

RADIO TEST REPORT

REPORT NUMBER: M2112040-8

**TEST STANDARD: FCC PART 15 SUBPART C
SECTION 15.247**

ISED RSS-247 SECTION 5.0

**CLIENT: MINELAB ELECTRONICS PTY
LTD**

**DEVICE: PLATYPUS2 METAL
DETECTOR**

MODEL: EQUINOX 900

FCC ID: Z4C-0054A

IC: 24927-0054A

DATE OF ISSUE: 4 MAY 2022

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REVISION TABLE

Version	Sec/Para Changed	Change Made	Date
1		Initial issue of document	4/05/2022



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TEST CERTIFICATE

Device: Platypus2 Metal Detector
Model Number: Equinox 900
Serial Number: 23890650365 (Conducted sample); 13650759359 (Radiated sample)
Variant Model: Equinox 700
Manufacturer: Minelab Electronics Pty Ltd

Radio: Bluetooth Low Energy (Nordic nRF5340)
FCC ID: Z4C-0054A
IC: 24927-0054A

Tested for: Minelab Electronics Pty Ltd
Address: 2 Second Avenue, Mawson Lakes, SA 5095, Australia
Contact: Charles Edwards
Phone Number: +61 8 8238 0823
Email: Charles.Edwards@codan.com.au

Standard: FCC Part 15, Subpart C, Section 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz

ISED RSS-247, Issue 2, Section 5 Standard specifications for frequency hopping systems and digital transmission systems operating in the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz

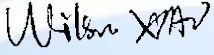
Result: The Platypus2 Metal Detector complied with the applicable requirements of the above standards. Refer to Report M2112040-8 for full details.

Test Date: 23 February - 02 March 2022

Issue Date: 4 May 2022

Test Engineer: 
Ian Paul Ng

Attestation: *I hereby certify that the device(s) described herein were tested as described in this report and that the data included is that which was obtained during such testing.*

Authorised Signatory: 
Wilson Xiao
Lead Engineer - Radio

Issued by: EMC Technologies Pty. Ltd.,
176 Harrick Road, Keilor Park, VIC, 3042, Australia.

Phone: +61 3 9365 1000

E-mail: emc-general@emctech.com.au

Web: www.emctech.com.au



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RADIO TEST REPORT

1 TEST SUMMARY

Sec.	Description	FCC	ISED	Result(s)
6.1	Antenna Requirement	§15.203	RSS-Gen 6.8	Complied
6.2	Restricted Bands of Operation	§15.205	RSS-Gen 8.10	Complied
6.3	Conducted Limits	§15.207	RSS-Gen 8.8	Not Applicable
6.4	Radiated emission limits; general requirements	§15.209	RSS-Gen 8.9	Complied
6.5	6 dB Bandwidth	§15.247(a)(2)	RSS-247 5.2(a)	Complied
6.6	Peak Output Power	§15.247(b)(3)	RSS-247 5.4(d)	Complied
6.7	Out-of-Band/Spurious Emissions	§15.247(d)	RSS-247 5.5	Complied
6.8	Band-Edge Emission Measurements	§15.247(d)	RSS-247 5.5	Complied
6.9	Power spectral density	§15.247(e)	RSS-247 5.2(b)	Complied
6.10	Maximum Permissible Exposure	§15.247(i)	RSS-102	Complied
6.11	Occupied Bandwidth – 99% power	§15.215	RSS-Gen 6.7	Complied

2 TEST FACILITY

2.1 General

EMC Technologies Pty Ltd is accredited by the FCC as a test laboratory able to perform compliance testing for the public. EMC Technologies Pty Ltd has also been designated as a Conformity Assessment Body (CAB) by Australian Communications and Media Authority (ACMA) under the APECTEL MRA and is designated to perform compliance testing on equipment subject to Declaration of Conformity (DoC) and Certification under Parts 15 and 18 of the FCC Commission's rules – **Registration Number 494713 & Designation number AU0001.**

EMC Technologies Pty Ltd is also an ISED Canada recognized testing laboratory – **ISED company number: 3569B and CAB identifier number: AU0001.**

2.2 Test Laboratory/Accreditations

NATA is the Australian National laboratory accreditation body and has accredited EMC Technologies to operate to the IEC/ISO17025 requirements. A major requirement for accreditation is the assessment of the company and its personnel as being technically competent in testing to the standards. This requires fully documented test procedures, continued calibration of all equipment to the National Standard at the National Measurements Institute (NMI) and an internal quality system similar to ISO 9002. NATA has mutual recognition agreements with the National Voluntary Laboratory Accreditation Program (NVLAP) and the American Association for Laboratory Accreditation (A²LA).

All testing in this report has been conducted in accordance with EMC Technologies' scope of NATA accreditation to ISO 17025 for both testing and calibration and ISO 17020 for Inspection – **Accreditation Number 5292.**

The current full scope of accreditation can be found on the NATA website: www.nata.com.au

3 TEST EQUIPMENT CALIBRATION

Measurement instrumentation and transducers were calibrated in accordance with the applicable standards by an independent NATA registered laboratory such as Keysight Technologies (Australia) Pty Ltd or the National Measurement Institute (NMI) or in-house. All equipment calibration is traceable to Australian national standards at the National Measurements Institute.

Equipment Type	Make/Model/Serial Number	Last Cal. dd/mm/yyyy	Due Date dd/mm/yyyy	Cal. Interval
Chamber	Frankonia SAC-3-2 (R-144)	10/08/2020	10/08/2023	3 Year ^{*1}
EMI Receiver	R&S ESW26 Sn: 101306 (R-143)	21/06/2021	21/06/2022	1 Year ^{*2}
Antennas	EMCO 6502 Active Loop Antenna Sn: 2021 (A-310)	31/08/2020	31/08/2022	2 Year ^{*2}
	SUNOL JB1 Sn: A052518 (A-434)	13/11/2020	13/11/2022	2 Year ^{*2}
	EMCO 3115 Horn Antenna Sn: 9501-4398 (A-406)	10/01/2022	10/01/2025	3 Year ^{*1}
	ETS-Lindgren 3160-09 Horn Antenna Sn:66032 (A307)	30/04/2021	30/04/2024	3 Year ^{*1}
Cables ^{*3}	Huber & Suhner Sucoflex 104A Sn: 503055 (C-457)	26/11/2021	26/11/2022	1 Year ^{*1}
	Huber & Suhner Sucoflex 104A Sn: 800448 (C-520)	26/11/2021	26/11/2022	1 Year ^{*1}
	Huber & Suhner Sucoflex 104A Sn: 27319 (C-273)	15/03/2022	15/03/2023	1 Year ^{*1}

Note *1. Internal NATA calibration.

Note *2. External NATA / A2LA calibration.

Note *3. Cables are verified before measurements are taken.

4 MEASUREMENT UNCERTAINTY

EMC Technologies has evaluated the equipment and the methods used to perform the emissions testing. The estimated measurement uncertainties for emissions tests shown within this report are as follows:

Radiated Emissions:	9 kHz to 30 MHz	±4.1 dB
	30 MHz to 300 MHz	±5.1 dB
	300 MHz to 1000 MHz	±4.7 dB
	1 GHz to 18 GHz	±4.6 dB
	18 GHz to 40 GHz	±4.6 dB
Peak Output Power:		±1.5 dB

The above expanded uncertainties are based on standard uncertainties multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Application of measurement uncertainty for this report:

The referenced uncertainty standard specifies that determination of compliance shall be based on measurements without considering measurement instrumentation uncertainty. However, the measurement uncertainty shall appear in the test report.

5 Device Details

Equinox 700 & Equinox 900 (project name: Platypus2) is designed as a high-performance coin & treasure metal detector. The product is designed to detect metal targets buried at varying depths in the ground. The metal detector supports a low-latency wireless audio connection for use with wireless headphones.

Equinox 700 uses the exact same radio components, PCB, and design, and is identical to the tested model Equinox 900. The only differences between these products are model branding, reduced functional features and pack-out of the Equinox 700.

5.1 EUT (Transmitter) Details

Radio:	Bluetooth Low Energy (Nordic nRF5340)
Frequency band:	2400 – 2483.5 MHz
Number of Channels:	40
Operating Frequency:	Low Channel: 2402 MHz (BT LE Advertising Channel 37) Mid Channel: 2440 MHz (BT LE Data Channel 17) High Channel: 2480 MHz (BT LE Advertising Channel 39)
Modulation:	Gaussian Frequency Shift Modulation (GFSK)
Nominal Bandwidth:	2 MHz
Data Rate:	2 Mbps
Antenna:	PCB Trace Antenna TEXAS INSTRUMENTS 2.4-GHz Inverted F Antenna (TI AP #SWRU120D)
Antenna Peak Gain:	3.3 dBi

5.2 EUT (Host) Details

Test Sample:	Platypus2 Metal Detector
Model Number:	Equinox 900
Serial Number:	23890650365 (Conducted sample); 13650759359 (Radiated sample)
Variant Model:	Equinox 700
Supply Rating:	3.7VDC (Battery Powered only – 1x internal, rechargeable Li-Ion)

5.3 Test Configuration

Testing was performed with the EUT's Transceiver set to transmit continuously at Low Channel (2402 MHz), Mid Channel (2440 MHz) and High Channel (2480 MHz).

5.4 Modifications

No modifications were required to achieve compliance.

5.5 Deviations from the Standard

No deviation from the standard.

6 RESULTS

6.1 §15.203/ RSS-Gen 6.8 Antenna Requirement

The test sample's Transceiver incorporates a PCB Trace Antenna and cannot be replaced by another type.

Antenna Brand: Texas Instruments

Antenna Type: 2.4 GHz Inverted F Antenna - PCB Trace Antenna (TI AP #SWRU120D)

Antenna Peak Gain: 3.3 dBi

Connector: Not Applicable

The above installation will prevent any unauthorised switching of antennas.

6.2 §15.205/ RSS-Gen 8.10/ RSS-247 3.3 Restricted Bands of Operation

The provisions of the §15.205/ RSS-Gen 8.10/ RSS-247 3.3 restricted bands of operation and §15.209 radiated emissions limits have been met, refer to section 6.7

6.3 §15.207/ RSS-Gen 8.8 Conducted Limits

The device is battery DC powered and does not connect directly or indirectly to the AC mains network. Test was not applicable.

6.4 §15.209/ RSS-Gen 8.9 Radiated Emission Limits; General Requirements

The provisions of the §15.205/ RSS-Gen 8.10/ RSS-247 3.3 restricted bands of operation and §15.209/ RSS-Gen 8.9 radiated emissions limits have been met, refer to section 6.7

6.5 §15.247(a)(2)/ RSS-247 5.2(a) 6 dB bandwidth

6.5.1 Test Procedure

The tests were performed in accordance with ANSI C63.10: 2013 Clause 11.8 DTS bandwidth.

The 6 dB bandwidth was measured while the device was transmitting with typical modulation applied. The resolution bandwidth of 100 kHz and the video bandwidth of 300 kHz were utilised when measuring the bandwidth.

6.5.2 Limits

In the band 2400-2483.5MHz, the minimum 6 dB bandwidth shall be at least 500 kHz.

6.5.3 Results

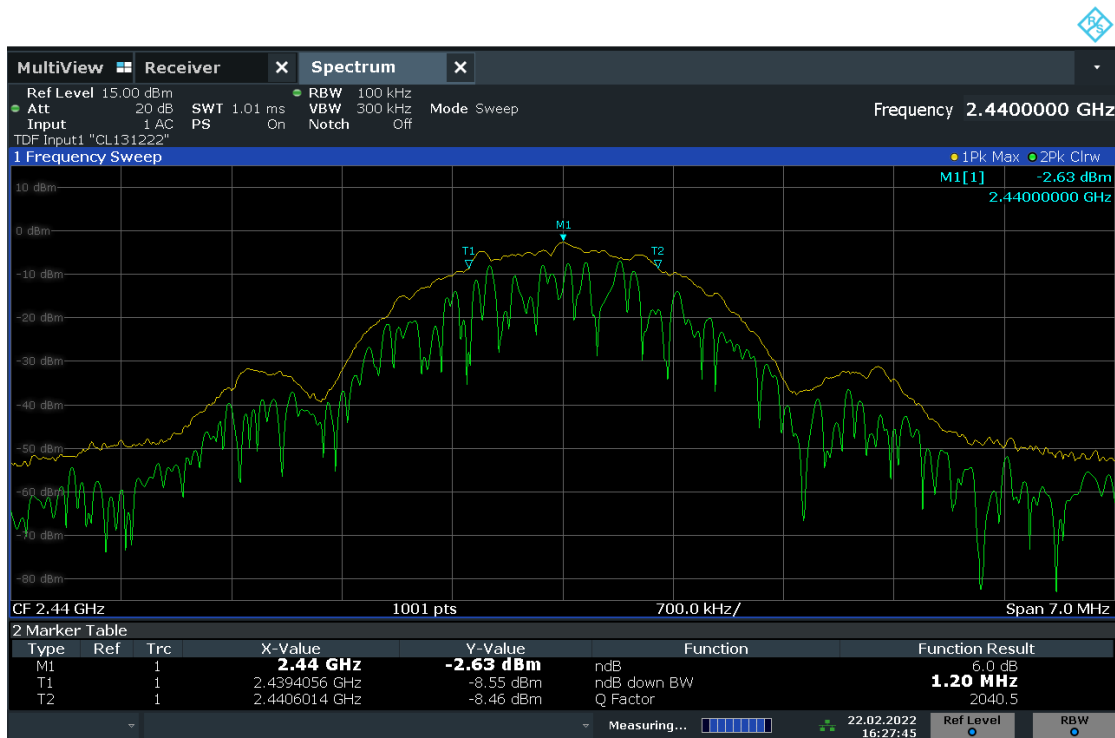
Table 6-1: 6 dB Bandwidth

Frequency (MHz)	6 dB Bandwidth (kHz)	Limit (kHz)
2402	1260	≥ 500
2440	1200	≥ 500
2480	1250	≥ 500



16:29:17 22.02.2022

Graph 6-1: 6 dB bandwidth, 2402 MHz



16:27:46 22.02.2022

Graph 6-2: 6 dB bandwidth, 2440 MHz



16:25:56 22.02.2022

Graph 6-3: 6 dB bandwidth, 2480 MHz

6.6 §15.247(b)(3)/ RSS-247 5.4(d) Peak Output Power

6.6.1 Test Procedure

The maximum peak conducted output power was measured in accordance with ANSI C63.10: 2013 clause 11.9.1.1.

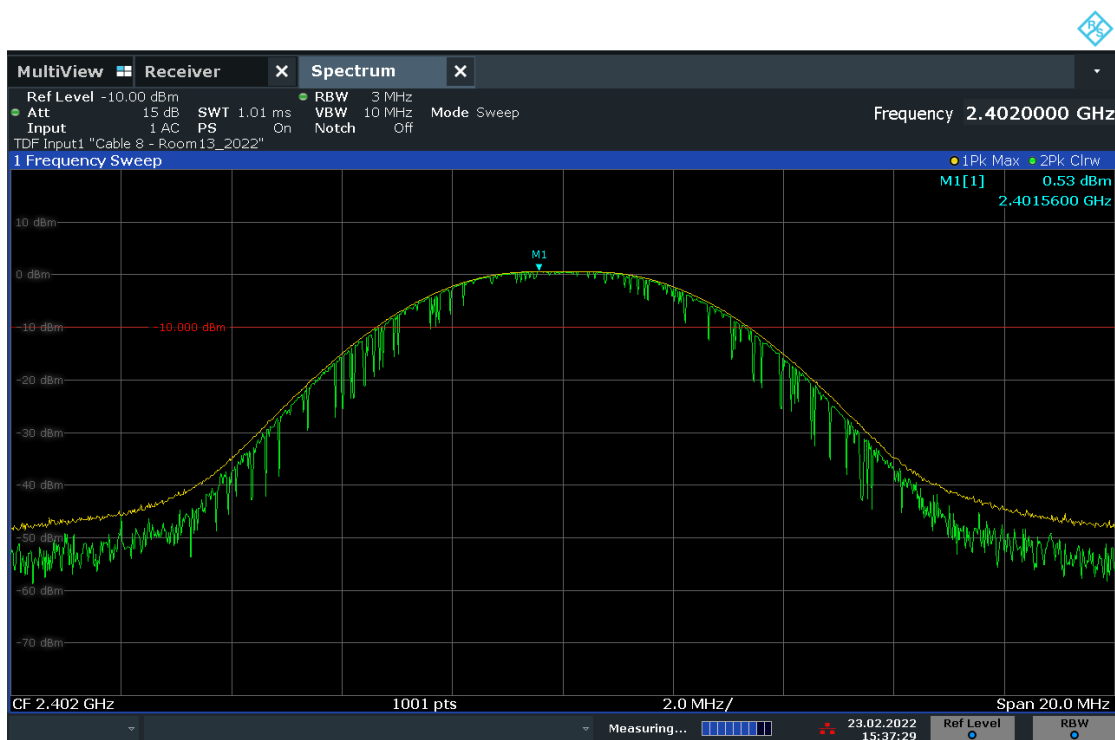
6.6.2 Limits

The maximum peak conducted output power at 2400-2483.5 MHz is 1 Watt or 30 dBm.

6.6.3 Results

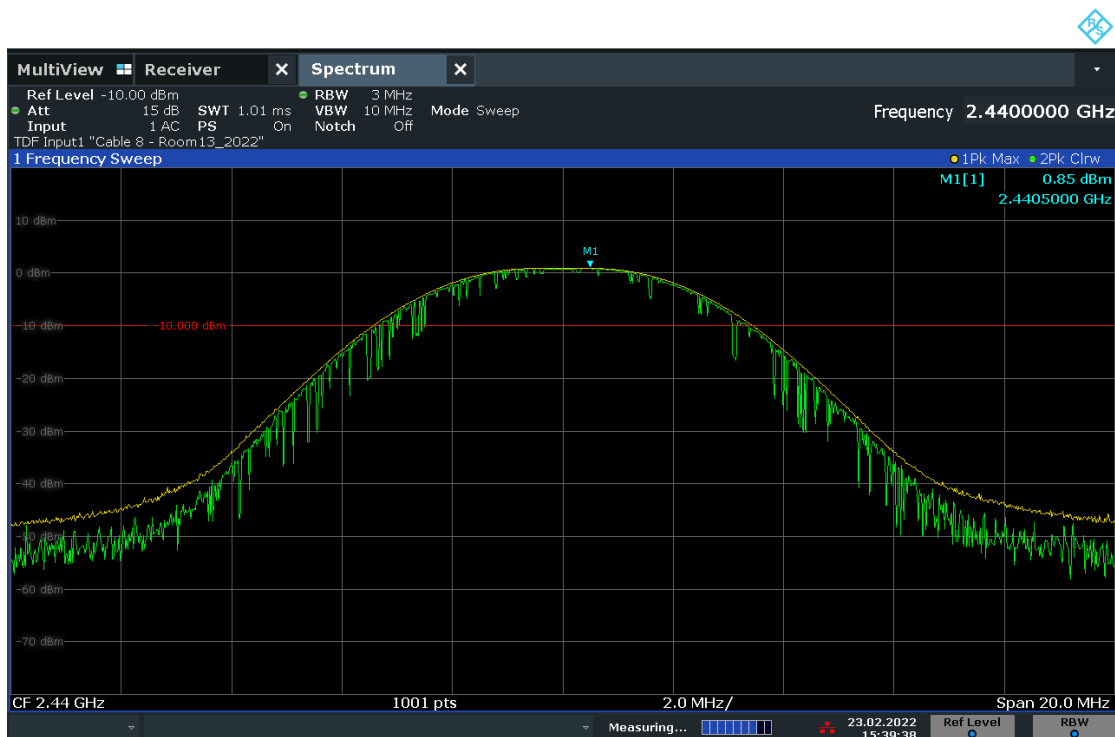
Table 6-2: Maximum peak conducted power

Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Results
2402	0.53	30	Complied
2440	0.85	30	Complied
2480	1.31	30	Complied



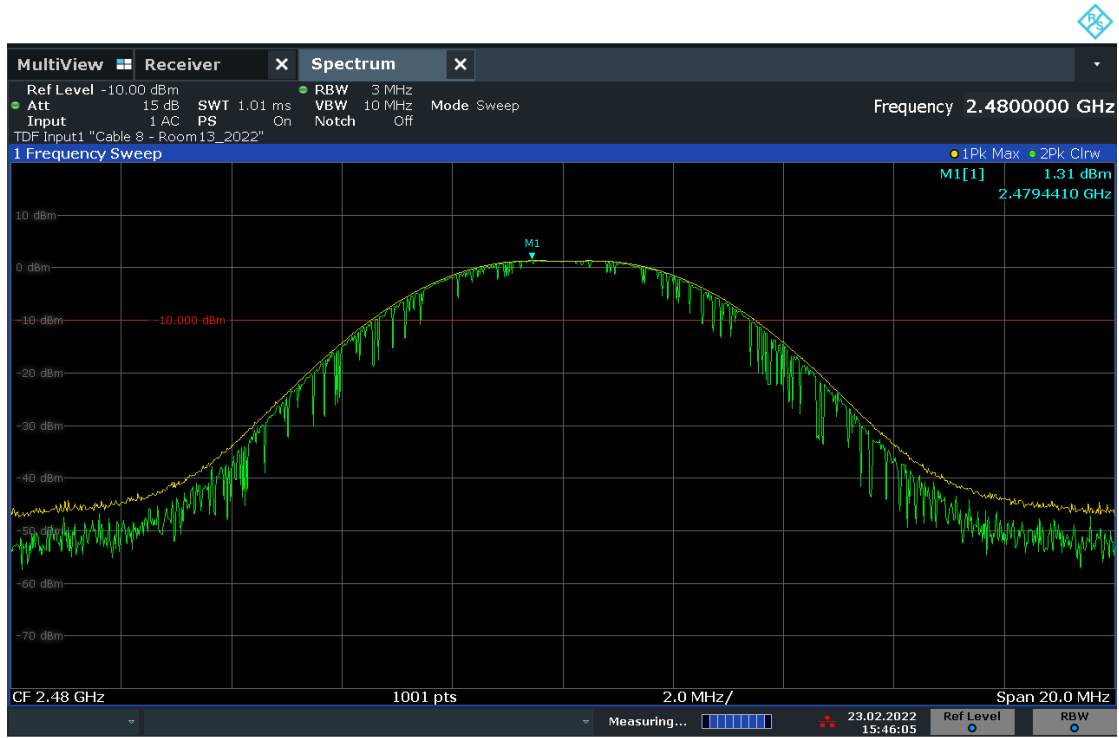
15:37:29 23.02.2022

Graph 6-4: Maximum peak conducted power, 2402 MHz



15:39:39 23.02.2022

Graph 6-5: Maximum peak conducted power, 2440 MHz



15:46:05 23.02.2022

Graph 6-6: Maximum peak conducted power, 2480MHz



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6.7 §15.247(d)/ RSS-247 5.5 Out-of-Band/Spurious Emissions

6.7.1 Test procedure

Radiated out-of-band/spurious emissions measurements were performed in a semi-anechoic chamber compliant with ANSI C63.4: 2014.

The test frequency range was sub-divided into smaller bands with the defined resolution bandwidths to permit reliable display and identification of emissions.

Frequency range (MHz)	Measurement Bandwidth (kHz)	Measurement Distance (m)	Antenna
0.009 to 0.150	0.2	3	0.6 metre loop antenna
0.150 to 30	9	3	
30 to 1000	120	3	
1000 to 18 000	1000	3	Biconilog hybrid
18 000 to 40 000	1000	1	
			Standard gain or broadband horn

EUT was set at a height of 0.8 m for measurements below 1000 MHz and set at a height of 1.5 m for measurements above 1000 MHz.

The sample was slowly rotated with the spectrum analyser set to Max-Hold. This was performed for at least two antenna heights. When an emission was located, it was positively identified, and its maximum level was found by rotating the automated turntable and by varying the antenna height. For below 1000 MHz the emissions were measured with a Quasi-Peak detector, and for above 1000 MHz the emissions were measured with Peak and Average detectors.

Measurements on the worst axis are presented.

The measurement data for each frequency range was corrected for cable losses, antenna factors and preamplifier gain. This process was performed for both horizontal and vertical polarisations of the measurement antenna.

6.7.2 Evaluation of field strength

Field strengths were calculated automatically by the software using pre-stored calibration data. The method of calculation is shown below:

$$E = V + AF - G + L$$

Where: E = Radiated Field Strength in dB μ V/m.

V = EMI Receiver Voltage in dB μ V.

AF = Antenna Factor in dB/m (stored as a data array).

G = Preamplifier Gain in dB (stored as a data array).

L = Cable loss in dB (stored as a data array of Insertion Loss versus frequency).

6.7.3 Limits

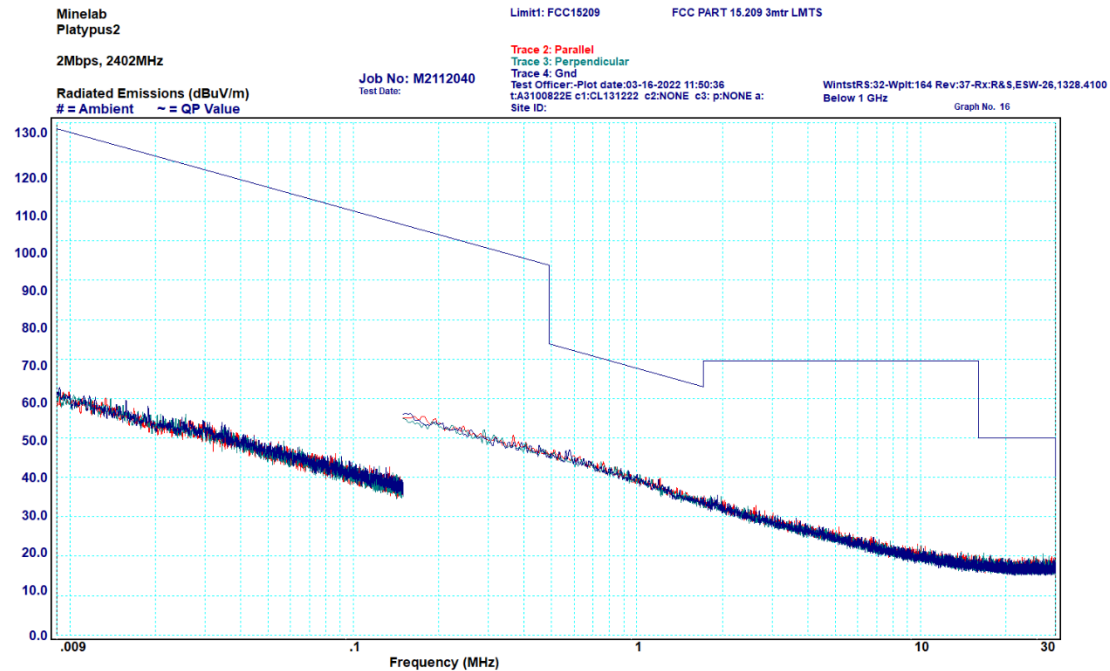
The limit applied is in accordance with the out-of-band/spurious emissions limit defined in §15.247(d).

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

The in-band peak PSD in 100 kHz bandwidth were measured on all three channels. The maximum PSD level was used to establish the limit. However, the general limits of §15.209 apply for the restricted bands of operation defined in §15.205.

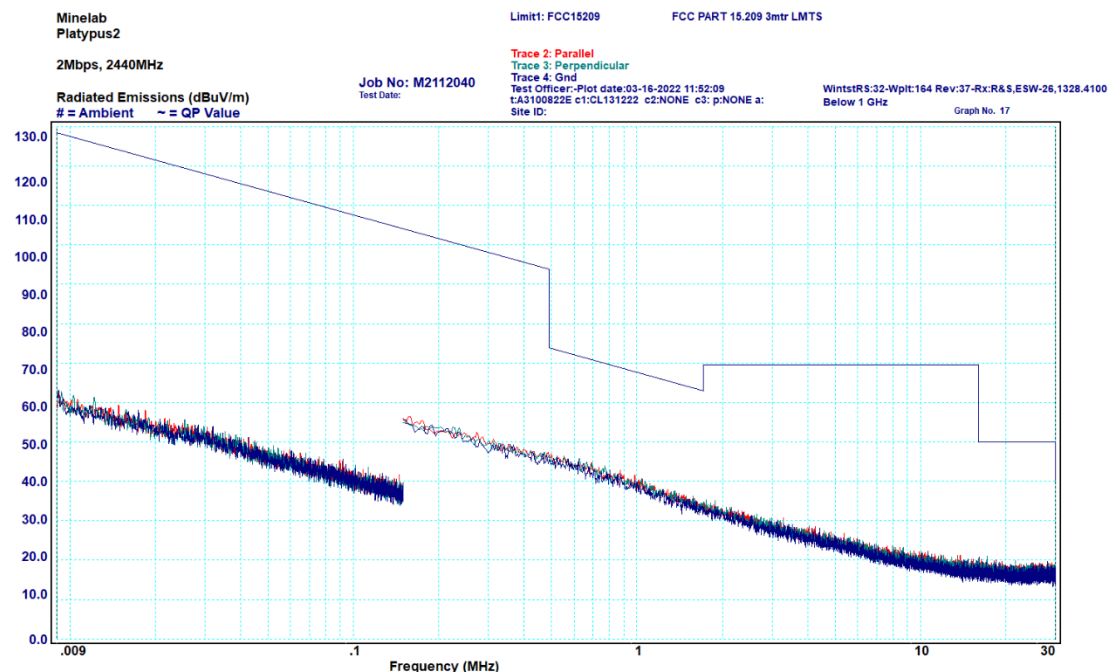
6.7.4 Transmitter Spurious Emissions: 9 kHz to 30 MHz

All emissions measured in the frequency band 9kHz - 30MHz complied with the requirements of the standard.



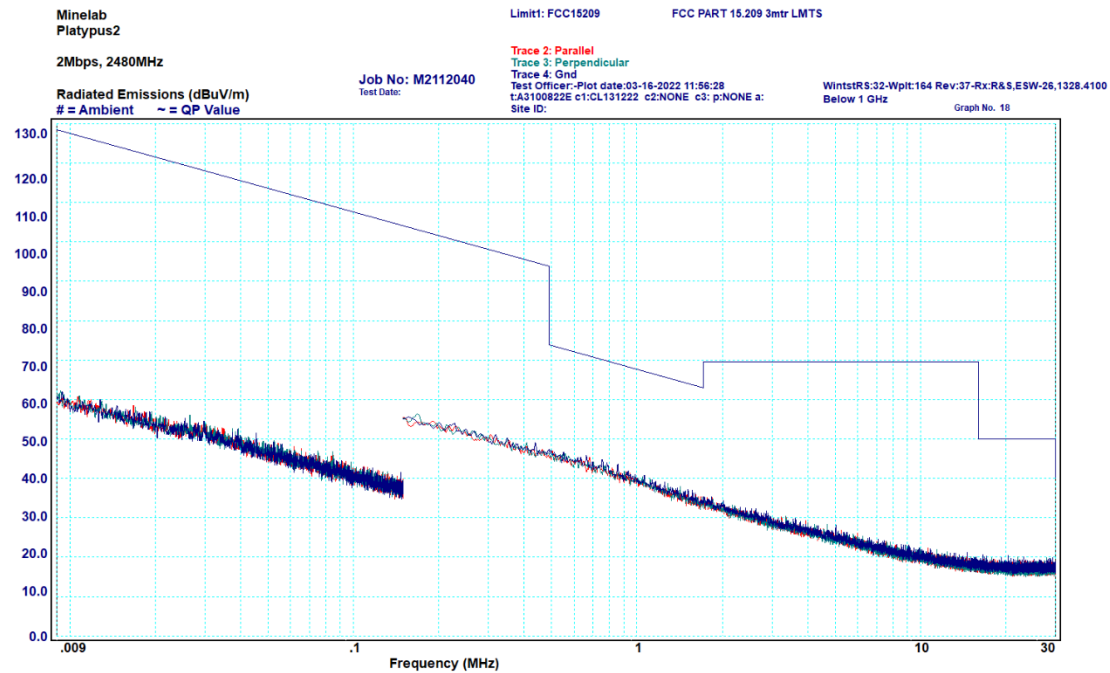
Graph 6-7: Transmitter Spurious Emissions, 9 kHz – 30 MHz, 2402 MHz

No peaks were measured within 10 dB of the limit.



Graph 6-8: Transmitter Spurious Emissions, 9 kHz – 30 MHz, 2440 MHz

No peaks were measured within 10 dB of the limit.

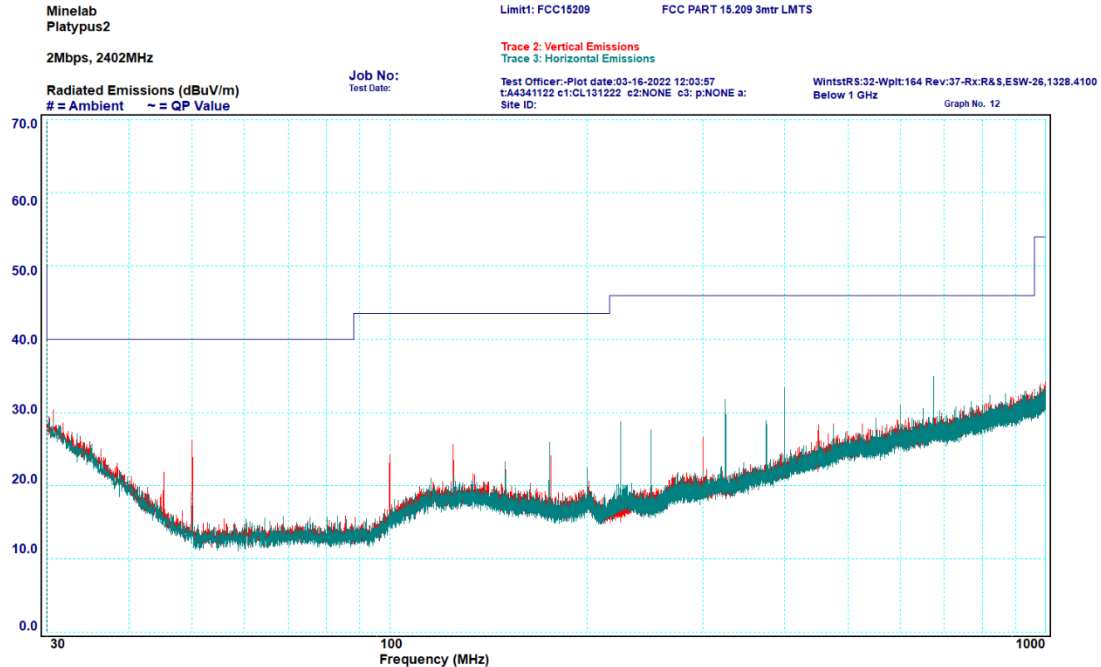


Graph 6-9: Transmitter Spurious Emissions, 9 kHz – 30 MHz, 2480 MHz

No peaks were measured within 10 dB of the limit.

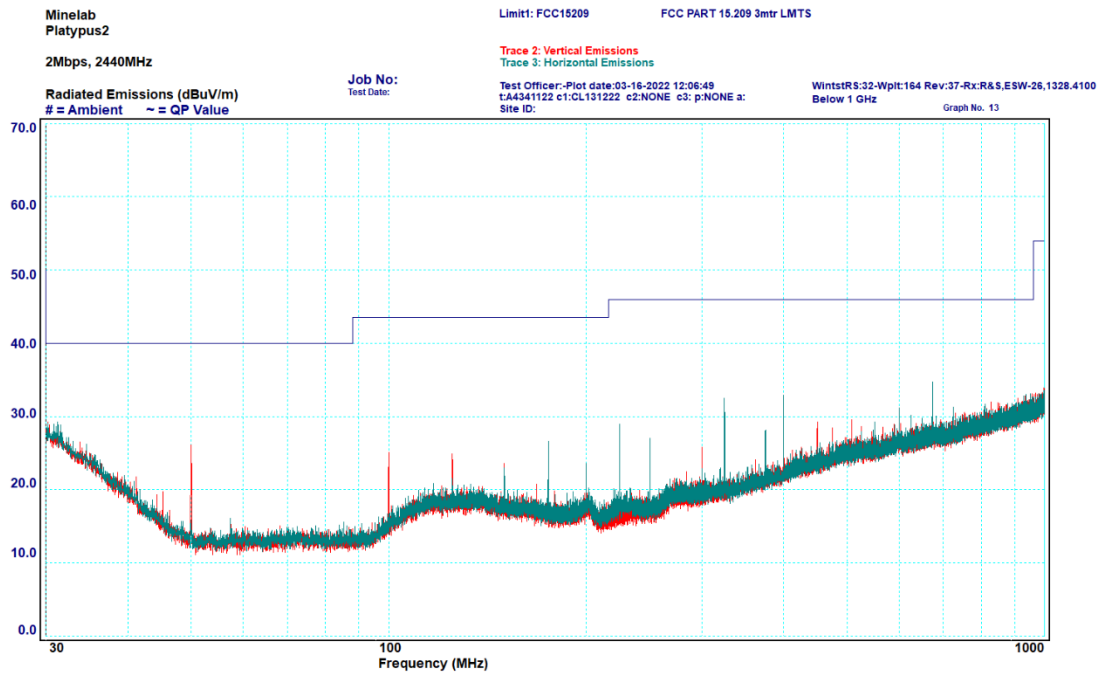
6.7.5 Transmitter Spurious Emissions: 30 - 1000 MHz

All emissions measured in the frequency band 30 – 1000 MHz complied with the requirements of the standard.



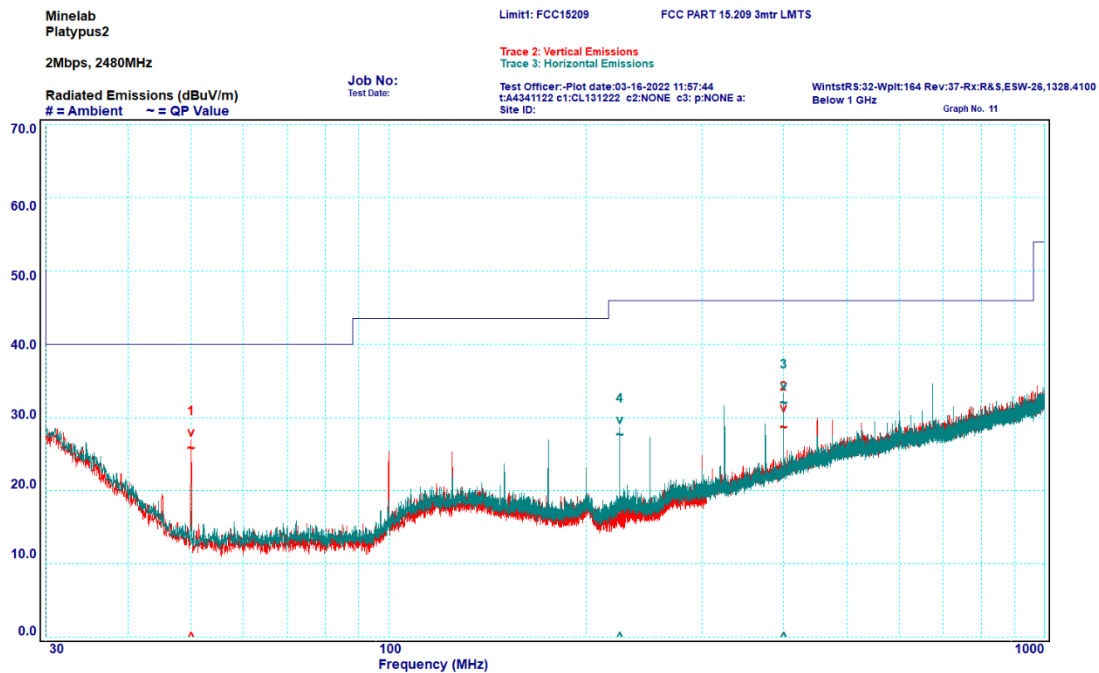
Graph 6-10: Transmitter Spurious Emissions, 30 – 1000 MHz, 2402 MHz

No peaks were measured within 10 dB of the limit.



Graph 6-11: Transmitter Spurious Emissions, 30 – 1000 MHz, 2440 MHz

No peaks were measured within 10 dB of the limit.



Graph 6-12: Transmitter Spurious Emissions, 30 – 1000 MHz, 2480 MHz

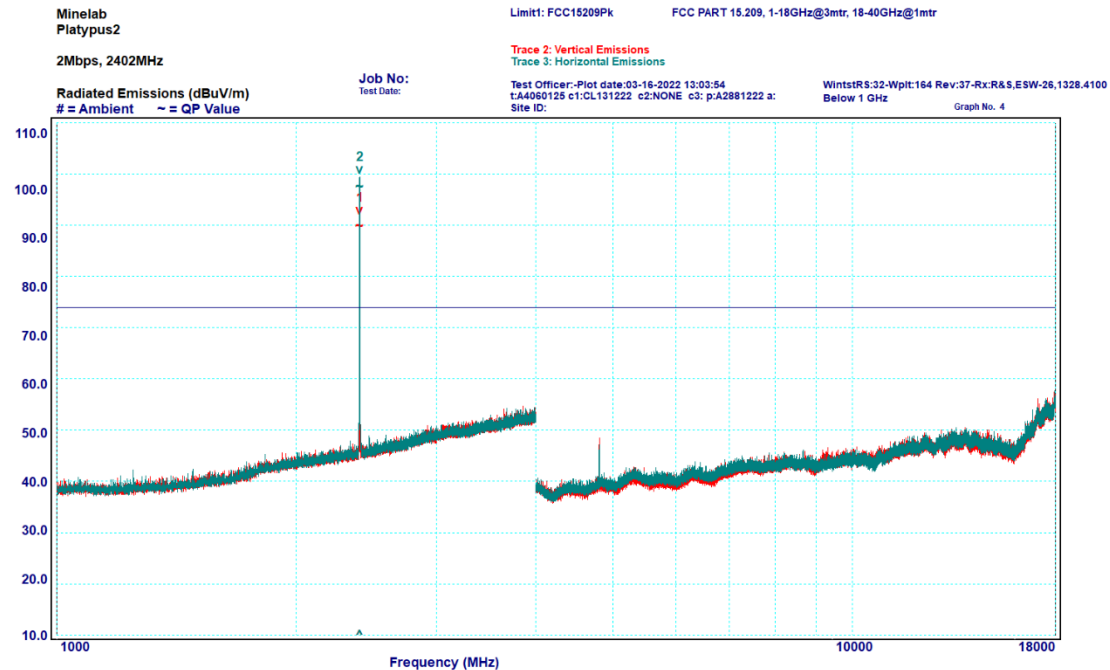
Table 6-3: Transmitter Spurious Emissions, 30 – 1000 MHz, 2480 MHz

Peak	Frequency (MHz)	Polarisation	Quasi Peak		
			Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
1	50.00	Vertical	25.7	40.0	-14.3
2	399.97	Vertical	28.6	46.0	-17.4
3	399.96	Horizontal	31.9	46.0	-14.1
4	224.99	Horizontal	27.6	46.0	-18.4

6.7.6 Transmitter Spurious Emissions: 1 - 18 GHz

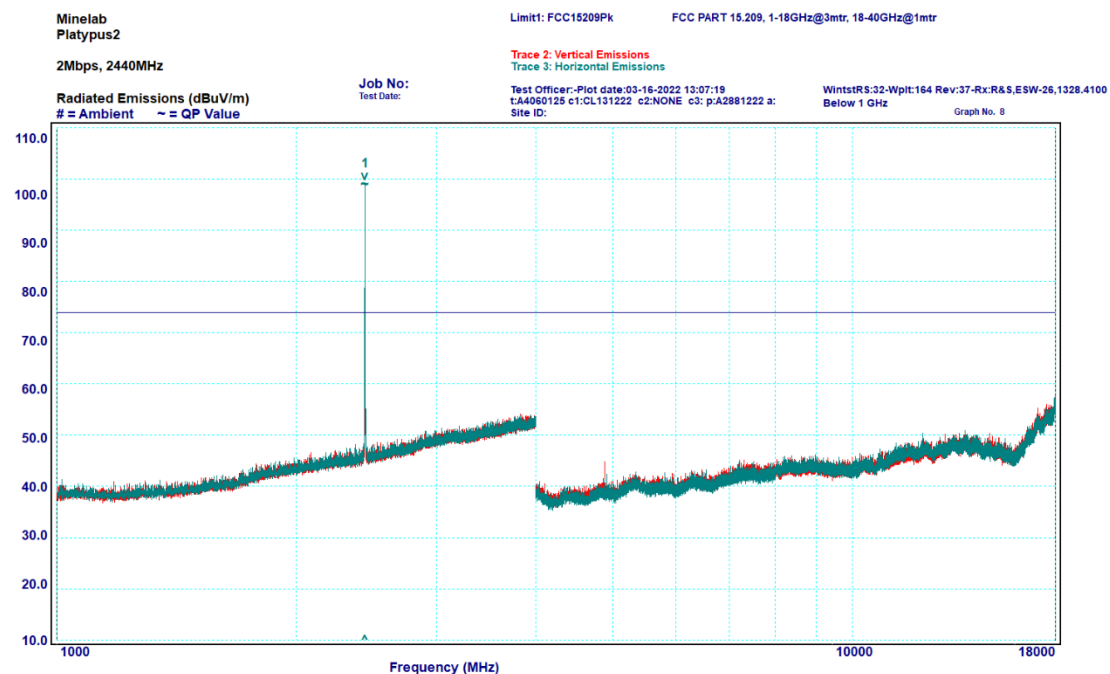
All emissions measured in the frequency band 1 – 18 GHz complied with the requirements of the standard.

Peak Measurement:



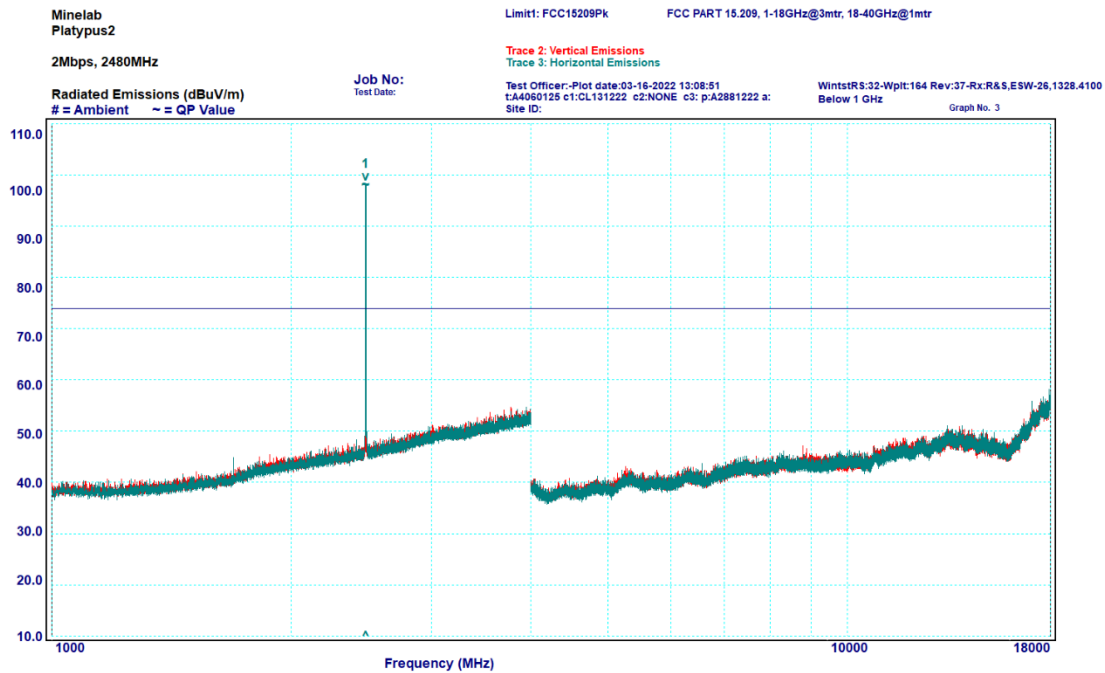
Graph 6-13: Transmitter Spurious Emissions, 1 – 18 GHz, 2402 MHz, Peak

Note: Peaks above the limit are the fundamental transmission and not subject to the spurious emissions limit of the standard



Graph 6-14: Transmitter Spurious Emissions, 1 – 18 GHz, 2440 MHz, Peak

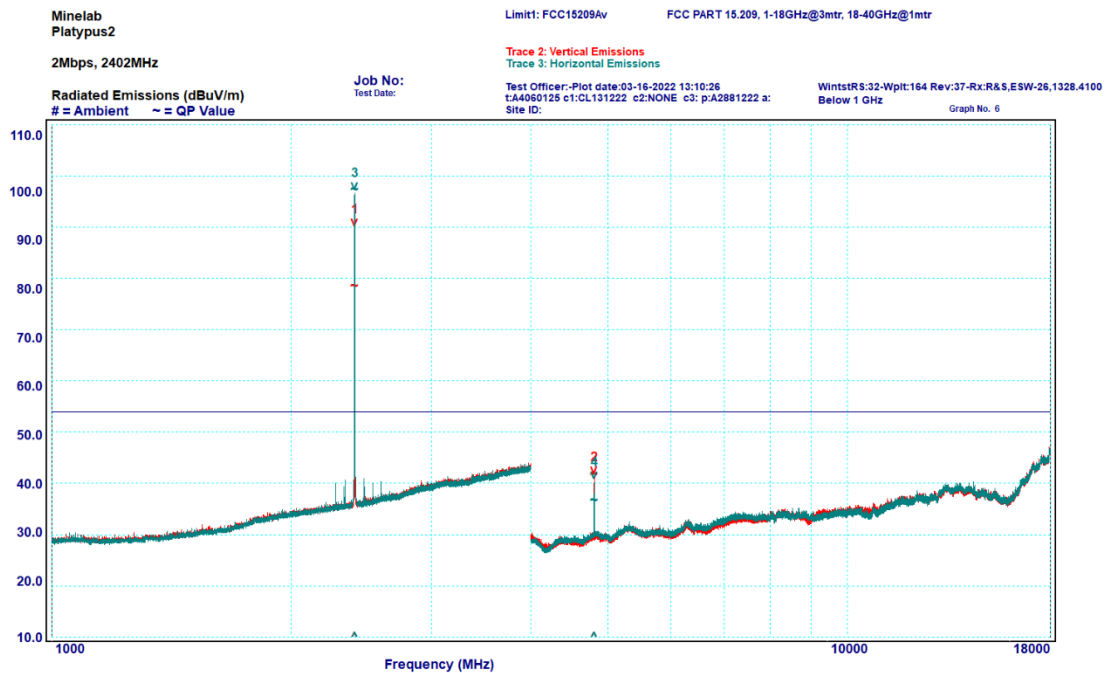
Note: Peaks above the limit are the fundamental transmission and not subject to the spurious emissions limit of the standard



Graph 6-15: Transmitter Spurious Emissions, 1 – 18 GHz, 2480 MHz, Peak

Note: Peaks above the limit are the fundamental transmission and not subject to the spurious emissions limit of the standard

Average Measurement:



Graph 6-16: Transmitter Spurious Emissions, 1 – 18 GHz, 2402 MHz, Average

Table 6-4: Transmitter Spurious Emissions, 1 – 18 GHz, 2402 MHz, Average

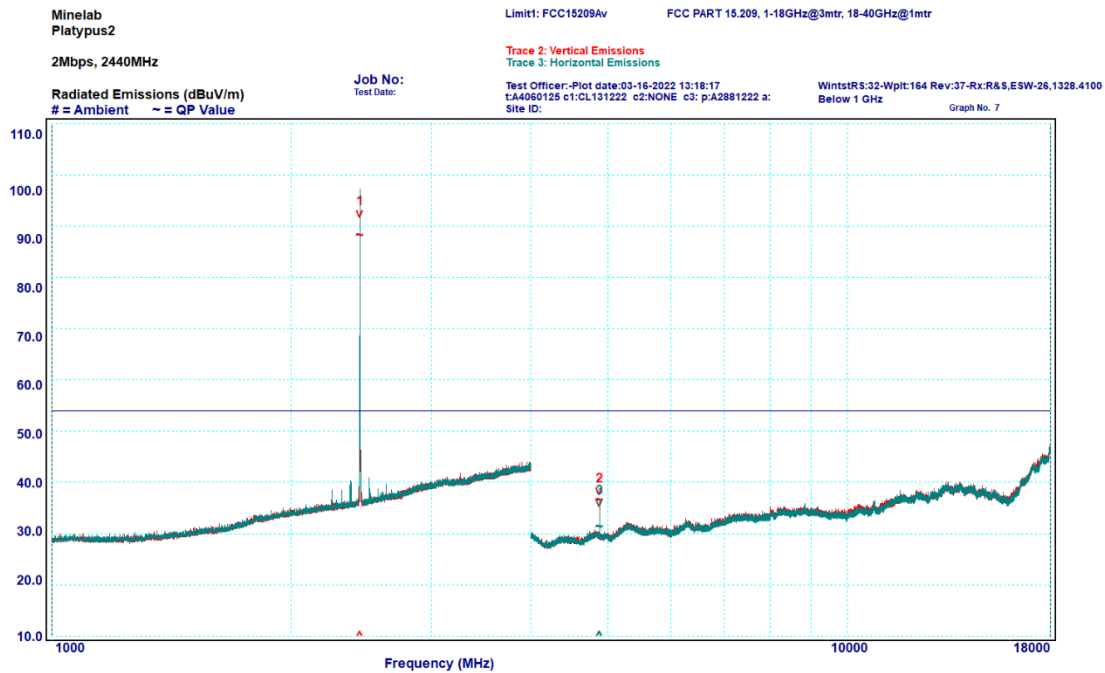


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Peak	Frequency (MHz)	Polarisation	Average		
			Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
1*	2402.01	Vertical	N/A	N/A	N/A
2	4803.87	Vertical	41.8	54.0	-12.2
3*	2402.04	Horizontal	N/A	N/A	N/A
4	4803.99	Horizontal	36.7	54.0	-17.3

*Note: Peaks above the limit are the fundamental transmission and not subject to the spurious emissions limit of the standard

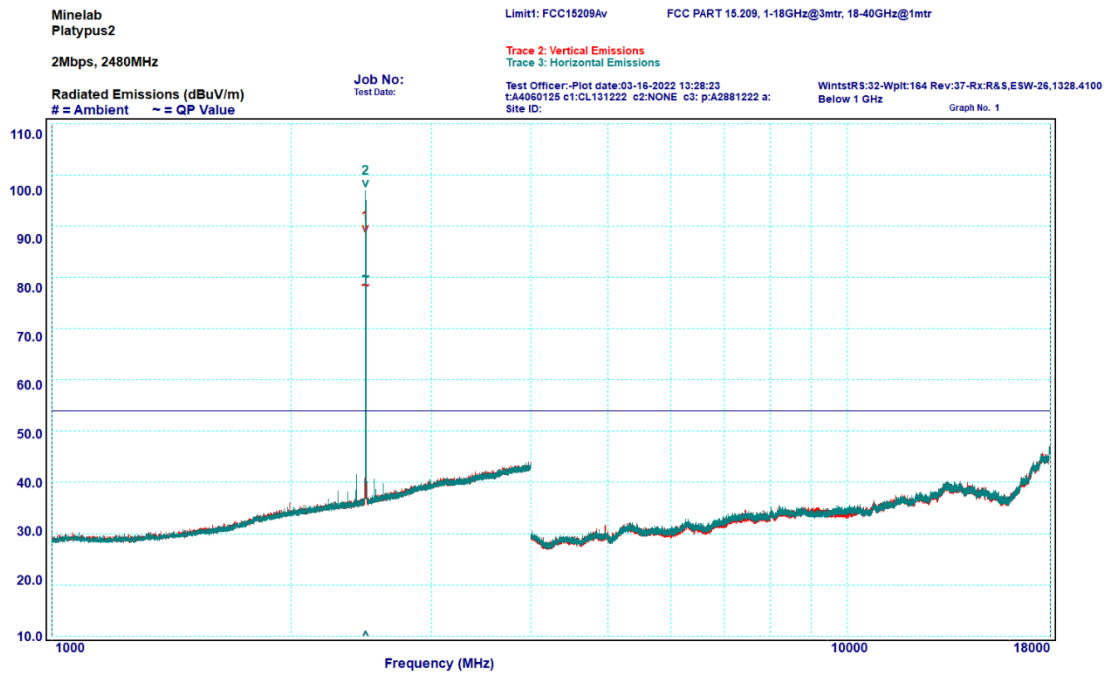


Graph 6-17: Transmitter Spurious Emissions, 1 – 18 GHz, 2440 MHz, Average

Table 6-5: Transmitter Spurious Emissions, 1 – 18 GHz, 2440 MHz, Average

Peak	Frequency (MHz)	Polarisation	Average		
			Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
1*	2440.00	Vertical	N/A	N/A	N/A
2	4880.06	Vertical	36.5	54.0	-17.5
3	4879.81	Horizontal	31.4	54.0	-22.6

*Note: Peaks above the limit are the fundamental transmission and not subject to the spurious emissions limit of the standard



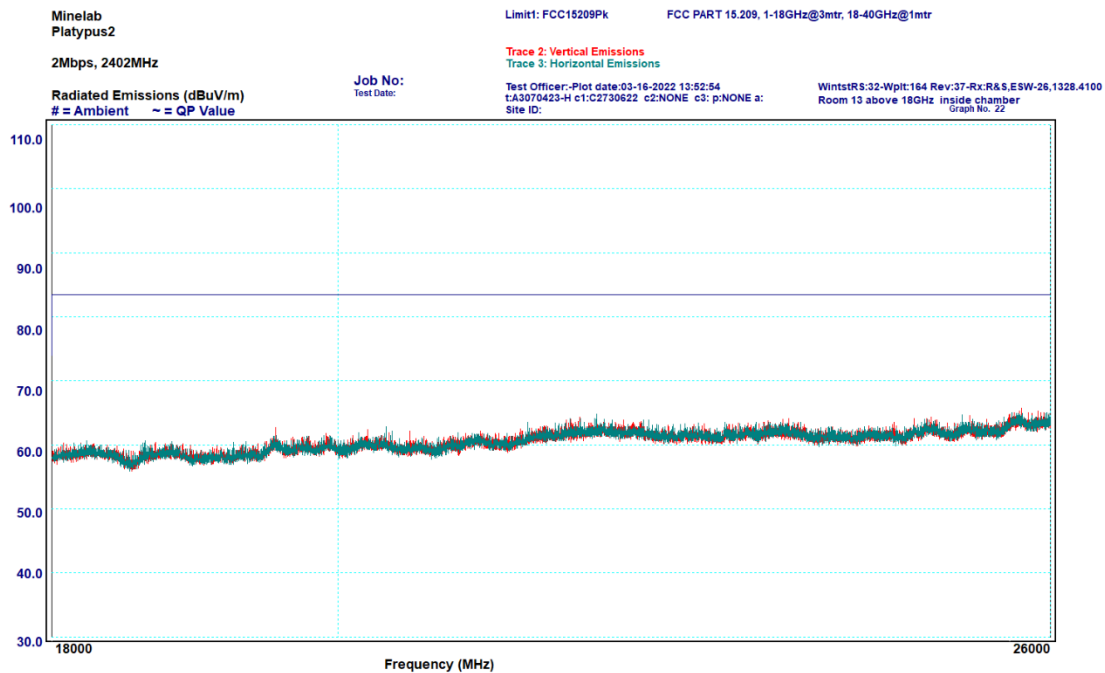
Graph 6-18: Transmitter Spurious Emissions, 1 – 18 GHz, 2480 MHz, Average

*Note: Peaks above the limit are the fundamental transmission and not subject to the spurious emissions limit of the standard

6.7.7 Transmitter Spurious Emissions: 18 – 26 GHz

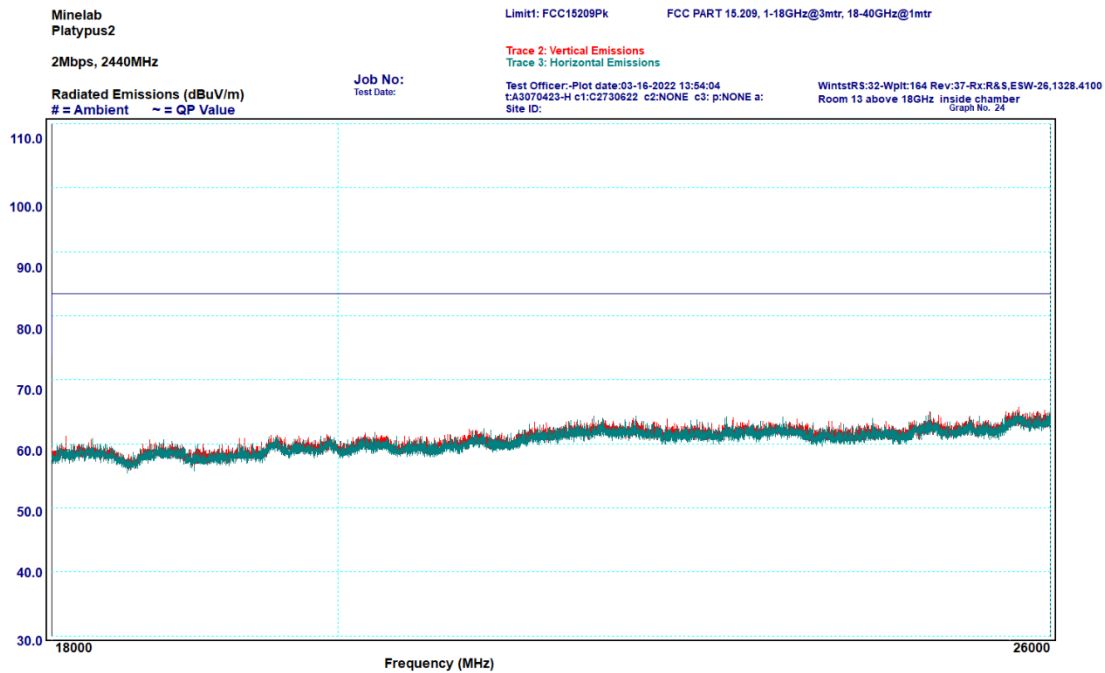
All emissions measured in the frequency band 18 – 26 GHz complied with the requirements of the standard.

Peak Measurement:



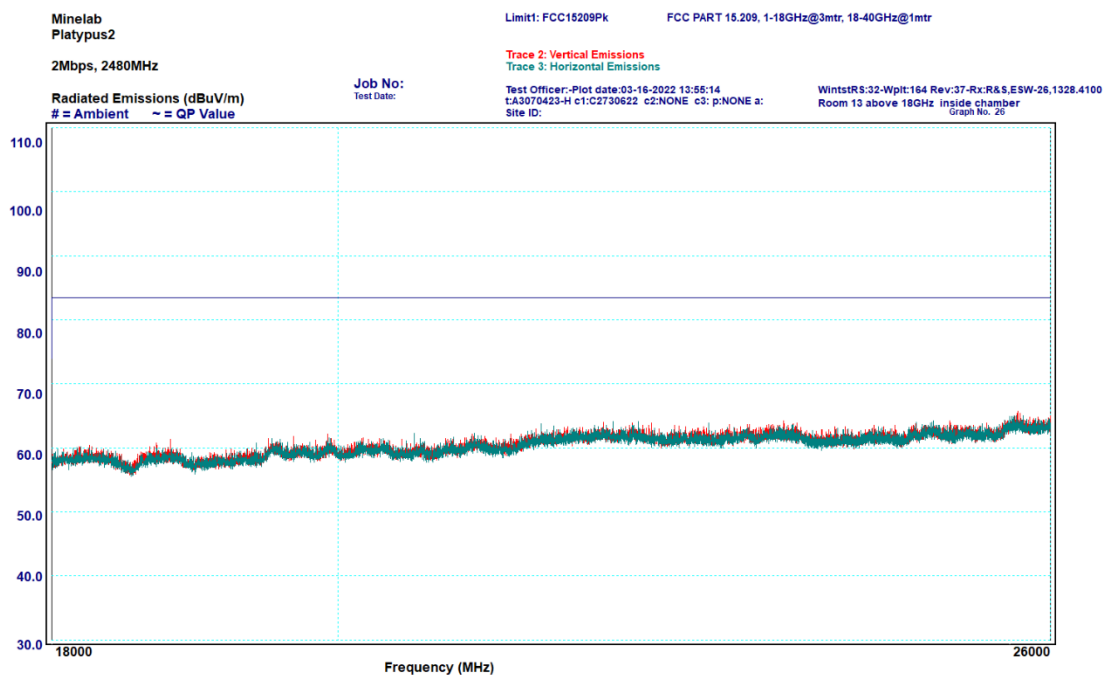
Graph 6-19: Transmitter Spurious Emissions, 18 – 26 GHz, 2402 MHz, Peak

No peaks were measured within 10 dB of the limit.



Graph 6-20: Transmitter Spurious Emissions, 18 – 26 GHz, 2440 MHz, Peak

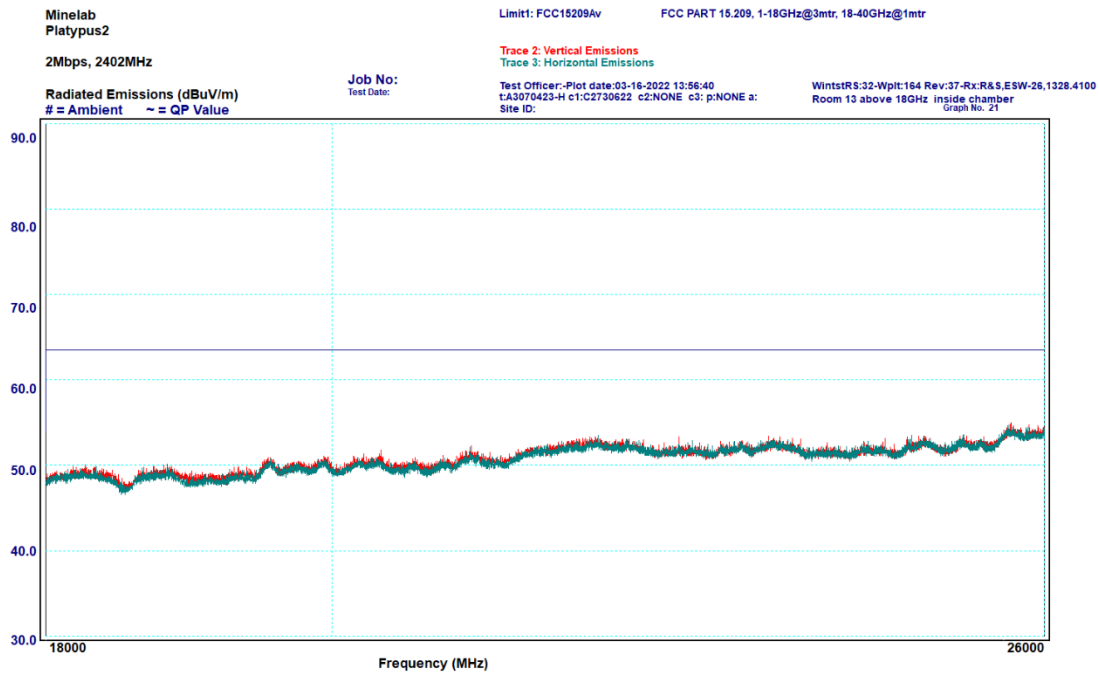
No peaks were measured within 10 dB of the limit.



Graph 6-21: Transmitter Spurious Emissions, 18 – 26 GHz, 2480 MHz, Peak

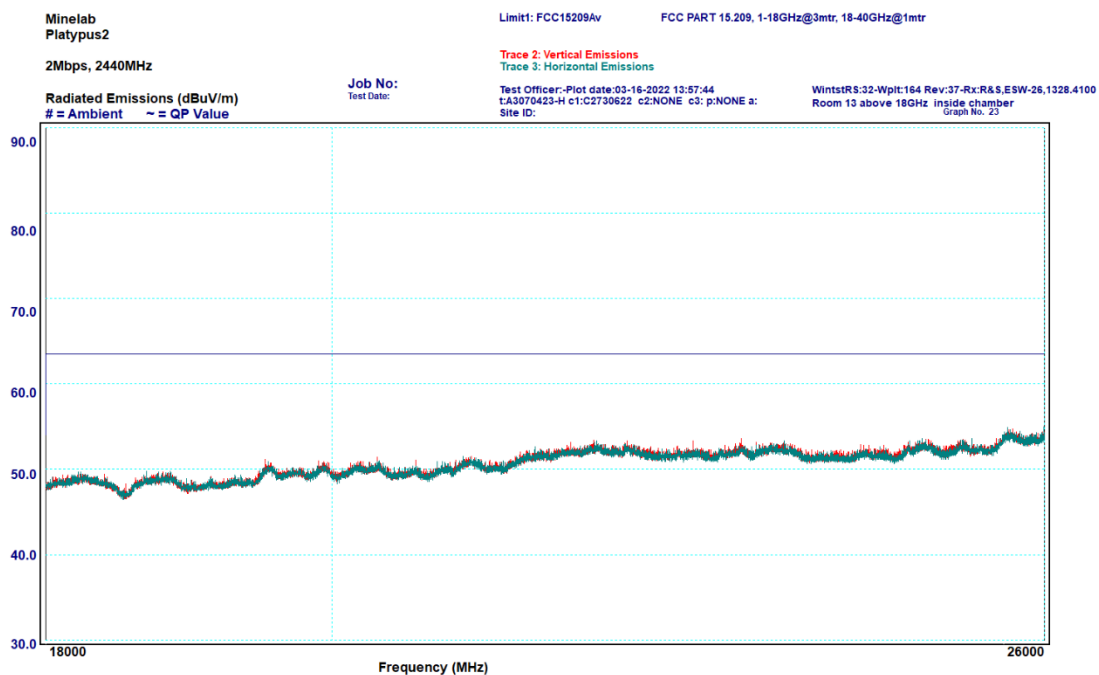
No peaks were measured within 10 dB of the limit.

Average Measurement:



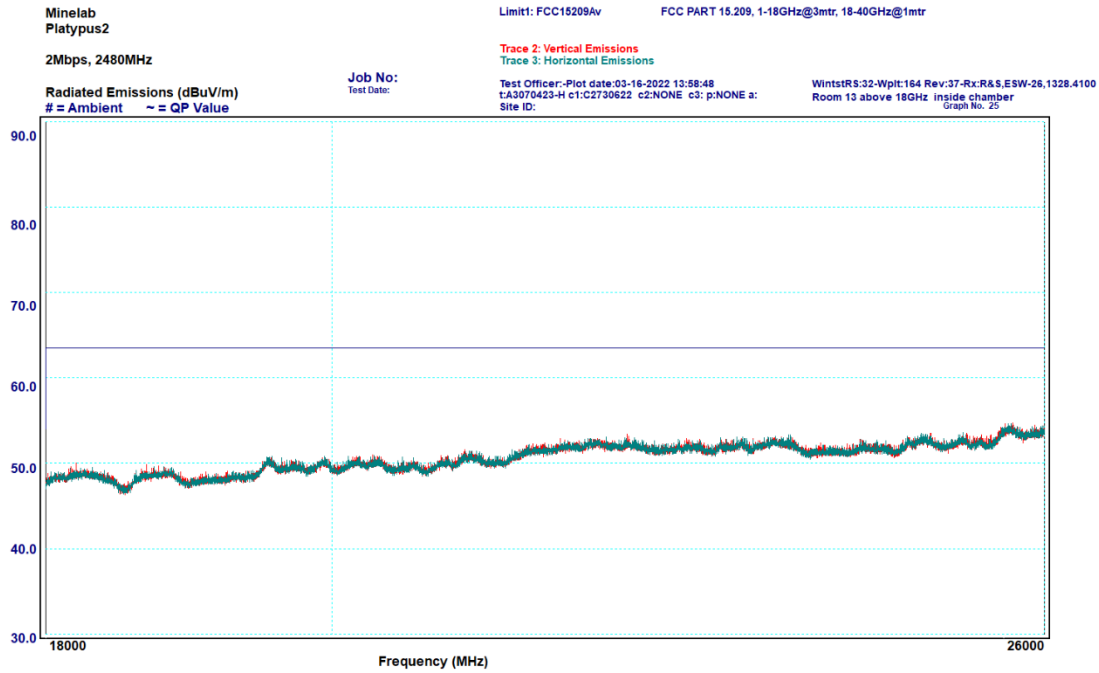
Graph 6-22: Transmitter Spurious Emissions, 18 – 26 GHz, 2402 MHz, Average

No peaks were measured within 10 dB of the limit.



Graph 6-23: Transmitter Spurious Emissions, 18 – 26 GHz, 2440 MHz, Average

No peaks were measured within 10 dB of the limit.

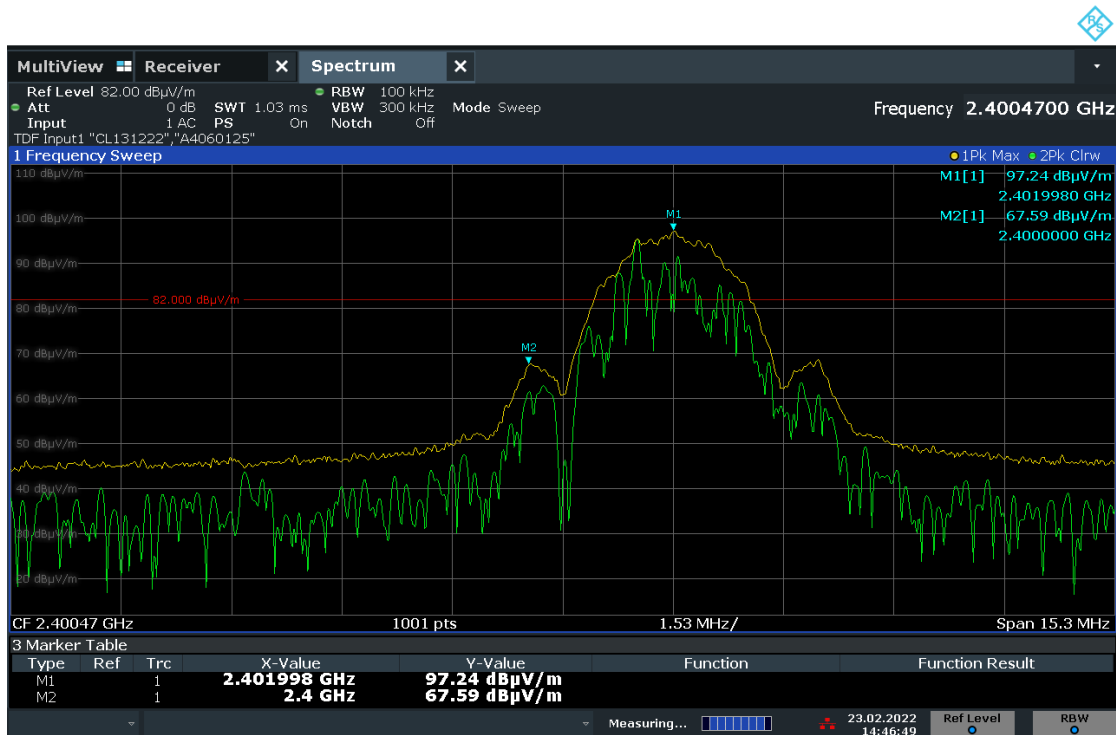


Graph 6-24: Transmitter Spurious Emissions, 18 – 26 GHz, 2480 MHz, Average

No peaks were measured within 10 dB of the limit.

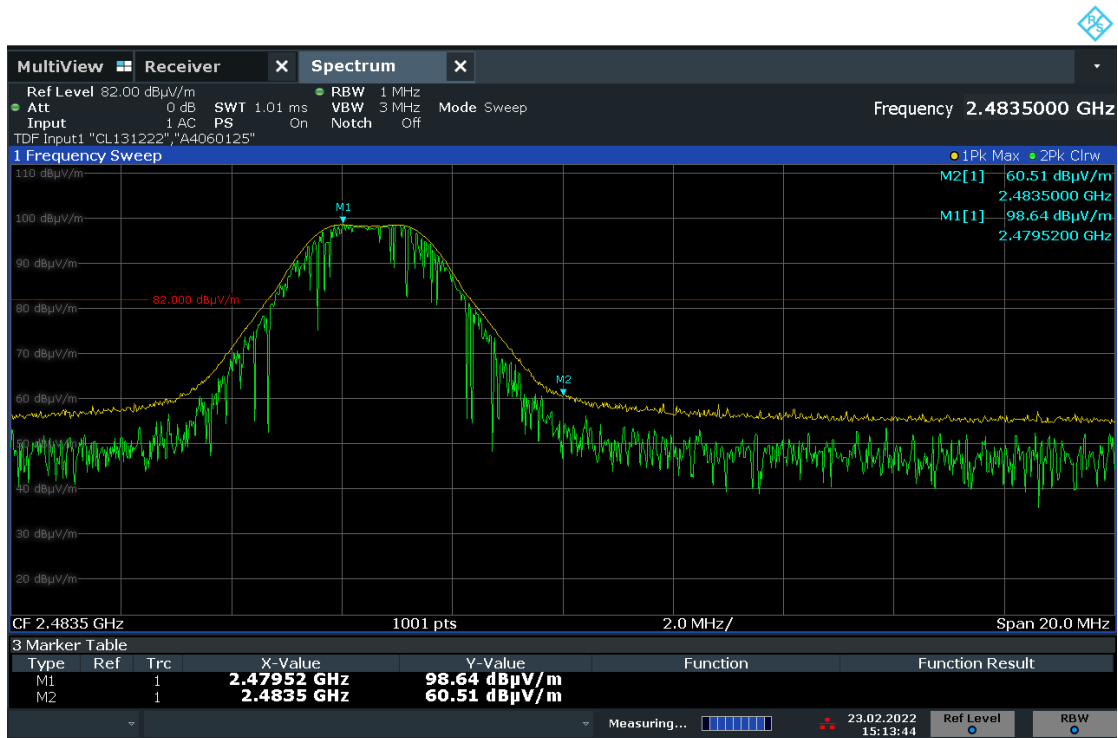
6.8 §15.247(d)/ RSS-247 5.5 Band Edge Emission Measurements

Band-edge radiated measurements were done in accordance with ANSI C63.10 clause 6.10. All emissions measured near the lower and higher band edge complied with the requirements of §15.247/ RSS-247 5.0.



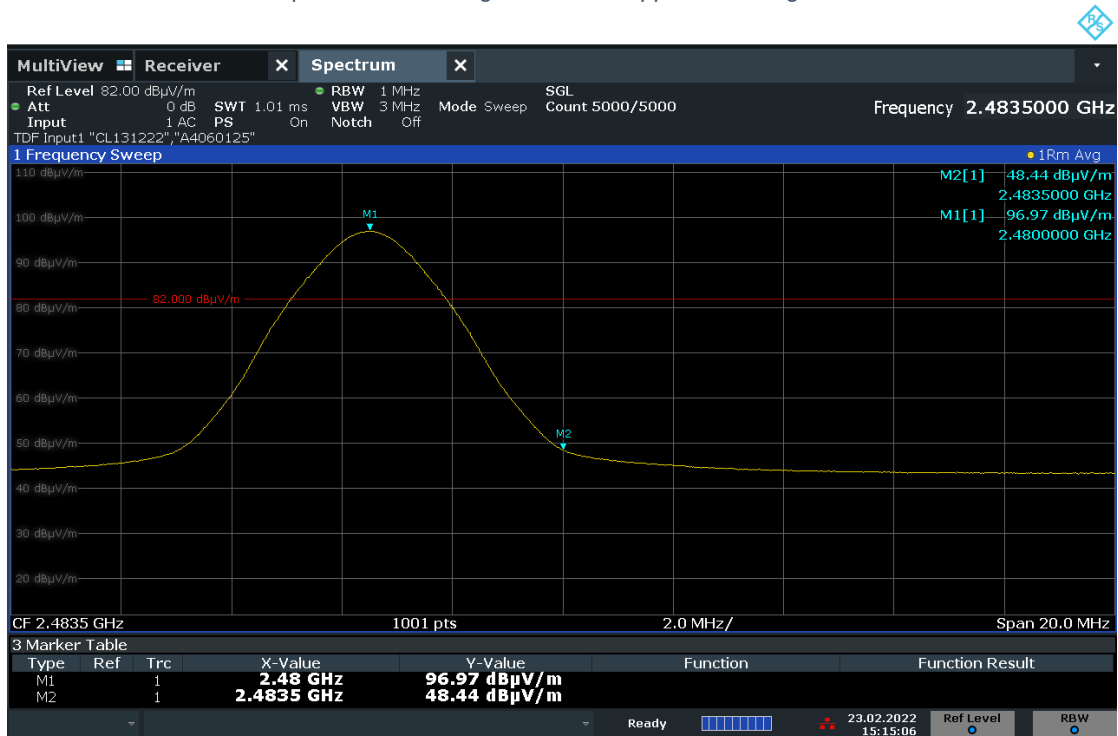
14:46:49 23.02.2022

Graph 6-25: Band Edge Emission, Lower Band-edge



15:13:44 23.02.2022

Graph 6-26: Band Edge Emission, Upper Band-edge, Peak



15:15:07 23.02.2022

Graph 6-27: Band Edge Emission, Upper Band-edge, Average

Table 6-6: Band Edge Emission

Measurement Type	Freq (MHz)	Measurement (dBμV/m)	Limit (dBμV/m)	Result
Peak	2400	67.59	74	Complied
Peak	2483.5	60.51	74	Complied
Average	2483.5	48.44	54	Complied

6.9 §15.247(e)/ RSS-247 5.2(b) Power Spectral Density

6.9.1 Test procedure

Maximum power spectral density level in the fundamental emission was measured in accordance with ANSI C63.10: 2013 Clause 11.10

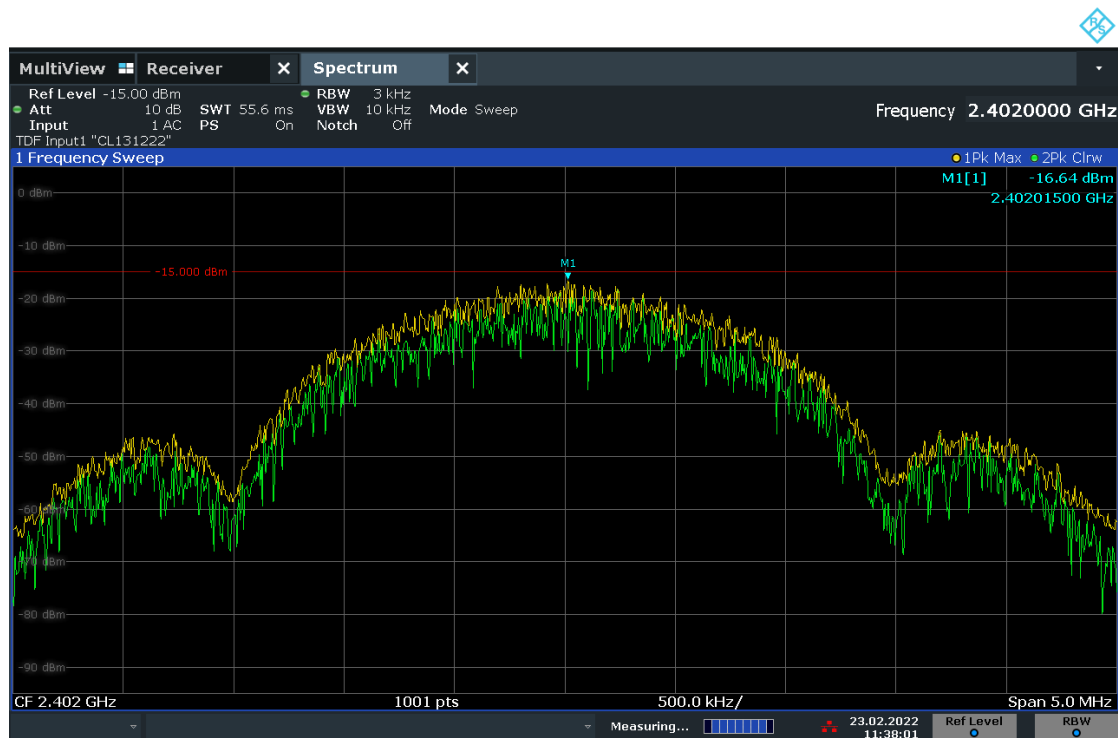
6.9.2 Limits

The maximum peak conducted power spectral density (PSD) is 8 dBm per 3 kHz.

6.9.3 Results

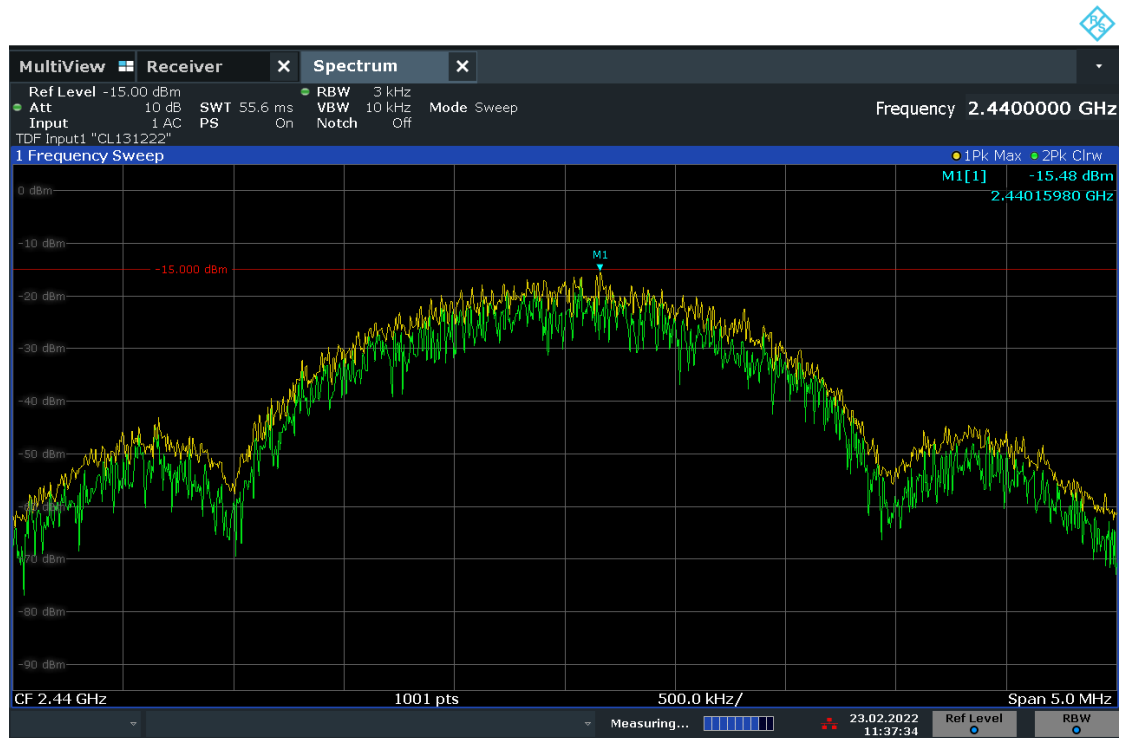
Table 6-7: Power spectral density

Frequency (MHz)	Power Spectral Density (dBm)	Limit (dBm)	Results
2402	-16.64	8	Complied
2440	-15.48	8	Complied
2480	-13.34	8	Complied



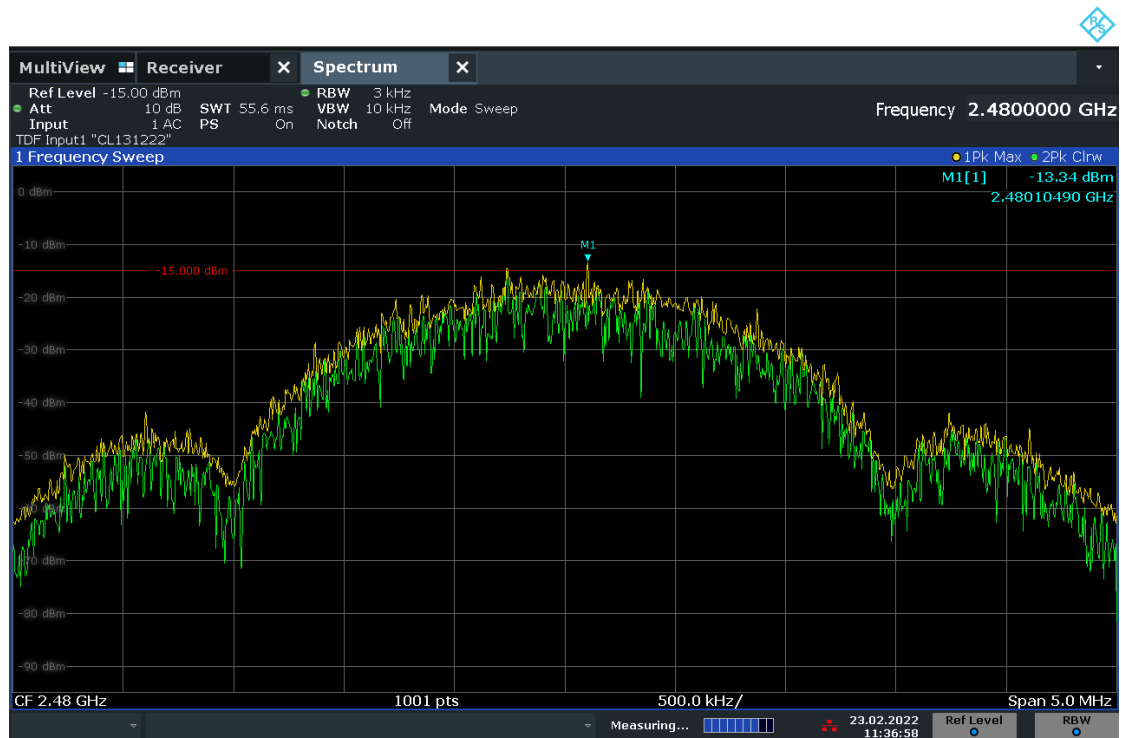
11:38:01 23.02.2022

Graph 6-28: Power Spectral Density, 2402 MHz



11:37:34 23.02.2022

Graph 6-29: Power Spectral Density, 2440 MHz



11:36:59 23.02.2022

Graph 6-30: Power Spectral Density, 2480 MHz



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6.10 §15.247(i)/ RSS-Gen 3.4/RSS-102 Maximum Permissible Exposure

The EUT complied with the applicable maximum permissible exposure levels. Refer to EMC Technologies report M2112040-6 and M2112040-7.

6.11 §15.215/ RSS-Gen 6.7 Occupied Bandwidth – 99% power

6.11.1 Test procedure

The bandwidth containing 99% power of the transmitted signal was measured using the procedure from ANSI C63.10 section 6.9.

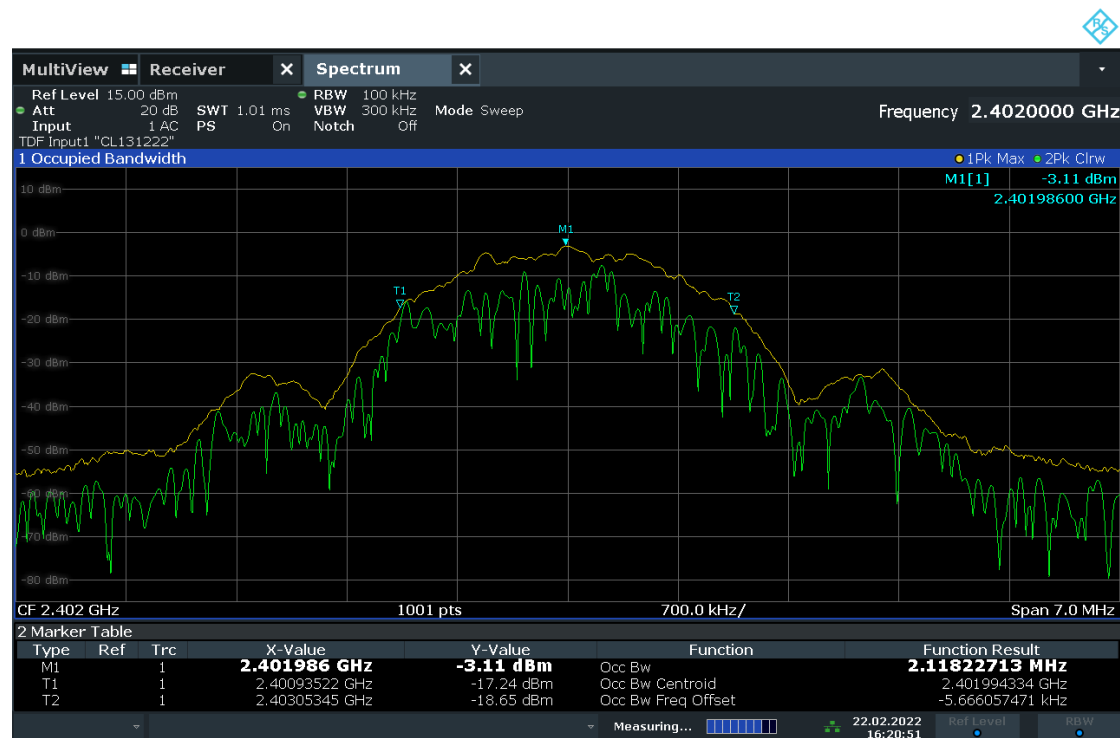
6.11.2 Limits

The 99% power should be contained within the frequency band 2400 – 2483.5 MHz.

6.11.3 Results

Table 6-8: Occupied Bandwidth

Freq. (MHz)	99% Bandwidth (MHz)	Lower Frequency (MHz)	Upper Frequency (MHz)	Result
2402	2.118	2400.93	2403.05	Complied
2440	2.115	2438.93	2441.04	Complied
2480	2.124	2478.92	2481.04	Complied



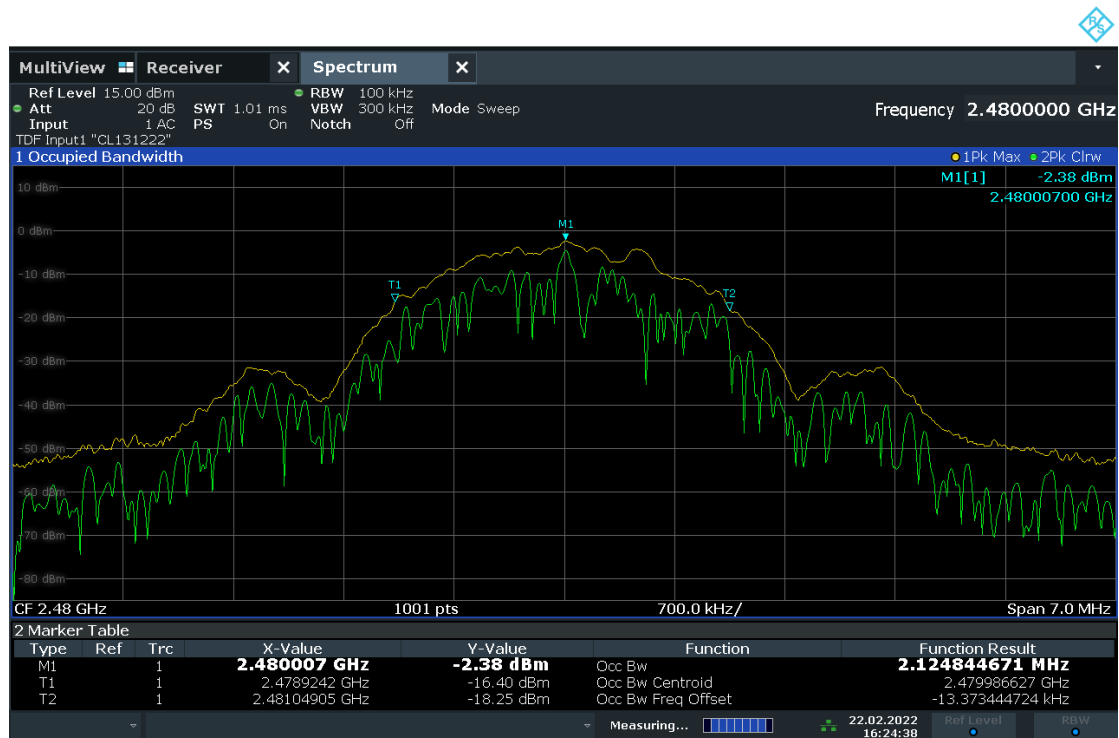
16:20:51 22.02.2022

Graph 6-31: Occupied bandwidth, 2402 MHz



16:22:49 22.02.2022

Graph 6-32: Occupied bandwidth, 2440 MHz



16:24:39 22.02.2022

Graph 6-33: Occupied bandwidth, 2480 MHz

END OF REPORT