

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

Test Report number: C14603TR2

Project number: B5109

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Issue	Description						Issue by	Date
2	Copy 1		Copy 2		PDF	√	MR	5 <sup>th</sup> May 2022

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



CONTENTS

**Test Report Change History .....4**

**Section 1 Test Location.....5**

1.1 UKAS Accreditation.....5

**Section 2 Customer Information .....6**

**Section 3 Equipment Details.....7**

3.1 Equipment Under Test (EUT).....7

3.2 EUT Photographs.....8

3.3 Configuration of EUT.....8

3.4 EUT Monitoring/Auxiliary Equipment .....8

3.5 Monitoring Software .....8

**Section 4 Test Specifications .....9**

4.1 Knowledge Database References..... 11

4.1.1 Radiated Emissions (30MHz to 1000MHz) ..... 11

4.1.2 Radiated Emissions (1GHz to 40GHz) ..... 11

4.2 Compliance Statement..... 11

**Section 5 Spurious Emission Results – Radiated and Conducted..... 12**

5.1 Test Specification ..... 12

5.2 Procedure and Test Software Version ..... 12

5.3 Radiated Emissions (30MHz to 1GHz) ..... 13

5.3.1 Limits at 3m ..... 13

5.3.2 Emissions measurements ..... 13

5.3.3 Date of Test..... 13

5.3.4 Test Area..... 13

5.3.5 Tested by..... 13

5.3.6 Test Setup ..... 14

5.3.7 Electric field emissions, 30MHz to 1GHz ..... 15

5.4 Radiated Emissions (1GHz to 18GHz)..... 17

5.4.1 Limits ..... 17

5.4.2 Receiver Settings ..... 17

5.4.3 Emissions measurements ..... 17

5.4.4 Date of Test..... 17

5.4.5 Test Area..... 17

5.4.6 Tested by..... 17

5.4.7 Test Setup ..... 18

5.4.8 Exploratory Radiated Emission Maximization ..... 19

5.4.9 Electric field emissions, 1GHz to 18GHz ..... 20

5.4.10 Example field strength calculation ..... 24

5.4.11 Sample Data..... 24

5.5 Radiated Emissions (18GHz to 26GHz) ..... 25

5.5.1 Limits ..... 25

5.5.2 Receiver Settings ..... 25

5.5.3 Emissions measurements ..... 25

5.5.4 Date of Test..... 25

5.5.5 Test Area..... 25

5.5.6 Tested by..... 25

5.5.7 Test Setup ..... 25

5.5.8 Exploratory Radiated Emission Maximization ..... 26

5.6 Conducted Spurious Emissions 30MHz to 25GHz ..... 28

5.6.1 Limits ..... 28

5.6.2 Emissions measurements ..... 28

5.6.3 Date of Test..... 28

5.6.4 Test Area..... 28

5.6.5 Tested by..... 28

5.6.6 Test Setup ..... 29

5.6.7 Test Results ..... 29

5.6.8 Antenna port conducted emissions, 30MHz to 25GHz ..... 30

**Section 6 6dB Bandwidth and 99% Occupied Bandwidth ..... 32**

6.1 Test Specification ..... 32

6.2 Procedure and Test Software Version ..... 32

6.2.1 Emissions measurements ..... 33

6.2.2 Date of Test ..... 33

6.2.3 Test Area ..... 33

6.2.4 Tested by ..... 33

6.2.5 Test Setup ..... 33

6.2.6 Test Results ..... 33

**Section 7 Peak Output Power ..... 36**

7.1 Test Specification ..... 36

7.2 Procedure and Test Software Version ..... 36

7.2.1 Emissions measurements ..... 37

7.2.2 Date of Test ..... 37

7.2.3 Test Area ..... 37

7.2.4 Tested by ..... 37

7.2.5 Test Setup ..... 37

7.2.6 Test Result ..... 38

**Section 8 Power Spectral Density ..... 41**

8.1 Test Specification ..... 41

8.2 Procedure and Test Software Version ..... 41

8.2.1 Emissions measurements ..... 42

8.2.2 Date of Test ..... 42

8.2.3 Test Area ..... 42

8.2.4 Tested by ..... 42

8.2.5 Test Setup ..... 42

8.2.6 Test Results ..... 43

**Section 9 Band Edge Compliance ..... 46**

9.1 Test Specification ..... 46

9.2 Procedure and Test Software Version ..... 46

9.2.1 Emissions measurements ..... 47

9.2.2 Date of Test ..... 47

9.2.3 Test Area ..... 47

9.2.4 Tested by ..... 47

9.2.5 Test Setup ..... 47

9.2.6 Test Results ..... 47

**Appendix A EUT Test Photos ..... 51**

**Appendix B Test Equipment List ..... 52**

## Test Report Change History

Issue	Date	Modification Details
1	22 <sup>nd</sup> April 2022	First Issue
2	5 <sup>th</sup> May 2022	Company name updated
3		
4		
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) Bluetooth Low Energy (BLE)		
<b>Modulation schemes</b>	PRBS9		
<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: 2402MHz, 2440MHz and 2480MHz		
<b>Test software:</b>	bt_mfg_test.uf2 Test Firmware installed		
<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

### **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>
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
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)	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**

28<sup>th</sup> March 2022

**5.3.4 Test Area**

LAB 1 (SAC)

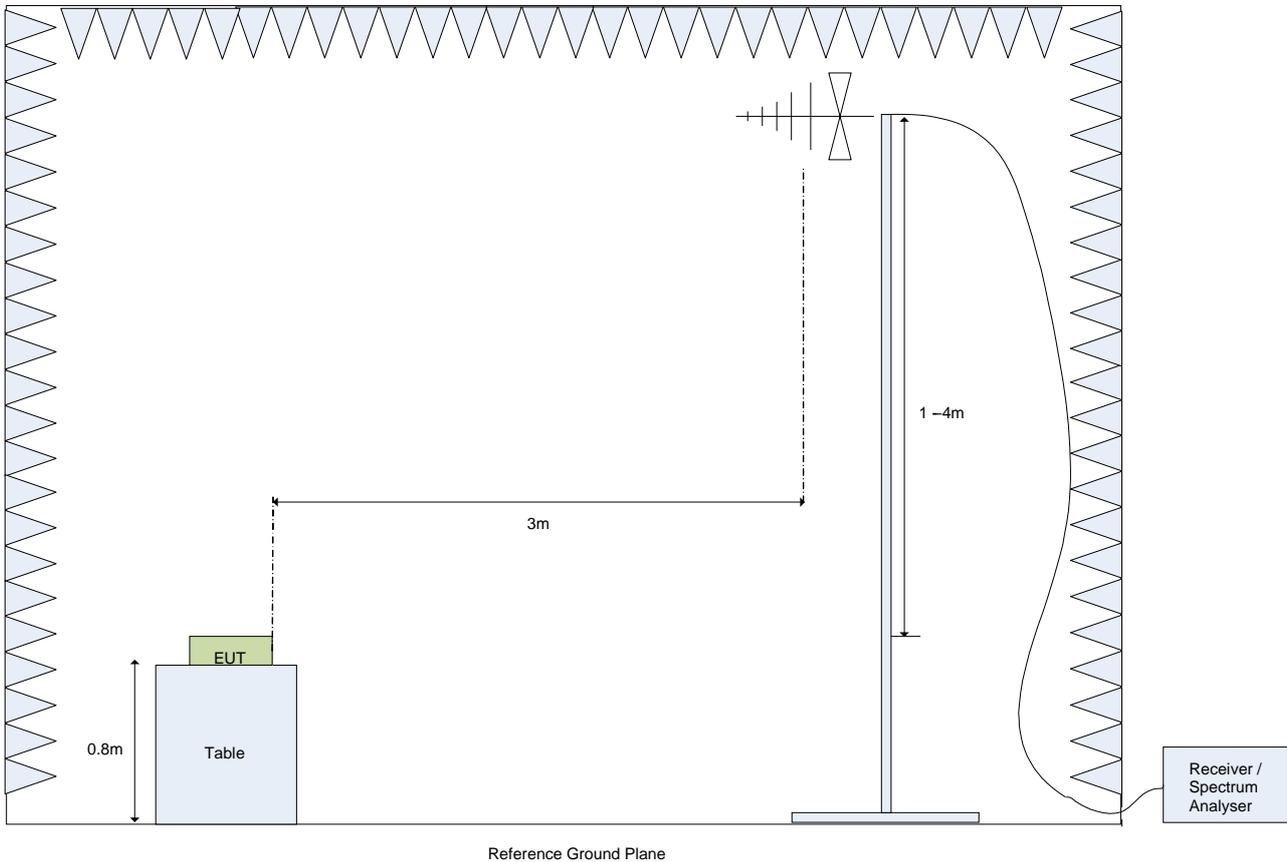
**5.3.5 Tested by**

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: 2402MHz, 2440MHz and 2480MHz 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 2440MHz

5.3.7 Electric field emissions, 30MHz to 1GHz

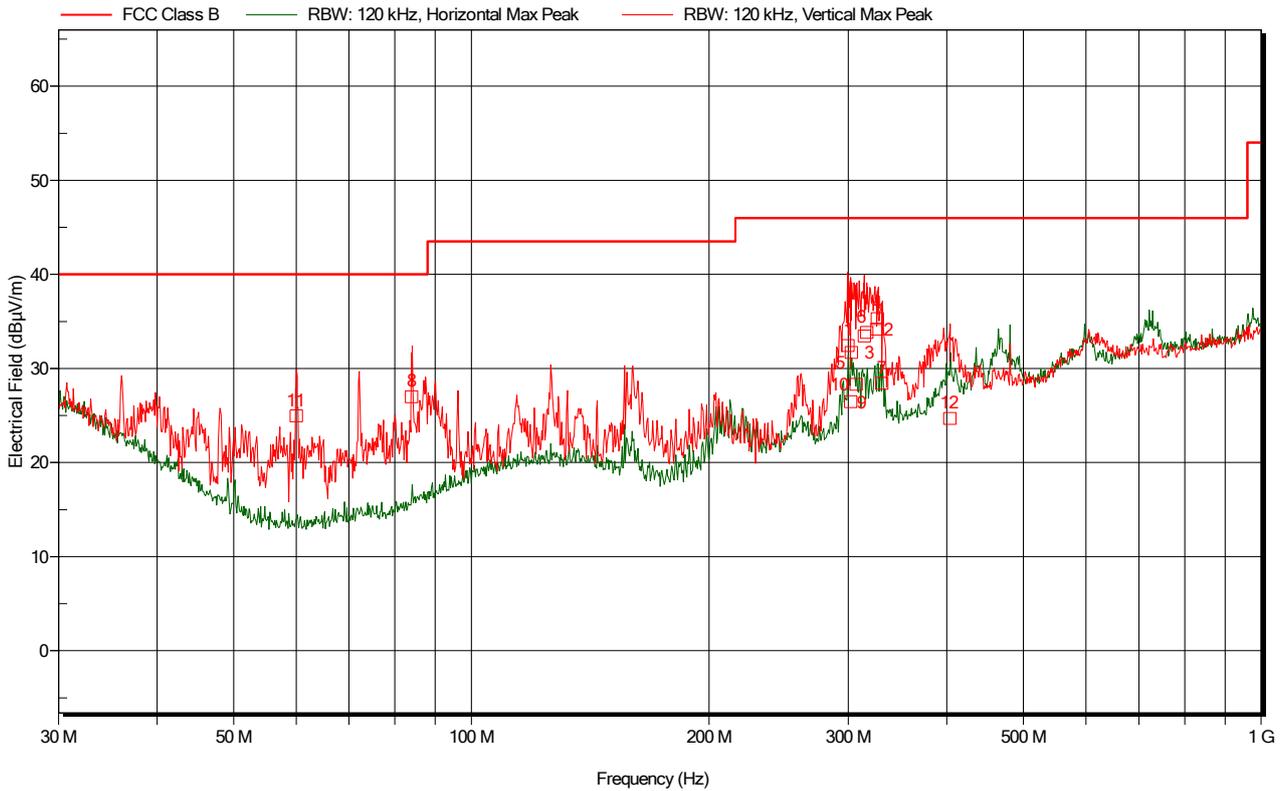


Figure 5.3.7.1: Electric field emissions Plot, 30MHz to 1GHz, 2440MHz Operation

Frequency	Quasi-Peak	Quasi Peak Limit	Quasi-Peak Difference	Quasi-Peak Status	Angle	Height	Polarization
MHz	dBµV/m	dBµV/m	dB		degrees	m	
299.70	32.4	46	-13.6	Pass	360	1.6	Vertical
326.34	34.2	46	-11.8	Pass	135	1.1	Vertical
314.34	33.5	46	-12.5	Pass	110	1.0	Vertical
326.52	35.3	46	-10.7	Pass	105	1.0	Vertical
302.58	31.7	46	-14.3	Pass	50	1.4	Vertical
316.62	33.8	46	-12.2	Pass	75	1.1	Vertical
330.90	28.4	46	-17.6	Pass	130	1.4	Vertical
84.00	27.0	40	-13.0	Pass	5	1.2	Vertical
302.04	26.5	46	-19.5	Pass	5	1.5	Vertical
306.84	28.3	46	-17.7	Pass	25	1.3	Vertical
60.00	25.0	40	-15.0	Pass	125	1.0	Vertical
403.50	24.7	46	-21.3	Pass	100	1.2	Vertical

Table 5.3.7.1 Electric Field Emissions Peaks, 30MHz to 1GHz. 2440MHz Operation

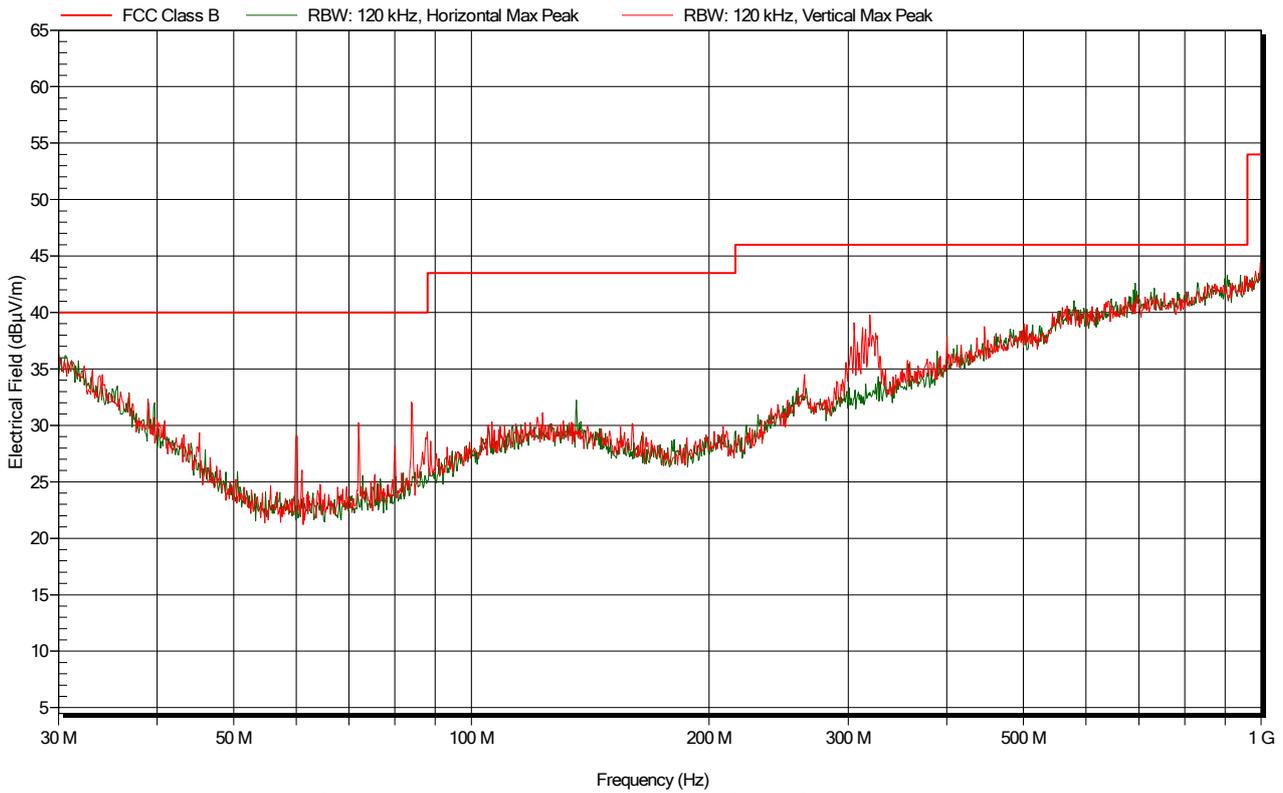


Figure 5.3.7.2: Electric field emissions Plot, 30MHz to 1GHz, Operation on 2402MHz - Peak detector scan

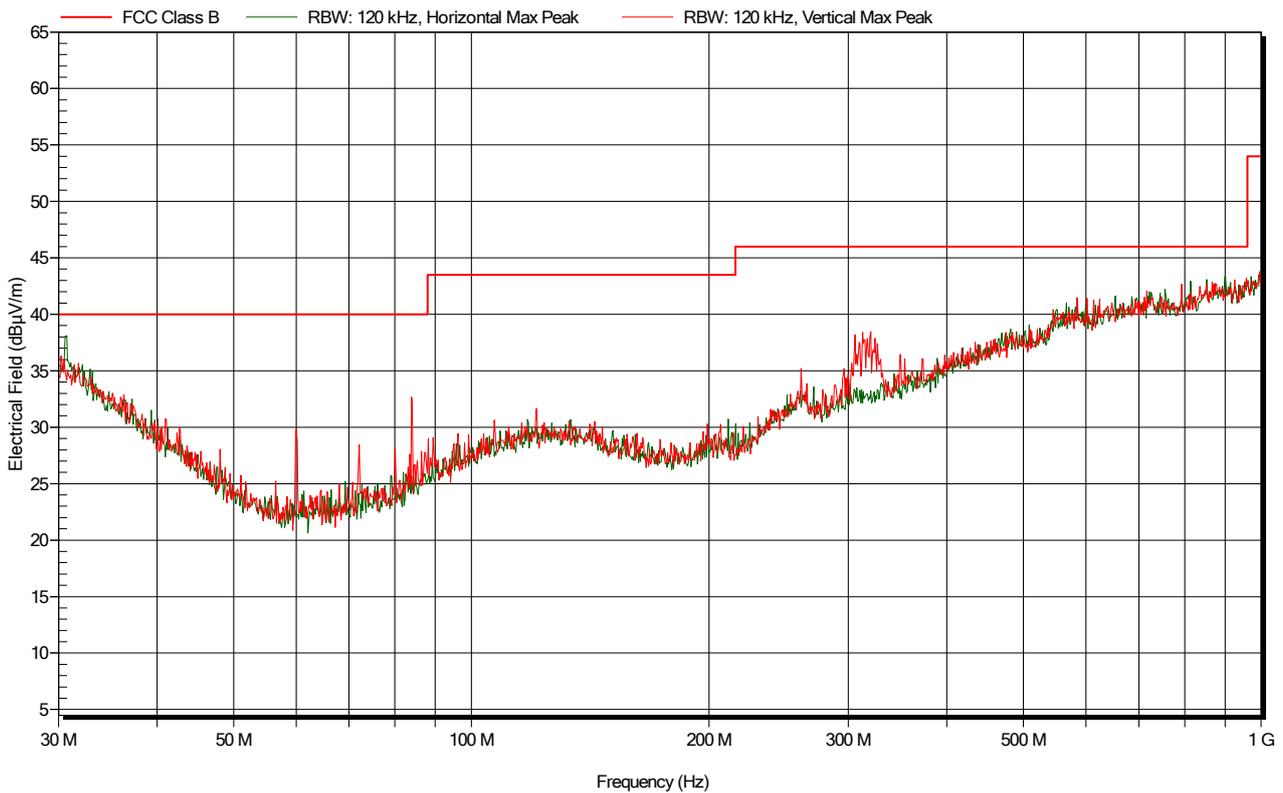


Figure 5.3.7.3: Electric field emissions Plot, 30MHz to 1GHz, Operation on 2480MHz - Peak detector scan

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

Frequency (GHz)	Limit (dB $\mu$ 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**29<sup>th</sup> March 2022**5.4.5 Test Area**

LAB 1 (SAC)

**5.4.6 Tested by**

M Dyster

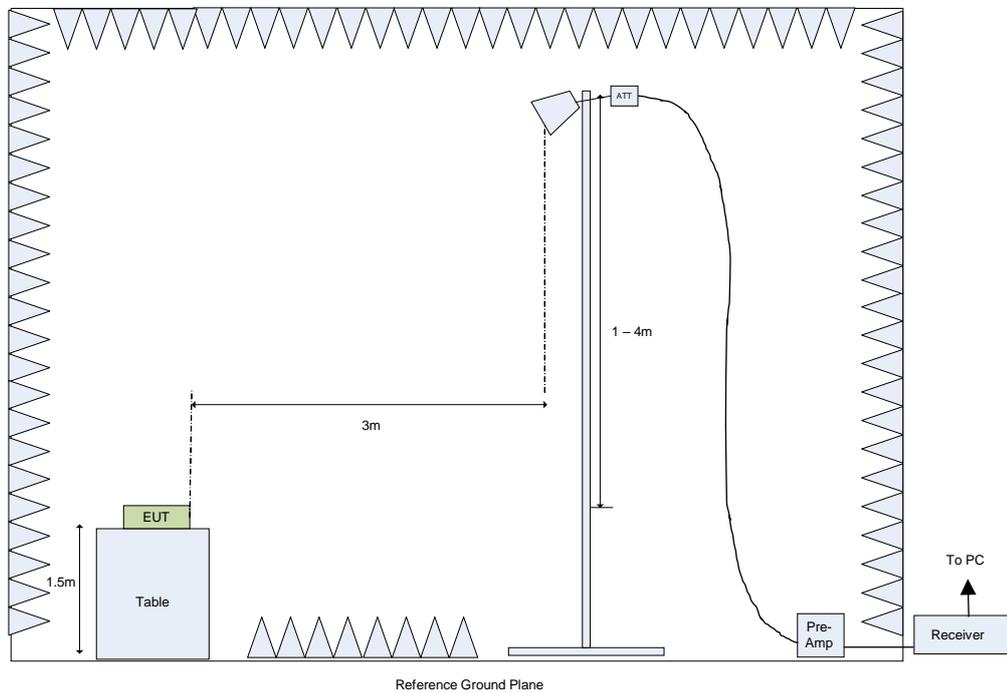
### 5.4.7 Test Setup

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
4.8055	Transmitting on channel 2402MHz	front face	0	1.5	V
3.8433	Transmitting on channel 2402MHz	front face	0	1.5	V
1.4395	Transmitting on channel 2402MHz	front face	0	1.5	V
1.9206	Transmitting on channel 2402MHz	front face	0	1.5	V
1.4412	Transmitting on channel 2440MHz	front face	0	1.5	V
1.9206	Transmitting on channel 2440MHz	front face	0	1.5	V
3.8195	Transmitting on channel 2440MHz	front face	0	1.5	V
3.9045	Transmitting on channel 2440MHz	front face	0	1.5	V
4.8803	Transmitting on channel 2440MHz	front face	0	1.5	V
3.8195	Transmitting on channel 2480MHz	front face	0	1.5	V
4.9602	Transmitting on channel 2480MHz	front face	0	1.5	V
3.9691	Transmitting on channel 2480MHz	front face	0	1.5	V
1.9223	Transmitting on channel 2480MHz	front face	0	1.5	V
1.4412	Transmitting on channel 2480MHz	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, 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 2440MHz

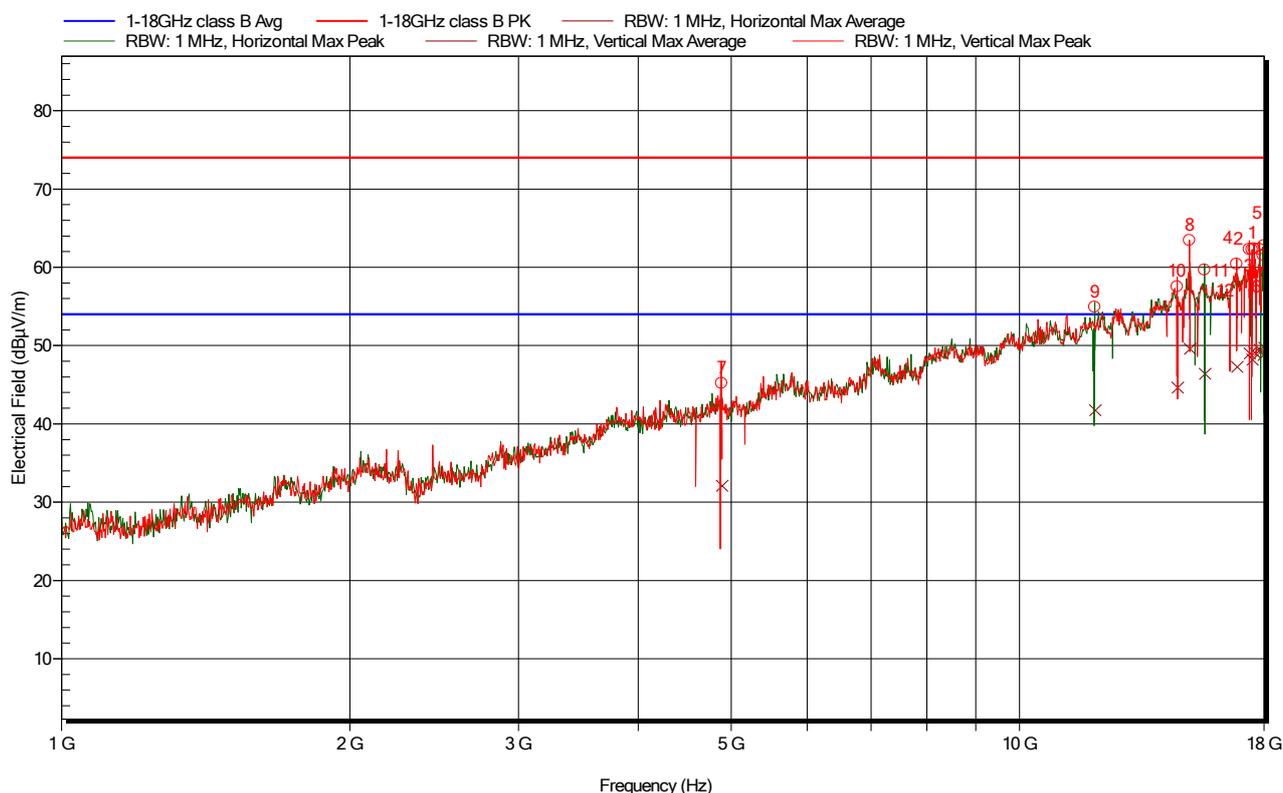


Figure 5.4.9.1: Electric field emissions Plot, 1GHz to 18GHz. Operation on 2440MHz

Frequency	Average	Average Limit	Average Difference	Average Status	Angle	Height	Polarization
GHz	dBµV/m	dBµV/m	dB		degrees	m	
17.483	48.24	54	-5.76	Pass	345	2.7	Vertical
17.370	49.06	54	-4.94	Pass	25	3.9	Vertical
17.569	49.18	54	-4.82	Pass	165	3.3	Vertical
17.803	49.53	54	-4.47	Pass	210	3.1	Vertical
17.999	49.75	54	-4.25	Pass	185	3.4	Horizontal
17.950	48.85	54	-5.15	Pass	310	3.7	Horizontal
4.887	32.14	54	-21.86	Pass	165	3.8	Vertical
15.041	49.66	54	-4.34	Pass	270	2.0	Vertical
11.977	41.79	54	-12.21	Pass	335	3.8	Horizontal
14.597	44.71	54	-9.29	Pass	315	3.8	Vertical
15.599	46.45	54	-7.55	Pass	180	1.3	Horizontal
16.842	47.35	54	-6.65	Pass	50	2.1	Vertical

Table 5.4.9.1 Electric Field Emissions Peaks, 1GHz to 18GHz – Operation on 2440MHz

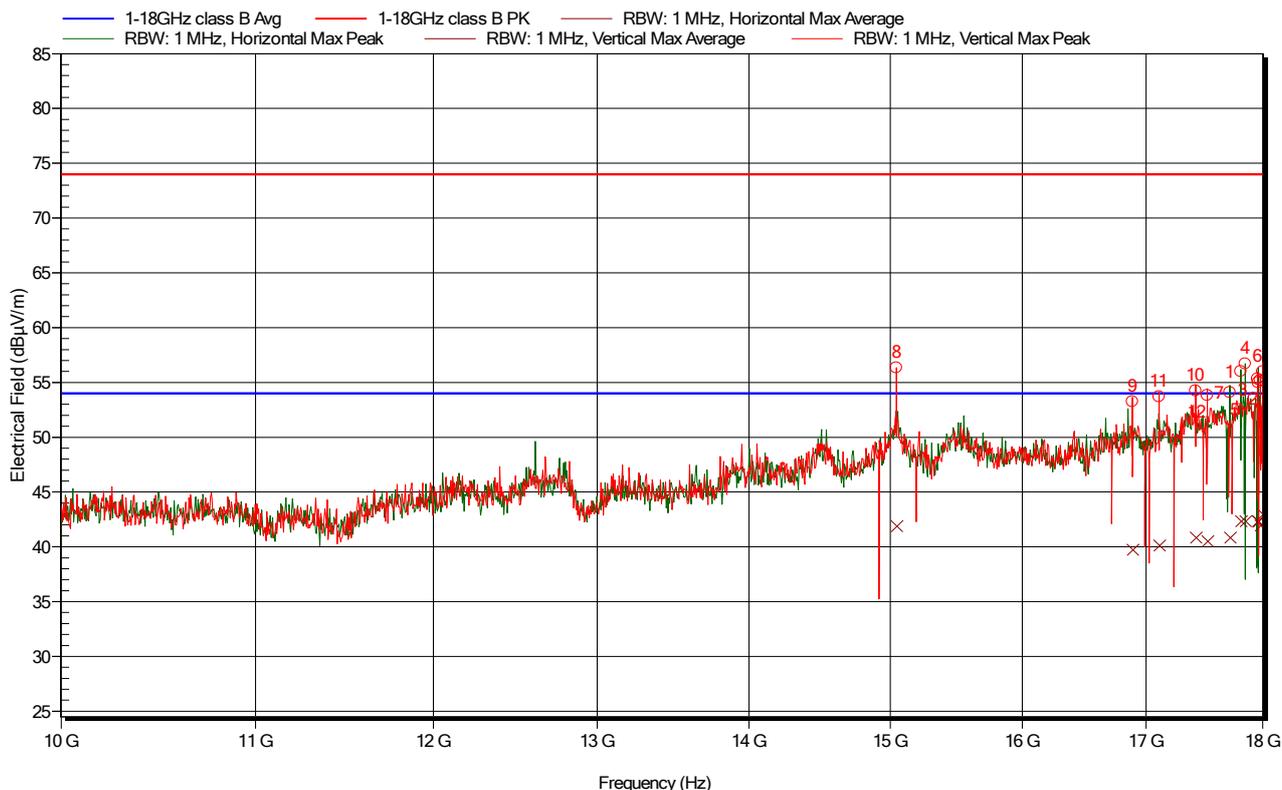


Figure 5.4.9.2: Electric field emissions Plot, 10GHz to 18GHz. 1m measurement distance. Operation on 2440MHz

Frequency	Average	Average Limit	Average Difference	Average Status	Angle	Height	Polarization
GHz	dBµV/m	dBµV/m	dB		degrees	m	
17.803	42.39	54	-11.61	Pass	40	1.7	Horizontal
17.956	42.35	54	-11.65	Pass	115	1.0	Horizontal
17.950	42.36	54	-11.64	Pass	215	1.2	Vertical
17.843	42.38	54	-11.62	Pass	250	1.3	Horizontal
17.975	41.99	54	-12.01	Pass	240	2.3	Vertical
17.994	42.99	54	-11.01	Pass	325	2.1	Vertical
17.709	40.89	54	-13.11	Pass	230	1.7	Horizontal
15.046	41.92	54	-12.08	Pass	195	1.6	Vertical
16.884	39.77	54	-14.23	Pass	250	3.3	Vertical
17.417	40.87	54	-13.13	Pass	360	2.1	Vertical
17.107	40.16	54	-13.84	Pass	295	2.7	Vertical
17.513	40.53	54	-13.47	Pass	50	2.9	Vertical

Table 5.4.9.2 Electric Field Emissions Peaks, 10GHz to 18GHz. 1m measurement distance – Operation on 2440MHz

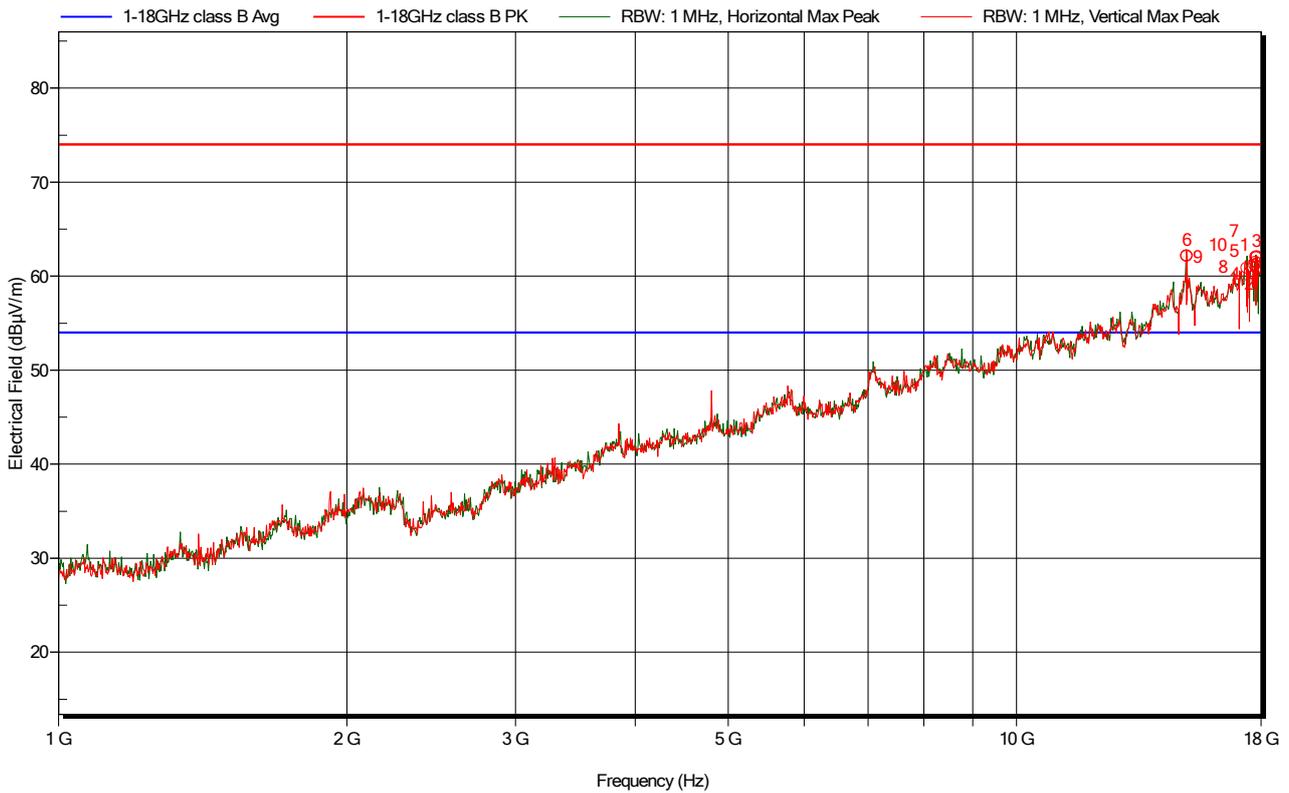


Figure 5.4.9.3: Electric field emissions Plot, 1GHz to 18GHz, Operation on 2402MHz - Peak detector scan

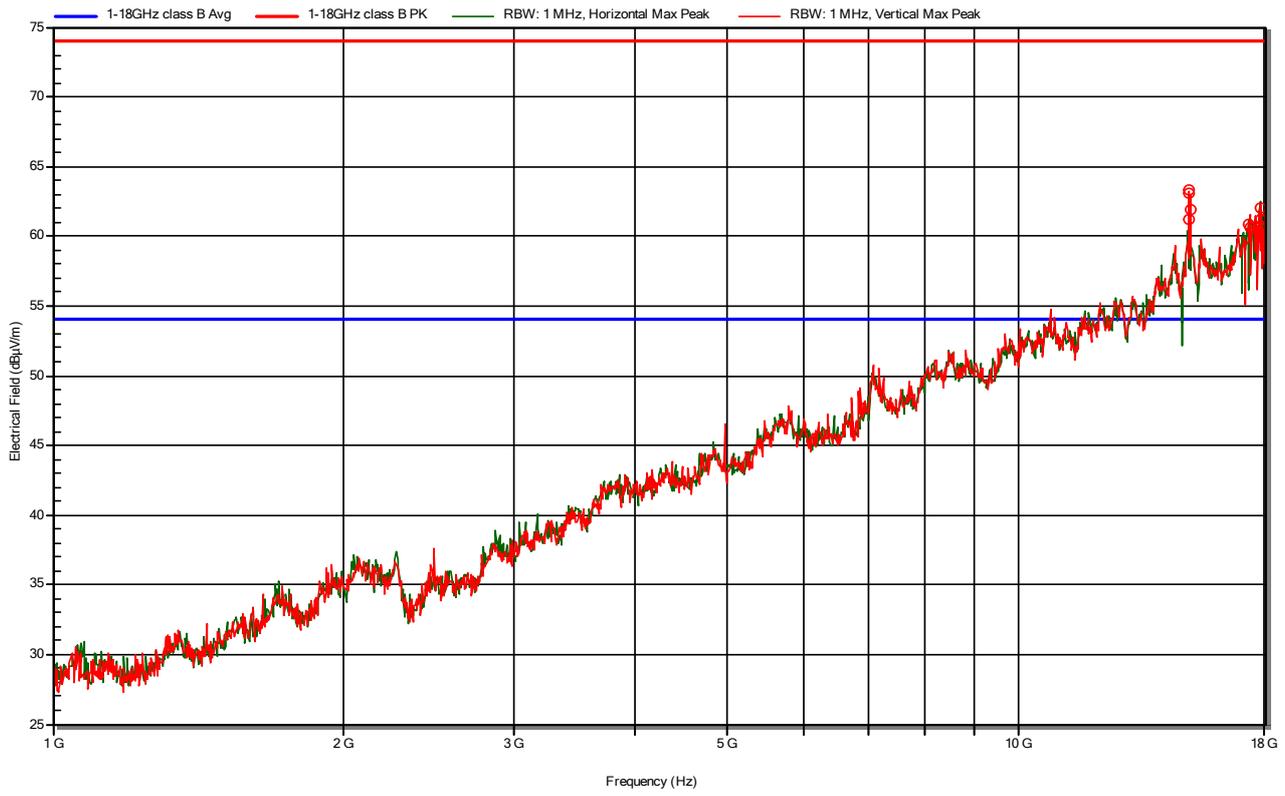


Figure 5.4.9.4: Electric field emissions Plot, 1GHz to 18GHz, Operation on 2480MHz – Peak detector scan

#### 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:

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

#### 5.4.11 Sample Data

From Figure 5.4.9.2 and table 5.4.9.2, The Average level at 17.803GHz is calculated as follows:

$$\text{FS (dB}\mu\text{V/m)} = 40.37(\text{dB}\mu\text{V}) - 9.5(\text{dB}) - 49.68(\text{dB}) + 48.25(\text{dB/m}) + 12.93 (\text{dB}) = 42.39\text{B}\mu\text{V/m}$$

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**29<sup>th</sup> March 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

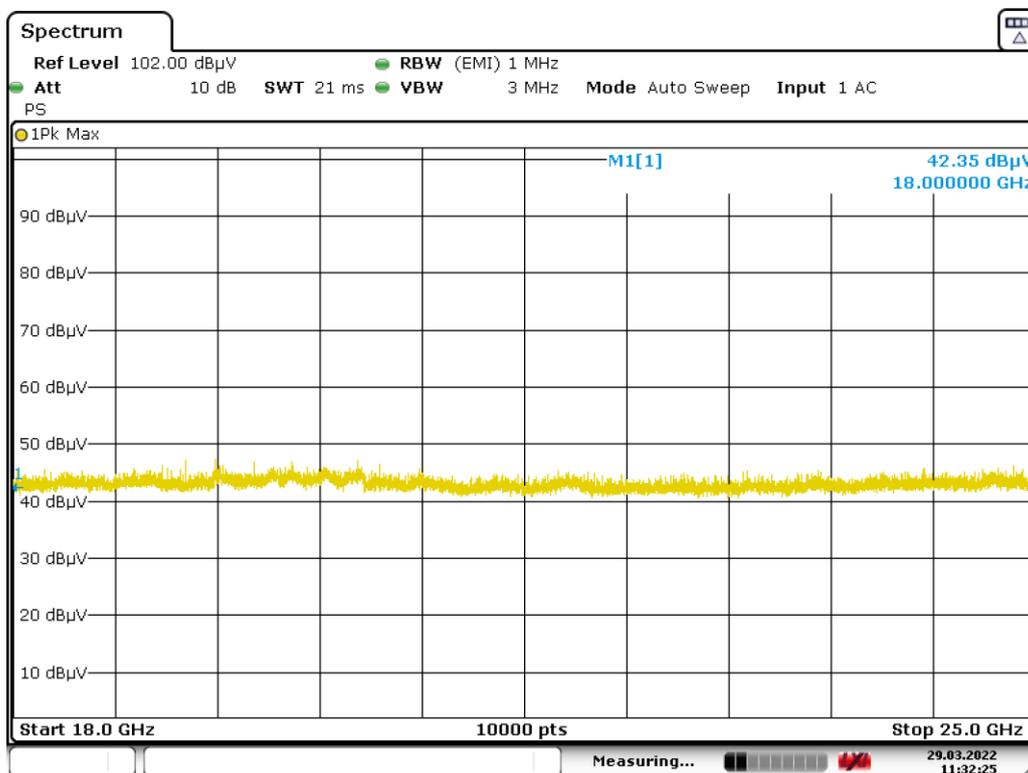
During exploratory testing, suspect emissions from the EUT were identified both in terms of the frequency and directionality. This was achieved by manually positioning the antenna close to the EUT and also by scanning it over all sides of the EUT whilst observing a spectral display. The typical distance 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 2402MHz, 2440MHz and 2480MHz.	-	-	-	-

Table 4: Frequencies identified during Exploratory Radiated Emission maximization

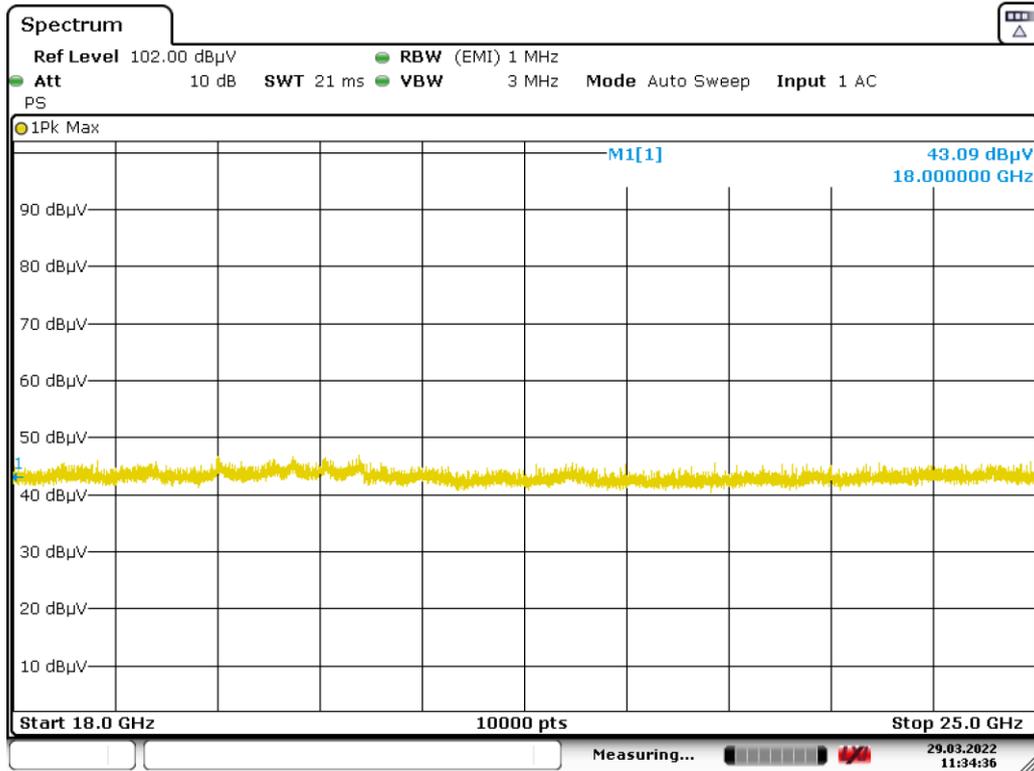
Note 2 : The front face of the EUT is deemed to be 0°, which is then turned in a clockwise direction through 360°.

No emissions were identified for further investigation above 18GHz.



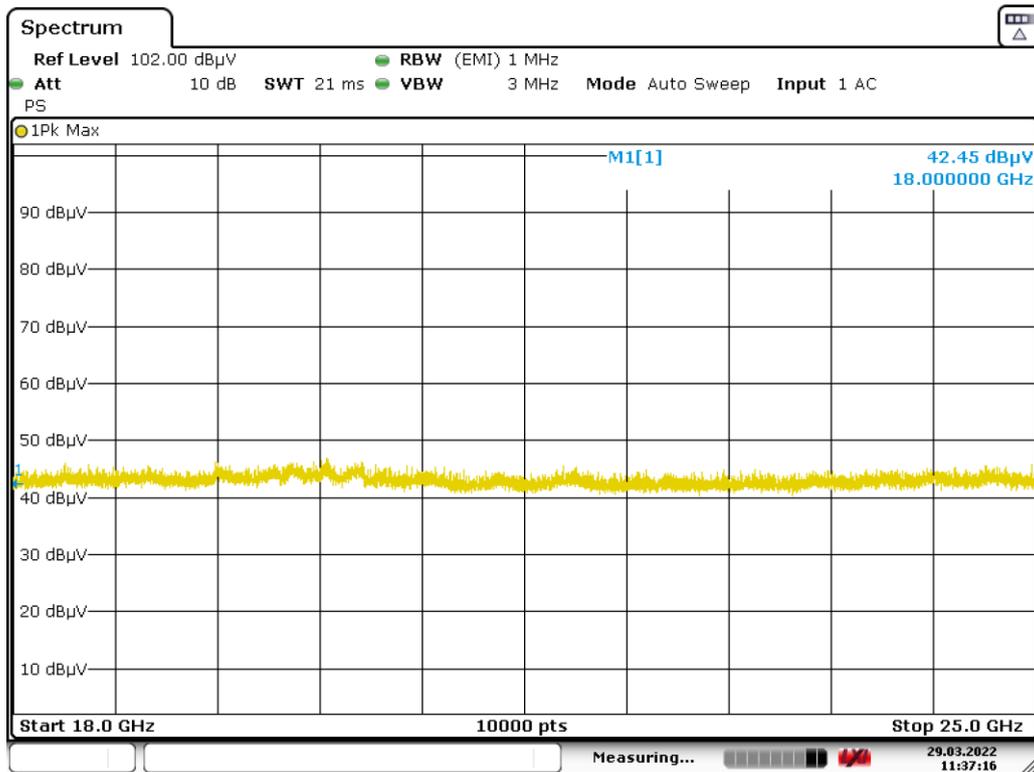
Date: 29.MAR.2022 11:32:26

Figure 5.5.8.1 – manual investigation – Operating on channel 2402MHz



Date: 29.MAR.2022 11:34:37

Figure 5.5.8.2 – manual investigation – Operating on channel 2440MHz



Date: 29.MAR.2022 11:37:17

Figure 5.5.8.3 – manual investigation – Operating on 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	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**

5<sup>th</sup> April 2022

**5.6.4 Test Area**

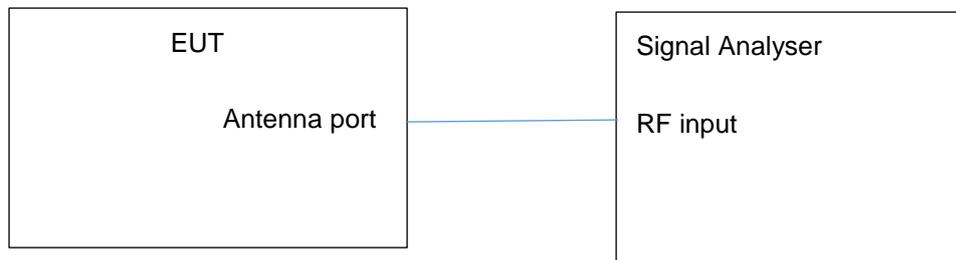
LAB 1

**5.6.5 Tested by**

J Beevers

### 5.6.6 Test Setup

The antenna port was connected directly to the signal analyser.

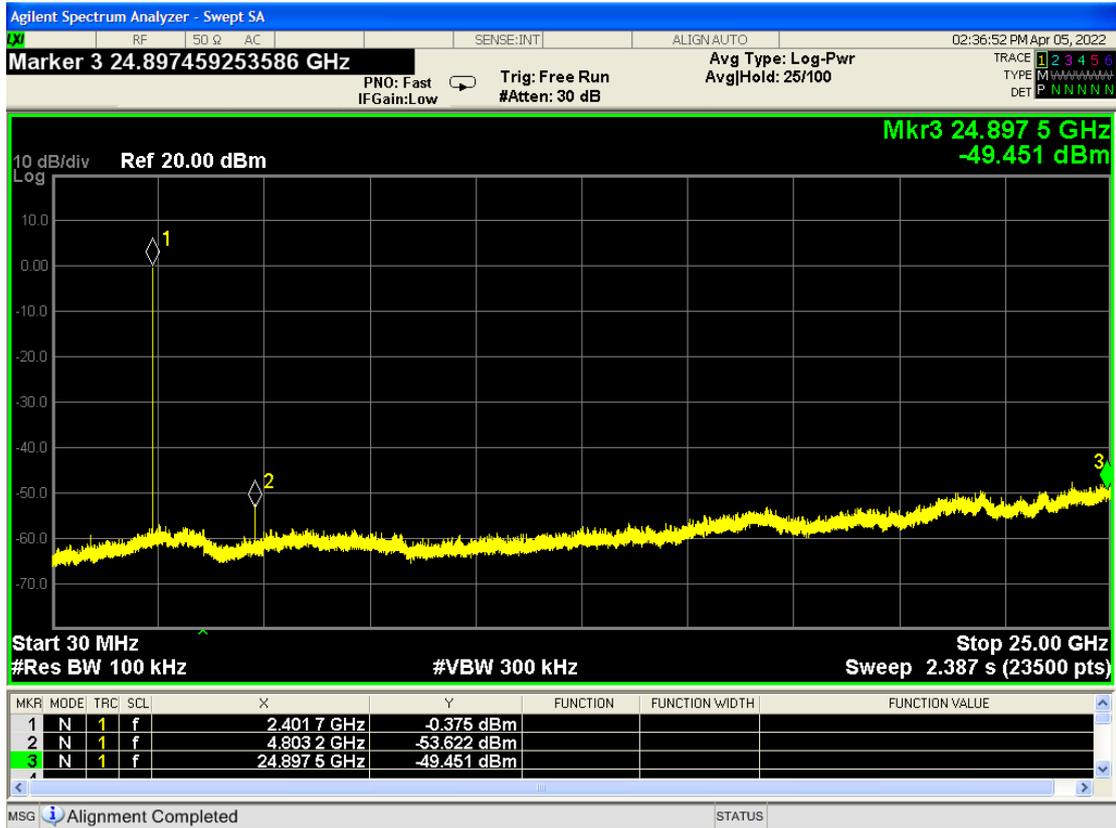


### 5.6.7 Test Results

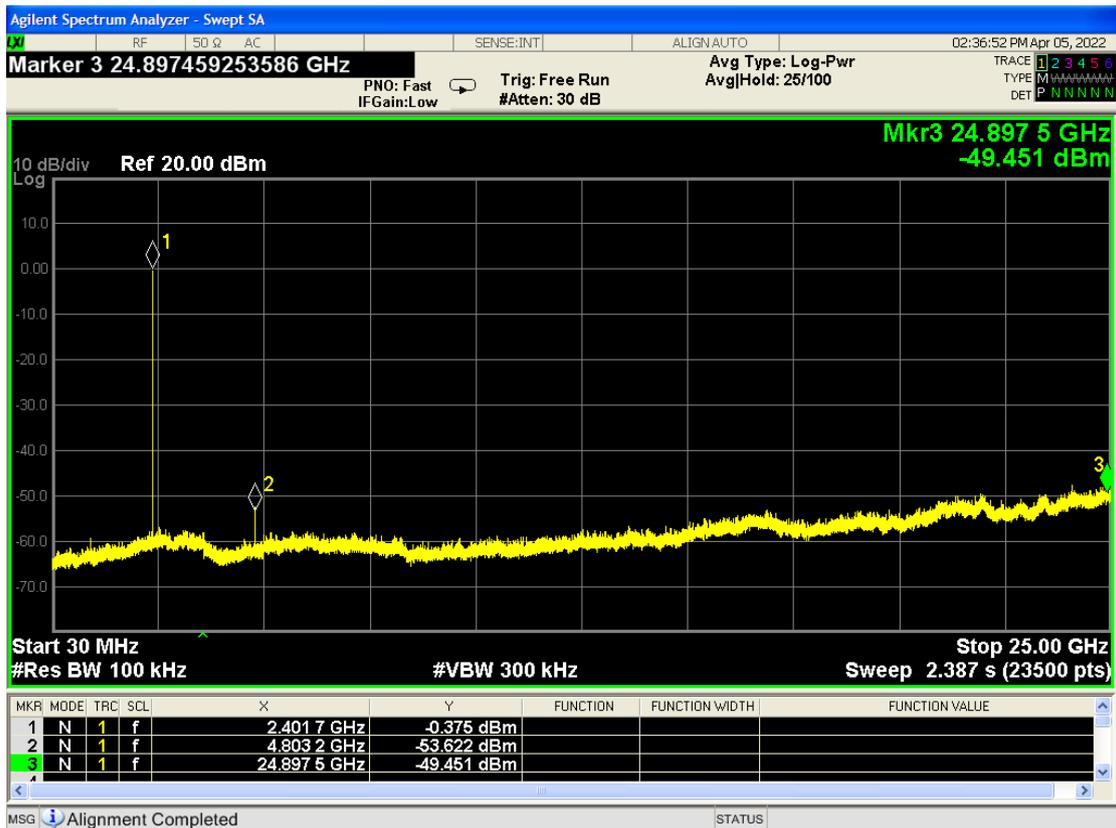
The results of the conducted spurious emissions are stated below and by the signal analyser images.

All disturbances detected were > 20dB below the carrier.

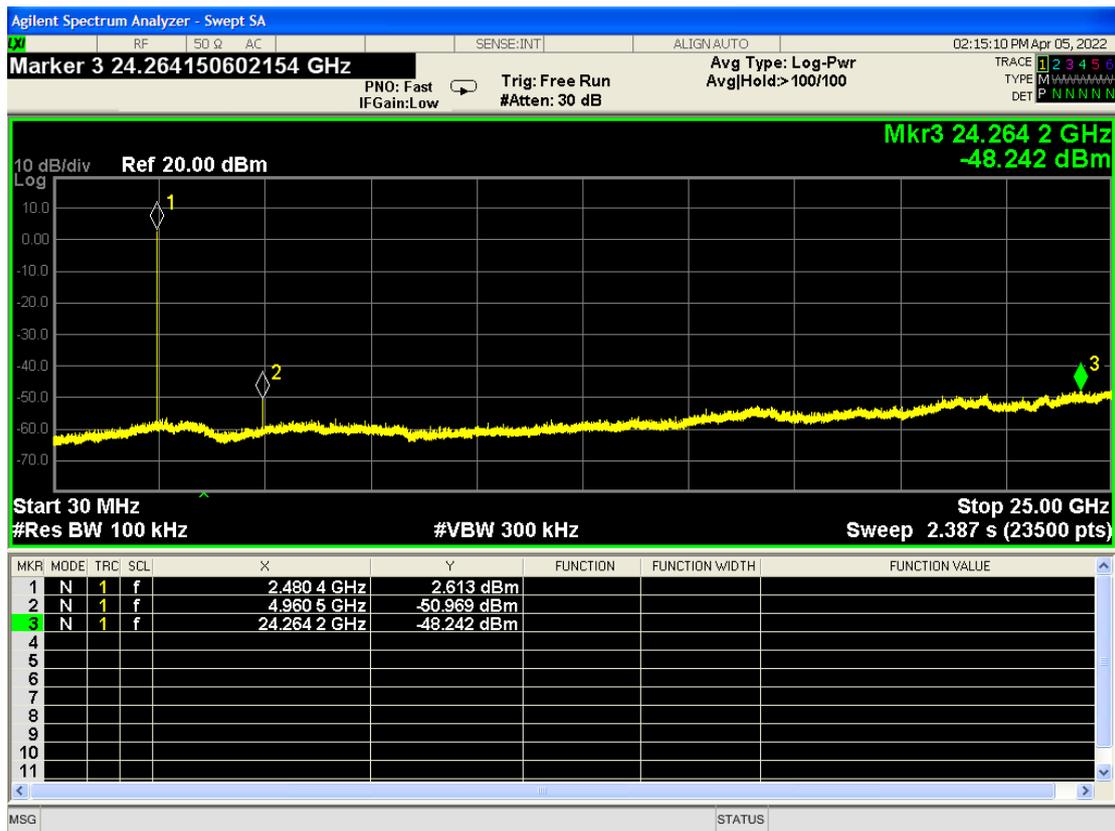
5.6.8 Antenna port conducted emissions, 30MHz to 25GHz



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



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



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

### 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	50kHz
Video Bandwidth	150kHz
Sweep rate	Auto couple
Trace mode	Max hold

**6.2.1 Emissions measurements**

**6.2.2 Date of Test**

5<sup>th</sup> April 2022

**6.2.3 Test Area**

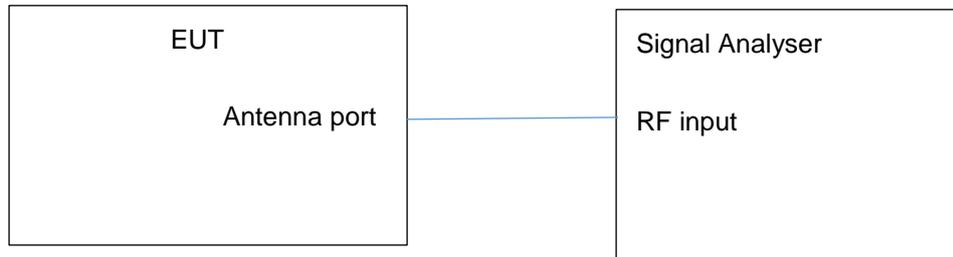
LAB 1

**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 (kHz)	Minimum requirement (kHz)	Figure	Result
2402.0	1.2018	793.4	500.0	6.2.6.1	Pass
2440.0	1.2063	771.4	500.0	6.2.6.2	Pass
2480.0	1.2049	764.2	500.0	6.2.6.3	Pass

**Bandwidth Measurements**

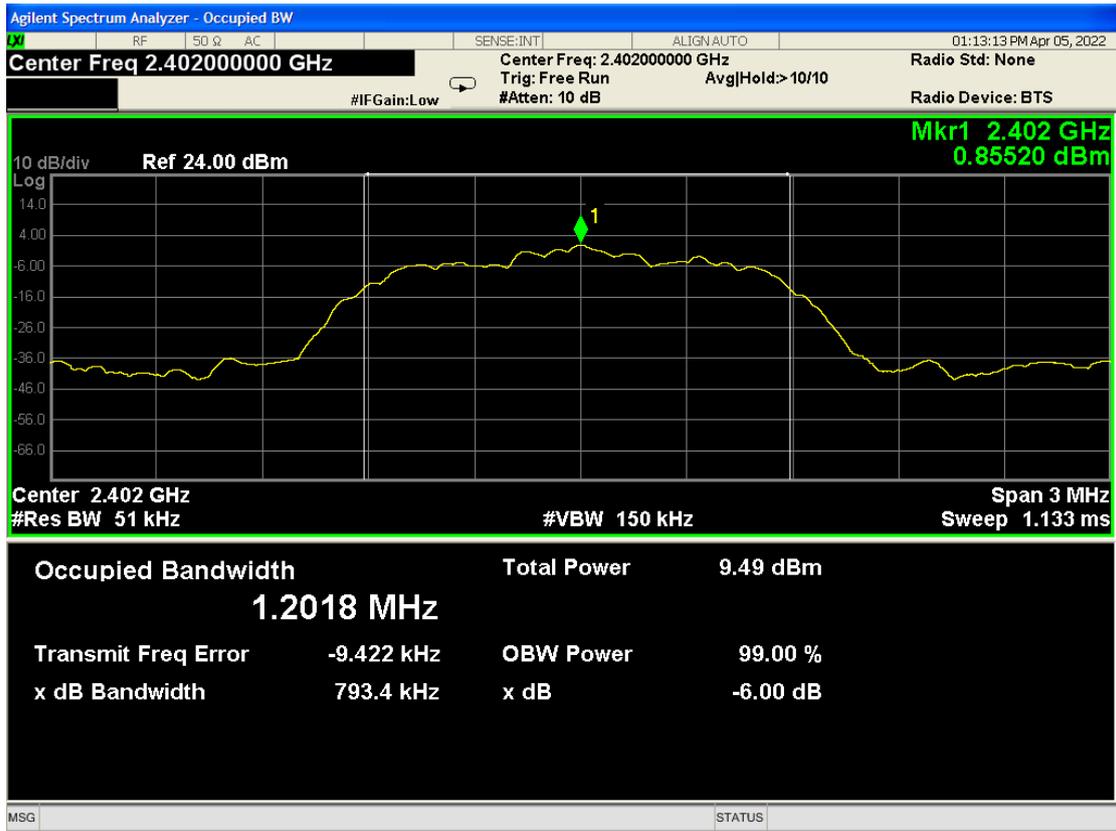


Figure 6.2.6.1 Bandwidth at 6dB Point and 99% Occupied Bandwidth. Operation on channel 2402MHz

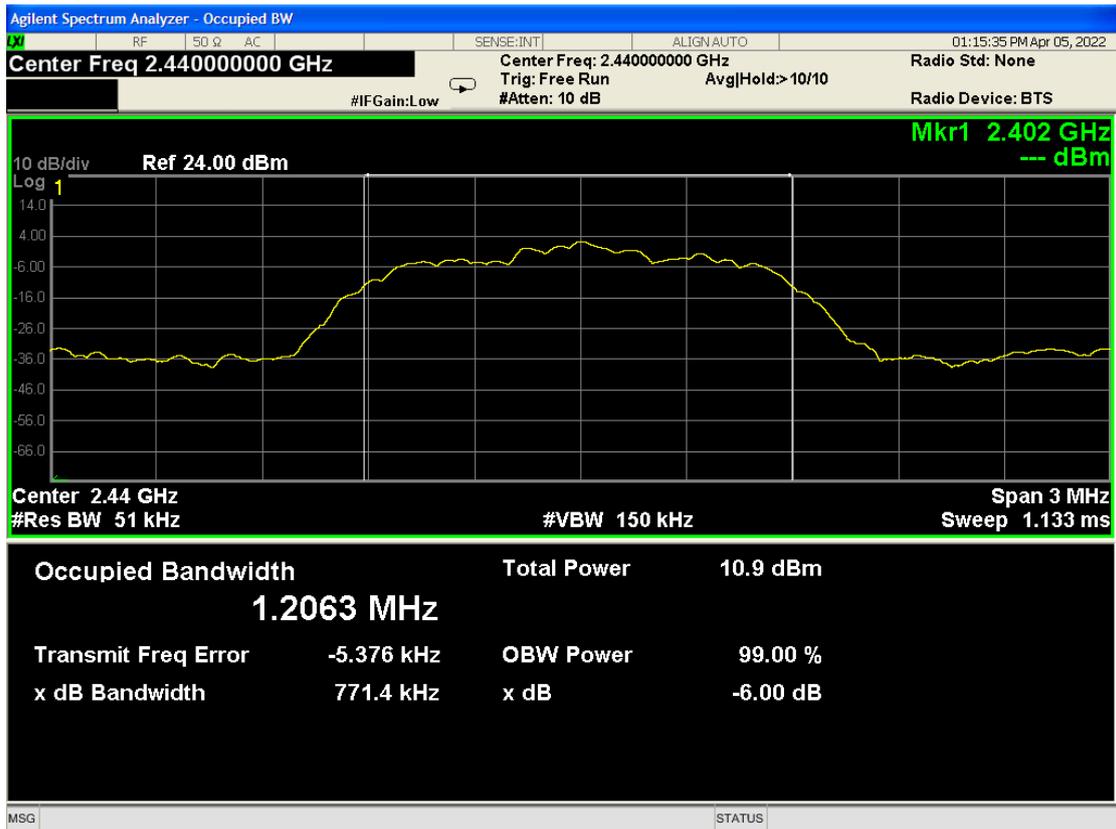


Figure 6.2.6.2 Bandwidth at 6dB Point and 99% Occupied Bandwidth. Operation on channel 2440MHz

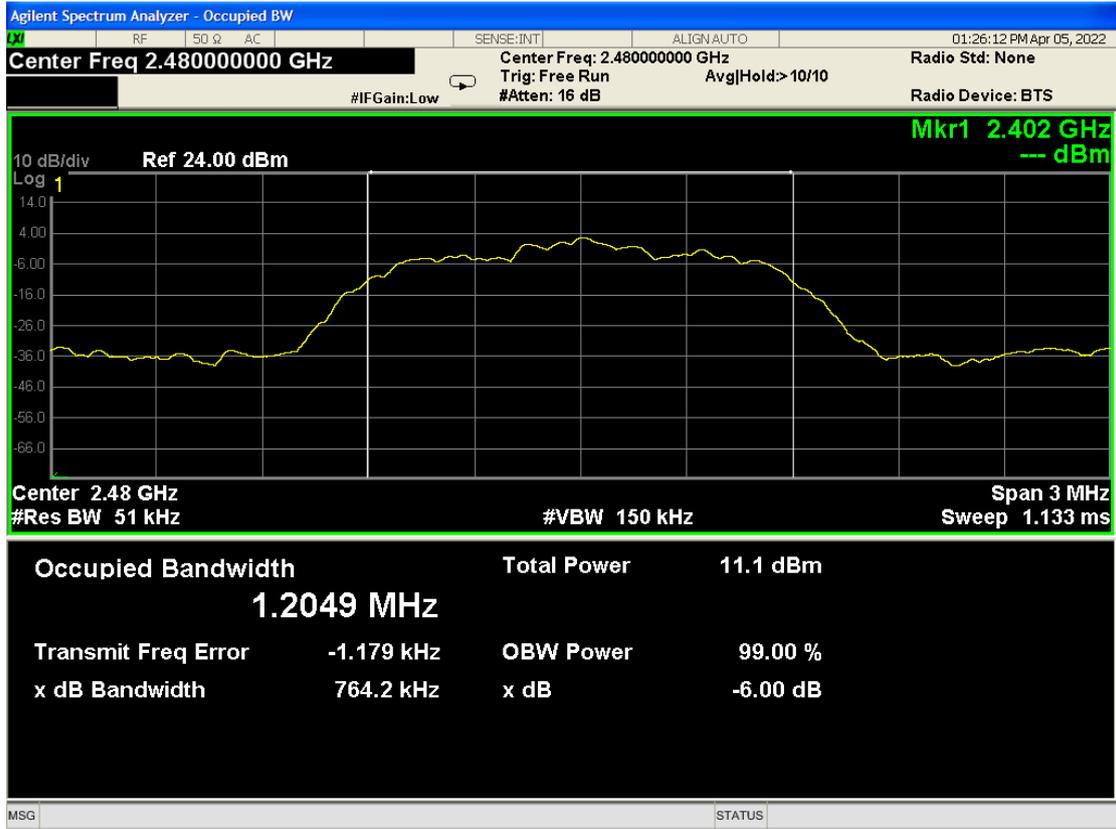


Figure 6.2.6.3 Bandwidth at 6dB Point and 99% Occupied Bandwidth. Operation on channel 2480MHz

## Section 7 Peak Output Power

### 7.1 Test Specification

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

### 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 (>DTS Bandwidth)
Video Bandwidth	6MHz
Sweep rate	Auto couple
Trace mode	Max hold

**7.2.1 Emissions measurements**

**7.2.2 Date of Test**

5<sup>th</sup> April 2022

**7.2.3 Test Area**

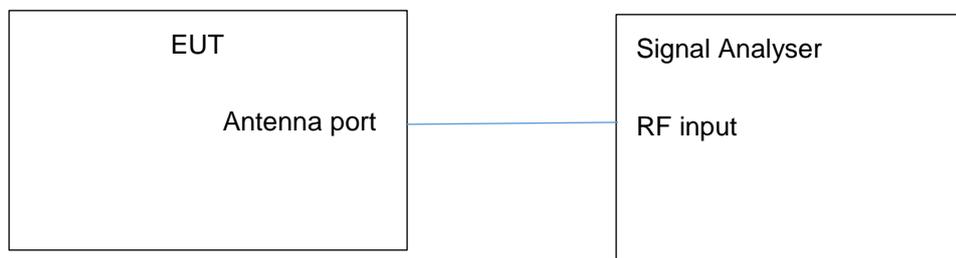
LAB 1

**7.2.4 Tested by**

J Bevers

**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	3.774	0.00238	1	7.2.6.1
2440	4.959	0.00313	1	7.2.6.2
2480	5.125	0.00325	1	7.2.6.3

**Peak Output Power Measurement**

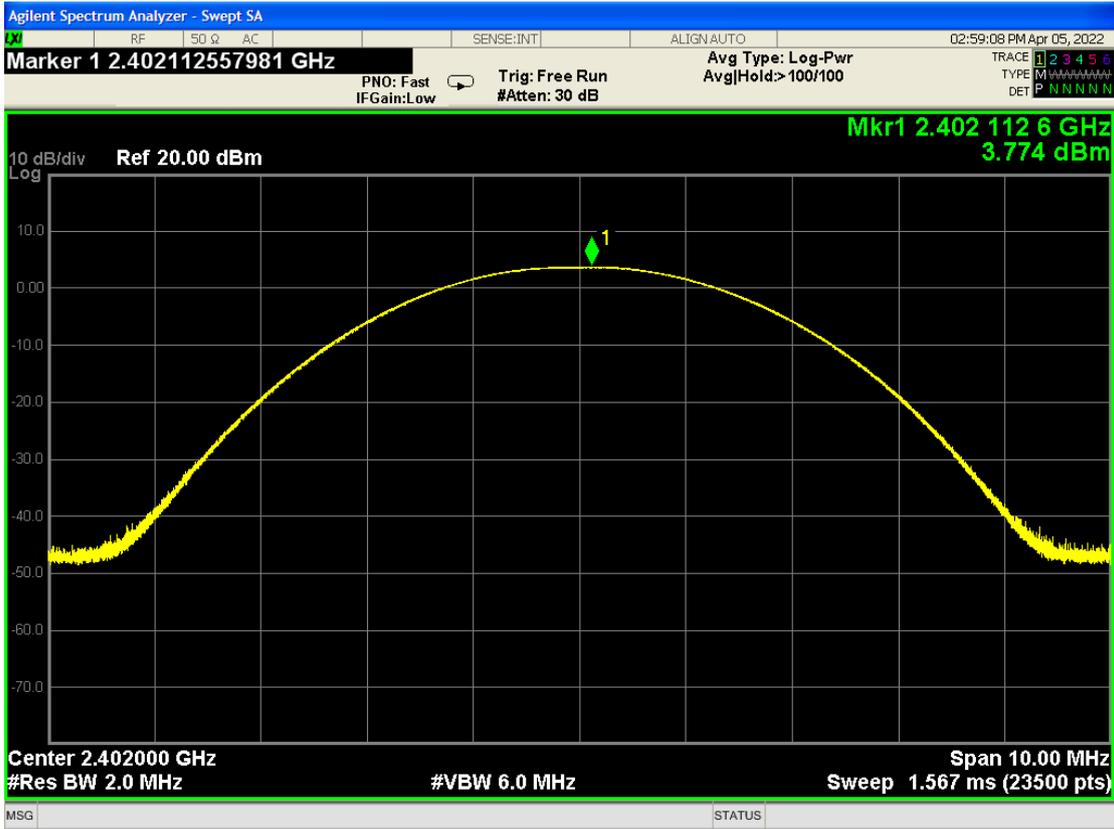


Figure 7.2.6.1 Peak output power, Operation on channel 2402MHz

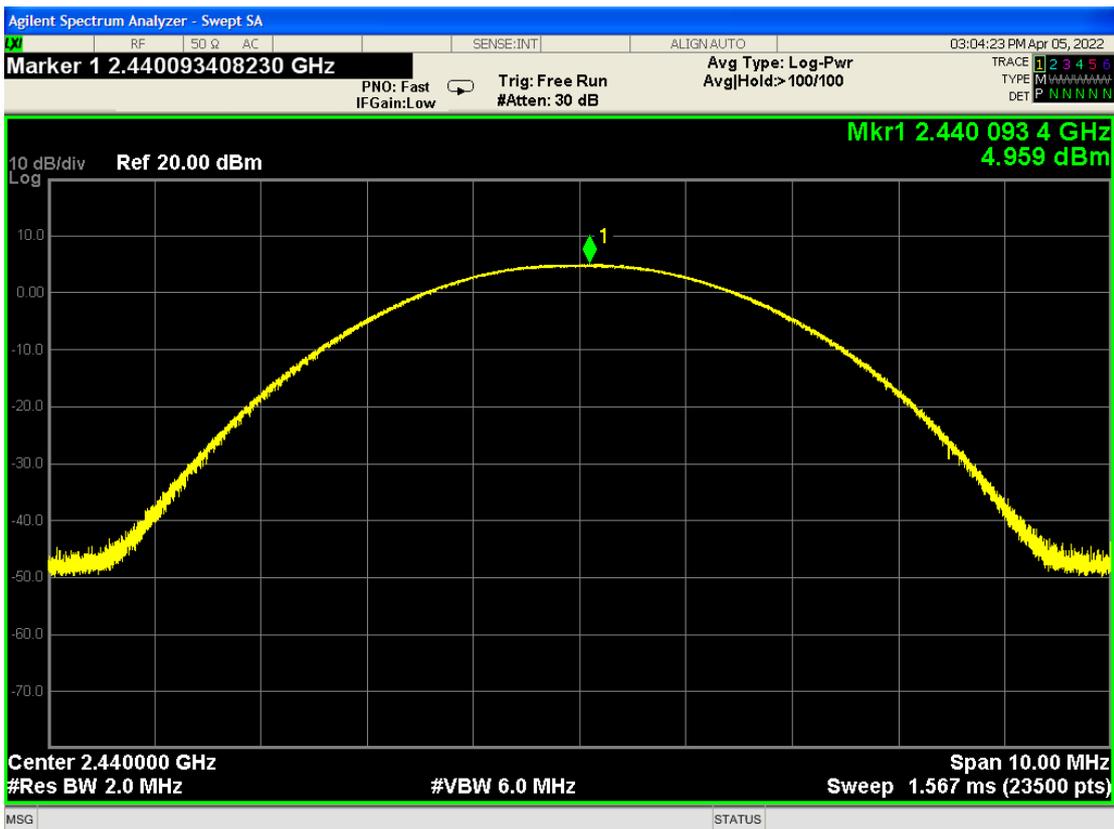


Figure 7.2.6.2 Peak output power, Operation on channel 2440MHz

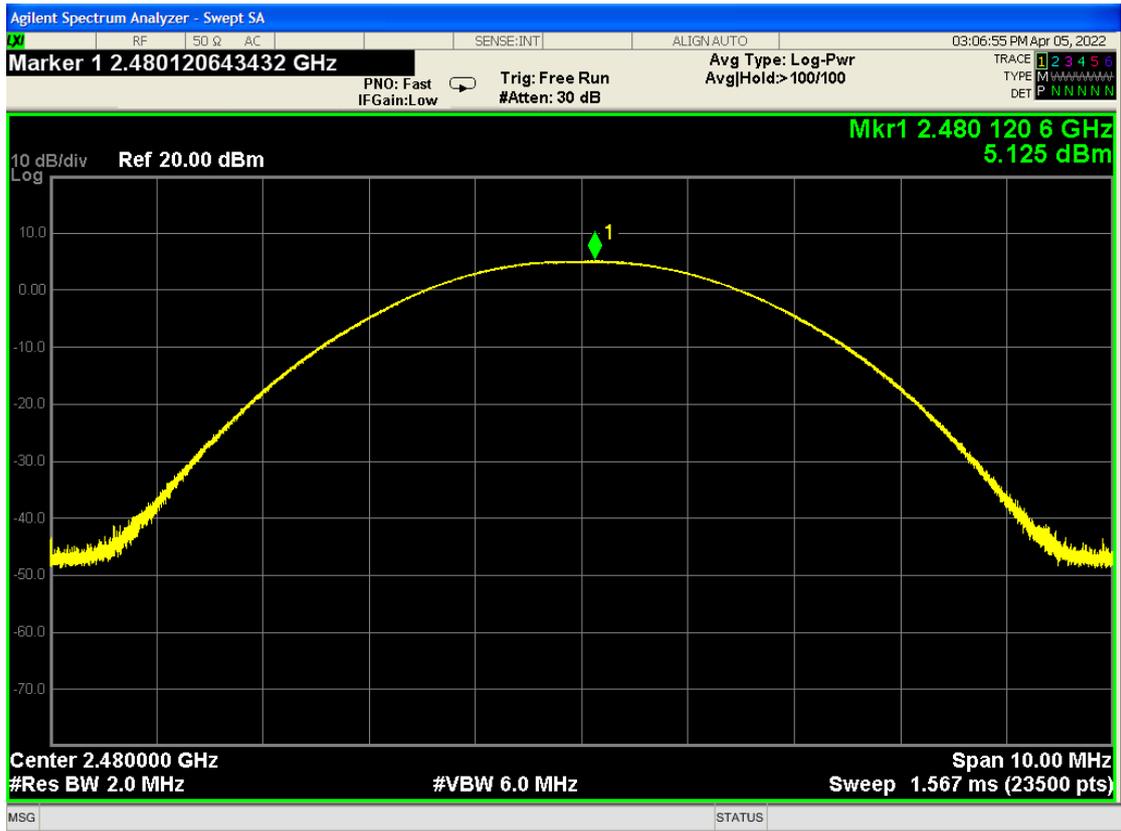


Figure 7.2.6.3 Peak output power, Operation on channel 2480MHz

## Section 8 Power Spectral Density

### 8.1 Test Specification

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

### 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**

5<sup>th</sup> April 2022

**8.2.3 Test Area**

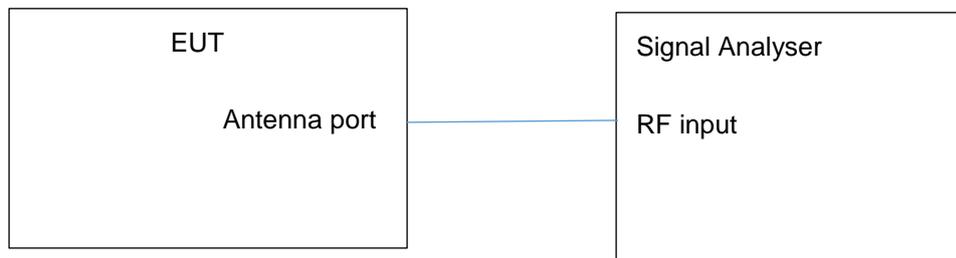
LAB 1

**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**

<b>Channel (MHz)</b>	<b>Power in 3kHz RBW (dBm)</b>	<b>Limit (dBm)</b>	<b>Figure</b>	<b>Result</b>
2402	-11.17	8.0	8.2.6.1	Pass
2440	-9.56	8.0	8.2.6.2	Pass
2480	-9.56	8.0	8.2.6.3	Pass

**Peak Spectral Density Measurement**

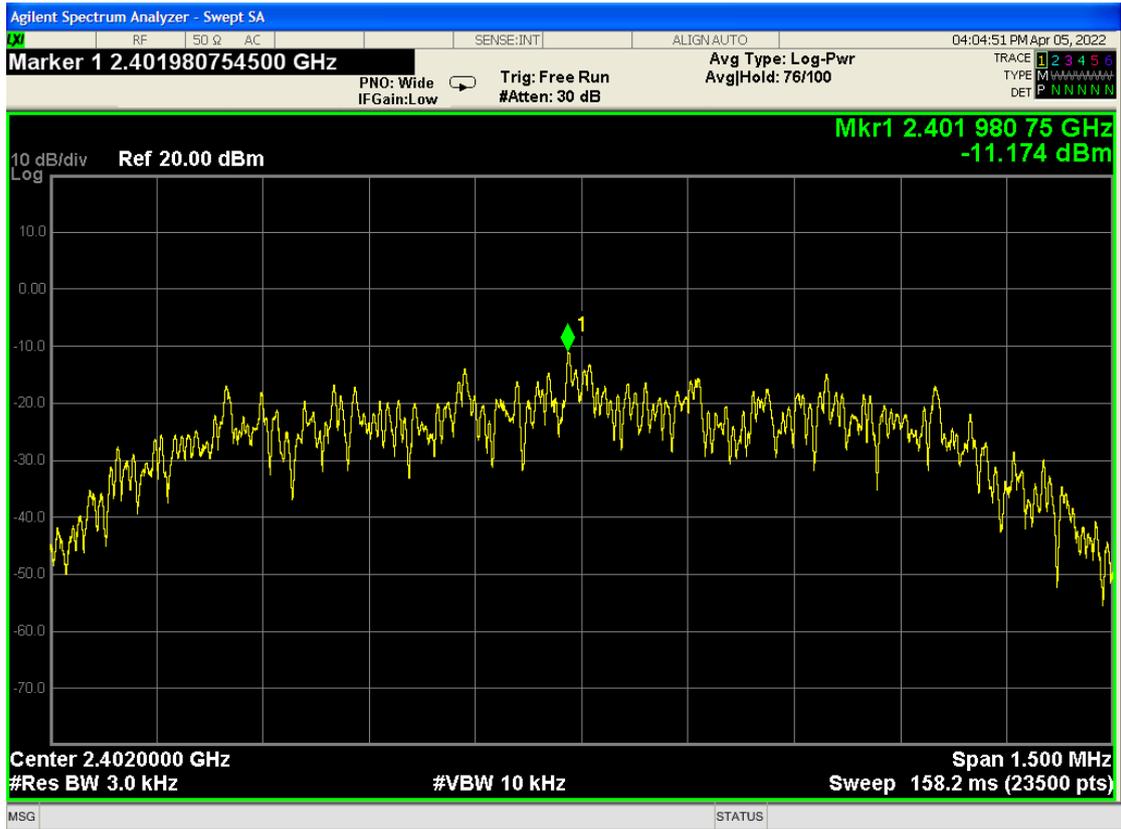


Figure 8.2.6.1 Power spectral density, Operation on channel 2402MHz

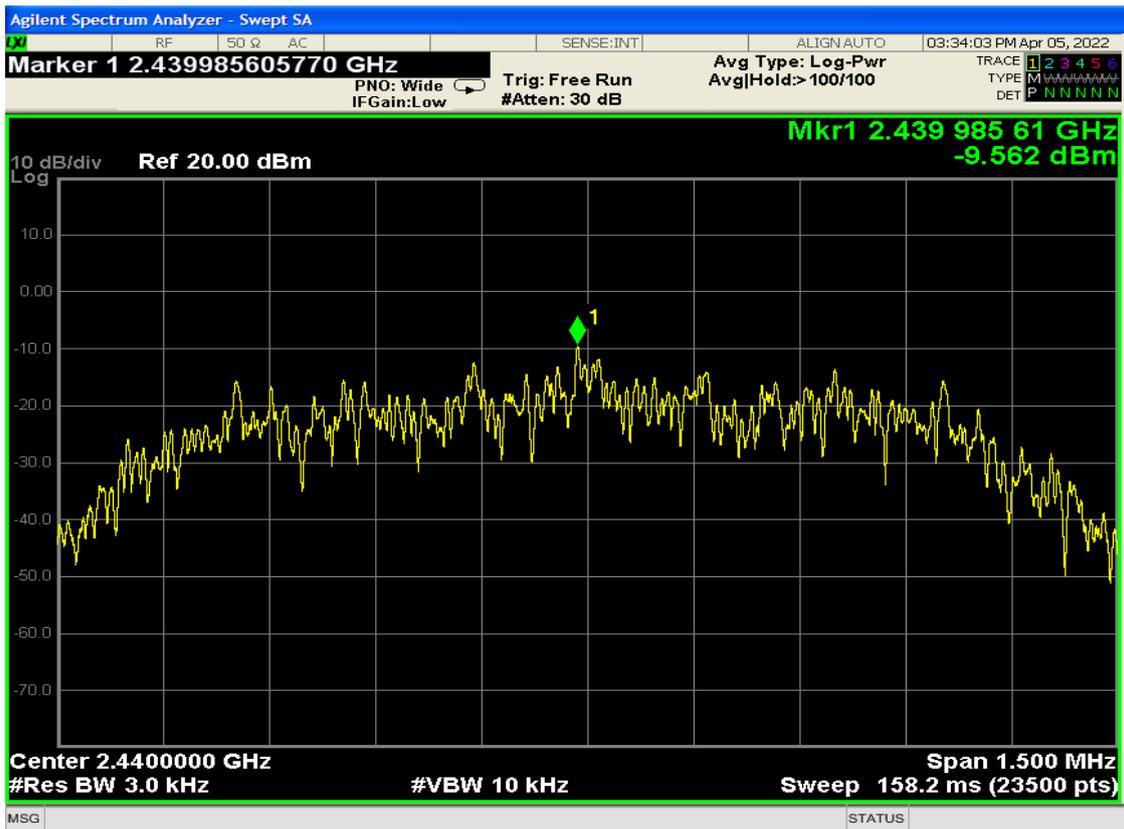


Figure 8.2.6.2 Power spectral density, Operation on channel 2440MHz

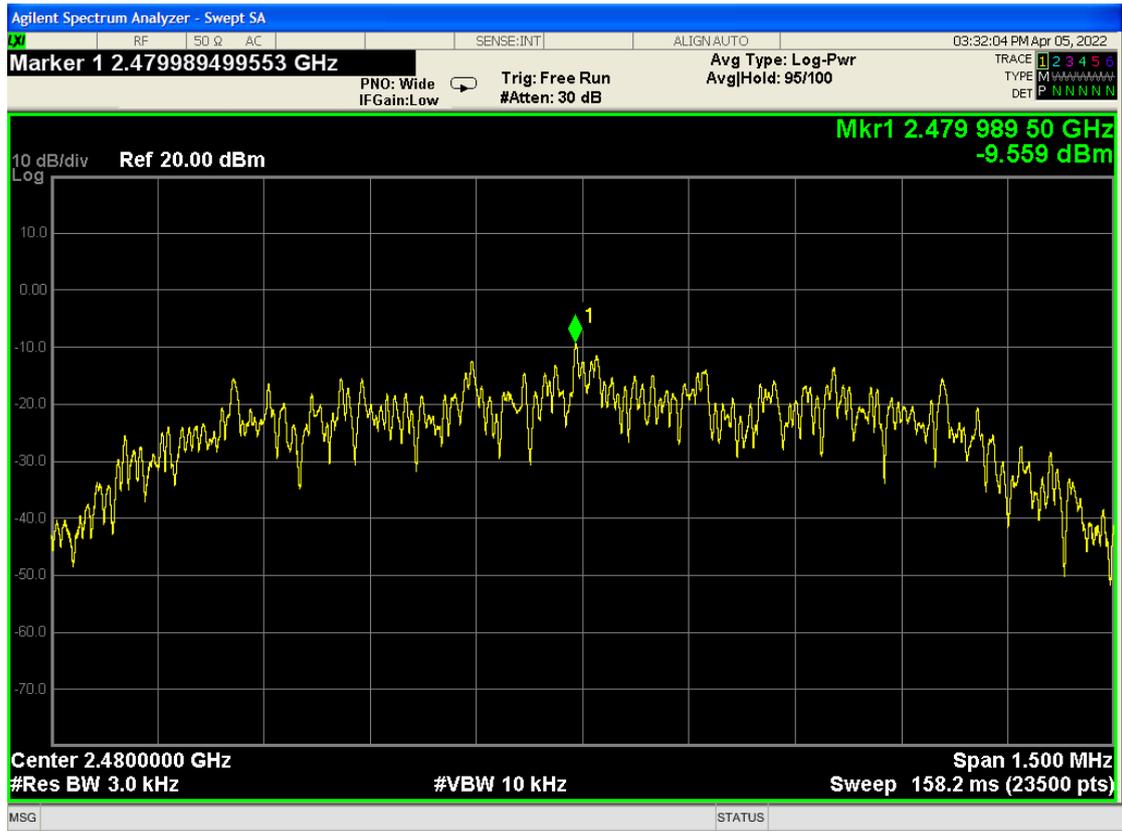


Figure 8.2.6.3 Power spectral density, Operation on channel 2480MHz

## Section 9 Band Edge Compliance

### 9.1 Test Specification

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

### 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**

4<sup>th</sup> April 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**

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	62.6	54.269	4.277	29.887	42.494	74	-31.506
V	2483.5	70.5	54.269	4.277	29.887	50.394	74	-23.606

**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	45.5	54.269	4.28	29.89	25.394	54	-28.606
V	2483.5	46.2	54.269	4.28	29.89	26.094	54	-27.906

**Operation on Channel 2480MHz, average detector measurements**

**Lower band edge**

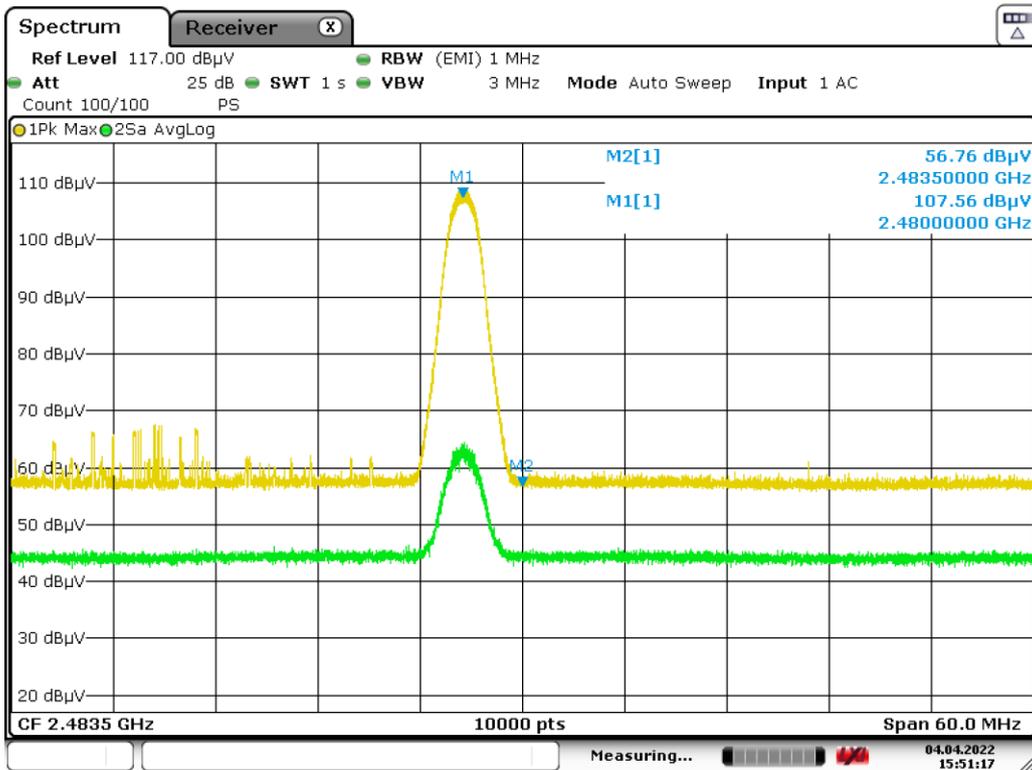
Polarity	frequency (MHz)	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF(dB/m)	E (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	2400	72.1	54.242	4.16	29.67	51.688	74	-22.312
V	2400	77.3	54.242	4.16	29.67	56.888	74	-17.112

**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	50.8	54.242	4.16	29.67	30.388	54	-23.612
V	2400	54.0	54.242	4.16	29.67	33.588	54	-20.412

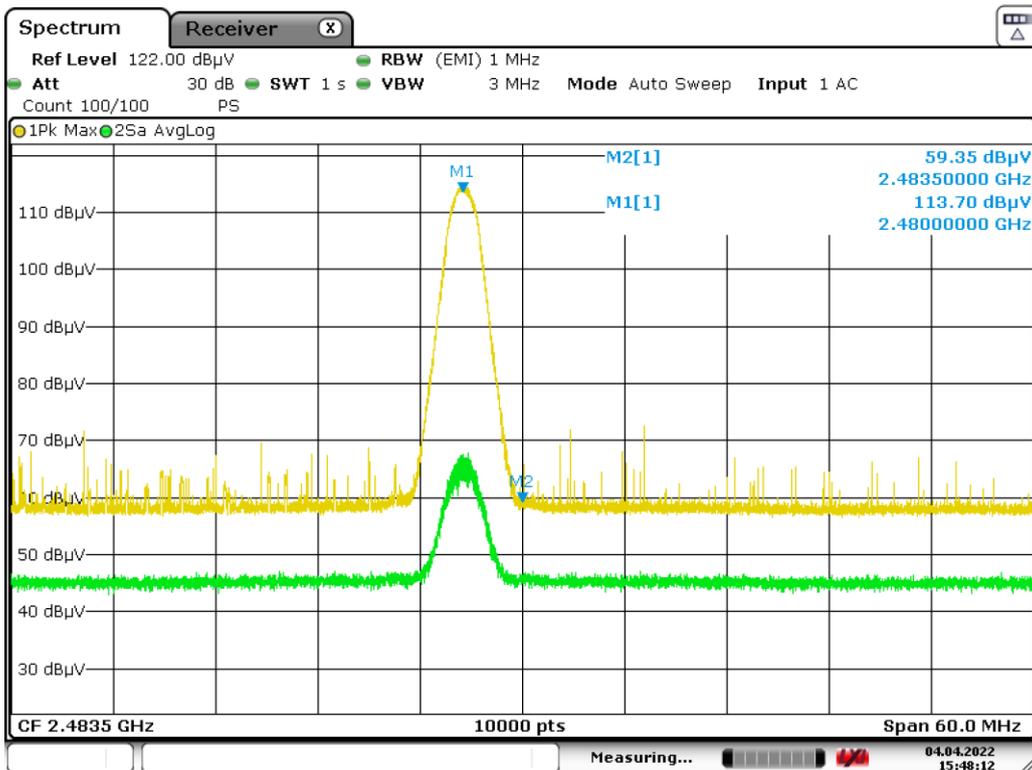
**Operation on channel 2402MHz average detector measurements**

Spectrum analyser displays



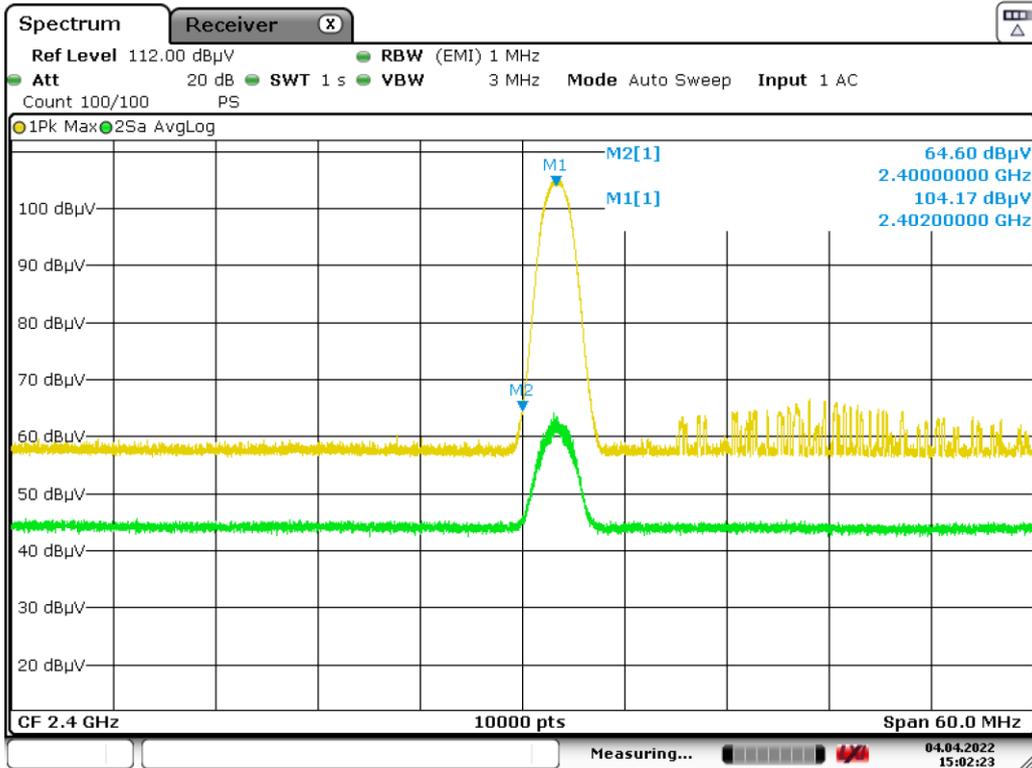
Date: 4.APR.2022 15:51:17

Band Edge Measurement – upper band edge - horizontal polarity



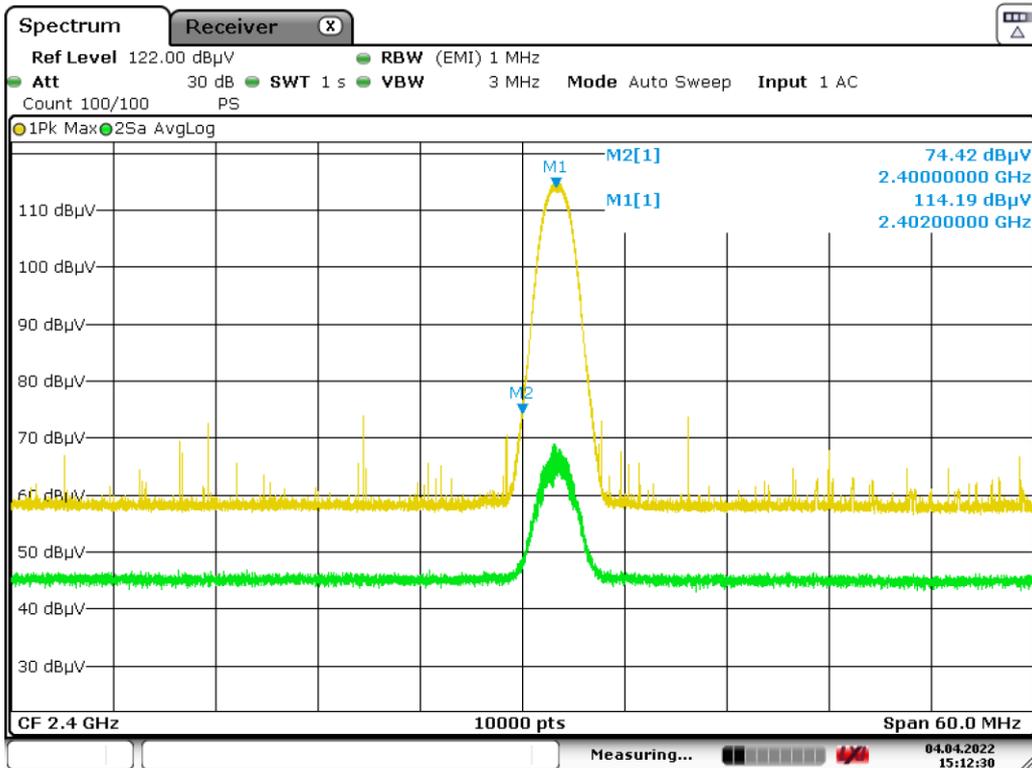
Date: 4.APR.2022 15:48:12

Band Edge Measurement – upper band edge - vertical polarity



Date: 4.APR.2022 15:02:23

**Band Edge Measurement – lower band edge - horizontal polarity**



Date: 4.APR.2022 15:12:31

**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 14	January 2022	12 Months
Agilent MXE EMI Receiver	C0339	25 <sup>th</sup> January 2022	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