


Test Report for the FCC and ISED Testing of a Raspberry Pi RMC2GW4B52 to FCC Rule 47CFR 15.247 and ISED RSS-247 for Raspberry Pi Ltd

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Issue	Description						Issue by	Date
4	Copy 1		Copy 2		PDF	√	JB	2 nd April 2024

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

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Test Report Change History

Issue	Date	Modification Details
1	2 nd February 2024	First Issue
2	14 th February 2024	Customer address updated
3	26 th March 2024	Channel list added
4	2 nd April 2024	Clarification of output power result added
5		
6		
7		
8		
9		
10		

Section 1 Test Location

All testing was performed at;

Eurofins E&E UK	Unit 5
	Speedwell Road
	Castleford
	WF10 5PY
Tel:	01977 731173
Website	http://www.yorkemc.co.uk
UKAS Testing No.	1574

1.1 UKAS Accreditation

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

Eurofins E&E UK latest accreditation schedule can be found at:

http://www.ukas.org/testing/lab_detail.asp?lab_id=989&location_id=&vMenuOption=3

Eurofins E&E UK Castleford Laboratory, is an Accredited facility recognised by the Federal Communications Commission (FCC) for certification testing. The appropriate FCC Designation Number is UK2013, dated 1st March 2021.

Eurofins E&E UK Castleford Laboratory is recognised by ISED for certification testing.

ISED Assigned Code: 22959

CAB Identifier: UK0004

Section 2 Customer Information

Company name	Raspberry Pi Ltd
Address	194 Cambridge Science Park
	Milton Road
	Cambridge
	CB4 0AB
	United Kingdom
Contact	Tom Westcott
Email	tom.westcott@raspberrypi.com

Section 3 Equipment Details

3.1 Equipment Under Test (EUT)

Date received:	15 th November 2023
EUT name:	Raspberry Pi RMC2GW4B52
PMN:	Raspberry Pi RMC2GW4B52
HVIN:	Raspberry Pi RMC2GW4B52
FCC ID:	2ABCB-RMC2GW4B52
IC:	20953-RMC2GW4B52
EUT description:	The RMC2GW4B52 is a radio module with an on board antenna. The module has 2.4GHz Wi-Fi, Bluetooth classic and Bluetooth Low Energy functionality, which allows the user to connect to a 2.4GHz Wi-Fi network, BT Classic 5 compliant devices and BLE devices.
Antenna	Integral Antenna
Transmission	Digital Transmission System (DTS) Bluetooth Low Energy (BLE)
Modulation schemes	PRBS9
Operating frequency band	2400MHz to 2483.5MHz
No of units tested:	Unit 1: radiated tests Unit 2: conducted tests
EUT power:	3.3V via USB port
Highest internal frequency:	2.480GHz
Mode/s of operation:	Continuous transmit of packetised data at top, middle and bottom channels. Channels used: 2402MHz, 2440MHz and 2480MHz
Test software:	bt_mfg_test.uf2 Test Firmware installed. The radio module was mounted on a representative PCB and the test modes were controlled via USB connection to a Raspberry Pi 400 device. The output power was set to the default value in the test software.
Modifications incorporated during testing:	N/A

Ports and Cables	Cable Length	Screened/ unscreened	Connected to
USB cable	1m	unscreened	Raspberry Pi 400

EUT Monitoring/Auxiliary Equipment

Equipment name	Type no.	Serial no
Raspberry Pi 400	RPI-400	80000290905

3.2 EUT Photographs

Photographs are supplied separately.

3.3 Configuration of EUT

The apparatus was supplied in one single possible configuration.

BLE Channel Number	Frequency	BLE Channel Number	Frequency
0	2404 MHz	20	2446 MHz
1	2406 MHz	21	2448 MHz
2	2408 MHz	22	2450 MHz
3	2410 MHz	23	2452 MHz
4	2412 MHz	24	2454 MHz
5	2414 MHz	25	2456 MHz
6	2416 MHz	26	2458 MHz
7	2418 MHz	27	2460 MHz
8	2420 MHz	28	2462 MHz
9	2422 MHz	29	2464 MHz
10	2424 MHz	30	2466 MHz
11	2428 MHz	31	2468 MHz
12	2430 MHz	32	2470 MHz
13	2432 MHz	33	2472 MHz
14	2434 MHz	34	2474 MHz
15	2436 MHz	35	2476 MHz
16	2438 MHz	36	2478 MHz
17	2440 MHz	37*	2402 MHz
18	2442 MHz	38*	2426 MHz
19	2444 MHz	39*	2480 MHz

*Advertising channels.

BLE Channelization

Lowest channel	Default
Middle channel	Default
Highest channel	Default

Power settings table

Note: Modulation type PRBS9 Pattern. Packet type 3-DH1. Packet length 65535 used for all tests.

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:**

Regulation / Test Standard	<p>Regulation:</p> <p>Title 47 of the Code of Federal Regulations (CFR) Part 15 (47CFR15) Subpart C – Intentional Radiators</p> <p>Measurement standard:</p> <p>ANSI C63.10-2013 American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices</p>
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Requirement	FCC Rule Part	Comments	Result Summary
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:

Regulation / Test Standard	<p>RSS-247 Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices Issue 3 August 2023</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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Requirement	ISED Regulation	Comments	Results Summary
99% 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
414788	Test Site Validation Requirements above 1 GHz.	07/12/2018
414788	Comparison Noise Emitter (CNE), reference noise source, .pdf	07/12/2018
913591	Measurement of radiated emissions at the band-edge for a Part 15 RF Device	04/05/2017
414788	Comparison Noise Emitters (CNE), test equipment, Broadband.pdf	07/12/2018

4.2 Compliance Statement

The Raspberry Pi RMC2GW4B52, as tested, was shown to meet requirements of the standards listed in Section 4 of this report.

Note: Only the Bluetooth Low Energy (BLE) functionality has been testing in 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 expended 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 +/- 5.01dB for the frequency range from 9kHz to 30MHz +/- 6.26dB for the frequency range 30MHz to 1GHz +/- 5.14dB for the frequency range from 1GHz to 6GHz +/- 5.45dB for the frequency range from 6GHz to 18GHz
Measurement Uncertainty Conducted Power tests	± 1.4 dB

5.2 Procedure and Test Software Version

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

Eurofins E&E UK test procedure (30MHz to 1GHz)	CEP23 Issue 9
Eurofins E&E UK test procedure (1GHz to 40GHz)	CEP64 Issue 10
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)	Electric Field Strength 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**

20th November 2023

5.3.4 Test Area

LAB 1 (SAC)

5.3.5 Tested by

L Trickett

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.

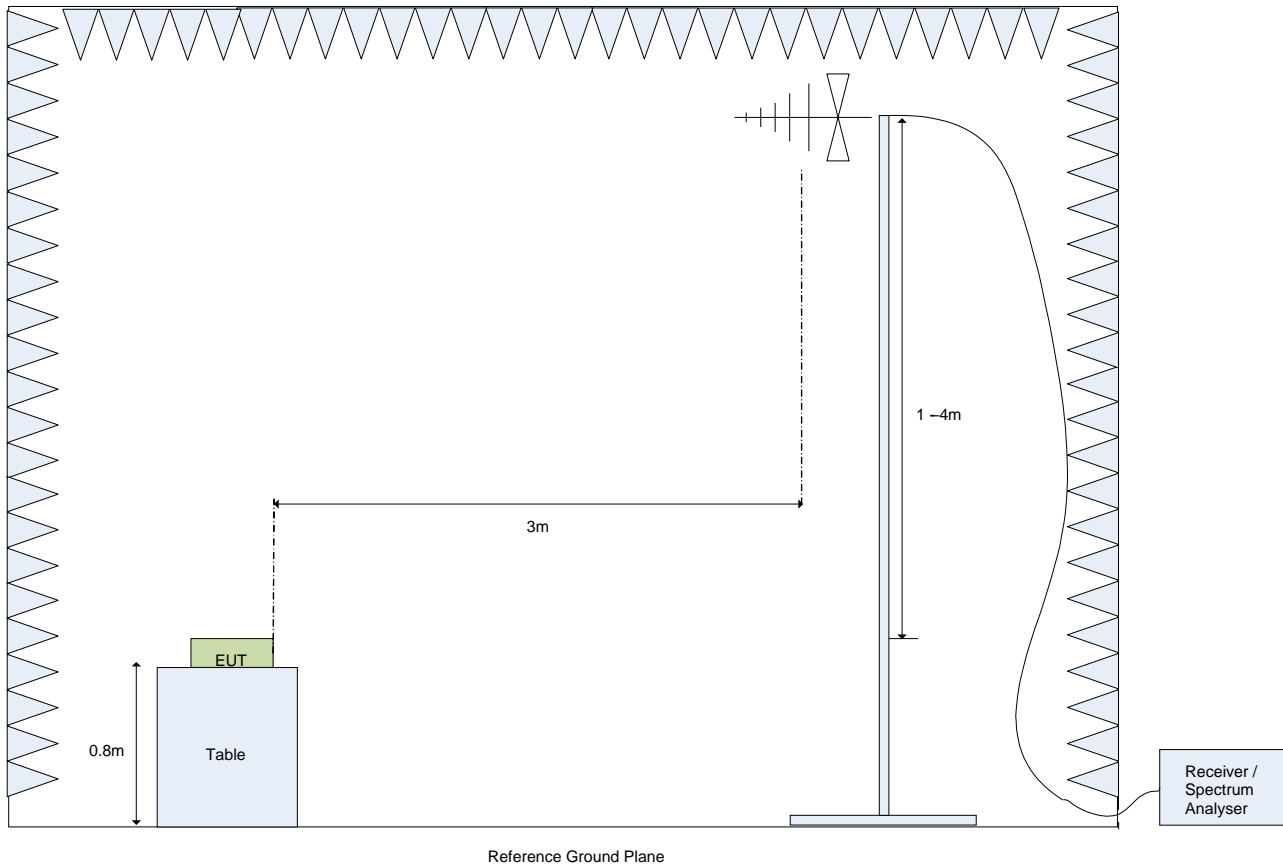


Figure 1 Test Setup for E-Field Measurements from 30MHz to 1GHz

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: 2402MHz, 2440MHz and 2480MHz.

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 2440MHz.

5.3.7 Electric field emissions, 30MHz to 1GHz



Figure 2 Electric field emissions Plot, 30MHz to 1GHz, 2440MHz Operation

Frequency	Quasi-Peak	Quasi Peak Limit	Quasi-Peak Difference	Quasi-Peak Status	Angle	Height	Polarization
MHz	dBμV/m	dBμV/m	dB		degrees	m	
148.5	39.1	43.5	-4.4	Pass	245	1.0	Vertical
211.9	21.8	43.5	-21.7	Pass	245	1.3	Vertical
319.0	11.4	46.0	-34.6	Pass	225	2.1	Vertical
480.0	27.6	46.0	-18.4	Pass	360	1.0	Horizontal
93.7	30.6	43.5	-12.9	Pass	35	1.0	Vertical
91.5	29.7	43.5	-13.8	Pass	25	1.0	Vertical
76.4	22.4	40.0	-17.6	Pass	50	1.4	Vertical

Table 1 Electric Field Emissions Peaks, 30MHz to 1GHz. 2440MHz Operation

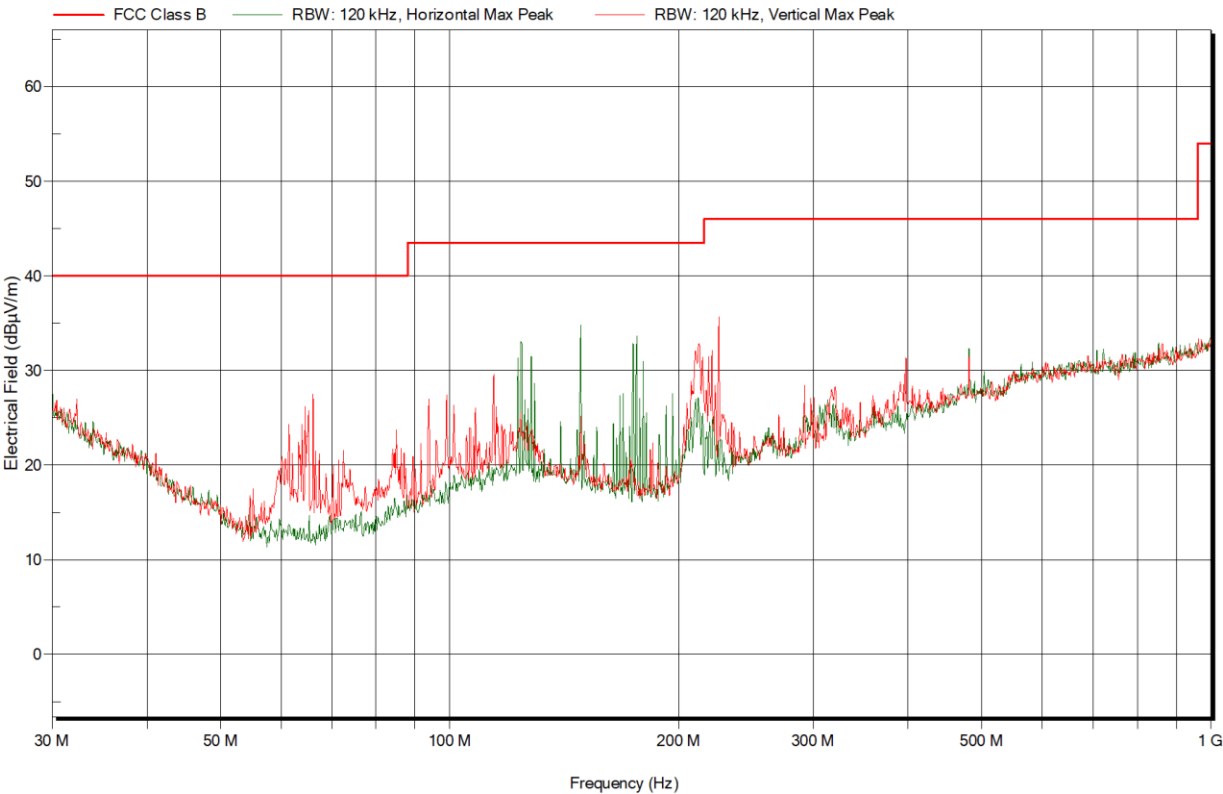


Figure 3 Electric field emissions Plot, 30MHz to 1GHz, Operation on 2402MHz - Peak detector scan



Figure 4 Electric field emissions Plot, 30MHz to 1GHz, Operation on 2480MHz - Peak detector scan

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

Frequency (GHz)	Limit (dB μ V/m)	Limit (dB μ 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**21st November 2023**5.4.5 Test Area**

LAB 1 (SAC)

5.4.6 Tested by

L Trickett

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.

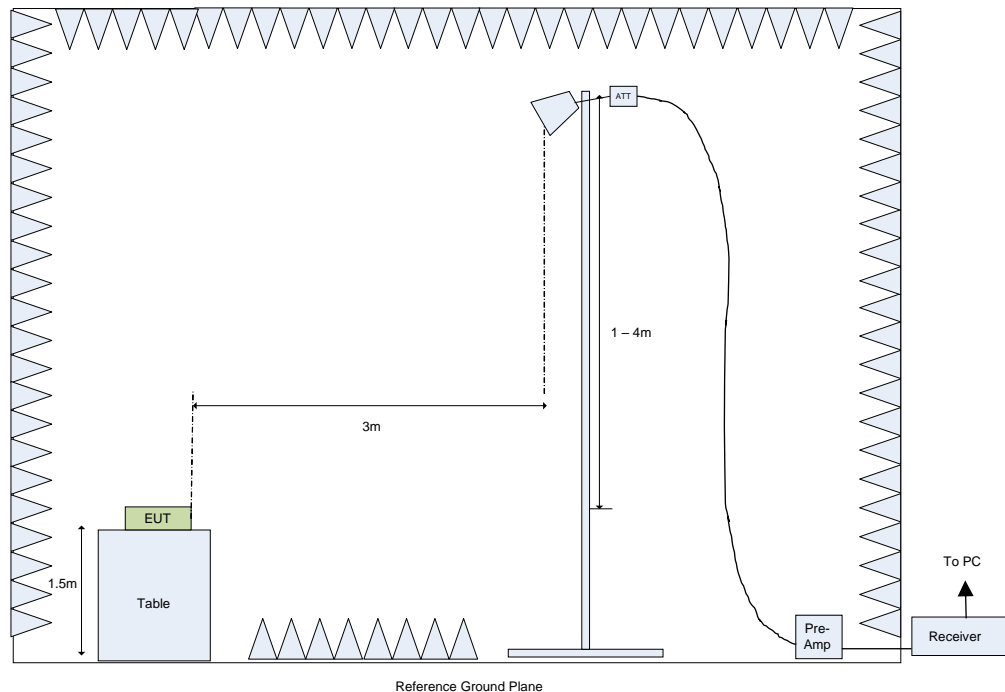


Figure 5.4.7.1: Test Setup for Final E-Field Measurements from 1GHz to 18GHz

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: 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
1.006	Transmitting on channel 2402MHz	front face	0	1.5	H
1.008	Transmitting on channel 2440MHz	front face	0	1.5	H
1.060	Transmitting on channel 2480MHz	front face	0	1.5	H
1.139	Transmitting on channel 2480MHz	front face	0	1.5	H
1.144	Transmitting on channel 2402MHz	front face	0	1.5	H
1.147	Transmitting on channel 2440MHz	front face	0	1.5	H
1.304	Transmitting on channel 2402MHz	front face	0	1.5	H
1.691	Transmitting on channel 2402MHz	front face	0	1.5	H
1.693	Transmitting on channel 2440MHz	front face	0	1.5	H
1.740	Transmitting on channel 2440MHz	front face	0	1.5	H
1.761	Transmitting on channel 2402MHz	front face	0	1.5	H
1.806	Transmitting on channel 2440MHz	front face	0	1.5	H
1.807	Transmitting on channel 2402MHz	front face	0	1.5	H
1.896	Transmitting on channel 2480MHz	front face	0	1.5	H
1.897	Transmitting on channel 2402MHz	front face	0	1.5	H
2.049	Transmitting on channel 2440MHz	front face	0	1.5	H

4.794	Transmitting on channel 2480MHz	front face	0	1.5	H
4.804	Transmitting on channel 2402MHz	front face	0	1.5	H
4.881	Transmitting on channel 2440MHz	front face	0	1.5	H
4.960	Transmitting on channel 2480MHz	front face	0	1.5	H

Table 2 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°.

Note 2: With no emissions observed above 5GHz during the exploratory investigation, final measurements were performed up to 7GHz only.

5.4.9 Electric field emissions, 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 2480MHz

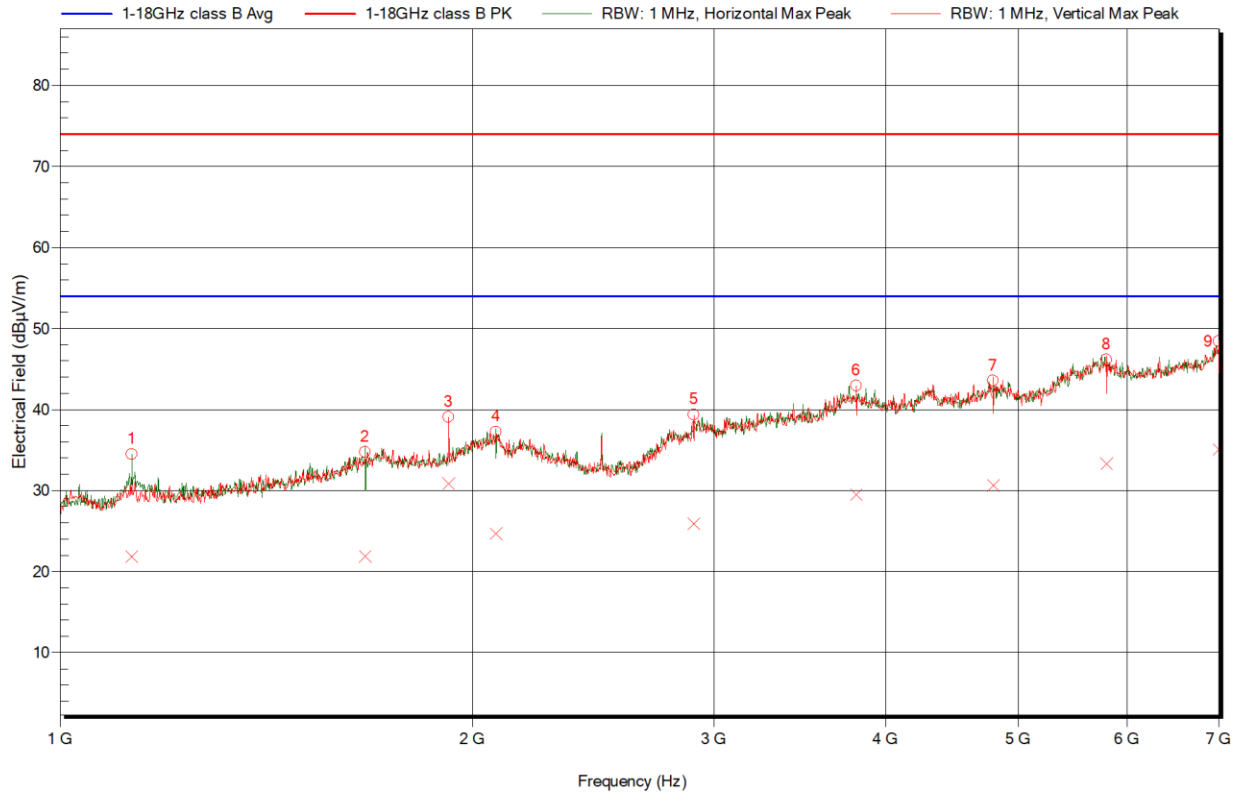


Figure 5 Electric field emissions Plot, 1GHz to 7GHz. Operation on 2480MHz

Frequency	Average	Average Limit	Average Difference	Average Status	Angle	Height	Polarization
GHz	dBμV/m	dBμV/m	dB		degrees	m	
1.13	21.8	54	-32.2	Pass	355	3.3	Horizontal
1.67	21.9	54	-32.1	Pass	200	1.6	Horizontal
1.92	30.9	54	-23.1	Pass	315	2.5	Vertical
2.08	24.7	54	-29.3	Pass	210	1.1	Horizontal
2.90	25.9	54	-28.1	Pass	40	1.4	Vertical
3.81	29.5	54	-24.5	Pass	265	1.7	Vertical
4.79	30.6	54	-23.4	Pass	210	2.9	Vertical
5.79	33.3	54	-20.7	Pass	125	1.2	Vertical
7.00	35.1	54	-18.9	Pass	55	3.3	Vertical

Table 3 Electric Field Emissions Peaks, 1GHz to 7GHz – Operation on 2480MHz

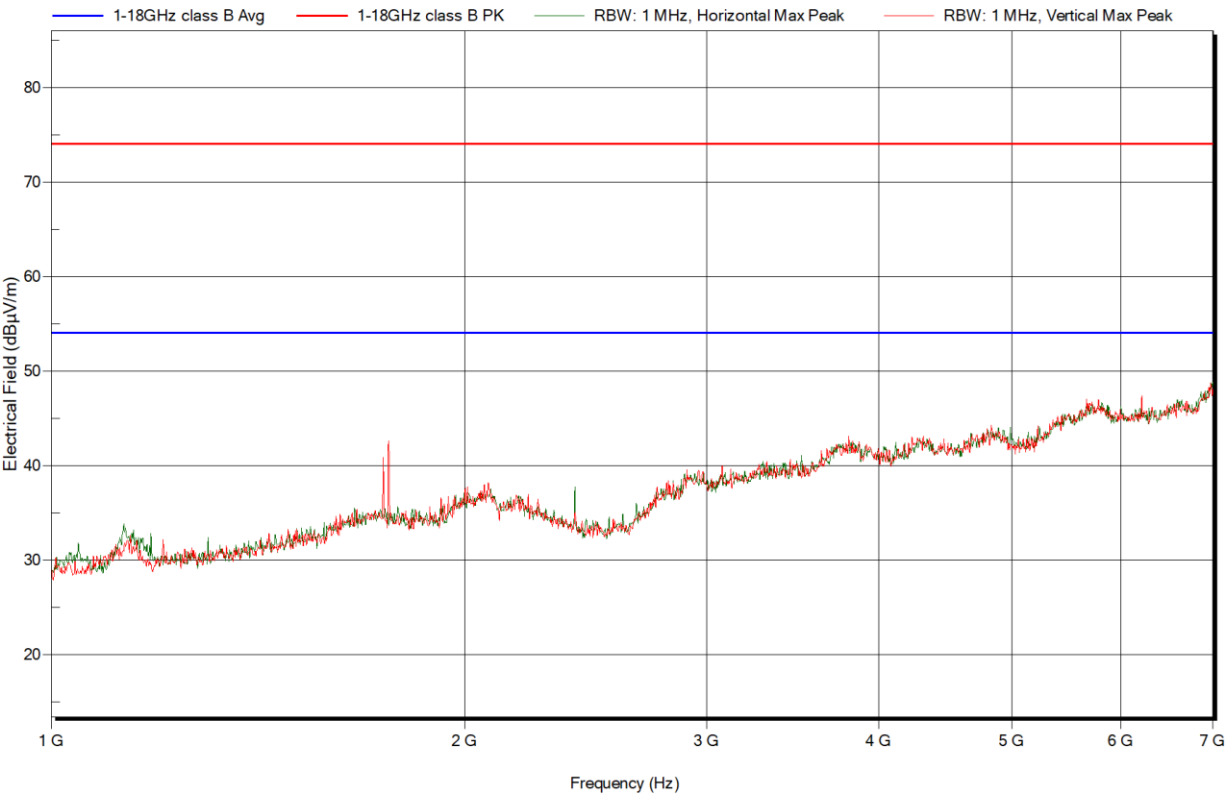


Figure 6 Electric field emissions Plot, 1GHz to 7GHz, Operation on 2402MHz - Peak detector scan

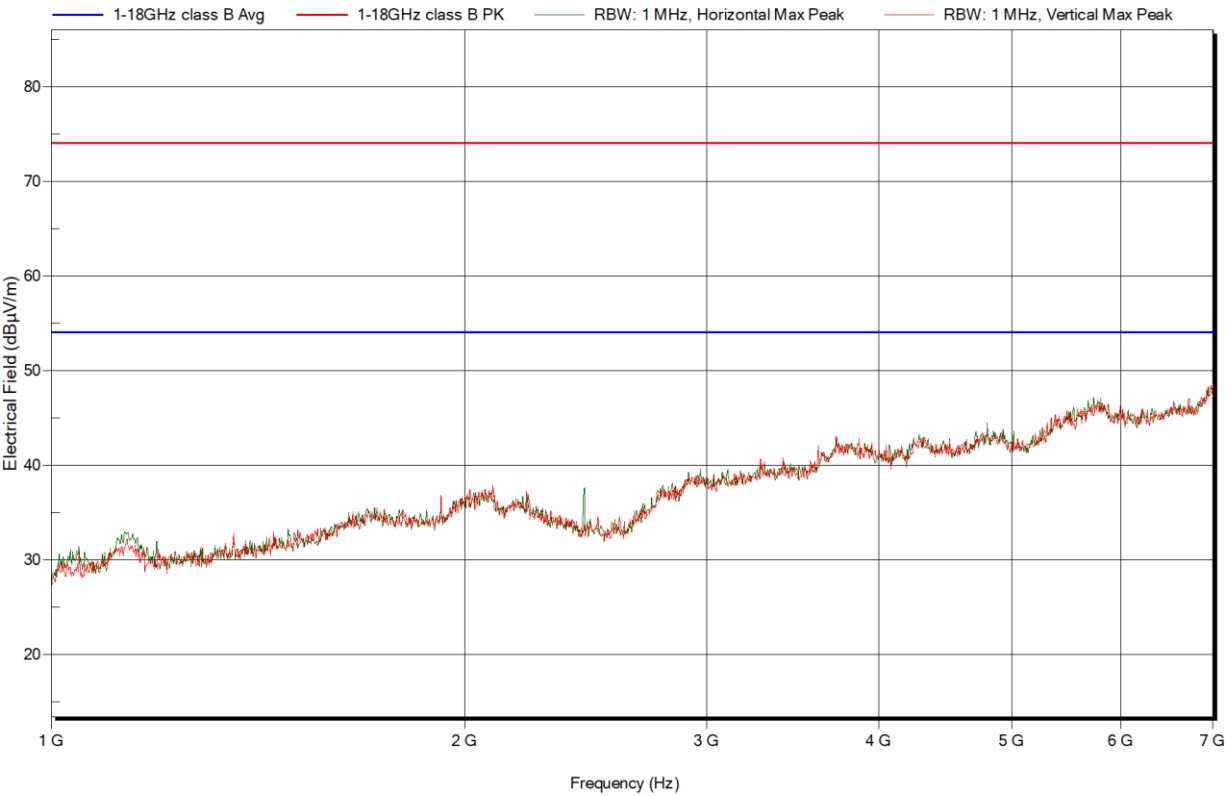


Figure 7 Electric field emissions Plot, 1GHz to 7GHz, Operation on 2440MHz – Peak detector scan

5.4.10 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:

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

5.4.11 Sample Data

From Figure 5 and table 3. The Average level at 7.00GHz is calculated as follows:

$$\text{FS (dB}\mu\text{V/m)} = 42.52(\text{dB}\mu\text{V}) - 54.93(\text{dB}) + 39.71(\text{dB/m}) + 7.80(\text{dB}) = 35.1\text{dB}\mu\text{V/m}$$

5.5 Radiated Emissions (18GHz to 25GHz)**5.5.1 Limits**

Frequency (GHz)	Limit (dB μ V/m)	Limit (dB μ V/m)
	Peak	Average
18-25	74.0	54.0

5.5.2 Receiver Settings

Receiver Parameters	Setting
Detector Function	Average and Peak
Start Frequency	18GHz
Stop Frequency	25GHz
Resolution Bandwidth	1MHz
Video Bandwidth	Auto

5.5.3 Emissions measurements**5.5.4 Date of Test**8th November 2023**5.5.5 Test Area**

LAB 1 (SAC)

5.5.6 Tested by

L Trickett

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 2402MHz, 2440MHz and 2480MHz.	-	-	-	-

Table 4 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°.

Note 2: No emissions were identified for further investigation above 18GHz.

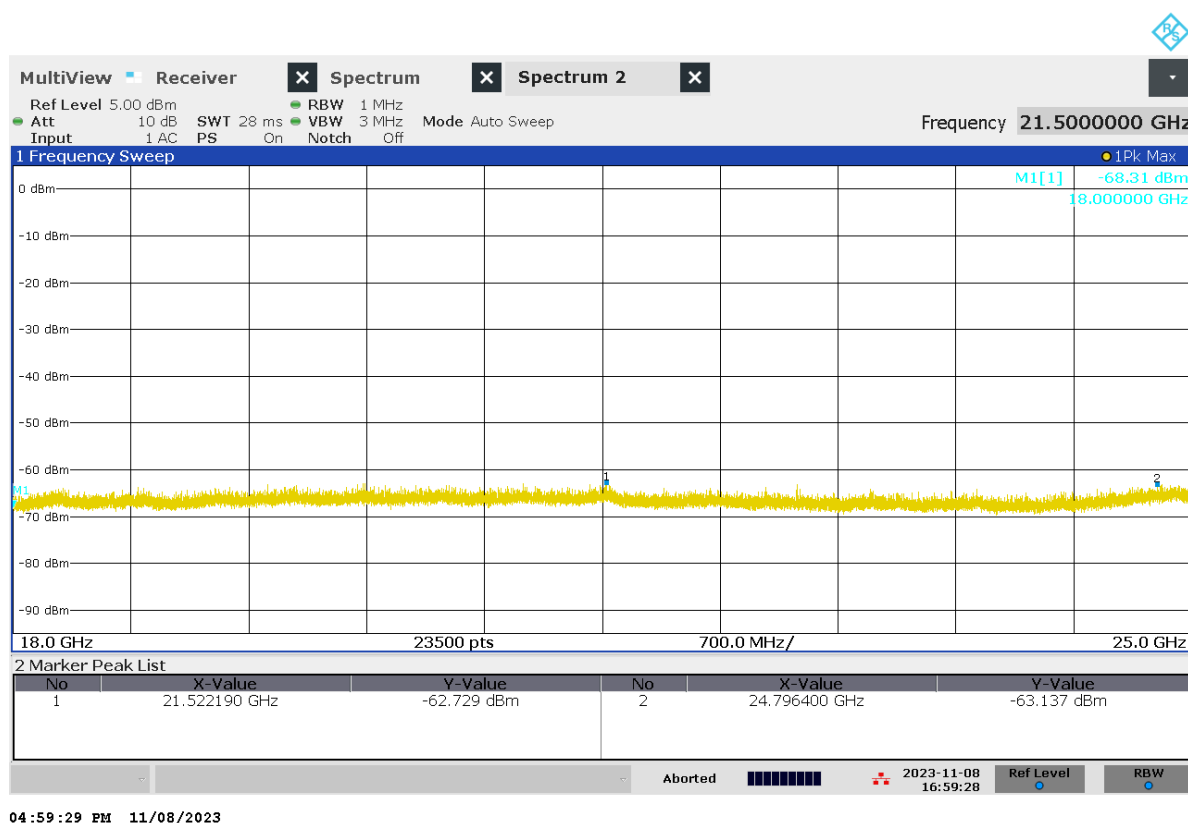


Figure 8 – Manual investigation – Operating on BLE channel 2402MHz

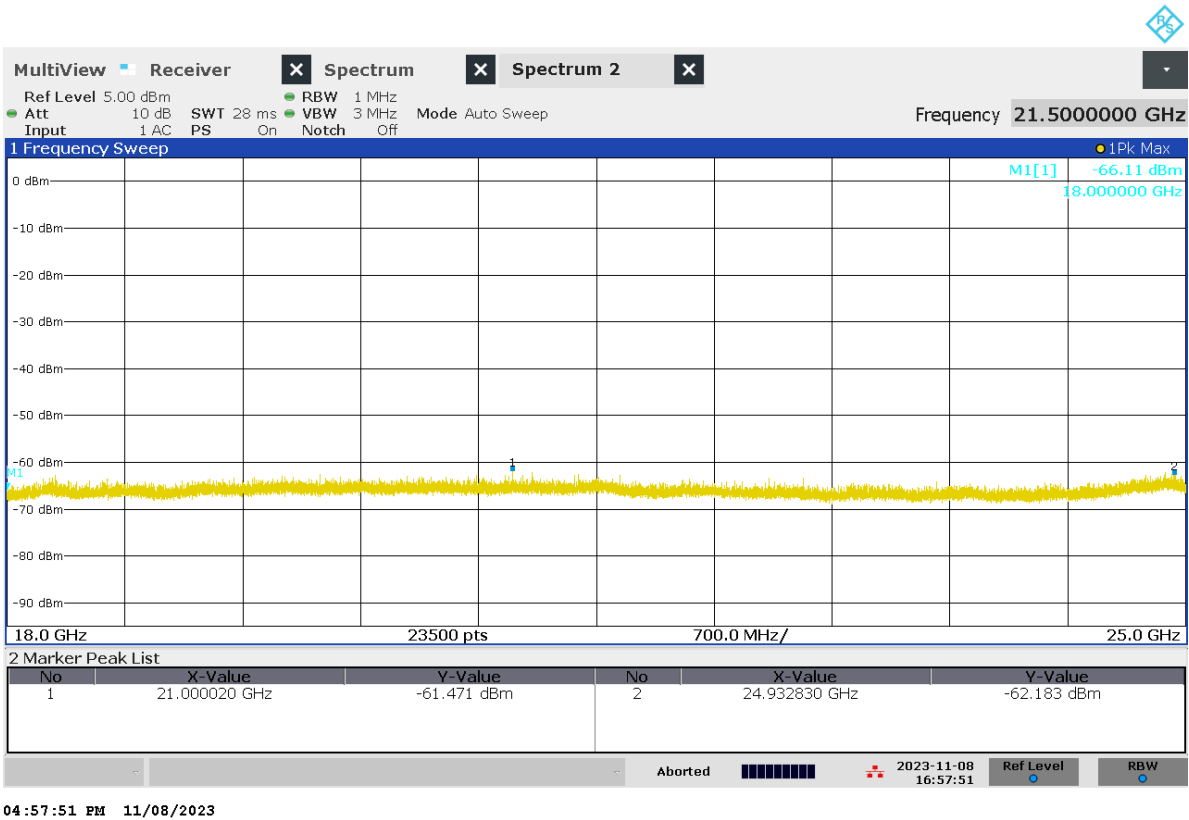


Figure 9 – Manual investigation – Operating on BLE channel 2440MHz

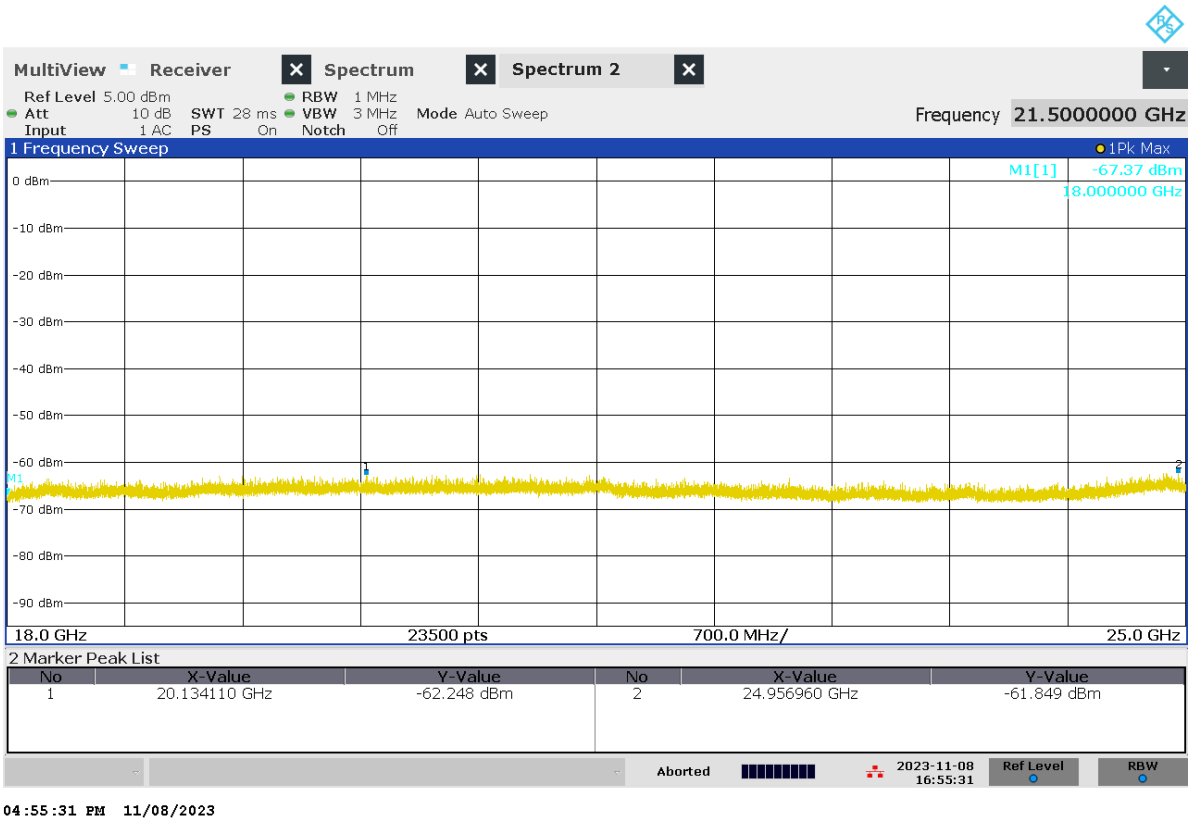


Figure 10 – Manual investigation – Operating on BLE channel 2480MHz

5.6 Conducted Spurious Emissions 30MHz to 25GHz**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	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**

16th November 2023

5.6.4 Test Area

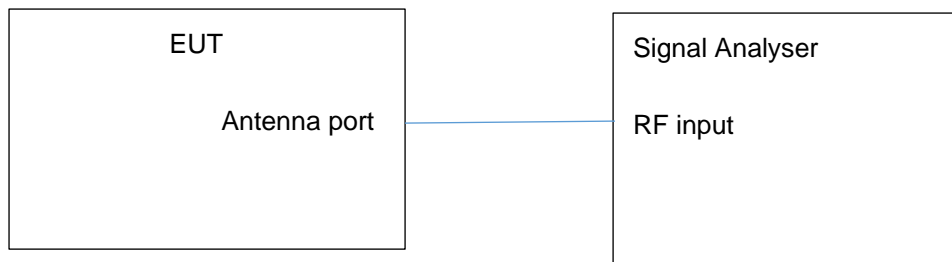
LAB 5

5.6.5 Tested by

L Trickett

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, 30MHz to 25GHz

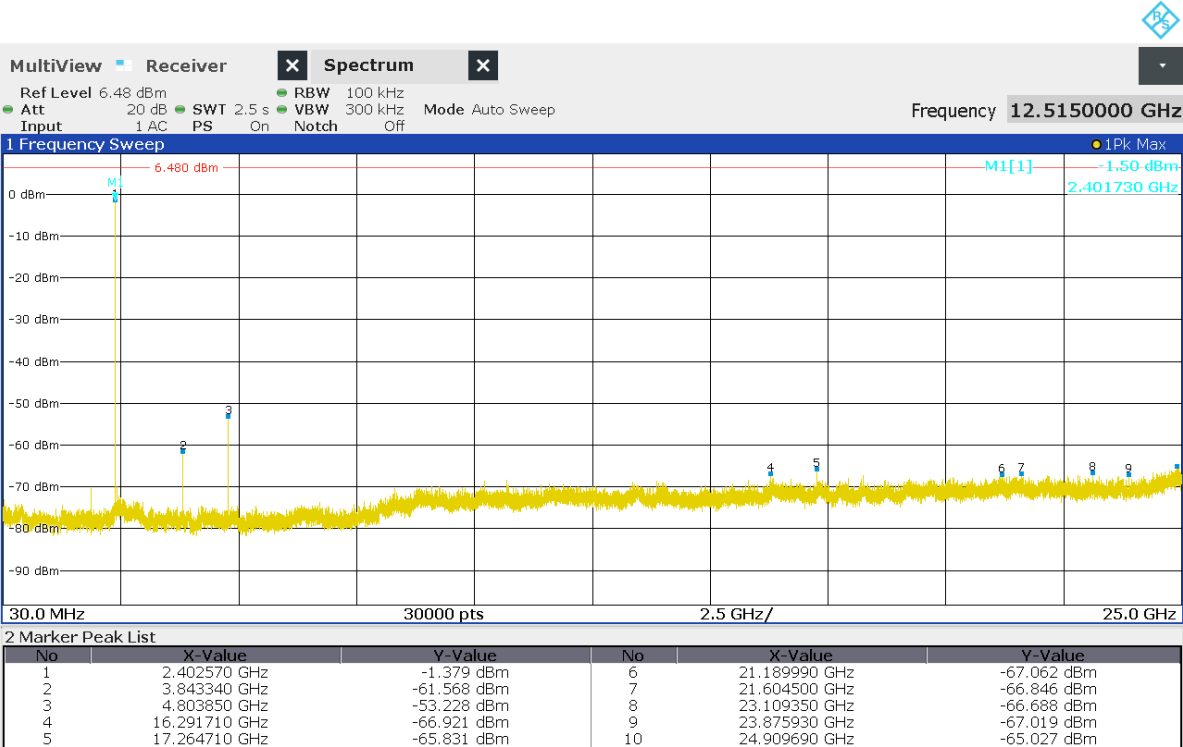


Figure 11 Conducted emissions 30MHz to 25GHz. Operation on channel 2402MHz.

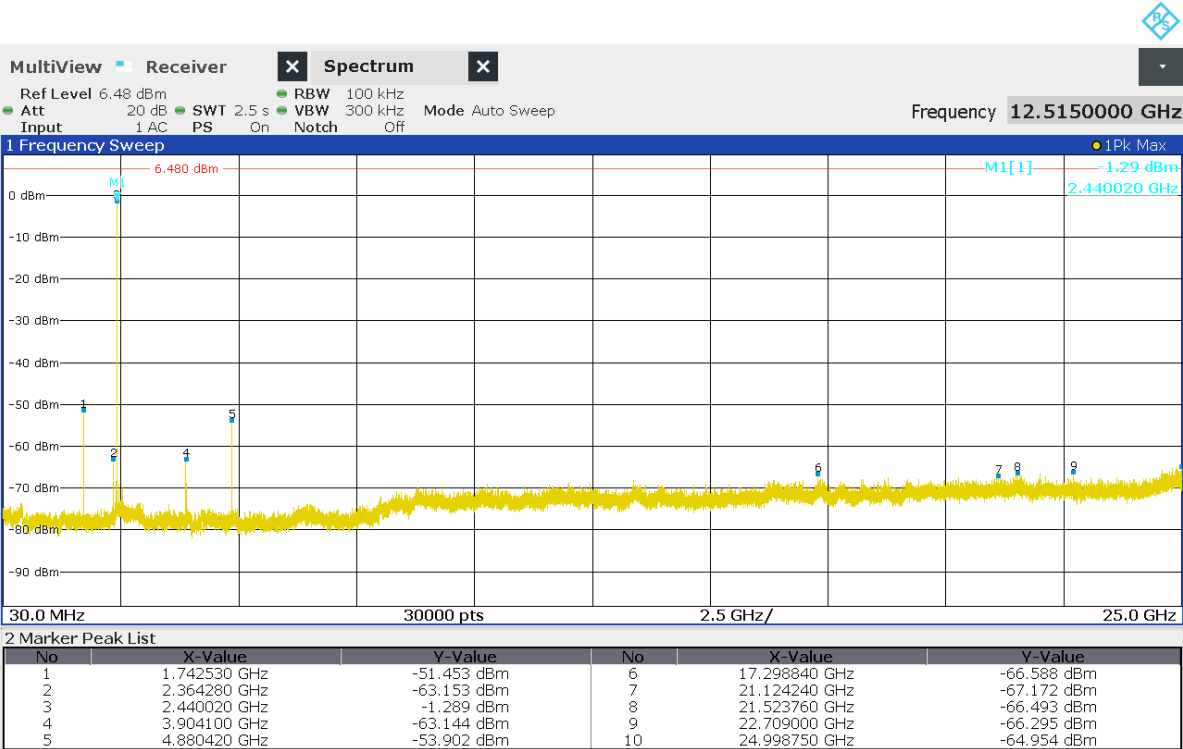


Figure 12 Conducted emissions 30MHz to 25GHz. Operation on channel 2440MHz.

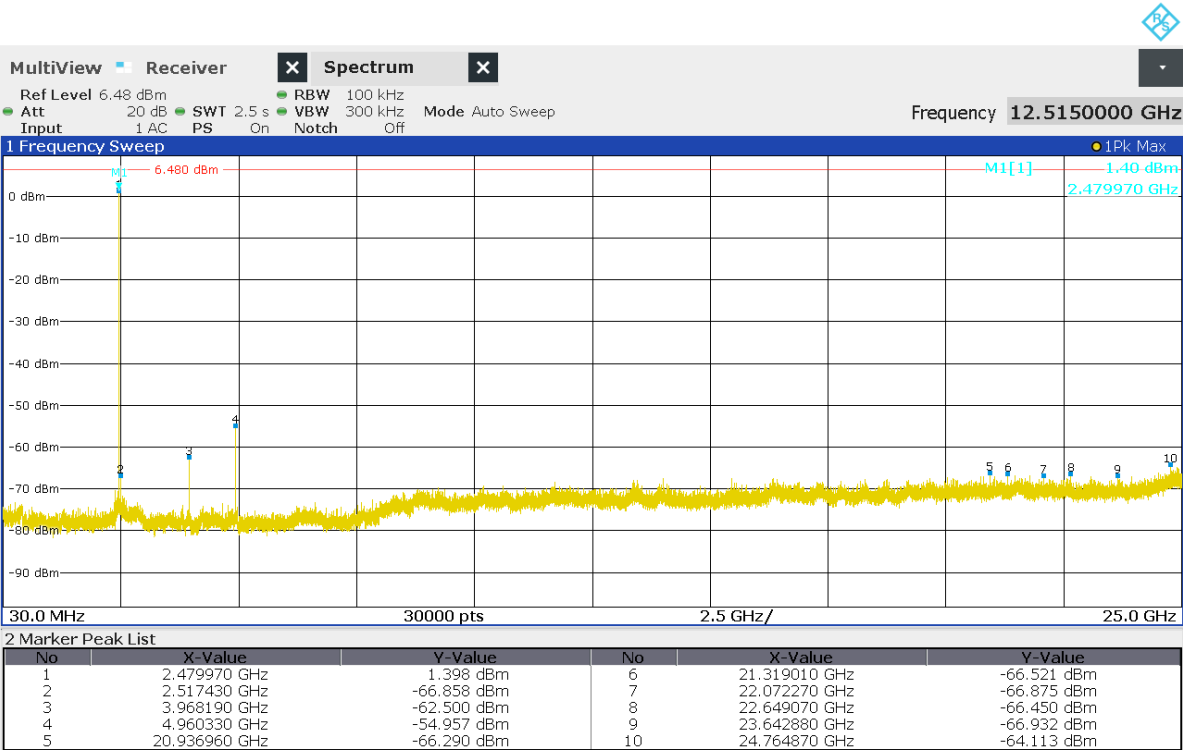


Figure 13 Conducted emissions 30MHz to 25GHz. Operation on channel 2480MHz.

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
Measurement Uncertainty Frequency tests	$\pm 9 \times 10^{-8}$

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	3MHz
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**16th November 2023**6.2.3 Test Area**

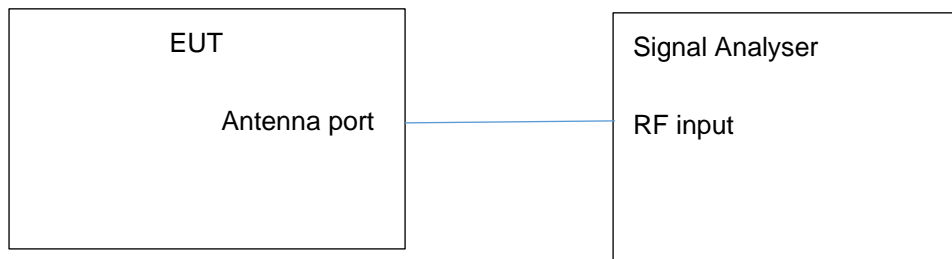
LAB 5

6.2.4 Tested by

L Trickett

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 (kHz)	Minimum requirement (kHz)	Figure	Result
2402.0	1.1878	1011.0	500.0	14 & 17	Pass
2440.0	1.1873	1010.0	500.0	15 & 18	Pass
2480.0	1.1885	1010.0	500.0	16 & 19	Pass

Table 5 Bandwidth Measurements

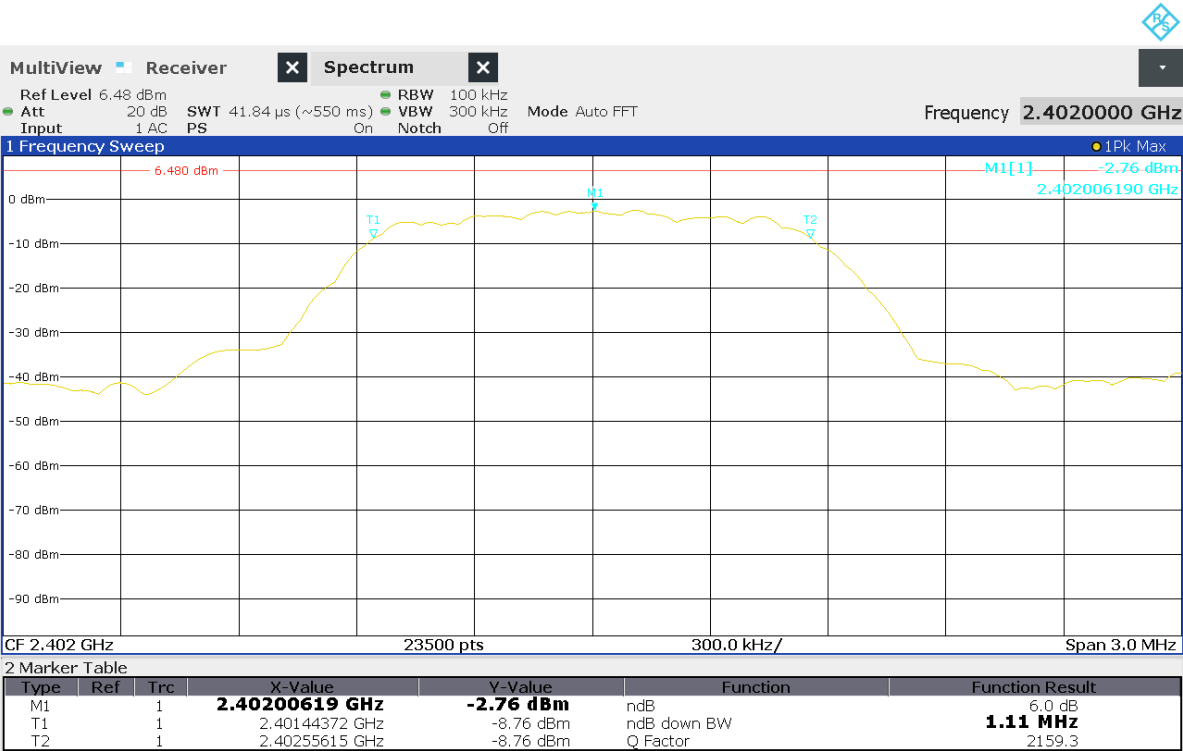


Figure 14 Bandwidth at 6dB Point. Operation on channel 2402MHz



Figure 15 Bandwidth at 6dB Point. Operation on channel 2440MHz



Figure 16 Bandwidth at 6dB Point. Operation on channel 2480MHz

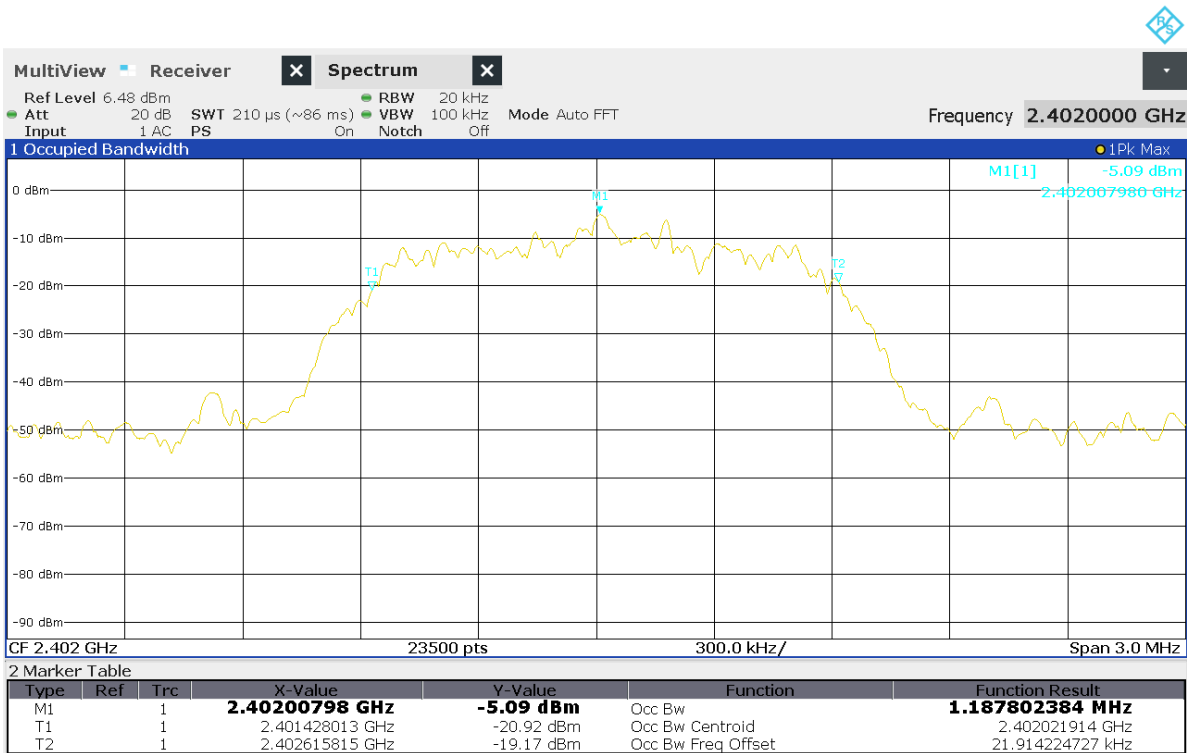


Figure 17 99% Occupied Bandwidth. Operation on channel 2402MHz



Figure 18 99% Occupied Bandwidth. Operation on channel 2440MHz

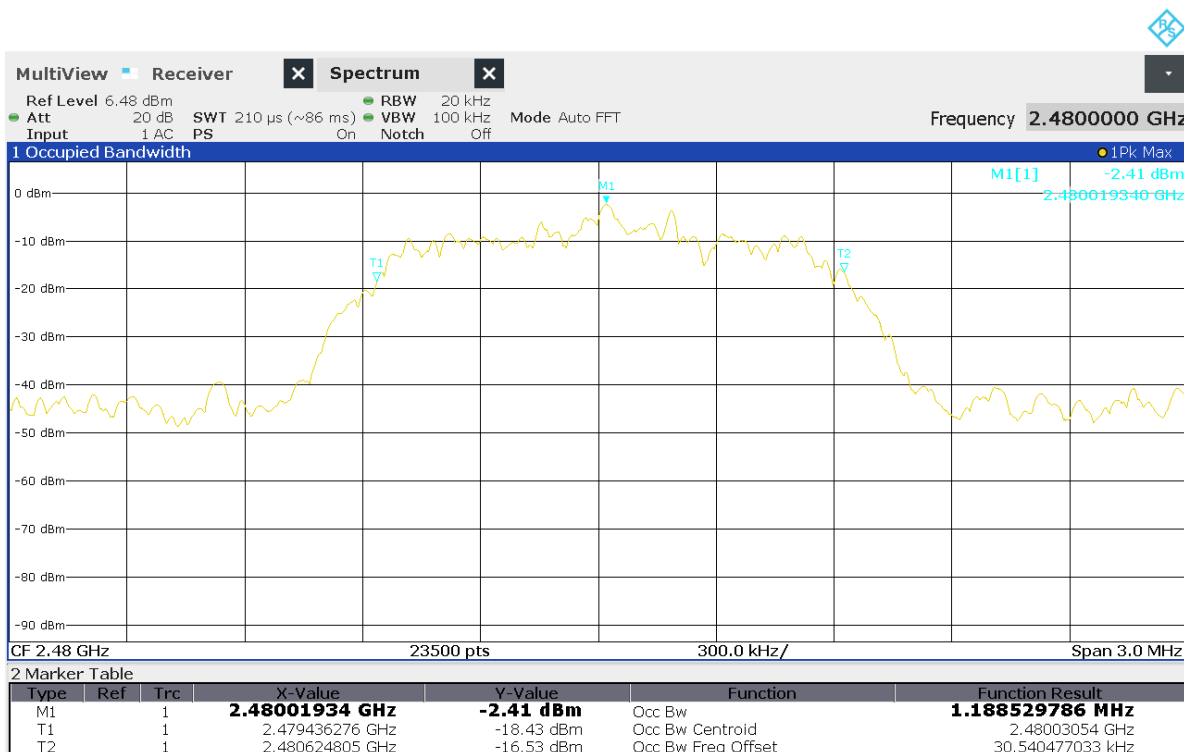


Figure 19 99% Occupied Bandwidth. Operation on channel 2480MHz

Section 7 Peak Output Power

7.1 Test Specification

FCC Rule Part	46CFR 15.247 (b)(3)
Standard	ANSI C63.10:2013
Measurement Uncertainty Conducted Power tests	±1.4dB

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	10MHz
Resolution Bandwidth	2MHz
Video Bandwidth	10MHz
Sweep rate	Auto couple
Trace mode	Max hold

7.2.1 Emissions measurements**7.2.2 Date of Test**16th November 2023**7.2.3 Test Area**

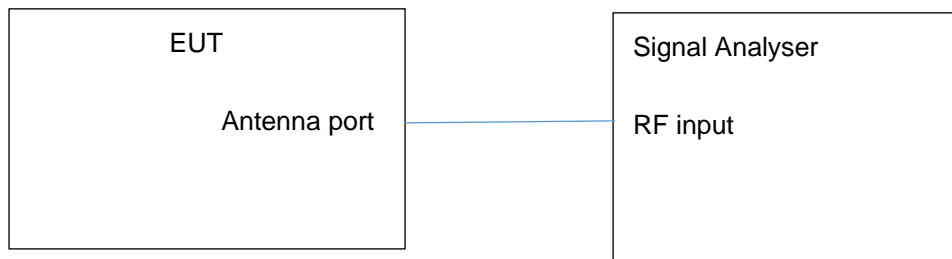
LAB 5

7.2.4 Tested by

L Trickett

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.

Channel (MHz)	Peak Power (dBm)	Peak Power (Watts)	Limit (Watts)	Figure
2402	2.98	0.00198	1	20
2440	4.70	0.00295	1	21
2480	5.47	0.00352	1	22

Table 6 Peak Output Power Measurements

Note: Values in the table above adjusted for a cable loss of 0.6dB

The MAX antenna gain is 4.2 dBi, MAX EIRP=MAX peak power *MAX antenna gain=5.47+4.2=9.67 dBm, The Max EIRP is 9.67 dBm (0.0093W) and does not exceed 4W, which meets the EIRP requirement of RSS-247 section 5.4.

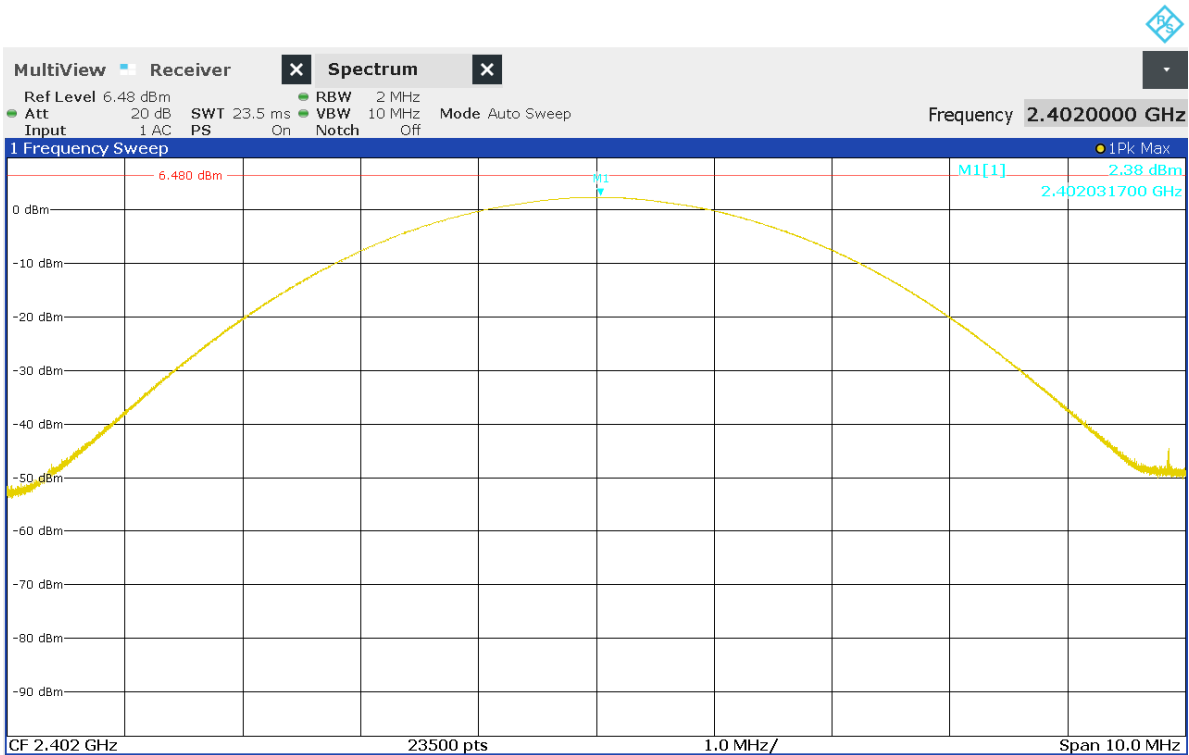


Figure 20 Peak output power, Operation on channel 2402MHz

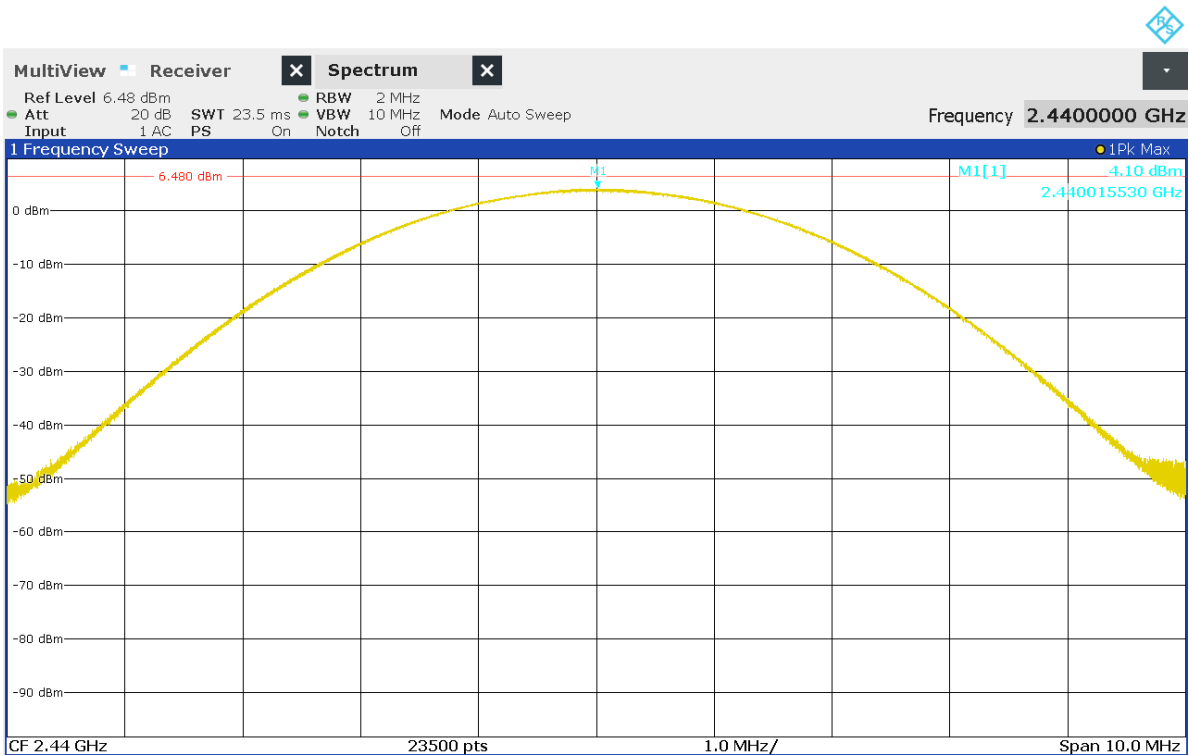


Figure 21 Peak output power, Operation on channel 2440MHz

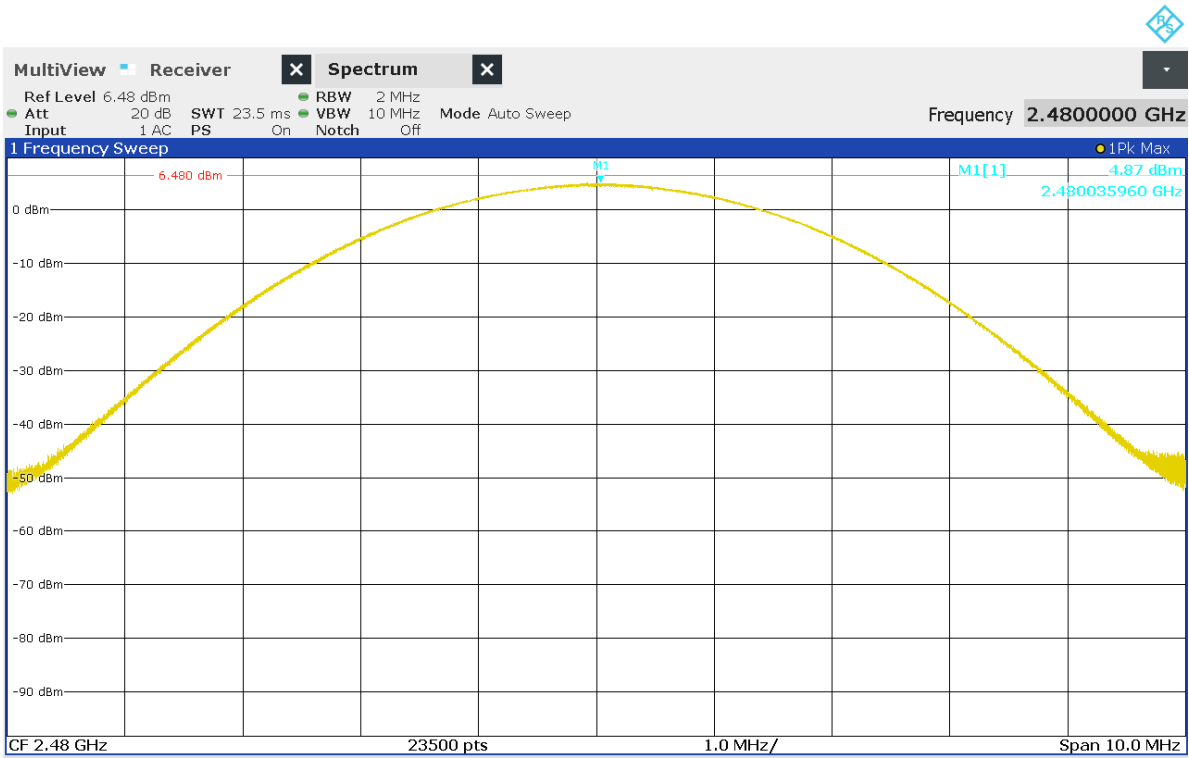


Figure 22 Peak output power, Operation on channel 2480MHz

Section 8 Power Spectral Density

8.1 Test Specification

FCC Rule Part	46CFR 15.247 (e)
Standard	ANSI C63.10:2013
Measurement Uncertainty Conducted Power tests	±1.4dB

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	1.5 x DTS 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

16th November 2023

8.2.3 Test Area

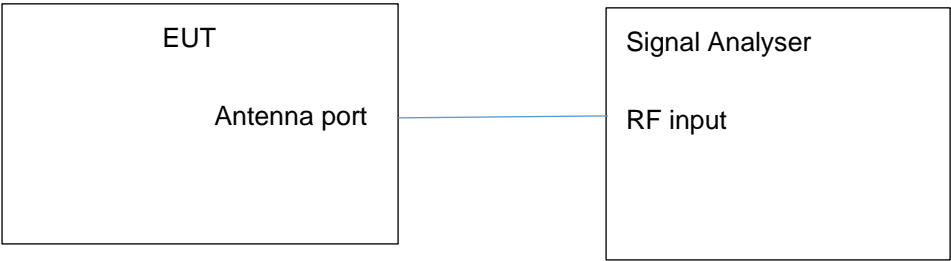
LAB 5

8.2.4 Tested by

L Trickett

8.2.5 Test Setup

The antenna port was connected directly to the signal analyser.



8.2.6 Test Results

Channel (MHz)	Power in 3kHz RBW (dBm)	Limit (dBm)	Figure	Result
2402	-13.01	8.0	23	Pass
2440	-11.13	8.0	24	Pass
2480	-10.27	8.0	25	Pass

Table 7 Peak Spectral Density Measurements

Note: Values in the table above adjusted for a cable loss of 0.6dB

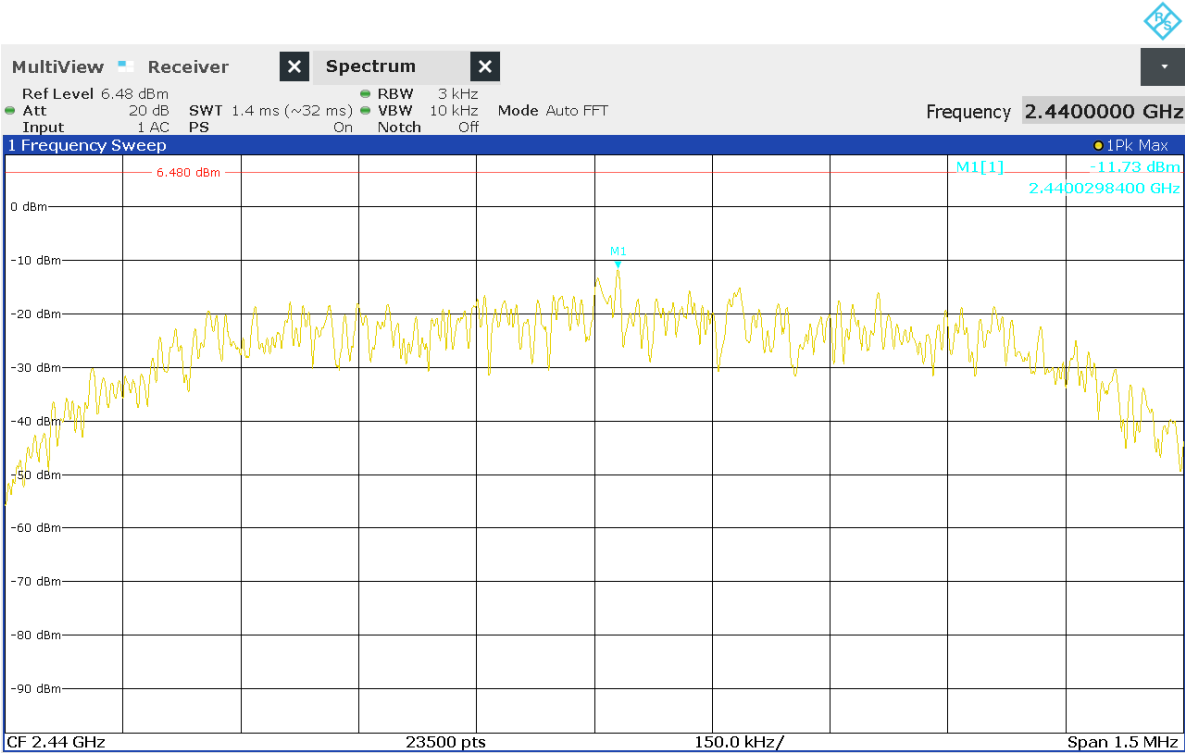




Figure 25 Power spectral density, Operation on channel 2480MHz

Section 9 Band Edge Compliance

9.1 Test Specification

FCC Rule Part	46CFR 15.205 and 47CFR15.209
Standard	ANSI C63.10:2013
Measurement Uncertainty Radiated tests	The reported uncertainty of measurement $y \pm U$, where expended 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 $\pm 5.14\text{dB}$ for the frequency range from 1GHz to 6GHz

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**

21st November 2023

9.2.3 Test Area

LAB 1

9.2.4 Tested by

L Trickett

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

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	66.20	54.03	3.19	29.89	45.25	74	28.75
V	2483.5	68.60	54.03	3.19	29.89	47.65	74	26.35

Table 8 Operation on 2480MHz 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	47.90	54.03	3.19	29.89	26.95	54	27.06
V	2483.5	49.40	54.03	3.19	29.89	28.45	54	25.56

Table 9 Operation on Channel 2480MHz, average detector measurements**Lower band edge**

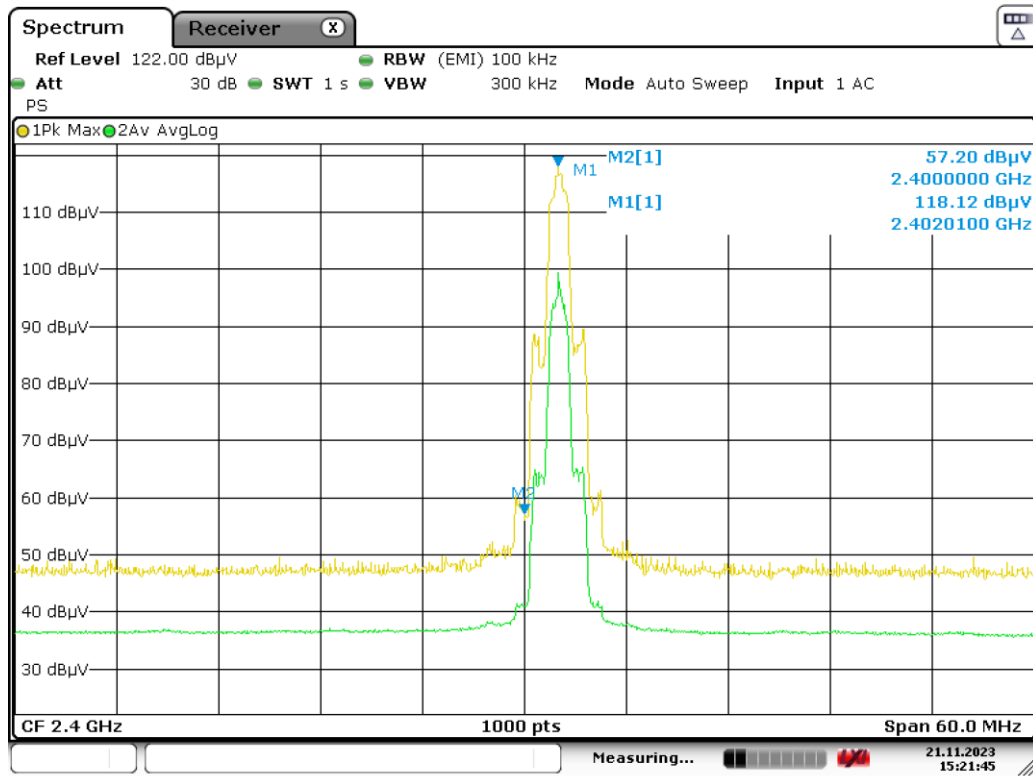
Polarity	frequency (MHz)	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF(dB/m)	E (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	2400	89.80	54.02	3.14	29.67	68.59	74	5.41
V	2400	86.80	54.02	3.14	29.67	65.59	74	8.41

Table 10 Operation on channel 2402MHz 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	63.70	54.02	3.14	29.67	42.49	54	11.51
V	2400	61.10	54.02	3.14	29.67	39.89	54	14.11

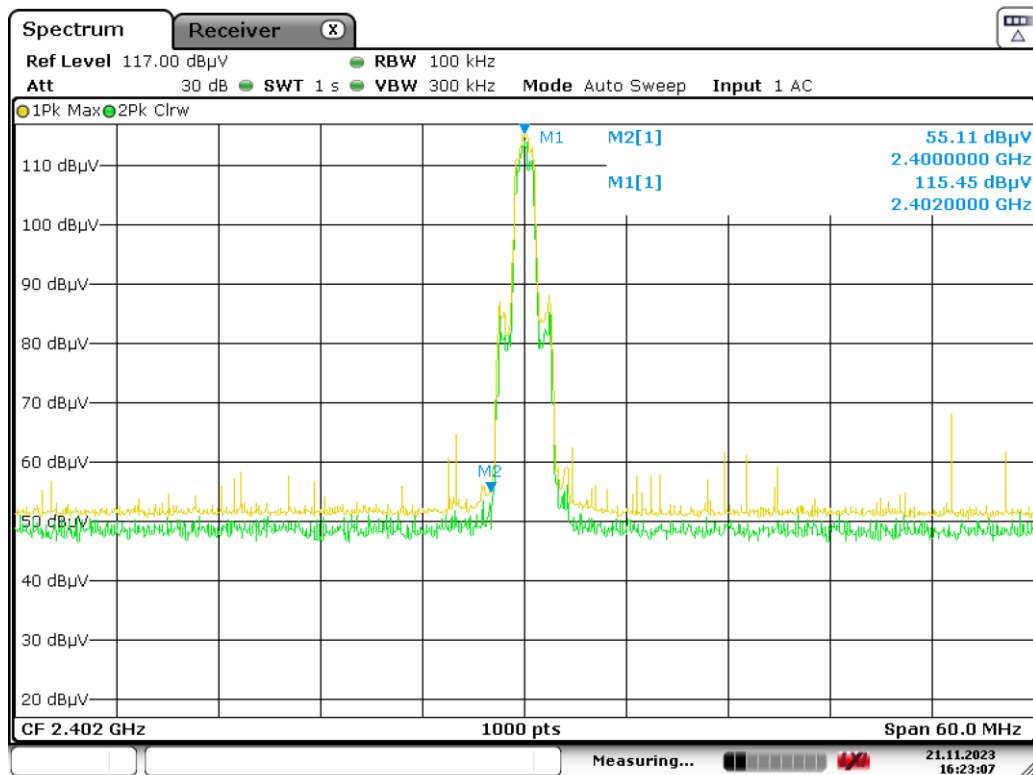
Table 11 Operation on channel 2402MHz average detector measurements

Spectrum analyser displays



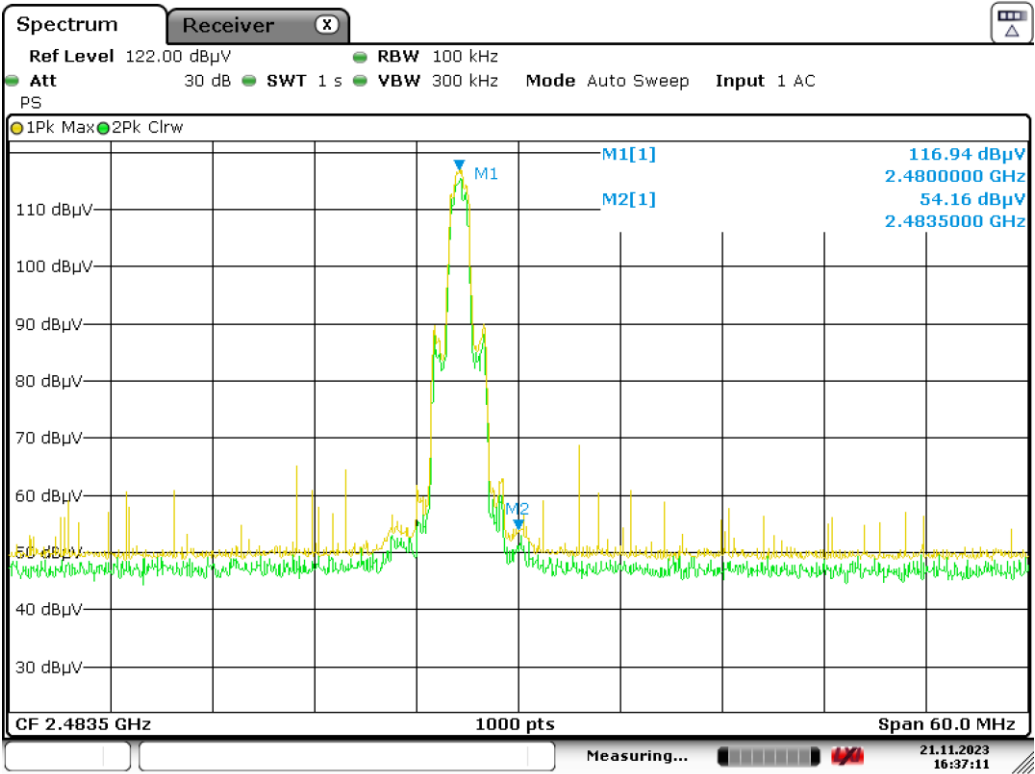
Date: 21.NOV.2023 15:21:46

Figure 26 Band Edge Measurement – upper band edge - horizontal polarity



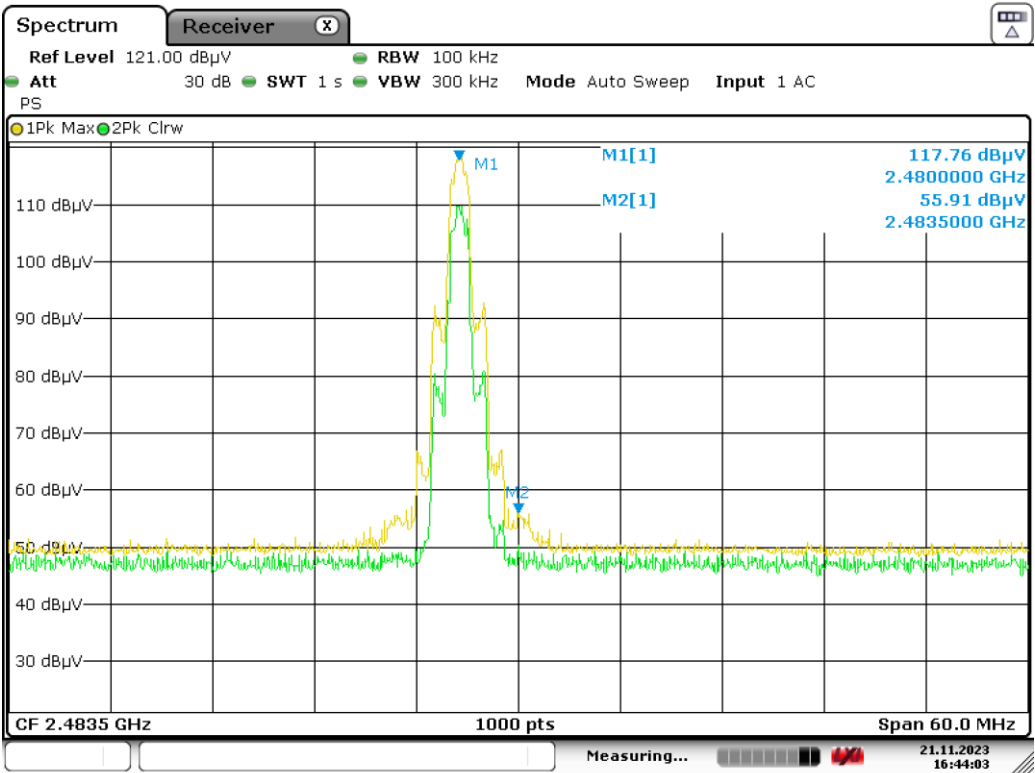
Date: 21.NOV.2023 16:23:07

Figure 27 Band Edge Measurement – upper band edge - vertical polarity



Date: 21.NOV.2023 16:37:11

Figure 28 Band Edge Measurement – lower band edge - horizontal polarity



Date: 21.NOV.2023 16:44:04

Figure 29 Band Edge Measurement – 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 23	30 th November 2022	12 Months
R&S ESW44 EMI Receiver	C0751	10 th July 2023	12 Months
Kikusui PCR200M	C0198	-	-

Radiated Emissions Equipment

Item	Serial No.	Last Calibration Date	Calibration Interval
Laboratory 1 Semi-Anechoic Chamber	C0471	6 th December 2022	36 Months
ETS Lindgren 2017B Mast (1 – 4m) with tilting mechanism	--	N/A	N/A
R & S ESR26	C0502	8 th August 2023	12 Months
R&S ESW44 EMI Receiver	C0751	10 th July 2023	12 Months
Kikusui PCR200M	C0198	-	-
Teseq CBL6112D Bilog Antenna	C0506	12 th January 2023	36 Months
HF29 Cable	20147.01.09.001	30 th November 2022	12 Months
HF31 Cable	19148.06.13.002	30 th November 2022	12 Months
HF35 Cable	19149.02.13.003	30 th November 2022	12 Months
HF27 Cable	19149.03.13.004	30 th November 2022	12 Months
Schwarzbeck STLP 9148 Antenna 1-18GHz	C0626	12 th April 2022	24 Months
2.4GHz Microtronics BRM50702 notch filter	79178	1 st December 2022	12 Months
BONN BLMA 0118-M Preamplifier	C0702	7 th July 2023	12 Months
ETS Lingren 3116C-PA Horn Antenna 18-40GHz	C0433	28 th September 2023	36 Months

-----END OF REPORT-----