Test Report

FCC ID: 2ADCB-RMODIT3
IC: 6715C-RMODIT3

FCC Rule Part: 15.247
ISED Canada Radio Standards Specification: RSS-247

Report Number: AT72166602-1P0

Manufacturer: Acuity Brands Lighting Inc.
Model: rMODIT3

Test Begin Date: April 5, 2021
Test End Date: May 03, 2021

Report Issue Date: May 11, 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.

Prepared By:

Divya Adusumilli
Senior Wireless Engineer

TÜV SÜD America Inc.

Reviewed by:

Kirby Munroe
Wireless / EMC Technical and Certification Manager, North America
TÜV SÜD America Inc.

This report contains 29 pages

TABLE OF CONTENTS

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-247 for the tests documented herein for a Class II Permissive Change.

The purpose of this Permissive Change is to add an additional data rate of 250kbps.

1.2 Applicant Information

Acuity Brands Lighting Inc.
1 Acuity Way
Decatur, GA 30035

1.3 Product Description

rMODIT3 is the next generation nLight Air radio module that will be used on all nLight Air products. The module includes a 915MHz proprietary radio as well as a 2.4GHz BLE radio. This report addresses the 915MHz proprietary radio only.

Technical Details:

Detail	Description
Frequency Range (MHz)	904 – 926MHz
Number of Channels	12
Modulation Format	OQPSK- DSSS
Data Rates	100kbps, 250kbps
Operating Voltage	3.3Vdc
Antenna Type(s) / Gain(s)	Dual band Monopole / 1.5dBi

Test Sample Serial Number(s): Not Labeled

Test Sample Condition: The equipment was provided in good condition without any physical damage.

1.4 Test Methodology and Considerations

The module was tested using representative Dual Band Monopole Antenna assuming as a worst case from the original filing.

Software was provided by the customer to configure the device power, channel, and modulation.

Only those parameters which showed degradation were evaluated in full (e.g. 20dB BW / 99% OBW). All other parameters were limited in evaluation to show no degradation.

For radiated emissions, the EUT was evaluated in the worst-case axis which is in Y-orientation.

For antenna port conducted emissions, an SMA pigtail was used to directly connect the DUT to the measuring equipment through suitable attenuation.

Power level setting for 915MHz radio during test:200

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
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.

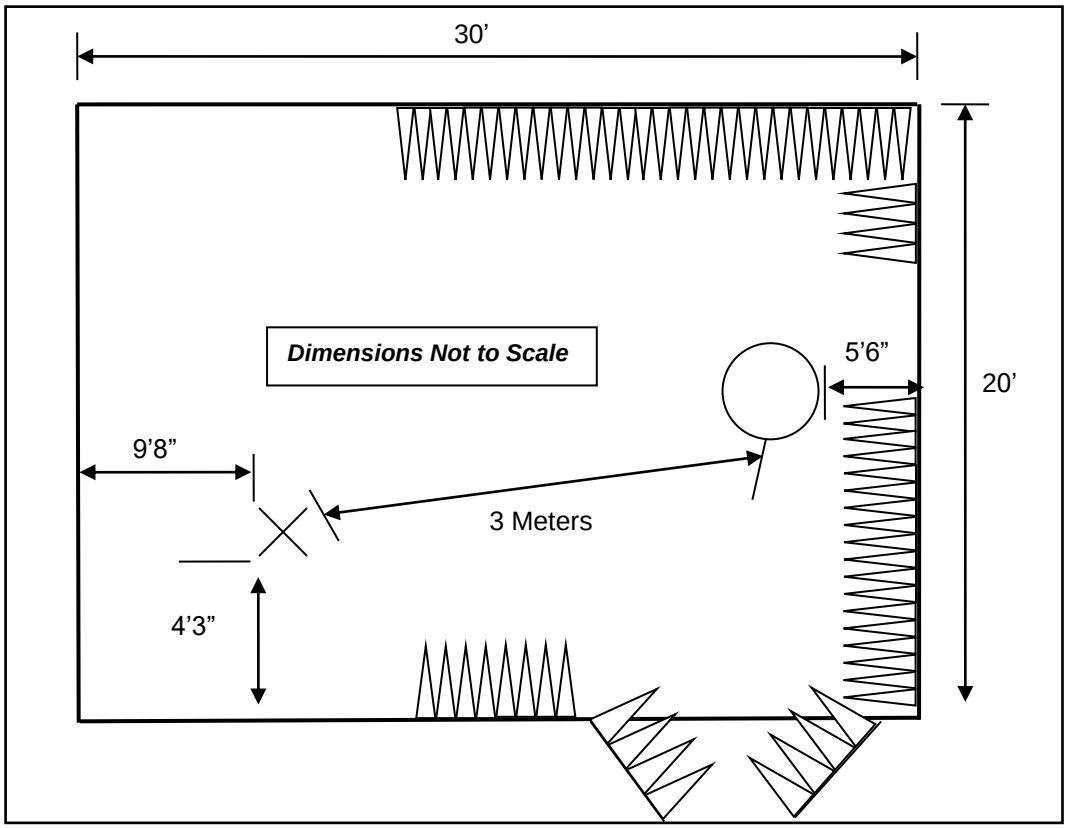


Figure 2.3.1-1: Semi-Anechoic Chamber Test Site – Chamber A

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.

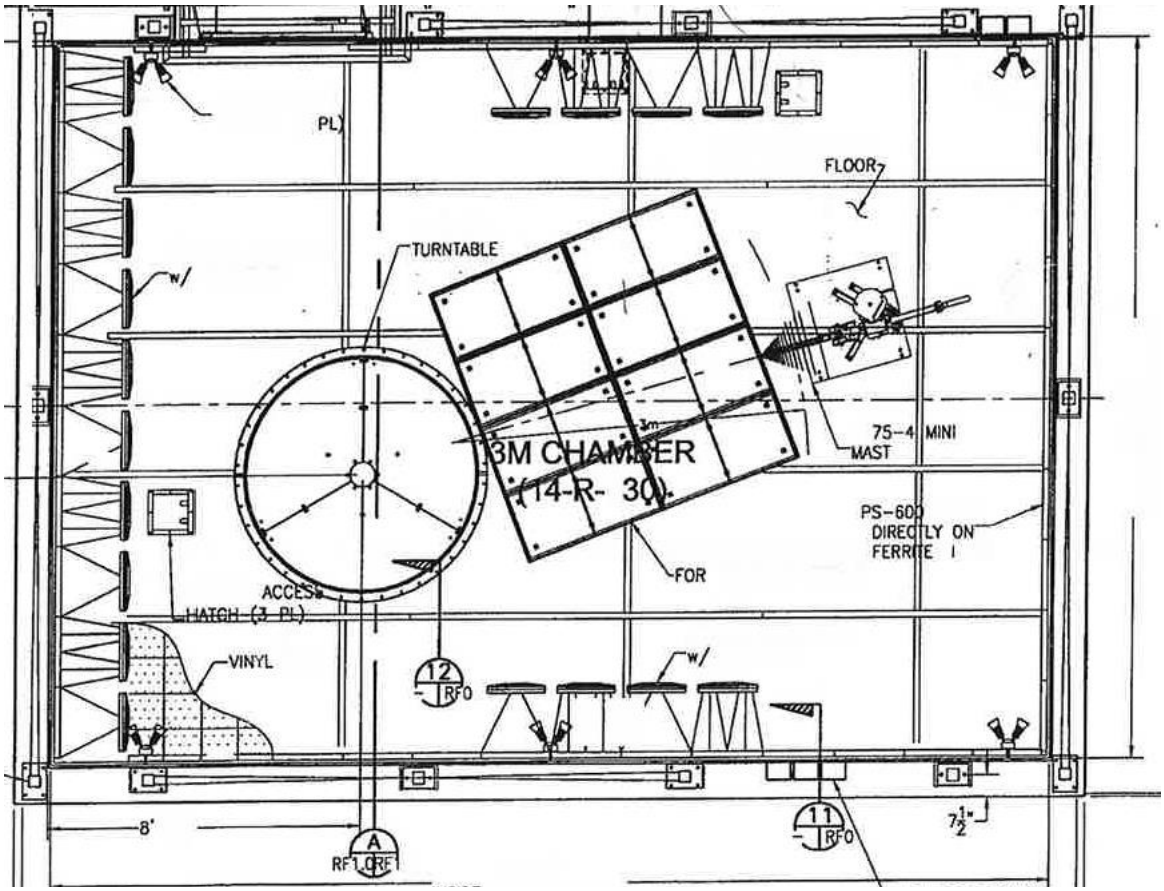


Figure 2.3.2-1: Semi-Anechoic Chamber Test Site – Chamber B

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.

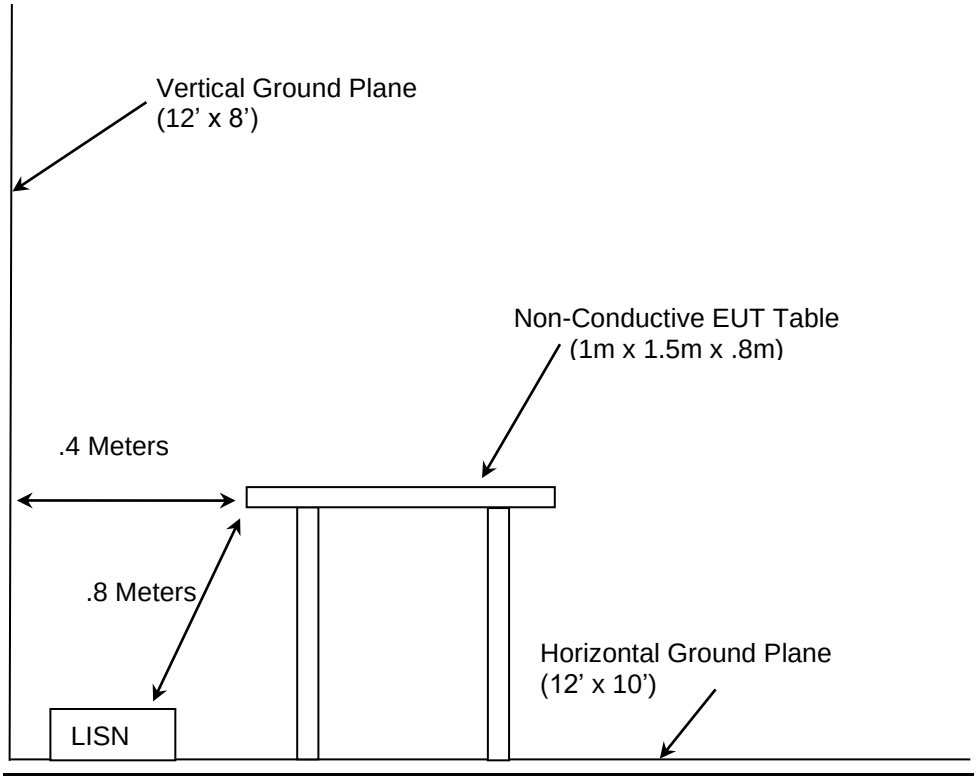


Figure 2.4.1-1: AC Mains Conducted EMI Site

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, 2020
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2020
- FCC KDB 558074 D01 15.247 Measure Guidance v05r02 – Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under Section 15.247 of the FCC Rules, April 2, 2019
- ISED Canada Radio Standards Specification: RSS-247 – Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-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, 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
813	PMM	9010	EMI Receiver; RF Input 50ohm; 10Hz-50MHz; 10Hz-30MHz	697WW30606	03/03/2020	06/03/2021
324	ACS	Belden	Conducted EMI Cable	8214	3/2/2021	3/2/2022
3010	Rohde & Schwarz	ENV216	Two-Line V-Network	3010	06/23/2020	06/23/2021
827	TUV SUD	TS8997 Rack Cable Set	TS8997 Rack Cable Set	N/A	09/04/2020	09/04/2021
622	Rohde & Schwarz	FSV40 (v3.40)	FSV Signal Analyzer 10Hz to 40GHz	101338	08/24/2020	08/24/2021
857	ETS Lindgren	3117	Horn Antenna 1-18GHz	00153608	11/12/2019	11/12/2021
321	Hewlett Packard	HPC 8447D	Low Freq. Pre-Amp	1937A02809	08/10/2020	08/10/2021
22	Hewlett Packard	8449B	High Frequency Pre-Amp	3008A00526	10/19/2020	10/19/2021
628	EMCO	6502	Active Loop Antenna 10kHz-30MHz	9407-2877	02/11/2019	05/11/2021
3161	Teseq;Huber + Suhner	CBL6112D;6804-17-A	Bilog Antenna; Attenuator	51323;01252019A	3/19/2021	3/19/2022
882	Rohde & Schwarz	ESW44	ESW44 EMI TEST RECEIVER	101961	07/28/2020	07/28/2021
292	Florida RF Cables	SMR-290AW-480.0-SMR	High Freq. Cables	None	NCR	NCR

NCR = No Calibration Required
NOTE: All test equipment was used only during active calibration cycles as reported above.

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number
1	EUT	Acuity Brands Lighting Inc.	rMODIT3	29B4
2	Wall wart	XP	VEL05US050-US-JA	N/A
3	EUT	Acuity Brands Lighting Inc.	rMODIT3	N/A
4	Interface board	Silicon Labs	BRD 4001A Rev.A01	N/A
5	TUV SUD Test Laptop	DELL	N/A	N/A

Notes:1. Item 1 & 2 are used for Radiated Emission and Conducted Emission Testing.
2. Item 3 ,4 & 5 are used for Antenna Port Conducted Measurements.

Table 5-2: Cable Description

Item	Cable Type	Length	Shield
A	DC Power Cable	1.5m	No
B	Data Cable	0.5m	No
C	USB Type C Cable	1.5m	No

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

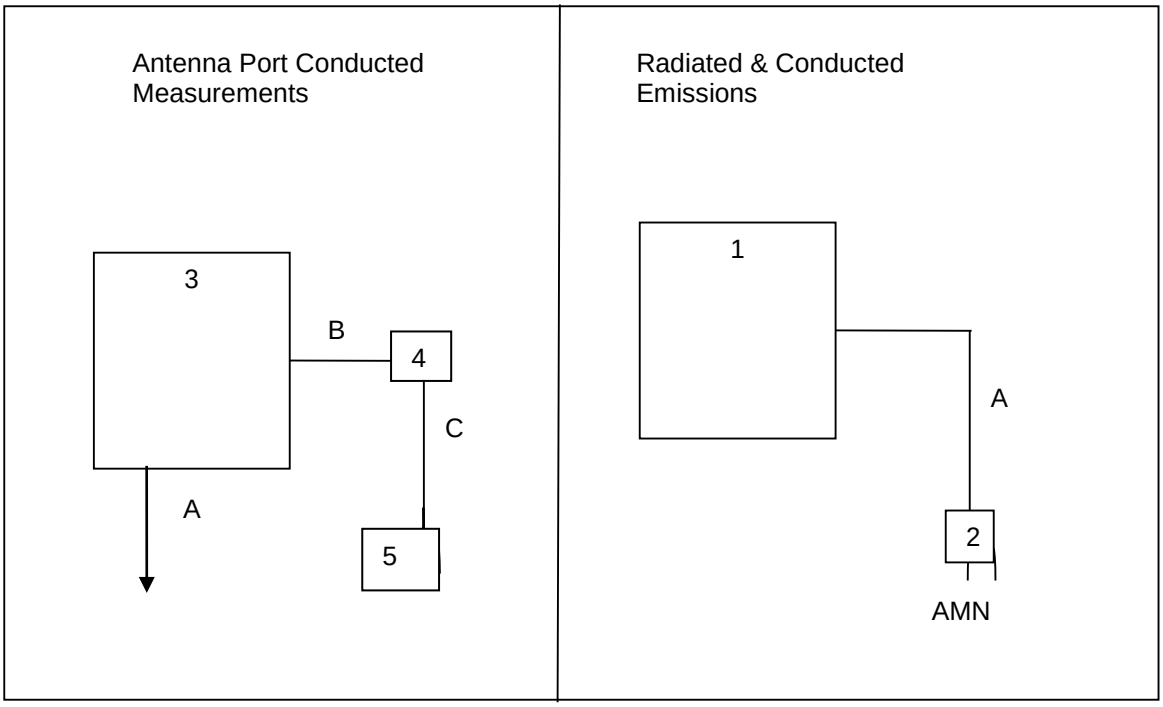


Figure 6-1: Test Setup Block Diagram

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 Dual band Monopole Antenna which is internal to the device and cannot be removed or replaced by the end user.

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

7.2.1 Measurement Procedure

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 – 120VAC/60Hz – 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	30.94	22.19	66	56	-35.06	-33.81	9.68
0.158	31.84	13.21	65.57	55.57	-33.73	-42.36	9.68
0.182	30.78	12.37	64.39	54.39	-33.61	-42.02	9.68
0.202	29.47	10.59	63.53	53.53	-34.06	-42.94	9.67
2.266	25.76	10.71	56	46	-30.24	-35.29	9.78
2.534	27.22	12.07	56	46	-28.78	-33.93	9.79
2.658	26.79	10.84	56	46	-29.21	-35.16	9.79
2.998	26.5	10.94	56	46	-29.5	-35.06	9.79
7.218	24.35	10.7	60	50	-35.65	-39.3	9.82
29.986	26.95	13.74	60	50	-33.05	-36.26	10.03

Table 7.2.2-2: Conducted EMI Results – 120VAC/60Hz – Line 2

Frequency (MHz)	Corrected Reading		Limit		Margin		Correction (dB)
	Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average	
	(dBµV)	(dBµV)	(dBµV)	(dBµV)	(dB)	(dB)	
0.162	36.1	22.89	65.36	55.36	-29.26	-32.47	9.67
0.182	34.48	22.79	64.39	54.39	-29.91	-31.6	9.67
0.194	35.22	22.71	63.86	53.86	-28.64	-31.15	9.67
0.214	32.61	22.59	63.05	53.05	-30.44	-30.46	9.67
0.234	30.91	22.48	62.31	52.31	-31.4	-29.83	9.67
0.286	30.83	22.41	60.64	50.64	-29.81	-28.23	9.66
0.318	30.81	22.43	59.76	49.76	-28.95	-27.33	9.66
0.35	30.81	22.43	58.96	48.96	-28.15	-26.53	9.65
0.382	30.8	22.42	58.24	48.24	-27.44	-25.82	9.65
29.998	27.23	13.83	60	50	-32.77	-36.17	10.12

7.3 6dB / 99% Bandwidth – FCC: 15.247(a)(2), ISED Canada: RSS-247 5.2(a), RSS-GEN 6.7

7.3.1 Measurement Procedure

The 6dB bandwidth was measured in accordance with the FCC KDB 558074 D01 Section 8.2 which references Subclause 11.8 of ANSI C63.10. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 100 kHz. The Video Bandwidth (VBW) was set to ≥ 3 times the RBW. The trace was set to max hold with a peak detector active. The marker-delta function of the spectrum analyzer was utilized to determine the 6dB 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 from 1% to 5% of the occupied bandwidth and the video bandwidth set to at least 3 times the resolution bandwidth. A peak detector was used.

7.3.2 Measurement Results

Performed by: Divya Adusumilli

Table 7.3.2-1: 6dB / 99% Bandwidth

Modulation	Frequency [MHz]	6dB Bandwidth [MHz]	99% Bandwidth [MHz]
OQPSK-DSSS / 250kbps	904	1.69	2.33
OQPSK-DSSS / 250kbps	914	1.68	2.38
OQPSK-DSSS / 250kbps	926	1.68	2.38

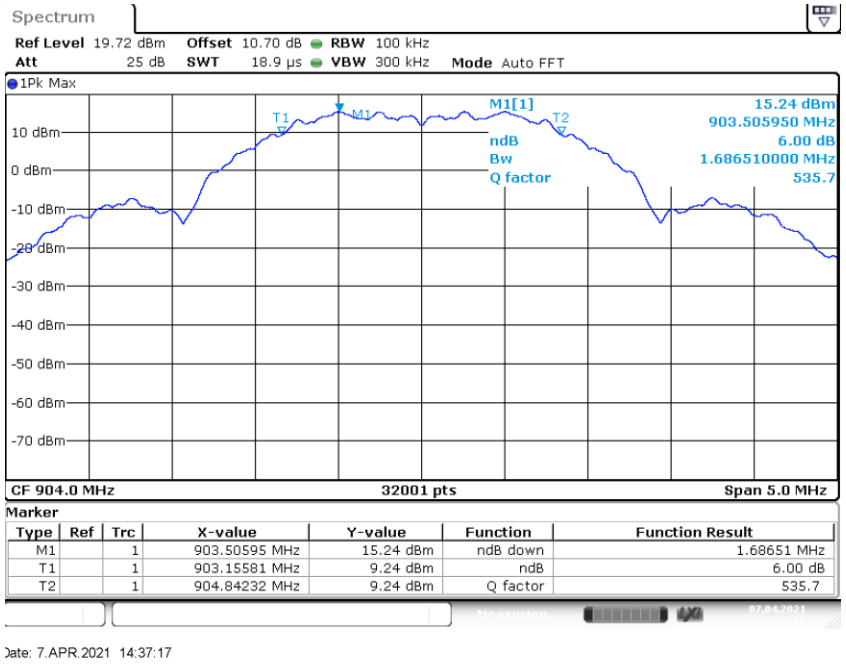


Figure 7.3.2-1: 904MHz LCH - 6dB BW

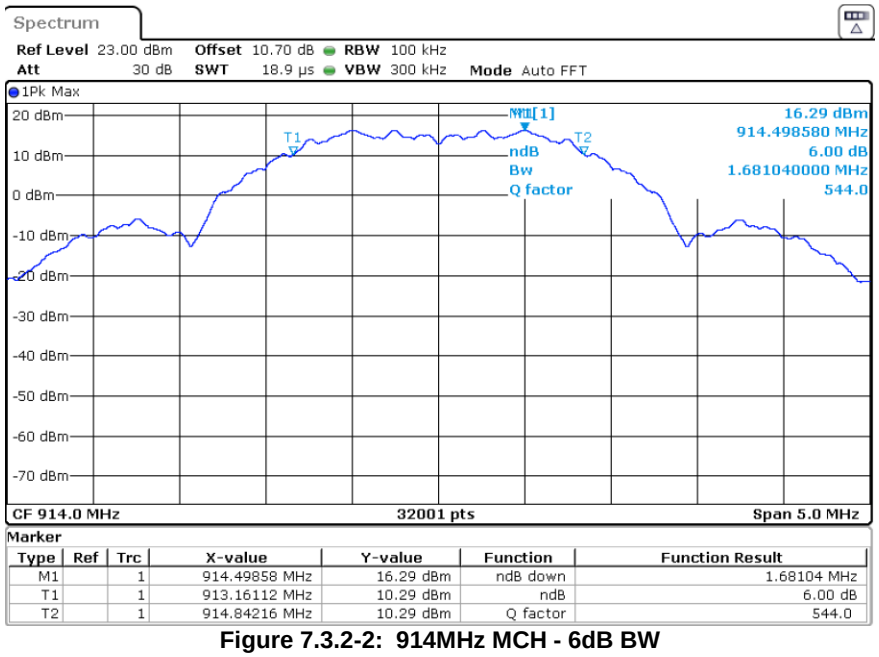


Figure 7.3.2-2: 914MHz MCH - 6dB BW

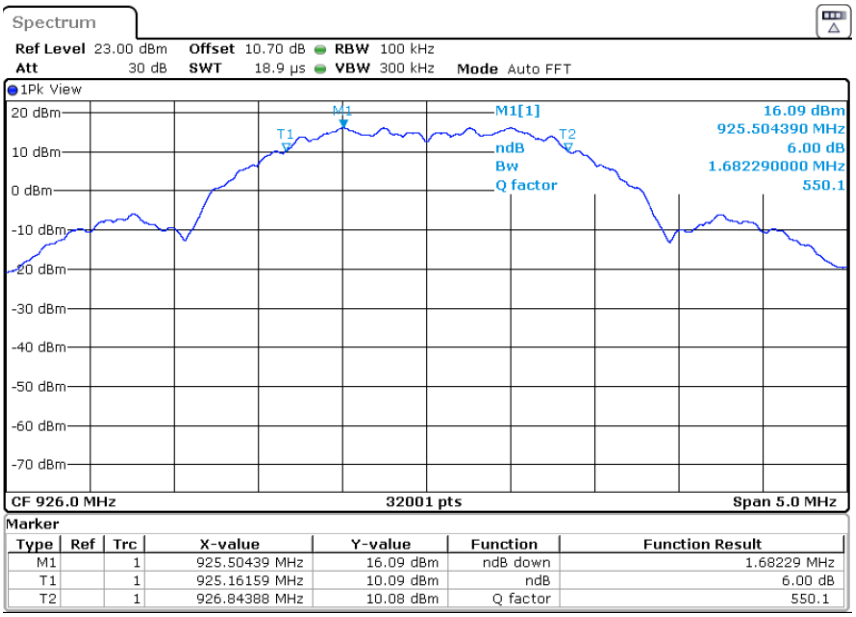


Figure 7.3.2-3: 926MHz HCH - 6dB BW

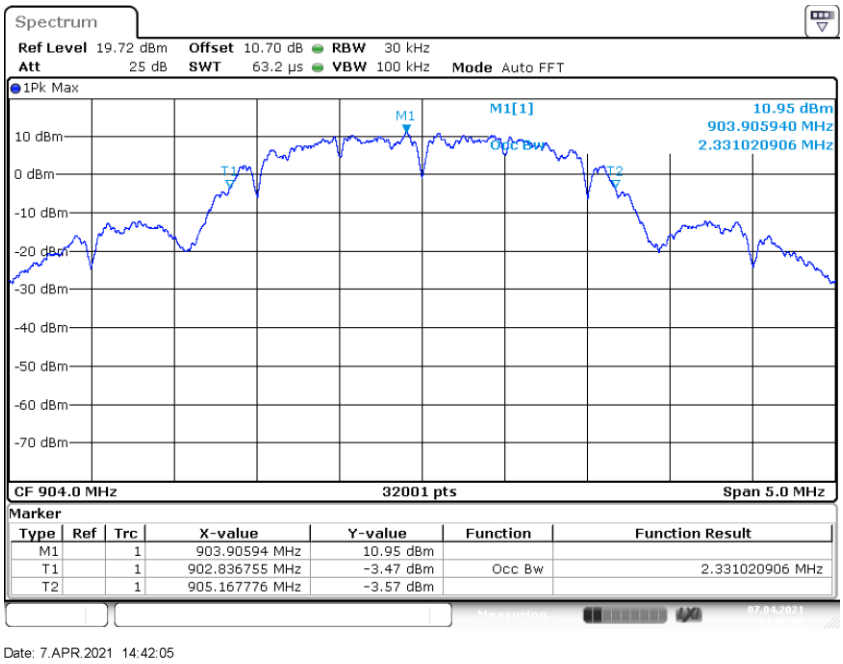


Figure 7.3.2-4: 904MHz LCH – 99% BW

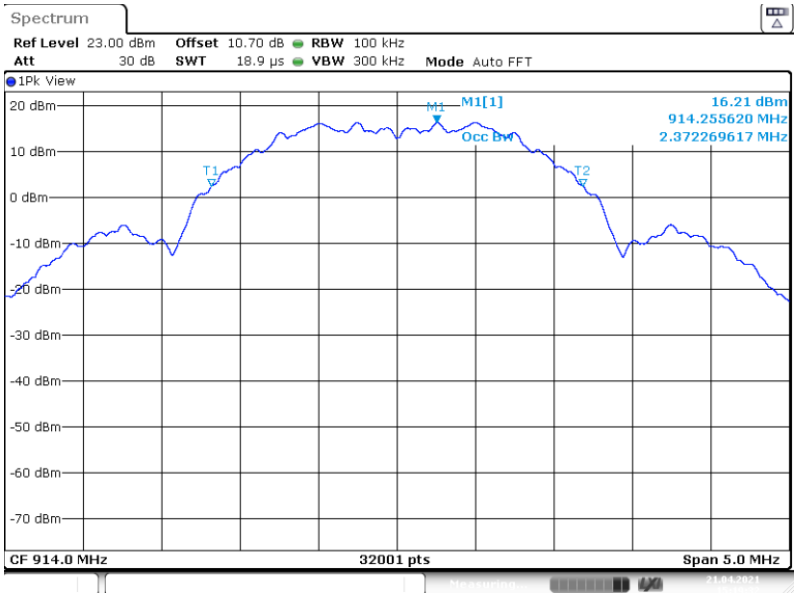


Figure 7.3.2-5: 914MHz MCH – 99% BW

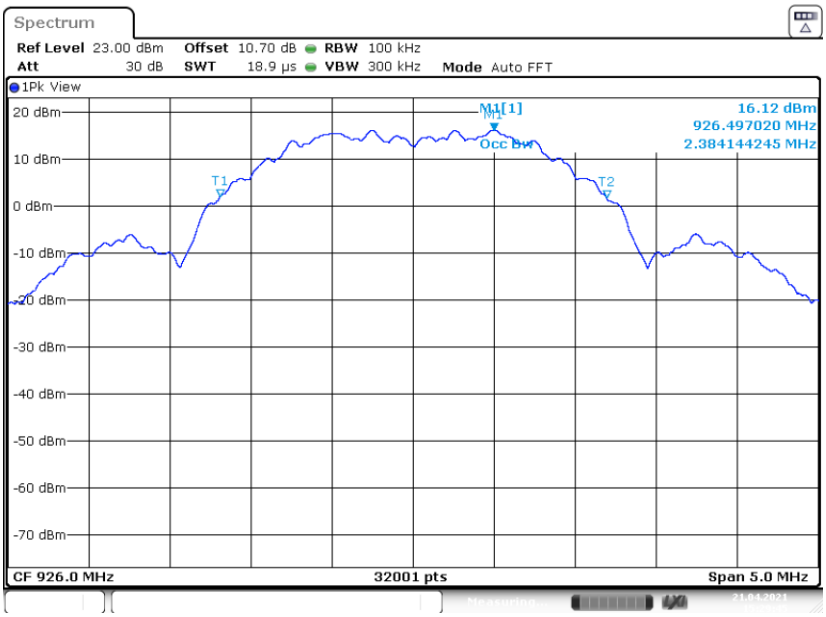


Figure 7.3.2-6: 926MHz HCH – 99% BW

7.4 Fundamental Emission Output Power – FCC: 15.247(b)(3), ISED Canada: RSS-247 5.4(d)

7.4.1 Measurement Procedure

The maximum peak conducted output power was measured in accordance with FCC KDB 558074 D01 15.247 Meas Guidance v05r02 utilizing the PKPM1 Peak power meter method. The RF output of the equipment under test was directly connected to the input of the peak power meter applying suitable attenuation.

7.4.2 Measurement Results

Performed by: Divya Adusumilli

Table 7.4.2-1: Maximum Peak Conducted Output Power

Modulation	Frequency [MHz]	Peak Power [dBm]
OQPSK-DSSS / 250kbps	904	19.27

7.5 Emission Levels

7.5.1 Emissions into Non-restricted Frequency Bands – FCC: 15.247(d); ISED Canada: RSS-247 5.5

7.5.1.1 Measurement Procedure

The unwanted emissions into non-restricted bands were measured conducted in accordance with FCC KDB 558074 D01 Section 8.5. The RF output of the equipment under test was directly connected to the input of the spectrum analyzer applying suitable attenuation. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 100 kHz. The Video Bandwidth (VBW) was set to ≥ 300 kHz. The resulting spectrum analyzer peak level was used to determine the reference level with respect to the 20 dBc limit at the band edges. The spectrum span was then adjusted for the measurement of spurious emissions from 30MHz to 25GHz, 10 times the highest fundamental frequency. The worst-case for each modulation was investigated at the lower and upper band edges.

7.5.1.2 Measurement Results

Performed by: Divya Adusumilli

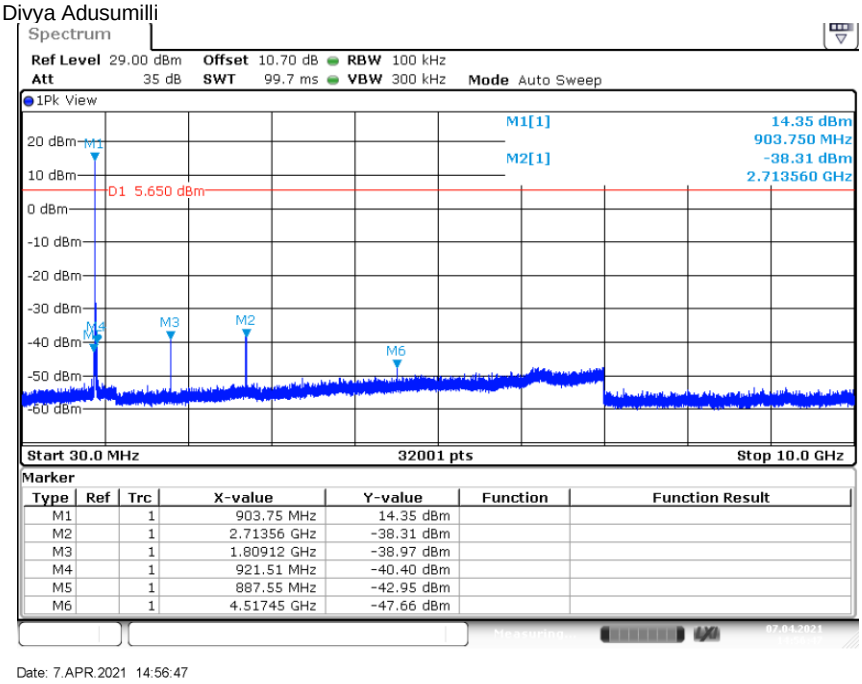


Figure 7.5.1.2-1: 904MHz LCH – 30MHz – 10GHz

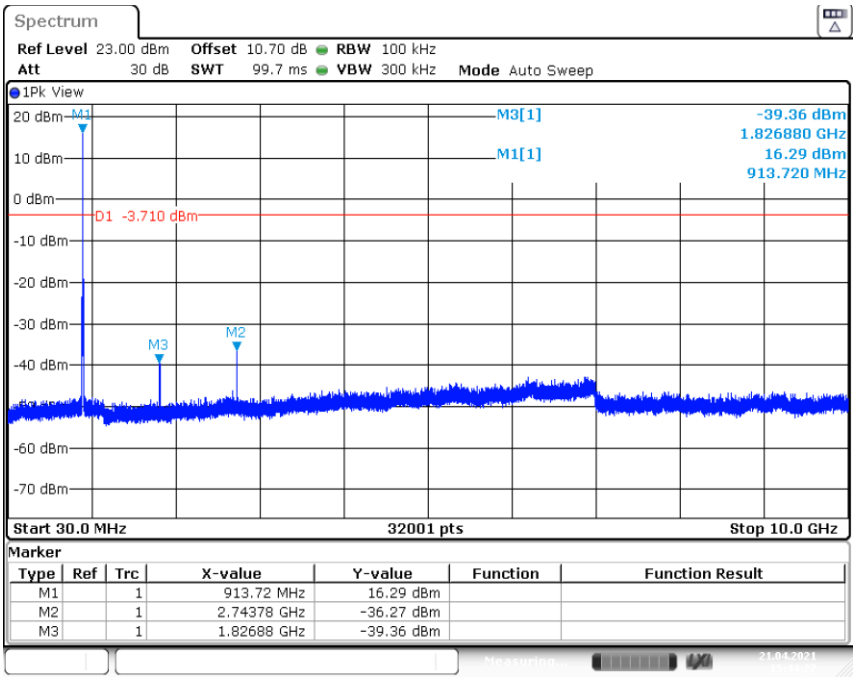


Figure 7.5.1.2-2: 914MHz MCH – 30MHz – 10GHz

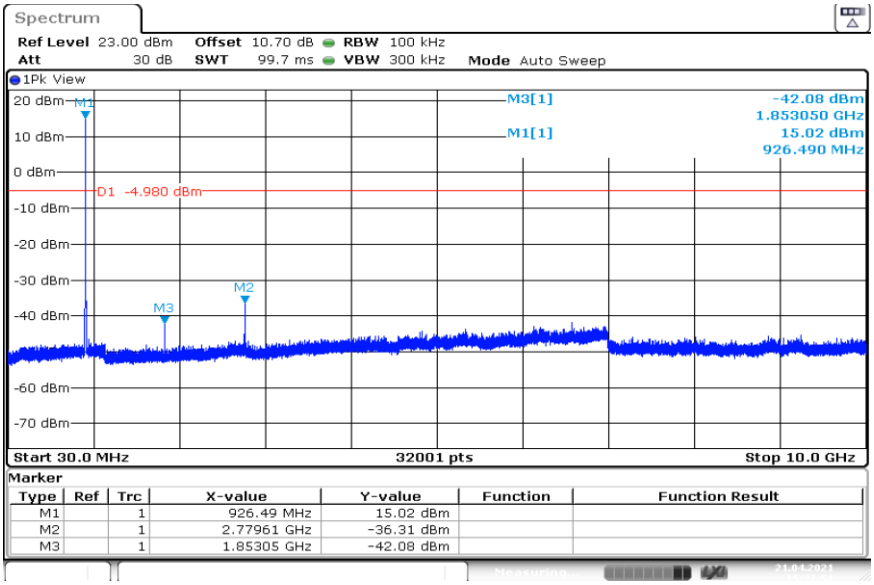


Figure 7.5.1.2-3: 926MHz MCH – 30MHz – 10GHz

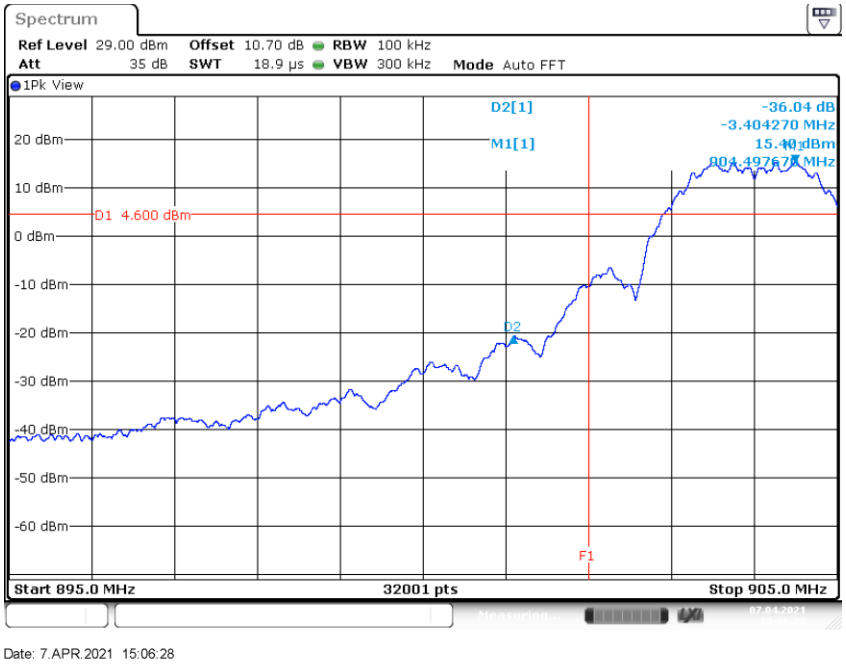


Figure 7.5.1.2-4: 904MHz Lower Band Edge

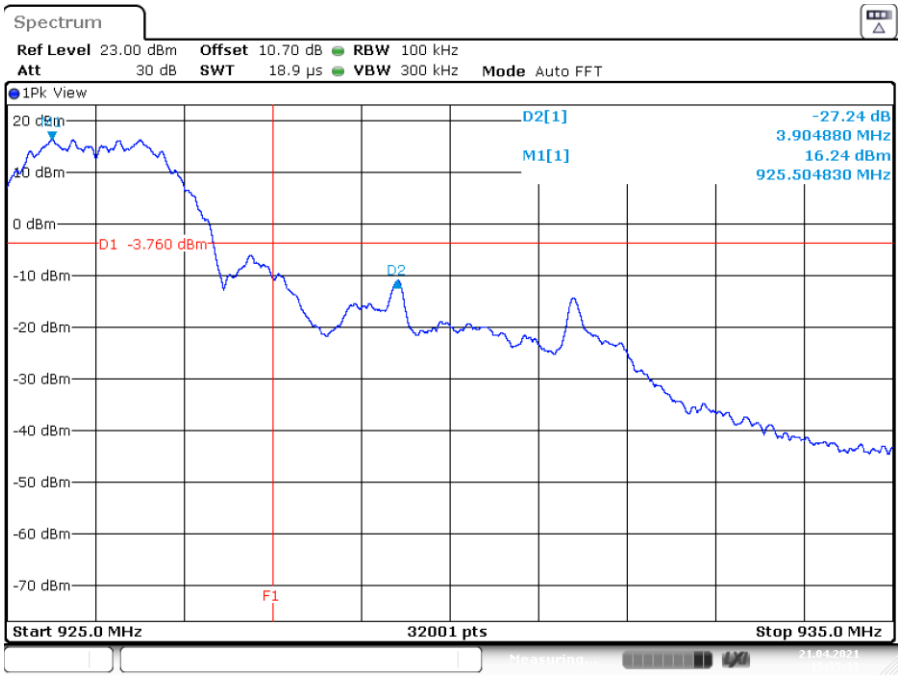


Figure 7.5.1.2-5: 926MHz Upper Band Edge

7.5.2 Emissions into Restricted Frequency Bands – FCC: 15.205, 15.209; ISED Canada: RSS-Gen 8.9 / 8.10

7.5.2.1 Measurement Procedure

The unwanted emissions into restricted bands were measured radiated over the frequency range of 30MHz to 10GHz, 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.

Each emission found to be in a restricted band as defined by section 15.205, including any emission at the operational band-edge, was compared to the radiated emission limits as defined in section 15.209.

7.5.2.2 Duty Cycle Correction

For average radiated measurements, using a 30.48% duty cycle, the measured level was reduced by a factor 10.32dB. The duty cycle correction factor is determined using the formula: 20log (30.48/100) = -10.32dB.

As detailed analysis of the duty cycle timing is provided in the Theory of Operation accompanying the application for certification.

7.5.2.3 Measurement Results

Performed by: Paul Villarreal

Table 7.5.2.3-1: Radiated Spurious Emissions Tabulated Data – Dual Band Monopole Antenna

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
2710.75	41.00	29.90	H	5.38	46.38	24.96	74.0	54.0	27.6	29.0
2710.75	48.80	38.60	V	5.38	54.18	33.66	74.0	54.0	19.8	20.3
3616	39.8	31.7	H	6.88	46.68	28.26	74.0	54.0	27.3	25.7
3616	44	35.8	V	6.88	50.88	32.36	74.0	54.0	23.1	21.6

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 – LCH

Corrected Level: 41.00 + 5.38 = 46.38dBuV/m
Margin: 74dBuV/m – 46.38dBuV/m = 27.62dB

Example Calculation: Average – LCH

Corrected Level: 29.90 + 5.38 – 10.32 = 24.96dBuV
Margin: 54dBuV – 24.96dBuV = 29.04dB

7.6 Maximum Power Spectral Density in the Fundamental Emission – FCC: 15.247(e) ISED Canada: RSS-247 5.2(b)

7.6.1 Measurement Procedure

The power spectral density was measured in accordance with the FCC KDB 558074 D01 15.247 Meas Guidance v05r02 utilizing the PKPSD (peak PSD) method. The RF output of the equipment under test was directly connected to the input of the spectrum analyzer applying suitable attenuation. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 3 kHz. The Video Bandwidth (VBW) was set to 10 kHz. Span was set to 1.5 times the DTS Bandwidth. The trace was set to max hold with the peak detector active.

7.6.2 Measurement Results

Performed by: Divya Adusumilli

Table 7.6.2-1: Power Spectral Density

Modulation	Frequency [MHz]	PSD [dBm]
OQPSK-DSSS / 250kbps	904	3.49

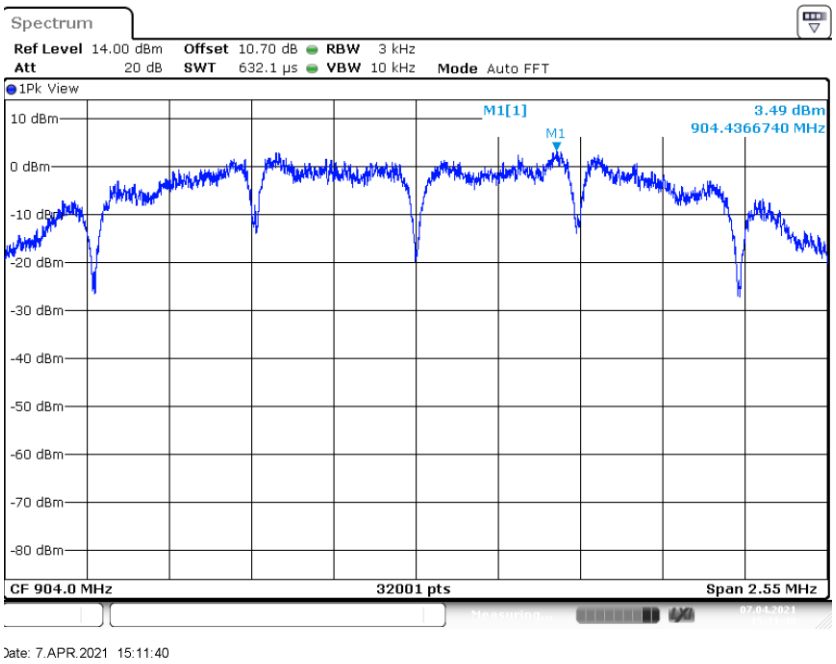


Figure 7.6.2-1: 904MHz LCH - PSD

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 rMODIT3, manufactured by Acuity brands Lighting Inc. 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

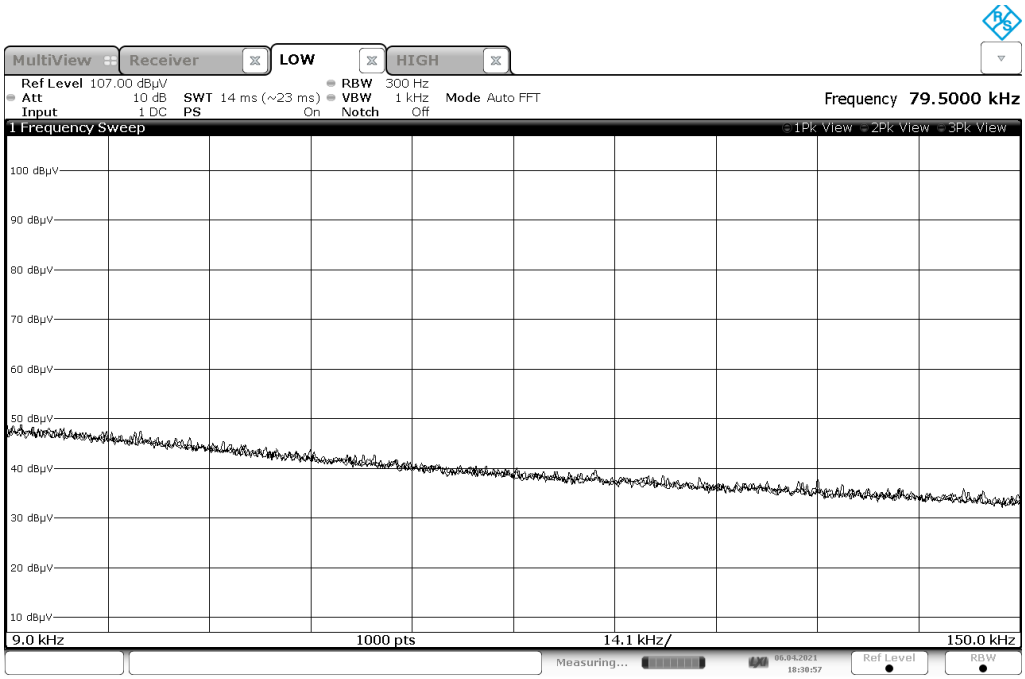
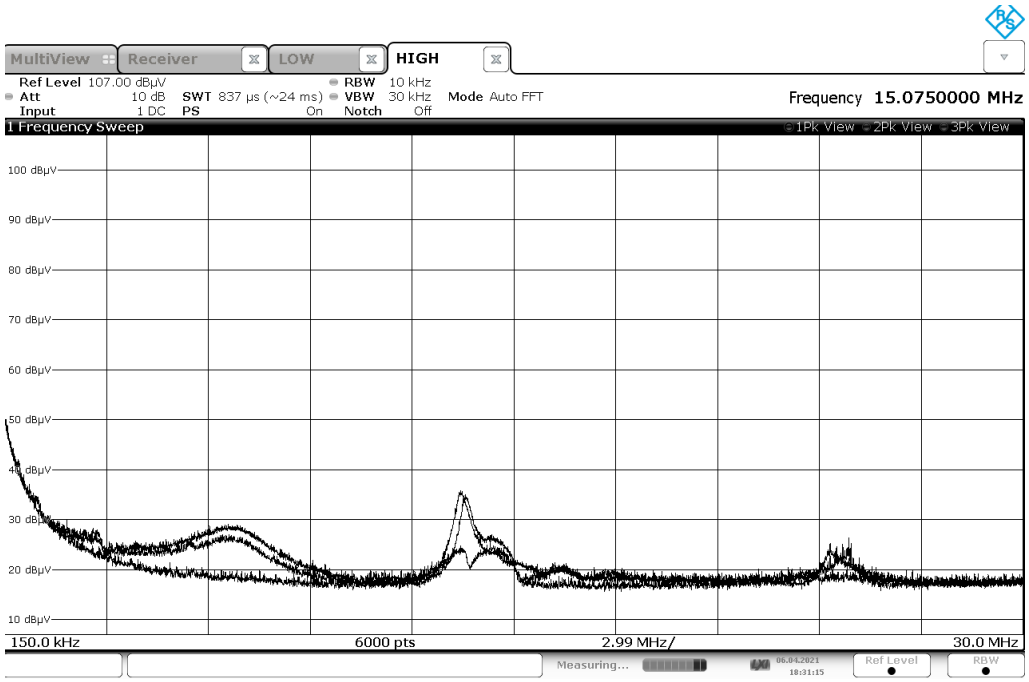
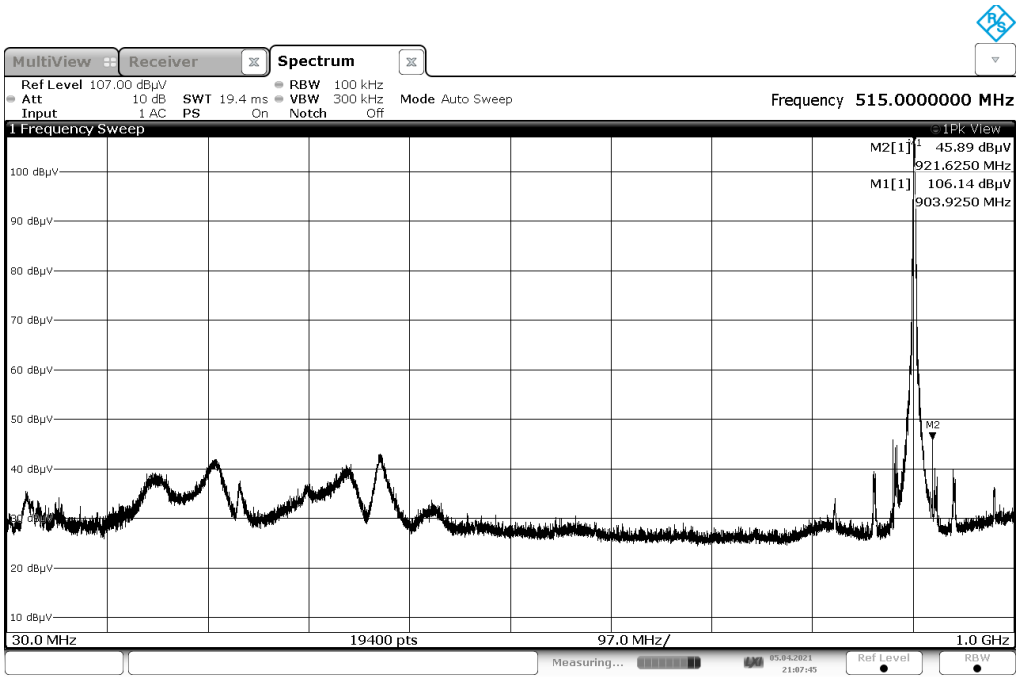


Figure A-1: 9kHz-150kHz



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

Figure A-2: 150kHz-30MHz



Note: Emissions above the noise floor are not associated with the radio, except fundamental emission or located in a restricted.

Figure A-3: 30MHz-1GHz

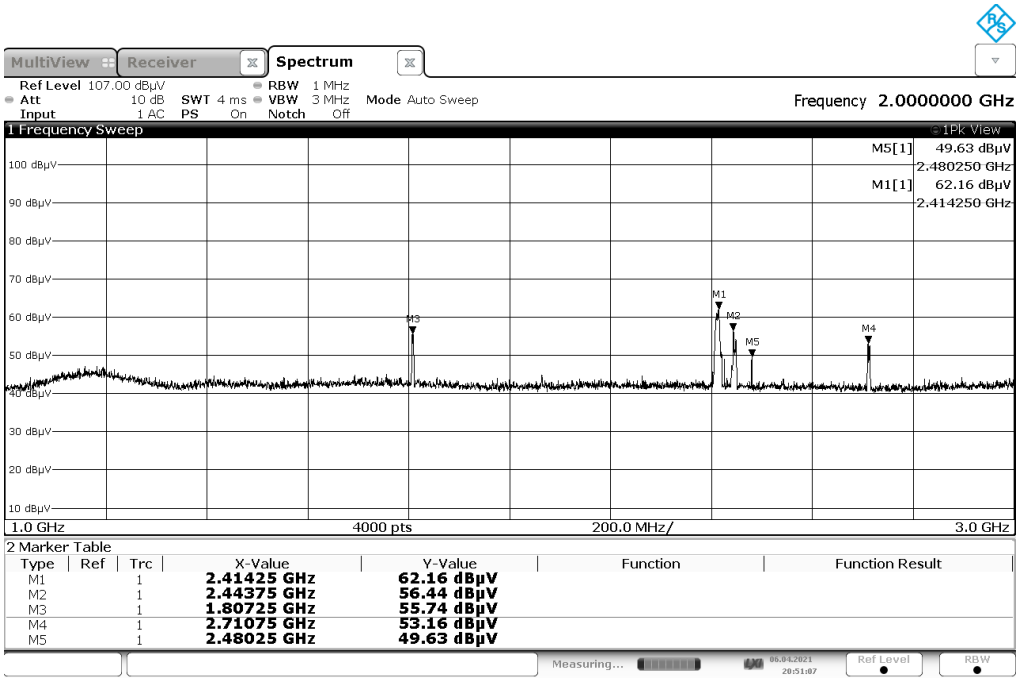


Figure A-4: 1GHz-3GHz

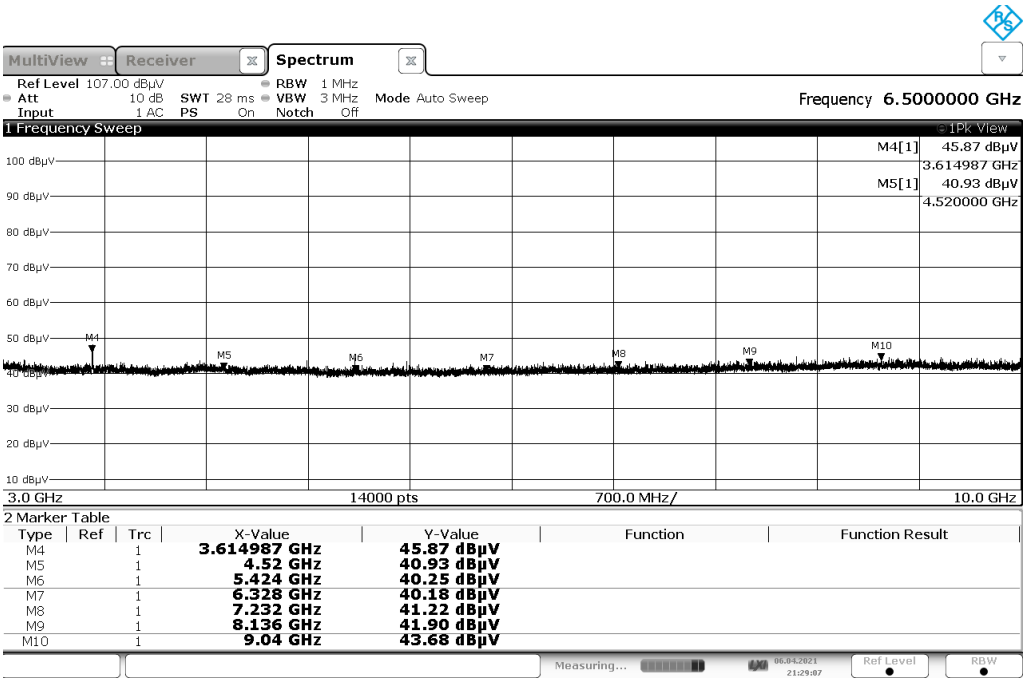


Figure A-5: 3GHz-10GHz

END REPORT