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RADIO TEST REPORT

REPORT NUMBER: M2112041-7

TEST STANDARD: SPOT CHECK EVALUATION TO FCC PART 15 SUBPART C SECTION 15.247 ISED RSS-247 SECTION 5.0

CLIENT: MINELAB ELECTRONICS PTY LTD

DEVICE: TORMENTOR METAL DETECTOR

MODEL: X-TERRA PRO

FCC ID: Z4C-0054

IC: 24927-0054

DATE OF ISSUE: 15 JUNE 2022

REVISION TABLE

Version	Sec/Para Changed	Change Made	Date
1		Initial issue of document	15/06/2022

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TEST CERTIFICATE

Device:	Tormentor Metal Detector
Model Number:	X-TERRA PRO
Manufacturer:	Minelab Electronics Pty Ltd
Radio:	Bluetooth Low Energy (Nordic nRF5340)
FCC ID:	Z4C-0054
IC:	24927-0054
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
Test:	Spot Check Evaluation for Bluetooth Low Energy (Nordic nRF5340)
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 Tormentor Metal Detector complied with the applicable requirements of the above standards. Refer to Report M2112041-7 for full details.
Test Date:	01-02 March 2022
Issue Date:	15 June 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

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RADIO TEST REPORT FOR SPOT CHECK EVALUATION

1 TEST SUMMARY

Sec.	Description	FCC	ISED	Tested Frequency	Result(s)
6.1	Antenna Requirement	§15.203	RSS-Gen 6.8	N/A	Complied
6.2	Restricted Bands of Operation	§15.205	RSS-Gen 8.10	2402 MHz	Complied
6.3	Radiated emission limits; general requirements	§15.209	RSS-Gen 8.9	2402 MHz	Complied
6.4	Peak Output Power	§15.247(b)(3)	RSS-247 5.4(d)	2402,2440,2480 MHz	Complied
6.5	Out-of-Band/Spurious Emissions	§15.247(d)	RSS-247 5.5	2402 MHz	Complied
6.6	Band-Edge Emission Measurements	§15.247(d)	RSS-247 5.5	2402 & 2480 MHz	Complied
6.7	Power spectral density	§15.247(e)	RSS-247 5.2(b)	N/A	Complied
6.8	Maximum Permissible Exposure	§15.247(i)	RSS-102	N/A	Complied
-	*6 dB Bandwidth	§15.247(a)(2)	RSS-247 5.2(a)	N/A	Complied
-	*Occupied Bandwidth – 99% power	§15.215	RSS-Gen 6.7	N/A	Complied

*Note:
The radio transceiver is electrically identical with the grant FCC ID: Z4C-0054A and IC: 24927-0054A and the only changed is the radio transceiver embedded in a different host.
The tests were not performed and test data from FCC ID: Z4C-0054A and IC: 24927-0054A test report: M2112040-8 are applicable for the device under test in this report.

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 (A^2LA).

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 taking into account measurement instrumentation uncertainty. However, the measurement uncertainty shall appear in the test report.

5 Device Details

(Information supplied by the Client)

The X-TERRA PRO 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.

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:	Tormentor Metal Detector
Model Number:	X-TERRA PRO
Serial Number:	44766057456 (Conducted sample); 43727958151 (Radiated sample)
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 Bluetooth 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 6.5.

6.3 §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 6.5

6.4 §15.247(b)(3)/ RSS-247 5.4(d) Peak Output Power

6.4.1 Test Procedure

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

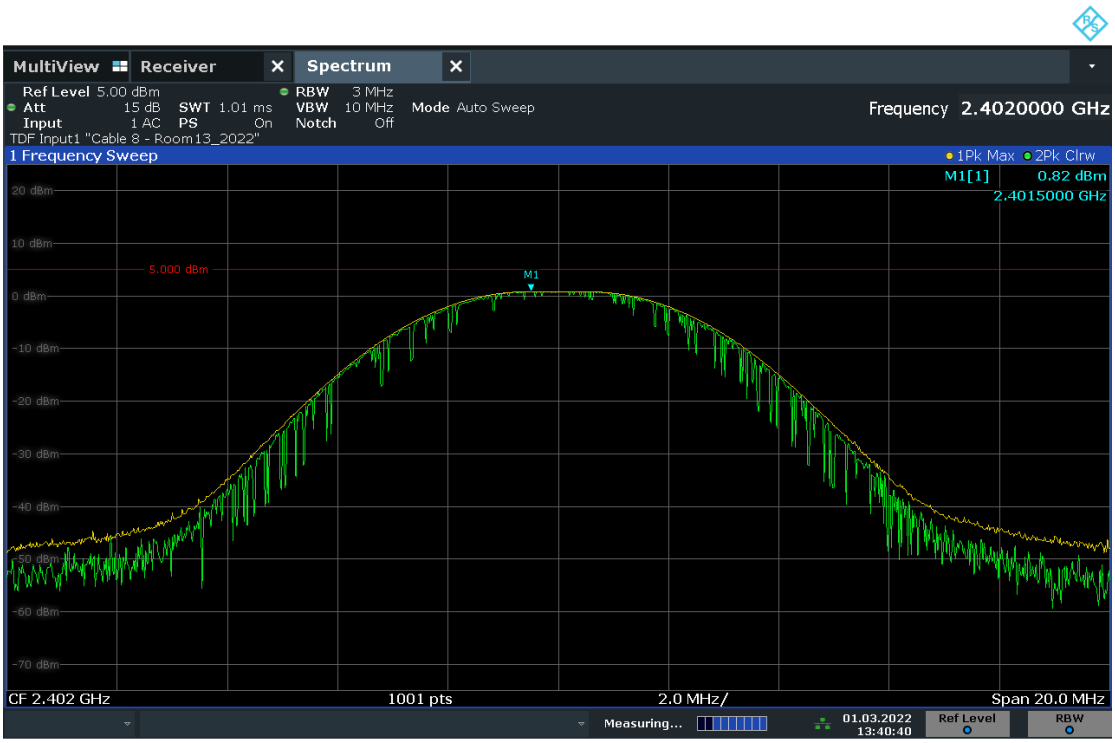
6.4.2 Limits

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

6.4.3 Results

Table 6-1: Maximum peak conducted power

Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Results
2402	0.82	30	Complied
2440	1.01	30	Complied
2480	1.21	30	Complied



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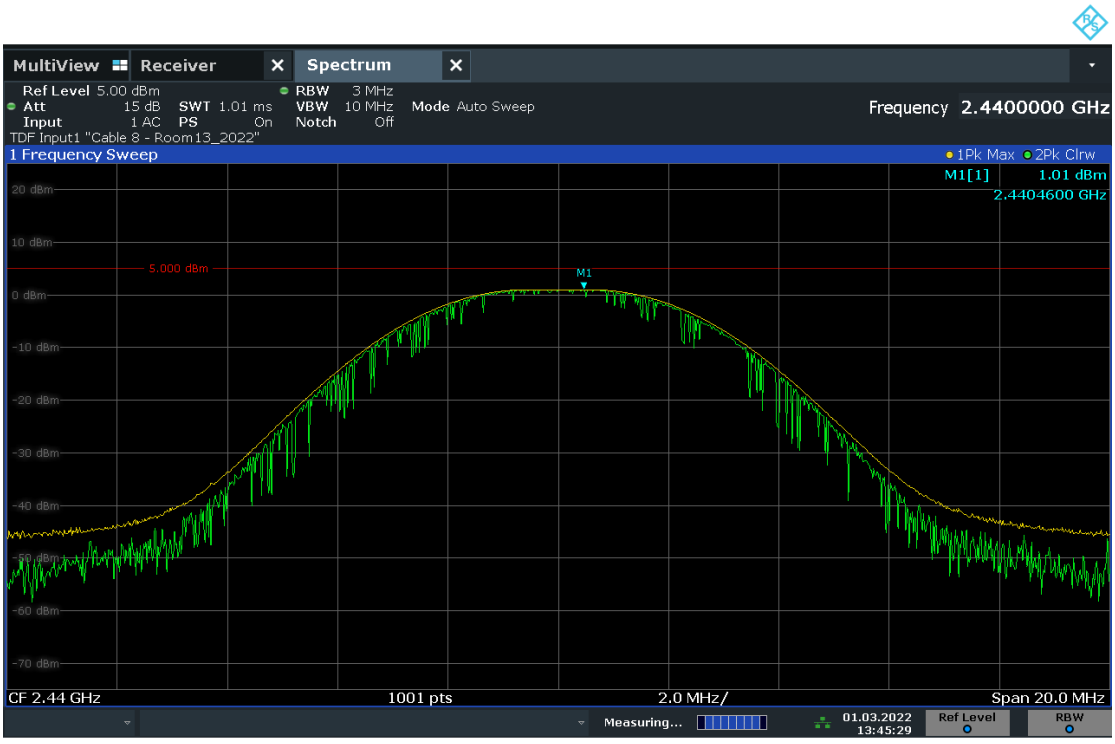
Graph 6-1: Max Output Power, 2402 MHz



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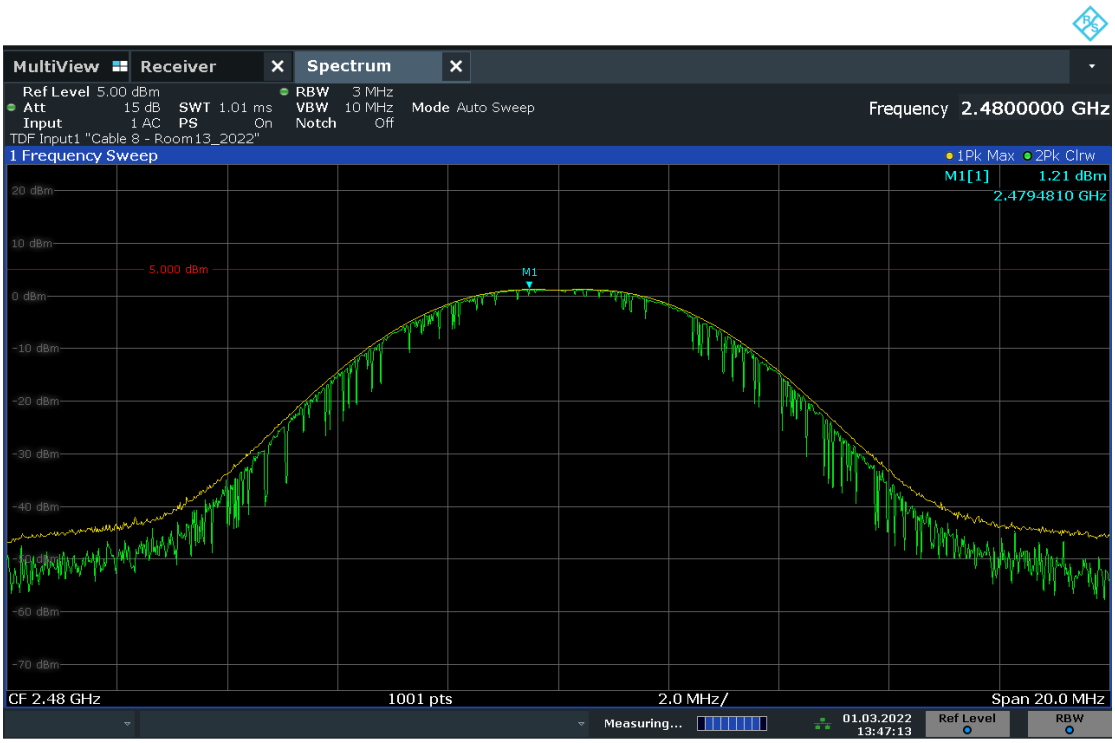
Graph 6-2: Max Output Power, 2440 MHz



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Graph 6-3: Max Output Power, 2480 MHz

6.5 §15.247(d)/ RSS-247 5.5 Out-of-Band/Spurious Emissions

6.5.1 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	Biconilog hybrid
1000 to 18 000	1000	3	Standard gain or broadband horn
18 000 to 40 000	1000	1	

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.

EUT was investigated on all three axes (x, y, and z). 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.

6.5.2 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 dBμV/m.
V = EMI Receiver Voltage in dBμV.
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).

6.5.3 Limits

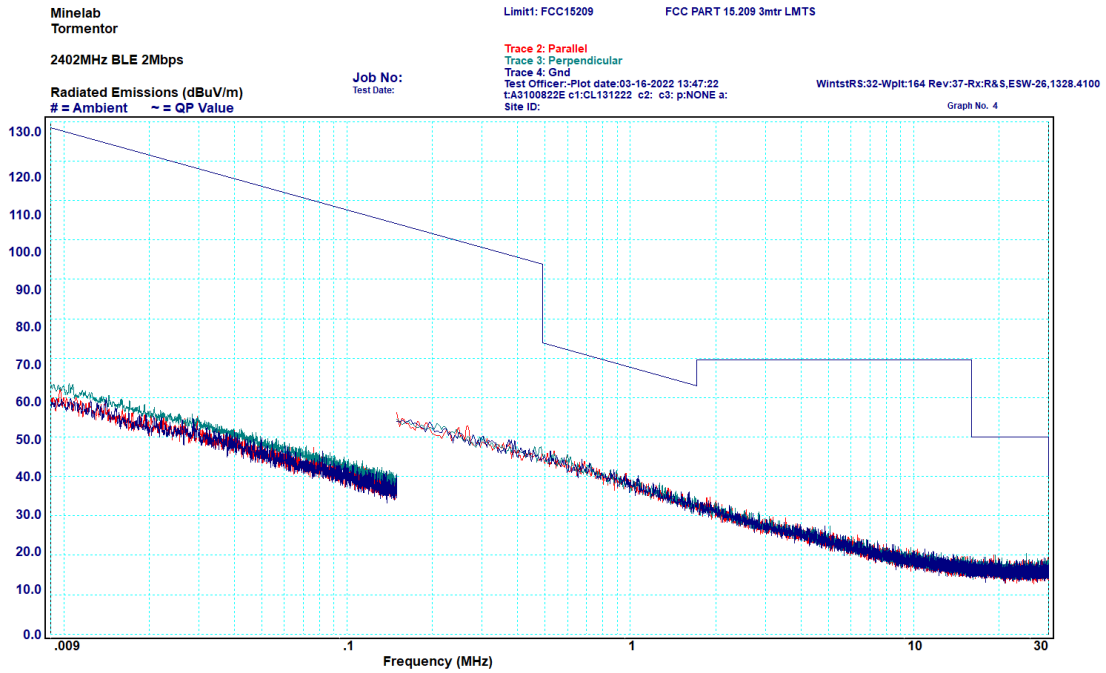
The limit applied is in accordance with the out-of-band/spurious emissions limit defined in §15.247(d).

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.

6.5.4 Transmitter Spurious Emissions: 9 kHz to 30 MHz

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

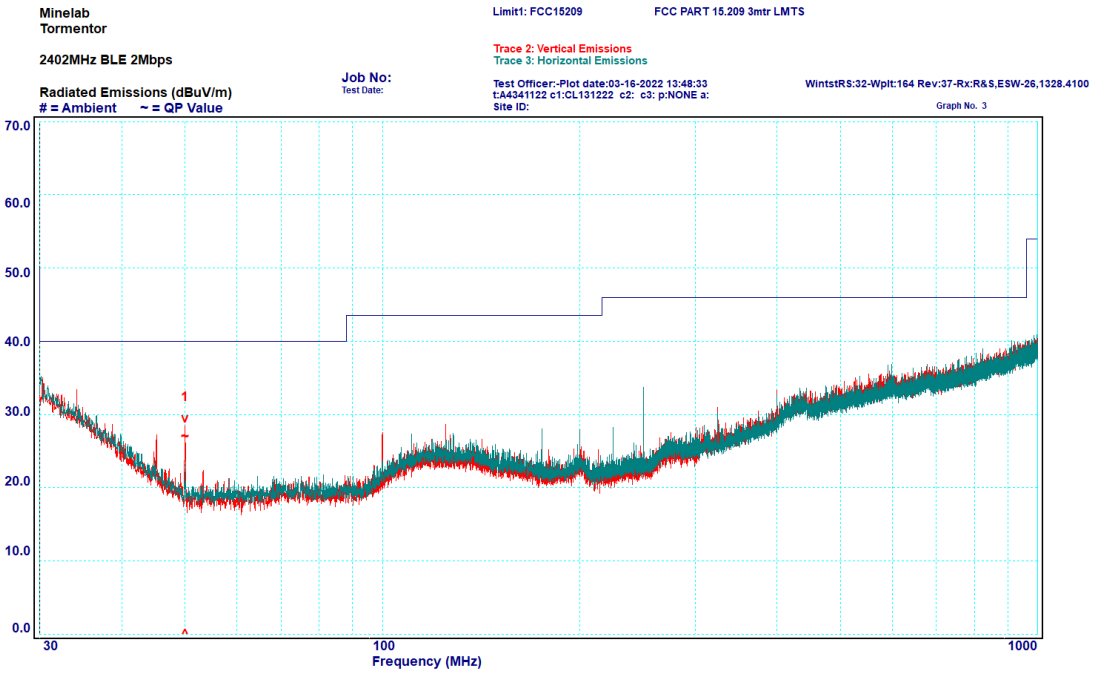


Graph 6-4: Transmitter Spurious Emissions, 9 kHz – 30 MHz, 2402 MHz

No peaks were measured within 10 dB of the limit.

6.5.5 Transmitter Spurious Emissions: 30 - 1000 MHz

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



Graph 6-5: Transmitter Spurious Emissions, 30 – 1000 MHz, 2402 MHz

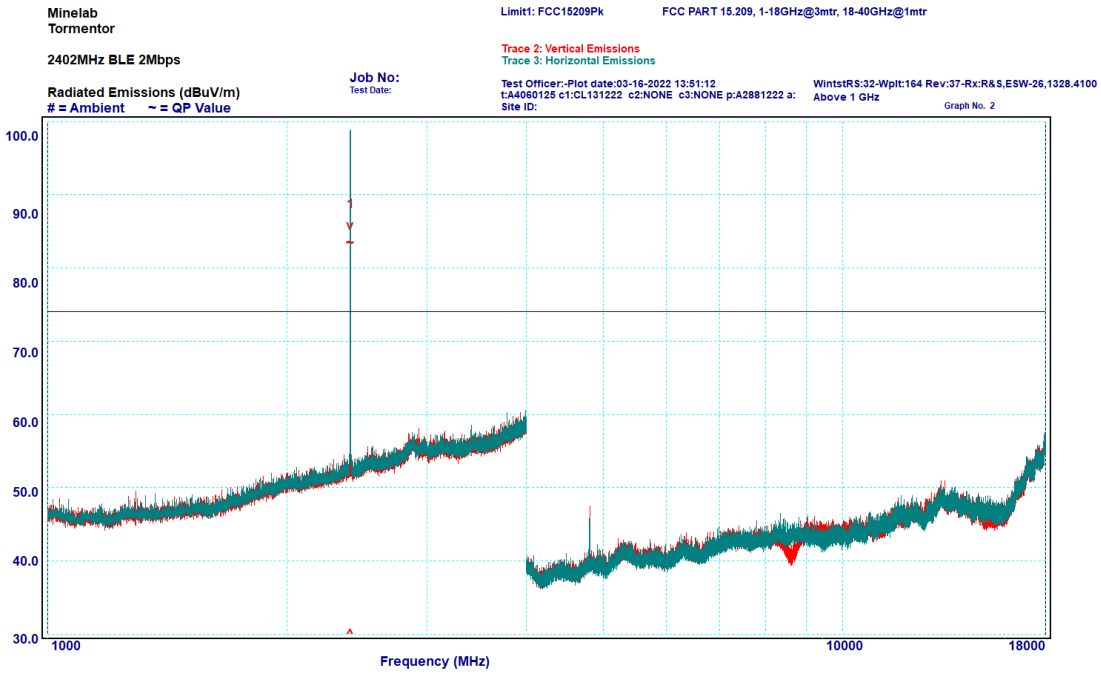
Table 6-2: Transmitter Spurious Emissions, 30 – 1000 MHz, 2402 MHz

Peak	Frequency (MHz)	Polarisation	Quasi Peak		
			Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1	50.00	Vertical	26.9	40	-13.1

6.5.6 Transmitter Spurious Emissions: 1 - 18 GHz

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

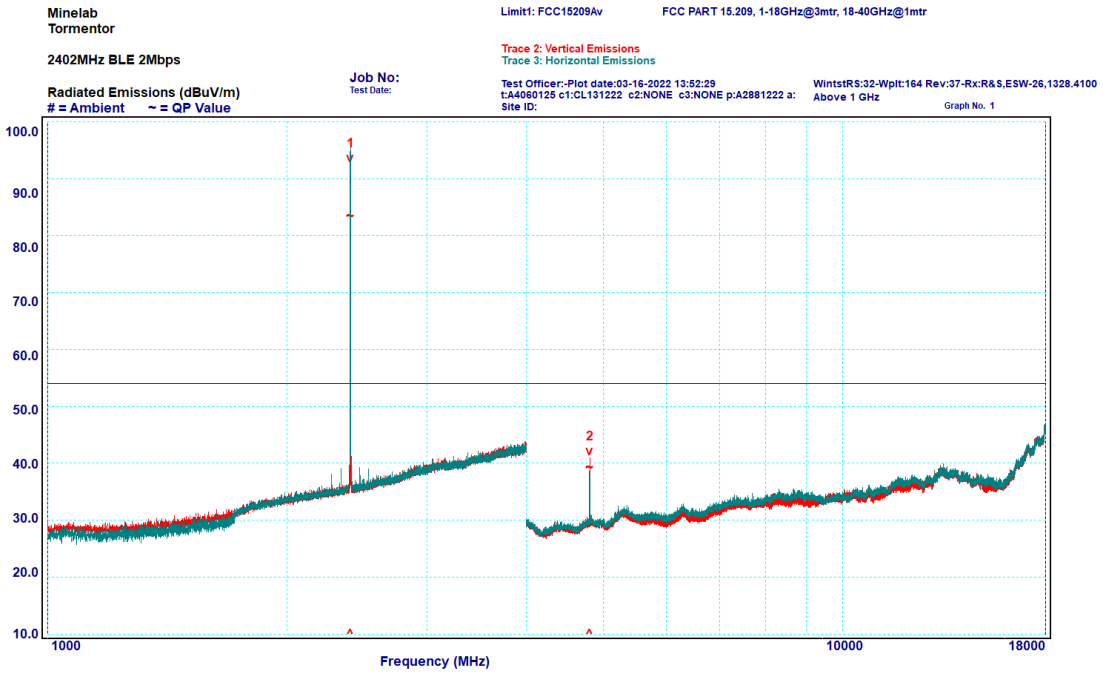
Peak Measurement:



Graph 6-6: 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

Average Measurement:



Graph 6-7: Transmitter Spurious Emissions, 1 – 18 GHz, 2402 MHz, Average

Table 6-3: Transmitter Spurious Emissions, 1 – 18 GHz, 2402 MHz, Average

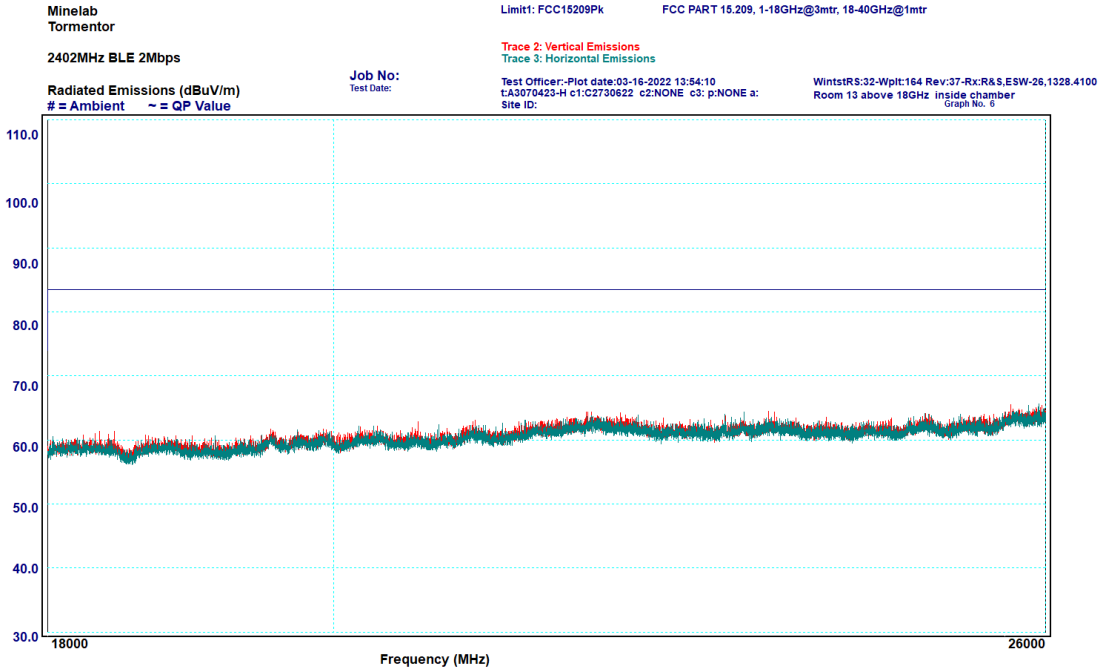
Peak	Frequency (MHz)	Polarisation	Peak		
			Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1*	2402.00	Vertical	N/A	N/A	N/A
2	4803.98	Vertical	39.2	54	-14.8

*Note: Peak 1 is the fundamental transmission and not subject to the spurious emissions limit of the standard

6.5.7 Transmitter Spurious Emissions: 18 – 26 GHz

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

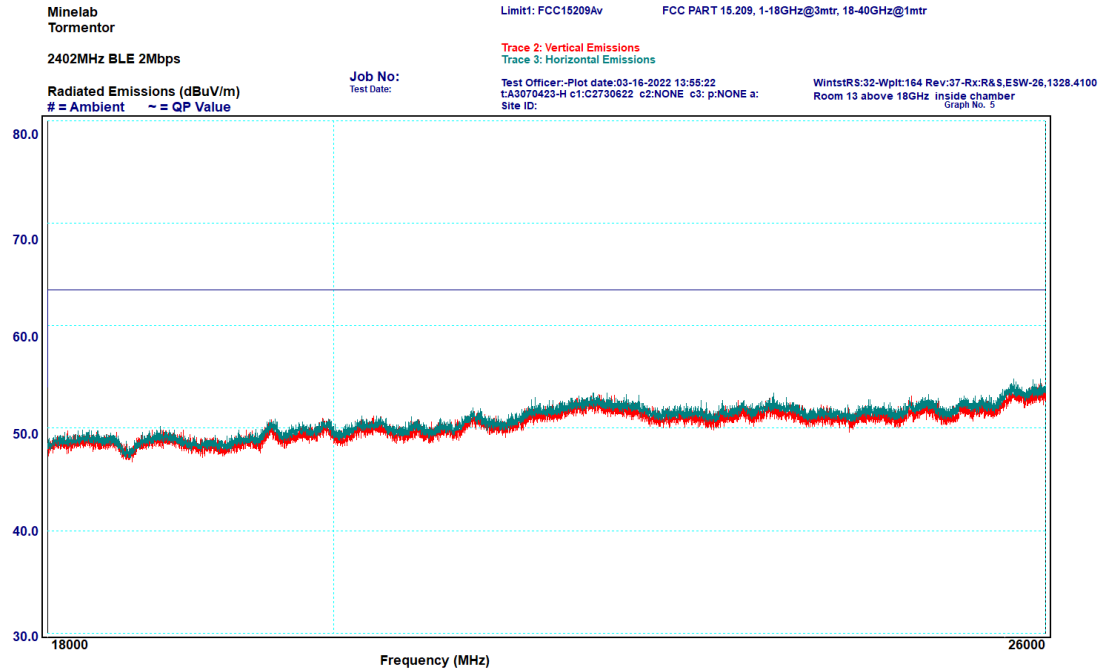
Peak Measurement:



Graph 6-8: Transmitter Spurious Emissions, 18 – 26 GHz, 2402 MHz, Peak

No peaks were measured within 10 dB of the limit.

Average Measurement:

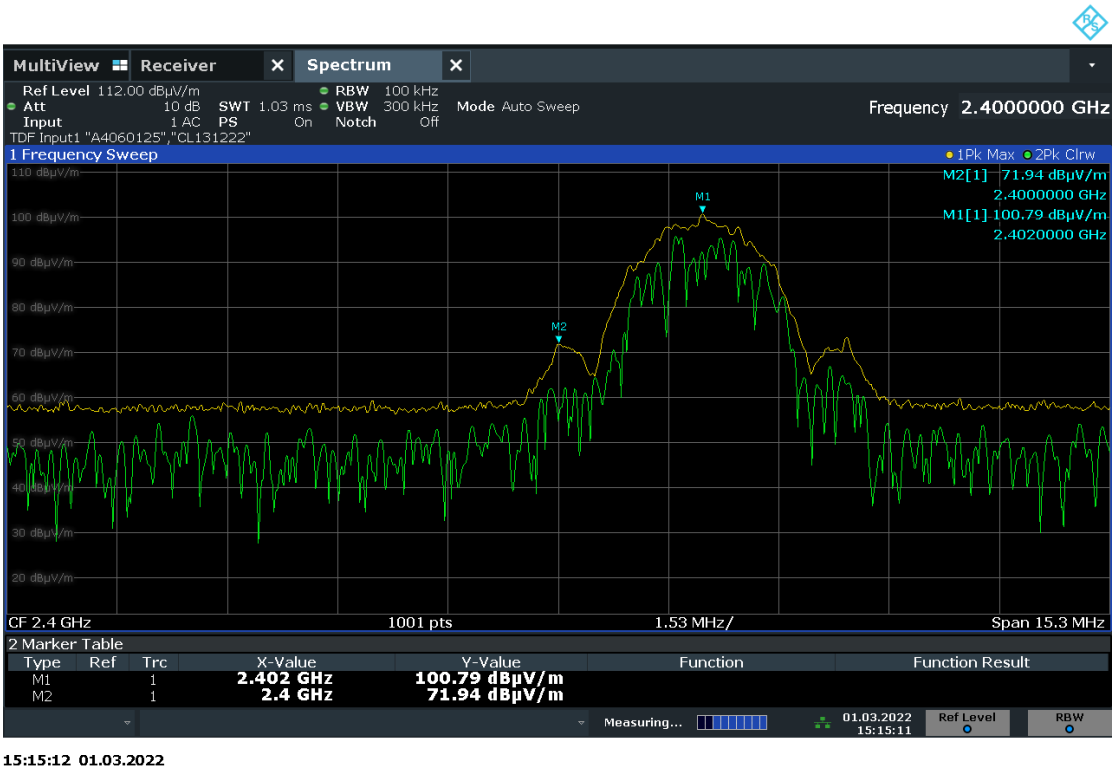


Graph 6-9: Transmitter Spurious Emissions, 18 – 26 GHz, 2402 MHz, Average

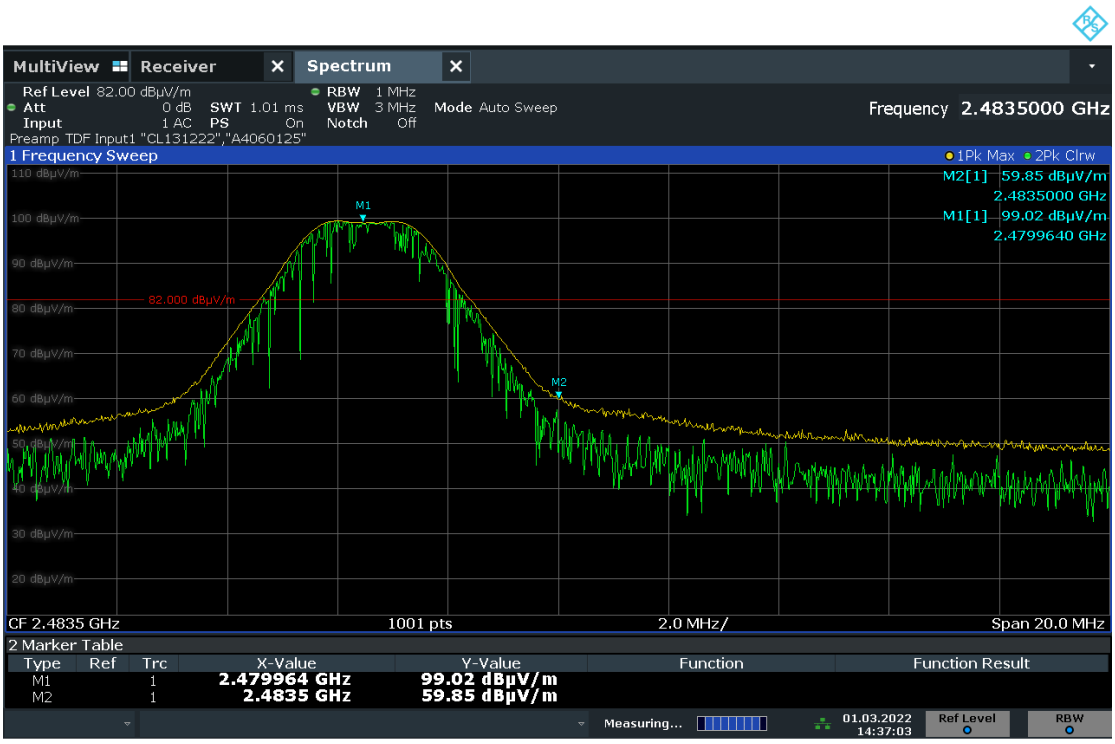
No peaks were measured within 10 dB of the limit.

6.6 §15.247(d)/ RSS-247 5.5 Band Edge Emission Measurements

Band-edge measurements were done in accordance to 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.



Graph 6-10: Band Edge Emission, Lower Band-edge



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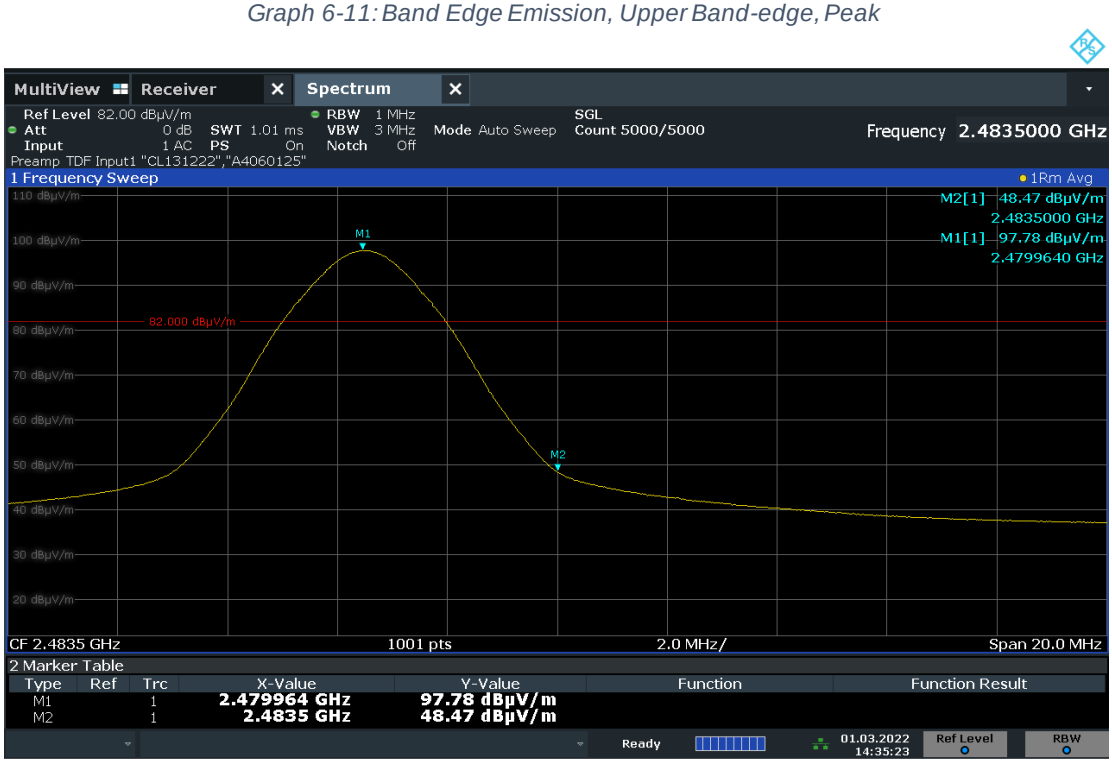
Graph 6-11: Band Edge Emission, Upper Band-edge, Peak



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Graph 6-12: Band Edge Emission, Upper Band-edge, Average

Table 6-4: Band Edge Emission

Measurement Type	Freq (MHz)	Measurement (dBµV/m)	Limit (dBµV/m)	Result
Peak	2400	71.94	74	Complied
Peak	2483.5	59.85	74	Complied
Average	2483.5	48.47	54	Complied

6.7 §15.247(e)/ RSS-247 5.2(b) Power Spectral Density

The EUT maximum conducted power is found to be 1.21 dBm.

Refer to the section 6.4 Peak Output Power for detail.

The EUT is deemed to comply the power spectral density requirements 8 dBm per 3 kHz without the testing.

6.8 §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 M2112041-5 and M2112041-6.

END OF REPORT