Certification Test Report

FCC ID: HSW-500M
IC: 4492A-500M

FCC Rule Parts: 15.249
ISED Canada Radio Standards Specification: RSS-210

Report Number: AT72170058-2C0

Manufacturer: Murata Electronics North America
Model: 500M

Test Begin Date: June 17, 2021
Test End Date: June 23, 2021

Report Issue Date: August 17, 2021

FOR THE SCOPE OF ACCREDITATION UNDER Certificate Number: 2955.09

This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the Federal Government.

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This report contains 23 pages

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1 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 15 Subpart C of the FCC's Code of Federal Regulations and Innovation, Science and Economic Development Canada's Radio Standards Specification RSS-210 for certification.

1.2 Product description

The Murata 500M is a Wireless communications radio module optimized for battery-powered devices enabling the Internet of Things. The 500M leverages Itron's proven, self-forming, self-healing networking capabilities to bring connectivity to a new class of IoT devices. The small form factor and power-optimized design brings secure, reliable two-way integrated IPv6 connectivity to critical infrastructure.

Technical Information:
The model 500M provides 1 distinct proprietary mode of operation as outlined below.

Mode of Operation	Frequency Range (MHz)	Number of Channels	Channel Separation (kHz)	Modulation	Data Rates Supported (kbps)
1	903-926.8	120	200	OOK	16.384

Antenna Type / Gain: WP WPANT30182-R1A-OMNI / 2 dBi (Host antenna trace design to host MMCX connector)
Voltage: 6.0 VDC

Manufacturer Information:
Murata Electronics North America.
2200 Lake Park Dr, Smyrna, GA 30080

EUT Serial Numbers 59B47D36 (Radiated Emission)
59B47D4B (RF Antenna Port Measurements)

Test Sample Condition: The test samples were provided in good working order with no visible defects

1.3 Test Methodology and Considerations

For radiated emissions, the EUT was evaluated in three orthogonal orientations. The worst-case orientation was Z-position. See test setup photos for more information. The EUT was programmed to generate a continuously modulated signal on each channel evaluated.

For RF Conducted measurements, the EUT was connected to the test equipment with a MMCX to SMA connector. The EUT was programmed to generate a continuously modulated signal on each channel evaluated.

Software power setting during test: Mode 1: 0x200C8334 (Low Power Software Configuration)

2 TEST FACILITIES

2.1 Location

The radiated and conducted emissions test sites are located at the following addresses:

TÜV SÜD America, Inc.
5945 Cabot Pkwy, Suite 100
Alpharetta, GA 30005
Phone: (678) 341-5900

2.2 Laboratory Accreditations/Recognitions/Certifications

TÜV SÜD America, Inc. is accredited to ISO/IEC 17025 by the American Association for Laboratory Accreditation/A2LA accreditation program and has been issued certificate number 2955.09 in recognition of this accreditation.

Unless otherwise specified, all test methods described within this report are covered under the ISO/IEC 17025 scopes of accreditation.

The Semi-Anechoic Chamber Test Sites and Conducted Emissions Sites have been fully described, submitted to, and accepted by the FCC, ISED Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

FCC Designation Accreditation Number:	US1233
FCC Test Site Registration Number:	967699
ISED Canada Lab Code:	23932
VCCI Member Number:	1831
• VCCI Registration Number	A-0295

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site – Chamber A

The Semi-Anechoic Chamber Test Site consists of a 20' x 30' x 18' shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 101 x 101 x 19mm thick and weighs approximately 550 grams. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber.

The turntable is 5' in diameter and is located 5'6" from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is all steel, flush mounted EMCO Model 1060 installed in an all-steel frame. The table is remotely operated from inside the control room located 25' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Behind the turntable is a 3' x 6' x 4' deep shielded pit used for support equipment if necessary. The pit is equipped with 1 - 4" PVC chase from the turntable to the pit that allows for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit.

The chamber rear wall is covered with a mixture of Siepel pyramidal absorber. The side walls of the chamber are partially covered with Siepel pyramidal absorber.

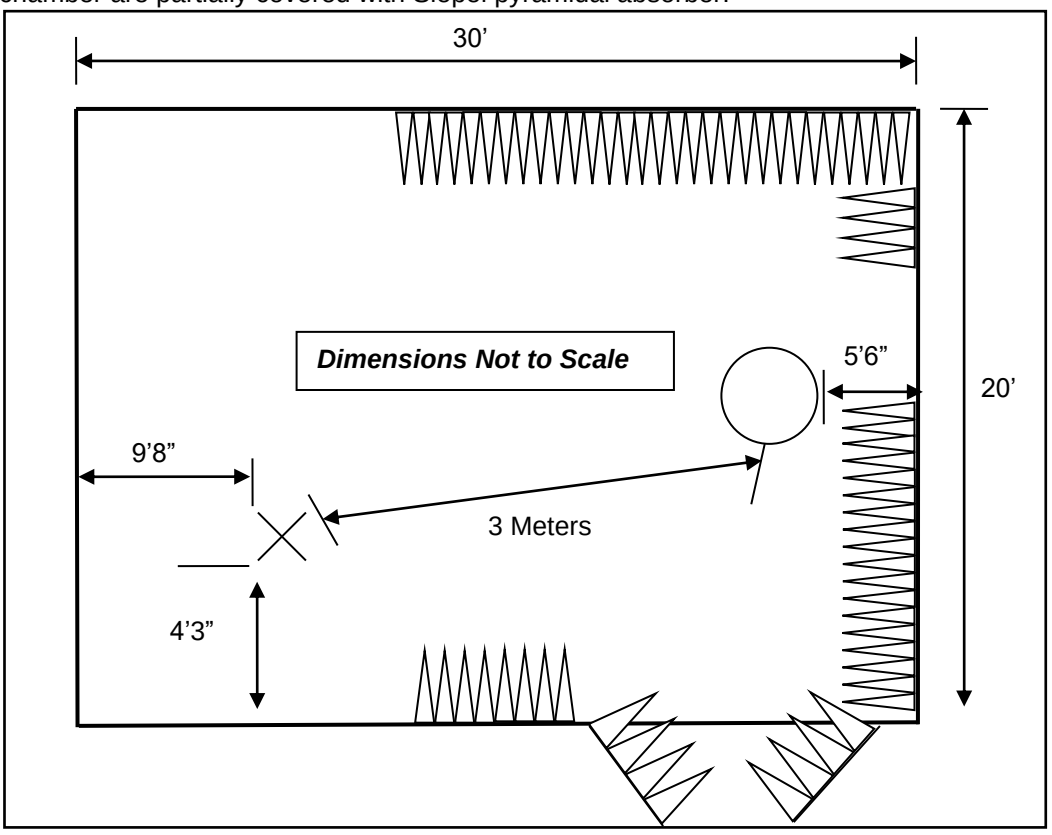


Figure 2.3.1-1: Semi-Anechoic Chamber Test Site – Chamber A

2.3.2 Semi-Anechoic Chamber Test Site – Chamber B

The Semi-Anechoic Chamber Test Site consists of a 20'W x 30'L x 20'H shielded enclosure. The chamber is lined with ETS-Lindgren Ferrite Absorber, model number FT-1500. The ferrite tile 600 mm x 600 mm (2.62 in x 23.62 in) panels and are mounted directly on the inner walls of the chamber shield.

The specular regions of the chamber are lined with additional ETS-Lindgren PS-600 hybrid absorber to extend its frequency range up to 18GHz and beyond.

The turntable is a 2m ETS-Lindgren Model 2170 and installed off the center axis is located 5'6" from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the shield using #8 solid copper wire.

The antenna mast is an EMCO 1060 and is remotely controlled from the control room for both antenna height and polarization.

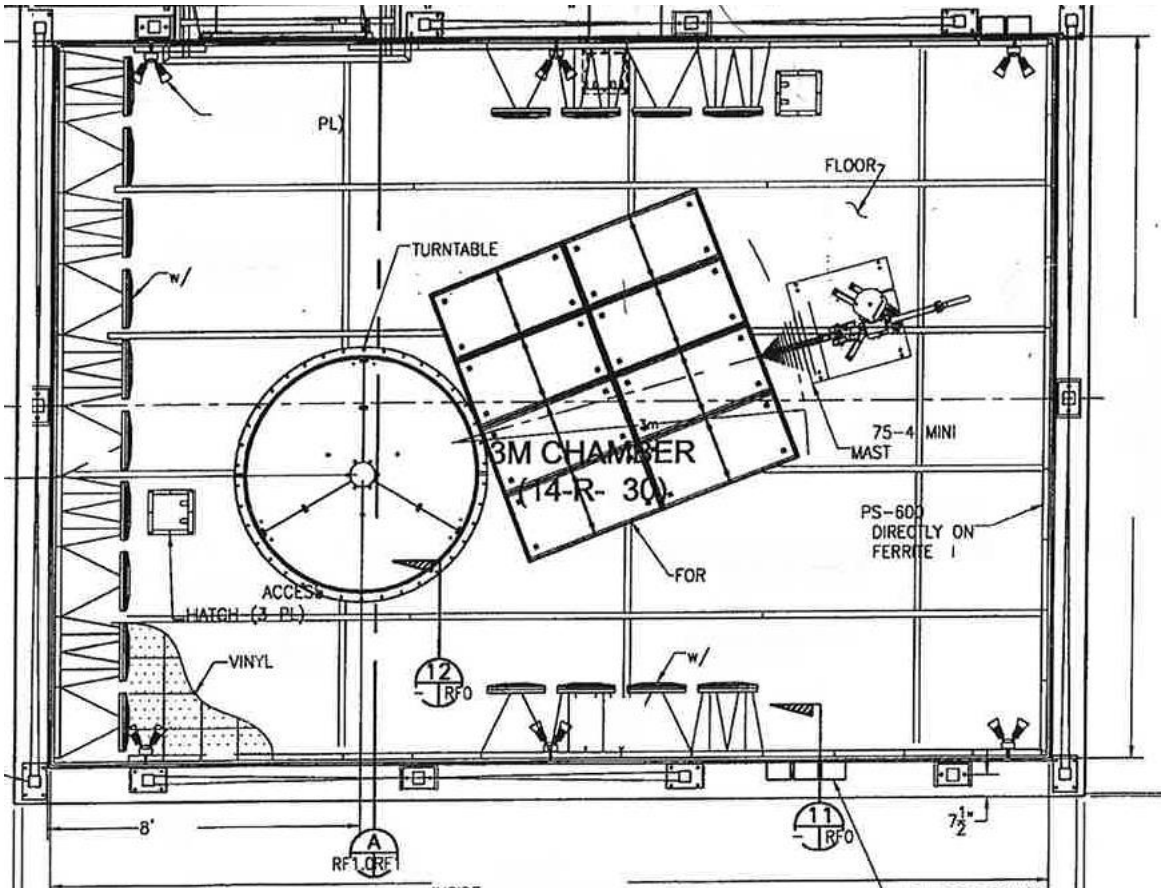


Figure 2.3.2-1: Semi-Anechoic Chamber Test Site – Chamber B

2.4 Conducted Emissions Test Site Description

2.4.1 Conducted Emissions Test Site

The AC mains conducted EMI site is located in the main EMC lab. It consists of a 12' x 10' horizontal coupling plane (HCP) as well as a 12'x8' vertical coupling plane (VCP). The HGP is constructed of 4' x 10' sheets of particle board sandwiched by galvanized steel sheets. These panels are bonded using 11AWG 1/8" x 2" by 10' galvanized sheet steel secured to the panels via by screws. The VCP is constructed of three 4'x8' sheets of 11AWG solid aluminum.

The HCP and VCP are electrically bonded together using 1"x1" angled aluminum secured with screws.

The site is of sufficient size to test tabletop and floor standing equipment in accordance with section 6.1.4 of ANSI C63.10.

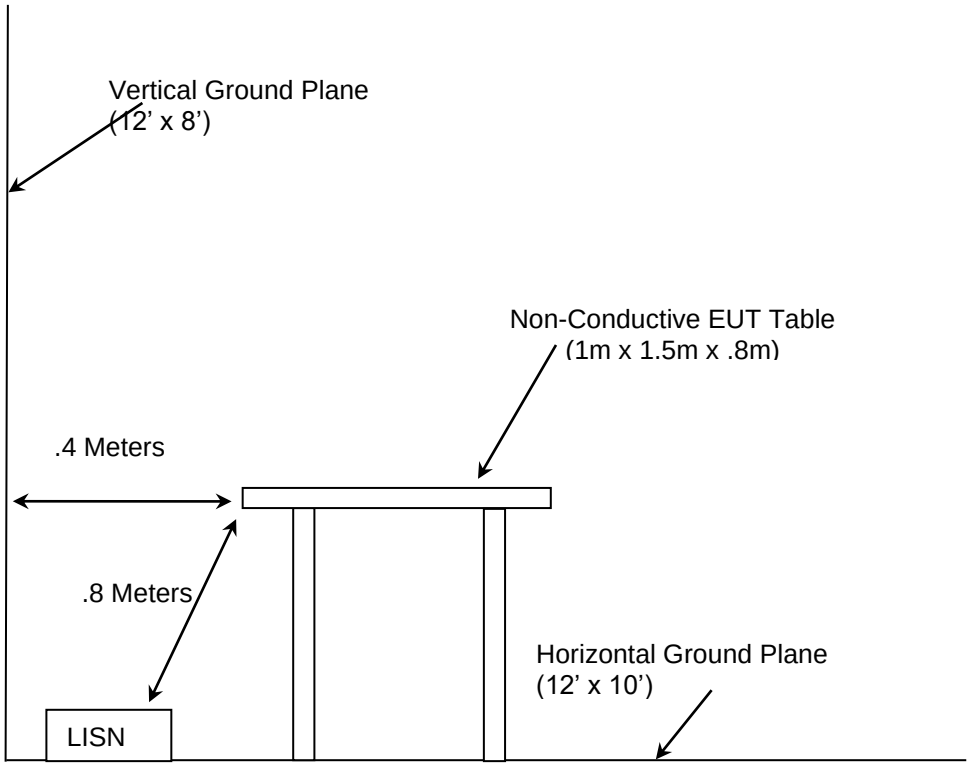


Figure 2.4.1-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2021
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2021
- Innovation, Science and Economic Development Canada Radio Standards Specification: RSS-210 – License-Exempt Radio Apparatus: Category I Equipment, Issue 10, December 2019
- ISED Canada Radio Standards Specification: RSS-GEN – General Requirements for Compliance of Radio Apparatus, Issue 5, Amendment 1 (March 2019), Amendment 2 (February 2021)

4 LIST OF TEST EQUIPMENT

The calibration interval of test equipment is annually or the manufacturer's recommendations. Where the calibration interval deviates from the annual cycle based on the instrument manufacturer's recommendations, it shall be stated below.

Table 4-1: Test Equipment

Asset ID	Manufacturer	Model	Equipment Type	Serial Number	Last Calibration Date	Calibration Due Date
628	EMCO	6502	Active Loop Antenna 10kHz-30MHz	9407-2877	2/7/2019	6/11/2021
628	EMCO	6502	Active Loop Antenna 10kHz-30MHz	9407-2877	6/8/2021	6/8/2023
852	Teseq; Huber+suhner	CBL 6112D;6804-17-A	Bilog Antenna	51617	10/13/2020	10/13/2021
857	ETS Lindgren	3117	Horn Antenna 1-18GHz	153608	11/12/2019	11/12/2021
213	TEC	PA 102	Amplifier	44927	7/30/2020	7/30/2021
338	Hewlett Packard	8449B	High Frequency Pre-Amp	3008A01111	7/15/2019	7/15/2021
338	Hewlett Packard	8449B	High Frequency Pre-Amp	3008A01111	6/22/2021	6/22/2023
337	Hewlett Packard	H1G513G1	Microwave Bandpass filter	282706	6/9/2020	6/9/2021
337	Hewlett Packard	H1G513G1	Microwave Bandpass filter	282706	6/9/2021	6/9/2022
819	Rohde & Schwarz	ESR26	EMI Test Receiver	101345	4/7/2021	4/7/2022
827	Rohde & Schwarz	TS8997 Rack Cable Set	TS8997 Rack Cable Set	N/A	9/4/2020	9/4/2021
267	Hewlett Packard	N1911A	Power Meter	MY45100129	7/26/2019	7/26/2021
622	Rohde & Schwarz	FSV40	FSV Signal Analyzer 10Hz to 40 GHz	101338	8/24/2020	8/24/2021

NOTE: All test equipment was used only during active calibration cycles.

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number
1	Module	Itron	500M	KM0128ES2
2	Representative Host Board	Itron	N/A	1721501561
3	Programming board	Itron	N/A	N/A
4	Laptop for configuration	DELL	N/A	N/A
5	AC/DC Adapter	CUI INC	SWI10-5-N	N/A

Table 5-2: Cable Description

Item	Cable Type	Length	Shield
A	AC/DC Power Cable	2m	Yes
B	USB Cable	1m	Yes
C	Data Cable	0.2m	Yes

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

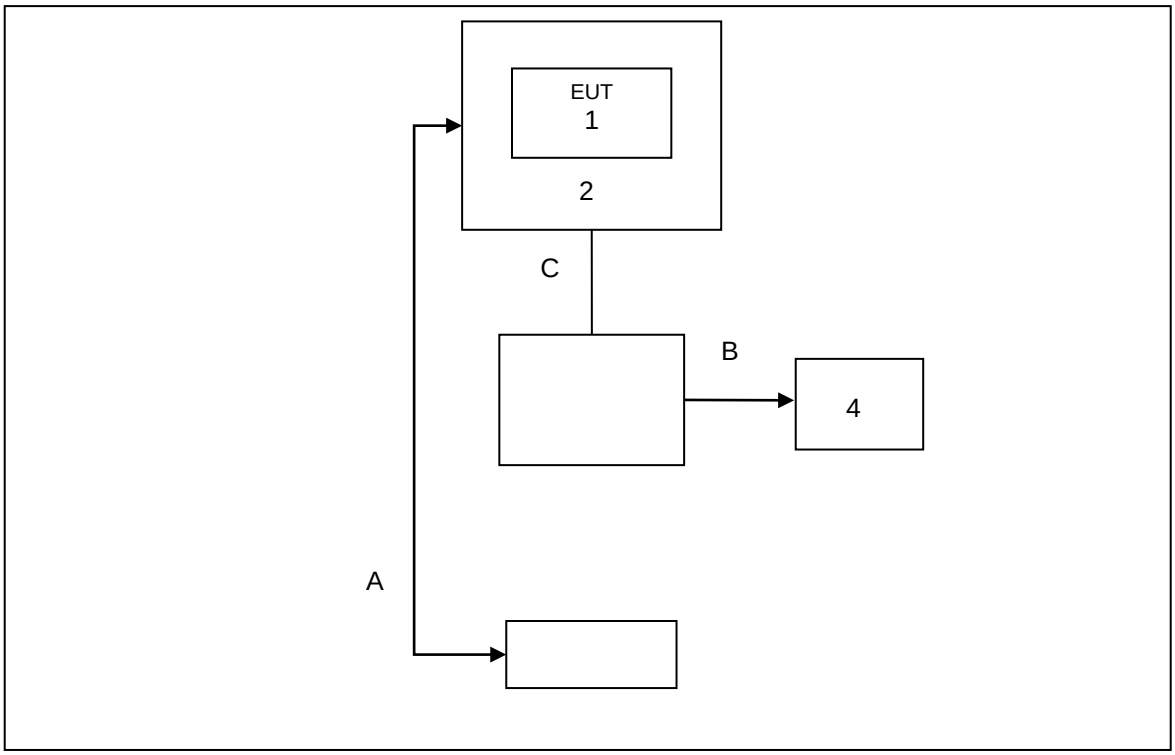


Figure 6-1: Test Setup Block Diagram

7 SUMMARY OF TESTS

Along with the tabular data shown below, plots were taken of all signals deemed important enough to document.

7.1 Antenna Requirement – FCC 15.203

The EUT utilizes WP WPANT30182-R1A-OMNI antenna with 2 dBi gain (Host antenna trace design to host MMCX connector), therefore satisfying the requirements of Section 15.203.

7.2 Power Line Conducted Emissions – FCC 15.207, ISED Canada: RSS-Gen 8.8

7.2.1 Measurement Procedure

ANSI C63.10 section 6 was the guiding documents for this evaluation. Conducted emissions were performed from 150kHz to 30MHz with the spectrum analyzer's resolution bandwidth set to 9kHz and the video bandwidth set to 30kHz. The calculation for the conducted emissions is as follows:

Corrected Reading = Analyzer Reading + LISN Loss + Cable Loss
Margin = Corrected Reading – Applicable Limit

7.2.2 Measurement Results

Performed by: Sean Vick

Table 7.2.2-1: Conducted EMI Results-Avg – Line 1

Frequency (MHz)	Avg Limit	Avg Level Corrected	Avg Level	Correction Fact.	Avg Margin	Result
0.56	46.0	18.2	8.6	9.653	-27.8	PASS
0.99	46.0	17.5	7.8	9.679	-28.5	PASS
1.04	46.0	17.6	7.9	9.679	-28.4	PASS
1.62	46.0	17.4	7.8	9.662	-28.6	PASS
2.82	46.0	17.0	7.3	9.69	-29.0	PASS
2.88	46.0	16.7	7.0	9.69	-29.3	PASS

Table 7.2.2-2: Conducted EMI Results-QP – Line 1

Frequency (MHz)	QP Limit	QP Level Corrected	QP Level	Correction Fact.	QP Margin	Result
0.56	56.0	26.4	16.8	9.653	-29.6	PASS
0.99	56.0	25.9	16.2	9.679	-30.1	PASS
1.04	56.0	26.3	16.6	9.679	-29.7	PASS
1.62	56.0	25.8	16.2	9.662	-30.2	PASS
2.82	56.0	24.1	14.4	9.690	-31.9	PASS
2.88	56.0	25.0	15.3	9.690	-31.0	PASS

Table 7.2.2-3: Conducted EMI Results-Avg – Line 2

Frequency (MHz)	Avg Limit	Avg Level Corrected	Avg Level	Correction Fact.	Avg Margin	Result
0.15	56.0	22.8	13.2	9.675	-33.1	PASS
0.22	53.9	17.7	8.0	9.668	-36.2	PASS
0.50	46.0	15.1	5.5	9.630	-31.0	PASS
2.00	46.0	14.2	4.6	9.660	-31.8	PASS
2.16	46.0	14.5	4.8	9.663	-31.5	PASS
2.59	46.0	13.8	4.1	9.674	-32.2	PASS

Table 7.2.2-4: Conducted EMI Results-QP – Line 2

Frequency (MHz)	QP Limit	QP Level Corrected	QP Level	Correction Fact.	QP Margin	Result
0.15	66.0	32.2	22.6	9.675	-33.8	PASS
0.22	63.9	26.8	17.2	9.668	-37.0	PASS
0.5	56.0	19.8	10.2	9.630	-36.2	PASS
2.00	56.0	18.9	9.20	9.660	-37.1	PASS
2.16	56.0	19.0	9.40	9.663	-37.0	PASS
2.59	56.0	18.9	9.20	9.674	-37.1	PASS

7.3 20dB / 99% Bandwidth – FCC: Section 15.215, ISED Canada: RSS-Gen 4.6.1

7.3.1 Measurement Procedure

The span of the spectrum analyzer display was set between two times and five times the occupied bandwidth (OBW) of the emission. The RBW of the spectrum analyzer was set to approximately 1 % to 5 % of the OBW. The trace was set to max hold with a peak detector active. The ndB down and delta function of the analyzer was utilized to determine the 20 dB bandwidth of the emission.

The occupied bandwidth measurement function of the spectrum analyzer was used to measure the 99% bandwidth. The span of the analyzer was set to capture all products of the modulation process, including the emission sidebands. The resolution bandwidth was set to 1% to 5% of the occupied bandwidth. The video bandwidth was set to 3 times the resolution bandwidth. A peak detector was used.

7.3.2 Measurement Results

Performed by: Bhagyashree Chaudhary

Table 7.3.2-1: 20dB / 99% Bandwidth

Frequency [MHz]	20dB Bandwidth [kHz]	99% Bandwidth [kHz]	Data Rate (kbps)	Mode(s)
903.0	109.340	301.240	16.384	1
916.0	109.694	300.772	16.384	1
926.8	108.899	300.772	16.384	1

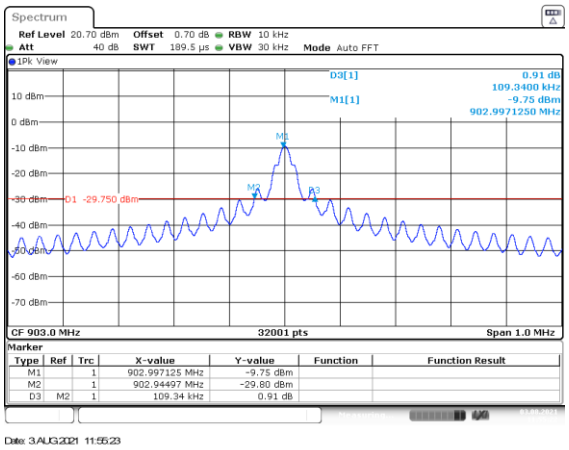


Figure 7.3.2-1: 20dB BW Low Channel – 16.384kbps

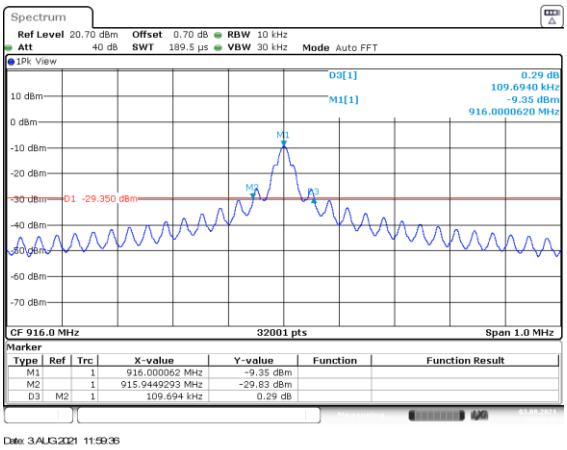


Figure 7.3.2-2: 20dB BW Mid Channel – 16.384kbps

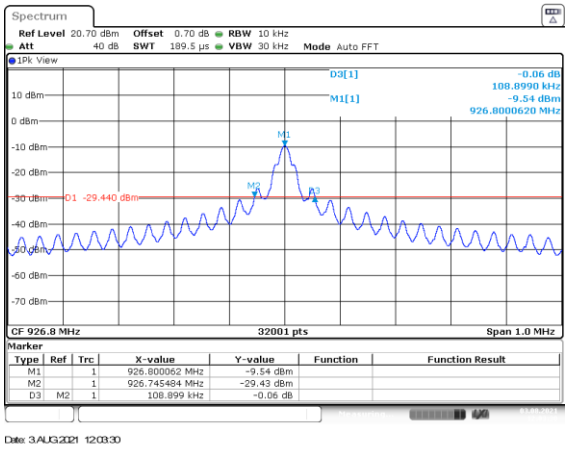


Figure 7.3.2-3: 20dB BW High Channel – 16.384kbps

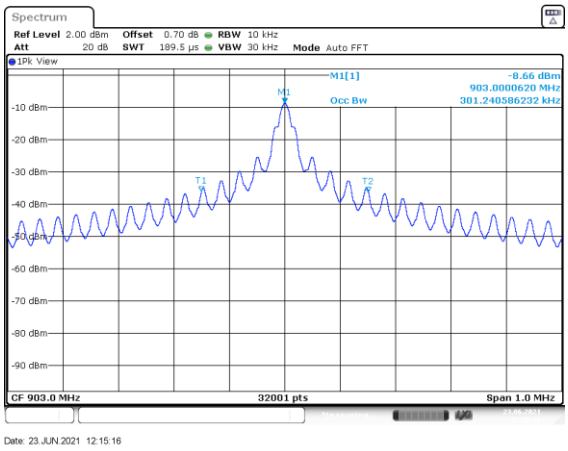


Figure 7.3.2-4: 99% BW Low Channel – 16.384kbps

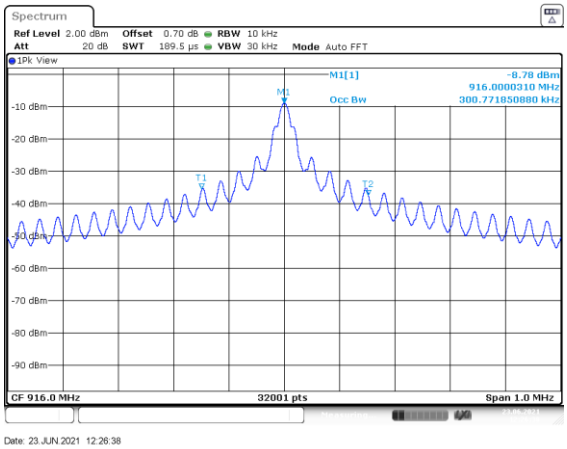


Figure 7.3.2-5: 99% BW Low Channel – 16.384kbps

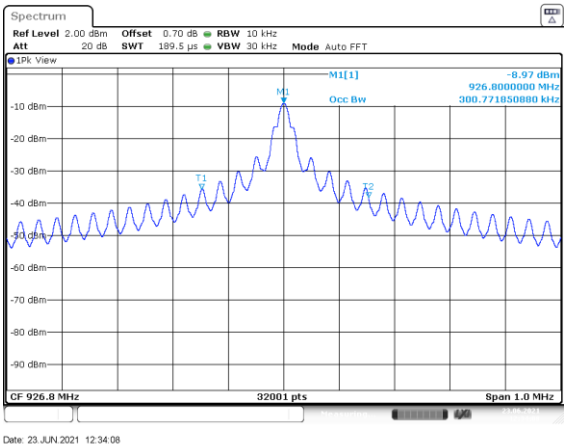


Figure 7.3.2-6: 99% BW Low Channel – 16.384kbps

7.4 Fundamental Field Strength – FCC: Section 15.249(a), ISED Canada: RSS-210 B.10

7.4.1 Measurement Procedure

The EUT was rotated through 360° and the receive antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. Quasi-peak measurements were made with RBW and VBW of 100 kHz and 300 kHz respectively.

7.4.2 Measurement Results

Performed By: Bhagyashree Chaudhary

Table 7.4.2-1: Fundamental Field Strength

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
903	---------	83.30	H	3.37	---------	86.67	--------	94.0	--------	7.3
903	---------	89.80	V	3.37	---------	93.17	--------	94.0	--------	0.8
916	---------	81.00	H	3.12	---------	84.12	--------	94.0	--------	9.9
916	---------	89.90	V	3.12	---------	93.02	--------	94.0	--------	1.0
926.8	---------	82.80	H	3.20	---------	86.00	--------	94.0	--------	8.0
926.8	---------	88.20	V	3.20	---------	91.40	--------	94.0	--------	2.6

7.5 Radiated Spurious Emissions – FCC: Section 15.249(a)(d)(e), ISED Canada: RSS-210 B.10

7.5.1 Measurement Procedure

Section 15.33(a)(4) specifies, if the intentional radiator contains a digital device, regardless of whether this digital device controls the functions of the intentional radiator or the digital device is used for additional control or function purposes other than to enable the operation of the intentional radiator, the frequency range shall be investigated up to frequency specified in 15.33(b)(1) for unintentional radiators. The upper frequency range for the digital device is 18GHz which greater than the 10th harmonic of the fundamental frequency. The upper frequency range measured was 18GHz.

Measurements below 30MHz were performed in a semi-anechoic chamber with a 3meter separation distance between the EUT and measurement antenna. The EUT was rotated 360º and the loop antenna rotated through three orthogonal axes. The magnetic loop receiving antenna was positioned with its lowest point 1 meter above the ground.

The spectrum analyzer's resolution and video bandwidth were set to 300 Hz and 1 kHz respectively for frequencies below 150 kHz and 10 kHz and 30 kHz respectively for frequencies above 150 kHz and below 30 MHz. For measurements in the frequency bands 9-90 kHz and 110-490 kHz, a peak detector was used. When average measurements are specified, the peak emissions were also compared to a limit corresponding to 20 dB above the maximum permitted average limit according to Part 15.35. All other emissions were measured using a peak detector.

Measurements above 30 MHz were performed in a semi-anechoic chamber with a 3meter separation distance between the EUT and measurement antenna. The EUT was rotated through 360° and the receive antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. For frequencies below 1000 MHz, quasi-peak measurements were made using a resolution bandwidth (RBW) of 100 kHz and a video bandwidth (VBW) of 300 kHz. For frequencies above 1000 MHz, peak and average measurements were made using a resolution bandwidth (RBW) of 1 MHz and a video bandwidth (VBW) of 3 MHz. See Appendix A for more information.

For measurements of fundamental emissions where average measurements are specified, the spectrum analyzer's resolution bandwidth (RBW) was adjusted equal to or greater than the emission bandwidth (EBW).

7.5.1.1 Distance Correction for Measurements Below 30 MHz – Part 15.31

Radiated measurements were performed at a distance closer than 300 meters and 30m as required, according to Part 15. 209.Therefore a correction factor was applied to account for propagation loss at the specified distance. The propagation loss was determined by using the square of an inverse linear distance extrapolation factor (40dB/decade) according to 15.31. A sample calculation of the distance correction factor is shown below for limits expressed at a 300m measurement distance and a 30m measurement distance.

Distance correction factor (300m Specified Test Distance) = 40*Log (Test Distance/300)
= 40*Log (3/300)
= - 80 dB

Distance correction factor (30m Specified Test Distance) = 40*Log (Test Distance/30)
= 40*Log (3/30)
= - 40 dB

7.5.1.2 Measurement Results

Performed by: Bhagyashree Chaudhary

Table 7.5.1.2-1: Radiated Spurious Emissions

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel										
111.949	---------	18.6	H	-7.58	---------	11.02	--------	43.5	---------	32.5
111.949	---------	26.3	V	-7.58	---------	18.72	--------	43.5	---------	24.8
266.920	---------	17.3	H	-5.68	---------	11.62	--------	46.0	---------	34.4
266.920	---------	17.2	V	-5.68	---------	11.52	--------	46.0	---------	34.5
Middle Channel										
113.500	---------	19.1	H	-7.49	---------	11.61	--------	43.5	---------	31.9
113.500	---------	25.9	V	-7.49	---------	18.41	--------	43.5	---------	25.1
269.250	---------	17.4	H	-5.85	---------	11.55	--------	46.0	---------	34.4
269.250	---------	17.0	V	-5.85	---------	11.15	--------	46.0	---------	34.8
High Channel										
111.949	---------	18.6	H	-7.58	---------	11.02	--------	43.5	---------	32.5
111.949	---------	26.1	V	-7.58	---------	18.52	--------	43.5	---------	25.0
266.920	---------	17.3	H	-5.68	---------	11.62	--------	46.0	---------	34.4
266.920	---------	17.2	V	-5.68	---------	11.52	--------	46.0	---------	34.5

Sample Calculation:

$R_C = R_U + CF_T$

Where:

CF_T = Total Correction Factor (AF+CA+AG)-DC (Average Measurements Only)
R_U = Uncorrected Reading
R_C = Corrected Level
AF = Antenna Factor
CA = Cable Attenuation
AG = Amplifier Gain
DC = Duty Cycle Correction Factor

Example Calculation: Quasi -Peak

Corrected Level: 26.3 + -7.58 = 18.72dBuV/m
Margin: 43.5dBuV/m – 18.72dBuV/m = 24.8dB

8 ESTIMATION OF MEASUREMENT UNCERTAINTY

The expanded laboratory measurement uncertainty figures (U_{Lab}) provided below correspond to an expansion factor (coverage factor) k = 1.96 which provide confidence levels of 95%.

Table 8-1: Estimation of Measurement Uncertainty

Parameter	U_{lab}
Occupied Channel Bandwidth	± 0.009 %
RF Conducted Output Power	± 0.349 dB
Power Spectral Density	± 0.372 dB
Antenna Port Conducted Emissions	± 1.264 dB
Radiated Emissions ≤ 1 GHz	± 5.814 dB
Radiated Emissions > 1 GHz	± 4.318 dB
Temperature	± 0.860 °C
Radio Frequency	± 2.832 x 10^{-8}
AC Power Line Conducted Emissions	± 3.360 dB

9 CONCLUSION

In the opinion of TUV SUD the Model 500M, manufactured by Murata Electronics North America meets the requirements of the FCC's Code of Federal Regulations Part 15 Subpart C and Innovation, Science and Economic Development Canada's Radio Standards Specification RSS-210 for the tests documented in this test report.

Appendix A: Plots

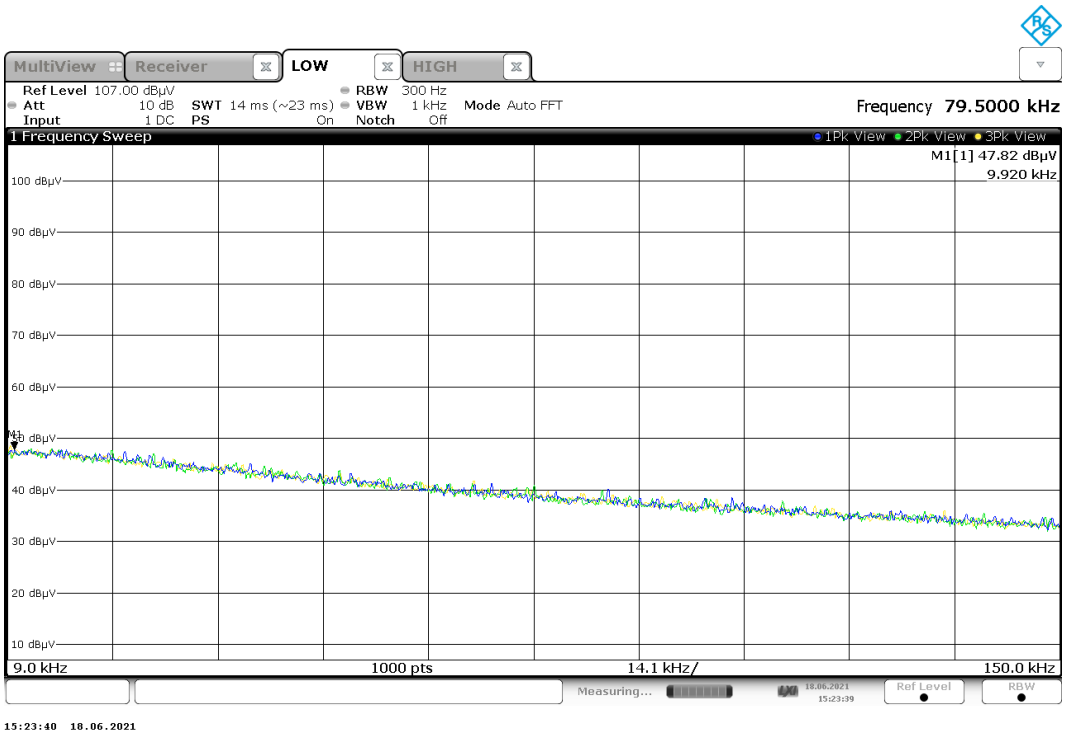
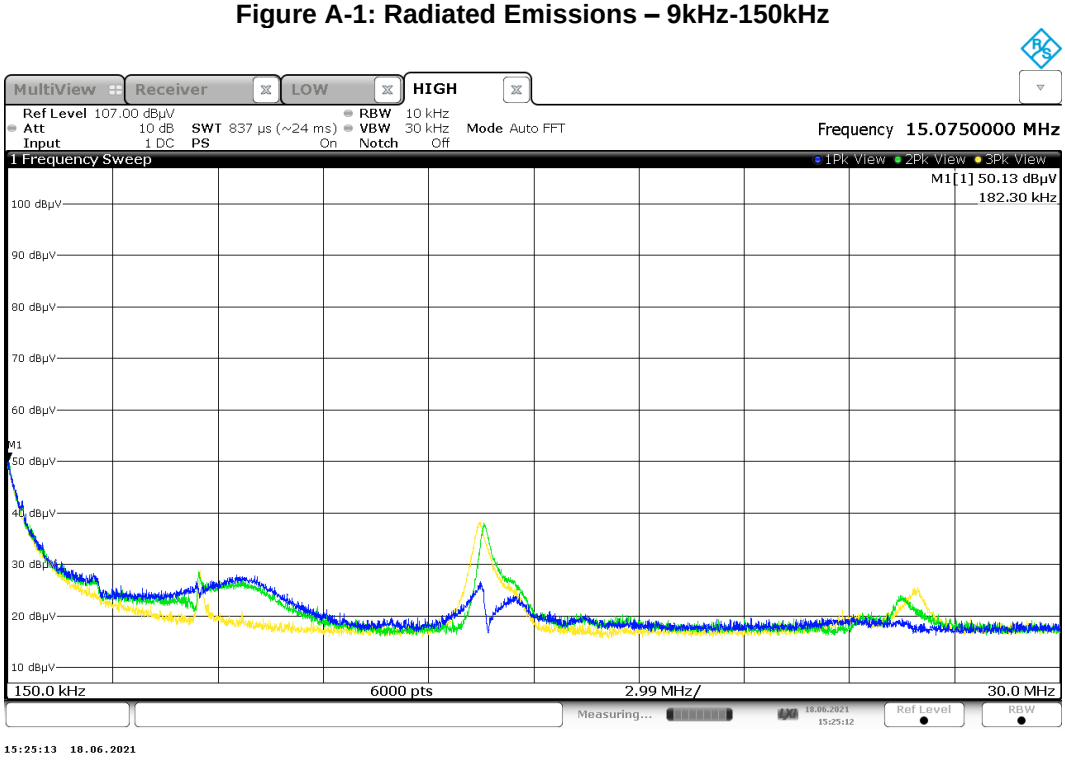
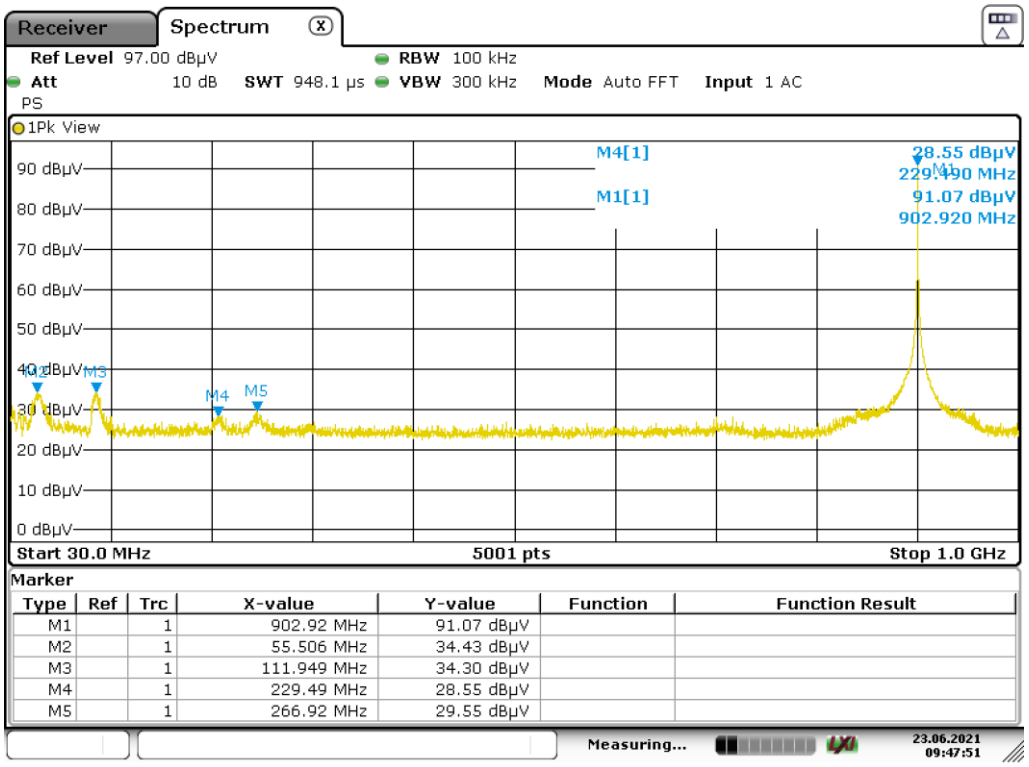


Figure A-1: Radiated Emissions – 9kHz-150kHz



Note: Emissions above the noise floor are ambient noise and not associated with the DUT.

Figure A-2: Radiated Emissions – 150kHz-30MHz



Date: 23.JUN.2021 09:47:51

Note: Only emissions within restricted bands were evaluated.
Figure A-3: Radiated Emissions – 30MHz-1GHz

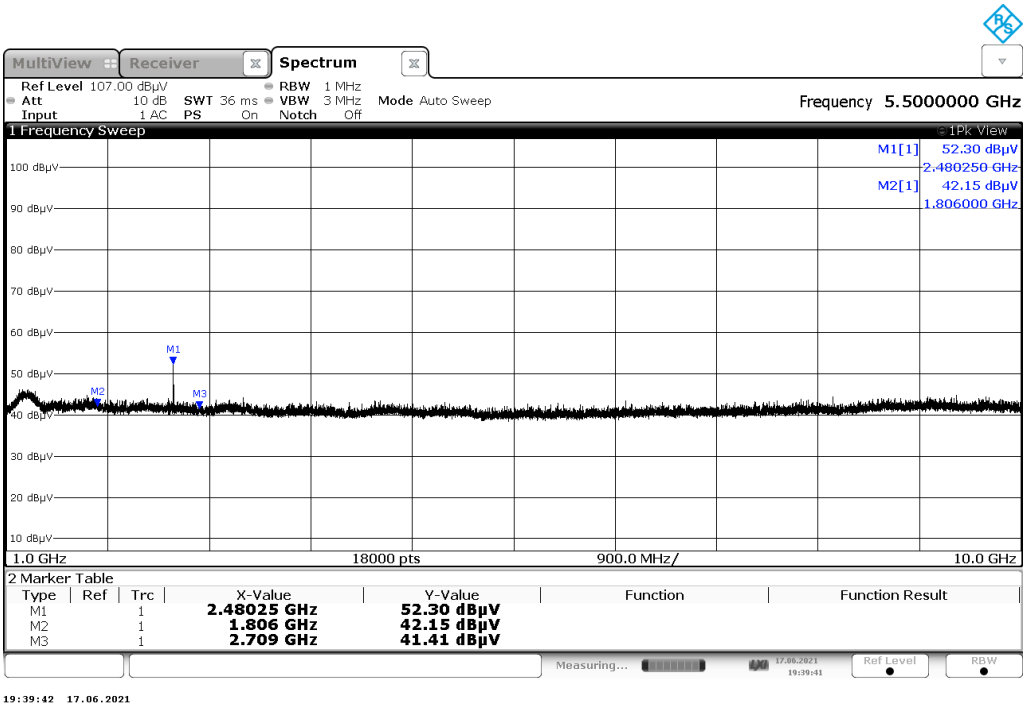


Figure A-4: Radiated Emissions – 1GHz-10GHz
Note: Only emissions within restricted bands were evaluated. Emission within 2.4GHz is ambient noise and not associated with the EUT.

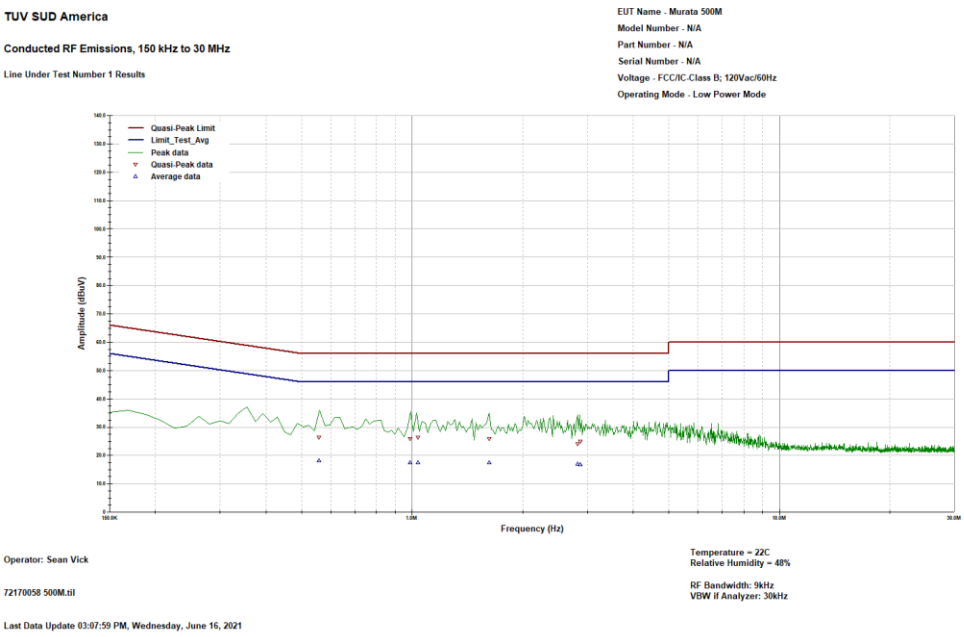


Figure A-5: Conducted Emissions – Line 1

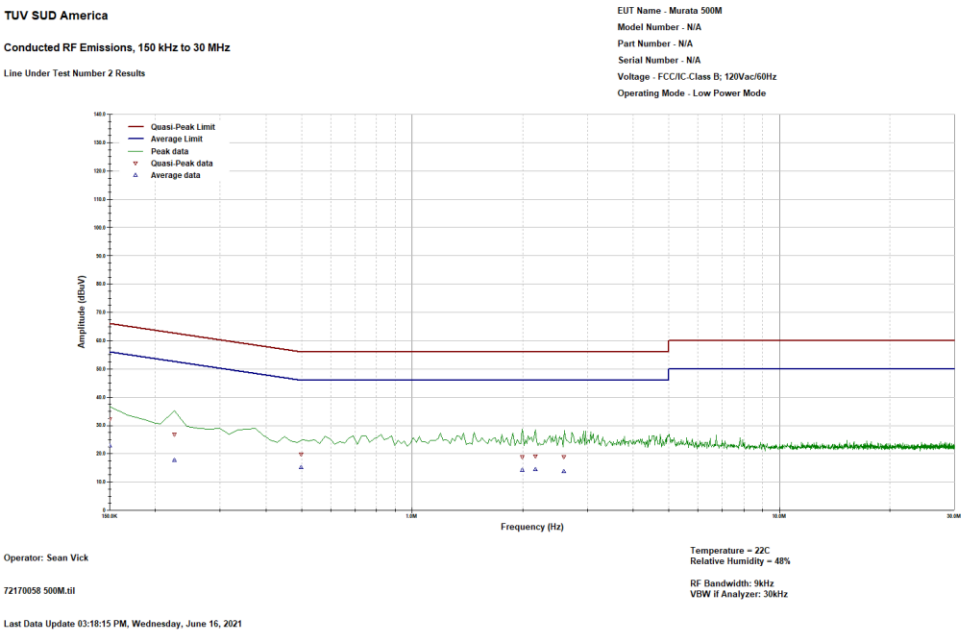


Figure A-6: Conducted Emissions – Neutral

END REPORT