



Certification Test Report

**FCC ID: HSW-2410NF
IC: 4492A-2410NF**

FCC Rule Part: 15.247

Report Number: AT72157466-1P2

**Manufacturer: Murata Electronics North America
Model: WIT2410NF**

**Test Begin Date: March 16, 2020
Test End Date: March 27, 2020**

Report Issue Date: May 6, 2020



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.

Prepared By:

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This report contains 19 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 ISED Canada's Radio Standards Specification RSS-247 for a Class II Permissive Change.

The purpose of this Class II Permissive Change is to add a new antenna.

1.2 Product description

The WIT2410NF is a 2.4 GHz frequency hopping transceiver.

Technical Details:

Detail	Description
Frequency Range	2401.6896 – 2469.888 MHz
Number of Channels	75
Channel Spacing	921.6 kHz
Modulation Format	FSK
Data Rates	460 kbps
Operating Voltage	12Vdc
Antenna Type(s) / Gain(s)	Corner Reflector / 12dBi

Manufacturer Information:

Murata Electronics North America
2200 Lake Park Drive
Smyrna, GA 30080

Test Sample Serial Number: 1916200313

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

1.3 Test Methodology and Considerations

All modes of operation, including all available data rates, were evaluated. The data presented in this report represents the worst case where applicable.

For radiated emissions, the EUT was programmed to generate a continuously modulated signal on each channel evaluated.

Software power setting during test: Not set in software

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 tests 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.

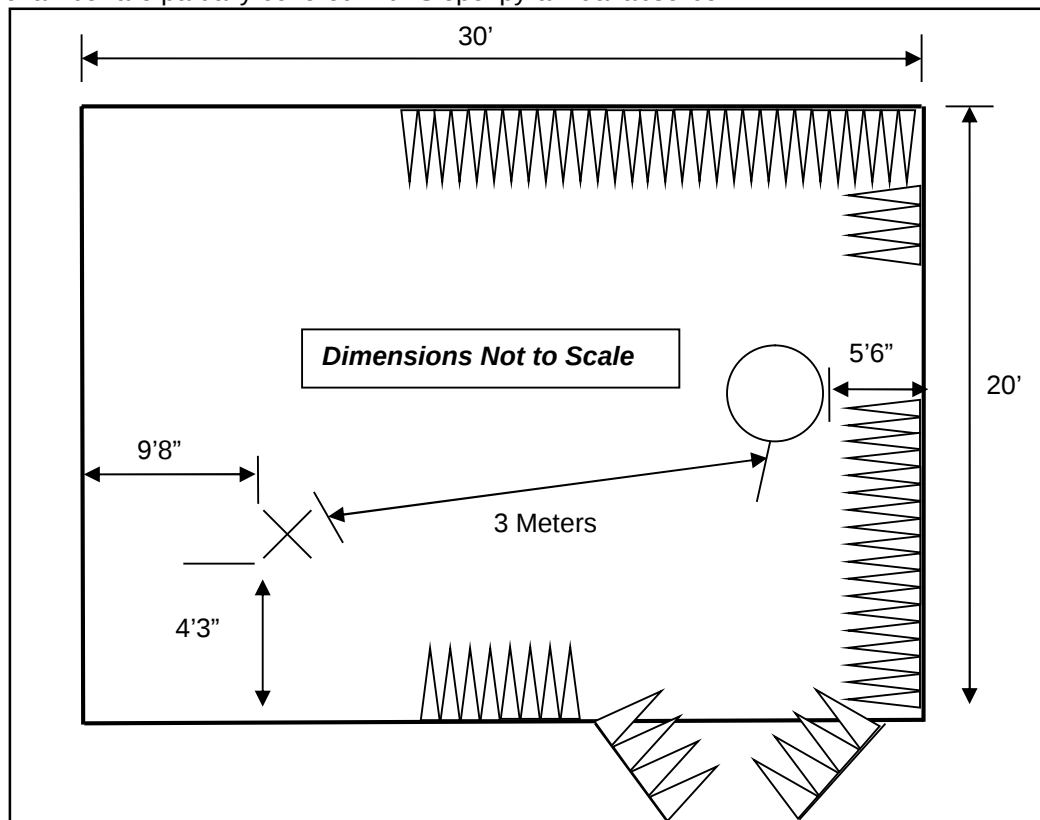


Figure 2.3.1-1: Semi-Anechoic Chamber Test Site – Chamber A

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.

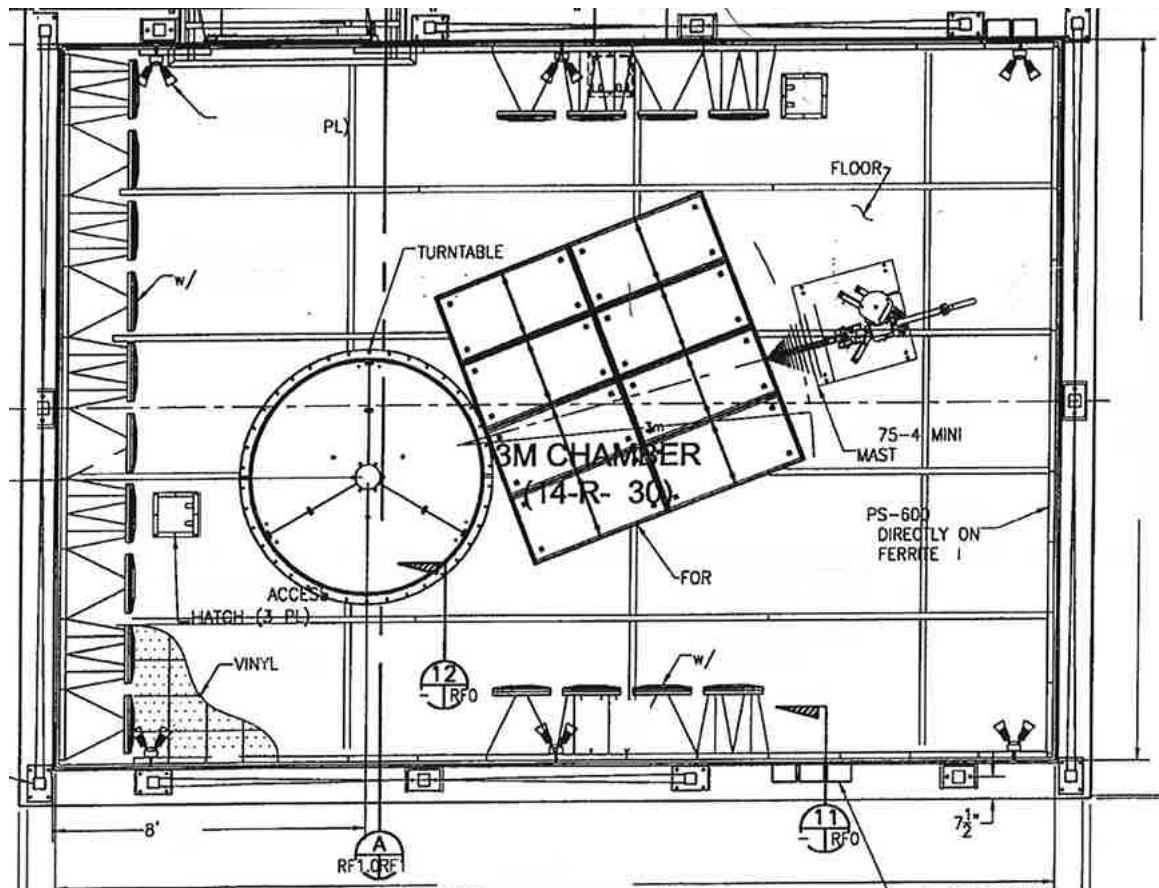


Figure 2.3.2-1: Semi-Anechoic Chamber Test Site – Chamber B

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 HCP 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 table top and floor standing equipment in accordance with section 6.1.4 of ANSI C63.10.

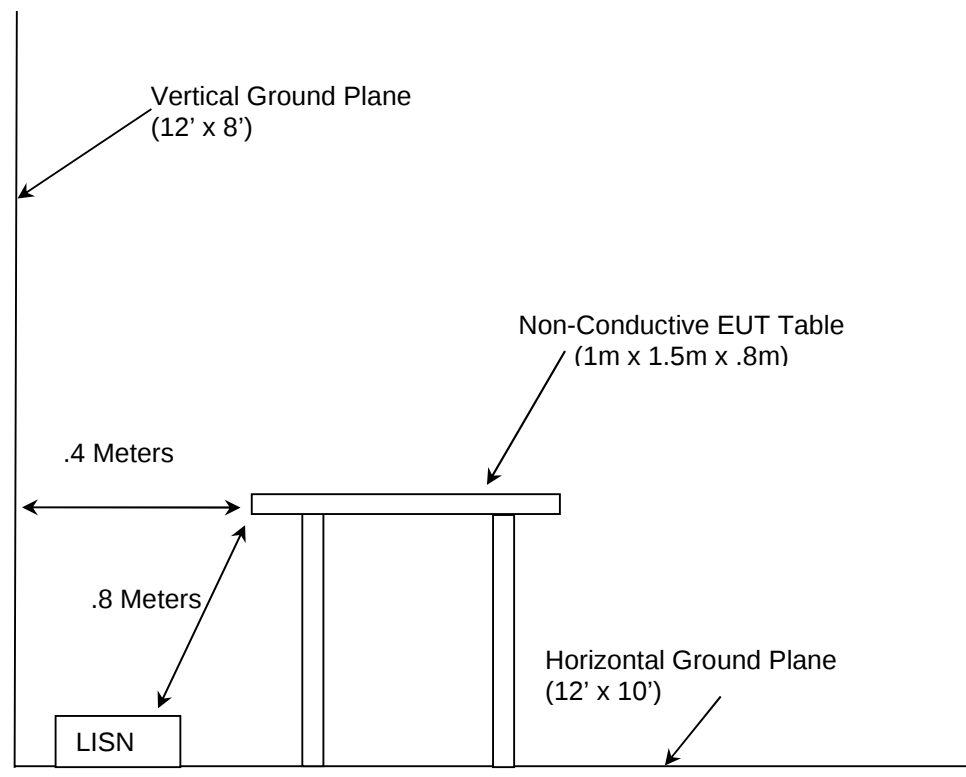


Figure 2.4.1-1: AC Mains Conducted EMI Site

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, 2020
- ❖ US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2020
- ❖ FCC KDB 558074 D01 DTS Meas Guidance v05r02 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247, April 2, 2019
- ❖ ISED Canada Radio Standards Specification: RSS-247 – Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices, Issue 2, February 2017.
- ❖ ISED Canada Radio Standards Specification: RSS-GEN – General Requirements for Compliance of Radio Apparatus, Issue 5, April 2018 + Amendment 1, March 2019

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
213	TEC	PA 102	Amplifier	44927	07/22/2019	07/22/2020
324	ACS	Belden	Conducted EMI Cable	8214	03/19/2019	03/19/2020
335	Suhner	SF-102A	Cable (40GHz)	882/2A	07/08/2019	07/08/2020
338	Hewlett Packard	8449B	High Frequency Pre-Amp	3008A01111	07/15/2019	07/15/2021
345	Suhner Sucoflex	102A	Cable 42(GHz)	1077/2A	07/09/2019	07/09/2020
432	Microwave Circuits	H3G020G4	Highpass Filter	264066	05/31/2019	05/31/2020
628	EMCO	6502	Active Loop Antenna 10kHz-30MHz	9407-2877	02/11/2019	11/02/2021
651	Rohde & Schwarz	TS-PR26	18GHz to 26.5GHz Pre-Amplifier	100023	07/10/2019	07/10/2020
652	Rohde & Schwarz	3160-09	High Frequency Antenna 18GHz to 26.5GHz	060922-21894	NCR	NCR
819	Rohde & Schwarz	ESR26	EMI Test Receiver	101345	11/1/2018	05/01/2020
836	ETS Lindgren	SAC Cable Set	SAC Cable Set includes 620, 837, 838	N/A	05/01/2019	05/01/2020
853	Teseq	CBL 6112D; 6804.17.A	Bilog Antenna; Attenuator	51616; 20181110A	10/15/2018	10/15/2020
857	ETS Lindgren	3117	Horn Antenna 1-18GHz	00153608	11/12/2019	11/12/2021
872	Agilent	E7402A	EMC Spectrum Analyzer	US40240258	05/09/2019	05/09/2020
3010	Rohde & Schwarz	ENV216	Two-Line V-Network	3010	07/10/2019	07/10/2020
RE880	Rhode & Schwarz USA	Test Receiver	R&S ESW44	1206247	11/06/2019	11/6/2020

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

5 SUPPORT EQUIPMENT

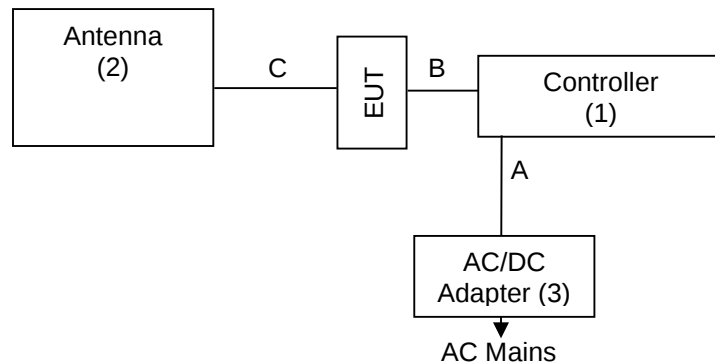
Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model/Part Number	Serial Number
1	Evaluation Board	Digital Wireless Corp	WIT2410E Power and Interface Board	Not Labeled
2	Corner Reflector	Invivo Corp	SCR12-2400	453564287801
3	AC/DC Adapter	Globtek, Inc	GT-41052-1509	Not Labeled

Table 5-2: Cable Description

Cable	Cable Type	Length	Shield	Termination
A	DC Power Cable	2.0m	No	1 - 3
B	Ribbon	0.1m	No	1 - EUT
C	Coax	1.0m	Coax	EUT - 2

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: Section 15.203

The EUT utilizes an MMCX connector therefore satisfying the requirements of Section 15.203.

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

7.2.1 Measurement Procedure

ANSI C63.10 was the guiding document 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: Tyler Leeson

Table 7.2.2-1: Conducted EMI Results – Line 1

Frequency (MHz)	Corrected Reading		Limit		Margin		Correction (dB)
	Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average	
	(dBμV)	(dBμV)	(dBμV)	(dBμV)	(dB)	(dB)	
0.15	36.16	20.86	45.76	30.46	66.00	56.00	9.60
0.2097	27.71	13.79	37.31	23.39	63.22	53.22	9.60
0.2921	23.19	13.7	32.81	23.32	60.46	50.46	9.62
0.3959	23.4	19.53	33.04	29.17	57.94	47.94	9.64
0.8231743	15.54	10.32	25.28	20.06	56.00	46.00	9.74
3.77675	12.65	6.8	22.63	16.78	56.00	46.00	9.98

Table 7.2.2-2: Conducted EMI Results –Line 2

Frequency (MHz)	Corrected Reading		Limit		Margin		Correction (dB)
	Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average	
	(dB μ V)	(dB μ V)	(dB μ V)	(dB μ V)	(dB)	(dB)	
0.164925	30.06	17.31	39.69	26.94	65.21	55.21	9.63
0.1963073	30.83	19.34	40.45	28.96	63.77	53.77	9.62
0.2535478	24.8	13.19	34.42	22.81	61.64	51.64	9.62
0.3132	24.75	18.86	34.38	28.49	59.89	49.89	9.63
0.6895	18.75	14.67	28.45	24.37	56.00	46.00	9.70
2.297	13.52	7.74	23.34	17.56	56.00	46.00	9.82

7.3 Radiated Spurious Emissions – FCC: Section 15.205, 15.209; ISED Canada: RSS-Gen 8.9/8.10

7.3.1.1 Measurement Procedure

Radiated emissions tests were made over the frequency range of 9kHz to 25GHz, 10 times the highest fundamental frequency.

The EUT was rotated through 360° and the receive antenna height was varied from 1 meter to 4 meters 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 120 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000 MHz, peak and average measurements were made with RBW and VBW of 1 MHz and 3 MHz respectively.

The EUT was caused to generate a continuous modulated carrier on the hopping channel.

Each emission found to be in a restricted band was compared to the applicable radiated emission limits.

Radiated spurious emissions were evaluated for all combinations of operating modes and data rates with worst case data provided. Emissions not reported were below the noise floor of the measurement system. Peak data below 30MHz was more than 20dB below the applicable limits.

7.3.1.2 Average Measurement Duty Cycle Correction Factor

For average radiated emissions measurements, the measured level was reduced by a factor of 25.10 dB to account for the duty cycle of the EUT. The worst-case duty cycle was applied from the original certification of the EUT.

7.3.1.3 Measurement Results

Performed by: Jeremy Pickens

Table 7.4.1.2-1: Radiated Spurious Emissions Tabulated Data

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
2401.6896 MHz										
1200.845	55.4	51.1	H	-8.29	47.11	17.71	74.0	54.0	26.9	36.3
1200.845	53.3	47.8	V	-8.29	45.01	14.41	74.0	54.0	29.0	39.6
2390	47.7	33.4	H	-1.17	46.53	7.13	74.0	54.0	27.5	46.9
2390	61.7	39.6	V	-1.17	60.53	13.33	74.0	54.0	13.5	40.7
4803.3792	61.9	53.1	H	3.86	65.76	31.87	74.0	54.0	8.2	22.1
4803.3792	58.9	51.6	V	3.86	62.76	30.37	74.0	54.0	11.2	23.6
7205.0688	63.1	56.6	H	7.34	70.44	38.84	74.0	54.0	3.6	15.2
7205.0688	58.8	51.5	V	7.34	66.14	33.74	74.0	54.0	7.9	20.3
2435.788 MHz										
1217.894	53.90	48.70	H	-8.21	45.69	15.39	74.0	54.0	28.3	38.6
1217.894	54.4	49.3	V	-8.21	46.19	15.99	74.0	54.0	27.8	38.0
4871.5776	65.4	56.7	H	3.91	69.31	35.51	74.0	54.0	4.7	18.5
4871.5776	65.7	57.3	V	3.91	69.61	36.11	74.0	54.0	4.4	17.9
7307.3664	63	55.2	H	7.45	70.45	37.55	74.0	54.0	3.5	16.4
7307.3664	60	52.1	V	7.45	67.45	34.45	74.0	54.0	6.5	19.5
2469.888 MHz										
1234.944	56.80	53.30	H	-8.13	48.67	20.07	74.0	54.0	25.3	33.9
1234.944	55.90	51.60	V	-8.13	47.77	18.37	74.0	54.0	26.2	35.6
2483.5	56.90	43.10	H	-0.96	55.94	17.04	74.0	54.0	18.1	37.0
2483.5	58.90	43.90	V	-0.96	57.94	17.84	74.0	54.0	16.1	36.2
4939.776	68.30	57.50	H	3.95	72.25	36.35	74.0	54.0	1.8	17.7
4939.776	66.80	56.50	V	3.95	70.75	35.35	74.0	54.0	3.3	18.7
7409.664	62.50	54.10	H	7.56	70.06	36.56	74.0	54.0	3.9	17.4
7409.664	57.60	51.90	V	7.56	65.16	34.36	74.0	54.0	8.8	19.6

7.3.1.4 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: Peak

Corrected Level: $68.3 - 3.95 = 72.25\text{dBuV/m}$

Margin: $74\text{dBuV/m} - 72.25\text{dBuV/m} = 1.8\text{dB}$

Example Calculation: Average

Corrected Level: $57.5 - 3.95 - 25.10 = 36.35\text{dBuV}$

Margin: $54\text{dBuV} - 36.35\text{dBuV} = 17.7\text{dB}$

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%.

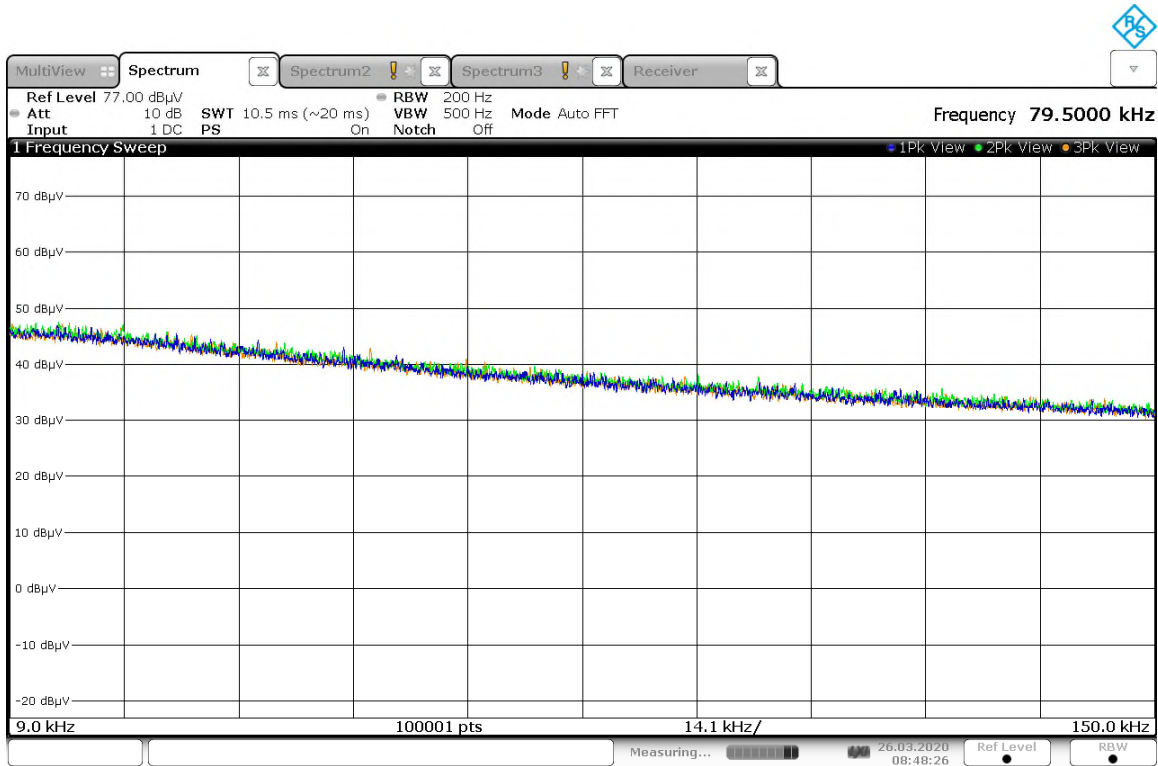
Table 8-1: Estimation of Measurement Uncertainty

Parameter	U_{lab}
Occupied Channel Bandwidth	$\pm 0.009 \%$
RF Conducted Output Power	$\pm 0.349 \text{ dB}$
Power Spectral Density	$\pm 0.372 \text{ dB}$
Antenna Port Conducted Emissions	$\pm 1.264 \text{ dB}$
Radiated Emissions $\leq 1 \text{ GHz}$	$\pm 5.814 \text{ dB}$
Radiated Emissions $> 1 \text{ GHz}$	$\pm 4.318 \text{ dB}$
Temperature	$\pm 0.860 \text{ }^\circ\text{C}$
Radio Frequency	$\pm 2.832 \times 10^{-8}$
AC Power Line Conducted Emissions	$\pm 3.360 \text{ dB}$

9 CONCLUSION

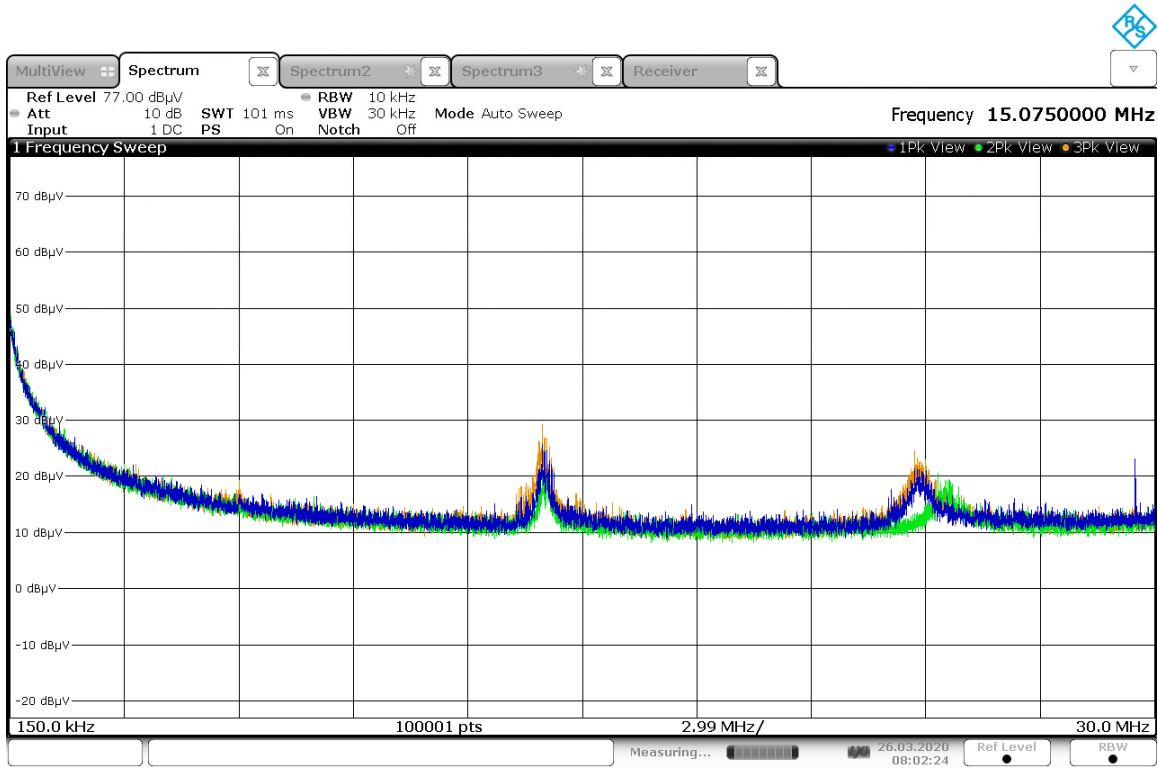
In the opinion of TÜV SÜD America, Inc. the WIT2410NF, manufactured by Murata Electronics North America meets the requirements of FCC Part 15 subpart C and ISED Canada's Radio Standards Specification RSS-247 for the tests documented herein.

Appendix A: Plots



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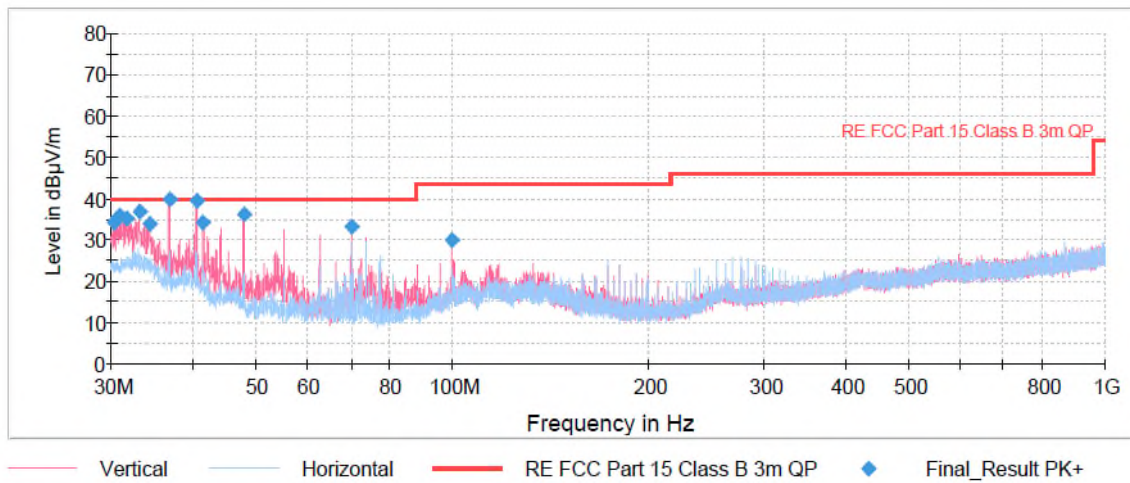
Figure A-1: 9kHz-150kHz



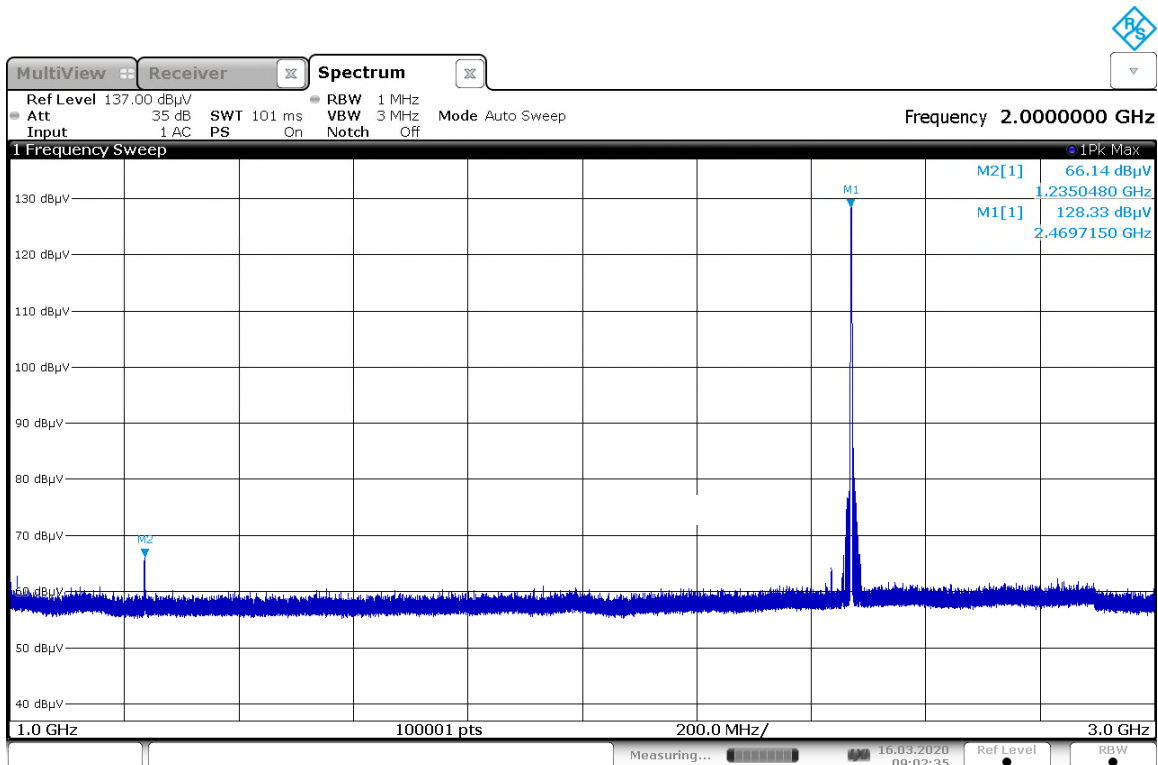
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Note: Emissions above the noise floor are not associated with the DUT.

Figure A-2: 150kHz-30MHz

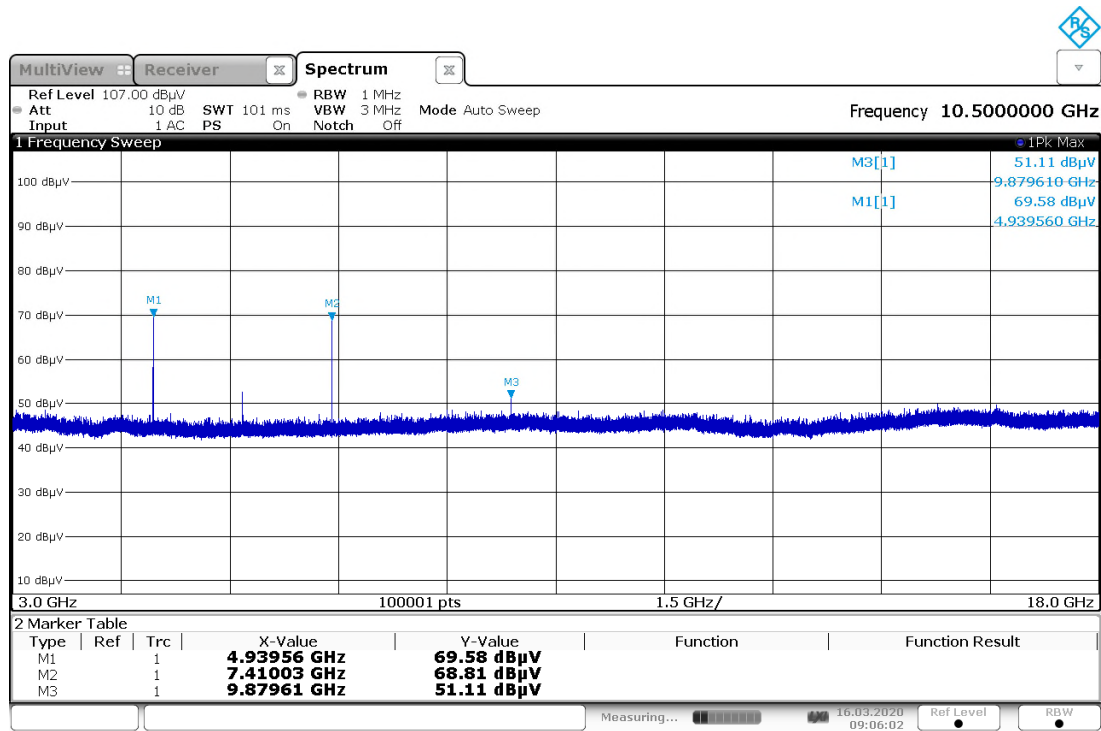


Note: Emissions above the noise floor are from the digital sections of the DUT and not associated with the radio.
Figure A-3: 30MHz-1GHz



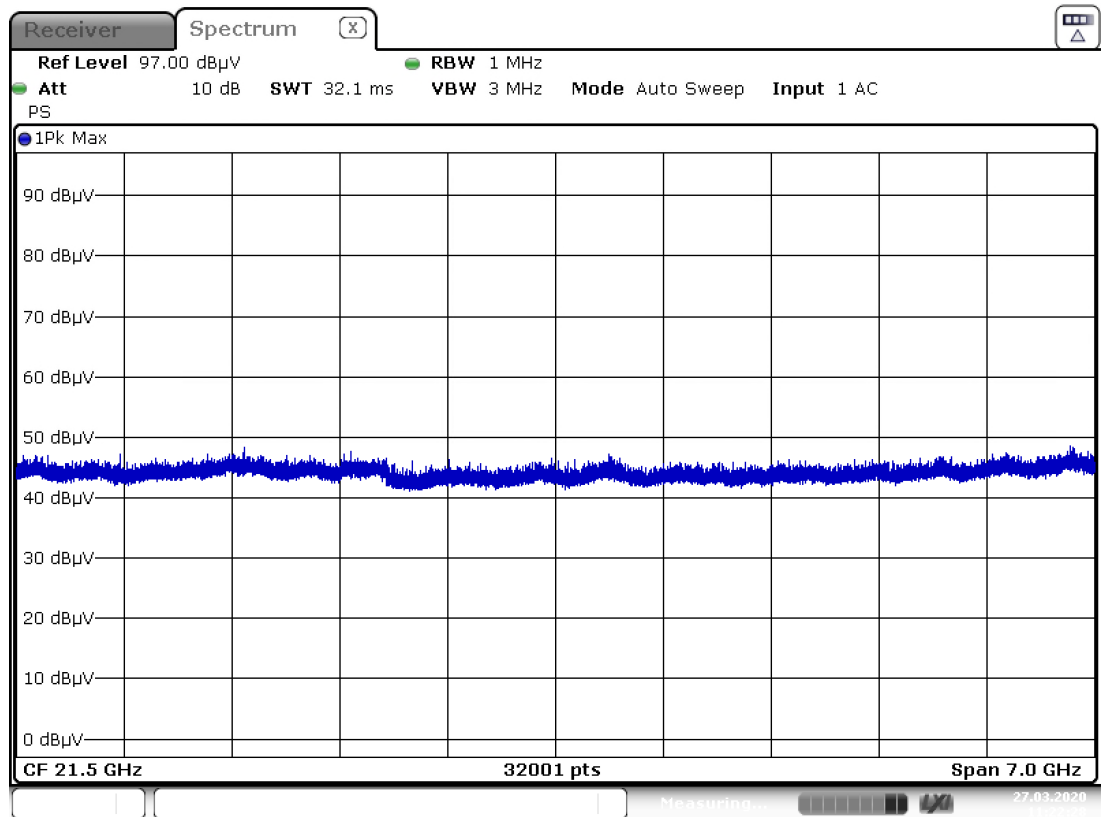
09:02:36 16.03.2020

Note: Emission at 1.235GHz are ambient and unassociated from the radio.
Figure A-4: 1GHz-3GHz



09:06:02 16.03.2020

Figure A-5: 3GHz-18GHz



Date: 27.MAR.2020 11:22:28

Figure A-6: 18GHz-25GHz

END REPORT