Report on the Testing of the

OCEASOFT SAS
LoRMic Daughter Card

In accordance with:
FCC 47 CFR part 15.247
ISED RSS-247 Issue 2, February 2017

Prepared for: OCEASOFT SAS
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America

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FCC Accreditation Designation Number US1233
FCC Test Site Registration Number 967699
Innovation, Science, and Economic Development Canada Lab Code 23932

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with the standards listed above.

A2LA Cert. No. 2955.09

ACCREDITATION

Our A2LA Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our A2LA Accreditation.

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1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Table 1.1-1 – Modification Record

Issue	Description of Change	Date of Issue
0	First Issue	1/4/2022

1.2 Introduction

The purpose of this report is to demonstrate compliance with Part 15 Subpart C of the FCC's Code of Federal Regulations Section 15.247 and Innovation Science and Economic Development Canada's Radio Standards Specification RSS-247 for the tests documented herein to support a change in identification and class II permissive change to address the differences between the RF trace design to the antenna.

Applicant	Laurent Rousseau
Manufacturer	OCEASOFT SAS
Applicant's Email Address	l.rousseau@oceasoft.com
Module Manufacturer	Microchip Technology Inc.
Module Model Name	LoRMic Daughter Card
Module Model Number(s)	RN2903
Module Serial Number(s)	2112TJ5
Module FCC ID	XTLRN2903
Module ISED Certification Number	9337A-RN2903
Hardware Version(s)	1.1
Software Version(s)	1
Number of Samples Tested	1
Test Specification/Issue/Date	US Code of Federal REgulation (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2021 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.
Order Number	72174120

Date of Receipt of EUT	10/20/2021
Start of Test	11/23/2021
Finish of Test	12/9/2021
Related Document(s)	ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Device. FCC OET KDB 558074 D01 15.247 Meas 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 US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2021. ISED Canada Radio Standards Specification: RSS-GEN – General Requirements for Compliance of Radio Apparatus, Issue 5, Amendment 1 (March 2019), Amendment 2 (February 2021)

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC Part 15.247 and ISED Canada's RSS-247 is shown below.

Table 1.3-1: Test Result Summary

Test Parameter	Test Plan (Yes/No)	Test Result	FCC 47 CFR Rule Part	ISED Canada's RSS	Test Report Page No
Antenna Requirement	Yes	Pass	15.203, 15.204	-------	10
Carrier Frequency Separation	No	Not Tested	15.247(a)(1)	RSS-247 5.1(b)	-------
Number of Hopping Channels	No	Not Tested	15.247(a)(1)(i)	RSS-247 5.1(c)	-------
Channel Dwell Time	No	Not Tested	15.247(a)(1)(i)	RSS-247 5.1(c)	-------
20 dB Bandwidth	No	Not Tested	15.247(a)(1)(i)	RSS-247 5.1(c)	-------
99% Bandwidth	No	Not Tested	-------	RSS-GEN 6.7	-------
Peak Output Power	No	Not Tested	15.247(b)(2)	RSS-247 5.4(a)	-------
Band-Edge Compliance of RF Conducted Emissions	No	Not Tested	15.247(d)	RSS-247 5.5	-------
RF Conducted Spurious Emissions	No	Not Tested	15.247(d)	RSS-247 5.5	-------
Radiated Spurious Emissions into Restricted Frequency Bands	Yes	Pass	15.205, 15.209	RSS-GEN 8.9, 8.10	13
Power Spectral Density	No	Not Tested	15.247(e)	RSS-247 5.2(b)	-------
Power Line Conducted Emissions	Yes	Pass	15.207	RSS-GEN 8.8	11
Duty Cycle	No	--------			-------

1.4 Product Information

1.4.1 Technical Description

The Microchip, RN2903 is a low power long range LoRa Technology transceiver module which provides an easy to use low-power solution for long range wireless data transmission 902 – 928 MHz LoRa Technology modules with an external antenna connector. Daughter card embedding a LoRa radio module with its antenna and used in dataloggers devices.

Table 1.4-1 – Wireless Module Technical Information

Detail	Description
Module FCC ID	XTLRN2903
Module IC ID	9337A-RN2903
Transceiver Model #	LoRMic Daughter Card
Frequency Range	902.3 – 927.5 MHz
Modulation Format	CSS
Antenna Type / Description:	Whip antenna / +2 dBi

A full description and detailed product specification details are available from the manufacturer.

Figure 1.4.1-1 –Front view of the EUT

Figure 1.4.1-2 – Back view of the EUT

Figure 1.4.1-3– EUT with programming cable

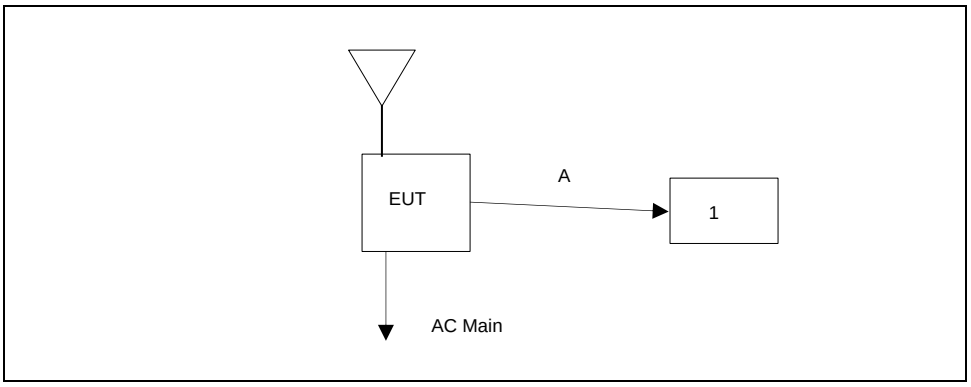


Figure 1.4.1-4 – Test Setup Block Diagram

Table 1.4.1-1 – Cable Descriptions

Item	Cable/Port	Description
A	Programming Cable	Connected to Laptop

Table 1.4.1-2 – Support Equipment Descriptions

Item	Make/Model	Description
1	Lenovo	Laptop used for configuring wireless module

1.4.2 Modes of Operation

The Microchip LoRa module RN2903 provides 1 modes of operation using hybrid classifications as outlined below.

Mode of Operation	Frequency Range (MHz)	Number of Channels	Channel Separation (kHz)	Modulation	Data Rates Supported (kbps)	Classification
1	902.3 – 927.5	64	200	CSS	SF7 – SF10	Hybrid

1.4.3 Monitoring of Performance

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.

Worst case mode for all parameters measured listed below:

Test case	Mode of Operation / Spreading factor	Tested Frequency (MHz)
Radiated spurious emissions	Hybrid / SF10	902.3, 914.9, 927.5
Power Line Conducted Emissions	Hybrid / SF10	902.3

Power setting during test: Mode of operation 1: 20 dBm

1.5 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

1.6 EUT Modification Record

The table below details modifications made to the EUT during the test program. The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
0	Initial State		

The equipment was tested as provided without any modifications.

1.7 Test Location

TÜV SÜD conducted the following tests at our Alpharetta, GA test laboratory.

Test Name	Name of Engineer(s)	Accreditation
DC Powered Operating		
Antenna Requirement	Bhagyashree Chaudhary	A2LA
Power Line Conducted Emissions	Divya Adusumilli	A2LA
Radiated Spurious Emissions into Restricted Frequency Bands	Bhagyashree Chaudhary	A2LA

Office address:
TÜV SÜD America
5945 Cabot Parkway, Suite 100
Alpharetta, GA 30005, USA

2 Test Details

2.1 Antenna Requirement

2.1.1 Specification Reference

FCC Section: 15.203, 15.204

2.1.2 Equipment Under Test and Modification State

As shown in §1.4 with modification state “0”, as noted in §1.6.

2.1.3 Date of Test

11/23/2021

2.1.4 Test Method

N/A

2.1.5 Environmental Conditions

The EUT was evaluated within the temperature, humidity and pressure range of the EUT as specified by the standard. The laboratory shall have an ambient temperature range of 15°C to 35°C, relative humidity range of 30% to 60%.

Ambient Temperature	22.3 °C
Relative Humidity	53.8 %

2.1.6 Test Results

The EUT utilizes compressed whip antenna with peak gain +2.0 dBi which is mounted on the top of the printed circuit board. The EuT uses a U.FL. Connector, therefore satisfying the requirements of Section 15.203.

2.2 Power Line Conducted Emissions

2.2.1 Specification Reference

FCC Section: 15.207
ISED Canada: RSS-Gen 8.8

2.2.2 Equipment Under Test and Modification State

As shown in §1.4 with modification state “0”, as noted in §1.6.

2.2.3 Date of Test

12/9/2021

2.2.4 Test Method

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

2.2.5 Environmental Conditions

The EUT was evaluated within the temperature, humidity and pressure range of the EUT as specified by the standard. The laboratory shall have an ambient temperature range of 15°C to 35°C, relative humidity range of 30% to 60%.

Ambient Temperature	22.3 °C
Relative Humidity	53.8 %

2.2.6 Test Results

Table 2.2.6-1: Conducted EMI Results-Avg – Line 1

Frequency (MHz)	Avg Limit	Avg Level Corrected	Avg Level	Correction Fact.	Avg Margin	Result
0.67	46	19	9.3	9.66	-27	PASS
4.84	46	16.9	7.2	9.707	-29.1	PASS
5.22	50	19.5	9.8	9.72	-30.5	PASS
5.7	50	17.6	7.9	9.716	-32.4	PASS
6.23	50	19.2	9.5	9.71	-30.8	PASS
24	50	22.9	13	9.91	-27.1	PASS

Table 2.2.6-2: Conducted EMI Results-QP – Line 1

Frequency (MHz)	QP Limit	QP Level Corrected	QP Level	Correction Fact.	QP Margin	Result
0.67	56	28	18.3	9.66	-28	PASS
4.84	56	26.1	16.4	9.707	-29.9	PASS
5.22	60	29	19.2	9.72	-31	PASS
5.7	60	27.3	17.6	9.716	-32.7	PASS
6.23	60	26.4	16.7	9.71	-33.6	PASS
24	60	26.6	16.7	9.91	-33.4	PASS

Table 2.2.6-3: Conducted EMI Results-Avg – Line 2

Frequency (MHz)	Avg Limit	Avg Level Corrected	Avg Level	Correction Fact.	Avg Margin	Result
4.76	46	14.4	4.7	9.695	-31.6	PASS
5.01	50	14.9	5.2	9.691	-35.1	PASS
5.12	50	16	6.3	9.695	-34	PASS
5.32	50	15.4	5.7	9.703	-34.6	PASS
5.62	50	14.5	4.8	9.712	-35.5	PASS
5.67	50	15	5.3	9.713	-35	PASS

Table 2.2.6-4: Conducted EMI Results-QP – Line 2

Frequency (MHz)	QP Limit	QP Level Corrected	QP Level	Correction Fact.	QP Margin	Result
4.76	56	26.3	16.6	9.695	-29.7	PASS
5.01	60	25.5	15.8	9.691	-34.5	PASS
5.12	60	30.2	20.5	9.695	-29.8	PASS
5.32	60	29.2	19.5	9.703	-30.8	PASS
5.62	60	27.4	17.7	9.712	-32.6	PASS
5.67	60	28.6	18.9	9.713	-31.4	PASS

2.3 Radiated Spurious Emissions into Restricted Frequency Bands

2.3.1 Specification Reference

FCC Sections: 15.205, 15.209.
ISED Canada: RSS – Gen 8.9/8.10

2.3.2 Equipment Under Test and Modification State

As shown in §1.4 with modification state “0”, as noted in §1.6.

2.3.3 Date of Test

11/23/2021

2.3.4 Test Method

Radiated emissions tests were made over the frequency range of 9 kHz to 10 GHz, 10 times the highest fundamental frequency of 900 MHz 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.

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 150 kHz, quasi-peak measurements were made using a resolution bandwidth RBW of 300 Hz and a video bandwidth VBW of 1 kHz and frequencies between 150 kHz and 30MHz, quasi-peak measurements were made using a resolution bandwidth RBW of 10 kHz and a video bandwidth VBW of 30 kHz. For frequencies between 30 MHz and 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 with RBW of 1 MHz and VBW of 3 MHz

2.3.5 Environmental Conditions

The EUT was evaluated within the temperature, humidity and pressure range of the EUT as specified by the standard. The laboratory shall have an ambient temperature range of 15°C to 35°C, relative humidity range of 30% to 60%.

Ambient Temperature	22.3 °C
Relative Humidity	53.8 %

2.3.6 Test Results

Test Summary: EUT was set to transmit mode.

Test Results: Pass

See data below for detailed results.

Table 2.3.6-1: Radiated Spurious Emissions Tabulated Data

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
LCH										
121.8	---------	19.90	H	-7.57	---------	12.33	--------	43.5	---------	31.2
121.8	---------	32.00	V	-7.57	---------	24.43	--------	43.5	---------	19.1
123.09	---------	18.80	H	-7.62	---------	11.18	--------	43.5	---------	32.3
123.09	---------	32.50	V	-7.62	---------	24.88	--------	43.5	---------	18.6
124.24	---------	22.60	H	-7.67	---------	14.93	--------	43.5	---------	28.6
124.24	---------	33.00	V	-7.67	---------	25.33	--------	43.5	---------	18.2
2706.9	47.80	34.10	H	0.49	48.29	34.59	74.0	54.0	25.7	19.4
2706.9	49.20	36.20	V	0.49	49.69	36.69	74.0	54.0	24.3	17.3
5413.8	46.90	34.30	H	4.35	51.25	38.65	74.0	54.0	22.7	15.3
5413.8	47.90	37.90	V	4.35	52.25	42.25	74.0	54.0	21.7	11.7
MCH										
121.392	---------	19.30	H	-7.56	---------	11.74	--------	43.5	---------	31.8
121.392	---------	33.40	V	-7.56	---------	25.84	--------	43.5	---------	17.7
123.05	---------	18.80	H	-7.62	---------	11.18	--------	43.5	---------	32.3
123.05	---------	33.30	V	-7.62	---------	25.68	--------	43.5	---------	17.8
124.299	---------	19.80	H	-7.67	---------	12.13	--------	43.5	---------	31.4
124.299	---------	33.00	V	-7.67	---------	25.33	--------	43.5	---------	18.2
126.11	---------	20.80	H	-7.72	---------	13.08	--------	43.5	---------	30.4
126.11	---------	32.70	V	-7.72	---------	24.98	--------	43.5	---------	18.5
2744.7	47.50	34.90	H	0.49	47.99	35.39	74.0	54.0	26.0	18.6
2744.7	49.10	36.20	V	0.49	49.59	36.69	74.0	54.0	24.4	17.3
HCH										
127.512	---------	21.00	H	-7.75	---------	13.25	--------	43.5	---------	30.3
127.512	---------	30.00	V	-7.75	---------	22.25	--------	43.5	---------	21.3
283.76	---------	22.30	H	-6.70	---------	15.60	--------	46.0	---------	30.4
283.76	---------	29.20	V	-6.70	---------	22.50	--------	46.0	---------	23.5
2782.5	48.10	35.50	H	0.48	48.58	35.98	74.0	54.0	25.4	18.0
2782.5	48.40	36.10	V	0.48	48.88	36.58	74.0	54.0	25.1	17.4

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: 49.20 + 0.49 = 49.69dBµV/m
Margin: 74dBµV/m – 49.69dBµV/m = 24.3dB

Example Calculation: Average

Corrected Level: 36.20 + 0.49 - 0 = 36.69dBµV
Margin: 54dBµV – 36.69dBµV = 17.3dB

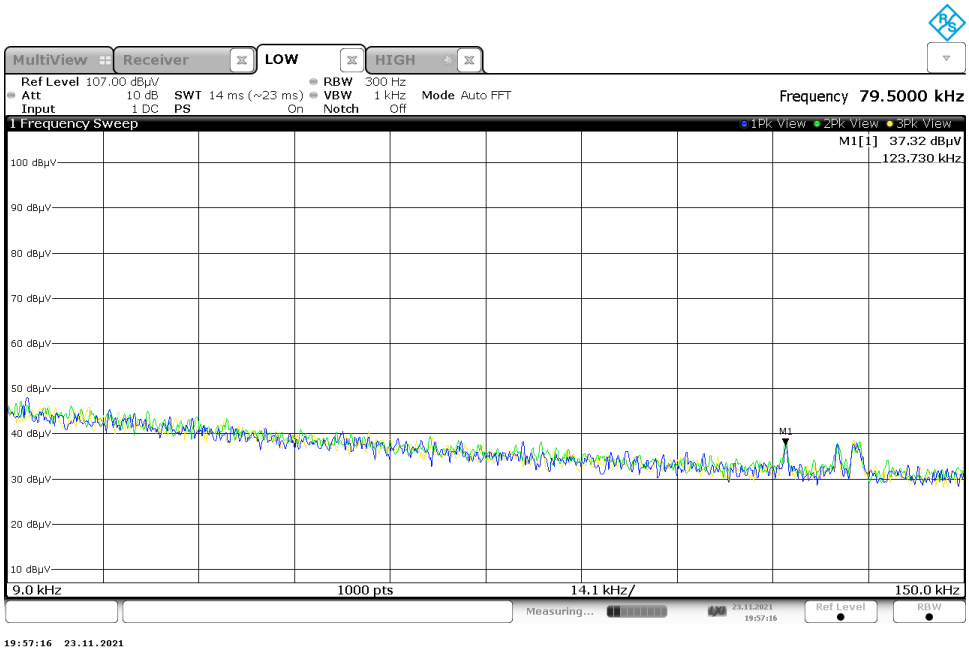


Figure 1: Reference plot for Radiated Spurious Emissions – 9 kHz – 150 kHz

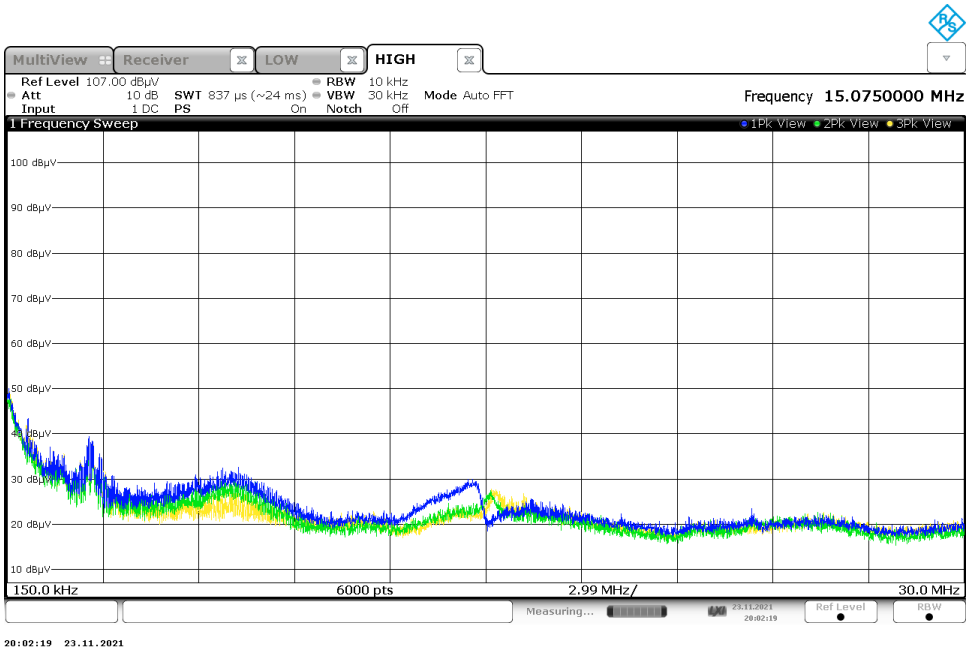


Figure 2: Reference plot for Radiated Spurious Emissions– 150 kHz – 30 MHz
Note: Emissions above the noise floor are ambient not associated with the EUT.

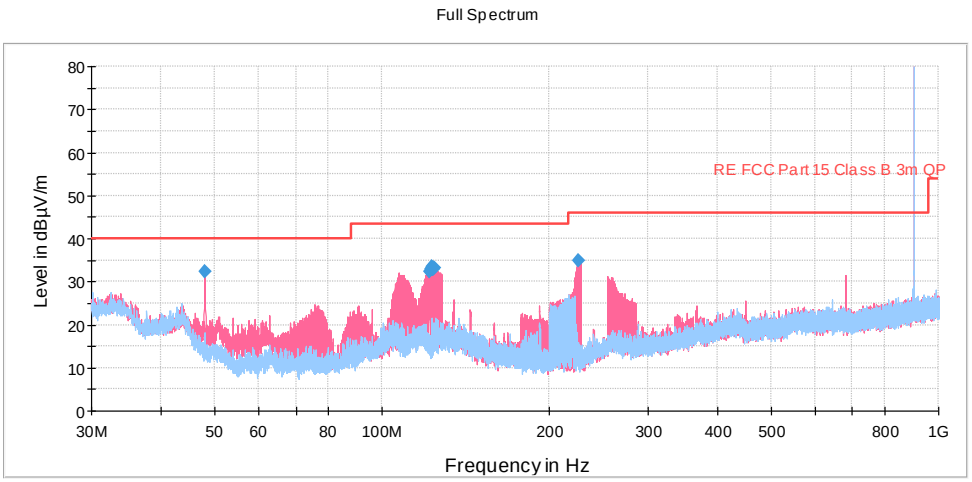


Figure 3: Reference plot for Radiated Spurious Emissions – 30 MHz – 1 GHz
Note: Only restricted band emissions above the noise were evaluated.

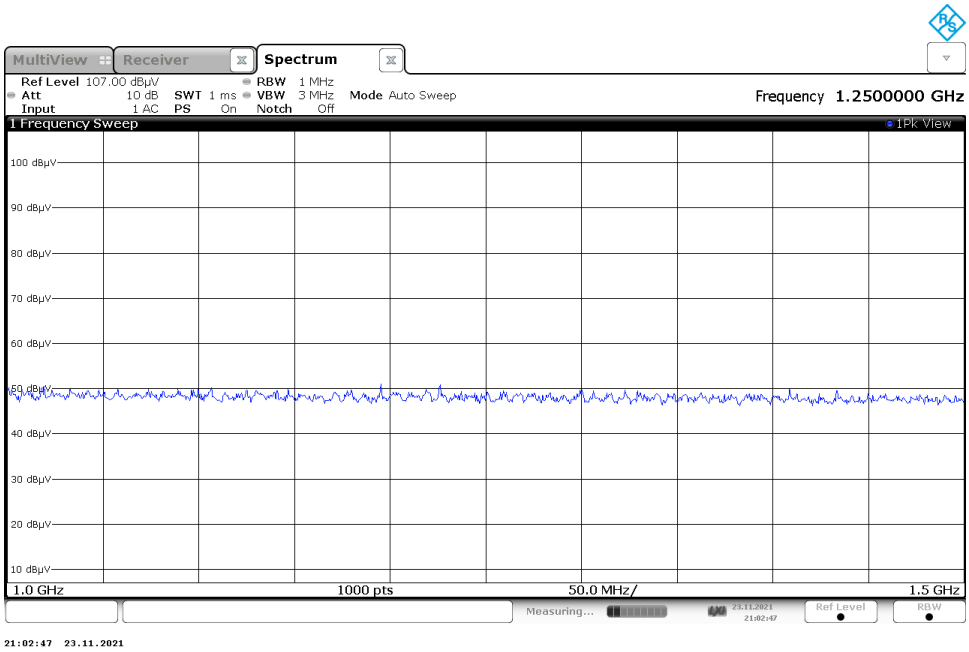


Figure 4: Reference plot for Radiated Spurious Emissions – 1 GHz – 1.5 GHz

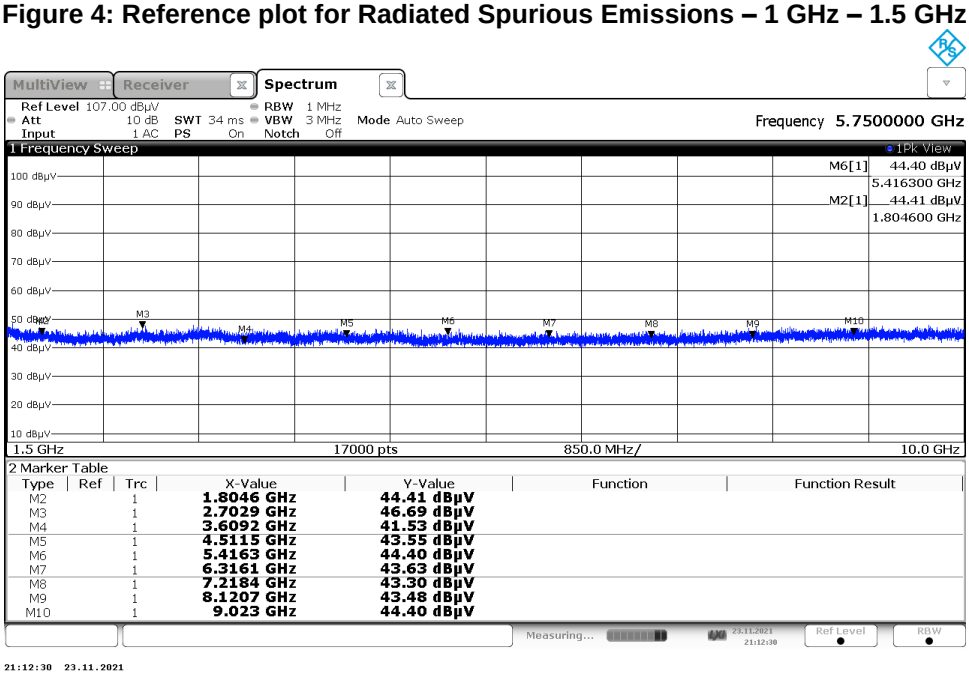


Figure 5: Reference plot for Radiated Spurious Emissions – 1.5 GHz – 10 GHz

2.4 Test Equipment Used

Table 2.4-1 –Equipment List

Asset ID	Manufacturer	Model	Equipment Type	Serial Number	Last Calibration Date	Calibration Due Date
628	EMCO	6502	Active Loop Antenna 10kHz-30MHz	9407-2877	6/8/2021	6/8/2023
884	ETS Lindgren	3117	Horn Antenna 1-18GHz	00240106	05/06/2021	05/06/2022
DEMC3161	Ametek CTS Germany GmbH	CBL 6112D	Bilog Antenna; Attenuator	51323	3/19/2021	3/19/2023
213	TEC	PA 102	Amplifier	44927	7/30/2021	7/30/2022
338	Hewlett Packard	8449B	High Frequency Pre-Amp	3008A01111	06/22/2021	06/22/2023
331	Microwave Circuits	H1G513G1	Microwave Bandpass Filter	31417	6/9/2021	6/9/2022
882	Rohde & Schwarz	ESW44	Test Receiver	111961	6/24/2021	6/24/2022
836	ETS Lindgren	SAC Cable Set	SAC Cable Set includes 620, 837, 838	N/A	5/11/2021	5/11/2022
3010	Rohde & Schwarz	ENV216	Two-Line V-Network	3010	6/23/2021	6/23/2022
872	Agilent	E7402A	EMC Spectrum Analyzer	US40240258	6/22/2021	6/22/2022
861	Com-Power Corporation	LI-1100C	Line Impedance Stabilization Network	20180038	2/26/2021	2/26/2022
862	Com-Power Corporation	LI01100C	Line Impedance Stabilization Network	20180039	2/26/2021	2/26/2022
703	Hewlett Packard	8594E	Spectrum Analyzer	3523A02134	NCR	NCR
856	Huber & Suhner	Multiflex 104	Blue Cable	326050	NCR	NCR
691	Com-Power Corp.	691	E-Field Fine Tip (100kHz to 5GHz), H-Field Loop (9kHz to 5GH	151514	NCR	NCR
813	PMM	9010	EMI Receiver; RF Input 50ohm; 10Hz-50MHz; 10Hz-30MHz	697WW30606	6/8/2021	6/8/2022
168	Hewlett Packard	11947A	Transient Pulse Limiter	44829	3/3/2021	3/3/2022

N/A – Not Applicable
NCR – No Calibration Required

3 Diagram of Test Set-ups

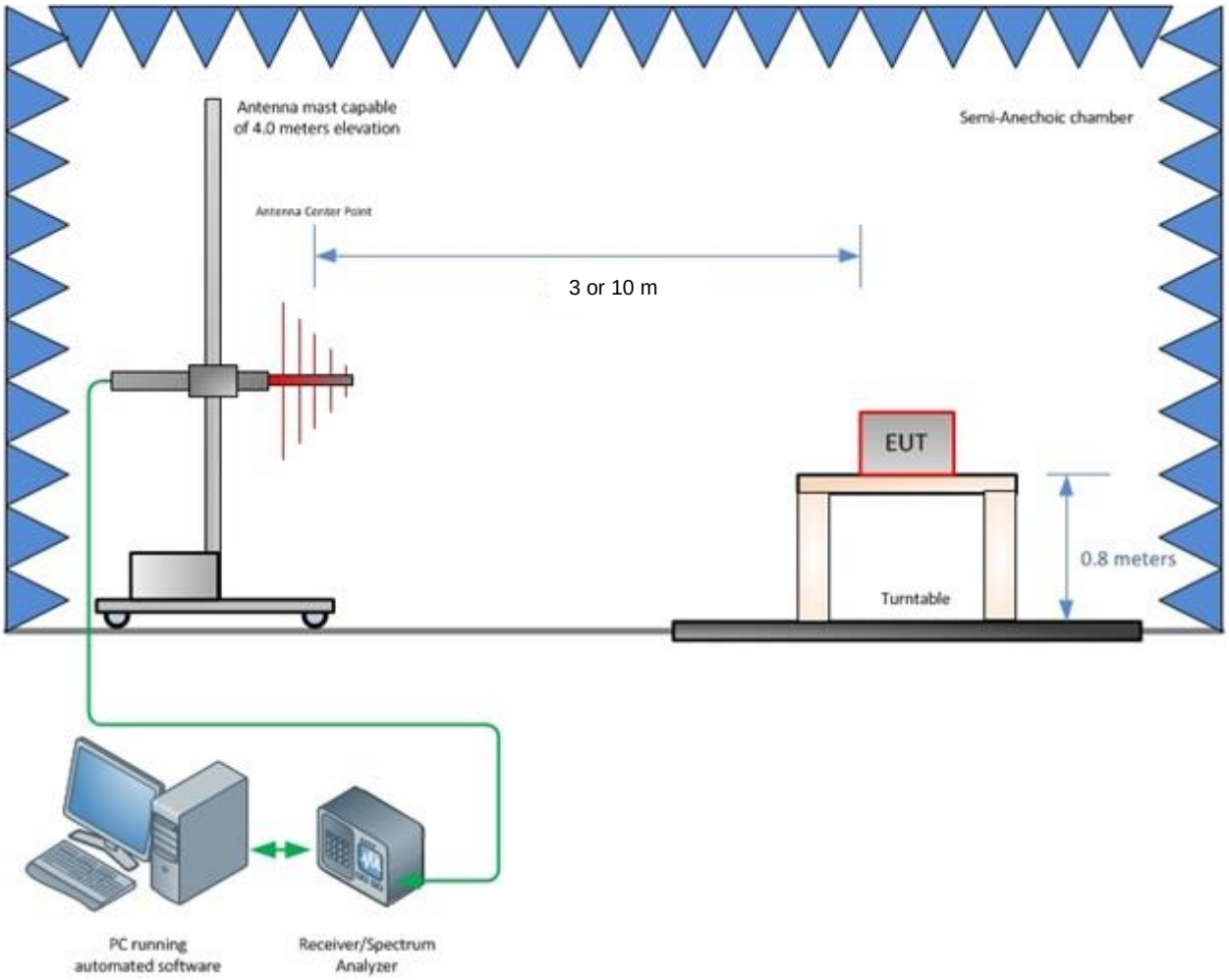


Figure 3-1 – Radiated Emissions Test Setup up to 1 GHz

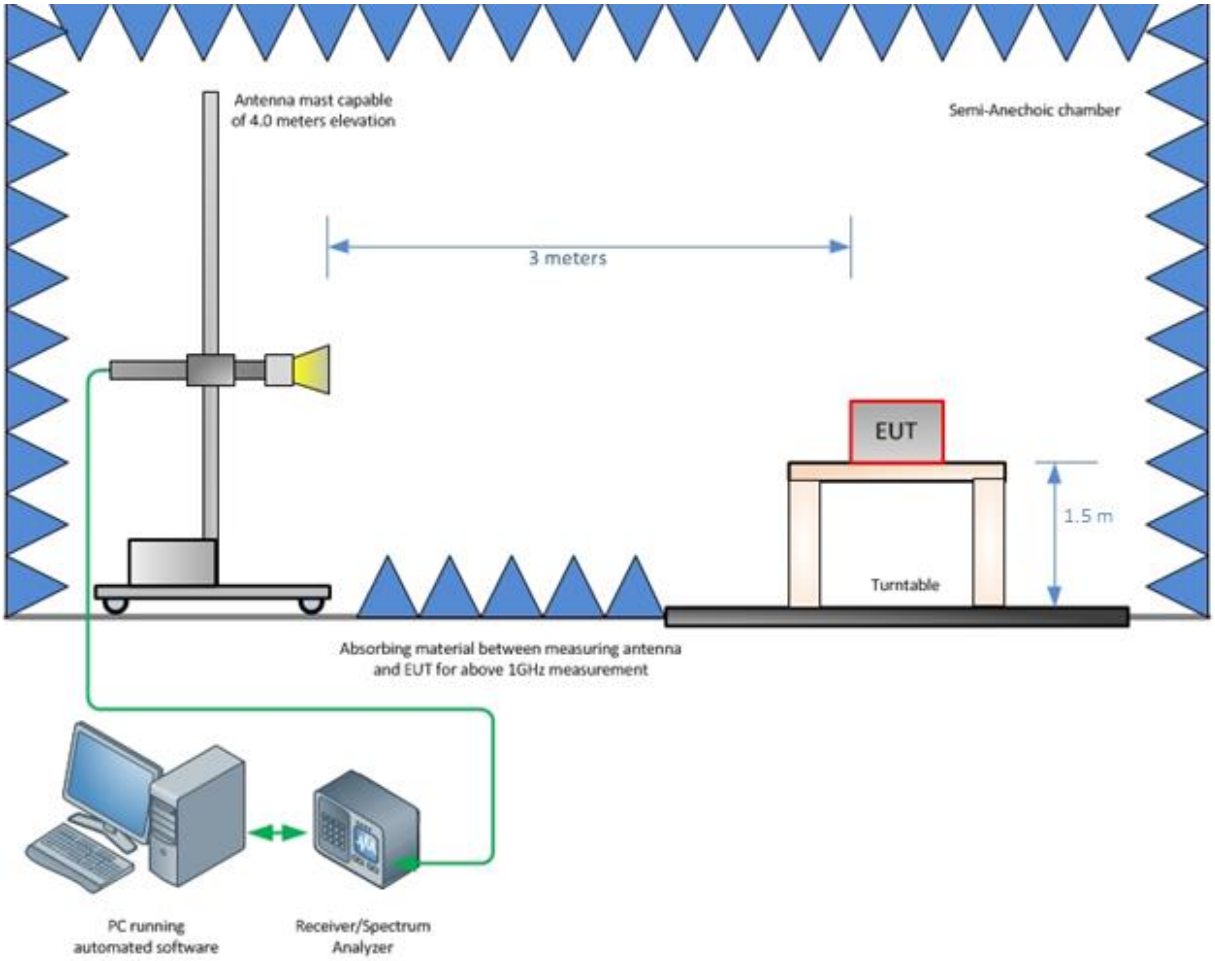
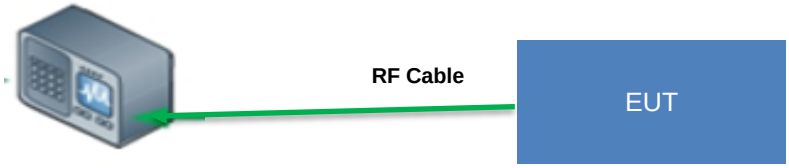


Figure 3-2 – Radiated Emissions Test Setup above 1 GHz



Spectrum Analyzer

Figure 3-3 – Conducted Test Setup: Antenna Port measurement

4 Accreditation, Disclaimers and Copyright

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STATEMENT 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 4-1: Estimation of Measurement Uncertainty

Parameter	U_{lab}
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

TEST EQUIPMENT

All measurement instrumentation is traceable to the National Institute of Standards and Technology and is calibrated to meet test method standard requirements and/or manufacturer's specifications.

END REPORT