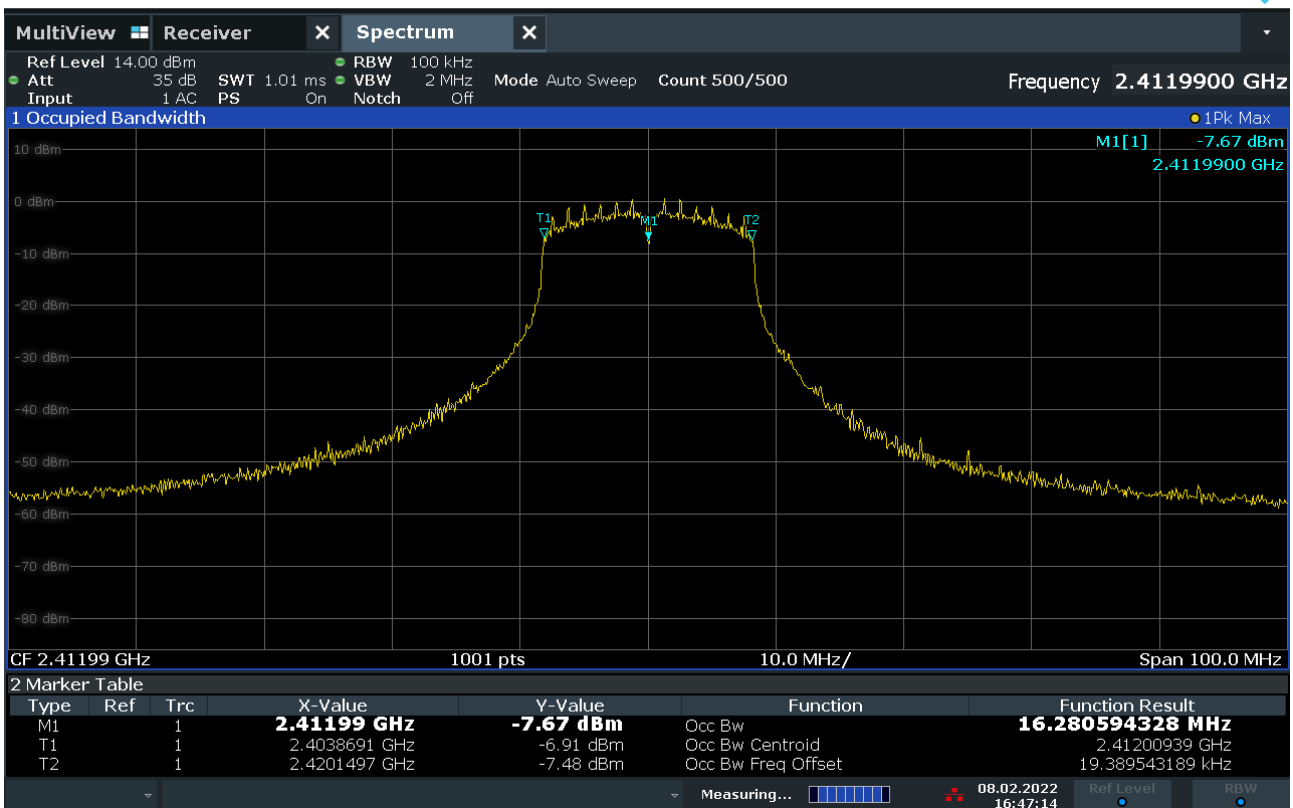


Figure 6.2.6.13 99% Occupied Bandwidth. Operation on IEEE 802.11g channel 2412MHz

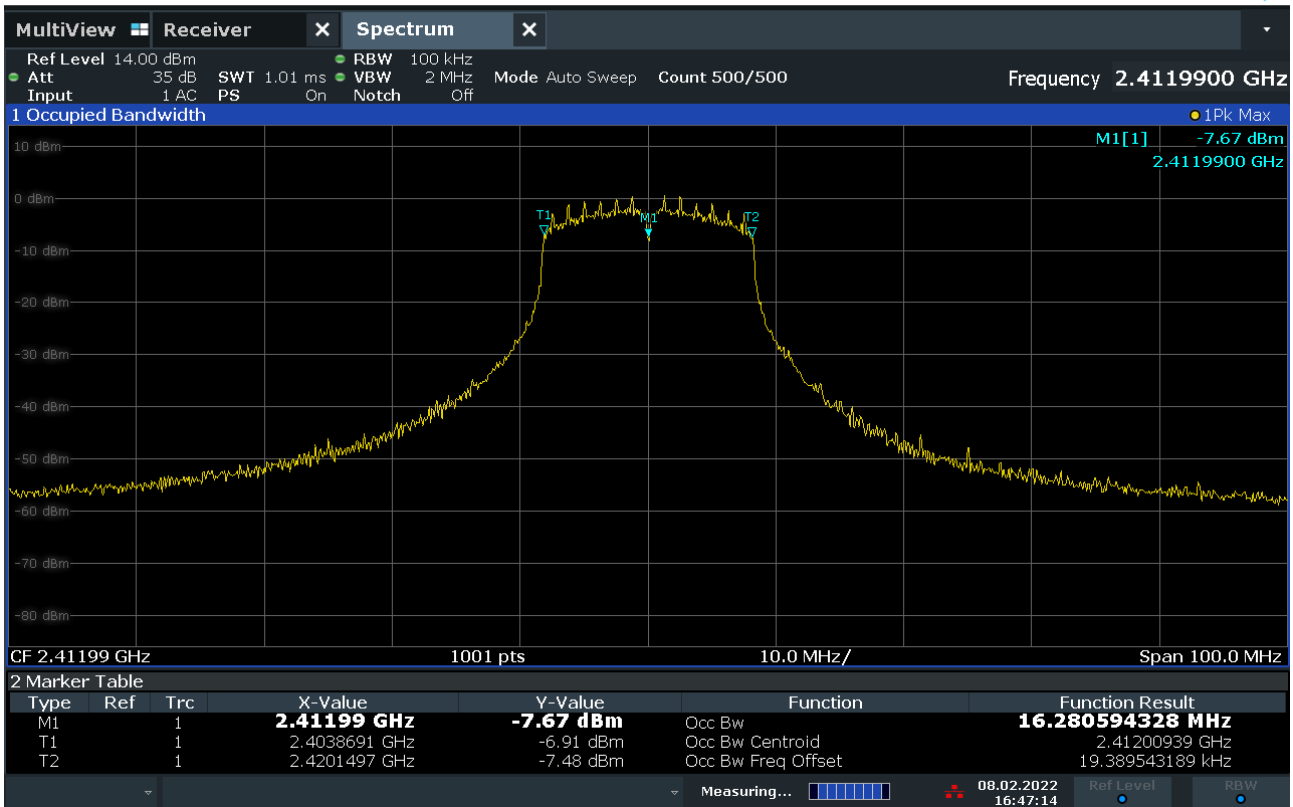


Figure 6.2.6.14 99% Occupied Bandwidth. Operation on IEEE 802.11g channel 2442MHz

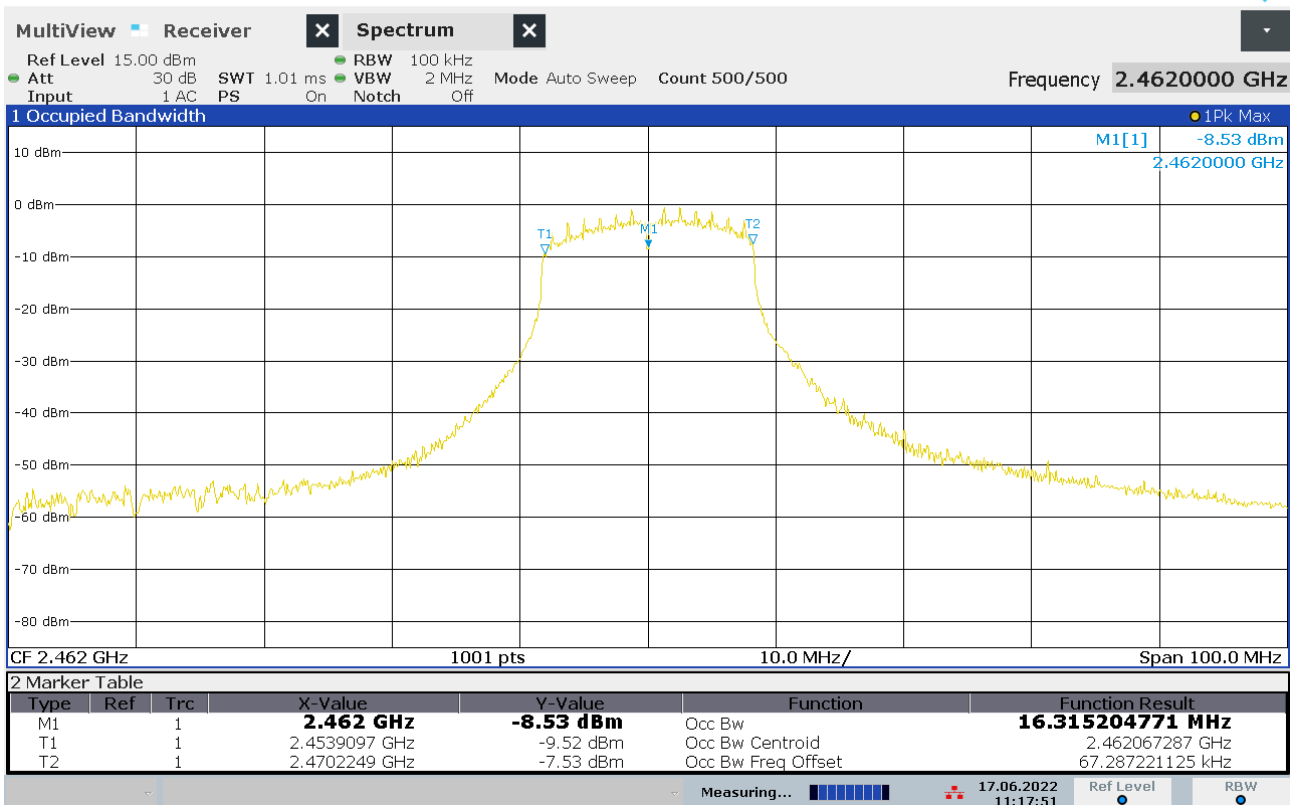


Figure 6.2.6.15 99% Occupied Bandwidth. Operation on IEEE 802.11g channel 2462MHz

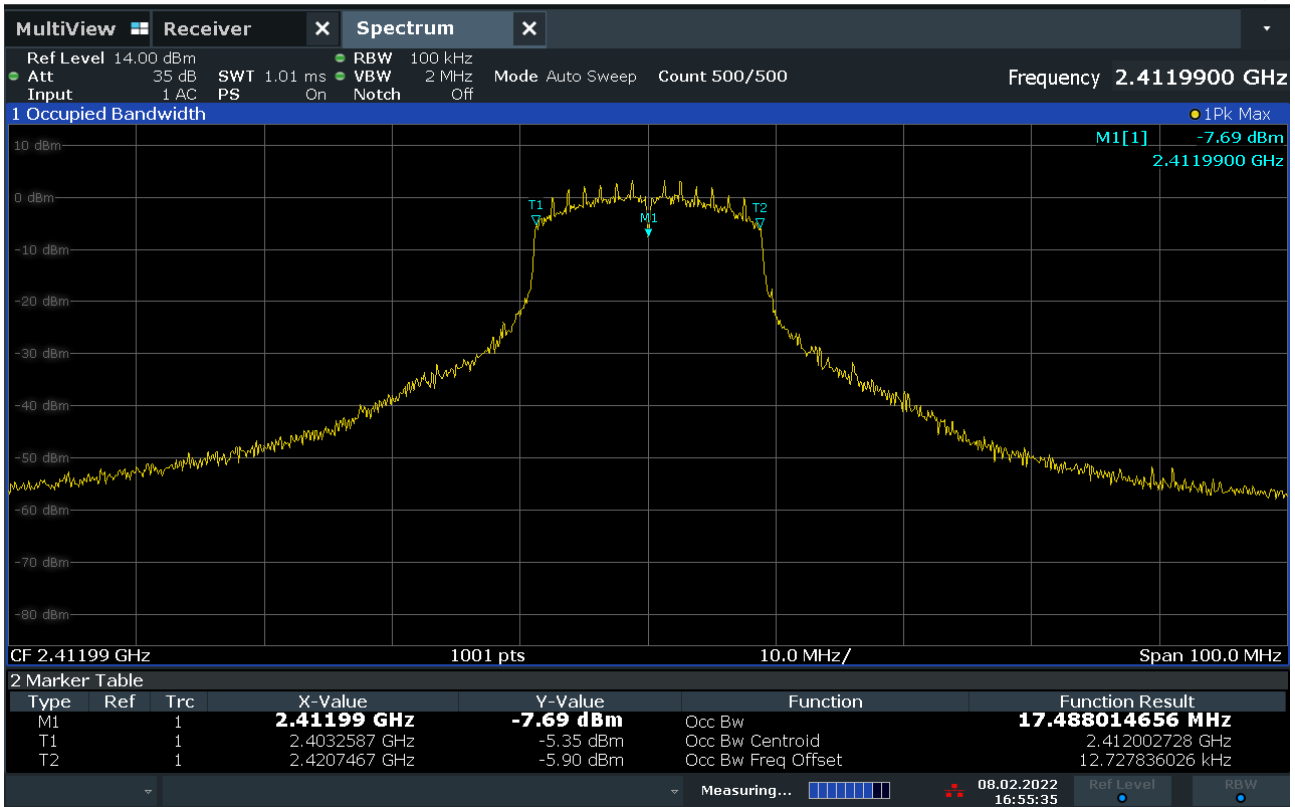


Figure 6.2.6.16 99% Occupied Bandwidth. Operation on IEEE 802.11n channel 2412MHz

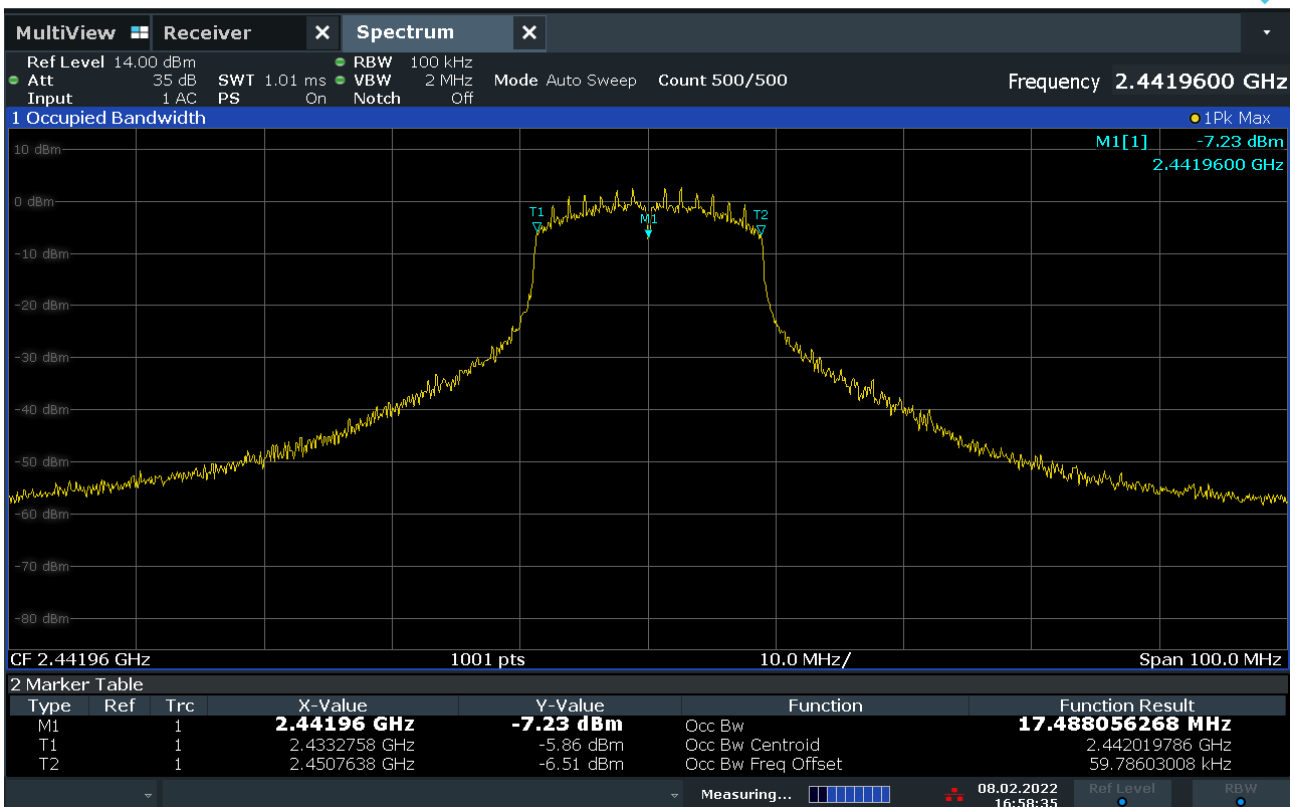


Figure 6.2.6.17 99% Occupied Bandwidth. Operation on IEEE 802.11n channel 2442MHz

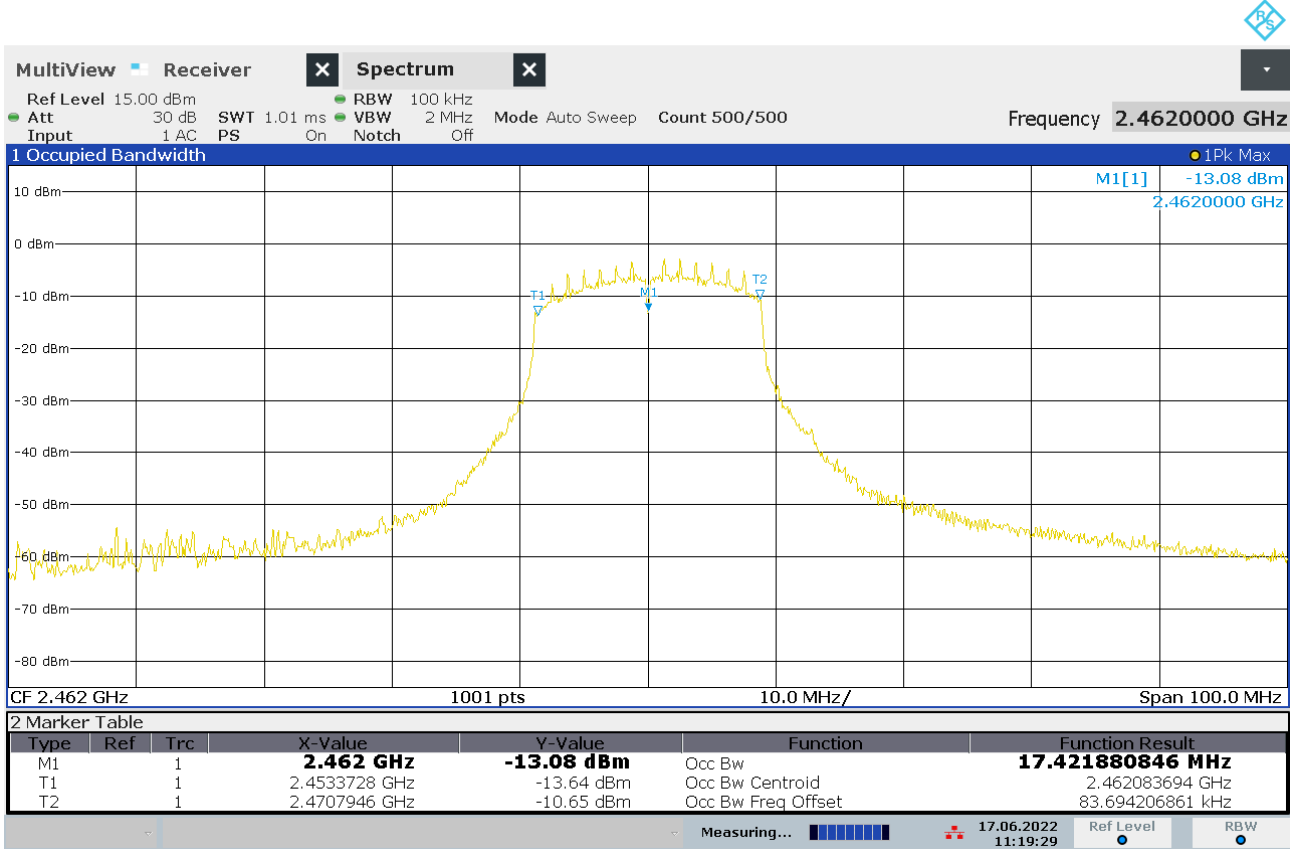


Figure 6.2.6.18 99% Occupied Bandwidth. Operation on IEEE 802.11n channel 2462MHz



## Section 7 Peak Output Power

### 7.1 Test Specification

FCC Rule Part	46CFR 15.247 (b)(3)
Standard	ANSI C63.10:2013

### 7.2 Procedure and Test Software Version

#### Conducted Tests

ANSi C63.10-2013 Clause reference:	11.9.1.1 (RBS>DTS bandwidth)
Test software	N/A

Frequency (MHz)	Limit, 47CFR 15.247(b)(2)
	Peak
2400MHz to 2483.5MHz	1 watt

Spectrum analyser settings as specified by ANSI C63.10-2013 Clause 11.11.2

Receiver Parameters	Setting
Detector Function	Peak
Span	3 x RBW
Resolution Bandwidth	1MHz (>DTS Bandwidth)
Video Bandwidth	3MHz
Sweep rate	Auto couple
Trace mode	Max hold

**7.2.1 Emissions measurements**

**7.2.2 Date of Test**

16<sup>th</sup> February and 16<sup>th</sup> June 2022

**7.2.3 Test Area**

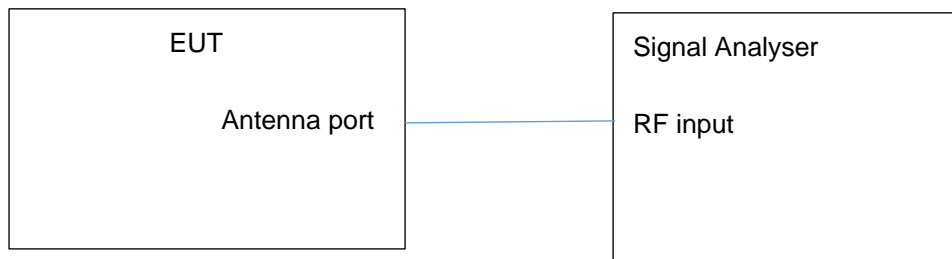
LAB 1

**7.2.4 Tested by**

J Beavers

**7.2.5 Test Setup**

The antenna port was connected directly to the signal analyser.



**7.2.6 Test Result**

The results of the peak output power measurements are stated in the table below and by the signal analyser images.

<b>Modulation scheme</b>	<b>Channel (MHz)</b>	<b>Peak Power (dBm)</b>	<b>Peak Power (Watts)</b>	<b>Limit (Watts)</b>	<b>Figure</b>
IEEE 802.11b	2412	12.64	0.0184	1	7.2.6.1
IEEE 802.11b	2442	12.11	0.0163	1	7.2.6.2
IEEE 802.11b	2462	14.96	0.0313	1	2.2.6.3
IEEE 802.11g	2412	18.83	0.0764	1	7.2.6.4
IEEE 802.11g	2442	18.71	0.0743	1	7.2.6.5
IEEE 802.11g	2462	18.91	0.0788	1	2.2.6.6
IEEE 802.11n	2412	16.13	0.0410	1	7.2.6.7
IEEE 802.11n	2442	19.16	0.0824	1	7.2.6.8
IEEE 802.11n	2462	18.37	0.0687	1	2.2.6.9

**Peak Output Power Measurement**

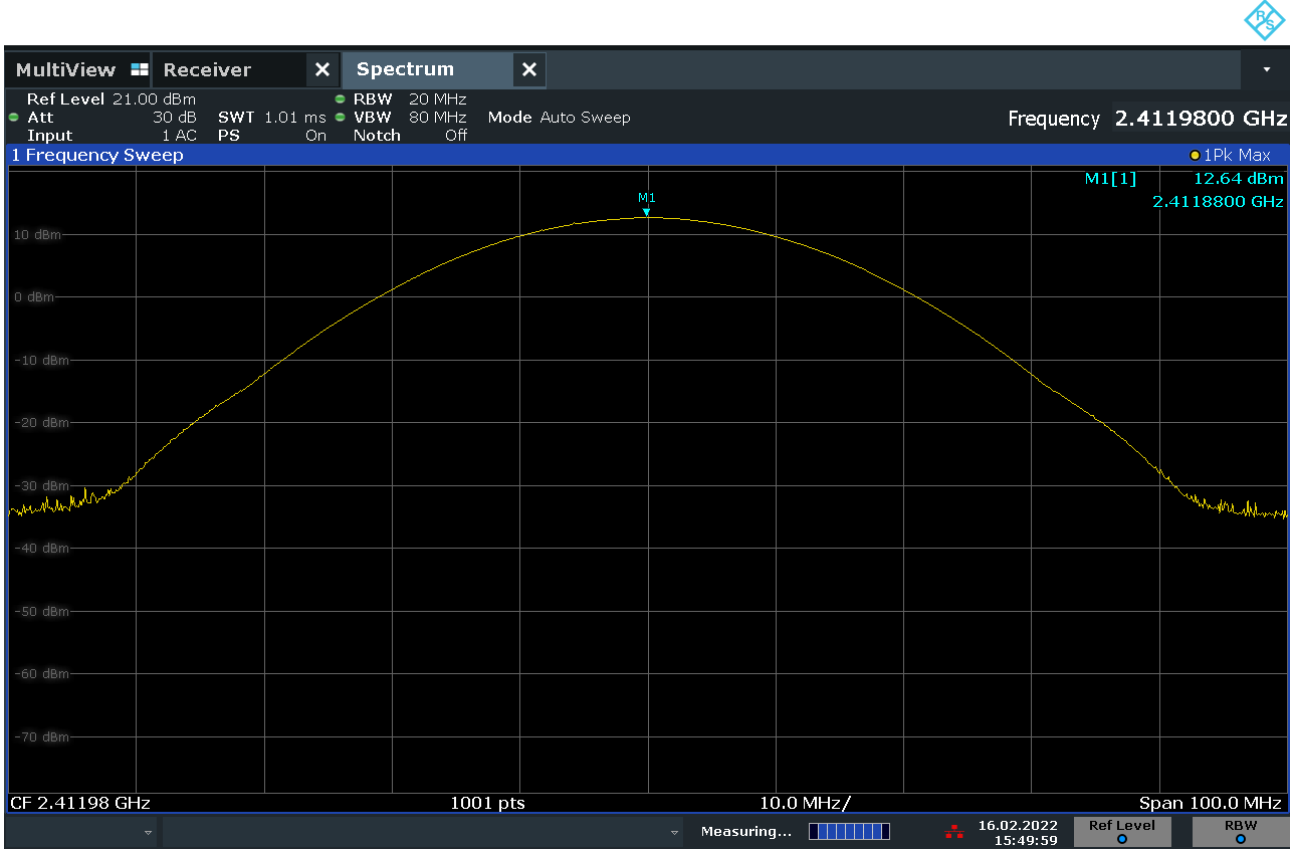


Figure 7.2.6.1 Peak output power, Operation on IEEE 802.11b channel 2412MHz

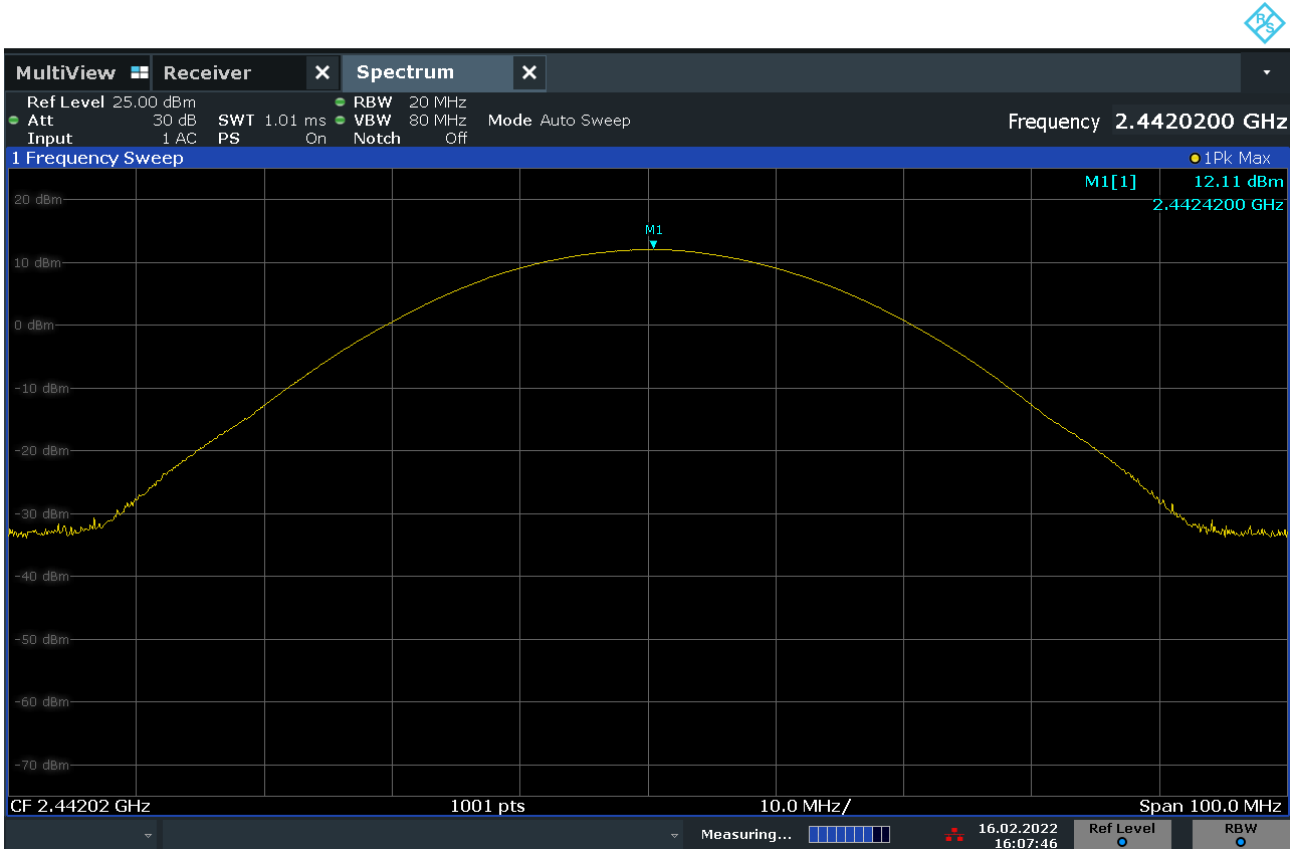


Figure 7.2.6.2 Peak output power, Operation on IEEE 802.11b channel 2442MHz

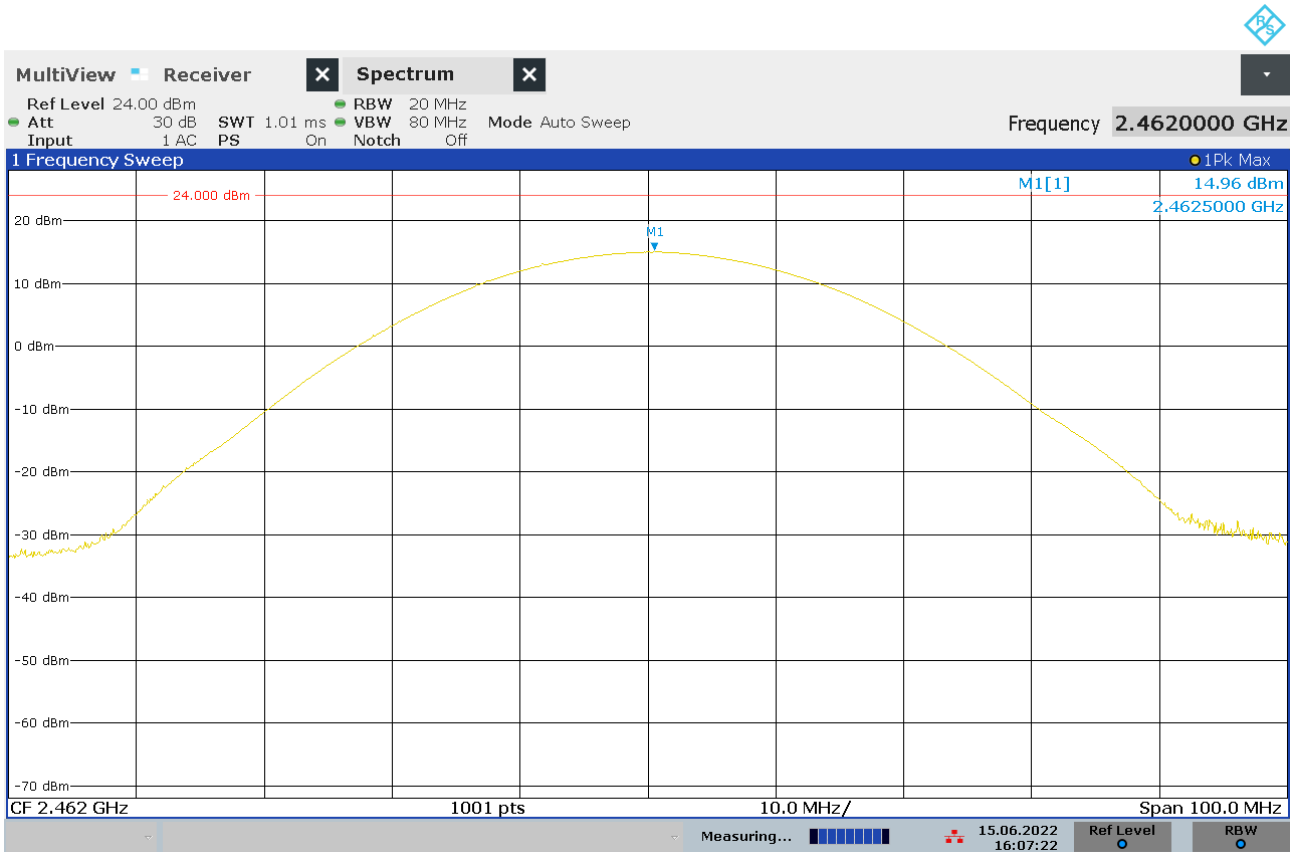


Figure 7.2.6.3 Peak output power, Operation on IEEE 802.11b channel 2462MHz

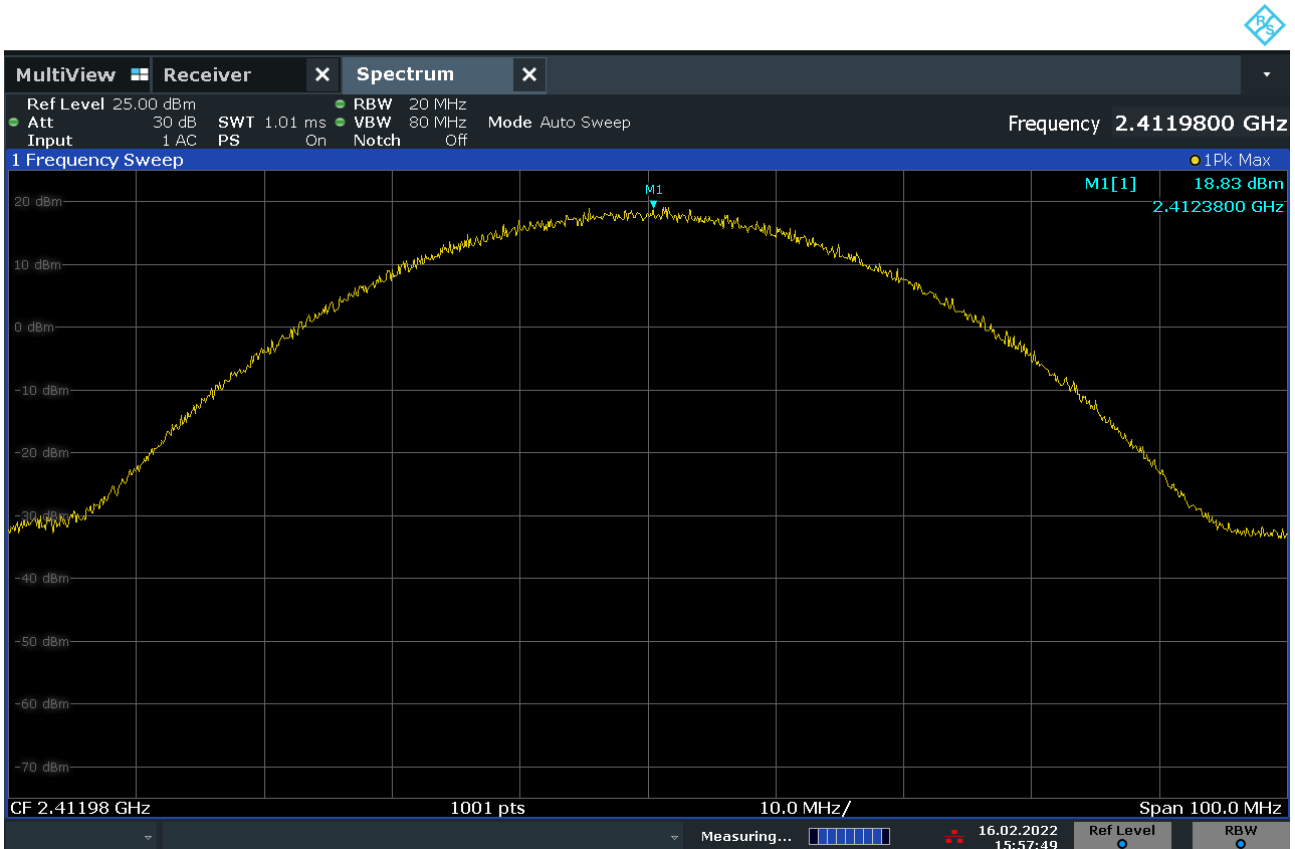


Figure 7.2.6.4 Peak output power, Operation on IEEE 802.11g channel 2412MHz

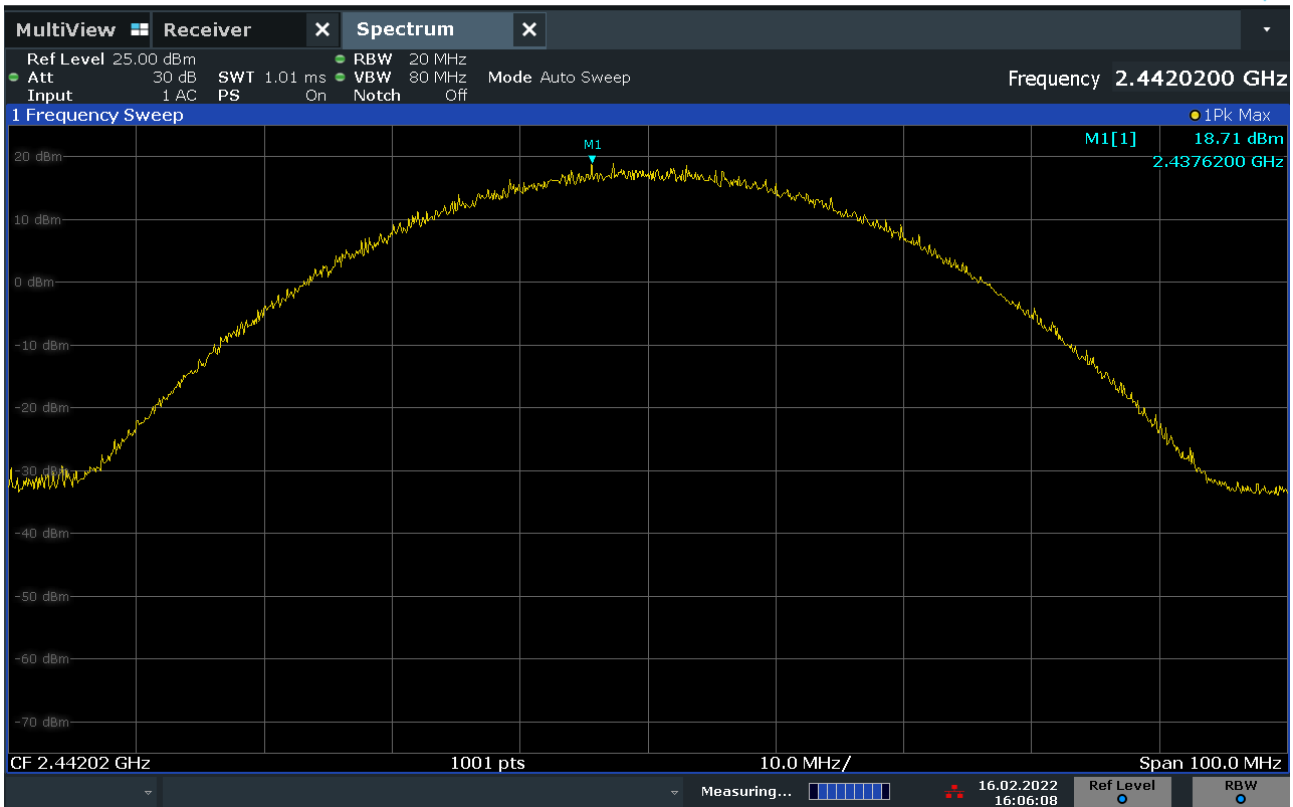


Figure 7.2.6.5 Peak output power, Operation on IEEE 802.11g channel 2442MHz

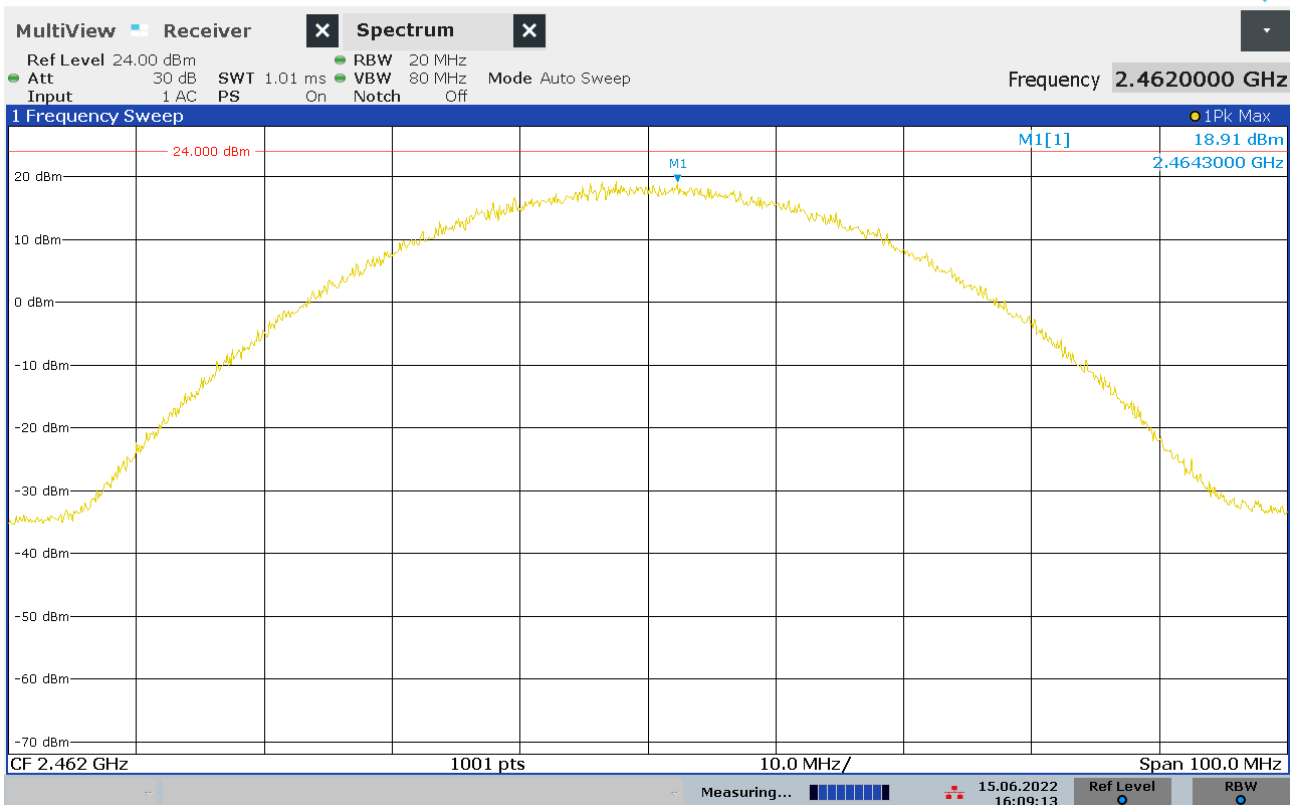


Figure 7.2.6.6 Peak output power, Operation on IEEE 802.11g channel 2462MHz

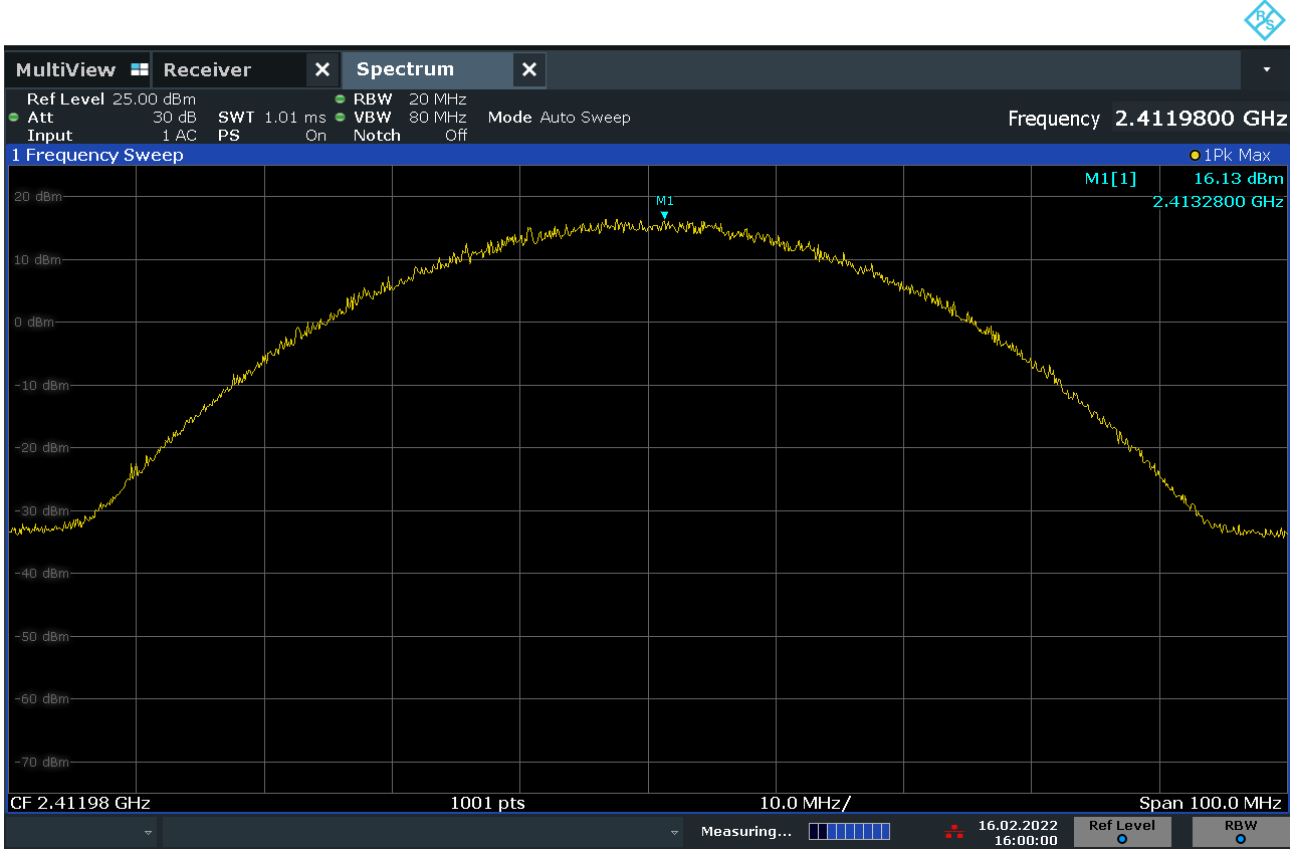


Figure 7.2.6.7 Peak output power, Operation on IEEE 802.11n channel 2412MHz

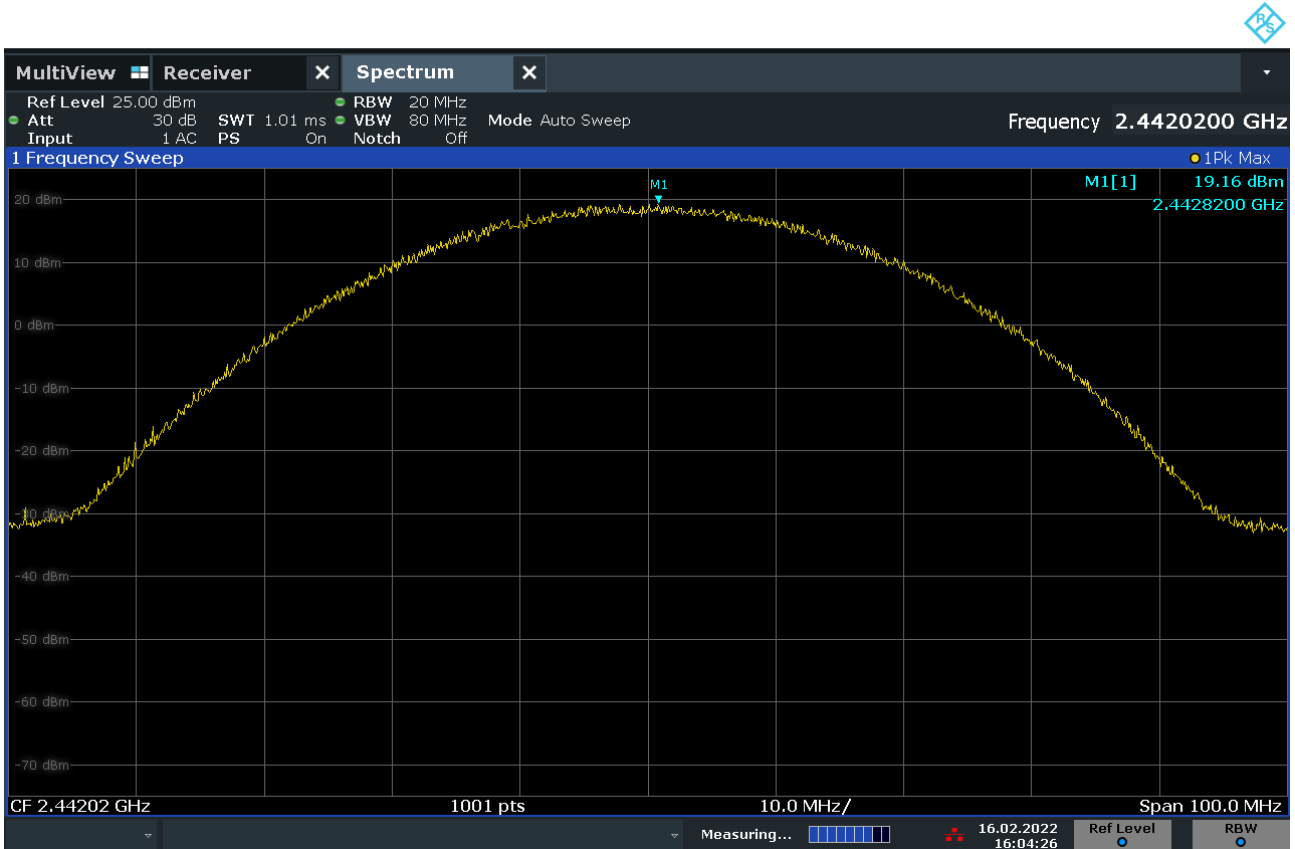


Figure 7.2.6.8 Peak output power, Operation on IEEE 802.11n channel 2442MHz

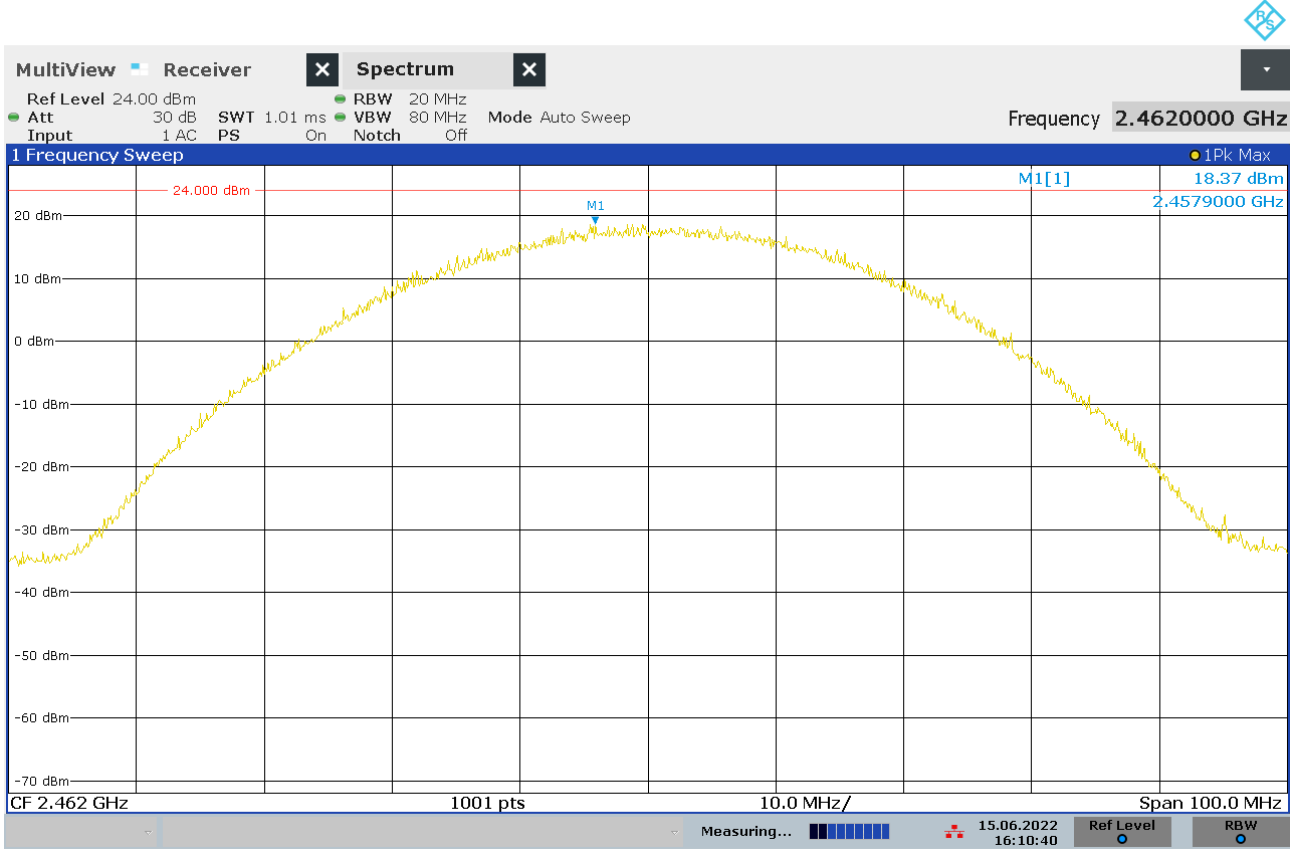


Figure 7.2.6.9 Peak output power, Operation on IEEE 802.11n channel 2462MHz



## Section 8 Power Spectral Density

### 8.1 Test Specification

FCC Rule Part	46CFR 15.247 (e)
Standard	ANSI C63.10:2013

### 8.2 Procedure and Test Software Version

#### Conducted Tests

ANSi C63.10-2013 Clause reference:	Clause 11.10.2
Test software	N/A

Frequency (MHz)	Limit, 47CFR 15.247(e)
	Peak
2400MHz to 2483.5MHz	<8dBm in any 3kHz band during any time interval of complete transmission

Spectrum analyser settings as specified by ANSI C63.10-2013 Clause 11.10.2

Receiver Parameters	Setting
Detector Function	Peak
Span	1.5xDTS bandwidth
Resolution Bandwidth	3kHz ≤RBW ≤100kHz
Video Bandwidth	3 x RBW
Sweep rate	Auto couple
Trace mode	Max hold

**8.2.1 Emissions measurements**

**8.2.2 Date of Test**

16<sup>th</sup> February and 17<sup>th</sup> June 2022

**8.2.3 Test Area**

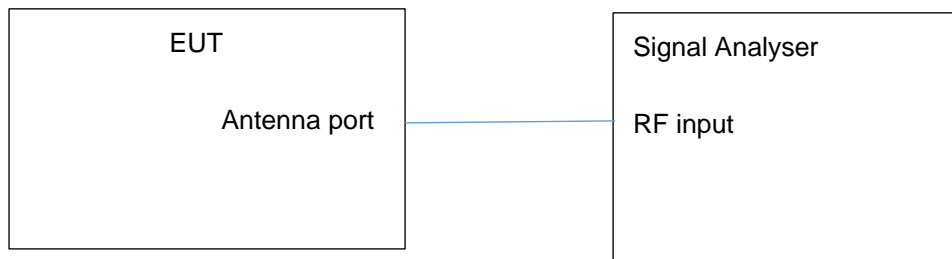
LAB 1

**8.2.4 Tested by**

J Bevers

**8.2.5 Test Setup**

The antenna port was connected directly to the signal analyser.



## 8.2.6 Test Results

Modulation scheme	Channel (MHz)	Power in 3kHz RBW (dBm)	Limit (dBm)	Figure	Result
IEEE 802.11b	2412	-10.21	8.0	8.2.6.1	Pass
IEEE 802.11b	2442	-6.96	8.0	8.2.6.2	Pass
IEEE 802.11b	2462	-8.88	8.0	8.2.6.3	Pass
IEEE 802.11g	2412	-17.21	8.0	8.2.6.4	Pass
IEEE 802.11g	2442	-16.12	8.0	8.2.6.5	Pass
IEEE 802.11g	2462	-13.85	8.0	8.2.6.6	Pass
IEEE 802.11n	2412	-19.14	8.0	8.2.6.7	Pass
IEEE 802.11n	2442	-16.10	8.0	8.2.6.8	Pass
IEEE 802.11n	2462	-14.31	8.0	8.2.6.9	Pass

**Peak Spectral Density Measurement**

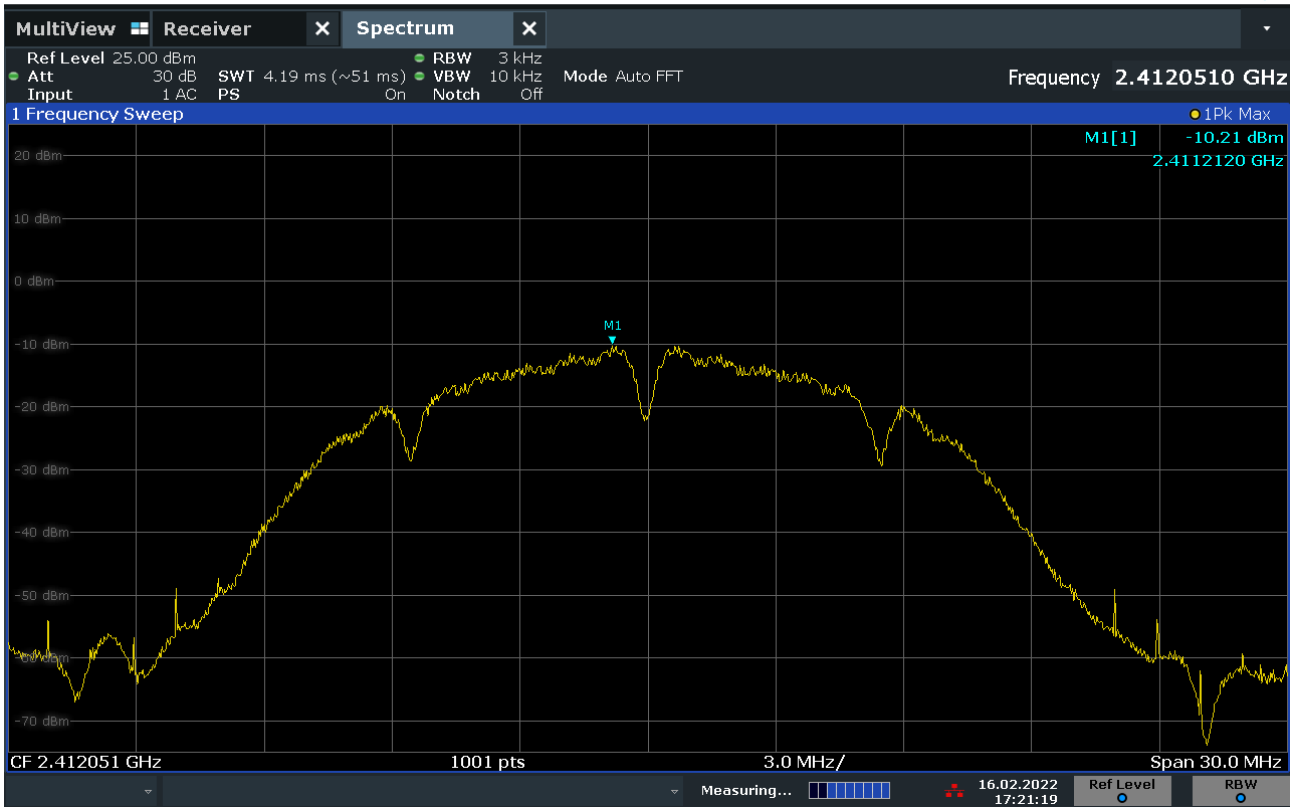


Figure 8.2.6.1 Power spectral density, Operation on IEEE 802.11b channel 2412MHz

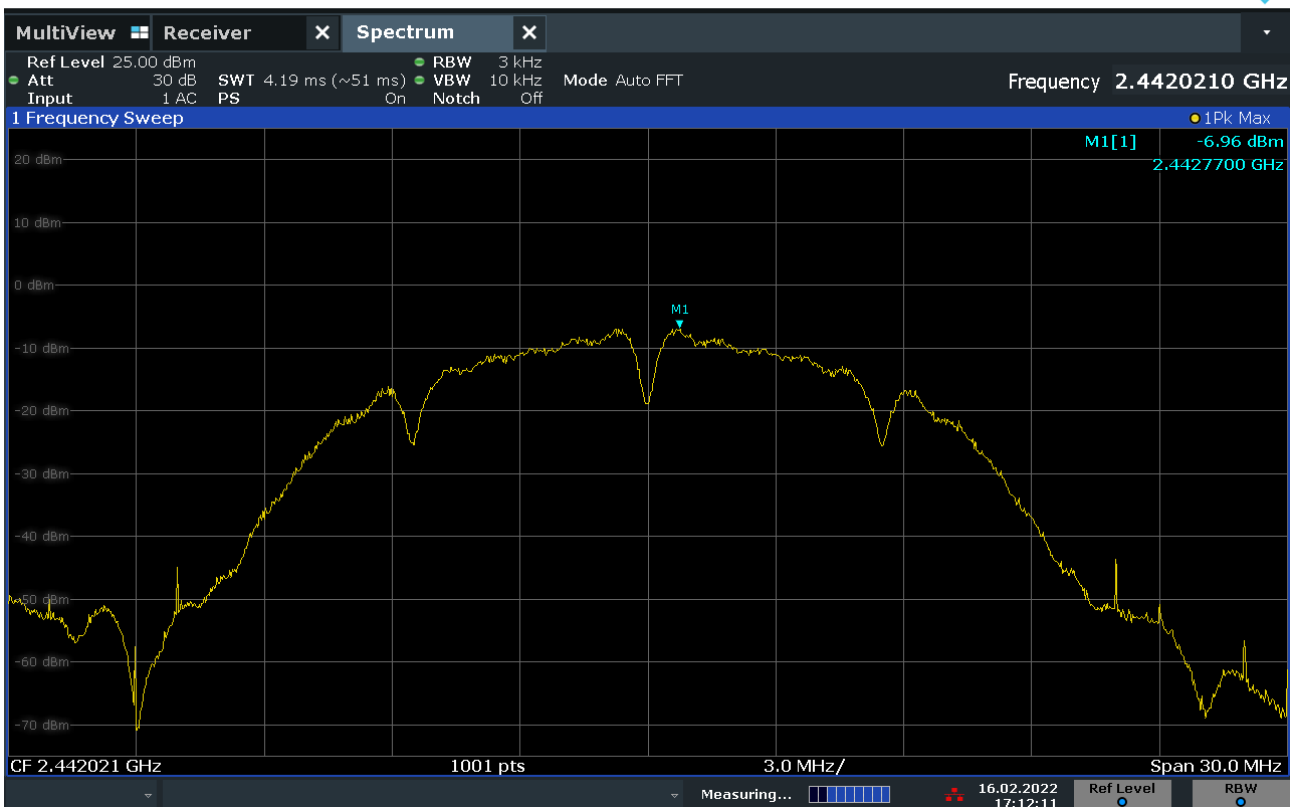


Figure 8.2.6.2 Power spectral density, Operation on IEEE 802.11b channel 2442MHz

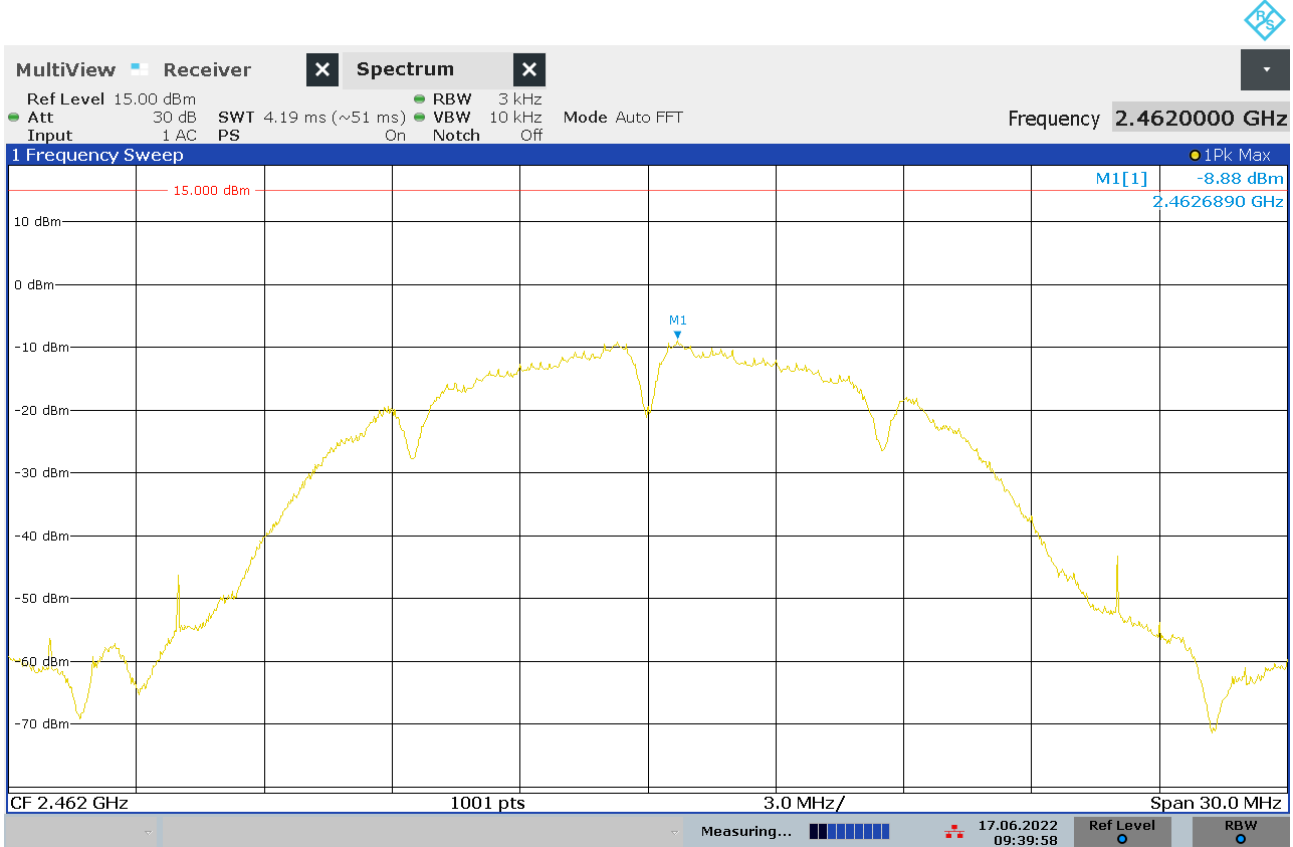


Figure 8.2.6.3 Power spectral density, Operation on IEEE 802.11b channel 2462MHz

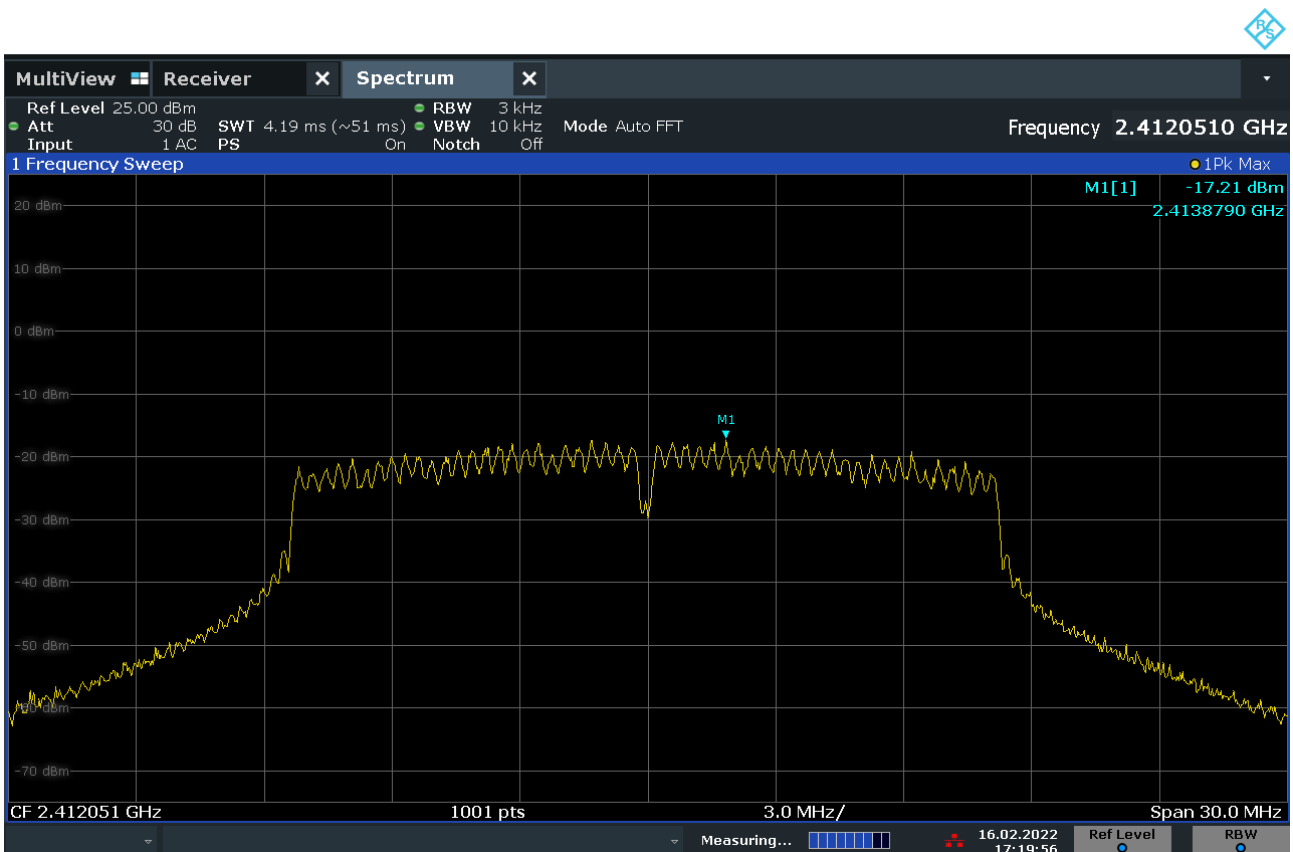


Figure 8.2.6.4 Power spectral density, Operation on IEEE 802.11g channel 2412MHz

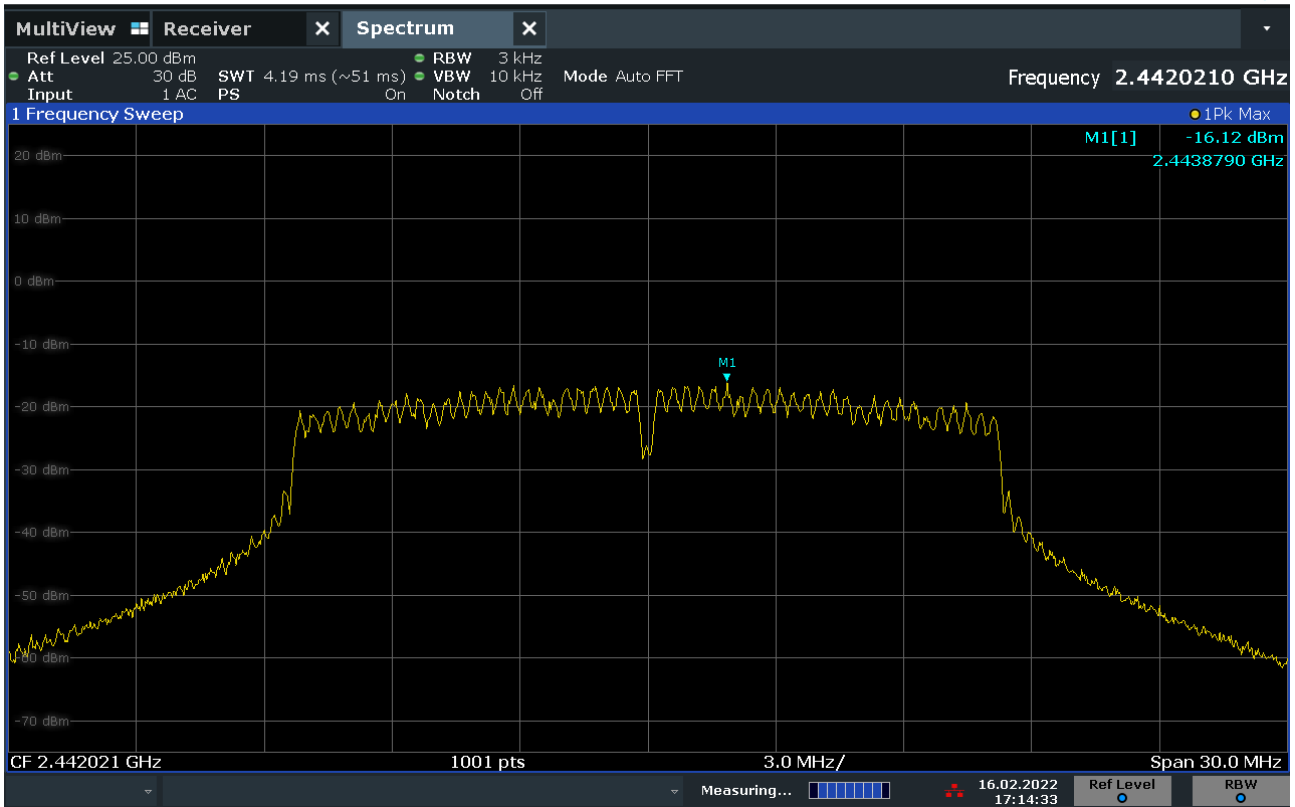


Figure 8.2.6.5 Power spectral density, Operation on IEEE 802.11g channel 2442MHz

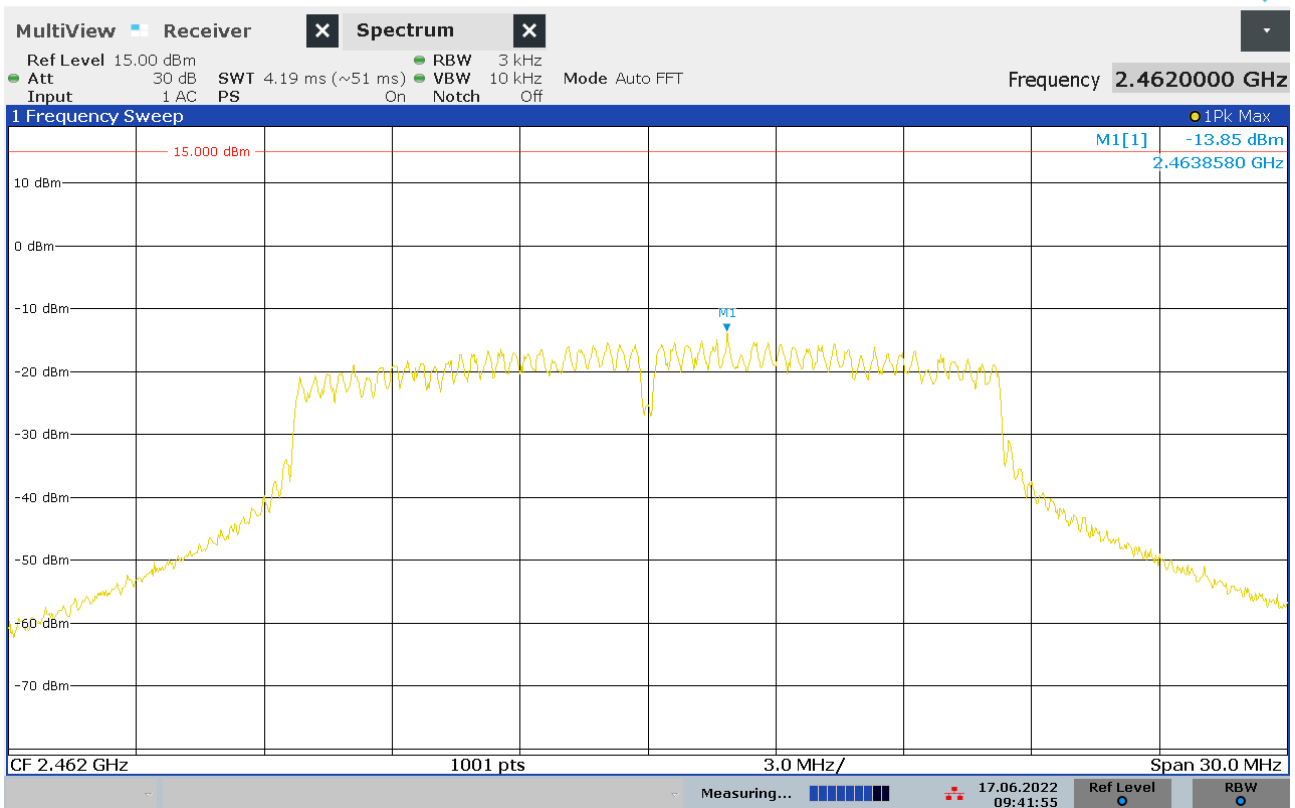


Figure 8.2.6.6 Power spectral density, Operation on IEEE 802.11g channel 2462MHz

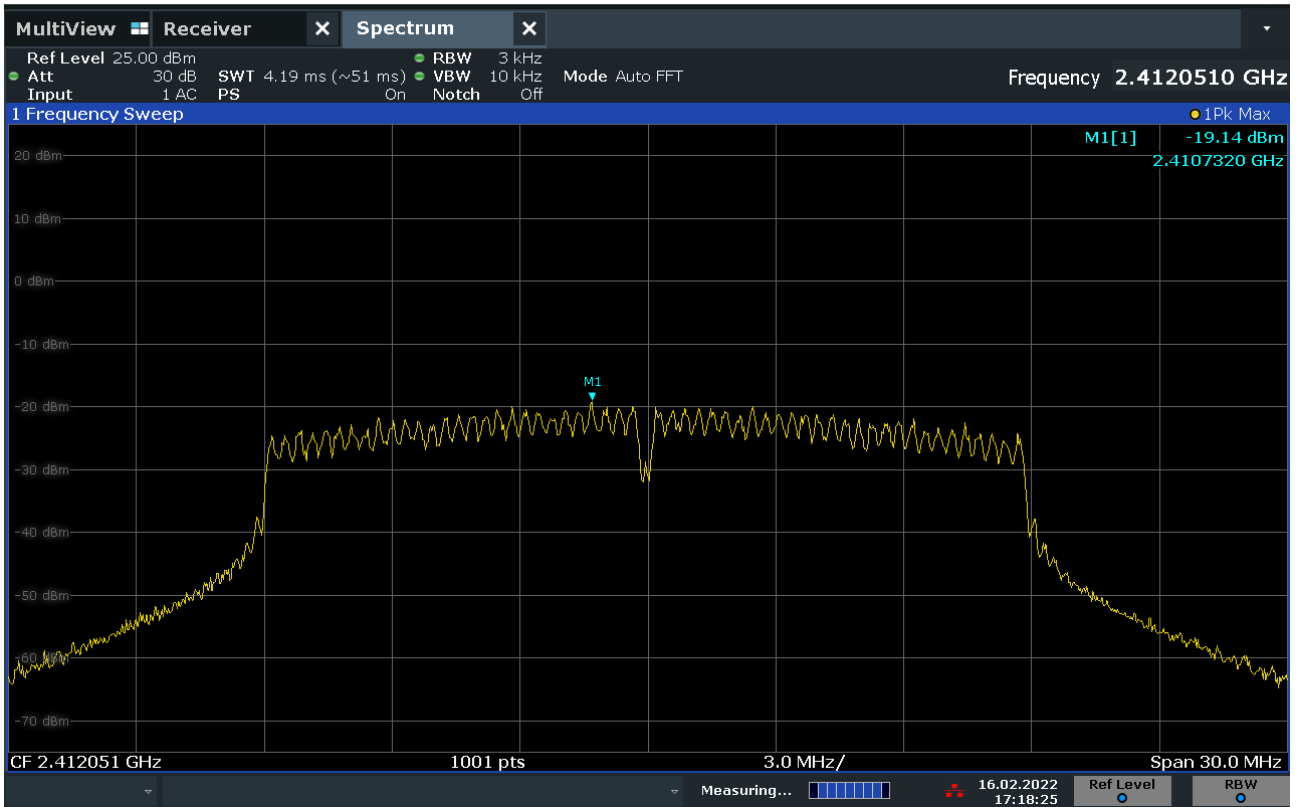


Figure 8.2.6.7 Power spectral density, Operation on IEEE 802.11n channel 2412MHz

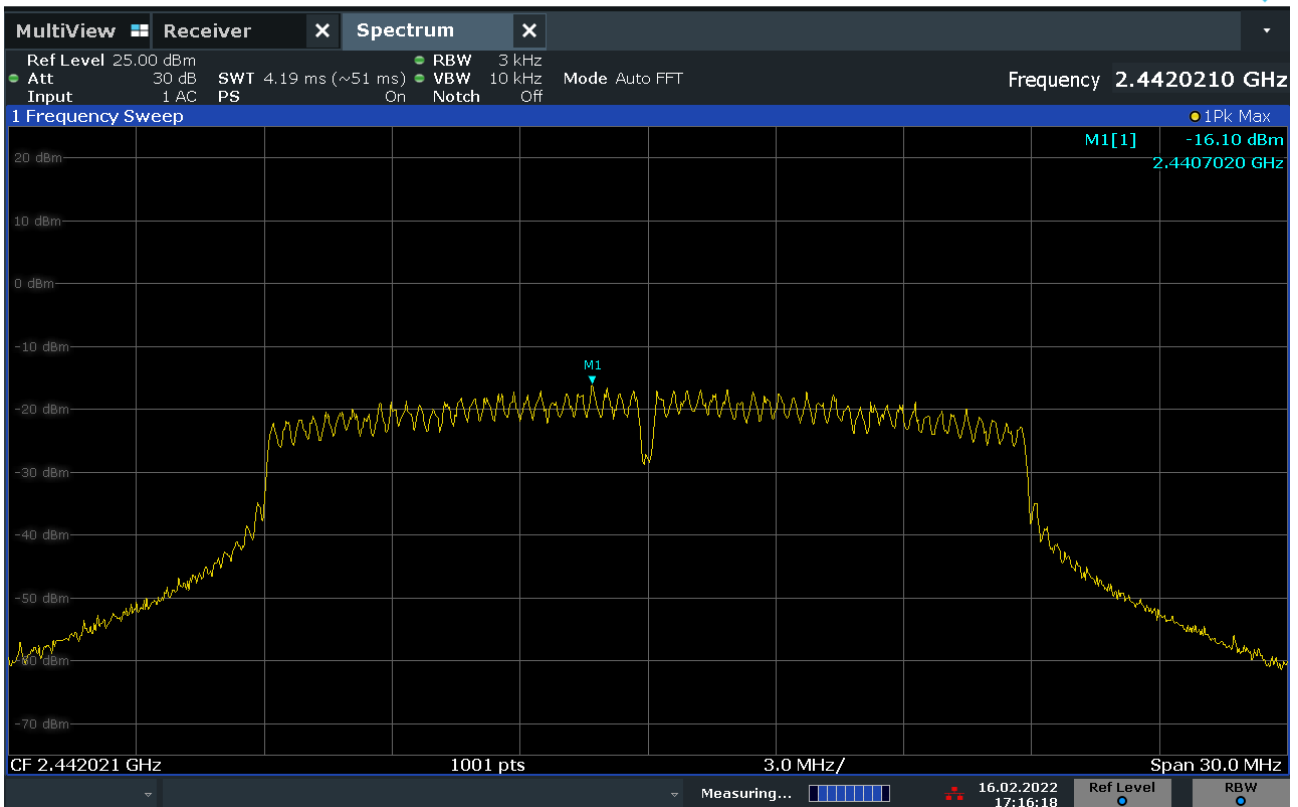


Figure 8.2.6.8 Power spectral density, Operation on IEEE 802.11n channel 2442MHz

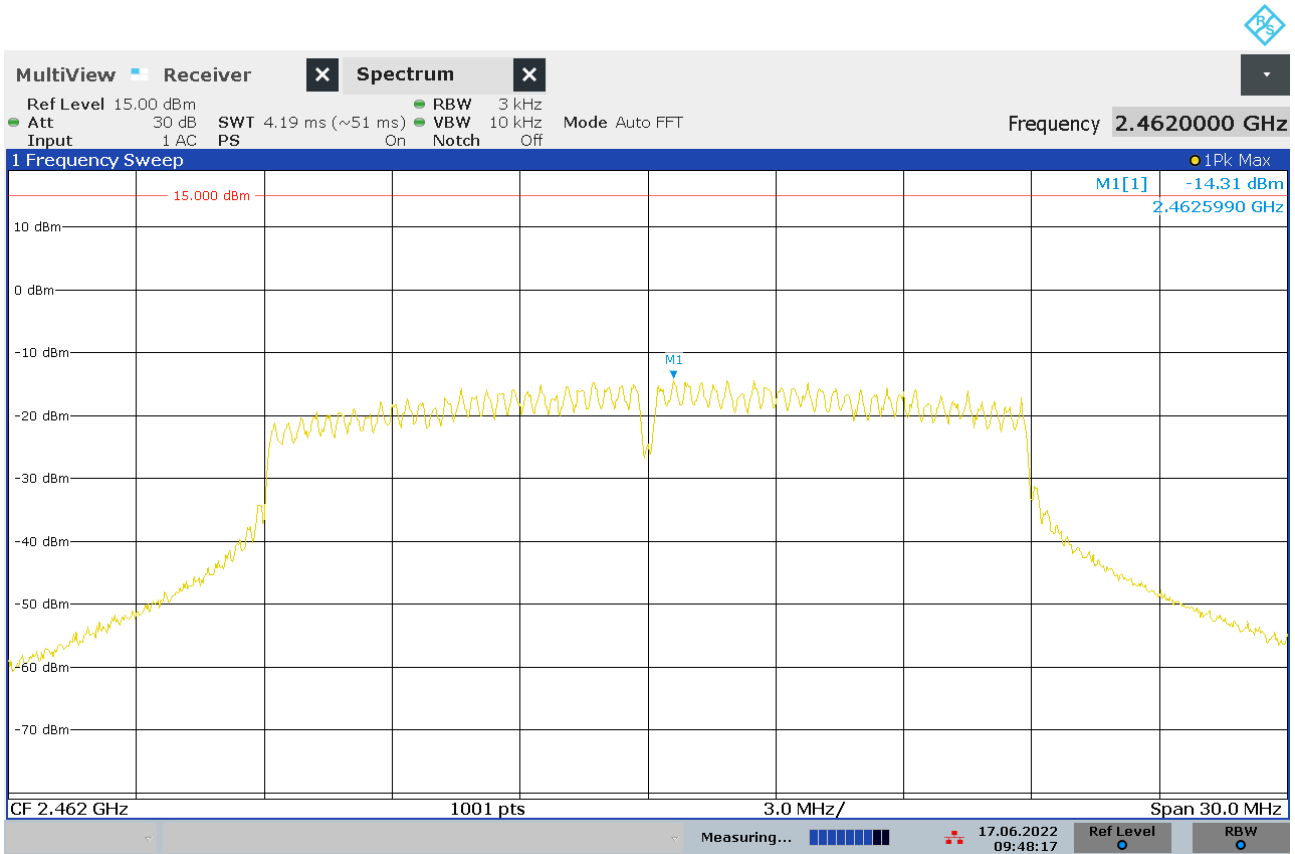


Figure 8.2.6.9 Power spectral density, Operation on IEEE 802.11n channel 2462MHz



## Section 9 Band Edge Compliance

### 9.1 Test Specification

FCC Rule Part	46CFR 15.205 and 47CFR15.209
Standard	ANSI C63.10:2013

### 9.2 Procedure and Test Software Version

#### Conducted Tests

ANSi C63.10-2013 Clause reference:	Clause 6.10.4 Authorised band-edge measurements
Test software	N/A

Frequency (MHz)	Limit, 47CFR 15.247(e)
	Peak
2400MHz to 2483.5MHz	Measured signal at the band edge must be below the radiated emission limits of 47CFR15.209

Spectrum analyser settings as specified by ANSI C63.10-2013 Clause 6.10.5 “Restricted band-edge measurements”

Receiver Parameters	Setting
Detector Function	Peak
Span	As necessary
Resolution Bandwidth	1MHz
Video Bandwidth	3 x RBW
Sweep rate	Auto couple
Trace mode	Max hold

**9.2.1 Emissions measurements**

**9.2.2 Date of Test**

11<sup>th</sup> February and 16<sup>th</sup> June 2022

**9.2.3 Test Area**

LAB 1

**9.2.4 Tested by**

J Beevers

**9.2.5 Test Setup**

The test setup was identical to radiated emissions testing 1-18GHz.

**9.2.6 Test Results**

Results are presented in two formats:

Tabular results of measurements at the band edges. Manual measurements were performed to measure the maximum value of signal at the band edge. The tabular data includes the following:

1. Polarity of the measurement antenna
2. Frequency at the band edge
3. Amplitude of signal at the input of the test receiver
4. Pre-amplifier gain
5. Cable loss
6. Antenna factor
7. Resultant Electric field strength = 3-4+5+6

Spectrum analyser screen displays are also included. Please note that the screen displays do not include losses or antenna factor.

## Tabular Data IEEE 802.11b modulation

The following radiated measurements were made at the band edges:

## Upper band edge

Polarity	frequency (MHz)	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF(dB/m)	E (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	2483.5	64.70	50.61	4.28	29.89	48.25	74	25.75
V	2483.5	85.00	50.61	4.28	29.89	68.55	74	5.45

Operation on IEEE 802.11b 2462MHz Channel, Peak detector measurements

Polarity	frequency (MHz)	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF(dB/m)	E (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	2483.5	51.80	50.61	4.28	29.89	35.35	54	18.65
V	2483.5	64.50	50.61	4.28	29.89	48.05	54	5.95

Operation on IEEE 802.11b Channel 2462MHz, average detector measurements

## Lower band edge

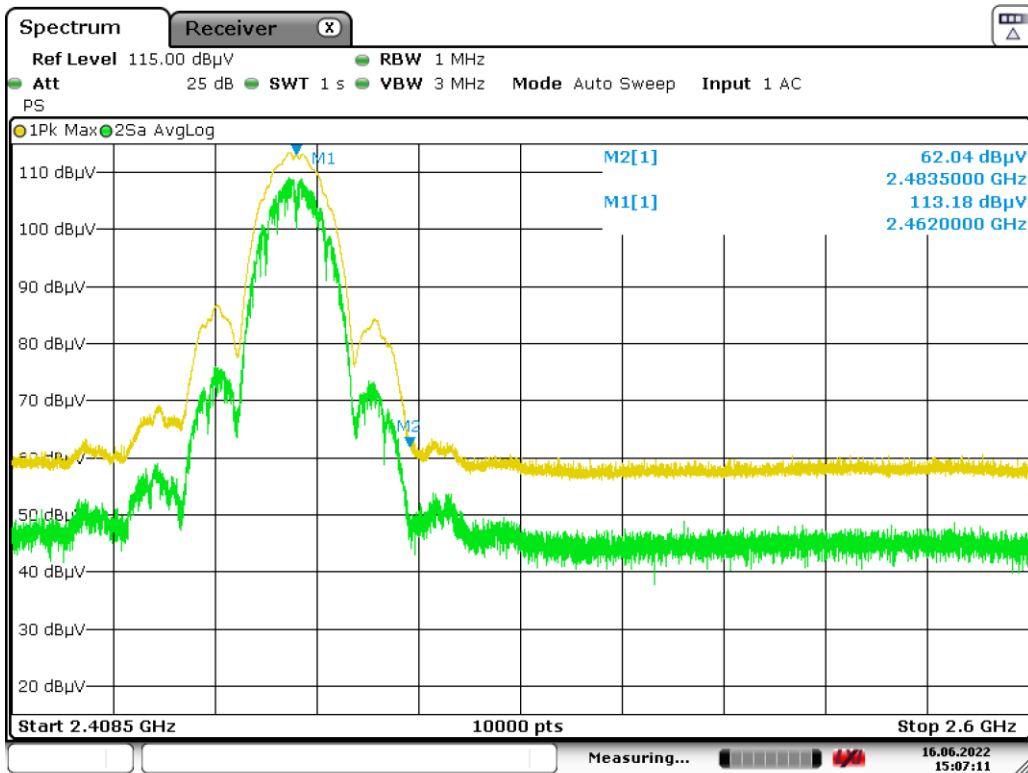
Polarity	frequency (MHz)	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF(dB/m)	E (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	2400	59.70	50.61	4.16	29.67	42.92	74	-31.08
V	2400	73.60	50.61	4.16	29.67	56.82	74	-17.18

Operation on IEEE 802.11b channel 2412MHz Peak detector measurements

Polarity	frequency (MHz)	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF(dB/m)	E (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	2400	49.50	50.61	4.16	29.67	32.72	54	-21.28
V	2400	69.50	50.61	4.16	29.67	52.72	54	-1.28

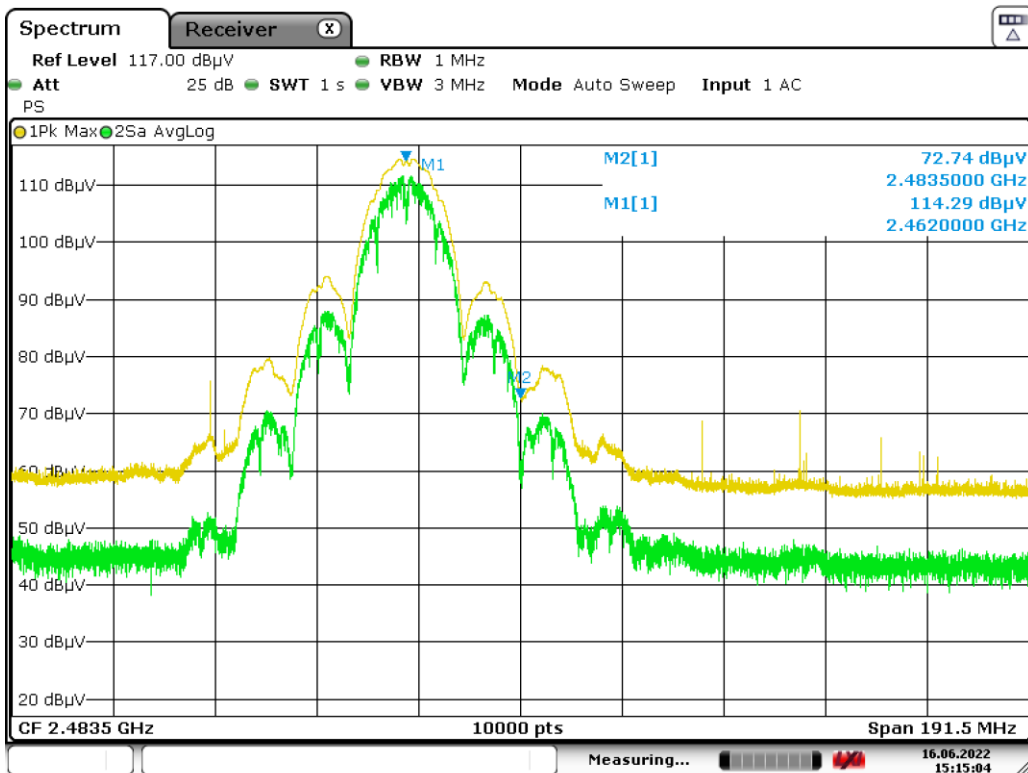
Operation on IEEE 802.11b channel 2412MHz average detector measurements

Spectrum analyser displays IEEE 802.11b modulation



Date: 16 JUN.2022 15:07:11

Band Edge Measurement IEEE 802.11b – upper band edge - horizontal polarity



Date: 16 JUN.2022 15:15:05

Band Edge Measurement IEEE 802.11b – upper band edge - vertical polarity



**Tabular Data IEEE 802.11g modulation**

The following radiated measurements were made at the band edges:

**Upper band edge**

Polarity	frequency (MHz)	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF(dB/m)	E (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	2483.5	83.70	50.61	4.28	29.89	67.25	74	6.75
V	2483.5	82.90	50.61	4.28	29.89	66.45	74	7.55

**Operation on IEEE 802.11g 2462MHz Channel, Peak detector measurements**

Polarity	frequency (MHz)	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF(dB/m)	E (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	2483.5	64.00	50.61	4.28	29.89	47.55	54	6.45
V	2483.5	61.90	50.61	4.28	29.89	45.45	54	8.55

**Operation on IEEE 802.11g Channel 2462MHz, average detector measurements****Lower band edge**

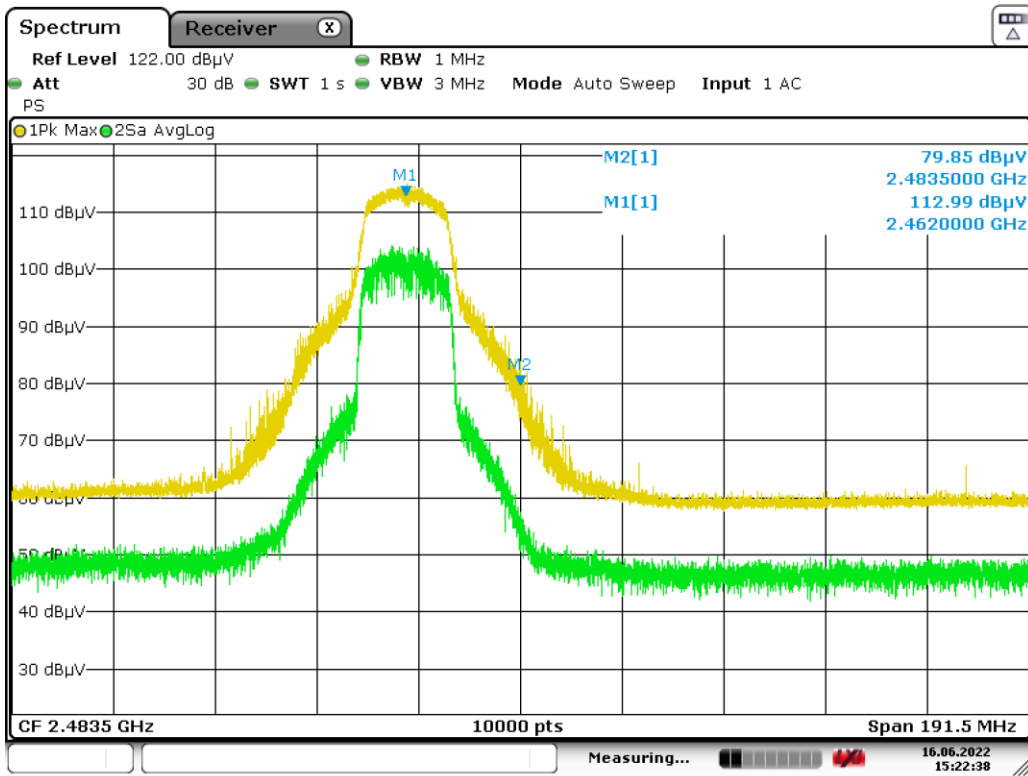
Polarity	frequency (MHz)	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF(dB/m)	E (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	2400	71.10	50.61	4.16	29.67	54.32	74	-19.68
V	2400	87.30	50.61	4.16	29.67	70.52	74	-3.48

**Operation on IEEE 802.11g channel 2412MHz Peak detector measurements**

Polarity	frequency (MHz)	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF(dB/m)	E (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	2400	51.90	50.61	4.16	29.67	35.12	54	-18.88
V	2400	69.10	50.61	4.16	29.67	52.32	54	-1.68

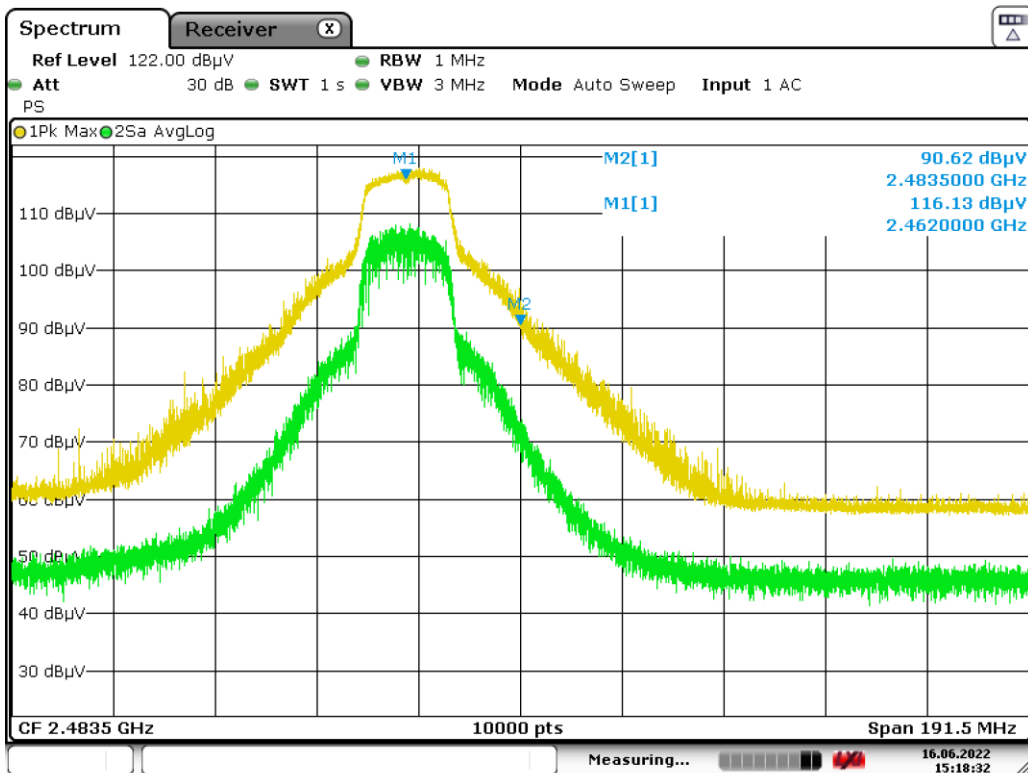
**Operation on IEEE 802.11g channel 2412MHz average detector measurements**

Spectrum analyser displays IEEE 802.11g modulation



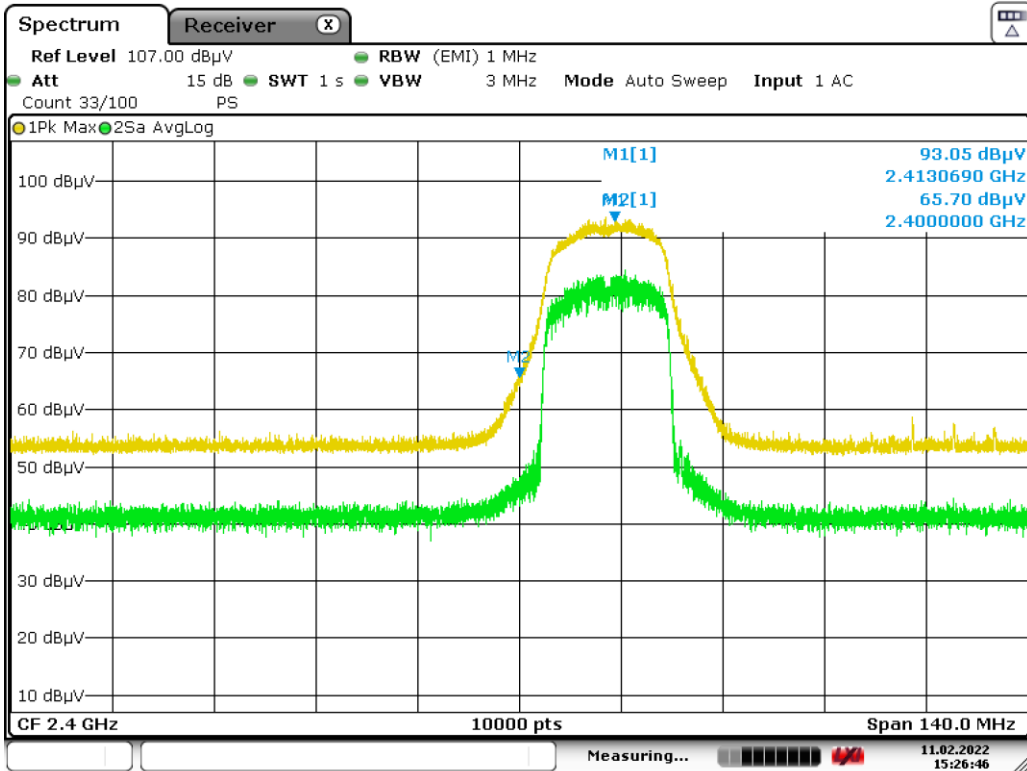
Date: 16 JUN.2022 15:22:38

Band Edge Measurement IEEE 802.11g – upper band edge - horizontal polarity



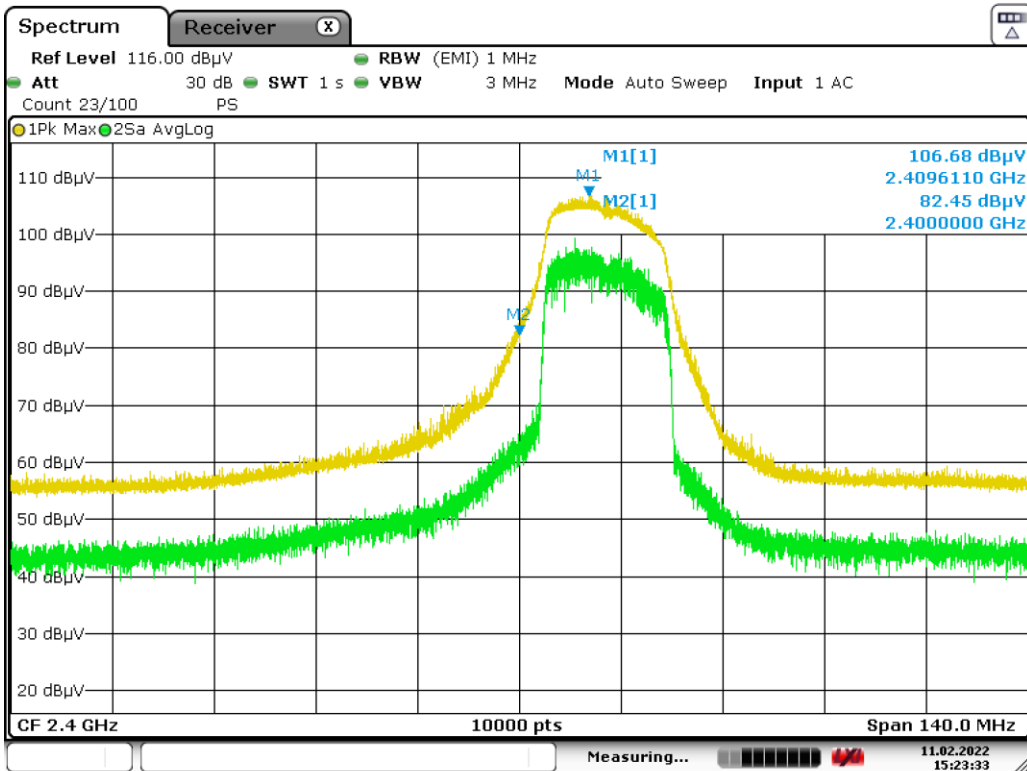
Date: 16 JUN.2022 15:18:32

Band Edge Measurement IEEE 802.11g – upper band edge - vertical polarity



Date: 11.FEB.2022 15:26:46

**Band Edge Measurement IEEE 802.11g – lower band edge - horizontal polarity**



Date: 11.FEB.2022 15:23:33

**Band Edge Measurement IEEE 802.11g – lower band edge - vertical polarity**



## Tabular Data IEEE 802.11n modulation

The following radiated measurements were made at the band edges:

## Upper band edge

Polarity	frequency (MHz)	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF(dB/m)	E (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	2483.5	88.80	50.61	4.28	29.89	72.35	74	1.65
V	2483.5	70.70	50.61	4.28	29.89	54.25	74	19.75

Operation on IEEE 802.11n 2462MHz Channel, Peak detector measurements

Polarity	frequency (MHz)	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF(dB/m)	E (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	2483.5	68.50	50.61	4.28	29.89	52.05	54	1.95
V	2483.5	50.50	50.61	4.28	29.89	34.05	54	19.95

Operation on IEEE 802.11n Channel 2462MHz, average detector measurements

## Lower band edge

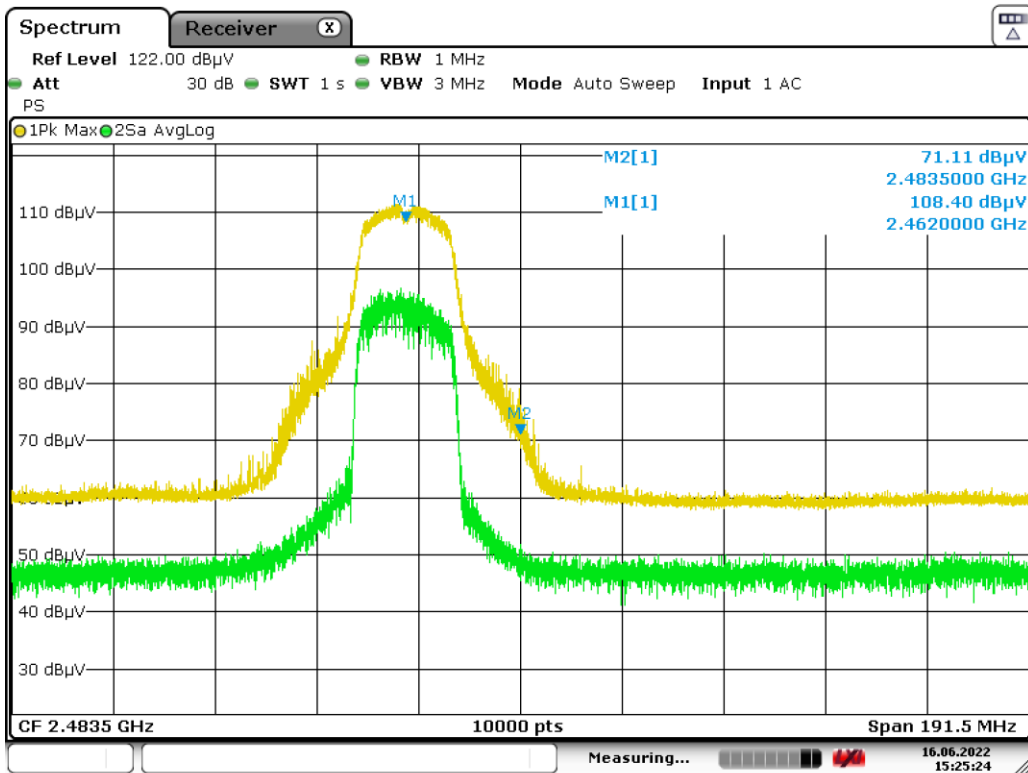
Polarity	frequency (MHz)	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF(dB/m)	E (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	2400	71.10	50.61	4.16	29.67	54.32	74	-19.68
V	2400	87.90	50.61	4.16	29.67	71.12	74	-2.88

Operation on IEEE 802.11n channel 2412MHz Peak detector measurements

Polarity	frequency (MHz)	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF(dB/m)	E (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	2400	50.60	50.61	4.16	29.67	33.82	54	-20.18
V	2400	68.00	50.61	4.16	29.67	51.22	54	-2.78

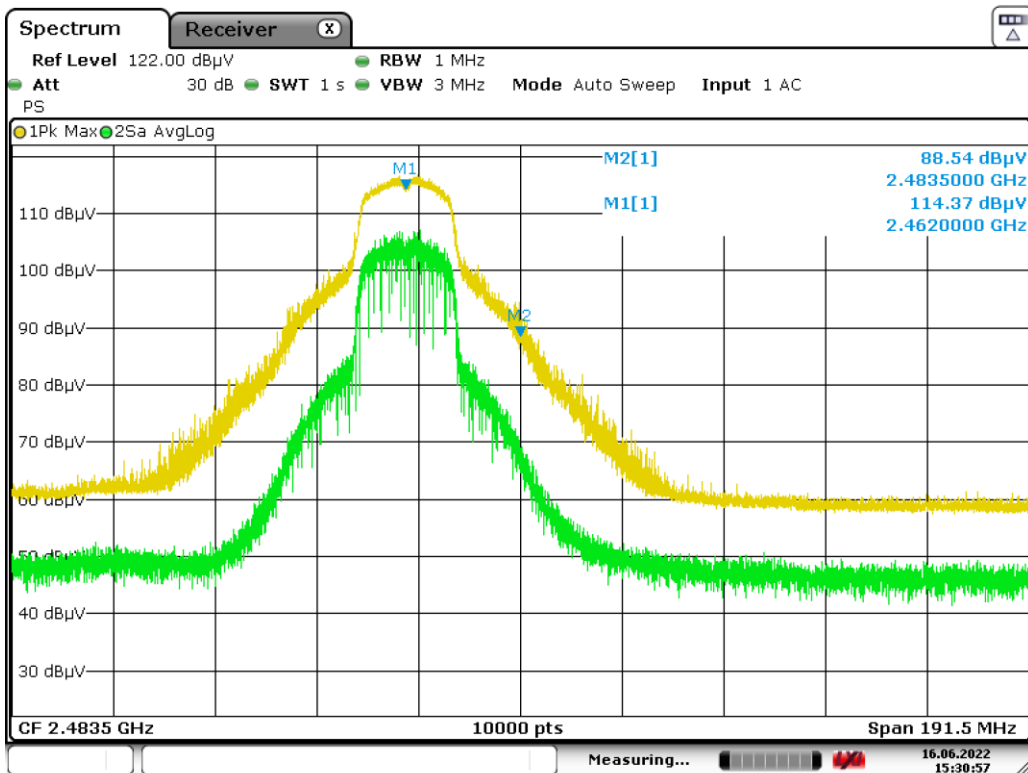
Operation on IEEE 802.11n channel 2412MHz average detector measurements

Spectrum analyser displays IEEE 802.11n modulation



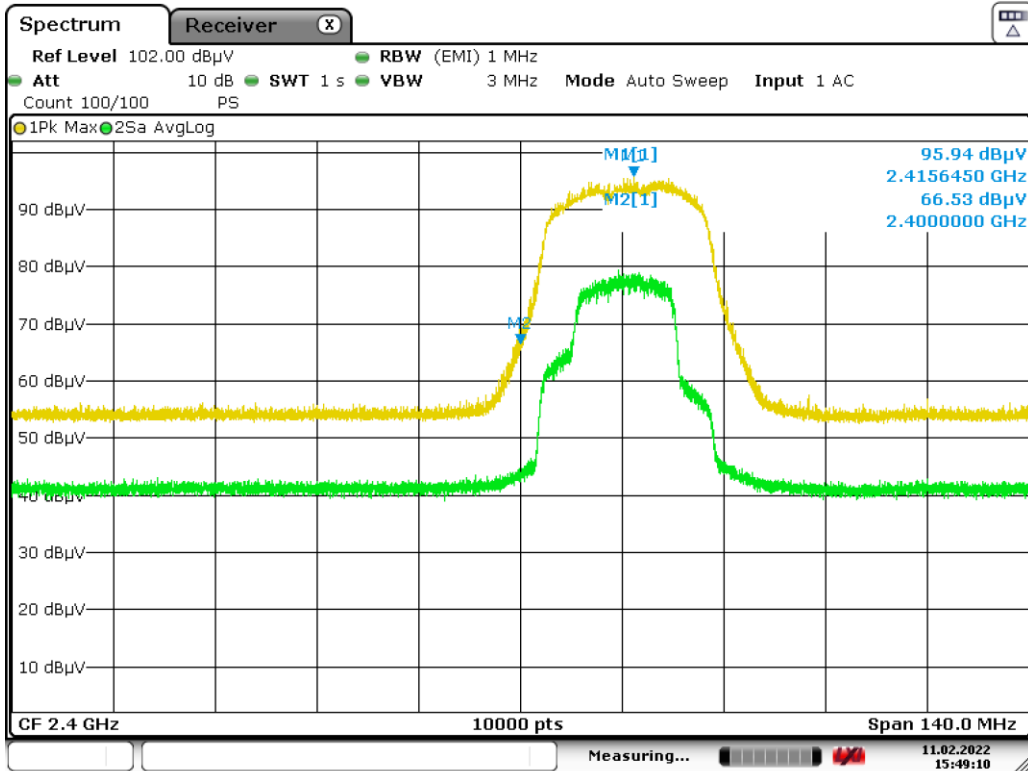
Date: 16 JUN.2022 15:25:24

Band Edge Measurement IEEE 802.11n – upper band edge - horizontal polarity



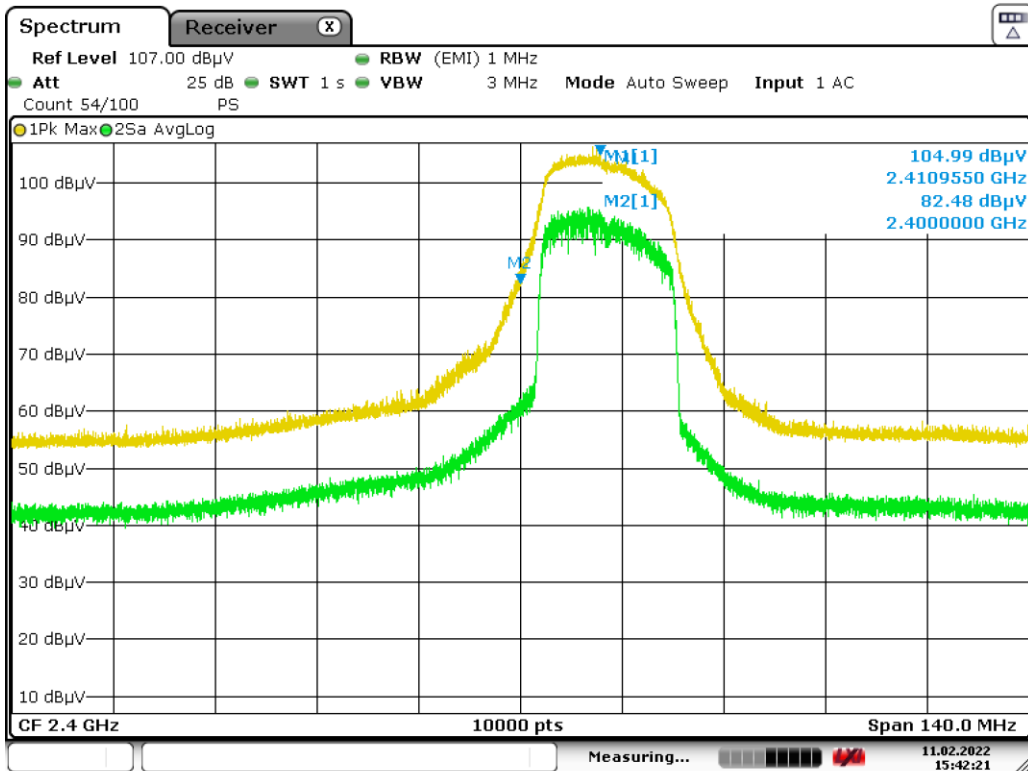
Date: 16 JUN.2022 15:30:58

Band Edge Measurement IEEE 802.11n – upper band edge - vertical polarity



Date: 11.FEB.2022 15:49:10

**Band Edge Measurement IEEE 802.11n – lower band edge - horizontal polarity**



Date: 11.FEB.2022 15:42:21

**Band Edge Measurement IEEE 802.11n – lower band edge - vertical polarity**

## Appendix A EUT Test Photos

Test set up photographs are supplied separately.

## Appendix B Test Equipment List

### Conducted Emissions from Antenna Port

Item	Serial No.	Last Calibration Date	Calibration Interval
RF Cable	Cable 14	January 2022	12 Months
Rhode & Schwarz ESW EMI Receiver	C0658	15 <sup>th</sup> November 2021	12 Months

**Radiated Emissions Equipment**

<b>Item</b>	<b>Serial No.</b>	<b>Last Calibration Date</b>	<b>Calibration Interval</b>
Laboratory 1 Semi-Anechoic Chamber	Lab 1	28 <sup>th</sup> January 2020	36 Months
ETS Lindgren 2017B Mast (1 – 4m) with tilting mechanism	--	N/A	N/A
R & S ESR26	C0502	10 <sup>th</sup> November 2021	12 Months
Teseq CBL 6112D Bilog antenna	C0506	15 <sup>th</sup> July 2021	36 Months
6dB Attenuator (For use with Bilog Antenna)	C0506B	15 <sup>th</sup> July 2021	36 Months
Teseq CBL6112D Bilog Antenna	C0506	15 <sup>th</sup> July 2021	36 Months
HF26 Cable	HF26	17 <sup>th</sup> January 2022	12 Months
HF35 Cable	HF35	17 <sup>th</sup> January 2022	12 Months
HF27 Cable	HF27	17 <sup>th</sup> January 2022	12 Months
Schwarzbeck D-69250 Antenna 1-18GHz	C0626	23 <sup>rd</sup> December 2021	24 Months
2.4GHz Microtronics BRM50702 notch filter	C0473	11 <sup>th</sup> January 2022	12 Months
BONN BLMA 0118-M Preamplifier	G0327	6 <sup>th</sup> January 2022	12 Months
ETS Lingren 3116C-PA Horn Antenna 18-40GHz	C0433	17 <sup>th</sup> October 2019	36 Months